

EBASCO

REM III PROGRAM

REMEDIAL PLANNING ACTIVITIES
AT SELECTED UNCONTROLLED
HAZARDOUS SUBSTANCE DISPOSAL SITES

735114

EPA CONTRACT 68-01-7250

EBASCO SERVICES INCORPORATED

FINAL
SOILS
FEASIBILITY STUDY REPORT
VOLUME II OF II
APPENDICES A-E

WHITMOYER LABORATORIES SITE
LEBANON COUNTY, PENNSYLVANIA

JULY 1990
W.A. NO. 200-3LC9

NOTICE

AR300184

JULY 6, 1990

FINAL

SOILS FEASIBILITY STUDY REPORT
(VOLUME II OF II)
APPENDIX A-E

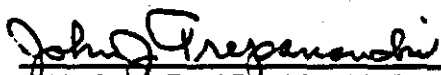
WHITMOYER LABORATORIES SITE
LEBANON COUNTY, PENNSYLVANIA

EPA WORK ASSIGNMENT NUMBER 200-3LC9
UNDER
CONTRACT NUMBER 68-01-7250

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NUS CORPORATION
PITTSBURGH, PENNSYLVANIA

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AR300185

AR300186

APPENDIX A

**SOILS FEASIBILITY, RISK, VOLUME,
AND QUANTITY CALCULATIONS**

AR300187

CLIENT: EPA ==	FILE NO.: 1817	BY: DDB	PAGE 1 OF 25
SUBJECT: Whit. Appendix A		CHECKED BY: GSR	DATE: 7/5/90

1 Potential Remedial Action Levels For contaminated Soils and Sediments (See Sheets 14-18 for Risk Assessment)

Soil Ingestion Based Action Levels

Residential Use

$$\begin{aligned} \text{Dose} &= \frac{[\text{mg/Kg}] \times 0.2 \text{ g/day} \times \frac{\text{Kg}}{10^3} \times 365 \text{ d/yr} \times 35 \text{ yr}}{13 \text{ Kg} \times 365 \text{ d/yr} \times 70 \text{ yr}} \\ &+ \frac{[\text{mg/Kg}] \times 0.1 \text{ g/day} \times \frac{\text{Kg}}{10^3} \times 365 \text{ d/yr} \times 65 \text{ yr}}{70 \text{ Kg} \times 365 \text{ d/yr} \times 70 \text{ yr}} \\ &= [\text{mg/Kg}] \times 2.4 \times 10^{-6} \end{aligned}$$

Commercial Use

$$\begin{aligned} \text{Dose} &= \frac{[\text{mg/Kg}] \times 0.1 \text{ g/day} \times \frac{\text{Kg}}{10^3} \times 115 \text{ d/yr} \times 40 \text{ yr}}{70 \text{ Kg} \times 365 \text{ d/yr} \times 70 \text{ yr}} \\ &= [\text{mg/Kg}] \times 3.7 \times 10^{-7} \end{aligned}$$

Agricultural Use

$$\begin{aligned} \text{Dose} &= \frac{[\text{mg/Kg}] \times 5.1 \times \frac{\text{Kg}}{10^3} \times \frac{90 \text{ d}}{\text{yr}} \times 40 \text{ yr}}{70 \text{ Kg} \times 365 \text{ d/yr} \times 70 \text{ yr}} \quad \left(\frac{\text{mg/m}^2}{\text{at dose}} \right) \\ &+ \frac{[\text{mg/Kg}] \times 1.3 \text{ m}^3/\text{hr} \times 12 \text{ h/d} \times \frac{15 \text{ d}}{\text{yr}} \times 40 \text{ yr} \times \frac{10^{-6}}{\text{m}^3}}{70 \text{ Kg} \times 365 \text{ d/yr} \times 70 \text{ yr}} \\ &= (2.01 \times 10^{-7} + 3.5 \times 10^{-7}) \text{ mg/Kg} \end{aligned}$$

CLIENT: EPA	FILE NO.: 1817	BY: ADB	PAGE 2 OF 25
SUBJECT: Appendix A		CHECKED BY: GJR	DATE: 4/5/90

Corresponding Soil Concentration (mg/kg)

Parameter	CPF (Ingestion)	Residential Use 1×10^{-6} CR	Commercial Use 1×10^{-6} CR	Aggricultural Use 1×10^{-6} CR
Arsenic	1.8 (150)	0.23	1.5	1.7
Benzene	0.029	14	93	170
T12DCE	0.02	1,300	31,000	31,000
TCE	0.01 (0.013)	38	246	443
PCF	0.051 (0.0033)	8.2	53	97
Hydrene	0.26	1.6	11	19
B1a1P	3.22 (0.453)	0.13	0.83	1.5
B1b1F	0.45	0.93	6.1	11
MVDA	0.005	85	560	980
Ambro	0.006	73	480	810
IN2,3,4,5,6,7,8	0.75	0.56	3.6	6.5

- ① Calculation: $\text{mg/kg} = \frac{1 \times 10^{-6}}{\text{CPF} \times 2.4 \times 10^{-6}}$
 T12DCE is not identified as a carcinogen, but Due to its use, it is 1
- ② Calculation: $\text{mg/kg} = 100 \times (1 \times 10^{-6} \text{ Value})$
 For arsenic, under the residential & commercial use, dose & CPF used are for ingestion only, for the Benzene, dose is calculated for plowing is also included for arsenic & organics
- ③ Calculation: $\text{mg/kg} = \frac{1 \times 10^{-6}}{\text{CPF} \times 3.7 \times 10^{-7}}$
- ④ Calculation: $\text{mg/kg} = \frac{1 \times 10^{-6}}{\text{CPF} \times 2.05 \times 10^{-7}}$

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SUBJECT: Whit - Append. A.		CHECKED BY: GJR	DATE: 4/5/90

Since risk based levels are excess cancer risk, consider background levels.

For the site use the following locations and analytical data

Location	As Conc.
SB - 14	6.5, 6
SB - 83	1.4, 21
SB - 82	3, 3.3
SB - 12	12, 13
SB - 7	11, 15
SB - 11	13, 17

Results $\bar{x} = 10.4 \text{ mg/kg}$
 $\sigma = 6.4$

Use 95% of all background data less than

$$10.4 + 1.645 \times 6.4 = 21 \text{ mg/kg}$$

1×10^{-6} Excess Cancer Risk

Residential Use: $21 + 0.23 = 21 \text{ mg/kg}$

Commercial Use: $21 + 1.5 = 22.5$

Agricultural Use: $21 + 1.9 = 22.9$

1×10^{-4} Excess Cancer Risk

Residential Use: $21 + 23 = 44 \text{ mg/kg}$

Commercial Use: $21 + 150 = 170 \text{ mg/kg}$

Agricultural Use: $21 + 190 = 210$

For organics, there is no normal background concentration.

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SUBJECT: <i>Wh. t- Append A.</i>	CHECKED BY: <i>GTR</i>	DATE: <i>4/15/90</i>	

Groundwater Ingestion - Soil Leaching Approach

For parameters with an MCL, use that concentration. For other contaminants calculate the concentration corresponding to a 1×10^{-6} ECR

From this groundwater concentration, back calculate a soil concentration using the soil/water distribution coefficient

Use two scenarios, 1) is drinkable leachate and 2) drinkable groundwater considering dilution from site underflow (Vadose zone soils)

Dilution from site underflow is ^{estimated at} 425 to 1, (see sheet 6)

Parameter	CPF/MCL	Drinkable GW Concent. (mg/L)	K _d ^② (L/Kg)	Soil Concentration (mg/Kg)	
				C _{Drinkable leachate}	C _{Drinkable GW with underflow d.l}
Arsenic	MCL :	0.05	4260 ^②	213 ^②	465 (see 450)
Benzene	MCL :	0.005	0.4	0.002	0.009
T, 1,2 DCE	MCL :	0.10	0.37	0.037	0.16
TCE	MCL :	0.005	0.8	0.004	0.017
PCE	MCL (mg/L):	0.005	2.4	0.012	0.052
Hydrene	0.26	0.00013	250	0.033	0.14
B(6)P	3.2	0.00001	10,400	0.104	0.440
B(6)F	0.45	0.00007	3,600	0.25	1.1
N-N DPA	0.005	0.007	4.2	0.03	0.13
Aniline	0.006	0.006	0.29	0.002	0.009
I(1,2,3,4)P	0.75	0.00005	10,400	0.52	2.2

① Concentration: $1 \times 10^{-6} \times 70 \text{ Kg} / 2814 \times \text{CPF}$ ② see sheets 5-9

NUS CORPORATION AND SUBSIDIARIES

STANDARD CALCULATION SHEET

CLIENT: <i>EPA</i>	FILE NO.: <i>1817</i>	BY: <i>NAB</i>	PAGE <i>5</i> OF <i>25</i>
SUBJECT: <i>What Appeal A</i>	CHECKED BY: <i>DMW</i>	DATE: <i>6/24/90</i>	

Soil Action Levels based on Groundwater Contamination with 150 to 1 dilution (MCL or 1×10^{-6} excess cancer risk) & Max. MCL required at 1×10^{-4} ecr

Parameter	Soil Concentration (mg/Kg)			
	100:1 Dilution	Drinkable	Drinkable GW (1×10^{-4} ECR)	
	MCL or 1×10^{-6} ECR (under the TELP Extract)	Leachate (1×10^{-4} ECR)	4.25:1 D.I.	100:1 D.I.
Arsenic	1000	*	*	*
Benzene	0.2 (10)	*	*	*
T,1,2 DCE	3.7 (200)	*	*	*
TCE	0.40 (10)	*	*	*
PCE	1.2 (14)	*	*	*
Pyrene	3.3	3.3	14	325
B(a)P	10	10	44	1,000
B(b)F	25	25	110	2,500
N-NDPA	3 (14)	3	13	300
Aniline	0.2 (12)	0.2	0.9	20
I(1,2,3cd)P	52	52	221	5,250

* MCL Based

Values in () indicate a upward correction assuming 100% solubility and 20 to 1 dilution in the TELP extraction.

Kd calculations

KOC **

Benzene	65	
T,1,2 DCE	59	
TCE	126	** From RI,
PCE	364	Table 5-1
Pyrene	38,000	
B(a)P	200,000	
B(b)F	550,000	
N-NDPA	648	
Aniline	44	
I(1,2,3-cd)P	11,000	

AR300192

CLIENT: USEPA --	FILE NO.: 1517	BY: JPB	PAGE 6 OF 25
SUBJECT: Whitmoyer		CHECKED BY: SJC 4-6-90	DATE: 3/23/90

Leaching Dilution Calculations

A) Based on RI Report

Infiltration Rate (IR) = 18,200 gpd across site

Shallow Bedrock Discharge Rate along downgradient edge of site (Q) = 350,000 gpd

Assuming that infiltration @ site mixes w/ shallow bedrock groundwater only (conservative approach),

$$\text{Dilution} = Q/IR$$

$$= 350,000 \text{ gpd} / 18,200 \text{ gpd}$$

= 19:1 = Infiltration concentrations diluted by a factor of 19 in shallow groundwater

B) Based on Alternative analysis presented in FS

Geometric Mean T, shallow wells (<60' deep) = 137.4 ft²/day" " " Medium " (60' < M < 150') = 16.9 ft²/day" " " Deep " (150' < D) = 6.4 ft²/dayTotal T = 160.7 ft²/day

Total Discharge rate along downgradient edge of site, all bedrock (Q_r) = 62.5 gpm (From FS Calc's)

Discharge rate thru shallow bedrock (Q_s) = Q_r $\times \frac{\text{Mean T, shallow wells}}{\text{Mean T, Total}}$

$$Q_s = (62.5 \text{ gpm}) \left(\frac{137.4 \text{ ft}^2/\text{day}}{160.7 \text{ ft}^2/\text{day}} \right)$$

$$Q_s = (62.5 \text{ gpm} \times .86) = 53.75 \text{ gpm} = 77,400 \text{ gpd}$$

$$\text{Dilution} = Q_s / IR$$

$$= 77,400 \text{ gpd} / 18,200 \text{ gpd}$$

$$= 4.25:1$$

Use same IR as in (A)

NUS CORPORATION AND SUBSIDIARIES

STANDARD CALCULATION
SHEET

CLIENT: <i>EPA --</i>	FILE NO.: <i>1817</i>	BY: <i>ADB</i>	PAGE 7 OF 15
SUBJECT: <i>Whit Append A</i>	CHECKED BY: <i>GJR</i>	DATE: <i>4/6/80</i>	

K_d is defined as: $\frac{\text{Soil Conc}}{\text{Water Conc}}$

For organics, it can be estimated from the soil TOC = 0.65% (0.0065) from soil washing TS data (subsurface soils)

For arsenic, the relationship between soil and leachate concentration was measured during the Soil washing TS

SAMPLE NUMBER	RATIO <i>Soil Conc</i> W/S	WATER CONC	SOIL CONC	ARITHMETIC REGRESSION
TS-201	45	5 0.006 -2.22184	45 1.652922	Regression Output:
		20 0.004 -2.39794	45 1.652439	Constant 366.2591
		50 0.007 -2.15490	45 1.649821	Std Err of Y Est 691.3838
		100 0.007 -2.15490	44 1.646483	R Squared 0.785133
TS-203	158	5 0.044 -1.35654	158 2.198851	No. of Observations 20
		20 0.030 -1.52287	157 2.197804	Degrees of Freedom 18
		50 0.026 -1.58582	157 2.195868	
		100 0.022 -1.65757	156 2.192567	X Coefficient(s) 309.4667
TS-205	113	5 0.013 -1.98388	113 2.852838	Std Err of Coef. 38.15845
		20 0.012 -1.92081	113 2.852155	
		50 0.006 -2.22184	113 2.851923	LOG REGRESSION
		100 0.003 -2.52287	113 2.851923	
TS-208	850	5 0.990 -0.00436	845 2.926882	Regression Output:
		20 0.000 -0.89691	834 2.921166	Constant 3.828969
		50 0.748 -0.13076	813 2.910090	Std Err of Y Est 0.153120
		100 0.627 -0.20273	787 2.896140	R Squared 0.954840
TS-207	4000	5 15.900 1.201397	3,921 3.593341	No. of Observations 20
		20 9.400 0.973127	3,812 3.581152	Degrees of Freedom 18
		50 6.000 0.832508	3,660 3.563481	
		100 4.000 0.682059	3600 3.556382	X Coefficient(s) 0.539848
				Std Err of Coef. 0.027672

Equation: $\text{Soil Conc} = 1070 (\text{Water Conc})^{0.54}$
0.05 mg/L Arsenic
Soil concentration is: 213 mg/kg
 $K_d = \frac{213}{0.05} = 4260$

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SUBJECT: <u>Whit - Appendix A</u>	CHECKED BY: <u>GJR</u>	DATE: <u>4/6/90</u>	

@ Leachate conc = $4.25 \times 0.05 = 0.212 \text{ mg/l}$

Soil Conc = 465 mg/Kg
(soy 450)

For Soils which exhibit the characteristics of a hazardous waste. Use TCLP data

SAMPLE NUMBER	TCLP CONCENTRATION		SOIL CONCENTRATION		ARITHMETIC REGRESSION Regression Outputs:
	MG/L	LOG CONC	MG/KG	LOG CONC	
TP1707	1.240	0.09	970	2.99	Constant 1136.078
TP1903	0.041	-1.39	131	2.12	Std Err of Y Est 2702.636
TP2305	26.000	1.43	2,740	3.44	R Squared 0.293191
TP3402	22.400	1.35	2,250	3.35	No. of Observations 14
TP4103	12.300	1.09	11,400	4.06	Degrees of Freedom 12
TP4203	1.000	0.26	1,100	3.07	
TP4404	0.188	-0.73	958	3.00	X Coefficient(s) 164.8353
SB0402	0.941	-0.03	1,210	3.08	Std Err of Coef. 73.88049
SB3506	15.400	1.19	3,600	3.56	
SB4108	11.600	1.06	3,150	3.50	LOG REGRESSION
SB4306	25.500	1.41	6,710	3.83	Constant 2.960003
SB5706	0.053	-1.26	92	1.96	Std Err of Y Est 0.259597
SB5807	4.960	0.70	1,560	3.19	R Squared 0.831716
SB7207	0.061	-1.21	236	2.37	No. of Observations 14
					Degrees of Freedom 12
					X Coefficient(s) 0.524559
					Std Err of Coef. 0.068114

Equation: Soil Conc = $9/2$ (Water Conc)^{0.52}

@ 5 mg/l (EPA's Value), SC = 2100 mg/Kg

Due to uncertainties, select an
80% confidence interval @ 5 mg/l (10% chance
of being wrong)

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SUBJECT: <i>Wh. t. Append A.</i>	CHECKED BY: <i>GJR</i>		DATE: <i>4/6/70</i>

$$\text{Soil Conc} = \text{inv log} (0.52 \times 0.7 + 2.96 - 1.282 \times 0.26)$$

$$= 980 \text{ mg/kg}$$

$$\text{Soil } 1000 \text{ mg/kg}$$

2. Area & Volume Calculations

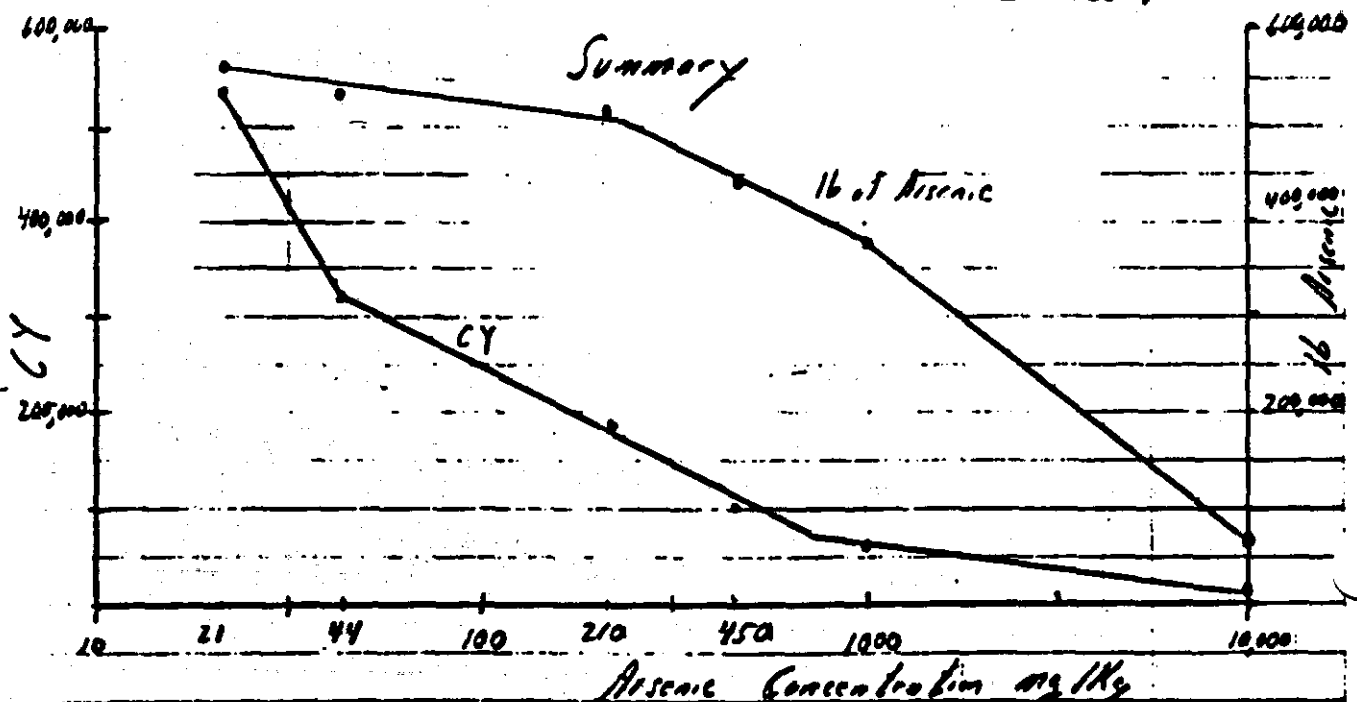
Figures 2-1, 2-2, 2-3, 2-4, 2-5, & 2-6 were used.

Raw Data is presented on Figures:

2-1-A, 2-3-A, 2-5-A

Depth to Bedrock & (W), used in calculating Thickness are presented in 2-3-B. See sheets 15-17 for calculations

