
Brewer Gold Mine

Jefferson, South Carolina

EPA Facility ID: SCD987577913

Basin: Lynches

HUC: 03040202

Executive Summary

The Brewer Gold Mine site is an abandoned gold mine encompassing approximately 400 ha (1,000 acres) in a forested rural area of Jefferson, Chesterfield County, South Carolina. The Brewer Gold Mine property is on a ridge that divides the Little Fork Creek and Lynches River basins. Small-scale pit mining, a process that used mercury, began at the site around 1828. Large-scale open pit mining, a process that used a cyanide solution, was conducted from 1987 to 1993. The primary contaminants of concern to NOAA are cyanide and selenium and metals, including arsenic, chromium, copper, lead, mercury, nickel, silver, and zinc. Surface water runoff, direct discharge, and sediment transport are the primary pathways for the migration of contaminants from the site to NOAA trust resources; groundwater transport is a secondary pathway. NOAA trust resources that use Little Fork Creek, Fork Creek, and the Lynches River for spawning, nursery, or adult habitat are the anadromous American shad and striped bass, and the catadromous American eel.

Site Background

The Brewer Gold Mine site is an abandoned gold mine encompassing approximately 400 ha (1,000 acres) in a forested rural area of Jefferson, Chesterfield County, South Carolina (Figure 1). The Brewer Gold Mine property is on a ridge that divides the Little Fork Creek and Lynches River basins. East of the ridge, Little Fork Creek forms the eastern border of the property (Figure 2). The Lynches River is to the west of the ridge. The majority of the property is in the Little Fork Creek watershed (USEPA 2003).

Small-scale pit mining began at the site around 1828. In this process, mercury was used to isolate gold particles from crushed rock, forming an amalgam. The amalgam was heated in a furnace to extract the gold from the mercury. The mercury was then reclaimed, and the waste was discarded in a tailings pile located between the Brewer Pit and Sediment Control Pond (Figure 2) ((USEPA 2003).

From 1987 to 1993, large-scale open pit mining also occurred at the site. In this process, a cyanide solution was sprayed over piles of crushed ore to dissolve gold into solution. Some of the leftover solution was recharged with cyanide and reused. Waste solutions that were not recycled were treated with calcium hypochlorite to reduce cyanide and copper concentrations before they were discharged into Little Fork Creek. Waste rock was disposed of on site (Black & Veatch 2004; USEPA 2003, 2005).

In 1990, a dam failed at the Pad 6 Pond, which held a solution of sodium-cyanide, resulting in a fish kill along 79 km (49 mi) of the Lynches River. The dam failure also resulted in severe impacts to macroinvertebrate communities in Little Fork Creek, Fork Creek, and the Lynches River (Black & Veatch 2004; USEPA 2003, 2005).

