Missouri
Department of
Natural Resources

U.S. FISH & WILDLIFE SERVICE

PREASSESSMENT SCREEN AND DETERMINATION
Big River Mine Tailings Site, St. Francois County, Missouri
by
U.S. Fish and Wildlife Service
Missouri Department of Natural Resources

This is the Preassessment Screen (PAS) and determination for the Big River Mine Tailings (BRMT) Superfund Site, and surrounding area located in St. Francois County, Missouri. This document has been prepared by the Missouri Department of Natural Resources (MDNR) and the U.S. Department of the Interior (DOI) who are Trustees for natural resources at the Big River Mine Tailings Superfund Site (collectively referred to hereinafter as "Trustees") in accordance with Natural Resource Damage Assessment (NRDA) procedures. 43 C.F.R. Part 11.

I. AUTHORITY

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as amended, 42 U.S.C. § 9601 *et seq.*, the Oil Pollution Act of 1990 (OPA), 33 U.S.C. § 2701 *et seq.*, and the Federal Water Pollution Control Act (FWPCA), as amended, 33 U.S.C. § 1251 *et seq.*, authorize the United States, States and Indian tribes to recover damages for injuries to natural resources and their supporting ecosystems, belonging to, managed by, appertaining to, or otherwise controlled by them.

In accordance with 42 U.S.C. § 9607(f)(2)(B) and the National Contingency Plan, 40 C.F.R. § 300.600 (NCP), the Director of the MDNR has been designated the natural resource trustee by the Governor of Missouri. The MDNR acts on behalf of the public as Trustee for natural resources, including their supporting ecosystems, within the boundary of Missouri or belonging to, managed by, appertaining to, or otherwise controlled by Missouri.

The U.S. Fish and Wildlife Service (Service) is acting on behalf of the Secretary of the Interior as trustee for natural resources. The President has designated the Secretary of the Department of the Interior to act on behalf of the public as trustee for natural resources and their supporting ecosystems, managed or otherwise controlled by the DOI. Executive Order 12580, Section 1(c), January 23, 1987; 40 C.F.R. § 300.600. The official authorized to act on behalf of the Secretary at the Big River Mine Tailings Superfund Site and surrounding area is the Regional Director for Region 3 of the U.S. Fish and Wildlife Service.

PURPOSE

The purpose of this PAS is to provide a review of readily available information on discharges or releases of hazardous substances and the potential resulting impacts on natural resources at the Big River Mine Tailings Superfund Site and surrounding area for which the DOI and/or MDNR may assert trusteeship under section 107(f) of CERCLA.

Federal regulations at 43 CFR § 11.23(a) provide for the Trustees to complete a PAS and make a determination as to whether there is a reasonable probability of making a successful claim for natural resource damages before additional assessment efforts are undertaken. This document fulfills that requirement and follows the structure of Federal Regulations at 43 CFR Part 11. These regulations provide a method for the assessment of natural resource damages resulting from releases of hazardous substances under CERCLA. Adherence to the methods set forth in these regulations is not mandatory and does not preclude the Trustees' use of alternate methods of assessing damages or arriving at a negotiated settlement with potentially responsible parties.

II. SITE INFORMATION

The BRMT Superfund Site is located within the Old Lead Belt Mining District of Southeast Missouri which occurs on the eastern edge of the Ozark Uplift in Missouri. Topography in the Old Lead Belt is characterized by rolling hills dissected by narrow floodplain, creek, and river valleys. Hills and ridges are generally steep sided with flat tops consisting of thin mantles of clayey soils. The major physical features of the area are the St. Francois Mountains in the south, the dissected topography of the Salem Plateau in the northern portion, and the Farmington Plain in the eastern section (USEPA, 1993). The principal drainage system for St. Francois County is the north flowing Big River and its tributaries. The south flowing St. Francois River and its tributaries comprise a second drainage system within St. Francois County. Due to local geology, tributaries to the abovementioned drainages frequently gain or lose flow through bedrock and can be intermittent or perennial (Fluor Daniel, 1995).

This PAS addresses all six of the major mine sites in the Big River Mine Tailings Superfund Site including Bonne Terre, Desloge, Elvins (Rivermines), Federal/St. Joe State Park, Leadwood, and National (Flat River) as well as waterbodies within the Superfund Site, Shaw Branch, Flat River Creek and the Big River. To a lesser degree, this PAS will discuss the smaller operations at Doe Run and Hayden Creek. The Trustees believe that there may be injuries to natural resources outside of St. Francois County, Missouri resulting from releases within the BRMT Superfund Site. This PAS will also address those injuries outside of the St. Francois County within the Big River floodplain in Washington and Jefferson Counties. For purposes of the PAS, this entire geographic area is referred to as "BRMT site."

