DRAFT TREATABILITY STUDY REPORT
SOIL WASHING/METALS RECOVERY AND CHROMIUM REDUCTION/IMMOBILIZATION

ALARK HARD CHROME
2777 MAIN STREET
RIVERSIDE, CALIFORNIA

Prepared for:

California Department of Toxic Substances Control
Region 4 Site Mitigation Branch
Task Order Number 4-088-6.0-400003
Contract Number 91-T0088

Prepared by:

URS Consultants, Inc.
4675 MacArthur Court, Suite 850
Newport Beach, CA 92660

August 20, 1993

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APPROVAL FORM

Document Title: Draft Report for Soil Treatability Study
Alark Hard Chrome Site

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IDENTIFICATION FORM

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Document Coverage:	This report documents the bench-scale treatability study performed on contaminated soil collected at the Alark Hard Chrome site. The treatability study is designed for obtaining information towards soil remediation for the Alark site. URS Consultants, Inc. is retained by the Department of Toxic Substances Control to provide services in soil remediation design.

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1.0 EXECUTIVE SUMMARY

URS Consultants, Inc., (URS) was retained by the California Department of Toxic Substances Control (DTSC) under Contract No. 91-T0088, Task Order No. 4-088-6.0-400003 to conduct a treatability study investigation at the Alark Hard Chrome site (Alark, the site) located at 2777 Main Street in the City of Riverside, San Bernardino County, California.

Previous DTSC investigations at the Alark site identified soil contaminated with chromium VI and total chromium, cadmium, lead, and nickel. The concentrations of these metals are at levels that warrant soil remediation to protect human health and the percent contamination of surface water and groundwater.

The treatability study encompassed the use of soil washing and soil immobilization: technologies deemed potentially applicable for Alark site remediation The primary purpose of the bench-scale study was to provide an evaluation of the technical feasibility of a particular treatment approach. Specific objectives for soil washing and soil immobilization treatability tests were to determine optimum parameters that would result in treatment of affected soils to the desired cleanup and regulatory action levels.

Based on data provided by DTSC, URS selected the locations on the Alark site with the highest concentration of metals of concern. Representative soil samples were collected from each designated location. These samples constituted the untreated/baseline soil samples that were used to complete treatability testing.

Size Segregation

Prior to the start of soil washing treatability testing, size segregation testing was performed on the untreated soil samples. The objective of soil segregation and analysis was to obtain information regarding the quantity of each size fraction and the distribution of metals of concern within the separate size fractions. This information is useful in evaluating the potential for reduction in volume of soil requiring treatment.

The results of size segregation testing suggest that the distribution of the metals of concern among the fractions did not follow the typical pattern of increase in concentration levels in the smaller sized fractions. Total chromium, chromium VI, cadmium, and nickel had similar distribution patterns: the greatest concentrations were identified in the #4 or #10 mesh; concentrations decreased as the particle size decreased in the mid range (#40 and #60 mesh), and increased as the particle size decreased to the smallest size fractions (#230 and pan).

Soil Washing

Soil washing testing was initiated with screening of the untreated soil via a 3/8-inch screen. Only undersized (<3/8") soil fractions were used for treatability testing. The experimental process implemented in the treatability tests included use of an extractant agent to mobilize the metals of concern from the soil phase to aqueous phase. The aqueous phase containing the free metals was then treated to precipitate the metals into a recyclable form.

Prior to start of full-scale soil washing treatability tests, beaker tests were executed. The objectives of the beaker test were to provide qualitative information regarding the performance of the extraction agents. Beaker tests were conducted using plain water, hydrogen peroxide (five different concentrations), and nitric acid (two different concentrations). The results of the beaker tests illuminated several disadvantages to the proposed use of hydrogen peroxide

(h202). Therefore, with approval from DTSC, URS eliminated all proposed H_2O_2 extractants from experimental conditions.

Based on the results of the beaker tests, six experimental conditions were explored for the soil washing tests. The soil washing treatability study was a 3 X 2 experimental design using three wash solutions: hot water, dilute warm 3N HNO_3, and moderate-strength warm 6N HNO_3. Extractions were performed for each of the three solutions at two soil retention (wash) times, seven and fifteen minutes. Test procedures for the soil washing tests were based on the methodologies presented in the EPA publication Lab-Scale Screening Test for Soil Washing Technologies.

Soil washing test results suggest removal of a significant amount of metals, yet the treated soil did not meet the STLC criteria for soluble total chromium and the risk-based criteria for total chromium. The high levels of chromium were too formidable for the mild and moderately aggressive extractants, 3N and 6N nitric acid. Soil washing, however, was able to reduce significant total and soluble total chromium concentrations. Additionally, chromium VI was removed by the nitric acid washes. All cleanup levels were attained, except the risk-based level for inhalation. The inhalation standard may have been met for the pan fraction, which was below the detection limit. Three of the nitric acid washes removed chromium VI from the smallest particles (pan), a phenomena that runs counter to the usual soil washing observations. The larger particle size fractions may have difficulty adsorbing onto the highly mobile chromium VI in the present of an oxidizing wash - nitric acid.

Soil washing with nitric acid significantly reduced total and soluble cadmium. The 60 mesh and 230 mesh fractions attained all cleanup levels; the pan fractions retained much greater amounts of total cadmium. The nitric washing removed moderate and significant amounts of total and soluble lead respectively. The soluble fraction was reduced below the cleanup levels; however, the initial concentration of total lead in untreated soil was below the three cleanup levels. Lead has been shown to be a good candidate for soil washing, although in other test chelating agents were used - agents that would not prove effective for chromium (Rayford et al. 1986; Evangelista et al. 1987; 1988). Soil washing removed nickel, total and soluble, from Alark soil in a classic fashion. The removals achieved were high in the 60 mesh fraction, moderate in the 230 mesh fraction, and low in the pan fraction.

Soil Immobilization

Immobilization treatability testing encompassed several distinct stages to ensure the immobility of the metals of concern and the durability of the immobilized matrix. These stages included: soil screening, pretreatment chemical/reduction, immobilization, and the first and the second tier of analyses.

The immobilization study was of a 2 x 4 x 2 experimental design. Two types of pretreatment reduction methods and four types of immobilization binders were tested. Each binder was tested at two, binder-to-soil ratios.

Immobilization treatability testing was initiated with soil screening. In the soil screening stage, untreated soil was screened with a 3/8-inch mesh to remove oversized soil particles to provide some uniformity to the soil within the immobilized matrix.

Following screening, the untreated soil fraction was subjected to a pretreatment/chemical reduction process. The chemical reduction step involved the conversion of the highly mobile Cr^{+6} species to the less mobile Cr^{+3}. This step explored the efficiency of two reducing agents: ferrous sulfate ($FeSO_4$), and sodium hydrosulfite ($Na_2S_2O_4$).

The pretreated/chemically reduced soil was then immobilized using the following four binders:

1. Portland cement.
2. Portland cement with soluble silicate
3. High alkaline (self-cementing) fly ash
4. High alkaline fly ash with soluble silicate.

The cement and fly ash binders were evaluated using two binder/soil ratios, 10% and 40% ($^{W}/_{W}$).

Analytical testing of the immobilized sample was divided into two tiers. The first tier placed primary emphasis on the STLC leach test. Those immobilization mixtures with the lowest STLC values were tested in the second tier of analyses. In addition, the pH of the immobilized matrix was measured, as was the increase in volume. The second tier of analyses involves measuring the monolith's engineering/geotechnical properties for long-term leaching performance, structural durability, and design or disposal purposes.

Immobilization of Alark soil with Portland cement 40% ($^{W}/_{W}$) significantly lowered the mobility of the soluble metals of concern. In general, the addition of soluble silicate to the 40% Portland cement admix did not significantly improve the performance of the cement. Although the 40% Portland cement (with or without soluble silicate) performed best among the tested admixtures, the resulting immobilized matrix was still a California hazardous waste and waste of concern. STLC, F006, and D-code cleanup levels for total chromium and the risk-based level for chromium VI was not achieved.

The concentration of total chromium requiring immobilization was too high for the tested reagents to adequately meet all cleanup criteria for all metals of concern. Some of this high concentration of total chromium may have been transformed into chromium VI during the experiment. For several reagents, the soluble concentration of chromium VI was higher after immobilization. In a situation where the initial concentration of total chromium is much higher than chromium VI, excess reducing reagent may be necessary to minimize the formation of chromium VI.

The results of the two reducing agent, ferrous sulfate and sodium hydrosulfite, differed little from each other. The effect of the eight immobilization admixtures on the 5 metals of concern showed the same pattern of results irrespective of which reducing agent was used. Therefore, the sodium hydrosulfite was the reducing agent that would be easiest to implement in a field-scale operation, since it could be added at the same time and into the same equipment as Portland cement additive.

This treatability study was the first phase of remedial procedures explored to cleanup the Alark site. Some procedures worked to significantly reduce the presence or mobility of heavy metals in Alark soil; others did not. The treated soil did not meet all the regulatory requirements. Further treatability testing is recommended to develop process parameters that will result in remediation of the affected soil to the designated treatment levels..

Additional treatability studies should identify procedures and reagents that may increase the mobility (wash) or decrease the mobility (immobilize) of chromium. This recommendation still maintains the original technologies proposed but process identification of parameters that will improve the process chemistry.

For mobilizing chromium from soil, a very strong oxidizing agent should be used to oxidize Cr^{+3} to Cr^{+6}. One recommended oxidant is a cyanide leach solution, similar to the type used in

hydrometallurgy potentially have the oxidizing power to convert all the total chromium to chromium VI, then wash it out of the soil. To enhance the removal rates, Alark soil can be leached for extended duration or can be exposed to extractants at elevated temperatures and pressures. The first method compensates for slow reaction kinetics by making reaction times longer; the second method increases the kinetics.

Additional admixtures should be explored for immobilizing chromium. These admixtures can be generic and/or proprietary. Many admixtures can be tested in a relatively short period of time. Therefore, we recommend to test for just soluble total chromium by Cal WET (STLC) until an immobilized matrix is less than the mandated cleanup levels (STLC, F006, and D-code). If an immobilized matrix meets the cleanup levels for soluble chromium, additional analyses can be performed for additional metals of concern.

Another recommendation for future testing is the addition of a much greater excess of a reducing agent. The soil evaluated for this treatability study contained much higher concentrations of total chromium than chromium VI. Since the concentration of reducing reagents were based on the initial concentration of chromium VI plus some excess, the concentration of reducing agent may be insufficient to reduce chromium VI that was transformed from the total chromium during the experiment.

Bench-scale testing of an additional alternative and innovative technology to remove metals from Alark soil such as electro-kinetic technology also is recommended. Metals can be mobilized from soil by migration to specialized electrodes in the presence of electrolytes applied to the soil. The electrodes can remove the metals from the soil phase on site.

In summary, soil washing and soil immobilization tests show partial effectiveness of these processes for site remediation. Additional testing to refine the process parameters used in this study is recommended. For soil washing, this refinement should include use of more powerful extraction agents, elevated reaction temperature and/or residence times, and use of a stronger oxidizing agent. Additional practical concerns such as dewatering of the washed soil and residual management should also be considered. Additional testing will result in development of a soil washing process capable of treating the soil to the desired treatment levels.

The results of soil reduction/immobilization suggest the efficacy of sodium hydrosulfite as a reducing agent and Portland cement as a binder. Additional refinement of soil to binder ratio and the sodium silicate concentration will result in development of a formulation capable of treating the soil to the desired treatment levels.

2.0 INTRODUCTION

URS Consultants, Inc., (URS) was retained by the California Department of Toxic Substances Control (DTSC) under Contract No. 91-T0088, Task Order No. 4-088-6.0-400003 to conduct a treatability study investigation at the Alark Hard Chrome site (Alark, the site) located at 2777 Main Street in the City of Riverside, San Bernardino County, California (Figure 1). The treatability study results will be used to evaluate the feasibility of potentially applicable remedial alternatives for the treatment of two areas of contaminated soil identified during previous DTSC investigations at the site.

This treatability study addresses only the treatment of soil. It addresses two treatment technologies: soil washing and soil immobilization.

This report documents the results of the treatability study, and provides remedial design recommendations for site remediation. All field and laboratory work performed on the treatability study was completed in accordance with the DTSC-approved Workplan for Treatability Study of Soils, dated December 11, 1992, as amended.

2.1 Site Description

The Alark Hard Chrome (Alark) site is the former location of an electroplating shop. The site is located approximately 1 mile west of the intersection of the 60, 91, and 215 Freeways in Riverside, California (Figure 1). The site consists of an approximately one quarter acre parcel that is relatively flat with minor areas built up by fill material. The majority of the site is covered by one large slab on grade building that is approximately 10,000 square feet. Electroplating operations at the facility have ceased and most of the building is currently vacant. A barber shop continues to operate out of a small commercial business space located in the eastern corner of the building (Figure 2).

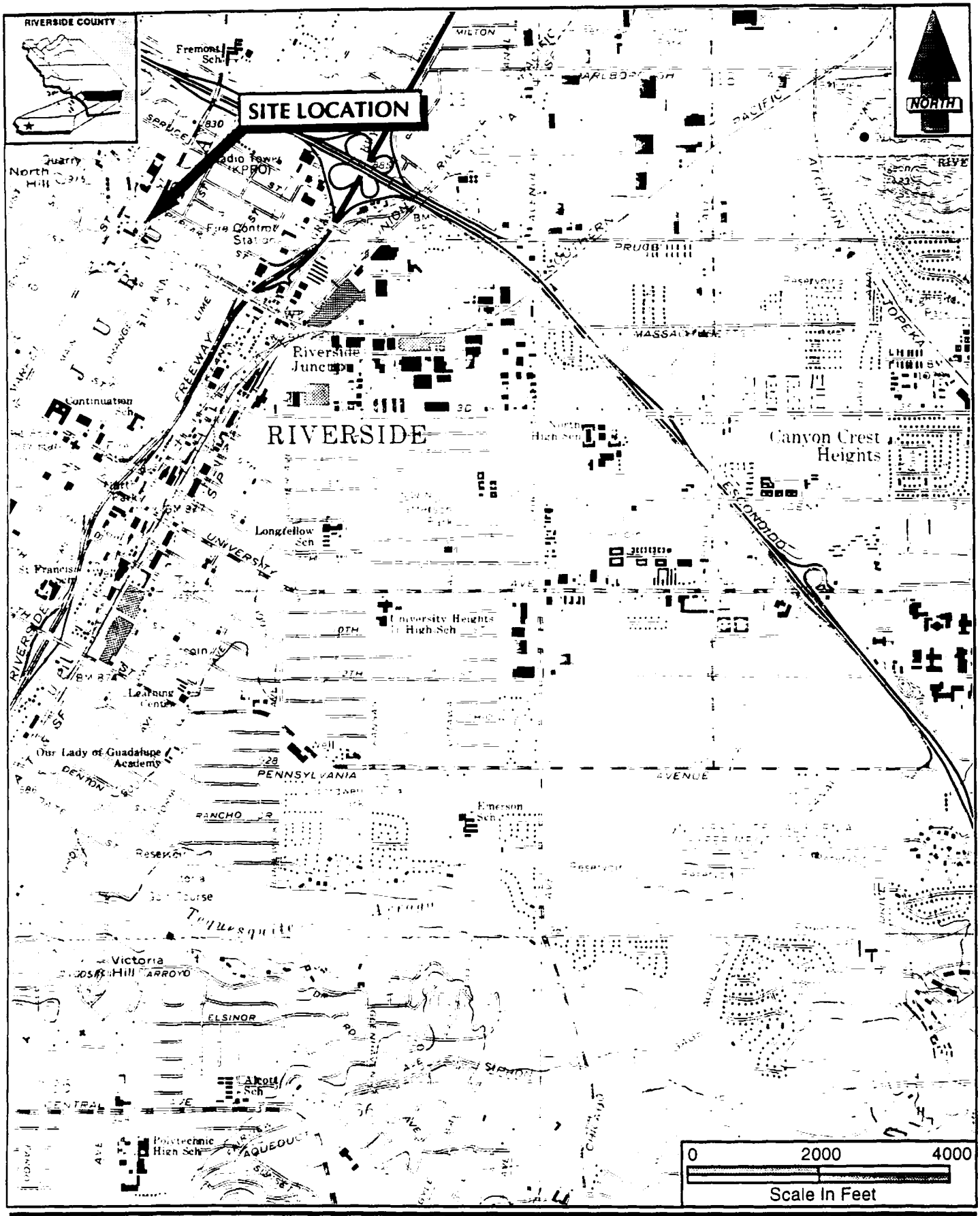
The site is located in a light industrial area. To the northeast of the site is the Klure and Harris (K&H) Metals and Supply and to the south, Precision Auto (an auto body and paint shop). The closest residential areas are located one block southeast and two blocks west of the site.

The building is divided into three areas: a front room with attached barber shop, a medium-sized middle room, and a small back room and office area on the east side (Figure 2). The soil sampling activities conducted for the treatability study were focused in the middle room.

Previous DTSC investigations at the Alark site identified soils contaminated with trivalent and chromium VI (Cr^{+3} and Cr^{+6}), cadmium, lead and nickel. The concentrations of these contaminants are at levels that warrant soil remediation to protect potential human receptors from exposure to soil-bound contaminants, and to prevent potential contamination of groundwater and surface waters in the vicinity of the site.

Soil contamination extends to approximately 40 feet deep in some areas of the site. Approximately 2,700 cubic yards of contaminated soil will require remediation to reduce the volume, toxicity, or mobility of the contaminants identified at the site (DTSC, 1991).

Of the contaminants identified at the site, total chromium and chromium VI (Cr^{+6}) appear to be the most prevalent with the greatest concentrations found in the soil underlying the middle room. Elevated concentrations of metals of concern in the soil under the back room appear to be limited vertically to approximately the first ten feet of soil (DTSC 1991).



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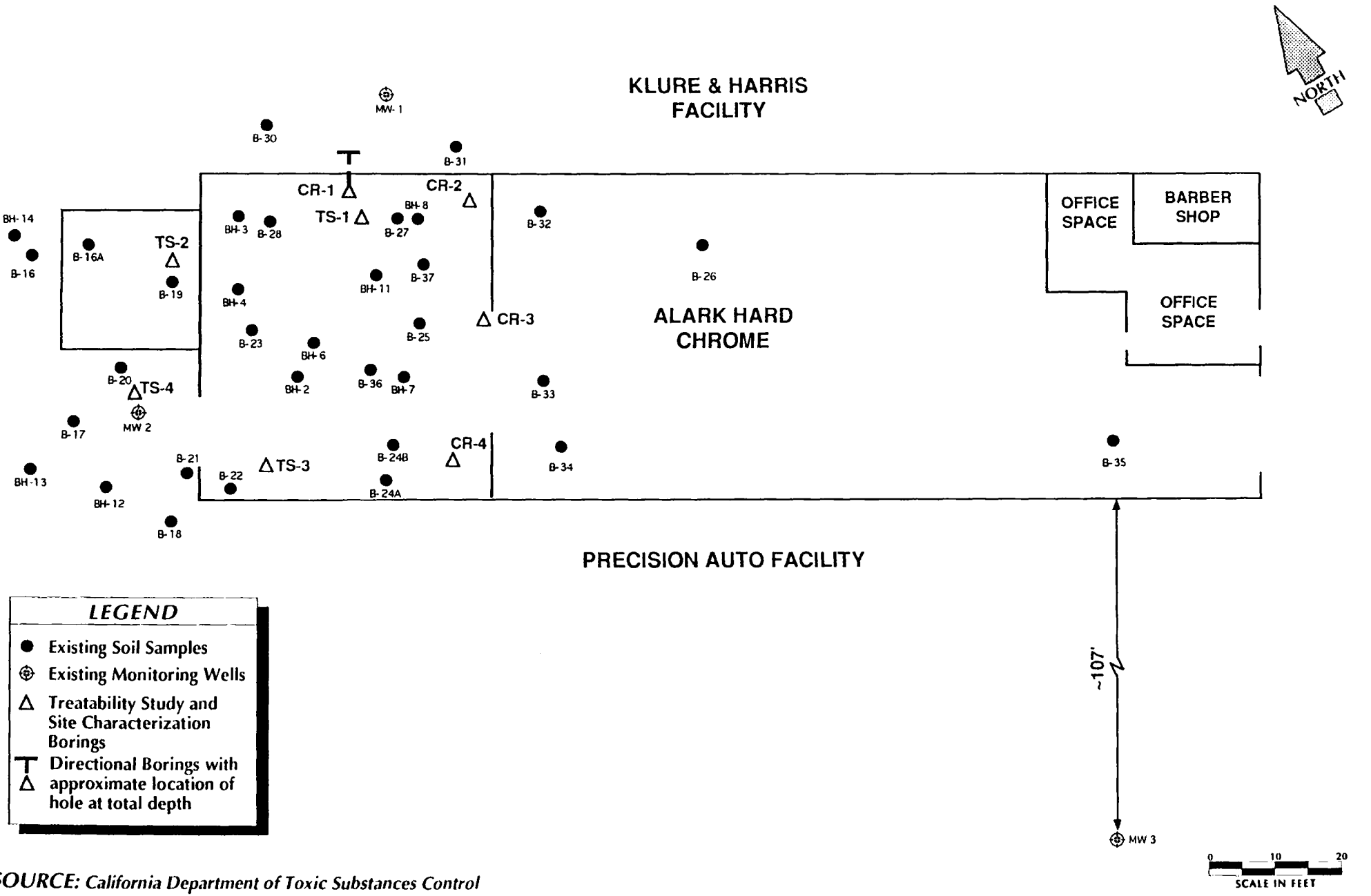
June 02, 1993

Site Location Map

Alark Hard Chrome
2777 Main Street, Riverside, CA

FIGURE

1



SOURCE: California Department of Toxic Substances Control Region 4, Site Mitigation Branch

URS Consultants
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Newport Beach, CA 92660
August 16, 1993

FACILITY MAP

Alark Hard Chrome
2777 Main St., Riverside, CA

FIGURE
2

The back room contained the greatest concentrations of cadmium in soil. Elevated concentrations of metals of concern, particularly lead and nickel, were also present in the soil beneath the back room and in the soil behind the Alark building (DTSC 1991).

URS selected the locations with the greatest concentrations of metals of concern to collect soil samples for use in the treatability study. Sample locations were selected using data provided to URS by DTSC. Soil boring and sample locations were approved by DTSC staff prior to field operations. The sample locations for treatability study samples are illustrated on Figure 2, and treatability study sampling details are described in detail in Section 3.2.2 of this report.

2.2 Remedial Technology Description

The soil treatment technologies evaluated for the Alark site consist of soil washing and soil immobilization. The associated bench-scale treatability studies consisted of a series of tests designed to quantitatively evaluate the technical performance of each treatment method. The primary purpose of the bench-scale study is to provide an evaluation of the technical feasibility of a particular treatment approach. The following paragraphs provide a brief description of the treatability study technologies tested for the Alark site. A complete discussion of the technologies and rationale for treatability study testing is provided in the following sections of this report.

2.2.1 Soil Washing

Soil washing technologies consist of processing the soil (after excavation) in the presence of a liquid. The purpose of soil washing is to increase the mobility of contaminants in the soil phase so that they may be collected in the liquid phase. The types of soil washing technologies evaluated during the Alark treatability study were volume reduction and extraction.

Soil washing for volume reduction has two technical components that occur during the processing of soil. The first is a grain size grading process, whereby the soil is separated into coarse and fine fractions. If contamination is confined to a specific fraction, it is possible to reduce the amount of soil requiring remediation (hence, volume reduction). The second component is to process the coarse soil fraction so as to physically and chemically mobilize or extract the contaminants from the soil through use of an extracting agent. The extracting agent washes the soil and the residual leachate contains the mobilized contaminants of concern.

The volume reduction process uses machinery and procedures typically found in the aggregate industry. These produce materials of various size grade. In this treatability study, soil samples were wet-sieved to determine the size gradations of the soils and chemical analyses of the size fractions were conducted to determine if contamination preferentially resides within a discrete soil fraction.

The soil washing for extraction, removes soil-bound contaminants using liquid extraction agents. For this treatability study the extraction agents used were hot water (control solution), 3N nitric acid (HNO_3), and 6N HNO_3. The extraction agents are placed in contact with the excavated soil matrix to mobilize contaminants that are chemically or physically attached to the soil particles. This process increases the mobility of contaminants in the soil phase so that they may be collected in the liquid phase.

2.2.2 Immobilization

Immobilization technologies are methods that limit the migration of contaminants with or without major modification to the physical state, characteristics, or appearance of the waste

matrix. The waste matrix in the case of this treatability study is soil. The goal of reduction/immobilization to decrease the mobility of contaminants in the soil phase (the opposite of soil washing). Immobilization techniques involve the addition of chemical reagents, and/or other substances to the waste matrix to transform the contaminants into an acceptably low form of mobility.

Immobilization involves the use of two general techniques to treat soil: stabilization/fixation and solidification. Stabilization/fixation techniques alter the contaminants chemically to limit their solubility, mobility, or chemical reactivity. Reagents or materials are added to the waste matrix to maintain the metals of concern in their least mobile or toxic form. Examples of this technique are the conversion of metals into their lower mobility hydroxide or sulfide species, or the change of the metal's valence or oxidation state to one of lower solubility.

Solidification is the result of treatment that produces a solid mass of waste material that has high structural integrity. The resulting product is often called a monolith. A mechanical enclosure of contaminants by reagents, called micro-encapsulation, generally takes place during solidification. A chemical interaction between reagents and contaminants may also occur. Contaminant loss from the solidified matrix is limited by the encapsulating mechanism, which locks in and isolates the waste from the environment, and by the reduction of surface area, which lowers the amount of waste exposed to environmental affects.

In this treatability study, a chemical reduction step was performed prior to proceeding with the immobilization procedure. The purpose of the chemical reduction step was to reduce Cr^{+6}, which is highly mobile, to its less mobile state, Cr^{+3}.

Once the chemical reduction step was conducted, the screened, pre-treated soil was immobilized using the following four (4) binders: Portland Cement, Portland Cement with soluble silicate, high alkaline (self-cementing) fly ash, and high alkaline fly ash with soluble silicate. The cement and fly ash binders were evaluated at 10% and 40% ($^{W}/_{W}$) mixtures.

3.0 TREATABILITY STUDY APPROACH

3.1 Test Objectives

The overall objective of this treatability study was to evaluate the technical feasibility of two soil treatment technologies: soil washing and chemical immobilization. The purpose of the bench-scale tests were to ascertain optimum operating parameters and to obtain preliminary remedial design and preliminary cost information for remediating contamination identified at the Alark site.

3.1.1 Soil Washing

The specific objective of soil washing was to mobilize the metals of concern from the soil matrix into an aqueous rinsate where removal, recycling, or disposal of the metals of concern could more readily take place. For this treatability study, soil washing technologies that would reduce the concentration of metals of concern in the soil matrix to levels at or below the DTSC health risk-based concentrations, Total Threshold Limit Concentration (TTLC) and Soluble Threshold Limit Concentration (STLC) were applied. These levels are summarized on Table 1. Soil washing technologies applied during this treatability study were designed in effort to reduce the leachable and total concentrations of the metals of concern in treatability study samples by 90%.

The following technology-related objectives were used to determine the optimum operating parameters for soil washing and the site-specific feasibility:

- The time required to leach the soil to reduce the metals of concern to their respective cleanup levels;
- The concentration of the extraction solutions;
- The ability to recycle or dispose of the extraction solutions; and
- The suitability of the Alark soil for soil washing.

3.1.2 Immobilization

The specific objectives of immobilization are to chemically stabilize/fix the metals of concern so as to severely limit their solubility and mobility, and to solidify the soil matrix to reduce the leaching potential of the contaminants into groundwater. Reduction/immobilization technologies applied during this treatability study were designed to reduce the leaching capacity of chromium VI in the soil matrix to levels at or below the DTSC health risk-based levels, and to reduce the mobility of all metals of concern to levels below the soluble threshold limit concentration (STLC). Further, immobilization techniques that would allow for a minimum unconfined compressive strength of 50 pounds per square inch (psi) were applied to ensure long-term in-situ stability should the immobilization technology be selected for remediation of the Alark site.

TABLE 1
HEALTH RISK-BASED LEVELS FOR SOIL

Metal of Concern	Risk-based level (mg/kg)	Exposure Route	TTLC (mg/kg)	STLC (mg/L)
Chromium VI	1.7	Ingestion	NA	NA
	0.08	Inhalation	500	5
Total Chromium	7000	Ingestion	2500	5
	23	Inhalation	NA	NA
Cadmium	350	Ingestion	100	1
	2.27	Inhalation	NA	NA
Lead	1300	Ingestion-adult	1000	5
	300	Ingestion-child	NA	NA
	NC	Inhalation	NA	NA
Nickel	14000	Ingestion	2000	20
	44	Inhalation	NA	NA

NA Not Available

Results of the immobilization bench-scale testing were evaluated against State (risk-based and STLC) and Federal (F006 standard and D-Code) cleanup goals. Federal cleanup levels F006 standard and D-Code are based on land disposal restrictions. Immobilization testing was conducted by the California Waste Extraction Test (WET) method at the request of DTSC. Initially, immobilization testing was to be conducted using the Toxicity Characteristic Leaching Procedure (TCLP) and not the WET (see Section 4.2, Deviations from Work Plan). State and Federal cleanup goals for immobilized soil are summarized on Table 2.

The following technology-related objectives were used to determine optimum operating parameters and the feasibility of immobilization as a remedial option at the site:

- The performance of the two selected reducing agents in reducing chromium VI to trivalent chromium;
- The reduction of chromium within the short reaction time needed for a continuous operation;
- The binder (immobilization reagents) that provides the lowest mobility for the metals of concern and meets the cleanup goals for these chemicals;
- The volumetric increase of matrix after immobilization by the various reducing agent-binder combination.

3.1.3 Treatability Study Sampling

The objective of sampling for the treatability study was to collect soil samples from locations containing the greatest concentrations of the metals of concern and to homogenize such samples to form discrete soil comprised of representative contaminant concentrations. These samples would subsequently provide the baseline sampling results from which the effectiveness of treatability testing would be determined.

Soil boring and sample locations were selected based on their proximity to areas known to contain the greatest concentrations of the metals of concern (as determined during the DTSC 1991 remedial investigation). On May 25, 1993, URS' drilling subcontractor drilled soil borings at the locations illustrated on Figure 2. Samples were collected from Boring TS-1 at 5 feet and 30 feet, Boring TS-3 at 4 feet, Boring CR-2 at 5 feet, and Boring CR-3 at 5 feet. Boring TS-3 was originally scheduled to be sampled at 5 feet; however, refusal was encountered at 4 feet and the sample had to be collected at that depth. Boring TS-2, which was originally selected because of its proximity to high cadmium-concentrated soil, was canceled by DTSC due to equipment limitations. Instead, a composite sample was collected from Borings CR-2 and CR-3 at a 1:1 ratio from approximately 5 feet bgs.

Approximately five gallons of soil from each of the four discrete sample locations was collected and placed in a clean plastic container and mixed thoroughly (homogenized) in a 20-gallon drum for 15 minutes. Representative samples were collected from each container and analyzed for cadmium, chromium (total), chromium VI, nickel, and lead for both total and soluble concentrations by EPA Method 6010/7196 and California Administrative Code Title 26 Waste Extraction Test (WET), respectively. A summary of these initial sample results is provided in Table 3.

TABLE 2
CLEANUP GOALS FOR IMMOBILIZED SOIL

Metal of Concern	Risk Based Level (mg/L)	STLC (mg/L)	F006 Standard (mg/L)	D-Code (mg/L)
Chromium VI	0.08	5	NA	NA
Total Chromium	NA	5	5.2	5.0
Cadmium	NA	1	0.066	1.0
Lead	NA	5	0.51	5.0
Nickel	NA	20	0.32	20.0

NA Not Available

Table 3
Baseline Soil Sample Results

SAMPLE DESCRIPTION	CHROMIUM TOTAL TOTAL (mg/kg)	CHROMIUM VI TOTAL (mg/kg)	CADMIUM TOTAL (mg/kg)	LEAD TOTAL (mg/kg)	NICKEL TOTAL (mg/kg)
TTLC	2,500	500	100	1,000	2,000
TS-1 @ 5' Homogenized	4,500	0.28	21	150	19
TS-1 @ 30' Homogenized	2,000	0.29	0.27	3.3	7.1
TS-3 @ 4' Homogenized	250	18	8.9	260	86
CR-2/CR-3 @ 5' Homogenized	73	6.3	0.44	12	11
*Untreated Soil sample	2,800	2,100	9.2	84	12

SAMPLE DESCRIPTION	CHROMIUM TOTAL SOLUBLE CONCEN-TRATION (mg/l)	CHROMIUM VI SOLUBLE CONCEN-TRATION (mg/l)	CADMIUM SOLUBLE CONCEN-TRATION (mg/l)	LEAD SOLUBLE CONCEN-TRATION (mg/l)	NICKEL SOLUBLE CONCEN-TRATION (mg/l)
STLC	560	5	1	5	20
TS-1 @ 5'	220	0.15	1.7	5.3	0.40
TS-1 @ 30'	190	0.12	ND	0.070	0.18
TS-3 @ 4'	11	3.9	0.80	15	3.2
CR-2/CR-3 @ 5'	3.1	2.3	ND	1.6	0.19
Untreated Soil	210	27	0.97	3.9	0.30

* Untreated Soil Sample was the <3/8" fraction of a composite sample prepared from sample TS-1 collected at 5' and 30'.
ND = Non-detect

Laboratory analytical results indicated that contaminant levels for metals of concern found in Boring CR-2/CR-3 and TS-3 were lower than anticipated. In accordance with recommendations provided by DTSC staff, these samples were not used for treatability testing. The two discrete samples collected from TS-1 at 5 feet and 30 feet were then composited into a 20-gallon drum and mixed thoroughly. One sample of the composite soil was collected and analyzed for total and soluble concentrations of cadmium, chromium (total), chromium VI, nickel, and lead by EPA Method 6010/7196 and WET, respectively. The concentrations of the contaminants identified in this composite sample are the baseline untreated sample results used to calculate the effectiveness of soil washing and immobilization treatment technologies. The baseline analytical results are provided on Table 3 (see Untreated Soil Sample).

Subsequent post-treatment treatability study sampling was also performed to establish the extent to which the soil had been washed or immobilized in comparison to baseline analytical results. A discussion of bench-scale testing, applied treatment technologies and results is provided in Section 4.0.

3.1.4 Analytical Methods

The following testing was conducted during the treatability study: materials balance testing, engineering/geotechnical testing, and chemical analysis. All analyses were performed on screened soils with the exception of the grain size distribution analysis conducted as part of the engineering/geotechnical testing. All soils were screened with a 3/8-inch screen to remove large soil particles prior to the treatability study testing. Procedures and rationale for materials balance testing, engineering/geotechnical testing and chemical analysis are discussed below.

Materials Balancing

Materials balancing accounts for all of the reactants and products of a chemical reaction or mixing process. It involves weighing or determining the volume and density of each reactant and each treated matrix. The materials balance also includes measuring the total composition of each reactant and reaction product.

During the immobilization phase of the treatability study, reagents added to the soil produced an immobilized soil matrix. There were no gaseous product releases observed during the immobilization phase of the study. Only dilution effects caused by the addition of immobilization reagents required consideration during the bench-scale study.

The materials balance was dependent on the accurate measurements of:

- The volume and weight of the raw (or untreated) soil and any water added to the soil;
- The volumes and weights of each constituent reagent (solid and/or liquid) in the immobilization process; and
- The volume and weight of the immobilized and washed soil.

3.1.5 Engineering/Geotechnical Tests

Engineering/geotechnical tests required the use of physical methods to characterize the treatability study samples and the subsequent immobilized matrices. Testing was conducted to determine soil mass as a function of grain size. Soil samples were wet-sieved to determine the size gradation of the soils and then chemical analysis of the size fractions was conducted to determine if contamination preferentially resided within a discrete soil fraction.

Additional tests provided measurements of the structural capacity of the solidified mass, porosity of the immobilized material, and the degree of encapsulation of the treated wastes. These factors provided information relative to the efficiency and effectiveness of the immobilization process. Grain size or particle-size distribution of a soil was an important consideration in the evaluation of treatment technologies. Fine-grained soil generally presents a more significant handling problem than its larger grained soil counterparts. Fine-grained soil also presents a problem in producing high-strength solidified wastes. Large percentages of fine particles lower the ultimate strength of cement/soil composites. The particle size distributions of soil samples was determined by combined sieve analysis and hydrometer analysis described in ASTM 422-63.

Water content is the ratio of the weight of water retained by a solid to the weight of solids, expressed as a percent. Standard methods for water content are ASTM Method D2216-80 and Test Methods for Solid Waste Characterization (TMSWC)-4. ASTM Method D2216-80 is used to determine the water content of raw waste samples. Moisture is determined on a dry-weight basis by measuring the mass of water removed after drying the sample to a constant mass at 110°C ± 5°C. This method was not applicable to solidified waste because hydrated water can be lost when the sample is dried at 110°C. TMSWC-4 was used to determine the water content of solidified waste. The mass of the sample is measured before and after it is dried in an oven maintained at 60°C ± 3°C. The dry weight must remain constant with a mass change of less than 0.03 g in 4 hours.

The bulk densities of the immobilized waste, along with the unconfined compressive strength (UCS) and permeability help to evaluate the leachability of the solidified waste. The bulk density of raw waste was determined using the American Society of Agronomy Method (ASA)-13-3 Bulk density was calculated based on a soil sample of known volume and dry mass. The bulk density of the immobilized soil was determined using TMSWC-2. Bulk density was determined by weighing and measuring a cube or cylinder and dividing the mass by the volume. This information was used to convert waste weight to volume for material handling calculations.

The unconfined compressive strength (UCS) of immobilized soil was measured in accordance with ASTM method D-1633. This test method determined the UCS characteristics of molded soil-cement cylinders using strain-controlled application of an axial load. UCS was defined as the load per unit area in psi at which an unconfined cylindrical sample of solids fails a compression test. UCS tests were used to provide information on the stability of the immobilized treatability soil samples in a disposable environment.

3.1.6 Chemical Analyses

Chemical analyses were conducted using the following USEPA and State of California (California Administrative Code [CAC]) approved testing methods. Analytical methods for priority pollutant metals are based on the EPA publication Test Methods for Evaluating Solid Wastes, SW-846, 3rd Edition, November 1986. The analytical methods used are identified below:

- EPA Method 6010 for total chromium, cadmium, nickel, and lead in soil.
- EPA Method 7196 for chromium VI.
- CAC Title 22 Metals
- CAC Title 26 Waste Extraction Test (WET)

The WET determines the mobility of both organic and inorganic contaminants present in liquid, solid, and multiphasic wastes. The WET was used during the treatability study to estimate the

chemical stability of immobilized soil. The WET was used at the request of DTSC as opposed to the initially-proposed Toxicity Characteristic Leaching Procedure (TCLP).

All chemical analyses were subject to the data validation procedures specified in the Treatability Study Workplan, as amended (URS 1992). Samples were evaluated for holding time violations, method blank results, and matrix spike and matrix spike duplicate recoveries (expressed as accuracy and precision). A detailed summary of data validation procedures and subsequent findings are provided in Appendix B.

4.0 SOIL WASHING TREATABILITY TESTING

4.1 Test Methodology

4.1.1 Size Segregation Testing

Prior to initiation of soil washing treatability testing, a composite soil sample of untreated soil was prepared from soil samples TS-1 collected at 5 and 30 feet. The composite soil sample was then segregated by particle size into separate size fractions. Grain-size distribution was performed according to the methodologies stated in Subsection 3.2.4. Following size distribution, each dried soil fraction was placed in a separate sample jars and analyzed for total metals of concern following the methodologies stated in Subsection 3.2.5. The objective of size segregation and analysis was to obtain information regarding the quantity of each size fraction and the distribution of the metals of concern within the separate size fractions. This information is useful in evaluating the potential for reduction in volume of soil requiring treatment.

