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MEMORANDUM

US EPA Region 7
Oronogo Duenweg Mining Belt Site
Deep Tilling Pilot Study

B&V Project 044743

8/1/2013

To: Mark Doolan

From: Michael Naughter, PE

INTRODUCTION

The Deep Tilling Pilot Study for the Oronogo-Duenweg Mining Belt Site Operable Unit 1 Remedial Action was conducted by Black & Veatch Special Projects Corp. under contract with the U. S. Environmental Projection Agency Region 7. This document briefly describes the work that was performed and the results of the Pilot Study.

Site Location

The Oronogo-Duenweg Mining Belt Site (Site) is part of the Tri-State Mining District that encompasses approximately 2,500 square-miles in Missouri, Kansas, and Oklahoma. The Site encompasses 11 former mining areas or designated areas (DAs) in Jasper County and portions of Newton County, Missouri. The Pilot Study was conducted on an approximately 8 acre area in Jasper Countiy, Missouri.

Regulatory Background

EPA listed the Site on the National Priorities List (NPL) in 1990. The site has been divided into five operable units (OUs) for cleanup activities. The OUs include:

- OU 1: Mining and Milling Wastes
- OU 2: Smelter Waste Residential Yards
- OU 3: Mine Waste Residential Yards
- OU 4: Groundwater
- OU 5: Spring River

EPA signed a Record of Decision for OU 1 on September 30, 2004. EPA has already completed a series of remedial actions to address human health risks at the site associated with OUs 2, 3, and 4.

Remedial Action Objectives and Action Levels

The Remedial Action Objectives for the Oronogo-Duenweg Mining Belt Site Operable Unit 1 were identified in the Record of Decision, dated September 30, 2004, as the following:

- Source Material: Mitigate risks to terrestrial vermivores from exposure to contaminants of concern (COCs) from mine, mill, and smelter wastes within the Site, such that the calculated toxicity quotients or hazard indexes are less than or equal to 1.0.
- Sediment: Mitigate risks to aquatic biota in Class P streams and their tributaries exceeding Federal ALCs for the COCs by controlling the transport of mine, mill, and smelter wastes from source areas to waters of the state.

- Surface Water:
  - Mitigate exposure of aquatic biota to COCs released and transported from mine and mill wastes where surface water applicable or relevant and appropriate requirements (ARARs) are exceeded in Class P streams and in tributaries.
  - Mitigate exposure of aquatic biota to COCs released and transported from Site mine-related pits and ponds where surface water ARARs are exceeded in Class P streams and in tributaries.
- Groundwater: Mitigate exposure of aquatic biota to COCs in releases of groundwater from flowing mine shafts of the site where surface water ARARs are exceeded in Class P streams and in tributaries.

The ROD identified the action levels for Operable Unit 1 to be the following:

- Lead: 400 parts per million (ppm)
- Cadmium: 40 ppm
- Zinc: 6,400 ppm

In addition the EPA has established sediment cleanup criteria for tributaries to Class P stream as follows:

- Lead: 219 ppm
- Cadmium: 17 ppm
- Zinc: 2,949 ppm

Background Documents

Existing site investigation reports including the following and can be found in the site Administrative Record file located at the Webb City Public Library, 101 South Liberty, Webb City, Missouri, or the Joplin Public Library, 300 Main, Joplin, Missouri:

- EPA Superfund Record of Decision: Oronogo/Duenweg Mining Belt Site, Jasper County, Missouri, Mine and Mill Waste, Operable Unit 1, EPA ID: MOD980686281; 09/30/2004.
- Final Remedial Investigation, Neck/Alba, Snap, Oronogo/Duenweg, Joplin, Thomas, Carl Junction, and Waco Designated Areas, Jasper County site, Jasper County, Missouri; Dames & Moore; October 31, 1995.
- Feasibility Study, Mine and Mill Waste Operable Unit, OU-1; Jasper County Site, Jasper County, Missouri; New Fields; April 2003.

Pilot Study Objective

The Record of Decision for the site discussed the use of deep tilling technology as a remedial option for the site. The purpose of this pilot study was to determine if the technology was effective on this site.

To determine the effectiveness of deep tilling, the pilot study sought to test the technology on varied site conditions and levels of contamination.

