# Site Assessment for the Proposed Coke Point Dredged Material Containment Facility at Sparrows Point

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November 2009

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## BALTIMORE COUNTY, MARYLAND

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# EXECUTIVE SUMMARY

Capacity of existing placement sites for dredged material from the Baltimore Harbor remains extremely limited, resulting in an ongoing need to study, select, and construct new sites capable of accepting dredged material from within the Baltimore Harbor. A group of community members, citizens groups, and local government representatives, referred to as the Harbor Team, was tasked by the Maryland Port Administration (MPA) with identifying possible locations for placement of dredged material from the navigation channels in Baltimore Harbor. After an extensive screening process by MPA and the Harbor Team, the Coke Point Peninsula (the Peninsula) on the Sparrows Point Facility was identified as one of the potential sites for construction of a Dredged Material Containment Facility (DMCF) to help meet the 20-year dredged material placement requirements. The Sparrows Point Facility is located on approximately 2,300 acres on the north side of the Patapsco River in Baltimore County, Maryland, approximately nine miles southeast of downtown Baltimore. The Coke Point Peninsula comprises about 300 acres of the Sparrows Point property.

The Sparrows Point Facility has a long history of steelmaking activities. Coke production facilities (which were located on the Coke Point Peninsula) were built in the 1930s and operated until 1991. During a portion of this period, byproducts of coking operations and process activities, including coal tar and benzene, were stored in the Coal Tar Storage Area and Benzol Processing Area, respectively. Previous investigations of environmental conditions on the Coke Point Peninsula, which focused on groundwater, indicated that concentrations of multiple organic compounds and metals at the site exceed background concentrations and/or regulatory standards (CH2M 2001, 2002; URS 2005a, 2005b, 2006). These reports concluded that the Coke Point Peninsula, particularly the Coke Oven Area on the Peninsula, is the most impacted portion of the Sparrows Point Facility (USEPA 2009a). Of particular concern were materials associated with the steelmaking process, including petroleum oils and coal tar, which are generally referred to as light non-aqueous phase liquids (LNAPLs) and dense non-aqueous phase liquids (DNAPLs).

Prior to the design/construction of a DMCF, a property transaction would be required between MPA and the current property owner. Because groundwater and soil impacts from historical activity on the Peninsula were suspected to have degraded the offshore surface water and sediment quality, MPA required additional onshore and offshore environmental information before moving forward with consideration of its options regarding the property.

This Site Assessment for the proposed Coke Point DMCF at Sparrows Point was prepared by EA Engineering, Science, and Technology (EA) on behalf of the Maryland Environmental Service (MES), under contract to MPA. This study was designed to collect data to evaluate the nature and extent of onshore sources and to assess the potential impacts to offshore sediment and surface water in support of the ongoing Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI). Results of this study provide updated information related to the conceptual site model for fate and transport and allow for a preliminary evaluation of a range of potential remedial technologies and process options (hereinafter "Remedial Options") that could be implemented to address legacy onshore and offshore impacts on, and adjacent to, the site. These results also could provide a basis for a Corrective Measures Study (CMS), which, in

conjunction with the RFI, is a reporting requirement defined as part of the active RCRA enforcement for the Coke Point geographic region of the Sparrows Point Facility.

The Site Assessment utilized results from previous investigations to assess data gaps and to interpret and analyze the data. One previous study indicated that benzene and naphthalene, which are byproducts of the coking process, were the primary organic constituents in groundwater at the site (URS 2005a, 2006). Metals were also detected in groundwater, but at much lower concentrations than the organics. Impacts appeared to be limited to the upper two aquifers present beneath the site. The shallow, unconfined aquifer exists within the steelmaking slag fill material that comprises the top approximately 30 ft of subsurface across most of the Peninsula. Underlying the shallow aquifer is the intermediate aquifer, which is composed of native sandy material from the upper portion of the Talbot Formation. The aquifers are hydraulically interconnected, but are partially separated by discontinuous lenses of silt and clay. Previous reports indicated that the groundwater impacts to these two aquifers were found to be primarily focused in the Benzol Processing and Graving Dock Areas on the northwestern part of the Peninsula as well as in the Coal Tar Storage Area on the eastern part (URS 2005a, 2006).

Though previous investigations adequately characterized the nature and extent of groundwater impacts, the source areas had not previously been evaluated (with respect to the character of the fill material or the extent of the non-aqueous phase liquid [NAPL]). In addition, the potential impacts to the offshore environment (surface water and sediment) had not previously been characterized, although a limited study indicated that benzene, toluene, and other volatile organic compounds were present in near-shore water along the northwestern shoreline of the Peninsula in the Patapsco River (URS 2005b).

The objectives of the field investigations for this study were to further delineate the sources (i.e., NAPL and impacted slag fill material) of the previously observed subsurface impacts in the Benzol Processing, Graving Dock, and Coal Tar Storage Areas, and to assess the effects of the sources on surface water and sediment quality in the Patapsco River and the turning basin adjacent to the Peninsula. Information gathered through field activities and sample analyses was used to refine the conceptual site model and to conduct a preliminary evaluation to screen Remedial Options that would address human health and ecological risk as well as be complementary to future use of the site as a DMCF.

The onshore and offshore investigations each included a drilling component, in which continuous cores were collected using a hollow stem auger and split-spoon sampler to the depth of the native material. The cores were field screened for indications of NAPL, and samples from each borehole were collected for chemical analysis (volatile organic compounds [VOCs], polycyclic aromatic hydrocarbons [PAHs], and metals). Other analyses that were conducted on various samples included PAH fingerprinting (to determine the industrial source(s) of these compounds), total organic carbon (TOC), and grain size analysis. The offshore investigation also included collection of shallow, intermediate, and deep surface water samples co-located with the surface sediment samples for use in assessing fate and transport of anthropogenic constituents within the Patapsco River environment.

The onshore investigation included installation of NAPL monitoring wells in specific areas where NAPL was positively identified during field screening. The wells were gauged for the presence of NAPL, and recovery testing was conducted where NAPL was present, to assess the viability of different recovery methods for remediation purposes. In addition, NAPL samples were collected for analyses of chemical and physical properties to further characterize these sources.

Onshore results indicated the presence of mobile and residual LNAPL in the Benzol Processing Area and residually trapped DNAPL in the Coal Tar Storage Area. These NAPLs represent sources of organic compounds in groundwater, including mono aromatic hydrocarbons (MAHs) such as benzene, ethylbenzene, and toluene; and PAHs, such as naphthalene. Several MAHs, PAHs, and metals were present in the onshore soils at concentrations exceeding Maryland Department of the Environment (MDE) standards for protection of groundwater. The mobile LNAPL is recoverable, and mass distribution calculations indicate that its removal would significantly decrease the total mass of source material of organic constituents to groundwater. More exhaustive groundwater management measures would be required to address the groundwater impacts that would persist following removal of free NAPL.

The Graving Dock Area was investigated and did not show evidence of NAPL impacts in slag fill material. This supports previous conclusions that high concentrations of dissolved hydrocarbons in this area probably resulted from preferential groundwater flow north/northwest from the Benzol Processing Area because of hydraulic influences related to dewatering of the graving dock.

Results of the offshore investigation showed dissolved MAHs and PAHs in surface water off the northwestern and eastern parts of the Peninsula. The occurrence of these offshore dissolved constituents appears to be related to fluxes from impacted groundwater emanating from the identified onshore source areas. Modeling of the effects of groundwater on surface water indicated that elevated levels of benzene in surface water around the graving dock could exceed the U.S. Environmental Protection Agency (USEPA) ambient water quality criteria for protection of human health (USEPA 2009b). Historical surface water sampling supports this finding (URS 2005b). Although metals were also found to be present in groundwater (URS 2005a, 2006) at concentrations above standards set by MDE (2008), mass flux modeling indicates that metals concentrations in groundwater were not high enough to cause adverse impacts to surface water.

Offshore sediment also had elevated PAHs and metals, with many constituents present at concentrations exceeding average background sediment concentrations in the Baltimore Harbor channels (EA 2009). Calculations based on sediment analyses indicated that PAHs were likely present in some sediment locations as residual NAPLs. These NAPLs are associated with placement of byproducts of coking operations, or with historical placement of slag laden with byproducts. The magnitude of sediment impacts did not correlate with the highest fluxes of impacted groundwater, and sorption modeling indicated that the naphthalene present in the sediments could not result solely from contact with groundwater. However, PAH fingerprinting suggested that the sediment impacts are related to release(s) resulting from industrial practices at Sparrows Point.

A preliminary screening level evaluation of Remedial Options was conducted to address NAPL, groundwater impacts, slag fill impacts, and sediment impacts. In the evaluation, Remedial Options that were incompatible with site conditions and potential future use as a DMCF were screened out. Remedial technologies carried forward for further evaluation in a later step include:

- ***Onshore NAPL Removal*** - *Multi-Phase Extraction* (removal of impacted groundwater, separate-phase petroleum product, and/or hydrocarbon vapor using a high-vacuum system) and *Surfactant Enhanced Product Recovery* (addition of non-toxic food-grade surfactants to mobilize and recover NAPL from impacted regions of the subsurface);
- ***Onshore Groundwater Containment/Control*** - *Slurry Wall Containment* (trenches filled with a low-permeability semi-liquid mixture of soil, bentonite, and water, to cut off, contain, or divert impacted groundwater) and *Aerobically Enhanced Bioremediation* (adding oxygen into groundwater to stimulate biodegradation of organic constituents);
- ***Isolation of Onshore Slag Fill Material*** - *DMCF Capping* (placement of low permeability dredged material over the existing land surface) and *Engineered Capping* (placement of low-permeability geotextiles, liners, or clay material from offsite over the existing land surface); and
- ***Removal and/or Isolation of Offshore Sediments*** - *DMCF Capping* (low permeability dredged material placed within the dikes constructed for the DMCF), *Offshore Impermeable Capping* (placing a layer of low-permeability material at a thickness of up to 5 feet over impacted sediments), and *Dredging* (removing impacted sediments for placement on land).

It is important to stress that the MPA has not finished its executive deliberations on the Remedial Options under consideration, or on other matters related to acquiring a portion of the Sparrows Point Property. It should be noted, however, that this preliminary evaluation indicates that there are several Remedial Options that would be feasible, implementable, and effective corrective measures for the environmental conditions discussed in this Site Assessment. In particular, capping and containment remedies would be very effective at mitigating environmental impacts to offshore sediments and onshore subsurface media and could be seamlessly implemented with the DMCF construction.

If MPA were to acquire the Coke Point Peninsula for use as a DMCF, the Remedial Options for each of the impacted media would be further evaluated within the framework of the RCRA CMS process. Specific recommendations for further study include the following:

- Conduct groundwater modeling to confirm the direction and velocity of groundwater flow in response to dredged material placement;
- Assess the Graving Dock pumping to evaluate the necessary design parameters for groundwater response measures in this area;
- Conduct a geotechnical investigation to evaluate the potential for differential settling that may affect groundwater flow in response to dredged material loading on the existing land surface;
- Conduct additional offshore investigations to the southwest to further delineate sediment impacts for the design of offshore dikes; and

- Comply with additional reporting requirements as part of the RCRA enforcement at the site and the National Environmental Policy Act (NEPA) requirements for potential DMCF use.

Once MPA's internal deliberations about the site are complete, they anticipate that any recommendations arising from their deliberations would be shared and discussed with the Harbor Team. Further, any Remedial Options that could ultimately serve as corrective measures at the site will need to be further evaluated within the framework of the RCRA CMS process in accordance with MDE and USEPA review and concurrence.

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## LIST OF ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| AAS | Atomic Absorption Spectrophotometric |
| AOC | Area of Concern |
| ASTM | American Society for Testing and Materials |
| atm | atmospheres |
| | |
| bgs | Below Ground Surface |
| BH | Baltimore Harbor |
| BOH | Bottom of Hole |
| BP | Benzol Processing and Graving Dock Areas |
| BSC | Bethlehem Steel Corporation |
| | |
| °C | degrees Celsius |
| C2HM | CH2M-Hill |
| CDF | Confined Disposal Facility |
| cfs | Cubic Feet per Second |
| CMS | Corrective Measures Study |
| COC | Chain of Custody |
| CSIR | Compound-Specific Stable Carbon Isotope Ratios |
| CSM | Conceptual Site Model |
| CT | Coal Tar Storage Area |
| cu yds | cubic yards |
| CVAA | Cold Vapor Atomic Absorption |
| | |
| DCM | dichloromethane |
| DGPS | Differential Global Positioning System |
| DI | De-ionized [water] |
| DMCF | Dredge Material Containment Facility |
| DNAPL | Dense Non-Aqueous Phase Liquid |
| DO | Dissolved Oxygen |
| DUP | Duplicate |
| | |
| EA | EA Engineering, Science, and Technology, Inc. |
| ECD | Electron Capture Detector |
| Eh | Redox Potential |
| EMPC | Estimated Maximum Possible Concentration |
| ERL | Effects Range Low |
| ERM | Effects Range Median |
| | |
| $^{o}$F | Degrees Fahrenheit |
| FPD | Flame Photometric Detector |
| ft | Foot or Feet |
| $ft^2$ | Square Feet |
| $ft^3$ | Cubic Feet |

## LIST OF ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| $g/cm^3$ | grams per centimeter cubed |
| g/s | grams per second |
| gal | Gallons |
| gal/day | Gallons per Day |
| GC/FID | Gas Chromatography / Flame Ionization Detection |
| GIS | Geographic Information System |
| GPS | Global Positioning System |
| | |
| Hg | Mercury |
| HMI | Hart-Miller Island |
| $HNO_3$ | Nitric Acid |
| hr | Hour or Hours |
| HSA | Hollow Stem Auger |
| | |
| ICP/MS | Inductively Coupled Plasma/ Mass Spectrometry |
| IDL | Instrument Detection Limit |
| IDW | Investigation-Derived Waste |
| IFP | Oil-Water Interface Probe |
| in. | Inch or inches |
| IRMS | Isotope Ratio Mass Spectrometer |
| | |
| lbs | Pounds (U.S.) |
| LCS | Laboratory Control Sample |
| LNAPL | Light Non-Aqueous Phase Liquid |
| | |
| MAH | Mono Aromatic Hydrocarbon |
| mcy | million cubic yards |
| MD | Maryland |
| MDE | Maryland Department of the Environment |
| MDL | Method Detection Limit |
| MES | Maryland Environmental Service |
| META | META Environmental, Inc. |
| mg/L | Milligrams per Liter |
| mg/kg | Milligrams per Kilogram |
| MLW | mean low water |
| mol | mole(s) |
| MPA | Maryland Port Administration |
| MS | Matrix Spike |
| MS/SIM | Mass Spectrometry / Selected Ion Monitoring |
| MSA | Method of Standard Additions |
| MSD | Matrix Spike Duplicate |

## LIST OF ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| MW | Monitoring Well |
| N&E | Nature and Extent |
| NAD83 | 1983 North Atlantic Datum |
| NAPL | Non-Aqueous Phase Liquid |
| ND | Non-Detect |
| NEPA | National Environmental Policy Act |
| NIST | National Institute of Standards and Technology |
| NTU | Nephelometric Turbidity Units |
| oz. | ounce |
| PAH | Polycyclic Aromatic Hydrocarbon |
| PDB | Peedee Belemnite |
| PID | Photo-ionization Detector |
| PPE | Personal Protective Equipment |
| ppb | Part(s) per Billion |
| ppm | Part(s) per Million |
| ppt | Part(s) per Thousand |
| PRC | PRC Environmental Management |
| PTS | PTS Laboratories |
| PVC | Polyvinyl Chloride |
| QA | Quality Assurance |
| QC | Quality Control |
| RCRA | Resource Conservation and Recovery Act |
| RE&I | Rust Environmental & Infrastructure |
| REV | Representative Elementary Volume |
| RFI | RCRA Facilities Investigation |
| RL | Reporting Limit |
| RPD | Relative Percent Difference |
| RSC | Release Site Characterization |
| SED | Sediment |
| SIM | Selective Ion Monitoring |
| SMS | Surfacewater Modeling System |
| SO | Soil |
| SOP | Standard Operating Procedure |
| SPT | Standard Penetration Test |
| SRM | Standard Reference Material |
| SS | Split Spoon |
| SSA | Special Study Area |

## LIST OF ACRONYMS AND ABBREVIATIONS

| | |
|---|---|
| SWI | Site Wide Investigation |
| SWMU | Solid Waste Management Units |
| TCLP | Toxicity Characteristic Leaching Procedures |
| TDL | Target Detection Limit |
| TIC | Tentatively Identified Compound |
| TOC | Total Organic Carbon |
| µg/kg | Micrograms per Kilogram |
| µg/L | Micrograms per Liter |
| URS | URS Corporation |
| USACE | U.S. Army Corps of Engineers |
| USBM | United States Bureau of Mines |
| USEPA | U.S. Environmental Protection Agency |
| VOCs | Volatile Organic Compounds |
| W | Surface Water |
| WOR | Weight of Rod |

# 1. INTRODUCTION

The Sparrows Point Facility is located on approximately 2,300 acres on the north side of the Patapsco River in Baltimore County, Maryland, approximately nine miles southeast of downtown Baltimore (**Figure 1-1**). The Maryland Port Administration (MPA) has expressed an interest in acquiring the Coke Point Peninsula (the Peninsula) on the Sparrows Point property as a potential site for a Dredged Material Containment Facility (DMCF) for placement of dredged material from channels in Baltimore Harbor. Because groundwater and soil impacts from historical activity on the Peninsula may potentially be affecting offshore surface water and sediment, additional environmental information was required by MPA for due diligence in considering its options regarding the property. If a property transaction occurs, data from this assessment will be used to support the ongoing Resource Conservation and Recovery Act (RCRA) Corrective Action, in particular the RCRA Facility Investigation (RFI) and subsequent Corrective Measures Study (CMS), for the Sparrows Point Facility.

This Site Assessment for the proposed Coke Point DMCF at Sparrows Point was prepared by EA Engineering, Science, and Technology (EA) on behalf of the Maryland Environmental Service (MES), under contract to MPA. This study was designed to collect data to evaluate the nature and extent of onshore sources and to assess the potential impacts to offshore sediment and surface water in support of the ongoing Resource Conservation and Recovery Act (RCRA) Facility Investigation (RFI). Results of this study provide updated information related to the conceptual site model for fate and transport and allow for a preliminary evaluation of a range of potential remedial technologies and process options (hereinafter "Remedial Options") that could be implemented to address legacy onshore and offshore impacts on and adjacent to the site. These results also could provide a basis for a Corrective Measures Study (CMS), which, in conjunction with the RFI, is a reporting requirement defined as part of the active RCRA enforcement for the Coke Point geographic region of the Sparrows Point Facility.

## 1.1 PROJECT BACKGROUND

The Coke Point Peninsula comprises approximately 300 acres on the southwest portion of the Sparrows Point property, which borders the Patapsco River and is located one mile east of the Francis Scott Key Bridge (**Figure 1-1**). MPA is considering the Peninsula as a potential location to build a DMCF to help meet the 20-year Baltimore Harbor dredged material placement target and the annual dredged material placement capacity need of 1.5 million cubic yards (mcy). Sediment dredged from the Patapsco River west of the North Point-Rock Point line (**Figure 1-1**) is statutorily prohibited, by the State of Maryland, from being re-deposited in an unconfined manner into or onto any portion of the Chesapeake Bay waters or its tributaries. Existing placement sites for dredged material from the Baltimore Harbor (Patapsco River west of North Point-Rock Point line) include the Hart-Miller Island (HMI) DMCF, the Cox Creek DMCF, and the Masonville DMCF (under construction) (**Figure 1-1**). With only two existing placement sites currently available, a dredged material placement capacity shortfall would begin in Maryland with the closure of the HMI DMCF (by December 31, 2009), resulting in an ongoing need to study, select, and implement new sites capable of accepting dredged material from within the Baltimore Harbor. To this end, a group of community members, citizens groups, and local government representatives, referred to as the Harbor Team, was tasked by MPA with

identifying possible locations for placement of dredged material. After an extensive screening process by the Harbor Team, the Coke Point Peninsula was identified as one of the potential sites for construction of a DMCF. Therefore, MPA initiated this study to collect due diligence information for assessment of corrective measure alternatives to address known historical impacts at the site and to collect additional information to satisfy existing data gaps.

The Sparrows Point Facility has a long history of steelmaking activities. Pennsylvania Steel built the first furnace at Sparrows Point in 1887. Bethlehem Steel Corporation (BSC) purchased the facility in 1916 and enlarged it by building mills to produce hot rolled sheet, cold rolled sheet, galvanized sheet tin mill products, and steel plate. During peak steel production in 1959, the facility operated twelve coke-oven batteries, ten blast furnaces, and four open-hearth furnaces. Coke production facilities (which were located in the Coke Oven Area on the Peninsula) were built in the 1930s and operated until 1991 [Rust Environmental & Infrastructure (RE&I 1998)]. Coal tar, a primary byproduct of coking operations, was contained while awaiting sale in the Coal Tar Storage Area, adjacent to the Coke Oven Area along the east coast of the Peninsula (**Figure 1-2**). In addition to tar, the gas stream from the coking ovens also contained volatile organic compounds (VOCs), including benzene, toluene, xylenes, and diphenyl, which were removed from the gas using an absorbing oil. The VOCs were extracted from the oil and then distilled for sale in the Benzol Processing Area, to the west of the coking ovens (**Figure 1-2**). Organic compounds associated with these byproducts of the coking process, in particular benzene and naphthalene, have been identified in previous reports as the primary constituents of concern in groundwater on the Peninsula [CH2MHill (CH2M) 2001]. Coking operations ceased in 1991 and the coke batteries have been torn down. The Sparrows Point Facility is still an active steelmaking operation.

A Consent Decree for the Sparrows Point Facility was issued by the U.S. Environmental Protection Agency (USEPA) and the Maryland Department of the Environment (MDE) in 1997. The Consent Decree provided a synopsis of activities and conditions of concern at Sparrows Point, outlined corrective measures, and included requirements for interim measures, a Site Wide Investigation (SWI), and a CMS. In addition, the Consent Decree mandated a comprehensive evaluation of the potential for both current and future risk to human health and the environment from current and past releases of hazardous waste and hazardous constituents at the Facility. The USEPA is the lead regulatory agency for the active enforcement of RCRA requirements at the Sparrows Point Facility.

Previous studies (**Table 1-1**) at the Sparrows Point Facility have focused on documenting current conditions and characterizing the subsurface hydrogeology and groundwater impacts within five special study areas. The Description of Current Conditions (RE&I 1998) reviewed the potential sources of impacts and proposed a detailed framework for future investigations. Follow-on SWI reports [CH2M 2001, 2002; URS Corporation (URS) 2005a, 2005b, 2006] focused on characterizing the nature and extent of groundwater impacts within these study areas. Conclusions of these reports indicate that the Coke Point Peninsula, in particular the Coke Oven Area, is the most impacted portion of the Sparrows Point Facility, with non-aqueous phase volatile and semi-volatile organic constituents dissolving into groundwater (USEPA 2009a).

Most of the surface of the Coke Point Peninsula consists of slag fill material approximately 30 feet (ft) thick. The underlying native geological formations include the Talbot Formation (primarily soft marine silt and sand with bivalve shells) that is underlain by the Patapsco Formation (generally sand and gravel with lenses of sandy clay). The Talbot Formation in the area ranges in thickness from 5 to 100 ft, whereas the Patapsco Formation ranges from 145 to 255 ft in thickness (RE&I 1998; EA 2009a).

Recent findings on groundwater impacts have been identified in reports related to the nature and extent of releases to groundwater (URS 2005a, 2005b). Unconfined groundwater exists within a shallow aquifer composed of the slag fill material, and intermediate and deep aquifers exist within the Talbot and Patapsco formations, respectively. The three aquifers are hydraulically interconnected, but are partially separated in areas by discontinuous lenses of silt and clay. Groundwater flow direction in the shallow aquifer is radially away from the north central portion of the Peninsula toward adjacent shoreline areas (**Figure 1-2**). More specifically, radial flow on the western side of the Peninsula, in the Benzol Processing Area, is toward the Patapsco River to the west. Flow on the south side of the Peninsula is south toward the southern shoreline. Flow on the east side of the Peninsula, in the Coal Tar Storage Area, is toward the Turning Basin to the east. Groundwater flow direction within the intermediate aquifer along the western portion of the Peninsula is northwestward, apparently influenced by historic pumping activities in the area of the Graving Dock (URS 2005a, 2006). Groundwater flow direction within the intermediate aquifer along the eastern portion of the Peninsula is south-southwest in the apparent direction of the natural gradient. Groundwater flow direction within the deep aquifer is unidirectionally to the east-northeast.

Observed groundwater impacts resulting from historic releases in the Coke Oven Area are limited to the shallow and intermediate aquifers. Impacts to shallow groundwater include dissolved mono aromatic hydrocarbons (MAHs), in particular benzene and toluene, emanating from the Benzol Processing Area that have migrated in a westerly and northwesterly direction toward the Patapsco River and the Graving Dock Area (URS 2005a, 2006). Impacts to shallow groundwater also include dissolved polycyclic aromatic hydrocarbon (PAHs), primarily naphthalene, emanating from the Coal Tar Storage Area that have migrated in an easterly direction toward the Turning Basin (URS 2005a, 2006). The presence of hydrocarbon non-aqueous phase liquid (NAPL) in the groundwater source regions of the shallow aquifer was indicated by areas where the aqueous phase solubility of pure benzene and naphthalene exceeded 10 percent. Areas where benzene and/or naphthalene exceeded 10 percent solubility (the 10 percent solubility rule for groundwater) (Suthersan 1997) within the shallow aquifer are shown as highlighted regions on **Figure 1-2**. Benzene exceedance of the 10 percent solubility rule also occurs within the intermediate aquifer of the site region referred to as the Graving Dock Area (**Figure 1-2**), presumably because historic pumping activities beneath the Graving Dock pulled the shallow groundwater benzene plume downward and northwestward (URS 2005a, 2006).

Though previous investigations have adequately characterized the nature and extent of groundwater impacts, the source regions have not been evaluated (through independent assessment of site fill material, soil, and/or NAPL). Such an assessment would be beneficial to (1) confirm previous assumptions concerning source areas inferred from groundwater data, (2) verify the exact location of source material, and (3) quantify source mass for evaluation of

cleanup response actions. In addition, the potential for migration of constituents of interest to the offshore environment (surface water and sediment) has not been characterized. A limited surface water sampling event was previously conducted along the northwestern shoreline of the Peninsula, and indicated detectable presence of a number of volatile organic compounds (VOCs), including dissolved benzene and toluene up to 330 and 49 µg/L, respectively (URS 2006). This finding alludes to the importance of evaluating offshore surface water and sediment quality, and potential impacts by migration of onshore constituents and/or historic site practices.

## 1.2 PURPOSE AND OBJECTIVES

The purpose of the project was twofold: (1) to delineate (within the Peninsula) the onshore subsurface source areas inferred from previous groundwater data, and (2) to assess the impact of potential migration of observed onshore constituents on water and sediment quality in the Patapsco River and Turning Basin adjacent to the Peninsula.

The onshore component of this Site Assessment focused on source characterization of the three onshore areas—the Benzol Processing Area, the Graving Dock Area, and the Coal Tar Storage Area (**Figure 1-2**) — inferred to contain NAPL based on previous groundwater studies. The offshore component of this Site Assessment was designed to characterize potential impacts to water and sediment quality around the entire Peninsula.

Objectives for the onshore and offshore components of the site assessment are outlined below.

***Onshore Investigation***

- Evaluate the nature and extent of impacts within the subsurface source regions of the Benzol Processing Area and Coal Tar Storage Area documented in previous investigations;
- Determine whether previous deductions related to groundwater migration of organic constituents to the Graving Dock Area are correct (or if this region is also a source area containing NAPL);
- Collect environmental forensics data to determine the likelihood that the slag/fill material impacts resulted from steelmaking or coking operations at Sparrows Point;
- Assess the amount, extent, and mobility of subsurface light non-aqueous phase liquids (LNAPL) and/or dense non-aqueous phase liquids (DNAPL) present in each of the source areas;
- Analyze the chemical and physical properties of mobile NAPL to determine contribution to the observed groundwater impacts and the mobility/recoverability of the NAPL;
- Assess whether mass flux of constituents of interest within the groundwater discharging to the Patapsco River and Turning Basin has impaired (or could potentially impair) surface water and sediment quality in these areas; and
- Evaluate and make recommendations on remedial technologies and process options (herein referred to as "Remedial Options") for source area cleanup that will be protective

of human health and the environment and are compatible with DMCF construction and use.

***Offshore Investigation***

- Characterize the nature and extent of surface water and surface sediment impacts surrounding the Coke Point Peninsula;
- Identify the depths at which the sediments are impacted and assess whether these impacts are contributing to surface water quality impairment;
- Collect environmental forensics data to determine the likelihood that observed sediment impacts (if any) resulted from steelmaking or coking operations at Sparrows Point;
- Assess the extent of surface water and sediment impacts that have resulted from groundwater migration from onsite source locations, by determining mass flux of constituents of interest discharging from groundwater to adjacent surface water;
- Assess the potential for impairment of surface water in the Patapsco River and Turning Basin by groundwater discharge using hydrodynamic surface water modeling; and
- Evaluate and make recommendations on Remedial Options for water and sediment cleanup that will be protective of human health and the environment and are compatible with DMCF construction and use.

## 1.3 TECHNICAL APPROACH

The technical approach used to collect the data necessary to meet the project objectives included onshore and offshore field activities and data analysis, followed by a comprehensive synthesis of the results with historic groundwater and surface water data to assess sources, fate and transport of constituents of interest, and remedial alternatives consistent with MPA's potential use of the site.

### 1.3.1 Onshore Investigation

***Field Sampling***

The field sampling for the onshore investigation was focused in on the Benzol Processing Area, the Graving Dock Area, and the Coal Tar Storage Area (**Figure 1-2**). For ease of reporting, the Graving Dock Area was included as part of the investigation of the Benzol Processing Area. Therefore, the boring and sample nomenclature for the Graving Dock Area investigative location was given a Benzol Processing Area identification. The nature and extent of impacts in these areas was delineated using a phased drilling program, during which initial field screening and observations dictated whether additional investigational activities would need to be conducted. In each source area, five initial borehole locations were field-screened for LNAPL and DNAPL during the first drilling phase. If field screening indicated that NAPL was encountered in the borehole, one or more NAPL monitoring wells were installed within the slag fill material at each location to assess the mobility and recoverability of the product. If mobile (or free) LNAPL or DNAPL was identified at a location, additional delineation of the product occurrence was performed by moving outward an average of 50-100 ft until the limits of the occurrence were

bounded. One to three fill material samples were collected from each borehole for laboratory analysis of cyanide, metals, percent solids, polycyclic aromatic hydrocarbons (PAHs), and volatile organic compounds (VOCs) (**Table 1-2**). Analysis of the fill material was performed to (1) aid in the relative determination of source area location, (2) compare to soil regulatory criteria established for leaching to groundwater, and (3) assess NAPL saturation based on chemical concentration.

NAPL monitoring wells were used to (1) assess whether mobile LNAPL or DNAPL was present through gauging; (2) if NAPL was present, collect NAPL sample for chemical analysis (VOCs and PAHs) and physical properties (density, viscosity, interfacial tension, and wettability); and (3) if NAPL was present, assess the potential for NAPL recovery by conducting bail-down tests.

***Data Analysis***

Field sampling results were compiled, tabulated, and summarized to assist in interpretation of various site processes to meet the objectives as described in Section 1.2 above. Slag fill material chemical analyses were compared to the Maryland Department of the Environment (MDE) soil standards for protection of groundwater (MDE 2008). Other data, such as NAPL properties and field screening, were used to establish a conceptual site model (CSM) by characterizing mass distribution of constituents of interest and assessing their fate and transport. The CSM was used along with other interpretations of field data to evaluate potential response actions to address site corrective measures.

### 1.3.2 Offshore Investigation

***Field Sampling***

The offshore component of the investigation was conducted by collecting water and sediment samples to characterize potential offshore impacts. Because there are no historical data from the sediments in the vicinity of the Coke Point Peninsula, 18 initial locations around the Peninsula were targeted for sampling. Based on the results of field screening, observations of the lateral and vertical extent of the fill material layer, and results of sediment samples submitted for analysis, 6 additional locations were sampled. These additional locations targeted areas where additional information was needed to determine the horizontal extent of impacted sediment. If field screening of the subsurface sediment samples indicated the presence of NAPL, additional delineation was conducted by moving farther offshore from the impacted area and drilling additional boreholes.

At each of the initial 18 locations, water samples from the Patapsco River (deep, intermediate, and shallow), surface sediment samples, and subsurface sediment samples were collected. Water samples were analyzed for VOCs and PAHs. The analytical program for the offshore sediment investigation included VOCs, PAHs, metals, cyanide, grain size, percent solids, and total organic carbon (**Table 1-2)**.

***Data Analysis***

Similar to the onshore investigation, field sampling results were compiled, tabulated, and summarized to assist in interpretation of various site processes to meet the objectives as described in Section 1.2 above. Offshore cross sections showing geologic media and field

screening observations were compiled to illustrate areas of offshore impacts to sediments (Appendix D). Field screening information and analytical data were assimilated into the CSM to establish an overall interpretation of the impacts to onshore and offshore areas, including mass distribution as well as fate and transport. The CSM was used to evaluate potential offshore Remedial Options.

## 1.4 REPORT ORGANIZATION

This Sparrows Point Site Assessment includes the following chapters:

- Chapter 1 (Introduction) provides an introduction to the investigation, including project background, objectives, technical approach, and report organization.
- Chapter 2 (Field Activities) describes the methods used to collect site data and analytical samples for the onshore and offshore components of the Site Assessment.
- Chapter 3 (Results of the Onshore Investigation) discusses the field screening, analytical, and NAPL distribution and characteristics data for the onshore component of the Site Assessment.
- Chapter 4 (Results of the Offshore Investigation) discusses the field screening, analytical, and NAPL distribution and characteristics data for the offshore component of the Site Assessment.
- Chapter 5 (Fate and Transport) integrates data from historical information, modeling, and the results of the onshore and offshore components of the investigation; culminating in a conceptual site model of the sources, transport, and receptors of impacted material.
- Chapter 6 (Summary of Preliminary Evaluation of Remedial Technologies) identifies several Remedial Options that could be considered for addressing observed onshore and offshore impacts on and around the Peninsula.
- Chapter 7 (Conclusions and Recommendations) provides conclusions of the report findings and lists recommendations to address additional data gaps and follow-on work.
- Chapter 8 (References) provides a list of references used in preparing this report.

Appendices and Attachments included with the report are as follows:

- Appendix A: Boring Logs and Field Notes
- Appendix B: Analytical Methods
- Appendix C: Mass Distribution Calculations
- Appendix D: Offshore Geologic Cross Sections
- Appendix E: Mass Flux Calculations and Surface Water Modeling
- Appendix F: Sediment Sorption Calculations

- Attachment I: Analytical Results – Soil
- Attachment II: Analytical Results – Water

- Attachment III:  Analytical Results – Sediment
- Attachment IV:  Analytical Report – Environmental Forensics (Soil and Sediment)

Site Assessment for Proposed Coke Point Dredged Material Containment Facility at Sparrows Point

**Legend**

Coke Point Peninsula

Existing/Planned Dredged Material Placement Sites

Sources
Tele Atlas North America Inc., ESRI, 2006

Miles
0 1 2

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.

H:\projects\1453406\MXD\2009_Report\Figure 1-1

**Figure 1-1. Site Map, Coke Point Peninsula, Baltimore, Maryland**


Site Assessment for Proposed Coke Point Dredged Material Containment Facility at Sparrows Point

**Legend**

Shallow Aquifer Groundwater Flow Direction

Area of Concern

Sources
ESRI, i-cubed, GeoEye, 2009
Tele Atlas North America Inc., ESRI, 2006

Feet
0 500 1,000

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.


H:\projects\1453406\MXD\2009_Report\Figure 1-2

**Figure 1-2. Areas of Concern, Coke Point Peninsula, Baltimore, Maryland**

**Table 1-1. Chronological Summary of Previous Studies Relevant to the Coke Point Peninsula, Sparrows Point, Baltimore, Maryland**

| Reference | Summary |
|---|---|
| **D'Appolonia 1980. Phase I Investigation, Existing Waste Disposal Areas, Letter Report, August 8, 1980.** | Evaluated geology and hydrology based on available literature, reviewed boring logs in the Coke Oven Area and other areas. |
| **Kearney 1993. Final RCRA Facility Assessment Phase II Report of the Bethlehem Steel Corporation Sparrows Point, Maryland. EPA ID Number MDD053945432. Submitted by A.T. Kearney, Inc. Alexandria, VA to Region III, U.S. Environmental Protection Agency, Philadelphia, PA, August 12, 1993** | Report (1) updated the initial draft, (2) updated the list of Solid Waste Management Units (SWMUs) and Areas of Concern (AOCs), (3) evaluated SWMUs and AOCs for their potential to release hazardous constituents to the environment, and (4) suggested further actions needed. |
| **Rust 1998. Description of Current Conditions, Bethlehem Steel Corporation, Sparrows Point, Maryland. Prepared by Rust Environmental and Infrastructure, Harrisburg/Philadelphia. January.** | Reviewed the potential contaminant sources and proposed a detailed framework for future investigations. |
| **PRC 1998. Interim Draft Deport, Bethlehem Steel Corporation RCRA Facility Assessment, Prepared by PRC Environmental Management, April 12, 1998.** | Reports on Preliminary Review and Visual Site Inspection. |
| **CH2M Hill 2001. Site-Wide Investigation: Groundwater Study Report, Bethlehem Steel Corporation, Sparrows Point Division** | Study (1) improved understanding of geologic material from surface to 120 ft deep, (2) investigated permeability and hydraulic head between layers, (3) characterized inputs and outputs of groundwater flow, (4) modeled groundwater flow, and (5) provided data on-site and off-site groundwater use. |
| **CH2M Hill 2002. Site-Wide Investigation Release Site Characterization Study** | Release Site Characterization (RSC) study focused on five Special Study Area (SSAs), one of which was the Coke Oven Area (COA). Defined the stratigraphy of 100-120 ft of subsurface materials to define the occurrence, movement, and quality of groundwater within the upper groundwater system. |
| **URS 2005a. Site Wide Investigation, Report of Nature and Extent of Releases to Groundwater from the Special Study Areas, International Steel Group, ISG Sparrows Point, Inc. Facility, Sparrows Point, Maryland** | Evaluated the nature and extent (N&E) of releases to groundwater |
| **URS 2005b. *CA725 Facility Investigation and Human Health Risk Evaluation (HHRE) Findings, ISG Sparrows Point*. Presentation to Maryland Department of Environment and U.S. Environmental Protection Agency, Region III, June 9, 2005, 39 pp.** | Assessed Environmental Indicators for onshore human health and ecological risk receptors |
| **URS 2006. Response to EPA Comments (4) and (5) dated December 15, 2005. Prepared by URS for ISG Sparrows Point LLC. Attachment to letter by Robert Abate, ISG Sparrows Point LLC to Andrew Fan U.S. EPA Region III and Richard Johnson, MDE, December 6, 2006, 17 pp.** | Revisions to Nature & Extent Report based on USEPA Comments on report. |

## Table 1-2. Analytical Testing Program

**Coke Point Penisula, Sparrows Point Site Assessment (2009), Baltimore, Maryland**

| Physical / Chemical Constituent | Onshore Soil | NAPL | Offshore Surface Water | Offshore Surface Sediment | Offshore Subsurface Sediment |
|---|---|---|---|---|---|
| Volatile Organic Compounds (VOCs) | X | X | X | X | X |
| Polycyclic Aromatic Hydrocarbons (PAHs) | X | X | X | X | X |
| Metals (including Mercury) | X | | | X | X |
| Total Organic Carbon (TOC) | X | | | X | X |
| Cyanide | X | | | X | X |
| Grain Size | X | | | X | X |
| Physical Properties (density, viscosity, interfacial tension, and wettability) | | X | | | |
| Total Solids | X | | | X | X |

# 2. FIELD ACTIVITIES

Field sampling for the Sparrows Point Site Assessment was conducted in two phases – the onshore phase and the offshore phase.

- The onshore component included subsurface drilling, soil sampling, and well installation at 10 locations in the Benzol Processing Area (**Figure 2-1**), one location in the Graving Dock Area, and five locations in the Coal Tar Storage Area (**Figure 2-2**). Mobilization for the onshore component of the project commenced on May 15, 2009, and drilling, sampling, well installation, and gauging were conducted from May 18 through June 25, 2009 (**Appendix A**).
- The offshore component included surface water sampling, surficial sediment sampling, drilling, and subsurface sediment sampling at a total of 24 locations adjacent to the shoreline around the Coke Point Peninsula of the Sparrows Point Facility (**Figure 2-3**). Mobilization for the offshore component of the project commenced on February 2, 2009 (in advance of the onshore component), and sampling was conducted from February 2 through March 12, 2009 (**Appendix A**).

Many of the same field methods for drilling and subsurface sampling were utilized for both the onshore and offshore components of the Site Assessment, and are described in **Section 2.1**. Field methods that were specific to either the onshore component or the offshore component are described in **Sections 2.2 and 2.3**, respectively.

## 2.1 GENERAL FIELD METHODS

### 2.1.1 Hollow Stem Auger Drilling

Hollow stem auger (HSA) drilling was used to collect continuous subsurface samples of onshore slag fill material and offshore sediment (and slag) for the purposes of: (1) field screening for evidence of hydrocarbon impacts (or NAPL) from historic release(s), (2) analytical testing, and (3) installing onshore wells for gauging and characterization of NAPL, if encountered.

A Standard Penetration Test (SPT) split spoon (SS) sampler was used to collect samples and to measure the penetration resistance (N-value) of subsurface materials. Subsurface sampling was conducted with a 2 foot (ft) long 3-inch diameter SS sampler advanced by a standard 140 pound (lb) hammer. The SS sampling was performed intermittently between periods of drilling with a 6 1/4-inch diameter HSA auger. Samples were collected by advancing an acetate-lined SS sampler ahead of the previous drilling depth. After retrieving a sample from the acetate liner from the SS sampler, the hollow-stem auger was then advanced 2 ft to the bottom of that particular sample. The process was repeated until the target depth for the bottom of the borehole was achieved. The target depth for the onshore boreholes was the interface between the fill and the native soil or a depth of 50 ft below ground surface (bgs). Targeted depth for the offshore boreholes was approximately 30 ft below the sediment/water interface or to the depth of the native soil, whichever was shallower. This onshore and offshore drilling method resulted in the collection of continuous subsurface cores to be used for onsite field screening, lithologic descriptions, and subsampling for analyses in fixed laboratories.

### 2.1.2 Field Screening

***Field Headspace Measurement***—Total volatile organic compound (VOC) concentrations were semi-quantitatively determined using a sample jar and photo-ionization detector (PID). Initial core processing of soil and sediment samples included gross screening of the core with a PID when the SS sampler and the acetate liner were opened. One 4-oz jar from each 2-ft depth interval was filled to two thirds capacity with sample (soil or sediment), allowing space for VOC volatilization. The jarred sample was allowed to equilibrate for a minimum of 10 minutes, after which a PID was used to measure total VOC concentration in the headspace. The PID was calibrated in accordance with manufacturer's recommendations and checked each morning and evening to ensure that calibration tolerances were met. The PID headspace reading (in parts per million [ppm] total VOCs) was recorded on the boring log.

***Dye shaker tests***—Hydrophobic dye shaker tests were conducted on selected jarred samples (slag fill material and/or sediment) that exhibited elevated PID headspace readings. The dye shaker tests were performed on jarred samples using Sudan IV hydrophobic dye to determine the presence or absence of residual or free NAPL. The Sudan IV qualitatively allows an observer to detect the presence of LNAPL or DNAPL by turning the NAPL a red color. Because DNAPL is denser than water, its presence is indicated by small red globules at the bottom of the jar or attached to the walls of the container near the bottom. LNAPL, which is less dense than water, will be found (if present) as red globules at the top of the soil/water slurry or on the sides of the jar near the top.

Tap water or deionized water was added to jars of material suspected to contain NAPL and the contents were vigorously shaken. A small quantity of Sudan IV hydrophobic dye (approximately 50 milligrams) was added to the soil/water slurry, and again the contents were vigorously shaken. The jarred sample was then allowed to sit undisturbed so the sample could settle and the results could be observed. Results from the dye shaker test were recorded as "NEG" (negative), "POS" (positive), or "TRACE" at the appropriate interval on the boring log. NAPL type (LNAPL or DNAPL) also generally was indicated. The test was intended to measure the presence or absence of NAPL, and no attempt was made to quantify (or infer) the volume of NAPL within the jarred samples.

### 2.1.3 Borehole Logs

Standardized borehole logs were constructed using information observed from each of the SS samples retrieved from onshore and offshore borings. Borehole logs included descriptions of material characteristics, observed indicators of organic compounds or NAPLs, and the results of field screening (**Appendix A**). A tape measure was used to accurately indicate the depths of the various observations performed for each SS sampling interval. The logs also indicated the intervals from which media samples were collected, including the sample number and sample type. In addition, onshore boring descriptions included intervals of water-saturated soil to indicate the approximate depth of the water table. Subsurface depths recorded on offshore boring logs were referenced to surface water level (rather than depth below water/sediment line) at the time of the work. Depth conversion to standardized mean low water (MLW) was performed subsequent to the field work and recorded on the boring log.

Boring log material characteristics included the presence and descriptions of slag fill material and native soil or sediment (depending upon whether onshore or offshore). Color, grading (or sorting), angularity, grain size, moisture, degree of plasticity, and lithologic (or anthropogenic) composition were observed and recorded. Lithologic descriptions conformed to the American Society for Testing and Materials (ASTM) Standard for visual-manual description of soils. Other metrics including SS hammer blow counts, starting depth of SS sampler, and amount of sample recovered were recorded, as applicable.

Indicators of organic impacts that were recorded included observed odor, staining, visible sheens or oily substances, and total volatile organics of jarred headspace samples (as measured by PID). The impact indicators were recorded with as much detail as could be discerned in the field. Characteristic odors (such as coal tar, benzene, or naphthalene) were recorded, where differentiable.

## 2.2 ONSHORE FIELD METHODS

The onshore component of the investigation began with the HSA drilling program. Details of the five onshore boreholes designed for initial subsurface sampling of the Benzol Processing Area and the Graving Dock Area (at locations BP-01 through BP-05) are provided in **Table 2-1**. The target depth for HSA source delineation boreholes was the interface between the fill material and native soil, which generally was encountered between 18 and 36 ft below ground surface (bgs) (see boring logs in **Appendix A**). A total of four NAPL monitoring wells (BP-MW-02S, BP-MW-02D, BP-MW-04, and BP-MW-05) were installed at three of the initial five borehole locations in the Benzol Processing Area (**Figure 2-1**). Two NAPL monitoring wells (one shallow and one deep) were installed at boring location BP-02 to assess accordingly the presence of LNAPL (at the water table interface) and DNAPL (at the slag/native soil interface). The two borehole locations where NAPL monitoring wells were not installed (BP-01 and BP-03) showed no signs of NAPL presence and, thus, were properly abandoned by sealing the borehole with hydrated bentonite hole plug.

Following the advancement of the initial five boreholes in the Benzol Processing and Graving Dock Areas, six additional delineation boreholes were drilled in the Benzol Processing Area (at locations BP-06 through BP-11) to spatially delineate the LNAPL occurrence identified at BP-MW-05 (**Figure 2-1**, **Table 2-1**). NAPL monitoring wells were installed at the water table interface in each of these additional boreholes. A total of ten NAPL monitoring wells (eight LNAPL detection wells and two DNAPL detection wells [BP-MW-2D and BP-MW-4]) were installed in the Benzol Processing Area during this investigation.

Subsequent to field activities in the Benzol Processing Area, drilling was conducted in the Coal Tar Storage Area (**Figure 2-2; Table 2-1**). A total of five boreholes were drilled to the onshore target depth (native soil interface). Field screening was used to determine whether to install monitoring wells for detection of potential NAPL presence. Based on screening data, locations CT-MW-01 and CT-MW-05 were selected as candidates for well installation. These wells did not indicate the presence of free or mobile NAPL (based on monitoring well indicators). Therefore, additional NAPL monitoring wells or other boreholes were not installed. The three

boreholes not receiving monitoring wells were properly abandoned by sealing the borehole with hydrated bentonite hole plug.

The field sampling objectives for the onshore investigation were:

- Collect soil cores to the fill material/native soil interface using an HSA drill rig with a split spoon sampler for all borehole locations;
- Complete soil boring logs for each location;
- Determine the depth of impacted soil using field screening techniques as described above;
- Collect samples from impacted soil for physical and chemical analyses;
- Distribute soil samples into appropriate containers for submittal to appropriate laboratories;
- Complete appropriate chain-of-custody (COC) documentation;
- Provide soil quality data to help characterize the source areas;
- Install NAPL monitoring wells at HSA boring locations where NAPL presence was indicated from field screening;
- Drill additional HSA boreholes and/or install additional NAPL monitoring wells as needed to delineate NAPL source areas;
- Gauge NAPL monitoring wells to assess product thickness;
- Collect NAPL samples for laboratory analysis of physical and chemical properties; and
- Perform bail-down tests for wells with gauged NAPL presence to determine NAPL recovery rates for use in analysis of potential remedial technologies and process options.

### 2.2.1 Soil Sample Collection

Soil samples were collected at each of the boreholes. At least three soil samples were collected from each of the 10 initial boreholes drilled within the Benzol Processing Area, Graving Dock Area, and Coal Tar Storage Area (BP-01 through -05 and CT-01 through -05). One to three soil samples were collected in the six additional boreholes drilled in the Benzol Processing Area for LNAPL delineation (**Table 2-2**). Soils were divided into 2-foot intervals during the boring. Each 2-foot interval was screened with a PID and select samples were tested for the presence of NAPL with the Sudan IV shaker test (see **Section 2.1.2**). Based on the results of the field screening and visual observation, soil samples from impacted intervals were chosen for analytical testing.

Soil samples chosen were analyzed for VOCs, polycyclic aromatic hydrocarbons (PAHs), metals (including mercury), and cyanide. VOC samples were collected as a grab sample directly from the core using a Terra Core sampler. Subsequently, the interval was subsampled and homogenized for the remaining chemical analyses. The samples were placed into appropriate laboratory-cleaned containers, and shipped via overnight delivery to TestAmerica–Pittsburgh on

the day of collection. The sample containers, preservatives, and holding times for soil samples are provided in **Appendix B**.

Additional grab samples were collected from select locations and shipped to META Environmental, Inc. (META) for PAH fingerprinting. Onshore samples submitted for PAH fingerprinting were collected from a total of five locations – two in the Benzol Processing Area (at BP-MW-02S and BP-MW-05), one in the Graving Dock Area (at BP-HSA-03), and two in the Coal Tar Storage Area (at CT-MW-01and CT-MW-05) (**Figure 2-4**; **Table 2-2**).

### 2.2.2 Non-Aqueous Phase Liquid (NAPL) Well Installation

Based on subsurface field observations during boring advancement, previous onsite experience, and the physical and chemical properties of non-aqueous phase product, standard subsurface monitoring wells were constructed for the gauging, sampling, and characterization of NAPL at this site. NAPL wells were constructed of 2-inch polyvinyl chloride (PVC) well screen and riser pipe as described in the well construction logs in **Appendix A**. Each well was constructed with a sand pack, bentonite seal, cement grout, and above-ground steel protective casing.

Onshore source delineation boreholes were drilled through the fill material to the native soil interface and field screening was conducted on the continuous core obtained during the drilling. NAPL monitoring wells were installed at depths coinciding with positive field screening results. NAPL impacts were generally either near the water table (shallow) or near the native soil interface (deep). In general, wells were installed within the existing delineation borehole. In one case, however, the potentially NAPL-impacted depth was relatively long, so two wells (BP-MW-2S and BP-MW-2D) were installed. The deeper well was installed in the existing borehole, and an offset borehole was drilled to an appropriate depth for installation of the shallow well.

The horizontal location of each of the newly installed NAPL wells was surveyed in reference to the Maryland State Plane Coordinate System, 1983 North Atlantic Datum (NAD83) using global positioning system (GPS) technology. Vertical surveying of the wells was not required because the wells were utilized only for NAPL gauging/sampling and not for assessing groundwater elevation. Groundwater elevation and gradient were established in previous investigations.

### 2.2.3 Non-Aqueous Phase Liquid Characterization

LNAPL and DNAPL were characterized by gauging and sampling in the twelve newly installed wells and in one existing well (C013-PZM-008). The NAPL analyses were performed to determine analytical makeup and potential mobility of the NAPL phase. Where NAPL was identified in monitoring wells, product bail down tests were performed to determine the rate of recovery of the NAPL. All NAPL characterization field work was performed in modified Level D personal protective equipment (PPE).

In wells where NAPL was identified, a bail-down test was performed to determine the potential well recovery rate. Bail-down testing was conducted by removing NAPL from the wells with a bailer and measuring the thickness and depth to NAPL in the well as it recovers. The objective of the test was to remove product in the well to a minimal thickness and time the recovery of

product to 80 percent of its original thickness, thereby obtaining data to help determine the potential effectiveness of NAPL recovery as a remedial technology.

A total of two LNAPL samples (from wells BP-MW-05, BP-MW-08) and one DNAPL sample (from well CO13-PZM-008) were collected from the wells using disposable bailers. Prior to sampling, NAPL thickness was determined by gauging with an oil-water interface probe (IFP). The IFP was slowly lowered in the well from top to bottom to allow detection of LNAPL and/or DNAPL. Depths to LNAPL, water, and/or DNAPL were recorded on a field sheet. Based on the IFP reading, the bailer was lowered to a level to ensure collection of sufficient NAPL volume in one or more bailers, depending on NAPL thickness. Collected NAPL was drained from the bailer into laboratory-supplied sample bottles and submitted for chemical and physical-property analyses.

Chemical (VOCs and PAHs) properties of the three NAPL samples were analyzed by TestAmerica-Pittsburgh. Physical (density, viscosity, interfacial tension, and wettability) characteristics of the three NAPL samples were analyzed by PTS Laboratory (PTS) to determine mobility parameters of the NAPL.

## 2.3 OFFSHORE FIELD METHODS

Sampling locations for the offshore areas of the Sparrows Point Site Assessment were chosen by EA and approved by MPA and MES prior to the start of sampling. The initial sampling locations were selected to adequately provide information for the entire perimeter of the Peninsula. Northing and easting coordinates, sampling dates, water depths, and sample information for site water and surface sediment sampling locations are summarized in **Tables 2-3 and 2-4**, respectively. Northing and easting coordinates, sampling dates, and water depths for sediment borings are provided in **Table 2-5**. Positioning was determined in the field using a Trimble Differential Global Positioning System (DGPS). Copies of the field notes from each sampling effort are located in **Appendix A**.

Mobilization for the offshore sampling started on February 2, 2009. Site water samples were collected at eighteen (18) locations on February 2 and 3, 2009, and surface sediment samples were collected at nineteen (19) locations (18 plus a reference site for PAH fingerprinting samples) on February 6 and 9, 2009. Drilling operations to obtain subsurface sediment samples at 18 locations started on February 13, 2009, and finished on March 5, 2009. Six (6) additional boring locations were added to the project; sampling for the additional 6 locations started on March 9, 2009, and was completed on March 12, 2009.

The additional borings were added to the sampling program to delineate the lateral and vertical extent of impacts to the sediments adjacent to the Coke Point Peninsula.

The field sampling objectives for the offshore investigation were:

- Collect site water grab samples at surface, mid-depth and bottom depths at 18 locations for laboratory analysis of VOCs and PAHs;

- Collect and homogenize the required volume of surficial sediment using a Van Veen sampler at 19 locations for physical and chemical analyses (18 locations and the reference site);
- Collect sediment cores to 30-ft below the sediment / water interface using a drill rig with a Standard Penetration Test (SPT) sampler at 18 locations;
- Complete boring logs for subsurface samples collected at each location;
- Determine the depth of impacted subsurface sediment using PID screening and hydrophobic dye shaker tests;
- Collect the required volume of subsurface sediment (at the depth of impacted sediment) for physical and chemical analyses;
- Distribute homogenized sediment samples into appropriate containers for submittal to appropriate laboratories;
- Measure and record *in situ* water quality information (temperature, salinity, pH, dissolved oxygen (DO), and turbidity);
- Submit equipment blanks for analytical testing;
- Complete appropriate chain-of-custody (COC) documentation; and
- Provide sediment quality data to identify potentially impacted areas.

### 2.3.1 Site Water Collection

Site water for chemical analysis was collected at the surface, mid-depth, and bottom (one foot from the sediment / water interface) of the water column at 18 sampling locations (**Figure 2-3**). Water was collected using an ISCO pump with dedicated Tygon tubing from EA's 28-ft work vessel. Water for analytical testing was stored in certified cleaned, laboratory-prepared containers with appropriate preservatives. Water samples were shipped via overnight delivery to TestAmerica–Pittsburgh on the day of collection.

Water samples were analyzed for VOCs and PAHs. The sample containers, preservatives, and holding time requirements for site water and equipment blanks are provided in **Appendix B**. Holding times for the site water began when the samples were collected and placed into the appropriate sample containers.

### 2.3.2 Surface Sediment Collection

Surface sediment samples were collected at 19 sampling locations to approximately 1 ft below the sediment surface using a stainless steel Van Veen grab sampler (**Table 2-4**). Sampling operations were conducted from EA's 28-ft work vessel. Surface sediment samples were analyzed for VOCs, PAHs, metals (including mercury), cyanide, total organic carbon (TOC), total solids, grain size, and moisture content. VOC samples were collected using Terra Cores. VOC samples were collected from the grab sample immediately after collection, prior to sample homogenization.

After VOC samples were collected, the remaining sediment was homogenized, placed into appropriate laboratory-cleaned containers using stainless steel spoons, and shipped via overnight delivery to TestAmerica–Pittsburgh on the day of collection. At location 3A, an additional sediment sample was collected for PAH fingerprinting analysis.

The sample containers, preservatives, and holding time requirements for sediment samples are provided in **Appendix B**. The holding time for the surface sediment was initiated at sample collection.

### 2.3.3 Subsurface Sediment Collection

Subsurface sediment samples were initially collected at 18 locations around the Peninsula (**Figure 2-3**). After the initial 18 locations were sampled, the additional six locations were added to the project to delineate potential impacts to the offshore environment. Subsurface sediment samples were collected with a hollow stem auger (HSA) on an 80-ft spud barge positioned with a tugboat provided by Smith Shipyard, Inc. of Baltimore, Maryland. Findling, Inc. provided a drill rig that was placed on the barge to facilitate collection of the core samples.

A SPT SS sampler was used to collect samples and to measure the penetration resistance (N-value) of subsurface sediments. Rigid plastic core liners with an inner diameter of 3.0 inches were placed inside the SS sampler to obtain sediment samples. Target depths for the subsurface samples were 30 ft below the sediment/water interface or to the depth of native material.

Sediment cores were collected in 2-ft sections from the SS device. Cores collected during the project were field screened and processed onboard the barge. Core liners were opened and boring logs were completed for each core. Hydrophobic dye shaker tests were completed on subsamples from discrete 2-ft sections at each location (**Table 2-5**).

Using the information collected during the visual observations and hydrophobic dye shaker test, sediment was collected from the most impacted 2-ft section of sediment for laboratory analysis of metals (including mercury), VOCs, PAHs, cyanide, TOC, total solids, grain size, and moisture content (**Table 2-5**). Cores were sampled for VOC analysis using the Terra Core sampling method. VOC samples were collected from the core sample as soon as possible after collection, prior to sample homogenization. If no impacts were observed through the core, a 2-ft section was selected by the field crew for further chemical sampling, based on the depths at which impacted sediments were observed at adjacent sampling locations.

Following Terra Core sampling for VOCs, subsurface sediment was homogenized for physical and chemical analysis, placed into appropriate laboratory-cleaned containers using stainless steel spoons, and shipped via overnight delivery to TestAmerica–Pittsburgh on the day of collection. At locations 3A, 3E, 5, 10, 13C and 17, an additional sample was collected for PAH fingerprinting analysis (**Figure 2-4**).

The sample containers, preservatives, and holding time requirements for sediment samples are provided in **Appendix B**. Because the subsurface sediment was processed onboard the work boat, the holding time was initiated at sample collection. Sample-processing equipment that

came into direct contact with the sediment was decontaminated according to the protocols specified in **Section 2.4**.

### 2.3.4 *In-Situ* Water Quality Measurements

Water quality measurements were recorded *in situ* at sampling locations using a YSI water quality probe. Measurements were recorded at the surface, mid-depth, and bottom (one foot from the sediment / water interface) of the water column for the site water, surface sediment, and subsurface sediment phases of the sampling. The following parameters were recorded in the field log book:

- Sampling location number
- Sampling date and time
- Water depth
- Water temperature (degrees Celsius)
- Salinity (parts per thousand)
- pH
- Dissolved oxygen (milligrams per liter)
- Turbidity (nephelometric turbidity units [NTUs])

The water quality measurements recorded during the site water, surface sediment, and subsurface sediment sampling are presented in **Appendix B.**

## 2.4 EQUIPMENT DECONTAMINATION PROCEDURES

Equipment that was used for onshore and offshore sampling, but did not contact the sample (e.g., SS samplers), was steam cleaned or scrubbed with a non-phosphate detergent and rinsed prior to use. When blowing dust was a problem, equipment was covered with plastic sheeting during storage.

### 2.4.1 Soil Sampling Equipment

Non-dedicated soil sampling equipment (i.e., spoons, trowels, bowls, etc.) that contacted the sample was decontaminated prior to use in the field and between samples as described below:

- Scrub to remove gross (visible) contamination using appropriate brushes, potable water, and non-phosphate laboratory detergent (a detergent spray and steam cleaning may be substituted).
- Rinse off detergent with potable water.
- Rinse with acid solution (hydrochloric for non-stainless steel and nitric acid for stainless steel).
- Rinse with potable water.

- Rinse with pesticide-grade alcohol, isopropyl alcohol, or both.
- Triple rinse with de-ionized (DI) water.
- Allow to air dry.

If a sampler was not used immediately following decontamination, it was wrapped in one of the following: aluminum foil, clean plastic sheeting, or a new zip-seal bag (size permitting).

Electronic NAPL gauging indicators were decontaminated as follows:

- Spray with non-phosphate laboratory detergent.
- Rinse off detergent with DI water and wipe dry with clean towel.
- Spray with reagent grade alcohol.
- Spray with DI water.
- Coil on spool and allow to air dry.

### 2.4.2 Sediment Sampling Equipment

Equipment that came into direct contact with sediment during offshore surface and subsurface sampling was decontaminated prior to deployment in the field to minimize cross-contamination. This included core liners, core caps, stainless steel cutters, stainless steel catchers, stainless steel Van Veen grab sampler, and stainless steel processing equipment (spoons, knives, bowls, extruder, etc.). Nose cones and core catchers were reused in the field and were decontaminated onboard the sampling vessel between sampling locations. While performing the decontamination procedure, phthalate-free nitrile gloves were used to prevent phthalate contamination of the sampling equipment or the samples.

The decontamination procedure is described below:

- Rinse with site water
- Rinse with 10 percent nitric acid ($HNO_3$)
- Rinse with distilled or de-ionized water
- Rinse with methanol followed by hexane
- Rinse with distilled or de-ionized water
- Air dry (in area not adjacent to the decontamination area)

Waste liquids were contained during decontamination procedures and transferred to a 55-gal drum on board the barge.

## 2.5 SAMPLE LABELING, CHAIN-OF-CUSTODY, AND DOCUMENTATION

### 2.5.1 Field Logbook

Field notes were recorded in permanently bound, dedicated field logbooks and on field data sheets (**Appendix A**). Sampling coordinates, sample locations, water depths, *in situ* water quality, and any observed sheens or odors were also recorded in the log in indelible ink. Personnel names, local weather conditions, and other information were recorded daily. Similar appropriate information was recorded in the logbook as samples were processed and submitted to the laboratories for analyses. Each page of the logbook was numbered and dated by the personnel entering information. Corrections to documentation were made with a single line through the error with the author's initials and date.

Daily information recorded in the field logbook included:

- Work performed
- Sampling performed (specifics as to location, type of samples, log number)
- Field analyses performed including instrument checks and calibration
- Problems encountered and corrective actions taken (specifics regarding sampling problems and alternate sampling methods utilized)
- Quality control activities including descriptions of problems and corrective actions taken

Additional data sheets that were used include lithologic logs, well completion logs, and chain-of-custody records. Full copies of the project logbooks and data sheets are included in **Appendix A**.

### 2.5.2 Sample Numbering System

Field samples collected during this investigation were assigned a unique sample tracking number. Sample designation was an alpha-numeric code which identified each sample by the geographic area, matrix, location, and beginning sample depth. The matrix was identified by a one-to-three letter code.

The following is a guide for identification of collected onshore and offshore surface and subsurface samples, for example:

| **BP** | - | **SO** | - | **01** | - | **2** |
|---|---|---|---|---|---|---|
| Unique Area Identifier | | Sample Matrix | | Sample Location | | Beginning Sample Depth |

**Area Identifier**: BP = Benzol Processing Area
CT = Coal Tar Storage Area

**Matrix**:

| | | |
|---|---|---|
| SED | = | Sediment |
| SO | = | Soil |
| W | = | Surface Water |
| HSA | = | HSA Borehole Subsequently Abandoned |
| MW | = | HSA Borehole Completed as Monitoring Well |

**Sample Location**:

- For sediment and site water, consecutive numbers 01 to 18 were used. Locations 3 and 13 were transect locations and the sample location was followed by a letter (A, B, C etc.) to identify the location within the transect.
- For onshore samples, sampling locations were numbered consecutively from 01 to 11 for the combined Benzol Processing-Graving Dock Area and from 01 to 05 for the Coal Tar Storage Area.

**Depth**:

- For site water, S, M and D were used to indicate surface, mid-depth and deep, respectively.
- For subsurface and boring samples, the beginning depth from which the sample was collected was used.

***Field Quality Control Samples***

Soil and sediment duplicate samples, collected for quality assurance / quality control (QA/QC) purposes, were designated by the area designator followed by matrix and sequential duplicate number with a "DUP" prefix; for example, for the first Benzol Processing Area soil duplicate: BP-SO-DUP1. The location of the duplicate was recorded in field logbooks and on boring logs (for subsurface soil and sediment duplicates).

The sequential numbering convention was also used for designation of rinsate blanks. The prefix for rinsate blanks was "RB." For example, CT-SO-RB1 represents the first rinsate blank collected from soil sampling equipment used in the Coal Tar Storage Area investigation. Similarly, BH-SED-RB1 represents the first rinsate blank for equipment used to collect sediment in the offshore area.

Note that matrix spikes / matrix spike duplicates (MS/MSDs) are not separate samples, but rather additional aliquots of normal samples. As such, the additional aliquots to support MS/MSDs were labeled identically to the normal sample. However, a note was made on the chain-of-custody alerting the lab that additional sample volume was collected to allow for the analysis of an MS/MSD.

### 2.5.3 Sample Labeling

Sample containers were affixed with a sample label that was filled out at the time of collection. Information on the sample label included, at a minimum, the following:

- Client

- EA project number
- Site location
- Sample location
- Date and time of collection
- Name of sampler
- Sample preservative(s)

### 2.5.4 Chain-of-Custody Records

Samples collected in the field were documented on a COC sheet that included the date and time the sample was collected, the analyses requested, and the signatures of the personnel who collected and relinquished the samples. This COC accompanied all samples shipped for sample analyses. Copies of COCs for the onshore and offshore phases of the Sparrows Point Site Assessment are located in **Appendix B**.

### 2.5.5 Sample Packing and Shipping

Soil, surface sediment, subsurface sediment, water, and rinsate blanks were stored in an ice-filled cooler at the work site until the end of each sampling day. Samples for chemical analysis were packaged in bubble wrap, placed in an ice-filled cooler, and shipped via overnight delivery to the appropriate laboratory. Bubble wrap was used to line the bottom and sides of the sample cooler and fill voids where needed to cushion the sample containers during transportation. Cooler(s) were sealed, and a completed chain-of-custody record representing the packaged samples was be taped to the inside of the cooler lid.

