SITE EXPOSURE POTENTIAL

Site Description

The Berrys Creek Watershed is located within the Hackensack Meadowlands in northeastern New Jersey and is part of the coastal management area of the Hackensack River Basin (Figure 1). This site is unique in that it encompasses an entire watershed which contains three NPL sites: Ventron Chemical Corporation, Scientific Chemical Processing, and Universal Oil Products.

Ventron Chemical occupied a 16 hectare industrial site located on the headwaters of Berrys Creek. The Ventron site is also referred to in documents as the Woodridge site, the Velsicol site, and sometimes the Berrys Creek site. These names reflect the ownership at a particular time and the extent of off-site investigation. The site was operated from 1929 to 1974 by various chemical companies which used the facility as a mercury processing plant. For the majority of this period, untreated mercury-containing waste effluent was discharged directly into Berrys Creek. The exact quantities of mercury released to the environment is unknown, it is believed that the watershed presently contains between 50 and 400 tons of mercury (NJDEP 1987).

Along with mercury products, the Ventron facility produced fungicides, bactericides, and specialty chemicals. Solid wastes that were produced at the facility, along with municipal wastes, were disposed of on-site between the operating buildings and Berrys Creek. The plant ceased operation in 1975. Remediation performed to date has included removing the buildings, the excavation of topsoils, and isolation of the subsurface soils beneath two warehouses and a parking lot. The Ventron site is a New Jersey state-lead site (NJDEP 1987).

The Scientific Chemical Processing (SCP) site encompasses 2.4 hectares on Peach Island Creek, a tributary of Berrys Creek, and is a former waste-processing facility that operated from 1941 to its closure in 1980 (Reger 1983). SCP received liquid by-products from chemical and other industrial firms, then processed the wastes to reclaim marketable products. In 1979, the New Jersey Department of Environmental Protection (NJDEP) determined that the site was contaminated from leaking storage tanks, lack of containment and inadequate maintenance. Petroleum leachate was observed discharging from the site to Peach Island Creek and a municipal sewer system. When the site was closed in 1980, over 1,136 m³ of waste and recyclable materials were stored on the property. These wastes materials were removed upon closure of the facility. Much of this site is contaminated with
Ventron/Velsicol

NJD980529879

This document "Environmental Assessment Report (Draft) for the Berrys Creek Watershed compiled by the National Oceanic and Atmospheric Administration and dated December 1, 1989" is currently classified as NON-CONFIDENTIAL by the USEPA.

Seth Ausubel
Remedial Project Manager

10/17/2002
Date

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Figure 1. Location of Ventron, Scientific Chemical Processing (SCP), and Universal Oil Products in the Berrys Creek watershed.
polychlorinated biphenyls (PCBs), other organic chemicals and trace elements (Dames and Moore 1988). SCP is a U.S. EPA-lead site.

Universal Oil Products is located adjacent to Berrys Creek downstream of Ventron and SCP. The site encompasses 34 hectares and was used from 1955 to 1960 as a recovery facility for solvents and waste chemicals. An estimated 17,000 m$^3$ of wastes were discharged into two unlined lagoons. The facility was officially closed in 1980 (Maguire Inc. 1989). All above ground structures were removed. The major contaminants of concern at this site include organic compounds, particularly PCBs, and inorganic substances. Akermans Creek, a small tidal creek, flows through the property adjacent to the lagoon and discharges into Berrys Creek. Akermans Creek has several forks, including a main one and two small branches that do not have direct connection to the main branch, but likely connect via subsurface flows. The Universal Oil property has been divided into five operable units for investigation purposes. Areas 1, 2, and 5 include the terrestrial portion of the property. A Remedial Investigation (RI) was completed on Areas 1, 2, and 5. Area 3 includes the two lagoons and is presently considered the primary source of contaminants to the environment. PCBs were detected in sediments from the lagoon at concentrations greater than 1000 ppm. The draft remedial workplan for the lagoons (Area 3) calls for sediment removal by spring of 1990. A sampling plan for the RI/FS for Area 4, which includes Akermans Creek, has been approved by the state and is currently being implemented. The RI for Area 4 is scheduled to be completed by spring of 1990 (Schnitzer personal communication). Universal Oil is a New Jersey state-lead site.

Along with the three NPL sites addressed in this report, there are numerous other potential sources of contaminants to the watershed. There are a total of 14 permitted discharges within Berrys Creek watershed, including 12 industrial and 2 municipal discharges. Inactive and active landfills are located throughout the area. There are also numerous facilities in the Hackensack River and Newark Bay Complex that could impact the watershed through tidal exchanges.

Physical Description

The Hackensack River Basin (HRB) lies almost entirely within the metropolitan area of Greater New York and extends from Newark Bay northward for 55 km to Haverstraw, New York. It drains an area of 510 km$^2$, 65 percent of which is in New Jersey (USFWS 1983). The HRB from Oredell Dam to Newark Bay is described by Miceli (1976) as a coastal plain estuary highly disturbed by man. The four major natural habitats existing in the area are freshwater marshes, salt marshes, meadowlands, and secondary growth lowland forest (Miceli 1976). The basin is divided into two distinct areas according to elevation. The upper third of the basin consists of a river valley typical of the Piedmont plateau, with a proportional increase in marshland and decrease in secondary growth lowland forest as one progresses down the Hackensack River. The lower two-thirds of the basin below Teaneck and Hackensack is known as the Hackensack Meadows or Meadowlands. This area is a wide, flat valley consisting of meadows, tidal marshes, tidal flats, and isolated lowland forests (USFWS 1983). The Meadowlands encompass approximately 1,929 hectares of wetlands extending 16 kilometers upstream from the river's mouth. The Hackensack Meadowlands have been significantly altered by development and industry resulting in loss of habitat and degraded water quality from industrial and municipal waste discharges (Byrne 1989).

The Hackensack River system is tidally influenced as far upstream as the Oredell Dam, 35 kilometers from the mouth. A bottom layer of higher saline water, known as a salt wedge, extends upstream from the mouth, with the extent of its intrusion depending on the height.
of the tides and the amount of freshwater runoff within the drainage basin (USFWS 1983).

