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EVALUATION OF SOLIDIFICATION/STABILIZATION FOR TREATING CONTAMINATED SOILS FROM THE FRONTIER HARD CHROME SITE

by

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13. ABSTRACT (Maximum 200 words)

Solidification/stabilization (S/S) of chromium in contaminated soils has proven to be one of the more intractable problems in applying S/S technology. This is particularly true when attempting to reduce the mobility of the chromium VI ion. The evaluation problem is compounded by the availability of numerous "proprietary" S/S mixes. This paper describes a study in which eight formulations were evaluated for their ability to reduce the mobility of chromium III and chromium VI.

The physical and contaminant release properties of a generic formulation and formulations provided by seven vendors were evaluated in a rigidly controlled study conducted at the US Army Engineer Waterways Experiment Station. The suite of physical tests included unconfined compressive strength, wet/dry durability, permeability, moisture content, Atterberg limits, Proctor density, bulk density, specific gravity, slump, cracking, bleed water, and resistance to penetration.

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The Toxicity Characteristic Leaching Procedure (TCLP) and the first extraction of the Monofilled Waste Extraction Procedure (MWEP-1) were used to evaluate contaminant release and were performed by Radian, Inc.

In general, all vendor formulations and the generic formulation resulted in significant improvements in the physical strength and durability properties of the soil.

The results of contaminant release testing were less encouraging. Neither the generic formulation nor the vendor-supplied formulations produced a product capable of meeting the stringent 0.05-mg/L goal set for the MWEP-1. All formulations satisfied the TCLP goal of 5.0 mg/L. However, several formulations appeared to increase the mobility of chromium.

14. (Concluded).

Chromium	Stabilization
Hexavalent chromium	TCLP
MWEP	UCS
Permeability	Wet/dry
Solidification	

PREFACE

The work reported herein was conducted for the US Army Engineer District, Kansas City (CEMRK), and the US Environmental Protection Agency (USEPA), Region X, by the US Army Engineer Waterways Experiment Station (WES) under Intra-Army Order No. KC-89-116. Mr. Bill McFarland was the Project Manager for CEMRK. Mr. Bill Adams was the Project Manager for the USEPA. This study was conducted as a bench-scale evaluation of the feasibility of using chemical solidification/stabilization for treating contaminated soils from the Frontier Hard Chrome site in Vancouver, WA.

The report was prepared by Ms. Elizabeth C. Fleming and Dr. M. John Cullinane, Jr., of the Water Supply and Waste Treatment Group (WSWTG), Environmental Engineering Division (EED), Environmental Laboratory (EL), WES. Waste extractions and chemical analyses were performed by Radian, Inc.

The study was conducted under the direct supervision of Mr. Norman R. Francingues, Chief, WSWTG, and under the general supervision of Dr. Raymond L. Montgomery, Chief, EED, and Dr. John Harrison, Director, EL.

At the time of publication of this report, Director of WES was Dr. Robert W. Whalin. Commander and Deputy Director was COL Leonard G. Hassell, EN.

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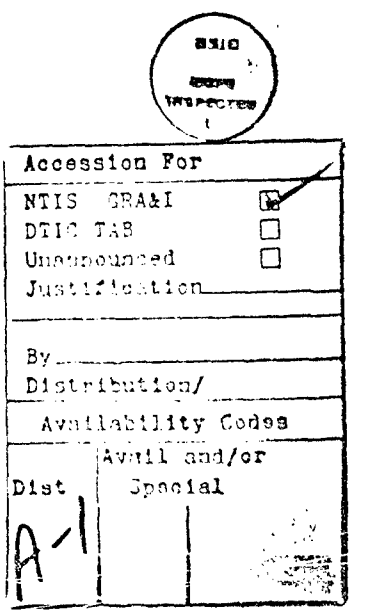

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LIST OF ACRONYMS

ACCRML	Average Cumulative, Corrected Relative Mass Loss
ANOVA	Analysis of Variance
ASR	Additive to Soil Ratio
ASTM	American Society for Testing Materials
BFS	Blast furnace slag
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
CI	Cone Index Test
CRS	Chrome Reduction Study
FHC	Frontier Hard Chrome
MWEP	Monofilled Waste Extraction Procedure
NMLC	Normalized mass leached concentration
MNMCSL	Mean normalized mass chromium (VI) leached
MNMTCL	Mean normalized mass total chromium leached
NPL	National Priority List
QA/QC	Quality Assurance/Quality Control
ROD	Record of Decision
RSD	Relative standard deviation
S/S	Solidification/Stabilization
TCLP	Toxicity Characteristic Leaching Procedure
UCS	Unconfined Compressive Strength
WDOE	Washington Department of Ecology
WSR	Water-to-Soil Ratio

CONVERSION FACTORS, NON-SI TO SI UNITS OF MEASUREMENT

Non-SI units of measurement used in this report can be converted to SI units as follows:

Multiply	By	To Obtain
acres	4,046.873	square meters
cubic feet	0.02831685	cubic meters
degrees (angle)	0.01745329	radians
Fahrenheit degrees	5/9	Celsius degrees or kelvins*
feet	0.3048	meters
gallons (US liquid)	3.785412	liters
inches	2.54	centimeters
miles (US statute)	1.609347	kilometers
pounds (force) per square inch	6.894757	kilopascals
pounds (mass)	0.4535924	kilograms
pounds (mass) per cubic foot	16.01846	kilograms per cubic meter
quarts (US liquid)	0.9463529	liters
square inches	6.4516	square centimeters

* To obtain Celsius (C) temperature readings from Fahrenheit (F) readings, use the following formula: $C = (5/9)(F - 32)$. To obtain Kelvin (K) readings, use: $K = (5/9)(F - 32) + 273.15$.

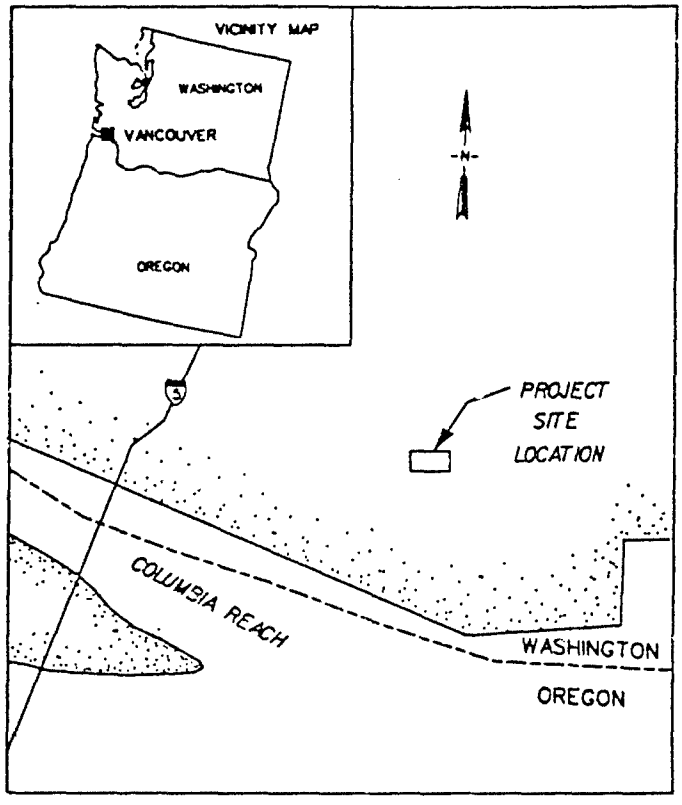

Figure 1. Location of Frontier Hard Chrome site

AN EVALUATION OF SOLIDIFICATION/STABILIZATION FOR TREATING CONTAMINATED SOILS FROM THE FRONTIER HARD CHROME SITE

PART I: INTRODUCTION

Background

1. Frontier Hard Chrome (FHC) site is an inactive industrial facility located at 113 Y Street, Vancouver, Clark County, Washington. Figure 1 shows the general location of the 0.5-acre* site, which is bordered to the east by Grand Avenue, to the south by Richardson Metal Works, and to the west by Y Street. Contamination of the site is the result of industrial chrome-plating operations conducted for a period of 25 years. From 1958 to 1983, the site was used for metal-plating operations for several metal fabricators in the Vancouver area. After that time, the FHC facility and the surrounding area were leased to neighboring businesses.

2. From 1958 to 1970 the site was used by Pioneer Plating, and from 1970 until 1983 it was used by FHC. During FHC operations, effluent from the facility was discharged to the sanitary sewer system. In 1975, the Washington Department of Ecology (WDOE) halted further discharges into the sewer system and required FHC to install a pretreatment system for chromium. At that point, FHC began discharging the effluent into the dry well located behind the FHC building.

3. In 1976, FHC was issued a wastewater treatment permit by WDOE to discharge waters to the dry well; the permit included a plan for chromium treatment systems to be installed. However, FHC did not install a treatment system and continued to discharge wastewaters to the dry well.

4. In 1982, after extensions of the deadline for installation of the treatment system had passed, it was found that an industrial supply well 0.25 mile southwest of the FHC site was contaminated with chromium at levels above the drinking water standard of 0.05 mg/L. The WDOE granted FHC a new deadline for compliance with the wastewater treatment permit requirements. FHC again failed to meet the deadline for installation of a treatment system. In 1983, the FHC site was placed on the National Priority List (NPL) under the

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* A table of factors for converting non-SI units of measurement to SI units is presented on page 7.

Comprehensive Environmental Response Compensation and Liability ACT (CERCLA). Industrial operations at the FHC site ceased.

5. The USEPA authorized the WDOE to begin investigating the cleanup of the FHC site under the Superfund program. In 1987, WDOE contracted with Dames & Moore to conduct a feasibility study for remediation of the FHC site. In 1987, a Record of Decision (ROD) was issued concerning soil contamination at the site. In March 1988, the US Environmental Protection Agency (USEPA) regained the lead control of cleanup investigations at the FHC site and contracted with the US Army Engineer District, Kansas City (CEMRK), to aid in the investigation.

6. The contamination of the site is divided into two units: a soils unit and a groundwater unit. The soils unit is subdivided into two types of material, a fill and a clay. Primary contaminants of interest are chromium (VI) and chromium (III). Contamination at depths up to 16 ft has been identified. Table 1 lists the major soil contaminants found at the FHC site, as documented in the remedial investigation conducted by the WDOE in the fall of 1984.

Solidification/Stabilization

Description

7. Solidification/stabilization (S/S) is a process that involves the mixing of a contaminated soil with a binder material to enhance the physical and chemical properties of the soil and to chemically bind any free liquid (USEPA 1986b). Typically, the binder is a cement, pozzolan, or thermoplastic. Proprietary additives may also be added. In most cases, the S/S process is changed to accommodate specific contaminants and soil matrices. Since it is not possible to discuss all possible modifications to a S/S process, discussions of most S/S processes have to be related directly to generic process types. The performance observed for a specific S/S system may vary widely from its generic type, but the general characteristics of a process and its products are usually similar. Comprehensive general discussions of waste S/S processes are given in Malone and Jones (1979), Malone, Jones, and Larson (1980), and USEPA (1986c).

Table 1

Concentration of Chromium in FHC Soils in Analysis Conducted in the RI

Soil Sample Designation	Depth ft	Total Cr, ppm	Cr(VI) ppm	% Cr(VI)
B85-2	0-1.5	40	0.5	1
	5-6.5	15	<0.5	
	10-10.5	90	5	6
	15-16.5	44	NA	
	20-21(b)	340	110	32
	20-21(b)	350	88	25
	25-25.3	110	18	16
	29-29.8	46	4.0	9
	33.5-33.8	34	NA	
B85-3	0-1.5	1,400	41	3
	5-6.5	970	16	2
	10-10.5	150	5.5	4
	15-16.5(b)	25	<0.5	
	15-16.5(b)	31	<0.5	
	20-21.5(b)	230	<0.5	
	20-21.5(b)	160	<0.5	
	25-25.5	65	<0.5	
	29-29.3	23	<0.5	
B85-4	0-1.5	12	<0.5	
	5	12	1.5	13
	10-11.5	6	<0.5	
	15-16.5(b)	8	<0.5	
	15-16.5(b)	7	<0.5	
	20-21(b)	51	<0.5	
	20-21(b)	38	<0.5	
B85-5	0.5-2.0	75	<0.5	
	10-11	55	<0.5	
	15-16.5(b)	200	1.5	1
	15-16.5(b)	210	2.5	1
	25	63	0.5	1
	30	30	<2.5	
B85-6	0-1.5	25	<2.5	
	5-6.5	24	<2.5	
	10-11.5	35	<0.5	
	15-16.5(b)	190	<2.5	
	15-16.5(b)	180	<0.5	
	20-21.5(b)	200	1.5	1
	20-21.5(b)	200	1.5	1
	25	67	<0.5	
	30	43	0.5	1

(Continued)

Table 1 (Continued)

Soil Sample Designation	Depth ft	Total Cr, ppm	Cr(VI) ppm	% Cr(VI)
B87-8	0-1	22	<0.5	
	13	50	<0.5	
	14	39	<0.5	
	19.5	28	<0.5	
B87-9	1.5	37	0.6	2
	12.5	12	<0.5	
	19.5(b)	40	0.6	2
	19.5(b)	38	0.6	2
	24.5	21	<0.5	
B87-10	0.5	430	<0.5	
	7.5	28	0.6	2
	12.5(b)	41	0.6	1
	12.5(b)	44	0.5	1
	16.5	56	0.6	1
	20.5	45	0.7	2
B87-11	16	17,000	750	4
	16.5	12,000	470	4
	17.5	3,100	67	2
PW-1A	18.5	20	NA	
PW-1B	17.5	88	NA	
S7	1	6,900	540	8
	2	2,000	170	9
	3	1,200	67	6
S8	1	3,900	300	8
	2	12,000	430	4
	3	9,200	430	5
S9	1	610	2.3	0
	2	700	3.5	1
S10	1	360	2.4	1
	2	26	0.3	1
	3	15	0.2	1
S-1-1	1	590	61	10
S-1-3	3	300	NA	
S-2-1	1	6,200	1,300	21
S-3-1	1	6,500	400	6
S-3-3	3	230	NA	
S-4-1	1	23	0.2	1
S-4-3	3	10	NA	

(Continued)

Table 1 (Concluded)

Soil Sample Designation	Depth ft	Total Cr, ppm	Cr(VI) ppm	% Cr(VI)
S-5-2	2	330	4.8	1
S-5-4	4	160	22	14
S-6-2	2	7,800	950	12
S-6-3 1/2	3.5	4,100	1,200	29

S/S treatment systems

8. Solidification/stabilization systems that have potential application to the FHC soils include:

a. Portland cement processes.

b. Pozzolan processes.

9. Portland cement processes use Portland cement to produce a type of soil/concrete composite. Contaminant migration is reduced by microencapsulation of the contaminants in the concrete matrix. The addition of soluble silicates to Portland cement processes may accelerate hardening. As with lime/fly ash and other pozzolanic systems, metals are also converted to less soluble forms.

10. Pozzolanic processes use the finely divided, noncrystalline silica in fly ash and the calcium in lime to produce low-strength cementation. Waste containment is produced by entrapping the waste in the pozzolan concrete matrix (microencapsulation). Metals are also converted to less soluble forms that further inhibit leaching.

Objective and Scope of Study

General objective

11. The general objectives of this study were to

a. Determine the effects of S/S techniques on contaminated soils from the FHC site.

b. Evaluate the physical and chemical properties of the solidified/stabilized soils to determine if S/S techniques will substantially reduce the chromium (VI) to chromium (III), reduce the amount of contaminants in the leachate, and improve the physical handling properties of the soil.

Specific objective

12. The specific objective of this treatability study was to develop S/S formulations (one for each type of soil) that, if incorporated in a remedial soil S/S treatment action at the site, will effectively eliminate leaching of chromium from the soils and consequently protect groundwater from further degradation. The following treatment goals were established for the S/S process:

a. The treated soils should have a minimum unconfined compressive strength (UCS) of 50 psi, or the minimum defined by local building codes, whichever is greater.

b. Chromium in the Toxicity Characteristic Leaching Procedure (TCLP) extracts of treated soils should not exceed 5.0 mg/L.

c. Chromium concentrations in one extraction of the Monofilled Waste Extraction Procedure (MWEP-1) extracts should not exceed 0.05 mg/L.

d. The permeability of the treated soils should be at least two orders of magnitude less than the permeability of the untreated soils. The goal of the treatment process is to achieve permeability values of 1×10^{-8} cm/sec.

e. The treated soil should exhibit high wet/dry durability. Loss of 30 percent solids after 12 cycles constitutes failure.

Organization of Report

13. This report is divided into four basic sections:

a. Part I briefly describes the background for this study and introduces the concept of S/S.

b. Part II describes the methods used for sampling, treatment, and testing of the contaminated soil.

c. Parts III and IV describe the results of physical and contaminant mobility testing of the S/S soil.

d. Part V presents conclusions and recommendations based on the results of the testing program.

14. Additional information on the study methods and test results is presented in seven appendixes: initial screening test by WES (Appendix A), results of physical tests on untreated fill and untreated clay (Appendixes B and C), results of physical and chemical tests on treated fill and treated clay (Appendixes D and E), and Radian, Inc., laboratory procedures (Appendix F).

PART II: MATERIALS AND METHODS

General Approach to the Investigation

15. This investigation was conducted in the six primary phases summarized below and illustrated in Figures 2-4.

a. Phase I: Identification of Vendors. CEMRK advertised in the Commerce Business Daily (27 February 1990) for vendors interested in participating in an evaluation of S/S technology for application to contaminated soils collected from the FHC site. Forty-three vendors responded to the initial advertisement. Following the exchange of fact sheets, seven vendors agreed to participate in the study. In addition, the WES participated as an eighth "vendor" by preparing a generic S/S mix.

b. Phase II: Sample Collection. Five gallons each of clay and fill material were shipped to six vendors and WES for pretesting. Vendor 4 did not receive samples because of logistical problems within their laboratory. Samples of contaminated fill and clay were collected and shipped to WES by Radian, Inc. (the CEMRK contractor), for the vendor demonstration.

c. Phase III: Preliminary Testing. Vendors performed preliminary tests to determine the additives and additive-to-soil ratios (ASR, a fraction based on wet weight) for preparation of the specimens at WES. The preliminary testing results for the vendors are not presented. WES conducted a preliminary investigation that included an evaluation of binders and a chromium reduction study (CRS). The results are presented in a later section.

d. Phase IV: Preparation of Test Specimens for Detailed Evaluation. Test specimens for detailed evaluation of solidified/stabilized fill and clay were prepared by WES and vendors.

e. Phase V: Detailed Evaluation. Physical characteristics of the treated soil were evaluated by WES using the UCS, bulk density, permeability, slump, bleed water, cracking, moisture content, specific gravity, set time, and wet/dry tests. Contaminant-release tests were conducted by Radian, Inc., using the TCLP and MWEP-1. Radian, Inc., also conducted bulk chemistry analyses.

f. Phase VI: Data Analysis and Report Preparation. Data from WES and Radian, Inc., were consolidated and evaluated.

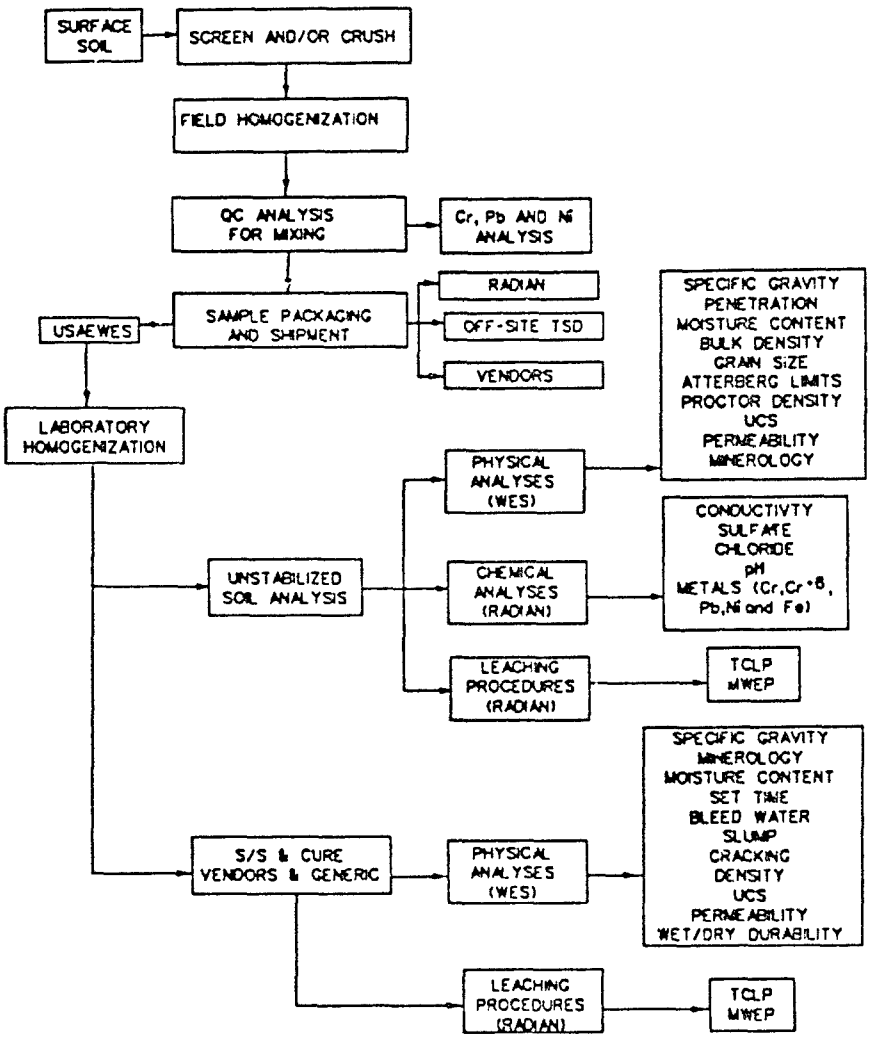

Figure 2. Schematic of S/S treatability study for fill

Sample Collection

Materials of interest

16. The materials of interest were contaminated soils obtained from the FHC site. Contaminants of interest included chromium (VI) and total chromium (Cr). Based upon the points of known high contaminant concentration, a composite sample was collected by personnel of Radian, Inc., during the week of 21 May 1990. Samples were collected from the 12- to 14-ft depth for the fill and the 14- to 16-ft depth for the clay. Five gallons each of clay and fill

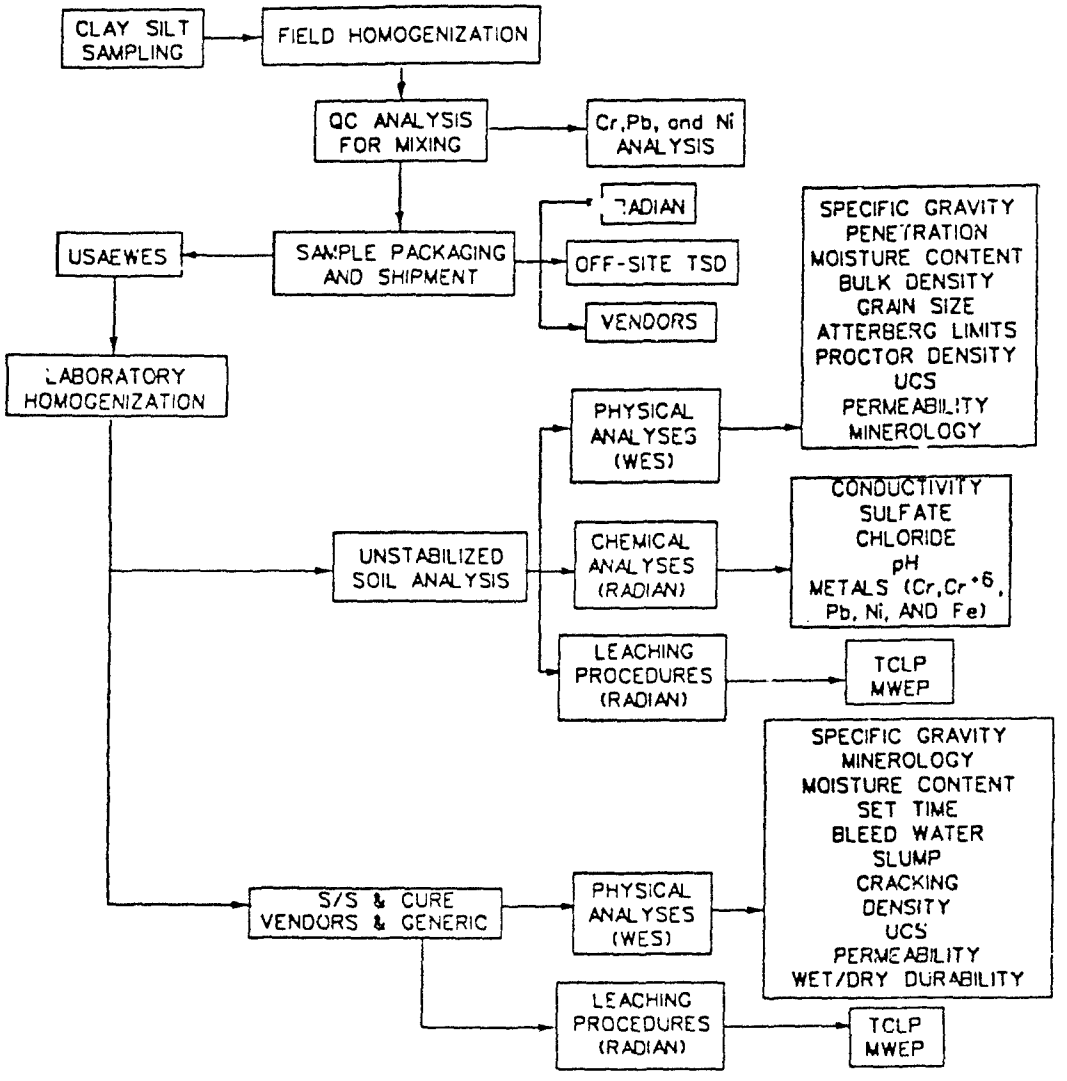

Figure 3. Schematic of S/S treatability study for clay

were shipped to each vendor for development of their S/S process. Clay and fill (255 gal each) were collected and shipped to WES. Upon receipt at WES, the sample was placed in cold storage to await implementation of the S/S evaluation protocol.

17. Homogenization of the FHC fill and clay was conducted in the field by Radian, Inc., before shipment to the WES. Homogenization consisted of manual mixing and mechanical mixing with an auger. The clay and fill arrived at WES in 102 five-gallon buckets, i.e., 51 buckets of clay and 51 buckets of fill. WES homogenized the fill manually and sieved the material through a

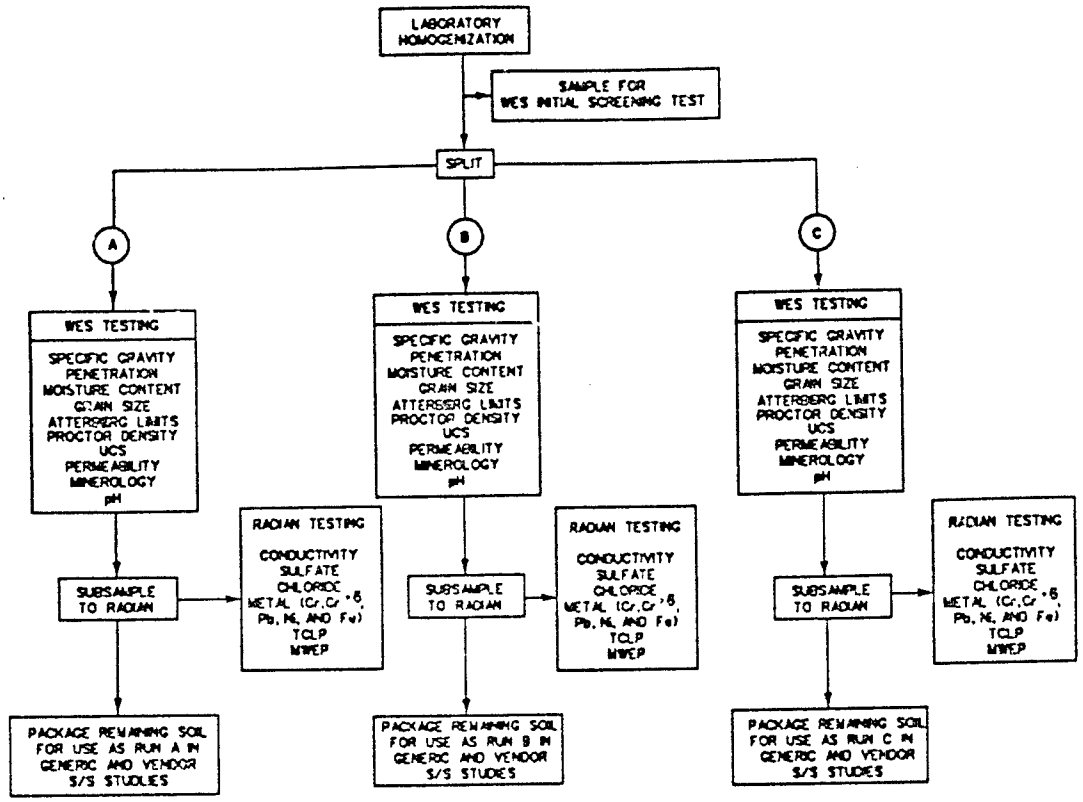

Figure 4. Schematic of the S/S process

1/2-in. screen. Selection of a 1/2-in. screen was based upon the particle sizes allowable for the molds to be used in physical testing. The clay was not homogenized manually due to the texture of the material. The fill and clay were separately placed into three 85-gal drums each and mixed with a hydraulic mixer. Each set of three drums was intermixed twice and homogenized with the hydraulic mixer for both the fill and clay.

18. To ensure that soils collected for S/S studies were in fact contaminated and for comparison of the results for treated soils, Radian, Inc., performed a MWEP-1 and a bulk chemical analysis on the untreated soils collected at the sample points located as shown in Figure 5. Tables 2 and 3 present the results of these analyses for the fill and clay, respectively.

Materials classification

19. Clay and fill collected from the site were classified according to US Geological Survey (USGS) classifications as sandy silt and sandy, silty

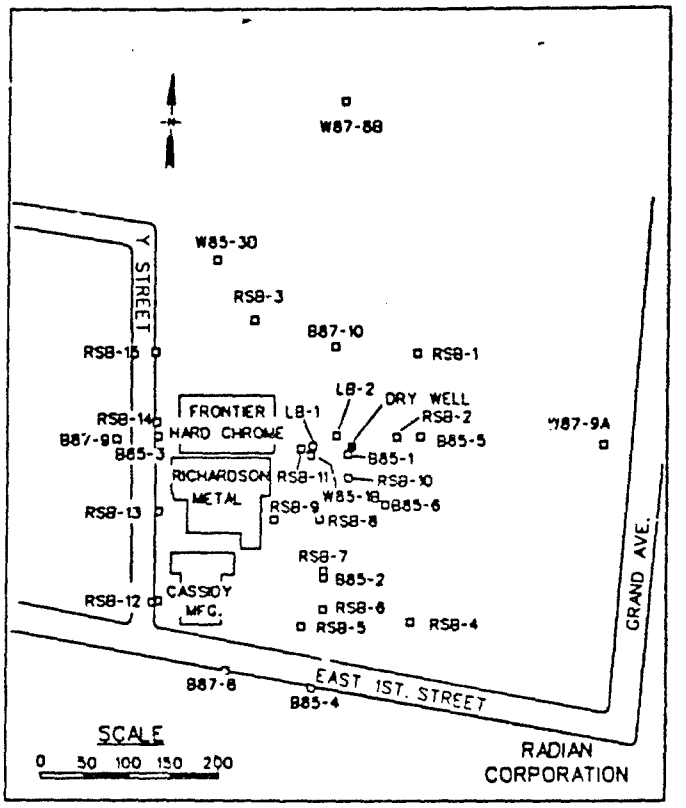

Figure 5. Sample collection points on the FHC site

gravel, respectively. USGS classifications for the clay and fill were MH and GM, respectively.

Preliminary Testing

20. Six vendors and the WES received fill and clay samples to conduct preliminary testing before preparation of the specimens for detailed evaluation at WES. The results of the preliminary testing conducted by the vendors were not reported; the methods and results of the WES preliminary tests are presented in Appendix A. Vendor 4 did not receive samples for the preliminary testing; however, this vendor did participate in the detailed evaluation phase.

Table 2

Results of Chromium Analysis Conducted on Fill by Radian, Inc., for the Frontier Hard Chrome Site

Boring No.	Soil Cr mg/kg	MWEP Cr mg/L	Soil Cr(VI) mg/kg	MWEP Cr(VI) mg/L
RSB-1	51	0.007	ND*	ND
RSB-2	11	0.003	0.12	ND
RSB-3	16	ND	ND	ND
RSB-4	24	ND	0.26	ND
RSB-5	6.3	0.011	ND	0.009
RSB-6	22	ND	0.16	ND
RSB-7	3,430	0.168	11	0.174
RSB-8	1,180	1.37	22	ND
RSB-9	62	0.054	0.71	0.053
RSB-10	180	0.239	24	0.206
RSB-11	5,100	0.719	150	--
RSB-12	170	0.063	0.15	ND
RSB-13	640	0.095	1.4	ND
RSB-14	420	ND	0.73	ND
RSB-15	19	0.004	0.08	ND
Large boring	1,570	0.395	32	0.354

* Not detected.

Table 3

Results of Chromium Analysis on Clay Conducted by Radian, Inc., for the Frontier Hard Chrome Site

Boring No.	Soil Cr mg/kg	MWEP Cr mg/L	Soil Cr(VI) mg/kg	MWEP Cr(VI) mg/L
RSB-1	47	0.005	ND*	ND
RSB-2	23	ND	0.17	ND
RSB-3	31	ND	ND	ND
RSB-4	30	ND	ND	ND
RSB-5	37	ND	ND	ND
RSB-6	50	ND	ND	0.008
RSB-7	640	0.405	1.7	0.372
RSB-8	1,100	0.134	3.2	0.120
RSB-9	66	0.013	0.1	ND
RSB-10	380	3.19	50	2.67
RSB-11	110	0.008	0.61	0.079
RSB-12	580	0.017	0.58	ND
RSB-13	44	0.007	0.19	ND
RSB-14	84	ND	ND	ND
RSB-15	33	ND	0.06	ND
Large boring	2,630	0.065	10	0.070

* Not detected.

Initial screening tests

21. The WES conducted preliminary tests that included minimum evaluation of binders and water addition. The objectives of the initial screening test were threefold: (a) to determine the appropriate water-to-soil ratio (WSR), a fraction of water to wet soil; (b) to select the binder for preparation of specimens for detailed evaluation; and (c) to select the appropriate ASR for detailed testing.

22. Although the clay and fill had considerable moisture content, it was necessary to add water to the contaminated fill and clay for S/S to be effective. Initial screening tests were conducted on a wide range of ASRs and WSRs. The matrices of test specimens prepared for fill and clay during the WES initial screening test are presented in Appendix A.

23. Determination of the appropriate WSR and ASR for preparation of clay and fill specimens for detailed evaluation was based on the results of the cone index (CI) test performed on the initial screening test specimens after they had cured for 1, 4, 8, and 24 hr. The CI measures the resistance of a material to the penetration of a 30-deg right circular cone. The method specified in Technical Manual (TM) 5-530 was followed (Headquarters, Department of the Army (HQDA) 1971). The CI value is reported as force per unit surface area (pounds per square inch) of the cone base required to push the cone through a test material at a rate of 72 in./min. Two cones are available for this test: the standard WES cone having an area of 0.5 sq in. and the airfield penetrometer having a base area of 0.2 sq in. It was necessary to use the standard WES cone on material with a CI less than 100 psi and to use the airfield penetrometer on materials with a CI greater than 100 psi. The maximum CI value that can be measured by the airfield penetrometer is 750 psi; therefore, materials having CI values greater than 750 psi are reported simply as >750 psi.

24. The results of the initial screening test define the appropriate ASR required to produce physical strength and narrow the range for a selection of a WSR. The test specimens generated during the initial screening test were not used for further evaluation.

Chromium reduction study

25. The objectives of the WES chromium (VI) reduction study were: (a) to determine if reagents could be added to the fill and clay to reduce Cr(VI) to Cr(III), (b) to determine the dosages of reagent necessary for

reduction of Cr(VI) to Cr(III), and (c) to determine the reaction time required for reduction of Cr(VI) to Cr(III).

26. Blast furnace slag (BFS) and ferrous sulfate were selected as additives for reduction of Cr(VI). A wide range of ASRs were evaluated to determine the amount of additive necessary to reduce Cr(VI) to Cr(III). The minimum BFS to soil ratio and ferrous sulfate to soil ratio was selected based on stoichiometric ratios of initial Cr(VI) concentrations. The appropriate ASRs for the clay and fill to be prepared in the detailed evaluation were determined by analysis of the treated specimens for Cr(VI) according to SW-846 Method 3060 (USEPA 1986d) with modifications. The reagents used were 0.1N NaOH, 0.1N Na_2CO_3, 10% H_2SO_4, and a color reagent (see SW-846 Method 7196). The method of extraction was to add 50 ml each of 0.1N NaOH and 0.1N Na_2CO_3 to 25 g of the clay or fill, tumble for 2 hr, and filter with a 0.45-μ filter; the leachate was analyzed according to SW-846 Method 7196. For leachate analysis, 3 ml of 10% H_2SO_4 and 2 ml of the color reagent were diluted to 95 ml according to SW-846 Method 7196.

Preparation of Test Specimens for Detailed Evaluation

General description of S/S process

27. Solidified specimens were prepared by mixing water and additives with the contaminated clay and fill in a Hobart H600T mixer. The soil and additives were mixed for 5 min, after which the sides of the container were scraped to remove material adhering to the sides of the container. After scraping, the mixture was mixed an additional 5 min. Variations from this method, if any, are discussed for each vendor in the paragraphs that follow. Immediately after mixing was completed, a slump test was conducted according to methods described in ASTM C 143-89 (ASTM 1990). The remaining water/additive/soil slurry was poured into molds for physical and chemical testing. To aid in removing test specimens from the molds, a light coat of grease was applied to the molds used to cast the UCS specimens. Specimens used for the bulk chemistry, MWEP-1, and TCLP were prepared in ungreased molds. Immediately after the additive/water/soil mixtures were placed in the molds, they were vibrated on a Sentron model VP61D1 vibration table to remove voids. Visual observations of the specimens were recorded for the bleed water test according to methods in ASTM C 232-87 (1990). For some vendor sample preparations, the additive/water/contaminated soil mixture was very viscous, and

vibration was an ineffective method for removing voids. These specimens were tamped according to ASTM C 109-86 (ASTM 1990) using a model CT-25A tamper.

28. The molded, solidified/stabilized materials were cured in the molds at 23 °C and 98-percent relative humidity for a minimum of 24 hr. Specimens were removed from the molds when they developed sufficient strength to be free standing, and were cured under the same temperature and relative humidity conditions until further testing.

29. After the solidified/stabilized soil was cured, the physical and chemical properties of the solidified/stabilized soil were determined. The UCS, moisture content, bulk density, permeability, specific gravity, set time, slump, and wet/dry tests were used to determine the physical characteristics, and the TCLP and MWEP-1 were used to measure the leachability of the contaminants from the solidified/stabilized soil.

30. One formulation was prepared by each vendor for each of the clay and fill materials. Additive systems developed by each vendor were used to solidify/stabilize the soil and are differentiated by the type of additive material used in the process. The processes selected by the vendors are discussed below.

Preparation of fill material specimens

31. Vendor 1. Vendor 1 added two proprietary additives (Ensol and Landtreat) and water. Ensol contains sodium silicate and a chelating agent. Landtreat is an insoluble polysilicate. Vendor 1 varied the amount of Ensol among replicates according to the following schedule.

Replicate	WSR	Ensol	Landtreat
A	0.02	0.04	0.05
B	--	0.04	0.07
C	0.02	0.08	0.10

For replicates A and C, Vendor 1 added WSRs of 0.02 but added no water to replicate B. Vendor 1 added Ensol and Landtreat to the fill and initiated mixing. During the first 5 min of mixing, they slowly added 400 ml of water to replicate A. As mixing progressed, Vendor 1 decided to add an additional 150 g of Landtreat powder due to the apparent moisture in the mix. Vendor 1 added Ensol and Landtreat to replicates B and C after initiation of mixing but did not add water to replicate B. The replicate mixtures were mixed for 5 min, scraped, and mixed for an additional 5 min.

32. Vendor 2. Vendor 2 added cement and a chemical reducing agent to the fill at the following ASRs.

Replicate	WSR	Cement	Chemical Reducing Agent
A	--	0.15	0.05
B	--	0.15	0.07
C	--	0.15	0.10

The cement was added at a constant rate of 0.15 ASR for replicates A, B, and C, but the chemical reducing agent ASR was varied (0.05, 0.07, and 0.10 for replicates A, B, and C, respectively). The mixing times were consistent among replicates, and mixing was conducted as discussed in paragraph 27.

33. Vendor 3. Vendor 3 added portland cement, silica, and water to the fill, and ASRs remained consistent for the three replicates.

Replicate	WSR	Portland Cement	Silica
A	0.09	0.21	0.14
B	0.09	0.21	0.14
C	0.09	0.21	0.14

Vendor 3 added the silica and one half the water, mixed for 5 min, scraped the container, and added the remaining water and portland cement for all replicates.

34. Vendor 4. Vendor 4 added cement, a metal complexing reagent, a cementitious reagent, and water at consistent dosages for the replicates.

Replicate	WSR	Cement	Metal Complex Reagent	Cementitious Reagent
A	0.20	0.20	0.08	0.05
B	0.20	0.20	0.07	0.05
C	0.20	0.20	0.07	0.05

Vendor 4 used consistent mixing processes for all replicates and began by mixing the metal complexing reagent and slowly adding the fill for 5 min. The container was scraped, and the cement was added. After mixing an additional minute, the cementitious reagent was added, and the mixture was mixed an additional 4 min.

35. Vendor 5. Vendor 5 added cement, sodium silicate, and water to the fill at the ratios listed below.

Replicates	WSR	Cement	Sodium Silicate
A	0.17	0.25	0.20
B	0.17	0.25	0.20
C	0.17	0.25	0.20

Vendor 5 mixed the water, fill, and sodium silicate for 5 min, scraped the container, and then added the cement and mixed for an additional 5 min.

36. Vendor 6. Vendor 6 added cement, ferrous sulfate, and water to the fill at the ASRs listed below.

Replicates	WSR	Cement	Ferrous Sulfate
A	0.25	0.20	0.02
B	0.25	0.20	0.02
C	0.25	0.20	0.02

Vendor 6 began preparation of their specimens by first adding ferrous sulfate and water to the fill and mixing for 2 min. The cement was then added, and mixing was continued for 3 min. The container was scraped, and the mixture was mixed an additional 5 min.

37. Vendor 7. Vendor 7 used cement, type C fly ash, and Urichem for their process. Water was added to replicate A only.

Replicates	WSR	Cement	Fly Ash	Urichem
A	0.02	0.06	0.30	0.04
B	--	0.05	0.30	0.04
C	--	0.05	0.30	0.04

First, Urichem was added to the fill and mixed for 5 min. The cement and fly ash were composited before they were added to the fill. After mixing, the container was scraped, and the fly ash, cement, and water were added and mixed an additional 5 min.

38. Vendor 8. Vendor 8 added cement, blast furnace slag, and water to the fill at the following ASRs.

Replicates	WSR	Cement	BFS
A	0.15	0.10	0.40
B	0.15	0.10	0.40
C	0.15	0.10	0.40

The cement, BFS, and water were added to the fill before mixing was initiated. The fill and additives were mixed for 5 min, the container was scraped, and the mixture was mixed an additional 5 min.

Preparation of clay material specimens

39. Vendor 1. Vendor 1 varied the amounts of water and additives added among replicates for the clay according to the following schedule.

Replicates	WSR	Ensol	Landtreat
A	0.07	0.08	0.08
B	0.03	0.08	0.08
C	0.06	0.10	0.10

The additives were mixed according to the methods described for the fill (see paragraph 31).

40. Vendor 2. Vendor 2 added cement and a chemical reducing agent to the clay at the following ASRs.

Replicates	WSR	Cement	Chemical Reducing Agent
A	--	0.15	0.08
B	--	0.15	0.08
C	--	0.10	0.10

Vendor 2 did not add water to any of the replicates. The mixing was conducted according to the methods described for preparation of fill specimens by Vendor 2 (see paragraph 32).

41. Vendor 3. Vendor 3 added portland cement, silica, and water to the clay at the ratios listed below.

Replicates	WSR	Portland Cement	Silica
A	0.23	0.21	0.14
B	0.23	0.21	0.14
C	0.23	0.21	0.14

The clay and additives were mixed according to the methods used by Vendor 3 for the fill (see paragraph 33).

42. Vendor 4. Vendor 4 added water, cement, a metal complexing reagent, and a cementitious reagent to the clay. Vendor 4's cement, metal complexing reagent, and cementitious reagent additions were consistent among replicates at the ASRs listed below.

Replicates	WSR	Cement	Metal Complex Reagent	Cementitious Reagent
A	0.21	0.20	0.07	0.05
B	0.23	0.20	0.07	0.05
C	0.26	0.20	0.07	0.05

The water additions varied for replicates A, B, and C. The mixing process was conducted according to methods used by Vendor 4 for the fill (see paragraph 34).

43. Vendor 5. Vendor 5 added cement, sodium silicate, and water to the clay at the following ratios.

Replicates	WSR	Cement	Sodium Silicate
A	0.23	0.25	0.23
B	0.23	0.25	0.20
C	0.24	0.25	0.20

The cement/sodium silicate/water mixture was mixed according to the same methods used for the fill (see paragraph 35).

44. Vendor 6. Vendor 6 added cement, ferrous sulfate, and water to the clay for each of the replicates at the ratios listed below.

Replicates	WSR	Cement	Ferrous Sulfate
A	0.36	0.20	0.02
B	0.37	0.20	0.02
C	0.37	0.20	0.02

The additive/clay mixtures were mixed according to the same methods used by Vendor 6 for the fill (see paragraph 36).

45. Vendor 7. Vendor 7's additives were Urichem, fly ash, cement, and water.

Replicates	WSR	Cement	Fly Ash	Urichem
A	0.11	0.07	0.42	0.04
B	0.11	0.10	0.40	0.04
C	0.12	0.10	0.40	0.04

Additives were added in the order described for the fill and mixed according to the methods used for the fill (see paragraph 37).

46. Vendor 8. Vendor 8 added BFS, water, and cement to the FHC clay at the following ratios.

Replicates	WSR	Cement	Blast Furnace Slag
A	0.15	0.10	0.36
B	0.15	0.10	0.36
C	0.15	0.10	0.36

The mixture was mixed according to methods described for the mixing methods for the fill (see paragraph 38).

Detailed Evaluation Methods

47. The success of a S/S process can be evaluated in a number of ways. This section describes the protocol of physical and chemical testing methods used to evaluate the effectiveness of S/S.

Physical testing

48. The parameters UCS, wet/dry, and permeability were selected to evaluate the physical effectiveness of S/S. Tests of specific gravity, moisture content, bulk density, bleed water, slump, and set time were also used to characterize the treated specimens.

49. Unconfined compressive strength. The UCS test was used to characterize the effects of the S/S process on the strength characteristics of the clay and fill materials. The UCS was determined according to ASTM method D 2166 (ASTM 1990). The only deviation from this method was vibration or tamping of the specimens, as previously discussed (see paragraph 27). The UCS tests were performed in triplicate on 3-in.-diam by 6-in.-long cylinders after they had cured for 28 days. Triplicate specimens were tested for each vendor system. The surface area of each cylinder was determined by using a Fowler Max-cal caliper. The force required to fracture the specimens was measured with a Tinius Olsen Super L compression apparatus. UCS was reported as the pounds per square inch required to fracture the cylinder. A UCS goal of 50 psi was chosen based on information found in the Office of Solid Waste and Emergency Response (OSWER) Policy Directive 9487.00-2A (USEPA 1986d).

50. Wet/dry. ASTM method D 4843-88 (ASTM 1990) was used to evaluate resistance of the S/S specimens to successive wetting and drying periods. The wet/dry test simulates the effects of weathering on the integrity of the S/S specimens after 28 days of cure. The wet/dry test uses a 1-3/4-in.-diam by 3-in.-long cylindrical specimen. Wet/dry results were reported as the average cumulative, corrected relative mass loss after each cycle. Triplicate test and triplicace control specimens were subjected to the wet/dry test. One specimen was evaluated for moisture content according to ASTM method D 2216 (ASTM 1990). Loss of 30 percent of the original dry weight of the specimen constitutes failure of the test.

51. Permeability. Permeability determinations were made by measuring the falling head through a specimen with a triaxial cell according to methods described in Engineer Manual 1110-2-1906, Appendix VII (US Army Corps of Engineers 1970). Permeability tests were run on 3-in.-diam by 3-in.-long

cylinders after a minimum of 28 days for curing. Triplicate readings were performed on each replicate. In some cases, the specimens were shaved in order for them to adjust to the size of the triaxial cell. Permeability was calculated as the time required for a certain head loss through the specimen. A permeability of 1×10^{-8} cm/sec or a permeability two orders of magnitude less than the permeability of the untreated fill/clay was selected as the criterion for the treated specimens.

52. Specific gravity. The specific gravity of the S/S specimens was determined according to ASTM method D 854-83 (ASTM 1990). Specific gravity of the specimens expresses the relationship between air, water, and solids in a given volume of material and was determined in triplicate for each vendor formulation after 28 days of cure.

53. Moisture content determinations. Moisture content of the specimens was reported as the percentage of dry solids as evaluated according to ASTM method D 2216 (ASTM 1990). Moisture content was used to determine the water content of the untreated and treated specimens, and established consistency among replicates. Moisture contents were reported in triplicate for untreated and treated specimens. Moisture contents of the treated fill and clay were determined after 28 days of cure.

54. Workability (slump). Workability of the treated specimens was evaluated using the slump test, ASTM method C 143 (ASTM 1989). Slump was determined by measuring the vertical displacement of the center of the treated sample after 2.5 min. Slump measurements were taken in triplicate for the clay and fill material immediately after preparation of the formulations.

55. Bulk density. The bulk densities were determined based on methods described in ASA 13 (American Society of Agronomy 1965). For the untreated material, bulk density was determined on the materials at their Proctor density in triplicate. The bulk density of the treated specimens was determined in triplicate for each replicate after 28 days of cure.

56. Set time. Set time was estimated using the cone index (CI) described in TM 5-530 specifications (HQDA 1971). Set time was determined by measuring the resistance of the treated and untreated fill and clay to penetration of an airfield penetrometer (in psi). The CI measurements were taken at 2-, 4-, 8-, 24-, and 48-hr intervals for the treated and untreated specimens in triplicate using 4-in.-diam by 4-in.-long cylinders.

57. Bleed water. Bleed water was measured immediately after preparation of the detailed test specimens. Visual observations were noted after the samples were molded.

58. Cracking. Evaluation of cracking was conducted visually after extrusion of the specimens from the molds. Surface voids and cracks were reported after 28 days of cure.

Contaminant release testing

59. The TCLP and MWEP-1 were selected for evaluation of chromium stabilization success. The TCLP standard is 5.0 mg/L for chromium (40 CFR Part 261), and the MWEP-1 total chromium goal established for the FHC soils was 0.05 mg/L chromium, based on the drinking water maximum concentration level for chromium.

60. Toxicity Characteristics Leaching Procedure. The TCLP extracts were analyzed for metals according to the methods and within the time constraints summarized in the Federal Register (USEPA 1990) and specified in SW-846 (USEPA 1986d).

61. Monofilled Waste Extraction Procedure-1. The MWEP-1 was analyzed for metals according to methods described in the EPA Technical Resource Document SW-924. Extraction of the specimens was performed one time.

62. Quality assurance/quality control. The quality assurance/quality control (QA/QC) for this project was divided between WES and Radian, Inc. The WES was responsible for preparing the solidified/stabilized soil specimens and performing physical tests. Radian, Inc., was responsible for laboratory QA/QC related to the conduct of the MWEP-1, TCLP, and total extractions and chemical analysis of the resulting extracts. The Radian, Inc., QA/QC reports are presented in Appendix G.

PART III: DISCUSSION OF RESULTS FOR FILL MATERIAL TESTING

Analysis of Homogenization

63. A major concern during the conduct of the study was the use of a homogenized sample for the application of the vendor S/S processes. An attempt was made to provide each vendor with a statistically homogeneous sample. The homogeneity of the samples was evaluated by normalizing the total chrome for dilution effects of binder addition, and conducting an analysis of variance (ANOVA) on the normalized chromium values.

Normalization process

64. Normalization of the total chromium and Cr(VI) bulk chemistry analyses indicates the amount of total chromium and Cr(VI) in the samples presented to the vendors and accounts for dilution due to additives in the S/S process. The normalized total Cr and Cr(VI) for each vendor was calculated from the following equation (on a 1 kg dry weight basis):

$$NM_{tcr} = C_{tcr}\left[\frac{M_s}{B_t\left(1 - \frac{w_{cs/s}}{B_t}\right)}\right] \qquad (1)$$

NM_{tcr} - normalized concentration of total chromium in soil presented to the vendors

C_{tcr} - concentration of total chromium in the S/S soil (dry weight basis)

M_s - 1 kg dry solids (per kilogram dry solids basis)

B_t - weight fraction of fill/clay in S/S waste, calculated as

$$B_t = \frac{M_s + M_s(w_{cs/s})}{M_s + M_s(ASR)}$$

$w_{cs/s}$ - water content of S/S fill/clay

65. Normalized mass leached concentration (NMLC) chromium values in the MWEP-1 and TCLP were calculated to compensate for the dilution effects of adding water and binder to the fill.

66. For the untreated fill, the following equation was used:

$$Cd_r = \frac{C_r}{W_r \times M_r} \quad (2)$$

where

Cd_r = contaminant mass/dry weight untreated waste, mg/kg

C_r = untreated fill/clay mass for the contaminant of interest, mg (calculated as: extract contaminant concentration (mg/L) × extraction solution volume, L)

W_r = weight of fill/clay extracted, kg

M_r = solids content of the untreated fill/clay used in the extraction expressed as a decimal

67. The equation for treated NMLC was

$$Cd_t = \frac{C_t}{W_t \times M_t \times B_t} \quad (3)$$

where

Cd_t = contaminant concentration/dry weight waste after S/S, mg/kg

C_t = S/S fill/clay mass for the contaminant of interest, mg (calculated as: extract contaminant concentration (mg/L) × extraction solution volume, L)

W_t = weight of wet S/S fill/clay, kg

M_t = solids content of the S/S fill/clay used in the extraction, expressed as a decimal

68. The efficiency of the S/S treatment was calculated from the following formula:

$$Eff. = \frac{Cd_r - Cd_t}{Cd_r} \times 100 \quad (4) \quad (4)$$

Analysis of Variance

69. An ANOVA conducted on the normalized total chromium concentrations demonstrated the homogeneity of the samples received by the vendors for their demonstration. Normalization of the total chromium in the fill was performed to account for dilution effects caused by addition of additives in the mixing process. The results of the normalization of total chromium and Cr(VI) for bulk chemistry are presented in Table 4. An analysis of variance was conducted on the treated and untreated fill for normalized total chromium to determine variability among vendors; these results are presented in Table 5.

Chrome Reduction Study

70. The results of the WES chromium (VI) reduction study are presented in Table 6 and discussed below. Two additives were tested, BFS and ferrous sulfate, at varying dosages and reaction times.

Untreated fill

71. Cr(VI) analyses were conducted in triplicate on the untreated fill. The average concentration was 7.74 mg/kg.

Blast furnace slag

72. Four ASRs were tested for the BFS: 0.018, 0.1, 0.2, and 0.36. At the lowest ASR, the average concentration of Cr(VI) remained >10 mg/L after 24 hr. At an ASR of 0.1, the average concentration of Cr(VI) decreased to 4.57 mg/L after 24 hr. The lowest average concentration of Cr(VI) was 3.53 mg/L for an ASR of 0.36. An ASR for BFS/fill of 0.40 was selected for the detailed evaluation due to more effective reduction of Cr(VI) in the BFS-treated fill than in the ferrous sulfate-treated fill. The increase in BFS from an ASR of 0.36 in the CRS to 0.40 for the detailed evaluation is based on a direct relationship between increased ASRs to decreased Cr(VI) concentrations demonstrated in the CRS.

Ferrous sulfate

73. The results of the CRS for ferrous sulfate were not consistent for an additive-to-soil ratio of 0.00052. The average concentration was initially 3.78 mg/kg, and after 24 hr was 5.94 mg/kg. At the 0.0013 ASR, the initial average concentration was 3.29 mg/kg and decreased with time to 2.04 mg/kg after 24 hr.

Table 4

Results of Normalizing Total Chromium and Cr(VI) for Treated and Untreated Frontier Hard Chrome Fill*

Vendor	Mean Total Cr mg/kg	Norm. Total Cr mg/kg	Mean Cr(VI) mg/kg	Norm. Cr(VI) mg/kg
		Untreated Fill		
--	1,567		32.0	
		Treated Fill		
1	1,090	1,277	0.075	0.088
2	1,000	1,268	2.0	2.5
3	790	1,147	3.5	5.1
4	963	1,436	4.5	6.3
5	787	1,297	3.6	6.6
6	1,077	1,438	3.6	4.8
7	1,147	1,710	3.2	4.8
8	643	1,082	0.086	0.10

* Treatment objective was total chromium ≤0.05 mg/L.

Table 5

Results of ANOVA for Bulk Chemistry Conducted on Untreated Fill

Vendor	Mean NMLC (mg/kg)
7	1,710
--*	1,566
6	1,438
4	1,436
5	1,297
1	1,277
2	1,268
3	1,146
8	1,082

* Untreated fill.

Table 6

Results of Chrome Reduction Study for Fill*

Additive-to-Soil Ratio	Reaction Time, hr 0	2	4	6	24
Blast furnace slag/fill					
0.018	11.30	9.48	13.53	10.66	10.34
0.1	12.92	14.84	11.13	4.86	4.57
0.2	7.70	7.78	7.67	5.58	4.00
0.36	3.44	9.81	7.75	7.44	3.53
Ferrous sulfate/fill					
0.0052	3.78	3.71	1.43	1.57	5.94
0.013	3.29	1.59	1.50	1.30	2.04

Note: Average Cr(VI) concentration in the untreated fill was 7.74 mg/kg.
* Results are presented as mg/kg of Cr(VI).

Initial Screening Test Results

74. The results of the initial screening test on the fill conducted by WES are summarized below. The detailed results are presented in Appendix A. Each time a stabilization process was applied, a batch of material was generated. As shown, 8 batches each of solidified fill were prepared for the cement, and 15 batches were prepared for the lime/fly ash process.

Cement binder

75. In the initial screening test, water ratios of 0.1 and 0.3 were tested to evaluate the effects of water addition on strength development. After 24 hr, a 0.1 ASR/0.1 WSR gained strength >750 psi. At ASRs of 0.4 and 0.7 combined with a WSR of 0.1, CI values were >750 psi after 8 hr of cure. At the 0.1/1.4 WSR/ASR, CI values >750 psi were measured after 1 hr of cure. A WSR/ASR of 0.3/0.1 had an average CI measurement of 100 psi after 24 hr of cure. ASRs of 0.4, 0.7, and 1.4 with a WSR of 0.3 had CI values >750 psi after 24 hr. The 0.1 ASR tested with a WSR of 0.1 gained strengths >750 psi with sufficient hydration of the sample and was the basis of selection of a 0.1/0.1 WSR/ASR for detailed evaluation.

Lime/fly ash binder

76. The 0.4/0.1 lime/fly ash ASR combined with a WSR of 0.1 was the only mixture with a CI value approaching 750 psi. The average CI value after

24 hr for the 0.4/0.1/0.1 lime/fly ash/water ASR/WSR mixture was 703 psi. The highest average CI value after 24 hr for a WSR of 0.3 was 280 psi. Cement was selected by WES for evaluation because of its greater strength development than lime/fly ash. No further evaluations of lime/fly ash treatment of the FHC fill were conducted.