Soil, sediment, and water samples collected for chemical analysis were sent directly to the following address:

TestAmerica–Pittsburgh
301 Alpha Dr.
RIDC Park
Pittsburgh, PA. 15238
(412) 963-7058
Attn: Sample Receiving

Soil and sediment samples collected for PAH fingerprinting analysis were sent directly to the following address:

META Environmental, Inc.
49 Clarendon Street
Watertown, MA 02472
(617) 923-4662
Attn: Sample Receiving

NAPL samples collected for NAPL physical properties analysis were sent directly to the following address:

PTS Laboratories
8100 Secura Way
Santa Fe Springs, CA 90670
(562) 347-2500
Attn: Rachel Spitz


Site Assessment for Proposed Coke Point Dredged Material Containment Facility at Sparrows Point

**Legend**

- Borehole Locations
- NAPL Monitoring Wells
- Area of Concern
- Coke Oven Area

Sources
ESRI, i-cubed, GeoEye, 2009
Tele Atlas North America Inc., ESRI, 2006

Feet
0 500 1,000

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H:\projects\1453406\MXD\2009_Report\Figure 2-1

**Figure 2-1. Location of Onshore Boreholes and NAPL Monitoring Wells, Benzol Processing Area, Coke Point Peninsula, Baltimore, Maryland**


# Site Assessment for Proposed Coke Point Dredged Material Containment Facility at Sparrows Point

**Legend**

- Borehole Locations
- Existing Monitoring Well
- NAPL Monitoring Wells
- Area of Concern

Sources
ESRI, i-cubed, GeoEye, 2009
Tele Atlas North America Inc., ESRI, 2006

N

Feet
0 250 500

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.


H:\projects\1453406\MXD\2009_Report\Figure 2-2

**Figure 2-2. Location of Onshore Boreholes and NAPL Monitoring Wells, Coal Tar Storage Area, Coke Point Peninsula, Baltimore, Maryland**

Site Assessment for Proposed Coke Point Dredged Material Containment Facility at Sparrows Point

**Legend**

Sampling Locations

Shallow Aquifer Groundwater Flow Direction

Area of Concern

Sources
ESRI, i-cubed, GeoEye, 2009
Tele Atlas North America Inc., ESRI, 2006

Feet
0 500 1,000

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.


H:\projects\1453406\MXD\2009_Report\Figure 2-3

**Figure 2-3. Location of Offshore Boreholes and Surface Water Sampling Locations, Coke Point Peninsula, Baltimore, Maryland**

Site Assessment for Proposed Coke Point Dredged Material Containment Facility at Sparrows Point

**Legend**

- Onshore Sampling Locations
- Offshore Sampling Locations
- PAH Fingerprint Samples
- Shallow Aquifer Groundwater Flow Direction
- Area of Concern

Sources
ESRI, i-cubed, GeoEye, 2009
Tele Atlas North America Inc., ESRI, 2006

Feet
0 500 1,000

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.

H:\projects\14534061MXD\2009_Report\Figure 2-4

**Figure 2-4. Location of Offshore and Onshore Environmental Forensics Sampling, Coke Point Peninsula, Baltimore, Maryland**

## Table 2-1. Onshore Investigation: Borings and Monitoring Well Locations

**Coke Point Peninsula, Sparrows Point Site Assessment (2009), Baltimore, Maryland**

| Location | Monitoring Well ID | Date | Completion Time | Sampling Coordinates (MD State Plane NAD83, ft) | | Water Depth (ft bgs) | Total Boring Depth (ft bgs) | Total Well Depth (ft bgs) | Top of Well Screen (ft bgs) | Bottom of Well Screen (ft bgs) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Northing | Easting | | | | | |
| **Benzol Processing and Graving Dock Areas** | | | | | | | | | | |
| BP-01 | borehole only | 5/20-21/09 | 0920 | 562756.277 | 1455104.630 | 7.5 | 24 | NA | NA | NA |
| BP-02S | BP-MW-02S | 5/28/2009 | 1256 | 562711.275 | 1455446.840 | 9 | 14 | 14.5 | 4 | 14 |
| BP-02D | BP-MW-02D | 5/26/2009 | 1130 | 562705.340 | 1455441.897 | 8 | 24.5 | 24.5 | 14 | 24 |
| BP-03 | borehole only | 5/19-20/09 | 1045 | 563183.012 | 1454761.631 | 5.5 | 36 | NA | NA | NA |
| BP-04 | BP-MW-04 | 5/22/2009 | 1055 | 562449.852 | 1455344.678 | 8 | 26.5 | 26.5 | 16 | 26 |
| BP-05 | BP-MW-05 | 5/27/2009 | 1409 | 562619.761 | 1455839.781 | 6 | 15 | 15 | 4 | 14 |
| BP-06 | BP-MW-06 | 6/11/2009 | 1055 | 562576.599 | 1455879.371 | 4.5 | 18 | 18 | 6 | 16 |
| BP-07 | BP-MW-07 | 6/11/2009 | 1515 | 562665.491 | 1455815.261 | 6.25 | 18 (Offset total) | 16 | 6 | 16 |
| BP-08 | BP-MW-08 | 6/15/2009 | 1110 | 562656.188 | 1455944.920 | 6.5 | 18 | 18 | 6 | 16 |
| BP-09 | BP-MW-09 | 6/15/2009 | 1510 | 562512.736 | 1455771.461 | 8.5 | 20 | 20 | 8 | 18 |
| BP-10 | BP-MW-10 | 6/19/2009 | 1345 | 562725.238 | 1456035.290 | 7.5 | 18 | 18 | 4 | 14 |
| BP-11 | BP-MW-11 | 6/22/2009 | 1410 | 562842.578 | 1456189.447 | 6.5 | 18 | 16 | 4 | 14 |
| **Coal Tar Storage Area** | | | | | | | | | | |
| CT-01 | CT-MW-01 | 6/2/2009 | 1316 | 561624.282 | 1457351.212 | 9 | 24 (Offset total) | 24 | 13.5 | 23.5 |
| CT-02 | borehole only | 6/8/2009 | 1421 | 561825.293 | 1457610.153 | 9.5 | 22 (Offset total) | NA | NA | NA |
| CT-03 | borehole only | 5/29/2009 | 1500 | 561879.584 | 1457845.413 | 10 | 26 | NA | NA | NA |
| CT-04 | borehole only | 6/4/2009 | 1209 | 561864.072 | 1457350.333 | 9 | 22 (Offset total) | NA | NA | NA |
| CT-05 | CT-MW-05 | 6/9/2009 | 1419 | 561908.793 | 1457457.335 | 9 | 22 | 22 | 10 | 20 |

(a) coordinates recorded only for location where monitoring well was installed

**ft bgs** = feet below ground surface

**BP**=Benzol Processing and Graving Dock Areas

**CT**=Coal Tar Storage Area

**HSA**=hollow stem auger

**MW**=monitoring well

## Table 2-2. Onshore Investigation: Field Screening Results and Analytical Sample Program

**Coke Point Peninsula, Sparrows Point Site Assessment (2009), Baltimore, Maryland**

| Location | Date | Sample Time | Sample ID | Sample Interval (ft bgs) | Sudan IV Screening | PID Screening (ppm) | ANALYTICAL PROGRAM | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Metals, PAHs, VOCs, and Cyanide | PAHs and VOCs | Total Organic Carbon | PAH Fingerprinting | NAPL fluid properties |
| **Soils from Benzol Processing and Graving Dock Areas** | | | | | | | | | | | |
| BP-01 | 5/20/2009 | 1530 | BP-SO-B01-8 | 8-10 | NEGATIVE | 1,010 | X | | | | |
| | 5/21/2009 | 0900 | BP-SO-B01-14 | 14-16 | TRACE | > 10,000 | X | | | | |
| | 5/21/2009 | 930 | BP-SO-B01-20 | 20-22 | NEGATIVE | 540 | X | | | | |
| BP-02D | 5/22/2009 | 1245 | BP-SO-B02-08 | 8-10 | -- | >10,000 | X | | | | |
| | 5/22/2009 | 1345 | BP-SO-B02-14 | 14-16 | NEGATIVE | >10,000 | X | | | | |
| | 5/22/2009 | 1410 | BP-SO-B02-20 | 20-22 | NEGATIVE | >10,000 | | | | | |
| BP-02S | 5/28/2009 | 0930 | BP-SO-B02S-8 | 8-10 | TRACE | >10,000 | X | | | X | |
| BP-03 | 5/19/2009 | 1410 | BP-SO-B03-04 | 4-6 | -- | 1.7 | X | | | | |
| | 5/19/2009 | 1520 | BP-SO-B03-12 | 12-14 | NEGATIVE | 261 | X | | | | |
| | 5/19/2009 | 1545 | BP-SO-B03-18 | 18-20 | -- | 8.9 | | | | X | |
| | 5/20/2009 | 1120 | BP-SO-B03-32 | 32-34 | NEGATIVE | 42.5 | X | | | | |
| BP-04 | 5/21/2009 | 1230 | BP-SO-B04-10 | 10-12 | NEGATIVE | 2,464 | X | | | | |
| | 5/21/2009 | 1510 | BP-SO-B04-16 | 16-18 | -- | 5,648 | X | | | | |
| | 5/22/2009 | 0820 | BP-SO-B04-24 | 24-26 | -- | 176 | X | | | | |
| BP-05 | 6/23/2009 | -- | BP-HSA-05 0-2 | 0-2 | -- | -- | | | X | | |
| | 5/27/2009 | 920 | BP-SO-B05-06 | 6-8 | POSITIVE | >10,000 | | | | X | |
| | 5/27/2009 | 0945 | BP-SO-B05-08 | 8-10 | POSITIVE | >10,000 | X | | | | |
| | 5/27/2009 | 1050 | BP-SO-B05-14 | 14-16 | NEGATIVE | 2,035 | X | | | | |
| | 6/24/2009 | -- | BP-HSA-05 14-16 | 14-16 | -- | -- | | | | | X |
| | 5/27/2009 | 1045 | BP-SO-B05-20 | 20-22 | NEGATIVE | 1,090 | X | | | | |
| BP-06 | 6/11/2009 | 0815 | BP-SO-B06-8 | 8-10 | NEGATIVE | 9,999 | X | | | | |
| | 6/11/2009 | 0900 | BP-SO-B06-12 | 12-14 | POSITIVE | >10,000 | X | | | | |
| | 6/11/2009 | 0940 | BP-SO-B06-16 | 16-18 | -- | 1,749 | X | | | | |
| BP-07 | 6/11/2009 | 1330 | BP-SO-B07-12 | 12-14 | POSITIVE | >10,000 | X | | | | |
| BP-08 | 6/15/2009 | 0900 | BP-SO-B08-6 | 6-8 | -- | 928 | X | | | | |
| | 6/15/2009 | 0950 | BP-SO-B08-10 | 10-12 | NEGATIVE | 8,590 | X | | | | |
| | 6/15/2009 | 1030 | BP-SO-B08-16 | 16-18 | -- | 2,018 | X | | | | |
| BP-09 | 6/15/2009 | 1230 | BP-SO-B09-8 | 8-10 | -- | 20.8 | X | | | | |
| | 6/15/2009 | 1330 | BP-SO-B09-14 | 14-16 | NEGATIVE | >10,000 | X | | | | |
| | 6/15/2009 | 1400 | BP-SO-B09-18 | 18-20 | -- | 3,569 | X | | | | |
| BP-10 | 6/19/2009 | 1020 | BP-SO-B10-4 | 4-6 | -- | 7.1 | X | | | | |
| BP-11 | 6/22/2009 | 1330 | BP-SO-B11-4 | 4-6 | -- | 1.9 | X | | | | |

**ft bgs** = feet below ground surface

NA = not applicable

-- = screening not conducted at this depth interval

**Table 2-2. (continued)**

| Location | Date | Sample Time | Sample ID | Sample Interval (ft bgs) | Sudan IV Screening | PID Screening (ppm) | ANALYTICAL PROGRAM | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Metals, PAHs, VOCs, and Cyanide | PAHs and VOCs | Total Organic Carbon | PAH Fingerprinting | NAPL fluid properties |
| **Soils from Coal Tar Storage Area** | | | | | | | | | | | |
| CT-01 | 6/2/2009 | 0915 | CT-SO-B01-10 | 10-12 | -- | 2.5 | X | | | | |
| | 6/2/2009 | 1100 | CT-SO-B01-14 | 14-16 | -- | 26.7 | X | | | | |
| | 6/2/2009 | 1030 | CT-SO-B01-18 | 18-20 | NEGATIVE | 1,460 | X | | | X | |
| CT-02 | 6/8/2009 | 1320 | CT-SO-B02-12 | 12-14 | -- | 0.0 | X | | | | |
| | 6/8/2009 | 1400 | CT-SO-B02-16 | 16-18 | -- | 20.7 | X | | | | |
| | 6/8/2009 | 1420 | CT-SO-B02-20 | 20-22 | -- | 90 | X | | | | |
| CT-03 | 5/29/2009 | 1300 | CT-SO-B03-10 | 10-12 | -- | 0.0 | X | | | | |
| | 5/29/2009 | 1430 | CT-SO-B03-20 | 20-22 | -- | 47.4 | X | | | | |
| | 5/29/2009 | 1500 | CT-SO-B03-22 | 22-24 | -- | 18.0 | X | | | | |
| CT-04 | 6/24/2009 | -- | CT-HSA-04 6-8 | 6-8 | -- | -- | | | | | X |
| | 6/4/2009 | 1110 | CT-SO-B04-10 | 10-12 | -- | 0.0 | X | | | | |
| | 6/4/2009 | 1230 | CT-SO-B04-14 | 14-16 | -- | 0.0 | X | | | | |
| | 6/4/2009 | 1210 | CT-SO-B04-18 | 18-20 | -- | 37.1 | X | | | | |
| CT-05 | 6/9/2009 | 1120 | CT-SO-B05-8 | 8-10 | -- | 0 | X | | | | |
| | 6/24/2009 | -- | CT-HSA-05 10-12 | 10-12 | -- | -- | | | | | |
| | 6/9/2009 | 1215 | CT-SO-B05-16 | 16-18 | -- | 3.5 | X | | | | |
| | 6/9/2009 | 1230 | CT-SO-B05-20 | 20-22 | NEGATIVE | 98.3 | X | | | X | |
| **NAPL Sampling from Monitoring Wells** | | | | | | | | | | | |
| BP-05 | 6/23/2009 | 1000 | BP-MW-5 | -- | -- | -- | | X | | | X |
| BP-08 | 6/23/2009 | 1140 | BP-MW-8 | -- | -- | -- | | X | | | X |
| CO13-PZM-008 | 6/23/2009 | 1330 | CO13-PZM-008 | -- | -- | -- | | X | | | X |

**ft bgs** = feet below ground surface

NA = not applicable

-- = screening not conducted at this depth interval

**Table 2-3. Offshore Investigation: Site Water Sampling Locations**

**Coke Point Peninsula, Sparrows Point Site Assessment (2009), Baltimore, Maryland**

| Location | Sampling Coordinates (MD State Plane NAD83, ft) | | Water Depth (ft MLW) | Date | Time | Water Sample IDs |
|---|---|---|---|---|---|---|
| | Northing | Easting | | | | |
| 1 | 563450.96 | 1455289.15 | 21.2 | 2/2/2009 | 1105 | BH-W-01-S |
| | | | | 2/2/2009 | 1110 | BH-W-01-M |
| | | | | 2/2/2009 | 1115 | BH-W-01-D |
| 2 | 563044.48 | 1454180.58 | 7.2 | 2/2/2009 | 1150 | BH-W-02-S |
| | | | | 2/2/2009 | 1155 | BH-W-02-M |
| | | | | 2/2/2009 | 1200 | BH-W-02-D |
| 3A | 562260.41 | 1453767.77 | 2.2 | 2/2/2009 | 1225 | BH-W-03A-S |
| | | | | 2/2/2009 | 1230 | BH-W-03A-M |
| | | | | 2/2/2009 | 1235 | BH-W-03A-D |
| 3B | 562245.83 | 1453677.43 | 10.8 | 2/2/2009 | 1330 | BH-W-03B-S |
| | | | | 2/2/2009 | 1335 | BH-W-03B-M |
| | | | | 2/2/2009 | 1340 | BH-W-03B-D |
| 3C | 562222.17 | 1453530.73 | 13.4 | 2/2/2009 | 1400 | BH-W-03C-S |
| | | | | 2/2/2009 | 1405 | BH-W-03C-M |
| | | | | 2/2/2009 | 1410 | BH-W-03C-D |
| 4 | 561529.43 | 1454106.67 | 9.6 | 2/2/2009 | 1440 | BH-W-04-S |
| | | | | 2/2/2009 | 1445 | BH-W-04-M |
| | | | | 2/2/2009 | 1450 | BH-W-04-D |
| 5 | 561510.98 | 1454975.05 | 3.7 | 2/2/2009 | 1510 | BH-W-05-S |
| | | | | 2/2/2009 | 1515 | BH-W-05-M |
| | | | | 2/2/2009 | 1520 | BH-W-05-D |
| 6 | 560624.10 | 1454346.86 | 13.1 | 2/3/2009 | 1000 | BH-W-06-S |
| | | | | 2/3/2009 | 1005 | BH-W-06-M |
| | | | | 2/3/2009 | 1010 | BH-W-06-D |
| 7 | 559977.43 | 1454818.01 | 12.4 | 2/3/2009 | 1030 | BH-W-07-S |
| | | | | 2/3/2009 | 1035 | BH-W-07-M |
| | | | | 2/3/2009 | 1040 | BH-W-07-D |
| 8 | 559376.96 | 1455381.53 | 12.5 | 2/3/2009 | 1100 | BH-W-08-S |
| | | | | 2/3/2009 | 1105 | BH-W-08-M |
| | | | | 2/3/2009 | 1110 | BH-W-08-D |
| 9 | 559672.57 | 1456425.44 | 9.1 | 2/3/2009 | 1130 | BH-W-09-S |
| | | | | 2/3/2009 | 1135 | BH-W-09-M |
| | | | | 2/3/2009 | 1140 | BH-W-09-D |
| 10 | 559644.86 | 1457580.20 | 7.1 | 2/3/2009 | 1225 | BH-W-10-S |
| | | | | 2/3/2009 | 1230 | BH-W-10-M |
| | | | | 2/3/2009 | 1235 | BH-W-10-D |
| 11 | 560125.24 | 1458365.44 | 12.6 | 2/3/2009 | 1300 | BH-W-11-S |
| | | | | 2/3/2009 | 1305 | BH-W-11-M |
| | | | | 2/3/2009 | 1310 | BH-W-11-D |
| 12 | 561196.86 | 1458365.44 | 18.1 | 2/3/2009 | 1320 | BH-W-12-S |
| | | | | 2/3/2009 | 1325 | BH-W-12-M |
| | | | | 2/3/2009 | 1330 | BH-W-12-D |
| 13A | 561994.86 | 1458115.43 | 6.0 | 2/3/2009 | 1345 | BH-W-13A-S |
| | | | | 2/3/2009 | 1350 | BH-W-13A-M |
| | | | | 2/3/2009 | 1355 | BH-W-13A-D |
| 13B | 562013.35 | 1458202.78 | 19.2 | 2/3/2009 | 1405 | BH-W-13B-S |
| | | | | 2/3/2009 | 1410 | BH-W-13B-M |
| | | | | 2/3/2009 | 1415 | BH-W-13B-D |
| 13C | 562044.68 | 1458350.81 | 31.8 | 2/3/2009 | 1445 | BH-W-13C-S |
| | | | | 2/3/2009 | 1450 | BH-W-13C-M |
| | | | | 2/3/2009 | 1455 | BH-W-13C-D |
| 14 | 562711.91 | 1458282.29 | 23.9 | 2/3/2009 | 1510 | BH-W-14-S |
| | | | | 2/3/2009 | 1515 | BH-W-14-M |
| | | | | 2/3/2009 | 1520 | BH-W-14-D |

## Table 2-4. Offshore Investigation: Surface Sediment Sampling Locations

**Coke Point Peninsula, Sparrows Point Site Assessment (2009), Baltimore, Maryland**

| Location | Sampling Coordinates (MD State Plane NAD83, ft) | | Date | Time | Water Depth (ft MLW) | Surface Sediment Sample IDs | ANALYTICAL PROGRAM | |
|---|---|---|---|---|---|---|---|---|
| | Northing | Easting | | | | | metals, cyanide, grain size, VOCs, PAHs, total organic carbon | PAH Fingerprinting |
| 1 | 563445.1 | 1455268.7 | 2/6/2009 | 1015 | 23.5 | BH-SED-01-00 | X | |
| 2 | 563027.4 | 1454157.2 | 2/6/2009 | 1115 | 8.3 | BH-SED-02-00 | X | |
| 3A | 562236.4 | 1453695.3 | 2/6/2009 | 1200 | 10.0 | BH-SED-03A-00 | X | X |
| 3B | 562235.9 | 1453617.7 | 2/6/2009 | 1300 | 13.4 | BH-SED-03B-00 | X | |
| 3C | 562184.3 | 1453486.8 | 2/6/2009 | 1330 | 14.4 | BH-SED-03C-00 | X | |
| 4 | 561559.6 | 1454108.6 | 2/6/2009 | 1400 | 8.7 | BH-SED-04-00 | X | |
| 5 | 561518.1 | 1454980.1 | 2/6/2009 | 1430 | 4.8 | BH-SED-05-00 | X | |
| 6 | 560632.0 | 1454363.6 | 2/9/2009 | 1015 | 12.7 | BH-SED-06-00 | X | |
| 7 | 560004.5 | 1454829.1 | 2/9/2009 | 1045 | 11.0 | BH-SED-07-00 | X | |
| 8 | 559372.0 | 1455401.4 | 2/9/2009 | 1110 | 12.6 | BH-SED-08-00 | X | |
| 9 | 559658.9 | 1456424.0 | 2/9/2009 | 1155 | 9.9 | BH-SED-09-00 | X | |
| 10 | 559620.3 | 1457565.3 | 2/9/2009 | 1215 | 8.1 | BH-SED-10-00 | X | |
| 11 | 560114.5 | 1458360.9 | 2/9/2009 | 1240 | 12.8 | BH-SED-11-00 | X | |
| 12 | 561204.2 | 1458361.3 | 2/9/2009 | 1305 | 16.4 | BH-SED-12-00 | X | |
| 13A | 562009.0 | 1458142.9 | 2/9/2009 | 1355 | 10.6 | BH-SED-13A-00 | X | |
| 13B | 562048.0 | 1458214.7 | 2/9/2009 | 1440 | 22.4 | BH-SED-13B-00 | X | |
| 13C | 562094.9 | 1458372.3 | 2/9/2009 | 1505 | 29.2 | BH-SED-13C-00 | X | |
| 14 | 562730.4 | 1458318.0 | 2/9/2009 | 1525 | 24.6 | BH-SED-14-00 | X | |
| REFERENCE* | 565840.7 | 1448015.6 | 2/9/2009 | 1610 | 17.1 | REFERENCE | | X |

* Reference for PAH fingerprint analysis only

**Table 2-5. Offshore Investigation: Subsurface Sediment Field Screening Results and Analytical Program**

**Coke Point Peninsula, Sparrows Point Site Assessment (2009), Baltimore, Maryland**

| Location | Sample Date | Sample Time | Sampling Coordinates (MD State Plane NAD83, ft) | | Depth to Sediment (ft MLW) | Depth to Bottom of Core (ft MLW) | Sample ID | Sample Interval (ft bgs) | Sudan IV Screening | PID Screening (ppm) | ANALYTICAL PROGRAM | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Northing | Easting | | | | | | | metals, cyanide, grain size, VOCs, PAHs | Total Organic Carbon | PAH Fingerprinting |
| BH-SED-01 | 2/16/2009 | 1630 | 563423.1 | 1455326.4 | 21.9 | 51.9 | BH-SED-01-8 | 8-10 | POSITIVE in 2-ft interval above and below | 0.0 | X | X | |
| BH-SED-02 | 2/19/2009 | 1150 | 563017.7 | 1454165.9 | 8.4 | 32.4 | BH-SED-02-4 | 4-6 | POSITIVE | 8.4 | X | | |
| | | 1155 | | | | | BH-SED-02-TOC | 22-24 | -- | 13.0 | | X | |
| BH-SED-03A | 2/25/2009 | 1100 | 562223.9 | 1453743.6 | 5.5 | 29.5 | BH-SED-03A-12 | 12-14 | -- | 0.0 | X | | X |
| | | 1105 | | | | | BH-SED-03A-TOC | 16-18 | -- | 0.0 | | X | |
| BH-SED-03B | 2/17/2009 | 1250 | 562217.2 | 1453680.5 | 10.9 | 30.9 | BH-SED-03B-2 | 2-4 | POSITIVE | 0.4 | X | X | |
| BH-SED-03C | 2/17/2009 | 1030 | 562223.3 | 1453539.0 | 14.8 | 34.9 | BH-SED-03C-02 | 2-4 | -- | 5.0 | X | X | |
| BH-SED-03D | 3/11/2009 | 1300 | 562168.5 | 1453293.3 | 15.8 | 37.8 | BH-SED-03D-2 | 2-4 | -- | 0.0 | X | | |
| | | 1305 | | | | | BH-SED-03D-TOC | 20-22 | -- | 0.0 | | X | |
| BH-SED-03E | 3/9/2009 | 1030 | 562068.6 | 1452779.2 | 17.6 | 37.6 | BH-SED-03E-2 | 2-4 | NEGATIVE | 0.0 | X | | X |
| | | 1035 | | | | | BH-SED-03E-TOC | 18-20 | -- | 0.0 | | X | |
| BH-SED-04 | 3/4/2009 | 1555 | 561520.1 | 1454086.0 | 12 | 36.0 | BH-SED-04-8 | 8-10 | NEGATIVE | 0.0 | X | | |
| | | 1600 | | | | | BH-SED-04-TOC | 22-24 | -- | 0.0 | | X | |
| BH-SED-05 | 3/4/2009 | 1340 | 561501.4 | 1454974.8 | 6.9 | 32.9 | BH-SED-05-4 | 4-6 | NEGATIVE | 0.0 | X | | X |
| | | 1345 | | | | | BH-SED-05-TOC | 24-26 | -- | 0.0 | | X | |
| BH-SED-06 | 2/17/2009 | 1450 | 560619.9 | 1454343.1 | 14.6 | 34.6 | BH-SED-06-6 | 6-8 | NEGATIVE | 220.0 | X | X | |
| BH-SED-07 | 3/5/2009 | 1025 | 559977.6 | 1454829.4 | 13.4 | 33.4 | BH-SED-07-6 | 6-8 | NEGATIVE | 0.0 | X | | |
| | | 1030 | | | | | BH-SED-07-TOC | 18-20 | -- | 0.0 | | X | |
| BH-SED-08 | 3/5/2009 | 1300 | 559401.1 | 1455394.6 | 9.7 | 29.7 | BH-SED-08-10 | 10-12 | NEGATIVE | 0.0 | X | | |
| | | 1305 | | | | | BH-SED-08-TOC | 18-20 | -- | 0.0 | | X | |
| BH-SED-09 | 2/26/2009 | 1530 | 559693.4 | 1456419.9 | 10.8 | 40.8 | BH-SED-09-12 | 12-14 | -- | 0.0 | X | | |
| | | 1550 | | | | | BH-SED-09-TOC | 28-30 | -- | 0.0 | | X | |
| BH-SED-10 | 2/24/2009 | 1320 | 559629.1 | 1457583.5 | 9.1 | 39.1 | BH-SED-10-2 | 2-4 | Inconclusive | 0.0 | X | | X |
| | | 1300 | | | | | BH-SED-10-TOC | 24-26 | -- | 0.0 | | X | |
| BH-SED-11 | 2/24/2009 | 1600 | 560106.7 | 1458348.4 | 13.1 | 43.1 | BH-SED-11-2 | 2-4 | NEGATIVE | 0.0 | X | | |
| | | 1515 | | | | | BH-SED-11-TOC | 20-22 | NEGATIVE | 0.0 | | X | |
| BH-SED-12 | 2/13/2009 | 1410 | 561186.0 | 1458355.7 | 14.1 | 40.1 | BH-SED-12-4 | 4-6 | -- | 0.0 | X | X | |
| BH-SED-13A | 2/25/2009 | 1415 | 562005.3 | 1458136.3 | 9.4 | 39.4 | BH-SED-13A-6 | 6-8 | -- | 0.0 | X | | |
| | | 1346 | | | | | BH-SED-13A-TOC | 24-26 | -- | 0.0 | | X | |
| BH-SED-13B | 2/26/2009 | 1105 | 562022.9 | 1458169.3 | 17.9 | 43.9 | BH-SED-13B-8 | 8-10 | -- | 0.0 | X | | |
| | | 1110 | | | | | BH-SED-13B-TOC | 24-26 | -- | 0.0 | | X | |
| BH-SED-13C | 3/4/2009 | 1045 | 562169.2 | 1458141.2 | 12.6 | 34.6 | BH-SED-13C-6 | 6-8 | -- | 0.0 | X | | X |
| | | 1050 | | | | | BH-SED-13C-TOC | 20-22 | -- | 0.0 | | X | |
| BH-SED-14 | 2/26/2009 | 1310 | 562720.8 | 1458291.8 | 24.5 | 44.5 | BH-SED-14-8 | 8-10 | -- | 0.0 | X | | |
| | | 1315 | | | | | BH-SED-14-TOC | 16-18 | -- | 0.0 | | X | |
| BH-SED-15 | 3/11/2009 | 1100 | 561632.1 | 1458222.3 | 20.1 | 44.1 | BH-SED-15-2 | 2-4 | NEGATIVE | 0.0 | X | | |
| | | 1105 | | | | | BH-SED-15-TOC | 22-24 | -- | 0.0 | | X | |
| BH-SED-16 | 3/12/2009 | 1005 | 562957.6 | 1453211.1 | 15.9 | 25.9 | BH-SED-16-0 | 0-2 | NEGATIVE | 0.0 | X | | |
| | | 1010 | | | | | BH-SED-16-TOC | 4-6 | -- | 0.0 | | X | |
| BH-SED-17 | 3/10/2009 | 1020 | 562900.1 | 1452711.1 | 16.6 | 46.6 | BH-SED-17-0 | 0-2 | NEGATIVE | 0.0 | X | | X |
| | | 1030 | | | | | BH-SED-17-TOC | 24-26 | -- | 0.0 | | X | |
| BH-SED-18 | 3/10/2009 | 1250 | 560876.8 | 1453193.8 | 18.2 | 46.2 | BH-SED-18-0 | 0-2 | NEGATIVE | 0.0 | X | | |
| | | 1305 | | | | | BH-SED-18-TOC | 24-26 | -- | 0.0 | | X | |

# 3. RESULTS OF THE ONSHORE INVESTIGATION

Previously observed impacts to groundwater indicate the presence of potential sources (such as NAPL and/or sorbed constituents) within regions of the Benzol Processing Area, Coal Tar Storage Area, and possibly the Graving Dock Area (URS 2005a, 2006). Borehole locations for this study were selected based on groundwater concentrations reported in earlier studies that exceeded 10 percent solubility of benzene and naphthalene in water, which is indicative of the probable presence of NAPL. Historical groundwater data indicated that NAPL-impacted slag fill material was the primary source of organic constituents in groundwater; therefore, borehole depths were targeted to investigate fill within the suspected source areas. The onshore investigation was focused on delineation of source impacts; an overall characterization of soil quality was not an objective of the sampling program.

The purpose and objective of the onshore investigation was to detect, delineate, and characterize the chemical and physical properties of NAPL and adsorbed constituents within the Benzol Processing Area, the Coal Tar Storage Area, and to a lesser extent the Graving Dock Area. Therefore, the investigation was targeted at identifying and characterizing impacted areas that potentially contribute to observed groundwater plumes.

## 3.1 GROUNDWATER DATA

Groundwater chemistry data for the Sparrows Point Site were provided by URS in the Nature and Extent (N&E) report (URS 2005a) and the response to regulatory comments for this document (URS 2006). Sampling for the N&E report was conducted in January 2002 and July 2004. Below is a summary of data findings.

Impacted groundwater samples, collected using piezometers, were found in two depth ranges, designated as the shallow and intermediate aquifers. In the name of each sample, the last number designates the depth of the piezometer used to collect it. Shallow aquifer samples were collected from the unconfined groundwater contained in the slag fill material, which is approximately 30 feet thick on average. The intermediate aquifer is composed of native sandy soil of the Pleistocene upper Talbot formation, averages approximately 40 feet thick, and is hydraulically interconnected to the shallow aquifer, but at times discontinuously separated from it by the Talbot Clay aquitard. Samples were also collected from a "lower groundwater zone", generally in the lower Talbot formation, but these groundwater samples were not found to be impacted.

### 3.1.1 Volatile Organic Compounds

***Benzol Processing and Graving Dock Areas*** – The previous groundwater investigation indicated that a highly concentrated plume of VOCs is present in groundwater within and to the west of the Benzol Processing and Graving Dock Areas. Benzene is the most abundant VOC (up to 790,000 µg/L), followed by toluene (up to 71,000 µg/L), total xylenes (up to 6,400 µg/L), and ethylbenzene (up to 1,200 µg/L). Benzene isoconcentration contours for the shallow and intermediate aquifers are shown in **Figures 3-1 and 3-2**, respectively. The benzene appears to originate in and around the Benzol Processing Area, and the plume extends to the north/northwest toward the graving dock and to the south/southwest toward the shoreline. These

areas exhibit benzene concentrations far above the MDE groundwater cleanup standard of 5 µg/L (MDE 2008).

Maximum concentrations observed along the shoreline exist in the Graving Dock Area and are in the range of 10,000-50,000 µg/L in the shallow aquifer, and 350,000-390,000 µg/L in the intermediate aquifer. Previous work inferred that the high benzene concentrations in the groundwater of this area, which are in excess of 10 percent solubility of benzene in water (>100 mg/L), result from induced gradients due to graving dock pumping (URS 2006). These gradients drew impacted water to the northwest from the Benzol Processing Area.

***Coal Tar Storage Area*** – Small, isolated areas of benzene over 1,000 µg/L occur in shallow groundwater in proximity to the eastern shoreline within the Coal Tar Storage Area (**Figure 3-1**). However, constituents such as benzene are present at concentrations no higher than 3,000 µg/L, which is two orders of magnitude lower than source concentrations in the Benzol Processing Area. Areas of benzene in groundwater appear to correlate with areas containing naphthalene (and other PAHs). Maximum benzene concentration adjacent to the Turning Basin shoreline reaches approximately 500 µg/L. As indicated by the presence of VOCs and PAHs, the chemical signature of the dissolved phase plume in this area is suggestive of a coal tar source.

### 3.1.2 Polycyclic Aromatic Hydrocarbons

***Benzol Processing and Graving Dock Areas*** – The previous groundwater investigation indicated that naphthalene was the most abundant PAH (up to 4,800 µg/L), followed by 2-methylnapthalene (230 µg/L) and phenanthrene (up to 35 µg/L). **Figures 3-3 and 3-4** show naphthalene isoconcentration contours above 1,000 µg/L within the shallow and intermediate aquifers. Naphthalene above this concentration was detected within the shallow aquifer immediately west-southwest of the Benzol Processing Area and within the intermediate aquifer in the Graving Dock Area.

***Coal Tar Storage Area*** – The highest PAH concentrations occurred in the shallow aquifer, in the vicinity of the Coal Tar Storage Area. Groundwater naphthalene concentrations exceeded 10,000 µg/L in the shallow aquifer (**Figure 3-3**); well CO13-PZM-008 showed the highest dissolved naphthalene concentration (22,000 µg/L). The naphthalene plume originating in this area occurs primarily within the limits of the Coal Tar Storage Area, with substantial concentrations (up to 5,700 µg/L) occurring along the eastern shoreline adjacent to the Turning Basin. Some naphthalene (up to ~3,000 µg/L) was also detected in the intermediate aquifer beneath the Coal Tar Storage Area. The MDE groundwater cleanup standard for naphthalene is 0.65 µg/L (MDE 2008).

### 3.1.3 Metals

The N&E report (URS 2005a) shows that arsenic, lead, and vanadium concentrations were elevated above MDE groundwater standards (MDE 2008) in the groundwater beneath the Benzol Processing Area and the Coal Tar Storage Areas. Comparison of total to dissolved metal concentrations indicates that lead is particle-associated, while arsenic and vanadium are present in the dissolved phase.

***Benzol Processing and Graving Dock Areas*** – The previous groundwater investigation indicated that high levels of lead and vanadium occurred within the Benzol Processing Area, especially in the shallow aquifer, while arsenic concentrations were highest in the intermediate aquifer downgradient, along the northwest shore of the Peninsula.

The area of lead concentrations elevated above the MDE standard of (15 µg/L) is roughly confined to the boundaries of the Benzol Processing Area and to the shallow aquifer, with slightly elevated lead concentrations also observed in the natural aquifer underlying the fill material. All monitoring wells within 300 feet of the shoreline, downgradient of the Benzol Processing Area, showed lead concentrations in groundwater below the MDE standard.

High vanadium concentrations (up to 538 µg/L) were also measured in the shallow aquifer near the southern boundary of the Benzol Processing Area, with an apparent plume spreading to the southwest. Vanadium has an MDE groundwater standard of 3.7 µg/L, and is a good tracer of hydrocarbon impacts.

Arsenic concentrations above the MDE groundwater standard (10 µg/L) occurred primarily in the intermediate aquifer underlying the slag fill material in the area west of the Benzol Processing Area and in the Graving Dock Area. The maximum total arsenic concentration measured was 194 µg/L.

***Coal Tar Storage Area –*** Slightly elevated lead and arsenic concentrations were seen in the shallow and intermediate aquifers near the Coal Tar Storage Area. The maximum concentrations observed for lead and arsenic were 39 µg/L and 22 µg/L respectively.

The highest concentrations of vanadium measured were in the shallow aquifer below the Coal Tar Storage Area, at concentrations up to 3,370 µg/L. Lower vanadium concentrations, still exceeding the MDE standard, also extended into the intermediate aquifer in this area.

## 3.2 RESULTS OF FIELD SCREENING

Field screening was used as a real-time indicator of the presence or absence of NAPL in subsurface material within each borehole. Because the drilling program was focused on finding highly impacted areas, field screening was an effective way to determine specific depths to collect soil samples, along with locations to install wells where mobile NAPL may be present.

***Benzol Processing and Graving Dock Areas*** – Results of the field screening from the Benzol Processing Area borehole logs (**Appendix A**) are summarized in **Table 3-1**. Positive dye tests and/or visual identification confirmed the presence of at least residual NAPL in five borings (at locations BP-01, BP-02, BP-05, BP-06, and BP-07). Elevated PID readings (near or above 10,000 ppm) were measured at various intervals in most of the boreholes, which is consistent with the historical processing and handling of highly volatile mono aromatic hydrocarbons (MAHs) such as benzene, ethylbenzene, and toluene in the area. Positive dye tests and/or visible sheens were noted at or near the water table depth in borings at BP-02, BP-05, BP-06, and BP-07. The NAPL depths were consistent with the probable presence of floating product

(LNAPL) and with smear zones caused by water table fluctuation. Field screening of subsurface samples in the Graving Dock Area (BP-03) did not find evidence of NAPL.

***Coal Tar Storage Area*** – Field screening results from the Coal Tar Storage Area indicated the presence of residual (or sorbed) NAPL in each of the five borings except at location CT-04 (**Table 3-2**). For all borings, none of the dye tests were positive; however, sheens on the soil, split spoon, and/or acetate liner in four of the five boreholes were definitive indicators of residual (or entrapped) NAPL within specific intervals (generally 18 to 24 ft below ground surface) toward the bottom of the holes. The relatively low PID readings even where sheens were noted could have resulted from the low volatility of the NAPL in this area (i.e., PAHs within coal tar), limitations of the PID with regard to PAHs (e.g. ionization potential), and/or the loss of volatile MAHs over time as the NAPL ages. The depth at which NAPL was encountered in the boreholes was consistent with the properties of coal tar, which is denser than water.

## 3.3 CHEMICAL ANALYSES OF FILL MATERIAL

Samples were collected from fill material in each of the boreholes within the two onshore investigation areas. Samples collected during drilling activities were analyzed for VOCs, PAHs, and metals at a fixed laboratory. Analytical methods, detection limits, and definitions of data qualifiers are provided in **Appendix B**, and data sheets and QA/QC results are included in **Attachment I**. In data tables, bolded values represent detected chemical constituents and shaded values exceed MDE protection of groundwater soil cleanup standards (MDE 2008). Results are summarized below.

### 3.3.1 Volatile Organic Compounds

***Benzol Processing and Graving Dock Areas*** – Benzene, toluene, and ethylbenzene were the only VOCs detected in slag fill material samples from the Benzol Processing Area (**Table 3-3**). Each of these MAHs was detected at concentrations exceeding the protection of groundwater soil cleanup standard in several of the samples (MDE 2008). Benzene and toluene were also detected in the Graving Dock Area, but at much lower concentrations than in Benzol Processing Area samples. The benzene cleanup standard is four orders of magnitude lower than that of ethylbenzene or toluene; however, the concentrations of benzene were generally higher than the other MAHs. Although benzene, toluene, and ethylbenzene are lighter (less dense) than water, the concentrations did not appear to correlate with sample depth.

***Coal Tar Storage Area*** – As in the Benzol Processing Area, benzene, toluene, and ethylbenzene were the primary VOCs reported above the reporting limit in fill material samples in the Coal Tar Storage Area (**Table 3-4**). Concentrations of these three MAHs were considerably lower (up to five orders of magnitude) than those in the Benzol Processing Area, and they represented only a small percentage of the total hydrocarbons within the Coal Tar Storage Area fill material samples.

### 3.3.2 Polycyclic Aromatic Hydrocarbons

***Benzol Processing and Graving Dock Areas*** – PAHs were frequently detected at the mg/kg level in slag fill material samples from the Benzol Processing Area (**Table 3-5**). Seven PAHs (benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, dibenzo[a,h]anthracene, indeno[1,2,3-cd]pyrene, 2-methylnaphthalene, and/or naphthalene) were reported at concentrations exceeding protection of groundwater cleanup standards (MDE 2008) in one or more samples from each boring. Concentrations of most of the compounds, with the exception of naphthalene, were comparable to those of other PAHs. The naphthalene concentrations in many cases were one or more orders of magnitude higher than the rest. PAH concentrations were generally much lower in the Graving Dock Area (corroborating inferred finding that this is not a source area), although four were elevated above groundwater cleanup standards in the deepest sample (32-34 feet), and naphthalene was elevated above its standard at all depths.

***Coal Tar Storage Area*** – As with the Benzol Processing Area, PAHs were frequently detected in fill material samples from the Coal Tar Storage Area (**Table 3-6**). Ten PAHs (acenaphthylene, benzo[a]anthracene, benzo[a]pyrene, benzo[b]fluoranthene, chrysene, dibenzo[a,h]anthracene, fluorene, indeno[1,2,3-cd]pyrene, 2-methylnaphthalene, and/or naphthalene) were reported at concentrations exceeding protection of groundwater cleanup standards (MDE 2008) in one or more samples from each boring. Total PAHs generally were one or more orders of magnitude greater at depths from 18 to 22 ft (correlating with depth of bottom of slag fill material) than at shallower depths. The borehole at CT-03 was the only one sampled at a depth below 22 ft, and PAH concentrations at that depth were lower than those in the sample from the same borehole at 20 to 22 ft (**Table 3-6**). Concentrations of naphthalene tended to be higher than those of other PAHs, although in two borehole samples (at CT-01, 10 to 12 ft, and at CT-05, 8 to 10 ft), fluoranthene concentrations exceeded those of naphthalene, and in one sample (at CT-03, 20 to 22 ft), phenanthrene concentration was highest.

### 3.3.3 Metals

***Benzol Processing and Graving Dock Areas*** – Seven metals (antimony, arsenic, cadmium, chromium, lead, thallium, and zinc) were detected in samples from the Benzol Processing Area at concentrations above the MDE protection of groundwater soil cleanup standard (MDE 2008). Arsenic and especially chromium were also elevated above the MDE standards in the Graving Dock Area. Although arsenic concentrations were relatively low compared to some other metals such as lead, copper, nickel, and zinc, arsenic exceeded the MDE cleanup standard in each of the samples collected from the Benzol Processing Area (**Table 3-7**). Chromium concentrations also exceeded the cleanup standard (42 mg/kg) in samples from various depths in boreholes at locations BP-01, BP-02, BP-03, BP-04, BP-06 and BP-09. Lead exceeded the MDE cleanup standard (1,000 mg/kg) in samples at one depth (20-22 ft) in the borehole at BP-01, at two depths (8-10 and 20-22 ft) at BP-02, and at one depth (14-16 ft) at BP-09. Thallium and zinc exceeded the MDE cleanup standard at one depth in boreholes at BP-01 (20-22 ft) and BP-02 (20-22 ft) respectively (**Table 3-7**).

***Coal Tar Storage Area*** – Arsenic concentrations exceeded the MDE cleanup standard in each of the samples collected from the Coal Tar Storage Area (**Table 3-8**). However, most of the arsenic

values in samples from the Coal Tar Storage Area were either biased high or detected in the method blank (**Table 3-8**), indicating that actual environmental concentrations most likely lower than reported. Chromium concentrations also exceeded the cleanup standard (42 mg/kg) in all of the samples except for 18-20 ft in the borehole at CT-04. Lead exceeded the MDE cleanup standard (1,000 mg/kg) in samples at two depths (10-12 and 14-16 ft) in the borehole at CT-01.

## 3.4 NON-AQUEOUS PHASE LIQUID

Field screening (**Section 3.2**) confirmed the presence NAPL in subsurface fill material in the Benzol Processing and Coal Tar Storage Areas. Several other methods were used to assess the distribution, characteristics, and saturation of subsurface NAPL, including gauging, recovery testing, and sampling for laboratory chemical and physical analysis.

### 3.4.1 Gauging and Distribution

***Benzol Processing Area*** – Ten NAPL monitoring wells were installed in the Benzol Processing Area (**Figure 2-1**). Of these, measureable, free LNAPL (floating on the water table) was observed in BP-MW-05 (3.6 ft), BP-MW-08 (4.6 ft), and BP-MW-10 (0.6 ft) (**Table 3-9**) during a gauging event on June 23, 2009. The estimated footprint of the free LNAPL occurrence (based on this solitary gauging event) is shown on **Figure 3-5**.

Based on data from the monitoring wells, a conservative estimate of LNAPL volume and mass was calculated for this Benzol Processing Area occurrence. Geographic Information System (GIS) was used to determine the area encompassed by the estimated LNAPL footprint from **Figure 3-5** (33,000 $ft^2$). An average thickness of 3 ft was calculated from NAPL gauging results. The soil porosity filled with NAPL was assumed to be 15 percent of the bulk volume of soil. Based on these conservative assumptions, as much as 11,000 gal (82,000 lbs) of mobile LNAPL may be present in the Benzol Processing Area (**Appendix C**).

***Coal Tar Storage Area*** – Because little evidence of NAPL was found during the drilling program at the Coal Tar Storage Area, only two monitoring wells (CT-MW-01 and CT-MW-05) were installed for gauging (**Figure 2-2**). However, no LNAPL or DNAPL was observed in the wells during the June 23, 2009 gauging event (**Table 3-9**). The only measurable DNAPL (0.88 ft thick) that was observed during the NAPL gauging investigation on June 23, 2009 in the Coal Tar Storage Area occurred in existing well C013-PZM-008, which had historically exhibited measureable NAPL. Because the DNAPL was only observed in one point, a volume estimate could not be calculated. However, it is likely confined to a limited area surrounding the well.

### 3.4.2 Recovery Testing

Potential NAPL recovery rates were calculated using results from the field bail-down tests to assess the viability of product recovery as a remediation tool. The time to recovery of approximately 80 percent of the initial thickness of NAPL following bail down can be used to estimate the rate at which NAPL could be removed from the well in a sustained manner, assuming a continuous NAPL source. Calculations from each recovery test are presented in **Appendix C**.

***Benzol Processing Area*** – LNAPL recovery testing was conducted on June 24, 2009 for monitoring wells BP-MW-05, BP-MW-08, and BP-MW-10 (Appendix C). Results are summarized below:

- **BP-MW-05** – The well was bailed for 33 minutes, and the initial 4.1 ft of NAPL could only be drawn down to a thickness of 2.59 ft, which alone is indicative of a potentially high sustainable recovery rate. Following bail down, 80 percent recovery occurred in about 6 minutes. The volume of recovered NAPL was determined for a 2-in. diameter well and recovery rate was extrapolated to determine an approximate daily rate of 14.5 gal/day.
- **BP-MW-08** – This well was bailed for a total of 8 minutes to attain a thickness of 10 percent of its original 4.49 ft thickness, which is indicative of a much slower recovery rate than BP-MW-05. Eighty percent recovery was not attained by the end of the field day, but was linearly extrapolated to occur at approximately 540 minutes after bailing ceased. From this, an approximate recovery rate of 0.43 gal/day was calculated.
- **BP-MW-10** – Less NAPL (0.70 ft) was initially present in this well, and was drawn down to less than 10 percent of its thickness within 4 minutes. A 505-minute recovery time was extrapolated from the data, but because the initial thickness was so small, the estimated recovery rate (0.07 gal/day) was slower than BP-MW-08.

***Coal Tar Storage Area*** – DNAPL recovery testing was attempted at existing well C013-PZM-008 where DNAPL was observed. However, due to the limited volume (and/or very high viscosity), DNAPL did not return to the well when it was bailed down, indicating that traditional product recovery of flowing DNAPL would be impractical as a remedial alternative (at subsurface temperatures) in the Coal Tar Storage Area.

### 3.4.3 Physical Characteristics

LNAPL samples were collected from wells BP-MW-5 and BP-MW-8 in the Benzol Processing Area and a DNAPL sample was collected from well C013-PZM-008 in the Coal Tar Storage Area. These samples were collected on June 23, 2009 and submitted to PTS Laboratories to determine product fluid properties. **Table 3-10** shows the results of the physical analyses.

As expected, the LNAPL samples from the Benzol Processing Area were less dense than water (approximate specific gravity of 0.89 $g/cm^3$) and had a viscosity (resistance to flow) only slightly above that of water. In contrast, the DNAPL sample from the Coal Tar Storage Area was denser than water (approximate specific gravity of 1.15 $g/cm^3$) and had a viscosity that was considerably higher (two orders of magnitude higher at $70^o$ F) than that of the LNAPL samples. The wettability index values (which indicate whether a liquid is likely to spread out over a solid surface or to minimize contact with the solid) indicated that the LNAPL from the Benzol Processing Area was preferentially water wet, whereas the DNAPL from the Coal Tar Storage Area was preferentially NAPL wet. This means that the DNAPL strongly adheres to the solid making it very difficult to remove, whereas the LNAPL is more easily mobilized and more conducive to entrainment in water or mobilization and recovery in a product recovery system.

### 3.4.4 NAPL Chemistry

Additional NAPL samples collected from the same wells (BP-MW-5, BP-MW-8 and C013-PZM-008) on June 23, 2009 were submitted to TestAmerica for PAH and VOC chemical analysis. The results of PAH analysis of NAPL from the Benzol Processing and Coal Tar Storage Areas are shown in **Table 3-11**; the results of VOC analysis for both areas are provided in **Table 3-12**.

***Benzol Processing Area*** – The sum of identifiable compounds within the two LNAPL samples from the Benzol Processing Area is dominated by benzene, toluene, and naphthalene (**Tables 3-11 and 3-12**). Identified compounds in the LNAPL sample from BP-MW-05 account for 35.3 percent of the total NAPL mass. Benzene and toluene alone account for 29.6 percent of the LNAPL mass, and naphthalene accounts for 5 percent.

The sum of identified compounds in BP-MW-08 is approximately 21.5 percent of the LNAPL mass. As with the LNAPL from BP-MW-05, benzene, toluene, and naphthalene account for most of the identified total (20.7 percent of the NAPL mass).

***Coal Tar Storage Area*** – PAHs account for approximately 25.8 percent of identifiable compounds detected in the DNAPL sample from C013-PZM-008 (**Table 3-11**). The naphthalene concentration (110,000 mg/kg or 11 percent) is higher than any of the other PAHs, but acenaphthylene, fluoranthene, fluorene, 2-methylnaphthalene, phenanthrene, and pyrene each contribute 1 percent (10,000 mg/kg) or more to the sum of identified NAPL components. Toluene and benzene each contribute 1.4 percent of the total (**Table 3-12**).

## 3.5 SATURATION CALCULATIONS FOR FILL MATERIAL

As described earlier, field screening indicated the presence of at least residual NAPL in many locations within the onshore investigation areas. Free LNAPL was observed within part of the Benzol Processing Area (**Figure 3-5**), but field screening results were also positive for other borehole samples, indicating that residually trapped NAPL may exist in other source regions. Fill material analytical data (MAHs and PAHs) were used to calculate NAPL saturation within slag materials to assess the overall mass of entrapped residual NAPL within the onshore investigation areas. This method of calculation was an attempt to roughly estimate NAPL saturation for a relative comparison of NAPL impacts between areas and to predict (in an overall sense) the distribution of organic constituents in NAPL relative to other environmental media (see Chapter 5). Actual NAPL saturation cannot be determined with absolute certainty by this (or other) methods due to sample heterogeneity and calculation assumptions.

NAPL saturation is defined as the fraction of pore space occupied by NAPL within a representative elementary volume (REV) around a particular point such as a soil sample (Mariner et al. 1997). NAPL saturation in soil and sediment was determined through the use of a model called NAPLANAL (Mariner et al. 1997). The model is capable of calculating saturation of a multi-component NAPL within a soil sample. The model utilizes the following information in the calculation:

- Relative volumetric contents of water, soil, and air
- Fraction of organic carbon ($f_{oc}$)
- Concentration of individual organic constituents
- Chemical characteristics of individual organic constituents

From these, the model calculates NAPL saturation from the total mass and total volume of each component in each phase using equilibrium partitioning equations (Mariner et al. 1997).

Two somewhat different methods were used to estimate relative volumetric contents of water, soil, and air during this investigation. For saturated samples, moisture content was assumed to represent total porosity and volumetric water content; air volume was zero, and relative soil volume was one minus the volumetric water content. For unsaturated samples, total porosity was assumed to be 0.3 and moisture content was again used for volumetric water content, allowing calculation of volumetric air and soil contents using simple arithmetic as above.

The fraction of organic carbon used in the calculations was the model default value of 0.01, which was based on the likelihood that little organic carbon would remain in slag material that had been historically processed through a blast furnace. This means that measured $f_{oc}$ values would be dominated, in most cases, by anthropogenic organic inputs; therefore, these measured values were not used in this calculation. The concentrations of organic constituents were obtained from laboratory analytical soil results, and chemical characteristics of individual constituents were from an internal model database, which was compiled from published literature values. Results of NAPL saturation calculations are listed in **Table 3-13 and 3-14** and model output is provided in **Appendix C**. Results are summarized below.

***Benzol Processing and Graving Dock Areas*** – Results of NAPL saturation calculations in the Benzol Processing Area indicate the presence of residual NAPL in one or more depth intervals within the boreholes, with the exception of those at BP-10 and BP-11, where single soil samples were collected at intervals that did not match those where there was field evidence and well gauging indicating free (BP-MW-10) or residual (BP-MW-11) LNAPL (**Table 3-13; Figure 3-5)**. Non-zero saturation values from the equilibrium models ranged from approximately 0.0017 percent of the available pore space within the soil in the Graving Dock Area to 10.7 percent of the pore space at location BP-09 in the Benzol Processing Area, near the occurrence of floating product (**Figure 3-5**). NAPL saturation calculations performed on data for samples from the Graving Dock Area (BP-03) do not indicate a NAPL source in this area; thus, the previously inferred findings that groundwater impacts are pulled to this area due to graving dock pumping appear correct.

***Coal Tar Storage Area*** – Results of NAPL saturation calculations in the Coal Tar Storage Area are summarized in **Table 3-14**. Results indicate the likely presence of residual NAPL in one or more depth intervals within each of the five boreholes. Non-zero saturation values from the equilibrium models ranged from approximately 0.06 to 3.5 percent of the available pore space within the soil.

## 3.6 SUMMARY OF ONSHORE RESULTS

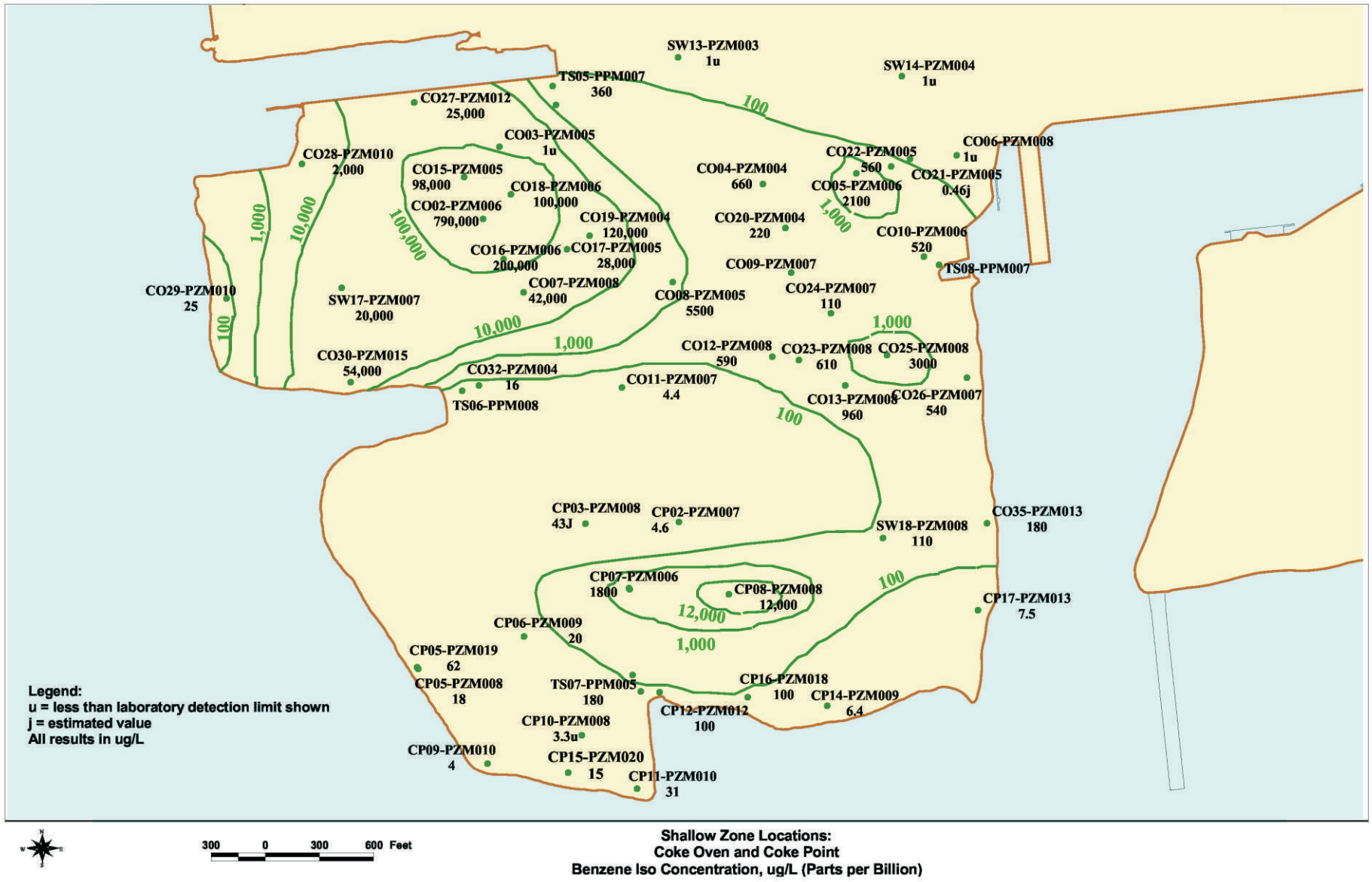
A total of 10 locations in the Benzol Processing Area, one location in the Graving Dock Area, and five locations in the Coal Tar Storage Area were sampled for subsurface media (slag fill material and NAPL). Field screening, analysis of lithologic logs, and physical/chemical testing of soil samples were used to identify the source area of historically documented high concentrations of benzene and naphthalene in groundwater. Slag fill material samples from each location were submitted for analysis of VOCs, PAHs, and metals. NAPL samples, if identified and recoverable, were also submitted for physical and chemical testing.

The results of the onshore investigation include:

- High groundwater naphthalene and benzene concentrations documented by previous reports spatially correlated with the NAPL and soil impacts observed in the Benzol Processing Area and the Coal Tar Storage Area.
- Field screening and subsurface analytical data confirmed that the Graving Dock Area is not a source area containing NAPL; therefore, previous inferences that groundwater transports organic constituents to this area because of graving dock pumping appear to be accurate.
- Concentrations of chemicals of concern in subsurface fill material and groundwater exceeded applicable regulatory standards for industrial use of the Site.
- Residual NAPLs and sorbed organic constituents were widespread in the investigation areas, corresponding to high levels of MAHs and PAHs observed in the subsurface slag fill materials.
- High metals concentrations were observed in the groundwater and the slag fill material.
- A region of the subsurface in the Benzol Processing Area containing mobile LNAPL (floating on groundwater), associated with high concentrations of benzene, toluene, and naphthalene, can be addressed by product recovery.
- A larger region of the subsurface in the Benzol Processing Area containing residually entrapped NAPL (at and below the water table) is contributing organic constituents to westerly flowing groundwater and, thus, should be addressed in eventual cleanup actions. However, due to the region's prohibitively large size, a groundwater management strategy may be the only implementable course of action.
- A region of the subsurface in the Coal Tar Storage containing residually entrapped DNAPL (at the bottom of slag fill material below the water table) is contributing organic constituents to easterly flowing groundwater and, thus, should be addressed in eventual cleanup actions. However, the DNAPL is entrapped in the subsurface and is very difficult to recover as evidenced by its oil wettability (measure of how strongly it is sorbed to aquifer material). A groundwater management strategy may be the only implementable course of action.

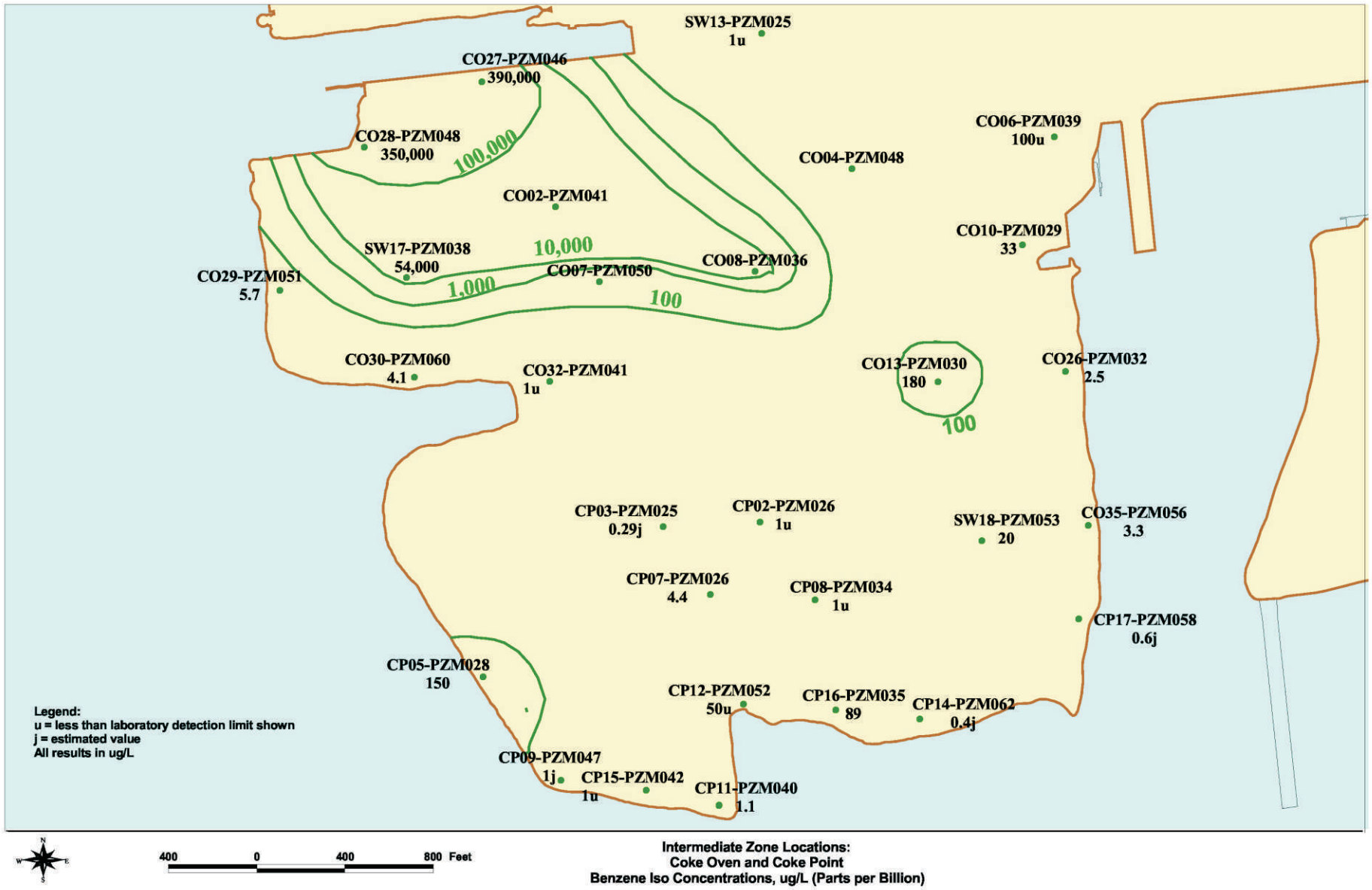
The occurrence and distribution of VOCs, PAHs, and metals in the offshore environment (sediments and surface water) is examined in Chapter 4. In Chapter 5, the potential transport of

these constituents of interest from onshore subsurface source areas to offshore environmental compartments, particularly through groundwater mass flux, is examined.