1) Time, quantity, duration and frequency of the discharge or release

The Trustees reviewed relevant information which indicates that hazardous substances have been discharged, allowed to escape, disposed or otherwise released into BRMT. The BRMT site covers an area of approximately 110 square miles. Lead (Pb) was first discovered in the area in the early 1700's. Until the 1860's, mining in the Old Lead Belt was restricted to shallow workings and pits. The early, primitive mining resulted in small quantities of comparatively highly contaminated mine wastes. In 1864, the St. Joseph Lead Company bought 964 acres and initiated mining in Bonne Terre, Missouri. The introduction of the diamond-bit core drill in 1869 led to the discovery of numerous Pb-

rich ore deposits under what became the towns of Bonne Terre, Desloge, Flat River, Leadwood, and Elvins. As many as fifteen companies were engaged in mining these deposits in the late 1800's and early 1900's (McHenry, 2006).

By 1933, the St. Joseph Lead Company had acquired all of the properties in the area, including the Federal Mine and Mill. The St. Joe Lead Company, whose direct descendant is The Doe Run Company, operated the Bonne Terre mine from 1864 to 1961, the Desloge Mine from 1929 to 1958, the Federal Mine from 1923 to 1972, and the Leadwood Mine from 1915 to 1962 (McHenry, 2006). Mining activities commenced near the Rivermines site in 1890 and ceased in 1940 (Barr, 2002). The National (Flat River) Mine operated continuously from 1898 to 1933. Mining activities in the Old Lead Belt of St. Francois County decreased through the 1950's and 1960's as ore bodies were depleted and higher grade ores were discovered in the Viburnum Trend of Crawford, Iron, and Reynolds Counties. The Federal Mine and Mill were the last to close in St. Francois County in 1972 (EPA, 1993). The U.S. Environmental Protection Agency (USEPA) listed the BRMT Superfund Site on the National Priorities List (NPL) in 1992.

There exist over 2,800 acres of chat[1], tailings[2], vegetated chat and transition zone soils contaminated primarily with Pb in and around the six (6) major piles of the BRMT site. The number of impacted acres is based on a review of topographical maps and aerial photography. Soils contaminated by runoff from tailings, chat, and vegetated chat represent a transition area around the piles. The transition zone soils vary in width from 50 to 2,800 feet from the piles (USEPA, 2006).

The quantity of the chat in the six major piles of the BRMT site was estimated in 1954:

National	9,000,000 tons
Leadwood	3,500,000 tons
Desloge	3,500,000 tons
Federal	3,500,000 tons
Rivermines	6,600,000 tons
Bonne Terre	3,600,000 tons

These estimates are solely for the chat piles and do not reflect the quantity of material discharged to tailings impoundments (McHenry, 2006). The tailings impoundments in the BRMT site account for millions of tons of additional material beyond those listed above. Most of the mountainous piles of material in St. Francois County are composed of chat, whereas the tailings at the various sites are retained behind berms and dams, most notably in the valley-fill manner seen at St. Joe State Park. Newfields "Focused Remedial Investigation for Mined Areas in St. Francois County", (2006) provides a more recent volume estimate of chat and tailings still in place at the site:

[1] Chat is the waste product of early gravity based milling processes and consists of grain sized particles typically 0.06 to 2.4 mm in diameter (EPA, 2006).
[2] Tailings are the waste product of a chemical floatation process that produces particles 0.004 to 0.06 mm in diameter (USEPA, 2006).

Table 1. Tailings and Chat Distribution in the BRMT Site

Site	Estimated Tailings Acreage	Estimated Chat Acreage	Estimated Volume (cy)
Desloge [1]	275	95	6,500,000
National [1]	108	44	6,400,000
Leadwood [1]	528	35	5,100,000
Elvins/Rivermines[1]	77	72	10,400,000
Bonne Terre [1]	306	39	5,700,000
Federal [1,2]	1130	32	5,200,000
Doe Run [1]	0	9	NA
Hayden Creek [1]	8	0	NA

Source: [1] (Newfields, 2006), [2] (USFWS and MDNR, 2007)

Due to the construction of the mines and mills in riparian or near riparian areas and the constant discharge of waste products from uncontrolled piles, releases from mine waste areas have been continuing since mining activities began in the 18th century. The largest releases were initiated with the advent of industrial scale milling in the late 19th century. As described earlier, the first mills relied upon crushing and gravity to separate Pb from its host rock, whereas the milling process after 1930 employed crushing and various chemical floatation techniques, resulting in massive quantities of tailings or "slime" (McHenry, 2006). Additionally, the St. Joseph Lead Company re-milled many of the existing chat piles following the introduction of floatation technology to recover Pb that was previously discarded in chat piles. Floatation milling techniques were employed at all 6 of the major BRMT site locations, thus fine grained tailings are also found at these locations (USFWS, 2008).

