RECORD OF DECISION

KOPPERS CO., INC. (NEWPORT PLANT) SUPERFUND SITE

NEWPORT / NEW CASTLE COUNTY, DELAWARE

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION 3, PHILADELPHIA, PENNSYLVANIA
September 2005

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I. DECLARATION

KOPPERS CO., INC. (NEWPORT PLANT)
SUPERFUND SITE

NEWPORT / NEW CASTLE COUNTY, DELAWARE

RECORD OF DECISION
KOPPERS CO., INC. (NEWPORT PLANT)
SUPERFUND SITE

DECLARATION

Site Name and Location

Koppers Co., Inc. (Newport Plant) Superfund Site
Newport / New Castle County, Delaware
CERCLIS ID Number DED980552244

Statement of Basis and Purpose

This decision document presents the selected remedial action for the Koppers Co., Inc. Superfund Site ("Site" or "Koppers") located just outside of Newport, in New Castle County, Delaware, (see Figure 1) which was chosen in accordance with the requirements of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 ("CERCLA"), as amended, and, to the extent practicable, the National Oil and Hazardous Substances Pollution Contingency Plan ("NCP"), 40 C.F.R. Part 300. This decision document explains the factual and legal basis for selecting the remedial action for this Site. The information supporting this decision is contained in the Administrative Record for this Site.

The Delaware Department of Natural Resources and Environment Control ("DNREC") concurs with the selected remedy.

Assessment of the Site

Pursuant to duly delegated authority, I hereby determine, pursuant to Section 106 of CERCLA, 42 U.S.C. § 9606, that actual or threatened releases of hazardous substances from this Site, if not addressed by implementing the response action selected in this Record of Decision ("ROD"), may present an imminent and substantial endangerment to public health, welfare, or the environment.

Description of the Remedy

The remedial action described here comprises a comprehensive remedy for the Site. Wood-treating operations conducted at the Site have resulted in residual contamination, mainly of creosote constituents (primarily quantified as total polycyclic aromatic hyrdocarbons, or "total PAHs"), in soils, sediments and ground water, with some areas having very high levels of contamination, including liquid creosote, a non-aqueous phase liquid ("NAPL") with a density only slightly greater than water. This contamination is considered to be a principal threat waste since it is a continuous source for ground water contamination. The remedial action addresses contaminated soils in upland areas of the Site (including the "Process Area", "Drip Track", and "Wood Storage Yard"), contaminated sediments in wetland areas of the Site (including the "Fire

Pond", "South Ponds", "K Area", "Hershey Run", "Hershey Run Marsh", and the "Western Central Marsh"), and contaminated ground water throughout the Site.

The selected remedy includes:

1. Excavating and consolidating all contaminated soils and sediments (soils with total PAHs greater than 600 mg/kg and sediments with total PAHs greater than 150 mg/kg) into one or two on-site landfills or containment areas, herein referred to collectively as "the Containment Area," to be located in the areas of the worst NAPL contamination;

1. Installing, operating and maintaining a ground water treatment system (e.g., liquid carbon filtration) to prevent the migration of contaminated ground water, as well as to prevent the discharge of contaminated ground water from the recovery operation; and an oil-water separator (e.g., belt skimmer or baffle tank) to facilitate the recovery of free-phase NAPL, as well as to prevent NAPL from reaching the ground water treatment system;

2. Treating ground water as necessary to meet discharge requirements;

3. Constructing ground water barrier walls and collection systems (e.g., passive recovery trenches) in the Containment Area to prevent further migration of ground water contamination, including NAPL;

4. Managing the hydraulic head of ground water and collecting NAPL contamination in the ground water through the use of the passive recovery trenches;

5. Separating creosote from ground water and transporting creosote off-site for disposal or recycling in accordance with Section 121(d)(3) of CERCLA;

6. Moving debris to a location on-site where they can be placed under the RCRA (Resource Conservation and Recovery Act) modified cap;

7. Installing a RCRA modified cap across the Containment Area;

8. Relocating a portion of the existing channel of Hershey Run, if the Containment Area shall extend into the Hershey Run wetlands;

9. Creating wetlands to replace any that are filled in as part of the landfill construction;

10. Monitoring ground water, surface water, sediments and wetlands to ensure the effectiveness of the remedy;

11. Prevent exposure to contamination inside the Containment Area or in ground water beneath the Site, and prevent the drawdown of contamination into the deeper aquifer or elsewhere, through land and ground water use restrictions for the Site and surrounding area (as appropriate).

Data Certification Checklist

The following information is included in the Decision Summary of this ROD. Additional information can be found in the Administrative Record for this Site.

ROD CERTIFICATION CHECKLIST	
Information	Location/Page Number
Chemicals of concern and respective concentrations	Section 7.1.1, Page 8 Tables 1, 2, 3, 4, 5
Baseline risk	Section 7.1, Page 7 Tables 7, 8
Clean-up levels and the basis for these levels	Section 8, Page 18 Section 11.2, Page 35
How source materials constituting principal threat are addressed	Section 2, Page 1 Section 4, Page 3 Section 8, Page 18 Section 11.1, Page 34 Figures 4 - 7, 11
Current and reasonably anticipated future land use assumptions and potential future beneficial uses of ground water	Section 6, Page 6 Section 11.4, Page 44
Potential future land and ground water use that will be available at the Site as a result of the selected remedy	Section 6, Page 6 Section 11.4, Page 44
Estimated capital, annual operation and maintenance, and total present worth costs, discount rate, and the number of years over which the remedy cost estimates are projected	Section 12.3, Page 46 Table 10
Key factors that led to selecting the remedy	Section 10, Page 27 Section 11.1, Page 34

Statutory Determinations

The selected remedial action is protective of human health and the environment, complies with federal and State requirements that are legally applicable or relevant and appropriate to the remedial action, is cost-effective, and utilizes permanent solutions and alternative treatment (or resource recovery) technologies to the maximum extent practicable.

This remedy also satisfies the statutory preference for treatment as a principal element of the remedy (i.e., reduces the toxicity, mobility, or volume of hazardous substances, pollutants, or contaminants as a principal element through treatment).

Because this remedy will result in hazardous substances remaining on-site above levels that allow for unlimited use and unrestricted exposure, a review will be conducted within five years after commencement of the remedial action to ensure that the remedy continues to provide adequate protection of human health and the environment. Such reviews will be conducted every five years thereafter, until EPA determines that hazardous substances remaining at the Site do not prevent unlimited use and unrestricted exposure at the Site.

Abraham Ferdas, Director
Hazardous Site Cleanup Division
EPA Region III

9/30/05
Date

II. DECISION SUMMARY

KOPPERS CO., INC. (NEWPORT PLANT) SUPERFUND SITE

NEWPORT / NEW CASTLE COUNTY, DELAWARE

1.0 SITE NAME, LOCATION AND DESCRIPTION

The Koppers Co., Inc. (Newport Plant) Superfund Site ("Site" or "Koppers") is comprised of approximately 300 acres and is located in the northern part of New Castle County, in the State of Delaware, southwest of the town of Newport and northwest of the Route I-95 and Route 141 interchange (see Figures 1 and 2), and includes the areal extent of contamination from the property. To the north, the Site is bordered by high-speed railroad lines. Beyond the rail lines are a former municipal sewage treatment facility, an industrial property, and a residential area. To the east, the Site is bordered by the former DuPont Holly Run Plant and the Christina River. To the south and west, the Site is bordered by White Clay Creek and Hershey Run, respectively. To the west of the Site, across Hershey Run, lies the Bread and Cheese Island property. The Site previously contained a wood-treatment facility. The Site consists of 163 acres of upland areas, 136 acres of wetlands, and three ponds. Soil and ground water at the Site are contaminated as a result of past wood-treatment activities. Contamination at the Site is present in the following areas: 1) upland soils, 2) Hershey Run, 3) the Fire Pond, 4) the South Pond area (the non-tidal South Pond itself and the tidal West Central Drainage area), 5) the K Pond area and 6) ground water (see Figure 2). Only the East Central and Central Drainage Areas (the marshes bordering the Christina River) and the wooded uplands to the south of the former facilities are generally free of site-related contaminants. The Comprehensive Environmental Response, Compensation, and Liability Information System ("CERCLIS") identification number for this Site is DED980552244.

The U.S. Environmental Protection Agency ("EPA") is the lead agency for Site activities and the Delaware Department of Natural Resources and Environment Control ("DNREC") is the support agency. EPA has reached prior settlements with potentially responsible parties ("PRPs") under which the PRPs have performed a Remedial Investigation and Feasibility Study and maintained the Site.

This action addresses contamination in the sediments, soils and ground water at the Site in the areas designated by Figures 4-6. This action comprises a comprehensive remedy for the Site, and no further actions are anticipated.

2.0 SITE HISTORY AND ENFORCEMENT ACTIVITIES

In 1929, a group of parcels comprising the Site was conveyed by Lynam and Wright to the Delaware Wood Preserving Company, which began conducting wood-treatment operations on the property. In 1931, the Site was sold to Century Wood Preserving Company (Century). Four years later in 1935, the Wood Preserving Company acquired the property and all associated stock from Century. Through liquidation of the Wood Preserving Company, Koppers Company acquired the Site in 1940 and reorganized in 1944 into Koppers Company, Inc. (Koppers). Koppers then continued wood-treatment operations at the Site until 1971, when the property was sold to DuPont. The Site has remained largely inactive since wood-treating operations ceased in 1971.

From 1974 to 1977, the New Castle County Department of Public Works leased the northern part of the Site, and then built and operated a wastewater treatment facility to temporarily maintain the County's wastewater treatment capabilities until permanent facilities were built. In 1977, the County sold the building to DuPont and discontinued wastewater treatment operations at the Site.

The primary material used in the wood-treatment processes was a creosote/coal tar solution, which was used to preserve railroad ties, telephone poles, and other wood products (this is typical of the type of wood-treatment used today for railroad ties and telephone poles). Pentachlorophenol (PCP) was also used to treat the wood, although to a much smaller degree. Throughout a large area of the Site (approximately two-thirds of the operations area), an array of railroad tracks provided for the movement of wood and materials to and from the Site. Based on available records, former Site areas where creosote handling occurred included the Process Area and Drip Track Area (Figure 2).

Located in the northwestern portion of the Site, the Process Area was utilized for the application of wood preservatives and contained various types of wood-treatment equipment and associated structures. This area also provided storage for approximately 1,000,000 gallons of creosote and other process-related materials. The treatment consisted of heating and pressurizing tanks filled with creosote and wood, forcing the creosote into the wood. After treatment, the freshly-treated wood products were temporarily allowed to cure and drip dry in the Drip Track Area prior to transfer to the Wood Storage Area. The Fire Pond was created as a source of water for fire-fighting purposes.

Sloppy operations, including spills and leaks, allowed contaminants to seep into the soil. It is likely that the contaminants escaped into Hershey Run by flowing as a separate phase with the shallow ground water, or by being washed toward Hershey Run during storm events.

The Site was identified as a potential hazardous waste site in 1979. Following multiple subsequent investigations, the Site was proposed to the NPL in 1989, and formally listed on August 30, 1990. In 1991, Beazer East ("Beazer," the successor corporation to Koppers) and DuPont (the land owner at that time; Beazer has since acquired the property from DuPont) signed an agreement with EPA to conduct the Remedial Investigation/Feasibility Study (RI/FS).

In 1991, an Administrative Order on Consent was signed by EPA and the PRPs, requiring the PRPs to conduct a Remedial Investigation and Feasibility Study ("RI/FS") at the Site. These reports and other documentation provided in the Administrative Record provide the basis for the determinations found in this Record of Decision.

3.0 COMMUNITY PARTICIPATION

The Koppers Remedial Investigation, Feasibility Study, and Baseline Risk Assessment, and other Administrative Record documents relating to the Site, were made available to the public. They are located in the Administrative Record, which can be viewed at http://www.epa.gov/arweb, or at the Administrative Record link on the sidebar of the U.S. EPA Region 3 Hazardous Site Cleanup Division Homepage at http://www.epa.gov/reg3hwmd. In addition, the detailed Administrative Record can be examined at the following locations:

Kirkwood Public Library 6000 Kirkwood Highway Wilmington, DE 19808 (302) 995-7663	Delaware Department of Natural Resources & Environmental Control Superfund Branch 391 Lukens Drive New Castle, DE 19720 (302) 395-2600	Admin. Records Room US EPA Region III 1650 Arch Street Philadelphia, PA 19103 (215) 814-3157 (Please call ahead.)

The notice of availability of these documents was published in the *Wilmington News Journal* on October 7, 2004. In addition, EPA sent a fact sheet summarizing the Agency's preferred remedial alternative for the Site to residences and businesses within an approximately one-mile radius of the Site in October 2004.

From October 7, 2004 to December 7, 2004, EPA held a 60-day public comment period to accept public comments on the remedial alternatives presented in the *Feasibility Study* and the Proposed Plan and the other documents contained within the Administrative Record for the Site. On October 21, 2004, EPA held a public meeting to discuss the Proposed Plan and accept comments. A transcript of this meeting is included in the Administrative Record. The summary of significant comments received during the public comment period and EPA's responses are included in the Responsiveness Summary, which is a part of this Record of Decision.

4.0 SCOPE AND ROLE

The actions proposed by EPA in this document constitute a comprehensive approach for addressing all of the environmental problems at the Site. The actions proposed at this time are expected to be the final actions that will be necessary to completely address the risks from the contamination at the Site. There have been no previous cleanup efforts at the Site by EPA or the State.

5.0 SITE CHARACTERISTICS

5.1 Surface Features, Soil and Geology, and Hydrogeology

Surface Features and Resources. The Site is located in the Coastal Plain Physiographic Province in New Castle County, Delaware (see Figure 1), near the fall line with the Piedmont Physiographic Province.

Existing facilities/structures and other physical features at the Site include one warehouse building (constructed by the New Castle Department of Public Works), a paved access road, and secondary roads providing access to overhead power lines that traverse the Site. Generally, the railroad lines once present throughout the Site no longer exist.

Access to the Site is restricted through the use of 24-hour security-guarded gates at the CibaSC facility, fencing, and posting. Natural barriers, such as the Christina River, White Clay Creek, and Hershey Run, and the surrounding marshes and wetlands also limit access to the Site, as does the high-speed Amtrak rail line to the north (see Figure 2). However, signs of trespass, including spent shotgun shells, numerous hunting blinds and well-worn foot paths, have been found.

The Site consists of 163 acres of upland areas, 136 acres of wetlands and three ponds. Wetlands cover approximately 45 percent of the Site and dominate the southern and western portions. The wetland cover types include freshwater tidal marsh (115 acres), non-tidal emergent wetlands (11 acres), non-tidal forested wetlands (9 acres), and non-tidal scrub/shrub wetlands (1 acre). Tidal wetlands at the Site individually drain into Hershey Run, White Clay Creek and the Christina River. Non-tidal wetlands occur in the South Ponds Area, K Area, Fire Pond Area, and approximately 15 smaller disjunct non-tidal wetlands occupy low-lying areas in the uplands of the Process and Wood Storage Areas.

White Clay Creek is Delaware's only "National Wild and Scenic River," a designation that is administered by the National Park Service (NPS) under the authority of the Wild and Scenic Rivers Act of 1968. The final reach of White Clay Creek, from the southern boundary of United Water Delaware Corporation's property (where the Amtrak lines cross the Creek) to the confluence with the Christina River, is the nearest and adjacent section of the Creek to hold this designation. Work at the Site will be conducted in consultation with the NPS in order to ensure that cleanup work at the Site does not negatively affect this reach.

Several plants that occur on Delaware's Rare Native Vascular Plant List exist at the Site. These plants include the swamp white oak, sessile leaved tick-trefoil, swamp milkweed, and closed gentian. While it is not expected that these plants will be impacted by the remedy, this will be evaluated in further detail during design work.

The Site may contain suitable habitat for the bog turtle, a federally endangered species. A survey to determine whether or not it is present will be conducted during the Remedial Design. The State has recently reported that a bald eagle was observed nesting on Bread and Cheese Island, adjacent to the Site.

Soil and Geology. Figure 3 shows a geological cross-section of the Site. Fill is the uppermost unit encountered in the uplands area, and varies in thickness from 0 to approximately 9 ft with greater thicknesses observed in the Process Area and Fire Pond Area. The fill is composed primarily of silts with lesser amounts of sands, gravels, and clays. In addition, the fill contains various anthropogenic materials including stone fill; brick and concrete fragments; asphalt pavement; railroad tie pieces; coal and ash debris; and wood, steel, and iron debris. In the former production areas of the Site, creosote is present within the fill, primarily in a dry, weathered form.

Fluvial Quaternary (Recent) sediments overlie much, if not all, of the unconsolidated Columbia Formation (Pleistocene). The Quaternary (Recent) sediments are generally comprised of silts with lesser amounts of sand, gravel, and clay as well as organic matter in the form of roots, peat, reeds, and other organic debris. These deposits range in thickness from 0 to upwards of approximately 10 to 15 ft and generally decrease in thickness near drainage areas. Holocene deposits are present in drainageways and marsh areas and consist of silty clay with lesser amounts of fine sand and thicknesses ranging from 0 to 6 ft. In the marsh areas a gray clay is

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present which is described as a drier and firmer clay at depth. This clay unit ranges in depth from 1 to 4 ft below ground surface (bgs), and its thickness ranges from 1 to 5 ft. This "marsh clay" is present in over 95 percent of the borings which were advanced below 2 ft or more in depth in the marsh areas. For the probes that penetrated through the gray clay layer, the thickness ranged from approximately 1 to 3 ft with an average thickness of approximately 2 ft. The marsh clay is apparently absent below sections of Hershey Run, or may be present at depths greater than that to which probes were advanced.

The Columbia Formation is composed of primarily silty sands and gravels with seams and thin beds (up to 2 ft in thickness) of silts. The Columbia Formation was encountered in thicknesses ranging from 0 ft to approximately 20 to 25 ft, and is generally thicker near the Process Area and Drip Track Area.

The Potomac Formation is composed of silts and clays interlayered with medium to fine sands. At the Site, a lower-permeability layer is typically observed at the top of this unit and can vary from clay to a clayey silt or clayey sand. There are no known areas of direct recharge from the Columbia to the lower Potomac at the Site, although the two aquifers are referred to in the literature as "leaky" and "interconnected." The Potomac Formation is distinguished from the Columbia Formation by smaller grain sizes and the usual presence of the lower-permeability clayey layer at the contact with the Columbia Formation. The maximum thickness of the fine-grained layers at the top of the Potomac, where encountered at the Site, ranged from 1.3 to 5 ft (in seven borings). Where present, the fine-grained unit may act as a lower-permeability capillary barrier, potentially retarding the downward movement of NAPL between the Columbia and Potomac Formation.

Hydrogeology. During high tides, ground water in the upper aquifer (which occurs in the Columbia and Fill geologic units) appears to be recharged by surface water in the West Central Drainageway and Hershey Run; during low tides the upper aquifer appears to discharge ground water to the West Central Drainageway and Hershey Run. Horizontal hydraulic conductivities measured in the upper aquifer ranged from 2×10^{-1} to 4×10^{-4} cm/sec.

Using the highest horizontal hydraulic gradient observed in the upper aquifer (0.013 ft/ft), the mean hydraulic conductivity (3.2×10^{-2} cm/sec), and an assumed effective porosity of 0.3, an average linear ground water flow velocity of approximately 4 ft/day was calculated.

No drinking water wells are located within the Site boundaries. Local sources of drinking water include surface water from White Clay Creek (approximately one mile upstream) and municipal supply wells located within a few miles of the Site and screened in the Potomac aquifer.

5.2 Nature and Extent of Contamination

The nature and extent of contamination in certain areas and environmental media at the Site were evaluated during the Remedial Investigation. This information is documented in the Administrative Record and is only briefly summarized in this section of the ROD. More than 100,000 data were obtained for surface soil, sediment, ground water, surface water, air, tissue and other media from the Site and surrounding area.

As a result of the former wood-treatment operations conducted at this Site, creosote NAPL has been released to the subsurface. These highly concentrated contaminant liquids do not dissolve readily in water, are usually slightly heavier than water and, therefore, move downward with gravity to sink in and through the soil and ground water until they run into a less permeable clay layer. NAPLs behave as continuing sources of contamination, as upgradient clean ground water flows through the Site and comes into contact with the NAPL. Contamination slowly dissolves from the NAPL into the ground water, which eventually flows to surface water bodies, or migrates downward through the lower aquifer. Creosote NAPL was observed in both subsurface soils and in wetland sediments at the Site. In addition, creosote NAPL sheens have been observed in the surface waters of Hershey Run. Shallow soils, subsurface soils, ground water and sediments at the Site have been contaminated to varying degrees with PAHs, the primary chemical of concern (COC) identified at this Site (see Figures 4 – 6). For more information, refer to Section 4 of the Remedial Investigation Report for the Site (May 2003) and EPA's comments regarding the report, which are available in the Administrative Record.

5.3 Conceptual Site Model

A Conceptual Site Model ("CSM") diagrams contaminant sources, contaminant release mechanisms and migration routes, exposure pathways, and potential human and ecological receptors. It documents what is known about human and environmental exposure under current and potential future Site conditions. The risk assessment and final response action for this Site are based on the CSM.

The CSM for this Site (see Figure 7) illustrates residual NAPL in the shallow soil being released from past wood-treatment activities at the Site. Contamination at the Site was released into the soil and migrated into the subsurface, adjacent wetlands and wetland sediments. Once NAPLs enter the ground water, they act as a major source of ground water contamination (via dissolution), and surface water contamination (due to discharge of contaminated ground water and/or movement of NAPLs). Site receptors include individuals and ecological receptors that may be exposed to the contaminants in the soil, sediments, and ground water.

6.0 CURRENT AND POTENTIAL FUTURE LAND USES

Land use within the surrounding area includes a mix of industrial, commercial and residential activities. The Site (see Figure 2) is zoned for industrial use, according to the zoning board of New Castle County, Delaware, and the properties in use immediately adjacent to the Site are used for residential or industrial purposes. U.S. Census Bureau data indicates that New Castle County has experienced significant growth in recent years. Because of the very limited access to the Site and because it is zoned for industrial use, EPA's assumed future use for the Site was for industrial purposes. However, based on more recent discussions between EPA, DNREC and the property owner of the Site, EPA has also considered the possible future use of the Site as a wetlands bank.

7.0 SUMMARY OF SITE RISKS

A baseline human health risk assessment was conducted in order to estimate the probability and magnitude of potential adverse human health effects from exposure to contaminants in on-site soil, sediments and ground water, assuming no further response actions are undertaken. Both a human health and an ecological risk assessment were conducted for this Site. The risk assessments provide the basis for taking action and identify the contaminants and exposure pathways that need to be addressed by the remedial action at the Site.

This section of the ROD summarizes the results of the baseline human health and the ecological risk assessments.

7.1 Summary of Human Health Risk Assessment

The Baseline Risk Assessment ("BLRA") for the Site is comprised of the *Human Health Risk Assessment for the Former Koppers Company, Inc. Site, Newport, Delaware* submitted by DuPont and Beazer, and prepared by Environmental Standards, Inc. The Human Health Risk Assessment was accepted by EPA on September 20, 2001. The BLRA was prepared in order to determine the current and potential future effects of contaminants in soil and ground water in the absence of further cleanup actions at the Site. The BLRA considered the effects of exposure to soil and ground water. The BLRA consisted of a four step process: (1) the identification of chemicals of potential concern ("COPCs"), i.e., those that have the potential to cause adverse health effects; (2) an exposure assessment, which identified actual and potential exposure pathways, potentially exposed populations, and the magnitude of possible exposure; (3) a toxicity assessment, which identified the adverse health effects associated with exposure to each COPC and the relationship between the extent of exposure and the likelihood or severity of adverse effects; and (4) a risk characterization, which integrated the three earlier steps to summarize the potential and actual risks posed by hazardous substances at the Site, including carcinogenic and non-carcinogenic risks. A summary of those aspects of the human health risk assessment, which support the need for remedial action, is discussed below.

7.1.1 Contaminants of Potential Concern

During the Remedial Investigation, a number of organic and inorganic chemicals were detected in Site soils, sediments and ground water. Chemicals with maximum concentrations and/or analytical method detection limits of less than Risk-Based Concentrations ("RBCs")[1] were eliminated from further consideration in the risk assessment. Risk calculations were based on either the upper 95th percentile confidence limit on the mean ("UCL95") or the maximum detected concentration for each chemical. The lower of these two values (designated the "medium-specific concentration" or "MSC") was used in the risk calculations as the exposure point concentration for that chemical in that medium. Table 1 lists Summary Statistics and COPC Selection for Site soil, sediment and ground water. PAHs are the primary COC at this Site, with the respective exposure point concentrations used in the risk assessment presented in each scenario's individual risk calculation (presented in Table 6). Please note that the tables and risk assessment, generated during the Remedial Investigation, included dioxin (specifically 2,3,7,8-TCDD) as a COC; it has since been determined that this was in error, and that dioxin was only detected due to a lab spike error. As a result, dioxin is not a COC at the Koppers Site.

7.1.2 Exposure Assessment

Potential human health effects associated with exposure to the COPCs were estimated quantitatively or qualitatively through the evaluation of several actual or potential exposure pathways. These pathways were developed to reflect the potential for exposure to hazardous substances at the Site. Demographics and land use were evaluated to assess present and potential future populations working or otherwise spending time at the Site. The exposure scenarios evaluated in the *Baseline Risk Assessment* are presented below.

The *Baseline Risk Assessment* considered the effects of ingestion of, and dermal contact with, soils, sediments, surface water and ground water at the Site. The BLRA also considered the inhalation of chemical volatilization from ground water and dermal contact while showering.

Five different current or future exposure scenarios were developed in order to estimate risks for the following populations: (1) on-site construction worker; (2) on-site industrial worker; (3) adolescent trespasser; (4) adolescent swimmer; and (5) angler.

A number of assumptions were used in the risk assessment process to calculate the dose for each exposure pathway since it is seldom possible to measure a specific dose. The following assumptions were used to estimate reasonable maximum exposure for each of the five populations identified above (see Table 3 for complete exposure parameters):

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[1] The identification of chemicals of potential concern was performed utilizing the EPA guidance, "Selecting Exposure Routes and Contaminants of Concern by Risk-Based Screening" (EPA Region III, 1992).

On-site construction worker (Future)

- The on-site construction worker was assumed to have a body weight of 70 kilograms ("kg").
- The exposure duration was 1 year.
- The frequency of exposure to soil, NAPL and air emissions was assumed to be 120 days per year ("days/yr").
- The soil ingestion rate was assumed to be 50 milligrams per day ("mg/day").
- The skin surface area for dermal contact was assumed to be 1,820 square centimeters per day ("cm^2/day").
- A soil-to-skin adherence factor of 0.11 milligrams per square centimeter ("mg/cm^2") was used.
- The inhalation rate was assumed to be 20 cubic meters per day ("m^3/day").

On-site industrial worker (Future)

- The on-site industrial worker was assumed to have a body weight of 70 kg.
- The exposure duration was 25 years.
- The frequency of exposure to soil and NAPL was assumed to be 134 days/yr.
- The frequency of contact with ground water (via ingestion or while showering) was assumed to be 250 days/yr (1 shower/day at 15 minutes/shower).
- Ground water ingestion rate was 1L/day.
- The soil ingestion rate was assumed to be 50 mg/day.
- The skin surface area for dermal contact was assumed to be 1,820 cm^2 (or 20,000 cm^2 while showering).
- A soil-to-skin adherence factor of 0.11 mg/cm^2 was used.

Adolescent trespasser (Current and Future)

- The adolescent trespasser was assumed to have a body weight of 56 kg.
- The exposure duration was 6 years (ages 12-18).
- The frequency of exposure to soil, NAPL and surface water was assumed to be 24 events/yr, and 10 events/yr for exposure to sediment.
- The soil ingestion rate was assumed to be 100 mg/event.
- The skin surface area for dermal contact was assumed to be 4,381 cm^2, based on area of face, upper extremities, and lower legs (and 207 cm^2 for legs wading in non-river surface water at 1 hour/event).
- A soil/sediment-to-skin adherence factor of 0.025 mg/cm^2 was used.

Adolescent swimmer (Current and Future)

- The body weight of the adolescent swimmer was assumed to be 56 kg.
- The exposure duration was 6 years.
- The frequency of exposure to river surface water and sediment was assumed to be 24 events/yr at 1 hour/event.
- The ingestion rate was assumed to be 50 mL/hr.
- The skin surface area for dermal contact with water was assumed to be 15,758 cm^2 (or 1,103 cm^2 for feet exposed to sediment).
- A sediment-to-skin adherence factor of 0.063 mg/cm^2 was used.

Angler (Current and Future)

- The angler was assumed to have a body weight of 70 kg.
- The exposure duration was 25 years.
- The frequency of exposure was assumed to be 365 days/yr.
- The ingestion rate was assumed to be 25 g/day.

7.1.3 Toxicity Assessment

Excess lifetime cancer risks were determined for each exposure pathway by incorporating the chemical-specific cancer slope factor. Cancer slope factors have been developed by EPA from epidemiological or animal studies to reflect a conservative "upper bound" of the risk posed by potentially carcinogenic substances. The resulting risk estimates are expressed in scientific notation as a probability (e.g., 1×10^{-6} or 1/1,000,000) and indicate (using this example) that an average individual is not likely to have greater than a one in a million chance of developing cancer over 70 years as a result of site-related exposure to the compound at the stated concentrations. All risks estimated represent an "excess lifetime cancer risk," or the additional cancer risk on top of that which we all face from other causes such as cigarette smoke or exposure to ultraviolet radiation from the sun. EPA's generally acceptable risk range for site-related exposure is 10^{-4} to 10^{-6}. Current EPA practice considers carcinogenic risks to be additive when assessing exposure to multiple hazardous substances or exposure via multiple pathways.

In assessing the potential for exposure to a chemical to cause adverse health effects other than cancer, a hazard quotient ("HQ") is calculated by dividing the daily intake level by the reference dose ("RfD") or other suitable benchmark. EPA has developed reference doses for many chemicals which represent a level of exposure that is expected to result in no adverse health effects. RfDs are derived from epidemiological or animal studies and incorporate uncertainty factors to help ensure that the potential for adverse health effects will not be underestimated. An HQ ≤ 1 indicates that a receptor's dose of a single contaminant is less than the RfD and that harmful non-cancer effects from that chemical are unlikely. The Hazard Index ("HI") is generated by adding the HQs for all COPCs that affect the same target organ (e.g., liver) within or across those pathways by which the same individual may reasonably be exposed. An HI ≤ 1 indicates that harmful non-cancer health effects are not expected as a result of exposure to all of the COPCs within a single or multiple exposure pathway(s).

A summary of the cancer and non-cancer toxicity data relevant to the COPCs in the *Baseline Risk Assessment* is presented in Table 4.

7.1.4 Risk Characterization

The Baseline Risk Assessment was conducted in order to determine the current and potential future effects (if no cleanup actions were taken at the Site) of contaminants in sediments, soils and ground water on human health and the environment. The current and potential future land use plays a key role when EPA determines the exposure scenarios to be evaluated in the Baseline Risk Assessment. Although historically used for industrial purposes and currently zoned as industrial, the Site is currently not in use other than as wildlife habitat. The adjacent properties (the former DuPont Holly Run plant and the existing CibaSC facility) have both been used for industrial purposes throughout the history of the Site. Therefore, with regard to human health, EPA evaluated the potential risks associated with industrial use of the Site, construction workers, anglers, adolescent swimmers and adolescent trespassers. EPA does not believe the Site could reasonably be used for residential purposes because of the difficulty of access (through an active chemical plant) and the isolation of the property (surrounded by railroad tracks [Amtrak's Northeast Corridor line], water, and the active facility).

The Baseline Risk Assessment considered the hazards from potential exposure to contamination if an industrial facility were to be built at the Site. Potential effects were evaluated from the incidental ingestion of sediments and soils, ingestion of ground water contaminated with creosote constituents, dermal contact with Site sediments, soils and ground water, and the inhalation of vapors emitted from ground water were it to be used (i.e., for showering). The future industrial worker scenario resulted in the greatest calculated risks; for details of the other scenarios evaluated, please refer to the Human Health Risk Assessment (HHRA) in the AR, and to the risk summary tables in this ROD.

For soils, the Human Health Risk Assessment found that the carcinogenic risk for an industrial worker from ingestion and dermal exposure 2.4×10^{-4}. The majority of the risk was caused by the incidental ingestion of soil (1.8×10^{-4}). The contaminant that contributed the most to the risk was benzo(a)pyrene, with other PAHs (including benzo(a)anthracene, benzo(b)fluoranthene, and dibenz(a,h)anthracene) also contributing.

For groundwater, the carcinogenic risk from dermal exposure for a future industrial worker was 1.3×10^{-3} and the carcinogenic risk from ingestion was 4.6×10^{-1}. Scenarios evaluating exposure to ground water without NAPL present did not result in carcinogenic risk outside of the acceptable range.

The non-carcinogenic risks from groundwater to a future industrial worker resulted in a Hazard Index (HI) of 115 (or 115 times greater than EPA's threshold) from dermal exposure and an HI of 170 (170 times greater than EPA's threshold) from the ingestion scenario. The risk to a future industrial worker where NAPL was not present in the ground water produced an HI of 1.3 when the dermal, ingestion, and inhalation pathways were combined. The HI exceedance of 1 was largely caused by high background levels of metals that occur in Columbia Aquifer ground water, which contributed to the ingestion pathway.

There were no site-related contaminants found in the Potomac Aquifer wells at the Site, but these wells were intentionally not located in the vicinity of the worst areas of contamination to avoid creating a pathway for contamination. A summary of the risk calculations for all of the scenarios evaluated is presented in Table 5.

EPA believes the risk from exposure to soil and sediment may be underestimated due to the presence of creosote NAPL, at the surface, in both soils and sediments at the Site. The presence of surficial creosote NAPL has the potential to cause acute toxicity if a trespasser were to be exposed to that material, as PAHs are dermal irritants on direct contact.

In summary, unacceptable risks exist to human health from groundwater at the Site. In addition, there exists the potential risk of exposure to creosote material in soils and sediments for any person traversing the Site.

7.1.5 Uncertainty in Risk Characterization

Risk assessment provides a systematic means of organizing, analyzing and presenting information on the nature and magnitude of risks posed by chemical exposures. Uncertainties are present in all risk assessments because of the quality of available data and the need to make assumptions and develop inferences based on incomplete information about existing conditions and future circumstances. Below is a brief discussion of the major uncertainties associated with the *Baseline Risk Assessment.*

- Dermal Contact Pathway - The use of adjusted toxicity values for the assessment of dermal risks is a source of uncertainty in the risk assessment. Adjusted oral toxicity values were generated based on currently available oral absorption factors. Adjustment factors ranging from less than 1 percent (inorganic) to 100 percent (VOCs) were applied to toxicity values to account for absorbed doses.

- Risk Characterization - Constituent-specific risks are generally assumed to be additive. This oversimplifies the fact that some constituents are thought to act synergistically ($1 + 1 > 2$) while others act antagonistically ($1 + 1 < 2$). The overall effect of these mechanisms on multi-constituent, multi-media risk estimates is difficult to determine but the effects are usually assumed to balance.

- There is inherent variability in environmental sampling results, given the spatial distribution of contamination and composition of the matrix sampled. Small numbers of analytical samples for a given area may not completely characterize the numbers and concentrations of constituents actually present.

- Exposure parameters for the Site risk assessment were obtained from EPA guidance or peer review literature. Most of these assumptions are considered average or reasonable maximum exposure estimates that would not likely underestimate exposure. While there are situations where the parameters used may produce underestimates, it is unlikely that the cumulative effect of all exposure parameter estimates will lead to underestimates of risk.

7.1.6 Principal Threat Waste

EPA characterizes waste on-site as either principal threat waste or low-level threat waste. The concept of principal threat waste and low-level threat waste, as developed by EPA in the National Oil and Hazardous Substances Pollution Contingency Plan ("NCP"), is applied on a site-specific basis when characterizing source material. "Source material" is defined as material that includes or contains hazardous substances, pollutants, or contaminants that act as a reservoir for migration of contamination to ground water, to surface water, to air, or that act as a source for direct exposure. Principal threat wastes are those source materials considered to be highly toxic or highly mobile, which would present a significant risk to human health or the environment should exposure occur.

The proposed cleanup addresses areas where contamination is just above the cleanup criteria to areas where contamination is so high and prevalent that it is visible and flows freely as a separate phase. From the results of the RI/FS for the Koppers Site, EPA considers the NAPL in the shallow and subsurface soils and sediments to be principal threat waste because it is source material that contains hazardous substances, pollutants, or contaminants that act as a reservoir for the migration of contamination to surface water and/or ground water.

Section 300.430(a)(1)(iii) of the NCP states that "EPA expects to use treatment to address the principal threats posed by a site, wherever practicable," that "EPA expects to use engineering controls, such as containment, for waste that poses a relatively low, long-term threat or where treatment is impracticable," and that "EPA expects to use a combination of methods, as appropriate, to achieve protection of human health and the environment." It also states that "EPA expects to use institutional controls...to supplement engineering controls as appropriate...," and that institutional controls may be used "where necessary, as a component of the completed remedy." However, the NCP also states that institutional controls "shall not substitute for active response measures...as the sole remedy unless such active measures are determined not to be practicable..." After giving careful consideration to the expectations in the NCP regarding principal threat waste and to the nine criteria in the NCP, which EPA is required to use to evaluate various possible remedial alternatives, EPA is proposing an alternative that uses containment rather than treatment to address principal threat waste. The range of alternatives includes a treatment alternative. EPA's rationale for proposing a containment remedy is discussed in detail in later sections of this Record of Decision.

In regard to ground water, the NCP describes EPA's expectation to return contaminated ground water to its beneficial use, which in this case would be to a condition that would allow human consumption. While EPA's experience is that is difficult to clean up ground water that contains NAPL to such a degree as to allow drinking, EPA believes that at this Site, by isolating the worst NAPL in the containment areas, ground water outside the containment areas can be returned to its beneficial use. In addition, because this contaminated ground water represents an ongoing source as described above, this will prevent the future recontamination of surface waters and sediments.

7.2 Summary of Ecological Risk Assessment

Like a Human Health Risk Assessment, an Ecological Risk Assessment (ERA) serves to evaluate the potential for risks due to exposure to site contaminants specific to ecological receptors (such as wildlife, fish, and plants). Since the ERA evaluates many species that have drastically different exposure pathways, the ERA can appear complicated. Numerous environmental processes and ecological receptor groups (part of what is referred to as "assessment endpoints") are evaluated, and there are differences in contaminant exposures and sensitivity to contaminants between groups. For example, wildlife are mainly exposed through their diet, while soil organisms are exposed through direct contact with the soil in which they live. The complexity of the ERA arises from the need to evaluate the important exposure pathways to the relevant receptors. The toxicology varies between the different ecological groups. In addition, some contaminants are effectively transferred up the food chain, concentrating and thereby posing risks, while other contaminants are not transferred because they are either metabolized, biologically regulated or simply not absorbed. Some compounds may be metabolized into more or less toxic daughter compounds, which may be transferable.

Superfund site-specific ERAs are conducted using an eight-step process which minimally consists of two tiers of evaluation: a Screening Level ERA ("SLERA" - steps 1 and 2) and the full Baseline ERA ("BERA" - steps 3 through 7). Step 8 is a risk management step. The function of the SLERA is to determine if a BERA is necessary, along with which contaminants should be evaluated further. A SLERA uses published conservative toxicity benchmarks found in literature for water, sediment and soil, and compares site concentrations to these benchmarks.

The BERA begins with the results of the SLERA and with problem formulation, which establishes the goals, breadth and focus of the investigation. It also establishes the assessment endpoints, which are the specific valued ecological communities to be protected. The questions and issues to be addressed in the BERA are defined based on potentially complete exposure pathways and ecological effects. A conceptual site model (CSM) is developed that includes questions about the assessment endpoints and the relationship between exposure and effects. The CSM describes the approach, types of data and analytical tools to be used for the analysis phase of the BERA. Information is generated through literature reviews and field studies, results are compiled and conclusions are reached. Once it has been concluded that ecological risk exists, the information is used to meet other objectives, such as determining what exposure level may minimize any unacceptable risk.

A CSM relies on contaminant and habitat characteristics to identify critical exposure pathways to the selected measurement endpoints. A measurement endpoint is a measurable biological response to a stressor that can be related to the assessment endpoint. The CSM for the Koppers Site, for example, illustrates that contaminants were spilled onto the ground in the past and have migrated overland and/or through the subsurface into the adjacent wetlands (i.e., Hershey Run and the Western Central Marsh adjacent to the South Ponds), where macroinvertebrates, insects, fish and other organisms may be exposed. The potential for risk exists where organisms are exposed to contamination directly (e.g., insect larvae living in contact with contaminated sediments, fish contacting contaminated sediments and/or earthworms and other burrowing organisms living in contact with soil), as well as when organisms higher in the food chain consume organisms lower in the food chain that have been in contact with contamination and have stored contamination in their bodies (e.g., insects may store contaminants, then fish eat the insects, birds eat the fish, and so on). The SLERA identified PAHs and other contaminants exceeding benchmarks in sediment, soil and water.

At the Koppers Site, a total of 12 assessment endpoints were evaluated, six related to direct exposure and six related to exposure to contamination through the food chain for non-aquatic receptors. Only the six related to direct exposure (see Table 7) identified risks associated with the creosote contamination. These conclusions are largely based upon the results of the site-specific toxicity tests conducted with Site sediment on the amphipod (a small shelled organism), *Hyalella azteca*, and the midge (a small fly), *Chironomus tentans*, and with Site soil on the earthworm, *Eisenia foetida*, as supplemented with plant community observations.

For both the sediment and soil toxicity tests, the distribution of contaminants at the Site presented a dilemma in obtaining samples for testing and the determination of NOAEL (No Observed Adverse Effects Level) and LOAEL (Lowest Observed Adverse Effects Level) values. The distribution of total PAH contamination can be characterized as having sharply defined highly contaminated areas and limited areas that have intermediate levels of contamination. The result of these circumstances is that the toxicity results do not generate a gradient of toxicity responses; the results were either that the soil or sediment sample caused death or had no measured effect. While this presented technical difficulties in the risk calculations, it clearly defines where severe ecological risks exist and do not exist. In addition, the physical areas of uncertainty (the area and volume of intermediately contaminated soil and sediment) is a relatively small zone around areas of high contamination levels. Therefore, the cleanup volumes are not very sensitive to changes in the cleanup goals.

The amphipod, *Hyallela azteca*, lives in close association with sediments, as does the larva of the midge, *Chironomus tentans*. These two organisms were used under standardized solid-phase sediment testing procedures to determine if the contaminated sediments at the Site caused mortality (the test organisms died when exposed to sediment from the Site) or non-lethal adverse effects (such as reduced growth). Where adverse effects were determined, the concentrations of contaminants in test sediments were used to evaluate at what concentrations minimal or no adverse effects may occur (the NOAEL), and above what contaminant levels adverse effects would be expected (the LOAEL). In addition, the type of the adverse effect (e.g., death or reduced growth) was taken into consideration in evaluating the certainty and the severity of risk. The NOAEL was calculated to be 83 mg/kg, and the LOAEL was calculated to be 198 mg/kg for total PAHs.[2]

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[2] Note that there appeared to be risk caused by zinc as well which is not a site-related contaminant.

Fish that utilize the Site can be impacted by contaminants in two ways: (1) short-term toxicity and (2) long-term reproductive effects on organisms exposed as larvae or juveniles. Short-term toxicity of Site contaminants to killifish (*Fundulus heteroclitus*) embryos was assessed in a 10-day solid-phase sediment toxicity test. The bioaccumulation potential of each contaminant was assessed through a review of the fish tissue data collected at the Site. Indirect effects on fish populations were inferred through the midge and amphipod toxicity tests, since benthic macroinvertebrates comprise a large percentage of predatory fish forage. No significant correlations between fish survival and level of measured contaminants were found. A NOAEL for total PAH concentration was calculated at 33.5 mg/kg based upon sublethal effects. However, recent studies conducted by the USFWS and the State found an approximately 40% incidence of liver tumors, among other health effects, in fish in Hershey Run. Follow-up studies have strongly suggested that this high incidence of liver tumors is unique to Hershey Run in the area. (Copies of both studies are available in the Administrative Record.)

To evaluate the potential effects of Site contaminants on the structure and function of the soil community, 7, 14, and 28-day solid-phase toxicity tests were conducted with the earthworm, *Eisenia foetida*. The toxicity tests provided information on the toxicity of soil contaminants to this species and potentially other soil invertebrate species found on-site. In addition, the bioaccumulation potential of Site contaminants was assessed by analyzing all surviving earthworms for contaminants of concern potentially present in their tissues.

Earthworm survival was reduced in PAH-contaminated samples from the upland area of the Site, with complete mortality occurring by day 7 of the 28 day test (none of the worms survived). Survival in all other soil samples was greater than 94 percent. Growth was significantly lower in the PAH-contaminated samples from the upland wood storage yard. From the toxicity data, PAHs were determined to be the compounds that were responsible for the observed toxicity. The NOAEL for total PAH concentration for the tests conducted was determined to be 587 mg/kg and the LOAEL was 1,264 mg/kg.

Vegetation surveys conducted during the Remedial Investigation showed negative effects of contaminants on upland plants, particularly in areas of visible contamination.

In summary, it is concluded that PAHs pose ecological risks to the upland, wetland and aquatic communities at the Site, specifically to organisms low in the food chain (i.e., earthworms, insects, shelled organisms, fish and frog embryos, and both upland and aquatic plants).[3] In

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[3] Zinc, which can be found at levels in the thousands of parts per million, poses an ecological risk at the Site as well. Although EPA does not believe that the zinc is site-related, EPA's preferred alternative would address the vast majority of the elevated zinc in the areas where the elevated zinc is co-located with elevated levels of PAHs. When the zinc is not co-located with PAHs, it exists at depth in sediments such that it does not pose a threat to ecological receptors. EPA believes that the zinc most likely came from the adjacent DuPont-Newport Superfund site, where zinc was a major contaminant. EPA notes that there are other zinc sources in the watershed, most notably the NVF Yorklyn site upstream on Red Clay Creek. However, data evaluated during the DuPont-Newport remedy selection process showed that the zinc from

general the aquatic assessment endpoints were more sensitive than the terrestrial assessment endpoints with respect to the calculated NOAEL and LOAEL levels. For the aquatic assessment endpoints the NOAEL was calculated to be 82.87 mg/kg total PAHs and the LOAEL was calculated to be 197.6 mg/kg. For the terrestrial assessment endpoints the NOAEL was determined to be 587 mg/kg total PAHs, with a LOAEL of 1,264 mg/kg.

Based on the results of the risk assessment, EPA has determined that for this Site, a sediment cleanup criteria of 150 mg/kg total PAHs (approximately the geometric mean between the sediment NOAEL of 83 and the LOAEL of 198) and a soil cleanup criteria of 600 mg/kg total PAHs (just above the NOAEL of 587)[4] are the appropriate levels to provide protection to the environment.

7.3 Conclusion of Risk Assessments

EPA has concluded that risks to a construction worker, industrial worker, adolescent trespasser, adolescent swimmer or angler exceed NCP target risk levels for carcinogenic and non-carcinogenic risks. In addition, EPA has concluded that PAHs pose unacceptable ecological risks to the upland, wetland and aquatic communities at the Site. By comparing maps of total PAH values to those of benzo(a)pyrene equivalences ("B(a)P equivalence"), EPA has determined that the cleanup criteria described above will be protective of both the environment and human health for potential future industrial workers and current and future trespassers.

EPA has determined that the remedial action selected in this ROD is necessary to reduce the risks for these receptors to levels within or below EPA's risk range.

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the NVF site was not causing sediment contamination in the vicinity of the Koppers and DuPont sites. Since the time of the DuPont-Newport Record of Decision, work has been conducted to help control zinc discharges in the watershed, which will only further prevent recontamination. In addition, the State has been developing a TMDL for zinc for both the Red Clay Creek and the Christina River, which should help minimize the potential for recontamination in the future.

[4] EPA does not believe that using the geometric mean of the soil NOAEL and LOAEL to determine the soil cleanup criteria would be protective because the result would be much higher and could result in potential for contaminated soil to act as continuing source of contamination to the wetlands. EPA believes that the 600 mg/kg soil cleanup criterion would provide adequate protection to the wetlands, since it is a "not-to-exceed" value that would result in average surface soil concentrations of total PAHs of a much lower value. Once vegetation has been reestablished after the cleanup, the possibility for recontamination is very remote. One hypothetical area where it could happen is if an area of soil was just below the 600 mg/kg soil cleanup criteria and located adjacent to a wetland that was just below the 150 mg/kg sediment cleanup criteria such that erosion could increase the wetland concentration to above 150 mg/kg, thus creating an unacceptable risk. With the fact that the concentration gradients at the Site are steep (i.e., the contamination goes from high to low in a short distance), any areas that would match this condition would be small and would not warrant a change in the soil cleanup criteria.

8.0 REMEDIAL ACTION OBJECTIVES

Based on the information relating to the types of contaminants, environmental media of concern, and potential exposure pathways, Remedial Action Objectives ("RAOs") were developed to aid in the development and screening of alternatives. EPA has established the following RAOs to mitigate and/or prevent existing and future potential threats to human health and the environment:

1. Prevent current or future direct contact with contaminated soils and sediments that would result in unacceptable levels of risk to ecological receptors by reducing levels of total PAHs concentrations to below 150 mg/kg in sediment and 600 mg/kg in soil (150 mg/kg in soil that is to be converted to wetlands);

2. Prevent unacceptable human health risks due to exposure to contaminated ground water;

3. Minimize the on-going contamination of ground water from the presence of NAPL through removal and/or containment;

4. Prevent any direct contact threat to an adult or child trespasser and to an industrial worker;

5. Protect potential future residents from contact with contaminated soil and/or ground water, by preventing the construction of residential buildings on any part of the Site (which is currently prohibited by local zoning; a future zoning change and potential residential use of the Site would require a residential risk assessment scenario and an evaluation by EPA);

6. Restore ground water at the Site to its beneficial use.

9.0 SUMMARY OF REMEDIAL ALTERNATIVES

9.1 Remedial Alternatives Common Elements

During the **Feasibility Study**, various alternatives to cleanup contamination at the Site were developed. EPA evaluated a number of alternatives, including the range of alternatives described in detail below, in order to determine which cleanup method would be best. EPA's preferred alternative is Alternative 4 (see page 23). Further information may be obtained from the Administrative Record.

The alternatives describe possible actions to address contamination in the following areas: 1) upland soils, 2) Hershey Run, 3) the Fire Pond, 4) the South Pond area (the non-tidal South Pond itself and the tidal West Central Drainage area), 5) the K Pond area and 6) ground water. (See Figure 2.)

Each alternative, except the "no action" alternative, contains some common elements that were considered in the evaluation process. The common elements include:

1. Ground Water: Each alternative includes monitoring of dissolved phase contamination in both the Columbia and Potomac aquifers until such a time as contaminant levels fall below levels EPA determines are safe to drink (approximately 20 wells - 10 in the Columbia and 10 in the Potomac aquifer). Although no creosote contamination was found in the Potomac aquifer during the RI, monitoring is necessary to ensure that contamination does not spread into the Potomac, since mobile NAPL was found in the Columbia aquifer. Several new Potomac aquifer wells would be installed closer to the processing areas to aid in this monitoring. DNREC would create a ground water management zone (GMZ) that would include the Site and enough adjacent areas such that pumping wells could not draw contamination from the Site, either laterally or downward into the Potomac. (There currently exists a GMZ encompassing much of the adjacent DuPont-Newport Superfund Site.) The GMZ would have to remain in effect in perpetuity for Alternatives 2 and 3 because they do not fully address ground water contamination, and for Alternative 4 because of the waste remaining in the containment areas (although this could be smaller in size once EPA has determined that ground water outside the containment areas is safe to drink). Under Alternative 5, this GMZ could be lifted once MNA has succeeded in reducing contaminant concentrations to acceptable levels (presumably in 30 years, though possibly more). For those alternatives that include NAPL recovery, a characterization of any recovered NAPL would be conducted in order to determine an optimal method for disposal. For the purposes of estimating costs, it was assumed that all recovered NAPL would be drummed, characterized and disposed of off-site at an appropriate permitted facility (in accordance with CERCLA 121(d)(3)), although it is possible that the creosote NAPL may be suitable for recycling (also in accordance with CERCLA 121(d)(3)). In addition to these measures, each alternative would include an evaluation to be conducted to verify the extent of NAPL at the Site, including along the ballast of the Amtrak railroad line along the northern boundary of the Site.

2. Land-Use Restrictions: Land-use restrictions or institutional controls would be used (1) to ensure that the land was not used for residential purposes or other purposes that would cause a risk to human health due to any contamination that would remain on-site after the cleanup was complete, and (2) to ensure that any activities that may take place on the Site after cleanup do not interfere with any components of the remedy and are conducted in a manner to protect the health of future construction workers. For example, if any structures were to be constructed in the future on top of the containment area, they may be restricted to minimal intrusion into the subsurface in order to protect the cap (e.g., foundations may be restricted to a minimum number of pilings with slab construction above, thereby potentially limiting the size of a structure). These institutional controls could include such things as restrictive covenants, and/or requirements that workers who might come into contact with any remaining contamination on-site be properly protected in accordance with the current Site Health and Safety Plan and/or Operations and Maintenance Manual. The institutional controls may include restrictions that will operate as a covenant running with the land burdening the property such as: (a) activity restrictions (limitations on activities and use which may be conducted on the property, i.e. only those activities which do not interfere with the ongoing protectiveness and effectiveness of the Remedial Action); (b) restrictions on the disturbance of the soil (limitations on activities that could cause interference with or disturbance of the Remedial Action, disturbance of surface soils

or protective Site features, or a risk of soil erosion or exposure to remaining contamination, especially in the containment area); and (c) ground water restrictions (limitations on activities that would use ground water or cause a change in hydraulic conditions that could interfere with the ongoing protectiveness and effectiveness of the Remedial Action).

9.2 Remedial Alternatives

Note that the Total Present Worth Cost for each alternative was calculated using a 7% discount rate and an Operations and Maintenance ("O&M") period of 30 years (unless mentioned otherwise).

Alternative 1 *No Action*

Capital Cost:	$ 0
Annual O&M Costs:	$ 0
Total O&M Costs:	$ 0
Total Present Worth Cost:	$ 0

Under this alternative, no remedial measures would be implemented at the Site to prevent exposure to the sediments, soil, NAPL and ground water contamination. The "no action" alternative is included because the National Contingency Plan (NCP) requires that a "no action" alternative be developed as a baseline for evaluating other remedial alternatives.

Alternative 2 *Covering upland soils; Sediment cap in Fire Pond, South Pond and K Pond; Sheetpile and NAPL collection at Fire Pond and South Pond; Monitored Natural Recovery (MNR) in Hershey Run and tidal wetlands; Monitored Natural Attenuation of ground water contamination*

Capital Cost:	$ 15,934,988
Annual O&M Costs:	$ 125,500 *(for years 1-5)*
	$ 117,500 *(for years 6-30)*
Total O&M Costs:	$ 1,490,864
Total Present Worth Cost:	$ 17,425,852

In addition to the common elements described above, Alternative 2 includes the remedial measures detailed below, according to media. See Figure 8 for the further details.

Soils

In order to protect trespassers and ecological receptors from contaminated soils, this alternative includes the installation of a soil cover on top of the existing grade. This cover would consist of a geotextile layer followed by a 2-foot (ft) soil cover, including a burrow-inhibiting layer of stone, installed over upland surficial soils (0-24 inch layer) containing visual NAPL or total PAH concentrations greater than 600 mg/kg. Approximately 125,000 cy of cover materials would be brought in and placed over a total of 39 acres.

Sediments

In order to protect trespassers and ecological receptors from contaminated sediments, this alternative includes the installation of a 2-ft reactive (sorbent) cap over sediments in the Fire Pond, South Ponds, and K Area (totaling approximately 0.7 acres). This cap will be constructed (from bottom to top) of geotextile, approximately 1 ft of sorbent material (e.g., a mixture of clay, anthracite, and soil that significantly retards potential movement of contaminants through the cap), and 1 ft of sand. This alternative also includes monitored natural recovery of sediments in Hershey Run, Hershey Run Marsh, and the West Central Marsh Drainage.

Ground Water

To prevent future releases of NAPL to surface water and sediments that could cause risks to trespassers and ecological receptors, Alternative 2 includes the installation of approximately 1,000 and 1,100 ft of sealed steel sheetpile walls at the South Ponds and Fire Pond, respectively. This sheetpile would be installed within the Columbia aquifer, keyed into the lower permeability, finer-grained layer underlying the Site at depths ranging from approximately 15 to 30 ft bgs (at the top of the Potomac aquifer). Shallow hydraulic gates would be incorporated into the top of the walls of the sheetpiling to allow ground water to flow through the upper portions of the Columbia aquifer (thus preventing buildup of hydraulic head behind the wall) while NAPL is retained below. In addition, this alternative includes monitoring and passively removing NAPL from interceptor trenches installed behind these sheetpile walls, with the collected NAPL to be disposed of or recycled off-site in accordance with CERCLA 121(d)(3). NAPL would remain in the ground water outside the containment area, preventing the restoration of ground water to its beneficial use.

Alternative 3 *Excavate, consolidate and cap shallow soils and shallow tidal sediments; Cap Fire, K and South Ponds; Sheetpile and NAPL collection at Fire Pond and South Ponds areas; Rechannelization of Hershey Run; Wetlands mitigation; Monitored Natural Attenuation of ground water contamination*

Capital Cost:	$ 40,094,305
Annual O&M Costs:	$ 261,937 *(for years 1-5)*
	$ 261,937 *(for years 6-30)*
Total O&M Costs:	$ 3,250,383
Total Present Worth Cost:	$ 43,344,688

In addition to the common elements described above, Alternative 3 includes the remedial measures detailed below, according to media. See Figures 9 and 10 for the further details.

Soils

In order to protect trespassers and ecological receptors from contaminated soils, this alternative includes the excavation of upland surficial soils containing visual NAPL or total PAH concentrations greater than 600 mg/kg to a depth of 2 ft bgs, followed by consolidation in an on-site containment area (approximately 115,000 cy of surficial soils would be removed over an approximately 35-acre area into a 4-acre containment area in either the former Process area or Drip Track area) which would then be capped with a geomembrane (see Figure 9). The excavated areas would be filled with clean soil to restore the grade. In areas that the soil at 2 ft bgs still remained above the soil cleanup criteria of 600 ppm total PAHs, a geotextile layer would be placed to separate the contaminated soil from the clean soil.

Sediments

In order to protect trespassers and ecological receptors from contaminated sediments, this alternative includes the installation of a cap over sediments in the Fire Pond, South Pond, and K Area as described in Alternative 2.

In addition, Alternative 3 would include the relocation of the channel of the upper portion of Hershey Run, as depicted in Figure 10, so that the new channel would bypass the NAPL-impacted area to the west of the Fire Pond which would be contained using sheetpile (described below). To create the new channel (approximately 800 ft long and 0.8 acre in size), this alternative would require the removal of approximately 6,500 cy of marsh sediment which would be deposited behind the sheetpile to fill the currently existing channel. The new channel would be constructed in such a way as to maximize habitat and control erosion. Additional clean fill would be required within the sheetpile area to bring the grade to the top of the sheetpile (set at approximately 6-ft elevation or high high tide). EPA expects that this area would remain a wetland, although non-tidal.

While the added containment area would enclose the majority of the NAPL underneath Hershey Run and adjacent wetlands, it would not contain all of the NAPL. Therefore, to prevent any NAPL migration to the surface in this area where it could present a risk to trespassers and ecological receptors, the portions of existing Hershey Run that would be outside the containment area yet, due to the geometry, not be part of the new channel, would be capped with 1 ft of reactive cap material and 1 ft of sediments.

In the remainder of the Hershey Run channel (the lower portion) and marsh and the West Central Drainage Areas, surficial sediments (within the upper 1 ft bgs) containing total PAHs greater than 150 mg/kg would be excavated, thus providing protection for trespassers and ecological receptors. This excavation of surficial sediments is expected to generate 23,000 cy over an area of 9 acres.

Where contamination exists below 1 ft bgs, an additional 1 ft of sediment would be excavated and a cap installed. Installation of a cap would inhibit the migration or erosion of PAH-contaminated materials which could recontaminate the wetlands or migrate off-site. The cap constructed in the channel portion of the drainage areas would consist of 0.5 ft of reactive material, on top of which would be placed 1.5 ft of sand, geotextile, and 0.5 ft of armor stone, respectively. The marsh area cap would be of similar construction; however, 0.5 ft of soil would be placed on top of the sand, instead of the geotextile and armor stone, as erosional forces are expected to be less outside the channel in the marsh areas. The additional excavation needed to accommodate the cap is expected to generate 25,000 cy over an area of 6.2 acres. Sediment monitoring would be conducted in wetlands with caps to verify that the contaminated materials remain isolated. Monitoring would also take place where any wetlands were disturbed to ensure that restoration activities were successful.

If any wetland acreage is lost within the containment area, this alternative would, to comply with EPA's Wetlands Policy, include creating replacement wetlands commensurate with the acreage of wetlands filled at the Site (at a minimum ratio of 1:1).

Overall, approximately 55,000 cy of sediments (including about 15% added volume due to stabilization to improve soil properties to support a cap) would be added to the landfill area created with consolidated upland surface soils.

Ground Water

To prevent future releases of NAPL to surface water and sediments where it could cause risks to trespassers and ecological receptors, this alternative includes sheetpile wall installations at the Fire and South Ponds as described in Alternative 2. However, due to the rechannelization of Hershey Run, in Alternative 3 an additional 600 ft of sealed steel sheetpile would be installed in the Fire Pond area to contain subsurface NAPL extending from the Fire Pond underneath wetlands across Hershey Run from the pond (See Figure 10). The sheetpile in the marsh would be set at or above the high high-tide elevation to preclude consistent surface water inundation. NAPL would remain in the ground water outside the containment area, preventing the restoration of ground water to its beneficial use.

Alternative 4 *Excavate, consolidate and cap all contaminated soils and sediments; Subsurface ground water barrier wall around consolidation area(s) with passive NAPL recovery; Restoration of ground water through excavation of NAPL-contaminated aquifer material outside of consolidation areas; Rechannelization of Hershey Run; Wetlands mitigation; Monitoring of ground water contamination*

Capital Cost:	$ 49,837,587
Annual O&M Costs:	$ 227,267 *(for years 1-5)*
	$ 118,767 *(for years 6-30)*
Total O&M Costs:	$ 1,918,652
Total Present Worth Cost:	$ 51,756,239

In addition to the common elements described above, Alternative 4 includes the remedial measures detailed below, according to media. See Figure 11 for the further details.

Soils

In order to protect trespassers and ecological receptors from contaminated soils, soil would be excavated as in Alternative 3 (soil with visible NAPL or total PAHs above 600 mg/kg). In addition, excavation would continue in those areas where wetlands are to be created until the total PAH concentration was 150 mg/kg or below. Excavation depths will potentially reach as deep as 30 ft bgs in a few locations, although the average excavation depth is expected to be 5 to 15 ft. Instead of backfilling the excavated areas, the areas would be graded appropriately, and wetlands would be created, minimizing the increase in cost over a shallower excavation since no outside fill would be needed. An estimated 113,000 cy of soil would be excavated and consolidated into two on-site landfills. The location of the landfills would coincide with the areas of upland that have the greatest amount of NAPL in soil and the ground water, thus reducing the amount of excavation required and allowing the landfills and the NAPL recovery areas (described below) to be located together. The two landfills would cover approximately 38 acres and would be used to contain all contaminated material excavated as part of this alternative. This alternative would allow for the cover material (over the geomembrane) to come from areas of the Site with clean soil. This fits with one possible reuse of the Site - wetland creation - since extra excavation would be required to create the wetlands. The cost estimate for this alternative assumes that the cover material is coming from an on-site source (borrow area).

Sediments

In order to protect trespassers and ecological receptors from contaminated sediments, this alternative would involve the complete excavation (and consolidation into on-site landfills) of contaminated sediments (containing total PAHs above 150 mg/kg) in the Fire Pond, South Pond, K Area, West Central Drainage Area, lower Hershey Run and the marsh adjacent to the upper portion of Hershey Run. The depth of excavation ranges from 0 to 13 ft with an average of 2-4 ft. Restoration activities would take place as appropriate to provide suitable ecological habitat. Backfilling shall be required to restore the original stream profile, unless it can be otherwise shown, as determined by EPA, that an alternate design may be hydrodynamically stable and ecologically advantageous. If that is the case, there would likely be a cost savings associated with the reduction in need for backfill. The use of minor backfilling may be able to effectively increase the diversity of the wetland types at the Site.

As in Alternative 3, this alternative would involve the rechannelization of upper Hershey Run to allow the installation of sheetpile and passive NAPL recovery (see below). Any wetland acreage that was lost would be replaced at the Site. It is estimated that a total of approximately 75,000 cy of stabilized sediments would be added to the consolidation area (including a 15% increase in volume for stabilization to improve soil/sediment properties to support a cap).

Ground Water

In order to achieve the restoration of ground water, NAPL-contaminated aquifer material located outside of the containment areas would be excavated to depth (generally 5 to 15 ft deep, and occasionally to 30 ft) and isolated in the on-site landfills (as described above). To prevent future releases of NAPL to surface water and sediments that could cause risks to trespassers and ecological receptors, as well as to control the source of ground water contamination, this alternative includes the sheetpile and passive NAPL collection in the area of the Fire Pond as in Alternative 3, with the extensive addition of sheetpile or other low permeability ground water barrier[5] (and associated passive NAPL recovery) around the two landfills. The landfills would be located over the areas of most extensive NAPL contamination where NAPL, based on

[5]The cost estimate assumed 1,375 ft (25%) of sheetpile and 4,125 ft (75%) of slurry wall.

observations during the RI, may still be mobile. This alternative also includes the excavation of NAPL material from below the wetlands in the South Pond and adjacent West Central Drainage area, as well as from the K area. By aggressively addressing these NAPL areas (i.e., the sources of contamination), natural attenuation would restore the ground water outside of the containment area to its beneficial reuse, and no sediment caps would be required to prevent the recontamination of the wetlands. The passive NAPL recovery trenches would also be used to manage the level of ground water inside of the barrier walls, draining ground water for surface discharge (following treatment via oil-water separation and carbon filtration, if necessary). Monitoring of ground water and sediments would be conducted to verify the effectiveness of containment and the continued attenuation of any dissolved phase contamination.

Studies, including ground water modeling as appropriate, would be conducted during the Remedial Design to determine the optimal configuration for the passive NAPL recovery trenches and system, and would specifically seek to minimize the complexity of the system and, to the extent possible, minimize the need for ground water treatment prior to discharge. Given the mobility of NAPL at the Site, as demonstrated by the extent to which NAPL has already migrated beneath and into the Hershey Run marsh, EPA believes that passive NAPL recovery would successfully and significantly reduce the volume of mobile NAPL at the Site. At the same time, this NAPL recovery system would provide the opportunity for managing ground water (as described above). If monitoring shows that it is necessary to ensure compliance with the substantive requirements of the NPDES program and State Water Quality Standards, ground water drained through the recovery trenches would be treated using an oil-water separator and/or carbon filtration system in order to remove any contamination before it is discharged to surface water.

Alternative 5 *In-situ steam-enhanced extraction of subsurface NAPL; excavation and off-site treatment of sediments and certain soils; Wetland restoration; Monitored Natural Attenuation of ground water contamination*

Capital Cost:	$ 189,365,815
Annual O&M Costs:	$ 169,000 *(for years 1-5)*
	$ 87,500 *(for years 6-30)*
Total O&M Costs:	$ 1,419,957
Total Present Worth Cost:	$ 190,785,772

In addition to the common elements described above, Alternative 5 includes the remedial measures detailed below, according to media. See Figure 12 for the further details.

Soils

Upland soils containing visual, weathered NAPL would be excavated and transported off-site for treatment via low temperature thermal desorption (LTTD) and then landfilled in accordance with Section 121(d)(3) of CERCLA and 40 C.F.R. §300.440. In addition, upland soils with total PAH concentrations greater than 600 mg/kg that are outside of the area undergoing *in-situ* steam-enhanced extraction (see description below for ground water) would be excavated to a depth of 2 ft bgs and treated off-site. The excavated areas would be backfilled with clean fill and revegetated. Approximately 106,000 cy of surficial soils would be removed and backfilled over a 33-acre area. A staging area would be constructed in the former Process or Drip Track areas.

Sediments

The sediments in the Fire Pond, South Ponds, and K Area would be addressed as part of the *in-situ* steam-enhanced extraction at the subsurface NAPL areas (see below).

As described in Alternative 3, the upper portion of Hershey Run would be rechannelized so that the new channel would bypass the NAPL-impacted area adjacent to the Fire Pond (which would be addressed through *in-situ* steam-enhanced extraction, as described below under for ground water). Although the NAPL would eventually be addressed by the *in-situ* steam-enhanced extraction, the rechannelization and sheetpile would be necessary to prevent Hershey Run from becoming an infinite heat sink, substantially increasing fuel costs and likely preventing the appropriate temperature increase.

All surface and subsurface sediments containing total PAHs greater than 150 mg/kg would be excavated from the lower portion of Hershey Run, Hershey Run Marsh to the west of the proposed sheeting, and the West Central Drainage Area waterway and marsh, with removal depths up to 13 ft. The excavated sediments would be treated and disposed of along with the soils, as described above.

Ground Water

To prevent future releases of NAPL to surface water and sediments where it could cause risks to trespassers and ecological receptors, as well as to restore ground water to its beneficial use through source control and natural attenuation, NAPL contamination would be addressed through thermally-enhanced *in-situ* extraction. The particular thermal enhancement proposed is known as "steam injection" or dynamic underground stripping. This technique would be used to remove subsurface NAPL at all upland areas and subsurface NAPL beneath the Fire Pond and South Ponds areas.

In-situ steam-enhanced extraction would require steam to be generated at the surface and injected into arrays of injection wells in an effort to heat the subsurface NAPL zones and recover NAPL through multi-phase extraction wells. During steam injection, some of the NAPL constituents would distill or volatilize, become more mobile, and could then be removed via extraction wells. Due to the high heat and oxygen introduced in the steam, some NAPL would be destroyed through physical and chemical degradation. The injection and extraction wells would be spaced according to the depth of the impacted zones, which may range from approximately 5 to 15 ft bgs, and in some cases up to 30 ft bgs. Because of the shallow depth of the target zone, the soil surface would have to be covered, potentially with asphalt, to prevent steam from venting at the surface. Steam, liquid, and noncondensible gases would be removed from the ground and captured in a recovery system, where fluid separation and treatment technologies would be required. Recovered NAPL would be retained in storage tanks prior to transport and off-site incineration. Three-phase resistive heating may be used as a complement to *in-situ* steam injection in an effort to heat low-permeability soil zones within the target areas. As part of the pre-design investigation, an extensive pilot study would first be required to develop process control parameters.

Infrastructure would be constructed at the Site including an electrical supply grid, steam boilers, boiler fuel supply such as propane or natural gas, injection and extraction wells, steam conveyance piping, recovered fluids conveyance piping, and a network of roads to access all of the treatment areas. The fluid separation system would separate vapors, liquids, and NAPL. A vapor treatment system would be designed and constructed to treat recovered vapors prior to discharge to the atmosphere. A water treatment system would be designed and constructed to treat recovered liquid prior to discharge.

Once the steam injection and extraction is completed (over a period of several years), monitored natural attenuation would allow for the eventual restoration of ground water at the Site to a beneficial use (potentially in 30 years).

10.0 EVALUATION OF ALTERNATIVES

The five remedial alternatives described above were evaluated in detail to determine which would best meet the requirements of the Comprehensive Environmental Response, Compensation and Liability Act of 1980, as amended, ("CERCLA") and the NCP, and achieve the remedial action objectives identified in section 8.0 of this ROD. EPA uses the nine criteria set forth in the NCP, 40 C.F.R. §300.430(e)(9)(iii), to evaluate remedial alternatives. The first two criteria (overall protection of human health and the environment, and compliance with applicable or relevant and appropriate requirements ("ARARs")) are threshold criteria. The selected remedy must meet both of these threshold criteria (except when an ARAR waiver is invoked). The next five criteria (long-term effectiveness and permanence; reduction of toxicity, mobility or volume through treatment; short-term effectiveness; implementability; and cost) are the primary balancing criteria. The remaining two criteria (state and community acceptance) are referred to as modifying criteria and are taken into account after public comment is received on the Proposed Remedial Action Plan.

The following discussion summarizes the evaluation of the five remedial alternatives developed for the Site against the nine evaluation criteria.

Overall Protection of Human Health and the Environment

A primary requirement of CERCLA is that the selected remedial action be protective of human health and the environment. A remedy is protective if it reduces, to acceptable levels, current and potential risks associated with each exposure pathway at a site.

The "no action" alternative (Alternative 1) does not meet this threshold criterion for several reasons. Without any active remediation at the Site, a number of risks (both current and potential) would remain, including: (1) risks would remain for potential future industrial or construction workers from exposure to both soil and ground water; (2) current risks would remain to ecological receptors in aquatic areas such as the Fire and South Ponds, the K Area, Hershey Run and associated wetlands and in upland soil areas; (3) potential future risks to

ecological receptors could increase if the Site were developed to increase wetland acreage; and (4) while not readily quantifiable, risks to trespassers would remain from exposure to NAPL that can be released while wading in sediments in Hershey Run. Since the "no action" alternative does not meet this threshold criterion, it will not be considered any further.
Each of the other alternatives (Alternatives 2, 3, 4, and 5) would offer protection of human health from soil contamination through the use of institutional controls to prevent future use of the Site for residential purposes and to ensure that any industrial use was conducted in such a way as to ensure the protection of workers.

For human health risks due to ground water, each alternative would initially address risks through the creation of a ground water management zone (GMZ) by the State of Delaware that would prevent any drinking water wells from being installed. Each alternative would include monitoring until the ground water is restored to its beneficial use (which for Alternatives 2 and 3 could practically be forever). Alternatives 2, 3 and 4 would control NAPL to varying degrees with the use of ground water barrier walls, creating areas that would not be cleaned up and would rely solely on the GMZ. Additionally, Alternative 4 would excavate NAPL found outside of the consolidation areas and provide for complete containment of NAPL through far more extensive barrier walls. Alternative 4 is further augmented by extensive efforts to passively recover NAPL within the containment areas. Alternative 5 would aggressively address NAPL with *in-situ* steam-enhanced extraction followed by monitored natural attenuation to finish the cleanup. Only Alternatives 4 and 5 provide overall protection to human health from ground water risks and restoration of ground water to its beneficial use (one of the RAOs), thus restoring the ground water to its beneficial use.

In regard to protection of the environment, each of the alternatives would protect upland species. Alternatives 2 and 3 would provide a clean "living layer" of soil by either covering soil contamination (soil with total PAH concentrations above 600 mg/kg) with clean soil (Alternative 2) or by removing and replacing the top layer of soil (Alternative 3). Alternative 4 would address risks from upland soil by removing all soil that is above the Site-specific soil cleanup criteria of 600 mg/kg with replacement (whole or partial) possibly occurring depending on the type of habitat desired. Alternative 5 addresses these risks by removing contamination through a combination of excavation (when weathered NAPL is visible) and removal and/or destruction of contaminants through *in-situ* steam-enhanced extraction.

Alternative 2 would involve sediment caps in the Fire Pond, South Pond, and K Area to prevent receptors from coming into contact with contamination. Sheetpile would be installed at the Fire Pond and the South Pond, along with passive NAPL collection, to prevent NAPL migration to water bodies. However, Alternative 2 would not be protective in Hershey Run because, like the "no action" alternative, it would not address NAPL and PAHs in the sediments of lower Hershey Run except through natural recovery. EPA does not believe that natural recovery could reduce the risks posed by the sediments in lower Hershey Run because of the amount of contamination present. In addition, this material was used in the wood treating industry to prevent biodegradation of wood. Any biodegradation that would take place would do so at a slow rate.

Alternative 3 would also involve sediment caps in the Fire Pond, South Pond, and K Area to prevent receptors from coming into contact with contamination. In addition, aquatic risk in

Hershey Run and the adjacent marsh and the West Central Drainage area would be addressed by excavating the top 2 ft with a reactive cap placed in areas where elevated levels of contamination remained below. Sheetpile would also be installed at the Fire Pond (although over a greater area to enclose more NAPL, but resulting in the need to rechannelize Hershey Run) and the South Pond, along with passive NAPL collection, in order to prevent NAPL migration to water bodies and to mitigate an on-going source of contamination to the water bodies.

Alternative 4 would address risks to aquatic receptors by aggressively excavating all sediment above the site-specific cleanup criteria of 150 mg/kg total PAHs in the South Pond, K Area, Hershey Run and adjacent marsh and the West Central drainage area. Risks in the Fire Pond would be addressed by filling the Fire Pond as part of the consolidation of contaminated soils and sediments.

Alternative 5 would address risks to aquatic receptors by removing and/or destroying subsurface contamination using *in-situ* steam-enhanced extraction, and by removing all contaminated sediments for treatment off-site.

In terms of comparison, EPA believes Alternatives 4 and 5 provide the highest degree of overall protection of human health and the environment since they address all of the risks, provide the most aggressive cleanup and rely the least on institutional controls. Alternative 3 provides a greater degree of protection compared to Alternative 2 since it provides for a greater degree of capture of NAPL at the Fire Pond/Hershey Run area and addresses contaminated sediments in lower Hershey Run and the West Central Drainage area.

Compliance with ARARs

This criterion addresses whether a remedy will meet all of the applicable or relevant and appropriate requirements ("ARARs") of federal and state environmental and facility siting laws and/or will provide grounds for invoking a waiver.

Any cleanup alternative selected by EPA must comply with all applicable or relevant and appropriate federal and state environmental requirements or, under certain conditions, waive one or more ARARs. Applicable requirements are those substantive environmental standards, requirements, criteria, or limitations promulgated under federal or state law that are legally applicable to the Remedial Action to be implemented at a site. Relevant and appropriate requirements, while not being directly applicable, address problems or situations sufficiently similar to those encountered at a site such that their use is well-suited to the particular site. EPA is not waiving any ARARs for this Site.

Alternatives 2, 3, 4 and 5 each meet this threshold criterion. Some of the major ARARs for the Site include:

1. State and Federal water and air discharge requirements – Air emissions for any excavation or on-site treatment; water discharge or re-injection for de-watering during construction activities and for ground water collected in the recovery of NAPL.

2. State Water Quality Standards – State water quality standards will be attained during any Remedial Action taken. Any surface water discharge will meet the substantive requirements of the NPDES program and will be monitored to ensure compliance with these standards.

3. National Historic Preservation Act – Due to the long industrial and prior history of this Site, additional cultural resources surveys must be conducted prior to the beginning of any Remedial Action. If cultural resources are found that are on, or eligible for, the National Register of Historic Places and would be impacted by the cleanup, including being covered by a cap or disturbed by excavation, mitigation activities may be required.

4. RCRA Hazardous Waste Disposal Regulations – Since creosote is a listed waste, off-site disposal costs would be high. All creosote ultimately left on-site would be consolidated within an "area of contamination" without triggering RCRA's "land-ban" regulations.

5. Ground Water Regulations **(Maximum Contaminant Levels or MCLs and non-zero Maximum Contaminant Level Goals or MCLGs)** – The ground water at the Site is a Class IIB aquifer, meaning that it is a potential source of drinking water. As such, MCLs and MCLGs are relevant and appropriate requirements. Only Alternatives 4 and 5 would meet these ARARs because only these alternatives aggressively address the NAPL (the source of the ground water contamination) outside of any area of consolidation or waste management area. Note that Section 300.430(f)(5)(iii)(A) of the NCP states that performance (for example, attainment of ARARs) shall be measured at appropriate locations in the ground water, surface water, etc. The preamble to the NCP explains that for ground water, remediation levels should generally be attained throughout the contaminated plume or at and beyond the edge of a waste management area when waste is left in place (55 FR 8753). Alternatives 2 and 3 would require an ARAR waiver in order to be selected as the cleanup for the Site.

6. Wetlands Regulations – Any activity at the Site which will permanently fill wetlands must include the creation of compensatory wetlands resulting in no net loss of wetlands acreage at the Site.

A complete list of ARARs for the selected remedy for the Site is presented in Table 8.

Long-term Effectiveness and Permanence

This criterion considers the ability of an alternative to maintain protection of human health and the environment over time. The evaluation takes into account the residual risk remaining from untreated waste at the conclusion of remedial activities, as well as the adequacy and reliability of containment systems and institutional controls.

Since any containment system requires on-going Operations and Maintenance (O&M), Alternative 5, which includes *in-situ* treatment and excavation and off-site disposal, offers the highest degree of long-term protection because it would permanently remove contamination from the Site. The other alternatives that include containment on-site do provide long-term effectiveness, although to significantly varying degrees.

Of the on-site containment alternatives, Alternative 4 offers the highest degree of long-term effectiveness and permanence because all of the contamination is consolidated into two areas. Alternatives 2 and 3 leave more contamination in the wetland areas (Alternative 2 does not address NAPL contamination in lower Hershey Run) and rely on sediment caps to prevent recontamination (note that generally only an additional 2 ft of excavation would be required to remove all of the contamination and eliminate the need for the sediment caps). The inclusion in Alternative 4 of NAPL recovery from within the containment area would provide an additional degree of long-term effectiveness and permanence by removing NAPL that otherwise that may have the potential to flow downward into the Potomac. Alternatives 2 and 3 would be more susceptible to waste being exposed during severe storm or other erosional event as compared to Alternative 4.

Reduction of Toxicity, Mobility or Volume of Contaminants through Treatment

This evaluation criterion addresses the statutory preference for selecting remedial actions that employ treatment technologies that permanently and significantly reduce the toxicity, mobility, or volume of the hazardous substances as their principal element. This preference is satisfied when treatment is used to reduce the principal threats at a site.