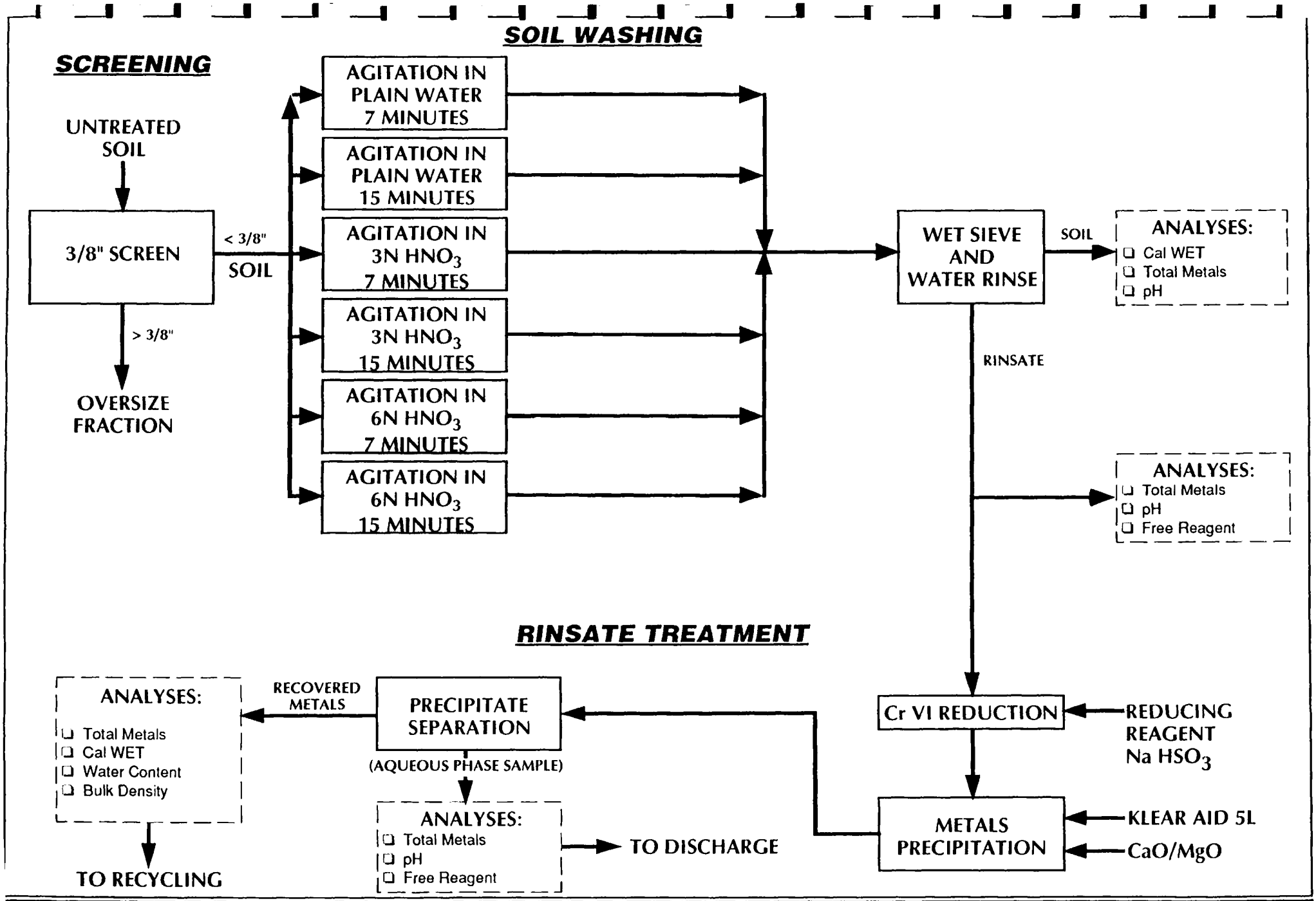
4.1.2 Soil Washing Test Methodology

Soil washing treatability tests were conducted using the methodologies presented in EPA publication *Laboratory-Scale Screening Test for Soil Washing Technology,* developed by the Office of Research and Development, Risk Reduction Engineering Laboratory (RREL). (A copy of this protocol is provided in Appendix A.) In addition to these protocols, experimental designs and procedures used during soil washing; were based on the guidance provided in the *Guidance for Conducting Treatability Studies under CERCLA: Soil Washing.*

Prior to soil washing treatability testing the untreated soil sample (composite sample prepared from Samples TS-1 collected at 5 and 30 feet) was sieved via a 3/8-inch screen. This effectively removed particles of sufficient size which could have interfered with bench-scale testing. Only articles smaller than 3/8 inches were used for this study. Oversized particles were not treated in this study, however, in a full-scale remedial process, the oversized fraction would either be spray washed or crushed to <3/8 inches and reintroduced into the process. A sample of the undersized particles was collected and analyzed for total and soluble concentrations for the metals of concern. The analytical results of this sample constitute the baseline contaminant levels of the treatable soil fraction.

The experimental process implemented in the treatability tests included use of an extraction agent to mobilize the metals of concern from the soil phase to the aqueous phase. The aqueous phase containing the free metals was then treated to precipitate the metals into a recyclable form. A diagram detailing the overall process of soil washing treatability testing is presented in Figure 3. A complete list of equipment and materials used during testing is provided in Appendix C.

Prior to performing full-scale testing beaker tests were executed. The objective of the beaker tests was to provide qualitative information regarding the performance of the extraction agents prior to the start of full-scale lab testing. The beaker tests were divided into two types: aqueous and soil tests.



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SOIL WASHING (VOLUME REDUCTION) SCHEMATIC

FIGURE 3

Aqueous beaker tests used wastewater collected from a chrome plating bath; generally, this water will contain 1.5 lbs of chromium VI per gallon. After diluting with tap water twenty times, approximately 20 ml of 30% hydrogen peroxide was added to 500 ml of the diluted plating wastewater. Introduction of the peroxide resulted in the solution to turn from orange-yellow to light green-yellow indicating the reduction of chromium VI to chromium III, the opposite of the desired and anticipated results of peroxide additions. The objective of adding peroxide was to maximize the conversion of Cr^{+3} (chromium III) to Cr^{+6} (chromium VI,) the species with the greatest mobility; so that the greatest amount of chromium could be mobilized and washed out.

Beaker tests for the soil phase were carried out using eight wash solutions at two soil/wash solution ratios: 1:2 and 1:3. The wash solutions were as follows:

1. One control solution using tap water;
2. Five H_2O_2 solutions: of 2.5%, 5%, 10%, 15% and 30%; and
3. Two HNO_3 solutions: 3N and 6N.

For each test, 10 mg of soil was used with 20 ml (soil:wash solution weight ratio of 1:2) or 30 ml (soil:wash solution weight ratio of 1:3) of wash solution. Qualitative results such as temperature, pH, and physical reactivity were noted for each test.

Soil phase testing with the H_2O_2 wash solutions (all concentrations) resulted in a violent exothermic reaction within the beaker. No aggressive chemical reaction was observed with 3N/6N HNO_3 solution.

The results of beaker testing illuminated several disadvantages to the proposed use of hydrogen peroxide: (1) for full-scale process the moderate to severe exothermic reaction and gas generation would be difficult and costly to contain; and (2) the exothermic reaction might require cooling to dissipate the evolved heat. Therefore, with approval from DTSC, URS eliminated all proposed hydrogen peroxide extractants from the experimental conditions.

Based on the results of the beaker tests, six experimental conditions were explored for the soil washing tests. The soil washing treatability study was a 3 X 2 experimental design. As noted in Figure 3, the soil washing treatability study explored three wash solutions: hot water, dilute warm 3N HNO_3, and moderate-strength warm 6N HNO_3. Extractions were performed for each of the three solutions at two soil retention (wash) times, seven and fifteen minutes. The use of various wash conditions (independent variables) was recommended in U.S. EPA guidance document (1991). This soil washing treatability study enhanced the experimental conditions beyond the basic screening capability of the above RREL methodology.

Following the wash step, soil slurry from each test condition was screened into three distinct soil fractions: #60 mesh, #230 mesh, and pan. Size segregation to #10 mesh (as suggested by the RREL protocol) was not incorporated to reduce analytical cost. The wet screening step was performed in concert with a rinse step using 17 ohm deionized (DI) water to remove the extraction agents from the soil phase. After rinsing with DI water, soil samples were collected from each size fraction and analyzed for total and leachable metals of concern. The aqueous phase generated by the washing and rinsing steps was composited and analyzed for the metals of concern and free reagents.

The aqueous phase generated by the treatability tests was treated to precipitate the metals mobilized by the soil washing tests. Treatment of the aqueous phase was initiated with the addition of $NaHSO_3$ to reduce Cr^{+6} to Cr^{+3}, both CaO (quicklime) and MgO (magnesium oxide) were then added to increase the pH of the aqueous phase to 9.5. Increased pH effectively

reduced the solubility of the metals and thereby resulted in precipitation of metals. A proprietary flocculate agent, Klear Aid A5L, was added to the aqueous phase to promote the settling rate of the precipitate. The precipitate was filtered from the aqueous phase and a sample was collected for analysis of total metals of concern, pH, bulk density, and water content. The results of this analyses will be used to determine acceptance of the sludge at a metals recycling facility. A sample of the aqueous phase was also collected and tested for total metals of concern, pH, and free reagent (HNO_3).

4.2 Deviations from the Work Plan

A few deviations from the work plan occurred during the study.

Hydrogen peroxide was not used as an experimental soil washing extraction agent following beaker testing. Tests found that hydrogen peroxide is unsuitable as an extraction agent for two reasons. First, hydrogen peroxide reacted vigorously for an extended period when mixed with the Alark soil; reagent and soil slurry were observed to foam out of the container. Second, the addition of hydrogen peroxide to a spent chrome plating bath solution turned the solution a light green indicating the conversion of some of the chromium VI to chromium III. Therefore, hydrogen peroxide was not used as an extraction agent during the soil washing.

Bulk density and water content calculations were not performed on the washed soil. These tests were placed in the work plan in case the physical characteristic of soil significantly changed after the nitric acid wash. However, observations made throughout the soil washing tests identified no significant changes. Therefore, to reduce analytical costs, bulk density and water content analyses on washed soil were not performed.

4.3 Test Results

4.3.1 Size Segregation Testing

Prior to the soil washing experiments, the unsieved, untreated soil was wet sieved and the resulting soil fractions were analyzed for the metals of concern. Size segregation test results are provided in Table 4. Copies of the lab results are provided in Appendix D.

As noted in Table 4, total chromium was found in greatest concentrations in the #4 mesh fraction (particle size greater than the #4 mesh and less than the 3/8 inch mesh). The total chromium concentration tended to decrease with the smaller sized fractions. However concentrations did increase in the smallest fractions, #230 mesh and pan (<#230), although not to the levels detected in the #4 mesh fraction.

Cr^{+6}, Cd, and Ni also followed a trend similar to total chromium: the greatest concentrations of Cr^{+6}, Cd, and Ni were detected in the #10, #4, and #4 mesh fractions, respectively. Concentrations for all of these metals decreased in the smaller sized fractions, until the smallest fraction, #230 mesh and pan, when the concentration increased though not to the levels detected in the #4 or #10 mesh fractions.

Lead concentrations did not follow the same pattern as total chromium, chromium VI, cadmium, and nickel concentrations. Lead concentrations increased with decreasing particle size and peaked with the #60 mesh size, then decreased slowly as particle size decreased.

Table 4
Size Segregation Test Results

SAMPLE FRACTION	METALS OF CONCERN					PARTICLE SIZE		
	CHROMIUM TOTAL (mg/kg)	CHROMIUM VI (mg/kg)	CADMIUM (mg/kg)	LEAD (mg/kg)	NICKEL (mg/kg)	PERCENT PASSING (screen)	PERCENT PASSING (duplicate)	PERCENT RETAINED ON SCREEN
3/8 Inch	270	6.5	2.9	6.5	5.5	99	99	1
#4	3,000	77	19	10	11	99	98	0.5
#10	1,400	110	7.9	8.2	3.3	93	94	5
#20	830	57	3.2	11	3.0	83	86	9
#40	530	56	3.6	120	2.7	77	77	7.5
#60	500	33	3.8	170	3.1	71	69	7
#100	510	51	4.1	130	4.7	66	63	5.5
#230	850	86	5.0	120	8.3	50	49	15
Pan	780	75	4.1	110	7.0	49	51	49.5

NOTE: Soil sample used for size segregation study was an unsieved composite of samples TS-1 collected @ 5' and 30'.
Pan < #230 mesh sieve

The above patterns of heavy metal concentration as a function of soil particle size does not conform to the typical pattern. Usually, as particle size decreases, the concentration of heavy metals increases, especially for the smallest particles (Rayford et al. 1986; Evangelista et al. 1987; 1988), as a result of several physical and chemical phenomena. As particle size decreases, particle surface area per unit mass increases. As the surface area increases, more metal ions can be accommodated at the soil surface.

Another phenomena which causes the smallest particle sizes to retain heavy metals, is the cation exchange capacity (CEC), which measures the ability of a soil particle to attract, and retain, heavy metal cations (positively charged ions). Since the CEC of clay, which makes up the smallest particles, is much greater than the CEC of sand or silt, more metals are adsorbed onto the smallest soil particles. The exchange of an aluminum molecule within the alumino-silica matrix of clay, for a heavy metal molecule of similar size may also have an effect on the association of heavy metals with small particle size. This substitution has been demonstrated to occur in a previous soil washing treatability study (Evangelista et al. 1987).

The distribution of the heavy metals of concern in the Alark soil did not follow any previously observed pattern. Although no explanation is put forward for this result, the failure of Alark soil to conform to the typical distribution pattern is a favorable result. The soil fraction containing the smallest particles is usually not treatable by soil washing because of the difficulty in removing the high concentration of metals. Further, dewatering of fines requires special process considerations. This fraction therefore usually requires further treatment or disposal. Lower metal concentrations in the smallest fractions of Alark soil is therefore a favorable characteristic.

4.3.2 Soil Washing Test Results

Soil washing test results for the six experimental runs are presented in Tables 5 and 6. Table 5 presents the total concentrations for the metals of concern for both the untreated soil fraction and the treated soil fractions. Table 5 also provides total metal concentrations normalized to dry weight. Normalization calculations are based on a moisture content of 11% for the untreated soil fractions and assuming 20%, 30%, 40% moisture contents for the #60, #230 and the pan fractions, respectively. Soluble concentrations of the untreated soil and the treated soil fractions are presented in Table 6. Copies of lab results are provided in Appendix C.

For all of the experimental runs, noticeable reduction in total and soluble concentrations of total chromium was observed in all of the treated size fractions. All washed size fractions were below the TTLC of 2,500 mg/kg and risk based level of ingestion of 7,000 mg/kg. However, none of the washed size fractions were below the risk based levels of in halation (23 mg/kg) or STLC of 5 mg/L. For total levels, nitric acid washes were moderately more effective than the water washes. No such effect was observed for soluble total chromium levels. Little or no difference in soil washing process effectiveness was found between 3N and 6N nitric acid solutions or between 7 and 15 minutes of wash duration. In summary, soil washing with the process condition used, was only partially effective in reducing total chromium levels.

For Cr^{+6}, all of the experimental runs were effective in reducing the total and soluble concentrations of Cr^{+6} in all of the treated size fractions. In particular, the 3N and 6N HNO_3 wash solutions were capable of reducing the total Cr^{+6} levels in the pan fraction to non-detectable levels and the soluble chromium levels to below its respective STLC of 5 mg/L.

Soil washing significantly reduced total and soluble cadmium levels in the majority of the treated size fractions. Using 3N and 6N HNO_3 wash solutions, total cadmium levels in the #60 and #230 fractions were reduced to below the cleanup levels for TTLC (100 mg/kg), risk based levels for ingestion (350 mg/kg), and risk based levels for inhalation (2.27 mg/kg). HNO_3 wash

solution was also capable of reducing the soluble cadmium levels to below STLC for all of the washed size fractions.

For lead and nickel, all of the six experimental runs were capable of reducing the soluble and total levels in all of the washed size fractions. However, it should be noted that the untreated soil concentrations were below TTLC and STLC for lead and nickel.

4.3.3 Wash Water Sludge Results

Aqueous phases obtained from soil washing tests using a 3N and 6N HNO_3 solution were composited. The composite aqueous phase sample was then treated to precipitate the metals out of the aqueous phase. The results of untreated and the treated aqueous phases are presented in Table 7. The table also presents the total and soluble metal concentrations of the precipitated/filtered wash water sludge. Copies of lab results are provided in Appendix D.

As noted in the table, metal precipitation significantly reduced metal concentrations in the aqueous phase. Therefore, the treated aqueous phase could easily be recycled back into the process, or could possibly be discharged in to the local sewage treatment system.

Wash water showed high acidity and very low pH before treatment. After treatment, the acidity was below detection limits; and alkalinity increased to a moderately alkaline level of 220 ppm; pH increased to 9.20.

For the metals of concern, detected STLC and TTLC concentrations were below the regulatory limits. The sludge consisted of total chromium, 1,100 mg/kg, with low levels of cadmium (2.7 mg/kg), lead (33 mg/kg), and nickel (2.9 mg/kg). Chromium VI concentration in the sludge was very low, 0.24 mg/kg.

4.4 Comparison to Test Objectives

Table 8 presents the comparison of soil washing treatability test results with the test objectives stated in Subsection 3.1. As noted in the table, for each metal of concern, treatability test results are compared to the maximum total and soluble concentration limits (TTLC and STLC) and the respective risk based clean-up levels (RBCLs). When a process condition used in the treatability testing reduced the metals of concern below STLC, TTLC, or RCBL, the test objectives were met and a *yes* was inserted in the table. Where objectives were not met by the process condition, a *no* was inserted. Results indicate that the process condition employed for treatability testing were not fully capable of accomplishing the test objectives, and thereby, indicating the need for further testing.

Table 5
Total Metal Concentration Results of Washed Alark Soil

SAMPLE DESCRIPTION	CHROMIUM TOTAL		CHROMIUM VI		CADMIUM		LEAD		NICKEL	
	TOTAL (mg/kg)	NORM. TOTAL (mg/kg)	TOTAL (mg/kg)	NORM. TOTAL (mg/kg)	TOTAL (mg/kg)	NORM. TOTAL (mg/kg)	TOTAL (mg/kg)	NORM. TOTAL (mg/kg)	TOTAL (mg/kg)	NORM. TOTAL (mg/kg)
Untreated Soil	2,800	3,146	2,100	2,360	9.2	10	84	94	12	13
Untreated Soil (Duplicate)	3,300	3,708	480	539	8.6	10	73	82	14	16
Untreated Soil, Average	3,050	3,427	1,290	1,449	9	10	79	88	13	15
Plain Water, 7 min. wash										
+ 60 Mesh Soil	620	775	120	150	3.8	5	70	88	2.7	3
+ 230 Mesh Soil	710	1,014	160	229	3.9	6	110	157	7.4	11
Pan Soil	2,300	3,833	240	400	15	25	120	200	26	43
3N Nitric, 7 Min. Wash										
+ 60 Mesh Soil	320	400	21	26	0.5	1	45	56	1.7	2
+ 230 Mesh Soil	410	586	160	229	0.6	1	25	36	6.5	9
Pan Soil	1,500	2,500	ND	0	2.2	4	38	63	19	32
6N Nitric, 7 Min. Wash										
+ 60 Mesh Soil	190	238	95	119	0.7	1	59	74	2.1	3
+ 230 Mesh Soil	350	500	73	104	ND	0	30	43	4.8	7
Pan Soil	1,500	2,500	ND	0	3.3	6	51	85	14	23
Plain Water, 15 Min. Wash										
+ 60 Mesh Soil	470	588	57	71	4.0	5	94	118	2.4	3
+ 230 Mesh Soil	800	1,143	57	81	4.4	6	110	157	8.5	12
Pan Soil	2,300	3,833	470	783	13	22	120	200	21	35
3N Nitric, 15 Min. Wash										
+ 60 Mesh Soil	150	188	14	18	0.2	0	45	56	1.7	2
+ 230 Mesh Soil	410	586	84	120	ND	0	28	40	5.8	8
Pan Soil	1,900	3,167	46	77	2.6	4	37	62	24	40
6N Nitric, 15 Min. Wash										
+ 60 Mesh Soil	130	163	12	15	0.2	0	130	163	1.3	2
+ 230 Mesh Soil	360	514	35	50	0.6	1	18	26	6.1	9
Pan Soil	1,300	2,167	ND	0	3.3	6	65	108	13	22

NOTES: * Untreated soils based on moisture content of 11%.
60 mesh soils have an assumed moisture content of 20%.
230 mesh soils have an assumed moisture content of 30%.
Pan soils have an assumed moisture content of 40%.
Normalized total = (total / % solid)
ND=Non-Detect

Table 6
Soluble Metal Concentration Results of Washed Alark Soil

SAMPLE DESCRIPTION	CHROMIUM TOTAL SOLUBLE CONCENTRATION (mg/l)	CHROMIUM VI SOLUBLE CONCENTRATION (mg/l)	CADMIUM SOLUBLE CONCENTRATION (mg/l)	LEAD SOLUBLE CONCENTRATION (mg/l)	NICKEL SOLUBLE CONCENTRATION (mg/l)
STLC	560	5	1	5	20
Untreated Soil	210	27	0.97	3.9	0.30
Plain Water, 7 min. wash					
+ 60 Mesh Soil	17	9.6	0.33	1.2	0.10
+ 230 Mesh Soil	23	14	0.44	4.4	0.18
Pan Soil	94	57	1.6	3.9	0.66
3N Nitric, 7 Min. Wash					
+ 60 Mesh Soil	8.2	1.6	0.06	0.92	0.06
+ 230 Mesh Soil	17	1.2	0.05	0.79	0.17
Pan Soil	150	1.0	0.24	0.64	0.73
6N Nitric, 7 Min. Wash					
+ 60 Mesh Soil	9.1	0.61	ND	2.4	0.06
+ 230 Mesh Soil	20	3.2	ND	0.34	0.13
Pan Soil	170	0.054	0.31	1.1	1.2
Plain Water, 15 Min. Wash					
+ 60 Mesh Soil	14	5.2	0.28	1.9	0.08
+ 230 Mesh Soil	25	5.7	0.49	6.5	0.17
Pan Soil	96	61	1.7	3.6	0.67
3N Nitric, 15 Min. Wash					
+ 60 Mesh Soil	5.1	0.9	0.08	0.16	ND
+ 230 Mesh Soil	16	3.7	ND	0.20	0.16
Pan Soil	180	36	0.32	0.76	0.94
6N Nitric, 15 Min. Wash					
+ 60 Mesh Soil	7.6	ND	ND	0.46	ND
+ 230 Mesh Soil	18	0.36	ND	0.13	0.15
Pan Soil	120	ND	0.19	0.58	0.97

NOTE: ND = Non-Detect

Table 7
Aqueous Phase and Washed Sludge Results

TOTAL METAL CONCENTRATION RESULTS

SAMPLE DESCRIPTION	CHROMIUM TOTAL		CHROMIUM VI		CADMIUM		LEAD		NICKEL	
	TOTALS (ppm)	REDUCTION (%)	TOTALS (ppm)	REDUCTION (%)	TOTALS (ppm)	REDUCTION (%)	TOTALS (ppm)	REDUCTION (%)	TOTALS (ppm)	REDUCTION (%)
Untreated Aqueous Phase	630	-	0.06	-	1.8	-	19	-	1.4	-
Treated Aqueous Phase	0.57	99.9	ND	>58	ND	>99.7	ND	>99.9	ND	>96
Wash Water Sludge	1,100	-	0.24	-	2.7	-	33	-	2.9	-

SAMPLE DESCRIPTION	ACIDITY (ppm)	ALKALINITY (ppm)	PH	ENG. / GEOTECH. TESTS		
				DRY DENSITY (lb/ft3)	NATIVE DENSITY (lb/ft3)	MOISTURE CONTENT (%)
Untreated Aqueous Phase	170,000	ND	0.0	-	-	-
Treated Aqueous Phase	ND	220	9.2	-	-	-
Wash Water Sludge	-	-	-	52.8	69.2	75.1

SOLUBLE METAL CONCENTRATION RESULTS

SAMPLE DESCRIPTION	CHROMIUM TOTAL		CHROMIUM VI		CADMIUM		LEAD		NICKEL	
	SOLUBLE CONCEN-TRATION (mg/l)	REDUCTION (%)	SOLUBLE CONCEN-TRATION (mg/l)	REDUCTION (%)	SOLUBLE CONCEN-TRATION (mg/l)	REDUCTION (%)	SOLUBLE CONCEN-TRATION (mg/l)	REDUCTION (%)	SOLUBLE CONCEN-TRATION (mg/l)	REDUCTION (%)
Untreated Aqueous Phase	-	-	-	-	-	-	-	-	-	-
Treated Aqueous Phase	-	-	-	-	-	-	-	-	-	-
Wash Water Sludge	250	-	ND	-	0.52	-	1.8	-	0.93	-

NOTE: ppm = parts per million = mg/kg for sludge, mg/l for wash water.
ND = Non-Detect

TABLE 8
COMPARISON TO SOIL WASHING TEST OBJECTIVES

Process Condition*	TTLC Yes or No	STLC Yes or No	RBCL Yes or No
TOTAL CHROMIUM			
Plain H_2O/7 min/all size fractions	Yes	No	No
3N HNO_3/7 min/all size fractions	Yes	No	No
6N HNO_3/7 min/all size fractions	Yes	No	No
Plain H_2O/15 min/all size fractions	Yes	No	No
3N HNO_3/15 min/all size fractions	Yes	No	No
6N HNO_3/15 min/all size fractions	Yes	No	No
CHROMIUM VI			
Plain H_2O/7 min/all size fractions	Yes	Yes	No
3N HNO_3/7 min/all size fractions	Yes	Yes	No
6N HNO_3/7 min/all size fractions	Yes	Yes	No
Plain H_2O/15 min/all size fractions	Yes	No	No
3N HNO_3/15 min/all size fractions	Yes	No	No
6N HNO_3/15 min/all size fractions	Yes	Yes	No
CADMIUM			
Plain H_2O/7 min/all size fractions	Yes	No	No
3N HNO_3/7 min/all size fractions	Yes	Yes	Yes
6N HNO_3/7 min/all size fractions	Yes	Yes	No
Plain H_2O/15 min/all size fractions	Yes	No	No
3N HNO_3/15 min/all size fractions	Yes	Yes	No
6N HNO_3/15 min/all size fractions	Yes	Yes	No
LEAD			
Plain H_2O/7 min/all size fractions	Yes	Yes	Yes
3N HNO_3/7 min/all size fractions	Yes	Yes	Yes
6N HNO_3/7 min/all size fractions	Yes	Yes	Yes
Plain H_2O/15 min/all size fractions	Yes	No	Yes
3N HNO_3/15 min/all size fractions	Yes	Yes	Yes
6N HNO_3/15 min/all size fractions	Yes	Yes	Yes
NICKEL			
Plain H_2O/7 min/all size fractions	Yes	Yes	Yes
3N HNO_3/7 min/all size fractions	Yes	Yes	Yes
6N HNO_3/7 min/all size fractions	Yes	Yes	Yes
Plain H_2O/15 min/all size fractions	Yes	Yes	Yes
3N HNO_3/15 min/all size fractions	Yes	Yes	Yes
6N HNO_3/15 min/all size fractions	Yes	Yes	Yes

* Wash Solution/Wash Duration/Mesh Size

'All size fractions' include #60, #230, and Pan Fractions

5.0 IMMOBILIZATION TREATABILITY TESTING

5.1 Test Methodology

The treatability study to immobilize the Alark soil encompassed several distinct stages to ensure the immobility of the metals of concern and the durability of the immobilized matrix. These stages included: soil screening, pretreatment chemical/reduction, immobilization, and the first and the second tier of analyses.

The immobilization study was of a 2 x 4 x 2 experimental design. Two types of pretreatment reduction methods and four types of immobilization binders were tested. Each binder was tested at two, binder-to-soil ratios. The experimental designs for soil immobilization are shown in Figures 4 and 5.

Immobilization treatability testing was initiated with soil screening. In the soil screening stage, untreated soil (a composite of soil samples TS-1 collected @ 5 and 30 feet) was screened with a 3/8-inch mesh to remove oversized soil particles to provide some uniformity to the soil within the immobilized matrix. This increase in uniformity gives strength to the immobilized matrix and exposes more soil surface area to the reducing reagents and immobilization binders, thereby, exposing more of the metals of concern to the reducing reagents and binders. Additionally, any diffusion-limiting mechanisms within a soil particle to soil pretreatment were minimized by the smaller particle size, which favorably affected the reaction kinetics. The oversized soil fraction was not used in this treatability study; however, in a full-scale remediation process, the oversized particles may be crushed, re-screened and reintroduced into the immobilization process.

Following screening, the untreated soil fraction was subjected to a pretreatment/chemical reduction process. The chemical reduction step involved the conversion of the highly mobile Cr^{+6} species to the less mobile Cr^{+3}. This study explored the efficiency of two reducing agents: ferrous sulfate ($FeSO_4$), and sodium hydrosulfite ($Na_2S_2O_4$).

Ferrous Sulfate

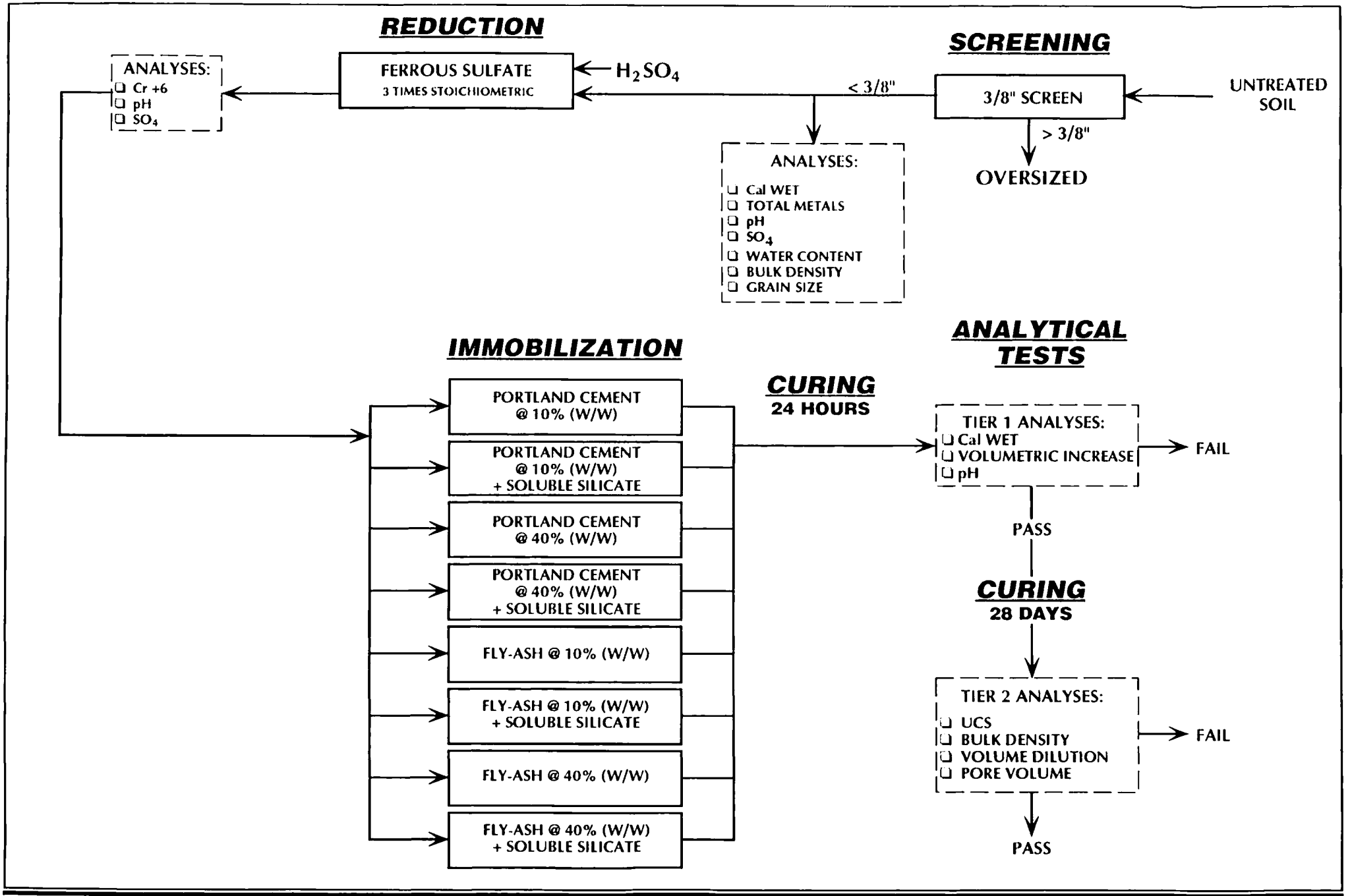
Chemical reduction with ferrous sulfate involved the use of a three-step procedure. Details of the procedure are provided in Appendix A>

1. Using sulfuric acid, the pH of the soil was lowered to 2 to 3;
2. Ferrous sulfate was then added to the soil at three times the stoichiometric quantity of Cr^{+6} and mixed for 15 minutes; and
3. The soil pH was raised to 7 or above to precipitate chromium as a hydroxide or as a co-precipitate with ferric and ferrous iron.

In this final step, the ferrous iron (Fe^{+2}) is oxidized to ferric (Fe^{+3}) thereby destroying any residual reagent.

Sodium Hydrosulfite

Chemical reduction with sodium hydrosulfite involved a one-step procedure. Hydrosulfite was added to the soil at 1.25 times the stoichiometric quantity of Cr^{+6}, along with the immobilization binder(s), and mixed for 15 minutes.



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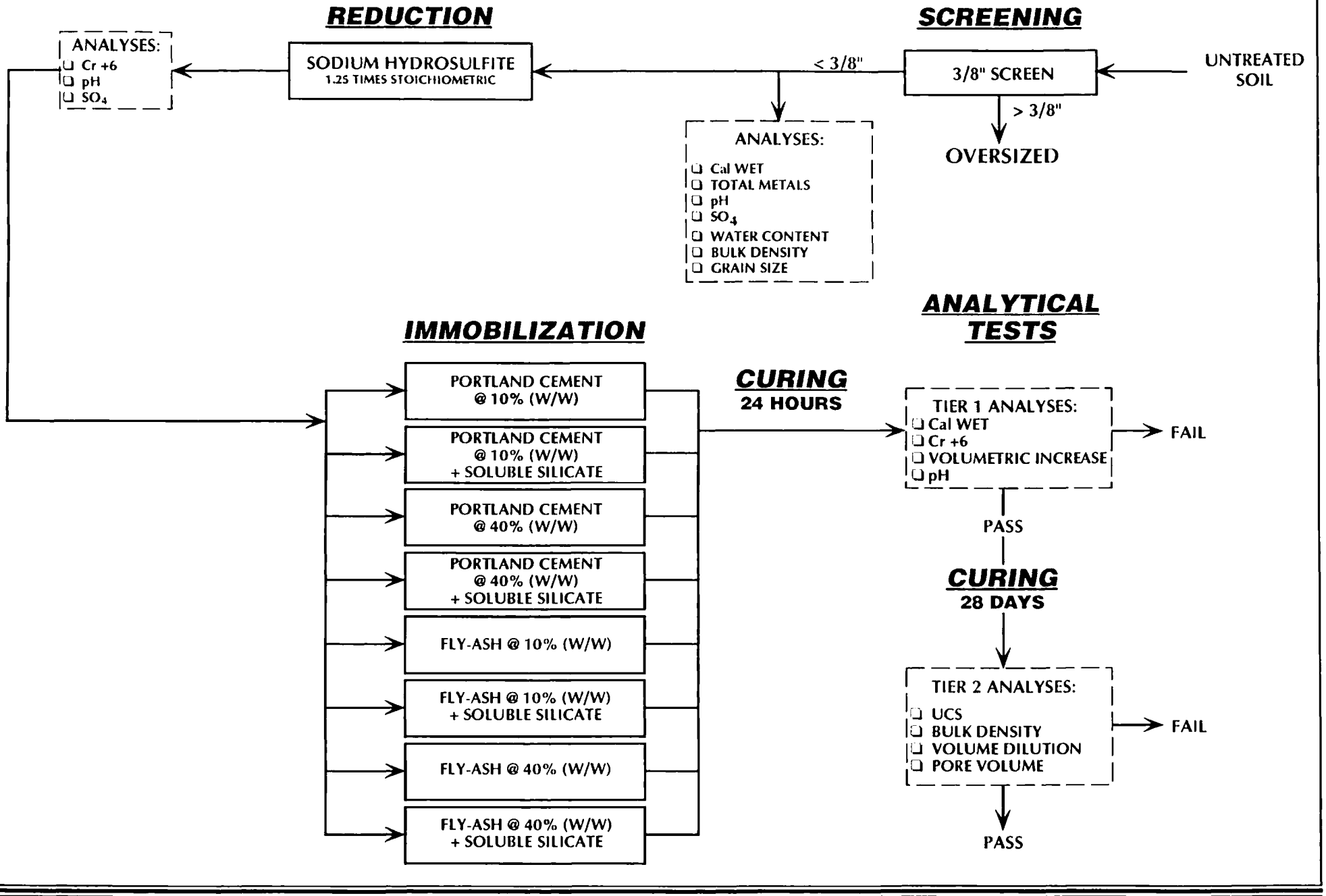
August 06, 1993

SOIL IMMOBILIZATION SCHEMATIC
FERROUS SULFATE REDUCTION

FIGURE
4



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August 19, 1993

SOIL IMMOBILIZATION SCHEMATIC
SODIUM HYDROSULFITE REDUCTION

FIGURE
5

The next treatment stage was immobilization of the screened, pretreatment/chemically reduced soil. The four binders were:

1. Portland cement.
2. Portland cement with soluble silicate
3. High alkaline (self-cementing) fly ash
4. High alkaline fly ash with soluble silicate.

The cement and fly ash binders were evaluated using two binder/soil ratios, 10% and 40% ($^{W}/_{W}$).

Analytical testing of the immobilized sample was divided into two tiers. The first tier placed primary emphasis on the STLC leach test. Those immobilization mixtures with the lowest STLC values were tested in the second tier of analyses. In addition, the pH of the immobilized matrix was measured, as was the increase in volume.

The second tier of analyses involves measuring the monolith's engineering/geotechnical properties for long-term leaching performance, structural durability, and design or disposal purposes. The methods for measurement are described in Subsections 3.2.4 and 3.2.5; long-term leaching was estimated by measuring pore volume; durability was measured by the unconfined compressive strength analysis; and the bulk density was measured for design or disposal purposes.

5.2 Test Results

5.2.1 Ferrous Sulfate Reduction/Immobilization Test Results

Ferrous sulfate, $FeSO_4$ is commonly used as a reducing agent for immobilizing chromium-laden wastes: ferrous sulfate is safe, inexpensive (relative to other reducing agents), and co-precipitates well with other heavy metals. Its disadvantages are: the large volume increases and the requirement of low pH for acceptable, but relatively slower, reaction kinetics (processing time).