Additionally, unknown, but tremendous amounts of the original chat piles in place prior to the advent of floatation milling were hauled away from the BRMT site to be used as railroad and highway ballast, agricultural lime, substrate for concrete and asphalt, and other uses. The Federal Mine chat pile, which was located directly north of the Federal Mill Number 3 (currently Missouri Mines State Historic Site), has been hauled away in its entirety. Thus, contaminated material was spread throughout the region and is known to have been shipped as far away as Texas (McHenry, 2006).

Due to the steep angle of repose of chat, releases from chat piles have been occurring since the day the material was deposited. Similarly, releases from the tailings impoundments are a common occurrence in the area, as dams built to retain the material were often hastily constructed of tailings, chat, development rock, and other mine wastes. Davis Creek, now known as Shaw Branch, was impounded in 1947 to create an additional tailings storage area at the Federal Mill Number 3. Shortly thereafter, the dam failed, releasing thousands of tons of tailings into Davis Creek, Flat River Creek, and eventually the Big River (Medine, 2007). According to Swenty, "an estimated 390,000 cubic yards of tailings had been eroded from the impoundment since the commencement of operations" (Swenty 1995, as cited in NewFields 2006), and "there are an estimated 10,000 to 30,000 cubic yards of tailings in Shaw Branch in the reach between the reconstructed dams and the confluence with Flat River Creek." The single largest

documented release of mining waste occurred in 1977 at the Desloge tailings pile. During a severe storm, an estimated 50,000 to 75,000 cubic yards of tailings were released directly into the Big River (USEPA, 2006). Tailings from this release and others can be observed in the Big River for most of its 93 mile course below the Leadwood Site to the confluence with the Meramec River in Jefferson County.

Incremental releases continue to occur to terrestrial and aquatic environs on a regular basis due to the forces of water and wind erosion as well as human disturbance of the chat and tailings disposal areas. Permitted and unpermitted off-road vehicle use on the piles and impoundments has destroyed the minimal existing vegetation, aggravating erosion at some sites.

2) The hazardous substances released

Much of the mine and mill waste is highly contaminated with hazardous substances, including cadmium (CAS # 7440439), lead (CAS # 7439921) and zinc (CAS # 7440666). These compounds or mixtures have been identified under CERCLA §101 (14) as hazardous substances (40 CFR §302, Table 302.4). Pb is by far the most common contaminant of concern in the St. Francois County sites. (EPA 2006).

3) History of the current and past use of the Site

The current and past land uses in the county are un-impacted natural land, mining-related, urban, arable agriculture (mainly wheat, sorghum, corn, soybeans, and hay) as well as cattle grazing. Pb and Zn mining began in St. Francois County in the early-18th century and reached peak production during the Second World War. The depletion of major ore bodies and the discovery of new, richer deposits in the Viburnum Trend led to the closure of the mining industry in St. Francois County in 1972. While many millions of tons of mine waste have been removed from the Big River Mine Tailings Superfund Site to provide fill, serve as aggregate for buildings and roads, and for agricultural lime, thousands of acres of contaminated wastes still remain on the surface (USEPA, 2007).

4) Relevant operations occurring at or near the Site

Early mining operations in St. Francois County were principally surface mines. The surface deposits of Pb lay in veins of pure ore and were hand dug to depths of up to 40 feet. Following the introduction of the diamond bit core drill in 1869, underground mining of massive ore bodies began near Bonne Terre, Missouri. In general, the raw ore was brought to the surface and crushed in stages with the metals being separated by gravity separation or chemical flotation. Waste rock, development rock, chat, and tailings materials were usually dumped on the surface in waste piles or impoundments. Many wastes were re-milled as more efficient separation techniques became available.

5) Additional hazardous substances potentially released from the BRMT site

Other hazardous substances potentially released from the BRMT Superfund Site include copper (CAS # 7440-50-8), nickel (CAS # 7440-02-0), barium (CAS # 7440-39-3), and cobalt (CAS#7440-48-4).

6) Potentially Responsible Parties

The Potentially Responsible Parties at this site include, but are not limited to, National Lead Inc., The Doe Run Resources Company d/b/a The Doe Run Company, and the Missouri Department of Natural Resources, Division of State Parks.[3] Through agreements with EPA, the Doe Run Resources Company has participated in removal activities at the BRMT Superfund Site.

III. NO STATUTORY EXCLUSIONS FROM LIABILITY UNDER CERCLA APPLY AT THIS SITE

Injuries to natural resources and damages resulting from the discharge or release of the hazardous substances at the BRMT site were not identified in any environmental impact statement, pursuant to the National Environmental Policy Act (NEPA), as amended (42 U.S.C. 4321 et seq.), or any similar review or document.

The release or discharge of the hazardous substances at the BRMT site are ongoing and did not occur wholly before enactment of CERCLA, nor the 1977 amendments to the FWPCA. Injuries to natural resources and damages to the public from the release or discharge of the hazardous substances are ongoing and did not occur wholly before enactment of CERCLA, nor the 1977 amendments to the FWPCA.

