
Macalloy Corporation

North Charleston, South Carolina

USEPA Facility ID: SCD003360476

Basin: Cooper

HUC: 03050201

Executive Summary

The Macalloy Corporation site, where ferrochromium alloy was produced from 1942 to 1998, is located just west of Shipyard Creek, a tributary of the Cooper River, in North Charleston, South Carolina. Byproducts of the alloy production process were disposed of in an unlined surface impoundment located on the site property. Surface water runoff containing chromium concentrations that exceeded NPDES permit limits was discharged from the site into Shipyard Creek via four outfalls. The migration of metal contaminants from the site into the creek has been documented during several field investigations. The NOAA trust habitats of concern are the estuarine waters of the lower Cooper River, including Shipyard Creek and upper Charleston Harbor. NOAA trust resources, including estuarine and anadromous fish, are present in the sediment and surface waters surrounding the Macalloy Corporation site.

Site Background

The Macalloy Corporation site encompasses 51 hectares (125 acres) in North Charleston, South Carolina. The facility is bordered on the east by Shipyard Creek, a tributary of the Cooper River (Figure 1). The Cooper River connects to Charleston Harbor approximately 3.8 km (2.4 mi) downstream of the Macalloy site.

Ferrochromium alloy was produced at the Macalloy Corporation site from 1942 to 1998. The process involved smelting iron and chromium ore in electric arc furnaces. Byproducts of the ferrochromium alloy production process included slag; fine particulate matter, ash, and dust (PMAD); gas conditioning tower (GCT) sludge; GCT wastewater; electrostatic precipitator (ESP) dust; and baghouse dust (USEPA 2002b). Untreated ESP dust, GCT sludge, and slag were used to fill a lake (Figure 2) and various other low areas around the Macalloy site (Tetra Tech EM Inc. 1999). Until 1997, ESP dust was also disposed of in an unlined surface impoundment (Figure 2) constructed out of approximately 36 million kg (40,000 tons) of GCT sludge. The Macalloy Corporation operated four surface water outfalls that discharged into Shipyard Creek under a National Pollutant Discharge Elimination System (NPDES) permit. NPDES permit limits for chromium and hexavalent chromium were exceeded several times during the facility's operation (USEPA 2002b).

On the basis of a stormwater inspection conducted in 1997, the U.S. Environmental Protection Agency (USEPA) and South Carolina Department of Health and Environmental Control (SCDHEC) concluded that stormwater discharge had occurred at site locations other than permitted outfalls. A hazard ranking system package was prepared for the Macalloy Corporation site in July 1998. The USEPA placed the Macalloy Corporation site on the National Priorities List in February 2000 (USEPA 2002b).