SCOPE OF WORK

Areas Selected for Pilot Study

Areas selected for inclusion on the Pilot Study were based on the depth and level of concentration. The areas ranged in size from 1.9 acres to 3.7 acres, with contamination ranging from as little as 3 inches up to 3.5 feet below ground surface.

Area 1 of the Pilot Study was 3.7 acres with the shallowest contamination; ranging from 3 inches to 9 inches below ground surface. The levels of contamination in Area 1 were minimal. Lead levels ranged from 16 ppm to 446 ppm, with an average of 174 ppm at the surface and 105 ppm in the top 1 foot of soil. Cadmium levels ranged from Non-Detect to 164 ppm, with an average of 68 ppm at the surface and 36 ppm in the top 1 foot of soil. Zinc levels in Area 1 were below action levels for the site prior to the Pilot Study work. Area 1 contamination is described in Table 1-1 below.

Table 1-1, Area 1 Contamination

Test Pit #	Zn	Cd	Pb	Sample Depth (inches)
12	1141	40	107	0
12	1444	78	148	3
12	345	ND	16	6
13	3992	164	72	0
13	939	ND	25	6
14	3428	61	79	0
14	186	ND	29	8
15	3841	46	243	0
15	1332	ND	34	8
17	2794	65	66	0
17	486	ND	48	4
18	3237	49	283	0
18	270	ND	25	6
19	2408	46	95	0
19	248	ND	41	4
20	5860	70	446	0
20	388	ND	20	8
Average surface value	3338	68	174	
Average 1ft value	1902	36	105	

Area 2 of the Pilot Study was 2.4 acres with contamination ranging from 1 foot to 1.5 feet below ground surface. Lead levels in the soils ranged from 18 ppm to 4,663 ppm, with an average of 2,083 ppm at the surface and 827 ppm in the top 2 feet of soil. Cadmium levels ranged from Non-Detect to 212 ppm, with an average 116 ppm at the surface and 66 ppm in the top 2 feet of soil. Zinc levels ranged from 224 ppm to 28,709 ppm, with an average of 12,641 ppm at the surface and 5,279 ppm in the top 2 feet of soil. Area 2 contamination is described in Table 1-2 below.

Table 1-2 Area 2 Contamination				
Test Pit #	**Zn**	**Cd**	**Pb**	**Sample Depth (inches)**
62	15005	112	2722	0
62	3771	112	765	2
62	445	29	44	12
63	20587	179	2985	0
63	28709	212	4663	8
63	1706	ND	18	18
70	8040	110	1574	0
70	224	55	40	2
70	1116	15	112	12
80	6933	63	1051	0
80	8080	177	1339	2
80	284	32	21	12
Average surface value	12641	116	2083	
Average 2ft value	5279	66	827	

Area 3 of the Pilot Study was 1.9 acres with contamination ranging from 1.5 feet to 3.5 feet below ground surface. Lead levels in the soils ranged from 22 ppm to 7,458 ppm, with an average of 1,933 ppm at the surface and 1,731 ppm in the top 2 feet of soil. Cadmium levels ranged from Non-Detect to 604 ppm, with an average of 17 ppm at the surface and 130 ppm in the top 2 feet of soil. Zinc levels for the area ranged from 89 ppm to 94,502 ppm, with an average of 15,235 ppm at the surface and 21,816 ppm in the top 2 feet of soil. Area 3 contamination is described in Table 1-3 below.

Table 1-3 Area 3 Contamination				
Test Pit #	**Zn**	**Cd**	**Pb**	**Sample Depth (inches)**
35	4328	ND	478	0
35	6787	98	737	2
35	5999	140	652	12
35	3442	55	289	20
36	39874	ND	4733	0
36	83919	604	7458	18
36	94502	498	3161	24
36	173	ND	22	39
49	14172	ND	2097	7
49	89	ND	28	18
50	2564	69	424	2
50	3890	98	495	12
50	2224	1	217	24
Average surface value	15235	17	1933	
Average 2ft value	21816	130	1731	

Method of Deep Tilling

The general approach to the deep tilling operation was to lower the contamination levels in the soils by tilling the contaminated soils into the underlying uncontaminated materials.

For Areas 1 and 2 a rome plow was available that could reach sufficient depth to accomplish the objectives of the Pilot Study. The rome plow used was capable of reaching depths of 3 feet below ground surface. For Area 3, the rome plow alone was not sufficient to reach the required depths. A dozer was used to bulk mix the soils to an approximate depth of 5 feet prior to the rome plow being used to thoroughly mix the soil.