The hazardous substances at the BRMT site are not pesticide products registered under the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA), as amended (7 U.S.C. 135-135k). Injuries to natural resources and damages resulting from the discharge or release of the hazardous substances at the Big River Mine Tailings Superfund Site did not result from the application of a FIFRA registered pesticide product.

Injuries to natural resources and damages resulting from the discharge or release of the hazardous substances at the BRMT site did not result from any federally permitted release as defined in CERCLA §101 (10).

The hazardous substances are not recycled oil products as described in CERCLA §107(a)(3) or (4). Injuries to natural resources and damages resulting from the discharge or release of the hazardous substances at the BRMT site did not result from release of a recycled oil product.

No exclusion from damages is applicable to this site, pursuant to the CERCLA and FWPCA.

[3] ASARCO, LLC is also a potentially responsible party at the BRMT site; however ASARCO LLC filed for bankruptcy on August 9, 2005. The Trustees filed a Proof of Claim in the bankruptcy proceedings for natural resource damages within the BRMT site where ASARCO LLC had owner/operator liability.

IV. PRELIMINARY IDENTIFICATION OF RESOURCES POTENTIALLY AT RISK

1) Preliminary identification of pathways

Surficial mine and mill wastes, soils, and surface water all act as sources of hazardous substances (including Pb, Zn, and Cd) to the environment at the BRMT Superfund Site. Hazardous substances can be released directly from these sources into the air, surface water, groundwater, and soils. Additionally, air can entrain and transport metals as it flows over fugitive dust sources such as chat piles and tailings impoundments.

Surface water can receive hazardous substances directly from erosion of various types of mine waste during runoff. Direct exposure to suspended and dissolved metals can occur to aquatic organisms dwelling in the water column. Stream sediment is habitat for a wide-variety of benthic invertebrates and fish. Contaminated sediment provides exposure through incidental ingestion and by increasing metal concentrations in the pore water of the sediment. Contaminated pore-water is a direct exposure pathway through the gills of aquatic organisms.

Rain water percolating through the mine waste piles can leach hazardous substances into the soil beneath the waste pile. Groundwater can also be affected as it flows through underground mine workings and comes into contact with exposed ore bodies. Groundwater contamination may be of limited scope at the BRMT site due to the high pH of the ore's dolomitic host rock. Additionally, groundwater can be injured from contaminated losing streams within the watershed.

Air, surface water, groundwater, and soils may receive hazardous substances not only directly from the sources, but also from each other. Air can transport hazardous substances and deposit them directly into surface water or onto soils. Hazardous substances can also move back and forth between ground and surface water through discharge and recharge.

Terrestrial and aquatic biota may be exposed to contaminants in environmental media either directly (for example, plants exposed directly to hazardous substances in soils) or indirectly through food chain transfer. For example, contaminated soils may provide an exposure pathway to heavy metals contamination for migratory birds. Depending upon the species, migratory birds will feed on terrestrial seeds and berries, soil invertebrates, fish, aquatic invertebrates, or aquatic plants (Galbraith, 2007).

An Ecological Risk Assessment (ERA) completed by the USEPA in 2006 found adverse impacts to terrestrial and aquatic habitat from mining activities throughout the BRMT Superfund Site. The ERA specifically identified contaminated sediments in the Big River from Leadwood Site to the confluence with the Mineral Fork in Jefferson County as posing a significant risk to aquatic communities. The ERA also identified the Flat River Creek downstream from Bannister Branch to the confluence of the Big River as

having contaminated sediments that posed a significant threat to aquatic communities. Significant levels of Pb, Cd, and Zn contamination in soils were shown to exist site wide, with soil on or near the piles posing the greatest risk to terrestrial vermivores (USEPA, 2006).

2) Exposed Areas

Areas exposed to the released hazardous substances include the waters, wetlands, stream banks, sediments, soil and biota of the BRMT site. Over 2,800 acres of contaminated mill waste and soil provides an exposure pathway for wildlife. In addition, areas downstream of the Big River Mine Tailings Superfund Site are impacted from releases of hazardous substances attributable to the mining operations within the Superfund Site.

3) Exposed Water Estimates

The principal drainage system for Big River Mine Tailings Superfund Site is the Big River and its tributaries. Based on recent sampling conducted by the Service in June and December 2007, the Big River contains at least 75 miles of contaminated sediment which exceeds the Probable Effect Concentration (PEC). Over 95 miles of sediment in the Big River exceeds the Threshold Effect Concentration (TEC). In addition, approximately one mile of Shaw Branch and 4 miles of Flat River Creek contain contaminated sediment originating from the Federal Mill #3 tailings impoundment at St. Joe State Park (USFWS, 2007).