The Reaction

Acid reduction of Cr^{+6} with ferrous sulfate consists of adding ferrous sulfate heptahydrate solids (Fe SO_4 7 H_2O) to an acidic (pH 2 to 3) soil. The ferrous iron (Fe^{+2}) reacts with the chromium VI, reducing the chromium and oxidizing the ferrous iron to ferric iron (Fe^{+3}) sulfate. The reaction that occurred was as follows:

$$2H_2CrO_4 + 6FeSO_4 + 7H_2O + 6H_2SO_4 = Cr_2(SO_4)_3 + 3Fe_2(SO_4)_3 + 15H_2O$$

As noted in the equation, three moles of ferrous ions were required per mole of chromium VI reduced. The converted three moles of ferric iron (Fe^{+3}) precipitated contributed greatly to the amount of sludge generated.

Test results (Table 9) for the treatability study involving the use of ferrous sulfate as a reducing agent suggest reduction of Cr^{+6} to Cr^{+3} by approximately 55%. Table 10 summarizes the results of the ferrous sulfate reduced immobilized soil for the eight admixtures described below. Copies of lab results are provided in Appendix D.

TABLE 9
CR^{+6} REDUCTION RESULTS

	Cr^{+6} (mg/kg)	Reduction (%)
Untreated Soil	2100	
Post $FeSO_4$ Reduced, Pre-Immobilized Soil	960	54%
Post $FeSO_4$ Reduced, Pre-Immobilized Soil (Duplicate)	940	55%
Post $Na_2S_2O_4$ Reduced, Pre-Immobilized Soil	920	56%
Post $Na_2S_2O_4$ Reduced, Pre-Immobilized Soil (Duplicate)	970	54%

Table 10
Soluble Metal Results of Ferrous Sulfate-Reduced/Immobilized Alark Soil

SAMPLE DESCRIPTION	CHROMIUM TOTAL		CHROMIUM VI		CADMIUM		LEAD		NICKEL	
	SOLUBLE METALS (mg/l)	REDUCTION (%)	SOLUBLE METALS (mg/l)	REDUCTION (%)	SOLUBLE METALS (mg/l)	REDUCTION (%)	SOLUBLE METALS (mg/l)	REDUCTION (%)	SOLUBLE METALS (mg/l)	REDUCTION (%)
Untreated Soil	210	-	27	-	0.97	-	3.9	-	0.30	-
FeSO4/Portland Cement 10%	130	38	4.7	83	0.52	41	2.3	41	0.24	20
FeSO4/Portland Cement 10% /ss	130	38	2.4	91	0.49	49	9.5	0	0.25	17
FeSO4/Portland Cement 40%	62	71	2.0	93	ND	>95	0.69	82	0.13	57
FeSO4/Portland Cement 40% /ss	55	74	0.90	97	ND	>95	0.36	91	0.15	50
FeSO4/Fly Ash 10%	140	33	59	0	0.53	45	4.9	0	0.30	0
FeSO4/Fly Ash 10% /ss	140	33	24	11	0.56	42	5.7	0	0.28	7
FeSO4/Fly Ash 40%	120	43	45	0	0.46	53	3.2	18	0.38	0
FeSO4/Fly Ash 40% /ss	78	63	54	0	0.52	46	2.6	33	0.40	0
STLC Maximum Limit	560	-	5	-	1	-	5	-	20	-

LEGEND
FeSO4 = Ferrous Sulfate
ss = Soluble Silicate

NOTE: ND = Non-Detect

Total Chromium

Immobilization provided only a modest reduction of soluble total chromium, as measured by Cal WET. All of the immobilized samples were found to be below 560 mg/L (STLC). However, all of the immobilized samples exceeded F006 and D-code maximum limits of 5.2 and 5 mg/L, respectively. The 40% Portland cement (without and with soluble silicate) reduced soluble total chromium 71% and 74%, respectively. The other admixtures reduced soluble total chromium 33% to 63%. In summary, immobilization of Alark soil did not adequately reduce soluble total chromium to meet the F006 or D-code cleanup levels for Alark soil.

Chromium VI

Immobilization with Portland cement provided a significant reduction of soluble Cr^{+6}. Portland cement 10%, Portland cement 10% with soluble silicate, Portland cement 40%, and Portland cement 40% with soluble silicate were capable of reducing the Cr^{+6} soluble levels to below STLC levels (5 mg/L). However, no immobilization admixture reduced the soluble chromium VI below the risk based level of 0.08 mg/L. In summary, immobilization of Alark soil with 10% or 40% Portland cement binder (with or without soluble silicate) significantly reduced soluble chromium VI and met STLC cleanup levels, but did not meet the very conservative risk base cleanup level, nearly two orders of magnitude lower than the STLC level.

Cadmium

Immobilization with 40% Portland cement (with or without soluble silicate) provided a significant reduction of soluble cadmium. Since the concentration of soluble cadmium in untreated soil was slightly below the STLC and D-code maximum limits, the effectiveness of the various immobilization mixtures on soluble cadmium could only be performed on a relative basis – percent reduction. Immobilization with 40% Portland cement (with or without soluble silicate) reduced the soluble cadmium below the STLC, F006 and D-code maximum limits of 1, 0.006, and 1 mg/L, respectively. Both immobilized soil samples were below 0.05 mg/L, the detection limit, and had greater than a 95% reduction of soluble cadmium. The reduction of six other admixtures ranged from 41% to 53%. In summary, both 40% Portland cement admixes provided sufficient immobilization of soluble cadmium to meet all three cleanup levels.

Lead

Immobilization provided a significant reduction of soluble lead. Since the concentration of soluble lead in the untreated soil was slightly below the STLC and D-code maximum limits, the effectiveness of the various immobilization mixtures could only be performed on a relative basis – percent reduction. Immobilization with Portland cement 40% (with soluble silicate) reduced soluble lead below the STLC, F006, and D-code maximum limits of 5, 0.51 and 5 mg/L. Portland cement 40% (with soluble silicate) admixture reduced soluble lead to 0.36 mg/L, a 91% reduction the removal of soluble silicate from the Portland cement 40% reduces its the effectiveness to a 82% reduction. The other six admixtures ranged from 0% to 41% percent reduction. In summary, immobilization of Alark soil using Portland cement 40% (with soluble silicate) met all three cleanup levels.

Nickel

Immobilization provided modest to no reduction in soluble nickel, as measured by Cal WET. Since the concentration of soluble nickel in the untreated soil was nearly two orders of magnitude lower than the STLC and D-code cleanup levels, and slightly below the F006 cleanup level, the effect of immobilization on soluble nickel could only be performed on a relative basis

– percent reduction. Both Portland cement 40% admixtures (with and without soluble silicate) had the greatest percent reduction: 50% and 57%, respectively. The other six admixtures varied from 0% to 20% reduction. In summary, the low initial concentration of soluble nickel made it difficult to evaluate the effectiveness of immobilization; however, the above results appear to show that immobilization would be only moderately effective at reducing soluble nickel.

5.2.2 Sodium Hydrosulfite Reduction/Immobilization Test Results

Sodium hydrosulfite is the only readily available reactant that will reduce chromium VI to the trivalent state in alkaline soil. This property makes sodium hydrosulfite uniquely valuable for the treatment of soil containing chromium VI. Soil can be treated in one-step and without the need for lowering or raising the soil pH, as with ferrous sulfate reduction.

The Reaction

Sodium hydrosulfite reduces chromium VI as follows:

$$2Na_2CrO_4 + 3Na_2S_2O_4 + 4H_2O = 2Cr(OH)_3 + 4Na_2SO_3 + 2NaHSO_3$$

As noted in the equation, 1.5 moles of sodium hydrosulfite are required per mole of chromium VI reduced. Compared with ferrous sulfate, this reduction process produces relatively lower sludge volume.

Treatability tests using $Na_2S_2O_4$ as a reducing agent indicate a reduction of Cr^{+6} to Cr^{+3} by a approximately 55% (Table 9). Table 11 summarizes the results of the sodium hydrosulfite reduced/immobilized for the eight admixtures described below

Total Chromium

Immobilization provided a reduction of soluble total chromium. All of the immobilized samples were below the 560 mg/L (STLC) for total chromium. However, all of the immobilized samples exceeded the F006 and D-code maximum limits of 5.2, and 5 mg/L, respectively. The 40% Portland cement binders (with and without soluble silicate) reduced soluble total chromium 70% and 67%, respectively, to 63 mg/L and 69 mg/L, respectively. The other six admixtures reduced soluble total chromium 38% to 43%. In summary, immobilization of Alark soil did not adequately reduce soluble total chromium to meet F006 and D-code cleanup levels.

Chromium VI

Immobilization with Portland cement at high concentrations provided a significant reduction in soluble chromium VI, as measured by Cal WET. The two Portland cement 40% binder (with and without soluble silicate) samples were below 5 mg/L (STLC) for chromium VI. Immobilization of Alark soil by these two admixtures reduced soluble chromium VI, 91% and 94%, respectively and reduced concentrations to 2.5 and 1.7 mg/L, respectively. The other six admixtures reduced soluble chromium VI from 0% to 48%, with four admixtures showing no reduction in soluble chromium VI. No immobilization admixture reduced the soluble chromium VI below the risk-based cleanup level of 0.08 mg/L. In summary, immobilization of Alark soil with 40% Portland cement, with or without soluble silicate, significantly reduced soluble chromium VI and met STLC cleanup levels, but did not meet the very conservative risk based cleanup levels nearly two orders of magnitude lower than the STLC level.

Table 11
Soluble Metals Results of Sodium Hydrosulfite-Reduced/Immobilized Alark Soil

SAMPLE DESCRIPTION	CHROMIUM TOTAL		CHROMIUM VI		CADMIUM		LEAD		NICKEL	
	SOLUBLE CONCEN-TRATION (mg/l)	REDUCTION (%)	SOLUBLE CONCEN-TRATION (mg/l)	REDUCTION (%)	SOLUBLE CONCEN-TRATION (mg/l)	REDUCTION (%)	SOLUBLE CONCEN-TRATION (mg/l)	REDUCTION (%)	SOLUBLE CONCEN-TRATION (mg/l)	REDUCTION (%)
Untreated Soil	210	-	27	-	0.97	-	3.9	-	0.30	-
Na2S2O4/Portland Cement 10%	130	38	37	0	0.51	47	2.0	49	0.24	20
Na2S2O4/Portland Cement 10% /ss	130	38	44	0	0.52	46	1.8	54	0.25	17
Na2S2O4/Portland Cement 40%	69	67	2.5	91	ND	>95	0.19	95	0.12	60
Na2S2O4/Portland Cement 40% /ss	63	70	1.7	94	ND	>95	1.8	54	0.12	60
Na2S2O4/Fly Ash 10%	130	38	100	0	0.54	44	3.2	18	0.27	10
Na2S2O4/Fly Ash 10% /ss	120	43	14	48	0.49	49	2.4	38	0.27	10
Na2S2O4/Fly Ash 40%	120	43	25	7	0.41	58	2.7	31	0.37	0
Na2S2O4/Fly Ash 40% /ss	120	43	95	0	0.42	57	3.3	15	0.32	0
STLC Maximum Limit	560	-	5	-	1	-	5	-	20	-

LEGEND
Na2S2O4 = Sodium Hydrosulfite
ss = Soluble Silicate

NOTE: ND = Non-Detect

Cadmium

Immobilization with 40% Portland cement, with or without soluble silicate, provided significant reduction of soluble cadmium, as measured by Cal WET. Since the concentration of soluble cadmium in the untreated soil was slightly below the STLC and D-code maximum limits, the effectiveness of the various immobilization mixture on soluble cadmium could only be performed on a relative basis – percent reduction. Immobilization with 40% Portland cement binder (with and without soluble silicate) reduced the soluble cadmium below the STLC, F006, and D-code maximum limits of 1, 0.066, and 1 mg/L, respectively. Both immobilized soil samples were below 0.05 mg/L, the detection limit, and had greater than 95% reduction of soluble cadmium. The reduction of the six other admixtures ranged from 44% to 58%. In summary, both 40% Portland cement admixtures provided sufficient immobilization of soluble cadmium to meet all three cleanup levels.

Lead

One immobilization admixture provided a significant reduction of soluble lead. Since the concentration of soluble lead in the untreated soil was slightly below the STLC and D-code maximum limits, the effectiveness of the various immobilization mixtures could only be performed on a relative basis - percent reduction. Immobilization with Portland cement 40% admixture, reduced soluble lead below the STLC, F006, and D-code maximum limits of 5, 0.51, and 5 mg/L. The Portland cement 40% (without soluble silicate) reduced soluble lead to 0.19 mg/L, a 95% reduction. The addition of soluble silicate to the Portland cement 40% decreased its effectiveness to a 54% reduction. However the value still exceeded the F006 maximum limit. The other six admixtures ranged from 15% to 54% reduction. In summary, the immobilization of Alark soil with Portland cement 40% binder (without soluble silicate) will meet all three cleanup levels.

Nickel

Immobilization provided no to moderate reduction in soluble nickel, as measured by Cal WET. Since the concentration of soluble nickel in the untreated soil was nearly two orders of magnitude lower than the STLC and D-code cleanup levels, and only slightly below the F006 cleanup levels, the effect of immobilization on soluble nickel could only performed on a relative basis – percent reduction. Both Portland cement 40% admixtures samples (with and without soluble silicate) had the greatest percent reduction: 60% each. The other six admixtures varied from 0% to 20% reduction. In summary, the low initial concentration of soluble nickel made it difficult to evaluate the effectiveness of immobilization: however, the above results appear to show that immobilization would be only moderately effective at reducing soluble nickel.

5.2.3 Engineering/Geotechnical Tests

The results of engineering/geotechnical analyses on pre- and post-immobilization soil are reported in Table 12.

Loose, dry bulk density increased approximately 50% from 59 lb/ft^3 to at least 90 lb/ft^3 after immobilization. Loose porosity decreased approximately 66% after immobilization. The decrease in porosity increases the encapsulation of the excavated soil.

Unconfined compressive strength (UCS) of immobilized soil was high. UCS ranges from 102,542 to 299,203 lb/ft^2. These high values indicate that the selected samples of Alark soil should be stable for a significant period of time.

Table 12
Engineering/Geotechnical Tests of Immobilized Alark Soil

SAMPLE DESCRIPTION	LOOSE DRY BULK DENSITY (lb/ft3)	COMPACTED DRY BULK DENSITY (lb/ft3)	LOOSE POROSITY (n)	COMPACTED POROSITY (n)	UCS (lb/ft3)	STRAIN (%)	MOISTURE (%)	SAND EQUIVALENT (%)
Untreated Soil	60	106	0.646	0.371	--	--	11.3	4
Untreated Soil, d	58	103	0.656	0.390	--	--	11.4	5
Untreated Soil, Average	59	104.5	0.651	0.381	--	--	11.4	6
FeSO4/Portland Cement 40%	90	--	0.459	--	102,542	0.6	28	--
FeSO4/Portland Cement 40% /ss	95	--	0.426	--	299,203	1	21.4	--
Na2S2O4/Portland Cement 40%	96	--	0.420	--	254,376	0.7	22.2	--
Na2S2O4/Portland Cement 40% /ss	94	--	0.431	--	244,857	0.5	22	--

LEGEND	
FeSO4	= Ferrous Sulfate
Na2SO4	= Sodium Hydrosulfite
ss	= Soluble Silicate
d	= Duplicate

The values for sand equivalent value were low, with only an average of 5% of the soil passing the criteria for sand. This result affected the experimental condition for soil washing stated in the U.S. EPA protocol (Appendix A).

Volume increase and volumetric dilution of immobilized soil is shown in Table 13.

Alark soil had a significant volume increase after immobilization. The volume increase of soil was calculated from measured values. A consistent difference in the increase of volume was found for immobilized matrices with soluble silicate added. After immobilization with added soluble silicate, soil increased 77% from the native volume. Without soluble silicate, soil only increased 55% or 60%. In either case, with or without soluble silicate, the immobilized matrix would range from 1.55 to 1.77 cubic yard per cubic yard of untreated soil.

Volumetric dilution ranged 10% to 13% for the 10% Fly ash or Portland cement experimental conditions; dilution ranged 41% to 43% for the 40% Fly ash or Portland cement conditions.

5.3 Comparison to Test Objective

Table 14 presents the comparison of immobilization treatability test results to the test objectives stated in Subsection 3.1. In the table, treatability test results are compared to the maximum soluble concentration limit (STLC), for each metal of concern. When a specific process condition achieved or surpassed the test objectives, a *yes* was inserted; if the test objectives were not achieved, a *no* was used. As noted in the table, the process conditions used for treatability testing were not fully capable of accomplishing the test objectives.

Table 13
Volume Increase and Volumetric Dilution of Immobilized Soil

SAMPLE DESIGNATION	VOLUME INCREASE				VOLUME DILUTION (%)
	NATIVE VOLUME (cc)a	LOOSE VOLUME (cc)	IMMOBILIZED VOLUME (cc)	VOLUME INCREASE (%)b	
FeSO4/Portland Cement 10%	564	1,000	900	60	12
FeSO4/Portland Cement 10% /ss	564	1,000	900	60	13
FeSO4/Portland Cement 40%	564	1,000	1000	77	42
FeSO4/Portland Cement 40% /ss	564	1,000	1000	77	43
FeSO4/Fly Ash 10%	564	1,000	900	60	12
FeSO4/Fly Ash 10% /ss	564	1,000	900	60	13
FeSO4/Fly Ash 40%	451	800	800	77	42
FeSO4/Fly Ash 40% /ss	451	800	800	77	43
Na2S2O4/Portland Cement 10%	451	800	700	55	10
Na2S2O4/Portland Cement 10% /ss	451	800	700	55	11
Na2S2O4/Portland Cement 40%	451	800	800	77	40
Na2S2O4/Portland Cement 40% /ss	451	800	800	77	41
Na2S2O4/Fly Ash 10%	451	800	700	55	10
Na2S2O4/Fly Ash 10% /ss	451	800	700	55	11
Na2S2O4/Fly Ash 40%	451	800	800	77	40
Na2S2O4/Fly Ash 40% /ss	451	800	800	77	41

LEGEND
a = Native volume 56.4 percent of loose volume (calculated from loose and compacted bulk densities, Table 12)
b = Percent volume increase of immobilized volume over native volume
ss = Soluble Silicate

TABLE 14
COMPARISON TO IMMOBILIZATION TEST OBJECTIVES

Process Condition*	STLC Yes or No
TOTAL CHROMIUM	
NaS_2O_4/PC(10%)	No
NaS_2O_4/PC-SS(10%)	No
NaS_2O_4/PC(40%)	No
NaS_2O_4/PC-SS(40%)	No
NaS_2O_4/FA(10%)	No
NaS_2O_4/FA-SS(10%)	No
NaS_2O_4/FA(40%)	No
NaS_2O_4/FA-SS(40%)	No
$FeSO_4$/PC(10%)	No
$FeSO_4$/PC-SS(10%)	No
$FeSO_4$/PC(40%)	No
$FeSO_4$/PC-SS(40%)	No
$FeSO_4$/FA(10%)	No
$FeSO_4$/FA-SS(10%)	No
$FeSO_4$/FA(40%)	No
$FeSO_4$/FA-SS(40%)	No
CHROMIUM VI	
NaS_2O_4/PC(10%)	No
NaS_2O_4/PC-SS(10%)	No
NaS_2O_4/PC(40%)	Yes
NaS_2O_4/PC-SS(40%)	No
NaS_2O_4/FA(10%)	No
NaS_2O_4/FA-SS(10%)	No
NaS_2O_4/FA(40%)	No
NaS_2O_4/FA-SS(40%)	No
$FeSO_4$/PC(10%)	Yes
$FeSO_4$/PC-SS(10%)	Yes
$FeSO_4$/PC(40%)	Yes
$FeSO_4$/PC-SS(40%)	Yes
$FeSO_4$/FA(10%)	No
$FeSO_4$/FA-SS(10%)	No
$FeSO_4$/FA(40%)	No
$FeSO_4$/FA-SS(40%)	No

Process Condition*	STLC Yes or No
CADMIUM	
NaS_2O_4/PC(10%)	Yes
NaS_2O_4/PC-SS(10%)	Yes
NaS_2O_4/PC(40%)	Yes
NaS_2O_4/PC-SS(40%)	Yes
NaS_2O_4/FA(10%)	No
NaS_2O_4/FA-SS(10%)	No
NaS_2O_4/FA(40%)	No
NaS_2O_4/FA-SS(40%)	No
$FeSO_4$/PC(10%)	Yes
$FeSO_4$/PC-SS(10%)	Yes
$FeSO_4$/PC(40%)	Yes
$FeSO_4$/PC-SS(40%)	Yes
$FeSO_4$/FA(10%)	No
$FeSO_4$/FA-SS(10%)	No
$FeSO_4$/FA(40%)	No
$FeSO_4$/FA-SS(40%)	No
LEAD	
NaS_2O_4/PC(10%)	Yes
NaS_2O_4/PC-SS(10%)	Yes
NaS_2O_4/PC(40%)	Yes
NaS_2O_4/PC-SS(40%)	Yes
NaS_2O_4/FA(10%)	Yes
NaS_2O_4/FA-SS(10%)	Yes
NaS_2O_4/FA(40%)	Yes
NaS_2O_4/FA-SS(40%)	Yes
$FeSO_4$/PC(10%)	Yes
$FeSO_4$/PC-SS(10%)	No
$FeSO_4$/PC(40%)	Yes
$FeSO_4$/PC-SS(40%)	Yes
$FeSO_4$/FA(10%)	Yes
$FeSO_4$/FA-SS(10%)	No
$FeSO_4$/FA(40%)	Yes
$FeSO_4$/FA-SS(40%)	Yes

TABLE 14 *(CONT.)*
COMPARISON TO IMMOBILIATION TEST OBJECTIVES

Process Condition*	STLC Yes or No
NICKEL	
NaS_2O_4/PC(10%)	Yes
NaS_2O_4/PC-SS(10%)	Yes
NaS_2O_4/PC(40%)	Yes
NaS_2O_4/PC-SS(40%)	Yes
NaS_2O_4/FA(10%)	Yes
NaS_2O_4/FA-SS(10%)	Yes
NaS_2O_4/FA(40%)	Yes
NaS_2O_4/FA-SS(40%)	Yes
$FeSO_4$/PC(10%)	Yes
$FeSO_4$/PC-SS(10%)	Yes
$FeSO_4$/PC(40%)	Yes
$FeSO_4$/PC-SS(40%)	Yes
$FeSO_4$/FA(10%)	Yes
$FeSO_4$/FA-SS(10%)	Yes
$FeSO_4$/FA(40%)	Yes
$FeSO_4$/FA-SS(40%)	Yes

* Reducing Agent/Binder (% Binder to Soil)

PC Portland Cement
SS Soluble Silicate
FA Fly Ash

6.0 CONCLUSIONS

6.1 Size Segregation Tests

Total metal analyses performed on the 8 grain size fractions suggests that the distribution of the metals of concern among the fractions did not follow the typical pattern of increase in concentration levels in the smaller sized fractions. Total chromium, chromium VI, cadmium, and nickel had similar distribution patterns: the greatest concentrations were identified in the #4 or #10 mesh: concentrations decreased as the particle size decreased in the mid range (#40 and #60 mesh), and increased as the particle size decreased to the smallest size fractions (#230 and pan).

6.2 Soil Washing

Beaker tests found hydrogen peroxide was not a suitable extractant for soil washing. Hydrogen peroxide was too unstable after addition to the Alark soil. Severe gas evolution carried off the extractant -soil slurry from the beaker making this reagent unsuitable for field application. In addition, the exothermic reaction may require cooling of the wash solution. Hydrogen peroxide is a general, non-specific oxidizing agent that reacts with all oxidizable components in soil. This non specificity of reaction caused hydrogen peroxide to react with soil components creating conditions within the reactor that would not be suitable for implementation in the field. Lastly, hydrogen peroxide did not appear to be a strong enough oxidizing agent under potential field conditions.

The washing of the Alark soil removed a significant amount of metals, yet the soil did not meet the STLC criteria for soluble total chromium and the risk-based criteria for total chromium. The high levels of chromium were too formidable for the mild and moderately aggressive extractants, 3N and 6N nitric acid. The conclusion of each washed metal follows.

- Soil washing significantly reduced total and soluble total chromium that was adsorbed on to the soil particles. However, the risk-based and STLC cleanup levels for total and soluble total chromium were not met. The mild and moderate wash conditions could not sufficiently mobilize the high total chromium concentrations in aged soil. Therefore, soil washing using 3N and 6N HNO3 was reagents could not adequately remove the total chromium to meet DTSC criteria for clean soil.
- Chromium VI was removed by the nitric acid washes. All cleanup levels were attained, except the risk-based level for inhalation. The inhalation standard may have been met for the pan fraction, which was below the detection limit. Three of the nitric acid washes removed chromium VI from the smallest particles (pan), a phenomena that runs counter to the usual soil washing observations. The larger particle size fractions may have difficulty adsorbing onto the highly mobile chromium VI in the present of an oxidizing wash - nitric acid.
- Soil washing with nitric acid significantly reduced total and soluble cadmium. The 60 mesh and 230 mesh fractions attained all cleanup levels; the pan fractions retained much greater amounts of total cadmium.
- The nitric washing removed moderate and significant amounts of total and soluble lead respectively. The soluble fraction was reduced below the cleanup levels; however, the initial concentration of total lead in untreated soil was below the three cleanup levels.

Lead has been shown to be a good candidate for soil washing, although in other test chelating agents were used - agents that would not prove effective for chromium (9, 10, 11).

- Soil washing removed nickel, total and soluble, from Alark soil in a classic fashion. The removals achieved were high in the 60 mesh fraction, moderate in the 230 mesh fraction, and low in the pan fraction. Because the concentration of nickel in untreated soil was low, soil washing could not evaluate the achievement of cleanup levels; therefore, this metal was of relative little consequence.

6.3 Immobilization

The immobilization of Alark soil with Portland cement 40% ($^{W}/_{W}$) significantly lowered the mobility of the soluble metals of concern. In general, the addition of soluble silicate to the 40% Portland cement admix did not significantly improve the performance of the cement. Although the 40% Portland cement (with or without soluble silicate) performed best among the tested admixtures, the resulting immobilized matrix was still a California hazardous waste and waste of concern. STLC, F006, and D-code cleanup levels for total chromium and the risk-based level for chromium VI was not achieved.

The concentration of total chromium requiring immobilization was too high for the tested reagents to adequately meet all cleanup criteria for all metals of concern. Some of this high concentration of total chromium may have been transformed into chromium VI during the experiment. For several reagents, the soluble concentration of chromium VI was higher after immobilization. In a situation where the initial concentration of total chromium is much higher than chromium VI, excess reducing reagent may be necessary to minimize the formation of chromium VI.

The results of the two reducing agent, ferrous sulfate and sodium hydrosulfite, differed little from each other. The effect of the eight immobilization admixtures on the 5 metals of concern showed the same pattern of results irrespective of which reducing agent was used. Therefore, the sodium hydrosulfite was the reducing agent that would be easiest to implement in a field-scale operation, since it could be added at the same time and into the same equipment as Portland cement additive.

The volume increase of 40% Portland cement, with or without soluble silicate, was 77%. A cubic yard of Alark soil would become 1.77 cubic yards of immobilized matrix. This increase of soil volume after immobilization treatment would have to be accommodated at the site, by placing the additional volume inside the building or in an area from which clean soil was removed.

7.0 RECOMMENDATIONS

This draft treatability study report is the first phase of remedial procedures explored to cleanup the Alark site. Some procedures worked to significantly reduce the presence or mobility of heavy metals in Alark soil; others did not. The treated soil did not meet all the regulatory requirements. Further treatability testing is recommended to develop process parameters that will result in remediation of the affected soil to the designated treatment levels..

Additional treatability studies should identify procedures and reagents that may increase the mobility (wash) or decrease the mobility (immobilize) of chromium. This recommendation still maintains the original technologies proposed but process identification of parameters that will improve the process chemistry.

For mobilizing chromium from soil, a very strong oxidizing agent should be used to oxidize Cr^{+3} to Cr^{+6}. One recommended oxidant is a cyanide leach solution, similar to the type used in hydrometallurgy potentially have the oxidizing power to convert all the total chromium to chromium VI, then wash it out of the soil. To enhance the removal rates, Alark soil can be leached for extended duration or can be exposed to extractants at elevated temperatures and pressures. The first method compensates for slow reaction kinetics by making reaction times longer; the second method increases the kinetics.

Additional admixtures should be explored for immobilizing chromium. These admixtures can be generic and/or proprietary. Many admixtures can be tested in a relatively short period of time. Therefore, we recommend to test for just soluble total chromium by Cal WET (STLC) until an immobilized matrix is less than the mandated cleanup levels (STLC, F006, and D-code). If an immobilized matrix meets the cleanup levels for soluble chromium, additional analyses can be performed for additional metals of concern.

Another recommendation for future testing is the addition of a much greater excess of a reducing agent. The soil evaluated for this treatability study contained much higher concentrations of total chromium than chromium VI. Since the concentration of reducing reagents were based on the initial concentration of chromium VI plus some excess, the concentration of reducing agent may be insufficient to reduce chromium VI that was transformed from the total chromium during the experiment.

Bench-scale testing of an additional alternative and innovative technology to remove metals from Alark soil such as electro-kinetic technology also is recommended. Metals can be mobilized from soil by migration to specialized electrodes in the presence of electrolytes applied to the soil. The electrodes can remove the metals from the soil phase on site.

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APPENDIX A
SOIL WASHING TEST PROTOCOL

DRAFT

PROTOCOL FOR LABORATORY-SCALE SCREENING TEST FOR SOIL WASHING TECHNOLOGY

By

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Draft
Soil Washing
Screening Protocol

1. Test Purpose

This laboratory-scale screening protocol is to determine the potential applicability of the soil washing technology for remediation purposes.

1.1 This test procedure describes washing of contaminated soils with specified reagents and equipment under standard operating conditions. Chemical analyses of the washed soil and the resulting washing liquid indicate the potential of removing the contaminants from the soil by washing.

1.2 Separation of the soil, during the washing process, into preselected fractions determines the effectiveness of the washing process in removing the contaminants from these soil fractions.

1.3 The qualitative nature of information obtained from this procedure is used to determine whether further testing of this technology, for example, bench scale study, should be pursued.

2. Limitations

2.1 Tests are carried out at atmospheric pressure and at temperatures not exceeding 150F. These tests only show the potential application of the technology for the site under consideration. For design purposes, bench and pilot scale studies are necessary.

Note: Potable water is used for both wash solution preparation and rinsing of soil.

2.2 This screening protocol does not provide either a procedure for the selection of appropriate washing liquids or their compositions.

2.3 The identities and concentrations of contaminants of interest present in the soil should be provided by the RPM.

3. Cautions and Warnings

- This protocol may involve hazardous materials, operations, and equipment. This standard does not purport to address all of the safety problems associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.

- EPA regulations for shipping containers, methods of preservation and storage of the sample need to be scrupulously observed (49 CFR Subchapter C, Parts 100 through 199).

- Shipping regulations provide some information as to the chemical composition of the sample. For example, whether the sample contains acute toxic compounds such as dioxins, PCBs, etc.

- When receiving shipment of soils and samples from the field observe whether sample labels, seals, and chain of custody records are in order.

- Note whether proper containers and preservation methods (Appendix A) have been observed and the shipping container is at proper temperature.

- Identity (Identities) and concentration(s) of the contaminant(s) present in the soil sample(s) should be provided by the shipper.

- Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

4. Reference Documents and Procedures

4.1 Documents

ASTM D421 - Practice for Dry Preparation of Soil Samples for Particle Size Analysis and Determination of Soil Constants.

ASTM D1429 - Standard Test Methods Specific Gravity of Water and Brine.

ASTM D2216 - Standard Method for Laboratory Determination of Water (Moisture) Content of Soil, Rock, and Soil-Aggregate Mixtures.

ASTM D2419 - Standard Test Method for Sand Equivalent Value of Soils and Fine Aggregates.

ASTM E11 - Sieve Specifications.

49CFR Subchapter C, Parts 100 through 199 - The Hazardous Materials Regulations.

40CFR 261.4(f) - Samples Undergoing Treatability Studies at Laboratories and Testing Facilities.

4.2 Physical/Chemical Measurement Methods

All physical/chemical measurement methods are from USEPA SW-846 - Test Methods for Evaluating Solid Waste and are listed in Appendix A.

5. Reagents and Supplies

Reagents and supplies necessary for the screening of one soil in triplicate:

1 Aggregate scoop pan with tapered design to transfer soil into splitter, sieves, graduated cylinders, and jars. Soiltest model CL-292 or equivalent.

2 Polyethylene carboys with spigot for storing wash and rinse fluids. Two gallon (8 L) capacity. Fisher model 02-963-6A or equivalent.

2 Washing bottles (500 mL) for washing/rinsing of soil. Fisher models 03-409-10E or equivalent.

1 each Graduated cylinders, 1 L, 500 mL, 250 mL capacities for the measurement of liquids.

3 1.5 L heavy duty graduated pyrex beakers.

18 Wide mouth glass sample bottles (4 oz, 144 mL) with teflon lined screw caps for analysis of organic and inorganic contaminants in soils and for inorganic contaminants in liquids.

12 Borosilicate glass vials (40 mL capacity) with black phenolic, teflon lined screw cap for organic contaminants in liquids.

3 Rubber policemen/scrapers with angled or wing-shaped edge to scrape solids from beakers, sieves, etc. Fisher model 14-105A or equivalent.

3 Buchner funnels with fixed perforated filter plate (25 cm diameter) with glass filtering flask (1000 mL capacity) with tubulation.

1 box filter paper suitable for Buchner funnel filtration. Particle size retention up to 2.5 μm and good wet strength (Whatman #5 or equivalent).

1 Mercury thermometer from 20 to 150C with 1/5C subdivision, precision grade. Fisher model 15-043C or equivalent.

- Sand equivalent cylinder, clear plastic, 32 mm in diameter, 32x432 mm height and graduated to 381x2.54 mm. Soiltest model CL-231 or equivalent.
- 1 Stop watch or timer (digital with alarms) capable of measuring time in seconds.
- 2 Wide mouth glass or plastic funnels for pouring the soil slurry into sand equivalent cylinder.
- 1 bottle each standard buffer solutions, pH 4, 7 and 10.
- 6 Aluminum weigning dishes, 300 mL to 500 mL capacity.
- 2 Heavy-duty canvas or plastic sheets (1.5 m x 1 m; 5 ft x 3 ft).
- 2 Trowels. Soiltest model CN-840 or equivalent.
- 1 Hydrometer. Soiltest model CL-277 or equivalent.
- 1 Pycnometer.
- 1 Box phosphate free laboratory detergent.
- 1 5-gallon pail with lid.
- 1 Roll of aluminum foil.
- 2 55-gallon disposal drums.

6. Test Equipment

- 1 Top loading balance, readability 0.1 g; reproducibility ±0.1 g; and linearity ±0.1 g. Capacity 4 kg.
- 1 Set of National Institute of Science and Technology (NIST) Class F standard weights, 500 mg, 1 g, 2 g, 5 g, 100 g, 200 g, 500 g, 1 kg and 2 kg.

3 Sets of screening sieves (U.S. Standard per ASTM E11) with pans (204 mm, 8 inch diameter) each set containing following:

No.4 (4.75 mm)
No.10 (2 mm)
No.60 (250 µm)
No.230 (63 µm)

3 204 mm (8 inch) diameter pans.

1 Sieve shaker with timer. Tyler Ro-Tap sieve shaker or equivalent.

1 Mechanical sand equivalent shaker. Soiltest model CL-232C or equivalent.

1 Mechanical stirrer system with motor assembly and speed-control unit for agitating soil with wash solutions. Fisher model 14-498-45 or equivalent.

1 Drying oven, forced air, automatic temperature control (accuracy ±5C) from ambient to at least 150C. Two cubic feet capacity.

1 pH meter with glass electrode, accuracy ±0.05 pH, 0-14 pH range.

1 Standard single head vacuum pump or aspirator filter pumps. Fisher model 13-875-220 or equivalent.

1 Sample splitter (Riffle) with 14 chutes, 13 mm (1/2 inch) wide. Soiltest model CL-280 or equivalent.

7. Calibration of Equipment

Record all calibration data in laboratory note book used for the screening study.

Balance — Calibrate the top loading balance using NIST Class F weights For small weights (eg., filter paper), calibrate the balance using 500 mg, 1 g, 2 g and 5 g. For large weights (eg., sieves), calibrate the balance using 100 g, 200 g, 500 g and 1 kg. Get the calibration curve and coefficients of regression using either LOTUS 1-2-3 or programmable calculator. Table 1 shows the data sheet for balance calibration. Keep the balance pan free from dust and wipe off any spills immediately. Check the accuracy of the balance daily. Deviation should not exceed ±0.1 g for small weights and ±1 g for large weights from the standard weights.

pH Meter — Calibrate the pH meter, after washing the electrodes thoroughly with distilled water, using the three buffer solutions, pH 4.0, 7.0 and 10.0. Follow the instructions supplied with the instrument and electrode. Keep the pH electrode soaked in either distilled water or in the pH buffer 4.0 when not in use.

Oven — Check whether the temperature controller of the oven is working properly. The temperature should be within ±5C of the setting.

8. Sample Characterization Requirements

This test requires 1.5 kg of soil sample passing through No.4 screen (U.S. Standard) to conduct each set of tests in triplicate.

- The soil sample (7 kg) shipped to the laboratory should be in airtight containers to preserve the original moisture content.
- Chemical composition of the soil, even when available from the shipper, should be confirmed by the laboratory performing the screening tests.

9. Test Sample and Wash Solutions Preparation

Record all data in the laboratory note book.

9.1 Well mix the soil (7 kg) by shaking and tumbling in a 5-gallon pail fitted with a lid.

9.2 Pour the content of the pail on a clean heavy-duty quartering canvas.

Remove (hand picking) all large (6.4 mm or 0.25 inch) gravels and stones and all other foreign materials, for example, pieces of cloth, plastics, tree parts, and other debris.

Place all rejects in the disposal drum.

Determine the weight of the debris-free soil.

9.3 A procedure similar to ASTM D2216 is used for moisture content determination.

Weigh close to 300 g of the debris-free soil with an accuracy of ±1 g, in a preweighed aluminum weighing dish and dry at 110±5C in the oven overnight to constant weight (less than 5% weight change).

Record the weights of the sample before and after drying.

Determine the moisture content of the soil as follows (Table 2):

$$\% \text{ Moisture content} = \frac{\text{Wt. of wet soil} - \text{Wt. of dry soil}}{\text{Wt. of dry soil}} \times 100$$

9.4 Sieve the debris-free soil through a No. 4 screen using the sieve shaker.

Collect all soil passing through the No.4 screen.

Weigh on the top loading balance.

Record the weight.

9.5 Riffle the screened sample (ASTM D421) close to 1000 g.

Reserve 50 g for chemical analysis of contaminants of interest.

Note: If the soil characteristics prevent screening through the No. 4 screen, follow Step 9.6 instead of Steps 9.4 and 9.5.

9.6 Pour the debris-free soil (from Step 9.2) on a clean quartering canvas and reduce, using a clean trowel, the volume of the soil sample weighing approximately 1000 g.

Reserve 50 g of the sample for chemical analysis of contaminants of interest.

9.7 Prepare 3 L of the wash solution according to the direction provided by RPM.

Store in a polyethylene carboy with spigot.

Record the pH of the wash solution.