Alternative 5, by including *in-situ* extraction of subsurface NAPL, would provide the highest degree of reduction in the toxicity, mobility or volume of contaminants. The steam injection would destroy some contamination and would remove a majority from the environment, to be disposed of off-site.

The other alternatives would include sheetpiling and passive recovery (with off-site treatment and disposal) of NAPL (with Alternative 4 offering the most extensive recovery) that would provide for a reduction of the volume and mobility of NAPL.

Short-term Effectiveness

This evaluation criterion addresses the effects of the alternative, during the construction and implementation phase until remedial action objectives are met. It considers risk to the community and on-site workers and available mitigation measures, as well as the time frame for attainment of the response objectives.

The construction of a soil cover or engineered cap in Alternatives 2, 3 and 4 would involve the delivery of a significant amount of clean soil, creating risks due to traffic through the small town of Newport and the Ciba Specialty Chemicals facility. This would be minimized by avoiding or minimizing the need for imported fill (i.e., through the use of clean soil from the Site for Alternative 4), and through the use of flag men and a zero-tolerance policy on speeding by the truck drivers.

The use of erosion and surface water control measures in each of the alternatives would minimize the potential for any release of contaminated sediment or soil to Hershey Run and White Clay Creek during construction. There is a chance for an air release of dust and contamination during excavation and when stockpiled material is stabilized or graded (a common element to several alternatives), but this can be monitored and controlled. Dust will have to be controlled during construction for any of the alternatives.

Alternative 5 offers the lowest degree of short-term effectiveness since it would take the longest to complete and would involve potential impacts due to the transportation of contaminated soil for off-site treatment and disposal. In addition, Alternative 5 includes the risk that high-temperature steam or contamination could escape to the air during the *in-situ* treatment.

From one aspect, Alternative 2 offers the highest degree of short-term effectiveness since it could be implemented in the shortest time period and would disturb the least acreage of the Site, minimizing the potential for a release of contamination during construction. However, Alternative 2 would not involve any steps to reduce risk in lower Hershey Run. Alternatives 3 and 4 provide nearly the same degree of short-term effectiveness, with Alternative 4 providing slightly less because it involves the disturbance of more contaminated material.

Implementability

The evaluation of alternatives under this criterion considers the technical and administrative feasibility of implementing an alternative and the availability of services and materials required during implementation.

Each of the alternatives is implementable, and the services and materials required for each alternative are readily available. However, some would be more difficult to implement than others.

Alternatives 2 and 5 would be significantly more difficult to implement since they would require far more truck trips to bring in or remove material. This truck traffic would have to pass through an operating chemical plant, then through a small town. The added traffic burden to both the plant and the town is likely to meet some resistance, in addition to posing safety hazards for both.

Alternatives 2, 3 and 4 use simple construction techniques that are well understood. Alternatives 3 and 4 would require the minimum truck traffic of all of the alternatives. Alternative 4 has the added benefit of localizing the construction of containment systems into just two areas, rather than the widespread construction of caps and covers included in Alternative 3. In addition, both Alternatives 3 and 4 would excavate sediments in Hershey Run. However, Alternative 3 also proposes to construct caps where contamination extends to depth. Alternative 4 does not require capping over widespread areas of the Site, but instead increases the depth of excavation, introducing some difficulties associated with any deeper excavation (e.g., slope stabilization).

Alternative 5 utilizes complex technology that is not widely regarded as proven and is by no means simple. In addition to a great deal of equipment that would have to be brought in, Alternative 5 would require the most infrastructure to be built at the Site.

Each of the alternatives (besides "no action") requires construction within a floodplain, which presents several difficulties. Steps must be taken to make sure that, for example, soil or sediment is not washed downstream if an extreme storm event occurs during construction.

In addition, each of the alternatives requires actions to be taken in the wetlands on-site. Numerous difficulties are presented when working in a wetland, specifically related to the prevalence of soft ground and the added difficulty of de-watering all excavated or dredged materials. However, these difficulties are neither unique nor insurmountable.

Cost

Alternative 4 is the most cost-effective alternative. In evaluating the costs for the alternatives, it is worth noting that the O&M costs may appear high for Alternative 4 due to the inclusion in that alternative of extensive efforts to passively recovery NAPL and manage ground water. For Alternative 5 the O&M costs may appear low due to the inclusion of the operating costs of the *in-situ* steam extraction with the capital cost as part of the alternative. Under the preferred alternative, NAPL recovery would be expected to taper off, which would reduce O&M costs. Alternatives 2 and 3 do not include aggressive efforts to recover NAPL, nor do they include provisions to manage ground water, which could build up behind the containment areas and potentially re-contaminate wetlands. The high O&M costs associated with Alternative 3 are largely due to the need to maintain caps and wetlands across a large area for 30 years.

Several points stand out when evaluating the costs. First, there is a large increase in cost for Alternative 5, as compared to Alternatives 2, 3 and 4. Alternatives 2 through 4 are containment remedies. Alternative 5 has been included as representative of a treatment remedy – other treatment remedies were considered in detail in the Feasibility Study. Some treatment remedies were less costly (i.e., solidification/stabilization at approximately $85 million), and others were more costly (i.e., *in-situ* thermally-enhanced extraction of subsurface NAPL combined with excavation and off-site incineration of soils and sediments at approximately $280 million). Second, the preferred alternative, Alternative 4, is approximately $8.4 million more costly than Alternative 3. For this increase in cost, Alternative 4 restores ground water outside the containment area to its beneficial use and consolidates all of the contamination to two areas, thus avoiding long-term monitoring of vast areas of wetlands for recontamination.

The Alternative Cost Summary Table (see Table 9) summarizes the capital, annual operation and maintenance ("O&M"), and total present worth costs for each alternative. The total present worth is based on an O&M time period of 30 years for the engineered cover, containment, NAPL recovery and ground water treatment systems. A discount rate of 7% was used on the present worth calculation. For an additional cost estimate breakdown, see the Administrative Record.

State Acceptance

DNREC has reviewed comments from the public and the Record of Decision, and concurs with the selected remedy

Community Acceptance

From October 7, 2004 to December 7, 2004, EPA held a 60-day public comment period to accept public comments on the remedial alternatives presented in the *Feasibility Study* and the Proposed Plan and the other documents contained within the Administrative Record for the Site. On October 21, 2004, EPA held a public meeting to discuss the Proposed Plan and accept comments. A transcript of this meeting is included in the Administrative Record. The summary of significant comments received during the public comment period and EPA's responses are included in the Responsiveness Summary, which is a part of this Record of Decision.

11.0 SELECTED REMEDY

Following review and consideration of the information in the Administrative Record, the requirements of CERCLA and the NCP, and public comment, EPA has selected Alternative 4 (see page 23), as the remedy for the Koppers Site.

11.1 Summary of the Rationale for the Selected Remedy

EPA's preferred alternative meets the threshold criteria of overall protection to human health and the environment and compliance with ARARs.[6] Based on the information currently available, EPA (the lead agency) believes Alternative 4 provides the best balance of tradeoffs among the alternatives with respect to the balancing criteria. For example, EPA's preferred alterative:

1) will be protective of both human health and the environment in the least amount of time;

2) will, compared to Alternatives 2 and 5, have significantly less impact to the community during construction; and

3) is the least costly of the alternatives that provide overall protection to human health and the environment.

Alternative 4 also offers the highest degree of State acceptance since it provides for the maximum flexibility in the reuse of the Site. In addition, EPA's preferred alternative is consistent with EPA's ground water policy and policies pertaining to the removal and/or containment of NAPL. Overall, EPA's preferred alternative satisfies the statutory requirements

[6]Note that while each alternative, (other than the "no action" alternative) addresses some of the risks at the Site, the only other alternative to completely meet these threshold criteria was Alternative 5.

of CERCLA §121(b) by being protective of human health and the environment; complying with ARARs; being cost-effective; utilizing permanent solutions and alternative treatment technologies to the maximum extent practicable; and satisfying the preference for treatment as a principal element.

11.2 Description of the Selected Remedy and Performance Standards

Based on the comparison of the nine criteria, EPA's preferred alternative is Alternative 4. The total present worth cost of EPA's preferred alternative is $51,760,000. In addition to the common elements described on page 17 (e.g., ground water monitoring and institutional controls), the major components of Alternative 4 (as discussed in detail on page 23) are:

The selected remedy includes:

1. Excavating and consolidating all contaminated soils and sediments (soils with total PAHs greater than 600 mg/kg and sediments with total PAHs greater than 150 mg/kg) into one or two on-site landfills or containment areas, herein referred to collectively as "the Containment Area," to be located in the areas of the worst NAPL contamination;

2. Installing, operating and maintaining a ground water treatment system (e.g., liquid carbon filtration) to prevent the migration of contaminated ground water, as well as to prevent the discharge of contaminated ground water from the recovery operation; and an oil-water separator (e.g., belt skimmer or baffle tank) to facilitate the recovery of free-phase NAPL, as well as to prevent NAPL from reaching the ground water treatment system;

3. Treating ground water as necessary to meet discharge requirements;

4. Constructing ground water barrier walls and collection systems (e.g., passive recovery trenches) in the Containment Area to prevent further migration of ground water contamination, including NAPL;

5. Managing the hydraulic head of ground water and collecting NAPL contamination in the ground water through the use of the passive recovery trenches;

6. Separating creosote from ground water and transporting creosote off-site for disposal or recycling in accordance with Section 121(d)(3) of CERCLA;

7. Moving debris to a location on-site where they can be placed under the RCRA (Resource Conservation and Recovery Act) modified cap;

8. Installing a RCRA modified cap across the Containment Area;

9. Relocating a portion of the existing channel of Hershey Run, if the Containment Area shall extend into the Hershey Run wetlands;

10. Creating wetlands to replace any that are filled in as part of the landfill construction;

11. Monitoring ground water, surface water, sediments and wetlands to ensure the effectiveness of the remedy;

12. Prevent exposure to contamination inside the Containment Area or in ground water beneath the Site, and prevent the drawdown of contamination into the deeper aquifer or elsewhere, through land and ground water use restrictions for the Site and surrounding area (as appropriate).

Institutional controls shall be implemented in order to ensure the effectiveness of the remedial action. The selected remedy shall meet all applicable or relevant and appropriate requirements contained in the attached Table 8.

11.2.1 Excavate and Consolidate Contaminated Soils and Sediments

Soils and sediments exceeding cleanup criteria shall be excavated and consolidated on-site into one or two containment areas (referred to as the "Containment Area") with amendments for geotechnical stabilization added as necessary to achieve adequate compaction and slope stability. The exact location and configuration of the Containment Area will be determined during the remedial design, and subject to EPA approval. Roads constructed for the purpose of excavating sediments shall be constructed in a manner to minimize disturbance to wetlands.

Performance Standards for Excavating and Consolidating Contaminated Soils and Sediments

1. Develop and follow plans for excavation near any historic structures in accordance with the National Historic Preservation Act of 1966, as amended.

2. Translocate faunal populations present in intended excavation areas to alternate suitable locations in advance of excavation activities.

3. In areas lying outside the boundary of the Containment Area (as described in 4, below), excavate all soils and sediments having PAHs present at concentrations greater than 600 mg/kg and 150 mg/kg respectively (the soil and sediment cleanup criteria); excavation depths on average will be 5-15 ft, with a few locations expected to reach depths of 30 ft.

4. Consolidate all excavated material into a Containment Area(s) to be located approximately within the former Process Area (the portion of the upland nearest the active railroad tracks and the Fire Pond; see Figure 11).

5. Air emissions during Site grading activities shall comply with the substantive requirements of Delaware emission standards and Delaware regulations governing toxic air pollutants.

6. Any NAPL discovered during excavation or grading activities shall be collected and managed on-site in compliance with substantive requirements of regulations applicable to generators of hazardous waste; and treated and/or disposed of off-site at a RCRA

hazardous waste facility, in compliance with the permitting and other requirements of RCRA and applicable state hazardous waste regulations.

7. All excavation activities that will affect wetlands, floodplains, or waters of the United States shall be conducted in accordance with the substantive requirements of Federal Regulation of Activities in or Affecting Wetlands/Floodplains, 40 C.F.R. Sections 6.302(a) and (b), and Delaware Water Management: Construction on Non-tidal Waters and Floodplains regulations.

11.2.2 Install, Operate and Maintain a Ground Water Collection and Treatment System

Prevent the migration of contaminated ground water and facilitate the recovery of free-phase NAPL through the installation, operation and maintenance of a ground water collection and treatment system (to be supplied with ground water from the passive collection systems described in Sections 11.2.4 and 11.2.5).

Ground water from within the Containment Area shall be contained, collected and treated as necessary on-site, by using a constructed ground water and NAPL containment and recovery system to achieve the following performance standards. The ground water collection and treatment system consists of four main components: (1) ground water treatment system (e.g., liquid carbon filtration; see 11.2.2 and 11.2.3); (2) sub-surface barrier walls to provide containment and isolate contaminated ground water from clean ground water and from tidal influences (see 11.2.4); (3) collection trenches, drainage ways, piping, and associated pumping and NAPL/water separation equipment (see 11.2.4); and (4) an impervious protective cover to prevent direct contact and excessive rainwater infiltration (see 11.2.8).

Performance Standards for Ground Water Collection and Treatment System

1. Prevent the migration of contaminated ground water from the Containment Area and facilitate the recovery of free phase NAPL from the Containment Area through the installation, operation and maintenance of a ground water collection (e.g., holding tanks) and treatment system (e.g., liquid carbon filtration or equivalent technology) on-site.

2. Operate and maintain the ground water collection and treatment system until NAPL is no longer recovered and ground water contamination levels are such that contamination will not spread beyond the Containment Area for a period of three consecutive years. EPA approval shall be required in the determination that these conditions have been met.

3. Separate collected NAPL from collected ground water and prevent NAPL from reaching the ground water treatment system through the installation, operation and maintenance of an oil-water separator (e.g., belt skimmer or baffle tanks).

11.2.3 Treat Collected Ground Water as Necessary to Meet Discharge Requirements

Collected ground water shall be treated to achieve NPDES discharge requirements (for example, through the use of liquid carbon filtration or equivalent technology). The treated ground water shall be discharged to Hershey Run, the Christina River, or possibly the publicly owned treatment works ("POTW"; the final discharge location and configuration shall be determined during the design, subject to EPA approval).

Performance Standards for Treating Collected Ground Water as Necessary to Meet Discharge Requirements

1. Collected ground water shall be treated prior to discharge to comply with the substantive requirements of the National Pollutant Discharge Elimination System ("NPDES") program and the Delaware Regulations Governing the Control of Water Pollution and monitoring requirements.

2. Treated collected ground water shall be discharged to either Hershey Run, the Christina River or the local POTW.

3. A capacity evaluation shall be completed during the remedial design to determine if additional treatment capacity is required. The evaluation shall consider the volume of ground water currently being collected, and the volume, with a safety factor, that could reasonably be assumed to be collected during a wet weather year. The evaluation shall be documented and submitted to EPA in a report. Based on the capacity evaluation report, which shall be updated every two years (unless otherwise specified by EPA), EPA will determine if expansion is necessary to prevent untreated ground water from bypassing the containment system. If expansion or other modifications are deemed necessary by EPA, the system shall be modified accordingly.

4. Treatment system components shall be maintained and replaced, as necessary, to minimize downtime and equipment leaks, and to maximize treatment performance.

5. Monitoring reports shall be submitted to EPA at such frequency and in such detail to allow EPA to determine whether or not the NAPL recovery and ground water treatment systems are in compliance with this ROD and, in particular, whether performance standards 1 through 3 above have been achieved and are being maintained.

6. On-site handling of hazardous waste and solid waste, resulting from the operation of the ground water treatment plant, shall be in accordance with ARARs. Waste resulting from the operation of the plant shall be disposed of off-site. Off-site disposal and handling shall be in accordance with State and Federal waste laws and regulations, as set forth in Section 121(d)(3) of CERCLA and 40 CFR 300.440. Waste streams shall be characterized on a yearly basis, unless regulations require more frequent characterization.

11.2.4 Construct Ground Water Barrier Walls and Collection Systems

Prevent the horizontal migration of contaminated ground water and/or creosote NAPL through the construction and installation of subsurface ground water barrier walls (e.g., slurry walls or sheetpiling). Collect accumulating ground water and creosote NAPL for recovery and treatment through the construction and installation of a collection system such as a stone-filled passive recovery trench (with associated piping, drainage structures and collection sumps to direct collected ground water to the oil-water separator and ground water treatment system described in Section 11.2.2).

Performance Standards for Ground Water Barrier Walls and Collection Systems

1. Prevent the horizontal migration of contaminated ground water and creosote NAPL by means of ground water barrier walls installed to surround the Containment Area on all down-gradient sides. The barrier walls shall be impermeable (10^{-7}) to ground water and shall extend to such depth as to key into the clayey layers in the subsurface, up to 30 feet deep. The barrier walls shall also prevent the entry of clean ground water from down-gradient into the collection systems.

2. Intercept, collect and drain accumulating ground water and creosote NAPL, directing collected materials to a collection area near the oil-water separator and ground water treatment systems through the use of collection systems such as passive recovery trenches (e.g., a stone-filled passive recovery trench and piping) installed up-gradient of the ground water barrier walls. The collection trenches shall be constructed in such a way as to present a preferential pathway of high permeability and conductivity such that ground water and NAPL freely drain into them.

11.2.5 Manage the Hydraulic Head of Ground Water and Collect NAPL Contamination Through the Use of the Passive Recovery Trenches

The ground water inside the Containment Area shall be managed in such a way to prevent mounding inside the Containment Area and to prevent up-gradient mounding or flooding; ground water gradient shall be maintained through the use of the passive recovery trenches described in Section 11.2.4; trenches shall also be used for the passive recovery of creosote NAPL from inside of the Containment Areas.

Performance Standards for Managing the Hydraulic Head of Ground Water and Collecting NAPL Contamination Through the Use of the Passive Recovery Trenches

1. Manage the hydraulic head of ground water inside of the Containment Area to be kept lower than surrounding areas, thereby creating an inward-gradient, minimizing the risk of contaminated ground water or NAPL escaping into the deeper aquifer.

2. Manage ground water so as to prevent flooding up-gradient of the barrier walls and Containment Area (i.e., to the north of the active railroad line).

3. Collect NAPL from within the Containment Area through the use of the passive recovery trenches and the oil-water separator described in Section 11.2.2.

11.2.6 Separate Creosote NAPL from Ground Water for Off-Site Disposal or Recycling

Creosote NAPL recovered pursuant to 11.2.2(3) and 11.2.5(3) above shall be separated, collected and disposed of or recycled off-site, in accordance with CERCLA 121(d)(3) and 40 CFR 300.440. Creosote that is stored on-site while awaiting off-site disposal or recycling shall be managed in accordance with RCRA.

Performance Standards for Separating Creosote NAPL from Ground Water for Off-Site Disposal or Recycling

1. Creosote NAPL recovered pursuant to 11.2.2(3) and 11.2.5(3) above shall be separated, collected and disposed of or recycled off-site, in accordance with CERCLA 121(d)(3) and 40 CFR 300.440. Creosote that is stored on-site while awaiting off-site disposal or recycling shall be managed in accordance with RCRA.

11.2.7 Move Debris to a Location On-Site where they can be placed Under the RCRA Modified Cap

Debris (such as old railroad ties and concrete from old foundations) encountered at the Site shall be consolidated and placed into the Containment Area. Debris consolidation is required to: (1) enable proper installation of the RCRA modified cap and to ensure its integrity; (2) remove the potential hazard posed to people by the debris; and (3) enable excavation and grading of contaminated areas of the Site without the need to send truck traffic off-site for debris disposal. The use of on-site soil and debris that meet COMAR 26.04.07.04C(5) will minimize the need for clean-fill during preparation of the sub-base for the RCRA modified cap.

Performance Standards for Moving Debris to a Location On-Site where they can be placed under the RCRA Modified Cap

1. Move and place debris (such as old railroad ties and concrete from old foundations) into the Containment Area.

2. Cover debris with consolidated soil and sediment so as to not extend into the sub-base for the cap (and risk puncturing the cap).

11.2.8 Install a RCRA Modified Cap across the Containment Area

Prevent direct contact with contaminated soils, sediments and ground water, which would result in unacceptable exposure risks, and divert rainwater infiltration, which would hinder the capacity of the ground water collection and treatment system, through the installation and maintenance of a RCRA modified cap across the Containment Area as identified in Figure 11 (the precise location of which shall be determined during the remedial design, subject to EPA approval). Final grading shall promote drainage off of the Site and provide a vegetative cover to prevent erosion.

Performance Standards for Installing a RCRA Modified Cap across the Containment Area

1. Prepare the sub-base for the RCRA modified cap:

a. Stockpiled soils and debris piles shall be graded as part of the sub-base.

b. The sub-base (e.g., clean soil fill) shall be placed over consolidated materials in the Containment Area, and shall provide a clean base for the RCRA modified cap.

c. Grading shall be performed to provide a sub-base to the cap that will serve to divert water off of the cap.

d. The graded sub-base soils shall not contain stones or debris that could cause a puncture in the cap.

2. Install a low-permeability cover (cap), with a permeability of 1×10^{-7} cm/sec or less, over the consolidated materials (contaminated soils and sediments and debris and the sub-base) placed in the Containment Area. The cap shall have at least two layers of low-permeability material (e.g., 60 mil high density polyethylene, "HDPE"), one of which shall be a geosynthetic membrane.

3. The cap shall be installed to completely cover the Containment Area (see Figure 11 for the approximate area of this cap).

4. The cap shall be designed and constructed: to function with minimum maintenance; to promote drainage and minimize erosion or abrasion of the cover; to accommodate settling so that the cover's integrity is maintained; and to provide adequate freeze protection for the liner material.

5. The cap shall be designed and constructed to accommodate access to monitoring wells and NAPL recovery/ground water treatment trench maintenance points and associated piping and tanks.

6. Vegetate and maintain the cap in such a way as to prevent erosion of soils above the liner material. The vegetation on the cap shall be controlled so as to prevent or limit the growth of any plants which would damage the cap with deep root systems (for example, by mowing to trim back woody plants). The types of vegetation shall be identified in the remedial design. The remedial design shall be submitted to EPA and the State for review and approval by EPA.

7. If needed, the cap shall be designed to permit gas venting. Presently, it is not known whether VOC emissions beneath the cap would exceed levels that require control under Federal and State regulations. Field data shall be collected during the remedial design in order to assess air emissions, and controls shall be implemented as necessary to comply with the Federal and State ARARs identified in this ROD.

11.2.9 Relocate a Portion of the Existing Channel of Hershey Run

If the Containment Area shall extend into the wetlands areas (which shall be determined during the remedial design), relocate the Hershey Run channel away from such Containment Area.

Consideration of the hydrodynamics of Hershey Run shall be included in the remedial design to determine the optimal configuration of the new channel. Ensure the stability of the filled former channel and the Containment Area in the former wetlands through the installation of appropriate armoring. The new channel shall not alter in any negative way the existing capacity of Hershey Run for the conveyance of water. The new channel shall not alter drainage in the area in such a way as to promote flooding upstream.

Performance Standards for Relocating a Portion of the Existing Channel of Hershey Run

1. Locate the new channel so that the stream is routed away from the portion of the Containment Area that extends into the wetlands.

2. Configure the new channel so that it conveys both normal water levels (including the incoming and outgoing tides) and storm water runoff in a manner similar to the original channel, so as to prevent any increased negative effects to the area (e.g., abnormal flooding).

3. Configure the new channel so that it creates environments similar in type and function to those of the original channel (to protect fish and wildlife resources).

4. The location and configuration of the new channel shall be determined in consideration of both the hydrodynamic and the ecological trade-offs associated with determining its final path; this consideration shall be made through a hydrodynamic study and wetland assessment to be conducted during the remedial design in consultation with USFWS, DNREC and EPA.

5. Ensure the stability of the filled former channel and the Containment Area in the former wetlands through the installation of appropriate armoring.

11.2.10 Create Wetlands to replace any that are filled in as part of the Landfill Construction

Create replacement wetlands of similar type and ecological function according to what was filled or excavated during excavation of contaminated sediments (restoration), relocate the Hershey Run channel away from the Containment Area (if the Containment Area shall extend into the wetlands) and construct the Containment Area extending into the former wetlands (unless it is determined during design that the Containment Area shall not extend into the wetlands). Vegetation in the replacement or restored wetlands shall be similar to the filled or disturbed wetlands.

Performance Standards for Creating Wetlands to replace any that are filled in as part of the Landfill Construction

1. Create at least as many acres of wetlands having a similar type, function and ecological diversity as any acres of wetlands that are filled as part of the remedial action (resulting, at a minimum, in no net loss of wetlands).

11.2.11 Monitor Ground Water, Surface Water, Sediments and Wetlands to Ensure the Effectiveness of the Remedy

Collect and analyze data from the ground water within and surrounding the Containment Area, surface water and sediments to determine if the containment, NAPL recovery and ground water treatment systems are operating effectively. Develop and follow a plan to accomplish this during the remedial design.

Performance Standards for Monitoring Ground Water, Surface Water, Sediments and Wetlands to Ensure the Effectiveness of the Remedy

1. Collect and analyze ground water, surface water, soil and sediment samples from multiple locations on-site; the specific locations and frequency shall be determined in the Operations and Maintenance Monitoring Plan, which will be drafted as a part of the remedial design, and finalized following implementation of the remedy.

2. Update the monitoring plan every five years, coinciding with EPA's five year reviews, unless EPA accepts an alternate schedule.

11.2.12 Land and Ground Water Use Restrictions for the Site and Surrounding Area (as appropriate) since Contamination will Remain at the Site

A Land Use Control Assurance Plan ("LUCAP") shall be developed to address institutional controls, including land and ground water use restrictions, for the Site. The institutional controls contained in this ROD are based on current, reasonably anticipated uses of the Site and areas in the vicinity of the Site. The purpose of the institutional controls shall be to prevent exposure to unacceptable risks associated with remaining Site-related contaminants and to protect the components of the selected remedy. A status report on such institutional controls shall be prepared and submitted for EPA's review every five (5) years following the issuance of the ROD, unless EPA approves an alternate schedule.

Performance Standards for Land and Ground Water Use Restrictions for the Site and Surrounding Area

1. Maintain and protect the integrity of the protective cap over the Containment Area and prohibit interference with the integrity of the cap.

   The integrity of the cap shall not be disturbed. There shall be no activity or property use within the Containment Area that could compromise the integrity of the cap, including erosion resulting from activities that would disturb the vegetated soil layer or direct excavation, construction of below-grade foundations or footers, borings, well installation, or placement of heavy equipment, trailers, or other similar activities, without EPA's prior determination that such use could not compromise the integrity of the cap. Institutional controls, such as land use restrictions (e.g., restrictive covenants), shall be implemented to accomplish this.

2. Prohibit exposure to contaminated ground water.

Use and/or contact with contaminated ground water at the Site, via ingestion, vapor inhalation or dermal contact shall be prohibited to avoid unacceptable exposure to contaminants in ground water. Institutional controls shall be implemented for the Site and the Containment Area on-site (see Figure 11) to accomplish this.

3. Prohibit interference with the NAPL recovery and ground water treatment systems.

Any activity or use that could interfere with the operation of the NAPL Recovery and Ground Water Treatment Systems, such as excavation and/or construction within the area of the trenches or treatment system, shall be prohibited. Institutional controls shall be implemented to accomplish this.

4. Prohibit interference with the structure and function of restored wetlands.

Any activity that could interfere with the structure and function of restored wetlands at the Site shall be prohibited. Institutional controls shall be implemented to accomplish this.

11.3 Summary of the Estimated Remedy Costs

The estimated present worth cost of the selected remedy is $51,756,239. This figure includes the costs presented in the detailed cost summary in Table 10.

The information in this cost estimate summary table is based on the best available information regarding the anticipated scope of the response action. This is an order-of-magnitude engineering cost estimate that is expected to be within +50 to -30 percent of the actual project cost. Changes in the cost elements are likely to occur as a result of new information and data collected during the engineering design of the remedial alternative. Minor changes may be documented in the form of a memorandum in the Administrative Record. Changes that are significant, but not fundamental, may be documented in an Explanation of Significant Differences. Any fundamental changes would be documented in a ROD amendment.

11.4 Expected Outcomes of the Selected Remedy

This section presents the expected outcomes of the selected remedy in terms of resulting land and ground water uses and risk reduction achieved as a result of the response action.

The consolidation and containment of contaminated soils and sediments at the Site will end the ongoing hazard posed to human health and the environment by the high levels of PAHs present. The containment and the NAPL recovery and ground water treatment system will allow Hershey Run to undergo an enormous reduction in risk posed to ecological receptors by the very high levels of PAHs in the sediments. The ecological habitat that will be developed in the constructed wetlands or restored in other areas at the Site will continue to be maintained as a natural environmental setting, which benefits people and wildlife. The ultimate future use of the Site will be determined by the landowner provided that such use is compatible with the restrictions outlined in this document.

At this time, it is anticipated that the Site itself will be mostly re-vegetated open space, with constructed wetlands occupying any deeper excavation areas that remain wet. However, if the property owner chooses, it may be further developed into a larger wetlands bank in a manner consistent with the land use restrictions identified above. While the creation of a wetlands bank is one possible scenario, the future use of the remediated uplands of the Site has not been determined at this time. Once Hershey Run has been restored, biological and toxicological monitoring will show that risks to ecological receptors (such as fish) will have been dramatically reduced. Site visitors and workers could enter the Site knowing that there is a protective cap or barrier between them and the contamination below. The plastic layer of the cap will provide a clear separation between clean cover soil above and contaminated soil and sediment below, and will be beneficial in the event of storm erosion or flood wash-outs.

Institutional controls will restrict residential development and any use of ground water within the Site and activities that could interfere with the protective barrier cap, operation of the NAPL Recovery and Ground Water Treatment Systems.

12.0 STATUTORY DETERMINATIONS

Under CERCLA, selected remedies must protect human health and the environment, comply with ARARs, be cost-effective and use permanent solutions and alternative treatment technologies or resource recovery technologies to the maximum extent practicable. Additionally, CERCLA includes a preference for remedies that use treatment to significantly and permanently reduce the volume, toxicity or mobility of hazardous wastes, as their principal element. The following sections discuss how the selected remedy for the Koppers Site meets these statutory requirements.

12.1 Protection of Human Health and the Environment

The selected remedy will protect human health and the environment by eliminating exposure or the potential for exposure to Site-related contaminants through the consolidation and containment of contaminated soils and sediments. In addition, the NAPL recovery system and ground water treatment system will prevent the recontamination of Hershey Run surface waters and sediments. A multi-layer cap over the consolidation area will provide protection against direct contact with consolidated contaminated soils and sediments for potential future industrial/construction workers or other visitors to the Site.

The potential for contamination to migrate down from the Containment Area into the Potomac Aquifer ground water will be prevented by restricting ground water pumping in the area and by managing hydraulic head within the Containment Area via the recovery trenches. The trenches will also provide a preferential pathway for the contamination to be recovered, thereby reducing the volume that could potentially migrate downward.

Treated ground water, which may be discharged to Hershey Run, will meet all appropriate water quality standards and NPDES limitations in order to prevent any adverse human health and environmental effects.

12.2 Compliance with Applicable or Relevant and Appropriate Requirements

The selected remedy will attain all applicable or relevant and appropriate requirements, which are identified as a performance standard in Section 11.2 and specified in Table 8 of this ROD.

12.3 Cost Effectiveness

The selected remedy is cost effective in that it eliminates or mitigates the risks posed by the contaminants at the Site, meets all requirements of CERCLA and the NCP, and its overall effectiveness in meeting the remedial action objectives is proportional to its cost. In fact, the selected remedy is nearly the lowest cost (see Table 9), yet ranks the highest or near highest in terms of long-term effectiveness and permanence; reduction in toxicity, mobility or volume; and short-term effectiveness, as compared to the other alternatives.

12.4 Utilization of Permanent Solutions and Alternative Treatment Technologies to the Maximum Extent Practicable

The selected remedy utilizes long-term solutions and treatment technologies to the maximum extent practicable through the use of containment, collection, and treatment of contaminants of concern from soil, sediments and ground water. Of those alternatives that are protective of human health and the environment and comply with ARARs, EPA has determined that the selected remedy provides the best balance of tradeoffs, in terms of long-term effectiveness and permanence, reduction in toxicity, mobility, or volume through treatment, short-term effectiveness, implementability, and cost, while also considering the statutory preference for treatment as a principal element, and State and community acceptance.

12.5 Preference for Treatment as a Principal Element

The selected remedy will meet the statutory preference for treatment as a principal element, since it treats the principal threat waste present at the Site. This is done through a combination consolidation of contaminated soil and sediment, which contains principal threat wastes, and passive NAPL recovery, including ground water treatment as needed. While Alternative 5 may have best met this preference for treatment, it would have done so at a drastically higher cost with significant implementability issues and no assurance of complete success, as discussed in the evaluation of alternatives.

12.6 Five-Year Review Requirements

Because the remedy will result in hazardous substances remaining on-site above levels that will allow for unlimited use and unrestricted exposure, a review will be conducted at least every five years after initiation of the remedial action, pursuant to CERCLA Section 121(c) and the NCP, 40 C.F.R. Section 300.430(f)(5)(iii)(C), in order to ensure that the remedy continues to provide adequate protection of human health and the environment.

13.0 DOCUMENTATION OF SIGNIFICANT CHANGES

There have been no significant or fundamental changes to the proposed remedy as a result of public comments.

III. RESPONSIVENESS SUMMARY

KOPPERS CO., INC. (NEWPORT PLANT) SUPERFUND SITE

NEWPORT / NEW CASTLE COUNTY, DELAWARE

RESPONSIVENESS SUMMARY

This Responsiveness Summary documents public participation in the remedy selection process for the Koppers Co., Inc. Superfund Site. It contains a summary of the major comments received by EPA during the public comment period on the Proposed Remedial Action Plan ("Proposed Plan" or "PRAP") for the Site and EPA's responses to those comments.

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I. Comments from October 21, 2004 Public Meeting and Written Comments with EPA Responses

EPA held a public meeting near the Site on October 21, 2004 to accept public comments on EPA's Proposed Plan. The significant comments received regarding the plan are summarized here, along with EPA's responses thereto. Because this Responsiveness Summary is a statutorily required document designed to meet the legal requirement that EPA summarize and respond to significant comments received regarding the Proposed Plan, EPA will provide a brief overview of the comments related to the remedy issues and the Agency's response. The entire transcript of the meeting, including all comments received on any topic and EPA's response, is included in the publicly available portion of the Administrative Record for anyone who wants to view them.

A. General Comments

Comments in Support of the Proposed Remedy

[Resident/citizen] - I would prefer to accept the recommendation of the EPA - Alternative 4 - how can I ensure that this is what is carried out?

[Resident/citizen] - Regarding the Koppers Superfund Site, I agree that this mess should be cleaned up.

[Ciba] - Ciba does not object to the preferred remedial alternative stated in the Proposed Plan.

[DuPont] - Overall, DuPont supports the EPA proposed alternative of on-site containment rather than treatment to address principal waste threat. We also believe it is important that future land use of the Site be considered in developing the Proposed Plan.

EPA RESPONSE: *EPA notes for the Administrative Record the above-referenced general comments in support of the proposed remedy.*

B. Specific Comments

Miscellaneous Comments

[Oral Comment] - What is the cap and how will it look?

EPA RESPONSE: *It is a cap that will be designed to RCRA landfill specifications. It will probably consist of a high-density polyethylene (HDPE) barrier and other layers of sands and soils. It is likely to look like a grassy hill when it is done.*

[Oral Comment] - What about RR ties on site? Will property values be affected?

EPA RESPONSE: *Ties on the site will likely end up in the consolidation area under the RCRA modified cap. EPA's experience is that land values are not normally affected. The Site is being cleaned up, and is under control. This may be considered better than living next to an unknown.*

[Resident/citizen] - Is this why the community is voting?

EPA RESPONSE: *The Koppers Superfund Site is unrelated to any vote currently occurring in the community.*

Comments Concerning Funding for the Cleanup

[Resident/citizen] - ... who is paying for this clean up?

[Oral Comment] - A gentleman made a theatrical appearance, drinking some water in which he had placed a chip of dried creosote, presumably to demonstrate the lack of toxicity of creosote, and indicated that there was lots of creosote around in railroad ties and telephone poles that nobody seemed concerned about. After his statement, he asked, "...who pays for cleanup of the site?"

EPA RESPONSE: *During the Public Meeting, EPA explained the PRP aspects of CERCLA and indicated that not only did Beazer and DuPont (both of the PRPs) pay for what has been done so far, including the cost of EPA oversight, but will very likely pay for the cleanup as well. However, not only is the recommended alternative for remediation of the site out for comment by the public, but it is also open for comment by the PRPs at this time. EPA would like to add that there exists abundant information about the toxicity of creosote, and while it is likely that the water the gentleman drank contained only trace amounts of any of the PAH compounds found in creosote, EPA would caution against anyone knowingly consuming water contaminated by creosote or creosote constituents; to do so on a regular basis could constitute a significant risk to health.*

Comments Concerning Drinking Water

[Resident/citizen] - I live [nearby] - is my water at risk for contamination?

[Oral Comment] - Where is the public water coming from? There is some sort of pump in the neighborhood.

EPA RESPONSE: *State records show no wells using the aquifer in the vicinity of the Site. Public drinking water does not come from the Site. There appears to be a pumping station for either sewer or the public water supply in the area. Public water in the area is supplied from* *surface water or ground water from the Potomac aquifer, though not from the immediate vicinity of the Site.*

[Oral Comment] - Concerns regarding the flow of groundwater off-site were expressed.

EPA RESPONSE: *EPA assured the questioner that the groundwater's normal flow is away from the residential areas. In addition, the creosote is not very mobile and groundwater monitoring has indicated that it is not leaving the Site.*

[Oral Comment] - Will the probability of contamination of the Potomac aquifer be increased?

EPA RESPONSE: *No. The proposed alternative includes passive recovery trenches that will act as a "drain" within the containment area. This "drain" will relieve any pressure head of groundwater and inhibit groundwater migration through the clayey layers and into the Potomac aquifer.*

[Oral Comment] - What happens regarding past exposure to water in wells (before public water supplies)?

EPA RESPONSE: *Any wells in the residential area are up-gradient of the site, so this is not likely a problem. Regarding past exposure, any wells that were up-gradient of the Site probably did not have any Site-related contamination, but it is impossible to know with any certainty. Current records show no wells in the vicinity of the Site.*

Comments Concerning Short-term Impacts of the Remedy

[Resident/citizen] - I only ask you to consider those residents nearby. We have not been exposed to that much of the hazard since most of the problem is in the water, not airborne. That will change as dust rises. Also all the little, and not so little, rodents and snakes will go searching for new homes. You might consider starting near the railroad to chase the animals toward the river, and providing adequate or better dust control.

[Oral Comment] - During construction, will wildlife flee to the neighborhoods and will they be looked after? There are bald eagles in the neighborhood that may be disturbed as well as countless other critters that might be scared out of their normal habitat.

EPA RESPONSE: *Wildlife inhabiting the Site could be disturbed during construction. EPA is working closely with wildlife authorities to coordinate remedial activities to prevent negatively impacting existing wildlife and endangered species in particular. However, the translocation of species is contemplated in the ROD, if the natural habitats are affected by the remedial activities. Air emissions and dust control are concerns of the EPA and will be monitored and controlled during remediation of the Site.*

[Oral Comment] - How far will they dig down and what about air emissions during construction?

EPA RESPONSE: *Depth will vary between 15 and 30 feet in soils and around 2 to 4 feet in most of the sediments. Air emissions and dust control are concerns of the EPA and will be monitored and controlled during remediation of the Site.*

[Oral Comment] - Will there be enough commotion during construction to damage house foundations?

EPA RESPONSE: *EPA expects that, as with any excavation and consolidation activities, there would be some vibrations, but any such vibrations would probably be less noticeable than when a fast train passes.*

Comments Concerning Health Effects

[Oral Comment] - In reviewing the plan, it seems that EPA is moving the creosote-contaminated soil and sediment closer to the public by consolidating it along the RR tracks. Should we be concerned about eating deer meat from animals taken in that area? Should we be concerned about breathing smoke from the brush fire that was at the site two years ago?

EPA RESPONSE: *The material is being consolidated to the areas where it is already at its worst. The material will be contained by sheet piles, a RCRA hazardous waste landfill cap, and the clay layer of soil between the Columbia formation and the Potomac formation. It should be much safer than now. Creosote does not bioaccumulate, so it should not be a problem when consuming an animal that lives in the immediate area. The fire was not in an area where creosote is a problem. Creosote is on the surface at only few locations, it is mostly sub surface and in sediment. The fire was confined to brush in an area where there is no surface creosote.*

[Oral Comment] - Concern was expressed regarding the effect of creosote on fish.

EPA RESPONSE: *Studies indicated that 43% of fish sampled had liver tumors. Recent studies have indicated that this high incidence of tumors is unique in the area to Hershey Run in the vicinity of the Site. Even if not cancerous, such a high incidence of tumors is not normal and is one of the reasons remediation is planned. In addition, there is a fish consumption advisory in the area of the Site due to the presence of PCBs in fish tissue (although the PCBs are not Site-related contaminants).*

[Oral Comment] - Vincent Gruff of the Pleasant Hills community association asked if anybody's kids will get sick. There are quite a few homes (about 40 of the 80 homes in the association) in the area where somebody in the family has cancer. Could a study of the situation be performed?

EPA RESPONSE: *EPA introduced ATSDR (from CDC) and the state public health official. The representative from CDC explained that cause and effect in cancer clusters is normally very hard to show. The purpose of EPA's risk assessment is to determine the risks posed to human health and the environment if the Site is not remediated. The EPA's risk assessment for the Site revealed that ecological-risk was posed by the hazardous substances at the Site. The selected remedy will address the identified risks. After the implementation of the ROD, during 5-year reviews, the protectiveness of the remedy will be evaluated on an on-going basis.*

Comments Concerning Construction Traffic and Access

[Ciba] - ...Ciba's main concerns relate to the means of access to the Koppers site required to implement the proposed remedy. Ciba requests that this plan be amended to include construction of an access route to the Koppers site through a means other than Ciba's private right-of-way. As the Proposed Plan (p.1) and Figure 1 note, Ciba's Newport facility is adjacent to the Koppers site; and the current single means of access to the Koppers site is via a private road (the "Roadway") extending due west from James Street which runs through the middle of Ciba's Newport pigments production facility and which serves as the main artery for vehicular and pedestrian traffic at this facility. Ciba is deeply concerned that the use of this private road would pose significant disruption to the operations being conducted at its Newport facility, would

present significant safety and security concern and would impose significant expense upon Ciba, in addition to depriving it of its property rights.
Ciba's concerns--should its private Roadway be used to allow access of construction personnel, supervision, machinery and heavy equipment to the Koppers site--focus on a number of areas, including safety, security, disruption of business activities, imposition of additional expenses, and the deprivation of property rights.
...Ciba, while not objecting to the preferred remedy contained in the Proposed Plan, requests that it be further amended to provide for the construction of a separate access road to the Koppers site-one that will not traverse Ciba's property and which will not result in increased safety and security risks, disruption of Ciba's Newport operations and the burden of additional expense to Ciba.

EPA RESPONSE: *EPA will work with CIBA and the PRP, as well as other stakeholders, to address these potential issues and concerns regarding truck traffic and site-access during the critical remedial design phase of the work.*

Comments Concerning Metals/PCBs in Sediments

[DuPont] - Specific comments on the Proposed Plan are limited to the second footnote on page 15 and 16. This footnote discusses elevated concentrations of zinc at the Site that are co-located with PAHs, as well as zinc that was detected at depth in the sediment (and does not pose a potential threat to ecological receptors). Within this footnote, EPA indicates that zinc "most likely" came from the adjacent DuPont-Newport Superfund site.

As indicated by EPA in the Proposed Plan, there are numerous sources of zinc within the Christina River watershed. We suggest that EPA review the Technical Background and Basis Documents for the Total Maximum Daily Loads (TMDLs) that have been established by the Delaware Department of Natural Resources and Environmental Control (DNREC) for zinc. In 1999, TMDLs were established for zinc in both the Red Clay and White Clay Creeks. According to the DNREC TMDL website (http://www.dnrec.state.de.us/water2000/sections/watershed/tmdl/tmdlinfo.htm), a TMDL for zinc was not established, nor is one proposed for the Christina River. According to the Technical Background and Basis Documents, NVF Yorklyn Site is the major source of zinc to the Red Clay Creek, and the NVF Newark Site is the major source of zinc to the White Clay Creek. Historic and current discharges (contaminated groundwater and permitted discharges) from both of these facilities entered into the Red Clay and White Clay Creeks. The Red Clay Creek enters into the White Clay Creek near Stanton upgradient of the Koppers Site. The White Clay Creek flows past the Koppers property before flowing into the Christina River.

With these known major sources of zinc located upstream of the Site in the Red and White Clay Creeks, and the uncertainty associated with potential upstream sources in Hershey Run, there is a great deal of uncertainty in stating that zinc came from only one potential source. We believe that EPA needs to acknowledge this uncertainty and remove the reference to the DuPont Newport Site.

EPA RESPONSE: *EPA acknowledges that there are numerous other potential sources of zinc in the area, though the adjacent DuPont-Newport Superfund Site remains the closest in proximity and was found to have zinc as a major site-contaminant.*

[Oral Comment] - What about metals and PCBs in sediments and surface waters in the area? Some areas have PCB warnings for fish. Has testing been done on the North side of the RR tracks?

EPA RESPONSE: *This is an industrial area. PCBs and metals contaminations are from other sites and have accumulated in the sediments and wetlands of this site and surrounding areas.*

The sediments that get removed will be consolidated into the containment area. Anything in the sediments will end up there. Overall, things should be cleaner even beyond the Site-related contamination. Testing of ground water from monitoring wells on the north side of the tracks has shown no contamination to date, though future delineation and monitoring will occur there. PCBs in fish near industrial areas are not uncommon.

Comments Concerning Flooding

[Oral Comments] - Concern was expressed regarding flooding if Hershey Run is rechanneled. Recent flooding has been a problem.

EPA RESPONSE: *The redesign of the channel will have to take worst-case flood scenarios into account. These flood scenarios will be considered during the remedial design phase. Recent flooding was caused by flow restrictions north of the RR tracks. Modifications to the channel are all south of the RR tracks and should not impact the up gradient locations that recently experienced flooding.*

AR 15964

II. Comments Submitted by Beazer East, Inc. (PRP)

A. Beazer's Comment Letter

This letter summarizes Beazer East, Inc.'s ("Beazer's") comments on the United States Environmental Protection Agency's ("EPA's") Proposed Remedial Action Plan ("PRAP") issued on October 7, 2004 for the Koppers Company Inc. ("Newport Plant") Superfund Site ("Site") located in Newport, Delaware. The EPA previously granted Beazer an extension of time within which to file these comments until December 6, 2004. As you know, Section 121(a) of the Comprehensive Environmental Response, Compensation and Liability Act of 1980 ("CERCLA"), as amended, 42 U.S.C. 9601 et seq. ("Superfund"), requires that when the EPA selects a remedial action in accordance with its Superfund authority, the EPA must "select *appropriate* remedial actions determined to be *necessary* to be carried out... which are in accordance with this section and, to the extent practicable, the national contingency plan, and which provide for a cost-effective response." In general, Beazer does not believe that EPA's action in proposing the remedy selected in the PRAP comports with its statutory obligations. Beazer believes that many components of the EPA's preferred cleanup alternative ("Alternative 4") are unnecessary, inappropriate and/or not cost-effective given the data that have been generated during the Site investigations and the feasibility analyses.

EPA RESPONSE: *EPA has carefully considered Beazer's assertions regarding EPA's action, but does not believe that they are correct. The basis for EPA's actions are supported by the studies and investigations conducted over many years at the Site, which are available for review in the Administrative Record. Additionally, the selected remedy is analyzed in accordance with EPA's statutory obligations and is evaluated in light of the nine-criteria set forth in the NCP. EPA's analysis of the selected remedy is fully documented in the Administrative Record.*

In particular, Beazer has significant concerns with respect to the projected costs for implementation of Alternative 4 in the PRAP. Section 121(a) of Superfund directly addresses this key component of remedy selection as follows: "In evaluating the cost-effectiveness of proposed alternative remedial actions, [EPA] shall take into account the total short- and long-term costs of such actions, including the costs of operation and maintenance for the entire period during which such activities will be required." A close review of the PRAP indicates that the EPA has taken different elements of the alternatives presented by Beazer in the Feasibility Study ("FS") and the FS Addendum and added additional elements of significant cost to develop the PRAP. As a result, the PRAP now contains a number of redundant elements that have been incorporated at a significant cost but do not improve the performance of the remedy. Furthermore, Beazer believes that the EPA has improperly considered or ignored a number of technical issues, and inappropriately integrated considerations of a possible future reuse, to create a PRAP which we believe is not supportable under CERCLA or the National Oil and Hazardous Substances Pollution Contingency Plan ("NCP"), 40 C.F.R. Part 300.

EPA RESPONSE: *EPA has carefully considered Beazer's assertions, but does not believe that they are correct. EPA does not believe that any components of the remedy are redundant. EPA reviewed and considered Beazer's supplemental cost estimates for various components of the remedy. Issues related to potential future use are discussed in more detail within this document, however, the proposed remedy does not make any decision regarding future use, as is suggested in the comment. Rather, the proposed remedy is stated to be "...compatible with one potential future use..." referring to the proposal that Beazer brought before EPA to possibly use the Site as a wetlands bank for the Delaware Department of Transportation (DelDOT). For the purposes of* *comparison, EPA retained the discussion of future wetlands development as provided in Beazer's FS Addendum (Alternative 10) cost estimates, but these costs were not included in the cost of the proposed remedy itself, as they are related to additional excavation work associated with a potential future use and not directly related to the remedy.*

We request that the EPA address these comments to the PRAP and select a revised remedial action at the Newport Site that not only comports with the requirements of law but, in addition, provides a practical answer to the complex remediation issues that this Site presents. Failure to do so represents agency action that is arbitrary, capricious, an abuse of discretion, and otherwise contrary to law. A summary of the most significant issues is provided in this letter and an expanded discussion of these points is contained in the attached document.

EPA RESPONSE: *EPA has carefully considered Beazer's comments and believes that the selected remedy addresses the risks posed by the Site. The basis of EPA's selected remedy includes a decade of data collection, which EPA has carefully reviewed and evaluated. EPA has proposed a cost-effective remedial action that is consistent with CERCLA, the NCP, and ARARs. The basis for the proposed remedy is well documented in the Administrative Record, including, but not limited to, EPA's numerous comments on the Remedial Investigation and Feasibility Study, EPA's presentation and response to the National Remedy Review Board, and the Proposed Remedial Action Plan. As stated previously, EPA has proposed a remedy that is consistent with CERCLA, the NCP, and ARARs. Furthermore, EPA's proposed remedy is largely based on an alternative developed by and proposed by Beazer as an addendum to the FS and based upon studies and investigations, which Beazer financed, conducted and submitted to EPA for review and consideration.*

GENERAL ISSUES

1. The Site-specific cleanup ecological risk-based criterion developed for polycyclic aromatic hydrocarbons (PAHs) in sediments (150 milligrams per kilogram [mg/kg]) has been inappropriately applied as a universal soil cleanup criterion, resulting in deeper and more extensive soil removal than is required to mitigate site risks. Beazer's best estimate of the cost, including contingency, for this deeper and more extensive soil removal, is approximately $6.7 million based upon the information provided by the EPA.

EPA RESPONSE: *EPA has considered Beazer's assertions, but does not believe that the cleanup criteria are inappropriate for the risks posed at this Site. As discussed in the PRAP and in the ROD, the sediment cleanup criterion is protective and is to apply to those soils where wetlands will be created. Regarding matters of cost, EPA has prepared an extensive analyses of costs, which is attached hereto. Beazer's submittal to EPA of supplemental cost estimates or various components of the remedy were carefully reviewed and considered in EPA's discussion of the cost criterion. Note that PRAP Alternative 3 details what a 2-foot excavation of soil with backfill and cover would cost. Soil excavation for Alternative 3 totaled approximately $7.2M, while soil excavation in Alternative 4 totaled approximately $8.4M - while this is a significant difference, it is not as large a difference as suggested in the comment. As discussed earlier in this document, note that the original cost estimates in the 2003 FS Addendum (FS Alternative 10) split the cost of deeper soil excavations (beyond that required by the remedy) between the remedy and the "wetlands developer". EPA adopted this approach in order to be consistent for the purposes of comparison, but is not requiring the further excavations of materials to create a wetlands bank, as that is not part of the selected remedy. Rather, as stated in the PRAP, EPA's selected remedy is compatible with that potential future use, should such a use materialize in the future.*

2. The EPA has inappropriately required an extensive sediment removal action in Lower Hershey Run and other aquatic Site areas (such as the Fire Pond, South Pond, K Area, and West

Central Drainage Area) through misapplication of both the risk-based site-specific cleanup criterion, and EPA's document titled Principles for Managing Contaminated Sediment Risks at Hazardous Waste Sites (EPA, 2002). Beazer's best estimate of the cost, including contingency, for the extensive sediment removal in Hershey Run alone is approximately $13.8 million, based upon the information provided by the EPA.

EPA RESPONSE: *EPA has considered Beazer's assertions, but does not believe that they are correct. As stated in the PRAP, the sediment in Hershey Run contains very high levels of TPAHs, in some areas the levels are so high as to constitute a principal threat source area. Therefore, addressing this sediment is certainly appropriate. Regarding matters of cost, please see the attached discussion of cost estimates, and please also refer to Beazer's own supplemental cost estimates for various components of the remedy. In response to EPA's comments on the 2003 FS Addendum, Beazer provided its best-cost estimate for the sediment removal as $3.2 million. Beazer's FS Addendum states:*

> *"Removal of NAPL-contaminated sediments from the lower reaches of Hershey Run would include the removal of approximately 21,300 cubic yards of sediment from the upper 1 to 4 feet, disposal in the onsite containment area, and backfill with clean sand as is proposed for FS alternatives 6 through 9. ...The additional cost of this option is estimated to be $3.2 million based on the FS costs for Alternatives 6 through 9."*

In contrast, the estimate that EPA presented to the National Remedy Review Board ("NRRB") regarding the additional cost of addressing the sediments in the lower reaches of Hershey Run was approximately $6.5M.

3. The proposed EPA plan for passive and possibly active groundwater and dense non-aqueous phase liquids ("DNAPL") collection within the vertically contained consolidation areas is largely a redundant remedial element. Both the vertical barrier wall and the groundwater and DNAPL system are intended to control the source of groundwater impacts and prevent future releases of DNAPL to surface water and sediments. Beazer's best estimate of the cost, including contingency, for the DNAPL collection element is approximately $7.4 million, based upon the information provided by the EPA.

EPA RESPONSE: *EPA has considered Beazer's assertions, but does not believe that they are correct. Due to the actual mobility and the potential for mobilization of NAPL in the subsurface during construction, the vertical barrier wall will prevent any lateral migration of NAPL out of the containment area during the installation of the recovery trench system, as well as during the subsequent excavation of material outside of the containment area which will most certainly change the hydraulic conditions in the surrounding area of the Site. In addition, the vertical barrier wall will isolate ground water outside of the containment area, ensuring that only ground water from within is collected by the passive recovery trenches. Therefore, EPA does not believe that this remedial component is redundant, but is necessary to address the mobility of NAPL. EPA's cost estimate shows a cost of approximately $4.5 million for the DNAPL recovery trench system.*

4. The EPA-recommended remedy is supported largely by its unfounded intention to restore Site groundwater to its beneficial use as a potential source of drinking water. Beazer considers this intention to be both inappropriate and technically impracticable. The goal is inappropriate because the impacted aquifer is not a source of drinking water and technically impracticable because no proven technologies exist that could restore this impacted shallow groundwater to drinking water standards. Moreover, any serious efforts at exploiting shallow groundwater for potable purposes could result in a greater damage to the environment due to the likelihood of saltwater intrusion. Thus, Beazer believes that the EPA has incorrectly

designated the aquifer for potable use thereby applying incorrect Applicable or Relevant and Appropriate Requirements ("ARARs") in the PRAP. In the alternative, if the groundwater ARARs are found to be appropriate, a position with which Beazer strongly disagrees, Beazer should qualify for an ARAR waiver for impacted shallow groundwater. We note, for the record, that the EPA approved an ARAR waiver for shallow groundwater for similar reasons and incorporated it into a 1993 Record of Decision ("ROD") at the adjacent E.I. DuPont de Nemours & Co., Inc. Pigment Plant Landfill Site (in Newport, Delaware). Estimated costs are included under point 1 above.

EPA RESPONSE: *EPA has considered Beazer's assertions, but does not believe that they are correct. The PRAP neither refers to, nor suggests, that the Columbia aquifer is or should be restored to conditions consistent with potable use. Rather, the PRAP states that the Columbia Aquifer is a "potential drinking water aquifer," as designated by the State. EPA does not designate an aquifer for potable use, since such designations for ground water use is a State function. EPA does, however, pursuant to its statutory obligation, "expect to restore ground water to its beneficial use, to the maximum extent practicable." Contrary to the assertion in the comment, EPA believes and states in the PRAP that the excavation and consolidation of the NAPL- and PAH-contaminated material present in the aquifer will allow for physical and biological attenuation processes to ultimately eliminate any residual contamination, thus restoring the ground water outside of the containment area.*

5. The PRAP unfairly assumes that future reuse of the Site will occur and this assumption drives key components of the remedy. Aggressive cleanup of wetlands and groundwater to allow specific reuse of the Site as a wetlands bank is premature and represents an unacceptable basis for establishing the extent of soil and sediment cleanup required. Aggressive wetlands cleanup may also permanently disturb wetland habitat and function. Additionally, it is our understanding that alternative properties in the area may be more viable options for wetland construction and/or banking than the Site. Since the time Beazer evaluated reuse of the Site as a wetlands bank, other types of uses have been proposed by Site and area stakeholders, including the potential for the location of a drinking water storage reservoir at the Site; it is evident that an appropriate reuse scenario will not be determined for some time.

EPA RESPONSE: *EPA has considered Beazer's assertions and recognizes their role as the property owner regarding the future use of the Site. The PRAP does not assume any future re-use scenario; rather, the remedial components are driven by the risk assessment data and the proposed remedy is stated to be "compatible" with future use, with no expected restriction on land use outside of the containment area. The soil and sediment cleanup is driven by the risks posed at the Site. EPA understands that the cleanup may disturb wetland habitat and function; however, any wetlands disturbance during the cleanup will be mitigated in accordance with the stated ARARs. The extent of excavation is not for the purposes of creating a wetlands bank which is not a remedial component of the selected remedy, but rather to address the Site risks posed by the hazardous substances in soils and sediments. EPA understands the future use of the Site has not been determined yet.*

6. The agency has arbitrarily mandated several prescriptive requirements to the remedy that are likely to change during the remedial design (e.g., the location and size of the on-site containment areas, the extent of areas that need to be excavated, etc.). Beazer believes that it is unnecessary and unreasonably restrictive to incorporate these requirements into the preferred remedy at this stage.

EPA RESPONSE: *EPA has considered Beazer's assertions, but does not believe that they are correct. EPA is aware that estimates of areas and volumes to be excavated and contained are just that: estimates. For the purposes of estimating the cost and to evaluate completely* *the suitability of the remedy, detailed estimates were created, and the text of the PRAP stated that these exact figures and locations would likely change during the Remedial Design and further delineation efforts to determine the scope and extent of the hazardous substances on-Site.*

7. The agency has failed to clearly specify the cost components of the preferred remedy in sufficient detail for Beazer and the other stakeholders to understand the basis for EPA's decisions. Failure to adequately disclose the amounts and underlying rationale for these enormous costs deprives Beazer of an opportunity to comment meaningfully on the PRAP, in violation of Section 121(a) of CERCLA and due process of law.

EPA RESPONSE: *EPA has considered Beazer's assertions, but does not believe that they are correct. There is significant identification and discussion of the remedial cost components in the Administrative Record. The cost estimates were (1) based on FS documents submitted to EPA by Beazer, (2) clearly documented in the Administrative Record, and (3.) presented to the NRRB for rigorous review. The original early estimates of volumes of soils and sediments potentially subject to remediation were developed by EPA due to Beazer's continued failure to provide that information upon EPA's request during the RI/FS process. Since that time, Beazer's additional studies, and EPA's subsequent evaluation of the new and existing data have provided EPA with sufficient information concerning the Site-contamination, and therefore, the estimated volumes of materials potentially subject to remediation. Further delineation will be performed during the RD, which is consistent with the Superfund process.*

8. Finally, Beazer believes that the EPA has improperly applied the required analysis of the nine criteria contained in 40 C.F.R. 300.430(e)(9) in selecting its preferred remedy in contravention of the agency's obligation in the NCP. In particular, and without limitation, Beazer believes that the threshold criteria have been misapplied inasmuch as cleanup beyond that necessary to protect human health and the environment has been proposed, and the ARARs for potable groundwater have been misinterpreted and applied to require extensive subsurface excavation activities. Secondly, and without limitation, the balancing criteria have been unfairly weighted particularly for short-term effectiveness, implementability, and cost, particularly with respect to the mandatory requirements for soils and sediments discussed above and for other reasons discussed in the attachment.

EPA RESPONSE: *EPA has considered Beazer's assertions, but does not believe that they are correct. EPA has responded to the "potable use" issue above in #4. As stated in the PRAP, EPA expects to restore ground water outside of the containment area to beneficial use.*

*The comment underestimates the downward pathway of contamination to the underlying Potomac aquifer. Nonetheless, the Columbia **is** classified as a potential drinking water aquifer (a designation placed by the state, not by EPA), creosote NAPL at the Site **is** mobile and **has been** discharging to surface water for many years. Due to its mobility, EPA's remedial action components have been selected to mitigate this potential spread of contaminant.*

9. Conclusion -- Beazer requests that the EPA take all of these comments into account in its further decision-making at this Site to achieve an appropriate and practical resolution of Site cleanup.

EPA RESPONSE: *EPA has carefully reviewed all the information and data presented to EPA by Beazer during the many years it has conducted the Site investigations and studies. EPA has thoughtfully considered the comments presented by Beazer during each phase of the Superfund process, including the comments submitted herein on the PRAP. EPA has selected* *a remedy in accordance with CERCLA, the NCP and ARARs. The information forming the basis of EPA's decision has been made available in the Administrative Record for the Site.*

B. Beazer's Comments Attachment

Beazer Comments on the PRAP for the Koppers Company, Inc. Superfund Site

This attachment presents Beazer East, Inc.'s ("Beazer") comments in response to the United States Environmental Protection Agency's ("EPA") Proposed Remedial Action Plan ("PRAP") issued on October 7, 2004 for the Koppers Company Inc. ("Newport Plant") Superfund Site ("Site") located in Newport, Delaware. Provided below is a brief description of what Beazer believes are the most significant issues related to EPA's recommended remedy, followed by a more detailed discussion of these issues, and finally, a specific page-by-page comments.

1.0 GENERAL ISSUES

1. The Site-specific cleanup ecological risk-based criterion developed for polycyclic aromatic hydrocarbons (PAHs) in sediments (150 milligrams per kilogram [mg/kg]) has been inappropriately applied as a universal soil cleanup criterion, resulting in deeper and more extensive soil removal than is required to mitigate Site risks. Beazer's best estimate of the cost, including contingency, for this deeper and more extensive soil removal, is approximately $6.7 million based upon the information provided by the EPA.

EPA RESPONSE: *EPA has thoughtfully considered Beazer's assertions, but does not believe that they are correct. EPA has fully addressed this comment in EPA's response to Beazer's Comment 1, above.*

2. The EPA has inappropriately required an extensive sediment removal action in Lower Hershey Run and other aquatic Site areas (such as the Fire Pond, South Pond, K Area, and West Central Drainage Area) through misapplication of both the risk-based Site-specific cleanup criterion, and the EPA's document titled Principles for Managing Contaminated Sediment Risks at Hazardous Waste Sites (EPA, 2002). Beazer's best estimate of the cost, including contingency, for the extensive sediment removal in Hershey Run alone is approximately $13.8 million, based upon the information provided by the EPA.

EPA RESPONSE: *EPA has thoughtfully considered Beazer's assertions, but does not believe that they are correct. EPA has fully addressed this comment in EPA's response to Beazer's Comment 2. above.*

3. The proposed EPA plan for passive and possibly active groundwater and dense non-aqueous phase liquids ("DNAPL") collection within the vertically contained consolidation areas is largely a redundant remedial element. Both the vertical barrier wall and the groundwater and DNAPL system are intended to control the source of groundwater impacts and prevent future releases of DNAPL to surface water and sediments. Beazer's best estimate of the cost, including contingency, for the DNAPL collection element is approximately $7.4 million, based upon the information provided by the EPA.

EPA RESPONSE: *EPA has thoughtfully considered Beazer's assertions, but does not believe that they are correct. EPA has fully addressed this comment in EPA's response to Beazer's Comment 3, above*

4. The EPA-recommended remedy is supported largely by its unfounded intention to restore Site groundwater to its beneficial use as a potential source of drinking water. Beazer considers this intention to be both inappropriate and technically impracticable. The goal is inappropriate because the impacted aquifer is not a source of drinking water and technically impracticable because no proven technologies exist that could restore this impacted shallow groundwater to drinking water standards. Moreover, any serious efforts at exploiting shallow groundwater for potable purposes could result in a greater damage to the environment due to the likelihood of saltwater intrusion. Thus, Beazer believes that the EPA has incorrectly designated the aquifer for potable use thereby applying incorrect Applicable or Relevant and Appropriate Requirements ("ARARs") in the PRAP. In the alternative, if the groundwater ARARs are found to be appropriate, a position with which Beazer strongly disagrees, Beazer should qualify for an ARAR waiver for impacted shallow groundwater. We note, for the record, that the EPA approved an ARAR waiver for shallow groundwater for similar reasons and incorporated it into a 1993 Record of Decision ("ROD") at the adjacent E.I. DuPont de Nemours & Co., Inc. Pigment Plant Landfill Site (in Newport, Delaware). Estimated costs are included under point 1 above.

EPA RESPONSE: *EPA has thoughtfully considered Beazer's assertions, but does not believe that they are correct. EPA has fully addressed this comment in EPA's response to Beazer's Comment 4, above. Additionally, with respect to the ARAR waiver at the DuPont (Newport) Site, although similarities exist between Superfund sites, EPA's remedies are Site-specific with remedial components identified through the nine criteria set forth in the NCP. The ARAR waiver at DuPont (Newport) is not relevant to this Site.*

5. The PRAP unfairly assumes that future reuse of the Site will occur and this assumption drives key components of the remedy. Aggressive cleanup of wetlands and groundwater to allow specific reuse of the Site as a wetlands bank is premature and represents an unacceptable basis for establishing the extent of soil and sediment cleanup required. Aggressive wetlands cleanup may also permanently disturb wetland habitat and function. Additionally, it is our understanding that alternative properties in the area may be more viable options for wetland construction and/or banking than the Site. Since the time, Beazer evaluated reuse of the Site as a wetlands bank, other types of uses have been proposed by Site and area stakeholders including the potential for the location of a drinking water storage reservoir at the Site; it is evident that an appropriate reuse scenario will not be determined for some time.

EPA RESPONSE: *EPA has thoughtfully considered Beazer's assertions. EPA has fully addressed this comment in EPA's response to Beazer's Comment 5, above.*

6. The agency has arbitrarily mandated several prescriptive requirements to the remedy that are likely to change during the remedial design (e.g., the location and size of the onsite containment areas, the extent of areas that need to be excavated, etc.). Beazer believes that it is unnecessary and unreasonably restrictive to incorporate these requirements into the preferred remedy at this stage.

EPA RESPONSE: *EPA has thoughtfully considered Beazer's assertions, but does not believe that they are correct. EPA has fully addressed this comment in EPA's response to Beazer's Comment 6, above.*

7. The agency has failed to clearly specify the cost components of the preferred remedy in sufficient detail for Beazer and the other stakeholders to understand the basis for EPA's decisions. Failure to adequately disclose the amounts and underlying rationale for these enormous costs deprives Beazer of an opportunity to comment meaningfully on the PRAP in violation of Section 121(a) of CERCLA and due process of law.

EPA RESPONSE: *EPA has thoughtfully considered Beazer's assertions, but does not believe that they are correct. EPA has fully addressed this comment in EPA's response to Beazer's Comment 7, above.*

8. Finally, Beazer believes that the EPA has improperly applied the required analysis of the nine criteria contained in 40 C.F.R. 300.430(e)(9) in selecting its preferred remedy in contravention of the agency's obligation in the National Oil and Hazardous Substances Pollution Contingency Plan ("NCP"). In particular, and without limitation, Beazer believes that the threshold criteria have been misapplied inasmuch as cleanup beyond that necessary to protect HH and the environment has been proposed, and the ARARs for potable groundwater have been misinterpreted and applied to require extensive subsurface excavation activities. Secondly, and without limitation, the balancing criteria have been unfairly weighted particularly for short-term effectiveness, implementability, and cost, particularly with respect to the mandatory requirements for soils and sediments discussed above and for other reasons discussed in the attachment.

EPA RESPONSE: *EPA has thoughtfully considered Beazer's assertions, but does not believe that they are correct. EPA has fully addressed this comment in EPA's response to Beazer's Comment 7, above.*

The estimated total cost of the issues addressed above amounts to approximately $27.9 million, which represents over 50% of the total remedy cost. Beazer believes that a significant portion of these costs is unnecessary to protect human health and the environment and improperly imposed in the PRAP as result of improper balancing of the NCP balancing criteria in 40 C.F.R. 300.430(e)(9).

EPA RESPONSE: *EPA has considered Beazer's assertions, but does not believe that they are correct. Regarding matters of cost, please see the attached discussion of cost estimates, and please also refer to Beazer's own supplemental cost estimates for various components of the remedy. Note that PRAP Alternative 3 details what a 2-foot excavation of soil with backfill and cover would cost. Soil excavation for Alternative 3 totaled approximately $7.2M, while soil excavation in Alternative 4 totaled approximately $8.4M - while this is a significant difference, it is not as large a difference as suggested in the comment. As discussed earlier in this document, note that the original cost estimates in the 2003 FS Addendum (FS Alternative 10) split the cost of deeper soil excavations (beyond that required by the remedy) between the remedy and the "wetlands developer". EPA adopted this approach in order to be consistent for the purposes of comparison, but is not requiring the further excavations of materials to create a wetlands bank, as that is not part of the selected remedy. Rather, as stated in the PRAP, EPA's selected remedy is compatible with that potential future use, should such a use materialize in the future.*

2.0 DISCUSSION OF GENERAL ISSUES

This section expands upon the issues outlined above.

2.1 ISSUE 1: SOIL CLEANUP CRITERIA AND APPROACHES

Under the PRAP, the EPA proposes to excavate all surface and subsurface soil with PAH concentrations greater than 150 mg/kg PAH. Beazer believes that the EPA's proposal is arbitrary and without basis for several reasons. First, the 150 mg/kg PAH criterion is the *sediment cleanup criterion* and has no significance for surface and subsurface soils. The EPA prematurely states that the application of this criterion is necessary for soils and subsoils because of its determination regarding future use of the Site for wetlands banking. However, even if conversion of terrestrial habitats to wetlands for wetland banking purposes is considered a viable end use, the requirement to remove all soil with PAH concentrations above 150 mg/kg is overly protective.

EPA RESPONSE: *EPA has considered Beazer's assertions, and agrees that "the 150 mg/kg PAH criterion is the sediment cleanup criterion." However, the PRAP and the ROD clearly state that the sediment cleanup criterion shall be applied to soils in those areas where wetlands will be created. Furthermore, wetlands creation is listed as a possible future use, and not prescribed at all as part of the remedy. In response to this comment, EPA has further clarified this point in the description of Alternative 4.*

Second, the EPA has decided to use this criterion as a fixed cleanup target without consideration of the option of placing clean surface soils as a buffer to mitigate potential exposure risks. This approach results in excessive soil removal volumes and greatly increases the cost and technical complexity associated with huge soil excavation and movement projects. Third, this approach will result in excessive and unnecessary disturbance to unique ecologically sensitive habitats that are present at the Site. These negative impacts are greatly exacerbated by EPA's insistence in the PRAP to remove all soil where concentrations exceed the target criterion, including material at depth, not just in the biologically active zone. The result of this approach is that soil excavation depth will average 5 to 15 feet, up to a maximum of 30 feet below ground surface.

EPA RESPONSE: *EPA has considered Beazer's assertions, and notes that in the PRAP EPA considered several options for cleanup. Specifically, in the PRAP Alternative 2, EPA clearly considered "the option of placing clean surface soils," even including a liner and burrow-inhibition layer. For the reasons clearly and carefully outlined and considered in the PRAP, including evaluation against the nine criteria, EPA believes this to be an inferior alternative to the selected remedy. Please refer to the previous comment regarding the actual application of the cleanup criteria, and please refer to the PRAP for a discussion of the comparison of the selected remedy and a cover-in-place alternative. EPA's selected remedy may temporarily disturb sensitive habitats, but will provide for the translocation of the species and provide permanent relief.*

With respect to the possible future exposure of aquatic organisms in created wetlands, Beazer's extensive review of the Site data indicate that it is not ecologically warranted. A review of the ecological literature indicates that sediment-dwelling organisms rarely occur at depths deeper than 10 to 30 centimeters. For example, 95% of chironomid larvae reside in the upper 10 centimeters of the sediment column in soft-bottom habitats (American Society for Testing and Materials [ASTM], 1995). Also, studies of the burrowing behavior of a broad range of freshwater insect taxa from four orders (i.e., Diptera, Ephemeroptera, Megaloptera, and Trichoptera) showed that burrows rarely exceeded 10 cm (Charbonneau et al., 1997; Charbonneau and Hare, 1998). These results indicate that removal of 1 to 2 feet of soil, and capping, if necessary, would be sufficient to prevent ecological organisms from re-exposure to PAHs remaining in soils underlying created wetlands. Furthermore, the EPA is not clear regarding its estimates of the associated impacted soil volumes. In the PRAP, excavation to the 600 mg/kg goal established based on earthworm toxicity tests is estimated at 115,000 cubic yards (cy) (see discussion of Alternative 3) and excavation to the more stringent goal of 150 mg/kg based on sediment toxicity tests is estimated at *a lesser* volume of 113,000 cy (see discussion of Alternative 4). Clearly, the EPA's calculations for soil removal volumes are incorrect.

EPA RESPONSE: *EPA has considered Beazer's assertions, and does not believe that they are correct. Regarding capping sediments please refer to the extensive discussions of a cover-in-place alternative presented in the PRAP Alternative 2, as further explained in the previous response. Regarding volumes, the PRAP proposes a smaller containment area in Alternative 3, resulting in a larger acreage to be excavated (due to the smaller footprint of the containment/consolidation area which results in greater excavation outside of that footprint).*

The previous response addresses EPA's selection of the cleanup criteria, and provides a further discussion of the ARARs as they apply to the media to be cleaned-up.

This issue was also noted by the National Remedy Review Board ("NRRB") in its first recommendation, in which it indicated that such deep excavations were not justified to achieve a protective remedy and that "the preferred alternative should identify only those CERCLA remedial actions necessary for a protective remedy." In response to this, the EPA indicated that the extensive depth of excavation was to restore groundwater in the Columbia formation for use as a potential drinking water source. The EPA has not provided any justification to prove that the excavation of soils exceeding 150 mg/kg is necessary for the protection of groundwater. As explained below (see Issue 4), evidence indicates that the Columbia aquifer cannot be used as a drinking water source due to its poor water quality by non-Site related constituents.

EPA RESPONSE: *EPA has considered Beazer's assertions, and notes that the comment does not accurately state the NRRB comment. Please note that what the NRRB actually commented was, "PRAP does not present the justification..." In response to the NRRB comment, EPA has included the thorough discussion of the justifications for deeper excavation and consolidation. In addition, EPA notes that while the Columbia aquifer is not presently used for drinking water, it is classified as a "potential drinking water source."*

To summarize then, Beazer believes that the EPA improperly has required the application of a more stringent standard for soil excavation than is required to protect human health and the environment, and has failed to consider the use of a suitable clean soil cover, or a combination of excavation and cover, as an equally protective approach.

EPA RESPONSE: *EPA has carefully considered Beazer's assertions. EPA did consider the use of a clean soil cover, or a combination of excavation and cover in Alternative 2 of the PRAP.*

2.2 ISSUE 2: SEDIMENT REMEDIATION IN HERSHEY RUN

The EPA proposes to excavate all sediment from lower Hershey Run, and the marsh adjacent to the upper portion of Hershey Run where PAH concentrations exceed 150 mg/kg. Again, EPA's decision to use these criteria as cleanup targets improperly fails to consider: 1) the applicability of the cleanup target which applies to surficial sediments only; 2) the option of placing clean material covers to mitigate potential exposure risks; and 3) the unnecessarily excessive sediment removal volumes that will result in excessive disturbance to unique ecologically sensitive habitats to support the proposed excavation.

For aquatic plant and benthic invertebrate communities, the risk assessment for the Site (EPA, 2003a) concluded that impacts were only observed in localized areas within Hershey Run. Biodiversity increases with downstream distance from the Fire Pond, and the downstream area of Hershey Run is a diverse and functioning benthic community. However, the proposed alternative includes extensive sediment removal from all reaches of Hershey Run down to its confluence with White Clay Creek.

EPA RESPONSE: *EPA has carefully considered Beazer's assertions, and does not believe they are correct. The toxicity data provided the most reliable indication of ecological risk. In addition, EPA believes that the benthic survey data has limited applicability, since the survey sampling was not conducted at the same time or in the same sampling locations as where toxicity samples were collected -- an issue which was thoroughly discussed in the Ecological Risk Assessment ("ERA"). In addition, the resultant biodiversity data are not as conclusive as the toxicity data, as the ERA explains. The proposed alternative provides estimates of potential sediment excavation volumes, clearly stating that delineation efforts will be conducted during the RD.*

The EPA indicates that its proposed plan is consistent with the Eleven Risk Management Principles recommended in *Principles For Managing Contaminated Sediment Risks At Hazardous Waste Sites,* (OSWER Directive 9285.6-08) (EPA 2002) championed by the Contaminated Sediments Technical Advisory Group (CSTAG). The PRAP goes far beyond what is required to meet a sound risk management approach outlined in the above directive. The first oversight is that principles 1, 5, and 11 of the OSWER Directive should be considered in conjunction with each other. These principles include: control sources early, use an iterative approach, and monitor during and after remediation. These principles point to a sediment solution that would cut off the upland DNAPL seeps near the Fire Pond, coupled with relocation of Upper Hershey Run as proposed by Beazer and by the EPA in the draft PRAP, followed by a period of monitoring to assess the benefits of this source control before implementing downstream remediation activities.

EPA RESPONSE: *EPA has carefully considered Beazer's assertions, and does not believe that they are correct. EPA believes that Hershey Run is a principle threat source area. Creosote NAPL -- free product -- was observed throughout a significant distance of Hershey Run, well downstream of the proposed source control of the containment area. The "Eleven Principles" were indeed considered carefully, and a specific presentation was made to the CSTAG as part of the NRRB documents.*

The second oversight is that the EPA inappropriately contends that Monitored Natural Attenuation ("MNA") for sediments is not a viable option because Site operations ceased 30 years ago and there has been no reduction in risk. The EPA notes having seen DNAPL seeps to Hershey Run near the Fire Pond. Until source control measures are taken and monitoring data collected to assess the effectiveness of source control activities, the EPA is without basis to make statements regarding the viability of MNA. In fact, existing data provides indication of MNA, which might be greatly accelerated if upland sources (to the extent they exist) are mitigated.

EPA RESPONSE: *EPA has carefully considered Beazer's assertions, but does not believe that they are correct. EPA's position is well documented in the Administrative Record. EPA disagrees with Beazer that "monitored natural recovery" (MNR) or "monitored natural attenuation" (MNA), which may be appropriate for low concentrations of PAHs (10s-100s of mg/kg in sediment), is appropriate for this Site where thousands of PPM of PAHs occur. Under such high concentrations, the very organisms which would degrade the contaminants are unable to survive. MNA / MNR is not regarded as effective where such high concentrations as to constitute a principal threat are found. EPA does not agree that existing data provide any clear indication of MNA / MNR in sediments. However, EPA is confident that the toxicity and other data do provide a clear indication of ecological risk in much of Hershey Run.*

The EPA also contends that the potential disturbance of impacted sediments is high and can be caused by activities such as wading or bioturbation. The majority of impacted sediments in Lower Hershey Run is found at depth and generally considered stable with ongoing deposition of new material (0.24 to 0.36 inch per year) covering and more thoroughly containing Site-related PAHs over time. Field activities performed in 2002 paint a different picture than that proposed by the EPA in the PRAP. These activities indicate that the sediments were only disturbed through intrusive coring and probing activities, not wading. Additionally most literature indicates that the bioturbation is generally limited to the upper 6 inches of sediment.

EPA RESPONSE: *EPA has carefully considered Beazer's assertions, and does not believe that they are correct. The photographs and documents in the Administrative Record do not support Beazer's assertions. Free product creosote NAPL is easily liberated from shallow sediments through the simple action of wading. In addition, Beazer continues to argue that "natural encapsulation" will isolate these contaminants because a total of 2 sediment samples analyzed* *from the Site, both taken from isolated locations well outside of any major drainage channel, indicated a depositional setting. EPA, whose position regarding this argument is well-documented in the Administrative Record, does not agree (1.) that these 2 isolated samples can necessarily speak for the center of the Hershey Run channel, which drains many square miles of impervious surfaces, and (2.) that even if these samples were from Hershey Run itself, a particular environment can change from depositional to erosional quite literally overnight. Hershey Run is not immune to flooding problems, which occur in the area. EPA remains convinced that principle threat sediments and NAPL in Hershey Run must be remediated and not left susceptible to erosion or exposure.*

The EPA further contends that capping is not a cost effective action because generally only 1 to 2 feet of material will need to be removed and a cap would require the removal of 2 feet to maintain the existing grade. The EPA has failed to balance the advantages of suitable alternatives recommended by Beazer. Obviously, in these areas the removal of only the impacted material is appropriate; however, in areas where proposed sediment removal is greater than 2 feet, such as in Reach 8, capping is still a viable option that would adequately reduce risk, provide suitable benthic habitat, and would do so in a cost effective manner with reduced short-term impacts on the environment.