The Berrys Creek Watershed lies within the Hackensack Meadowlands and is one of the largest tidal tributaries of the lower Hackensack River. Berrys Creek is 11.3 km long, has a 31 km² drainage area, and can reach 61 m wide in its lower reach at high tide. Headwaters of Berrys Creek include East and West Riser Ditches, both of which are freshwater due to tide gates near their mouth (ERM 1985). All waters below the tide gates are tidal and brackish with salinity usually ranging from 0.5 to 5 parts per thousand (ppt), although levels of 15 ppt have been recorded in the lower reaches (Kraus personal communication). Tributaries of Berrys Creek include Peach Island Creek which flows adjacent to the SCP site, Akermans Creek which flows through the Universal Oil site, and numerous drainage ditches that are interconnected throughout the wetlands. The lower reach of Berrys Creek is divided into Berrys Creek Canal, through which the majority of the stream flow passes, and the original stream channel, which has only a small connection to the present stream. All surface water from Berrys Creek discharge into the Hackensack River, which flows for 10 km before discharging into Newark Bay (ERM 1985). The majority of the surface waters within Berrys Creek watershed are classified as TW-2 by NJDEP water quality standards, which means that the waters should be suitable for secondary contact recreation, fish propagation and maintenance, and the migration of anadromous fish (NJDEP 1987).

Habitats and Species Description

The dominant habitats of concern to NOAA include the Hackensack River, Berrys Creek, and their associated wetlands. The upper reaches of Berrys Creek, which includes Berrys Creek from Walden Swamp to the headwaters, and associated habitats play only a minor role in relation to resources of interest to NOAA.

Hackensack River

The lower reach of the Hackensack River from Newark Bay to approximately 3 km upstream of Berrys Creek Canal is mesohaline, with salinity levels ranging from 5 to 18 ppt. The reach of the Hackensack River above this is oligohaline with salinities from 0.5 to 5 ppt. Marine, resident brackish-water, and anadromous species all utilize the Hackensack River estuary during varying stages in their life history (Table 1; USFWS 1983).

The fish resources in the upper reach of the Hackensack River just below Ordel Dam are dominated by freshwater resident fish. This reach was reported to historically have had spawning areas used by both alewife, blueback herring and American shad (Zich 1978), but the construction of the dam eliminated the majority of the spawning areas (USFWS 1983). The majority of the resources of interest to NOAA in the Hackensack River are found from approximately 6 km upriver of the mouth of Berrys Creek Canal downstream to Newark Bay. This reach supports a number of fish species (Table 1). The Hackensack Meadowlands Development Commission (1989) reported that a total of 44 fish species have been recorded from the Hackensack River.
Table 1. Invertebrate and finfish species present in lower Berry's Creek and the Hackensack River (Zich 1977; Beccasio et al. 1981; HRM 1987; HRM 1989; Kraus personal communication; Kraus and Bragin 1989; Hauge personal communication; Andrews personal communication).

<table>
<thead>
<tr>
<th>Species</th>
<th>Spawning Area</th>
<th>Nursery Area</th>
<th>Adult Habitat</th>
<th>Migration Route</th>
<th>Recreational Fishing</th>
<th>Commercial Fishing</th>
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<tr>
<td><strong>Lower Berry's Creek</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
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<td>x</td>
<td>x</td>
<td>x</td>
<td></td>
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</tr>
<tr>
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<tr>
<td>Blueback herring</td>
<td>x</td>
<td>x</td>
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<td></td>
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<tr>
<td>Blue clow crab</td>
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<td>x</td>
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</tr>
<tr>
<td>Grass shrimp</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>Mummichog</td>
<td>x</td>
<td>x</td>
<td></td>
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<tr>
<td>White perch</td>
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</tr>
<tr>
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<td>x</td>
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<td>American shad</td>
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<td>Blueback herring</td>
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<tr>
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<td>Summer flounder</td>
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<tr>
<td>Weakfish</td>
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<tr>
<td>White perch</td>
<td>x</td>
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</tr>
</tbody>
</table>

1: Prohibition against the sale or consumption due to dioxins (Hauge personal communication)
2: Advisory against eating more than one meal per week due to PCBs and dioxins (Hauge personal communication).
3: Prohibition against the sale due to dioxins (Hauge personal communication)
4: Bait fishery only (Hauge personal communication)

Anadromous fish do not utilize the Hackensack River to the same degree they once did. This is due to a combination of events, including reduced physical habitat and decreased water quality. Spawning grounds for anadromous fish were greatly reduced by the construction of Ordell Dam, although there are believed to be small areas where blueback herring and alewife may still spawn. The Hackensack River does, however, still act as an important nursery ground and adult foraging area for a wide variety of anadromous fish. American shad, a New Jersey threatened species, is occasionally collected in the river, although it is believed to no longer have a natural run (Zich 1978).

The resident brackish-water species compose the largest fish group using the Hackensack River (Maguire1987). Species represented in this group include white perch, mummichog (common killfish), and striped and banded killfishes. These fish are euryhaline and are able to utilize a wide variety of habitats of varying salinities within the river. The resident brackish water species will typically spawn within the river, using the river for both nursery and adult habitat. The Atlantic tomcod is of special interest since it is a euryhaline
species that is classified as threatened by New Jersey (NJDEP 1987). This species was once thought to no longer occur in the Hackensack River, but a study by Kraus and Bragin (1989) found that juvenile fish use the river during the spring, with adults found in summer and autumn. According to the authors, Atlantic tomcod use the river as a nursery ground, refuge, and spawning area.

Marine species utilizing the lower, higher salinity portion of the estuary includes Atlantic menhaden, weakfish, spot, Atlantic croaker, summer flounder, winter flounder, silver perch, bluefish, and bay anchovy. The marine species utilize the lower portion of the estuary as nursery and adult habitat.

The catadromous American eel use the entire extent of the lower river below the Oradell Dam for adult habitat.

A number of invertebrates are found throughout the Hackensack River, although there is not a great deal known about abundances and distribution near Berrys Creek. Adult blue crabs utilizing the section of the river within the salt wedge (Byrne 1989). The lower portions of the Hackensack River may have also have some significance as nursery habitat for blue crab, though their use of the river has not been well characterized (Papson 1989).

The only commercial fishery on the Hackensack River currently operating is a bait fishery for mummichogs, killifish, and grass shrimp. Other commercial fisheries are closed due to the presence of PCBs and dioxins (Hauge personal communication). Recreational fishing is also restricted in the Hackensack River. Due to PCB contamination, the New Jersey Department of Environmental Protection (NJDEP) has imposed a prohibition on the sale or consumption of American eel, striped bass, and blue crab, and has issued an advisory to consume no more than one meal per week of white perch and bluefish (Byrne 1989; NJFWD 1989). The contaminant listed as the reason for a particular prohibition or advisory relates to which contaminant was found first, and does not imply that a particular species is contaminated with only one chemical.