Results of Physical Testing of Fill Material

77. The results of the bulk density, Atterberg limits, Proctor density, UCS, permeability, specific gravity and set time for the untreated fill are summarized in Table 7. The results of grain size and moisture content analyses for the fill are presented in Appendix B.

UCS results

78. UCS measurements were performed in triplicate for each replicate after 28 days of cure. Figure 6 presents the results of the UCS tests conducted on the treated fill. All specimens developed strengths greater than the 50-psi criterion.

79. Untreated fill. The untreated specimens were prepared at the Proctor density and cured for 28 days but were not cohesive enough to conduct UCS tests on the replicates. Specimens were cured for 28 days to enable direct comparison with the results obtained with the treated specimens, which were also cured for 28 days. Curing also allowed the evaluation of the untreated fill material for self-setting properties.

80. Vendor 1. The Ensol/Landtreat process did not produce cementitious properties. Extrusion of the samples from the molds damaged the replicates to such an extent that no UCS measurements could be made.

81. Vendor 2. The average UCS values of replicates A, B, and C were 231, 118, and 105 psi, respectively. UCS measurements were taken on only one specimen of replicate C due to fracture of two specimens during extrusion. ASRs for the chemical reducing agent varied among replicates, possibly causing the wide range in UCS results. All specimens evaluated had UCSs >50 psi.

82. Vendor 3. Average UCS values for replicates A, B, and C were 455, 481, and 565 psi, respectively. Vendor 3 was consistent in ASRs of Portland cement and silica to the replicates, and all replicates developed strengths greater than 50 psi.

83. Vendor 4. The average UCS readings for replicates A, B, and C were 351, 383, and 153 psi, respectively. Although Vendor 4 added the same

Table 7

Results of Physical Tests Conducted on Untreated Fill

Parameter	Replicate A	Replicate B	Replicate C
Bulk density, pcf	86.4	84.2	77.8
Proctor density, pcf	149.7	150.3	148.4
Specific gravity	2.70	2.69	2.69
Resistance to penetration, psi*	87	113	110
Permeability, cm/sec*	8.59E-05	2.83E-04	5.56E-05
UCS, psi	N/A	N/A	N/A
Moisture, % dry weight**	28.77	26.22	27.45
Atterberg limits			
Plasticity index	5	4	10
Liquid limit	37	44	43
Plastic limit	32	40	33

* Represents an average of three replicates.
** Represents an average of 33 replicates.

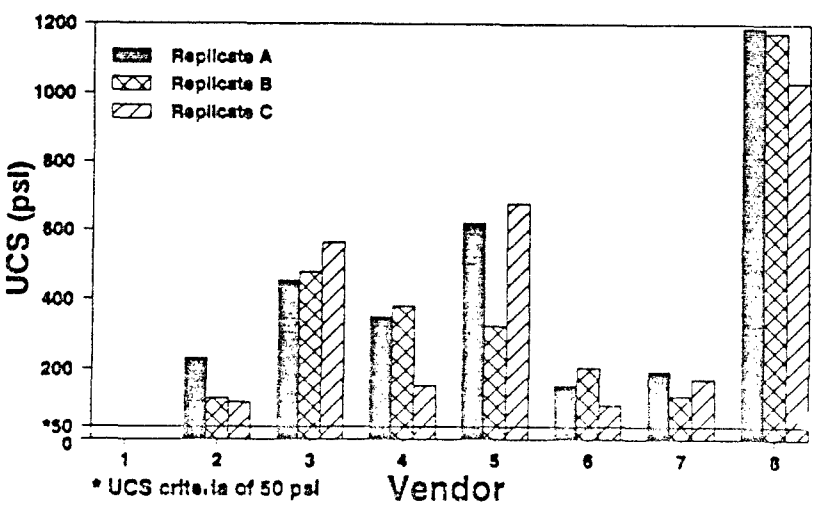

Figure 6. 28-day UCS results for the FHC fill

amount of binder to each replicate, replicate C developed less strength than replicates A and B. The reactions within S/S processes are not clearly understood, and explanations for higher/lower strength development are not easily determined. All replicates developed strengths greater than 50 psi.

84. Vendor 5. The average UCS values for replicates A, B, and C were 620, 324, and 678 psi, respectively. Although Vendor 5 used the same ASR and WSR for all replicates, two specimens of replicate B had UCSs of 251 and 176 psi, while the remaining UCSs were greater than 500 psi.

85. Vendor 6. The average UCS values were 154, 204, and 97 psi, for replicates A, B, and C, respectively. Although the same ASRs were used throughout the Vendor 6 demonstration, the average UCS of replicate B was twice the average UCS of replicate C. All replicates developed strengths greater than 50 psi.

86. Vendor 7. The average UCS values for replicates A, B, and C were 195, 125, and 171 psi, respectively. Two specimens of replicate B gained less strength (88 and 89 psi) than the other specimen (198 psi). Vendor 7 added ASRs of 0.058 cement and 0.052 cement to replicates A and C, respectively, and an ASR of 0.049 to replicate B. The lower ASR used for replicate B may have resulted in the lower UCS values. All replicate UCSs were greater than the 50-psi criteria.

87. Vendor 8. The average UCS values for Vendor 8 were 1,190, 1,175, and 1,032 psi for replicates A, B, and C, respectively. Vendor 8 ASRs and WSRs were consistent among replicates. Vendor 8 specimens developed the highest strengths of any process evaluated. One specimen of replicate C developed less strength than the remaining replicates (774 psi), but all replicates gained strengths much greater than 50 psi.

Wet/dry results

88. To determine the durability of the specimens, the wet/dry test was conducted on three test specimens and three control specimens after 28 days of cure. Moisture contents were determined on one specimen in order to evaluate the percent solids loss for the specimens. The specimens were subjected to 12 cycles of wetting and drying, and the weight of the specimen was taken after each cycle to determine the loss during that cycle. The average results of the wet/dry test for the fill are presented in Table 8. The detailed results by replicate are presented in Appendix C.

Table 8

Results of the Wet/Dry Tests Conducted on Frontier Hard Chrome Fill

Vendor	ACCRML After 12 Cycles, g	Test Specimen (% Loss)	Control Specimen (% Loss)
1	NA	100	100
2	-0.11*	0.32	0.42
3	-0.07*	0.23	0.30
4	-0.08*	0.39	0.47
5	-0.11*	0.36	0.47
6	-0.05*	0.49	0.53
7	-0.24*	0.83	1.07
8	0.03	0.17	0.01
Goal	--	30	30

* Negative result due to greater average relative mass loss in control sample than in treated sample.

89. Vendor 1. The wet/dry specimens prepared by Vendor 1 did not develop sufficient durability and failed the wet/dry test after one cycle. The test and control specimens deteriorated when subjected to the water-addition portion of the cycle, and 100 percent of the specimen solids was lost.

90. Vendor 2. The wet/dry test and control specimens prepared by Vendor 2 passed 12 cycles of the wet/dry test. There was no significant loss of material from the specimens during the 12 wet/dry cycles. The average percent solids lost from the test specimens was 0.32 percent, and the percent solids lost from the controls was 0.42 percent. The average cumulative, corrected relative mass loss (ACCRML) after 12 cycles was -0.11 g for the fill. The negative result is due to a greater mass loss in the control specimens than in the test specimens.

91. Vendor 3. The test specimens lost 0.23 percent of the solid mass in 12 cycles, and the controls lost 0.30 percent in 12 cycles. Specimens for the fill had an ACCRML of -0.07 g. The control specimens lost more mass than the test specimens; therefore, the result of the ACCRML was negative. All test and control specimens passed 12 cycles of the wet/dry test.

92. Vendor 4. The test and control specimens lost averages of 0.39 and 0.47 percent of the solid mass, respectively. The ACCRML results of the wet/

dry test for the test and control specimens were -0.08 g. The control specimens lost slightly more sample tha the test specimens, but there was no significant loss of sample from the test or control specimens. All specimens passed 12 cycles of the wet/dry test.

93. Vendor 5. The test and control specimens prepared by Vendor 5 passed 12 cycles of the wet/dry test. The average solids loss for the test and control specimens was 0.36 and 0.47 percent, respectively. There was a greater mass loss from the controls than the test specimens, which is represented by an ACCRML of -0.11 g.

94. Vendor 6. The average solids loss from the test and control specimens was 0.49 and 0.53 percent, respectively. The ACCRML for the test and control specimens prepared by Vendor 6 was -0.05 g. The control specimens lost slightly more sample than the test specimens, causing a negative ACCRML. All specimens passed 12 cycles of the wet/dry test.

95. Vendor 7. The test and control specimens passed 12 cycles of the wet/dry test with an average solids loss of 0.83 percent and 1.07 percent, respectively. The control specimens lost more cumulative sample than the test specimens, and as a result, the ACCRML was -0.24 g.

96. Vendor 8. The average solids loss for the test and control specimens was 0.17 and 0.01 percent, respectively. The ACCRML for the Vendor 8 test and control specimens was 0.03 g. The test specimens lost more mass than the control specimens, but all specimens passed 12 cycles of the wet/dry test.

Permeability results

97. The results of the permeability test conducted on the untreated and treated fill are summarized in Table 9 and represented in Figure 7. Triplicate readings were conducted on each replicate to obtain an average permeability after 28 days of cure. Detailed results of permeability testing are presented in Appendix C.

98. Untreated fill. The specimens were prepared at the Proctor density and cured for 28 days. The average permeabilities of replicates A, B, and C were 8.59E-05, 2.83E-04, and 5.56E-05 cm/sec, respectively. The average permeability of the replicates is 1.4E-04 cm/sec.

99. Vendor 1. The average results for the triplicate readings of the permeability tests conducted on replicates B and C were 6.52E-07 and 1.02E-06 cm/sec, respectively. No readings were taken for replicate A because of the destruction of the replicates during extrusion from the molds. Replicate A contained the highest percentage of water added and the lowest

Table 9

Summary of Permeability Test Results for the Fill

Vendor	Replicate	Average Permeability cm/sec
--*	A	8.59E-05
	B	2.83E-04
	C	5.56E-05
Vendor 1	A	NA
	B	6.52E-07
	C	1.02E-06
Vendor 2	A	3.04E-05
	B	1.61E-04
	C	3.62E-05
Vendor 3	A	2.89E-06
	B	1.41E-06
	C	1.62E-06
Vendor 4	A	1.02E-05
	B	7.15E-06
	C	9.38E-07
Vendor 5	A	2.33E-07
	B	3.47E-06
	C	4.92E-06
Vendor 6	A	1.79E-05
	B	7.45E-06
	C	6.36E-06
Vendor 7	A	1.17E-05
	B	9.98E-07
	C	1.34E-06
Vendor 8	A	1.15E-07
	B	NA
	C	3.00E-06

* Untreated fill.

percentage of binder added in the soil/additive mixture prepared for the three replicates. None of the replicates attained the criteria of 1E-08 cm/sec.

100. Vendor 2. The average permeabilities of replicates A, B, and C were 3.04E-05, 1.61E-04, and 3.62E-05 cm/sec, respectively. The average permeability of the treated replicates was 7.59E-05 cm/sec. None of the replicates attained the criteria of 1E-08 cm/sec.

101. Vendor 3. The average permeabilities of replicates A, B, and C were 2.89E-06, 1.41E-06, and 1.62E-06 cm/sec, respectively. The average

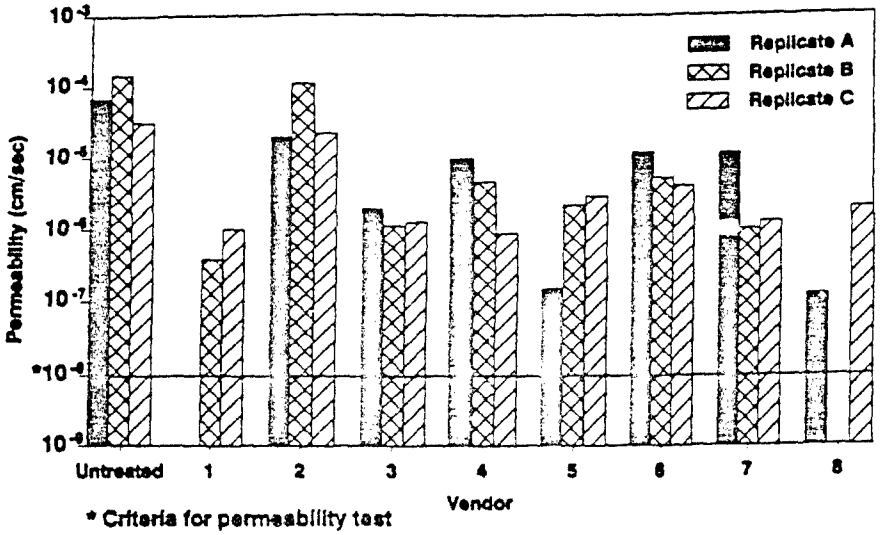

Figure 7. 28-day permeability results for FHC fill

permeabilities of the triplicate readings of replicate B and C were orders of magnitude less than the permeabilities of the untreated fill. The average permeabilities of replicates A and C of the treated fill were one order of magnitude less than the permeabilities of replicates A and C for the untreated fill. The permeabilities were greater than the 1E-08 cm/sec criteria.

102. Vendor 4. The average permeabilities for the three replicates A, B, and C were 1.02E-05, 7.15E-06, and 9.38E-07 cm/sec, respectively. None of the replicates was two orders of magnitude less than the permeabilities of the untreated fill, and all were greater than the 1E-08 cm/sec criteria for permeability of the treated fill.

103. Vendor 5. Replicate A had an average permeability two orders of magnitude less than the permeability of the untreated fill at 2.33E-07 cm/sec. Replicates B and C were one order of magnitude less than the permeability of the untreated fill at 3.47E-06 and 4.92E-06 cm/sec, respectively. None of the replicates attained the criteria of 1E-08 cm/sec.

104. Vendor 6. The average permeabilities were 1.79E-05, 7.45E-06, and 6.36E-06 cm/sec for replicates A, B, and C, respectively. All permeability readings were greater than 1E-08 cm/sec. The reduction in permeability due to treatment was approximately one order of magnitude.

105. Vendor 7. The average permeabilities for replicates A, B, and C were 1.17E-05, 9.98E-07, and 1.34E-06 cm/sec, respectively. Compared to the

untreated fill, the Vendor 7 S/S process reduced the permeability of the fill by one order of magnitude. The average permeability of the three replicates was 4.68E-6 cm/sec. None of the replicates was permeable at the rate of 1E-08 cm/sec or less.

106. Vendor 8. The average permeabilities of replicates A and C were 1.15E-07 and 3.00E-06 cm/sec, respectively. The operator was unable to saturate replicate B with water and was therefore unable to record permeability readings for that replicate. None of the replicates had permeabilities less than 1E-08 cm/sec, and the Vendor 8 treatment process did not reduce the permeability by two orders of magnitude.

Bulk density

107. The bulk density was measured in triplicate for each replicate, and the results are presented in Appendix C.

Volumetric change

108. Based on the bulk density of the treated material and the Proctor density of the untreated fill, the volumetric change caused by the addition of binders was calculated and the results are summarized in Table 10 and presented in Figure 8. The volumetric change was calculated using Equations 5-7 below.

$$V_1 = \frac{W_s}{D_1} \tag{5}$$

where

V_1 = volume of fill/clay

W_s = weight of fill/clay

D_1 = Proctor density of the untreated fill/clay

$$V_2 = \frac{(W_s + R \times W_s)}{D_2} \tag{6}$$

Table 10

Results of Volumetric Change Calculations for the Fill

Vendor	Replicate	Bulk Density lb/ft^3	Volumetric Increase, %
--*	A	86	
	B	84	
	C	78	
1	A	149	15
	B	148	13
	C	143	21
2	A	125	44
	B	121	56
	C	129	52
3	A	116	74
	B	121	69
	C	125	72
4	A	106	89
	B	100	99
	C	98	99
5	A	109	99
	B	111	98
	C	110	95
6	A	109	68
	B	112	64
	C	113	61
7	A	123	70
	B	123	70
	C	123	68
8	A	117	93
	B	116	95
	C	117	90

* Untreated fill.

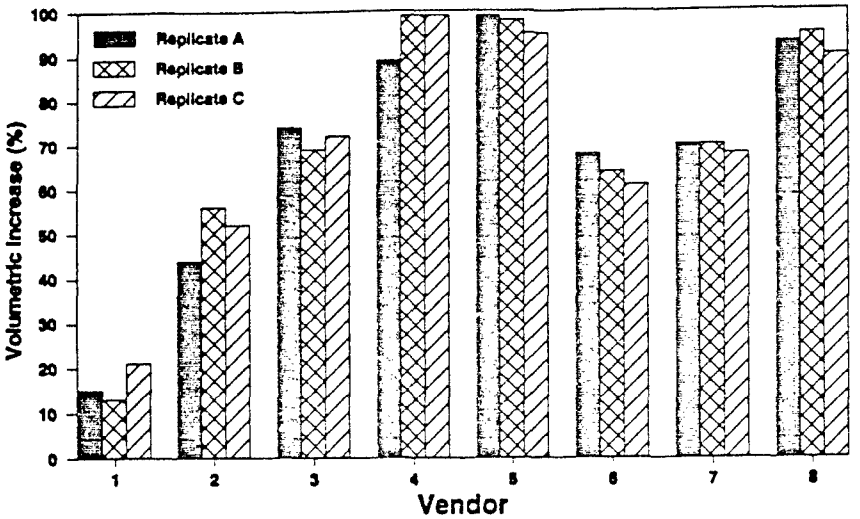

Figure 8. Volumetric change due to the addition of additives for FHC fill

where

V_2 = volume of binder and fill/clay

R = binder-to-soil ratio (BSR)

D_2 = bulk density of fill/clay and binder

$$\% \ Volumetric \ Change = \frac{(V_2 - V_1)}{V_1} \tag{7}$$

109. It should be noted that the volumetric increases are substantially higher than those reported in the literature. This results from the use of the Proctor density as the baseline for measuring the volumetric increase.

110. Untreated fill. The Proctor density for the untreated fill was 149.7, 150.3, and 148.4 lb/ft^3 for replicates A, B, and C, respectively. The bulk density for the untreated fill was 86.4, 84.2, and 77.8 lb/ft^3 for replicates A, B, and C, respectively.

111. Vendor 1. The Vendor 1 process increased the volume for replicates A, B, and C by 15, 13, and 21 percent, respectively. Compared to the remaining vendors, Vendor 1's process produced the smallest volumetric increase in the fill.

112. Vendor 2. The Vendor 2 process increased the volume required for the treatment of the fill due to the addition of cement and a chemical reducing agent. The volumetric increases for the average bulk densities were 44, 56, and 52 percent, for replicates A, B, and C, respectively.

113. Vendor 3. Vendor 3 increased the volume of the fill through the addition of additives by 74, 69, and 72 percent, for replicates A, B, and C, respectively, based on average bulk densities.

114. Vendor 4. Vendor 4 added cement, a metal complex reagent, and a cementitious reagent, causing an 89-, 99-, and 99-percent volumetric increase for replicates A, B, and C, respectively. The addition of binders approximately doubled the volume of the fill.

115. Vendor 5. Vendor 5 doubled the volume of the fill by adding cement and sodium silicate. The volumetric increase was 99, 98, and 95 percent for replicates A, B, and C, respectively, representing the greatest volumetric increase for the fill among the vendors.

116. Vendor 6. Vendor 6 had volumetric increases of 68, 64, and 61 percent for replicates A, B, and C, respectively.

117. Vendor 7. Vendor 7 produced volumetric increases of 70, 70, and 68 percent for replicates A, B, and C, respectively, on the basis of average bulk densities. Vendor 7 added an ASR of 0.30 fly ash to the fill that may have contributed greatly to the volume increase.

118. Vendor 8. Vendor 8 approximately doubled the volume required for treatment of the fill. The volumetric increases for replicates A, B, and C were 93, 95, and 90 percent, respectively. The volumetric increase may be largely attributed to the 0.40 ASR for blast furnace slag added to the fill.

Slump

119. The slump was measured for each replicate of the fill immediately after the mixing process was complete. When two consecutive tests showed a falling away characteristic, the mixture lacked cohesiveness. Thus, the slump test was not applicable. The results of the slump test are presented in Appendix C and discussed below.

120. Vendor 1 slumps for replicates A, B, and C were 7, 0, and 1.25 in., respectively. Replicate B showed the least slump, which may be related to no water being added to the replicate mixture. Slumps of 0 in. were calculated for all replicates of mixtures from Vendors 2, 3, 4, and 7. Vendor 5 slumps were measured for replicates A, B, and C and were 8, 6.5, and 7.25 in., respectively, and Vendor 8 slumps were 1.25, 0.25, and 0 in. for

replicates A, B, and C, respectively. Vendor 6 mixtures were not free-standing, and slump measurements were not available.

Moisture results

121. The results of moisture content tests conducted on the treated fill are presented in Appendix C. Moisture tests were performed in triplicate for each replicate of the treated fill after 28 days of cure.

Set time

122. The results of the set time conducted on the treated fill after 2, 4, 8, 24, and 48 hr of cure are presented in Appendix C. CI readings were taken in triplicate for each curing time.

Specific gravity

123. The specific gravities were measured in triplicate for the treated fill after 28 days of cure and are presented in Appendix C.

Bleed water

124. Vendor 1's specimens had a layer of free water approximately 2 mm thick on the surface of replicate A for the fill. Vendor 5 had a layer of free water approximately 1 mm in thickness on the surface of the fill specimens. The Vendor 3, 7, and 8 specimens had a layer of free water approximately 1 mm thick on the surface of the fill specimens. Specimens prepared by the remaining vendors (Vendors 2, 4, and 6) did not have a layer of free water on their surface.

Cracking

125. Vendor 1's specimens did not have cementitious properties. The replicate C specimens deformed when extruded from the molds. One specimen of replicate C for the fill prepared by Vendor 2 was cracked around the middle and broke in half during dimensional measurements. Specimens from Vendors 3 and 4 had small voids in each of the replicates for the fill. Vendor 5's specimens had cracks in three replicates for the fill. Vendor 7's specimens had voids in each of their replicates for the fill. The Vendor 8 specimens had cracks approximately 2 to 3 mm in length on three replicate fill specimens.

Results of Contaminant Release Testing

MWEP-1 results

126. The results of the mean total chromium and Cr(VI) concentrations in the MWEP-1 for treated and untreated fill for each vendor S/S process are

presented in Appendix C. Figure 9 represents the MWEP-1 concentrations for total chromium, and Figure 10 represents the MWEP-1 results for Cr(VI).

127. Untreated fill. The results of the MWEP-1 run on the untreated fill were above the 0.05-mg/L drinking water standard for total chromium by a factor of 10. Triplicate analyses of the MWEP-1 extracts provided a mean total chromium concentration of 0.40 mg/L. The mean Cr(VI) concentration was 0.35 mg/L. The majority of the total chromium MWEP-1 concentration exists as Cr(VI).

128. Vendor 1. Mean concentrations for Cr(VI) and total Cr were <0.029 and 0.115 mg/L, respectively. The total chromium concentration was twice the 0.05 mg/L standard assigned to MWEP-1 leachates for total chromium.

129. Vendor 2. Mean concentrations for Cr(VI) and total Cr were 0.147 mg/L, meaning the Cr existed as Cr(VI). The total Cr concentration tripled the 0.05-mg/L drinking water standard designated in the remedial design objectives.

130. Vendor 3. The mean Cr(VI) and total Cr concentrations were 0.073 and 0.078 mg/L, respectively. Most of the Cr exists in the extract as Cr(VI). Total Cr concentrations were above the 0.05-mg/L criterion as a result of the presence of Cr(VI).

131. Vendor 4. The mean Cr(VI) and total Cr concentrations were 0.12 and 0.13 mg/L, respectively. Total Cr concentration exceeded the 0.05-mg/L criterion as a result of the presence of Cr(VI).

132. Vendor 5. The mean Cr(VI) and total Cr concentrations were 0.099 and 0.10 mg/L, respectively. Most of the total Cr present was in the form of Cr(VI). The total Cr concentration was twice the 0.05-mg/L criterion.

133. Vendor 6. The mean Cr(VI) and total Cr concentrations were 0.12 and 0.11 mg/L, respectively. The total Cr was twice the 0.05-mg/L criterion. The bulk of the total Cr was in the form of Cr(VI).

134. Vendor 7. The mean concentrations of Cr(VI) and total Cr in the MWEP-1 extracts were 0.11 and 0.10 mg/L, respectively. The mean concentration of Cr(VI) exceeded the mean total Cr concentration. One replicate Cr(VI) concentration exceeded the total Cr concentration by 0.033 mg/L, causing a greater mean Cr(VI) concentration. The total Cr was present in the form of Cr(VI). Total Cr in the MWEP-1 extract exceeded the drinking water standard of 0.05 mg/L.

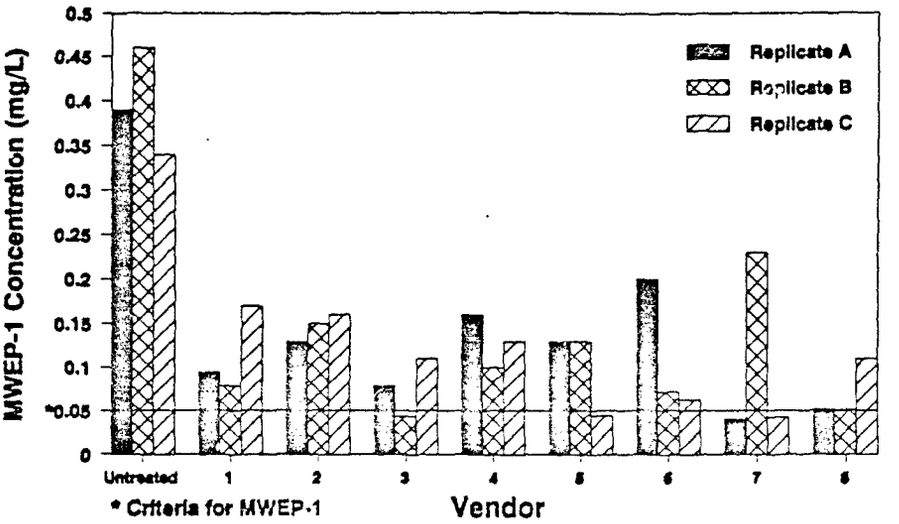

Figure 9. Results of MWEP-1 concentrations of total chromium in treated and untreated fill

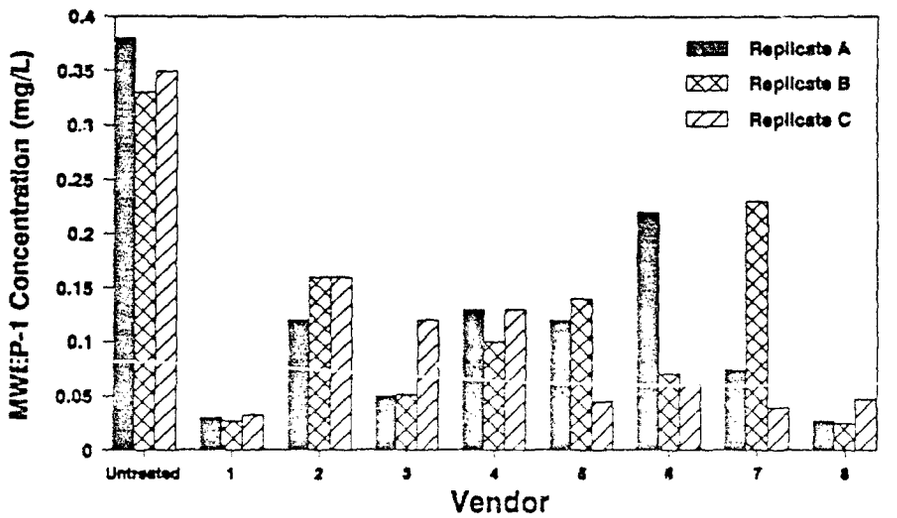

Figure 10. Results of MWEP-1 concentrations of Cr(VI) in treated and untreated fill

135. Vendor 8. The mean Cr(VI) concentration in the MWEP-1 extract was <0.033 mg/L. The mean total Cr concentration was 0.071 mg/L. Two replicates had concentrations of 0.051 and 0.052 mg/L, only slightly higher than the 0.05-mg/L criterion. Total Cr concentration exceeded the 0.05-mg/L criterion established in the remedial design objectives. Most of the Cr present in the MWEP-1 extract was in the form of Cr(III).

TCLP results for fill

136. The mean concentrations of total chromium and Cr(VI) in the TCLP conducted on treated and untreated FHC fill are presented in Appendix C and discussed below. Figures 11 and 12 represent the results of the TCLP for total chromium and Cr(VI).

137. Untreated fill. The criterion for total chromium concentration in TCLP leachates is 5.0 mg/L (40 CFR 261). The concentration of total chromium in the replicates was 0.16, 0.16, and 0.081 mg/L, with a mean of 0.13 mg/L. Cr(VI) concentrations were all <0.020 mg/L. The replicate total chromium and Cr(VI) concentrations were all below the 5.0-mg/L criterion for total chromium.

138. Vendor 1. The replicate total chromium concentrations in the Vendor 1 leachates were 2.0, 2.3, and 2.2 mg/L. The mean total chromium concentration in the TCLP leachates was 2.2 mg/L. Cr(VI) concentrations of the replicates were <0.020 mg/L. The chromium present was in the trivalent form.

139. Vendor 2. The replicate total chromium TCLP concentrations in the Vendor 2 leachates were 0.049, 0.065, and 0.026 mg/L. The replicate Cr(VI) concentrations were 0.028, 0.038, and <0.020 mg/L. The TCLP concentrations were below the 5.0-mg/L criterion for chromium in the TCLP.

140. Vendor 3. The concentrations of Cr(VI) in the TCLP conducted on the treated fill were 0.068, 0.058, and 0.050 mg/L. The concentrations were below the criterion of 5.0 mg/L. The total chromium concentrations were 0.079, 0.032, and 0.062 mg/L.

141. Vendor 4. The mean total chromium concentration for the replicates was 0.12 mg/L. The replicate concentrations were below the 5.0-mg/L criterion. The chromium present in the leachates was in the trivalent form, shown by concentrations of Cr(VI) of <0.020, <0.020, and 0.042 mg/L.

142. Vendor 5. The concentrations of total chromium in the TCLP were 0.62, 0.63, and 0.33 mg/L. The concentrations of Cr(VI) were 0.61, 0.67, and 0.32 mg/L. The chromium present was in the hexavalent form.

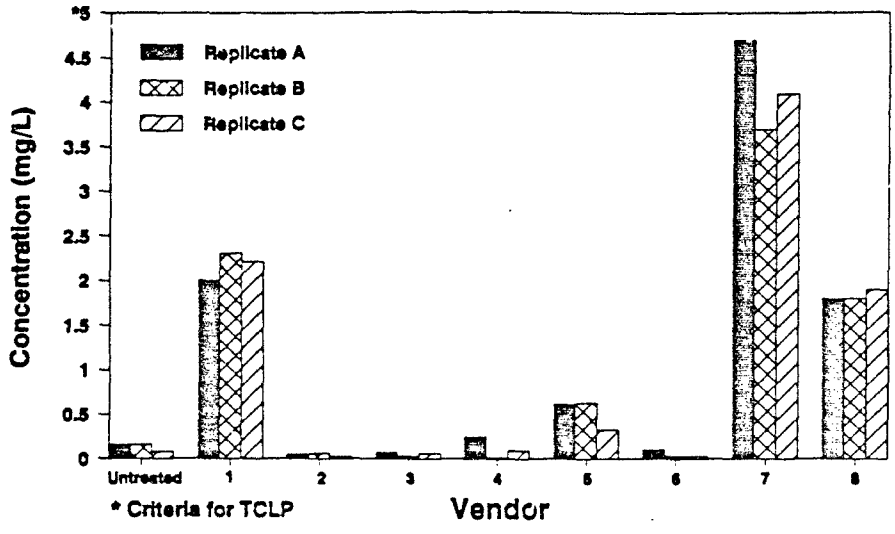

Figure 11. Results of TCLP concentrations of total chromium in treated and untreated fill

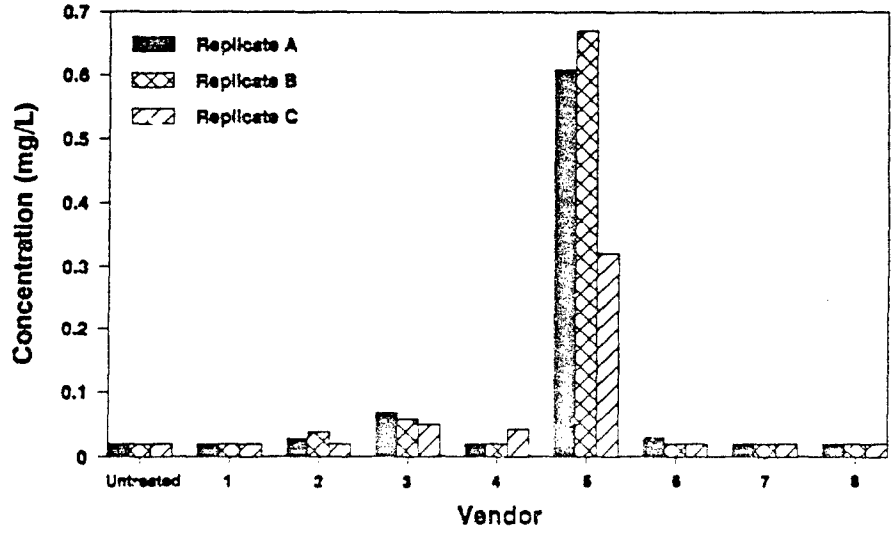

Figure 12. Results of TCLP concentrations of Cr(VI) in treated and untreated fill

143. Vendor 6. The concentrations of total chromium were 0.11, 0.028, and 0.032 mg/L. Two replicate concentrations of Cr(VI) were <0.020 mg/L, and the other replicate concentration was 0.033 mg/L. The concentrations of chromium in the TCLP were all less than 5.0 mg/L.

144. Vendor 7. The concentrations of Cr(VI) were all <0.020 mg/L. The concentrations of total chromium were 4.7, 3.7, and 4.1 mg/L. Chromium is present in the trivalent form. The total chromium concentrations were below the 5.0-mg/L criterion.

145. Vendor 8. The Cr(VI) concentrations were all <0.020 mg/L. The total chromium concentrations were 1.8, 1.8, and 1.9 mg/L. Chromium was present as Cr(III). The mean total chromium concentration was 1.8 mg/L, and all concentrations were <5.0 mg/L.

Effects of Dilution on Leaching

MWEP-1 results for fill

146. Untreated fill. The mean NMLC for total chromium and Cr(VI) was 5.01 and 4.48 mg/kg, respectively. Based on the NMLCs for MWEP-1 conducted on the fill for total chromium and Cr(VI), the efficiency of the treatment processes was evaluated.

147. Vendor 1. The mean normalized mass total chromium leached (MNMTCL) in the MWEP-1 was 1.742 mg/kg, 65 percent less than the MNMTCL in the mean MWEP-1 for the untreated fill. Normalization of the MWEP-1 Cr(VI) concentrations presented Cr(VI) leached at a mean of 0.443 mg/kg, representing a 90-percent reduction in the mean normalized mass Cr(VI) leached (MNMCSL) compared to the untreated fill.

148. Vendor 2. The MNMTCL in the MWEP-1 presented was 59 percent less than the MNMTCL in the MWEP-1 conducted on the untreated fill, and the MNMCSL was reduced by 54 percent compared to the untreated fill.

149. Vendor 3. Reductions of 75 and 74 percent were noted for MNMTCL and MNMCSL, respectively, from the MWEP-1 conducted on the treated fill in comparison with the MWEP-1 conducted on the untreated fill. The reduction in total chromium was mainly a representation of reduction in Cr(VI).

150. Vendor 4. The Vendor 4 S/S process reduced the MNMTCL concentration by 54 percent for total chromium and the MNMCSL by 52 percent for Cr(VI) compared to the untreated fill. The reduction of 54 percent of leachable total chromium was mainly represented by a reduction of leachable Cr(VI).

151. Vendor 5. There was a 63-percent reduction in the leachable total chromium based upon the MNMTCLs for treated and untreated fill. The MNMCSL was reduced by 59 percent, based on the MNMCSL for the untreated fill and the fill treated by Vendor 5.

152. Vendor 6. The mean NMLC for the fill was 1.905 mg/kg total chromium and 1.992 mg/kg Cr(VI). Compared to the mean NMLC for the untreated fill, the Vendor 6 efficiency for total chromium was 62 percent and for Cr(VI), 56 percent.

153. Vendor 7. The mean NMLC for the total chromium was 1.734; the mean NMLC Cr(VI) was 1.896 mg/kg. The MNMTCL was reduced by 65 percent, and the MNMCSL by 58 percent.

154. Vendor 8. The mean NMLC for total chromium and Cr(VI) was 1.291 and 0.601, respectively. The Vendor 8 process reduced the MNMTCL by 74 percent and the MNMCSL by 87 percent.

TCLP results

155. Normalization of the TCLP results was calculated according to the methods described for normalization of the MWEP-1 in paragraph 68, and the results are presented in Appendix C for the fill.

156. Untreated fill. The mean NMLC, which represents the normalized amount of total chromium and Cr(VI) leached, was 3.377 and 0.507 mg/kg, respectively. The NMLC for Cr(VI) is based on the detection limit of <0.020 mg/L. Based on the NMLCs for total chromium and Cr(VI), the efficiency of the treatment processes for each vendor was calculated.

157. Vendor 1. The Vendor 1 process represented an increase in the MNMTCL of 1,806 percent and an increase in the MNMCSL of 17 percent based on the MNMTCL of 64.358 mg/kg and the MNMCSL of 0.047 mg/kg. The MNMCSL was calculated based on the concentration for all replicates of <0.020 mg/L.

158. Vendor 2. Vendor 2's process efficiency for the MNMTCL was 61 percent based on a MNMTCL of 1.317 mg/kg; the MNMCSL was increased by 60 percent based on a MNMCSL of 0.809 mg/kg.

159. Vendor 3. The mean NMLCs for total chromium and Cr(VI) were 1.841 and 1.885 mg/kg, respectively. Vendor 3 reduced the MNMTCL by 45 percent but increased the MNMCSL by 272 percent.

160. Vendor 4. The mean NMLC for total chromium was 4.299 mg/kg, and the mean NMLC for Cr(VI) was 0.965 mg/kg. Based on the NMLCs, Vendor 4 increased the MNMTCL in the TCLP by 27 percent and increased the MNMCSL by 90 percent.

161. Vendor 5. Compared to the untreated fill, Vendor 5 increased the total chromium leached in the TCLP by 472 percent and increased the Cr(VI) in the TCLP by 3,760 percent. The MNMTCL was 19.310 mg/kg, and the MNMCSL was 19.553 mg/kg. The chromium present was in the form of Cr(VI).

162. Vendor 6. The mean NMLCs for total chromium and Cr(VI) were 1.932 and 0.827 mg/kg, respectively. The Vendor 6 process reduced the MNMTCL by 43 percent for total chromium and increased the MNMCSL by 63 percent for the Cr(VI).

163. Vendor 7. The MNMTCL was 136.684 mg/kg, and the MNMCSL was 0.656 mg/kg. The MNMCSL was calculated from the concentration of 0.020 mg/L based on the detection limit. The process produced a 3,947-percent increase in the MNMTCL and an increase in the MNMCSL of 29 percent.

164. Vendor 8. The Vendor 8 process produced an increase in the MNMTCL of 1,879 percent and an increase in the MNMCSL of 44 percent based on a MNMTCL of 66.815 mg/kg and a MNMCSL of 0.729 mg/kg. All Cr(VI) concentrations were below the detection limit, <0.020 mg/L. The detection limit was the basis for a calculation of the MNMCSL.

Standard Deviation and Relative Standard Deviation

165. Standard deviation was calculated for the fill and clay from the following equation:

$$s = \sqrt{\frac{\sum (x_i - x)^2}{n - 1}} \tag{8}$$

where

s = standard deviation of n observations

x_i = observation

x = mean of the observations

n = number of observations

166. The relative standard deviation (RSD) was calculated from the following equation:

$$RSD = \frac{s}{\bar{x}} \times 100 \quad (9)$$

MWEP - total chromium

167. Untreated. The NMLCs for the untreated fill were 5.00, 5.68, and 4.36 mg/kg for replicates A, B, and C, respectively. Based on the NMLC, the standard deviation was 0.661 and the RSD was 13 percent for the fill.

168. Vendor 1. Vendor 1 varied the amount of additive used among its replicates; therefore, precision of the results must be based on the NMLC. The NMLC for the fill was 1.38, 1.10, and 2.75 mg/kg for replicates A, B, and C, respectively. The standard deviation of the NMLC for fill was 0.883. The MWEP-1 concentrations for the treated fill had an average precision of 51 percent based on NMLC calculations.

169. Vendor 2. The NMLCs for replicates A, B, and C were 1.84, 2.11, and 2.27 mg/kg, respectively. Precision of the NMLC for the fill was 11 percent. The standard deviation of the NMLC calculated for the fill was 0.22.

170. Vendor 3. The NMLCs were 1.24, 0.73, and 1.75 mg/kg for replicates A, B, and C, respectively. The NMLC standard deviation for the fill was 0.51. Based on the NMLC, the precision of the fill was 41 percent.

171. Vendor 4. The NMLCs for replicates A, B, and C were 2.92, 1.76, and 2.26 mg/kg, respectively. The NMLC standard deviation for the fill was 0.58, and the NMLC RSD was 25 percent.

172. Vendor 5. The NMLCs for replicates A, B, and C were 2.33, 2.39, and 0.86 mg/kg, respectively. Vendor 5's NMLC standard deviation for the fill was 0.87, and the NMLC RSD was 47 percent. One replicate had a concentration one order of magnitude less than the other two replicates, causing the RSD to be increased.

173. Vendor 6. The NMLCs for replicates A, B, and C were 3.44, 1.26, and 1.02 mg/kg, respectively. The NMLC standard deviation for the fill was 1.33, and the NMLC RSD based on the mean NMLC concentration was 70 percent. The highest fill concentration was 0.20 mg/L; the other concentrations were 0.072 and 0.063 mg/L, causing a higher NMLC RSD.

174. Vendor 7. The NMLCs for the fill replicates were 0.68, 3.84, and 0.68 mg/kg. The NMLC standard deviation was 1.82 with a NMLC RSD of 105 percent. The NMLC RSD was >100 percent due to one concentration being one order of magnitude greater than the other concentrations.

175. Vendor 8. One concentration of the fill was 0.11 mg/L, approximately twice the concentration of the other replicates (0.052 and 0.051 mg/L). The NMLC standard deviation was 0.60, and the NMLC RSD was 47 percent.

MWEP - chromium (VI)

176. Untreated. The NMLCs were 4.87, 4.08, and 4.49 mg/kg, respectively, for replicates A, B, and C. The NMLC standard deviation was 0.398, and the NMLC RSD was 9 percent.

177. Vendor 1. The NMLCs were <0.44, <0.37, and <0.52 mg/kg, respectively, for replicates A, B, and C. The NMLC standard deviation, calculated based on the detection limit, was 0.072; the NMLC RSD was 16 percent.

178. Vendor 2. The NMLCs for the replicates were 1.70, 2.25, and 2.27 mg/kg. The NMLC standard deviation was 0.33 with an NMLC RSD of 16 percent.

179. Vendor 3. The NMLCs for the replicates were 0.76, 0.84, and 1.91 mg/kg, with an NMLC standard deviation of 0.64 and NMLC RSD of 55 percent. One concentration was double the other two concentrations, causing the NMLC RSD to be 55 percent.

180. Vendor 4. The concentrations of the Cr(VI) in the fill were 0.13, 0.10, and 0.13 mg/L. The NMLCs for the replicates were 2.38, 1.76, and 2.26 mg/kg. Based on the NMLC concentrations, the standard deviation was 0.33 and the NMLC RSD was 15 percent.

181. Vendor 5. The NMLCs for the replicates were 2.15, 2.57, and 0.84 mg/kg. The NMLC standard deviation for the fill was 0.90, and the NMLC RSD was 49 percent. One concentration was one third less than the other two, causing the NMLC RSD to be 49 percent.

182. Vendor 6. Vendor 6's NMLC standard deviation was 1.55, and the NMLC RSD was 78 percent. The NMLCs were 3.78, 1.22, and 0.98 mg/kg. One concentration was considerably higher than the other two, causing an NMLC RSD of 78 percent.

183. Vendor 7. One concentration among the replicates was one order of magnitude greater than the other concentrations, causing a relatively high NMLC RSD. The NMLCs were 1.23, 3.84, and 0.62 mg/kg. The NMLC standard deviation was 1.55, and the NMLC RSD was 78 percent.

184. Vendor 8. Two concentrations for the fill were <0.027 and <0.025 mg/L; the other concentration was 0.047 mg/L. The NMLC were calculated based on the detection limit listed for that concentration and were 0.51,

based on the detection limit listed for that concentration and were 0.51, 0.45, and 0.85 mg/kg. The NMLC standard deviation was 0.218 mg/L, and the NMLC RSD was 36 percent.

TCLP - total chromium

185. Untreated. The total chromium concentrations for the fill were 0.160, 0.160, and 0.081 mg/L and were normalized to 4.102, 3.952, and 2.077 mg/kg, respectively. The NMLC standard deviation was 1.129, and the NMLC RSD was 33 percent.

186. Vendor 1. The NMLC standard deviation for the fill was 6.5. The NMLC RSD for the fill was 10 percent. The concentrations for the fill were within 0.3 mg/L among replicates, providing an NMLC RSD of 10 to 11 percent. The NMLCs were 58.12, 63.83, and 71.13 mg/kg.

187. Vendor 2. The fill NMLCs were 1.385, 1.827, and 0.738 mg/kg for the replicates, providing an NMLC standard deviation of 0.547 and an NMLC RSD of 42 percent.

188. Vendor 3. The NMLCs for the fill were 2.49, 1.058, and 1.976 mg/kg. Based on the NMLC concentrations, the NMLC RSD was 39 percent.

189. Vendor 4. One of the replicate concentrations was one order of magnitude greater than the other replicates. The NMLC concentrations were 9.14, 0.493, and 3.266 mg/L with an NMLC RSD of 103 percent.

190. Vendor 5. The concentrations of total chromium in the TCLP conducted on the fill were 0.62, 0.63, and 0.33 mg/L. The NMLC was 22.21, 23.13, and 12.60 mg/kg, respectively, with a standard deviation of 5.83 and an NMLC RSD of 30 percent.

191. Vendor 6. The concentrations of total chromium in the fill replicates were 0.11, 0.028, and 0.032 mg/L and were normalized to 3.78, 0.98, and 1.04 mg/kg, respectively. Based on the NMLC, the standard deviation was 1.60 and the NMLC RSD was 83 percent. One concentration (0.11 mg/L) was approximately four times the other replicates, causing a high NMLC RSD.

192. Vendor 7. The concentrations of total chromium in the fill were 4.7, 3.7, and 4.1 mg/L and were normalized to 156.60, 123.50, and 129.95 mg/kg, respectively. Based on the NMLC, the standard deviation was 17.55 and the RSD was 13 percent.

193. Vendor 8. For the fill, the concentrations of total chromium were 1.8, 1.8, and 1.9 mg/L. These concentrations were normalized to 67.5, 64.3, and 68.7 mg/kg, respectively, with an NMLC standard deviation of 2.3 and an NMLC RSD of 3 percent.

TCLP - chromium (VI)

194. Untreated. The concentrations of Cr(VI) in the fill were <0.020 mg/L for all replicates. Based on the detection limit of 0.020 mg/L, the NMLCs were calculated as 0.513, 0.494, and 0.513 mg/kg. The NMLC standard deviation for the fill was 0.011, and the NMLC RSD was 2 percent.

195. Vendor 1. The concentrations of Cr(VI) for the fill were all <0.020 mg/L. The NMLCs were 0.581, 0.555, and 0.647 mg/kg, respectively, with an NMLC standard deviation of 0.047 and an NMLC RSD of 8 percent.

196. Vendor 2. The concentrations of Cr(VI) in the fill were 0.028, 0.038, and <0.020 mg/L. Vendor 2 mobilized Cr(VI) based on the concentrations in the untreated fill and clay. Based on the concentrations in the fill, the NMLCs were 0.792, 1.068, and 0.568 mg/kg with a standard deviation of 0.251 and an NMLC RSD of 31 percent.

197. Vendor 3. Based on the concentrations of Cr(VI) in the untreated fill, Vendor 3 mobilized Cr(VI). The concentrations of Cr(VI) in the fill replicates were 0.068, 0.058, and 0.05 mg/L, corresponding to NMLCs of 2.143, 1.918, and 1.593 mg/kg, respectively. The standard deviation of the NMLCs were 0.276, and the NMLC RSD was 15 percent.

198. Vendor 4. For the fill, two replicate concentrations were <0.020 mg/L and the other replicate concentration was 0.042 mg/L. Normalization of the concentrations presented 0.731, 0.704, and 1.459 mg/kg of Cr(VI) leached, with a standard deviation of 0.429 and an NMLC RSD of 44 percent.

199. Vendor 5. The concentrations of Cr(VI) in the fill TCLP extracts were 0.61, 0.67, and 0.32 mg/L and were normalized to 21.85, 24.60, and 12.21 mg/kg, respectively. Based on the NMLCs, the standard deviation was 6.50 and the NMLC RSD was 33 percent.

200. Vendor 6. The NMLCs for the fill replicates were 1.134, 0.697, and 0.651 mg/kg with a standard deviation of 0.267 and an NMLC RSD of 32 percent. Two concentrations in the fill leachates were <0.020 mg/L, and the other concentration was 0.030 mg/L. NMLC concentrations were calculated based on the detection limit of 0.020 mg/L for the two replicates.

201. Vendor 7. The concentrations of Cr(VI) in the fill leachates were all <0.020 mg/L. Normalization was based on 0.020 mg/L for the fill, and the NMLCs were 0.666, 0.668, and 0.634 mg/kg with a standard deviation of 0.019 and an NMLC RSD of 3 percent.

202. Vendor 8. The Vendor 8 concentrations in the TCLP extracts for the fill were all <0.020 mg/L. NMLCs were calculated based on a concentration

of 0.020 mg/L. Based on the NMLCs for the fill, the standard deviation was 0.019 and the NMLC RSD was 3 percent.

Analysis of variance for MWEP-1 and TCLP

203. MWEP-1. The results of an ANOVA conducted on the MWEP-1 for the fill are presented in Table 11. The ANOVA on the MWEP-1 showed two groups: the untreated MWEP-1 data and the data of the samples treated by the vendors. The MWEP-1 conducted on the untreated fill is significantly different from the treated fill.

204. TCLP. The results of an ANOVA conducted on the TCLP for the fill are presented in Table 11. For the fill, an ANOVA conducted on the TCLP data provided four groups of data that are different. Vendor 7's TCLP is different from the remaining vendors. Vendor 5 is significantly different from the remaining vendors. Vendors 8 and 1 are not significantly different, but Vendors 7, 8, and 1 are different from the remaining vendors.

Table 11

Results of ANOVA for TCLP and MWEP-1 for the Fill

Vendor	Mean NMLC mg/kg	Group
	MWEP-1	
--*	6.420	1
4	2.314	2
2	2.072	2
6	1.905	2
5	1.858	2
1	1.742	2
7	1.734	2
8	1.291	2
3	1.242	2
	TCLP	
7	136.684	1
8	66.815	2
1	64.358	2
5	19.310	3
--*	5.013	4
4	4.299	4
6	1.932	4
3	1.841	4
2	1.317	4

* Untreated fill.

PART IV: DISCUSSION OF RESULTS FOR CLAY MATERIAL TESTING

Analysis of Homogenization

205. A major concern during the conduct of the study was the use of a homogenized sample for the application of the S/S processes. An attempt was made to provide each vendor with a statistically homogeneous sample. The homogeneity of the samples was evaluated by normalizing the total chrome for dilution effects of binder addition and by conducting an ANOVA on the normalized chromium values.

Normalization process

206. Normalized mass leached concentration chromium values, which were calculated to compensate for the dilution effects of adding water and binder to the clay, are presented in Appendix E. Normalization of the bulk analysis was calculated for the untreated and treated clay using Equations 1 and 2. The results of the normalization of total chromium and Cr(VI) for bulk chemistry are presented in Table 12.

Analysis of variance

207. The results of the ANOVA conducted on the clay are presented in Table 13. The ANOVA presents five groups that are significantly different. Vendor 6's sample was different compared to the remaining vendors and was the highest in total chromium (5,140 mg/kg). The samples from Vendors 5 and 4 were not significantly different and had normalized total chromium values of 4,390 and 3,767 mg/kg, respectively. The third group contains Vendors 2, 1, and 7 and the untreated clay, and are not significantly different with normalized total chromium concentrations of 2,944, 2,633, 2,440, and 2,386 mg/kg, respectively. The normalized total chromium values for Vendors 8 and 3 were 2,125 and 1,830 mg/kg, respectively. The fourth group contains the untreated clay and Vendors 7, 1, and 8; the fifth group contains Vendors 7, 8, 1, and 3.

Chrome Reduction Study

208. The results of the WES CRS are presented in Table 14 and discussed below. Two additives were tested, BFS and ferrous sulfate, at varying dosages and reaction times of 0, 2, 4, 6, and 24 hours in triplicate.

Table 12

Results of Normalizing Total Chromium and Cr(VI) for Treated and Untreated Frontier Hard Chrome Clay*

Vendor	Mean Total Cr mg/kg	Norm. Total Cr mg/kg	Mean Cr(VI) mg/kg	Norm. Cr(VI) mg/kg
--**	2,633		10	
1	1,867	2,386	0.014	0.017
2	2,267	2,944	7.3	9.5
3	1,167	1,830	6.9	10.7
4	2,467	3,767	8.4	12.6
5	2,267	4,390	8.4	13.5
6	3,567	5,140	3.6	9.0
7	1,300	2,440	3.2	0.20
8	1,267	2,125	0.140	0.10

* Treatment objective was total chromium ≤0.05 mg/L.
** Untreated clay.

Table 13

Results of Anova for Bulk Chemistry Conducted on Untreated Clay

Vendor	Mean NMLC mg/kg	Group
6	5,140	1
5	4,390	2
4	3,767	2
2	2,944	3
--*	2,633	3,4
7	2,440	3,4,5
1	2,386	3,4,5
8	2,125	4,5
3	1,830	5

* Untreated clay.

Table 14

Results for the Chrome Reduction Study Conducted on the Clay*

Additive-to-Soil Ratio	Reaction Time, hr 0	2	4	6	24
Blast furnace slag/clay					
0.006	2.29	2.51	6.13	1.97	2.88
0.12	1.49	1.57	2.05	1.17	2.53
0.24	0.51	0.86	0.71	1.10	0.68
0.36	0.46	0.50	0.48	0.78	0.43
Ferrous sulfate/clay					
0.000026		3.45	2.25	2.87	3.30
0.00052	6.38	2.98	3.23	2.65	4.53
0.0013	4.11	2.07	3.63	2.55	2.00
0.0026	1.93	2.20	2.39	1.94	3.93

Note: Average Cr(VI) concentration in the untreated clay was 3.67 mg/kg.
* Results are presented as mg/kg of Cr(VI).

Untreated clay

209. Triplicate analyses of the untreated clay were conducted to compare the treated and untreated results for reduction of Cr(VI). The average of the replicates was 3.67 mg/kg Cr(VI).

Blast furnace slag

210. The ASRs tested were 0.006, 0.12, 0.24, and 0.36. The lowest average concentration after 24 hr was 0.43 mg/L at an ASR of 0.36. BFS reduced Cr(VI) more effectively than ferrous sulfate and was selected as the additive for the detailed evaluation of clay at an ASR of 0.36.

Ferrous sulfate

211. Four ASRs were tested for ferrous sulfate. At the highest ASR, 0.0026, the average concentration was initially 1.93 mg/kg but reached 3.93 mg/kg after 24 hr. The other ASRs had average concentrations of 3.30, 4.53, and 2.00 mg/kg after 24 hr.

Initial Screening Test Results

212. The results of the initial screening test for the clay conducted by WES are summarized below. The detailed results are presented in Appendix A. Each time a stabilization process was applied, a batch of material was

generated. As shown, 8 batches of solidified clay were prepared for the cement and 15 batches were prepared for the lime/fly ash process.

Cement binder

213. Two WSRs and four ASRs were evaluated. After 8 hours, the 0.4 and 0.7 ASRs with a WSR of 0.1 had CI readings >750 psi. The 1.4/0.1 ASR/WSR mixture had CI measurements >750 psi after 1 hr. The 0.1/0.1 ASR/WSR mixture had an average CI reading of 487 psi after 24 hr. The 0.3 WSR produced CI values >750 psi for ASRs of 0.4, 0.7, and 1.4. A cement ASR of 0.1 with a WSR of 0.1 was selected for the preparation of specimens for detailed evaluation.

Lime/fly ash binder

214. WSRs of 0.1 and 0.3 were evaluated in the initial screening test. Four ASRs were evaluated with each WSR. None of the ASR/WSR combinations provided average CI values >267 psi. Lime/fly ash treatment of the FHC clay was not evaluated further, and cement was selected as the binder to be evaluated in the detailed evaluation.

Results of Physical Testing of Clay Material

215. The results of tests on bulk density, Atterberg limits, Proctor density, UCS, permeability, specific gravity, and set time for the untreated clay are summarized in Table 15. The results of grain size and moisture content analyses for the clay are presented in Appendix D.

UCS results

216. Measurements of UCS were performed in triplicate for each replicate after 28 days of cure. Figure 13 presents the results of the UCS tests conducted on the treated clay.

217. Untreated clay. The untreated clay specimens were prepared at Proctor density and allowed to cure for 28 days. The specimens fractured upon removal from the molds; therefore, UCS tests were not conducted.

218. Vendor 1. The Ensol/Landtreat process did not produce cementitious properties. Removal of the specimens from the molds damaged the specimens because there was no strength gain. No UCS measurements were taken.

219. Vendor 2. The average UCS values of replicates A, B, and C were 266, 271, and 200 psi, respectively. ASRs for the cement and chemical reducing agent varied slightly among replicates, possibly causing the UCS variability. Lower average UCS values for replicate C may be attributed to a smaller amount of cement addition. Replicates A and B had cement ASRs of 0.15, and

Table 15

Results of Physical Tests Conducted on Untreated Clay

Parameter	Replicate 1	Replicate 2	Replicate 3
Bulk density, pcf	97.2	101.5	105.8
Proctor density, pcf	134.1	137.2	134.1
Specific gravity	2.66	2.65	2.65
Resistance to penetration, psi*	50	47	48
Permeability, cm/sec*	N/A	N/A	3.95E-05
UCS, psi	N/A	N/A	N/A
Moisture, % dry weight**	46.13	46.14	47.14
Atterberg limits			
Plasticity index	24	25	27
Liquid limit	58	57	59
Plastic limit	34	32	32

* Represents an average of three replicates.
** Represents an average of 33 replicates.

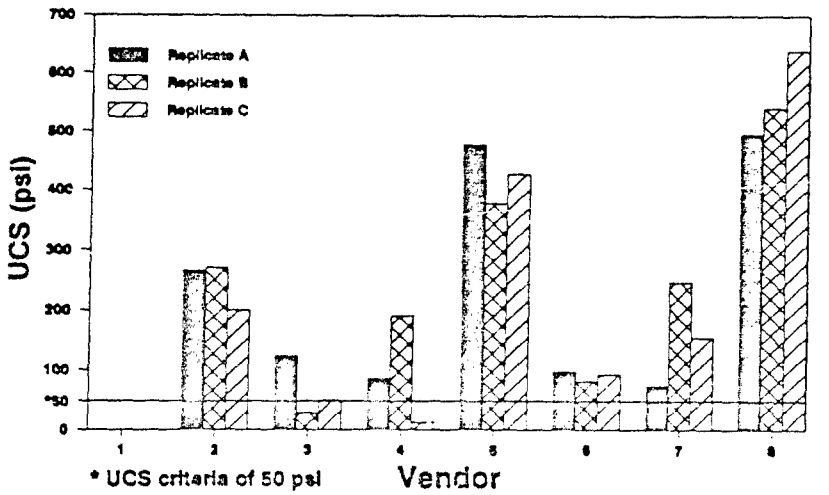

Figure 13. 28-day UCS results for FHC clay

replicate C had an ASR of 0.1 for cement. Replicate C had a larger ASR for the chemical reducing agent (0.1), while replicates A and B had an ASR of 0.08.