EPA RESPONSE: *EPA has carefully considered Beazer's comments, and believes they are not correct. The PRAP includes an alternative, which carefully considered sediment capping, and was balanced against the nine criteria in the consideration of alternatives.*

Beazer believes that more appropriate alternatives to the above selected removal approach, could include selected hotspot removal followed by natural recovery, capping, or rechannelization of the complete length of Hershey Run coupled with backfilling and habitat restoration of the existing channel.

EPA RESPONSE: *EPA has carefully considered Beazer's assertions and believes it has carefully considered multiple options, as have been clearly documented in the PRAP, NRRB documents and the AR, and has selected a remedy that best satisfies the nine criteria for remedy selection. EPA disagrees that hot spot removal, in the context of the comment, is a viable alternative because it would leave in place contaminated sediments with PAH levels exceeding the risk-based cleanup criterion, and therefore would not be protective; natural recovery would not reliably reduce risk in the remaining contaminated sediment, as is explained in the earlier response regarding "monitored natural recovery."*

2.3 ISSUE 3: PASSIVE DNAPL RECOVERY WITHIN THE CONTAINMENT AREAS

As discussed in the *Final Draft Remedial Investigation Report* (RI Report) (BBL, 2002), DNAPL in subsurface soils occurs in zones typically associated with historic Site operations. Within these zones, DNAPL was reported to occur either as discontinuous layers of potentially mobile liquid up to a few inches thick, as blebs that are not mobile, or as dry weathered seams that represent a residual and non-mobile phase. Contrary to the impression provided by the EPA in the PRAP, the data indicate that there is not a large mobile mass of DNAPL that poses any significant threat should it migrate, or that can be effectively removed. It is not physically or technically practicable under these conditions to remove even the mobile portion of the DNAPL because the product occurs in thin discontinuous layers, it migrates very slowly, if at all, and will not readily enter a collection well or trench.

EPA RESPONSE: *The boring logs and monitoring well data for the Site show that fluid NAPL has indeed migrated throughout the subsurface, even entering sediments and surface waters in Hershey Run. While there are limited data at depth in the subsurface where NAPL has been* *encountered, the data obtained are consistent with the behavior of creosote NAPL at other wood treatment sites, and indicate that fluid mobile NAPL is present.*

Beazer's review of the data submitted in the RI Report and subsequent data gathering indicates that only two Site monitoring wells (i.e., MW-2 and MW-8) have ever had DNAPL accumulations that would indicate the potential presence of recoverable quantities of DNAPL. Apparent DNAPL thicknesses measured at these monitoring wells were approximately 1 to 2 feet during RI activities in 1996. On the other hand, subsequent testing at these monitoring wells in 2003 indicated DNAPL thicknesses less than 0.01 foot. With such significant reductions in DNAPL thickness over time, it is not likely to be practicable to remove significant quantities of DNAPL.

EPA RESPONSE: *EPA has carefully considered Beazer's assertions, and believes they are not correct. Data from the boring logs and the monitoring wells indicate that the DNAPL has moved over the years. The NAPL that was detected in earlier sampling events remains present in the subsurface. The fact that it is no longer present in those wells indicates that EPA's contention that NAPL is mobile is in fact accurate. In addition, NAPL need not be encountered in a significant thickness in order to be recoverable; a one-inch NAPL-saturated sand seam can recover a great deal of NAPL (potentially thousands of gallons), behaving in a way similar to a large pipe over time, given the large surface area with which such a seam would intersect a collection trench.*

Furthermore, the PRAP already incorporates a barrier wall around the above-referenced DNAPL areas. The application of barrier walls to isolate DNAPL is a proven technology that has been instituted at a number of wood treating and other chemical sites as a source control measure. These consolidation areas will also be covered with a low-permeability liner that prevents precipitation infiltration into the areas. This will further serve to contain the DNAPL soils, and the mobility of any associated free-phase DNAPL. Given the redundant source containment measures included in the PRAP, it is apparent that DNAPL removal to the extent outlined in the PRAP would not be needed.

As previously recommended by Beazer, if DNAPL removal is required, a position with which Beazer does not agree at this time, before DNAPL removal is required, its feasibility and effectiveness should be evaluated. We therefore continue to recommend that passive DNAPL recovery not be a required remedial element, but rather DNAPL removal pilot testing be conducted to determine the need for and potential effectiveness of a DNAPL recovery system within the proposed consolidation areas. This pilot testing could be done in parallel with the remedial design process, and the soil containment area design could allow for the inclusion of DNAPL removal systems should the pilot testing establish its feasibility and effectiveness.

Therefore, Beazer believes that the EPA has not demonstrated the need for a passive DNAPL removal system when there is no evidence to suggest there are significant removable quantities of DNAPL and the DNAPL will be contained, in any event, within a barrier wall. DNAPL removal pilot studies can be conducted, thus allowing implementation of a more cost-effective DNAPL removal approach, tailored to Site-specific conditions.

EPA RESPONSE: *EPA has carefully considered Beazer's assertions, and believes that they are not correct. Due to the actual mobility and the potential for mobilization of NAPL in the subsurface during construction, the vertical barrier wall will prevent and lateral migration of NAPL out of the containment area during the installation of the recovery trench system, as well as during the subsequent excavation of material outside of the containment area which will most certainly change the hydraulic conditions in the surrounding area of the Site. If EPA determines during the Remedial Design phase that the certainty of horizontal containment that this "belt and suspenders" approach could be achieved without the vertical barrier wall, both during* *construction and in perpetuity, EPA may revisit the necessity of the vertical barrier wall. Also, without a "drain" (the recovery trench system), the wall would cause mounding within the containment area, threatening the Potomac, and potentially causing up gradient flooding, threatening the rail lines and up gradient properties. Therefore, EPA does not believe that this remedial component is redundant, but is necessary to address the mobility of NAPL.*

2.4 ISSUE 4: GROUNDWATER REMEDIATION
The EPA recommended remedy is supported largely by its anticipated ability to restore Site groundwater to its beneficial use as a potential source of drinking water. Beazer considers restoration of Site groundwater to beneficial use as a potential source of drinking water to be both inappropriate and technically impracticable for the reasons outlined below.

Groundwater at the Site is found within two water-bearing zones. The upper, shallow groundwater-bearing zone resides in the Columbia Formation geologic unit and exists under unconfined, or water-table conditions. A limited portion of this shallow groundwater has been impacted with wood-treating residuals at the Site and is the focus of remedial alternatives being considered by the EPA.

The lower hydrostratigraphic unit, or deep groundwater-bearing zone, resides within the Potomac Formation geologic unit and exists under confining conditions. Groundwater in the lower hydrostratigraphic unit can be extracted at sufficient quantities, and is of sufficient quality, to render it an "aquifer" and has been given the name "Potomac Aquifer" in the state of Delaware. There are no users of this aquifer at or adjacent to the Site. The lower hydrostratigraphic unit has not been found to be impacted with Site-related constituents and, as a result, the PRAP proposes long-term monitoring of the lower unit as a protective measure.

EPA RESPONSE: *In addition to preventing ground water mounding in the overlying containment area, the ground water recovery system will maintain a safe hydraulic gradient for the containment of contaminants by not increasing vertical head, which would potentially force contaminants down into the Potomac if they are not already present. This hydraulic head management will (1) prevent any further release into the Potomac, and (2) enhance the effectiveness of the recovery trench by dragging/pushing NAPL into it.*

These two hydrostratigraphic units are separated by a low-permeability; fine grained silt and clay layer of varying thickness that the data demonstrate to be continuous across the Site. Evidence for the continuity of the low-permeability, fine grained silt and clay layer across the Site includes the fact that it has been detected in over 100 soil borings completed at the Site and the fact that the lower hydrostratigraphic unit has not been found to be impacted with Site-related constituents.

EPA RESPONSE: *EPA has carefully considered Beazer's assertions, and believes that they are not correct. As has been discussed in numerous documents over the past several years during the extensive study and investigation of this Site, neither the data presented, nor literature of local geology reviewed support the claim of a continuous clay layer. The Columbia and Potomac Formations are fluvial in origin, and as such are laterally quite variable. They have been described in the literature as an "interconnected system," and as having variegated clays with interbedded silts, sands and gravel. While some of the boring logs for the Site describe the "clay," the lab analytical data for some of those same samples identify particle size distributions more consistent with silt or sand, not clay. The ground water data for the Site also indicate a connection between the Columbia and Potomac aquifers (e.g., similar flow direction, similar response to tidal fluctuations, and varying differences in hydraulic head). EPA understands that there may exist a competent clay layer functioning as an aquitard between these aquifers at other Sites, but at this Site, which is* *especially large in size, it is not surprising to find the lateral variability of these deposits occurring within the Site boundaries.*

The data indicate, and it is supported by the literature reviewed by EPA, that there is not likely a continuous clay beneath the Site. There are areas where lenses or stringers of clay with low permeability will inhibit downward flow of both ground water and NAPL, but due to the lateral variability and heterogeneity of the subsurface materials, the "clay layer" does not present the kind of vertical barrier to contaminant transport that Beazer describes.

Irrespective of any impacts from wood treating constituents at the Site, groundwater in the Columbia Formation at and near the Site does not represent a suitable potential future supply of potable water due to its characteristically poor quality. Therefore, selection of a remedial action objective (RAO) to restore groundwater in the Columbia formation to drinking water standards is not only inappropriate, but it is also impracticable. Groundwater in the Columbia Formation at many locations in New Castle County has been found to contain naturally occurring elevated concentrations of iron to render it non-potable without significant pre-treatment (Bachman and Ferrari, 1995; Woodruff, 1970; Rima, et al., 1964). Iron concentrations in background groundwater samples collected at up gradient monitoring wells ranged between approximately 306 and 5,280 micrograms per liter (µg/L; BBL, 2002), exceeding the EPA secondary drinking water regulation level of 300 µg/L.

Similarly, groundwater in the Columbia Formation at many locations in New Castle County has been found to contain elevated concentrations of nitrate and other septic wastes to render it nonpotable without significant pre-treatment (Miller, 1975; Goehring and Carr, 1980; Svatos and Goehring, 1981; Hamilton and Shedlock, 1989). Although nitrate concentrations have never exceeded the EPA maximum contaminant level (MCL) of 10 milligrams per liter (mg/L) in any groundwater sample collected at the Site, nitrate concentrations in background groundwater samples collected at up gradient monitoring wells screened in the Columbia Formation during remedial investigations were found to range from approximately 0.6 to 1.3 mg/L. Since nitrate concentrations above 0.4 mg/L are indicative of septic wastes (Bachman and Ferrari, 1995) and therefore not Site-related.

Furthermore, adopting EPA's preferred approach to groundwater in the PRAP could have the negative effect of exacerbating the already poor quality of the existing aquifer. Any attempt at extracting groundwater from the Columbia Formation at the Site for water supply purposes would likely result in the intrusion of high-salinity-content surface water from the Christina River, White Clay Creek, and Hershey Run Creek. These surface water features are tidally influenced with an average tidal range of about 6 feet and a salinity range of approximately 500 to 5,000 mg/L (BBL, 2002). Since groundwater in the Columbia Formation is hydraulically connected to, and temporarily recharged by these surface water features during high tide, attempts at exploiting groundwater in the Columbia Formation at this Site for water supply purposes run the likely risk of degrading water quality due to salt water intrusion. Instances of salt-water intrusion at pumping sites in New Castle County have been documented by Hayes et al. (1998). Furthermore, Groot (1983) concluded that no water supply wells should be constructed within several miles of the presence of brackish water if drinking water quality is required."

EPA RESPONSE: *EPA has carefully considered Beazer's assertions, and believes that they are not correct. Beazer's barrier wall, as proposed, will isolate the containment area from tidal influence, and without a "drain" (the recovery trench system), the wall would cause mounding within the containment area, threatening the Potomac, and potentially causing up gradient flooding, threatening the rail lines and up gradient properties.*

The above Site-specific ground water quality information is consistent with the finding that ground water in the Columbia Formation is undesirable as a drinking water supply throughout much of the county. It is therefore evident that there would be no benefit achieved if wood treatment-related constituents could be removed from groundwater outside of the containment areas, particularly since the PRAP incorporates institutional controls that will prevent access to this water. Furthermore, as noted on page 10 of the PRAP, "exposure to groundwater without DNAPL present did not result in carcinogenic results outside the acceptable range"; and non-carcinogenic risk in groundwater without DNAPL present "was largely caused by high background levels of metals that occur in Columbia Aquifer ground water."

In summary, then, EPA's recommended remedy for groundwater is arbitrary and an abuse of the agency's discretion. EPA's goal of returning the impacted aquifer to potable status is inappropriate and technically impracticable. The EPA is applying ARARs that are not appropriate for this Site in violation of CERCLA and the NCP, which have a significant outcome on the remedy selection process. Section 300.430(a)(iii)(F) of the NCP directly addresses EPA's expectations for groundwater at a Site such as the Newport Plant. Although the NCP does establish an expectation on behalf of the EPA that it will return usable groundwater to its beneficial uses wherever practicable, the NCP states "[w]hen restoration of ground water to beneficial uses is not practicable, EPA expects to prevent further migration of the plume, prevent exposure to the contaminated ground water, and evaluate further risk reduction." 40 C.F.R. 430(a)(iii)(F). Beazer believes that the Site data establish that the return of this aquifer to potable status is impracticable and that further migration of the plume and exposure to contaminated groundwater would both be prevented by Beazer's recommended approach.

EPA RESPONSE: *EPA has carefully considered Beazer's assertions, but does not believe they are correct. The PRAP does not assert a position regarding the potable status of the Columbia aquifer; only to restore ground water to beneficial use to the maximum extent practicable outside of the containment area through consolidation only. Any remaining residual contamination would attenuate through physical and biological processes.*

Furthermore, even if the potable water ARARs were appropriate for this Site, a position with which Beazer does not agree, it is widely recognized that technical impracticality waivers are considered appropriate for these types of sites (EPA, 1993 and 1995). Because of these reasons, an ARAR waiver for the impacted portion of groundwater in the Columbia Formation at the former Koppers Co. Inc. Site would be appropriate given the following:

- Shallow groundwater has already been determined to be undesirable as a supply of potable water in New Castle County;
- No proven technologies exist that could restore impacted shallow groundwater to drinking water standards at the Site;
- Any serious efforts at exploiting shallow groundwater as a potable supply would likely result in greater risk to human health and the environment due to salt water intrusion; and
- The EPA has already approved an ARAR waiver for shallow groundwater in the Columbia Formation for similar reasons at the adjacent E.I. DuPont de Nemours & Co., Inc. Pigment Plant Landfill Site.

EPA RESPONSE: *EPA has considered Beazer's assertions, and does not believe they are correct. The PRAP does not assert a position regarding the potable status of the Columbia aquifer, which has been addressed in previous responses. EPA has not designated the aquifer as a potential drinking water aquifer, but EPA does expect to restore ground water to its beneficial use, to the maximum extent practicable. Again, the issue of ground water restoration to beneficial use has been addressed in previous responses.*

2.5 ISSUE 5: REMEDIATION FOR A SPECIFIC SITE REUSE

Beazer objects to EPA's PRAP in that it assumes that the future reuse of the Site will include wetlands banking, a fact that drives enormous increases in costs to implement such reuse. Although Beazer recognizes the benefits of combining remediation with future reuse, we are not willing to finance the incremental future reuse costs, particularly those associated with specific reuse as a wetlands bank or as the location of a drinking water supply reservoir. Two very significant cost components in EPA's recommended remedy include: 1) costs to consolidate/dispose of an estimated 423,000 CY of excavated soil (currently considered acceptable for offsite reuse) if offsite reuse is deemed unacceptable or an offsite use cannot be identified; and 2) a wetland developer willing and able to cover the estimated $8.5 million to construct the wetlands. The EPA would therefore either have to wait for a third party investor in wetlands to commit, or allow for a lesser, more reasonable, amount of soil excavation and surface restoration as part of the remedy.

EPA RESPONSE: *EPA has considered Beazer's assertions, but does not believe that they are correct. As stated in the PRAP, the sediment cleanup criterion is to apply to those soils where wetlands will be created. Regarding matters of cost, please see the attached discussion of cost estimates, and please also refer to Beazer's own supplemental cost estimates for various components of the remedy. Note that PRAP Alternative 3 details what a 2-foot excavation of soil with backfill and cover would cost. Soil excavation for Alternative 3 totaled approximately $7.2M, while soil excavation in Alternative 4 totaled approximately $8.4M - while this is a significant difference, it is not as large a difference as suggested in the comment. As discussed earlier in this document, note that the original cost estimates in the 2003 FS Addendum (FS Alternative 10) split the cost of deeper soil excavations (beyond that required by the remedy) between the remedy and the "wetlands developer". EPA adopted this approach in order to be consistent for the purposes of comparison, but is not requiring the further excavations of materials to create a wetlands bank, as that is not part of the selected remedy. Rather, as stated in the PRAP, EPA's selected remedy is compatible with that potential future use, should such a use materialize in the future.*

The PRAP does not assert a position regarding future use, and specifically mentions that EPA has generally little input regarding future use. Beazer, in its submittals to EPA has identified a possible future use scenario. The PRAP does identifies portions of the Site could be available for future use, with restrictions placed on use of the containment area.

Beazer does not believe that either CERCLA or the NCP require that the EPA alter its remedy selection in order to accommodate a future use option that has been neither fully evaluated nor finalized. The appropriate reuse determination for the Site is within the Site owner's discretion and cannot be mandated by the EPA in a PRAP.

To summarize, Beazer believes that it is feasible to initiate some of the elements of the remedial action based on protection of human health and the environment, and upon establishing viable Site reuse, then complete remediation of the Site, consistent with the viable redevelopment plan.

EPA RESPONSE: *The PRAP does not assert a position regarding future use, and specifically mentions that EPA has generally little input regarding future use. Beazer, in its submittals to EPA has identified a possible future use scenario. The PRAP does identifies portions of the Site could be available for future use, with restrictions placed on use of the containment area.*

2.6 ISSUE 6: PRESCRIPTIVE REQUIREMENTS

The PRAP contains arbitrarily mandated prescriptive elements of the remedy that are likely to change during the remedial design process or during further implementation of remedial action at this Site. These include:

- Two onsite landfills covering 38 acres (consolidation areas). The objective in these areas is to contain mobile DNAPL. In the design, one or more areas may be selected. The designs will be based on further investigative work and groundwater modeling to locate and size the containment areas.
- Soils from approximately 39 acres of uplands would be excavated. The remedial design would select areas to be excavated and these are likely to be different. Specific areas to be excavated would be identified as part of the remedial design.
- Passive DNAPL recovery trenches and drainages. As discussed above, the specific DNAPL removal technology should be based on science established through pilot testing, and not an arbitrarily selected high cost technology.

EPA RESPONSE: *EPA agrees that the PRAP identifies remedial components of the selected remedy. During Remedial Design, it is appropriate for the implementation of the remedial components to be planned for with specificity—for example the location and size of the containment system will be determined. Furthermore, the passive recovery trenches and drainages were selected as a remedial component. They are well understood to be more effective and less costly than recovery wells, and therefore, EPA believes they are less costly technology for DNAPL recovery. This "balancing" was discussed in the PRAP. Other effective options include in-situ or ex-situ thermal treatment and are fully discussed in the FS and PRAP.*

Beazer believes that it is unnecessary and unreasonably restrictive to incorporate these requirements into the preferred remedy at this stage. EPA's insistence on these premature requirements is particularly problematic to Beazer because we cannot determine from the PRAP whether these costs have been included within the total costs picture provided by the EPA. To the extent that the costs do not include these prescriptive components, Beazer believes that the EPA has not complied with its duty under the NCP to fairly apprise the stakeholders of the costs of the preferred remedy.

EPA RESPONSE: *EPA has carefully considered Beazer's assertions, and does not believe they are correct. It is appropriate for area and volume estimates, with exact delineations, are deferred to the RD. The PRAP clearly details assumptions for the cost estimates, which are well documented in the AR and were presented to the NRRB in detail. Please note that EPA's cost estimates are based on Beazer's estimates, with greater detail added and a number of refinements made by EPA to account for discrepancies.*

3.0 SPECIFIC PAGE BY PAGE ISSUES

1. Page 1 - EPA's stated goal of "...restoring groundwater to its beneficial use as a potential drinking water aquifer." ignores the technical impracticability of achieving such a goal. Beazer incorporates by reference its discussion regarding this issue elsewhere in these comments and in the cover letter. This goal is used throughout the PRAP to justify the removal and management of thousands of yards of soil at increased cost without the application of previously calculated present or future predicted risks posed by the Site. The EPA is also acting contrary to the recommendations issued by the NRRB on June 14, 2004, which stated that the preferred alternative should identify only those CERCLA remedial actions necessary for a protective remedy. This overriding theme adds significant and unnecessary costs to the remedy.

EPA RESPONSE: *EPA has carefully considered Beazer's assertions, and does not believe that they are correct. The NRRB requested that the PRAP be modified to include a more detailed* *justification of the remedial actions. EPA provided this justification. The NRRB did not suggest that there was a lack of justification or that such justification was not possible, as the comment suggests.*

Restoration of impacted groundwater at former creosote wood treating facilities has proven to be both complex and technically infeasible at a growing number of sites. Several relevant quotes from a report developed by an EPA - convened expert panel that examined the issue of DNAPL source depletion (EPA, 2003b) are provided below which support this:

- As far as the Panel is aware, there is no documented, peer-reviewed case study of DNAPL source zone depletion beneath the water table where U.S. drinking water standards, or MCLs have been achieved and sustained throughout the affected subsurface volume, regardless of the in-situ technology applied."
- "... it is highly uncertain that MCLs can be achieved in source zones impacted with DNAPLs in most geologic settings."

EPA RESPONSE: *The NRRB is a peer-review process, which subjects EPA's remedies to a high-level of scrutiny. The Koppers Site PRAP was reviewed, commented upon and accepted by the Panel. The Final Report of the NRRB accepted that excavation can be 100% effective; passive NAPL recovery will recover DNAPL and will provide for a safe preferential pathway, which is necessary since neither a safe pathway nor effective containment now exist.*

This goal is also inconsistent with the ROD issued for groundwater media at the neighboring DuPont Newport Superfund Site for the same aquifer. Beazer would recommend that the EPA provide flexibility in the PRAP to incorporate the application of ARAR waivers, common for many RODs issued for sites containing DNAPL.

EPA RESPONSE: *EPA has carefully considered the assertions posed by Beazer. However, EPA believes that based upon the extensive study of creosote NAPL at the Site, the selected remedy will address the risks posed by the hazardous substances. Additionally, with respect to the ROD issued for the DuPont (Newport) Site, although similarities exist between Superfund sites, EPA's remedies are Site-specific with remedial components identified through the nine criteria set forth in the NCP. ARARs and performance standards are determined for each remedial component identified for the Site. Therefore, the ROD for the DuPont (Newport) Site may be distinguished on many bases and is not relevant to the Koppers Site.*

2. Page 2, paragraph 1 - The PRAP states that DNAPL material would be excavated "to the maximum extent practicable," correctly recognizing that removal of "all" DNAPL is not likely. Given this statement, it is inconsistent for the EPA to assume and state in the following paragraph that "...groundwater at the Site would be restored to its beneficial use (as a potential source of drinking water)." The requirement for removal of subsurface DNAPL outside of the containment area should be eliminated from the PRAP.

EPA RESPONSE: *"Practicable" is generally defined as "capable of being accomplished." While EPA recognizes that recovery of all NAPL is difficult and may present implementability challenges during construction of the remedy, EPA believes that this does not make it impracticable.*

3. Page 2, paragraph 3 - It appears that future Site use has played a role in supporting the EPA's decision to recommend extensive deep upland Site excavation (see also page 35, State Acceptance). The NRRB seems to have made similar observations, and rightfully noted, "The

preferred Alternative should identify only those CERCLA remedial actions necessary for a protective remedy." While the EPA noted in its response to NRRB comments that extensive upland removal was necessary to restore the Columbia aquifer (due to EPA's "general" expectation" at Superfund sites to return groundwater to its beneficial use), restoration as EPA has suggested is neither technically supportable, nor appropriate given the Site setting/history. In the absence of risk or a defined reuse plan with financial backing, extensive deep upland excavation is not justified and should not be a part of any Proposed Plan for the Site. The PRAP should specifically state that no remedial measures proposed at the Site are driven by expectations of some "undefined possible future land use."

EPA RESPONSE: *EPA has carefully considered Beazer's assertions and does not believe they are correct. EPA has not made a designation regarding future use of the Site. The PRAP states that EPA makes no decisions regarding future use of a property (except where Institutional Controls restricting certain uses are warranted for the protection of human health and the environment and to ensure the integrity of the remedy).*

4. Page 2 - The EPA's discussion of the use of institutional controls to restrict the installation of drinking water wells is incompatible and appears to be counter to its stated goal of restoring groundwater to its beneficial reuse as a drinking water supply.

EPA RESPONSE: *EPA has carefully considered Beazer's assertions, and does not believe that they are correct. There is an hydraulic connection between the Columbia and Potomac aquifers. The Columbia is designated by the State as a potential drinking water source; the Potomac is a drinking water aquifer. Wells in the Potomac in the vicinity of the containment area would have the potential to draw contamination downward out of the containment area and into the Potomac. Therefore, consistent with CERCLA and the NCP, it is the goal of the Superfund program to restore ground water to beneficial use to the maximum extent possible. The Institutional Controls of restricting the installation of drinking water wells are warranted at this time in light of the high levels of creosote NAPL in the ground water. Also, the State may extend a Ground Water Management Zone in this area, both to protect public health and to minimize the potential for the downward migration of NAPL through well pumping that could affect the hydraulic regime at the Site.*

5. Page 2 - Beazer has not been provided with a copy of the comments and statement of position received from the Delaware Department of Natural Resources and Environmental Control (DNREC) by the EPA to understand how these were utilized in preparation of the PRAP. Beazer assumes that these documents will be included in the Administrative Record for review by the stakeholders. This statement is reiterated on Page 35.

EPA RESPONSE: *As stated in the PRAP, DNREC has expressed its support for the proposed remedy, but actual concurrence is not received on the PRAP; rather, it is evaluated for the ROD. DNREC's letter of concurrence or non-concurrence will be included in the Administrative Record with the ROD.*

6. Page 8 - The EPA has failed to provide the reference or source used to determine that the extent of DNAPL zones is approximately 82,000 CY.

EPA RESPONSE: *The FS submitted by Beazer did not provide clear estimates of affected acreage or potential volumes of soil or sediment to be cleaned; therefore, EPA developed these estimates using data, maps, figures and tables provided by Beazer during the RI/FS to provide a certain degree of specificity based upon all the available Site information.*

7. Pages 8/9 - The EPA raises the concept of the "halo" effect stating that DNAPL related constituents "...are not migrating in ground water" and that the "...plume exists in ground water only very near the NAPL itself, like a halo, and is quickly attenuated in only a short distance". Beazer concurs with these conclusions and therefore does not understand why later on in the PRAP, the EPA uses DNAPL to justify the extensive removal and containment of thousands of cubic yards of soil without any corresponding risk justification.

EPA RESPONSE: *Creosote DNAPL is often mobile or readily mobilized. The DNAPL at the Site is mobile. EPA, USFWS, DNREC and others have witnessed flowing liquid creosote at this Site. Beazer's own contractors have witnessed DNAPL accumulations in wells "disappear." The actual cleanup goals include consolidating all DNAPL, with excavation considered complete once TPAH levels are below the soil or sediment cleanup goals listed in the PRAP.*

8. Page 9 - states that DNAPL or highly contaminated sediment is present through "...virtually the entire length of Hershey Run..." Beazer disagrees with this statement and to the best of Beazer's knowledge; the EPA has not disclosed the data and supporting information that were used to reach this conclusion.

EPA RESPONSE: *EPA carefully reviewed the analytical data to which Beazer is referring, most of which was obtained from sediment samples taken from the 0-0.5 feet interval in Hershey Run, as well as the detailed boring logs and first-hand accounts that support EPA's position with regard to the channel and the overbank wetlands. This information may be found in the Administrative Record for the Site, in the RI/FS documents.*

9. Page 9 - The EPA makes a claim that DNAPL has been mobile and migrating for over 24 years. This appears to be counter intuitive to other statements made by the EPA that the material is quickly attenuated in the subsurface. Beazer expects that such hypothetical conclusions will be excluded from the PRAP unless factual evidence throughout the entire time interval, is presented to support this statement.

EPA RESPONSE: *EPA has carefully considered Beazer's assertions, and believes that they are not correct. It is important to distinguish between NAPL, which does not attenuate in the subsurface below the water table, and a limited aqueous phase plume of sparsely soluble constituents, which are somewhat readily attenuated because in general it is the low-molecular-weight constituents that are sparsely soluble. It is those same constituents that tend to be degradable in the aqueous phase. This information may be found in the Administrative Record for the Site, in the RI/FS documents.*

10. Page 9 - The fish tissue survey referred to is a Hershey Run mummichog histopathology report (Harshberger, 2003). That report was not used as a line of evidence in the final ecological risk assessment (ERA) for the Site (EPA, 2003a), but is presented as such in the PRAP, citing as evidence of effects a reported 40% prevalence of liver tumors in fish collected from Hershey Run. To be more accurate, the Harshberger report only found a 30% prevalence of liver tumors (hepatocellular carcinomas), with precursor alterations in another 6% of the 30 fish sampled. The Harshberger report concludes that Hershey Run is "confirmed to be a hazardous waterway," but provides no context as to what exactly is meant by that statement with regard to the results presented. A fundamental problem with the histopathology report is that no fish from any reference locations were evaluated. Consequently, there is no way to contrast prevalence of tumors in mummichog from Hershey Run with typical background levels and, therefore, no way to put these reported results into a proper risk perspective.

EPA RESPONSE: *The 2003 report has been supplemented by a subsequent report, published in late 2004, in which numerous other waterways (or "reference locations") in the area are compared to Hershey Run with striking results: Hershey Run is indeed far worse off than any other waterway, and is clearly a "hazardous waterway." A copy of this report is included in the Administrative Record.*

11. Page10 - Beazer agrees with the EPA that the Site could not be used for residential purposes and therefore questions the EPA's rationale for issuing a goal to clean groundwater to drinking water quality. While Beazer understands it is the EPA's general expectation at Superfund sites to return groundwater to its beneficial use, for reasons presented in General Comment 4, Beazer believes it is both unnecessary and unachievable (not driven by risk), and given the cost to implement, should be eliminated as a remedial goal for the Site.

EPA RESPONSE: *EPA has considered Beazer's comments and does not believe that they are correct. Neither EPA's rationale nor the stated goal in the PRAP mention cleaning "groundwater to drinking water quality." EPA is aware that the Columbia's natural condition does not necessarily make it suitable for drinking without treatment, and would refer Beazer to the actual text of the PRAP which clearly refers to the Columbia aquifer as a state-designated "potential drinking water aquifer."*

12. Page 10 - Beazer disagrees with EPA's statement that "...the risk from exposure to soil and sediment may be underestimated" and requests that such speculative statements be retracted. While Beazer does not deny that potential risks may exist, many of the components of the human and ecological risk assessments are based on generally conservative assumptions, suggesting that actual risks are less than those estimated. With specific regard to surface soils, the EPA correctly states on Page 8:

    "Deposits of NAPL were observed in surficial soils of the Upland Area, primarily in the Process, Drip Tank, and Wood Storage Areas (Figure 4). Other smaller deposits were observed along the access road leading to the southwest corner of the uplands and in the South Ponds and K Areas. In surface soils of these areas, creosote was found in a dry weathered form, typical of creosote NAPL and tar-like material that has been significantly weathered and dried over time. As a result, the material appeared to be immobile and it possessed little detectable odor."

    Given this, one would expect risks due to dermal exposure to PAHs by trespassers to be overestimated, not underestimated.

EPA RESPONSE: *EPA has carefully considered Beazer's assertions. EPA believes that Beazer is likely more familiar with creosote constituents, NAPL and PAHs in general than most citizens. As such, EPA expects that Beazer is familiar with the known contact hazards presented by a large number of the constituents in creosote. Since these constituents do not appear in the dermal exposure risk assessment scenarios (because they are known contact hazards and do not have associated risk parameters to estimate their potential for risk), any such scenario would therefore underestimate risk whenever actual creosote NAPL would be encountered (for example, NAPL pools in soils or NAPL releases from sediments).*

13. Page 13 - Beazer disagrees with the conclusion that plant community observations corroborate risks associated with creosote contamination in upland soil communities. The ERA for the Site (EPA 2003a) indicates that upland vegetation is adversely affected in areas of high PAH concentrations, but provides no quantitative data to support this assertion. Site surveys show high plant diversity in areas not directly affected by creosote, suggesting that

upland communities over much of the Site are unaffected, and effects that are observed may be due to hard matrix effects of creosote, not phytotoxicity.

EPA RESPONSE: *EPA has carefully considered Beazer's assertions, and does not believe that they are correct. EPA's conclusions are based on a complete consideration of the Ecological Risk Assessment, which accorded the most significance to the evidence derived from the toxicity testing.*

14. Page 14 - The ERA synopsis notes that the distribution of PAH concentrations in soil and sediment did not generate a gradient of toxicity responses, which presented technical difficulties in the risk calculations. However, as Beazer has noted in previous submissions, there are statistical methods that can deal with dose-response data of the type observed in bioassays performed with Koppers sediment and soil. For example, a point estimate approach can be applied to use regression statistics for all of the data in a concentration-response series to derive an effective concentration that corresponds to a selected response level and unlike a no-observed-adverse-effect level (NOAEL) or lowest-observed-adverse-effect level (LOAEL), is not constrained to be one of the tested concentrations. As noted, based on available data there is little difference in the areal extent of sediment or soil where PAH concentrations exceed effective concentration values versus the extent that exceeds EPA's RAOs based on NOAEL and LOAEL values. Thus, while remedial decisions may be comparable, EPA should have considered alternative statistical approaches when determining effects thresholds.

EPA RESPONSE: *EPA has carefully considered Beazer's assertions, and notes that the previous submittals mentioned in the comment were considered and responded to, with the result being that EPA remained confident with the conclusions of the Ecological Risk Assessment.*

15. Page 15- Table 1 lists southern leopard frogs (Rana pipiens) as the ecological receptor, and states that the weight of evidence concludes that "risk exists, effects levels consistent with other sediment contamination related risks." In fact, toxicity tests were performed using an exotic species, the African clawed frog, Xenopus laevis, as a test surrogate because of problems maintaining Rana pipiens in laboratory conditions. While not inappropriate to use surrogate species, the summary should note that the results are not derived directly from the selected ecological receptor. Furthermore, Beazer's review of the test data has shown consistently high mortality rates in control groups and in groups tested using reference location samples. This consistently high control and reference mortality indicates problems with the Xenopus bioassay and that this line of evidence should not be considered as sufficient to conclude that risk exists to amphibians at effect levels consistent with other sediment related risks.

EPA RESPONSE: *The PRAP describes the complete list of lines of evidence listed in the comment, and specifically addresses the weight of each line of evidence. A more complete discussion is presented in the Ecological Risk Assessment. The data support EPA's conclusions.*

16. Page 15 - Evaluation of potential effects of Site contaminants to fish populations was assessed on four lines of evidence in the ERA (EPA, 2003a). Greatest weight was given to an indirect effect, benthic macroinvertebrate toxicity, and Beazer is still unclear how this represents the best measurement of direct toxicity to fish. The second line of evidence used was short-term toxicity testing with mummichog (*Fundulus heteroclitus*). The tests were subject to high control mortality (33%), which renders this dataset unsuitable for quantitative use in risk characterization. As noted above, the fish histopathology analysis was not included as a line of evidence in the ERA, and technical problems indicated previously limit the

relevance of conclusions presented in the ERA report. Based on these issues, Beazer does not understand how the ecological risk synopsis can conclude that PAHs pose ecological risks to fish, as stated in the last paragraph on page 15.

EPA RESPONSE: *The PRAP describes the complete list of lines of evidence listed in the comment, and specifically addresses the weight of each line of evidence. A more complete discussion is presented in the Ecological Risk Assessment. The data support EPA's conclusions.*

17. Page 15 - Beazer disagrees with the statement that "vegetation surveys conducted during the Remedial Investigation showed negative effects of contaminants on upland plants, particularly in areas of visible contamination." As noted above, the ERA (EPA 2003a) provides no quantitative data to support this assertion or evidence that effects are due to phytotoxicity, rather than a lack of pervious ground suitable for rooting due to hard matrix effects of creosote.

EPA RESPONSE: *EPA has carefully considered Beazer's assertions, and does not believe that they are correct. The PRAP describes the complete list of lines of evidence listed in the comment, and specifically addresses the weight of each line of evidence. A more complete discussion is presented in the Ecological Risk Assessment. The data support EPA's conclusions.*

18. Page 15 - Beazer strongly believes that the statement, "In summary, it is concluded that PAHs pose ecological risks to upland, wetland, and aquatic communities at the Site, specifically to organisms low in the food chain (i.e., earthworms, insects, shelled organisms, fish and frog embryos, and both upland and aquatic plants)" grossly overstates the extent of risk to ecological communities by not sufficiently considering all available lines of evidence. All conclusions regarding ecological risk are based on results of sediment and soil toxicity tests using Site media, as are the sediment and soil cleanup criteria. Other lines of evidence, such as surveys of benthic invertebrate communities or wetland and upland plant communities do not support these conclusions. Furthermore, technical problems with fish and frog toxicity tests, as described above, limit the ability to use these lines of evidence in making conclusions of risk to fish and amphibian communities.

EPA RESPONSE: *The PRAP describes the complete list of lines of evidence listed in the comment, and specifically addresses the weight of each line of evidence. As discussed in both the PRAP and the Administrative Record, the toxicity data provided the clearest indication of ecological risk, and therefore were accorded more weight in the risk assessment. A more complete discussion of the lines of evidence, their respective weights in reaching a conclusion, and the technical issues encountered is presented in the Ecological Risk Assessment.*

19. Page 15 - The EPA recognizes in footnotes 2/3 that zinc (a non-Site-related constituent) poses an ecological risk at the Site but has not addressed zinc from a source control standpoint. Beazer believes that even if the wood treating constituents were addressed to EPA's satisfaction at the Site, that the Site would be not be completely protective of human health and the environment due to the presence of zinc from offsite sources. The EPA has failed to address how zinc impacts at the Site are to be addressed as part of the PRAP.

EPA RESPONSE: *The PRAP notes that zinc in sediments generally coincides with high levels of total PAHs in sediments, and will be successfully addressed via containment along with the PAH-contaminated materials.*

20. Page 17 - As previously mentioned, the EPA's treatment of DNAPL is linked with the concept of restoring groundwater to drinking water quality as a new RAO while generating no further incremental protection of human and health and the environment offered by the selected remedy discussed later in the document. In fact, there are several other alternatives that would provide an "equivalent standard of performance" as provided under CERCLA 121(d)(4)(D). This provision allows for one alternative if a potable water ARAR is ultimately determined to be appropriate, a position with which Beazer disagrees, that is, a waiver of an ARAR (i.e., restoring groundwater to drinking water standards) if "the remedial action selected will attain a standard of performance that is equivalent to that required under the otherwise applicable standard, requirement, criteria or limitation, through use of another method or approach". As previously discussed, there are other DNAPL source control technologies, in concert with soil management options previously reviewed in the FS, that can achieve the same level of protection, provide the same level of performance and offer the same future reliability and thus can be considered "equivalent". Therefore, the RAO of restoring groundwater to drinking water standards should be eliminated from the PRAP.

EPA RESPONSE: *Please see previous responses regarding ground water cleanup and restoration of ground water to beneficial use to the maximum extent practicable.*

21. Page 18 - A number of the RAOs specified by EPA should be eliminated, or modified in a manner consistent with that specified in EPA's RI/FS guidance document (EPA, 1988). As noted in the guidance document:

    "Remedial action objectives consist of medium-specific or operable unit-specific goals for protecting human health and the environment. The objectives should be as specific as possible but not so specific that the range of alternatives that can be developed is unduly limited."

    "Remedial action objectives for protecting human receptors should express both a contaminant level and an exposure route, rather than contaminant levels alone, because protectiveness may be achieved by reducing exposure (such as capping an area, limiting access, or providing an alternate water supply) as well as by reducing contaminant levels."

    Several of the RAO's provided by the EPA actually specify a remedial technology and/or "unduly limit" the range of alternatives considered or viable as remedial approaches. Examples include:

    - RAO-1, which excludes capping and institutional controls as viable remedy components by specifying "...reducing levels of total PAH concentrations to below 150 mg/kg and 600 mg/kg in soil..." to prevent current or future direct contact;
    - RAO-3, which specifically requires RAO achievement "through removal and/or containment"; and
    - RAO-6, which specifies groundwater restoration to its beneficial use, without recognition of the potential impracticability of achievement[1], nor recognition that the RAO is not risk driven.

FOOTNOTE*1 There are countless examples of similar sites where this has been demonstrated to be infeasible. Not only is it difficult to thoroughly characterize the presence and extent of subsurface DNAPL at a site as complex and large as the Koppers Site, but EPA recognizes that some residual may remain behind during the proposed deep upland excavation activities (page 2, paragraph 1) in areas where DNAPL is known to be present. Beazer believes that the burden rests upon EPA to provide the technical basis for concluding that at the Kopper's Inc. Site, achievement of drinking water status in the Columbia Formation is feasible.

EPA RESPONSE: *EPA believes that the RAOs are appropriate and were developed in accordance with EPA guidance. Please see previous responses regarding ground water cleanup and restoration of ground water to beneficial use to the maximum extent practicable.*

22. Page 18 - The RAO-1 states that the cleanup number for soils is 600, but for soils where wetlands are to be created (as in EPA's preferred alternative), the clean up number shifts to 150 mg/kg. Beazer objects to this because it exceeds the actions "necessary for a protective remedy."

EPA RESPONSE: *Please see previous response regarding volumes and cleanup criteria. As explained previously, in areas where wetlands are to be created, the sediment cleanup criterion applies.*

23. Page 18 - The EPA states that the Feasibility Study was used to develop remedial alternatives, and directs the reader to the Administrative Record if additional information regarding alternative development is required. Noting that the EPA has created a new list of remedial alternatives in the PRAP, Beazer requests that the EPA provide a more specific reference(s) to Administrative Record materials, which may support EPA's development/selection of alternatives.

EPA RESPONSE: *The FS and numerous comments and meetings regarding the FS and FS Addendum are all well represented in the Administrative Record, and EPA believes that the PRAP clearly explains each included alternative.*

24. Page 19 - While Beazer understands that it is EPA's general expectation at Superfund sites to return groundwater to its beneficial use, there is sufficient Site-specific data to conclude that this is both unachievable (see general comment 4) and unnecessary (EPA does not believe the Site would be reasonably used for residential purposes and proposes institutional controls to "prevent residential use and the installation of drinking water wells on the property"). Returning the Columbia aquifer to drinking water status should be eliminated from the PRAP as a RAO and a Ground Management Zone (similar to the adjacent DuPont - Newport Superfund Site) should be assumed in perpetuity (similar to Alternatives 2 and 3),

EPA RESPONSE: *Please see previous response regarding ground water cleanup and restoration to beneficial use.*

25. Page 19 - Beazer agrees that land-use restrictions should be a component of each active remedial alternative considered. As noted previously, implementation of groundwater and future land use restrictions at the Site should preclude the need to implement extensive (and expensive) active remedial measures which attempt to cleanup the shallow Site groundwater to drinking water quality.

EPA RESPONSE: *Please see previous responses regarding potential future use and ground water cleanup and restoration to beneficial use to the maximum extent practicable.*

26. Page 20 - Beazer believes that the EPA has failed to provide the technical justification to support selection of the soil cover thickness (i.e., 2-foot soil cover with a burrow-inhibiting/layer).

EPA RESPONSE: *EPA has considered Beazer's assertions, and does not believe they are correct. EPA notes the following as necessary: a one-foot clean soil layer would be underlain by a small buffer of soil and a stone layer to inhibit organisms known to inhabit the Site and which burrow well below one foot. (If only one foot of cover were used, organisms could burrow right into the contaminated material below.)*

27. Page 23 - Beazer believes that the EPA's soil removal volumes may be underestimated, given: 1) EPA's proposal to remove 2 feet of surficial soil to protect trespassers and ecological receptors (compared to 1 foot removal assumed by Beazer in the FS Report) (BBL, 2003); and 2) EPA's proposal to continue in these areas to remove all soils containing total PAHs in excess of 150 mg/kg, to depths up to 30 feet (Beazer did not assume such extensive removal in the FS Addendum).

EPA RESPONSE: *Please see previous response regarding volumes and cleanup criteria.*

28. Page 23 - The cost description makes no reference to the estimated $8.5 million to be bourne by Wetlands developers (see Alternative 4 cost estimate), which is part of the total cost to implement the remedy (i.e. the cost to implement Alternative 4 would actually be $60.3 million). The EPA has failed to include these costs, which are critical for Beazer and the public to be able to evaluate its response to the PRAP.

EPA RESPONSE: *Please see previous response regarding these costs, which are not part of the remedy, but rather of a potential future use. As discussed earlier in this document, note that the original cost estimates in the 2003 FS Addendum (FS Alternative 10) split the cost of deeper soil excavations (beyond that required by the remedy) between the remedy and the "wetlands developer". EPA adopted this approach in order to be consistent for the purposes of comparison, but is not requiring the further excavations of materials to create a wetlands bank, as that is not part of the selected remedy. Rather, as stated in the PRAP, EPA's selected remedy is compatible with that potential future use, should such a use materialize in the future.*

29. Page 23/24 - The description of soil removal under Alternative 4 indicates that 115,000 cy of soil will be excavated "in order to protect trespassers and ecological receptors" (i.e., same as Alternative 3), and that excavation would continue in these areas until "the total PAH concentration was 150 mg/kg or below, with excavation depths potentially reaching as deep as 30 ft bgs in a few locations, though the average excavation depths is expected to be 5 to 15 ft." While the excavation volume is never specified, it is likely significant, and appears to be proposed to support "one possible reuse of the Site - wetland excavation". Beazer requests that the EPA clarify both assumptions.

EPA RESPONSE: *Please see previous responses regarding volumes and cleanup criteria, as well as the potential reuse of the site.*

30. Page 24 - Assumptions made by the EPA regarding the volume and ultimate disposition of excavated soil are not clearly described. While the text states 113,000 CY of soil would be excavated and consolidated into two onsite landfill, it also notes that 115,000 CY of surface soils will be excavated to protect trespassers and ecological receptors, with continued excavation as deep as 30 feet to achieve 150 mg/kg. The EPA has failed to clarify its assumptions of costs or volumes. In addition, Beazer does not believe that the onsite landfills have been costed to handle such a capacity.

EPA RESPONSE: *Please see previous response regarding volumes. In addition, in Beazer's response to EPA comments, Beazer stated that the volume capacity of the landfills as drawn* *was approximately 1,000,000 cubic yards. EPA does not anticipate approaching this capacity.*

31. Page 24 - The EPA has failed to provide an adequate description of the sediment removal volumes estimated from various portions of the Site, which apparently total 75,000 CY, once stabilized. The EPA must specify these volumes particularly as referenced in Alternative 4.

EPA RESPONSE: *EPA has considered Beazer's assertions, and does not believe they are correct. In both the text and the figures of the PRAP, the volumes were clearly stated and drawn, with assumptions regarding the potential need to add amendments for geotechnical purposes also clarified. Please refer again to this text and to Figure 6, "Hershey Run Marsh and West Central Marsh Volume."*

32. Page 24 - The PRAP text again notes that excavating of DNAPL at depths up to 30 feet is proposed, "In order to achieve the restoration of ground water..." As noted previously, there is sufficient Site-specific data to conclude that restoring the Columbia aquifer to drinking water standards is unachievable, unnecessary (the EPA has noted in the PRAP that it does not believe the Site would be reasonably used for residential purposes, and proposes institutional controls to "prevent residential use and the installation of drinking water wells on the property"), and inconsistent with the decision documented in the ROD for the adjacent E.I. DuPont de Nemours & Co. Inc. Pigment Plant Landfill Site (see general Comment 4).

EPA RESPONSE: *EPA has considered Beazer's comments and does not believe that they are correct. Neither EPA's rationale nor the stated goal in the PRAP mentions cleaning "groundwater to drinking water quality." EPA is aware that the Columbia's natural condition does not necessarily make it suitable for drinking without treatment, and would refer Beazer to the actual text of the PRAP which clearly refers to the Columbia aquifer as a state-designated "potential drinking water aquifer."*

33. Page 25 - The EPA has unnecessarily specified a passive DNAPL recovery system within the onsite consolidation areas, as "EPA believes that DNAPL recovery would successfully and significantly reduce the volume of mobile DNAPL at the Site" (see General Comment 3). Beazer believes that the EPA has failed to provide technical justification for its inclusion, given the following:

    a. The proposed remedy currently includes construction of a barrier wall around the consolidation areas, keyed into an underlying confining unit and covered with a low permeability cover which should adequately contain any mobile DNAPL; and
    b. Only two Site monitoring wells (i.e. MW-2 and MW-8, both with recorded DNAPL thickness of less than 0.01 foot in 2003) have ever historically had DNAPL accumulations, and data collected from these wells was not encouraging regarding the practicability of removing significant quantities of DNAPL.

EPA RESPONSE: *EPA has carefully considered Beazer's assertions, and does not believe that they are correct. As has been discussed in numerous documents over the past several years, neither the data presented, nor literature of local geology reviewed support the claim of a continuous clay layer. The Columbia and Potomac Formations are fluvial in origin, and as such are laterally quite variable. They have been described in the literature as an "interconnected system," and as having variegated clays with interbedded silts, sands and gravel. While some of the boring logs for the Site describe the "clay," the lab analytical data for some of those same samples identify particle size distributions more consistent with silt or sand, not clay. The ground water data for the Site also indicate a connection between the Columbia and Potomac aquifers (e.g., similar flow direction, similar response to tidal* *fluctuations, and varying differences in hydraulic head). EPA understands that there may exist a competent clay layer functioning as an aquitard between these aquifers at other Sites, but at this Site, which is especially large in size, it is not surprising to find the lateral variability of these deposits occurring within the Site boundaries.*

The data indicate, and it is supported by the literature reviewed by EPA, that there is not likely a continuous clay layer beneath the Site. There are areas where lenses or stringers of clay with low permeability will inhibit downward flow of both ground water and NAPL, but due to the lateral variability and heterogeneity of the subsurface materials, the "clay layer" does not present the kind of vertical barrier to contaminant transport that the Beazer describes.

A passive NAPL recovery trench can work to recover product despite the heterogeneous subsurface lithology, whereas pumping NAPL from a well would be severely hampered by this heterogeneity. A well can only intersect a one-inch creosote-saturated sand seam for the diameter of the well screen, but a recovery trench will intersect the same sand seam for the entire length of the trench. Note that a one-inch sand seam 1/8th of a mile long would be roughly equivalent to a 7-foot diameter sand-filled pipe; a recovery trench built to intersect such a seam could recover copious amounts of NAPL. EPA did not propose NAPL recovery using wells because such attempts would not work at this Site. Please also note that the NAPL that had accumulated in the two wells cited did not simply disappear, but rather moved away from the wells.

34. Page 27 - In the "Evaluation of Alternatives", the EPA has rightfully recognized the importance of RAO achievement when comparing and selecting remedial Alternatives. As noted in Specific Comment 21, a number of the RAOs specified by EPA are inappropriate, and if developed consistent with EPA guidance on RAO development (EPA, 1988), could very likely have resulted in selection of Alternative 3. Beazer requests that the EPA revise the RAOs in a manner consistent with EPA guidance and revise the comparative analysis accordingly to confirm that an appropriate remedy is selected for the Site.

EPA RESPONSE: *EPA has considered Beazer's assertions and does not believe they are correct. The RAOs were developed in accordance with EPA guidance, and the selected remedy was proposed after careful consideration of all the Site-related data balanced against the nine criteria for remedy selection.*

35. Page 29 - Regarding EPA's failure to provide technical justification to support the conclusion that Alternative 4 will restore groundwater to its beneficial use, see previous comments.

EPA RESPONSE: *EPA has considered Beazer's assertions and does not believe they are correct. The RAOs were developed in accordance with EPA guidance, and the selected remedy was proposed after careful consideration of all the Site-related data balanced against the nine criteria for remedy selection.*

36. Page 29 - The EPA has concluded that for Alternative 2, natural recovery would not reduce the risks posed by sediments in lower Hershey River "because of the amount of contamination present." This statement is not supported by any data that Beazer is aware of, and ignores the potential benefits of source control activities (proposed as part of Alternative 2) at accelerating the natural recovery process (a concept supported by EPA's OSWER Directive titled Principles for Managing Contaminated Sediment Risks at Hazardous Waste Sites [EPA, 2002]).

As discussed in the FS Report (BBL, 2003) the presence of DNAPL noted during the investigation was generally limited to the centerline of the channel in the lower portion of Hershey Run and the majority of DNAPL observations were deeper than the 0- to 6-inch depth interval (i.e. bioavailable zone). Geochronologic-dating information collected from the Hershey Run Drainage Area indicates that deposition of new material is occurring at a rate between 0.24 and 0.36 inch per year. As such, the drainage basin is considered to be a net sediment deposition area, with clean sediment (assuming upland source control is completed as in Alternative 2) gradually providing a cover for impacted sediments (Section 3.4 of the RI Report [BBL, 2002]). In addition to the deposition of new material, the weathering of existing PAHs in sediments (BBL, 2002) would also continue to reduce concentrations over time. Again, Beazer believes that the EPA has failed to provide the technical justification for the statement regarding natural recovery, and requests that it be revised to more accurately reflect data collected during the RI/FS, giving due consideration to the potential benefits of upland source control as a remedy component.

EPA RESPONSE: *EPA has carefully considered Beazer's assertions, and does not believe that they are correct. Source control does not "accelerate natural recovery." It stops ongoing releases, and where appropriate, may allow for natural recovery to then occur. As stated previously, Beazer has failed to recognize that NAPL throughout the sediments of Hershey Run is source material and thus qualifies as needing source control, and at such high concentrations as to be considered a source, will not naturally degrade in any reasonable timeframe. Please see previous response regarding "natural encapsulation" (the deposition of new material) and erosion.*

37. Page 31. As noted by the EPA, "The preamble to the NCP explains that for groundwater, remediation levels should generally be attained throughout the contaminated plume or at and beyond the edge of a waste management area when waste is left in place (55FR 8753)." (emphasis added). Consistent with the latter part of this statement, EPA recognized earlier in the PRAP that Site-related impacts to groundwater have only been noted in close proximity to source material. As correctly stated on pages 8 and 9 of the PRAP:

"Groundwater analytical data have shown that creosote NAPL constituents are not migrating in ground water. This is consistent with the low solubilities of creosote and PAHs. Where constituents have been detected, borings have shown that NAPL is present in very close proximity. The plume exists in ground water only very near the DNAPL itself, like a halo, and is quickly attenuated in only a short distance."

Given this, Beazer disagrees with EPA's rationale for including a very extensive and costly subsurface soil excavation program in the proposed remedy.

EPA RESPONSE: *EPA has carefully considered Beazer's assertions, and does not believe that they are correct. As stated throughout the PRAP and in previous responses to comments submitted, the excavation of source material is expected to result in the eventual elimination of any ground water contamination. The source material itself is a principal threat waste and warrants remediation.*

38. Page 33 - Beazer believes that the EPA has understated some of the implementation challenges which will be posed by Alternative 4, including digging up to 30 feet deep (and below the water table) in soils, up to 13 feet deep in the marsh/Hershey Run sediments, and removing "all subsurface NAPL" to achieve drinking water standards in the Columbia aquifer. Please either provide text down playing what we perceive as the potential complexities of performing these activities, or give them due consideration when selecting the final remedy.

EPA RESPONSE: *EPA has considered Beazer's comments and does not believe that they are correct. Neither EPA's rationale nor the stated goal in the PRAP mentions cleaning "groundwater to drinking water quality." EPA is aware that the Columbia's natural condition does not necessarily make it suitable for drinking without treatment, and would refer Beazer to the actual text of the PRAP which clearly refers to the Columbia aquifer as a state-designated "potential drinking water aquifer." The PRAP does not specify "drinking water standards" as Beazer incorrectly asserts. EPA is aware of the technical challenges posed by excavation, and has considered these carefully in the PRAP and the ROD.*

39. Page 34 - As noted previously, Alternative 4 has failed to consider and include the additional $8.5 million that would be required by a wetlands developer to perform deep excavation and wetlands construction.

EPA RESPONSE: *EPA has considered Beazer's assertions, but does not believe that they are correct. Regarding matters of cost, EPA has prepared an extensive analyses of costs, which is attached hereto. Beazer's submittal to EPA of supplemental cost estimates or various components of the remedy were carefully reviewed and considered in EPA's discussion of the cost criterion. Note that PRAP Alternative 3 details what a 2-foot excavation of soil with backfill and cover would cost. Soil excavation for Alternative 3 totaled approximately $7.2M, while soil excavation in Alternative 4 totaled approximately $8.4M - while this is a significant difference, it is not as large a difference as suggested in the comment. As discussed earlier in this document, note that the original cost estimates in the 2003 FS Addendum (FS Alternative 10) split the cost of deeper soil excavations (beyond that required by the remedy) between the remedy and the "wetlands developer". EPA adopted this approach in order to be consistent for the purposes of comparison, but is not requiring the further excavations of materials to create a wetlands bank, as that is not part of the selected remedy. Rather, as stated in the PRAP, EPA's selected remedy is compatible with that potential future use, should such a use materialize in the future. The text of Alternative 4 clearly states that the additional $8.5 million is excluded because it is tied to a potential future use, and not part of the remedy.*

IV. TABLES

KOPPERS CO., INC. (NEWPORT PLANT)
SUPERFUND SITE

NEWPORT / NEW CASTLE COUNTY, DELAWARE

Table 1. Statistical Summary and COPC Selection for Risk Scenarios Evaluated
[HHRA Tables 1 – 16]

Table 1
Statistical Summary and COPC Selection for Construction Worker Exposed to Soils (0-18' bgs)
Former Koppers Company, Inc., Newport, DE

Analyte	Total # of Samples	Hits	Hit Frequency %	Minimum Detected mg/kg	Mean mg/kg	Lognormal Mean mg/kg	Maximum Detected mg/kg	Standard Deviation mg/kg
Dioxins								
2,3,7,8-TCDD Equiv.	27	27	100	1.14E-04	8.55E-04	3.79E-04	7.34E-03	1.49E-03
Inorganics								
Aluminum	137	136	99.27	1.98E+03	1.44E+04	1.26E+04	3.65E+04	6.76E+03
Antimony	73	15	20.55	4.90E-01	1.99E+01	8.84E+00	1.21E+01	1.37E+01
Arsenic	123	112	91.06	8.60E-01	4.76E+00	3.88E+00	2.19E+01	3.19E+00
Barium	137	137	100	1.51E+01	2.37E+02	1.33E+02	1.65E+03	3.12E+02
Beryllium	131	129	98.47	2.60E-01	1.20E+00	1.03E+00	3.90E+00	7.48E-01
Cadmium	135	28	20.74	2.40E-01	2.07E+00	1.57E+00	1.23E+01	1.26E+00
Chromium	137	137	100	3.70E+00	2.46E+01	2.22E+01	1.19E+02	1.29E+01
Cobalt	130	119	91.54	6.10E-01	8.13E+00	6.11E+00	3.25E+01	5.53E+00
Copper	134	134	100	1.40E+00	2.31E+01	1.37E+01	5.28E+02	5.23E+01
Iron	137	137	100	4.43E+03	1.78E+04	1.66E+04	4.89E+04	6.44E+03
Lead[1]	137	137	100	1.80E+00	3.12E+01	1.47E+01	5.66E+02	7.35E+01
Manganese	137	137	100	4.06E+01	1.12E+03	3.62E+02	1.51E+04	2.27E+03
Mercury	122	35	28.69	5.00E-02	3.21E-01	1.26E-01	8.30E+00	9.61E-01
Nickel	131	130	99.24	3.40E+00	1.27E+01	1.14E+01	5.18E+01	6.85E+00
Selenium	117	15	12.82	8.60E-01	2.15E+00	1.89E+00	2.30E+00	7.20E-01
Silver	137	2	1.46	1.10E+00	4.35E+00	3.16E+00	1.50E+00	1.63E+00
Thallium	130	29	22.31	1.60E+00	5.01E+00	3.89E+00	4.44E+01	4.38E+00
Vanadium	137	136	99.27	7.60E+00	5.81E+01	4.49E+01	3.06E+02	5.72E+01
Zinc	133	133	100	5.20E+00	7.57E+01	4.31E+01	2.50E+03	2.28E+02
PCBs/Pesticides								
4,4'-DDD	24	1	4.17	3.80E-03	2.81E-02	4.73E-03	3.80E-03	6.66E-02
4,4'-DDE	24	3	12.5	1.40E-02	1.65E-02	4.23E-03	2.40E-01	4.91E-02
4,4'-DDT	24	5	20.83	2.90E-04	1.62E-02	4.37E-03	1.20E-01	3.44E-02
alpha-Chlordane[2]	24	1	4.17	1.80E-04	1.46E-02	2.33E-03	1.80E-04	3.44E-02
Dieldrin	24	5	20.83	2.20E-04	2.01E-02	3.61E-03	1.30E-02	5.65E-02
Endosulfan II[3]	24	2	8.33	4.50E-04	2.79E-02	4.15E-03	7.30E-04	6.67E-02
Endrin	24	1	4.17	1.10E-01	2.49E-02	4.81E-03	1.10E-01	5.91E-02
Endrin ketone[4]	24	1	4.17	2.90E-02	2.19E-02	4.56E-03	2.90E-02	5.76E-02
Heptachlor	24	1	4.17	5.30E-03	1.07E-02	2.22E-03	5.30E-03	2.93E-02
Heptachlor epoxide	24	2	8.33	1.00E-02	6.92E-03	2.12E-03	2.00E-02	1.92E-02
Methoxychlor	22	3	13.64	2.90E-01	9.87E-02	2.49E-02	9.20E-01	2.24E-01
PCB-1254	24	1	4.17	4.60E-01	2.99E-01	5.25E-02	4.60E-01	6.65E-01
PCB-1260	25	1	4	3.40E-01	2.86E-01	5.32E-02	3.40E-01	6.52E-01
Semivolatiles								
2-Methylnaphthalene	136	24	17.65	1.40E-01	2.03E+01	8.01E-01	6.10E+02	8.64E+01
Acenaphthene	136	28	20.59	1.80E-01	2.70E+01	8.73E-01	7.90E+02	1.16E+02
Acenaphthylene	136	17	12.5	5.90E-02	7.22E+00	7.43E-01	4.40E+01	2.65E+01
Anthracene	137	55	40.15	8.30E-02	3.84E+01	9.25E-01	2.60E+03	2.37E+02
Benzo(a)anthracene	137	87	63.5	1.10E-01	2.04E+01	1.56E+00	3.10E+02	4.63E+01
Benzo(a)pyrene	137	75	54.74	8.40E-02	1.65E+01	1.36E+00	2.40E+02	3.84E+01
Benzo(b)fluoranthene	137	86	62.77	8.50E-02	2.81E+01	2.01E+00	3.70E+02	5.94E+01
Benzo(g,h,i)perylene	137	67	48.91	8.40E-02	1.14E+01	1.18E+00	1.70E+02	2.75E+01
Benzo(k)fluoranthene	137	66	48.18	9.10E-02	1.17E+01	1.11E+00	1.10E+02	2.97E+01
bis(2-Ethylhexyl)phthalate	130	5	3.85	4.20E-02	7.43E+00	7.72E-01	7.90E-01	2.70E+01
Carbazole	135	38	28.15	9.60E-02	1.66E+01	7.76E-01	1.20E+03	1.07E+02
Chrysene	137	90	65.69	7.20E-02	2.17E+01	1.62E+00	2.60E+02	4.77E+01
Di-n-butylphthalate[5]	136	50	36.76	2.90E-02	7.36E+00	6.90E-01	5.30E-01	2.66E+01

Table 1

Statistical Summary and COPC Selection for Construction Worker Exposed to Soils (0-18' bgs)

Former Koppers Company, Inc., Newport, DE

Analyte	95% UCL mg/kg	Lognormal 95% UCL mg/kg	Distribution 99% Confidence	Exposure Point Concentration mg/kg	Industrial Soil RBC mg/kg	Is Maximum >RBC?	Is Detection Frequency >5%?
Dioxins							
2,3,7,8-TCDD Equiv.	1.35E-03	1.37E-03	Unknown	1.37E-03	3.80E-05	yes	yes
Inorganics							
Aluminum	1.54E+04	1.71E+04	Unknown	1.71E+04	2.00E+05	no	
Antimony	2.26E+01	7.70E+01	Unknown	1.21E+01	8.20E+01	no	
Arsenic	5.24E+00	5.61E+00	Unknown	5.61E+00	3.80E+00	yes	yes
Barium	2.81E+02	2.68E+02	Lognormal	2.68E+02	1.40E+04	no	
Beryllium	1.31E+00	1.30E+00	Unknown	1.30E+00	4.10E+02	no	
Cadmium	2.25E+00	2.81E+00	Unknown	2.81E+00	2.00E+02	no	
Chromium	2.65E+01	2.65E+01	Unknown	2.65E+01	3.10E+05	no	
Cobalt	8.93E+00	1.21E+01	Unknown	1.21E+01	1.20E+04	no	
Copper	3.06E+01	2.16E+01	Unknown	2.16E+01	8.20E+03	no	
Iron	1.87E+04	1.90E+04	Unknown	1.90E+04	6.10E+04	no	
Lead[1]	4.16E+01	2.87E+01	Unknown	2.87E+01	7.50E+02	no	
Manganese	1.44E+03	1.23E+03	Unknown	1.23E+03	2.90E+04	no	
Mercury	4.66E-01	2.31E-01	Unknown	2.31E-01	6.10E+01	no	
Nickel	1.37E+01	1.35E+01	Unknown	1.35E+01	4.10E+03	no	
Selenium	2.26E+00	2.59E+00	Unknown	2.30E+00	1.00E+03	no	
Silver	4.58E+00	8.31E+00	Unknown	1.50E+00	1.00E+03	no	
Thallium	5.65E+00	6.33E+00	Unknown	6.33E+00	1.40E+01	yes	yes
Vanadium	6.62E+01	6.18E+01	Unknown	6.18E+01	1.40E+03	no	
Zinc	1.08E+02	6.52E+01	Unknown	6.52E+01	6.10E+04	no	
PCBs/Pesticides							
4,4'-DDD	5.15E-02	4.80E-02	Unknown	3.80E-03	2.40E+01	no	
4,4'-DDE	3.37E-02	2.08E-02	Unknown	2.08E-02	1.70E+01	no	
4,4'-DDT	2.82E-02	3.33E-02	Unknown	3.33E-02	1.70E+01	no	
alpha-Chlordane[2]	2.66E-02	3.05E-02	Unknown	1.80E-04	1.60E+01	no	
Dieldrin	3.99E-02	2.92E-02	Unknown	1.30E-02	3.60E-01	no	
Endosulfan II[3]	5.13E-02	5.68E-02	Unknown	7.30E-04	1.20E+03	no	
Endrin	4.56E-02	4.28E-02	Unknown	4.28E-02	6.10E+01	no	
Endrin ketone[4]	4.21E-02	3.19E-02	Unknown	2.90E-02	6.10E+01	no	
Heptachlor	2.09E-02	1.38E-02	Unknown	5.30E-03	1.30E+00	no	
Heptachlor epoxide	1.37E-02	9.19E-03	Unknown	9.19E-03	6.30E-01	no	
Methoxychlor	1.81E-01	1.85E-01	Unknown	1.85E-01	1.00E+03	no	
PCB-1254	5.32E-01	6.41E-01	Unknown	4.60E-01	2.90E+00	no	
PCB-1260	5.09E-01	5.54E-01	Unknown	3.40E-01	2.90E+00	no	
Semivolatiles							
2-Methylnaphthalene	3.26E+01	1.01E+01	Unknown	1.01E+01	4.10E+03	no	
Acenaphthene	4.36E+01	1.35E+01	Unknown	1.35E+01	1.20E+04	no	
Acenaphthylene	1.10E+01	6.34E+00	Unknown	6.34E+00	NA	NA	yes
Anthracene	7.19E+01	1.95E+01	Unknown	1.95E+01	6.10E+04	no	
Benzo(a)anthracene	2.70E+01	5.62E+01	Unknown	5.62E+01	7.80E+00	yes	yes
Benzo(a)pyrene	2.20E+01	4.24E+01	Unknown	4.24E+01	7.80E-01	yes	yes
Benzo(b)fluoranthene	3.65E+01	1.02E+02	Unknown	1.02E+02	7.80E+00	yes	yes
Benzo(g,h,i)perylene	1.53E+01	2.43E+01	Unknown	2.43E+01	NA	NA	yes
Benzo(k)fluoranthene	1.60E+01	2.27E+01	Unknown	2.27E+01	7.80E+01	yes	yes
bis(2-Ethylhexyl)phthalate	1.14E+01	6.58E+00	Unknown	7.90E-01	4.10E+02	no	
Carbazole	3.19E+01	7.59E+00	Unknown	7.59E+00	2.90E+02	yes	yes
Chrysene	2.85E+01	6.54E+01	Unknown	6.54E+01	7.80E+02	no	
Di-n-butylphthalate	1.11E+01	7.14E+00	Unknown	5.30E-01	2.00E+04	no	

Table 1
Statistical Summary and COPC Selection for Construction Worker Exposed to Soils (0-18' bgs)
Former Koppers Company, Inc., Newport, DE

Analyte	Total # of Samples	Hits	Hit Frequency %	Minimum Detected mg/kg	Mean mg/kg	Lognormal Mean mg/kg	Maximum Detected mg/kg	Standard Deviation mg/kg
Dibenz(a,h)anthracene	136	45	33.09	7.40E-02	6.85E+00	8.02E-01	1.30E+02	2.30E+01
Dibenzofuran	137	30	21.9	2.70E-01	2.03E+01	8.53E-01	5.80E+02	8.37E+01
Diethylphthalate	135	1	0.74	1.00E-01	7.43E+00	7.80E-01	1.00E-01	2.66E+01
Fluoranthene	137	95	69.34	8.20E-02	5.36E+01	2.29E+00	1.20E+03	1.62E+02
Fluorene	137	31	22.63	6.60E-02	2.80E+01	8.54E-01	7.70E+02	1.17E+02
Indeno(1,2,3-c,d)pyrene	138	68	49.28	5.60E-02	1.22E+01	1.26E+00	1.10E+02	2.66E+01
Naphthalene	136	30	22.06	3.50E-02	5.92E+01	8.87E-01	3.00E+03	3.18E+02
Pentachlorophenol	136	6	4.41	1.30E-01	1.76E+01	1.80E+00	5.50E+00	6.58E-01
Phenanthrene	134	77	57.46	4.10E-02	7.08E+01	1.23E+00	2.10E+03	2.97E+02
Pyrene	137	95	69.34	4.10E-02	4.64E+01	2.19E+00	8.50E+02	1.28E+02
Volatiles								
1,1,2,2-Tetrachloroethane	143	13	9.09	1.00E-01	5.26E-02	1.02E-02	4.00E-01	1.51E-01
2-Butanone	130	21	16.15	2.00E-03	3.61E-02	7.76E-03	3.80E-02	1.45E-01
2-Hexanone	130	1	0.77	6.00E-03	3.56E-02	7.54E-03	6.00E-03	1.46E-01
Acetone	100	34	34	3.00E-03	9.03E-02	1.65E-02	2.10E+00	2.57E-01
Benzene	130	7	5.38	1.10E-02	3.36E-02	7.96E-03	5.30E-01	1.30E-01
Carbon Disulfide	130	5	3.85	4.00E-03	3.55E-02	7.51E-03	7.00E-03	1.46E-01
Ethylbenzene	130	19	14.62	1.00E-03	1.14E-01	8.71E-03	4.30E+00	5.51E-01
Styrene	130	9	6.92	5.00E-03	7.82E-02	8.24E-03	3.10E+00	3.94E-01
Tetrachloroethene	127	50	39.37	1.00E-03	3.82E-02	8.28E-03	7.40E-02	1.47E-01
Toluene	130	40	30.77	1.00E-03	1.10E-01	8.46E-03	5.70E+00	5.88E-01
Xylenes (total)	130	29	22.31	2.00E-03	4.86E-01	1.02E-02	2.40E+01	2.68E+00

Table 1
Statistical Summary and COPC Selection for Construction Worker Exposed to Soils (0-18' bgs)
Former Koppers Company, Inc., Newport, DE

Analyte	95% UCL mg/kg	Lognormal 95% UCL mg/kg	Distribution 99% Confidence	Exposure Point Concentration mg/kg	Industrial Soil RBC mg/kg	Is Maximum >RBC?	Is Detection Frequency >5%?
Dibenz(a,h)anthracene	1.01E-01	7.15E+00	Unknown	7.15E+00	7.80E-01	yes	yes
Dibenzofuran	3.22E+01	1.11E+01	Unknown	1.11E+01	8.20E+02	no	
Diethylphthalate	1.12E-01	6.35E+00	Unknown	1.00E-01	1.60E+05	no	
Fluoranthene	7.66E+01	1.99E+02	Unknown	1.99E+02	8.20E+03	no	
Fluorene	4.45E+01	1.46E+01	Unknown	1.46E+01	8.20E+03	no	
Indeno(1,2,3-c,d)pyrene	1.60E+01	2.89E+01	Unknown	2.89E+01	7.80E+00	yes	yes
Naphthalene	1.04E+02	1.96E+01	Unknown	1.96E+01	4.10E+03	no	
Pentachlorophenol	2.70E+01	1.37E+01	Unknown	5.50E+00	4.80E+01	no	
Phenanthrene	1.13E+02	5.65E+01	Unknown	5.65E+01	NA	NA	yes
Pyrene	6.45E+01	1.83E+02	Unknown	1.83E+02	6.10E+03	no	
Volatiles							
1,1,2,2-Tetrachloroethane	7.35E-02	3.24E-02	Unknown	3.24E-02	2.90E+01	no	
2-Butanone	5.73E-02	1.54E-02	Unknown	1.54E-02	1.20E+05	no	
2-Hexanone	5.67E-02	1.43E-02	Unknown	6.00E-03	NA	NA	no
Acetone	1.33E-01	9.55E-02	Unknown	9.55E-02	2.00E+04	no	
Benzene	5.25E-02	1.55E-02	Unknown	1.55E-02	2.00E+02	no	
Carbon Disulfide	5.67E-02	1.42E-02	Unknown	7.00E-03	2.00E+04	no	
Ethylbenzene	1.94E-01	2.87E-02	Unknown	2.87E-02	2.00E+04	no	
Styrene	1.35E-01	2.04E-02	Lognormal	2.04E-02	4.10E+04	no	
Tetrachloroethene	5.98E-02	1.87E-02	Unknown	1.87E-02	1.10E+02	no	
Toluene	1.96E-01	2.92E-02	Unknown	2.92E-02	4.10E+04	no	
Xylenes (total)	8.76E-01	6.47E-02	Unknown	6.47E-02	4.10E+05	no	

This data set includes samples from the Process/Wood Storage and Drip Track areas.
NA - Not available
[1] The screening level of 750 mg/kg is based on US EPA's adult blood lead uptake model under default exposure assumptions.
[2] These compounds have no published RBC or RfD values. They are sufficiently close in toxicity to Chlordane so that the Chlordane RBC is applicable to its congeners as a provisional benchmark.
[3] These compounds have no published RBC or RfD values. They are sufficiently close in toxicity to Endosulfan so that the Endosulfan RBC is applicable to its congeners as a provisional benchmark.
[4] These compounds have no published RBC or RfD values. They are sufficiently close in toxicity to Endrin so that the Endrin RBC is applicable to its congeners as a provisional benchmark.