Berrys Creek and tributaries
Berrys Creek is a tidally-influenced, brackish-water stream with salinity levels averaging 4.2 ppt. A 1987 survey of lower Berrys Creek and Berrys Canal found some use of these waterways by NOAA resources. Species collected from lower Berrys Creek included a number of euryhaline and catadromous species, including mummichog, white perch and American eel. Mummichog were found in the greatest numbers, with the other species caught only rarely. Species found in Berrys Creek Canal included the catadromous American eel, white perch and mummichog in addition to the anadromous blueback herring and alewife. The presence of alewife and blueback herring during spring sampling may indicate that the canal serves as nursery habitat. However, only small numbers of these species were caught, indicating that the canal is not a spawning area. The dominant fish species in Berrys Creek Canal was the mummichog, a pollution tolerant species (Maguire 1987).

Little is known about the invertebrate community in Berrys Creek. Blue crab are known to use the lower reaches for adult habitat and a nursery ground. Other invertebrates that have been collected in lower Berrys Creek, but for which little is known locally, include barnacles (Balanus) and bivalves (Macoma) (HMDC 1989).

The naturally low dissolved oxygen levels and high water temperatures during the summer in the area of Berrys Creek above Walden Swamp permit only a few resident fish species to survive, primarily the pollution tolerant mummichog. There are very little data presently
available on other species that may periodically enter the upper reaches when conditions are favorable.

**Berrys Creek Wetlands**
The wetland surrounding Berrys Creek is an emergent brackish-water marsh with salinity ranging from 2.5 ppt in the upper portion of the marsh to 4.9 ppt in the lower areas. The wetland area is dominated by common reed (*Phragmites*), with some cattail (*Typha*), and cordgrass (*Spartina*) present in localized areas. Average tidal range is 15 cm, which is sufficient to inundate a large portion of the wetlands on a daily basis. The wetland is within the 100 year flood plain of Berrys Creek (ERM 1985).

Although there is presently little information on the importance of wetlands within the Berrys Creek watershed to resources of concern to NOAA, wetlands in the lower reaches near the Hackensack River most likely provide nursery habitat. Wetland habitat in the middle and upper reaches (Eight Day Swamp, near the Ventrion site, and Walden Swamp) provide food that is utilized by species throughout the watershed, even if species of concern to NOAA do not utilize these wetlands directly.

**CHEMICAL HAZARDS**

**Chemical Contaminants and Concentrations**

There are an array of contaminants recorded within the Berrys Creek watershed. Of the contaminants present, mercury (Hg) has been considered to be the major problem due primarily to the quantities that have been released into the system and the extent of its known distribution throughout the watershed. However, other contaminants such as PCBs and other trace elements also are present in concentrations that could be a threat to resources of concern to NOAA. A wide variety of other organic compounds, including pesticides, volatile organic compounds and semi-volatile organic compounds, are present in the watershed, but little is presently known about their spatial distribution.

Contaminant data for this Environmental Assessment Report is taken from two key documents. The major study for this watershed, performed by ERM (1985), presents a thorough review and synthesis of data that were collected between 1972 and 1984 on contaminants associated with the Ventrion site. This report was part of the RI/IS for the Ventrion site (then called the Woodridge/Berrys Creek site). The ERM report used only data that was considered reliable based on criteria developed by ERM and approved by the Berrys Creek Technical Advisory Group (TAG). One important criterion was that data had to met EPA standards. Therefore, the ERM (1985) report does not include all of the data that have been collected to date, but only those of comparable quality. The ERM report focused on trace metals as the dominant contaminants, with organic contamination treated less thoroughly. The second major report is the Remedial Investigation for Scientific Chemical Processors (SCP) (Dames and Moore 1988). This study addressed all of the major contaminants, but was limited to the assessment of the SCP site and Peach Island Creek.

The Berrys Creek Study by ERM (1985) at the Ventrion site included samples on-site groundwater (10 stations), on-site surface water (9 stations), on-site soils (21 stations), off-site soils (limited data, number of stations not specified), Berrys Creek sediment (50 samples) and surface water (13 stations), and wetland soils (60 stations). All samples were analyzed for mercury. Most of the samples were analyzed for other trace elements, but the exact number of metals measured varied from station to station. Analyses for organic
compounds were conducted infrequently in the studies examined, and only a limited number of organic compounds were measured. ERM (1985) also incorporated data assessing whether mercury was bioaccumulated by species present in the watershed. Fish were collected from a total of 26 stations throughout the watershed. Fish species sampled included killifish (*Fundulus* sp.), spot, goldfish, and whitefish. Bioaccumulation of mercury in wetland plants measured at 14 stations within the wetland. The main plants sampled included *Phragmites* (common reed), *Spartina* (cord grass), and *Typha* (cattail). A variety of other aquatic and terrestrial organisms (mammals, birds, and invertebrates) were also tested for concentrations of mercury in their tissue.

Data from the SCP site were derived from 17 on-site groundwater stations, 37 on-site soil stations, and four surface water and sediment stations in Peach Island Creek. No samples were collected past the mouth of Peach Island Creek. All samples were analyzed for both inorganic substances and organic compounds. There were no bioaccumulation studies done for the RI at the SCP site (Dames and Moore 1988).

Data for the Universal Oil Products site were derived from 34 on-site groundwater wells, an unspecified number of soil/sediment samples, and 26 sediment stations from the two lagoons, all of which were on-site (CDM 1987). Samples were analyzed for a wide variety of contaminants including organic compounds and inorganic substances.

For purposes of comparison, Berrys Creek watershed has been divided into three areas: upper Berrys Creek (the area north of Paterson Plank Road including the headwaters of Berrys Creek, Berrys Creek, and Peach Island Creek), middle Berrys Creek (the area between Paterson Plank Road and U.S. Highway 3, including Akermans Creek), and lower Berrys Creek (the area south of Hwy. 3 to the Hackensack River).