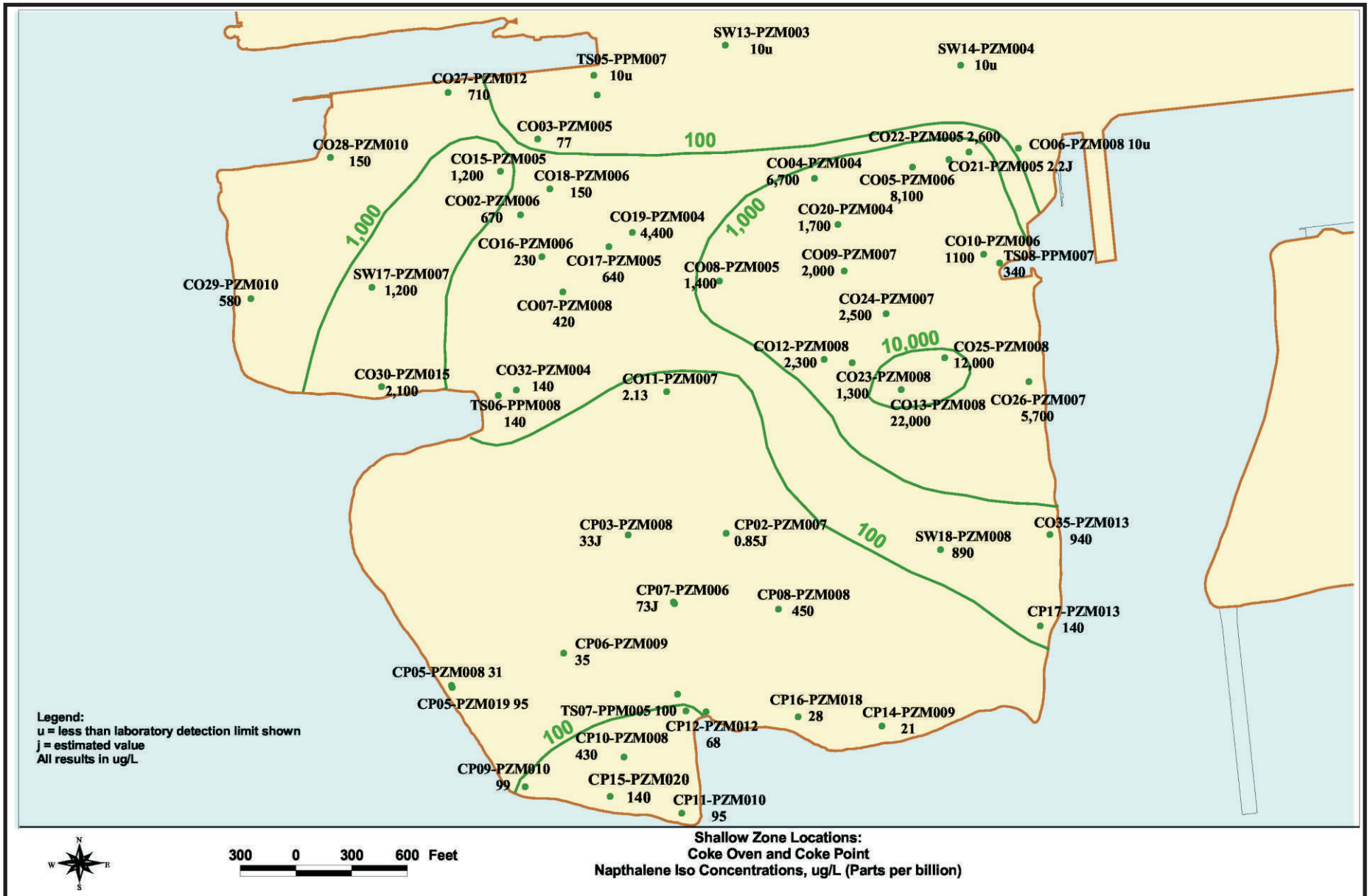

Source: URS. 2006. Response to EPA Comments (4) and (5) dated December 15, 2005. Prepared by URS, under contract to ISG Sparrows Point LLC. Attachment to letter by Robert Abate, ISG Sparrows Point LLC to Andrew Fan, U.S. Environmental Protection Agency, Region III, and Richard Johnson, Maryland Department of Environment, December 6, 2006, 17 pp.

**Figure 3-1. Benzene Distribution in Shallow Groundwater, Coke Point Peninsula, Baltimore, Maryland.**



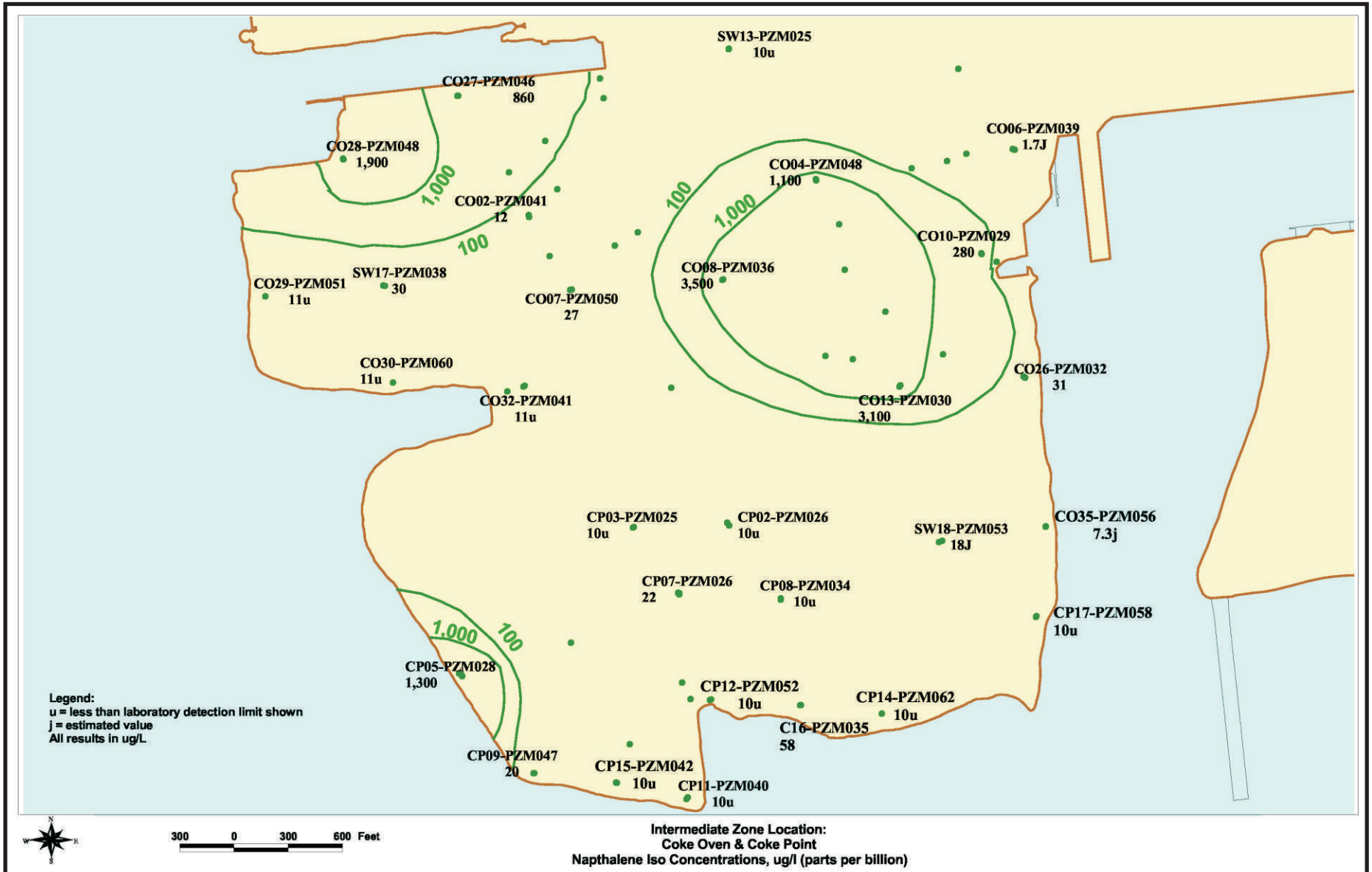

Source: URS. 2006. Response to EPA Comments (4) and (5) dated December 15, 2005. Prepared by URS, under contract to ISG Sparrows Point LLC. Attachment to letter by Robert Abate, ISG Sparrows Point LLC to Andrew Fan, U.S. Environmental Protection Agency, Region III, and Richard Johnson, Maryland Department of Environment, December 6, 2006, 17 pp.

**Figure 3-2. Benzene Distribution in Intermediate Groundwater, Coke Point Peninsula, Baltimore, Maryland.**



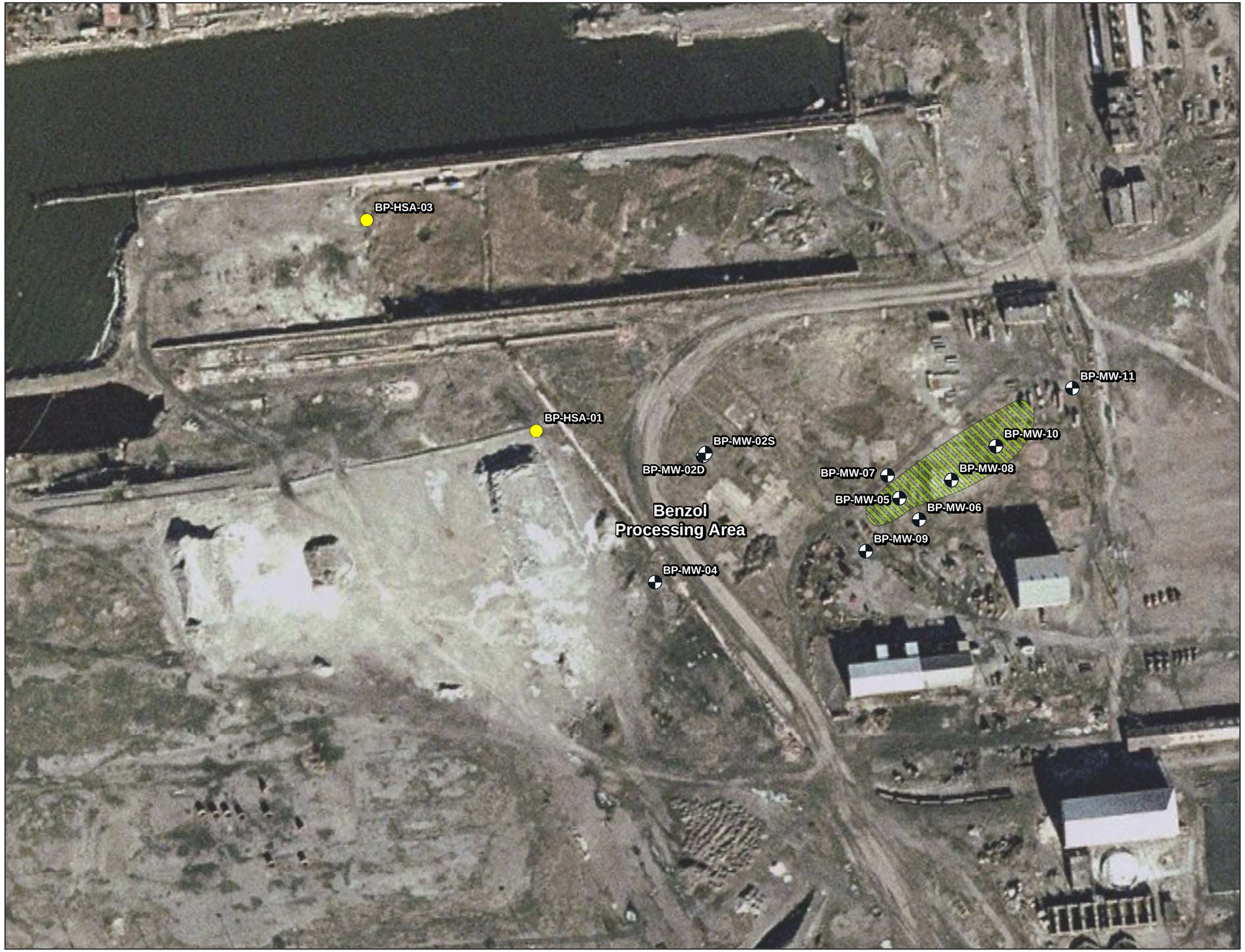

Source: URS. 2006. Response to EPA Comments (4) and (5) dated December 15, 2005. Prepared by URS, under contract to ISG Sparrows Point LLC. Attachment to letter by Robert Abate, ISG Sparrows Point LLC to Andrew Fan, U.S. Environmental Protection Agency, Region III, and Richard Johnson, Maryland Department of Environment, December 6, 2006, 17 pp.

**Figure 3-3. Naphthalene Distribution in Shallow Groundwater, Coke Point Peninsula, Baltimore, Maryland.**




Source: URS. 2006. Response to EPA Comments (4) and (5) dated December 15, 2005. Prepared by URS, under contract to ISG Sparrows Point LLC. Attachment to letter by Robert Abate, ISG Sparrows Point LLC to Andrew Fan, U.S. Environmental Protection Agency, Region III, and Richard Johnson, Maryland Department of Environment, December 6, 2006, 17 pp.

**Figure 3-4. Naphthalene Distribution in Intermediate Groundwater, Coke Point Peninsula, Baltimore, Maryland.**




Site Assessment for Proposed Coke Point Dredged Material Containment Facility at Sparrows Point

**Legend**

Borehole Locations

NAPL Monitoring Wells

Floating Product Footprint

Sources
ESRI, i-cubed, GeoEye, 2009
Tele Atlas North America Inc., ESRI, 2006

Feet
0 250 500

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.


H:\projects\1453406\MXD\2009_Report\Figure 3-5

**Figure 3-5. Estimated Footprint of Floating Product Occurrence, Benzol Processing Area, Coke Point Peninsula, Baltimore, Maryland**

## Table 3-1. Field Screening Indicators of Non-Aqueous Phase Liquid and/or Highly Impacted Fill Material

**Benzol Processing and Graving Dock Areas, Coke Point Peninsula, Sparrows Point Site Assessment (2009), Baltimore, Maryland**

| Depth Interval (ft bgs) | BP-01 | | | BP-02 | | | BP-03 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Dye test / Visual | PID (ppm) | Odor | Dye test / Visual | PID (ppm) | Odor | Dye test / Visual | PID (ppm) | Odor |
| **0 - 2** | -- | 272 | **SLIGHT** | -- | 0 | **SLIGHT** | -- | 0 | -- |
| **2 - 4** | -- | 171 | -- | -- | 8.6 | -- | -- | 0 | -- |
| **4 - 6** | NEGATIVE | 1,866 | -- | -- | 61.1 | -- | -- | 1.7 | -- |
| **6 - 8** | -- | 300 | -- | **SLIGHT SHEEN** | 16.6 | **YES** | -- | 18.1 | -- |
| **8 - 10** | NEGATIVE | -- | -- | **TRACE (DYE)** | **>10K** | **YES** | NEGATIVE | 86.4 | -- |
| **10 - 12** | NEGATIVE | -- | -- | **SHEEN** | **>10K** | **YES** | -- | 15.9 | -- |
| **12 - 14** | NEGATIVE | **>10K** | -- | NEGATIVE | **>10K** | -- | NEGATIVE | 261 | -- |
| **14 - 16** | **TRACE (DYE)** | **>10K** | -- | NEGATIVE | **>10K** | -- | NEGATIVE | 48.5 | -- |
| **16 - 18** | NEGATIVE | **>10K** | -- | NEGATIVE | **>10K** | -- | -- | 2.0 | -- |
| **18 - 20** | NEGATIVE | 3,436 | -- | NEGATIVE | **>10K** | -- | -- | 8.9 | -- |
| **20 - 22** | NEGATIVE | 540 | -- | NEGATIVE | **>10K** | -- | NEGATIVE | 289 | -- |
| **22 - 24** | -- | 936 | -- | NEGATIVE | **>10K** | -- | NEGATIVE | 304 | -- |
| **24 - 26** | | (BOH at 24 ft) | | | (BOH at 24 ft) | | -- | -- | -- |
| **26 - 28** | | | | | | | NEGATIVE | 28.3 | -- |
| **28 - 30** | | | | | | | NEGATIVE | 299 | -- |
| **30 - 32** | | | | | | | NEGATIVE | 72.5 | -- |
| **32 - 34** | | | | | | | NEGATIVE | 42.5 | -- |
| **34 - 36** | | | | | | | NEGATIVE | 532 | -- |
| **36 - 38** | | | | | | | | (BOH at 36 ft) | |
| **38 - 40** | | | | | | | | | |

Notes:

**BOH** = Bottom of Hole

-- = Screening not conducted at this depth interval.

Bold font and shaded cells indicate definite presence of NAPL.

Bold font cells indicate highly impacted soil with possible presence of NAPL.

## Table 3-1. (continued)

| Depth Interval (ft bgs) | BP-04 | | | BP-05 | | | BP-06 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Dye test / Visual | PID (ppm) | Odor | Dye test / Visual | PID (ppm) | Odor | Dye test / Visual | PID (ppm) | Odor |
| **0 - 2** | -- | 0 | -- | -- | 5.3 | -- | -- | 16.5 | -- |
| **2 - 4** | NEGATIVE | 928 | -- | NEGATIVE | 539 | -- | -- | 3 | -- |
| **4 - 6** | NEGATIVE | 1,239 | **SLIGHT** | NEGATIVE | 1,127 | **SLIGHT** | -- | 223 | -- |
| **6 - 8** | NEGATIVE | 464 | -- | **POS (DYE)** | **>10K** | -- | **TRACE** | **9,999** | -- |
| **8 - 10** | -- | 137 | -- | **POS (SHEEN/DYE)** | **>10K** | -- | NEGATIVE | **9,999** | -- |
| **10 - 12** | NEGATIVE | 2,464 | **YES** | **TRACE (SHEEN/DYE)** | **>10K** | -- | **POS (VIS/DYE)** | **>10K** | -- |
| **12 - 14** | -- | 460 | -- | **TRACE (SHEEN/DYE)** | **>10K** | -- | **POS (DYE)** | **>10K** | -- |
| **14 - 16** | -- | 559 | -- | **SHEEN** | 2,035 | -- | NEGATIVE | **>10K** | -- |
| **16 - 18** | -- | 5,648 | -- | NEGATIVE | 3,903 | -- | -- | 1,749 | **YES** |
| **18 - 20** | NEGATIVE | **>10K** | **YES** | NEGATIVE | 3,303 | -- | | (BOH at 18 ft) | |
| **20 - 22** | NEGATIVE | 1,624 | -- | NEGATIVE | 1,090 | -- | | | |
| **22 - 24** | NEGATIVE | 1,585 | -- | -- | 121 | -- | | | |
| **24 - 26** | -- | 176 | -- | | (BOH at 24 ft) | | | | |
| **26 - 28** | | (BOH at 26 ft) | | | | | | | |
| **28 - 30** | | | | | | | | | |
| **30 - 32** | | | | | | | | | |
| **32 - 34** | | | | | | | | | |
| **34 - 36** | | | | | | | | | |
| **36 - 38** | | | | | | | | | |
| **38 - 40** | | | | | | | | | |

Notes:

**BOH** = Bottom of Hole

-- = Screening not conducted at this depth interval.

Bold font and shaded cells indicate definite presence of NAPL.

Bold font cells indicate highly impacted soil with possible presence of NAPL.

## Table 3-1. (continued)

| Depth Interval (ft bgs) | BP-07 | | | BP-08 | | | BP-09 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Dye test / Visual | PID (ppm) | Odor | Dye test / Visual | PID (ppm) | Odor | Dye test / Visual | PID (ppm) | Odor |
| **0 - 2** | -- | 3.8 | -- | -- | 0.4 | -- | -- | 0 | -- |
| **2 - 4** | -- | 2.9 | -- | -- | 280 | -- | -- | 0 | -- |
| **4 - 6** | -- | 461 | -- | -- | 942 | **YES** | -- | 0 | -- |
| **6 - 8** | -- | 1,534 | -- | -- | 928 | -- | -- | 0 | -- |
| **8 - 10** | **TRACE** | **>10K** | -- | -- | 271 | -- | -- | 20.8 | -- |
| **10 - 12** | **POS (DYE)** | **>10K** | -- | NEGATIVE | **8,590** | -- | -- | 189 | -- |
| **12 - 14** | **POS (DYE)** | **>10K** | -- | -- | 4,795 | -- | -- | 365 | -- |
| **14 - 16** | -- | 3,762 | -- | -- | 1,370 | -- | NEGATIVE | **>10K** | -- |
| **16 - 18** | -- | 810 | **SLIGHT** | -- | 2,018 | **SLIGHT** | NEGATIVE | 6,054 | -- |
| **18 - 20** | | (BOH at 18 ft) | | | (BOH at 18 ft) | | -- | 3,569 | **STRONG** |
| **20 - 22** | | | | | | | | (BOH at 20 ft) | |
| **22 - 24** | | | | | | | | | |
| **24 - 26** | | | | | | | | | |
| **26 - 28** | | | | | | | | | |
| **28 - 30** | | | | | | | | | |
| **30 - 32** | | | | | | | | | |
| **32 - 34** | | | | | | | | | |
| **34 - 36** | | | | | | | | | |
| **36 - 38** | | | | | | | | | |
| **38 - 40** | | | | | | | | | |

Notes:

**BOH** = Bottom of Hole

-- = Screening not conducted at this depth interval.

Bold font and shaded cells indicate definite presence of NAPL.

Bold font cells indicate highly impacted soil with possible presence of NAPL.

## Table 3-1. (continued)

| Depth Interval (ft bgs) | BP-10 | | | BP-11 | | |
|---|---|---|---|---|---|---|
| | Dye test / Visual | PID (ppm) | Odor | Dye test / Visual | PID (ppm) | Odor |
| **0 - 2** | -- | 0.6 | -- | -- | 0.4 | -- |
| **2 - 4** | -- | 24.2 | -- | -- | 0.4 | -- |
| **4 - 6** | -- | 7.1 | -- | -- | 1.9 | -- |
| **6 - 8** | -- | 47.0 | -- | -- | 34.9 | -- |
| **8 - 10** | -- | 134 | -- | -- | 15.5 | -- |
| **10 - 12** | -- | 428 | -- | -- | 29.8 | -- |
| **12 - 14** | -- | 741 | -- | -- | 56.1 | -- |
| **14 - 16** | -- | 272 | -- | -- | 31.5 | -- |
| **16 - 18** | -- | 232 | **STRONG** | -- | 2.3 | **STRONG** |
| **18 - 20** | | (BOH at 18 ft) | | | (BOH at 18 ft) | |
| **20 - 22** | | | | | | |
| **22 - 24** | | | | | | |
| **24 - 26** | | | | | | |
| **26 - 28** | | | | | | |
| **28 - 30** | | | | | | |
| **30 - 32** | | | | | | |
| **32 - 34** | | | | | | |
| **34 - 36** | | | | | | |
| **36 - 38** | | | | | | |
| **38 - 40** | | | | | | |

Notes:

**BOH** = Bottom of Hole

-- = Screening not conducted at this depth interval.

Bold font and shaded cells indicate definite presence of NAPL.

Bold font cells indicate highly impacted soil with possible presence of NAPL.

## Table 3-2. Field Screening Indicators of Non-Aqueous Phase Liquid and/or Highly Impacted Fill Material

**Coal Tar Storage Area, Coke Point Peninsula, Sparrows Point Site Assessment (2009), Baltimore, Maryland**

| Depth Interval (ft bgs) | CT-01 | | | CT-02 | | | CT-03 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Dye test / Visual | PID (ppm) | Odor | Dye test / Visual | PID (ppm) | Odor | Dye test / Visual | PID (ppm) | Odor |
| 0 - 2 | -- | 0 | -- | -- | 0 | -- | -- | 8.5 | -- |
| 2 - 4 | -- | 1 | -- | -- | 0.0 | -- | -- | 11 | -- |
| 4 - 6 | -- | 0 | -- | -- | 0.1 | -- | -- | 0.1 | -- |
| 6 - 8 | -- | 0 | -- | -- | 0.2 | -- | -- | 1.2 | -- |
| 8 - 10 | -- | 0 | -- | -- | 0.9 | -- | -- | 0 | -- |
| 10 - 12 | -- | 2.5 | -- | -- | 0.1 | -- | -- | 0 | -- |
| 12 - 14 | -- | 109 | -- | -- | 0 | -- | -- | 5.3 | -- |
| 14 - 16 | -- | 26.7 | -- | -- | 0.3 | -- | -- | 1 | -- |
| 16 - 18 | -- | 15.2 | **YES** | -- | 20.7 | -- | -- | 20.5 | -- |
| 18 - 20 | NEGATIVE | 1,460 | -- | **SHEEN** | 112 | **YES** | -- | 21.2 | -- |
| 20 - 22 | **SHEEN (DYE NEG)** | 267 | **STRONG** | -- | 90 | **SLIGHT** | **SLIGHT SHEEN** | 47.4 | **SLIGHT** |
| 22 - 24 | NEGATIVE | 197 | **SLIGHT** | | (BOH at 22 ft) | | -- | 18 | -- |
| 24 - 26 | | (BOH at 24 ft) | | | | | -- | 8 | -- |
| 26 - 28 | | | | | | | | (BOH at 26 ft) | |
| 28 - 30 | | | | | | | | | |
| 30 - 32 | | | | | | | | | |
| 32 - 34 | | | | | | | | | |
| 34 - 36 | | | | | | | | | |
| 36 - 38 | | | | | | | | | |
| 38 - 40 | | | | | | | | | |

Notes:

**BOH** = Bottom of Hole

-- = Screening not conducted at this depth interval.

Bold font and shaded cells indicate definite presence of NAPL.

Bold font cells indicate highly impacted soil with possible presence of NAPL.

## Table 3-2. (continued)

| Depth Interval (ft bgs) | CT-04 | | | CT-05 | | |
|---|---|---|---|---|---|---|
| | Dye test / Visual | PID (ppm) | Odor | Dye test / Visual | PID (ppm) | Odor |
| **0 - 2** | -- | 0 | -- | -- | 0 | -- |
| **2 - 4** | -- | -- | -- | -- | -- | -- |
| **4 - 6** | -- | 0 | -- | -- | 0 | -- |
| **6 - 8** | -- | -- | -- | -- | 0 | -- |
| **8 - 10** | -- | 0 | -- | -- | 0 | -- |
| **10 - 12** | -- | 0 | -- | -- | 0 | -- |
| **12 - 14** | -- | 0 | -- | -- | 0 | -- |
| **14 - 16** | -- | 0 | -- | -- | 2.7 | -- |
| **16 - 18** | -- | 2.2 | -- | -- | 3.5 | -- |
| **18 - 20** | -- | 37.1 | **SLIGHT** | **SHEEN (DYE NEG)** | 226 | **YES** |
| **20 - 22** | -- | -- | -- | NEGATIVE | 98.3 | -- |
| **22 - 24** | | (BOH at 22 ft) | | | (BOH at 22 ft) | |
| **24 - 26** | | | | | | |
| **26 - 28** | | | | | | |
| **28 - 30** | | | | | | |
| **30 - 32** | | | | | | |
| **32 - 34** | | | | | | |
| **34 - 36** | | | | | | |
| **36 - 38** | | | | | | |
| **38 - 40** | | | | | | |

Notes:

**BOH** = Bottom of Hole

-- = Screening not conducted at this depth interval.

Bold font and shaded cells indicate definite presence of NAPL.

Bold font cells indicate highly impacted soil with possible presence of NAPL.

## Table 3-3. Volatile Organic Compound Concentrations in Fill Material from the Benzol Processing and Graving Dock Areas

**Coke Point Peninsula, Sparrows Point Site Assessment (2009), Baltimore, Maryland**

| | | | | BP-01 | | | BP-02 | | | BP-03 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Depth (ft)[1] | 8-10 | 14-16 | 20-22 | 8-10 | 14-16 | 20-22 | 4-6 | 12-14 | 32-34 |
| ANALYTE | UNITS | Average MDL | Soil: Groundwater Standard[2] | | | | | | | | | |
| 1,1,1-TRICHLOROETHANE | UG/KG | 42,095 | 32,000 | 31,000 U | 310,000 U | 7,400 U | 21,000 U | 9,300 U | 18,000 U | 4.7 U | 4.9 U | 3,300 U |
| 1,1,2,2-TETRACHLOROETHANE | UG/KG | 42,095 | 0.68 | 31,000 U | 310,000 U | 7,400 U | 21,000 U | 9,300 U | 18,000 U | 4.7 U | 4.9 U | 3,300 U |
| 1,1,2-TRICHLOROETHANE | UG/KG | 42,095 | 0.78 | 31,000 U | 310,000 U | 7,400 U | 21,000 U | 9,300 U | 18,000 U | 4.7 U | 4.9 U | 3,300 U |
| 1,1-DICHLOROETHANE | UG/KG | 42,095 | 5,100 | 31,000 U | 310,000 U | 7,400 U | 21,000 U | 9,300 U | 18,000 U | 4.7 U | 4.9 U | 3,300 U |
| 1,1-DICHLOROETHENE | UG/KG | 42,095 | 2,900 | 31,000 U | 310,000 U | 7,400 U | 21,000 U | 9,300 U | 18,000 U | 4.7 U | 4.9 U | 3,300 U |
| 1,2-DICHLOROBENZENE | UG/KG | 42,095 | 4,600 | 31,000 U | 310,000 U | 7,400 U | 21,000 U | 9,300 U | 18,000 U | 4.7 U | 4.9 U | 3,300 U |
| 1,2-DICHLOROETHANE | UG/KG | 42,095 | 1.0 | 31,000 U | 310,000 U | 7,400 U | 21,000 U | 9,300 U | 18,000 U | 4.7 U | 4.9 U | 3,300 U |
| 1,2-DICHLOROPROPANE | UG/KG | 42,095 | 3.4 | 31,000 U | 310,000 U | 7,400 U | 21,000 U | 9,300 U | 18,000 U | 4.7 U | 4.9 U | 3,300 U |
| 1,3-DICHLOROBENZENE | UG/KG | 42,095 | 290 | 31,000 U | 310,000 U | 7,400 U | 21,000 U | 9,300 U | 18,000 U | 4.7 U | 4.9 U | 3,300 U |
| 1,4-DICHLOROBENZENE | UG/KG | 42,095 | 4.2 | 31,000 U | 310,000 U | 7,400 U | 21,000 U | 9,300 U | 18,000 U | 4.7 U | 4.9 U | 3,300 U |
| 2-BUTANONE (MEK) | UG/KG | 42,095 | 29,000 | 31,000 U | 310,000 U | 7,400 U | 21,000 U | 9,300 U | 18,000 U | 4.7 U | 4.9 U | 3,300 U |
| 2-CHLOROETHYL VINYL ETHER | UG/KG | 85,305 | none | 62,000 U | 610,000 U | 15,000 U | 42,000 U | 19,000 U | 35,000 U | 9.4 U | 9.8 U | 6,600 U |
| ACROLEIN | UG/KG | 853,053 | none | R | R | R | R | R | R | R | R | R |
| ACRYLONITRILE | UG/KG | 853,053 | none | 620,000 U | 6,100,000 U | 150,000 U | 420,000 U | 190,000 U | 350,000 U | 94 U | 98 U | 66,000 U |
| BENZENE | UG/KG | 48,295 | 1.9 | **5,700,000** | **4,300,000** | **140,000** | **360,000** | **150,000** | **360,000** | **41** | **72** | **65,000** |
| BROMODICHLOROMETHANE | UG/KG | 42,095 | 1.1 | 31,000 U | 310,000 U | 7,400 U | 21,000 U | 9,300 U | 18,000 U | 4.7 U | 4.9 U | 3,300 U |
| BROMOFORM | UG/KG | 42,095 | 67 | 31,000 U | 310,000 U | 7,400 U | 21,000 U | 9,300 U | 18,000 U | 4.7 U | 4.9 U | 3,300 U |
| BROMOMETHANE | UG/KG | 42,095 | 41 | 31,000 U | 310,000 U | 7,400 U | 21,000 U | 9,300 U | 18,000 U | 4.7 U | 4.9 U | 3,300 U |
| CARBON TETRACHLORIDE | UG/KG | 42,095 | 2.1 | 31,000 U | 310,000 U | 7,400 U | 21,000 U | 9,300 U | 18,000 U | 4.7 U | 4.9 U | 3,300 U |
| CHLOROETHANE | UG/KG | 42,095 | 19 | 31,000 U | 310,000 U | 7,400 U | 21,000 U | 9,300 U | 18,000 U | 4.7 U | 4.9 U | 3,300 U |
| CHLOROFORM | UG/KG | 42,095 | 0.91 | 31,000 U | 310,000 U | 7,400 U | 21,000 U | 9,300 U | 18,000 U | 4.7 U | 4.9 U | 3,300 U |
| CHLOROMETHANE | UG/KG | 42,095 | 930 | 31,000 U | 310,000 U | 7,400 U | 21,000 U | 9,300 U | 18,000 U | 4.7 U | 4.9 U | 3,300 U |
| CIS-1,3-DICHLOROPROPENE | UG/KG | 42,095 | 3.1 | 31,000 U | 310,000 U | 7,400 U | 21,000 U | 9,300 U | 18,000 U | 4.7 U | 4.9 U | 3,300 U |
| DIBROMOCHLOROMETHANE | UG/KG | 42,095 | 0.83 | 31,000 U | 310,000 U | 7,400 U | 21,000 U | 9,300 U | 18,000 U | 4.7 U | 4.9 U | 3,300 U |
| DICHLORODIFLUOROMETHANE | UG/KG | 42,095 | none | 31,000 U | 310,000 U | 7,400 U | 21,000 U | 9,300 U | 18,000 U | 4.7 U | 4.9 U | 3,300 U |
| ETHYLBENZENE | UG/KG | 42,095 | 15,000 | **140,000** | **81,000 J** | **920 J** | **14,000 J** | 9,300 U | 18,000 U | 4.7 U | 4.9 U | 3,300 U |
| METHYLENE CHLORIDE | UG/KG | 42,095 | 19 | 31,000 U | 310,000 U | 7,400 U | 21,000 U | 9,300 U | 18,000 U | **1.6 B** | **1.8 B** | 3,300 U |
| TETRACHLOROETHENE | UG/KG | 42,095 | 4.7 | 31,000 U | 310,000 U | 7,400 U | 21,000 U | 9,300 U | 18,000 U | 4.7 U | 4.9 U | 3,300 U |
| TOLUENE | UG/KG | 42,095 | 27,000 | **140,000** | **820,000** | **20,000** | **140,000** | **43,000** | **58,000** | **8.8** | **23** | **9,800** |
| TRANS-1,2-DICHLOROETHENE | UG/KG | 42,095 | 720 | 31,000 U | 310,000 U | 7,400 U | 21,000 U | 9,300 U | 18,000 U | 4.7 U | 4.9 U | 3,300 U |
| TRANS-1,3-DICHLOROPROPENE | UG/KG | 42,095 | 3.1 | 31,000 U | 310,000 U | 7,400 U | 21,000 U | 9,300 U | 18,000 U | 4.7 U | 4.9 U | 3,300 U |
| TRICHLOROETHENE | UG/KG | 42,095 | 0.26 | 31,000 U | 310,000 U | 7,400 U | 21,000 U | 9,300 U | 18,000 U | 4.7 U | 4.9 U | 3,300 U |
| TRICHLOROFLUOROMETHANE | UG/KG | 42,095 | none | 31,000 U | 310,000 U | 7,400 U | 21,000 U | 9,300 U | 18,000 U | 4.7 U | 4.9 U | 3,300 U |
| VINYL CHLORIDE | UG/KG | 42,095 | 0.12 | 31,000 U | 310,000 U | 7,400 U | 21,000 U | 9,300 U | 18,000 U | 4.7 U | 4.9 U | 3,300 U |

[1] depth below ground surface

[2] Protection of groundwater cleanup standard (MDE 2008)

[3] Collected at location BP-03 at a depth of 32-34 feet below ground surface

[4] Collected at location BP-06 at a depth of 12-14 feet below ground surface

**NOTES:** Bolded values represent detected concentrations; Shaded and bold values exceed comparison criteria

**MDL** = method detection limit

**B** (organic) = compound was detected in the method blank.

**J** (organic) = compound detected below reporting limit (value is estimated).

**R** = Data were rejected by the validator and are unusable.

**U** = compound was analyzed, but not detected.

**Table 3-3. (continued)**

| | | | | BP-04 | | | BP-05 | | | BP-06 | | | BP-07 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Depth (ft)[1] | 10-12 | 16-18 | 24-26 | 8-10 | 14-16 | 20-22 | 8-10 | 12-14 | 16-18 | 12-14 |
| ANALYTE | UNITS | Average MDL | Soil: Groundwater Standard[2] | | | | | | | | | | |
| 1,1,1-TRICHLOROETHANE | UG/KG | 42,095 | 32,000 | 5,700 U | 5,200 U | 3,000 U | 14,000 U | 1,800 U | 1,900 U | 30,000 U | 160,000 U | 39,000 U | 28,000 U |
| 1,1,2,2-TETRACHLOROETHANE | UG/KG | 42,095 | 0.68 | 5,700 U | 5,200 U | 3,000 U | 14,000 U | 1,800 U | 1,900 U | 30,000 U | 160,000 U | 39,000 U | 28,000 U |
| 1,1,2-TRICHLOROETHANE | UG/KG | 42,095 | 0.78 | 5,700 U | 5,200 U | 3,000 U | 14,000 U | 1,800 U | 1,900 U | 30,000 U | 160,000 U | 39,000 U | 28,000 U |
| 1,1-DICHLOROETHANE | UG/KG | 42,095 | 5,100 | 5,700 U | 5,200 U | 3,000 U | 14,000 U | 1,800 U | 1,900 U | 30,000 U | 160,000 U | 39,000 U | 28,000 U |
| 1,1-DICHLOROETHENE | UG/KG | 42,095 | 2,900 | 5,700 U | 5,200 U | 3,000 U | 14,000 U | 1,800 U | 1,900 U | 30,000 U | 160,000 U | 39,000 U | 28,000 U |
| 1,2-DICHLOROBENZENE | UG/KG | 42,095 | 4,600 | 5,700 U | 5,200 U | 3,000 U | 14,000 U | 1,800 U | 1,900 U | 30,000 U | 160,000 U | 39,000 U | 28,000 U |
| 1,2-DICHLOROETHANE | UG/KG | 42,095 | 1.0 | 5,700 U | 5,200 U | 3,000 U | 14,000 U | 1,800 U | 1,900 U | 30,000 U | 160,000 U | 39,000 U | 28,000 U |
| 1,2-DICHLOROPROPANE | UG/KG | 42,095 | 3.4 | 5,700 U | 5,200 U | 3,000 U | 14,000 U | 1,800 U | 1,900 U | 30,000 U | 160,000 U | 39,000 U | 28,000 U |
| 1,3-DICHLOROBENZENE | UG/KG | 42,095 | 290 | 5,700 U | 5,200 U | 3,000 U | 14,000 U | 1,800 U | 1,900 U | 30,000 U | 160,000 U | 39,000 U | 28,000 U |
| 1,4-DICHLOROBENZENE | UG/KG | 42,095 | 4.2 | 5,700 U | 5,200 U | 3,000 U | 14,000 U | 1,800 U | 1,900 U | 30,000 U | 160,000 U | 39,000 U | 28,000 U |
| 2-BUTANONE (MEK) | UG/KG | 42,095 | 29,000 | 5,700 U | 5,200 U | 3,000 U | 14,000 U | 1,800 U | 1,900 U | 30,000 U | 160,000 U | 39,000 U | 28,000 U |
| 2-CHLOROETHYL VINYL ETHER | UG/KG | 85,305 | none | 11,000 U | 10,000 U | 6,100 U | 27,000 U | 3,600 U | 3,800 U | 61,000 U | 330,000 U | 78,000 U | 57,000 U |
| ACROLEIN | UG/KG | 853,053 | none | R | R | R | R | R | R | R | R | R | R |
| ACRYLONITRILE | UG/KG | 853,053 | none | 110,000 U | 100,000 U | 61,000 U | 270,000 U | 36,000 U | 38,000 U | 610,000 UJ | 3,300,000 UJ | 780,000 UJ | 570,000 UJ |
| BENZENE | UG/KG | 48,295 | 1.9 | **79,000** | **91,000** | **38,000** | **470,000** | **22,000** | **21,000** | **440,000** | **1,500,000** | **760,000** | **680,000** |
| BROMODICHLOROMETHANE | UG/KG | 42,095 | 1.1 | 5,700 U | 5,200 U | 3,000 U | 14,000 U | 1,800 U | 1,900 U | 30,000 U | 160,000 U | 39,000 U | 28,000 U |
| BROMOFORM | UG/KG | 42,095 | 67 | 5,700 U | 5,200 U | 3,000 U | 14,000 U | 1,800 U | 1,900 U | 30,000 U | 160,000 U | 39,000 U | 28,000 U |
| BROMOMETHANE | UG/KG | 42,095 | 41 | 5,700 U | 5,200 U | 3,000 U | 14,000 U | 1,800 U | 1,900 U | 30,000 U | 160,000 U | 39,000 U | 28,000 U |
| CARBON TETRACHLORIDE | UG/KG | 42,095 | 2.1 | 5,700 U | 5,200 U | 3,000 U | 14,000 U | 1,800 U | 1,900 U | 30,000 U | 160,000 U | 39,000 U | 28,000 U |
| CHLOROETHANE | UG/KG | 42,095 | 19 | 5,700 U | 5,200 U | 3,000 U | 14,000 U | 1,800 U | 1,900 U | 30,000 U | 160,000 U | 39,000 U | 28,000 U |
| CHLOROFORM | UG/KG | 42,095 | 0.91 | 5,700 U | 5,200 U | 3,000 U | 14,000 U | 1,800 U | 1,900 U | 30,000 U | 160,000 U | 39,000 U | 28,000 U |
| CHLOROMETHANE | UG/KG | 42,095 | 930 | 5,700 U | 5,200 U | 3,000 U | 14,000 U | 1,800 U | 1,900 U | 30,000 U | 160,000 U | 39,000 U | 28,000 U |
| CIS-1,3-DICHLOROPROPENE | UG/KG | 42,095 | 3.1 | 5,700 U | 5,200 U | 3,000 U | 14,000 U | 1,800 U | 1,900 U | 30,000 U | 160,000 U | 39,000 U | 28,000 U |
| DIBROMOCHLOROMETHANE | UG/KG | 42,095 | 0.83 | 5,700 U | 5,200 U | 3,000 U | 14,000 U | 1,800 U | 1,900 U | 30,000 U | 160,000 U | 39,000 U | 28,000 U |
| DICHLORODIFLUOROMETHANE | UG/KG | 42,095 | none | 5,700 U | 5,200 U | 3,000 U | 14,000 U | 1,800 U | 1,900 U | 30,000 U | 160,000 U | 39,000 U | 28,000 U |
| ETHYLBENZENE | UG/KG | 42,095 | 15,000 | 5,700 U | **1,500 J** | 3,000 U | **17,000** | **770 J** | **590 J** | **5,500 J** | **29,000 J** | **12,000 J** | **8,400 J** |
| METHYLENE CHLORIDE | UG/KG | 42,095 | 19 | 5,700 U | 5,200 U | 3,000 U | 14,000 U | 1,800 U | 1,900 U | 30,000 U | 160,000 U | 39,000 U | 28,000 U |
| TETRACHLOROETHENE | UG/KG | 42,095 | 4.7 | 5,700 U | 5,200 U | 3,000 U | 14,000 U | 1,800 U | 1,900 U | 30,000 U | 160,000 U | 39,000 U | 28,000 U |
| TOLUENE | UG/KG | 42,095 | 27,000 | **3,900 J** | **32,000** | **2,300 J** | **330,000** | **14,000** | **12,000** | **170,000** | **770,000** | **310,000** | **250,000** |
| TRANS-1,2-DICHLOROETHENE | UG/KG | 42,095 | 720 | 5,700 U | 5,200 U | 3,000 U | 14,000 U | 1,800 U | 1,900 U | 30,000 U | 160,000 U | 39,000 U | 28,000 U |
| TRANS-1,3-DICHLOROPROPENE | UG/KG | 42,095 | 3.1 | 5,700 U | 5,200 U | 3,000 U | 14,000 U | 1,800 U | 1,900 U | 30,000 U | 160,000 U | 39,000 U | 28,000 U |
| TRICHLOROETHENE | UG/KG | 42,095 | 0.26 | 5,700 U | 5,200 U | 3,000 U | 14,000 U | 1,800 U | 1,900 U | 30,000 U | 160,000 U | 39,000 U | 28,000 U |
| TRICHLOROFLUOROMETHANE | UG/KG | 42,095 | none | 5,700 U | 5,200 U | 3,000 U | 14,000 U | 1,800 U | 1,900 U | 30,000 U | 160,000 U | 39,000 U | 28,000 U |
| VINYL CHLORIDE | UG/KG | 42,095 | 0.12 | 5,700 U | 5,200 U | 3,000 U | 14,000 U | 1,800 U | 1,900 U | 30,000 U | 160,000 U | 39,000 U | 28,000 U |

[1] depth below ground surface

[2] Protection of groundwater cleanup standard (MDE 2008)

[3] Collected at location BP-03 at a depth of 32-34 feet below ground surface

[4] Collected at location BP-06 at a depth of 12-14 feet below ground surface

**NOTES:** Bolded values represent detected concentrations; Shaded and bold values exceed comparison criteria

**MDL** = method detection limit

**B** (organic) = compound was detected in the method blank.

**J** (organic) = compound detected below reporting limit (value is estimated).

**R** = Data were rejected by the validator and are unusable.

**U** = compound was analyzed, but not detected.

**Table 3-3. (continued)**

| | | | | BP-08 | | | BP-09 | | | BP-10 | BP-11 | BP-DUP1[3] | BP-DUP2[4] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Depth (ft)[1] | 6-8 | 10-12 | 16-18 | 8-10 | 14-16 | 18-20 | 4-6 | 4-6 | -- | -- |
| ANALYTE | UNITS | Average MDL | Soil: Groundwater Standard[2] | | | | | | | | | | |
| 1,1,1-TRICHLOROETHANE | UG/KG | 42,095 | 32,000 | 6,400 U | 1,400 U | 3,500 U | 2,900 U | 290,000 U | 730,000 U | 250 U | 260 U | 3,700 U | 160,000 U |
| 1,1,2,2-TETRACHLOROETHANE | UG/KG | 42,095 | 0.68 | 6,400 U | 1,400 U | 3,500 U | 2,900 U | 290,000 U | 730,000 U | 250 U | 260 U | 3,700 U | 160,000 U |
| 1,1,2-TRICHLOROETHANE | UG/KG | 42,095 | 0.78 | 6,400 U | 1,400 U | 3,500 U | 2,900 U | 290,000 U | 730,000 U | 250 U | 260 U | 3,700 U | 160,000 U |
| 1,1-DICHLOROETHANE | UG/KG | 42,095 | 5,100 | 6,400 U | 1,400 U | 3,500 U | 2,900 U | 290,000 U | 730,000 U | 250 U | 260 U | 3,700 U | 160,000 U |
| 1,1-DICHLOROETHENE | UG/KG | 42,095 | 2,900 | 6,400 U | 1,400 U | 3,500 U | 2,900 U | 290,000 U | 730,000 U | 250 U | 260 U | 3,700 U | 160,000 U |
| 1,2-DICHLOROBENZENE | UG/KG | 42,095 | 4,600 | 6,400 U | 1,400 U | 3,500 U | 2,900 U | 290,000 U | 730,000 U | 250 U | 260 U | 3,700 U | 160,000 U |
| 1,2-DICHLOROETHANE | UG/KG | 42,095 | 1.0 | 6,400 U | 1,400 U | 3,500 U | 2,900 U | 290,000 U | 730,000 U | 250 U | 260 U | 3,700 U | 160,000 U |
| 1,2-DICHLOROPROPANE | UG/KG | 42,095 | 3.4 | 6,400 U | 1,400 U | 3,500 U | 2,900 U | 290,000 U | 730,000 U | 250 U | 260 U | 3,700 U | 160,000 U |
| 1,3-DICHLOROBENZENE | UG/KG | 42,095 | 290 | 6,400 U | 1,400 U | 3,500 U | 2,900 U | 290,000 U | 730,000 U | 250 U | 260 U | 3,700 U | 160,000 U |
| 1,4-DICHLOROBENZENE | UG/KG | 42,095 | 4.2 | 6,400 U | 1,400 U | 3,500 U | 2,900 U | 290,000 U | 730,000 U | 250 U | 260 U | 3,700 U | 160,000 U |
| 2-BUTANONE (MEK) | UG/KG | 42,095 | 29,000 | 6,400 U | 1,400 U | 3,500 U | 2,900 U | 290,000 U | 730,000 U | 250 U | 260 U | 3,700 U | 160,000 U |
| 2-CHLOROETHYL VINYL ETHER | UG/KG | 85,305 | none | 13,000 UJ | 2,900 U | 7,000 UJ | 5,900 UJ | 590,000 U | 1,500,000 U | 510 U | 510 U | 7,300 U | 320,000 U |
| ACROLEIN | UG/KG | 853,053 | none | R | R | R | R | R | R | R | R | R | R |
| ACRYLONITRILE | UG/KG | 853,053 | none | 130,000 UJ | 29,000 UJ | 70,000 UJ | 59,000 UJ | 5,900,000 UJ | 15,000,000 UJ | 5,100 U | 5,100 U | 73,000 U | 3,200,000 UJ |
| BENZENE | UG/KG | 48,295 | 1.9 | **130,000** | **15,000** | **50,000** | **56,000** | **6,100,000** | **5,600,000** | **6,100** | 260 U | **76,000** | **1,700,000** |
| BROMODICHLOROMETHANE | UG/KG | 42,095 | 1.1 | 6,400 U | 1,400 U | 3,500 U | 2,900 U | 290,000 U | 730,000 U | 250 U | 260 U | 3,700 U | 160,000 U |
| BROMOFORM | UG/KG | 42,095 | 67 | 6,400 U | 1,400 U | 3,500 U | 2,900 U | 290,000 U | 730,000 U | 250 U | 260 U | 3,700 U | 160,000 U |
| BROMOMETHANE | UG/KG | 42,095 | 41 | 6,400 U | 1,400 U | 3,500 U | 2,900 U | 290,000 U | 730,000 U | 250 U | 260 U | 3,700 U | 160,000 U |
| CARBON TETRACHLORIDE | UG/KG | 42,095 | 2.1 | 6,400 U | 1,400 U | 3,500 U | 2,900 U | 290,000 U | 730,000 U | 250 U | 260 U | 3,700 U | 160,000 U |
| CHLOROETHANE | UG/KG | 42,095 | 19 | 6,400 U | 1,400 U | 3,500 U | 2,900 U | 290,000 U | 730,000 U | 250 U | 260 U | 3,700 U | 160,000 U |
| CHLOROFORM | UG/KG | 42,095 | 0.91 | 6,400 U | 1,400 U | 3,500 U | 2,900 U | 290,000 U | 730,000 U | 250 U | 260 U | 3,700 U | 160,000 U |
| CHLOROMETHANE | UG/KG | 42,095 | 930 | 6,400 U | 1,400 U | 3,500 U | 2,900 U | 290,000 U | 730,000 U | 250 U | 260 U | 3,700 U | 160,000 U |
| CIS-1,3-DICHLOROPROPENE | UG/KG | 42,095 | 3.1 | 6,400 U | 1,400 U | 3,500 U | 2,900 U | 290,000 U | 730,000 U | 250 U | 260 U | 3,700 U | 160,000 U |
| DIBROMOCHLOROMETHANE | UG/KG | 42,095 | 0.83 | 6,400 U | 1,400 U | 3,500 U | 2,900 U | 290,000 U | 730,000 U | 250 U | 260 U | 3,700 U | 160,000 U |
| DICHLORODIFLUOROMETHANE | UG/KG | 42,095 | none | 6,400 U | 1,400 U | 3,500 U | 2,900 U | 290,000 U | 730,000 U | 250 U | 260 U | 3,700 U | 160,000 U |
| ETHYLBENZENE | UG/KG | 42,095 | 15,000 | **36,000** | **530 J** | **5,600** | **4,100** | **47,000 J** | **350,000 J** | **570** | 260 U | 3,700 U | **210,000 J** |
| METHYLENE CHLORIDE | UG/KG | 42,095 | 19 | 6,400 U | 1,400 U | 3,500 U | 2,900 U | 290,000 U | 730,000 U | 250 U | 260 U | 3,700 U | 160,000 U |
| TETRACHLOROETHENE | UG/KG | 42,095 | 4.7 | 6,400 U | 1,400 U | 3,500 U | 2,900 U | 290,000 U | 730,000 U | 250 U | 260 U | 3,700 U | 160,000 U |
| TOLUENE | UG/KG | 42,095 | 27,000 | **54,000** | **6,700** | **53,000** | **33,000** | **2,900,000** | **3,800,000** | **1,900** | **75 J** | **11,000** | **480,000** |
| TRANS-1,2-DICHLOROETHENE | UG/KG | 42,095 | 720 | 6,400 U | 1,400 U | 3,500 U | 2,900 U | 290,000 U | 730,000 U | 250 U | 260 U | 3,700 U | 160,000 U |
| TRANS-1,3-DICHLOROPROPENE | UG/KG | 42,095 | 3.1 | 6,400 U | 1,400 U | 3,500 U | 2,900 U | 290,000 U | 730,000 U | 250 U | 260 U | 3,700 U | 160,000 U |
| TRICHLOROETHENE | UG/KG | 42,095 | 0.26 | 6,400 U | 1,400 U | 3,500 U | 2,900 U | 290,000 U | 730,000 U | 250 U | 260 U | 3,700 U | 160,000 U |
| TRICHLOROFLUOROMETHANE | UG/KG | 42,095 | none | 6,400 U | 1,400 U | 3,500 U | 2,900 U | 290,000 U | 730,000 U | 250 U | 260 U | 3,700 U | 160,000 U |
| VINYL CHLORIDE | UG/KG | 42,095 | 0.12 | 6,400 U | 1,400 U | 3,500 U | 2,900 U | 290,000 U | 730,000 U | 250 U | 260 U | 3,700 U | 160,000 U |

[1] depth below ground surface

[2] Protection of groundwater cleanup standard (MDE 2008)

[3] Collected at location BP-03 at a depth of 32-34 feet below ground surface

[4] Collected at location BP-06 at a depth of 12-14 feet below ground surface

**NOTES:** Bolded values represent detected concentrations; Shaded and bold values exceed comparison criteria

**MDL** = method detection limit

**B** (organic) = compound was detected in the method blank.

**J** (organic) = compound detected below reporting limit (value is estimated).

**R** = Data were rejected by the validator and are unusable.

**U** = compound was analyzed, but not detected.

**Table 3-4. Volatile Organic Compound Concentrations in Fill Material from the Coal Tar Storage Area**
**Coke Point Peninsula, Sparrows Point Site Assessment (2009), Baltimore, Maryland**

| | | | | CT-01 | | | CT-02 | | | CT-03 | | | CT-04 | | | CT-05 | | | CT-DUP1[3] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Depth (ft)[1] | 10-12 | 14-16 | 18-20 | 12-14 | 16-18 | 20-22 | 10-12 | 20-22 | 22-24 | 10-12 | 14-16 | 18-20 | 8-10 | 16-18 | 20-22 | -- |
| ANALYTE | UNITS | Average MDL | Soil: Groundwater Standard[2] | | | | | | | | | | | | | | | | |
| 1,1,1-TRICHLOROETHANE | UG/KG | 42,095 | 32,000 | 280 U | 290 U | 1,600 U | 320 U | 300 U | 1,800 U | 5.7 U | 290 U | 280 U | 310 U | 300 U | 300 U | 270 U | 300 U | 310 U | 280 U |
| 1,1,2,2-TETRACHLOROETHANE | UG/KG | 42,095 | 0.68 | 280 U | 290 U | 1,600 U | 320 U | 300 U | 1,800 U | 5.7 U | 290 U | 280 U | 310 U | 300 U | 300 U | 270 U | 300 U | 310 U | 280 U |
| 1,1,2-TRICHLOROETHANE | UG/KG | 42,095 | 0.78 | 280 U | 290 U | 1,600 U | 320 U | 300 U | 1,800 U | 5.7 U | 290 U | 280 U | 310 U | 300 U | 300 U | 270 U | 300 U | 310 U | 280 U |
| 1,1-DICHLOROETHANE | UG/KG | 42,095 | 5,100 | 280 U | 290 U | 1,600 U | 320 U | 300 U | 1,800 U | 5.7 U | 290 U | 280 U | 310 U | 300 U | 300 U | 270 U | 300 U | 310 U | 280 U |
| 1,1-DICHLOROETHENE | UG/KG | 42,095 | 2,900 | 280 U | 290 U | 1,600 UJ | 320 U | 300 U | 1,800 U | 5.7 U | 290 U | 280 U | 310 U | 300 U | 300 U | 270 U | 300 U | 310 U | 280 U |
| 1,2-DICHLOROBENZENE | UG/KG | 42,095 | 4,600 | 280 U | 290 U | 1,600 U | 320 U | 300 U | 1,800 U | 5.7 U | 290 U | 280 U | 310 U | 300 U | 300 U | 270 U | 300 U | 310 U | 280 U |
| 1,2-DICHLOROETHANE | UG/KG | 42,095 | 1.0 | 280 U | 290 U | 1,600 U | 320 U | 300 U | 1,800 U | 5.7 U | 290 U | 280 U | 310 U | 300 U | 300 U | 270 U | 300 U | 310 U | 280 U |
| 1,2-DICHLOROPROPANE | UG/KG | 42,095 | 3.4 | 280 U | 290 U | 1,600 U | 320 U | 300 U | 1,800 U | 5.7 U | 290 U | 280 U | 310 U | 300 U | 300 U | 270 U | 300 U | 310 U | 280 U |
| 1,3-DICHLOROBENZENE | UG/KG | 42,095 | 290 | 280 U | 290 U | 1,600 U | 320 U | 300 U | 1,800 U | 5.7 U | 290 U | 280 U | 310 U | 300 U | 300 U | 270 U | 300 U | 310 U | 280 U |
| 1,4-DICHLOROBENZENE | UG/KG | 42,095 | 4.2 | 280 U | 290 U | 1,600 U | 320 U | 300 U | 1,800 U | 5.7 U | 290 U | 280 U | 310 U | 300 U | 300 U | 270 U | 300 U | 310 U | 280 U |
| 2-BUTANONE (MEK) | UG/KG | 42,095 | 29,000 | 280 U | 290 U | 1,600 U | 320 U | 300 U | 1,800 U | 5.7 U | 290 U | 280 U | 310 U | 300 U | 300 U | 270 U | 300 U | 310 U | 280 U |
| 2-CHLOROETHYL VINYL ETHER | UG/KG | 85,305 | none | 560 U | 580 U | 3,200 U | 640 U | 610 U | 3,600 U | 11 U | 580 U | 570 U | 620 U | 590 U | 600 U | 540 U | 600 U | 630 U | 570 U |
| ACROLEIN | UG/KG | 853,053 | none | R | R | R | R | R | R | R | R | R | R | R | R | R | R | R | R |
| ACRYLONITRILE | UG/KG | 853,053 | none | 5,600 U | 5,800 U | 32,000 U | 6,400 U | 6,100 U | 36,000 U | 110 U | 5800 U | 5700 U | 6,200 U | 5,900 U | 6,000 U | 5400 U | 6,000 U | 6,300 U | 5,700 U |
| BENZENE | UG/KG | 48,295 | 1.9 | **490** | **630** | **15,000 L** | **170 J** | **1,600** | **13,000** | 5.7 U | **680** | **320** | **510** | **750** | **4,700** | **120 J** | **1,700** | **7,100** | **400** |
| BROMODICHLOROMETHANE | UG/KG | 42,095 | 1.1 | 280 U | 290 U | 1,600 U | 320 U | 300 U | 1,800 U | 5.7 U | 290 U | 280 U | 310 U | 300 U | 300 U | 270 U | 300 U | 310 U | 280 U |
| BROMOFORM | UG/KG | 42,095 | 67 | 280 U | 290 U | 1,600 U | 320 U | 300 U | 1,800 U | 5.7 U | 290 U | 280 U | 310 U | 300 U | 300 U | 270 U | 300 U | 310 U | 280 U |
| BROMOMETHANE | UG/KG | 42,095 | 41 | 280 U | 290 U | 1,600 U | 320 U | 300 U | 1,800 U | 5.7 U | 290 U | 280 U | 310 U | 300 U | 300 U | 270 U | 300 U | 310 U | 280 U |
| CARBON TETRACHLORIDE | UG/KG | 42,095 | 2.1 | 280 U | 290 U | 1,600 U | 320 U | 300 U | 1,800 U | 5.7 U | 290 U | 280 U | 310 U | 300 U | 300 U | 270 U | 300 U | 310 U | 280 U |
| CHLOROETHANE | UG/KG | 42,095 | 19 | 280 U | 290 U | 1,600 U | 320 U | 300 U | 1,800 U | 5.7 U | 290 U | 280 U | 310 U | 300 U | 300 U | 270 U | 300 U | 310 U | 280 U |
| CHLOROFORM | UG/KG | 42,095 | 0.91 | 280 U | 290 U | 1,600 U | 320 U | 300 U | 1,800 U | 5.7 U | 290 U | 280 U | 310 U | 300 U | 300 U | 270 U | 300 U | 310 U | 280 U |
| CHLOROMETHANE | UG/KG | 42,095 | 930 | 280 U | 290 U | 1,600 U | 320 U | 300 U | 1,800 U | 5.7 U | 290 U | 280 U | 310 U | 300 U | 300 U | 270 U | 300 U | 310 U | 280 U |
| CIS-1,3-DICHLOROPROPENE | UG/KG | 42,095 | 3.1 | 280 U | 290 U | 1,600 U | 320 U | 300 U | 1,800 U | 5.7 U | 290 U | 280 U | 310 U | 300 U | 300 U | 270 U | 300 U | 310 U | 280 U |
| DIBROMOCHLOROMETHANE | UG/KG | 42,095 | 0.83 | 280 U | 290 U | 1,600 U | 320 U | 300 U | 1,800 U | 5.7 U | 290 U | 280 U | 310 U | 300 U | 300 U | 270 U | 300 U | 310 U | 280 U |
| DICHLORODIFLUOROMETHANE | UG/KG | 42,095 | none | 280 U | 290 U | 1,600 U | 320 U | 300 U | 1,800 U | 5.7 U | 290 U | 280 U | 310 U | 300 U | 300 U | 270 U | 300 U | 310 U | 280 U |
| ETHYLBENZENE | UG/KG | 42,095 | 15,000 | **54 J** | **58 J** | **1,300 J** | 320 U | **290 J** | **1,700 J** | 5.7 U | **120 J** | **95 J** | 310 U | **40 J** | **320** | 270 U | **110 J** | **540** | **120 J** |
| METHYLENE CHLORIDE | UG/KG | 42,095 | 19 | 280 U | 290 U | 1,600 U | 320 U | 300 U | 1,800 U | **2 B** | 290 U | 280 U | 310 U | 300 U | 300 U | 270 U | 300 U | 310 U | 280 U |
| TETRACHLOROETHENE | UG/KG | 42,095 | 4.7 | 280 U | 290 U | 1,600 U | 320 U | 300 U | 1,800 U | 5.7 U | 290 U | 280 U | 310 U | 300 U | 300 U | 270 U | 300 U | 310 U | 280 U |
| TOLUENE | UG/KG | 42,095 | 27,000 | **380** | **510** | **26,000 L** | **400 B** | **4,500** | **33,000** | 5.7 U | **740** | **430** | **280 J** | 300 U | **4,500** | **320 B** | **2,000 B** | **10,000** | **560** |
| TRANS-1,2-DICHLOROETHENE | UG/KG | 42,095 | 720 | 280 U | 290 U | 1,600 U | 320 U | 300 U | 1,800 U | 5.7 U | 290 U | 280 U | 310 U | 300 U | 300 U | 270 U | 300 U | 310 U | 280 U |
| TRANS-1,3-DICHLOROPROPENE | UG/KG | 42,095 | 3.1 | 280 U | 290 U | 1,600 U | 320 U | 300 U | 1,800 U | 5.7 U | 290 U | 280 U | 310 U | 300 U | 300 U | 270 U | 300 U | 310 U | 280 U |
| TRICHLOROETHENE | UG/KG | 42,095 | 0.26 | 280 U | 290 U | 1,600 UL | 320 U | 300 U | 1,800 U | **2.6 J** | 290 U | 280 U | 310 U | 300 U | 300 U | 270 U | 300 U | 310 U | 280 U |
| TRICHLOROFLUOROMETHANE | UG/KG | 42,095 | none | 280 U | 290 U | 1,600 U | 320 U | 300 U | 1,800 U | 5.7 U | 290 U | 280 U | 310 U | 300 U | 300 U | 270 U | 300 U | 310 U | 280 U |
| VINYL CHLORIDE | UG/KG | 42,095 | 0.12 | 280 U | 290 U | 1,600 U | 320 U | 300 U | 1,800 U | 5.7 U | 290 U | 280 U | 310 U | 300 U | 300 U | 270 U | 300 U | 310 U | 280 U |

[1] depth below ground surface

[2] Protection of groundwater cleanup standard (MDE 2008)

[3] Collected at location CT-03 at a depth of 20-22 feet below ground surface

**NOTES:** Bold values represent detected concentrations
Shaded and bold values exceed comparison criteria

**MDL** = method detection limit

**B** (organic) = compound was detected in the method blank.

**J** (organic) = compound was detected, but below the reporting limit (value is estimated).

**L** = The reported value may be biased low, the actual value is expected to be higher than reported.

**R** = Data were rejected by the validator and are unusable.

**U** = compound was analyzed, but not detected.

## Table 3-5. Polycyclic Aromatic Hydrocarbon Concentrations in Fill Material from the Benzol Processing and Graving Dock Areas

**Coke Point Peninsula, Sparrows Point Site Assessment (2009), Baltimore, Maryland**

| | | | | BP-01 | | | BP-02 | | | BP-03 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Depth (ft)[2] | 8-10 | 14-16 | 20-22 | 8-10 | 14-16 | 20-22 | 4-6 | 12-14 | 32-34 |
| ANALYTE | UNITS[1] | Average MDL | Soil: Groundwater Standard[3] | | | | | | | | | |
| ACENAPHTHENE | MG/KG | 1.16 | 100 | **0.94** | **0.71** | **1.5** | 0.37 U | **2.0** | **2.0** | **0.014** | **0.0072** | **0.20** |
| ACENAPHTHYLENE | MG/KG | 1.16 | 100 | **4.1** | **1.5** | **4.2** | **0.84** | **1.8** | **1.4** | **0.0038** | **0.0078** | **1.0** |
| ANTHRACENE | MG/KG | 5.72 | 470 | **8.4** | **1.4** | **11** | **1.8** | **7.8** | **4.4** | **0.0056 J** | **0.012 J** | **1.5** |
| BENZO(A)ANTHRACENE | MG/KG | 1.16 | 0.48 | **12** | **2.6** | **14** | **3.8** | **10** | **6.3** | **0.028** | **0.0073** | **2.1** |
| BENZO(A)PYRENE | MG/KG | 1.16 | 0.12 | **10** | **1.8** | **9.8 J** | **3.0** | **9** | **3.4** | **0.047** | **0.0084** | **1.4** |
| BENZO(B)FLUORANTHENE | MG/KG | 1.16 | 1.50 | **12** | **3.2** | **16 J** | **5.4** | **14** | **6.3** | **0.065** | **0.013** | **1.5** |
| BENZO(GHI)PERYLENE | MG/KG | 1.16 | 680 | **6.2** | **1.2** | **5.4 J** | **1.9** | **6.3** | **1.6** | **0.047** | **0.0088** | **0.93** |
| BENZO(K)FLUORANTHENE | MG/KG | 1.16 | 15.0 | **5.5** | 0.22 U | 0.42 U | 0.37 U | 0.64 U | 1.3 U | 0.0038 U | 0.0037 U | **0.77** |
| CHRYSENE | MG/KG | 1.16 | 48.0 | **13** | **2** | **14** | **3.5** | **10** | **7.1** | **0.030** | **0.0078** | **2.1** |
| DIBENZO(A,H)ANTHRACENE | MG/KG | 1.16 | 0.46 | **2.0** | **0.21 J** | **1.6 J** | **0.62** | **1.5** | **0.55 J** | **0.012** | **0.002 J** | **0.32** |
| FLUORANTHENE | MG/KG | 1.91 | 6,300 | **18** | **6.7** | **39** | **7.6** | **24** | **17** | **0.029** | **0.018** | **4.8** |
| FLUORENE | MG/KG | 1.16 | 140 | **11** | **8.9** | **8.9** | **15** | 0.64 U | **6.1** | **0.0058** | **0.011** | **2.3** |
| INDENO(1,2,3-CD)PYRENE | MG/KG | 1.16 | 4.20 | **5.9** | **1.1** | **5.2 J** | **1.8** | **5.4** | **1.5** | **0.042** | **0.0073** | **0.81** |
| 1-METHYLNAPHTHALENE | MG/KG | 1.16 | none | **3.7** | **1.4** | **3.7** | **2.4** | **2.6** | **11** | **0.017** | **0.018** | **0.76** |
| 2-METHYLNAPHTHALENE | MG/KG | 1.90 | 4.40 | **7.4** | **2.1** | **7.8** | **5.3** | **4.3** | **23** | **0.027** | **0.038** | **1.8** |
| NAPHTHALENE | MG/KG | 2.36 | 0.15 | **29** | **67** | **48** | **63** | **45** | **260** | **0.22** | **0.46** | **16** |
| PHENANTHRENE | MG/KG | 1.93 | 470 | **18** | **5.7** | **36** | **8.7** | **24** | **20** | **0.033** | **0.051** | **4.6** |
| PYRENE | MG/KG | 1.16 | 680 | **16** | **4.5** | **20** | **6.1** | **19** | **10** | **0.027** | **0.013** | **3.2** |
| TOTAL PAHs (ND=0) | MG/KG | -- | -- | 183 | 112 | 246 | 131 | 187 | 381 | 0.653 | 0.691 | 46.1 |
| TOTAL PAHs (ND=1/2MDL) | MG/KG | -- | -- | 183 | 113 | 246 | 131 | 188 | 382 | 0.655 | 0.692 | 46.1 |
| TOTAL PAHs (ND=MDL) | MG/KG | -- | -- | 183 | 113 | 247 | 132 | 188 | 383 | 0.657 | 0.694 | 46.1 |

[1] Values were converted from μg/kg (as reported in laboratory analytical results).