Areal Extent (Table 2-7) used, Figure 3-1-A see sheet 19



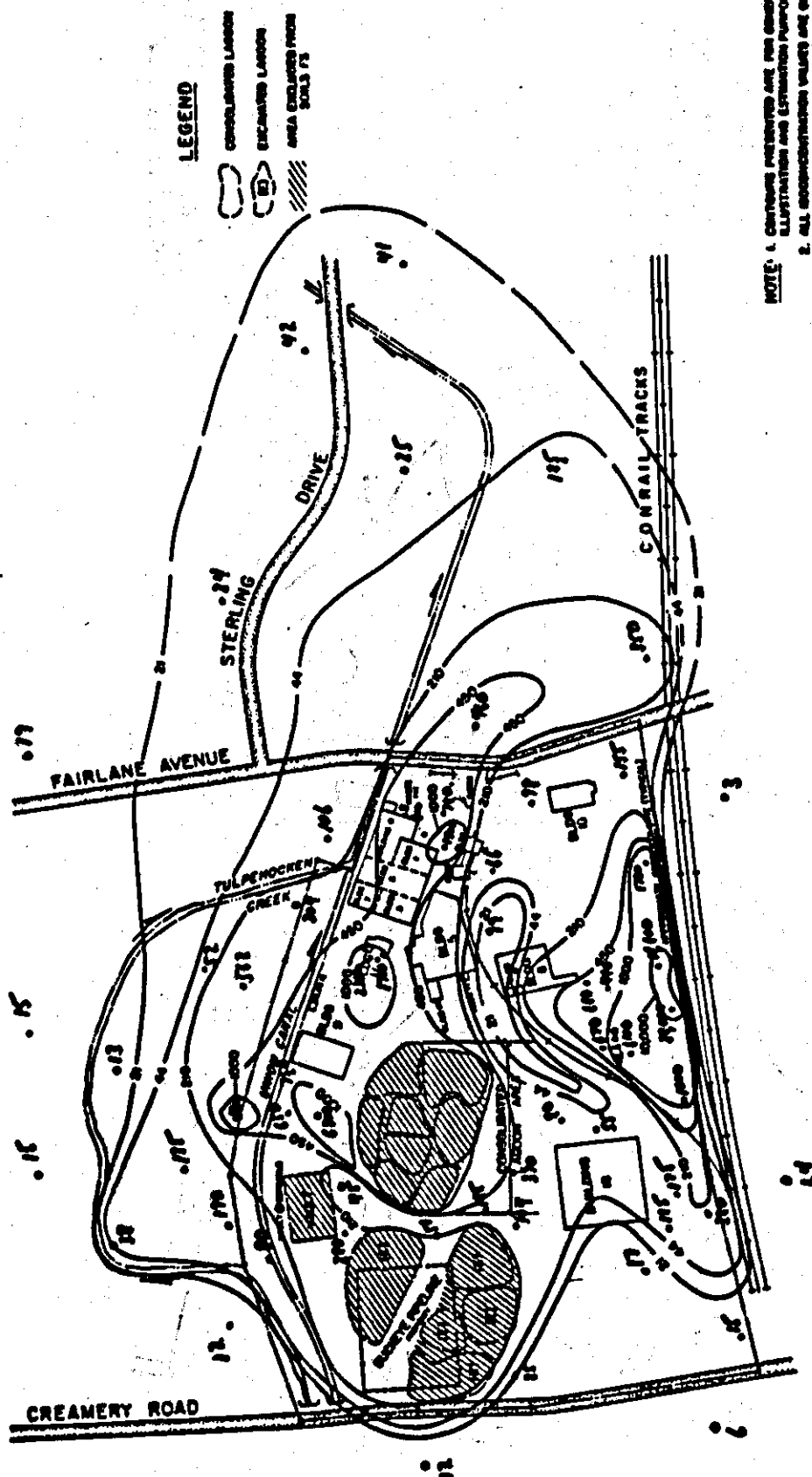


FIGURE 2-1-1



SURFACE SOILS - ARSENIC ISOCONCENTRATION CONTOURS
WITMOTER LABORATORIES SITE, LEBANON CO., PA

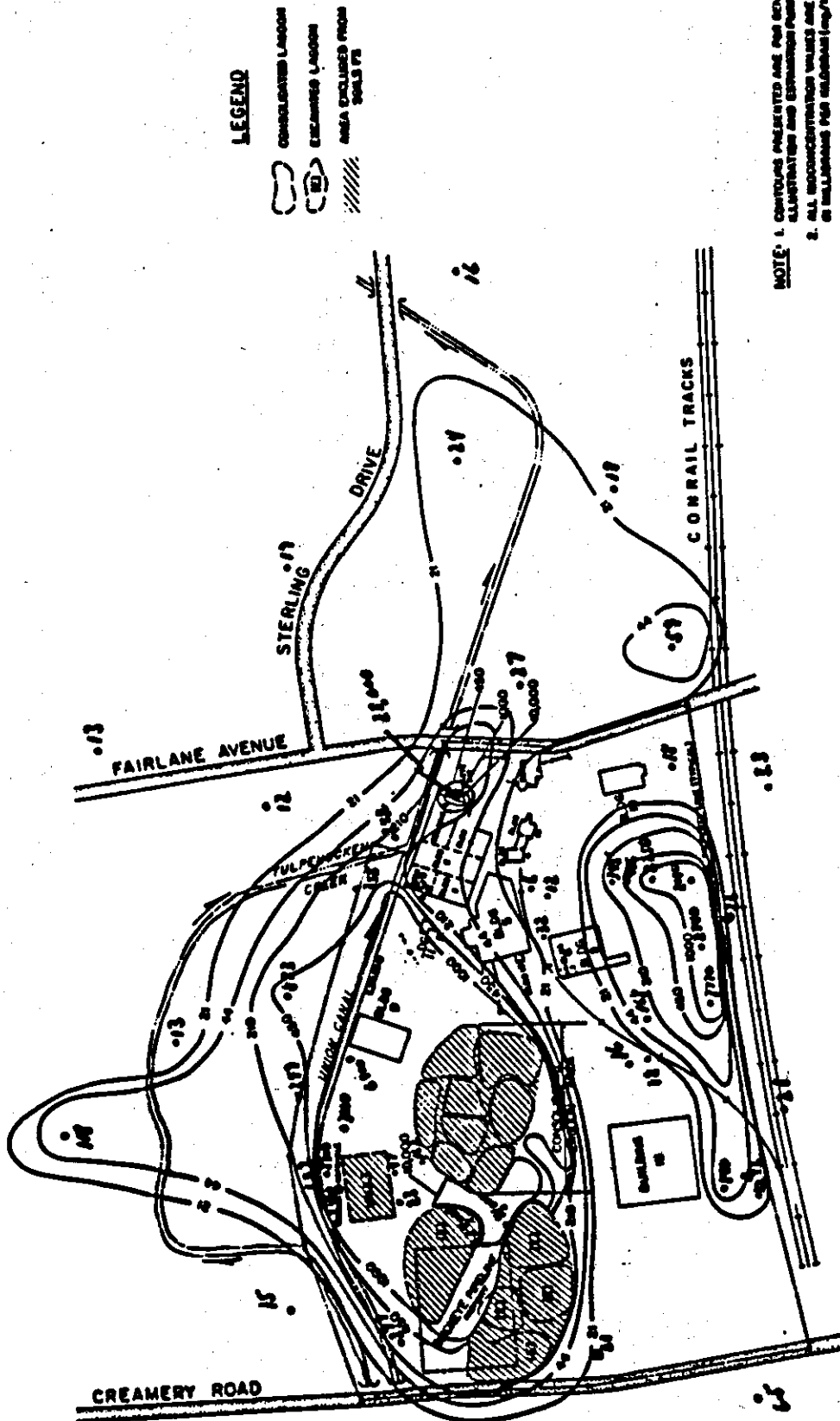
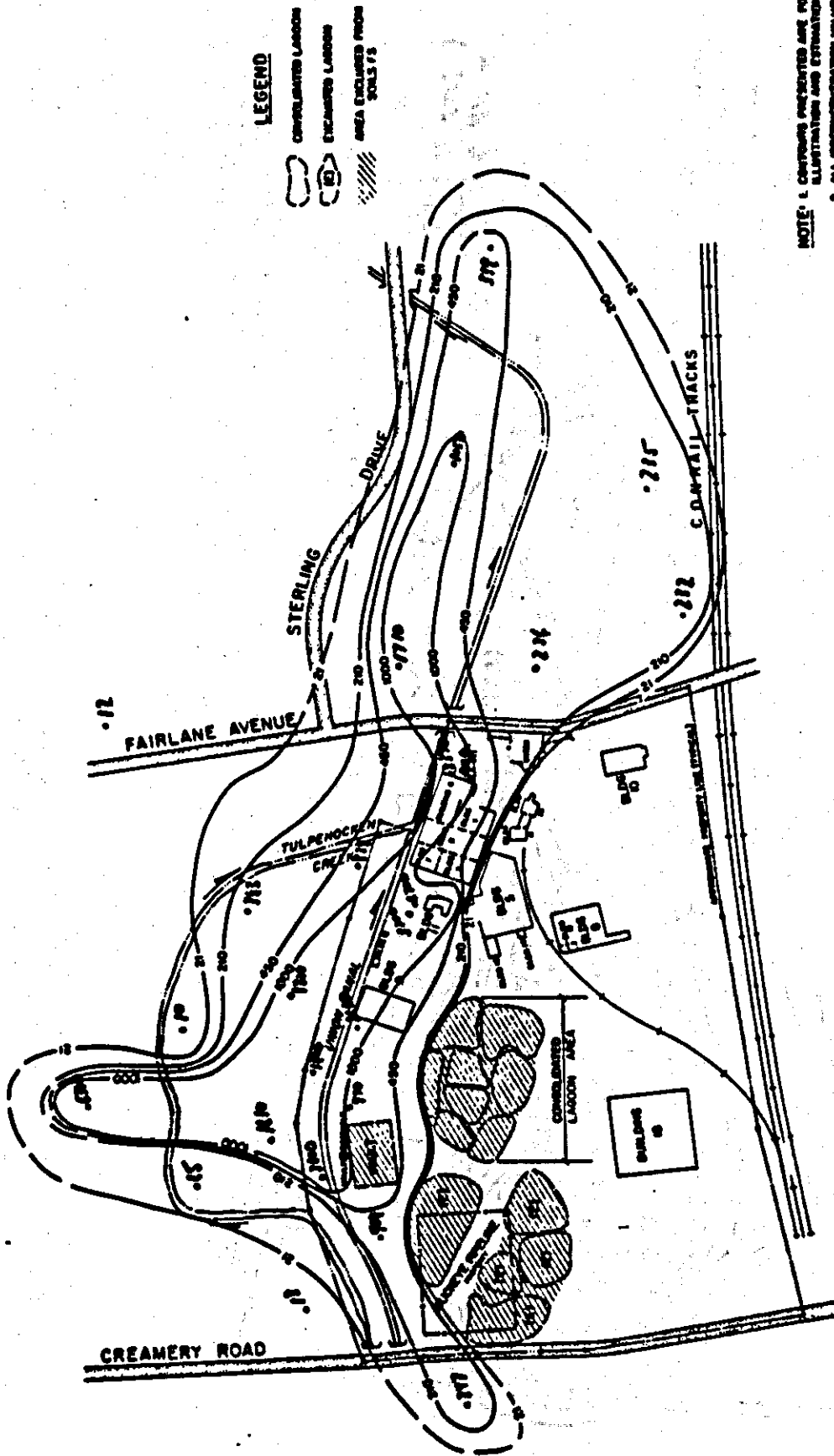


FIGURE 2-3-1



SUBSURFACE SOILS (2 TO 6 FEET) - ARSENIC ISOCONCENTRATION CONTOURS
WHITMAYER LABORATORIES SITE, LEBANON CO., PA



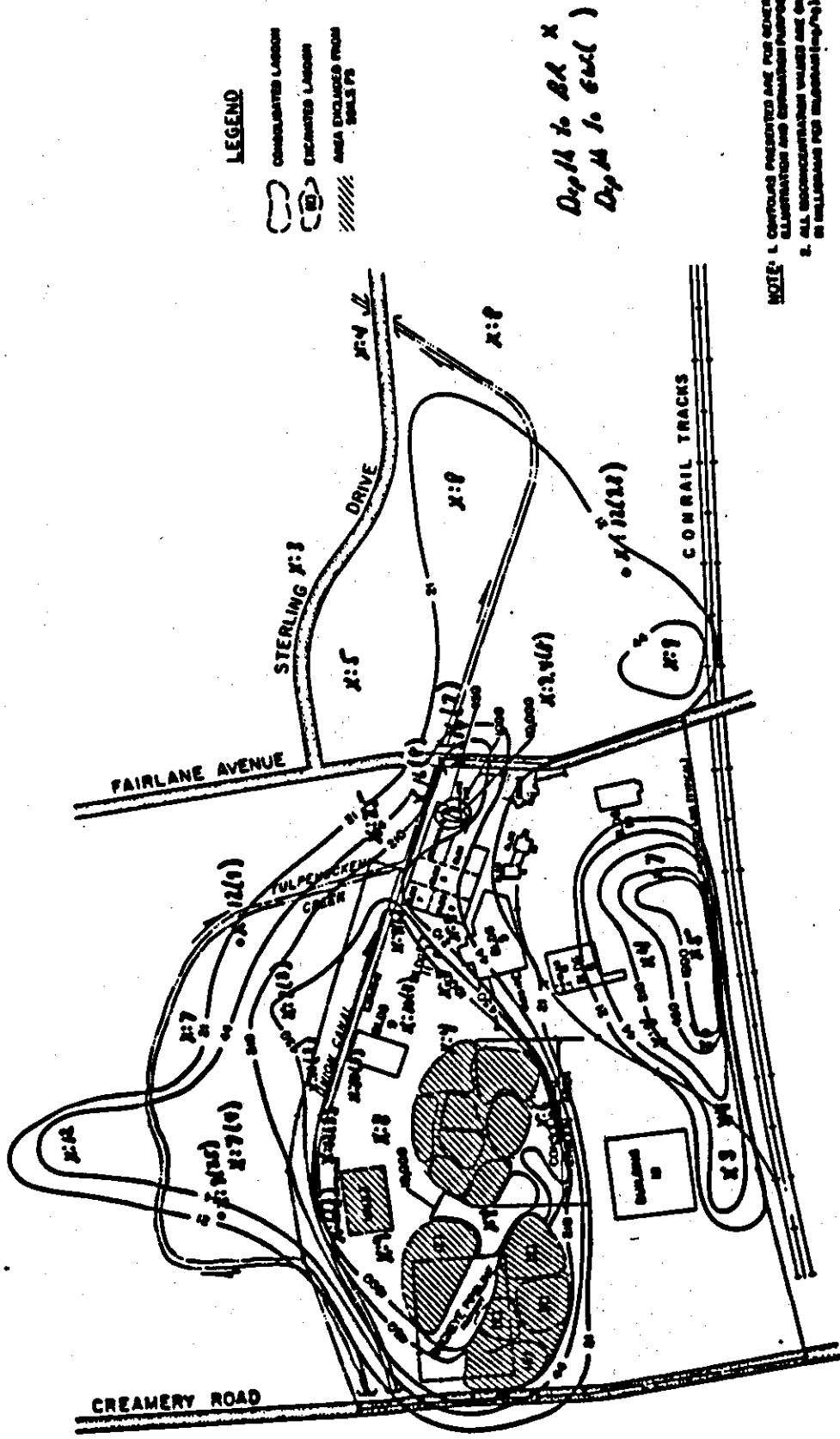
NOTE: 1. CONCENTRATIONS REPORTED ARE FOR GENERAL ILLUSTRATION AND ESTIMATION PURPOSES ONLY.
2. ALL CONCENTRATION VALUES ARE GIVEN IN MILLIGRAMS PER MILLILITER (mg/ml).

FIGURE 2-5-1



SUBSURFACE SOILS (GREATER THAN 6 FEET) - ARSENIC ISOCONCENTRATION CONTOURS

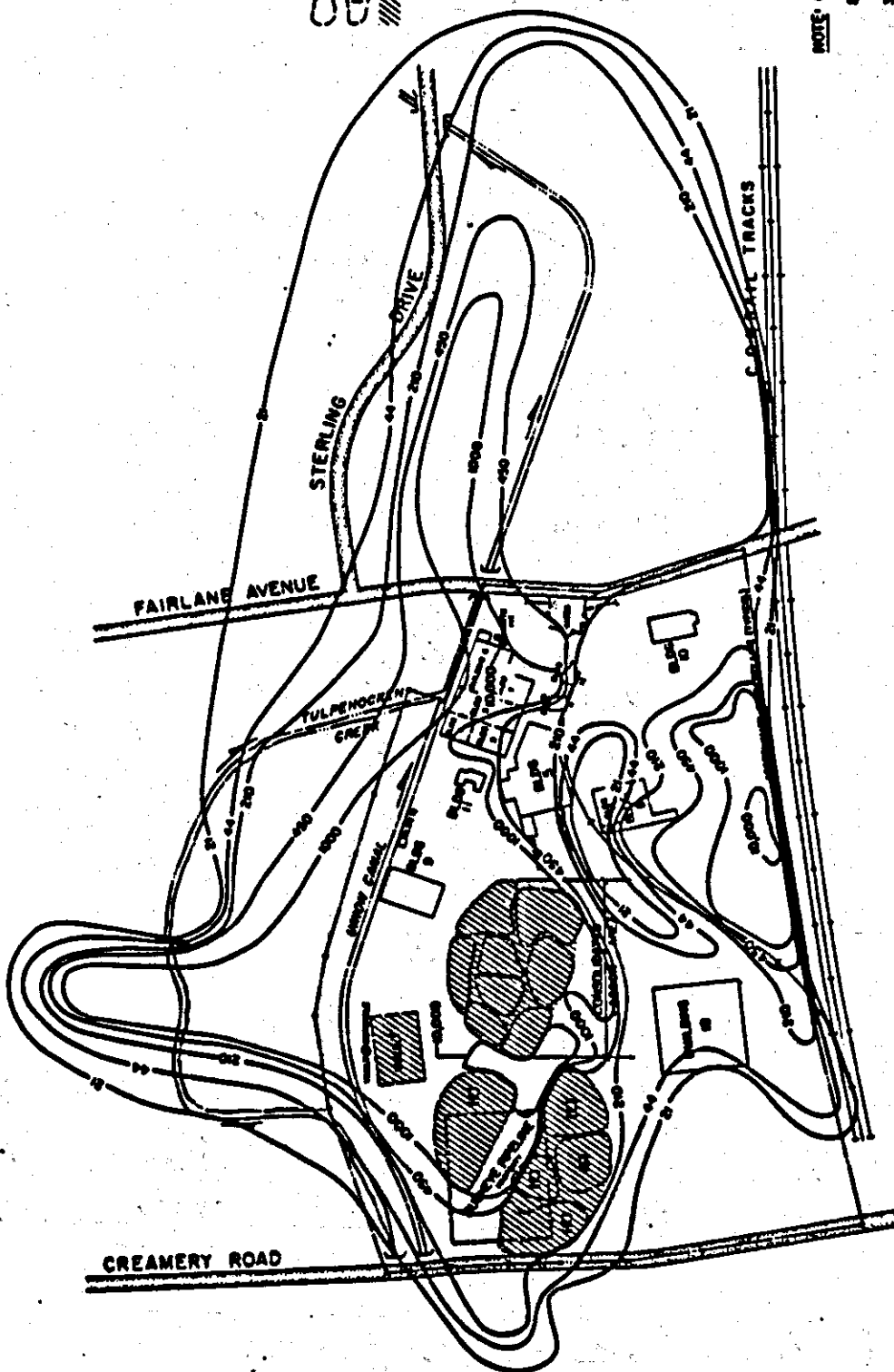
WHITMOYER LABORATORIES SITE, LEBANON CO., PA





LEGEND

CONSOLIDATED LAGOON
EXCAVATED LAGOON
AREA EXCLUDED FROM
SOLUS FS



NOTE: 1. CONTOURS PRESENTED ARE FOR GENERAL
ILLUSTRATION AND ESTIMATION PURPOSES.
2. ALL ISOCONCENTRATION VALUES ARE GIVEN
IN MILLIGRAMS PER MILLILITER (mg/l).
3. CONTOURS REFLECT PEAK CONCENTRATION
MEASURED AT ANY DEPTH.

FIGURE 3-1-A



COMPOSITE OF SURFACE, SHALLOW, AND
DEEP ARSENIC ISOCONCENTRATION CONTOURS
WHITMOYER LABORATORIES SITE, LEBANON CO., PA

CHECK PRINT
2/74 4/6/86

AR300201

CLIENT: <u>EPA --</u>	FILE NO.: <u>1817</u>	BY: <u>NAB</u>	PAGE <u>15</u> OF <u>25</u>
SUBJECT: <u>Soil Volume & Quantity Calculation</u>		CHECKED BY: <u>GJR</u>	DATE: <u>3/15/90</u>

Figures 2-1 through 2-6 were used to determine areas of contamination for each zone.

Surface Soils (From planimeter readings)

	Area	Depth (Est)	Volume	Lbs./CY
As > 10,000 mg/kg	2,400 SF	1 Ft	70 CY	2,400 Lb
10,000 > As > 1,000	56,000	1	2,100	18,000
1,000 > As > 450	220,000	1	8,800	14,000
450 > As > 210	270,000	1	10,800	8,000
210 > As > 44	570,000	1	21,000	5,400
44 > As > 21	633,000	1	23,000	1,900
	<u>40 acres</u>		<u>64,000</u>	<u>50,000</u>

Organic > Action Level - BNA, Only
(No VOCs are expected to be present in the surface soils)

108,000 mg/kg	74,000 SF	: 2700 CY & 860 Lb
7,600	13,000	: 480 CY & 10
9,600	6,400	: 240 CY & 6
2,500	5,000	: 190 CY & 1
	<u>2.3</u>	<u>3600 CY</u> <u>820 Lb</u>

Subsurface Soils (2 to 6 Feet)

	Area	Depth (Est)	Volume	Lbs./CY
As > 10,000	16,000 SF	3.7 Ft (3.7)	2,200 CY	59,000 Lb
10,000 > As > 1,000	150,000	4.4	24,000 CY	205,000
1,000 > As > 450	60,000	4.4	4,800	18,000
450 > As > 210	120,000	4.4	20,000	17,000
210 > As > 44	233,000	5	43,000	11,000
44 > As > 21	722,000	5	134,000	11,000
	<u>30 acres</u>		<u>280,000 CY</u>	<u>320,000 Lb</u>

* 2700 lb/CY is used as density of soil, average As concentration is calculated using the log average

** 2-6' soils encompasses the depth zone of 1805 Feet

CLIENT: <i>EPA --</i>	FILE NO.: <i>1917</i>	BY: <i>DNB</i>	PAGE <i>16</i> OF <i>25</i>
SUBJECT: _____		CHECKED BY: <i>GJR</i>	DATE: <i>3/15/90</i>

Organics > Action Level

BNA

<i>17,900</i>	<i>11,000 SF</i>	<i>@ 5 ft</i>	<i>2000 CY</i>	<i>8</i>	<i>.97</i>
<i>71,000</i>	<i>42,000 SF</i>	<i>@ 3.5 ft</i>	<i>5400 CY</i>	<i>8</i>	<i>1000</i>
<i>4,500</i>	<i>16,000 SF</i>	<i>@ 5 ft</i>	<i>3000 CY</i>	<i>8</i>	<i>.56</i>
	<i>1.6 acres</i>		<i>10,400 CY</i>		<i>1100</i>

VOA

<i>1,100 ug/kg</i>	<i>12,000 SF</i>	<i>@ 5 ft</i>	<i>2200 CY</i>	<i>8</i>	<i>7 1/2</i>
<i>403</i>	<i>6,400</i>	<i>@ 5 ft</i>	<i>1,200 CY</i>	<i>8</i>	<i>1 1/2</i>
	<i>0.4 acres</i>		<i>3,400 CY</i>		<i>8 1/2</i>

Sub surface Soils (Greater than 6 feet)

<i>1000</i>	<i>As > 1000 mg/kg</i>	<i>234,000 SF</i>	<i>@ 3.8 ft</i>	<i>33000 CY</i>	<i>8</i>	<i>89,000 lb</i>
<i>450</i>	<i>As > 450</i>	<i>190,000</i>	<i>3.0</i>	<i>27,000</i>		<i>38,000</i>
<i>210</i>	<i>As > 210</i>	<i>542,000</i>	<i>3.0</i>	<i>65,000</i>		<i>50,000</i>
	<i>As > 21,44</i>	<i>588,000 SF</i>	<i>3.0</i>	<i>65,000</i>	<i>8</i>	<i>10,000</i>
		<i>36 acres</i>		<i>180,000 CY</i>		<i>190,000</i>

Organics > Action Level

BNA

<i>31,700 ug/kg</i>	<i>21,000 SF</i>	<i>@ 5.3 ft</i>	<i>4100 CY</i>	<i>350 lb</i>
<i>550,000 ug/kg</i>	<i>23,000 SF</i>	<i>@ 4.2 ft</i>	<i>3600 CY</i>	<i>5300 lb</i>
			<i>7700 CY</i>	<i>5700 lb</i>

NUS CORPORATION AND SUBSIDIARIES

STANDARD CALCULATION SHEET

CLIENT: <i>EPA</i>	FILE NO.: <i>1717</i>	BY: <i>DAB</i>	PAGE <i>17</i> OF <i>25</i>
SUBJECT:		CHECKED BY: <i>GJR</i>	DATE: <i>3/15/90</i>

VOA

$18,300 \text{ mg/kg}, 6400 \text{ SF}, @ 5.3 \text{ ft} : 1300 \text{ CY} \& 64 \text{ lb}$
 $4,500 \text{ mg/kg}, 2800 \text{ SF}, 2.3 \text{ ft} : 200 \text{ CY} \& 2 \text{ lb}$
 $250 \text{ mg/kg}, 7900 \text{ SF}, 3.1 : 900 \text{ CY} \& 0.5 \text{ lb}$

 $0.4 \text{ Yards} \quad 2,400 \quad 66 \text{ lb}$

Summary

	Volume	lb Arsenic	Avg Conc.
As > 450 mg/kg	100,000 CY	440,000 lb	1600 mg/kg
As > 210 mg/kg	190,000 CY	520,000	1000
As > 44 mg/kg	320,000 CY	540,000	630
As > 21 mg/kg	480,000 CY	560,000	430

BNA Totals	22,000 CY	7,600 lb	130,000 mg/kg
VOA Totals	5,800 CY	74 lbs	4,700 mg/kg

Totals Organics, (Combining BNA & VOA)

24,000 CY

Plus Organics between 210 & 450 level (= 2,200 lb BNA & 4 lb VOA)

For hazardous determination Use Soil Cont. Index

= 1000 mg/kg, 61,400 CY 373,000 lbs 2,250 mg/kg

Average TCLP conc = $\frac{2250}{912} \times 1.52 = 5.7 \text{ mg/l}$

CLIENT: <i>EPA</i>	FILE NO.: <i>1417</i>	BY: <i>MB</i>	PAGE 18 OF 25
SUBJECT: <i>Appendix A</i>		CHECKED BY: <i>DMW</i>	DATE: <i>7/5/90</i>

Soils for Treatment / a comparison
of the organic action levels with the RI,
Appendix K)

Surface Soils

TP- 2300 & 2400

$$200 \times 70 \times 1' / 27 = 500 \text{ CY (Dirt Storage)}$$

2-6'

TP-2403

$$150 \times 60 \times 5' / 27 = 1700 \text{ CY (Dirt Storage)}$$

>6'

TP-1707

$$\pi \times 40^2 \times 4' / 27 = 700 \text{ CY (Dirt Storage)}$$

TP-5807 & 6010

$$60' \times 150' \times 8' / 27 = 2700 \text{ CY (Wash RI)}$$

TOTAL 5600 CY

AR300205

NUS CORPORATION AND SUBSIDIARIES

STANDARD CALCULATION SHEET

CLIENT: <i>--</i>	FILE NO.:	BY: <i>DAB</i>	PAGE 19 OF 25
SUBJECT:		CHECKED BY: <i>GJR</i>	DATE: <i>3/21/90</i>

Revised 7/6/90

Saturated Soil with $A_s > 210$

2 to 6 Feet

Area Depth Volume

450 $A_s > 210$

35,000

2.8'

3,600

> 6 Feet

450 $A_s > 210$

165,000

2'

12,200

15,800

Total Saturated Soils: 16,000
450 $A_s > 210$ mg/kg

CLIENT: <i>EPA</i>	FILE NO.: <i>1817</i>	BY: <i>DOB</i>	PAGE 20 OF 25
SUBJECT:		CHECKED BY: <i>GJR</i>	DATE: <i>4/12/90</i>

3 *Alcos affected by remediation*

*Figure 3-1 was developed by averaging
Figures 2-1, 2-3, and 2-5. The peak
contamination at each point was used.
Planimeter reading with calibration factor
are as follows.*

For Arsenic

$$> 10,000 : \left(\frac{2.33 - 2.3}{3} + \frac{22.2 - 21.5}{3} \right) \times \frac{56,000 \text{ SF}}{\text{Planimeter Reading}} = 9300 \text{ SF}$$

$$> 1,000 : \left(\frac{22.71 - 21.14}{2} + \frac{11.33 - 4.1}{2} \right) \times \frac{56,000}{43,560} = 10 \text{ acres}$$

$$> 450 : \left(\frac{38.7 - 36.01}{2} + \frac{37.81 - 12.11}{2} \right) \times \frac{56,000}{43,560} = 15$$

$$> 210 : \left(\frac{58.97 - 55.10}{2} + \frac{47.23 - 27.03}{2} \right) \times \frac{56,000}{43,560} = 28$$

$$> 44 : \left(\frac{139.41 - 81.14}{2} + \frac{48.93 - 42.52}{2} \right) \times \frac{56,000}{43,560} = 38$$

$$> 21 : \left(\frac{112.23 - 40.85}{2} + \frac{21.22 - 20.43}{2} \right) \times \frac{56,000}{43,560} = 46$$

NUS CORPORATION AND SUBSIDIARIES

STANDARD CALCULATION SHEET

CLIENT: USEPA-Region III	FILE NO.: 1317	BY: L.A. Sinagoga	PAGE 2/ OF 25
SUBJECT: WhitMayer Laboratory		CHECKED BY: amz	DATE: 4/6/90

Form worker exposure scenario (during tilling of the land) (Not modeled)
 and growing of crops. as in RI
 Accidental Ingestion Exposure Scenario

Assumptions: 100mg/d ingestion rate
 90 d/yr (3 month intensive contact w/ soil)
 40 yrs lifetime (includes tilling and cultivation of land
 10 days only for actual plowing)

Non carcinogenic exposure dose:
 (not time weighted)

$$= \frac{[mg/kg] \times 0.1 gms/d \times 1 kg/10^3 g}{70 kg}$$

$$= [mg/kg] \times 1.43 \times 10^{-6}$$

(time weighted)

$$= \frac{[mg/kg] \times 0.1 gms/d \times 1 kg/10^3 g}{70 kg \times 365 d}$$

$$= [mg/kg] \times 3.52 \times 10^{-7}$$

Concentration corresponding to HI = 1 (Reference dose for As = $1 \times 10^{-3} mg/kg/d$)
 (not time weighted) (time weighted)

$$[mg/kg] = \frac{0.001 mg/kg/d}{1.43 \times 10^{-6}} = 700$$

$$= [mg/kg] = \frac{0.001 mg/kg/d}{3.52 \times 10^{-7}} = 2836$$

Carcinogenic

Exposure dose: $[mg/kg] \times 0.1 gms/d \times 90 d/yr \times 1 kg/10^3 g \times 40 yr$
 $70 kg \times 365 d/yr \times 70 yr$

$$= [mg/kg] \times 2.01 \times 10^{-7}$$

Concentration corresponding to 1×10^{-6} excess lifetime cancer risk:

$$Dose \times CPE = 1 \times 10^{-6}$$

$$[mg/kg] \times 2.01 \times 10^{-7} \times 1.8 = 1 \times 10^{-6}$$

$$[mg/kg] = \frac{1 \times 10^{-6}}{1.8} : 2.01 \times 10^{-7}$$

$$= 0.76$$

$$-10^5 = 276$$

$$-10^4 = 276$$

CLIENT: USEPA - Region III	FILE NO.: 1317	BY: L.A. Sinagoga	PAGE 22 OF 25
SUBJECT: Whitman Laboratories		CHECKED BY: J.M.3	DATE: 4/6/90

Farm workers exposure scenarios:

- Assumptions:
- 1.3 m³/hr inhalation rate (assume farmer is seated on top of tractor)
 - 12 hrs/day
 - 10 days/year
 - 40 yr exposure time frame
 - Conservatively, a 100% absorption factor is assumed.