**Contaminants with Potential to Cause Injury**

**Inorganic Substances**

**Trace Elements**

Trace elements are persistent environmental contaminants that tend to sorb to particulates and sediments, are toxic at relatively low concentrations, and can bioaccumulate in aquatic organisms (Clement 1985). Trace elements were detected in surface waters of Berrys Creek at concentrations that can be toxic to aquatic organisms (Table 2). While a number of trace elements were found in the surface water of Berrys Creek at elevated levels, the variability in the contaminant levels, the lack of data from middle Berrys Creek, and the tidal nature of the area, make it difficult to determine clear spatial patterns of contaminant distribution in surface waters. Of the trace elements detected, mercury was found at the highest levels, over 3 orders of magnitude greater than its chronic ambient water quality criterion (AWQC) value for the protection of marine life. Surface water data from the Hackensack River are more limited. Mercury was measured at several locations in the river, with maximum concentrations about an order of magnitude lower than observed in Berrys Creek. These values were still higher than the chronic AWQC for mercury (EPA 1985).

Groundwater data from the watershed were extremely limited for a variety of reasons. To date, groundwater studies have been performed only on-site at SCP, Universal Oil, and Ventron (Table 2). Mercury, lead, and zinc were the primary trace elements observed with levels exceeding their respective chronic AWQC by between 500 and 148,000 times at the Ventron site (ERM 1985). The concentrations of inorganic contaminants in groundwater...
### Table 2: Concentrations of contaminants in surface waters and groundwater (μg/L) in the Berries Creek Watershed and vicinity

<table>
<thead>
<tr>
<th>Contaminant</th>
<th>Upper 1</th>
<th>Middle 2</th>
<th>Lower 3</th>
<th>Hackensack River</th>
</tr>
</thead>
<tbody>
<tr>
<td>Acetic Acid</td>
<td>AOC</td>
<td>Groundwater</td>
<td>Universal</td>
<td>SCP Universal</td>
</tr>
<tr>
<td>Ammonium</td>
<td>Groundwater</td>
<td>Universal</td>
<td>SCP Universal</td>
<td>SCP Universal</td>
</tr>
</tbody>
</table>

**Criteria for the Protection of Surface Waters (EPA 1986):**

<table>
<thead>
<tr>
<th>Contaminant</th>
<th>Upper 1</th>
<th>Middle 2</th>
<th>Lower 3</th>
<th>Hackensack River (EPA 1982, CNW 1987, Daniels and Moore 1998)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Berries Creek</td>
<td>Groundwater</td>
<td>Universal</td>
<td>SCP Universal</td>
<td>Universal</td>
</tr>
</tbody>
</table>

**Inorganic Substances:**

- Zn: Nickel
- Hg: Mercury
- Cd: Lead
- Cu: Copper
- Zn: Chromium
- Cu: Cadmium
- As: Arsenic

**Organic Compounds:**

- Total PoAs: 110-370 NA
- Zn: 2.7 NA
- Hg: 0.47 NA
- Cd: 1.2 NA
- Cu: 1.4 NA
- Zn: 2.75 NA
- Cu: 1.25 NA
- Zn: 1.61 NA
from the SCP and Universal Oil sites were generally lower than at the Ventron site. There is lack of groundwater data downgradient from the three NPL sites, so that large scale spatial distributions of the contaminated groundwater could not be determined.

There are extensive data on inorganic contaminants in sediments in the Berrys Creek watershed (Table 3). Concentrations of metals in sediments from Berrys Creek were highest in the upper reaches adjacent to the Ventron site, with concentrations decreasing in a downstream direction. Mercury was found to have the highest levels within the sediments, with a maximum value of 89,162 mg/kg near the discharge point at the Ventron Site (Figure 2). Concentrations of metals in sediments were typically higher in the upper layers of sediment than in the deeper layers.

No criteria are presently available to evaluate the hazard of sediment contaminant concentrations that are comparable to the ambient water quality criteria. One approach currently applicable to trace elements that is under consideration by the EPA Science Advisory Board is the Apparent Effects Threshold (AET). The AET approach, which was developed in Puget Sound (Washington), uses field data (chemical concentrations in sediment) and at least one biological indicator of injury (sediment bioassays, altered benthic infauna abundance) to determine the concentration of a given contaminant above which statistically significant biological effects would be expected (PTI 1988). Although AET values have only been derived for Puget Sound and there are limitations in applying those values to other areas, they can provide some guidance in identifying contaminant concentrations of concern. The maximum concentrations of six metals measured in the sediments in upper and middle Berrys Creek exceeded their respective AET value (Table 3). In the lower reach, cadmium, chromium, and mercury exceeded their respective AET. Mercury was the most elevated compared to its AET value.

Concentrations of trace elements in sediments from the Hackensack River were lower than in Berrys Creek, but mercury is the only metal that has been measured to any great extent (Table 3, Figure 2). While there was a great deal of variability in the concentrations of mercury in Hackensack River sediments, the general pattern was that concentrations of mercury in the sediments were greater downriver of the mouth of Berrys Creek compared to levels found upriver. Maximum concentrations of mercury both upriver and downriver exceeded the upper AET value for that metal.

On-site soils were sampled at the Ventron, SCP, and Universal Oil sites. Results from these studies found soils from all three sites to be heavily contaminated with trace metals. Maximum concentrations of trace elements in soil at the Ventron site included arsenic (146 ppm), cadmium (120 ppm), lead (14,300 ppm), mercury (123,000 ppm), nickel (362 ppm), and zinc (28,000 ppm). Maximum concentrations of metals in on-site soils at the SCP included arsenic (62 ppm), cadmium (132 ppm), chromium (870 ppm), copper (71,600 ppm), lead (2,810 ppm), mercury (21 ppm), nickel (116 ppm), and zinc (44,400 ppm). All of these maximum levels greatly exceed the average values recorded in natural New Jersey soils (Toth undated, in ERM 1985). Soils at Universal Oil were found to be contaminated with arsenic (45 ppm), cadmium (4 ppm), chromium (2880 ppm), lead (90.2 ppm), mercury (2.4 ppm), and zinc (2200 ppm) (CDM 1987).