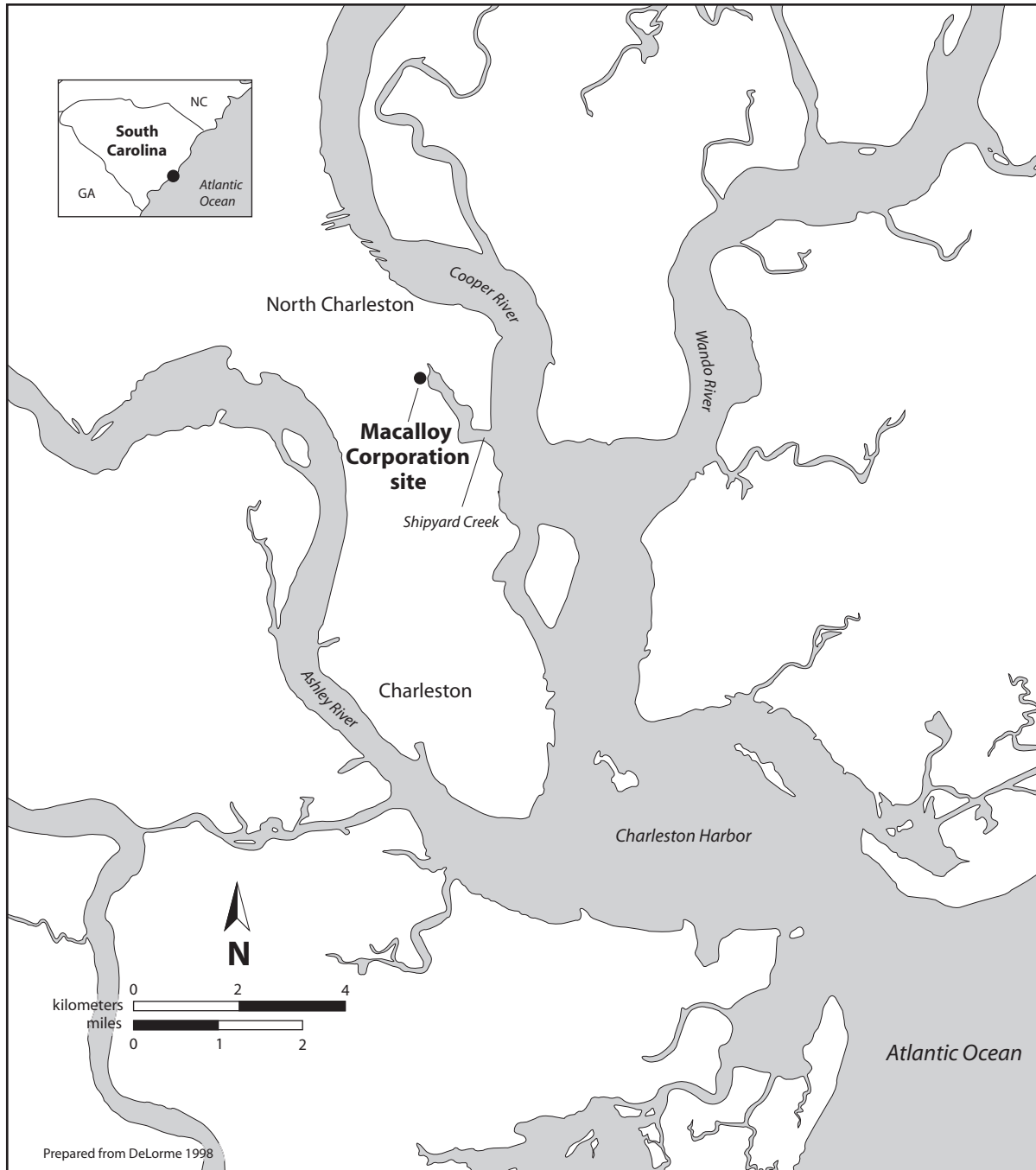


Figure 1. Location of the Macalloy Corporation site in North Charleston, South Carolina.

The primary pathways for migration of contaminants to NOAA trust resources are groundwater discharge and surface water runoff into Shipyard Creek. An approximately 9.3-hectare (23-acre) chromium-contaminated groundwater plume is located below the unlined surface impoundment. The groundwater below the site property flows northeast to Shipyard Creek and is encountered at 4.3 to 6.7 m (14 to 22 ft) below ground surface (USEPA 1999).