Carcinogenic Exposure dose:

$$= \frac{[\text{mg}/\text{m}^3] \times 1.3 \text{ m}^3/\text{hr} \times 12 \text{ hrs}/\text{d} \times 10 \text{ d}/\text{yr} \times 40 \text{ yrs}}{70 \text{ kg} \times 365 \text{ d}/\text{yr} \times 70 \text{ yr}}$$

$$= [\text{mg}/\text{m}^3] \times 0.0035 \frac{\text{m}^3}{\text{kg} \cdot \text{d}}$$

Concentration corresponding to the 1×10^{-6} excess lifetime cancer risk level.

$$\text{Dose} \times \text{CPF} = 1 \times 10^{-6}$$

$$[\text{mg}/\text{m}^3] \times 0.0035 \frac{\text{m}^3}{\text{kg} \cdot \text{d}} \times 50 \frac{\text{kg}}{\text{m}^3} = 1 \times 10^{-6}$$

$$[\text{mg}/\text{m}^3] = \frac{1 \times 10^{-6}}{0.0035 \frac{\text{m}^3}{\text{kg} \cdot \text{d}} \times 50 \frac{\text{kg}}{\text{m}^3}} = 5.7 \times 10^{-6} \text{ mg}/\text{m}^3$$

Extreme worst case: Assume there is 10 mg/m³ dust in air:

$$\frac{5.7 \times 10^{-6} \text{ mg}}{10 \text{ mg}} = 0.57 \text{ ppm} - \text{Conc. of As in Soil}$$

Combined exposure: Assume there is 1 mg/m³ dust in air:

$$\frac{1}{2.9} + \frac{1}{5.7} = \frac{1}{x}$$

$$x = 1.9 \text{ mg}/\text{kg}$$

$$\frac{5.7 \times 10^{-6} \text{ mg}}{1 \text{ mg}} = 5.7 \text{ ppm} - \text{Conc. of As in Soil}$$

Assume there is 0.1 mg/m³ dust in air:

$$\frac{5.7 \times 10^{-6} \text{ mg}}{0.1 \text{ mg}} = 57 \text{ ppm} - \text{Conc. of As in Soil}$$

CLIENT: USEPA - Region III	FILE NO.: 1817	BY: L.A. Sinagoga	PAGE 23 OF 25
SUBJECT: Whitney Labs		CHECKED BY: Jm3	DATE: 4/6/90

Worker exposure scenarios during construction

Accidental Ingestion Exposure Scenario

- Assumptions:
- 100mg/day ingestion Rate
 - 10 days/yr
 - 1 yr/Lifetime

Non carcinogenic

Exposure dose:
$$\frac{[mg/Kg] \times 0.1gms/d \times \frac{1Kg}{10^3g}}{70Kg}$$

$$= [mg/Kg] \times 1.43 \times 10^{-6}$$

Concentration corresponding to $HI = 1$ (Reference dose for As = $1 \times 10^{-3} mg/Kg/d$):

$$[mg/Kg] = \frac{0.001 mg/Kg/d}{1.43 \times 10^{-6}} = 700$$

Carcinogenic

Exposure dose:
$$= \frac{[mg/Kg] \times 0.1gms/d \times 10d/yr \times 1Kg/10^3g \times 1yr}{70Kg \times 365d/yr \times 70yr}$$

$$= [mg/Kg] \times 5.6 \times 10^{-10}$$

Concentration corresponding to 1×10^{-6} excess lifetime cancer risk:

$$Dose \times CPE = 1 \times 10^{-6}$$

$$[mg/Kg] \times 5.6 \times 10^{-10} = \frac{1 \times 10^{-6}}{1.8}$$

$$[mg/Kg] = \left(\frac{1 \times 10^{-6}}{1.8} \right) \div 5.6 \times 10^{-10}$$

$$[mg/Kg] = 993$$

CLIENT: USEPA - Region III	FILE NO.: 1517	BY: L.A. Sinagoga	PAGE 24 OF 25
SUBJECT: Whitmoyer Labs		CHECKED BY: DM3	DATE: 4/6/90

Worker exposure scenarios during construction:

Inhalation Exposure Scenario:

Assumptions: • Adult male inhalation rate (moderate work)
- $2.8 \text{ m}^3/\text{hour}$

• Body weight - 70 Kg

• Exposure duration:

- 8 hrs/day

- 10 days/yr

- 1 yr/lifetime

• Assume - particulate level in atmosphere
is at a nuisance dust level - 10 mg/m^3

• Assume dust in air is comparable to
metals content in soils

• Conservatively, a 100% absorption factor is assumed

Carcinogenic Exposure dose:

$$= \frac{[\text{mg/m}^3] \times 2.8 \text{ m}^3/\text{hr} \times 8 \text{ hrs/d} \times 10 \text{ d/yr} \times 1 \text{ yr}}{70 \text{ Kg} \times 365 \text{ d/yr} \times 70 \text{ yr}}$$

$$= [\text{mg/m}^3] \times 1.25 \times 10^{-4}$$

$$= [\text{mg/m}^3] \times 1.25 \times 10^{-4}$$

Concentrations corresponding to 1×10^{-6} excess lifetime cancer risk

$$\text{Dose} \times \text{CPF} = 1 \times 10^{-6}$$

$$[\text{mg/m}^3] \times 1.25 \times 10^{-4} \times 50 = 1 \times 10^{-6}$$

$$[\text{mg/m}^3] = \frac{1 \times 10^{-6}}{1.25 \times 10^{-4} \times 50}$$

$$[\text{mg/m}^3] = 1.6 \times 10^{-4}$$

CLIENT: USEPA-Region III	FILE NO.: 1317	BY: L.A. Sinegoga	PAGE 25 OF 25
SUBJECT: Whitmoyer Labs		CHECKED BY: DMZ	DATE: 4/6/90

Extreme worst case: Assume there is 10 mg/m^3 dust in air:

$$\frac{1.6 \times 10^{-4} \text{ mg}}{10 \text{ mg}} = \underline{\underline{1.6 \text{ ppm}}}$$

Assume there is 1 mg/m^3 dust in air:

$$\frac{1.6 \times 10^{-4} \text{ mg}}{1 \text{ mg}} = \underline{\underline{16 \text{ ppm}}}$$

Assume there is 0.1 mg/m^3 dust in air:

$$\frac{1.6 \times 10^{-4} \text{ mg}}{0.1 \text{ mg}} = \underline{\underline{1600 \text{ ppm}}}$$

Please note that 0.017 mg/m^3 was cited in the ^{II}Uncland Report as an ambient airborne particulate concentrations for rural.

Combined Risk

Ingestion @ 992 plus
Inhalation @ 1600

$$\frac{1}{\frac{1}{992} + \frac{1}{1600}} = 612$$

Using a 40% safety factor,

$$\rightarrow \frac{612}{1.4} = 437 \sim \underline{\underline{450 \text{ mg/kg}}}$$

AR300212

AR300213

APPENDIX B
FIXATION TREATABILITY STUDY REPORT

AR300214

FINAL
SOILS FIXATION TREATABILITY
STUDY REPORT

WHITMOYER LABORATORIES SITE
LEBANON COUNTY, PENNSYLVANIA

JULY 1990
W.A. NO. 200-3LC9

AR300215

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1.0 INTRODUCTION

Ebasco Services Incorporated (Ebasco), under contract to the U.S. Environmental Protection Agency (USEPA), conducted a treatability study to evaluate the effectiveness of fixation on contaminated soils from the Whitmoyer Laboratories Superfund Site. The study was performed by NUS Corporation (NUS) at the NUS Pittsburgh Testing Facility. This work was performed under subcontract to Ebasco, as part of Work Assignment 200-3LC9, Contract Number 68-01-7250.

This treatability study report consists of four sections.

- Section 1 consists of the site, waste stream, and remedial technology descriptions.
- Section 2 provides the conclusions and recommendations derived from this study.
- Section 3 provides the treatability study approach and methodology.
- Section 4 includes the presentation and a discussion of results (including QA/QC).

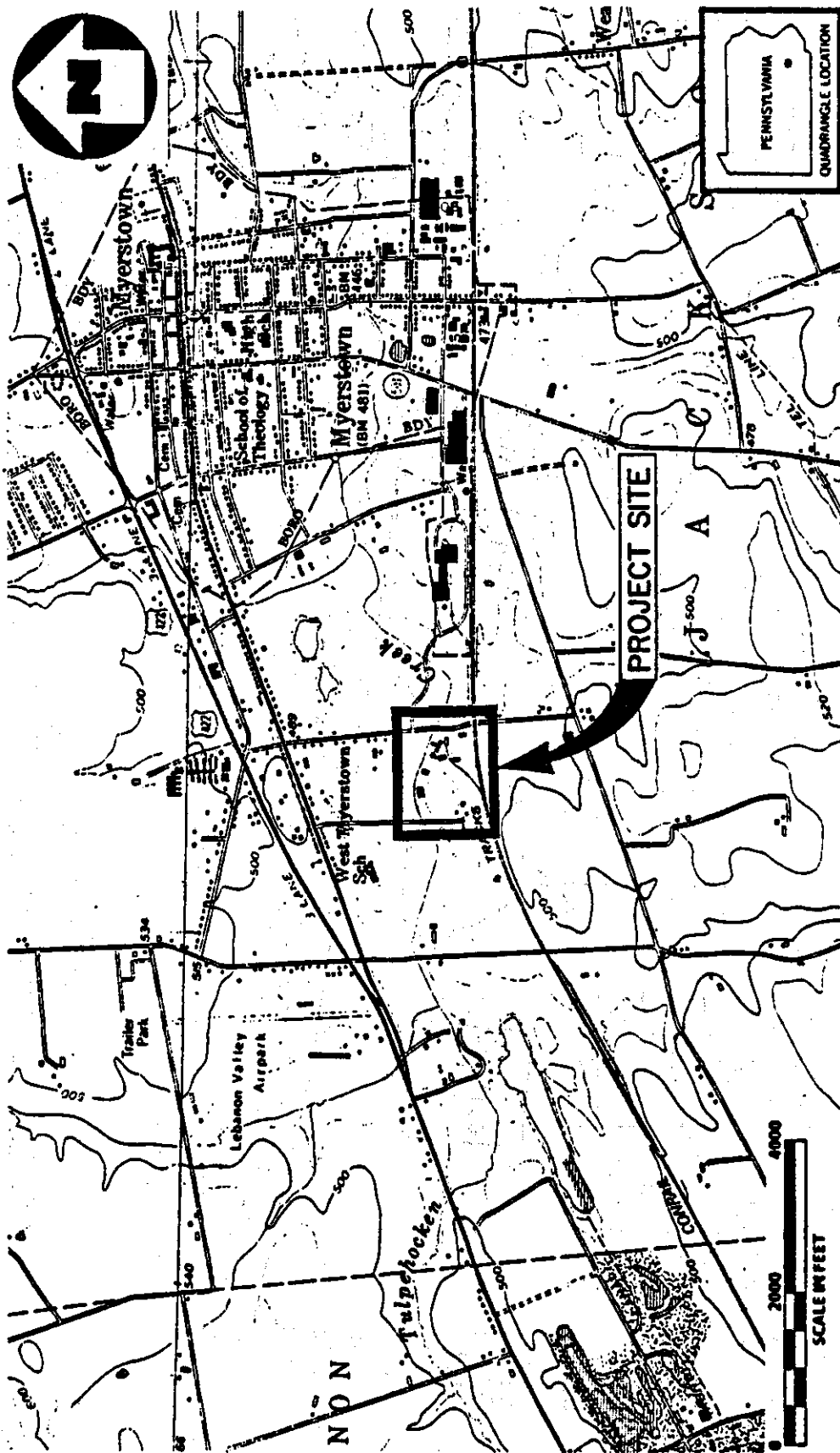
This study was conducted in accordance with the Guide for Conducting Treatability Studies Under CERCLA, (Interim Final) (USEPA, 1989).

1.1 SITE DESCRIPTION

Whitmoyer Laboratories Site is located in Lebanon County, Pennsylvania (see Figure 1-1). Whitmoyer Laboratories reportedly initiated operations at the site in 1934 as a veterinary pharmaceutical company, and, in 1957, started production of organic arsenical compounds (primarily arsenilic acid and carbarsone). Production continued until 1987, when the plant closed. Other products produced at the facility include piperazine, chlorhexidine gluconate, phenolphthalein, cresylic acid-based products, iodine-based products, and vitamin supplements.

Until 1964, plant wastewater was treated with lime (to precipitate arsenic) and sent to an unlined lagoon located directly on top of bedrock. In 1964, the lagoon sludge was excavated and placed in a concrete vault. At the same time, groundwater contaminated with arsenic was pumped and treated by ferric sulfate addition. The resulting ferric arsenate sludge was stored in the initial lagoon (consolidated lagoon), and in a second, compartmentalized lagoon (excavated lagoon, see Figure 1-2).

The treated plant wastewater and groundwater were permitted to infiltrate into the subsurface through the base of the lagoon(s). This large-scale infiltration created an artificial



BASE MAP IS A PORTION OF THE U.S.G.S. RICHLAND, PA QUADRANGLE (75 MINUTE SERIES, 1955, PHOTOREVISED 1969) CONTOUR INTERVAL 20'.

FIGURE 1-1

LOCATION MAP
WHITMOYER LABORATORIES SITE, LEBANON COUNTY, PA



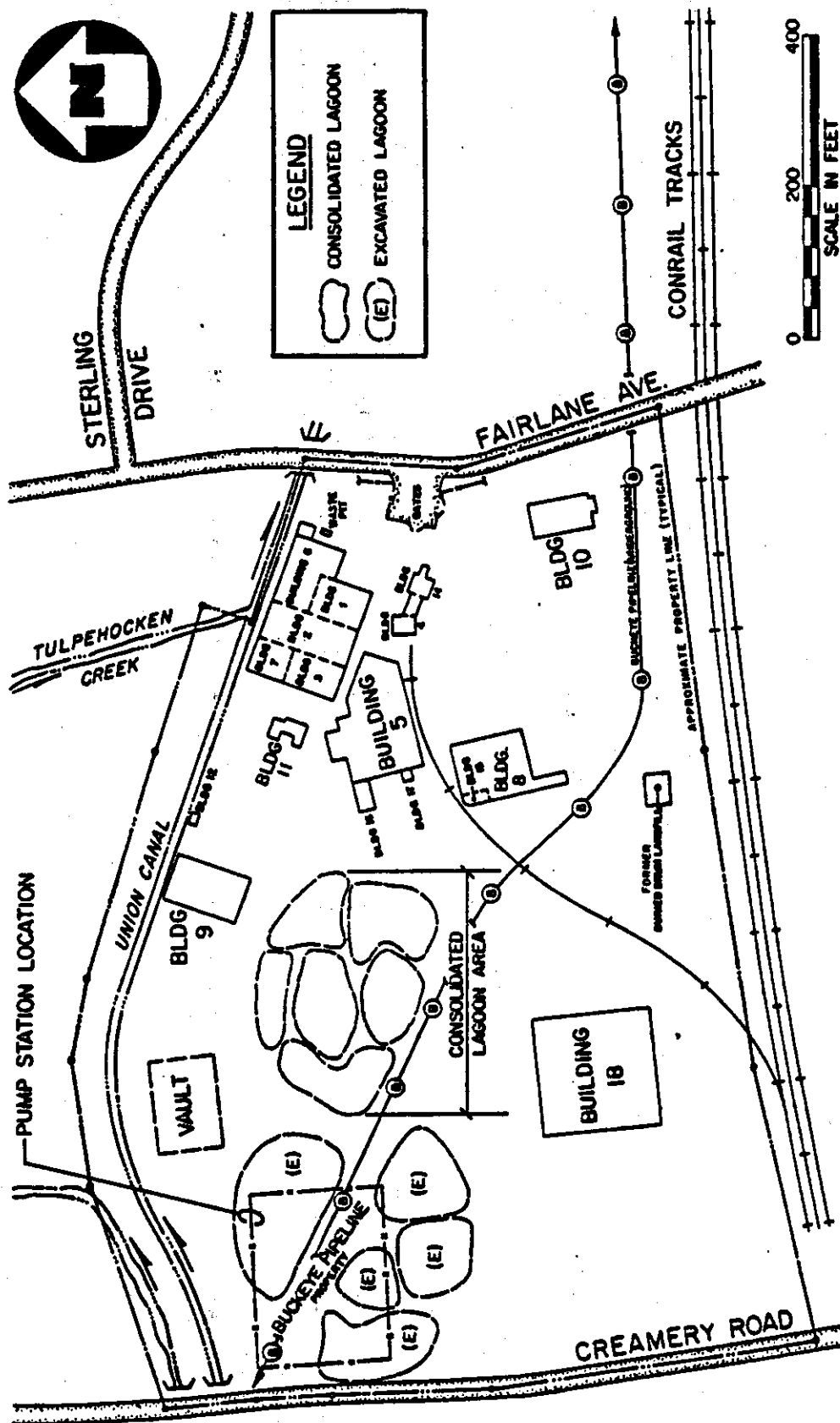


FIGURE 1-2



GENERAL ARRANGEMENT
WHITMOYER LABORATORIES SITE, MYERSTOWN, PA

SOURCE: GENERAL LAYOUT DRAWING, PREPAREDNESS, PREVENTION & CONTINGENCY PLAN, DEC. 22, 1982.

groundwater mound; infiltration water, which still contained dissolved arsenic, contaminated onsite and offsite soils surrounding the lagoons. Via adsorption (and possibly precipitation), these soils became contaminated to various degrees with arsenic (and possibly other contaminants).

Spills, leaks, direct discharge of wastewater to the ground, storage of uncontained wastes on the ground surface, and direct waste burial have added to the soil contamination over the years of plant operation.

In 1965, Whitmoyer Laboratories, Inc., conducted an augering and coring program to evaluate the arsenic concentration of subsurface soil and rock. As expected, with arsenic's affinity for soil adsorption, the lower layers of the soil mantle (which were in contact with groundwater containing arsenic) had accumulated significant amounts of arsenic (the available 1965 analytical results for the soil directly above bedrock averaged 1,500 mg/kg). Most of this accumulation reportedly occurred around and along the contact surface between the soil mantle and the underlying rock formations. The soil's arsenic accumulations were later confirmed during a 1973 United States Geological Survey (USGS) study. A USGS conclusion was that the majority of the arsenic in the soil in 1965 had remained there through the pump and treat program.

In late 1976 and 1977, the lagoon sludges were consolidated. Sludge was excavated from the westernmost lagoons and placed in the easternmost lagoons.

In November 1987 the EPA, with assistance from the REM III Project Team, began the remedial investigation/feasibility study (RI/FS) at the Whitmoyer Laboratories Site. RI (Ebasco, 1989a) results confirm the widespread arsenic contamination in the soils. Additionally, several "hot spots" of elevated arsenic and/or organic contamination have been tentatively identified.

1.2 WASTE STREAM DESCRIPTION

1.2.1 Waste Matrix

Native soils at the site consist predominantly of silts and clays. With the exceptions noted below, the silty clay deposits cover the majority of the study area, both on site and off site. Bedrock depth varies from 0 feet at outcrops to about 19 feet near Tulpehocken Creek.

North of the site, within the flood plain of Tulpehocken Creek, alluvial deposits consisting of silts, sands, clays, and gravels are present. In the area of the excavated lagoons and consolidated lagoons, soils consist primarily of fill material. The fill material from the excavated lagoons contains silts, clays, and limestone gravel, and extends to the bedrock surface. On the southern end of the site, bedrock is very shallow. However, fill material is present in the area of the railroad

spur and Building 8. This fill material is made up of miscellaneous debris and a black, carbon-like waste overlying naturally deposited silty clay. In the area of the process buildings, fill material is present on the surface. The fill material consists predominantly of debris and silty clay, whereas the underlying natural overburden appears to consist of silts, sands, clays, and gravels. Items such as the vault and lagoon sludges were specifically excluded from consideration in this study.

Several prominent physical structures are present in the study area, including Tulpehocken Creek, Union Canal, railroad tracks, buildings, roads, a petroleum hydrocarbon pump station, and pipeline.

The Tulpehocken Creek is estimated to have a normal flow of about 1.6 million gallons per day (MGD). This flow is distributed between the canal and the creek. The groundwater at the site is predominantly in the bedrock. However, the soils near and under the creek are saturated. About 20 percent of those soils preliminarily classified as contaminated are believed to be saturated.

1.2.2 Chemical Analysis

From August through November 1988, the REM III Project Team collected soil samples at the Whitmoyer Laboratories Site as part of the RI (Ebasco, 1989a). This sampling included roughly 81 soil borings and 52 test pits. Selected soil samples were analyzed for Target Compound List (TCL) organic and Target Analyte List inorganic compounds. In addition, some of the soil samples were subjected to the USEPA Resource Conservation and Recovery Act (RCRA) Toxicity Characteristic Leachate Procedure (TCLP) (metals analysis only). A selected summary of the analytical results is presented in Table 1-1. Additional analytical detail is provided in the Whitmoyer Remedial Investigation Report (Ebasco 1989a).

1.3 REMEDIAL TECHNOLOGY DESCRIPTION

1.3.1 Treatment Process and Scale

The treatment process investigated under this study was the chemical fixation of arsenic compounds (and other contaminants) contained in a soil matrix. Chemical fixation was one of the technologies identified in the "Treatability Study Evaluation Report" (Ebasco 1989b), as potentially applicable for treating the site soils. Chemical fixating agents evaluated under this study were as follows:

- Cement
- Cement kiln dust
- Fly ash
- Lime

TABLE 1-1

CONTAMINATED SOIL ANALYTICAL SUMMARY
WHITMOYER LABORATORIES SITE
LEBANON COUNTY, PENNSYLVANIA

Parameter	Estimated Average Concentration (mg/kg)	Maximum Concentration (mg/kg)
Arsenic - Total	380	28,200
Arsenic - TCLP leachate	0.15	27
Semi-volatile Organics	7	590
Volatile Organics	0.05	18.3

- Ferric sulfate
- Activated carbon

A conceptual treatment train for the soils fixation process is shown on Figure 1-3.

In general, the treatment process consisted of screening out oversize material, followed by mixing the screened soil with fixating reagent(s). For pozzolanic reagents, the mixture was hydrated and cured. A preroasting (heating) step was also investigated for one pozzolanic reagent mixture. If incorporated, this roasting step occurred after the reagent mixing but prior to hydration.

1.4 PREVIOUS TREATABILITY STUDIES AT THE SITE

Two treatability studies were conducted on the Whitmoyer Laboratories Site lower vault wastes and lagoon wastes in 1988 and 1989. These studies evaluated the effectiveness of cement-based fixation and clay pelletizing and sintering technologies. The studies were conducted by Engineers International in association with Montana Tech.

Conclusions from these studies include the following:

- The clay pelletizing/sintering technology did not stabilize the sludges sufficiently to meet project objectives, and resulted in significant arsenic volatilization.
- Cement fixation was effective in stabilizing the calcium-arsenic sludges, but was ineffective for the iron-arsenic sludge.
- Cement fixation with a preroasting step was effective in stabilizing both the calcium- and iron-arsenic sludges. However, significant quantities (about 5 percent) of arsenic volatilized during the preroasting step.

Study results are presented in the "Feasibility Study Report" for the Whitmoyer Laboratories Site (Ebasco, 1990a).

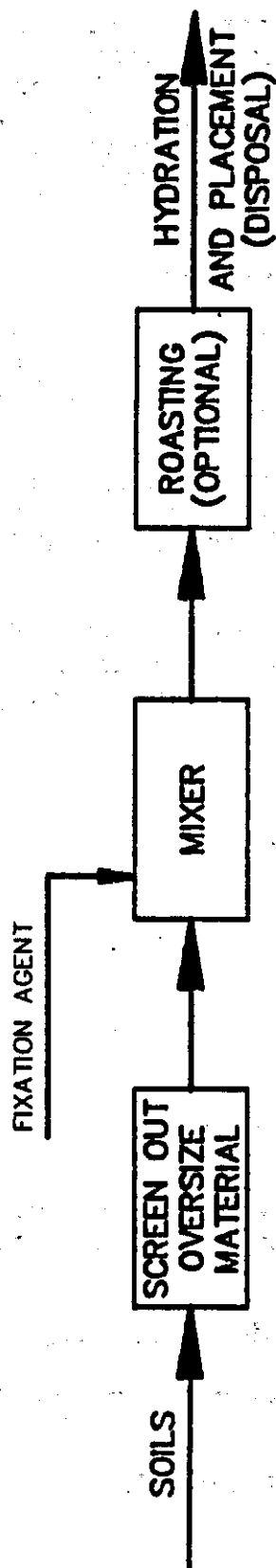


FIGURE 1-3



SOILS FIXATION TREATMENT TRAIN
WHITMOYER LABORATORIES SITE

2.0 TREATABILITY STUDY APPROACH

2.1 TEST OBJECTIVES AND RATIONALE

The treatability study objectives were to characterize selected site soil samples and to determine the feasibility of using the fixation technology to immobilize contaminants in the soils and allow for environmentally safe placement of the treated soils. The three exposure routes of concerns for these contaminants are continuing contamination of groundwater, surface runoff, and direct ingestion of soils. Fixation by itself is not anticipated to directly address the ingestion route. This route will be addressed in the design for the placement of the stabilized wastes.

At this site, arsenic and volatile and semivolatile organics are identified as significant contaminants in the soils. Treatability study goals were as follows:

- Organics - 90 to 99 percent reduction in leachable organics, as determined by the American Society for Testing of Materials (ASTM) D-3987-85 and modified ASTM leachate procedures.
- Arsenic - 90 to 99 percent reduction and/or 50 µg/L (whichever is higher) in the leachate, as determined by the ASTM, modified ASTM, Extraction Procedure (EP) Toxicity and TCLP leachate procedures.

2.2 EQUIPMENT AND MATERIALS

The following equipment and reagents were used during the testing.

- Stainless-steel Hobart blender
- Triple beam balance
- 2-pound hammer
- Stainless-steel drying pans
- Roasting oven
- pH meter
- 3/8-inch brass sieve
- Humidity chambers
- Reagents
 - Cement - Portland Type I from Keystone Cement Company.
 - Fly ash - Type F from Pennsylvania Power and Light, Montour Plant.
 - Lime - Fisher, reagent grade.
 - Ferric sulfate - Fisher, reagent grade $\text{Fe}_2(\text{SO}_4)_3 \cdot 4 \text{H}_2\text{O}$.
 - Cement kiln dust with 10 percent cement - from Keystone Cement Company.
 - Distilled water.
 - Powdered activated carbon - Calgon WPL Powdered.