220. Vendor 3. The average UCS values for replicates A, B, and C were 124, 28, and 49 psi, respectively. One B replicate fractured when extruded from the mold. Vendor 3 was consistent in the addition of portland cement and silica to the replicates, but only replicate A developed strengths greater than 50 psi.

221. Vendor 4. The average UCS values for replicates A, B, and C were 86, 191, and 13 psi, respectively. Vendor 4 increased the ASRs for water with each replicate, from 0.21 to 0.23 to 0.26 for replicates A, B, and C, respectively. Replicates A and B had UCSs above the 50-psi criterion, but replicate C did not.

222. Vendor 5. The average UCS values for replicates A, B, and C were 478, 378, and 428 psi, respectively. Vendor 5 added 0.23 ASR of sodium silicate for replicate A and 0.20 ASR sodium silicate for replicates B and C. The cement ASR remained constant, and all replicates gained strengths greater than 50 psi.

223. Vendor 6. The average UCS values were 97, 81, and 93 psi, respectively. Vendor 6 was consistent in the ASRs added among replicates. All replicate UCSs were greater than 50 psi.

224. Vendor 7. The average UCS values for replicates A, B, and C were 74, 247, and 154 psi, respectively. The average UCS of replicate B was three times the average UCS of replicate A. The cement ASRs for replicates A and B were 0.07 and 0.10, respectively, possibly causing the difference in average UCS readings. All replicates had UCS values greater than 50 psi.

225. Vendor 8. The average UCS values were 496, 541, and 639 psi for replicates A, B, and C, respectively. Vendor 8 was consistent among replicates in the addition of ASRs and water, but the average UCS values varied by 143 psi from replicate A to replicate C. Vendor 8 specimens gained the greatest strengths among processes evaluated, and all UCS readings were >50 psi.

Wet/dry results

226. To determine the durability of the specimens, the wet/dry test was conducted on three test specimens and three control specimens after 28 days of cure. The specimens were subjected to 12 cycles of wetting and drying, and the weight of the specimen was taken after each cycle to determine the loss during that cycle. Moisture contents were determined on one specimen in order

to evaluate the percent solids loss for the specimens. A total weight loss of 30 percent constitutes failure of the specimen (ASTM 1990). The average results of the wet/dry test for the clay are presented in Table 16. The detailed results by replicate are presented in Appendix E.

Table 16

Results of the Wet/Dry Tests Conducted on Frontier Hard Chrome Clay

Vendor	ACCRML After 12 Cycles, g	Test Specimen (% Loss)	Control Specimen (% Loss)
1	NA	100	100
2	-0.31*	0.58	0.89
3	-0.22*	1.20	1.43
4	0.31	1.95	1.65
5	-0.20*	0.33	0.53
6	0.14	1.41	1.28
7	-0.15*	0.60	0.75
8	-0.04*	0.30	0.34
Goal	--	30	30

* Negative result due to greater average relative mass loss in control sample than in treated sample.

227. Vendor 1. The specimens prepared by Vendor 1 did not have cementitious properties and failed the wet/dry test after one cycle. All of the specimens suffered 100 percent solid mass loss.

228. Vendor 2. The average percent solid mass loss from the test and control specimens was 0.58 percent and 0.89 percent, respectively. The specimens prepared by Vendor 2 passed 12 cycles of the wet/dry test. The ACCRML was -0.31 g, representing a greater mass loss from the controls than the test specimens.

229. Vendor 3. The average percent solid mass loss from the test and control specimens was 1.20 percent and 1.43 percent, respectively. Vendor 3's specimens had an ACCRML of -0.22 g. The specimens passed 12 cycles of the wet/dry test, with more sample mass loss from the controls than from the test specimens.

230. Vendor 4. The average percent solids loss from the test and control specimens was 1.95 percent and 1.65 percent, respectively. The test specimens lost more mass than the controls, which is represented by a positive ACCRML of 0.31 g. No specimens experienced a mass loss ≥30 percent, and the specimens passed 12 cycles of the wet/dry test.

231. Vendor 5. Vendor 5's test and control specimens passed 12 cycles of the wet/dry test. There was no significant loss of material from the specimens during the 12 wet/dry cycles. The average percent solids mass loss for the test and control specimens was 0.33 percent and 0.53 percent, respectively. The ACCRML for the specimens was -0.20 g, meaning there was a greater mass loss from the control specimens than the test specimens.

232. Vendor 6. The test specimens lost more mass than the control specimens, which is indicated by a positive ACCRML of 0.14 g. The test and control specimens' average percent solids mass loss was 1.41 percent and 1.28 percent, respectively. The test and control specimens passed 12 cycles of the wet/dry test.

233. Vendor 7. The ACCRML for the wet/dry specimens was -0.15 g. The average percent solid mass loss from the test and control specimens was 0.60 percent and 0.75 percent, respectively. More mass was lost from the control specimens than the test specimens, and the specimens passed 12 cycles of the wet/dry test.

234. Vendor 8. The Vendor 8 specimens had an average ACCRML of -0.04 g, indicating a greater mass loss from the control specimens than the test specimens. The average percent solid mass loss from the test and control specimens was 0.30 percent and 0.34 percent, respectively. The specimens passed 12 cycles of the wet/dry test.

Permeability results

235. The results of the permeability test conducted on the untreated and treated clay are summarized in Table 17 and illustrated in Figure 14. Triplicate readings were conducted on each replicate to obtain an average permeability after 28 days of cure. Detailed results of permeability testing are presented in Appendix E.

236. Untreated clay. The permeability specimens were prepared at Proctor density and allowed to cure for 28 days. Only one permeability specimen, replicate C, was cohesive enough for permeability testing, with a permeability of 3.95E-05 cm/sec. Replicates A and B fractured upon removal from the molds.

Table 17

Summary of Permeability Test Results for the Clay

Vendor	Replicate	Average Permeability cm/sec
--*	A	NA
	B	NA
	C	3.95E-05
1	A	7.56E-05
	B	4.80E-07
	C	1.43E-06
2	A	7.63E-06
	B	2.61E-06
	C	4.87E-06
3	A	8.67E-08
	B	7.66E-07
	C	7.38E-05
4	A	1.73E-05
	B	6.01E-07
	C	1.16E-06
5	A	9.54E-04
	B	NA
	C	1.57E-07
6	A	6.96E-06
	B	2.43E-06
	C	4.61E-07
7	A	4.30E-06
	B	4.26E-07
	C	6.63E-07
8	A	2.14E-07
	B	1.61E-07
	C	1.37E-06

Note: Permeability goal was 1E-08 cm/sec or two orders of magnitude less than untreated clay.

* Untreated clay.

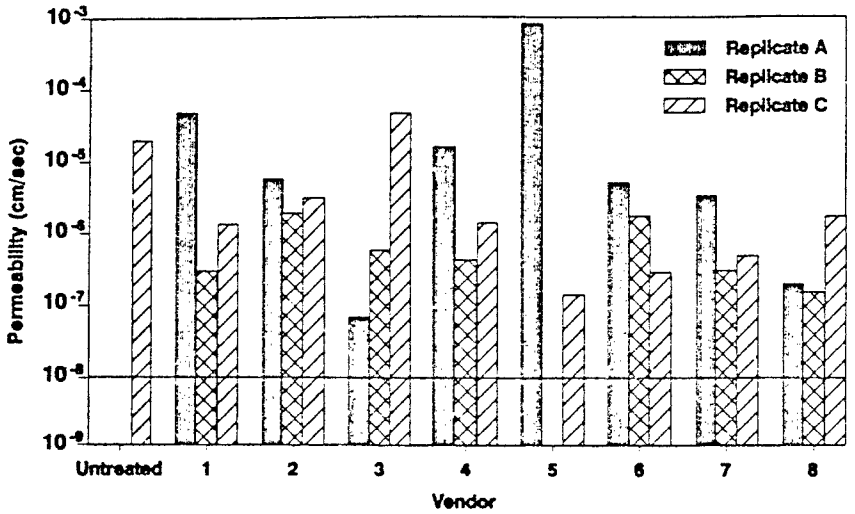

Figure 14. 28-day permeability results for FHC clay

237. Vendor 1. The average permeabilities of replicates A, B, and C were 7.56E-05, 4.80E-07, and 1.43E-06 cm/sec, respectively. The additions of water and binder to the clay varied among replicates, possibly causing the variance among the permeability readings. Treated replicate B had a permeability two orders of magnitude less than the permeability of the untreated clay replicate C. None of the permeabilities was less than 1E-08 cm/sec.

238. Vendor 2. The average permeabilities of Vendor 2's replicates were 7.63E-06, 2.61E-06, and 4.87E-06 cm/sec, for A, B, and C, respectively. The permeabilities of these specimens were one order of magnitude less than the untreated clay replicate permeability. None of the permeability readings was less than 1E-08 cm/sec.

239. Vendor 3. The first permeability reading for replicate A was 5.52E-08 cm/sec, five times the permeability goal of 1E-08 cm/sec. The average permeability of replicate A was 8.67E-08 cm/sec, approximately three orders of magnitude less than the permeability of the untreated clay. Replicate B had an average permeability two orders of magnitude less than the untreated permeability, but replicate C had an average permeability of 7.38E-05 cm/sec, twice the permeability of the untreated clay sample. None of the permeabilities was equal to or less than 1E-08 cm/sec, and replicate C was not two orders of magnitude less than the untreated clay.

240. Vendor 4. The average permeabilities of replicates A, B, and C were 1.73E-05, 6.01E-07, and 1.16E-06 cm/sec, respectively. The

permeabilities were consistent among replicates, but were not equal to or less than 1E-08 cm/sec, the goal for permeability of the treated clay, nor were the permeabilities two orders of magnitude less than the untreated clay permeability.

241. Vendor 5. The average permeabilities of replicates A and C were 9.54E-04 and 1.57E-07 cm/sec, respectively. The operator was unable to saturate replicate B; therefore, no permeability readings were recorded. The average permeability of replicate A was one order of magnitude greater than the permeability of the untreated clay, but the average permeability of replicate C was two orders of magnitude less than the permeability of the untreated clay. Vendor 5 representatives added more sodium silicate to replicate A (at a ratio of 0.23 g sodium silicate/g wet clay) than replicates B and C (at 0.20 g sodium silicate/g wet clay), which may explain the difference in permeabilities. However, Vendor 5 representatives added the same amounts of cement and sodium silicate to replicates B and C, but no permeability reading was recorded for replicate B.

242. Vendor 6. The average permeabilities of replicates A, B, and C were 6.96E-06, 2.43E-06, and 4.61E-07 cm/sec, respectively. One permeability reading on replicate C was two orders of magnitude less than the permeability of the untreated clay, and no permeability readings were less than or equal to 1E-08 cm/sec. The permeabilities did not meet the designated criterion.

243. Vendor 7. The average permeabilities for replicates A, B, and C were 4.30E-06, 4.26E-07, and 6.63E-07 cm/sec, respectively. The average permeability of replicate B was approximately two orders of magnitude less than the permeability of the untreated clay. The permeabilities among replicates remained consistent, but no individual permeabilities were less than or equal to 1E-08 cm/sec.

244. Vendor 8. The average permeabilities were 2.14E-07, 1.61E-07, and 1.37E-06 cm/sec for replicates A, B, and C, respectively. Two replicates, A and B, had permeabilities two orders of magnitude less than the permeability of the untreated clay, but the average permeability of replicate C was only one order of magnitude less than the permeability of the untreated clay. No permeability readings were equal to or less than 1E-08 cm/sec.

Bulk density

245. The bulk density was measured in triplicate for each replicate, and the results are presented in Appendix E.

Volumetric change

246. Based on the bulk density of the treated material and the Proctor density of the untreated clay, the volumetric change caused by the addition of binders was calculated as described in the fill section. These results are summarized in Table 18 and represented in Figure 15.

247. Untreated clay. The Proctor densities of the untreated clay were 134.1, 137.2, and 134.1 lb/ft^3, for replicates A, B, and C, respectively, and were the basis for volumetric increase calculations. The bulk densities of

Table 18

Results of Volumetric Change Calculations for the Clay

Vendor	Replicate	Bulk Density lb/ft^3	Volumetric Increase, %
--*	A	97	
	B	102	
	C	106	
1	A	120	29
	B	126	28
	C	121	33
2	A	125	51
	B	121	56
	C	129	46
3	A	116	77
	B	121	79
	C	125	77
4	A	106	86
	B	100	63
	C	98	62
5	A	109	104
	B	111	102
	C	110	98
6	A	109	71
	B	112	79
	C	113	70
7	A	123	89
	B	123	96
	C	123	95
8	A	117	87
	B	116	85
	C	117	84

* Untreated clay.

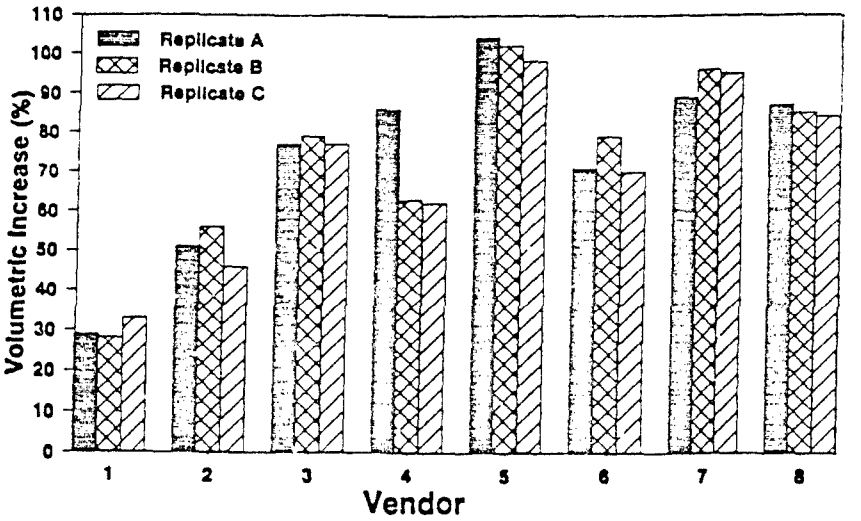

Figure 15. Volumetric change resulting from the addition of additives for FHC clay

the untreated clay were 97.2, 101.5, and 105.8 lb/ft^3, for replicates A, B, and C, respectively, and were the basis for volumetric increase calculations.

248. Vendor 1. The volumetric increases for replicates A, B, and C were 29, 28, and 33 percent, respectively. Vendor 1 had the lowest volume increase of any of the vendors.

249. Vendor 2. The volumetric increase caused by the addition of additives for replicates A, B, and C were 51, 56, and 46 percent, respectively.

250. Vendor 3. The Vendor 3 process increased the volume based on the average bulk densities for replicates A, B, and C by 77, 79, and 77 percent, respectively.

251. Vendor 4. The volume increase for replicate A was 86 percent, and the volume increases for replicates B and C were 63 and 62 percent, respectively. The higher volume increase for replicate A may be attributed to any number of factors. The variable factor in the mixing process was a 0.21 WSR for replicate A and WSRs of 0.23 and 0.26 for replicates B and C, respectively.

252. Vendor 5. Vendor 5's process doubled the volume required for the treated material. The volumetric increases were 104, 102, and 98 percent for replicates A, B, and C, respectively. Vendor 5's volumetric increases resulted mainly from additions of 0.25 cement and 0.20 sodium silicate.

253. Vendor 6. Vendor 6 increased the volume occupied by the untreated material by 70, 79 and 70 percent for treated replicates A, B, and C, respectively.

254. Vendor 7. Vendor 7 increased the volume of the clay by 89, 96, and 95 percent for replicates A, B, and C, respectively, approximately doubling the volume required for the clay. The volumetric increase may be largely due to the 0.42 ASR of fly ash added to the clay.

255. Vendor 8. The Vendor 8 process increased the volume of the clay for replicates A, B, and C by 87, 85, and 84 percent, respectively. Vendor 8 added a 0.36 ASR of blast furnace slag to the clay, which may have largely contributed to the volumetric increase.

Slump

256. The slump was measured for each replicate of the clay immediately after the mixing process was complete. When two consecutive tests showed a falling away characteristic, the mixture lacked cohesiveness and the slump test was not applicable. The results of the slump are presented in Appendix E.

257. Vendor 1 slumps for the replicates were 6, 5, and 6.25 in. for A, B, and C, respectively. Slumps of 0 in. were calculated for all replicates of mixtures from Vendors 2, 3, 4, 7, and 8. Vendor 5's replicate A had a slump of 0.5 in., and Vendor 6 slumps were 6 in. for replicate C and 5 in. for replicates A and B.

Moisture results

258. The results of moisture content tests conducted on the treated clay are presented in Appendix E. Moisture tests were performed in triplicate for each replicate of the treated clay after 28 days of cure.

Set time

259. The results of the set time conducted on the treated clay after 2, 4, 8, 24, and 48 hr of cure are presented in Appendix E. CI readings were taken in triplicate for each curing time.

Specific gravity

260. The specific gravities were measured in triplicate for the treated clay after 28 days of cure and are presented in Appendix E.

Bleed water

261. Vendor 1's specimens had a layer of water approximately 2 mm thick on the surface of the one specimen, replicate A. Vendor 5 had a layer of water approximately 1 mm in thickness on the surface of all the specimens.

Specimens prepared by Vendors 3, 7, 2, 4, and 6 did not have a layer of water on their surface.

Cracking

262. Vendor 1's specimens did not have cementitious properties. The replicate C specimens deformed when extruded from the molds. The Vendor 3 and Vendor 4 specimens had small voids in each of the replicates. Vendor 6's specimens had small voids on replicates B and C for the clay. The Vendor 7 specimens had voids in each of the replicates for the clay. The Vendor 8 specimens had cracks approximately 2 to 3 mm in length on all three replicates for the clay.

Results of Contaminant Release Testing

MWEP-1 results for clay

263. The results of total chromium and Cr(VI) in the MWEP-1 for treated and untreated clay for each vendor S/S process are presented in Appendix E. Figures 16 and 17 represent the results of MWEP-1 concentrations of total chromium and Cr(VI), respectively.

264. Untreated clay. The replicate concentrations for the MWEP-1 leachates were 0.081, 0.071 and 0.049 mg/L for total chromium, and 0.091, 0.069, and 0.057 mg/L for Cr(VI). Replicate A shows a greater concentration of Cr(VI) than total chromium, apparently an anomaly in the results. Most of the total chromium present in the leachates was in the form of Cr(VI).

265. Vendor 1. The MWEP-1 concentrations of total chromium were all above the MWEP-1 0.05-mg/L criterion. The mean MWEP-1 concentration was 0.11 mg/L, and the mean Cr(VI) concentration was <0.038 mg/L.

266. Vendor 2. The MWEP-1 concentrations were all above the 0.05-mg/L drinking water criterion for chromium. The chromium present was in the form of Cr(VI). The mean Cr(VI) concentration was 0.74 mg/L, and the mean total chromium concentration was 0.757 mg/L.

267. Vendor 3. The mean MWEP-1 concentration was 0.12 mg/L total chromium, and the mean Cr(VI) concentration was 0.12 mg/L. The chromium present was in the hexavalent form and caused the replicate concentrations to be above the 0.05-mg/L criterion.

268. Vendor 4. The mean concentration of the replicate total chromium was 0.28 mg/L, and the Cr(VI) was 0.29 mg/L. The concentration of Cr(VI) was

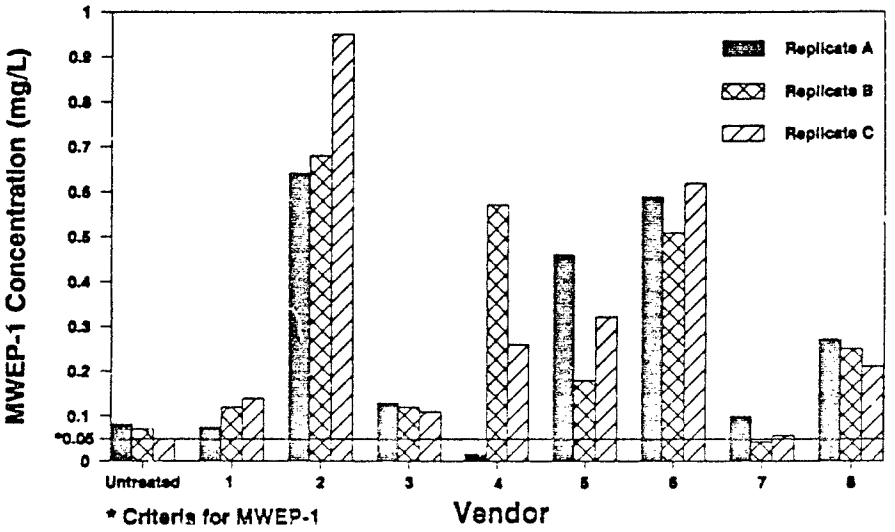

Figure 16. Results of MWEP-1 concentrations of total chromium in treated and untreated clay

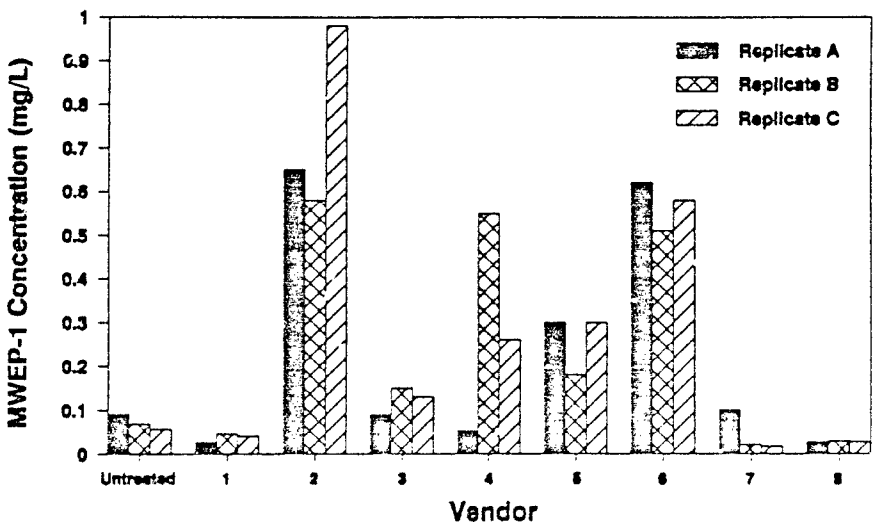

Figure 17. Results of MWEP-1 concentrations of Cr(VI) in treated and untreated clay

greater than the concentration of total chromium. The chromium in Vendor 4's specimens was in the form of Cr(VI).

269. Vendor 5. The concentrations of total chromium in the MWEP-1 leachates were 0.46, 0.18, and 0.32 mg/L for all replicates. The concentrations were above the 0.05-mg/L criterion for the MWEP-1. The mean total chromium concentration was 0.32 mg/L, and the mean Cr(VI) concentration was 0.26 mg/L, indicating a majority of the chromium exists as Cr(VI).

270. Vendor 6. The total chromium concentrations of the MWEP-1 replicates were 0.59, 0.51, and 0.62 mg/L. The total chromium replicate concentrations were above the 0.05-mg/L criterion. The mean total chromium concentration and the Cr(VI) concentration were 0.57 mg/L, indicating that chromium that was present in the hexavalent form.

271. Vendor 7. The concentrations of total chromium in the MWEP-1 replicates were 0.10, 0.042, and 0.056 mg/L. The concentrations of Cr(VI) were 0.10, 0.021, and 0.017 mg/L. The second replicate total chromium concentration was less than the 0.05-mg/L criterion, but the remaining concentrations were greater than the 0.05-mg/L criterion.

272. Vendor 8. The mean MWEP-1 concentration of total chromium in the replicates was 0.24 mg/L, and the mean MWEP-1 Cr(VI) concentration was <0.028 mg/L. The chromium existed in the leachates as Cr(III). The replicate leachate concentrations were above the 0.05-mg/L concentration designated for the MWEP-1.

TCLP results for clay

273. The results of the TCLP conducted on treated and untreated clay for total chromium and Cr(VI) are presented in Appendix E. Figures 18 and 19 represent the results of the TCLP for total chromium and Cr(VI), respectively.

274. Untreated clay. The Cr(VI) TCLP concentrations for untreated clay were all <0.020 mg/L. The total chromium concentrations were 0.22, 0.18, and 0.18 mg/L, with a mean total chromium concentration of 0.19 mg/L. The concentrations were below the 5.0-mg/L criterion for the TCLP.

275. Vendor 1. The Vendor 1 process produced total chromium concentrations of 4.4, 4.2, and 4.4 mg/L. Cr(VI) concentrations were all <0.020 mg/L, meaning the chromium present was in the trivalent form.

276. Vendor 2. The total chromium concentrations in the TCLP conducted on clay treated by Vendor 2 were 0.094, 0.063, and 0.11 mg/L, with a mean of 0.089 mg/L. The concentrations of Cr(VI) were 0.075, 0.046, and 0.10 mg/L, producing a mean concentration of 0.074 mg/L Cr(VI).

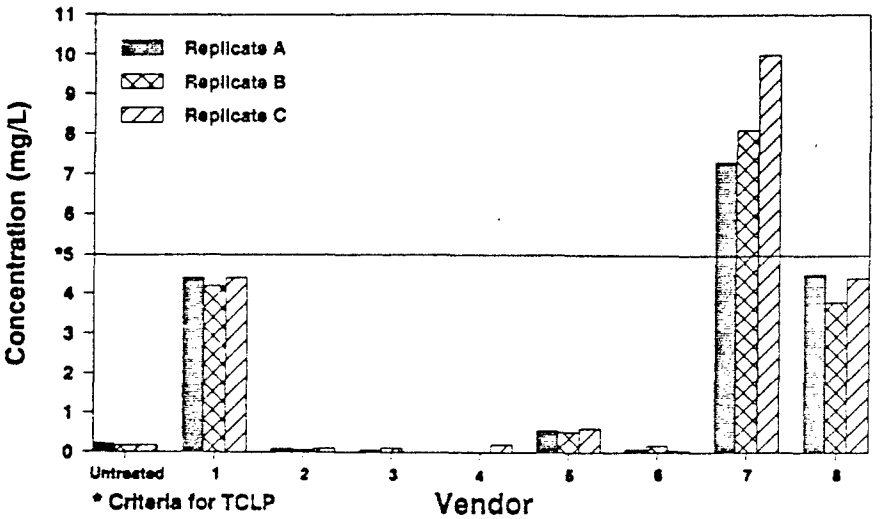

Figure 18. Results of TCLP concentrations of total chromium in treated and untreated clay

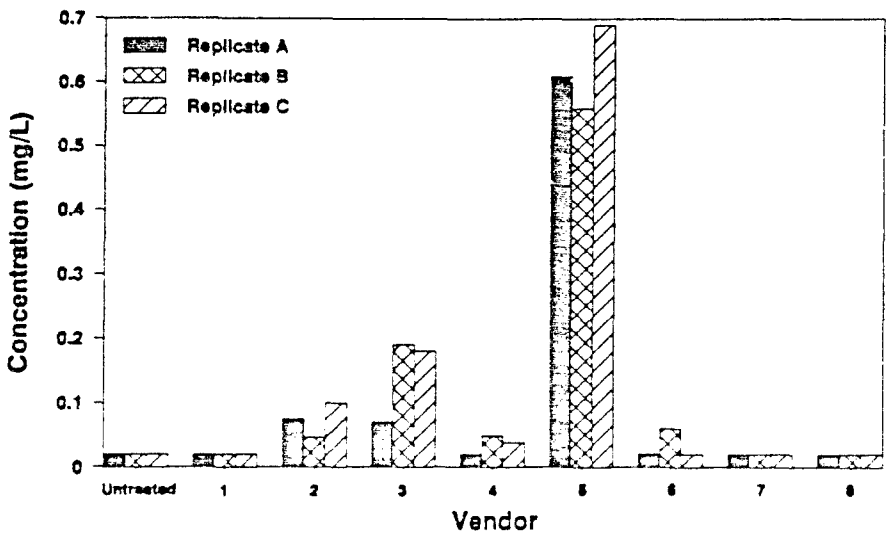

Figure 19. Results of TCLP concentrations of Cr(VI) in treated and untreated clay

277. Vendor 3. The total chromium concentrations were 0.062, 0.12, and 0.004 mg/L; the Cr(VI) concentrations were 0.069, 0.19, and 0.18 mg/L. The Cr(VI) concentrations were higher than the total chromium concentrations, apparently representing an anomaly in the results. The mean concentrations for Cr(VI) and total chromium were 0.15 and 0.062 mg/L, respectively.

278. Vendor 4. The total chromium concentrations for the clay were 0.012, 0.019, and 0.21 mg/L. The Cr(VI) concentrations were <0.020, 0.049, and 0.038 mg/L for replicates 1, 2, and 3, respectively.

279. Vendor 5. The chromium present in the leachates was in the hexavalent form. The TCLP conducted on the treated clay had concentrations of 0.57, 0.53, and 0.62 mg/L for total chromium and 0.61, 0.56, and 0.69 mg/L for Cr(VI). The Cr(VI) concentrations were higher than the total chromium concentrations for all replicates.

280. Vendor 6. The chromium present in the TCLP conducted on the treated clay was in the trivalent form. The concentrations of total chromium were 0.072, 0.17, and 0.050 mg/L; the Cr(VI) concentrations were 0.021, 0.061, and <0.020 mg/L. The concentrations of total chromium were all below the 5.0-mg/L criterion for total chromium designated by the TCLP.

281. Vendor 7 Cr(VI) concentrations in the TCLP conducted on the treated clay were all <0.020 mg/L. The total chromium concentrations were 7.3, 8.1, and 10 mg/L. The concentrations of total chromium in the TCLP leachate are above the 5.0-mg/L criterion for total chromium in the TCLP.

282. Vendor 8. The Cr(VI) concentrations in the TCLP were all <0.020 mg/L, and the total chromium concentrations were 4.5, 3.8, and 4.4 mg/L. The concentrations were below the 5.0-mg/L criterion for total chromium in the TCLP.

Effects of Dilution on Leaching

MWEP-1 results for clay

283. Untreated clay. The mean NMLCs of total chromium and Cr(VI) were 0.977 and 1.053 mg/kg, respectively. Based on the NMLC for total chromium and Cr(VI), the efficiency of the vendor processes was evaluated.

284. Vendor 1. Normalization of the total chromium concentrations presented a MNMTCL of 1.938 mg/kg. The mean NMLC of the MNMTCL increased by 98 percent, and the MNMCSL was decreased by 38 percent. Vendor 1 decreased mobilization of Cr(VI) but increased mobilization of Cr(III).

285. Vendor 2. The mean NMLC of total chromium was 11.74 mg/kg, resulting in an increase in the MNMTCL of 1,102 percent. The mean NMLC for Cr(VI) was 11.41 mg/kg, representing an increase in the MNMCSL of 984 percent.

286. Vendor 3. The mean NMLC for total chromium was 2.249 mg/kg, and the mean NMLC for Cr(VI) was 2.291 mg/kg. The Vendor 3 process caused an increase in the MNMTCL of 130 percent and an increase in the MNMCSL of 118 percent.

287. Vendor 4. Based on the mean total chromium NMLC (5.883 mg/kg), and the mean Cr(VI) NMLC (6.001 mg/kg), there was an increase in the MNMTCL of 502 percent and an increase in the MNMCSL of 470 percent. The presence of Cr(VI) caused the increase in the MNMTCL.

288. Vendor 5. Based on the MNMTCL of 7.207 mg/kg, the increase in MNMTCL was 638 percent. The MNMCSL was 5.842 mg/kg, causing an increase in MNMCSL from the untreated clay of 455 percent.

289. Vendor 6. Compared to the mean normalized concentration of the untreated MWEP-1 leachate, there was an increase of total chromium in the treated leachate of 1,115 percent and an increase in Cr(VI) of 1,020 percent.

290. Vendor 7. The second replicate represented an increase in the MNMTCL of 60 percent when compared to the untreated MWEP-1 concentration for that replicate. There was an increase in the MNMTCL of 40 percent and a decrease in the MNMCSL of 9 percent.

291. Vendor 8. The Vendor 8 treatment process caused an increase in the MNMTCL of 366 percent and a decrease in the MNMCSL of 50 percent. Vendor 8 successfully reduced Cr(VI), but Cr(III) remained mobile.

TCLP results

292. Normalization of the TCLP results was calculated according to the methods described for normalization of the MWEP-1 (paragraph 206). These results are presented in Appendix E.

293. Untreated clay. The NMLCs were 5.603 mg/kg total chromium and 0.578 mg/kg Cr(VI) in the TCLP. Based on the NMLCs for the untreated clay, the efficiency of each vendor process was calculated as a percentage of the untreated NMLC.

294. Vendor 1. The mean NMLC of total chromium was 146.8 mg/kg chromium, producing a 2,520-percent increase in the MNMTCL in the TCLP for clay. The concentrations of Cr(VI) were all <0.020 mg/L. The mean NMLC for Cr(VI) was 0.678 mg/kg based on the detection limit, producing a 17-percent increase in the MNMCSL.

295. Vendor 2. Normalization of the total chromium produced masses of 2.863, 2.013, and 3.384 mg/kg, respectively, for the replicates. Vendor 2 reduced the MNMTCL in the treated TCLP by 51 percent and increased the MNMCSL by 294 percent.

296. Vendor 3. Based on total chromium concentrations, Vendor 3 reduced the MNMTCL by 59 percent and increased the MNMCSL by 843 percent. The MNMTCL was 2.303 mg/kg, and the MNMCSL was 5.455 mg/kg.

297. Vendor 4. The mean normalized total chromium leached was 2.586 mg/kg, producing a 54-percent reduction in the MNMTCL compared to the total chromium leached in the TCLP conducted on the untreated clay. The mean NMLC for Cr(VI) was 1.348 mg/kg, resulting in a 133-percent increase in the MNMCSL.

298. Vendor 5. The mean NMLCs for total chromium and Cr(VI) were 25.666 and 27.764 mg/kg, respectively. The Vendor 5 process increased the NMTCL for the treated clay compared to NMTCL for untreated clay by 358 percent. The MNMCSL was increased by 4,701 percent.

299. Vendor 6. The mean NMLC of total chromium was 3.999 mg/kg, decreasing the MNMTCL by 29 percent. The mean NMLC for Cr(VI) was 1.397 mg/kg, resulting in a 142-percent increase in the MNMCSL.

300. Vendor 7. The NMLC was 347.174 mg/kg total chromium, representing a 6,097-percent increase in total chromium leached in the TCLP. All Cr(VI) concentrations were <0.020 mg/L. The mean NMLC for Cr(VI) was 0.823 based on the detection limit, an increase in the MNMCSL of 42 percent.

301. Vendor 8. The MNMTCL was 158.328 mg/kg, representing a 2,726-percent increase in the MNMTCL in the TCLP. All Cr(VI) concentrations were <0.020 mg/L. Based on the detection limit, the mean NMLC for Cr(VI) was 0.749 mg/kg, an increase in the MNMCSL of 30 percent.

Standard Deviation and Relative Standard Deviation

MWEP - total chromium

302. Untreated. The NMLCs for replicates A, B, and C were 1.21, 1.06, and 0.66 mg/kg, respectively. The NMLC standard deviation for the clay was 0.283 with a NMLC RSD of 29 percent.

303. Vendor 1. Vendor 1 varied the amount of additive used among their replicates; therefore, precision of the results must be based on the NMLC. The NMLCs for replicates A, B, and C were 1.09, 2.18, and 2.54 mg/kg,

respectively. The standard deviation of the NMLC for clay was 0.76. The MWEP-1 concentrations for the treated clay had an average precision of 39 percent for the clay, based on NMLC calculations.

304. Vendor 2. The NMLCs for replicates A, B, and C were 9.75, 10.86, and 14.61 mg/kg, respectively. Precision of the NMLC for the clay was 22 percent. The standard deviation of the NMLC calculated for the clay was 2.55.

305. Vendor 3. The NMLCs for replicates A, B, and C were 2.48, 2.20, and 2.07 mg/kg, respectively. The NMLC standard deviation for the clay was 0.21. Based on the NMLC, the precision of the clay was 9 percent.

306. Vendor 4. The NMLCs for replicates A, B, and C were 0.34, 11.76, and 5.55 mg/kg, respectively. The NMLC standard deviation for the clay was 5.88, and the NMLC RSD was 97 percent. Two replicate concentrations were 0.57 and 0.26 mg/L. The other replicate concentration for the MWEP-1 was 0.02 mg/L, causing a large NMLC RSD.

307. Vendor 5. The NMLCs were 10.47, 3.90, and 7.25 mg/kg for replicates A, B, and C, respectively. The clay NMLC standard deviation was 3.29 with an NMLC RSD of 46 percent.

308. Vendor 6. The NMLCs were 12.20, 10.37, and 13.04 mg/kg for replicates A, B, and C, respectively. Based on NMLC concentrations, the standard deviation was 1.36 and the NMLC RSD 11 percent.

309. Vendor 7. The NMLCs were 2.12, 0.86, and 1.12 mg/kg for replicates A, B, and C, respectively. The NMLC standard deviation for the clay was 0.66 and the NMLC RSD was 49 percent.

310. Vendor 8. The NMLCs were 4.93, 4.80, and 3.93 mg/kg for replicates A, B, and C, respectively. The NMLC standard deviation for the clay was 0.54 and the NMLC RSD was 12 percent.

MWEP - chromium (VI)

311. Untreated. The NMLCs for replicates A, B, and C were 1.36, 1.03, and 0.77 mg/kg, respectively. The NMLC standard deviation for the clay was 0.295 with an NMLC RSD of 28 percent.

312. Vendor 1. The NMLCs for replicates A, B, and C were <0.39, <0.83, and <0.74 mg/kg, respectively. The NMLC standard deviation was 0.233, and the NMLC RSD was 35 percent.

313. Vendor 2. The NMLCs for replicates A, B, and C were 9.90, 9.27, and 15.08 mg/kg, respectively. The NMLC standard deviation for the clay was 3.19, with an NMLC RSD of 28 percent.

314. Vendor 3. The NMLCs for replicates A, B, and C were 1.68, 2.75, and 2.45 mg/kg, respectively. The NMLC standard deviation for the clay was 0.55, and the NMLC RSD was 24 percent.

315. Vendor 4. The NMLCs for replicates A, B, and C were 1.11, 11.35, and 5.55 mg/kg, respectively. The NMLC RSD was 86 percent. The high NMLC RSD for the clay was the result of one concentration that was one order of magnitude less than the remaining two. In calculating the NMLC RSD, the detection limit was used with the other two replicate concentrations.

316. Vendor 5. The NMLCs were 6.83, 3.90, and 6.80 mg/kg for replicates A, B, and C, respectively. The NMLC standard deviation was 1.68 with an NMLC RSD of 29 percent.

317. Vendor 6. The concentrations of the clay replicates were 0.62, 0.51, and 0.58 mg/L, all within a 0.11-mg/L difference. The NMLCs were 12.82, 10.37, and 12.20 mg/kg for replicates A, B, and C, respectively. For the clay, the NMLC standard deviation was 1.27 and the NMLC RSD was 11 percent.

318. Vendor 7. The NMLCs were 2.11, 0.43, and 0.34 mg/kg, for replicates A, B, and C, respectively. One concentration among the replicates was one order of magnitude greater than the other concentrations, causing a relatively high NMLC RSD. The NMLC standard deviation was 1.00 with an NMLC RSD of 104 percent.

319. Vendor 8. For the clay, the concentrations were <0.027, <0.029, and <0.028 mg/L. Based on the detection limit concentrations, the NMLC concentrations were calculated. The NMLCs were 0.49, 0.56, and 0.52 mg/kg for replicates A, B, and C, respectively. The NMLC standard deviation was 0.032, and the NMLC RSD was 6 percent.

TCLP - total chromium

320. Untreated. The replicate concentrations were within 0.03 mg/L among replicates. The NMLCs for replicates A, B, and C were 6.57, 5.37, and 4.86 mg/kg, respectively. The NMLC standard deviation was 0.875, and the NMLC RSD was 16 percent.

321. Vendor 1. The NMLCs for replicates A, B, and C were 128.15, 152.30, and 160.00 mg/kg, respectively. The NMLC standard deviation was 16.61. The NMLC RSD clay was 11 percent.

322. Vendor 2. The NMLCs for replicates A, B, and C were 2.86, 2.01, and 3.38 mg/kg, respectively, providing a NMLC RSD for the clay of 25 percent.

323. Vendor 3. The NMLCs were 2.37, 4.39, and 0.151 mg/kg for replicates A, B, and C, respectively. The lowest NMLC was based on a TCLP

concentration of 0.004 mg/L and was two orders of magnitude less than one of the replicates. The NMLC RSD was 92 percent.

324. Vendor 4. The concentrations of chromium in the clay were 0.012, 0.019, and 0.21, which normalized to 0.511, 0.784, and 6.46 mg/kg, respectively. Based on the NMLC concentrations, the NMLC RSD was 130 percent.

325. Vendor 5. TCLP concentrations of 0.57, 0.53, and 0.62 mg/L normalized to 25.95, 22.95, and 28.10 mg/kg, respectively. The NMLC standard deviation was 2.59 with a NMLC RSD of 10 percent.

326. Vendor 6. The TCLP concentrations were 0.07, 0.17, and 0.05 mg/L, which correspond to NMLCs of 2.98, 6.91, and 2.10 mg/kg, respectively. The NMLC standard deviation was 2.56, and the NMLC RSD was 64 percent.

327. Vendor 7. The total chromium concentrations in the clay replicates were 7.3, 8.1, and 10.0 mg/L. The NMLCs were 309.26, 331.91, and 400.35 mg/kg, respectively. The NMLC standard deviation was 47.4, and the NMLC RSD was 14 percent.

328. Vendor 8. The concentrations of total chromium in the clay were 4.5, 3.8, and 4.4 mg/L and were normalized to 164.3, 146.0, and 164.7 mg/kg, respectively. Based on the NMLC, the standard deviation was 10.7 and the NMLC RSD was 7 percent.

TCLP - chromium (VI)

329. Untreated. The concentrations of Cr(VI) in the clay were <0.020 mg/L for all replicates. Based on the detection limit of 0.020 mg/L, the NMLCs were calculated as 0.60, 0.60, and 0.54 mg/kg for the clay. The NMLC standard deviation for the clay was 0.033, and the NMLC RSD was 6 percent.

330. Vendor 1. The concentrations of Cr(VI) for the clay were all <0.020 mg/L. The clay NMLCs were 0.58, 0.73, and 0.73 mg/kg with a standard deviation of 0.083 and NMLC RSD of 12 percent.

331. Vendor 2. The NMLCs for clay were 2.28, 1.47, and 3.08 mg/kg with a standard deviation of 0.803 and NMLC RSD of 35 percent.

332. Vendor 3. Based on the concentrations of Cr(VI) in the untreated clay, Vendor 3 mobilized Cr(VI). The concentrations of Cr(VI) were 0.07, 0.19, and 0.18 mg/L and were normalized to 2.63, 6.96, and 6.78 mg/kg, respectively. The NMLC RSD was 45 percent.

333. Vendor 4. The NMLCs for the clay were 0.85, 2.02, and 1.17 mg/kg with a standard deviation of 0.605 and NMLC RSD of 45 percent.

334. Vendor 5. The concentrations in the TCLP extracts were 0.61, 0.56, and 0.69 mg/L. The NMLCs were 27.77, 24.25, and 31.28 mg/kg of Cr(VI) leached with a standard deviation of 3.515 and NMLC RSD of 13 percent.

335. Vendor 6. The NMLC standard deviation and NMLC RSD for the clay were 0.939 and 67 percent, respectively, based on NMLCs of 0.87, 2.48, and 0.84 mg/kg.

336. Vendor 7. The concentrations of Cr(VI) in the clay leachates were all <0.020 mg/L. Normalization based on 0.020 mg/L for the clay resulted in NMLCs of 0.85, 0.82, and 0.80 mg/kg. The NMLC standard deviation was 0.023, and the NMLC RSD was 3 percent.

337. Vendor 8. The Vendor 8 concentrations in the TCLP extracts for the clay were all <0.020 mg/L. NMLCs, which were calculated based on a concentration of 0.020 mg/L, were 0.73, 0.77, and 0.75 mg/kg. The NMLC standard deviation and NMLC RSD for the clay were 0.019 and 3 percent, respectively.

Analysis of variance for MWEP-1 and TCLP

338. MWEP-1. The results of the ANOVA conducted on the clay for the MWEP-1 are presented in Table 19. An ANOVA conducted on the MWEP-1 data showed four groups of data. Vendors 6 and 2 are not significantly different, and Vendors 4 and 5 are not significantly different. Vendors 4, 8, 3, 1, and 7 are intertwined in groups that are not significantly different.

339. TCLP. The results of an ANOVA conducted on the clay on the TCLP are also presented in Table 19. For the clay, the TCLP data contains three groups. Vendor 7 is significantly different from the remaining vendors. Vendors 8 and 1 are not significantly different and are the second group. Group 3 contains the remaining vendors, which are not significantly different.

Table 19

Results of ANOVA for TCLP and MWEP-1 for Total Chromium in the Clay

Vendor	Mean NMLC mg/kg	Group
	MWEP-1	
6	11.871	1
2	11.742	1
5	7.207	2
4	5.883	2,3
8	4.554	2,3,4
3	2.249	3,4
1	1.938	3,4
7	1.367	3,4
--*	0.977	4
	TCLP	
7	347.17	1
8	158.33	2
1	146.81	2
5	25.67	3
--*	5.60	3
6	4.00	3
2	2.75	3
4	2.59	3
3	2.30	3

* Untreated clay.

PART V: CONCLUSIONS AND RECOMMENDATIONS

Conclusions

340. A bench-scale study conducted on FHC fill and clay was conducted to evaluate the effectiveness of S/S technologies on immobilization of chromium and Cr(VI). The physical tests conducted on the untreated fill and clay were moisture content, UCS, bulk density, permeability, grain size analysis, Proctor density, specific gravity, Atterberg limits, and resistance to penetration. The physical tests conducted on the treated fill and clay were moisture content, UCS, bulk density, permeability, specific gravity, set time, bleed water, slump, cracking, and wet/dry durability. Chemical characterization consisted of MWEP-1, TCLP, and bulk chemistry analyses for the treated and untreated fill and clay. Tables 20 and 21 present the results of the physical and chemical tests for the fill and clay, respectively, on a pass/fail basis. Conclusions based on these results are summarized below.

Table 20

Results of Physical and Chemical Tests Conducted on Frontier Hard Chrome Fill

	Criterion				
Vendor	UCS - ≥50 psi	Permeability - 1E-08 cm/sec or 2 Orders of Magn. < Untreated	Wet/Dry - 30% Solids Loss	MWEP-1 - 0.05 mg/L	TCLP - 5.0 mg/L
--*	Fail	Fail**	NA	Fail	Pass
1	Fail	Fail	Fail	Fail	Pass
2	Pass	Fail	Pass	Fail	Pass
3	Pass	Fail	Pass	Fail	Pass
4	Pass	Fail	Pass	Fail	Pass
5	Pass	Fail	Pass	Fail	Pass
6	Pass	Fail	Pass	Fail	Pass
7	Pass	Fail	Pass	Fail	Pass
8	Pass	Fail	Pass	Fail	Pass

* Untreated fill.
** The permeability results for the untreated fill were not <1E-08 cm/sec.

Table 21

Results of Physical and Chemical Tests Conducted on Frontier Hard Chrome Clay

	Criterion				
Vendor	UCS - >50 psi	Permeability - 1E-08 cm/sec or 2 Orders of Magn. < Untreated	Wet/Dry - 30% Solids Loss	MWEP-1 - 0.05 mg/L	TCLP - 5.0 mg/L
--*	Fail	Fail**	NA	Fail	Pass
1	Fail	Fail	Fail	Fail	Pass
2	Pass	Fail	Pass	Fail	Pass
3	Fail	Fail	Pass	Fail	Pass
4	Fail	Fail	Pass	Fail	Pass
5	Pass	Fail	Pass	Fail	Pass
6	Pass	Fail	Pass	Fail	Pass
7	Pass	Fail	Pass	Fail	Fail
8	Pass	Fail	Pass	Fail	Pass

* Untreated clay.
** The permeability results for the untreated fill were not <1E-08 cm/sec.

a. Binders can be added to the fill and clay to produce UCS values above the 50-psi criteria. The following vendors were successful in meeting the 50-psi criteria for the fill and clay: Vendor 2, Vendor 5, Vendor 6, Vendor 7, and Vendor 8.

b. None of the vendors was successful in reducing the permeability of the fill and clay to 1E-08 cm/sec or two orders of magnitude less than the permeability of the untreated fill and clay.

c. The S/S processes applied in this investigation can produce specimens that pass 12 cycles of the wet/dry test. Vendor 1 specimens failed to pass the wet/dry test, but the remaining vendors were successful.

d. Although a large portion of the fill contains debris, the fill and clay can be mixed with the binders.

e. The treated fill and clay can pass the 5.0-mg/L TCLP criterion for chromium. Excluding Vendor 7, the remaining vendors passed the TCLP.

f. The S/S processes applied in this investigation did not pass the 0.05-mg/L criterion for chromium in the MWEP-1.

g. Cr(VI) can be reduced by reagents added to the S/S process. Cr(VI) concentrations in the untreated fill and clay were

<0.020, indicating that reactions with the acetic acid leachate fluid may reduce Cr(VI) without treatment. In the MWEP-1, three vendors were successful in reducing Cr(VI) in the fill and clay: Vendor 1, Vendor 7, and Vendor 8. Although Cr(VI) was reduced, the total chromium concentration did not meet the criterion for the MWEP-1.

Recommendations

341. Recommendations based on results of this study are summarized below.

a. The criteria designated for the permeability were not met. Discussions during the design phase of the bench-scale investigation revealed that the criteria may not be within reach. Reevaluation of the criteria may be necessary.

b. Although some of the S/S processes reduced the leachability of chromium in the MWEP-1, the 0.05-mg/L criterion was not achieved. Determinations as to whether this criterion is applicable must be made before preceding with application of the S/S technologies demonstrated in this investigation.

c. Based on the bench-scale evaluation, application of some of the S/S technologies investigated in this study improves the physical handling properties of the soils and reduces Cr(VI), indicating success might be attainable in a field investigation. However, the chromium concentrations in TCLP and MWEP-1 leachates were greater after treatment than they were before treatment, indicating that S/S technologies should not be applied to improve chemical properties of the soils.

REFERENCES

American Society of Agronomy. 1965. "Methods of Soil Analysis; Part 1, Physical and Mineralogical Properties," Madison, WI.

American Society for Testing and Materials. 1990. "Construction; Cement; Lime; Gypsum," Vol 0401, Annual Bank of ASTM Standards, Philadelphia, PA.

Cullinane, M. J., Jr., Jones, L. W., and Malone, P. G. 1986. "Handbook for Stabilization/Solidification of Hazardous Waste," EPA/540/2-86/001, US Environmental Protection Agency, Cincinnati, OH.

Headquarters, Department of the Army. 1971. "Materials Testing," Technical Manual 5-530, Section XV, Washington, DC.

Malone, P. G., and Jones, L. W. 1979. "Survey of Solidification/Stabilization and Technology for Hazardous Industrial Wastes," EPA-600/2-79056, US Environmental Protection Agency, Cincinnati, OH.

Malone, P. G., Jones, L. W., and Larson, R. J. 1980. "Guide to the Disposal of Chemically Stabilized and Solidified Waste," WS-872, Office of Water and Waste Management, US Environmental Protection Agency, Washington, DC.

US Army Corps of Engineers. 1970. "Laboratory Soils Testing," Engineer Manual 1110-2-1906, Government Printing Office, Washington, DC.

US Environmental Protection Agency. 1984. "Solid Waste Leaching Procedure," SW-924, Office of Solid Waste and Emergency Response, Washington, DC.

_____. 1986a. "Quality Criteria for Water," EPA-440/5-86-001, Office of Water Regulations and Standards. Washington, DC

_____. 1986b (7 Nov). Federal Register, Vol 51, No. 142, Office of Solid Waste, Washington, DC.

_____. 1986c (Jun). "Handbook for Stabilization/Solidification of Hazardous Wastes," Hazardous Waste Engineering Research Laboratory, Cincinnati, OH.

_____. 1986d (Nov). "Test Methods for Evaluation of Solid Waste: Physical/Chemical Methods," SW-846, 3rd ed., Office of Solid Waste and Emergency Response, Washington, DC.

_____. 1986e. "Prohibition on Placement of Bulk Liquid Hazardous Waste in Landfills; Statutory Interpretive Guidance," EPA 530 SW-86-016, OSWER Policy Directive 9487.00-24, Office of Solid Waste and Emergency Response, Washington, DC.

_____. 1989. "Stabilization/Solidification of CERCLA and RCRA Wastes," EPA/625/6-89/022, Risk Reduction Engineering Laboratory, Cincinnati, OH.

_____. 1990. Federal Register, Vol 55, No. 61, Office of Solid Waste, Washington, DC.

APPENDIX A: INITIAL SCREENING TEST RESULTS, WES

Table A1

Matrix of Specimens Prepared for Initial Soil/Binder Screening for the Frontier Hard Chrome Fill

Binder/Soil Ratio	Water/Soil Ratio	Number of Specimens
Cement/soil		
0.1	0.1	1
0.4	0.1	1
0.7	0.1	1
1.4	0.1	1
0.1	0.3	1
0.4	0.3	1
0.7	0.3	1
1.4	0.3	1
		Total: 8
Lime/fly ash/soil		
0.1/0.1	0.1	1
0.1/0.4	0.1	1
0.1/0.7	0.1	1
0.4/0.1	0.1	1
0.4/0.4	0.1	1
0.4/0.7	0.1	1
0.7/0.1	0.1	1
0.1/0.1	0.3	1
0.1/0.4	0.3	1
0.1/0.7	0.3	1
0.4/0.1	0.3	1
0.4/0.4	0.3	1
0.4/0.7	0.3	1
0.7/0.1	0.3	1
0.7/0.4	0.3	1
0.7/0.7	0.3	1
		Total: 16

Table A2

Results of the Initial Screening Tests Conducted by

WES on Frontier Hard Chrome Fill

Binder/Soil Ratio	Water/Soil Ratio	*Cone Index Value, psi (Cure Time, hr)			
Cement/soil		1	4	8	24
0.1	0.1	0	60	247	750+
0.4	0.1	37	177	750+	750+
0.7	0.1	137	703	750+	750+
1.4	0.1	750+	750+	750+	750+
0.1	0.3	0	0	293	100
0.4	0.3	0	0	30	750+
0.7	0.3	0	20	643	750+
1.4	0.3	17	490	750+	750+
Lime/fly ash/soil					
0.1/0.1	0.1	35	25	40	63
0.1/0.4	0.1	10	27	23	33
0.1/0.7	0.1	87	158	150	217
0.4/0.1	0.1	387	357	583	703
0.4/0.4	0.1	183	340	193	83
0.4/0.7	0.1	192	607	700	307
0.7/0.1	0.1	527	517	505	500
0.1/0.1	0.3	0	0	0	0
0.1/0.4	0.3	0	0	0	3
0.1/0.7	0.3	0	0	0	7
0.4/0.1	0.3	20	20	30	30
0.4/0.4	0.3	73	133	103	207
0.4/0.7	0.3	147	247	223	280
0.7/0.1	0.3	207	250	190	297
0.7/0.4	0.3	180	180	133	217
0.7/0.7	0.3	153	173	160	203

* Represents an average of three replicates.

Table A3

Matrix of Specimens Prepared for Initial Clay/Binder Screening for the Frontier Hard Chrome Clay

Binder/Clay Ratio	Water/Clay Ratio	Number of Specimens
Cement/clay		
0.1	0.1	1
0.4	0.1	1
0.7	0.1	1
1.4	0.1	1
0.1	0.2	1
0.4	0.2	1
0.7	0.3	1
1.4	0.3	1
		Total: 8
Lime/fly ash/clay		
0.1/0.1	0.1	1
0.1/0.4	0.1	1
0.1/0.7	0.1	1
0.4/0.1	0.1	1
0.4/0.4	0.1	1
0.4/0.7	0.1	1
0.1/0.1	0.3	1
0.1/0.4	0.3	1
0.1/0.7	0.3	1
0.4/0.1	0.3	1
0.4/0.4	0.3	1
0.4/0.7	0.3	1
0.7/0.1	0.3	1
0.7/0.4	0.3	1
0.7/0.7	0.3	1
		Total: 15

Table A4

Results of the Initial Screening Tests Conducted by WES on Frontier Hard Chrome Clay

Binder/Clay Ratio	Water/Clay Ratio	*Cone Index Value, psi (Cure Time, hr)			
Cement/clay		1	4	8	24
0.1	0.1	25	147	347	487
0.4	0.1	160	348	750+	750+
0.7	0.1	245	190	750+	750+
1.4	0.1	750+	750+	750+	750+
0.1	0.2	0	55	127	217
0.4	0.2	18	262	387	750+
0.7	0.3	43	150	447	750+
1.4	0.3	127	408	750+	750+
Lime/fly ash/clay					
0.1/0.1	0.1	60	67	183	63
0.1/0.4	0.1	130	173	190	193
0.1/0.7	0.1	35	63	53	65
0.4/0.1	0.1	117	160	143	203
0.4/0.4	0.1	75	103	133	180
0.4/0.7	0.1	102	133	167	195
0.1/0.1	0.3	0	0	0	13
0.1/0.4	0.3	0	7	3	10
0.1/0.7	0.3	3	7	20	37
0.4/0.1	0.3	43	50	30	100
0.4/0.4	0.3	180	193	190	263
0.4/0.7	0.3	140	153	187	197
0.7/0.1	0.3	167	163	193	217
0.7/0.4	0.3	217	163	357	267
0.7/0.7	0.3	157	150	223	150

* Represents an average of three replicates.

APPENDIX B: RESULTS OF PHYSICAL TESTS CONDUCTED ON UNTREATED FILL

Table B1

Results of Moisture Content Conducted on Fill

Sample ID		Moisture* (%)
	Replicate A	
UC-SA-B1		29.75
UC-SA-B2		24.22
UC-SA-B3		25.05
UC-SA-B4		29.36
UC-SA-B5		28.71
UC-SA-B6		28.87
UC-SA-B7		28.34
UC-SA-B8		27.23
UC-SA-B9		29.96**
UC-SA-B10		27.25
UC-SA-B11		28.18
	Average	27.9
	Replicate B	
UC-SB-B1		23.07
UC-SB-B2		23.88
UC-SB-B3		22.77
UC-SB-B4		24.21
UC-SB-B5		20.92
UC-SB-B6		20.04
UC-SB-B7		17.11**
UC-SB-B8		24.31
UC-SB-B9		17.33
UC-SB-B10		22.90
UC-SB-B11		22.47
	Average	21.7
	Replicate C	
UC-SB-B1		23.75
UC-SB-B2		26.94
UC-SB-B3		24.95
UC-SC-B4		24.93
UC-SC-B5		24.07
UC-SC-B6		24.37
UC-SC-B7		23.68
UC-SC-B8		22.71**
UC-SC-B9		25.64
UC-SC-B10		24.51
UC-SC-B11		28.28
	Average	24.8

* Moisture based on wet weight/dry solids.

** These buckets were used by WES for initial screening tests and Cr(VI) reduction studies.

Table B2

Results of Moisture Contents Conducted on Sieved Fill*

Sample ID	Moisture** (%)
UC-SA-B1	40.36
UC-SA-B2	42.16
UC-SA-B3	42.31
UC-SA-B4	41.31
UC-SA-B5	33.89
UC-SA-B6	43.50
UC-SA-B7	41.76
UC-SA-B8	39.59
UC-SA-B9	40.29
UC-SA-B10	40.64
UC-SA-B11	38.98
UC-SB-B1	32.84
UC-SB-B2	35.80
UC-SB-B3	37.76
UC-SB-B4	37.50
UC-SB-B5	35.94
UC-SB-B6	38.26
UC-SB-B7	30.84
UC-SB-B8	33.04
UC-SB-B9	35.94
UC-SB-B10	35.85
UC-SB-B11	37.61
UC-SC-B1	37.50
UC-SC-B2	34.53
UC-SC-B3	39.11
UC-SC-B4	37.37
UC-SC-B5	35.94
UC-SC-B6	39.08
UC-SC-B7	38.12
UC-SC-B8	38.71
UC-SC-B9	38.31
UC-SC-B10	38.62
UC-SC-B11	39.12

* Sieved through a No. 10 (2.0-mm) sieve.
** Moisture based on wet weight/dry solids.