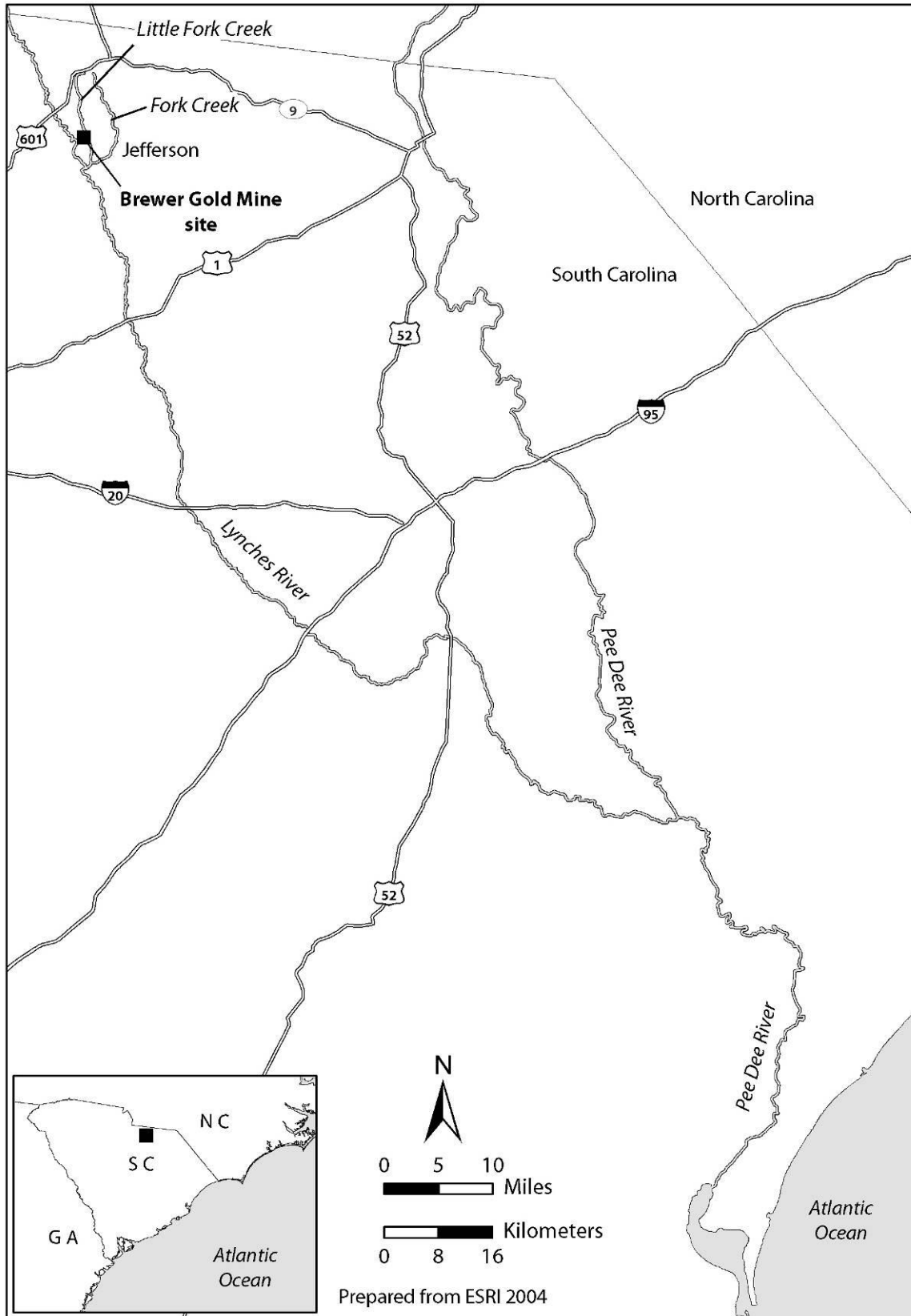
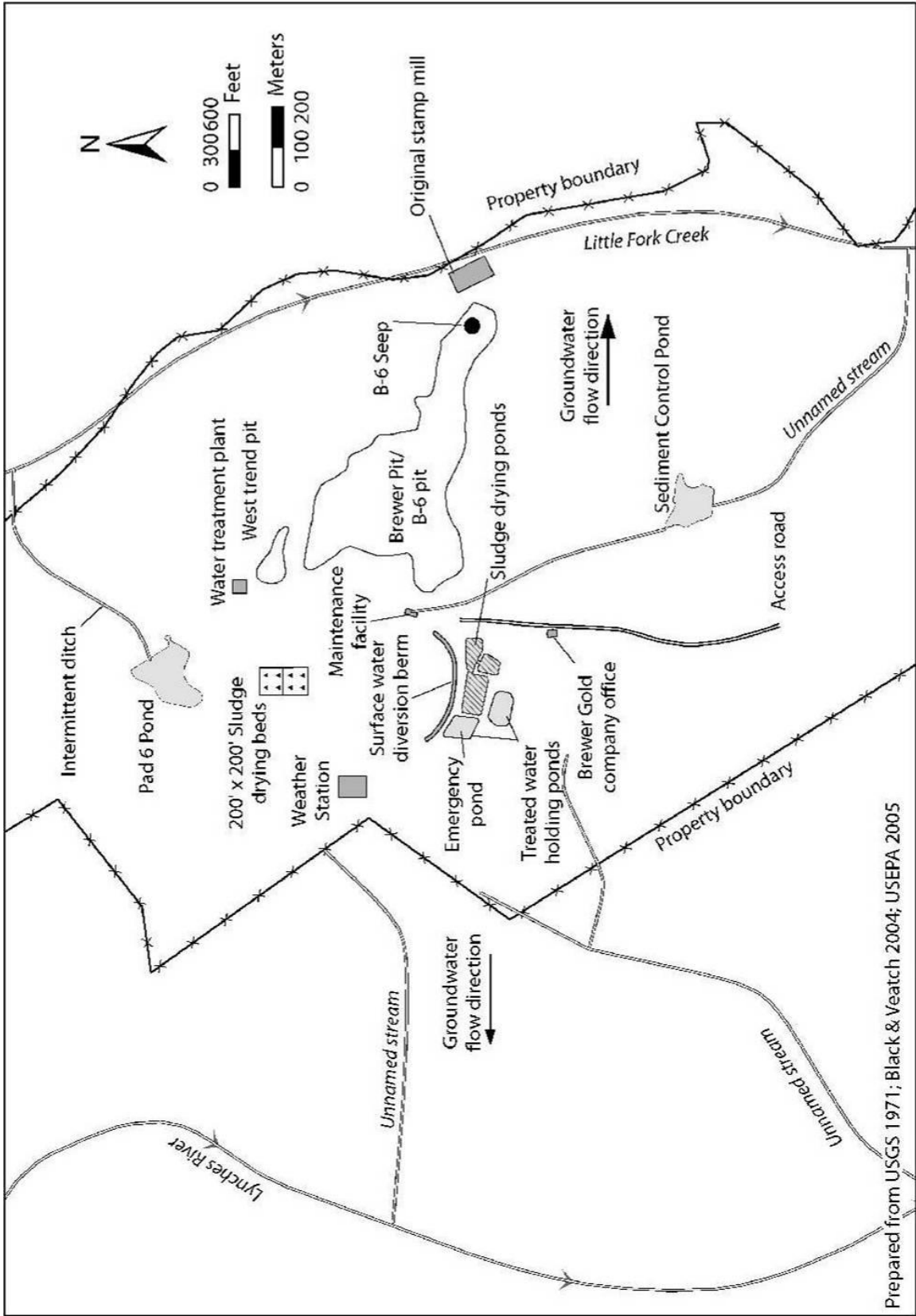