- Decontamination Chemicals
 - Alconox
 - Reagent-grade nitric acid

2.3 EXPERIMENTAL DESIGN AND PROCEDURES

The experimental design and procedures for the soils fixation study are detailed in the study Work Plan (Ebasco, 1990b) and Quality Assurance Project Plan (Ebasco, 1990c). Testing was conducted on two soil samples from the Whitmoyer Laboratories Site. One sample was a composite sample collected from three individual sample points. This sample was intended to represent average soil contamination at the site. The second sample was a discrete sample. This sample was intended to represent a worst-case soil contamination level at the site. Additional details on sample collection and compositing are provided in Section 2.4. For this study, both the discrete worst-case soil sample and the composite average sample were subjected to the same testing matrix. The reagents evaluated were selected based on the "Treatability Study Evaluation Report" (Ebasco, 1989b), as well as subsequent research. The testing matrix is summarized in Table 2-1 and discussed below.

Phase 1 Design

Phase 1 testing consisted of evaluating the effectiveness of cement alone, cement in combination with fly ash, and ferric sulfate/lime. In addition, one cement mixture was roasted prior to hydration, to determine the effects of preroasting.

Two different cement-to-soil ratios were evaluated. The first ratio was a 1-to-1 cement-to-soil ratio (by weight) and represents a relative maximum quantity of cement without excessively increasing the volume of waste. The second cement-to-soil ratio was 0.1 to 1, which is a common ratio for fixation of soils. In a third test, fly ash was added in addition to cement to determine potential benefits from silicates in the fly ash. The fourth test used ferric sulfate and lime as reagents. The ferric sulfate was used to lower the pH of the soils as well as to stabilize the arsenic. Lime was added to buffer the excess acidity of the ferric sulfate and to maintain a soil pH above 4.0 standard units (S.U.). The fifth test included preroasting of a 1-to-1 soil/cement mix prior to hydration. This test was based on the successful immobilization of arsenic in previous treatability studies conducted on the vault and lagoon wastes (Trepanowski et al., 1989).

TABLE 2-1

TESTING MATRIX
CONTAMINATED SOILS FIXATION TREATABILITY STUDY
WHITMOYER LABORATORIES SITE
LEBANON COUNTY, PENNSYLVANIA

Test Number	Soil	Mix Ratio(s), Additive/Sample					
		Cement	Cement Kiln Dust (10% Cement Added)	Fly Ash	Ferric Sulfate/Lime	Activated Carbon	Water

PHASE 1

01	CA	1	-	-	-	-	0.45	-
02	CA	0.1	-	-	-	-	0.28	-
03	CA	0.1	-	0.05	-	-	0.30	-
04	CA	-	-	-	0.1/0.03	-	0.15	-
05*	CA	1	-	-	-	-	0.81	-
06	WC	1	-	-	-	-	0.56	-
07	WC	0.1	-	-	-	-	0.30	-
08	WC	0.1	-	0.05	-	-	0.35	-
09	WC	-	-	-	0.1/0.04	-	0.20	-
10*	WC	1	-	-	-	-	0.90	-

TABLE 2-1
TESTING MATRIX
CONTAMINATED SOILS FIXATION TREATABILITY STUDY
WHITMOYER LABORATORIES SITE
LEBANON COUNTY, PENNSYLVANIA
PAGE TWO

Test Number	Soil	Mix Ratio(s), Additive/Sample					
		Cement	Cement Kiln Dust (10% Cement Added)	Fly Ash	Ferric Sulfate/Lime	Activated Carbon	Water
							Sodium Bicarbonate

PHASE 2

12	CA	1	-	-	-	0.05	0.72	-
13	CA	-	-	-	0.1/0.03	-	0.20	0.2
14	CA	-	-	-	0.05/0.02	-	0.21	-
15	CA	-	-	-	0.1/0.03	0.05	0.20	-
16	CA	-	1.5	-	-	-	0.88	-
17	WC	1	-	-	-	0.05	0.70	-
18	WC	-	-	-	0.1/0.04	-	0.25	0.06
19	WC	-	-	-	0.05/0.02	-	0.20	-
20	WC	-	-	-	0.1/0.04	0.05	0.25	-
21	WC	-	1.5	-	-	-	0.73	-

* Preroasted sample. Water added after roasting.

CA Composite average sample.

WC Worst case sample.

Note: Test Number 11 did not involve soils treatment and is not included in this table.

Phase 1 - 5-Day Results

The Phase 1 - 5-day TCLP results are summarized as follows.

Test No.	Soil	Reagent(s)	TCLP Leachate Concentration (mg/L)
01	CA	cement	0.40
02	CA	cement	0.77
03	CA	cement/fly ash	0.70
04	CA	iron/lime	<0.005
05	CA	cement/roasting	<0.005
06	WC	cement	0.32
07	WC	cement	2.7
08	WC	cement/fly ash	Not Determined
09	WC	iron/lime	0.0068
10	WC	cement/roasting	0.014

An evaluation of these results indicates that iron-based fixation and cement-based fixation (with roasting) resulted in lowest arsenic concentrations in the TCLP extract. Each of these mixtures achieved the objectives for arsenic reduction. Cement and cement with flyash-based fixation (without roasting) did not achieve these objectives.

Phase 2 Design

To expedite the study, the Phase 2 testing matrix was designed using the Phase 1 5-day cure TCLP results. In one test activated carbon was added to a 1-to-1 cement/soil mixture to immobilize organics and, potentially, organo-arsenical compounds. Due to the Phase 1 success using ferric sulfate, three additional ferric sulfate tests were conducted in Phase 2. The first test involved the addition of sodium bicarbonate to the ferric sulfate/lime mixture to evaluate the potential for more alkaline conditions (pH>7) and bicarbonate (as potentially derived from the site groundwater and acid rain) to remobilize the arsenic. This test should represent a worst-case, long-term scenario, since relatively high ratios of sodium bicarbonate were used. The second test was similar to the Phase 1 ferric sulfate test; however, only about half as much ferric sulfate and lime were used. This test was conducted to potentially optimize costs associated with iron-based fixation. The third test was also similar to the Phase 1 ferric sulfate test; however, activated carbon was also added to immobilize organics and, potentially, organo-arsenical compounds. For the last

test, cement kiln dust (with 10 percent cement added to provide pozzolanic properties), at a relatively high dust-to-soil ratio of 1.5 to 1, was evaluated. Cement kiln dust was considered, since the properties associated with it are potentially different than cement. Preroasting was not investigated in Phase 2.

Sample Drying Procedure

All soils were air dried prior to weighing and mixing. Air drying was conducted on a table in an air-conditioned room. The air temperature was maintained between 65°F and 75°F. The samples were generally dried overnight to achieve a visually dry appearance. This drying was conducted to normalize the moisture contents of the soils as well as to allow clumps of clay in the samples to be subjected to size reduction. The relative moisture content of the soils was tracked by recording weight versus time of a segregated sample subjected to the same conditions. Total weight loss from air drying was 2 percent and 7 percent, for the composite average sample and worst-case sample, respectively. (The worst-case sample was wetter than the composite-average sample.)

Size Reduction Procedure

Size reduction was conducted in a stainless-steel pan using a 2-pound hammer. The materials were then screened using a 3/8-inch sieve. The raw materials were observed to be either clumps of clay or limestone. The limestone fragments (greater than 3/8-inch) were manually removed prior to size reduction and during screening. These fragments were set aside and not used in any subsequent testing. During the screening, it was apparent that a portion of the limestone passed the 3/8-inch sieve; however, the majority of the limestone was removed from the screened soils.

Mixing Procedure

Mixing was conducted in a 2-gallon Hobart paddle mixer. The paddle rotated as well as revolved around the edge of the bowl. The air-dried soils, reagents, and water were weighed and then added to the mixer. Mixing was conducted for a period of about 5 to 10 minutes. Approximately halfway through the mix time, the paddle and bowl were manually scraped to improve the uniformity of the mixture. The samples for (curing and) analysis were taken directly from the bowl. The bowl and paddle were decontaminated in between each batch using potable water, Alconox soap, and dilute nitric acid washes; as well as a distilled water rinse.

Water Addition Procedure

Distilled water was added to each mixture based on the preferred consistency of each mix. For the pozzolanic mixtures, a relatively fluid blend was developed. This blend was created to

provide sufficient water for hydration and to compensate for water that would become bound into the matrix. A mixture that may be described as a moderate slump was achieved. Water was added after the roasting step for the preroasting tests. For the nonpozzolanic mixtures, a damp but nonflowable soil-like blend was formed. The water-to-soil ratios are provided in Table 2-1.

Sample Casting and Curing

Following water addition and mixing, the mixtures were placed into 2-inch diameter by 2-inch or 4-inch long cylinders. These casts were placed into a constant humidity chamber and allowed to cure. A 100 percent relative humidity was maintained by placing an open container of water in the chamber. This chamber was sealed during curing and maintained at a temperature of 65°F to 75°F. Cure times were 5 days for the Phase 1 5-day cure samples and 28 days for the remaining samples.

Roasting Procedures

For tests CA-05 and WC-10, the composite average and worst-case samples were roasted at 700°C after mixing with cement but prior to hydration and curing. The air-dried soil sample was dry mixed with cement at a 1-to-1 ratio. These samples were then placed into a oven maintained at 700°C. The samples were placed in the oven for a total of 75 minutes, 15 minutes of which was used to allow the sample to heat up. After roasting, the samples were allowed to cool to room temperature, prior to hydration and curing.

Lime Determination Procedure

For the ferric sulfate-based iron fixation tests, lime was used to neutralize the excess acidity associated with ferric sulfate. The general objective of adding lime was to achieve a final mixture pH of between 4 and 6 S.U. To determine the quantity of lime required, 100 grams of soil, 10 grams of ferric sulfate, and 110 grams of water (or equivalent ratios) were placed in a 500 ml beaker. The solution was periodically mixed over a 1-hour period. Small quantities of lime were then added. The quantity of lime added and the resulting pH were recorded until the target pH range was achieved. An equivalent lime/ferric sulfate ratio was used in preparing the samples.

2.4 SAMPLING AND ANALYSIS

Seven soil samples and one background groundwater sample were collected by the REM III Team at the Whitmoyer Laboratories Site on October 9 and 10, 1989 (see Attachment 1). The soil samples were collected and stored in plastic lined, carbon steel, 5-gallon containers. The groundwater sample was collected and stored in plastic, 5-gallon containers. A 32-ounce split of each sample was submitted to an independent laboratory for total arsenic analysis. The results of this analysis are presented in

Attachment 2. Based on these results, sample WL-TS-207-06 was selected as the worst-case sample. A composite average sample WL-TS-208-99 was generated from compositing equal portions of samples WL-TS-203-05, WL-TS-204-03, and WL-TS-206-05 on November 9, 1989.

Two 5-gallon buckets of the composite average and the worst-case samples were shipped to HAZCON, Inc., on that date under chain-of-custody. (HAZCON, Inc. was originally going to conduct the treatability study, but was unable to conduct it). HAZCON performed minimal activities with these soils. These samples were returned to the REM III Team under chain-of-custody. These samples were received in the NUS testing room (EPA ID Number PAD 982682718) on March 5, 1990. The treatability study was initiated on that date.

All chemical analyses (except the initial independent laboratory analysis) was conducted by Western Research Institute under the REM III Laboratory Program. Copies of the chain-of-custody forms for all analyses are presented in Attachment 1. The untreated samples were analyzed for the parameters presented in Table 2-2. The Phase 1 and Phase 2 treated samples were analyzed for the parameters presented in Table 2-3.

2.5 DATA MANAGEMENT

The REM III Project Team kept detailed logs and records of all sampling and testing activities, including any pretreatment and post-treatment steps. Testing procedures were documented, using dedicated bound notebooks, photographs, etc. Backup copies of critical items of data were made. A copy of all drawings, logs, records, data, and other documents generated during the project are present in the project file.

2.6 HEALTH AND SAFETY

A separate Health and Safety Plan (HASP) was prepared for this treatability study (Ebasco, 1990d). This HASP utilized information contained in the RI HASP (Ebasco, 1988). All study activities were conducted in accordance with the study HASP. No notable health and safety incidents occurred.

2.7 RESIDUALS MANAGEMENT

All potentially contaminated solid residuals were labeled and returned to the Whitmoyer Laboratories Site. These residuals consisted of approximately 1.4 cubic feet of contaminated personal protective equipment (gloves, etc.) and soils. These materials will ultimately be disposed with other site waste during site remediation. Archive samples were also returned to the site for long-term storage.

TABLE 2-2

**INITIAL WASTE CHARACTERIZATION
ANALYTICAL TESTING SCHEME
WHITMOYER LABORATORIES SITE
LEBANON COUNTY, PENNSYLVANIA**

Sample Description	Number of Samples	Analysis to be Performed
Upgradient Groundwater (to be used for modified ASTM procedure)	1	Total arsenic, TDS, pH, TOC, Ca, Mg, Na, Fe, SO ₄ ⁻ , Cl
Composite Average	1	Total Arsenic, TOC, +5As, +3As, pH TCLP Leachate Procedure: Arsenic, pH EP Leachate Procedure: Arsenic, pH ASTM Leachate Procedure: Arsenic, TDS, TOC, pH, +5As, +3As Modified ASTM Leachate Procedure*: Arsenic, TOC, TDS, pH, +5As, +3As
Worst Case	1	Total Arsenic, TOC, +5As, +3As, pH TCLP Leachate Procedure: Arsenic, pH EP Leachate Procedure: Arsenic, pH ASTM Leachate Procedure: Arsenic, TDS, TOC, pH, +5As, +3As Modified ASTM Leachate Procedure*: Arsenic, TOC, TDS, pH, +5As, +3As

* Identical to ASTM Leachate Procedure, except that upgradient groundwater was used as the extraction fluid.

TDS - Total Dissolved Solids.
 TOC - Total Organic Carbon.
 +5As - Pentavalent Arsenic.
 +3As - Trivalent Arsenic.
 TCLP - RCRA 268 Toxicity Characteristic Leaching Procedure.
 EP - RCRA 261 Extraction Procedure.
 ASTM - D-3987-85 Shake Extraction of Solid Waste with Water.

TABLE 2-3

TREATED WASTE CHARACTERIZATION
ANALYTICAL TESTING SCHEME
WHITMOYER LABORATORIES SITE
LEBANON COUNTY, PENNSYLVANIA

Sample Description	Number of Samples	Analysis to be Performed
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PHASE 1

5-day cure: (2 roasted and 8 unroasted)	10	• TCLP: Arsenic, pH
28-day cure: (2 roasted and 8 unroasted)	10	• Total Arsenic • TCLP Leachate Procedure: Total Arsenic, pH • EP Leachate Procedure: Total Arsenic, pH • ASTM Leachate Procedure: Total Arsenic, TOC, pH, TDS • Modified ASTM Procedure*: Total Arsenic, TOC, pH, TDS • Unconfined compressive strength (ASTM-D2166) • Bulk density

PHASE 2

28-day cure: (2 roasted and 8 unroasted)	10	• Total Arsenic, +5As, +3As • TCLP Leachate Procedure: Total Arsenic, pH • EP Leachate Procedure: Total Arsenic, pH • ASTM Leachate Procedure: Total Arsenic, +5As, +3As, TOC, pH, TDS • Modified ASTM Procedure*: Total Arsenic, TOC, pH, TDS, +5As, +3As • Unconfined compressive strength (ASTM-D2166) • Bulk density
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* Procedure duplicated ASTM leachate except upgradient groundwater from the site was used as an extraction fluid.

+5As - Pentavalent Arsenic.

+3As - Trivalent Arsenic.

TOC - Total Organic Carbon.

TDS - Total Dissolved Solids.

2.8 DEVIATIONS FROM THE WORK PLAN

Only minor deviations from the Work Plan (Ebasco, 1990b) (e.g. using a 3/8-inch sieve rather than a 1/4-inch sieve for screening) occurred during the study. All deviations from the Work Plan are noted in this document.

3.0 RESULTS AND DISCUSSION

3.1 DATA ANALYSIS AND INTERPRETATION

3.1.1 Analysis of Untreated Soils and Groundwater

The composite-average and worst-case soil samples were analyzed for the parameters indicated in Table 2-1. The analytical results are presented in Table 3-1. These results indicate that the total arsenic present in the untreated samples is 250 mg/kg and 2,400 mg/kg for the composite-average and worst-case samples, respectively. However, based on calculations using the arsenic concentrations measured in the treated samples and appropriate reagent dilution factors (presented in Attachment 2), the average arsenic concentration in the composite-average sample is more likely to be about 600 mg/kg. The composite average sample total arsenic value presented in Table 3-1 may be low; a large analytical variation could be due to the use of only a small portion of the sample for the analysis. A similarly calculated arsenic concentration for the worst-case sample is 2,700 mg/kg, which is in reasonable agreement with the value presented in Table 3-1.

The analytical results for the four leachate tests on the untreated samples are also provided in Table 3-1. For the composite-average sample, the EP Toxicity Procedure was found to be the least aggressive, and the ASTM leachate procedure was found to be the most aggressive for leaching arsenic. (The arsenic leachate concentrations varied from 0.077 mg/L to 0.54 mg/L.) The ASTM and modified ASTM leachates had pHs about one to two standard units (S.U.) higher than the TCLP and EP leachates. Since more arsenic was detected in the ASTM and modified ASTM leachates, the presence of iron-arsenic compounds, (which are more soluble at higher pHs) in the soils is indicated.

The leachate testing for the worst-case sample indicated much higher arsenic concentrations; these concentrations varied from about 8.7 mg/L to 14 mg/L.

The groundwater used in the modified ASTM leachate procedure was found to contain low levels of arsenic (0.009 mg/L). This water was obtained upgradient of the main Whitmoyer Laboratories Site contaminant plume. The moderate levels of TDS (315 mg/L) and pH (7.3 S.U.) are likely characteristics of uncontaminated groundwater at the site.

3.1.2 Analysis of Treated Soils

A summary of the arsenic leachate results for the Phase 1 testing are provided in Table 3-2. In general, these results indicate that at a cement-to-soil ratio of about 1 to 1 (without roasting), the arsenic leachate concentration is about 0.12 mg/L to 0.35 mg/L. This range was observed for both the composite average and worst-case sample. At the lower cement-to-soil

TABLE 3-1

INITIAL SOIL CHARACTERIZATION
WHITMOYER LABORATORIES SITE
LEBANON COUNTY, PENNSYLVANIA

Sample	Parameter	Total Analysis (mg/kg)	TCLP (mg/L)	EP Tox (mg/L)	ASTM (mg/L)	Modified ASTM (mg/L)
Composite Average (TS-208)	Arsenic (total)	250	0.12	0.077	0.54	0.23
	Arsenic (+5)	<10	-	-	<0.005	<0.005
	Arsenic (+3)	<10	-	-	<0.005	<0.005
	TOC	<10	-	-	<10	<10
	pH (S.U.)	8.2	6.4	5.3	7.9	7.9
	TDS	-	-	-	53	335
Worst Case (TS-207)	Arsenic (total)	2,400	13.9	10.0	10.6	8.7
	Arsenic (+5)	1,400	-	-	9.4	7.8
	Arsenic (+3)	<10	-	-	<0.005	<0.005
	TOC	<10	-	-	<10	<10
	pH (S.U.)	7.4	5.5	5.4	7.8	7.9
	TDS	-	-	-	76	340
Groundwater (total) (mg/L)	Arsenic (total)	0.009J				
	Calcium	64J				
	Magnesium	29J				
	Sodium	2.8J				
	Iron	19J				
	Sulfate	36J				
	Chloride	5.2J				
	TDS	315J				
	TOC	24J				
	pH (S.U.)	7.3J				

J - Reported value may not be accurate or precise (holding time was exceeded).

TABLE 3-2

TREATED SAMPLE ARSENIC LEACHATE RESULTS
WHITMOYER LABORATORIES SITE
LEBANON COUNTY, PENNSYLVANIA

Sample Number	Reagents	Reagent-to-Soil Ratio	Arsenic Concentration (mg/L)				
			5-Day TCLP	28-Day TCLP	EP Tox	ASTM	Modified ASTM
PHASE 1							
CA-01	CEM	1	0.40	0.25K	0.35	0.21	0.12
CA-02	CEM	0.1	0.77	2.7K	1.1	1.2	1.7
CA-03	CEM/FA	0.1/0.05	0.70	2.7K	0.99	0.28	1.7
CA-04	FE	0.1	<0.005	<0.005	<0.005	0.039	0.11
CA-05	CEM/R	1	<0.005	0.082K	<0.005	0.036	0.088
WC-06	CEM	1	0.32/ 0.32*	0.36K	0.20/0.18*	0.23	0.34
WC-07	CEM	0.1	2.7/2.3*	2.6K/2.6K*	1.8	1.6	1.6
WC-08	CEM/FA	0.1/0.05	2.8	4.2K	2.1	1.9/1.5*	2.2
WC-09	FE	0.1	0.007	0.14K	0.12	0.044	0.010J/ <0.005J*
WC-10	CEM/R	1	0.014	0.072K	0.077	<0.005	0.74

CA - Composite Average
WC - Worst Case

TABLE 3-2
TREATED SAMPLE ARSENIC LEACHATE RESULTS
WHITMOYER LABORATORIES SITE
LEBANON COUNTY, PENNSYLVANIA
PAGE TWO

Sample Number	Reagents	Reagent-to-Soil Ratio	Arsenic Concentration (mg/L)				
			5-Day TCLP	28-Day TCLP	EP Tox	ASTM	Modified ASTM
PHASE 2							
CA-12	CEM/AC	1/0.05	-	0.21	0.02	0.46	0.12/ 0.13*
CA-13	FE/CO3	0.1	-	<0.005	<0.005	0.41/0.47*	0.13
CA-14	FE	0.05	-	0.075	0.010	<0.005	0.006
CA-15	FE/AC	0.1/0.05	-	<0.005	0.008/<0.005*	0.005	<0.005
CA-16	CKD	1.5	-	0.31	1.1	1.4	1.3
WC-17	CEM/AC	1/0.05	-	0.2	0.32/0.32*	1.3	0.14
WC-18	FE/CO3	0.1/0.06	-	0.05	0.01	0.006/0.005*	0.069
WC-19	FE	0.05	-	0.08	0.008	0.022	<0.005/ <0.005*
WC-20	FE/AC	0.1/0.05	-	0.05/0.05*	<0.005	0.017	<0.005
WC-21	CKD	1.5	-	0.72/0.69*	0.82	1.4	1.4

CEM - Cement
FA - Fly Ash
FE - Ferric Sulfate/4 Hydrate/Lime
R - Roasted
AC - Activated Carbon
CKD - Cement Kiln Dust (with 10 percent cement added)
CO₃ - Sodium Bicarbonate
* - Duplicate Results
J - Reported value may not be accurate or precise.
K - Analyte present; reported value may be biased high.
- - Not Analyzed

ratio of 0.1 to 1 (with or without flyash), the arsenic leachate concentration ranged from about 0.7 mg/L to 4.2 mg/L. Only the 0.28 mg/L value for the composite average ASTM leachate is inconsistent with this range. Again, similar results were observed for the composite average and worst-case sample. Both iron fixation and cement fixation with roasting achieved much lower arsenic leachate concentrations. For the iron-based fixation, arsenic leachate concentrations varied from about <0.005 mg/L to as high as 0.14 mg/L. The average arsenic leachate concentrations for the worst-case sample were only slightly higher than the concentrations for composite average sample. Results similar to the iron-based fixation were achieved for the cement with roasting test. Only the 0.74 mg/L arsenic concentration for the worst-case modified ASTM leachate is inconsistent with this range.

Based on the Phase 1 5-day TCLP results, the Phase 2 testing matrix was developed. This Phase 2 matrix expanded on the iron-based fixation testing. Cement with activated carbon and cement kiln dust were also evaluated. Phase 2 test results are also presented in Table 3-2.

Cement-based fixation with the addition of activated carbon provided minimal, if any, decrease in the leachate concentrations of arsenic, when compared to cement fixation without activated carbon. Cement kiln dust, at relatively high ratios (1.5 to 1), produced leachates with arsenic concentrations similar to the low cement to soil ratio (0.1 to 1). The arsenic leachate concentrations ranged from about 0.3 mg/L to 1.4 mg/L.

The use of activated carbon with iron-based fixation appeared to significantly decrease the arsenic leachate concentrations, when compared to iron-based fixation without activated carbon. The maximum observed arsenic leachate concentration was 0.05 mg/L, and 75 percent of the arsenic leachate concentrations were at 0.005 mg/L or less. Without the use of activated carbon, the maximum arsenic leachate concentration (at an equivalent Fe/As ratio) was 0.140 mg/L, and only 25 percent of the arsenic leachate concentrations were at 0.005 mg/L or less.

At a reduced iron to soil ratio of 0.05 to 1, results similar to the 0.1 to 1 ratio were observed. This indicates that additional optimization of iron dosages may be warranted.

In one iron-based test, sodium bicarbonate was added to evaluate the impact of long-term carbonate attack on the iron-stabilized matrix. For the worst-case sample leachate tests and the composite-average sample EP toxicity and TCLP testing, there appeared to be no significant increase in arsenic leachate concentrations from bicarbonate addition. However, for the composite-average ASTM and modified ASTM testing, the arsenic leachate concentration increased significantly. The most significant factor causing this increase might have been the elevated pH. For the worst-case sample and the EP toxicity and

TCLP testing of the composite-average sample, the pH of leachate was 7.8 S.U. or less; whereas, for the leachates with the elevated arsenic levels, the leachate pHs were 9.1 and 9.5 S.U.

The pH and TDS leachate results for the ASTM leachate and modified ASTM leachate testing are provided in Table 3-3. In general, these results indicate that cement-based fixation resulted in TDS leachate concentrations of 500 mg/L to 1,600 mg/L and pHs of 11.9 to 12.5 S.U. For the iron-based fixation testing (except for the NaHCO_3 tests), TDS concentrations ranged from 1,500 mg/L to 2,400 mg/L and the pH ranged from 6.1 to 7.8 S.U. The TDS probably results from calcium sulfate (with a solubility of 2,000 mg/L) generated from the reaction between calcium hydroxide and ferric sulfate. The pH range developed is higher than desired for optimum ferric arsenate precipitation, indicating that optimization (i.e., less lime addition) may provide improved results.

For the CKD-based fixation testing, the leachate TDS concentration ranged from about 4,800 mg/L to 6,600 mg/L and the leachate pH ranged from 11.4 to 11.8 S.U.

Arsenic speciation testing was conducted on the untreated and Phase 2 treated samples as well as on the ASTM and modified ASTM leachates of these samples. These results are presented in Table 3-4. A review of the speciation data indicates that trivalent arsenic (As^{+3}) is present in the majority of the treated samples. However, As^{+3} was not detected in the untreated samples. For the leachate testing, the treated and untreated sample inorganic arsenic results are all less than 5 $\mu\text{g/L}$, except for the untreated worst-case sample and the samples treated with kiln dust, which leached predominantly pentavalent arsenic. The inability to detect As^{+3} or As^{+5} in the leachate indicates one of two factors. The first is that the analytical test procedure was flawed and did not accurately measure the arsenic species. The second factor is that the analytical procedures are accurate but the arsenic which leached was not As^{+3} or As^{+5} , but rather, an organic arsenic compound. In partial support of this second consideration is that the use of activated carbon with ferric sulfate (CA-15 and WC-20) resulted in the lowest arsenic leachate concentrations of any of the tests. However, activated carbon did not lower leachate arsenic concentrations for cement-fixed samples. The speciation data are too variable to make meaningful conclusions.