9.8 Store rinse fluid (potable water) in a separate carboy.

10. Test Procedure

10.1 Determination of Approximate Composition of Soil

This test determines, under standard conditions, the relative proportions of sand and clay-like fines in soils that pass through

the No. 4 (4.75 mm) sieve or debris-free quartered sample. This procedure determines the amount of sample required for the screening protocol - 200 g of sandy soils or 115 g of either silt or clayey soils. Soils containing less than 60% clay are considered sandy soils and soils containing 60 or greater percent clay are considered clayey soils. A procedure similar to ASTM D2419 (sand equivalent value of soils and fine aggregates) is used for this determination.

10.1.1 Weigh out, nearest to 0.1 g, 60±2 g of the representative soil (from Step 9.5 or 9.6) on a weighing dish.

Transfer the weighed soil via a wide mouth funnel into a sand equivalent measurement cylinder.

Measure 180±5 mL of potable water, in a graduated cylinder.

Add the measured water to the soil in the sand equivalent measurement cylinder (normal Soil:Potable water = 1:3).

10.1.2 Agitate the slurry using the mechanical sand equivalent shaker for a period of 45±1 s.

10.1.3 Remove the cylinder from the shaker.

Keep the cylinder vertical and the base in contact with the work surface.

Start the timer.

10.1.4 Allow the cylinder to stand undisturbed for 20±5 minutes.

10.1.5 At the end of the 20 minutes sedimentation period, visually define, either by color or texture, or both, the soil fractions.

Record the number of phases formed. Sand will be at the bottom and clay on top of the sand phase.

Record, from the cylinder graduations, the volumes of the fractions in Table 3.

Record any floating substances at the top of the water layer.

10.1.6 Empty the content of the cylinder in the disposal drum.

10.2 Laboratory Scale Soil Washing

The attached flow diagram (Figure 1) summarizes the laboratory scale soil washing protocol. These screening tests are carried out in triplicate and in sequence.

10.2.1 Thoroughly clean the sieves using a phosphate free laboratory detergent followed by distilled water.

Make sure that no solids remain adhered to the screens.

Dry the screens to constant weight at 110±5C.

Record the weights of each screen and mark the screens for identification.

Note: Special precautions should be taken when using corrosive liquids, for example, acidic, basic or highly concentrated salt solutions. In case of corrosive liquid it may be necessary to use sieves made of either stainless steel or polyethylene instead of brass.

Note: Do not force soil particles through the screen either by a spatula or brush or water stream. Place the screen upside down in the sink and then pour water over the screen to dislodge any soil particles from the screen.

10.2.2 Weigh with an accuracy of ±0.1 g of the well mixed and representative soil (from Step 9.5 or 9.6), close to 115 g of clayey soil or 200 g of sandy soil, in an aluminum dish.

10.2.3 Stack the three sets of marked sieves and the collection pans in the order shown in Figure 1.

Place the whole assembly securely on the shaker.

10.2.4 Transfer the weighed soil from the weighing dish to the 1.5 L beaker.

10.2.5 Measure wash solution (600 mL for sandy soils or 345 mL for clayey soils) using a graduated cylinder (normal Soil:Wash solution = 1:3).

Use wash solution to transfer any residue from weighing dish to the 1.5 L beaker.

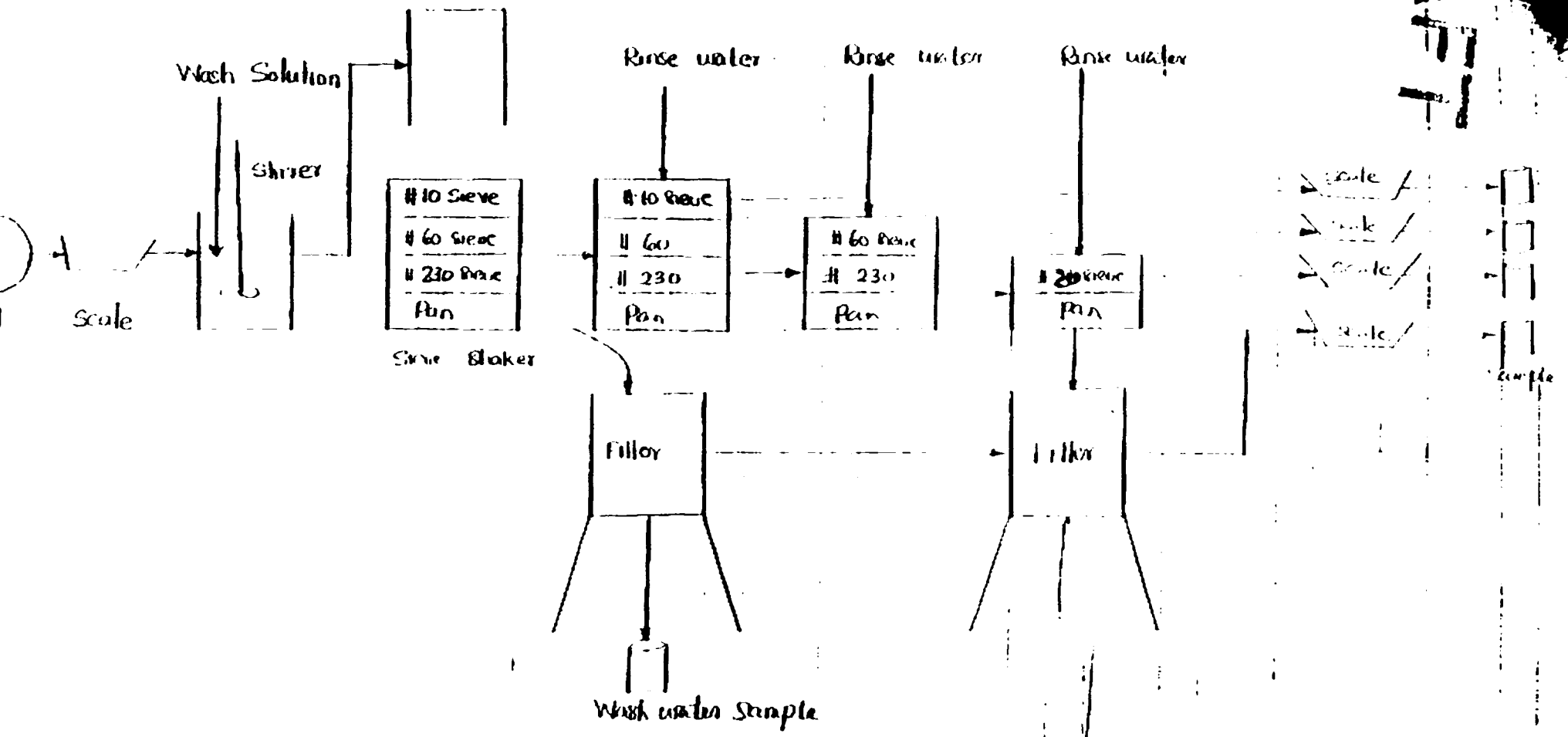

Figure 1: Laboratory Scale Coal washing Procedure

Add rest of the wash solution to the soil.

10.2.6 Stir the slurries using the mechanical stirring system for a period of 15±1 minutes.

Adjust the stirring rate, using the speed controller, so that all solids remain in suspension.

Record the setting of the speed controller and use the same setting for all tests.

10.2.7 Transfer the entire content of each beaker onto the screen assembly (Figure 1).

Use the rubber policeman or scrapper to transfer all residue from the beaker to the screens.

Allow the screen assembly to stand for 10±1 minutes to drain all the liquids into the collecting pan assisted by gentle tapping of the sides of the screen assembly.

Note: Do not use any rinse liquid to transfer the residue from the beaker to the screens.

Assemble the Buchner funnel, filter paper and flask and connect to either a vacuum pump or an aspirator.

Adjust the vacuum so that the filtration takes place smoothly. Too high a vacuum may cause the filter paper to develop leaks.

10.2.8 Transfer the slurry from the collecting pan, with the aid of a glass rod, into the Buchner funnel-filter paper-flask assembly.

Filter under vacuum either using a vacuum pump or an aspirator.

Measure and record the volume and pH of the filtrate.

Note the color and any other characteristic (clear or cloudy) of the filtrate.

Transfer a portion of the filtrate in the borosilicate glass vial and preserve them appropriately (Appendix A) for analysis.

Weigh the wet soil on the filter paper and record the weight.

Then dry the soil on the filter paper to constant weight at 110±5C.

Record the weight.

Note: If complete transfer of the soil from the pan to the filter paper is not possible, weigh the pan with the soil and record the weight.

Then dry the pan and its content at 110±5C and determine the weight of the dry soil.

Combine these two weights to report the total weight of soil in the pan. This is used to get the suspended solids concentration.

10.2.9 Put a new preweighed pan underneath the screen assembly (Figure 1) to start the rinse cycle.

10.2.10 Use the washing bottles for the rinse cycles.

Mark the bottles (unless graduated) in 100 mL intervals.

Transfer any residue from the beaker (Step 10.2.7) using a washing bottle to the No.10 screen.

Spray the 10, 60 and 230 mesh screens in sequence (Figure 1), with 100 mL of potable water for each rinse cycle.

Screen the soil by shaking the stacked sieves on a sieve shaker for 5±1 minutes for each rinse cycle.

Note: Keep the rinse water volume to a total of 100 mL in each cycle (water for transfer of soil residue from the beaker + spraying the screens). Same collecting pan is used for collecting liquids for all the three rinse cycles.

10.2.11 Filter contents of the pan via the Buchner filtering set up.

Measure and record the total volume and pH of the filtrate.

Collect a portion of the filtrate in borosilicate glass vial for analysis.

Weigh the wet soil on the filter paper and record the weight.

Then dry the soil on the filter paper to constant weight at 110±5C and record the weight.

Note: If complete transfer of the soil from the pan to the filter paper is not possible, weigh the pan with the soil and record the weight.

Then dry the pan and its content at 110±5C and determine the weight of the dry soil.

Combine these two weights to report the total weight of soil in the pan. This is used to get the suspended solids concentration.

10.2.12 Weigh each screen (No. 10, No. 60, and No. 230) together with the soil and record the wet weights of each screen.

10.2.13 Dry all the screens in the oven to constant weight at 110±5C.

Record the dry weights of each soil fraction.

Difference between the dry and wet weights is the weight of filtrate attached to the soil.

Note: Place a large sheet of aluminium foil underneath each screen when placing in the oven for drying. Any solid collecting on the aluminum sheets should be added to the respective soils to determine the total weights of dry soils.

Note: The volume of the filtrate attached to the soil can be obtained by dividing its weight by its specific gravity. The specific gravity of the filtrate can be obtained either using a hydrometer or a pycnometer (ASTM D1429) (see Table 2 for calculation).

10.2.14 Place the dried soils (three screens and the filter papers) into four separate and marked 4 oz glass jars for analysis.

10.2.15 Decontaminate all equipment and glassware by washing with a phosphate free laboratory detergent and then rinsing with potable water.

Store all the washings in the disposal drum.

10.2.16 Analyze all samples as soon as possible.

Consult USEPA SW-846 guidelines for sample preservation technique, holding time, and analytical procedures (Appendix A).

Record all the analytical results in Table 8.

11. Calculation/Data Reduction

11.1 Approximate composition of soil

Table 3 shows the data sheet for the determination of "approximate physical composition" of soil.

11.1.1 Record the volumes of all the soil fractions.

11.1.2 Compute the percentage of clay as follows:

$$\text{Percentage of clay} = \frac{\text{clay volume}}{\text{(clay+sand) volume}} \times 100$$

For example, if the volume of the clay fraction is 15 mL and that of the sand layer is 35 mL, then the percentage of clay is equal to 15/(15+35) X 100 = 30%.

11.2 Soil washing

Tables 4 and 5 show the data sheets for recording the results of soil washing.

11.2.1 Record the volumes and weights of wash and rinse filtrates.

11.2.2 Record the weights of wet materials remaining on each sieve and in the pan.

11.2.3 Record the weights of dry materials remaining on each sieve and in the pan.

11.2.4 Calculate the difference between the wet and dry weights for each sieve and pan.

Convert the weights to volumes using the specific gravity.

Add all the volumes.

This is the amount of free moisture in the wet soils.

11.2.5 Add the volumes of wash and rinse filtrates and compare with the original volume.

This is to detect any loss of liquid in the soil washing procedure. An example of data sheet is shown in Table 6 (Assume that the moisture content of the soil is 10% and the specific gravity of filtrate is 1.023).

11.2.6 Add the dry weights of soil fractions remaining on each sieve and in the pan and compare with the original weight.

This is to detect any loss of soil in the washing procedure. A loss of more than 10% by weight is considered unsatisfactory. In that case, repetition of the test may be necessary.

11.2.7 Compute the percent of soil retained on each sieve by dividing the dry weight retained on each sieve by the original sample weight. For example, from the displayed data sheet in Table 7, the quantity retained on No. 10 sieve is (34.1/200) x 100 = 17.05 percent. Similarly, percents retained on screens No. 60 and 230 are 68.70 and 9.25, respectively.

11.2.8 Compute the suspended solids concentration by dividing the dry weight of the soil, in mg, in the pan, by the total volume of the filtrate.

12. Data Reporting

12.1 Grain size distribution is reported graphically (Figure 2), by plotting the cumulative weight percent as a function of particle size (mm).

12.2 Concentrations of the contaminant(s) in bulk soil and in the washed soil fractions are displayed in tabular form in Table 8 and as histogram in Figure 3.

13. Waste/Decontamination

Compute the total amount of wastes generated from the volumes of liquids and the weights of solids recorded in Steps 9.2, 9.3, 9.4, 9.5, 9.6, 10.1.6, 10.2.8, 10.2.11, 10.2.14 and 10.2.15 (Tables 4 and 5).

14. Cost Projection

Labor

Approximately 16 hours each of two technicians' time will be needed to run the soil washing laboratory scale screening study in triplicate.

Transportation/Disposal

Disposal costs are dependant on the nature of the washing fluids, for example, acidic/basic/presence of surfactants or chelating agents, etc. used. Conventional wastewater treatment such as granular activated carbon, chemical precipitation may not work.

The total volume of the waste (including the 7 kg of soil received) generated in this test procedure will be approximately 17 L or 4.5 gallons. However, any unused sample can be, according to 40 CFR Chapter I, 261.4(f), returned to the originator. In that case the volume of the waste generated will be reduced.

Also, the transportation cost, the major item in the disposal of wastes, depends largely on the location of the disposal site.

In general the wastes in the treatability facility are stored either in 55 gallon drums or in larger containers and cost of disposal of larger containers are less on per volume basis than those of drums. Assuming total disposal cost of $250/drum, the cost of disposal of 4.5 gallons of waste will be approximately $21.00.

Utilities

Utilities such as chemicals, water and electricity needed for the triplicate tests are minimal and should be included in the laboratory overhead.

APPENDIX B
QA/QC PROCEDURES FOR LABORATORY DATA

FIELD AND LABORATORY QUALITY ASSURANCE/QUALITY CONTROL

Procedures

To assess the integrity of field sampling techniques, quality assurance samples were collected and analyzed. Additionally, quality control and quality assurance was performed by the analytical laboratories. Field and laboratory quality assurance data was evaluated to ensure compliance with EPA-approved or California Administrative Code (CAC) Title 22/26 methods. Analytical data discrepancies were identified during the course of this evaluation and their possible effects on environmental samples was determined. The results of field quality assurance samples and the evaluation of laboratory quality assurance procedures is provided below. A summary of all samples collected for the treatability study are summarized on Table 1.

Field Quality Assurance Results

The collection and analysis of environmental quality assurance samples provides quality control checks on the representativeness of the environmental samples collected, the precision of sample collection and handling procedures, and the thoroughness of field equipment decontamination procedures. During the treatability study, duplicate samples were collected and analyzed.

Laboratory Quality Assurance Results

Analytical quality control procedures are implemented to identify possible introduction of contaminants into environmental and quality control samples as a result of equipment contamination and/or analytical procedures, and to assess the validity, accuracy, and precision of analytical results. Specific quality control procedures for each analytical method were evaluated to ensure that accuracy, precision, representativeness, and completeness data quality objectives were met. The evaluation process is generally referred to as data validation. This section presents a overview of the data validation process and a summary of the laboratory/analytical quality assurance results.

Data Validation Overview and Results

One focus of the data validation process is to assess the accuracy and precision of the analytical methods and procedures used. Accuracy is determined by evaluating matrix spike recovery limits. A matrix spike is a sample with a known concentration of certain compounds of interest (spike) added to a sample matrix. The amount, or percent, of the spike compound that is recovered is used to assess the accuracy of the analysis. The matrix spike recovery limits must be within control limits established by historical matrix spike values (historical laboratory values must also be within ranges established by the EPA). Sample results that fall outside of the quality control limit range do not meet accuracy standards and are flagged accordingly.

Precision is determined by evaluating the recovery results obtained by a second analysis of the matrix spike (matrix spike duplicate). The recovery values, or recovery percent, are evaluated by calculating the relative percent difference (RPD) between the two samples. Just as the control limits set forth for matrix spike recovery limits, or accuracy, must be within set control limits, the relative percent difference between the matrix spike and the matrix spike duplicate must also be within established acceptance criteria for precision.

Table 1

Summary of Samples Collected for the Alark Hard Chrome Treatability Study

URS Sample Number	Sample Description	Laboratory Number	Chain of Custody No.	Analyses Requested:
T-S-3-@4'	Initial Soil Sample Collected from TS-3 at ~4'	CE02576	89686	Sulfate WET and Total Cr, CrVI, Ni, Pb, Cd
CR2-and -CR3-@5'	Initial Composite Soil Sample Collected from CR2 and CR3 at ~5'	CE02577	89686	Sulfate WET and Total Cr, CrVI, Ni, Pb, Cd
T-S-1-@5'	Initial Soil Sample from TS-1 at ~5'	CE02578	89686	Sulfate WET and Total Cr, CrVI, Ni, Pb, Cd
T-S-1-@30'	Initial Soil Sample from TS-1 at ~30'	CE02579	89686	Sulfate WET and Total Cr, CrVI, Ni, Pb, Cd
UTS---	Untreated Soil - Composite of Initial Soil Samples from Boring TS-1	CF00045	13567	Title 22 Metals Cr, CrVI, Cd, Ni, Pb STLC
Fe-SO4-1-	Post Ferrous Sulfate Reduced, Pre-immobilized Soil	CF00294	014413	Hexavalent Chromium
Fe-SO4-2-	Post Ferrous Sulfate Reduced, Pre-immobilized Soil	CF00295	014413	Hexavalent Chromium
ITE-1--	Post Sodium Hydrosulfite Reduced Soil	CF00296	014413	Hexavalent Chromium
ITE-3--	Post Sodium Hydrosulfite Reduced Soil	CF00297	014413	Hexavalent Chromium
ITE-3-D-	Post Sodium Hydrosulfite Reduced Soil, Duplicate	CF00298	014413	Hexavalent Chromium
1---	3N Nitric, 15 Minuite Wash, +60 Mesh Soil	CF00499	S/E #1	Total Cr, CrVI, Cd, Ni, Pb WET Cr, CrVI, Cd, Ni, Pb
2---	3N Nitric, 15 Minuite Wash, +230 Mesh Soil	CF00500	S/E #1	Total Cr, CrVI, Cd, Ni, Pb WET Cr, CrVI, Cd, Ni, Pb
3---	3N Nitric, 15 Minute Wash, Pan Soil	CF00501	S/E #1	Total Cr, CrVI, Cd, Ni, Pb WET Cr, CrVI, Cd, Ni, Pb
4---	Plain Water, 15 Minute Wash, +60 Mesh Soil	CF00502	S/E #1	Total Cr, CrVI, Cd, Ni, Pb WET Cr, CrVI, Cd, Ni, Pb
5---	Plain Water, 15 Minute Wash, +230 Mesh Soil	CF00503	S/E #1	Total Cr, CrVI, Cd, Ni, Pb WET Cr, CrVI, Cd, Ni, Pb
6---	Plain Water, 15 Minute Wash, Pan Soil	CF00504	S/E #1	Total Cr, CrVI, Cd, Ni, Pb WET Cr, CrVI, Cd, Ni, Pb
7---	3N Nitric, 7 Minute Wash, +60 Mesh Soil	CF00505	S/E #1	Total Cr, CrVI, Cd, Ni, Pb WET Cr, CrVI, Cd, Ni, PB
8---	3N Nitric, 7 Minute Wash, +230 Mesh Soil	CF00506	S/E #1	Total Cr, CrVI, Cd, Ni, Pb WET Cr, CrVI, Cd, Ni, PB
9---	3N Nitric, 7 Minute Wash, Pan Soil	CF00507	S/E #1	Total Cr, CrVI, Cd, Ni, Pb WET Cr, CrVI, Cd, Ni, PB
10---	Plain Water, 7 Minute Wash, +60 Mesh Soil	CF00508	S/E #1	Total Cr, CrVI, Cd, Ni, Pb WET Cr, CrVI, Cd, Ni, PB

Table 1 *(cont.)*

Summary of Samples Collected for the Alark Hard Chrome Treatability Study

URS Sample Number	Sample Description	Laboratory Number	Chain of Custody No.	Analyses Requested:
11---	Plain Water, 7 Minute Wash, +230 Mesh Soil	CF00509	S/E #2	Total Cr, CrVI, Cd, Ni, Pb WET Cr, CrVI, Cd, Ni, PB
12---	Plain Water, 7 Minute Wash, Pan Soil	CF00510	S/E #2	Total Cr, CrVI, Cd, Ni, Pb WET Cr, CrVI, Cd, Ni, PB
3/8"---	Screened Soil, Untreated Soil Fraction	CF00515	S/E #4	Total Cr, CrVI, Cd, Pb, Ni
100---	Screened Soil, Untreated Soil Fraction	CF00516	S/E #4	Total Cr, CrVI, Cd, Pb, Ni
20---	Screened Soil, Untreated Soil Fraction	CF00517	S/E #4	Total Cr, CrVI, Cd, Pb, Ni
230-Pan--	Screened Soil, Untreated Soil Fraction	CF00518	S/E #4	Total Cr, CrVI, Cd, Pb, Ni
40---	Screened Soil, Untreated Soil Fraction	CF00519	S/E #4	Total Cr, CrVI, Cd, Pb, Ni
#230- - -	Screened Soil, Untreated Soil Fraction	CF00520	S/E #4	Total Cr, CrVI, Cd, Pb, Ni
4---	Screened Soil, Untreated Soil Fraction	CF00521	S/E #4	Total Cr, CrVI, Cd, Pb, Ni
10---	Screened Soil, Untreated Soil Fraction	CF00522	S/E #4	Total Cr, CrVI, Cd, Pb, Ni
60---	Screened Soil, Untreated Soil Fraction	CF00523	S/E #4	Total Cr, CrVI, Cd, Pb, Ni
Wash-Water--	Water Used to Screen Soil	CF00524	S/E #4	Total Cr, CrVI, Cd, Pb, Ni
13---	6N Nitric, 7 Minute Wash, +60 Mesh Soil	CF00535	S/E #3	Total Cr, CrVI, Cd, Pb, Ni WET Cr, CrVI, Cd, Pb, Ni
14---	6N Nitric, 7 Minute Wash, +230 Mesh Soil	CF00536	S/E #3	Total Cr, CrVI, Cd, Pb, Ni WET Cr, CrVI, Cd, Pb, Ni
15---	6N Nitric, 7 Minute Wash, Pan Soil	CF00537	S/E #3	Total Cr, CrVI, Cd, Pb, Ni WET Cr, CrVI, Cd, Pb, Ni
16---	6N Nitric, 15 Minute Wash, +60 Soil	CF00538	S/E #3	Total Cr, CrVI, Cd, Pb, Ni WET Cr, CrVI, Cd, Pb, Ni
17---	6N Nitric, 15 Minute Wash, +230 Soil	CF00539	S/E #3	Total Cr, CrVI, Cd, Pb, Ni WET Cr, CrVI, Cd, Pb, Ni
18---	6N Nitric, 15 Minute Wash, Pan Soil	CF00540	S/E #3	Total Cr, CrVI, Cd, Pb, Ni WET Cr, CrVI, Cd, Pb, Ni
19---	Soil Washing Water Before Water Treatment	CF00541	S/E #3	Total Cr, CrVI, Cd, Pb, Ni Alkalinity pH
#20---	Soil Washing Water After Water Treatment	CF00542	S/E #3	Total Cr, CrVI, Cd, Pb, Ni Alkalinity

Table 1 *(cont.)*

Summary of Samples Collected for the Alark Hard Chrome Treatability Study

URS Sample Number	*Sample Description*	*Laboratory Number*	*Chain of Custody No.*	*Analyses Requested:*
21---	*Waste Water Sludge (Precipitate)*	*CF00543*	*S/E #3*	*Total Cr, CrVI, Cd, Pb, Ni* *WET Cr, CrVI, Cd, Pb, Ni*
22---	*Duplicate, Washed Soil*	*CF00544*	*S/E #3*	*Total Cr, CrVI, Cd, Pb, Ni* *WET Cr, CrVI, Cd, Pb, Ni*
Fe-SO4-Port-10%	*Ferrous Sulfate Reduced, Portland Cement 10% Immobilized Soil*	*CF00745*	*014414*	*WET Cr, CrVI, Cd, Pb, Ni*
FeSO4-Port-10%-SS	*Ferrous Sulfate Reduced, Portland Cement 10%, Soluble Silicate Immobilized Soil*	*CF00746*	*014414*	*WET Cr, CrVI, Cd, Pb, Ni*
FeSO4-Port-40%-	*Ferrous Sulfate Reduced, Portland Cement 40%, Immobilized Soil*	*CF00747*	*014414*	*WET Cr, CrVI, Cd, Pb, Ni*
FeSO4-Port-40%-SS	*Ferrous Sulfate Reduced, Portland Cement 40%, Soluble Silicate Immobilized Soil*	*CF00748*	*014414*	*WET Cr, CrVI, Cd, Pb, Ni*
FeSO4-FA-10%-	*Ferrous Sulfate Reduced, Fly Ash 10% Immobilized Soil*	*CF00749*	*014414*	*WET Cr, CrVI, Cd, Pb, Ni*
FeSO4-FA-10%-SS	*Ferrous Sulfate Reduced, Fly Ash 10%, Soluble Silicate Immobilized Soil*	*CF00750*	*014414*	*WET Cr, CrVI, Cd, Pb, Ni*
Fe-SO4-40%-	*Ferrous Sulfate Reduced, Fly Ash 40% Immobilized Soil*	*CF00751*	*014414*	*WET Cr, CrVI, Cd, Pb, Ni*
Fe-SO4-40%-SS	*Ferrous Sulfate Reduced, Fly Ash 40%, Soluble Silicate Immobilized Soil*	*CF00752*	*014414*	*WET Cr, CrVI, Cd, Pb, Ni*
ITE-Port-10%-	*Sodium Hydrosulfite Reduced, Portland Cement 10% Immobilized Soil*	*CF00753*	*014414*	*WET Cr, CrVI, Cd, Pb, Ni*
ITE-Port-10%-SS	*Sodium Hydrosulfite Reduced, Portland Cement 10%, Soluble Silicate Immobilized Soil*	*CF00754*	*014414*	*WET Cr, CrVI, Cd, Pb, Ni*
ITE-Port-40%-	*Sodium Hydrosulfite Reduced, Portland Cement 40% Immobilized Soil*	*CF00755*	*014414*	*WET Cr, CrVI, Cd, Pb, Ni*
ITE-Port-40%-SS	*Sodium Hydrosulfite Reduced, Portland Cement 40%, Soluble Silicate Immobilized Soil*	*CF00756*	*014415*	*WET Cr, CrVI, Cd, Pb, Ni*
ITE-FA-10%-	*Sodium Hydrosulfite Reduced, Fly Ash10% Immobilized Soil*	*CF00757*	*014415*	*WET Cr, CrVI, Cd, Pb, Ni*
ITE-FA-10%-SS	*Sodium Hydrosulfite Reduced, Fly Ash10% Soluble Silicate Immobilized Soil*	*CF00758*	*014415*	*WET Cr, CrVI, Cd, Pb, Ni*
ITE-FA-40%-	*Sodium Hydrosulfite Reduced, Fly Ash 40% Immobilized Soil*	*CF00759*	*014415*	*WET Cr, CrVI, Cd, Pb, Ni*
ITE-FA-40%-SS	*Sodium Hydrosulfite Reduced, Fly Ash 40% , Soluble Silicate Immobilized Soil*	*CF00760*	*014415*	*WET Cr, CrVI, Cd, Pb, Ni*

Samples that fall outside of these control limits do not meet precision standards and are also flagged.

The data validation process also evaluates the possibility of external contamination of environmental or quality assurance samples in the laboratory. This assessment is accomplished through the use of method blank analyses. Method blanks are used to identify any contaminants introduced to the sample during analytical procedures. Method blanks are simply blank samples (e.g., do not contain target analytes) that are analyzed by the same method as the environmental samples. Each environmental and quality assurance sample has a corresponding method blank that is analyzed for contamination. If contamination is observed, external contaminants have entered the method blank sample and each of the corresponding environmental and quality assurance samples are flagged with a qualifier noting that contamination in the blank is present.

Certain analytical methods require surrogate spikes. Surrogate spikes are used to determine method accuracy by assessing the percent recovery for the surrogate spike. Surrogate spikes differ from matrix spikes in that the chemicals used to spike the sample are not compounds of interest but rather are chemically-similar species. The percentage of the "spiked" species recovered indicate a loss or gain of accuracy resulting from the analytical equipment or procedures used. Like other accuracy and precision measurements, surrogate spike recovery values must fall within established control limits. Surrogate spikes that are outside of the acceptance criteria range indicate potential accuracy problems and the corresponding environmental samples are flagged accordingly. During the treatability study, there were no analytical tests conducted that required the use of surrogate spikes.

The data validation process also evaluates sample holding times. Sample holding time requirements apply to all samples. The holding time is defined as the maximum allowable time that can elapse from the time a sample is collected until its extraction or analysis in the laboratory. Each analytical method has a specific allowable holding time. Samples that violate the maximum allowable holding time are flagged accordingly, and the analytical results are generally used for estimation purposes only. All samples collected during the treatability study met the respective holding times for the metals of concern, with the exception of hexavalent chromium. The stability of hexavalent chromium in extraction procedures is not completely understood at this time. Therefore, EPA Method 7196 suggests that hexavalent chromium sample analyses be conducted within a 24-hour holding time. However, the processes involved in soil washing and reduction/immobilization as applied in this treatability study automatically violate the holding time for hexavalent chromium. For example, the time for reduction, immobilization, and curing can range from 24 hours to 28 days. Hexavalent chromium results that were obtained outside the 24-hour holding time are flagged accordingly on Tables 2 and 3.

Method blanks associated with the samples collected for the treatability study were all analyte-free. All matrix spike and matrix spike duplicate samples were within acceptable control limits (accuracy). Precision values for all elements were within control limits. Surrogate spikes were not conducted for metals analyses. All associated treatability study sample results are considered valid and usable, with exception of the hexavalent chromium sample results that were obtained outside the 24-hour holding time. These data are considered for estimation purposes only. Analytical and geotechnical laboratory reports are provided in Appendix D.

Table 2

Treatability Sample Results for Cadmium, Total Chromium, Hexavalent Chromium Nickel and Lead (Total Concentrations)

Sample Number	Sample Description	TTLC	Inorganic Constituents* Cd 100	Cr 2500	Cr^{+6} 500	Ni 2000	Pb 1000
T-S-3-@4'	*Initial Soil Sample Collected from TS-3 at ~4'*		8.9	250	18	86	260
CR2-and -CR3-@5'	*Initial Composite Soil Sample Collected from CR2 and CR3 at ~5'*		0.44	73	6.3	11	12
T-S-1-@5'	*Initial Soil Sample from TS-1 at ~5'*		21	4500 R	0.28	19	150
T-S-1-@30'	*Initial Soil Sample from TS-1 at ~30'*		0.27	2000	0.29	7.1	3.3
Fe-SO4-2-	*Post Ferrous Sulfate Reduced, Pre-immobilized Soil*		-	-	940 R	-	-
ITE-1--	*Post Sodium Hydrosulfite Reduced Soil*		-	-	920 R	-	-
ITE-3--	*Post Sodium Hydrosulfite Reduced Soil*		-	-	1100 R	-	-
ITE-3-D-	*Post Sodium Hydrosulfite Reduced Soil, Duplicate*		-	-	970 R	-	-
1---	*3N Nitric, 15 Minuite Wash, +60 Mesh Soil*		0.2	150	14†	1.7	45
2---	*3N Nitric, 15 Minuite Wash, +230 Mesh Soil*		ND	410	84†	5.8	28
3---	*3N Nitric, 15 Minute Wash, Pan Soil*		2.6	1900	46†	24	37
4---	*Plain Water, 15 Minute Wash, +60 Mesh Soil*		4.0	470	57†	2.4	94

ND = Not Detected
R = Result Exceeds the TTLC
TTLC - Total Threshold Limit Concentration
† = Analysis Not Conducted within 24 Hour Holding Time

**Values reported in mg/kg*

Table 2 *(cont.)*

Treatability Sample Results for Cadmium, Total Chromium, Hexavalent Chromium Nickel and Lead (Total Concentrations)

Sample Number	Sample Description	TTLC	Inorganic Constituents* Cd 100	Cr 2500	Cr^{+6} 500	Ni 2000	Pb 1000
4---	*Plain Water, 15 Minute Wash, +60 Mesh Soil*		4.0	470	57†	2.4	94
5---	*Plain Water, 15 Minute Wash, +230 Mesh Soil*		4.4	800	57†	8.5	110
6---	*Plain Water, 15 Minute Wash, Pan Soil*		13	2300	470†	21	120
7---	*3N Nitric, 7 Minute Wash, +60 Mesh Soil*		0.5	320	21†	1.7	45
8---	*3N Nitric, 7 Minute Wash, +230 Mesh Soil*		0.6	410	160†	6.5	25
9---	*3N Nitric, 7 Minute Wash, Pan Soil*		2.2	1500	ND†	19	38
10---	*Plain Water, 7 Minute Wash, +60 Mesh Soil*		3.8	620	120†	2.7	2.770
11---	*Plain Water, 7 Minute Wash, +230 Mesh Soil*		3.9	710	160†	7.4	110
12---	*Plain Water, 7 Minute Wash, Pan Soil*		15	2300	240†	26	120
3/8"---	*Screened Soil, Untreated Soil Fraction*		2.9	270	6.5†	5.5	6.5
100---	*Screened Soil, Untreated Soil Fraction*		4.1	510	51†	4.7	130
20---	*Screened Soil, Untreated Soil Fraction*		3.2	830	57†	3.0	11
230-Pan--	*Screened Soil, Untreated Soil Fraction*		4.1	780	75†	7.0	110

ND = Not Detected
R = Result Exceeds the TTLC
TTLC - Total Threshold Limit Concentration
† = Analysis Not Conducted within 24 Hour Holding Time

**Values reported in mg/kg*

Table 2 *(cont.)*

Treatability Sample Results for Cadmium, Total Chromium, Hexavalent Chromium Nickel and Lead (Total Concentrations)

Sample Number	Sample Description	TTLC	*Inorganic Constituents**				
			Cd	Cr	Cr^{+6}	Ni	Pb
			100	2500	500	2000	1000
40---	*Screened Soil, Untreated Soil Fraction*		3.6	530	56†	2.7	120
#230- - -	*Screened Soil, Untreated Soil Fraction*		5.0	850	86†	8.3	120
4---	*Screened Soil, Untreated Soil Fraction*		19	3000 R	77†	11	10
10---	*Screened Soil, Untreated Soil Fraction*		7.9	1400	110†	3.3	8.2
60---	*Screened Soil, Untreated Soil Fraction*		3.8	500	33†	3.1	170
13---	*6N Nitric, 7 Minute Wash, +60 Mesh Soil*		0.7	190	95†	2.1	59
14---	*6N Nitric, 7 Minute Wash, +230 Mesh Soil*		ND	350	73†	4.8	30
15---	*6N Nitric, 7 Minute Wash, Pan Soil*		3.3	1500	ND†	14	51
16---	*6N Nitric, 15 Minute Wash, +60 Soil*		0.2	130	12†	1.3	130
17---	*6N Nitric, 15 Minute Wash, +230 Soil*		0.6	360	35†	6.1	18
18---	*6N Nitric, 15 Minute Wash, Pan Soil*		3.3	1300	ND†	13	65
21---	*Waste Water Sludge (Precipitate)*		2.7	1100	0.24†	2.9	33
22---	*Duplicate, Washed Soil*		5.1	ND	ND†	ND	98

ND = Not Detected
R = Result Exceeds the TTLC
TTLC - Total Threshold Limit Concentration
† = Analysis Not Conducted within 24 Hour Holding Time

**Values reported in mg/kg*

Table 3

Treatability Sample Results for Cadmium, Total Chromium, Hexavalent Chromium Nickel and Lead (WET Concentrations)

Sample Number	Sample Description		Inorganic Constituents*				
		STLC	Cd 1	Cr 560	Cr^{+6} 5	Ni 20	Pb 5
T-S-3-@4'	*Initial Soil Sample Collected from TS-3 at ~4'*		0.80	11	3.9	3.2	15
CR2-and -CR3-@5'	*Initial Composite Soil Sample Collected from CR2 and CR3 at ~5'*		ND	3.1	2.3	0.19	1.6
T-S-1-@5'	*Initial Soil Sample from TS-1 at ~5'*		1.7 R	220	0.15	0.40	5.3
T-S-1-@30'	*Initial Soil Sample from TS-1 at ~30'*		ND	190	0.12	0.18	0.070
UTS---	*Untreated Soil - Composite of Initial Soil Samples from Boring TS-1*		0.97	210	27 † R	0.30	3.9
1---	*3N Nitric, 15 Minuite Wash, +60 Mesh Soil*		0.08	5.1	0.9 †	ND	0.16
2---	*3N Nitric, 15 Minuite Wash, +230 Mesh Soil*		ND	16	3.7 †	0.16	0.20
3---	*3N Nitric, 15 Minute Wash, Pan Soil*		0.32	180	36 † R	0.94	0.76
4---	*Plain Water, 15 Minute Wash, +60 Mesh Soil*		0.28	14	5.2 † R	0.08	1.9
5---	*Plain Water, 15 Minute Wash, +230 Mesh Soil*		0.49	25	5.7 † R	0.17	6.5
6---	*Plain Water, 15 Minute Wash, Pan Soil*		1.7 R	96	61 † R	0.67	3.6
7---	*3N Nitric, 7 Minute Wash, +60 Mesh Soil*		0.06	8.2	1.6 †	0.06	0.92
8---	*3N Nitric, 7 Minute Wash, +230 Mesh Soil*		0.05	17	1.2 †	0.17	0.79
9---	*3N Nitric, 7 Minute Wash, Pan Soil*		0.24	150	1.0 †	0.73	0.64

ND = Not Detected
STLC - Soluble Threshold Limit Concentration
† = Not Analyzed within 24 Hour Holding Time

**Values reported in mg/L*

Table 3 *(cont.)*

Treatability Sample Results for Cadmium, Total Chromium, Hexavalent Chromium Nickel and Lead (WET Concentrations)

Sample Number	Sample Description		Inorganic Constituents*				
		STLC	Cd 1	Cr 560	Cr^{+6} 5	Ni 20	Pb 5
10---	*Plain Water, 7 Minute Wash, +60 Mesh Soil*		0.33	17	9.6 † R	0.10	1.2
11---	*Plain Water, 7 Minute Wash, +230 Mesh Soil*		0.44	23	14 † R	0.18	4.4
12---	*Plain Water, 7 Minute Wash, Pan Soil*		1.6 R	94	57 † R	0.66	3.9
13---	*6N Nitric, 7 Minute Wash, +60 Mesh Soil*		ND	9.1	0.61 †	0.06	2.4
14---	*6N Nitric, 7 Minute Wash, +230 Mesh Soil*		ND	20	3.2 †	0.13	0.34
15---	*6N Nitric, 7 Minute Wash, Pan Soil*		0.31	170	0.054†	1.2	1.1
16---	*6N Nitric, 15 Minute Wash, +60 Soil*		ND	7.6	ND †	ND	0.46
17---	*6N Nitric, 15 Minute Wash, +230 Soil*		ND	18	0.36 †	0.15	0.13
18---	*6N Nitric, 15 Minute Wash, Pan Soil*		0.19	120	ND †	0.97	0.58
19---	*Soil Washing Water Before Water Treatment*		1.8 R	630 R	0.06 †	1.4	19
#20---	*Soil Washing Water After Water Treatment*		ND	0.57	ND †	ND	ND
21---	*Waste Water Sludge (Precipitate)*		0.52	250	ND †	0.93	1.8
Fe-SO4-Port-10%	*Ferrous Sulfate Reduced, Portland Cement 10% Immobilized Soil*		0.52	130	4.7 †	0.24	2.3
FeSO4-Port-10%-SS	*Ferrous Sulfate Reduced, Portland Cement 10%, Soluble Silicate Immobilized Soil*		0.49	130	2.4 †	0.25	9.5

ND = Not Detected
STLC - Soluble Threshold Limit Concentration
† = Not Analyzed within 24 Hour Holding Time

**Values reported in mg/L*

Table 3 *(cont.)*

Treatability Sample Results for Cadmium, Total Chromium, Hexavalent Chromium Nickel and Lead (WET Concentrations)

Sample Number	Sample Description	STLC	Inorganic Constituents* Cd 1	Cr 560	Cr^{+6} 5	Ni 20	Pb 5
FeSO4-Port-40%-	*Ferrous Sulfate Reduced, Portland Cement 40%, Immobilized Soil*		ND	62	2.0 †	0.13	0.69
FeSO4-Port-40%-SS	*Ferrous Sulfate Reduced, Portland Cement 40%, Soluble Silicate Immobilized Soil*		ND	55	0.90 †	0.15	0.36
FeSO4-FA-10%-	*Ferrous Sulfate Reduced, Fly Ash 10% Immobilized Soil*		0.53	140	59 † R	0.30	4.9
FeSO4-FA-10%-SS	*Ferrous Sulfate Reduced, Fly Ash 10%, Soluble Silicate Immobilized Soil*		0.56	140	24 † R	0.28	5.7
Fe-SO4-40%-	*Ferrous Sulfate Reduced, Fly Ash 40% Immobilized Soil*		0.46	120	45 † R	0.38	3.2
Fe-SO4-40%-SS	*Ferrous Sulfate Reduced, Fly Ash 40%, Soluble Silicate Immobilized Soil*		0.52	78	54 † R	0.40	2.6
ITE-Port-10%-	*Sodium Hydrosulfite Reduced, Portland Cement 10% Immobilized Soil*		0.51	130	37 † R	0.24	2.0
ITE-Port-10%-SS	*Sodium Hydrosulfite Reduced, Portland Cement 10%, Soluble Silicate Immobilized*		0.52	130	44 † R	0.25	1.8
ITE-Port-40%-	*Sodium Hydrosulfite Reduced, Portland Cement 40% Immobilized Soil*		ND	69	2.5 †	0.12	0.19
ITE-Port-40%-SS	*Sodium Hydrosulfite Reduced, Portland Cement 40%, Soluble Silicate Immobilized*		ND	63	1.7 †	0.12	1.8
ITE-FA-10%-	*Sodium Hydrosulfite Reduced, Fly Ash10% Immobilized Soil*		0.54	130	100 † R	0.27	3.2
ITE-FA-10%-SS	*Sodium Hydrosulfite Reduced, Fly Ash10% Soluble Silicate Immobilized Soil*		0.49	120	14 † R	0.27	2.4
ITE-FA-40%-	*Sodium Hydrosulfite Reduced, Fly Ash 40% Immobilized Soil*		0.41	120	25 † R	0.37	2.7
ITE-FA-40%-SS	*Sodium Hydrosulfite Reduced, Fly Ash 40% , Soluble Silicate Immobilized Soil*		0.42	120	95 † R	0.32	3.3

ND = Not Detected
STLC - Soluble Threshold Limit Concentration
† = Not Analyzed within 24 Hour Holding Time

**Values reported in mg/L*

Data Management

Technical interpretations were based on accurate, timely, and valid data. Data on which decisions were made must be formalized into a permanent project record. Implementation of a standard data management system ensured that data accurately and precisely characterized the conditions and situations on which significant site-specific decision and actions were based.