Table 2
Statistical Summary and COPC Selection for Construction Worker Exposed to Soils and NAPL (0-18' bgs)
Former Koppers Company, Inc., Newport, DE

Analyte	Total # of Samples	Hits	Hit Frequency %	Minimum Detected mg/kg	Mean mg/kg	Lognormal Mean mg/kg	Maximum Detected mg/kg	Standard Deviation mg/kg
Dioxins								
2,3,7,8-TCDD Equiv.	27	27	100	1.14E-04	8.55E-04	3.79E-04	7.34E-03	1.49E-03
Inorganics								
Aluminum	164	163	99.39	1.98E+03	1.43E+04	1.26E+04	3.65E+04	6.61E+03
Antimony	98	19	19.39	4.90E-01	1.52E+01	4.63E+00	1.21E+01	1.44E+01
Arsenic	150	139	92.67	8.60E-01	5.00E+00	4.00E+00	3.10E+01	3.90E+00
Barium	164	164	100	1.51E+01	2.43E+02	1.40E+02	1.65E+03	3.04E+02
Beryllium	152	150	98.68	2.60E-01	1.20E+00	1.02E+00	3.90E+00	7.53E-01
Cadmium	160	34	21.25	2.40E-01	1.81E+00	1.09E+00	1.23E+01	1.33E+00
Chromium	164	164	100	3.70E+00	2.67E+01	2.28E+01	2.44E+02	2.29E+01
Cobalt	157	145	92.36	6.10E-01	7.80E+00	5.92E+00	3.25E+01	5.42E+00
Copper	161	161	100	9.10E-01	2.42E+01	1.43E+01	5.28E+02	5.07E+01
Iron	164	164	100	4.43E+03	1.83E+04	1.69E+04	7.73E+04	8.34E+03
Lead[1]	164	164	100	1.80E+00	3.80E+01	1.60E+01	8.92E+02	9.77E+01
Manganese	164	164	100	3.52E+01	1.11E+03	3.88E+02	1.51E+04	2.14E+03
Mercury	140	51	36.43	1.90E-02	2.95E-01	1.16E-01	8.30E+00	9.00E-01
Nickel	157	156	99.36	3.40E+00	1.26E+01	1.13E+01	5.18E+01	6.59E+00
Selenium	144	22	15.28	8.50E-01	1.85E+00	1.47E+00	2.30E+00	9.13E-01
Silver	162	3	1.85	2.10E-01	3.70E+00	1.83E+00	1.50E+00	2.15E+00
Thallium	157	38	24.2	8.90E-01	4.30E+00	2.90E+00	4.44E+01	4.29E+00
Vanadium	164	163	99.39	7.60E+00	5.58E+01	4.39E+01	3.06E+02	5.33E+01
Zinc	156	156	100	5.20E+00	7.85E+01	4.66E+01	2.50E+03	2.14E+02
PCBs/Pesticides								
4,4'-DDD	24	1	4.17	3.80E-03	2.81E-02	4.73E-03	3.80E-03	6.66E-02
4,4'-DDE	24	3	12.5	1.40E-02	1.65E-02	4.23E-03	2.40E-01	4.91E-02
4,4'-DDT	24	5	20.83	2.90E-04	1.62E-02	4.37E-03	1.20E-01	3.44E-02
alpha-Chlordane[2]	24	1	4.17	1.80E-04	1.46E-02	2.33E-03	1.80E-04	3.44E-02
Dieldrin	24	5	20.83	2.20E-04	2.01E-02	3.61E-03	1.30E-02	5.65E-02
Endosulfan II[3]	24	2	8.33	4.50E-04	2.79E-02	4.15E-03	7.30E-04	6.67E-02
Endrin	24	1	4.17	1.10E-01	2.49E-02	4.81E-03	1.10E-01	5.91E-02
Endrin ketone[4]	24	1	4.17	2.90E-02	2.19E-02	4.56E-03	2.90E-02	5.76E-02
Heptachlor	24	1	4.17	5.30E-03	1.07E-02	2.22E-03	5.30E-03	2.93E-02
Heptachlor epoxide	24	2	8.33	1.00E-02	6.92E-03	2.12E-03	2.00E-02	1.92E-02
Methoxychlor	22	3	13.64	2.90E-01	9.87E-02	2.49E-02	9.20E-01	2.24E-01
PCB-1254	24	1	4.17	4.60E-01	2.99E-01	5.25E-02	4.60E-01	6.65E-01
PCB-1260	25	1	4	3.40E-01	2.86E-01	5.32E-02	3.40E-01	6.52E-01
Semivolatiles								
2,4-Dimethylphenol	163	1	0.61	1.20E+01	6.08E+00	6.57E-01	1.20E+01	2.43E+01
2-Methylnaphthalene	163	36	22.09	4.10E-02	1.84E+01	6.95E-01	6.10E+02	8.08E+01
4-Methylphenol	163	1	0.61	3.10E+01	6.20E+00	6.61E-01	3.10E+01	2.43E+01
Acenaphthene	163	45	27.61	4.60E-02	3.12E+01	7.30E-01	1.40E+03	1.52E+02
Acenaphthylene	163	37	22.7	5.90E-02	6.82E+00	7.15E-01	9.90E+01	2.53E+01

Table 2
Statistical Summary and COPC Selection for Construction Worker Exposed to Soils and NAPL (0-18' bgs)
Former Koppers Company, Inc., Newport, DE

Analyte	95% UCL mg/kg	Lognormal 95% UCL mg/kg	Distribution 99% Confidence	Exposure Point Concentration mg/kg	Industrial Soil RBC mg/kg	Is Maximum >RBC?	Is Detection Frequency >5%?
Dioxins							
2,3,7,8-TCDD Equiv.	1.35E-03	1.37E-03	Unknown	1.37E-03	3.80E-05	yes	yes
Inorganics							
Aluminum	1.51E+04	1.65E+04	Unknown	1.65E+04	2.00E+05	no	
Antimony	1.76E+01	5.80E+01	Unknown	1.21E+01	8.20E+01	no	
Arsenic	5.53E+00	5.71E+00	Unknown	5.71E+00	3.80E+00	yes	yes
Barium	2.83E+02	2.74E+02	Lognormal	2.74E+02	1.40E+04	no	
Beryllium	1.30E+00	1.29E+00	Unknown	1.29E+00	4.10E+02	no	
Cadmium	1.98E+00	3.42E+00	Unknown	3.42E+00	2.00E+02	no	
Chromium	2.96E+01	2.80E+01	Unknown	2.80E+01	3.10E+05	no	
Cobalt	8.51E+00	1.09E+01	Unknown	1.09E+01	1.20E+04	no	
Copper	3.08E+01	2.31E+01	Unknown	2.31E+01	8.20E+03	no	
Iron	1.94E+04	1.94E+04	Unknown	1.94E+04	6.10E+04	yes	yes
Lead[1]	5.07E+01	3.34E+01	Unknown	3.34E+01	7.50E+02	yes	yes
Manganese	1.39E+03	1.24E+03	Unknown	1.24E+03	2.90E+04	no	
Mercury	4.21E-01	2.28E-01	Unknown	2.28E-01	6.10E+01	no	
Nickel	1.34E+01	1.33E+01	Unknown	1.33E+01	4.10E+03	no	
Selenium	1.98E+00	2.33E+00	Unknown	2.30E+00	1.00E+03	no	
Silver	3.98E+00	1.17E+01	Unknown	1.50E+00	1.00E+03	no	
Thallium	4.87E+00	5.85E+00	Unknown	5.85E+00	1.40E+01	yes	yes
Vanadium	6.27E+01	5.85E+01	Unknown	5.85E+01	1.40E+03	no	
Zinc	1.07E+02	7.03E+01	Unknown	7.03E+01	6.10E+04	no	
PCBs/Pesticides							
4,4'-DDD	5.15E-02	4.80E-02	Unknown	3.80E-03	2.40E+01	no	
4,4'-DDE	3.37E-02	2.08E-02	Unknown	2.08E-02	1.70E+01	no	
4,4'-DDT	2.82E-02	3.33E-02	Unknown	3.33E-02	1.70E+01	no	
alpha-Chlordane[2]	2.66E-02	3.05E-02	Unknown	1.80E-04	1.60E+01	no	
Dieldrin	3.99E-02	2.92E-02	Unknown	1.30E-02	3.60E-01	no	
Endosulfan II[3]	5.13E-02	5.68E-02	Unknown	7.30E-04	1.20E+03	no	
Endrin	4.56E-02	4.28E-02	Unknown	4.28E-02	6.10E+01	no	
Endrin ketone[4]	4.21E-02	3.19E-02	Unknown	2.90E-02	6.10E+01	no	
Heptachlor	2.09E-02	1.38E-02	Unknown	5.30E-03	1.30E+00	no	
Heptachlor epoxide	1.37E-02	9.19E-03	Unknown	9.19E-03	6.30E-01	no	
Methoxychlor	1.81E-01	1.85E-01	Unknown	1.85E-01	1.00E+03	no	
PCB-1254	5.32E-01	6.41E-01	Unknown	4.60E-01	2.90E+00	no	
PCB-1260	5.09E-01	5.54E-01	Unknown	3.40E-01	2.90E+00	no	
Semivolatiles							
2,4-Dimethylphenol	9.23E+00	4.05E+00	Unknown	4.05E+00	4.10E+03	no	
2-Methylnaphthalene	2.88E+01	7.46E+00	Unknown	7.46E+00	4.10E+03	no	
4-Methylphenol	9.36E+00	4.17E+00	Unknown	4.17E+00	1.00E+03	no	
Acenaphthene	5.09E+01	1.07E+01	Unknown	1.07E+01	1.20E+04	no	
Acenaphthylene	1.01E+01	5.41E+00	Unknown	5.41E+00	NA	NA	yes

Table 2
Statistical Summary and COPC Selection for Construction Worker Exposed to Soils and NAPL (0-18' bgs)
Former Koppers Company, Inc., Newport, DE

Analyte	Total # of Samples	Hits	Hit Frequency %	Minimum Detected mg/kg	Mean mg/kg	Lognormal Mean mg/kg	Maximum Detected mg/kg	Standard Deviation mg/kg
Anthracene	164	76	46.34	8.30E-02	3.96E+01	9.15E-01	2.60E+03	2.35E+02
Benzo(a)anthracene	164	112	68.29	6.70E-02	2.84E+01	1.68E+00	1.60E+03	1.31E+02
Benzo(a)pyrene	164	100	60.98	6.30E-02	2.00E+01	1.49E+00	7.40E+02	6.70E+01
Benzo(b)fluoranthene	164	111	67.68	8.50E-02	3.42E+01	2.34E+00	1.20E+03	1.07E+02
Benzo(g,h,i)perylene	164	90	54.88	4.70E-02	1.22E+01	1.28E+00	2.70E+02	3.26E+01
Benzo(k)fluoranthene	164	88	53.66	5.20E-02	1.23E+01	1.14E+00	3.20E+02	3.65E+01
bis(2-Ethylhexyl)phthalate	133	5	3.76	4.20E-02	7.28E+00	7.64E-01	7.90E-01	2.67E+01
Butylbenzylphthalate	164	2	1.22	6.50E-02	6.41E+00	6.71E-01	9.30E-02	2.44E+01
Carbazole	162	59	36.42	6.10E-02	1.85E+01	7.12E-01	1.20E+03	1.13E+02
Chrysene	164	116	70.73	4.60E-02	3.00E+01	1.82E+00	1.60E+03	1.31E+02
Di-n-butylphthalate	163	53	32.52	2.90E-02	6.43E+00	6.02E-01	5.30E-01	2.45E+01
Di-n-octylphthalate	164	1	0.61	4.30E-02	6.41E+00	6.72E-01	4.30E-02	2.44E+01
Dibenz(a,h)anthracene	163	64	39.26	7.40E-02	6.67E+00	8.23E-01	1.30E+02	2.22E+01
Dibenzofuran	164	45	27.44	8.50E-02	2.50E+01	7.45E-01	1.30E+03	1.26E+02
Diethylphthalate	162	2	1.23	6.40E-02	6.49E+00	6.81E-01	1.00E-01	2.46E+01
Fluoranthene	164	122	74.39	5.70E-02	9.98E+01	2.49E+00	8.60E+03	6.84E+02
Fluorene	164	44	26.83	5.40E-02	3.87E+01	7.40E-01	2.50E+03	2.21E+02
Indeno(1,2,3-c,d)pyrene	165	91	55.15	5.50E-02	1.35E+01	1.37E+00	3.40E+02	3.57E+01
Naphthalene	163	47	28.83	3.50E-02	5.09E+01	7.75E-01	3.00E+03	2.92E+02
Pentachlorophenol	163	15	9.2	4.20E-02	1.54E+01	1.47E+00	5.50E+00	6.07E+01
Phenanthrene	161	99	61.49	4.10E-02	1.28E+02	1.22E+00	1.10E+04	9.04E+02
Phenol	163	1	0.61	5.70E+01	6.36E+00	6.64E-01	5.70E+01	2.46E+01
Pyrene	164	121	73.78	4.10E-02	7.61E+01	2.45E+00	5.70E+03	4.57E+02
Volatiles								
1,1,2,2-Tetrachloroethane	152	13	8.55	1.00E-01	4.99E-02	9.90E-03	4.00E-01	1.47E-01
2-Butanone	139	21	15.11	2.00E-03	3.42E-02	7.65E-03	3.80E-02	1.41E-01
2-Hexanone	139	1	0.72	6.00E-03	3.37E-02	7.45E-03	6.00E-03	1.41E-01
Acetone	102	35	34.31	3.00E-03	9.08E-02	1.67E-02	2.10E+00	2.55E-01
Benzene	139	7	5.04	1.10E-02	3.18E-02	7.83E-03	5.30E-01	1.26E-01
Carbon Disulfide	139	5	3.6	4.00E-03	3.36E-02	7.42E-03	7.00E-03	1.41E-01
Ethylbenzene	139	19	13.67	1.00E-03	1.07E-01	8.52E-03	4.30E+00	5.33E-01
Styrene	139	9	6.47	5.00E-03	7.35E-02	8.09E-03	3.10E+00	3.81E-01
Tetrachloroethene	136	50	36.76	1.00E-03	3.60E-02	8.13E-03	7.40E-02	1.42E-01
Toluene	139	40	28.78	1.00E-03	1.03E-01	8.29E-03	5.70E+00	5.69E-01
Trichloroethene	139	1	0.72	2.00E-03	3.36E-02	7.39E-03	2.00E-03	1.41E-01
Xylenes (total)	139	29	20.86	2.00E-03	4.55E-01	9.83E-03	2.40E+01	2.59E+00

Table 2
Statistical Summary and COPC Selection for Construction Worker Exposed to Soils and NAPL (0-18' bgs)
Former Koppers Company, Inc., Newport, DE

Analyte	95% UCL mg/kg	Lognormal 95% UCL mg/kg	Distribution 99% Confidence	Exposure Point Concentration mg/kg	Industrial Soil RBC mg/kg	Is Maximum >RBC?	Is Detection Frequency >5%?
Anthracene	7.00E+01	1.58E+01	Unknown	1.58E+01	6.10E+04	no	
Benzo(a)anthracene	4.53E+01	5.92E+01	Unknown	5.92E+01	7.80E+00	yes	yes
Benzo(a)pyrene	2.87E+01	4.66E+01	Unknown	4.66E+01	7.80E-01	yes	yes
Benzo(b)fluoranthene	4.81E+01	1.12E+02	Unknown	1.12E+02	7.80E+00	yes	yes
Benzo(g,h,i)perylene	1.64E+01	2.45E+01	Unknown	2.45E+01	NA	NA	yes
Benzo(k)fluoranthene	1.71E+01	2.08E+01	Unknown	2.08E+01	7.80E+01	yes	yes
bis(2-Ethylhexyl)phthalate	1.11E+01	6.32E+00	Unknown	7.90E-01	4.10E+02	no	
Butylbenzylphthalate	9.57E+00	4.56E+00	Unknown	9.30E-02	4.10E+04	no	
Carbazole	3.33E+01	6.63E+00	Unknown	6.63E+00	2.90E+02	yes	yes
Chrysene	4.70E+01	7.33E+01	Unknown	7.33E+01	7.80E+02	yes	yes
Di-n-butylphthalate	9.61E+00	5.23E+00	Unknown	5.30E-01	2.00E+04	no	
Di-n-octylphthalate	9.57E+00	4.57E+00	Unknown	4.30E-02	4.10E+03	no	
Dibenz(a,h)anthracene	9.55E+00	6.58E+00	Unknown	6.58E+00	7.80E-01	yes	yes
Dibenzofuran	4.13E+01	8.65E+00	Unknown	8.65E+00	8.20E+02	yes	
Diethylphthalate	9.68E+00	4.70E+00	Unknown	1.00E-01	1.60E+05	no	
Fluoranthene	1.88E+02	2.09E+02	Unknown	2.09E+02	8.20E+03	yes	yes
Fluorene	6.73E+01	1.16E+01	Unknown	1.16E+01	8.20E+03	no	
Indeno(1,2,3-c,d)pyrene	1.81E+01	2.95E+01	Unknown	2.95E+01	7.80E+00	yes	yes
Naphthalene	8.88E+01	1.35E+01	Unknown	1.35E+01	4.10E+03	no	
Pentachlorophenol	2.33E+01	1.12E+01	Unknown	5.50E+00	4.80E+01	no	
Phenanthrene	2.46E+02	4.98E+01	Unknown	4.98E+01	NA	NA	yes
Phenol	9.55E+00	4.27E+00	Unknown	4.27E+00	1.20E+05	no	
Pyrene	1.35E+02	1.88E+02	Unknown	1.88E+02	6.10E+03	no	
Volatiles							
1,1,2,2-Tetrachloroethane	6.96E-02	2.95E-02	Unknown	2.95E-02	2.90E+01	no	
2-Butanone	5.40E-02	1.45E-02	Unknown	1.45E-02	1.00E+05	no	
2-Hexanone	5.35E-02	1.35E-02	Unknown	6.00E-03	NA	NA	no
Acetone	1.33E-01	9.83E-02	Unknown	9.83E-02	2.00E+04	no	
Benzene	4.95E-02	1.46E-02	Unknown	1.46E-02	2.00E+02	no	
Carbon Disulfide	5.34E-02	1.35E-02	Unknown	7.00E-03	2.00E+04	no	
Ethylbenzene	1.82E-01	2.60E-02	Unknown	2.60E-02	2.00E+04	no	
Styrene	1.27E-01	1.89E-02	Unknown	1.89E-02	4.10E+04	no	
Tetrachloroethene	5.63E-02	1.74E-02	Unknown	1.74E-02	1.10E+02	no	
Toluene	1.83E-01	2.64E-02	Unknown	2.64E-02	4.10E+04	no	
Trichloroethene	5.34E-02	1.35E-02	Unknown	2.00E-03	5.20E+02	no	
Xylenes (total)	8.20E-01	5.55E-02	Unknown	5.55E-02	4.10E+05	no	

This data set includes samples from the Process/Wood Storage and Drip Track areas.
NA - Not available
[1] The screening level of 750 mg/kg is based on US EPA's adult blood lead uptake model under default exposure assumptions.
[2] These compounds have no published RBC or RfD values. They are sufficiently close in toxicity to Chlordane so that the Chlordane RBC is applicable to its congeners as a provisional benchmark.
[3] These compounds have no published RBC or RfD values. They are sufficiently close in toxicity to Endosulfan so that the Endosulfan RBC is applicable to its congeners as a provisional benchmark.
[4] These compounds have no published RBC or RfD values. They are sufficiently close in toxicity to Endrin so that the Endrin RBC is applicable to its congeners as a provisional benchmark.

Table 3
Statistical Summary and COPC Selection for Industrial Worker Exposed to Surface Soils (0-12" bgs)
Former Koppers Company, Inc., Newport, DE

Analyte	Total # of Samples	Hits	Hit Frequency %	Minimum Detected mg/kg	Mean mg/kg	Lognormal Mean mg/kg	Maximum Detected mg/kg	Standard Deviation mg/kg
Dioxins								
2,3,7,8-TCDD Equiv.	12	12	100	1.48E-04	1.69E-03	9.77E-04	7.34E-03	1.98E-03
Inorganics								
Aluminum	43	43	100	2.07E+03	1.73E+04	1.45E+04	3.65E+04	9.54E+03
Antimony	24	10	41.67	6.50E-01	1.25E+01	3.24E+00	1.21E+01	1.41E+01
Arsenic	38	36	94.74	1.20E+00	6.31E+00	4.88E+00	2.19E+01	4.60E+00
Barium	43	43	100	2.11E+01	5.29E+02	3.62E+02	1.65E+03	4.15E+02
Beryllium	42	42	100	2.60E-01	1.72E+00	1.42E+00	3.90E+00	9.82E-01
Cadmium	42	23	54.76	2.40E-01	1.43E+00	9.56E-01	2.10E+00	1.04E+00
Chromium	43	43	100	3.70E+00	2.42E+01	1.99E+01	1.19E+02	1.93E+01
Cobalt	41	33	80.49	6.10E-01	6.45E+00	3.54E+00	1.20E+01	5.99E+00
Copper	42	42	100	5.30E+00	4.76E+01	2.52E+01	5.28E+02	8.82E+01
Iron	43	43	100	4.43E+03	1.59E+04	1.49E+04	2.82E+04	5.18E+03
Lead[1]	43	43	100	3.80E+00	6.20E+01	3.53E+01	4.77E+02	9.29E+01
Manganese	43	43	100	4.06E+01	2.55E+03	1.24E+03	9.81E+03	2.81E+03
Mercury	35	17	48.57	5.00E-02	6.45E-01	1.64E-01	8.30E+00	1.56E+00
Nickel	39	39	100	4.00E+00	1.23E+01	1.01E+01	5.18E+01	1.02E+01
Selenium	37	7	18.92	8.60E-01	1.73E+00	1.27E+00	2.30E+00	9.79E-01
Silver	43	2	4.65	1.10E+00	3.57E+00	1.65E+00	1.50E+00	2.21E+00
Thallium	42	19	45.24	1.60E+00	5.56E+00	3.23E+00	4.44E+01	7.44E+00
Vanadium	43	42	97.67	7.60E+00	8.94E+01	5.70E+01	3.06E+02	9.01E+01
Zinc	43	43	100	6.40E+00	9.92E+01	6.28E+01	8.74E+02	1.39E+02
PCBs/Pesticides								
4,4'-DDD	7	1	14.29	3.80E-03	8.71E-02	1.58E-02	3.80E-03	1.06E-01
4,4'-DDE	7	3	42.86	1.40E-02	4.72E-02	1.07E-02	2.40E-01	8.75E-02
4,4'-DDT	7	4	57.14	6.90E-03	4.64E-02	1.59E-02	1.20E-01	5.47E-02
alpha-Chlordane[2]	7	1	14.29	1.80E-04	4.53E-02	7.28E-03	1.80E-04	5.46E-02
Dieldrin	7	3	42.86	2.40E-03	6.11E-02	1.07E-02	1.30E-02	9.72E-02
Endosulfan	7	1	14.29	4.50E-04	8.78E-02	1.46E-02	4.50E-04	1.06E-01
Endrin	7	1	14.29	1.10E-01	7.59E-02	1.67E-02	1.10E-01	9.53E-02
Endrin ketone[1]	7	1	14.29	2.90E-02	6.57E-02	1.39E-02	2.90E-02	9.76E-02
Heptachlor	7	1	14.29	5.30E-03	3.19E-02	6.11E-03	5.30E-03	5.03E-02
Heptachlor epoxide	7	2	28.57	1.00E-02	1.90E-02	5.21E-03	2.00E-02	3.42E-02
Methoxychlor	7	3	42.86	2.90E-01	2.66E-01	7.02E-02	9.20E-01	3.57E-01
PCB-1260	8	1	12.5	3.40E-01	8.13E-01	1.96E-01	3.40E-01	9.94E-01

Table 3
Statistical Summary and COPC Selection for Industrial Worker Exposed to Surface Soils (0-12" bgs)
Former Koppers Company, Inc., Newport, DE

Analyte	95% UCL mg/kg	Lognormal 95% UCL mg/kg	Distribution 99% Confidence	Exposure Point Concentration mg/kg	Industrial Soil RBC mg/kg	Is Maximum >RBC?	Is Detection Frequency >5%?
Dioxins							
2,3,7,8-TCDD Equiv.	2.71E-03	5.44E-03	Lognormal	5.44E-03	3.80E-05	yes	yes
Inorganics							
Aluminum	1.98E+04	2.21E+04	Normal/Lognormal	2.21E+04	2.00E+05	no	
Antimony	1.74E+01	1.20E+02	Unknown	1.21E+01	8.20E+01	no	
Arsenic	7.57E+00	8.56E+00	Lognormal	8.56E+00	3.80E+00	yes	yes
Barium	6.36E+02	8.53E+02	Lognormal	8.53E+02	1.40E+04	no	
Beryllium	1.98E+00	2.21E+00	Normal/Lognormal	2.21E+00	4.10E+02	no	
Cadmium	1.70E+00	2.30E+00	Unknown	2.10E+00	2.00E+02	no	
Chromium	2.92E+01	2.94E+01	Lognormal	2.94E+01	3.10E+05	no	
Cobalt	8.02E+00	2.17E+01	Unknown	1.20E+01	1.20E+04	no	
Copper	7.06E+01	5.89E+01	Lognormal	5.89E+01	8.20E+03	no	
Iron	1.73E+04	1.81E+04	Normal	1.73E+04	6.10E+04	no	
Lead[1]	8.58E+01	8.22E+01	Lognormal	8.22E+01	7.50E+02	no	
Manganese	3.27E+03	5.50E+03	Lognormal	5.50E+03	2.90E+04	no	
Mercury	1.09E+00	8.57E-01	Unknown	8.57E-01	6.10E+01	no	
Nickel	1.51E+01	1.44E+01	Unknown	1.44E+01	4.10E+03	no	
Selenium	2.00E+00	2.84E+00	Unknown	2.30E+00	1.00E+03	no	
Silver	4.14E+00	2.05E+01	Unknown	1.50E+00	1.00E+03	no	
Thallium	7.49E+00	8.56E+00	Unknown	8.56E+00	1.40E+01	yes	yes
Vanadium	1.13E+02	1.28E+02	Lognormal	1.28E+02	1.40E+03	no	
Zinc	1.35E+02	1.28E+02	Lognormal	1.28E+02	6.10E+04	no	
PCBs/Pesticides							
4,4'-DDD	1.65E-01	6.23E+02	Unknown	3.80E-03	2.40E+01	no	
4,4'-DDE	1.11E-01	8.03E+00	Lognormal	2.40E-01	1.70E+01	no	
4,4'-DDT	8.66E-02	7.59E+00	Normal/Lognormal	1.20E-01	1.70E+01	no	
alpha-Chlordane[2]	8.54E-02	3.69E+03	Normal/Lognormal	1.80E-04	1.60E+01	no	
Dieldrin	1.32E-01	4.36E+01	Lognormal	1.30E-02	3.60E-01	no	
Endosulfan II[3]	1.65E-01	4.37E+03	Normal/Lognormal	4.50E-04	1.20E+03	no	
Endrin	1.46E-01	1.72E+02	Normal/Lognormal	1.10E-01	6.10E+01	no	
Endrin ketone[4]	1.37E-01	5.35E+01	Lognormal	2.90E-02	6.10E+01	no	
Heptachlor	6.88E-02	1.87E+01	Lognormal	5.30E-03	1.30E+00	no	
Heptachlor epoxide	4.41E-02	1.78E+00	Lognormal	2.00E-02	6.30E-01	no	
Methoxychlor	5.28E-01	1.34E+02	Normal/Lognormal	9.20E-01	1.00E+03	no	
PCB-1260	1.48E+00	4.17E+02	Lognormal	3.40E-01	2.90E+00	no	

Table 3
Statistical Summary and COPC Selection for Industrial Worker Exposed to Surface Soils (0-12" bgs)
Former Koppers Company, Inc., Newport, DE

Analyte	Total # of Samples	Hits	Hit Frequency %	Minimum Detected mg/kg	Mean mg/kg	Lognormal Mean mg/kg	Maximum Detected mg/kg	Standard Deviation mg/kg
Semivolatiles								
Acenaphthene	43	7	16.28	5.00E-01	9.52E+00	2.37E+00	1.50E+02	2.40E+01
Acenaphthylene	43	12	27.91	6.20E-01	6.92E+00	2.68E+00	1.30E+01	9.71E+00
Anthracene	43	27	62.79	1.40E-01	7.33E+01	3.10E+00	2.60E+03	3.97E+02
Benzo(a)anthracene	43	40	93.02	3.80E-01	4.10E+01	1.50E+01	1.70E+02	4.52E+01
Benzo(a)pyrene	43	40	93.02	3.40E-01	3.48E+01	1.26E+01	2.40E+02	4.48E+01
Benzo(b)fluoranthene	43	40	93.02	9.30E-01	6.98E+01	2.51E+01	3.70E+02	8.00E+01
Benzo(g,h,i)perylene	43	39	90.7	3.40E-01	2.06E+01	8.98E+00	9.40E+01	2.07E+01
Benzo(k)fluoranthene	43	39	90.7	1.70E-01	2.28E+01	8.59E+00	1.10E+02	2.60E+01
Carbazole	43	20	46.51	9.80E-02	3.42E+01	2.29E+00	1.20E+03	1.82E+02
Chrysene	43	40	93.02	5.60E-01	4.73E+01	1.67E+01	2.60E+02	5.83E+01
Di-n-butylphthalate[5]	44	2	4.55	1.90E-01	7.33E+00	2.61E+00	2.10E-01	1.08E+01
Dibenz(a,h)anthracene	43	32	74.42	3.90E-01	7.52E+00	3.25E+00	2.20E+01	8.74E+00
Dibenzofuran	43	9	20.93	1.00E+00	1.11E+01	2.44E+00	2.30E+02	3.54E+01
Fluoranthene	43	41	95.35	9.40E-02	6.63E+01	2.12E+01	3.90E+02	9.33E+01
Fluorene	43	6	13.95	7.10E-01	1.81E+01	2.44E+00	5.20E+02	7.90E+01
Indeno(1,2,3-c,d)pyrene	44	41	93.18	3.00E-01	2.47E+01	1.03E+01	1.10E+02	2.48E+01
Naphthalene	43	10	23.26	4.70E-01	9.75E+00	2.55E+00	1.50E+02	2.40E+01
Pentachlorophenol	43	3	6.98	6.50E-01	1.65E+01	5.80E+00	2.30E+00	2.47E+01
Phenanthrene	43	37	86.05	1.30E-01	3.07E+01	4.02E+00	8.50E+02	1.30E+02
Pyrene	43	40	93.02	5.10E-01	6.74E+01	2.20E+01	4.10E+02	9.06E+01
Volatiles								
1,1,2,2-Tetrachloroethane	38	2	5.26	1.00E-01	1.63E-02	7.23E-03	3.00E-01	4.97E-02
2-Butanone	36	2	5.56	6.00E-03	6.90E-03	6.31E-03	3.80E-02	5.36E-03
Acetone	35	5	14.29	4.00E-03	1.27E-02	7.19E-03	1.50E-01	2.70E-02
Benzene	36	1	2.78	1.10E-02	6.24E-03	6.17E-03	1.10E-02	1.07E-03
Ethylbenzene	36	4	11.11	1.00E-03	1.13E-02	6.27E-03	2.00E-01	3.24E-02
Tetrachloroethene	36	25	69.44	4.00E-03	1.17E-02	8.88E-03	7.40E-02	1.27E-02
Toluene	36	16	44.44	1.00E-03	1.15E-02	7.09E-03	1.50E-01	2.43E-02
Xylenes (total)	36	6	16.67	3.30E-03	2.68E-02	6.99E-03	7.40E-01	1.22E-01

Table 3
Statistical Summary and COPC Selection for Industrial Worker Exposed to Surface Soils (0-12" bgs)
Former Koppers Company, Inc., Newport, DE

Analyte	95% UCL mg/kg	Lognormal 95% UCL mg/kg	Distribution 99% Confidence	Exposure Point Concentration mg/kg	Industrial Soil RBC mg/kg	Is Maximum >RBC?	Is Detection Frequency >5%?
Semivolatiles							
Acenaphthene	1.57E+01	1.76E+01	Lognormal	1.76E+01	1.20E+04	no	
Acenaphthylene	9.41E+00	1.58E+01	Lognormal	1.30E+01	NA	NA	yes
Anthracene	1.75E+02	6.96E+01	Lognormal	6.96E+01	6.10E+04	no	
Benzo(a)anthracene	5.26E+01	2.13E+02	Unknown	1.70E+02	7.80E+00	yes	yes
Benzo(a)pyrene	4.63E+01	1.61E+02	Lognormal	1.61E+02	7.80E-01	yes	yes
Benzo(b)fluoranthene	9.04E+01	4.22E+02	Unknown	3.70E+02	7.80E+00	yes	yes
Benzo(g,h,i)perylene	2.59E+01	8.16E+01	Unknown	8.16E+01	NA	NA	yes
Benzo(k)fluoranthene	2.95E+01	1.11E+02	Unknown	1.10E+02	7.80E+01	yes	yes
Carbazole	8.11E+01	2.96E+01	Lognormal	2.96E+01	2.90E+02	yes	yes
Chrysene	6.23E+01	2.42E+02	Lognormal	2.42E+02	7.80E+02	no	
Di-n-butylphthalate	1.01E+01	1.60E+01	Lognormal	2.10E-01	2.00E+04	no	
Dibenz(a,h)anthracene	9.77E+00	1.99E+01	Lognormal	1.99E+01	7.80E-01	yes	yes
Dibenzofuran	2.02E+01	1.76E+01	Lognormal	1.76E+01	8.20E+02	no	
Fluoranthene	9.03E+01	4.11E+02	Lognormal	3.90E+02	8.20E+03	no	
Fluorene	3.84E+01	2.25E+01	Lognormal	2.25E+01	8.20E+03	no	
Indeno(1,2,3-c,d)pyrene	3.10E+01	1.11E+02	Unknown	1.10E+02	7.80E+00	yes	yes
Naphthalene	1.59E+01	1.96E+01	Lognormal	1.96E+01	4.10E+03	no	
Pentachlorophenol	2.28E+01	3.61E+01	Lognormal	2.30E+00	4.80E+01	no	
Phenanthrene	6.42E+01	5.16E+01	Lognormal	5.16E+01	NA	NA	yes
Pyrene	9.07E+01	3.90E+02	Lognormal	3.90E+02	6.10E+03	no	
Volatiles							
1,1,2,2-Tetrachloroethane	3.00E-02	1.28E-02	Unknown	1.28E-02	2.90E+01	no	
2-Butanone	8.42E-03	7.31E-03	Unknown	7.31E-03	1.00E+05	no	
Acetone	2.04E-02	1.25E-02	Unknown	1.25E-02	2.00E+04	no	
Benzene	6.54E-03	6.50E-03	Unknown	6.50E-03	2.00E+02	no	
Ethylbenzene	2.04E-02	9.97E-03	Unknown	9.97E-03	2.00E+04	no	
Tetrachloroethene	1.53E-02	1.39E-02	Unknown	1.39E-02	1.10E+02	no	
Toluene	1.84E-02	1.22E-02	Unknown	1.22E-02	4.10E+04	no	
Xylenes (total)	6.14E-02	1.37E-02	Unknown	1.37E-02	1.00E+05	no	

This data set includes samples from the Process/Wood Storage and Drip Track areas.
NA - Not available
[1] The screening level of 750 mg/kg is based on US EPA's adult blood lead uptake model under default exposure assumptions.
[2] These compounds have no published RBC or RfD values. They are sufficiently close in toxicity to Chlordane so that the Chlordane RBC is applicable to its congeners as a provisional benchmark.
[3] These compounds have no published RBC or RfD values. They are sufficiently close in toxicity to Endosulfan so that the Endosulfan RBC is applicable to its congeners as a provisional benchmark.
[4] These compounds have no published RBC or RfD values. They are sufficiently close in toxicity to Endrin so that the Endrin RBC is applicable to its congeners as a provisional benchmark.

Table 4
Statistical Summary and COPC Selection for Industrial Worker Exposed to Surface Soils and NAPL (0-12" bgs)
Former Koppers Company, Inc., Newport, DE

Analyte	Total # of Samples	Hits	Hit Frequency %	Minimum Detected mg/kg	Mean mg/kg	Lognormal Mean mg/kg	Maximum Detected mg/kg	Standard Deviation mg/kg
Dioxins								
2,3,7,8-TCDD Equiv.	12	12	100	1.48E-04	1.69E-03	9.77E-04	7.34E-03	1.98E-03
Inorganics								
Aluminum	67	67	100	2.07E+03	1.59E+04	1.36E+04	3.65E+04	8.63E+03
Antimony	46	14	30.43	6.50E-01	7.23E+00	1.60E+00	1.21E+01	1.16E+01
Arsenic	62	60	96.77	1.20E+00	6.34E+00	4.86E+00	3.10E-01	5.34E+00
Barium	67	67	100	2.11E+01	4.47E+02	2.91E+02	1.65E+03	3.85E+02
Beryllium	60	60	100	2.60E-01	1.58E+00	1.28E+00	3.90E+00	9.61E-01
Cadmium	64	29	45.31	2.40E-01	1.09E+00	5.30E-01	2.10E+00	1.02E+00
Chromium	67	67	100	3.70E+00	2.93E+01	2.19E+01	2.44E+02	3.43E+01
Cobalt	65	56	86.15	6.10E-01	6.49E+00	4.14E+00	2.50E+01	5.52E+00
Copper	66	66	100	9.10E-01	4.19E-01	2.23E+01	5.28E+02	7.54E-01
Iron	67	67	100	4.43E+03	1.77E+04	1.59E+04	7.73E+04	1.00E+04
Lead[1]	67	67	100	2.30E+00	6.85E-01	3.25E+01	8.92E+02	1.31E+02
Manganese	67	67	100	4.06E+01	2.07E+03	9.90E+02	9.81E+03	2.48E+03
Mercury	50	31	62	2.10E-02	4.93E-01	1.33E-01	8.30E+00	1.32E+00
Nickel	62	62	100	4.00E+00	1.25E+01	1.06E+01	5.18E+01	8.68E+00
Selenium	61	13	21.31	8.50E-01	1.26E+00	8.66E-01	2.30E+00	9.80E-01
Silver	65	3	4.62	2.10E-01	2.40E+00	6.24E-01	1.50E+00	2.43E+00
Thallium	66	26	39.39	8.90E-01	3.85E+00	1.83E+00	4.44E-01	6.35E+00
Vanadium	67	66	98.51	7.60E+00	7.32E+01	5.00E+01	3.06E+02	7.64E+01
Zinc	66	66	100	6.40E+00	9.78E+01	6.61E+01	8.74E-02	1.25E+02
PCBs/Pesticides								
4,4'-DDD	7	1	14.29	3.80E-03	8.71E-02	1.58E-02	3.80E-03	1.06E-01
4,4'-DDE	7	3	42.86	1.40E-02	4.72E-02	1.07E-02	2.40E-01	8.75E-02
4,4'-DDT	7	4	57.14	6.90E-03	4.64E-02	1.59E-02	1.20E-01	5.47E-02
alpha-Chlordane[2]	7	1	14.29	1.80E-04	4.53E-02	7.28E-03	1.80E-04	5.46E-02
Dieldrin	7	3	42.86	2.40E-03	6.11E-02	1.07E-02	1.30E-02	9.72E-02
Endosulfan II[3]	7	1	14.29	4.50E-04	8.78E-02	1.46E-02	4.50E-04	1.06E-01
Endrin	7	1	14.29	1.10E-01	7.59E-02	1.67E-02	1.10E-01	9.53E-02
Endrin ketone[4]	7	1	14.29	2.90E-02	6.57E-02	1.39E-02	2.90E-02	9.76E-02
Heptachlor	7	1	14.29	5.30E-03	3.19E-02	6.11E-03	5.30E-03	5.03E-02
Heptachlor epoxide	7	2	28.57	1.00E-02	1.90E-02	5.21E-03	2.00E-02	3.42E-02
Methoxychlor	7	3	42.86	2.90E-01	2.66E-01	7.02E-02	9.20E-01	3.57E-01
PCB-1260	8	1	12.5	3.40E-01	8.13E-01	1.96E-01	3.40E-01	9.94E-01
Semivolatiles								
2,4-Dimethylphenol	67	1	1.49	1.20E+01	4.63E+00	1.24E+00	1.20E+01	8.51E+00
2-Methylnaphthalene	67	18	26.87	4.10E-02	1.00E+01	1.22E+00	2.20E+02	3.48E+01
4-Methylphenol	67	1	1.49	3.10E+01	4.91E+00	1.26E+00	3.10E+01	9.06E+00
Acenaphthene	67	22	32.84	4.60E-02	2.71E+01	1.14E+00	1.40E+03	1.71E+02
Acenaphthylene	67	31	46.27	1.10E-01	6.36E+00	1.66E+00	9.90E+01	1.42E+01

Table 4
Statistical Summary and COPC Selection for Industrial Worker Exposed to Surface Soils and NAPL (0-12" bgs)
Former Koppers Company, Inc., Newport, DE

Analyte	95% UCL mg/kg	Lognormal 95% UCL mg/kg	Distribution 99% Confidence	Exposure Point Concentration mg/kg	Industrial Soil RBC mg/kg	Is Maximum >RBC?	Is Detection Frequency >5%?
Dioxins							
2,3,7,8-TCDD Equiv.	2.71E-03	5.44E-03	Lognormal	5.44E-03	3.80E-05	yes	yes
Inorganics							
Aluminum	1.76E+04	1.86E+04	Unknown	1.86E+04	2.00E+05	no	
Antimony	1.01E+01	1.83E+01	Unknown	1.21E+01	8.20E+01	no	
Arsenic	7.48E+00	7.70E+00	Unknown	7.70E+00	3.80E+00	yes	yes
Barium	5.25E+02	6.51E+02	Unknown	6.51E+02	1.40E+04	no	
Beryllium	1.79E+00	1.95E+00	Unknown	1.95E+00	4.10E+02	no	
Cadmium	1.31E+00	2.50E+00	Normal	1.31E+00	2.00E+02	no	
Chromium	3.63E+01	3.28E+01	Unknown	3.28E+01	3.10E+05	no	
Cobalt	7.63E+00	1.37E+01	Unknown	1.37E+01	1.20E+04	no	
Copper	5.74E+01	5.02E+01	Lognormal	5.02E+01	8.20E+03	no	
Iron	1.97E+04	1.94E+04	Unknown	1.94E+04	6.10E+04	yes	yes
Lead[1]	9.54E+01	8.31E+01	Unknown	8.31E+01	7.50E+02	yes	yes
Manganese	2.57E+03	3.46E+03	Unknown	3.46E+03	2.90E+04	no	
Mercury	8.08E-01	5.65E-01	Unknown	5.65E-01	6.10E+01	no	
Nickel	1.43E+01	1.39E+01	Unknown	1.39E+01	4.10E+03	no	
Selenium	1.47E+00	1.72E+00	Unknown	1.72E+00	1.00E+03	no	
Silver	2.91E+00	1.19E+01	Unknown	1.50E+00	1.00E+03	no	
Thallium	5.16E+00	5.40E+00	Unknown	5.40E+00	1.40E+01	yes	yes
Vanadium	8.88E+01	8.78E+01	Unknown	8.78E+01	1.40E+03	no	
Zinc	1.23E+02	1.15E+02	Unknown	1.15E+02	6.10E+04	no	
PCBs/Pesticides							
4,4'-DDD	1.65E-01	6.23E+02	Unknown	3.80E-03	2.40E+01	no	
4,4'-DDE	1.11E-01	8.03E+00	Lognormal	2.40E-01	1.70E+01	no	
4,4'-DDT	8.66E-02	7.59E+00	Normal/Lognormal	1.20E-01	1.70E+01	no	
alpha-Chlordane[2]	8.54E-02	3.69E+03	Normal/Lognormal	1.80E-04	1.60E+01	no	
Dieldrin	1.32E-01	4.36E+01	Lognormal	1.30E-02	3.60E-01	no	
Endosulfan II[3]	1.65E-01	4.37E+03	Normal/Lognormal	4.50E-04	1.20E+03	no	
Endrin	1.46E-01	1.72E+02	Normal/Lognormal	1.10E-01	6.10E+01	no	
Endrin ketone[4]	1.37E-01	5.35E+01	Lognormal	2.90E-02	6.10E+01	no	
Heptachlor	6.88E-02	1.87E+01	Lognormal	5.30E-03	1.30E+00	no	
Heptachlor epoxide	4.41E-02	1.78E+00	Lognormal	2.00E-02	6.30E-01	no	
Methoxychlor	5.28E-01	1.34E+02	Normal/Lognormal	9.20E-01	1.00E+03	no	
PCB-1260	1.48E+00	4.17E+02	Lognormal	3.40E-01	2.90E+00	no	
Semivolatiles							
2,4-Dimethylphenol	6.36E+00	8.47E+00	Unknown	8.47E+00	4.10E+03	no	
2-Methylnaphthalene	1.71E+01	1.40E+01	Unknown	1.40E+01	4.10E+03	no	
4-Methylphenol	6.76E+00	9.06E+00	Unknown	9.06E+00	1.00E+03	no	
Acenaphthene	6.21E+01	1.86E+01	Unknown	1.86E+01	1.20E+04	no	
Acenaphthylene	9.25E+00	1.21E+01	Unknown	1.21E+01	NA	NA	yes

Table 4

Statistical Summary and COPC Selection for Industrial Worker Exposed to Surface Soils and NAPL (0-12" bgs)

Former Koppers Company, Inc., Newport, DE

Analyte	Total # of Samples	Hits	Hit Frequency %	Minimum Detected mg/kg	Mean mg/kg	Lognormal Mean mg/kg	Maximum Detected mg/kg	Standard Deviation mg/kg
Anthracene	67	46	68.66	1.20E-01	6.55E+01	2.05E+00	2.60E+03	3.48E+02
Benzo(a)anthracene	67	63	94.03	6.70E-02	5.39E+01	8.46E+00	1.60E+03	1.96E+02
Benzo(a)pyrene	67	63	94.03	6.30E-02	3.74E+01	7.68E+00	7.40E+02	9.54E+01
Benzo(b)fluoranthene	67	63	94.03	1.60E-01	7.11E+01	1.57E+01	1.20E+03	1.57E+02
Benzo(g,h,i)perylene	67	60	89.55	4.70E-02	1.98E+01	5.73E+00	2.70E+02	3.63E+01
Benzo(k)fluoranthene	67	59	88.06	5.20E-02	2.09E+01	4.68E+00	3.20E+02	4.36E+01
Butylbenzylphthalate	68	2	2.94	6.50E-02	5.44E+00	1.29E+00	9.30E-02	9.97E+00
Carbazole	67	39	58.21	6.10E-02	3.33E+01	1.36E+00	1.20E+03	1.71E+02
Chrysene	67	64	95.52	4.60E-02	5.95E+01	1.02E+01	1.60E+03	1.98E+02
Di-n-butylphthalate	68	5	7.35	3.90E-02	5.43E+00	1.24E+00	2.10E-01	9.97E+00
Di-n-octylphthalate	68	1	1.47	4.30E-02	5.44E+00	1.30E+00	4.30E-02	9.97E+00
Dibenz(a,h)anthracene	67	50	74.63	2.90E-01	7.12E+00	2.25E+00	9.50E+01	1.33E+01
Dibenzofuran	67	22	32.84	8.50E-02	2.66E+01	1.27E+00	1.30E+03	1.61E+02
Diethylphthalate	68	1	1.47	6.40E-02	5.44E+00	1.31E+00	6.40E-02	9.97E+00
Fluoranthene	67	65	97.01	6.80E-02	1.77E+02	1.24E+01	8.60E+03	1.05E+03
Fluorene	67	17	25.37	5.40E-02	4.91E+01	1.25E+00	2.50E+03	3.11E+02
Indeno(1,2,3-c,d)pyrene	68	62	91.18	8.40E-02	2.39E+01	6.57E+00	3.40E+02	4.50E+01
Naphthalene	67	26	38.81	5.20E-02	1.00E+01	1.30E+00	2.40E+02	3.46E+01
Pentachlorophenol	67	11	16.42	6.50E-02	1.22E+01	2.58E+00	2.30E+00	2.32E+01
Phenanthrene	67	56	83.58	1.00E-01	1.85E+02	2.66E+00	1.10E+04	1.35E+03
Phenol	67	1	1.49	5.70E+01	5.30E+00	1.27E+00	5.70E+01	1.06E+01
Pyrene	67	64	95.52	6.10E-02	1.35E+02	1.33E+01	5.70E+03	6.95E+02
Volatiles								
1,1,2,2-Tetrachloroethane	47	2	4.26	1.00E-01	1.44E-02	7.02E-03	3.00E-01	4.47E-02
2-Butanone	45	2	4.44	6.00E-03	6.77E-03	6.28E-03	3.80E-02	4.79E-03
Acetone	37	6	16.22	4.00E-03	1.84E-02	7.86E-03	2.30E-01	4.44E-02
Benzene	45	1	2.22	1.10E-02	6.23E-03	6.17E-03	1.10E-02	9.86E-04
Ethylbenzene	45	4	8.89	1.00E-03	1.03E-02	6.26E-03	2.00E-01	2.89E-02
Tetrachloroethene	45	25	55.56	4.00E-03	1.06E-02	8.27E-03	7.40E-02	1.15E-02
Toluene	45	16	35.56	1.00E-03	1.05E-02	6.91E-03	1.50E-01	2.18E-02
Trichloroethene	45	1	2.22	2.00E-03	6.04E-03	5.95E-03	2.00E-03	9.03E-04
Xylenes (total)	45	6	13.33	3.30E-03	2.27E-02	6.83E-03	7.40E-01	1.09E-01

Table 4
Statistical Summary and COPC Selection for Industrial Worker Exposed to Surface Soils and NAPL (0-12" bgs)
Former Koppers Company, Inc., Newport, DE

Analyte	95% UCL mg/kg	Lognormal 95% UCL mg/kg	Distribution 99% Confidence	Exposure Point Concentration mg/kg	Industrial Soil RBC mg/kg	Is Maximum >RBC?	Is Detection Frequency >5%?
Anthracene	1.37E+02	4.08E+01	Unknown	4.08E+01	6.10E+04	no	
Benzo(a)anthracene	9.39E+01	2.92E+02	Unknown	2.92E+02	7.80E+00	yes	yes
Benzo(a)pyrene	5.69E+01	2.02E+02	Unknown	2.02E+02	7.80E-01	yes	yes
Benzo(b)fluoranthene	1.03E+02	4.29E+02	Unknown	4.29E+02	7.80E+00	yes	yes
Benzo(g,h,i)perylene	2.72E+01	7.85E+01	Unknown	7.85E+01	NA	NA	yes
Benzo(k)fluoranthene	2.97E+01	9.95E+01	Unknown	9.95E+01	7.80E+01	yes	yes
Butylbenzylphthalate	7.46E+00	1.11E+01	Unknown	9.30E-02	4.10E+04	no	
Carbazole	6.81E+01	2.11E+01	Unknown	2.11E+01	2.90E+02	yes	yes
Chrysene	9.98E+01	3.27E+02	Unknown	3.27E+02	7.80E+02	yes	yes
Di-n-butylphthalate	7.45E+00	1.24E+01	Unknown	2.10E-01	2.00E+04	no	
Di-n-octylphthalate	7.46E+00	1.11E+01	Unknown	4.30E-02	4.10E+03	no	
Dibenz(a,h)anthracene	9.84E+00	1.55E+01	Unknown	1.55E+01	7.80E-01	yes	yes
Dibenzofuran	5.94E+01	1.55E+01	Unknown	1.55E+01	8.20E+02	yes	yes
Diethylphthalate	7.46E+00	1.09E+01	Unknown	6.40E-02	1.60E+05	no	
Fluoranthene	3.91E+02	6.59E+02	Unknown	6.59E+02	8.20E+03	yes	yes
Fluorene	1.12E+02	2.15E+01	Unknown	2.15E+01	8.20E+03	no	
Indeno(1,2,3-c,d)pyrene	3.31E+01	1.01E+02	Unknown	1.01E+02	7.80E+00	yes	yes
Naphthalene	1.71E+01	1.54E+01	Unknown	1.54E+01	4.10E+03	no	
Pentachlorophenol	1.70E+01	3.19E+01	Unknown	2.30E+00	4.80E+01	no	
Phenanthrene	4.59E+02	6.75E+01	Unknown	6.75E+01	NA	NA	yes
Phenol	7.47E+00	9.56E+00	Unknown	9.56E+00	1.20E+05	no	
Pyrene	2.76E+02	5.67E+02	Unknown	5.67E+02	6.10E+03	no	
Volatiles							
1,1,2,2-Tetrachloroethane	2.54E-02	1.11E-02	Unknown	1.11E-02	2.90E+01	no	
2-Butanone	7.97E-03	7.07E-03	Unknown	7.07E-03	1.00E+05	no	
Acetone	3.08E-02	1.71E-02	Unknown	1.71E-02	2.00E+04	no	
Benzene	6.48E-03	6.45E-03	Unknown	6.45E-03	2.00E+02	no	
Ethylbenzene	1.75E-02	8.98E-03	Unknown	8.98E-03	2.00E+04	no	
Tetrachloroethene	1.35E-02	1.20E-02	Unknown	1.20E-02	1.10E+02	no	
Toluene	1.59E-02	1.06E-02	Unknown	1.06E-02	4.10E+04	no	
Trichloroethene	6.27E-03	6.38E-03	Unknown	2.00E-03	5.20E+02	no	
Xylenes (total)	5.01E-02	1.15E-02	Unknown	1.15E-02	4.10E+05	no	

This data set includes samples from the Process/Wood Storage and Drip Track areas.
NA - Not available
[1] The screening level of 750 mg/kg is based on US EPA's adult blood lead uptake model under default exposure assumptions
[2] These compounds have no published RBC or RfD values. They are sufficiently close in toxicity to Chlordane so that the Chlordane RBC is applicable to its congeners as a provisional benchmark.
[3] These compounds have no published RBC or RfD values. They are sufficiently close in toxicity to Endosulfan so that the Endosulfan RBC is applicable to its congeners as a provisional benchmark.
[4] These compounds have no published RBC or RfD values. They are sufficiently close in toxicity to Endrin so that the Endrin RBC is applicable to its congeners as a provisional benchmark.

Table 5
Statistical Summary and COPC Selection of Constituents in Columbia Aquifer Groundwater*
Former Koppers Company, Inc., Newport, DE

Analyte	Total # of Samples	Hits	Hit Frequency %	Minimum Detected mg/L	Mean mg/L	Lognormal Mean mg/L	Maximum Detected mg/L	Standard Deviation mg/L
Inorganics								
Aluminum	2	2	100	2.52E-01	2.73E-01	2.72E-01	2.94E-01	2.97E-02
Antimony	10	2	20	5.70E-03	2.07E-03	1.12E-03	9.00E-03	2.90E-03
Arsenic	11	1	9.09	3.30E-03	1.14E-03	9.81E-04	3.30E-03	7.75E-04
Barium	11	11	100	2.90E-02	6.75E-02	5.32E-02	2.13E-01	5.65E-02
Cadmium	12	1	8.33	2.10E-03	5.70E-04	3.83E-04	2.10E-03	5.95E-04
Cobalt	12	8	66.67	8.70E-04	4.96E-03	1.94E-03	2.82E-02	8.13E-03
Copper	11	1	9.09	1.50E-03	8.20E-04	6.21E-04	1.50E-03	6.09E-04
Iron	9	6	66.67	6.07E-01	1.21E+00	2.83E-01	3.20E+00	1.32E+00
Lead	10	2	20	5.10E-03	1.48E-03	8.45E-04	5.40E-03	1.99E-03
Manganese	16	15	93.75	2.44E-02	5.17E-01	1.39E-01	1.86E+00	6.80E-01
Nickel	11	3	27.27	7.10E-03	3.19E-03	1.26E-03	1.22E-02	4.50E-03
Selenium	11	3	27.27	3.20E-03	2.64E-03	1.60E-03	1.17E-02	3.35E-03
Vanadium	13	2	15.38	2.90E-03	8.67E-04	5.45E-04	3.40E-03	1.05E-03
Zinc	3	2	66.67	8.80E-03	9.22E-03	5.92E-03	1.75E-02	8.08E-03
Pesticides								
4,4'-DDD	3	1	33.33	1.40E-04	8.00E-05	7.05E-05	1.40E-04	5.20E-05
4,4'-DDE	3	2	66.67	1.00E-05	2.47E-05	1.91E-05	1.40E-05	2.20E-05
4,4'-DDT	3	1	33.33	5.00E-05	5.00E-05	5.00E-05	5.00E-05	0.00E+00
alpha-BHC	3	1	33.33	1.50E-06	1.72E-05	9.79E-06	1.50E-06	1.36E-05
Dieldrin	3	1	33.33	3.50E-05	4.50E-05	4.44E-05	3.50E-05	8.66E-06
Endosulfan II	3	1	33.33	2.90E-05	4.30E-05	4.17E-05	2.90E-05	1.21E-05
Endosulfan Sulfate	3	1	33.33	1.40E-05	3.80E-05	3.27E-05	1.40E-05	2.08E-05
Endrin	3	1	33.33	3.80E-05	4.60E-05	4.56E-05	3.80E-05	6.93E-06
gamma-Chlordane	3	1	33.33	1.60E-05	2.20E-05	2.15E-05	1.60E-05	5.20E-06
Heptachlor	3	1	33.33	1.80E-05	2.27E-05	2.24E-05	1.80E-05	4.04E-06
Heptachlor epoxide	3	1	33.33	6.60E-05	3.87E-05	3.46E-05	6.60E-05	2.37E-05
Semivolatiles								
Acenaphthene	17	1	5.88	3.00E-03	3.29E-03	2.15E-03	3.00E-03	2.18E-03
Benzo(a)anthracene	17	1	5.88	2.00E-03	3.47E-03	2.25E-03	2.00E-03	2.17E-03
Benzo(b)fluoranthene	17	1	5.88	1.00E-03	3.44E-03	2.31E-03	1.00E-03	2.18E-03
Benzo(k)fluoranthene	17	1	5.88	1.00E-03	3.59E-03	2.83E-03	1.00E-03	1.97E-03
bis(2-Ethylhexyl)phthalate	16	1	6.25	1.50E-02	4.22E-03	2.61E-03	1.50E-02	3.57E-03
Butylbenzylphthalate	17	1	5.88	1.00E-03	3.44E-03	2.31E-03	1.00E-03	2.18E-03
Chrysene	17	1	5.88	1.00E-03	3.59E-03	2.83E-03	1.00E-03	1.97E-03
Dibenzofuran	17	1	5.88	3.00E-03	3.47E-03	2.75E-03	3.00E-03	1.94E-03
Di-n-butylphthalate	17	1	5.88	1.00E-03	3.18E-03	2.02E-03	1.00E-03	2.25E-03
Fluoranthene	17	1	5.88	4.00E-03	3.53E-03	2.80E-03	4.00E-03	1.94E-03
Fluorene	17	1	5.88	4.00E-03	3.35E-03	2.19E-03	4.00E-03	2.18E-03
Naphthalene	17	1	5.88	2.00E-03	3.41E-03	2.68E-03	2.00E-03	1.97E-03
Phenanthrene	17	2	11.76	2.00E-03	3.85E-03	2.52E-03	1.10E-02	2.78E-03
Pyrene	17	1	5.88	1.00E-03	3.44E-03	2.31E-03	1.00E-03	2.18E-03
Volatiles								
Acetone	17	1	5.88	6.00E-03	4.62E-03	4.56E-03	6.00E-03	7.19E-04

Table 5
Statistical Summary and COPC Selection of Constituents in Columbia Aquifer Groundwater*
Former Koppers Company, Inc., Newport, DE

Analyte	95% UCL mg/L	Lognormal 95% UCL mg/L	Distribution 99% Confidence	Exposure Point Concentration mg/L	Tap Water RBC mg/L	Is Maximum Greater than RBC?	Is Detection Frequency >5%?
Inorganics							
Aluminum	4.06E-01	4.21E-01	Unknown	2.94E-01	3.70E+00	no	
Antimony	3.75E-03	5.74E-03	Unknown	5.74E-03	1.50E-03	yes	yes
Arsenic	1.56E-03	1.68E-03	Lognormal	1.68E-03	4.50E-05	yes	yes
Barium	9.84E-02	1.12E-01	Lognormal	1.12E-01	2.60E-01	no	
Cadmium	8.79E-04	1.14E-03	Unknown	1.14E-03	1.80E-03	yes	yes
Cobalt	9.18E-03	2.22E-02	Lognormal	2.22E-02	2.20E-01	no	
Copper	1.15E-03	1.66E-03	Lognormal	1.50E-03	1.50E-01	no	
Iron	2.03E+00	3.42E+03	Normal/Lognormal	3.20E+00	1.10E+00	yes	yes
Lead†	2.63E-03	3.58E-03	Unknown	3.58E-03	NA	NA	no
Manganese	8.15E-01	4.43E+01	Lognormal	1.86E+00	7.30E-02	yes	yes
Nickel	5.65E-03	1.63E-02	Unknown	1.22E-02	7.30E-02	no	
Selenium	4.47E-03	6.30E-03	Lognormal	6.30E-03	1.80E-02	no	
Vanadium	1.38E-03	1.67E-03	Unknown	1.67E-03	2.60E-02	no	
Zinc	2.28E-02	1.62E+05	Normal/Lognormal	1.75E-02	1.10E+00	no	
Pesticides							
4,4'-DDD	1.68E-04	2.17E-03	Unknown	1.40E-04	2.80E-04	no	
4,4'-DDE	6.18E-05	2.11E-02	Normal/Lognormal	1.40E-05	2.00E-04	no	
4,4'-DDT	5.00E-05	5.00E-05	Unknown	5.00E-05	2.00E-04	no	
alpha-BHC	4.00E-05	1.42E+06	Unknown	1.50E-06	1.10E-05	no	
Dieldrin	5.96E-05	7.37E-05	Unknown	3.50E-05	4.20E-06	yes	yes
Endosulfan II[1]	6.34E-05	1.13E-04	Unknown	2.90E-05	2.20E-02	no	
Endosulfan Sulfate[1]	7.30E-05	6.22E-03	Unknown	1.40E-05	2.20E-02	no	
Endrin	5.77E-05	6.49E-05	Unknown	3.80E-05	1.10E-03	no	
gamma-Chlordane[2]	3.08E-05	4.39E-05	Unknown	1.60E-05	1.90E-04	no	
Heptachlor	2.95E-05	3.52E-05	Unknown	1.80E-05	2.30E-06	yes	yes
Heptachlor epoxide	7.86E-05	7.26E-04	Unknown	6.60E-05	1.20E-06	yes	yes
Semivolatiles							
Acenaphthene	4.22E-03	8.92E-03	Unknown	3.00E-03	2.20E-01	no	
Benzo(a)anthracene	4.39E-03	1.06E-02	Unknown	2.00E-03	9.20E-05	yes	yes
Benzo(b)fluoranthene	4.36E-03	8.97E-03	Unknown	1.00E-03	9.20E-05	yes	yes
Benzo(k)fluoranthene	4.42E-03	6.21E-03	Unknown	1.00E-03	9.20E-04	yes	yes
bis(2-Ethylhexyl)phthalate	5.78E-03	1.31E-02	Unknown	1.31E-02	4.80E-03	yes	yes
Butylbenzylphthalate	4.36E-03	8.97E-03	Unknown	1.00E-03	7.30E-01	no	
Chrysene	4.42E-03	6.21E-03	Unknown	1.00E-03	9.20E-03	no	
Dibenzofuran	4.29E-03	5.90E-03	Unknown	3.00E-03	2.40E-03	yes	yes
Di-n-butylphthalate	4.13E-03	8.58E-03	Unknown	1.00E-03	3.70E-01	no	
Fluoranthene	4.35E-03	6.05E-03	Unknown	4.00E-03	1.50E-01	no	
Fluorene	4.28E-03	9.23E-03	Unknown	4.00E-03	1.50E-01	no	
Naphthalene	4.25E-03	5.79E-03	Unknown	2.00E-03	7.30E-02	no	
Phenanthrene+	5.03E-03	1.04E-02	Unknown	1.04E-02	NA	NA	no
Pyrene	4.36E-03	8.97E-03	Unknown	1.00E-03	1.10E-01	no	
Volatiles							
Acetone	4.92E-03	4.97E-03	Unknown	4.97E-03	3.70E-01	no	

* Data set includes MW-1, MW-3, MW-9, and MW-15. Metals statistics are based on filtered samples.
+Lead and phenanthrene were considered COPCs and not eliminated based on detection frequency because of their presence in other media
[1] These compounds have no published RBC or RfD values. They are sufficiently close in toxicity to Endosulfan so that the Endosulfan RBC is applicable to its congeners as a provisional benchmark.
[2] These compounds have no published RBC or RfD values. They are sufficiently close in toxicity to Chlordane so that the Chlordane RBC is applicable to its congeners as a provisional benchmark.

Table 6
Statistical Summary and COPC Selection of Constituents in Columbia Aquifer Groundwater and NAPL*
Former Koppers Company, Inc., Newport, DE

Analyte	Total # of Samples	Hits	Hit Frequency %	Minimum Detected mg/L	Mean mg/L	Lognormal Mean mg/L	Maximum Detected mg/L	Standard Deviation mg/L
Dioxins								
2,3,7,8-TCDD Equiv.	5	2	40	6.72E-06	2.37E-04	7.26E-06	1.17E-03	5.24E-04
Inorganics								
Aluminum	9	8	88.89	2.51E-02	6.07E-01	1.67E-01	9.24E-02	1.92E-01
Antimony	21	3	14.29	5.70E-03	1.51E-02	2.98E-03	1.51E-03	3.79E-03
Arsenic	25	7	28	2.20E-03	4.80E-03	1.62E-03	1.28E-03	1.21E-03
Barium	29	29	100	2.27E-02	2.34E-01	7.44E-02	5.86E-02	5.74E-02
Beryllium	17	1	5.88	2.30E-04	2.30E-04	3.55E-04	3.35E-04	1.25E-04
Cadmium	22	1	4.55	2.10E-03	2.10E-03	5.52E-04	3.90E-04	5.06E-04
Cobalt	27	23	85.19	8.70E-04	2.82E-02	9.03E-03	4.78E-03	8.30E-03
Copper	20	1	5	1.50E-03	1.50E-03	8.02E-04	6.01E-04	6.00E-04
Iron	27	24	88.89	6.07E-01	3.83E+01	1.50E+01	4.13E+00	1.41E+01
Lead	19	5	26.32	1.60E-03	5.40E-03	1.47E-03	9.48E-04	1.62E-03
Manganese	34	33	97.06	2.44E-02	9.74E+00	2.02E+00	5.61E-01	2.78E+00
Nickel	21	9	42.86	1.80E-03	1.76E-02	5.05E-03	2.12E-03	6.19E-03
Selenium	28	10	35.71	3.10E-03	3.30E-02	4.89E-03	2.28E-03	7.08E-03
Thallium	24	7	29.17	7.00E-03	1.94E-02	5.11E-03	3.66E-03	4.90E-03
Vanadium	25	8	32	9.30E-04	3.60E-03	9.98E-04	6.95E-04	9.68E-04
Zinc	7	6	85.71	7.50E-03	1.15E-01	3.05E-02	1.50E-02	3.92E-02
Pesticides								
4,4'-DDD	5	2	40	2.10E-05	6.22E-05	5.16E-05	1.40E-04	4.53E-05
4,4'-DDE	5	2	40	1.00E-05	4.48E-05	3.23E-05	1.40E-05	3.63E-05
4,4'-DDT	4	2	50	5.00E-05	5.75E-05	5.62E-05	8.00E-05	1.50E-05
alpha-BHC	5	1	20	1.50E-06	2.53E-05	1.64E-05	1.50E-06	1.72E-05
alpha-Chlordane[1]	5	1	20	1.10E-04	4.20E-05	3.36E-05	1.10E-04	3.80E-05
Dieldrin	5	1	20	3.50E-05	5.70E-05	5.35E-05	3.50E-05	2.49E-05
Endosulfan II[2]	5	1	20	2.90E-05	5.58E-05	5.15E-05	2.90E-05	2.63E-05
Endosulfan Sulfate[2]	5	1	20	1.40E-05	5.28E-05	4.45E-05	1.40E-05	3.06E-05
Endrin	5	1	20	3.80E-05	5.76E-05	5.44E-05	3.80E-05	2.43E-05
gamma-Chlordane[1]	5	1	20	1.60E-05	2.82E-05	2.63E-05	1.60E-05	1.28E-05
Heptachlor	5	1	20	1.80E-05	2.86E-05	2.69E-05	1.80E-05	1.23E-05
Heptachlor epoxide	5	1	20	6.60E-05	3.82E-05	3.49E-05	6.60E-05	1.89E-05
Semivolatiles								
2,4-Dimethylphenol	34	7	20.59	1.00E+00	1.30E+00	1.31E-02	1.50E+01	3.54E+00
2-Methylnaphthalene	34	12	35.29	5.60E-01	7.15E-01	2.00E-02	1.30E+01	2.24E+00
2-Methylphenol	34	7	20.59	4.70E-01	1.36E+00	1.19E-02	2.20E+01	4.46E+00
4-Methylphenol	34	9	26.47	1.80E-02	3.60E+00	1.89E-02	5.20E+01	1.14E+01
Acenaphthene	34	13	38.24	3.00E-03	5.12E-01	1.73E-02	1.00E+01	1.71E+00
Acenaphthylene	34	9	26.47	2.50E-02	4.21E-02	7.26E-03	5.80E-01	1.04E-01
Anthracene	34	9	26.47	2.20E-02	9.43E-02	7.83E-03	2.30E+00	3.92E-01
Benzo(a)anthracene	34	7	20.59	2.00E-03	8.00E-02	6.41E-03	2.10E+00	3.58E-01
Benzo(a)pyrene	34	3	8.82	1.30E-02	4.07E-02	6.34E-03	6.50E-01	1.15E-01
Benzo(b)fluoranthene	34	7	20.59	1.00E-03	5.05E-02	6.31E-03	1.00E+00	1.73E-01
Benzo(g,h,i)perylene	34	1	2.94	6.00E-03	3.44E-02	6.27E-03	6.00E-03	7.41E-02
Benzo(k)fluoranthene	34	3	8.82	1.00E-03	4.28E-02	7.87E-03	5.50E-01	1.04E-01
bis(2-Ethylhexyl)phthalate	33	1	3.03	1.50E-02	3.35E-02	6.96E-03	1.50E-02	6.86E-02

Table 6
Statistical Summary and COPC Selection of Constituents in Columbia Aquifer Groundwater and NAPL*
Former Koppers Company, Inc., Newport, DE

Analyte	95% UCL mg/L	Lognormal 95% UCL mg/L	Distribution 99% Confidence	Exposure Point Concentration mg/L	Tap Water RBC mg/L	Is Maximum Greater than RBC?	Is Detection Frequency >5%?
Dioxins							
2,3,7,8-TCDD Equiv	7.36E-04	4.22E+05	Lognormal	1.17E-03	NA	NA	NA
Inorganics							
Aluminum	2.86E-01	8.66E-01	Normal/Lognormal	9.24E-02	3.70E+00	no	
Antimony	4.40E-03	6.06E-03	Unknown	1.51E-03	1.50E-03	yes	yes
Arsenic	2.03E-03	2.18E-03	Lognormal	1.28E-03	4.50E-05	yes	yes
Barium	9.25E-02	9.63E-02	Lognormal	5.86E-02	2.60E-01	no	
Beryllium	4.08E-04	4.20E-04	Unknown	3.35E-04	1.60E-05	yes	yes
Cadmium	7.38E-04	8.28E-04	Unknown	3.90E-04	1.80E-03	no	
Cobalt	1.18E-02	2.52E-02	Lognormal	4.78E-03	2.20E-01	no	
Copper	1.03E-03	1.25E-03	Unknown	6.01E-04	1.50E-01	no	
Iron	1.96E+01	1.09E+03	Unknown	4.13E+00	1.10E+00	yes	yes
Lead	2.11E-03	2.33E-03	Unknown	9.48E-04	NA	NA	yes
Manganese	2.83E+00	3.07E+01	Unknown	5.61E-01	7.30E-02	yes	yes
Nickel	7.38E-03	1.53E-02	Unknown	2.12E-03	7.30E-02	no	
Selenium	7.16E-03	9.20E-03	Lognormal	2.28E-03	1.80E-02	no	
Thallium	6.82E-03	7.23E-03	Unknown	3.66E-03	2.60E-04	yes	yes
Vanadium	1.33E-03	1.47E-03	Lognormal	6.95E-04	2.60E-02	no	
Zinc	5.93E-02	6.72E-01	Normal/Lognormal	1.50E-02	1.10E+00	no	
Pesticides							
4,4'-DDD	1.05E-04	2.14E-04	Normal/Lognormal	1.40E-04	2.80E-04	no	
4,4'-DDE	7.94E-05	5.12E-04	Normal/Lognormal	1.40E-05	2.00E-04	no	
4,4'-DDT	7.51E-05	8.19E-05	Unknown	8.00E-05	2.00E-04	no	
alpha-BHC	4.17E-05	3.65E-03	Normal/Lognormal	1.50E-06	1.10E-05	no	
alpha-Chlordane[1]	7.82E-05	1.34E-04	Unknown	1.10E-04	1.90E-04	no	yes
Dieldrin	8.07E-05	9.47E-05	Normal/Lognormal	3.50E-05	4.20E-06	yes	yes
Endosulfan II[2]	8.09E-05	1.04E-04	Normal/Lognormal	2.90E-05	2.20E-02	no	
Endosulfan Sulfate[2]	8.20E-05	2.16E-04	Normal/Lognormal	1.40E-05	2.20E-02	no	
Endrin	8.07E-05	9.19E-05	Normal/Lognormal	3.80E-05	1.10E-03	no	
gamma-Chlordane[1]	4.04E-05	4.93E-05	Normal/Lognormal	1.60E-05	1.90E-04	no	
Heptachlor	4.04E-05	4.68E-05	Normal/Lognormal	1.80E-05	2.30E-06	yes	yes
Heptachlor epoxide	5.63E-05	7.54E-05	Normal/Lognormal	6.60E-05	1.20E-06	yes	yes
Semivolatiles							
2,4-Dimethylphenol	2.33E+00	4.88E+01	Unknown	1.50E+01	7.30E-02	yes	yes
2-Methylnaphthalene	1.37E+00	8.72E+01	Unknown	1.30E+01	1.20E-02	yes	yes
2-Methylphenol	2.66E+00	2.39E+01	Unknown	2.20E+01	1.80E-01	yes	yes
4-Methylphenol	6.91E+00	1.13E+02	Unknown	5.20E+01	1.80E-02	yes	yes
Acenaphthene	1.01E+00	3.31E+01	Unknown	1.00E+01	2.20E-01	yes	yes
Acenaphthylene	7.25E-02	1.84E-01	Unknown	1.84E-01	NA	NA	yes
Anthracene	2.08E-01	3.06E-01	Unknown	3.06E-01	1.10E+00	yes	yes
Benzo(a)anthracene	1.84E-01	1.70E-01	Unknown	1.70E-01	9.20E-05	yes	yes
Benzo(a)pyrene	7.43E-02	1.33E-01	Unknown	1.33E-01	9.20E-06	yes	yes
Benzo(b)fluoranthene	1.01E-01	1.30E-01	Unknown	1.30E-01	9.20E-05	yes	yes
Benzo(g,h,i)perylene†	5.59E-02	1.29E-01	Unknown	6.00E-03	NA	NA	no
Benzo(k)fluoranthene	7.29E-02	1.05E-01	Unknown	1.05E-01	9.20E-04	yes	yes
bis(2-Ethylhexyl)phthalate†	5.37E-02	1.30E-01	Unknown	1.50E-02	4.80E-03	yes	no

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Table 6
Statistical Summary and COPC Selection of Constituents in Columbia Aquifer Groundwater and NAPL*
Former Koppers Company, Inc., Newport, DE

Analyte	Total # of Samples	Hits	Hit Frequency %	Minimum Detected mg/L	Mean mg/L	Lognormal Mean mg/L	Maximum Detected mg/L	Standard Deviation mg/L
Butylbenzylphthalate	34	1	2.94	1.00E-03	3.21E-02	6.36E-03	1.00E-03	6.72E-02
Carbazole	34	12	35.29	9.00E-02	1.56E-01	1.22E-02	1.80E+00	3.43E-01
Chrysene	34	7	20.59	1.00E-03	7.33E-02	8.00E-03	1.60E+00	2.75E-01
Di-n-butylphthalate	34	1	2.94	1.00E-03	3.10E-02	5.91E-03	1.00E-03	6.45E-02
Di-n-octylphthalate	34	1	2.94	1.00E-03	2.89E-02	6.21E-03	1.00E-03	5.83E-02
Dibenzofuran	34	13	38.24	3.00E-03	3.50E-01	1.74E-02	7.20E+00	1.23E+00
Fluoranthene	34	10	29.41	4.00E-03	3.46E-01	1.19E-02	9.90E+00	1.69E+00
Fluorene	34	13	38.24	4.00E-03	3.70E-01	1.42E-02	8.60E+00	1.46E+00
Indeno(1,2,3-c,d)pyrene	34	1	2.94	5.00E-03	2.80E-02	5.89E-03	5.00E-03	5.64E-02
Naphthalene	34	16	47.06	2.00E-03	4.91E+00	4.41E-02	6.00E+01	1.14E+01
Pentachlorophenol	34	11	32.35	1.40E-03	1.41E-02	1.02E-03	6.00E-02	4.34E-02
Phenanthrene	34	14	41.18	2.00E-03	7.92E-01	1.72E-02	2.10E+01	3.58E+00
Phenol	34	11	32.35	9.00E-03	4.85E+00	2.12E-02	5.80E+01	1.34E+01
Pyrene	34	10	29.41	1.00E-03	2.29E-01	9.04E-03	6.50E+00	1.11E+00
Volatiles								
1,1,2-Trichloroethane	40	1	2.5	5.30E-02	2.80E-03	5.76E-03	5.30E-02	1.08E-02
2-Hexanone	40	1	2.5	1.00E-02	3.90E-03	5.49E-03	1.00E-02	7.79E-03
4-Methyl-2-Pentanone	40	1	2.5	3.00E-03	3.99E-03	5.64E-03	3.00E-03	8.16E-03
Acetone	33	6	18.18	6.00E-03	8.35E-03	6.08E-03	2.00E-02	9.78E-03
Benzene	31	7	22.58	1.50E-02	8.63E-02	6.64E-03	9.20E-01	2.30E-01
Chlorobenzene	35	1	2.86	3.00E-03	4.69E-03	2.39E-03	3.00E-03	8.17E-03
Ethylbenzene	35	13	37.14	4.00E-03	4.90E-02	8.38E-03	4.10E-01	9.32E-02
Methylene Chloride	31	1	3.23	2.00E-03	4.68E-03	2.40E-03	2.00E-03	8.66E-03
Styrene	35	10	28.57	2.00E-03	3.29E-02	4.63E-03	5.20E-01	9.83E-02
Toluene	35	13	37.14	2.00E-03	1.17E-01	7.25E-03	1.50E+00	3.32E-01
Xylenes (total)	34	13	38.24	1.20E-02	1.77E-01	1.34E-02	1.90E+00	3.87E-01

Table 6
Statistical Summary and COPC Selection of Constituents in Columbia Aquifer Groundwater and NAPL*
Former Koppers Company, Inc., Newport, DE

Analyte	95% UCL mg/L	Lognormal 95% UCL mg/L	Distribution 99% Confidence	Exposure Point Concentration mg/L	Tap Water RBC mg/L	Is Maximum Greater than RBC?	Is Detection Frequency >5%?
Butylbenzylphthalate	5.16E-02	1.14E-01	Unknown	1.00E-03	7.30E-01	no	
Carbazole	2.56E-01	2.96E+00	Unknown	1.80E+00	3.30E-03	yes	yes
Chrysene	1.53E-01	1.32E-01	Unknown	1.32E-01	9.20E-03	yes	yes
Di-n-butylphthalate	4.98E-02	1.20E-01	Unknown	1.00E-03	3.70E-01	no	
Di-n-octylphthalate	4.59E-02	1.01E-01	Unknown	1.00E-03	7.30E-02	no	
Dibenzofuran	7.08E-01	5.69E+00	Unknown	5.69E+00	2.40E-03	yes	yes
Fluoranthene	8.39E-01	8.18E-01	Unknown	8.18E-01	1.50E-01	yes	yes
Fluorene	7.96E-01	8.19E+00	Unknown	8.19E+00	1.50E-01	yes	yes
Indeno(1,2,3-c,d)pyrene†	4.44E-02	1.01E-01	Unknown	5.00E-03	9.20E-05	yes	no
Naphthalene	8.23E+00	2.33E+04	Unknown	6.00E+01	7.30E-02	yes	yes
Pentachlorophenol	2.67E-02	1.88E-01	Unknown	6.00E-02	5.60E-04	yes	yes
Phenanthrene	1.83E+00	1.85E+01	Unknown	1.85E+01	NA	NA	yes
Phenol	8.76E+00	4.65E+02	Unknown	5.80E+01	2.20E+00	yes	yes
Pyrene	5.52E-01	6.37E-01	Unknown	6.37E-01	1.10E-01	yes	yes
Volatiles							
1,1,2-Trichloroethane	8.67E-03	8.60E-03	Unknown	8.60E-03	1.90E-04	yes	no
2-Hexanone	7.58E-03	6.43E-03	Unknown	6.43E-03	NA	NA	no
4-Methyl-2-Pentanone	7.83E-03	6.45E-03	Unknown	3.00E-03	2.90E-01	no	
Acetone	1.12E-02	9.78E-03	Unknown	9.78E-03	3.70E-01	no	
Benzene	1.56E-01	2.64E-01	Unknown	2.64E-01	3.60E-04	yes	yes
Chlorobenzene	7.03E-03	8.66E-03	Unknown	3.00E-03	3.50E-03	no	
Ethylbenzene	7.58E-02	1.79E-01	Unknown	1.79E-01	1.30E-01	yes	yes
Methylene Chloride	7.32E-03	8.02E-03	Unknown	2.00E-03	4.10E-03	no	
Styrene	6.11E-02	6.49E-02	Unknown	6.49E-02	1.60E-01	yes	yes
Toluene	2.12E-01	5.48E-01	Unknown	5.48E-01	7.50E-02	yes	yes
Xylenes (total)	2.90E-01	2.39E+00	Unknown	1.90E+00	1.20E+00	yes	yes

* Data set includes MW-1, MW-2, MW-3, MW-8, MW-9, and MW-15. Metals statistics are based on filtered samples.
NA - Not available
† Benzo(ghi)perylene, bis(2-ethylhexyl)phthalate, and indeno(1,2,3-cd)pyrene were considered COPCs and not eliminated based on detection frequency because of their presence in other media.
[1] These compounds have no published RBC or RfD values. They are sufficiently close in toxicity to Chlordane so that the Chlordane RBC is applicable to its congeners as a provisional benchmark.
[2] These compounds have no published RBC or RfD values. They are sufficiently close in toxicity to Endosulfan so that the Endosulfan RBC is applicable to its congeners as a provisional benchmark.

Table 7
Statistical Summary and COPC Selection of Constituents in Potomac Aquifer Groundwater*
Former Koppers Company, Inc., Newport, DE

Analyte	Total # of Samples	Hits	Hit Frequency %	Minimum Detected mg/L	Mean mg/L	Lognormal Mean mg/L	Maximum Detected mg/L	Standard Deviation mg/L	95% UCL mg/L	Lognormal 95% UCL mg/L	Distribution 99% Confidence	Exposure Point Concentration mg/L	Tap Water RBC mg/L	Is Maximum Greater than RBC?	Is Detection Frequency >5%?
Inorganics															
Antimony	3	2	66.67	2.10E-03	1.80E-03	1.69E-03	2.30E-03	7.00E-04	2.98E-03	1.28E-02	Normal/Lognormal	2.30E-03	1.50E-03	yes	yes
Barium	2	2	100	9.40E-03	9.80E-03	9.79E-03	1.02E-02	5.66E-04	1.23E-02	1.20E-02	Unknown	1.02E-02	2.60E-01	no	
Cobalt	3	1	33.33	1.20E-03	6.90E-04	6.10E-04	1.20E-03	4.42E-04	1.43E-03	1.70E-02	Unknown	1.20E-03	2.20E-01	no	
Iron	2	[illegible]	100	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Unknown	[illegible]	[illegible]	no	
Lead	3	1	33.33	3.50E-03	1.50E-03	9.56E-04	3.50E-03	1.73E-03	4.42E-03	2.07E+02	Unknown	3.50E-03	NA	NA	yes
Manganese	3	3	100	2.90E-02	3.77E-02	3.65E-02	5.15E-02	1.21E-02	5.81E-02	9.30E-02	Normal/Lognormal	5.15E-02	7.30E-02	no	
Selenium	3	1	33.33	3.60E-03	1.70E-03	1.22E-03	3.60E-03	1.66E-03	4.51E-03	2.10E+01	Normal/Lognormal	3.60E-03	1.80E-02	no	
Pesticides															
4,4'-DDD	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	1.08E+45	Unknown	2.90E-06	2.80E-04	no	
4,4'-DDT	2	[illegible]	50	1.70E-05	3.35E-05	2.92E-05	1.70E-05	2.33E-05	1.38E-04	3.40E+02	Unknown	1.70E-05	2.00E-04	no	
Endosulfan I[1]	2	1	50	3.10E-06	1.41E-05	8.80E-06	3.10E-06	1.55E-05	8.32E-05	5.70E+21	Unknown	3.10E-06	2.20E-02	no	
Endosulfan II[1]	2	1	50	5.70E-06	2.79E-05	1.69E-05	5.70E-06	3.13E-05	1.68E-04	1.77E+24	Unknown	5.70E-06	2.20E-02	no	
Heptachlor epoxide	2	2	100	5.90E-06	6.00E-06	6.00E-06	6.10E-06	1.41E-07	6.63E-06	6.50E-06	Unknown	6.10E-06	1.20E-06	yes	yes

* Data set includes MW-15. Metals statistics are based on filtered samples.
[1] These compounds have no published RBC or RfD values. They are sufficiently close in toxicity to Endosulfan so that the Endosulfan RBC is applicable to its congeners as a provisional benchmark.