There were numerous stations in the Berrys Creek wetlands at which metals were measured, but the stations were not distributed in all areas of the wetland and, except for mercury, not all metals were measured at each station (Table 3). Mercury concentrations in the upper wetland area, near the Ventron site, reached 2000 mg/kg, with levels decreasing downstream. Maximum concentrations observed in the upper, middle, and lower wetland exceeded the average mercury level found in New Jersey (0.3 ppm). The other metals
<table>
<thead>
<tr>
<th>NA</th>
<th>0.1% - 1.6%</th>
<th>1.7% - 4.4%</th>
<th>4.5% - 5.8%</th>
<th>5.9% - 6.6%</th>
<th>6.7% - 15.4%</th>
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<tr>
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<td>NA</td>
<td>NA</td>
<td>60</td>
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<tr>
<td>1%</td>
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</tr>
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<td>4.0%</td>
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<td>0.20</td>
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<td>0.42</td>
<td>0.18</td>
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<td>0.06</td>
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**Organic Compounds**

<table>
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<tbody>
<tr>
<td>7.0%</td>
<td>3</td>
<td>15.5</td>
<td>12.3</td>
</tr>
<tr>
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<td>9.0%</td>
<td>2</td>
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<td>12.4</td>
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<tr>
<td>10%</td>
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<td>1</td>
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<td>11.4</td>
</tr>
<tr>
<td>12%</td>
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**Inorganic Substances**

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<th>Lower 2</th>
<th>Middle 1</th>
<th>Middle 2</th>
<th>Upper 1</th>
<th>Upper 2</th>
<th>AET</th>
</tr>
</thead>
<tbody>
<tr>
<td>8.5%</td>
<td>1.6</td>
<td>1.8</td>
<td>1.1</td>
<td>1.4</td>
<td>1.6</td>
<td>1.8</td>
<td></td>
</tr>
</tbody>
</table>

**Meta conclusions:** These values are for soils in New Jersey (Tolnai and others 1985).

**Table 3.** Meta conclusions (mg/kg) in Berts Creek and Hocker Creek River sediments (ERM 1985; Dantes and Moore 1988).
Figure 2. Mercury concentrations (mg/kg) in channel sediments and wetland soils (ERM 1985).
that were measured in the wetland soils demonstrated a similar spatial pattern, levels generally decreased with distance from the upper reach of Berry's Creek (ERM 1985).

Mercury was found in a number of animals and plants within the Berry's Creek Watershed, including three invertebrates, one freshwater fish (catfish), three fish species, and three wetland plant species (Table 4). Maximum concentrations of mercury ranged from 1.9 mg/kg (ppm) in catfish to 150 ppm in snails. Because it was found throughout Berry's Creek, killifish (*Fundulus* sp.) were used to examine the spatial distribution of mercury. Killifish sampled from upstream of the tide gate on East Riser Ditch, which is upstream of the Ventron site, had a maximum mercury concentration of 0.2 ppm. Mercury concentrations in killifish collected from adjacent to the Ventron site to 1 km downstream exceeded 1 ppm. Mercury concentrations in killifish from the middle reaches of Berry's Creek to the Hackensack River were typically below 0.5 ppm, with some values falling below 0.2 ppm. The highest concentration of mercury in killifish, based upon whole body analysis, was 3.3 ppm; however, heart tissue from one killifish sample had a level of 59 ppm (ERM 1985).

<table>
<thead>
<tr>
<th>Organism</th>
<th>Tissue</th>
<th>Mercury</th>
<th>PCBs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fish</td>
<td>whole</td>
<td>1.9</td>
<td></td>
</tr>
<tr>
<td>Catfish</td>
<td>whole</td>
<td>4.9</td>
<td></td>
</tr>
<tr>
<td>Eel</td>
<td>whole</td>
<td>3.3</td>
<td>89.0</td>
</tr>
<tr>
<td>Killifish</td>
<td>heart</td>
<td>59.0</td>
<td></td>
</tr>
<tr>
<td>White perch</td>
<td>whole</td>
<td>6.2</td>
<td></td>
</tr>
<tr>
<td>Invertebrates</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Barnacles</td>
<td>whole</td>
<td>4.9</td>
<td></td>
</tr>
<tr>
<td>Blue crab</td>
<td>muscle</td>
<td>&gt;2.0</td>
<td></td>
</tr>
<tr>
<td>Snail</td>
<td>whole</td>
<td>150</td>
<td></td>
</tr>
<tr>
<td>Plants</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spartina</td>
<td>rhizomes</td>
<td>5.6</td>
<td></td>
</tr>
<tr>
<td>Phragmites</td>
<td>rhizomes</td>
<td>3.5</td>
<td></td>
</tr>
<tr>
<td>Typha</td>
<td>rhizomes</td>
<td>7.9</td>
<td></td>
</tr>
</tbody>
</table>

The analyses of plant tissue for the bioaccumulation of mercury found that, of the plant parts examined (stem, rhizome, leaf), rhizomes typically had the highest levels due to their growth rates and direct contact with wetland soils. Mercury concentration in plant rhizomes were greater than 1 ppm throughout the wetland. The maximum concentration was 7.9 ppm from *Typha* rhizomes (ERM 1985).

Other inorganic substances
Total cyanide was found at high concentrations in groundwater samples from on-site wells on the SCP property. The maximum concentration recorded was 3640 µg/l, which was over 3 orders of magnitude higher than the acute AWQC of 1.0 µg/l. A maximum concentration of cyanide of 20 µg/l was found in groundwater at the Universal Oil site (ENRS 1987).
Organic Compounds

PCBs
PCBs are very persistent compounds in the aquatic environment (Clement 1985). Once adsorbed to soils and sediments, PCBs may remain for years with slow desorption providing continuous, low-level exposure to the surrounding environment. While PCBs were not detected in surface waters from Berrys Creek, few studies have examined PCBs within the watershed. PCBs were detected in the shallow aquifer at the SCP and Universal Oil sites at concentrations that exceeded the chronic AWQC for PCBs by factors of 390,000 and 3333, respectively (Table 2).

PCBs were detected in on-site soils at the SCP site at concentrations up to 15,000 mg/kg and 770 mg/kg in stream sediment from Peach Island Creek, with the maximum level found adjacent to the site (Table 3) (Dames and Moore 1988). PCB concentrations have been observed in sediments from the lagoons at the Universal Oil site that exceed 1000 ppm (CDM 1987). These concentrations are over 2 orders of magnitude greater than levels in marine sediments of Puget Sound, Washington that were always associated with significant biological effects in amphipod, oyster larvae and microtox bioassays and in reductions in the abundance of benthic macroinvertebrates (PTI 1988).

Data on the bioaccumulation of PCBs by aquatic organisms within the Berrys Creek watershed are limited. ENSR (1989) reported concentrations of PCBs in killifish to range from 31 to 89 ppm (Table 4). Other work is presently in progress that will assess PCBs in the vicinity of Akermans Creek (Schnitzer personal communication).

Pesticides
The pesticides DDT and endrin were only detected in the water table aquifer at the SCP site with maximum concentrations of 1.8 and 15 μg/l, respectively. Both of these concentrations exceeded the applicable acute AWQC (EPA 1986). Pesticides were not detected in any other media.