[2] depth below ground surface

[3] Protection of groundwater cleanup standard (MDE 2008)

[4] Collected at location BP-03 at a depth of 32-34 feet below ground surface

[5] Collected at location BP-06 at a depth of 12-14 feet below ground surface

**NOTES:** Bold values represent detected concentrations

Shaded and bold values exceed comparison criteria

**MDL** = method detection limit

**J** (organic) = compound detected below reporting limit (value is estimated).

**U** = compound was analyzed, but not detected.

## Table 3-5. (continued)

| ANALYTE | UNITS[1] | Average MDL | Soil: Groundwater Standard[3] | BP-04 Depth (ft)[2] 10-12 | BP-04 16-18 | BP-04 24-26 | BP-05 8-10 | BP-05 14-16 | BP-05 20-22 | BP-06 8-10 | BP-06 12-14 | BP-06 16-18 | BP-07 12-14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ACENAPHTHENE | MG/KG | 1.16 | 100 | **0.16** | **1.1** | **1.7** | **4.6** | **0.8** | **0.84** | **8.2** | **2 J** | **0.16** | **1.9** |
| ACENAPHTHYLENE | MG/KG | 1.16 | 100 | **0.029 J** | **0.34** | **1.6** | **19** | **3.1** | **3.7** | **8.2** | **8.4** | **0.61** | **8.7** |
| ANTHRACENE | MG/KG | 5.72 | 470 | **0.061 J** | **2.4** | **3.2** | **2.3** | **0.44 J** | **0.54 J** | **1.9** | **1.2 J** | **0.12 J** | **1.1 J** |
| BENZO(A)ANTHRACENE | MG/KG | 1.16 | 0.48 | **0.087 J** | **3.2** | **4.2** | **1.1** | **0.20 J** | **0.51 J** | 6.2 U | 6.8 U | **0.084** | **0.46 J** |
| BENZO(A)PYRENE | MG/KG | 1.16 | 0.12 | **0.06 J** | **2.5** | **3.6** | **0.78** | 0.51 U | **0.45 J** | 6.2 U | 6.8 U | **0.065** | **0.30 J** |
| BENZO(B)FLUORANTHENE | MG/KG | 1.16 | 1.50 | **0.10** | **3.6** | **5.6** | **1.2** | **0.11 J** | **0.37 J** | 6.2 U | 6.8 U | **0.087** | **0.27 J** |
| BENZO(GHI)PERYLENE | MG/KG | 1.16 | 680 | 0.1 U | **1.5** | **1.8** | **0.51 J** | 0.51 U | **0.19 J** | 6.2 U | 6.8 U | **0.037 J** | 0.79 U |
| BENZO(K)FLUORANTHENE | MG/KG | 1.16 | 15.0 | 0.1 U | 0.19 U | 0.89 U | 0.74 U | 0.51 U | 0.54 U | 6.2 U | 6.8 U | 0.053 U | 0.79 U |
| CHRYSENE | MG/KG | 1.16 | 48.0 | **0.075 J** | **3.1** | **4.0** | **1** | **0.21 J** | **0.51 J** | 6.2 U | 6.8 U | **0.080** | **0.44 J** |
| DIBENZO(A,H)ANTHRACENE | MG/KG | 1.16 | 0.46 | 0.1 U | **0.40** | **0.52 J** | 0.74 U | 0.51 U | 0.54 U | 6.2 U | 6.8 U | 0.053 U | 0.79 U |
| FLUORANTHENE | MG/KG | 1.91 | 6,300 | **0.20** | **7.0** | **10** | **3.7** | **0.63** | **1.2** | **3.2 J** | **2.1 J** | **0.26** | **1.4** |
| FLUORENE | MG/KG | 1.16 | 140 | 0.1 U | **1.6** | **3.0** | **14** | **2.5** | **2.8** | **10** | **9.1** | **0.58** | **6.8** |
| INDENO(1,2,3-CD)PYRENE | MG/KG | 1.16 | 4.20 | 0.1 U | **1.5** | **1.8** | **0.46 J** | 0.51 U | **0.23 J** | 6.2 U | 6.8 U | **0.034 J** | 0.79 U |
| 1-METHYLNAPHTHALENE | MG/KG | 1.16 | none | **0.33** | **0.74** | **1.1** | **24** | **3.8** | **4.4** | **18** | **16** | **1.0** | **11** |
| 2-METHYLNAPHTHALENE | MG/KG | 1.90 | 4.40 | **0.64** | **1.3** | **3.0** | **64** | **10** | **11** | **44** | **40** | **2.6** | **29** |
| NAPHTHALENE | MG/KG | 2.36 | 0.15 | **7.3** | **12** | **19** | **1,000** | **130** | **120** | **710** | **720** | **34** | **420** |
| PHENANTHRENE | MG/KG | 1.93 | 470 | **0.31** | **8.0** | **11** | **15** | **2.7** | **3.2** | **12** | **8.5** | **0.86** | **7.2** |
| PYRENE | MG/KG | 1.16 | 680 | **0.15** | **5.2** | **6.5** | **3.1** | **0.49 J** | **0.89** | **2.8 J** | 6.8 U | **0.22** | **1.4** |
| TOTAL PAHs (ND=0) | MG/KG | -- | -- | 9.50 | 55.5 | 81.5 | 1,155 | 155 | 151 | 818 | 807 | 40.8 | 490 |
| TOTAL PAHs (ND=1/2MDL) | MG/KG | -- | -- | 9.75 | 55.6 | 82.0 | 1,155 | 156 | 151 | 843 | 838 | 40.9 | 492 |
| TOTAL PAHs (ND=MDL) | MG/KG | -- | -- | 10.0 | 55.7 | 82.4 | 1,155 | 157 | 152 | 868 | 869 | 40.9 | 493 |

[1] Values were converted from μg/kg (as reported in laboratory analytical results).

[2] depth below ground surface

[3] Protection of groundwater cleanup standard (MDE 2008)

[4] Collected at location BP-03 at a depth of 32-34 feet below ground surface

[5] Collected at location BP-06 at a depth of 12-14 feet below ground surface

**NOTES:** Bold values represent detected concentrations
Shaded and bold values exceed comparison criteria

**MDL** = method detection limit

**J** (organic) = compound detected below reporting limit (value is estimated).

**U** = compound was analyzed, but not detected.

## Table 3-5. (continued)

| ANALYTE | UNITS[1] | Average MDL | Soil: Groundwater Standard[3] | BP-08 | | | BP-09 | | | BP-10 | BP-11 | BP-DUP1[4] | BP-DUP2[5] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Depth (ft)[2] | 6-8 | 10-12 | 16-18 | 8-10 | 14-16 | 18-20 | 4-6 | 4-6 | -- | -- |
| ACENAPHTHENE | MG/KG | 1.16 | 100 | **14** | **2.7** | **1.1** | **2.0 J** | **3.1 J** | **0.71 J** | **4.3** | **0.025** | **0.23** | **1.3 J** |
| ACENAPHTHYLENE | MG/KG | 1.16 | 100 | **2.7 J** | **1.2** | **1.5** | **1.4 J** | **5.4** | **1.1 J** | **3.6** | **0.024** | **1.0** | **6.3** |
| ANTHRACENE | MG/KG | 5.72 | 470 | **1.7 J** | **0.52** | **0.35 J** | 10 U | **27** | **7.8 J** | **1.1 J** | **0.020 J** | **1.4** | **0.78 J** |
| BENZO(A)ANTHRACENE | MG/KG | 1.16 | 0.48 | 4.4 U | 0.76 U | **0.18 J** | 2.1 U | **29** | **11** | **0.9** | 0.0081 U | **2.2** | 1.7 U |
| BENZO(A)PYRENE | MG/KG | 1.16 | 0.12 | 4.4 U | 0.76 U | **0.1 J** | **0.87 J** | **26** | **8.5** | **0.65 J** | **0.011** | **1.4** | 1.7 U |
| BENZO(B)FLUORANTHENE | MG/KG | 1.16 | 1.50 | 4.4 U | 0.76 U | **0.11 J** | **1.1 J** | **37** | **13** | **0.64 J** | **0.029** | **1.8** | 1.7 U |
| BENZO(GHI)PERYLENE | MG/KG | 1.16 | 680 | 4.4 U | 0.76 U | 0.24 U | **0.86 J** | **14** | **2.8** | **0.46 J** | **0.011** | **0.93** | 1.7 U |
| BENZO(K)FLUORANTHENE | MG/KG | 1.16 | 15.0 | 4.4 U | 0.76 U | 0.24 U | 2.1 U | 4.1 U | 2.5 U | 0.83 U | 0.0081 U | **0.53** | 1.7 U |
| CHRYSENE | MG/KG | 1.16 | 48.0 | 4.4 U | 0.76 U | **0.15 J** | 2.1 U | **3.1** | **11** | **0.81 J** | **0.092** | **2.2** | 1.7 U |
| DIBENZO(A,H)ANTHRACENE | MG/KG | 1.16 | 0.46 | 4.4 U | 0.76 U | 0.24 U | 2.1 U | 4.1 U | **1.1 J** | 0.83 U | **0.0041 J** | **0.34** | 1.7 U |
| FLUORANTHENE | MG/KG | 1.91 | 6,300 | **1.9 J** | **0.75 J** | **0.55** | **1.8 J** | **89** | **26** | **2.9** | **0.084** | **4.8** | **1.5 J** |
| FLUORENE | MG/KG | 1.16 | 140 | **6.7** | **1.7** | **1.40** | **6.1** | **18** | 2.5 U | **3.0** | **0.76** | **2.4** | **7.0** |
| INDENO(1,2,3-CD)PYRENE | MG/KG | 1.16 | 4.20 | 4.4 U | 0.76 U | 0.24 U | **0.40 J** | **12** | **3.6** | **0.360 J** | **0.0087** | **0.82** | 1.7 U |
| 1-METHYLNAPHTHALENE | MG/KG | 1.16 | none | **10** | **2.2** | **2.0** | **3.7** | **5.9** | **3.6** | **1.4** | **0.20** | **0.86** | **11** |
| 2-METHYLNAPHTHALENE | MG/KG | 1.90 | 4.40 | **22** | **5.4** | **5.0** | **7.6** | **14** | **7.7** | **2.1** | **0.50** | **2.0** | **28** |
| NAPHTHALENE | MG/KG | 2.36 | 0.15 | **550** | **90** | **74** | **82** | **110** | **130** | **25** | **2.2** | **17** | **340** |
| PHENANTHRENE | MG/KG | 1.93 | 470 | **8.0** | **2.3** | **1.9** | **2.9** | **94** | **21** | **3.5** | **0.30** | **4.4** | **5.8** |
| PYRENE | MG/KG | 1.16 | 680 | **1.4 J** | **0.51 J** | **0.41** | **2.3** | **52** | **20** | **2.1** | **0.085** | **3.3** | **1.3** |
| TOTAL PAHs (ND=0) | MG/KG | -- | -- | 618 | 107 | 88.8 | 113 | 567 | 268 | 52.8 | 4.35 | 47.6 | 403 |
| TOTAL PAHs (ND=1/2MDL) | MG/KG | -- | -- | 636 | 110 | 89.2 | 122 | 572 | 271 | 53.6 | 4.36 | 47.6 | 410 |
| TOTAL PAHs (ND=MDL) | MG/KG | -- | -- | 653 | 113 | 89.7 | 131 | 576 | 273 | 54.5 | 4.37 | 47.6 | 417 |

[1] Values were converted from μg/kg (as reported in laboratory analytical results).

[2] depth below ground surface

[3] Protection of groundwater cleanup standard (MDE 2008)

[4] Collected at location BP-03 at a depth of 32-34 feet below ground surface

[5] Collected at location BP-06 at a depth of 12-14 feet below ground surface

**NOTES:** Bold values represent detected concentrations
Shaded and bold values exceed comparison criteria
**MDL** = method detection limit
**J** (organic) = compound detected below reporting limit (value is estimated).
**U** = compound was analyzed, but not detected.

## Table 3-6. Polycyclic Aromatic Hydrocarbon Concentrations in Fill Material from the Coal Tar Storage Area

**Coke Point Peninsula, Sparrows Point Site Assessment (2009), Baltimore, Maryland**

| | | | | CT-01 | | | CT-02 | | | CT-03 | | | CT-04 | | | CT-05 | | | CT-DUP1[4] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Depth (ft)[2] | 10-12 | 14-16 | 18-20 | 12-14 | 16-18 | 20-22 | 10-12 | 20-22 | 22-24 | 10-12 | 14-16 | 18-20 | 8-10 | 16-18 | 20-22 | -- |
| ANALYTE | UNITS[1] | Average MDL | Soil: Groundwater Standard[3] | | | | | | | | | | | | | | | | |
| ACENAPHTHENE | MG/KG | 1.16 | 100 | **0.047 J** | **0.052** | **19** | **0.027** | **0.91** | **4.4** | **0.038 J** | **3.7 J** | **0.77** | **0.16 J** | **0.12** | **4.9** | **0.011 J** | **0.07** | **3.1 J** | **0.70 J** |
| ACENAPHTHYLENE | MG/KG | 1.16 | 100 | **0.086 J** | **0.14** | **350** | **0.087** | **14.0** | **83.0** | **0.015** | **31 J** | **7.1** | **0.77** | **0.67** | **56** | **0.024 J** | **0.66** | **56** | **6.6 J** |
| ANTHRACENE | MG/KG | 5.72 | 470 | **0.21 J** | **0.26** | **140** | **0.072** | **4.5** | **33.0** | **0.026** | **30 J** | **1.7** | **0.7 J** | **0.86** | **33** | **0.081 J** | **0.088 J** | **31 J** | **1.6 J** |
| BENZO(A)ANTHRACENE | MG/KG | 1.16 | 0.48 | **0.77 J** | **0.54** | **130** | **0.15** | **3.80** | **29.0** | **0.14** | **24 J** | **0.54** | **1.5** | **1.4** | **34** | **0.51** | **0.046** | **25** | **0.53 J** |
| BENZO(A)PYRENE | MG/KG | 1.16 | 0.12 | **0.47 J** | **0.39** | **99** | **0.11** | **3.0** | **22.0** | **0.11** | **18 J** | **0.38** | **1.2** | **1.2** | **28** | **0.36** | **0.032 J** | **20** | **0.42 J** |
| BENZO(B)FLUORANTHENE | MG/KG | 1.16 | 1.50 | **1.0 J** | **0.68** | **130** | **0.19** | **4.0** | **29** | **0.22** | **25 J** | **0.55** | **2.2** | **1.6** | **36** | **0.79** | **0.06** | **29** | **0.59 J** |
| BENZO(GHI)PERYLENE | MG/KG | 1.16 | 680 | **0.41 J** | **0.28** | **47** | **0.08** | **1.40** | **9.5** | **0.086** | **9.4 J** | **0.25** | **0.78** | **0.61** | **13** | **0.32** | **0.022 J** | **11** | **0.22 J** |
| BENZO(K)FLUORANTHENE | MG/KG | 1.16 | 15.0 | **0.037 J** | 0.039 U | 1.8 U | 0.079 U | 0.58 U | 1.3 U | 0.039 U | 0.6 U | 0.27 U | 0.35 U | 0.10 U | 1.8 U | 0.056 U | 0.039 U | 8.4 U | 0.19 J |
| CHRYSENE | MG/KG | 1.16 | 48.0 | **1.1 J** | **0.60** | **110** | **0.16** | **3.3** | **24** | **0.17** | **20 J** | **0.56** | **1.8** | **1.3** | **32** | **0.58** | **0.05** | **27** | **0.58 J** |
| DIBENZO(A,H)ANTHRACENE | MG/KG | 1.16 | 0.46 | **0.12 J** | **0.077** | **14** | **0.026** | **0.31 J** | **3.4** | **0.028** | **3.0 J** | **0.068 J** | **0.29** | **0.17** | **4.0** | **0.09** | 0.039 U | **2.2 J** | **0.061 J** |
| FLUORANTHENE | MG/KG | 1.91 | 6,300 | **2.6 J** | **1.30** | **19** | **0.36** | **10** | **73** | **0.32** | **84 J** | **3.2** | **3.1** | **2.8** | **86** | **1.1** | **0.14** | **66** | **3.0 J** |
| FLUORENE | MG/KG | 1.16 | 140 | **0.11 J** | **0.19** | **190** | **0.059** | **7.1** | **45** | **0.008** | **32 J** | **5.3** | **0.63** | **0.60** | **47** | 0.056 U | **0.42** | **35** | **5.0 J** |
| INDENO(1,2,3-CD)PYRENE | MG/KG | 1.16 | 4.20 | **0.33 J** | **0.25** | **46** | **0.072** | **1.4** | **10** | **0.083** | **9.5 J** | **0.25 J** | **0.73** | **0.62** | **13** | **0.30** | **0.0096 J** | **10** | **0.22 J** |
| 1-METHYLNAPHTHALENE | MG/KG | 1.16 | none | **0.23 J** | **0.12** | **160** | **0.075** | **6.7** | **36** | **0.010** | **8.5 J** | **3.6** | **1.0** | **0.48** | **34** | **0.07** | **0.43** | **18** | **3.3** |
| 2-METHYLNAPHTHALENE | MG/KG | 1.90 | 4.40 | **0.36 J** | **0.29** | **22** | **0.18** | **16** | **90** | **0.019** | **13** | **8.5** | **1.9** | **1.2** | **83** | **0.14** | **1.1** | **46** | **8.1** |
| NAPHTHALENE | MG/KG | 2.36 | 0.15 | **0.93 J** | **2.00** | **230** | **1.5 K** | **110** | **660** | **0.16** | **81** | **43** | **10** | **7.1** | **470** | **0.74** | **7.7** | **570** | **40.0** |
| PHENANTHRENE | MG/KG | 1.93 | 470 | **2.0 J** | **1.10** | **28** | **0.29** | **16** | **110** | **0.16** | **120** | **11** | **3.5** | **2.6** | **130** | **0.68** | **0.45** | **100** | **10 J** |
| PYRENE | MG/KG | 1.16 | 680 | **1.4 J** | **0.84** | **200** | **0.24** | **6.0** | **43** | **0.20** | **44** | **1.8** | **2.2** | **2.0** | **56** | **0.88** | **0.11** | **50** | **1.7 J** |
| TOTAL PAHs (ND=0) | MG/KG | -- | -- | 12.2 | 9.1 | 1,934 | 3.7 | 208 | 1,304 | 1.8 | 556 | 88.6 | 32.0 | 25.3 | 1,160 | 6.7 | 11.4 | 1,099 | 82.6 |
| TOTAL PAHs (ND=1/2MDL) | MG/KG | -- | -- | 12.2 | 9.1 | 1,935 | 3.7 | 208 | 1,305 | 1.8 | 556 | 88.7 | 32.2 | 25.4 | 1,161 | 6.7 | 11.4 | 1,104 | 82.7 |
| TOTAL PAHs (ND=MDL) | MG/KG | -- | -- | 12.2 | 9.1 | 1,936 | 3.7 | 209 | 1,306 | 1.8 | 557 | 88.8 | 32.4 | 25.4 | 1,162 | 6.8 | 11.5 | 1,108 | 82.8 |

[1] Values were converted from µg/kg (as reported in laboratory analytical results).

[2] depth below ground surface

[3] Non-residential cleanup standard (MDE 2008)

[4] Collected at location CT-03 at a depth of 20-22 feet below ground surface

**NOTES:** Bold values represent detected concentrations

Shaded and bold values exceed comparison criteria

**MDL** = method detection limit

**J** (organic) = compound detected below reporting limit (value is estimated).

**K** = reported value may be biased high; actual may be lower than reported.

**U** = compound was analyzed, but not detected.

## Table 3-7. General Chemistry and Metals Concentrations in Fill Material from the Benzol Processing and Graving Dock Areas

**Coke Point Peninsula, Sparrows Point Site Assessment (2009), Baltimore, Maryland**

| | | | | BP-01 | | | BP-02 | | | BP-03 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Depth (ft)[1] | 8-10 | 14-16 | 20-22 | 8-10 | 14-16 | 20-22 | 4-6 | 12-14 | 32-34 |
| ANALYTE | UNITS | Average RL/MDL[2] | Soil: Groundwater Standard[3] | | | | | | | | | |
| ANTIMONY | MG/KG | 0.479 | 13 | **1.1 L** | **1.2 L** | **6 L** | **11.9 J** | **0.8 J** | **17.1 J** | **0.54 L** | **0.52 L** | **2.4 L** |
| ARSENIC | MG/KG | 0.240 | 0.026 | **16.5 K** | **6 K** | **34.3 K** | **11.4** | **10.2** | **43.1** | **2.6 L** | **2.8 L** | **17.4 K** |
| BERYLLIUM | MG/KG | 0.240 | 1,200 | **1.1** | **0.66** | **1.3** | **0.62 J** | **0.48 J** | **0.7 J** | **0.36 J** | **0.36 J** | **0.66** |
| CADMIUM | MG/KG | 0.240 | 27 | **1.7** | **0.92** | **25.5** | **6.5 L** | **1 L** | **41.6 L** | **0.4 J** | **0.39 J** | **5.1** |
| CHROMIUM | MG/KG | 0.479 | 42 | **309** | **57.9** | **133** | **633 L** | **31.9 L** | **242 L** | **1,580** | **1,620** | **1,140** |
| COPPER | MG/KG | 0.479 | 11,000 | **148 K** | **35.1 K** | **268 K** | **224 L** | **39.6 L** | **562 L** | **46.9 L** | **40 L** | **88.1 K** |
| LEAD | MG/KG | 0.240 | 1,000 | **330** | **173** | **5,420** | **3,050** | **768** | **7,220** | **43.2** | **26** | **930** |
| MERCURY | MG/KG | 0.055 | none | **2.3** | **10** | **2.5** | **0.41** | **0.15** | **0.62** | 0.019 U | 0.018 U | **0.84** |
| NICKEL | MG/KG | 0.240 | none | **280 L** | **35.7 L** | **85.6 L** | **48.8 L** | **9.1 L** | **248 L** | **10.5** | **9.8** | **22.6 L** |
| SELENIUM | MG/KG | 1.20 | 19 | **1.8 L** | **1.8 L** | **5.6 L** | **0.5 L** | **1.4 L** | **7.4 L** | 2.4 UL | 2.5 UL | **1.5 L** |
| SILVER | MG/KG | 0.240 | 31 | **0.41** | **0.26** | **4.3** | **5** | **0.46** | **7.3** | **0.1 J** | **0.085 J** | **1.9** |
| THALLIUM | MG/KG | 0.240 | 3.6 | **0.29 J** | **0.18** | **3.7** | **0.55** | **0.66** | **3.4** | **0.1 J** | **0.065 J** | **1.5** |
| ZINC | MG/KG | 1.20 | 14,000 | **406** | **309** | **10,900** | **1,350** | **786** | **20,200** | **140 L** | **108 L** | **1,430** |
| PERCENT SOLIDS | % | 1 | none | **78.3** | **74.6** | **63.4** | **89.1** | **78.1** | **66.8** | **89.2** | **90.2** | **69.7** |
| TOTAL CYANIDE | MG/KG | 1.75 | 150 | **48.2 L** | **13.2 L** | **64 L** | **5.5 K** | **2.2 K** | **47.3 K** | **0.32 L** | 0.55 UL | **17.8 L** |

[1] depth below ground surface

[2] RL reported for percent solids and total cyanide

[3] Protection of groundwater cleanup standard (MDE 2008)

[4] Collected at location BP-03 at a depth of 32-34 feet below ground surface

[5] Collected at location BP-06 at a depth of 12-14 feet below ground surface

**NOTES:** Bolded values represent detected concentrations

Shaded and bolded values exceed comparison criteria

**MDL** = method detection limit

**RL** = Reporting Limit

**B** (inorganic) = compound was detected, but below the reporting limit (value is estimated).

**J** (inorganic) = compound was detected in the method blank.

**K** = The reported value may be biased high, the actual value is expected to be lower than reported.

**L** = The reported value may be biased low, the actual value is expected to be higher than reported.

**R** = Data were rejected by the validator and is unusable.

**U** = compound was analyzed, but not detected.

## Table 3-7. (continued)

| | | | | BP-04 | | | BP-05 | | | BP-06 | | | BP-07 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Depth (ft)[1] | 10-12 | 16-18 | 24-26 | 8-10 | 14-16 | 20-22 | 8-10 | 12-14 | 16-18 | 12-14 |
| ANALYTE | UNITS | Average RL/MDL[2] | Soil: Groundwater Standard[3] | | | | | | | | | | |
| ANTIMONY | MG/KG | 0.479 | 13 | **3.3 L** | **2 L** | **0.98 J** | **0.11 L** | **0.085 L** | **0.27 L** | **0.44 L** | **0.046 L** | **0.13 L** | **0.041 L** |
| ARSENIC | MG/KG | 0.240 | 0.026 | **13.8 K** | **5.2 K** | **13.5** | **2 J** | **2.1 J** | **1.6 J** | **5.4 L** | **1.1 L** | **2.5 L** | **1.8 L** |
| BERYLLIUM | MG/KG | 0.240 | 1,200 | **0.16 J** | **0.31** | **0.33 J** | **3.1** | **4.2** | **4.3** | **2.6 L** | **3.5 L** | **5.2 L** | **4.2 L** |
| CADMIUM | MG/KG | 0.240 | 27 | **0.26 J** | **4.8** | **2.7 L** | **0.33** | **0.46** | **0.53** | **0.51** | **0.37** | **0.47** | **0.4** |
| CHROMIUM | MG/KG | 0.479 | 42 | **88.7** | **1,130** | **34.6 L** | **7.5 J** | **1.9 J** | **4 J** | **44.5 J** | **4.3 J** | **3.7 J** | **1.9 J** |
| COPPER | MG/KG | 0.479 | 11,000 | **230 K** | **405 K** | **41 L** | **19 L** | **13.2 L** | **16.2 L** | **40.8 L** | **12.7 L** | **14.7 L** | **11.6 L** |
| LEAD | MG/KG | 0.240 | 1,000 | **135** | **404** | **306** | **9.2** | **4.6** | **13.9** | **84.2** | **3.9** | **6.8** | **1.6** |
| MERCURY | MG/KG | 0.055 | none | 0.02 U | **1.1** | **0.39** | **2.5** | **0.033** | **0.1** | **4.3** | **0.27** | **0.1** | **0.25** |
| NICKEL | MG/KG | 0.240 | none | **78.8 L** | **30.8 L** | **23.4 L** | **2.4 J** | **1.1 J** | **1.6 J** | **23.5 J** | **2 J** | **1.1 J** | **0.3 J** |
| SELENIUM | MG/KG | 1.20 | 19 | **0.52 J** | **0.42 J** | **0.8 L** | **3.3 J** | **3.1 J** | **2.4 J** | **2.2 K** | **2.5 K** | **2.6 K** | **2.8 K** |
| SILVER | MG/KG | 0.240 | 31 | **0.083 J** | **0.51** | **0.47** | **0.078 L** | **0.14 L** | **0.13 L** | **0.097 J** | **0.092 J** | **0.13 J** | **0.097 J** |
| THALLIUM | MG/KG | 0.240 | 3.6 | **0.041 J** | **0.14 J** | **0.44** | **0.0061 J** | **0.019 J** | **0.021 J** | **0.2** | **0.027 J** | **0.013 J** | **0.0036 J** |
| ZINC | MG/KG | 1.20 | 14,000 | **46.5** | **787** | **849** | **34.8 L** | **2.6 L** | **12.9 L** | **89.4 L** | **7.7 L** | **6.7 L** | **2.4 L** |
| PERCENT SOLIDS | % | 1 | none | **82** | **87.5** | **75.3** | **90** | **65.1** | **61.8** | **80.8** | **73.8** | **63.1** | **84.1** |
| TOTAL CYANIDE | MG/KG | 1.75 | 150 | **0.15 J** | **9.8 L** | **2.2 K** | **43.9** | **53.9** | **31.4** | **14.6** | **30.8** | **57.5** | **27.7** |

[1] depth below ground surface

[2] RL reported for percent solids and total cyanide

[3] Protection of groundwater cleanup standard (MDE 2008)

[4] Collected at location BP-03 at a depth of 32-34 feet below ground surface

[5] Collected at location BP-06 at a depth of 12-14 feet below ground surface

**NOTES:** Bold values represent detected concentrations

Shaded and bold values exceed comparison criteria

**MDL** = method detection limit

**RL** = Reporting Limit

**B** (inorganic) = compound was detected, but below the reporting limit (value is estimated).

**J** (inorganic) = compound was detected in the method blank.

**K** = The reported value may be biased high, the actual value is expected to be lower than reported.

**L** = The reported value may be biased low, the actual value is expected to be higher than reported.

**R** = Data were rejected by the validator and is unusable.

**U** = compound was analyzed, but not detected.

## Table 3-7. (continued)

| | | | | BP-08 | | | BP-09 | | | BP-10 | BP-11 | BP-DUP1[4] | BP-DUP2[5] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Depth (ft)[1] | 6-8 | 10-12 | 16-18 | 8-10 | 14-16 | 18-20 | 4-6 | 4-6 | -- | -- |
| ANALYTE | UNITS | Average RL/MDL[2] | Soil: Groundwater Standard[3] | | | | | | | | | | |
| ANTIMONY | MG/KG | 0.479 | 13 | **0.15 L** | **0.11 L** | **0.02 L** | **1.2 L** | **1.8 L** | **1.1 L** | **0.065 L** | **0.2 L** | **2.3 L** | **0.037 L** |
| ARSENIC | MG/KG | 0.240 | 0.026 | **3.4** | **1.4** | **0.73** | **5.9** | **8.6** | **10** | **3.1 K** | **1.6** | **16.8 K** | **1.5 L** |
| BERYLLIUM | MG/KG | 0.240 | 1,200 | **0.36** | **2.1** | **2.4** | **1.9** | **1.1** | **1.9** | **0.82** | **2.7** | **0.57** | **3.5 L** |
| CADMIUM | MG/KG | 0.240 | 27 | **0.21** | **0.24 J** | **0.43** | **4** | **4.3** | **3** | **0.31** | **0.18 J** | **4.7** | **0.41** |
| CHROMIUM | MG/KG | 0.479 | 42 | **19.2 L** | **8.3 L** | **4.6 L** | **566 L** | **182 L** | **53.6 L** | **39.6 K** | **5.1** | **1,010** | **3.5 J** |
| COPPER | MG/KG | 0.479 | 11,000 | **12.9 L** | **25.4 L** | **29.3 L** | **87.5 L** | **66.9 L** | **50.8 L** | **27.4** | **69.6** | **85.4 K** | **12.5 L** |
| LEAD | MG/KG | 0.240 | 1,000 | **39** | **30** | **7.5** | **152** | **1,070** | **371** | **42.2** | **2.6 L** | **902** | **3.4** |
| MERCURY | MG/KG | 0.055 | none | **4 K** | **4 K** | **0.31 K** | **0.045 K** | **0.55 K** | **0.53 K** | **1.5** | R | **0.74** | **0.25** |
| NICKEL | MG/KG | 0.240 | none | **5.3** | **3** | **1.2** | **25.5** | **26.8** | **38.1** | **11** | **3.4 J** | **21.2 L** | **3.5 J** |
| SELENIUM | MG/KG | 1.20 | 19 | **0.72** | **4.2** | **6.2** | **2.7** | **3.9** | **5.3** | **1.1 K** | **5.8** | **1.7 L** | **1.9 K** |
| SILVER | MG/KG | 0.240 | 31 | **0.03 J** | **0.022 J** | **0.05 J** | **0.5** | **0.6** | **0.3 J** | **0.058 J** | 0.3 U | **1.8** | **0.11 J** |
| THALLIUM | MG/KG | 0.240 | 3.6 | **0.037 J** | **0.018 B** | **0.013 B** | **0.074 J** | **0.89** | **0.92** | **0.079 J** | **0.07 J** | **1.5** | **0.0062 J** |
| ZINC | MG/KG | 1.20 | 14,000 | **25.6 L** | **12.7 L** | **8.5 L** | **447 L** | **2,070 L** | **1,110 L** | **78.5 L** | **6.3** | **1,430** | **5 L** |
| PERCENT SOLIDS | % | 1 | none | **76.4** | **87.1** | **71.1** | **81.2** | **81.6** | **66.5** | **80.4** | **82.6** | **63.9** | **76.1** |
| TOTAL CYANIDE | MG/KG | 1.75 | 150 | **19.8 L** | **54.5 L** | **45.7 L** | **6.8 L** | **18.9 L** | **8 L** | **1.7** | **3.3** | **19.2 L** | **22.1** |

[1] depth below ground surface

[2] RL reported for percent solids and total cyanide

[3] Protection of groundwater cleanup standard (MDE 2008)

[4] Collected at location BP-03 at a depth of 32-34 feet below ground surface

[5] Collected at location BP-06 at a depth of 12-14 feet below ground surface

**NOTES:** Bolded values represent detected concentrations
Shaded and bolded values exceed comparison criteria

**MDL** = method detection limit

**RL** = Reporting Limit

**B** (inorganic) = compound was detected, but below the reporting limit (value is estimated).

**J** (inorganic) = compound was detected in the method blank.

**K** = The reported value may be biased high, the actual value is expected to be lower than reported.

**L** = The reported value may be biased low, the actual value is expected to be higher than reported.

**R** = Data were rejected by the validator and is unusable.

**U** = compound was analyzed, but not detected.

**Table 3-8. General Chemistry and Metal Concentrations in Fill Material from the Coal Tar Storage Area**

**Coke Point Peninsula, Sparrows Point Site Assessment (2009), Baltimore, Maryland**

| | | | | CT-01 | | | CT-02 | | | CT-03 | | | CT-04 | | | CT-05 | | | CT-DUP1[4] |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Depth (ft)[1] | 10-12 | 14-16 | 18-20 | 12-14 | 16-18 | 20-22 | 10-12 | 20-22 | 22-24 | 10-12 | 14-16 | 18-20 | 8-10 | 16-18 | 20-22 | -- |
| **ANALYTE** | **UNITS** | **Average RL/MDL[2]** | **Soil: Groundwater Standard[3]** | | | | | | | | | | | | | | | | |
| ANTIMONY | MG/KG | 0.479 | 13 | **3.4 J** | **1.6 J** | **1 J** | **1.3 J** | **2.3 J** | **1.1 J** | **1.9 J** | **1.7 J** | **2.2 J** | **0.38 L** | **0.62 L** | **0.12 L** | **1.4 L** | **0.7 L** | **0.87 L** | **1.3 J** |
| ARSENIC | MG/KG | 0.240 | 0.026 | **11.4 K** | **6.1 K** | **7.7 K** | **3.9 J** | **6.1 J** | **4.4 J** | **4 J** | **5.5 J** | **4.9 J** | **7.5** | **8** | **2.2** | **6.8 J** | **4.2 J** | **5.8 J** | **3.2 J** |
| BERYLLIUM | MG/KG | 0.240 | 1,200 | **0.54** | **0.47** | **0.86** | **0.97** | **0.65** | **0.38** | **0.58** | **0.5** | **0.49** | **2.6** | **3.1** | **0.48** | **0.43** | **0.49** | **0.5** | **0.5** |
| CADMIUM | MG/KG | 0.240 | 27 | **20.8** | **4.4** | **2.5** | **1.1** | **3.1** | **2.3** | **2.1 L** | **5.2 L** | **11.5 L** | **0.53** | **0.5** | **0.2** | **2.4 L** | **0.47 L** | **1.6 L** | **5.1 L** |
| CHROMIUM | MG/KG | 0.479 | 42 | **1,220** | **1,280** | **468** | **962** | **966** | **254** | **1,420** | **729** | **626 J** | **67.6 K** | **70.2 K** | **25.2 K** | **1,250** | **1,540** | **1,010** | **678** |
| COPPER | MG/KG | 0.479 | 11,000 | **95.8 L** | **64.3 L** | **59.3 L** | **76.9** | **106** | **64.1** | **82.5 J** | **92 J** | **106 J** | **31.6 K** | **30.3 K** | **10.4 K** | **64.3 J** | **49.1 J** | **51.6 J** | **75.2 J** |
| LEAD | MG/KG | 0.240 | 1,000 | **3,630** | **1,690** | **555** | **80** | **111** | **112** | **219** | **384** | **306** | **87.3** | **43.8** | **31.5** | **134** | **27.3** | **71.9** | **244** |
| MERCURY | MG/KG | 0.055 | none | **0.28 L** | **0.34 L** | **0.36 L** | **0.046** | 0.019 U | **0.44** | **0.075 K** | **0.048 K** | **0.039 K** | **0.072** | **0.087** | **0.029** | **0.034** | 0.02 U | **0.034** | **0.023 K** |
| NICKEL | MG/KG | 0.240 | none | **31 L** | **26.8 L** | **67.4 L** | **46.1 K** | **101 K** | **51.9 K** | **25.5 J** | **44.6 J** | **50.6 J** | **64.3** | **26.7** | **22** | **27.3 J** | **17.3 J** | **23.1 J** | **36.5 J** |
| SELENIUM | MG/KG | 1.20 | 19 | **0.59 K** | **0.32 K** | **1 K** | **0.62 L** | **0.66 L** | **0.38 L** | 1.4 UL | **0.76 L** | **0.56 L** | **4.5** | **3.8 J** | **0.7** | 1.4 UL | **0.34 L** | **0.29 L** | **0.38 L** |
| SILVER | MG/KG | 0.240 | 31 | **1.8** | **0.53** | **0.38** | **0.15 J** | **0.43** | **0.23 J** | **0.32** | **0.23 J** | **0.39** | **0.2** | **0.13** | **0.064 J** | **0.18 J** | 0.3 U | **0.057 J** | **0.086 J** |
| THALLIUM | MG/KG | 0.240 | 3.6 | **0.52** | **0.37** | **0.33** | **0.072 J** | **0.03 J** | **0.039 J** | **0.15 J** | **0.083 J** | **0.027 J** | **0.078 J** | **0.063 J** | **0.05 J** | **0.087 J** | **0.086 J** | **0.092 J** | **0.034 J** |
| ZINC | MG/KG | 1.20 | 14,000 | **3,140** | **829** | **581** | **278 J** | **374 J** | **446 J** | **640 J** | **2,090 J** | **2,140 J** | **89.8 L** | **55.5 L** | **52.4 L** | **451 J** | **80.5 J** | **235 J** | **1,190 J** |
| PERCENT SOLIDS | % | 1 | none | **89.7** | **85.2** | **76.3** | **84.3** | **86.1** | **80.1** | **86.3** | **83.8** | **85.5** | **75.7** | **81.9** | **76.1** | **90.1** | **84.4** | **79.6** | **87.1** |
| TOTAL CYANIDE | MG/KG | 1.75 | 150 | **9.1 K** | **4.4 K** | **5.5 K** | **5.7** | **6.7** | **2.6** | **2.2** | **6** | **6.3** | **8.3 L** | **9.2 L** | **3 L** | **0.69 L** | **4.7 L** | **6.7 L** | **10.9** |

[1] depth below ground surface

[2] RL reported for percent solids and total cyanide

[3] Protection of groundwater cleanup standard (MDE 2008)

[4] Collected at location CT-03 at a depth of 20-22 feet.

**NOTES:** Bold values represent detected concentrations

Shaded and bold values exceed comparison criteria

**MDL** = method detection limit

**RL** = Reporting Limit

**J** (inorganic) = compound was detected in the method blank.

**K** = The reported value may be biased high, the actual value is expected to be lower than reported.

**L** = The reported value may be biased low, the actual value is expected to be higher than reported.

**U** = compound was analyzed, but not detected.

## Table 3-9. Summary of Non-Aqueous Phase Liquid Gauging
**Coke Point Peninsula, Sparrows Point Site Assessment (2009), Baltimore, Maryland**

| Well No. | Date | Depth to Top of Product (ft) | Depth to Bottom of Product* (ft) | Product Thickness (ft) | Remarks |
|---|---|---|---|---|---|
| BP-MW-02S | 6/23/2009 | -- | 8.87 | -- | No product present |
| BP-MW-02D | 6/23/2009 | -- | 8.91 | -- | No product present |
| BP-MW-04 | 6/23/2009 | -- | 9.60 | -- | No product present |
| BP-MW-05 | 6/23/2009 | 6.15 | 9.74 | 3.59 | **LNAPL** |
| BP-MW-06 | 6/23/2009 | -- | 4.36 | -- | No product present |
| BP-MW-07 | 6/23/2009 | -- | 6.24 | -- | No product present |
| BP-MW-08 | 6/23/2009 | 6.91 | 11.55 | 4.64 | **LNAPL** |
| BP-MW-09 | 6/23/2009 | -- | 6.59 | -- | No product present |
| BP-MW-10 | 6/23/2009 | 7.06 | 7.68 | 0.62 | **LNAPL** |
| BP-MW-11 | 6/23/2009 | -- | 6.70 | -- | No product present |
| CT-MW-01 | 6/23/2009 | -- | 10.17 | -- | No product present |
| C013-PZM-008 | 6/23/2009 | 19.68 | 20.56 | 0.88 | **DNAPL** |

*If no product was present, depth to water table is presented

-- No product was present

## Table 3-10. Physical Properties of Non-Aqueous Phase Liquids

**Coke Point Peninsula, Sparrows Point Site Assessment (2009), Baltimore, Maryland**

| SAMPLE ID | MATRIX | TEMPERATURE (°F) | SPECIFIC GRAVITY[a] | DENSITY[a] g/cm$^3$ | VISCOSITY[b] | | INTERFACIAL TENSION[c] (dynes/cm) | WETTABILITY[d] |
|---|---|---|---|---|---|---|---|---|
| | | | | | centistokes | centipoise | | |
| BP-MW-5 | NAPL | 70 | 0.891 | 0.889 | 2.81 | 2.49 | 13.6 | water wet |
| | | 100 | 0.885 | 0.879 | 2.00 | 1.75 | not tested | |
| | | 130 | 0.880 | 0.867 | 1.53 | 1.33 | not tested | |
| | | | | | | | | |
| BP-MW-8 | NAPL | 70 | 0.889 | 0.887 | 4.45 | 3.94 | 15.1 | water wet |
| | | 100 | 0.883 | 0.877 | 2.98 | 2.61 | not tested | |
| | | 130 | 0.878 | 0.866 | 2.19 | 1.89 | not tested | |
| | | | | | | | | |
| CO13-PZM-008 | NAPL | 70 | 1.15 | 1.15 | 532 | 612 | 23.4 | oil wet |
| | | 100 | 1.15 | 1.14 | 102 | 117 | not tested | |
| | | 130 | 1.15 | 1.13 | 37.0 | 41.9 | not tested | |

***Analytical Methods***

[a] ASTM D1481

[b] ASTM D445

[c] DuNuoy Method - ASTM D971

[d] U.S. Bureau of Mines (USBM) Wettability

## Table 3-11. Polycyclic Aromatic Hydrocarbon Concentrations in Non-Aqueous Phase Liquid Samples

**Coke Point Peninsula, Sparrows Point Site Assessment (2009), Baltimore, Maryland**

| ANALYTE | UNITS | AVERAGE MDL | BP-MW-5 | BP-MW-8 | CO13-PZM-008 |
|---|---|---|---|---|---|
| ACENAPHTHENE | MG/KG | 1,200 | **190 J** | **310 J** | **1,100 J** |
| ACENAPHTHYLENE | MG/KG | 1,200 | **810 J** | **1,100** | **18,000** |
| ANTHRACENE | MG/KG | 1,200 | 1,000 U | 1,000 U | **7,000** |
| BENZO(A)ANTHRACENE | MG/KG | 1,200 | 1,000 U | 1,000 U | **6,200** |
| BENZO(A)PYRENE | MG/KG | 1,200 | 1,000 U | 1,000 U | **5,100** |
| BENZO(B)FLUORANTHENE | MG/KG | 1,200 | 1,000 U | 1,000 U | **6,800** |
| BENZO(GHI)PERYLENE | MG/KG | 1,200 | 1,000 U | 1,000 U | **2,300** |
| BENZO(K)FLUORANTHENE | MG/KG | 1,200 | 1,000 U | 1,000 U | 1,600 U |
| CHRYSENE | MG/KG | 1,200 | 1,000 U | 1,000 U | **6,400** |
| DIBENZO(A,H)ANTHRACENE | MG/KG | 1,200 | 1,000 U | 1,000 U | **660 J** |
| FLUORANTHENE | MG/KG | 1,200 | **140 J** | **190 J** | **16,000** |
| FLUORENE | MG/KG | 1,200 | **660 J** | **760 J** | **10,000** |
| INDENO(1,2,3-CD)PYRENE | MG/KG | 1,200 | 1,000 U | 1,000 U | **1,800** |
| 1-METHYLNAPHTHALENE | MG/KG | 1,200 | **1,200** | **1,300** | **8,600** |
| 2-METHYLNAPHTHALENE | MG/KG | 1,200 | **3,000** | **3,300** | **21,000** |
| NAPHTHALENE | MG/KG | 1,200 | **50,000** | **54,000** | **110,000** |
| PHENANTHRENE | MG/KG | 1,200 | **670 J** | **820 J** | **26,000** |
| PYRENE | MG/KG | 1,200 | 1,000 U | 1,000 U | **11,000** |
| TOTAL PAHs (ND=0) | MG/KG | -- | **56,670** | **61,780** | **257,960** |
| TOTAL PAHs (ND=1/2MDL) | MG/KG | -- | **61,670** | **66,780** | **258,760** |
| TOTAL PAHs (ND=MDL) | MG/KG | -- | **66,670** | **71,780** | **259,560** |

**NOTE:** Bold values represent detected concentrations.

**MDL** = method detection limit.

**J** (organic) = compound was detected, but below the reporting limit (value is estimated).

**U** = compound was analyzed, but not detected.

## Table 3-12. Volatile Organic Compound Concentrations in Non-Aqueous Phase Liquid Samples

**Coke Point Peninsula, Sparrows Point Site Assessment (2009), Baltimore, Maryland**

| ANALYTE | UNITS | AVERAGE MDL | BP-MW-5 | BP-MW-8 | CO13-PZM-008 |
|---|---|---|---|---|---|
| 1,1,1-TRICHLOROETHANE | MG/KG | 5,000 | 12,000 U | 2,500 U | 500 U |
| 1,1,2,2-TETRACHLOROETHANE | MG/KG | 5,000 | 12,000 U | 2,500 U | 500 U |
| 1,1,2-TRICHLOROETHANE | MG/KG | 5,000 | 12,000 U | 2,500 U | 500 U |
| 1,1-DICHLOROETHANE | MG/KG | 5,000 | 12,000 U | 2,500 U | 500 U |
| 1,1-DICHLOROETHENE | MG/KG | 5,000 | 12,000 U | 2,500 U | 500 U |
| 1,2-DICHLOROBENZENE | MG/KG | 5,000 | 12,000 U | 2,500 U | 500 U |
| 1,2-DICHLOROETHANE | MG/KG | 5,000 | 12,000 U | 2,500 U | 500 U |
| 1,2-DICHLOROPROPANE | MG/KG | 5,000 | 12,000 U | 2,500 U | 500 U |
| 1,3-DICHLOROBENZENE | MG/KG | 5,000 | 12,000 U | 2,500 U | 500 U |
| 1,4-DICHLOROBENZENE | MG/KG | 5,000 | 12,000 U | 2,500 U | 500 U |
| 2-BUTANONE (MEK) | MG/KG | 5,000 | 12,000 U | 2,500 U | 500 U |
| 2-CHLOROETHYL VINYL ETHER | MG/KG | 10,333 | 25,000 U | 5,000 U | 1,000 U |
| ACROLEIN | MG/KG | 103,333 | R | R | R |
| ACRYLONITRILE | MG/KG | 103,333 | 250,000 U | 50,000 U | 10,000 U |
| BENZENE | MG/KG | 5,000 | **170,000** | **74,000** | **14,000** |
| BROMODICHLOROMETHANE | MG/KG | 5,000 | 12,000 U | 2,500 U | 500 U |
| BROMOFORM | MG/KG | 5,000 | 12,000 U | 2,500 U | 500 U |
| BROMOMETHANE | MG/KG | 5,000 | 12,000 U | 2,500 U | 500 U |
| CARBON TETRACHLORIDE | MG/KG | 5,000 | 12,000 U | 2,500 U | 500 U |
| CHLOROETHANE | MG/KG | 5,000 | 12,000 U | 2,500 U | 500 U |
| CHLOROFORM | MG/KG | 5,000 | 12,000 U | 2,500 U | 500 U |
| CHLOROMETHANE | MG/KG | 5,000 | 12,000 U | 2,500 U | 500 U |
| CIS-1,3-DICHLOROPROPENE | MG/KG | 5,000 | 12,000 U | 2,500 U | 500 U |
| DIBROMOCHLOROMETHANE | MG/KG | 5,000 | 12,000 U | 2,500 U | 500 U |
| DICHLORODIFLUOROMETHANE | MG/KG | 5,000 | 12,000 U | 2,500 U | 500 U |
| ETHYLBENZENE | MG/KG | 5,000 | **6,100 J** | **4,200** | **830** |
| METHYLENE CHLORIDE | MG/KG | 5,000 | 12,000 U | 2,500 U | 500 U |
| TETRACHLOROETHENE | MG/KG | 5,000 | 12,000 U | 2,500 U | 500 U |
| TOLUENE | MG/KG | 5,000 | **120,000** | **75,000** | **14,000** |
| TRANS-1,2-DICHLOROETHENE | MG/KG | 5,000 | 12,000 U | 2,500 U | 500 U |
| TRANS-1,3-DICHLOROPROPENE | MG/KG | 5,000 | 12,000 U | 2,500 U | 500 U |
| TRICHLOROETHENE | MG/KG | 5,000 | 12,000 U | 2,500 U | 500 U |
| TRICHLOROFLUOROMETHANE | MG/KG | 5,000 | 12,000 U | 2,500 U | 500 U |
| VINYL CHLORIDE | MG/KG | 5,000 | 12,000 U | 2,500 U | 500 U |

**NOTE:** Bold values represent detected concentrations.

**MDL** = method detection limit.

**J** (organic) = compound was detected, but below the reporting limit (value is estimated).

**U** = compound was analyzed, but not detected.

**R** = Data were rejected by the validator and is unusable.

## Table 3-13. Summary of Residual Non-Aqueous Phase Liquid Saturation

**Benzol Processing and Graving Dock Areas, Coke Point Peninsula, Sparrows Point Site Assessment (2009), Baltimore, Maryland**

| Borehole Location | Sample ID | Depth (ft) | NAPL Saturation (%) | Primary Compounds (concentrations in mg/kg) | NAPL Manifestation |
|---|---|---|---|---|---|
| BP-01 | BP-SO-01-8 | 8-10 | 5.2341 | Benzene 5,700 | None |
| | BP-SO-01-14 | 14-16 | 3.7684 | Benzene 4,300; toluene 820 | Trace (dye); PID >10,000 ppm |
| | BP-SO-01-20 | 20-22 | 0.0888 | Benzene 140 | PID >3,000 ppm |
| BP-02 | BP-SO-02-8 | 8-10 | 0.0221 | Benzene 360; toluene 140 | None |
| | BP-SO-02-14 | 14-16 | Model did not converge | Benzene 150, naphthalene 45 | PID >10,000 ppm |
| | BP-SO-02-20 | 20-22 | 0.1347 | Benzene 360; naphthalene 260 | PID >10,000 ppm |
| BP-03 | BP-SO-03-4 | 4-6 | 0 | -- | None |
| | BP-SO-03-12 | 12-14 | 0 | -- | None |
| | BP-SO-03-32 | 32-34 | 0.0017 | Benzene 65 | None |
| BP-04 | BP-SO-04-10 | 10-12 | 0 | -- | None |
| | BP-SO-04-16 | 16-18 | Model did not converge | Benzene 91 | Odor, PID > 5,000 ppm |
| | BP-SO-04-24 | 24-26 | 0.0134 | Benzene 38; naphthalene 19 | None |
| BP-05 | BP-SO-05-8 | 8-10 | 3.1209 | Naphthalene 1,000; benzene 470; toluene 330 | Dye POS; PID >10,000 ppm; LNAPL in well; sheen on liner |
| | BP-SO-05-14 | 14-16 | 0.8814 | Naphthalene 1,300; benzene 220; toluene 140 | Dye POS; PID >2,035 ppm; LNAPL in well; sheen on liner |
| | BP-SO-05-20 | 20-22 | 0 | Naphthalene 120 | PID >1,000 ppm |
| BP-06 | BP-SO-06-8 | 8-10 | 0.9316 | Naphthalene 710; benzene 440; toluene 170 | Trace (dye); PID 10,000 ppm |
| | BP-SO-06-12 | 12-14 | 1.8091 | Benzene 1,500; toluene 770; naphthalene 720 | Dye POS; PID >10,000 ppm; NAPL on liner |
| | BP-SO-06-16 | 16-18 | 0 | Benzene 760; toluene 310 | PID >1,000 ppm |
| BP-07 | BP-SO-07-12 | 12-14 | 0.7790 | Benzene 680; naphthalene 420; toluene 250 | Dye POS; PID >10,000 ppm |
| BP-08 | BP-SO-08-6 | 6-8 | 0.3232 | Naphthalene 550; benzene 130 | PID 930 |
| | BP-SO-08-10 | 10-12 | 0 | Naphthalene 90 | LNAPL in well; PID 8,600 |
| | BP-SO-08-16 | 16-18 | 0 | Naphthalene 74; toluene 53; benzene 50 | LNAPL in well; PID 2,000 |
| BP-09 | BP-SO-09-8 | 8-10 | 0 | -- | None |
| | BP-SO-09-14 | 14-16 | 10.7296 | Benzene 6,100; toluene 2,900 | PID >10,000 |
| | BP-SO-09-18 | 18-20 | 5.8172 | Benzene 5,600; toluene 3,800 | Strong odor; PID 3,600 |
| BP-10 | BP-SO-10-4 | 4-6 | 0 | Naphthalene 25 | LNAPL in well; staining on liner |
| BP-11 | BP-SO-11-4 | 4-6 | 0 | -- | Evidence of NAPL noted on borelog from 11 to 14 ft |

## Table 3-14. Summary of Residual Non-Aqueous Phase Liquid Saturation

**Coal Tar Storage Area, Coke Point Peninsula, Sparrows Point Site Assessment (2009), Baltimore, Maryland**

| Borehole Location | Sample ID | Depth (ft) | NAPL Saturation (%) | Primary Compounds (concentrations in mg/kg) | NAPL Manifestation |
|---|---|---|---|---|---|
| CT-01 | CT-SO-01-10 | 10-12 | 0 | Total PAHs and VOCs 13 | None |
| | CT-SO-01-14 | 14-16 | 0 | Total PAHs and VOCs 10 | Naphthalene odor |
| | CT-SO-01-18 | 18-20 | 3.5135 | Naphthalene 1,100; total PAHs and VOCs 4,000 | Strong napthalene odor - sheen on liner and soil water |
| CT-02 | CT-SO-02-12 | 12-14 | 0 | Total PAHs and VOCs 4 | None |
| | CT-SO-02-16 | 16-18 | 0.0595 | Naphthalene 110; total PAHs and VOCs 210 | None |
| | CT-SO-02-20 | 20-22 | 1.0313 | Naphthalene 660; total PAHs and VOCs 1,200 | Napthalene odor - dark staining - sheen on split spoons |
| CT-03 | CT-SO-03-10 | 10-12 | 0 | Total PAHs and VOCs 2 | None |
| | CT-SO-03-20 | 20-22 | 0.6508 | Phenanthrene 120; naphthalene 81; fluoranthene 79; total 560 | Slight sheen on acetate liner |
| | | 22-24 | 0 | Naphthalene 43; total PAHs and VOCs 89 | None |
| CT-04 | CT-SO-04-10 | 10-12 | 0 | Total PAHs and VOCs 33 | None |
| | CT-SO-04-14 | 14-16 | 0 | Total PAHs and VOCs 26 | None |
| | CT-SO-04-18 | 18-20 | 0.7686 | Naphthalene 470; phenanthrene 110; total 1,100 | Slight naphthalene odor |
| CT-05 | CT-SO-05-8 | 8-10 | 0 | Total PAHs and VOCs 8 | None |
| | CT-SO-05-16 | 16-18 | 0 | Total PAHs and VOCs 13 | None |
| | CT-SO-05-20 | 20-22 | 1.0093 | Naphthalene 570; phenanthrene 110; total 1,100 | Naphthalene odor - sheen on soil |

# 4. RESULTS OF THE OFFSHORE INVESTIGATION

The offshore phase of sample collection included surface water, surface sediment, and subsurface sediment sampling at 18 locations around the Peninsula, and additional subsurface sediment sampling at six locations (**Figure 2-3**). Physical and chemical characteristics of surface water and sediment samples were evaluated for possible impacts by groundwater migration from the Peninsula. On the western side of the Peninsula, transects oriented perpendicular to the shoreline were sampled to delineate the horizontal and vertical extent of sediment impacts. The transect locations were chosen based on historical groundwater data indicating the offshore areas that would most likely be impacted by discharging groundwater plumes.

Surface water and surface sediment samples were collected from 18 locations in the Patapsco River. Water was collected from the surface, mid-depth, and bottom of the water column. At each sampling location, *in situ* water quality measurements were recorded using YSI-650 instrumentation. Water temperature, salinity, and pH were recorded at each location at surface, mid, and bottom depths. A table of the water quality results is located in **Appendix B**, and copies of the project logbook with the raw data are located in **Appendix A**.

Subsurface sediment samples were also collected from each of the 18 offshore locations initially, with an additional six locations added to the sampling program based on the field observations and analytical results from the first 18 locations. Using the information collected during the visual field observations and hydrophobic dye shaker tests, sediment samples were collected from the most impacted 2-foot section of sediment for laboratory analysis. If no impacts were observed through the core, a 2-foot section was selected by the field crew for chemical sampling, based on the depths at which impacted sediments were observed at adjacent sampling locations. Surface water, surface sediment, and subsurface sediment collection methods, holding times, and preservation techniques are described in Chapter 2 and **Appendix B**.

## 4.1 DATA ANALYSIS

### 4.1.1 Geographic Division of the Site

To focus the discussion of the results, the area around the Coke Point Peninsula was divided into four sections. The divisions are based on historical information about groundwater concentrations, relationship to areas of concern on the Peninsula (the Benzol Processing Area and the Coal Tar Storage Area), and the field screening and chemical analysis of the surface and subsurface sediment samples conducted during this site assessment. Locations were grouped together such that the predominant physical factors influencing the transport of chemical constituents (groundwater flow, tidal encroachment, diffusion from sediments) and the likelihood of groundwater inputs, based on existing information about plumes of organic constituents, were similar for all locations assigned to the section. The locations were divided as described below:

***Northwestern Section*:** This section includes a total of 12 locations, including location 1 (Graving Dock) and three transects oriented perpendicular to the shoreline (**Figure 2-3**):

Transect 1: locations 2, 16, and 17

Transect 2: locations 3A, 3B, 3C, 3D, and 3E
Transect 3: locations 5, 4, and 18

In this section of the Coke Point Peninsula, shallow groundwater transport is radially outward from the Benzol Processing Area and intermediate groundwater transport is to the north. In both the shallow and the intermediate aquifers, groundwater is transported though the regions of the Benzol Processing Area and the Graving Dock Area, which were designated as Areas of Concern because of the high benzene and naphthalene concentrations (greater than 10 percent solubility) observed in groundwater. VOCs have also been detected previously in surface waters offshore from this part of the Peninsula (URS 2005b).

***Southwestern Section*:** This section includes three locations - locations 6, 7, and 8 - situated adjacent to the shoreline (**Figure 2-3**). Historically, the portion of the Peninsula located onshore from location 6 was used as a dredged material placement site, and a landfill was located to the south. Shallow groundwater flow in this region is across the Peninsula to the southwest, but previous investigations did not identify impacts to the groundwater of this portion of the site.

***Southern Section*:** This section also includes three locations situated adjacent to the shoreline - locations 9, 10, and 11 (**Figure 2-3**). Shallow groundwater transport in this area of the Peninsula is generally to the south.

***Turning Basin*:** This section includes six locations – locations 12, 13A, 13B, 13C, 14, and 15 – located adjacent to the eastern shoreline of the site (**Figure 2-3**). Shallow groundwater transport on the Peninsula is generally to the east-southeast, flowing across the Coal Tar Storage Area. The Coal Tar Storage Area was designated an Area of Concern because of the high naphthalene concentrations (greater than 10 percent solubility) observed in groundwater.

These groupings were identified after the data collection and sample analysis were completed. However, analysis and interpretation of results from specific locations were not confined to interpretation only for the section in which they were located.

### 4.1.2 Analytical Methods

Surface water and surface and subsurface sediments were analyzed for target analytes identified in the approved project Work Plan (EA 2008). Project-specific analytical methods and detection limits for sediment samples are provided in **Appendix B**. For sediment samples, sample weights were adjusted for percent moisture (up to 50 percent moisture) prior to analysis to achieve the lowest possible detection limits. Analytical results are reported on a dry weight basis.

The lab QA/QC included analysis of project-specific MS/MSDs, laboratory control samples, and standard reference materials (SRMs). Results for QC samples are in **Attachment II**.

Definitions of inorganic and organic data qualifiers are presented in **Appendix B**. Values for detected chemical constituents are bolded in the data tables, and either method detection limits (MDLs) or reporting limits (RLs) are presented for non-detected (ND) chemical constituents.

Analytical narratives that include an evaluation of laboratory QA/QC results and copies of final raw data sheets (Form I's) for the surface water and sediment are provided in **Attachments II and III**, respectively. TestAmerica–Pittsburgh will retain and archive the results of these analyses for seven years from the date of issuance of the final results.

### 4.1.3 Calculation of Total PAH

Total PAH concentrations were determined for each sample by summing the concentrations of the individual PAHs. Three values are reported in tables showing total PAH, representing the following methods for treating concentrations below the analytical detection limit:

- Non-detects = 0 (ND=0)
- Non-detects = 1/2 of the method detection limit (ND=½MDL)
- Non-detects = method detection limit (ND=MDL)

Of these scenarios, the ND=MDL scenario is the most conservative estimate of total PAH concentrations because it substitutes the highest value for the non-detects. This method, however, tends to produce results that over-estimate total PAH concentrations (biased high), especially in data sets where the majority of samples are non-detects. This overestimation is important to consider when comparing the calculated total values to criteria values.

### 4.1.4 Comparison to Baltimore Harbor Channel Sediment Concentrations

Because the concentrations of PAHs and metals detected in the sediments around the Coke Point Peninsula were so high, comparison to standard sediment quality guidelines [effects range-low (ERL) and effects range-median (ERM)] was not an appropriate comparison. The majority of the total PAH concentrations considerably exceeded the ERM value (44.8 mg/kg), and many of the metals concentrations also exceeded ERM values. Since any proposed remedial design would focus on the areas of highest concentrations (related to unacceptable risks), a detailed discussion of exceedances of sediment quality guidelines is not included in this Site Assessment.

Concentrations of target analytes in the surface and subsurface sediments were, however, compared to ambient sediment concentrations from the Baltimore Harbor Federal navigation channel sediments (EA 2009b, 2007). Surface sediments sampled in the Federal navigation channels were from shoaled areas targeted for maintenance dredging; therefore, the results of these studies represent the ambient concentrations in sediments being naturally deposited.

The Baltimore Harbor Federal navigation channel sediments are characterized every three years to evaluate suitability of maintenance dredged material for beneficial uses and upland placement options. Comparison of results from each year has indicated that the mean concentrations of tested analytes are generally consistent, indicating that the overall conditions influencing the distribution of target analytes in the Baltimore Harbor navigation channels have not changed substantially since the triennial sampling program began in 1998 (EA 2009b).

Physical and chemical testing of the Baltimore Harbor channel sediments was conducted in 1998, 2002, 2005, and 2008 (EA 2000, 2006, 2007, 2009b). Mean concentrations were

calculated using the results from all four studies. For grain size, PAHs and metal concentrations, the mean concentrations were calculated using a sample size of 127 (n=127). For the VOC concentrations, the mean concentrations were calculated using n=90.

## 4.2 CHEMICAL ANALYSIS OF SURFACE WATER

A total of 54 offshore site water samples (18 locations, with samples from surface, mid-depth, and bottom of the water column at each location) were analyzed for VOCs and PAHs (**Tables 4-1 and 4-2)**.

***VOC Results*.** VOC concentrations were generally low, and the majority of the tested VOCs were not detected in any of the surface water samples from around the Coke Point Peninsula. Benzene and toluene were, however, detected in the majority of the surface water samples. Ethylbenzene (five locations) and 1,2-dichlorobenzene and chloroform (one location each) were detected in isolated surface water samples. Benzene concentrations were highest in the surface water collected from locations off the northwestern section of the Peninsula (**Figure 4-1**).

At locations 1 and 2, benzene concentrations of 15 to 21 µg/L were detected in the surface of the water column, and benzene concentrations of 19 to 21 µg/L were also detected in the mid-depth and bottom samples at location 2. For the transect that includes locations 3A, 3B, and 3C, benzene concentrations of approximately 10 µg/L were detected at locations 3A and 3B at the mid-depth and bottom of the water column, respectively. At location 4 (in both the primary and duplicate samples), benzene was detected throughout the water column, with concentrations approximately 15 µg/L at the surface, approximately 20 µg/L at mid-depth, and approximately 40 µg/L at the bottom of the water column. Location 5 had the highest benzene concentrations with values of 72, 52, and 49 µg/L in the surface, mid-depth, and bottom portions of the water column, respectively.

Independent measurements of VOCs in surface water were made previously, as part of a Facility Investigation and Human Health Risk Evaluation (URS 2005b). Surface water was sampled at surface, mid-depth and bottom of the water column at each of six locations along two transects off the northwestern shore of the Coke Point Peninsula (**Figure 4-2**). Benzene concentrations over twice as high as the highest value detected in this Site Assessment were found, with concentrations over 200 µg/L in samples 10 feet offshore in both transects (**Table 4-3**). In the transect at the entrance to the graving dock, the surface water 100 ft offshore had a benzene concentration of 330 µg/L, suggesting the presence of a plume of benzene-rich water at the surface. This, along with the dramatically higher concentrations, indicates that different hydrological conditions were present during the two sampling periods. A hydrodynamic driving force (e.g., dilution/dispersion resulting from Patapsco River tidal flux) behind the variations is further supported by the fact that toluene concentrations were also approximately 10 times higher in the previous study than in the present one. Given the short time (3-4 years) between these two studies, and the abundance of NAPL on the Peninsula, it is unlikely that these variations resulted from a depletion of the source of these compounds. The historical data also showed ethylbenzene and xylenes (not included in this study) at measurable concentrations 10 ft offshore, as well as in surface water further offshore.

The benzene detections in the surface water at locations along the northwestern section of the Peninsula most likely resulted from groundwater flow from the shallow aquifer on the Coke Point Peninsula. This deduction is further discussed in Chapter 5. Groundwater from this shallow aquifer is documented to have high concentrations of benzene (**Figure 3-1**).

***PAH Results.*** PAH and total PAH concentrations (calculated assuming ND=MDL) in the surface water around the Coke Point Peninsula were generally low and consistent between locations and throughout the water column. Concentrations of individual PAHs were generally less than 1 µg/L, while total PAH concentrations (ND=MDL) generally ranged from 1.7 to 6 µg/L (**Table 4-2**). However, higher total PAH concentrations were observed at several locations.

At location 2, off the northwestern section of the Peninsula, the total PAH concentration at the bottom of the water column was 60.1 µg/L, compared to concentrations of about 4 µg/L in the water sampled at the surface and the mid-depth at that location. The total PAH concentration observed at location 2 resulted from concentrations of several PAHs (not including naphthalene) at concentrations between 4.7 and 7.6 µg/L (**Table 4-2**). At locations 3A and 11, on the northwestern and southeastern sides of the Peninsula, respectively, the total PAH concentration (ND=MDL) in the surface water were elevated (81.5 and 77.2 µg/L), compared to concentrations at the mid-depth and bottom of the water column (2.56 to 3.62 µg/L). The elevated total PAH concentrations resulted from concentrations of several PAHs (not including naphthalene) at concentrations between 5.8 and 11 µg/L (**Table 4-2**).