Table B3

Particle Size Analysis for Frontier Hard Chrome Fill

Weight g	Sieve Size (in.) or Number	Opening mm	Percent Finer	Cumulative Percent
		Fill Replicate 1		
0.00	1.5	37.50	100.00	0.00
93.90	1	25.00	98.50	1.50
708.70	3/4	19.10	86.90	13.10
927.70	1/2	12.50	71.80	28.20
654.30	3/8	9.50	61.20	38.80
405.80	No. 3	6.35	54.60	45.40
216.90	No. 4	4.75	51.10	48.90
6.00	No. 6	3.35	46.40	53.60
15.60	No. 10	2.00	39.00	61.00
20.80	No. 16	1.18	35.00	65.00
23.80	No. 20	0.85	32.70	67.30
26.70	No. 30	0.60	30.40	69.60
29.90	No. 40	0.43	28.00	72.00
33.60	No. 50	0.30	25.10	74.90
36.30	No. 70	0.21	22.80	77.20
39.00	No. 100	0.15	20.90	79.10
40.60	No. 140	0.11	19.70	80.30
41.80	No. 200	0.08	18.80	81.20

% Gravel	- 43.9	Liquid limit	- 37
% Sand	- 32.3	Plasticity limit	- 32
% Fines	- 18.8	Plasticity index	- 5
		Specific gravity	- 2.70

(Continued)

Table B3 (Continued)

Weight g	Sieve Size (in.) or Number	Opening mm	Percent Finer	Cumulative Percent
		Fill Replicate 2		
0.00	1.5	37.50	100.00	0.00
101.30	1	25.00	98.20	1.80
317.30	3/4	19.10	92.70	7.30
733.90	1/2	12.50	79.90	20.10
536.00	3/8	9.50	70.50	29.50
518.30	No. 3	6.35	61.50	38.50
315.30	No. 4	4.75	56.00	44.00
5.80	No. 6	3.35	52.20	47.80
18.70	No. 10	2.00	43.80	56.20
27.00	No. 16	1.18	38.30	61.70
31.90	No. 20	0.85	35.10	64.90
36.40	No. 30	0.60	32.20	67.80
41.50	No. 40	0.43	28.90	71.10
48.20	No. 50	0.30	24.50	75.50
53.20	No. 70	0.21	21.20	78.80
57.10	No. 100	0.15	18.60	81.40
59.90	No. 140	0.11	16.80	83.20
62.00	No. 200	0.08	15.40	84.60

% Gravel	= 44.0	Liquid limit	= 44
% Sand	= 40.6	Plasticity limit	= 40
% Fines	= 15.4	Plasticity index	= 4
		Specific gravity	= 2.69

(Continued)

Table B3 (Concluded)

Weight g	Sieve Size (in.) or Number	Opening mm	Percent Finer	Cumulative Percent
		Fill Replicate 3		
0.00	2	50.00	100.00	0.00
50.90	1.5	37.50	99.20	0.80
122.90	1	25.00	97.30	2.70
328.20	3/4	19.10	92.20	7.80
860.60	1/2	12.50	78.90	21.10
648.40	3/8	9.50	68.90	31.10
588.00	No. 3	6.35	59.80	40.20
447.70	No. 4	4.75	52.90	47.10
7.70	No. 6	3.35	48.30	51.70
19.00	No. 10	2.00	41.60	58.40
27.80	No. 16	1.18	36.30	63.70
32.90	No. 20	0.85	33.30	66.70
37.50	No. 30	0.60	30.63	69.40
42.60	No. 40	0.43	27.50	72.50
49.00	No. 50	0.30	23.70	76.30
54.10	No. 70	0.21	20.70	79.30
57.90	No. 100	0.15	18.40	81.60
60.80	No. 140	0.11	16.70	83.30
63.00	No. 200	0.08	15.40	84.60

% Gravel - 47.1
% Sand - 37.5
% Fines - 15.4

Liquid limit - 43
Plasticity limit - 43
Plasticity index - 10
Specific gravity - 2.69

(Sheet 3 of 3)

APPENDIX C: RESULTS OF PHYSICAL AND CHEMICAL TESTS ON TREATED FILL

Table C1

Results of the Wet/Dry Test Conducted on

Frontier Hard Chrome Fill

Vendor	Sample	Replicate	Total % Lost
1	Test	1	NA
		2	100.00
		3	100.00
	Control	1	NA
		2	100.00
		3	100.00
2	Test	1	0.32
		2	0.31
		3	0.32
	Control	1	0.40
		2	0.47
		3	0.40
3	Test	1	0.21
		2	20.26
		3	0.21
	Control	1	0.30
		2	0.38
		3	0.21
4	Test	1	0.36
		2	0.30
		3	0.51
	Control	1	0.42
		2	0.42
		3	0.58
5	Test	1	0.43
		2	0.31
		3	0.34
	Control	1	0.33
		2	0.49
		3	0.58
6	Test	1	0.46
		2	0.66
		3	0.34
	Control	1	0.51
		2	0.73
		3	0.35

(Continued)

Table C1 (Concluded)

Vendor	Sample	Replicate	Total % Lost
7	Test	1	0.42
		2	1.29
		3	0.78
	Control	1	1.01
		2	1.19
		3	1.01
8	Test	1	0.18
		2	0.09
		3	0.23
	Control	1	0.13
		2	0.04
		3	0.22

Table C2

Results of Moisture Content, Specific Gravity, and Slump Tests Conducted on Frontier Hard Chrome Fill

Vendor	Replicate		Moisture %	Specific Gravity	Slump in.
1	A	1	44.29	2.71	7
		2	48.59		
		3	45.87		
	B	1	36.74	2.72	0
		2	35.31		
		3	37.15		
	C	1	36.98	2.76	1.25
		2	39.13		
		3	39.41		
2	A	1	13.55	2.8	0
		2	12.61		
		3	10.92		
	B	1	13.61	2.82	0
		2	13.70		
		3	12.80		
	C	1	15.23	2.82	0
		2	15.72		
		3	15.95		
		3	39.41		
3	A	1	18.07	2.64	0
		2	18.68		
		3	19.20		
	B	1	17.55	2.65	0
		2	17.07		
		3	15.75		
	C	1	11.48	2.66	0
		2	14.81		
		3	13.95		
4	A	1	36.68	2.78	0
		2	36.59		
		3	36.09		
	B	1	34.64	2.89	0
		2	35.80		
		3	35.74		
	C	1	34.42	2.92	0
		2	35.25		
		3	35.16		

(Continued)

Table C2 (Concluded)

Vendor	Replicate		Moisture %	Specific Gravity	Slump in.
5	A	1	25.61	2.78	8
		2	25.22		
		3	25.48		
	B	1	26.80	2.78	6.5
		2	25.88		
		3	26.97		
	C	1	31.86	2.79	7.25
		2	30.04		
		3	32.75		
6	A	1	47.66	2.78	NA
		2	47.26		
		3	47.12		
	B	1	52.97	2.81	NA
		2	52.83		
		3	53.45		
	C	1	47.25	2.82	NA
		2	47.97		
		3	47.65		
7	A	1	25.04	2.72	0
		2	25.18		
		3	24.98		
	B	1	26.52	2.71	0
		2	26.46		
		3	26.38		
	C	1	25.25	2.72	0
		2	25.52		
		3	25.37		
8	A	1	21.39	2.77	1.[illegible]
		2	21.73		
		3	22.55		
	B	1	17.03		0.25
		2	17.57		
		3	17.31		
	C	1	18.47	2.79	0
		2	23.48		
		3	18.50		

Table C3

Results of Set Time Tests Conducted on

Frontier Hard Chrome Fill

Sample ID	Average Cone Index, psi (Time, hr)				
	2	4	8	24	48
V1-SA	0	0	0	0	0
V1-SB	27	48	85	117	47
V1-SC	25	35	32	38	57
V2-SA	397	497	490	750+	750+
V2-SB	427	620	750+	750+	750+
V2-SC	412	487	530	750+	750+
V3-SA	133	333	750+	750+	750+
V3-SB	167	360	750+	750+	750+
V3-SC	185	460	750+	750+	750+
V4-SA	20	25	38	107	173
V4-SB	12	25	28	98	183
V4-SC	17	12	22	52	117
V5-SA	58	170	290	750+	750+
V5-SB	95	167	750+	750+	750+
V5-SC	113	137	750+	750+	750+
V6-SA	0	0	10	47	292
V6-SB	0	0	7	73	323
V6-SC	0	0	3	58	283
V7-SA	273	283	350	550	593
V7-SB	332	363	300	527	517
V7-SC	227	247	197	507	620
V8-SA	108	260	400	750+	750+
V8-SB	137	357	543	750+	750+
V8-SC	157	340	487	750+	750+

Table C4

Results of UCS, Bulk Density, and Permeability, Conducted on Treated Frontier Hard Chrome Fill

Vendor/Replicate		Average UCS, psi		Bulk Density pcf	Volume Increase %	Permeability cm/sec
Vendor 1						
A	1	NA		140		NA
	2	NA		142		NA
	3	NA	NA	145	15	NA
B	1	NA		148		6.82E-07
	2	NA		149		6.62E-07
	3	NA	NA	146	13	6.13E-07
C	1	NA		143		9.60E-07
	2	NA		145		8.38E-07
	3	NA	NA	146	21	1.25E-06
Vendor 2						
A	1	467		124		2.90E-05
	2	102		128		3.01E-05
	3	124	231	123	44	3.21E-05
B	1	131		118		1.64E-04
	2	100		119		1.62E-04
	3	122	118	127	56	1.56E-04
C	1	NA		NA		3.75E-05
	2	105		129		3.38E-05
	3	NA	105*	NA	52	3.71E-05
Vendor 3						
A	1	486		117		2.87E-06
	2	496		117		2.71E-06
	3	382	455	114	74	3.10E-06
B	1	552		122		1.51E-06
	2	462		120		1.35E-06
	3	429	481	121	69	1.38E-06
C	1	621		123		1.68E-06
	2	446		125		1.55E-06
	3	627	565	126	62	1.63E-06
Vendor 4						
A	1	353		106		1.05E-05
	2	389		111		1.04E-05
	3	311	351	101	89	9.76E-06
B	1	371		100		8.13E-06
	2	411		99		6.90E-06
	3	367	383	100	99	6.43E-06
C	1	141		100		9.47E-07
	2	171		97		8.40E-07
	3	146	153	98	99	1.03E-06

(Continued)

Table C4 (Concluded)

Vendor/Replicate		Average UCS, psi		Bulk Density pcf	Volume Increase %	Permeability cm/sec
Vendor 5						
A	1	562		109		2.18E-07
	2	643		106		2.36E-07
	3	655	620	111	99	2.45E-07
B	1	251		109		3.40E-06
	2	545		111		3.58E-06
	3	176	324	112	98	3.42E-06
C	1	671		109		5.09E-06
	2	664		110		4.54E-06
	3	698	678	111	95	5.14E-06
Vendor 6						
A	1	157		112		1.79E-05
	2	155		106		1.86E-05
	3	151	154	108	68	1.72E-05
B	1	213		116		7.41E-06
	2	208		109		7.42E-06
	3	192	204	110	64	7.53E-06
C	1	94		114		6.19E-06
	2	92		114		6.65E-06
	3	104	97	110	61	6.24E-06
Vendor 7						
A	1	223		126		1.26E-05
	2	188		118		1.16E-05
	3	175	195	125	70	1.09E-05
B	1	88		125		1.15E-06
	2	89		123		8.44E-07
	3	198	125	120	70	1.00E-06
C	1	179		126		1.45E-06
	2	153		117		1.29E-06
	3	182	171	126	68	1.29E-06
Vendor 8						
A	1	1,233		120		1.53E-07
	2	1,269		111		9.74E-08
	3	1,068	1,190	119	93	9.44E-08
B	1	1,189		119		3.67E-06
	2	1,050		112		2.80E-06
	3	1,285	1,175	117	95	2.52E-06
C	1	1,233		124		
	2	774		111		
	3	1,090	1,032	116	90	

Table C5

Results of Wet/Dry Tests Conducted

on Frontier Hard Chrome Fill

Relative Mass Loss Calculations	% Loss - Cycle No.												Total %
Replicate	1	2	3	4	5	6	7	8	9	10	11	12	Lost
Vendor 1													
Test													
1	NA												NA
2	100												100
3	100												100
Control													
1	NA												NA
2	100												100
3	100												100
Vendor 2													
Test													
	0.08	0.04	0.04	0.04	0.04	0	0	0.04	0	0.04	0	0	0.32
	0	0	0.08	0.04	0	0	0	0.08	0.08	0	0	0.04	0.31
	0.04	0.04	0.04	0.04	0	0	0.08	0.04	0.04	0	0	0	0.32
Control													
	0.04	0.04	0.08	0.04	0	0	0.04	0.12	0.04	0	0	0	0.40
	0.08	0.08	0.04	0.04	0.08	0	0	0.08	0.04	0	0.04	0	0.47
	0.08	0.04	0.04	0.04	0.04	0	0	0.04	0.08	0.04	0	0	0.40
Vendor 3													
Test													
	0.04	0	0	0.09	0.04	0.04	0	0	0	0	0	0	0.21
	0	0.04	0	0	0.04	0.08	0	0	0	0.04	0	0.05	0.26
	0.04	0	0	0	0	0.08	0	0.04	0	0	0.04	0	0.21
Control													
	0.04	0.09	0.04	0.04	0	0.04	0	0.04	0	0	0	0	0.30
	0.08	0.08	0	0.04	0.04	0	0	0.08	0	0	0	0.04	0.38
	0.04	0.04	0	0.04	0.04	0	0	0.04	0	0	0	0	0.21

(Continued)

Table C5 (Continued)

Relative Mass Loss Calculations Replicate	% Loss - Cycle No.												Total % Lost
	1	2	3	4	5	6	7	8	9	10	11	12	
Vendor 4 Test													
	0.06	0	0.06	0.06	0	0	0.12	0.06	0	0	0	0	0.36
	0.06	0	0.12	0.06	0	0	0.06	0	0	0	0	0	0.30
	0.06	0	0.19	0.06	0	0.06	0.06	0	0.06	0	0	0	0.31
Control													
	0.06	0.06	0.06	0.06	0	0	0.18	0	0	0	0	0	0.42
	0.06	0.06	0.12	0	0	0	0	0.06	0	0	0	0	0.42
	0.06	0	0.13	0.19	0.06	0	0.06	0	0	0.06	0	0	0.58
Vendor 5 Test													
	0.11	0.16	0.05	0	0	0.11	0	0	0	0	0	0	0.43
	0.05	0.05	0	0	0.05	0.10	0	0	0	0.05	0	0	0.31
	0.10	0.10	0	0	0	0.05	0.05	0	0	0.05	0	0	0.34
Control													
	0.11	0.11	0	0	0	0.11	0	0	0	0	0	0	0.33
	0.11	0.11	0.05	0	0	0.11	0	0	0	0	0.05	0.05	0.49
	0.11	0.11	0.11	0	0	0.21	0	0	0.05	0	0	0	0.58
Vendor 6 Test													
	0.06	0.17	0.11	0	0	0	0	0.06	0.06	0	0	0	0.46
	0.06	0.24	0.12	0	0	0	0	0	0.18	0.06	0	0	0.66
	0	0.11	0.11	0	0	0	0.06	0	0	0.06	0	0	0.34
Control													
	0.06	0	0.17	0.11	0	0	0	0	0	0.06	0.11	0	0.51
	0.06	0.28	0.11	0	0.11	0	0	0.06	0	0.06	0.06	0	0.73
	0	0.18	0.18	0	0	0	0	0	0	0	0	0	0.35

(Continued)

Table C5 (Concluded)

Relative Mass Loss Calculations	% Loss - Cycle No.												Total %
Replicate	1	2	3	4	5	6	7	8	9	10	11	12	Lost
Vendor 7													
Test													
	0.32	0.05	0	0	0.05	0	0	0	0	0	0	0	0.42
	0.55	0.32	0	0.14	0	0.09	0	0.05	0	0	0.14	0	1.29
	0.23	0.28	0	0	0.09	0.09	0	0.05	0	0	0.05	0	0.78
Control													
	0.28	0.23	0.09	0.05	0	0.14	0	0.05	0	0	0.09	0.09	1.01
	0.23	0.37	0	0.09	0	0.09	0	0.14	0	0.05	0.23	0	1.19
	0.32	0.23	0.23	0.05	0	0.14	0	0	0	0	0.05	0	1.01
Vendor 8													
Test													
	0	0	0.04	0	0.09	0	0	0.04	0	0	0.04	0	0.22
	0	0	0	0	0.09	0	0	0	0	0	0	0	0.09
	0	0.05	0	0	0.09	0	0	0.09	0	0	0.05	0	0.27
Control													
	0.04	0	0	0	0.09	0	0	0	0	0	0.04	0	0.18
	0	0	0	0	0.04	0	0	0	0	0	0.04	0	0.09
	0	0	0	0.04	0.13	0	0	0.04	0	0	0	0	0.22

Table C6

Normalization of Total Chromium Contained

in Frontier Hard Chrome Fill

Replicate	Moisture %	pH	Total Cr Conc. (mg/L)	Mean Total Cr	Normalized Total Chromium	Mean Total Cr	Total Cr Standard Deviation	RSD %	Total Cr Standard Deviation	Total Cr RSD %
Untreated										
1	0.282	8.9	1800	1567			252	16		
2	0.235	8.8	1600							
3	0.282	8.8	1300							
Vendor 1										
1	0.333	9.1	1100	1090	1236	1277	115	11	80	6
2	0.25	9.2	1200		1370					
3	0.37	9.5	970		1226					
Vendor 2										
1	0.176	10	1000	1000	1246	1268	0	0	24	2
2	0.149	8.4	1000		1265					
3	0.136	8.6	1000		1294					
Vendor 3										
1	0.163	12	740	790	1064	1147	46	6	72	6
2	0.22	12	800		1176					
3	0.176	12	830		1200					
Vendor 4										
1	0.37	11	1100	963	1674	1436	237	25	362	25
2	0.333	11	690		1019					
3	0.316	11	1100		1615					
Vendor 5										
1	0.235	12	800	787	1297	190	24	300	23	
2	0.266	12	970		1598					
3	0.316	12	590		997					
Vendor 6										
1	0.408	12	1200	1077	1608	1438	137	13	196	14
2	0.429	12	1100		1482					
3	0.333	12	930		1224					

(Continued)

Table C6 (Concluded)

Replicate	Moisture %	pH	Total Cr Conc. (mg/L)	Mean Total Cr	Normalized Total Chromium	Mean Total Cr	Total Cr Standard Deviation	RSD %	Total Cr Standard Deviation	Total Cr RSD %
Vendor 7										
1	0.19	10	990	1147	1500	1710	591	52	858	50
2	0.205	10	650		977					
3	0.136	10	1800		2654					
Vendor 8										
1	0.25	11	660	643	1131	1082	96	15	168	16
2	0.19	11	540		895					
3	0.205	10	750		1220					

Table C7

Results of Total Chromium in the MWEP-1 Conducted on

Frontier Hard Chrome Fill

Replicate	Moisture %	pH	MWEP-1 Conc. (mg/L)	Mean MWEP	MWEP-1 Standard Deviation	RSD %	NMLC (mg/kg)	Mean NMLC	NML Standard Deviation	NML RSD %	% Efficiency	% Efficiency Mean NMLC
Untreated												
1	0.282	9.1	0.390	0.40	0.0603	15.20	5.000	5.013	0.661	13		
2	0.235	9.1	0.460				5.681					
3	0.282	9	0.340				4.359					
Vendor 1												
1	0.333	10	0.095	0.115	0.0486	42.37	1.380	1.742	0.883	51	72	65
2	0.25	10	0.079				1.096				81	
3	0.37	11	0.17				2.748				37	
Vendor 2												
1	0.176	12	0.13	0.147	0.0153	10.41	1.838	2.072	0.219	11	63	59
2	0.149	12	0.15				2.108				63	
3	0.136	12	0.16				2.272				48	
Vendor 3												
1	0.163	11	0.08	0.078	0.0330	45.52	1.245	1.242	0.513	41	75	75
2	0.22	11	0.044				0.727				87	
3	0.176	11	0.11				1.753				60	
Vendor 4												
1	0.37	11	0.16	0.130	0.0300	23.08	2.924	2.314	0.584	25	42	54
2	0.333	11	0.10				1.760				69	
3	0.316	11	0.13				2.258				48	
Vendor 5												
1	0.235	12	0.13	0.102	0.0491	48.27	2.328	1.858	0.866	47	53	63
2	0.266	12	0.13				2.386				58	
3	0.316	12	0.045				0.859				80	
Vendor 6												
1	0.408	12	0.20	0.112	0.0766	68.62	3.436	1.905	1.330	70	31	62
2	0.429	12	0.072				1.255				78	
3	0.333	12	0.063				1.025				76	

(Continued)

Table C7 (Concluded)

Replicate	Moisture %	pH	MWEP-1 Conc. (mg/L)	Mean MWEP	MWEP-1 Standard Deviation	RSD %	NMLC (mg/kg)	Mean NMLC	NML Standard Deviation	NML RSD %	% Efficiency	% Efficiency Mean NMLC
Vendor 7												
1	0.19	11	0.041	0.105	0.1085	103.71	0.683	1.734	1.822	105	86	65
2	0.205	11	0.23				3.839				32	
3	0.136	11	0.043				0.681				84	
Vendor 8												
1	0.25	11	0.052	0.071	0.0338	47.58	0.975	1.291	0.605	47	80	74
2	0.19	11	0.051				0.910				84	
3	0.205	11	0.11				1.988				54	

Table C8

Results of Total Chromium in the TCLP Conducted on Frontier Hard Chrome Fill

TCLP Replicate	Moisture %	pH	TCLP Conc (mg/L)	Mean TCLP	TCLP Standard Deviation	TCLP RSD %	NMLC (mg/kg)	Mean NMLC	NMLC Standard Deviation	NMLC Precision %	% Efficiency	% Efficiency Mean NMLC
Untreated												
1	0.282	5.5	0.160	0.13	0.05	34.12	4.102	3.377	1.129	33.42		
2	0.235	5.5	0.160				3.952					
3	0.282	5.6	0.081				2.077					
Vendor 1												
1	0.333	4.4	2.000	2.167	0.15	7.05	58.119	64.358	6.5232	10.13	-1317	-1806
2	0.25	4.6	2.300				63.825				-1515	
3	0.37	4.8	2.2				71.130				-3325	
Vendor 2												
1	0.176	7.1	0.049	0.047	0.02	42.01	1.385	1.317	0.547	41.57	66	61
2	0.149	6.8	0.065				12.827				54	
3	0.136	6.7	0.026				0.738				64	
Vendor 3												
1	0.163	10	0.08	0.058	0.02	41.27	2.490	1.841	0.725	39.40	39	45
2	0.22	9.4	0.032				1.058				73	
3	0.176	9.7	0.062				1.976				5	
Vendor 4												
1	0.37	7	0.25	0.119	0.12	100.58	9.138	4.299	4.414	102.69	-123	-27
2	0.333	6.4	0.014				0.493				88	
3	0.316	5.8	0.094				3.266				-57	
Vendor 5												
1	0.235	9.6	0.62	0.527	0.17	32.35	22.205	19.310	5.834	30.21	-441	-472
2	0.266	8	0.63				23.130				-485	
3	0.316	9.2	0.316				12.594				-506	

(Continued)

Table C8 (Continued)

TCLP Replicate	Moisture %	pH	TCLP Conc (mg/L)	Mean TCLP	TCLP Standard Deviation	TCLP RSD %	NMLC (mg/kg)	Mean NMLC	NMLC Standard Deviation	NMLC Precision %	% Efficiency	% Efficiency Mean NMLC
Vendor 6												
1	0.408	2.2	0.11	0.057	0.05	81.58	3.779	1.932	1.500	82.81	8	43
2	0.429	1.2	0.028				0.976				75	
3	0.333	1.2	0.032				1.041				50	
Vendor 7												
1	0.19	4.6	4.700	4.167	0.50	12.08	156.604	136.684	17.550	12.84	-3717	-3947
2	0.2-5	4.5	3.70				123.500				-3025	
3	0.136	4.7	4.100				129.947				-6157	
Vendor 8												
1	0.25	4.8	1.800	1.833	0.06	3.15	67.500	66.815	2.291	3.43	-1545	-1878
2	0.19	4.8	1.800				64.260				-1526	
3	0.205	4.9	1.90				68.685				-3207	

Table C9

Normalization of Cr(VI) Contained

in Frontier Hard Chrome Fill

Replicate	Moisture %	pH	Cr(VI) Conc. (mg/L)	Mean Total Cr	Total Cr Standard Deviation	RSD %	Normalized Total Chromium	Mean (NML)	NML Standard Deviation	NML RSD %
Untreated										
1	0.282	3.9	30	32	4.36	13.62				
2	0.235	8.8	37							
3	0.282	8.8	29							
Vendor 1										
1	0.333	9.1	0.082	0.075	0.01	12.04	0.092	0.088	0.01	6
2	0.25	9.2	0.079				0.090			
3	0.37	9.5	0.065				0.082			
Vendor 2										
1	0.176	10	2.3	2.0	0.31	15.53	2.9	2.5	0.36	14
2	0.149	8.4	1.7				2.?			
3	0.136	8.6	1.9				2.5			
Vendor 3										
1	0.163	12	3.3	3.5	0.26	7.56	4.7	5.1	0.38	7
2	0.22	12	3.4				5.0			
3	0.176	12	3.8				5.5			
Vendor 4										
1	0.37	11	4.4	4.5	0.68	14.93	6.7	6.3	0.86	14
2	0.333	11	3.6				5.3			
3	0.316	11	4.7				6.9			
Vendor 5										
1	0.235	12	5.4	3.6	2.59	71.95	7.8	6.6	3.33	51
2	0.266	12	6.3				9.1			
3	0.316	12	1.9				2.8			
Vendor 6										
1	0.408	12	4.7	3.6	1.05	29.27	6.3	4.8	1.41	29
2	0.429	12	2.6				3.5			
3	0.333	12	3.5				4.6			

(Continued)

Table C9 (Concluded)

Replicate	Moisture %	pH	Cr(VI) Conc. (mg/L)	Mean Total Cr	Total Cr Standard Deviation	RSD %	Normalized Total Chromium	Mean (NML)	NML Standard Deviation	NML RSD %
Vendor 7										
1	0.19	10	1.6	3.2	2.04	63.81	2.4	4.8	3.08	64
2	0.205	10	5.5				8.3			
3	0.136	10	2.5				3.7			
Vendor 8										
1	0.25	11	<0.085	0.086	0.10	122.47	0.146	0.144	0.01	4
2	0.19	11	<0.083				0.138			
3	0.205	10	<0.089				0.149			

Table C10

Results of Chromium (VI) in the MWEP-1 Conducted on

Frontier Hard Chrome Fill

Replicate	Moisture %	pH	MWEP-1 Conc. (mg/L)	Mean MWEP	MWEP-1 Standard Deviation	RSD %	NMLC (mg/kg)	Mean NMLC	NML Standard Deviation	NML RSD %	% Efficiency	% Efficiency Mean NMLC
Untreated												
1	0.282	9.1	0.380	0.35	0.025	7.12	4.872	4.478	0.398	9		
2	0.282	9.1	0.330				4.076					
3	0.282	9	0.350				4.487					
Vendor 1												
1	0.333	10	<0.030	<0.029	0.003	9.12	0.436	0.443	0.072	16	91	90
2	0.25	10	<0.027				0.375				91	
3	0.37	11	<0.032				0.517				88	
Vendor 2												
1	0.173	12	0.12	0.147	0.023	15.75	1.696	2.072	0.326	16	65	54
2	0.149	12	0.16				2.248				45	
3	0.136	12	0.16				2.272				49	
Vendor 3												
1	0.163	11	0.05	0.073	0.041	55.80	0.756	1.171	0.644	55	84	74
2	.022	11	0.051				0.843				79	
3	0.176	11	0.12				1.912				57	
Vendor 4												
1	0.37	11	0.13	0.120	0.017	14.43	2.376	2.131	0.327	15	51	52
2	0.333	11	0.10				1.760				57	
3	0.316	11	0.13				2.258				50	
Vendor 5												
1	0.235	12	0.12	0.101	0.051	49.98	2.149	1.853	0.902	49	56	59
2	0.266	12	0.14				2.570				37	
3	0.316	12	0.044				0.840				81	
Vendor 6												
1	0.408	12	0.22	0.117	0.090	76.82	3.779	1.992	1.553	78	22	56
2	0.429	12	0.070				1.220				70	
3	0.333	12	0.060				0.976				78	

(Continued)

Table C10 (Concluded)

Replicate	Moisture %	pH	MWEP-1 Conc. (mg/L)	Mean MWEP	MWEP-1 Standard Deviation	RSD %	NMLC (mg/kg)	Mean NMLC	NML Standard Deviation	NML RSD %	% Efficiency	% Efficiency Mean NMLC
Vendor 7												
1	0.19	11	0.074	0.114	0.102	88.94	1.233	1.896	1.710	90	75	58
2	0.205	11	0.23				3.839				6	
3	0.136	11	0.039				0.618				86	
Vendor 8												
1	0.25	11	<0.027	<0.033	0.012	36.87	0.506	0.601	0.218	36	90	87
2	0.19	11	<0.025				0.446				89	
3	0.205	11	0.047				0.850				81	

Table C11

Results of Cr(VI) in the TCLP Conducted on Frontier Hard Chrome Fill

TCLP Replicate	Moisture %	pH	Cr(VI) TCLP Conc. (mg/L)	Mean TCLP	TCLP Standard Deviation	TCLP RSD %	NMLC (mg/kg)	Mean NMLC	NML Standard Deviation	NML Precision %	% Efficiency	% Efficiency Mean NMLC
Untreated												
1	0.282	5.5	<0.020	<0.020	0.00	0.00	0.513	0.507	0.011	2		
2	0.235	5.5	<0.020				0.494					
3	0.282	5.6	<0.020				0.513					
Vendor 1												
1	0.333	4.4	<0.020	<0.020	0.00	0.00	0.581	0.594	0.047	8	-13	-17
2	0.25	4.6	<0.020				0.555				-12	
3	0.37	4.8	<0.020				0.647				-26	
Vendor 2												
1	0.176	7.1	0.028	0.029	0.01	31.46	0.792	0.809	0.250	31	-54	-60
2	0.149	6.8	0.038				1.068				-116	
3	0.136	6.7	<0.020				0.568				-11	
Vendor 3												
1	0.163	10	0.07	0.059	0.01	15.37	2.143	1.885	0.276	15	-318	-272
2	0.22	9.4	0.058				1.918				-288	
3	0.176	9.7	0.05				1.593				-211	
Vendor 4												
1	0.37	7	<0.020	0.027	0.01	46.47	0.731	0.965	0.428	44	-43	-90
2	0.333	6.4	<0.020				0.704				-42	
3	0.316	5.8	0.042				1.459				-185	
Vendor 5												
1	0.235	9.6	0.61	0.533	0.19	35.09	21.847	19.553	6.504	33	-4160	-3760
2	0.266	8	0.67				24.598				-4879	
3	0.316	9.2	0.320				12.212				-2282	

(Continued)

Table C11 (Concluded)

TCLP Replicate	Moisture %	pH	Cr(VI) TCLP Conc. (mg/L)	Mean TCLP	TCLP Standard Deviation	TCLP RSD %	NMLC (mg/kg)	Mean NMLC	NML Standard Deviation	NML Precision %	% Efficiency	% Efficiency Mean NMLC
Vendor 6												
1	0.408	2.2	0 03	0.024	0.01	30.84	1.134	0.827	0.266	32	-121	-63
2	0.429	1.2	<0.020				0.697				-41	
3	0.333	1.2	<0.020				0.651				-27	
Vendor 7												
1	0.19	4.6	<0.020	<0.020	0.00	0.00	0.666	0.656	0.019	3	-30	-29
2	0.205	4.5	<0.020				0.668				-35	
3	0.136	4.7	<0.020				0.634				-24	
Vendor 8												
1	0.25	4.8	<0.020	<0.020	0.00	0.00	0.750	0.729	0.019	3	-46	-44
2	0.19	4.8	<0.020				0.714				-45	
3	0.205	4.9	<0.020				0.723				-41	

APPENDIX D: RESULTS OF PHYSICAL TESTS CONDUCTED ON UNTREATED CLAY

Table D1

Results of Moisture Content Conducted on Clay

Sample ID	Moisture* (%)
UC-CA-B1	37.24**
UC-CA-B2	47.94
UC-CA-B3	45.10
UC-CA-B4	47.59
UC-CA-B5	49.73
UC-CA-B6	49.08
UC-CA-B7	45.31
UC-CA-B8	50.17
UC-CA-B9	44.45
UC-CA-B10	43.22
UC-CA-B11	47.62
UC-CB-B1	50.17
UC-CB-B2	40.04**
UC-CB-B3	45.76
UC-CB-B4	48.99
UC-CB-B5	49.26
UC-CB-B6	39.73
UC-CB-B7	47.87
UC-CB-B8	49.21
UC-CB-B9	45.29
UC-CB-B10	44.77
UC-CB-B11	46.40
UC-CC-B1	49.02
UC-CC-B2	46.57
UC-CC-B3	47.37
UC-CC-B4	45.97
UC-CC-B5	46.94
UC-CC-B6	47.09
UC-CC-B7	46.80
UC-CC-B8	46.47
UC-CC-B9	51.99
UC-CC-B10	41.32**
UC-CC-B11	48.97

* Moisture based on wet weight/dry solids.

** These buckets were used by WES for initial screening tests and Cr^{+6} reduction studies.

Table D2

Particle Size Analysis for Frontier Hard Chrome Clay

Weight g	Sieve Size (in.) or Number	Opening mm	Percent Finer	Cumulative Percent
		Clay Replicate 1		
0.00	3	75.00	100.00	0.00
9.90	2	50.00	99.90	0.10
164.90	1.5	37.50	98.00	2.00
87.10	1	25.00	97.10	2.90
97.10	3/4	19.10	96.00	4.00
190.30	1/2	12.50	93.80	6.20
156.70	3/8	9.50	92.10	7.90
166.20	No. 3	6.35	90.20	9.80
100.00	No. 4	4.75	89.00	11.00
1.30	No. 6	3.35	87.40	12.60
2.70	No. 10	2.00	85.70	14.30
3.80	No. 16	1.18	84.40	15.60
4.50	No. 20	0.85	83.60	16.40
5.10	No. 30	0.60	82.90	17.10
5.90	No. 40	0.43	81.90	18.10
6.90	No. 50	0.30	80.70	19.30
7.60	No. 70	0.21	79.90	20.10
8.30	No. 100	0.15	79.00	21.00
9.00	No. 140	0.11	78.20	21.80
10.10	No. 200	0.08	76.90	23.20

% Gravel - 11.0
% Sand - 12.1
% Fines - 76.9

Liquid limit - 58
Plasticity limit - 34
Plasticity index - 24
Specific gravity - 2.66

(Continued)

Table D2 (Continued)

Weight g	Sieve Size (in.) or Number	Opening mm	Percent Finer	Cumulative Percent
		Clay Replicate 2		
0.00	2	50.00	100.00	0.00
120.10	1.5	37.50	98.20	1.80
23.60	1	25.00	97.90	2.10
176.60	3/4	19.10	95.30	4.70
211.40	1/2	12.50	92.20	7.80
111.60	3/8	9.50	90.60	9.40
161.00	No. 3	6.35	88.20	11.80
82.10	No. 4	4.75	87.00	13.00
1.80	No. 6	3.35	85.20	14.80
4.20	No. 10	2.00	82.80	17.20
5.60	No. 16	1.18	81.40	18.60
6.40	No. 20	0.85	80.60	19.40
7.20	No. 30	0.60	79.80	20.20
8.10	No. 40	0.43	78.90	21.10
9.30	No. 50	0.30	77.70	22.30
10.20	No. 70	0.21	76.80	23.20
11.00	No. 100	0.15	76.00	24.00
11.70	No. 140	0.11	75.40	24.60
12.80	No. 200	0.08	74.30	25.70

% Gravel	= 13.0	Liquid limit	= 57
% Sand	= 12.7	Plasticity limit	= 32
% Fines	= 74.3	Plasticity index	= 25
		Specific gravity	= 2.65

(Continued)

Table D2 (Concluded)

Weight g	Sieve Size (in.) or Number	Opening mm	Percent Finer	Cumulative Percent
		Clay Replicate 3		
0.00	3	75.00	100.00	0.00
138.30	2	50.00	97.90	2.10
0.00	1.5	37.50	97.90	2.10
73.30	1	25.00	96.80	3.20
146.10	3/4	19.10	94.60	5.40
199.60	1/2	12.50	91.50	8.50
140.70	3/8	9.50	89.40	10.60
125.70	No. 6	3.35	87.50	12.50
79.90	No. 4	4.75	86.20	13.80
1.00	No. 6	3.35	85.00	15.00
2.50	No. 10	2.00	83.10	16.90
3.50	No. 16	1.18	81.80	18.20
4.10	No. 20	0.85	81.10	18.90
4.80	No. 30	0.60	80.20	19.80
5.50	No. 40	0.43	79.30	20.70
6.20	No. 50	0.30	78.40	21.60
7.00	No. 70	0.21	77.40	22.60
7.60	No. 100	0.15	76.70	23.20
8.00	No. 140	0.11	76.20	23.80
8.80	No. 200	0.08	75.20	24.80

% Gravel - 13.8
Sand - 11.1
% Fines - 75.2

Liquid limit - 59
Plasticity limit - 32
Plasticity index - 27
Specific gravity - 2.65

(Sheet 3 of 3)

Table D3

Moisture Content* of Frontier Hard Chrome Clay

	Container Number										
Replicate	1	2	3	4	5	6	7	8	9	10	11
A	37.2	47.9	45.1	47.6	49.7	49.1	45.3	50.2	44.4	43.2	47.6
					Average:	42.1					
B	50.2	40.0	45.8	49.0	49.3	39.7	47.9	49.2	45.3	44.8	46.4
					Average:	46.1					
C	49.0	46.6	47.4	46.0	46.9	47.1	46.8	46.5	52.0	41.3	49.0
					Average :	47.1					

Overall clay average: 45.1

* Expressed as ratio of water content to content of dry material.

APPENDIX E: RESULTS OF PHYSICAL AND CHEMICAL TESTS ON TREATED CLAY

Table E1

Results of the Wet/Dry Test Conducted on

Frontier Hard Chrome Clay

Vendor	Sample	Replicate	Total % Lost
1	Test	1	100.00
		2	100.00
		3	100.00
	Control	1	100.00
		2	100.00
		3	100.00
2	Test	1	0.46
		2	0.61
		3	0.68
	Control	1	0.23
		2	0.73
		3	0.72
3	Test	1	0.44
		2	0.45
		3	0.72
	Control	1	1.10
		2	2.32
		3	0.87
4	Test	1	3.33
		2	0.85
		3	1.68
	Control	1	2.76
		2	0.64
		3	1.54
5	Test	1	0.38
		2	0.30
		3	0.30
	Control	1	0.53
		2	0.61
		3	0.45
6	Test	1	2.10
		2	1.01
		3	1.13
	Control	1	1.22
		2	1.52
		3	1.09

(Continued)

Table E1 (Concluded)

Vendor	Sample	Replicate	Total % Lost
7	Test	1	1.12
		2	0.46
		3	0.23
	Control	1	1.18
		2	0.62
		3	0.45
8	Test	1	0.23
		2	0.28
		3	0.28
	Control	1	0.28
		2	0.23
		3	0.33

Table E2

Results of Moisture Content, Specific Gravity, and Slump Tests Conducted on Frontier Hard Chrome Clay

Vendor	Replicate		Moisture %	Specific Gravity	Slump in.
1	A	1	52.21	2.72	6
		2	53.27		
		3	52.36		
	B	1	49.95	2.73	5
		2	50.01		
		3	50.11		
	C	1	54.02	2.76	6.25
		2	53.29		
		3	52.84		
2	A	1	22.50	2.8	0
		2	22.92		
		3	21.56		
	B	1	23.05	2.79	0
		2	25.76		
		3	24.98		
	C	1	22.99	2.8	0
		2	24.54		
		3	24.57		
3	A	1	36.05	2.62	0
		2	35.72		
		3	36.40		
	B	1	32.85	2.6	0
		2	31.68		
		3	35.82		
	C	1	33.34	2.61	0
		2	33.32		
		3	33.56		
4	A	1	49.08	2.9	0
		2	49.33		
		3	48.94		
	B	1	34.28	2.9	0
		2	33.78		
		3	33.76		
	C	1	49.26	2.92	0
		2	48.94		
		3	53.50		

(Continued)

Table E2 (Concluded)

Vendor	Replicate		Moisture %	Specific Gravity	Slump in.
5	A	1	63.72	2.74	0.5
		2	40.48		
		3	40.86		
	B	1	24.77		0.5
		2	43.19		
		3	41.01		
	C	1	45.64	2.74	0
		2	45.41		
		3	45.68		
6	A	1	66.98	2.78	5
		2	66.34		
		3	67.11		
	B	1	61.47	2.78	5
		2	60.73		
		3	60.63		
	C	1	62.55	2.8	6
		2	63.07		
		3	62.30		
7	A	1	34.46	2.7	0
		2	34.60		
		3	34.59		
	B	1	31.32	2.72	0
		2	31.35		
		3	31.79		
	C	1	33.76	2.73	0
		2	30.92		
		3	31.26		
8	A	1	29.24	2.78	0
		2	29.44		
		3	29.42		
	B	1	29.72	2.78	0
		2	29.61		
		3	30.02		
	C	1	26.30	2.79	0
		2	28.17		
		3	27.95		

Table E3

Results of Set Time Tests Conducted on

Frontier Hard Chrome Clay

Sample ID	Average Cone Index, psi (Time, hr) 2	4	8	24	48
V1-CA	15	40	30	35	45
V1-CB	8	38	30	37	32
V1-CC	30	37	22	32	38
V2-CA	313	347	407	750+	750+
V2-CB	283	317	353	633	700
V2-CC	257	320	353	560	700
V3-CA	92	103	167	323	567
V3-CB	28	53	58	90	137
V3-CC	48	88	127	220	273
V4-CA	30	53	40	42	103
V4-CB	23	42	42	68	103
V4-CC	12	12	18	32	43
V5-CA	140	227	750+	750+	750+
V5-CB	97	310	750+	750+	750+
V5-CC	130	250	750+	750+	750+
V6-CA	0	0	32	165	170
V6-CB	0	0	25	133	170
V6-CC	0	0	15	133	167
V7-CA	68	110	150	200	343
V7-CB	225	330	367	420	727
V7-CC	200	257	270	393	513
V8-CA	97	207	360	750+	750+
V8-CB	102	233	343	750+	750+
V8-CC	123	247	320	750+	750+

Table E4

Results of UCS, Bulk Density, and Permeability, Conducted on Treated Frontier Hard Chrome Clay

Vendor/Replicate		Average UCS, psi		Bulk Density pcf	Volume Increase %	Permeability cm/sec
Vendor 1						
A	1	NA		120		8.56E-05
	2	NA		121		7.35E-05
	3	NA	NA	121	29	6.77E-05
B	1	NA		126		6.65E-07
	2	NA		124		3.11E-07
	3	NA	NA	122	28	4.63E-07
C	1	NA		121		9.07E-07
	2	NA		120		1.95E-06
	3	NA	NA	123	33	1.43E-06
Vendor 2						
A	1	243		108		7.24E-06
	2	283		110		9.13E-06
	3	272	266	110	51	6.53E-06
B	1	264		108		2.75E-06
	2	285		111		2.47E-06
	3	264	271	112	56	2.61E-06
C	1	200		110		6.34E-06
	2	198		108		4.05E-06
	3	203	200	113	46	4.22E-06
Vendor 3						
A	1	101		102		5.52E-08
	2	146		105		1.38E-07
	3	125	124	102	77	6.69E-08
B	1	34		103		9.13E-07
	2	22		105		6.66E-07
	3	NA	28*	NA	79	7.19E-07
C	1	61		103		7.56E-05
	2	47		101		7.53E-05
	3	40	49	103	77	7.05E-05
Vendor 4						
A	1	84		91		1.72E-05
	2	92		98		1.69E-05
	3	83	86	96	86	1.78E-05
B	1	225		112		6.25E-07
	2	151		109		5.62E-07
	3	198	191	111	63	6.17E-07
C	1	16		110		1.44E-06
	2	6		108		9.77E-07
	3	16	13	110	62	1.06E-06

(Continued)

Table E4 (Concluded)

Vendor/Replicate		Average UCS, psi		Bulk Density pcf	Volume Increase %	Permeability cm/sec
Vendor 5						
A	1	462		96		1.32E-03
	2	459		98		9.14E-04
	3	514	478	98	104	6.32E-04
B	1	359		97		NA
	2	423		101		NA
	3	351	379	98	102	NA
C	1	465		97		2.42E-07
	2	380		99		1.11E-07
	3	438	428	99	98	1.20E-07
Vendor 6						
A	1	94		95		6.87E-06
	2	92		98		7.18E-06
	3	104	97	94	71	6.83E-06
B	1	69		94		2.47E-06
	2	88		96		2.50E-06
	3	87	81	91	79	2.33E-06
C	1	92		96		4.05E-07
	2	94		96		6.16E-07
	3	93	93	97	70	3.63E-07
Vendor 7						
A	1	93		113		4.19E-06
	2	60		105		4.56E-06
	3	70	74	107	89	4.14E-06
B	1	313		108		4.49E-07
	2	230		106		3.96E-07
	3	198	247	109	96	4.33E-07
C	1	133		106		7.06E-07
	2	135		107		6.54E-07
	3	195	154	105	95	6.30E-07
Vendor 8						
A	1	459		109		2.96E-07
	2	456		103		1.35E-07
	3	573	496	103	87	2.10E-07
B	1	554		109		1.10E-07
	2	592		109		1.86E-07
	3	476	541	107	85	1.88E-07
C	1	534		105		1.27E-06
	2	615		109		1.08E-06
	3	767	639	105	84	1.77E-06

Table E5

Results of Wet/Dry Tests Conducted

on Frontier Hard Chrome Clay

Relative Mass Loss Calculations	% Loss - Cycle No.												Total %
Replicate	1	2	3	4	5	6	7	8	9	10	11	12	Lost
Vendor 1 Test													
1	4.36	1.76	0	0.46	FAIL								100
2	2.94	1.18	0	0.34	0.17	0	0	14.95	0.84	1.01	FAIL		100
3	FAIL												100
Control													
1	4.14	1.65	0	0.74	0.28	0.37	0	3.22	FAIL				100
2	3.74	1.36	0	0.68	0.85	0.34	19.96	0.34	4.08	0.17	0.25	0	31.76
3	FAIL												100
Vendor 2 Test													
1	0.05	0.05	0.10	0	0.05	0.05	0.05	0.05	0	0	0.05	0	0.46
2	0.10	0.10	0	0.05	0.10	0	0.05	0.05	0.05	0.05	0	0.05	0.61
3	0.16	0.05	0	0	0.10	0.05	0.05	0.05	0.05	0.10	0	0.05	0.68
Control													
1	0.19	0.12	0.12	0.06	0.19	0.12	0	0.12	0.12	0.12	0.06	0	1.23
2	0.10	0.05	0.10	0.05	0.05	0.16	0.10	0	0.05	0.05	0	0	0.73
3	0.05	0.05	0.10	0.10	0.10	0.05	0	0.05	0	0.05	0.15	0	0.72
Vendor 3 Test													
1	0.26	0.13	0.07	1.58	0.07	0.13	0.07	0.13	0	0	0	0	2.44
2	0.06	0	0.19	0	0	0.13	0	0	0	0	0.06	0	0.45
3	0.13	0.13	0.07	0	0.07	0.20	0	0	0	0	0.07	0.07	0.72

(Continued)

Table E5 (Continued)

Relative Mass Loss Calculations		% Loss - Cycle No.												Total %
	Replicate	1	2	3	4	5	6	7	8	9	10	11	12	Lost
Control														
	1	0.13	0.26	0.13	0.13	0.13	0.26	0.06	0	0	0	0	0	1.10
	2	0.46	0.26	0.26	0.20	0.13	0.20	0.07	0.26	0.20	0	0.20	0.07	2.32
	3	0.20	0.13	0.13	0	0.13	0.20	0	0.07	0	0	0	0	0.87
Vendor 4 Test														
	1	0.30	1.26	0.59	0.37	0.15	0	0.30	0.15	0	0.07	0.07	0.07	3.33
	2	0.09	0.19	0.19	0.09	0.09	0	0.19	0	0	0	0	0	0.85
	3	0.24	0.16	0.24	0.24	0.08	0	0.16	0.08	0.08	0.08	0.16	0.16	1.68
Control														
	1	0.90	1.12	0.30	0.07	0	0.07	0.07	0.07	0	0.07	0	0.07	2.76
	2	0.09	0.09	0.09	0	0	0.09	0.18	0.09	0	0	0	0	0.64
	3	0.32	0.24	0.16	0.16	0.16	0.16	0	0	0	0.08	0.08	0.16	1.54
Vendor 5 Test														
	1	0.15	0.08	0	0	0	0.15	0	0	0	0	0	0	0.38
	2	0	0.07	0	0	0	0.15	0	0	0	0.07	0	0	0.30
	3	0	0	0.07	0	0	0.15	0	0.07	0	0	0	0	0.30
Control														
	1	0.15	0.08	0.08	0	0	0.08	0	0	0	0	0.15	0	0.53
	2	0.23	0.08	0	0.08	0	0.08	0	0	0.08	0	0.08	0	0.61
	3	0.23	0	0	0.15	0	0.08	0	0	0	0	0	0	0.45
Vendorn 6 Test														
	1	0	0.37	0.25	0.37	0.25	0	0	0	0.49	0	0.37	0	2.10
	2	0	0.38	0.13	0	0	0	0	0	0.38	0.13	0	0	1.01
	3	0	0.38	0.25	0	0	0	0	0.13	0.38	0	0	0	1.13

(Continued)

Table E5 (Concluded)

Relative Mass Loss Calculations		% Loss - Cycle No.												Total %
	Replicate	1	2	3	4	5	6	7	8	9	10	11	12	Lost
Control														
	1	0.12	0.37	0.24	0	0	0.12	0	0	0.37	0	0	0	1.22
	2	0.13	0.51	0.38	0	0	0.13	0	0	0.38	0	0	0	1.52
	3	0.24	0.36	0.12	0	0	0	0	0	0.24	0.12	0	0	1.09
Vendor 7 Test														
	1	0.53	0.36	0	0.18	0	0.06	0	0	0	0	0	0	1.12
	2	0	0.06	0.06	0	0	0.06	0	0.12	0.12	0	0	0.06	0.46
	3	0	0.11	0	0	0	0	0	0.06	0.06	0	0	0	0.23
Control														
	1	0.39	0.28	0.11	0.06	0.06	0.17	0	0.06	0.06	0	0	0	1.18
	2	0.11	0.11	0	0	0	0.11	0	0.06	0	0.06	0.11	0.06	0.62
	3	0.06	0.11	0.06	0	0	0.06	0	0.06	0	0	0	0.06	0.45
Vendor 8 Test														
	1	0	0.06	0.12	0.06	0	0	0	0	0	0	0.06	0.06	0.35
	2	0.06	0.06	0.06	0	0.11	0	0	0	0	0	0	0	0.28
	3	0.06	0.06	0.06	0.06	0.06	0	0	0	0	0	0	0	0.28
Control														
	1	0	0.06	0.06	0	0.11	0	0	0.06	0	0	0.06	0	0.34
	2	0	0.06	0	0	0.11	0.06	0	0	0	0	0	0.06	0.28
	3	0.11	0.06	0	0	0.11	0.06	0	0	0	0	0.06	0	0.39

Table E6

Normalization of Total Chromium

Contained in Frontier Hard Chrome Clay

Replicate	Moisture %	pH	Total Cr Conc. (mg/L)	Mean Total Cr	Normalized Total Chronium	Mean Total Cr	Total Cr Standard Deviation	RSD %	Total Cr Standard Deviation	Total Cr RSD %
Untreated										
1	0.493	7.9	2800	2633			473	18		
2	0.493	7.8	3000							
3	0.351	7.8	2100							
Vendor 1										
1	0.25	10	1700	1867	2066	2386	153	8	277	12
2	0.563	9.5	2000		2550					
3	0.515	9.6	1900		2542					
Vendor 2										
1	0.235	8.3	2200	2267	2870	2944	58	3	86	3
2	0.299	11	2300		3038					
3	0.282	11	2300		2925					
Vendor 3										
1	0.408	12	1200	1167	1901	1830	58	5	111	6
2	0.351	12	1100		1703					
3	0.389	12	1200		1887					
Vendor 4										
1	0.613	11	2200	2467	3613	4037	643	26	1093	27
2	0.563	11	2000		3220					
3	0.613	11	3200		5279					
Vendor 5										
1	0.538	12	2300	2267	4589	4390	252	11	590	13
2	0.493	12	2000		3727					
3	0.563	12	2500		4855					
Vendor 6										
1	0.695	12	3500	3567	5041	5140	404	11	621	12
2	0.667	12	3200		4575					
3	0.724	11	4000		5805					

(Continued)

Table E6 (Concluded)

Replicate	Moisture %	pH	Total Cr Conc. (mg/L)	Mean Total Cr	Normalized Total Chronium	Mean Total Cr	Total Cr Standard Deviation	RSD %	Total Cr Standard Deviation	Total Cr RSD %
Vendor 7										
1	0.389	11	1400	1300	2683	2440	100	8	223	9
2	0.333	11	1200		2246					
3	0.299	11	1300		2390					
Vendor 8										
1	0.25	11	1300	1267	2145	2125	58	5	68	3
2	0.316	11	1200		2050					
3	0.282	11	1300		2181					

Table E7

Results of Total Chromium in the MWEP-1 Conducted on

Frontier Hard Chrome Clay

Replicate	Moisture %	pH	MWEP-1 Conc. (mg/L)	Mean MWEP	MWEP-1 Standard Deviation	RSD %	NMLC (mg/kg)	Mean NMLC	NML Standard Deviation	NML RSD %	% Efficiency	% Efficiency Mean NMLC
Untreated												
1	0.493	8	0.081	0.067	0.0164	24.43	1.209	0.977	0.283	29		
2	0.493	7.6	0.071				1.060					
3	0.351	8	0.049				0.662					
Vendor 1												
1	0.25	10	0.08	0.112	0.0333	29.81	1.092	1.938	0.755	39	10	-98
2	0.563	10	0.12				2.176				-105	
3	0.515	11	0.14				2.545				-284	
Vendor 2												
1	0.235	12	0.64	0.757	0.1686	22.28	9.746	11.742	2.550	22	-706	-1102
2	0.299	12	0.68				10.865				-925	
3	0.282	12	0.95				14.615				-2108	
Vendor 3												
1	0.408	11	0.13	0.120	0.0100	8.33	2.480	2.249	0.210	9	-105	-130
2	0.351	11	0.12				2.197				-107	
3	0.389	11	0.11				2.070				-213	
Vendor 4												
1	0.613	11	0.02	0.282	0.2777	98.46	0.341	5.883	5.717	97	72	-502
2	0.563	11	0.57				11.760				-1009	
3	0.563	11	0.26				5.548				-738	
Vendor 5												
1	0.538	12	0.46	0.320	0.1400	43.75	10.471	7.207	3.287	46	-766	-638
2	0.493	12	0.18				3.897				-268	
3	0.563	12	0.32				7.252				-996	
Vendor 6												
1	0.695	11	0.59	0.573	0.0569	9.92	12.201	11.871	1.364	11	-909	-1115
2	0.667	11	0.51				10.372				-878	
3	0.724	11	0.62				13.040				-1870	

(Continued)

Table E7 (Concluded)

Replicate	Moisture %	pH	MWEP-1 Conc. (mg/L)	Mean MWEP	MWEP-1 Standard Deviation	RSD %	NMLC (mg/kg)	Mean NMLC	NML Standard Deviation	NML RSD %	% Efficiency	% Efficiency Mean NMLC
Vendor 7												
1	0.389	11	0.10	0.066	0.0303	45.86	2.118	1.367	0.664	49	-75	-40
2	0.333	11	0.042				0.861				19	
3	0.299	11	0.056				1.121				-69	
Vendor 8												
1	0.25	11	0.27	0.243	0.0306	12.57	4.928	4.554	0.543	12	-705	-366
2	0.316	11	0.25				4.803				-353	
3	0.282	11	0.21				3.931				-494	

Table E8

Results of Total Chromium in TCLP Conducted on Frontier Hard Chrome Clay

TCLP Replicate	Moisture %	pH	Cr(VI) TCLP Conc. (mg/L)	Mean TCLP	TCLP Standard Deviation	TCLP RSD %	NMLC (mg/kg)	Mean NMLC	NML Standard Deviation	NML Precision %	% Efficiency	% Efficiency Mean NMLC
Untreated												
1	0.493	5.1	0.220	0.193	0.02	11.95	6.569	5.603	0.875	16		
2	0.493	5.2	0.180				5.375					
3	0.351	5.1	0.180				4.864					
Vendor 1												
1	0.25	4.6	4.40	4.333	0.12	2.66	128.150	146.811	16.611	11	-1851	-2520
2	0.563	4.5	4.20				152.299				-2734	
3	0.515	4.7	4.40				159.984				-3189	
Vendor 2												
1	0.235	6.8	0.094	0.089	0.02	26.85	2.863	2.753	0.692	25	56	51
2	0.299	7.2	0.063				2.013				63	
3	0.282	7.2	0.110				3.384				30	
Vendor 3												
1	0.408	12	0.06	0.062	0.06	93.55	2.366	2.303	2.122	92	64	59
2	0.351	12	0.12				4.393				18	
3	0.389	12	0.004				0.151				97	
Vendor 4												
1	0.613	7	0.012	0.080	0.11	139.85	0.511	2.586	3.360	130	92	54
2	0.563	8.4	0.019				0.784				85	
3	0.613	5.8	0.21				6.462				-33	
Vendor 5												
1	0.538	8.8	0.57	0.573	0.05	7.86	25.949	25.666	2.589	10	-295	-358
2	0.493	9	0.53				22.947				-327	
3	0.563	7.9	0.62				28.103				-478	

(Continued)

Table E8 (Concluded)

TCLP Replicate	Moisture %	pH	Cr(VI) TCLP Conc. (mg/L)	Mean TCLP	TCLP Standard Deviation	TCLP RSD %	NMLC (mg/kg)	Mean NMLC	NML Standard Deviation	NML Precision %	% Efficiency	% Efficiency Mean NMLC
Vendor 6												
1	0.695	1.2	0.07	0.097	0.06	65.64	2.978	3.999	2.563	64	55	29
2	0.667	1.2	0.17				6.915				-29	
3	0.724	1.3	0.05				2.103				57	
Vendor 7												
1	0.389	4.7	7.30	8.467	1.39	16.38	309.261	347.174	47.425	14	-4608	-6097
2	0.333	5.1	8.100				331.909				-6075	
3	0.299	5	10.000				400.352				-8132	
Vendor 8												
1	0.25	5	4.50	4.233	0.38	8.94	164.250	158.328	10.659	7	-2400	-2726
2	0.316	5.1	3.80				146.023				-2617	
3	0.282	5.2	4.40				164.711				-3287	