Table 8
Statistical Summary and COPC Selection for Trespasser Exposed to Surface Soils (0-12" bgs)
Former Koppers Company, Inc., Newport, DE

Analyte	Total # of Samples	Hits	Hit Frequency %	Minimum Detected mg/kg	Mean mg/kg	Lognormal Mean mg/kg	Maximum Detected mg/kg	Standard Deviation mg/kg
Dioxins								
2,3,7,8-TCDD Equiv.	18	18	100	9.31E-05	1.75E-03	7.21E-04	7.34E-03	2.35E-03
Inorganics								
Aluminum	72	72	100	2.07E-03	1.48E+04	1.27E+04	3.65E+04	8.29E+03
Antimony	43	19	44.19	6.50E-01	9.35E+00	2.10E+00	1.21E+01	1.32E+01
Arsenic	66	64	96.97	1.20E+00	6.99E+00	5.54E+00	3.19E+01	5.39E+00
Barium	72	72	100	2.11E+01	3.85E+02	2.52E+02	1.65E+03	3.71E+02
Beryllium	68	68	100	2.60E-01	1.36E+00	1.11E+00	3.90E+00	9.07E-01
Cadmium	71	41	57.75	8.00E-02	1.40E+00	8.87E-01	3.40E+00	1.05E+00
Chromium	72	72	100	3.70E+00	2.33E+01	2.03E+01	1.19E+02	1.53E+01
Cobalt	69	61	88.41	6.10E-01	7.12E+00	4.50E+00	4.64E+01	7.11E+00
Copper	70	70	100	5.30E+00	3.93E+01	2.34E+01	5.28E+02	7.11E+01
Iron	72	72	100	4.43E+03	1.75E+04	1.65E+04	3.12E+04	5.40E+03
Lead[1]	72	72	100	3.80E+00	5.81E+01	3.86E+01	4.77E+02	7.45E+01
Manganese	72	72	100	4.06E+01	1.70E+03	6.78E+02	9.81E+03	2.45E+03
Mercury	59	31	52.54	5.00E-02	1.17E+00	2.10E-01	1.96E+01	3.09E+00
Nickel	67	67	100	4.00E+00	1.22E+01	1.08E+01	5.18E+01	7.96E+00
Selenium	65	14	21.54	8.60E-01	1.69E+00	1.23E+00	3.30E+00	9.92E-01
Silver	72	2	2.78	1.10E+00	3.47E+00	1.50E+00	1.50E+00	2.26E+00
Thallium	68	22	32.35	1.60E+00	5.18E+00	3.30E+00	4.44E+01	6.19E+00
Vanadium	72	71	98.61	7.60E+00	7.05E+01	4.93E+01	3.06E+02	7.38E+01
Zinc	72	72	100	6.40E+00	9.35E+01	6.77E+01	8.74E+02	1.11E+02
PCBs/Pesticides								
4,4'-DDD	16	4	25	3.80E-03	7.88E-02	1.76E-02	1.00E-01	9.23E-02
4,4'-DDE	17	8	47.06	2.20E-04	2.55E-02	7.47E-03	2.40E-01	5.71E-02
4,4'-DDT	15	7	46.67	6.90E-03	2.79E-02	1.17E-02	1.20E-01	4.04E-02
alpha-Chlordane[2]	17	3	17.65	1.80E-04	3.45E-02	6.57E-03	2.80E-02	4.75E-02
Dieldrin	15	5	33.33	3.10E-04	6.10E-02	1.18E-02	2.70E-02	9.05E-02
Endosulfan II[3]	17	2	11.76	4.50E-04	6.45E-02	1.24E-02	4.70E-03	9.26E-02
Endrin	17	1	5.88	1.10E-01	5.99E-02	1.38E-02	1.10E-01	8.70E-02
Endrin ketone[4]	17	2	11.76	2.90E-02	5.73E-02	1.34E-02	4.70E-02	8.68E-02
gamma-Chlordane[2]	17	1	5.88	1.10E-04	3.35E-02	6.31E-03	1.10E-04	4.79E-02
Heptachlor	17	1	5.88	5.30E-03	2.80E-02	6.16E-03	5.30E-03	4.50E-02
Heptachlor epoxide	17	2	11.76	1.00E-02	2.27E-02	5.77E-03	2.00E-02	3.89E-02
Methoxychlor	16	5	31.25	4.20E-02	2.11E-01	6.59E-02	9.20E-01	3.35E-01
PCB-1254	17	1	5.88	4.02E-02	6.50E-01	1.47E-01	4.02E-02	9.23E-01
PCB-1260	18	4	22.22	8.30E-03	6.36E-01	1.50E-01	3.40E-01	8.96E-01
Semivolatiles								
2,4-Dimethylphenol	72	1	1.39	3.60E-02	1.75E+01	2.08E+00	3.60E-02	5.80E+01
2-Methylnaphthalene	72	16	22.22	9.80E-02	8.71E+01	2.39E+00	2.90E+03	3.90E+02
4-Methylphenol	72	2	2.78	7.20E-02	1.41E+01	2.06E+00	1.10E+02	4.33E+01
Acenaphthene	72	19	26.39	4.30E-02	1.14E+02	2.23E+00	3.10E+03	4.85E+02
Acenaphthylene	72	22	30.56	1.50E-01	1.37E+01	2.32E+00	8.20E+01	4.21E+01
Anthracene	72	47	65.28	5.30E-02	5.50E+02	4.12E+00	1.50E+04	2.24E+03
Benzo(a)anthracene	72	65	90.28	9.30E-02	8.87E+01	1.25E+01	1.20E+03	2.10E+02
Benzo(a)pyrene	72	64	88.89	8.10E-02	5.64E+01	9.87E+00	5.50E+02	1.10E+02
Benzo(b)fluoranthene	72	66	91.67	1.60E-01	9.74E+01	1.89E+01	7.50E+02	1.62E+02
Benzo(g,h,i)perylene	72	62	86.11	1.20E-01	2.87E+01	6.95E+00	2.40E+02	4.82E+01
Benzo(k)fluoranthene	72	62	86.11	4.60E-02	3.82E+01	6.64E+00	4.70E+02	7.66E+01
bis(2-Ethylhexyl)phthalate	70	4	5.71	6.70E-02	1.80E+01	2.17E+00	5.30E-01	5.88E+01

Table 8
Statistical Summary and COPC Selection for Trespasser Exposed to Surface Soils (0-12" bgs)
Former Koppers Company, Inc., Newport, DE

Analyte	95% UCL mg/kg	Lognormal 95% UCL mg/kg	Distribution 99% Confidence	Exposure Point Concentration mg/kg	Industrial Soil RBC mg/kg	Is Maximum >RBC?	Is Detection Frequency >5%?
Dioxins							
2,3,7,8-TCDD Equiv.	2.72E-03	6.56E-03	Lognormal	6.56E-03	3.80E-05	yes	yes
Inorganics							
Aluminum	1.64E+04	1.70E+04	Unknown	1.70E+04	2.00E+05	no	
Antimony	1.27E+01	3.07E+01	Unknown	1.21E+01	8.20E+01	no	
Arsenic	8.10E+00	8.40E+00	Unknown	8.40E+00	3.80E+00	yes	yes
Barium	4.59E+02	5.08E+02	Unknown	5.08E+02	1.40E+04	no	
Beryllium	1.55E+00	1.59E+00	Unknown	1.59E+00	4.10E+02	no	
Cadmium	1.61E+00	2.20E+00	Unknown	2.20E+00	2.00E+02	no	
Chromium	2.63E+01	2.61E+01	Unknown	2.61E+01	3.10E+05	no	
Cobalt	8.55E+00	1.42E+01	Unknown	1.42E+01	1.20E+04	no	
Copper	5.35E+01	4.21E+01	Unknown	4.21E+01	8.20E+03	no	
Iron	1.85E+04	1.90E+04	Unknown	1.90E+04	6.10E+04	no	
Lead[1]	7.28E+01	6.91E+01	Unknown	6.91E+01	7.50E+02	no	
Manganese	2.18E+03	2.61E+03	Unknown	2.61E+03	2.90E+04	no	
Mercury	1.85E+00	1.37E+00	Unknown	1.37E+00	6.10E+01	no	
Nickel	1.38E+01	1.34E+01	Unknown	1.34E+01	4.10E+03	no	
Selenium	1.90E+00	2.50E+00	Unknown	2.50E+00	1.00E+03	no	
Silver	3.91E+00	1.59E+01	Unknown	1.50E+00	1.00E+03	no	
Thallium	6.43E+00	7.12E+00	Unknown	7.12E+00	1.40E+01	yes	yes
Vanadium	8.51E+01	8.23E+01	Unknown	8.23E+01	1.40E+03	no	
Zinc	1.15E+02	1.08E+02	Unknown	1.08E+02	6.10E+04	no	
PCBs/Pesticides							
4,4'-DDD	1.19E-01	2.43E+00	Unknown	1.00E-01	2.40E+01	no	
4,4'-DDE	4.97E-02	1.24E-01	Lognormal	1.24E-01	1.70E+01	no	
4,4'-DDT	4.62E-02	1.04E-01	Lognormal	1.04E-01	1.70E+01	no	
alpha-Chlordane[2]	5.46E-02	9.82E-01	Lognormal	2.80E-02	1.60E+01	no	
Dieldrin	1.02E-01	1.75E+00	Lognormal	2.70E-02	3.60E-01	no	
Endosulfan II	1.04E-01	1.16E+00	Lognormal	4.70E-03	1.20E+03	no	
Endrin	9.67E-02	6.18E-01	Unknown	1.10E-01	6.10E+01	no	
Endrin ketone	9.41E-02	5.26E-01	Unknown	4.70E-02	6.10E+01	no	
gamma-Chlordane[2]	5.37E-02	8.44E-01	Lognormal	1.10E-04	4.40E+00	no	
Heptachlor	4.70E-02	2.11E-01	Unknown	5.30E-03	1.30E+00	no	
Heptachlor epoxide	3.91E-02	1.27E-01	Lognormal	2.00E-02	6.30E-01	no	
Methoxychlor	3.58E-01	1.14E+00	Lognormal	9.20E-01	1.00E+03	no	
PCB-1254	1.04E+00	6.99E+00	Unknown	4.02E-02	2.90E+00	no	
PCB-1260	1.00E+00	7.51E+00	Lognormal	3.40E-01	2.90E+00	no	
Semivolatiles							
2,4-Dimethylphenol	2.90E+01	3.10E+01	Unknown	3.60E-02	4.10E+03	no	
2-Methylnaphthalene	1.64E+02	8.69E+01	Unknown	8.69E+01	4.10E+03	no	
4-Methylphenol	2.27E+01	2.65E+01	Unknown	2.65E+01	1.00E+03	no	
Acenaphthene	[illegible].10E+02	1.20E+02	Unknown	1.20E+02	1.20E+04	no	
Acenaphthylene	2.20E+01	2.52E+01	Unknown	2.52E+01	NA	NA	yes
Anthracene	[illegible].91E+02	8.14E+02	Unknown	8.14E+02	6.10E+04	no	
Benzo(a)anthracene	1.30E+02	5.64E+02	Unknown	5.64E+02	7.80E+00	yes	yes
Benzo(a)pyrene	7.81E+01	3.59E+02	Unknown	3.59E+02	7.80E-01	yes	yes
Benzo(b)fluoranthene	1.29E+02	8.56E+02	Unknown	7.50E+02	7.80E+00	yes	yes
Benzo(g,h,i)perylene	5.82E+01	1.32E+02	Unknown	1.32E+02	NA	NA	yes
Benzo(k)fluoranthene	5.33E+01	2.36E+02	Unknown	2.36E+02	7.80E+01	yes	yes
bis(2-Ethylhexyl)phthalate	[illegible].98E+01	3.21E+01	Unknown	5.30E-01	4.10E+02	no	

Table 8
Statistical Summary and COPC Selection for Trespasser Exposed to Surface Soils (0-12" bgs)
Former Koppers Company, Inc., Newport, DE

Analyte	Total # of Samples	Hits	Hit Frequency %	Minimum Detected mg/kg	Mean mg/kg	Lognormal Mean mg/kg	Maximum Detected mg/kg	Standard Deviation mg/kg
Butylbenzylphthalate	73	4	5.48	4.70E-02	1.78E+01	2.13E+00	1.70E-01	5.77E+01
Carbazole	72	38	52.78	4.00E-02	2.65E+02	2.68E+00	8.70E+03	1.19E+03
Chrysene	72	65	90.28	1.60E-01	8.70E+01	1.32E+01	1.10E+03	1.92E+02
Dibenz(a,h)anthracene	72	49	68.06	6.30E-02	1.87E+01	3.03E+00	8.10E+01	5.76E+01
Dibenzofuran	72	22	30.56	5.40E-02	1.11E+02	2.35E+00	3.20E+03	4.71E+02
Di-n-butylphthalate	72	6	8.33	1.20E-01	1.81E+01	2.29E+00	5.80E-01	5.80E+01
Fluoranthene	72	68	94.44	9.40E-02	2.26E+02	1.75E+01	4.70E+03	7.30E+02
Fluorene	72	21	29.17	4.70E-02	1.95E+02	2.40E+00	5.60E+03	8.35E+02
Indeno(1,2,3-c,d)pyrene	73	65	89.04	5.80E-02	3.33E+01	7.86E+00	2.70E+02	5.42E+01
Naphthalene	72	25	34.72	6.20E-02	1.04E+02	2.41E+00	3.50E+03	4.74E+02
Pentachlorophenol	72	12	16.67	2.10E-01	4.04E+01	4.83E+00	1.20E+02	1.42E+02
Phenanthrene	69	56	81.16	1.30E-01	3.68E+02	4.74E+00	8.80E+03	1.52E+03
Phenol	72	1	1.39	7.70E+01	1.37E+01	2.08E+00	7.70E+01	4.24E+01
Pyrene	72	67	93.06	2.10E-01	2.12E+02	1.89E+01	3.60E+03	6.29E+02
Volatiles								
1,1,2,2-Tetrachloroethane	43	2	4.65	1.00E-01	1.52E-02	7.14E-03	3.00E-01	4.67E-02
2-Butanone	41	2	4.88	6.00E-03	6.85E-03	6.33E-03	3.80E-02	5.02E-03
Acetone	40	9	22.5	3.00E-03	1.28E-02	7.20E-03	1.50E-01	2.60E-02
Benzene	41	1	2.44	1.10E-02	6.27E-03	6.20E-03	1.10E-02	1.02E-03
Ethylbenzene	41	4	9.76	1.00E-03	1.07E-02	6.30E-03	2.00E-01	3.03E-02
Tetrachloroethene	41	28	68.29	4.00E-03	1.17E-02	8.73E-03	7.40E-02	1.27E-02
Toluene	41	17	41.46	1.00E-03	1.10E-02	7.08E-03	1.50E-01	2.28E-02
Xylenes (total)	41	7	17.07	3.30E-03	2.43E-02	6.90E-03	7.40E-01	1.15E-01

Table 8

Statistical Summary and COPC Selection for Trespasser Exposed to Surface Soils (0-12" bgs)

Former Koppers Company, Inc., Newport, DE

Analyte	95% UCL mg/kg	Lognormal 95% UCL mg/kg	Distribution 99% Confidence	Exposure Point Concentration mg/kg	Industrial Soil RBC mg/kg	Is Maximum >RBC?	Is Detection Frequency >5%?
Butylbenzylphthalate	2.91E+01	3.44E+01	Unknown	1.70E-01	4.10E+04	no	
Carbazole	4.99E+02	2.99E+02	Unknown	2.99E+02	2.90E+02	yes	yes
Chrysene	1.25E+02	5.85E+02	Unknown	5.85E+02	7.80E+02	yes	yes
Dibenz(a,h)anthracene	3.00E+01	3.95E+01	Unknown	3.95E+01	7.80E-01	yes	yes
Dibenzofuran	2.04E+02	1.24E+02	Unknown	1.24E+02	8.20E+02	yes	yes
Di-n-butylphthalate	2.95E+01	3.15E+01	Unknown	5.80E-01	2.00E+04	no	
Fluoranthene	3.70E+02	1.52E+03	Unknown	1.52E+03	8.20E+03	no	
Fluorene	3.60E+02	2.29E+02	Unknown	2.29E+02	8.20E+03	no	
Indeno(1,2,3-c,d)pyrene	4.39E+01	1.90E+02	Unknown	1.90E+02	7.80E+00	yes	yes
Naphthalene	1.97E+02	1.22E+02	Unknown	1.22E+02	4.10E+03	no	
Pentachlorophenol	6.83E+01	6.62E+01	Unknown	6.62E+01	4.80E+01	yes	yes
Phenanthrene	6.74E+02	4.93E+02	Unknown	4.93E+02	NA	NA	yes
Phenol	2.20E+01	2.47E+01	Unknown	2.47E+01	1.20E+05	no	
Pyrene	3.36E+02	1.44E+03	Unknown	1.44E+03	6.10E+03	no	
Volatiles							
1,1,2,2-Tetrachloroethane	2.72E-02	1.18E-02	Unknown	1.18E-02	2.90E+01	no	
2-Butanone	8.17E-03	7.20E-03	Unknown	7.20E-03	1.00E+05	no	
Acetone	1.98E-02	1.28E-02	Unknown	1.28E-02	2.00E+04	no	
Benzene	6.54E-03	6.50E-03	Unknown	6.50E-03	2.00E+02	no	
Ethylbenzene	1.87E-02	9.40E-03	Unknown	9.40E-03	2.00E+04	no	
Tetrachloroethene	1.50E-02	1.38E-02	Unknown	1.38E-02	1.10E+02	no	
Toluene	1.70E-02	1.13E-02	Unknown	1.13E-02	4.10E+04	no	
Xylenes (total)	5.44E-02	1.23E-02	Unknown	1.23E-02	4.10E+05	no	

This data set includes samples from all on-site areas and Hershey Run sediment.

NA Not available

[1] The screening level of 750 mg/kg is based on US EPA's adult blood lead uptake model under default exposure assumptions.

[2] These compounds have no published RBC or RfD values. They are sufficiently close in toxicity to Chlordane so that the Chlordane RBC is applicable to its congeners as a provisional benchmark.

[3] These compounds have no published RBC or RfD values. They are sufficiently close in toxicity to Endosulfan so that the Endosulfan RBC is applicable to its congeners as a provisional benchmark.

[4] These compounds have no published RBC or RfD values. They are sufficiently close in toxicity to Endrin so that the Endrin RBC is applicable to its congeners as a provisional benchmark.

Table 9
Statistical Summary and COPC Selection for Trespasser Exposed to Surface Soils and NAPL (0-12" bgs)
Former Koppers Company, Inc., Newport, DE

Analyte	Total # of Samples	Hits	Hit Frequency %	Minimum Detected mg/kg	Mean mg/kg	Lognormal Mean mg/kg	Maximum Detected mg/kg	Standard Deviation mg/kg
Dioxins								
2,3,7,8-TCDD Equiv.	18	18	100	9.31E-05	1.75E-03	7.21E-04	7.34E-03	2.35E-03
Inorganics								
Aluminum	114	114	100	2.07E+03	1.39E+04	1.22E+04	3.65E+04	7.35E+03
Antimony	82	25	30.49	6.50E-01	5.59E+00	1.37E+00	1.21E+01	1.04E+01
Arsenic	108	106	98.15	1.20E+00	6.63E+00	5.27E+00	3.19E+01	5.30E+00
Barium	114	114	100	2.04E+01	3.42E+02	2.25E+02	1.65E+03	3.29E+02
Beryllium	100	98	98	2.00E-01	1.23E+00	9.53E-01	3.90E+00	8.81E-01
Cadmium	110	50	45.45	8.00E-02	1.06E+00	5.35E-01	3.40E+00	1.00E+00
Chromium	114	114	100	3.70E+00	2.60E+01	2.13E+01	2.44E+02	2.67E+01
Cobalt	111	102	91.89	6.10E-01	6.84E+00	4.89E+00	4.64E+01	6.05E+00
Copper	112	112	100	9.10E-01	3.57E+01	2.10E+01	5.28E+02	6.16E-01
Iron	114	114	100	4.43E+03	1.83E+04	1.69E+04	7.73E+04	8.25E+03
Lead[1]	114	114	100	2.30E+00	6.23E+01	3.51E+01	8.92E+02	1.06E+02
Manganese	114	114	100	4.06E+01	1.40E+03	6.21E+02	9.81E+03	2.10E+03
Mercury	82	53	64.63	1.50E-02	8.88E-01	1.68E-01	1.96E+01	2.66E+00
Nickel	103	103	100	4.00E+00	1.24E+01	1.11E+01	5.18E+01	6.96E+00
Selenium	107	26	24.3	8.50E-01	1.25E+00	8.65E-01	3.30E+00	9.70E-01
Silver	112	3	2.68	2.10E-01	2.28E+00	5.98E-01	1.50E+00	2.41E+00
Thallium	110	32	29.09	8.40E-01	3.49E+00	1.75E+00	4.44E+01	5.33E+00
Vanadium	114	113	99.12	7.60E+00	6.00E+01	4.45E+01	3.06E+02	6.19E+01
Zinc	111	111	100	6.40E+00	9.38E+01	6.83E+01	8.74E+02	1.05E+02
PCBs/Pesticides								
4,4'-DDD	16	4	25	3.80E-03	7.88E-02	1.76E-02	1.00E-01	9.23E-02
4,4'-DDE	17	8	47.06	2.20E-04	2.55E-02	7.47E-03	2.40E-01	5.71E-02
4,4'-DDT	15	7	46.67	6.90E-03	2.79E-02	1.17E-02	1.20E-01	4.04E-02
alpha-Chlordane[2]	17	3	17.65	1.80E-04	3.45E-02	6.57E-03	2.80E-02	4.75E-02
Dieldrin	15	5	33.33	3.10E-04	6.10E-02	1.18E-02	2.70E-02	9.05E-02
Endosulfan II[3]	17	2	11.76	4.50E-04	6.45E-02	1.24E-02	4.70E-03	9.26E-02
Endrin	17	1	5.88	1.10E-01	5.99E-02	1.38E-02	1.10E-01	8.70E-02
Endrin ketone[4]	17	2	11.76	2.90E-02	5.73E-02	1.34E-02	4.70E-02	8.68E-02
gamma-Chlordane[2]	17	1	5.88	1.10E-04	3.35E-02	6.31E-03	1.10E-04	4.79E-02
Heptachlor	17	1	5.88	5.30E-03	2.80E-02	6.16E-03	5.30E-03	4.50E-02
Heptachlor epoxide	17	2	11.76	1.00E-02	2.27E-02	5.77E-03	2.00E-02	3.89E-02
Methoxychlor	16	5	31.25	4.20E-02	2.11E-01	6.59E-02	9.20E-01	3.35E-01
PCB-1254	17	1	5.88	4.02E-02	6.50E-01	1.47E-01	4.02E-02	9.23E-01
PCB-1260	18	4	22.22	8.30E-03	6.36E-01	1.50E-01	3.40E-01	8.96E-01
Semivolatiles								
2,4-Dimethylphenol	114	4	3.51	3.60E-02	1.18E+01	1.10E+00	1.20E+01	4.68E+01
2-Methylnaphthalene	114	33	28.95	4.10E-02	7.03E+01	1.29E+00	2.90E+03	3.40E+02
4-Methylphenol	114	6	5.26	4.20E-02	9.81E+00	1.09E+00	1.10E+02	3.52E+01
Acenaphthene	114	41	35.96	4.30E-02	1.09E+02	1.18E+00	3.10E+03	4.80E+02
Acenaphthylene	114	53	46.49	5.50E-02	1.11E+01	1.44E+00	1.30E+02	3.67E+01
Anthracene	114	80	70.18	4.60E-02	4.37E+02	2.28E+00	1.50E+04	1.97E+03
Benzo(a)anthracene	114	105	92.11	3.50E-02	8.82E+01	7.05E+00	1.60E+03	2.65E+02
Benzo(a)pyrene	114	103	90.35	4.00E-02	5.25E+01	6.19E+00	7.40E+02	1.28E+02
Benzo(b)fluoranthene	114	106	92.98	1.00E-01	9.14E+01	1.22E+01	1.20E+03	2.01E+02
Benzo(g,h,i)perylene	114	100	87.72	4.70E-02	2.54E+01	4.41E+00	2.70E+02	5.18E+01
Benzo(k)fluoranthene	114	95	83.33	4.60E-02	3.24E+01	3.70E+00	4.70E+02	8.02E+01
bis(2-Ethylhexyl)phthalate	78	4	5.13	6.70E-02	1.63E+01	1.93E+00	5.30E-01	5.59E+01
Butylbenzylphthalate	115	10	8.7	4.70E-02	1.22E+01	1.10E+00	1.70E-01	4.67E+01

Table 9
Statistical Summary and COPC Selection for Trespasser Exposed to Surface Soils and NAPL (0-12" bgs)
Former Koppers Company, Inc., Newport, DE

Analyte	95% UCL mg/kg	Lognormal 95% UCL mg/kg	Distribution 99% Confidence	Exposure Point Concentration mg/kg	Industrial Soil RBC mg/kg	Is Maximum >RBC?	Is Detection Frequency >5%?
Dioxins							
2,3,7,8-TCDD Equiv.	2.72E-03	6.56E-03	Lognormal	6.56E-03	3.80E-05	yes	yes
Inorganics							
Aluminum	1.50E+04	1.52E+04	Unknown	1.52E+04	2.00E+05	no	
Antimony	7.50E+00	7.65E+00	Unknown	7.65E+00	8.20E+01	no	
Arsenic	7.48E+00	7.48E+00	Unknown	7.48E+00	3.80E+00	yes	yes
Barium	3.93E+02	4.24E+02	Unknown	4.24E+02	1.40E+04	no	
Beryllium	1.38E+00	1.47E+00	Unknown	1.47E+00	4.10E+02	no	
Cadmium	1.22E+00	1.96E+00	Unknown	1.96E+00	2.00E+02	no	
Chromium	3.02E+01	2.75E+01	Unknown	2.75E+01	3.10E+05	no	
Cobalt	7.80E+00	1.04E+01	Unknown	1.04E+01	1.20E+04	no	
Copper	4.55E+01	3.83E+01	Unknown	3.83E+01	8.20E+03	no	
Iron	1.95E+04	1.94E+04	Unknown	1.94E+04	6.10E+04	yes	yes
Lead[1]	7.89E+01	7.05E+01	Unknown	7.05E+01	7.50E+02	yes	yes
Manganese	1.73E+03	1.75E+03	Unknown	1.75E+03	2.90E+04	no	
Mercury	1.38E+00	8.50E-01	Unknown	8.50E-01	6.10E+01	no	
Nickel	1.35E+01	1.32E+01	Unknown	1.32E+01	4.10E+03	no	
Selenium	1.41E+00	1.58E+00	Unknown	1.58E+00	1.00E+03	no	
Silver	2.66E+00	7.54E+00	Unknown	1.50E+00	1.00E+03	no	
Thallium	4.34E+00	4.50E+00	Unknown	4.50E+00	1.40E+01	yes	yes
Vanadium	6.97E+01	6.48E+01	Unknown	6.48E+01	1.40E+03	no	
Zinc	1.10E+02	1.04E+02	Unknown	1.04E+02	6.10E+04	no	
PCBs/Pesticides							
4,4'-DDD	1.19E-01	2.43E+00	Unknown	1.00E-01	2.40E+01	no	
4,4'-DDE	4.97E-02	1.24E-01	Lognormal	1.24E-01	1.70E+01	no	
4,4'-DDT	4.62E-02	1.04E-01	Lognormal	1.04E-01	1.70E+01	no	
alpha-Chlordane[2]	5.46E-02	9.82E-01	Lognormal	2.80E-02	1.60E+01	no	
Dieldrin	1.02E-01	1.75E+00	Lognormal	2.70E-02	3.60E-01	no	
Endosulfan II[3]	1.04E-01	1.16E+00	Lognormal	4.70E-03	1.20E+03	no	
Endrin	9.67E-02	6.18E-01	Unknown	1.10E-01	6.10E+01	no	
Endrin ketone[4]	9.41E-02	5.26E-01	Unknown	4.70E-02	6.10E+01	no	
gamma-Chlordane[2]	5.37E-02	8.44E-01	Lognormal	1.10E-04	1.60E+01	no	
Heptachlor	4.70E-02	2.11E-01	Unknown	5.30E-03	1.30E+00	no	
Heptachlor epoxide	3.91E-02	1.27E-01	Lognormal	2.00E-02	6.30E-01	no	
Methoxychlor	3.58E-01	1.14E+00	Lognormal	9.20E-01	1.00E+03	no	
PCB-1254	1.04E+00	5.99E+00	Unknown	4.02E-02	2.90E+00	no	
PCB-1260	1.00E+00	7.51E+00	Lognormal	3.40E-01	2.90E+00	no	
Semivolatiles							
2,4-Dimethylphenol	1.91E+01	1.28E+01	Unknown	1.20E+01	4.10E+03	no	
2-Methylnaphthalene	1.24E+02	3.78E+01	Unknown	3.78E+01	4.10E+03	no	
4-Methylphenol	1.53E+01	1.24E+01	Unknown	1.24E+01	1.00E+03	no	
Acenaphthene	1.85E+02	5.73E+01	Unknown	5.73E+01	1.20E+04	no	
Acenaphthylene	1.68E+01	1.52E+01	Unknown	1.52E+01	NA	NA	yes
Anthracene	7.46E+02	2.82E+02	Unknown	2.82E+02	6.10E+04	no	
Benzo(a)anthracene	1.30E+02	5.00E+02	Unknown	5.00E+02	7.80E+00	yes	yes
Benzo(a)pyrene	7.24E+01	2.90E+02	Unknown	2.90E+02	7.80E-01	yes	yes
Benzo(b)fluoranthene	1.23E+02	6.26E+02	Unknown	6.26E+02	7.80E+00	yes	yes
Benzo(g,h,i)perylene	3.35E+01	1.05E+02	Unknown	1.05E+02	NA	NA	yes
Benzo(k)fluoranthene	4.50E+01	1.37E+02	Unknown	1.37E+02	7.80E+01	yes	yes
bis(2-Ethylhexyl)phthalate	2.69E+01	2.53E+01	Unknown	5.30E-01	4.10E+02	no	
Butylbenzylphthalate	1.95E+01	1.54E+01	Unknown	1.70E-01	4.10E+04	no	

ENVIRONMENTAL STANDARDS

Table 9
Statistical Summary and COPC Selection for Trespasser Exposed to Surface Soils and NAPL (0-12" bgs)
Former Koppers Company, Inc., Newport, DE

Analyte	Total # of Samples	Hits	Hit Frequency %	Minimum Detected mg/kg	Mean mg/kg	Lognormal Mean mg/kg	Maximum Detected mg/kg	Standard Deviation mg/kg
Carbazole	114	68	59.65	4.00E-02	2.16E+02	1.50E+00	8.70E+03	1.05E+03
Chrysene	114	107	93.86	4.60E-02	9.38E+01	8.15E+00	2.20E+03	2.91E+02
Di-n-butylphthalate	114	9	7.89	3.90E-02	1.23E+01	1.16E+00	5.80E-01	4.69E+01
Di-n-octylphthalate	115	1	0.87	4.30E-02	1.22E+01	1.17E+00	4.30E-02	4.67E+01
Dibenz(a,h)anthracene	114	80	70.18	6.30E-02	1.47E+01	2.03E+00	1.30E+02	4.82E+01
Dibenzofuran	114	41	35.96	5.40E-02	1.06E+02	1.33E+00	3.20E+03	4.69E+02
Diethylphthalate	115	2	1.74	6.40E-02	1.22E+01	1.16E+00	7.80E-02	4.67E+01
Fluoranthene	114	110	96.49	4.70E-02	3.05E+02	1.01E+01	9.20E+03	1.30E+03
Fluorene	114	38	33.33	4.70E-02	1.89E+02	1.30E+00	5.60E+03	8.38E+02
Indeno(1,2,3-c,d)pyrene	115	104	90.43	5.10E-02	3.01E+01	4.95E+00	3.50E+02	6.19E+01
Naphthalene	114	48	42.11	5.20E-02	8.40E+01	1.36E+00	3.50E+03	4.12E+02
Pentachlorophenol	114	22	19.3	6.50E-02	2.78E+01	2.45E+00	1.20E+02	1.15E+02
Phenanthrene	111	89	80.18	5.50E-02	4.74E+02	2.79E+00	1.60E+04	2.17E+03
Phenol	114	4	3.51	9.00E-02	9.53E+00	1.12E+00	7.70E+01	3.45E+01
Pyrene	114	109	95.61	6.10E-02	2.47E+02	1.12E+01	6.40E+03	9.31E+02
Volatiles								
1,1,2,2-Tetrachloroethane	56	2	3.57	1.00E-01	1.31E-02	6.93E-03	3.00E-01	4.10E-02
2-Butanone	54	2	3.7	6.00E-03	6.72E-03	6.32E-03	3.80E-02	4.37E-03
Acetone	42	10	23.81	3.00E-03	1.78E-02	7.78E-03	2.30E-01	4.21E-02
Benzene	54	1	1.85	1.10E-02	6.28E-03	6.22E-03	1.10E-02	9.30E-04
Chloroform	50	1	2	2.00E-03	6.02E-03	5.95E-03	2.00E-03	7.89E-04
Ethylbenzene	54	4	7.41	1.00E-03	9.64E-03	6.29E-03	2.00E-01	2.64E-02
Tetrachloroethene	54	28	51.85	4.00E-03	1.04E-02	8.06E-03	7.40E-02	1.13E-02
Toluene	54	17	31.48	1.00E-03	9.85E-03	6.88E-03	1.50E-01	1.99E-02
Trichloroethene	54	1	1.85	2.00E-03	6.12E-03	6.04E-03	2.00E-03	8.68E-04
Xylenes (total)	54	7	12.96	3.30E-03	2.00E-02	6.75E-03	7.40E-01	9.99E-02

Table 9
Statistical Summary and COPC Selection for Trespasser Exposed to Surface Soils and NAPL (0-12" bgs)
Former Koppers Company, Inc., Newport, DE

Analyte	**95% UCL mg/kg**	**Lognormal 95% UCL mg/kg**	**Distribution 99% Confidence**	**Exposure Point Concentration mg/kg**	**Industrial Soil RBC mg/kg**	**Is Maximum >RBC?**	**Is Detection Frequency >5%?**
Carbazole	3.80E+02	1.09E+02	Unknown	1.09E+02	2.90E+02	yes	yes
Chrysene	1.39E+02	5.42E+02	Unknown	5.42E+02	7.80E+02	yes	yes
Di-n-butylphthalate	1.97E+01	1.51E-01	Unknown	5.80E-01	2.00E+04	no	
Di-n-octylphthalate	1.95E-01	1.39E-01	Unknown	4.30E-02	4.10E+03	no	
Dibenz(a,h)anthracene	2.22E+01	2.46E+01	Unknown	2.46E+01	7.80E-01	yes	yes
Dibenzofuran	1.80E+02	5.25E-01	Unknown	5.25E+01	8.20E+02	yes	yes
Diethylphthalate	1.95E+01	1.40E+01	Unknown	7.80E-02	1.60E+05	no	
Fluoranthene	5.08E+02	1.48E+03	Unknown	1.48E+03	8.20E+03	yes	yes
Fluorene	3.21E+02	8.91E+01	Unknown	8.91E+01	8.20E+03	no	
Indeno(1,2,3-c,d)pyrene	3.98E+01	1.51E+02	Unknown	1.51E+02	7.80E+00	yes	yes
Naphthalene	1.48E+02	5.01E+01	Unknown	5.01E+01	4.10E+03	no	
Pentachlorophenol	4.57E+01	3.44E+01	Unknown	3.44E+01	4.80E+01	yes	yes
Phenanthrene	8.18E+02	3.45E+02	Unknown	3.45E+02	NA	NA	yes
Phenol	1.49E+01	1.14E+01	Unknown	1.14E-01	1.20E+05	no	
Pyrene	3.92E+02	1.26E+03	Unknown	1.26E+03	6.10E+03	yes	yes
Volatiles							
1,1,2,2-Tetrachloroethane	2.23E-02	1.01E-02	Unknown	1.01E-02	2.90E+01	no	
2-Butanone	7.72E-03	6.97E-03	Unknown	6.97E-03	1.00E+05	no	
Acetone	2.88E-02	1.68E-02	Unknown	1.68E-02	2.00E+04	no	
Benzene	6.49E-03	6.46E-03	Unknown	6.46E-03	2.00E+02	no	
Chloroform	6.21E-03	6.31E-03	Unknown	2.00E-03	9.40E+02	no	
Ethylbenzene	1.57E-02	8.47E-03	Unknown	8.47E-03	2.00E+04	no	
Tetrachloroethene	1.30E-02	1.15E-02	Unknown	1.15E-02	1.10E+02	no	
Toluene	1.44E-02	9.76E-03	Unknown	9.76E-03	4.10E+04	no	
Trichloroethene	6.32E-03	6.41E-03	Unknown	2.00E-03	5.20E+02	no	
Xylenes (total)	4.28E-02	1.04E-02	Unknown	1.04E-02	4.10E+05	no	

This data set includes samples from all on-site areas and Hersh[illegible] [illegible]n sediment.
NA - Not available
[1] *The screening level of 750 mg/kg is based on US EPA's adult [illegible] d lead uptake model under default exposure assumptions.*
[2] These compounds have no published RBC or RfD values. T[illegible] [illegible]e sufficiently close in toxicity to Chlordane so that the Chlordane RBC is applicable to its congeners as a provisional benchmark
[3] *These compounds have no published RBC or RfD values. T[illegible] [illegible]e sufficiently close in toxicity to Endosulfan so that the Endosulfan RBC is applicable to its congeners as a provisional benchmark.*
[4] These compounds have no published RBC or RfD values. T[illegible] [illegible]e sufficiently close in toxicity to Endrin so that the Endrin RBC is applicable to its congeners as a provisional benchmark.

Table 10
Statistical Summary and COPC Selection for Trespasser Exposed to Non-River Surface Water
Former Koppers Company, Inc., Newport, DE

Analyte	Total # of Samples	Hits	Hit Frequency %	Minimum Detected mg/L	Mean mg/L	Lognormal Mean mg/L	Maximum Detected mg/L	Standard Deviation mg/L
Dioxins								
2,3,7,8-TCDD Equiv.	14	1	7.14	1.99E-06	2.43E-06	2.35E-06	1.99E-06	6.37E-07
Inorganics								
Aluminum	40	38	95	3.38E-02	7.07E-01	3.72E-01	3.90E+00	8.92E-01
Antimony	52	3	5.77	2.20E-03	2.25E-02	1.43E-02	5.80E-03	1.25E-02
Arsenic	45	11	24.44	1.40E-03	4.25E-03	3.84E-03	1.01E-02	1.85E-03
Barium	59	59	100	2.32E-02	9.13E-02	8.00E-02	3.47E-01	5.32E-02
Cadmium	54	1	1.85	1.40E-03	2.23E-03	1.88E-03	1.40E-03	7.29E-04
Chromium	55	26	47.27	7.00E-04	4.14E-03	3.14E-03	1.11E-02	2.49E-03
Cobalt	49	5	10.2	1.50E-03	2.02E-02	1.32E-02	1.31E-02	9.29E-03
Copper	53	29	54.72	1.30E-03	8.72E-03	7.33E-03	1.57E-02	4.11E-03
Iron	56	55	98.21	1.49E-01	3.65E+00	1.62E+00	3.42E+01	5.85E+00
Lead	58	22	37.93	2.00E-03	4.01E-03	2.54E-03	2.92E-02	5.41E-03
Manganese	59	59	100	8.90E-03	6.92E-01	2.76E-01	6.52E+00	1.08E+00
Mercury	58	1	1.72	1.30E-04	8.66E-05	7.08E-05	1.30E-04	3.31E-05
Nickel	51	1	1.96	8.00E-03	1.86E-02	1.59E-02	8.00E-03	4.86E-03
Thallium	55	4	7.27	7.60E-03	5.24E-03	4.78E-03	2.46E-02	3.03E-03
Vanadium	49	23	46.94	1.40E-03	1.64E-02	1.16E-02	2.88E-02	1.02E-02
Zinc	44	43	97.73	2.15E-02	7.17E-02	5.35E-02	4.70E-01	7.69E-02
PCBs/Pesticides								
alpha-Chlordane	14	5	35.71	5.00E-06	1.89E-05	1.63E-05	1.00E-05	8.59E-06
Endosulfan II	13	1	7.69	8.00E-06	4.68E-05	4.34E-05	8.00E-06	1.16E-05
gamma-Chlordane	14	1	7.14	1.00E-05	2.39E-05	2.34E-05	1.00E-05	4.01E-06
Methoxychlor	14	2	14.29	2.00E-05	2.17E-04	1.77E-04	2.40E-05	8.28E-05
PCB-1260	14	1	7.14	5.90E-04	5.06E-04	5.06E-04	5.90E-04	2.41E-05
Semivolatiles								
Acenaphthene	47	2	4.26	7.00E-03	6.87E-03	5.62E-03	7.70E-02	1.05E-02
Anthracene	47	2	4.26	3.00E-03	5.70E-03	5.39E-03	2.60E-02	3.13E-03
Benzo(a)anthracene	47	2	4.26	5.00E-03	6.45E-03	5.55E-03	5.90E-02	7.87E-03
Benzo(a)pyrene	47	2	4.26	3.00E-03	5.77E-03	5.40E-03	2.90E-02	3.56E-03
Benzo(b)fluoranthene	47	4	8.51	2.00E-03	6.35E-03	5.47E-03	5.40E-02	7.19E-03
Benzo(g,h,i)perylene	47	1	2.13	2.60E-02	5.74E-03	5.45E-03	2.60E-02	3.11E-03
Benzo(k)fluoranthene	47	2	4.26	3.00E-03	6.15E-03	5.46E-03	4.70E-02	6.14E-03
bis(2-Ethylhexyl)phthalate	46	1	2.17	3.00E-03	5.77E-03	5.41E-03	3.00E-03	3.52E-03
Chrysene	47	4	8.51	2.00E-03	7.01E-03	5.44E-03	9.00E-02	1.24E-02
Di-n-butylphthalate[1]	47	1	2.13	3.00E-03	5.76E-03	5.40E-03	3.00E-03	3.49E-03
Dibenzofuran	47	1	2.13	1.40E-02	5.49E-03	5.38E-03	1.40E-02	1.47E-03
Fluoranthene	47	4	8.51	3.00E-03	1.06E-02	5.78E-03	2.50E-01	3.57E-02
Fluorene	47	2	4.26	4.00E-03	5.55E-03	5.38E-03	1.80E-02	2.01E-03
Indeno(1,2,3-c,d)pyrene	47	1	2.13	2.80E-02	5.79E-03	5.46E-03	2.80E-02	3.39E-03
Naphthalene	47	1	2.13	1.70E-02	5.55E-03	5.40E-03	1.70E-02	1.86E-03
Phenanthrene	47	2	4.26	2.00E-03	6.02E-03	5.40E-03	4.20E-02	5.44E-03
Pyrene	47	4	8.51	2.00E-03	9.69E-03	5.67E-03	2.10E-01	2.99E-02
Volatiles								
Acetone	39	3	7.69	4.00E-03	4.97E-03	4.97E-03	5.00E-03	1.60E-04
Bromomethane	49	2	4.08	3.00E-03	4.98E-03	4.97E-03	6.00E-03	3.22E-04
Carbon Disulfide	49	1	2.04	2.10E-02	5.33E-03	5.15E-03	2.10E-02	2.29E-03
Chloromethane	48	2	4.17	1.70E-02	5.63E-03	5.29E-03	2.30E-02	3.09E-03
Toluene	49	1	2.04	2.00E-03	4.94E-03	4.91E-03	2.00E-03	4.29E-04

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ENVIRONMENTAL STANDARDS

Table 10
Statistical Summary and COPC Selection for Trespasser Exposed to Non-River Surface Water
Former Koppers Company, Inc., Newport, DE

Analyte	95% UCL mg/L	Lognormal 95% UCL mg/L	Distribution 99% Confidence	Exposure Point Concentration mg/L	Adjusted Tap Water RBC* mg/L	Is Maximum Greater than RBC?	Is Detection Frequency >5%?
Dioxins							
2,3,7,8-TCDD Equiv	2.[illegible]E-06	2.79E-06	Normal/Lognormal	1.99E-06	9.00E-09	yes	yes
Inorganics							
Aluminum	9.46E-01	1.23E+00	Lognormal	1.23E+00	7.40E+01	no	
Antimony	2.[illegible]E-02	5.00E-02	Unknown	5.80E-03	3.00E-02	no	
Arsenic	4.71E-03	4.95E-03	Unknown	4.95E-03	9.00E-04	yes	yes
Barium	1.[illegible]E-01	1.03E-01	Unknown	1.03E-01	5.20E+00	no	
Cadmium	[illegible]E-03	3.24E-03	Unknown	1.40E-03	3.60E-02	no	
Chromium	[illegible]E-03	6.16E-03	Unknown	6.16E-03	1.10E+02	no	
Cobalt	2.24E-02	5.77E-02	Unknown	1.31E-02	4.40E+00	no	
Copper	9.[illegible]7E-03	1.14E-02	Unknown	1.14E-02	3.00E+00	no	
Iron	[illegible]E+00	6.21E+00	Unknown	6.21E+00	2.20E+01	yes	yes
Lead	[illegible]E-03	4.49E-03	Unknown	4.49E-03	NA	NA	yes
Manganese	[illegible]E-01	1.36E+00	Unknown	1.36E+00	1.46E+00	yes	yes
Mercury	[illegible]E-05	1.26E-04	Unknown	1.26E-04	2.20E-02	no	
Nickel	[illegible]E-02	2.99E-02	Unknown	8.00E-03	1.46E+00	no	
Thallium	[illegible]E-03	5.77E-03	Unknown	5.77E-03	5.20E-03	yes	yes
Vanadium	[illegible]E-02	2.61E-02	Unknown	2.61E-02	5.20E-01	no	
Zinc	[illegible]E-02	8.52E-02	Lognormal	8.52E-02	2.20E+01	no	
PCBs/Pesticides							
alpha-Chlordane	[illegible]E-05	2.95E-05	Unknown	1.00E-05	1.04E-03	no	
Endosulfan II	[illegible]E-05	6.75E-05	Unknown	8.00E-06	4.40E-01	no	
gamma-Chlordane	[illegible]E-05	2.74E-05	Unknown	1.00E-05	1.04E-03	no	
Methoxychlor	[illegible]E-04	4.95E-04	Unknown	2.40E-05	3.60E-01	no	
PCB-1260	[illegible]E-04	5.17E-04	Unknown	5.17E-04	1.46E-03	no	
Semivolatiles							
Acenaphthene	[illegible]E-03	6.81E-03	Unknown	6.81E-03	4.40E+00	no	
Anthracene	[illegible]E-03	6.00E-03	Unknown	6.00E-03	2.20E+01	no	
Benzo(a)anthracene	[illegible]E-03	6.55E-03	Unknown	6.55E-03	1.84E-03	yes	no
Benzo(a)pyrene	[illegible]E-03	6.06E-03	Unknown	6.06E-03	1.84E-04	yes	no
Benzo(b)fluoranthene	[illegible]E-03	6.59E-03	Unknown	6.59E-03	1.84E-03	yes	yes
Benzo(g,h,i)perylene	[illegible]E-03	6.02E-03	Unknown	6.02E-03	NA	NA	no
Benzo(k)fluoranthene	[illegible]E-03	6.36E-03	Unknown	6.36E-03	1.84E-02	yes	no
bis(2-Ethylhexyl)phthalate	[illegible]E-03	6.07E-03	Unknown	3.00E-03	9.60E-02	no	
Chrysene	[illegible]E-02	6.87E-03	Unknown	6.87E-03	1.84E-01	no	
Di-n-butylphthalate	[illegible]E-03	6.05E-03	Unknown	3.00E-03	7.40E+00	no	
Dibenzofuran	[illegible]E-03	5.72E-03	Unknown	5.72E-03	3.00E-01	no	
Fluoranthene	[illegible]E-02	8.18E-03	Unknown	8.18E-03	3.00E+00	no	
Fluorene	[illegible]E-03	5.81E-03	Unknown	5.81E-03	3.00E+00	no	
Indeno(1,2,3-c,d)pyrene	[illegible]E-03	6.06E-03	Unknown	6.06E-03	1.84E-03	yes	no
Naphthalene	[illegible]E-03	5.80E-03	Unknown	5.80E-03	3.00E+01	no	
Phenanthrene	[illegible]E-03	6.31E-03	Unknown	6.31E-03	NA	NA	no
Pyrene	[illegible]E-02	7.86E-03	Unknown	7.86E-03	2.20E-01	no	
Volatiles							
Acetone	[illegible]E-03	5.02E-03	Unknown	5.00E-03	7.40E-01	no	
Bromomethane	[illegible]E-03	5.08E-03	Unknown	5.08E-03	1.74E-02	no	
Carbon Disulfide	[illegible]E-03	5.53E-03	Unknown	5.53E-03	2.00E+00	no	
Chloromethane	[illegible]E-03	5.91E-03	Unknown	5.91E-03	2.80E-02	no	
Toluene	[illegible]E-03	5.11E-03	Unknown	2.00E-03	1.50E+00	no	

* See text for explanation of RBC adjustments.

Table 11
Statistical Summary and COPC Selection for Trespasser Exposed to Non-River Sediment (0-12" bgs)
Former Koppers Company, Inc., Newport, DE

Analyte	Total # of Samples	Hits	Hit Frequency %	Minimum Detected mg/kg	Mean mg/kg	Lognormal Mean mg/kg	Maximum Detected mg/kg	Standard Deviation mg/kg
Dioxins								
2,3,7,8-TCDD Equiv	31	31	100	9.20E-05	6.77E-04	2.86E-04	6.22E-03	1.42E-03
Inorganics								
Aluminum	163	163	100	8.92E+02	1.93E+04	1.78E+04	3.39E+04	6.67E+03
Antimony	92	44	47.83	8.60E-01	9.58E+00	3.17E+00	9.20E+00	1.26E+01
Arsenic	141	135	95.74	1.70E+00	1.06E+01	8.83E+00	3.19E+01	6.40E+00
Barium	163	163	100	2.63E+01	4.21E+02	3.25E+02	3.06E+03	4.03E+02
Beryllium	145	138	95.17	3.80E-01	1.53E+00	1.44E+00	3.80E+00	4.89E-01
Cadmium	155	114	73.55	3.90E-01	2.72E+00	1.41E+00	2.59E+01	3.58E+00
Chromium	163	162	99.39	8.40E+00	5.42E+01	4.93E+01	1.36E+02	2.23E+01
Cobalt	148	145	97.97	3.60E+00	1.62E+01	1.50E+01	5.00E+01	5.95E+00
Copper	163	163	100	4.20E+00	6.64E+01	5.33E+01	1.88E+02	4.19E+01
Iron	163	163	100	2.20E+03	3.07E+04	2.92E+04	5.48E+04	8.30E+03
Lead[1]	163	163	100	4.50E+00	1.19E+02	7.82E+01	3.15E+03	2.52E+02
Manganese	163	163	100	5.76E+01	7.74E+02	5.54E+02	5.27E+03	7.72E+02
Mercury	149	128	85.91	4.60E-02	4.75E-01	2.68E-01	8.80E+00	1.13E+00
Nickel	162	161	99.38	8.00E+00	2.73E+01	2.49E+01	1.11E+02	1.22E+01
Selenium	151	40	26.49	1.40E+00	1.91E+00	1.48E+00	6.60E+00	1.18E+00
Silver	151	16	10.6	2.00E-01	3.23E+00	1.45E+00	5.80E+00	2.30E+00
Thallium	138	31	22.46	1.40E+00	3.74E+00	2.67E+00	3.26E+01	3.96E+00
Vanadium	163	163	100	4.50E+00	7.80E+01	6.77E+01	6.52E+02	7.07E+01
Zinc	163	163	100	3.54E+01	1.07E+03	5.78E+02	8.54E+03	1.35E+03
PCBs/Pesticides								
4,4'-DDD	43	30	69.77	3.70E-04	1.05E-01	1.18E-02	4.00E-01	3.21E-01
4,4'-DDE	43	32	74.42	1.50E-03	7.23E-02	1.05E-02	3.20E-01	3.06E-01
4,4'-DDT	43	16	37.21	1.80E-03	8.63E-02	1.47E-02	1.20E+00	2.16E-01
Aldrin	42	3	7.14	1.80E-03	5.86E-02	7.66E-03	1.20E-02	1.64E-01
alpha-Chlordane[2]	42	6	14.29	6.20E-04	5.93E-02	7.25E-03	4.30E-02	1.64E-01
Dieldrin	43	6	13.95	1.80E-03	9.81E-02	1.27E-02	2.90E-02	3.20E-01
Endosulfan II[3]	43	5	11.63	3.90E-03	1.06E-01	1.43E-02	5.80E-02	3.21E-01
Endosulfan Sulfate[3]	43	5	11.63	2.10E-04	1.13E-01	1.37E-02	3.80E-02	3.23E-01
Endrin	43	2	4.65	1.10E-02	1.15E-01	1.52E-02	2.20E-02	3.26E-01
Endrin aldehyde[4]	42	6	14.29	1.40E-03	1.12E-01	1.41E-02	2.00E-02	3.29E-01
Endrin ketone[4]	43	1	2.33	2.70E-02	1.30E-01	1.84E-02	2.70E-02	3.28E-01
gamma-Chlordane[2]	43	17	39.53	4.20E-04	6.61E-02	7.48E-03	5.30E-03	1.66E-01
Heptachlor	43	1	2.33	3.20E-03	6.61E-02	8.68E-03	3.20E-03	1.66E-01
Heptachlor epoxide	43	1	2.33	8.30E-04	6.64E-02	8.79E-03	8.30E-04	1.66E-01
Methoxychlor	38	3	7.89	1.60E-03	6.24E-01	6.74E-02	2.10E-02	1.74E+00
PCB-1254	43	13	30.23	1.80E-02	1.33E+00	2.22E-01	5.80E-01	3.27E+00
PCB-1260	43	10	23.26	1.20E-02	1.31E+00	1.87E-01	5.40E-01	3.27E+00
Semivolatiles								
1,2,4-Trichlorobenzene	162	2	1.23	1.60E-01	3.72E+01	1.05E+00	1.00E+00	2.36E+02
1,2-Dichlorobenzene	162	1	0.62	7.80E-02	3.72E+01	1.04E+00	7.80E-02	2.36E+02
2,4-Dichlorophenol	161	1	0.62	2.70E-01	3.75E+01	1.05E+00	2.70E-01	2.37E+02
2,4-Dimethylphenol	161	2	1.24	1.90E-01	3.75E+01	1.04E+00	3.80E+00	2.37E+02
2-Chlorophenol	161	2	1.24	1.70E-01	3.75E+01	1.05E+00	7.80E-01	2.37E+02
2-Methylnaphthalene	162	49	30.25	4.90E-02	1.03E+02	1.66E+00	3.20E+03	4.14E+02
2-Nitrophenol	161	1	0.62	3.20E-01	3.75E+01	1.05E+00	3.20E-01	2.37E+02
3,3'-Dichlorobenzidine	162	1	0.62	7.40E+00	3.73E+01	1.05E+00	7.40E+00	2.36E+02
Acenaphthene	162	66	40.74	6.90E-02	2.45E+02	2.12E+00	8.60E+03	1.01E+03
Acenaphthylene	162	41	25.31	7.70E-02	3.95E+01	1.15E+00	2.80E+02	2.37E+02
Anthracene	162	88	54.32	6.90E-02	2.98E+02	2.94E+00	1.20E+04	1.23E+03
Benzo(a)anthracene	162	123	75.93	7.20E-02	1.20E+02	2.92E+00	3.40E+03	4.27E+02
Benzo(a)pyrene	162	110	67.9	9.20E-02	5.90E+01	2.33E+00	7.50E+02	2.45E+02
Benzo(b)fluoranthene	162	124	76.54	6.70E-02	6.63E+01	3.39E+00	1.70E+03	2.09E+02
Benzo(g,h,i)perylene	162	96	59.26	7.50E-02	4.41E+01	1.71E+00	1.90E+02	2.36E+02
Benzo(k)fluoranthene	162	110	67.9	6.70E-02	3.93E+01	1.86E+00	8.20E+02	1.70E+02

Table 11
Statistical Summary and COPC Selection for Trespasser Exposed to Non-River Sediment (0-12" bgs)
Former Koppers Company, Inc., Newport, DE

Analyte	95% UCL mg/kg	Lognormal 95% UCL mg/kg	Distribution 99% Confidence	Exposure Point Concentration mg/kg	Industrial Soil RBC mg/kg	Is Maximum >RBC?	Is Detection Frequency >5%?
Dioxins							
2,3,7,8-TCDD Equiv.	1.11E-03	7.96E-04	Unknown	7.96E-04	3.80E-05	yes	yes
Inorganics							
Aluminum	2.01E+04	2.10E+04	Unknown	2.10E+04	2.00E+05	no	
Antimony	1.18E+01	1.70E-01	Unknown	9.20E+00	8.20E+01	no	
Arsenic	1.15E+01	1.19E+01	Unknown	1.19E+01	3.80E+00	yes	yes
Barium	4.73E+02	4.65E+02	Unknown	4.65E+02	1.40E+04	no	
Beryllium	1.60E+00	1.63E+00	Unknown	1.60E+00	4.10E+02	no	
Cadmium	3.19E+00	4.73E+00	Unknown	4.73E+00	2.00E+02	no	
Chromium	5.71E+01	5.88E+01	Unknown	5.71E+01	3.10E+05	no	
Cobalt	1.70E+01	1.74E+01	Unknown	1.74E+01	1.20E+04	no	
Copper	7.18E+01	7.67E+01	Unknown	7.67E+01	8.20E+03	no	
Iron	3.18E+04	3.29E+04	Unknown	3.29E+04	6.10E+04	no	
Lead[1]	1.51E+02	1.27E+02	Unknown	1.27E+02	7.50E+02	yes	yes
Manganese	8.75E+02	8.85E+02	Unknown	8.85E+02	2.90E+04	no	yes
Mercury	6.29E-01	4.27E-01	Unknown	4.27E-01	6.10E+01	no	
Nickel	2.89E+01	2.92E+01	Unknown	2.92E+01	4.10E+03	no	
Selenium	2.07E+00	2.30E+00	Unknown	2.07E+00	1.00E+03	no	
Silver	3.54E+00	8.57E+00	Unknown	5.80E+00	1.00E+03	no	
Thallium	4.30E+00	4.32E+00	Unknown	4.32E+00	1.40E+01	yes	yes
Vanadium	8.72E+01	8.10E+01	Unknown	8.72E+01	1.40E+03	no	
Zinc	1.24E+03	1.51E+03	Unknown	1.51E+03	6.10E+04	no	
PCBs/Pesticides							
4,4'-DDD	1.87E-01	2.17E-01	Unknown	2.17E-01	2.40E+01	no	
4,4'-DDE	1.51E-01	6.82E-02	Unknown	6.82E-02	1.70E+01	no	
4,4'-DDT	1.42E-01	1.44E-01	Unknown	1.44E-01	1.70E+01	no	
Aldrin	1.01E-01	1.08E-01	Unknown	1.20E-02	3.40E-01	no	
alpha-Chlordane[2]	1.02E-01	1.41E-01	Unknown	4.30E-02	1.60E+01	no	
Dieldrin	1.80E-01	1.27E-01	Unknown	2.90E-02	3.60E-01	no	
Endosulfan I[3]	1.88E-01	1.64E-01	Unknown	5.80E-02	1.20E+03	no	
Endosulfan sulfate[3]	1.96E-01	3.05E-01	Unknown	3.80E-02	1.20E+03	no	
Endrin	1.99E-01	2.04E-01	Unknown	2.20E-02	6.10E+01	no	
Endrin aldehyde[4]	1.97E-01	1.96E-01	Unknown	2.00E-02	6.10E+01	no	
Endrin ketone	2.14E-01	3.22E-01	Unknown	2.70E-02	6.10E+01	no	
gamma-Chlordane[2]	1.09E-01	2.42E-01	Unknown	5.30E-03	1.60E+01	no	
Heptachlor	1.09E-01	1.64E-01	Unknown	3.20E-03	1.30E+00	no	
Heptachlor epoxide	1.09E-01	1.73E-01	Unknown	8.30E-04	6.30E-01	no	
Methoxychlor	1.10E+00	1.66E+00	Unknown	2.10E-02	1.00E+03	no	
PCB-1254	2.17E+00	3.60E+00	Unknown	5.80E-01	2.90E+00	no	
PCB-1260	2.15E+00	3.94E+00	Unknown	5.40E-01	2.90E+00	no	
Semivolatiles							
1,2,4-Trichlorobenzene	6.81E+01	6.88E+00	Unknown	1.00E+00	2.00E+03	no	
1,2-Dichlorobenzene	*6.80E+01*	*6.92E+00*	*Unknown*	7.80E-02	1.80E+04	no	
2,4-Dichlorophenol	6.85E+01	6.93E+00	Unknown	2.70E-01	6.10E+02	no	
2,4-Dimethylphenol	6.85E+01	6.92E+00	Unknown	3.80E+00	4.10E+03	no	
2-Chlorophenol	6.85E+01	6.95E+00	Unknown	7.80E-01	1.00E+03	no	
2-Methylnaphthalene	1.57E+02	8.86E+01	Unknown	8.86E+01	4.10E+03	no	
2-Nitrophenol	6.85E+01	6.93E+00	Unknown	3.20E-01	NA	NA	no
3,3'-Dichlorobenzidine	6.81E+01	6.90E+00	Unknown	6.90E+00	1.30E+00	yes	no
Acenaphthene	3.76E+02	3.62E+02	Unknown	3.62E+02	1.20E+04	no	
Acenaphthylene	7.04E+01	9.47E+00	Unknown	9.47E+00	NA	no	
Anthracene	4.58E+02	7.40E+02	Unknown	7.40E+02	6.10E+04	no	
Benzo(a)anthracene	1.76E+02	3.20E+02	Unknown	3.20E+02	7.80E+00	yes	yes
Benzo(a)pyrene	9.09E+01	9.10E+01	Unknown	9.10E+01	7.80E-01	yes	yes
Benzo(b)fluoranthene	9.35E+01	1.65E+02	Unknown	1.65E+02	7.80E+00	yes	yes
Benzo(g,h,i)perylene	7.49E+01	3.42E+01	Unknown	3.42E+01	NA	no	
Benzo(k)fluoranthene	6.15E+01	5.51E+01	Unknown	5.51E+01	7.80E+01	yes	yes

Table 11

Statistical Summary and COPC Selection for Trespasser Exposed to Non-River Sediment (0-12" bgs)

Former Koppers Company, Inc., Newport, DE

Analyte	Total # of Samples	Hits	Hit Frequency %	Minimum Detected mg/kg	Mean mg/kg	Lognormal Mean mg/kg	Maximum Detected mg/kg	Standard Deviation mg/kg
bis(2-Ethylhexyl)phthalate	131	29	22.14	6.00E-02	4.59E+01	1.17E+00	1.50E+00	2.62E+02
Butylbenzylphthalate	163	35	21.47	7.90E-02	3.70E+01	8.41E-01	1.20E+00	2.36E+02
Carbazole	162	58	35.8	4.60E-02	1.11E+02	1.85E+00	4.20E+03	4.63E+02
Chrysene	162	123	75.93	7.20E-02	9.34E+01	3.19E+00	2.10E+03	2.95E+02
Dibenz(a,h)anthracene	162	65	40.12	7.60E-02	3.87E+01	1.30E+00	4.20E+01	2.36E+02
Dibenzofuran	162	69	42.59	5.80E-02	1.77E+02	1.94E+00	5.80E+03	6.99E+02
Diethylphthalate	164	5	3.05	7.40E-02	3.68E+01	1.01E+00	2.30E-01	2.35E+02
Di-n-butylphthalate	164	38	23.17	8.20E-02	3.68E+01	9.16E-01	7.50E-01	2.35E+02
Fluoranthene	162	132	81.48	4.80E-02	4.97E+02	4.57E+00	1.70E+04	1.97E+03
Fluorene	162	74	45.68	6.20E-02	2.69E+02	2.45E+00	9.50E+03	1.07E+03
Indeno(1,2,3-c,d)pyrene	164	103	62.8	7.20E-02	4.62E+01	1.84E+00	2.40E+02	2.35E+02
Isophorone	162	1	0.62	9.00E-02	3.72E+01	1.04E+00	9.00E-02	2.36E+02
Naphthalene	162	58	35.8	7.40E-02	1.95E+02	1.76E+00	7.70E+03	9.54E+02
Nitrobenzene	162	1	0.62	2.90E-01	3.72E+01	1.05E+00	2.90E-01	2.36E+02
Pentachlorophenol	161	8	4.97	6.00E-02	9.38E+01	2.49E+00	2.20E+01	5.94E+02
Phenanthrene	162	104	64.2	8.40E-02	7.85E+02	3.41E+00	2.90E+04	3.34E+03
Phenol	159	1	0.63	1.50E+00	3.79E+01	1.07E+00	1.50E+00	2.39E+02
Pyrene	162	130	80.25	4.60E-02	3.31E+02	4.05E+00	1.20E+04	1.29E+03
Volatiles								
1,1,2,2-Tetrachloroethane	104	3	2.88	3.00E-01	6.89E-02	1.42E-02	1.00E+00	2.28E-01
2-Butanone	100	70	70	8.00E-03	8.40E-02	3.04E-02	1.10E+00	2.10E-01
Acetone	92	69	75	5.00E-03	2.86E-01	8.62E-02	1.00E+01	1.05E+00
Benzene	101	4	3.96	2.00E-03	5.36E-02	1.23E-02	1.10E-02	2.08E-01
Carbon Disulfide	101	4	3.96	4.00E-03	5.38E-02	1.25E-02	8.00E-03	2.08E-01
Ethylbenzene	101	17	16.83	2.00E-03	1.44E-01	1.52E-02	3.70E+00	5.56E-01
Methylene Chloride	59	1	1.69	6.40E-02	8.36E-02	1.45E-02	6.40E-02	2.69E-01
Styrene	101	5	4.95	5.00E-03	7.75E-02	1.27E-02	3.10E+00	3.63E-01
Tetrachloroethene	101	46	45.54	2.00E-03	5.36E-02	1.17E-02	3.30E-02	2.08E-01
Toluene	101	18	17.82	4.00E-03	8.97E-02	1.36E-02	2.70E+00	3.84E-01
Xylenes (total)	101	21	20.79	1.00E-03	6.57E-01	1.77E-02	3.50E+01	3.73E+00

Table 11
Statistical Summary and COPC Selection for Trespasser Exposed to Non-River Sediment (0-12" bgs)
Former Koppers Company, Inc., Newport, DE

Analyte	95% UCL mg/kg	Lognormal 95% UCL mg/kg	Distribution 99% Confidence	Exposure Point Concentration mg/kg	Industrial Soil RBC mg/kg	Is Maximum >RBC?	Is Detection Frequency >5%?
bis(2-Ethylhexyl)phthalate	8.39E+01	1.34E+01	Unknown	1.50E+00	4.10E+02	no	
Butylbenzylphthalate	6.76E+01	8.19E+00	Unknown	1.20E+00	4.10E+04	no	
Carbazole	1.71E+02	1.02E+02	Unknown	1.02E+02	2.90E+02	yes	yes
Chrysene	1.32E+02	2.64E+02	Unknown	2.64E+02	7.80E+02	yes	yes
Dibenz(a,h)anthracene	6.95E+01	1.25E+01	Unknown	1.25E+01	7.80E-01	yes	yes
Dibenzofuran	2.68E+02	2.55E+02	Unknown	2.55E+02	8.20E+02	yes	yes
Diethylphthalate	6.72E+01	6.89E+00	Unknown	2.30E-01	1.60E+05	no	
Di-n-butylphthalate	6.72E+01	7.18E+00	Unknown	7.50E-01	2.00E+04	no	
Fluoranthene	7.54E+02	2.27E+03	Unknown	2.27E+03	8.20E+03	yes	yes
Fluorene	4.08E+02	5.67E+02	Unknown	5.67E+02	8.20E+03	yes	yes
Indeno(1,2,3-c,d)pyrene	7.67E+01	4.56E+01	Unknown	4.56E+01	7.80E+00	yes	yes
Isophorone	6.80E+01	6.91E+00	Unknown	9.00E-02	6.00E+03	no	
Naphthalene	3.19E+02	1.13E+02	Unknown	1.13E+02	4.10E+03	yes	
Nitrobenzene	6.80E+01	6.84E+00	Unknown	2.90E-01	1.00E+02	no	
Pentachlorophenol	1.71E+02	1.86E+01	Unknown	1.86E+01	4.80E+01	no	
Phenanthrene	1.22E+03	3.16E+03	Unknown	3.16E+03	NA	no	
Phenol	6.93E+01	7.17E+00	Unknown	1.50E+00	1.20E+05	no	
Pyrene	5.00E+02	1.17E+03	Unknown	1.17E+03	6.10E+03	yes	yes
Volatiles							
1,1,2,2-Tetrachloroethane	1.06E-01	4.10E-02	Unknown	4.10E-02	2.90E+01	no	
2-Butanone	1.19E-01	8.84E-02	Unknown	8.84E-02	1.00E+05	no	
Acetone	4.69E-01	4.72E-01	Unknown	4.72E-01	2.00E+04	no	
Benzene	8.82E-02	2.87E-02	Unknown	1.10E-02	2.00E+02	no	
Carbon Disulfide	8.84E-02	2.91E-02	Unknown	8.00E-03	2.00E+04	no	
Ethylbenzene	2.37E-01	6.78E-02	Unknown	6.78E-02	2.00E+04	no	
Methylene Chloride	1.43E-01	5.46E-02	Unknown	5.46E-02	7.60E+02	no	
Styrene	1.38E-01	3.22E-02	Unknown	3.22E-02	4.10E+04	no	
Tetrachloroethene	8.82E-02	2.94E-02	Unknown	2.94E-02	1.10E-02	no	
Toluene	1.54E-01	4.10E-02	Unknown	4.10E-02	4.10E+04	no	
Xylenes (total)	1.28E+00	1.59E-01	Unknown	1.59E-01	4.10E+05	no	

This data set includes samples from all on-site non-river sediment areas.
NA - Not available
[1] The screening level of 750 mg/kg is based on US EPA's adult blood lead uptake model under default exposure assumptions.
[2] These compounds have no published RBC or RfD values. They are sufficiently close in toxicity to Chlordane so that the Chlordane RBC is applicable to its congeners as a provisional benchmark.
[3] These compounds have no published RBC or RfD values. They are sufficiently close in toxicity to Endosulfan so that the Endosulfan RBC is applicable to its congeners as a provisional benchmark.
[4] These compounds have no published RBC or RfD values. They are sufficiently close in toxicity to Endrin so that the Endrin RBC is applicable to its congeners as a provisional benchmark.

Table 12
Statistical Summary and COPC Selection for Swimmer Exposed to Surface Water From Christina River
Former Koppers Company, Inc., Newport, DE

Analyte	Total # of Samples	Hits	Hit Frequency %	Minimum Detected mg/L	Mean mg/L	Lognormal Mean mg/L	Maximum Detected mg/L	Standard Deviation mg/L	95% UCL mg/L	Lognormal 95% UCL mg/L	Distribution 99% Confidence	Exposure Point Concentration mg/L	Adjusted Tap Water RBC* mg/L	Is Maximum Greater than RBC?	Is Detection Frequency >5%?
Inorganics															
Aluminum	18	18	100	2.17E-01	7.81E-01	6.77E-01	1.60E+00	3.91E-01	9.42E-01	1.08E+00	Normal/Lognormal	1.08E+00	7.40E+01	no	
Barium	19	19	100	4.41E-02	6.45E-02	6.35E-02	8.18E-02	1.17E-02	6.92E-02	6.99E-02	Normal/Lognormal	6.99E-02	5.20E+00	no	
Chromium	17	14	82	5.50E-04	2.95E-03	2.65E-03	4.20E-03	1.26E-03	3.48E-03	4.01E-03	Normal/Lognormal	4.01E-03	1.10E+02	no	
Cobalt	19	7	37	8.80E-04	8.46E-03	2.17E-03	1.90E-03	1.15E-02	1.31E-02	5.32E-02	Unknown	1.90E-03	4.40E+00	no	
Copper	14	14	100	2.80E-03	3.89E-03	3.78E-03	6.30E-03	9.87E-04	4.35E-03	4.38E-03	Normal/Lognormal	4.38E-03	3.00E+00	no	
Iron	19	19	100	3.75E-01	1.49E+00	1.36E+00	2.68E+00	5.86E-01	1.72E+00	1.90E+00	Normal/Lognormal	1.90E+00	2.20E+01	no	
Lead	19	15	79	3.10E-03	3.85E-03	3.31E-03	1.18E-02	2.30E-03	4.76E-03	5.22E-03	Lognormal	5.22E-03	NA	NA	yes
Manganese	19	19	100	9.47E-02	1.75E-01	1.67E-01	2.91E-01	5.60E-02	1.97E-01	2.02E-01	Normal/Lognormal	2.02E-01	1.46E+00	no	
Mercury	19	1	5	3.60E-04	7.14E-05	2.68E-05	3.60E-04	1.19E-04	1.19E-04	1.75E-04	Unknown	1.75E-04	2.20E-02	no	
Nickel	7	1	14	2.70E-03	1.75E-02	1.50E-02	2.70E-03	6.54E-03	2.23E-02	5.13E-02	Unknown	2.70E-03	1.46E+00	no	
Vanadium	17	14	82	2.70E-03	5.72E-03	3.59E-03	4.70E-03	7.31E-03	8.82E-03	1.13E-02	Unknown	4.70E-03	5.20E-01	no	
Zinc	12	12	100	4.06E-02	6.59E-02	6.49E-02	7.90E-02	1.09E-02	7.15E-02	7.32E-02	Normal/Lognormal	7.32E-02	2.20E+01	no	
Semivolatiles															
bis(2-Ethylhexyl)phthalate	6	1	17	1.00E-03	[illegible]	3.82E-03	1.00E-03	1.63E-03	5.68E-03	1.16E-02	Unknown	1.00E-03	9.60E-02	no	

* See text for explanation of RBC adjustments.
NA - Not available

Table 13

Statistical Summary and COPC Selection for Swimmer Exposed to Surface Water From White Clay Creek

Former Koppers Company, Inc., Newport, DE

Analyte	Total # of Samples	Hits	Hit Frequency %	Minimum Detected mg/L	Mean mg/L	Lognormal Mean mg/L	Maximum Detected mg/L	Standard Deviation mg/L	95% UCL mg/L	Lognormal 95% UCL mg/L	Distribution 99% Confidence	Exposure Point Concentration mg/L	Adjusted Tap Water RBC* mg/L	Is Maximum Greater than RBC?	Is Detection Frequency >5%?
Inorganics															
Aluminum	4	4	100	2.31E-01	6.24E-01	5.49E-01	8.99E-01	3.15E-01	9.94E-01	3.32E+00	Normal/Lognormal	8.99E-01	7.40E+01	no	
Barium	9	9	100	3.45E-02	5.30E-02	5.11E-02	7.47E-02	1.53E-02	6.25E-02	6.57E-02	Normal/Lognormal	6.57E-02	5.20E+00	no	
Chromium	7	1	14	2.40E-03	3.95E-03	2.91E-03	2.40E-03	1.90E-03	5.34E-03	3.80E-02	Unknown	2.40E-03	1.10E+02	no	
Copper	9	9	100	3.10E-03	4.80E-03	4.58E-03	9.20E-03	1.78E-03	5.90E-03	5.97E-03	Lognormal	5.97E-03	3.00E+00	no	
Iron	9	9	100	1.95E-01	8.09E-01	6.24E-01	2.10E+00	6.18E-01	1.19E+00	1.85E+00	Normal/Lognormal	1.85E+00	2.20E+01	no	
Lead	9	2	22	4.80E-03	2.17E-03	1.84E-03	4.80E-03	1.51E-03	3.10E-03	3.49E-03	Unknown	3.49E-03	NA	NA	yes
Manganese	9	9	100	5.51E-02	1.40E-01	1.21E-01	2.83E-01	7.68E-02	1.88E-01	2.43E-01	Normal/Lognormal	2.43E-01	1.46E+00	no	
Vanadium	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Unknown	[illegible]	5.20E-01	no	
Zinc	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Lognormal	[illegible]	[illegible]	no	
Semivolatiles															
bis(2-Ethylhexyl)phthalate	7	1	14	8.00E-03	5.71E-03	5.64E-03	8.00E-03	1.07E-03	6.50E-03	6.55E-03	Lognormal	6.55E-03	9.60E-02	no	

* See text for explanation of RBC adjustments.