The distribution of naphthalene concentrations in the surface water is presented in **Figure 4-3**. The highest concentrations of naphthalene in the surface water were observed at locations 4 and 5 (2.9 and 3.4 µg/L, respectively) on the northwestern section of the site, and at locations 13A and 13B in the turning basin (6.7 and 3.3 µg/L, respectively).

## 4.3 CHEMICAL ANALYSIS OF SEDIMENT

Bulk sediments were analyzed for metals, cyanide, PAHs, VOCs, grain size, and TOC. Details of analytical methods and detection limits are provided in **Appendix B**. A total of 42 sediment samples were analyzed, including 18 surface sediments samples and 24 subsurface sediment samples.

### 4.3.1 Surface Sediment Samples

Results of the analyses of surface sediment samples are presented in **Tables 4-4 through 4-7**. The grain size of the surface sediments varied widely (**Table 4-4**). Most of the Coke Point Peninsula is 'made land', land that was created using slag fill material throughout the history of the Sparrows Point facility. As such, the sediments adjacent to the Peninsula have the potential to contain slag (and other anthropogenic constituents), and do not represent the natural geology of the Patapsco River estuarine environment. These anthropogenic constituents, depending on depositional history, proximity to industrial outfalls and other past release(s), may have varying degrees of impacts by organic and inorganic constituents. The entire offshore area around the Peninsula has been subject to up to a century of potential impact(s) from diffuse sources related to steelmaking and other industrial practices.

***VOC Results.*** VOC concentrations in the surface sediment were generally low (**Table 4-5**). Only a few VOCs were detected in the surface sediments, notably benzene (11 µg/kg) and toluene (2.4 µg/kg) at location 5 and benzene (79 µg/kg), ethylbenzene (4.9 µg/kg), and toluene (57 µg/kg) at location 13A. However, these concentrations were much higher than ambient concentrations in the Baltimore Harbor channel sediments, where the average benzene concentration is 1.1 µg/kg, the average toluene concentration is 1.2 µg/kg, and the ethylbenzene concentration is 1.8 µg/kg.

***PAH Results.*** PAH concentrations in the surface sediments adjacent to the Coke Point Peninsula were much higher than the average total PAH concentration (ND=MDL) detected in the Baltimore Harbor channel sediments. Total PAH concentrations (ND=MDL) in the surface sediments adjacent to the Coke Point Peninsula ranged from 5.97 (location 13C) to 495 mg/kg (location 7), with one outlier with a concentration of 7,354 mg/kg (location 3B) (**Table 4-6**). These concentrations were 1.8 to 151 times greater (location 3B is 2,250 times greater) than the Baltimore Harbor average total PAH concentrations (ND=MDL) of 3.27 mg/kg.

Because naphthalene is a byproduct of coking operations and was identified in the groundwater in previous studies (URS 2005a), the proportion of the total PAH concentration (ND=MDL) that was naphthalene was determined for each location (**Table 4-8**). Naphthalene comprised the majority of the total PAH concentration at locations 3A (63 percent), 3B (98 percent), 3C (62 percent), and 4 (61 percent). Each of these locations is on the northwestern side of the Peninsula, where a groundwater plume of naphthalene was observed within the shallow aquifer (**Figure 3-1**).

In samples from the surface sediments in the southwestern section (location 6, 7, and 8), southern section (locations 9, 10, and 11), and the turning basin (locations 12, 13 A, 13B, 13C, and 14), the naphthalene proportion of the total PAHs was lower than at locations in the northwestern region of the site, ranging from 2.8 to 23.5 percent (**Table 4-8**). Overall, naphthalene comprised greater than 10 percent of the total PAH concentration at 13 of the 18 locations.

To determine the relative contribution of groundwater migration of benzene and naphthalene to the observed concentrations in the offshore sediments (and water), expected discharge of these constituents out of groundwater to offshore environments was modeled. Results of this modeling are detailed in Chapter 5.

***Metals Results.*** Each of the tested metals was detected at each location, and many metals were detected at concentrations that were consistent with ambient concentrations from the Baltimore Harbor channel sediments (**Table 4-7**). However, the concentrations of zinc, chromium, and lead in surface sediments at the majority of the locations were elevated compared to the average ambient Baltimore Harbor channel concentrations. The presence of these elevated metals concentrations is consistent with the placement of industrial byproducts containing these metals from onshore into the offshore environment.

***Data from Pre-Pilot study of sediment quality.*** Additional samples of offshore sediment, from six locations off the southeastern shore of the Coke Point Peninsula, were analyzed for PAHs, VOCs, and metals, as part of a separate Pre-Pilot study during March 2009 (EA 2009c). These

analyses confirm that sediments impacted by PAHs and metals are found up to 2,000 feet offshore in this area of the Peninsula. Benzene, toluene, and ethylbenzene were not detectable in surface sediments from these sites.

PAH concentrations were elevated above background levels in surface sediments at all six sites, and generally decreased with distance from the Peninsula. Two sites 500-1000 ft offshore showed the highest total PAH (ND=1/2DL), at 189 and 460 mg/kg, similar to surface sediments off the western and southern shores of the Peninsula. Three additional sites at increasing distance from the shore (up to approximately 2,000 ft.) show concentrations falling from 53 mg/kg to 18 mg/kg. The exception to this trend is the site closest to the Peninsula (site 1), where PAHs were only slightly elevated above background, similar to Locations 13B and 13C, with total PAHs at 6.5 mg/kg.

As with the samples from other locations around the Peninsula, all metals analyzed were detected in all six of these samples, and some were elevated above Baltimore Harbor background concentrations. Zinc and lead concentrations showed a trend similar to the PAHs, with more highly elevated concentrations nearer to the shore, with the exception of site 1 (where concentrations were not elevated above background). Lead concentrations at the other five sites were between 1,280 mg/kg and 146 mg/kg, and zinc concentrations were between 2,250 mg/kg and 478 mg/kg. Chromium showed the same general trend, but was not as highly elevated above background.

### 4.3.2 Subsurface Sediment Samples

***Field Screening of Subsurface Sediment Samples.*** Field screening was used as a real-time indicator of the presence or absence of NAPL (or substantial organic impacts) in subsurface sediment within each borehole. Field screening and visual observations were used to help find highly impacted depth intervals for collecting subsurface samples for chemical analysis. Locations where impacts were indicated through field screening are shown in **Figure 4-4**. Field screening results are summarized in **Table 4-9**.

Several offshore subsurface locations adjacent to the Benzol Processing Area and Coal Tar Storage Area exhibited positive dye tests and/or visible evidence of NAPL such as sheens. Odors (e.g., naphthalene, coal tar, hydrocarbon) were noted (**Table 4-9**) at many locations. PID readings were uniformly low except for slightly elevated readings in some intervals at location 2 and location 6.

Analytical results of the subsurface sediment samples are presented in **Tables 4-10 to 4-13**, and are summarized in the following sections.

***VOC Results.*** VOC concentrations in the subsurface sediment samples were generally low, although benzene, ethylbenzene, and toluene were each detected at several locations (**Table 4-11**). In the northwestern section of the site, these three VOCs were detected at locations 2, 3C, and 4, and benzene and ethylbenzene were detected at location 3B. Concentrations at depth were higher at all four locations than in other samples, and were higher than in the surface sediments (**Table 4-11**). A similar pattern was observed in the benzene,

ethylbenzene, and toluene concentrations detected at locations 13A and 13C in the turning basin, the only other part of the site where VOCs were detected. Concentrations at depth were higher at both locations, and also were higher than in the surface sediments (**Table 4-11**).

***PAH Results.*** PAH concentrations in the subsurface sediment samples adjacent to the Coke Point Peninsula were elevated relative to ambient concentrations in Baltimore Harbor channel sediments, and in several cases were higher than concentrations observed in the surface sediment. In the northwestern section of the site, total PAH concentrations (ND=MDL) varied widely, ranging from 10 to 4,796 mg/kg (**Table 4-12**). Extremely high concentrations (2,967 and 4,796 mg/kg) of total PAHs were detected at locations 3C (2-4 ft below sediment surface) and location 4 (8-10 ft below sediment surface), respectively.

Results from the three transects sampled in the northwestern section of the site indicate that total PAH concentrations are typically much lower in samples more than 300 feet from the shoreline than in near-shore samples. However, the overall concentrations at the locations farthest from the Peninsula are still highly elevated compared to ambient concentrations in the Baltimore Harbor channel sediments.

The proportion of the total PAH concentration (ND=MDL) that was naphthalene was determined at each location for the subsurface sediment samples (**Table 4-8**). The results from the samples located in the northwestern portion of the site indicate that naphthalene is the dominant component of the total PAH concentrations detected in sediments collected adjacent to the shoreline – naphthalene proportions ranged from 47 to 94 percent of the total PAH concentrations. At locations farther offshore (locations 16, 17, 3D, 3E, and 18), not only are the total PAH concentrations generally lower, but naphthalene constitutes a much lower proportion (2.6 to 14 percent) of the total PAH concentration. Higher naphthalene concentrations in the near-shore environment are a strong indicator of a Peninsula source to these sediment impacts.

In the southwestern section of the site, the total PAH concentrations also varied widely, with a concentration of 1,188 mg/kg at location 6, and concentrations of 20.4 and 28.5 mg/kg at locations 7 and 8, respectively. Each of these three locations is adjacent to the shoreline, and, similar to the distribution observed in the northwestern portion of the site, naphthalene was the dominant component of the total PAH concentration (48 to 60 percent) (**Table 4-8**) in the subsurface sediments. Surface sediments at these locations had high total PAH concentrations (95.4 to 495 mg/kg), but the naphthalene proportion was much lower (3 to 13 percent).

Total PAH concentrations (ND=MDL) in the subsurface sediment in the southern section of the site varied widely, with concentrations of 0.512 mg/kg at location 9, 136 mg/kg at location 10, and 2,798 mg/kg at location 11 (**Table 4-12**). At location 11, naphthalene comprised approximately 86 percent of the total PAH concentration, indicating that the substrate sampled was most likely impacted by offshore release(s) (historic diffuse and/or point sources) of naphthalene-rich material.

In the turning basin, total PAH concentrations in the subsurface sediments were lower compared to other sections of the site. Total PAH concentrations ranged from 0.539 to 34.3 mg/kg (**Table 4-12**). Naphthalene proportions ranged from 1.4 to 39 percent of the total PAH

concentration. In the turning basin, although the proportion of naphthalene was lower compared to other portions of the site, the naphthalene concentrations were still elevated relative to ambient concentrations in Harbor sediments. There is a documented naphthalene plume in groundwater emanating from the Coal Tar Storage Area (**Figure 3-1**), which may be contributing to the high concentrations of naphthalene detected at these locations.

***Metals Results.*** Metals concentrations were elevated compared to the ambient concentration from the Baltimore Harbor channel surface sediments. In particular, concentrations of arsenic, chromium, copper, lead, and zinc were elevated at the same locations, specifically at the majority of the locations in the northwestern section, locations 6 and 8 in the southwestern section, locations 10 and 11 in the southern section, and location 14 in the turning basin (**Table 4-13**). The results from locations 3E, 16, 17, and 18 indicate that impacted surface sediments extend up to 1,000 ft west of the Peninsula, evidenced by the high concentrations of chromium (164 to 794 mg/kg), lead (333 to 1,160 mg/kg), and zinc (510 to 2,500 mg/kg) at these locations.

***Data from Pre-Pilot study of sediment quality.*** Sediment cores were also collected at the sites where surface sediment was sampled in the Pre-Pilot study, and constituents of interest were analyzed in samples collected from intervals up to 50 feet below the surface. As with the surface sediments, benzene, toluene, and ethylbenzene were not detected.

PAH and metals concentrations in the subsurface were generally lower than at the surface, but also showed elevated concentrations up to 2,000 feet from the Peninsula. Total PAH concentrations (ND=1/2MDL) in samples incorporating the top 25 ft. of sediment were 32.3 mg/kg in a near-shore sample and 15.1 mg/kg in the sample collected farthest from shore (approximately 2,000 ft). These values were elevated above the background concentration. Similarly, lead and zinc concentrations in the 0-25 ft. interval were elevated above background levels at most sites, including the farthest from shore. These data indicate that impacts off the southeastern corner of the Peninsula extend deep within the sediments, as well as at substantial distances offshore.

## 4.4 OFFSHORE CROSS-SECTIONS

Offshore boring logs from around the Coke Point Peninsula were used to classify lithology with depth, into three major units: slag fill material, river bottom sediment (with or without intermixed anthropogenic material), and Pleistocene lowland deposits. Geologic cross sections were then constructed using RockWorks software, by interpolating the lithologic units between the boring locations. Field evidence of hydrocarbons is represented in the cross sections as pockets of residual NAPL, and was also interpolated between logs where possible. Cross sections were constructed for sections both parallel and perpendicular to the shoreline of the Peninsula, and all sections are shown with 10x vertical exaggeration to improve resolution of the different units (**Appendix D**).

Two of the cross sections (C – C' and I – I') are discussed here and shown in **Figures 4-5 and 4-6**, respectively. Section C – C' runs perpendicular to the shoreline on the western side of the Peninsula near the Benzol Processing Area (**Figure 4-5**). For much of the cross section, slag fill material represents the uppermost unit. Field screening results (**Table 4-9**) showed positive

evidence of at least residual NAPL within this unit in the boreholes at locations 3B, 3C, and 3D. Cross section I – I' (**Figure 4-6**) is east of the Peninsula and runs parallel to the shoreline in the turning basin. The section shows that the only slag fill encountered was in the boreholes at locations 13B and 13C, which are adjacent to the Coal Tar Storage Area. A sheen was noted in the borehole at location 13C, which also was noted in adjacent location 13A (not on section I – I') at approximately the same depth (**Table 4-9**).

## 4.5 DISTRIBUTION OF IMPACTS

### 4.5.1 Saturation Calculations for Surface and Subsurface Sediment

As described earlier, field screening indicated the presence of at least residual NAPL in many locations within the offshore investigation area surrounding the Coke Point Peninsula. No investigation of mobile NAPL was conducted offshore, because NAPL monitoring wells could not be installed in navigable waters. To estimate the presence of residual NAPL in the offshore investigation areas, analytical data were used to calculate NAPL saturation within surface and subsurface sediment, as described in Chapter 3 for onshore sample locations.

The calculations were conducted using the same NAPL saturation modeling techniques as in the onshore areas. The values used for fraction of organic carbon were 0.01 for samples collected within fill material (expected to have low $f_{oc}$ because of high temperature blast furnace steel processing) and 0.033 for samples collected in sediment (based on the ambient value for Baltimore Harbor navigation channel sediments).

Results of NAPL saturation calculations (**Table 4-14**) indicate the presence of residual NAPL in one or more depth intervals except for Locations 12, 13B, 13C, 14, 15, 16, and 17. Non-zero saturation values ranged from 0.0009 to 2.0120 percent (**Table 4-14**) and the highest value was for location 3B, where sheens were visually observed in subsurface sediment samples.

### 4.5.2 Impacts to Sediments

The distribution of the concentrations of target analytes in the surface and subsurface sediment are plotted in **Figures 4-7** through **4-11**. Because many target analytes were detected in both surface and subsurface sediment samples, only the highest concentration detected at each location is represented on the figures.

The highest concentration of benzene was detected at location 2, which is in the northwestern section of the site, adjacent to the Graving Dock Area (**Figure 4-7**). The benzene concentration detected at location 2 was 36,000 µg/kg, at least 50 times higher than any other benzene concentration detected in the sediments. Benzene concentrations that were elevated relative to background levels were also observed along the transect locations 3A, 3B, and 3C (490, 200, and 720 µg/kg, respectively), at location 6 (630 µg/kg), and at location 13A (490 µg/kg). As with naphthalene, the transect data show that the benzene concentration generally decreases away from the shoreline, indicating that historical release(s) (whether diffuse and/or point sources) from the Peninsula represent the origin of observed benzene in subsurface sediments.

Concentrations of naphthalene and total PAHs exhibit a similar pattern, with the highest concentrations located along the western shoreline (locations 3B, 3C, 4, 5, and 6), and an area of high concentrations also located along the southern shoreline at locations 9, 10, and 11 (**Figures 4-8 and 4-9**). Along the southern shoreline, naphthalene concentrations constitute a lower proportion of the detected total PAH concentration, except at location 11 where naphthalene is elevated to concentrations similar to those in the northwestern section (**Figures 4-8 and 4-9**).

Concentrations of lead and zinc that were elevated relative tobackground values, were detected at most locations around the Peninsula (**Figures 4-10 and 4-11**). Concentrations of lead and zinc were consistently high at the turning basin locations, but the highest concentrations of both were detected in sediments located in the southern section of the site (locations 10 and 11) and in the northwestern section of the site (locations 3C, 3D, 4, and 16).

## 4.6 SUMMARY OF OFFSHORE RESULTS

A total of 42 sediment samples (18 surface and 24 subsurface) and 54 offshore water samples were collected adjacent to the Coke Point Peninsula during February and March 2009. The samples were analyzed for grain size (sediments only), VOCs, PAHs, and metals. Results from the field screening, analytical testing, and cross-section analysis of the samples are summarized below.

Results indicated that:

- Benzene, toluene, and ethylbenzene (and in one instance 1,2-dichlorobenzene) were the only VOCs detected in the surface water. Concentrations of the majority of PAHs and metals in near-shore sediments were highly elevated above average background concentrations in the Baltimore Harbor Federal navigation channels.
- The area of impacted sediments was not confined to one or two localized regions. High concentrations of PAHs and metals were detected all around the Coke Point Peninsula, both in surface sediments and at depth. The widespread nature of these constituents suggests that they result from historical releases to the offshore environment.
- Transect data indicate that MAHs and PAHs observed in water and sediment samples were elevated close to the shoreline relative to offshore locations, indicating that historical release(s) (from diffuse and/or point sources) from the Peninsula represent the origin of observed impacts.
- Although both benzene and naphthalene impacts were observed in multiple locations around the Peninsula, observed trends in surface water and sediment do not spatially correlate on a location by location basis.

The sources and potential transport mechanisms of organic compounds and metals to the offshore sediments is evaluated in Chapter 5. PAH fingerprinting of soil and sediment samples was conducted to determine whether the PAHs in the offshore sediments could be traced to historic industrial activities on the Coke Point Peninsula. Factors that affect the mobility of the compounds of interest, and potential pathways for their transport to surface water and sediment

are evaluated using groundwater mass flux calculations, models of surface water hydrodynamics, and sediment-water partitioning of groundwater-derived organics.


# Site Assessment for Proposed Coke Point Dredged Material Containment Facility at Sparrows Point

## Legend

Benzene Distribution in Surface Water

- <5 µg/L
- 5-10 µg/L
- 10-50 µg/L
- 50-100 µg/L
- Not Sampled
- Shallow Aquifer Groundwater Flow Direction
- Area of Concern

Note
Results reflect sample with highest concentration in the water column.

Sources
ESRI, i-cubed, GeoEye, 2009
Tele Atlas North America Inc., ESRI, 2006

Feet
0 500 1,000

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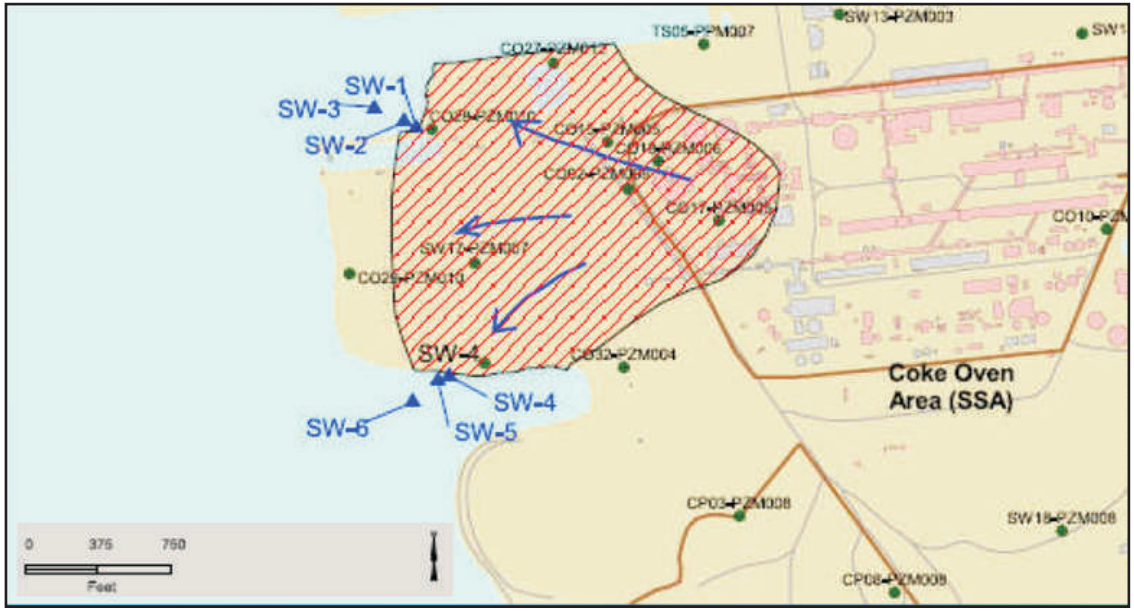
H:\projects\1453406\MXD\2009_Report\WATER-Benzene

**Figure 4-1. Benzene Distribution in Surface Water, Coke Point Peninsula, Baltimore, Maryland**




URS. 2005b. CA725 Facility Investigation and Human Health Risk Evaluation (HHRE) Findings, ISG Sparrows Point. Presentation to Maryland Department of Environment and U.S. Environmental Protection Agency, Region III, June 9, 2005, 39 pp.

**Figure 4-2. Locations of Measurements for Historical VOCs in Surface Water, Coke Point Peninsula, Baltimore, Maryland.**


# Site Assessment for Proposed Coke Point Dredged Material Containment Facility at Sparrows Point

## Legend

Naphthalene Distribution in Surface Water

- <0.5 µg/L
- 0.5-1 µg/L
- 1-10 µg/L
- Not Sampled
- Shallow Aquifer Groundwater Flow Direction
- Area of Concern

Note

Results reflect sample with highest concentration in the water column.

Sources

ESRI, i-cubed, GeoEye, 2009
Tele Atlas North America Inc., ESRI, 2006

Feet
0 500 1,000

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.


H:\projects\1453406\MXD\2009_Report\WATER-Naphth

**Figure 4-3. Naphthalene Distribution in Surface Water, Coke Point Peninsula, Baltimore, Maryland**


Site Assessment for Proposed Coke Point Dredged Material Containment Facility at Sparrows Point

**Legend**

- Field Screening Evidence of Hydrocarbon Sheen and Odors Observed in Subsurface Sediment Samples
- Sampling Locations
- Shallow Aquifer Groundwater Flow Direction
- Area of Concern

Sources
ESRI, i-cubed, GeoEye, 2009
Tele Atlas North America Inc., ESRI, 2006

Feet
0 500 1,000

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.


H:\projects\1453406\MXD\2009_Report\FieldImpacts

**Figure 4-4. Offshore Locations of Field-Observed Impacts, Coke Point Peninsula, Baltimore, Maryland**

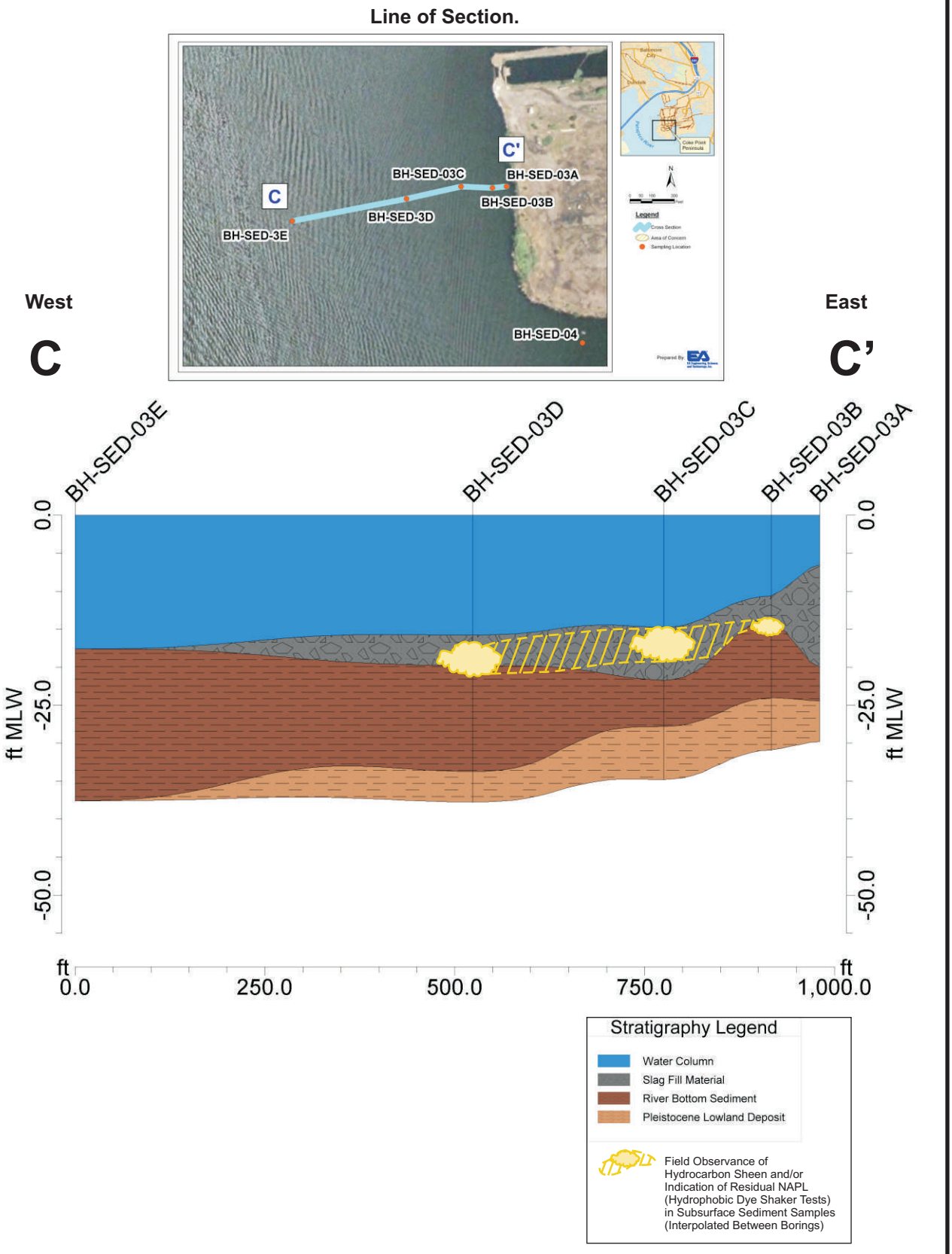
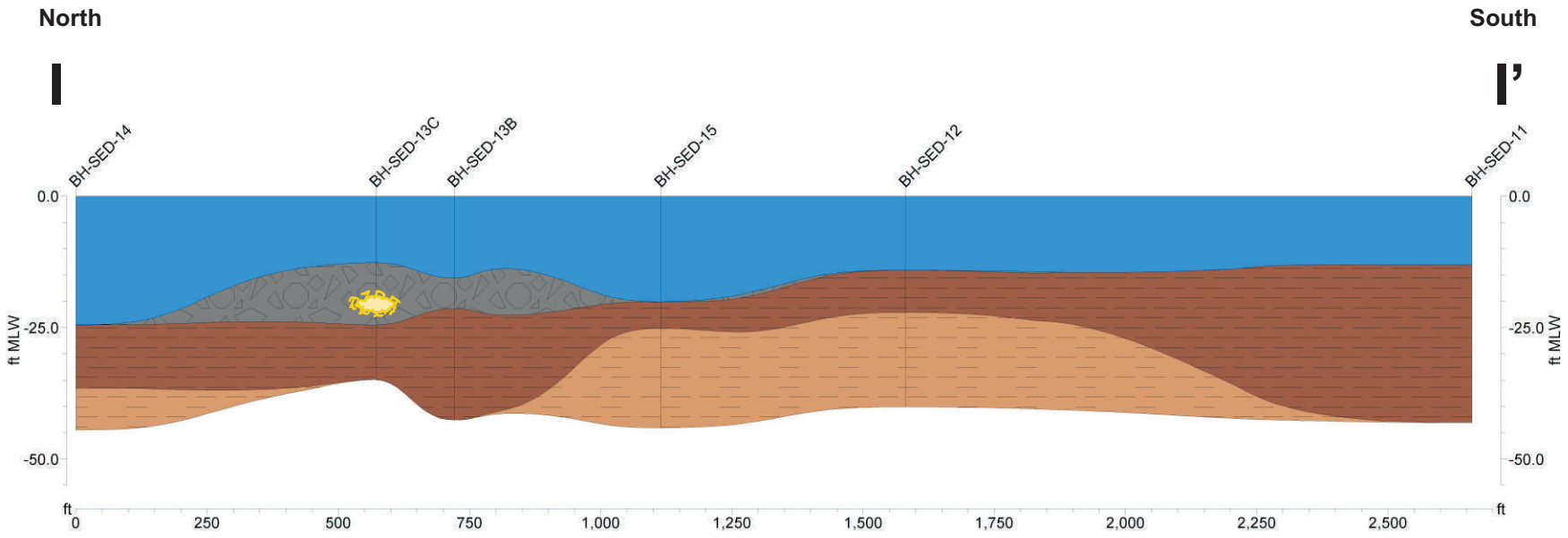



**Figure 4-5. Offshore Northwest Geologic Cross Section**
**Coke Point Peninsula, Baltimore, Maryland.**




**Line of Section.**

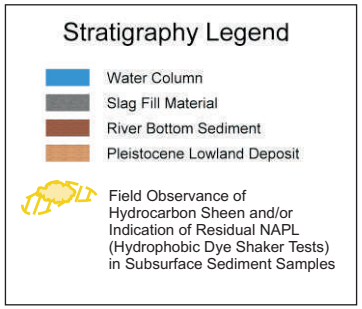




**Figure 4-6. Offshore Turning Basin Geologic Cross Section Coke Point Peninsula, Baltimore, Maryland.**

P:\Projects\State&Local\State\Maryland\Projects\1453405SparrowsPointRCRAandLandfill\Phase0001RCRA\Report_Draft\Graphics\Fig4-6.cdr


# Site Assessment for Proposed Coke Point Dredged Material Containment Facility at Sparrows Point

## Legend

Benzene in Sediments

- <100 µg/kg
- 100-1,000 µg/kg
- >1,000 µg/kg
- Shallow Aquifer Groundwater Flow Direction
- Area of Concern

Note

Results reflect sample with highest concentration in boring.

Sources

ESRI, i-cubed, GeoEye, 2009
Tele Atlas North America Inc., ESRI, 2006

Feet

0 500 1,000

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.


H:\projects\1453406\MXD\2009_Report\Figure 4-7

**Figure 4-7. Benzene in Sediments, Coke Point Peninsula, Baltimore, Maryland**


# Site Assessment for Proposed Coke Point Dredged Material Containment Facility at Sparrows Point

## Legend

Naphthalene in Sediments

- <1 mg/kg
- 1-100 mg/kg
- 100-1,000 mg/kg
- >1,000 mg/kg
- Shallow Aquifer Groundwater Flow Direction
- Area of Concern

Note

Results reflect sample with highest concentration in boring.

Sources

ESRI, i-cubed, GeoEye, 2009

Tele Atlas North America Inc., ESRI, 2006

Feet

0 500 1,000

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.


H:\projects\1453406\MXD\2009_Report\Figure 4-8

**Figure 4-8. Naphthalene in Sediments, Coke Point Peninsula, Baltimore, Maryland**


# Site Assessment for Proposed Coke Point Dredged Material Containment Facility at Sparrows Point

## Legend

Total PAH in Sediments

- <10 mg/kg
- 10-100 mg/kg
- 100-1,000 mg/kg
- >1,000 mg/kg
- Shallow Aquifer Groundwater Flow Direction
- Area of Concern

Note

Results reflect sample with highest concentration in boring.

Sources

ESRI, i-cubed, GeoEye, 2009

Tele Atlas North America Inc., ESRI, 2006

Feet

0 500 1,000

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.


H:\projects\1453406\MXD\2009_Report\Figure 4-9

**Figure 4-9. Total PAH in Sediments, Coke Point Peninsula, Baltimore, Maryland**


# Site Assessment for Proposed Coke Point Dredged Material Containment Facility at Sparrows Point

## Legend

Lead in Sediments

- <100 mg/kg
- 100-1,000 mg/kg
- >1,000 mg/kg

Shallow Aquifer Groundwater Flow Direction

Area of Concern

Note

Results reflect sample with highest concentration in boring.

Sources

ESRI, i-cubed, GeoEye, 2009

Tele Atlas North America Inc., ESRI, 2006

Feet

0 500 1,000

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.


H:\projects\1453406\MXD\2009_Report\Figure 4-10

**Figure 4-10. Lead in Sediments, Coke Point Peninsula, Baltimore, Maryland**


# Site Assessment for Proposed Coke Point Dredged Material Containment Facility at Sparrows Point

## Legend

Zinc in Sediments

100-1,000 mg/kg

>1,000 mg/kg

Shallow Aquifer Groundwater Flow Direction

Area of Concern

Note

Results reflect sample with highest concentration in boring.

Sources

ESRI, i-cubed, GeoEye, 2009

Tele Atlas North America Inc., ESRI, 2006

Feet

0 500 1,000

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.


H:\projects\1453406\MXD\2009_Report\Figure 4-11

**Figure 4-11. Zinc in Sediments, Coke Point Peninsula, Baltimore, Maryland**

## Table 4-1. Volatile Organic Compound Concentrations in Surface Water Around the Coke Point Peninsula

**Sparrows Point Site Assessment (2009), Baltimore, Maryland**

| | | | NORTHWESTERN SECTION | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Location 1 | | | Location 2 | | | Location 3A | | |
| ANALYTE | UNITS | Average MDL | Surface | Mid-Depth | Bottom | Surface | Mid-Depth | Bottom | Surface | Mid-Depth | Bottom |
| 1,1,1-TRICHLOROETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1,1,2,2-TETRACHLOROETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1,1,2-TRICHLOROETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1,1-DICHLOROETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1,1-DICHLOROETHENE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1,2-DICHLOROBENZENE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1,2-DICHLOROETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1,2-DICHLOROPROPANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1,3-DICHLOROBENZENE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1,4-DICHLOROBENZENE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 2-BUTANONE (MEK) | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 2-CHLOROETHYL VINYL ETHER | UG/L | 10 | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| ACROLEIN | UG/L | 100 | R | R | R | R | R | R | R | R | R |
| ACRYLONITRILE | UG/L | 100 | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U |
| BENZENE | UG/L | 5 | **15** | **5.5** | 5 U | **21** | **19** | **21** | **6.4** | **9.9** | **4.9 J** |
| BROMODICHLOROMETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| BROMOFORM | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| BROMOMETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| CARBON TETRACHLORIDE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| CHLOROETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| CHLOROFORM | UG/L | 5 | 5 U | 5 U | 5 U | **1 J** | 5 U | 5 U | 5 U | 5 U | 5 U |
| CHLOROMETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| CIS-1,3-DICHLOROPROPENE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| DIBROMOCHLOROMETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| DICHLORODIFLUOROMETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| ETHYLBENZENE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| METHYLENE CHLORIDE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| TETRACHLOROETHENE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| TOLUENE | UG/L | 5 | **3 J** | **1.5 J** | **1.2 J** | **3.7 J** | **3.4 J** | **3.3 J** | **2.5 J** | **2.4 J** | **1.5 J** |
| TRANS-1,2-DICHLOROETHENE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| TRANS-1,3-DICHLOROPROPENE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| TRICHLOROETHENE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| TRICHLOROFLUOROMETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| VINYL CHLORIDE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |

**NOTE:** Bolded values represent detected concentrations

**MDL** = method detection limit

**J** (organic) = compound was detected, but below the reporting limit (value is estimated)

**R** = Data was rejected by the validator and is unusable

**U** = compound was analyzed, but not detected

**Table 4-1. (continued)**

| ANALYTE | UNITS | Average MDL | NORTHWESTERN SECTION | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Location 3B | | | Location 3C | | | Location 4 | | | Location 4 - Duplicate | | |
| | | | Surface | Mid-Depth | Bottom | Surface | Mid-Depth | Bottom | Surface | Mid-Depth | Bottom | Surface | Mid-Depth | Bottom |
| 1,1,1-TRICHLOROETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1,1,2,2-TETRACHLOROETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1,1,2-TRICHLOROETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1,1-DICHLOROETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1,1-DICHLOROETHENE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1,2-DICHLOROBENZENE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1,2-DICHLOROETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1,2-DICHLOROPROPANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1,3-DICHLOROBENZENE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1,4-DICHLOROBENZENE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 2-BUTANONE (MEK) | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 2-CHLOROETHYL VINYL ETHER | UG/L | 10 | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| ACROLEIN | UG/L | 100 | R | R | R | R | R | R | R | R | R | R | R | R |
| ACRYLONITRILE | UG/L | 100 | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U |
| BENZENE | UG/L | 5 | **4.3 J** | **3.1 J** | **10** | **5.2** | **2.5 J** | **2.8 J** | **15** | **33** | **43** | **14** | **31** | **38** |
| BROMODICHLOROMETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| BROMOFORM | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| BROMOMETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| CARBON TETRACHLORIDE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| CHLOROETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| CHLOROFORM | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| CHLOROMETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| CIS-1,3-DICHLOROPROPENE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| DIBROMOCHLOROMETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| DICHLORODIFLUOROMETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| ETHYLBENZENE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| METHYLENE CHLORIDE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| TETRACHLOROETHENE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| TOLUENE | UG/L | 5 | **2 J** | **1.3 J** | **1.3 J** | **3.6 J** | **1.2 J** | **1.2 B** | **2.3 B** | **3.1 B** | **3.8 B** | **2.3 B** | **3 B** | **3.4 B** |
| TRANS-1,2-DICHLOROETHENE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| TRANS-1,3-DICHLOROPROPENE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| TRICHLOROETHENE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| TRICHLOROFLUOROMETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| VINYL CHLORIDE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |

**NOTE:** Bolded values represent detected concentrations
**MDL** = method detection limit
**B** (organic) = compound was detected in the method blank
**J** (organic) = compound was detected, but below the reporting limit (value is estimated)
**R** = Data was rejected by the validator and is unusable
**U** = compound was analyzed, but not detected

**Table 4-1. (continued)**

| ANALYTE | UNITS | Average MDL | NORTHWESTERN SECTION | | | SOUTHWESTERN SECTION | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Location 5 | | | Location 6 | | | Location 7 | | |
| | | | Surface | Mid-Depth | Bottom | Surface | Mid-Depth | Bottom | Surface | Mid-Depth | Bottom |
| 1,1,1-TRICHLOROETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1,1,2,2-TETRACHLOROETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1,1,2-TRICHLOROETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1,1-DICHLOROETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1,1-DICHLOROETHENE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1,2-DICHLOROBENZENE | UG/L | 5 | 5 U | 5 U | **2.9 J** | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1,2-DICHLOROETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1,2-DICHLOROPROPANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1,3-DICHLOROBENZENE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1,4-DICHLOROBENZENE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 2-BUTANONE (MEK) | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 2-CHLOROETHYL VINYL ETHER | UG/L | 10 | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U |
| ACROLEIN | UG/L | 100 | R | R | R | R | R | R | R | R | R |
| ACRYLONITRILE | UG/L | 100 | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | R | 100 U |
| BENZENE | UG/L | 5 | **72 L** | **52** | **49** | **4.3 J** | **4.1 J** | **1.7 J** | **1.9 J** | **1 J** | 5 U |
| BROMODICHLOROMETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| BROMOFORM | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| BROMOMETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| CARBON TETRACHLORIDE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| CHLOROETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| CHLOROFORM | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| CHLOROMETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| CIS-1,3-DICHLOROPROPENE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| DIBROMOCHLOROMETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| DICHLORODIFLUOROMETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| ETHYLBENZENE | UG/L | 5 | 5 U | 5 U | **2 J** | **0.75 J** | 5 U | 5 U | 5 U | 5 U | 5 U |
| METHYLENE CHLORIDE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| TETRACHLOROETHENE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| TOLUENE | UG/L | 5 | **6.3** | **6.3** | **15** | **5.1** | **4.5 B** | **1.2 B** | **1.2 B** | **1.2 B** | **1.1 B** |
| TRANS-1,2-DICHLOROETHENE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| TRANS-1,3-DICHLOROPROPENE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| TRICHLOROETHENE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| TRICHLOROFLUOROMETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| VINYL CHLORIDE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |

**NOTE:** Bolded values represent detected concentrations
**MDL** = method detection limit
**B** (organic) = compound was detected in the method blank
**J** (organic) = compound was detected, but below the reporting limit (value is estimated)
**L** = The reported value may be biased low, the actual value is expected to be higher than reported
**R** = Data was rejected by the validator and is unusable
**U** = compound was analyzed, but not detected

**Table 4-1. (continued)**

| ANALYTE | UNITS | Average MDL | SOUTHWESTERN SECTION | | | SOUTHERN SECTION | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Location 8 | | | Location 9 | | | Location 9 - Duplicate | | | Location 10 | | |
| | | | Surface | Mid-Depth | Bottom | Surface | Mid-Depth | Bottom | Surface | Mid-Depth | Bottom | Surface | Mid-Depth | Bottom |
| 1,1,1-TRICHLOROETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1,1,2,2-TETRACHLOROETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1,1,2-TRICHLOROETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1,1-DICHLOROETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1,1-DICHLOROETHENE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1,2-DICHLOROBENZENE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1,2-DICHLOROETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1,2-DICHLOROPROPANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1,3-DICHLOROBENZENE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1,4-DICHLOROBENZENE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 2-BUTANONE (MEK) | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 2-CHLOROETHYL VINYL ETHER | UG/L | 10 | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 U | 10 UJ | 10 UJ | 10 UJ |
| ACROLEIN | UG/L | 100 | R | R | R | R | R | R | R | R | R | R | R | R |
| ACRYLONITRILE | UG/L | 100 | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U |
| BENZENE | UG/L | 5 | **1.1 J** | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | **1.6 J** | **1 J** | 5 U |
| BROMODICHLOROMETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| BROMOFORM | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| BROMOMETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| CARBON TETRACHLORIDE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| CHLOROETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| CHLOROFORM | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| CHLOROMETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| CIS-1,3-DICHLOROPROPENE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| DIBROMOCHLOROMETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| DICHLORODIFLUOROMETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| ETHYLBENZENE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | **0.74 J** | **1.6 J** | **40** | **0.93 J** | 5 U | 5 U |
| METHYLENE CHLORIDE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| TETRACHLOROETHENE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| TOLUENE | UG/L | 5 | **2.7 B** | **2.9 B** | **1.1 B** | **1.1 B** | **1.2 B** | **1.1 B** | **1.5 J** | **1.7 J** | **11** | **5.4** | **3.1 J** | **1.1 J** |
| TRANS-1,2-DICHLOROETHENE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| TRANS-1,3-DICHLOROPROPENE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| TRICHLOROETHENE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| TRICHLOROFLUOROMETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 UJ | 5 UJ | 5 UJ | 5 U | 5 U | 5 U |
| VINYL CHLORIDE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |

**NOTE:** Bolded values represent detected concentrations
**MDL** = method detection limit
**B** (organic) = compound was detected in the method blank
**J** (organic) = compound was detected, but below the reporting limit (value is estimated)
**R** = Data was rejected by the validator and is unusable
**U** = compound was analyzed, but not detected
**UJ** = Analyte was not detected. The associated detection limit is an estimate and may be inaccurate or impricise

**Table 4-1. (continued)**

| ANALYTE | UNITS | Average MDL | SOUTHERN SECTION | | | TURNING BASIN SECTION | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Location 11 | | | Location 12 | | | Location 13A | | |
| | | | Surface | Mid-Depth | Bottom | Surface | Mid-Depth | Bottom | Surface | Mid-Depth | Bottom |
| 1,1,1-TRICHLOROETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1,1,2,2-TETRACHLOROETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1,1,2-TRICHLOROETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1,1-DICHLOROETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1,1-DICHLOROETHENE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1,2-DICHLOROBENZENE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1,2-DICHLOROETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1,2-DICHLOROPROPANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1,3-DICHLOROBENZENE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1,4-DICHLOROBENZENE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 2-BUTANONE (MEK) | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 2-CHLOROETHYL VINYL ETHER | UG/L | 10 | 10 UJ | 10 UJ | 10 U | 10 U | 10 U | 10 U | 10 UJ | 10 U | 10 UJ |
| ACROLEIN | UG/L | 100 | R | R | R | R | R | R | R | R | R |
| ACRYLONITRILE | UG/L | 100 | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U |
| BENZENE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | **2.9 J** | **1.8 J** | **1.5 J** |
| BROMODICHLOROMETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| BROMOFORM | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| BROMOMETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| CARBON TETRACHLORIDE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| CHLOROETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| CHLOROFORM | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| CHLOROMETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| CIS-1,3-DICHLOROPROPENE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| DIBROMOCHLOROMETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| DICHLORODIFLUOROMETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| ETHYLBENZENE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| METHYLENE CHLORIDE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| TETRACHLOROETHENE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| TOLUENE | UG/L | 5 | **1.1 J** | **1.1 J** | **1.1 J** | **3.7 J** | **1.3 J** | **1.2 J** | **2.3 J** | **1.6 J** | **1.3 J** |
| TRANS-1,2-DICHLOROETHENE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| TRANS-1,3-DICHLOROPROPENE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| TRICHLOROETHENE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| TRICHLOROFLUOROMETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| VINYL CHLORIDE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |

**NOTE:** Bolded values represent detected concentrations
**MDL** = method detection limit
**J** (organic) = compound was detected, but below the reporting limit (value is estimated)
**R** = Data was rejected by the validator and is unusable
**U** = compound was analyzed, but not detected
**UJ** = Analyte was not detected. The associated detection limit is an estimate and may be inaccurate or impricise

**Table 4-1. (continued)**

| ANALYTE | UNITS | Average MDL | TURNING BASIN SECTION | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Location 13B | | | Location 13C | | | Location 14 | | |
| | | | Surface | Mid-Depth | Bottom | Surface | Mid-Depth | Bottom | Surface | Mid-Depth | Bottom |
| 1,1,1-TRICHLOROETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1,1,2,2-TETRACHLOROETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1,1,2-TRICHLOROETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1,1-DICHLOROETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1,1-DICHLOROETHENE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1,2-DICHLOROBENZENE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1,2-DICHLOROETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1,2-DICHLOROPROPANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1,3-DICHLOROBENZENE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 1,4-DICHLOROBENZENE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 2-BUTANONE (MEK) | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| 2-CHLOROETHYL VINYL ETHER | UG/L | 10 | 10 UJ | 10 UJ | 10 UJ | 10 UJ | 10 U | 10 UJ | 10 U | 10 U | 10 U |
| ACROLEIN | UG/L | 100 | R | R | R | R | R | R | R | R | R |
| ACRYLONITRILE | UG/L | 100 | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U | 100 U |
| BENZENE | UG/L | 5 | **1.5 J** | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| BROMODICHLOROMETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| BROMOFORM | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| BROMOMETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| CARBON TETRACHLORIDE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| CHLOROETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| CHLOROFORM | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| CHLOROMETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| CIS-1,3-DICHLOROPROPENE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| DIBROMOCHLOROMETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| DICHLORODIFLUOROMETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| ETHYLBENZENE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | **2.5 J** | **1 J** |
| METHYLENE CHLORIDE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| TETRACHLOROETHENE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| TOLUENE | UG/L | 5 | **1.5 J** | **1.1 J** | **1.1 J** | **1.2 J** | **1.1 J** | **1.1 J** | **1.2 J** | **1.8 J** | **1.5 J** |
| TRANS-1,2-DICHLOROETHENE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| TRANS-1,3-DICHLOROPROPENE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| TRICHLOROETHENE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |
| TRICHLOROFLUOROMETHANE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 UJ | 5 UJ |
| VINYL CHLORIDE | UG/L | 5 | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U | 5 U |

**NOTE:** Bolded values represent detected concentrations

**MDL** = method detection limit

**J** (organic) = compound was detected, but below the reporting limit (value is estimated)

**R** = Data was rejected by the validator and is unusable

**U** = compound was analyzed, but not detected

**UJ** = Analyte was not detected. The associated detection limit is an estimate and may be inaccurate or impricise

## Table 4-2. Polycyclic Aromatic Hydrocarbon Concentrations in Surface Water Around the Coke Point Peninsula

**Sparrows Point Site Assessment (2009), Baltimore, Maryland**

| | | | NORTHWESTERN SECTION | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Location 1 | | | Location 2 | | | Location 3A | | |
| ANALYTE | UNITS | Average MDL | Surface | Mid-Depth | Bottom | Surface | Mid-Depth | Bottom | Surface | Mid-Depth | Bottom |
| ACENAPHTHENE | UG/L | 0.19 | **0.041 J** | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U |
| ACENAPHTHYLENE | UG/L | 0.19 | **0.023 J** | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U |
| ANTHRACENE | UG/L | 0.19 | 0.19 U | 0.19 U | 0.19 U | **0.024 J** | 0.19 U | **0.69** | **1** | **0.016 J** | 0.19 U |
| BENZO(A)ANTHRACENE | UG/L | 0.19 | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | **6.4** | **8.7** | 0.19 U | 0.19 U |
| BENZO(A)PYRENE | UG/L | 0.19 | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | **4.7** | **6.8** | 0.19 U | 0.19 U |
| BENZO(B)FLUORANTHENE | UG/L | 0.19 | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | **6.1** | **8** | 0.19 U | 0.19 U |
| BENZO(GHI)PERYLENE | UG/L | 0.19 | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | **6.8** | **9.3** | 0.19 U | 0.19 U |
| BENZO(K)FLUORANTHENE | UG/L | 0.19 | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | **6.3** | **9.2** | 0.19 U | 0.19 U |
| CHRYSENE | UG/L | 0.19 | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | **6.7** | **9.6** | 0.19 U | 0.19 U |
| DIBENZO(A,H)ANTHRACENE | UG/L | 0.19 | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | **7.6** | **11** | 0.19 U | 0.19 U |
| FLUORANTHENE | UG/L | 0.19 | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | **2.7** | **3.1** | 0.19 U | 0.19 U |
| FLUORENE | UG/L | 0.19 | **0.04 J** | 0.19 U | 0.19 U | 0.19 U | 0.19 U | **0.068 J** | **0.068 J** | 0.19 U | 0.19 U |
| INDENO(1,2,3-CD)PYRENE | UG/L | 0.19 | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | **7.2** | **9.9** | 0.19 U | 0.19 U |
| 1-METHYLNAPHTHALENE | UG/L | 0.19 | **0.065 J** | 0.19 U | 0.19 U | **0.061 J** | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U |
| 2-METHYLNAPHTHALENE | UG/L | 0.19 | **0.077 J** | 0.19 U | 0.19 U | **0.097 J** | **0.049 J** | 0.19 U | **0.058 J** | **0.062 J** | 0.19 U |
| NAPHTHALENE | UG/L | 0.19 | **0.73** | **0.72** | **0.093 J** | **1.2** | **0.94** | **0.9** | **0.53** | **0.74** | **0.39** |
| PHENANTHRENE | UG/L | 0.19 | **0.12 J** | 0.19 U | **0.071 J** | **0.1 J** | **0.079 J** | **0.35** | **0.3** | **0.11 J** | 0.19 U |
| PYRENE | UG/L | 0.19 | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | **2.8** | **3.4** | 0.19 U | 0.19 U |
| TOTAL PAHs (ND=0) | UG/L | -- | **1.1** | **0.72** | **0.164** | **1.48** | **1.07** | **59.3** | **81.0** | **0.928** | **0.39** |
| TOTAL PAHs (ND=1/2MDL) | UG/L | -- | **2.14** | **2.34** | **1.68** | **2.72** | **2.49** | **59.7** | **81.2** | **2.26** | **2.01** |
| TOTAL PAHs (ND=MDL) | UG/L | -- | **3.19** | **3.95** | **3.2** | **3.95** | **3.92** | **60.1** | **81.5** | **3.59** | **3.62** |

**NOTE:** Bolded values represent detected concentrations

**MDL** = method detection limit

**J** (organic) = compound was detected, but below the reporting limit (value is estimated)

**U** = compound was analyzed, but not detected

**Table 4-2. (continued)**

| ANALYTE | UNITS | Average MDL | NORTHWESTERN SECTION | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Location 3B | | | Location 3C | | | Location 4 | | | Location 4 - Duplicate | | |
| | | | Surface | Mid-Depth | Bottom | Surface | Mid-Depth | Bottom | Surface | Mid-Depth | Bottom | Surface | Mid-Depth | Bottom |
| ACENAPHTHENE | UG/L | 0.19 | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | **0.038 J** | **0.038 J** | **0.063 J** |
| ACENAPHTHYLENE | UG/L | 0.19 | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | **0.028 J** | **0.045 J** | **0.058 J** |
| ANTHRACENE | UG/L | 0.19 | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | **0.048 J** | **0.02 J** | **0.036 J** |
| BENZO(A)ANTHRACENE | UG/L | 0.19 | 0.19 U | 0.19 U | 0.19 U | 0.19 U | **0.15 J** | 0.19 U | 0.19 U | 0.19 U | 0.19 U | **0.2** | 0.19 U | 0.19 U |
| BENZO(A)PYRENE | UG/L | 0.19 | 0.19 U | 0.19 U | 0.19 U | 0.19 U | **0.086 J** | 0.19 U | 0.19 U | 0.19 U | 0.19 U | **0.12 J** | 0.19 U | 0.19 U |
| BENZO(B)FLUORANTHENE | UG/L | 0.19 | 0.19 U | 0.19 U | 0.19 U | 0.19 U | **0.13 J** | 0.19 U | 0.19 U | 0.19 U | 0.19 U | **0.086 J** | **0.016 J** | 0.19 U |
| BENZO(GHI)PERYLENE | UG/L | 0.19 | 0.19 U | 0.19 U | 0.19 U | 0.19 U | **0.15 J** | 0.19 U | 0.19 U | 0.19 U | 0.19 U | **0.18 J** | **0.017 J** | 0.19 U |
| BENZO(K)FLUORANTHENE | UG/L | 0.19 | 0.19 U | 0.19 U | 0.19 U | 0.19 U | **0.17 J** | 0.19 U | 0.19 U | 0.19 U | 0.19 U | **0.22** | **0.021 J** | 0.19 U |
| CHRYSENE | UG/L | 0.19 | 0.19 U | 0.19 U | 0.19 U | 0.19 U | **0.16 J** | 0.19 U | 0.19 U | 0.19 U | 0.19 U | **0.28** | 0.19 U | 0.19 U |
| DIBENZO(A,H)ANTHRACENE | UG/L | 0.19 | 0.19 U | 0.19 U | 0.19 U | 0.19 U | **0.14 J** | 0.19 U | 0.19 U | 0.19 U | 0.19 U | **0.21** | 0.19 U | 0.19 U |
| FLUORANTHENE | UG/L | 0.19 | 0.19 U | 0.19 U | 0.19 U | 0.19 U | **0.067 J** | 0.19 U | 0.19 U | 0.19 U | 0.19 U | **0.054 J** | **0.026 J** | **0.059 J** |
| FLUORENE | UG/L | 0.19 | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | **0.038 J** | **0.047 J** | **0.093 J** |
| INDENO(1,2,3-CD)PYRENE | UG/L | 0.19 | 0.19 U | 0.19 U | 0.19 U | 0.19 U | **0.15 J** | 0.19 U | 0.19 U | 0.19 U | 0.19 U | **0.16 J** | **0.019 J** | **0.02 J** |
| 1-METHYLNAPHTHALENE | UG/L | 0.19 | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | **0.052 J** | 0.19 U | 0.19 U | **0.042 J** | **0.046 J** | **0.07 J** |
| 2-METHYLNAPHTHALENE | UG/L | 0.19 | 0.19 U | 0.19 U | 0.19 U | **0.07 J** | 0.19 U | 0.19 U | **0.09 J** | **0.072 J** | 0.19 U | **0.066 J** | **0.091 J** | **0.1 J** |
| NAPHTHALENE | UG/L | 0.19 | **0.3** | **0.26** | **0.34** | **0.47** | **0.18 J** | **0.32** | **1.1** | **2.1** | **1.6** | **1.2** | **2.5** | **2.9** |
| PHENANTHRENE | UG/L | 0.19 | **0.073 J** | **0.074 J** | **0.078 J** | **0.079 J** | **0.081 J** | **0.094 J** | **0.11 J** | **0.089 J** | **0.063 J** | **0.11 J** | **0.1 J** | **0.18 J** |
| PYRENE | UG/L | 0.19 | 0.19 U | 0.19 U | 0.19 U | 0.19 U | **0.073 J** | 0.19 U | 0.19 U | 0.19 U | 0.19 U | **0.044 J** | **0.017 J** | **0.04 J** |
| TOTAL PAHs (ND=0) | UG/L | -- | **0.373** | **0.334** | **0.418** | **0.619** | **1.54** | **0.414** | **1.35** | **2.26** | **1.66** | **3.12** | **3.00** | **3.62** |
| TOTAL PAHs (ND=1/2MDL) | UG/L | -- | **1.89** | **1.85** | **1.94** | **2.04** | **2.11** | **1.93** | **2.68** | **3.69** | **3.18** | **3.12** | **3.38** | **4.28** |
| TOTAL PAHs (ND=MDL) | UG/L | -- | **3.41** | **3.37** | **3.46** | **3.47** | **2.68** | **3.45** | **4.01** | **5.11** | **4.7** | **3.12** | **3.76** | **4.95** |

**NOTE:** Bolded values represent detected concentrations

**MDL** = method detection limit

**J** (organic) = compound was detected, but below the reporting limit (value is estimated)

**U** = compound was analyzed, but not detected

## Table 4-2. (continued)

| ANALYTE | UNITS | Average MDL | NORTHWESTERN SECTION | | | SOUTHWESTERN SECTION | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Location 5 | | | Location 6 | | | Location 7 | | |
| | | | Surface | Mid-Depth | Bottom | Surface | Mid-Depth | Bottom | Surface | Mid-Depth | Bottom |
| ACENAPHTHENE | UG/L | 0.19 | **0.1 J** | **0.059 J** | **0.05 J** | 0.19 U | **0.024 J** | 0.19 U | **0.031 J** | **0.025 J** | **0.028 J** |
| ACENAPHTHYLENE | UG/L | 0.19 | **0.12 J** | **0.066 J** | **0.066 J** | 0.19 U | 0.19 U | 0.19 U | **0.017 J** | 0.19 U | 0.19 U |
| ANTHRACENE | UG/L | 0.19 | **0.11 J** | **0.02 J** | **0.032 J** | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U |
| BENZO(A)ANTHRACENE | UG/L | 0.19 | **0.22** | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | **0.061 J** | **0.13 J** | **0.11 J** |
| BENZO(A)PYRENE | UG/L | 0.19 | **0.15 J** | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | **0.068 J** | **0.21** | **0.12 J** |
| BENZO(B)FLUORANTHENE | UG/L | 0.19 | **0.18 J** | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | **0.14 J** | **0.34** | **0.15 J** |
| BENZO(GHI)PERYLENE | UG/L | 0.19 | **0.21** | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | **0.23** | **0.61** | **0.3** |
| BENZO(K)FLUORANTHENE | UG/L | 0.19 | **0.22** | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | **0.18 J** | **0.4** | **0.24** |
| CHRYSENE | UG/L | 0.19 | **0.25** | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | **0.08 J** | **0.2** | **0.17 J** |
| DIBENZO(A,H)ANTHRACENE | UG/L | 0.19 | **0.22** | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | **0.28** | **0.59** | **0.31** |
| FLUORANTHENE | UG/L | 0.19 | **0.14 J** | **0.024 J** | **0.031 J** | **0.01 J** | **0.015 J** | **0.023 J** | **0.015 J** | **0.023 J** | **0.033 J** |
| FLUORENE | UG/L | 0.19 | 0.19 U | **0.081 J** | **0.071 J** | **0.037 J** | **0.029 J** | **0.024 J** | **0.038 J** | **0.033 J** | **0.034 J** |
| INDENO(1,2,3-CD)PYRENE | UG/L | 0.19 | **0.22** | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | **0.27** | **0.63** | **0.27** |
| 1-METHYLNAPHTHALENE | UG/L | 0.19 | **0.13 J** | **0.083 J** | **0.092 J** | **0.06 J** | **0.037 J** | **0.018 J** | **0.021 J** | **0.016 J** | 0.19 U |
| 2-METHYLNAPHTHALENE | UG/L | 0.19 | **0.2** | **0.14 J** | **0.14 J** | **0.11 J** | **0.072 J** | **0.029 J** | **0.038 J** | **0.033 J** | 0.19 U |
| NAPHTHALENE | UG/L | 0.19 | **2.9** | **3.4** | **3.3** | **0.66** | **0.57** | **0.35** | **0.52** | **0.43** | **0.18 J** |
| PHENANTHRENE | UG/L | 0.19 | **0.2** | **0.15 J** | **0.16 J** | **0.08 J** | **0.075 J** | **0.075 J** | **0.08 J** | **0.09 J** | **0.097 J** |
| PYRENE | UG/L | 0.19 | **0.15 J** | **0.019 J** | **0.025 J** | 0.19 U | 0.19 U | 0.19 U | **0.012 J** | **0.02 J** | **0.02 J** |
| TOTAL PAHs (ND=0) | UG/L | -- | **5.72** | **4.04** | **3.97** | **0.957** | **0.822** | **0.519** | **2.08** | **3.78** | **2.06** |
| TOTAL PAHs (ND=1/2MDL) | UG/L | -- | **5.82** | **4.80** | **4.73** | **2.1** | **1.87** | **1.66** | **2.18** | **3.97** | **2.44** |
| TOTAL PAHs (ND=MDL) | UG/L | -- | **5.91** | **5.56** | **5.49** | **3.24** | **2.91** | **2.8** | **2.27** | **4.16** | **2.82** |

**NOTE:** Bolded values represent detected concentrations

**MDL** = method detection limit

**J** (organic) = compound was detected, but below the reporting limit (value is estimated)

**U** = compound was analyzed, but not detected

**Table 4-2. (continued)**

| | | | SOUTHWESTERN SECTION | | | SOUTHERN SECTION | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Location 8 | | | Location 9 | | | Location 9 - Duplicate | | | Location 10 | | |
| ANALYTE | UNITS | Average MDL | Surface | Mid-Depth | Bottom | Surface | Mid-Depth | Bottom | Surface | Mid-Depth | Bottom | Surface | Mid-Depth | Bottom |
| ACENAPHTHENE | UG/L | 0.19 | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U |
| ACENAPHTHYLENE | UG/L | 0.19 | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U |
| ANTHRACENE | UG/L | 0.19 | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | **0.45** | 0.19 U | 0.19 U | 0.19 U | 0.19 U |
| BENZO(A)ANTHRACENE | UG/L | 0.19 | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | **2.5** | 0.19 U | 0.19 U | 0.19 U | 0.19 U |
| BENZO(A)PYRENE | UG/L | 0.19 | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | **1.9** | 0.19 U | 0.19 U | 0.19 U | 0.19 U |
| BENZO(B)FLUORANTHENE | UG/L | 0.19 | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | **3.4** | 0.19 U | 0.19 U | 0.19 U | 0.19 U |
| BENZO(GHI)PERYLENE | UG/L | 0.19 | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | **3.6** | 0.19 U | 0.19 U | 0.19 U | 0.19 U |
| BENZO(K)FLUORANTHENE | UG/L | 0.19 | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | **3.7** | 0.19 U | 0.19 U | 0.19 U | 0.19 U |
| CHRYSENE | UG/L | 0.19 | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | **3.8** | 0.19 U | 0.19 U | 0.19 U | 0.19 U |
| DIBENZO(A,H)ANTHRACENE | UG/L | 0.19 | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | **4.1** | 0.19 U | 0.19 U | 0.19 U | 0.19 U |
| FLUORANTHENE | UG/L | 0.19 | 0.19 U | **0.023 J** | **0.026 J** | **0.025 J** | **0.024 J** | 0.19 U | 0.19 U | **0.66** | 0.19 U | **0.015 J** | **0.019 J** | **0.03 J** |
| FLUORENE | UG/L | 0.19 | **0.037 J** | **0.052 J** | **0.028 J** | **0.05 J** | **0.029 J** | **0.034 J** | **0.019 J** | **0.046 J** | 0.19 U | **0.035 J** | **0.045 J** | **0.056 J** |
| INDENO(1,2,3-CD)PYRENE | UG/L | 0.19 | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U | **3.8** | 0.19 U | 0.19 U | 0.19 U | 0.19 U |
| 1-METHYLNAPHTHALENE | UG/L | 0.19 | **0.023 J** | **0.023 J** | 0.19 U | **0.021 J** | 0.19 U | 0.19 U | **0.02 J** | 0.19 U | 0.19 U | **0.043 J** | **0.021 J** | 0.19 U |
| 2-METHYLNAPHTHALENE | UG/L | 0.19 | **0.035 J** | **0.045 J** | **0.02 J** | **0.032 J** | **0.021 J** | 0.19 U | **0.03 J** | 0.19 U | 0.19 U | **0.083 J** | **0.044 J** | 0.19 U |
| NAPHTHALENE | UG/L | 0.19 | **0.17 J** | **0.21** | **0.18 J** | **0.2** | **0.22** | **0.24** | **0.23** | **0.24** | **0.23** | **0.26** | **0.16 J** | **0.13 J** |
| PHENANTHRENE | UG/L | 0.19 | **0.1 J** | **0.2** | **0.15 J** | **0.24** | **0.14 J** | **0.11 J** | **0.077 J** | **0.19** | **0.13 J** | **0.16 J** | **0.17 J** | **0.27** |
| PYRENE | UG/L | 0.19 | 0.19 U | **0.011 J** | **0.014 J** | **0.013 J** | 0.19 U | 0.19 U | 0.19 U | **0.59** | 0.19 U | 0.19 U | 0.19 U | **0.012 J** |
| TOTAL PAHs (ND=0) | UG/L | -- | **0.365** | **0.564** | **0.418** | **0.581** | **0.434** | **0.384** | **0.376** | **29.0** | **0.36** | **0.596** | **0.459** | **0.498** |
| TOTAL PAHs (ND=1/2MDL) | UG/L | -- | **1.60** | **1.61** | **1.56** | **1.63** | **1.67** | **1.81** | **1.61** | **29.4** | **1.88** | **1.74** | **1.60** | **1.73** |
| TOTAL PAHs (ND=MDL) | UG/L | -- | **2.84** | **2.65** | **2.70** | **2.67** | **2.90** | **3.23** | **2.85** | **29.7** | **3.4** | **2.88** | **2.74** | **2.97** |