4) Estimates of Concentrations

a. Chat, Tailings, and Soil

Samples of transition zone soils collected throughout the BRMT site by the EPA in 2006 had maximum Cd, Pb, and Zn concentrations of 18 mg/kg, 1,540 mg/kg, and 1,640 mg/kg, respectively. Concentrations of Pb and Zn were found to exceed ecotoxicity screening values (ESVs) for 100 percent of the soil samples collected around the Desloge, Elvins, Leadwood, and National Piles. The ESVs for soils are EPA's Ecological Soil Screening Levels (Eco SSLs) and are summarized in Table 2 below. All samples exceed the screening levels except that minimum concentrations reported at the sampling sites do not exceed Eco SSLs established for soil invertebrates.

Table 2: USEPA's Ecological Soil Screening Levels (mg/kg)

Cadmium			
Plants	**Soil Invertebrates**	**Wildlife**	
		Avian	**Mammalian**
32	140	0.77	0.36
Lead			
Plants	**Soil Invertebrates**	**Wildlife**	
		Avian	**Mammalian**
110	1,700	11	56

Zinc			
Plants	**Soil Invertebrates**	**Wildlife**	
		Avian	**Mammalian**
50	100	46	79

Source: USEPA, 2006.

Concentrations of source material (chat and tailings) from the BRMT site vary widely by location and readily available concentration information is summarized below in Table 3.

Table 3. Cadmium, Lead, and Zinc in BRMT Site Mill Wastes

Site	Number of Samples	Minimum mg/kg	Maximum mg/kg	Average
Lead				
All Sites	531	349	17,000	2,818
Leadwood	108	597	17,000	2,382
Desloge	74	826	6,200	2,105
National	96	1,100	9,283	3,661
Elvins/Rivermines	92	851	11,600	4,440
Bonne Terre	88	660	7,610	2,945
Federal	69	349	4,638	885
Cadmium				
All Sites	526	0.88	1,870	77
Leadwood	107	9.3	1,870	250
Desloge	74	6.8	78.6	26.3
National	96	2.0	87.0	7.9
Elvins/Rivermines	92	19.8	202	105
Bonne Terre	88	3.0	29.5	12.0
Federal	69	0.88	18.2	6.5
Zinc				
All Sites	531	34	25,800	2,285
Leadwood	107	400	25,800	4,691
Desloge	74	233	3,990	1,243
National	96	34	5,055	417
Elvins/Rivermines	93	108	11,900	5,541
Bonne Terre	88	51	1,470	457

Federal	69	43	1,057	293

Source: (Newfields, 2006)

b. Sediment

Sediment samples collected in 2007 by the Service in the Big River and its tributaries exceeded the MacDonald Consensus-Based Sediment Quality Guidelines TEC and/or PEC for Pb and/or Zn for approximately 75 miles from the Leadwood Site to the confluence with the Meramec River in Jefferson County. MacDonald et al (2000) identified consensus-based PECs for sediment of 128, 459, and 4.98 mg/kg for Pb, Zn and Cd, respectively. The maximum concentrations found in the Big River by the Service were 927 mg/kg Pb at Highway K and 952 mg/kg Zn at Highway 67 in St. Francois County. Sediment samples collected by the USEPA in 2006 had maximum concentrations of Cd at 227 mg/kg, Pb at 6,259 mg/kg, and Zn at 6,259 mg/kg. The USEPA found the highest concentrations of Cd and Pb in sediment at the Desloge pile and the highest concentrations of Zn in Flat River Creek near the Elvins chat pile and the Federal tailings pile (USEPA, 2006).

c. Surface Water

The most recent surface water sampling from the Big River and its tributaries was conducted by the USEPA in 2006. Maximum concentrations of Pb (52 µg/l) in Flat River Creek at the National pile and Zn (575 µg/L) in Flat River Creek above the Shaw Branch exceeded the chronic National Ambient Water Quality Criteria (NAWQC) for Pb (2.5 µg/l) and Zn (120 µg/l) respectively. No surface water samples exceeded the Cd NAWQC (0.00025 µg/l) at any sampling sites. Lead concentrations exceeded the screening value in 94 percent of the samples analyzed, and Zn concentrations exceeded the screening value in 31 percent of samples analyzed. USEPA concluded that Pb contamination in surface water is, "widespread and likely to be a source of chronic stress on aquatic communities throughout the site" (USEPA, 2006).

Additionally, the MDNR listed 93 miles of the Big River and 5 miles of Flat River Creek, a tributary of the Big River that flows through mine impacted areas, on the state's list of impaired waters (Section 303(d) of the Clean Water Act). Ninety-three miles of the Big River, from Leadwood Site to the confluence with the Meramec River, are listed because of dissolved Pb and non-volatile suspended solids (NVSS). Five miles of Flat River Creek, from the Elvins/Rivermines pile to the confluence with the Big River, are listed because of dissolved Pb, dissolved Zn, and NVSS. In listing the above segments, the MDNR calculated a hardness value for the Big River watershed at the 25th percentile of 262 hardness records taken within the basin, or 200 mg/L. Using 200 mg/L hardness, the following impairment criteria were calculated:

Lead: 136 and 5 µg/L for acute and chronic respectively.
Zinc: 211 and 193 µg/L for acute and chronic respectively.