To assure the accuracy, precision, completeness, representativeness and comparability of field and analytical data, processes and procedures were developed for collecting, accessing, screening, validating, storing, retrieving, transferring, modifying and securing data. These processes and procedures ensured that data, and the reports in which the data were presented, are scientifically valid, legally defensible, and of known accuracy and precision.

An effective data management program includes established documentation protocols and documentation validation procedures. Implementation of a documentation validation process ensured that field and laboratory data were collected, processed, and documented in accordance with the protocols set forth in project guidance documents. Data failing to meet established guidelines may therefore be eliminated from consideration during the treatability study or may be used for limited purposes only.

During the feasibility study, field observations and raw data were recorded in a bound project notebook. Photographs were taken when possible. The bound notebook was the repository of the field activity daily log. Field personnel documented in the project notebook each day, at a minimum:

- project name,
- project number,
- data,
- treatability activity subject,
- description of treatability activities,
- changes from plans and specifications, and other special orders and important decisions,
- samples collected,
- sample preservations, as appropriate
- chain-of-custody numbers used, and
- supervisor's signature.

Data interpretation commenced upon completion of the treatability study. Validated analytical and geotechnical data was summarized and evaluated to determine the performance of the treatment process.

APPENDIX C
EQUIPMENT AND MATERIAL LIST

Test	Item	Manufacturer/Source
IM & SW	3/8" sieve, stainless	Fisher (04-883G)
SW	Bottle wash, HDPE	Fisher (03-409-10E)
SW	Carboy	Fisher (02-963-6A)
IM & SW	Beaker, 2L	Fisher (02-55E)
IM & SW	Weighing disk, 63 mm	Fisher (08-232-5C)
SW	Ploceman	Fisher (14-105A)
SW	Dynamix Stirrer	Fisher (14-498-45)
IM & SW	Versa Clean Detergent	Fisher (04-342)
SW	Stir Rod, 12 inch	Fisher (11-380C)
IM & SW	pH Test Kit	Fisher (A998)
SW	Thermometer	Generic
SW	Filter Paper	Fisher (09-795E)
SW	Filter Paper	Fisher (09-801D)
SW	Filter Paper	Fisher (09-803-5E)
IM & SW	Bistle Brush, 4"	Fisher (03-541)
IM & SW	Bistle Brush, 12"	Fisher (03-621A)
SW	Carboy	Fisher (02-961-10B)
IM & SW	Stoppers, #9	Fisher (14-135N)
SW	Clamp Holder Swivel	Fisher (05-762)
SW	Clamp Holder	Fisher (05-754)
SW	Support Stand	Fisher (14-675D)
IM & SW	Graduated Cylinders, 10 ml	Fisher (08-554-4H)
IM & SW	Graduated Cylinders, 250 ml	Fisher (08-552-4D)
IM & SW	Graduated Cylinders, 500 ml	Fisher (08-552-4E)
IM & SW	Graduated Cylinders, 1,000 ml	Fisher (08-552-4F)
IM	Sodium Silicate Solution	Fisher (5718-500)
IM	Type I/II Portland Cement	Generic
IM & SW	Beaker, 1L	Fisher (02-539P)
IM	Ferrous Sulfate, Lab Grade	Fisher (F285-500)
SW	Nitric Acid, ACS grade, 2.5L	Fisher (N500-2.5)
SW	Filter Paper	Fisher (09-795-G)
SW	Filter Paper	Fisher (09-803-GH)

SW	Filter Paper	Fisher (09-803-5G)
IM	Fly Ash, Type F Mohave	Western Ash
IM	Sodium Hydrosulfite (Reactivate)	Hoechst
IM	20 quart Hobart Mixer	Caswell
IM	5 quart Kenwood Mixer	Kleentek
IM	Cylinder Molds	Smith-Emery Company
SW	Buchner funnels	Smith-Emery Company
SW	Side-arm flasks	Smith-Emery Company
SW	Vacuum pump	Smith-Emery Company
SW	17-ohm deionized water	Smith-Emery Company
IM	17-ohm deionized water	Del Mar Analytical
IM & SW	Assorted plastic jugs	Amico Scientific
IM & SW	Eye droppers	Amico Scientific
IM & SW	5-gallon plastic buckets	Generic
IM	Miscellaneous supplies	Del Mar Analytical
SW	Miscellaneous supplies	Smith-Emery Company

APPENDIX D
LABORATORY DATA

SMITH-EMERY COMPANY
The Full Service Independent Testing Laboratory, Established 1904

781 East Washington Boulevard • Los Angeles, California 90021 • (213) 749-3411 • Fax: (213) 746-7228
P.O. Box 880550, Hunter's Point Shipyard Bldg. 114 • San Francisco, California 94188 • (415) 330-3000 • Fax: (415) 822-5864
5427 East La Palma Avenue • Anaheim, California 92807 • (714) 693-1026 • Fax: (714) 693-1034

August 13, 1993

SECo File No: 27091
SECo Report No: G-93-5734
Your Project No: 4564213.01

URS Consultants
4675 MacArthur Court, Suite 850
Newport Beach, CA 92668

Attention: Robert Evangelista

RE: Alark Treatability Study

SAMPLE I.D.:
1. $FeSO_4$/Port 40%
2. $FeSO_4$/Port 40%/ss
3. ITE/Port 40%
4. ITE/Port 40%/ss

DATE RECEIVED: August 3, 1993

Smith-Emery Company has completed testing as required. Laboratory tests required were bulk density, porosity, and unconfined compressive strength. Pore volume from the bulk density was calculated with an assumed specific gravity of 2.65. Results of tests are as follows:

REPORT OF TEST

Sample 1 -- $FeSO_4$/Port 40%

Dry Density = 90 pounds per cubic foot
Porosity (n) = 0.459
Unconfined Compressive Strength = 102,542 pounds per square foot
Strain = 0.6 Percent

Sample 2 -- $FeSO_4$/Port 40%/ss

Dry Density = 95 pounds per cubic foot
Porosity (n) = 0.426
Unconfined Compressive Strength = 299,203 pounds per square foot
Strain = 1.0 Percent

SMITH-EMERY COMPANY
The Full Service Independent Testing Laboratory, Established 1904

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P.O. Box 880550, Hunter's Point Shipyard Bldg. 114 • San Francisco, California 94188 • (415) 330-3000 • Fax: (415) 822-5864
5427 East La Palma Avenue • Anaheim, California 92807 • (714) 693-1026 • Fax: (714) 693-1034

SECo File No: 27091
SECo Report No: G-93-5734
Your Project No: 4564213.01

TEST RESULTS, CONT.

Sample 3 -- ITE/Port 40%

Dry Density = 96 pounds per cubic foot
Porosity (n) = 0.420
Unconfined Compressive Strength = 254,376 pounds per square foot
Strain = 0.7 Percent

Sample 4 -- ITE/Port 40%/ss

Dry Density = 94 pounds per cubic foot
Porosity (n) = 0.431
Unconfined Compressive Strength = 244,857 pounds per square foot
Strain = 0.5 Percent

Should you have any questions, please call.

Respectfully submitted,

SMITH-EMERY COMPANY

Raf Hutalla

Raf Hutalla
GeoServices Division Manager

RH:cw

SMITH-EMERY COMPANY
The Full Service Independent Testing Laboratory, Established 1904

781 East Washington Blvd.
Los Angeles, California 90021
(213) 749-3411
Fax (213) 746-7228

June 9, 1993

SECo File No.: 72476
SECo Report No.: G-93-5547
Your File No.: 4564213-01

URS Consultants
4675 MacArthur Court, Suite 850
Newport Beach, California 92668

Attention: Robert Evangelista

RE: Alark Treatability Study

SAMPLE I.D.: 1. TS 1 @ 5 and 30
2. TS 1 @ 5 and 30D

DATE RECEIVED: June 1, 1993, Soil Sample were in glass jars in disturbed condition.

Laboratory tests required are bulk density, moisture content, particle size analyses and sand equivalent. Pore volume from the bulk density is to be calculated with an assume specific gravity. Results of test are as follows:

REPORT OF TEST

A. BULK DRY DENSITY (POUNDS PER CUBIC FOOT)

TS1 @ 5 and 30		TS1 @ 5 and 30D	
Loose Condition	Compacted Condition	Loose Condition	Compacted Condition
60	106	58	103

	TS1 @ 5 and 30		TS1 @ 5 and 30D	
	Loose Condition	Compacted Condition	Loose Condition	Compacted Condition
Porosity (n)	0.646	0.371	0.656	0.390

Anaheim

5427 East La Palma Ave.
Anaheim, California 92807
(714) 693-1026
Fax (714) 693-1034

San Francisco

Hunters Point Shipyard, Bldg. 114
P.O. Box 880550
San Francisco, California 94188
(415) 822-8880
Fax (415) 822-[illegible]

B. MOISTURE CONTENT (AS RECEIVED)

	TS1 @ 5 and 30 Percent Passing	TS1 @ 5 and 30D Percent Passing
	11.3 percent	11.4 percent

C. PARTICLE SIZE ANALYSES

Sieve Size/Dia,mm	TS1 @ 5 and 30 Percent Passing	TS1 @ 5 and 30D Percent Passing
1/2"	100	100
3/8"	99	99
No. 4	99	98
No. 10	93	94
No. 20	83	86
No. 40	77	77
No. 60	71	69
No. 100	66	63
No. 230	50	49
.0686	49	51
.0494	45	44
.0454	41	42
.0325	38	37
.0232	31	34
.0166	27	28
.0122	24	25
.0087	21	22
.0062	18	18
.0031	15	15

D. SAND EQUIVALENT TEST

	TS1 @ 5 and 30 Percent Passing	TS1 @ 5 and 30D Percent Passing
Sand Equivalent Average of 3 test	4	6

Should you have any questions, please call.

Respectfully submitted,

SMITH - EMERY COMPANY

Raf Hutalla

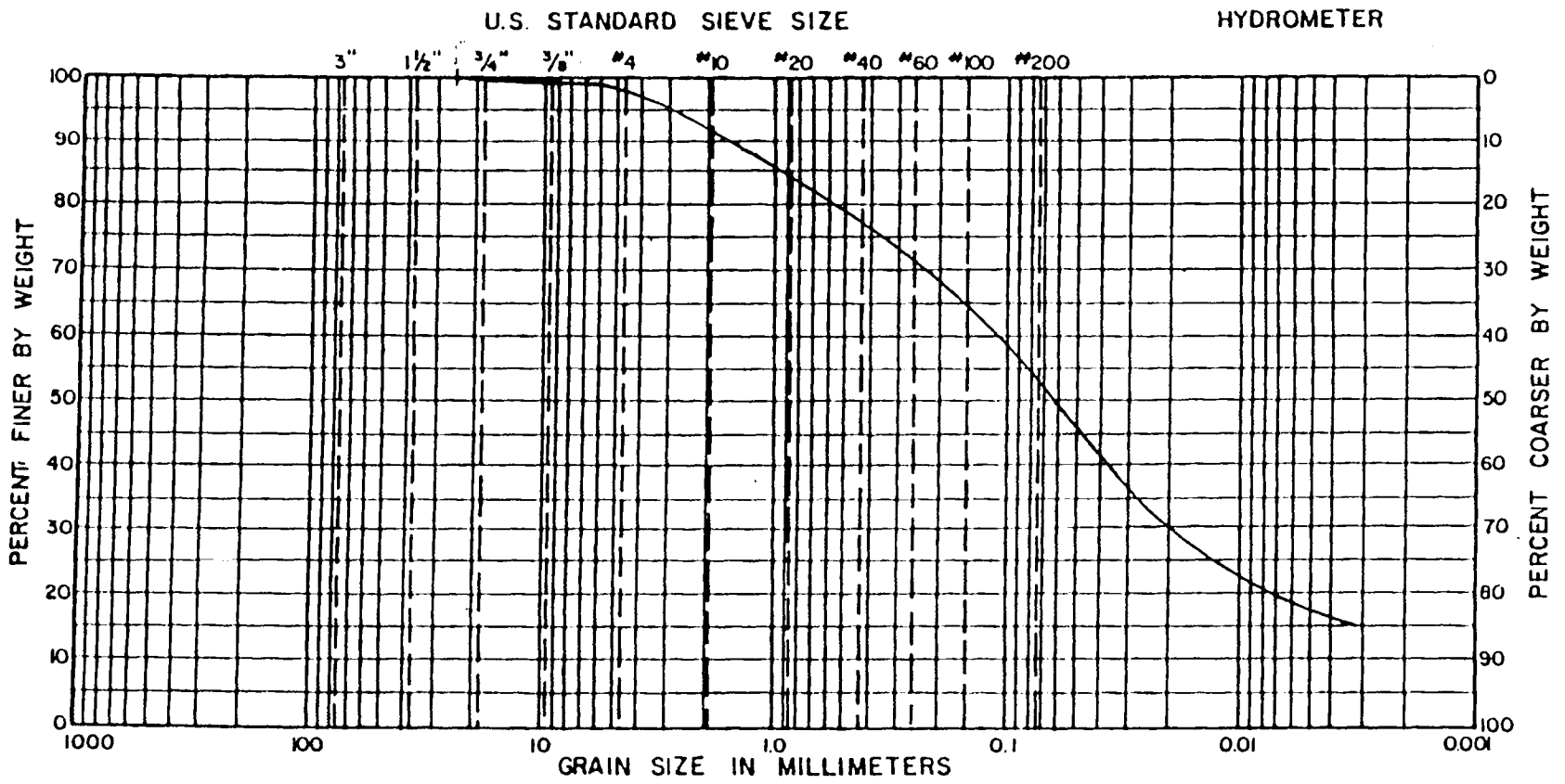
RAF HUTALLA
Geotechnical Manager

RH/fw

Attachment: Grain size Distribution Graphs

cc: 1 - Chemical Department
Rick Young

DWN AF HKD RL DAT 1/4 PROJECT: [illegible] CONSULTANTS: ALARE TREATABILITY STUDY FILE:



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

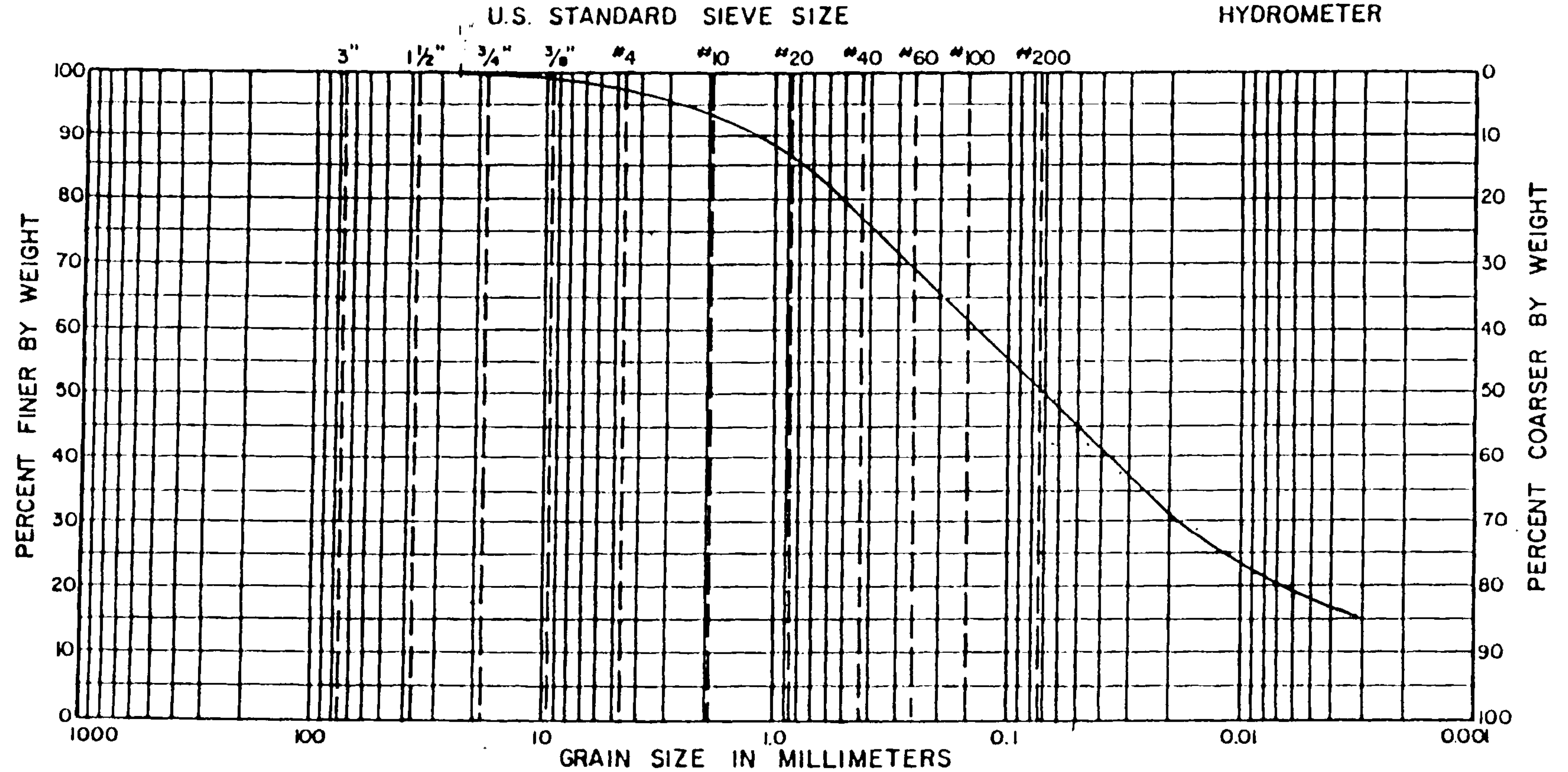
KEY	BORING	DEPTH	CLASSIFICATION
	TS1 @ 5 & 30		Brown slightly silty SAND (SM-ML) with some clay and trace
			of fine gravel

SMITH-EMERY COMPANY

PLATE

GRAIN SIZE DISTRIBUTION

DATE PROJ FILE:



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

KEY	BORING	DEPTH	CLASSIFICATION
	TS1@ 5 &30'		Brown slightly silty SAND (SM-ML) with some clay and trace of
			fine gravel

GRAIN SIZE DISTRIBUTION

SMITH-EMERY COMPANY

PLATE

Del Mar Analytical

2852 Alton Ave., Irvine, CA 92714 (714) 261-1022 FAX (714) 261-1228
1014 E. Cooley Dr., Suite A, Colton, CA 92324 (909) 370-4667 FAX (909) 370-1046
16525 Sherman Way, Suite C-11, Van Nuys, CA 91406 (818) 779-1844 FAX (818) 779-1843

URS Consultants	Client Project ID: Alark Site	Sampled: Jun 2, 1993
4675 MacArthur Court, Suite 850		Received: Jun 3, 1993
Newport Beach, CA 92660	Sample Descript Soil	Analyzed: Jun 4, 1993
Attention: Stephen Niou	First Sample #: CF00294	Reported: Jun 17, 1993

LABORATORY ANALYSIS FOR: CHROMIUM VI (EPA 7196)

Laboratory Number	Sample Description	Detection Limit mg/Kg (ppm)	Sample Result mg/Kg (ppm)
CF00294	FeSO4-1	50	960
CF00295	FeSO4-2	50	940
CF00296	ite-1	50	920
CF00297	ite-3	50	1,100
CF00298	ite-3D	50	970

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

Del Mar Analytical

2852 Alton Ave., Irvine, CA 92714 (714) 261-1022 FAX (714) 261-1228
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URS Consultants
4675 MacArthur Court, Suite 850
Newport Beach, CA 92660
Attention: Stephen Niou

Method Blank

Analyzed: Jun 4, 1993
Reported: Jun 17, 1993
Matrix: Soil

LABORATORY ANALYSIS FOR: CHROMIUM VI (EPA 7196)

Laboratory Description	Detection Limit mg/Kg (ppm)	Sample Result mg/Kg (ppm)
Method Blank	0.25	N.D.

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

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16525 Sherman Way, Suite C-11
Van Nuys, California 91406
(818) 779 1844
FAX (818) 779-1843

U14413

CHAIN OF CUSTODY/REQUEST FOR ANALYSIS

#213-745-6372

Client Name/Address	Project
URS Consultants 714 666 Newport Beach, CA 7676	Alark ~~Hazard Chrome~~ Site
Project Manager: Stephen Niou	**Sampler:** Robert Engelstein

Sample Description	Sample Matrix	Container Type	# of Cont	Sampling Date/Time	Preservatives	Analysis Required: Cr VI	Special Instructions
FeSO4-1	Soil	GLASS	1	6/2/93 eve	none	X	PLEASE NOTE EXTRACTION
FeSO4-2						X	TIME ON Cr VI
ite-1						X	
ite-3				10:30		X	
ite-3D				10:30		X	

(2)

Relinquished By:	Date/Time:	Received By:	Date/Time:
Robert Engelstein	6/3/93 12:30 AM		
Relinquished By: Eddie Curls	Date/Time: 6/3/93	Received By:	Date/Time:
Relinquished By:	Date/Time:	Received in Lab By:	Date/Time:

Note: Samples will be disposed of after 30 days

Turnaround Time (check)
same day ____ 72 hours ____
24 hours ____ 5 days ____
48 hours ____ normal X

Sample Integrity (check)
intact ____ on ice ____

Del Mar Analytical

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URS Consultants
4675 MacArthur Court, Suite 850
Newport Beach, CA 92660
Attention: Stephen Niou

Client Project ID: Alark Site
Sample Descript: Soil, 3/8"
Lab Number: CF00515

Sampled: Jun 3, 1993
Received: Jun 4, 1993
Analyzed: Jun 7-16, 1993
Reported: Jun 17, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/Kg (ppm)	TTLC Sample Result mg/Kg (ppm)
Cadmium	6010	1	100	0.1	2.9
Chromium (VI)	7196	5	500	2.0	6.5
Chromium (Total	6010	5	2,500	0.5	270
Lead	6010	5	1,000	1.0	6.5
Nickel	6010	20	2,000	0.5	5.5

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

Del Mar Analytical

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URS Consultants	Client Project ID:	Alark Site	Sampled: Jun 3, 1993
4675 MacArthur Court, Suite 850			Received: Jun 4, 1993
Newport Beach, CA 92660	Sample Descript:	Soil, #100	Analyzed: Jun 7-16, 1993
Attention: Stephen Niou	Lab Number:	CF00516	Reported: Jun 17, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/Kg (ppm)	TTLC Sample Result mg/Kg (ppm)
Cadmium	6010	1	100	0.1	4.1
Chromium (VI)	7196	5	500	5.0	51
Chromium (Total	6010	5	2,500	0.5	510
Lead	6010	5	1,000	1.0	130
Nickel	6010	20	2,000	0.5	4.7

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

Del Mar Analytical

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URS Consultants	Client Project ID:	Alark Site	Sampled: Jun 3, 1993
4675 MacArthur Court, Suite 850			Received: Jun 4, 1993
Newport Beach, CA 92660	Sample Descript:	Soil, #20	Analyzed: Jun 7-16, 1993
Attention: Stephen Niou	Lab Number:	CF00517	Reported: Jun 17, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/Kg (ppm)	TTLC Sample Result mg/Kg (ppm)
Cadmium	6010	1	100	0.1	3.2
Chromium (VI)	7196	5	500	5.0	57
Chromium (Total	6010	5	2,500	0.5	830
Lead	6010	5	1,000	1.0	11
Nickel	6010	20	2,000	0.5	3.0

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

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URS Consultants	Client Project ID:	Alark Site	Sampled: Jun 3, 1993
4675 MacArthur Court, Suite 850			Received: Jun 4, 1993
Newport Beach, CA 92660	Sample Descript:	Soil, <#230 (PAN)	Analyzed: Jun 7-16, 1993
Attention: Stephen Niou	Lab Number:	CF00518	Reported: Jun 17, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/Kg (ppm)	TTLC Sample Result mg/Kg (ppm)
Cadmium	6010	1	100	0.1	4.1
Chromium (VI)	7196	5	500	5.0	75
Chromium (Total	6010	5	2,500	0.5	780
Lead	6010	5	1,000	1.0	110
Nickel	6010	20	2,000	0.5	7.0

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

Del Mar Analytical

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16525 Sherman Way, Suite C-11, Van Nuys, CA 91406 (818) 779-1844 FAX (818) 779-1843

URS Consultants	Client Project ID:	Alark Site	Sampled: Jun 3, 1993
4675 MacArthur Court, Suite 850			Received: Jun 4, 1993
Newport Beach, CA 92660	Sample Descript:	Soil, #40	Analyzed: Jun 7-16, 1993
Attention: Stephen Niou	Lab Number:	CF00519	Reported: Jun 17, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/Kg (ppm)	TTLC Sample Result mg/Kg (ppm)
Cadmium	6010	1	100	0.1	3.6
Chromium (VI)	7196	5	500	5.0	56
Chromium (Total	6010	5	2,500	0.5	530
Lead	6010	5	1,000	1.0	120
Nickel	6010	20	2,000	0.5	2.7

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

Del Mar Analytical

2852 Alton Ave., Irvine, CA 92714 (714) 261-1022 FAX (714) 261-1228
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URS Consultants
4675 MacArthur Court, Suite 850
Newport Beach, CA 92660
Attention: Stephen Niou

Client Project ID: Alark Site
Sample Descript: Soil, #230
Lab Number: CF00520

Sampled: Jun 3, 1993
Received: Jun 4, 1993
Analyzed: Jun 7-16, 1993
Reported: Jun 17, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/Kg (ppm)	TTLC Sample Result mg/Kg (ppm)
Cadmium	6010	1	100	0.1	5.0
Chromium (VI)	7196	5	500	5.0	86
Chromium (Total	6010	5	2,500	0.5	850
Lead	6010	5	1,000	1.0	120
Nickel	6010	20	2,000	0.5	8.3

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

Del Mar Analytical

2852 Alton Ave., Irvine, CA 92714 (714) 261-1022 FAX (714) 261-1228
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16525 Sherman Way, Suite C-11, Van Nuys, CA 91406 (818) 779-1844 FAX (818) 779-1843

URS Consultants	Client Project ID:	Alark Site	Sampled: Jun 3, 1993
4675 MacArthur Court, Suite 850			Received: Jun 4, 1993
Newport Beach, CA 92660	Sample Descript:	Soil, #4	Analyzed: Jun 7-16, 1993
Attention: Stephen Niou	Lab Number:	CF00521	Reported: Jun 17, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/Kg (ppm)	TTLC Sample Result mg/Kg (ppm)
Cadmium	6010	1	100	0.1	19
Chromium (VI)	7196	5	500	5.0	77
Chromium (Total	6010	5	2,500	5.0	3,000
Lead	6010	5	1,000	1.0	10
Nickel	6010	20	2,000	0.5	11

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

Del Mar Analytical

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16525 Sherman Way, Suite C-11, Van Nuys, CA 91406 (818) 779-1844 FAX (818) 779-1843

URS Consultants	Client Project ID:	Alark Site	Sampled: Jun 3, 1993
4675 MacArthur Court, Suite 850			Received: Jun 4, 1993
Newport Beach, CA 92660	Sample Descript:	Soil, #10	Analyzed: Jun 7-16, 1993
Attention: Stephen Niou	Lab Number:	CF00522	Reported: Jun 17, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/Kg (ppm)	TTLC Sample Result mg/Kg (ppm)
Cadmium	6010	1	100	0.1	7.9
Chromium (VI)	7196	5	500	5.0	110
Chromium (Total	6010	5	2,500	5.0	1,400
Lead	6010	5	1,000	1.0	8.2
Nickel	6010	20	2,000	0.5	3.3

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

Del Mar Analytical

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URS Consultants
4675 MacArthur Court, Suite 850
Newport Beach, CA 92660
Attention: Stephen Niou

Client Project ID: Alark Site
Sample Descript: Soil, #60
Lab Number: CF00523

Sampled: Jun 3, 1993
Received: Jun 4, 1993
Analyzed: Jun 7-16, 1993
Reported: Jun 17, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/Kg (ppm)	TTLC Sample Result mg/Kg (ppm)
Cadmium	6010	1	100	0.1	3.8
Chromium (VI)	7196	5	500	5.0	33
Chromium (Total	6010	5	2,500	0.5	500
Lead	6010	5	1,000	1.0	170
Nickel	6010	20	2,000	0.5	3.1

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

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URS Consultants	Client Project ID: Alark Site	Sampled: Jun 3, 1993
4675 MacArthur Court, Suite 850		Received: Jun 4, 1993
Newport Beach, CA 92660	Sample Descript: Water, Wash Water	Analyzed: Jun 4-16, 1993
Attention: Stephen Niou	Lab Number: CF00524	Reported: Jun 17, 1993

Analyte	EPA Method	Detection Limit mg/L (ppm)	Sample Result mg/L (ppm)
Cadmium	6010	0.005	0.09
Chromium (VI)	7196	0.025	0.20
Chromium (Total	7191	0.05	47
Lead	7421	0.05	0.22
Nickel	6010	0.05	0.11

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

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URS Consultants
4675 MacArthur Court, Suite 850
Newport Beach, CA 92660
Attention: Stephen Niou

Method Blank

Analyzed: Jun 7-16, 1993
Reported: Jun 17, 1993
Matrix: Soil

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/Kg (ppm)	TTLC Sample Result mg/Kg (ppm)
Antimony	6010	15	500	5.0	N.D.
Arsenic	6010	5	500	1.0	N.D.
Barium	6010	100	10,000	0.5	N.D.
Beryllium	6010	0.75	75	0.1	N.D.
Cadmium	6010	1	100	0.1	N.D.
Chromium (VI)	7196	5	500	0.25	N.D.
Chromium (Total	6010	5	2,500	0.5	N.D.
Cobalt	6010	80	8,000	0.5	N.D.
Copper	6010	25	2,500	0.5	N.D.
Lead	6010	5	1,000	1.0	N.D.
Mercury	7471	0.2	20	0.075	N.D.
Molybdenum	6010	350	3,500	0.5	N.D.
Nickel	6010	20	2,000	0.5	N.D.
Selenium	6010	1	100	1.0	N.D.
Silver	6010	5	500	0.5	N.D.
Thallium	6010	7	700	5.0	N.D.
Vanadium	6010	24	2,400	0.5	N.D.
Zinc	6010	250	5,000	0.5	N.D.

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

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URS Consultants
4675 MacArthur Court, Suite 850
Newport Beach, CA 92660
Attention: Stephen Niou

Method Blank

Analyzed: Jun 4-16, 1993
Reported: Jun 17, 1993
Matrix: Water

Analyte	EPA Method	Detection Limit mg/L (ppm)	Sample Result mg/L (ppm)
Cadmium	6010	0.05	N.D.
Chromium (VI)	7196	0.025	N.D.
Chromium (Total	7191	0.05	N.D.
Lead	7421	0.05	N.D.
Nickel	6010	0.05	N.D.

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

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QC DATA REPORT

EPA METHOD: 3060/7196
matrix: soil

DATE: 6/7/93

SAMPLE # Blank

Analyte	R1	Sp	MS	MSD	PR1	PR2	RPD	MEAN PR
	ppm	ppm	ppm	ppm	%	%	%	%
Chromium +6	0	0.2	0.154	0.141	77%	71%	8.8%	74%

Definition of Terms:

R1..... Result of Sample Analysis

Sp..... Spike Concentration Added to Sample

MS..... Matrix Spike Result

MSD..... Matrix Spike Duplicate Result

PR1..... Percent Recovery of MS; (MS-R1) / SP X 100

PR2..... Percent Recovery of MSD; ((MSD-R1) / SP) X 100

RPD..... Relative Percent Difference; ((MS-MSD)/(MS+MSD)/2)) X 100

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QC DATA REPORT

METHOD Metals
Instrument: AA
Matrix: soil

DATE: 6/16/93

SAMPLE # CF00535

Analyte	R1	SP	MS	MSD	PR1	PR2	RPD
	ppb	ppb	ppb	ppb	%	%	%
Chromium	1761	1000	2745	2881	98%	112%	4.8%

R1..... Result of Sample Analysis
Sp..... Spike Concentration Added to Sample
MS..... Matrix Spike Result
MSD..... Matrix Spike Duplicate Result
PR1..... Percent Recovery of MS; (MS-R1) / SP X 100
PR2..... Percent Recovery of MSD; ((MSD-R1) / SP X 100
RPD..... Relative Percent Difference; ((MS-MSD)/(MS+MSD)/2)) X

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QC DATA REPORT

METHOD Metals
Instrument: ICP
Date: 6/15/93 Matrix: SOIL

SAMPLE # CF00551

Analyte	R1	SP	MS	MSD	PR1	PR2	RPD
	ppb	ppb	ppb	ppb	%	%	%
Cadmium	0	1000	925	930	93%	93%	0.5%
Chromium	734	1000	1831	1800	110%	107%	1.7%
Copper	770	1000	2024	1928	125%	116%	4.9%
Lead	462	1000	1424	1427	96%	97%	0.2%
Nickel	501	1000	1449	1404	95%	90%	3.2%
Vanadium	2417	1000	3624	3610	121%	119%	0.4%
Zinc	2447	1000	3646	3446	120%	100%	5.6%

R1..... Result of Sample Analysis
Sp..... Spike Concentration Added to Sample
MS..... Matrix Spike Result
MSD..... Matrix Spike Duplicate Result
PR1..... Percent Recovery of MS; ((MS-R1) / SP) X 100
PR2..... Percent Recovery of MSD; ((MSD-R1) / SP) X 100
RPD..... Relative Percent Difference; ((MS-MSD)/(MS+MSD)/2)) X

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CHAIN OF CUSTODY AND ANALYSIS REQUEST

DATE: 9/4/93 PAGE 1 OF 1
FILE NO. _____ LAB NO. _____

CLIENT NAME: URS Consultants

PROJECT NAME: Alameda St. PROJECT NO. P.O. NO.

ADDRESS: Newport Beach, CA

PROJECT MANAGER: Stephen Mee PHONE #: 7146607683 FAX #: 7146607677

SAMPLER NAME: Robert Evangelista (Printed) Robert Evangelista (Signature)

TAT (Analytical Turn Around Time) 0 = Same Day; 1 = 24 Hour; 2 = 48 Hour; (Etc.)