**NOTE:** Bolded values represent detected concentrations

**MDL** = method detection limit

**J** (organic) = compound was detected, but below the reporting limit (value is estimated)

**U** = compound was analyzed, but not detected

## Table 4-2. (continued)

| ANALYTE | UNITS | Average MDL | SOUTHERN SECTION | | | TURNING BASIN SECTION | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Location 11 | | | Location 12 | | | Location 13A | | |
| | | | Surface | Mid-Depth | Bottom | Surface | Mid-Depth | Bottom | Surface | Mid-Depth | Bottom |
| ACENAPHTHENE | UG/L | 0.19 | **0.035 J** | 0.19 U | 0.19 U | **0.058 J** | **0.095 J** | 0.19 U | **0.046 J** | **0.054 J** | **0.032 J** |
| ACENAPHTHYLENE | UG/L | 0.19 | **0.026 J** | 0.19 U | 0.19 U | **0.043 J** | **0.084 J** | 0.19 U | **0.24** | **0.21** | **0.1 J** |
| ANTHRACENE | UG/L | 0.19 | **1.8** | **0.026 J** | **0.024 J** | **0.084 J** | **0.13 J** | 0.19 U | 0.19 U | 0.19 U | 0.19 U |
| BENZO(A)ANTHRACENE | UG/L | 0.19 | **7.4** | 0.19 U | 0.19 U | **0.093 J** | **0.17 J** | 0.19 U | 0.19 U | **0.075 J** | 0.19 U |
| BENZO(A)PYRENE | UG/L | 0.19 | **5.8** | 0.19 U | 0.19 U | **0.058 J** | **0.12 J** | 0.19 U | 0.19 U | **0.052 J** | **0.04 J** |
| BENZO(B)FLUORANTHENE | UG/L | 0.19 | **8** | 0.19 U | 0.19 U | **0.06 J** | **0.13 J** | 0.19 U | 0.19 U | **0.05 J** | 0.19 U |
| BENZO(GHI)PERYLENE | UG/L | 0.19 | **9.6** | 0.19 U | 0.19 U | **0.088 J** | **0.15 J** | 0.19 U | 0.19 U | **0.076 J** | **0.046 J** |
| BENZO(K)FLUORANTHENE | UG/L | 0.19 | **6.9** | 0.19 U | 0.19 U | **0.062 J** | **0.13 J** | 0.19 U | 0.19 U | **0.07 J** | 0.19 U |
| CHRYSENE | UG/L | 0.19 | **7.9** | 0.19 U | 0.19 U | **0.076 J** | **0.16 J** | 0.19 U | 0.19 U | **0.081 J** | 0.19 U |
| DIBENZO(A,H)ANTHRACENE | UG/L | 0.19 | **9.4** | 0.19 U | 0.19 U | **0.076 J** | **0.12 J** | 0.19 U | 0.19 U | **0.083 J** | **0.057 J** |
| FLUORANTHENE | UG/L | 0.19 | **4.7** | **0.016 J** | 0.19 U | **0.095 J** | **0.15 J** | **0.02 J** | **0.027 J** | **0.038 J** | **0.027 J** |
| FLUORENE | UG/L | 0.19 | **0.15 J** | **0.03 J** | **0.032 J** | **0.074 J** | **0.12 J** | **0.023 J** | **0.12 J** | **0.11 J** | **0.061 J** |
| INDENO(1,2,3-CD)PYRENE | UG/L | 0.19 | **9.4** | 0.19 U | 0.19 U | **0.077 J** | **0.15 J** | 0.19 U | 0.19 U | **0.083 J** | **0.057 J** |
| 1-METHYLNAPHTHALENE | UG/L | 0.19 | **0.018 J** | 0.19 U | 0.19 U | **0.069 J** | **0.067 J** | 0.19 U | **0.2** | **0.17 J** | **0.11 J** |
| 2-METHYLNAPHTHALENE | UG/L | 0.19 | **0.03 J** | **0.02 J** | 0.19 U | **0.12 J** | **0.098 J** | 0.19 U | **0.35** | **0.31** | **0.16 J** |
| NAPHTHALENE | UG/L | 0.19 | **0.12 J** | **0.099 J** | **0.08 J** | **0.31** | **0.89** | **0.19** | **6.7** | **6.2** | **3.6** |
| PHENANTHRENE | UG/L | 0.19 | **1.2** | **0.086 J** | **0.15 J** | **0.16 J** | **0.21** | **0.11 J** | **0.19** | **0.19** | **0.11 J** |
| PYRENE | UG/L | 0.19 | **4.7** | 0.19 U | 0.19 U | **0.079 J** | **0.14 J** | 0.19 U | 0.19 U | **0.031 J** | 0.19 U |
| TOTAL PAHs (ND=0) | UG/L | -- | **77.2** | **0.277** | **0.286** | **1.68** | **3.11** | **0.343** | **7.87** | **7.88** | **4.40** |
| TOTAL PAHs (ND=1/2MDL) | UG/L | -- | **77.2** | **1.42** | **1.62** | **1.68** | **3.11** | **1.67** | **8.82** | **7.98** | **4.97** |
| TOTAL PAHs (ND=MDL) | UG/L | -- | **77.2** | **2.56** | **2.95** | **1.68** | **3.11** | **3.00** | **9.77** | **8.07** | **5.54** |

**NOTE:** Bolded values represent detected concentrations

**MDL** = method detection limit

**J** (organic) = compound was detected, but below the reporting limit (value is estimated)

**U** = compound was analyzed, but not detected

## Table 4-2. (continued)

| ANALYTE | UNITS | Average MDL | TURNING BASIN SECTION | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Location 13B | | | Location 13C | | | Location 14 | | |
| | | | Surface | Mid-Depth | Bottom | Surface | Mid-Depth | Bottom | Surface | Mid-Depth | Bottom |
| ACENAPHTHENE | UG/L | 0.19 | **0.05 J** | 0.19 U | 0.19 U | **0.031 J** | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U |
| ACENAPHTHYLENE | UG/L | 0.19 | **0.1 J** | 0.19 U | 0.19 U | **0.038 J** | 0.19 U | 0.19 U | **0.025 J** | 0.19 U | 0.19 U |
| ANTHRACENE | UG/L | 0.19 | 0.19 U | 0.19 U | 0.19 U | **0.076 J** | 0.19 U | 0.19 U | 0.19 U | 0.19 U | 0.19 U |
| BENZO(A)ANTHRACENE | UG/L | 0.19 | 0.19 U | 0.19 U | 0.19 U | **0.46** | 0.19 U | 0.19 U | 0.19 U | 0.19 U | **0.058 J** |
| BENZO(A)PYRENE | UG/L | 0.19 | 0.19 U | 0.19 U | 0.19 U | **0.35** | 0.19 U | 0.19 U | 0.19 U | 0.19 U | **0.034 J** |
| BENZO(B)FLUORANTHENE | UG/L | 0.19 | 0.19 U | 0.19 U | 0.19 U | **0.45** | 0.19 U | 0.19 U | 0.19 U | 0.19 U | **0.056 J** |
| BENZO(GHI)PERYLENE | UG/L | 0.19 | 0.19 U | 0.19 U | 0.19 U | **0.54** | 0.19 U | 0.19 U | 0.19 U | 0.19 U | **0.059 J** |
| BENZO(K)FLUORANTHENE | UG/L | 0.19 | 0.19 U | 0.19 U | 0.19 U | **0.55** | 0.19 U | 0.19 U | 0.19 U | 0.19 U | **0.053 J** |
| CHRYSENE | UG/L | 0.19 | 0.19 U | 0.19 U | 0.19 U | **0.51** | 0.19 U | 0.19 U | 0.19 U | 0.19 U | **0.057 J** |
| DIBENZO(A,H)ANTHRACENE | UG/L | 0.19 | 0.19 U | 0.19 U | 0.19 U | **0.56** | 0.19 U | 0.19 U | 0.19 U | 0.19 U | **0.058 J** |
| FLUORANTHENE | UG/L | 0.19 | **0.025 J** | 0.19 U | **0.027 J** | **0.22** | **0.026 J** | **0.02 J** | **0.014 J** | 0.19 U | **0.029 J** |
| FLUORENE | UG/L | 0.19 | **0.085 J** | 0.19 U | **0.041 J** | **0.048 J** | **0.038 J** | **0.033 J** | **0.034 J** | **0.019 J** | **0.025 J** |
| INDENO(1,2,3-CD)PYRENE | UG/L | 0.19 | 0.19 U | 0.19 U | 0.19 U | **0.57** | 0.19 U | 0.19 U | 0.19 U | 0.19 U | **0.028 J** |
| 1-METHYLNAPHTHALENE | UG/L | 0.19 | **0.11 J** | 0.19 U | 0.19 U | **0.053 J** | 0.19 U | 0.19 U | **0.035 J** | 0.19 U | 0.19 U |
| 2-METHYLNAPHTHALENE | UG/L | 0.19 | **0.21** | 0.19 U | **0.025 J** | **0.082 J** | **0.028 J** | 0.19 U | **0.057 J** | 0.19 U | 0.19 U |
| NAPHTHALENE | UG/L | 0.19 | **3.3** | **0.34** | **0.24** | **1.3** | **0.22** | **0.11 J** | **0.92** | **0.24** | **0.17 J** |
| PHENANTHRENE | UG/L | 0.19 | **0.2** | **0.091 J** | **0.22** | **0.17 J** | **0.18 J** | **0.12 J** | **0.097 J** | **0.08 J** | **0.08 J** |
| PYRENE | UG/L | 0.19 | 0.19 U | 0.19 U | 0.19 U | **0.19** | 0.19 U | 0.19 U | 0.19 U | 0.19 U | **0.021 J** |
| TOTAL PAHs (ND=0) | UG/L | -- | **4.08** | **0.431** | **0.553** | **6.20** | **0.492** | **0.283** | **1.18** | **0.339** | **0.728** |
| TOTAL PAHs (ND=1/2MDL) | UG/L | -- | **5.03** | **1.95** | **1.79** | **6.20** | **1.73** | **1.61** | **2.23** | **1.76** | **1.20** |
| TOTAL PAHs (ND=MDL) | UG/L | -- | **5.98** | **3.47** | **3.02** | **6.20** | **2.96** | **2.94** | **3.27** | **3.19** | **1.68** |

**NOTE:** Bolded values represent detected concentrations

**MDL** = method detection limit

**J** (organic) = compound was detected, but below the reporting limit (value is estimated)

**U** = compound was analyzed, but not detected

**Table 4-3. Surface Water VOC Concentrations from a Previous Investigation**
**Coke Point Peninsula, Baltimore, Maryland**

| | | Northern Transect (West to East) | | | Southern Transect (West to East) | | |
|---|---|---|---|---|---|---|---|
| | **Site**[1] | **SW-1** | **SW-2** | **SW-3** | **SW-4** | **SW-5** | **SW-6** |
| | **Feet from shoreline** | 10 | 100 | 250 | 10 | 100 | 250 |
| **Benzene (µg/L)** | Shallow | 260 D | 330 D | 6.8 | 32 | 140 D | 38 |
| | Mid | 210 D | 1.9 | 1.4 | 140 D | 52 D | 2.9 |
| | Deep | 110 D | 8.9 | N/A | 220 D | 8.3 K | 4.9 |
| **Toluene (µg/L)** | Shallow | 42 | 49 D | 0.35 J | 4.1 | 18 | 4.2 |
| | Mid | 34 | 0.29 J | 0.21 J | 21 | 6.9 | 0.39 J |
| | Deep | 14 | 1.3 | 1.0 U | 34 | 0.99 D | 0.6 J |
| **Ethylbenzene (µg/L)** | Shallow | 0.6 J | 0.6 J | 1.0 U | 1.0 U | 0.3 J | 1.0 U |
| | Mid | 0.4 J | 1.0 U | 1.0 U | 0.3 J | 1.0 U | 1.0 U |
| | Deep | 0.2 J | 1.0 U | 1.0 U | 0.4 J | 1.0 U | 1.0 U |
| **Total Xylenes (µg/L)** | Shallow | 9.9 | 11 | 2.0 U | 1.1 J | 4.3 | 1.2 J |
| | Mid | 5.9 | 2.0 U | 2.0 U | 4.7 | 1.6 J | 2.0 U |
| | Deep | 2.7 | 2.0 U | 2.0 U | 7.4 | 2.0 U | 2.0 U |

Source: URS 2005b

[1] See Figure 4-2 for Site locations

**D** = Compound analyzed at a secondary dilution factor

**J** (organic) = compound was detected, but below the reporting limit (value is estimated)

**K** = The analyte is present. The reported value may be biased high. The actual value is expected to be lower than reported.

**U** = compound was analyzed, but not detected

## Table 4-4. Physical Characteristics of Surface Sediments Around the Coke Point Peninsula

**Sparrows Point Site Assessment (2009), Baltimore, Maryland**

| | | | | NORTHWESTERN SECTION | | | | | | | SOUTHWESTERN SECTION | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ANALYTE** | **UNITS** | **Average RL** | **Background Concentration[(a)]** | **Location 1** | **Location 2** | **Location 3A** | **Location 3B** | **Location 3C** | **Location 4** | **Location 5** | **Location 6** | **Location 7** | **Location 8** |
| GRAVEL | % | -- | 0.343 | 0 | 1.6 | 6 | 0.2 | 0 | 0.3 | 5.4 | 0.2 | 7.3 | 0.6 |
| SAND | % | -- | 6.7 | 1.1 | 73.7 | 68.3 | 15.7 | 15.1 | 15.4 | 68.7 | 24.8 | 57.8 | 38.4 |
| SILT | % | -- | 75.5 | 80.1 | 22.8 | 11.7 | 67.6 | 80.9 | 67.4 | 21.5 | 48.1 | 25.9 | 50.1 |
| CLAY | % | -- | 17.5 | 18.8 | 1.9 | 14 | 16.5 | 4 | 16.9 | 4.4 | 26.9 | 9 | 10.9 |
| SILT+CLAY | % | -- | 93.0 | 98.9 | 24.7 | 25.7 | 84.1 | 84.9 | 84.3 | 25.9 | 75.0 | 34.9 | 61.0 |
| MOISTURE CONTENT | % | 0 | -- | 404 | 61.8 | 80.1 | 176 | 181 | 111 | 71 | 134 | 89.2 | 161 |
| PERCENT SOLIDS | % | 1 | 24.5 | 18.3 | 66.1 | 56.9 | 36.1 | 31.5 | 54.7 | 61.6 | 41.3 | 49.4 | 36 |
| TOTAL CYANIDE | MG/KG | 1.19 | 1.08 | 2.7 U | **6.4** | 0.88 U | **0.47 J** | **13.7** | **3.9** | **0.27 J** | **1.4 L** | **1.2 L** | 1.4 UL |
| TOTAL ORGANIC CARBON | % | 0.256 | 3.3 | **5.76 K** | **28.0 K** | **29.7 K** | **22.9 K** | **22.5 K** | **9.3 K** | **42.0 K** | **5.87** | **8.39** | **10.0** |

(a) Average concentration in surface sediment from Baltimore Harbor Channels. Source: EA 2009. *FY08 Evaluation of Dredged Material: Baltimore Harbor Federal Navigation Channels*

**NOTE:** Bold values represent detected concentrations
**RL** = Reporting Limit
**J** (inorganic) = compound was detected in the method blank

**K** = The reported value may be biased high, the actual value is expected to be lower than reported
**L** = The reported value may be biased low, the actual value is expected to be higher than reported
**UL** = Analyte was not detected. The reported quantitation limit is probably higher than reported
**U** = compound was analyzed, but not detected

**Table 4-4. (continued)**

| ANALYTE | UNITS | Average RL | Background Concentration[(a)] | SOUTHERN SECTION | | | TURNING BASIN SECTION | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Location 9 | Location 10 | Location 11 | Location 12 | Location 13A | Location 13B | Location 13C | Location 14 |
| GRAVEL | % | -- | 0.343 | 0.4 | 1.9 | 0 | 0 | 28.5 | 0 | 0 | 0 |
| SAND | % | -- | 6.7 | 40.8 | 34.3 | 25.2 | 50.2 | 56.7 | 7 | 4.6 | 11.7 |
| SILT | % | -- | 75.5 | 47.9 | 60.3 | 69.6 | 41.2 | 12.2 | 83.2 | 87.4 | 80.3 |
| CLAY | % | -- | 17.5 | 11 | 3.5 | 5.3 | 8.7 | 2.7 | 9.8 | 8 | 8 |
| SILT+CLAY | % | -- | 93.0 | 58.9 | 63.8 | 74.9 | 49.9 | 14.9 | 93.0 | 95.4 | 88.3 |
| MOISTURE CONTENT | % | 0 | -- | 92.1 | 121 | 123 | 91.5 | 37.1 | -- | 342 | 321 |
| PERCENT SOLIDS | % | 1 | 24.5 | 51 | 40.5 | 42.3 | 50.2 | 76.3 | 26.8 | 22.4 | 23.8 |
| TOTAL CYANIDE | MG/KG | 1.19 | 1.08 | **1.1 L** | **11.3 L** | **11.7 L** | **2.2 L** | **7.5 L** | **1.1 L** | **0.93 L** | **1.3 L** |
| TOTAL ORGANIC CARBON | % | 2,560 | 3.3 | **12.9** | **10.8** | **8.31** | **14.6** | **4.96** | **8.13** | **6.12** | **6.56** |

(a) Average concentration in surface sediment from Baltimore Harbor Channels. Source: EA 2009. *FY08 Evaluation of Dredged Material: Baltimore Harbor Federal Navigation Channels*

**NOTE:** Bold values represent detected concentrations
**RL** = Reporting Limit
**L** = The reported value may be biased low, the actual value is expected to be higher than reported
**--** = Not Tested

## Table 4-5. Volatile Organic Compound Concentrations in Surface Sediments Around the Coke Point Peninsula

**Sparrows Point Site Assessment (2009), Baltimore, Maryland**

| ANALYTE | UNITS | Average MDL | Background Concentration[(a)] | NORTHWESTERN SECTION | | | | | | | SOUTHWESTERN SECTION | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Location 1 | Location 2 | Location 3A | Location 3B | Location 3C | Location 4 | Location 5 | Location 6 | Location 7 | Location 8 |
| 1,1,1-TRICHLOROETHANE | UG/KG | 84.3 | 0.533 | 29 U | 8.2 U | 7.8 U | 13 U | 16 U | 8.8 U | 7.5 U | 12 U | 8.3 U | 13 U |
| 1,1,2,2-TETRACHLOROETHANE | UG/KG | 84.3 | 0.886 | 29 U | 8.2 U | 7.8 U | 13 U | 16 U | 8.8 U | 7.5 U | 12 U | 8.3 U | 13 U |
| 1,1,2-TRICHLOROETHANE | UG/KG | 84.3 | 1.34 | 29 U | 8.2 U | 7.8 U | 13 U | 16 U | 8.8 U | 7.5 U | 12 U | 8.3 U | 13 U |
| 1,1-DICHLOROETHANE | UG/KG | 84.3 | 0.571 | 29 U | 8.2 U | 7.8 U | 13 U | 16 U | 8.8 U | 7.5 U | 12 U | 8.3 U | 13 U |
| 1,1-DICHLOROETHENE | UG/KG | 84.3 | 1.16 | 29 U | 8.2 U | 7.8 U | 13 U | 16 U | 8.8 U | 7.5 U | 12 U | 8.3 U | 13 U |
| 1,2-DICHLOROBENZENE | UG/KG | 84.3 | 1.83 | 29 U | 8.2 U | 7.8 U | 13 U | 16 U | 8.8 U | 7.5 U | 12 U | 8.3 U | 13 U |
| 1,2-DICHLOROETHANE | UG/KG | 84.3 | 0.594 | 29 U | 8.2 U | 7.8 U | 13 U | 16 U | 8.8 U | 7.5 U | 12 U | 8.3 U | 13 U |
| 1,2-DICHLOROPROPANE | UG/KG | 84.3 | 1.24 | 29 U | 8.2 U | 7.8 U | 13 U | 16 U | 8.8 U | 7.5 U | 12 U | 8.3 U | 13 U |
| 1,3-DICHLOROBENZENE | UG/KG | 84.3 | 1.80 | 29 U | 8.2 U | 7.8 U | 13 U | 16 U | 8.8 U | 7.5 U | 12 U | 8.3 U | 13 U |
| 1,4-DICHLOROBENZENE | UG/KG | 84.3 | 1.34 | 29 U | 8.2 U | 7.8 U | 13 U | 16 U | 8.8 U | 7.5 U | 12 U | 8.3 U | 13 U |
| 2-BUTANONE (MEK) | UG/KG | 84.3 | 4.43 | 29 U | 8.2 U | 7.8 U | 13 U | 16 U | 8.8 U | 7.5 U | 12 U | 8.3 U | 13 U |
| 2-CHLOROETHYL VINYL ETHER | UG/KG | 170 | 18.1 | 58 U | 16 U | 16 U | 26 U | 32 U | 18 U | 15 U | 24 U | 17 U | 26 U |
| ACROLEIN | UG/KG | 1,700 | 187 | R | R | R | R | R | R | R | R | R | R |
| ACRYLONITRILE | UG/KG | 1,700 | 52.375 | 580 U | 160 U | 160 U | 260 U | 320 U | 180 U | 150 U | 240 U | 170 U | 260 U |
| BENZENE | UG/KG | 146 | 1.08 | 29 U | **4 J** | 7.8 U | 13 U | 16 U | 8.8 U | **11** | 12 U | 8.3 U | 13 U |
| BROMODICHLOROMETHANE | UG/KG | 84.3 | 0.491 | 29 U | 8.2 U | 7.8 U | 13 U | 16 U | 8.8 U | 7.5 U | 12 U | 8.3 U | 13 U |
| BROMOFORM | UG/KG | 84.3 | 1.21 | 29 U | 8.2 U | 7.8 U | 13 U | 16 U | 8.8 U | 7.5 U | 12 U | 8.3 U | 13 U |
| BROMOMETHANE | UG/KG | 84.3 | 1.84 | 29 U | 8.2 U | 7.8 U | 13 U | 16 U | 8.8 U | 7.5 U | 12 U | 8.3 U | 13 U |
| CARBON TETRACHLORIDE | UG/KG | 84.3 | 0.491 | 29 U | 8.2 U | 7.8 U | 13 U | 16 U | 8.8 U | 7.5 U | 12 U | 8.3 U | 13 U |
| CHLOROETHANE | UG/KG | 84.3 | 1.86 | 29 U | 8.2 U | 7.8 U | 13 U | 16 U | 8.8 U | 7.5 U | 12 U | 8.3 U | 13 U |
| CHLOROFORM | UG/KG | 84.3 | 0.491 | 29 U | 8.2 U | 7.8 U | 13 U | 16 U | 8.8 U | 7.5 U | 12 U | 8.3 U | 13 U |
| CHLOROMETHANE | UG/KG | 84.3 | 0.570 | 29 U | 8.2 U | 7.8 U | 13 U | 16 U | 8.8 U | 7.5 U | 12 U | 8.3 U | 13 U |
| CIS-1,3-DICHLOROPROPENE | UG/KG | 84.3 | 0.570 | 29 U | 8.2 U | 7.8 U | 13 U | 16 U | 8.8 U | 7.5 U | 12 U | 8.3 U | 13 U |
| DIBROMOCHLOROMETHANE | UG/KG | 84.3 | 0.515 | 29 U | 8.2 U | 7.8 U | 13 U | 16 U | 8.8 U | 7.5 U | 12 U | 8.3 U | 13 U |
| DICHLORODIFLUOROMETHANE | UG/KG | 84.3 | 0.997 | 29 U | 8.2 U | 7.8 U | 13 U | 16 U | 8.8 U | 7.5 U | 12 U | 8.3 U | 13 U |
| ETHYLBENZENE | UG/KG | 84.3 | 1.84 | 29 U | 8.2 U | 7.8 U | 13 U | 16 U | 8.8 U | 7.5 U | 12 U | 8.3 U | 13 U |
| METHYLENE CHLORIDE | UG/KG | 84.3 | 12.5 | 29 U | 8.2 U | 7.8 U | 13 U | 16 U | 8.8 U | 7.5 U | 12 U | 8.3 U | 13 U |
| TETRACHLOROETHENE | UG/KG | 84.3 | 1.51 | 29 U | 8.2 U | 7.8 U | 13 U | 16 U | 8.8 U | 7.5 U | 12 U | 8.3 U | 13 U |
| TOLUENE | UG/KG | 84.3 | 1.16 | 29 U | 8.2 U | 7.8 U | 13 U | 16 U | 8.8 U | **2.4 J** | 12 U | 8.3 U | 13 U |
| TRANS-1,2-DICHLOROETHENE | UG/KG | 84.3 | 1.29 | 29 U | 8.2 U | 7.8 U | 13 U | 16 U | 8.8 U | 7.5 U | 12 U | 8.3 U | 13 U |
| TRANS-1,3-DICHLOROPROPENE | UG/KG | 84.3 | 0.544 | 29 U | 8.2 U | 7.8 U | 13 U | 16 U | 8.8 U | 7.5 U | 12 U | 8.3 U | 13 U |
| TRICHLOROETHENE | UG/KG | 84.3 | 1.70 | 29 U | 8.2 U | 7.8 U | 13 U | 16 U | 8.8 U | 7.5 U | 12 U | 8.3 U | 13 U |
| TRICHLOROFLUOROMETHANE | UG/KG | 84.3 | 2.38 | 29 U | 8.2 U | 7.8 U | 13 U | 16 U | 8.8 U | 7.5 U | 12 U | 8.3 U | 13 U |
| VINYL CHLORIDE | UG/KG | 84.3 | 1.30 | 29 U | 8.2 U | 7.8 U | 13 U | 16 U | 8.8 U | 7.5 U | 12 U | 8.3 U | 13 U |

(a) Average concentration in surface sediment from Baltimore Harbor Channels. Source: EA 2007. *FY05 Evaluation of Dredged Material: Baltimore Harbor Federal Navigation Channels*

**NOTE:** Bold values represent detected concentrations

**MDL** = method detection limit

**R** = Data was rejected by the validator and is unusable

**J** (organic) = compound was detected, but below the reporting limit (value is estimated)

**U** = compound was analyzed, but not detected

**Table 4-5. (continued)**

| ANALYTE | UNITS | Average MDL | Background Concentration[(a)] | SOUTHERN SECTION | | | TURNING BASIN SECTION | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Location 9 | Location 10 | Location 11 | Location 12 | Location 13A | Location 13B | Location 13C | Location 14 |
| 1,1,1-TRICHLOROETHANE | UG/KG | 84.3 | 0.533 | 9.5 U | 13 U | 10 U | 9.7 U | 6.6 U | 18 U | 21 U | 21 U |
| 1,1,2,2-TETRACHLOROETHANE | UG/KG | 84.3 | 0.886 | 9.5 U | 13 U | 10 U | 9.7 U | 6.6 U | 18 U | 21 U | 21 U |
| 1,1,2-TRICHLOROETHANE | UG/KG | 84.3 | 1.34 | 9.5 U | 13 U | 10 U | 9.7 U | 6.6 U | 18 U | 21 U | 21 U |
| 1,1-DICHLOROETHANE | UG/KG | 84.3 | 0.571 | 9.5 U | 13 U | 10 U | 9.7 U | 6.6 U | 18 U | 21 U | 21 U |
| 1,1-DICHLOROETHENE | UG/KG | 84.3 | 1.16 | 9.5 U | 13 U | 10 U | 9.7 U | 6.6 U | 18 U | 21 U | 21 U |
| 1,2-DICHLOROBENZENE | UG/KG | 84.3 | 1.83 | 9.5 U | 13 U | 10 U | 9.7 U | 6.6 U | 18 U | 21 U | 21 U |
| 1,2-DICHLOROETHANE | UG/KG | 84.3 | 0.594 | 9.5 U | 13 U | 10 U | 9.7 U | 6.6 U | 18 U | 21 U | 21 U |
| 1,2-DICHLOROPROPANE | UG/KG | 84.3 | 1.24 | 9.5 U | 13 U | 10 U | 9.7 U | 6.6 U | 18 U | 21 U | 21 U |
| 1,3-DICHLOROBENZENE | UG/KG | 84.3 | 1.80 | 9.5 U | 13 U | 10 U | 9.7 U | 6.6 U | 18 U | 21 U | 21 U |
| 1,4-DICHLOROBENZENE | UG/KG | 84.3 | 1.34 | 9.5 U | 13 U | 10 U | 9.7 U | 6.6 U | 18 U | 21 U | 21 U |
| 2-BUTANONE (MEK) | UG/KG | 84.3 | 4.43 | 9.5 U | 13 U | 10 U | 9.7 U | 6.6 U | 18 U | 21 U | 21 U |
| 2-CHLOROETHYL VINYL ETHER | UG/KG | 170 | 18.1 | 19 U | 25 U | 21 U | 19 U | 13 U | 37 U | 42 U | 42 U |
| ACROLEIN | UG/KG | 1,700 | 187 | R | R | R | R | R | R | R | R |
| ACRYLONITRILE | UG/KG | 1,700 | 52.375 | 190 U | 250 U | 210 U | 190 U | 130 U | 370 U | 420 U | 420 U |
| BENZENE | UG/KG | 146 | 1.08 | 9.5 U | 13 U | 10 U | 9.7 U | **79** | 18 U | 21 U | 21 U |
| BROMODICHLOROMETHANE | UG/KG | 84.3 | 0.491 | 9.5 U | 13 U | 10 U | 9.7 U | 6.6 U | 18 U | 21 U | 21 U |
| BROMOFORM | UG/KG | 84.3 | 1.21 | 9.5 U | 13 U | 10 U | 9.7 U | 6.6 U | 18 U | 21 U | 21 U |
| BROMOMETHANE | UG/KG | 84.3 | 1.84 | 9.5 U | 13 U | 10 U | 9.7 U | 6.6 U | 18 U | 21 U | 21 U |
| CARBON TETRACHLORIDE | UG/KG | 84.3 | 0.491 | 9.5 U | 13 U | 10 U | 9.7 U | 6.6 U | 18 U | 21 U | 21 U |
| CHLOROETHANE | UG/KG | 84.3 | 1.86 | 9.5 U | 13 U | 10 U | 9.7 U | 6.6 U | 18 U | 21 U | 21 U |
| CHLOROFORM | UG/KG | 84.3 | 0.491 | 9.5 U | 13 U | 10 U | 9.7 U | 6.6 U | 18 U | 21 U | 21 U |
| CHLOROMETHANE | UG/KG | 84.3 | 0.570 | 9.5 U | 13 U | 10 U | 9.7 U | 6.6 U | 18 U | 21 U | 21 U |
| CIS-1,3-DICHLOROPROPENE | UG/KG | 84.3 | 0.570 | 9.5 U | 13 U | 10 U | 9.7 U | 6.6 U | 18 U | 21 U | 21 U |
| DIBROMOCHLOROMETHANE | UG/KG | 84.3 | 0.515 | 9.5 U | 13 U | 10 U | 9.7 U | 6.6 U | 18 U | 21 U | 21 U |
| DICHLORODIFLUOROMETHANE | UG/KG | 84.3 | 0.997 | 9.5 U | 13 U | 10 U | 9.7 U | 6.6 U | 18 U | 21 U | 21 U |
| ETHYLBENZENE | UG/KG | 84.3 | 1.84 | 9.5 U | 13 U | 10 U | 9.7 U | **4.9 J** | 18 U | 21 U | 21 U |
| METHYLENE CHLORIDE | UG/KG | 84.3 | 12.5 | 9.5 U | 13 U | 10 U | 9.7 U | 6.6 U | 18 U | 21 U | 21 U |
| TETRACHLOROETHENE | UG/KG | 84.3 | 1.51 | 9.5 U | 13 U | 10 U | 9.7 U | 6.6 U | 18 U | 21 U | 21 U |
| TOLUENE | UG/KG | 84.3 | 1.16 | 9.5 U | 13 U | 10 U | 9.7 U | **57** | 18 U | 21 U | 21 U |
| TRANS-1,2-DICHLOROETHENE | UG/KG | 84.3 | 1.29 | 9.5 U | 13 U | 10 U | 9.7 U | 6.6 U | 18 U | 21 U | 21 U |
| TRANS-1,3-DICHLOROPROPENE | UG/KG | 84.3 | 0.544 | 9.5 U | 13 U | 10 U | 9.7 U | 6.6 U | 18 U | 21 U | 21 U |
| TRICHLOROETHENE | UG/KG | 84.3 | 1.70 | 9.5 U | 13 U | 10 U | 9.7 U | 6.6 U | 18 U | 21 U | 21 U |
| TRICHLOROFLUOROMETHANE | UG/KG | 84.3 | 2.38 | 9.5 U | 13 U | 10 U | 9.7 U | 6.6 U | 18 U | 21 U | 21 U |
| VINYL CHLORIDE | UG/KG | 84.3 | 1.30 | 9.5 U | 13 U | 10 U | 9.7 U | 6.6 U | 18 U | 21 U | 21 U |

(a) Average concentration in surface sediment from Baltimore Harbor Channels. Source: EA 2007. *FY05 Evaluation of Dredged Material: Baltimore Harbor Federal Navigation Channels*

**NOTE:** Bold values represent detected concentrations
**MDL** = method detection limit
**R** = Data was rejected by the validator and is unusable
**J** (organic) = compound was detected, but below the reporting limit (value is estimated)
**U** = compound was analyzed, but not detected

## Table 4-6. Polycyclic Aromatic Hydrocarbon Concentrations in Surface Sediments Around the Coke Point Peninsula

**Sparrows Point Site Assessment (2009), Baltimore, Maryland**

| | | | | NORTHWESTERN SECTION | | | | | | | SOUTHWESTERN SECTION | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ANALYTE** | **UNITS[a]** | **Average MDL** | **Background Concentration[b]** | **Location 1** | **Location 2** | **Location 3A** | **Location 3B** | **Location 3C** | **Location 4** | **Location 5** | **Location 6** | **Location 7** | **Location 8** |
| ACENAPHTHENE | MG/KG | 0.237 | 0.0555 | **0.073 J** | **1** | **0.83** | **5.9** | **3** | **0.58** | **3.3** | **4.2** | **4.6** | **0.76** |
| ACENAPHTHYLENE | MG/KG | 0.237 | 0.118 | **0.23** | **4.3** | **1.7** | **1.4** | **1.7** | **1.7** | **9.1** | **8.4** | **8.1** | **2** |
| ANTHRACENE | MG/KG | 1.16 | 0.0374 | **0.31** | **5** | **1.7** | **8.2** | **3.8** | **2.4** | **17** | **18** | **21** | **3.7** |
| BENZO(A)ANTHRACENE | MG/KG | 0.325 | 0.0565 | **0.68** | **7.6** | **4.4** | **11** | **9.3** | **4.8** | **48** | **32** | **61** | **8.1** |
| BENZO(A)PYRENE | MG/KG | 0.300 | 0.108 | **1.1** | **9.3** | **5.3** | **9.9** | **10** | **6** | **26** | **26** | **56** | **8.8** |
| BENZO(B)FLUORANTHENE | MG/KG | 0.265 | 0.205 | **1.3** | **9.3** | **5.5** | **10** | **11** | **6** | **53** | **31** | **24** | **8.8** |
| BENZO(GHI)PERYLENE | MG/KG | 0.237 | 0.234 | **0.95** | **6.3** | **3.9** | **7** | **7.2** | **4.2** | **16** | **20** | **18** | **5.4** |
| BENZO(K)FLUORANTHENE | MG/KG | 0.237 | 0.403 | **0.44** | 0.130 U | 0.130 U | 0.190 U | 0.210 U | 0.130 U | 0.130 U | **17** | **18** | **3.6** |
| CHRYSENE | MG/KG | 0.325 | 0.229 | **0.68** | **6.5** | **3.9** | **8.1** | **8.5** | **4.3** | **40** | **31** | **63** | **7.6** |
| DIBENZO(A,H)ANTHRACENE | MG/KG | 0.237 | 0.137 | **0.19** | **1.3** | 0.130 U | **0.900 J** | **1.9** | **0.89** | 0.130 U | **6.3** | **4.3** | **1.5** |
| FLUORANTHENE | MG/KG | 1.63 | 0.215 | **1.3** | **25** | **8.4** | **32** | **25** | **9** | **88** | **44** | **140** | **14** |
| FLUORENE | MG/KG | 0.237 | 0.328 | **0.2** | **3** | **0.69** | **3.5** | **1.9** | **1.3** | **2.5** | **2.5** | **2.4** | **0.61** |
| INDENO(1,2,3-CD)PYRENE | MG/KG | 0.237 | 0.422 | **0.74** | **5.3** | **3.5** | **6 J** | **6.1** | **3.7** | **25** | **19** | **17** | **4.9** |
| 1-METHYLNAPHTHALENE | MG/KG | 0.237 | 0.0609 | **0.170 J** | **1.8** | **1.3** | **2.8** | **2.5** | **1.6** | **1.1** | **0.76** | **0.63** | **0.3** |
| 2-METHYLNAPHTHALENE | MG/KG | 1.40 | 0.181 | **0.34** | **3.2** | **1.8** | **6.5** | **4.2** | **3.8** | **2.3** | **1.4** | **0.99** | **0.67** |
| NAPHTHALENE | MG/KG | 5.34 | 0.282 | **3.7** | **85** | **90** | **7,200** | **190** | **97** | **50** | **20** | **14** | **12** |
| PHENANTHRENE | MG/KG | 0.663 | 0.232 | **0.61** | **14** | **3.2** | **20** | **5.6** | **5.2** | **17** | **16** | **15** | **3.6** |
| PYRENE | MG/KG | 0.337 | 0.368 | **1.2** | **16** | **5.6** | **21** | **15** | **5.5** | **59** | **32** | **27** | **9.1** |
| TOTAL PAHs (ND=0) | MG/KG | -- | 3.24 | **14.2** | **204** | **142** | **7,354** | **307** | **158** | **457** | **330** | **495** | **95.4** |
| TOTAL PAHs (ND=1/2MDL) | MG/KG | -- | 3.25 | **14.2** | **204** | **142** | **7,354** | **307** | **158** | **457** | **330** | **495** | **95.4** |
| TOTAL PAHs (ND=MDL) | MG/KG | -- | 3.27 | **14.2** | **204** | **142** | **7,354** | **307** | **158** | **458** | **330** | **495** | **95.4** |

(a) Values were converted from μg/kg (as reported in laboratory analytical results).

(b) Average concentration in surface sediment from Baltimore Harbor Channels. Source: EA 2009. *FY08 Evaluation of Dredged Material: Baltimore Harbor Federal Navigation Channels*

**NOTE:** Bold values represent detected concentrations

**MDL** = method detection limit

**J** (organic) = compound was detected, but below the reporting limit (value is estimated)

**U** = compound was analyzed, but not detected

**Table 4-6. (continued)**

| ANALYTE | UNITS[a] | Average MDL | Background Concentration[b] | SOUTHERN SECTION | | | TURNING BASIN SECTION | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Location 9 | Location 10 | Location 11 | Location 12 | Location 13A | Location 13B | Location 13C | Location 14 |
| ACENAPHTHENE | MG/KG | 0.237 | 0.0555 | **1.1** | **1.8** | **1.2** | **0.24** | **0.91** | **0.098** | **0.059 J** | **0.240 J** |
| ACENAPHTHYLENE | MG/KG | 0.237 | 0.118 | **3.5** | **3** | **1.6** | **0.95** | **1.5** | **0.2** | **0.110 J** | **0.200 J** |
| ANTHRACENE | MG/KG | 1.16 | 0.0374 | **6.5** | **4.9** | **4.3** | **1.2** | **2.2** | **0.28** | **0.160 J** | **0.390 J** |
| BENZO(A)ANTHRACENE | MG/KG | 0.325 | 0.0565 | **19** | **15** | **13** | **4.8** | **4** | **0.58** | **0.31** | **0.77** |
| BENZO(A)PYRENE | MG/KG | 0.300 | 0.108 | **25** | **15** | **12** | **5.5** | **3.6** | **0.63** | **0.31** | **0.73** |
| BENZO(B)FLUORANTHENE | MG/KG | 0.265 | 0.205 | **20** | **13** | **10** | **4.9** | **3.6** | **1.5** | **1.4** | **1.7** |
| BENZO(GHI)PERYLENE | MG/KG | 0.237 | 0.234 | **15** | **7.9** | **6** | **3.5** | **1.8** | **0.46** | **0.220 J** | **0.51** |
| BENZO(K)FLUORANTHENE | MG/KG | 0.237 | 0.403 | **11** | **8.1** | **5.9** | **3** | **1.8** | **0.35** | **0.190 J** | **0.29** |
| CHRYSENE | MG/KG | 0.325 | 0.229 | **18** | **14** | **11** | **4.8** | **3.3** | **0.64** | **0.31** | **0.88** |
| DIBENZO(A,H)ANTHRACENE | MG/KG | 0.237 | 0.137 | **4.9** | **2.6** | **1.9** | **1** | **0.53** | **0.086** | 0.300 J | **0.120 J** |
| FLUORANTHENE | MG/KG | 1.63 | 0.215 | **29** | **31** | **26** | **7.5** | **8.9** | **1.1** | **0.59** | **1.7** |
| FLUORENE | MG/KG | 0.237 | 0.328 | **1** | **1.7** | **1.6** | **0.35** | **1.8** | **0.15** | **0.100 J** | **0.32** |
| INDENO(1,2,3-CD)PYRENE | MG/KG | 0.237 | 0.422 | **14** | **7.4** | **5.4** | **3.1** | **1.7** | **0.4** | **0.180 J** | **0.4** |
| 1-METHYLNAPHTHALENE | MG/KG | 0.237 | 0.0609 | **0.35** | **0.59** | **0.76** | **0.18** | **0.83** | **0.14** | **0.070 J** | **0.170 J** |
| 2-METHYLNAPHTHALENE | MG/KG | 1.40 | 0.181 | **0.61** | **0.68** | **1.6** | **0.37** | **1.6** | **0.28** | **0.140 J** | **0.32** |
| NAPHTHALENE | MG/KG | 5.34 | 0.282 | **13** | **9.9** | **37** | **5.3** | **16** | **1.7** | **0.77** | **1.5** |
| PHENANTHRENE | MG/KG | 0.663 | 0.232 | **8.1** | **6.4** | **5.6** | **1.7** | **7.9** | **0.53** | **0.31** | **0.86** |
| PYRENE | MG/KG | 0.337 | 0.368 | **17** | **21** | **17** | **5** | **6** | **0.79** | **0.43** | **1.2** |
| TOTAL PAHs (ND=0) | MG/KG | -- | 3.24 | **207** | **164** | **162** | **53.4** | **68.0** | **9.91** | **5.67** | **12.3** |
| TOTAL PAHs (ND=1/2MDL) | MG/KG | -- | 3.25 | **207** | **164** | **162** | **53.4** | **68.0** | **9.91** | **5.82** | **12.3** |
| TOTAL PAHs (ND=MDL) | MG/KG | -- | 3.27 | **207** | **164** | **162** | **53.4** | **68.0** | **9.91** | **5.97** | **12.3** |

(a) Values were converted from μg/kg (as reported in laboratory analytical results).

(b) Average concentration in surface sediment from Baltimore Harbor Channels. Source: EA 2009. *FY08 Evaluation of Dredged Material: Baltimore Harbor Federal Navigation Channels*

**NOTE:** Bold values represent detected concentrations

**MDL** = method detection limit

**J** (organic) = compound was detected, but below the reporting limit (value is estimated)

**U** = compound was analyzed, but not detected

## Table 4-7. Metal Concentrations in Surface Sediments Around the Coke Point Peninsula

**Sparrows Point Site Assessment (2009), Baltimore, Maryland**

| | | | | NORTHWESTERN SECTION | | | | | | | SOUTHWESTERN SECTION | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **ANALYTE** | **UNITS** | **Average MDL** | **Background Concentration(a)** | **Location 1** | **Location 2** | **Location 3A** | **Location 3B** | **Location 3C** | **Location 4** | **Location 5** | **Location 6** | **Location 7** | **Location 8** |
| ANTIMONY | MG/KG | 0.25 | 0.398 | **1.6 J** | **0.39 J** | **0.47 J** | **1.1 J** | **2.3 J** | **0.8 J** | **0.58 J** | **1.1 L** | **0.96 L** | **1.3 L** |
| ARSENIC | MG/KG | 0.125 | 20.6 | **17.2** | **4.5** | **9.8** | **25.2** | **50.1** | **21.4** | **9.4** | **19.2** | **22.9** | **20** |
| BERYLLIUM | MG/KG | 0.125 | 1.7 | **1.9** | **0.5** | **0.98** | **1.3** | **1.4** | **0.93** | **0.96** | **1.4** | **1.6** | **1.6** |
| CADMIUM | MG/KG | 0.125 | 1.38 | **2.1** | **0.93** | **0.8** | **3.4** | **4.9** | **1.8** | **1** | **1.7 L** | **1.8 L** | **1.9 L** |
| CHROMIUM | MG/KG | 0.25 | 125 | **249** | **105** | **120** | **296** | **450** | **376** | **138** | **180** | **261** | **283** |
| COPPER | MG/KG | 0.25 | 118 | **139 L** | **50.1 L** | **44.5 L** | **177 L** | **595 L** | **81.7 L** | **51.7 L** | **97.3** | **87.7** | **129** |
| LEAD | MG/KG | 0.202 | 109 | **175** | **68.4** | **65.8** | **373** | **602** | **216** | **70.6** | **166** | **208** | **171** |
| MERCURY | MG/KG | 0.0491 | 0.396 | **0.47 L** | **0.33 L** | **0.24 L** | **0.7 L** | **1.1 L** | **0.34 L** | **0.24 L** | **0.5** | **0.43** | **0.44** |
| NICKEL | MG/KG | 0.125 | 41.3 | **56.2** | **17.7** | **24** | **37.9** | **51.6** | **34.9** | **28.7** | **36.4** | **35** | **47.5** |
| SELENIUM | MG/KG | 0.626 | 3.11 | **2.8 L** | **0.48 L** | **1.4 L** | **3.5 L** | **7.7 L** | **1.9 L** | **1.5 L** | **2.3** | **2.8** | **2.3** |
| SILVER | MG/KG | 0.125 | 0.722 | **1.4** | **0.34** | **0.3** | **1.8** | **2.8** | **0.61** | **0.3** | **0.86** | **0.71** | **0.93** |
| THALLIUM | MG/KG | 0.125 | 0.354 | **0.49** | **0.53** | **0.23** | **0.71** | **0.95** | **0.33** | **0.22** | **0.29** | **0.37** | **0.4** |
| ZINC | MG/KG | 1.28 | 306 | **861** | **373** | **279** | **1,070** | **1,790** | **838** | **418** | **498** | **617** | **597** |

(a) Average concentration in surface sediment from Baltimore Harbor Channels. Source: EA 2009. *FY08 Evalution of Dredged Material: Baltimore Harbor Federal Navigation Channels*

**NOTE:** Bold values represent detected concentrations
**MDL** = method detection limit
**J (inorganic)** = compound was detected in the method blank
**L** = The reported value my be biased low, the actual value is expected to be higher than reported

## Table 4-7. (continued)

| ANALYTE | UNITS | Average MDL | Background Concentration[(a)] | SOUTHERN SECTION | | | TURNING BASIN SECTION | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Location 9 | Location 10 | Location 11 | Location 12 | Location 13A | Location 13B | Location 13C | Location 14 |
| ANTIMONY | MG/KG | 0.25 | 0.398 | **0.84 L** | **1.9 L** | **1.4 L** | **0.82 L** | **0.38 L** | **0.79 L** | **0.71 L** | **0.69 L** |
| ARSENIC | MG/KG | 0.125 | 20.6 | **12.5** | **46.8** | **34.1** | **12.6** | **7.8** | **13.6** | **14.8** | **13.3** |
| BERYLLIUM | MG/KG | 0.125 | 1.7 | **1** | **1.6** | **1.3** | **1** | **0.66** | **1.7** | **1.9** | **1.8** |
| CADMIUM | MG/KG | 0.125 | 1.38 | **1.4 L** | **7.4 L** | **4.4 L** | **1.9 L** | **0.61 L** | **1.8 L** | **1.9 L** | **1.9 L** |
| CHROMIUM | MG/KG | 0.25 | 125 | **156** | **200** | **235** | **107** | **178** | **127** | **124** | **137** |
| COPPER | MG/KG | 0.25 | 118 | **60.4** | **130** | **275** | **75.5** | **30.9** | **80.6** | **87.7** | **89.6** |
| LEAD | MG/KG | 0.202 | 109 | **146** | **1,150** | **567** | **268** | **87.2** | **167** | **169** | **166** |
| MERCURY | MG/KG | 0.0491 | 0.396 | **0.45** | **1.7** | **1.1** | **0.59** | **0.13** | **0.3** | **0.32** | **0.31** |
| NICKEL | MG/KG | 0.125 | 41.3 | **35.6** | **56.4** | **42.2** | **31.5** | **19** | **45** | **49.2** | **47.8** |
| SELENIUM | MG/KG | 0.626 | 3.11 | **1.5** | **7.8** | **5.1** | **1.6** | **0.32 J** | **2.4** | **2.6** | **2.4** |
| SILVER | MG/KG | 0.125 | 0.722 | **0.5** | **1.1** | **1.9** | **0.67** | **0.17** | **0.96** | **0.99** | **0.92** |
| THALLIUM | MG/KG | 0.125 | 0.354 | **0.25** | **0.85** | **0.76** | **0.4** | **0.41** | **0.65** | **0.68** | **0.65** |
| ZINC | MG/KG | 1.28 | 306 | **619** | **2,730** | **1,400** | **609** | **150** | **479** | **495** | **511** |

(a) Average concentration in surface sediment from Baltimore Harbor Channels. Source: EA 2009. *FY08 Evaluation of Dredged Material: Baltimore Harbor Federal Navigation Channels*

**NOTE:** Bold values represent detected concentrations
**MDL** = method detection limit
**J** (inorganic) = compound was detected in the method blank
**L** = The reported value may be biased low, the actual value is expected to be higher than reported

## Table 4-8. Naphthalene Proportion of Total Polycyclic Aromatic Hydrocarbon Concentration in Sediment Samples

**Coke Point Peninsula, Sparrows Point Site Assessment (2009), Baltimore, Maryland**

| | SURFACE SEDIMENTS | | SUBSURFACE SEDIMENTS | |
|---|---|---|---|---|
| | Total PAH Concentration[1] (ug/kg) | % Naphthalene | Total PAH Concentration[1] (ug/kg) | % Naphthalene |
| **Background** | 3.27 | 8.6% | 3.27 | 8.62% |
| **Location 1** | 14.2 | 26.0% | 59.5 | 47.1% |
| **Location 2** | 204 | 41.7% | 359 | 80.8% |
| **Location 3A** | 142 | 63.4% | 36.1 | 80.4% |
| **Location 3B** | 7,354 | 97.9% | 68.2 | 74.8% |
| **Location 3C** | 307 | 61.9% | 2,967 | 94.4% |
| **Location 3D** | NT | NA | 38.1 | 13.9% |
| **Location 3E** | NT | NA | 10.0 | 8.7% |
| **Location 4** | 158 | 61.4% | 4,796 | 91.7% |
| **Location 5** | 458 | 10.9% | 674 | 87.5% |
| **Location 6** | 329 | 6.1% | 1,188 | 52.2% |
| **Location 7** | 485 | 2.9% | 20.4 | 48.1% |
| **Location 8** | 95 | 12.6% | 28.5 | 59.6% |
| **Location 9** | 207 | 6.3% | 0.51 | ND |
| **Location 10** | 164 | 6.0% | 136 | 23.6% |
| **Location 11** | 162 | 22.9% | 2,798 | 85.8% |
| **Location 12** | 53.4 | 9.9% | 27.0 | 7.0% |
| **Location 13A** | 68.0 | 23.5% | 7.92 | 30.3% |
| **Location 13B** | 9.91 | 17.1% | 0.54 | 1.4% |
| **Location 13C** | 5.97 | 12.9% | 21.6 | 38.9% |
| **Location 14** | 12.3 | 12.2% | 34.3 | 17.8% |
| **Location 15** | NT | NA | 18.4 | 17.4% |
| **Location 16** | NT | NA | 43.1 | 4.4% |
| **Location 17** | NT | NA | 49.8 | 4.8% |
| **Location 18** | NT | NA | 91.9 | 2.6% |

**NT** = not tested

**NA** = not applicable

[1] Calculated using ND=MDL

**Table 4-9. Field Screening Indicators of Non-Aqueous Phase Liquid and/or Highly Impacted Sediment Surrounding the Coke Point Peninsula**

**Sparrows Point Site Assessment (2009), Baltimore, Maryland**

| | Location 1 | | | Location 2 | | | Location 3A | | | Location 3B | | | Location 3C | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Depth Interval (ft bgs)** | **Dye test / Visual** | **PID (ppm)** | **Odor** | **Dye test / Visual** | **PID (ppm)** | **Odor** | **Dye test / Visual** | **PID (ppm)** | **Odor** | **Dye test / Visual** | **PID (ppm)** | **Odor** | **Dye test / Visual** | **PID (ppm)** | **Odor** |
| **0 - 2** | -- | 0.4 | **SLIGHT** | -- | 3.6 | **SLIGHT** | **SHEEN** | -- | **YES** | -- | 8.6 | **YES** | **SHEEN** | 5.0 | **YES** |
| **2 - 4** | -- | 0.0 | **SLIGHT** | -- | -- | -- | -- | 0.0 | **YES** | **POSITIVE** | 0.4 | **YES** | **SHEEN** | 0.0 | **YES** |
| **4 - 6** | -- | 0.0 | **SLIGHT** | **POSITIVE** | 8.4 | **YES** | NEGATIVE | 0.0 | **YES** | -- | 11.0 | **YES** | -- | 0.0 | **YES** |
| **6 - 8** | **POSITIVE** | 0.0 | **VERY SLIGHT** | **POSITIVE** | 14.2 | **SLIGHT** | -- | 0.0 | **YES** | -- | 1.5 | **YES** | -- | 0.0 | **YES** |
| **8 - 10** | **SHEEN** | 0.0 | **YES** | **SHEEN** | 24.0 | **YES** | -- | 0.0 | **YES** | -- | 1.0 | **YES** | -- | 0.0 | **SLIGHT** |
| **10 - 12** | **POSITIVE** | 0.0 | **YES** | **SHEEN** | 21.8 | **YES** | -- | 0.0 | **YES** | -- | 0.0 | NO | -- | 0.0 | -- |
| **12 - 14** | -- | 0.0 | **SLIGHT** | **SHEEN** | 20.0 | **YES** | -- | 0.0 | **SLIGHT** | -- | 0.8 | NO | -- | 0.0 | -- |
| **14 - 16** | -- | 0.0 | -- | -- | 2.6 | -- | -- | 0.0 | NO | -- | 0.0 | -- | -- | 0.0 | **SLIGHT** |
| **16 - 18** | -- | 0.0 | -- | -- | 57.0 | -- | -- | 0.0 | **SLIGHT** | -- | 0.0 | -- | -- | 0.0 | -- |
| **18 - 20** | -- | 0.0 | -- | **POSITIVE** | 112.0 | **YES** | -- | 0.0 | **SLIGHT** | -- | 0.0 | -- | -- | 0.0 | -- |
| **20 - 22** | -- | 0.0 | -- | -- | 30.2 | **YES** | -- | 0.0 | **SLIGHT** | | | | | | |
| **22 - 24** | -- | 0.0 | -- | | 13.0 | **YES** | | | | | | | | | |
| **24 - 26** | -- | 0.0 | **YES** | | | | | | | | | | | | |
| **26 - 28** | -- | 0.0 | **YES** | | | | | | | | | | | | |
| **28 - 30** | -- | -- | -- | | | | | | | | | | | | |

Notes:

-- = No field screening results noted on borelog.

Bold font and shaded cells indicate definite presence of NAPL.

Bold font cells indicate highly impacted sediment with possible presence of NAPL.

Sheen and odor in the 0 - 2 interval for location 3A were noted during surface sediment sampling

## Table 4-9. (continued)

| | Location 3D | | | Location 3E | | | Location 4 | | | Location 5 | | | Location 6 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Depth Interval (ft bgs)** | **Dye test / Visual** | **PID (ppm)** | **Odor** | **Dye test / Visual** | **PID (ppm)** | **Odor** | **Dye test / Visual** | **PID (ppm)** | **Odor** | **Dye test / Visual** | **PID (ppm)** | **Odor** | **Dye test / Visual** | **PID (ppm)** | **Odor** |
| 0 - 2 | **SHEEN** | 0.0 | **YES** | -- | 0.0 | NO | -- | 0.0 | **SLIGHT** | -- | -- | -- | -- | 7.1 | **YES** |
| 2 - 4 | **SHEEN** | 0.0 | **YES** | NEGATIVE | 0.0 | -- | -- | -- | -- | -- | 0.0 | **YES** | -- | 9.0 | **YES** |
| 4 - 6 | -- | 0.0 | **YES** | -- | 0.0 | NO | -- | 0.0 | **YES** | NEGATIVE | 0.0 | **YES** | -- | 14.2 | **YES** |
| 6 - 8 | -- | 0.0 | **YES** | -- | 0.0 | NO | -- | 0.0 | **YES** | -- | 0.0 | **SLIGHT** | NEGATIVE | 220.0 | -- |
| 8 - 10 | -- | 0.0 | **SLIGHT** | -- | 0.0 | NO | NEGATIVE | 0.0 | **YES** | -- | 0.0 | **SLIGHT** | -- | 2.5 | -- |
| 10 - 12 | -- | 0.0 | NO | -- | 0.0 | NO | -- | 0.0 | **SLIGHT** | -- | 0.0 | **SLIGHT** | -- | 0.2 | -- |
| 12 - 14 | -- | 0.0 | NO | -- | 0.0 | NO | -- | 0.0 | -- | **SHEEN** | 0.0 | **YES** | -- | 0.0 | -- |
| 14 - 16 | -- | 0.0 | NO | -- | 0.0 | NO | -- | 0.0 | **SLIGHT** | **SHEEN** | 0.0 | **YES** | -- | 1.7 | -- |
| 16 - 18 | -- | 0.0 | NO | -- | 0.0 | NO | -- | 0.0 | NO | -- | 0.0 | **YES** | -- | 0.0 | -- |
| 18 - 20 | -- | 0.0 | NO | -- | 0.0 | NO | -- | 0.0 | NO | -- | 0.0 | **SLIGHT** | -- | 0.0 | -- |
| 20 - 22 | -- | 0.0 | NO | | | | -- | 0.0 | NO | -- | 0.0 | **SLIGHT** | | | |
| 22 - 24 | | | | | | | -- | 0.0 | NO | -- | 0.0 | **SLIGHT** | | | |
| 24 - 26 | | | | | | | | | | -- | 0.0 | **SLIGHT** | | | |
| 26 - 28 | | | | | | | | | | | | | | | |
| 28 - 30 | | | | | | | | | | | | | | | |

Notes:

-- = No field screening results noted on borelog.

Bold font and shaded cells indicate definite presence of NAPL.

Bold font cells indicate highly impacted sediment with possible presence of NAPL.

## Table 4-9. (continued)

| | Location 7 | | | Location 8 | | | Location 9 | | | Location 10 | | | Location 11 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Depth Interval (ft bgs)** | **Dye test / Visual** | **PID (ppm)** | **Odor** | **Dye test / Visual** | **PID (ppm)** | **Odor** | **Dye test / Visual** | **PID (ppm)** | **Odor** | **Dye test / Visual** | **PID (ppm)** | **Odor** | **Dye test / Visual** | **PID (ppm)** | **Odor** |
| 0 - 2 | -- | 0.0 | NO | -- | 0.0 | NO | -- | -- | -- | -- | 0.0 | **SLIGHT** | -- | 0.0 | NO |
| 2 - 4 | -- | 0.0 | **SLIGHT** | -- | 0.0 | NO | -- | 0.0 | NO | INCONCLUSIVE | 0.0 | **SLIGHT** | NEGATIVE | 0.0 | **YES** |
| 4 - 6 | -- | 0.0 | **SLIGHT** | -- | 0.0 | NO | -- | -- | -- | -- | 0.0 | NO | -- | 0.0 | **SLIGHT** |
| 6 - 8 | NEGATIVE | 0.0 | NO | -- | -- | -- | -- | 0.0 | NO | -- | 0.0 | **SLIGHT** | -- | 0.0 | **SLIGHT** |
| 8 - 10 | -- | 0.0 | NO | -- | 0.0 | **YES** | -- | 0.0 | NO | -- | 0.0 | NO | -- | 0.0 | **SLIGHT** |
| 10 - 12 | -- | 0.0 | NO | NEGATIVE | 0.0 | **SLIGHT** | -- | 0.0 | NO | -- | 0.0 | NO | -- | 0.0 | NO |
| 12 - 14 | -- | 0.0 | NO | -- | 0.0 | **SLIGHT** | -- | 0.0 | NO | -- | 0.0 | **SLIGHT** | -- | 0.0 | NO |
| 14 - 16 | -- | 0.0 | -- | -- | 0.0 | NO | -- | 0.0 | NO | -- | 0.0 | **SLIGHT** | -- | 0.0 | NO |
| 16 - 18 | -- | 0.0 | NO | -- | 0.0 | **SLIGHT** | -- | 0.0 | NO | -- | 0.0 | **SLIGHT** | -- | 0.0 | NO |
| 18 - 20 | -- | 0.0 | NO | -- | 0.0 | **SLIGHT** | -- | 0.0 | NO | -- | 0.0 | NO | -- | 0.0 | NO |
| 20 - 22 | | | | | | | -- | 0.0 | NO | -- | 0.0 | NO | -- | 0.0 | NO |
| 22 - 24 | | | | | | | -- | 0.0 | NO | -- | 0.0 | NO | -- | 0.0 | NO |
| 24 - 26 | | | | | | | -- | 0.0 | NO | -- | 0.0 | NO | -- | 0.0 | NO |
| 26 - 28 | | | | | | | -- | 0.0 | NO | -- | 0.0 | NO | -- | 0.0 | NO |
| 28 - 30 | | | | | | | -- | 0.0 | NO | -- | 0.0 | NO | -- | 0.0 | NO |

Notes:

-- = No field screening results noted on borelog.

Bold font and shaded cells indicate definite presence of NAPL.

Bold font cells indicate highly impacted sediment with possible presence of NAPL.

## Table 4-9. (continued)

| | Location 12 | | | Location 13A | | | Location 13B | | | Location 13C | | | Location 14 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Depth Interval (ft bgs)** | **Dye test / Visual** | **PID (ppm)** | **Odor** | **Dye test / Visual** | **PID (ppm)** | **Odor** | **Dye test / Visual** | **PID (ppm)** | **Odor** | **Dye test / Visual** | **PID (ppm)** | **Odor** | **Dye test / Visual** | **PID (ppm)** | **Odor** |
| 0 - 2 | -- | 0.0 | -- | -- | 0.0 | **YES** | -- | 0.0 | NO | -- | 0.0 | -- | -- | -- | -- |
| 2 - 4 | -- | 0.0 | -- | -- | -- | -- | -- | 0.0 | NO | -- | 0.0 | **YES** | -- | -- | -- |
| 4 - 6 | -- | 0.0 | -- | NEGATIVE | 0.0 | **YES** | -- | 0.0 | NO | -- | 0.0 | **SLIGHT** | -- | -- | -- |
| 6 - 8 | -- | 0.0 | -- | -- | 0.0 | **YES** | -- | 0.0 | NO | -- | 0.0 | **YES** | -- | 0.0 | NO |
| 8 - 10 | -- | 0.0 | -- | -- | 0.0 | **YES** | -- | 0.0 | NO | **SHEEN** | 0.0 | **SLIGHT** | -- | 0.0 | **YES** |
| 10 - 12 | -- | 0.0 | -- | **SHEEN** | 0.0 | **YES** | -- | 0.0 | NO | -- | 0.0 | **SLIGHT** | -- | 0.0 | **YES** |
| 12 - 14 | -- | 0.0 | -- | -- | 0.0 | **SLIGHT** | -- | 0.0 | NO | -- | 0.0 | NO | -- | 0.0 | NO |
| 14 - 16 | -- | 0.0 | -- | -- | 0.0 | **SLIGHT** | -- | 0.0 | NO | -- | 0.0 | NO | -- | 0.0 | NO |
| 16 - 18 | -- | 0.0 | -- | -- | -- | -- | -- | 0.0 | NO | -- | 0.0 | NO | -- | 0.0 | NO |
| 18 - 20 | -- | 0.0 | -- | -- | 0.0 | **SLIGHT** | -- | 0.0 | NO | -- | 0.0 | NO | -- | 0.0 | NO |
| 20 - 22 | -- | 0.0 | -- | -- | 0.0 | NO | -- | 0.0 | NO | -- | 0.0 | NO | | | |
| 22 - 24 | -- | 0.0 | -- | -- | 0.0 | **SLIGHT** | -- | 0.0 | NO | | | | | | |
| 24 - 26 | -- | 0.0 | -- | -- | 0.0 | -- | -- | 0.0 | NO | | | | | | |
| 26 - 28 | | | | -- | 0.0 | NO | | | | | | | | | |
| 28 - 30 | | | | -- | 0.0 | NO | | | | | | | | | |

Notes:

-- = No field screening results noted on borelog.

Bold font and shaded cells indicate definite presence of NAPL.

Bold font cells indicate highly impacted sediment with possible presence of NAPL.

## Table 4-9. (continued)

| | Location 15 | | | Location 16 | | | Location 17 | | | Location 18 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Depth Interval (ft bgs)** | **Dye test / Visual** | **PID (ppm)** | **Odor** | **Dye test / Visual** | **PID (ppm)** | **Odor** | **Dye test / Visual** | **PID (ppm)** | **Odor** | **Dye test / Visual** | **PID (ppm)** | **Odor** |
| 0 - 2 | -- | 0.0 | NO | NEGATIVE | 0.0 | NO | NEGATIVE | 0.0 | NO | NEGATIVE | 0.0 | **SLIGHT** |
| 2 - 4 | NEGATIVE | 0.0 | **SLIGHT** | -- | 0.0 | NO | -- | -- | -- | -- | -- | -- |
| 4 - 6 | -- | 0.0 | **SLIGHT** | -- | 0.0 | NO | -- | 0.0 | NO | -- | 0.0 | **SLIGHT** |
| 6 - 8 | -- | 0.0 | **SLIGHT** | -- | 0.0 | NO | -- | 0.0 | NO | -- | 0.0 | **SLIGHT** |
| 8 - 10 | -- | 0.0 | NO | -- | 0.0 | NO | -- | 0.0 | NO | -- | 0.0 | NO |
| 10 - 12 | -- | 0.0 | **SLIGHT** | | | | -- | 0.0 | NO | -- | 0.0 | -- |
| 12 - 14 | -- | 0.0 | NO | | | | -- | 0.0 | NO | -- | 0.0 | NO |
| 14 - 16 | -- | 0.0 | NO | | | | -- | 0.0 | NO | -- | 0.0 | NO |
| 16 - 18 | -- | 0.0 | NO | | | | -- | 0.0 | NO | -- | 0.0 | NO |
| 18 - 20 | -- | 0.0 | NO | | | | -- | 0.0 | NO | -- | 0.0 | NO |
| 20 - 22 | -- | 0.0 | NO | | | | -- | 0.0 | NO | -- | 0.0 | NO |
| 22 - 24 | -- | 0.0 | NO | | | | -- | 0.0 | NO | -- | 0.0 | NO |
| 24 - 26 | | | | | | | -- | 0.0 | NO | -- | 0.0 | NO |
| 26 - 28 | | | | | | | -- | 0.0 | NO | -- | 0.0 | NO |
| 28 - 30 | | | | | | | -- | 0.0 | NO | | | |

Notes:

-- = No field screening results noted on borelog.

Bold font and shaded cells indicate definite presence of NAPL.

Bold font cells indicate highly impacted sediment with possible presence of NAPL.