Table E9

Normalization of Cr(VI) Contained

in Frontier Hard Chrome Clay

Replicate	Moisture %	pH	Cr(VI) Conc. (mg/L)	Mean Total Cr	Total Cr Standard Deviation	RSD %	Normalized Total Chromium	Mean (NML)	NML Standard Deviation	NML RSD %
Untreated										
1	0.493	7.9	9.5	10	0.76	7.51				
2	0.493	7.8	11							
3	0.351	7.8	10							
Vendor 1										
1	0.25	10	0.023	0.0135	0.01	60.58	0.028	0.017	0.01	56
2	0.563	9.5	0.0089				0.011			
3	0.515	9.6	0.0087				0.012			
Vendor 2										
1	0.235	8.3	7.2	7.3	1.01	13.73	9.392	9.509	1.12	12
2	0.299	11	6.4				8.453			
3	0.282	11	8.4				10.682			
Vendor 3										
1	0.408	12	5.4	6.9	1.75	25.45	8.556	10.746	2.60	24
2	0.351	12	8.8				13.621			
3	0.389	12	6.4				10.061			
Vendor 4										
1	0.613	11	6.2	8.4	4.89	57.95	10.181	13.775	8.14	59
2	0.563	11	5.0				8.050			
3	0.613	11	14				23.095			
Vendor 5										
1	0.538	12	11.0	8.4	16.39	75.66	17.540	13.453	3.99	30
2	0.493	12	6.1				9.560			
3	0.563	12	8.2				13.260			
Vendor 6										
1	0.695	12	14	22	9	43	20.163	31.163	13	42
2	0.667	12	32				45.754			
3	0.724	11	19				27.572			

(Continued)

Table E9 (Concluded)

Replicate	Moisture %	pH	Cr(VI) Conc. (mg/L)	Mean Total Cr	Total Cr Standard Deviation	RSD %	Normalized Total Chromium	Mean (NML)	NML Standard Deviation	NML RSD %
Vendor 7										
1	0.389	11	3.8	3.6	0.20	5.56	7.282	6.757	0.52	8
2	0.333	11	3.6				6.738			
3	0.299	11	3.4				6.250			
Vendor 8										
1	0.25	11	<0.080	0.083	0.10	122.47	0.132	0.140	0.01	8
2	0.316	11	<0.089				0.152			
3	0.282	11	<0.081				0.136			

Table E10

Results of Chromium (VI) in the MWEP-1 Conducted on

Frontier Hard Chrome Clay

Replicate	Moisture %	pH	MWEP-1 Conc. (mg/L)	Mean MWEP	MWEP-1 Standard Deviation	RSD %	NMLC (mg/kg)	Mean NMLC	NML Standard Deviation	NML RSD %	% Efficiency	% Efficiency Mean NMLC
Untreated												
1	0.493	8	0.091	0.072	0.017	23.84	1.359	1.053	0.295	28		
2	0.493	7.6	0.069				1.030					
3	0.351	8	0.057				0.770					
Vendor 1												
1	0.25	10	<0.027	<0.038	0.010	25.92	0.393	0.658	0.233	35	71	38
2	0.563	10	<0.046				0.834				19	
3	0.515	11	<0.041				0.745				3	
Vendor 2												
1	0.235	12	0.65	0.737	0.214	29.00	9.898	11.414	3.188	28	-629	-984
2	0.299	12	0.58				9.267				-800	
3	0.282	12	0.98				15.076				-1858	
Vendor 3												
1	0.408	11	0.09	0.123	0.032	25.80	1.679	2.291	0.550	24	-24	-118
2	0.351	11	0.15				2.746				-167	
3	0.389	11	0.13				2.447				-218	
Vendor 4												
1	0.613	11	<0.052	0.029	0.430	1483.36	1.107	6.001	5.135	86	19	-470
2	0.563	11	0.55				11.347				-1002	
3	0.613	11	0.26				5.548				-621	
Vendor 5												
1	0.538	12	0.30	0.260	0.069	26.65	6.829	5.842	1.684	29	-403	-455
2	0.493	12	0.18				3.897				-278	
3	0.563	12	0.30				6.799				-783	
Vendor 6												
1	0.695	11	0.62	0.570	0.056	9.77	12.821	11.797	1.273	11	-844	-1020
2	0.667	11	0.51				10.372				-907	
3	0.724	11	0.58				12.199				-1484	

(Continued)

Table E10 (Concluded)

Replicate	Moisture %	pH	MWEP-1 Conc. (mg/L)	Mean MWEP	MWEP-1 Standard Deviation	RSD %	NMLC (mg/kg)	Mean NMLC	NML Standard Deviation	NML RSD %	% Efficiency	% Efficiency Mean NMLC
Vendor 7												
1	0.389	11	0.10	0.046	0.047	101.76	2.118	0.963	1.002	104	-56	9
2	0.333	11	0.021				0.430				58	
3	0.299	11	0.017				0.340				56	
Vendor 8												
1	0.25	11	<0.027	<0.028	0.001	3.57	0.493	0.525	0.032	6	64	50
2	0.316	11	<0.029				0.557				46	
3	0.282	11	<0.028				0.524				32	

Table E11

Results of Cr(VI) in the TCLP Conducted on Frontier Hard Chrome Clay

TCLP Replicate	Moisture %	pH	Cr(VI) TCLP Conc. (mg/L)	Mean TCLP	TCLP Standard Deviation	TCLP RSD %	NMLC (mg/kg)	Mean (NML)	NML Standard Deviation	NML Precision %	% Efficiency	% Efficiency Mean NMLC
Untreated												
1	0.493	5.1	<0.020	<0.020	0.00	0.00	0.597	0.578	0.033	6		
2	0.493	5.2	<0.020				0.597					
3	0.351	5.1	<0.020				0.540					
Vendor 1												
1	0.25	4.6	<0.020	<0.020	0.00	0.00	0.583	0.678	0.083	12	2	-17
2	0.563	4.5	<0.020				0.725				-21	
3	0.515	4.7	<0.020				0.727				-35	
Vendor 2												
1	0.235	6.8	<0.075	0.074	0.03	36.69	2.284	2.277	0.803	35	-282	-294
2	0.299	7.2	0.046				1.470				-146	
3	0.282	7.2	0.100				3.077				-469	
Vendor 3												
1	0.408	12	0.07	0.15	0.07	45.89	2.633	5.455	2.446	45	-341	-843
2	0.351	12	0.19				6.956				-1065	
3	0.389	12	0.18				6.776				-1154	
Vendor 4												
1	0.613	7	<0.020	0.036	0.01	41.05	0.852	1.348	0.605	45	-43	-133
2	0.563	8.4	0.049				2.022				-239	
3	0.613	5.8	0.038				1.169				-116	
Vendor 5												
1	0.538	8.8	0.61	0.620	0.07	10.58	27.770	27.764	3.515	13	-4550	-4701
2	0.493	9	0.56				24.246				-3960	
3	0.563	7.9	0.69				31.276				-5687	

(Continued)

Table E11 (Concluded)

TCLP Replicate	Moisture %	pH	Cr(VI) TCLP Conc. (mg/L)	Mean TCLP	TCLP Standard Deviation	TCLP RSD %	NMLC (mg/kg)	Mean (NML)	NML Standard Deviation	NML Precision %	% Efficiency	% Efficiency Mean NMLC
Vendor 6												
1	0.695	1.2	0.021	0.034	0.02	68.79	0.889	1.397	0.939	67	-45	-142
2	0.667	1.2	0.061				2.481				-315	
3	0.724	1.3	<0.020				0.841				-56	
Vendor 7												
1	0.389	4.7	<0.020	<0.020	0.00	0.00	0.847	0.823	0.023	3	-42	-42
2	0.333	5.1	<0.020				0.820				-37	
3	0.229	5	<0.020				0.801				-48	
Vendor 8												
1	0.25	5	<0.020	<0.020	0.00	0.00	0.730	0.749	0.019	3	-22	-30
2	0.316	5.1	<0.020				0.769				-29	
3	0.282	5.2	<0.020				0.749				-39	

APPENDIX F: RADIAN, INC., QUALITY ASSURANCE/QUALITY CONTROL

Table F1

Summary of Blank Results, Frontier Hard Chrome

Date	True Value	Det Flag	Measured Value	% Recovery
Method: ICP Metals by SW6010				
Matrix: Solid				
Analyte: Iron				
Type of Control Sample: Calibration Control Sample, continued				
17-Jun-90	5.000 mg/L		5.020 mg/L	100.40
19-Jun-90	5.000 mg/L		5.050 mg/L	101.00
19-Jun-90	5.000 mg/L		5.090 mg/L	101.80
19-Jun-90	5.000 mg/L		5.160 mg/L	101.80
19-Jun-90	5.000 mg/L		5.100 mg/L	102.00
19-Jun-90	5.000 mg/L		5.030 mg/L	101.80
20-Jun-90	5.000 mg/L		5.130 mg/L	102.60
20-Jun-90	5.000 mg/L		5.140 mg/L	102.80
20-Jun-90	5.000 mg/L		5.020 mg/L	100.40
20-Jun-90	5.000 mg/L		4.990 mg/L	99.80
21-Jun-90	5.000 mg/L		5.020 mg/L	100.40
21-Jun-90	5.000 mg/L		5.100 mg/L	102.00
25-Jun-90	5.000 mg/L		5.340 mg/L	106.80
25-Jun-90	5.000 mg/L		5.210 mg/L	104.20
11-Jul-90	5.000 mg/L		5.060 mg/L	101.20
11-Jul-90	5.000 mg/L		5.050 mg/L	101.00
12-Jul-90	5.000 mg/L		5.460 mg/L	109.20
12-Jul-90	5.000 mg/L		5.400 mg/L	108.00
12-Jul-90	5.000 mg/L		5.130 mg/L	102.60
12-Jul-90	5.000 mg/L		5.450 mg/L	109.00
12-Jul-90	5.000 mg/L		5.010 mg/L	100.20
12-Jul-90	5.000 mg/L		5.050 mg/L	101.00
12-Jul-90	5.000 mg/L		5.110 mg/L	102.20
12-Jul-90	5.000 mg/L		5.120 mg/L	102.40
13-Jul-90	5.000 mg/L		5.180 mg/L	103.60
13-Jul-90	5.000 mg/L		5.190 mg/L	103.80
17-Jul-90	5.000 mg/L		4.960 mg/L	99.20
17-Jul-90	5.000 mg/L		5.100 mg/L	102.00
17-Jul-90	5.000 mg/L		5.150 mg/L	103.00
17-Jul-90	5.000 mg/L		5.040 mg/L	100.80
24-Jul-90	200.0 mg/L		200.000 mg/L	100.00
24-Jul-90	50.0 mg/L		48.900 mg/L	97.80
24-Jul-90	50.0 mg/L		47.600 mg/L	97.00
24-Jul-90	50.0 mg/L		47.900 mg/L	95.80
24-Jul-90	50.0 mg/L		48.500 mg/L	97.00
25-Jul-90	50.0 mg/L		50.600 mg/L	101.20
25-Jul-90	50.0 mg/L		49.000 mg/L	98.00
25-Jul-90	50.0 mg/L		49.900 mg/L	99.80

(Continued)

Table F1 (Continued)

SUMMARY OF BLANK RESULTS FOR MATRIX = MW EP LEACHATE; Submatrix = N/A

Method Type / Parameter	Total Number of Blanks	Total Number above Detection Limit	Concentration Range Minimum - Maximum	Maximum Detection Limit	Units
Chromium by ICPES					
Field Blank					
Chromium	16	16	0.0030 - 0.067	0.0030	mg/L
Iron by SW6010					
Field Blank					
Iron	16	16	0.210 - 21.0	0.0070	mg/L
ICP Metals by SW6010					
Preparation					
Chromium	4	0		0.0030	mg/L
Iron	4	0		0.0070	mg/L
Lead	3	0		0.042	mg/L
Nickel	3	0		0.015	mg/L
Nickel by SW6010					
Field Blank					
Nickel	4	4	0.015 - 0.015	0.015	mg/L
Lead by SW6010					
Field Blank					
Lead	4	4	0.042 - 0.042	0.042	mg/L

(Continued)

Table F1 (Continued)

SUMMARY OF BLANK RESULTS FOR MATRIX = SOLID; Submatrix = All

Method Type / Parameter	Total Number of Blanks	Total Number above Detection Limit	Concentration Range Minimum	Concentration Range Maximum	Maximum Detection Limit	Units
Chrome VI by SW7196						
Preparation						
Chromium VI	4	0			0.0050	mg/L

(Continued)

Table F1 (Continued)

SUMMARY OF BLANK RESULTS FOR MATRIX = SOLID; Submatrix = N/A

Method Type / Parameter	Total Number of Blanks	Total Number above Detection Limit	Concentration Range Minimum - Maximum	Maximum Detection Limit	Units
Conductivity (E120.1)					
Method Blank					
Conductivity	1	0		1.000	umhos/c
Preparation					
Conductivity	2	0		1.000	umhos/c
Chloride by IC (E300.0)					
Method Blank					
Chloride	1	0		0.020	mg/Kg
Preparation					
Chloride	2	0		5.000	mg/Kg
ICP Metals by SW6010					
Preparation					
Chromium	11	0		1.000	mg/Kg
Iron	11	1	2.400 - 2.4	4.000	mg/Kg
Lead	11	0		5.000	mg/Kg
Nickel	11	0		2.000	mg/Kg
Chrome VI by SW7196					
Field Blank					
Chromium VI	15	3	0.0050 - 0.010	0.190	mg/Kg
Preparation					
Chromium VI	10	0		0.200	mg/Kg
Sulfate by IC (E300.0)					
Preparation					
Sulfate	1	0		12.5	mg/Kg

(Continued)

Table F1 (Continued)

SUMMARY OF BLANK RESULTS FOR MATRIX = TREATED; Submatrix = MW

Method Type / Parameter	Total Number of Blanks	Total Number above Detection Limit	Concentration Range Minimum - Maximum	Maximum Detection Limit	Units
ICP Metals by SW6010					
Preperation					
Chromium	4	1	0.0080 - 0.0080	0.020	mg/L
Iron	3	0		0.040	mg/L
Lead	3	0		0.050	mg/L
Nickel	3	0		0.020	mg/L
Chrome VI by SW7196					
Preperation					
Chromium VI.	1	0		0.0050	mg/L

(Continued)

Table F1 (Concluded)

SUMMARY OF BLANK RESULTS FOR MATRIX = TREATED; Submatrix = T

Method Type / Parameter	Total Number of Blanks	Total Number above Detection Limit	Concentration Range Minimum - Maximum	Maximum Detection Limit	Units
Arsenic by AA (E206.2)					
Preparation					
Arsenic	2	0		0.0040	mg/L
Conductivity (E120.1)					
Method Blank					
Conductivity	1	0		1.000	umhos/cr
Preparation					
Conductivity	1	0		1.000	umhos/cr
Mercury by Cold Vapor AA (E245.1)					
Preparation					
Mercury	1	1	0.00020 - 0.00020		mg/L
ICP Metals by SW6010					
Preparation					
Barium	3	0		0.010	mg/L
Cadmium	3	1	0.0093 - 0.0093	0.0050	mg/L
Chromium	6	1	0.0040 - 0.0040	0.010	mg/L
Iron	5	2	0.040 - 0.081	0.040	mg/L
Lead	6	0		0.050	mg/L
Nickel	5	0		0.020	mg/L
Silver	3	1	0.013 - 0.013	0.010	mg/L
Selenium by AA (E270.2)					
Preparation					
Selenium	2	0		0.0050	mg/L
Chrome VI by SW7196					
Preparation					
Chromium VI	3	0		0.020	mg/L
Sulfate by IC (E300.0)					
Method Blank					
Sulfate	1	0		0.050	mg/L
Preparation					
Sulfate	1	0		12.0	mg/L

Table F2

Detailed Listing of Blank Results, Frontier Hard Chrome

SUMMARY OF BLANK RESULTS FOR MATRIX = TREATED; Submatrix = N/A

Method Type / Parameter	Total Number of Blanks	Total Number above Detection Limit	Concentration Range Minimum - Maximum	Maximum Detection Limit	Units
Arsenic by AA (E206.2)					
Preparation					
Arsenic	1	0		0.0040	mg/Kg
Chloride by IC (E300.0)					
Preparation					
Chloride	1	0		5.000	mg/Kg
ICP Metals by SW6010					
Preparation					
Chromium	6	3	0.0080 - 0.40	0.300	mg/Kg
Iron	5	2	0.060 - 8.9	4.000	mg/Kg
Lead	4	0		5.000	mg/Kg
Nickel	4	0		2.000	mg/Kg
Selenium by AA (E270.2)					
Preparation					
Selenium	1	0		0.00	mg/Kg
Chrome VI by SW7196					
Preparation					
Chromium VI	1	0		0.0050	mg/Kg
Sulfate by IC (E300.0)					
Preparation					
Sulfate	1	0		12.5	mg/Kg

(Continued,

Table F2 (Continued)

Blank Results for Matrix = MW EP LEACHATE; Submatrix = N/A

Date	Type of Blank	Detection Flag	Result	Detection Limit	Units
	Method: Chromium by ICPES				
	Analyte: Chromium				
28-May-90	Field Blank		0.0030	0.0030	mg/L
28-May-90	Field Blank	<5X	0.0030	0.0030	mg/L
28-May-90	Field Blank	<5X	0.0140	0.0030	mg/L
29-May-90	Field Blank		0.0180	0.0030	mg/L
29-May-90	Field Blank	<5X	0.0110	0.0030	mg/L
29-May-90	Field Blank	<5X	0.0070	0.0030	mg/L
02-Jun-90	Field Blank		0.0260	0.0030	mg/L
02-Jun-90	Field Blank	<5X	0.0140	0.0030	mg/L
02-Jun-90	Field Blank	<5X	0.0120	0.0030	mg/L
02-Jun-90	Field Blank		0.0380	0.0030	mg/L
02-Jun-90	Field Blank		0.0030	0.0030	mg/L
18-Jun-90	Field Blank	<5X	0.0060	0.0030	mg/L
18-Jun-90	Field Blank	<5X	0.0040	0.0030	mg/L
18-Jun-90	Field Blank		0.0200	0.0030	mg/L
18-Jun-90	Field Blank		0.0670	0.0030	mg/L
18-Jun-90	Field Blank		0.0220	0.0030	mg/L
	Total Number of Blanks = 16		Concentration Range	0.0030 - 0.067	
	Total Number above Detection Limit = 16		Maximum Detection Limit =		
	Method: Iron by SW6010				
	Analyte: Iron				
28-May-90	Field Blank		0.2100	0.0070	mg/L
28-May-90	Field Blank		0.4200	0.0070	mg/L
28-May-90	Field Blank		0.6600	0.0070	mg/L
29-May-90	Field Blank		3.3000	0.0070	mg/L
29-May-90	Field Blank		0.4800	0.0070	mg/L
29-May-90	Field Blank		5.8000	0.0070	mg/L
02-Jun-90	Field Blank		1.2000	0.0070	mg/L
02-Jun-90	Field Blank		2.3000	0.0070	mg/L
02-Jun-90	Field Blank		2.5000	0.0070	mg/L
02-Jun-90	Field Blank		21.0000	0.0070	mg/L
02-Jun-90	Field Blank		3.6000	0.0070	mg/L
18-Jun-90	Field Blank		0.3800	0.0070	mg/L
18-Jun-90	Field Blank		2.3000	0.0070	mg/L
18-Jun-90	Field Blank		2.8000	0.0070	mg/L
18-Jun-90	Field Blank		3.0000	0.0070	mg/L

(Continued)

Table F2 (Continued)

Blank Results for Matrix = MW EP LEACHATE; Submatrix = N/A

Date	Type of Blank	Detection Flag	Result	Detection Limit	Units
Analysis for Iron by SW6010					
Analyte: Iron continued					
18-Jun-90	Field Blank		1.5000	0.0070	mg/L
Total Number of Blanks = 16			Concentration Range	0.210 - 21.0	
Total Number above Detection Limit = 16			Maximum Detection Limit =		
Method: ICP Metals by SW6010					
Analyte: Chromium					
23-May-90	Preparation	ND	0.0030	0.0030	mg/L
01-Jun-90	Preparation	ND	0.0030	0.0030	mg/L
02-Jun-90	Preparation	ND	0.0030	0.0030	mg/L
17-Jul-90	Preparation	ND	0.0030	0.0030	mg/L
Total Number of Blanks = 4			Concentration Range	NC	
Total Number above Detection Limit = 0			Maximum Detection Limit = 0.0030		
Method: ICP Metals by SW6010					
Analyte: Iron					
23-May-90	Preparation	ND	0.0070	0.0070	mg/L
01-Jun-90	Preparation	ND	0.0070	0.0070	mg/L
02-Jun-90	Preparation	ND	0.0070	0.0070	mg/L
17-Jul-90	Preparation	ND	0.0070	0.0070	mg/L
Total Number of Blanks = 4			Concentration Range	NC	
Total Number above Detection Limit = 0			Maximum Detection Limit = 0.0070		
Method: ICP Metals by SW6010					
Analyte: Lead					
23-May-90	Preparation	ND	0.0420	0.0420	mg/L
01-Jun-90	Preparation	ND	0.0420	0.0420	mg/L
02-Jun-90	Preparation	ND	0.0420	0.0420	mg/L

(Continued)

Table F2 (Continued)

Blank Results for Matrix = MW EP LEACHATE; Submatrix = N/A

Date	Type of Blank	Detection Flag	Result	Detection Limit	Units
Analysis for ICP Metals by SW6010					
Analyte: Lead continued					
	Total Number of Blanks = 3		Concentration Range NC		
	Total Number above Detection Limit = 0		Maximum Detection Limit = 0.042		
Method: ICP Metals by SW6010					
Analyte: Nickel					
23-May-90	Preparation	ND	0.0150	0.0150	mg/L
01-Jun-90	Preparation	ND	0.0150	0.0150	mg/L
02-Jun-90	Preparation	ND	0.0150	0.0150	mg/L
	Total Number of Blanks = 3		Concentration Range NC		
	Total Number above Detection Limit = 0		Maximum Detection Limit = 0.015		
Method: Nickel by SW6010					
Analyte: Nickel					
28-May-90	Field Blank		0.0150	0.0150	mg/L
29-May-90	Field Blank		0.0150	0.0150	mg/L
02-Jun-90	Field Blank		0.0150	0.0150	mg/L
18-Jun-90	Field Blank		0.0150	0.0150	mg/L
	Total Number of Blanks = 4		Concentration Range 0.015 - 0.015		
	Total Number above Detection Limit = 4		Maximum Detection Limit =		
Method: Lead by SW6010					
Analyte: Lead					
28-May-90	Field Blank		0.0420	0.0420	mg/L
29-May-90	Field Blank		0.0420	0.0420	mg/L
02-Jun-90	Field Blank		0.0420	0.0420	mg/L
18-Jun-90	Field Blank		0.0420	0.0420	mg/L

(Continued)

Table F2 (Continued)

Blank Results for Matrix = HW EP LEACHATE; Submatrix = N/A

Date	Type of Blank	Detection Flag	Result	Detection Limit	Units

Analysis for Lead by SW6010
Analyte: Lead continued

Total Number of Blanks = 4
Total Number above Detection Limit = 4

Concentration Range 0.042 - 0.042
Maximum Detection Limit =

(Continued)

Table F2 (Continued)

Blank Results for Matrix = SOLID; Submatrix = NA

Date	Type of Blank	Detection Flag	Result	Detection Limit	Units
Method: Chrome VI by SW7196					
Analyte: Chromium VI					
15-May-90	Preparation	ND	0.0050	0.0050	mg/L
16-May-90	Preparation	ND	0.0050	0.0050	mg/L
17-May-90	Preparation	ND	0.0050	0.0050	mg/L
18-May-90	Preparation	ND	0.0050	0.0050	mg/L

Total Number of Blanks = 4
Concentration Range NC
Total Number above Detection Limit = 0
Maximum Detection Limit = 0.0050

(Continued)

Table F2 (Continued)

Blank Results for Matrix = SOLID; Submatrix = N/A

Date	Type of Blank	Detection Flag	Result	Detection Limit	Units
Method: Conductivity (E120.1)					
Analyte: Conductivity					
26-Jul-90	Method Blank	ND	1.0000	1.0000	umhos/cm
26-Jul-90	Preparation	ND	1.0000	1.0000	umhos/cm
04-Sep-90	Preparation	ND	1.0000	1.0000	umhos/cm
Total Number of Blanks = 3			Concentration Range NC		
Total Number above Detection Limit = 0			Maximum Detection Limit = 1.0		
Method: Chloride by IC (E300.0)					
Analyte: Chloride					
09-Jul-90	Method Blank	ND	0.0200	0.0200	mg/Kg
09-Jul-90	Preparation	ND	5.0000	5.0000	mg/Kg
14-Sep-90	Preparation	ND	5.0000	5.0000	mg/Kg
Total Number of Blanks = 3			Concentration Range NC		
Total Number above Detection Limit = 0			Maximum Detection Limit = 5.0		
Method: ICP Metals by SW6010					
Analyte: Chromium					
21-May-90	Preparation	ND	0.3000	0.3000	mg/Kg
23-May-90	Preparation	ND	0.3000	0.3000	mg/Kg
31-May-90	Preparation	ND	0.3000	0.3000	mg/Kg
15-Jun-90	Preparation	ND	0.3000	0.3000	mg/Kg
21-Jun-90	Preparation	ND	0.3000	0.3000	mg/Kg
11-Jul-90	Preparation	ND	0.3000	0.3000	mg/Kg
12-Jul-90	Preparation	ND	0.3000	0.3000	mg/Kg
17-Jul-90	Preparation	ND	0.3000	0.3000	mg/Kg
24-Jul-90	Preparation	ND	1.0000	1.0000	mg/Kg
25-Jul-90	Preparation	ND	0.0100	0.0100	mg/Kg
26-Jul-90	Preparation	ND	0.3000	0.3000	mg/Kg

(Continued)

Table F2 (Continued)

Blank Results for Matrix = SOLID; Submatrix = N/A

Date	Type of Blank	Detection Flag	Result	Detection Limit	Units
Analysis for ICP Metals by SW6010					
Analyte: Chromium continued					
Total Number of Blanks = 11			Concentration Range NC		
Total Number above Detection Limit = 0			Maximum Detection Limit = 1.0		
Method: ICP Metals by SW6010					
Analyte: Iron					
21-May-90	Preparation	ND	0.7000	0.7000	mg/Kg
23-May-90	Preparation	ND	0.7000	0.7000	mg/Kg
31-May-90	Preparation	<5X	2.4000		mg/Kg
15-Jun-90	Preparation	ND	0.7000	0.7000	mg/Kg
21-Jun-90	Preparation	ND	0.7000	0.7000	mg/Kg
11-Jul-90	Preparation	ND	0.7000	0.7000	mg/Kg
12-Jul-90	Preparation	ND	0.7000	0.7000	mg/Kg
17-Jul-90	Preparation	ND	0.7000	0.7000	mg/Kg
24-Jul-90	Preparation	ND	4.0000	4.0000	mg/Kg
25-Jul-90	Preparation	ND	0.0400	0.0400	mg/Kg
26-Jul-90	Preparation	ND	0.7000	0.7000	mg/Kg
Total Number of Blanks = 11			Concentration Range 2.400 - 2.4		
Total Number above Detection Limit = 1			Maximum Detection Limit = 4.0		
Method: ICP Metals by SW6010					
Analyte: Lead					
21-May-90	Preparation	ND	4.2000	4.2000	mg/Kg
23-May-90	Preparation	ND	4.2000	4.2000	mg/Kg
31-May-90	Preparation	ND	4.2000	4.2000	mg/Kg
15-Jun-90	Preparation	ND	4.2000	4.2000	mg/Kg
21-Jun-90	Preparation	ND	4.2000	4.2000	mg/Kg
11-Jul-90	Preparation	ND	4.2000	4.2000	mg/Kg
12-Jul-90	Preparation	ND	4.2000	4.2000	mg/Kg
17-Jul-90	Preparation	ND	4.2000	4.2000	mg/Kg
24-Jul-90	Preparation	ND	5.0000	5.0000	mg/Kg
25-Jul-90	Preparation	ND	0.0500	0.0500	mg/Kg
26-Jul-90	Preparation	ND	4.2000	4.2000	mg/Kg

(Continued)

Table F2 (Continued)

Blank Results for Matrix = SOLID; Submatrix = N/A

Date	Type of Blank	Detection Flag	Result	Detection Limit	Units
Analysis for ICP Metals by SW6010					
Analyte: Lead continued					
Total Number of Blanks = 11			Concentration Range NC		
Total Number above Detection Limit = 0			Maximum Detection Limit = 5.0		
Method: ICP Metals by SW6010					
Analyte: Nickel					
21-May-90	Preparation	ND	1.5000	1.5000	mg/Kg
23-May-90	Preparation	ND	1.5000	1.5000	mg/Kg
31-May-90	Preparation	ND	1.5000	1.5000	mg/Kg
15-Jun-90	Preparation	ND	1.5000	1.5000	mg/Kg
21-Jun-90	Preparation	ND	1.5000	1.5000	mg/Kg
12-Jul-90	Preparation	ND	1.5000	1.5000	mg/Kg
17-Jul-90	Preparation	ND	1.5000	1.5000	mg/Kg
24-Jul-90	Preparation	ND	2.0000	2.0000	mg/Kg
25-Jul-90	Preparation	ND	0.0200	0.0200	mg/Kg
26-Jul-90	Preparation	ND	1.5000	1.5000	mg/Kg
Total Number of Blanks = 10			Concentration Range NC		
Total Number above Detection Limit = 0			Maximum Detection Limit = 2.0		
Method: Chrome VI by SW7196					
Analyte: Chromium VI					
15-May-90	Field Blank	ND	0.0200	0.0200	mg/Kg
15-May-90	Field Blank	ND	0.0090	0.0090	mg/Kg
15-May-90	Field Blank	ND	0.0200	0.0200	mg/Kg
15-May-90	Field Blank	ND	0.0050	0.0050	mg/Kg
15-May-90	Field Blank	ND	0.1900	0.1900	mg/Kg
16-May-90	Field Blank	ND	0.0050	0.0050	mg/Kg
16-May-90	Field Blank		0.0100		mg/Kg
16-May-90	Field Blank	ND	0.0050	0.0050	mg/Kg
16-May-90	Field Blank	ND	0.0050	0.0050	mg/Kg
17-May-90	Field Blank	ND	0.0050	0.0050	mg/Kg
17-May-90	Field Blank	ND	0.0050	0.0050	mg/Kg
17-May-90	Field Blank	ND	0.0050	0.0050	mg/Kg
17-May-90	Field Blank		0.0060		mg/Kg
18-May-90	Field Blank	ND	0.0050	0.0050	mg/Kg

(Continued)

Table F2 (Continued)

Blank Results for Matrix = SOLID; Submatrix = N/A

Date	Type of Blank	Detection Flag	Result	Detection Limit	Units
Analysis for Chrome VI by SW7196					
Analyte: Chromium VI continued					
18-May-90	Field Blank		0.0050		mg/Kg
15-May-90	Preparation	ND	0.0050	0.0050	mg/Kg
16-May-90	Preparation	ND	0.0050	0.0050	mg/Kg
17-May-90	Preparation	ND	0.0050	0.0050	mg/Kg
17-May-90	Preparation	ND	0.0050	0.0050	mg/Kg
17-May-90	Preparation	ND	0.0050	0.0050	mg/Kg
18-May-90	Preparation	ND	0.0050	0.0050	mg/Kg
18-May-90	Preparation	ND	0.0050	0.0050	mg/Kg
18-May-90	Preparation	ND	0.0050	0.0050	mg/Kg
22-Jul-90	Preparation	ND	0.2000	0.2000	mg/Kg
23-Aug-90	Preparation	ND	0.0800	0.0800	mg/Kg
Total Number of Blanks = 25			Concentration Range	0.0050 - 0.010	
Total Number above Detection Limit = 3			Maximum Detection Limit = 0.20		
Method: Sulfate by IC (E300.0)					
Analyte: Sulfate					
14-Sep-90	Preparation	ND	12.5000	12.5000	mg/Kg
Total Number of Blanks = 1			Concentration Range	NC	
Total Number above Detection Limit = 0			Maximum Detection Limit = 12.5		

(Continued)

Table F2 (Continued)

Blank Results for Matrix = TREATED; Submatrix = WW

Date	Type of Blank	Detection Flag	Result	Detection Limit	Units
	Method: ICP Metals by SW6010				
	Analyte: Chromium				
19-Sep-90	Preparation	ND	0.0030	0.0030	mg/L
19-Sep-90	Preparation	ND	0.0030	0.0030	mg/L
25-Sep-90	Preparation	ND	0.0200	0.0200	mg/L
26-Sep-90	Preparation	<5X	0.0080		mg/L
	Total Number of Blanks = 4		Concentration Range	0.0080 - 0.0080	
	Total Number above Detection Limit = 1		Maximum Detection Limit = 0.020		
	Method: ICP Metals by SW6010				
	Analyte: Iron				
19-Sep-90	Preparation	ND	0.0400	0.0400	mg/L
20-Sep-90	Preparation	ND	0.0400	0.0400	mg/L
26-Sep-90	Preparation	ND	0.0400		mg/L
	Total Number of Blanks = 3		Concentration Range	NC	
	Total Number above Detection Limit = 0		Maximum Detection Limit = 0.040		
	Method: ICP Metals by SW6010				
	Analyte: Lead				
19-Sep-90	Preparation	ND	0.0500	0.0500	mg/L
20-Sep-90	Preparation	ND	0.0500	0.0500	mg/L
26-Sep-90	Preparation	ND	0.0500		mg/L
	Total Number of Blanks = 3		Concentration Range	NC	
	Total Number above Detection Limit = 0		Maximum Detection Limit = 0.050		
	Method: ICP Metals by SW6010				
	Analyte: Nickel				
19-Sep-90	Preparation	ND	0.0200	0.0200	mg/L
20-Sep-90	Preparation	ND	0.0200	0.0200	mg/L
26-Sep-90	Preparation	ND	0.0200		mg/L

(Continued)

Table F2 (Continued)

Blank Results for Matrix = TREATED; Submatrix = WW

Date	Type of Blank	Detection Flag	Result	Detection Limit	Units
Analysis for ICP Metals by SW6010					
Analyte: Nickel continued					
Total Number of Blanks = 3			Concentration Range NC		
Total Number above Detection Limit = 0			Maximum Detection Limit = 0.020		
Method: Chrome VI by SW7196					
Analyte: Chromium VI					
19-May-90	Preparation	ND	0 0050	0.0050	mg/L
Total Number of Blanks = 1			Concentration Range NC		
Total Number above Detection Limit = 0			Maximum Detection Limit = 0.0050		

(Continued)

Table F2 (Continued)

Blank Results for Matrix = TREATED; Submatrix = T

Date	Type of Blank	Detection Flag	Result	Detection Limit	Units
Method: Arsenic by AA (E206.2)					
Analyte: Arsenic					
27-Aug-90	Preparation	ND	0.0040	0.0040	mg/L
16-Oct-90	Preparation	ND	0.0040		mg/L
	Total Number of Blanks = 2		Concentration Range NC		
	Total Number above Detection Limit = 0		Maximum Detection Limit = 0.0040		
Method: Conductivity (E120.1)					
Analyte: Conductivity					
12-Jul-90	Method Blank	ND	1.0000	1.0000	umhos/cm
12-Jul-90	Preparation	ND	1.0000	1.0000	umhos/cm
	Total Number of Blanks = 2		Concentration Range NC		
	Total Number above Detection Limit = 0		Maximum Detection Limit = 1.0		
Method: Mercury by Cold Vapor AA (E245.1)					
Analyte: Mercury					
16-Oct-90	Preparation		0.0002		mg/L
	Total Number of Blanks = 1		Concentration Range 0.00020 - 0.00020		
	Total Number above Detection Limit = 1		Maximum Detection Limit =		
Method: ICP Metals by SW6010					
Analyte: Barium					
27-Aug-90	Preparation	ND	0.0100	0.0100	mg/L
04-Sep-90	Preparation	ND	0.0100	0.0100	mg/L
03-Oct-90	Preparation	ND	0.0100		mg/L

(Continued)

Table F2 (Continued)

Blank Results for Matrix = TREATED; Submatrix = T

Date	Type of Blank	Detection Flag	Result	Detection Limit	Units
Analysis for ICP Metals by SW6010					
Analyte: Barium continued					
	Total Number of Blanks = 3		Concentration Range NC		
	Total Number above Detection Limit = 0		Maximum Detection Limit = 0.010		
Method: ICP Metals by SW6010					
Analyte: Cadmium					
27-Aug-90	Preparation	<5X	0.0093		mg/L
04-Sep-90	Preparation	ND	0.0050	0.0050	mg/L
03-Oct-90	Preparation	ND	0.0050		mg/L
	Total Number of Blanks = 3		Concentration Range 0.0093 - 0.0093		
	Total Number above Detection Limit = 1		Maximum Detection Limit = 0.0050		
Method: ICP Metals by SW6010					
Analyte: Chromium					
27-Aug-90	Preparation	ND	0.0100	0.0100	mg/L
04-Sep-90	Preparation	ND	0.0030	0.0030	mg/L
03-Oct-90	Preparation	<5X	0.0040		mg/L
04-Oct-90	Preparation	ND	0.0030	0.0030	mg/L
04-Oct-90	Preparation	ND	0.0030	0.0030	mg/L
08-Oct-90	Preparation	ND	0.0030	0.0030	mg/L
	Total Number of Blanks = 6		Concentration Range 0.0040 - 0.0040		
	Total Number above Detection Limit = 1		Maximum Detection Limit = 0.010		
Method: ICP Metals by SW6010					
Analyte: Iron					
04-Sep-90	Preparation	ND	0.0400	0.0400	mg/L
03-Oct-90	Preparation	<5X	0.0400		mg/L
03-Oct-90	Preparation	<5X	0.0810		mg/L
04-Oct-90	Preparation	ND	0.0400	0.0400	mg/L
09-Oct-90	Preparation	ND	0.0400	0.0400	mg/L

(Continued)

Table F2 (Continued)

Blank Results for Matrix = TREATED; Submatrix = T

Date	Type of Blank	Detection Flag	Result	Detection Limit	Units
Analysis for ICP Metals by SW6010					
Analyte: Iron continued					
	Total Number of Blanks = 5		Concentration Range	0.040 - 0.081	
	Total Number above Detection Limit = 2		Maximum Detection Limit = 0.040		
Method: ICP Metals by SW6010					
Analyte: Lead					
27-Aug-90	Preparation	ND	0.0500	0.0500	mg/L
04-Sep-90	Preparation	ND	0.0500	0.0500	mg/L
03-Oct-90	Preparation	ND	0.0500	0.0500	mg/L
03-Oct-90	Preparation	ND	0.0500	0.0500	mg/L
04-Oct-90	Preparation	ND	0.0500	0.0500	mg/L
08-Oct-90	Preparation	ND	0.0500	0.0500	mg/L
	Total Number of Blanks = 6		Concentration Range	NC	
	Total Number above Detection Limit = 0		Maximum Detection Limit = 0.050		
Method: ICP Metals by SW6010					
Analyte: Nickel					
04-Sep-90	Preparation	ND	0.0200	0.0200	mg/L
03-Oct-90	Preparation	ND	0.0200	0.0200	mg/L
03-Oct-90	Preparation	ND	0.0200	0.0200	mg/L
04-Oct-90	Preparation	ND	0.0200	0.0200	mg/L
08-Oct-90	Preparation	ND	0.0200	0.0200	mg/L
	Total Number of Blanks = 5		Concentration Range	NC	
	Total Number above Detection Limit = 0		Maximum Detection Limit = 0.020		
Method: ICP Metals by SW6010					
Analyte: Silver					
27-Aug-90	Preparation	<5X	0.0130		mg/L
04-Sep-90	Preparation	ND	0.0100	0.0100	mg/L
03-Oct-90	Preparation	ND	0.0100		mg/L

(Continued)

Table F2 (Continued)

Blank Results for Matrix = TREATED; Submatrix = T

Date	Type of Blank	Detection Flag	Result	Detection Limit	Units
Analysis for ICP Metals by SW6010					
Analyte: Silver continued					
	Total Number of Blanks = 3		Concentration Range	0.013 - 0.013	
	Total Number above Detection Limit = 1		Maximum Detection Limit = 0.010		
Method: Selenium by AA (E270.2)					
Analyte: Selenium					
27-Aug-90	Preparation	ND	0.0050	0.0050	mg/L
16-Oct-90	Preparation	ND	0.0050		mg/L
	Total Number of Blanks = 2		Concentration Range	NC	
	Total Number above Detection Limit = 0		Maximum Detection Limit = 0.0050		
Method: Chrome VI by SW7196					
Analyte: Chromium VI					
06-Jul-90	Preparation	ND	0.0200	0.0200	mg/L
06-Jul-90	Preparation	ND	0.0200	0.0200	mg/L
23-Aug-90	Preparation	ND	0.0200	0.0200	mg/L
	Total Number of Blanks = 3		Concentration Range	NC	
	Total Number above Detection Limit = 0		Maximum Detection Limit = 0.020		
Method: Sulfate by IC (E300.0)					
Analyte: Sulfate					
10-Jul-90	Method Blank	ND	0.0500	0.0500	mg/L
10-Jul-90	Preparation	ND	12.0000	12.0000	mg/L
	Total Number of Blanks = 2		Concentration Range	NC	
	Total Number above Detection Limit = 0		Maximum Detection Limit = 12.0		

(Continued)

Table F2 (Continued)

Blank Results for Matrix = TREATED; Submatrix = N/A

Date	Type of Blank	Detection Flag	Result	Detection Limit	Units
Method: Arsenic by AA (E206.2)					
Analyte: Arsenic					
20-Sep-90	Preparation	ND	0.0040	0.0040	mg/Kg
Total Number of Blanks = 1			Concentration Range NC		
Total Number above Detection Limit = 0			Maximum Detection Limit = 0.0040		
Method: Chloride by IC (E300.0)					
Analyte: Chloride					
28-Sep-90	Preparation	ND	5.0000	5.0000	mg/Kg
Total Number of Blanks = 1			Concentration Range NC		
Total Number above Detection Limit = 0			Maximum Detection Limit = 5.0		
Method: ICP Metals by SW6010					
Analyte: Chromium					
20-Sep-90	Preparation	<5X	0.4000		mg/Kg
25-Sep-90	Preparation	ND	0.0800	0.0800	mg/Kg
26-Sep-90	Preparation	<5X	0.4000		mg/Kg
28-Sep-90	Preparation	ND	0.3000		mg/Kg
28-Sep-90	Preparation	<5X	0.0080		mg/Kg
03-Oct-90	Preparation	ND	0.3000	0.3000	mg/Kg
Total Number of Blanks = 6			Concentration Range 0.0080 - 0.40		
Total Number above Detection Limit = 3			Maximum Detection Limit = 0.30		
Method: ICP Metals by SW6010					
Analyte: Iron					
26-Sep-90	Preparation	ND	4.0000	4.0000	mg/Kg
28-Sep-90	Preparation	<5X	8.9000		mg/Kg
01-Oct-90	Preparation	<5X	0.0600		mg/Kg
03-Oct-90	Preparation	ND	4.0000	4.0000	mg/Kg
03-Oct-90	Preparation	ND	0.0400		mg/Kg

(Continued)

Table F2 (Concluded)

Blank Results for Matrix = TREATED; Submatrix = N/A

Date	Type of Blank	Detection Flag	Result	Detection Limit	Units
Analysis for ICP Metals by SW6010					
Analyte: Iron continued					
Total Number of Blanks = 5			Concentration Range 0.060 - 8.9		
Total Number above Detection Limit = 2			Maximum Detection Limit = 4.0		
Method: ICP Metals by SW6010					
Analyte: Lead					
26-Sep-90	Preparation	ND	5.0000	5.0000	mg/Kg
28-Sep-90	Preparation	ND	5.0000		mg/Kg
03-Oct-90	Preparation	ND	5.0000	5.0000	mg/Kg
03-Oct-90	Preparation	ND	0.0500		mg/Kg
Total Number of Blanks = 4			Concentration Range NC		
Total Number above Detection Limit = 0			Maximum Detection Limit = 5.0		
Method: ICP Metals by SW6010					
Analyte: Nickel					
26-Sep-90	Preparation	ND	2.0000	2.0000	mg/Kg
28-Sep-90	Preparation	ND	2.0000		mg/Kg
01-Oct-90	Preparation	ND	0.0200		mg/Kg
03-Oct-90	Preparation	ND	2.0000	2.0000	mg/Kg
Total Number of Blanks = 4			Concentration Range NC		
Total Number above Detection Limit = 0			Maximum Detection Limit = 2.0		
Method: Selenium by AA (E270.2)					
Analyte: Selenium					
20-Sep-90	Preparation	ND	0.0000	0.0000	mg/Kg
Total Number of Blanks = 1			Concentration Range NC		
Total Number above Detection Limit = 0			Maximum Detection Limit = 0.00000		

Table F3

Summary of Quality Control Check Sample (QCCS)

Results, Frontier Hard Chrome

Blank Results for Matrix = TREATED; Submatrix = N/A

Date	Type of Blank	Detection Flag	Result	Detection Limit	Units
Method: Chrome VI by SW7196					
Analyte: Chromium VI					
20-Sep-90	Preparation	ND	0.0050	0.0050	mg/Kg
Total Number of Blanks = 1			Concentration Range NC		
Total Number above Detection Limit = 0			Maximum Detection Limit = 0.0050		
Method: Sulfate by IC (E300.0)					
Analyte: Sulfate					
28-Sep-90	Preparation	ND	12.5000	12.5000	mg/Kg
Total Number of Blanks = 1			Concentration Range NC		
Total Number above Detection Limit = 0			Maximum Detection Limit = 12.5		

(Continued)

Table F3 (Continued)

SUMMARY OF QCCS RESULTS FOR MATRIX = MW EP LEACHATE

Parameter	Number of Samples	Mean % Recovery	CV (%)
ICP Metals by SW6010			
Calibration Control Sample			
Chromium	5	98.9	1.3
Iron	7	98.2	1.3
Lead	7	97.5	1.0
Nickel	7	97.9	1.3

(Continued)

Table F3 (Continued)

SUMMARY OF QCCS RESULTS FOR MATRIX = Solid

Parameter	Number of Samples	Mean % Recovery	CV (%)
Arsenic by AA (E206.2)			
Calibration Control Sample			
Arsenic	5	96.8	6.0
Conductivity (E120.1)			
Calibration Control Sample			
CONO	5	98.5	2.0
Conductivity	5	100.0	.4
Chloride by IC (E300.0)			
Calibration Control Sample			
Chloride	7	98.3	1.0
Mercury by Cold Vapor AA (E245.1)			
Calibration Control Sample			
Mercury	3	98.3	1.5
ICP Metals by SW6010			
Calibration Control Sample			
Barium	4	97.0	1.6
Cadmium	4	95.9	2.4
Chromium	79	101.6	3.3
Iron	77	100.9	3.3
Lead	80	101.7	3.3
Nickel	72	101.3	3.4
Silver	4	97.5	1.1
Laboratory Control Sample			
Chromium	2	96.0	4.4
Iron	2	104.8	3.8
Lead	2	94.7	4.9
Nickel	2	90.9	14.2
Selenium by AA (E270.2)			
Calibration Control Sample			
Selenium	5	96.8	3.1
Chrome VI			
Calibration Control Sample			
Chromium VI	4	98.9	1.3

(Continued)

Table F3 (Continued)

SUMMARY OF QCCS RESULTS FOR MATRIX = Solid

Parameter	Number of Samples	Mean % Recovery	CV (%)
Chrome VI			
Laboratory Control Sample			
Chromium VI	27	98.0	3.7
Sulfate by IC (E300.0)			
Calibration Control Sample			
Sulfate	5	97.7	1.2

(Continued)

Table F3 (Concluded)

SUMMARY OF QCCS RESULTS FOR MATRIX = TREATED

Parameter	Number of Samples	Mean % Recovery	CV (%)
Arsenic by AA (E206.2)			
Calibration Control Sample			
Arsenic	5	99.4	8.5
Laboratory Control Sample			
Arsenic	1	114.4	
Conductivity (E120.1)			
Calibration Control Sample			
Conductivity	12	100.2	.9
Chloride by IC (E300.0)			
Calibration Control Sample			
Chloride	14	98.0	2.5
Mercury by Cold Vapor AA (E245.1)			
Calibration Control Sample			
Mercury	4	98.1	2.6
ICP Metals by SW6010			
Calibration Control Sample			
Barium	9	99.5	1.4
Cadmium	9	95.6	3.5
Chromium	44	100.7	2.1
Chromium VI	1	102.0	
Iron	45	98.7	2.0
Lead	42	101.8	5.2
Nickel	39	101.8	4.9
Silver	9	97.8	2.5
Laboratory Control Sample			
Barium	1	102.0	
Cadmium	1	102.0	
Chromium	8	94.6	6.8
Iron	6	91.8	10.3
Lead	7	96.4	7.2
Nickel	7	90.7	9.9
Silver	1	99.7	
pH by SW9045			

Table F4

Detailed Listing of Quality Control Check Sample (QCCS)

Results, Frontier Hard Chrome

SUMMARY OF QCCS RESULTS FOR MATRIX = TREATED

Parameter	Number of Samples	Mean % Recovery	CV (%)
pH by SW9045			
Calibration Control Sample			
pH	3	100.9	.8
Selenium by AA (E270.2)			
Calibration Control Sample			
Selenium	5	96.7	3.8
Laboratory Control Sample			
Selenium	1	83.6	
Chrome VI			
Calibration Control Sample			
Chromium VI	31	102.1	2.1
Sulfate by IC (E300.0)			
Calibration Control Sample			
Sulfate	15	97.0	2.4

(Continued)

Table F4 (Continued)

Date	True Value	Det Flag	Measured Value	% Recovery
Method: Arsenic by AA (E206.2)				
Matrix: Solid				
Analyte: Arsenic				
Type of Control Sample: Calibration Control Sample.				
27-Aug-90	0.050 mg/L		0.052 mg/L	104.00
27-Aug-90	0.050 mg/L		0.049 mg/L	98.00
06-Sep-90	0.050 mg/L		0.046 mg/L	92.00
06-Sep-90	0.050 mg/L		0.050 mg/L	100.00
06-Sep-90	0.050 mg/L		0.045 mg/L	90.00
Number of Samples = 5	Mean % Recovery = 96.8		CV (%) = 6.0	
Method: Arsenic by AA (E206.2)				
Matrix: TREATED				
Analyte: Arsenic				
Type of Control Sample: Calibration Control Sample.				
06-Sep-90	0.050 mg/L		0.050 mg/L	100.00
06-Sep-90	0.050 mg/L		0.046 mg/L	92.00
06-Sep-90	0.050 mg/L		0.045 mg/L	90.00
16-Oct-90	0.050 mg/L		0.053 mg/l	105.00
16-Oct-90	0.050 mg/L		0.055 mg/l	110.00
Type of Control Sample: Laboratory Control Sample.				
16-Oct-90	0.050 mg/L		0.057 mg/l	114.40
Number of Samples = 6	Mean % Recovery = 101.9		CV (%) = 9.6	

(Continued)

Table F4 (Continued)

Date	True Value		Det Flag	Measured Value		% Recovery
Method: Conductivity (E120.1)						
Matrix: Solid						
Analyte: COND						
Type of Control Sample: Calibration Control Sample.						
12-Jul-90	1403.0	umhos/cm		1384.000	mhos	98.65
12-Jul-90	1403.0	umhos/cm		1409.000	mhos	100.43
12-Jul-90	1403.0	umhos/cm		1405.000	mhos	100.14
26-Jul-90	1403.0	umhos/cm		1345.000	mhos	95.87
26-Jul-90	1403.0	umhos/cm		1365.000	mhos	97.29
Number of Samples = 5	Mean % Recovery = 98.5			CV (%) = .0		
Method: Conductivity (E120.1)						
Matrix: Solid						
Analyte: Conductivity						
Type of Control Sample: Calibration Control Sample.						
04-Sep-90	1400.0	umhos/cm		1395.000	umhos/cm	99.64
04-Sep-90	1400.0	umhos/cm		1409.000	umhos/cm	100.64
04-Sep-90	1400.0	umhos/cm		1398.000	umhos/cm	99.86
05-Sep-90	1400.0	umhos/cm		1399.000	umhos/cm	99.93
05-Sep-90	1400.0	umhos/cm		1397.000	umhos/cm	99.79
Number of Samples = 5	Mean % Recovery = 100.0			CV (%) = .0		
Method: Conductivity (E120.1)						
Matrix: TREATED						
Analyte: Conductivity						
Type of Control Sample: Calibration Control Sample.						
04-Sep-90	1400.0	umhos/cm		1409.000	umhos/cm	100.64
04-Sep-90	1400.0	umhos/cm		1409.000	umhos/cm	100.64
04-Sep-90	1400.0	umhos/cm		1398.000	umhos/cm	99.86
04-Sep-90	1400.0	umhos/cm		1395.000	umhos/cm	99.64
04-Sep-90	1400.0	umhos/cm		1395.000	umhos/cm	99.64
04-Sep-90	1400.0	umhos/cm		1398.000	umhos/cm	99.86

(Continued)

Table F4 (Continued)

Date	True Value	Det Flag	Measured Value	% Recovery
Method: Chloride by IC (E300.0)				
Matrix: TREATED				
Analyte: Chloride				
Type of Control Sample: Calibration Control Sample.				
14-Sep-90	8.000 mg/L		7.841 mg/L	98.01
14-Sep-90	8.000 mg/L		7.890 mg/L	98.63
14-Sep-90	8.000 mg/L		7.840 mg/L	98.00
14-Sep-90	8.000 mg/L		8.010 mg/L	100.13
14-Sep-90	8.000 mg/L		7.890 mg/L	98.63
14-Sep-90	8.000 mg/L		7.841 mg/L	98.01
14-Sep-90	8.000 mg/L		7.890 mg/L	98.63
14-Sep-90	8.000 mg/L		8.010 mg/L	100.13
28-Sep-90	8.000 mg/L		8.210 mg/L	102.63
28-Sep-90	8.000 mg/L		7.940 mg/L	99.25
28-Sep-90	8.000 mg/L		7.750 mg/L	96.88
03-Oct-90	8.000 mg/L		7.543 mg/L	94.29
03-Oct-90	8.000 mg/L		7.581 mg/L	94.76
03-Oct-90	8.000 mg/L		7.516 mg/L	93.95
Number of Samples = 14	Mean % Recovery = 98.0		CV (%) = 2.5	
Method: Mercury by Cold Vapor AA (E245.1)				
Matrix: Solid				
Analyte: Mercury				
Type of Control Sample: Calibration Control Sample.				
27-Aug-90	0.0040 mg/L		0.004 mg/L	100.00
27-Aug-90	0.0040 mg/L		0.004 mg/L	97.50
04-Sep-90	0.0040 mg/L		0.004 mg/L	97.50
Number of Samples = 3	Mean % Recovery = 98.3		CV (%) = 1.5	

(Continued)

Table F4 (Continued)

Date	True Value	Det Flag	Measured Value	% Recovery
Method: Chloride by IC (E300.0)				
Matrix: TREATED				
Analyte: Chloride				
Type of Control Sample: Calibration Control Sample.				
14-Sep-90	8.000 mg/L		7.841 mg/L	98.01
14-Sep-90	8.000 mg/L		7.890 mg/L	98.63
14-Sep-90	8.000 mg/L		7.840 mg/L	98.00
14-Sep-90	8.000 mg/L		8.010 mg/L	100.13
14-Sep-90	8.000 mg/L		7.890 mg/L	98.63
14-Sep-90	8.000 mg/L		7.841 mg/L	98.01
14-Sep-90	8.000 mg/L		7.890 mg/L	98.63
14-Sep-90	8.000 mg/L		8.010 mg/L	100.13
28-Sep-90	8.000 mg/L		8.210 mg/L	102.63
28-Sep-90	8.000 mg/L		7.940 mg/L	99.25
28-Sep-90	8.000 mg/L		7.750 mg/L	96.88
03-Oct-90	8.000 mg/L		7.543 mg/l	94.29
03-Oct-90	8.000 mg/L		7.581 mg/l	94.76
03-Oct-90	8.000 mg/L		7.516 mg/l	93.95
Number of Samples = 14	Mean % Recovery = 98.0		CV (%) = 2.5	
Method: Mercury by Cold Vapor AA (E245.1)				
Matrix: Solid				
Analyte: Mercury				
Type of Control Sample: Calibration Control Sample.				
27-Aug-90	0.0040 mg/L		0.004 mg/L	100.00
27-Aug-90	0.0040 mg/L		0.004 mg/L	97.50
04-Sep-90	0.0040 mg/L		0.004 mg/L	97.50
Number of Samples = 3	Mean % Recovery = 98.3		CV (%) = 1.5	

(Continued)

Table F4 (Continued)

Date	True Value	Det Flag	Measured Value	% Recovery
Method: Mercury by Cold Vapor AA (E245.1)				
Matrix: TREATED				
Analyte: Mercury				
Type of Control Sample: Calibration Control Sample.				
04-Sep-90	0.0040 mg/L		0.004 mg/L	95.00
04-Sep-90	0.0040 mg/L		0.004 mg/L	97.50
16-Oct-90	0.0040 mg/L		0.004 mg/l	99.00
16-Oct-90	0.0040 mg/L		0.004 mg/l	101.00
Number of Samples = 4	Mean % Recovery = 98.1		CV (%) = 2.6	
Method: ICP Metals by SW6010				
Matrix: MW EP LEACHATE				
Analyte: Chromium				
Type of Control Sample: Calibration Control Sample.				
18-Jun-90	5.000 mg/L		4.980 mg/L	99.60
18-Jun-90	5.000 mg/L		5.000 mg/L	100.00
18-Jun-90	5.000 mg/L		4.890 mg/L	97.80
18-Jun-90	5.000 mg/L		4.860 mg/L	97.20
18-Jun-90	5.000 mg/L		4.990 mg/L	99.80
Number of Samples = 5	Mean % Recovery = 98.9		CV (%) = 1.3	
Method: ICP Metals by SW6010				
Matrix: MW EP LEACHATE				
Analyte: Iron				
Type of Control Sample: Calibration Control Sample.				
18-Jun-90	5.000 mg/L		4.880 mg/L	97.60
18-Jun-90	5.000 mg/L		4.840 mg/L	96.80
18-Jun-90	5.000 mg/L		4.980 mg/L	99.60
18-Jun-90	5.000 mg/L		4.950 mg/L	99.00
18-Jun-90	5.000 mg/L		4.960 mg/L	99.20
18-Jun-90	5.000 mg/L		4.940 mg/L	98.80
18-Jun-90	5.000 mg/L		4.820 mg/L	96.40

(Continued)

Table F4 (Continued)

Date	True Value	Det Flag	Measured Value	% Recovery
Method: ICP Metals by SW6010				
Matrix: MW EP LEACHATE				
Analyte: Iron				
Type of Control Sample: Calibration Control Sample. continued				
Number of Samples = 7	Mean % Recovery =	98.2	CV (%) =	1.3
Method: ICP Metals by SW6010				
Matrix: MW EP LEACHATE				
Analyte: Lead				
Type of Control Sample: Calibration Control Sample.				
18-Jun-90	5.000 mg/L		4.830 mg/L	96.60
18-Jun-90	5.000 mg/L		4.890 mg/L	97.80
18-Jun-90	5.000 mg/L		4.810 mg/L	96.20
18-Jun-90	5.000 mg/L		4.860 mg/L	97.20
18-Jun-90	5.000 mg/L		4.950 mg/L	99.00
18-Jun-90	5.000 mg/L		4.910 mg/L	98.20
18-Jun-90	5.000 mg/L		4.880 mg/L	97.60
Number of Samples = 7	Mean % Recovery =	97.5	CV (%) =	1.0
Method: ICP Metals by SW6010				
Matrix: MW EP LEACHATE				
Analyte: Nickel				
Type of Control Sample: Calibration Control Sample.				
18-Jun-90	5.000 mg/L		4.830 mg/L	96.60
18-Jun-90	5.000 mg/L		4.890 mg/L	97.80
18-Jun-90	5.000 mg/L		4.780 mg/L	95.60
18-Jun-90	5.000 mg/L		4.960 mg/L	99.20
18-Jun-90	5.000 mg/L		4.940 mg/L	98.80
18-Jun-90	5.000 mg/L		4.920 mg/L	98.40
18-Jun-90	5.000 mg/L		4.930 mg/L	98.60
Number of Samples = 7	Mean % Recovery =	97.9	CV (%) =	1.3

(Continued)

Table F4 (Continued)