The Missouri standards for NVSS are found in the general criteria section of the Water Quality Standards, 10 CSR 20-7.031(3)(A), (C) and (G) and states:

> -Waters shall be free from substances in sufficient amounts to cause the formation of putrescent, unsightly or harmful bottom deposits or prevent full maintenance of beneficial uses.
> -Waters shall be free from substances in sufficient amounts to cause unsightly color or turbidity, offensive odor or prevent full maintenance of beneficial uses.
> -Waters shall be free from physical, chemical or hydrologic changes that would impair the natural biological community. (MDNR, 2007)

Thus, 93 miles of the Big River and 5 miles of Flat River Creek exceed either the acute or chronic criteria for Pb, Zn, as well as the qualitative standards for impairment from NVSS.

Similarly, 93 miles of the Big River and 6 miles of Flat River Creek remain on the 2007 Missouri Department of Health and Senior Services (DHSS) Fish Consumption Advisory list. The advisory warns against the consumption of any amount of sunfish, carp, redhorse and all other sucker species in the Big River and Flat River Creek by any person due to high concentrations of Pb found in the tissue, organs, bone, and skin of the fish (DHSS, 2007). Similar advisories for these two waterways have been issued continuously by the DHSS since 1985, representing a significant and ongoing loss of natural resource and recreational services to the surrounding communities.

d. Potentially Affected Resources

Natural resources and their supporting ecosystems that have been or potentially have been affected by the release of hazardous substances, include but are not limited to terrestrial environments; surface water, sediments, and biological resources including aquatic and terrestrial plants and microorganisms; aquatic and aquatic dependent mammals; fish; aquatic invertebrates; terrestrial invertebrates; and migratory birds including waterfowl, shorebirds, raptors and songbirds.

Site response investigations have documented severe impacts to terrestrial environments. Concentrations of Cd, Pb, and Zn at un-vegetated and partially vegetated mine wastes are on average one to three orders of magnitude greater than background soil concentrations. Soils within 1000 feet of mine waste piles contain Cd, Pb, and Zn concentrations that are on average one order of magnitude greater than background soils with maximum concentrations up to three orders of magnitude greater than background (USEPA, 2006). Concentrations of hazardous substances including Cd, Pb, and Zn in and adjacent to mine wastes greatly exceed the national and state average soil concentrations and concentrations known to be toxic to individual plant species (Kabata-Pendias and Pendias, 1992).

Plant communities in the Big River Mine Tailings Superfund Site have been highly modified to the extent that they now provide limited wildlife habitat. The phytotoxic effects of hazardous substances in mine wastes may be responsible for some or all of the observed injuries to the vegetative communities. Kaputska (2007) determined that Cd, Pb, and Zn occurred at concentrations that are toxic to plants within the BRMT site. Kaputska developed a set of lower and upper threshold values for phytotoxic response to the three metals of concern, as detailed below.

Table 4. Phytotoxicity Threshold Values (mg/kg dry weight soil)

Element	Lower Threshold	Upper Threshold
Cadmium	3	100
Lead	100	1,000
Zinc	70	500

Source: Kaputska, 2007.

When compared to the average concentrations of metals found at the site (Table 2), the phytotoxicity thresholds established by Kaputska have clearly been exceeded, often by an order of magnitude. Kaputska indicated that the decreased fitness of plants exhibited at BRMT site may partially be the result of decreased soil microbial function. Soil microbes, which are responsible for the production, maintenance and cycling of fertile soil, are most likely impaired by the concentrations of metals found at the BRMT site.

Surface water represents another injured natural resource. Surface waters provide habitat for aquatic species such as aquatic insects and fish, supports non-aquatic organisms such as birds and mammals by providing habitat for prey species, vegetation used for food and nesting materials, and resting locations along migratory routes. Injury to surface water is determined by exceedences of applicable water quality criteria, 43 CFR 11.62 (b)(1)(iii), and as discussed in the previous section, "Surface Water."

Perhaps the most critical and widespread injury attributable to the dissemination of mine wastes from the BRMT site is the injury to the aquatic environment via sediments in the Big River and its tributaries. As stated by Donlan:

> The most ubiquitous and constant route of exposure of aquatic resources to metals in the Big River is through sediment. Because of the propensity of metals to adsorb to particles, the slow movement of sediment through the aquatic system, and the fact that metals do not readily degrade, contaminants such as Cd, Pb, and Zn have a long residence time in riverine sediments. (Donlan, 2007)

In addition to high concentrations of metals contaminating the sediments in the Big River watershed, studies have shown that the metals are generally bioavailable. For example mussel, fish and clam tissues collected from the watersheds have accumulated high levels of metals in their system. Further, the watershed is not a carbon-rich ecosystem and the acid volatile sulfide (AVS) is low, both facts support the finding that the metals are bioavailable (Schmitt, 1987, and 2007).