CONTAINER TYPES: B = Brass, G = Glass, P = Plastic, V = Voa Vial, O = Other:

ANALYSES REQUESTED:

REMARKS:

#5/64

Intact + RM Temp

SAMPLE NO.	DATE SAMPLED	TIME SAMPLED	SAMPLE DESCRIPTION	MATRIX: WATER	SOIL	SLUDGE	OTHER	TAT	CONTAINER: #	TYPE	8015M GAS ☐ DIESEL ☐	602/8020 BTEX	418.1	TOTAL CR VI, Cr, Cd, Pb, Ni					SAMPLE CONDITION/ COMMENTS:
3/5 11	9/3/93	3PM	(F (3))		X			Norm 41	1	G				X					Please Note CR VI MUST
#100			3 6		X					G				X					BE PERFORMED WITHIN
#20			3 1		X									X					24 HOURS OF SAMPLING
<#230 (RW)			3 1 1		X									X					
#40			3 1 4		X									X					
#230			3 2 C		X									X					
#4			3 1 1		X									X					
#10			3 1 2		X									X					
#60			3 1 3		X									X					
WASH WATER			3 1 4	X										X					

Relinquished By: (Signature and Printed Name) Received By: (Signature and Printed Name) Date: 6/4/93 Time: 8:30 AM

Relinquished By: (Signature and Printed Name) Rich Young Received By: (Signature and Printed Name) Date: 6/4/93 Time: 10:20 AM

Relinquished By: (Signature and Printed Name) Freddie Cook 6/21/93 Received By: (Signature and Printed Name) Date: Time:

SPECIAL INSTRUCTIONS:

SAMPLE DISPOSITION:
1. Samples returned to client? (YES) NO
2. Samples will not be stored over 30 days, unless additional storage time is requested.
3. Storage time requested: 40 days

By Robert Evangelista Date 9/4/93

DISTRIBUTION: WHITE, YELLOW, PINK TO SECO — GOLD TO CLIENT

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16525 Sherman Way, Suite C-11, Van Nuys, CA 91406 (818) 779-1844 FAX (818) 779-1843

URS Consultants	Client Project ID:	Alark Site	Sampled: Jun 4, 1993
4675 MacArthur Court, Suite 850			Received: Jun 4, 1993
Newport Beach, CA 92660	Sample Descript:	STLC Extract of a Soil, 13	Analyzed: Jun 9-16, 1993
Attention: Stephen Niou	Lab Number:	CF00535	Reported: Jun 18, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/L (ppm)	STLC Sample Result mg/L (ppm)
Cadmium	6010	1	100	0.05	N.D.
Chromium (VI)	7196	5	500	0.25	0.61
Chromium (Total)	6010	5	2,500	0.05	9.1
Lead	6010	5	1,000	0.05	2.4
Nickel	6010	20	2,000	0.05	0.06

Prior to analysis, the sample was extracted using the WET method as described in California Title 22, Section 66261, Appendix II.

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

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URS Consultants	Client Project ID:	Alark Site	Sampled: Jun 4, 1993
4675 MacArthur Court, Suite 850			Received: Jun 4, 1993
Newport Beach, CA 92660	Sample Descript:	STLC Extract of a Soil, 14	Analyzed: Jun 9-16, 1993
Attention: Stephen Niou	Lab Number:	CF00536	Reported: Jun 18, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/L (ppm)	STLC Sample Result mg/L (ppm)
Cadmium	6010	1	100	0.05	N.D.
Chromium (VI)	7196	5	500	0.5	3.2
Chromium (Total)	6010	5	2,500	0.05	20
Lead	6010	5	1,000	0.05	0.34
Nickel	6010	20	2,000	0.05	0.13

Prior to analysis, the sample was extracted using the WET method as described in California Title 22, Section 66261, Appendix II.

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

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URS Consultants	Client Project ID:	Alark Site	Sampled: Jun 4, 1993
4675 MacArthur Court, Suite 850			Received: Jun 4, 1993
Newport Beach, CA 92660	Sample Descript:	STLC Extract of a Soil, 15	Analyzed: Jun 9-16, 1993
Attention: Stephen Niou	Lab Number:	CF00537	Reported: Jun 18, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/L (ppm)	STLC Sample Result mg/L (ppm)
Cadmium	6010	1	100	0.05	0.31
Chromium (VI)	7196	5	500	0.025	0.054
Chromium (Total)	6010	5	2,500	0.05	170
Lead	6010	5	1,000	0.05	1.1
Nickel	6010	20	2,000	0.05	1.2

Prior to analysis, the sample was extracted using the WET method as described in California Title 22, Section 66261, Appendix II.

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

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URS Consultants	Client Project ID:	Alark Site	Sampled: Jun 4, 1993
4675 MacArthur Court, Suite 850			Received: Jun 4, 1993
Newport Beach, CA 92660	Sample Descript:	STLC Extract of a Soil, 16	Analyzed: Jun 9-16, 1993
Attention: Stephen Niou	Lab Number:	CF00538	Reported: Jun 18, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/L (ppm)	STLC Sample Result mg/L (ppm)
Cadmium	6010	1	100	0.05	N.D.
Chromium (VI)	7196	5	500	0.5	N.D.
Chromium (Total)	6010	5	2,500	0.05	7.6
Lead	6010	5	1,000	0.05	0.46
Nickel	6010	20	2,000	0.05	N.D.

Prior to analysis, the sample was extracted using the WET method as described in California Title 22, Section 66261, Appendix II.

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

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URS Consultants	Client Project ID:	Alark Site	Sampled: Jun 4, 1993
4675 MacArthur Court, Suite 850			Received: Jun 4, 1993
Newport Beach, CA 92660	Sample Descript:	STLC Extract of a Soil, 17	Analyzed: Jun 9-17, 1993
Attention: Stephen Niou	Lab Number:	CF00539	Reported: Jun 18, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/L (ppm)	STLC Sample Result mg/L (ppm)
Cadmium	6010	1	100	0.05	N.D.
Chromium (VI)	7196	5	500	0.025	0.36
Chromium (Total)	6010	5	2,500	0.05	18
Lead	6010	5	1,000	0.05	0.13
Nickel	6010	20	2,000	0.05	0.15

Prior to analysis, the sample was extracted using the WET method as described in California Title 22, Section 66261, Appendix II.

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

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URS Consultants	Client Project ID:	Alark Site	Sampled: Jun 4, 1993
4675 MacArthur Court, Suite 850			Received: Jun 4, 1993
Newport Beach, CA 92660	Sample Descript:	STLC Extract of a Soil, 18	Analyzed: Jun 9-17, 1993
Attention: Stephen Niou	Lab Number:	CF00540	Reported: Jun 18, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/L (ppm)	STLC Sample Result mg/L (ppm)
Cadmium	6010	1	100	0.05	0.19
Chromium (VI)	7196	5	500	5.0	N.D.
Chromium (Total)	6010	5	2,500	0.05	120
Lead	6010	5	1,000	0.05	0.58
Nickel	6010	20	2,000	0.05	0.97

Prior to analysis, the sample was extracted using the WET method as described in California Title 22, Section 66261, Appendix II.

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

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URS Consultants	Client Project ID:	Alark Site	Sampled: Jun 4, 1993
4675 MacArthur Court, Suite 850			Received: Jun 4, 1993
Newport Beach, CA 92660	Sample Descript:	Water, 19	Analyzed: Jun 4-17, 1993
Attention: Stephen Niou	Lab Number:	CF00541	Reported: Jun 18, 1993

Analyte	EPA Method	Detection Limit mg/L (ppm)	Sample Result mg/L (ppm)
Cadmium	6010	0.005	1.8
Chromium (VI)	7196	0.025	0.06
Chromium (Total)	6010	0.5	630
Lead	7421	1.0	19
Nickel	6010	0.05	1.4

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
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URS Consultants	Client Project ID:	Alark Site	Sampled: Jun 4, 1993
4675 MacArthur Court, Suite 850			Received: Jun 4, 1993
Newport Beach, CA 92660	Sample Descript:	Water, 20	Analyzed: Jun 4-17, 1993
Attention: Stephen Niou	Lab Number:	CF00542	Reported: Jun 18, 1993

Analyte	EPA Method	Detection Limit mg/L (ppm)	Sample Result mg/L (ppm)
Cadmium	6010	0.005	N.D.
Chromium (VI)	7196	0.025	N.D.
Chromium (Total)	6010	0.005	0.57
Lead	7421	0.005	N.D.
Nickel	6010	0.05	N.D.

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
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URS Consultants	Client Project ID:	Alark Site	Sampled: Jun 4, 1993
4675 MacArthur Court, Suite 850			Received: Jun 4, 1993
Newport Beach, CA 92660	Sample Descript:	Sludge, 21	Analyzed: Jun 4-18, 1993
Attention: Stephen Niou	Lab Number:	CF00543	Reported: Jun 18, 1993

Analyte	EPA Method	Detection Limit mg/Kg (ppm)	Sample Result mg/Kg (ppm)
Cadmium	6010	0.1	2.7
Chromium (VI)	7196	0.025	0.24
Chromium (Total)	6010	5.0	1.100
Lead	6010	1.0	33
Nickel	6010	0.5	2.9

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

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URS Consultants	Client Project ID:	Alark Site	Sampled: Jun 4, 1993
4675 MacArthur Court, Suite 850			Received: Jun 4, 1993
Newport Beach, CA 92660	Sample Descript:	STLC Extract of a Sludge, 21	Analyzed: Jun 9-17, 1993
Attention: Stephen Niou	Lab Number:	CF00543	Reported: Jun 18, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/L (ppm)	Detection Limit mg/L (ppm)	STLC Sample Result mg/L (ppm)
Cadmium	6010	1	100	0.05	0.52
Chromium (VI)	7196	5	500	0.025	N.D.
Chromium (Total)	6010	5	2,500	0.05	250
Lead	6010	5	1,000	0.05	1.8
Nickel	6010	20	2,000	0.05	0.93

Prior to analysis, the sample was extracted using the WET method as described in California Title 22, Section 66261, Appendix II.

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

Del Mar Analytical

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16525 Sherman Way, Suite C-11, Van Nuys, CA 91406 (818) 779-1844 FAX (818) 779-1843

URS Consultants	Client Project ID:	Alark Site	Sampled: Jun 4, 1993
4675 MacArthur Court, Suite 850			Received: Jun 4, 1993
Newport Beach, CA 92660	Sample Descript:	Soil, 22	Analyzed: Jun 7-16, 1993
Attention: Stephen Niou	Lab Number:	CF00544	Reported: Jun 18, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/Kg (ppm)	TTLC Sample Result mg/Kg (ppm)
Antimony	6010	15	500	5.0	10
Arsenic	6010	5	500	1.0	N.D.
Barium	6010	100	10,000	0.5	86
Beryllium	6010	0.75	75	0.1	0.2
Cadmium	6010	1	100	0.1	5.1
Chromium (VI)	7196	5	500	0.25	N.D.
Chromium (Total)	6010	5	2,500	0.5	N.D.
Cobalt	6010	80	8,000	0.5	2,400
Copper	6010	25	2,500	0.5	6.9
Lead	6010	5	1,000	1.0	98
Mercury	7471	0.2	20	0.075	56
Molybdenum	6010	350	3,500	0.5	N.D.
Nickel	6010	20	2,000	0.5	N.D.
Selenium	6010	1	100	1.0	16
Silver	6010	5	500	0.5	N.D.
Thallium	6010	7	700	5.0	N.D.
Vanadium	6010	24	2,400	0.5	9.1
Zinc	6010	250	5,000	0.5	66

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

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URS Consultants	Client Project ID:	Alark Site	Sampled:	Jun 4, 1993
4675 MacArthur Court, Suite 850			Received:	Jun 4, 1993
Newport Beach, CA 92660	Sample Descript:	Water, 19	Analyzed:	Jun 8, 1993
Attention: Stephen Niou	Lab Number:	CF00541	Reported:	Jun 18, 1993

LABORATORY ANALYSIS

Analyte	EPA Method	Detection Limit mg/L (ppm)	Sample Result mg/L (ppm)
Acidity	305.1	2.0	170,000
Alkalinity	310.1	2.0	N.D.
pH (pH units)	150.1	N.A.	0.0

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

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16525 Sherman Way, Suite C-11, Van Nuys, CA 91406 (818) 779-1844 FAX (818) 779-1843

URS Consultants	Client Project ID:	Alark Site	Sampled:	Jun 4, 1993
4675 MacArthur Court, Suite 850			Received:	Jun 4, 1993
Newport Beach, CA 92660	Sample Descript:	Water, 20	Analyzed:	Jun 8, 1993
Attention: Stephen Niou	Lab Number:	CF00542	Reported:	Jun 18, 1993

LABORATORY ANALYSIS

Analyte	EPA Method	Detection Limit mg/L (ppm)	Sample Result mg/L (ppm)
Acidity	305.1	2.0	N.D.
Alkalinity	310.1	2.0	220

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

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URS Consultants	Client Project ID:	Alark Site	Sampled: Jun 4, 1993
4675 MacArthur Court, Suite 850			Received: Jun 4, 1993
Newport Beach, CA 92660	Sample Descript:	Sludge, 21	Analyzed: Jun 16, 1993
Attention: Stephen Niou	Lab Number:	CF00543	Reported: Jun 18, 1993

LABORATORY ANALYSIS

Analyte	EPA Method	Detection Limit	Sample Result
Percent Solids (%)	160.3	N.A.	15

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

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URS Consultants
4675 MacArthur Court, Suite 850
Newport Beach, CA 92660
Attention: Stephen Niou

Method Blank

Analyzed: Jun 9-17, 1993
Reported: Jun 18, 1993
Matrix: Soil

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/L (ppm)	STLC Sample Result mg/L (ppm)
Cadmium	6010	1	100	0.05	N.D.
Chromium (VI)	7196	5	500	0.025	N.D.
Chromium (Total)	6010	5	2,500	0.05	N.D.
Lead	6010	5	1,000	0.05	N.D.
Nickel	6010	20	2,000	0.05	N.D.

Prior to analysis, the sample was extracted using the WET method as described in California Title 22, Section 66261, Appendix II.

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

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URS Consultants
4675 MacArthur Court, Suite 850
Newport Beach, CA 92660
Attention: Stephen Niou

Method Blank

Analyzed: Jun 4-18, 1993
Reported: Jun 18, 1993
Matrix: Water

Analyte	EPA Method	Detection Limit mg/L (ppm)	Sample Result mg/L (ppm)
Cadmium	6010	0.005	N.D.
Chromium (VI)	7196	0.025	N.D.
Chromium (Total	7191	0.005	N.D.
Lead	7421	0.005	N.D.
Nickel	6010	0.05	N.D.

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

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URS Consultants
4675 MacArthur Court, Suite 850
Newport Beach, CA 92660
Attention: Stephen Niou

Method Blank

Analyzed: Jun 4-18, 1993
Reported: Jun 18, 1993
Matrix: Water

Analyte	EPA Method	Detection Limit mg/L (ppm)	Sample Result mg/L (ppm)
Cadmium	6010	0.005	N.D.
Chromium (VI)	7196	0.025	N.D.
Chromium (Total)	6010	0.005	N.D.
Lead	6010	0.005	N.D.
Nickel	6010	0.05	N.D.

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

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URS Consultants
4675 MacArthur Court, Suite 850
Newport Beach, CA 92660
Attention: Stephen Niou

Method Blank

Analyzed: Jun 9-17, 1993
Reported: Jun 18, 1993
Matrix: Water

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/L (ppm)	Detection Limit mg/L (ppm)	STLC Sample Result mg/L (ppm)
Cadmium	6010	1	100	0.05	N.D.
Chromium (VI)	7196	5	500	0.025	N.D.
Chromium (Total)	7191	5	2,500	0.05	N.D.
Lead	7421	5	1,000	0.05	N.D.
Nickel	6010	20	2,000	0.05	N.D.

Prior to analysis, the sample was extracted using the WET method as described in California Title 22, Section 66261, Appendix II.

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

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URS Consultants
4675 MacArthur Court, Suite 850
Newport Beach, CA 92660
Attention: Stephen Niou

Method Blank

Analyzed: Jun 7-16, 1993
Reported: Jun 18, 1993
Matrix: Soil

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/Kg (ppm)	TTLC Sample Result mg/Kg (ppm)
Antimony	6010	15	500	5.0	N.D.
Arsenic	6010	5	500	1.0	N.D.
Barium	6010	100	10,000	0.5	N.D.
Beryllium	6010	0.75	75	0.1	N.D.
Cadmium	6010	1	100	0.1	N.D.
Chromium (VI)	7196	5	500	0.25	N.D.
Chromium (Total)	6010	5	2,500	0.5	N.D.
Cobalt	6010	80	8,000	0.5	N.D.
Copper	6010	25	2,500	0.5	N.D.
Lead	6010	5	1,000	1.0	N.D.
Mercury	7471	0.2	20	0.075	N.D.
Molybdenum	6010	350	3,500	0.5	N.D.
Nickel	6010	20	2,000	0.5	N.D.
Selenium	6010	1	100	1.0	N.D.
Silver	6010	5	500	0.5	N.D.
Thallium	6010	7	700	5.0	N.D.
Vanadium	6010	24	2,400	0.5	N.D.
Zinc	6010	250	5,000	0.5	N.D.

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

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URS Consultants	Client Project ID:	Alark Site	Sampled: Jun 4, 1993
4675 MacArthur Court, Suite 850			Received: Jun 4, 1993
Newport Beach, CA 92660	Sample Descript:	Soil, 13	Analyzed: Jun 7-16, 1993
Attention: Stephen Niou	Lab Number:	CF00535	Reported: Jun 18, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/Kg (ppm)	TTLC Sample Result mg/Kg (ppm)
Cadmium	6010	1	100	0.1	0.7
Chromium (VI)	7196	5	500	5.0	95
Chromium (Total)	6010	5	2,500	0.5	190
Lead	6010	5	1,000	1.0	59
Nickel	6010	20	2,000	0.5	2.1

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

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16525 Sherman Way, Suite C-11, Van Nuys, CA 91406 (818) 779-1844 FAX (818) 779-1843

URS Consultants	Client Project ID:	Alark Site	Sampled: Jun 4, 1993
4675 MacArthur Court, Suite 850			Received: Jun 4, 1993
Newport Beach, CA 92660	Sample Descript:	Soil, 14	Analyzed: Jun 7-16, 1993
Attention: Stephen Niou	Lab Number:	CF00536	Reported: Jun 18, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/Kg (ppm)	TTLC Sample Result mg/Kg (ppm)
Cadmium	6010	1	100	0.1	N.D.
Chromium (VI)	7196	5	500	5.0	73
Chromium (Total)	6010	5	2,500	0.5	350
Lead	6010	5	1,000	1.0	30
Nickel	6010	20	2,000	0.5	4.8

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

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16535 Sherman Way, Suite C-11, Van Nuys, CA 91406 (818) 779-1844 FAX (818) 779-1843

URS Consultants	Client Project ID:	Alark Site	Sampled: Jun 4, 1993
4675 MacArthur Court, Suite 850			Received: Jun 4, 1993
Newport Beach, CA 92660	Sample Descript:	Soil, 15	Analyzed: Jun 7-16, 1993
Attention: Stephen Niou	Lab Number:	CF00537	Reported: Jun 18, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/Kg (ppm)	TTLC Sample Result mg/Kg (ppm)
Cadmium	6010	1	100	0.1	3.3
Chromium (VI)	7196	5	500	0.25	N.D.
Chromium (Total)	6010	5	2,500	0.5	1,500
Lead	6010	5	1,000	1.0	51
Nickel	6010	20	2,000	0.5	14

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

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Laboratory Director

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URS Consultants
4675 MacArthur Court, Suite 850
Newport Beach, CA 92660
Attention: Stephen Niou

Client Project ID: Alark Site
Sample Descript: Soil, 16
Lab Number: CF00538

Sampled: Jun 4, 1993
Received: Jun 4, 1993
Analyzed: Jun 7-16, 1993
Reported: Jun 18, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/Kg (ppm)	TTLC Sample Result mg/Kg (ppm)
Cadmium	6010	1	100	0.1	0.2
Chromium (VI)	7196	5	500	5.0	12
Chromium (Total)	6010	5	2,500	0.5	130
Lead	6010	5	1,000	1.0	130
Nickel	6010	20	2,000	0.5	1.3

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

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16525 Sherman Way, Suite C-11, Van Nuys, CA 91406 (818) 779-1844 FAX (818) 779-1843

URS Consultants	Client Project ID:	Alark Site	Sampled: Jun 4, 1993
4675 MacArthur Court, Suite 850			Received: Jun 4, 1993
Newport Beach, CA 92660	Sample Descript:	Soil, 17	Analyzed: Jun 7-16, 1993
Attention: Stephen Niou	Lab Number:	CF00539	Reported: Jun 18, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/Kg (ppm)	TTLC Sample Result mg/Kg (ppm)
Cadmium	6010	1	100	0.1	0.6
Chromium (VI)	7196	5	500	5.0	35
Chromium (Total)	6010	5	2,500	0.5	360
Lead	6010	5	1,000	1.0	18
Nickel	6010	20	2,000	0.5	6.1

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

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16525 Sherman Way, Suite C-11, Van Nuys, CA 91406 (818) 779-1844 FAX (818) 779-1843

URS Consultants	Client Project ID:	Alark Site	Sampled: Jun 4, 1993
4675 MacArthur Court, Suite 850			Received: Jun 4, 1993
Newport Beach, CA 92660	Sample Descript:	Soil, 18	Analyzed: Jun 7-16, 1993
Attention: Stephen Niou	Lab Number:	CF00540	Reported: Jun 18, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/Kg (ppm)	TTLC Sample Result mg/Kg (ppm)
Cadmium	6010	1	100	0.1	3.3
Chromium (VI)	7196	5	500	0.25	N.D.
Chromium (Total)	6010	5	2,500	0.5	1,300
Lead	6010	5	1,000	1.0	65
Nickel	6010	20	2,000	0.5	13

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

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QC DATA REPORT

METHOD Metals
Instrument: ICP
Matrix: SOIL

Date: 6/15/93

SAMPLE # CF00551

Analyte	R1	SP	MS	MSD	PR1	PR2	RPD
	ppb	ppb	ppb	ppb	%	%	%
Cadmium	0	1000	925	930	93%	93%	0.5%
Chromium	734	1000	1831	1800	110%	107%	1.7%
Copper	770	1000	2024	1928	125%	116%	4.9%
Lead	462	1000	1424	1427	96%	97%	0.2%
Nickel	501	1000	1449	1404	95%	90%	3.2%
Vanadium	2417	1000	3624	3610	121%	119%	0.4%
Zinc	2447	1000	3646	3446	120%	100%	5.6%

R1..... Result of Sample Analysis
Sp..... Spike Concentration Added to Sample
MS..... Matrix Spike Result
MSD..... Matrix Spike Duplicate Result
PR1..... Percent Recovery of MS; ((MS-R1) / SP) X 100
PR2..... Percent Recovery of MSD; ((MSD-R1) / SP) X 100
RPD..... Relative Percent Difference; ((MS-MSD)/(MS+MSD)/2)) X

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16525 Sherman Way, Suite C-11, Van Nuys, CA 91406 (818) 779-1844 FAX (818) 779-1843

QC DATA REPORT

EPA METHOD: 3060/7196
matrix: soil

DATE: 6/7/93

SAMPLE # Blank

Analyte	R1	Sp	MS	MSD	PR1	PR2	RPD	MEAN PR
	ppm	ppm	ppm	ppm	%	%	%	%
Chromium +6	0	0.2	0.154	0.141	77%	71%	8.8%	74%

Definition of Terms:

R1..... Result of Sample Analysis

Sp..... Spike Concentration Added to Sample

MS..... Matrix Spike Result

MSD..... Matrix Spike Duplicate Result

PR1..... Percent Recovery of MS; (MS-R1) / SP X 100

PR2..... Percent Recovery of MSD; ((MSD-R1) / SP) X 100

RPD..... Relative Percent Difference; ((MS-MSD)/(MS+MSD)/2)) X 100

Del Mar Analytical

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#-05

CHAIN OF CUSTODY AND ANALYSIS REQUEST

DATE: 6/4/93 PAGE 1 OF 1
FILE NO. ____ LAB NO. ____

REMARKS: #5/E3

CLIENT NAME: URS Consultants
PROJECT NAME: Alrack Site PROJECT NO. P.O. NO.
ADDRESS: Newport Beach CA
PROJECT MANAGER: Stephen Niou PHONE #: 714 660 7683 FAX #: 714 660 7677
SAMPLER NAME: Robert Enyelbrta (Printed) Robert Evangelista (Signature)

TAT (Analytical Turn Around Time) 0 = Same Day; 1 = 24 Hour; 2 = 48 Hour; (Etc.)

CONTAINER TYPES: B = Brass, G = Glass, P = Plastic, V = Voa Vial, O = Other:

ANALYSES REQUESTED:

SAMPLE NO.	DATE SAMPLED	TIME SAMPLED	SAMPLE DESCRIPTION	MATRIX: WATER	MATRIX: SOIL	MATRIX: SLUDGE	MATRIX: OTHER	TAT	CONTAINER: #	CONTAINER: TYPE	8015M GAS ☐ DIESEL ☐	602/8020 BTEX	~~418.1~~ CAM 17 Metals	CAL-WET Cr VI, Cr, Cd, Pb, Ni	Total Cr VI, Cr, Cd, Pb, Ni	Acidity/Alkalinity	pH	% total moisture on solids	SAMPLE CONDITION/ COMMENTS:
13	6/4/93	10^00 A			X			Norm	1	G				X	X				Please note:
14	6/4/93	10^30 A			X				1	G				X	X				CR VI must
15	6/4/93	10^30 A			X				1	G				X	X				be analyzed
16	6/4/93	12^30 P			X				1	G				X	X				within 24 hrs
17	6/4/93	12^30 P			X				1	G				X	X				of sampling
18	6/4/93	12^30 P			X				1	G				X	X				Cr VI, Cr, Cd, Pb, Ni MS + MSD
19	6/4/93	1 P		X					1	G					X	X	X		
20	6/4/93	1 P		X					1	G					X	X			Cr VI, Cr, Cd, Pb, Ni MS & MSD
21	6/4/93	1 P				X			1	G				X	X			X	Mix well immediately before taking sample
22	6/4/93	1 P			X				1	G			X						

Relinquished By: (Signature and Printed Name) Robert Evangelista for
Received By: (Signature and Printed Name) Robert Evangelista Marco Lemus
Date: 2:31 PM Time: 6/4/93

Relinquished By: (Signature and Printed Name)
Received By: (Signature and Printed Name)
Date: Time:

Relinquished By: (Signature and Printed Name) Fidela Dunb 6/21/93
Received By: (Signature and Printed Name)
Date Time

SPECIAL INSTRUCTIONS: Recieved Intact & cool

SAMPLE DISPOSITION:
1. Samples returned to client? YES NO
2. Samples will not be stored over 30 days, unless additional storage time is requested.
3. Storage time requested ____ days
By ____ Date

DISTRIBUTION: WHITE, YELLOW, PINK TO SECO ... GOLD TO CLIENT

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URS Consultants
4675 MacArthur Court, Suite 850
Newport Beach, CA 92660
Attention: Stephen Niou

Client Project ID: Alark Site
Sample Descript: Soil, 1
Lab Number: CF00499

Sampled: Jun 3, 1993
Received: Jun 4, 1993
Analyzed: Jun 7-16, 1993
Reported: Jun 18, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/Kg (ppm)	TTLC Sample Result mg/Kg (ppm)
Cadmium	6010	1	100	0.1	0.2
Chromium (VI)	7196	5	500	2.0	14
Chromium (Total	6010	5	2,500	0.5	150
Lead	6010	5	1,000	1.0	45
Nickel	6010	20	2,000	0.5	1.7

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

Del Mar Analytical

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URS Consultants	Client Project ID:	Alark Site	Sampled: Jun 3, 1993
4675 MacArthur Court, Suite 850			Received: Jun 4, 1993
Newport Beach, CA 92660	Sample Descript:	Soil, 2	Analyzed: Jun 7-16, 1993
Attention: Stephen Niou	Lab Number:	CF00500	Reported: Jun 18, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/Kg (ppm)	TTLC Sample Result mg/Kg (ppm)
Cadmium	6010	1	100	0.1	N.D.
Chromium (VI)	7196	5	500	5.0	84
Chromium (Total	6010	5	2,500	0.5	410
Lead	6010	5	1,000	1.0	28
Nickel	6010	20	2,000	0.5	5.8

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

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URS Consultants
4675 MacArthur Court, Suite 850
Newport Beach, CA 92660
Attention: Stephen Niou

Client Project ID: Alark Site
Sample Descript: Soil, 3
Lab Number: CF00501

Sampled: Jun 3, 1993
Received: Jun 4, 1993
Analyzed: Jun 4-16, 1993
Reported: Jun 18, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/Kg (ppm)	TTLC Sample Result mg/Kg (ppm)
Cadmium	6010	1	100	0.1	2.6
Chromium (VI)	7196	5	500	2.5	46
Chromium (Total	6010	5	2,500	5.0	1,900
Lead	6010	5	1,000	1.0	37
Nickel	6010	20	2,000	0.5	24

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

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URS Consultants	Client Project ID:	Alark Site	Sampled: Jun 3, 1993
4675 MacArthur Court, Suite 850			Received: Jun 4, 1993
Newport Beach, CA 92660	Sample Descript:	Soil, 4	Analyzed: Jun 7-16, 1993
Attention: Stephen Niou	Lab Number:	CF00502	Reported: Jun 18, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/Kg (ppm)	TTLC Sample Result mg/Kg (ppm)
Cadmium	6010	1	100	0.1	4.0
Chromium (VI)	7196	5	500	5.0	57
Chromium (Total	6010	5	2,500	0.5	470
Lead	6010	5	1,000	1.0	94
Nickel	6010	20	2,000	0.5	2.4

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

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URS Consultants	Client Project ID:	Alark Site	Sampled: Jun 3, 1993
4675 MacArthur Court, Suite 850			Received: Jun 4, 1993
Newport Beach, CA 92660	Sample Descript:	Soil, 5	Analyzed: Jun 7-16, 1993
Attention: Stephen Niou	Lab Number:	CF00503	Reported: Jun 18, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/Kg (ppm)	TTLC Sample Result mg/Kg (ppm)
Cadmium	6010	1	100	0.1	4.4
Chromium (VI)	7196	5	500	5.0	57
Chromium (Total	6010	5	2,500	0.5	800
Lead	6010	5	1,000	1.0	110
Nickel	6010	20	2,000	0.5	8.5

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

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URS Consultants	Client Project ID:	Alark Site	Sampled: Jun 3, 1993
4675 MacArthur Court, Suite 850			Received: Jun 4, 1993
Newport Beach, CA 92660	Sample Descript:	Soil, 6	Analyzed: Jun 7-16, 1993
Attention: Stephen Niou	Lab Number:	CF00504	Reported: Jun 18, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/Kg (ppm)	TTLC Sample Result mg/Kg (ppm)
Cadmium	6010	1	100	0.1	13
Chromium (VI)	7196	5	500	25	470
Chromium (Total	6010	5	2,500	5.0	2,300
Lead	6010	5	1,000	1.0	120
Nickel	6010	20	2,000	0.5	21

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

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URS Consultants	Client Project ID:	Alark Site	Sampled: Jun 4, 1993
4675 MacArthur Court, Suite 850			Received: Jun 4, 1993
Newport Beach, CA 92660	Sample Descript:	Soil, 7	Analyzed: Jun 7-16, 1993
Attention: Stephen Niou	Lab Number:	CF00505	Reported: Jun 18, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/Kg (ppm)	TTLC Sample Result mg/Kg (ppm)
Cadmium	6010	1	100	0.1	0.5
Chromium (VI)	7196	5	500	5.0	21
Chromium (Total	6010	5	2,500	0.5	320
Lead	6010	5	1,000	1.0	45
Nickel	6010	20	2,000	0.5	1.7

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

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URS Consultants	Client Project ID:	Alark Site	Sampled: Jun 4, 1993
4675 MacArthur Court, Suite 850			Received: Jun 4, 1993
Newport Beach, CA 92660	Sample Descript:	Soil, 8	Analyzed: Jun 7-16, 1993
Attention: Stephen Niou	Lab Number:	CF00506	Reported: Jun 18, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/Kg (ppm)	TTLC Sample Result mg/Kg (ppm)
Cadmium	6010	1	100	0.1	0.6
Chromium (VI)	7196	5	500	5.0	160
Chromium (Total	6010	5	2,500	0.5	410
Lead	6010	5	1,000	1.0	25
Nickel	6010	20	2,000	0.5	6.5

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

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URS Consultants
4675 MacArthur Court, Suite 850
Newport Beach, CA 92660
Attention: Stephen Niou

Client Project ID: Alark Site
Sample Descript: Soil, 9
Lab Number: CF00507

Sampled: Jun 4, 1993
Received: Jun 4, 1993
Analyzed: Jun 7-16, 1993
Reported: Jun 18, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/Kg (ppm)	TTLC Sample Result mg/Kg (ppm)
Cadmium	6010	1	100	0.1	2.2
Chromium (VI)	7196	5	500	0.25	N.D.
Chromium (Total	6010	5	2,500	5.0	1,500
Lead	6010	5	1,000	1.0	38
Nickel	6010	20	2,000	0.5	19

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

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URS Consultants	Client Project ID:	Alark Site	Sampled: Jun 4, 1993
4675 MacArthur Court, Suite 850			Received: Jun 4, 1993
Newport Beach, CA 92660	Sample Descript:	Soil, 10	Analyzed: Jun 7-16, 1993
Attention: Stephen Niou	Lab Number:	CF00508	Reported: Jun 18, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/Kg (ppm)	TTLC Sample Result mg/Kg (ppm)
Cadmium	6010	1	100	0.1	3.8
Chromium (VI)	7196	5	500	15	120
Chromium (Total	6010	5	2,500	0.5	620
Lead	6010	5	1,000	1.0	70
Nickel	6010	20	2,000	0.5	2.7

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

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URS Consultants	Client Project ID:	Alark Site	Sampled: Jun 4, 1993
4675 MacArthur Court, Suite 850			Received: Jun 4, 1993
Newport Beach, CA 92660	Sample Descript:	Soil, 11	Analyzed: Jun 7-16, 1993
Attention: Stephen Niou	Lab Number:	CF00509	Reported: Jun 18, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/Kg (ppm)	TTLC Sample Result mg/Kg (ppm)
Cadmium	6010	1	100	0.1	3.9
Chromium (VI)	7196	5	500	15	160
Chromium (Total	6010	5	2,500	0.5	710
Lead	6010	5	1,000	1.0	110
Nickel	6010	20	2,000	0.5	7.4

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

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URS Consultants	Client Project ID:	Alark Site	Sampled: Jun 4, 1993
4675 MacArthur Court, Suite 850			Received: Jun 4, 1993
Newport Beach, CA 92660	Sample Descript:	Soil, 12	Analyzed: Jun 7-16, 1993
Attention: Stephen Niou	Lab Number:	CF00510	Reported: Jun 18, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/Kg (ppm)	TTLC Sample Result mg/Kg (ppm)
Cadmium	6010	1	100	0.1	15
Chromium (VI)	7196	5	500	25	240
Chromium (Total	6010	5	2,500	5.0	2,300
Lead	6010	5	1,000	1.0	120
Nickel	6010	20	2,000	0.5	26

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

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URS Consultants
4675 MacArthur Court, Suite 850
Newport Beach, CA 92660
Attention: Robert Evangelista

Client Project ID: #4564213
Alark Hard Chrome
Sample Descript: Soil, TS-3@ 4' Homogenized
Lab Number: CE02576

Sampled: May 25, 1993
Received: May 26, 1993
Analyzed: ay 26-27, 1993
Reported: May 27, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/Kg (ppm)	TTLC Sample Result mg/Kg (ppm)
Cadmium	6010	1	100	0.1	8.9
Chromium (VI)	7196	5	500	2.5	18
Chromium (Total)	6010	560	2,500	0.5	250
Lead	6010	5	1,000	1.0	260
Nickel	6010	20	2,000	0.5	86

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
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URS Consultants
4675 MacArthur Court, Suite 850
Newport Beach, CA 92660
Attention: Robert Evangelista

Client Project ID: #4564213
Alark Hard Chrome
Sample Descript: Soil, CR-2/CR-3@ 5' Homogenized
Lab Number: CE02577

Sampled: May 25, 1993
Received: May 26, 1993
Analyzed: ay 26-27, 1993
Reported: May 27, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/Kg (ppm)	TTLC Sample Result mg/Kg (ppm)
Cadmium	6010	1	100	0.1	0.44
Chromium (VI)	7196	5	500	2.5	6.3
Chromium (Total)	6010	560	2,500	0.5	73
Lead	6010	5	1,000	1.0	12
Nickel	6010	20	2,000	0.5	11

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
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URS Consultants
4675 MacArthur Court, Suite 850
Newport Beach, CA 92660
Attention: Robert Evangelista

Client Project ID: #4564213
Alark Hard Chrome
Sample Descript: Soil, TS-1@ 5' Homogenized
Lab Number: CE02578

Sampled: May 25, 1993
Received: May 26, 1993
Analyzed: ay 26-27, 1993
Reported: May 27, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/Kg (ppm)	TTLC Sample Result mg/Kg (ppm)
Cadmium	6010	1	100	0.1	21
Chromium (VI)	7196	5	500	0.25	0.28
Chromium (Total)	6010	560	2,500	0.5	4,500
Lead	6010	5	1,000	1.0	150
Nickel	6010	20	2,000	0.5	19

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

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URS Consultants
4675 MacArthur Court, Suite 850
Newport Beach, CA 92660
Attention: Robert Evangelista

Client Project ID: #4564213
Alark Hard Chrome
Sample Descript: Soil, TS-1@ 30' Homogenized
Lab Number: CE02579

Sampled: May 25, 1993
Received: May 26, 1993
Analyzed: ay 26-27, 1993
Reported: May 27, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/Kg (ppm)	TTLC Sample Result mg/Kg (ppm)
Cadmium	6010	1	100	0.1	0.27
Chromium (VI)	7196	5	500	0.25	0.29
Chromium (Total)	6010	560	2,500	0.5	2,000
Lead	6010	5	1,000	1.0	3.3
Nickel	6010	20	2,000	0.5	7.1

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

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URS Consultants
4675 MacArthur Court, Suite 850
Newport Beach, CA 92660
Attention: Robert Evangelista

Client Project ID: #4564213
Alark Hard Chrome
Sample Descript: STLC Extract of a Soil, TS-3@ 4'
Homogenized
Lab Number: CE02576

Sampled: May 25, 1993
Received: May 26, 1993
Analyzed: May 28, 1993
Reported: May 28, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/L (ppm)	STLC Sample Result mg/L (ppm)
Cadmium	6010	1	100	0.05	0.80
Chromium (VI)	7196	5	500	0.25	3.9
Chromium (Total)	6010	560	2,500	0.05	11
Lead	6010	5	1,000	0.05	15
Nickel	6010	20	2,000	0.05	3.2

Prior to analysis, the sample was extracted using the WET method as described in California Title 22, Section 66261, Appendix II.

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

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URS Consultants
4675 MacArthur Court, Suite 850
Newport Beach, CA 92660
Attention: Robert Evangelista

Client Project ID: #4564213
Alark Hard Chrome
Sample Descript: STLC Extract of a Soil, CR-2/CR-3@ 5'
Homogenized
Lab Number: CE02577

Sampled: May 25, 1993
Received: May 26, 1993
Analyzed: May 28, 1993
Reported: May 28, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/L (ppm)	STLC Sample Result mg/L (ppm)
Cadmium	6010	1	100	0.05	N.D.
Chromium (VI)	7196	5	500	0.25	2.3
Chromium (Total)	6010	560	2,500	0.05	3.1
Lead	6010	5	1,000	0.05	1.6
Nickel	6010	20	2,000	0.05	0.19

Prior to analysis, the sample was extracted using the WET method as described in California Title 22, Section 66261, Appendix II.

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

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URS Consultants
4675 MacArthur Court, Suite 850
Newport Beach, CA 92660
Attention: Robert Evangelista

Client Project ID: #4564213
Alark Hard Chrome
Sample Descript: STLC Extract of a Soil, TS-1@ 5'
Homogenized
Lab Number: CE02578

Sampled: May 25, 1993
Received: May 26, 1993
Analyzed: May 28, 1993
Reported: May 28, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/L (ppm)	STLC Sample Result mg/L (ppm)
Cadmium	6010	1	100	0.05	1.7
Chromium (VI)	7196	5	500	0.025	0.15
Chromium (Total)	6010	560	2,500	0.05	220
Lead	6010	5	1,000	0.05	5.3
Nickel	6010	20	2,000	0.05	0.40

Prior to analysis, the sample was extracted using the WET method as described in California Title 22, Section 66261, Appendix II.