The total organic carbon (TOC) analytical results are not discussed in this section, since the results are all reported as less than or very near the detection limit. The analytical results are provided in Attachment 3.

The bulk density and unconfined compressive strength (UCS) results of analyses are presented in Table 3-5. These results indicate that, at a 1-to-1 cement-to-soil ratio, a relatively high-strength concrete was developed [3,000 pounds per square inch (psi) is considered a standard for general

TABLE 3-3

pH AND TDS LEACHATE RESULTS
WHITMOYER LABORATORIES SITE
LEBANON COUNTY, PENNSYLVANIA

Sample Number	Reagent	ASTM Leachate		Modified ASTM Leachate	
		pH (S.U.)	TDS (mg/L)	pH (S.U.)	TDS (mg/L)

PHASE 1

CA-01	Cem	12.5	1,500	12.4	1,300
CA-02	Cem	12.1	550	11.8	460
CA-03	Cem/FA	11.9	500	11.8	460
CA-04	Fe	7.5	2,500	7.8	2,700
CA-05	Cem/R	12.4	1,100	12.4	1,100
WC-06	Cem	12.5	1,600	12.4	1,300
WC-07	Cem	12.1	590	11.9	530
WC-08	Cem/FA	11.9	500	11.8	460
WC-09	Fe	6.1	2,500	7.8	2,700
WC-10	Cem/R	12.5	1,500	12.4	1,200

PHASE 2

CA-12	Cem/AC	12.5	1,600	12.5	1,500
CA-13	Fe/CO ₃	9.5/8.0*	4,000	9.1	4,500
CA-14	Fe	6.9	1,500	7.8	1,800
CA-15	Fe/AC	7.3	2,400	7.4	2,600
CA-16	CKD	11.8	4,800	11.7	5,200
WC-17	Cem/AC	12.5	1,400	12.5	1,500
WC-18	Fe/CO ₃	7.5/7.9*	2,700	7.8	2,800
WC-19	Fe	7.0	2,200	7.5	2,100
WC-20	Fe/AC	6.7	2,300	7.6	2,500
WC-21	CKD	11.5	5,900	11.4	6,600

Cem - Cement
 FA - Fly Ash
 Fe - Ferric Sulfate/4 Hydrate/Lime
 R - Roasted
 AC - Activated Carbon
 CKD - Cement Kiln Dust
 CO₃ - Sodium Bicarbonate

* Duplicate data

TABLE 3-4

ARSENIC SPECIATION DATA
WHITMOYER LABORATORIES SITE
LEBANON COUNTY, PENNSYLVANIA

Sample Number	As Received (mg/kg)			ASTM Leachate (µg/L)			Modified ASTM Leachate (µg/L)		
	As (Total)	As+3	As+5	As (Total)	As+3	As+5	As (Total)	As+3	As+5
CA*	248	<10	<10	542	<5	<5	234	<5	<5
CA-12	316	213	100	455	<5	<5	130/120**	<5	<5
CA-13	372/344**	<100	226	469/407**	<5	<5	130	<5	<5
CA-14	468	375	<100	<5	<5	<5	6	<5	<5
CA-15	245	196	<100	5	<5	<5	<5	<5	<5
CA-16	170	143	<100	1,400	<5	1,200	1,300	<5	<5
WC*	2,424	<10	1,425	10,600	<5	9,430	8,720	<5	7,800
WC-17	540	252	<100	1,300	<5	<5	140	<5	<5
WC-18	900	418	<100	5.1/6**	<5	<5	69	<5	<5
WC-19	644	363	<100	22	<5	<5	<5/<5**	<5	<5
WC-20	234	<100	165	17	<5	<5	<5	<5	<5
WC-21	958	176	<100	1,400	<5	1,400	1,400	<5	1,200

* Untreated samples

** Data from duplicate analyses

TABLE 3-5

**BULK DENSITY AND UNCONFINED COMPRESSIVE
STRENGTH RESULTS
WHITMOYER LABORATORIES SITE
LEBANON COUNTY, PENNSYLVANIA**

Sample Number	Reagent	Bulk Density (g/cm ³)	Unconfined Compressive Strength (psi)
CA-01	Cem	2.0	4,300
CA-02	Cem	1.8	340
CA-03	Cem/FA	1.8	220
CA-04	Fe	1.9	320
CA-05	Cem/R	1.9	4,100
WC-06	Cem	2.0	4,400
WC-07	Cem	1.8	330
WC-08	Cem/FA	1.6	200
WC-09	Fe	1.6	290
WC-10	Cem/R	1.8	2,700
CA-12	Cem/AC	1.8	2,400
CA-13	Fe/CO ₃	1.5	40
CA-14	Fe	1.8	740
CA-15	Fe/AC	1.9	1,400
CA-16	CKD	1.9	240
WC-17	Cem/AC	2.0	3,600
WC-18	Fe/CO ₃	2.1	700
WC-19	Fe	2.0	2,500
WC-20	Fe/AC	1.9	60
WC-21	CKD	2.0	150

Cem - Cement
 FA - Fly Ash
 Fe - Ferric Sulfate/4 Hydrate/Lime
 R - Roasted
 AC - Activated Carbon
 CKD - Cement Kiln Dust
 CO₃ - Sodium Bicarbonate

construction uses]. At lower cement ratios, UCSs characteristic of soils were developed. The use of iron and other additives resulted in UCSs ranging from 40 psi to 1,400 psi. The value of 1,400 psi on sample CA-15 (using iron, lime, and activated carbon) is indicative of pozzolanic properties. This finding is inconsistent, since no pozzolanic materials were used in this test. For the CKD-treated samples, UCSs of only 150 to 204 psi were developed. This indicates that significant pozzolanic reactions did not occur in the 28-day cure period.

The bulk densities of the treated samples generally range from about 1.6 to 2.0. This range is common for soils but low for common concrete, which has a value of about 2.5. The minimum bulk density occurred with sample CA-13. During the preparation of this sample, the volume of the sample was observed to increase with time. Release of carbon dioxide within the sample is suspected for this volume increase.

During the sample preparation and curing, the color and consistency were observed. The untreated samples were red to orange. The resulting colors of the treated samples were dependent on the reagents used. Cement and kiln dust treatment resulted in a gray mixture color. The inclusion of fly ash or activated carbon darkened this color. Iron treatment resulted in a red coloring. Each of the pozzolanic-based test samples solidified, whereas the iron-based test samples had a damp, soil-like consistency.

During the sample curing, an obvious mold (or similar growth) grew on the iron-fixated, worst-case samples. This mold was not noted on the untreated samples; pozzolanic-fixated samples; or composite average, iron-fixated soil.

Calculations are presented in Attachment 2 which evaluate the potential volatilization of arsenic during the roasting step. This evaluation found that no significant volatilization of arsenic resulted. However, due to the limited sampling (since determining arsenic volatilization during roasting was not a treatability study objective), and since arsenic is somewhat volatile at the roasting temperature used, it is likely that some arsenic did volatilize.

3.1.3 Comparison of Test Objectives

As presented in Section 2.1, the primary objectives of this study were to reduce the mobility of arsenic and organics. Four leachate tests were conducted. Of these four tests, the TCLP and EP toxicity testings were conducted for regulatory purposes. The ASTM procedure was used to evaluate conditions, in which soil constituents were the predominant factors in general leachate characteristics. The modified ASTM is similar to the ASTM, except that site groundwater was used. This test was conducted to evaluate the effects of groundwater on saturated soils at the site.

The reductions in arsenic mobility, as measured by the leachate concentrations, are presented in Tables 3-6 and 3-7, for pozzolanic- and iron-based reagents, respectively. Also presented for comparison are the untreated arsenic leachate concentrations. The reductions presented have not been corrected for the quantity of reagent added (to correct for simple dilution benefits). If used, these correction factors would be about 0.07 to 0.19 for the iron-based fixation and 0.28 to 2.4 for the pozzolanic-based fixation. An evaluation of the reduction in mobility of organics as measured by the TOC analysis is not possible, since most of the organic results were near or below the detection limits.

For treated samples using pozzolanic-based reagents, mixed results were observed. For the composite-average samples, pozzolanic reagents appear to increase the mobility of arsenic. For the worst-case sample, a consistent decrease in arsenic mobility was observed. The arsenic leachate concentrations appeared to approach a concentration of about 0.2 mg/L and 1 mg/L for the cement-to-waste ratios of 1 to 1 and 0.1 to 1, respectively. The results of the CKD testing were similar to the results for the cement-to-waste 0.1-to-1 ratio. The CKD contained 10 percent cement; thus 0.15 part cement was present. The cement fixation, coupled with roasting, resulted in a consistent decrease in arsenic mobility, as measured by the leachate procedures, for both the composite-average sample and the worst-case sample. These results are similar to those observed for the vault and lagoon treatability studies (Ebasco, 1990a).

For the iron-based fixation reagents, consistent and substantial reductions in arsenic mobility were observed under all cases that were tested. The reagent which resulted in the lowest arsenic leachate concentrations were the iron/activated carbon combination, with reductions ranging from greater than 96 percent to greater than 99.9 percent. Only three of the leachate results did not achieve the objective of 90 to 99 percent reduction in arsenic mobility. Two of these results are associated with the composite average soil sodium bicarbonate test (CA-13) in which the pH exceeded 9.0 S.U. This elevated pH would not be expected to be observed at the site. (Site groundwater has a pH of about 7 to 8 S.U.). The iron-stabilized worst-case sample was also treated with sodium bicarbonate. Under the more realistic conditions (pH range of 7.5 to 7.9 for the ASTM and modified ASTM tests) of this test (WC-18), the fixated arsenic appeared to be stable. The third result (CA-04, modified ASTM analysis) could not be explained. The corresponding arsenic concentration was about twice the MCL for arsenic.

3.2 QUALITY ASSURANCE/QUALITY CONTROL

This soils fixation treatability study was conducted in accordance with the Quality Assurance Project Plan (QAPjP) (Ebasco, 1990c) for the project. Exceptions are noted below.

TABLE 3-6

**REDUCTION IN MOBILITY USING POZZOLANIC-BASED REAGENTS
WHITMOYER LABORATORIES SITE
LEBANON COUNTY, PENNSYLVANIA**

Reagent	Reagent Ratio	Percent Change in Leachate Concentration		
		TCLP	ASTM	Modified ASTM
Composite Average, Untreated		120 µg/L	540 µg/L	230 µg/L
Cement	1:1	110%	(61)%	(48)%
Cement	0.1:1	2,200	120	640
Cement/Fly Ash	0.1/0.05:1	2,200	(48)	640
Cement/AC	1/0.05:1	75	(15)	(48)
Cement/Roasted	1:1	(33)	(93)	(62)
Worst-Case, Untreated		13,900 µg/L	10,600 µg/L	8,700 µg/L
Cement	1:1	(97)%	(97)%	(96)
Cement	0.1:1	(81)	(85)	(82)
Cement/Fly Ash	0.1/0.05:1	(70)	(82)	(75)
Cement/AC	1/0.05:1	(99)	(88)	(98)
Cement/Roasted	1:1	(99.5)	(>99.9)	(91)
Composite Average, Kiln Dust	1.5:1	160%	120%	470%
Worst-Case, Kiln Dust	1.5:1	(95)%	(84)%	(84)%

AC - Activated Carbon

EP Toxicity leachate results resemble TCLP results.

Parentheses indicate a reduction in leachate concentration.

TABLE 3-7

REDUCTION IN MOBILITY USING IRON-BASED REAGENTS
WHITMOYER LABORATORIES SITE
LEBANON COUNTY, PENNSYLVANIA

Reagent	Reagent Ratio	Percent Change in Leachate Concentration		
		TCLP	ASTM	Modified ASTM
Composite Average, Untreated		120 µg/L	540 µg/L	230 µg/L
Fe	0.05:1	(38)%	(>99)%	(>97)%
Fe	0.10:1	(>96)	(93)	(52)
Fe/AC	0.1/0.05:1	(>96)	(99)	(>98)
Fe/CO ₃	0.1:1	(>96)	(24)	(43)
Worst-Case, Untreated		13,900 µg/L	10,600 µg/L	8,700 µg/L
Fe	0.05:1	(99.4)%	(99.8)%	(>99.9)%
Fe	0.1:1	(99.0)	(99.6)	(99.9)
Fe/AC	0.1/0.05:1	(99.6)	(99.8)	(>99.9)
Fe/CO ₃	0.1:1	(99.6)	(99.9)	(99.2)

Fe - Ferric Sulfate/Lime

AC - Activated Carbon

CO₃ - Sodium Bicarbonate

EP leachate results resemble TCLP results.

Parentheses indicate a reduction in leachate concentration.

In the QAPjP, the proposed analytical methods for trivalent and pentavalent arsenic in water were methods from an U.S. Army Corps of Engineers (1973) research project. Western Research Institute, the analytical subcontractor, analyzed for these arsenic species using an alternate method, ion chromatography. Additionally, two arsenic analyses (the total arsenic analysis for the untreated composite average sample and the 5-day TCLP analysis for sample WC-08) could not be performed using the specified arsine generation method, because of matrix interferences. Following digestion, these samples were analyzed for arsenic content using Atomic Adsorption and Inductively Coupled Plasma methodology, respectively.

Key quality assurance objectives for the project include 95 percent completeness; USEPA Contract Laboratory Program (CLP) accuracy criteria for laboratory spikes, method blanks, and "blind" blanks; CLP precision criteria for laboratory duplicates; and a criterion of ± 50 percent Relative Percent Difference (RPD) for "blind" duplicates.

All of the treatability study analytical data met the QA objectives, except as follows:

- Positive Phase 1 28-day TCLP arsenic results were qualified with a "K," indicating that the reported values may be biased high, since the two spike recoveries for this sample set were 137 percent and 134 percent. QC limits of ± 25 percent were specified.
- The modified ASTM arsenic analytical results for the laboratory duplicates of sample WC-09 were qualified with a "J," indicating that the reported values may not be accurate or precise, since the RPD for these analyses were outside the ± 25 percent limit for laboratory duplicates. Both analytical results were less than 10 $\mu\text{g/L}$.
- The analytical results for the background groundwater used in the modified ASTM leaching procedure were qualified with a "J," since the holding times for these analyses were exceeded. This exceedance is not considered important to the project, since it is unlikely that the concentration of major ions in the groundwater changed significantly during the extended holding period.

The qualified data are highlighted on Tables 3-1 and 3-2. The remaining analytical data was validated without qualification. Data validation packages were prepared and forwarded to the USEPA Region III Central Regional Laboratory for review and concurrence.

One blind reagent blank consisting of hydration water and fixatives only (no wastes) was submitted for TCLP extraction and analysis with both the Phase 1 5-day and Phase 2 28-day sample sets. For the Phase 1 sample set, the blank consisted of

20 parts cement to 1 part fly ash. For the Phase 2 sample set, the blank consisted of cement kiln dust only. No arsenic (detection limit = 5 µg/L) was detected in the TCLP leachates from these reagent blanks.

Chain-of-custody procedures were maintained for all samples generated during the treatability study. Samples were preserved and shipped in accordance with REM III protocols.

During the study, all laboratory measurement devices were calibrated according to the manufacturer's specifications. These calibrations were recorded in the laboratory logbook. Analytical laboratory equipment was calibrated in accordance with the analytical methodology in all cases.

Other than the reanalysis of samples with matrix interferences and the data qualification cited above, no corrective actions were required for the treatability study.

3.3 PROCESS DESIGN/COSTS

Based on the successful treatability study results using iron-based fixation, a preliminary conceptual design was developed for soil fixation using this reagent. A schematic of this process is provided in Figure 3-1 and discussed below.

The soils would be excavated, screened, and placed in the first of two pug mills. Ferric sulfate would be metered in an approximate ratio of about 0.1 pounds per pound of soil. When organic-contaminated soils are being processed, activated carbon would also be added at a ratio of about 0.05 pounds per pound of soil. The first pug mill would discharge directly to a second pug mill, where hydrated lime at a ratio of about 0.04 pounds per pound of soil would be added. The treated material would then be backfilled on site or landfilled off site.

The three reagents would be stored in silos and dry fed to the pug mills. Ventilation and air pollution controls would be required for both pug mills. Offgas considerations include dusts generated from the dry addition of ferric sulfate, hydrated lime, and activated carbon. In addition, in the first pug mill, carbon dioxide may be released from calcium carbonate to carbonic acid conversion; and volatile organics (VOCs) may be released from the 30,000 CY of VOC-contaminated soils. An exhaust hood with a baghouse would be used to capture the dusts generated. Carbon dioxide would only be a concern if it would be concentrated in an enclosed space. The dust from the baghouses would be returned to the treatment process. The potential VOC release is not expected to be a significant concern, because of the small quantity of VOCs.

The estimated cost associated with treating 115,000 cubic yards (CY) of contaminated soils with iron (and treating 30,000 CY of these soils with activated carbon) are detailed in Table 3-8 and total about \$7,500,000 (\$65/CY). If activated

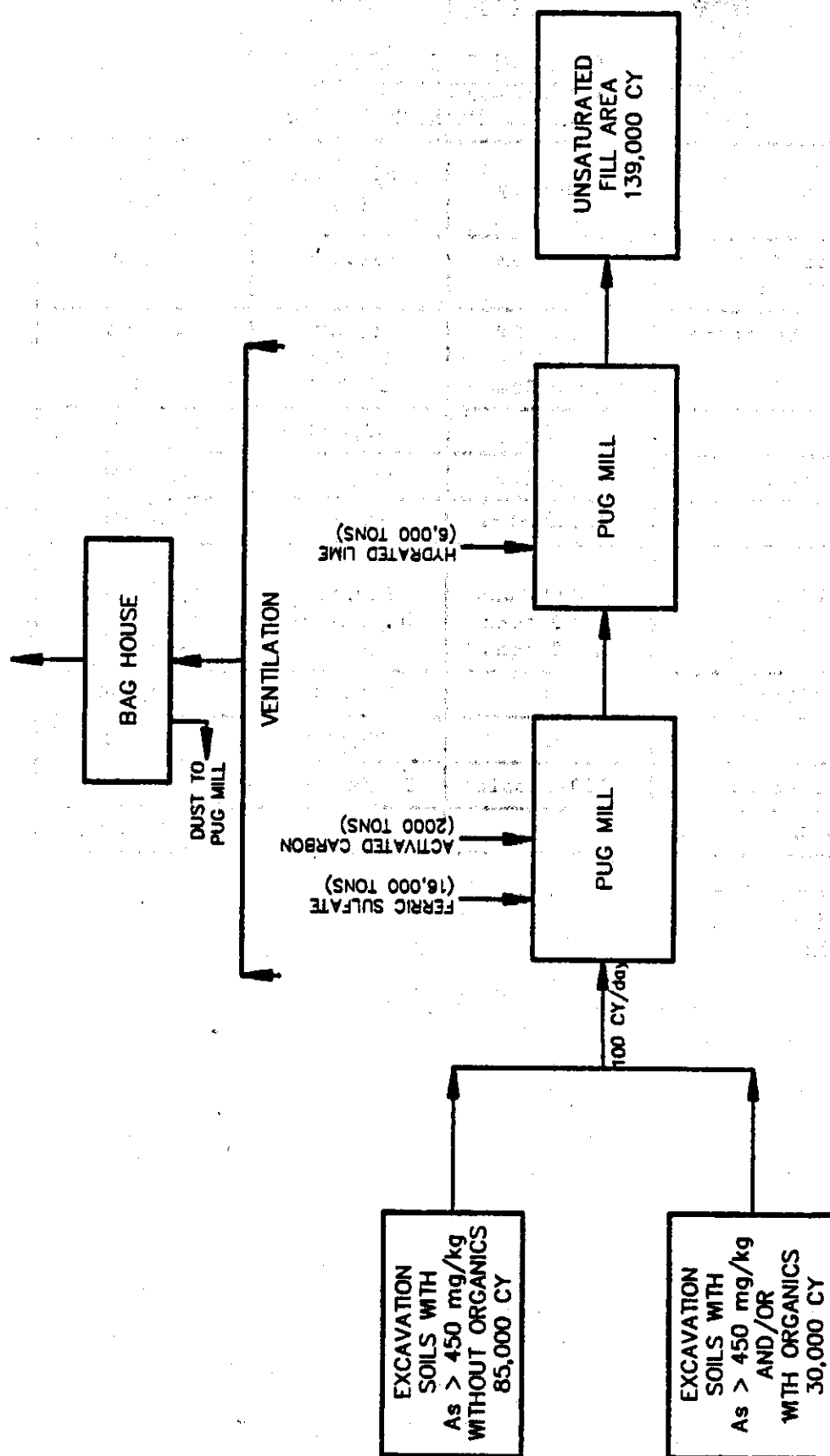


FIGURE 3-1



TREATMENT PROCESS SCHEMATIC
IRON-BASED FIXATION OF CONTAMINATED SOILS
WHITMOYER LABORATORIES SITE, LEBANON COUNTY, PA

TABLE 3-8

**ESTIMATED FIXATION TREATMENT COST
WHITMOYER LABORATORIES SITE
LEBANON COUNTY, PENNSYLVANIA**

Item	Quantity	Unit Cost (\$)	Total (\$)
1 Mobilization/ Demobilization	Lump Sum	\$50,000	\$50,000
2 Temporary Structure Foundation	4,000 SF	10/SF	40,000
Electrical	40 CY	500/CY	20,000
	Lump Sum	50,000	50,000
3 Pug Mill	2	80,000	160,000
4 Ventilation/Baghouse	Lump Sum	150,000	150,000
5 Labor	28,000 mhrs	35/mhr	980,000
6 Reagents			
Ferric Sulfate	16,000 tons	120/ton	1,920,000
Activated Carbon	2,000 tons	1,400/ton	2,800,000
Lime	6,000 tons	60/ton	360,000
7 Chemical Silos	3	120,000	360,000
8 Conveyors	3	20,000	60,000
9 Chemical testing	1,000 samples	500/sample	500,000
TOTAL			\$7,450,000

SF - Square feet
CY - Cubic yards
mhr - Manhours

carbon is not used, the estimated cost is \$4,600,000 (\$40/CY). These costs include only the treatment of the soils. Costs associated with excavation and landfilling are specifically excluded. In addition, these costs do not include any engineering, health and safety considerations, markup, or contingency.

3.4 KEY CONTACTS

Key contacts for this treatability study are Mr. John Trepanowski, P.E., of the NUS Corporation Wayne, Pennsylvania, office; Mr. David Brayack, P.E., of the NUS Corporation Pittsburgh, Pennsylvania, office; and Mr. Anthony Dappalone, P.E., of the USEPA Region III Philadelphia, Pennsylvania, office.

4.0 CONCLUSIONS AND RECOMMENDATIONS

4.1 CONCLUSIONS

The conclusions of the soil fixation treatability study for the Whitmoyer Laboratories Site are as follows:

1. Iron-based fixation (ferric sulfate and lime) reduced the mobility of arsenic by 90 percent to 99.9 percent, as indicated by leachate testing.
2. At leachate pHs of about 7.8 or less, iron-fixated soils are stable in the presence of carbonate. At pHs above 9.0, a reduction in mobility still resulted from treatment; however, arsenic leachate concentrations as high as 0.41 mg/L were measured.
3. Iron-based fixation in combination with activated carbon provided the best reduction in mobility. The arsenic leachate concentration was measured to be equal to, or less than, the Safe Drinking Water Act Maximum Contaminant Level (MCL) for arsenic (50 µg/L) under all leachate tests.
4. Only two iron-to-soil ratios were evaluated. Both of these ratios resulted in similar reductions, indicating that further optimization of reagent dosages are possible.
5. During the curing period, mold (or similar growth) was observed on the iron-fixated worst-case samples. This growth may indicate that arsenic inhibitions to natural biological degradation of organics in the soils could be reduced or eliminated because of the arsenic immobilization.
6. Use of pozzolanic-based fixation reagents generated mixed results. For the composite average sample, with relatively low initial arsenic leachate concentrations, the use of cement or cement kiln dust resulted in minimal reduction in, or actually increased, the mobility of arsenic. For the worst-case sample, with relatively higher initial arsenic leachate concentrations, the use of cement or cement kiln dust resulted in a 75 percent to 98 percent reduction in arsenic mobility.
7. Cement fixation preceded by a roasting step consistently reduced arsenic mobility from 33 percent to greater than 99.9 percent. Significant arsenic volatilization was not measured during the roasting step.
8. Cement or cement kiln dust elevated the mixture pH to about 12 to 12.5 S.U. Iron-based fixation resulted in a neutral mixture pH of about 6 to 8 S.U.

9. The total dissolved solids (TDS) concentrations in all of the leachates were elevated as a result of the fixation. At low cement-to-soil ratios (0.1 to 1), the leachate TDS concentration was about 400 to 500 mg/L. (The background groundwater TDS concentration is about 320 mg/L.) At higher cement-to-soil ratios, the leachate TDS concentrations were about 1,000 to 1,500 mg/L. The use of iron and lime resulted in leachate TDS concentrations of approximately 1,500 mg/L to 2,500 mg/L. Use of cement kiln dust resulted in leachate TDS concentrations of about 5,000 mg/L to 7,000 mg/L.
10. Efforts to determine whether the chemical fixatives immobilized soil organic contaminants were not conclusive, because of the investigatory approach adopted (i.e., look for differences in total organic carbon (TOC) concentrations in treated and untreated leachates), relatively low TOC concentrations in the soils and leachates, and relatively high TOC method detection limits.

4.2 RECOMMENDATIONS

The following recommendations were developed, based on this treatability study.

1. Iron-based fixation alone, or iron fixation in combination with activated carbon, should be considered as a representative technology for soils fixation at the Whitmoyer Laboratories Site.
2. Ferric sulfate • 4H₂O and powdered activated carbon at reagent-to-soil ratios of 0.1 and 0.05, respectively, should be considered for preliminary design estimates. However, since activated carbon is very expensive, its use should be limited to only those soils with significant levels of organic contaminants.
3. Because of the potential for the treated soils to leach significant concentrations of TDS (most likely calcium sulfate), the treated soils should be located above the groundwater table.
4. Additional treatability studies during the remedial design would be warranted to optimize the use of iron, lime, and activated carbon.
5. If biological degradation of the organics is considered as an alternative, iron-based fixation preceding the biodegradation should be evaluated.
6. If the leachability of organics in the treated wastes becomes a concern, treated and untreated soils leachates should be subjected to analyses for specific target

analytes (e.g., aniline), with appropriate detection limits.