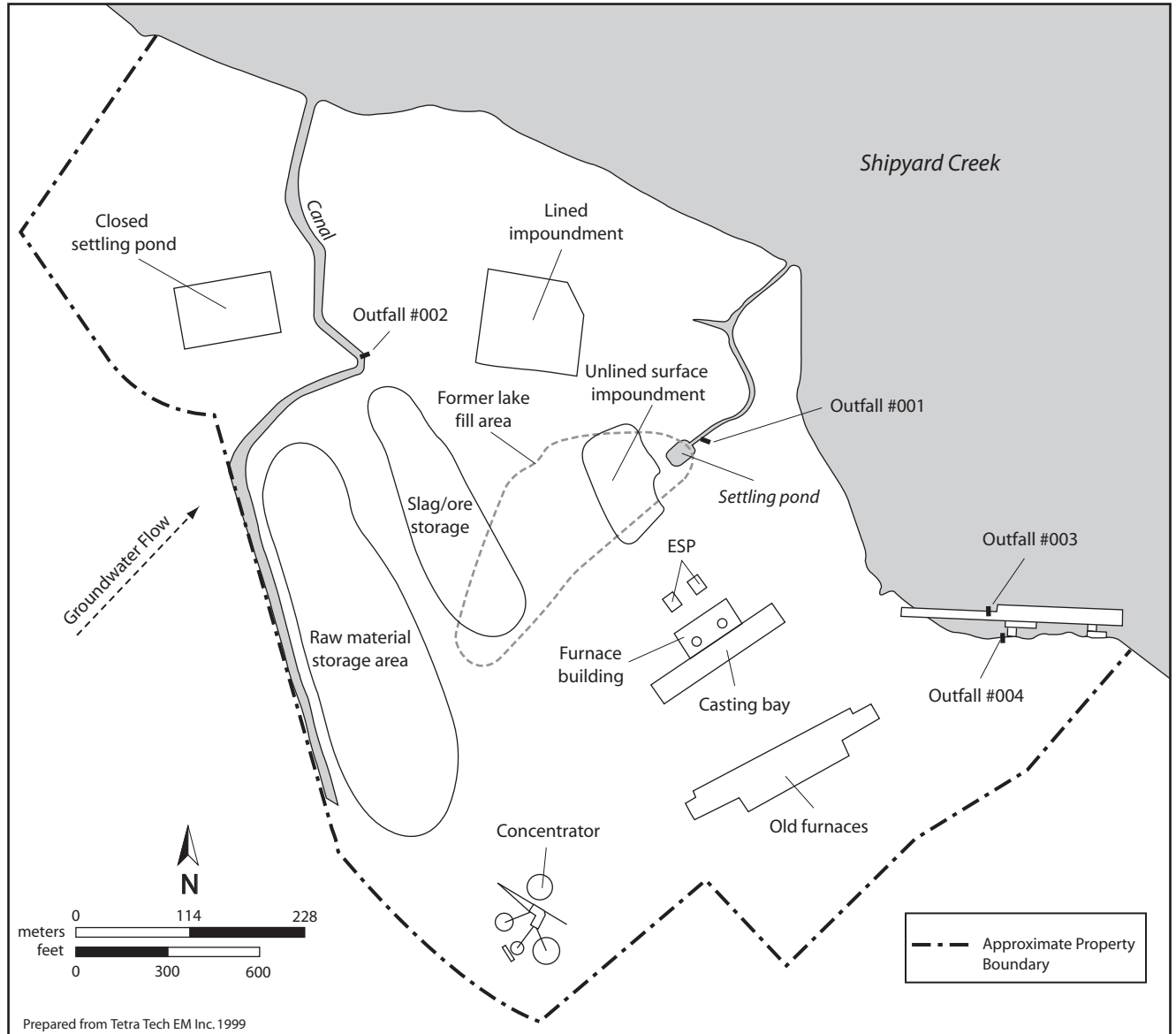


Figure 2. Detail of the Macalloy Corporation property.

NOAA Trust Resources

The NOAA trust habitats of concern are the estuarine waters of the lower Cooper River, including Shipyard Creek and upper Charleston Harbor. Adjacent to the site, the Cooper River is estuarine river-mouth habitat about 1 km (0.6 mi) in width and up to 9 m (30 ft) in depth, with salinities ranging from 14 to 25 parts per thousand (ppt). Shipyard Creek, a tributary of the lower Cooper River, is about 2 km (1.2 mi) in length, 200 m (660 ft) in width, and up to 5.5 m (18 ft) in depth. The upland areas adjacent to Shipyard Creek are highly developed. Little freshwater input enters Shipyard Creek (Marine Resources Research Institute 2000; USGS 2000). Sediments in the lower Cooper River are heterogeneous, ranging from sandy to very muddy and silty (Marine Resources Research Institute 2000). Lower Charleston Harbor, an estuary of the Atlantic Ocean, has depths ranging up to

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12 m (40 ft) and salinities ranging from 15 ppt to full seawater (which generally has salinities of approximately 30 to 40 ppt) (Nelson et al. 1991; USGS 2000).