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

Del Mar Analytical

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16525 Sherman Way, Suite C-11, Van Nuys, CA 91406 (818) 779-1844 FAX (818) 779-1843

URS Consultants
4675 MacArthur Court, Suite 850
Newport Beach, CA 92660
Attention: Robert Evangelista

Client Project ID: #4564213
Alark Hard Chrome
Sample Descript: STLC Extract of a Soil, TS-1@ 30'
Homogenized
Lab Number: CE02579

Sampled: May 25, 1993
Received: May 26, 1993
Analyzed: May 28, 1993
Reported: May 28, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/L (ppm)	STLC Sample Result mg/L (ppm)
Cadmium	6010	1	100	0.05	N.D.
Chromium (VI)	7196	5	500	0.025	0.12
Chromium (Total)	6010	560	2,500	0.05	190
Lead	6010	5	1,000	0.05	0.070
Nickel	6010	20	2,000	0.05	0.18

Prior to analysis, the sample was extracted using the WET method as described in California Title 22, Section 66261, Appendix II.

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

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URS Consultants	Client Project ID:	Alark Site	Sampled: Jun 3, 1993
4675 MacArthur Court, Suite 850			Received: Jun 4, 1993
Newport Beach, CA 92660	Sample Descript:	STLC Extract of a Soil, 1	Analyzed: Jun 9-17, 1993
Attention: Stephen Niou	Lab Number:	CF00499	Reported: Jun 18, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/L (ppm)	STLC Sample Result mg/L (ppm)
Cadmium	6010	1	100	0.05	0.08
Chromium (VI)	7196	5	500	0.5	0.9
Chromium (Total	6010	5	2,500	0.05	5.1
Lead	6010	5	1,000	0.05	0.16
Nickel	6010	20	2,000	0.05	N.D.

Prior to analysis, the sample was extracted using the WET method as described in California Title 22, Section 66261, Appendix II.

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

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URS Consultants	Client Project ID:	Alark Site	Sampled: Jun 3, 1993
4675 MacArthur Court, Suite 850			Received: Jun 4, 1993
Newport Beach, CA 92660	Sample Descript:	STLC Extract of a Soil, 2	Analyzed: Jun 9-17, 1993
Attention: Stephen Niou	Lab Number:	CF00500	Reported: Jun 18, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/L (ppm)	STLC Sample Result mg/L (ppm)
Cadmium	6010	1	100	0.05	N.D.
Chromium (VI)	7196	5	500	0.5	3.7
Chromium (Total	6010	5	2,500	0.05	16
Lead	6010	5	1,000	0.05	0.20
Nickel	6010	20	2,000	0.05	0.16

Prior to analysis, the sample was extracted using the WET method as described in California Title 22, Section 66261, Appendix II.

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

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16525 Sherman Way, Suite C-11, Van Nuys, CA 91406 (818) 779-1844 FAX (818) 779-1843

URS Consultants	Client Project ID:	Alark Site	Sampled: Jun 3, 1993
4675 MacArthur Court, Suite 850			Received: Jun 4, 1993
Newport Beach, CA 92660	Sample Descript:	STLC Extract of a Soil, 3	Analyzed: Jun 9-17, 1993
Attention: Stephen Niou	Lab Number:	CF00501	Reported: Jun 18, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/L (ppm)	STLC Sample Result mg/L (ppm)
Cadmium	6010	1	100	0.05	0.32
Chromium (VI)	7196	5	500	5.0	36
Chromium (Total	6010	5	2,500	0.05	180
Lead	6010	5	1,000	0.05	0.76
Nickel	6010	20	2,000	0.05	0.94

Prior to analysis, the sample was extracted using the WET method as described in California Title 22, Section 66261, Appendix II.

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

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URS Consultants	Client Project ID:	Alark Site	Sampled: Jun 3, 1993
4675 MacArthur Court, Suite 850			Received: Jun 4, 1993
Newport Beach, CA 92660	Sample Descript:	STLC Extract of a Soil, 4	Analyzed: Jun 9-17, 1993
Attention: Stephen Niou	Lab Number:	CF00502	Reported: Jun 18, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/L (ppm)	STLC Sample Result mg/L (ppm)
Cadmium	6010	1	100	0.05	0.28
Chromium (VI)	7196	5	500	0.5	5.2
Chromium (Total	6010	5	2,500	0.05	14
Lead	6010	5	1,000	0.05	1.9
Nickel	6010	20	2,000	0.05	0.08

Prior to analysis, the sample was extracted using the WET method as described in California Title 22, Section 66261, Appendix II.

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

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URS Consultants
4675 MacArthur Court, Suite 850
Newport Beach, CA 92660
Attention: Stephen Niou

Client Project ID: Alark Site
Sample Descript: STLC Extract of a Soil, 5
Lab Number: CF00503

Sampled: Jun 3, 1993
Received: Jun 4, 1993
Analyzed: Jun 9-17, 1993
Reported: Jun 18, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/L (ppm)	STLC Sample Result mg/L (ppm)
Cadmium	6010	1	100	0.05	0.49
Chromium (VI)	7196	5	500	1.0	5.7
Chromium (Total	6010	5	2,500	0.05	25
Lead	6010	5	1,000	0.05	6.5
Nickel	6010	20	2,000	0.05	0.17

Prior to analysis, the sample was extracted using the WET method as described in California Title 22, Section 66261, Appendix II.

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

Del Mar Analytical

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URS Consultants
4675 MacArthur Court, Suite 850
Newport Beach, CA 92660
Attention: Stephen Niou

Client Project ID: Alark Site
Sample Descript: STLC Extract of a Soil, 6
Lab Number: CF00504

Sampled: Jun 3, 1993
Received: Jun 4, 1993
Analyzed: Jun 9-17, 1993
Reported: Jun 18, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/L (ppm)	STLC Sample Result mg/L (ppm)
Cadmium	6010	1	100	0.05	1.7
Chromium (VI)	7196	5	500	5.0	61
Chromium (Total	6010	5	2,500	0.05	96
Lead	6010	5	1,000	0.05	3.6
Nickel	6010	20	2,000	0.05	0.67

Prior to analysis, the sample was extracted using the WET method as described in California Title 22, Section 66261, Appendix II.

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

Del Mar Analytical

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16525 Sherman Way, Suite C-11, Van Nuys, CA 91406 (818) 779-1844 FAX (818) 779-1843

URS Consultants	Client Project ID:	Alark Site	Sampled: Jun 4, 1993
4675 MacArthur Court, Suite 850			Received: Jun 4, 1993
Newport Beach, CA 92660	Sample Descript:	STLC Extract of a Soil, 7	Analyzed: Jun 9-17, 1993
Attention: Stephen Niou	Lab Number:	CF00505	Reported: Jun 18, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/L (ppm)	STLC Sample Result mg/L (ppm)
Cadmium	6010	1	100	0.05	0.06
Chromium (VI)	7196	5	500	0.5	1.6
Chromium (Total	6010	5	2,500	0.05	8.2
Lead	6010	5	1,000	0.05	0.92
Nickel	6010	20	2,000	0.05	0.06

Prior to analysis, the sample was extracted using the WET method as described in California Title 22, Section 66261, Appendix II.

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

CF00499.URG <19>

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URS Consultants
4675 MacArthur Court, Suite 850
Newport Beach, CA 92660
Attention: Stephen Niou

Client Project ID: Alark Site
Sample Descript: STLC Extract of a Soil, 8
Lab Number: CF00506

Sampled: Jun 4, 1993
Received: Jun 4, 1993
Analyzed: Jun 9-17, 1993
Reported: Jun 18, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/L (ppm)	STLC Sample Result mg/L (ppm)
Cadmium	6010	1	100	0.05	0.05
Chromium (VI)	7196	5	500	0.5	1.2
Chromium (Total	6010	5	2,500	0.05	17
Lead	6010	5	1,000	0.05	0.79
Nickel	6010	20	2,000	0.05	0.17

Prior to analysis, the sample was extracted using the WET method as described in California Title 22, Section 66261, Appendix II.

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

Del Mar Analytical

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URS Consultants	Client Project ID:	Alark Site	Sampled: Jun 4, 1993
4675 MacArthur Court, Suite 850			Received: Jun 4, 1993
Newport Beach, CA 92660	Sample Descript:	STLC Extract of a Soil, 9	Analyzed: Jun 9-17, 1993
Attention: Stephen Niou	Lab Number:	CF00507	Reported: Jun 18, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/L (ppm)	STLC Sample Result mg/L (ppm)
Cadmium	6010	1	100	0.05	0.24
Chromium (VI)	7196	5	500	0.5	1.0
Chromium (Total	6010	5	2,500	0.05	150
Lead	6010	5	1,000	0.05	0.64
Nickel	6010	20	2,000	0.05	0.73

Prior to analysis, the sample was extracted using the WET method as described in California Title 22, Section 66261, Appendix II.

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

CF00499.URS <21>

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16525 Sherman Way, Suite C-11, Van Nuys, CA 91406 (818) 779-1844 FAX (818) 779-1843

URS Consultants	Client Project ID:	Alark Site	Sampled: Jun 4, 1993
4675 MacArthur Court, Suite 850			Received: Jun 4, 1993
Newport Beach, CA 92660	Sample Descript:	STLC Extract of a Soil, 10	Analyzed: Jun 9-17, 1993
Attention: Stephen Niou	Lab Number:	CF00508	Reported: Jun 18, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/L (ppm)	STLC Sample Result mg/L (ppm)
Cadmium	6010	1	100	0.05	0.33
Chromium (VI)	7196	5	500	0.5	9.6
Chromium (Total	6010	5	2,500	0.05	17
Lead	6010	5	1,000	0.05	1.2
Nickel	6010	20	2,000	0.05	0.10

Prior to analysis, the sample was extracted using the WET method as described in California Title 22, Section 66261, Appendix II.

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

Del Mar Analytical

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URS Consultants
4675 MacArthur Court, Suite 850
Newport Beach, CA 92660
Attention: Stephen Niou

Client Project ID: Alark Site
Sample Descript: STLC Extract of a Soil, 11
Lab Number: CF00509

Sampled: Jun 4, 1993
Received: Jun 4, 1993
Analyzed: Jun 9-17, 1993
Reported: Jun 18, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/L (ppm)	STLC Sample Result mg/L (ppm)
Cadmium	6010	1	100	0.05	0.44
Chromium (VI)	7196	5	500	2.0	14
Chromium (Total	6010	5	2,500	0.05	23
Lead	6010	5	1,000	0.05	4.4
Nickel	6010	20	2,000	0.05	0.18

Prior to analysis, the sample was extracted using the WET method as described in California Title 22, Section 66261, Appendix II.

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

CF00499.URS <23>

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URS Consultants
4675 MacArthur Court, Suite 850
Newport Beach, CA 92660
Attention: Stephen Niou

Client Project ID: Alark Site
Sample Descript: STLC Extract of a Soil, 12
Lab Number: CF00510

Sampled: Jun 4, 1993
Received: Jun 4, 1993
Analyzed: Jun 9-17, 1993
Reported: Jun 18, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/L (ppm)	STLC Sample Result mg/L (ppm)
Cadmium	6010	1	100	0.05	1.6
Chromium (VI)	7196	5	500	5.0	57
Chromium (Total	6010	5	2,500	0.05	94
Lead	6010	5	1,000	0.05	3.9
Nickel	6010	20	2,000	0.05	0.66

Prior to analysis, the sample was extracted using the WET method as described in California Title 22, Section 66261, Appendix II.

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

CF00499.URS <24>

Del Mar Analytical

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URS Consultants
4675 MacArthur Court, Suite 850
Newport Beach, CA 92660
Attention: Stephen Niou

Method Blank

Analyzed: Jun 4-16, 1993
Reported: Jun 18, 1993
Matrix: Soil

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/Kg (ppm)	TTLC Sample Result mg/Kg (ppm)
Cadmium	6010	1	100	0.1	N.D.
Chromium (VI)	7196	5	500	0.25	N.D.
Chromium (Total	6010	5	2,500	0.5	N.D.
Lead	6010	0.75	75	1.0	N.D.
Nickel	6010	20	2,000	0.5	N.D.

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

CF00499.URS <25>

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URS Consultants
4675 MacArthur Court, Suite 850
Newport Beach, CA 92660
Attention: Stephen Niou

Method Blank

Analyzed: Jun 9-17, 1993
Reported: Jun 18, 1993
Matrix: Soil

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/L (ppm)	STLC Sample Result mg/L (ppm)
Cadmium	6010	1	100	0.05	N.D.
Chromium (VI)	7196	5	500	0.025	N.D.
Chromium (Total	6010	5	2,500	0.05	N.D.
Lead	6010	5	1,000	0.05	N.D.
Nickel	6010	20	2,000	0.05	N.D.

Prior to analysis, the sample was extracted using the WET method as described in California Title 22, Section 66261, Appendix II.

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

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QC DATA REPORT

EPA METHOD: 3060/7196
matrix: soil

DATE: 6/7/93

SAMPLE # Blank

Analyte	R1	Sp	MS	MSD	PR1	PR2	RPD	MEAN PR
	ppm	ppm	ppm	ppm	%	%	%	%
Chromium +6	0	0.2	0.154	0.141	77%	71%	8.8%	74%

Definition of Terms:

R1..... Result of Sample Analysis

Sp..... Spike Concentration Added to Sample

MS..... Matrix Spike Result

MSD..... Matrix Spike Duplicate Result

PR1..... Percent Recovery of MS; (MS-R1) / SP X 100

PR2..... Percent Recovery of MSD; ((MSD-R1) / SP) X 100

RPD..... Relative Percent Difference; ((MS-MSD)/(MS+MSD)/2)) X 100

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QC DATA REPORT

METHOD Metals
Instrument: ICP
Date: 6/15/93 Matrix: SOIL

SAMPLE # CF00551

Analyte	R1	SP	MS	MSD	PR1	PR2	RPD
	ppb	ppb	ppb	ppb	%	%	%
Cadmium	0	1000	925	930	93%	93%	0.5%
Chromium	734	1000	1831	1800	110%	107%	1.7%
Copper	770	1000	2024	1928	125%	116%	4.9%
Lead	462	1000	1424	1427	96%	97%	0.2%
Nickel	501	1000	1449	1404	95%	90%	3.2%
Vanadium	2417	1000	3624	3610	121%	119%	0.4%
Zinc	2447	1000	3646	3446	120%	100%	5.6%

R1..... Result of Sample Analysis
Sp..... Spike Concentration Added to Sample
MS..... Matrix Spike Result
MSD..... Matrix Spike Duplicate Result
PR1..... Percent Recovery of MS; ((MS-R1) / SP) X 100
PR2..... Percent Recovery of MSD; ((MSD-R1) / SP) X 100
RPD..... Relative Percent Difference; ((MS-MSD)/(MS+MSD)/2)) X

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CHAIN OF CUSTODY AND ANALYSIS REQUEST

DATE 6/4/93 PAGE 1 OF 2

FILE NO. _____ LAB NO. _____

CLIENT NAME: URS Consultants

PROJECT NAME: Alark site PROJECT NO. P.O. NO.

ADDRESS: Newport Beach CA

PROJECT MANAGER: Stephen Niou PHONE #: 7146107683 FAX #: 7146607677

SAMPLER NAME: Robert Evangelista (Printed) Robert Evangelista (Signature)

TAT (Analytical Turn Around Time) 0 = Same Day; 1 = 24 Hour; 2 = 48 Hour; (Etc.)

CONTAINER TYPES: B = Brass, G = Glass, P = Plastic, V = Voa Vial, O = Other:

ANALYSES REQUESTED:

REMARKS: #S/E 1

INTACT & RM TEMP

SAMPLE NO.	DATE SAMPLED	TIME SAMPLED	SAMPLE DESCRIPTION	MATRIX: WATER	SOIL	SLUDGE	OTHER	TAT	CONTAINER: #	TYPE	8015M GAS ☐ DIESEL ☐	602/8020 BTEX	418.1	Total Cr VI, Cr, Cd, Ni, Pb	CAL WET Cr VI, Cr, Cd, Ni, Pb				SAMPLE CONDITION/ COMMENTS:
1	6/3/93	9P			X			NORMAL	1	G				X	X				PLEASE NOTE EXTRACTION
2	6/3/93	9P			X				1	G				X	X				AND RUN TIMES FOR Cr VI
3	6/3/93	9P			X				1	G				X	X				ANALYSES
4	6/3/93	11P			X				1	G				X	X				Cr VI MUST BE RUN WITHIN
5	6/3/93	11P			X				1	G				X	X				24 HOURS
6	6/3/93	11P			X				1	G				X	X				AFTER SAMPLING
7	6/4/93	12 30P			X				1	G				X	X				
8	6/4/93	12 30P			X				1	G				X	X				
9	6/4/93	12 30P			X				1	G				X	X				
10	6/4/93	8 AM			X				1	G				X	X				

Relinquished By: (Signature and Printed Name) Robert Evangelista — Received By: (Signature and Printed Name) Rick Young — Date 6/4/93 — Time 8 30 AM

Relinquished By: (Signature and Printed Name) Rick Young — Received By: (Signature and Printed Name) Monica Romero — Date 6/4/93 — Time 10:20

Relinquished By: (Signature and Printed Name) Linda Davis 6/21/93 — Received By: (Signature and Printed Name) — Date — Time

SPECIAL INSTRUCTIONS:

SAMPLE DISPOSITION:

1. Samples returned to client? (YES) NO
2. Samples will not be stored over 30 days, unless additional storage time is requested.
3. Storage time requested 40 days

By Robert Evangelista Date 6/4/93

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CHAIN OF CUSTODY AND ANALYSIS REQUEST

DATE 6/4/93 PAGE 2 OF 2
FILE NO. _____ LAB NO. _____

CLIENT NAME: URS Consultants
PROJECT NAME: Alark Site PROJECT NO. P.O. NO.
ADDRESS: Newport Beach CA
PROJECT MANAGER: Stephen Nico PHONE #: 714 660 7613 FAX #: 714 660 7677
SAMPLER NAME: Robert Bumgardner (Printed) Robert Engelke (Signature)
TAT (Analytical Turn Around Time) 0 = Same Day; 1 = 24 Hour; 2 = 48 Hour; (Etc.)
CONTAINER TYPES: B = Brass, G = Glass, P = Plastic, V = Voa Vial, O = Other:

ANALYSES REQUESTED:

REMARKS: #5/E2

SAMPLE NO.	DATE SAMPLED	TIME SAMPLED	SAMPLE DESCRIPTION	MATRIX: WATER	SOIL	SLUDGE	OTHER	TAT	CONTAINER: #	TYPE	8015M GAS ☐ DIESEL ☐	602/8020 BTEX	418.1	Total Cr, Cd, Pb, Ni	Cal WET Cr VI, Cr, Cd, Pb, Ni				SAMPLE CONDITION/ COMMENTS:
11	6/3/93	8AM			X			Nor MAL	1	G				X	X				INTACT & RM Temp
12	6/4/93	8AM			X				1	G				X	X				

Relinquished By (Signature and Printed Name) Robert Engelke Received By (Signature and Printed Name) Rich Vours Date 6/4/93 Time 830 AM
Relinquished By (Signature and Printed Name) Rich Vours Received By (Signature and Printed Name) Monica Lemus Date 6/4/93 Time 16:20
Relinquished By (Signature and Printed Name) Fidela Cuch 6/21/93 Received By (Signature and Printed Name) Date Time

SPECIAL INSTRUCTIONS:

SAMPLE DISPOSITION:
1. Samples returned to client? (YES) NO
2. Samples will not be stored over 30 days, unless additional storage time is requested.
3. Storage time requested: 40 days
By Robert Engelke Date 8/4/93

Del Mar Analytical

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URS Consultants
4675 MacArthur Court, Suite 850
Newport Beach, CA 92660
Attention: Stephen Niou

Client Project ID: Alark Hard Chrome
Sample Descript Soil, UTS
Lab Number: CF00045

Sampled: Jun 1, 1993
Received: Jun 1, 1993
Analyzed: June 2-14, 1993
Reported: Jun 14, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/Kg (ppm)	TTLC Sample Result mg/Kg (ppm)
Antimony	6010	15	500	5.0	N.D.
Arsenic	6010	5	500	1.0	N.D.
Barium	6010	100	10,000	0.5	96
Beryllium	6010	0.75	75	0.1	N.D.
Cadmium	6010	1	100	0.1	9.2
Chromium (VI)	7196	5	500	0.25	2,100
Chromium (Total)	6010	560	2,500	0.5	2,800
Cobalt	6010	80	8,000	0.5	5.9
Copper	6010	25	2,500	0.5	43
Lead	6010	5	1,000	1.0	84
Mercury	7471	0.2	20	0.075	N.D.
Molybdenum	6010	350	3,500	0.5	N.D.
Nickel	6010	20	2,000	0.5	12
Selenium	6010	1	100	1.0	N.D.
Silver	6010	5	500	0.5	N.D.
Thallium	6010	7	700	5.0	N.D.
Vanadium	6010	24	2,400	0.5	25
Zinc	6010	250	5,000	0.5	63

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

Del Mar Analytical

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URS Consultants	Client Project ID:	Alark Hard Chrome	Sampled:	Jun 1, 1993
4675 MacArthur Court, Suite 850			Received:	Jun 1, 1993
Newport Beach, CA 92660	Sample Descript:	STLC Extract of a Soil, UTS	Analyzed:	Jun 7, 1993
Attention: Stephen Niou	Lab Number:	CF00045	Reported:	Jun 14, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/L (ppm)	STLC Sample Result mg/L (ppm)
Cadmium	6010	1	100	0.05	0.97
Chromium (VI)	7196	5	500	0.025	27
Chromium (Total)	6010	560	2,500	0.05	210
Lead	6010	5	1,000	0.05	3.9
Nickel	6010	20	2,000	0.05	0.30

Prior to analysis, the sample was extracted using the WET method as described in California Title 22, Section 66261, Appendix II.

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Kevin Draper
Project Manager

Del Mar Analytical

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URS Consultants
4675 MacArthur Court, Suite 850
Newport Beach, CA 92660
Attention: Stephen Niou

Method Blank

Analyzed: June 2-14, 1993
Reported: Jun 14, 1993
Matrix: Soil

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/Kg (ppm)	TTLC Sample Result mg/Kg (ppm)
Antimony	6010	15	500	5.0	N.D.
Arsenic	6010	5	500	1.0	N.D.
Barium	6010	100	10,000	0.5	N.D.
Beryllium	6010	0.75	75	0.1	N.D.
Cadmium	6010	1	100	0.1	N.D.
Chromium (VI)	7196	5	500	0.25	N.D.
Chromium (Total)	6010	560	2,500	0.5	N.D.
Cobalt	6010	80	8,000	0.5	N.D.
Copper	6010	25	2,500	0.5	N.D.
Lead	6010	5	1,000	1.0	N.D.
Mercury	7471	0.2	20	0.075	N.D.
Molybdenum	6010	350	3,500	0.5	N.D.
Nickel	6010	20	2,000	0.5	N.D.
Selenium	6010	1	100	1.0	N.D.
Silver	6010	5	500	0.5	N.D.
Thallium	6010	7	700	5.0	N.D.
Vanadium	6010	24	2,400	0.5	N.D.
Zinc	6010	250	5,000	0.5	N.D.

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Kevin Draper
Project Manager

Del Mar Analytical

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13567

CHAIN OF CUSTODY/REQUEST FOR ANALYSIS

Client Name Address
URS Consultants Inc
4675 MacArthur Court, Suite 850
Newport Beach CA 92660

Project: Black Hart Chrome

Project Manager
~~Robert Runcorn~~ / RAC
Stephen Niou

Sampler: Robert Runcorn

Analysis Required: Chrome VI (Method 7196) + TDS + MSD; Cr, Cd, Pb, Ni (Method 7000/6010); CAM 17 metals (Method 7000/6010); Cal WET — STLC EXTRACTION; Cr, Cd, Pb, Ni, Zn Cal WET Extraction (EXTRACT)

Sample Description	Sample Matrix	Container Type	# of Cont	Sampling Date/Time	Preservatives	Chrome VI + TDS + MSD	Cr, Cd, Pb, Ni (Method 7000/6010)	CAM 17 metals (Method 7000/6010)	Cal WET — STLC EXTRACTION	Cr, Cd, Pb, Ni, Zn Cal WET Extraction (EXTRACT)				Special Instructions
UTS	Soil	8oz Glass	1	6/1/93 11:00AM	None	X	X	X	X	X				NEED 24HR TAT FOR Cr VI ONLY NEED MS + MSD FOR Cr VI ONLY

Relinquished By: Robert Runcorn — Date/Time: 6/1/93 11:30 AM

Relinquished By — Date/Time

Relinquished By — Date/Time

Note: Samples will be disposed of after 30 days

Received By — Date/Time

Received By — Date/Time

Received in Lab By: Kimi Martel — Date/Time: 6/1/93 11:30am

Turnaround Time (check)
Same day ____ 72 hours ____
24 hours ____ 5 days ____
48 hours ____ normal ____

Sample Integrity (check)
intact X on ice ____

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URS Consultants
4675 MacArthur Court, Suite 850
Newport Beach, CA 92660
Attention: Stephen Niou

Client Project ID: Alark Site/ #NB-93-P-0107
Hard Chrome
Sample Descript: Soil, UTS
Lab Number: CH00140

Sampled: Jun 1, 1993
Received: Jun 1, 1993
Analyzed: Aug 4, 1993
Reported: Aug 6, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/Kg (ppm)	TTLC Sample Result mg/Kg (ppm)
Cadmium	6010	1	100	0.10	8.6
Chromium (VI)	7196	5	500	25	480
Chromium (Total)	6010	560	2500	0.50	3,300
Lead	6010	5	1000	1.0	73
Nickel	6010	20	2000	0.50	14

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

Del Mar Analytical

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URS Consultants
4675 MacArthur Court, Suite 850
Newport Beach, CA 92660
Attention: Stephen Niou

Method Blank

Analyzed: Aug 4, 1993
Reported: Aug 6, 1993
Matrix: Soil

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/Kg (ppm)	TTLC Sample Result mg/Kg (ppm)
Cadmium	6010	1	100	0.10	N.D.
Chromium (VI)	7196	5	500	0.25	N.D.
Chromium (Total)	6010	560	2500	0.50	N.D.
Lead	6010	5	1000	1.0	N.D.
Nickel	6010	20	2000	0.50	N.D.

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

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URS Consultants	Client Project ID:	Alark Site	Sampled:	Jun 2, 1993
4675 MacArthur Court, Suite 850			Received:	Jun 4, 1993
Newport Beach, CA 92660	Sample Descript:	STLC Extract of a Soil, FeSO4/Port 10%	Analyzed:	Jun 11-17, 1993
Attention: Stephen Niou	Lab Number:	CF00745	Reported:	Jun 18, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/L (ppm)	STLC Sample Result mg/L (ppm)
Cadmium	6010	1	100	0.05	0.52
Chromium (VI)	7196	5	500	0.5	4.7
Chromium (Total)	6010	5	2,500	0.05	130
Lead	6010	5	1,000	0.05	2.3
Nickel	6010	20	2,000	0.05	0.24

Prior to analysis, the sample was extracted using the WET method as described in California Title 22, Section 66261, Appendix II.

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

Del Mar Analytical

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URS Consultants	Client Project ID:	Alark Site	Sampled: Jun 2, 1993
4675 MacArthur Court, Suite 850			Received: Jun 4, 1993
Newport Beach, CA 92660	Sample Descript:	STLC Extract of a Soil, FeSO4/Port 10%/SS	Analyzed: Jun 11-17, 1993
Attention: Stephen Niou	Lab Number:	CF00746	Reported: Jun 18, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/L (ppm)	STLC Sample Result mg/L (ppm)
Cadmium	6010	1	100	0.05	0.49
Chromium (VI)	7196	5	500	1.0	2.4
Chromium (Total)	6010	5	2,500	0.05	130
Lead	6010	5	1,000	0.05	9.5
Nickel	6010	20	2,000	0.05	0.25

Prior to analysis, the sample was extracted using the WET method as described in California Title 22, Section 66261, Appendix II.

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

Del Mar Analytical

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URS Consultants	Client Project ID:	Alark Site	Sampled:	Jun 2, 1993
4675 MacArthur Court, Suite 850			Received:	Jun 4, 1993
Newport Beach, CA 92660	Sample Descript:	STLC Extract of a Soil, FeSO4/Port 40%	Analyzed:	Jun 11-17, 1993
Attention: Stephen Niou	Lab Number:	CF00747	Reported:	Jun 18, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/L (ppm)	STLC Sample Result mg/L (ppm)
Cadmium	6010	1	100	0.05	N.D.
Chromium (VI)	7196	5	500	0.5	2.0
Chromium (Total)	6010	5	2,500	0.05	62
Lead	6010	5	1,000	0.05	0.69
Nickel	6010	20	2,000	0.05	0.13

Prior to analysis, the sample was extracted using the WET method as described in California Title 22, Section 66261, Appendix II.

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

Del Mar Analytical

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URS Consultants	Client Project ID:	Alark Site	Sampled: Jun 2, 1993
4675 MacArthur Court, Suite 850			Received: Jun 4, 1993
Newport Beach, CA 92660	Sample Descript:	STLC Extract of a Soil, FeSO4/Port 40%/SS	Analyzed: Jun 11-17, 1993
Attention: Stephen Niou	Lab Number:	CF00748	Reported: Jun 18, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/L (ppm)	STLC Sample Result mg/L (ppm)
Cadmium	6010	1	100	0.05	N.D.
Chromium (VI)	7196	5	500	0.025	0.90
Chromium (Total)	6010	5	2,500	0.05	55
Lead	6010	5	1,000	0.05	0.36
Nickel	6010	20	2,000	0.05	0.15

Prior to analysis, the sample was extracted using the WET method as described in California Title 22, Section 66261, Appendix II.

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

Del Mar Analytical

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URS Consultants	Client Project ID:	Alark Site	Sampled: Jun 2, 1993
4675 MacArthur Court, Suite 850			Received: Jun 4, 1993
Newport Beach, CA 92660	Sample Descript:	STLC Extract of a Soil, FeSO4/FA 10%	Analyzed: Jun 11-17, 1993
Attention: Stephen Niou	Lab Number:	CF00749	Reported: Jun 18, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/L (ppm)	STLC Sample Result mg/L (ppm)
Cadmium	6010	1	100	0.05	0.53
Chromium (VI)	7196	5	500	2.5	59
Chromium (Total)	6010	5	2,500	0.05	140
Lead	6010	5	1,000	0.05	4.9
Nickel	6010	20	2,000	0.05	0.30

Prior to analysis, the sample was extracted using the WET method as described in California Title 22, Section 66261, Appendix II.

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

Del Mar Analytical

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16525 Sherman Way, Suite C-11, Van Nuys, CA 91406 (818) 779-1844 FAX (818) 779-1843

URS Consultants	Client Project ID:	Alark Site	Sampled: Jun 2, 1993
4675 MacArthur Court, Suite 850			Received: Jun 4, 1993
Newport Beach, CA 92660	Sample Descript:	STLC Extract of a Soil, FeSO4/FA 10%/SS	Analyzed: Jun 11-17, 1993
Attention: Stephen Niou	Lab Number:	CF00750	Reported: Jun 18, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/L (ppm)	STLC Sample Result mg/L (ppm)
Cadmium	6010	1	100	0.05	0.56
Chromium (VI)	7196	5	500	5.0	24
Chromium (Total)	6010	5	2,500	0.05	140
Lead	6010	5	1,000	0.05	5.7
Nickel	6010	20	2,000	0.05	0.28

Prior to analysis, the sample was extracted using the WET method as described in California Title 22, Section 66261, Appendix II.

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

Del Mar Analytical

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16525 Sherman Way, Suite C-11, Van Nuys, CA 91406 (818) 779-1844 FAX (818) 779-1843

URS Consultants	Client Project ID:	Alark Site	Sampled:	Jun 2, 1993
4675 MacArthur Court, Suite 850			Received:	Jun 4, 1993
Newport Beach, CA 92660	Sample Descript:	STLC Extract of a Soil, FeSO4/FA 40%	Analyzed:	Jun 11-17, 1993
Attention: Stephen Niou	Lab Number:	CF00751	Reported:	Jun 18, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/L (ppm)	STLC Sample Result mg/L (ppm)
Cadmium	6010	1	100	0.05	0.46
Chromium (VI)	7196	5	500	2.5	45
Chromium (Total)	6010	5	2,500	0.05	120
Lead	6010	5	1,000	0.05	3.2
Nickel	6010	20	2,000	0.05	0.38

Prior to analysis, the sample was extracted using the WET method as described in California Title 22, Section 66261, Appendix II.

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

Del Mar Analytical

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URS Consultants
4675 MacArthur Court, Suite 850
Newport Beach, CA 92660
Attention: Stephen Niou

Client Project ID: Alark Site
Sample Descript: STLC Extract of a Soil, FeSO4/FA 40%/SS
Lab Number: CF00752

Sampled: Jun 2, 1993
Received: Jun 4, 1993
Analyzed: Jun 11-17, 1993
Reported: Jun 18, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/L (ppm)	STLC Sample Result mg/L (ppm)
Cadmium	6010	1	100	0.05	0.52
Chromium (VI)	7196	5	500	2.5	54
Chromium (Total)	6010	5	2,500	0.05	78
Lead	6010	5	1,000	0.05	2.6
Nickel	6010	20	2,000	0.05	0.40

Prior to analysis, the sample was extracted using the WET method as described in California Title 22, Section 66261, Appendix II.

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

Del Mar Analytical

2852 Alton Ave., Irvine, CA 92714 (714) 261-1022 FAX (714) 261-1228
1014 E. Cooley Dr., Suite A, Colton, CA 92324 (909) 370-4667 FAX (909) 370-1046
16525 Sherman Way, Suite C 11, Van Nuys, CA 91406 (818) 779-1844 FAX (818) 779-1843

URS Consultants	Client Project ID:	Alark Site	Sampled: Jun 2, 1993
4675 MacArthur Court, Suite 850			Received: Jun 4, 1993
Newport Beach, CA 92660	Sample Descript:	STLC Extract of a Soil, ite/Port 10%	Analyzed: Jun 11-17, 1993
Attention: Stephen Niou	Lab Number:	CF00753	Reported: Jun 18, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/L (ppm)	STLC Sample Result mg/L (ppm)
Cadmium	6010	1	100	0.05	0.51
Chromium (VI)	7196	5	500	5.0	37
Chromium (Total)	6010	5	2,500	0.05	130
Lead	6010	5	1,000	0.05	2.0
Nickel	6010	20	2,000	0.05	0.24

Prior to analysis, the sample was extracted using the WET method as described in California Title 22, Section 66261, Appendix II.

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

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URS Consultants
4675 MacArthur Court, Suite 850
Newport Beach, CA 92660
Attention: Stephen Niou

Client Project ID: Alark Site
Sample Descript: STLC Extract of a Soil, ite/Port 10%/SS
Lab Number: CF00754

Sampled: Jun 2, 1993
Received: Jun 4, 1993
Analyzed: Jun 11-17, 1993
Reported: Jun 18, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/L (ppm)	STLC Sample Result mg/L (ppm)
Cadmium	6010	1	100	0.05	0.52
Chromium (VI)	7196	5	500	2.5	44
Chromium (Total)	6010	5	2,500	0.05	130
Lead	6010	5	1,000	0.05	1.8
Nickel	6010	20	2,000	0.05	0.25

Prior to analysis, the sample was extracted using the WET method as described in California Title 22, Section 66261, Appendix II.

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

CF00745.URS <10>

Del Mar Analytical

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16525 Sherman Way, Suite C-11, Van Nuys, CA 91406 (818) 779-1844 FAX (818) 779-1843

URS Consultants	Client Project ID:	Alark Site	Sampled: Jun 2, 1993
4675 MacArthur Court, Suite 850			Received: Jun 4, 1993
Newport Beach, CA 92660	Sample Descript:	STLC Extract of a Soil, ite/Port 40%	Analyzed: Jun 11-17, 1993
Attention: Stephen Niou	Lab Number:	CF00755	Reported: Jun 18, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/L (ppm)	STLC Sample Result mg/L (ppm)
Cadmium	6010	1	100	0.05	N.D.
Chromium (VI)	7196	5	500	0.5	2.5
Chromium (Total)	6010	5	2,500	0.05	69
Lead	6010	5	1,000	0.05	0.19
Nickel	6010	20	2,000	0.05	0.12

Prior to analysis, the sample was extracted using the WET method as described in California Title 22, Section 66261, Appendix II.

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

Del Mar Analytical

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URS Consultants	Client Project ID:	Alark Site	Sampled: Jun 2, 1993
4675 MacArthur Court, Suite 850			Received: Jun 4, 1993
Newport Beach, CA 92660	Sample Descript:	STLC Extract of a Soil, ite/Port 40%/SS	Analyzed: Jun 11-17, 1993
Attention: Stephen Niou	Lab Number:	CF00756	Reported: Jun 18, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/L (ppm)	STLC Sample Result mg/L (ppm)
Cadmium	6010	1	100	0.05	N.D.
Chromium (VI)	7196	5	500	0.5	1.7
Chromium (Total)	6010	5	2,500	0.05	63
Lead	6010	5	1,000	0.05	1.8
Nickel	6010	20	2,000	0.05	0.12

Prior to analysis, the sample was extracted using the WET method as described in California Title 22, Section 66261, Appendix II.

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

Del Mar Analytical

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URS Consultants	Client Project ID:	Alark Site	Sampled:	Jun 2, 1993
4675 MacArthur Court, Suite 850			Received:	Jun 4, 1993
Newport Beach, CA 92660	Sample Descript:	STLC Extract of a Soil, ite/FA 10%	Analyzed:	Jun 11-17, 1993
Attention: Stephen Niou	Lab Number:	CF0757	Reported:	Jun 18, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/L (ppm)	STLC Sample Result mg/L (ppm)
Cadmium	6010	1	100	0.05	0.54
Chromium (VI)	7196	5	500	5.0	100
Chromium (Total)	6010	5	2,500	0.05	130
Lead	6010	5	1,000	0.05	3.2
Nickel	6010	20	2,000	0.05	0.27

Prior to analysis, the sample was extracted using the WET method as described in California Title 22, Section 66261, Appendix II.

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

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URS Consultants	Client Project ID:	Alark Site	Sampled: Jun 2, 1993
4675 MacArthur Court, Suite 850			Received: Jun 4, 1993
Newport Beach, CA 92660	Sample Descript:	STLC Extract of a Soil, ite/FA 10%/SS	Analyzed: Jun 11-17, 1993
Attention: Stephen Niou	Lab Number:	CF0758	Reported: Jun 18, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/L (ppm)	STLC Sample Result mg/L (ppm)
Cadmium	6010	1	100	0.05	0.49
Chromium (VI)	7196	5	500	5.0	14
Chromium (Total)	6010	5	2,500	0.05	120
Lead	6010	5	1,000	0.05	2.4
Nickel	6010	20	2,000	0.05	0.27

Prior to analysis, the sample was extracted using the WET method as described in California Title 22, Section 66261, Appendix II.