NA - Not available

AR316036

Table 14

Statistical Summary and COPC Selection for Swimmer Exposed to River Sediments From Christina River
Former Koppers Company, Inc., Newport, DE

Analyte	Total # of Samples	Hits	Hit Frequency %	Minimum Detected mg/kg	Mean mg/kg	Lognormal Mean mg/kg	Maximum Detected mg/kg	Standard Deviation mg/kg
Dioxins								
2,3,7,8-TCDD Equiv	3	3	100	9.18E-05	1.01E-04	1.01E-04	1.16E-04	1.27E-05
Inorganics								
Aluminum	37	37	100	1.19E+03	1.46E+04	1.25E+04	2.47E+04	5.70E+03
Antimony	23	4	17	2.40E-01	4.26E+00	5.87E-01	1.40E+00	1.02E+01
Arsenic	33	33	100	2.20E+00	7.72E+00	7.01E+00	1.74E+01	3.53E+00
Barium	37	37	100	1.29E+01	2.08E+02	1.46E+02	1.24E+03	2.26E+02
Beryllium	29	28	97	2.90E-01	1.13E+00	1.01E+00	2.10E+00	5.28E-01
Cadmium	34	16	47	4.60E-01	2.07E+00	6.07E-01	2.23E+01	4.13E+00
Chromium	37	37	100	6.90E+00	4.24E+01	3.64E+01	1.50E+02	2.38E+01
Cobalt	29	29	100	3.40E+00	1.12E+01	1.05E+01	1.66E+01	3.33E+00
Copper	35	35	100	7.20E+00	2.84E+01	2.29E+01	6.64E+01	1.85E+01
Iron	37	37	100	4.46E+03	2.38E+04	2.18E+04	3.39E+04	7.67E+03
Lead[1]	37	37	100	6.60E+00	4.86E+01	3.18E+01	2.20E+02	4.66E+01
Manganese	37	37	100	7.57E+01	6.39E+02	5.23E+02	1.30E+03	3.48E+02
Mercury	34	28	82	1.40E-02	1.69E-01	9.54E-02	6.30E-01	1.67E-01
Nickel	37	37	100	3.00E+00	1.93E+01	1.77E+01	2.77E+01	6.18E+00
Selenium	35	12	34	3.40E-01	1.11E+00	7.56E-01	1.90E+00	8.83E-01
Thallium	28	3	11	1.26E+00	2.08E+00	1.23E+00	3.50E+00	1.97E+00
Vanadium	37	37	100	7.30E+00	4.08E+01	3.74E+01	5.78E+01	1.29E+01
Zinc	[illegible]	37	100	4.02E+01	4.46E+02	2.28E+02	3.09E+03	6.25E+02
PCBs/Pesticides								
4,4'-DDD	25	14	56	9.50E-05	1.90E-01	3.33E-03	3.80E+00	7.63E-01
4,4'-DDE	15	12	80	2.70E-04	7.58E-02	2.33E-03	1.10E+00	2.83E-01
4,4'-DDT	20	8	40	4.10E-05	1.25E+00	3.33E-03	2.40E+01	5.36E+00
alpha-BHC	28	2	7	6.30E-05	2.83E-02	1.91E-03	1.30E-03	1.16E-01
alpha-Chlordane[2]	28	11	39	1.80E-04	7.61E-03	1.74E-03	1.70E-02	2.90E-02
delta-BHC[3]	25	3	12	2.10E-04	7.45E-03	1.44E-03	4.10E-04	3.07E-02
Dieldrin	14	4	29	3.50E-04	2.36E-02	2.69E-03	4.40E-03	7.96E-02
Endrin aldehyde[4]	25	6	24	9.30E-05	3.82E-02	2.67E-03	3.70E-03	1.31E-01
Endrin ketone[4]	28	3	11	2.20E-04	6.67E-02	3.49E-03	1.40E-03	2.86E-01
gamma-Chlordane[2]	28	21	75	8.30E-05	7.35E-03	8.74E-04	1.90E-02	2.92E-02
Heptachlor epoxide	23	2	9	3.70E-05	3.41E-02	1.98E-03	1.50E-03	1.27E-01
Methoxychlor	28	9	32	1.20E-04	6.48E-02	5.68E-03	2.20E-03	2.91E-01
PCB-1254	28	6	21	3.80E-02	2.13E-01	5.19E-02	1.30E+00	6.04E-01
PCB-1260	28	8	29	3.60E-03	1.70E-01	3.85E-02	3.30E-01	5.68E-01

Table 14
Statistical Summary and COPC Selection for Swimmer Exposed to River Sediments From Christina River
Former Koppers Company, Inc., Newport, DE

Analyte	95% UCL mg/kg	Lognormal 95% UCL mg/kg	Distribution 99% Confidence	Exposure Point Concentration mg/kg	Industrial Soil RBC* mg/kg	Is Maximum >RBC?	Is Detection Frequency >5%?
Dioxins							
2,3,7,8-TCDD Equiv	1.22E-04	1.30E-04	Normal/Lognormal	1.16E-04	3.80E-05	yes	yes
Inorganics							
Aluminum	1.62E+04	2.06E+04	Unknown	2.06E+04	2.00E+06	no	
Antimony	7.91E+00	8.82E+00	Unknown	1.40E+00	8.20E+01	no	
Arsenic	8.77E+00	9.03E+00	Normal/Lognormal	9.03E+00	3.80E+00	yes	yes
Barium	2.71E-02	2.96E+02	Lognormal	2.96E+02	1.40E+04	no	
Beryllium	1.30E+00	1.38E+00	Normal/Lognormal	1.38E+00	4.10E+02	no	
Cadmium	3.27E+00	5.98E+00	Lognormal	5.98E+00	2.00E+02	no	
Chromium	4.90E+01	5.37E+01	Unknown	5.37E+01	3.10E+05	no	
Cobalt	1.23E+01	1.31E+01	Normal	1.31E+01	1.20E+04	no	
Copper	3.38E+01	3.69E+01	Lognormal	3.69E+01	8.20E+03	no	
Iron	2.60E+04	2.88E+04	Unknown	2.88E+04	6.10E+04	no	
Lead[1]	6.16E+01	7.31E+01	Lognormal	7.31E+01	7.50E+02	no	
Manganese	7.36E+02	8.77E+02	Normal	8.77E-02	2.90E+04	no	
Mercury	2.18E-01	3.35E-01	Lognormal	3.35E-01	6.10E+01	no	
Nickel	2.10E+01	2.36E+01	Unknown	2.36E+01	4.10E+03	no	
Selenium	1.37E+00	1.85E+00	Unknown	1.85E+00	1.00E+03	no	
Thallium	2.72E+00	4.09E+00	Unknown	3.50E+00	1.40E-01	no	
Vanadium	4.44E+01	4.94E+01	Unknown	4.94E-01	1.40E-03	no	
Zinc	6.20E+02	7.08E+02	Lognormal	7.08E-02	6.10E+04	no	
PCBs/Pesticides							
4,4'-DDD	4.52E-01	6.66E-01	Unknown	6.66E-01	2.40E+01	no	
4,4'-DDE	2.05E-01	2.65E-01	Unknown	2.65E-01	1.70E+01	no	
4,4'-DDT	3.32E+00	2.27E+01	Unknown	2.27E+01	1.70E+01	yes	yes
alpha-BHC	6.55E-02	1.73E-02	Unknown	1.30E-03	9.10E-01	no	
alpha-Chlordane[2]	1.70E-02	6.49E-03	Unknown	6.49E-03	1.60E+01	no	
delta-BHC[3]	1.80E-02	4.86E-03	Unknown	4.10E-04	9.10E-01	no	
Dieldrin	6.13E-02	5.00E-02	Unknown	4.40E-03	3.60E-01	no	
Endrin aldehyde[4]	8.31E-02	6.71E-02	Unknown	3.70E-03	6.10E+01	no	
Endrin ketone[4]	1.59E-01	3.60E-02	Unknown	1.40E-03	6.10E+01	no	
gamma-Chlordane[2]	1.67E-02	1.15E-02	Lognormal	1.15E-02	1.60E+01	no	
Heptachlor epoxide	7.97E-02	3.93E-02	Unknown	1.50E-03	6.30E-01	no	
Methoxychlor	1.59E-01	1.91E-01	Unknown	2.20E-03	1.00E+03	no	
PCB-1254	4.08E-01	2.33E-01	Unknown	2.33E-01	2.90E+00	no	
PCB-1260	3.52E-01	1.89E-01	Unknown	1.89E-01	2.90E+00	no	

Table 14
Statistical Summary and COPC Selection for Swimmer Exposed to River Sediments From Christina River
Former Koppers Company, Inc., Newport, DE

Analyte	Total # of Samples	Hits	Hit Frequency %	Minimum Detected mg/kg	Mean mg/kg	Lognormal Mean mg/kg	Maximum Detected mg/kg	Standard Deviation mg/kg
Semivolatiles								
1,2,4-Trichlorobenzene	38	1	3	4.00E-01	4.78E-01	3.68E-01	4.00E-01	5.74E-01
2-Methylnaphthalene	38	1	3	5.00E-02	4.71E-01	3.50E-01	5.00E-02	5.78E-01
4-Methylphenol	38	1	3	7.10E-02	4.72E-01	3.54E-01	7.10E-02	5.77E-01
Acenaphthene	38	5	13	6.00E-02	4.61E-01	3.35E-01	8.80E-01	5.84E-01
Anthracene	38	4	11	8.20E-02	4.55E-01	3.25E-01	1.30E-01	5.85E-01
Benzo(a)anthracene	38	23	61	6.80E-02	4.33E-01	2.61E-01	1.60E+00	6.30E-01
Benzo(a)pyrene	38	19	50	3.30E-02	3.93E-01	2.45E-01	3.30E-01	5.98E-01
Benzo(b)fluoranthene	38	23	61	4.90E-02	4.35E-01	2.88E-01	9.50E-01	5.95E-01
Benzo(g,h,i)perylene	38	12	32	6.70E-02	4.21E-01	2.71E-01	2.50E-01	5.98E-01
Benzo(k)fluoranthene	38	12	32	4.70E-02	4.09E-01	2.51E-01	3.10E-01	5.99E-01
bis(2-Ethylhexyl)phthalate	28	17	61	5.90E-02	8.03E-01	4.34E-01	3.50E+00	9.62E-01
Butylbenzylphthalate	38	8	21	6.50E-02	4.39E-01	2.85E-01	1.20E-01	5.95E-01
Chrysene	34	19	56	5.40E-02	4.58E-01	3.00E-01	1.30E+00	6.33E-01
Di-n-butylphthalate	37	12	32	3.70E-02	4.10E-01	2.42E-01	1.60E-01	6.10E-01
Dibenz(a,h)anthracene	38	1	3	7.00E-02	4.71E-01	3.53E-01	7.00E-02	5.78E-01
Dibenzofuran	38	1	3	6.50E-02	4.71E-01	3.52E-01	6.50E-02	5.78E-01
Diethylphthalate	38	1	3	9.40E-01	5.03E-01	3.86E-01	9.40E-01	5.78E-01
Fluoranthene	38	25	66	6.10E-02	6.08E-01	3.43E-01	5.70E+00	1.03E+00
Fluorene	38	6	16	4.80E-02	4.60E-01	3.10E-01	1.30E+00	6.02E-01
Indeno(1,2,3-c,d)pyrene	37	12	32	5.70E-02	4.16E-01	2.67E-01	3.60E-01	6.04E-01
Naphthalene	38	5	13	6.20E-02	4.66E-01	3.26E-01	7.50E-01	5.87E-01
Pentachlorophenol	38	2	5	6.50E-02	1.16E+00	8.23E-01	1.30E-01	1.45E+00
Phenanthrene	38	22	58	6.00E-02	5.58E-01	2.78E-01	6.00E+00	1.09E+00
Pyrene	38	24	63	8.50E-02	5.80E-01	3.52E-01	4.80E+00	9.13E-01
Volatiles								
1,1,2,2-Tetrachloroethane	17	5	29	2.00E-01	8.93E-02	2.46E-02	4.00E-01	1.38E-01
2-Butanone	12	5	42	1.60E-02	1.86E-02	1.35E-02	6.30E-02	1.75E-02
Acetone	11	6	55	1.50E-01	2.40E-01	6.64E-02	9.10E-01	3.37E-01

Table 14

Statistical Summary and COPC Selection for Swimmer Exposed to River Sediments From Christina River Former Koppers Company, Inc., Newport, DE

Analyte	95% UCL mg/kg	Lognormal 95% UCL mg/kg	Distribution 99% Confidence	Exposure Point Concentration mg/kg	Industrial Soil RBC* mg/kg	Is Maximum >RBC?	Is Detection Frequency >5%?
Semivolatiles							
1,2,4-Trichlorobenzene	6.36E-01	5.24E-01	Unknown	4.00E-01	2.00E+03	no	
2-Methylnaphthalene	6.30E-01	5.44E-01	Unknown	5.00E-02	4.10E+03	no	
4-Methylphenol	6.31E-01	5.34E-01	Unknown	7.10E-02	1.00E+03	no	
Acenaphthene	6.22E-01	5.34E-01	Unknown	5.34E-01	1.20E+04	no	
Anthracene	6.16E-01	5.32E-01	Unknown	1.30E-01	6.10E+04	no	
Benzo(a)anthracene	6.06E-01	5.51E-01	Lognormal	5.51E-01	7.80E+00	no	
Benzo(a)pyrene	5.58E-01	4.88E-01	Unknown	3.30E-01	7.80E-01	no	
Benzo(b)fluoranthene	5.99E-01	5.43E-01	Lognormal	5.43E-01	7.80E+00	no	
Benzo(g,h,i)perylene	5.85E-01	5.20E-01	Unknown	2.50E-01	NA	NA	yes
Benzo(k)fluoranthene	5.74E-01	5.41E-01	Unknown	3.10E-01	7.80E+01	no	
bis(2-Ethylhexyl)phthalate	1.11E+00	1.44E+00	Lognormal	1.44E+00	4.10E+02	no	
Butylbenzylphthalate	6.03E-01	5.68E-01	Unknown	1.20E-01	4.10E+04	no	
Chrysene	6.42E-01	5.72E-01	Unknown	5.72E-01	7.80E+02	no	
Di-n-butylphthalate	5.80E-01	5.65E-01	Lognormal	1.60E-01	2.00E+04	no	
Dibenz(a,h)anthracene	6.30E-01	5.34E-01	Unknown	7.00E-02	7.80E-01	no	
Dibenzofuran	6.30E-01	5.36E-01	Unknown	6.50E-02	8.20E+02	no	
Diethylphthalate	6.61E-01	5.60E-01	Unknown	5.60E-01	1.60E+05	no	
Fluoranthene	8.92E-01	7.56E-01	Unknown	7.56E-01	8.20E+03	no	
Fluorene	6.25E-01	5.81E-01	Unknown	5.81E-01	8.20E+03	no	
Indeno(1,2,3-c,d)pyrene	5.85E-01	5.15E-01	Unknown	3.60E-01	7.80E+00	no	
Naphthalene	6.28E-01	5.76E-01	Unknown	5.76E-01	4.10E+03	no	
Pentachlorophenol	1.56E+00	1.47E+00	Unknown	1.30E-01	4.80E+01	no	
Phenanthrene	8.58E-01	6.65E-01	Unknown	6.65E-01	NA	NA	yes
Pyrene	8.32E-01	6.92E-01	Unknown	6.92E-01	6.10E+03	no	
Volatiles							
1,1,2,2-Tetrachloroethane	1.48E-01	4.06E-01	Unknown	4.00E-01	2.90E+01	no	
2-Butanone	2.76E-02	3.35E-02	Lognormal	3.35E-02	1.20E+05	no	
Acetone	4.24E-01	1.01E+01	Lognormal	9.10E-01	2.00E+04	no	

* Since the only sediment exposure route evaluated for the swimmer scenario was dermal contact, comparison of maximum concentrations to the industrial soil RBC was most appropriate.

NA - Not available

[1] The screening level of 750 mg/kg is based on US EPA's adult blood lead uptake model under default exposure assumptions.

[2] These compounds have no published RBC or RfD values. They are sufficiently close in toxicity to Chlordane so that the Chlordane RBC is applicable to its congeners as a provisional benchmark.

[3] This compound has no published RBC or RfD value. It is sufficiently close in toxicity to alpha-BHC so that the alpha-BHC RBC is applicable to its congener as a provisional benchmark.

[4] These compounds have no published RBC or RfD values. They are sufficiently close in toxicity to Endrin so that the Endrin RBC is applicable to its congeners as a provisional benchmark.

Table 15
Statistical Summary and COPC Selection for Swimmer Exposed to River Sediments From White Clay Creek
Former Koppers Company, Inc., Newport, DE

Analyte	Total # of Samples	Hits	Hit Frequency %	Minimum Detected mg/kg	Mean mg/kg	Lognormal Mean mg/kg	Maximum Detected mg/kg	Standard Deviation mg/kg
Dioxins								
2,3,7,8-TCDD Equiv.	2	2	100	1.35E-04	1.65E-04	1.63E-04	1.95E-04	4.22E-05
Inorganics								
Aluminum	17	17	100	3.35E+03	1.47E+04	1.23E+04	2.67E+04	7.44E+03
Arsenic	14	11	79	1.20E+00	4.50E+00	3.83E+00	8.30E+00	2.25E+00
Barium	17	17	100	3.63E+01	1.81E+02	1.37E+02	6.67E+02	1.52E+02
Beryllium	15	15	100	2.80E-01	1.02E+00	9.19E-01	1.60E+00	4.24E-01
Cadmium	17	6	35	4.20E-01	1.67E+00	8.05E-01	3.70E+00	1.23E+00
Chromium	17	17	100	1.04E+01	3.24E+01	2.88E+01	5.21E+01	1.44E+01
Cobalt	17	17	100	3.00E+00	1.25E+01	1.08E+01	2.26E+01	5.93E+00
Copper	17	17	100	4.50E+00	2.08E+01	1.68E+01	5.00E+01	1.30E+01
Iron	17	17	100	7.65E+03	2.09E+04	1.91E+04	3.11E+04	7.88E+03
Lead[1]	17	17	100	6.80E+00	2.99E+01	2.32E+01	7.92E+01	2.19E+01
Manganese	17	17	100	1.34E+02	4.33E+02	3.74E+02	1.01E+03	2.37E+02
Mercury	17	9	53	2.90E-02	1.05E-01	9.08E-02	2.40E-01	5.83E-02
Nickel	16	16	100	4.20E+00	1.85E+01	1.63E+01	2.77E+01	7.61E+00
Thallium	13	2	15	4.00E+00	4.86E+00	4.85E+00	4.20E+00	3.40E-01
Vanadium	17	17	100	1.31E+01	4.35E+01	3.83E+01	6.71E+01	1.89E+01
Zinc	17	17	100	7.34E+01	4.11E+02	2.95E+02	1.21E+03	3.54E+02
PCBs/Pesticides								
4,4'-DDD	6	6	100	3.20E-05	4.59E-03	9.84E-04	2.30E-02	9.04E-03
4,4'-DDE	6	5	83	5.40E-04	2.21E-03	1.34E-03	6.60E-03	2.48E-03
4,4'-DDT	6	3	50	6.40E-04	3.03E-02	4.22E-03	1.70E-01	6.84E-02
alpha-Chlordane[2]	6	4	67	1.80E-04	8.83E-04	6.33E-04	9.10E-04	7.13E-04
delta-BHC[3]	6	1	17	1.90E-04	1.27E-03	1.04E-03	1.90E-04	6.03E-04
Dieldrin	6	2	33	8.30E-05	1.94E-03	9.26E-04	1.30E-04	1.54E-03
Endrin aldehyde[4]	6	2	33	2.00E-04	1.66E-03	1.06E-03	2.30E-04	1.20E-03
gamma-Chlordane[2]	6	4	67	2.00E-04	8.05E-04	5.49E-04	6.30E-04	7.42E-04
Heptachlor epoxide	6	1	17	4.60E-04	1.24E-03	1.12E-03	4.60E-04	5.23E-04
Methoxychlor	6	3	50	3.20E-04	8.48E-03	3.04E-03	1.00E-03	8.78E-03
Semivolatiles								
Benzo(a)anthracene	17	5	29	2.30E-01	5.25E-01	4.28E-01	4.30E-01	4.03E-01
Benzo(a)pyrene	17	1	6	7.30E-01	5.49E-01	4.71E-01	7.30E-01	3.59E-01
Benzo(b)fluoranthene	17	8	47	4.60E-02	4.89E-01	3.77E-01	8.30E-01	3.90E-01
Benzo(g,h,i)perylene	17	1	6	2.60E-01	5.54E-01	4.60E-01	2.60E-01	3.93E-01
Benzo(k)fluoranthene	17	1	6	1.10E-01	5.65E-01	4.61E-01	1.10E-01	3.94E-01
bis(2-Ethylhexyl)phthalate	14	3	21	2.20E-01	5.91E-01	4.85E-01	3.90E-01	4.23E-01
Chrysene	17	4	24	1.50E-01	5.26E-01	4.20E-01	4.30E-01	4.07E-01
Di-n-butylphthalate	17	3	18	1.60E-01	5.45E-01	4.41E-01	3.70E-01	4.02E-01
Fluoranthene	17	8	47	4.80E-02	5.42E-01	4.49E-01	1.10E+00	2.89E-01
Indeno(1,2,3-c,d)pyrene	17	1	6	2.40E-01	5.52E-01	4.58E-01	2.40E-01	3.94E-01
Naphthalene	17	1	6	4.00E-01	5.85E-01	5.04E-01	4.00E-01	3.76E-01
Phenanthrene	17	7	41	1.80E-01	4.84E-01	3.92E-01	6.40E-01	3.81E-01
Pyrene	17	8	47	4.10E-02	5.43E-01	4.01E-01	8.00E-01	3.89E-01

Table 15
Statistical Summary and COPC Selection for Swimmer Exposed to River Sediments From White Clay Creek
Former Koppers Company, Inc., Newport, DE

Analyte	95% UCL mg/kg	Lognormal 95% UCL mg/kg	Distribution 99% Confidence	Exposure Point Concentration mg/kg	Industrial Soil RBC mg/kg	Is Maximum >RBC?	Is Detection Frequency >5%?
Dioxins							
2,3,7,8-TCDD Equiv.	3.54E-04	8.36E-04	Unknown	1.95E-04	3.80E-05	yes	yes
Inorganics							
Aluminum	1.79E+04	2.28E+04	Normal/Lognormal	2.28E+04	2.00E+06	no	
Arsenic	5.57E+00	7.10E+00	Normal/Lognormal	7.10E+00	3.80E+00	yes	yes
Barium	2.45E+02	2.91E+02	Lognormal	2.91E+02	1.40E+04	no	
Beryllium	1.21E+00	1.40E+00	Normal/Lognormal	1.40E+00	4.10E+02	no	
Cadmium	2.19E+00	1.59E+01	Unknown	3.70E+00	2.00E+02	no	
Chromium	3.85E+01	4.38E+01	Normal/Lognormal	4.38E+01	3.10E+05	no	
Cobalt	1.50E+01	1.81E+01	Normal/Lognormal	1.81E+01	1.20E+04	no	
Copper	2.63E+01	3.22E+01	Normal/Lognormal	3.22E+01	8.20E+03	no	
Iron	2.42E+04	2.71E+04	Normal	2.71E+04	6.10E+04	no	
Lead[1]	3.91E+01	4.74E+01	Normal/Lognormal	4.74E+01	7.50E+02	no	
Manganese	5.34E+02	5.98E+02	Normal/Lognormal	5.98E+02	2.90E+04	no	
Mercury	1.30E-01	1.47E-01	Lognormal	1.47E-01	6.10E+01	no	
Nickel	2.18E+01	2.64E+01	Normal	2.64E+01	4.10E+03	no	
Thallium	5.03E+00	5.05E+00	Unknown	4.20E+00	1.40E+01	no	
Vanadium	5.15E+01	6.09E+01	Normal	6.09E+01	1.40E+03	no	
Zinc	5.61E+02	6.93E+02	Lognormal	6.93E+02	6.10E+04	no	
PCBs/Pesticides							
4,4'-DDD	1.20E-02	1.89E+01	Lognormal	2.30E-02	2.40E+01	no	
4,4'-DDE	4.25E-03	1.82E-02	Normal/Lognormal	6.60E-03	1.70E+01	no	
4,4'-DDT	8.66E-02	1.50E+01	Lognormal	1.70E-01	1.70E+01	no	
alpha-Chlordane[2]	1.47E-03	5.24E-03	Normal/Lognormal	9.10E-04	1.60E+01	no	
delta-BHC[3]	1.77E-03	6.08E-03	Normal	1.90E-04	9.10E-01	no	
Dieldrin	3.20E-03	6.68E-01	Normal/Lognormal	1.30E-04	3.60E-01	no	
Endrin aldehyde[4]	2.65E-03	3.71E-02	Normal/Lognormal	2.30E-04	6.10E+01	no	
gamma-Chlordane[2]	1.42E-03	4.96E-03	Normal/Lognormal	6.30E-04	1.60E+01	no	
Heptachlor epoxide	1.67E-03	2.35E-03	Normal/Lognormal	4.60E-04	6.30E-01	no	
Methoxychlor	1.57E-02	7.37E+00	Normal/Lognormal	1.00E-03	1.00E+03	no	
Semivolatiles							
Benzo(a)anthracene	6.96E-01	7.27E-01	Lognormal	4.30E-01	7.80E+00	no	
Benzo(a)pyrene	7.01E-01	7.33E-01	Lognormal	7.30E-01	7.80E-01	no	
Benzo(b)fluoranthene	6.54E-01	8.16E-01	Lognormal	8.16E-01	7.80E+00	no	
Benzo(g,h,i)perylene	7.20E-01	7.62E-01	Lognormal	2.60E-01	NA	NA	yes
Benzo(k)fluoranthene	7.32E-01	8.39E-01	Lognormal	1.10E-01	7.80E+01	no	
bis(2-Ethylhexyl)phthalate	7.92E-01	8.85E-01	Lognormal	3.90E-01	4.10E+02	no	
Chrysene	6.98E-01	7.62E-01	Lognormal	4.30E-01	7.80E+02	no	
Di-n-butylphthalate	7.15E-01	7.85E-01	Lognormal	3.70E-01	2.00E+04	no	
Fluoranthene	6.65E-01	9.05E-01	Normal/Lognormal	9.05E-01	8.20E+03	no	
Indeno(1,2,3-c,d)pyrene	7.19E-01	7.63E-01	Lognormal	2.40E-01	7.80E+00	no	
Naphthalene	7.45E-01	7.75E-01	Lognormal	4.00E-01	4.10E+03	no	
Phenanthrene	6.46E-01	6.79E-01	Lognormal	6.40E-01	NA	NA	yes
Pyrene	7.08E-01	1.17E+00	Normal	8.00E-01	6.10E+03	no	

Table 15
Statistical Summary and COPC Selection for Swimmer Exposed to River Sediments From White Clay Creek
Former Koppers Company, Inc., Newport, DE

Analyte	Total # of Samples	Hits	Hit Frequency %	Minimum Detected mg/kg	Mean mg/kg	Lognormal Mean mg/kg	Maximum Detected mg/kg	Standard Deviation mg/kg
Volatiles								
2-Butanone	13	3	23	1.00E-02	1.07E-02	9.56E-03	2.60E-02	6.31E-03
Acetone	11	5	45	1.00E-02	3.59E-02	1.85E-02	1.50E-01	4.52E-02
Carbon Disulfide	13	1	8	5.00E-03	7.77E-03	7.63E-03	5.00E-03	1.52E-03
Tetrachloroethene	13	4	31	1.00E-03	7.88E-03	6.93E-03	1.30E-02	3.04E-03
Toluene	13	1	8	1.00E-02	8.15E-03	8.05E-03	1.00E-02	1.39E-03

Table 15
Statistical Summary and COPC Selection for Swimmer Exposed to River Sediments From White Clay Creek Former Koppers Company, Inc., Newport, DE

Analyte	95% UCL mg/kg	Lognormal 95% UCL mg/kg	Distribution 99% Confidence	Exposure Point Concentration mg/kg	Industrial Soil RBC mg/kg	Is Maximum >RBC?	Is Detection Frequency >5%?
Volatiles							
2-Butanone	1.38E-02	1.38E-02	Unknown	1.38E-02	1.20E+05	no	
Acetone	6.06E-02	1.27E-01	Lognormal	1.27E-01	2.00E+04	no	
Carbon Disulfide	8.52E-03	8.66E-03	Normal/Lognormal	5.00E-03	2.00E+04	no	
Tetrachloroethene	9.38E-03	1.32E-02	Normal	1.30E-02	1.10E+02	no	
Toluene	8.84E-03	8.91E-03	Normal/Lognormal	8.91E-03	4.10E+04	no	

* Since the only sediment exposure route evaluated for the swimmer scenario was dermal contact, comparison of maximum concentrations to the industrial soil RBC were most appropriate.
NA - Not available
[1] The screening level of 750 mg/kg is based on US EPA's adult blood lead uptake model under default exposure assumptions.
[2] These compounds have no published RBC or RfD values. They are sufficiently close in toxicity to Chlordane so that the Chlordane RBC is applicable to its congeners as a provisional benchmark.
[3] These compounds have no published RBC or RfD values. They are sufficiently close in toxicity to alpha-BHC so that the alpha-BHC RBC is applicable to its congeners as a provisional benchmark.
[4] These compounds have no published RBC or RfD values. They are sufficiently close in toxicity to Endrin so that the Endrin RBC is applicable to its congeners as a provisional benchmark.

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Table 16
Statistical Summary* and COPC Selection for Angler Ingesting Locally Caught Fish
Former Koppers Company, Inc., Newport, DE

Analyte	Total # of Samples	Hits	Hit Frequency %	Minimum Detected mg/kg	Mean mg/kg	Lognormal Mean mg/kg	Maximum Detected mg/kg	Standard Deviation mg/kg	95% UCL mg/kg	Lognormal 95% UCL mg/kg	Distribution 99% Confidence	Exposure Point Concentration mg/kg	Fish RBC mg/kg	Is Maximum >RBC?	Is Detection Frequency >5%?
Dioxins															
2,3,7,8-TCDD Equiv.	3	3	100	8.02E-07	8.89E-07	8.86E-07	9.90E-07	9.46E-08	1.05E-06	1.10E-06	Normal/Lognormal	9.90E-07	2.10E-08	yes	yes
Inorganics															
Aluminum	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	Normal/Lognormal	2.23E+00	1.40E+02	no	
Arsenic	3	3	100	3.33E-01	5.40E-01	5.17E-01	6.59E-01	1.80E-01	8.43E-01	2.13E+00	Normal/Lognormal	6.59E-01	2.10E-03	yes	yes
Barium	3	3	100	9.41E-02	1.05E-01	1.04E-01	1.27E-01	1.86E-02	1.37E-01	1.53E-01	Normal/Lognormal	1.27E-01	9.50E+00	no	
Chromium	3	3	100	9.52E-02	1.13E-01	1.13E-01	1.26E-01	1.60E-02	1.40E-01	1.55E-01	Normal/Lognormal	1.26E-01	2.00E+02	no	
Copper	3	3	100	4.60E-01	4.98E-01	4.97E-01	5.18E-01	3.30E-02	5.54E-01	5.65E-01	Normal/Lognormal	5.18E-01	5.40E+00	no	
Iron	[illegible]	3	[illegible]	4.20E+00	4.95E+00	4.89E+00	5.80E+00	8.09E-01	6.30E+00	7.03E+00	Normal/Lognormal	5.80E+00	4.10E+01	no	
Lead	3	3	100	1.10E-01	1.19E-01	1.18E-01	1.27E-01	8.55E-03	1.33E-01	1.36E-01	Normal/Lognormal	1.27E-01	NA	NA	yes
Mercury	3	3	100	1.11E-01	1.69E-01	1.59E-01	2.54E-01	7.51E-02	2.95E-01	9.09E-01	Normal/Lognormal	2.54E-01	4.10E-02	yes	yes
Nickel	3	1	33.33	1.74E-01	9.95E-02	8.75E-02	1.74E-01	6.49E-02	2.09E-01	2.79E+00	Normal/Lognormal	1.74E-01	2.70E+00	no	
Selenium	3	3	100	3.69E-01	3.95E-01	3.95E-01	4.28E-01	3.02E-02	4.46E-01	4.56E-01	Normal/Lognormal	4.28E-01	6.80E-01	no	
Zinc	3	3	100	4.47E+00	4.64E+00	4.64E+00	4.85E+00	1.92E-01	4.96E+00	5.00E+00	Normal/Lognormal	4.85E+00	4.10E+01	no	
PCBs/Pesticides															
Aroclor 1254	3	3	100	3.40E-01	3.77E-01	3.75E-01	4.20E-01	4.04E-02	4.45E-01	4.65E-01	Normal/Lognormal	4.20E-01	1.60E-03	yes	yes
Aroclor 1260	3	3	100	1.40E-01	1.93E-01	1.89E-01	2.40E-01	5.03E-02	2.78E-01	4.15E-01	Normal/Lognormal	2.40E-01	1.60E-03	yes	yes
4,4'-DDD	3	3	100	2.40E-02	3.23E-02	3.13E-02	4.40E-02	1.04E-02	4.99E-02	8.26E-02	Normal/Lognormal	4.40E-02	1.30E-02	yes	yes
4,4'-DDE	3	3	100	6.90E-02	9.37E-02	9.03E-02	1.30E-01	3.21E-02	1.48E-01	2.63E-01	Normal/Lognormal	1.30E-01	9.30E-03	yes	yes
Volatiles															
Tetrachloroethene	3	2	66.67	9.00E-04	2.30E-03	1.65E-03	1.00E-03	2.34E-03	6.24E-03	1.32E+01	Normal/Lognormal	1.00E-03	6.10E-02	no	

*Statistics were calculated on a wet-weight basis from data derived from edible fish tissue samples collected in White Clay Creek.

Table 2. Exposure Pathway Analysis for Risk Scenarios Evaluated
[HHRA Table 17]

Table 17
Exposure Pathway Analysis
Former Koppers Company, Inc., Newport, DE

Media	Potential Exposure Point	Potential Exposure Route	Potentially Exposed Population	Selected for Analysis	Data Set to be Used	Exposure Assumptions
Soil, Non-river Sediment	On-site	Dermal contact Ingestion Inhalation	Construction Worker	Yes	Soil and NAPL Data combined	Occupational
	On-site	Dermal contact w/ Ingestion	Industrial Worker	Yes	Soil and NAPL Data combined	Occupational
	On-site	Dermal contact w/ Ingestion	Adolescent Trespasser	Yes	Soil and Non-River Sediment separately	Recreational
	On-site	Dermal contact Ingestion Inhalation	Future On-site Residence	No - Not conducive to residential development	N/A	N/A
River Sediment	On-site	Dermal contact	Adolescent Swimmer	Yes	Christina River, White Clay Creek sediment	Recreational
Non-river Surface Water	On-site	Dermal contact	Adolescent Trespasser	Yes	Non-river, Hershey Run surface water	Recreational
River Surface Water	On-site	Dermal contact Ingestion	Adolescent Swimmer	Yes	Christina River, White Clay Creek surface water	Recreational
Ground Water	On-site	Dermal contact Ingestion Inhalation	Industrial Worker	Yes	Columbia, Potomac aquifer ground water	Occupational
	Future Residential Drinking Water	Ingestion Dermal contact Inhalation	Future On-site Residence	No - Not conducive to residential development	N/A	N/A

Table 17
Exposure Pathway Analysis
Former Koppers Company, Inc., Newport, DE

Media	Potential Exposure Point	Potential Exposure Route	Potentially Exposed Population	Selected for Analysis	Data Set to be Used	Exposure Assumptions
Air						
	On-site	Inhalation	Construction Worker	Yes	Soil/NAPL Data	Occupational
	On-site	Inhalation	Industrial Worker	No - wet conditions preclude volatilization	N/A	N/A
	On-site	Inhalation	Trespasser	No - wet conditions preclude volatilization	N/A	N/A
	On-site	Inhalation	Resident	No - Not conducive to residential development	N/A	N/A
Fish Tissue						
	On-site	Ingestion	Local Fisherperson	Yes	Edible fish filet data	Recreational

N/A Not Applicable

ENVIRONMENTAL STANDARDS

Table 3. RME Exposure Parameters Used in the Assessment of Potential Intakes
[HHRA Table 19]

Table 19
Reasonable Maximum Exposure Parameters Used in the Assessment of Potential Intakes
Former Koppers Company, Inc., Newport, DE

Receptor/Pathway/Route	Contact Rate	Exposure Frequency and Duration	Absorption	Body Weight	Averaging Time
Future Construction Worker					
Soil/NAPL					
Dermal	Total surface area: 20,000 cm^2 (5) Fraction surface area available: 9.1% (2) Exposed surface area: (face, hands) 1820 cm^2	120 days/year (1) 1 year (1) Adherence: 0.11 mg/cm^2 (4)	0.01 for inorganics (7) 0.10 for semivolatiles (7) 0.10 for pesticides/PCBs (7)	70 kg (3)	For noncarcinogenic effects: Exposure is averaged over 1-year period; exposure is of subchronic duration For carcinogenic effects: Exposure is averaged over a 70-year lifetime
Oral	Ingestion Rate: 50 mg/day (6)	120 days/year (1) 1 year (1)		70 kg (3)	For noncarcinogenic effects: Exposure is averaged over 1-year period; exposure is of subchronic duration For carcinogenic effects: Exposure is averaged over a 70-year lifetime
Inhalation	Inhalation Rate: 20 m^3/day (6)	120 days/year (1) 1 year (1)	Retention Factors: Volatiles - 1.0 or 0.5 (11) Dusts - 0.75 (9) Fraction of PM_{15} respirable - 0.84	70 kg (3)	For noncarcinogenic effects: Exposure is averaged over 1-year period; exposure is of subchronic duration For carcinogenic effects: Exposure is averaged over a 70-year lifetime
Future Industrial Worker					
Soil/NAPL					
Dermal	Total surface area: 20,000 cm^2 (5) Fraction surface area available: 9.1% (2) Exposed surface area: (face, hands) 1820 cm^2	134 days/year (8) 25 years (6) Adherence: 0.11 mg/cm^2 (4)	0.01 for inorganics (7) 0.10 for semivolatiles (7) 0.10 for pesticides/PCBs (7)	70 kg (3)	For noncarcinogenic effects: Exposure is averaged over 25-year period; exposure is of chronic duration For carcinogenic effects: Exposure is averaged over a 70-year lifetime

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Receptor/Pathway/Route	Contact Rate	Exposure Frequency and Duration	Absorption	Body Weight	Averaging Time
Oral	Ingestion Rate: 50 mg/day (6)	134 days/year (8) 25 years (6)		70 kg (3)	For noncarcinogenic effects: Exposure is averaged over 25-year period, exposure is of chronic duration For carcinogenic effects Exposure is averaged over a 70-year lifetime
Ground water					
Dermal (while showering)	Total surface area: 20,000 cm^2 (5) Fraction surface area available: 100% (1) Exposed surface area: 20,000 cm^2	15 min/shower (5) 250 showers/year (10) 25 years (6)	chemical specific (5)	70 kg (3)	For noncarcinogenic effects: Exposure is averaged over 25-year period; exposure is of chronic duration For carcinogenic effects: Exposure is averaged over a 70-year lifetime
Oral	Ingestion Rate: 1 L/day (6)	250 days/year (10) 25 years (6)		70 kg (3)	For noncarcinogenic effects: Exposure is averaged over 25-year period; exposure is of chronic duration For carcinogenic effects: Exposure is averaged over a 70-year lifetime
Inhalation (while showering)	Air Exchange Rate: 0.5 /hr (10) Ventiliation Rate: 15 L/min (10) Shower Room Air Volume: 6 m^3 (10)	Duration in Shower Room: 5 min (2) 15 min/shower (4) 250 showers/year (10) 25 years (6)	chemical specific (5)	70 kg (3)	For noncarcinogenic effects: Exposure is averaged over 25-year period, exposure is of chronic duration For carcinogenic effects. Exposure is averaged over a 70-year lifetime
Adolescent Trespasser (Ages 12-18)					
Soil/SNAPL					
Dermal	Total Skin Surface Area 15758 cm^2 (4) Fraction surface area available: 27.8% (2) Exposed surface area (Face, arms, hands, legs) 4381 cm^2	24 events/year (1) 6 years (1) Adherence: 0.025mg/cm^2 (4)	0.01 for inorganics (7) 0.10 for semivolatiles (7) 0.10 for pesticides/PCBs (7)	56 kg (4)	For noncarcinogenic effects. Exposure is averaged over 6-year period; exposure is of subchronic duration For carcinogenic effects: Exposure is averaged over a 70-year lifetime

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Table 19

Reasonable Maximum Exposure Parameters Used in the Assessment of Potential Intakes

Former Koppers Company, Inc., Newport, DE

Receptor/Pathway/Route	Contact Rate	Exposure Frequency and Duration	Absorption	Body Weight	Averaging Time
Oral	Ingestion Rate: 100 mg event (6)	24 events/year (1) 6 years (1)		56 kg (4)	For noncarcinogenic effects: Exposure is averaged over 6-year period; exposure is of subchronic duration For carcinogenic effects: Exposure is averaged over a 70-year lifetime
Sediment					
Dermal	Total Skin Surface Area 15758 cm^2 (4) Fraction surface area available: 7% (2) Exposed surface area: (Face, arms, hands, legs) 1103 cm^2	10 events/year (1) 6 years (1) Adherence: 0.025mg/cm^2 (4)	0.01 for inorganics (7) 0.10 for semivolatiles (7) 0.10 for pesticides/PCBs (7)	56 kg (4)	For noncarcinogenic effects: Exposure is averaged over 6-year period; exposure is of subchronic duration For carcinogenic effects: Exposure is averaged over a 70-year lifetime
Oral	Ingestion Rate: 100 mg/event (6)	10 events/year (1) 6 years (1)		56 kg (4)	For noncarcinogenic effects: Exposure is averaged over 6-year period; exposure is of subchronic duration For carcinogenic effects: Exposure is averaged over a 70-year lifetime
Non-river surface water					
Dermal	Exposed surface area: (Lower legs) 207 cm^2 (5)	1.0 hr/event (5) 24 events/year (1) 6 years (1)	chemical specific (5)	56 kg (4)	For noncarcinogenic effects: Exposure is averaged over 6-year period; exposure is of subchronic duration For carcinogenic effects: Exposure is averaged over a 70-year lifetime
Adolescent Swimmer (Ages 12-18)					
River surface water*					
Dermal	Total Skin Surface Area 15758 cm^2 (4) Fraction surface area available 100% (1)	1.0 hr/event (5) 24 events/year (1) 6 years (1)	0.01 for inorganics (7) 0.10 for semivolatiles (7) 0.10 for pesticides/PCBs (7)	56 kg (4)	For noncarcinogenic effects. Exposure is averaged over 6-year period; exposure is of subchronic duration For carcinogenic effects. Exposure is averaged over a 70-year lifetime

Table 19

Reasonable Maximum Exposure Parameters Used in the Assessment of Potential Intakes

Former Koppers Company, Inc., Newport, DE

Receptor/Pathway/Route	Contact Rate	Exposure Frequency and Duration	Absorption	Body Weight	Averaging Time
Oral	Ingestion Rate: 50 ml/hr (3)	1.0 hr/event (5) 24 events/year (1) 6 years (1)		56 kg (4)	For noncarcinogenic effects: Exposure is averaged over 6-year period; exposure is of subchronic duration For carcinogenic effects: Exposure is averaged over a 70-year lifetime
River sediment					
Dermal	Total Skin Surface Area 15758 cm^2 (4) Fraction surface area available: 7% (2) Exposed surface area: (feet) 1103 cm^2	24 events/year (1) 6 years (1) Adherence: 0.63 mg/cm^2 (4)	0.01 for inorganics (7) 0.10 for semivolatiles (7) 0.10 for pesticides/PCBs (7)	56 kg (4)	For noncarcinogenic effects: Exposure is averaged over 6-year period; exposure is of subchronic duration For carcinogenic effects: Exposure is averaged over a 70-year lifetime
Adult Fisherperson					
Locally caught fish					
Oral	Ingestion Rate: 25 g/day (2)	365 events/year (3) 25 years (1)		70 kg (3)	For noncarcinogenic effects: Exposure is averaged over 25-year period; exposure is of chronic duration For carcinogenic effects: Exposure is averaged over a 70-year lifetime

* These exposure routes could not be evaluated as lead was the only COPC selected and lead does not have published toxicity values.

(1) Best Professional Judgement

(2) US EPA 1996, Exposures Factors Handbook

(3) US EPA, 1989, RAGS Part A

(4) Calculated based on data in US EPA 1996, Exposure Factors Handbook

(5) US EPA, 1992, Dermal Exposure Assessment

(6) US EPA 1991, Human Health Evaluation Manual, Supplemental Guidance, Standard Default Exposure Factors

(7) US EPA 1995, Region III

(8) Calculated based on Michigan Dept. of Natural Resources 1995, Operational Memorandum #14, Rev 2

(9) International Commission on Radiological Protection

(10) Foster and Chrostowski, "Inhalation Exposures to Volatile Organic Contaminants in the Shower."

(11) Depending on whether toxicity benchmark (RfD or CSF) is based on administered or absorbed dose

Table 4. Summary of Toxicity Indices
[HHRA Table 21]

Table 21
Summary of Toxicity Indices
Former Koppers Company, Inc, Newport, DE

Chemical	Oral Chronic RfD mg/kg-day	Sourc	Inhalation Chronic RfD mg/kg-day	Sourc	GI Tract Absorption Factor	Dermal Chronic RfD[1] mg/kg-day	Oral Subchronic RfD mg/kg-day	Sourc	Inhalation Subchronic RfD mg/kg-day	Source	Dermal Subchronic RfD[1] mg/kg-day	Oral CSF 1/(mg/kg-day)	Source	Inhalation CSF 1/(mg/kg-day)	Source	Dermal CSF[1] 1/(mg/kg-day)
Dioxins																
2,3,7,8-TCDD	NA		NA		0.5	NA	NA		NA		NA	1.50E+05	H	1.50E+05	H	3.00E+05
Inorganics																
Antimony	4.00E-04	IRIS	NA		0.01	4.00E-06	4.00E-04	H	NA		4.00E-06	NA		NA		NA
Arsenic	3.00E-04	IRIS	NA		0.95	2.85E-04	3.00E-04	H	NA		2.85E-04	1.50E+00	IRIS	1.51E+01	IRIS	1.58E+00
Beryllium	2.00E-03	IRIS	5.70E-06	IRIS	0.1	2.00E-04	5.00E-03	H	NA		5.00E-04	4.30E+00	IRIS	8.40E+00	IRIS	4.30E+01
Cadmium-Water	5.00E-04	IRIS	5.71E-05	W	0.6	3.00E-04	NA		NA		NA	NA		6.30E+00	IRIS	NA
Copper	4.00E-02	H	NA		0.6	2.40E-02	3.71E-02	H	NA		2.23E-02	NA		NA		NA
Iron	3.00E-01	E	NA		0.5	1.50E-01	NA		NA		NA	NA		NA		NA
Lead	NA		NA		NA	NA	NA		NA		NA	NA		NA		NA
Manganese-water	1.40E-01	IRIS	1.43E-05	IRIS	NA	NA	NA		NA		NA	NA		NA		NA
Manganese-soils	2.00E-02	IRIS	1.43E-05	IRIS	0.05	1.00E-03	1.40E-01	H	NA		7.00E-03	NA		NA		NA
Mercury	NA		8.60E-05	IRIS	0.07	NA	3.00E-04	H	8.57E-05	HE	2.10E-05	NA		NA		NA
Thallium	7.00E-05	O	NA		0.8	5.60E-05	NA		NA		NA	NA		NA		NA
PCBs/Pesticides																
alpha-Chlordane	5.00E-04	IRIS	2.00E-04	IRIS	0.3	1.50E-04	6.00E-05	H	NA		1.80E-05	3.50E-01	IRIS	3.50E-01	IRIS	1.17E+00
Aroclor 1254	2.00E-05	IRIS	NA		0.9	1.80E-05	5.00E-05	H	NA		4.50E-05	2.00E+00	IRIS	2.00E+00	IRIS	2.22E+00
Aroclor 1260	2.00E-05	IRIS	NA		0.9	1.80E-05	NA	H	NA		NA	2.00E+00	IRIS	2.00E+00	IRIS	2.22E+00
4,4'-DDD	NA		NA		0.7	NA	NA		NA		NA	2.40E-01	IRIS	NA		3.43E-01
4,4'-DDE	NA		NA		0.7	NA	NA		NA		NA	3.40E-01	IRIS	NA		4.86E-01
4,4'-DDT	5.00E-04	IRIS	NA		0.7	3.50E-04	5.00E-04	H	NA		3.50E-04	3.40E-01*	IRIS	3.40E-01	IRIS	4.86E-01
Dieldrin	5.00E-05	IRIS	NA		0.3	1.50E-05	5.00E-05	H	NA		1.50E-05	1.60E+01	IRIS	1.60E+01	IRIS	5.33E+01
Heptachlor	5.00E-04	IRIS	NA		0.3	1.50E-04	5.00E-04	H	NA		1.50E-04	4.50E+00	IRIS	4.50E+00	IRIS	1.50E+01
Heptachlor epoxide	1.30E-05	IRIS	NA		0.3	3.90E-06	1.30E-05	H	NA		3.90E-06	9.10E+00	IRIS	9.10E+00	IRIS	3.03E+01
Semivolatiles																
2,4-Dimethylphenol	2.00E-02	IRIS	NA		0.7	1.40E-02	2.00E-01	H	NA		1.40E-01	NA		NA		NA
2-Methylnaphthalene	2.00E-02	O	NA		0.7	1.40E-02	NA		NA		NA	NA		NA		NA
2-Methylphenol	5.00E-02	IRIS	NA		0.7	3.50E-02	5.00E-01	H	NA		3.50E-01	NA		NA		NA
4-Methylphenol	5.00E-03	H	NA		0.7	3.50E-03	5.00E-03	H	NA		3.50E-03	NA		NA		NA
Acenaphthene	6.00E-02	IRIS	NA		0.7	4.20E-02	6.00E-01	H	NA		4.20E-01	NA		NA		NA

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Table 21
Summary of Toxicity Indices
Former Koppers Company, Inc, Newport, DE

Chemical	Oral Chronic RfD mg/kg-day	Sourc	Inhalation Chronic RfD mg/kg-day	Sourc	GI Tract Absorption Factor	Dermal Chronic RfD(1) mg/kg-day	Oral Subchronic RfD mg/kg-day	Sourc	Inhalation Subchronic RfD mg/kg-day	Source	Dermal Subchronic RfD(1) mg/kg-day	Oral CSF 1/(mg/kg-day)	Source	Inhalation CSF 1/(mg/kg-day)	Source	Dermal CSF(1) 1/(mg/kg-day)
Acenaphthylene	NA		NA		NA	NA	NA		NA		NA	NA		NA		NA
Anthracene	3.00E-01	IRIS	NA		0.7	2.10E-01	3.00E+00	H	NA		2.10E+00	NA		NA		NA
Benzo(a)anthracene	NA		NA		NA	NA	NA		NA		NA	7.30E-01	E	NA		NA
Benzo(a)pyrene	NA		NA		NA	NA	NA		NA		NA	7.30E+00	IRIS	3.10E+00	E	NA
Benzo(b)fluoranthene	NA		NA		NA	NA	NA		NA		NA	7.30E-01	E	NA		NA
Benzo(g,h,i)perylene	NA		NA		NA	NA	NA		NA		NA	NA		NA		NA
Benzo(k)fluoranthene	NA		NA		NA	NA	NA		NA		NA	7.30E-02	E	NA		NA
Bis(2-ethylhexyl) phthalate	2.00E-02	IRIS	NA		0.7	1.40E-02	NA		NA		NA	1.40E-02	IRIS	1.40E-02	E	2.00E-02
Carbazole	NA		NA		NA	NA	NA		NA		NA	2.00E-02	H	NA		NA
Chrysene	NA		NA		NA	NA	NA		NA		NA	7.30E-03	E	NA		NA
Dibenz(a,h)anthracene	NA		NA		NA	NA	NA		NA		NA	7.30E+00	E	NA		NA
Dibenzofuran	4.00E-03	E	NA		0.7	2.80E-03	NA		NA		NA	NA		NA		NA
Fluoranthene	4.00E-02	IRIS	NA		0.7	2.80E-02	4.00E-01	H	NA		2.80E-01	NA		NA		NA
Fluorene	4.00E-02	IRIS	NA		0.7	2.80E-02	4.00E-01	H	NA		2.80E-01	NA		NA		NA
Indeno(1,2,3-cd)pyrene	NA		NA		NA	NA	NA		NA		NA	7.30E-01	E	NA		NA
Naphthalene	2.00E-02	IRIS	9.00E-04	IRIS	0.7	1.40E-02	NA		NA		NA	NA		NA		NA
Pentachlorophenol	3.00E-02	IRIS	NA		0.7	2.10E-02	3.00E-02	H	NA		2.10E-02	1.20E-01	IRIS	NA		1.71E-01
Phenanthrene	NA		NA		NA	NA	NA		NA		NA	NA		NA		NA
Phenol	6.00E-01	IRIS	NA		0.7	4.20E-01	6.00E-01	H	NA		4.20E-01	NA		NA		NA
Pyrene	3.00E-02	IRIS	NA		0.7	2.10E-02	3.00E-01	H	NA		2.10E-01	NA		NA		NA
Volatiles																
Benzene	3.00E-03	E	1.70E-03	E	0.95	2.85E-03	NA		NA		NA	2.90E-02	IRIS	2.90E-02	IRIS	3.05E-02
Ethylbenzene	1.00E-01	IRIS	2.90E-01	IRIS	0.95	9.50E-02	NA		NA		NA	NA		NA		NA
Styrene	2.00E-01	IRIS	2.86E-01	IRIS	0.95	1.90E-01	8.57E-01	HE	8.57E-01	HE	NA	NA		NA		NA
Toluene	2.00E-01	IRIS	1.14E-01	IRIS	0.95	1.90E-01	2.00E+00	H	NA		1.90E+00	NA		NA		NA
Xylenes (total)	2.00E+00	IRIS	NA		0.87	1.74E+00	NA		NA		NA	NA		NA		NA

(1) - Published oral toxictiy values were adjusted for gastrointestinal absorption to convert to dermal toxicity values.
H - values are published in HEAST, 1997
HE - values are published in HEAST, 1997 as RfC values and are converted by ESI to RfD values
H2 - values are published in Table 2 - Alternate Methods in HEAST, 1997
IRIS - values are available in IRIS, 1999
NA - published value not available/not applicable
Reg III - Region III Risk Based Concentration Tables - 10/98

Table 5. Summary of Hazard and Estimated Potential Risk Calculations for the Risk Scenarios Evaluated
[HHRA Tables 23 - 26]

Table 23

Summary of Hazard and Estimated Potential Risk Calculations for the Construction Worker

Former Koppers Company, Inc., Newport, DE

Source/Pathway	Potentially Exposed Population	Total Hazard Index	Total Estimated Potential Cancer Risk	Table Referenced
Central Tendency				
Dermal Exposure to Soil	Construction Workers	0.00003	9E-08	27
Ingestion of Soil	Construction Workers	0.0003	8E-08	28
Inhalation of Ambient Air and Dust	Construction Workers	NA	3E-08	29
	Total:	0.0003	2E-07	
Reasonable Maximum				
Dermal Exposure to Soil	Construction Workers	0.0001	4E-07	30
Ingestion of Soil	Construction Workers	0.003	8E-07	31
Inhalation of Ambient Air and Dust	Construction Workers	NA	8E-08	32
	Total:	0.003	1E-06	
Central Tendency w/NAPL				
Dermal Exposure to Soil	Construction Workers	0.00003	9E-08	33
Ingestion of Soil	Construction Workers	0.0003	8E-08	34
Inhalation of Ambient Air and Dust	Construction Workers	NA	3E-08	35
	Total:	0.0003	2E-07	
Reasonable Maximum w/NAPL				
Dermal Exposure to Soil	Construction Workers	0.0001	4E-07	36
Ingestion of Soil	Construction Workers	0.003	2E-06	37
Inhalation of Ambient Air and Dust	Construction Workers	NA	1E-07	38
	Total:	0.003	2E-06	

Table 24

Summary of Hazard and Estimated Potential Risk Calculations for the Industrial Worker

Former Koppers Company, Inc., Newport, DE

Source/Pathway	Potentially Exposed Population	Total Hazard Index	Total Estimated Potential Cancer Risk	Table Referenced
Central Tendency				
Dermal Exposure to Soil	Industrial Workers	0.00009	4E-06	39
Ingestion of Soil	Industrial Workers	0.0002	1E-06	40
	Total:	0.0003	5E-06	
Reasonable Maximum				
Dermal Exposure to Soil	Industrial Workers	0.0019	6E-05	41
Ingestion of Soil	Industrial Workers	0.040	2E-04	42
	Total:	0.04	3E-04	
Central Tendency w/NAPL				
Dermal Exposure to Soil	Industrial Workers	0.00008	4E-06	43
Ingestion of Soil	Industrial Workers	0.0002	1E-06	44
	Total:	0.0003	5E-06	
Reasonable Maximum w/NAPL				
Dermal Exposure to Soil	Industrial Workers	0.003	6E-05	45
Ingestion of Soil	Industrial Workers	0.05	3E-04	46
	Total:	0.05	3E-04	
Columbia Aquifer - Central Tendency				
Dermal Exposure to Ground Water	Industrial Workers	0.61	8E-06	47
Ingestion of Ground Water	Industrial Workers	0.25	5E-06	48
Inhalation of VOC Vapors	Industrial Workers	NA	2E-10	49
	Total:	0.86	1E-05	
Columbia Aquifer - Reasonable Maximum				
Dermal Exposure to Ground Water	Industrial Workers	0.73	4E-05	50
Ingestion of Ground Water	Industrial Workers	0.52	2E-05	51
Inhalation of VOC Vapors	Industrial Workers	NA	1E-09	52
	Total:	1.2	6E-05	

Table 24
Summary of Hazard and Estimated Potential Risk Calculations for the Industrial Worker
Former Koppers Company, Inc., Newport, DE

Source/Pathway	Potentially Exposed Population	Total Hazard Index	Total Estimated Potential Cancer Risk	Table Referenced
Columbia Aquifer - Central Tendency with MW-2 and MW-8				
Dermal Exposure to Ground Water	Industrial Workers	44.9	1E+00	53
Ingestion of Ground Water	Industrial Workers	104.5	1E-01	54
Inhalation of VOC Vapors	Industrial Workers	0.0000009	1E-06	55
	Total:	149.35	1E+00	
Columbia Aquifer - Reasonable Maximum with MW-2 and MW-8				
Dermal Exposure to Ground Water	Industrial Workers	115	1E+00	56
Ingestion of Ground Water	Industrial Workers	170	5E-01	57
Inhalation of VOC Vapors	Industrial Workers	0.0033	7E-06	58
	Total:	284.86	1E+00	
Potomac Aquifer - Central Tendency				
Dermal Exposure to Ground Water	Industrial Workers	0.07	4E-07	59
Ingestion of Ground Water	Industrial Workers	0.06	4E-08	60
Inhalation of VOC Vapors	Industrial Workers	NA	4E-12	61
	Total:	0.13	5E-07	
Potomac Aquifer - Reasonable Maximum				
Dermal Exposure to Ground Water	Industrial Workers	0.08	2E-06	62
Ingestion of Ground Water	Industrial Workers	0.06	2E-07	63
Inhalation of VOC Vapors	Industrial Workers	NA	3E-11	64
	Total:	0.14	2E-06	

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Table 25

Summary of Hazard and Estimated Potential Risk Calculations for the Adolescent Trespasser

Former Koppers Company, Inc., Newport, DE

Source/Pathway	Potentially Exposed Population	Total Hazard Index	Total Estimated Potential Cancer Risk	Table Referenced
Central Tendency				
Dermal Exposure to Soil	Adolescent Trespassers	0.00002	6E-07	65
Ingestion of Soil	Adolescent Trespassers	0.00005	5E-07	66
	Total:	0.0001	1E-06	
Reasonable Maximum				
Dermal Exposure to Soil	Adolescent Trespassers	0.00008	2E-06	67
Ingestion of Soil	Adolescent Trespassers	0.004	5E-05	68
	Total:	0.004	5E-05	
Central Tendency w/NAPL				
Dermal Exposure to Soil	Adolescent Trespassers	0.00002	6E-07	69
Ingestion of Soil	Adolescent Trespassers	0.00005	4E-07	70
	Total:	0.00007	1E-06	
Reasonable Maximum w/NAPL				
Dermal Exposure to Soil	Adolescent Trespassers	0.00005	2E-06	71
Ingestion of Soil	Adolescent Trespassers	0.004	4E-05	72
	Total:	0.004	4E-05	
Central Tendency				
Dermal Exposure to Non-River Surface Water	Adolescent Trespassers	0.0000002	2E-05	73
	Total:	0.0000002	2E-05	
Reasonable Maximum				
Dermal Exposure to Non-River Surface Water	Adolescent Trespassers	0.0000008	6E-05	74
	Total:	0.0000008	6E-05	
Central Tendency				
Dermal Exposure to Non-River Sediment	Adolescent Trespassers	0.000007	8E-09	75
Ingestion of Non-River Sediment	Adolescent Trespassers	0.00004	5E-08	76
	Total:	0.00005	6E-08	
Reasonable Maximum				
Dermal Exposure to Non-River Sediment	Adolescent Trespassers	0.00002	3E-08	77
Ingestion of Non-River Sediment	Adolescent Trespassers	0.003	5E-06	78
	Total:	0.003	5E-06	

Table 26
Summary of Hazard and Estimated Potential Risk Calculations for the Adolescent Swimmer and Angler
Former Koppers Company, Inc., Newport, DE

Source/Pathway	Potentially Exposed Population	Total Hazard Index	Total Estimated Potential Cancer Risk	Table Referenced
Central Tendency				
Dermal Exposure to Christina River Sediment	Adolescent Swimmers	0.001	2E-08	79
	Total:	0.001	2E-08	
Reasonable Maximum				
Dermal Exposure to Christina River Sediment	Adolescent Swimmers	0.006	9E-08	80
	Total:	0.006	9E-08	
Central Tendency				
Dermal Exposure to White Clay Creek Sediment	Adolescent Swimmers	0.00004	2E-09	81
	Total:	0.00004	2E-09	
Reasonable Maximum				
Dermal Exposure to White Clay Creek Sediment	Adolescent Swimmers	0.0002	8E-09	82
	Total:	0.0002	8E-09	
Central Tendency				
Ingestion of Locally Caught Fish	Anglers	4	3E-05	83
	Total:	4	3E-05	
Reasonable Maximum				
Ingestion of Locally Caught Fish	Anglers	13	3E-04	84
	Total:	13	3E-04	

Table 6. RME Risk Calculations for the Exposure Pathways and Risk Scenarios Evaluated
[HHRA Tables 30 – 84, non-inclusive]

Table 30

Reasonable Maximum Dermal Exposure to Soil by a Construction Worker

Former Koppers Company, Inc, Newport, DE

$$\text{Intake (mg/kg-day)} = \frac{Cs*SA*FX*AF*ABS*EF*ED*CF}{BW*AT}$$

Cs - Concentration in soil =	mg/kg	chemical specific	
SA - Adult skin surface area available for exposure =	cm^2/day	1820	calculated
SA_t - Total Adult Surface area =	cm^2	20000	USEPA 1989, EFH
F_s - Fraction of skin surface area available for exposure =		9.1%	reasonable maximum
FX - Fraction of exposed skin covered with soil =		100%	reasonable maximum
AF -Soil Adherence Factor =	mg/cm^2	0.11	USEPA 1995, EFH
ABS_d - Absorption for dioxins =		0.1	US EPA 1995, Region III
ABS_i - Absorption for inorganics =		0.01	USEPA 1995, Region III
EF - Exposure frequency =	days/year	80	Reasonable maximum
ED - Exposure duration =	years	1	Reasonable maximum
CF - Conversion factor (1 kg/1,000,000 mg) =	kg/mg	1.00E-06	
BW - Body weight =	kg	70	USEPA 1991, HHEM
AT_n - Averaging Time noncarcinogenic =	days	365	Reasonable maximum
AT_c - Averaging Time carcinogenic =	days	25550	USEPA 1991, HHEM

Analyte	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Dermal Subchronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Dioxins							
2,3,7,8- TCDD Equiv.	1.37E-03	8.59E-11	NA	NA	1.23E-12	3.00E+05	3.68E-07
Inorganics							
Arsenic	5.61E+00	3.52E-08	2.85E-04	1.23E-04	5.02E-10	1.58E+00	7.93E-10
Thallium	6.33E+00	3.97E-08	NA	NA	5.67E-10	NA	NA

NA - Not available — Total Hazard Index: 0.0001 — Total Cancer Risk: 3.69E-07

Table 31

Reasonable Maximum Exposure by Ingestion of Soil by a Construction Worker

Former Koppers Company, Inc, Newport, DE

Intake (mg/kg-day) = $\frac{Cs*IngR*EF*ED*CF*FI}{BW*AT}$

Cs - Concentration in soil	mg/kg	chemical specific	
IngR - Ingestion rate =	mg/day	50	USEPA 1991, HHEM
EF - Exposure frequency =	days/year	80	Reasonable maximum
ED - Exposure duration =	years	1	Reasonable maximum
CF - Conversion factor (1 kg/1,000,000 mg) =	kg/mg	1.00E-06	
FI - Fraction of total daily soil ingested at site =		1	reasonable maximum
BW - Body weight	kg	70	USEPA 1991, HHEM
AT_n - Averaging Time noncarcinogenic =	days	365	Reasonable maximum
AT_c - Averaging Time carcinogenic =	days	25550	USEPA 1991, HHEM

Chemical	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Oral Subchronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Slope Factor 1/(mg/kg-day)	Cancer Risk
Dioxins							
2,3,7,8-TCDD Equiv.	1.37E-03	2.15E-10	NA	NA	3.07E-12	1.50E+05	4.60E-07
Inorganics							
Arsenic	5.61E+00	8.78E-07	3.00E-04	2.93E-03	1.25E-08	1.50E+00	1.88E-08
Thallium	6.33E+00	9.92E-07	NA	NA	1.42E-08	NA	NA
Semivolatiles							
Acenaphthylene	6.34E+00	9.93E-07	NA	NA	1.42E-08	NA	NA
Benzo(a)anthracene	5.62E+01	8.80E-06	NA	NA	3.65E-08	7.30E-01	2.66E-08
Benzo(a)pyrene	4.24E+01	6.64E-06	NA	NA	2.75E-08	7.30E+00	2.01E-07
Benzo(b)fluoranthene	1.02E+02	1.60E-05	NA	NA	6.63E-08	7.30E-01	4.84E-08
Benzo(g,h,i)perylene	2.43E+01	3.80E-06	NA	NA	5.43E-08	NA	NA
Benzo(k)fluoranthene	2.27E+01	3.55E-06	NA	NA	1.47E-08	7.30E-02	1.07E-09
Carbazole	7.59E+00	1.19E-06	NA	NA	4.92E-09	2.00E-02	9.85E-11
Dibenz(a,h)anthracene	7.15E+00	1.12E-06	NA	NA	4.64E-09	7.30E+00	3.39E-08
Indeno(1,2,3-c,d)pyrene	2.89E+01	4.53E-06	NA	NA	1.87E-08	7.30E-01	1.37E-08
Phenanthrene	5.65E+01	8.85E-06	NA	NA	1.26E-07	NA	NA

NA - Not available Total Hazard Index: 0.003 Total Cancer Risk: 8.03E-07

Table 32

Reasonable Maximum Exposure to Construction Worker via Inhalation of Vapors and Dust

Former Koppers Company, Inc, Newport, DE

Intake (mg/kg-day) = $\frac{Ca*InhR*EF*ED*RA*RF}{BW*AT}$

Ca - Concentration in air =	mg/m^3	chem.spec.	
InhR - Inhalation Rate =	m^3/day	20	USEPA 1991, HHEM
EF - Exposure Frequency =	days/year	80	Reasonable maximum
ED - Exposure Duration =	years	1	Reasonable maximum
RA - Fraction of PM_{15} respirable (≤ 10 um) =		0.84	Cowherd, 1985
RF - Retention Factor for dusts (non-VOAs) =		0.75	Reasonable maximum
BW - Body Weight =	kg	70	USEPA 1991, HHEM
AT_n - Averaging Time noncarcinogenic =	days	365	Reasonable maximum
AT_c - Averaging Time carcinogenic =	days	25550	USEPA 1991, HHEM

Ca = Concentration in Air (mg/m^3) = $E_i/(H_b*W_b*V)$

E_i - Emission Rate of Component (mg/sec) = chemical specific

H_b - Downwind Ht (m) = 5.11

W_b - Width (m) = 55

V - Wind speed (m/sec) = 4.99

Length (downwind distance) (m) = 55

r - Roughness Ht. (m) = 0.20

z - downwind distance (m) = 55

$z = 6.25r[H_b/r * Ln(H_b/r) - 1.58*H_b/r + 1.58]$

E_i - Emission Rate (mg/sec) = $C_s*(PER_v+PER_e)$

C_s - Concentration in soil =	mg/kg	chem.spec.
PER_v - Fugitive Dust Emission Rate (Vehicular movement) =	kg/sec	2.93E-05
PER_e - Fugitive Dust Emission Rate (Excavation) =	kg/sec	4.21E-04

Chemicals	Concentration in Soil mg/kg	Emission Rate mg/sec	Concentration in Air mg/m^3	Average Daily Intake mg/kg-day	Inhalation Subchronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Inhalation Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Dioxins									
2,3,7,8-TCDD Equiv.	1.37E-03	6.17E-07	4.40E-10	1.74E-11	NA	NA	2.48E-13	1.50E+05	3.72E-08
Inorganics									
Arsenic	5.61E+00	2.52E-03	1.80E-06	7.10E-08	NA	NA	1.01E-09	1.51E+01	1.53E-08
Thallium	6.33E+00	2.85E-03	2.03E-06	8.02E-08	NA	NA	1.15E-09	NA	NA
Semivolatiles									
Acenaphthylene	6.34E+00	2.85E-03	2.04E-06	8.03E-08	NA	NA	1.15E-09	NA	NA
Benzo(a)anthracene	5.62E+01	2.53E-02	1.80E-05	7.12E-07	NA	NA	1.02E-08	NA	NA
Benzo(a)pyrene	4.24E+01	1.91E-02	1.36E-05	5.37E-07	NA	NA	7.67E-09	3.10E+00	2.38E-08
Benzo(b)fluoranthene	1.02E+02	4.60E-02	3.28E-05	1.29E-06	NA	NA	1.85E-08	NA	NA
Benzo(g,h,i)perylene	2.43E+01	1.09E-02	7.79E-06	3.07E-07	NA	NA	4.39E-09	NA	NA
Benzo(k)fluoranthene	2.27E+01	1.02E-02	7.28E-06	2.87E-07	NA	NA	4.10E-09	NA	NA
Carbazole	7.59E+00	3.42E-03	2.44E-06	9.61E-08	NA	NA	1.37E-09	NA	NA
Dibenz(a,h)anthracene	7.15E+00	3.22E-03	2.30E-06	9.06E-08	NA	NA	1.29E-09	NA	NA
Indeno(1,2,3-c,d)pyrene	2.89E+01	1.30E-02	9.27E-06	3.66E-07	NA	NA	5.23E-09	NA	NA
Phenanthrene	5.65E+01	2.54E-02	1.81E-05	7.16E-07	NA	NA	1.02E-08	NA	NA

NA - Not available

Total Hazard Index: NA

Total Cancer Risk: 7.63E-08

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Table 36

Reasonable Maximum Dermal Exposure to Soil and NAPL by a Construction Worker

Former Koppers Company, Inc, Newport, DE

$$\text{Intake (mg/kg-day)} = \frac{Cs*SA*FX*AF*ABS*EF*ED*CF}{BW*AT}$$

Cs - Concentration in soil and NAPL =	mg/kg	chemical specific	
SA - Adult skin surface area available for exposure =	cm^2/day	1820	calculated
SA_t - Total Adult Surface area =	cm^2	20000	USEPA 1989, EFH
F_s - Fraction of skin surface area available for exposure =		9.1%	reasonable maximum
FX - Fraction of exposed skin covered with soil =		100%	reasonable maximum
AF -Soil Adherence Factor =	mg/cm^2	0.11	USEPA 1995, EFH
ABS_d - Absorption for dioxins =		0.1	US EPA 1995, Region III
ABS_i - Absorption for inorganics =		0.01	USEPA 1995, Region III
EF - Exposure frequency =	days/year	80	Reasonable maximum
ED - Exposure duration =	years	1	Reasonable maximum
CF - Conversion factor (1 kg/1,000,000 mg) =	kg/mg	1.00E-06	
BW - Body weight =	kg	70	USEPA 1991, HHEM
AT_n - Averaging Time noncarcinogenic =	days	365	Reasonable maximum
AT_c - Averaging Time carcinogenic =	days	25550	USEPA 1991, HHEM

Analyte	Concentration in Soil and NAPL mg/kg	Average Daily Intake mg/kg-day	Dermal Subchronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Dioxins							
2,3,7,8-TCDD Equiv.	1.37E-03	8.59E-11	NA	NA	1.23E-12	3.00E+05	3.68E-07
Inorganics							
Arsenic	5.71E+00	3.58E-08	2.85E-04	1.26E-04	5.11E-10	1.58E+00	8.07E-10
Iron	1.94E+04	1.21E-04	NA	NA	1.74E-06	NA	NA
Lead	3.34E+01	2.10E-07	NA	NA	2.99E-09	NA	NA
Thallium	5.85E+00	3.67E-08	NA	NA	5.24E-10	NA	NA

NA - Not available

Total Hazard Index: 0.0001

Total Cancer Risk: 3.69E-07

Table 37

Reasonable Maximum Exposure by Ingestion of Soil and NAPL by a Construction Worker

Former Koppers Company, Inc, Newport, DE

Intake (mg/kg-day) = $\frac{Cs*IngR*EF*ED*CF*FI}{BW*AT}$

Cs - Concentration in soil and NAPL =	mg/kg	chemical specific	
IngR - Ingestion rate =	mg/day	50	USEPA 1991, HHEM
EF - Exposure frequency =	days/year	80	Reasonable maximum
ED - Exposure duration =	years	1	Reasonable maximum
CF - Conversion factor (1 kg/1,000,000 mg) =	kg/mg	1.00E-06	
FI - Fraction of total daily soil ingested at site =		1	reasonable maximum
BW - Body weight =	kg	70	USEPA 1991, HHEM
AT_n - Averaging Time noncarcinogenic =	days	365	Reasonable maximum
AT_c - Averaging Time carcinogenic =	days	25550	USEPA 1991, HHEM

Chemical	Concentration in Soil and NAPL mg/kg	Average Daily Intake mg/kg-day	Oral Subchronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Slope Factor 1/(mg/kg-day)	Cancer Risk
Dioxins							
2,3,7,8-TCDD Equiv.	1.37E-03	2.15E-10	NA	NA	3.07E-12	1.50E+05	4.60E-07
Inorganics							
Arsenic	5.71E+00	8.93E-07	3.00E-04	2.98E-03	1.28E-08	1.50E+00	1.91E-08
Iron	1.94E+04	3.03E-03	NA	NA	4.33E-05	NA	NA
Lead	3.34E+01	5.23E-06	NA	NA	7.48E-08	NA	NA
Thallium	5.85E+00	9.16E-07	NA	NA	1.31E-08	NA	NA
Semivolatiles							
Acenaphthylene	5.41E+00	8.48E-07	NA	NA	1.21E-08	NA	NA
Benzo(a)anthracene	5.92E+01	9.27E-06	NA	NA	1.32E-07	7.30E-01	9.67E-08
Benzo(a)pyrene	4.66E+01	7.30E-06	NA	NA	1.04E-07	7.30E+00	7.61E-07
Benzo(b)fluoranthene	1.12E+02	1.75E-05	NA	NA	2.50E-07	7.30E-01	1.82E-07
Benzo(k)fluoranthene	2.45E+01	3.84E-06	NA	NA	5.49E-08	7.30E-02	NA
Benzo(g,h,i)perylene	2.08E+01	3.26E-06	NA	NA	4.65E-08	NA	NA
Carbazole	6.63E+00	1.04E-06	NA	NA	1.48E-08	2.00E-02	2.96E-10
Chrysene	7.33E+01	1.15E-05	NA	NA	1.64E-07	7.30E-03	1.20E-09
Dibenz(a,h)anthracene	6.58E+00	1.03E-06	NA	NA	1.47E-08	7.30E+00	1.07E-07
Fluoranthene	2.09E+02	3.27E-05	4.00E-01	8.17E-05	4.67E-07	NA	NA
Indeno(1,2,3-c,d)pyrene	2.95E+01	4.62E-06	NA	NA	6.59E-08	7.30E-01	4.81E-08
Phenanthrene	4.98E+01	7.80E-06	NA	NA	1.11E-07	NA	NA

NA - Not available

Total Hazard Index: 0.003

Total Cancer Risk: 1.68E-06

Table 38

Reasonable Maximum Exposure to Construction Worker via Inhalation of Vapors and Dust*

Former Koppers Company, Inc, Newport, DE

$$\text{Intake (mg/kg-day)} = \frac{Ca*InhR*EF*ED*RA*RF}{BW*AT}$$

Ca - Concentration in air =	mg/m^3	chem.spec.	
InhR - Inhalation Rate =	m^3/day	20	USEPA 1991, HHEM
EF - Exposure Frequency =	days/year	80	Reasonable maximum
ED - Exposure Duration =	years	1	Reasonable maximum
RA - Fraction of PM_{15} respirable (≤ 10 um) =		0.84	Cowherd, 1985
RF - Retention Factor for dusts (non-VOAs) =		0.75	Reasonable maximum
BW - Body Weight =	kg	70	USEPA 1991, HHEM
AT_n - Averaging Time noncarcinogenic =	days	365	Reasonable maximum
AT_c - Averaging Time carcinogenic =	days	25550	USEPA 1991, HHEM

Ca = Concentration in Air (mg/m^3) = E_i /(H_b*W_b*V)

E_i - Emission Rate of Component (mg/sec) = chemical specific

H_b - Downwind Ht (m) = 5.11

W_b - Width (m) = 55

V - Wind speed (m/sec) = 4.99

Length (downwind distance) (m) = 55

r - Roughness Ht. (m) = 0.20

z - downwind distance (m) = 55

$z = 6.25r[H_b/r * Ln(H_b/r) - 1.58*H_b/r + 1.58]$

E_i - Emission Rate (mg/sec) = C_s*(PER_v+PER_e)

C_s - Concentration in soil and NAPL =	mg/kg	chem.spec.	
PER_v - Fugitive Dust Emission Rate (Vehicular movement) =	kg/sec	2.93E-04	Calculated
PER_e - Fugitive Dust Emission Rate (Excavation) =	kg/sec	4.21E-04	Calculated

Chemicals	Concentration in Soil and NAPL mg/kg	Emission Rate mg/sec	Concentration in Air mg/m^3	Average Daily Intake mg/kg-day	Inhalation Subchronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Inhalation Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Dioxins									
2,3,7,8-TCDD Equiv	1.37E-03	9.79E-07	6.98E-10	2.75E-11	NA	NA	3.93E-13	1.50E+05	5.90E-08
Inorganics									
Arsenic	5.71E+00	4.08E-03	2.91E-06	1.15E-07	NA	NA	1.64E-09	1.51E+01	2.47E-08
Iron	1.94E+04	1.38E+01	9.86E-03	3.89E-04	NA	NA	5.56E-06	NA	NA
Lead	3.34E+01	2.39E-02	1.70E-05	6.71E-07	NA	NA	9.59E-09	NA	NA
Thallium	5.85E+00	4.18E-03	2.98E-06	1.18E-07	NA	NA	1.68E-09	NA	NA
Semivolatiles									
Acenaphthylene	5.41E+00	3.87E-03	2.76E-06	1.09E-07	NA	NA	1.55E-09	NA	NA
Benzo(a)anthracene	5.92E+01	4.23E-02	3.02E-05	1.19E-06	NA	NA	1.70E-08	NA	NA
Benzo(a)pyrene	4.66E+01	3.33E-02	2.37E-05	9.36E-07	NA	NA	1.34E-08	3.10E+00	4.15E-08
Benzo(b)fluoranthene	1.12E+02	7.97E-02	5.68E-05	2.24E-06	NA	NA	3.20E-08	NA	NA
Benzo(k)fluoranthene	2.45E+01	1.75E-02	1.25E-05	4.93E-07	NA	NA	7.04E-09	NA	NA
Benzo(g,h,i)perylene	2.08E+01	1.49E-02	1.06E-05	4.18E-07	NA	NA	5.97E-09	NA	NA
Carbazole	6.63E+00	4.73E-03	3.37E-06	1.33E-07	NA	NA	1.90E-09	NA	NA

Table 38

Reasonable Maximum Exposure to Construction Worker via Inhalation of Vapors and Dust*

Former Koppers Company, Inc, Newport, DE

Intake (mg/kg-day) = $\frac{Ca*InhR*EF*ED*RA*RF}{BW*AT}$

Ca - Concentration in air =	mg/m^3	chem.spec.	
InhR - Inhalation Rate =	m^3/day	20	USEPA 1991, HHEM
EF - Exposure Frequency =	days/year	80	Reasonable maximum
ED - Exposure Duration =	years	1	Reasonable maximum
RA - Fraction of PM_{15} respirable (≤ 10 um) =		0.84	Cowherd, 1985
RF - Retention Factor for dusts (non-VOAs) =		0.75	Reasonable maximum
BW - Body Weight =	kg	70	USEPA 1991, HHEM
AT_n - Averaging Time noncarcinogenic =	days	365	Reasonable maximum
AT_c - Averaging Time carcinogenic =	days	25550	USEPA 1991, HHEM

Ca – Concentration in Air (mg/m^3) = $E_i/(H_b*W_b*V)$

E_i - Emission Rate of Component (mg/sec) = chemical specific

H_b - Downwind Ht (m) = 5.11

W_b - Width (m) = 55

V - Wind speed (m/sec) = 4.99

Length (downwind distance) (m) = 55

r - Roughness Ht. (m) = 0.20

z - downwind distance (m) = 55

$z = 6.25r[H_b/r * Ln(H_b/r) - 1.58*H_b/r + 1.58]$

E_i - Emission Rate (mg/sec) = $C_s*(PER_v+PER_e)$

C_s - Concentration in soil and NAPL =	mg/kg	chem spec.	
PER_v - Fugitive Dust Emission Rate (Vehicular movement) =	kg/sec	2.93E-04	Calculated
PER_e - Fugitive Dust Emission Rate (Excavation) =	kg/sec	4.21E-04	Calculated

Chemicals	Concentration in Soil and NAPL mg/kg	Emission Rate mg/sec	Concentration in Air mg/m^3	Average Daily Intake mg/kg-day	Inhalation Subchronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Inhalation Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Chrysene	7.33E+01	5.24E-02	3.73E-05	1.47E-06	NA	NA	2.10E-08	NA	NA
Dibenz(a,h)anthracene	6.58E+00	4.70E-03	3.35E-06	1.32E-07	NA	NA	1.89E-09	NA	NA
Fluoranthene	2.09E+02	1.49E-01	1.06E-04	4.19E-06	NA	NA	5.99E-08	NA	NA
Indeno(1,2,3-c,d)pyrene	2.95E+01	2.11E-02	1.50E-05	5.92E-07	NA	NA	8.46E-09	NA	NA
Phenanthrene	4.98E+01	3.56E-02	2.54E-05	1.00E-06	NA	NA	1.43E-08	NA	NA

Total Hazard Index: NA   Total Cancer Risk: 1.25E-07

* Includes NAPL data

NA - Not available

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ENVIRONMENTAL STANDARDS

Table 41

Reasonable Maximum Dermal Exposure to Soil by an Industrial Worker

Former Koppers Company, Inc, Newport, DE

Intake (mg/kg-day) = $\frac{Cs * SA * FX * AF * ABS * EF * ED * CF}{BW * AT}$

Cs - Concentration in soil =	mg/kg	chemical specific	
SA - Adult skin surface area available for exposure =	cm^2/day	1820	calculated
SA_t - **Total** Adult Surface area =	cm^2	20000	USEPA 1989, EFH
F_s - Fraction of skin surface area available for exposure =		9.1%	reasonable maximum
FX - Fraction of exposed skin covered with soil =		100%	reasonable maximum
AF -Soil Adherence Factor =	mg/cm^2	0.11	USEPA 1995, EFH
ABS_d - Absorption for dioxins =		0.1	US EPA 1995, Region III
ABS_n - Absorption for inorganics =		0.01	USEPA 1995, Region III
EF - Exposure frequency =	days/year	134	reasonable maximum
ED - Exposure duration =	years	25	USEPA 1991, HHEM
CF - Conversion factor (1 kg/1,000,000 mg)-	kg/mg	1.00E-06	
BW - Body weight =	kg	70	USEPA 1991, HHEM
AT_n - Averaging Time noncarcinogenic =	days	9125	USEPA 1991, HHEM
AT_c - Averaging Time carcinogenic =	days	25550	USEPA 1991, HHEM

Analyte	**Concentration in Soil mg/kg**	**Average Daily Intake mg/kg-day**	**Dermal Chronic RfD mg/kg-day**	**Hazard Index**	**Average Lifetime Daily Intake mg/kg-day**	**Cancer Slope Factor 1/(mg/kg-day)**	**Cancer Risk**
Dioxins							
2,3,7,8-TCDD Equiv.	5.44E-03	5.71E-10	NA	NA	2.04E-10	3.00E+05	6.12E-05
Inorganics							
Arsenic	8.56E+00	8.99E-08	2.85E-04	3.15E-04	3.21E-08	1.58E+00	5.07E-08
Thallium	8.56E+00	8.99E-08	5.60E-05	1.61E-03	3.21E-08	NA	NA
NA - Not available			Total Hazard Index:	0.0019			6.13E-05

Table 42
Reasonable Maximum Exposure by Ingestion of Soil by an Industrial Worker
Former Koppers Company, Inc, Newport, DE

Intake (mg/kg-day) = $\frac{Cs * IngR * EF * ED * CF * FI}{BW * AT}$

C_s - Concentration in soil =	mg/kg	chemical specific	
$I_{ng}R$ - Ingestion rate =	mg/day	50	USEPA 1991, HHEM
EF - Exposure frequency =	days/year	134	reasonable maximum
ED - Exposure duration =	years	25	USEPA 1991, HHEM
CF - Conversion factor (1 kg/1,000,000 mg)=	kg/mg	1.00E-06	
FI - Fraction of total daily soil ingested at site =		1	reasonable maximum
BW - Body weight =	kg	70	USEPA 1991, HHEM
AT_n - Averaging Time noncarcinogenic =	days	9125	USEPA 1991, HHEM
AT_c - Averaging Time carcinogenic =	days	25550	USEPA 1991, HHEM

Analyte	Concentration in Soil mg/kg	Average Daily Intake mg/kg-day	Oral Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Dioxins							
2,3,7,8-TCDD Equiv.	5.44E-03	1.43E-09	NA	NA	5.10E-10	1.50E+05	7.64E-05
Inorganics							
Arsenic	8.56E+00	2.24E-06	3.00E-04	7.48E-03	8.02E-07	1.50E+00	1.20E-06
Thallium	8.56E+00	2.25E-06	7.00E-05	3.21E-02	8.02E-07	NA	NA
Semivolatiles							
Acenaphthylene	1.30E+01	3.41E-06	NA	NA	1.22E-06	NA	NA
Benzo(a)anthracene	1.70E+02	4.46E-05	NA	NA	1.59E-05	7.30E-01	1.16E-05
Benzo(a)pyrene	1.61E+02	4.21E-05	NA	NA	1.50E-05	7.30E+00	1.10E-04
Benzo(b)fluoranthene	3.70E+02	9.70E-05	NA	NA	3.47E-05	7.30E-01	2.53E-05
Benzo(g,h,i)perylene	8.16E+01	2.14E-05	NA	NA	7.64E-06	NA	NA
Benzo(k)fluoranthene	1.10E+02	2.88E-05	NA	NA	1.03E-05	7.30E-02	7.52E-07
Carbazole	2.96E+01	7.76E-06	NA	NA	2.77E-06	2.00E-02	5.55E-08
Dibenz(a,h)anthracene	1.99E+01	5.21E-06	NA	NA	1.86E-06	7.30E+00	1.36E-05
Indeno(1,2,3-c,d)pyrene	1.10E+02	2.88E-05	NA	NA	1.03E-05	7.30E-01	7.52E-06
Phenanthrene	5.16E+01	1.35E-05	NA	NA	4.83E-06	NA	NA

NA - Not available | Total Hazard Index: 0.040 | 2.46E-04

Table 45

Reasonable Maximum Dermal Exposure to Soil and NAPL by an Industrial Worker

Former Koppers Company, Inc, Newport, DE

$$\text{Intake (mg/kg-day)} = \frac{Cs * SA * FX * AF * ABS * EF * ED * CF}{BW * AT}$$