Numerous estuarine and marine species use the lower Cooper River and Charleston Harbor estuaries as a juvenile nursery and adult residence (Table 1). Resident estuarine fish species include bay anchovy, killifishes, sheepshead minnow, and silversides. All life stages of these species are spent within the estuary, and several of these species are considered abundant. Species such as bluefish, mullets, pinfish, and the sciaenids (Atlantic croaker, black drum, spot, spotted seatrout, weakfish) are coastal spawners; eggs and larval stages drift offshore and juvenile stages migrate into the estuary. Because many of these species are long-lived, juveniles may spend several years in the estuary. Adults of several of the species can also be found within the estuary seasonally. Species such as cobia and Spanish mackerel are pelagic and migratory; juveniles are primarily found in estuaries, which also receive some seasonal use by adults (Nelson et al. 1991; Wenner 2002).

Several anadromous species, including American shad, blueback herring, striped bass, and white perch, spawn in freshwater portions of the Cooper River upstream of the site. The Cooper River is an actively managed anadromous fish stream. Dam and lock systems such as the Pinopolis Dam on the Lake Moultrie impoundment, located approximately 48 km (30 mi) upstream of the site, allow passage of migrating fish during spawning seasons (Cooke and Cappelear 1992). All of the anadromous species are spring spawners (Nelson et al. 1991). The catadromous American eel is also present in Shipyard Creek in the vicinity of the site (Wenner 2002). Adult residents in the Cooper River and Charleston Harbor are considered common to abundant.

Many invertebrate species are present in the estuary, including blue crab, daggerblade grass shrimp, eastern oyster, northern quahog, and penaeid shrimp. Juvenile and adult blue crab are abundant; mating and larval stages are also observed in the estuary although females usually migrate to coastal waters to brood and release eggs. Daggerblade grass shrimp, eastern oyster, northern quahog, and penaeid shrimp spend all their life stages in the estuary (Nelson et al. 1991; Wenner 2002).

Commercial and recreational fishing and shellfish collection occur in the lower Cooper River and Charleston Harbor. Sixteen estuarine and three anadromous fish species are fished commercially in the vicinity of the Macalloy site (Table 1). In addition, there is recreational fishing of 18 estuarine and three anadromous fish species in the lower Cooper River and Charleston Harbor (Table 1). Several of these species, including American eel, Atlantic menhaden, killifish, and striped mullet, are collected solely for use as bait (Wenner 2002). There is also an active, year-round recreational harvest of penaeid shrimp (SCDNR 2003).

No fish consumption advisories are currently in effect for Shipyard Creek. In 1998, the SCDHEC issued an emergency order closing Shipyard Creek to the harvest of all shellfish because of high levels of chromium in edible tissue. However, this advisory was lifted in November 2001 (SCDHEC 2001).

Site-Related Contamination

The primary contaminants of concern at the site are metals. A site investigation (SI), a preliminary ecological risk evaluation (PERE), and a Phase II remedial investigation (RI) have documented the migration of these contaminants from the site into Shipyard Creek. Fifteen surface water samples collected from Shipyard Creek during the SI were analyzed for metals. One hundred sediment samples collected during the SI, 15 collected during the PERE, and eight collected during the RI were analyzed for metals, semivolatile organic compounds (including polynuclear aromatic hydrocarbons [PAHs]), pesticides, and polychlorinated biphenyls (PCBs). Maximum concentrations of selected contaminants of concern are summarized in Table 2.

Table 1. Fish and invertebrate species present in the lower Cooper River and Charleston Harbor (Nelson et al. 1991; Wenner 2002).

