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DIXIE CAVERN LANDFILL SUPERFUND SITE

SUPPORTING DOCUMENTATION FOR FLYASH REMEDIATION PROPOSED PLAN

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Potential Health Risks Associated with Exposure to the Fly Ash Pile

Chemicals of Potential Concern: Table 1 presents the concentrations of cadmium, chromium, lead, nickel, and zinc detected in four samples collected from the Fly Ash Pile. The concentrations of these metals were elevated, particularly for cadmium, lead, and zinc. Lead and zinc comprise the largest fraction of the fly ash, 5 and 20 percent, respectively. The other trace metals (i.e., cadmium, chromium, and nickel) comprise 1 percent, or less, of the fly ash. As shown in Table 1, inorganic contamination in the Fly Ash Pile appeared to be fairly homogeneous. Lead in the fly ash appeared to be the primary chemical of concern. Thus, the potential health risks associated with exposure to fly ash will focus on the potential impacts associated with exposure to lead. Such an evaluation is sufficient for demonstrating a need for remediation of the Fly Ash Pile. Other inorganics detected in the fly ash also may be of concern to human health including exposure to cadmium, chromium, nickel, and zinc.

Exposure Assessment: Children who trespass at the site may come in direct contact with contaminated fly ash. The exposure route of primary concern is incidental ingestion of fly ash while playing. Dermal absorption of inorganics bound in the fly ash matrix is considered negligible. Inhalation of wind-borne dust from the Fly Ash Pile also may be of concern to public health, but appears insignificant relative to direct ingestion of fly ash. This assessment will focus on the primary exposure route of concern (i.e., incidental ingestion of lead by children while playing) which is sufficient for demonstrating a need for remediation of the Fly Ash Pile. No carcinogenic toxicity criteria were available for lead, nor for the other inorganic chemicals of concern. Therefore, potential carcinogenic risks associated with direct contact with fly ash could not be evaluated.

Lead exposure to children from incidental ingestion of fly ash was quantified using a pharmacokinetic model known as the Integrated Uptake/Biokinetic (IU/BK) model. This is a computerized pharmacokinetic model which is used to evaluate the effects of lead exposure on children. The typical approach for evaluating noncarcinogenic hazards associated with exposure to chemicals (i.e., estimating chronic daily intakes) cannot be used to analyze the effects of lead poisoning because unlike most chemicals (which have a threshold for noncarcinogenic effects) lead may impact development of neurological function in children at any dose level (i.e., no threshold).

The IU/BK model essentially quantifies the distribution of possible lead concentrations in the blood using a multimedia approach. The IU/BK consists of two basic modules: 1) the uptake of lead, and 2) the biokinetics of lead in the body. Uptake of lead is defined as the amount of lead that is absorbed into the body's blood-plasma system from various sources (i.e, ingestion, inhalation, and dermal absorption). Using absorption factors calculated from the above uptakes, the biokinetic model calculates the amount of lead that will occur in a number of "body compartments." In the body, lead is exchanged among body compartments such as plasma and the extra cellular fluid (ECF) pool, red blood cells (RBC pool), kidneys,

Table 1

Concentrations of Inorganic Chemicals Detected in Four Samples
Collected from the Fly Ash Pile at the Dixie Caverns Site
(Units: mg/kg)

Chemical	Sample No. FAP-10	FAP-11	FAP-12	FAP-13
Cadmium	1,270	1,520	1,270	1,410
Chromium	1,010	1,090	1,020	1,100
Lead	42,400	49,500	44,900	43,000
Nickel	208	222	207	217
Zinc	208,000	220,000	218,000	201,000

liver, trabecular bone, cortical bone, and other soft tissue pools. The important factor of the biokinetic module is the transition time for the movement of lead between compartments (which includes removal by feces and urine). The transition time is the rate determining factor which determines the rate at which lead enters, resides, and then leaves each compartment during a monthly iteration. The transition time is calculated on a monthly basis and is dependant upon the body weight and individual compartment weight at that monthly age.

The 95th upper confidence limit on the arithmetic mean of lead in fly ash was used as the exposure point concentration, in accordance with EPA guidance (1989). Background exposure to other sources of lead including air, drinking water, maternal sources, and dietary sources also were estimated using default parameter values in order to estimate the total body burden of lead.