Cs - Concentration in soil and NAPL =	mg/kg	chemical specific	
SA - Adult skin surface area available for exposure =	cm^2/day	1820	calculated
SA_t - Total Adult Surface area =	cm^2	20000	USEPA 1989, EFH
F_s - Fraction of skin surface area available for exposure =		9.1%	reasonable maximum
FX - Fraction of exposed skin covered with soil =		100%	reasonable maximum
AF -Soil Adherence Factor =	mg/cm^2	0.11	USEPA 1995, EFH
ABS_d - Absorption for dioxins =		0.1	US EPA 1995, Region III
ABS_n - Absorption for inorganics =		0.01	USEPA 1995, Region III
EF - Exposure frequency =	days/year	134	reasonable maximum
ED - Exposure duration =	years	25	USEPA 1991, HHEM
CF - Conversion factor (1 kg/1,000,000 mg)=	kg/mg	1.00E-06	
BW - Body weight =	kg	70	USEPA 1991, HHEM
AT_n - Averaging Time noncarcinogenic =	days	9125	USEPA 1991, HHEM
AT_c - Averaging Time carcinogenic =	days	25550	USEPA 1991, HHEM

Analyte	Concentration in Soil and NAPL mg/kg	Average Daily Intake mg/kg-day	Dermal Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Dioxins							
2,3,7,8-TCDD Equiv	5.44E-03	5.71E-10	NA	NA	2.04E-10	3.00E+05	6.12E-05
Inorganics							
Arsenic	7.70E+00	8.08E-08	2.85E-04	2.84E-04	2.89E-08	1.58E+00	4.56E-08
Iron	1.94E+04	2.04E-04	1.50E-01	1.36E-03	7.27E-05	NA	NA
Lead	8.31E+01	8.73E-07	NA	NA	3.12E-07	NA	NA
Thallium	5.40E+00	5.67E-08	5.60E-05	1.01E-03	2.02E-08	NA	NA
NA - Not available			Total Hazard Index:	0.003			6.13E-05

Table 46
Reasonable Maximum Exposure by Ingestion of Soil and NAPL by an Industrial Worker
Former Koppers Company, Inc, Newport, DE

$$\text{Intake (mg/kg-day)} = \frac{Cs * IngR * EF * ED * CF * FI}{BW * AT}$$

Cs - Concentration in soil and NAPL =	mg/kg	chemical specific	
IngR - Ingestion rate =	mg/day	50	USEPA 1991, HHEM
EF - Exposure frequency =	days/year	134	reasonable maximum
ED - Exposure duration =	years	25	USEPA 1991, HHEM
CF - Conversion factor (1 kg/1,000,000 mg)=	kg/mg	1.00E-06	
FI - Fraction of total daily soil ingested at site =		1	reasonable maximum
BW - Body weight =	kg	70	USEPA 1991, HHEM
AT_n - Averaging Time noncarcinogenic =	days	9125	USEPA 1991, HHEM
AT_c - Averaging Time carcinogenic =	days	25550	USEPA 1991, HHEM

Analyte	Concentration in Soil and NAPL mg/kg	Average Daily Intake mg/kg-day	Oral Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Dioxins							
2,3,7,8-TCDD Equiv.	5.44E-03	1.43E-09	NA	NA	5.10E-10	1.50E+05	7.64E-05
Inorganics							
Arsenic	7.70E+00	2.02E-06	3.00E-04	6.73E-03	7.21E-07	1.50E+00	1.08E-06
Iron	1.94E+04	5.09E-03	3.00E-01	1.70E-02	1.82E-03	NA	NA
Lead	8.31E+01	2.18E-05	NA	NA	7.79E-06	NA	NA
Thallium	5.40E+00	1.42E-06	7.00E-05	2.02E-02	5.06E-07	NA	NA
Semivolatiles							
Acenaphthylene	1.21E+01	3.18E-06	NA	NA	1.14E-06	NA	NA
Benzo(a)anthracene	2.92E+02	7.65E-05	NA	NA	2.73E-05	7.30E-01	2.00E-05
Benzo(a)pyrene	2.02E+02	5.30E-05	NA	NA	1.89E-05	7.30E+00	1.38E-04
Benzo(b)fluoranthene	4.29E+02	1.13E-04	NA	NA	4.02E-05	7.30E-01	2.93E-05
Benzo(g,h,i)perylene	7.85E+01	2.06E-05	NA	NA	7.35E-06	NA	NA
Benzo(k)fluoranthene	9.95E+01	2.61E-05	NA	NA	9.32E-06	7.30E-02	6.80E-07
Carbazole	2.11E+01	5.52E-06	NA	NA	1.97E-06	2.00E-02	3.94E-08
Chrysene	3.27E+02	8.57E-05	NA	NA	3.06E-05	7.30E-03	2.23E-07
Dibenz(a,h)anthracene	1.55E+01	4.06E-06	NA	NA	1.45E-06	7.30E+00	1.06E-05
Dibenzofuran	1.55E+01	4.06E-06	4.00E-03	1.01E-03	1.45E-06	NA	NA
Fluoranthene	6.59E+02	1.73E-04	4.00E-02	4.32E-03	6.18E-05	NA	NA
Indeno(1,2,3-c,d)pyrene	1.01E+02	2.66E-05	NA	NA	9.50E-06	7.30E-01	6.93E-06
Phenanthrene	6.75E+01	1.77E-05	NA	NA	6.32E-06	NA	NA

NA - Not available | Total Hazard Index: 0.05 | 2.83E-04

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Table 50

Reasonable Maximum Dermal Exposure to Columbia Aquifer Groundwater to an Industrial Worker Showering

Former Koppers Company, Inc., Newport, DE

Average Daily Intake (mg/kg-day) = $\frac{DA * EF * ED * *FS * SAt}{BW * AT}$

DA - Absorbed dose =	chem. specific	mg day-cm²	
EF- Exposure frequency =	250	day/year	US EPA 1991, HHEM Supp. Guidance
ED - Exposure duration =	25	year	Carey, 1988
SA - Skin surface area available for contact =	20000	cm²	calculated
SAt - Total skin surface area =	20000	cm²	US EPA 1989, RAGS Part A
FS - Fraction of skin surface area available for contact =	100%		reasonable maximum
BW - Body weight =	70	kg	US EPA 1989, RAGS Part A
AT_n - Averaging Time noncarcinogenic =	9125	days	US EPA 1989, RAGS Part A
AT_c - Averaging Time carcinogenic =	25550	days	US EPA 1989, RAGS Part A

For Inorganics:

$DA\ (mg/day\text{-}cm^2) = Kp * Cgw * t * CF$

Kp - Dermal permeability constant =	chem. specific	cm/hr	
Cgw - Chemical concentration in groundwater =	chem. specific	mg/L	
t - Event duration =	0.25	hr	US EPA 1992, Dermal Exp. Assess.
CF - Conversion factor =	1.00E-03	L/cm³	

For Organics:

If $t < t^*$, then $DA = 2 * CF * Cgw * Kp * (6 * \tau * t / \pi)^{0.5}$

If $t > t^*$, then $DA = Kp * Cgw * CF * (t/(1+B) + (2 * \tau * ((1+3B) / (1+B)))$

t* - Percutaneous absorption time =	chem. specific	hr
B - Partitioning coefficient =	chem. specific	dimensionless
τ - Lag time =	chem. specific	hr

Analyte	Concentration in Groundwater mg/L	Kp cm/hr	t* hr	B	τ hr	Absorbed Dose mg/day-cm²	Average Daily Intake mg/kg-day	Dermal Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Inorganics												
Antimony	5.74E-03	1.00E-03	NA	NA	NA	1.44E-09	2.81E-07	4.00E-06	7.02E-02	1.00E-07	NA	NA
Arsenic	1.68E-03	1.00E-03	NA	NA	NA	4.20E-10	8.23E-08	2.85E-04	2.89E-04	2.94E-08	1.58E+00	4.64E-08
Cadmium	1.14E-03	1.00E-03	NA	NA	NA	2.86E-10	5.59E-08	3.00E-04	1.86E-04	2.00E-08	NA	NA
Iron	3.20E+00	1.00E-03	NA	NA	NA	8.00E-07	1.57E-04	1.50E-01	1.04E-03	5.59E-05	NA	NA
Lead	3.58E-03	4.00E-06	NA	NA	NA	3.58E-12	7.01E-10	NA	NA	2.50E-10	NA	NA
Manganese	1.86E+00	1.00E-03	NA	NA	NA	4.65E-07	9.10E-05	NA	NA	3.25E-05	NA	NA
PCBs/Pesticides												
Dieldrin	3.50E-05	1.60E-02	9.40E+01	3.60E+00	1.80E+01	3.28E-09	6.43E-07	1.50E-05	4.28E-02	2.29E-07	5.33E+01	1.22E-05
Heptachlor	1.80E-05	1.10E-02	9.40E+01	1.90E+00	1.70E+01	1.13E-09	2.21E-07	1.50E-04	1.47E-03	7.89E-08	1.50E+01	1.18E-06
Heptachlor epoxide	6.60E-05	2.76E-02	1.30E+02	9.55E+00	2.07E+01	1.15E-08	2.24E-06	3.90E-06	5.75E-01	8.01E-07	3.03E+01	2.43E-05
Semivolatiles												
bis(2-Ethylhexyl)phthalate	1.31E-02	3.30E-02	1.00E+02	1.30E+01	2.10E+01	2.73E-06	5.34E-04	1.40E-02	3.82E-02	1.91E-04	2.00E-02	3.82E-06
Dibenzofuran	3.00E-03	1.51E-01	9.07E+00	1.32E+00	9.29E-01	6.04E-07	1.18E-04	2.80E-03	4.22E-02	4.22E-05	NA	NA
NA - Not Applicable								Total Hazard Index:	0.73			4.16E-05

Table 51

Reasonable Maximum Oral Exposure to Columbia Aquifer Groundwater While Drinking at the Job Site

Former Koppers Company, Inc., Newport, DE

Average Daily Intake (mg/kg-day) = $\frac{Cgw * IR * ED * EF}{BW * AT}$

Cgw - Concentration in groundwater =	chem specific	mg/L	
IR - Ingestion Rate =	1	L/day	US EPA 1991, HHEM Supp. Guidance
ED - Exposure duration =	25	year	US EPA 1991, HHEM Supp. Guidance
EF- Exposure frequency =	250	days/year	US EPA 1991, HHEM Supp. Guidance
BW - Body weight =	70	kg	US EPA 1989, RAGS Part A
AT_n - Averaging Time noncarcinogenic =	9125	days	US EPA 1989, RAGS Part A
AT_c - Averaging Time carcinogenic =	25550	days	US EPA 1989, RAGS Part A

Analyte	Concentration in Groundwater mg/L	Average Daily Intake mg/kg-day	Oral Chronic RfD mg/kg-day	Hazard Index	Lifetime Average Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Inorganics							
Antimony	5.74E-03	5.62E-05	4.00E-04	1.40E-01	2.01E-05	NA	NA
Arsenic	1.68E-03	1.65E-05	3.00E-04	5.49E-02	5.88E-06	1.50E+00	8.82E-06
Cadmium	1.14E-03	1.12E-05	5.00E-04	2.24E-02	3.99E-06	NA	NA
Iron	3.20E+00	3.13E-02	3.00E-01	1.04E-01	1.12E-02	NA	NA
Lead	3.58E-03	3.50E-05	NA	NA	1.25E-05	NA	NA
Manganese	1.86E+00	1.82E-02	1.40E-01	1.30E-01	6.50E-03	NA	NA
PCBs/Pesticides							
Dieldrin	3.50E-05	3.42E-07	5.00E-05	6.85E-03	1.22E-07	1.60E+01	1.96E-06
Heptachlor	1.80E-05	1.76E-07	5.00E-04	3.52E-04	6.29E-08	4.50E+00	2.83E-07
Heptachlor epoxide	6.60E-05	6.46E-07	1.30E-05	4.97E-02	2.31E-07	9.10E+00	2.10E-06
Semivolatiles							
Benzo(a)anthracene	2.00E-03	1.96E-05	NA	NA	6.99E-06	7.30E-01	5.10E-06
Benzo(b)fluoranthene	1.00E-03	9.78E-06	NA	NA	3.49E-06	7.30E-01	2.55E-06
Benzo(k)fluoranthene	1.00E-03	9.78E-06	NA	NA	3.49E-06	7.30E-02	2.55E-07
bis(2-Ethylhexyl)phthalate	1.31E-02	1.28E-04	2.00E-02	6.39E-03	4.57E-05	1.40E-02	6.39E-07
Dibenzofuran	3.00E-03	2.94E-05	4.00E-03	7.34E-03	1.05E-05	NA	NA
Phenanthrene	1.04E-02	1.02E-04	NA	NA	3.65E-05	NA	NA
			Total Hazard Index:	0.52			2.17E-05

Table 52

Reasonable Maximum Inhalation Exposure to VOC Vapors by an Industrial Worker Showering with Columbia Aquifer Groundwater

Former Koppers Company, Inc., Newport, DE

Average Daily Intake (mg/kg-day) = $\frac{\text{Dose} * \text{EF} * \text{ED}}{\text{AT}}$

Dose - Inhalation dose =	chem. specific		
EF - Exposure frequency =	250	showers/year	US EPA 1991, HHEM Supp. Guid.
Ed - Exposure duration =	25	years	Carey, 1988
AT_n - Averaging Time noncarcinogenic =	9125	days	US EPA 1989, RAGS Part A
AT_c - Averaging Time carcinogenic =	25550	days	US EPA 1989, RAGS Part A

Inhalation Dose (mg/kg-shower) =

$((VR * S) / (BW * Rex * 10^6)) * (Ds + (exp(-Rex * Dt) / Rex) - (exp(Rex * (Ds - Dt)) / Rex))$

VR - Ventilation Rate =	15	L/min	Foster, Chrostowski, 1987
S - Indoor VOC generation rate =	chem. specific	ug/m^3-min	
BW - Body Weight =	70	kg	US EPA 1989, RAGS Part A
Rex - Air Exchange Rate =	0.0083	exchange/min	Foster, Chrostowski, 1987
Ds - Duration in Shower =	15	min	US EPA 1995, Exp. Factors Handbook
Dt - Total Duration in Shower Room =	20	min	reasonable maximum

S (ug/m^3-min) = (Cwd * FR) / SV

Cwd - Concentration leaving shower droplet after time ts =	chem. specific	ug/L	
FR - Shower Water Flow Rate =	10	L/min	Foster, Chrostowski, 1987
SV - Shower Room Air Volume =	6	m^3	Foster, Chrostowski, 1987

Cwd (ug/L) = $Cwo * CF_1 * (1 - exp((-Kal * tsd) / (60 * d)))$

Cwo - Shower water concentration =	chem. specific	mg/L	
CF_1 - Conversion factor =	1.00E+03	ug/mg	
Kal - overall mass transfer coefficient =	chem. specific	cm/hr	
tsd - shower droplet drop time =	2	sec	Foster, Chrostowski, 1987
d - shower droplet diameter =	1	mm	Foster, Chrostowski, 1987

Kal (cm/hour) = $KL * ((T_1 * u_s) / (T_s * u_1))^{0.5}$

KL - mass transfer coefficient =	chem. specific	cm/hr
T_1 - calibration water temperature =	293	K
u_s - water viscosity at Ts =	0.596	cp
T_s - shower water temperature =	318	K
u_1 - water viscosity at Tl =	1.002	cp

KL (cm/hr) = $((1 / kl(voc)) + ((R * T) / (H * kg(voc))))^{-1}$

kl(voc) - liquid-film mass transfer coefficient =	chem. specific	cm/hr
R - universal gas constant =	8.20E-05	atm-m^3/mol K
T - absolute temperature =	293	K
H - Henry's Law Constant =	chem. specific	atm-m^3/mol
kg(voc) - gas-film mass transfer coefficient =	chem. specific	cm/hr

kg(voc) (cm/hr) = $kg(H_2O) * (18 / MWvoc)^{0.5}$

$kg(H_2O)$ =	3000	cm/hr
MW - molecular weight =	chem. specific	g/mol

kl(voc) (cm/hr) = $kl(CO_2) * (44 / MWvoc)^{0.5}$

$kl(CO_2)$ =	20	cm/hr

Constituent	Cwo mg/L	kl(voc) cm/hr	kg(voc) cm/hr	KL cm/hr	Kal cm/hr	Cwd ug/L	S ug/m^3-min	Inhalation Dose mg/kg-shower	Average Daily Intake mg/kg-day	Inhalation Chronic RfD mg/kg-day	Hazard Index	Lifetime Average Daily Intake mg/kg-day	Inhalation Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
PCBs/Pesticides														
Dieldrin	3.50E-05	6.80E+00	6.52E+02	1.28E+00	1.73E+00	1.96E-06	3.26E-06	1.24E-10	8.48E-11	NA	NA	3.03E-11	1.60E+01	4.84E-10
Heptachlor	1.80E-05	6.87E+00	6.59E+02	5.87E+00	7.93E+00	4.18E-06	6.97E-06	2.64E-10	1.81E-10	NA	NA	6.47E-11	4.50E+00	2.91E-10
Heptachlor epoxide	6.60E-05	6.72E+00	6.45E+02	7.62E-01	1.03E+00	2.23E-06	3.71E-06	1.41E-10	9.64E-11	NA	NA	3.44E-11	9.10E+00	3.13E-10
Semivolatiles														
Benzo(a)anthracene	2.00E-03	8.78E+00	8.42E+02	2.72E-01	3.68E-01	2.44E-05	4.06E-05	1.54E-09	1.06E-09	NA	NA	3.77E-10	NA	NA
Benzo(b)fluoranthene	1.00E-03	8.35E+00	8.01E+02	2.56E+00	3.46E+00	1.09E-04	1.82E-04	6.90E-09	4.72E-09	NA	NA	1.69E-09	NA	NA
Benzo(k)fluoranthene	1.00E-03	8.35E+00	8.01E+02	1.33E-02	1.80E-02	6.00E-07	9.99E-07	3.79E-11	2.60E-11	NA	NA	9.27E-12	NA	NA
bis(2-Ethylhexyl)phthalate	1.31E-02	6.71E+00	6.44E+02	3.72E-01	5.03E-01	2.17E-04	3.62E-04	1.37E-08	9.40E-09	NA	NA	3.36E-09	1.40E-02	4.70E-11
Dibenzofuran	3.00E-03	1.02E+01	9.81E+02	4.70E+00	6.35E+00	5.72E-04	9.54E-04	3.62E-08	2.48E-08	NA	NA	8.85E-09	NA	NA
Phenanthrene	1.04E-02	9.94E+00	9.53E+02	1.25E+00	1.69E+00	5.71E-04	9.52E-04	3.61E-08	2.47E-08	NA	NA	8.84E-09	NA	NA

Total Hazard Index: NA   1[illegible]9

Table 36

Reasonable Maximum Dermal Exposure to Columbia Aquifer Groundwater (Including MW-2 and MW-8) for an Industrial Worker Showering

Former Koppers Company, Inc., Newport, DE

$$\text{Average Daily Intake (mg/kg-day)} = \frac{DA * EF * ED * FS * SAt}{BW * AT}$$

DA - Absorbed dose =	chem. specific	mg day-cm^2	
EF- Exposure frequency =	250	day/year	US EPA 1991, HHEM Supp. Guidance
ED - Exposure duration =	25	year	Carey, 1988
SA - Skin surface area available for contact =	20000	cm^2	calculated
SAt - Total skin surface area =	20000	cm^2	US EPA 1989, RAGS Part A
FS - Fraction of skin surface area available for contact =	100%		reasonable maximum
BW - Body weight =	70	kg	US EPA 1989, RAGS Part A
AT_n - Averaging Time noncarcinogenic =	9125	days	US EPA 1989, RAGS Part A
AT_c - Averaging Time carcinogenic =	25550	days	US EPA 1989, RAGS Part A

For Inorganics:

$$DA \text{ (mg/day-cm}^2) = Kp * Cgw * t * CF$$

Kp - Dermal permeability constant =	chem. specific	cm/hr	
Cgw - Chemical concentration in groundwater =	chem. specific	mg/L	
t - Event duration =	0.25	hr	US EPA 1992, Dermal Exp. Assess.
CF - Conversion factor	1.00E-03	L/cm^3	

For Organics:

$$\text{If } t < t^*, \text{ then } DA = 2 * CF * Cgw * Kp * (6 * \tau * t / \pi)^{0.5}$$

$$\text{If } t > t^*, \text{ then } DA = Kp * Cgw * CF * (t/(1+B) + (2 * \tau * ((1+3B)/(1+B)))$$

t* - Percutaneous absorption time =	chem. specific	hr
B - Partitioning coefficient =	chem. specific	dimensionless
τ - Lag time =	chem. specific	hr

Analyte	Concentration in Groundwater mg/L	Kp cm/hr	t* hr	B	τ hr	Absorbed Dose mg/day-cm^2	Average Daily Intake mg/kg-day	Dermal Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Dioxins												
2,3,7,8-TCDD Equiv.*	1.17E-03	1.40E+00	3.80E+01	6.30E+02	8.10E+00	6.46E-06	1.26E-03	NA	NA	4.52E-04	3.00E+05	1.00E+00
Inorganics												
Antimony	1.51E-03	1.00E-03	NA	NA	NA	3.78E-10	7.39E-08	4.00E-06	1.85E-02	2.64E-08	NA	NA
Arsenic	1.28E-03	1.00E-03	NA	NA	NA	3.21E-10	6.28E-08	2.85E-04	2.20E-04	2.24E-08	1.58E+00	3.54E-08
Beryllium	3.35E-04	1.00E-03	NA	NA	NA	8.38E-11	1.64E-08	2.00E-04	8.20E-05	5.86E-09	4.30E+01	2.52E-07
Iron	4.13E+00	1.00E-03	NA	NA	NA	1.03E-06	2.02E-04	1.50E-01	1.35E-03	7.22E-05	NA	NA
Lead	9.48E-04	4.00E-06	NA	NA	NA	9.48E-13	1.86E-10	NA	NA	6.63E-11	NA	NA
Manganese	5.61E-01	1.00E-03	NA	NA	NA	1.40E-07	2.75E-05	NA	NA	9.80E-06	NA	NA
Thallium	3.66E-03	1.00E-03	NA	NA	NA	9.14E-10	1.79E-07	5.60E-05	3.20E-03	6.39E-08	NA	NA
PCBs/Pesticides												
alpha-Chlordane	7.82E-05	4.60E-02	1.30E+02	3.00E+01	2.80E+01	2.63E-08	5.15E-06	1.50E-04	3.43E-02	1.84E-06	1.17E+00	2.15E-06
Dieldrin	3.50E-05	1.60E-02	9.40E+01	3.60E+00	1.80E+01	3.28E-09	6.43E-07	1.50E-05	4.28E-02	2.29E-07	5.33E+01	1.22E-05
Heptachlor	1.80E-05	1.10E-02	9.40E+01	1.90E+00	1.70E+01	1.13E-09	2.21E-07	1.50E-04	1.47E-03	7.89E-08	1.50E+01	1.18E-06
Heptachlor epoxide	5.63E-05	2.76E-02	1.30E+02	9.55E+00	2.07E+01	9.77E-09	1.91E-06	3.90E-06	4.90E-01	6.83E-07	3.03E+01	2.07E-

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Table 36
Reasonable Maximum Dermal Exposure to Columbia Aquifer Groundwater (Including MW-2 and MW-8) for an Industrial Worker Showering
Former Koppers Company, Inc., Newport, DE

$$\text{Average Daily Intake (mg/kg-day)} = \frac{DA * EF * ED * FS * SAt}{BW * AT}$$

DA - Absorbed dose =	chem. specific	mg/day-cm^2	
EF- Exposure frequency =	250	day/year	US EPA 1991, HHEM Supp. Guidance
ED - Exposure duration =	25	year	Carey, 1988
SA - Skin surface area available for contact =	20000	cm^2	calculated
SAt - Total skin surface area =	20000	cm^2	US EPA 1989, RAGS Part A
FS - Fraction of skin surface area available for contact =	100%		reasonable maximum
BW - Body weight =	70	kg	US EPA 1989, RAGS Part A
AT_n - Averaging Time noncarcinogenic =	9125	days	US EPA 1989, RAGS Part A
AT_c - Averaging Time carcinogenic =	25550	days	US EPA 1989, RAGS Part A

For Inorganics:

$$DA\ (mg/day\text{-}cm^2) = Kp * Cgw * t * CF$$

Kp - Dermal permeability constant =	chem. specific	cm/hr	
Cgw - Chemical concentration in groundwater =	chem. specific	mg/L	
t - Event duration =	0.25	hr	US EPA 1992, Dermal Exp. Assess.
CF - Conversion factor	1.00E-03	L/cm^3	

For Organics:

If $t < t^*$, then $DA = 2 * CF * Cgw * Kp * (6 * \tau * t / \pi)^{0.5}$

If $t > t^*$, then $DA = Kp * Cgw * CF * (t/(1+B) + (2 * \tau * ((1+3B) / (1+B)))$

t* - Percutaneous absorption time =	chem. specific	hr
B - Partitioning coefficient =	chem. specific	dimensionless
τ - Lag time =	chem. specific	hr

Analyte	Concentration in Groundwater mg/L	Kp cm/hr	t* hr	B	τ hr	Absorbed Dose mg/day-cm^2	Average Daily Intake mg/kg-day	Dermal Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Semivolatiles												
2,4-Dimethylphenol	1.50E+01	1.10E-01	1.20E+00	2.00E-02	4.90E-01	1.60E-03	3.12E-01	1.40E-02	2.23E+01	1.12E-01	NA	NA
2-Methylphenol	2.20E+01	1.60E-02	1.57E-02	9.60E-01	8.90E-03	5.73E-05	1.12E-02	3.50E-02	3.20E-01	4.00E-03	NA	NA
4-Methylphenol	5.20E+01	1.80E-02	1.75E-02	9.60E-01	8.70E-03	1.52E-04	2.97E-02	3.50E-03	8.48E+00	1.06E-02	NA	NA
bis(2-Ethylhexyl)phthalate	1.50E-02	3.30E-02	1.00E+02	1.30E+01	2.10E+01	3.13E-06	6.13E-04	1.40E-02	4.38E-02	2.19E-04	2.00E-02	4.38E-06
Dibenzofuran	5.69E+00	1.51E-01	9.07E+00	1.32E+00	9.29E-01	1.14E-03	2.24E-01	2.80E-03	8.00E+01	8.00E-02	NA	NA
Pentachlorophenol	6.00E-02	6.50E-01	1.70E+01	7.20E+01	3.70E+00	1.04E-04	2.03E-02	2.10E-02	9.66E-01	7.25E-03	1.71E-01	1.24E-03
Phenol	5.80E+01	8.10E-03	7.90E-01	2.90E-03	3.30E-01	3.73E-04	7.30E-02	4.20E-01	1.74E-01	2.61E-02	NA	NA
Volatiles												
Benzene	2.64E-01	1.10E-01	6.30E-01	1.30E-02	2.60E-01	2.04E-05	4.00E-03	2.85E-03	1.40E+00	1.43E-03	3.05E-02	4.36E-05
Ethylbenzene	1.79E-01	1.00E+00	1.30E+00	1.40E-01	3.90E-01	1.55E-04	3.03E-02	9.50E-02	3.19E-01	1.08E-02	NA	NA
Styrene	6.49E-02	6.70E-01	9.10E-01	8.90E-02	3.80E-01	3.70E-05	7.25E-03	1.90E-01	3.81E-02	2.59E-03	NA	NA
Toluene	5.48E-01	1.00E+00	7.70E-01	5.40E-02	3.20E-01	4.29E-04	8.39E-02	1.90E-01	4.41E-01	2.99E-02	NA	NA
Xylenes (total)	1.90E+00	8.00E-02	6.53E+00	1.58E-01	3.89E-01	1.31E-04	2.56E-02	1.74E+00	1.47E-02	9.15E-03	NA	NA

NA - Not applicable/available

Total Hazard Index: 115.08 1.00E+

ENVIRONMENTAL STANDARDS

Table 57
Reasonable Maximum Oral Exposure to Columbia Aquifer Groundwater (Including MW-2 and MW-8) While Drinking at the Job Site
Former Koppers Company, Inc., Newport, DE

Average Daily Intake (mg/kg-day) = $\frac{Cgw * IR * ED * EF}{BW * AT}$

Cgw - Concentration in groundwater =	chem specific	mg/L	
IR - Ingestion Rate =	1	L/day	US EPA 1991, HHEM Supp. Guidance
ED - Exposure duration =	25	year	US EPA 1991, HHEM Supp. Guidance
EF- Exposure frequency =	250	days/year	US EPA 1991, HHEM Supp. Guidance
BW - Body weight =	70	kg	US EPA 1989, RAGS Part A
AT_n - Averaging Time noncarcinogenic =	9125	days	US EPA 1989, RAGS Part A
AT_c - Averaging Time carcinogenic =	25550	days	US EPA 1989, RAGS Part A

Analyte	Concentration in Groundwater mg/L	Average Daily Intake mg/kg-day	Oral Chronic RfD mg/kg-day	Hazard Index	Lifetime Average Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Dioxins							
2,3,7,8-TCDD Equiv.*	1.17E-03	1.15E-05	NA	NA	4.10E-06	1.50E+05	4.59E-01
Inorganics							
Antimony	1.51E-03	1.48E-05	4.00E-04	3.69E-02	5.28E-06	NA	NA
Arsenic	1.28E-03	1.26E-05	3.00E-04	4.19E-02	4.49E-06	1.50E+00	6.73E-06
Beryllium	3.35E-04	3.28E-06	2.00E-03	1.64E-03	1.17E-06	4.30E+00	5.04E-06
Iron	4.13E+00	4.05E-02	3.00E-01	1.35E-01	1.44E-02	NA	NA
Lead	9.48E-04	9.28E-06	NA	NA	3.31E-06	NA	NA
Manganese	5.61E-01	5.49E-03	1.40E-01	3.92E-02	1.96E-03	NA	NA
Thallium	3.66E-03	3.58E-05	7.00E-05	5.11E-01	1.28E-05	NA	NA
PCBs/Pesticides							
alpha-Chlordane	7.82E-05	7.66E-07	5.00E-04	1.53E-03	2.73E-07	3.50E-01	9.57E-08
Dieldrin	3.50E-05	3.42E-07	5.00E-05	6.85E-03	1.22E-07	1.60E+01	1.96E-06
Heptachlor	1.80E-05	1.76E-07	5.00E-04	3.52E-04	6.29E-08	4.50E+00	2.83E-07
Heptachlor epoxide	5.63E-05	5.50E-07	1.30E-05	4.23E-02	1.97E-07	9.10E+00	1.79E-06
Semivolatiles							
2,4-Dimethylphenol	1.50E+01	1.47E-01	2.00E-02	7.34E+00	5.24E-02	NA	NA
2-Methylnaphthalene	1.30E+01	1.27E-01	2.00E-02	6.36E+00	4.54E-02	NA	NA
2-Methylphenol	2.20E+01	2.15E-01	5.00E-02	4.31E+00	7.69E-02	NA	NA
4-Methylphenol	5.20E+01	5.09E-01	5.00E-03	1.02E+02	1.82E-01	NA	NA
Acenaphthene	1.00E+01	9.78E-02	6.00E-02	1.63E+00	3.49E-02	NA	NA
Acenaphthylene	1.84E-01	1.80E-03	NA	NA	6.42E-04	NA	NA
Anthracene	3.06E-01	3.00E-03	3.00E-01	9.99E-03	1.07E-03	NA	NA
Benzo(a)anthracene	1.70E-01	1.66E-03	NA	NA	5.93E-04	7.30E-01	4.33E-04
Benzo(a)pyrene	1.33E-01	1.30E-03	NA	NA	4.65E-04	7.30E+00	3.40E-03
Benzo(b)fluoranthene	1.30E-01	1.27E-03	NA	NA	4.53E-04	7.30E-01	3.31E-04
Benzo(g,h,i)perylene	6.00E-03	5.87E-05	NA	NA	2.10E-05	NA	NA
Benzo(k)fluoranthene	1.05E-01	1.02E-03	NA	NA	3.65E-04	7.30E-02	2.67E-05
bis(2-Ethylhexyl)phthalate	1.50E-02	1.47E-04	NA	NA	5.24E-05	1.40E-02	7.34E-07
Carbazole	1.80E+00	1.76E-02	NA	NA	6.29E-03	2.00E-02	1.26E-04
Chrysene	1.32E-01	1.29E-03	NA	NA	4.61E-04	7.30E-03	3.37E-06
Dibenzofuran	5.69E+00	5.56E-02	4.00E-03	1.39E+01	1.99E-02	NA	NA
Fluoranthene	8.18E-01	8.01E-03	4.00E-02	2.00E-01	2.86E-03	NA	NA
Fluorene	8.19E+00	8.01E-02	4.00E-02	2.00E+00	2.86E-02	NA	NA
Indeno(1,2,3-c,d)pyrene	5.00E-03	4.89E-05	NA	NA	1.75E-05	7.30E-01	1.28E-05
Naphthalene	6.00E+01	5.87E-01	2.00E-02	2.94E+01	2.10E-01	NA	NA
Pentachlorophenol	6.00E-02	5.87E-04	3.00E-02	1.96E-02	2.10E-04	1.20E-01	2.52E-05
Phenanthrene	1.85E+01	1.81E-01	NA	NA	6.48E-02	NA	NA
Phenol	5.80E+01	5.68E-01	6.00E-01	9.46E-01	2.03E-01	NA	NA
Pyrene	6.37E-01	6.23E-03	3.00E-02	2.08E-01	2.23E-03	NA	NA
Volatiles							
Benzene	2.64E-01	2.58E-03	3.00E-03	8.60E-01	9.22E-04	2.90E-02	2.67E-05
Ethylbenzene	1.79E-01	1.75E-03	1.00E-01	1.75E-02	6.27E-04	NA	NA
Styrene	6.49E-02	6.35E-04	2.00E-01	3.17E-03	2.27E-04	NA	NA
Toluene	5.48E-01	5.36E-03	2.00E-01	2.68E-02	1.92E-03	NA	NA
Xylenes (total)	1.90E+00	1.86E-02	2.00E+00	9.30E-03	6.64E-03	NA	NA
NA - Not available			Total Hazard Index	169.78			4.64E-01

* Cancer risks calculated using one-hit equation, US EPA RAGS Part A, 1989.

Table 58

Reasonable Maximum Exposure - Inhalation of VOC Vapors from Columbia Aquifer Groundwater (Including MW-2 and MW-8) by an Industrial Worker Showering
Former Koppers Company, Inc., Newport, DE

Average Daily Intake (mg/kg-day) = $\frac{\text{Dose * EF * ED}}{\text{AT}}$

Dose - Inhalation dose = chem. specific
EF - Exposure frequency = 250 showers/year US EPA 1991, HHEM Supp. Guid.
Ed - Exposure duration = 25 years Carey, 1988
AT_n - Averaging Time noncarcinogenic = 9125 days US EPA 1989, RAGS Part A
AT_c - Averaging Time carcinogenic = 25550 days US EPA 1989, RAGS Part A

Inhalation Dose (mg/kg-shower) =
((VR * S) / (BW * Rex * 10^6)) * (Ds + (exp(-Rex * Dt) / Rex) - (exp(Rex * (Ds - Dt)) / Rex))

VR - Ventilation Rate = 15 L/min Foster, Chrostowski, 1987
S - Indoor VOC generation rate = chem. specific ug/m³-min
BW - Body Weight = 70 kg US EPA 1989, RAGS Part A
Rex - Air Exchange Rate = 0.0083 exchange/mi Foster, Chrostowski, 1987
Ds - Duration in Shower = 15 min US EPA 1995, Exp. Factors Handbook
Dt - Total Duration in Shower Room = 20 min reasonable maximum

S (ug/m³-min) = (Cwd * FR) / SV

Cwd - Concentration leaving shower droplet after time ts = chem. specific ug/L
FR - Shower Water Flow Rate = 10 L/min Foster, Chrostowski, 1987
SV - Shower Room Air Volume = 6 m³ Foster, Chrostowski, 1987

Cwd (ug/L) = Cwo * CFi * (1-exp((-Kal * tsd) / (60 * d)))

Cwo - Shower water concentration = chem. specific mg/L
CFi - Conversion factor = 1.00E+03 ug/mg
Kal - overall mass transfer coefficient = chem. specific cm/hr
tsd - shower droplet drop time = 2 sec Foster, Chrostowski, 1987
d - shower droplet diameter = 1 mm Foster, Chrostowski, 1987

Kal (cm/hour) = KL / $((T_l * u_s) / (T_s * u_l))^{0.5}$

KL - mass transfer coefficient = chem. specific cm/hr
T_l - calibration water temperature = 293 K
u_s - water viscosity at Ts = 0.596 cp
T_s - shower water temperature = 318 K
u_l - water viscosity at Tl = 1.002 cp

KL (cm/hr) = $((1 / kl(voc)) + ((R * T) / (H * kg(voc))))^{-1}$

kl(voc) - liquid-film mass transfer coefficient = chem. specific cm/hr
R - universal gas constant = 8.20E-05 atm-m³/mol K
T - absolute temperature = 293 K
H - Henry's Law Constant = chem. specific atm-m³/mol
kg(voc) - gas-film mass transfer coefficient = chem. specific cm/hr

kg(voc) (cm/hr) = kg(H_2O) * $(18 / MWvoc)^{0.5}$

kg(H_2O) = 3000 cm/hr
MW - molecular weight = chem. specific g/mol

kl(voc) (cm/hr) = kl(CO_2) * $(44 / MW)^{0.5}$

kl(CO_2) = 20 cm/hr

Constituent	Cwo mg/L	kl(voc) cm/hr	kg(voc) cm/hr	KL cm/hr	Kal cm/hr	Cwd ug/L	S ug/m³-min	Inhalation Dose mg/kg-shower	Average Daily Intake mg/kg-day	Inhalation Chronic RfD mg/kg-day	Hazard Index	Lifetime Average Daily Intake mg/kg-day	Inhalation Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Dioxins														
2,3,7,8-TCDD Equiv	1.17E-03	7.39E+00	7.09E+02	5.86E-02	7.91E-02	3.09E-06	5.15E-06	1.95E-10	1.34E-10	NA	NA	4.78E-11	1.50E+05	7.17E-06
PCBs/Pesticides														
alpha-Chlordane	7.82E-05	6.55E+00	6.29E+02	3.81E+00	5.14E+00	1.23E-05	2.05E-05	7.79E-10	5.34E-10	2.00E-04	2.67E-06	1.91E-10	3.50E-01	6.67E-11
Dieldrin	3.50E-05	6.80E+00	6.52E+02	1.28E+00	1.73E+00	1.96E-06	3.26E-06	1.24E-10	8.48E-11	NA	NA	3.03E-11	1.60E+01	4.84E-10
Heptachlor	1.80E-05	6.87E+00	6.59E+02	5.87E+00	7.93E+00	4.18E-06	6.97E-06	2.64E-10	1.81E-10	NA	NA	6.47E-11	4.50E+00	2.91E-10
Heptachlor epoxide	5.63E-05	6.72E+00	6.45E+02	7.62E-01	1.03E+00	1.90E-06	3.16E-06	1.20E-10	8.22E-11	NA	NA	2.93E-11	9.10E+00	2.67E-10
Semivolatiles														
2,4-Dimethylphenol	1.50E+01	1.20E+01	1.15E+03	9.51E-02	1.28E-01	6.41E-02	1.07E-01	4.05E-06	2.78E-06	NA	NA	9.91E-07	NA	NA
2-Methylnaphthalene	1.30E+01	1.11E+01	1.07E+03	7.50E+00	1.01E+01	3.73E+00	6.21E+00	2.36E-04	1.61E-04	NA	NA	5.76E-05	NA	NA
2-Methylphenol	2.20E+01	1.28E+01	1.22E+03	6.08E-02	8.22E-02	6.02E-02	1.00E-01	3.81E-06	2.61E-06	NA	NA	9.31E-07	NA	NA
4-Methylphenol	5.20E+01	1.28E+01	1.22E+03	5.07E-02	6.85E-02	1.19E-01	1.98E-01	7.50E-06	5.14E-06	NA	NA	1.84E-06	NA	NA
Acenaphthene	1.00E+01	1.07E+01	1.02E+03	4.08E+00	5.52E+00	1.68E+00	2.80E+00	1.06E-04	7.28E-05	NA	NA	2.60E-05	NA	NA
Acenaphthylene	1.84E-01	1.08E+01	1.03E+03	3.36E+00	4.54E+00	2.58E-02	4.30E-02	1.63E-06	1.12E-06	NA	NA	3.99E-07	NA	NA

Table 58

Reasonable Maximum Exposure - Inhalation of VOC Vapors from Columbia Aquifer Groundwater (Including MW-2 and MW-8) by an Industrial Worker Showering

Former Koppers Company, Inc., Newport, DE

Average Daily Intake (mg/kg-day) = $\frac{Dose * EF * ED}{AT}$

Dose - Inhalation dose = chem. specific
EF - Exposure frequency = 250 showers/year US EPA 1991, HHEM Supp. Guid.
Ed - Exposure duration = 25 years Carey, 1988
AT_n - Averaging Time noncarcinogenic = 9125 days US EPA 1989, RAGS Part A
AT_c - Averaging Time carcinogenic = 25550 days US EPA 1989, RAGS Part A

Inhalation Dose (mg/kg-shower) =
((VR * S) / (BW * Rex * 10^6)) * (Ds + (exp(-Rex * Dt) / Rex) - (exp(Rex * (Ds - Dt)) / Rex))

VR - Ventilation Rate = 15 L/min Foster, Chrostowski, 1987
S - Indoor VOC generation rate = chem. specific ug/m^3-min
BW - Body Weight = 70 kg US EPA 1989, RAGS Part A
Rex - Air Exchange Rate = 0.0083 exchange/mi Foster, Chrostowski, 1987
Ds - Duration in Shower = 15 min US EPA 1995, Exp. Factors Handbook
Dt - Total Duration in Shower Room = 20 min reasonable maximum

S (ug/m^3-min) = (Cwd * FR) / SV

Cwd - Concentration leaving shower droplet after time ts = chem. specific ug/L
FR - Shower Water Flow Rate = 10 L/min Foster, Chrostowski, 1987
SV - Shower Room Air Volume = 6 m^3 Foster, Chrostowski, 1987

Cwd (ug/L) = Cwo * CFi * (1-exp((-Kal * tsd) / (60 * d)))

Cwo - Shower water concentration = chem. specific mg/L
CFi - Conversion factor = 1.00E+03 ug/mg
Kal - overall mass transfer coefficient = chem. specific cm/hr
tsd - shower droplet drop time = 2 sec Foster, Chrostowski, 1987
d - shower droplet diameter = 1 mm Foster, Chrostowski, 1987

Kal (cm/hour) = KL $((T_l * u_s) / (T_s * u_l))^{0.5}$

KL - mass transfer coefficient = chem. specific cm/hr
T_l - calibration water temperature = 293 K
u_s - water viscosity at Ts = 0.596 cp
T_s - shower water temperature = 318 K
u_l - water viscosity at Tl = 1.002 cp

KL (cm/hr) = $((1 / kl(voc)) + ((R * T) / (H * kg(voc))))^{-1}$

kl(voc) - liquid-film mass transfer coefficient = chem. specific cm/hr
R - universal gas constant = 8.20E-05 atm-m^3/mol K
T - absolute temperature = 293 K
H - Henry's Law Constant = chem. specific atm-m^3/mol
kg(voc) - gas-film mass transfer coefficient = chem. specific cm/hr

kg(voc) (cm/hr) = kg(H_2O) * $(18 / MWvoc)^{0.5}$

kg(H_2O) = 3000 cm/hr
MW - molecular weight = chem. specific g/mol

kl(voc) (cm/hr) = kl(CO_2) * $(44 / MW)^{0.5}$

kl(CO_2) = 20 cm/hr

Constituent	Cwo mg/L	kl(voc) cm/hr	kg(voc) cm/hr	KL cm/hr	Kal cm/hr	Cwd ug/L	S ug/m^3-min	Inhalation Dose mg/kg-shower	Average Daily Intake mg/kg-day	Inhalation Chronic RfD mg/kg-day	Hazard Index	Lifetime Average Daily Intake mg/kg-day	Inhalation Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Anthracene	3.06E-01	9.94E+00	9.53E+02	7.37E+00	9.96E+00	8.65E-02	1.44E-01	5.47E-06	3.75E-06	NA	NA	1.34E-06	NA	NA
Benzo(a)anthracene	1.70E-01	8.78E+00	8.42E+02	2.72E-01	3.68E-01	2.07E-03	3.45E-03	1.31E-07	8.97E-08	NA	NA	3.20E-08	NA	NA
Benzo(a)pyrene	1.33E-01	8.35E+00	8.01E+02	8.09E-02	1.09E-01	4.84E-04	8.07E-04	3.06E-08	2.10E-08	NA	NA	7.49E-09	3.10E+00	2.32E-08
Benzo(b)fluoranthene	1.30E-01	8.35E+00	8.01E+02	2.56E+00	3.46E+00	1.42E-02	2.36E-02	8.95E-07	6.13E-07	NA	NA	2.19E-07	NA	NA
Benzo(g,h,i)perylene	6.00E-03	7.98E+00	7.66E+02	5.07E-02	6.84E-02	1.37E-05	2.28E-05	8.65E-10	5.92E-10	NA	NA	2.11E-10	NA	NA
Benzo(k)fluoranthene	1.05E-01	8.35E+00	8.01E+02	1.33E-02	1.80E-02	6.27E-05	1.04E-04	3.96E-09	2.72E-09	NA	NA	9.70E-10	NA	NA
bis(2-Ethylhexyl)phthalate	1.50E-02	6.71E+00	6.44E+02	3.72E-01	5.03E-01	2.49E-04	4.15E-04	1.58E-08	1.08E-08	NA	NA	3.86E-09	1.40E-02	5.40E-11
Carbazole	1.80E+00	1.03E+01	9.84E+02	3.54E-03	4.79E-03	2.87E-04	4.78E-04	1.82E-08	1.24E-08	NA	NA	4.44E-09	NA	NA
Chrysene	1.32E-01	8.78E+00	8.42E+02	2.41E+00	3.25E+00	1.36E-02	2.26E-02	8.57E-07	5.87E-07	NA	NA	2.10E-07	NA	NA
Dibenzofuran	5.69E+00	1.02E+01	9.81E+02	4.70E+00	6.35E+00	1.08E+00	1.81E+00	6.86E-05	4.70E-05	NA	NA	1.68E-05	NA	NA
Fluoranthene	8.18E-01	9.33E+00	8.95E+02	3.28E+00	4.43E+00	1.12E-01	1.87E-01	7.11E-06	4.87E-06	NA	NA	1.74E-06	NA	NA
Fluorene	8.19E+00	1.03E+01	9.87E+02	2.94E+00	3.97E+00	1.01E+00	1.69E+00	6.41E-05	4.39E-05	NA	NA	1.57E-05	NA	NA

Table 58

Reasonable Maximum Exposure - Inhalation of VOC Vapors from Columbia Aquifer Groundwater (Including MW-2 and MW-8) by an Industrial Worker Showering
Former Koppers Company, Inc., Newport, DE

Average Daily Intake (mg/kg-day) = $\frac{\text{Dose} * \text{EF} * \text{ED}}{\text{AT}}$

Dose - Inhalation dose =	chem. specific		
EF - Exposure frequency =	250	showers/year	US EPA 1991, HHEM Supp. Guid.
Ed - Exposure duration =	25	years	Carey, 1988
AT_n - Averaging Time noncarcinogenic =	9125	days	US EPA 1989, RAGS Part A
AT_c - Averaging Time carcinogenic =	25550	days	US EPA 1989, RAGS Part A

Inhalation Dose (mg/kg-shower) =
$((VR * S) / (BW * Rex * 10^6)) * (Ds + (\exp(-Rex * Dt) / Rex) - (\exp(Rex * (Ds - Dt)) / Rex))$

VR - Ventilation Rate =	15	L/min	Foster, Chrostowski, 1987
S - Indoor VOC generation rate =	chem. specific	ug/m^3-min	
BW - Body Weight =	70	kg	US EPA 1989, RAGS Part A
Rex - Air Exchange Rate =	0.0083	exchange/mi	Foster, Chrostowski, 1987
Ds - Duration in Shower =	15	min	US EPA 1995, Exp. Factors Handbook
Dt - Total Duration in Shower Room =	20	min	reasonable maximum

S (ug/m^3-min) = (Cwd * FR) / SV

Cwd - Concentration leaving shower droplet after time ts =	chem. specific	ug/L	
FR - Shower Water Flow Rate =	10	L/min	Foster, Chrostowski, 1987
SV - Shower Room Air Volume =	6	m^3	Foster, Chrostowski, 1987

Cwd (ug/L) = Cwo * CFi * (1-exp((-Kal * tsd) / (60 * d)))

Cwo - Shower water concentration =	chem. specific	mg/L	
CFi - Conversion factor =	1.00E+03	ug/mg	
Kal - overall mass transfer coefficient =	chem. specific	cm/hr	
tsd - shower droplet drop time =	2	sec	Foster, Chrostowski, 1987
d - shower droplet diameter =	1	mm	Foster, Chrostowski, 1987

Kal (cm/hour) = $KL\ ((T_l * u_s) / (T_s * u_l))^{0.5}$

KL - mass transfer coefficient =	chem. specific	cm/hr
T_l - calibration water temperature =	293	K
u_s - water viscosity at Ts =	0.596	cp
T_s - shower water temperature =	318	K
u_l - water viscosity at Tl =	1.002	cp

KL (cm/hr) = $((1 / kl(voc)) + ((R * T) / (H * kg(voc))))^{-1}$

kl(voc) - liquid-film mass transfer coefficient =	chem. specific	cm/hr
R - universal gas constant =	8.20E-05	atm-m^3/mol K
T - absolute temperature =	293	K
H - Henry's Law Constant =	chem. specific	atm-m^3/mol
kg(voc) - gas-film mass transfer coefficient =	chem. specific	cm/hr

kg(voc) (cm/hr) = $kg(H_2O) * (18 / MWvoc)^{0.5}$

$kg(H_2O)$ =	3000	cm/hr
MW - molecular weight =	chem. specific	g/mol

kl(voc) (cm/hr) = $kl(CO_2) * (44 / MW)^{0.5}$

$kl(CO_2)$ =	20	cm/hr

Constituent	Cwo mg/L	kl(voc) cm/hr	kg(voc) cm/hr	KL cm/hr	Kal cm/hr	Cwd ug/L	S ug/m^3-min	Inhalation Dose mg/kg-shower	Average Daily Intake mg/kg-day	Inhalation Chronic RfD mg/kg-day	Hazard Index	Lifetime Average Daily Intake mg/kg-day	Inhalation Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Indeno(1,2,3-c,d)pyrene	5.00E-03	7.98E+00	7.66E+02	5.07E-02	6.84E-02	1.14E-05	1.90E-05	7.20E-10	4.93E-10	NA	NA	1.76E-10	NA	NA
Naphthalene	6.00E+01	1.17E+01	1.12E+03	7.72E+00	1.04E+01	1.76E+01	2.94E+01	1.11E-03	7.63E-04	9.00E-04	NA	2.72E-04	NA	NA
Pentachlorophenol	6.00E-02	8.13E+00	7.80E+02	7.95E-04	1.07E-03	2.15E-06	3.58E-06	1.36E-10	9.30E-11	NA	NA	3.32E-11	NA	NA
Phenanthrene	1.85E+01	9.94E+00	9.53E+02	1.25E+00	1.69E+00	1.01E+00	1.69E+00	6.41E-05	4.39E-05	NA	NA	1.57E-05	NA	NA
Phenol	5.80E+01	1.37E+01	1.31E+03	1.82E-02	2.45E-02	4.74E-02	7.90E-02	3.00E-06	2.05E-06	NA	NA	7.33E-07	NA	NA
Pyrene	6.37E-01	9.33E+00	8.95E+02	3.93E-01	5.30E-01	1.12E-02	1.86E-02	7.06E-07	4.83E-07	NA	NA	1.73E-07	NA	NA
Volatiles														
Benzene	2.64E-01	1.50E+01	1.44E+03	1.44E+01	1.94E+01	1.26E-01	2.09E-01	7.95E-06	5.44E-06	1.70E-03	3.20E-03	1.94E-06	2.90E-02	5.64E-08
Ethylbenzene	1.79E-01	1.29E+01	1.24E+03	1.25E+01	1.69E+01	7.71E-02	1.28E-01	4.87E-06	3.34E-06	2.90E-01	1.15E-05	1.19E-06	NA	NA
Styrene	6.49E-02	1.30E+01	1.25E+03	1.19E+01	1.61E+01	2.69E-02	4.49E-02	1.70E-06	1.17E-06	2.86E-01	4.08E-06	4.17E-07	NA	NA
Toluene	5.48E-01	1.38E+01	1.33E+03	1.33E+01	1.80E+01	2.47E-01	4.12E-01	1.56E-05	1.07E-05	1.14E-01	9.39E-05	3.82E-06	NA	NA
Xylenes (total)	1.90E+00	1.29E+01	1.24E+03	1.24E+01	1.68E+01	8.13E-01	1.36E+00	5.14E-05	3.52E-05	NA	NA	1.26E-05	NA	NA

NA - Not available

Total Hazard Index: 3.31E-03 7.25E-06

Table 62
Reasonable Maximum Dermal Exposure to Potomac Aquifer Groundwater to an Industrial Worker Showering
Former Koppers Company, Inc., Newport, DE

Average Daily Intake (mg/kg-day) = $\frac{DA * EF * ED * FS * SAt}{BW * AT}$

DA - Absorbed dose =	chem. specific	mg/day-cm^2	
EF- Exposure frequency =	250	day/year	US EPA 1991, HHEM Supp. Guidance
ED - Exposure duration =	25	year	Carey, 1988
SA - Skin surface area available for contact =	20000	cm^2	calculated
SAt - Total skin surface area =	20000	cm^2	US EPA 1989, RAGS Part A
FS - Fraction of skin surface area available for contact =	100%		reasonable maximum
BW - Body weight =	70	kg	US EPA 1989, RAGS Part A
AT_n - Averaging Time noncarcinogenic =	9125	days	US EPA 1989, RAGS Part A
AT_c - Averaging Time carcinogenic =	25550	days	US EPA 1989, RAGS Part A

For Inorganics:

DA (mg/day-cm^2) = Kp * Cgw * t * CF

Kp - Dermal permeability constant =	chem. specific	cm/hr	
Cgw - Chemical concentration in groundwater =	chem. specific	mg/L	
t - Event duration =	0.25	hr	US EPA 1992, Dermal Exp. Assess.
CF - Conversion factor	1.00E-03	L/cm^3	

For Organics:

If t < t*, then DA = 2 * CF * Cgw * Kp * $(6 * \tau * t / \pi)^{0.5}$
If t>t*, then DA = Kp * Cgw * CF * (t/(1+B) + (2 * τ * ((1+3B) / (1+B)))

t* - Percutaneous absorption time =	chem. specific	hr
B - Partitioning coefficient =	chem. specific	dimensionless
τ - Lag time =	chem. specific	hr

Analyte	Concentration in Groundwater mg/L	Kp cm/hr	t* hr	B	τ hr	Absorbed Dose mg/day-cm^2	Average Daily Intake mg/kg-day	Dermal Chronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Inorganics												
Antimony	2.30E-03	1.00E-03	NA	NA	NA	5.75E-10	1.13E-07	4.00E-06	2.81E-02	4.02E-08	NA	NA
Lead	3.50E-03	4.00E-06	NA	NA	NA	3.50E-12	6.85E-10	NA	NA	2.45E-10	NA	NA
PCBs/Pesticides												
Heptachlor epoxide	6.10E-06	2.76E-02	1.30E+02	9.55E+00	2.07E+01	1.06E-09	2.07E-07	3.90E-06	5.32E-02	7.40E-08	3.03E+01	2.24E-06

NA - Not applicable

Total Hazard Index: 0.08 Total Cancer Risk: 2.24E-06

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ENVIRONMENTAL STANDARDS

Table 63
Reasonable Maximum Oral Exposure to Potomac Aquifer Groundwater While Drinking at the Job Site
Former Koppers Company, Inc., Newport, DE

$$\text{Average Daily Intake (mg/kg-day)} = \frac{Cgw * IR * ED * EF}{BW * AT}$$

Cgw - Concentration in groundwater =	chem specific	mg/L	
IR - Ingestion Rate =	1.0	L/day	US EPA 1991, HHEM Supp. Guidance
ED - Exposure duration =	25	year	US EPA 1991, HHEM Supp. Guidance
EF- Exposure frequency =	250	days/year	US EPA 1991, HHEM Supp. Guidance
BW - Body weight =	70	kg	US EPA 1989, RAGS Part A
AT_n - Averaging Time noncarcinogenic =	9125	days	US EPA 1989, RAGS Part A
AT_c - Averaging Time carcinogenic =	25550	days	US EPA 1989, RAGS Part A

Analyte	Concentration in Groundwater mg/L	Average Daily Intake mg/kg-day	Oral Chronic RfD mg/kg-day	Hazard Index	Lifetime Average Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Inorganics							
Antimony	2.30E-03	2.25E-05	4.00E-04	5.63E-02	8.04E-06	NA	NA
Lead	3.50E-03	3.42E-05	NA	NA	1.22E-05	NA	NA
PCBs/Pesticides							
Heptachlor epoxide	6.10E-06	5.97E-08	1.30E-05	4.59E-03	2.13E-08	9.10E+00	1.94E-07
			Total Hazard Index:	0.06		Total Cancer Risk:	1.94E-07

Table 64

Reasonable Maximum Inhalation Exposure to VOC Vapors by an Industrial Worker Showering with Potomac Aquifer Groundwater

Former Koppers Company, Inc., Newport, DE

Average Daily Intake (mg/kg-day) = Dose * EF * ED / AT

Dose - Inhalation dose =	chem. specific		
EF - Exposure frequency =	250	showers/year	US EPA 1991, HHEM Supp. Guid.
Ed - Exposure duration =	25	years	Carey, 1988
AT_n - Averaging Time noncarcinogenic =	9125	days	US EPA 1989, RAGS Part A
AT_c - Averaging Time carcinogenic =	25550	days	US EPA 1989, RAGS Part A

Inhalation Dose (mg/kg-shower) =

((VR * S) / (BW * Rex * 10^6)) * (Ds + (exp(-Rex * Dt) / Rex) - (exp(Rex * (Ds - Dt)) / Rex))

VR - Ventilation Rate =	15	L/min	Foster, Chrostowski, 1987
S - Indoor VOC generation rate =	chem. specific	ug/m^3-min	
BW - Body Weight =	70	kg	US EPA 1989, RAGS Part A
Rex - Air Exchange Rate =	0.0083	exchange/mi	Foster, Chrostowski, 1987
Ds - Duration in Shower =	15	min	US EPA 1995, Exp. Factors Handbook
Dt - Total Duration in Shower Room =	20	min	reasonable maximum

S (ug/m^3-min) = (Cwd * FR) / SV

Cwd - Concentration leaving shower droplet after time ts =	chem. specific	ug/L	
FR - Shower Water Flow Rate =	10	L/min	Foster, Chrostowski, 1987
SV - Shower Room Air Volume =	6	m^3	Foster, Chrostowski, 1987

Cwd (ug/L) = Cwo * CFi * (1-exp((-Kal * tsd) / (60 * d)))

Cwo - Shower water concentration =	chem. specific	mg/L	
CFi - Conversion factor =	1.00E+03	ug/mg	
Kal - overall mass transfer coefficient =	chem. specific	cm/hr	
tsd - shower droplet drop time =	2	sec	Foster, Chrostowski, 1987
d - shower droplet diameter =	1	mm	Foster, Chrostowski, 1987

Kal (cm/hour) = KL $((T_l * u_s) / (T_s * u_l))^{0.5}$

KL - mass transfer coefficient =	chem. specific	cm/hr
T_l - calibration water temperature =	293	K
u_s - water viscosity at Ts =	0.596	cp
T_s - shower water temperature =	318	K
u_l - water viscosity at Tl =	1.002	cp

KL (cm/hr) = $((1 / kl(voc))+((R * T) / (H * kg(voc))))^{1}$

kl(voc) - liquid-film mass transfer coefficient =	chem. specific	cm/hr
R - universal gas constant =	8.20E-05	atm-m^3/mol K
T - absolute temperature	293	K
H - Henry's Law Constant =	chem. specific	atm-m^3/mol
kg(voc) - gas-film mass transfer coefficient =	chem. specific	cm/hr

kg(voc) (cm/hr) = $kg(H_2O) * (18 / MWvoc)^{0.5}$

$kg(H_2O)$ =	3000	cm/hr
MW - molecular weight =	chem. specific	g/mol

kl(voc) (cm/hr) = $kl(CO_2) * (44 / MW)^{0.5}$

$kl(CO_2)$ =	20	cm/hr

Constituent	Cwo mg/L	kl(voc) cm/hr	kg(voc) cm/hr	KL cm/hr	Kal cm/hr	Cwd ug/L	S ug/m^3-min	Inhalation Dose mg/kg-shower	Average Daily Intake mg/kg-day	Inhalation Chronic RfD mg/kg-day	Hazard Index	Lifetime Average Daily Intake mg/kg-day	Inhalation Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
PCBs/Pesticides														
Heptachlor epoxide	6.10E-06	6.72E+00	6.45E+02	7.62E-01	1.03E+00	2.06E-07	3.43E-07	1.30E-11	8.91E-12	NA	NA	3.18E-12	9.10E+00	2.90E-11
									Total Hazard Index:		NA		Total Cancer Risk:	2.90E-11

Table 67

Reasonable Maximum Dermal Exposure to Soils by a Trespasser (12 - 18 years old)

Former Koppers Company, Inc., Newport, DE

$$\text{Intake (mg/kg-day)} = \frac{Cs * SA * AF * ABS * EF * ED * CF}{BW * AT}$$

Cs - Concentration in soil and sediments =	mg/kg	chemical specific	
SA - Skin surface area available for exposure =	cm^2/day	4381	calculated
Total Surface area -	cm^2	15758	US EPA 1995, EFH
Fraction of skin surface area available for exposure =		27.8%	US EPA 1995, EFH
AF -Soil Adherence Factor =	mg/cm^2	0.025	US EPA 1995, EFH
ABS_d - Absorption for dioxins =		0.1	US EPA 1995, Region III
ABS_s - Absorption for semivolatiles =		0.1	US EPA 1995, Region III
ABS_n - Absorption for inorganics =		0.01	US EPA 1995, Region III
EF - Exposure frequency =	days/year	24	reasonable maximum
ED - Exposure duration =	years	6	reasonable mamimum
CF - Conversion factor (1 kg/1,000,000 mg) =	kg/mg	1.00E-06	
BW - Body weight =	kg	56	US EPA 1995, EFH
AT_n - Averaging time for noncarcinogenic effects =	days	2190	US EPA 1989, RAGS Part A
AT_c - Averaging time for carcinogenic effects =	days	25550	US EPA 1989, RAGS Part A

Chemical	Conc. in Soils mg/kg	Average Daily Intake mg/kg-day	Dermal Subchronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Dioxins							
2,3,7,8-TCDD Equiv.	6.56E-03	8.44E-11	NA	NA	7.23E-12	3.00E+05	2.17E-06
Inorganics							
Arsenic	8.40E+00	1.08E-08	2.85E-04	3.79E-05	9.26E-10	1.58E+00	1.46E-09
Thallium	7.12E+00	9.15E-09	NA	NA	7.85E-10	NA	NA
Semivolatiles							
Dibenzofuran	1.24E+02	1.59E-06	NA	NA	1.36E-07	NA	NA
Pentachlorophenol	6.62E+01	8.51E-07	2.10E-02	4.05E-05	7.30E-08	1.71E-01	1.25E-08
Phenanthrene	4.93E+02	6.34E-06	NA	NA	5.43E-07	NA	NA

NA - Not available — Total Hazard Index: 0.00008 — 2.18E-06

Table 68

Reasonable Maximum Exposure by Ingestion of Soils by a Trespasser (12 - 18 years old)

Former Koppers Company, Inc., Newport, DE

Intake (mg/kg-day) = $\frac{Cs * IngR * EF * ED * CF * FI}{BW * AT}$

Cs - Concentration in soil and sediments =	mg/kg	chemical specific	
IngR - Ingestion rate =	mg/day	100	Calabrese et al, 1987
EF - Exposure frequency =	days/year	24	reasonable maximum
ED - Exposure duration =	years	6	reasonable mamimum
CF - Conversion factor (1 kg/1,000,000 mg) =	kg/mg	1.00E-06	
FI - Fraction of daily soil ingested at site =		1	reasonable maximum
BW - Body weight =	kg	56	US EPA 1995, EFH
AT - Averaging time for noncarcinogenic effects =	days	2190	US EPA 1989, RAGS Part A
and for carcinogenic effects	days	25550	US EPA 1989, RAGS Part A

Chemical	Conc. in Soils mg/kg	Average Daily Intake mg/kg-day	Oral Subchronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Slope Factor 1/(mg/kg-day)	Cancer Risk
Dioxins							
2,3,7,8-TCDD Equiv.	6.56E-03	7.70E-10	NA	NA	6.60E-11	1.50E+05	9.90E-06
Inorganics							
Arsenic	8.40E+00	9.87E-07	3.00E-04	3.29E-03	8.46E-08	1.50E+00	1.27E-07
Thallium	7.12E+00	8.36E-07	NA	NA	7.16E-08	NA	NA
Semivolatiles							
2-Methylnaphthalene	8.69E+01	1.02E-05	NA	NA	8.74E-07	NA	NA
Acenaphthylene	2.52E+01	2.96E-06	NA	NA	2.54E-07	NA	NA
Benzo(a)anthracene	5.64E+02	6.62E-05	NA	NA	5.67E-06	7.30E-01	4.14E-06
Benzo(a)pyrene	3.59E+02	4.21E-05	NA	NA	3.61E-06	7.30E+00	2.64E-05
Benzo(b)fluoranthene	7.50E+02	8.81E-05	NA	NA	7.55E-06	7.30E-01	5.51E-06
Benzo(g,h,i)perylene	1.32E+02	1.55E-05	NA	NA	1.33E-06	NA	NA
Benzo(k)fluoranthene	2.36E+02	2.77E-05	NA	NA	2.38E-06	7.30E-02	1.73E-07
Carbazole	2.99E+02	3.51E-05	NA	NA	3.01E-06	2.00E-02	6.02E-08
Chrysene	5.85E+02	6.87E-05	NA	NA	5.89E-06	7.30E-03	4.30E-08
Dibenz(a,h)anthracene	3.95E+01	4.63E-06	NA	NA	3.97E-07	7.30E+00	2.90E-06
Dibenzofuran	1.24E+02	1.45E-05	NA	NA	1.24E-06	NA	NA
Indeno(1,2,3-c,d)pyrene	1.90E+02	2.24E-05	NA	NA	1.92E-06	7.30E-01	1.40E-06
Pentachlorophenol	6.62E+01	7.77E-06	3.00E-02	2.59E-04	6.66E-07	1.20E-01	8.00E-08
Phenanthrene	4.93E+02	5.79E-05	NA	NA	4.96E-06	NA	NA

NA - Not available — Total Hazard Index: 0.0035 — 5.07E-05

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ENVIRONMENTAL STANDARDS

Table 71

Reasonable Maximum Dermal Exposure to Soils and NAPL by a Trespasser (12 - 18 years old)

Former Koppers Company, Inc., Newport, DE

$$\text{Intake (mg/kg-day)} = \frac{Cs * SA * AF * ABS * EF * ED * CF}{BW * AT}$$

Cs - Concentration in soil and sediments =	mg/kg	chemical specific	
SA - Skin surface area available for exposure =	cm^2/day	4381	calculated
Total Surface area =	cm^2	15758	US EPA 1995, EFH
Fraction of skin surface area available for exposure =		27.8%	US EPA 1995, EFH
AF -Soil Adherence Factor =	mg/cm^2	0.025	US EPA 1995, EFH
ABS_d - Absorption for dioxins =		0.1	US EPA 1995, Region III
ABS_s - Absorption for semivolatiles =		0.1	US EPA 1995, Region III
ABS_n - Absorption for inorganics =		0.01	US EPA 1995, Region III
EF - Exposure frequency =	days/year	24	reasonable maximum
ED - Exposure duration =	years	6	reasonable mamimum
CF - Conversion factor (1 kg/1,000,000 mg) =	kg/mg	1.00E-06	
BW - Body weight =	kg	56	US EPA 1995, EFH
AT_n - Averaging time for noncarcinogenic effects =	days	2190	US EPA 1989, RAGS Part A
AT_c - Averaging time for carcinogenic effects =	days	25550	US EPA 1989, RAGS Part A

Chemical	Conc. in Soils and NAPL mg/kg	Average Daily Intake mg/kg-day	Dermal Subchronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Dioxins							
2,3,7,8-TCDD Equiv.	6.56E-03	8.44E-11	NA	NA	7.23E-12	3.00E+05	2.17E-06
Inorganics							
Arsenic	7.48E+00	9.61E-09	2.85E-04	3.37E-05	8.24E-10	1.58E+00	1.30E-09
Iron	1.94E+04	2.50E-05	NA	NA	2.14E-06	NA	NA
Lead	7.05E+01	9.07E-08	NA	NA	7.77E-09	NA	NA
Thallium	4.50E+00	5.79E-09	NA	NA	4.96E-10	NA	NA
Semivolatiles							
Dibenzofuran	5.25E+01	6.75E-07	NA	NA	5.79E-08	NA	NA
Pentachlorophenol	3.44E+01	4.42E-07	2.10E-02	2.11E-05	3.79E-08	1.71E-01	6.48E-09

NA - Not available   Total Hazard Index: 0.0001   2.18E-06

Table 72

Reasonable Maximum Exposure by Ingestion of Soils and NAPL by a Trespasser (12 - 18 years old)

Former Koppers Company, Inc., Newport, DE

Intake (mg/kg-day) = Cs * IngR * EF * ED * CF * FI / BW * AT

Cs - Concentration in soil and sediments =	mg/kg	chemical specific	
IngR - Ingestion rate =	mg/day	100	Calabrese et al, 1987
EF - Exposure frequency =	days/year	24	reasonable maximum
ED - Exposure duration =	years	6	reasonable mamimum
CF - Conversion factor (1 kg/1,000,000 mg) =	kg/mg	1.00E-06	
FI - Fraction of daily soil ingested at site		1	reasonable maximum
BW - Body weight =	kg	56	US EPA 1995, EFH
AT - Averaging time for noncarcinogenic effects =	days	2190	US EPA 1989, RAGS Part A
and for carcinogenic effects =	days	25550	US EPA 1989, RAGS Part A

Chemical	Conc. in Soils and NAPL mg/kg	Average Daily Intake mg/kg-day	Oral Subchronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Slope Factor 1/(mg/kg-day)	Cancer Risk
Dioxins							
2,3,7,8-TCDD Equiv.	6.56E-03	7.70E-10	NA	NA	6.60E-11	1.50E+05	9.90E-06
Inorganics							
Arsenic	7.48E+00	8.78E-07	3.00E-04	2.93E-03	7.52E-08	1.50E+00	1.13E-07
Iron	1.94E+04	2.28E-03	NA	NA	1.95E-04	NA	NA
Lead	7.05E+01	8.28E-06	NA	NA	7.10E-07	NA	NA
Thallium	4.50E+00	5.28E-07	NA	NA	4.53E-08	NA	NA
Semivolatiles							
Acenaphthylene	1.52E+01	1.78E-06	NA	NA	1.53E-07	NA	NA
Benzo(a)anthracene	5.00E+02	5.87E-05	NA	NA	5.03E-06	7.30E-01	3.67E-06
Benzo(a)pyrene	2.90E+02	3.40E-05	NA	NA	2.92E-06	7.30E+00	2.13E-05
Benzo(b)fluoranthene	6.26E+02	7.35E-05	NA	NA	6.30E-06	7.30E-01	4.60E-06
Benzo(g,h,i)perylene	1.05E+02	1.23E-05	NA	NA	1.06E-06	NA	NA
Benzo(k)fluoranthene	1.37E+02	1.61E-05	NA	NA	1.38E-06	7.30E-02	1.01E-07
Carbazole	1.09E+02	1.28E-05	NA	NA	1.10E-06	2.00E-02	2.19E-08
Chrysene	5.42E+02	6.37E-05	NA	NA	5.46E-06	7.30E-03	3.98E-08
Dibenz(a,h)anthracene	2.46E+01	2.89E-06	NA	NA	2.47E-07	7.30E+00	1.81E-06
Dibenzofuran	5.25E+01	6.16E-06	NA	NA	5.28E-07	NA	NA
Fluoranthene	1.48E+03	1.74E-04	4.00E-01	4.35E-04	1.49E-05	NA	NA
Indeno(1,2,3-c,d)pyrene	1.51E+02	1.78E-05	NA	NA	1.52E-06	7.30E-01	1.11E-06
Pentachlorophenol	3.44E+01	4.04E-06	3.00E-02	1.35E-04	3.46E-07	1.20E-01	4.15E-08
Phenanthrene	3.45E+02	4.06E-05	NA	NA	3.48E-06	NA	NA
Pyrene	1.26E+03	1.48E-04	3.00E-01	4.93E-04	1.27E-05	NA	NA

NA - Not available   Total Hazard Index: 0.004   4.27E-05

Table 74

Central Tendency Dermal Exposure to Non-River Surface Water - Adolescent Trespasser

Former Koppers Company, Inc., Newport, DE

Average Daily Intake (mg/kg-day) = $\frac{DA * EF * ED * SA}{BW * AT}$

DA - Absorbed dose =	chem. specific	$mg/day\text{-}cm^2$	
EF- Exposure frequency =	24	day/year	US EPA 1991, HHEM Supp. Guidance
ED - Exposure duration =	6	year	Carey, 1988
SA - Skin surface area available for contact =	207	cm^2	calculated
BW - Body weight =	56	kg	US EPA 1989, RAGS Part A
AT_n - Averaging Time noncarcinogenic =	2190	days	US EPA 1989, RAGS Part A
AT_c - Averaging Time carcinogenic =	25550	days	US EPA 1989, RAGS Part A

For Inorganics:

$DA\ (mg/day\text{-}cm^2) = Kp * Cgw * t * CF$

Kp - Dermal permeability constant =	chem. specific	cm/hr	US EPA 1992, Dermal Exp. Assess.
Cgw - Chemical concentration in groundwater =	chem. specific	mg/L	
t - Event duration =	0.2	hr	US EPA 1992, Dermal Exp. Assess.
CF - Conversion factor	1.00E-03	L/cm^3	

For Organics:

If $t < t^*$, then $DA = 2 * CF * Cgw * Kp * (6 * t * t / p)^{0.5}$

If $t > t^*$, then $DA = Kp * Cgw * CF * (t/(1+B) + (2 * t * ((1+3B) / (1+B)))$

t* - Percutaneous absorption time =	chem. specific	hr
B - Partitioning coefficient =	chem. specific	dimensionless
t - Lag time =	chem. specific	hr

Analyte	Concentration in Groundwater mg/L	Kp cm/hr	t* hr	B	t hr	Absorbed Dose $mg/day\text{-}cm^2$	Average Daily Intake mg/kg-day	Dermal Subchronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Dioxins												
2,3,7,8-TCDD Equiv	1.99E-06	1.40E+00	3.80E+01	6.30E+02	8.10E+00	9.81E-09	2.38E-09	NA	NA	2.04E-10	3.00E+05	6.13E-05
Inorganics												
Arsenic	4.95E-03	1.00E-03	NA	NA	NA	9.90E-10	2.41E-10	2.85E-04	8.44E-07	2.06E-11	1.58E+00	3.26E-11
Iron	6.21E+00	1.00E-03	NA	NA	NA	1.24E-06	3.02E-07	NA	NA	2.59E-08	NA	NA
Lead	4.49E-03	4.00E-06	NA	NA	NA	3.59E-12	8.74E-13	NA	NA	7.49E-14	NA	NA
Manganese	1.36E+00	1.00E-03	NA	NA	NA	2.71E-07	6.59E-08	NA	NA	5.65E-09	NA	NA
Thallium	5.77E-03	1.00E-03	NA	NA	NA	1.15E-09	2.80E-10	NA	NA	2.40E-11	NA	NA

NA - Not Applicable

Total Hazard Index: 0.0000008 | 6.13E-05

Table 77

Reasonable Maximum Dermal Exposure to Sediment* by a Trespasser (12 - 18 years old)

Former Koppers Company, Inc., Newport, DE

$$\text{Intake (mg/kg-day)} = \frac{Cs * SA * AF * ABS * EF * ED * CF}{BW * AT}$$

Cs - Concentration in soil and sediments =	mg/kg	chemical specific	
SA - Skin surface area available for exposure =	cm^2/day	1103	calculated
Total Surface area =	cm^2	15758	US EPA 1995, EFH
Fraction of skin surface area available for exposure =		7.0%	US EPA 1995, EFH
AF -Soil Adherence Factor =	mg/cm^2	0.025	US EPA 1995, EFH
ABS_d - Absorption for dioxins =		0.1	US EPA 1995, Region III
ABS_s - Absorption for semivolatiles =		0.1	US EPA 1995, Region III
ABS_n - Absorption for inorganics -		0.01	US EPA 1995, Region III
EF - Exposure frequency =	days/year	10	reasonable maximum
ED - Exposure duration =	years	6	reasonable mamimum
CF - Conversion factor (1 kg/1,000,000 mg) =	kg/mg	1.00E-06	
BW - Body weight =	kg	56	US EPA 1995, EFH
AT_n - Averaging time for noncarcinogenic effects =	days	2190	US EPA 1989, RAGS Part A
AT_c - Averaging time for carcinogenic effects =	days	25550	US EPA 1989, RAGS Part A

Chemical	Conc. in Soils and Sediments mg/kg	Average Daily Intake mg/kg-day	Dermal Subchronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Dioxins							
2,3,7,8-TCDD Equiv.	7.96E-04	1.07E-12	NA	NA	9.21E-14	3.00E+05	2.76E-08
Inorganics							
Arsenic	1.19E+01	1.60E-09	2.85E-04	5.63E-06	1.37E-10	1.58E+00	2.17E-10
Lead	1.27E+02	1.72E-08	NA	NA	1.47E-09	NA	NA
Manganese	8.85E+02	1.19E-07	7.00E-03	1.71E-05	1.02E-08	NA	NA
Thallium	4.32E+00	5.82E-10	NA	NA	4.99E-11	NA	NA
Semivolatiles							
Carbazole	1.02E+02	1.38E-07	NA	NA	1.18E-08	NA	NA
Dibenzofuran	2.55E+02	3.44E-07	NA	NA	2.95E-08	NA	NA
		Total Hazard Index:		0.00002		Total Cancer Risk	2.78E-08

* Includes Hershey Run sediments

NA - Not available

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Table 78

Reasonable Maximum Exposure by Ingestion of Sediment* by a Trespasser (12 - 18 years old)

Former Koppers Company, Inc., Newport, DE

$$\text{Intake (mg/kg-day)} = \frac{Cs * IngR * EF * ED * CF * FI}{BW * AT}$$

Cs - Concentration in soil and sediments =	mg/kg	chemical specific	
IngR - Ingestion rate =	mg/day	100	Calabrese et al, 1987
EF - Exposure frequency =	days/year	10	reasonable maximum
ED - Exposure duration =	years	6	reasonable mamimum
CF - Conversion factor (1 kg/1,000,000 mg) =	kg/mg	1.00E-06	
FI - Fraction of daily soil ingested at site =		1	reasonable maximum
BW - Body weight =	kg	56	US EPA 1995, EFH
AT - Averaging time for noncarcinogenic effects =	days	2190	US EPA 1989, RAGS Part A
and for carcinogenic effects =	days	25550	US EPA 1989, RAGS Part A

Chemical	Conc. in Soils and Sediments mg/kg	Average Daily Intake mg/kg-day	Oral Subchronic RfD mg/kg-day	Hazard Index	Average Lifetime Daily Intake mg/kg-day	Oral Slope Factor 1/(mg/kg-day)	Cancer Risk
Dioxins							
2,3,7,8-TCDD Equiv.	7.96E-04	3.89E-11	NA	NA	3.34E-12	1.50E+05	5.01E-07
Inorganics							
Arsenic	1.19E+01	5.81E-07	3.00E-04	1.94E-03	4.98E-08	1.50E+00	7.47E-08
Lead	1.27E+02	6.23E-06	NA	NA	5.34E-07	NA	NA
Manganese	8.85E+02	4.33E-05	1.40E-01	3.09E-04	3.71E-06	NA	NA
Thallium	4.32E+00	2.11E-07	NA	NA	1.81E-08	NA	NA
Semivolatiles							
Benzo(a)anthracene	3.20E+02	1.57E-05	NA	NA	1.34E-06	7.30E-01	9.80E-07
Benzo(a)pyrene	9.10E+01	4.45E-06	NA	NA	3.82E-07	7.30E+00	2.79E-06
Benzo(b)fluoranthene	1.65E+02	8.07E-06	NA	NA	6.92E-07	7.30E-01	5.05E-07
Benzo(k)fluoranthene	5.51E+01	2.70E-06	NA	NA	2.31E-07	7.30E-02	1.69E-08
Carbazole	1.02E+02	5.00E-06	NA	NA	4.29E-07	2.00E-02	8.58E-09
Chrysene	2.64E+02	1.29E-05	NA	NA	1.11E-06	7.30E-03	8.09E-09
Dibenz(a,h)anthracene	1.25E+01	6.09E-07	NA	NA	5.22E-08	7.30E+00	3.81E-07
Dibenzofuran	2.55E+02	1.25E-05	NA	NA	1.07E-06	NA	NA
Fluoranthene	2.27E+03	1.11E-04	4.00E-01	2.78E-04	9.53E-06	NA	NA
Fluorene	5.67E+02	2.77E-05	4.00E-01	6.93E-05	2.38E-06	NA	NA
Indeno(1,2,3-c,d)pyrene	4.56E+01	2.23E-06	NA	NA	1.91E-07	7.30E-01	1.39E-07
Pyrene	1.17E+03	5.70E-05	3.00E-01	1.90E-04	4.89E-06	NA	NA

* Includes Hershey Run sediments — Total Hazard Index: 0.003 — Total Cancer Risk: 5.40E-06