Species		Habitat Use			Fisheries	
		Spawning Area	Nursery Area	Adult Forage	Comm.	Rec.
Common Name	Scientific Name					
MARINE/ESTUARINE FISH						
Atlantic croaker	<i>Micropogonias undulatus</i>		◆	◆	◆	◆
Atlantic menhaden	<i>Brevoortia tyrannus</i>		◆		◆	◆ ^a
Bay anchovy	<i>Anchoa mitchilli</i>	◆	◆	◆		
Black drum	<i>Pogonias cromis</i>		◆	◆		◆
Bluefish	<i>Pomatomus saltatrix</i>		◆	◆	◆	◆
Cobia	<i>Rachycentron canadum</i>		◆	◆	◆	◆
Gray snapper	<i>Lutjanus griseus</i>		◆		◆	◆
Gulf flounder	<i>Paralichthys albigutta</i>		◆	◆		◆
Killifish	<i>Fundulus spp.</i>	◆	◆	◆	◆ ^a	◆ ^a
Pinfish	<i>Lagodon rhomboides</i>		◆	◆		
Red drum	<i>Sciaenops ocellatus</i>	◆	◆	◆	◆	◆
Sheepshead	<i>Archosargus probatocephalus</i>		◆	◆	◆ ^b	◆
Sheepshead minnow	<i>Cyprinodon variegatus</i>	◆	◆	◆		
Silversides	<i>Menidia spp.</i>	◆	◆	◆		
Southern flounder	<i>Paralichthys lethostigma</i>		◆	◆	◆	◆
Southern kingfish	<i>Menticirrhus americanus</i>		◆	◆	◆	◆
Spanish mackerel	<i>Scomberomorus maculatus</i>		◆	◆	◆	◆
Spot	<i>Leiostomus xanthurus</i>		◆	◆	◆	◆
Spotted seatrout	<i>Cynoscion nebulosus</i>		◆	◆	◆	◆
Striped mullet	<i>Mugil cephalus</i>		◆	◆	◆	◆ ^a
Summer flounder	<i>Paralichthys dentatus</i>		◆	◆	◆	◆
Weakfish	<i>Cynoscion regalis</i>		◆	◆	◆	◆
ANADROMOUS/CATADROMOUS FISH						
American eel	<i>Anguilla rostrata</i>		◆	◆	◆	◆ ^a
American shad	<i>Alosa sapidissima</i>		◆	◆	◆	◆
Blueback herring	<i>Alosa aestivalis</i>		◆	◆	◆	
Striped bass	<i>Morone saxatilis</i>		◆	◆		◆
White perch	<i>Morone americana</i>		◆	◆		
INVERTEBRATES						
Blue crab	<i>Callinectes sapidus</i>	◆	◆	◆	◆	◆
Daggerblade grass shrimp	<i>Palaemonetes pugio</i>	◆	◆	◆		
Eastern oyster	<i>Crassostrea virginica</i>	◆	◆	◆	◆	◆
Northern quahog	<i>Mercenaria mercenaria</i>	◆	◆	◆	◆	◆
Penaeid shrimps	<i>Penaeidae spp.</i>	◆	◆	◆	◆	◆

a: Species fished as bait

b: Species represents minor fishery

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Table 2. Maximum concentrations of selected contaminants of concern to NOAA detected in samples collected at the Macalloy Corporation site (Tetra Tech EM Inc. 1999, EnRisk 2000, BDY 2001). Contaminant values in bold exceeded screening guidelines.