Figure 1. Location of the Brewer Gold Mine site, Jefferson, South Carolina.



Prepared from USGS 1971; Black & Veatch 2004; USEPA 2005

Figure 2. Detail of the Brewer Gold Mine property.

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Elevated levels of metals and cyanide were detected in surface water, groundwater, sediment, and soil during numerous investigations conducted by state and federal agencies. In 1995, the open pits were backfilled with treated and untreated mine wastes and capped with a clay liner, low-permeability soil, and topsoil (Black & Veatch 2004; USEPA 2003, 2005).

Surface water runoff, direct discharge, and sediment transport are the primary pathways for the migration of contaminants from the site to NOAA trust resources; groundwater transport is a secondary pathway. Surface water and stormwater runoff from the eastern portion of the Brewer Gold Mine site discharges directly to Little Fork Creek. Stormwater and treated water from the Sediment Control Pond were directed into Little Fork Creek under a National Pollutant Discharge Elimination System (NPDES) permit. Groundwater underlying the site is encountered approximately 3 to 12 m (10 to 40 ft) below ground surface (Black & Veatch 2004; USEPA 2005). Most groundwater beneath the site flows to the east and discharges to Little Fork Creek, however some groundwater flows to the west and discharges to intermittent unnamed streams that are tributaries of the Lynches River. Treated acidic groundwater continues to be discharged into Little Fork Creek under an NPDES permit (USEPA 2005).

A hazard ranking system package was completed by the U.S. Environmental Protection Agency (USEPA) for the Brewer Gold Mine site in March 2002. The site was placed on the USEPA's National Priorities List in April 2005 (USEPA 2008). Two cleanup activities are still underway for Operable Unit 1 at the site. These include an RI/FS to determine a long-term solution, which began in September 2003, and a remedial action initiated by the USEPA, which began in September 2006 (USEPA 2008). All cleanup activities that have been completed to date at the site are described in USEPA (2008).

NOAA Trust Resources

The habitats of primary concern to NOAA are Little Fork Creek, Fork Creek, and the Lynches River (Figure 1). Little Fork Creek flows approximately 3.7 km (2.3 mi) before discharging into Fork Creek, which flows approximately 1.2 km (0.75 mi) before entering the Lynches River. The Lynches River flows approximately 160 km (100 mi) before discharging into the Pee Dee River. Little Fork Creek and Fork Creek range from approximately 1.5 to 5 m (5 to 15 ft) in width and are approximately 0.2 to 0.6 m (0.5 to 2 ft) deep. Substrates in the creeks consist of silt, sand, gravel, and cobbles. The habitat is characterized by sand bars, gravel bars, and rocky areas. The banks are scoured and highly eroded in places. The Lynches River is approximately 9 to 12 m (30 to 40 ft) in width and ranges from approximately 0.3 to 0.9 m (1 to 3 ft) in depth, with shallow bars and deeper pools present (USEPA 2005).