NA - Not available

AR316093

Table 84
Reasonable Maximum Exposure by Ingestion of Locally Caught Fish
Former Koppers Company, Inc., Newport, DE

Daily Intake (mg/kg-day) = $\frac{Cf * IRf * FI * EF * ED}{BW * AT}$

Cf - Concentration in fish =	chem. specific	mg/kg	
IRf - Ingestion rate of fish =	0.025	kg/day	From Ebert, 1992, Connelly et al., 1996; West, 1993
FI - Fraction of fish ingested from affected source =	100%		reasonable maximum
BW - Body weight =	70	kg	US EPA 1989, RAGS Part A
EF- Exposure frequency =	365	days/year	US EPA 1989, RAGS Part A
ED - Exposure duration =	25	year	US EPA 1991, Supp. Guid. to RAGS
AT_n - Averaging Time noncarcinogenic =	9125	days	US EPA 1989, RAGS Part A
AT_c - Averaging Time carcinogenic =	25550	days	US EPA 1989, RAGS Part A

Analyte	Concentration in Fish mg/kg	Average Daily Intake mg/kg-day	Oral Chronic RfD mg/kg-day	Hazard Index	Lifetime Average Daily Intake mg/kg-day	Oral Cancer Slope Factor 1/(mg/kg-day)	Cancer Risk
Dioxins							
2,3,7,8-TCDD Equiv	3.01E-07	1.08E-10	NA	NA	3.84E-11	1.50E+05	5.77E-06
Inorganics							
Arsenic	6.59E-01	2.35E-04	3.00E-04	7.85E-01	8.41E-05	1.50E+00	1.26E-04
Lead	1.27E-01	4.54E-05	NA	NA	1.62E-05	NA	NA
Mercury	2.54E-01	9.06E-05	NA	NA	3.24E-05	NA	NA
PCBs/Pesticides							
Aroclor 1254	4.20E-01	1.50E-04	2.00E-05	7.50E+00	5.36E-05	2.00E+00	1.07E-04
Aroclor 1260	2.40E-01	8.57E-05	2.00E-05	4.29E+00	3.06E-05	2.00E+00	6.12E-05
4,4'-DDD	4.40E-02	1.57E-05	NA	NA	5.61E-06	2.40E-01	1.35E-06
4,4'-DDE	1.30E-01	4.64E-05	NA	NA	1.66E-05	3.40E-01	5.64E-06

NA - Not available

Total Hazard Index: 12.57

Total Cancer Risk: 3.07E-04

Table 7. Ecological Risk Assessment Endpoints

Table 7. Ecological Risk Assessment Endpoints

Assessment Endpoint	Lines of Evidence	Ecological Receptor	Weight of Evidence
1) Protection of the structure and function of wetland communities and 2) Protection of the aquatic benthic invertebrate communities structure and function	Vegetation surveys		
	Toxicity test results	Amphipod and Midge	NOAEL 82.87 mg/kg total PAHs, LOAEL 197.6 mg/kg total PAHs
	Evaluation of the benthic macroinvertebrate population/ community structure		In areas of high total PAH sediment concentration, reduction in population of benthic organisms present
3) Protection of the upland soil community functioning	Toxicity test results	Earthworm	NOAEL 587 mg/kg total PAHs and LOAEL 1264 mg/kg total PAHs
	Plant community surveys		Areas of stressed vegetation associated with elevated levels of contamination
4) Protection of the structure and function of the terrestrial plant community	Plant community surveys		Negative effects of contamination on upland plants particularly in areas where visible contamination found
5) Protection of fish populations and communities from direct toxicity and reproductive impairment	Embryo toxicity tests	Killifish	NOAEL 33.5 mg/kg total PAHs
	Potential indirect effects based on benthic macroinvertebrate toxicity tests		
6) Protection of amphibian population, specifically in terms of recruitment	Toxicity test results	Southern Leopard Frog	Risk exists, effects levels consistent with other sediment contamination related risks

Table 8. Applicable or Relevant and Appropriate Requirements ("ARARs")

TABLE 8

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs) AND TO BE CONSIDERED MATERIAL (TBCs) KOPPERS (NEWPORT) SITE

ARAR or TBC	Legal Citation	ARAR Class	Requirement Synopsis	Applicability to Selected Remedy	Area of Concern
I. CHEMICAL SPECIFIC					
A. Water					
1. Safe Drinking Water Act	42 U.S.C. §§ 300f et seq.				
a. Maximum Contaminant Level Goals (MCLGs)	40 C.F.R § 141.50-51	Relevant and Appropriate	Non-enforceable health goals for public water supplies. The NCP requires that non-zero MCLGs shall be attained by remedial actions for ground water that is a current or potential source of drinking water, where the MCLGs are relevant and appropriate under the circumstances of the release.	The containment of NAPL and NAPL-contaminated soils and sediments will allow for natural attenuation processes to work in the Columbia aquifer. It is expected that attenuation processes will be able to restore impacted ground water outside of the containment area once containment is complete. There is no known contamination in the Potomac Aquifer. A State Ground Water Management Zone (GMZ) will be extended to encompass the Site in order to prevent the use of and exposure to Columbia ground water.	GW
b. Maximum Contaminant Levels (MCLs)	40 C.F.R § 141.11-12	Relevant and Appropriate	Enforceable standards for public drinking water supply systems (with at least fifteen service connections or used by at least 25 people). The NCP requires that MCLs, for those contaminants whose MCLG is zero, shall be attained by remedial actions for ground water that is a current or potential source of drinking water, where the MCLs are relevant and appropriate under the circumstances of the release.	The containment of NAPL and NAPL-contaminated soils and sediments will allow for natural attenuation processes to work in the Columbia aquifer. It is expected that attenuation processes will be able to restore impacted ground water outside of the containment area once containment is complete. There is no known contamination in the Potomac Aquifer. A State Ground Water Management Zone (GMZ) will be extended to encompass the Site in order to prevent the use of and exposure to Columbia ground water.	GW
2. Health Effects Assessment		To be Considered	Non-enforceable toxicity data for specific chemicals for use in public health assessments. Also "to be considered" are Carcinogenic Potency Factors and Reference Doses provided in the Superfund Public Health Evaluation Manual.	To be considered where remedial action addresses risk-based criteria or when setting clean-up standards for the protection of human health.	Site-wide

ARAR or TBC	Legal Citation	ARAR Class	Requirement Synopsis	Applicability to Selected Remedy	Area of Concern
3. Delaware Comprehensive Water Resources Management Committee Reports, December 13, 1983		To Be Considered	The reports were adopted as policy by the DNREC Secretary. Among these reports is the Groundwater Quality Management Report, July 1983, which provided Delaware with a number of tools for dealing with ground-water contamination.	To be considered for ground water monitoring.	GW
4. Clean Water Act	Clean Water Act, Section 303	Relevant and Appropriate	Water quality criteria set at levels to protect human health for water and fish ingestion and protection of aquatic life in streams, lakes, and rivers.	To be considered for ground water management if a surface water discharge will be required. To be considered for storm water management if a surface water discharge will be required.	Hershey Run, GW
5. Delaware Surface Water Quality Standards as amended, Feb. 26, 1993	Sections 3, 4, 5, 6, 8, 9, 10, 11.1, 11.2, 11.3, 11.4, 11.6, 12	Applicable	Criteria are provided to maintain surface water for streams, lakes, rivers, and standing water in wetlands of satisfactory quality consistent with public health and recreational purposes, the propagation and protection of fish and aquatic life, and other beneficial uses of water.	Any surface water discharge must meet these levels if more stringent than federal regulations.	Hershey Run
B. Air					
1. Clean Air Act	42 U.S.C. § 7401				
a. National Emissions Standards for Hazardous Air Pollutants	40 C.F.R. Part 61	Relevant and Appropriate	Standards promulgated for air emissions from specific source categories. Not applicable but may be relevant and appropriate for emissions from excavations at Superfund sites.	Relevant and appropriate for potential odors and emissions resulting from excavation.	Uplands
2. Delaware Ambient Air Quality Standards	Title 7, Delaware Code, Ch 60, Regulation 3, Section 6003	Applicable	Establishes ambient air quality standards.	Applicable for potential releases from excavation work or other remedial actions.	Uplands
II. LOCATION SPECIFIC					
1. Coastal Zone Management Act of 1972; Coastal Zone Act Reauthorization Amendments of 1990	16 U.S.C. §§ 1451 et seq. 15 C.F.R. Part 930	Applicable	Requires that Federal agencies conducting or supporting activities directly affecting the coastal zone, conduct or support those activities in a manner that is consistent with the approved appropriate State coastal zone management program. (See Delaware's Comprehensive Update and Routine Program Implementation, March 1993)	On-site remedial actions are required to be consistent, to the maximum extent practicable, with Delaware's coastal zone management program. EPA must notify Delaware of its determination that the actions are consistent to the maximum extent practicable.	Site-wide
2. The Archaeological and Historical Preservation Act of 1974	16 U.S.C. § 469	Applicable	Requirements relating to potential loss or destruction of significant scientific, historical, or archaeological data	The preferred alternative has the potential for disturbing archeological resources. Further action will be taken to identify the potentially affected resources and action will be taken to mitigate any adverse effects on those resources that would result from Remedial activities.	Site-wide

ARAR or TBC	Legal Citation	ARAR Class	Requirement Synopsis	Applicability to Selected Remedy	Area of Concern
3. Protection of Floodplains	40 C.F.R. Part 6, Appendix A; 40 C.F.R. § 6.302	Applicable	Sets forth EPA policy for carrying out provisions of Executive Order 11988 (Floodplain Management) which requires actions to avoid adverse effects, minimize potential harm, and restore and preserve natural and beneficial values.	Applicable since much of the remedial action will take place within both the 100-year and 500-year floodplains. Due to the encroachment of the containment area into tidal wetlands, wetlands will be constructed on site to mitigate the loss of volume inside the floodplain.	Site-wide
4. Protection of Wetlands	40 C.F.R. Part 6, Appendix A; 40 C.F.R. § 6.302	Applicable	Sets forth EPA policy for carrying out provisions of Executive Order 11990 (Protection of Wetlands) which requires actions to avoid adverse effects, minimize potential harm, and restore and preserve natural and beneficial values.	Applicable since the construction of the containment area will affect wetlands.	Wetlands
5. Delaware Coastal Zone Act, 7 Delaware Code Chapter 70; Coastal Zone Act Regulations, 6/9/93	7 Delaware Code, Sections 7003, 7004	To Be Considered	Controls the location, extent, and type of industrial development in Delaware's coastal areas.	Will be considered for consistency since the remedial action involves substantial aquatic habitat and is located in Delaware's coastal area although not in the defined coastal zone of this statute.	ALL
6. Delaware Wetlands Regulations Revised June 29, 1984	Sections 1, 2, 7	Applicable	Requires activities that may adversely affect wetlands in Delaware to be permitted. Permits must be approved by the county or municipality having jurisdiction.	Any substative requirements shall be met since wetlands will be destroyed and replaced in the Hershey Run marsh; and dredged (or excavated) and restored in the wetlands near the South Ponds. Since all of the wetland or remediation is considered "on-site", no permit will be required.	Wetlands
7. Delaware Regulations Governing the Use of Subaqueous Lands, amended September 2, 1992	Sections 1, 3, 4	Applicable	Requires activities that affect public or private subaqueous lands in the State be permitted.	Any substantive requirements shall be met since the remediation involves dredging and the potential rechannelization of Hershey Run. However, no permit shall be required.	Wetlands
8. Delaware Executive Order 56 on Freshwater Wetlands (1988)		To Be Considered	General policy to minimize the adverse effects to freshwater wetlands.	To be considered for wetland remediation and restoration.	Wetlands
9. Governor's Roundtable Report on Freshwater Wetlands (1989)		To Be Considered	General policy to minimize the adverse effects to freshwater wetlands.	To be considered for wetland remediation and restoration.	Wetlands
10. Ground Water Protection Strategy of 1984	EPA 440/6-84-002	To be Considered	Identifies ground water quality to be achieved during remedial actions based on aquifer characteristics and use.	The EPA aquifer classification will be taken into consideration during design and implementation of the remedy.	GW
11. Requirements pertaining to White Clay Creek, a Wild and Scenic River	Wild and Scenic River Act 36 C.F.R. Part 297	Applicable	Requirements to maintain the WSR in a free-flowing condition to protect the water quality and to fulfill other vital national conservation purposes	Applies to White Clay Creek, the stream into which Hershey Run drains	Site-wide

ARAR or TBC	Legal Citation	ARAR Class	Requirement Synopsis	Applicability to Selected Remedy	Area of Concern
III. ACTION SPECIFIC					
A. Miscellaneous					
1. Council on Environmental Quality	40 C.F.R. § 1500.2(f)	Relevant and Appropriate	Requires use of all practicable means, consistent with the requirements of NEPA to restore and enhance the quality of the human environment and avoid or minimize any possibe adverse effects upon the quality of the human environment.	Institutional controls shall be added to the Site to make sure the restored wetlands remain wildlife habitat.	Wetlands
2. Delaware Regulations Governing Hazardous Substance Cleanup, 1/93	Section 9	Relevant and Appropriate	Establishes clean-up criteria for hazardous waste sites. Only criteria considered relevant and appropriate are for ground water and soil ($1x10^{-5}$; Hazard Index of 1; or natural background if higher).	The cleanup criteria for the Site, though derived from the results of the Ecological Risk Assessment, are protective of Human Health as well.	Uplands, GW
3. Requirements for dredging,excavation and rechannelization	The Rivers and Harbors Act, Section 10	Applicable	Substantive requirements of a Section 10 permit for disposal of dredged and/or excavated materials at an approved facility or in a containment cell	Applies to all materials dredged or excavated during rechannelization of a navigable water of the U.S.	Site-wide
4. Requirements for dewatering from dredging operation	Clean Water Act, Section 404	Applicable	Substantive requirements for the discharge resulting from the dewatering of dredged or fill material into the waters of the U.S.	Applies to all discharges from materials dredged or excavated requiring dewatering during rechannelization of a navigable water	Site-wide
5. Delaware Land Use Restrictive Covenants	Title 7, Delaware Code Chapter 79	Applicable	To provide the required restrictions on land use to protect the integrity of the remedy as well as human health and the environment.	Applies to institutional controls to be implemented at the Site.	Site-wide
B. Water					
1. Clean Water Act (CWA); National Pollutant Discharge Elimination System Requirements	40 C.F.R. Part 122-125	Applicable	Enforceable standards for all discharges to waters of the United States.	Discharge limits shall be met for any on-site discharges to surface water including treated ground water (if necessary) and wastewater from dewatering dredge material. Only substantive requirements shall be met and no permit shall be required.	Wetlands GW
2. General Pretreatment Regulations	40 C.F.R Part 403	Applicable	Standards for discharge to POTW.	Applicable should the extracted ground water, treated ground water, or wastewater from dredge material be discharged to a POTW.	Wetlands GW
3. Section 10 of the River and Harbors Act	33 U.S.C. Section 403 33 C.F.R. Part 320-330	Applicable	Permitting requirements for dredging.	The stream and wetland dredging will comply to any substantive requirements, but no permit will be required.	Wetlands
4. State of Delaware Regulations Governing the Construction of Water Wells, January 20, 1987	Sections 3, 4, 5, 6, 7, 8, 9, 10	Applicable	Contain requirements governing the location, design, installation, use, disinfection, modification, repair, and abandonment of all wells and associated pumping equipment.	Installation of any monitoring and recovery wells and the abandonment of wells shall meet all substantive requirements.	Site-wide

ARAR or TBC	Legal Citation	ARAR Class	Requirement Synopsis	Applicability to Selected Remedy	Area of Concern
5. Delaware Water Quality Standards, as amended, February 26, 1993	Sections 3-6, 8-10, 11.1, 11.2, 11.3, 11.4, 11.6, 12	Applicable	Standards are established in order to regulate the discharge into state waters in order to maintain the integrity of the water.	Applicable because the ground water management system will most likely discharge to surface water (the final discharge point will be determined in design).	Hershey Run, GW
6. Delaware River Basin Commission (DRBC) Water Quality	DRBC Ground Water Protected Area Regulation, No. 4, 6(f), 9, 10; Water Code of the Basin, Sections 2.20.4, 2.50.2	To Be Considered	Regulate restoration, enhancement, and preservation of waters in the Delaware River basin.	To be considered if remedial action involves discharge of >50,000 gallons/day average over any month or a withdrawal of ground water of 100,000 gallons/day or more average over any month.	Hershey Run, GW
7. Delaware Regulations Governing the Allocation of Water March 1, 1987	Sections 1, 3, 5.05	Applicable	Contain information pertaining to water allocation permits and criteria for their approval.	May be applicable for the ground water management system. No permit required.	Hershey Run, GW
8. State of Delaware Groundwater Management Plan November 1, 1987		To Be Considered	Policy for ground-water management.	To be considered in setting the ground water management zone.	GW
9. Delaware Regulations Governing Control of Water Pollution, amended 6/23/83	Section 7, 8, 9, 10, 11, 12, 13	Applicable	Contain water quality regulations for the discharging into surface and ground water.	Applicable for potential discharge of treated ground water into surface water. Also applicable for potential storm water runoff into Hershey Run, White Clay Creek or the Christina River.	Surface Waters, GW
C. Sediments/Solids					
1. Delaware Sediment and Stormwater Regulations January 23, 1991	Section 3, 6, 9, 10, 11, 15	Applicable	Establishes a statewide sediment and stormwater management program.	A stormwater and sediment management plan consistent with Delaware requirements must be approved by EPA before construction disturbing over 5,000 square feet of land can begin.	Site-wide
D. Waste Handling and Disposal					
1. RCRA Subtitle D Landfill Regulations	40 C.F.R. § 258.60(a)	Relevant and Appropriate	Closure requirements for RCRA subtitle D landfills.	Provides some technical requirements for the cap for the containment area.	Uplands
2. Delaware Regulations Governing Hazardous Waste	SEE BELOW F.5, F.7, F.9, F.11, F.13, F.15, F.17	SEE BELOW	Delaware Regulations Governing Hazardous Waste Part 261 define "hazardous waste". The regulations listed below apply to the handling of such hazardous waste.	SEE BELOW	SEE BELOW

ARAR or TBC	Legal Citation	ARAR Class	Requirement Synopsis	Applicability to Selected Remedy	Area of Concern
3. Resource Conservation and Recovery Act of 1976; Hazardous and Solid Waste Amendments of 1984	SEE BELOW F.6, F.8, F.10, F.12, F.14, F.16, F.18 Federal regulations would not apply for those regulations which Delaware has the authority from EPA to administer.	SEE BELOW	Regulates the management of hazardous waste, to ensure the safe disposal of wastes, and to provide for resource recovery from the environment by controlling hazardous wastes "from cradle to grave."	SEE BELOW	SEE BELOW
4. Standards Applicable to Generators of Hazardous Waste	Delaware Regulations Governing Hazardous Waste, §§ 262.10-58	Applicable	Establishes standards for generators of hazardous wastes including waste determination manifests and pre-transport requirements. (Applies to recovered creosote NAPL drummed for off-site treatment or recycling.)	Applicable to operator(s) of the NAPL recovery and ground water management systems because the wastes to be recovered are a RCRA-hazardous waste.	Site-wide
5. Standards Applicable to Generators of Hazardous Waste	EPA Regulations, 40 C.F.R Part 262.10-58	Applicable	Establishes standards for generators of hazardous wastes including waste determination manifests and pre-transport requirements.	Applicable to operator(s) of the NAPL recovery and ground water management systems because the wastes to be recovered are a RCRA-hazardous waste.	Site-wide
6. Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities (TSDF)	Delaware Regulations Governing Hazardous Waste, Part 264 (40 C.F.R. §§ 264)	Applicable	Regulations for owners and operators of TSDFs which define acceptable management of hazardous wastes.	Applies to onsite recovery and treatment systems which handle hazardous waste	Site-wide
7. Standards for Owners and Operators of Hazardous Waste Treatment, Storage, and Disposal Facilities (TSDF)	EPA Regulations, 40 C.F.R. Part 264	Applicable	Regulations for owners and operators of TSDFs which define acceptable management of hazardous wastes.	Applies to onsite recovery and treatment systems which handle hazardous waste	Site-wide
8. RCRA Requirements for Use and Management of Containers	Delaware Regulations Governing Hazardous Waste, §§ 264.170-178	Applicable	Requirements for storage of hazardous waste in storage containers.	Applicable for temporary storage containers and on-site treatment systems.	Site-wide
9. RCRA Requirements for Use and Management of Containers	EPA Regulations, 40 C.F.R. §§ 264.170-178	Applicable	Requirements for storage of hazardous waste in storage containers.	Applicable for temporary storage containers and on-site treatment systems.	Site-wide
10. RCRA Requirements for Tanks Systems	Delaware Regulations Governing Hazardous Waste, §§ 264.190-199	Applicable	Requirements for storage or treatment of hazardous waste in tank systems.	Only applicable for onsite treatment systems and temporary storage tanks containing hazardous wastes.	Site-wide

ARAR or TBC	Legal Citation	ARAR Class	Requirement Synopsis	Applicability to Selected Remedy	Area of Concern
11. RCRA Requirements for Tanks Systems	EPA Regulations, 40 C.F.R. §§ 264.190-199	Applicable	Requirements for storage or treatment of hazardous waste in tank systems.	Only applicable for onsite treatment systems and temporary storage tanks containing hazardous wastes.	Site-wide
12. The Hazardous Waste Permit Program	Delaware Regulations Governing Hazardous Waste, Part 122	Applicable	Requires a permit for the treatment, storage, or disposal of any hazardous waste as identified or listed in Part 261.	Any substative requirements will be met. But no permit will be required	Site-wide
13. The Hazardous Waste Permit Program	EPA Regulations, 40 C.F.R. Part 122	Applicable	Requires a permit for the treatment, storage, or disposal of any hazardous waste as identified or listed in Part 261.	Any substative requirements will be met. But no permit will be required	Site-wide
14. Identification and Listing of Hazardous Wastes	Delaware Regulations Governing Hazardous Wastes, Part 261	Applicable	Identifies solid wastes which are regulated as hazardous wastes.	Use to determine which materials to be disposed of are hazardous wastes.	Site-wide
15. Identification and Listing of Hazardous Wastes	EPA Regulations, 40 C.F.R. Part 261	Applicable	Identifies solid wastes which are regulated as hazardous wastes.	Use to determine which materials to be disposed of are hazardous wastes.	Site-wide
16. RCRA Land Disposal Restrictions	Delaware Regulation Governing Hazardous Waste, Part 268	Applicable	Restrictions on land disposal of hazardous wastes.	Applies to consolidation of waste which is hazardous from across the Site. (EPA has herein designated the containment areas as Areas of Contamination.)	Site-wide
17. RCRA Land Disposal Restrictions	EPA Regulations, 40 C.F.R. Part 268	Applicable	Restrictions on land disposal of hazardous wastes.	Applies to consolidation of waste which is hazardous from across the Site. (EPA has herein designated the containment areas as Areas of Contamination.)	Site-wide

Table 9. Cost Summaries - Alternatives 1, 2, 3, 4, and 5

Table 9. Cost Summaries for Alternatives 1, 2, 3, 4, and 5

Remedial Alternative	Description	Capital Cost	Present Worth Operations & Maintenance Cost (7%, 30 Yrs)	Total Present Worth Cost
1	No Action	$0	$0	$0
2	Cover upland soils; Sediment cap in Fire Pond, South Pond and K Pond; Sheetpile & NAPL collection at Fire Pond and South Pond; MNR in Hershey Run and tidal wetlands; MNA of ground water contamination	$15,934,988	$1,490,864	$17,425,852
3	Excavate, consolidate and cap shallow soils and shallow tidal sediments; Cap Fire, K and South Ponds; Sheetpile and NAPL collection at Fire Pond and South Ponds areas; Rechannelization of Hershey Run; Wetlands mitigation; MNA of ground water contamination	$40,094,305	$40,094,305	$43,344,688
4	Excavate, consolidate and cap all contaminated soils and sediments; Subsurface ground water barrier wall around consolidation areas with passive NAPL recovery; Restoration of ground water through excavation of NAPL-contaminated aquifer material outside of consolidation areas; Rechannelization of Hershey Run; Wetlands mitigation; Monitoring of ground water contamination	$49,837,587	$1,918,652	$51,756,239
5	In-situ steam-enhanced extraction of subsurface NAPL; excavation and off-site treatment of sediments and certain soils; Wetland restoration; MNA of ground water contamination	$189,365,815	$1,419,957	$190,785,772

Table 10. Cost Estimate Details for Selected Remedy

Table 10. Cost Estimate Details for Selected Remedy

Item	Item Description	Estimated Quantity	Unit	Unit Price	Cost	Costs to be Bourne by Wetlands Developer*
	Capital Costs					
1	Pre-Design Investigation	1	LS	$500,000	$500,000	
2	Mobilization/Demobilization	1	LS	$100,000	$100,000	
3	Site Preparation					
3a	Clearing	102.7	Acres	$5,670	$582,309	
3b	Erosion/Sedimentation Control	1	LS	$35,000	$35,000	
4	Remove/Replace Surface Soils					
4a	Excavate/Trans/Stockpile Sediment From Upper Hershey	12,000	CY	$100	$1,200,000	
4b	Excavate/Trans/Stockpile NAPL Impacted Soil Below GW	48,400	CY	$100	$4,840,000	
4c	Soil Removal Excavate/Transport/Consolidation or Stockpile	715,619	CY	$6	$2,146,857	$2,146,857
4d	Compaction of Clean Soil Used To Fill in NAPL Excavations	48,400	CY	$6	$290,400	
4e	Water Treatment	1	LS	$500,000	$500,000	
5	NAPL Area Capping					
5a	Place 60 mil HDPE Liner In Former NAPL Areas	7.5	Acres	$25,700	$192,750	
6	Barrier Wall					
6a	Platform Construction/Backfill	1	LS	$20,000	$20,000	
6b1	Slurry Wall Installation	125,100	SF	$8	$1,000,800	
6b2	Sheetpile Wall Installation	41,700	SF	$22	$917,400	
6c	Cap on Slurry Wall	2,471	CY	$18	$44,480	
6d	NALP Interceptor Trench w / 2 - 75 Yard Finger Trenches:					
6d1	Excavation of Trench - In line with sheet piles & slurry wall	18,533	CY	$145	$2,687,285	
6d2	Excavation of Trench Fingers 210' X 21' X 3'	1,050	CY	$145	$152,250	
6d4	Filter Fabric for all trenches	60,707	SY	$0	$3,642	
6d5	Stone Backfill for Trenches	19,583	CY	$74	$1,449,142	
6d6	Perforated 36" Stand pipe - (1-31' & 22' = 53')	53	LF	$75	$3,975	
6d7	Two locking manhole covers	2	EA	$250	$500	
7	Excavation and Upper Hershey Run Rechannelization					
7a	Excavation of Channel [(PRP= [illegible] CY was [illegible] [illegible] 45,600 conservatively includes all of HR]	45,600	CY	$145	$6,612,000	
7b	Backfill in **Entire Channel** (6"=5,542cy) (3'=32,000cy)	32,000	CY	$65	$2,080,000	
7c	Geotextile	6.9	Acres	$2,550	$17,646	
7d	6-Inch Stone Backfill in New Channel	444	CY	$74	$32,874	
7e	Backfill Existing Channel (not expected to be required)	0	CY	$170	$0	
8	Wetlands Construction					
8a	Install Sediment Control Systems	1	LS	$50,000		$50,000
8b	Forested Riparian Wetlands -Organic Soil Placement	18,553	CY	$30		$556,600
8c	Forested Riparian Wetlands -Vegetation	23	Acres	$20,000		$460,000
8d	Tidal Marsh Wetlands -Organic Soil Placement	13713	CY	$30		$411,390
8e	Tidal Marsh Wetlands -Vegetation	17	Acres	$18,000		$306,000
8f	Wet Meadow/Emergent Wetlands -Organic Soil Placement	24,200	CY	$30		$726,000
8g	Meadow/Shrub Wetland and Emergent Wetlands -Vegetation	30.5	Acres	$19,000		$579,120
8h	Existing Meadow/Shrub Wetland Restoration -Remove	10	Acres	$43,000		$430,000
8i	Existing Meadow/Shrub Wetland Restoration -Seeding	10	Acres	$19,000		$190,000
9	On-site Consolidation (38 acre consolidation area)	38	Acres			
9a	Grading/Compaction of Surface	39,398	CY	$6	$236,388	
9b	Grading and Compaction of Impacted Soils	327,305	CY	$7	$2,291,135	
10	Low-Permeability Vegetative Cover					
10a1	Grade Traffic Areas (PRP= 351,408 SF, $42,178)	416,040	SF	$0	$49,925	
10a2	Geotextile on Traffic Areas (PRP= 8.1 Acres, $17,91[illegible])	11	Acres	$2,220	$24,489	
10a3	Install Gravel Pad and Haul Road (PRP= 4,[illegible] CY, $[illegible])	6,744	CY	$22	$150,402	
10b	HDPE Geomembrane Liner (acreage * 1.05 for overlap)	39.9	Acres	$25,700	$1,025,430	
10c	Geocomposite Drainage Layer	38.0	Acres	$41,385	$1,572,630	
10d	18-inch Backfill from Stockpiled Soil	91,960	CY	$3	$262,086	
10e	6-inch Topsoil/Seeding	30,653	CY	$61	$1,869,853	
10f	Drainage System V-Ditch Reinforced Concrete	80	LF	$10	$800	
11	Miscelaneous					
11a	Reseed All Areas other than Cap	7.8	Acres	$5,670	$44,226	
11b	Miscellaneous Site Restoration	1	LS	$20,000	$20,000	
11c	Miscellaneous Waste Disposal	1	LS	$600,000	$600,000	
12	NAPL Monitoring Wells	0	Well	$3,000	$0	
13	Groundwater MNA (Initial Evaluation & Well Installation)					
13a	Natural Attenuation Modeling	1	Model	$150,000	$150,000	
13b	Groundwater Monitoring Wells	20	Well	$3,000	$60,000	
13c	Groundwater Sampling	8	Events	$25,000	$200,000	
13d	Report	1	Report	$50,000	$50,000	

Table 10. Cost Estimate Details for Selected Remedy

14	Passive NAPL Recovery					
14a	Pilot Studies	12	Area	$5,000	$60,000	
14d	Oil Separator Units	6	Unit	$20,000	$120,000	
14e	Protective Housings (sheds)	6	Shed	$10,000	$60,000	
14f	NAPL Storage Tanks	7	Tank	$5,000	$35,000	
14g	Water Treatment (carbon filtration)	1	LS	$178,500	$178,500	
15	Indirects	63	Weeks	$20,540	$1,294,020	
16	Archaeological Evaluations	1	LS	$350,000	$350,000	
				Subtotal:	**$36,114,193**	**$5,855,967**
		Administration and Enigneering (15%)			$5,417,129	$878,395
			Contingency (20%)		$8,306,264	$1,346,872
			Total Capital Costs:		**$49,837,587**	**$8,081,234**
	Operations and Maintenance (O&M) Costs					
	30 year costs					
17	Site inspections (30 yrs)	1	Annual	$20,000	$20,000	
18	Landfill maintenance (i.e., mowing) (1/3 area from Item 9 per year)	12.67	Acres/YR	$100	$1,267	
19	Misc. Erosion Control and Repairs (i.e., clearing access roads of vegetation, etc.)	1	Annual	$1,500	$1,500	
20	NAPL Monitoring (30 yrs)	1	Annual	$15,000	$15,000	
21	NAPL Transport and Disposal (30 yrs)	25	GAL/YR	$100	$2,500	
22	Passive NAPL Recovery and Disposal (30 yrs)					
22a	Oil Separator Unit Maintenance (30 yrs)	1	Annual	$30,000	$30,000	
22b	Manual Bailing (30 yrs)	0	Annual	$60,000	$0	
22c	NAPL Disposal (30 yrs) (off-site disposal or recycling)	35	GAL / YR	$100	$3,500	
22d	Water Treatment (carbon filtration)	1	Annual	$30,000	$30,000	
23	Groundwater Monitoring (30 years)	2	Annual	$7,500	$15,000	
				Subtotal:	**$118,767**	**$0**
	P-Present Worth = A{[((1+i)^n)-1)]/[i(1+i)^n]}		A - Annual Payment		$118,767	$0
			I - interest Rate		7%	7%
				n - # years	30	30
			P-Present Worth (30) =		**$1,473,780**	**$0**
	5 year costs					
	Wetland Monitoring (5 yrs)	21.7	Acres/YR	$5,000	$108,500	$108,500
				Subtotal:	**$108,500**	**$108,500**
	P-Present Worth = A{[((1+i)^n)-1)]/[i(1+i)^n]}		A - Annual Payment		$108,500	$108,500
			I - interest Rate		7%	7%
				n - # years	5	5
			P-Present Worth (5) =		**$444,871**	**$444,871**
	* Note: Wetlands development costs are not part of the remedy but rather are presented for purposes of comparison with the FS Addendum "Alternative 10" cost estimates	**Total Present Worth O&M Cost:**			**$1,918,652**	**$444,871**
		Total Estimated Cost for Alternative 4:			**$51,756,239**	**$8,526,106**
		Total Rounded Cost for Alternative 4:			**$51,760,000**	**$8,530,000**

V. FIGURES

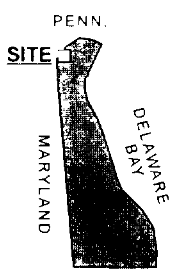
KOPPERS CO., INC. (NEWPORT PLANT) SUPERFUND SITE

NEWPORT / NEW CASTLE COUNTY, DELAWARE

MAP SOURCE
UNITED STATES GEOLOGICAL SURVEY
7.5 MINUTE TOPOGRAPHIC QUADRANGLE
SERIES "NEWARK EAST, DE" (1993) AND
"WILMINGTON SOUTH, DE-NJ" (1993)

2000 0 2000

APPROXIMATE SCALE IN FEET



FORMER KOPPERS COMPANY, INC. NEWPORT SITE
NEWPORT, DELAWARE

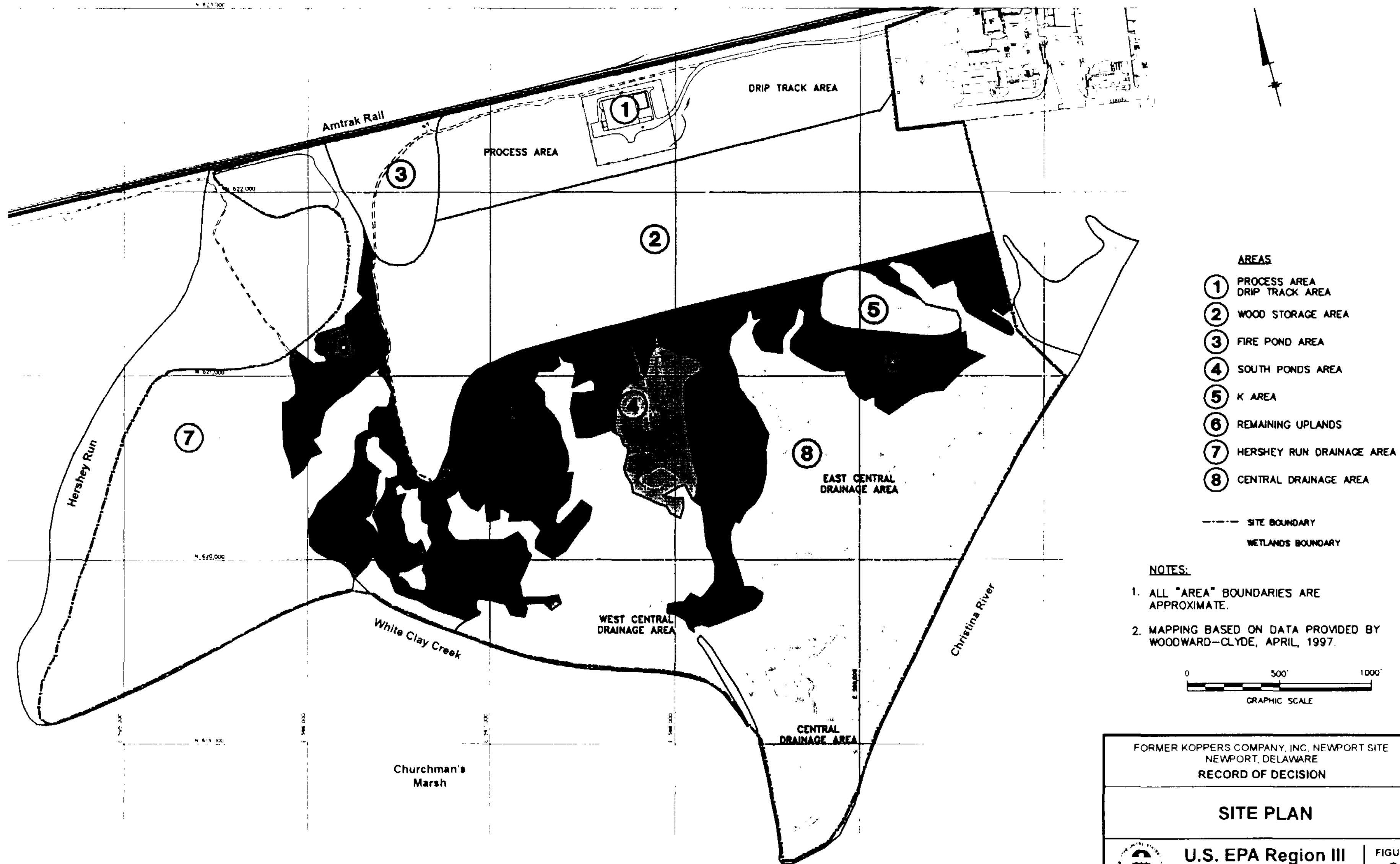
RECORD OF DECISION

SITE LOCATION MAP

U.S. EPA Region III
Philadelphia, PA

FIGURE
1

AR316111

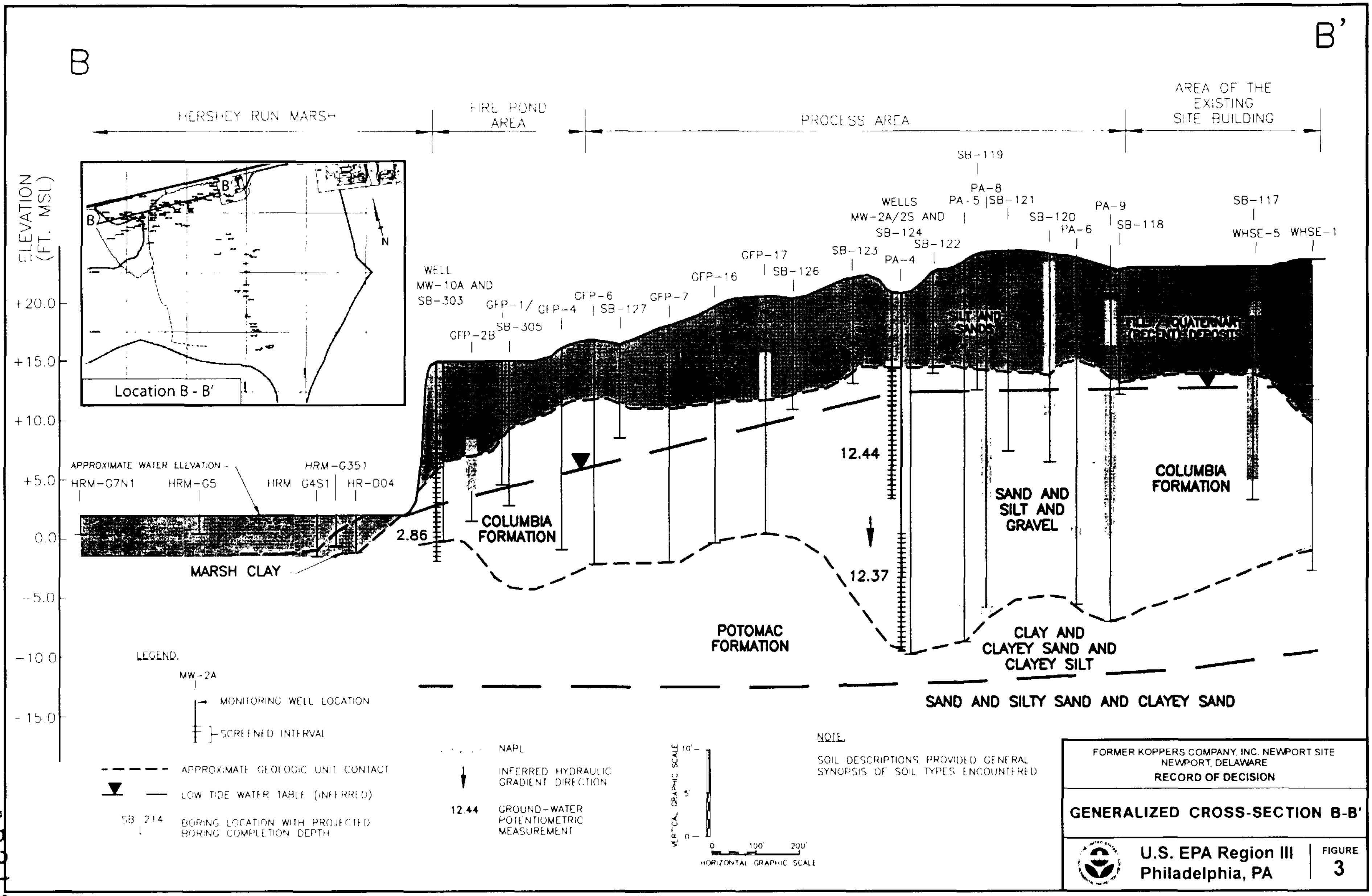


FORMER KOPPERS COMPANY, INC. NEWPORT SITE
NEWPORT, DELAWARE
RECORD OF DECISION

SITE PLAN

U.S. EPA Region III
Philadelphia, PA

FIGURE 2

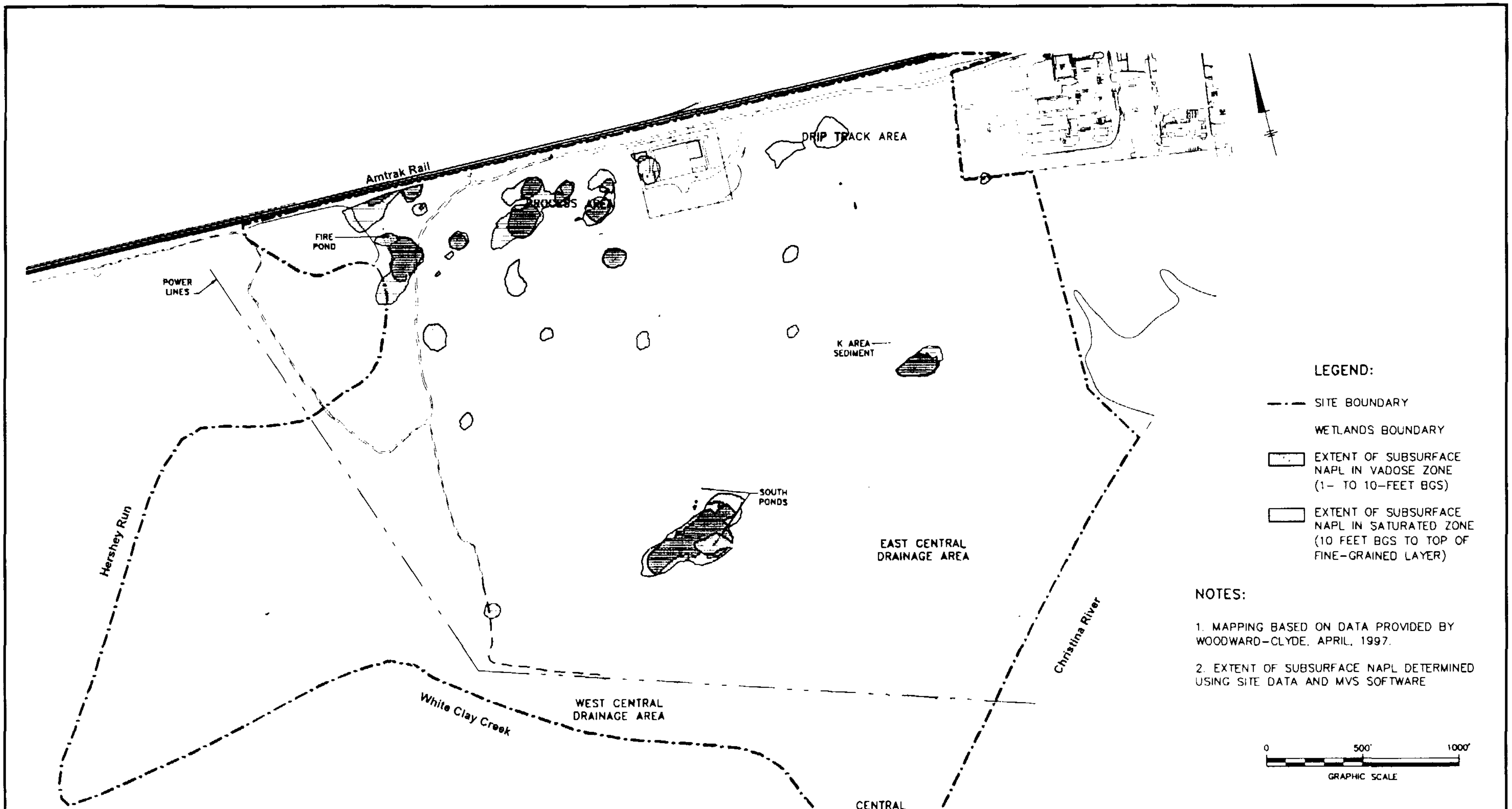

B
B'
HERSHEY RUN MARSH
FIRE POND AREA
PROCESS AREA
AREA OF THE EXISTING SITE BUILDING
ELEVATION (FT. MSL)
+20.0
+15.0
+10.0
+5.0
0.0
-5.0
-10.0
-15.0
Location B - B'
N
WELL MW-10A AND SB-303
GFP-2B
GFP-1/ SB-305
GFP-4
GFP-6
SB-127
GFP-7
GFP-16
GFP-17
SB-126
SB-123
WELLS MW-2A/2S AND SB-124
PA-4
SB-122
PA-5
SB-119
PA-8
SB-121
SB-120
PA-6
PA-9
SB-118
SB-117
WHSE-5
WHSE-1
APPROXIMATE WATER ELEVATION
HRM-G7N1
HRM-G5
HRM G4S1
HRM-G351
HR-D04
2.86
12.44
12.37
SILT AND SANDS
FILL / QUATERNARY (RECENT) DEPOSITS
MARSH CLAY
COLUMBIA FORMATION
SAND AND SILT AND GRAVEL
COLUMBIA FORMATION
POTOMAC FORMATION
CLAY AND CLAYEY SAND AND CLAYEY SILT
SAND AND SILTY SAND AND CLAYEY SAND
LEGEND.
MW-2A
MONITORING WELL LOCATION
SCREENED INTERVAL
APPROXIMATE GEOLOGIC UNIT CONTACT
LOW TIDE WATER TABLE (INFERRED)
SB 214
BORING LOCATION WITH PROJECTED BORING COMPLETION DEPTH
NAPL
INFERRED HYDRAULIC GRADIENT DIRECTION
12.44 GROUND-WATER POTENTIOMETRIC MEASUREMENT
VERTICAL GRAPHIC SCALE
10'
5'
0
0
100'
200'
HORIZONTAL GRAPHIC SCALE
NOTE.
SOIL DESCRIPTIONS PROVIDED GENERAL SYNOPSIS OF SOIL TYPES ENCOUNTERED
FORMER KOPPERS COMPANY, INC. NEWPORT SITE
NEWPORT, DELAWARE
RECORD OF DECISION
GENERALIZED CROSS-SECTION B-B'
U.S. EPA Region III
Philadelphia, PA
FIGURE
3

FORMER KOPPERS COMPANY, INC. NEWPORT SITE
NEWPORT, DELAWARE
RECORD OF DECISION

SURFICIAL SOIL CONTAINING GREATER THAN 600 MG/KG TOTAL PAHs

U.S. EPA Region III
Philadelphia, PA

FIGURE 4



FORMER KOPPERS COMPANY, INC. NEWPORT SITE
NEWPORT, DELAWARE
RECORD OF DECISION

EXTENT OF SUBSURFACE NAPL

U.S. EPA Region III
Philadelphia, PA

FIGURE 5

Estimated Surface and Subsurface Sediment Volumes

(Note Volumes if complete excavation were selected)

West Central Drainage Area Sediment				Potential	Surficial	Total
Area	Length (ft)	Width (ft)	Area (ft^2)	Removal Depth (ft)	Volume (cy)	Volume (cy)
1	385	20	7,700	3	290	860
2	310	20	6,200	2	230	460
3	605	10	6,050	6	220	1,300
4	190	10	1,900	2	70	140
5	185	10	1,850	7	69	480
6			37,700	2	1,400	2,800
7			41,200	2	1,500	3,100
Total			**103,000**		**3,800**	**9,100**

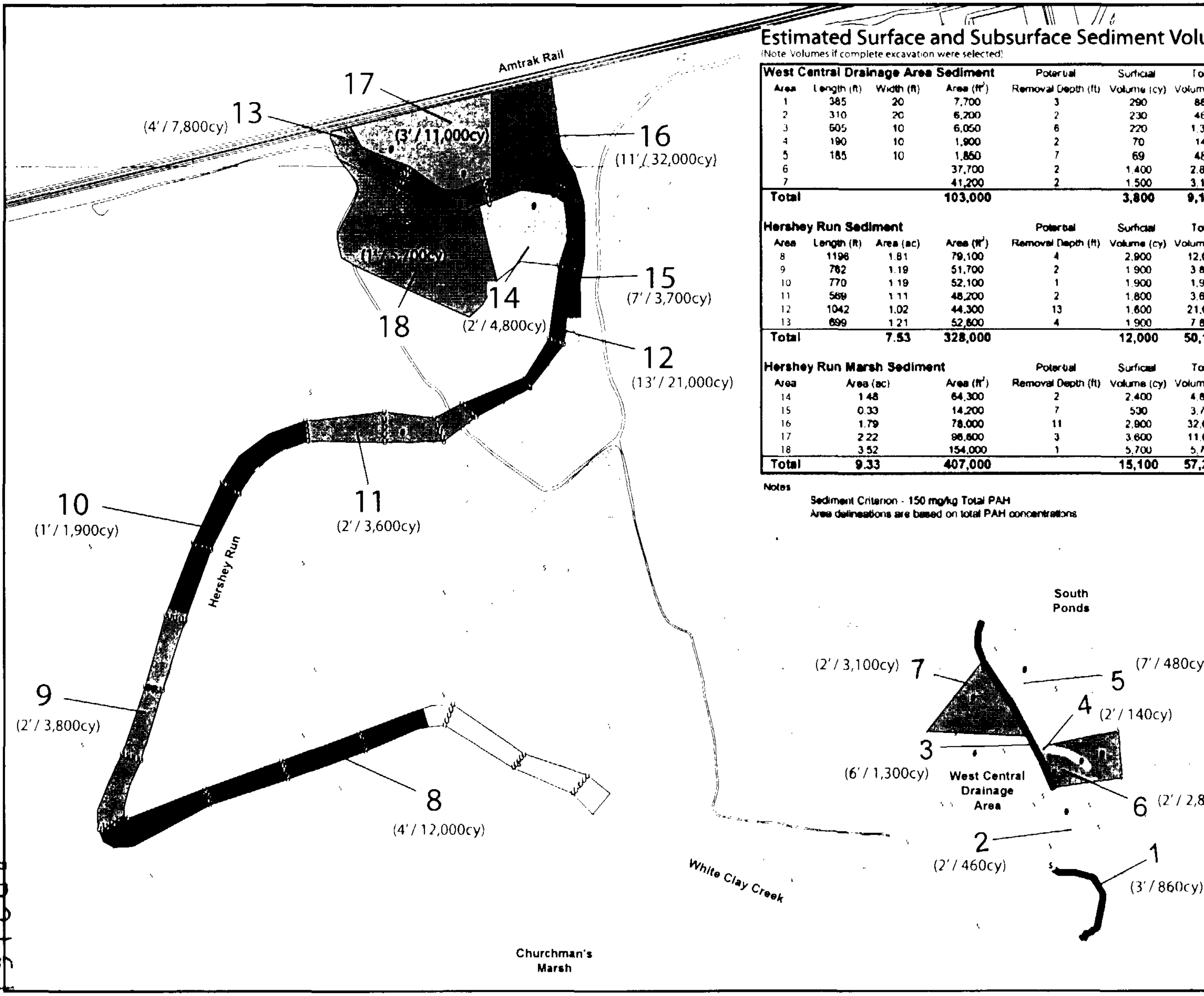
Hershey Run Sediment				Potential	Surficial	Total
Area	Length (ft)	Area (ac)	Area (ft^2)	Removal Depth (ft)	Volume (cy)	Volume (cy)
8	1196	1.81	79,100	4	2,900	12,000
9	762	1.19	51,700	2	1 900	3 800
10	770	1 19	52,100	1	1,900	1,900
11	569	1 11	48,200	2	1,800	3,600
12	1042	1.02	44,300	13	1,600	21,000
13	699	1 21	52,600	4	1 900	7 800
Total		**7.53**	**328,000**		**12,000**	**50,100**

Hershey Run Marsh Sediment			Potential	Surficial	Total
Area	Area (ac)	Area (ft^2)	Removal Depth (ft)	Volume (cy)	Volume (cy)
14	1 48	64,300	2	2,400	4,800
15	0.33	14,200	7	530	3,700
16	1.79	78,000	11	2,900	32,000
17	2 22	96,600	3	3,600	11,000
18	3 52	154,000	1	5,700	5,700
Total	**9.33**	**407,000**		**15,100**	**57,200**

Notes

Sediment Criterion - 150 mg/kg Total PAH

Area delineations are based on total PAH concentrations

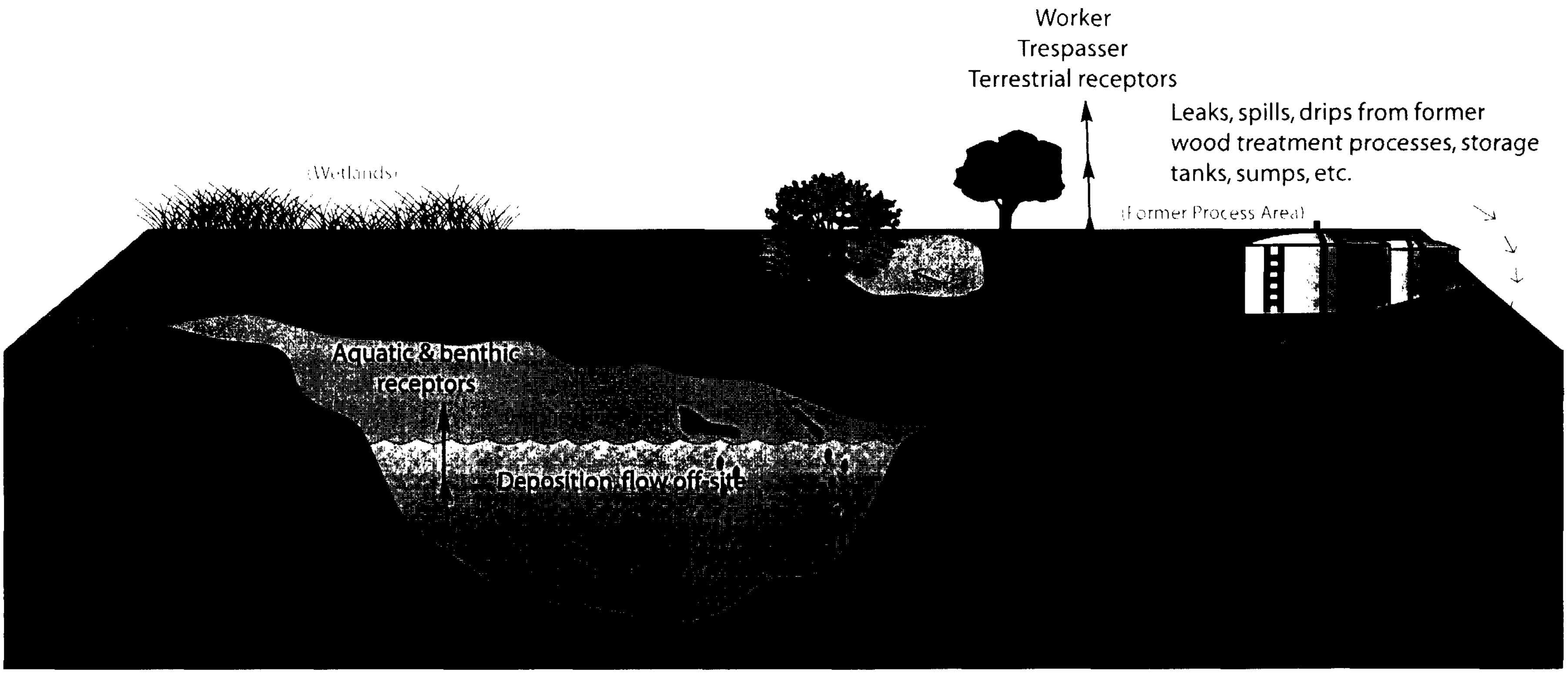


FORMER KOPPERS COMPANY, INC. NEWPORT SITE
NEWPORT, DELAWARE
RECORD OF DECISION

HERSHEY RUN MARSH AND WEST CENTRAL MARSH VOLUME

U.S. EPA Region III
Philadelphia, PA

FIGURE 6



LEGEND:

Contaminant migration pathway

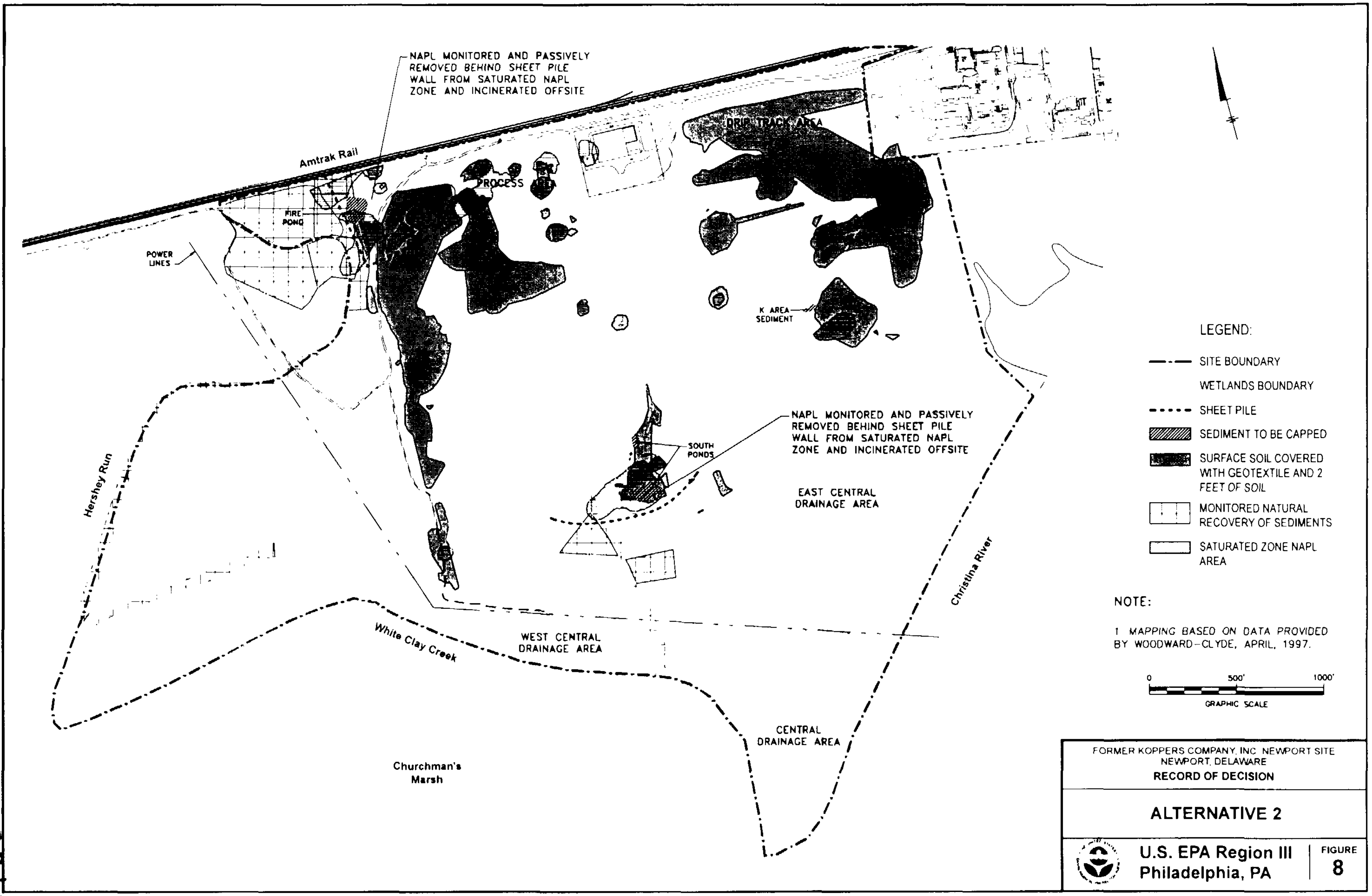
Exposure route

FORMER KOPPERS COMPANY, INC. NEWPORT SITE
NEWPORT, DELAWARE
RECORD OF DECISION

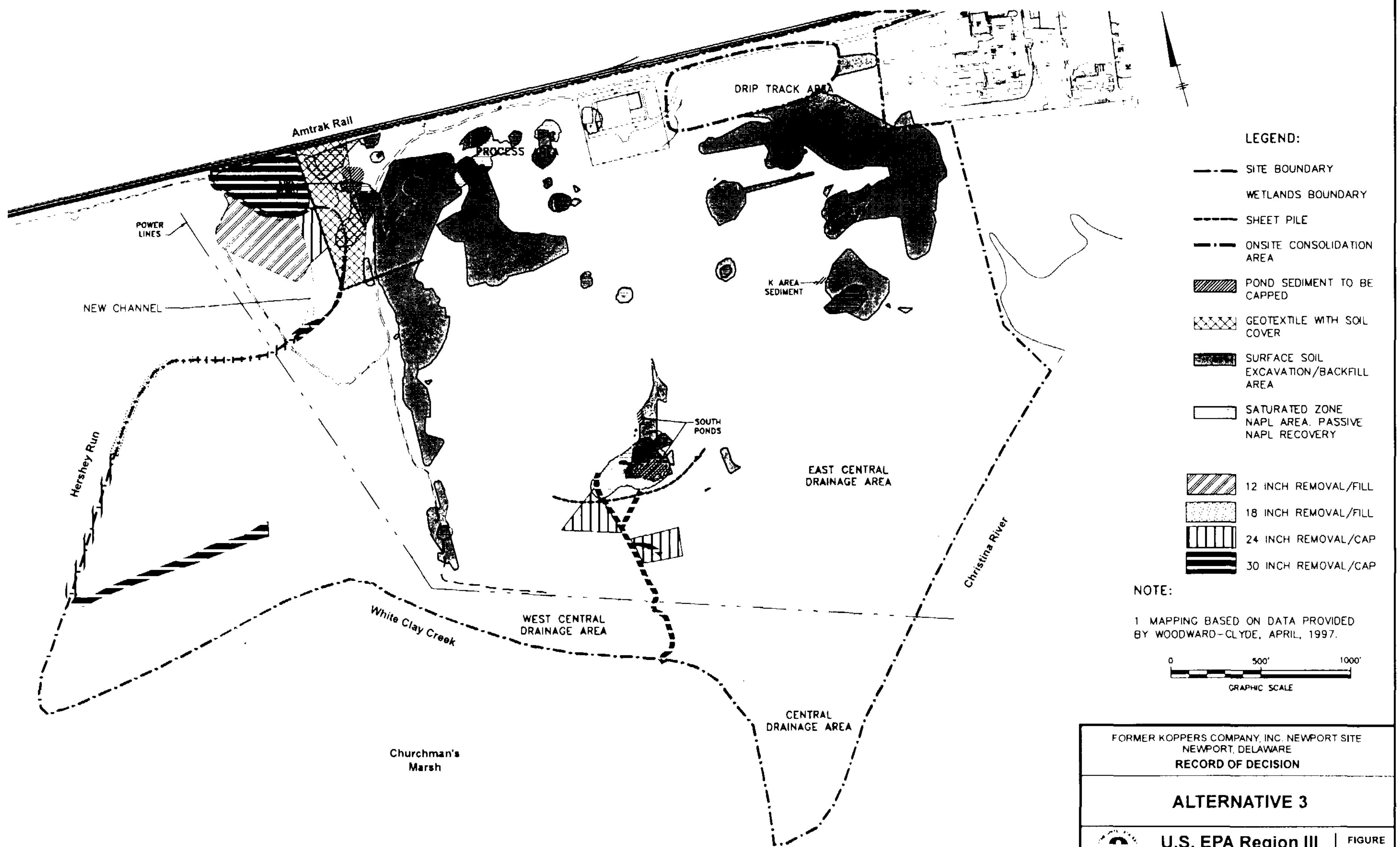
GENERALIZED CONCEPTUAL SITE MODEL

U.S. EPA Region III
Philadelphia, PA

FIGURE 7



NAPL MONITORED AND PASSIVELY REMOVED BEHIND SHEET PILE WALL FROM SATURATED NAPL ZONE AND INCINERATED OFFSITE
Amtrak Rail
FIRE POND
POWER LINES
PROCESS
DRIP TRACK AREA
K AREA SEDIMENT
SOUTH PONDS
NAPL MONITORED AND PASSIVELY REMOVED BEHIND SHEET PILE WALL FROM SATURATED NAPL ZONE AND INCINERATED OFFSITE
EAST CENTRAL DRAINAGE AREA
Hershey Run
Christina River
White Clay Creek
WEST CENTRAL DRAINAGE AREA
CENTRAL DRAINAGE AREA
Churchman's Marsh
LEGEND:
SITE BOUNDARY
WETLANDS BOUNDARY
SHEET PILE
SEDIMENT TO BE CAPPED
SURFACE SOIL COVERED WITH GEOTEXTILE AND 2 FEET OF SOIL
MONITORED NATURAL RECOVERY OF SEDIMENTS
SATURATED ZONE NAPL AREA
NOTE:
1. MAPPING BASED ON DATA PROVIDED BY WOODWARD-CLYDE, APRIL, 1997.
0 500' 1000'
GRAPHIC SCALE
FORMER KOPPERS COMPANY, INC. NEWPORT SITE
NEWPORT, DELAWARE
RECORD OF DECISION
ALTERNATIVE 2
U.S. EPA Region III
Philadelphia, PA
FIGURE
8

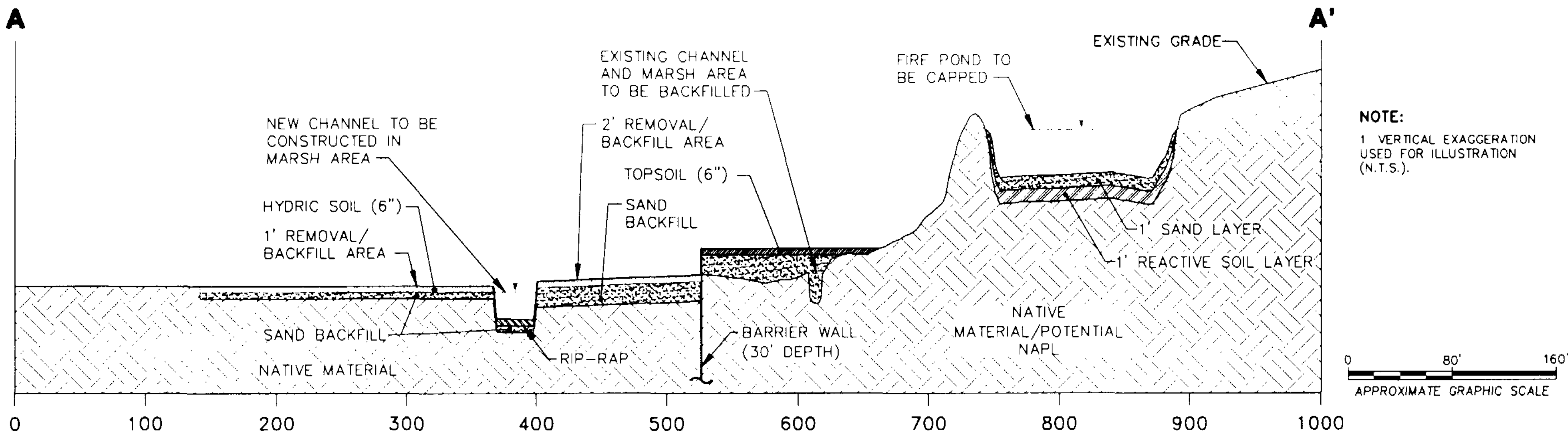


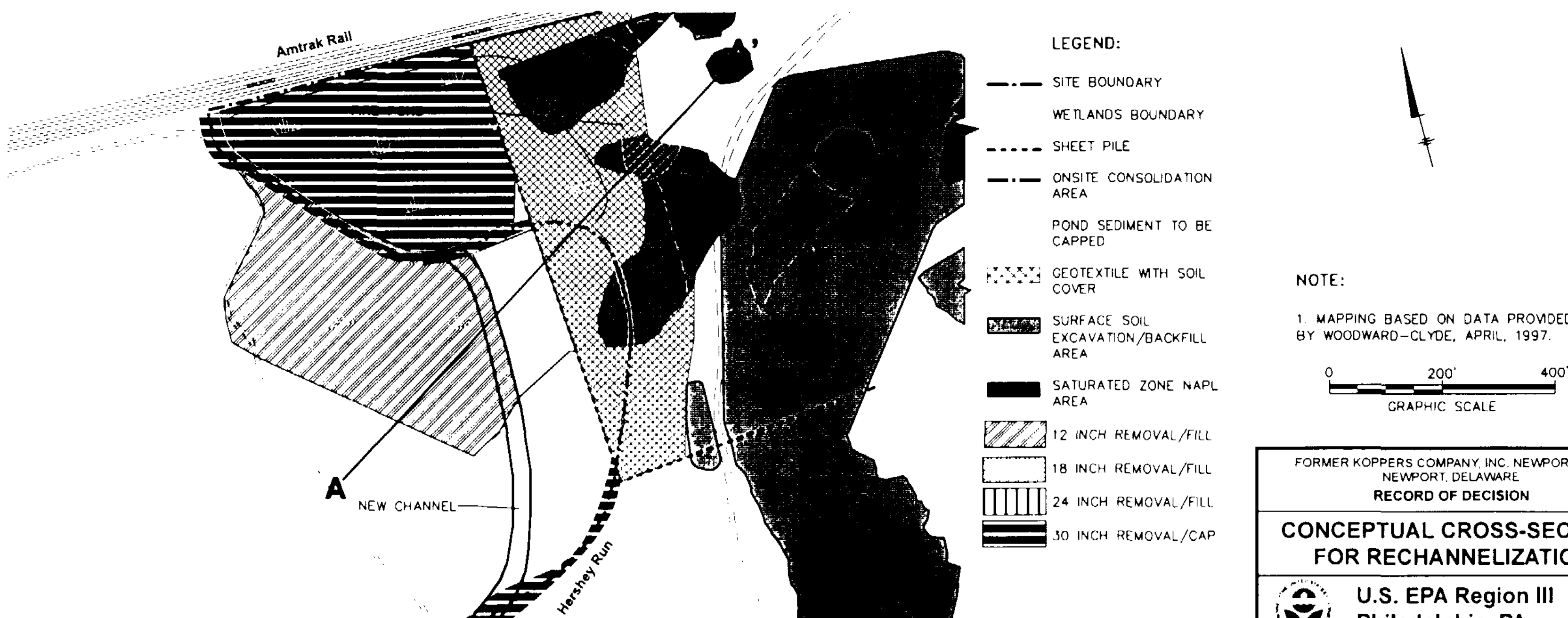
FORMER KOPPERS COMPANY, INC. NEWPORT SITE
NEWPORT, DELAWARE
RECORD OF DECISION

ALTERNATIVE 3

U.S. EPA Region III
Philadelphia, PA

FIGURE 9





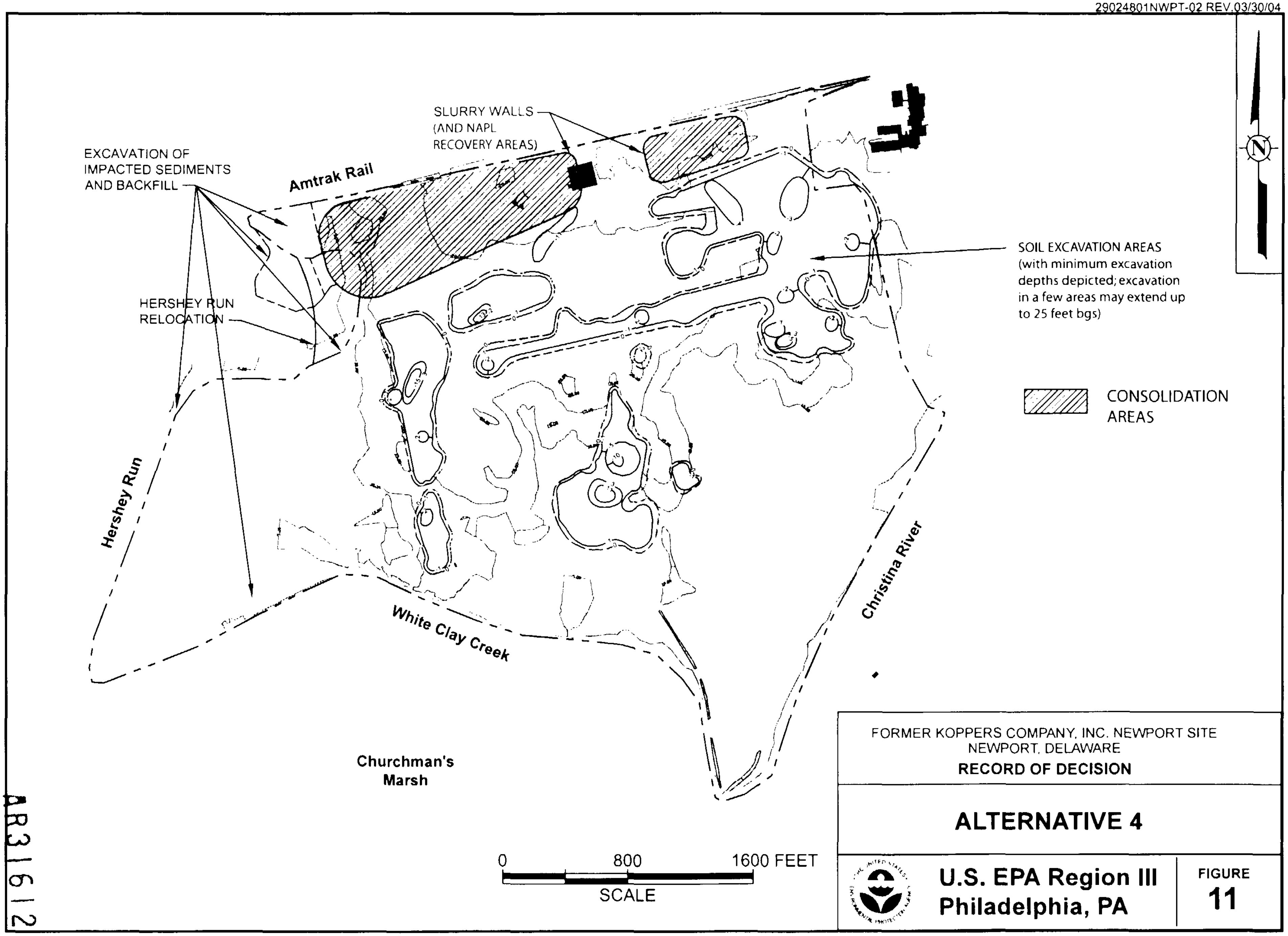
FORMER KOPPERS COMPANY, INC. NEWPORT SITE
NEWPORT, DELAWARE
RECORD OF DECISION

CONCEPTUAL CROSS-SECTION FOR RECHANNELIZATION

U.S. EPA Region III
Philadelphia, PA

FIGURE **10**

29024801NWPT-02 REV.03/30/04



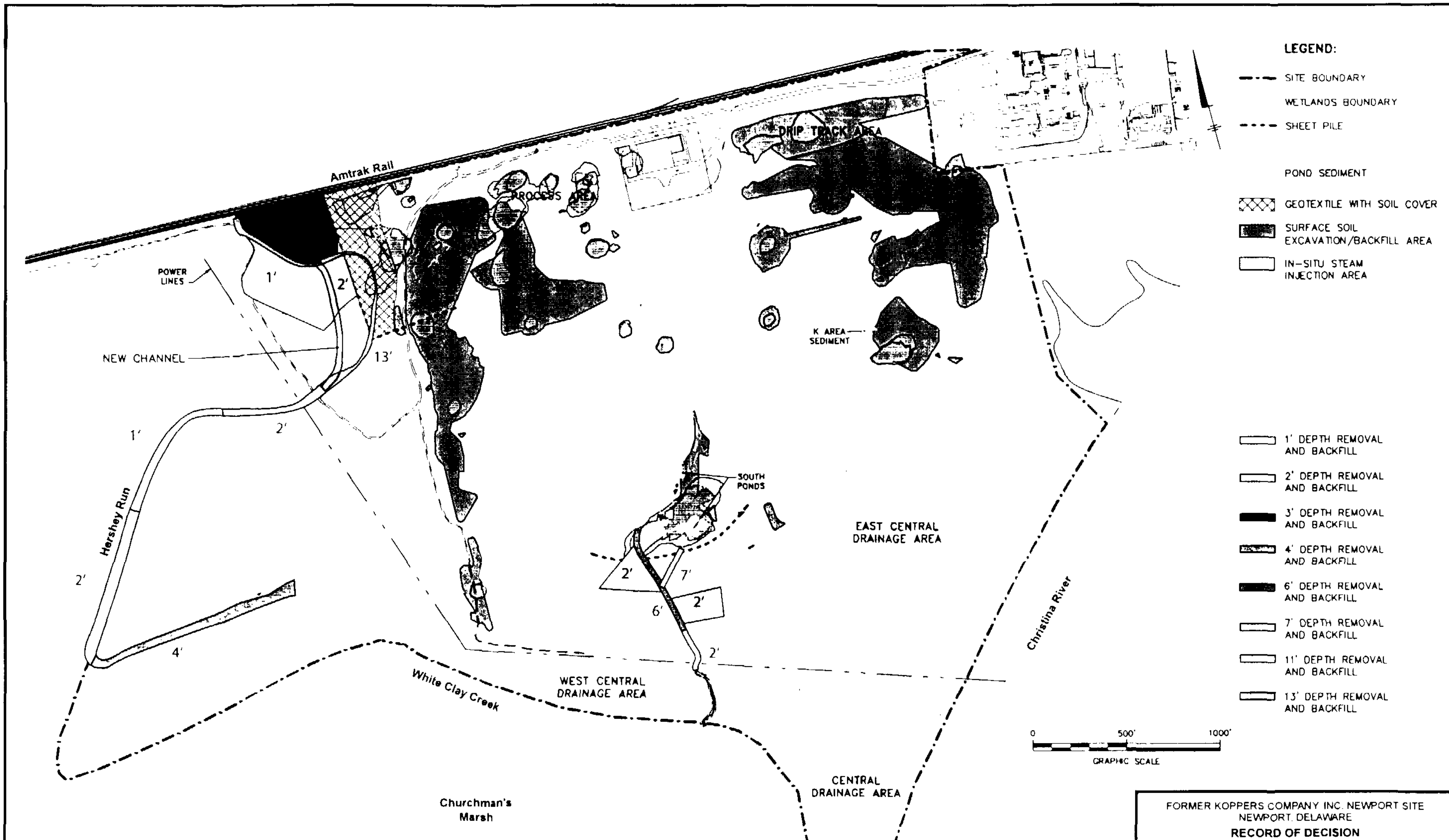
FORMER KOPPERS COMPANY, INC. NEWPORT SITE
NEWPORT, DELAWARE
RECORD OF DECISION

ALTERNATIVE 4

U.S. EPA Region III
Philadelphia, PA

FIGURE **11**

AR316121



NOTES:

1. MAPPING BASED ON DATA PROVIDED BY WOODWARD-CLYDE, APRIL, 1997.

FORMER KOPPERS COMPANY INC. NEWPORT SITE
NEWPORT, DELAWARE
RECORD OF DECISION

ALTERNATIVE 5

U.S. EPA Region III
Philadelphia, PA

FIGURE **12**

ORIGINAL

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION III

IN THE MATTER OF:	:	
	:	
KOPPERS CO., INC. (NEWPORT PLANT)	:	
SITE, New Castle County,	:	
Delaware	:	
	:	**CERCLA-Record of Decision**
	:	
	:	
	:	
	:	

ESTABLISHMENT OF THE ADMINISTRATIVE RECORD

Pursuant to authority vested in the President of the United States under Section 113(k) and Section 117 of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, as amended, (CERCLA), 42 U.S.C. Section 9613(k) and Section 9617; delegated to the Administrator of EPA by Executive Order No. 12580 [52 Fed. Reg. 2923 (January 29, 1987)]; further delegated to the Regional Administrators by EPA Delegation No. 14-22 (December 7, 2000), and in Region III further delegated to the Director, Hazardous Site Cleanup Division by EPA Regional Delegation No. 1200 TN RIII-164 (September 1, 2005), I hereby establish the attached documents as the Administrative Record supporting issuance of the Record of Decision for the Koppers Co., Inc. (Newport Plant) Superfund Site in New Castle County, Delaware.

Abe Ferdas
Director, Hazardous Site Cleanup Division
EPA Region III

9/30/05
Date

C:_Files\EPA_Projects_Koppers_ROD_PRAP\ROD\Koppers ROD Establishment of Admin Record 20050926.wpd [September 26, 2005]