## Table 4-10. Physical Characteristics of Subsurface Sediment Around the Coke Point Peninsula

**Sparrows Point Site Assessment (2009), Baltimore, Maryland**

| | | | | NORTHWESTERN SECTION | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Background Concentration[(b)] | Location 1 | Location 2 | Location 16 | Location 17 | Location 3A | Location 3B | Location 3C | Location 3D | Location 3E | Location 4 | Location 5 | Location 18 |
| | | Depth (ft)[(a)] | 0-1 | 8-10 | 4-6 | 0-2 | 0-2 | 12-14 | 2-4 | 2-4 | 2-4 | 2-4 | 8-10 | 4-6 | 0-2 |
| ANALYTE | UNITS | Average RL | | | | | | | | | | | | | |
| GRAVEL | % | -- | 0.343 | 19.2 | 3.6 | 2.1 | 5 | 49.9 | 1.2 | 3.0 | 0 | 0 | 0 | 0 | 0.3 |
| SAND | % | -- | 6.7 | 47.3 | 81.7 | 35.6 | 31 | 33.6 | 8.9 | 21.0 | 7.1 | 10.1 | 17.2 | 24.7 | 3 |
| SILT | % | -- | 75.5 | 30.2 | 7.8 | 52.9 | 56.4 | 7.7 | 52.8 | 57.9 | 89.4 | 36.7 | 43.9 | 42.8 | 90.7 |
| CLAY | % | -- | 17.5 | 3.4 | 6.9 | 9.4 | 7.5 | 8.9 | 37.1 | 18.1 | 3.4 | 53.1 | 38.8 | 32.5 | 6.1 |
| SILT+CLAY | % | -- | 93.0 | 33.6 | 14.7 | 62.3 | 63.9 | 16.6 | 89.9 | 76.0 | 92.8 | 89.8 | 82.7 | 75.3 | 96.8 |
| MOISTURE CONTENT | % | 0 | -- | 39.6 | 25.6 | 121.5 | 140.4 | 36.3 | -- | -- | 254 | 129 | 151 | 108 | 323.3 |
| PERCENT SOLIDS | % | 1 | 24.5 | 46.6 | 85.4 | 45.4 | 43.1 | 60 | 45.9 | 39.9 | 37.1 | 37.3 | 41 | 54.3 | 24.7 |
| TOTAL CYANIDE | MG/KG | 1.19 | 1.08 | **37.4** | **0.77** | **4.3 L** | **2 K** | **0.2 J** | 1.1 U | **5.9** | **12.3** | **3.4** | **17.9 K** | **1.7 K** | **53.3 K** |
| TOTAL ORGANIC CARBON | % | 2,560 | 3.3 | **31.1** | -- | -- | -- | -- | **4.30** | **7.39** | -- | -- | -- | -- | -- |

(a) depth below the sediment surface

(b) Average concentration in surface sediment from Baltimore Harbor Channels. Source: EA 2009. *FY08 Evaluation of Dredged Material: Baltimore Harbor Federal Navigation Channels*

**NOTE:** Shaded and bold values represent detected concentrations

**RL** = Reporting Limit

-- = Not Tested

**K** = The reported value may be biased high, the actual value is expected to be lower than reported

**J** (inorganic) = compound was detected in the method blank

**U** = compound was analyzed, but not detected

**Table 4-10. (continued)**

| | | | | SOUTHWESTERN SECTION | | | SOUTHERN SECTION | | | TURNING BASIN SECTION | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Background Concentration[b] | Location 6 | Location 7 | Location 8 | Location 9 | Location 10 | Location 11 | Location 12 | Location 13A | Location 13B | Location 13B | Location 13C | Location 13C | Location 14 | Location 15 |
| | | Depth (ft)[a] | 0-1 | 6-8 | 6-8 | 10-12 | 12-14 | 2-4 | 2-4 | 4-6 | 6-8 | 2-4 | 8-10 | 2-4 | 6-8 | 8-10 | 2-4 |
| ANALYTE | UNITS | Average RL | | | | | | | | | | | | | | | |
| GRAVEL | % | -- | 0.343 | 0 | 28.4 | 55.8 | 41 | 0 | 0 | 21.4 | 2.9 | 1.2 | 0 | 3 | 2.2 | 0.4 | 31.7 |
| SAND | % | -- | 6.7 | 7.6 | 8.6 | 32.9 | 17.3 | 10.3 | 10.7 | 27.1 | 86.7 | 8.9 | 0.8 | 21.1 | 84.8 | 15.5 | 33.1 |
| SILT | % | -- | 75.5 | 47.1 | 17.4 | 7.5 | 17.1 | 77.4 | 61.7 | 24.4 | 6.3 | 52.8 | 61.8 | 57.9 | 9.5 | 54 | 31.1 |
| CLAY | % | -- | 17.5 | 45.3 | 45.5 | 3.9 | 24.5 | 12.4 | 27.5 | 27 | 4 | 37.1 | 37.4 | 18.1 | 3.5 | 30.1 | 4 |
| SILT+CLAY | % | -- | 93.0 | 92.4 | 62.9 | 11.4 | 41.6 | 89.8 | 89.2 | 51.4 | 10.3 | 89.9 | 99.2 | 76 | 13 | 84.1 | 35.1 |
| | | | | | | | | | | | | | | | | | |
| MOISTURE CONTENT | % | 0 | -- | 157 | 119 | 25.9 | 68.8 | 133 | 118 | 69.5 | 23.8 | 119 | 52.2 | 133 | 35.5 | 139 | 95.3 |
| PERCENT SOLIDS | % | 1 | 24.5 | 41.5 | 42 | 44.9 | 69.3 | 41 | 45.8 | 56.1 | 80.9 | -- | 63.3 | -- | 57.9 | 29.7 | 59.8 |
| TOTAL CYANIDE | MG/KG | 1.19 | 1.08 | **18.4** | **1.7 K** | **3 K** | 0.72 UL | **6.8** | **9.3** | 0.89 U | **1.5** | -- | 0.79 UL | -- | **0.98 K** | **1.7 L** | **1.1** |
| TOTAL ORGANIC CARBON | % | 2,560 | 3.3 | **7.73** | -- | -- | -- | -- | -- | **3.79 K** | -- | -- | -- | -- | -- | -- | -- |

(a) depth below the sediment surface

(b) Average concentration in surface sediment from Baltimore Harbor Channels. Source: EA 2009. *FY08 Evaluation of Dredged Material: Baltimore Harbor Federal Navigation Channels*

**NOTE:** Shaded and bolded values represent detected concentrations

**RL** = Reporting Limit

**--** = Not Tested

**K** = The reported value may be biased high, the actual value is expected to be lower than reported

**L** = The reported value may be biased low, the actual value is expected to be higher than reported

**U** = compound was analyzed, but not detected

**UL** = Analyte was not detected. The reported quantitation limit is probably higher than reported

## Table 4-11. Volatile Organic Compound Concentrations in Subsurface Sediment Around the Coke Point Peninsula

**Sparrows Point Site Assessment (2009), Baltimore, Maryland**

| | | | | NORTHWESTERN SECTION | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Background Concentration[(b)] | Location 1 | Location 2 | Location 16 | Location 17 | Location 3A | Location 3B | Location 3C | Location 3D | Location 3E | Location 4 | Location 5 | Location 18 |
| | | Depth (ft)[(a)] | 0-1 | 8-10 | 4-6 | 0-2 | 0-2 | 12-14 | 2-4 | 2-4 | 2-4 | 2-4 | 8-10 | 4-6 | 0-2 |
| ANALYTE | UNITS | Average MDL | | | | | | | | | | | | | |
| 1,1,1-TRICHLOROETHANE | UG/KG | 84.3 | 0.533 | 11 U | 290 U | 11 U | 11 U | 490 U | 560 U | 730 U | 13 U | 14 U | 11 U | 9.9 U | 19 U |
| 1,1,2,2-TETRACHLOROETHANE | UG/KG | 84.3 | 0.886 | 11 U | 290 U | 11 U | 11 U | 490 U | 560 U | 730 U | 13 U | 14 U | 11 U | 9.9 U | 19 U |
| 1,1,2-TRICHLOROETHANE | UG/KG | 84.3 | 1.34 | 11 U | 290 U | 11 U | 11 U | 490 U | 560 U | 730 U | 13 U | 14 U | 11 U | 9.9 U | 19 U |
| 1,1-DICHLOROETHANE | UG/KG | 84.3 | 0.571 | 11 U | 290 U | 11 U | 11 U | 490 U | 560 U | 730 U | 13 U | 14 U | 11 U | 9.9 U | 19 U |
| 1,1-DICHLOROETHENE | UG/KG | 84.3 | 1.16 | 11 U | 290 U | 11 U | 11 U | 490 U | 560 U | 730 U | 13 U | 14 U | 11 U | 9.9 U | 19 U |
| 1,2-DICHLOROBENZENE | UG/KG | 84.3 | 1.83 | 11 U | 290 U | 11 U | 11 U | 490 U | 560 U | 730 U | 13 U | 14 U | 11 U | 9.9 U | 19 U |
| 1,2-DICHLOROETHANE | UG/KG | 84.3 | 0.594 | 11 U | 290 U | 11 U | 11 U | 490 U | 560 U | 730 U | 13 U | 14 U | 11 U | 9.9 U | 19 U |
| 1,2-DICHLOROPROPANE | UG/KG | 84.3 | 1.24 | 11 U | 290 U | 11 U | 11 U | 490 U | 560 U | 730 U | 13 U | 14 U | 11 U | 9.9 U | 19 U |
| 1,3-DICHLOROBENZENE | UG/KG | 84.3 | 1.80 | 11 U | 290 U | 11 U | 11 U | 490 U | 560 U | 730 U | 13 U | 14 U | 11 U | 9.9 U | 19 U |
| 1,4-DICHLOROBENZENE | UG/KG | 84.3 | 1.34 | 11 U | 290 U | 11 U | 11 U | 490 U | 560 U | 730 U | 13 U | 14 U | 11 U | 9.9 U | 19 U |
| 2-BUTANONE (MEK) | UG/KG | 84.3 | 4.43 | 11 U | 290 U | 11 U | 11 U | 490 UJ | 560 U | 730 U | 13 U | 14 U | 11 U | 9.9 U | 19 U |
| 2-CHLOROETHYL VINYL ETHER | UG/KG | 170 | 18.1 | 21 U | 590 U | 21 U | 21 U | 980 U | 1,100 U | 1,500 U | 27 U | 28 U | 22 U | 20 U | 39 U |
| ACROLEIN | UG/KG | 1,700 | 187 | R | 5,900 U | 210 U | R | R | R | R | R | R | R | R | R |
| ACRYLONITRILE | UG/KG | 1,700 | 52.4 | 210 U | 5,900 U | 210 U | 210 U | 9,800 U | 11,000 U | 15,000 U | 270 U | 280 U | 220 U | 200 U | 390 U |
| BENZENE | UG/KG | 146 | 1.08 | 11 U | **36,000** | 11 U | 11 U | 490 U | **200 J** | **720 J** | 13 U | 14 U | **53** | 9.9 UL | 19 U |
| BROMODICHLOROMETHANE | UG/KG | 84.3 | 0.491 | 11 U | 290 U | 11 U | 11 U | 490 U | 560 U | 730 U | 13 U | 14 U | 11 U | 9.9 U | 19 U |
| BROMOFORM | UG/KG | 84.3 | 1.21 | 11 U | 290 U | 11 U | 11 U | 490 U | 560 U | 730 U | 13 U | 14 U | 11 U | 9.9 U | 19 U |
| BROMOMETHANE | UG/KG | 84.3 | 1.84 | 11 U | 290 U | 11 U | 11 U | 490 U | 560 U | 730 U | 13 U | 14 U | 11 U | 9.9 U | 19 U |
| CARBON TETRACHLORIDE | UG/KG | 84.3 | 0.491 | 11 U | 290 U | 11 U | 11 U | 490 U | 560 U | 730 U | 13 U | 14 U | 11 U | 9.9 U | 19 U |
| CHLOROETHANE | UG/KG | 84.3 | 1.86 | 11 U | 290 U | 11 U | 11 U | 490 U | 560 U | 730 U | 13 U | 14 U | 11 U | 9.9 U | 19 U |
| CHLOROFORM | UG/KG | 84.3 | 0.49 | 11 U | 290 U | 11 U | 11 U | 490 U | 560 U | 730 U | 13 U | 14 U | 11 U | 9.9 U | 19 U |
| CHLOROMETHANE | UG/KG | 84.3 | 0.57 | 11 U | 290 U | 11 U | 11 U | 490 U | 560 U | 730 U | 13 U | 14 U | 11 U | 9.9 U | 19 U |
| CIS-1,3-DICHLOROPROPENE | UG/KG | 84.3 | 0.57 | 11 U | 290 U | 11 U | 11 U | 490 U | 560 U | 730 U | 13 U | 14 U | 11 U | 9.9 U | 19 U |
| DIBROMOCHLOROMETHANE | UG/KG | 84.3 | 0.52 | 11 U | 290 U | 11 U | 11 U | 490 U | 560 U | 730 U | 13 U | 14 U | 11 U | 9.9 U | 19 U |
| DICHLORODIFLUOROMETHANE | UG/KG | 84.3 | 1.00 | 11 U | 290 U | 11 U | 11 U | 490 U | 560 U | 730 U | 13 U | 14 U | 11 U | 9.9 U | 19 U |
| ETHYLBENZENE | UG/KG | 84.3 | 1.84 | 11 U | **87 J** | 11 U | 11 U | 490 U | **200 J** | **4,000** | 13 U | 14 U | **100** | 9.9 U | 19 U |
| METHYLENE CHLORIDE | UG/KG | 84.3 | 12.5 | 11 U | 290 U | **12 B** | 11 U | 490 U | 560 U | 730 U | **15 B** | 14 U | 11 U | 9.9 U | 19 U |
| TETRACHLOROETHENE | UG/KG | 84.3 | 1.51 | 11 U | 290 U | 11 U | 11 U | 490 U | 560 U | 730 U | 13 U | 14 U | 11 U | 9.9 U | 19 U |
| TOLUENE | UG/KG | 84.3 | 1.16 | 11 U | **500** | 11 U | 11 U | 490 U | 560 U | **3,600** | 13 U | 14 U | **100** | 9.9 U | 19 U |
| TRANS-1,2-DICHLOROETHENE | UG/KG | 84.3 | 1.29 | 11 U | 290 U | 11 U | 11 U | 490 U | 560 U | 730 U | 13 U | 14 U | 11 U | 9.9 U | 19 U |
| TRANS-1,3-DICHLOROPROPENE | UG/KG | 84.3 | 0.544 | 11 U | 290 U | 11 U | 11 U | 490 U | 560 U | 730 U | 13 U | 14 U | 11 U | 9.9 U | 19 U |
| TRICHLOROETHENE | UG/KG | 84.3 | 1.70 | 11 U | 290 U | 11 U | 11 U | 490 U | 560 U | 730 U | 13 U | 14 U | 11 U | 9.9 UL | 19 U |
| TRICHLOROFLUOROMETHANE | UG/KG | 84.3 | 2.38 | 11 U | 290 U | 11 U | 11 U | 490 U | 560 U | 730 U | 13 U | 14 U | 11 U | 9.9 U | 19 U |
| VINYL CHLORIDE | UG/KG | 84.3 | 1.30 | 11 U | 290 U | 11 U | 11 U | 490 U | 560 U | 730 U | 13 U | 14 U | 11 U | 9.9 U | 19 U |

(a) depth below the sediment surface

(b) Average concentration in surface sediment from Baltimore Harbor Channels. Source: EA 2007. *FY05 Evaluation of Dredged Material: Baltimore Harbor Federal Navigation Channels*

**NOTE:** Shaded and bold values represent detected concentrations

**MDL** = method detection limit

**R** = Data was rejected by the validator and is unusable

**B** (organic) = compound was detected in the method blank

**J** (organic) = compound was detected, but below the reporting limit (value is estimated)

**U** = compound was analyzed, but not detected

**Table 4-11. (continued)**

| | | | | SOUTHWESTERN SECTION | | | SOUTHERN SECTION | | | TURNING BASIN SECTION | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Background Concentration[b] | Location 6 | Location 7 | Location 8 | Location 9 | Location 10 | Location 11 | Location 12 | Location 13A | Location 13B | Location 13C | Location 14 | Location 15 |
| | | Depth (ft)[a] | 0-1 | 6-8 | 6-8 | 10-12 | 12-14 | 2-4 | 2-4 | 4-6 | 6-8 | 8-10 | 6-8 | 8-10 | 2-4 |
| ANALYTE | UNITS | Average MDL | | | | | | | | | | | | | |
| 1,1,1-TRICHLOROETHANE | UG/KG | 84.3 | 0.533 | 630 U | 11 U | 11 U | 8.1 U | 11 U | 10 U | 8.9 U | 400 U | 10 U | 8.9 U | 21 U | 8.6 U |
| 1,1,2,2-TETRACHLOROETHANE | UG/KG | 84.3 | 0.886 | 630 U | 11 U | 11 U | 8.1 U | 11 U | 10 U | 8.9 U | 400 U | 10 U | 8.9 U | 21 U | 8.6 U |
| 1,1,2-TRICHLOROETHANE | UG/KG | 84.3 | 1.34 | 630 U | 11 U | 11 U | 8.1 U | 11 U | 10 U | 8.9 U | 400 U | 10 U | 8.9 U | 21 U | 8.6 U |
| 1,1-DICHLOROETHANE | UG/KG | 84.3 | 0.571 | 630 U | 11 U | 11 U | 8.1 U | 11 U | 10 U | 8.9 U | 400 U | 10 U | 8.9 U | 21 U | 8.6 U |
| 1,1-DICHLOROETHENE | UG/KG | 84.3 | 1.16 | 630 U | 11 U | 11 U | 8.1 U | 11 U | 10 U | 8.9 U | 400 U | 10 U | 8.9 U | 21 U | 8.6 U |
| 1,2-DICHLOROBENZENE | UG/KG | 84.3 | 1.83 | 630 U | 11 U | 11 U | 8.1 U | 11 U | 10 U | 8.9 U | 400 U | 10 U | 8.9 U | 21 U | 8.6 U |
| 1,2-DICHLOROETHANE | UG/KG | 84.3 | 0.594 | 630 U | 11 U | 11 U | 8.1 U | 11 U | 10 U | 8.9 U | 400 U | 10 U | 8.9 U | 21 U | 8.6 U |
| 1,2-DICHLOROPROPANE | UG/KG | 84.3 | 1.24 | 630 U | 11 U | 11 U | 8.1 U | 11 U | 10 U | 8.9 U | 400 U | 10 U | 8.9 U | 21 U | 8.6 U |
| 1,3-DICHLOROBENZENE | UG/KG | 84.3 | 1.80 | 630 U | 11 U | 11 U | 8.1 U | 11 U | 10 U | 8.9 U | 400 U | 10 U | 8.9 U | 21 U | 8.6 U |
| 1,4-DICHLOROBENZENE | UG/KG | 84.3 | 1.34 | 630 U | 11 U | 11 U | 8.1 U | 11 U | 10 U | 8.9 U | 400 U | 10 U | 8.9 U | 21 U | 8.6 U |
| 2-BUTANONE (MEK) | UG/KG | 84.3 | 4.43 | 630 U | 11 U | 11 U | 8.1 U | 11 U | 10 U | 8.9 U | 400 UJ | 10 U | 8.9 U | 21 U | 8.6 U |
| 2-CHLOROETHYL VINYL ETHER | UG/KG | 170 | 18.1 | 1,300 U | 21 U | 23 U | 16 U | 21 U | 20 U | 18 U | 800 U | 20 U | 18 U | 42 U | 17 U |
| ACROLEIN | UG/KG | 1,700 | 187 | R | R | R | R | R | R | R | R | R | R | R | R |
| ACRYLONITRILE | UG/KG | 1,700 | 52.4 | 13,000 U | 210 U | 230 U | 160 U | 210 U | 200 U | 180 U | 8,000 U | 200 U | 180 U | 420 U | 170 U |
| BENZENE | UG/KG | 146 | 1.08 | 630 U | 11 U | 11 U | 8.1 U | 11 U | 10 U | 8.9 U | **490** | 10 U | **64** | 21 U | 8.6 U |
| BROMODICHLOROMETHANE | UG/KG | 84.3 | 0.491 | 630 U | 11 U | 11 U | 8.1 U | 11 U | 10 U | 8.9 U | 400 U | 10 U | 8.9 U | 21 U | 8.6 U |
| BROMOFORM | UG/KG | 84.3 | 1.21 | 630 U | 11 U | 11 U | 8.1 U | 11 U | 10 U | 8.9 U | 400 U | 10 U | 8.9 U | 21 U | 8.6 U |
| BROMOMETHANE | UG/KG | 84.3 | 1.84 | 630 U | 11 U | 11 U | 8.1 U | 11 U | 10 U | 8.9 U | 400 U | 10 U | 8.9 U | 21 U | 8.6 U |
| CARBON TETRACHLORIDE | UG/KG | 84.3 | 0.491 | 630 U | 11 U | 11 U | 8.1 U | 11 U | 10 U | 8.9 U | 400 U | 10 U | 8.9 U | 21 U | 8.6 U |
| CHLOROETHANE | UG/KG | 84.3 | 1.86 | 630 U | 11 U | 11 U | 8.1 U | 11 U | 10 U | 8.9 U | 400 U | 10 U | 8.9 U | 21 U | 8.6 U |
| CHLOROFORM | UG/KG | 84.3 | 0.491 | 630 U | 11 U | 11 U | 8.1 U | 11 U | 10 U | 8.9 U | 400 U | 10 U | 8.9 U | 21 U | 8.6 U |
| CHLOROMETHANE | UG/KG | 84.3 | 0.570 | 630 U | 11 U | 11 U | 8.1 U | 11 U | 10 U | 8.9 U | 400 U | 10 U | 8.9 U | 21 U | 8.6 U |
| CIS-1,3-DICHLOROPROPENE | UG/KG | 84.3 | 0.570 | 630 U | 11 U | 11 U | 8.1 U | 11 U | 10 U | 8.9 U | 400 U | 10 U | 8.9 U | 21 U | 8.6 U |
| DIBROMOCHLOROMETHANE | UG/KG | 84.3 | 0.515 | 630 U | 11 U | 11 U | 8.1 U | 11 U | 10 U | 8.9 U | 400 U | 10 U | 8.9 U | 21 U | 8.6 U |
| DICHLORODIFLUOROMETHANE | UG/KG | 84.3 | 0.997 | 630 U | 11 U | 11 U | 8.1 U | 11 U | 10 U | 8.9 U | 400 U | 10 U | 8.9 U | 21 U | 8.6 U |
| ETHYLBENZENE | UG/KG | 84.3 | 1.84 | 630 U | 11 U | 11 U | 8.1 U | 11 U | 10 U | 8.9 U | **57 J** | 10 U | **4.4 J** | 21 U | 8.6 U |
| METHYLENE CHLORIDE | UG/KG | 84.3 | 12.5 | 630 U | 11 U | 11 U | 8.1 U | 11 U | 10 U | 8.9 U | 400 U | 10 U | 8.9 U | 21 U | **6.7 B** |
| TETRACHLOROETHENE | UG/KG | 84.3 | 1.51 | 630 U | 11 U | 11 U | 8.1 U | 11 U | 10 U | 8.9 U | 400 U | 10 U | 8.9 U | 21 U | 8.6 U |
| TOLUENE | UG/KG | 84.3 | 1.16 | 630 U | 11 U | 11 U | 8.1 U | 11 U | 10 U | 8.9 U | **300 J** | 10 U | **7.2 J** | 21 U | 8.6 U |
| TRANS-1,2-DICHLOROETHENE | UG/KG | 84.3 | 1.29 | 630 U | 11 U | 11 U | 8.1 U | 11 U | 10 U | 8.9 U | 400 U | 10 U | 8.9 U | 21 U | 8.6 U |
| TRANS-1,3-DICHLOROPROPENE | UG/KG | 84.3 | 0.544 | 630 U | 11 U | 11 U | 8.1 U | 11 U | 10 U | 8.9 U | 400 U | 10 U | 8.9 U | 21 U | 8.6 U |
| TRICHLOROETHENE | UG/KG | 84.3 | 1.70 | 630 U | 11 U | 11 U | 8.1 U | 11 U | 10 U | 8.9 U | 400 U | 10 U | 8.9 U | 21 U | 8.6 U |
| TRICHLOROFLUOROMETHANE | UG/KG | 84.3 | 2.38 | 630 U | 11 U | 11 U | 8.1 U | 11 U | 10 U | 8.9 U | 400 U | 10 U | 8.9 U | 21 U | 8.6 U |
| VINYL CHLORIDE | UG/KG | 84.3 | 1.30 | 630 U | 11 U | 11 U | 8.1 U | 11 U | 10 U | 8.9 U | 400 U | 10 U | 8.9 U | 21 U | 8.6 U |

(a) depth below the sediment surface

(b) Average concentration in surface sediment from Baltimore Harbor Channels. Source: EA 2007. *FY05 Evaluation of Dredged Material: Baltimore Harbor Federal Navigation Channels*

**NOTE:** Shaded and bold values represent detected concentrations

**MDL** = method detection limit

**R** = Data was rejected by the validator and is unusable

**B** (organic) = compound was detected in the method blank

**J** (organic) = compound was detected, but below the reporting limit (value is estimated)

**U** = compound was analyzed, but not detected

## Table 4-12. Polycyclic Aromatic Hydrocarbon Concentrations in Subsurface Sediment Around the Coke Point Peninsula

**Sparrows Point Site Assessment (2009), Baltimore, Maryland**

| | | | | NORTHWESTERN SECTION | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Background Concentration[b] | Location 1 | Location 2 | Location 16 | Location 17 | Location 3A | Location 3B | Location 3C | Location 3D | Location 3E | Location 4 | Location 5 | Location 18 |
| | | Depth (ft)[a] | 0-1 | 8-10 | 4-6 | 0-2 | 0-2 | 12-14 | 2-4 | 2-4 | 2-4 | 2-4 | 8-10 | 4-6 | 0-2 |
| ANALYTE | UNITS | Average MDL | | | | | | | | | | | | | |
| ACENAPHTHENE | UG/KG | 237 | 55.5 | **300** | **1,100** | **98 J** | **150 J** | **75** | **180** | **3,100** | **150 J** | **31 J** | **2,500 J** | **6,600** | **200 J** |
| ACENAPHTHYLENE | UG/KG | 237 | 118 | **700** | **4,400** | **860** | **1,100** | **290** | **380** | **8,300** | **930** | **200** | **19,000** | **850** | **810** |
| ANTHRACENE | UG/KG | 1,160 | 37.4 | **1,000** | **4,000** | **800** | **1,400** | **150 J** | **500** | **3,600** | **870 J** | **230 J** | **13,000 J** | **5,200** | **2,000** |
| BENZO(A)ANTHRACENE | UG/KG | 325 | 56.5 | **3,000** | **2,800** | **3,400** | **4,200** | **420** | **1,100** | **5,700** | **2,800** | **830** | **22,000** | **4,900** | **6,500** |
| BENZO(A)PYRENE | UG/KG | 300 | 108 | **1,800** | **2,500** | **5,500** | **5,000** | **460** | **1,400** | **6,100** | **3,400** | **1,100** | **21,000** | **4,100** | **7,000** |
| BENZO(B)FLUORANTHENE | UG/KG | 265 | 205 | **2,500** | **3,600** | **8,300** | **6,000** | **500** | **2,700** | **7,600** | **3,600** | **1,100** | **24,000** | **4,700** | **6,300** |
| BENZO(GHI)PERYLENE | UG/KG | 237 | 234 | **2,000** | **1,200** | **3,400** | **2,700** | **260** | **1,100** | **3,600** | **1,800** | **650** | **12,000** | **2,200** | **3,100** |
| BENZO(K)FLUORANTHENE | UG/KG | 237 | 403 | **1,300** | 130 U | 150 U | **1,600** | **270** | 73 U | **1,900** | **1,700** | **580** | **8,200** | **1,600** | **3,500** |
| CHRYSENE | UG/KG | 325 | 229 | **1,600** | **2,300** | **3,100** | **3,600** | **320** | **1,800** | **4,800** | **2,200** | **920** | **21,000** | **3,900** | **6,100** |
| DIBENZO(A,H)ANTHRACENE | UG/KG | 237 | 13.7 | **320** | **160** | **1,000** | **810** | **66** | **210** | **1,100** | **500** | **170** | **3,400 J** | **500** | **820** |
| FLUORANTHENE | UG/KG | 1,630 | 215 | **4,800** | **10,000** | **4,500** | **7,500** | **600** | **2,500** | **12,000** | **5,800** | **980** | **67,000** | **11,000** | **14,000** |
| FLUORENE | UG/KG | 237 | 32.8 | **860** | **4,900** | **290** | **510** | **310** | **250** | **5,500** | **630** | **110** | **12,000** | **5,400** | **910** |
| INDENO(1,2,3-CD)PYRENE | UG/KG | 237 | 422 | **1,500** | **1,000** | **3,100** | **2,500** | **220** | **1,000** | **3,300** | **1,600** | **550** | **12,000** | **2,300** | **2,900** |
| 1-METHYLNAPHTHALENE | UG/KG | 237 | 60.9 | **1,200** | **2,400** | **140 J** | **180** | **600** | **470** | **15,000** | **330** | **66 J** | **26,000** | **2,100** | **560** |
| 2-METHYLNAPHTHALENE | UG/KG | 1,400 | 181 | **2,300** | **6,700** | **340** | **410** | **1,400** | **800** | **66,000** | **810** | **150** | **71,000** | **5,400** | **1,400** |
| NAPHTHALENE | UG/KG | 5,340 | 282 | **28,000** | **290,000** | **1,900** | **2,400** | **29,000** | **51,000** | **2,800,000** | **5,300** | **870** | **4,400,000** | **590,000** | **24,000** |
| PHENANTHRENE | UG/KG | 663 | 232 | **2,100** | **15,000** | **990** | **2,800** | **480** | **720** | **10,000** | **1,400** | **290** | **29,000** | **16,000** | **1,800** |
| PYRENE | UG/KG | 337 | 368 | **4,200** | **6,800** | **5,200** | **6,900** | **660** | **2,000** | **9,500** | **4,300** | **1,200** | **33,000** | **7,700** | **10,000** |
| TOTAL PAHs (ND=0) | UG/KG | -- | 3,240 | **59,480** | **358,860** | **42,918** | **49,760** | **36,081** | **68,110** | **2,967,100** | **38,120** | **10,027** | **4,796,100** | **674,450** | **91,900** |
| TOTAL PAHs (ND=1/2MDL) | UG/KG | -- | 3,250 | **59,480** | **358,925** | **42,993** | **49,760** | **36,081** | **68,147** | **2,967,100** | **38,120** | **10,027** | **4,796,100** | **674,450** | **91,900** |
| TOTAL PAHs (ND=MDL) | UG/KG | -- | 3,270 | **59,480** | **358,990** | **43,068** | **49,760** | **36,081** | **68,183** | **2,967,100** | **38,120** | **10,027** | **4,796,100** | **674,450** | **91,900** |

(a) depth below the sediment surface

(b) Average concentration in surface sediment from Baltimore Harbor Channels. Source: EA 2009. *FY08 Evaluation of Dredged Material: Baltimore Harbor Federal Navigation Channels*

**NOTE:** Shaded and bold values represent detected concentrations

**MDL** = method detection limit

**J** (organic) = compound was detected, but below the reporting limit (value is estimated)

**U** = compound was analyzed, but not detected

**Table 4-12. (continued)**

| | | | | SOUTHWESTERN SECTION | | | SOUTHERN SECTION | | | TURNING BASIN SECTION | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Background Concentration[(b)] | Location 6 | Location 7 | Location 8 | Location 9 | Location 10 | Location 11 | Location 12 | Location 13A | Location 13B | Location 13C | Location 14 | Location 15 |
| | | Depth (ft)[(a)] | 0-1 | 6-8 | 6-8 | 10-12 | 12-14 | 2-4 | 2-4 | 4-6 | 6-8 | 8-10 | 6-8 | 8-10 | 2-4 |
| ANALYTE | UNITS | Average MDL | | | | | | | | | | | | | |
| ACENAPHTHENE | UG/KG | 237 | 55.5 | **28,000** | **210** | **39** | 24 U | **1,600** | **17,000** | **75 J** | **110** | 26 U | **1,100** | **770** | **99 J** |
| ACENAPHTHYLENE | UG/KG | 237 | 118 | **4,700** | **160** | **180** | 24 U | **2,200** | **2,600** | **300** | **220** | 26 U | **140** | **380** | **340** |
| ANTHRACENE | UG/KG | 1,160 | 37.4 | **30,000** | **320** | **230** | 120 U | **5,000** | **16,000** | **630 J** | **260** | 130 U | **570** | **990** | **460 J** |
| BENZO(A)ANTHRACENE | UG/KG | 325 | 56.5 | **31,000** | **920** | **1,200** | 24 U | **9,900** | **18,000** | **2,600** | **340** | 26 U | **1,000** | **2,200** | **1,100** |
| BENZO(A)PYRENE | UG/KG | 300 | 108 | **25,000** | **980** | **1,400** | 24 U | **8,900** | **15,000** | **1,800** | **290** | 26 U | **720** | **2,100** | **1,500** |
| BENZO(B)FLUORANTHENE | UG/KG | 265 | 205 | **10,000** | **1,100** | **1,400** | 24 U | **10,000** | **14,000** | **4,200** | **310** | 26 U | **780** | **2,300** | **1,500** |
| BENZO(GHI)PERYLENE | UG/KG | 237 | 234 | **11,000** | **620** | **900** | 24 U | **4,200** | **7,300** | **2,000** | **150** | 26 U | **410** | **1,300** | **810** |
| BENZO(K)FLUORANTHENE | UG/KG | 237 | 403 | **28,000** | **460** | **590** | 24 U | **3,700** | **6,500** | 130 U | **140** | 26 U | **440** | **750** | **890** |
| CHRYSENE | UG/KG | 325 | 229 | **27,000** | **780** | **1,100** | 24 U | **8,000** | **16,000** | **2,700** | **320** | 26 U | **770** | **2,100** | **1,300** |
| DIBENZO(A,H)ANTHRACENE | UG/KG | 237 | 13.7 | **3,000** | **180** | **210** | 24 U | **1,400** | **2,500** | **250** | **41** | 26 U | **110** | **270** | **240** |
| FLUORANTHENE | UG/KG | 1,630 | 215 | **110,000** | **1,800** | **1,700** | 24 U | **20,000** | **85,000** | **4,200** | **870** | 26 U | **2,700** | **5,200** | **3,000** |
| FLUORENE | UG/KG | 237 | 32.8 | **23,000** | **180** | **58** | 24 U | **1,600** | **16,000** | **150** | **310** | 26 U | **560** | **810** | **220** |
| INDENO(1,2,3-CD)PYRENE | UG/KG | 237 | 422 | **10,000** | **580** | **790** | 24 U | **4,000** | **6,900** | **1,900** | **130** | 26 U | **390** | **1,100** | **720** |
| 1-METHYLNAPHTHALENE | UG/KG | 237 | 60.9 | **9,600** | **150** | **72** | 24 U | **940** | **12,000** | **64 J** | **120** | 26 U | **340** | **670** | **97 J** |
| 2-METHYLNAPHTHALENE | UG/KG | 1,400 | 181 | **17,000** | **320** | **200** | 24 U | **1,500** | **41,000** | **120 J** | **210** | 26 U | **180** | **1,200** | **240** |
| NAPHTHALENE | UG/KG | 5,340 | 282 | **620,000** | **9,800** | **17,000** | 24 U | **32,000** | **2,400,000** | **1,900** | **2,400** | **7.6 J** | **8,400** | **6,100** | **3,200** |
| PHENANTHRENE | UG/KG | 663 | 232 | **120,000** | **610** | **270** | **8.4 J** | **8,800** | **99,000** | **740** | **1,100** | **11 J** | **1,300** | **2,700** | **660** |
| PYRENE | UG/KG | 337 | 368 | **81,000** | **1,200** | **1,200** | 24 U | **12,000** | **23,000** | **3,200** | **600** | 26 U | **1,700** | **3,400** | **2,000** |
| TOTAL PAHs (ND=0) | UG/KG | -- | 3,240 | **1,188,300** | **20,370** | **28,539** | **8** | **135,740** | **2,797,800** | **26,829** | **7,921** | **19** | **21,610** | **34,340** | **18,376** |
| TOTAL PAHs (ND=1/2MDL) | UG/KG | -- | 3,250 | **1,188,300** | **20,370** | **28,539** | **260** | **135,740** | **2,797,800** | **26,894** | **7,921** | **279** | **21,610** | **34,340** | **18,376** |
| TOTAL PAHs (ND=MDL) | UG/KG | -- | 3,270 | **1,188,300** | **20,370** | **28,539** | **512** | **135,740** | **2,797,800** | **26,959** | **7,921** | **539** | **21,610** | **34,340** | **18,376** |

(a) depth below the sediment surface

(b) Average concentration in surface sediment from Baltimore Harbor Channels. Source: EA 2009. *FY08 Evaluation of Dredged Material: Baltimore Harbor Federal Navigation Channels*

**NOTE:** Shaded and bold values represent detected concentrations

**MDL** = method detection limit

**J** (organic) = compound was detected, but below the reporting limit (value is estimated)

**U** = compound was analyzed, but not detected

## Table 4-13. Metal Concentrations in Subsurface Sediment Around the Coke Point Peninsula

**Sparrows Point Site Assessment (2009), Baltimore, Maryland**

| | | | | NORTHWESTERN SECTION | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Background Concentration[(b)] | Location 1 | Location 2 | Location 16 | Location 17 | Location 3A | Location 3B | Location 3C | Location 3D | Location 3E | Location 4 | Location 5 | Location 18 |
| | | Depth (ft)[(a)] | 0-1 | 8-10 | 4-6 | 0-2 | 0-2 | 12-14 | 2-4 | 2-4 | 2-4 | 2-4 | 8-10 | 4-6 | 0-2 |
| **ANALYTE** | **UNITS** | **Average MDL** | | | | | | | | | | | | | |
| ANTIMONY | MG/KG | 0.25 | 0.398 | **1.1 L** | **0.2 L** | **1.8 J** | **1.6 L** | **0.25 L** | **1 L** | **1.3 L** | **2.6 L** | **1.2 J** | **2.5 L** | **0.35 L** | **3.7 L** |
| ARSENIC | MG/KG | 0.125 | 20.6 | **13.6** | **5.5** | **62.5** | **64.6** | **8.7** | **33.7** | **43.8** | **105 L** | **38.5 J** | **61.3** | **8.6** | **86.7** |
| BERYLLIUM | MG/KG | 0.125 | 1.7 | **1.2** | **0.26** | **1.1** | **1.4** | **0.86** | **1.3** | **1.1** | **1.8** | **1.4** | **1.7** | **1.8** | **1.3** |
| CADMIUM | MG/KG | 0.125 | 1.38 | **2.8 L** | **0.29** | **4.3 J** | **3.4 L** | **0.7** | **2.7 L** | **3.3 L** | **7.2 J** | **2.1 J** | **9.1** | **1.6** | **6.7 L** |
| CHROMIUM | MG/KG | 0.25 | 125 | **97.9** | **17.9 K** | **219** | **233** | **806** | **130** | **182** | **335** | **164** | **535 K** | **51.6 K** | **794** |
| COPPER | MG/KG | 0.25 | 118 | **81.5** | **14.6** | **148** | **154 L** | **29.8 L** | **84.5** | **120** | **267 L** | **98.5 J** | **414** | **41.3** | **300 L** |
| LEAD | MG/KG | 0.202 | 109 | **426** | **50.9** | **1,160** | **693** | **92.1** | **601** | **780** | **2,220** | **333** | **951** | **115** | **684** |
| MERCURY | MG/KG | 0.0491 | 0.396 | **0.79** | **0.12** | **0.94** | **1.1 L** | **0.25** | **0.48** | **1.1** | **1.1** | **0.53 L** | **2.7 L** | **0.17 L** | **1.9 L** |
| NICKEL | MG/KG | 0.125 | 41.3 | **22.1** | **5.1** | **34.1** | **37.8** | **19.5** | **33.8** | **32.8** | **40.6** | **36** | **54.8** | **44** | **53.5** |
| SELENIUM | MG/KG | 0.626 | 3.11 | **2.7** | **0.27 L** | **8** | **9.9** | **1.5 L** | **5.7** | **5.6** | **15.4 L** | **6.6 J** | **10.7 L** | **1.4 L** | **19.3** |
| SILVER | MG/KG | 0.125 | 0.722 | **1.7** | **0.11** | **1.5** | **1.2** | **0.17** | **0.67** | **1.2** | **3.9** | **0.7** | **3.8** | **0.35** | **3.7** |
| THALLIUM | MG/KG | 0.125 | 0.354 | **0.69** | **0.085 J** | **0.6** | **0.52** | **0.14** | **0.39** | **0.53** | **1.1** | **0.36** | **1.2** | **0.45** | **0.79** |
| ZINC | MG/KG | 1.28 | 306 | **1,030** | **92.4** | **1,310** | **943** | **183** | **701** | **954** | **2,890** | **510 J** | **3,230** | **548** | **2,500** |

(a) depth below the sediment surface

(b) Average concentration in surface sediment from Baltimore Harbor Channels. Source: EA 2009. *FY08 Evaluation of Dredged Material: Baltimore Harbor Federal Navigation Channels*

**NOTE:** Shaded and bold values represent detected concentrations

**MDL** = method detection limit

**J** (inorganic) = compound was detected in the method blank

**K** = The reported value may be biased high, the actual value is expected to be lower than reported

**L** = The reported value may be biased low, the actual value is expected to be higher than reported

**Table 4-13. (continued)**

| | | | | SOUTHWESTERN SECTION | | | SOUTHERN SECTION | | | TURNING BASIN SECTION | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Background Concentration[(b)] | Location 6 | Location 7 | Location 8 | Location 9 | Location 10 | Location 11 | Location 12 | Location 13A | Location 13B | Location 13C | Location 14 | Location 15 |
| | | Depth (ft)[(a)] | 0-1 | 6-8 | 6-8 | 10-12 | 12-14 | 2-4 | 2-4 | 4-6 | 6-8 | 8-10 | 6-8 | 8-10 | 2-4 |
| ANALYTE | UNITS | Average MDL | | | | | | | | | | | | | |
| ANTIMONY | MG/KG | 0.25 | 0.398 | **1.7 L** | **0.43 L** | **1.6 L** | **0.075 L** | **2.5 J** | **1.8 J** | **0.38 L** | **0.18 L** | **0.073 L** | **0.29 L** | **0.99 L** | **0.62 L** |
| ARSENIC | MG/KG | 0.125 | 20.6 | **45** | **19** | **38.8** | **4** | **102** | **37** | **8.6** | **5.2** | **5.3** | **8.2** | **24.2** | **13.2 L** |
| BERYLLIUM | MG/KG | 0.125 | 1.7 | **1.2** | **1.3** | **1.2** | **0.5** | **1.6** | **1.5** | **0.84** | **0.87** | **0.76** | **0.88** | **1.8** | **0.82** |
| CADMIUM | MG/KG | 0.125 | 1.38 | **4 L** | **1** | **2.5** | **0.19** | **8.6 J** | **5.6 J** | **0.75** | **0.27** | **0.25** | **0.79** | **3.4** | **2 J** |
| CHROMIUM | MG/KG | 0.25 | 125 | **330** | **68.5 K** | **327 K** | **15.7** | **362** | **199** | **46** | **31.6** | **22.9** | **31.1 K** | **165** | **73.9** |
| COPPER | MG/KG | 0.25 | 118 | **403** | **47.8** | **424** | **6.6 L** | **226** | **151** | **26** | **12.1 L** | **12.9 L** | **21.4** | **178 L** | **64.2 L** |
| LEAD | MG/KG | 0.202 | 109 | **604** | **112** | **265** | **7.2** | **2,990** | **900** | **72.3** | **69.3** | **11.9** | **110** | **340** | **311** |
| MERCURY | MG/KG | 0.0491 | 0.396 | **1.3** | **0.31 L** | **0.26 L** | **0.011 J** | **1.3** | **5.5** | **0.086** | **0.056** | **0.026** | **0.21 L** | **0.67** | **0.28** |
| NICKEL | MG/KG | 0.125 | 41.3 | **44.9** | **34** | **44.5** | **9.1** | **47.2** | **45.8** | **22** | **6.5** | **14.8** | **15.4** | **53.9** | **24.2** |
| SELENIUM | MG/KG | 0.626 | 3.11 | **7.9** | **1.9 L** | **6.9 L** | **0.59 L** | **14.8** | **6.2** | **0.65 L** | **0.47 L** | **0.77 L** | **0.68 L** | **4.8 L** | **2.4 L** |
| SILVER | MG/KG | 0.125 | 0.722 | **2.2** | **0.3** | **1.4** | **0.037 J** | **4.2 J** | **1.9 J** | **0.21** | **0.082** | **0.056 J** | **0.12** | **2** | **0.76** |
| THALLIUM | MG/KG | 0.125 | 0.354 | **0.7** | **0.24** | **0.45** | **0.064 J** | **1.2** | **0.8** | **0.19** | **0.059 J** | **0.11** | **0.17** | **0.86** | **0.38** |
| ZINC | MG/KG | 1.28 | 306 | **1,400** | **245** | **736** | **28.8** | **3,730** | **2,020** | **204** | **132** | **43.2** | **178** | **954** | **609** |

(a) depth below the sediment surface

(b) Average concentration in surface sediment from Baltimore Harbor Channels. Source: EA 2009. *FY08 Evaluation of Dredged Material: Baltimore Harbor Federal Navigation Channels*

**NOTE:** Shaded and bold values represent detected concentrations

**MDL** = method detection limit

**J** (inorganic) = compound was detected in the method blank

**K** = The reported value may be biased high, the actual value is expected to be lower than reported

**L** = The reported value may be biased low, the actual value is expected to be higher than reported

## Table 4-14. Summary of Residual Non-Aqueous Phase Liquid Saturation in Offshore Borings

**Coke Point Peninsula, Sparrows Point Site Assessment (2009), Baltimore, Maryland**

| Location No. | Sample ID | Depth (ft) | Matrix | NAPL Saturation (%) | Primary Compounds (concentrations in mg/kg) | NAPL Manifestation |
|---|---|---|---|---|---|---|
| **Location 1** | BH-SED-01-00 | Surface | Sediment | 0 | Total PAH 14 | None |
| | BP-SED-01-8 | 8-10 | Fill | 0.0009 | Total PAH 59 | Sheen, dye POS |
| **Location 2** | BH-SED-02-00 | Surface | Fill | 0.0856 | Naphthalene 290 | Slight HC odor |
| | BH-SED-02-4 | 4-6 | Fill | 0.1706 | Naphthalene 86 | Dye POS; sheen; HC odor |
| **Location 3A** | BH-SED-3A-00 | Surface | Fill | 0.0192 | Naphthalene 90 | Strong HC odor; sheen |
| | BH-SED-3A-12 | 12-14 | Fill | 0 | Total PAH 37 | Coal tar / naphthalene odor |
| **Location 3B** | BH-SED-3B-00 | Surface | Fill | 2.0120 | Naphthalene 7,200 | Strong HC odor; sheen |
| | BH-SED-3B-2 | 2-4 | Fill | 0 | Total PAH 67 | Dye POS; coal tar odor |
| **Location 3C** | BH-SED-3C-00 | Surface | Fill | 0.0452 | Naphthalene 190 | None |
| | BH-SED-3C-2 | 2-4 | Fill | 0.8189 | Naphthalene 2,800 | Coal tar odor; sheen |
| **Location 3D** | BH-SED-3D-2 | 2-4 | Fill | 0.0013 | Total PAH 38 | Small sheen; HC odor |
| **Location 3E** | BH-SED-3E-2 | 2-4 | Sediment | 0 | Total PAH 10 | None |
| **Location 4** | BH-SED-04-00 | Surface | Sediment | 0.0015 | Total PAH 184 | Strong HC odor; sheen |
| | BH-SED-04-8 | 8-10 | Sediment | 1.2340 | Naphthalene 4,400 | Slight naphthalene odor |
| **Location 5** | BH-SED-05-00 | Surface | Sediment | 0.1637 | Total PAH 542 | None |
| | BH-SED-05-4 | 4-6 | Sediment | 0.0266 | Naphthalene 590 | Naphthalene odor; sheen |
| **Location 6** | BH-SED-06-00 | Surface | Sediment | 0.0328 | Total PAH 262 | None |
| | BH-SED-06-6 | 6-8 | Sediment | 0.2505 | Naphthalene 620; Total PAH 1,340 | PID 220 ppm; no odor noted |
| **Location 7** | BH-SED-07-00 | Surface | Sediment | 0.1787 | Fluoranthene 140; Total PAH 680 | None |
| | BH-SED-07-6 | 6-8 | Sediment | 0 | Total PAH 20 | None |
| **Location 8** | BH-SED-08-00 | Surface | Fill | 0.0114 | Total PAH 95 | None |
| | BH-SED-08-10 | 10-12 | Fill | 0 | Total PAH 30 | Slight naphthalene odor |
| **Location 9** | BH-SED-09-00 | Surface | Sediment | 0.0171 | Total PAH 169 | None |
| | BH-SED-09-12 | 12-14 | Sediment | 0 | No analytes above detection limit | None |
| **Location 10** | BH-SED-10-00 | Surface | Sediment | 0.0136 | Total PAH 164 | Slight HC odor |
| | BH-SED-10-02 | 2-4 | Sediment | 0.0038 | Total PAH 123 | Dye inconclusive; slight HC odor |
| **Location 11** | BH-SED-11-00 | Surface | Sediment | 0.0107 | Total PAH 169 | HC odor |
| | BH-SED-11-02 | 2-4 | Sediment | 0.7592 | Naphthalene 2,400 | Naphthalene odor |
| **Location 12** | BH-SED-12-00 | Surface | Sediment | 0 | Total PAH 53 | HC odor |
| | BH-SED-12-4 | 4-6 | Sediment | 0 | Total PAH 27 | None |

## Table 4-14. (continued)

| Location No. | Sample ID | Depth (ft) | Matrix | NAPL Saturation (%) | Primary Compounds (concentrations in mg/kg) | NAPL Manifestation |
|---|---|---|---|---|---|---|
| **Location 13A** | BH-SED-13A-00 | Surface | Fill | 0.0090 | Total PAH 68; benzene, ethylbenzene, toluene present (~0.1 ppm) | HC odor |
| | BH-SED-13A-6 | 6-8 | Fill | 0 | Total PAH 9; benzene, ethylbenzene, toluene present (~1 ppm) | Naphthalene odor |
| **Location13B** | BH-SED-13B-00 | Surface | Fill | 0 | Total PAH 10 | None |
| | BH-SED-13B-8 | 8-10 | Fill | 0 | No analytes above detection limit | None |
| **Location 13C** | BH-SED-13C-00 | Surface | Fill | 0 | Total PAH 6 | None |
| | BH-SED-13C-6 | 6-8 | Fill | 0 | Total PAH 22; benzene, ethylbenzene, toluene present (~0.1 ppm) | Naphthalene odor |
| **Location 14** | BH-SED-14-00 | Surface | Sediment | 0 | Total PAH 12 | None |
| | BH-SED-14-8 | 8-10 | Sediment | 0 | Total PAH 34 | Coal tar odor in silty clay |
| **Location 15** | BH-SED-15-2 | 2-4 | Sediment | 0 | Total PAH 18 | Very slight HC odor |
| **Location 16** | BH-SED-16-00 | Surface | Sediment | 0 | Total PAH 43 | None |
| **Location 17** | BH-SED-17-00 | Surface | Sediment | 0 | Total PAH 50 | None |
| **Location 18** | BH-SED-18-00 | Surface | Sediment | 0.0021 | Total PAH 92 | Slight HC odor |

Notes Fraction of organic carbon used in the model was 0.01 for fill material and 0.033 for sediment.
The value for fill was based on the assumption that organic carbon in uncontaminated fill would have been burned off during materials processing. Organic carbon in sediment was based on ambient Baltimore Harbor channel sediment values.

# 5. FATE AND TRANSPORT

As discussed in Chapters 3 and 4, constituents of concern on and around the Coke Point Peninsula include MAHs such as benzene and toluene; PAHs such as naphthalene, benzo(a)pyrene and several others; and metals such as lead, arsenic, and vanadium. These constituents are elevated over natural background levels in onshore slag fill material, offshore sediment, groundwater, and surface water, and also occur as free-phase and residual NAPL. The major factors that control fate and transport of these constituents are physicochemical characteristics and site environmental characteristics.

This chapter builds upon information presented in Chapters 3 and 4 to examine sources and transport pathways of these constituents onshore and offshore. The chapter includes:

- Characterization of PAH sources through fingerprinting and carbon isotope analysis to determine if the PAHs were generated onsite or are derived from offsite industry or urban background.
- Discussion of the fate of the constituents in the main components of the site (NAPL, fill material, groundwater, offshore surface water, and offshore sediment).
- Calculation of the mass flux of selected constituents from groundwater to surface water and modeling of the resulting surface water concentrations.
- An assessment of the partitioning between sediment and groundwater to better constrain the mechanism of transport from onshore to offshore environments.
- Development of an overall conceptual model of the fate and transport of the constituents in and around the Peninsula.

## 5.1 PAH SOURCE ANALYSIS

### 5.1.1 Background

There are several possible sources of PAH compounds on and around the Coke Point Peninsula, including urban background sources, offsite industrial sources such as smokestacks, shipbuilding and repairs on the Peninsula, or onsite steelmaking activities at the Sparrows Point plant. Better constraint of the sources of PAHs was obtained using a method called PAH fingerprinting.

PAHs can be placed into different subgroups according to their origins. Subgroups include petrogenic (produced at relatively low temperatures over long periods of time) and pyrogenic (produced at high temperatures with a shortage of oxygen). Petrogenic PAHs are generally found in crude oil and similar materials, whereas pyrogenic PAHs are found in coal tar and related substances, as well as in combustion byproducts. Environmental samples can contain PAHs from one or both of these subgroups.

PAH fingerprinting uses recognition of qualitative patterns and quantitative comparisons of ratios of specific PAHs within a mixture to determine the relative contributions of petrogenic and

pyrogenic sources. By comparing PAH ratios from samples with ratios from materials of known origin, it is possible to determine the character of the source material of the PAHs. One key piece of information is the fluoranthene/pyrene ratio, which is used to distinguish combustion products (which typically occur only as a diffuse background signal) and byproducts of coal carbonization processes (including coke oven operations such as those occurring at Sparrows Point) from other pyrogenic and petrogenic PAH sources. Specifically, combustion and coal carbonization produce fluoranthene/pyrene ratios above 1, whereas other sources (other than steelmaking and urban background combustion) often give ratios less than 0.8. Fossil fuels and derivatives (e.g., crude oil and petroleum distillates) typically have ratios less than 0.4. PAHs derived from the Coke Point Peninsula are expected to be primarily pyrogenic, and petrogenic signals are therefore expected to be from other offsite sources.

Stable carbon isotope analysis can provide additional information on the source of the organic material within a hydrocarbon mixture. The ratio of $^{13}C$ to $^{12}C$ is altered in the environment by various biological and chemical processes. Similar ratios in two materials suggest a single source, whereas distinct ratios imply different sources. It is not possible to separate the signature of pyrogenic and petrogenic components in isotope analysis; rather, average isotope ratios for are given for each PAH analyzed in the sample. These two methods were used to assess possible relationships between the PAHs found offshore versus onshore in the investigation areas at the Coke Point Peninsula.

### 5.1.2 PAH Fingerprinting and Isotope Analysis

PAH fingerprinting and carbon isotope analysis were performed on samples from 12 locations (5 onshore and 7 offshore) chosen to represent a diversity of the onshore and offshore environments, as well as an offsite background sediment sample (collected near the Key Bridge) (Figure 2-4). All samples analyzed for PAH fingerprinting within the study area showed elevated levels of PAHs relative to the background concentrations, in agreement with the independent PAH analysis presented in Chapters 3 and 4.

Fingerprinting analyses showed that all samples contained a pyrogenic component. A variety of diagnostic ratios, along with the carbon isotope analyses, were used to interpret how the samples relate to various known sources of PAHs. Forensics reports are contained in **Attachment IV** and summarized by site area below.

***Benzol Processing and Graving Dock Areas –*** Onshore samples from the Benzol Processing Area (BP-SO-05-6 and BP-SO-02S-8) and Graving Dock Area (BP-SO-B03-18) (Figure 2-4) showed high PAH concentrations with pyrogenic signatures consistent with coal tar residues (fluoranthene/pyrene ratios of 1.2 to 1.3). In addition, samples BP-SO-B03-18 and BP-SO-02S-8 contained high concentrations of MAHs (benzene, toluene, and ethylbenzene), typical of benzolated absorbing oils, which were used in the Benzol Processing Area. Samples BP-SO-05-6 and BP-SO-02S-8 also contained a petrogenic component typical of certain fuel oils. The carbon isotope ratios of these samples are similar to those in the Coal Tar Storage Area, and fall in the range typical of coal-derived pyrogenic PAHs.

Near-surface sediment samples from directly offshore of the northwestern portion of the Peninsula (BH-SED-03A-00 and BH-SED-05-4) also contained PAHs with pyrogenic signatures consistent with coal tars, with fluoranthene/pyrene ratios of 1.3 and 1.5, respectively. In addition, BH-SED-03A-00 showed low levels of petrogenic material typical of urban background (e.g. runoff of petroleum products). These samples contained especially high concentrations of naphthalene, as also seen in the non-forensics analysis of PAHs (**Tables 4-6** [surface] **and 4-12** [subsurface]). Their carbon isotope ratios were similar to those from the onshore samples. However, the carbon isotope ratio for naphthalene from BH-SED-03A-00 was somewhat different from the onshore Benzol Processing Area ratios.

Sediment sample BH-SED-03A-12 was collected from a sediment core at depth (12 ft below sediment surface) offshore of the northwestern portion of the Peninsula. This sample also showed elevated naphthalene (relative to onshore Benzol Processing Area concentrations), although significantly less than seen nearer to the sediment surface (in BH-SED-03A-00 and BH-SED-05-4). This sample contained low levels of pyrogenic PAHs, with ratios similar to the background sediment sample (fluoranthene/pyrene ratio of 0.9), and thus more typical of urban background than of the coal tar signature seen in onshore samples. Carbon isotope ratios could not be determined for many PAHs in this sample because of low concentrations. However, the carbon isotope ratio for naphthalene is within the range of those for the onshore samples.

Samples BH-SED-03E-2 and BH-SED-17-0 were collected farther offshore from the northwestern portion of the Peninsula, and thus farther from the onshore sources of PAHs associated with steelmaking coking operations. PAH concentrations were lower in these samples, although still elevated relative to the sediment background sample, with pyrogenic PAH ratios similar to BH-SED-03A-12 and the background. BH-SED-03E-2 had a fluoranthene/pyrene ratio of 1.06, very similar to that of the background sediment sample, which appears to contain PAHs derived mostly from urban combustion. The fluoranthene/pyrene ratio for BH-SED-17-0 was much lower (0.6) and may reflect the large petrogenic component, which constituted the majority of PAHs in this sample. The petrogenic signature BH-SED-03E-2 was similar in character, but less abundant. The carbon isotope signature of BH-SED-03E-2, a location approximately 1,000 ft from the shoreline, indicated a source that may be distinct from the onshore samples as well as the other offshore samples.

***Coal Tar Storage Area –*** Onshore samples from the Coal Tar Storage Area (CT-SO-B01-20 and CT-SO-B05-20) showed pyrogenic PAH ratios consistent with coal tars and coke oven tars, with fluoranthene/pyrene ratios of approximately 1.4. The concentrations of PAHs were much higher than is typical of background combustion sources. The nearly identical carbon isotope ratios of these two samples are also consistent with those of coal-derived pyrogenic PAHs.

The sample from offshore of the Coal Tar Storage Area (BH-SED-13C-6) also exhibited PAH concentrations similar to onshore samples, with fingerprints and carbon isotope ratios consistent with coal tars and distinct from the sediment background sample. The fluoranthene/pyrene ratio in this sample was 1.5. In addition to a pyrogenic component, sample BH-SED-13C-6 also contained a complex petrogenic signal, signifying the presence of various petroleum-derived products.

***Southern Peninsula –*** Sample BH-SED-10-2 was collected from off the southern shoreline of the Coke Point Peninsula, not adjacent to either onshore investigation area (Benzol Processing Area or Coal Tar Storage Area). This sample contained naphthalene levels similar to BH-SED-03A-12, but higher concentrations of both petrogenic and pyrogenic PAHs. Its pyrogenic PAH ratios were consistent with coal tars, with a fluoranthene/pyrene ratio of 1.5. The petrogenic component was consistent with various petroleum products and oils. The carbon isotope signature of this sample was similar to that of BH-SED-03E-2, indicating the contribution from a source that may be distinct from the onshore samples. However, the isotopic ratio for naphthalene in this sample was consistent with the onshore samples.

In summary, PAH fingerprinting and carbon isotope analyses indicate that the organic anthropogenic material in the surface sediments directly offshore from the investigation areas (Benzol Processing Area and Coal Tar Storage Area) is likely derived from the sources associated with historic steelmaking coke production, coal tar storage, and benzol processing activities in the investigation areas. The PAH fingerprinting and carbon isotopes data suggest that impacts in both onshore and near-offshore sediments are consistent with similar coal tar-related substances. It appears that naphthalene from onshore may have spread to deeper offshore sediments, which contain relatively lower levels of other PAHs. Less impacted sediments approximately 1000 feet offshore appear to be less affected by the onshore Peninsula sources, and likely approximate a current outer limit of where other land-derived PAHs dominate the PAH signature of offshore sediments.

## 5.2 FATE AND TRANSPORT PATHWAYS

### 5.2.1 Onshore Sources

Currently, the primary sources of organic compounds and metals from the Coke Point Peninsula to groundwater and offshore environments are the slag materials that comprise the onsite shallow aquifer and the NAPL present within this aquifer. The degree to which constituents from these sources enter groundwater is determined by a number of factors.

#### ***5.2.1.a Factors Affecting Mobilization and Persistence***

***Effective Solubility –*** The potential of constituents in solid- and liquid-phase materials to partition into groundwater is largely determined by their solubilities under conditions present at the site. For example, a metal waste that is highly soluble under the given conditions will cause higher dissolved metal concentrations than one that is insoluble. Similarly, NAPL containing soluble organic constituents will contribute these constituents to groundwater. Solubility also affects the rate of dissolution and thus the lifetime of the source material. This is particularly important for NAPL, which acts as a continuous source of organic compounds to groundwater until all constituents of the NAPL have been depleted.

***Sorption/Partitioning –*** One of the most important processes for determining the effective solubility of a compound or metal is sorption onto solid phases. Once released into the aqueous phase from their original solid or liquid source, constituents can partition between the water and

the solid surfaces of the soil or aquifer. Many of the organic compounds and metals in the soils of the Coke Point Peninsula likely exist in sorbed phases. This interaction with the immobile solid phase causes them to move more slowly than the surrounding water, which decreases their transport potential. Sorption processes include the following:

- Adsorption – the solute clings to the surface of the solid
- Chemisorption – the solute is incorporated onto the solid by a chemical reaction
- Absorption – the solute diffuses into the solid and sorbs onto interior surfaces
- Ion Exchange – positively charged cations become attracted to the region close to a negatively charged material, such as a clay mineral surface, and take the place of other cations in neutralizing the charge.

The term "sorption" is general, and is used herein to indicate the overall result of these various processes.

The process by which a chemical species becomes distributed between the solution and the solid phase is called partitioning. Partitioning describes the equilibrium distribution of a chemical among phases in a system containing multiple phases. When concentrations of a species are at equilibrium with respect to all phases present, no further net transfer between phases should occur.

Partitioning between the aqueous and solid phase is given by a number of parameters in addition to solubility, such as sorption coefficients ($K_d$), and octanol-water ($K_{ow}$) and organic carbon ($K_{oc}$) partitioning coefficients. $K_{ow}$ and $K_{oc}$ are convenient partitioning parameters that can help determine the fate and transport of many organic compounds in the subsurface. Sorption coefficients ($K_d$) are used to describe adsorption of metals onto mineral surfaces, as well as the partitioning of organic compounds onto materials containing organic matter. These coefficients essentially describe an expected, constant ratio between the solid and aqueous phase concentrations of the species. They are unique to each combination of chemical species and solid phase, although they can often be generalized for similar solid phases or mixes of solids (e.g. typical soil in a given area, or typical fine-grained river sediment). The partitioning parameters are controlled by various factors including the charge or degree of hydrophobicity (water solubility) of the solute and the solid surface, the surface area available for sorption, and the organic fraction present in the solid phase.

Partitioning between solid, liquid, or aqueous phases and gaseous phases can also occur. This is primarily important for volatile organic compounds, such as MAHs, since other organic compounds and metals partition only minimally into gaseous phases. Because the main MAH sources onshore are in the subsurface and isolated from the atmosphere, their mobilization into the gaseous phase is negligible. However, MAH transport from the aqueous to the gaseous phase by volatilization may be important for interactions between air and MAH-containing surface water.

***Particulate Transport –*** Small (clay-sized) particles of solids or NAPLs can be suspended and transported in solution. The potential for a particulate to be transported depends on its size, its density relative to the water, and the flow rate of the water. Very small particulates that remain in solution indefinitely, or for lengthy periods of interest, are referred to as colloids. Both organic and inorganic materials can exist as colloids or slightly larger particulates in flowing water, including microorganisms, microemulsions of NAPL, mineral precipitates, and mineral fragments. Suspended particles can also act as adsorptive surfaces and facilitate transport of constituents in the subsurface.

***Physical Properties of NAPLs –*** NAPL fate and mobility is influenced by various physical properties, including density, viscosity, and wettability. NAPL density relative to water determines whether it manifests as LNAPL or DNAPL. Viscosity (resistance to flow) can be extremely important to NAPL mobility; more viscous liquids (e.g., coal tars) do not move as easily through the subsurface as those with lower viscosity (e.g., light aromatics or water). Wettability also influences mobility. NAPLs that are preferentially oil wet do not easily desorb from soil particles, whereas water wet NAPLs tend to be relatively mobile.

***Biodegradation*** – Organic compounds are often subject to oxidation by microorganisms, which can decrease their persistence in the environment. The rate of this biodegradation is determined by the thermodynamics of the individual compound, and by the availability of electron acceptors (e.g., oxygen) whose reduction can be paired with the oxidation.

Generally, oxidation of organic compounds is fastest when it occurs by aerobic respiration, paired to the reduction of oxygen. Therefore, organic compounds may persist longer in low-oxygen environments that are isolated from the atmosphere, such as aquifers and buried sediments. MAHs and low-molecular weight PAHs can be biologically degraded through aerobic respiration. For aromatic compounds such as benzene and naphthalene, degradation generally becomes slower with each additional aromatic ring; therefore, benzene (1 ring) is generally oxidized more quickly than naphthalene (2 rings).

Although metal phases can change due to microbial processes, metals themselves cannot be degraded.

### ***5.2.1.b Mobile Non-Aqueous Phase Liquids***

Mobile NAPL is generally continuous within subsurface pore spaces and can be transported vertically or laterally by gravity forces or pressure gradients. As a result, mobile NAPL can sometimes be successfully recovered by removing the liquid from a collection point (e.g., a well or trench) in ways that take advantage of gravity flow by creating a gradient, which increases the flow of NAPL toward the collection point. In many cases, the presence of mobile (or residual) NAPL creates a continuous source of organic compounds that are transported in the dissolved phase toward discharge areas such as surface water bodies or pumped wells.

As discussed in Chapter 3, mobile LNAPL was observed in three wells within the Benzol Processing Area (**Table 3-9**). This NAPL showed rapid recovery rates, consistent with its

relatively low viscosity (slightly greater than that of water) and the fact that it is preferentially water wet, which reduces sorption and provides greater mobility relative to oil wet NAPL. This mobility, as well as its abundance of benzene and toluene (which are soluble in water to 1,700 and 500 mg/L respectively [Montgomery 2000]) make this NAPL a likely source for groundwater impacts in the Benzol Processing Area.

Measureable DNAPL (0.88 ft thick) was observed in the fill material within one pre-existing well in the Coal Tar Storage Area (**Table 3-9**), but none was found in any of the additional borings drilled during this investigation. This NAPL is largely immobile because it is highly viscous (two orders of magnitude greater than water at room temperature) and preferentially oil wet. Under ambient temperatures, transport of existing DNAPL is highly unlikely and the product will essentially be immobile within the subsurface matrix. It therefore represents a stationary source of naphthalene, which is moderately soluble (30 mg/L) (Montgomery 2000), as well as some toluene and benzene, to groundwater.

#### ***5.2.1.c Sorbed and Residual Organic Constituents***

In addition to organic constituents present in mobile NAPL phases, the same constituents may be found in slag fill material within the investigation areas. These additional organics may be present in residual NAPL or sorbed onto soil particles. Residual NAPL is immobile, and therefore difficult to recover, because it does not occupy all of the available pore space, but can contribute organic compounds to groundwater.

***MAHs –*** Concentrations of benzene, toluene, and ethylbenzene in soil exceed MDE (2008) protection of groundwater cleanup standards in many samples from the Benzol Processing Area (**Table 3-3**) and to a lesser extent in the Graving Dock and Coal Tar Storage Areas (**Tables 3-3 and 3-4**). This closely reflects the composition of the NAPL, and thus these MAHs are likely contained in residual NAPL and/or in sorbed phases derived from it.