Date	True Value		Det Flag	Measured Value	% Recovery
Method: ICP Metals by SW6010					
Matrix: Solid					
Analyte: Barium					
Type of Control Sample: Calibration Control Sample.					
27-Aug-90	5.000	mg/L		4.790 mg/L	95.80
27-Aug-90	5.000	mg/L		4.810 mg/L	96.20
27-Aug-90	5.000	mg/L		4.830 mg/L	96.60
27-Aug-90	10.0	mg/L		9.930 mg/L	99.30
Number of Samples = 4	Mean % Recovery =		97.0	CV (%) =	1.6
Method: ICP Metals by SW6010					
Matrix: Solid					
Analyte: Cadmium					
Type of Control Sample: Calibration Control Sample.					
27-Aug-90	5.000	mg/L		4.740 mg/L	94.80
27-Aug-90	10.0	mg/L		9.940 mg/L	99.40
27-Aug-90	5.000	mg/L		4.720 mg/L	94.40
27-Aug-90	5.000	mg/L		4.750 mg/L	95.00
Number of Samples = 4	Mean % Recovery =		95.9	CV (%) =	2.4
Method: ICP Metals by SW6010					
Matrix: Solid					
Analyte: Chromium					
Type of Control Sample: Calibration Control Sample.					
21-May-90	5.000	mg/L		5.130 mg/L	102.60
21-May-90	5.000	mg/L		5.130 mg/L	102.60
23-May-90	5.000	mg/L		5.480 mg/L	109.60
23-May-90	5.000	mg/L		5.200 mg/L	104.00
28-May-90	5.000	mg/L		5.140 mg/L	102.80
28-May-90	5.000	mg/L		5.070 mg/L	101.40
29-May-90	5.000	mg/L		4.650 mg/L	93.00
29-May-90	5.000	mg/L		4.740 mg/L	94.80
29-May-90	5.000	mg/L		4.740 mg/L	94.80

(Continued)

Table F4 (Continued)

Date	True Value		Det Flag	Measured Value		% Recovery
Method: ICP Metals by SW6010						
Matrix: Solid						
Analyte: Chromium						
Type of Control Sample: Calibration Control Sample, continued						
29-May-90	5.000	mg/L		4.770	mg/L	95.40
29-May-90	5.000	mg/L		4.890	mg/L	97.80
29-May-90	5.000	mg/L		4.810	mg/L	96.20
29-May-90	5.000	mg/L		4.830	mg/L	96.60
31-May-90	5.000	mg/L		5.140	mg/L	102.80
31-May-90	5.000	mg/L		5.110	mg/L	102.20
01-Jun-90	5.000	mg/L		5.100	mg/L	102.00
01-Jun-90	5.000	mg/L		5.110	mg/L	102.20
01-Jun-90	5.000	mg/L		5.090	mg/L	101.80
02-Jun-90	5.000	mg/L		5.120	mg/L	102.40
02-Jun-90	5.000	mg/L		5.010	mg/L	100.20
02-Jun-90	5.000	mg/L		5.030	mg/L	100.60
03-Jun-90	5.000	mg/L		5.130	mg/L	102.60
03-Jun-90	5.000	mg/L		5.170	mg/L	103.40
03-Jun-90	5.000	mg/L		5.180	mg/L	103.60
03-Jun-90	5.000	mg/L		5.070	mg/L	101.40
14-Jun-90	5.000	mg/L		4.980	mg/L	99.60
14-Jun-90	5.000	mg/L		5.070	mg/L	101.40
17-Jun-90	5.000	mg/L		4.980	mg/L	99.60
17-Jun-90	5.000	mg/L		5.060	mg/L	101.20
19-Jun-90	5.000	mg/L		5.120	mg/L	102.40
19-Jun-90	5.000	mg/L		5.140	mg/L	102.80
19-Jun-90	5.000	mg/L		5.070	mg/L	101.40
19-Jun-90	5.000	mg/L		5.060	mg/L	101.20
19-Jun-90	5.000	mg/L		5.190	mg/L	101.40
19-Jun-90	5.000	mg/L		5.050	mg/L	101.00
20-Jun-90	5.000	mg/L		5.160	mg/L	103.20
20-Jun-90	5.000	mg/L		5.140	mg/L	102.80
21-Jun-90	5.000	mg/L		5.140	mg/L	102.80
21-Jun-90	5.000	mg/L		5.130	mg/L	102.60
25-Jun-90	5.000	mg/L		5.390	mg/L	107.80
25-Jun-90	5.000	mg/L		5.240	mg/L	104.80
11-Jul-90	5.000	mg/L		5.030	mg/L	101.80
11-Jul-90	5.000	mg/L		5.090	mg/L	101.80
12-Jul-90	5.000	mg/L		5.190	mg/L	103.80
12-Jul-90	5.000	mg/L		5.140	mg/L	102.80
12-Jul-90	5.000	mg/L		5.020	mg/L	100.40
12-Jul-90	5.000	mg/L		5.540	mg/L	110.80

(Continued)

Table F4 (Continued)

Date	True Value	Det Flag	Measured Value	% Recovery
Method: ICP Metals by SW6010				
Matrix: Solid				
Analyte: Chromium				
Type of Control Sample: Calibration Control Sample, continued				
12-Jul-90	5.000 mg/L		5.080 mg/L	101.60
12-Jul-90	5.000 mg/L		5.510 mg/L	110.20
12-Jul-90	5.000 mg/L		5.480 mg/L	109.60
12-Jul-90	5.000 mg/L		5.180 mg/L	103.60
13-Jul-90	5.000 mg/L		5.190 mg/L	104.60
13-Jul-90	5.000 mg/L		5.230 mg/L	104.60
17-Jul-90	5.000 mg/L		5.030 mg/L	100.60
17-Jul-90	5.000 mg/L		5.150 mg/L	103.00
17-Jul-90	5.000 mg/L		5.180 mg/L	103.60
17-Jul-90	5.000 mg/L		4.960 mg/L	99.20
24-Jul-90	10.0 mg/L		10.100 mg/L	101.00
24-Jul-90	5.000 mg/L		4.940 mg/L	98.80
24-Jul-90	5.000 mg/L		5.100 mg/L	102.00
24-Jul-90	5.000 mg/L		4.910 mg/L	98.20
24-Jul-90	5.000 mg/L		5.100 mg/L	102.00
25-Jul-90	10.0 mg/L		10.200 mg/L	102.00
25-Jul-90	5.000 mg/L		5.190 mg/L	103.80
25-Jul-90	5.000 mg/L		4.960 mg/L	99.20
25-Jul-90	5.000 mg/L		5.210 mg/L	104.20
25-Jul-90	5.000 mg/L		5.080 mg/L	101.60
26-Jul-90	5.000 mg/L		5.230 mg/L	104.60
26-Jul-90	5.000 mg/L		5.200 mg/L	104.00
26-Jul-90	5.000 mg/L		5.010 mg/L	100.20
26-Jul-90	5.000 mg/L		5.190 mg/L	103.80
2[illegible] Jul-90	10.0 mg/L		10.100 mg/L	101.00
27-Aug-90	5.000 mg/L		4.790 mg/L	95.80
27-Aug-90	10.0 mg/L		9.920 mg/L	99.20
27-Aug-90	5.000 mg/L		4.840 mg/L	96.80
27-Aug-90	5.000 mg/L		4.770 mg/L	95.40
08-Oct-90	10.0 mg/L		9.960 mg/L	99.60
08-Oct-90	5.000 mg/L		4.890 mg/L	97.80
08-Oct-90	5.000 mg/L		5.160 mg/L	103.20
Type of Control Sample: Laboratory Control Sample.				
24-Jul-90	1.000 mg/L		0.930 mg/L	93.00
26-Jul-90	1.000 mg/L		0.990 mg/L	99.00

(Continued)

Table F4 (Continued)

Date	True Value	Det Flag	Measured Value	% Recovery
Method: ICP Metals by SW6010				
Matrix: Solid				
Analyte: Chromium				
Type of Control Sample: Laboratory Control Sample, continued				
Number of Samples = 81	Mean % Recovery = 101.5		CV (%) = 3.4	
Method: ICP Metals by SW6010				
Matrix: Solid				
Analyte: Iron				
Type of Control Sample: Calibration Control Sample.				
21-May-90	5.000 mg/L		5.120 mg/L	102.40
21-May-90	5.000 mg/L		5.110 mg/L	102.20
23-May-90	5.000 mg/L		5.430 mg/L	108.60
23-May-90	5.000 mg/L		5.180 mg/L	103.60
28-May-90	5.000 mg/L		5.050 mg/L	101.00
28-May-90	5.000 mg/L		5.150 mg/L	103.00
29-May-90	5.000 mg/L		4.710 mg/L	94.20
29-May-90	5.000 mg/L		4.610 mg/L	92.20
29-May-90	5.000 mg/L		4.880 mg/L	97.60
29-May-90	5.000 mg/L		4.730 mg/L	94.60
29-May-90	5.000 mg/L		4.780 mg/L	95.60
29-May-90	5.000 mg/L		4.820 mg/L	96.40
29-May-90	5.000 mg/L		4.720 mg/L	94.40
31-May-90	5.000 mg/L		5.130 mg/L	102.60
31-May-90	5.000 mg/L		5.180 mg/L	103.60
01-Jun-90	5.000 mg/L		5.080 mg/L	101.60
01-Jun-90	5.000 mg/L		5.210 mg/L	104.20
01-Jun-90	5.000 mg/L		5.170 mg/L	103.40
01-Jun-90	5.000 mg/L		5.180 mg/L	103.60
02-Jun-90	5.000 mg/L		5.050 mg/L	101.00
02-Jun-90	5.000 mg/L		4.960 mg/L	99.20
02-Jun-90	5.000 mg/L		5.160 mg/L	103.20
03-Jun-90	5.000 mg/L		5.060 mg/L	101.20
03-Jun-90	5.000 mg/L		5.120 mg/L	102.40
03-Jun-90	5.000 mg/L		5.020 mg/L	100.40
03-Jun-90	5.000 mg/L		5.100 mg/L	102.00
14-Jun-90	5.000 mg/L		4.940 mg/L	98.80
14-Jun-90	5.000 mg/L		5.020 mg/L	100.40
17-Jun-90	5.000 mg/L		4.950 mg/L	99.00

(Continued)

Table F4 (Continued)

Date	True Value	Det Flag	Measured Value	% Recovery
Method: ICP Metals by SW6010				
Matrix: Solid				
Analyte: Iron				
Type of Control Sample: Calibration Control Sample. continued				
25-Jul-90	200.0 mg/L		202.000 mg/L	101.00
25-Jul-90	50.0 mg/L		48.200 mg/L	96.40
26-Jul-90	200.0 mg/L		202.000 mg/L	101.00
26-Jul-90	5.000 mg/L		5.180 mg/L	103.60
26-Jul-90	5.000 mg/L		5.210 mg/L	104.20
26-Jul-90	50.0 mg/L		47.000 mg/L	94.00
26-Jul-90	50.0 mg/L		49.200 mg/L	98.40
09-Oct-90	50.0 mg/L		49.500 mg/L	99.00
09-Oct-90	200.0 mg/L		192.000 mg/L	96.00
09-Oct-90	50.0 mg/L		50.200 mg/L	100.40
Type of Control Sample: Laboratory Control Sample.				
24-Jul-90	15700.0 mg/Kg		16900.000 mg/Kg	107.64
26-Jul-90	10.0 mg/L		10.200 mg/L	102.00
Number of Samples = 79	Mean % Recovery = 101.0		CV (%) =	3.4
Method: ICP Metals by SW6010				
Matrix: Solid				
Analyte: Lead				
Type of Control Sample: Calibration Control Sample.				
21-May-90	5.000 mg/L		5.160 mg/L	103.20
21-May-90	5.000 mg/L		5.150 mg/L	103.00
23-May-90	5.000 mg/L		5.070 mg/L	101.40
23-May-90	5.000 mg/L		5.460 mg/L	109.20
28-May-90	5.000 mg/L		5.150 mg/L	103.00
28-May-90	5.000 mg/L		4.900 mg/L	98.00
29-May-90	5.000 mg/L		4.620 mg/L	92.40
29-May-90	5.000 mg/L		4.750 mg/L	95.00
29-May-90	5.000 mg/L		4.730 mg/L	94.60
29-May-90	5.000 mg/L		4.820 mg/L	96.40
29-May-90	5.000 mg/L		4.860 mg/L	97.20
29-May-90	5.000 mg/L		4.890 mg/L	97.80
29-May-90	5.000 mg/L		4.760 mg/L	95.20

(Continued)

Table F4 (Continued)

Date	True Value	Det Flag	Measured Value	% Recovery
Method: ICP Metals by SW6010				
Matrix: Solid				
Analyte: Lead				
Type of Control Sample: Calibration Control Sample. continued				
31-May-90	5.000 mg/L		5.110 mg/L	102.20
31-May-90	5.000 mg/L		5.060 mg/L	101.20
01-Jun-90	5.000 mg/L		5.100 mg/L	102.00
01-Jun-90	5.000 mg/L		5.070 mg/L	101.40
01-Jun-90	5.000 mg/L		5.120 mg/L	102.40
02-Jun-90	5.000 mg/L		4.960 mg/L	99.20
02-Jun-90	5.000 mg/L		4.940 mg/L	98.80
02-Jun-90	5.000 mg/L		4.990 mg/L	99.80
03-Jun-90	5.000 mg/L		5.120 mg/L	102.40
03-Jun-90	5.000 mg/L		5.060 mg/L	101.20
03-Jun-90	5.000 mg/L		5.030 mg/L	100.60
03-Jun-90	5.000 mg/L		5.050 mg/L	101.00
14-Jun-90	5.000 mg/L		5.050 mg/L	101.00
14-Jun-90	5.000 mg/L		4.900 mg/L	98.00
17-Jun-90	5.000 mg/L		5.060 mg/L	101.20
17-Jun-90	5.000 mg/L		4.910 mg/L	98.20
19-Jun-90	5.000 mg/L		5.100 mg/L	102.00
19-Jun-90	5.000 mg/L		5.060 mg/L	101.20
19-Jun-90	5.000 mg/L		5.170 mg/L	103.40
19-Jun-90	5.000 mg/L		5.130 mg/L	102.60
19-Jun-90	5.000 mg/L		5.110 mg/L	102.20
19-Jun-90	5.000 mg/L		5.150 mg/L	103.00
20-Jun-90	5.000 mg/L		5.120 mg/L	102.40
20-Jun-90	5.000 mg/L		5.110 mg/L	102.20
21-Jun-90	5.000 mg/L		5.160 mg/L	103.20
21-Jun-90	5.000 mg/L		5.170 mg/L	103.40
25-Jun-90	5.000 mg/L		5.210 mg/L	104.20
25-Jun-90	5.000 mg/L		5.360 mg/L	107.20
11-Jul-90	5.000 mg/L		5.130 mg/L	102.60
11-Jul-90	5.000 mg/L		5.150 mg/L	103.00
12-Jul-90	5.000 mg/L		5.030 mg/L	100.60
12-Jul-90	5.000 mg/L		5.130 mg/L	102.60
12-Jul-90	5.000 mg/L		5.110 mg/L	102.20
12-Jul-90	5.000 mg/L		5.120 mg/L	102.40
12-Jul-90	5.000 mg/L		5.220 mg/L	104.40
12-Jul-90	5.000 mg/L		5.500 mg/L	110.00
12-Jul-90	5.000 mg/L		5.430 mg/L	108.60
12-Jul-90	5.000 mg/L		5.490 mg/L	109.80

(Continued)

Table F4 (Continued)

Date	True Value		Det Flag	Measured Value		% Recovery
Method: ICP Metals by SW6010						
Matrix: Solid						
Analyte: Lead						
Type of Control Sample: Calibration Control Sample. continued						
13-Jul-90	5.000	mg/L		5.230	mg/L	104.60
13-Jul-90	5.000	mg/L		5.110	mg/L	102.20
17-Jul-90	5.000	mg/L		5.170	mg/L	103.40
17-Jul-90	5.000	mg/L		5.270	mg/L	105.40
17-Jul-90	5.000	mg/L		5.190	mg/L	103.80
17-Jul-90	5.000	mg/L		5.130	mg/L	102.60
24-Jul-90	5.000	mg/L		5.200	mg/L	104.00
24-Jul-90	10.0	mg/L		10.100	mg/L	101.00
24-Jul-90	5.000	mg/L		4.890	mg/L	97.80
24-Jul-90	5.000	mg/L		5.010	mg/L	100.20
24-Jul 90	5.000	mg/L		4.990	mg/L	99.80
25-Jul-90	10.0	mg/L		10.100	mg/L	101.00
25-Jul-90	5.000	mg/L		4.880	mg/L	97.60
25-Jul-90	5.000	mg/L		5.020	mg/L	100.40
25-Jul-90	5.000	mg/L		5.170	mg/L	103.40
25-Jul-90	5.000	mg/L		5.110	mg/L	102.20
26-Jul-90	10.0	mg/L		10.100	mg/L	101.00
26-Jul-90	5.000	mg/L		5.090	mg/L	101.80
26-Jul-90	5.000	mg/L		5.270	mg/L	105.40
26-Jul-90	5.000	mg/L		5.170	mg/L	103.40
26-Jul-90	5.000	mg/L		5.280	mg/L	105.60
27-Aug-90	5.000	mg/L		4.880	mg/L	97.60
27-Aug-90	5.000	mg/L		4.910	mg/L	98.20
27-Aug-90	10.0	mg/L		9.980	mg/L	99.80
27-Aug-90	5.000	mg/L		4.770	mg/L	95.40
08-Oct-90	10.0	mg/L		9.950	mg/L	99.50
08-Oct-90	5.000	mg/L		5.260	mg/L	105.20
08-Oct-90	5.000	mg/L		5.110	mg/L	102.20
08-Oct-90	5.000	mg/L		5.370	mg/L	107.40
Type of Control Sample: Laboratory Control Sample.						
24-Jul-90	117.0	mg/Kg		107.000	mg/Kg	91.45
26-Jul-90	1.000	mg/L		0.980	mg/L	98.00
Number of Samples = 82	Mean % Recovery = 101.5			CV (%) = 3.5		

(Continued)

Table F4 (Continued)

Date	True Value	Measured Value	% Recovery
Method: ICP Metals by SW6010			
Matrix: Solid			
Analyte: Nickel			
Type of Control Sample: Calibration Control Sample.			
21-May-90	5.000 mg/L	5.070 mg/L	101.40
21-May-90	5.000 mg/L	5.100 mg/L	102.00
23-May-90	5.000 mg/L	5.160 mg/L	103.20
23-May-90	5.000 mg/L	5.520 mg/L	110.40
28-May-90	5.000 mg/L	4.996 mg/L	99.80
28-May-90	5.000 mg/L	5.050 mg/L	101.00
29-May-90	5.000 mg/L	4.750 mg/L	95.00
29-May-90	5.000 mg/L	4.700 mg/L	94.00
29-May-90	5.000 mg/L	4.780 mg/L	95.60
29-May-90	5.000 mg/L	4.580 mg/L	91.60
29-May-90	5.000 mg/L	4.700 mg/L	94.00
29-May-90	5.000 mg/L	4.700 mg/L	94.00
29-May-90	5.000 mg/L	4.840 mg/L	96.80
31-May-90	5.000 mg/L	5.040 mg/L	100.80
31-May-90	5.000 mg/L	5.080 mg/L	101.60
01-Jun-90	5.000 mg/L	5.070 mg/L	101.40
01-Jun-90	5.000 mg/L	5.090 mg/L	101.80
01-Jun-90	5.000 mg/L	5.050 mg/L	101.00
01-Jun-90	5.000 mg/L	5.120 mg/L	102.40
02-Jun-90	5.000 mg/L	5.150 mg/L	103.00
02-Jun-90	5.000 mg/L	5.080 mg/L	101.60
02-Jun-90	5.000 mg/L	4.980 mg/L	99.60
03-Jun-90	5.000 mg/L	5.040 mg/L	100.80
03-Jun-90	5.000 mg/L	5.240 mg/L	104.80
03-Jun-90	5.000 mg/L	5.250 mg/L	105.00
03-Jun-90	5.000 mg/L	5.220 mg/L	104.40
14-Jun-90	5.000 mg/L	4.880 mg/L	97.60
14-Jun-90	5.000 mg/L	5.010 mg/L	100.20
17-Jun-90	5.000 mg/L	4.920 mg/L	98.40
17-Jun-90	5.000 mg/L	5.010 mg/L	100.20
19-Jun-90	5.000 mg/L	5.150 mg/L	103.00
19-Jun-90	5.000 mg/L	5.130 mg/L	102.60
19-Jun-90	5.000 mg/L	5.040 mg/L	100.80
19-Jun-90	5.000 mg/L	5.110 mg/L	102.20
19-Jun-90	5.000 mg/L	5.000 mg/L	100.00
20-Jun-90	5.000 mg/L	5.110 mg/L	102.20
20-Jun-90	5.000 mg/L	5.090 mg/L	101.80
21-Jun-90	5.000 mg/L	5.050 mg/L	101.00

(Continued)

Table F4 (Continued)

Date	True Value	Det Flag	Measured Value	% Recovery
Method: ICP Metals by SW6010				
Matrix: Solid				
Analyte: Nickel				
Type of Control Sample: Calibration Control Sample, continued				
21-Jun-90	5.000 mg/L		5.010 mg/L	[illegible]
25-Jun-90	5.000 mg/L		5.440 mg/L	[illegible]
25-Jun-90	5.000 mg/L		5.220 mg/L	[illegible]
12-Jul-90	5.000 mg/L		5.000 mg/L	[illegible]
12-Jul-90	5.000 mg/L		5.120 mg/L	[illegible]
12-Jul-90	5.000 mg/L		5.410 mg/L	[illegible]
12-Jul-90	5.000 mg/L		5.080 mg/L	[illegible]
12-Jul-90	5.000 mg/L		5.440 mg/L	[illegible]
12-Jul-90	5.000 mg/L		5.040 mg/L	[illegible]
12-Jul-90	5.000 mg/L		5.400 mg/L	108.00
12-Jul-90	5.000 mg/L		5.120 mg/L	102.40
17-Jul-90	5.000 mg/L		4.910 mg/L	98.20
17-Jul-90	5.000 mg/L		5.070 mg/L	101.40
17-Jul-90	5.000 mg/L		5.040 mg/L	100.80
17-Jul-90	5.000 mg/L		5.120 mg/L	102.40
24-Jul-90	5.000 mg/L		5.200 mg/L	104.00
24-Jul-90	5.000 mg/L		5.200 mg/L	104.00
24-Jul-90	5.000 mg/L		4.930 mg/L	98.60
24-Jul-90	5.000 mg/L		4.980 mg/L	99.60
24-Jul-90	10.0 mg/L		10.100 mg/L	101.00
25-Jul-90	10.0 mg/L		10.100 mg/L	101.00
25-Jul-90	5.000 mg/L		4.990 mg/L	99.80
25-Jul-90	5.000 mg/L		4.830 mg/L	96.60
25-Jul-90	5.000 mg/L		5.080 mg/L	101.60
25-Jul-90	5.000 mg/L		5.130 mg/L	102.60
26-Jul-90	5.000 mg/L		4.970 mg/L	99.40
26-Jul-90	10.0 mg/L		10.100 mg/L	101.00
26-Jul-90	5.000 mg/L		5.120 mg/L	102.40
26-Jul-90	5.000 mg/L		5.170 mg/L	103.40
26-Jul-90	5.000 mg/L		5.180 mg/L	103.60
08-Oct-90	5.000 mg/L		5.350 mg/L	107.00
08-Oct-90	5.000 mg/L		5.080 mg/L	101.60
08-Oct-90	5.000 mg/L		5.180 mg/L	103.60
08-Oct-90	10.0 mg/L		9.940 mg/L	99.40

(Continued)

Table F4 (Continued)

Date	True Value	Det Flag	Measured Value	% Recovery
Method: ICP Metals by SW6010				
Matrix: Solid				
Analyte: Nickel				
Type of Control Sample: Laboratory Control Sample. continued				
Type of Control Sample: Laboratory Control Sample.				
24-Jul-90	225.0 mg/Kg		184.000 mg/Kg	81.78
26-Jul-90	1.000 mg/L		1.000 mg/L	100.00
Number of Samples = 74	Mean % Recovery = 101.0		CV (%) =	4.1
Method: ICP Metals by SW6010				
Matrix: Solid				
Analyte: Silver				
Type of Control Sample: Calibration Control Sample.				
27-Aug-90	5.000 mg/L		4.880 mg/L	97.60
27-Aug-90	10.0 mg/L		9.890 mg/L	98.90
27-Aug-90	5.000 mg/L		4.820 mg/L	96.40
27-Aug-90	5.000 mg/L		4.860 mg/L	97.20
Number of Samples = 4	Mean % Recovery = 97.5		CV (%) =	1.1
Method: ICP Metals by SW6010				
Matrix: TREATED				
Analyte: Barium				
Type of Control Sample: Calibration Control Sample.				
04-Sep-90	5.000 mg/L		5.050 mg/L	101.00
04-Sep-90	5.000 mg/L		5.040 mg/L	100.80
04-Sep-90	10.0 mg/L		9.940 mg/L	99.40
04-Sep-90	5.000 mg/L		4.890 mg/L	97.80
03-Oct-90	10.0 mg/L		9.820 mg/l	98.20
03-Oct-90	5.000 mg/L		4.960 mg/l	99.20
03-Oct-90	5.000 mg/L		5.040 mg/l	100.80
03-Oct-90	5.000 mg/L		5.030 mg/l	100.60

(Continued)

Table F4 (Continued)

Date	True Value	Det Flag	Measured Value	% Recovery
Method: ICP Metals by SW6010				
Matrix: TREATED				
Analyte: Barium				
Type of Control Sample: Calibration Control Sample. continued				
03-Oct-90	5.000 mg/L		4.870 mg/l	97.40
Type of Control Sample: Laboratory Control Sample.				
03-Oct-90	1.000 mg/L		1.020 mg/l	102.00
Number of Samples = 10	Mean % Recovery = 99.7		CV (%) = 1.6	
Method: ICP Metals by SW6010				
Matrix: TREATED				
Analyte: Cadmium				
Type of Control Sample: Calibration Control Sample.				
04-Sep-90	5.000 mg/L		4.980 mg/L	99.60
04-Sep-90	10.0 mg/L		9.950 mg/L	99.50
04-Sep-90	5.000 mg/L		4.850 mg/L	97.00
04-Sep-90	5.000 mg/L		4.860 mg/L	97.20
03-Oct-90	5.000 mg/L		4.650 mg/l	93.00
03-Oct-90	5.000 mg/L		4.610 mg/l	92.20
03-Oct-90	10.0 mg/L		9.830 mg/l	98.30
03-Oct-90	5.000 mg/L		4.580 mg/l	91.60
03-Oct-90	5.000 mg/L		4.610 mg/l	92.20
Type of Control Sample: Laboratory Control Sample.				
03-Oct-90	1.000 mg/L		1.020 mg/l	102.00
Number of Samples = 10	Mean % Recovery = 96.3		CV (%) = 3.9	

(Continued)

Table F4 (Continued)

Date	True Value	Det Flag	Measured Value	% Recovery
Method: ICP Metals by SW6010				
Matrix: TREATED				
Analyte: Chromium				
Type of Control Sample: Calibration Control Sample.				
04-Sep-90	5.000 mg/L		5.080 mg/L	101.60
04-Sep-90	10.0 mg/L		9.950 mg/L	99.50
04-Sep-90	5.000 mg/L		4.970 mg/L	99.40
19-Sep-90	10.0 mg/L		10.000 mg/L	100.00
19-Sep-90	5.000 mg/L		5.080 mg/L	101.60
19-Sep-90	5.000 mg/L		5.060 mg/L	101.20
19-Sep-90	10.0 mg/L		10.000 mg/L	100.00
19-Sep-90	5.000 mg/L		5.110 mg/L	102.20
19-Sep-90	5.000 mg/L		5.200 mg/L	104.00
19-Sep-90	5.000 mg/L		5.330 mg/L	106.60
19-Sep-90	5.000 mg/L		4.970 mg/L	99.40
19-Sep-90	5.000 mg/L		5.070 mg/L	101.40
19-Sep-90	5.000 mg/L		5.030 mg/L	100.60
26-Sep-90	5.000 mg/L		5.190 mg/L	103.80
26-Sep-90	5.000 mg/L		5.170 mg/L	103.40
26-Sep-90	5.000 mg/L		5.090 mg/L	101.80
26-Sep-90	10.0 mg/L		10.200 mg/L	102.00
26-Sep-90	5.000 mg/L		5.140 mg/L	102.80
26-Sep-90	5.000 mg/L		5.160 mg/L	103.20
26-Sep-90	5.000 mg/L		5.040 mg/L	100.80
26-Sep-90	10.0 mg/L		9.920 mg/L	99.20
26-Sep-90	5.000 mg/L		5.090 mg/L	101.80
26-Sep-90	5.000 mg/L		5.120 mg/L	102.40
26-Sep-90	5.000 mg/L		5.080 mg/L	101.60
28-Sep-90	5.000 mg/L		4.860 mg/L	97.20
28-Sep-90	10.0 mg/L		10.000 mg/L	100.00
28-Sep-90	5.000 mg/L		4.820 mg/L	99.64
28-Sep-90	5.000 mg/L		4.660 mg/L	93.20
03-Oct-90	5.000 mg/L		5.040 mg/L	100.80
03-Oct-90	5.000 mg/L		5.070 mg/L	101.40
03-Oct-90	5.000 mg/L		5.000 mg/L	100.00
03-Oct-90	5.000 mg/L		4.970 mg/L	99.40
03-Oct-90	5.000 mg/L		5.080 mg/L	101.60
03-Oct-90	5.000 mg/L		4.940 mg/L	98.80
03-Oct-90	10.0 mg/L		10.000 mg/L	100.00
03-Oct-90	5.000 mg/L		5.000 mg/L	100.00
03-Oct-90	10.0 mg/L		9.900 mg/L	99.00

(Continued)

Table F4 (Continued)

Date	True Value	Det Flag	Measured Value	% Recovery
Method: ICP Metals by SW6010				
Matrix: TREATED				
Analyte: Chromium				
Type of Control Sample: Calibration Control Sample, continued				
03-Oct-90	5.000 mg/L		4.950 mg/L	99.00
03-Oct-90	5.000 mg/L		4.940 mg/L	98.80
04-Oct-90	5.000 mg/L		5.010 mg/L	100.20
04-Oct-90	5.000 mg/L		5.020 mg/L	100.40
04-Oct-90	5.000 mg/L		4.950 mg/L	99.00
04-Oct-90	10.0 mg/L		9.960 mg/L	99.60
04-Oct-90	1.000 mg/L		1.010 mg/L	101.00
Type of Control Sample: Laboratory Control Sample.				
19-Sep-90	0.200 mg/L		0.194 mg/L	97.00
26-Sep-90	1.000 mg/L		0.940 mg/L	94.00
26-Sep-90	67.0 mg/Kg		63.500 mg/Kg	94.78
26-Sep-90	0.500 mg/L		0.486 mg/l	97.20
28-Sep-90	1.000 mg/L		0.856 mg/l	85.60
28-Sep-90	67.0 mg/Kg		57.000 mg/kg	85.07
03-Oct-90	67.0 mg/L		67.100 mg/L	100.15
03-Oct-90	1.000 mg/L		1.030 mg/L	103.00
Number of Samples = 52	Mean % Recovery = 99.7		CV (%) = 3.8	
Method: ICP Metals by SW6010				
Matrix: TREATED				
Analyte: Chromium VI				
Type of Control Sample: Calibration Control Sample.				
26-Sep-90	10.0 mg/L		10.200 mg/L	102.00
Number of Samples = 1	Mean % Recovery = 102.0		CV (%) =	

(Continued)

Table F4 (Continued)

Date	True Value	Det Flag	Measured Value	% Recovery
Method: ICP Metals by SW6010				
Matrix: TREATED				
Analyte: Iron				
Type of Control Sample: Calibration Control Sample.				
04-Sep-90	50.0 mg/L		49.200 mg/L	98.40
04-Sep-90	50.0 mg/L		48.600 mg/L	97.20
04-Sep-90	200.0 mg/L		195.000 mg/L	97.50
04-Sep-90	50.0 mg/L		48.100 mg/L	96.20
19-Sep-90	50.0 mg/L		50.200 mg/L	100.40
19-Sep-90	50.0 mg/L		50.000 mg/L	100.00
19-Sep-90	50.0 mg/L		49.800 mg/L	99.60
19-Sep-90	200.0 mg/L		199.000 mg/L	99.50
19-Sep-90	50.0 mg/L		49.000 mg/L	98.00
19-Sep-90	50.0 mg/L		49.900 mg/L	99.80
20-Sep-90	50.0 mg/L		48.200 mg/L	96.40
20-Sep-90	50.0 mg/L		49.900 mg/L	99.80
20-Sep-90	50.0 mg/L		49.000 mg/L	98.00
20-Sep-90	200.0 mg/L		199.000 mg/L	99.50
20-Sep-90	50.0 mg/L		49.800 mg/L	99.60
20-Sep-90	50.0 mg/L		50.200 mg/L	100.40
26-Sep-90	200.0 mg/L		204.000 mg/L	102.00
26-Sep-90	50.0 mg/L		50.300 mg/L	100.60
26-Sep-90	50.0 mg/L		49.200 mg/L	98.40
26-Sep-90	50.0 mg/L		49.400 mg/L	98.80
26-Sep-90	50.0 mg/L		49.900 mg/L	99.80
26-Sep-90	50.0 mg/L		49.600 mg/L	99.20
28-Sep-90	50.0 mg/L		47.600 mg/L	95.20
28-Sep-90	200.0 mg/L		200.000 mg/L	100.00
28-Sep-90	50.0 mg/L		48.300 mg/L	96.60
28-Sep-90	50.0 mg/L		47.500 mg/L	95.00
01-Oct-90	200.0 mg/L		193.000 mg/L	96.50
01-Oct-90	50.0 mg/L		48.700 mg/L	97.40
01-Oct-90	50.0 mg/L		48.400 mg/L	96.80
01-Oct-90	50.0 mg/L		47.700 mg/L	95.40
03-Oct-90	50.0 mg/L		48.900 mg/L	97.80
03-Oct-90	50.0 mg/L		48.800 mg/L	97.60
03-Oct-90	200.0 mg/L		201.000 mg/L	100.50
03-Oct-90	50.0 mg/L		49.600 mg/L	99.20
03-Oct-90	50.0 mg/L		50.100 mg/L	100.20
03-Oct-90	200.0 mg/L		195.000 mg/L	97.50
03-Oct-90	50.0 mg/L		49.000 mg/L	98.00

(Continued)

Table F4 (Continued)

Date	True Value	Det Flag	Measured Value	% Recovery
Method: ICP Metals by SW6010				
Matrix: TREATED				
Analyte: Iron				
Type of Control Sample: Calibration Control Sample. continued				
03-Oct-90	50.0 mg/L		49.100 mg/L	98.20
03-Oct-90	50.0 mg/L		50.100 mg/l	100.20
03-Oct-90	200.0 mg/L		198.000 m/g/l	99.00
03-Oct-90	50.0 mg/L		49.600 mg/l	99.20
04-Oct-90	200.0 mg/L		198.000 mg/L	99.00
04-Oct-90	50.0 mg/L		49.600 mg/L	99.20
04-Oct-90	50.0 mg/L		53.500 mg/L	107.00
04-Oct-90	50.0 mg/L		49.100 mg/L	98.20
Type of Control Sample: Laboratory Control Sample.				
26-Sep-90	10.0 mg/L		9.560 mg/L	95.60
26-Sep-90	15700.0 mg/Kg		15500.000 mg/Kg	98.73
28-Sep-90	15700.0 mg/Kg		14800.000 mg/kg	94.27
28-Sep-90	10.0 mg/L		8.550 mg/l	85.50
03-Oct-90	15700.0 mg/L		11900.000 mg/L	75.80
03-Oct-90	10.0 mg/L		10.100 mg/L	101.00
Number of Samples = 51	Mean % Recovery = 97.9		CV (%) = 4.3	
Method: ICP Metals by SW6010				
Matrix: TREATED				
Analyte: Lead				
Type of Control Sample: Calibration Control Sample.				
04-Sep-90	5.000 mg/L		4.950 mg/L	99.00
04-Sep-90	5.000 mg/L		4.920 mg/L	98.40
04-Sep-90	5.000 mg/L		5.090 mg/L	101.80
04-Sep-90	10.0 mg/L		9.990 mg/L	99.90
19-Sep-90	5.000 mg/L		5.480 mg/L	109.60
19-Sep-90	10.0 mg/L		9.990 mg/L	99.90
19-Sep-90	5.000 mg/L		5.410 mg/L	108.20
19-Sep-90	5.000 mg/L		5.490 mg/L	109.80
19-Sep-90	5.000 mg/L		5.310 mg/L	106.20
19-Sep-90	5.000 mg/L		5.490 mg/L	109.80
19-Sep-90	5.000 mg/L		5.360 mg/L	107.20

(Continued)

Table F4 (Continued)

Date	True Value	Det Flag	Measured Value	% Recovery
Method: ICP Metals by SW6010				
Matrix: TREATED				
Analyte: Lead				
Type of Control Sample: Calibration Control Sample. continued				
15-Sep-90	5.000 mg/L		5.380 mg/L	107.60
19-Sep-90	10.0 mg/L		9.990 mg/L	99.90
26-Sep-90	10.0 mg/Kg		10.100 mg/Kg	101.00
26-Sep-90	5.000 mg/L		5.450 mg/L	109.00
26-Sep-90	5.000 mg/L		5.290 mg/L	105.80
26-Sep-90	5.000 mg/L		5.440 mg/L	108.80
26-Sep-90	5.000 mg/L		5.460 mg/L	109.20
28-Sep-90	5.000 mg/L		5.100 mg/L	102.00
28-Sep-90	5.000 mg/L		5.310 mg/L	106.20
28-Sep-90	5.000 mg/L		4.990 mg/L	99.80
01-Oct-90	5.000 mg/L		4.820 mg/L	96.40
01-Oct-90	5.000 mg/L		4.740 mg/L	94.80
01-Oct-90	5.000 mg/L		4.820 mg/L	96.40
01-Oct-90	10.0 mg/L		10.100 mg/L	101.00
03-Oct-90	5.000 mg/L		4.720 mg/L	94.40
03-Oct-90	5.000 mg/L		4.650 mg/L	93.00
03-Oct-90	5.000 mg/L		4.770 mg/L	95.40
03-Oct-90	10.0 mg/L		9.930 mg/L	99.30
03-Oct-90	5.000 mg/L		4.780 mg/L	95.60
03-Oct-90	5.000 mg/L		4.750 mg/L	95.00
03-Oct-90	5.000 mg/L		4.710 mg/L	94.20
03-Oct-90	10.0 mg/L		10.000 mg/L	100.00
03-Oct-90	5.000 mg/L		4.720 mg/L	94.40
03-Oct-90	10.0 mg/L		9.750 mg/L	97.50
03-Oct-90	5.000 mg/L		5.170 mg/L	103.40
03-Oct-90	5.000 mg/L		5.080 mg/L	101.60
03-Oct-90	5.000 mg/L		5.150 mg/L	103.00
04-Oct-90	10.0 mg/L		9.890 mg/L	98.90
04-Oct-90	5.000 mg/L		5.340 mg/L	106.80
04-Oct-90	5.000 mg/L		5.490 mg/L	109.80
04-Oct-90	5.000 mg/L		5.200 mg/L	104.00
Type of Control Sample: Laboratory Control Sample.				
26-Sep-90	1.000 mg/L		0.908 mg/L	90.80
26-Sep-90	117.0 mg/Kg		116.000 mg/Kg	99.15
28-Sep-90	1.000 mg/L		0.873 mg/L	87.30
28-Sep-90	117.0 mg/Kg		108.000 mg/kg	92.31

(Continued)

Table F4 (Continued)

Date	True Value	Det Flag	Measured Value	% Recovery
Method: ICP Metals by SW6010				
Matrix: TREATED				
Analyte: Lead				
Type of Control Sample: Laboratory Control Sample, continued				
03-Oct-90	117.0 mg/L		123.000 mg/L	105.13
03-Oct-90	1.000 mg/L		1.050 mg/L	105.00
03-Oct-90	0.500 mg/L		0.477 mg/L	95.40
Number of Samples = 49	Mean % Recovery = 101.0		CV (%) =	5.7
Method: ICP Metals by SW6010				
Matrix: TREATED				
Analyte: Nickel				
Type of Control Sample: Calibration Control Sample.				
04-Sep-90	5.000 mg/L		4.930 mg/L	98.60
04-Sep-90	5.000 mg/L		5.040 mg/L	100.80
04-Sep-90	10.0 mg/L		10.100 mg/L	100.00
04-Sep-90	5.000 mg/L		4.950 mg/L	99.00
19-Sep-90	5.000 mg/L		5.270 mg/L	105.40
19-Sep-90	10.0 mg/L		10.000 mg/L	100.00
19-Sep-90	5.000 mg/L		5.350 mg/L	107.00
19-Sep-90	5.000 mg/L		5.330 mg/L	106.60
19-Sep-90	5.000 mg/L		5.430 mg/L	108.60
19-Sep-90	5.000 mg/L		5.430 mg/L	108.60
19-Sep-90	10.0 mg/L		10.000 mg/L	100.00
19-Sep-90	5.000 mg/L		5.380 mg/L	107.60
19-Sep-90	5.000 mg/L		5.350 mg/L	107.00
26-Sep-90	5.000 mg/L		5.440 mg/L	108.80
26-Sep-90	5.000 mg/L		5.410 mg/L	108.20
26-Sep-90	5.000 mg/L		5.430 mg/L	108.60
26-Sep-90	10.0 mg/L		10.200 mg/L	102.00
26-Sep-90	5.000 mg/L		5.340 mg/L	106.80
26-Sep-90	5.000 mg/L		5.460 mg/L	109.20
28-Sep-90	5.000 mg/L		4.870 mg/L	97.40
28-Sep-90	10.0 mg/L		9.980 mg/L	99.80
28-Sep-90	5.000 mg/L		5.170 mg/L	103.40
28-Sep-90	5.000 mg/L		5.150 mg/L	103.00
01-Oct-90	10.0 mg/L		9.760 mg/L	97.60
01-Oct-90	5.000 mg/L		4.750 mg/L	95.00

(Continued)

Table F4 (Continued)

Date	True Value	Det Flag	Measured Value	% Recovery
Method: ICP Metals by SW6010				
Matrix: TREATED				
Analyte: Nickel				
Type of Control Sample: Calibration Control Sample. continued				
01-Oct-90	5.000 mg/L		4.700 mg/l	94.00
01-Oct-90	5.000 mg/L		4.740 mg/l	94.80
03-Oct-90	5.000 mg/L		4.830 mg/L	96.60
03-Oct-90	5.000 mg/L		4.810 mg/L	96.20
03-Oct-90	10.0 mg/L		9.890 mg/L	98.90
03-Oct-90	5.000 mg/L		4.860 mg/L	97.20
03-Oct-90	5.000 mg/L		4.850 mg/L	97.00
03-Oct-90	5.000 mg/L		4.800 mg/L	96.00
03-Oct-90	5.000 mg/L		4.760 mg/L	95.20
03-Oct-90	10.0 mg/L		10.000 mg/L	100.00
04-Oct-90	5.000 mg/L		5.460 mg/L	109.20
04-Oct-90	5.000 mg/L		5.270 mg/L	105.40
04-Oct-90	5.000 mg/L		5.200 mg/L	104.00
04-Oct-90	10.0 mg/L		9.830 mg/L	98.30
Type or Control Sample: Laboratory Control Sample.				
26-Sep-90	1.000 mg/L		0.927 mg/L	92.70
26-Sep-90	225.0 mg/Kg		194.000 mg/Kg	86.22
28-Sep-90	1.000 mg/L		0.850 mg/l	85.00
28-Sep-90	225.0 mg/Kg		170.000 mg/kg	75.56
01-Oct-90	0.500 mg/L		0.487 mg/l	97.56
03-Oct-90	225.0 mg/L		216.000 mg/L	96.00
03-Oct-90	1.000 mg/L		1.020 mg/L	102.00
Number of Samples = 46	Mean % Recovery = 100.1		CV (%) = 6.9	

(Continued)

Table F4 (Continued)

Date	True Value	Det Flag	Measured Value	% Recovery
Method: ICP Metals by SW6010				
Matrix: TREATED				
Analyte: Silver				
Type of Control Sample: Calibration Control Sample.				
04-Sep-90	10.0 mg/L		9.950 mg/L	99.50
04-Sep-90	5.000 mg/L		5.000 mg/L	100.00
04-Sep-90	5.000 mg/L		5.110 mg/L	102.20
04-Sep-90	5.000 mg/L		4.910 mg/L	98.20
03-Oct-90	5.000 mg/L		4.820 mg/l	96.40
03-Oct-90	5.000 mg/L		4.840 mg/l	96.80
03-Oct-90	10.0 mg/L		9.790 mg/l	97.90
03-Oct-90	5.000 mg/L		4.740 mg/l	94.80
03-Oct-90	5.000 mg/L		4.740 mg/l	94.80
Type of Control Sample: Laboratory Control Sample.				
03-Oct-90	1.000 mg/L		0.997 mg/l	99.70
Number of Samples = 10	Mean % Recovery = 98.0		CV (%) = 2.4	
Method: pH by SW9045				
Matrix: TREATED				
Analyte: pH				
Type of Control Sample: Calibration Control Sample.				
19-Sep-90	7.000 pH units		7.099 pH units	101.41
19-Sep-90	7.000 pH units		7.093 pH units	101.33
19-Sep-90	7.000 pH units		7.003 pH units	100.04
Number of Samples = 3	Mean % Recovery = 100.9		CV (%) = .0	

(Continued)

Table F4 (Continued)

Date	True Value	Det Flag	Measured Value	% Recovery
Method: Selenium by AA (E270.2)				
Matrix: Solid				
Analyte: Selenium				
Type of Control Sample: Calibration Control Sample.				
27-Aug-90	0.050 mg/L		0.048 mg/L	96.00
27-Aug-90	0.050 mg/L		0.050 mg/L	100.00
05-Sep-90	0.050 mg/L		0.047 mg/L	94.00
05-Sep-90	0.050 mg/L		0.047 mg/L	94.00
05-Sep-90	0.050 mg/L		0.050 mg/L	100.00
Number of Samples = 5	Mean % Recovery = 96.8		CV (%) =	3.1
Method: Selenium by AA (E270.2)				
Matrix: TREATED				
Analyte: Selenium				
Type of Control Sample: Calibration Control Sample.				
05-Sep-90	0.050 mg/L		0.047 mg/L	94.00
05-Sep-90	0.050 mg/L		0.047 mg/L	94.00
05-Sep-90	0.050 mg/L		0.050 mg/L	100.00
16-Oct-90	0.050 mg/L		0.047 mg/l	94.20
16-Oct-90	0.050 mg/L		0.051 mg/l	101.40
Type of Control Sample: Laboratory Control Sample.				
16-Oct-90	0.050 mg/L		0.042 mg/l	83.60
Number of Samples = 6	Mean % Recovery = 94.5		CV (%) =	6.6

(Continued)

Table F4 (Continued)

Date	True Value	Det Flag	Measured Value	% Recovery
Method: Chrome VI by SW7196				
Matrix: Solid				
Analyte: Chromium VI				
Type of Control Sample: Calibration Control Sample.				
06-Jul-90	0.500 mg/L		0.490 mg/L	98.00
22-Jul-90	0.300 mg/L		0.300 mg/L	100.00
26-Jul-90	0.400 mg/L		0.390 mg/L	97.50
26-Jul-90	0.400 mg/L		0.400 mg/L	100.00
Type of Control Sample: Laboratory Control Sample.				
15-May-90	0.300 mg/L		0.322 mg/L	107.33
15-May-90	0.300 mg/L		0.312 mg/L	106.67
15-May-90	0.300 mg/L		0.320 mg/L	106.67
16-May-90	0.800 mg/L		0.786 mg/L	98.25
16-May-90	0.800 mg/L		0.793 mg/L	99.13
16-May-90	0.300 mg/L		0.287 mg/L	95.67
16-May-90	0.300 mg/L		0.289 mg/L	96.33
16-May-90	0.300 mg/L		0.289 mg/L	96.33
16-May-90	0.300 mg/L		0.278 mg/L	92.67
16-May-90	0.300 mg/L		0.292 mg/L	97.33
16-May-90	0.300 mg/L		0.284 mg/L	94.67
16-May-90	0.300 mg/L		0.300 mg/L	100.00
16-May-90	0.200 mg/L		0.200 mg/L	100.00
17-May-90	0.300 mg/L		0.299 mg/L	96.67
17-May-90	0.200 mg/L		0.190 mg/L	95.00
17-May-90	0.300 mg/L		0.290 mg/L	96.67
17-May-90	0.300 mg/L		0.301 mg/L	96.67
17-May-90	0.300 mg/L		0.290 mg/L	96.67
17-May-90	0.300 mg/L		0.290 mg/L	96.67
17-May-90	0.300 mg/L		0.290 mg/L	96.67
17-May-90	0.300 mg/L		0.290 mg/L	96.67
18-May-90	0.300 mg/L		0.296 mg/L	90.67
18-May-90	0.300 mg/L		0.292 mg/L	97.33
18-May-90	0.300 mg/L		0.286 mg/L	95.33
18-May-90	0.300 mg/L		0.286 mg/L	95.33
18-May-90	0.300 mg/L		0.292 mg/L	97.33
18-May-90	0.300 mg/L		0.294 mg/L	98.00
Number of Samples = 31	Mean % Recovery = 98.1		CV (%) = 3.4	

(Continued)

Table F4 (Continued)

Date	True Value	Det Flag	Measured Value	% Recovery
Method: Chrome VI by SW7196				
Matrix: Solid				
Analyte: Chromium VI				
Type of Control Sample: Laboratory Control Sample. continued				
Method: Chrome VI by SW7196				
Matrix: TREATED				
Analyte: Chromium VI				
Type of Control Sample: Calibration Control Sample.				
23-Aug-90	0.500 mg/L		0.511 mg/L	102.20
23-Aug-90	0.500 mg/L		0.512 mg/L	102.40
23-Aug-90	0.500 mg/L		0.485 mg/L	97.00
23-Aug-90	0.500 mg/L		0.498 mg/L	99.60
10-Sep-90	0.500 mg/L		0.503 mg/L	100.60
10-Sep-90	0.500 mg/L		0.500 mg/L	100.06
11-Sep-90	0.800 mg/L		0.840 mg/L	105.00
11-Sep-90	0.800 mg/L		0.820 mg/L	102.50
11-Sep-90	0.800 mg/L		0.800 mg/L	100.00
12-Sep-90	0.800 mg/L		0.830 mg/L	103.75
12-Sep-90	0.200 mg/L		0.210 mg/L	105.00
12-Sep-90	0.800 mg/L		0.810 mg/L	101.25
12-Sep-90	0.800 mg/L		0.840 mg/L	105.00
13-Sep-90	0.500 mg/L		0.519 mg/L	103.80
13-Sep-90	0.500 mg/L		0.520 mg/L	104.00
13-Sep-90	0.500 mg/L		0.523 mg/L	104.60
19-Sep-90	0.500 mg/L		0.495 mg/L	99.00
19-Sep-90	0.500 mg/L		0.496 mg/L	99.20
19-Sep-90	0.500 mg/L		0.497 mg/L	99.40
20-Sep-90	0.800 mg/L		0.820 mg/L	102.50
20-Sep-90	0.200 mg/L		0.200 mg/L	100.00
25-Sep-90	0.500 mg/L		0.506 mg/L	101.10
25-Sep-90	0.500 mg/L		0.507 mg/L	101.36
25-Sep-90	0.500 mg/L		0.508 mg/L	101.62
27-Sep-90	0.500 mg/L		0.510 mg/L	102.04
27-Sep-90	0.500 mg/L		0.510 mg/L	102.04
27-Sep-90	0.500 mg/L		0.517 mg/L	103.46
27-Sep-90	0.500 mg/L		0.510 mg/L	102.04
27-Sep-90	0.500 mg/L		0.519 mg/L	103.86
29-Sep-90	0.500 mg/L		0.528 mg/L	105.60

(Continued)

Table F4 (Continued)

Date	True Value	Det Flag	Measured Value [a]	% Recovery
Method: Chrome VI by SW7196				
Matrix: TREATED				
Analyte: Chromium VI				
Type of Control Sample: Calibration Control Sample. continued				
29-Sep-90	0.500 mg/L		0.525 mg/L	105.00
Number of Samples = 31	Mean % Recovery = 102.1		CV (%) = 2.1	
Method: Sulfate by IC (E300.0)				
Matrix: Solid				
Analyte: Sulfate				
Type of Control Sample: Calibration Control Sample.				
10-Jul-90	40.0 mg/L		38.940 mg/L	97.35
10-Jul-90	40.0 mg/L		39.040 mg/L	97.60
14-Sep-90	40.0 mg/L		39.890 mg/L	99.73
14-Sep-90	40.0 mg/L		38.820 mg/L	97.05
14-Sep-90	40.0 mg/L		38.720 mg/L	96.80
Number of Samples = 5	Mean % Recovery = 97.7		CV (%) = 1.2	
Method: Sulfate by IC (E300.0)				
Matrix: TREATED				
Analyte: Sulfate				
Type of Control Sample: Calibration Control Sample.				
14-Sep-90	40.0 mg/L		38.820 mg/L	97.05
14-Sep-90	40.0 mg/L		39.890 mg/L	99.73
14-Sep-90	40.0 mg/L		38.720 mg/L	96.80
14-Sep-90	40.0 mg/L		38.820 mg/L	97.05
14-Sep-90	40.0 mg/L		38.720 mg/L	96.80
14-Sep-90	40.0 mg/L		38.720 mg/L	96.80
14-Sep-90	40.0 mg/L		38.820 mg/L	97.05
14-Sep-90	40.0 mg/L		39.890 mg/L	99.73
28-Sep-90	40.0 mg/L		40.010 mg/L	100.03
28-Sep-90	20.0 mg/L		18.980 mg/L	94.90

(Continued)

Table F4 (Concluded)

Date	True Value	Det Flag	Measured Value	% Recovery
Method: Sulfate by IC (E300.0)				
Matrix: TREATED				
Analyte: Sulfate				
Type of Control Sample: Calibration Control Sample. continued				
28-Sep-90	40.0 mg/L		40.370 mg/L	100.93
03-Oct-90	40.0 mg/L		37.670 mg/L	94.18
03-Oct-90	40.0 mg/L		37.624 mg/L	94.06
03-Oct-90	40.0 mg/L		37.469 mg/L	93.67
03-Oct-90	40.0 mg/L		38.302 mg/L	95.76
Number of Samples = 15	Mean % Recovery = 97.0		CV (%) = 2.4	

Table F5

Summary of Spike Results, Frontier Hard Chrome

SUMMARY OF SPIKE RESULTS FOR MATRIX = MW EP LEACHATE; Submatrix = N/A

Parameter	Number of Samples	Number of Recoveries	Mean % Recovery	Standard Deviation	Number Below Acceptance Limits	Number Above Acceptance Limits	(Matrix) Acceptance Criteria
ICP Metals by SW6010							
Method Spike (Into Blank)							
Chromium	1	1	106.0		0	0	75.0 - 125.0
Iron	1	1	104.0		0	0	75.0 - 125.0
matrix spike							
Chromium	4	4	103.8	7.50000	0	0	75.0 - 125.0
Iron	6	6	107.5	13.17963	0	1	75.0 - 125.0
Lead	4	4	97.9	2.92347	0	0	75.0 - 125.0
Nickel	4	4	99.8	.86603	0	0	75.0 - 125.0

Statistics calculated only for samples with a valid recovery.

(Continued)

Table F5 (Continued)

SUMMARY OF SPIKE RESULTS FOR MATRIX = Solid; Submatrix = T

Parameter	Number of Samples	Number of Recoveries	Mean % Recovery	Standard Deviation	Number Below Acceptance Limits	Number Above Acceptance Limits	(Matrix) Acceptance Criteria
Arsenic by AA (E206.2)							
Predigestion Matrix Spike							
Arsenic	1	1	96.0		0	0	75.0 - 125.0
ICP Metals by SW6010							
Method Spike (Into Blank)							
Barium	1	1	95.9		0	0	75.0 - 125.0
Cadmium	1	1	92.9		0	0	75.0 - 125.0
Chromium	3	3	98.5	3.17857	0	0	75.0 - 125.0
Iron	2	2	98.7	.84853	0	0	75.0 - 125.0
Lead	3	3	97.7	1.50444	0	0	75.0 - 125.0
Nickel	2	2	101.0	1.41421	0	0	75.0 - 125.0
Silver	1	1	91.0		0	0	75.0 - 125.0
matrix spike							
Chromium	4	4	97.2	.95743	0	0	75.0 - 125.0
Iron	4	4	97.9	2.57481	0	0	75.0 - 125.0
Lead	4	4	91.3	2.49800	0	0	75.0 - 125.0
Nickel	4	4	95.4	1.37204	0	0	75.0 - 125.0
Selenium by AA (E270.2)							
Predigestion Matrix Spike							
Selenium	1	1	96.0		0	0	75.0 - 125.0
Chrome VI by SW7196							
matrix spike							
Chromium VI	4	4	100.3	7.21688	0	0	75.0 - 125.0

Statistics calculated only for samples with a valid recovery.

(Continued)

Table F5 (Continued)

SUMMARY OF SPIKE RESULTS FOR MATRIX = Solid; Submatrix = N/A

Parameter	Number of Samples	Number of Recoveries	Mean % Recovery	Standard Deviation	Number Below Acceptance Limits	Number Above Acceptance Limits	(Matrix) Acceptance Criteria
Chloride by IC (E300.0)							
matrix spike							
Chloride	4	4	77.9	6.81845	2	0	80.0 - 120.0
ICP Metals by SW6010							
Method Spike (Into Blank)							
Chromium	3	3	101.7	6.65833	0	0	75.0 - 125.0
Iron	3	3	100.6	4.40492	0	0	75.0 - 125.0
Lead	3	3	100.2	8.24379	0	0	75.0 - 125.0
Nickel	2	2	97.9	7.28320	0	0	75.0 - 125.0
matrix spike							
Chromium	42	28	106.1	48.83872	19	5	75.0 - 125.0
Iron	31	7	71.7	33.33179	27	0	75.0 - 125.0
Lead	36	31	107.1	79.25467	12	4	75.0 - 125.0
Nickel	26	24	98.9	11.90965	3	1	75.0 - 125.0
Chrome VI by SW7196							
matrix spike							
Chromium VI	10	10	97.1	9.76557	0	0	75.0 - 125.0
Sulfate by IC (E300.0)							
matrix spike							
Sulfate	4	4	94.8	7.98114	0	0	80.0 - 120.0

Statistics calculated only for samples with a valid recovery.

(Continued)

Table F5 (Continued)

SUMMARY OF SPIKE RESULTS FOR MATRIX = TREATED; Submatrix = MW

Parameter	Number of Samples	Number of Recoveries	Mean % Recovery	Standard Deviation	Number Below Acceptance Limits	Number Above Acceptance Limits	(Matrix) Acceptance Criteria
ICP Metals by SW6010							
Method Spike (into Blank)							
Chromium	3	3	97.2	3.48186	0	0	75.0 - 125.0
Iron	2	2	97.1	1.41421	0	0	75.0 - 125.0
Lead	2	2	96.3	3.95980	0	0	75.0 - 125.0
Nickel	2	2	97.6	3.46482	0	0	75.0 - 125.0
matrix spike							
Chromium	4	4	92.9	2.49583	0	0	75.0 - 125.0
Chrome VI by SW7196							
matrix spike							
Chromium VI	8	6	84.5	17.35089	3	0	75.0 - 125.0
Predigestion Matrix Spike							
Chromium VI	1	1	100.3		0	0	75.0 - 125.0

Statistics calculated only for samples with a valid recovery.