The Missouri Trustees selected a sediment quality guideline to apply to sediment concentration data collected in the Big River watershed to determine injury. Published scientific literature on sediment quality guidelines (SQGs) has developed and verified methodologies by which contaminant concentrations can be used to reliably predict toxicity. In other words, the SQG allows the Missouri Trustees to determine whether sediments sampled downstream from the Big River mining sites have high enough concentrations of at least one of the three contaminants of concern to be toxic.

The sediment quality guideline the Missouri Trustees selected for injury determination is the consensus-based Probable Effect Concentrations for freshwater sediment developed by MacDonald, et al (2000). The Probable Effect Concentrations represent concentrations of contaminants above which adverse effects on sediment-dwelling organisms are expected to occur frequently. Threshold Effect Concentrations represent concentrations of contaminants in sediment below which adverse effects on sediment-dwelling organisms are expected to occur infrequently. The TEC and PEC values for cadmium, lead and zinc appear below, in Table 2.

Table 5: TEC and PEC Values for Cd, Pb and Zn

Contaminant	TEC Value ppm	PEC Value ppm
Cadmium	0.99	4.98
Lead	35.8	128
Zinc	121	459

The Missouri Trustees determined that injury to aquatic resources occurs when the metal concentration in a sample exceeds a single PEC for a single contaminant. Although the Big River watershed is not a high carbon ecosystems, to be conservative the Missouri Trustees accounted for the impact carbon has on the bioavailability of metals in their injury determination by normalizing the sample concentration data to 1% total organic carbon.

The Missouri Trustees' injury threshold is supported by studies applying two other PEC-based SQGs to predict toxicity in sediments. The first PEC-based SQG is the mean metal PEC-Q which is calculated on a site-specific basis following a methodology developed by the EPA (2000). The mean PEC-Q for metals enables an analysis of the combined effects of multiple contaminants, i.e., cadmium, lead and zinc in sediments. The other SQG is the maximum metal PEC-Q, which uses the calculated PEC-Q value for one or two contaminants to predict whether the contamination is toxic at a certain level. Both the mean PEC-Q and the maximum metal PEC-Q, normalized to 1% Total Organic Carbon (TOC@1%) at > 1.0 predicted an incidence of toxicity at 72% and 65% respectively. Therefore, injury to aquatic trust resources occurs at a mean PEC-$Q_{TOC@1\%}$

>1.0 and maximum metal PEC-$Q_{TOC@1\%}$>1.0.[4] (See generally, C. Ingersoll Expert Report).

Table 6: Sediment concentrations at which injury to aquatic community occurs in the Big River watershed

SQG	Value at which injury occurs	Source
PEC	Cadmium: 4.98 Lead: 128 Zinc: 459	MacDonald, 2000
Mean PEC-$Q_{TOC@1\%}$	>1.0	Ingersoll, 2007, Fig. 4 and Table 8
Maximum PEC-$Q_{TOC@1\%}$	>1.0	Ingersoll , 2007, Fig. 5 and Table 9

As discussed in the "Estimates of Concentrations" section, injuries to aquatic resources from contaminated sediments remain widespread from the Big River at Leadwood Site to its confluence with the Meramec River. The USEPA 2006 Ecological Risk Assessment found concentrations of Cd above the PEC at 57% of its sediment sample sites; Pb above the PEC at 87% of sites; and Zn above the PEC at 42% of sample collection areas throughout the site. Every sediment sample collection site on Flat River Creek and all but two (2) on the Big River exceeded the PEC for Pb (USEPA, 2006).

Contaminated sediment and surface water in the Big River potentially impact aquatic species through direct exposure from water or ingestion of contaminated prey, which have themselves ingested site-related metals. Two federally listed endangered mussel species, the Pink Mucket *(Lampsilis orbiculata)* and Scaleshell *(Leptodea leptodon)* can still be found in the extreme lower reaches of the Big River. These species are in direct contact with contaminated sediment which exceeds the PEC for Pb, and are therefore at great risk of extirpation from the Big River watershed (Angelo, 2007). The Service found a negative correlation between population and diversity of mussels and sediment metal concentrations in the Big River (USFWS, 2007). Additionally, the Crystal Darter (*Ammocrypta asprella*), a state listed endangered fish species resides in the Big River.