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

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URS Consultants	Client Project ID:	Alark Site	Sampled:	Jun 2, 1993
4675 MacArthur Court, Suite 850			Received:	Jun 4, 1993
Newport Beach, CA 92660	Sample Descript:	STLC Extract of a Soil, ite/FA 40%	Analyzed:	Jun 11-17, 1993
Attention: Stephen Niou	Lab Number:	CF00759	Reported:	Jun 18, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/L (ppm)	STLC Sample Result mg/L (ppm)
Cadmium	6010	1	100	0.05	0.41
Chromium (VI)	7196	5	500	5.0	25
Chromium (Total)	6010	5	2,500	0.05	120
Lead	6010	5	1,000	0.05	2.7
Nickel	6010	20	2,000	0.05	0.37

Prior to analysis, the sample was extracted using the WET method as described in California Title 22, Section 66261, Appendix II.

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

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URS Consultants	Client Project ID:	Alark Site	Sampled: Jun 2, 1993
4675 MacArthur Court, Suite 850			Received: Jun 4, 1993
Newport Beach, CA 92660	Sample Descript:	STLC Extract of a Soil, ite/FA 40%/SS	Analyzed: Jun 11-17, 1993
Attention: Stephen Niou	Lab Number:	CF00760	Reported: Jun 18, 1993

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/L (ppm)	STLC Sample Result mg/L (ppm)
Cadmium	6010	1	100	0.05	0.42
Chromium (VI)	7196	5	500	2.5	95
Chromium (Total)	6010	5	2,500	0.05	120
Lead	6010	5	1,000	0.05	3.3
Nickel	6010	20	2,000	0.05	0.32

Prior to analysis, the sample was extracted using the WET method as described in California Title 22, Section 66261, Appendix II.

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

CF00745,URS <16>

Del Mar Analytical

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URS Consultants
4675 MacArthur Court, Suite 850
Newport Beach, CA 92660
Attention: Stephen Niou

Method Blank

Analyzed: Jun 11-17, 1993
Reported: Jun 18, 1993
Matrix: Soil

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/L (ppm)	STLC Sample Result mg/L (ppm)
Cadmium	6010	1	100	0.05	N.D.
Chromium (VI)	7196	5	500	0.025	N.D.
Chromium (Total)	6010	5	2,500	0.05	N.D.
Lead	6010	5	1,000	0.05	N.D.
Nickel	6010	20	2,000	0.05	N.D.

Prior to analysis, the sample was extracted using the WET method as described in California Title 22, Section 66261, Appendix II.

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

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U144 14

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CHAIN OF CUSTODY/REQUEST FOR ANALYSIS

Client Name/Address	Project
URS Consultants Inc Newport Beach, CA	Alaska Site
Project Manager	**Sampler**
Stephen Nitao	Robert Evangelista

Sample Description	Sample Matrix	Container Type	# of Cont	Sampling Date/Time	Preservatives	CAM WET (STLC) Cr VI, Cr, Cd, Pb, Ni	Analysis Required	Special Instructions
FeSO4/Port 10%	Immobilized Soil	Poly	1	6/2/93 eve	none	X		Do not run tests until 4 hours 11:55 PM 6/2/93
FeSO4/Port 10%/SS						X		
FeSO4/Port 40%						X		
FeSO4/Port 40%/SS						X		
FeSO4/FA 10%						X		
FeSO4/FA 10%/SS						X		
FeSO4/FA 40%						X		
FeSO4/FA 40%/SS						X		
Ite/Port 10%						X		
Ite/Port 10%/SS						X		
Ite/Port 40%						X		

Relinquished By	Date/Time	Received By	Date/Time
Robert A Evangelista	6/5/93 1230 PM		
Relinquished By	Date/Time	Received By	Date/Time
Freda Cunds	6/21/93		
Relinquished By	Date/Time	Received in Lab By	Date/Time
		Kim Martel	6/8/93 12:30

Note: Samples will be disposed of after 30 days

Turnaround Time: (check)
same day ____ 72 hours ____
24 hours ____ 5 days ____
48 hours ____ normal X

Sample Integrity: (check)
intact X on ice ____

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[illegible] California [illegible]140
(818) 779-1844
FAX (818) 779-1843

 20951

CHAIN OF CUSTODY/REQUEST FOR ANALYSIS

Client Name/Address	Project
URS Consultants 714 366 7676 Newport Beach, CA	Alaska Site
Project Manager	**Sampler**
Stephen Nico	Robert Evangelista

Sample Description	Sample Matrix	Container Type	# of Cont	Sampling Date/Time	Preservatives	Analysis Required: GI WET (STLC) CAT, Cr, Cd, Pb, Ni	Special Instructions
ITE/Post 40%/SS	Immobilized Soil	Poly	1	6/1/93 eve	None	X	Do not run TestAmerica after 11:53 PM 6/2/93
ITE/FA 10%	↓	↓	↓	↓	↓	X	
ITE/FA 10%/SS						X	
ITE/FA 40%						X	
ITE/FA 40%/SS						X	

Relinquished By	Date/Time	Received By	Date/Time
Robert Evangelista	6/2/93 1230 AM		
Relinquished By	Date/Time	Received By	Date/Time
Frederick Anders	6/21/93		
Relinquished By	Date/Time	Received in Lab By	Date/Time
			6/3/93 8:00

Note: Samples will be disposed of after 30 days

Turnaround Time (check)
same day ____ 72 hours ____
24 hours ____ 5 days ____
48 hours ____ normal ✓

Sample Integrity (check)
intact ✓ on ice ✓

Del Mar Analytical

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URS Consultants	Client Project ID:	Alark Site	Sampled: Jun 2, 1993
4675 MacArthur Court, Suite 850			Received: Jun 3, 1993
Newport Beach, CA 92660	Sample Descript:	Soil	Analyzed: Jun 4, 1993
Attention: Stephen Niou	First Sample #:	CF00294	Reported: Jun 17, 1993

LABORATORY ANALYSIS FOR: CHROMIUM VI (EPA 7196)

Laboratory Number	Sample Description	Detection Limit mg/Kg (ppm)	Sample Result mg/Kg (ppm)
CF00294	FeSO4-1	50	960
CF00295	FeSO4-2	50	940
CF00296	ite-1	50	920
CF00297	ite-3	50	1,100
CF00298	ite-3D	50	970

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

Del Mar Analytical

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URS Consultants
4675 MacArthur Court, Suite 850
Newport Beach, CA 92660
Attention: Stephen Niou

Method Blank

Analyzed: Jun 4, 1993
Reported: Jun 17, 1993
Matrix: Soil

LABORATORY ANALYSIS FOR: CHROMIUM VI (EPA 7196)

Laboratory Description	Detection Limit mg/Kg (ppm)	Sample Result mg/Kg (ppm)
Method Blank	0.25	N.D.

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

Del Mar Analytical

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QC DATA REPORT

EPA METHOD: 3060/7196
matrix: soil

DATE: 6/10/93

SAMPLE # Blank

Analyte	R1	Sp	MS	MSD	PR1	PR2	RPD	MEAN PR
	ppm	ppm	ppm	ppm	%	%	%	%
Chromium +6	0	0.2	0.17	0.16	85%	80%	6.1%	83%

Definition of Terms:

R1..... Result of Sample Analysis

Sp..... Spike Concentration Added to Sample

MS..... Matrix Spike Result

MSD..... Matrix Spike Duplicate Result

PR1..... Percent Recovery of MS; (MS-R1) / SP X 100

PR2..... Percent Recovery of MSD; ((MSD-R1) / SP) X 100

RPD..... Relative Percent Difference; ((MS-MSD)/(MS+MSD)/2)) X 100

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014413

CHAIN OF CUSTODY/REQUEST FOR ANALYSIS

Client Name/Address: URS Consultants 714 660 Newport Beach, CA 7676

Project: Alark ~~Hunsel Chrome~~ Site

Project Manager: Stephen Niou

Sampler: Robert Engelstad

Analysis Required: Cr VI

Sample Description	Sample Matrix	Container Type	# of Cont	Sampling Date/Time	Preservatives	Cr VI	Special Instructions
FeSOy-1	Soil	(JAR)	1	6/2/93 eve	none	X	PLEASE NOTE EXTRACTION TIME ON Cr VI
FeSOy-2	"	"	"	"	"	X	
ite-1	"	"	"	"	"	X	
ite-3	"	"	"	"	"	X	
ite-3D	"	"	"	"	"	X	

Relinquished By: Robert Engelstad Date/Time: 6/3/93 12:30 AM

Relinquished By: Fidelia Geeds Date/Time: 6/3/93

Relinquished By: Date/Time:

Note: Samples will be disposed of after 30 days

Received By: Date/Time:

Received By: Date/Time:

Received in Lab By: Marco Lemus Date/Time: 6/3/93 12:30AM

Turnaround Time: (check)
same day ____ 72 hours ____
24 hours ____ 5 days ____
48 hours ____ normal X

Sample Integrity: (check)
intact ✓ on ice ✓

Del Mar Analytical

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FAX (818) 779-1843

014413

CHAIN OF CUSTODY/REQUEST FOR ANALYSIS

#213-745-6372
#20908

Client Name/Address	Project
URS Consultants 714 66[illegible] Newport Beach, CA 7676	Alark ~~Hinkley~~ Chrome Site
Project Manager	**Sampler**
Stephen Niou	Robert Engelhardt

Sample Description	Sample Matrix	Container Type	# of Cont	Sampling Date/Time	Preservatives	Cr VI	Analysis Required	Special Instructions
FeSOy-1	Soil	(JAR)	1	6/2/93 eve	none	x		PLEASE NOTE EXTRACTION
FeSOy-2	↓	↓	↓	↓	↓	x		TIME ON Cr VI
ite-1.						x		
ite-3				10:30		x		
ite-3D				10:30		x		

(2)

Relinquished By:	Date/Time:	Received By:	Date/Time:
Robert Engelhardt	6/3/93 12:31 AM		
Relinquished By:	Date/Time:	Received By:	Date/Time:
Fidela Cuadra	6/3/93		
Relinquished By	Date/Time:	Received in Lab By:	Date/Time:

Note: Samples will be disposed of after 30 days

Turnaround Time: (check)

same day	____	72 hours	____
24 hours	____	5 days	____
48 hours	____	normal	X

Sample Integrity (check)

intact ____ on ice ____

Del Mar Analytical

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URS Consultants	Client Project ID: #4564213	Sampled: May 25, 1993
4675 MacArthur Court, Suite 850	Alark Hard Chrome	Received: May 26, 1993
Newport Beach, CA 92660	Sample Descript: Soil	Analyzed: ay 26-27, 1993
Attention: Robert Evangelista	First Sample #: CE02576	Reported: May 28, 1993

LABORATORY ANALYSIS FOR: SULFATE (EPA 300)

Laboratory Number	Sample Description	Detection Limit mg/Kg (ppm)	Sample Result mg/Kg (ppm)
CE02576	TS-3@ 4' Homogenized	50	340
CE02577	CR-2/CR-3@ 5' Homogenized	50	87
CE02578	TS-1@ 5' Homogenized	50	280
CE02579	TS-1@ 30' Homogenized	50	80

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

Del Mar Analytical

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URS Consultants
4675 MacArthur Court, Suite 850
Newport Beach, CA 92660
Attention: Robert Evangelista

Method Blank

Analyzed: ay 26-27, 1993
Reported: May 27, 1993
Matrix: Soil

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/Kg (ppm)	TTLC Sample Result mg/Kg (ppm)
Cadmium	6010	1	100	0.1	N.D.
Chromium (VI)	7196	5	500	0.25	N.D.
Chromium (Total)	6010	560	2,500	0.5	N.D.
Lead	6010	5	1,000	1.0	N.D.
Nickel	6010	20	2,000	0.5	N.D.

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

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16525 Sherman Way, Suite C-11, Van Nuys, CA 91406 (818) 779-1844 FAX (818) 779-1843

URS Consultants
4675 MacArthur Court, Suite 850
Newport Beach, CA 92660
Attention: Robert Evangelista

Method Blank

Analyzed: May 28, 1993
Reported: May 28, 1993
Matrix: Soil

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/L (ppm)	STLC Sample Result mg/L (ppm)
Cadmium	6010	1	100	0.05	N.D.
Chromium (VI)	7196	5	500	0.025	N.D.
Chromium (Total)	6010	560	2,500	0.05	N.D.
Lead	6010	5	1,000	0.05	N.D.
Nickel	6010	20	2,000	0.05	N.D.

Prior to analysis, the sample was extracted using the WET method as described in California Title 22, Section 66261, Appendix II.

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Gary Steube
Laboratory Director

Del Mar Analytical

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URS Consultants
4675 MacArthur Court, Suite 850
Newport Beach, CA 92660
Attention: Stephen Niou

Method Blank

Analyzed: Jun 7, 1993
Reported: Jun 14, 1993
Matrix: Soil

Analyte	EPA Method	STLC Max. Limit mg/L (ppm)	TTLC Max. Limit mg/Kg (ppm)	Detection Limit mg/L (ppm)	STLC Sample Result mg/L (ppm)
Cadmium	6010	1	100	0.05	N.D.
Chromium (VI)	7196	5	500	0.025	N.D.
Chromium (Total)	6010	560	2,500	0.05	N.D.
Lead	6010	5	1,000	0.05	N.D.
Nickel	6010	20	2,000	0.05	N.D.

Prior to analysis, the sample was extracted using the WET method as described in California Title 22, Section 66261, Appendix II.

Analytes reported as N.D. were not present above the stated limit of detection.

DEL MAR ANALYTICAL, IRVINE (ELAP #1197)

Kevin Draper
Project Manager

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QC DATA REPORT

EPA METHOD: 7471
matrix: soil

DATE: 6/2/93

SAMPLE # CE02923

Analyte	R1	Sp	MS	MSD	PR1	PR2	RPD	MEAN PR
	ppb	ppb	ppb	ppb	%	%	%	%
Mercury	0	8	8	8.1	100%	101%	1.2%	101%

Definition of Terms:

R1. . . . . Result of Sample Analysis

Sp. . . . . Spike Concentration Added to Sample

MS. . . . . Matrix Spike Result

MSD. . . . . Matrix Spike Duplicate Result

PR1. . . . . Percent Recovery of MS; (MS-R1) / SP X 100

PR2. . . . . Percent Recovery of MSD; ((MSD-R1) / SP X 100

RPD. . . . . Relative Percent Difference; ((MS-MSD)/(MS+MSD)/2)) X 100

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QC DATA REPORT

METHOD Metals
Instrument: ICP
Matrix: SOIL

Date: 6/7/93

SAMPLE # Blank

Analyte	R1	SP	MS	MSD	PR1	PR2	RPD
	ppb	ppb	ppb	ppb	%	%	%
Antimony	0	1000	896	988	90%	99%	9.8%
Arsenic	0	1000	923	1001	92%	100%	8.1%
Barium	0	1000	1051	1078	105%	108%	2.5%
Beryllium	0	1000	956	1017	96%	102%	6.2%
Cadmium	0	1000	974	1039	97%	104%	6.5%
Chromium	0	1000	1028	1063	103%	106%	3.3%
Cobalt	0	1000	1050	1098	105%	110%	4.5%
Copper	0	1000	1010	1182	101%	118%	15.7%
Lead	0	1000	924	993	92%	99%	7.2%
Molybdenum	0	1000	1054	1139	105%	114%	7.8%
Nickel	0	1000	981	1051	98%	105%	6.9%
Selenium	0	1000	871	991	87%	99%	12.9%
Silver	0	1000	1006	1056	101%	106%	4.8%
Thallium	0	1000	929	1019	93%	102%	9.2%
Vanadium	0	1000	1078	1176	108%	118%	8.7%
Zinc	0	1000	935	1028	94%	103%	9.5%

R1..... Result of Sample Analysis
Sp..... Spike Concentration Added to Sample
MS..... Matrix Spike Result
MSD..... Matrix Spike Duplicate Result
PR1..... Percent Recovery of MS; ((MS-R1) / SP) X 100
RPD..... Relative Percent Difference; ((MS-MSD)/(MS+MSD)/2)) X

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QC DATA REPORT

METHOD Metals
Instrument: ICP
Matrix: SOIL

Date: 6/9/93

SAMPLE # Blank

Analyte	R1	SP	MS	MSD	PR1	PR2	RPD
	ppb	ppb	ppb	ppb	%	%	%
Antimony	0	1000	899	1008	90%	101%	11.4%
Arsenic	0	1000	956	1010	96%	101%	5.5%
Barium	0	1000	1010	1027	101%	103%	1.7%
Beryllium	0	1000	903	999	90%	100%	10.1%
Cadmium	0	1000	914	942	91%	94%	3.0%
Chromium	0	1000	1078	1100	108%	110%	2.0%
Cobalt	0	1000	938	982	94%	98%	4.6%
Copper	0	1000	915	1091	92%	109%	17.5%
Lead	0	1000	1029	953	103%	95%	7.7%
Molybdenum	0	1000	979	1071	98%	107%	9.0%
Nickel	0	1000	904	970	90%	97%	7.0%
Selenium	0	1000	901	998	90%	100%	10.2%
Silver	0	1000	869	910	87%	91%	4.6%
Thallium	0	1000	904	1040	90%	104%	14.0%
Vanadium	0	1000	997	1059	100%	106%	6.0%
Zinc	0	1000	915	938	92%	94%	2.5%

R1..... Result of Sample Analysis
Sp..... Spike Concentration Added to Sample
MS..... Matrix Spike Result
MSD..... Matrix Spike Duplicate Result
PR1..... Percent Recovery of MS; ((MS-R1) / SP) X 100
RPD..... Relative Percent Difference; ((MS-MSD)/(MS+MSD)/2)) X

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URS Consultants

401 E. Ocean Blvd., Mezz. Level/Long Beach, CA 90802
(213) 436-9386 (213) 436-2029 (fax)

Chain of Custody/ Request for Analysis Record

CC# LB- 89686

Client: Hard Chrome

Project Number: 4564213

Sampler Name(s)/Signature(s): Robert Evangelista / Robert Evangelista

Sample Number	Date	Time	Material Sampled: S = Soil; L = Liquid; G = Gas	Sample Type*	Container Type: G = Glass; P = Plastic; M = Metal	Number of Containers	EPA 7196, Cr+6	EPA 6010, Cr, Cd, Ni, Pb	WET extraction	WET EXTRACT Cr+6	WET EXTRACT Cr, Cd, Ni, Pb	WET EXTRACT Sulfate	Remarks or Sample Location	Preservation: Iced	Preservation: Specify Preservative Added and Final pH, If Known
TS-3 at 4 feet HOMOGENIZED	5/25/93		S	C	G	1	X	X	X	X	X	X	Treatability Study Sample	X	
CR2/CR3 at 5 feet HOMOGENIZED	5/25/93		S	C	G	1	X	+	X	X	X	X	Treatability Study Sample	X	
TS-1 at 5 feet HOMOGENIZED	5/25/93		S	C	G	1	X	X	X	X	X	X	Treatability Study Sample	X	
TS1 at 30 feet HOMOGENIZED	5/25/93		S	C	G	1	X	X	X	X	X	X	Treatability Study Sample		

WET in metals only.

24 hr.

PLEASE NOTE THE SAMPLES labelled "HOMOGENIZED" ARE separate and distinct from ANY SAMPLES with SIMILAR NAME DESIGNATIONS

Relinquished by (Signature): ① Robert Evangelista	Date: 5/25/93	Time: 750	Received by (Signature): M Hayes	Relinquished by (Signature): ④ M Hayes	Date: 5/26/93	Time: 8:00	Shipped Via:	
Relinquished by (Signature): ②	Date:	Time:	Received by (Signature):	Received for Laboratory by (Signature):	Date: 5/26/93	Time: 8:00	Shipping Ticket No:	
Relinquished by (Signature): ③	Date:	Time:	Received by (Signature):	Name of Laboratory: Del Mar Analytical			Laboratory Control Number:	

*G = Grab; C = Composite; S = Split Spoon; ST = Shelby Tube; O = Other

White - Original (To Accompany Sample); Yellow - Main Office; Pink - Field Copy

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16525 Sherman Way, Suite C-11, Van Nuys, CA 91406 (818) 779-1844 FAX (818) 779-1843

QC DATA REPORT

METHOD *7196*
Matrix: *STLC Extract*

DATE: *5/27/93*

SAMPLE # *Blank*

Analyte	R1	SP	MS	MSD	PR1	PR2	RPD	MEAN PR
	ppm	*ppm*	*ppm*	*ppm*	*%*	*%*	*%*	*%*
Chromium (VI)	*0*	*0.2*	*0.17*	*0.173*	*85%*	*87%*	*1.7%*	*86%*

Definition of Terms:

R1.....*Result of Sample Analysis*
Sp.....*Spike Concentration Added to Sample*
MS.....*Matrix Spike Result*
MSD.....*Matrix Spike Duplicate Result*
PR1.....*Percent Recovery of MS; (MS-R1) / SP X 100*
PR2.....*Percent Recovery of MSD; ((MSD-R1) / SP X 100*
RPD.....*Relative Percent Difference; ((MS-MSD)/(MS+MSD)/2)) X 100*

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QC DATA REPORT

METHOD *7196*
Matrix: *STLC Extract*

DATE: *5/28/93*

SAMPLE # *Blank*

Analyte	R1	SP	MS	MSD	PR1	PR2	RPD	MEAN PR
	ppm	*ppm*	*ppm*	*ppm*	*%*	*%*	*%*	*%*
Chromium (VI)	*0*	*0.2*	*0.089*	*0.088*	*45%*	*44%*	*1.1%*	*44%*

Definition of Terms:

R1.....*Result of Sample Analysis*
Sp.....*Spike Concentration Added to Sample*
MS.....*Matrix Spike Result*
MSD.....*Matrix Spike Duplicate Result*
PR1.....*Percent Recovery of MS; (MS-R1) / SP X 100*
PR2.....*Percent Recovery of MSD; ((MSD-R1) / SP X 100*
RPD.....*Relative Percent Difference; ((MS-MSD)/(MS + MSD)/2)) X 100*

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QC DATA REPORT

METHOD *7196*
Matrix: *STLC Extract*

DATE: *6/2/93*

SAMPLE # *Blank*

Analyte	R1	SP	MS	MSD	PR1	PR2	RPD	MEAN PR
	ppm	*ppm*	*ppm*	*ppm*	*%*	*%*	*%*	*%*
Chromium (VI)	*0*	*0.2*	*0.158*	*0.156*	*79%*	*78%*	*1.3%*	*79%*

Definition of Terms:

R1.....*Result of Sample Analysis*
Sp.....*Spike Concentration Added to Sample*
MS.....*Matrix Spike Result*
MSD.....*Matrix Spike Duplicate Result*
PR1.....*Percent Recovery of MS; (MS-R1) / SP X 100*
PR2.....*Percent Recovery of MSD: ((MSD-R1) / SP X 100*
RPD.....*Relative Percent Difference; ((MS-MSD)/(MS+MSD)/2)) X 100*

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QC DATA REPORT

METHOD *7196*
Matrix: *STLC Extract*

DATE: *6/2/93*

SAMPLE # *CF00045*

Analyte	R1	SP	MS	MSD	PR1	PR2	RPD	MEAN PR
	ppm	*ppm*	*ppm*	*ppm*	*%*	*%*	*%*	*%*
Chromium (VI)	*0*	*0.2*	*0.014*	*0.028*	*7%*	*14%*	*66.7%*	*11%*

Definition of Terms:

R1.....*Result of Sample Analysis*
Sp.....*Spike Concentration Added to Sample*
MS.....*Matrix Spike Result*
MSD.....*Matrix Spike Duplicate Result*
PR1.....*Percent Recovery of MS; (MS-R1) / SP X 100*
PR2.....*Percent Recovery of MSD; ((MSD-R1) / SP X 100*
RPD.....*Relative Percent Difference; ((MS-MSD)/(MS+MSD)/2)) X 100*

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QC DATA REPORT

METHOD *7196*
Matrix: *STLC Extract*

DATE: *6/4/93*

SAMPLE # *CF00107*

Analyte	R1	SP	MS	MSD	PR1	PR2	RPD	MEAN PR
	ppm	*ppm*	*ppm*	*ppm*	*%*	*%*	*%*	*%*
Chromium (VI)	*0*	*0.2*	*0.14*	*0.136*	*70%*	*68%*	*2.9%*	*69%*

Definition of Terms:

R1.....*Result of Sample Analysis*
Sp.....*Spike Concentration Added to Sample*
MS.....*Matrix Spike Result*
MSD.....*Matrix Spike Duplicate Result*
PR1.....*Percent Recovery of MS; (MS-R1) / SP X 100*
PR2.....*Percent Recovery of MSD; ((MSD-R1) / SP X 100*
RPD.....*Relative Percent Difference; ((MS-MSD)/(MS+MSD)/2)) X 100*

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QC DATA REPORT

METHOD *7196*
Matrix: *STLC Extract*

DATE: *6/4/93*

SAMPLE # *Blank*

Analyte	R1	SP	MS	MSD	PR1	PR2	RPD	MEAN PR
	ppm	*ppm*	*ppm*	*ppm*	*%*	*%*	*%*	*%*
Chromium (VI)	*0*	*0.2*	*0.124*	*0.129*	*62%*	*65%*	*4.0%*	*63%*

Definition of Terms:

R1.....*Result of Sample Analysis*
Sp.....*Spike Concentration Added to Sample*
MS.....*Matrix Spike Result*
MSD.....*Matrix Spike Duplicate Result*
PR1.....*Percent Recovery of MS; (MS-R1) / SP X 100*
PR2.....*Percent Recovery of MSD; ((MSD-R1) / SP X 100*
RPD.....*Relative Percent Difference; ((MS-MSD)/(MS+MSD)/2)) X 100*

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QC DATA REPORT

METHOD *7196*
Matrix: *STLC Extract*

DATE: *6/4/93*

SAMPLE # *CF00296*

Analyte	R1	SP	MS	MSD	PR1	PR2	RPD	MEAN PR
	ppm	*ppm*	*ppm*	*ppm*	*%*	*%*	*%*	*%*
Chromium (VI)	0.272	0.2	0.149	0.586	0%	157%	118.9%	79%

Definition of Terms:

R1.....*Result of Sample Analysis*
Sp.....*Spike Concentration Added to Sample*
MS.....*Matrix Spike Result*
MSD.....*Matrix Spike Duplicate Result*
PR1.....*Percent Recovery of MS; (MS-R1) / SP X 100*
PR2.....*Percent Recovery of MSD; ((MSD-R1) / SP X 100*
RPD.....*Relative Percent Difference; ((MS-MSD)/(MS+MSD)/2)) X 100*

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QC DATA REPORT

METHOD *7196*
Matrix: *STLC Extract*

DATE: *6/7/93*

SAMPLE # *Blank*

Analyte	R1	SP	MS	MSD	PR1	PR2	RPD	MEAN PR
	ppm	*ppm*	*ppm*	*ppm*	*%*	*%*	*%*	*%*
Chromium (VI)	*0*	*0.2*	*0.125*	*0.126*	*63%*	*63%*	*0.8%*	*63%*

Definition of Terms:

R1.....*Result of Sample Analysis*
Sp.....*Spike Concentration Added to Sample*
MS.....*Matrix Spike Result*
MSD.....*Matrix Spike Duplicate Result*
PR1.....*Percent Recovery of MS; (MS-R1) / SP X 100*
PR2.....*Percent Recovery of MSD; ((MSD-R1) / SP X 100*
RPD.....*Relative Percent Difference; ((MS-MSD)/(MS+MSD)/2)) X 100*

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QC DATA REPORT

METHOD *7196*
Matrix: *STLC Extract*

DATE: *6/7/93*

SAMPLE # *Blank*

Analyte	R1	SP	MS	MSD	PR1	PR2	RPD	MEAN PR
	ppm	*ppm*	*ppm*	*ppm*	*%*	*%*	*%*	*%*
Chromium (VI)	*0*	*0.2*	*0.154*	*0.141*	*77%*	*71%*	*8.8%*	*74%*

Definition of Terms:

R1.....*Result of Sample Analysis*
Sp.....*Spike Concentration Added to Sample*
MS.....*Matrix Spike Result*
MSD.....*Matrix Spike Duplicate Result*
PR1.....*Percent Recovery of MS: (MS-R1) / SP X 100*
PR2.....*Percent Recovery of MSD; ((MSD-R1) / SP X 100*
RPD.....*Relative Percent Difference; ((MS-MSD)/(MS+MSD)/2)) X 100*

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QC DATA REPORT

METHOD *Metals*
Instrument: *ICP*
DATE: *6/7/93* *Matrix:* *STLC Extract*

SAMPLE # *CF00111*

Analyte	R1	SP	MS	MSD	PR1	PR2	RPD	MEAN PR
	ppb	*ppb*	*ppb*	*ppb*	*%*	*%*	*%*	*%*
Barium	4539	1000	5400	5483	86%	94%	1.5%	90%
Cadmium	88	1000	1352	1332	126%	124%	1.5%	125%
Copper	5063	1000	6319	6489	126%	143%	2.7%	134%
Lead	17967	1000	18808	19095	84%	113%	1.5%	98%
Nickel	2532	1000	3481	3504	95%	97%	0.7%	96%
Vanadium	2810	1000	3803	3858	99%	105%	1.4%	102%
Zinc	23887	1000	24733	25341	85%	145%	2.4%	115%

Definition of Terms:

R1.....*Result of Sample Analysis*
Sp.....*Spike Concentration Added to Sample*
MS.....*Matrix Spike Result*
MSD.....*Matrix Spike Duplicate Result*
PR1.....*Percent Recovery of MS; (MS-R1) / SP X 100*
PR2.....*Percent Recovery of MSD; ((MSD-R1) / SP X 100*
RPD.....*Relative Percent Difference; ((MS-MSD)/(MS+MSD)/2)) X 100*

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QC DATA REPORT

METHOD *7196*
Matrix: *STLC Extract*

DATE: *6/9/93*

SAMPLE # *CF00535*

Analyte	R1	SP	MS	MSD	PR1	PR2	RPD	MEAN PR
	ppm	*ppm*	*ppm*	*ppm*	*%*	*%*	*%*	*%*
Chromium (VI)	*0*	*0.2*	*0.095*	*0.085*	*48%*	*43%*	*11.1%*	*45%*

Definition of Terms:

R1.....*Result of Sample Analysis*
Sp.....*Spike Concentration Added to Sample*
MS.....*Matrix Spike Result*
MSD.....*Matrix Spike Duplicate Result*
PR1.....*Percent Recovery of MS; (MS-R1) / SP X 100*
PR2.....*Percent Recovery of MSD; ((MSD-R1) / SP X 100*
RPD.....*Relative Percent Difference; ((MS-MSD)/(MS+MSD)/2)) X 100*

Del Mar Analytical

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QC DATA REPORT

METHOD *7196*
Matrix: *STLC Extract*

DATE: *6/9/93*

SAMPLE # *Blank*

Analyte	R1	SP	MS	MSD	PR1	PR2	RPD	MEAN PR
	ppm	*ppm*	*ppm*	*ppm*	*%*	*%*	*%*	*%*
Chromium (VI)	*0*	*0.2*	*0.076*	*0.076*	*38%*	*38%*	*0.0%*	*38%*

Definition of Terms:

R1.....*Result of Sample Analysis*
Sp.....*Spike Concentration Added to Sample*
MS.....*Matrix Spike Result*
MSD.....*Matrix Spike Duplicate Result*
PR1.....*Percent Recovery of MS; (MS-R1) / SP X 100*
PR2.....*Percent Recovery of MSD; ((MSD-R1) / SP X 100*
RPD.....*Relative Percent Difference; ((MS-MSD)/(MS+MSD)/2)) X 100*

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16525 Sherman Way, Suite C-11, Van Nuys, CA 91406 (818) 779-1844 FAX (818) 779-1843

QC DATA REPORT

METHOD *7196*
Matrix: *STLC Extract*

DATE: *6/10/93*

SAMPLE # *Blank*

Analyte	R1	SP	MS	MSD	PR1	PR2	RPD	MEAN PR
	ppm	*ppm*	*ppm*	*ppm*	*%*	*%*	*%*	*%*
Chromium (VI)	*0*	*0.2*	*0.169*	*0.16*	*85%*	*80%*	*5.5%*	*82%*

Definition of Terms:

R1.....*Result of Sample Analysis*
Sp.....*Spike Concentration Added to Sample*
MS.....*Matrix Spike Result*
MSD.....*Matrix Spike Duplicate Result*
PR1.....*Percent Recovery of MS; (MS-R1) / SP X 100*
PR2.....*Percent Recovery of MSD; ((MSD-R1) / SP X 100*
RPD.....*Relative Percent Difference; ((MS-MSD)/(MS+MSD)/2)) X 100*

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QC DATA REPORT

METHOD *7196*
Matrix: *STLC Extract*

DATE: *6/11/93*

SAMPLE # *Blank*

Analyte	R1	SP	MS	MSD	PR1	PR2	RPD	MEAN PR
	ppm	*ppm*	*ppm*	*ppm*	*%*	*%*	*%*	*%*
Chromium (VI)	*0*	*0.2*	*0.074*	*0.082*	*37%*	*41%*	*10.3%*	*39%*

Definition of Terms:

R1.....*Result of Sample Analysis*
Sp.....*Spike Concentration Added to Sample*
MS.....*Matrix Spike Result*
MSD.....*Matrix Spike Duplicate Result*
PR1.....*Percent Recovery of MS; (MS-R1) / SP X 100*
PR2.....*Percent Recovery of MSD; ((MSD-R1) / SP X 100*
RPD.....*Relative Percent Difference; ((MS-MSD)/(MS+MSD)/2)) X 100*

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QC DATA REPORT

METHOD *7196*
Matrix: *STLC Extract*

DATE: *6/11/93*

SAMPLE # *CF00752*

Analyte	R1	SP	MS	MSD	PR1	PR2	RPD	MEAN PR
	ppm	*ppm*	*ppm*	*ppm*	*%*	*%*	*%*	*%*
Chromium (VI)	*0*	*0.2*	*0.087*	*0.067*	*44%*	*34%*	*26.0%*	*39%*

Definition of Terms:

R1.....*Result of Sample Analysis*
Sp.....*Spike Concentration Added to Sample*
MS.....*Matrix Spike Result*
MSD.....*Matrix Spike Duplicate Result*
PR1.....*Percent Recovery of MS; (MS-R1) / SP X 100*
PR2.....*Percent Recovery of MSD; ((MSD-R1) / SP X 100*
RPD.....*Relative Percent Difference; ((MS-MSD)/(MS+MSD)/2)) X 100*

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QC DATA REPORT

METHOD *7196*
Matrix: *STLC Extract*

DATE: *6/14/93*

SAMPLE # *CF01420*

Analyte	R1	SP	MS	MSD	PR1	PR2	RPD	MEAN PR
	ppm	*ppm*	*ppm*	*ppm*	*%*	*%*	*%*	*%*
Chromium (VI)	*0*	*0.2*	*0.008*	*0.016*	*4%*	*8%*	*66.7%*	*6%*

Definition of Terms:

R1.....*Result of Sample Analysis*
Sp.....*Spike Concentration Added to Sample*
MS.....*Matrix Spike Result*
MSD.....*Matrix Spike Duplicate Result*
PR1.....*Percent Recovery of MS; (MS-R1) / SP X 100*
PR2.....*Percent Recovery of MSD; ((MSD-R1) / SP X 100*
RPD.....*Relative Percent Difference; ((MS-MSD)/(MS+MSD)/2)) X 100*

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QC DATA REPORT

METHOD *7196*
Matrix: *STLC Extract*

DATE: *6/14/93*

SAMPLE # *Blank*

Analyte	R1	SP	MS	MSD	PR1	PR2	RPD	MEAN PR
	ppm	*ppm*	*ppm*	*ppm*	*%*	*%*	*%*	*%*
Chromium (VI)	*0*	*0.2*	*0.046*	*0.081*	*23%*	*41%*	*55.1%*	*32%*

Definition of Terms:

R1.....*Result of Sample Analysis*
Sp.....*Spike Concentration Added to Sample*
MS.....*Matrix Spike Result*
MSD.....*Matrix Spike Duplicate Result*
PR1.....*Percent Recovery of MS; (MS-R1) / SP X 100*
PR2.....*Percent Recovery of MSD; ((MSD-R1) / SP X 100*
RPD.....*Relative Percent Difference; ((MS-MSD)/(MS+MSD)/2)) X 100*

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QC DATA REPORT

METHOD *Metals*
Instrument: *ICP*
DATE: *6/17/93* *Matrix:* *STLC Extract*

SAMPLE # *CF00758*

Analyte	R1	SP	MS	MSD	PR1	PR2	RPD	MEAN PR
	ppb	*ppb*	*ppb*	*ppb*	*%*	*%*	*%*	*%*
Cadmium	*490*	*1000*	*1520*	*1479*	*103%*	*99%*	*2.7%*	*101%*
Lead	*2397*	*1000*	*3245*	*3259*	*85%*	*86%*	*0.4%*	*86%*
Nickel	*273*	*1000*	*1223*	*1168*	*95%*	*90%*	*4.6%*	*92%*

Definition of Terms:

R1.....*Result of Sample Analysis*
Sp.....*Spike Concentration Added to Sample*
MS.....*Matrix Spike Result*
MSD.....*Matrix Spike Duplicate Result*
PR1.....*Percent Recovery of MS; (MS-R1) / SP X 100*
PR2.....*Percent Recovery of MSD; ((MSD-R1) / SP X 100*
RPD.....*Relative Percent Difference; ((MS-MSD)/(MS + MSD)/2)) X 100*

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QC DATA REPORT

METHOD *Metals*
Instrument: *ICP*
DATE: *6/17/93* *Matrix:* *STLC Extract*

SAMPLE # *CF00758*

Analyte	R1	SP	MS	MSD	PR1	PR2	RPD	MEAN PR
	ppb	*ppb*	*ppb*	*ppb*	*%*	*%*	*%*	*%*
Cadmium	*0*	*1000*	*908*	*938*	*91%*	*94%*	*3.3%*	*92%*
Chromium (Total)	*1952*	*1000*	*2889*	*2920*	*94%*	*97%*	*1.1%*	*95%*
Lead	*0*	*1000*	*978*	*972*	*98%*	*97%*	*0.6%*	*98%*
Nickel	*0*	*1000*	*948*	*979*	*95%*	*98%*	*3.2%*	*96%*

Definition of Terms:

R1.....*Result of Sample Analysis*
Sp.....*Spike Concentration Added to Sample*
MS.....*Matrix Spike Result*
MSD.....*Matrix Spike Duplicate Result*
PR1.....*Percent Recovery of MS; (MS-R1) / SP X 100*
PR2.....*Percent Recovery of MSD; ((MSD-R1) / SP X 100*
RPD.....*Relative Percent Difference; ((MS-MSD)/(MS+MSD)/2)) X 100*

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QC DATA REPORT

METHOD *Metals*
Instrument: *ICP*
DATE: *6/17/93* *Matrix:* *STLC Extract*

SAMPLE # *CF00500*

Analyte	R1	SP	MS	MSD	PR1	PR2	RPD	MEAN PR
	ppb	*ppb*	*ppb*	*ppb*	*%*	*%*	*%*	*%*
Chromium (Total)	*1611*	*1000*	*2679*	*2557*	*107%*	*95%*	*4.7%*	*101%*

Definition of Terms:

R1.....*Result of Sample Analysis*
Sp.....*Spike Concentration Added to Sample*
MS.....*Matrix Spike Result*
MSD.....*Matrix Spike Duplicate Result*
PR1.....*Percent Recovery of MS; (MS-R1) / SP X 100*
PR2.....*Percent Recovery of MSD; ((MSD-R1) / SP X 100*
RPD.....*Relative Percent Difference; ((MS-MSD)/(MS+MSD)/2)) X 100*

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