Volatile Organic Compounds (VOCs)
The VOCs are not very persistent in aquatic systems (Clement 1985). Most VOCs are toxic to aquatic organisms only at high concentrations (>1,000 μg/l), but sensitive species may show toxic responses at lower levels. The migration of VOCs through environmental media generally result in considerable attenuation through dilution and volatilization, but the close proximity of VOC sources to NOAA habitats makes these substances a concern. There is at present extremely limited information on the contamination of surface waters in Berrys Creek Watershed from any organic compound. The most extensive study was that of Dames and Moore (1988) which examined organic compounds in Peach Island Creek and detected numerous VOCs, but at low concentrations. Maximum concentrations of the dominant VOCs ranged from 4 μg/l to 75 μg/l. ERM (1985) found scattered data on VOCs in the middle reach of Berrys Creek where a total of 38 VOCs had been measured. Of the VOCs detected, the dominant ones included methylene chloride (88 μg/l) and tetrachloroethylene (338 μg/l). None of the VOCs observed in surface waters exceeded their lowest observed effects levels (EPA 1986).

VOCs were detected in groundwater at the SCP site at concentrations higher than that found in surface water. Methyl methacrylate was measured at the highest concentration with a maximum level of 2,000,000 μg/l. The maximum levels of chlorobenzene (6,520 μg/l), tetrachloroethylene (161,000 μg/l), and toluene (90,000 μg/l) exceeded their respective lowest observed effect level (EPA 1986). Groundwater from Universal Oil was found to also contain VOCs, with a maximum concentration of 210,000 μg/l. Benzene was the dominant compound.
The assessment of VOCs in sediment was based on samples from Peach Island Creek (Dames and Moore 1988). Of the VOCs detected, only ethylbenzene (439 mg/kg), tetrachloroethylene (953 mg/kg), and xylene (1,707 mg/kg) exceeded their respective AET values (PTI 1988). The remaining VOCs in sediment were either present at low concentrations or do not at present have an established AET value.

**Semi-volatile organic compounds**

Semi-volatile organic compounds detected at the SCP site included PAHs, phthalates and phenols. PAHs and phthalates are persistent, tend to sorb to particulates and sediments, are toxic at moderate concentrations, and can bioaccumulate in aquatic organisms (Clement 1985).

Semi-volatile organic compounds were detected in all the media sampled at the SCP site (Table 2 and 3). Three contaminants in the sediment of Peach Island Creek were observed at levels that exceeded their AET value: bis (2-ethyl hexyl) phthalate, butyl benzyl phthalate, and naphthalene. Semi-volatile organic compounds were rarely detected in groundwater and surface water samples. Nitrobenzene and total phenols were detected in the shallow aquifer at concentrations that exceeded their acute AWQC. Total phenols were detected in the surface waters of Peach Island Creek, but the levels were low.

**INJURY ASSESSMENT**

**Threat to habitat and species**

Mercury and PCBs are the primary contaminants of concern. However, other contaminants, including the trace elements arsenic, cadmium, copper, nickel, and zinc, have also been reported at highly elevated concentrations at locations within the Berries Creek watershed.

**MERCURY**

Bioaccumulation of mercury from contaminated sediment by aquatic organisms and possible biomagnification in higher trophic levels may result in tissue levels that exceed the FDA action level. Acute toxicity tests have shown mercury to be lethal to a variety of aquatic organisms. Low concentrations of mercury have been reported to adversely affect reproduction, development, growth, behavior, metabolism, blood chemistry, osmoregulation, and oxygen exchange of marine and freshwater organisms (Eisler 1987; ACOE 1988).

**Bioaccumulation**

Accumulation in aquatic organisms may result in mercury tissue levels that exceed the FDA action level (1.0 mg methylmercury/kg) or cause chronic adverse effects on the organisms.

Bioconcentration of mercury by fish is high since uptake is rapid and depuration slow. In fish, uptake from water and food are both important exposure pathways. The biological half-life of mercury in fish is on the order of 2-3 years; even in the absence of mercury exposure, reduction in tissue levels are mainly the result of dilution by growth (EPA 1985). Long-lived, predator fish may accumulate high concentrations.

Accumulation of mercury from contaminated sediments is affected by a number of factors including temperature, salinity, dissolved oxygen, organic carbon content, pH, and the

**EAR: Berries Creek**
presence of other elements (e.g., sulfide or selenium). Organomercury compounds, especially methyl mercury, are much more readily absorbed than inorganic mercury. Methylmercury via microbial activity is known to occur in sediments and in the digestive tract of fish. Most of the mercury (70-80%) found in fish tissue is methylmercury (Eisler 1987).

A study by the U.S. Army Corps (U.S. ACOE 1988; Lee et al. 1989) examined, under laboratory conditions, the bioavailability of contaminants in sediments collected from Berrys Creek to two resident species, the common killifish or mummichog (Fundulus heteroclitus) and the marsh clam (Rangia cuneata). This study consisted of two phases: Phase I involved examining the effects of salinity, temperature, and total suspended solids on bioaccumulation. Phase II consisted of a 30-day bioaccumulation study using both the killifish and marsh clam, with concentrations of specific contaminants examined throughout the 30 day test period. The Phase I results showed that the bioavailability of mercury and other metals in Berrys Creek sediment was not affected by either salinity or temperature. Changes in total suspended solids did not significantly affect the uptake of metals by fish, but did slightly affect the uptake of metals by clams.

The laboratory exposure to suspensions of Berrys Creek sediment resulted in tissue levels of mercury, cadmium, chromium, copper and nickel in the clams that were significantly greater than the controls, but the fish did not show significant bioaccumulation of mercury under the test conditions (Lee et al. 1989). These results are similar to those from another study that also found that killifish did not accumulate mercury in their tissues when exposed to mercury-contaminated Berrys Creek sediment in the laboratory (Weis et al. 1986).

Killifish collected from Berrys Creek, however, were found to have whole body tissue residues as high as 3.3 mg/kg (ppm) and organ tissue residues up to 59.0 mg/kg; concentrations in killifish were reported to decrease with increasing distance from the Ventron site (ERM 1985). Killifish collected from Berrys Creek in late spring and summer had mercury levels in their tissues that were about 5 times greater than during other times of the year (Weis et al. 1986). The explanation for the apparent discrepancy between the lack of bioaccumulation observed in the laboratory with the observations of elevated levels of mercury in killifish collected from Berrys Creek may be related to exposure to contaminated food or bioavailable mercury in runoff (Weis et al. 1986).