***PAHs –*** A suite of PAHs (generally dominated by naphthalene) is present in the soil at concentrations exceeding protection of groundwater cleanup standards (MDE 2008) in the soils of the onshore investigation areas (**Tables 3-5 and 3-6)**. In the Coal Tar Storage Area, PAH concentrations tend to be higher at depth in the fill material, which is consistent with the density of PAH compounds and is further evidence of a DNAPL source.

***Calculations of NAPL Saturation –*** To assess the presence of NAPLs as opposed to sorbed phases, the concentrations of organic constituents were used to model the saturation of NAPL within the boreholes (**Section 3.5** and **Appendix C**). These calculations indicate the presence of residual NAPL primarily in the Benzol Processing and Coal Tar Storage Areas, up to 10.7 percent saturation (**Tables 3-13 and 3-14**). These residual NAPLs are not mobile under existing conditions, but rather dissolve in place and therefore represent a continuous stationary source of organic compounds to groundwater.

### *5.2.1.d Metals in Slag and Underlying Units*

Of the metals that were found to exceed protection of groundwater cleanup standards (MDE 2008) in the soils of the Benzol Processing and Coal Tar Storage Areas (**Tables 3-7 and 3-8**), arsenic, chromium, and lead are the most substantially and consistently elevated (relative to site background). These three heavy metals (along with vanadium, which was identified in the groundwater at the site) tend to be abundant in coal, and therefore are likely associated with coke oven (or blast furnace) waste.

***Benzol Processing and Graving Dock Areas –*** Arsenic concentrations are particularly high near the bottom of the fill material (20-32 feet) in these areas. Chromium is highest in the western section of the Benzol Processing Area, and particularly in the Graving Dock Area. Lead concentrations are highly variable, with higher concentrations generally found deeper in the fill material.

***Coal Tar Processing Area*** – Although arsenic concentrations in fill material exceed the protection of groundwater cleanup standard (MDE 2008), concentrations are relatively homogeneous and not highly elevated (above average soil concentrations) in this area. In contrast, chromium concentrations are more consistently high, and of similar magnitude to the highest values in the Benzol Processing Area. Lead only exceeds protection of groundwater standards at one site, in the southwest portion of the investigation area.

## 5.2.2 Groundwater Fate and Transport Flux

Incorporation into groundwater is a primary mechanism for mobilization of organic compounds and metals from NAPLs and from solid-phase sources, such as slag deposits. During transport in groundwater, the chemical species interact with the porous media by means of various physical and chemical processes, which affect their overall mobility. The propensity of a constituent to be transported is largely determined by its effective solubility and biodegradation rate, as discussed above. In a flowing groundwater, however, transport is also highly dependent on the characteristics of the aquifer. Some of these characteristics are discussed below.

### *5.2.2.a Aquifer and Groundwater Characteristics*

An aquifer is defined as a geologic unit that stores and transports groundwater. Aquifers can be made of any permeable geologic material. The characteristics of an aquifer determine the physics of water flow, and can also impact water chemistry.

***Porosity –*** Porosity is defined as the percentage of the volume of bulk soil that contains pore spaces, and is an index of how much water can be stored in a solid material. The porosities of the aquifers underlying the Coke Point Peninsula were estimated to be 0.25 for the shallow aquifer and 0.3 for the intermediate aquifer, based on literature values for materials with similar particle size distributions (Fetter 1994) (see **Appendix E**).

***Permeability*** – Permeability, also referred to as hydraulic conductivity, is a measurement of the ability of groundwater to move through a geologic formation. Values of 149 ft/day for the shallow aquifer and 23.2 ft/day for the intermediate aquifer were determined previously, using field tests (CH2M-Hill 2002).

***Flow velocity –*** Flow velocity is a function of the porosity and permeability of the aquifer, as well as its hydraulic gradient (slope). The average flow velocities for the aquifers under the Coke Point Peninsula were calculated to be 0.96-1.50 ft/day for the shallow aquifer and 0.12 ft/day for the less permeable intermediate aquifer (see **Appendix E**).

***Salinity*** – Salinity is the mass of dissolved inorganic constituents per kilogram of water, and can affect solubility.

***pH and Eh –*** The pH and Eh (redox potential) influence many aspects of aquifer chemistry, including the valence state and thus behavior of metals and the degradation rate of organic compounds. The dissolved oxygen concentration is closely related to the Eh. These properties can also influence how compounds and metals partition between the solid and aqueous phase (discussed further below).

The shallow aquifer under the Coke Point Peninsula is variable from slightly acidic to highly alkaline (pH 6-12), whereas the intermediate water is alkaline (pH 8-12). Both aquifers have negative Eh values and very low dissolved oxygen, indicating an environment where other chemical species, such as metals, are reduced in place of oxygen, and where degradation of many organic compounds is expected to be slower than in oxygenated environments.

***Advection –*** Advection is the process of solute transport by the bulk motion of the groundwater and is, therefore, defined by the velocity of groundwater within a given water-bearing zone. In the absence of chemical and physical factors that impede their transport (solubility, sorption, biodegradation, etc.), the extent of dissolved compound transport could be predicted by the advective flow of groundwater.

***Dispersion –*** In general, if all groundwater containing a solute were to travel at exactly the same rate, it would displace water that does not contain the solute and create an abrupt interface between the two waters. However, because the solute-containing water is not all traveling at the same velocity, mixing occurs along the flowpath – this mixing is called dispersion. Dispersion results in a dilution of the solute at the advancing (leading) edge of the plume (longitudinal dispersion) as well as the edges of the plume perpendicular to flow (transverse dispersion). Thus dispersion is often responsible for diluting groundwater plumes while also increasing their size.

#### ***5.2.2.b Organic Compounds in Groundwater of the Coke Point Peninsula***

The sediment PAH fingerprinting and surface water results indicate that organic constituents from the Coke Point Peninsula have impacted nearby offshore sediments and surface water. One likely mechanism for transport to these environments is groundwater, which contained high

levels of dissolved MAHs (predominantly benzene) and PAHs (predominantly naphthalene) (**Figures 3-1 and 3-2**).

***MAHs –*** High concentrations of benzene and related MAHs in groundwater exist in the aquifers underlying the Benzol Processing Area, extending across the northwestern portion of the Peninsula. These MAHs originate from NAPL contained within the slag fill material. The high MAH concentrations observed in the source areas exceed of 10% solubility of some constituents, a general indication of nearby NAPL. The dissolved-phase MAH plume over a large area, including downgradient of the Benzol Processing Area, indicates that, once dissolved, these MAHs are mobile and persistent in the groundwater environment. Intrinsic biodegradation of MAH constituents is likely to be retarded by the low availability of dissolved oxygen in the aquifers. If left in place, the large quantity of NAPL source present in this area has the potential to represent a continuous source of dissolved MAH concentrations.

***PAHs –*** High concentrations of naphthalene were detected in groundwater at the Coal Tar Storage Area along with other PAHs (URS 2005a). Based on exceedance of 10% solubility of naphthalene, the likely source of these dissolved constituents is coal tar DNAPL in specific locations (e.g., location of existing monitoring well CO13) of the Coal Tar Storage Area. During the investigation of this Area, free-phase coal tar DNAPL was not identified within soil samples or within installed monitoring wells; thus the source DNAPL is likely residual or entrapped. Naphthalene is the most soluble of the PAHs, which is consistent with the higher concentrations of naphthalene in groundwater relative to other PAHs. Naphthalene, like benzene, is highly mobile in the Coke Point groundwater, and dissolved naphthalene is present throughout the northeastern portion of the Peninsula (**Figures 3-3 and 3-4**). Residual coal tar DNAPL is likely to provide a continuous source of naphthalene to groundwater within this area.

### *5.2.2.c Metals in Groundwater of the Coke Point Peninsula*

Metals in groundwater were reported for the Coke Point Peninsula by URS (2005a). The discussion below focuses on the main constituents detected (lead, arsenic, and vanadium).

***Lead*** – A small area of lead concentrations above the MDE groundwater standards (MDE 2008) has been measured in groundwater sampled from the Benzol Processing Area. This lead is associated with particulates (not dissolved) and is therefore likely to be of limited mobility. The particulates likely originated in the lead-containing solids of the overlying slag (**Table 3-7**), and the extent of this occurrence is only about seven acres, much less than the area of the MAH and PAH groundwater plumes that cover much of the northwestern and northeastern portions of the Peninsula.

***Arsenic*** – Arsenic concentrations above the MDE standard has been observed in groundwater of the intermediate aquifer along the northwest portion of the Peninsula (URS 2005a). This occurrence may be related to relatively high concentrations of arsenic in the deeper slag deposits within the Benzol Processing Area (**Table 3-7**). The arsenic observed in groundwater of the Coal Tar Storage area may be derived from slag and or may result from the dissolution of this constituent from residual coal tar. Arsenic presence in the dissolved phase is somewhat unusual

because, like lead, this constituent generally partitions strongly onto solid phases. Given measured groundwater conditions, arsenic is expected to be present as a mix of oxidized and reduced oxide ions (arsenate and arsenite).

***Vanadium –*** Vanadium is commonly associated with fossil fuel-derived waste, and occurs in the dissolved phase in the Coke Point aquifers. Groundwater conditions (URS 2005a) indicate that it should be present as highly-oxidized $V^{5+}$ oxide ions, which are known to be soluble. Vanadium was detected at concentrations exceeding the MDE standard in both investigation areas, with the highest concentrations occurring in the areas where NAPLs were also observed. Although solid-phase vanadium data are not available, vanadium is known to be present in soluble oxidized phases in a variety of combustion products. The abundance and solubility of vanadium make it more likely than the other metals discussed to undergo groundwater transport resulting in additional impacts.

### ***5.2.2.d Calculations of Fluxes from Groundwater to Surface Water***

To evaluate the influence of impacted groundwater on other environmental media surrounding Sparrows Point, groundwater concentrations of constituents of interest were used to estimate the current flux of organic compounds and metals from the aquifers to the surrounding surface water. Calculations were performed for four representative species that were detectable in groundwater near the shoreline (benzene, naphthalene, vanadium, and arsenic). The shallow and intermediate aquifers along the northwestern and eastern shores of the Peninsula (**Figure 5-1**) were considered in the analysis, due to the presence in these areas of relatively high concentrations of one or more of the constituents of interest in near-shore groundwater.

Calculation of these fluxes necessitated two primary pieces of information: (1) the average concentrations of the species of interest in aquifers along each section of shoreline, and (2) the rate of groundwater flow into the surface water along each section. Details of these calculations are provided in **Appendix E**; a summary is provided here.

Concentrations in the individual aquifers along the shoreline boundaries were estimated by extrapolating from available data points further inland. To provide better estimates, the larger sections of the shoreline were subdivided into smaller segments with better constrained concentrations.

The volume of water passing through each section of the shoreline per second was calculated using the groundwater velocity and the calculated cross-sectional area of the aquifers along each section. This value, with the groundwater flow velocity (see **Section 5.2.2.a**) and the concentration values described above, was used to calculate the amount of each constituent carried across each boundary per second. The resulting flux values are shown in **Table 5-1**.

The total mass flux to surface water is highest for benzene, with most of the mass flowing from the northwestern section of the Peninsula. The flux from the intermediate aquifer dominates, due to the dramatically higher benzene concentrations in this aquifer. The total naphthalene flux is over ten times lower, and is heavily weighted toward flow to the Turning Basin from the eastern

section of the Peninsula. Vanadium flux is another factor of five lower, and is also concentrated in the eastern section. Arsenic was only detectable near the shoreline in the northeastern section, and its total flux is about five percent of the vanadium flux.

### 5.2.3 Surface Water Fate and Modeling

#### *5.2.3.a Introduction*

Impacts to surface water quality by sources on the Coke Point Peninsula are of concern due to potential impacts on aquatic ecosystems. The Patapsco River, as an estuarine ecosystem and Class I water body, is of particular interest (Rust 1998). The magnitude of impacts and potential for adverse effects are dependent on the size of the inputs and on the fate of organic compounds and metals once they reach the surface water.

The potential mechanisms of transport of organic compounds and metals from the Coke Point Peninsula to the surrounding surface water include groundwater flow, which may introduce species of interest in the dissolved or particulate phase, and surface runoff, which would transport particulates derived from natural erosion processes. Due to the very low relief of the Peninsula, which results from its origins as landfill, surface runoff is unlikely to be a significant source. Groundwater is therefore assumed to be the primary transport mechanism.

Chemical constituents flowing from groundwater into the surface water environment are subject to changing chemical conditions that may cause them to undergo phase transformations that significantly impact their mobility. Various differences are expected at the transition from groundwater to surface water in the study area, including increases in the salinity and dissolved oxygen, and changes in pH. These may decrease or increase the solubility of the constituents of interest, causing them to precipitate or dissolve. Particle-associated constituents may be released from their host particles, and dissolved constituents may sorb onto the offshore sediments, which are likely quite different from those present in the aquifer. Some particulates may remain suspended, while others settle out into the bottom sediments. Organic compounds likely experience increased degradation rates in the higher-oxygen environment, and may also volatilize at the air-surface water boundary.

#### *5.2.3.b Organic Compounds in Surface Waters Surrounding Coke Point*

***MAHs –*** Surface water samples show detectable MAHs, with the highest concentrations in the northwestern portion of the Peninsula (**Table 4-1, Figure 4-1**), where groundwater MAH concentrations were also at their highest levels (**Figures 3-1 and 3-2**). The highest concentration of benzene in the surface waters (72 µg/L) detected in this study occurs at offshore location 5, and is only 10-100 times less concentrated than the nearby groundwater. In the graving dock (locations 1 and 2), apparent dilution factors between groundwater and surface water are 500-1000. Historic data on benzene in near-shore surface water (URS 2005b; **Table 4-3**) shows less dilution, with concentrations over 200 µg/L, corresponding to a groundwater-to-surface water ratio of approximately 10-20. The variation between the two sampling events suggests that hydrodynamic variations, possibly associated with tidal cycles, lead to variations in benzene

concentrations. In addition to dilution by mixing of groundwater with surface water, benzene concentrations may also decrease due to volatilization and biodegradation. To investigate how much of the decrease in concentration can be attributed to mixing rather than chemical processes, hydrodynamic modeling was used to calculate the expected concentrations in the absence of any chemical loss (see **Section 5.2.3.d** below).

***PAHs –*** PAH concentrations in surface water are highest in the Turning Basin, apparently sourced from the high-naphthalene groundwater plume under the Coal Tar Storage Area. The highest naphthalene concentration measured was 6.7 µg/L, approximately 500 times less concentrated than the nearby groundwater (**Figure 3-1**). Naphthalene concentrations greater than 3 µg/L were also found off the northwestern section of the Peninsula, with concentrations again approximately 500 times less than those measured in the groundwater plume extending south from the Benzol Processing Area.

### *5.2.3.c Metals in Surface Waters Surrounding Coke Point*

Metals were not analyzed in the surface waters surrounding the Peninsula. However, groundwater data and its distribution with relation to the shoreline can be used to evaluate the potential for surface water impacts. Similar analysis was used to determine which metals and shoreline segments to include in mass flux calculations (**Section 5.2.2.d**).

***Lead –*** Lead did not exceed the MDE groundwater standard in sections of the aquifers near the shore of the Peninsula. Therefore, its transport offshore should be minimal.

***Arsenic*** – Although groundwater arsenic concentrations were moderately higher than MDE standards along parts of the shoreline, arsenic is unlikely to reach significant concentrations in surface water. This is due to the small magnitude of its flux into the surface water (**Table 5-1**) and also due to arsenic's strong propensity to adsorb onto natural sediments in high-oxygen environments.

***Vanadium –*** Vanadium is present at concentrations exceeding MDE standards in groundwater along the shorelines, and is highly soluble in oxidizing environments. Therefore, detectable vanadium in offshore surface waters originating from high-vanadium groundwater may be expected. Because vanadium flux to surface water is much higher than that of arsenic and other metals, vanadium was the only metal included in the surface water modeling described below.

### *5.2.3.d Groundwater-Surface Water Modeling*

To assess the potential impacts of groundwater on the surrounding surface waters and Baltimore Harbor, the calculated fluxes of benzene, naphthalene, and vanadium (see **Section 5.2.2.d**) were input into a mixing model for groundwater and surface waters, incorporating local tidal dynamics. Details of the model are provided in **Appendix E**. The model was constructed using a grid that included all of Baltimore Harbor and Bear Creek upstream of a transect between North Point and Rock Point. The inputs from Coke Point Peninsula groundwater were modeled as conservative tracers (i.e. no chemical degradation or removal processes were considered);

therefore, the modeled concentrations represent maximum possible surface water values under the given hydrodynamic conditions. Initial concentrations of constituents in the surface water were assumed to be zero, due to the relatively low background concentrations; thus the results only reflect inputs from the Peninsula.

Contoured concentration plume maps showing the steady-state modeled levels of benzene, naphthalene, and vanadium in the surface water following 100 days of build-up are provided in **Figures 5-2 to 5-4**. Reflecting the locations of the primary mass fluxes, the highest modeled benzene concentrations are off the northwest portion of Coke Point Peninsula, while the highest naphthalene and vanadium concentrations occur off the eastern portion, in the Turning Basin. The benzene plume extends the farthest, due to its highest flux from groundwater, with the extent of naphthalene concentrations also exceeding those of vanadium. For example, the 1 µg/L naphthalene contour extends approximately as far from the Peninsula as the 10-12 µg/L contours for benzene and the 0.20 µg/L contour for vanadium. These relationships indicate that total flux is roughly proportional to extent in surface water, as the total naphthalene flux from the groundwater is also approximately 10 times less than the benzene flux, and the vanadium flux is another 5 times less than that of naphthalene (**Table 5-1**).

***Benzene*** **–** A comparison of modeled benzene concentrations (**Figure 5-2**) to benzene measurements in surface water from this and a historical study demonstrates the effect of variations in hydrodynamic conditions, especially in the graving dock. The modeled concentrations exceed measured concentrations from this study for benzene in surface water off the northwestern shore of the Coke Point Peninsula, where the benzene flux is highest, by approximately 5-10 times; in other areas around the Peninsula, it agrees more closely (within a factor of 2-3). However, the historical surface water benzene data (URS 2005b), for both the entrance to the graving dock and farther south, exceed the modeled results. This contrast likely reflects the inability of the model, although it is tidally dynamic, to represent the complex variations in hydrodynamic conditions that occur in this estuarine environment. These variations, as well as the potential losses of benzene by volatilization and degradation, likely determine whether benzene concentrations exceed the USEPA's recommended water quality criterion for benzene in seawater from which organisms are harvested for human consumption (51 µg/L) (USEPA 2009b). The modeled and historical benzene values exceed this level, but the measured levels in this study fall below it. Ultimately, the model does not indicate a major missing source of benzene, and therefore groundwater appears to be the primary source of benzene to surface water.

***Naphthalene*** **–** The modeled concentrations of naphthalene in the surface water (**Figure 5-3**) are of the same magnitude as the measured surface water concentrations. For example, the model shows a naphthalene concentration of 4-5 µg/L offshore from the Coal Tar Storage Area, in the northern portion of the turning basin, and measured concentrations in this area are up to 6 µg/L. In the graving dock, the modeled and actual concentrations are 1.9 µg/L and 0.7 µg/L. This suggests that naphthalene is acting as a conservative tracer (i.e. this key model assumption is true for naphthalene) and that groundwater is the main source of naphthalene to surface water.

***Vanadium –*** The maximum modeled vanadium concentration was 1-2 µg/L (**Figure 5-4**), within the Turning Basin directly offshore of the primary vanadium flux. This corresponds to the location of modeled naphthalene concentrations of 4-5 µg/L. Comparisons to actual values are not possible, as metals were not measured in surface water.

Although the USEPA does not provide surface water quality criteria for vanadium, the lowest metal criterion listed for seawater from which organisms will be harvested for consumption is for arsenic, at 0.14 µg/L (USEPA 2009b). Given the observed direct relationship between groundwater fluxes and modeled surface water concentrations, the current groundwater fluxes from Coke Point are unlikely to produce metals concentrations in excess of the USEPA's surface water quality criteria in the area around Coke Point. For example, the mass flux of arsenic was 0.05 times that of vanadium, suggesting that its maximum concentrations in surface water should be <0.1 µg/L, less than the water quality criterion. All other metals had lower groundwater fluxes and higher criteria values, and are therefore less likely to reach levels of concern. Thus, the vanadium modeling indicates that, although some metals reach high concentrations in the groundwater on the Coke Point Peninsula, contributions of most metals from the Peninsula to the surrounding surface waters should be negligible.

### 5.2.4 Offshore Sediment Fate and Partitioning Calculations

Impacted offshore sediments can have significant effects on benthic organisms and higher food chain organisms that feed on the benthos, and are also closely interrelated with the fate of constituents of interest in the surrounding surface and groundwater. Organic compounds and metals impacting the sediments may be sourced from onshore, by groundwater or overland transport, or may originate from offshore sources or be released into the offshore environment. In the offshore environment, the migration of constituents from sediments into surface water is largely dependent on their effective solubilities.

#### *5.2.4.a Organic Compounds in Offshore Sediments Surrounding Coke Point*

***MAHs –*** MAHs are detected primarily in subsurface sediments off the northwest portion of the Peninsula, and in the turning basin, offshore from the Coal Tar Storage Area (**Figure 4-7**). Compounds detected include benzene, ethylbenzene, and toluene. Higher concentrations of MAHs at depth than in surface sediments may result from input by groundwater, or may indicate a historical release of material containing MAHs to the offshore environment. MAHs in the surface sediments may also undergo dissolution into the overlying water column, or be biodegraded in the upper, oxygenated zone of the sediments.

***PAHs –*** PAH concentrations are substantially elevated above background levels in the sediments surrounding all sides of the Coke Point Peninsula (**Figures 4-8 and 4-9**). These elevated concentrations extend to the farthest samples collected, as much as a thousand feet from the shoreline. The percent contribution of naphthalene to total PAH levels is highest (up to 98 percent) off the northwestern section of the Peninsula, whereas it constitutes less than 39 percent of the total PAHs in the sediments offshore from the Coal Tar Storage Area, where the most naphthalene-concentrated groundwater occurs. Furthermore, the highest PAH concentrations

occur off the western and southern shorelines, whereas the highest groundwater PAH concentrations are along the eastern shoreline. This suggests that groundwater is not the primary source of PAHs to offshore sediments. Yet, the similarity of PAH fingerprints in the offshore and onshore samples indicates that the offshore PAHs are most likely derived from sources associated with industrial activities on the Peninsula. Thus, it appears that pyrogenic PAH-rich hydrocarbon material similar to that seen in the onshore investigation areas was also released offshore.

***Residual NAPL saturation calculations*** – The measured concentrations of organic constituents and sediment characteristics were used to evaluate the abundance of residual NAPL offshore, as was done for onshore soils (**Section 3.5**). The analytical results indicate the presence of widespread residual-NAPL-level impacts adjacent to and along the western and southern shores of the Peninsula (**Table 4-14**), corresponding to the areas of highest PAH concentrations in the sediments. Given their high PAH content, these residual-level NAPLs should be minimally soluble and largely retained in the sediments.

### *5.2.4.b Metals in Offshore Sediments Surrounding Coke Point*

Metal concentrations offshore from Coke Point are generally highest in the subsurface sediments off of the western and southeastern shores of the Peninsula. A suite of metals including arsenic, chromium, copper, lead, and zinc is elevated above background levels at many locations. Surface sediments with elevated zinc, chromium, and lead are present around the Peninsula, including in the turning basin, where subsurface metal concentrations are low.

As with the PAHs, metal concentrations in the offshore sediments appear to be decoupled from potential sources on land. The metals present in the sediments were not elevated in discharging groundwater, suggesting that if the metals originated from the Coke Point Peninsula, they were transported in a solid phase by overland flow or released by some other mechanism to the offshore environment. As observed with lead in the Benzol Processing Area, such transport is gradual, and the concentration of metals at depth within the sediments would require the solid phase transport to have occurred historically. Thus, it appears that most of the metals in the offshore sediments originated from a Peninsula source, likely through historical offshore release(s) of impacted material.

### *5.2.4.c Sorption Modeling*

Partitioning coefficients (see **Section 5.2.1.a**) for benzene and naphthalene were used to determine whether transfer of organic compounds from groundwater could be responsible for the observed concentrations in offshore sediments. If the concentrations of the compounds in offshore sediments are at equilibrium with the groundwater flowing offshore from the Peninsula, then the sediment impacts likely originate from the groundwater. Details of the sorption calculations and results are provided in **Appendix F**.

Equilibrium sediment concentrations were calculated based on organic carbon partitioning coefficients for each compound (Suthersan 1997), and the average fraction of organic carbon

present in each sedimentary deposit. The groundwater concentrations used were approximated based on nearby onshore measurements, assuming that groundwater concentrations of the compounds are not diluted or degraded as they flow offshore. Therefore the equilibrium calculations represent the maximum concentrations expected to be associated with groundwater transfer.

***Benzene*** **–** Sorption modeling of benzene showed an inconsistent relationship between actual sediment concentrations and those expected at equilibrium with nearby groundwater. For many samples, the actual concentration was less than the equilibrium value. Thus, some benzene was most likely lost to dilution, volatilization, or degradation. This result agrees with surface water modeling. Without knowing the magnitude of this loss, it is not possible to evaluate the likelihood of additional sources of benzene to sediments, in addition to groundwater.

***Naphthalene*** – Actual concentrations of naphthalene in offshore sediments often exceed the values expected at equilibrium with groundwater. This was particularly true along the western and southeastern shores of the Peninsula, and indicates that groundwater is not the primary source of naphthalene to the offshore sediments in these areas. In contrast, given that naphthalene concentrations in surface waters along the shoreline are undersaturated and below equilibrium values expected given the sediment concentrations, the offshore sediments are likely a source of naphthalene to offshore waters. Thus, the sorption modeling provide further evidence that the offshore naphthalene, although related in origin to the onshore NAPLs, was most likely released directly offshore via a surface route, rather than transported by groundwater.

### 5.2.5 Mass Distribution of Organic Constituents

The total mass of organic constituents was calculated for the environmental media discussed above (NAPL, groundwater, soils, and sediments), to evaluate the current relative abundance of constituents in the onshore and offshore environments. Details of the calculations are provided in **Appendix C**. Results are shown in **Figure 5-5**. The largest mass of organic constituents occur in offshore sediments (41 percent), followed by onshore soils (33 percent), onshore mobile NAPL (15 percent), and groundwater (11 percent).

The mobile NAPL mass was determined in the Benzol Processing Area, based on the footprint and thickness of NAPL calculated from gauging results (**Section 3.4.1**). The NAPLANAL saturation results (**Sections 3.5 and 4.5.1; Appendix C**) were used to calculate the total mass of organic constituents in soils in the onshore investigation areas, and in offshore sediments. Groundwater mass of benzene, toluene, and naphthalene was estimated using the measured concentrations of these compounds in highly-impacted regions of the shallow and intermediate aquifers (**Section 3.1)**. The sum of the masses of benzene, toluene, and naphthalene was assumed to approximate the total organic mass in the aquifers, as they are the most abundant organic compounds measured in the Peninsula groundwater. The mass in surface waters was not calculated, due to the diffuse nature and low concentrations of organic constituents in this medium, and because surface water impacts result from transport from the other media.

## 5.3 GENERAL CONCEPTUAL SITE MODEL

**Figure 5-6** schematically illustrates the generalized conceptual site model (CSM) of current conditions at the Coke Point Peninsula. The CSM is based on observed findings as well as the above deductions regarding the fate, persistence, and migration of constituents of interest. MAHs originate primarily in mobile and residual LNAPLs in the Benzol Processing Area. PAHs, in particular naphthalene, originate in residually entrapped DNAPLs in the in the Coal Tar Storage Area, and to a lesser extent in the LNAPLs of the Benzol Processing Area. In NAPL form, MAHs and light-end PAHs (e.g., naphthalene) are soluble, and gradually dissolve into flowing groundwater. Although some biological degradation of these constituents has occurred in the shallow and intermediate aquifers, current anoxic conditions in groundwater allow MAHs and light-end PAHs to persist and flow from the subsurface of the Peninsula into the surface water. This has produced detectable levels of benzene (tens of µg/L) in the near-shore surface water off the northwestern portion of the Penninsula. However, modeled and measured results indicate that benzene levels fall below USEPA criteria in the distal offshore (>200 ft) environment. MAHs are less highly and consistently elevated (relative to background samples) than PAHs in the offshore sediments. Although some benzene from groundwater flowing into the subsurface adsorbs to the sediment, dissolution, degradation and volatilization have presumably resulted in lower overall sediment benzene concentrations. The primary source of the benzene in surface waters, thus, appears to be transport from onshore sources.

Mobile PAHs on the Peninsula originate primarily in residual DNAPLs, and secondarily in mobile and residual LNAPLs. Naphthalene is the most abundant PAH in groundwater, but it is present at concentrations much lower than those seen for benzene. From the aquifers, naphthalene discharges to the surface water, sometimes flowing through the offshore sediments. These sediments have been impacted by PAH-rich NAPL from a source not related to groundwater, and have very high concentrations of naphthalene relative to what would be expected from transport of dissolved phases. Although some additional naphthalene may dissolve from these sediments, its low solubility makes naphthalene unlikely to reach toxic levels in the surface water (no regulatory criteria are available for naphthalene in surface waters). However, disturbance of offshore sediments may cause PAHs to be released into the water column.

The primary sources of metals on the site are the highly heterogeneous solid components of the onshore slag. Soluble phases containing vanadium, arsenic, and lead dissolve from their primary phases, and move through the groundwater either in the dissolved phase or adsorbed onto other solid particles. The overall flux of metals to groundwater is much lower than that of the primary organic constituents, with vanadium having the highest flux among metals, followed by arsenic. Upon flowing from the aquifer into the surface waters, metals are diluted to concentrations expected to be lower than applicable surface water criteria. Some metals from groundwater may be sequestered in offshore sediments. However, as with PAHs, most metals in the offshore sediments appear to originate from historical release(s) of impacted fine-grained sediments from the Peninsula to the offshore environment.

In order to protect offshore environments from further degradation and reduce human health and ecological exposure risks, response actions would be required to address three key environmental media: NAPL (the primary source of MAHs to the offshore environment), groundwater (the main transport medium of MAHs to offshore surface water), and offshore sediments (a large reservoir of PAHs and metals). Chapter 6 outlines potential remedial alternatives that would eliminate the NAPL source, cut off or remediate the groundwater, and isolate or remove the most impacted sediments.


Site Assessment for Proposed Coke Point Dredged Material Containment Facility at Sparrows Point

**Legend**

Groundwater Mass Flux Boundary

Area of Concern

Sources
ESRI, i-cubed, GeoEye, 2009
Tele Atlas North America Inc., ESRI, 2006

Feet
0 500 1,000

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.


H:\projects\1453406\MXD\2009_Report\Figure 5-1

**Figure 5-1. Location of Groundwater Mass Flux Boundaries**

Site Assessment for Proposed Coke Point Dredged Material Containment Facility at Sparrows Point

**Legend**

Benzene Isoconcentration Contour

Sources
ESRI, i-cubed, GeoEye, 2009
Tele Atlas North America Inc., ESRI, 2006

Feet
0 2,000 4,000

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.


H:\projects\1453406\MXD\2009_Report\Figure 5-2

**Figure 5-2. Modeled Benzene Concentrations (µg/L) in Surface Water**


# Site Assessment for Proposed Coke Point Dredged Material Containment Facility at Sparrows Point

**Legend**

Naphthalene Isoconcentration Contour

Sources
ESRI, i-cubed, GeoEye, 2009
Tele Atlas North America Inc., ESRI, 2006

Feet
0 1,000 2,000

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.


H:\projects\14534061MXD\2009_Report\Figure 5-3

**Figure 5-3. Modeled Naphthalene Concentrations (µg/L) in Surface Water**

Site Assessment for Proposed Coke Point Dredged Material Containment Facility at Sparrows Point

**Legend**

Vanadium Isoconcentration Contour

Sources
ESRI, i-cubed, GeoEye, 2009
Tele Atlas North America Inc., ESRI, 2006

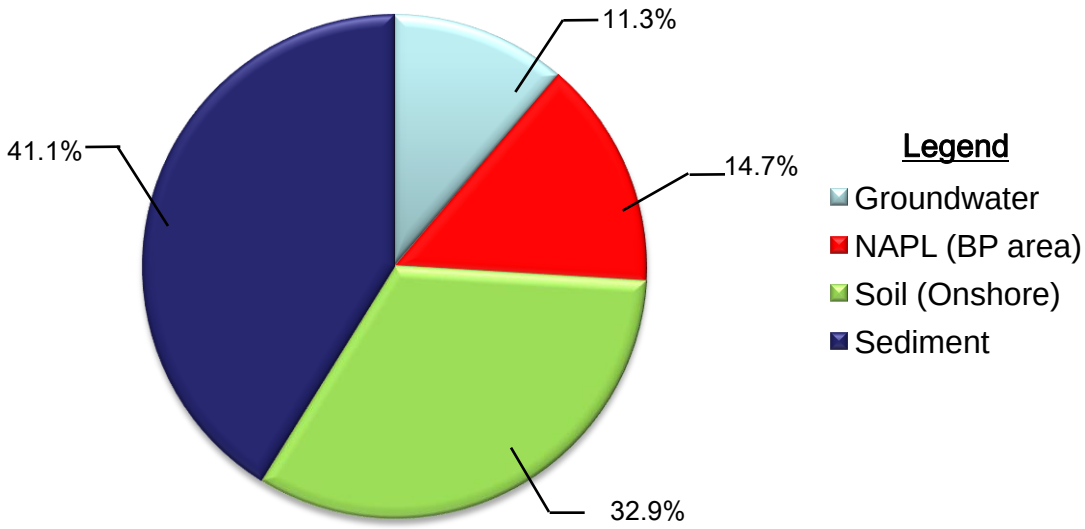
Feet
0 1,000 2,000

EA ENGINEERING, SCIENCE, AND TECHNOLOGY, INC.


H:\projects\1453406\MXD\2009_Report\Figure 5-4

Coke Point Peninsula
1.5
1.0
0.6
0.4
0.2
0.2
0.1
Patapsco River

**Figure 5-4. Modeled Vanadium Concentrations (µg/L) in Surface Water**




Note: 1) Supporting calculations shown in Appendix E.
2) Surface water mass not calculated because insignificant relative to other media and also because its impacts are a result of mass transfer from other compartments shown.

**Figure 5-5. Organic Constituent Mass Distribution.**

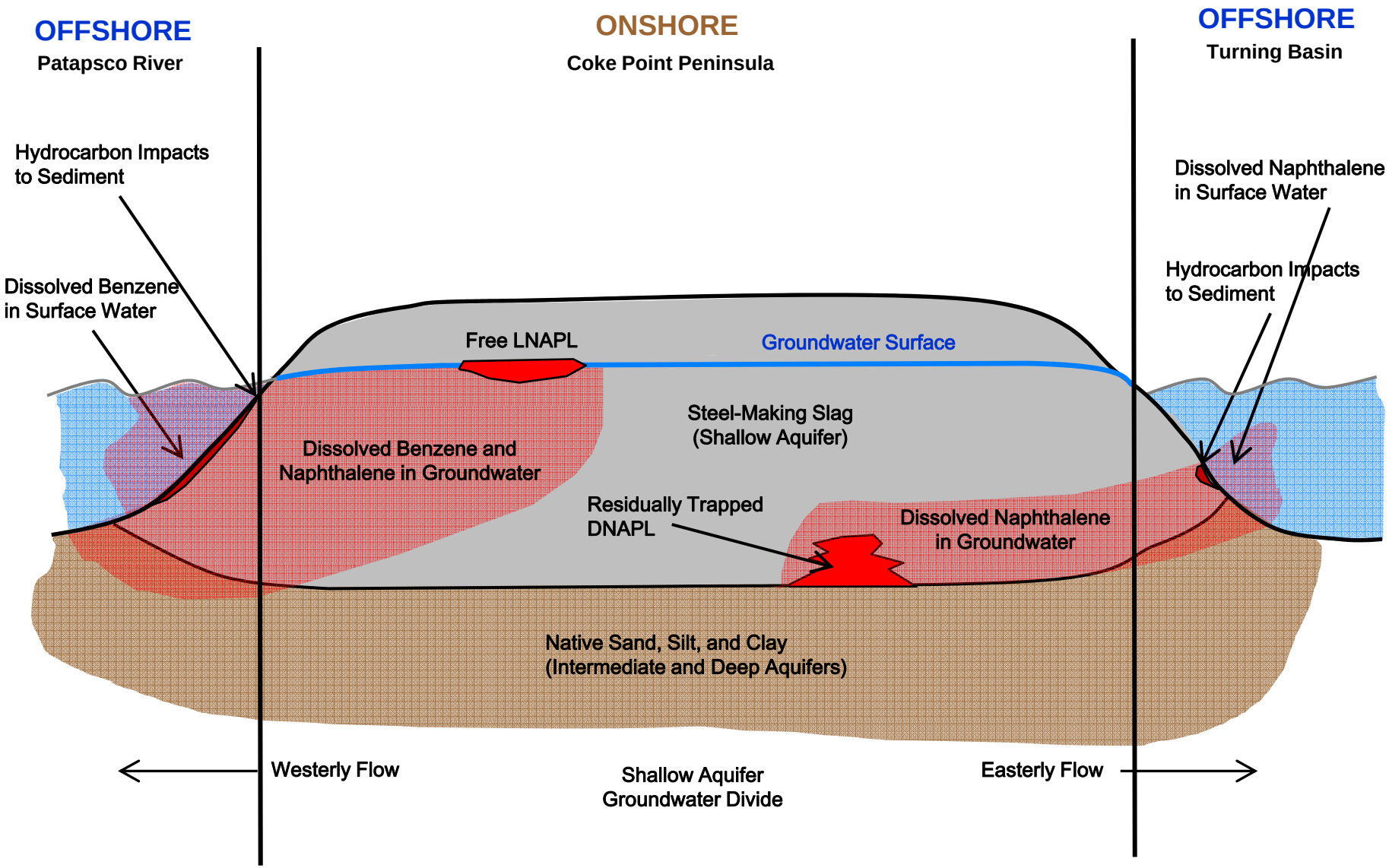



**Figure 5-6. Conceptual Site Model of Current Conditions**
**Coke Point Peninsula, 2009**

## Table 5-1. Mass Flux of Benzene, Naphthalene, Vanadium, and Arsenic

**Sparrows Point Site Assessment (2009)**

| Analyte | Section | Aquifer | Mass Flux (g/s)[1] | Mass Flux by Section (g/s) | Total Mass Flux (g/s) |
|---|---|---|---|---|---|
| ***Organic*** | | | | | |
| **Benzene** | Northwest | Shallow | 0.087 | 0.32 | 0.32 |
| | | Intermediate | 0.23 | | |
| | East | Shallow | 0.0026 | 0.0026 | |
| **Naphthalene** | Northwest | Shallow | 0.0062 | 0.0074 | 0.028 |
| | | Intermediate | 0.0012 | | |
| | East | Shallow | 0.020 | 0.020 | |
| ***Inorganic*** | | | | | |
| **Vanadium** | Northwest | Shallow | 0.00017 | 0.00020 | 0.0055 |
| | | Intermediate | 0.000027 | | |
| | East | Shallow | 0.0053 | 0.0053 | |
| **Arsenic** | Northwest | Intermediate | 0.00028 | 0.00028 | 0.00028 |

[1] g/s = grams per second

# 6. SUMMARY OF PRELIMINARY EVALUATION OF REMEDIAL TECHNOLOGIES

As part of this Site Assessment for a proposed DMCF at Sparrows Point, EA performed a preliminary evaluation of potential remedial technologies and process options (hereinafter "Remedial Options") that could be implemented as corrective measures to address the environmental site conditions described in Chapters 3, 4, and 5 of this Site Assessment. The preliminary evaluation identifies potential Remedial Options, describes those Remedial Options, and makes certain recommendations regarding the technical feasibility, implementability, and cost of the Remedial Options. However, since MPA is still currently deliberating those Remedial Options, this summary will only identify and describe the Remedial Options evaluated, and indicate that certain Remedial Options have been screened out.

On the other hand, it is important to note that this preliminary evaluation indicates that there are several Remedial Options that would be feasible, implementable, and effective corrective measures for the environmental conditions discussed in this Site Assessment. In particular, capping and containment remedies would be very effective at mitigating environmental impacts to offshore sediments and onshore subsurface media and could be seamlessly implemented with the DMCF construction.

While the preliminary screening evaluation performed by EA was not intended to serve as a Corrective Measures Study (CMS) that will likely be necessary as part of the future RCRA enforcement actions for the Site, it does provide sufficient detail to form the foundation for a future CMS. The preliminary evaluation is broad in its scope, considering Remedial Options for each medium of concern identified in Chapters 3, 4, and 5 of this Site Assessment (namely NAPL, groundwater, slag fill material, and sediments). The preliminary evaluation also utilizes standard RCRA factors in its initial assessment, including, protectiveness of human health and the environment, compliance with applicable laws and standards, effectiveness, implementability and cost. The preliminary evaluation also assesses the compatibility of the Remedial Options with the future use of the site as a DMCF.

## 6.1 IDENTIFICATION AND SCREENING OF POTENTIAL REMEDIAL TECHNOLOGIES

Using information obtained from former investigations (including this Site Assessment), the preliminary evaluation assesses Remedial Options that could be implemented as corrective measures, or part of a corrective measure, to address onshore and offshore environmental conditions. The Remedial Options evaluated by EA are graphically summarized in **Figure 6-1**. Each of the Remedial Options evaluated by EA is described in the following sections.

### 6.1.1 NAPL

At this site, NAPL exists both as a mobile and residual LNAPL in the Benzol Processing Area, and as residually entrapped DNAPL in the Coal Tar Storage Area. Both of these areas of product should be addressed with source removal or source containment to prevent them from remaining as a continuing source of contamination to groundwater. Two different remediation

technologies, free phase product recovery and enhanced product recovery, were evaluated to address LNAPL and DNAPL impacts.

***6.1.1.a Free Phase Product Recovery Technologies***

***Product Skimming*** is an in-well process where LNAPL or DNAPL is skimmed from the top and bottom of the aquifer, respectively, and collected for reuse or disposal. Aquifer drawdown can be used to accelerate product skimming.

Product skimming was ruled out for use as a potential Remedial Option at the Coke Point Peninsula for several reasons. First, product skimming is a slow process, one that is not conducive to the accelerated cleanup schedule that would support future use of the site as a DMCF. Because of the LNAPL occurrence in the Benzol Processing Area, other technologies discussed below would be more effective at accelerated product removal. In addition, DNAPL observed in the southwestern portion of the Coal Tar Storage Area is residually bound. Product skimming would not be an effective technology for DNAPL removal from this area.

***Multiphase Extraction*** is a process that uses a high-vacuum system to remove various combinations of impacted groundwater, separate-phase petroleum product, and hydrocarbon vapor from the subsurface. In general, this process option would accelerate contaminant removal relative to traditional product recovery (e.g., product skimming). Multiphase extraction generally will slightly lower the water table around the well while also producing a pressure gradient for extracting NAPL, groundwater, and vapor. Organic constituents in the vadose and saturated zones would be mobilized to the well for extraction and recovery. Once above ground, the extracted vapors, liquid-phase organics, and groundwater would be separated and treated.

Multiphase extraction was retained as a potential Remedial Option for the Coke Point Peninsula because of its applicability to address free LNAPL in an accelerated timeframe, and because it is a proven technology with equipment that is readily available. Observed LNAPL contains a significant amount of volatile constituents; thus, vapor-phase extraction has merit. In addition, residual saturation of DNAPL observed in the Coal Tar Storage Area could be more effectively reduced by this process option than by traditional product recovery.

***6.1.1.b Enhanced Product Recovery Technologies***

***Surfactant Enhanced Product Recovery*** is a process that facilitates NAPL and groundwater cleanup through the addition and recovery of non-toxic food-grade surfactants to NAPL-impacted regions of the subsurface. This Remedial Option would increase the mobility and/or solubility of organic constituents in the NAPL, groundwater, and sorbed phases in the treatment zone. Surfactants would facilitate the entrainment of hydrophobic compounds (e.g., NAPL and organic contamination to other media) to effectively remove (to ultra-low residual levels) multiphase organic materials. The timeframe for most surfactant enhanced recovery projects is weeks to months, a relatively fast timeframe compared to other NAPL cleanup technologies. The implementation of surfactant-enhanced recovery requires the injection of surfactants into the subsurface, followed by recovery of NAPL and surfactants (for recycling and reinjection).

While this Remedial Option has limitations related to its implementability in the field, and residual impacts, it was retained as a potential Remedial Option for the Coke Point Peninsula

because of its applicability to addressing NAPL cleanup and its ability to achieve better cleanup endpoints (than traditional product recovery) in an accelerated timeframe.

***Co-Solvent Enhanced Recovery*** is similar to surfactant enhanced recovery, in the delivery of reagents and mechanisms for NAPL removal. However instead of surfactants, co-solvents (e.g., primary alcohols) are used in place of (or in conjunction with) surfactants. The co-solvent is used to enhance the solubility of the organic compounds, thus quickening the pace of mass recovery in a dissolved form in recovered groundwater; a process referred to as enhanced NAPL solubilization. The main co-solvents being considered for environmental applications are water-miscible alcohols.

Co-solvent enhanced recovery was ruled out as a potential Remedial Option for the Coke Point Peninsula for several reasons. First, the process of NAPL solubilization used in co-solvent enhanced recovery would be slow and costly. Surfactant enhanced recovery usually can be accomplished in one third of the time (and at about half the cost) compared to co-solvent enhanced recovery. In addition, the reliance on NAPL solubilization may exacerbate groundwater impacts if the co-solvent injection and recovery treatment cell is not hydraulically contained.

### 6.1.2 Groundwater

On the Coke Point Peninsula, impacts to shallow groundwater include a benzene and toluene plume emanating from the Benzol Processing Area that has migrated in a westerly and northwesterly direction toward the Patapsco River, and a dissolved naphthalene plume emanating from the Coal Tar Storage Area that has migrated in an easterly direction toward the Turning Basin. Two plumes of dissolved vanadium and some occurrences of high arsenic groundwater have also been detected. However, calculations indicate that metals are not present at sufficiently high concentrations to cause negative impacts to surface waters; therefore, targeted remediation of metals was not considered. Technology options for groundwater remediation at the Coke Point Peninsula include groundwater containment to prevent intrusion of dissolved constituents into the surface water and enhanced bioremediation for *in-situ* groundwater treatment.

#### ***6.1.2.a Groundwater Containment Technologies***

***Slurry Wall Containment*** typically consists of a vertically excavated trench filled with a semi-liquid mixture of soil, bentonite, and water. The slurry hydraulically shores the trench to prevent collapse and forms a low permeability zone to reduce groundwater flow through the trench. Slurry walls often are used to contain lateral flow of impacted groundwater when the source mass is too large for (or not conducive to) direct treatment.

Slurry wall containment was retained as a potential Remedial Option at the Coke Point Peninsula to divert impacted groundwater to one or more relatively small areas where it could be effectively treated. In any slurry wall scenario that would be used at this site, predictive groundwater modeling would be necessary to evaluate how future placement of dredged material would affect conditions of groundwater flow. Modeling would ensure that slurry walls and

associated hydraulic controls or groundwater treatment zones would be placed downgradient in the modified hydrologic regime.

***Groundwater Pump and Treat*** generally entails extraction and *ex situ* treatment of impacted groundwater. Groundwater would be extracted from recovery wells installed within or at the perimeters of groundwater plumes at rates high enough to prevent water from migrating from the site. Well placement is often determined using groundwater modeling to identify the location, spacing, and flow rates required to maintain hydraulic control. Extracted water would require treatment for removal of the constituents of concern prior to return to the subsurface or before discharge. Water treatment for volatile organics could include air stripping, thermal oxidation, or granular activated carbon.

Groundwater pump and treat was not retained as Remedial Option for the Coke Point Peninsula because it would not likely be implementable at the site. The anticipated high flow volumes would require construction of an excessively large treatment system; in addition, the timeframe required to treat groundwater using this technology is excessively long, making it less protective of human health and the environment, too costly, and inconsistent with future site development as a DMCF.

#### ***6.1.2.b Enhanced Bioremediation Technologies***

Bioremediation is a remedial technology that stimulates the biodegradation of environmental pollutants. Specifically, the addition of electron acceptors and nutrients to the subsurface can enhance the biodegradation of organic constituents.

***Aerobic Bioremediation*** adds oxygen into groundwater to stimulate degradation of organic constituents such as the types of aromatic hydrocarbons found at the site. Biodegradation, a process in which microorganisms break down organic constituents found in soil and/or groundwater, would be enhanced by injecting oxygen throughout a portion of groundwater plumes exhibiting impacts from organic constituents. The organic constituents (e.g., benzene, toluene, and naphthalene) observed in groundwater at the site readily biodegrade given sufficient dissolved oxygen as an electron acceptor in biodegradation reactions. Aerobic bioremediation was retained as a potential Remedial Option for groundwater treatment, and could possibly be used in conjunction with slurry wall containment.

### 6.1.3 Slag Fill Material

As discussed in Chapter 3, areas of slag fill material impacted with MAHs and PAHs were encountered during source delineation at the Benzol Processing Area and Coal Tar Storage Area. To address these constituents of concern, potential Remedial Options evaluated for slag fill remediation included capping to isolate impacted fill material, and thermal treatment to remove organic constituents.

#### ***6.1.3.a Capping***

Capping refers to the placement of a covering or cap of clean material over waste material (e.g., a controlled or uncontrolled landfill) or impacted soil that remains in place. The purpose of a cap is to isolate the impacted material, thereby eliminating exposure and reducing leaching due to

infiltration. Cap designs can include low-permeability barriers such as synthetic geotextiles and liners, as well as native materials.

***DMCF Capping*** would entail placement of low permeability dredged material over the existing land surface onshore. The onshore slag material would be capped by the designed thickness of approximately 25 to 30 ft of low permeability dredged material that would be placed over time as the DMCF was filled with dredged material. Consolidated fine-grained dredged material has a permeability in the range of $10^{-7}$ to $10^{-10}$ cm/s (Palmero and Averett 2000), which would effectively limit infiltration of groundwater to the impacted slag.

The DMCF capping process was retained as a potential Remedial Option for the Coke Point Peninsula because it would adequately protect against further environmental impacts to groundwater from onshore fill material, and it could be implemented seamlessly with the construction of the DMCF.

***Engineered Capping*** includes placement of low-permeability geotextiles, liners, or clay material that would be brought onto the site and placed over the existing land surface. Similar to DMCF capping, the purpose of the engineered cap would be to reduce infiltration and potential leaching of source material to groundwater. This technology would require long-term maintenance to be effective.

The engineering capping was retained as a potential Remedial Option for the Peninsula because it also would protect against further environmental impacts to groundwater from onshore fill material. However, though the engineered cap is an implementable remedy, it would not necessarily be compatible with future use of the Peninsula as a DMCF.

***6.1.3.b Thermal Treatment Technology***

Thermal treatment technologies address removal or destruction of organic constituents through the heating of impacted media to cause volatilization, desorption, or pyrolysis. Available technologies can range in treatment temperatures from thermal desorption (approximately 200 to 1,200 $^{o}$F) to incineration (1,500 $^{o}$F and above). Thermal desorption technologies can be applied *in situ* or *ex situ* as needed. Based on the organic constituents noted in Chapter 3, low temperature methods are the most appropriate for this site. Two process options for thermal treatment of organic constituents in slag fill material are discussed below.

***Electrical Resistance Heating*** uses an electrical current to mass heat subsurface soils to an approximate temperature of 100ºC. This process option has been used to specifically target low permeability soils or fill materials, such as clays and fine-grained soils. Water and organic constituents released by vaporization during heating will migrate to relatively conductive subsurface regions, where they will be recovered via wells by vacuum extraction. Heating electrodes are placed directly into the soil or fill and activated so that electrical current passes through the electrodes, creating resistance, which then heats the material. The heat will dry out the soil, causing it to fracture. These fractures make the soil or fill material more permeable, allowing the use of vapor extraction to remove the steam and vaporized liquids. The heat created by this process also forces trapped liquids to vaporize and move to the steam zone for removal via the extraction wells.

Electrical resistance heating was ruled out as a potential Remedial Option for the slag fill material on the Coke Point Peninsula because, based on the size of the highly impacted regions of the site (about 20 acres), it would be cost prohibitive. In addition, residual LNAPL and DNAPL occurrences in the Benzol Processing Area and Coal Tar Storage Area, respectively, contain a significant fraction of non-volatile components that cannot be vaporized or efficiently mobilized at the temperatures utilized for electrical resistance heating. Finally, these temperatures may not be attainable by resistance heating due to the low resistivity of metals (e.g, iron) present in the fill material.

***Ex-situ Thermal Desorption*** is a process option that would involve excavation of impacted material followed by treatment through heating to volatilize organic constituents. *Ex situ* thermal desorption has been successfully used to remediate soils containing coking operations wastes, including MAHs and PAHs. The technology would be applied onsite with a mobile unit or at an offsite facility. This potential Remedial Option was not retained for further evaluation because it was considered not implementable due to the volume of material to be treated, the need to control/treat off gases, and the energy intensive nature of operations.

### 6.1.4 Sediment

Areas of impacted sediment were identified on the eastern and southern shores of the site, and within the turning basin. The sediment was found to contain chromium, lead, zinc, other metals, NAPL sheens, and PAHs. To address these constituents of concern, technologies evaluated for sediment remediation included capping/containment, dredging, and solidification.

#### ***6.1.4.a Capping***

Offshore capping refers to the placement of a subaqueous covering or cap of clean material over impacted sediment that remains in place (USEPA 2005). Offshore caps are generally constructed of granular material, such as clean sediment, sand, or gravel. A more complex cap design can include geotextiles, liners, and other permeable or impermeable elements in multiple layers that may include additions of material to attenuate the flux of organic carbon constituents. Offshore capping can quickly reduce exposure to impacted materials and, compared to dredging or excavation, requires less infrastructure in terms of material handling. Depending on the sediment environment and impacts, a cap is designed to reduce risk via the following mechanisms:

- Physical isolation of the sediment,
- Stabilization of sediment and erosion protection of sediment and cap, and
- Chemical isolation of sediment.

To prevent access to offshore impacted sediments, ***DMCF Capping*** would contain sediments within dikes built onshore and offshore as containment for the DMCF. The offshore sediment would be capped by low permeability dredged material and remain contained within the dikes constructed for the DMCF. If this process option were to be implemented, the dikes would be aligned to surround the areas of impacted sediments. The DMCF capping/containment process was retained as a potential Remedial Option for the Coke Point Peninsula because it would

adequately protect against further environmental impacts related to offshore sediments, and it could be implemented seamlessly with the construction of the DMCF.

***Offshore Impermeable Capping*** is a process option considered for containing impacted sediments. In this process option, a layer of low-permeability material (e.g., bentonite clay) would placed offshore at a thickness of up to 5 feet to isolate impacted sediments. As with DMCF capping/containment, an offshore impermeable cap would reduce exposure to sediment and mobility of constituents within the material.

This technology would require long-term maintenance (due to potential for erosion) to be effective. Also, the relatively shallow depth of the barrier that would result if this process option were implemented would likely impinge on future use of the site as a potential marine terminal that would require access channels and deep berths. Nevertheless, an offshore impermeable cap was retained as a potential Remedial Option for the Coke Point Peninsula because it adequately protects against environmental impacts from and exposure to impacted sediments.

#### *6.1.4.b Dredging*

***Dredging Removal*** is a process option where impacted sediments are removed from a water body for contained placement on land. In this case, since MPA is contemplating developing the site as a DMCF, the dredged material would be removed from the water body and be placed in the onshore DMCF. Dredging/Removal would transfer contaminated sediment from the water body to a proposed onsite upland DMCF, reducing the overall dredged material capacity at the facility for Harbor sediments. Dredging and DMCF placement was retained as a potential Remedial Option for further evaluation because it is technically practical and would remove impacted sediments from the waterway, eliminating the potential for future long-term adverse impacts in the aquatic environment.

#### *6.1.4.c In-Situ Stabilization/Solidification*

***In-Situ Stabilization/Solidification*** is a process in which the constituents are physically bound or enclosed within a stabilized mass (solidification), or chemical reactions are induced between the stabilizing agent and constituents to reduce their mobility (stabilization). *In-situ* stabilization/solidification was not retained as a potential Remedial Option for the Coke Point Peninsula because it is not considered implementable over the area of concern.

## 6.2 SUMMARY OF THE SCREENING EVALUATION

EA conducted a preliminary screening level evaluation of potential Remedial Options that could be implemented to address the environmental conditions identified in this Site Assessment. (See **Figure 6-2,** an aerial illustration of potential areas of concern and response areas). As part of its evaluation, EA considered the Remedial Options with regard to future development of the Coke Point Peninsula as a DMCF. The evaluation demonstrated that several Remedial Options should be retained for further analysis and consideration, including, but not limited to, DMCF capping of onshore fill and offshore sediment, which could effectively address environmental concerns at the site and be implemented seamlessly with DMCF construction. For the reasons noted in Chapter 6 above, some of the Remedial Options were screened out during this initial evaluation. Those that remain are protective of human health and the environment and are compatible with

DMCF construction and use. A summary of the Remedial Options preliminarily evaluated, and those screened out, is provided in **Figure 6-1**.

In conclusion, it is important to stress the preliminary nature of the evaluation in Chapter 6 of this Site Assessment, and the fact that the MPA has not finished its executive deliberations on the Remedial Options under consideration, or on other matters related to acquiring a portion of the Sparrows Point Property. Once MPA's internal deliberations are complete, it anticipates that any recommendations arising from its deliberations would be shared and discussed with the DMPP Harbor Team. Further, any Remedial Options that could ultimately serve as corrective measures at the site will need to be further evaluated within the framework of the RCRA CMS process in accordance with MDE and US EPA review and concurrence.

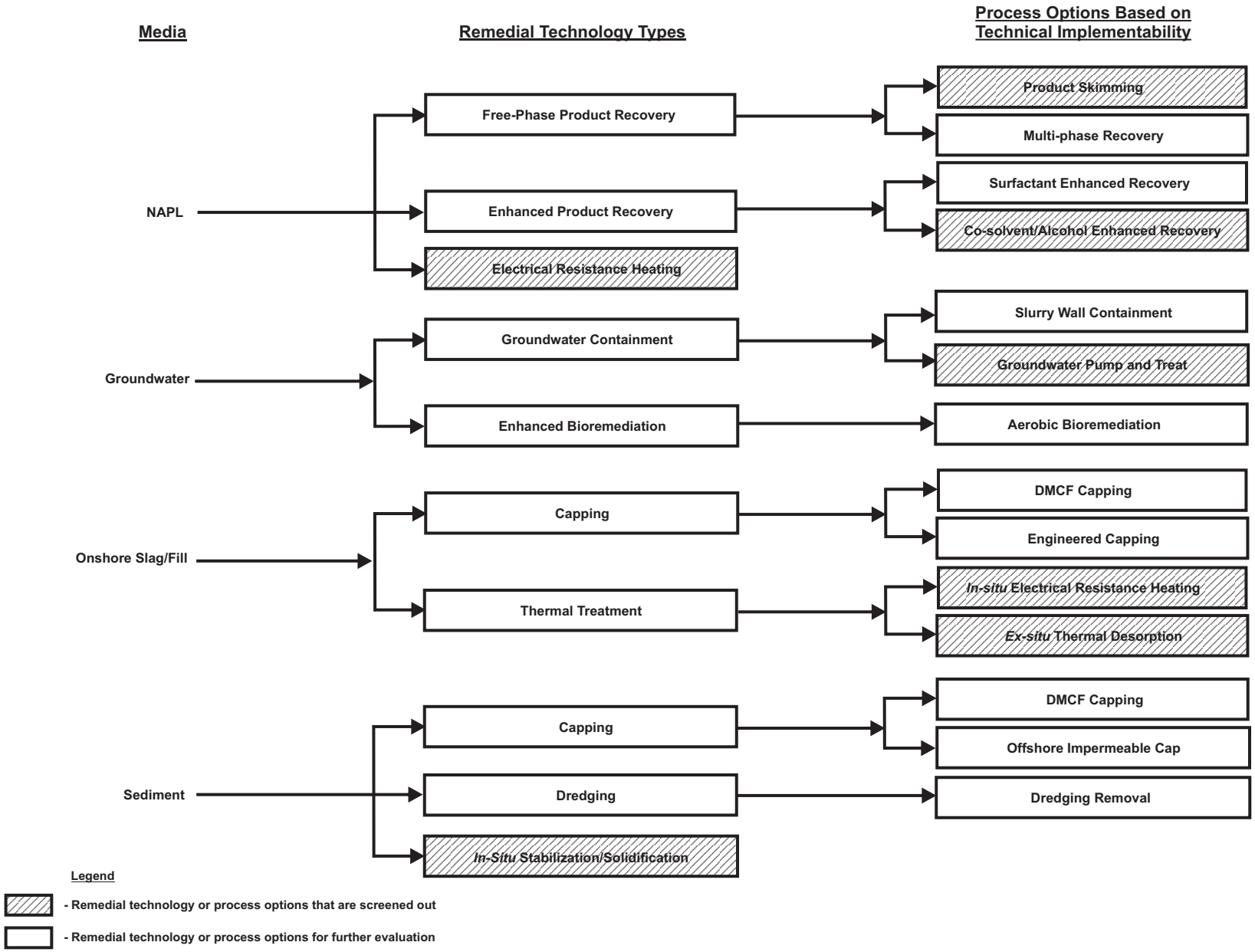



**Figure 6-1. Remedial Technology Screening Process.**

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Site Assessment for Proposed Coke Point Dredged Material Containment Facility at Sparrows Point

**Legend**

- Downgradient Groundwater Response Zones
- Onshore Areas of Concern
- Offshore Response Areas
- Potential NAPL Response Areas

Sources
ESRI, i-cubed, GeoEye, 2009
Tele Atlas North America Inc., ESRI, 2006

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**Figure 6-2. Areas Potentially Requiring Environmental Response Actions**

# 7. CONCLUSIONS AND RECOMMENDATIONS

A field investigation of the Coke Point Peninsula at Sparrows Point was conducted between March and June 2009 to determine the potential environmental liability associated with transfer of the property to MPA for potential construction of a DMCF at the Coke Point Peninsula. The investigation, which was conducted as part of an overall Site Assessment, included onshore sampling and analyses of slag fill material, groundwater, and hydrocarbon product to characterize areas of observed legacy impacts resulting from historic practices. Specifically, the areas of legacy impacts targeted for investigation included storage, processing, and recycling locations of coke-production wastes associated with steel making. The observed impacts resulted from historic release(s) to the surface and/or subsurface.

The field investigation included onshore and offshore components to characterize the nature and extent of impacts to fill material, surface water, surface sediment, and subsurface sediment. The onshore investigation was primarily focused on delineating and characterizing mobile and residual NAPL within areas previously identified through groundwater sampling as heavily impacted by hydrocarbons (the Benzol Processing Area, Coal Tar Storage Area, and Graving Dock Area). The offshore investigation was focused on surface water and sediment adjacent to the Coke Point Peninsula in the Patapsco River and the Turning Basin. The primary objective of the offshore investigation was to assess the effects of historical uses at the site, along with impacted groundwater fluxes, on the quality of the adjacent surface water and sediment.

Field methods used in each investigation included drilling, field screening, and analytical sampling (VOCs, metals, and PAHs, as well as PAH fingerprinting) of subsurface material. The onshore investigation also included installation of NAPL monitoring wells that were used for gauging, recovery tests, and chemical analysis of observed NAPL. The offshore investigation also collected surface water and surface sediment samples for VOC, PAH, and metals analysis. These data were used along with groundwater and surface water results from previous investigations to provide a comprehensive synthesis that assessed the sources, fate and transport, and Remedial Options consistent with the protection of the environment, as well as with MPA's potential use of the site.

The onshore investigation yielded information indicating that a region of the subsurface contains hydrocarbon product floating on groundwater that is contributing to offshore impacts and must be addressed in eventual cleanup actions. The investigative data additionally indicated a zone of dense hydrocarbon product existing below groundwater, though it appears to be trapped in a limited area of the subsurface and is probably not recoverable. In addition to these hydrocarbon products, concentrations of chemicals of concern (both organic compounds and metals) in subsurface slag fill material and groundwater also exceeded background concentrations and/or applicable regulatory standards.

Offshore data indicated that impacted groundwater fluxes from northwestern and eastern parts of the Peninsula to the adjacent Patapsco River and Turning Basin have negatively affected surface water quality. In addition, sediment quality is substantially impaired adjacent to most of the Peninsula shoreline, and concentrations of PAHs and metals are elevated above average background levels. This is true in areas where steelmaking slag was historically placed in the

river environment and also in other offshore areas where slag fill material was not detected in boring logs.

Environmental forensics analyses were performed to chemically fingerprint the industrial source of environmental impacts documented in offshore sediments. Onshore analyses were conducted for comparison to the chemical signature of offshore sediments. The forensics analyses suggest that offshore sediment impacts are related to historical offshore release(s) of steel-making byproducts from Sparrows Point.

A preliminary screening level evaluation of Remedial Options was conducted to address NAPL, groundwater impacts, slag fill impacts, and sediment impacts. In the evaluation, Remedial Options that were incompatible with site conditions and potential future use as a DMCF were screened out. Remedial technologies carried forward for further evaluation in a later step include:

- ***Onshore NAPL Removal*** - *Multi-Phase Extraction* (removal of impacted groundwater, separate-phase petroleum product, and/or hydrocarbon vapor using a high-vacuum system) and *Surfactant Enhanced Product Recovery* (addition of non-toxic food-grade surfactants to mobilize and recover NAPL from impacted regions of the subsurface);
- ***Onshore Groundwater Containment/Control*** - *Slurry Wall Containment* (trenches filled with a low-permeability semi-liquid mixture of soil, bentonite, and water, to cut off, contain, or divert impacted groundwater) and *Aerobically Enhanced Bioremediation* (adding oxygen into groundwater to stimulate biodegradation of organic constituents);
- ***Isolation of Onshore Slag Fill Material*** - *DMCF Capping* (placement of low permeability dredged material over the existing land surface) and *Engineered Capping* (placement of low-permeability geotextiles, liners, or clay material from offsite over the existing land surface); and
- ***Removal and/or Isolation of Offshore Sediments*** - *DMCF Capping* (low permeability dredged material placed within the dikes constructed for the DMCF), *Offshore Impermeable Capping* (placing a layer of low-permeability material at a thickness of up to 5 feet over impacted sediments), and *Dredging* (removing impacted sediments for placement on land).

It is important to stress that the MPA has not finished its executive deliberations on the Remedial Options under consideration, or on other matters related to acquiring a portion of the Sparrows Point Property. It should be noted, however, that this preliminary evaluation indicates that there are several Remedial Options that would be feasible, implementable, and effective corrective measures for the environmental conditions discussed in this Site Assessment. In particular, capping and containment remedies would be effective at mitigating environmental impacts to offshore sediments and onshore subsurface media and could be seamlessly implemented with the DMCF construction.

If MPA were to acquire the Coke Point Peninsula for use as a DMCF, the Remedial Options for each of the impacted media would be further evaluated within the framework of the RCRA Corrective Measures Study (CMS) process. Specific recommendations for further study include the following:

- Conduct groundwater modeling to confirm the direction and velocity of groundwater flow in response to dredged material placement;
- Assess the Graving Dock pumping to evaluate the necessary design parameters for groundwater response measures in this area;
- Conduct a geotechnical investigation to evaluate the potential for differential settling that may affect groundwater flow in response to dredged material loading on the existing land surface;
- Conduct additional offshore investigations to the southwest to further delineate sediment impacts for the design of offshore dikes; and
- Comply with additional reporting requirements as part of the RCRA enforcement at the site and the NEPA requirements for potential DMCF use.

Once MPA's internal deliberations about the site are complete, they anticipate that any recommendations arising from its deliberations would be shared and discussed with the Harbor Team. Further, any Remedial Options that could ultimately serve as corrective measures at the site will need to be further evaluated within the framework of the RCRA CMS process in accordance with Maryland Department of the Environment (MDE) and US Environmental Protection Agency (USEPA) review and concurrence.

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