In accordance with EPA Region III guidance (EPA 1991), the default geometric standard deviation (GSD) of 1.42 was changed to 1.7, based on more recent data on the GSD of blood-lead levels in children at hazardous waste sites (i.e., Baltimore Lead Abatement and Cincinnati Lead Abatement studies, as cited in EPA Region III guidance [1991]).

Risk Characterization: Figure 1 presents a probability density function of possible blood-lead concentrations assuming six year-old children play regularly on the Fly Ash Pile. The cut-off value of 10 μg/dl (vertical line on Figure 1) is the interim criterion for evaluating the potential hazards to children from elevated blood-lead levels (EPA 1991). Children with blood-lead levels in excess of 10 μg/dl may experience adverse effects associated with neurological development. As shown in Figure 1, there is a 99.7% chance that a child's blood-lead level would exceed the interim criterion of 10 μg/dl. In fact, the most typical blood-lead level of 45 μg/dl (geometric mean which is the 50 percentile of the distribution) is approximately 5 times higher than the interim criterion of 10 μg/dl. There also is a 5 percent chance that the blood-lead level would be greater than 110 μg/dl, which exceeds the interim criterion by a factor of 11. In addition, the minimum detected concentration of lead detected at the Fly Ash Pile exceeded the interim soil lead cleanup level at Superfund sites of 500 mg/kg (EPA 1989b) by more than a factor of 80. **Given the homogeneous nature of the collected samples, it appears that the entire Fly Ash Pile may pose an unacceptable health risk based on the evaluation of the primary pathway of concern. Additional hazards also may exist due to exposure to other chemicals and exposure routes not quantitatively evaluated in this assessment.**