Detailed technical specifications for the work performed under this Pilot Study are included in Appendix A of this Memorandum.

Results

After the deep tilling operation, contamination levels in the soils were checked by XRF to determine if the deep tilling was sufficient to reduce the soil contamination below action levels for the site.

XRF analysis in Area 1 confirmed the deep tilling operation lowered the contamination levels below the action levels for the site. Area 1 Pilot Study results can be found in Table 2-1 below.

Table 2-1 Area 1 Pilot Study Results

SAMPLE	LOCATION	Pb	Zn	Cd	Units
A1-1	Area 1	32.49	1044.78	ND	ppm
A1-2	Area 1	75.32	1408.57	26.8	ppm
A1-3	Area 1	43.13	381.7	ND	ppm
A1-4	Area 1	79.96	973.51	12.74	ppm
A1-6	Area 1	163.74	2233.23	20.97	ppm
A1-7	Area 1	99.9	1061.73	ND	ppm
A1-8	Area 1	83.35	852.55	14.13	ppm
A1-9	Area 1	74.89	772.99	10.8	ppm
A1-10	Area 1	84.79	1251.51	ND	ppm
A1-11	Area 1	38.52	428.7	ND	ppm
A1-12	Area 1	388.25	2289.52	27.64	ppm
A1-13	Area 1	34.42	314.42	ND	ppm
A1-14	Area 1	90.06	777.04	ND	ppm
A1-15	Area 1	39.89	629.47	ND	ppm
A1-16	Area 1	247.38	2364.62	ND	ppm
A1-17	Area 1	48.3	797.94	ND	ppm
A1-18	Area 1	168.03	2398.31	18.98	ppm

XRF analysis in Area 2 showed mixed results for the deep tilling operation; lowering lead levels in only 33% of the samples. Results for Zinc and Cadmium were better, but the deep tilling was not 100% effective. Area 2 Pilot Study results can be found in Table 2-2 below.

Table 2-2 Area 2 Pilot Study Results

SAMPLE	LOCATION	Pb	Zn	Cd	Units
A2-1	Area 2	3691.07	20694.67	129.59	ppm
A2-2	Area 2	329.85	2092.94	22.3	ppm
A2-3	Area 2	731.68	4538.1	23.15	ppm
A2-4	Area 2	304.35	1917.61	ND	ppm
A2-5	Area 2	982.85	6984.99	40.64	ppm
A2-6	Area 2	325.01	2131.04	ND	ppm
A2-7	Area 2	237.83	1808.16	ND	ppm
A2-8	Area 2	879.29	3459.38	21.54	ppm
A2-9	Area 2	1389.11	6790.21	45.67	ppm
A2-10	Area 2	583.52	2648.91	24.9	ppm
A2-11	Area 2	1335	9404.86	58.16	ppm
A2-12	Area 2	1174.61	6112.73	59.67	ppm

XRF analysis in Area 3 showed poor results for the deep tilling operation. Nearly all sample results remained above action levels for the site. Area 3 Pilot Study results can be found in Table 2-3 below.

Table 2-3 Area 3 Pilot Study Results

SAMPLE	LOCATION	Pb	Zn	Cd	Units
A3-1	AREA 2	3543.28	31026.52	177.75	ppm
A3-2	AREA 2	3559.74	28374.81	143.16	ppm
A3-3	AREA 2	2960	27121	150.02	ppm
A3-4	AREA 2	6020.67	46853.69	202.9	ppm
A3-5	AREA 3	1412.71	10635.21	59.91	ppm
A3-6	AREA 3	1995.18	14861.46	125.89	ppm
A3-7	AREA 3	3486.72	29085.93	154.54	ppm
A3-8	AREA 3	4950.4	40239.28	193.58	ppm
A3-9	AREA 3	565.9	3755.27	ND	ppm
A3-10	AREA 3	2528.81	18483.54	88.24	ppm
A3-11	AREA 3	3193.34	25760.9	140.86	ppm
A3-12	AREA 3	3189.49	28004.99	145.45	ppm

CONCLUSIONS

The results of the Pilot Study shown above indicate that the technology is only effective for low levels of contamination found in very shallow depths similar to the site conditions in Area 1.

Because these conditions are not typical for the Oronogo Duenweg site, deep tilling is not a viable technology for remediating this site.