REFERENCES

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ATTACHMENT 1

**SAMPLE COLLECTION
WEEKLY FIELD SUMMARY REPORTS AND
CHAIN-OF-CUSTODY FORMS**

1390026A

AR300260

WEEKLY FIELD SUMMARY REPORT

FILE COPY
FILE NO. 1.6

PROJECT SITE NAME: Whitmoyer Laboratories Site
EPA WORK ASSIGNMENT NO.: 291-3NC9 / 200-3LC9
PROJECT NO.: ~~887~~ 966M // 1817
DATE(S): October 9 thru 11, 1989

SUNDAY

Date : _____ Personnel _____
Weather: _____ Onsite _____
Site Activities: _____

MONDAY

Date : 10-9-89 Personnel Scott M. Krall
Weather: 45° cold windy : Onsite Dave Brayak
Site Activities: SMK/DB obtain samples from
7 TEST Pits. Samples are for Treatability study
WL-TS 201 thru WL-TS 207.

TUESDAY

Date : 10-10-89 Personnel Scott M. Krall
Weather: 60° cool windy Onsite Dave Brayak
Scott Krall John Trzpanowski
Site Activities: SMK/DB/JT obtain water (50 gals) from
MW105A. This water will be used for the Treatability study as
Background groundwater. Obtain TANK samples WL J⁰⁰¹⁹-1
thru WL-TA 0023-1. SENT 4 waters to Aquatic
for METALS, BOD, COD/TOC, AND TOX, 1 solid for METALS, COD/TOC, TOX.
COC# 3-498C, AB# 1872926521 under REM III # 503 uses. Also sent
7 soils and 25 gals of water to Britrol Inc AR30026 for treatability study
COC# 3-498C AB# 1872926532

WEDNESDAY

Date : 10-11-89

Weather: 60° cool/warm
Wind 5-10 mph W

Personnel DAVE BIAYAK

Onsite John Trepanowski

NJS

Scott M. Krall

Dick Kiest

Site Activities: SMK obtains rounds of water levels, JT/DB/DK
trace piping in all buildings to be used for Remedial Construction
activities as to which pipes need drained.

THURSDAY

Date : _____

Weather: _____

Personnel _____

Onsite _____

Site Activities: _____

FRIDAY

Date : _____

Weather: _____

Personnel _____

Onsite _____

Site Activities: _____

SATURDAY

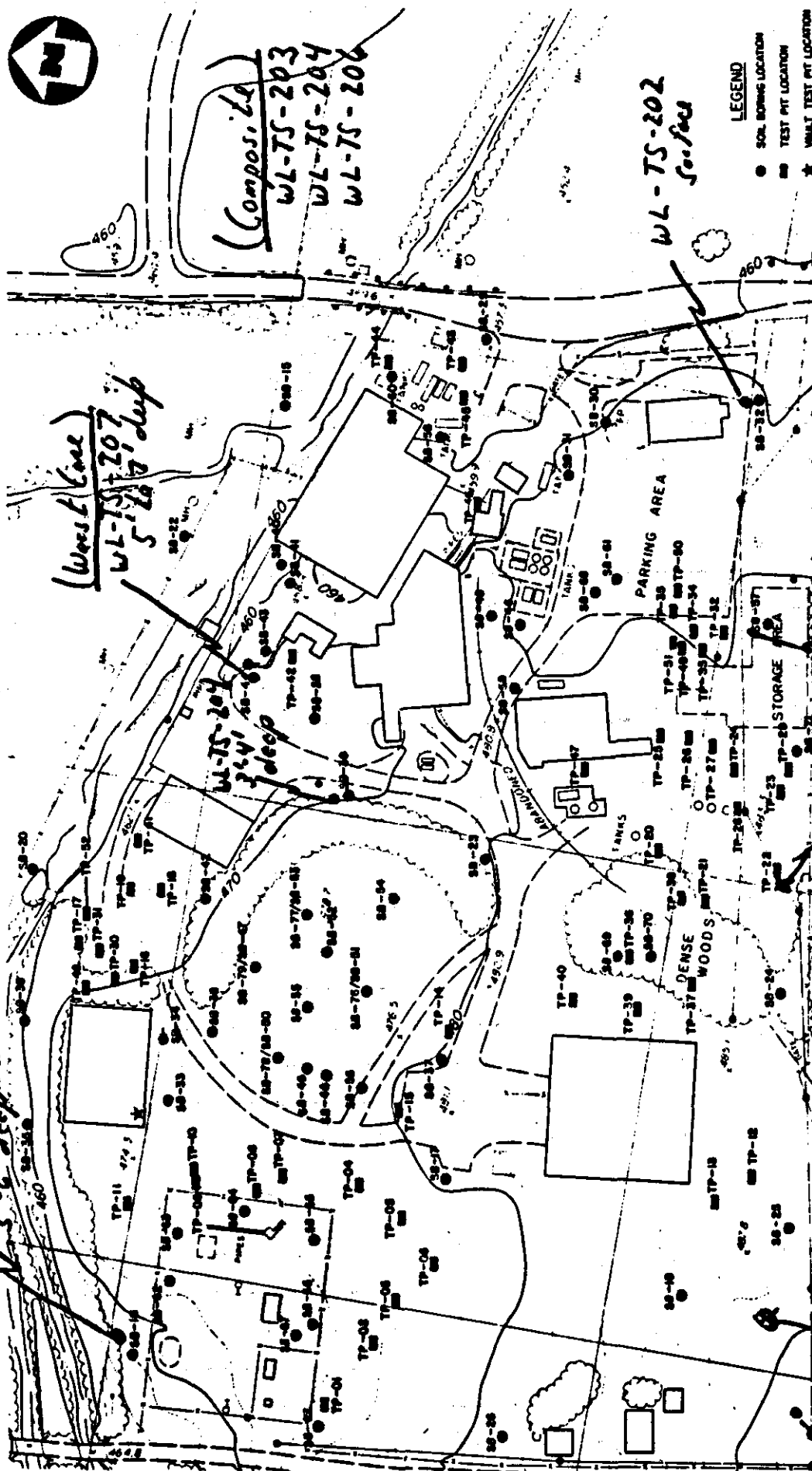
Date : _____

Weather: _____

Personnel _____

Onsite _____

Site Activities: _____



LEGEND

- SOIL BORING LOCATION
- TEST PIT LOCATION
- ★ VAULT TEST PIT LOCATION

FIGURE 2-1



2-7

AR300263

WL-TS-201
Surface
Background
Groundwater
Sample obtained
from MW105A

ONSITE SOIL BORING & TEST PIT LOCATIONS
WHITMOYER LABORATORIES SITE, MYERSTOWN, PA

Soils Traceability Study
Soil Sample Locations

Distribution: Original Accompanies Shipment; Copy to Coordinator Field Files

3-21413

Analysis Request and Chain of Custody Record

32522 McAllister Rd. • Brookshire, TX 77423 • 1-(2-B-SOLID • (713) 934-4500 • FAX (713) 934-3958

EBASCO SERVICE, INCORPORATED

Shipping Information:
FEDERAL EXPRESS
3/9/90
Name of Carrier
Date Shipped
1872926580
Airbill Number

SHIP TO: WESTERN RESEARCH INST.
9th + LEWIS ST.
LARAMIE, WY. 82001
ATTN: NANCY MISS
307 721 2011

Sampling Firm: NUS CORP
Sampling Contact: GREG ZIMMERMAN
(Name) (412) 788 1080
(Phone)

NO. 2 Charge Number
113417
Site Name/Code:
WHITMOYER LABS
200-SLC9

Sample No.		Date	Time	Station/Location	No. of Containers	Analytical Protocol R33.011				REMARKS
WLFPS-CA-01-S		3/9/90	NA	WLFPS-CA-01-S	1	1				
WLFPS-CA-02-S		3/9/90	NA	WLFPS-CA-02-S	1	1				
WLFPS-CA-03-S		3/9/90	NA	WLFPS-CA-03-S	1	1				
WLFPS-CA-04-S		3/9/90	NA	WLFPS-CA-04-S	1	1				
WLFPS-CA-04-S-S		3/9/90	NA	WLFPS-CA-04-S-S	1	1				LAB SPIKE
WLFPS-CA-05-S		3/9/90	NA	WLFPS-CA-05-S	1	1				
WLFPS-CA-06-S		3/9/90	NA	WLFPS-CA-06-S	1	1				
WLFPS-CA-06-S-S		3/9/90	NA	WLFPS-CA-06-S-S	1	1				
WLFPS-WC-07-S		3/9/90	NA	WLFPS-WC-07-S	1	1				
WLFPS-WC-08-S		3/9/90	NA	WLFPS-WC-08-S	1	1				
WLFPS-WC-09-S		3/9/90	NA	WLFPS-WC-09-S	1	1				
Relinquished by (Signature)		Date	Time	Received by (Signature)	Relinquished by (Signature)	Date	Time	Received by (Signature)		
WLFPS-CA-01-S		3/9/90	1600	FED EX						
Relinquished by (Signature)		Date	Time	Received by (Signature)	Relinquished by (Signature)	Date	Time	Received by (Signature)		
Relinquished by (Signature)		Date	Time	Received for Laboratory by (Signature)	Date	Time	Remarks: FEDERAL EXPRESS AB # 1872926 580			

EBASCO SERVICES INCORPORATED

NUS Charge Number 115117 Site Name/Code: WHITNEY LABS 200-3469	Sampling Firm: NUS Corp Sampling Contact: GREG ZIMMERMAN (Name) (412) 788 1080 (Phone)	Ship To: WESTERN RESEARCH INST QH & LEWIS ST. LARAMIE WY. 82070 Attn: NANCY NISS 307 721 2011	Shipping Information: FEDERAL EXPRESS Name of Carrier 3/9/90 Date Shipped 1872926580 Airbill Number
---	---	---	---

[illegible]

Distribution: Original Accompanies Shipment; Sec. Copy to RLSC Files; Third Copy to Project File

EBASCO SERVICE INCORPORATED

REM III PROGRAM CHAIN OF CUSTODY AND TRAFFIC RECORD

EBASCO Charge Number 1151171	Sampling Firm: <u>NYS Corp</u>	Ship To: <u>Western Research Inc</u>	Shipping Information: <u>Federal Express</u>
Ship Name/Owner: <u>Whitaker Laboratories</u>	Sampling Contact: <u>Greg Zimmerman</u>	<u>9th St Louis Street</u>	Name of Carrier: <u>04/03/90</u>
<u>200-3167</u>	(Name) <u>412-788-1080</u>	<u>Jacause NY 82070</u>	Date Shipped: <u>4/5/92</u>
	(Phone)	<u>Attn: Nancy Niss</u>	Airbill Number: <u>280673</u>

Sample No.	Date	Time	Station/Location	No. of Containers	Analysis Protocol	Remarks
105A	4/5/92		WT-BW-105A	1	X	Sample to be used for SAS No 5630101
105B	4/5/92		WT-BW-105B	1	X	Inst. Balance used
						Forward for tracking
						Hand-matched
						on SAS No 5630103
						Notes: Sample for a
						100.0000. Any results
						10.0000. 20.0000.00
						412-788-1080

Refiniquished by (Signature)	Date	Time	Received by (Signature)	Date	Time
<i>[Signature]</i>			<i>[Signature]</i>		
<i>[Signature]</i>			<i>[Signature]</i>		
<i>[Signature]</i>			<i>[Signature]</i>		

Refiniquished by (Signature)	Date	Time	Received for Laboratory by (Signature)	Date	Time	Remarks
<i>[Signature]</i>			<i>[Signature]</i>			Shipped via Federal Express
<i>[Signature]</i>			<i>[Signature]</i>			10 WAI REML SAS 5630101
<i>[Signature]</i>			<i>[Signature]</i>			REML SAS 5630103

1300268

EBASCO SERVICES INCORPORATED

EBASCO Charge Number 115117	Sampling Firm: <u>MYS Corp</u>	Ship To: <u>Western Research Inst.</u> <u>9th Lewis Streets</u> <u>Laramie, WY. 82070</u> Attn: <u>Nancy Niss</u>	Shipping Information: <u>Federal Express</u> Name of Carrier <u>2/5/88</u> <u>04/02/70</u> Date Shipped <u>1572936602</u> Airbill Number
Site Name Code: <u>Whitman-Leds</u> <u>200-3409</u>	Sampling Contact: <u>GREG ZIMMERMAN</u> (Name) <u>(412) 788-1080</u> (Phone)		

Sample No.	Date	Time	Station/Location	No. of Containers	Remarks

[illegible]

Relinquished by (Signature)	Date	Time	Received by (Signature)	Date	Time	Received by (Signature)
AR						

Relinquished by (Signature)	Date	Time	Received for Laboratory by (Signature)	Date	Time	Remarks:
002						Rem-III SAS# 5634103

EBASCO SERVICES, INCORPORATED

REM III PROGRAM CHAIN OF CUSTODY AND TRAFFIC RECORD

EBASCO Charge Number <u>1151112</u>	Sampling Firm: <u>ALUS Corp</u>	Ship To: <u>Western Research Inst</u>	Shipping Information: <u>Federal Express</u>
Site Name/Code: <u>Whitewater Labs</u>	Sampling Contact: <u>Greg Zamecena</u>	Name of Carrier: <u>04102190</u>	
<u>200-2669</u>	(Name) <u>(412) 788-1080</u>	Date Shipped: <u>1872926602</u>	
	(Phone) <u>Nancy Niss</u>	Airbill Number	

Samplers (Signature) <u>John Bortley</u> for Dave Bortley		Containers		Station/Location		Time		Remarks	
Sample No.	Date	Time	No. of Containers	Station/Location	Time	Date	Time	Remarks	
WETS-WC-08-28-S	4/14/90	NA	1	WETS-WC-08-28-S				Lab Spike	
WETS-WC-08-28-S			6	WETS-WC-08-28-S					
WETS-WC-08-28-D			1	WETS-WC-08-28-D				Duplicate	
WETS-WC-08-28-S			1	WETS-WC-08-28-S				Lab Spike	
WETS-WC-09-28-S			6	WETS-WC-09-28-S					
WETS-WC-09-28-D			1	WETS-WC-09-28-D				Duplicate	
WETS-WC-09-28-S			6	WETS-WC-09-28-S				Lab Spike	
WETS-WC-10-28-D			1	WETS-WC-10-28-D				Duplicate	
WETS-WC-10-28-S			6	WETS-WC-10-28-S				Lab Spike	
WETS-WC-10-28-D			1	WETS-WC-10-28-D				Duplicate	
WETS-WC-10-28-S			1	WETS-WC-10-28-S				Lab Spike	

Relinquished by (Signature) <u>John Bortley</u>	Date <u>4/2/90</u>	Time <u>0800</u>	Received by (Signature) <u>Federal Express</u>	Date	Time	Relinquished by (Signature)	Date	Time	Remarks: <u>Rem III SAS # 563 0103</u>
Relinquished by (Signature)	Date	Time	Received by (Signature)	Date	Time	Relinquished by (Signature)	Date	Time	
Relinquished by (Signature)	Date	Time	Received for Laboratory by (Signature)	Date	Time	Relinquished by (Signature)	Date	Time	

EBASCO SERVICES INCORPORATED

EBASCO Charge Number 11-3117	Sampling Firm: <u>MUS Corp</u>	Ship To: <u>Western Research Inst</u> <u>Guthrie's Streets</u> <u>Laramie, WY. 82070</u>	Shipping Information: <u>Federal Express</u>
Site Name/Code: <u>Whitmyer LabS</u>	Sampling Contact: <u>Greg Zimmerman</u>	Name of Carrier <u>04/02/90</u>	Date Shipped <u>1877926602</u>
	(Name) <u>(412) 788-1080</u>	Attn: <u>Nancy Niss</u>	Airbill Number
	(Phone)		

[illegible]

Distribution: Original Accompanies Shipment; Set 1 Copy to RLSC Files; Third Copy to Project File

~~AR300271~~

EBASCO SERVICE, INCORPORATED

EBASCO Charge Number: 115117 Site Name/Code: Whitmeyer Laboratories 200-3119	Sampling Firm: <u>Niles Corp</u> Sampling Contact: <u>Cory Zimmerman</u> (Name) <u>412-788-1080</u> (Phone)	Ship To: <u>Western Research Inst</u> <u>6th and Lewis Streets</u> <u>Laramie, WY. 82070</u> Attn: <u>Nancy Niss</u>	Shipping Information: <u>Federal Express</u> Name of Carrier <u>4/20/90</u> Date Shipped <u>1572726613</u> Airbill Number
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[illegible]

EBASCO SERVICES INCORPORATED

Ship To: Western Research Inst
8th and Grand Streets
Laramie, Wyo. 82070
Attn: Nancy Mills

ERASCO Charge Number: 115117
Site Name(s): Whitmyer Laboratories
300-365

[illegible]

EBASCO SERVICE, INCORPORATED

ERASCO Charge Number 115117	Sampling Firm: <u>MUS Corp.</u>	Ship To: <u>Western Research Inst.</u>	Shipping Information: <u>Federal Express</u>
Site Name/Code: <u>Mobil Oil Co. Laboratories</u>	Sampling Contact: <u>Greg Zimmerman</u>	<u>84 and Lewis Streets</u>	Name of Carrier <u>4/20/90</u>
<u>200-3469</u>	(Name) <u>412-288-1050</u>	<u>Laramie, WY. 82070</u>	Date Shipped <u>1872926613</u>
	(Phone) 	Attn: <u>Nancy Nils</u>	Airbill Number

[illegible]

EBASCO SERVICES INCORPORATED

EBASCO Charge Number <u>1151117</u> Site Name/Code: <u>LAJILMAYES LAJILMAYES</u> <u>2403-2163</u>	Sampling Firm: <u>MES Corp</u> Sampling Contact: <u>Larry Zimmerman</u> (Name) <u>512-758-1080</u> (Phone)	Ship To: <u>Western Research Inst.</u> <u>9th & Lewis Streets</u> <u>Laramie, Wyo. 82070</u> Attn: <u>Nancy Niss</u>	Shipping Information: <u>Federal Express</u> Name of Carrier <u>884433190</u> <u>4/20/90</u> Date Shipped <u>1872926613</u> Airbill Number
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[illegible]

EBASCO SERVICES INCORPORATED

ERASCO Charge Number 1151117 Site Name/Code: Laboratory Laboratories 200-3669	Sampling Firm: <u>MUS Corp.</u> Sampling Contact: <u>Greg Zimmerman</u> (Name) <u>412-788-1050</u> (Phone)	Ship To: Western Research Insto 9th and Lewis Streets Laramie, Wyo. 82070 Attn: <u>Nancy Niss</u>	Shipping Information: <u>Federal Express</u> Name of Carrier <u>4/20/90</u> Date Shipped <u>1873926613</u> Airbill Number
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[illegible]

ATTACHMENT 2

**2A BIOTROL DATA
2B CEMENT KILN DUST ANALYSIS
2C FLY-ASH ANALYSIS
2D CALCULATIONS**

AR300277

ATTACHMENT 2A

BIOTROL DATA

AR300277A

CHS LAB
SHEET SUBMITTAL FORM

Date: 10-30-89

Project No: 526

Test No: Heads

Project exp: ARZ

CONCENTRATIONS IN PPM, EXCEPT AS OTHERWISE INDICATED

Borehole	Lab No.	Whitmyer Site	Description	PH		COD		As TDS Urea Fe SO ₄ Cl		% (v)
				As	TDS	Urea	Fe	SO ₄	Cl	
89-28A		WL-TS 201-00		45						21.0
89-28B		WL-TS 202-00		62						20.6
89-28C		WL-TS 203-05		158						12.6
89-28D		WL-TS 204-03		960						15.1
89-28E		WL-TS 205-04		113						22.6
89-28F		WL-TS 206-05		1,425						23.9
89-28G		WL-TS 207-06		4,000						27.0
89-29		200 - BLC 9 Background Groundwater		30 (v)						
89-29		??		80 (v)						
4 Holes Presented										

00278

Comments (Naturally health risks, special handling req'd, etc.): (v): ppb ; (w): soil was dried 2 room temperature for 72 hours

AR300278

ATTACHMENT 2B
CEMENT KILN DUST ANALYSIS

AR300279



KEYSTONE CEMENT COMPANY

BATH, PENNSYLVANIA 18014

(215) 837-1881

CORPORATE
HEADQUARTERS
BATH, PA

SALES OFFICES
KING OF PRUSSIA, PA

PLANT
BATH, PA

January 26, 1989

Mr. John Trepanowski
NUS Corp.
One Devon Square, Suite 222
724 West Lancaster Avenue
Wayne, PA 19087

Dear Mr. Trepanowski:

I have requested our Chief Chemist, Mr. K. L. Wentzel, to ship via UPS one five-gallon can of Keystone Cement Kiln Dust (CKD) to:

Professor Larry Twidwell
Montana Tech
Butte, Montana 59701

A copy of a typical chemical analysis is attached for your information.

Any information garnered from Professor Twidwell's testing which you are willing to release would be greatly appreciated.

If we may be of further assistance, please do not hesitate to call.

Very truly yours,

J. D. Glassford
Manager, Aggregate Material Sales

JDG:lmw

Attachment

cc: Professor Larry Twidwell

AR300280

4/88



KEYSTONE CEMENT COMPANY

BATH, PENNSYLVANIA 18014

(215) 837-1881

CORPORATE
HEADQUARTERS
BATH, PA

SALES OFFICES
KING OF PRUSSIA, PA

PLANT
BATH, PA

KEYSTONE KILN DUST

Typical Analysis

Passing #100	92.0 - 98.0
Passing #200	82.0 - 88.0
CaO	40.0 - 45.0
MgO	2.0 - 3.0
Na ₂ O	0.4 - 4.0
Fe ₂ O ₃	1.0 - 2.0
SO ₃	3.0 - 16.0
SiO ₂	9.0 - 15.0
K ₂ O	4.0 - 15.0
Al ₂ O ₃	4.0 - 6.5
Loss	23.0 - 27.0
C.C.E.	75.6 - 86.7
E.N.P.	62.7 - 72.0
pH	12.7

Roger G. Wittmer
Director of Technical Services

AR300281

ATTACHMENT 2C
FLY-ASH ANALYSIS

AR300282

JTM ASH MANAGEMENT DIVISION
JTM INDUSTRIES, INC.

420 W. EMMAUS AVENUE
ALLENTOWN, PA 18103
OFFICE (215) 797-7674
DISPATCH (215) 797-7683
FAX (215) 797-6669

March 2, 1990

NUS Corporation
724 West Lancaster Avenue
Suite 222
Wayne, PA 19087
ATTN.: MR. JOHN TREPANOWSKI

RE: Montour Steam Electric Station Fly Ash

Dear Mr. Trepanowski,

I have enclosed a Montour plant data sheet and ASTM C618 Chemical and Physical Analysis for your information.

If you have any questions regarding the leachate analysis, they may be directed to Mr. Larry LaBuz at Pennsylvania Power & Light Company, 215-770-5340.

Sincerely,

Richard Mackow

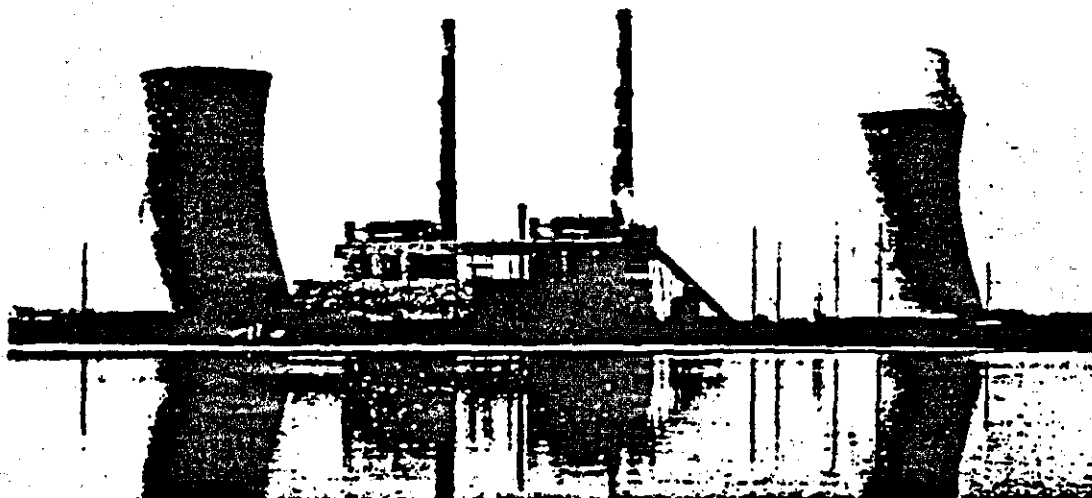
Richard A. Mackow
Technical Services Representative

RAM:tl

enclosures

RAMNUS1

AR300283



PP&L'S MONTOUR STEAM ELECTRIC STATION

Location:

On a 1,163-acre site in Derry Township, Montour County, approximately one mile northeast of Washingtonville.

Capacity:

Unit 1
750,000 kilowatts

Unit 2
750,000 kilowatts

Generators:

Speed
Voltage
Cooling

Stator
Rotor

3,600 rpm
24,000 volts
Water
Hydrogen at 75 psig
480 tons

3,600 rpm
24,000 volts
Water
Hydrogen at 75 psig
560 tons

Weight

Turbines:

Type
Steam Temperature
Steam Pressure

Tandem compound
1,000°F
3,675 psig

Tandem compound
1,000°F
3,675 psig

Turbine-Generators:

Length

175 feet

170 feet

Boilers: (1 per unit)

Steam Capacity
Heat Output
Tubing Length

5,850,000 pounds per hour
6,291,000,000 Btu per hour (sufficient to heat 157,000 homes)
Approximately 250 miles

Coal:

Each unit burns up to 275 tons per hour or more than 1,800,000 tons per year. Coal is delivered by Conrail in PP&L-owned "fleet trains" of 131 cars, with each car carrying 100 tons. Coal is mined at Greenwich Collieries, Garman, Pa., and at various market coal outlets in central Pa.

Coal Handling:

Coal unloading, stockpiling and transfer facilities are completely automated and capable of unloading a 170-car train in 4.5 hours.

Rotary Car Dumper
Car Positioners

Dumps one car every 2 minutes without uncoupling from train. Hydraulic pistons position each car in the rotary dumper without the use of a locomotive.

AR300284

RESOURCE MATERIALS TESTING, INC.