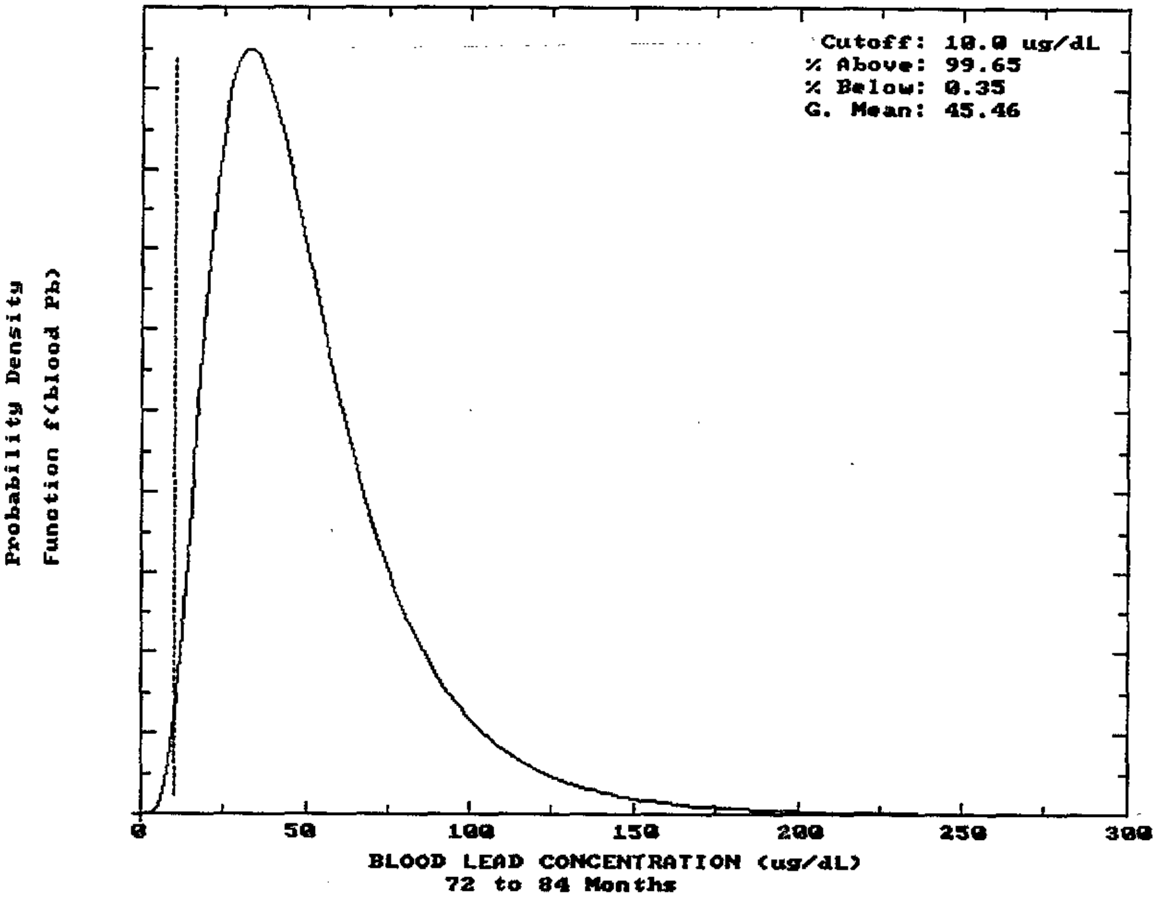

Figure 1. Probability Density Plot of Blood-Lead Levels in Children

References:

Environmental Protection Agency (EPA). 1989a. Risk Assessment Guidance for Superfund. Volume I: Human Health Evaluation Manual (Part A). Interim Final. OSWER Directive 9285.7-01a. December 1989.

Environmental Protection Agency (EPA). 1989b. Interim Guidance on Establishing Soil Lead Cleanup Levels at Superfund Sites. Office of Solid Waste and Emergency Response. (OSWER Directive 9355.4-02). September 7, 1989.

Environmental Protection Agency (EPA). 1991. The proposed use of an interim geometric standard deviation in the exploitation of the lead uptake/biokinetic model for blood-lead impact predictions. Region III Staff Document.

Table 2

Concentrations of Inorganic Analytes Detected in TCLP Leachate Derived from Solidified Fly Ash Collected at the Dixie Caverns Site (Units in ug/L)

Analyte	Location TFA-1	Location TFA-2	Location TFA-3	Location TFA-4
Antimony	18.60 B	30.80 B	40.10 B	48.20 B
Arsenic	6.90	2.00 U	22.60	2.00 U
Barium	846.00 J	1,000.00 J	1,070.00 J	1,230.00 J
Beryllium	1.00 U	1.00 U	1.00 U	1.00 U
Cadmium	1,310.00	1,650.00	1,500.00	1,440.00
Chromium	136.00	159.00	173.00	184.00
Lead	1,270.00 L	1,180.00 L	1,250.00 L	1,170.00 L
Mercury	0.20 U	0.20 U	0.20 U	0.20 U
Nickel	19.30 B	20.50 B	26.00 B	26.20 B
Selenium	5.90 J	3.00 UL	3.00 UL	3.00 UL
Silver	5.00 U	5.00 U	5.00 U	5.00 U
Thallium	3.00 U	3.00 UL	3.00 U	3.00 U
Vanadium	3.00 UL	3.00	3.00 UL	3.00 UL
Zinc	85,300.00	83,300.00	120,000.00	106,000.00

GLOSSARY OF DATA QUALIFIER CODES (INORGANIC)

CODES RELATED TO IDENTIFICATION (confidence concerning presence or absence of analytes):

U = Not detected. The associated number indicates approximate sample concentration necessary to be detected.

(NO CODE) = Confirmed identification.

B = Not detected substantially above the level reported in laboratory or field blanks.

CODES RELATED TO QUANTITATION (can be used for both positive results and sample quantitation limits):

J = Analyte present. Reported may not be accurate or precise.

L = Analyte present. Reported value may be biased low. Actual value is expected to be higher.

UJ = Not detected, quantitation limit may be inaccurate or imprecise.

UL = Not detected, quantitation limit is probably higher.

High Temperature Metals Recovery Process

The current Best Demonstrated Available Technology (BDAT) for delisting Electric Arc Furnace (EAF) wastes with high levels of zinc (greater than 15% by weight) is High Temperature Materials Recovery (HTMR). HTMR is a recovery technology which collects and concentrates the zinc for reuse. Other trace metals (lead and cadmium) are also recovered and sold as raw material to product manufactors.