(Continued)

Table F5 (Continued)

SUMMARY OF SPIKE RESULTS FOR MATRIX = TREATED; Submatrix = T

Parameter	Number of Samples	Number of Recoveries	Mean % Recovery	Standard Deviation	Number Below Acceptance Limits	Number Above Acceptance Limits	(Matrix) Acceptance Criteria
ICP Metals by SW6010							
Method Spike (Into Blank)							
Barium	1	1	98.3		0	0	75.0 - 125.0
Cadmium	1	1	98.7		0	0	75.0 - 125.0
Chromium	3	3	99.2	3.43948	0	0	75.0 - 125.0
Iron	3	3	96.3	4.65224	0	0	75.0 - 125.0
Lead	3	3	99.8	5.83809	0	0	75.0 - 125.0
Nickel	3	3	99.0	3.55012	0	0	75.0 - 125.0
Silver	1	1	93.9		0	0	75.0 - 125.0
Matrix spike							
Chromium	2	2	89.0	21.21320	1	0	75.0 - 125.0
Iron	2	2	90.0	14.14214	0	0	75.0 - 125.0
Lead	2	2	89.0	1.41421	0	0	75.0 - 125.0
Nickel	2	2	85.4	.70711	0	0	75.0 - 125.0
Chrome VI by SW7196							
matrix spike							
Chromium VI	8	8	99.0	5.59819	0	0	75.0 - 125.0

Statistics calculated only for samples with a valid recovery.

(Continued)

Table F5 (Continued)

SUMMARY OF SPIKE RESULTS FOR MATRIX = TREATED; Submatrix = N/A

Parameter	Number of Samples	Number of Recoveries	Mean % Recovery	Standard Deviation	Number Below Acceptance Limits	Number Above Acceptance Limits	(Matrix) Acceptance Criteria
Arsenic by AA (E206.2)							
Method Spike (Into Blank)							
Arsenic	2	2	92.0	.00000	0	0	75.0 - 125.0
Chloride by IC (E300.0)							
matrix spike							
Chloride	6	6	97.2	4.93892	0	0	80.0 - 120.0
Mercury by Cold Vapor AA (E245.1)							
Method Spike (Into Blank)							
Mercury	1	1	97.7		0	0	75.0 - 125.0
ICP Metals by SW6010							
Method Spike (Into Blank)							
Chromium	1	1	85.6		0	0	75.0 - 125.0
Iron	1	1	85.5		0	0	75.0 - 125.0
Lead	2	2	90.8	4.87904	0	0	75.0 - 125.0
Nickel	2	2	91.3	8.90955	0	0	75.0 - 125.0
matrix spike							
Chromium	4	4	- 217.0	348.28096	2	0	75.0 - 125.0
Iron	4	4	-4183.9	4932.7030	2	0	75.0 - 125.0
Lead	2	2	90.5	75.24788	1	1	75.0 - 125.0
Nickel	4	4	87.4	3.59762	0	0	75.0 - 125.0
Selenium by AA (E270.2)							
Method Spike (Into Blank)							
Selenium	3	3	392.3	506.22072	0	1	75.0 - 125.0

Statistics calculated only for samples with a valid recovery.

(Continued)

Table F5 (Concluded)

SUMMARY OF SPIKE RESULTS FOR MATRIX = TREATED; Submatrix = N/A

Parameter	Number of Samples	Number of Recoveries	Mean % Recovery	Standard Deviation	Number Below Acceptance Limits	Number Above Acceptance Limits	(Matrix) Acceptance Criteria
Chrome VI by SW7196							
Analytical							
Chromium VI	4	4	54.7	42.38677	2	0	75.0 - 125.0
Method Spike (Into Blank)							
Chromium VI	1	1	97.7		0	0	75.0 - 125.0
matrix spike							
Chromium VI	4		.0		2	0	75.0 - 125.0
Predigestion Matrix Spike							
Chromium VI	1	1	100.0		0	0	75.0 - 125.0
Sulfate by IC (E300.0)							
Analytical							
Sulfate	1	1	98.1		0	1	.0 - .0
matrix spike							
Sulfate	4	4	104.4	8.81752	0	0	80.0 - 120.0

Statistics calculated only for samples with a valid recovery.

Table F6

Detailed Listing of Matrix Spike Results, Frontier Hard Chrome

Date	Lab ID	Lab Fraction	Flag	Sample Result	Spiked Sample Result	Spike Added	% Recovery
Method: Arsenic by AA (E206.2)							
Matrix: Solid Submatrix: T							
Spiked Analyte: Arsenic							
Type of Spike = Predigestion Matrix Spike.							
27-Aug-90	9008041	00		0.00 mg/L	0.048 mg/L	0.050 mg/L	96.00
Total Number of Spikes = 1					Below acceptance = 0		
Number of Samples Used For Statistics = 1					Above acceptance = 0		
Mean % Recovery = 96					Within acceptance = 1		
Standard Deviation =					Acceptance Criteria	75.00 - 125.00	
Method: Arsenic by AA (E206.2)							
Matrix: TREATED Submatrix: N/A							
Spiked Analyte: Arsenic							
Type of Spike = Method Spike (into Blank).							
04-Sep-90	9008204	1		0.00 mg/Kg	0.046 mg/Kg	0.050 mg/Kg	92.00
06-Sep-90	9008204	0		0.00 mg/Kg	0.046 mg/Kg	0.050 mg/Kg	92.00
Total Number of Spikes = 2					Below acceptance = 0		
Number of Samples Used For Statistics = 2					Above acceptance = 0		
Mean % Recovery = 92					Within acceptance = 2		
Standard Deviation = .00					Acceptance Criteria	75.00 - 125.00	
Method: Chloride by IC (E300.0)							
Matrix: Solid Submatrix: N/A							
Spiked Analyte: Chloride							
Type of Spike = matrix spike.							
09-Jul-90	9007040	03B		143.0 mg/Kg	1213.7 mg/Kg	1273.9 mg/Kg	84.05
09-Jul-90	9007040	03C		143.0 mg/Kg	1198.7 mg/Kg	1273.9 mg/Kg	82.88
14-Sep-90	9008262	06B		248.4 mg/Kg	2687.0 mg/Kg	3500.0 mg/Kg	69.67
14-Sep-90	9008262	06C		248.4 mg/Kg	2868.5 mg/Kg	3500.0 mg/Kg	74.86
Total Number of Spikes = 4					Below acceptance = 2		
Number of Samples Used For Statistics = 4					Above acceptance = 0		

Statistics calculated only for samples with a valid recovery.NC: Not Calculable

(Continued)

Table F6 (Continued)

Date	Lab ID	Lab Fraction	Flag	Sample Result	Spiked Sample Result	Spike Added	% Recovery
Method: Chloride by IC (E300.0)							
Matrix: Solid Submatrix: N/A							
Analyte: Chloride							
Type of Spike: matrix spike. continued							
Mean % Recovery = 77					Within acceptance = 2		
Standard Deviation = 6.81					Acceptance Criteria	80.00 - 120.00	
Method: Chloride by IC (E300.0)							
Matrix: TREATED Submatrix: N/A							
Spiked Analyte: Chloride							
Type of Spike = matrix spike.							
14-Sep-90	9008399	07A		262.8 mg/Kg	2646.0 mg/Kg	2631.6 mg/Kg	90.56
14-Sep-90	9008399	08A		262.8 mg/Kg	2783.2 mg/Kg	2631.6 mg/Kg	95.77
14-Sep-90	9008204	03A		296.0 mg/Kg	2720.0 mg/Kg	2500.0 mg/Kg	96.96
14-Sep-90	9008204	02A		296.0 mg/Kg	2650.0 mg/Kg	2500.0 mg/Kg	94.16
03-Oct-90	9009103	06A		3678.4 mg/Kg	9044.8 mg/Kg	5268.6 mg/Kg	101.86
03-Oct-90	9009103	06B		3678.4 mg/Kg	9152.3 mg/Kg	5268.6 mg/Kg	103.90
Total Number of Spikes = 6					Below acceptance = 0		
Number of Samples Used For Statistics = 6					Above acceptance = 0		
Mean % Recovery = 97					Within acceptance = 6		
Standard Deviation = 4.93					Acceptance Criteria	80.00 - 120.00	
Method: Mercury by Cold Vapor AA (E245.1)							
Matrix: TREATED Submatrix: N/A							
Spiked Analyte: Mercury							
Type of Spike = Method Spike (Into Blank).							
04-Sep-90	9008204	1		0.00 mg/Kg	0.488 mg/Kg	0.500 mg/Kg	97.58
Total Number of Spikes = 1					Below acceptance = 0		
Number of Samples Used For Statistics = 1					Above acceptance = 0		
Mean % Recovery = 97					Within acceptance = 1		
Standard Deviation =					Acceptance Criteria	75.00 - 125.00	

Statistics calculated only for samples with a valid recovery.NC: Not Calculable

(Continued)

Table F6 (Continued)

Date	Lab ID	Lab Fraction	Flag	Sample Result	Spiked Sample Result	Spike Added	% Recovery
Method: ICP Metals by Sw6010							
Matrix: MW EP LEACHATE Submatrix: N/A							
Spiked Analyte: Chromium							
Type of Spike = Method Spike (Into Blank).							
12-Jul-90	S007047	00		0.00 mg/L	0.212 mg/L	0.200 mg/L	106.00
Type of Spike = matrix spike.							
01-Jun-90	S005159	45A		0.00 mg/L	0.200 mg/L	0.200 mg/L	100.00
01-Jun-90	S005159	45D		0.00 mg/L	0.200 mg/L	0.200 mg/L	100.00
18-Jun-90	S005189	11A		1.100 mg/L	1.300 mg/L	0.200 mg/L	100.00
18-Jun-90	S005189	10A		1.100 mg/L	1.330 mg/L	0.200 mg/L	115.00

Total Number of Spikes = 5		Below acceptance = 0	
Number of Samples Used For Statiscics = 5		Above acceptance = 0	
Mean % Recovery = 104		Within acceptance = 5	
Standard Deviation = 6.57		Acceptance Criteria	75.00 - 125.00

Method: ICP Metals by SW6010							
Matrix: MW EP LEACHATE Submatrix: N/A							
Spiked Analyte: Iron							
Type of Spike = Method Spike (Into Blank).							
12-Jul-90	S007047	00		0.00 mg/L	1.040 mg/L	1.000 mg/L	104.00
Type of Spike = matrix spike.							
01-Jun-90	S005159	45A		0.400 mg/L	1.500 mg/L	1.000 mg/L	110.00
01-Jun-90	S005159	45D		0.400 mg/L	1.400 mg/L	1.000 mg/L	100.00
18-Jun-90	S005189	10A		0.230 mg/L	1.110 mg/L	1.000 mg/L	88.00
18-Jun-90	S005189	11A		0.230 mg/L	1.500 mg/L	1.000 mg/L	127.00
12-Jul-90	S007047	22A		0.059 mg/L	1.120 mg/L	1.000 mg/L	106.10
12-Jul-90	S007047	22D		0.059 mg/L	1.200 mg/L	1.000 mg/L	114.10

Total Number of Spikes = 7		Below acceptance = 0	
Number of Samples Used For Statistics = 7		Above acceptance = 1	
Mean % Recovery = 107		Within acceptance = 6	
Standard Deviation = 12.10		Acceptance Criteria	75.00 - 125.00

Statistics calculated only for samples with a valid recovery.NC: Not Calculable

(Continued)

Table F6 (Continued)

Date	Lab ID	Lab Fraction	Flag	Sample Result	Spiked Sample Result	Spike Added	% Recovery
Method: ICP Metals by SW6010							
Matrix: MW EP LEACHATE Submatrix: N/A							
Spiked Analyte: Lead							
Type of Spike = matrix spike.							
01-Jun-90	S005159	45D		0.00 mg/L	0.500 mg/L	0.500 mg/L	100.00
01-Jun-90	S005159	45A		0.00 mg/L	0.500 mg/L	0.500 mg/L	100.00
18-Jun-90	S005189	10A	ND	0.042 mg/L	0.510 mg/L	0.500 mg/L	97.80
18-Jun-90	S005189	11A	ND	0.042 mg/L	0.490 mg/L	0.500 mg/L	93.30

Total Number of Spikes = 4 — Below acceptance = 0
Number of Samples Used For Statistics = 4 — Above acceptance = 0
Mean % Recovery = 97 — Within acceptance = 4
Standard Deviation = 2.92 — Acceptance Criteria 75.00 - 125.00

Date	Lab ID	Lab Fraction	Flag	Sample Result	Spiked Sample Result	Spike Added	% Recovery
Method: ICP Metals by SW6010							
Matrix: MW EP LEACHATE Submatrix: N/A							
Spiked Analyte: Nickel							
Type of Spike = matrix spike.							
01-Jun-90	S005159	45A		0.00 mg/L	0.500 mg/L	0.500 mg/L	100.00
01-Jun-90	S005159	45D		0.00 mg/L	0.500 mg/L	0.500 mg/L	100.00
18-Jun-90	S005189	11A	ND	0.015 mg/L	0.500 mg/L	0.500 mg/L	98.50
18-Jun-90	S005189	10A	ND	0.015 mg/L	0.510 mg/L	0.500 mg/L	100.50

Total Number of Spikes = 4 — Below acceptance = 0
Number of Samples Used For Statistics = 4 — Above acceptance = 0
Mean % Recovery = 99 — Within acceptance = 4
Standard Deviation = .86 — Acceptance Criteria 75.00 - 125.00

Statistics calculated only for samples with a valid recovery.NC: Not Calculable

(Continued)

Table F6 (Continued)

Date	Lab ID	Lab Fraction	Flag	Sample Result	Spiked Sample Result	Spike Added	% Recovery
Method: ICP Metals by SW6010							
Matrix: Solid Submatrix: T							
Spiked Analyte: Barium							
Type of Spike = Method Spike (Into Blank).							
27-Aug-90	9008041	00		0.00 mg/L	0.959 mg/L	1.000 mg/L	95.90
Total Number of Spikes = 1					Below acceptance = 0		
Number of Samples Used For Statistics = 1					Above acceptance = 0		
Mean % Recovery = 95					Within acceptance = 1		
Standard Deviation =					Acceptance Criteria 75.00 - 125.00		
Method: ICP Metals by SW6010							
Matrix: Solid Submatrix: T							
Spiked Analyte: Cadmium							
Type of Spike = Method Spike (Into Blank).							
27-Aug-90	9008041	00		0.00 mg/L	0.929 mg/L	1.000 mg/L	92.90
Total Number of Spikes = 1					Below acceptance = 0		
Number of Samples Used For Statistics = 1					Above acceptance = 0		
Mean % Recovery = 92					Within acceptance = 1		
Standard Deviation =					Acceptance Criteria 75.00 - 125.00		
Method: ICP Metals by SW6010							
Matrix: Solid Submatrix: T							
Spiked Analyte: Chromium							
Type of Spike = Method Spike (Into Blank).							
27-Aug-90	9008041	00		0.00 mg/L	0.949 mg/L	1.000 mg/L	94.90
04-Oct-90	9008262	00		0.00 mg/L	1.010 mg/L	1.000 mg/L	101.00
08-Oct-90	9008262	00		0.00 mg/L	0.995 mg/L	1.000 mg/L	99.50
Type of Spike = matrix spike.							
25-Jul-90	9007040	22A		0.391 mg/L	1.370 mg/L	1.000 mg/L	97.90
25-Jul-90	9007040	22B		0.391 mg/L	1.370 mg/L	1.000 mg/L	97.90
26-Jul-90	9007040	19A		0.081 mg/L	1.040 mg/L	1.000 mg/L	95.90

Statistics calculated only for samples with a valid recovery.NC: Not Calculable

(Continued)

Table F6 (Continued)

Date	Lab ID	Lab Fraction	Flag	Sample Result	Spiked Sample Result	Spike Added	% Recovery
Method: ICP Metals by SW6010							
Matrix: Solid Submatrix: T							
Analyte: Chromium							
Type of Spike: matrix spike, continued							
26-Jul-90	9007040	19B		0.081 mg/L	1.050 mg/L	1.000 mg/L	96.90
Total Number of Spikes = 7					Below acceptance = 0		
Number of Samples Used For Statistics = 7					Above acceptance = 0		
Mean % Recovery = 97					Within acceptance = 7		
Standard Deviation = 2.07					Acceptance Criteria	75.00 - 125.00	
Method: ICP Metals by SW6010							
Matrix: Solid Submatrix: T							
Spiked Analyte: Iron							
Type of Spike = Method Spike (Into Blank).							
03-Oct-90	9008262	00		0.00 mg/L	9.810 mg/L	10.0 mg/L	98.10
09-Oct-90	9008262	00		0.00 mg/L	9.930 mg/L	10.0 mg/L	99.30
Type of Spike = matrix spike.							
25-Jul-90	9007040	19B		3.920 mg/L	13.4 mg/L	10.0 mg/L	94.80
25-Jul-90	9007040	19A		3.920 mg/L	13.6 mg/L	10.0 mg/L	96.80
25-Jul-90	9007040	22A		0.153 mg/L	10.2 mg/L	10.0 mg/L	100.47
25-Jul-90	9007040	22B		0.153 mg/L	10.1 mg/L	10.0 mg/L	99.47
Total Number of Spikes = 6					Below acceptance = 0		
Number of Samples Used For Statistics = 6					Above acceptance = 0		
Mean % Recovery = 98					Within acceptance = 6		
Standard Deviation = 2.07					Acceptance Criteria	75.00 - 125.00	

Statistics calculated only for samples with a valid recovery.NC: Not Calculable

(Continued)

Table F6 (Continued)

Date	Lab ID	Lab Fraction	Flag	Sample Result	Spiked Sample Result	Spike Added	% Recovery
Method: ICP Metals by SW6010							
Matrix: Solid Submatrix: T							
Spiked Analyte: Lead							
Type of Spike = Method Spike (Into Blank).							
27-Aug-90	9008041	00		0.00 mg/L	0.961 mg/L	1.000 mg/L	96.10
04-Oct-90	9008262	00		0.00 mg/L	0.991 mg/L	1.000 mg/L	99.10
08-Oct-90	9008262	00		0.00 mg/L	0.978 mg/L	1.000 mg/L	97.80
Type of Spike = matrix spike.							
25-Jul-90	9007040	22A	ND	0.050 mg/L	0.948 mg/L	1.000 mg/L	92.30
25-Jul-90	9007040	22B	ND	0.050 mg/L	0.968 mg/L	1.000 mg/L	94.30
26-Jul-90	9007040	19A	ND	0.100 mg/L	0.937 mg/L	1.000 mg/L	88.70
26-Jul-90	9007040	19B	ND	0.100 mg/L	0.949 mg/L	1.000 mg/L	89.90
Total Number of Spikes = 7					Below acceptance = 0		
Number of Samples Used For Statistics = 7					Above acceptance = 0		
Mean % Recovery = 94					Within acceptance = 7		
Standard Deviation = 3.93					Acceptance Criteria 75.00 - 125.00		
Method: ICP Metals by SW6010							
Matrix: Solid Submatrix: T							
Spiked Analyte: Nickel							
Type of Spike = Method Spike (Into Blank).							
04-Oct-90	9008262	00		0.00 mg/L	1.000 mg/L	1.000 mg/L	100.00
08-Oct-90	9008262	00		0.00 mg/L	1.020 mg/L	1.000 mg/L	102.00
Type of Spike = matrix spike.							
25-Jul-90	9007040	22B	ND	0.020 mg/L	0.971 mg/L	1.000 mg/L	96.10
25-Jul-90	9007040	22A	ND	0.020 mg/L	0.968 mg/L	1.000 mg/L	95.80
26-Jul-90	9007040	19A		0.166 mg/L	1.100 mg/L	1.000 mg/L	93.40
26-Jul-90	9007040	19B		0.166 mg/L	1.130 mg/L	1.000 mg/L	96.40
Total Number of Spikes = 6					Below acceptance = 0		
Number of Samples Used For Statistics = 6					Above acceptance = 0		
Mean % Recovery = 97					Within acceptance = 6		

Statistics calculated only for samples with a valid recovery.NC: Not Calculable

(Continued)

Table F6 (Continued)

Date	Lab ID	Lab Fraction	Flag	Sample Result	Spiked Sample Result	Spike Added	% Recovery
Method: ICP Metals by SW6010							
Matrix: Solid Submatrix: T							
Analyte: Nickel							
Type of Spike: matrix spike. continued							
Standard Deviation = 3.13					Acceptance Criteria	75.00 - 125.00	
Method: ICP Metals by SW6010							
Matrix: Solid Submatrix: T							
Spiked Analyte: Silver							
Type of Spike = Method Spike (Into Blank).							
27-Aug-90	9008041	00		0.00 mg/L	0.910 mg/L	1.000 mg/L	91.00
Total Number of Spikes = 1					Below acceptance = 0		
Number of Samples Used For Statistics = 1					Above acceptance = 0		
Mean % Recovery = 91					Within acceptance = 1		
Standard Deviation =					Acceptance Criteria	75.00 - 125.00	
Method: ICP Metals by SW6010							
Matrix: Solid Submatrix: N/A							
Spiked Analyte: Chromium							
Type of Spike = Method Spike (Into Blank).							
11-Jul-90	S007047	00		0.00 mg/Kg	0.212 mg/Kg	0.200 mg/Kg	106.00
11-Jul-90	S007046	00A		0.00 mg/Kg	0.210 mg/Kg	0.200 mg/Kg	105.00
26-Sep-90	9008262	00		0.00 mg/Kg	0.940 mg/Kg	1.000 mg/Kg	94.00
Type of Spike = matrix spike.							
21-May-90	S005159	34A		312.2 mg/Kg	mg/Kg	27.9 mg/Kg	
21-May-90	S005159	35A		312.2 mg/Kg	mg/Kg	27.4 mg/Kg	
21-May-90	S005159	37A		85.5 mg/Kg	mg/Kg	25.9 mg/Kg	
21-May-90	S005159	39A		163.6 mg/Kg	mg/Kg	24.3 mg/Kg	
21-May-90	S005159	38A		163.6 mg/Kg	mg/Kg	24.8 mg/Kg	
21-May-90	S005159	36A		85.5 mg/Kg	mg/Kg	28.6 mg/Kg	
29-May-90	S005184	10A		10.7 mg/Kg	29.1 mg/Kg	19.6 mg/Kg	93.88
29-May-90	S005184	11A		10.7 mg/Kg	30.2 mg/Kg	18.8 mg/Kg	103.72
02-Jun-90	S005184	25A		11.6 mg/Kg	30.2 mg/Kg	19.4 mg/Kg	95.88

Statistics calculated only for samples with a valid recovery. NC: Not Calculable

(Continued)

Table F6 (Continued)

Date	Lab ID	Lab Fraction	Flag	Sample Result	Spiked Sample Result	Spike Added	% Recovery
Method: ICP Metals by SW6010							
Matrix: Solid Submatrix: N/A							
Analyte: Chromium							
Type of Spike: matrix spike. continued							
02-Jun-90	S005184	25D		11.6 mg/Kg	28.1 mg/Kg	18.0 mg/Kg	91.67
15-Jun-90	S005186	05A		44.6 mg/Kg	108.0 mg/Kg	26.4 mg/Kg	240.15
15-Jun-90	S005186	05D		44.6 mg/Kg	57.9 mg/Kg	25.0 mg/Kg	53.20
17-Jun-90	S005190	10A		586.2 mg/Kg	mg/Kg	721.0 mg/Kg	
17-Jun-90	S005190	09A		586.2 mg/Kg	mg/Kg	25.5 mg/Kg	
18-Jun-90	S005190	28A		48.6 mg/Kg	82.6 mg/Kg	31.4 mg/Kg	108.28
18-Jun-90	S005190	27A		48.6 mg/Kg	105.7 mg/Kg	29.5 mg/Kg	193.56
19-Jun-90	S005247	25A		1595.5 mg/Kg	mg/Kg	24.0 mg/Kg	
19-Jun-90	S005247	28A		4530.5 mg/Kg	mg/Kg	27.9 mg/Kg	
19-Jun-90	S005247	27A		4530.5 mg/Kg	mg/Kg	26.0 mg/Kg	
19-Jun-90	S005247	26A		1595.5 mg/Kg	mg/Kg	22.4 mg/Kg	
19-Jun-90	S005247	29A		4650.8 mg/Kg	mg/Kg	26.5 mg/Kg	
19-Jun-90	S005247	30A		4650.8 mg/Kg	mg/Kg	27.6 mg/Kg	
11-Jul-90	S007046	12A		4166.0 mg/Kg	6616.9 mg/Kg	2271.6 mg/Kg	107.89
11-Jul-90	S007046	13A		4166.0 mg/Kg	4384.5 mg/Kg	2198.7 mg/Kg	9.94
11-Jul-90	S007046	15A		3350.0 mg/Kg	4691.5 mg/Kg	2173.8 mg/Kg	61.71
11-Jul-90	S007046	16A		3350.0 mg/Kg	7270.1 mg/Kg	2070.9 mg/Kg	189.29
11-Jul-90	S007046	10A		1286.0 mg/Kg	1739.0 mg/Kg	572.4 mg/Kg	82.63
11-Jul-90	S007046	09A		1286.0 mg/Kg	2137.6 mg/Kg	544.6 mg/Kg	156.37
12-Jul-90	S007047	13A		88.0 mg/Kg	149.7 mg/Kg	72.3 mg/Kg	85.34
12-Jul-90	S007047	01D		551.0 mg/Kg	821.6 mg/Kg	227.7 mg/Kg	118.84
12-Jul-90	S007047	01A		551.0 mg/Kg	752.0 mg/Kg	233.5 mg/Kg	86.08
12-Jul-90	S007047	13D		88.0 mg/Kg	143.8 mg/Kg	69.8 mg/Kg	79.94
12-Jul-90	S007047	07D		28.0 mg/Kg	71.8 mg/Kg	38.9 mg/Kg	112.60
12-Jul-90	S007047	07A		28.0 mg/Kg	64.1 mg/Kg	35.5 mg/Kg	101.69
17-Jul-90	S007047	04D		48.0 mg/Kg	154.9 mg/Kg	91.3 mg/Kg	117.09
17-Jul-90	S007047	04A		48.0 mg/Kg	145.7 mg/Kg	93.5 mg/Kg	104.49
17-Jul-90	S007047	16A		231.0 mg/Kg	457.5 mg/Kg	122.5 mg/Kg	184.90
17-Jul-90	S007047	16D		231.0 mg/Kg	355.4 mg/Kg	117.3 mg/Kg	106.05
24-Jul-90	9007040	03B		1223.0 mg/Kg	4440.0 mg/Kg	3750.0 mg/Kg	85.79
24-Jul-90	9007040	03A		1223.0 mg/Kg	4030.0 mg/Kg	3000.0 mg/Kg	93.57
26-Jul-90	S007047	10A		7699.0 mg/Kg	11334.4 mg/Kg	6764.5 mg/Kg	53.74
26-Jul-90	S007047	10D		7699.0 mg/Kg	11234.5 mg/Kg	6776.0 mg/Kg	52.18
Total Number of Spikes = 45					Below acceptance = 19		
Number of Samples Used For Statistics = 31					Above acceptance = 5		

Statistics calculated only for samples with a valid recovery.NC: Not Calculable

(Continued)

Table F6 (Continued)

Date	Lab ID	Lab Fraction	Flag	Sample Result	Spiked Sample Result	Spike Added	% Recovery
Method: ICP Metals by SW6010							
Matrix: Solid Submatrix: N/A							
Analyte: Chromium							
Type of Spike: matrix spike, continued							
Mean % Recovery = 105					Within acceptance = 7		
Standard Deviation = 46.38					Acceptance Criteria 75.00 - 125.00		
Method: ICP Metals by SW6010							
Matrix: Solid Submatrix: N/A							
Spiked Analyte: Iron							
Type of Spike = Method Spike (Into Blank).							
11-Jul-90	S007046	00A		0.00 mg/Kg	1.021 mg/Kg	1.000 mg/Kg	102.10
11-Jul-90	S007047	00		0.00 mg/Kg	1.040 mg/Kg	1.000 mg/Kg	104.00
26-Sep-90	9008262	00		0.00 mg/Kg	9.560 mg/Kg	10.0 mg/Kg	95.60
Type of Spike = matrix spike.							
21-May-90	S005159	36A		24400.2 mg/Kg	mg/Kg	142.8 mg/Kg	
21-May-90	S005159	35A		10.5 mg/Kg	mg/Kg	137.1 mg/Kg	
21-May-90	S005159	39A		5783.6 mg/Kg	mg/Kg	121.4 mg/Kg	
21-May-90	S005159	37A		24400.2 mg/Kg	mg/Kg	129.6 mg/Kg	
21-May-90	S005159	38A		5783.6 mg/Kg	mg/Kg	124.1 mg/Kg	
21-May-90	S005159	34A		10.5 mg/Kg	11.1 mg/Kg	139.3 mg/Kg	0.43
29-May-90	S005184	11A		mg/Kg	15900.0 mg/Kg	93.9 mg/Kg	
29-May-90	S005184	10A		mg/Kg	15100.0 mg/Kg	97.9 mg/Kg	
02-Jun-90	S005184	25A		mg/Kg	10200.0 mg/Kg	96.8 mg/Kg	
02-Jun-90	S005184	25D		mg/Kg	15900.0 mg/Kg	93.9 mg/Kg	
15-Jun-90	S005186	05A		23873.4 mg/Kg	mg/Kg	97.8 mg/Kg	
15-Jun-90	S005186	05D		23873.4 mg/Kg	mg/Kg	92.6 mg/Kg	
17-Jun-90	S005190	09A		6096.6 mg/Kg	mg/Kg	127.5 mg/Kg	
17-Jun-90	S005190	10A		6096.6 mg/Kg	mg/Kg	7134.3 mg/Kg	
18-Jun-90	S005190	28A		24685.0 mg/Kg	mg/Kg	156.9 mg/Kg	
18-Jun-90	S005190	27A		24685.0 mg/Kg	mg/Kg	147.4 mg/Kg	
19-Jun-90	S005247	27A		30101.8 mg/Kg	mg/Kg	130.0 mg/Kg	
19-Jun-90	S005247	28A		30101.8 mg/Kg	mg/Kg	139.6 mg/Kg	
19-Jun-90	S005247	29A		31938.3 mg/Kg	mg/Kg	132.4 mg/Kg	
19-Jun-90	S005247	25A		34577.3 mg/Kg	mg/Kg	120.1 mg/Kg	
19-Jun-90	S005247	26A		34577.3 mg/Kg	mg/Kg	111.7 mg/Kg	

Statistics calculated only for samples with a valid recovery.NC: Not Calculable

(Continued)

Table F6 (Continued)

Date	Lab ID	Lab Fraction	Flag	Sample Result	Spiked Sample Result	Spike Added	% Recovery
Method: ICP Metals by SW6010							
Matrix: Solid Submatrix: N/A							
Analyte: Iron							
Type of Spike: matrix spike, continued							
19-Jun-90	S005247	30A		31938.3 mg/Kg	mg/Kg	137.9 mg/Kg	
11-Jul-90	S007046	12A		20927.0 mg/Kg	mg/Kg	mg/Kg	
11-Jul-90	S007046	15A		21425.0 mg/Kg	mg/Kg	mg/Kg	
11-Jul-90	S007046	09A		1351.0 mg/Kg	mg/Kg	mg/Kg	
12-Jul-90	S007047	01A		7179.0 mg/Kg	9443.4 mg/Kg	2335.3 mg/Kg	96.96
12-Jul-90	S007047	01D		7179.0 mg/Kg	8725.1 mg/Kg	2276.6 mg/Kg	67.91
17-Jul-90	S007047	16A		6897.0 mg/Kg	10201.7 mg/Kg	3674.2 mg/Kg	89.94
17-Jul-90	S007047	16D		6897.0 mg/Kg	10135.0 mg/Kg	3519.0 mg/Kg	92.01
26-Jul-90	S007047	10D		28471.0 mg/Kg	40022.2 mg/Kg	13552.0 mg/Kg	85.24
26-Jul-90	S007047	10A		28471.0 mg/Kg	37857.2 mg/Kg	13529.0 mg/Kg	69.38
Total Number of Spikes = 34					Below acceptance = 27		
Number of Samples Used for Statistics = 10					Above acceptance = 0		
Mean % Recovery = 80					Within acceptance = 17		
Standard Deviation = 30.65					Acceptance Criteria 75.00 - 125.00		
Method: ICP Metals by SW6010							
Matrix: Solid Submatrix: N/A							
Spiked Analyte: Lead							
Type of Spike = Method Spike (Into Blank).							
11-Jul-90	S007046	00A		0.00 mg/Kg	0.518 mg/Kg	0.500 mg/Kg	103.60
11-Jul-90	S007047	00		0.00 mg/Kg	0.531 mg/Kg	0.500 mg/Kg	106.20
26-Sep-90	9008262	00		0.00 mg/Kg	0.908 mg/Kg	1.000 mg/Kg	90.80
Type of Spike = matrix spike.							
21-May-90	S005159	38A		6.900 mg/Kg	69.6 mg/Kg	62.0 mg/Kg	101.13
21-May-90	S005159	34A		0.00 mg/Kg	1.700 mg/Kg	69.7 mg/Kg	2.44
21-May-90	S005159	39A		6.900 mg/Kg	69.0 mg/Kg	60.7 mg/Kg	102.31
21-May-90	S005159	35A		0.00 mg/Kg	102.5 mg/Kg	68.5 mg/Kg	149.64
21-May-90	S005159	36A		56.4 mg/Kg	mg/Kg	71.4 mg/Kg	
21-May-90	S005159	37A		56.4 mg/Kg	mg/Kg	64.8 mg/Kg	
29-May-90	S005184	10A		43.4 mg/Kg	79.1 mg/Kg	49.0 mg/Kg	72.86
29-May-90	S005184	11A		43.4 mg/Kg	99.2 mg/Kg	46.9 mg/Kg	118.98

Statistics calculated only for samples with a valid recovery.NC: Not Calculable

(Continued)

Table F6 (Continued)

Date	Lab ID	Lab Fraction	Flag	Sample Result	Spiked Sample Result	Spike Added	% Recovery
Method: ICP Metals by SW6010							
Matrix: Solid Submatrix: N/A							
Analyte: Lead							
Type of Spike: matrix spike, continued							
02-Jun-90	S005184	25A		14.9 mg/Kg	61.9 mg/Kg	48.4 mg/Kg	97.11
02-Jun-90	S005184	25D		14.9 mg/Kg	55.8 mg/Kg	44.9 mg/Kg	91.09
15-Jun-90	S005186	05D		31.4 mg/Kg	104.5 mg/Kg	62.6 mg/Kg	116.77
15-Jun-90	S005186	05A		31.4 mg/Kg	106.4 mg/Kg	66.1 mg/Kg	113.46
17-Jun-90	S005190	09A		7.100 mg/Kg	69.8 mg/Kg	63.8 mg/Kg	98.28
17-Jun-90	S005190	10A		7.100 mg/Kg	69.7 mg/Kg	60.9 mg/Kg	102.79
18-Jun-90	S005190	28A		30.6 mg/Kg	109.3 mg/Kg	78.5 mg/Kg	100.25
18-Jun-90	S005190	27A		30.6 mg/Kg	107.2 mg/Kg	73.7 mg/Kg	103.93
19-Jun-90	S005247	30A		332.6 mg/Kg	mg/Kg	69.0 mg/Kg	
19-Jun-90	S005247	29A		332.6 mg/Kg	mg/Kg	66.2 mg/Kg	
19-Jun-90	S005247	26A		347.1 mg/Kg	mg/Kg	55.9 mg/Kg	
19-Jun-90	S005247	28A		79.1 mg/Kg	297.3 mg/Kg	69.8 mg/Kg	312.61
19-Jun-90	S005247	27A		79.1 mg/Kg	359.8 mg/Kg	65.0 mg/Kg	431.85
19-Jun-90	S005247	25A		347.1 mg/Kg	414.5 mg/Kg	60.1 mg/Kg	112.15
11-Jul-90	S007046	16A		444.0 mg/Kg	1517.8 mg/Kg	1380.6 mg/Kg	77.78
11-Jul-90	S007046	15A		444.0 mg/Kg	1548.5 mg/Kg	1449.2 mg/Kg	74.10
11-Jul-90	S007046	09A		242.0 mg/Kg	1520.0 mg/Kg	1089.1 mg/Kg	117.34
11-Jul-90	S007046	10A		242.0 mg/Kg	1395.1 mg/Kg	1144.8 mg/Kg	100.73
11-Jul-90	S007046	12A		356.0 mg/Kg	1676.1 mg/Kg	1514.4 mg/Kg	87.17
11-Jul-90	S007046	13A		356.0 mg/Kg	1538.5 mg/Kg	1465.8 mg/Kg	80.67
12-Jul-90	S007047	19D		28.0 mg/Kg	90.1 mg/Kg	49.0 mg/Kg	126.73
12-Jul-90	S007047	13D		58.0 mg/Kg	146.9 mg/Kg	97.8 mg/Kg	90.90
12-Jul-90	S007047	13A		58.0 mg/Kg	155.1 mg/Kg	101.2 mg/Kg	95.95
12-Jul-90	S007047	19A		28.0 mg/Kg	81.5 mg/Kg	52.0 mg/Kg	102.88
24-Jul-90	9007040	03B		461.0 mg/Kg	528.0 mg/Kg	312.5 mg/Kg	21.44
24-Jul-90	9007040	03A		461.0 mg/Kg	507.0 mg/Kg	250.0 mg/Kg	18.40
26-Jul-90	S007047	10A		46.0 mg/Kg	703.5 mg/Kg	1352.9 mg/Kg	48.60
26-Jul-90	S007047	10D		46.0 mg/Kg	715.0 mg/Kg	1355.2 mg/Kg	49.37

Total Number of Spikes = 39
Number of Samples Used For Statistics = 34
Mean % Recovery = 106
Standard Deviation = 75.61

Below acceptance = 12
Above acceptance = 4
Within acceptance = 18
Acceptance Criteria 75.00 - 125.00

Statistics calculated only for samples with a valid recovery.NC: Not Calculable

(Continued)

Table F6 (Continued)

Date	Lab ID	Lab Fraction	Flag	Sample Result	Spiked Sample Result	Spike Added	% Recovery
Method: ICP Metals by SW6010							
Matrix: Solid Submatrix: N/A							
Spiked Analyte: Nickel							
Type of Spike = Method Spike (Into Blank).							
11-Jul-90	S007047	00		0.00 mg/Kg	0.515 mg/Kg	0.500 mg/Kg	103.00
26-Sep-90	9008262	00		0.00 mg/Kg	0.927 mg/Kg	1.000 mg/Kg	92.70
Type of Spike = matrix spike.							
21-May-90	S005159	39A		6.900 mg/Kg	71.1 mg/Kg	60.7 mg/Kg	105.77
21-May-90	S005159	38A		6.900 mg/Kg	72.2 mg/Kg	62.0 mg/Kg	105.32
21-May-90	S005159	35A		51.3 mg/Kg	118.4 mg/Kg	68.5 mg/Kg	97.96
21-May-90	S005159	34A		51.3 mg/Kg	110.4 mg/Kg	69.7 mg/Kg	84.79
21-May-90	S005159	36A		24.2 mg/Kg	mg/Kg	71.4 mg/Kg	
21-May-90	S005159	37A		24.2 mg/Kg	mg/Kg	64.3 mg/Kg	
29-May-90	S005184	11A		15.5 mg/Kg	62.5 mg/Kg	46.9 mg/Kg	100.21
29-May-90	S005184	10A		15.5 mg/Kg	65.1 mg/Kg	49.0 mg/Kg	101.22
02-Jun-90	S005184	25A		10.6 mg/Kg	60.9 mg/Kg	48.4 mg/Kg	103.93
02-Jun-90	S005184	25D		10.6 mg/Kg	57.7 mg/Kg	44.9 mg/Kg	104.90
15-Jun-90	S005186	05A		18.0 mg/Kg	84.0 mg/Kg	66.1 mg/Kg	98.64
15-Jun-90	S005186	05D		18.8 mg/Kg	79.4 mg/Kg	62.6 mg/Kg	96.81
17-Jun-90	S005190	09A		6.600 mg/Kg	68.9 mg/Kg	63.8 mg/Kg	97.65
17-Jun-90	S005190	10A		6.600 mg/Kg	71.0 mg/Kg	60.9 mg/Kg	105.75
18-Jun-90	S005190	27A		20.3 mg/Kg	96.2 mg/Kg	73.7 mg/Kg	102.99
18-Jun-90	S005190	28A		20.3 mg/Kg	99.8 mg/Kg	78.5 mg/Kg	101.27
19-Jun-90	S005247	30A		40.8 mg/Kg	132.4 mg/Kg	69.0 mg/Kg	132.75
19-Jun-90	S005247	27A		32.1 mg/Kg	97.7 mg/Kg	65.0 mg/Kg	100.97
19-Jun-90	S005247	28A		32.1 mg/Kg	108.6 mg/Kg	69.8 mg/Kg	109.60
19-Jun-90	S005247	25A		37.7 mg/Kg	102.8 mg/Kg	60.1 mg/Kg	108.32
19-Jun-90	S005247	29A		40.8 mg/Kg	100.6 mg/Kg	66.2 mg/Kg	90.33
19-Jun-90	S005247	26A		37.7 mg/Kg	78.8 mg/Kg	55.9 mg/Kg	73.52
12-Jul-90	S007047	13A		23.0 mg/Kg	113.2 mg/Kg	101.2 mg/Kg	89.13
12-Jul-90	S007047	13D		23.0 mg/Kg	109.1 mg/Kg	97.8 mg/Kg	88.02
24-Jul-90	9007040	03B		32.5 mg/Kg	65.6 mg/Kg	43.8 mg/Kg	75.57
24-Jul-90	9007040	03A		32.5 mg/Kg	66.7 mg/Kg	35.0 mg/Kg	97.71

Total Number of Spikes = 28 — Below acceptance = 3
Number of Samples Used For Statistics = 26 — Above acceptance = 1
Mean % Recovery = 98 — Within acceptance = 22

Statistics calculated only for samples with a valid recovery.NC: Not Calculable

(Continued)

Table F6 (Continued)

Date	Lab ID	Lab Fraction	Flag	Sample Result	Spiked Sample Result	Spike Added	% Recovery
Method: ICP Metals by SW6010							
Matrix: Solid Submatrix: N/A							
Analyte: Nickel							
Type of Spike: matrix spike, continued							
Standard Deviation = 11.51					Acceptance Criteria	75.00 - 125.00	
Method: ICP Metals by SW6010							
Matrix: TREATED Submatrix: MW							
Spiked Analyte: Chromium							
Type of Spike = Method Spike (Into Blank).							
19-Sep-90	9008204	0		0.00 mg/L	0.963 mg/L	1.000 mg/L	96.30
19-Sep-90	9008327	-		0.00 mg/L	1.010 mg/L	1.000 mg/L	101.00
26-Sep-90	9009182	00		0.00 mg/L	0.942 mg/L	1.000 mg/L	94.20
Type of Spike = matrix spike.							
19-Sep-90	9009045	19C		0.042 mg/L	0.235 mg/L	0.200 mg/L	96.50
19-Sep-90	9009045	19B		0.042 mg/L	0.224 mg/L	0.200 mg/L	91.00
19-Sep-90	9008399	21C	<5x	0.086 mg/L	0.271 mg/L	0.200 mg/L	92.50
19-Sep-90	9008399	21B	<5x	0.086 mg/L	0.269 mg/L	0.200 mg/L	91.50
Total Number of Spikes = 7					Below acceptance = 0		
Number of Samples Used for Statistics = 7					Above acceptance = 0		
Mean % Recovery = 94					Within acceptance = 7		
Standard Deviation = 3.52					Acceptance Criteria	75.00 - 125.00	
Method: ICP Metals by SW6010							
Matrix: TREATED Submatrix: MW							
Spiked Analyte: Iron							
Type of Spike = Method Spike (Into Blank).							
19-Sep-90	9008327	-		0.00 mg/L	9.810 mg/L	10.0 mg/L	98.10
20-Sep-90	9008204	0		0.00 mg/L	9.610 mg/L	10.0 mg/L	96.10
Total Number of Spikes = 2					Below acceptance = 0		
Number of Samples Used for Statistics = 2					Above acceptance = 0		
Mean % Recovery = 97					Within acceptance = 2		

Statistics calculated only for samples with a valid recovery.NC: Not Calculable

(Continued)

Table F6 (Continued)

Date	Lab ID	Lab Fraction	Flag	Sample Result	Spiked Sample Result	Spike Added	% Recovery
Method: ICP Metals by SW6010							
Matrix: TREATED Submatrix: MW							
Analyte: Iron							
Type of Spike: Method Spike (Into Blank). continued							
Standard Deviation = 1.41					Acceptance Criteria	75.00 - 125.00	
Method: ICP Metals by SW6010							
Matrix: TREATED Submatrix: MW							
Spiked Analyte: Lead							
Type of Spike = Method Spike (Into Blank).							
19-Sep-90	9008327	-		0.00 mg/L	0.991 mg/L	1.000 mg/L	99.10
19-Sep-90	9008204	0		0.00 mg/L	0.935 mg/L	1.000 mg/L	93.50
Total Number of Spikes = 2					Below acceptance = 0		
Number of Samples Used For Statistics = 2					Above acceptance = 0		
Mean % Recovery = 96					Within acceptance = 2		
Standard Deviation = 3.95					Acceptance Criteria	75.00 - 125.00	
Method: ICP Metals by SW6010							
Matrix: TREATED Submatrix: MW							
Spiked Analyte: Nickel							
Type of Spike = Method Spike (Into Blank).							
19-Sep-90	9008327	-		0.00 mg/L	1.000 mg/L	1.000 mg/L	100.00
19-Sep-90	9008204	0		0.00 mg/L	0.951 mg/L	1.000 mg/L	95.10
Total Number of Spikes = 2					Below acceptance = 0		
Number of Samples Used For Statistics = 2					Above acceptance = 0		
Mean % Recovery = 97					Within acceptance = 2		
Standard Deviation = 3.46					Acceptance Criteria	75.00 - 125.00	

Statistics calculated only for samples with a valid recovery.NC: Not Calculable

(Continued)

Table F6 (Continued)

Date	Lab ID	Lab Fraction	Flag	Sample Result	Spiked Sample Result	Spike Added	% Recovery
Method: ICP Metals by SW6010							
Matrix: TREATED Submatrix: T							
Spiked Analyte: Barium							
Type of Spike = Method Spike (Into Blank).							
04-Sep-90	9008204	0		0.00 mg/L	0.983 mg/L	1.000 mg/L	98.30
Total Number of Spikes = 1					Below acceptance = 0		
Number of Samples Used For Statistics = 1					Above acceptance = 0		
Mean % Recovery = 98					Within acceptance = 1		
Standard Deviation =					Acceptance Criteria	75.00 - 125.00	
Method: ICP Metals by SW6010							
Matrix: TREATED Submatrix: T							
Spiked Analyte: Cadmium							
Type of Spike = Method Spike (Into Blank).							
04-Sep-90	9008204	0		0.00 mg/L	0.987 mg/L	1.000 mg/L	98.70
Total Number of Spikes = 1					Below acceptance = 0		
Number of Samples Used For Statistics = 1					Above acceptance = 0		
Mean % Recovery = 98					Within acceptance = 1		
Standard Deviation =					Acceptance Criteria	75.00 - 125.00	
Method: ICP Metals by SW6010							
Matrix: TREATED Submatrix: T							
Spiked Analyte: Chromium							
Type of Spike = Method Spike (Into Blank).							
04-Sep-90	9008204	0		0.00 mg/L	0.983 mg/L	1.000 mg/L	98.30
03-Oct-90	9009182	00		0.00 mg/L	1.030 mg/L	1.000 mg/L	103.00
03-Oct-90	9008327	-		0.00 mg/L	0.963 mg/L	1.000 mg/L	96.30
Type of Spike = matrix spike.							
03-Oct-90	9009103	19A		9.960 mg/L	10.7 mg/L	1.000 mg/L	74.00
03-Oct-90	9009103	19B		9.960 mg/L	11.0 mg/L	1.000 mg/L	104.00

Statistics calculated only for samples with a valid recovery.NC: Not Calculable

(Continued)

Table F6 (Continued)

Date	Lab ID	Lab Fraction	Flag	Sample Result	Spiked Sample Result	Spike Added	% Recovery
Method: ICP Metals by SW6010							
Matrix: TREATED Submatrix: T							
Analyte: Chromium							
Type of Spike: matrix spike. continued							
Total Number of Spikes = 5					Below acceptance = 1		
Number of Samples Used For Statistics = 5					Above acceptance = 0		
Mean % Recovery = 95					Within acceptance = 4		
Standard Deviation = 12.23					Acceptance Criteria	75.00 - 125.00	
Method: ICP Metals by SW6010							
Matrix: TREATED Submatrix: T							
Spiked Analyte: Iron							
Type of Spike = Method Spike (Into Blank).							
04-Sep-90	9008204	0		0.00 mg/L	.170 mg/L	10.0 mg/L	91.70
03-Oct-90	9009182	00		0.00 mg/L	10.1 mg/L	10.0 mg/L	101.00
03-Oct-90	9008327	-		0.00 mg/L	9.610 mg/L	10.0 mg/L	96.10
Type of Spike = matrix spike.							
03-Oct-90	9009103	19B		114.0 mg/L	124.0 mg/L	10.0 mg/L	100.00
03-Oct-90	9009103	19A		114.0 mg/L	122.0 mg/L	10.0 mg/L	80.00
Total Number of Spikes = 5					Below acceptance = 0		
Number of Samples Used For Statistics = 5					Above acceptance = 0		
Mean % Recovery = 93					Within acceptance = 5		
Standard Deviation = 8.52					Acceptance Criteria	75.00 - 125.00	
Method: ICP Metals by SW6010							
Matrix: TREATED Submatrix: T							
Spiked Analyte: Lead							
Type of Spike = Method Spike (Into Blank).							
04-Sep-90	9008204	0		0.00 mg/L	1.010 mg/L	1.000 mg/L	101.00
03-Oct-90	9008327	-		0.00 mg/L	0.935 mg/L	1.000 mg/L	93.50
03-Oct-90	9009182	00		0.00 mg/L	1.050 mg/L	1.000 mg/L	105.00

Statistics calculated only for samples with a valid recovery.NC: Not Calculable

(Continued)

Table F6 (Continued)

Date	Lab ID	Lab Fraction	Flag	Sample Result	Spiked Sample Result	Spike Added	% Recovery
Method: ICP Metals by SW6010							
Matrix: TREATED Submatrix: T							
Analyte: Lead							
Type of Spike: matrix spike. continued							
Type of Spike = matrix spike.							
03-Oct-90	9009103	19B		0.250 mg/L	1.150 mg/L	1.000 mg/L	90.00
03-Oct-90	9009103	19A		0.250 mg/L	1.130 mg/L	1.000 mg/L	88.00
Total Number of Spikes = 5					Below acceptance = 0		
Number of Samples Used For Statistics = 5					Above acceptance = 0		
Mean % Recovery = 95					Within acceptance = 5		
Standard Deviation = 7.26					Acceptance Criteria 75.00 - 125.00		
Method: ICP Metals by SW6010							
Matrix: TREATED Submatrix: T							
Spiked Analyte: Nickel							
Type of Spike = Method Spike (Into Blank).							
04-Sep-90	9008204	0		0.00 mg/L	1.000 mg/L	1.000 mg/L	100.00
03-Oct-90	9008327	-		0.00 mg/L	0.951 mg/L	1.000 mg/L	95.10
03-Oct-90	9009182	00		0.00 mg/L	1.020 mg/L	1.000 mg/L	102.00
Type of Spike = matrix spike.							
03-Oct-90	9009103	19A		0.491 mg/L	1.340 mg/L	1.000 mg/L	84.90
03-Oct-90	9009103	19B		0.491 mg/L	1.350 mg/L	1.000 mg/L	85.90
Total Number of Spikes = 5					Below acceptance = 0		
Number of Samples Used For Statistics = 5					Above acceptance = 0		
Mean % Recovery = 93					Within acceptance = 5		
Standard Deviation = 7.88					Acceptance Criteria 75.00 - 125.00		

Statistics calculated only for samples with a valid recovery.NC: Not Calculable

(Continued)

Table F6 (Continued)

Date	Lab ID	Lab Fraction	Flag	Sample Result	Spiked Sample Result	Spike Added	% Recovery
Method: ICP Metals by SW6010							
Matrix: TREATED Submatrix: T							
Spiked Analyte: Silver							
Type of Spike = Method Spike (Into Blank).							
04-Sep-90	9008204	0		0.00 mg/L	0.939 mg/L	1.000 mg/L	93.90
Total Number of Spikes = 1					Below acceptance = 0		
Number of Samples Used For Statistics = 1					Above acceptance = 0		
Mean % Recovery = 93					Within acceptance = 1		
Standard Deviation =					Acceptance Criteria	75.00 - 125.00	
Method: ICP Metals by SW6010							
Matrix: TREATED Submatrix: N/A							
Spiked Analyte: Chromium							
Type of Spike = Method Spike (Into Blank).							
28-Sep-90	9009182	00		0.00 mg/Kg	0.856 mg/Kg	1.000 mg/Kg	85.60
Type of Spike = matrix spike.							
26-Sep-90	9008399	21C		954.0 mg/Kg	298.0 mg/Kg	110.0 mg/Kg	- 596.36
26-Sep-90	9008399	21B		954.0 mg/Kg	512.0 mg/Kg	103.0 mg/Kg	- 429.13
03-Oct-90	9008204	03A		1640.0 mg/Kg	3680.0 mg/Kg	2703.0 mg/Kg	75.47
03-Oct-90	9008204	02A		1640.0 mg/Kg	3920.0 mg/Kg	2778.0 mg/Kg	82.07
Total Number of Spikes = 5					Below acceptance = 2		
Number of Samples Used For Statistics = 5					Above acceptance = 0		
Mean % Recovery =- 156					Within acceptance = 3		
Standard Deviation = 330.58					Acceptance Criteria	75.00 - 125.00	

Statistics calculated only for samples with a valid recovery.NC: Not Calculable

(Continued)

Table F6 (Continued)

Date	Lab ID	Lab Fraction	Flag	Sample Result	Spiked Sample Result	Spike Added	% Recovery
Method: ICP Metals by SW6010							
Matrix: TREATED Submatrix: N/A							
Spiked Analyte: Iron							
Type of Spike = Method Spike (Into Blank).							
28-Sep-90	9009182	00		0.00 mg/Kg	8.550 mg/Kg	10.0 mg/Kg	85.50
Type of Spike = matrix spike.							
26-Sep-90	9008399	21B		116000 mg/Kg	31100.0 mg/Kg	1030.0 mg/Kg	- 8242.72
26-Sep-90	9008399	21C		116000 mg/Kg	20700.0 mg/Kg	1100.0 mg/Kg	- 8663.64
03-Oct-90	9008204	02A		104.0 mg/Kg	314.0 mg/Kg	231.5 mg/Kg	90.71
03-Oct-90	9008204	L3A		104.0 mg/Kg	308.0 mg/Kg	255.2 mg/Kg	79.94

Total Number of Spikes = 5 — Below acceptance = 2
Number of Samples Used For Statistics = 5 — Above acceptance = 0
Mean % Recovery = - 3330 — Within acceptance = 3
Standard Deviation = 4679.1 — Acceptance Criteria 75.00 - 125.00

Method: ICP Metals by SW6010
Matrix: TREATED Submatrix: N/A
Spiked Analyte: Lead

Type of Spike = Method Spike (Into Blank).