The Pee Dee River basin provides spawning, nursery, and adult habitat to numerous anadromous species, such as American shad, Atlantic sturgeon, blueback herring, shortnose sturgeon, striped bass, and striped mullet, as well as the catadromous American eel (Dorsey et al. 2004). NOAA trust resources that use Little Fork Creek, Fork Creek, or the Lynches River for spawning, nursery, or adult habitat are the anadromous American shad and striped bass and the catadromous American eel (Table 1).

American shad and American eel have been documented in the Lynches River in the vicinity of the site, and American eel have been documented in Little Fork Creek (USEPA 2005). It is also possible that striped bass use habitat in the vicinity of the site (Crochet 2004; Osier

2007). No dams or other impediments block fish from entering Fork Creek near its confluence with the Lynches River, so it is likely that American shad and striped bass are also present in Fork Creek and Little Fork Creek. However, it is highly unlikely that Atlantic sturgeon, blueback herring, shortnose sturgeon, or striped mullet are found this far upstream in the system (Crochet 2004).

Recreational fishing for warm-water species such as bluegill, catfish, largemouth bass, and sunfish occurs on the Lynches Rivers and its tributaries. American eel are not targeted but may be incidentally caught in the vicinity of the site and consumed by fishers (Osier 2007). There is no commercial fishery in the vicinity of the site.

The South Carolina Department of Health and Environmental Control has issued a fish consumption advisory for the Lynches River due to mercury contamination (SCDHEC 2007). The advisory recommends that consumption of redear sunfish be limited to one meal per week and consumption of largemouth bass and chain pickerel be limited to one meal per month. The advisory recommends against consuming channel catfish or bowfin (mudfish). Little Fork Creek and Fork Creek are not included in the advisory.

Table 1. NOAA trust resources present in Little Fork Creek, Fork Creek, and the Lynches River near the Brewer Gold Mine site (Crochet 2004; USEPA 2005; Osier 2007).

Species		Habitat Use			Fisheries	
		Spawning Area	Nursery Area	Adult Habitat	Comm.	Rec.
Common Name	Scientific Name					
ANADROMOUS FISH						
American shad	<i>Alosa sapidissima</i>	◆	◆			
Striped bass	<i>Morone saxatilis</i>	◆				
CATADROMOUS FISH						
American eel	<i>Anguilla rostrata</i>			◆		◆

Site-Related Contamination

Large numbers of surface water, sediment, groundwater, and soil samples have been collected over the course of numerous environmental investigations conducted at the Brewer Gold Mine site and analyzed for metals and cyanide (Black & Veatch 2004; USEPA 2003, 2005). The primary contaminants of concern to NOAA are cyanide and selenium and metals, including arsenic, chromium, copper, lead, mercury, nickel, silver, and zinc.

Table 2 summarizes the maximum concentrations of contaminants of concern to NOAA detected during the site investigations and compares them to relevant screening guidelines. Site-specific or regionally specific screening guidelines are always included when available. In this case, the screening guidelines for sediment in a freshwater environment are the ecological screening values recommended by USEPA Region 4 (USEPA 2001) and the threshold effects concentrations (TECs; MacDonald et al. 2000). The screening guidelines for surface water, groundwater, and soil are the ecological screening values recommended by USEPA Region 4 (USEPA 2001). Exceptions to these screening guidelines, if any, are noted on Table 2. Only maximum concentrations that exceeded relevant screening

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guidelines or for which no screening guidelines are currently available, are discussed below. When known, the general sampling locations are also provided (refer to Figure 2).

Table 2. Maximum concentrations of contaminants of concern to NOAA at the Brewer Gold Mine site (USEPA 2003; Black & Veatch 2004; USEPA 2005). Contaminant values in bold exceed or are equal to screening guidelines.

Contaminant	Soil (mg/kg)			Water (µg/L)		Sediment (mg/kg)		
	Soil	USEPA Region 4 ^a	Ground-water	Surface Water	USEPA Region 4 ^b	Sediment	TEC ^c	USEPA Region 4 ^d
METALS/INORGANICS								
Arsenic	7.7	10	32	180	190	24	9.79	7.24
Chromium	8.6	0.4	22	<10	11 ^e	20	43.4	52.3
Copper	120	40	40,000	110	6.54 ^f	140	31.6	18.7
Cyanide	3.6	0.9	62	11	5.2	1.3	NA	NA
Lead	28	50	4.9	<10	1.32 ^f	35	35.8	30.2
Mercury	0.22	0.00051 ^g	10	2	0.012	0.75	0.18	0.13
Nickel	2.4	30	200	ND	87.71 ^f	6.4	22.7	15.9
Selenium	5	0.81	140	ND	5	6.4	NA	NA
Silver	1.2	2	10	ND	0.012	1.3	4.5 ^h	2
Zinc	15	50	170	36	58.91 ^f	28	121	124

a: USEPA Region 4 recommended ecological screening values for soil (USEPA 2001).