Figure 2 illustrates the series of steps found in the typical HTMR process. Basically, EAF dust is heated twice in ovens or rotary kilns. This heating volitizes metals, permitting their recovery in baghouse filters. The HTMR process attempts to fully recycle all of the materials produced in the process waste streams. The primary products which result from HTMR are IRM (Iron Rich Materials), Zinc Oxide (or the more refined Zinc Calcine), and Lead/Cadmium concentrate.

Commercial firms presently available to perform the HTMR process operate at centralilized regional facilites. At this time, small scale HTMR process units suited for on-site treatment are not available. The EAF dust must be transported to the regional facility, which then takes responsiblity for the ulitmate disposal of products/wastes.

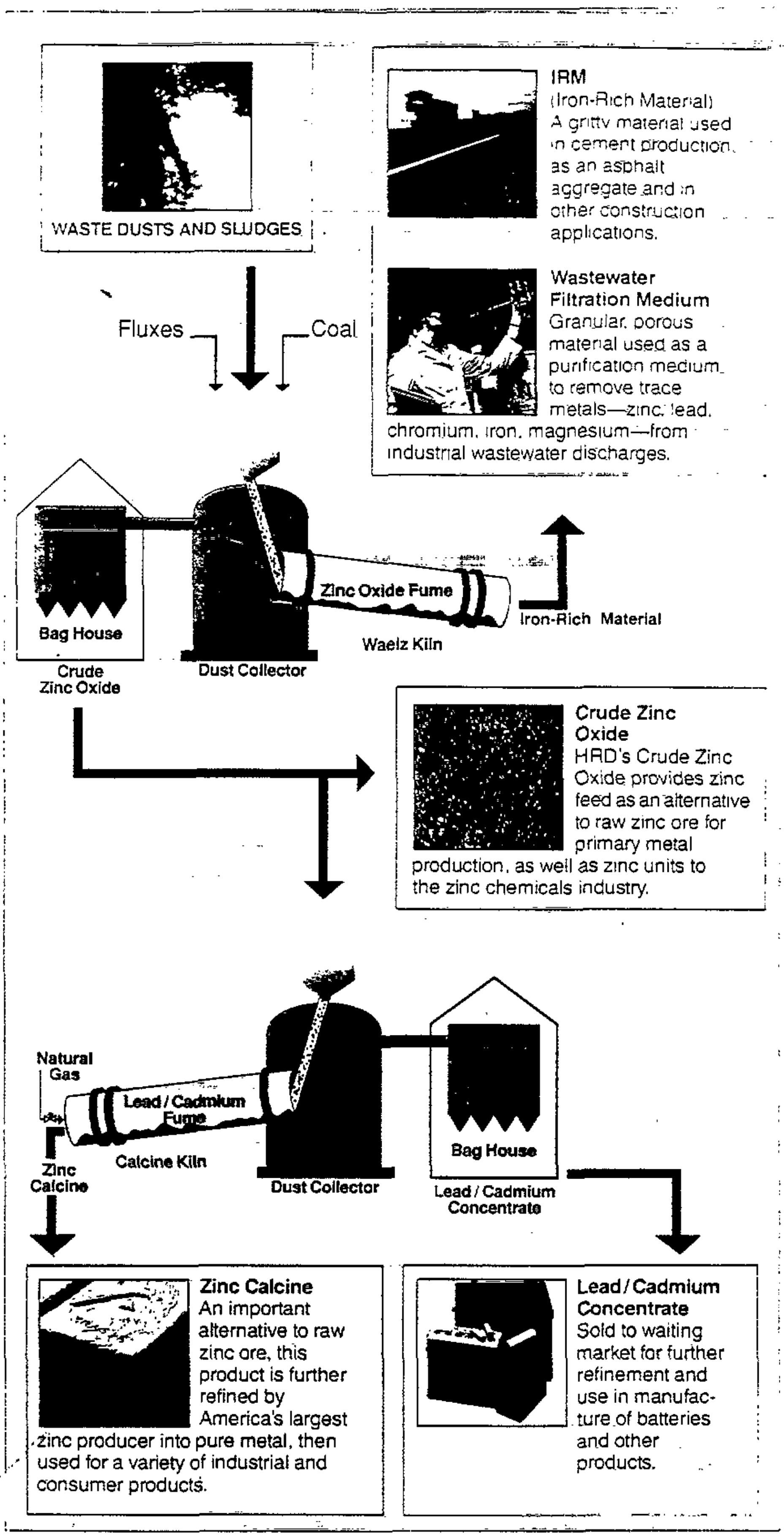

Figure 2. Flow Chart for a Typical HTMR Process

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DIXIE CAVERNS PRELIMINARY COST ESTIMATE