Contaminant	Surface Water (µg/L)		Sediment (mg/kg)	
	Surface Water	AWQC ^a	Sediment	ERL ^b
METALS/INORGANICS				
Arsenic	13	36	25	8.2
Cadmium	ND	8.8	2.3	1.2
Chromium ^c	2,600	50	3,900	81
Copper	50	3.1	98	34
Lead	130	8.1	620	46.7
Mercury	0.73	0.94 ^d	0.61	0.15
Nickel	56	8.2	610	20.9
Selenium	28	71	8	1.0 ^e
Zinc	730	81	4,800	150
PAHs				
Acenaphthene	N/A	710 ^f	0.11	0.016
Anthracene	N/A	300 ^{f,g,h}	0.37	0.0853
Benz(a)anthracene	N/A	300 ^{f,g,h}	6.8	0.261
Chrysene	N/A	300 ^{f,g,h}	9.4	0.384
Dibenz(a,h)anthracene	N/A	300 ^{f,g,h}	0.096	0.0634
Fluoranthene	N/A	16 ^f	4.9	0.6
Fluorene	N/A	NA	0.072	0.019
2-Methylnaphthalene	N/A	300 ^{f,g,h}	0.16	0.07
Naphthalene	N/A	2350 ^{f,g}	0.3	0.16
Phenanthrene	N/A	NA	0.6	0.24
Pyrene	N/A	300 ^{f,g,h}	9.6	0.665
PESTICIDES/PCBs				
Chlordane	N/A	0.004	0.024	0.0005
4,4'-DDE	N/A	NA	0.087	0.0022
4,4'-DDT	N/A	0.001	0.19	0.00158 ⁱ
Total PCBs	N/A	0.03	12	0.0227

a: Ambient water quality criteria for the protection of aquatic organisms (USEPA 2002a). Marine chronic criteria presented.

b: Effects range-low represents the 10th percentile for the dataset in which effects were observed or predicted in studies compiled by Long et al. (1998).

c: Screening guidelines represent concentrations for Cr.⁺⁶

d: Derived from inorganic, but applied to total mercury.

e: Marine apparent effects threshold (AET) for bivalve bioassays. The AET represents the concentration above which adverse biological impacts would be expected.

f: Lowest Observable Effect Level (LOEL) (USEPA 1986).

g: Chronic criterion not available; acute criterion presented.

h: Value for chemical class.

i: Expressed as Total DDT.

N/A: Not analyzed.

NA: Screening guidelines not available.

ND: Not detected.

Surface Water

Several metals were detected in surface water samples collected from Shipyard Creek. Maximum concentrations of detected metals ranged from 0.73 µg/L (mercury) to 2,600 µg/L (chromium). Maximum concentrations of chromium, copper, and lead in surface water samples exceeded the ambient water quality criteria (AWQC) screening guidelines by one order of magnitude. Mercury, nickel, and zinc were detected at maximum concentrations at least seven times the AWQC. Arsenic and selenium were also detected, but at maximum concentrations below the AWQC. Cadmium was not detected in the surface water samples. Both chromium and zinc were detected at concentrations exceeding the AWQC in six of the 15 surface water samples collected.

Sediment

Metals, PAHs, and pesticides were detected in several sediment samples collected from Shipyard Creek. The most frequently detected metals were chromium, copper, lead, and nickel. Maximum concentrations of chromium, lead, nickel, and zinc all exceeded the effects range-low (ERL) screening guidelines by one order of magnitude, while maximum concentrations of arsenic, cadmium, copper, mercury, and selenium exceeded the ERLs by factors ranging between approximately two and eight. Maximum concentrations of PAHs in sediment samples ranged from 0.072 mg/kg (fluorene) to 9.6 mg/kg (pyrene). The PAHs most frequently detected included chrysene, flouranthene, and phenanthrene. Benz(a)anthracene, chrysene, and pyrene were detected in a Shipyard Creek sediment sample collected near the shore opposite the site at maximum concentrations that exceeded the ERLs by one order of magnitude. Maximum concentrations of the other PAHs summarized in Table 2 exceeded ERLs by factors ranging between approximately two and eight. The pesticides chlordane, DDE, and DDT were detected in a sediment sample collected near where existing outfall #001 discharges into Shipyard Creek at maximum concentrations that exceeded the ERLs by one order of magnitude (chlordane, DDE) or two orders of magnitude (DDT). Total PCBs were detected at a maximum concentration that exceeded the ERL by two orders of magnitude.

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