b: USEPA Region 4 recommended ecological screening values for freshwater surface water (USEPA 2001).

c: Threshold Effects Concentration (TEC). Concentration below which harmful effects are unlikely to be observed (MacDonald et al. 2000).

d: USEPA Region 4 recommended ecological screening values for sediment (USEPA 2001).

e: Screening guidelines represent concentrations for Cr.^{*6}

f: Criterion expressed as a function of total hardness; concentrations shown correspond to hardness of 50 mg/L CaCO₃.

g: Oak Ridge National Laboratory (ORNL) final preliminary remediation goals (PRG) for ecological endpoints (Efroymsen et al. 1997).

h: Freshwater upper effects threshold (UET) for bioassays. The UET represents the concentration above which adverse biological impacts would be expected.

NA: Screening guideline not available.

ND: Not detected.

Surface Water

Two metals and cyanide were detected in surface water samples collected from the Brewer Gold Mine site at maximum concentrations that exceeded the USEPA Region 4 ecological screening values (Table 2). The maximum concentrations of copper, cyanide, and lead were detected in samples collected from Little Fork Creek. The maximum concentration of mercury exceeded the USEPA Region 4 ecological screening value by two orders of magnitude; copper exceeded screening value by one order of magnitude. The maximum concentration of cyanide exceeded the USEPA Region 4 ecological screening value by a factor of approximately two. The maximum concentration of lead in surface water cannot be evaluated because the analytical detection limit exceeded the USEPA Region 4 ecological screening value.

Sediment

Four metals were detected in sediment samples collected from the Brewer Gold Mine site at maximum concentrations that exceeded screening guidelines; cyanide and selenium were also detected however no screening guidelines are currently available for comparison (Table 2). The maximum concentrations of arsenic, copper, lead, and mercury were detected in samples collected from Little Fork Creek. The maximum concentrations of copper, mercury, and arsenic exceeded the USEPA Region 4 ecological screening values by factors of approximately seven, six, and three, respectively. The maximum concentrations of copper and mercury exceeded the TECs by a factor of approximately four, while arsenic exceeded the TEC by a factor of approximately two. The maximum concentration of lead slightly exceeded the USEPA Region 4 ecological screening value and did not exceed the TEC.

The maximum concentrations of cyanide and selenium were detected in a sample collected from an intermittent ditch that drains the Pad 6 Pond to Little Fork Creek. No screening guidelines are currently available for comparison to the maximum concentrations of cyanide and selenium detected in sediment samples.

Groundwater

Seven metals and cyanide and selenium were detected in groundwater samples collected from the Brewer Gold Mine site at maximum concentrations that exceeded the USEPA Region 4 ecological screening values (Table 2). The maximum concentrations of chromium, copper, cyanide, lead, mercury, nickel, selenium, silver, and zinc were detected in samples taken from the B-6 Seep. The maximum concentration of copper exceeded the USEPA Region 4 ecological screening value by three orders of magnitude; mercury and silver exceeded the screening values by two orders of magnitude, and cyanide and selenium exceeded the screening values by one order of magnitude. The maximum concentrations of lead and zinc exceeded the USEPA Region 4 ecological screening values by factors of approximately four and nearly three, respectively. The maximum concentrations of chromium and nickel exceeded the USEPA Region 4 ecological screening values by a factor of approximately two.

Soil

Three metals and cyanide and selenium were detected in soil samples collected from the Brewer Gold Mine at maximum concentrations that exceeded screening guidelines (Table 2). The maximum concentration of selenium, which was detected in a sample taken in the vicinity of the Pad 6 Pond, exceeded the USEPA Region 4 ecological screening value by a factor of six. The maximum concentrations of chromium, copper, cyanide, and mercury were detected in samples taken from the area of the original stamp mill. The maximum concentration of mercury exceeded the Oak Ridge National Laboratory final preliminary remediation goal for soil by two orders of magnitude. The maximum concentration of chromium exceeded the USEPA Region 4 ecological screening value by one order of magnitude. The maximum concentrations of cyanide and copper exceeded the USEPA Region 4 ecological screening values by factors of four and three, respectively.

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