Invertebrates collected from the Berrys Creek watershed generally had the highest concentrations of mercury. One snail downstream from the Ventron site had a whole body concentration of 150 mg/kg (ERM 1985).

Macrophyte species may play an important role in mercury cycling (Eisler 1987). For example, in southeastern Atlantic estuaries the salt marsh plant Spartina alterniflora was estimated to accumulate 17% of the mercury input annually into the system (Windom and Kendall 1979). Several species of plants from Berrys Creek wetlands were found to have elevated levels of mercury in their tissues, particularly in their rhizomes (ERM 1985).

Aquatic Toxicity: Water
Acute and chronic ambient water quality criteria for the protection of marine organisms (AWQC) were exceeded in samples collected from all areas of Berrys Creek, including both the upper and lower sections (ERM 1985). Maximum concentrations exceeded chronic AWQC by over 3 orders of magnitude.

Adverse effects on reproduction in several species of aquatic organisms have been reported at levels of 0.03 - 1.6 µg Hg/l (Eisler 1987). Similarly, reduced growth has been reported
at concentrations from as low as 0.04 µg Hg/l. Other chronic toxic effects include appetite loss, brain lesions, cataracts, reduced responsiveness to changes in light intensity, inability to capture food, abnormal motor coordination, and a variety of erratic behaviors (Eisler 1987).

For marine organisms, toxicity is generally higher at reduced salinities (Eisler 1987). Some species, such as the killifish, may show tolerance to mercury contamination (Weis 1984). Methylmercury has been reported to cause acute and chronic toxicity in aquatic organisms at lower concentrations than inorganic mercury (EPA 1985).

Aquatic Toxicity: Sediment
Sediment bioassay data from several studies indicates that sediment mercury concentrations reported from Berrys Creek may cause acute and chronic toxicity to aquatic organisms. A spiked-sediment bioassay with the marine amphipod *Rheopygynus abronius* had a 10-d LC50 of 13.1 mg/kg (Swartz et al. 1988). Exposure to sediment spiked with inorganic mercury concentrations as low as 0.18 mg/kg resulted in reduced egg and larval survival in rainbow trout; less than 50% survival was observed at concentrations of 1.05 mg/kg (Birge et al. 1976). Another study demonstrated behavioral effects (reduced activity) in the freshwater amphipod *Pontoporeia affinis* exposed to 2.15 mg Hg/kg in sediment in a 5-day bioassay (Magnuson et al. 1976).

Sediment levels of mercury above which biological effects were always observed in Puget Sound were 2.1 mg/kg for the marine amphipod *Rheopygynus abronius* (lethality in a 10-d bioassay), 0.59 mg/kg for the oyster larva abnormality bioassay, and 2.1 mg/kg for significant depressions of the abundance of at least one major taxa of benthic infauna (PTI 1988).

Maximum mercury levels reported in sediment from all areas of Berrys Creek and associated wetlands exceed levels shown to be toxic by the above studies by at least an order of magnitude.

Tissue Residue Effects
Very little information is available on the potential toxicity of mercury tissue residues. In chronic bioassays using methylmercury, McKim et al. (1976) observed reproductive impairment of brook trout at whole body tissue levels above 2.7 mg/kg. Birge et al. (1976), in a long-term experiment involving exposure of adult rainbow trout to inorganic mercury for over 400 days, reported reduced larval survival and high percentage of abnormalities in surviving larvae at mercury levels in gonads and eggs of 0.49 and 0.26 mg/kg, respectively.

PCBs
While acute toxicity of PCBs appears to be relatively low (EPA 1980), a number of field and laboratory studies provide evidence of reproductive effects on aquatic organisms at low tissue concentrations. Bioaccumulation of PCBs from contaminated sediment by aquatic organisms, and possible biomagnification in higher trophic levels, may result in tissue levels that exceed the FDA action level as well as causing chronic toxicity.

Bioaccumulation
Aquatic organisms have a strong tendency to accumulate PCBs from water and food sources. The bioconcentration factor (ratio of concentration in tissue to ambient water concentration) for fish is approximately 50,000 (EPA 1980). PCB concentrations in tissues of aquatic organisms will generally be greater than, or equal to, sediment
concentrations (Neff 1984). Thus, given the high levels of PCBs observed in the sediment adjacent to the site and the groundwater on-site (see Table 1), aquatic organisms in the vicinity of the site would be expected to have elevated tissue levels. Laboratory exposures of filter-feeding clams and killifish to suspended sediment from Berrys Creek demonstrated that both accumulated significant amounts of PCBs over the 30-day test period (Lee et al. 1989). Concentrations reported from killifish collected in the Berrys Creek watershed in the vicinity of the Universal Oil site were as high as 89 mg/kg (ENSR 1989). This could result in chronic toxicity to these organisms, provide a potential source of PCBs to predator organisms in the Hackensack River and Newark Bay, or contribute to tissue concentrations in recreational or commercial species that are above the FDA advisory limit of 2 mg/kg for human consumption.

Aquatic Toxicity: Water
Acute toxicity testing with a variety of freshwater and marine organisms results in LC50 values from 0.1 to 10.0 μg/l (Eisler 1987). Sublethal toxicity tests indicate a range of effects including decreased growth, reproductive toxicity, histopathology, and biochemical effects. Results from chronic toxicity tests indicate that PCB toxicity is directly related to the duration of exposure (EPA 1980).

Little analysis of PCB concentrations in the surface water of Berrys Creek has been conducted, but levels in the groundwater on the SCP site are several orders of magnitude higher than AWQC.

Aquatic Toxicity: Sediment
PCB concentrations greater than the AET values of 3.1 mg/kg in marine sediments of Puget Sound were always associated with significant biological effects in amphipod, oyster larvae, and Microtox bioassays and in the abundance of benthic macroinvertebrates. The PCB concentration in clean sediment spiked with PCB (Aroclor 1254) that resulted in acute toxicity (10-d LC50) to the marine amphipod Rhysoxynius abronius was 10.8 mg/kg (Swartz et al. 1988). The maximum values observed in sediment adjacent to the SCP site (770 mg/kg) and in lagoon sediment at the Universal Oil site (over 1000 mg/kg) greatly exceed levels shown to be acutely toxic in other areas.