FILE COPY

REPORT TO: JTM Industries
 Ash Management Division
 777 Franklin Road
 Suite 100
 Marietta, GA 30067
 Attn: Mr. Dave Boyenga

PROJECT NO.: RMT-025
 SAMPLE NO.: 1020
 DATE REC.: 12-19-89
 DATE REP.: 1-28-89

PROJECT NAME: Quality Assurance Program Oct., Nov., Dec. 1989 Composite
 (Montour)

SAMPLE ID: AMD Lab No. 120589-M

CHEMICAL ANALYSES		
PARAMETER	RESULTS	ASTM C618 SPEC. F/C
Silicon Dioxide, SiO ₂ , %	50.3	---
Aluminum Oxide, Al ₂ O ₃ , %	28.2	---
Iron Oxide, Fe ₂ O ₃ , %	12.6	---
Sum of SiO ₂ , Al ₂ O ₃ , Fe ₂ O ₃ , %	91.1	70/50 min
Calcium Oxide, CaO, %	4.3	---
Magnesium Oxide, MgO, %	0.83	---
Sodium Oxide, Na ₂ O, %	---	---
Potassium Oxide, K ₂ O, %	---	---
Sulfur Trioxide, SO ₃ , %	0.61	5.0 max
Moisture Content, %	0.18	3.0 max
Loss on Ignition, %	2.17	6.0 max
Available Alkalies as Na ₂ O, %*	0.47	1.5 max
PHYSICAL ANALYSES		
Amount Retained on No. 325 Sieve, %	25.0	34 max
Pozzolanic Activity Index		
Portland Cement at 7 days, % of Control	---	---
Portland Cement at 28 days, % of Control	82	75 min
Lime at 7 days, psi	1154	800/NA min
Water Requirement, % of Control	96	105 max
Autoclave Expansion, %	-0.04	0.8 max
Specific Gravity	2.40	---
Increase of Drying Shrinkage, %*	---	0.03 max
Reactivity with Cement Alkalies, %*		
Reduction of Mortar Expansion, %	---	---
Mortar Expansion, %	---	0.020 max

*Optional requirements applicable only when requested by the purchaser.

By Robert L. Smith
 Robert L. Smith, Ph.D.

RESOURCE MATERIALS TESTING, INC.

TO: JTM Industries
 Ash Management Division
 777 Franklin Road, Suite 100
 Marietta, GA 30067
 Attn: Mr. Dave Boyenga

PROJECT NO.: RMT-025
 SAMPLE NO.: 869
 DATE REC.: 10-20-89
 DATE REP.: 11-17-89

PROJECT NAME: Montour Plant Fly Ash QA Program

SAMPLE ID: Class F Fly Ash July, Aug., Sept., 1989 Composite
 AMD Lab. No. 891018-M

CHEMICAL ANALYSES		
PARAMETER	RESULTS	ASTM C618 SPEC. F/C
Silicon Dioxide, SiO ₂ , %	49.6	---
Aluminum Oxide, Al ₂ O ₃ , %	27.6	---
Iron Oxide, Fe ₂ O ₃ , %	13.3	---
Sum of SiO ₂ , Al ₂ O ₃ , Fe ₂ O ₃ , %	90.5	70/50 min
Calcium Oxide, CaO, %	3.0	---
Magnesium Oxide, MgO, %	1.7	---
Sodium Oxide, Na ₂ O, %	---	---
Potassium Oxide, K ₂ O, %	---	---
Sulfur Trioxide, SO ₃ , %	0.49	5.0 max
Moisture Content, %	0.21	3.0 max
Loss on Ignition, %	2.6	6.0 max
Available Alkalies as Na ₂ O, %*	0.35	1.5 max
PHYSICAL ANALYSES		
Amount Retained on No. 325 Sieve, %	26.6	34 max
Pozzolanic Activity Index		
Portland Cement at 7 days, % of Control		---
Portland Cement at 28 days, % of Control	88	75 min
Lime at 7 days, psi	1180	800/NA min
Water Requirement, % of Control	97	105 max
Autoclave Expansion, %	-0.03	0.8 max
Specific Gravity	2.38	---
Increase of Drying Shrinkage, %*	---	0.03 max
Reactivity with Cement Alkalies, %*		
Reduction of Mortar Expansion, %	---	---
Mortar Expansion, %	---	0.020 max

Optional requirements applicable only when requested by the purchaser.

By Robert L. Smith
 Robert L. Smith, Ph.D.

REPORT OF FLY ASH ANALYSIS

RESOURCE MATERIALS TESTING, INC.

REPORT TO: Ash Management Division
J.T.M. Industries
777 Franklin Road, Suite 100
Marietta, GA 30067
Attn: Mr. Dave Boyenga

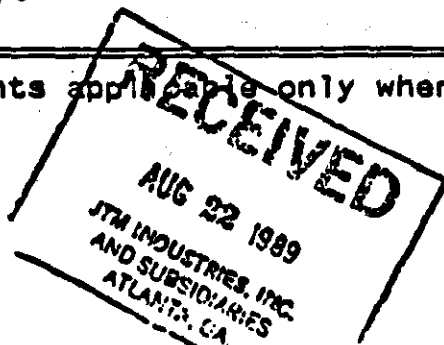
PROJECT NO.: RMT-025
SAMPLE NO.: 637
DATE REC.: 7-13-89
DATE REP.: 8-18-89

PROJECT NAME: Montour Plant Fly Ash Quality Assurance Program

SAMPLE ID: Class F Fly Ash April, May, June Composite
AMD 890707-M

CHEMICAL ANALYSES		
PARAMETER	RESULTS	ASTM C618 SPEC. F/C
Silicon Dioxide, SiO ₂ , %	49.9	---
Aluminum Oxide, Al ₂ O ₃ , %	28.2	---
Iron Oxide, Fe ₂ O ₃ , %	13.0	---
Sum of SiO ₂ , Al ₂ O ₃ , Fe ₂ O ₃ , %	91.1	70/50 min
Calcium Oxide, CaO, %	4.5	---
Magnesium Oxide, MgO, %	0.55	---
Sodium Oxide, Na ₂ O, %	0.23	---
Potassium Oxide, K ₂ O, %	2.5	---
Sulfur Trioxide, SO ₃ , %	1.0	5.0 max
Moisture Content, %	0.14	3.0 max
Loss on Ignition, %	2.5	6.0 max
Available Alkalies as Na ₂ O, %*	0.58	1.5 max
PHYSICAL ANALYSES		
Amount Retained on No. 325 Sieve, %	25.6	34 max
Pozzolanic Activity Index		
Portland Cement at 7 days, % of Control	---	---
Portland Cement at 28 days, % of Control	88	75 min
Lime at 7 days, psi	1201	800/NA min
Water Requirement, % of Control	95	105 max
Autoclave Expansion, %	-0.08	0.8 max
Specific Gravity	2.42	---
Increase of Drying Shrinkage, %*	---	0.03 max
Reactivity with Cement Alkalies, %*		
Reduction of Mortar Expansion, %	---	---
Mortar Expansion, %	---	0.020 max

Optional requirements apply only when requested by the purchaser.



By Robert L. Smith
Robert L. Smith, Ph.D.

RESOURCE MATERIALS TESTING, INC.

REPORT OF FLY ASH ANALYSIS

Report To: Ash Management Corporation
777 Franklin Road
Suite 100
Marietta, GA 30067
Attn: Mr. Dave Boyenga

Project No.: RMT-025

Sample No.: 357

Project Name: Montour Plant Fly Ash Quality Assurance Program

Date Received: 4-6-89

Date Reported: 5-9-89

Sample ID: Jan., Feb., March '89 Composite
AMD 890404-4

CHEMICAL ANALYSIS

PARAMETER	RESULTS	ASTMC618 SPEC. F/C
Silicon Dioxide (SiO ₂), %	<u>50.4</u>	
Aluminum Oxide (Al ₂ O ₃), %	<u>26.8</u>	
Iron Oxide (Fe ₂ O ₃), %	<u>13.2</u>	
Sum of SiO ₂ , Al ₂ O ₃ , and Fe ₂ O ₃ , %	<u>90.4</u>	<u>70/50 Min</u>
Calcium Oxide (CaO), %	<u>2.4</u>	
Magnesium Oxide (MgO), %	<u>0.76</u>	
Sodium Oxide (Na ₂ O), %	<u>0.32</u>	
Potassium Oxide (K ₂ O), %	<u>2.3</u>	
Sulfur Trioxide (SO ₃), %	<u>0.48</u>	<u>5.0 Max</u>
Moisture Content, %	<u>0.11</u>	<u>3.0 Max</u>
Loss on Ignition, %	<u>2.3</u>	<u>6.0 Max</u>
Available Alkalies as Na ₂ O, %*	<u>0.51</u>	<u>1.5 Max</u>

PHYSICAL ANALYSIS

PARAMETER	RESULTS	ASTMC618 SPEC. F/C
Amount Ret. on No. 325 Sieve, %	<u>23.5</u>	<u>34 Max</u>
Pozzolanic Activity Index		
P. Cement at 7 Days, % of Control	<u>---</u>	
P. Cement at 28 Days, % of Control	<u>85</u>	<u>75 Min</u>
Lime at 7 Days, psi	<u>1215</u>	<u>800/NA Min</u>
Water Requirement, % of Control	<u>95</u>	<u>105 Max</u>
Autoclave Expansion, %	<u>-0.07</u>	<u>0.8 Max</u>
Specific Gravity	<u>2.41</u>	
Increase of Drying Shrinkage, %*	<u>---</u>	<u>0.03 Max</u>
Reactivity with Cement Alkalies*		
Reduction of Mortar Expansion, %	<u>---</u>	
Mortar Expansion, %	<u>---</u>	<u>0.020 Max</u>

*Optional requirements applicable only when requested by the purchaser.

By Robert L. Smith
Robert L. Smith, Ph.D.

9852 West Gilton Drive
Lakewood, CO 80227
(303) 987-0410 / 0413

AR300288

PP&L
MATERIAL SAFETY DATA SHEET

Identity: FLY ASH

SECTION I

Manufacturers:

Pennsylvania Power & Light Company
Two North 9th Street
Allentown, PA 18101

Telephone: 215/770-6701

Date Prepared: March 1988

SECTION II - HAZARDOUS INGREDIENTS/IDENTITY INFORMATION

<u>Material</u>	<u>CAS Number</u>	<u>***</u>	<u>OSHA PEL</u>	<u>ACGIH TLV</u>
Major Elements:				
Aluminum	(7429-90-5)	13	10 mg/m ³ *	10 mg/m ³ *
Calcium	(1305-78-8)	2.0	5 mg/m ³ *	2 mg/m ³ *
Iron	(1309-37-1)	13	10 mg/m ³ *	5 mg/m ³ *
Magnesium	(1309-48-4)	0.65	15 mg/m ³ *	10 mg/m ³ *
Potassium	(7440-09-7)	2.3	---	---
Silicon	(7440-21-3)	28	---	10 mg/m ³
Titanium	(13463-67-7)	1.0	15 mg/m ³ *	10 mg/m ³ *
Silicon Dioxide (By X-Ray Analysis):				
Quartz	(14808-60-7)	8.0	1 mg/m ³ *** (total respirable dust)	0.1 mg/m ³ (Respirable)
Cristobalite	(14464-46-1)	2.9	1 mg/m ³ *** (total respirable dust)	0.05 mg/m ³ (Respirable)
Trace Elements:				
Arsenic	(7440-38-2)	0.043	10 mcg/m ³	0.2 mg/m ³
Chromium	(7440-47-3)	0.053	1 mg/m ³	0.5 mg/m ³
Copper	(7440-50-8)	0.020	0.1 mg/m ³ (fume)	0.2 mg/m ³ (fume)
Manganese	(7439-96-5)	0.067	15 mg/m ³ *	5 mg/m ³
Vanadium	(1314-62-1)	0.23	0.1 mg/m ³	0.05 mg/m ³
Zinc	(1314-13-2)	0.028	5 mg/m ³ *	5 mg/m ³ (fume)

* Limit values apply to the oxides of these elements.

** Values Approximate. Fly ash is derived from naturally occurring coal and is variable in its content. Values reported approximate the upper limit of known concentrations for these elements.

*** The OSHA Crystalline Silica Limit:

$$\text{Quartz (Respirable)} = \frac{10 \text{ mg/m}^3}{\% \text{ SiO}_2 \times 2}$$

For Cristobalite, use 1/2 the value for quartz.
Values in table are based on average bulk sample results.

This MSDS is for fly ash which is formed during the combustion of anthracite and bituminous coals in steam electric station boilers. The bulk of this ash consists of silicon, aluminum, magnesium, calcium, potassium, titanium, and iron. Trace elements are not believed to exist as well-defined chemical entities (such as PbO or CuSO₄) but are thought to be in dissolved states in the bulk phases of glass, mullite, magnetic spinel, and carbon.

SECTION III - PHYSICAL/CHEMICAL CHARACTERISTICS

Boiling Point:	N/A	Specific Gravity:	N/A
Vapor Pressure:	N/A	Melting Point:	1200°C
Vapor Density:	N/A	Evaporation Rate:	N/A
Solubility in Water:	5%		
Appearance and Odor:	Hygroscopic Light Gray Powder		

SECTION IV - FIRE AND EXPLOSION HAZARD DATA

Flash Point:	N/A
Flammable Limits:	N/A
Extinguishing Media:	N/A
Special Fire Fighting Procedures:	N/A
Unusual Fire/Explosions:	N/A

SECTION V - REACTIVITY DATA

Stability: Stable

Compatibility: Unknown

Hazardous Decomposition or Byproducts: Unknown

Hazardous Polymerization: None known to occur

SECTION VI - HEALTH HAZARD DATA

Routes of Entry: Inhalation and Skin

Health Hazards: Irritation of eyes, skin, and mucous membranes.

Medical Conditions Generally Aggravated by Exposure: Persons with lung dysfunction should be especially careful to avoid dusty conditions.

Emergency and First Aid Procedures:

Eye Contact: Wash eyes thoroughly with plenty of water to remove dust particles.

Skin Contact: Wash with soap and water.

Inhalation: Remove to fresh air.

Preplacement and periodic medical exams should be used to evaluate the lung function and skin of workers regularly exposed to this material. Airborne levels greater than the PEL for arsenic have been measured during visibly dusty conditions. OSHA regulations must be followed under those circumstances since inorganic arsenic is regulated by OSHA as a carcinogen.

NOTE: Arsenic is on the NIOSH Registry of Toxic Effects of Chemical Substance's list of potential carcinogens.

SECTION VII - PRECAUTIONS FOR SAFE HANDLING AND USE

Spills: Provide eye protection and dust respirators to prevent inhalation of dust.

Waste Disposal: Material can be disposed of as an inert solid in a landfill. Follow Federal, State and Local regulations.

Precautions for Handling and Storing: Utilize good housekeeping practices.

SECTION VIII - CONTROL MEASURES

Respiratory Protection: Use NIOSH approved respirator with high efficiency filters.

Ventilation: Use general and local exhaust ventilation and dust collection system to keep dust levels within acceptable limits.

Protective Gloves: Clean Work Gloves

Eye Protection: Goggles, Faceshields

Other Protective Clothing or Equipment: Body-covering work clothing may be necessary under very dusty conditions.

N/A = Not Applicable (No Applicable Information Found)

sag/b6751/dh,,56
2/24/88

**ASH MANAGEMENT DIVISION**

JTM INDUSTRIES, INC.

420 W. EMMAUS AVENUE
ALLENTOWN, PA 18103
OFFICE (215) 797-7674
DISPATCH (215) 797-7683
FAX (215) 797-6669

MATERIAL SAFETY DATA SHEET**SECTION 1. MATERIAL IDENTIFICATION**

Manufacturer Sources Located In: Carbo, VA; Fernandina Beach, FL; Haltwood, PA; Roxboro, NC; Washingtonville, PA; and other sources meeting Section 2 Typical Composition

Chemical Name

Coal Ash ASTM C-618 Class F

Trade Name

None

Chemical Family

Fused Amorphous (Non-Crystalline) Siliceous Glass

Formula

N/A

SECTION 2. TYPICAL COMPOSITION**%****HAZARD DATA**

CaO

0.5 to 5

SiO₂

25 to 55

Al₂O₃

5 to 35

Fe₂O₃

5 to 45

SO₃

0.5 to 5

Na₂O

0.1 to 1.5

Coal ash may cause irritation when inhaled or when in contact with the eyes or moist skin.
See Section 6.

SECTION 3. PHYSICAL DATA**Boiling Point**

Greater than 2000° F.

Specific Gravity (H₂O = 1)

2.0 to 2.5

Vapor Pressure (mm Hg)

0

pH in Water

5.0 to 9.0

Water Solubility

Approximately 0.5%

Heat of Reaction in Water

None

Appearance and Odor

Grey to Tan Fine Powder. No Odor.

SECTION 4. FIRE AND EXPLOSION DATA**Flammability**

Non-Combustible

SECTION 5. REACTIVITY DATA

Coal ash is an inert amorphous mineral residue formed during combustion of coal by melting clays, sands and other minerals contained in the coal fuel. This amorphous residue is non-reactive.

AR300292

SECTION 6. HEALTH HAZARD INFORMATION

Effect of Overexposure

Overexposure to coal ash may cause irritation of the respiratory tract, eyes, and moist skin.

Emergency First Aid

Eye Contact—

Flush the eyes with large amounts of clean water. Get medical attention promptly.

Skin Contact—

Wash affected areas thoroughly. If irritation persists, seek medical attention.

Inhalation—

Remove to fresh air. If problems develop or persist, seek medical attention.

SECTION 7. SPECIAL PROTECTION INFORMATION

Respiratory Protection—

Any NIOSH or MSMA approved dust respirator may be used.

Eye Protection—

Use goggles at all times. Avoid use of contact lenses around coal ash.

Skin Protection—

Limit skin contact.

SECTION 8. STORAGE AND HANDLING PROCEDURES

Store in a dry contained system. Pneumatic handling systems are appropriate. Use appropriate protection in handling.

SECTION 9. SPILL AND DISPOSAL PROCEDURES

Protect from blowing wind. Moisten to prevent dusting and dispose of in an appropriate container or location. No special handling is required for small spill amounts.

AR300293

Pennsylvania Power & Light Company
Montour Steam Electric Station

MONT

FA-1

10/26/88

Fly Ash/Leachate Analyses

*Alkaline media,
K₂O content higher
than optimal for
cement admixtures*

pH 10.7
Sp. Cond., umhos 1520.
Phenol. Alk. (as CaCO₃) 4700.
Total. Alk. (as CaCO₃) 11800.

Major Constituents	(%)	(%)	(mg/l)	(mg/l)
SiO ₂ /Silicon	51.79	24.20	5.2	22.8
Al ₂ O ₃ /Aluminum	27.03	14.30	<0.1	0.4
Fe ₂ O ₃ /Iron	10.98	7.68	<0.05	<0.05
CaO/Calcium	4.12	2.94	468.	639.
MgO/Magnesium	1.056	0.638	<0.05	10.8
Na ₂ O/Sodium	<0.162	<0.120	12.8	1360.
K ₂ O/Potassium	2.38	1.98	35.7	11.4
TiO ₂ /Titanium	1.49	0.89	<0.05	0.06
MnO/Manganese	0.040	0.031	<0.005	0.576
SO ₂ /Sulfur/Sulfate	1.002	0.501		
P ₂ O ₅ /Phosphorus	0.302	0.132		

Trace Constituents	(ppm)	(mg/l)	(mg/l)
Antimony	<206.5	<0.05	0.10
Arsenic	394.	0.02	0.65
Barium	<1200.	0.395	0.318
Beryllium		<0.005	<0.005
Boron		<0.1	1.2
Bromine	<29.1		
Cadmium	<130.	<0.005	0.021
Chloride	184.6		
Chromium	188.	0.53	0.29
Cobalt	<133.	<0.05	<0.05
Copper	149.	<0.05	0.31
Gallium	43.8		
Germanium	<17.4		
Lead	146.	<0.05	<0.05
Lithium		1.8	0.6
Mercury	<55.0	<0.0005	<0.0005
Molybdenum	61.0	8.23	1.37
Nickel	176.	<0.05	0.13
Rubidium	165.		
Selenium	<12.5	0.006	0.09
Silver	<104.	<0.05	<0.05
Strontium	721.	4.5	1.45
Thallium	<76.5	<0.1	0.2
Vanadium	248.	0.11	0.51
Zinc	324.	<0.05	0.71
Zirconium	280.		

NOTES: Composite sample collected 10/26/88 while burning low sulfur bituminous coal.

Element Analysis Corporation tracking number 13139.

Lancaster Laboratories Incorporated tracking number 13122.

AR300294

TOTAL P.03

ATTACHMENT 2D
CALCULATIONS

AR300295

CLIENT: <i>EHA</i>	FILE NO.: <i>1817/563</i>	BY: <i>ADB</i>	PAGE 1 OF 4
SUBJECT: <i>Whitney</i>		CHECKED BY: <i>DMW</i>	DATE: <i>6/4/90</i>

Arsenic Concentration - Initial

Composite Average:
Reported 250

Estimated Iron Treated samples

	<i>As Reported</i>	<i>Additive & Moisture</i>	<i>Calculated</i>	
<i>CA-01</i>	<i>208</i>	<i>x 2.45</i>	<i>510</i>	
<i>02</i>	<i>363</i>	<i>x 1.38</i>	<i>500</i>	
<i>03</i>	<i>411</i>	<i>x 1.45</i>	<i>600</i>	
<i>04</i>	<i>336</i>	<i>x 1.13</i>	<i>380</i>	<i>Fe</i>
<i>05</i>	<i>254</i>	<i>x 2.81</i>	<i>710</i>	
<i>12</i>	<i>316</i>	<i>x 2.77</i>	<i>880</i>	
<i>13</i>	<i>344</i>	<i>x 1.13</i>	<i>390</i>	<i>Fe</i>
<i>14</i>	<i>468</i>	<i>x 1.07</i>	<i>500</i>	<i>Fe (h)</i>
<i>15</i>	<i>245</i>	<i>x 1.18</i>	<i>290</i>	<i>Fe</i>
<i>16</i>	<i>170</i>	<i>x 3.38</i>	<i>570</i>	

For Cement based

$$\bar{x} = 630, \sigma_0 = 118$$

95% range =

$$630 \pm 1.96 \times 118 =$$

$$400 - 860 \text{ mg/kg}$$

For iron based (do not use CA-14)

$$\bar{x} = 350, n = 37$$

$$t \text{ test } t = \frac{630 - 350}{\sqrt{118^2/6 + 37^2/3}}$$

$$= 5.3$$

CLIENT: EPA	FILE NO.: 1817/563	BY: DDK	PAGE 2 OF 4
SUBJECT: Wh. Inogen		CHECKED BY: DMS	DATE: 6/4/90

$$DF = \left(\frac{7,700,000}{770,000 + 52,000} \right) - 2 = 7$$

$$\pm 22.5\% = 3.5$$

⇒ Probability is greater than 99.5% that means are different.

Use a value of 630 mg/kg.

Similarly For the Worst Case Sample

		Corrected	
WC 06	1030	2600	
WC 07	916	1300	
WC 08	2100	3100	
WC 09	1500	1700	Fe
WC 10	1700	4900	
WC 17	540	1500	
WC 18	900	1000	Fe
WC 19	644	670	Fe
WC 20	234	230	Fe
WC 21	958	3100	

For cement based

$$\bar{x} = 2750, \sigma = 1174$$

For iron based

$$\bar{x} = 922, \sigma = 523$$

t-test

$$\frac{2750 - 922}{\sqrt{\frac{1174^2}{6} + \frac{523^2}{4}}} = 3.3$$

AR300297

CLIENT: <i>EPA</i>	FILE NO.: <i>18171563</i>	BY: <i>ANB</i>	PAGE 3 OF 4
SUBJECT: <i>Whitney</i>		CHECKED BY: <i>DMW</i>	DATE: <i>6/4/90</i>

Conclusion, The iron used in the
fixation probably interferes with the
ability to analyze for arsenic

Arsenic Volatilization During Roasting

Composite average

Arsenic, unroasted: $630 \text{ mg/kg} \pm 230 \text{ mg/kg}$

Arsenic, roasted: 710 mg/kg (corrected)

⇒ No obvious volatilization occurred

Worst Case

Arsenic unroasted: $2750 \text{ mg/kg} \pm 2300 \text{ mg/kg}$

Arsenic roasted: 4900 mg/kg

⇒ No obvious volatilization occurred.

CLIENT: <i>EPA</i>	FILE NO.: <i>1917/563</i>	BY: <i>NAB</i>	PAGE 4 OF 4
SUBJECT: <i>Wh. Inger Soils Fixation TS</i>	CHECKED BY: <i>DMW</i>	DATE: <i>6/4/90</i>	

Air drying of samples

Composite Sample

Total wt loss during drying

$$\frac{(1038.5 - 1025.2)}{(1038.5 - 220)} = 1.6\%$$

Went Care Sample

$$\frac{1255.1 - 1178.8}{1255.1 - 221.1} = 7.4\%$$

ATTACHMENT 3

**ANALYTICAL RESULTS
(PRELIMINARY PENDING VALIDATION)**

- 3A UNTREATED SAMPLES**
- 3B PHASE 1 - 5-DAY CURE TCLP SAMPLE RESULTS**
- 3C PHASE 1 - 28-DAY CURE SAMPLE RESULTS**
- 3D PHASE 2 - 28-DAY CURE SAMPLE RESULTS**

AR300300

ATTACHMENT 3A
UNTREATED SAMPLES

AR300301

DATA SUMMARY FORM: INORGANICS

Site Name: WHITMOYER LABORATORIES SOIL SAMPLES
SAC (mg/Kg)

SAS # 5630101 Date: 11/9/89

Due to dilution, sample quantitation limit is affected.
See dilution table for specifics.

[illegible]**CADL = Contract Required Detection Limit**

Action Level Exists

SEE NARRATIVE FOR CODE DEFINITIONS

revised 10/99

DATA SUMMARY FORM: I N O R G A N I C S

Site Name: WHITMOYER LABORATORIES LEACHATE SAMPLES

SAS # 5630101 Sampling Date: 11/9/89

*Due to dilution, sample quantitation limit is affected.
See dilution table for specifics.