28-Sep-90	9009182	00		0.00 mg/Kg	0.873 mg/Kg	1.000 mg/Kg	87.30
01-Oct-90	9009182	00		0.00 mg/Kg	0.471 mg/Kg	0.500 mg/Kg	94.20
Type of Spike = matrix spike.							
26-Sep-90	9008399	21C		110.0 mg/Kg	151.0 mg/Kg	110.0 mg/Kg	37.27
26-Sep-90	9008399	21B		110.0 mg/Kg	258.0 mg/Kg	103.0 mg/Kg	143.69

Total Number of Spikes = 4 — Below acceptance = 1
Number of Samples Used For Statistics = 4 — Above acceptance = 1
Mean % Recovery = 90 — Within acceptance = 2
Standard Deviation = 43.53 — Acceptance Criteria 75.00 - 125.00

Statistics calculated only for samples with a valid recovery.NC: Not Calculable

(Continued)

Table F6 (Continued)

Date	Lab ID	Lab Fraction	Flag	Sample Result	Spiked Sample Result	Spike Added	% Recovery
Method: ICP Metals by SW6010							
Matrix: TREATED Submatrix: N/A							
Spiked Analyte: Nickel							
Type of Spike = Method Spike (Into Blank).							
28-Sep-90	9009182	00		0.00 mg/Kg	0.850 mg/Kg	1.000 mg/Kg	85.00
01-Oct-90	9009182	00		0.00 mg/Kg	0.488 mg/Kg	0.500 mg/Kg	97.60
Type of Spike = matrix spike.							
26-Sep-90	9008399	21C		16.8 mg/Kg	107.0 mg/Kg	110.0 mg/Kg	82.00
26-Sep-90	9008399	21B		16.8 mg/Kg	108.0 mg/Kg	103.0 mg/Kg	88.54
03-Oct-90	9008204	03A		20.2 mg/Kg	2840.0 mg/Kg	3153.5 mg/Kg	89.42
03-Oct-90	9008204	02A		20.2 mg/Kg	2920.0 mg/Kg	3241.0 mg/Kg	89.47
Total Number of Spikes = 6					Below acceptance = 0		
Number of Samples Used For Statistics = 6					Above acceptance = 0		
Mean % Recovery = 88					Within acceptance = 6		
Standard Deviation = 5.27					Acceptance Criteria	75.00 - 125.00	
Method: Selenium by AA (E270.2)							
Matrix: Solid Submatrix: T							
Spiked Analyte: Selenium							
Type of Spike = Predigestion Matrix Spike.							
27-Aug-90	9008041	00		0.00 mg/L	0.048 mg/L	0.050 mg/L	96.00
Total Number of Spikes = 1					Below acceptance = 0		
Number of Samples Used For Statistics = 1					Above acceptance = 0		
Mean % Recovery = 96					Within acceptance = 1		
Standard Deviation =					Acceptance Criteria	75.00 - 125.00	

Statistics calculated only for samples with a valid recovery.NC: Not Calculable

(Continued)

Table F6 (Continued)

Date	Lab ID	Lab Fraction	Flag	Sample Result	Spiked Sample Result	Spike Added	% Recovery
Method: Selenium by AA (E270.2)							
Matrix: TREATED Submatrix: N/A							
Spiked Analyte: Selenium							
Type of Spike = Method Spike (Into Blank).							
04-Sep-90	9008204	1		0.00 mg/Kg	0.488 mg/Kg	0.050 mg/Kg	976.80
05-Sep-90	9008204	0		0.00 mg/Kg	0.050 mg/Kg	0.050 mg/Kg	100.00
06-Sep-90	9008204	0		0.00 mg/Kg	0.050 mg/Kg	0.050 mg/Kg	100.00
Total Number of Spikes = 3					Below acceptance = 0		
Number of Samples Used For Statistics = 3					Above acceptance = 1		
Mean % Recovery = 392					Within acceptance = 2		
Standard Deviation = 506.22					Acceptance Criteria 75.00 - 125.00		
Method: Chrome VI by SW7196							
Matrix: Solid Submatrix: T							
Spiked Analyte: Chromium VI							
Type of Spike = matrix spike.							
06-Jul-90	9007040	19B	ND	0.020 mg/L	0.104 mg/L	0.100 mg/L	94.00
06-Jul-90	9007040	22B		0.347 mg/L	0.560 mg/L	0.200 mg/L	106.50
06-Jul-90	9007040	19C	ND	0.020 mg/L	0.106 mg/L	0.100 mg/L	94.00
06-Jul-90	9007040	22C		0.347 mg/L	0.560 mg/L	0.200 mg/L	106.50
Total Number of Spikes = 4					Below acceptance = 0		
Number of Samples Used For Statistics = 4					Above acceptance = 0		
Mean % Recovery = 100					Within acceptance = 4		
Standard Deviation = 7.21					Acceptance Criteria 75.00 - 125.00		

Statistics calculated only for samples with a valid recovery.NC: Not Calculable

(Continued)

Table F6 (Continued)

Date	Lab ID	Lab Fraction	Flag	Sample Result		Spiked Sample Result		Spike Added		% Recovery
Method: Chrome VI by SW7196										
Matrix: Solid Submatrix: N/A										
Spiked Analyte: Chromium VI										
Type of Spike = matrix spike.										
22-Jul-90	S005247	10D		18.2	mg/Kg	61.5	mg/Kg	49.2	mg/Kg	87.93
22-Jul-90	S005247	04A		3.100	mg/Kg	70.2	mg/Kg	60.8	mg/Kg	110.30
22-Jul-90	S005246	22D		5.510	mg/Kg	69.4	mg/Kg	61.2	mg/Kg	104.35
22-Jul-90	S005247	04D		3.100	mg/Kg	70.6	mg/Kg	60.8	mg/Kg	110.99
22-Jul-90	S005246	22A		5.510	mg/Kg	69.0	mg/Kg	61.2	mg/Kg	103.66
22-Jul-90	S005247	10A		18.2	mg/Kg	61.2	mg/Kg	49.2	mg/Kg	87.24
26-Jul-90	9007040	03B		27.4	mg/Kg	154.6	mg/Kg	126.7	mg/Kg	100.33
26-Jul-90	9007040	03C		27.4	mg/Kg	132.6	mg/Kg	119.3	mg/Kg	88.14
23-Aug-90	9008262	02B		1.723	mg/Kg	6.122	mg/Kg	4.975	mg/Kg	88.42
23-Aug-90	9008262	02C		1.723	mg/Kg	6.230	mg/Kg	5.000	mg/Kg	90.14

Total Number of Spikes = 10 — Below acceptance = 0
Number of Samples Used For Statistics = 10 — Above acceptance = 0
Mean % Recovery = 97 — Within acceptance = 10
Standard Deviation = 9.76 — Acceptance Criteria 75.00 - 125.00

Method: Chrome VI by SW7196										
Matrix: TREATED Submatrix: MW										
Spiked Analyte: Chromium VI										
Type of Spike = matrix spike.										
29-Aug-90	9008327	19B	<5X	0.079	mg/L		0.420	mg/L	0.400	mg/L	85.25
29-Aug-90	9008327	19C	<5X	0.079	mg/L		0.408	mg/L	0.400	mg/L	82.25
11-Sep-90	9008204	19C	ND	0.020	mg/L	ND	0.020	mg/L	0.400	mg/L	2.50
11-Sep-90	9008204	19B	ND	0.020	mg/L	ND	0.020	mg/L	0.400	mg/L	2.50
19-Sep-90	9009103	19B	ND	0.020	mg/L		1.010	mg/L	1.000	mg/L	100.00
19-Sep-90	9009103	19A	ND	0.020	mg/L		1.000	mg/L	1.000	mg/L	99.00
20-Sep-90	9009182	14B	ND	0.020	mg/L		0.199	mg/L	0.360	mg/L	52.50
20-Sep-90	9009182	14A	ND	0.020	mg/L		0.327	mg/L	0.360	mg/L	88.06
Type of Spike = Predigestion Matrix Spike.										
20-Sep-90	9008399	1		0.243	mg/L		0.644	mg/L	0.400	mg/L	100.25

Statistics calculated only for samples with a valid recovery.NC: Not Calculable

(Continued)

Table F6 (Continued)

Date	Lab ID	Lab Fraction	Flag	Sample Result	Spiked Sample Result	Spike Added	% Recovery
Method: Chrome VI by SW7196							
Matrix: TREATED Submatrix: MW							
Analyte: Chromium VI							
Type of Spike: Predigestion Matrix Spike. continued							
Total Number of Spikes = 9					Below acceptance = 3		
Number of Samples Used For Statistics = 7					Above acceptance = 0		
Mean % Recovery = 86					Within acceptance = 4		
Standard Deviation = 16.91					Acceptance Criteria	75.00 - 125.00	
Method: Chrome VI by SW7196							
Matrix: TREATED Submatrix: T							
Spiked Analyte: Chromium VI							
Type of Spike = matrix spike.							
29-Aug-90	9008327	08C	<5X	0.068 mg/L	0.175 mg/L	0.100 mg/L	107.00
29-Aug-90	9008327	08B	<5X	0.068 mg/L	0.175 mg/L	0.100 mg/L	107.00
13-Sep-90	9009045	13C	ND	0.020 mg/L	0.504 mg/L	0.500 mg/L	98.80
13-Sep-90	9009045	13B	ND	0.020 mg/L	0.506 mg/L	0.500 mg/L	99.20
13-Sep-90	9009011	13B		0.689 mg/L	1.662 mg/L	1.000 mg/L	97.30
13-Sep-90	9009011	13C		0.689 mg/L	1.667 mg/L	1.000 mg/L	97.80
20-Sep-90	9009103	09B		0.182 mg/L	0.511 mg/L	0.360 mg/L	91.39
20-Sep-90	9009103	09A		0.182 mg/L	0.519 mg/L	0.360 mg/L	93.61
Total Number of Spikes = 8					Below acceptance = 0		
Number of Samples Used For Statistics = 8					Above acceptance = 0		
Mean % Recovery = 99					Within acceptance = 8		
Standard Deviation = 5.59					Acceptance Criteria	75.00 - 125.00	
Method: Chrome VI by SW7196							
Matrix: TREATED Submatrix: N/A							
Spiked Analyte: Chromium VI							
Type of Spike = Analytical.							
25-Sep-90	9009011	03		0.103 mg/Kg	0.194 mg/Kg	0.099 mg/Kg	92.01
25-Sep-90	9009011	04		8.034 mg/Kg	8.164 mg/Kg	2.558 mg/Kg	5.08
25-Sep-90	9009045	05		17.9 mg/Kg	18.8 mg/Kg	2.498 mg/Kg	33.91
27-Sep-90	9009103	04A		3.151 mg/Kg	5.483 mg/Kg	2.658 mg/Kg	87.92

Statistics calculated only for samples with a valid recovery.NC: Not Calculable

(Continued)

Table F6 (Continued)

Date	Lab ID	Lab Fraction	Flag	Sample Result	Spiked Sample Result	Spike Added	% Recovery
Method: Chrome VI by SW7196							
Matrix: TREATED Submatrix: H/A							
Analyte: Chromium VI							
Type of Spike: Method Spike (Into Blank). continued							
Type of Spike = Method Spike (Into Blank).							
06-Sep-90	9008204	0		0.00 mg/Kg	0.488 mg/Kg	0.500 mg/Kg	97.68
Type of Spike = matrix spike.							
23-Aug-90	9008204	02A	<5X	0.023 mg/Kg	0.074 mg/Kg	3.995 mg/Kg	1.29
23-Aug-90	9008204	03A	<5X	0.023 mg/Kg	0.084 mg/Kg	3.995 mg/Kg	1.53
10-Sep-90	9008399	07A		4.158 mg/Kg	7.306 mg/Kg	3.846 mg/Kg	81.85
10-Sep-90	9008399	08A		4.158 mg/Kg	7.060 mg/Kg	3.842 mg/Kg	75.53
Type of Spike = Predigestion Matrix Spike.							
25-Sep-90	9009011	-		0.00 mg/Kg	0.160 mg/Kg	0.160 mg/Kg	100.00

Total Number of Spikes = 10 — Below acceptance = 4
Number of Samples Used For Statistics = 6 — Above acceptance = 0
Mean % Recovery = 69 — Within acceptance = 2
Standard Deviation = 63.86 — Acceptance Criteria 75.00 - 125.00

Method: Sulfate by IC (E300.0)
Matrix: Solid Submatrix: N/A
Spiked Analyte: Sulfate

Type of Spike = matrix spike.

10-Jul-90	9007040	03C		995.5 mg/Kg	6545.5 mg/Kg	6369.4 mg/Kg	88.36
10-Jul-90	9007040	03B		995.5 mg/Kg	6623.9 mg/Kg	6369.4 mg/Kg	88.36
14-Sep-90	9008262	06B		4815.1 mg/Kg	17534.1 mg/Kg	12987.0 mg/Kg	97.94
14-Sep-90	9008262	06C		4815.1 mg/Kg	18415.3 mg/Kg	12987.0 mg/Kg	104.72

Total Number of Spikes = 4 — Below acceptance = 0
Number of Samples Used For Statistics = 4 — Above acceptance = 0
Mean % Recovery = 94 — Within acceptance = 4
Standard Deviation = 7.98 — Acceptance Criteria 80.00 - 120.00

Statistics calculated only for samples with a valid recovery.NC: Not Calculable

(Continued)

Table F6 (Concluded)

Date	Lab ID	Lab Fraction	Flag	Sample Result	Spiked Sample Result	Spike Added	% Recovery
Method: Sulfate by IC (E300.0)							
Matrix: TREATED Submatrix: N/A							
Spiked Analyte: Sulfate							
Type of Spike = Analytical.							
03-Oct-90	9009103	06A		999.4 mg/Kg	13922.6 mg/Kg	13171.4 mg/Kg	98.12
Type of Spike = matrix spike.							
14-Sep-90	9008284	02A		9760.0 mg/Kg	22048.0 mg/Kg	12500.0 mg/Kg	98.30
14-Sep-90	9008399	08A		5900.0 mg/Kg	19125.3 mg/Kg	13053.0 mg/Kg	101.32
14-Sep-90	9008204	03A		9760.0 mg/Kg	24444.0 mg/Kg	12500.0 mg/Kg	117.47
14-Sep-90	9008399	07A		5900.0 mg/Kg	19009.8 mg/Kg	13053.0 mg/Kg	100.44

Total Number of Spikes = 5
Number of Samples Used For Statistics = 5
Mean % Recovery = 103
Standard Deviation = 8.13
Below acceptance = 0
Above acceptance = 0
Within acceptance = 5
Acceptance Criteria 80.00 - 120.00

Statistics calculated only for samples with a valid recovery.NC: Not Calculable

Table F7

Precision Estimates by Source of Variability, Frontier Hard Chrome

Matrix = MW EP LEACHATE; Submatrix = N/A

Parameter	# of Pairs	Range of Means	Pooled SD	Pooled CV
Chromium by ICPES				
Field Duplicate				
Chromium	4	0.0030 - 0.074 mg/L	0.00	45.5
Iron by SW6010				
Field Duplicate				
Iron	4	0.093 - 0.705 mg/L	0.25	49.3
ICP Metals by SW6010				
Analytical Dup (At Instrument)				
Chromium	5	ND - 0.119 mg/L	0.03	28.1
Iron	5	0.180 - 1.325 mg/L	0.12	20.0
Lead	4	ND - ND	NC	NC
Nickel	4	ND - ND	NC	NC
Matrix Spike Duplicate				
Chromium	1	107.5 - 107.5 mg/L	10.61	9.9
Iron	1	107.5 - 107.5 mg/L	27.58	25.7
Lead	1	95.8 - 95.8 mg/L	2.83	3.0
Nickel	1	99.5 - 99.5 mg/L	1.41	1.4
Nickel by SW6010				
Field Duplicate				
Nickel	4	0.015 - 0.015 mg/L	0.00	0.0
Lead by SW6010				
Field Duplicate				
Lead	4	0.042 - 0.042 mg/L	0.00	0.0

NC: Not Calculable

(Continued)

Table F7 (Continued)

Matrix = SOLID; Submatrix = MW

Parameter	# of Pairs	Range of Means	Pooled SD	Pooled CV
Chrome VI by SW7196				
Analytical Dup (At Instrument)				
Chromium VI	2	ND - ND	NC	NC
Field Duplicate				
Chromium VI	3	ND - ND	NC	NC
Predigestion Duplicate				
Chromium VI	4	ND - 0.0038 mg/L	0.00	47.1

NC: Not Calculable

(Continued)

Table F7 (Continued)

Matrix = SOLID; Submatrix = T

Parameter	# of Pairs	Range of Means	Pooled SD	Pooled CV
Chrome VI by SW7196				
Analytical Dup (At Instrument)				
Chromium VI	2	ND - 7.273 mg/L	0.05	0.7

NC: Not Calculable

(Continued)

Table F7 (Continued)

Matrix = SOLID; Submatrix = N/A

Parameter	# of Pairs	Range of Means			Pooled SD	Pooled CV
Chromium by ICPES						
Field Duplicate						
Chromium	10	9.800 -	550.0	mg/Kg	14.03	8.5
Chromium by ICPES						
Field Duplicate						
Chromium	4	0.0030 -	0.074	mg/Kg	0.00	45.5
Chloride by IC (E300.0)						
Analytical Dup (At Instrument)						
Chloride	1	260.1 -	260.1	mg/Kg	16.52	6.4
Matrix Spike Duplicate						
Chloride	1	83.5 -	83.5	mg/Kg	0.83	1.0
Iron by SW6010						
Field Duplicate						
Iron	10	6400.0 -	39500.0	mg/Kg	2554.60	8.9
Iron by SW6010						
Field Duplicate						
Iron	4	0.093 -	0.705	mg/Kg	0.25	49.3
ICP Metals by SW6010						
Analytical Dup (At Instrument)						
Chromium	7	0.080 -	604.5	mg/Kg	13.99	22.2
Iron	7	7000.0 -	36700.0	mg/Kg	5013.54	20.6
Lead	7	7.625 -	46.3	mg/Kg	3.99	21.5
Nickel	7	6.105 -	34.9	mg/Kg	2.90	19.0
Matrix Spike Duplicate						

NC: Not Calculable

(Continued)

Table F7 (Continued)

Matrix = SOLID; Submatrix = N/A

Parameter	# of Pairs	Range of Means			Pooled SD	Pooled CV
Chromium	16	53.0 -	150.9	mg/Kg	50.41	45.3
Iron	5	77.3 -	100.0	mg/Kg	10.51	12.9
Lead	16	19.9 -	372.2	mg/Kg	34.67	36.0
Nickel	14	86.6 -	111.5	mg/Kg	11.70	11.8
Percent moisture inorganic						
Field Duplicate						
Percent moisture	10	4.000 -	39.2	mg/Kg	2.73	15.0
Nickel by SW6010						
Field Duplicate						
Nickel	10	6.100 -	32.5	mg/Kg	3.29	18.4
Nickel by SW6010						
Field Duplicate						
Nickel	4	0.015 -	0.015	mg/Kg	0.00	0.0
Lead by SW6010						
Field Duplicate						
Lead	10	7.050 -	280.0	mg/Kg	44.75	16.9
Lead by SW6010						
Field Duplicate						
Lead	4	0.042 -	0.042	mg/Kg	0.00	0.0
Chrome VI by SW7196						
Analytical Dup (At Instrument)						
Chromium VI	22	ND -	23.0	mg/Kg	0.34	36.5
Field Duplicate						

NC: Not Calculable

(Continued)

Table F7 (Continued)

Matrix = SOLID; Submatrix = N/A

Parameter	# of Pairs	Range of Means			Pooled SD	Pooled CV
Chromium VI	7	ND -	47.9	mg/Kg	1.58	41.8
Matrix Spike Duplicate						
Chromium VI	6	87.6 -	110.6	mg/Kg	3.53	3.7
Predigestion Duplicate						
Chromium VI	1	0.063 -	0.063	mg/Kg	0.05	84.9
Sulfate by IC (E300.0)						
Analytical Dup (At Instrument)						
Sulfate	1	4816.3 -	4816.3	mg/Kg	1.73	0.0
Matrix Spike Duplicate						
Sulfate	1	88.4 -	88.4	mg/Kg	0.00	0.0

NC: Not Calculable

(Continued)

Table F7 (Continued)

Matrix = TREATED; Submatrix = MW

Parameter	# of Pairs	Range of Means			Pooled SD	Pooled CV
ICP Metals by SW6010						
Analytical Dup (At Instrument)						
Chromium	1	0.090 -	0.090	mg/L	0.07	83.3
Iron	1	0.637 -	0.637	mg/L	0.38	59.1
Lead	1	ND -	ND		NC	NC
Nickel	1	ND -	ND		NC	NC
Chrome VI by SW7196						
Analytical Dup (At Instrument)						
Chromium VI	4	ND -	0.080	mg/L	0.04	77.9

NC: Not Calculable

(Continued)

Table F7 (Continued)

Matrix = TREATED; Submatrix = T

Parameter	# of Pairs	Range of Means		Pooled SD	Pooled CV
Conductivity (E120.1)					
Analytical Dup (At Instrument)					
Conductivity	2	7655.0 - 30150.0	umhos/cm	150.08	0.5
pH by SW9045					
Analytical Dup (At Instrument)					
pH	1	5.014 - 5.014	mg/L	0.00	0.1
Chrome VI by SW7196					
Analytical Dup (At Instrument)					
Chromium VI	7	ND - 0.691	mg/L	0.01	6.8

NC: Not Calculable

(Continued)

Table F7 (Continued)

Matrix = TREATED; Submatrix = N/A

Parameter	# of Pairs	Range of Means			Pooled SD	Pooled CV
Conductivity (E120.1)						
Analytical Dup (At Instrument)						
Conductivity	2	1995.0 -	2600.0	umhos/cm	11.18	0.5
Chloride by IC (E300.0)						
Analytical Dup (At Instrument)						
Chloride	1	85.3 -	85.3	mg/Kg	11.08	13.0
Matrix Spike Duplicate						
Chloride	2	93.2 -	95.6	mg/Kg	2.96	3.2
ICP Metals by SW6010						
Matrix Spike Duplicate						
Chromium	3	-512.7 -	92.0	mg/Kg	68.33	13.8
Iron	2	-8453.2 -	85.3	mg/Kg	210.53	6.8
Lead	1	90.5 -	90.5	mg/Kg	75.25	83.2
Nickel	2	85.3 -	89.4	mg/Kg	3.27	3.8
pH by SW9045						
Analytical Dup (At Instrument)						
pH	1	11.2 -	11.2	mg/Kg	0.00	0.0
Chrome VI by SW7196						
Analytical Dup (At Instrument)						
Chromium VI	4	ND -	7.106	mg/Kg	0.12	4.9
Matrix Spike Duplicate						
Chromium VI	6	1.414 -	107.0	mg/Kg	2.03	5.5

NC: Not Calculable

(Continued)

Table F7 (Concluded)

Matrix = TREATED; Submatrix = N/A

Parameter	# of Pairs	Range of Means		Pooled SD	Pooled CV
Sulfate by IC (E300.0)					
Analytical Dup (At Instrument)					
Sulfate	2	703.0 -	944.0 mg/Kg	64.64	7.5
Matrix Spike Duplicate					
Sulfate	2	100.9 -	107.9 mg/Kg	9.59	8.9

NC: Not Calculable

Table F8

Detailed Duplicate Results, Frontier Hard Chrome

DUPLICATE (SAMPLES OR ANALYSES) FOR MATRIX = MW EP LEACHATE; Submatrix = N/A

Parameter	Routine Sample ID	Duplicate Sample ID	Routine Value		Duplicate Value	Mean Concentration	Standard Deviation	RPD (%)
Method: Chromium by ICPES								
Type = Field Duplicate								
Chromium	S00518703A	S00518704A	0.0030 mg/L		0.013 mg/L	0.0080	0.0071	125.0
Chromium	S00518902A	S00518904A	0.0030 mg/L	<5X	0.0040 mg/L	0.0035	0.00071	28.6
Chromium	S00518919A	S00518915A	0.0030 mg/L		0.0030 mg/L	0.0030	0.00	0.00
Chromium	S00518921A	S00518922A	0.069 mg/L		0.078 mg/L	0.074	0.0064	12.2
Method: ICP Metals by SW6010								
Type = Analytical Dup (At Instrument)								
Chromium	S00518904	S00518905	0.0040 mg/L		0.0040 mg/L	0.0040	0.00	0.00
Chromium	S00518902	S00518903	ND 0.0030 mg/L	ND	0.0030 mg/L	ND	NC	NC
Chromium	S00518922	S00518923	0.078 mg/L		0.160 mg/L	0.119	0.058	68.9
Chromium	S00518706	S00518707	ND 0.0030 mg/L	ND	0.0030 mg/L	ND	NC	NC
Chromium	S00704729	S00704730	0.080 mg/L		0.079 mg/L	0.080	0.00071	1.258
Iron	S00518706	S00518707	0.430 mg/L		0.420 mg/L	0.425	0.0071	2.353
Iron	S00518902	S00518903	0.160 mg/L		0.200 mg/L	0.180	0.028	22.2
Iron	S00518904	S00518905	0.860 mg/L		1.200 mg/L	1.030	0.240	33.0
Iron	S00704727	S00704728	1.310 mg/L		1.340 mg/L	1.325	0.021	2.264
Iron	S00518922	S00518923	0.230 mg/L		0.380 mg/L	0.305	0.106	49.2
Lead	S00518922	S00518923	ND 0.042 mg/L	ND	0.042 mg/L	ND	NC	NC
Lead	S00518904	S00518905	ND 0.042 mg/L	ND	0.042 mg/L	ND	NC	NC
Lead	S00518902	S00518903	ND 0.042 mg/L	ND	0.042 mg/L	ND	NC	NC
Lead	S00518706	S00518707	ND 0.042 mg/L	ND	0.042 mg/L	ND	NC	NC
Nickel	S00518706	S00518707	ND 0.015 mg/L	ND	0.015 mg/L	ND	NC	NC
Nickel	S00518904	S00518905	ND 0.015 mg/L	ND	0.015 mg/L	ND	NC	NC

NC: Not Calculable

(Continued)

Table F8 (Continued)

DUPLICATE (SAMPLES OR ANALYSES) FOR MATRIX = MW EP LEACHATE; Submatrix = N/A

Parameter	Routine Sample ID	Duplicate Sample ID	Routine Value	Duplicate Value	Mean Concentration	Standard Deviation	RPD (%)
Nickel	S00518902	S00518903	ND 0.015 mg/L	ND 0.015 mg/L	ND	NC	NC
Nickel	S00518922	S00518923	ND 0.015 mg/L	ND 0.015 mg/L	ND	NC	NC
Type = Matrix Spike Duplicate							
Chromium	S00518910A	S00518911A	115.0 mg/L	100.0 mg/L	107.5	10.6	14.0
Iron	S00518910A	S00518911A	88.0 mg/L	127.0 mg/L	107.5	27.6	36.3
Lead	S00518910A	S00518911A	97.8 mg/L	93.8 mg/L	95.8	2.828	4.175
Nickel	S00518910A	S00518911A	100.5 mg/L	98.5 mg/L	99.5	1.414	2.010
Method: Iron by SW6010							
Type = Field Duplicate							
Iron	S00518703A	S00518704A	0.650 mg/L	0.760 mg/L	0.705	0.078	15.6
Iron	S00518902A	S00518904A	0.160 mg/L	0.860 mg/L	0.510	0.495	137.3
Iron	S00518919A	S00518915A	0.099 mg/L	0.086 mg/L	0.093	0.0092	14.1
Iron	S00518921A	S00518922A	0.200 mg/L	0.230 mg/L	0.215	0.021	14.0
Method: Lead by SW6010							
Type = Field Duplicate							
Lead	S00518902A	S00518904A	0.042 mg/L	0.042 mg/L	0.042	0.00	0.00
Lead	S00518921A	S00518922A	0.042 mg/L	0.042 mg/L	0.042	0.00	0.00
Lead	S00518703A	S00518704A	0.042 mg/L	0.042 mg/L	0.042	0.00	0.00
Lead	S00518919A	S00518915A	0.042 mg/L	0.042 mg/L	0.042	0.00	0.00

NC: Not Calculable

(Continued)

Table F8 (Continued)

DUPLICATE (SAMPLES OR ANALYSES) FOR MATRIX = MW EP LEACHATE; Submatrix = N/A

Parameter	Routine Sample ID	Duplicate Sample ID	Routine Value	Duplicate Value	Mean Concentration	Standard Deviation	RPD (%)
Method: Nickel by SW6010							
Type = Field Duplicate							
Nickel	S00518703A	S00518704A	0.015 mg/L	0.015 mg/L	0.015	0.00	0.00
Nickel	S00518921A	S00518922A	0.015 mg/L	0.015 mg/L	0.015	0.00	0.00
Nickel	S00518919A	S00518915A	0.015 mg/L	0.015 mg/L	0.015	0.00	0.00
Nickel	S00518902A	S00518904A	0.015 mg/L	0.015 mg/L	0.015	0.00	0.00

NC: Not Calculable

(Continued)

Table F8 (Continued)

DUPLICATE (SAMPLES OR ANALYSES) FOR MATRIX = SOIL; Submatrix = HU

Parameter	Routine Sample ID	Duplicate Sample ID	Routine Value	Duplicate Value	Mean Concentration	Standard Deviation	RPD (%)
Method: Chrome VI by SW7196							
Type = Analytical Dup (At Instrument)							
Chromium VI	002391	002391	ND 0.0050 mg/L	ND 0.0050 mg/L	ND	NC	NC
Chromium VI	002151	002151	ND 0.0050 mg/L	ND 0.0050 mg/L	ND	NC	NC
Type = Field Duplicate							
Chromium VI	002231	002233	ND 0.0050 mg/L	ND 0.0050 mg/L	ND	NC	NC
Chromium VI	002641	002643	ND 0.0050 mg/L	ND 0.0050 mg/L	ND	NC	NC
Chromium VI	002H81	002H83	ND 0.0050 mg/L	ND 0.0050 mg/L	ND	NC	NC
Type = Predigestion Duplicate							
Chromium VI	002381	002381	ND 0.0050 mg/L	ND 0.0050 mg/L	ND	NC	NC
Chromium VI	002541	002541	0.0050 mg/L	ND 0.0050 mg/L	ND	NC	NC
Chromium VI	002641	002641	ND 0.0050 mg/L	ND 0.0050 mg/L	ND	NC	NC
Chromium VI	002H81	002H83	ND 0.0050 mg/L	ND 0.0050 mg/L	ND	NC	NC

NC: Not Calculable

(Continued)

Table F8 (Continued)

DUPLICATE (SAMPLES OR ANALYSES) FOR MATRIX = SOIL; Submatrix = T

Parameter	Routine Sample ID	Duplicate Sample ID	Routine Value		Duplicate Value		Mean Concentration	Standard Deviation	RPD (%)
Method: Chrome VI by SW7196									
Type = Analytical Dup (At Instrument)									
Chromium VI	900704031	900704031	ND	0.020 mg/L	ND	0.020 mg/L	ND	NC	NC
Chromium VI	900704006	900704006		7.238 mg/L		7.308 mg/L	7.273	0.050	0.967

NC: Not Calculable

(Continued)

Table F8 (Continued)

DUPLICATE (SAMPLES OR ANALYSES) FOR MATRIX = SOIL; Submatrix = N/A

Parameter	Routine Sample ID	Duplicate Sample ID		Routine Value		Duplicate Value	Mean Concentration	Standard Deviation	RPD (%)
Method: Chloride by IC (E300.0)									
Type = Analytical Dup (At Instrument)									
Chloride	900826206A	900826206B		248.4 mg/Kg		271.8 mg/Kg	260.1	16.5	8.982
Type = Matrix Spike Duplicate									
Chloride	9007040038	900704003C		84.1 mg/Kg		82.9 mg/Kg	83.5	0.831	1.408
Method: Chrome VI by SW7196									
Type = Analytical Dup (At Instrument)									
Chromium VI	001T21	001T21		0.490 mg/Kg		0.490 mg/Kg	0.490	0.00	0.00
Chromium VI	001511	001511	ND	0.070 mg/Kg	ND	0.070 mg/Kg	ND	NC	NC
Chromium VI	001F61	001F61		0.730 mg/Kg		0.600 mg/Kg	0.665	0.092	19.5
Chromium VI	001611	001611	ND	0.060 mg/Kg		0.160 mg/Kg	ND	NC	NC
Chromium VI	001621	001621	ND	0.060 mg/Kg	ND	0.060 mg/Kg	ND	NC	NC
Chromium VI	001H81	001H83		1.360 mg/Kg		1.440 mg/Kg	1.400	0.057	5.714
Chromium VI	001661	001661		1.310 mg/Kg		0.730 mg/Kg	1.020	0.410	56.9
Chromium VI	001731	001731		0.220 mg/Kg		0.220 mg/Kg	0.220	0.00	0.00
Chromium VI	001741	001741		6.980 mg/Kg		6.980 mg/Kg	6.980	0.00	0.00
Chromium VI	001831	001831		0.120 mg/Kg		0.120 mg/Kg	0.120	0.00	0.00
Chromium VI	001861	001861		3.170 mg/Kg		4.140 mg/Kg	3.655	0.686	
Chromium VI	001W11	001W11	ND	0.050 mg/Kg	ND	0.050 mg/Kg	ND	NC	N
Chromium VI	001331	001331		0.100 mg/Kg		0.100 mg/Kg	0.100	0.00	0.00
Chromium VI	001T61	001T61		23.7 mg/Kg		22.4 mg/Kg	23.0	0.919	5.640
Chromium VI	001341	001341	ND	0.060 mg/Kg		0.100 mg/Kg	ND	NC	NC
Chromium VI	001351	001351	ND	0.070 mg/Kg	ND	0.070 mg/Kg	ND	NC	NC
Chromium VI	001381	001381	ND	0.070 mg/Kg	ND	0.060 mg/Kg	ND	NC	NC
Chromium VI	001411	001411	ND	0.050 mg/Kg	ND	0.050 mg/Kg	ND	NC	NC
Chromium VI	001421	001421	ND	0.060 mg/Kg	ND	0.060 mg/Kg	ND	NC	NC

NC: Not Calculable

(Continued)

Table F8 (Continued)

DUPLICATE (SAMPLES OR ANALYSES) FOR MATRIX = SOIL; Submatrix = N/A

Parameter	Routine Sample ID	Duplicate Sample ID	Routine Value		Duplicate Value	Mean Concentration	Standard Deviation	RPD (%)
Chromium VI	001431	001431	ND 0.060 mg/Kg	ND	0.060 mg/Kg	ND	NC	NC
Chromium VI	001951	001951	0.710 mg/Kg		0.710 mg/Kg	0.710	0.00	0.00
Chromium VI	001471	001471	ND 0.070 mg/Kg	ND	0.0070 mg/Kg	ND	NC	NC
Type = Field Duplicate								
Chromium VI	001931	001934	0.320 mg/Kg		0.350 mg/Kg	0.335	0.021	8.955
Chromium VI	001861	001863	3.170 mg/Kg		2.380 mg/Kg	2.775	0.559	28.5
Chromium VI	001641	001643	0.160 mg/Kg	ND	0.070 mg/Kg	ND	NC	NC
Chromium VI	001F71	001F73	ND 0.140 mg/Kg	ND	0.140 mg/Kg	ND	NC	NC
Chromium VI	001E41	001E43	16.5 mg/Kg		17.5 mg/Kg	17.0	0.686	5.708
Chromium VI	001171	001173	50.3 mg/Kg		45.5 mg/Kg	47.9	3.408	10.1
Chromium VI	001471	001473	ND 0.070 mg/Kg	ND	0.080 mg/Kg	ND	NC	NC
Type = Matrix Spike Duplicate								
Chromium VI	S00524622A	S00524622D	103.7 mg/Kg		104.3 mg/Kg	104.0	0.485	0.660
Chromium VI	900704019B	900704019C	94.0 mg/Kg		94.0 mg/Kg	94.0	0.00	0.00
Chromium VI	900704003B	900704003C	100.3 mg/Kg		88.1 mg/Kg	94.2	8.613	12.9
Chromium VI	900704022B	900704022C	106.5 mg/Kg		106.5 mg/Kg	106.5	0.00	0.00
Chromium VI	S00524710A	S00524710D	87.2 mg/Kg		87.9 mg/Kg	87.6	0.489	0.789
Chromium VI	S00524704A	S00524704D	110.3 mg/Kg		111.0 mg/Kg	110.6	0.488	0.624
Type = Predigestion Duplicate								
Chromium VI	001331	001331	0.100 mg/Kg	ND	0.050 mg/Kg	ND	NC	NC
Method: Chromium by ICPES								
Type = Field Duplicate								
Chromium	S00518919A	S00518915A	0.0030 mg/Kg		0.0030 mg/Kg	0.0030	0.00	0.00
Chromium	S00518425A	S00518414A	15.0 mg/Kg		17.0 mg/Kg	16.0	1.414	12.5
Chromium	S00518902A	S00518904A	0.0030 mg/Kg	<5X	0.0040 mg/Kg	0.0035	0.00071	28.6

NC: Not Calculable

(Continued)

Table F8 (Continued)

DUPLICATE (SAMPLES OR ANALYSES) FOR MATRIX = SOIL; Submatrix = N/A

Parameter	Routine Sample ID	Duplicate Sample ID	Routine Value	Duplicate Value	Mean Concentration	Standard Deviation	RPD (%)
Chromium	S00518409A	S00518416A	11.0 mg/Kg	12.0 mg/Kg	11.5	0.707	8.696
Chromium	S00519921A	S00518922A	0.069 mg/Kg	0.078 mg/Kg	0.074	0.0064	12.2
Chromium	S00515929A	S00515955A	9.600 mg/Kg	10.0 mg/Kg	9.800	0.283	4.082
Chromium	S00518608A	S00518609A	160.0 mg/Kg	170.0 mg/Kg	165.0	7.071	6.061
Chromium	S00515903A	S00515953A	14.0 mg/Kg	18.0 mg/Kg	16.0	2.828	25.0
Chromium	S00515924A	S00515954A	86.0 mg/Kg	100.0 mg/Kg	93.0	9.899	15.1
Chromium	S00518435A	S00518436A	34.0 mg/Kg	30.0 mg/Kg	32.0	2.828	12.5
Chromium	S00518703A	S00518704A	0.0030 mg/Kg	0.013 mg/Kg	0.0080	0.0071	125.0
Chromium	S00518615A	S00518617A	520.0 mg/Kg	580.0 mg/Kg	550.0	42.4	10.9
Chromium	S00519016A	S00519018A	18.0 mg/Kg	19.0 mg/Kg	18.5	0.707	5.405
Chromium	S00519026A	S00519029A	49.0 mg/Kg	50.0 mg/Kg	49.5	0.707	2.020
Method: ICP Metals by SW6010							
Type = Analytical Dup (At Instrument)							
Chromium	S00518436	S00518437	29.8 mg/Kg	23.4 mg/Kg	26.6	4.525	24.1
Chromium	S00519018	S00519019	19.1 mg/Kg	22.1 mg/Kg	20.6	2.121	14.6
Chromium	S00518609	S00518610	170.0 mg/Kg	170.0 mg/Kg	170.0	0.00	0.00
Chromium	S00518617	S00518618	579.0 mg/Kg	630.0 mg/Kg	604.5	36.1	8.437
Chromium	S00518416	S00518417	12.4 mg/Kg	12.5 mg/Kg	12.5	0.071	0.803
Chromium	S00518414	S00518415	16.8 mg/Kg	7.400 mg/Kg	12.1	6.647	77.7
Chromium	S00704725	S00704726	0.080 mg/Kg	0.079 mg/Kg	0.080	0.00071	1.258
Iron	S00518416	S00518417	16600.0 mg/Kg	13600.0 mg/Kg	15100.0	2121.3	19.9
Iron	S00704725	S00704726	11700.0 mg/Kg	11700.0 mg/Kg	11700.0	0.00	0.00
Iron	S00518617	S00518618	28800.0 mg/Kg	44600.0 mg/Kg	36700.0	11172.3	43.1
Iron	S00518436	S00518437	29900.0 mg/Kg	27400.0 mg/Kg	28650.0	1767.8	8.726
Iron	S00519018	S00519019	6720.0 mg/Kg	7280.0 mg/Kg	7000.0	396.0	8.000
Iron	S00518414	S00518415	17500.0 mg/Kg	9710.0 mg/Kg	13605.0	5508.4	57.3
Iron	S00518609	S00518610	29900.0 mg/Kg	35000.0 mg/Kg	32450.0	3606.2	15.7

NC: Not Calculable

(Continued)

Table F8 (Continued)

DUPLICATE (SAMPLES OR ANALYSES) FOR MATRIX = SOIL; Submatrix = N/A

Parameter	Routine Sample ID	Duplicate Sample ID		Routine Value		Duplicate Value	Mean Concentration	Standard Deviation	RPD (%)
Lead	S00519018	S00519019		7.380 mg/Kg		7.870 mg/Kg	7.625	0.346	6.426
Lead	S00518416	S00518417		44.8 mg/Kg		47.8 mg/Kg	46.3	2.121	6.479
Lead	S00518436	S00518437		31.5 mg/Kg		25.3 mg/Kg	28.4	4.385	21.8
Lead	S00518414	S00518415	<5X	22.2 mg/Kg	<5X	10.0 mg/Kg	16.1	8.627	75.(
Lead	S00518617	S00518618		40.4 mg/Kg		35.4 mg/Kg	37.9	3.536	13.2
Lead	S00518609	S00518610		31.4 mg/Kg		32.7 mg/Kg	32.1	0.919	4.056
Lead	S00704725	S00704726		12.1 mg/Kg		12.4 mg/Kg	12.3	0.212	2.449
Nickel	S00519018	S00519019		5.970 mg/Kg		6.240 mg/Kg	6.105	0.191	4.423
Nickel	S00518416	S00518417		17.6 mg/Kg		13.5 mg/Kg	15.6	2.899	26.4
Nickel	S00518414	S00518415		16.1 mg/Kg		9.030 mg/Kg	12.6	4.999	56.3
Nickel	S00518609	S00518610		19.6 mg/Kg		24.9 mg/Kg	22.3	3.748	23.8
Nickel	S00704725	S00704726		10.7 mg/Kg		11.2 mg/Kg	11.0	0.354	4.566
Nickel	S00518436	S00518437		22.0 mg/Kg		17.3 mg/Kg	19.6	3.324	23.9
Nickel	S00518617	S00518618		35.1 mg/Kg		34.7 mg/Kg	34.9	0.283	1.146
Type = Matrix Spike Duplicate									
Chromium	S00518425A	S00518425D		95.9 mg/Kg		91.7 mg/Kg	93.8	2.977	4.489
Chromium	9007040038	900704003D		93.6 mg/Kg		85.8 mg/Kg	89.7	5.501	8.676
Chromium	S00704707A	S00704707D		101.7 mg/Kg		112.6 mg/Kg	107.1	7.712	10.2
Chromium	S00704713A	S00704713D		85.3 mg/Kg		79.9 mg/Kg	82.6	3.816	6.530
Chromium	S00704701A	S00704701D		86.1 mg/Kg		118.8 mg/Kg	102.5	23.2	32.0
Chromium	S00704612A	S00704613A		107.9 mg/Kg		9.938 mg/Kg	58.9	69.3	166.3
Chromium	S00704710A	S00704710D		53.7 mg/Kg		52.2 mg/Kg	53.0	1.107	2.956
Chromium	S00704609A	S00704610A		156.4 mg/Kg		82.6 mg/Kg	119.5	52.1	61.7
Chromium	S00519027A	S00519028A		193.6 mg/Kg		108.3 mg/Kg	150.9	60.3	56.5
Chromium	900704022A	9007040228		97.9 mg/Kg		97.9 mg/Kg	97.9	0.00	0.00
Chromium	S00704716A	S00704716D		184.9 mg/Kg		106.1 mg/Kg	145.5	55.8	54.2
Chromium	900704019A	9007040198		95.9 mg/Kg		96.9 mg/Kg	96.4	0.707	1.037

NC: Not Calculable

(Continued)

Table F8 (Continued)

DUPLICATE (SAMPLES OR ANALYSES) FOR MATRIX = SOIL; Submatrix = N/A

Parameter	Routine Sample ID	Duplicate Sample ID	Routine Value	Duplicate Value	Mean Concentration	Standard Deviation	RPD (%)
Chromium	S00704704A	S00704704D	104.5 mg/Kg	117.1 mg/Kg	110.8	8.906	11.4
Chromium	S00518410A	S00518411A	93.9 mg/Kg	103.7 mg/Kg	98.8	6.962	9.965
Chromium	S00704615A	S00704616A	61.7 mg/Kg	189.3 mg/Kg	125.5	90.2	101.7
Chromium	S00518605A	S00518605D	240.2 mg/Kg	53.2 mg/Kg	146.7	132.2	127.5
Iron	900704022A	900704022B	100.5 mg/Kg	99.5 mg/Kg	100.0	0.707	1.000
Iron	S00704701A	S00704701D	97.0 mg/Kg	67.9 mg/Kg	82.4	20.5	35.2
Iron	S00704710A	S00704710D	69.4 mg/Kg	85.2 mg/Kg	77.3	11.2	20.5
Iron	S00704716A	S00704716D	89.9 mg/Kg	92.0 mg/Kg	91.0	1.465	2.277
Iron	900704019A	900704019B	96.8 mg/Kg	94.8 mg/Kg	95.8	1.414	2.088
Lead	900704003A	900704003B	18.4 mg/Kg	21.4 mg/Kg	19.9	2.150	15.3
Lead	S00704713A	S00704713D	95.9 mg/Kg	90.9 mg/Kg	93.4	3.570	5.404
Lead	S00704710A	S00704710D	48.6 mg/Kg	49.4 mg/Kg	49.0	0.542	1.564
Lead	S00515934A	S00515935A	2.439 mg/Kg	149.6 mg/Kg	76.0	104.1	193.6
Lead	S00515938A	S00515939A	101.1 mg/Kg	102.3 mg/Kg	101.7	0.833	1.158
Lead	S00524727A	S00524728A	431.8 mg/Kg	312.6 mg/Kg	372.2	84.3	32.0
Lead	S00704615A	S00704616A	74.1 mg/Kg	77.8 mg/Kg	75.9	2.603	4.848
Lead	S00518410A	S00518411A	72.9 mg/Kg	119.0 mg/Kg	95.9	32.6	48.1
Lead	900704019A	900704019B	88.7 mg/Kg	89.9 mg/Kg	89.3	0.849	1.344
Lead	S00518605A	S00518605D	113.5 mg/Kg	116.8 mg/Kg	115.1	2.340	2.874
Lead	S00518425A	S00518425D	97.1 mg/Kg	91.1 mg/Kg	94.1	4.254	6.393
Lead	S00704612A	S00704613A	87.2 mg/Kg	80.7 mg/Kg	83.9	4.594	7.742
Lead	S00704609A	S00704610A	117.3 mg/Kg	100.7 mg/Kg	109.0	11.8	15.2
Lead	S00519027A	S00519028A	103.9 mg/Kg	100.3 mg/Kg	102.1	2.602	3.605
Lead	S00519009A	S00519010A	98.3 mg/Kg	102.8 mg/Kg	100.5	3.193	4.492
Lead	900704022A	900704022B	92.3 mg/Kg	94.3 mg/Kg	93.3	1.414	2.144
Nickel	S00515934A	S00515935A	84.8 mg/Kg	98.0 mg/Kg	91.4	9.309	14.4
Nickel	S00704713A	S00704713D	89.1 mg/Kg	88.0 mg/Kg	88.6	0.786	1.255

NC: Not Calculable

(Continued)

Table F8 (Continued)

DUPLICATE (SAMPLES OR ANALYSES) FOR MATRIX = SOIL; Submatrix = N/A

Parameter	Routine Sample ID	Duplicate Sample ID	Routine Value	Duplicate Value	Mean Concentration	Standard Deviation	RPD (%)
Nickel	S00515938A	S00515939A	105.3 mg/Kg	105.8 mg/Kg	105.5	0.314	0.420
Nickel	S00524729A	S00524730A	90.3 mg/Kg	132.8 mg/Kg	111.5	30.0	38.0
Nickel	S00524727A	S00524728A	101.0 mg/Kg	109.6 mg/Kg	105.3	6.102	8.197
Nickel	S00524725A	S00524726A	108.3 mg/Kg	73.5 mg/Kg	90.9	24.6	38.3
Nickel	900704003A	900704003B	97.7 mg/Kg	75.6 mg/Kg	86.6	15.7	25.6
Nickel	S00518410A	S00518411A	101.2 mg/Kg	100.2 mg/Kg	100.7	0.715	1.004
Nickel	900704019A	900704019B	93.4 mg/Kg	96.4 mg/Kg	94.9	2.121	3.161
Nickel	S00518425A	S00518425D	103.9 mg/Kg	104.9 mg/Kg	104.4	0.689	0.933
Nickel	S00518605A	S00518605D	98.6 mg/Kg	96.8 mg/Kg	97.7	1.296	1.876
Nickel	S00519027A	S00519028A	103.0 mg/Kg	101.3 mg/Kg	102.1	1.210	1.676
Nickel	S00519009A	S00519010A	97.6 mg/Kg	105.7 mg/Kg	101.7	5.726	7.903
Nickel	900704022A	900704022B	95.8 mg/Kg	96.1 mg/Kg	95.9	0.212	0.313
Method: Iron by SW6010							
Type = Field Duplicate							
Iron	S00515924A	S00515954A	24000.0 mg/Kg	31000.0 mg/Kg	27500.0	4949.7	25.5
Iron	S00518923A	S00518922A	0.200 mg/Kg	0.230 mg/Kg	0.215	0.021	14.0
Iron	S00518919A	S00518915A	0.099 mg/Kg	0.086 mg/Kg	0.093	0.0092	14.1
Iron	S00515929A	S00515955A	7200.0 mg/Kg	7600.0 mg/Kg	7400.0	282.8	5.405
Iron	S00518902A	S00518904A	0.160 mg/Kg	0.860 mg/Kg	0.510	0.495	137.3
Iron	S00518703A	S00518704A	0.650 mg/Kg	0.760 mg/Kg	0.705	0.078	15.6
Iron	S00518608A	S00518609A	33000.0 mg/Kg	30000.0 mg/Kg	31500.0	2121.3	9.524
Iron	S00519026A	S00519029A	25000.0 mg/Kg	26000.0 mg/Kg	25500.0	707.1	3.922
Iron	S00518425A	S00518414A	16000.0 mg/Kg	18000.0 mg/Kg	17000.0	1414.2	11.8
Iron	S00519016A	S00519018A	6100.0 mg/Kg	6700.0 mg/Kg	6400.0	424.3	9.375
Iron	S00518409A	S00518416A	15000.0 mg/Kg	16000.0 mg/Kg	15500.0	707.1	6.452
Iron	S00518435A	S00518436A	31000.0 mg/Kg	30000.0 mg/Kg	30500.0	707.1	3.279
Iron	S00518615A	S00518617A	25000.0 mg/Kg	29000.0 mg/Kg	27000.0	2828.4	14.8
Iron	S00515903A	S00515953A	36000.0 mg/Kg	43000.0 mg/Kg	39500.0	4949.7	17.7

NC: Not Calculable

(Continued)

Table F8 (Continued)

DUPLICATE (SAMPLES OR ANALYSES) FOR MATRIX = SOIL; Submatrix = N/A

Parameter	Routine Sample ID	Duplicate Sample ID		Routine Value		Duplicate Value	Mean Concentration	Standard Deviation	RPD (%)
Method: Lead by SW6010									
Type = Field Duplicate									
Lead	S00518435A	S00518436A		35.0 mg/Kg		32.0 mg/Kg	33.5	2.121	8.955
Lead	S00519026A	S00519029A	<5X	31.0 mg/Kg	<5X	30.0 mg/Kg	30.5	0.707	3.279
Lead	S00518703A	S00518704A		0.042 mg/Kg		0.042 mg/Kg	0.042	0.00	0.00
Lead	S00518921A	S00518922A		0.042 mg/Kg		0.042 mg/Kg	0.042	0.00	0.00
Lead	S00518917A	S00518915A		0.042 mg/Kg		0.042 mg/Kg	0.042	0.00	0.00
Lead	S00519016A	S00519018A	<5X	5.700 mg/Kg	<5X	7.400 mg/Kg	7.050	0.495	9.929
Lead	S00518608A	S00518609A		31.0 mg/Kg		31.0 mg/Kg	31.0	0.00	0.00
Lead	S00518902A	S00518904A		0.042 mg/Kg		0.042 mg/Kg	0.042	0.00	0.00
Lead	S00515924A	S00515954A		56.0 mg/Kg		61.0 mg/Kg	58.5	3.536	8.547
Lead	S00518615A	S00518617A		37.0 mg/Kg		40.0 mg/Kg	38.5	2.121	7.792
Lead	S00518425A	S00518414A	<5X	19.0 mg/Kg	<5X	22.0 mg/Kg	20.5	2.121	14.6
Lead	S00518409A	S00518416A		43.0 mg/Kg		45.0 mg/Kg	44.0	1.414	4.545
Lead	S00515929A	S00515955A	<5X	7.100 mg/Kg	<5X	7.700 mg/Kg	7.400	0.424	8.108
Lead	S00515903A	S00515953A		380.0 mg/Kg		180.0 mg/Kg	280.0	141.4	71.4
Method: Nickel by SW6010									
Type = Field Duplicate									
Nickel	S00515903A	S00515953A		11.0 mg/Kg		24.0 mg/Kg	17.5	9.192	74.3
Nickel	S00518902A	S00518904A		0.015 mg/Kg		0.015 mg/Kg	0.015	0.00	0.00
Nickel	S00518608A	S00518609A		23.0 mg/Kg		20.0 mg/Kg	21.5	2.121	14.0
Nickel	S00519026A	S00519029A		20.0 mg/Kg		20.0 mg/Kg	20.0	0.00	0.00
Nickel	S00518435A	S00518436A		24.0 mg/Kg		22.0 mg/Kg	23.0	1.414	8.696
Nickel	S00515924A	S00515954A		24.0 mg/Kg		24.0 mg/Kg	24.0	0.00	0.00
Nickel	S00518703A	S00518704A		0.015 mg/Kg		0.015 mg/Kg	0.015	0.00	0.00
Nickel	S00515929A	S00515955A	<5X	5.600 mg/Kg	<5X	6.600 mg/Kg	6.100	0.707	16.4

NC: Not Calculable

(Continued)

Table F8 (Continued)

DUPLICATE (SAMPLES OR ANALYSES) FOR MATRIX = SOIL; Submatrix = N/A

Parameter	Routine Sample ID	Duplicate Sample ID		Routine Value		Duplicate Value	Mean Concentration	Standard Deviation	RPD (%)
Nickel	S00518615A	S00518617A		30.0 mg/Kg		35.0 mg/Kg	32.5	3.536	15.4
Nickel	S00519016A	S00519018A	<5X	6.800 mg/Kg	<5X	6.000 mg/Kg	6.400	0.566	12.5
Nickel	S00518921A	S00518922A		0.015 mg/Kg		0.015 mg/Kg	0.015	0.00	0.00
Nickel	S00518409A	S00518416A		16.0 mg/Kg		18.0 mg/Kg	17.0	1.414	11.8
Nickel	S00518425A	S00518414A		14.0 mg/Kg		16.0 mg/Kg	15.0	1.414	13.3
Nickel	S00518919A	S00518915A		0.015 mg/Kg		0.015 mg/Kg	0.015	0.00	0.00
Method: Percent moisture inorganic									
Type = Field Duplicate									
Percent moisture	S00519016A	S00519018A		21.6 mg/Kg		21.6 mg/Kg	21.6	0.00	0.00
Percent moisture	S00515924A	S00515954A		32.2 mg/Kg		28.6 mg/Kg	30.4	2.546	11.8
Percent moisture	S00519026A	S00519029A		39.3 mg/Kg		39.1 mg/Kg	39.2	0.141	0.510
Percent moisture	S00518435A	S00518436A		26.3 mg/Kg		26.0 mg/Kg	26.2	0.212	1.147
Percent moisture	S00518608A	S00518609A		27.3 mg/Kg		28.0 mg/Kg	27.7	0.495	2.532
Percent moisture	S00518425A	S00518414A		23.0 mg/Kg		11.7 mg/Kg	17.4	7.990	65.1
Percent moisture	S00518615A	S00518617A		30.1 mg/Kg		28.8 mg/Kg	29.5	0.919	4.414
Percent moisture	S00518409A	S00518416A		4.100 mg/Kg		3.900 mg/Kg	4.000	0.141	5.000
Percent moisture	S00515929A	S00515955A		23.1 mg/Kg		21.6 mg/Kg	22.4	1.061	6.711
Percent moisture	S00515903A	S00515953A		26.6 mg/Kg		28.5 mg/Kg	27.6	1.344	6.897
Method: Sulfate by IC (E300.0)									
Type = Analytical Dup (At Instrument)									
Sulfate	9008262068A	9008262068		4815.1 mg/Kg		4817.5 mg/Kg	4816.3	1.732	0.051
Type = Matrix Spike Duplicate									
Sulfate	900704003B	900704003C		88.4 mg/Kg		88.4 mg/Kg	88.4	0.00	0.00

NC: Not Calculable

(Continued)

Table F8 (Continued)

DUPLICATE (SAMPLES OR ANALYSES) FOR MATRIX = SOIL; Submatrix = N/A

Parameter	Routine Sample ID	Duplicate Sample ID	Routine Value	Duplicate Value	Mean Concentration	Standard Deviation	RPD (%)

NC: Not Calculable

(Continued)

Table F8 (Continued)

DUPLICATE (SAMPLES OR ANALYSES) FOR MATRIX = TREATED; Submatrix = MW

Parameter	Routine Sample ID	Duplicate Sample ID		Routine Value		Duplicate Value	Mean Concentration	Standard Deviation	RPD (%)
Method: Chrome VI by SW7196									
Type = Analytical Dup (At Instrument)									
Chromium VI	900[illegible]04198	900820419C	ND	0.020 mg/L	ND	0.020 mg/L	ND	NC	NC
Chromium VI	900832719	900832719	<5X	0.080 mg/L	ND	0.020 mg/L	ND	NC	NC
Chromium VI	900839919	900839919	<5X	0.083 mg/L	<5X	0.077 mg/L	0.080	0.0042	7.500
Chromium VI	900918214A	900918214B	ND	0.020 mg/L	ND	0.020 mg/L	ND	NC	NC
Method: ICP Metals by SW6010									
Type = Analytical Dup (At Instrument)									
Chromium	900910310A	900910310A		0.037 mg/L		0.143 mg/L	0.090	0.075	117.8
Iron	900910310A	900910310A		0.903 mg/L		0.371 mg/L	0.637	0.376	83.5
Lead	900910310A	900910310A	ND	0.050 mg/L	ND	0.050 mg/L	ND	NC	NC
Nickel	900910310A	900910310A	ND	0.026 mg/L	ND	0.026 mg/L	ND	NC	NC

NC: Not Calculable

(Continued)

Table F8 (Continued)

DUPLICATE (SAMPLES OR ANALYSES) FOR MATRIX = TREATED; Submatrix = T

Parameter	Routine Sample ID	Duplicate Sample ID		Routine Value		Duplicate Value	Mean Concentration	Standard Deviation	RPD (%)
Method: Chrome VI by SW7196									
Type = Analytical Dup (At Instrument)									
Chromium VI	900820415B	900820415C	ND	0.020 mg/L	ND	0.020 mg/L	ND	NC	NC
Chromium VI	900820415B	900820415C	ND	0.020 mg/L	ND	0.020 mg/L	ND	NC	NC
Chromium VI	900901113	900901113		0.689 mg/L		0.693 mg/L	0.691	0.0028	0.579
Chromium VI	900832708	900832708	<5X	0.068 mg/L	<5X	0.071 mg/L	0.070	0.0021	4.317
Chromium VI	900904513	900904513	ND	0.020 mg/L	ND	0.020 mg/L	ND	NC	NC
Chromium VI	900904517	900904517		0.127 mg/L		0.108 mg/L	0.118	0.013	16.2
Chromium VI	900910319A	900910319A	ND	0.020 mg/L	ND	0.020 mg/L	ND	NC	NC
Method: Conductivity (E120.1)									
Type = Analytical Dup (At Instrument)									
Conductivity	900839915	900839915		7650.0 umhos/cm		7660.0 umhos/cm	7655.0	7.071	0.131
Conductivity	900904513	900904513		30300.0 umhos/cm		30000.0 umhos/cm	30150.0	212.1	0.995
Method: pH by SW9045									
Type = Analytical Dup (At Instrument)									
pH	900910319A	900910319A		5.017 mg/L		5.010 mg/L	5.014	0.0049	0.140

NC: Not Calculable

(Continued)

Table F8 (Continued)

DUPLICATE (SAMPLES OR ANALYSES) FOR MATRIX = TREATED; Submatrix = N/A

Parameter	Routine Sample ID	Duplicate Sample ID		Routine Value		Duplicate Value	Mean Concentration	Standard Deviation	RPD (%)
Method: Chloride by IC (E300.0)									
Type = Analytical Dup (At Instrument)									
Chloride	900918206A	900918206B		77.4 mg/Kg		93.1 mg/Kg	85.3	11.1	18.4
Type = Matrix Spike Duplicate									
Chloride	J839907A	900839908A		90.6 mg/Kg		95.8 mg/Kg	93.2	3.687	5.596
Chloride	900820402A	900820403A		94.2 mg/Kg		97.0 mg/Kg	95.6	1.980	2.930
Method: Chrome VI by SW7196									
Type = Analytical Dup (At Instrument)									
Chromium VI	900904504	900904504		7.012 mg/Kg		7.200 mg/Kg	7.106	0.133	2.646
Chromium VI	900901103	900901103		1.689 mg/Kg		1.536 mg/Kg	1.613	0.108	9.488
Chromium VI	900918201A	900918201B	ND	0.080 mg/Kg	ND	0.080 mg/Kg	ND	NC	NC
Chromium VI	900918204A	900918204B	ND	0.080 mg/Kg	ND	0.080 mg/Kg	ND	NC	NC
Type = Matrix Spike Duplicate									
Chromium VI	900820402A	900820403A		1.294 mg/Kg		1.534 mg/Kg	1.414	0.170	17.0
Chromium VI	900901113B	900901113C		97.3 mg/Kg		97.8 mg/Kg	97.6	0.354	0.513
Chromium VI	900820419B	900820419C		2.500 mg/Kg		2.500 mg/Kg	2.500	0.00	0.00
Chromium VI	900832708B	900832708C		107.0 mg/Kg		107.0 mg/Kg	107.0	0.00	0.00
Chromium VI	900839907A	900839908A		81.8 mg/Kg		75.5 mg/Kg	78.7	4.467	8.029
Chromium VI	900832719B	900832719C		85.3 mg/Kg		82.3 mg/Kg	83.8	2.121	3.582
Method: Conductivity (E120.1)									
Type = Analytical Dup (At Instrument)									
Conductivity	900839906	900839906		2000.0 umhos/cm		1990.0 umhos/cm	1995.0	7.071	0.501
Conductivity	900904504	900904504		2590.0 umhos/cm		2610.0 umhos/cm	2600.0	14.1	0.769

NC: Not Calculable

(Continued)

Table F8 (Concluded)

DUPLICATE (SAMPLES OR ANALYSES) FOR MATRIX = TREATED; Submatrix = N/A

Parameter	Routine Sample ID	Duplicate Sample ID	Routine Value	Duplicate Value	Mean Concentration	Standard Deviation	RPD (%)
Method: ICP Metals by SW6010							
Type = Matrix Spike Duplicate							
Chromium	900839921B	900839921C	91.5 mg/Kg	92.5 mg/Kg	92.0	0.707	1.087
Chromium	900839921B	900839921C	-429.1 mg/Kg	-596.4 mg/Kg	-512.7	118.3	-32.6
Chromium	900820402A	900820403A	82.1 mg/Kg	75.5 mg/Kg	78.8	4.668	8.381
Iron	900820402A	900820403A	90.7 mg/Kg	79.9 mg/Kg	85.3	7.619	12.6
Iron	900839921B	900839921C	-8242.7 mg/Kg	-8663.6 mg/Kg	-8453.2	297.6	- 5.0
Lead	900839921B	900839921C	143.7 mg/Kg	37.3 mg/Kg	90.5	75.2	117.6
Nickel	900839921B	900839921C	88.5 mg/Kg	82.0 mg/Kg	85.3	4.627	7.674
Nickel	900820402A	900820403A	89.5 mg/Kg	89.4 mg/Kg	89.4	0.038	0.061
Method: Sulfate by IC (E300.0)							
Type = Analytical Dup (At Instrument)							
Sulfate	900918206A	900918206A	669.7 mg/Kg	736.3 mg/Kg	703.0	47.1	9.474
Sulfate	900910306A	900910306A	999.4 mg/Kg	888.6 mg/Kg	944.0	78.3	11.7
Type = Matrix Spike Duplicate							
Sulfate	900839907A	900839908A	100.4 mg/Kg	101.3 mg/Kg	100.9	0.626	0.877
Sulfate	900820402A	900820403A	98.3 mg/Kg	117.5 mg/Kg	107.9	13.6	17.8
Method: pH by SW9045							
Type = Analytical Dup (At Instrument)							
pH	900910306A	900910306A	11.2 mg/Kg	11.2 mg/Kg	11.2	0.00071	0.0090

NC: Not Calculable

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