Item No.	Item Description		Capital Cost
I.	INSTITUTIONAL CONTROLS		
1.	Legal Fees (a)		$16,000
II.	PRELIMINARY		
1.	Engineering Design of Extraction Plan (b)		$25,000
Subtotal:			$41,000
2.	Mobilization/ Demobilization (c)	5% of Capital Subtotal	$122,724
Subtotal:			$122,724
3.	Site Preparation		
	a. Engineers Office (d)		$5,000
	b. Install Erosion and Sediment Control (e)		$10,000
	c. Stabilize Decontamination/Staging Area (f)		$10,000
	d. Watchperson Services (g)		$10,000
Subtotal:			$35,000
III.	MATERIAL EXTRACTION AND TREATMENT		
1.	Stabilize, Bond or Immobilize Material (h)		$5,000
2.	Material Excavation (i)		$90,000
	a. Overexcavation (j)		$15,000
	b. Inspection/ Monitoring/ Testing (k)		$10,000
	c. Select Backfill (l)		$15,000
	d. Vegetative Stabilization (m)		$52,000
Subtotal:			$187,000
IV.	MATERIAL TRANSPORTATION AND DISPOSAL		
1.	Transportation (n)		$241,500
2.	Disposal (o)		$1,811,250
Subtotal:			$2,052,750
CAPITAL SUBTOTAL (I,II,III and IV)			$2,454,474
V.	ADDITIONAL COSTS		
1.	Health and Safety	10% of Capital Subtotal	$245,447
2.	Bid Contingency	15% of Capital Subtotal	$368,171
3.	Scope of Work Contingency	15% of Capital Subtotal	$368,171
Subtotal:			$981,789
SUBTOTAL (I,II,III,IV and V)			$3,436,263
VI.	IMPLEMENTATION COSTS		
1.	Permitting and Legal Fees	5% of Capital Subtotal	$122,724
2.	Engineering Services During Construction	15% of Capital Subtotal	$368,171
Subtotal:			$490,895
TOTAL PRESENT WORTH OF CAPITAL AND ANNUAL COSTS			$3,927,158

NOTES AND ASSUMPTIONS FOR PRELIMINARY COST ESTIMATE:

(a) - Legal representation during contract negotiations. Assumed 40 hrs @ $400 ea.
(b) - Production of construction plans and calculations for permitting and implementation.
(c) - Equipment transportation to and from site.
(d) - Small construction trailer and portable toilet.
(e) - Implement erosion and sediment control measures for approximately 2 acres. Including, but not limited to: temporary perimeter ditching and/or berming, sediment sumps and/or traps, riprap and revetments, trim and dress existing drainage structures, silt fencing, filter fabric, etc. Assumed 2 acres @ $2500 ea. does not include site stabilization post-construction.
(f) - Stabilized subbase for decontamination area. Assumed 1 acre of 18" Class I riprap No. 57 aggregate, and restoration.
(g) - Assumed security personnel onsite 16 hrs/day for approximately 60 days.
(h) - Vapor foam or equivalent binder applied to flyash during removal and loading operations, includes final application for transportation. Assumed 1 gal/ton @ $8/gal.
(i) - Assumed $10/cy based on slope constraints.
(j) - Assumed a 2 ft overexcavation below flyash pile.
(k) - X-Ray Fluorescence validation of metal concentrations at final cut elevation.
(l) - Backfill all excavations to original contour elevation with uncontaminated soil suitable for revegetation.
(m) - Seed and mulch all disturbed areas. Assumed $0.12/sf over 10 acres. Includes reapplication.
(n) - Based on telephone conversations with HTMR facility. Assumed transportation rate of $20/ton.
(o) - Based on telephone conversations with HTMR facility. Assumed flyash density @ 90 lb/cf, and disposal fees of $150/ton.

Sources: Means, 1991; CORA v3.0; Virginia Regulations for the Control and Abatement of Air Pollution;