Tissue Residue Effects
Although no information is available on the chronic toxicity of PCBs to fish species in the vicinity of the Berrys Creek sites, a review of a number of studies indicates that sublethal effects may occur at concentrations below 1 ppm in a number of marine and freshwater species (Dexter and Field 1989). Of particular note are the number of marine and freshwater fish species that experienced chronic toxicity at PCB tissue levels of less than 1.0 ppm and as low as 0.1 ppm. For example, a field study in the Baltic Sea demonstrated reduction in the viable hatch of Baltic flounder eggs at PCB concentrations greater than 0.12 ppm (Von Westernhagen et al. 1981). In another field study, Spies et al. (1985) reported an inverse relationship between PCB concentrations in starry flounder eggs in San Francisco Bay and reproductive success. Results suggested that concentrations of PCBs in the ovaries of less than 0.2 ppm could affect reproductive success. Monod (1985) also reported a significant correlation between PCB concentrations in eggs (on a lipid weight basis) and total egg mortality in Lake Geneva char (at PCB concentrations ranging from 10-78 ppm lipid weight, 0.1-0.5 ppm wet weight). However, it should be noted that, for all of the above field studies, the possible presence of other contaminants complicates the interpretation of results.

A study by the Corps of Engineers (ACOE 1988) demonstrated an inverse relationship between tissue concentrations and reproductive success in fathead minnow exposed to PCB-contaminated sediment. Tissue PCB concentrations of 13.7-47.2 mg/kg resulted in
80-100% inhibition of reproduction. Another study reported an inverse relationship between concentration of PCBs in winter flounder eggs and the size and weight at hatch, which could result in reduced larval survival (Black et al. 1988).

Other Contaminants

Arsenic, cadmium, chromium, copper, lead, nickel and zinc all exceeded AWQC for at least one sample collected from Berrys Creek.

Sediment levels of cadmium, copper, and zinc in Berrys Creek were also found to exceed levels known to be toxic to aquatic organisms.

The laboratory exposure of marsh clams to suspensions of Berrys Creek sediment resulted in significant bioaccumulation of cadmium, chromium, copper and nickel in addition to mercury and PCBs (Lee et al. 1989).

Cadmium

The form of cadmium will influence the amount of free cadmium available to organisms. In sediments, natural high molecular weight organic compounds, sulfides, carbonates, iron and manganese oxides and hydroxides, and clay minerals all generally tend to bind cadmium. Oxidation-reduction conditions, pH and other factors influence the mobilization of cadmium and its availability and toxicity to organisms (Khalid et al. 1981).

Several investigators have conducted 10-d bioassays with sediment spiked with cadmium using the amphipod \textit{Rheopoxynius abronius} ; LC50 values range from 6.9 to 11.5 mg/kg (Swartz et al. 1985; Kemp et al. 1986; Mearns et al. 1986; Robinson et al. 1988). No mortality or behavioral affects were observed in the polychaete \textit{Nereis virens} in a 28-d bioassay at 20 mg/kg (Olla et al. 1988).

Restoration Options

Befuddling Factors

Some problems in dealing with the waste sites located on Berrys Creek are:

There are multiple sources of contamination, other industries and wastes sites contribute contamination to both Berrys Creek and the Hackensack River. The extent of the contamination from Berrys Creek and how much it is contributing to pollution in the Hackensack River is not known.

Due to the length of time this area has been industrialized, the species composition and use of the area is not well known. The species diversity and abundance expected in the watershed is not known. For example, no information on historical use by anadromous fish in the Hackensack River is currently available.

Other sources of contamination may continue to pollute the area even if releases from the 3 NPL sites are controlled. If other contaminant sources are not controlled, restoration actions may still not provide safe habitat.

Establishing the boundaries for the Berrys Creek area will not be straightforward, particularly in the Hackensack River.

EAR: Berrys Creek
The Hackensack River Basin has over 1,600 acres of landfills, three superfund sites, numerous hazardous waste sites, and a myriad of industrial sites and warehouse facilities. Development of the wetlands for landfills, roadways, warehouses, offices and other commercial/industrial uses has led to a significant decrease of wetlands since the 1950s and has placed an enormous amount of environmental stress on the area. There are a total of eight hazardous waste sites located within the Hackensack Meadowlands District with four located on Berrys Creek.

There are at least two landfills adjacent to Berrys Creek. Over fifty municipal, private and industrial wastewater discharges are scattered throughout the Hackensack Meadowlands. Numerous discharges occur in the upper reaches of Berrys Creek. There are approximately 12 wastewater discharges that discharge directly into Berrys Creek. The 75 million gallons per day (mgd) discharged from the Bergen County POTW and the nearby thermal discharge from the PSE&G power plant contribute to water quality problems in this poorly flushed section of the Hackensack River.

EPA and the Corps of Engineers have undertaken an Advanced Identification Study of the Hackensack Meadowlands' wetlands. The study evaluates wetland functions within the Hackensack Meadowlands. These functions include groundwater recharge and discharge, floodflow alteration, sediment stabilization, sediment/toxicant retention, nutrient removal/transformation, production export, aquatic diversity/abundance, general fish habitat, general wildlife habitat, general waterfowl habitat, wildlife diversity/abundance, and a number of waterfowl functions.

EPA and the Corps have joined with NOAA's NMFS the Hackensack Meadowlands Commission (HMDC), and the NJDEP in a Special Area Management Study (SAMP) within the Hackensack Meadowlands area. These agencies have embarked upon the SAMP in order to establish a cooperative interagency process for addressing Section 404 of the CWA and related federal laws and regulations in the context of HMDC's revision of its Master Plan.

The NJDEP has established a Berrys Creek technical advisory group to address issues surrounding the Ventron/Velsicol site. Currently the group is preparing a second contract proposal for preparing the RI/FS. The group meets approximately four times per year. NJDEP has contracted with the Corps. at Vicksburg, Miss. to conduct sediment bioassays. The Corps. is expected to submit the final results of the bioassay study in early 1990.

The HMDC recently completed a two year survey of the the lower Hackensack River in order to ascertain the fisheries values of the river, and to help guide Sec. 404 applications. A report titled, "Inventory of Fisheries Resources of the Hackensack River within the Jurisdictional Boundary of the Hackensack Meadowlands Development Commission from Kearny, Hudson County, to Ridgefield, Bergen County, New Jersey", dated May 18, 1989 was prepared presenting the results of the study. The HMDC also compiled a list of plant and animal species occurring in the area.

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829720021


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