According to Schmitt et al. (1987), "tailings constitute a significant percentage of the bottom sediments [in the Big River] as far as 100 km downstream from the mining district, and Pb and Cd concentrations in the biota are higher there than in upstream areas." Schmitt et al.found that Pb concentrations in the sediment were approximately 40 mg/kg at Irondale (above the influence of the mines), rose to roughly 2500 mg/kg within

[4] The mechanistically-based simultaneously extracted metals-acid volatile sulfide is another methodology used to predict toxicity in sediments. (EPA 2005). A $\sum$SEM-AVS/foc > 130 µmole/foc is equally predictive of toxicity in sediments as a mean PEC-$Q_{TOC@1\%}$ >1.0 and maximum metal PEC-$Q_{TOC@1\%}$>1.0.

the mining district, and then decreased with distance downstream from the district. Accordingly, Cd levels were less than 2.0 mg/kg at Irondale, rose to about 40 mg/kg within the mining district, and then declined with distance downstream. Additionally, Schmitt et al. tracked levels of Cd and Pb in transplanted Pocketbook (*Lampsilis cardium)* mussels over an 8 week exposure period at five sites in the Big River. No changes in tissue contaminant levels were observed at the upstream reference site (Irondale), whereas contaminant levels at four downstream locations increased in a log-linear manner over the course of the experiment. Final concentrations of Cd and Pb in the transplanted mussels closely paralleled the concentrations measured in locally obtained sediment samples. (Schmitt, 2007) Accordingly, if tissue concentrations in transplanted mussels closely track in stream sediment concentrations, then the metals of concern must be directly bioavailable for uptake and absorption by aquatic fauna.

Macroinvertebrate communities in the Big River and its tributaries have also been adversely impacted by contaminants from the BRMT site. Taxa richness (a measure of the distinctly different taxa within a sample) was calculated for each sample (total number of taxonomic groups). Unimpacted waters tend to have greater diversity (greater richness) without dominant taxa. In the Big River taxa richness was 42 percent less than at the background location, and in the Flat River taxa richness was reduced by 50 percent (USEPA, 2006).

Freshwater fish communities have been severely impacted by the release of contaminants from the BRMT site. In 2001, Gale *et al.* found whole body pelagic fish in the Big River and Flat River Creek to contain an average of 0.27 mg/kg Cd, 14.70 mg/kg Pb, and 52.17 mg/kg Zn. In an earlier study, average Pb concentration of fish in the Big River downstream of the confluence with Flat River Creek was 94.5 mg/kg whole body wet weight, and in background areas, concentrations in suckers range from 0.4 to 0.8 ppm whole body wet weight (Lowe et al., 1985). Additionally, Schmitt (2007) reviewed numerous studies from 1980, 1981, 1989, 2001, and 2005 that showed the activity of the enzyme δ (delta)-aminolevulinic acid dehydratase (ALA-D), an enzyme involved in heme synthesis, was reduced by more than 50%, and decreased as blood Pb concentrations increased at sampling locations on the Big River, downstream from Leadwood. Thus, numerous studies have demonstrated that lead is accumulated by fish; that it is biochemically active, and that it has elicited an adverse biochemical response specific to lead (Schmitt, 2007).

V. Other Considerations: ASARCO LLC Bankruptcy

The Trustees filed a claim for natural resources damages for parts of the BRMT site, including the Federal Mine, Flat River Creek, and Big River. Based on the analysis performed for the ASARCO bankruptcy, the natural resources damages for BRMT site exceed the reasonable costs of assessment.

VI. PRE-ASSESSMENT SCREEN DETERMINATION

Based upon a review of readily available data and an evaluation of the preassessment determination criteria, summarized in this document, the Trustees have reached the following conclusions with regard to the BRMT site:

1. Discharges or releases of hazardous substances have occurred;
2. Natural resources for which the Trustees may assert trusteeship under CERCLA and FWPCA have been adversely affected by the discharge or release of hazardous substances;
3. The quantity and concentration of the released hazardous substances are sufficient to potentially cause injury to natural resources;
4. Data sufficient to pursue an assessment are readily available or likely to be obtained at a reasonable cost; and
5. Response actions planned will not sufficiently restore, replace, or provide compensation for injured natural resources without further action.

The Trustees hereby determine that further investigation and assessment is warranted and should be carried out at this site in accordance with Federal Regulations at 43 C.F.R. §11, Subparts C and E. The Trustees further determine that current information indicates that there is a reasonable probability of making a successful natural resources damage claim pursuant to section 107 of the CERCLA and section 311 of the FWPCA and that all criteria and requirements in 43 CFR Part 11, generally, and 43 CFR 11.23(a)-(g), §11.24 and § 11.25, specifically, have been satisfied.

The information provided and conclusions made in this Preassessment Screen shall be used to direct further investigations and assessments and is not intended to preclude consideration of other resources later found to be affected or other parties found to be responsible for releases.

This Preassessment Screen may be executed in counterparts. A copy with all original executed signature pages affixed shall constitute the Preassessment Screen. The date of execution shall be the date of the final Trustee signature.

<SIGNATURE PAGES FOLLOW>

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