Sample No. Dilution Factor Location	WL-TS-202-06	WL-TS-203-77	WL-TS-207-04	WL-TS-207-04	WL-TS-207-04	WL-TS-208-79	WL-TS-209-79	WL-TS-209-79	WL-TS-209-79
ANALYTE	TCLP	TCLP	EP TOX	EP TOX	ASTM D-3987	ASTM D-3987	ASTM D-3987	ASTM D-3987	ASTM D-3987
5 TOTAL AS mg/L	13900	123	9950	76.7	542	8720	234		
PH units	5.5	6.4	6.4	5.3	7.9	7.9	7.9		
5 AS mg/L	NA	NA	NA	NA	NA	7800	210		
5 AS mg/L	NA	NA	NA	NA	NA	NA	335		
2 TDS mg/L	NA	NA	NA	NA	5.3	340			
13 TDS mg/L	NA	NA	NA	NA					
* MATRIX INTERFERENCES IN SAMPLE ABSORBANCE COULD NOT BE READ GLASS WOOD IN SCRUBBER AND ABSORBER SOLUTION TURNED BLACK EVEN AT HIGH DILUTION									

AR300304

CRDL = Contract Required Detection Limit

*Action Level Exists

SEE NARRATIVE FOR CODE DEFINITIONS

NA = NOT ANALYZED

revised 10/88

WESTERN RESEARCH INSTITUTE
P.O. Box 3395, University Station
Laramie, Wyoming 82071-3395
(307) 721-2243

May 21, 1990

TO: Greg Zimmerman, NUS Corporation

FROM: Western Research Institute

SUBJECT: Addendum to SAS 563010101; Total arsenic results for sample WL-TS-207-08
rerun by AA as requested by John Trepanowald

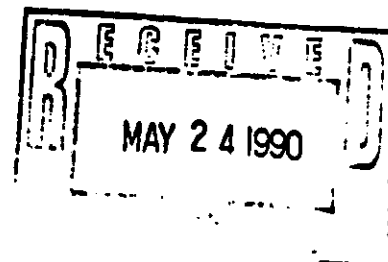
<u>Sample No.</u>	<u>Total AS (ug/L)</u>
WL-TS-207-08	10,600

If you have any questions, please call me at 721-2204.

Sincerely,

Nancy Niss

Nancy Niss
Chemical Analysis Supervisor
Division of Analytical Research



ATTACHMENT 3B

PHASE 1 - 5-DAY CURE TCLP SAMPLE RESULTS

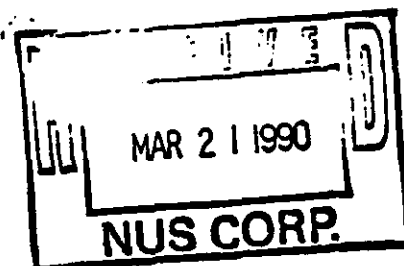
AR300306

WESTERN RESEARCH INSTITUTE
P.O. Box 3398, University Station
Laramie, Wyoming 82071-3398
(307) 721-2243

March 21, 1990

TO: NUS Corporation
FROM: Western Research Institute
SUBJECT: Verbal results for SAS 5630102; Corrected from 3/20/90- mistake
made in linear regression analysis.

<u>Sample No.</u>	<u>Total AS (ug/L)</u>	<u>pH</u>
WLFTS-CA-01-B	396	11.9
WLFTS-CA-02-B	768	5.58
WLFTS-CA-03-B	698	5.47
WLFTS-CA-04-B	<5	5.47
WLFTS-CA-05-B	<5	11.8
WLFTS-CA-11-3-B	<5	11.9
WLFTS-WC-06-B	321	12.1
WLFTS-WC-06-B-50	323	12.1
WLFTS-WC-07-B	2,740	5.97
WLFTS-WC-07-B-D	2,340	5.87
WLFTS-WC-08-B	.	5.20
WLFTS-WC-09-B	8.8	5.08
WLFTS-WC-10-B	14	11.9
Extraction Blank	<5	2.93



* Matrix interferences in sample; could not read absorbance. The glass wool in the scrubber and the absorber solution turned black no matter how much the sample was diluted.

If you have any questions, please call me at 721-2204.

Sincerely,

Nancy Niss

Nancy Niss
Chemical Analysis Supervisor
Division of Analytical Research

AR300307

ATTACHMENT 3C

PHASE 1 - 28-DAY CURE SAMPLE RESULTS

AR300308

WESTERN RESEARCH INSTITUTE
P.O. Box 3393, University Station
Laramie, Wyoming 82071

INORGANIC ANALYSIS RESULTS
SAS 5630103

Soil Sample Results

<u>Sample No.</u>	<u>ACN</u>	<u>Total As</u> (mg/kg)	<u>Bulk Density</u> (g/cm ³)	<u>Unconfined</u> <u>Comp. Strth</u> (psi)
NLFTS-CA-01-28	34378	208	6.40	4,270
NLFTS-CA-02-28	34379	363	5.68	340
NLFTS-CA-03-28	34380	411	5.80	220
NLFTS-CA-04-28	34381	336	5.95	320
NLFTS-CA-05-28	34382	254	5.96	4,050
NLFTS-NC-06-28	34383	1,030	6.26	4,400
NLFTS-NC-07-28	34384	916	5.65	330
NLFTS-NC-08-28	34385	2,070	5.05	200
NLFTS-NC-09-28	34386	1,480	4.92	290
NLFTS-NC-10-28	34387	1,730	5.79	2,700
NLFTS-NC-10-28D	34388	1,610	--	---

AR300309

WESTERN RESEARCH INSTITUTE
P.O. Box 3395, University Station
Laramie, Wyoming 82071

INORGANIC ANALYSIS RESULTS
SAS 5630103
TCLP LEACHATE RESULTS

<u>Sample</u>	<u>ACN</u>	<u>Leach Proc.</u>	<u>Total As (ug/L)</u>	<u>pH</u>
NLFTS-CA-01-28	34390	TCLP	252	11.9
NLFTS-CA-02-28	34391	TCLP	2,690	11.1
NLFTS-CA-03-28	34392	TCLP	2,700	11.0
NLFTS-CA-04-28	34393	TCLP	<5	5.46
NLFTS-CA-05-28	34394	TCLP	82	11.7
NLFTS-WC-06-28	34395	TCLP	360	12.0
NLFTS-WC-07-28	34396	TCLP	2,630	11.4
NLFTS-WC-08-28	34397	TCLP	4,180	11.1
NLFTS-WC-09-28	34398	TCLP	138	5.06
NLFTS-WC-10-28	34399	TCLP	72	11.9
NLFTS-WC-07-28D	34432 (DUP)	TCLP	2,600	--
Blank	---	TCLP	<5	4.95

AR300310

WESTERN RESEARCH INSTITUTE
P.O. Box 3395, University Station
Laramie, Wyoming 82071

INORGANIC ANALYSIS RESULTS
SAS 5630103

EP TOX LEACHATE RESULTS

Sample	ACN	Leach Proc.	Total As (ug/L)	pH
NLFTS-CA-01-28	34400	EP TOX	350	12.2
NLFTS-CA-02-28	34401	EP TOX	1,080	7.03
NLFTS-CA-03-28	34402	EP TOX	989	6.66
NLFTS-CA-04-28	34403	EP TOX	<5	5.47
NLFTS-CA-05-28	34404	EP TOX	<5	12.0
NLFTS-NC-06-28	34405	EP TOX	196	12.2
NLFTS-NC-07-28	34406	EP TOX	1,760	6.56
NLFTS-NC-08-28	34407	EP TOX	2,090	5.47
NLFTS-NC-09-28	34408	EP TOX	123	5.21
NLFTS-NC-10-28	34409	EP TOX	77	11.9
NLFTS-NC-06-28D	34430	EPTOX	183	--
	(DUP)			
EPTOX Blank-03	--	EPTOX	<5	2.85

AR300311

WESTERN RESEARCH INSTITUTE
P.O. Box 3395, University Station
Laramie, Wyoming 82071

INORGANIC ANALYSIS RESULTS

SAS 5630103

ASTM LEACHATE RESULTS

Sample	ACN	Leach Proc.	Total As (ug/L)	pH	TOC (mg/L)	TDS (mg/L)
WLFTS-CA-01-28	34410	ASTM	212	12.5	<10	1,450
WLFTS-CA-02-28	34411	ASTM	1,220	12.1	12	550
WLFTS-CA-03-28	34412	ASTM	278	11.9	<10	500
WLFTS-CA-04-28	34413	ASTM	39	7.50	<10	2,480
WLFTS-CA-05-28	34414	ASTM	36	12.4	<10	1,130
WLFTS-WC-06-28	34415	ASTM	229	12.5	<10	1,590
WLFTS-WC-07-28	34416	ASTM	1,610	12.1	<10	590
WLFTS-WC-08-28	34417	ASTM	1,860	11.9	<10	500
WLFTS-WC-09-28	34418	ASTM	44	6.14	<10	2,460
WLFTS-WC-10-28	34419	ASTM	<5	12.5	<10	1,450
WLFTS-WC-08-28D (DUP)	34434	ASTM	1,460	--	--	---
BLANK	---	ASTM	<5	4.24	<10	<10

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INORGANIC ANALYSIS RESULTS
SAS 5630103
MODIFIED ASTM LEACHATE RESULTS

Sample	ACN	Leach Prog.	Total As (ug/L)	pH	TOC (mg/L)	TDS (mg/L)
NLFTS-CA-01-28	34420	ASTM-MOD	124	12.4	<10	1,280
NLFTS-CA-02-28	34421	ASTM-MOD	1,730	11.8	<10	460
NLFTS-CA-03-28	34422	ASTM-MOD	1,720	11.8	<10	460
NLFTS-CA-04-28	34423	ASTM-MOD	110	7.77	<10	2,700
NLFTS-CA-05-28	34424	ASTM-MOD	88	12.4	<10	1,080
NLFTS-NC-06-28	34425	ASTM-MOD	338	12.4	<10	1,260
NLFTS-NC-07-28	34426	ASTM-MOD	1,550	11.9	<10	530
NLFTS-NC-08-28	34427	ASTM-MOD	2,220	11.8	<10	460
NLFTS-NC-09-28	34428	ASTM-MOD	9.5	7.82	<10	2,740
NLFTS-NC-10-28	34429	ASTM-MOD	736	12.4	<10	1,240
NLFTS-NC-09-28D (DUP)	34436	ASTM-MOD	<5	--	<10	---
BLANK (Groundwater)	--	ASTM-MOD	<5	7.97	<10	320

AR300313

ATTACHMENT 3D

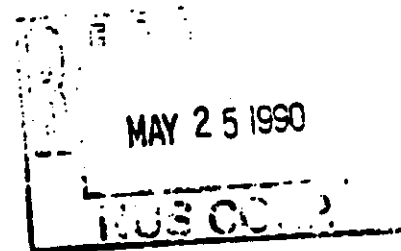
PHASE 2 - 28-DAY CURE SAMPLE RESULTS

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INORGANIC ANALYSIS RESULTS
SAS 5630104
Soil Sample Results

<u>Sample No.</u>	<u>ACN</u>	<u>Tot As</u> (mg/kg)	<u>As⁺³</u> (mg/kg)	<u>As⁺⁵</u> (mg/kg)	<u>Blk Density</u> (g/cm ³)	<u>Unconfined</u> <u>Comp. Strth</u> (psi)
NLITS-CA-12-28	34640	316	213	100	5.72	2,380
NLITS-CA-13-28	34641	344	<100	226	4.80	40
NLITS-CA-14-28	34642	468	375	<100	5.60	740
NLITS-CA-15-28	34643	243	196	<100	6.00	1,410
NLITS-CA-16-28	34644	170	143	<100	6.05	240
NLITS-WC-17-28	34645	540	252	<100	6.42	3,600
NLITS-WC-18-28	34646	900	418	<100	6.52	700
NLITS-WC-19-28	34647	644	363	<100	6.22	2,470
NLITS-WC-20-28	34648	234	<100	163	5.92	60
NLITS-WC-21-28	34649	958	176	<100	6.21	150
NLITS-CA-13-28D	34650	372	--	---	--	---
Blank	---	--	<100	<100	--	--



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INORGANIC ANALYSIS RESULTS
SAS 5630104
TCLP LEACHATE RESULTS

<u>Sample</u>	<u>ACN</u>	<u>Leach Proc.</u>	<u>Total As (ug/L)</u>	<u>pH</u>
WLFTS-CA-12-28	34665	TCLP	208	11.9
WLFTS-CA-13-28	34666	TCLP	<5	5.59
WLFTS-CA-14-28	34667	TCLP	75	5.34
WLFTS-CA-15-28	34668	TCLP	<5	5.48
WLFTS-CA-16-28	34669	TCLP	306	7.63
WLFTS-WC-17-28	34670	TCLP	199	12.0
WLFTS-WC-18-28	34671	TCLP	51	5.80
WLFTS-WC-19-28	34672	TCLP	82	5.16
WLFTS-WC-20-28	34673	TCLP	48	5.10
WLFTS-WC-21-28	34674	TCLP	717	7.28
WLFTS-WC-20-28-BD	34675	TCLP	48	5.11
WLFTS-WC-22-28	34676	TCLP	<5	6.41
WLFTS-WC-21-28-D	34677	TCLP	678	--
TCLP Blank-04	---	TCLP	<5	4.94

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INORGANIC ANALYSIS RESULTS
SAS 5630104
EP TOX LEACHATE RESULTS

Sample	ACN	Leach Proc.	Total As (ug/L)	pH
NLFTS-CA-12-28	34632	EP TOX	19	11.9
NLFTS-CA-13-28	34633	EP TOX	<5	5.75
NLFTS-CA-14-28	34634	EP TOX	10.3	5.15
NLFTS-CA-15-28	34635	EP TOX	<5	5.16
NLFTS-CA-16-28	34636	EP TOX	1,080	8.98
NLFTS-NC-17-28	34637	EP TOX	318	11.9
NLFTS-NC-18-28	34638	EP TOX	10.3	5.15
NLFTS-NC-19-28	34639	EP TOX	7.7	4.99
NLFTS-NC-20-28	34660	EP TOX	<5	4.95
NLFTS-NC-21-28	34661	EP TOX	816	7.25
NLFTS-CA-15-28-BD	34662	EPTOX	7.7	5.12
NLFTS-NC-17-28-D	34663	EPTOX	318	11.8
EPTOX Blank-03	--	EPTOX	<5	2.85

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INORGANIC ANALYSIS RESULTS
SAS 5630104
ASTM LEACHATE RESULTS

Sample	ACN	Leach Proc.	Tot As (ug/L)	As ⁺³ (ug/L)	As ⁺⁵ (ug/L)	pH	TOC (mg/L)	TDS (mg/L)
NLFTS-CA-12-28	34679	ASTM	455	<5	<5	12.5	<10	1,630
NLFTS-CA-13-28	34680	ASTM	407	<5	<5	9.51	23	3,980
NLFTS-CA-14-28	34681	ASTM	<5	<5	<5	6.92	<10	1,540
NLFTS-CA-15-28	34682	ASTM	5	<5	<5	7.28	<10	2,420
NLFTS-CA-16-28	34683	ASTM	1,410	<5	1,230	11.8	<10	4,830
NLFTS-WC-17-28	34684	ASTM	1,340	<5	<5	12.5	<10	1,430
NLFTS-WC-18-28	34685	ASTM	6.4	<5	<5	7.50	<10	2,740
NLFTS-WC-19-28	34686	ASTM	22	<5	<5	7.02	<10	2,160
NLFTS-WC-20-28	34687	ASTM	17	<5	<5	6.68	<10	2,320
NLFTS-WC-21-28	34688	ASTM	1,440	<5	1,430	11.5	<10	5,870
NLFTS-WC-18-28-D (DUP)	34689	ASTM	5.1	--	---	7.91	--	---
NLFTS-CA-13-28RD	34691	ASTM	469	--	---	7.96	--	---
ASTM Blank-04	---	ASTM	<5	<5	<5	4.24	<10	<10

10 5 3 5 1 7 7 10

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INORGANIC ANALYSIS RESULTS
SAS 5630104
MODIFIED ASTM LEACHATE RESULTS

Sample	ACN	Leach Proc.	Tot As (ug/L)	As ⁺³ (ug/L)	As ⁺⁵ (ug/L)	pH	TOC (mg/L)	TDS (mg/L)
NLFTS-CA-12-28	34692	ASTM-MOD	120	<5	<5	12.5	<10	1,510
NLFTS-CA-13-28	34693	ASTM-MOD	130	<5	<5	9.07	<10	4,530
NLFTS-CA-14-28	34694	ASTM-MOD	6.0	<5	<5	7.79	<10	1,800
NLFTS-CA-15-28	34695	ASTM-MOD	<5	<5	<5	7.42	<10	2,610
NLFTS-CA-16-28	34696	ASTM-MOD	1,280	<5	<5	11.7	<10	5,170
NLFTS-WC-17-28	34697	ASTM-MOD	144	<5	<5	12.5	<10	1,450
NLFTS-WC-18-28	34698	ASTM-MOD	69	<5	<5	7.82	<10	2,800
NLFTS-WC-19-28	34699	ASTM-MOD	<5	<5	<5	7.45	<10	2,090
NLFTS-WC-20-28	34700	ASTM-MOD	<5	<5	<5	7.59	<10	2,500
NLFTS-WC-21-28	34701	ASTM-MOD	1,410	<5	1,166	11.4	<10	6,560
NLFTS-WC-19-28-D (DUP)	34703	ASTM-MOD	<5	--	--	--	--	---
NLFTS-CA-12-28-BD	34702	ASTM-MOD	131	--	--	--	--	---
ASTM-MOD Blank-04 ---		ASTM-MOD	<5	<5	<5	7.92	<10	310

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APPENDIX C
SOIL WASHING TREATABILITY STUDY REPORT

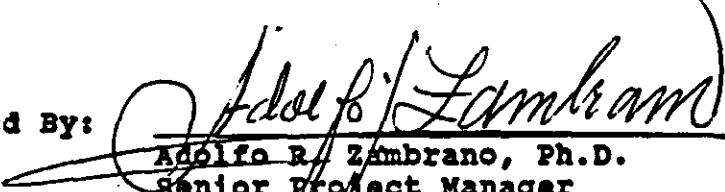
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FINAL REPORT
ON
SOIL LEACHING/SOLVENT EXTRACTIONS OF
INORGANIC AND ORGANIC CONTAMINANTS
FROM THE
WHITMOYER LABORATORIES SITE

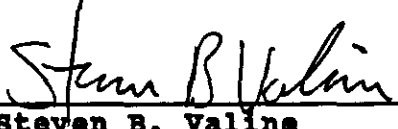
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July 3, 1990

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ABSTRACT

BioTrol, Inc. under contract to Ebasco Inc. performed a bench scale treatability study to ascertain the feasibility of soil washing/solvent extraction treatment to remediate contaminated soils at the Whitmoyer Laboratories Site.

The major components of this treatability study were: (1) an arsenic and TOC aqueous partition study, (2) a single-stage extractants search, (3) multi-stage extraction optimization, (4) arsenic speciation, and (5) order-of-magnitude cost estimate for full scale site remediation.

The conclusions, based on the reduced experimental data and the general experimental observations, can be summarized as follows:

- > The soluble fraction of arsenic in upgradient groundwater is relatively small. Up to 10% can be dissolved from soils containing more than 200 ppm arsenic in a water slurry containing 1% solids, but the extent of dissolution decreases to about 1% arsenic for slurries containing 17% solids. By inference, soil flushing does not appear practical. In addition, the presence of more than 80% slimes in the soil creates an effective barrier to percolation.
- > In the partition study, the majority of the water-soluble arsenic was determined to be pentavalent. The amount of trivalent arsenic was insignificant.
- > The single-stage extractants search revealed that the arsenic-bearing contaminants could not be leached at pH = 1 with hydrochloric, nitric, or sulfuric acids.
- > Sodium carbonate, Na_2CO_3 , appears the best arsenic extractant in the presence of sodium thiosulfate or Cyquest DP-6. It can extract about 65% arsenic in four (4) hours at pH=11 and room temperature.
- > Ethanol at a level of 200 lb per short ton of solids can extract about 60% arsenic. This system offers the potential for significant savings as a result of solvent recycle and minimum process water treatment. Additional effort towards system optimization is strongly recommended.
- > Multistage optimization of the best two carbonate systems failed to match the results of four-hour single-stage extractions. Thus, countercurrent extraction appears unnecessary and the residence time for optimal leaching extraction may be less than four hours.

- > The arsenic speciation procedure failed to quantify the pentavalent arsenic in leach solutions. There are procedural ambiguities that need to be resolved in order to guarantee reliable determinations.
- > The order-of-magnitude installed equipment cost for a 20 ton per hour full-scale treatment system is estimated at \$4,730,000.00. The operating cost to remediate 100,000 cubic yards of contaminated soil containing 1,800 ppm arsenic is estimated at \$158.00 per cubic yard. The estimated operating cost does not include excavation, feed preparation, or capital recovery.

**FINAL REPORT
ON
SOIL LEACHING/SOLVENT EXTRACTIONS OF
INORGANIC AND ORGANIC CONTAMINANTS
FROM THE
WHITMOYER LABORATORIES SITE**

1.0 INTRODUCTION

Biotrol, Inc. under contract to Ebasco Services Inc. performed a bench-scale treatability study to gather information necessary for determining the feasibility of soil washing/solvent extraction treatment for remediation of contaminated soils at the Whitmoyer Laboratories Site.

1.1 Site Background.

The Whitmoyer Laboratories Site is located in Lebanon County, Myerstown, Pennsylvania where several pharmaceutical products were produced from 1934 through 1987. The site geographical location and the preliminary location of contaminated soils are shown in Figures 1 and 2, respectively.

The history of activities at the site can be summarized as follows:

- > 1934: A veterinary pharmaceutical company initiated operations.
- > 1957: The company began production of organic arsenical compounds, primarily arsanilic acid and carbarsone, until closure in 1987.

Other chemicals produced at the facility included piperazine, chlorhexidine gluconate, phenolphthalein, cresylic acid-based products, iodine-based products, and vitamin supplements.

- > From 1957 through 1964 the arsenic in the plant wastewater was precipitated with lime and the slurry was sent to an unlined lagoon located directly on top of bedrock.
- > 1964: The lagoon sludge was excavated and placed in a concrete vault.

Arsenic-contaminated groundwater was treated with ferric sulfate and the ferric arsenate sludge was stored in the consolidated lagoon and in the excavated lagoon. However, the treated wastewater still containing dissolved arsenic infiltrated into the subsurface of the unlined lagoons and contaminated the offsite surroundings.

Final Report
Ebasco Services, Inc.

- > 1965: A soil augering and coring program was undertaken to determine the extent of contamination of subsurface soil and rock. The program revealed an average arsenic concentration of 1500 mg/kg along the contact surface between the soil mantle and the underlying rock formations.
- > 1973: A study by the United State Geological Survey confirmed the findings of the 1965 augering program.
- > 1976 to 1977: Lagoon sludges were consolidated. Sludge was excavated from the westernmost lagoons and placed in the easternmost lagoons.
- > 1987: The EPA, with assistance from the REM III Project Team, began the remedial investigation/feasibility study. Preliminary results confirmed the widespread arsenic contamination and tentatively identified "hot spots" of arsenic and/or organic contaminants.

The raw laboratory analytical results of the Remedial Investigation available at the time of proposal writing are summarized in Table 1.

The soil at the site consists predominantly of silts (2 to 20 microns) and clays (0.1 to 2 microns) and covers the majority of the study area, both on site and off site.

1.2 Samples Received.

To perform the bench-scale treatability study, Ebasco shipped seven (7) soil samples and one (1) upgradient groundwater sample to be used as the primary carrier fluid in this study.

These samples were identified as follows:

SOIL AND WATER SAMPLES FROM WHITMOYER SITE			
<u>BioTrol No.</u>	<u>Whitmoyer No.</u>	<u>Type</u>	<u>Amount</u>
89-28A	WL-TS201-00	Soil	32-Oz
89-28B	WL-TS202-00	Soil	32-Oz
89-28C	WL-TS203-05	Soil	32-Oz
89-28D	WL-TS204-03	Soil	32-Oz
89-28E	WL-TS205-04	Soil	32-Oz
89-28F	WL-TS206-05	Soil	32-Oz
89-28G	WL-TS207-06	Soil	32-Oz
89-29	WL-MW105-A	Water	25 gal

These samples were received on 10/11/89.

1.3 Treatability Study Objectives.

The primary objectives of this study are:

- > to characterize selected soil samples
- > to determine the feasibility of using soil washing technology to remove arsenic-bearing contaminants and other organic contaminants from the soils and allow for environmentally safe placement of the treated soils back onto the site
- > to collect appropriate data to establish preliminary sizing and operating requirements for a full-scale soil remediation operation, including any pre- and/or post-treatment requirements
- > to assess the state of development of the proposed technology and to evaluate requirements for additional pilot-scale testing
- > to develop an overall schedule to implement the remediation technology
- > to assess the compatibility of the process and equipment with the site, and
- > to develop an order-of-magnitude cost estimate for the remediation process.

2.0 TREATABILITY PHASES

A total of five (5) phases were conducted serially in this study in an effort to take advantage of conclusions from previous phases associated with the arsenic behavior in soil samples from this site. The different aspects of the treatability study were as follows:

2.1 Characterization of Soil Samples.

This effort consisted of analyses of total arsenic and Total Organic Carbon (TOC) in the initial seven soil samples in order to select five (5) samples to carry out the next phase of the study. Based on these initial results, a "worst case" sample was selected and a composite "average" sample was prepared and included in the 5-sample set for the partition study next phase.

The composite "average" sample was identified as WL-TS208-99

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Ebasco Services, Inc.

and made with equal amounts of samples TS-203, TS-204, and TS-206. Its chemistry was calculated as the average chemistry of the three contributing soil samples.

2.2 Arsenic and TOC Partition Phase.

The mobility of arsenic and TOC in a water slurry was established as a function of percent solids and time of contact with upgradient groundwater. The characteristics of the five soil samples chosen are given in Section 3.2.

2.3 Single-Stage Extractants Search.

Although arsenic-bearing as well as organic contaminants were the subject of this study, the effectiveness of soil remediation was primarily judged by the extent of arsenic removal. To identify the most promising leaching agents, a total of twelve (12) tests were conducted first using the composite soil sample.

The reagents investigated in these twelve tests included the following: HCl, HNO₃, H₂SO₄, NaOH, NaHS, Na₂CO₃, Na₂SO₃, Na₂S₂O₃, Xanthate Z-5, Cyquest DP-3 and DP-6, sodium EDTA, Ethanol, and other minor additives.

Based on the results of the first twelve tests, four additional leaching approaches were derived and tried on the "worst case" sample. The best two tests from the 16-test set were chosen for the optimization phase.

2.4 Leaching Extraction Optimization.

Because arsenic extraction in a single stage treatment reached a maximum of around 60%, there was a concern for the possibility that the arsenic extraction may have been hampered by either a solubility product barrier or insufficient leaching time. In an effort to define the effect of these two pertinent operating parameters, a countercurrent extraction simulation was implemented through an experimental design of cross-current leaching in four 4-hour stages (See Figure 3). Since fresh lixiviant is used at each stage, the potential solubility product barrier is eliminated while the time effect on extraction is quantified as the cumulative extraction for four 4-hour extraction stages.

The two extraction procedures subject to optimization were assigned the following labels: