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**QUALITY ASSURANCE PROJECT PLAN  
ELECTROKINETIC REMEDIATION DEMONSTRATION  
ALAMEDA POINT  
ALAMEDA, CALIFORNIA  
FINAL**

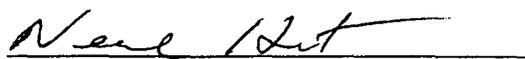
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FINAL  
QUALITY ASSURANCE PROJECT PLAN  
ELECTROKINETIC REMEDIATION  
DEMONSTRATION

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ATTACHMENTS

Attachment

- A STATEMENT OF WORK, SITE 5 ELECTROKINETIC TREATABILITY STUDY
- B STATEMENT OF WORK, SITE 5 SUBSURFACE DRILLING
- C GEOKINETICS DEMONSTRATION WORK PLAN
- D GEOKINETICS BENCH-SCALE TREATABILITY STUDY REPORT (1997)

**A2.1****ACRONYMS AND ABBREVIATIONS**

ASTM	American Standards of Testing and Materials
bgs	below ground surface
CLP	contract laboratory program
COC	chain-of-custody
CRDL	contract required detection limits
DC	direct current
DQO	data quality objectives
DR	deficiency report
EFA West	Naval Facilities Engineering Command, Engineering Field Activity West
EK	electrokinetic
EPA	U.S. Environmental Protection Agency
FS	Feasibility study
Geokinetics	Geokinetics International, Inc.
HSA	hollow-stem auger
HDPE	high density polyethylene
HSP	health and safety plan
ICP	inductively coupled plasma
IDL	instrument detection limits
IDW	investigation-derived waste
LIMS	laboratory's information management system
MD	matrix duplicate
MS	matrix spike
NAS	Naval Air Station
PARCC	precision, accuracy, representativeness, completeness, and comparability
PRG	preliminary remediation goals
QA	quality assurance
QAPP	quality assurance project plan
QC	quality control
QCSR	quality control summary report
RI	remedial investigation
RPD	relative percent difference
SDB	sample delivery group
SOP	Standard operating procedures
SOW	Statement of Work
TtEMI	Tetra Tech EM Inc.
UCL	upper confidence limit
XRF	X-ray fluorescence

### A3.0 DISTRIBUTION LIST

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Conrad Sherman	TtEMI
Neal Hutchison	TtEMI
Ron Ohta	TtEMI
Mark Wetters	TtEMI

## **A4.0 PROJECT ORGANIZATION AND RESPONSIBILITIES**

Tetra Tech EM Inc. (TtEMI) (formerly PRC Environmental Management, Inc.) was requested by the Navy to conduct a pilot-scale treatability study at Naval Air Station Alameda (NAS Alameda) which would demonstrate the capabilities of an electrokinetic separation (EK) technology to treat in-situ soils for metals contamination. For this project, TtEMI has procured a vendor that is capable of performing the design, implementation, operation, and evaluation of the EK technology on bench- and pilot-scales. Based on previous work performed for the Navy under the U.S. Environmental Protection Agency's (U.S. EPA) Superfund Innovative Technology Evaluation (SITE) program, Geokinetics International, Inc. of Berkeley, California (GII) has been chosen to perform the NAS Alameda Site 5 electrokinetic bench-scale and pilot-scale treatability studies.

Geokinetics International Inc. (Geokinetics) has developed an electrokinetic (EK) soil remediation process for removing metal and other charged or polar contaminants from soil and groundwater. Geokinetics has proposed to demonstrate this technology on chromium-contaminated soil located at installation restoration (IR) Site 5 (Site 5), which consists of Building 5 and the immediate surrounding areas of Building 5, at Alameda Point (formerly Naval Air Station [NAS] Alameda), California. The contaminated soil immediately beneath the Plating Shop in Building 5 is the result of activities involving the electrochemical plating of aircraft parts.

This quality assurance project plan (QAPP) was developed to document how quality assurance (QA) and quality control (QC) activities will be planned, implemented, and assessed during the EK treatability study at Alameda Point. Personnel responsibilities are briefly presented in the following paragraphs. The locations and telephone numbers of key project personnel are included at the end of this section.

### **A4.1 NAVY PERSONNEL**

The EFA West remedial project manager (Navy RPM) will be responsible for coordinating project-related activities for the Navy during the demonstration. The Alameda Point environmental compliance manager will be responsible for coordinating access to the treatment site in Building 5 and other related environmental compliance issues.

#### A4.2 TETRA TECH EM INC. PERSONNEL

The TtEMI project manager (PM) is responsible for all tasks performed by TtEMI and Geokinetics (from here forward known as the EK demonstration team) and will report to the Navy RPM. The TtEMI PM will be responsible for coordinating contract-related activities including procurement of Geokinetics and other contractors as necessary (see Attachments A and B). In addition, the TtEMI PM is responsible for assuring that all technical objectives, as outlined in the QAPP, are met by the EK demonstration team. The TtEMI project manager's responsibilities also include the following:

- Developing the QAPP
- Complying with the QAPP and health and safety plan (HSP)
- Managing staff
- Supervising staff and mobilization activities
- Providing required planning, cost, and schedule control; records documentation; and management for all field activities
- Ensure that treatment residuals and any hazardous waste produced during the demonstration are disposed of in compliance with Federal, state, and local requirements.

TtEMI's field oversight manager will support the TtEMI project manager and will coordinate all subcontractor field activities at the site. In addition, TtEMI's field oversight manager will perform sample collection and field measurements of process streams throughout the duration of the demonstration. The field oversight manager's responsibilities also include the following:

- Managing subcontractor field activities
- Complying with the QAPP and health and safety plan (HSP)
- Supervising staff and mobilization activities
- Performing sample collection and field measurements
- Overseeing the activities of TtEMI and TtEMI subcontractor personnel in the field
- Managing site health and safety during site preparation, drilling operations, and site restoration

TtEMI's QA manager will support the TtEMI project manager and will coordinate QA technical operations with project staff. In addition, TtEMI's QA manager will provide assistance and guidance through developing and revising the QAPP, as well as performing systems audits of demonstration QA/QC, standard operating procedures, and operations manuals to ensure the defined practices are appropriate for the demonstration. The QA manager's responsibilities include the following:

- Performing systems audits of project team QA/QC, standard operating procedures, and operations manuals
- Auditing project team operations
- Providing guidance and coordination to rapidly resolve any QA/QC issues
- Maintaining all QA records and QA data
- Providing QA of the field data/document control and ensuring chain-of-custody is maintained
- Reviewing the quality of data produced during the EK demonstration

#### **A4.3 GEOKINETICS INTERNATIONAL INC. PERSONNEL**

The Geokinetics project manager will provide project management for the implementation of the EK demonstration. The Geokinetics project manager will be responsible for technical support and operation of the demonstration equipment, including the preparation of the demonstration work plan (see Attachment C). The Geokinetics project manager will also be responsible for preparation and review of all documentation and reports to EFA West, including all progress reports and project reports.

Geokinetics' field operations manager will be responsible for all work assignments performed in the field by the EK demonstration team. He will oversee all work involving the demonstration hardware and ensure that all personnel understand and comply with the QA/QC plans set forth in this QAPP. The Geokinetics field operations manager will also be responsible for providing and operating all process equipment proposed in the demonstration and will coordinate all project activities related to this equipment. The Geokinetics field operations manager will provide demonstration status reports to Geokinetics' project manager, who will ensure personnel and resources are available to adequately support the needs of the demonstration.

Geokinetics will coordinate all health and safety activities with the EK demonstration team.

Geokinetics will be responsible for developing and revising the HSP, auditing project team operations to determine whether the defined operations are being performed safely, providing guidance and coordination to rapidly resolve any health and safety issues, and maintaining all health and safety records for inspection by the EK demonstration team and EFA West.

#### A4.4 ANALYTICAL LABORATORY SELECTION

Under the current remedial investigation (RI) at Alameda Point, TtEMI contracts analytical services under a basic ordering agreement with laboratories approved by both TtEMI and Naval Energy and Environmental Support Activity (NEESA). Because this demonstration is being performed as part of the RI/Feasibility study (FS), the analytical data used to confirm the reduction of contaminants at this site (pre-treatment and post-treatment soil analyses for the contaminants of interest) should be comparable to the current data being provided under TtEMI's laboratory services statement of work (SOW) (PRC 1995) and also the NAS Alameda QAPP (PRC 1993). This includes the analysis of samples using contract laboratory program (CLP) protocols with CLP deliverables and also third party data validation. Currently, the laboratory being used for laboratory support services at Alameda Point is Applied Chemical and Physical Laboratory (APCL) of Chino, California. APCL will be providing the analytical services for this treatability study.

#### A4.5 PERSONNEL LOCATIONS

The locations and telephone numbers of the EK demonstration team are as follows:

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#### **A5.0 PROBLEM DEFINITION AND BACKGROUND**

This demonstration is intended to collect technology performance data of known quantity and quality. Therefore, sampling and analysis procedures are critical, and approved QA/QC procedures will be stringently applied throughout the demonstration.

The EK demonstration team has prepared this QAPP according to the U.S. Environmental Protection Agency (EPA) requirements for QAPPs for environmental data operations (EPA 1994).

This section describes background information pertinent to the demonstration, as well as how the EK demonstration team will collect and analyze samples to evaluate the effectiveness of the EK process developed by Geokinetics.

## **A5.1 PROJECT DESCRIPTION**

This section describes the objectives of the EK remediation demonstration and provides background information on the Alameda Point site.

### **A5.1.1 Demonstration Objectives**

This demonstration is being conducted to allow the Navy to evaluate the ability of the EK process to remediate soils contaminated with heavy metals. The objective of the demonstration is to reduce chromium concentrations in the soil to achieve EPA Region IX preliminary remediation goals (PRG) for residential and to develop reliable performance and cost data for the process.

Specifically, the demonstration will address the following:

- Evaluate the effectiveness of the EK technology to treat metals in subsurface soils
- Identify system operating problems and corrective actions
- Determine site-specific system operating conditions
- Estimate approximate costs of capital equipment, operations and maintenance, and waste disposal

The objectives for this study are summarized in Table A5-1. Primary objectives are considered critical for the evaluation of the technology. The secondary objectives are not critical for technology evaluation, but provide important supporting information on the process and its effectiveness.

### **A5.1.2 Site Background**

Alameda Point (formerly NAS Alameda) is located on the east side of San Francisco Bay in Alameda, California. Alameda Point occupies the western end of the island of Alameda. Most of the eastern half of Alameda Point is developed with office and industrial facilities. Aircraft runways and support facilities occupy the western part of Alameda Point (Canonie 1989).

The EK demonstration will be conducted in the former Plating Shop in Building 5. The site is located between First and Second streets. The building was in operation between 1942 and 1996. Processes conducted in the Plating Shop included degreasing, caustic and acid etching, metal stripping and cleaning, and chrome, nickel, silver, cadmium, and copper plating (PRC 1996). The plating shop was closed in June 1990, when a replacement facility was opened in another part of the base. All of Building 5 is currently inactive.

The shop is constructed with a raised wooden floor, approximately 3 feet above a concrete subfloor. A dividing wall in the concrete subfloor, shown in Figure A5-1, separates the cadmium/cyanide processing section from the chrome processing section. Two 15 inch diameter, 18-foot-deep sumps, located on either side of the dividing wall, were used to collect wastewater discharged from the plating process lines.

Based on the historical information and analytical data to date, contaminants of potential concern include metals (chromium in particular), cyanide, phenol, and chlorinated hydrocarbons (chloroethane, 1,1-dichloroethane, 1,1-dichloroethene, and 1,1,1-trichloroethane) (PRC 1996).

### **A5.1.3 Site Characterization**

On July 7, 1995, two core samples were collected from the soil beneath the plating shop of Building 5 at Alameda Point by TtEMI. The first core sample was collected from the chromium plating section of the shop, and the second sample was collected from the cadmium plating section. Both of the 10 foot long cores were sectioned at 6-inch intervals, and TtEMI conducted a metals analysis of these sections on site using X-ray fluorescence (XRF). Two subsamples of each core were removed by TtEMI and sent to Huntingdon Engineering and Environmental, Inc., (St. Louis, Missouri) for detailed metals and organics compound analysis. The balance of the two core samples was taken to Geokinetics for use in a bench-scale treatability study.

The depths from which the samples were collected are given in Table A5-2. The metals analysis results are summarized in Table A5-3. Chromium concentrations detected ranged from 65 mg/kg to 492 mg/kg.

The organic analysis results are summarized in Table A5-4. No substantial concentration of organic chemicals was detected in Core 1. As indicated, however, Core 2 contained a number of organic chemicals. None of these organic chemicals will have an effect on the EK process during the demonstration of chromium removal.

## **A5.2 ELECTROKINETIC REMEDIATION PROCESS**

The adsorption and movement of contaminants in soil is regulated by the coupling between the soil's electrical, chemical, and hydraulic gradients. With respect to remediation, the two primary mechanisms by which the electrokinetic transport of contaminants through soil takes place are electromigration and electroosmosis. In electromigration, charged particles are transported through the soil solution. In contrast, electroosmosis is the movement of a liquid containing ions relative to a stationary charged surface. Of these two, electromigration is an order of magnitude greater than electroosmosis and is thus the principle mechanism for soil remediation.

Soil is composed of several components, some derived from the weathering of rock and the remainder from the addition of organic materials by living organisms. The permanent background of organic materials in soils, termed humus, is a complex mixture of humic and fulvic acids. Both of these acids are characterized by the highly functionalized aromatic structure. These acids have a very high ion exchange capacity and are generally found bound to clay particles with an ion exchange capacity in their own right.

Stevenson and Ardakani (1972) have described the attachment of humic acid molecules to clay particles by hydrogen bonding and metal-humate-clay site interactions. The total ion exchange capacity of the soil is lower than the sum of the contributions made by clay and humus because of this interaction. The metal-humate and metal-clay interactions may be replaced by hydrogen ions from the soil, causing the number of these interactions to be extremely sensitive to pH. At a pH of 7, the concentration of hydrogen ions is too low to produce a significant amount of replacement. For electrochemical remediation techniques, however, the relationship between pH and site interactions is crucial to the operation of the technology, as discussed below.

Thus, moist soil behaves as an ion exchange medium. When an ionic contaminant is introduced to soil, some of the contaminant dissolves in the solution around the soil particles, while the remainder adsorbs

onto the surfaces of the particles. The soluble ions are relatively mobile and can be removed by a variety of techniques. The amount of the contaminant adsorbed to the soil particles is directly dependent on the ion exchange capacity of the soil, which ultimately determines the concentration of contaminant ions in the soil. Removal of these adsorbed contaminants is challenging and is the principle barrier to achieving clean soil with most remediation technologies.

Remediation by electromigration functions through a three-step process. First, the contaminants are mobilized. For cations, mobilization is achieved by supplanting the adsorbed contaminants with hydrogen ions produced at the anode. These hydrogen ions migrate through the soil, displacing contaminant cations as they move. This displacement has been observed in practice as a moving front of heavy metals traveling through the soil towards the cathode, where the metals accumulate and are collected. Removal of anionic contaminants, which are adsorbed to the positively charged soil particle surfaces, requires a similar supplantation of the contaminant ion(s) by hydroxide ions produced at the cathode.

Second, the electric field introduced by the process causes the ionic contaminants to migrate through the soil. The velocity of migration is dependent on the specific ion. Hydrogen ions migrate through soil at the highest velocity, while hydroxide ions migrate at about half that velocity. The values for other ions are substantially lower. For heavy metals, migration continues until the metals reach the cathode or until they encounter an anion, which causes them to become nonmobile. For many metals, such a transformation can be induced by hydroxide ions produced at the cathode. For this reason, during metals collection, it is crucial to the success of the technique to control of the cathode electrolyte composition to minimize hydroxide ion production.

In the final step, the ionic contaminants, which have been collected into the aqueous electrolytes surrounding each electrode, are removed from the electrolyte. Heavy metals collect in the cathode electrolyte (catholyte) while anions collect in the anode electrolyte (anolyte). Both electrolytes are continuously circulated to an external processing system. Processing involves regeneration of the solution through removal and recovery of the contaminants and subsequent return of the regenerated solution to the electrode casings (Figure 1-2). Once the contaminants are removed, they can be concentrated for transportation to a suitable hazardous waste storage facility or processed to provide a refined raw material.

In principle, the technology is applied by inserting a series of electrode pairs into the contaminated soil and applying a direct current (DC) electric field across the electrodes. Under such conditions, moist soil behaves like an aqueous electrolyte, and ions and water move towards the electrodes. Metal ions (for example, cadmium, mercury, zinc, copper, and lead), ammonium ions, and positively charged, soluble organic compounds move toward the cathode. Anions such as chloride, fluoride, cyanide, nitrate, and negatively charged organic compounds move toward the anode.

In practice, the electrodes are not actually inserted into the soil directly but rather are positioned inside semipermeable casings that are inserted into the soil (Figure A5-2). Electrode spacing and orientation, along with the optimum voltage and current density for remediation, are determined from site characteristics. Electrodes can be installed in principle to any depth, either vertically or horizontally. The annulus of each electrode casing is filled with a selected electrolyte solution, and the power turned on.

The anodes inserted in the soil continually produce hydroxide cations that migrate through the soil displacing metal ions as they move. As described above, the metal ions are thus freed to move under the driving force supplied by the potential gradient between the anodes and cathodes. Thus, selection of electrode operating parameters and the appropriate compositions of the electrolyte solution(s) are made to tailor the contaminant removal to the specific characteristics of the site. In the same fashion that the pattern of electrodes or the current density of the field can be changed, the anolyte and catholyte can be formulated to increase the removal efficiency of the process. Optimal process efficiency is achieved by controlling the electrode reactions and influent-effluent chemistry to maintain EK flow.

The demonstration hardware includes the soil electrodes and electrode casings, the plumbing and wiring to connect them, the electrolyte circulation system, and the contaminant removal system. The operation of all of the systems is integrated and controlled by a process control computer.

### **A5.3 BENCH-SCALE TREATABILITY STUDY RESULTS**

A bench-scale treatability study was carried out on the two cores obtained from Alameda Point. Bench-scale studies were conducted in Geokinetics' standard Turbo electrochemical cell. As shown in Figure

A5-3, the Turbo cell is divided into three compartments: an electrolyte-filled compartment for the anode, a center compartment for the soil under study, and an electrolyte-filled compartment for the cathode.

A standard performance study was conducted using five different dilute acids as the cell electrolyte. Each turbo cell test was run for 24 hours and was conducted at the same electrical current density. This duration is not sufficient to completely remove chromium from the soil but serves as a means for (1) assessing the efficacy of the electrolyte, (2) estimating power requirements for complete remediation, and (3) estimating remediation duration.

Total concentrations of chromium in the substrate were measured using XRF both before and after EK treatment. Final chromium concentration was taken as the average of the sampled amount present in the soil at three points: in the soil next to the anode, in the soil at the center of the compartment, and in the soil next to the cathode. Because chromium exists in soil in two forms, one anionic and the other cationic, it is imperative that this partitioning be considered in assessing treatability. Chemical analysis determined that the initial soil ratio of chromium in cationic form to anionic form was 20:13. In addition, the dual ionic nature of this element dictates that both anolyte and catholyte streams be processed for chromium removal during the demonstration.

The treatability study results are summarized in Table A5-5. As these results indicate, neither dilute acetic acid nor dilute citric acid provided the desired remediation performance on this soil. Although the amount of chromium removed was acceptable with the acetic acid electrolyte, energy use is too high to be economical. For the citric acid electrolyte, energy use was much too high, and the amount of chromium removed was unacceptable.

The three dilute mineral acids all provided acceptable chromium removal with realistic energy use. Although any of the three dilute acids will provide an acceptable electrolyte for the demonstration, dilute hydrochloric acid will probably serve as the best electrolyte for this soil. It provides the second-highest chromium removal value with the lowest energy use.

In addition to the above mentioned bench-scale treatability study, TtEMI sent additional soil samples to Geokinetics for an additional bench-scale study. These samples were collected from the Plating Shop

during installation of the EK electrode well casings in May of 1996. Attachment D is an additional bench-scale treatability report prepared by Geokinetics based on results of this additional study.

## **A6.0 PROJECT AND TASK DESCRIPTION**

This section provides a brief overview of the demonstration project and several of its most pertinent aspects.

### **A6.1 DEMONSTRATION OVERVIEW**

For the demonstration, an array of 15 electrodes distributed on a 3-meter by 5-meter grid will be installed through holes drilled through the floor of Building 5. Power will be supplied to this array to cause the movement of chromium to the electrode casings, where it will be collected in the circulating electrolyte. The electrolyte will be treated to remove the chromium and recirculated to the electrode casings. Soil samples will be collected for chromium and other target metal analysis before and after the demonstration. These samples will be used to gauge the effectiveness of EK remediation. In addition, intermediate samples of the electrolyte will be collected to help document performance of the technology. During the demonstration, a computer monitor/control system will record the physical characteristics of the electrolytes (pH, electrical conductivity, temperature) and important process variables (pump pressure, power supply voltage, power supply amperage).

### **A6.2 SPECIAL PERSONNEL AND EQUIPMENT REQUIREMENTS**

This demonstration has no special requirements for personnel or equipment beyond the personnel and equipment supplied by the EK demonstration team. However, personnel and equipment will be employed to support continuous operation of the EK system.

### **A6.3 ASSESSMENT TOOLS REQUIRED**

The only assessment tools required by this demonstration will be drilling, sampling, and analytical instruments necessary to sample and analyze soil and electrolyte solutions. A technical memorandum will be prepared to assess the overall performance of EK remediation at Site 5.

**A6.4 PROJECT AND QUALITY RECORDS REQUIRED**

Project records required will include a daily log of hardware operation, intermediate electrolyte sample collection data (date, time, tools, methods, etc.), and computer records of monitored, time-stamped sensor values (electrolyte pH, electrical conductivity, temperature, flow rate, and pump pressure).

Quality records required will include initial and final soil sample data, as well as laboratory QA/QC data pertaining to equipment calibration and analytical method verification (supplied by the analytical laboratory).

**A6.5 SCHEDULE**

The total time for the field activities associated with the remediation process itself is estimated to be 150 days. The schedule for the EK remediation demonstration at the Alameda Point site is listed below.

<b>TASK</b>	<b>SCHEDULE</b>
Site preparation: Drilling, sampling, and casing installation	May 6 - May 9, 1996
EK system installation	November 1 - November 21, 1997
EK field demonstration	November 24, - March 27, 1998
Confirmational sampling	March 30 - April 3, 1998
Site restoration and demobilization	April 6 - April 10, 1998
Sample analysis complete	May 8, 1998
Prepare draft technical memorandum	May 11 - June 19, 1998
Navy review draft technical memorandum	June 22 - July 20, 1998
Prepare final draft technical memorandum	July 21 - August 21, 1998

## **A7.0 QUALITY OBJECTIVES AND CRITERIA FOR MEASUREMENT DATA**

The QA objectives for this treatability study are to produce well-documented data of known quality and sufficient quantity to properly evaluate the EK technology. Through the data validation process, the data will be evaluated for acceptable quality and quantity, based on the critical indicator parameters of precision, accuracy, representativeness, completeness, and comparability (PARCC). In addition, to properly evaluate the EK process, contract required detection limits (CRDL) for all analytical methods have been specified to the laboratory to reduce the possibility of receiving data with such high detection limits as to render the data useless. These objectives are discussed in Sections A7.1 through A7.6.

### **A7.1 PRECISION**

Analytical precision will be calculated for each analysis and will be expressed as the relative percent difference (RPD) between the results of original samples and the matrix duplicate (MD) samples. Field duplicate precision will also be evaluated on aqueous samples through the collection and analysis of field duplicate samples. Field duplicate precision not only evaluates the analytical precision of the laboratory methods, but also evaluates the sampling methods and sample handling procedures. Because of the nonhomogenous nature of soils, field duplicate precision for soils provides no additional information affecting the evaluation of data quality; therefore, no field duplicate soil samples will be collected. Table A7-1 summarizes the precision goals for the critical parameters.

### **A7.2 ACCURACY**

Analytical accuracy for inorganic methods is determined through the evaluation of matrix spikes and laboratory control samples. Accuracy will be calculated for each analysis and will be expressed as a percent recovery. Matrix spike samples will be prepared by spiking a known amount of the analytes into a sample; the spike sample is then prepared and analyzed as normal. Laboratory control samples will be prepared by spiking a known amount of reagent grade water with the analytes of interest. Percent recovery is determined by subtracting the concentration of analyte detected in the original sample from the total concentration of the analyte detected in the spike sample and then dividing the difference by the amount spiked. Results of matrix spikes not only represent the analytical accuracy of the method, but also indicate whether or not the matrix is affecting the recovery of the analytes.

Laboratory control samples only indicate the accuracy of the method. Table A7-1 summarizes the accuracy goals for the critical parameters.

### **A7.3 REPRESENTATIVENESS**

Sample results will be evaluated for representativeness by examining items related to the collection of samples, such as the chain-of-custody (COC) documentation, which includes labeling of samples, collection dates, and the condition of the samples upon receipt at the laboratory. Laboratory procedures will also be examined, including anomalies reported by the laboratory either upon receipt of the samples at the laboratory or during the analytical processes, holding times of samples before analysis, calibration of laboratory instruments, adherence to the analytical methods, quantitation limits reported for the samples, results of field blanks, equipment rinse samples, and method blanks, and completeness of data package documentation.

### **A7.4 COMPLETENESS**

Completeness is defined as the percentage of measurements judged valid compared to the total number of measurements collected. The validity of sample results is determined through the data validation process. During the data validation process, all sample results that are rejected and any missing analytical measurements will be considered incomplete. Data that are qualified as estimated will be considered valid and usable. The QA objective for the degree of completeness on this demonstration is 95 percent.

### **A7.5 COMPARABILITY**

Comparability of the data is a qualitative parameter that expresses the confidence with which one data set may be compared to another. Comparability of the data will be achieved by the use of standard methods of analysis, standard quantitation limits, and standardized data validation procedures. All soil results will be reported in dry weight units (adjusted for moisture content) for all analytical methods. Quantitation limits within a method may vary slightly from sample to sample because of the adjustments for moisture content.

All elevated reporting limits will be assessed during the data validation process to determine whether there is a justifiable reason for the raised limits. It may be expected that reporting limits will be frequently raised because of high concentrations of target or interfering compounds. During the data validation process, the elevated reporting limits for all samples will be evaluated on a sample-by-sample basis. If it is determined that a dilution analysis provided results that were rendered useless as a result of overly high detection limits, these results will be rejected.

#### **A7.6 CONTRACT REQUIRED DETECTION LIMITS**

CRDL for critical parameters are practical quantitation limits that can be achieved for normal samples, through normal methods, given acceptable system performance. However, for CLP metals analysis, the laboratory will be required to report any concentration of an analyte that is detected above the instrument detection limit, whether or not the detected value is above the CRDL. The laboratory will calculate instrument detection limits (IDL) twice a year. CRDLs for all analyses are presented in Table A7-2.

#### **A7.7 HANDLING OF DISCREPANCIES**

The following corrective actions will be taken for data that do not meet QA objectives: (1) verify that the analytical measurement system was in control, (2) thoroughly check all calculations, (3) reanalyze extracts or digests for the affected samples and/or QC samples, and, as a last resort, (4) reprepare and reanalyze samples and QC if sufficient sample volume exists. If all of the previous actions do not provide acceptable results within the acceptance criteria, the laboratory will (1) explain the reasons the data failed to meet the objectives (for example, because of matrix interferences) in the data summary narrative and (2) use data qualifiers (flags) when reporting the data. The laboratory will follow the CLP guidelines and the TtEMI laboratory services SOW (PRC 1995) for the proper use of laboratory data qualification.

#### **A8.0 PROJECT NARRATIVE**

This section presents a summary of the EK demonstration to be conducted at Alameda Point and describes the tasks to be completed to support the treatability study. Sampling and analytical requirements are outlined but discussed in detail within Section B.

## **A8.1 DEMONSTRATION WORK PLAN**

Planning documents for the EK demonstration include this QAPP and the EK work plan prepared by Geokinetics and follows the QAPP as Attachment C. The QAPP, including the attached EK work plan, is a comprehensive planning document that includes elements of a detailed work plan, field sampling and analysis plan, and a QA project plan. The EK demonstration is divided into four phases: site preparation, field demonstration, site cleanup and demobilization, and technology evaluation. These phases are described in the following sections.

### **A8.1.1 Site Preparation**

After mobilization, site preparation phase will include all tasks necessary to install the EK system and collect soil samples before the field demonstration is initiated. Wood floorboards above the concrete floor will be removed to allow access for drilling the borings and installation of the electrode casing and fluid handling equipment. 15 borings will be installed in a 3-meter by 5-meter demonstration area and spaced 1-meter apart. The holes will be cut in the concrete floor at the boring locations using a drill rig, concrete cutter, or other equipment. Borings will be drilled into the soil using a hollow stem auger rig for installation of the electrode casings. All soil cutting will be containerized in 55 gallon steel drums and stored on site in a designated investigation-derived waste (IDW) area. As these boring are drilled, soil samples will be collected at three intervals to determine the initial soil chromium concentration in the demonstration area. The detailed sampling plan is presented in Section B. As each boring is completed, an electrode casing will be installed. Following completion of the installation of the electrode casings, the plumbing and electrical DC feed lines will be positioned on the concrete floor and prepared for connection to the electrode casings and electrodes, respectively. The electrolyte processing equipment, including analyte and catholyte reservoirs, will then be installed on the concrete floor, and the power supply will be installed on a portion of the remaining wood floor. The main power supply will be connected to Building 5 main power (440VAC), and 110-120 VAC power lines will be extended for the secondary power supplies (pumps and other equipment) and to the control computer. Then the electrodes will be installed into the electrode casings, and the DC power will be connected to lines. Plumbing connections for the electrolyte recirculation system will be installed. The computer control system will be installed on the wood floor. All systems will be functionally tested before the EK system is started. In addition, a chemical precipitation system,

including a precipitation tank with secondary containment and a filter press, will be set up adjacent to the demonstration area.

#### **A8.1.2 Conduct Demonstration**

For the demonstration, an array of 15 electrodes distributed on a 3-meter by 5-meter grid will be used. The basic operating parameters for this array are summarized in Table A8-1. Based on the results of the bench-scale treatability studies (Section A5.3 and Attachment D), simulation model predictions indicate that the demonstration will require an energy input of between 2000 and 4000 Kwh/m<sup>3</sup> using a dilute hydrochloric acid-based electrolyte. After installation of the electrodes, process equipment, and power, all of the electrolyte and water reservoirs will be filled, and initial electrolyte samples will be collected and archived. The computer control system will then be powered up and the sensors calibrated. The electrolyte circulation pumps and the electrode arrays will be turned on one at a time, in that order, and checked for proper operation. The system will then be operated and maintained throughout the performance of the demonstration.

Initial conditioning of the soil will be performed using high voltage (up to 500 volts DC) and low amperage (up to 18 amps). Once soil conditioning has been achieved, the system will be operated at higher amperage (up to 250 amps) and lower voltage (up to 70 volts DC). Real-time data for monitoring system performance will be collected automatically by the control computer throughout the duration of the demonstration. In addition, intermediate electrolyte samples will be collected for laboratory analysis. The precipitation processing unit will be used intermittently to remove chromium and other metals from the catholyte and anolyte solutions. Hydroxide precipitation will be implemented using calcium hydroxide [Ca(OH)<sub>2</sub>] as the precipitant to remove metals as insoluble metal hydroxides. The precipitate will be recovered as a solid cake using a filter press. The cake will be dried to remove as much moisture as possible and containerized in 55-gallon drums and stored in the IDW area. After the demonstration, system power will be turned off. The composition of all fluids will be analyzed and the nonhazardous fluids will be disposed of as permitted. Any residual hazardous fluids will be placed into drums and disposed of as IDW by TtEMI.

### **A8.1.3 Site Cleanup/Demobilization**

After the demonstration is completed, site restoration will begin. Site cleanup will consist of first removing the computer control system, followed by disconnecting the DC power feed lines and removing the electrodes. Building 5 power mains will be disconnected, and the power supplies will be removed from the shop area. The processing equipment will be removed from the area, followed by removal of the plumbing and electrical (DC) feed lines. Holes for postremediation samples will be cut into the concrete floor, and borings will be drilled to obtain confirmational soil samples in the demonstration area. In addition, the electrolyte solutions and metals precipitate will be sampled to determine the appropriate disposal method of the EK by-products. These wastes will be containerized and stored on site until waste characterization is completed. All of the samples will be sent to an analytical laboratory for analysis. If necessary, the electrode casings will be removed, the electrode casing, and postremediation sample holes will be filled with soil. Concrete caps will be poured over all of the holes. All equipment will be demobilized and removed from the site. Finally, the wood floor will be replaced and fences will be removed from the site.

### **A8.1.4 Technology Evaluation**

After the sample analytical results are received from the laboratory, the data will be validated by TtEMI. Data validation reports will be prepared identifying any data needing qualification due to exceeded QA criteria. TtEMI will also prepare a quality assurance summary report (QCSR) summarizing the overall quality of the data and whether the data meets the DQOs for the project. Geokinetics will evaluate the operational and process parameters of the EK system and prepare a report documenting the EK system operation. TtEMI will evaluate the performance of EK remediation based on the sampling data and the demonstration objectives. TtEMI will prepare a comprehensive technology evaluation report that will include the QCSR and the Geokinetics EK evaluation report.

## **A8.2 TECHNOLOGY PARAMETERS EVALUATION**

Several factors can potentially affect the operating performance of the EK remediation process. These factors can be grouped into two categories: chemical parameters and physical parameters.

The chemical parameters that can affect the process include the chemical composition of the soil, the electrical conductivity of the soil, and the soil pH. The physical operating parameters that can affect the operation of the system and impact the desired treatment efficiency include the homogeneity of the soil, the presence of buried objects (for example, drums, pipes), and the moisture content of the soil. The sampling overview defining the evaluation parameters for the demonstration samples are summarized in Table B1-1.

### A8.3 DATA ANALYSIS

The upper confidence limit (UCL) of selected contaminants in the treated residuals will be determined at the 90 or 95 percent confidence level. A one-tailed Student's t-test will be performed, assuming that the data are normally distributed. The UCL for the treated residuals will be calculated using the following equation:

$$UCL = \bar{X} + \left( (t \cdot \delta) / \sqrt{n} \right) \quad (\text{Eq. A8-1})$$

where

$\bar{X}$	=	Sample mean contaminant concentration
t	=	Student's t-test statistic value at a 90 or 95 percent (one-tailed) confidence level
$\delta$	=	Sample standard deviation
n	=	Sample size (number of replicates)

The efficiency of the EK process in removing chromium will be expressed, using equation A8-2, as the total amount of contaminant removed from the soil. Total constituent mass will be used instead of constituent concentration to account for any loss in weight caused by the evaporation of soil moisture or the volatilization of organic compounds.

$$CRE = \frac{(C_I - C_R)}{C_I} \cdot 100 \% \quad (\text{Eq. A8-2})$$

where:

CRE	=	contaminant removal efficiency (percent)
C <sub>I</sub>	=	total amount of contaminant in soil initially (mg/kg)
C <sub>R</sub>	=	total amount of contaminant remaining in remediated soils (mg/kg)

## **A9.0 SPECIAL TRAINING OR CERTIFICATION REQUIREMENTS**

Personnel operating the demonstration hardware and collecting samples will be required to have a current 40-hour Hazardous Waste Operations certification. No additional special training or certification requirements exist for this demonstration.

## **A10.0 DOCUMENTATION AND RECORDS**

The following sections describe the information and records to be included in the data report package, field sampling and laboratory reports, and the disposition of records and documents generated during the demonstration.

### **A10.1 DATA REPORT PACKAGE**

The data report package will consist of the following:

- A narrative summary of the performance of the technology
- Summary of operating conditions, problems identified with the operation, and any changes made to the system during the demonstration
- Tabular data on the initial and postremediation chromium, total metal, and major anion concentrations in the treated soil
- Tabular data on overall mass balance derived from the data for chromium
- Summary on the quality of the data obtained during the demonstration
- Information in narrative and tabular form on the cost of implementing the technology

### **A10.2 FIELD SAMPLING AND LABORATORY REPORTS**

Field sampling reports will be prepared for each series of samples collected during a single sampling session, including initial soil, remediated soil, electrolyte samples, and solid precipitate. These reports will identify the nature of each sample and the sampling location. The reports will document (in narrative fashion) any treatment performed on the sample as well as any problems encountered during

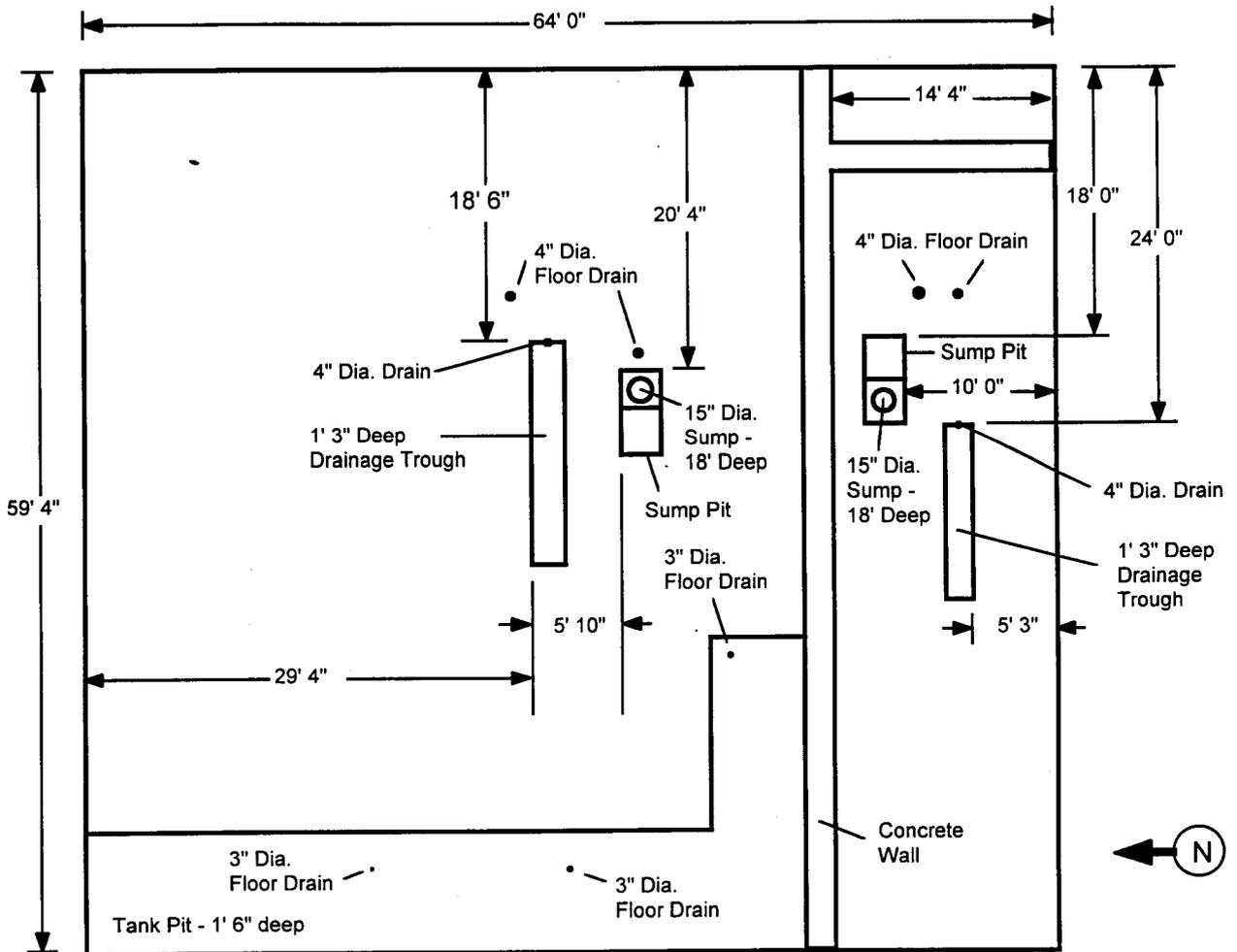
the sampling process. These reports will be hand-written on standardized data sheets and entered into the computer upon return from the field.

The laboratory will report all hard copy data using CLP-like deliverables and will provide an electronic deliverable in the TtEMI format no later than 35-days past the day of receipt. For results needed for the demonstration evaluation sooner than the standard 35-day turnaround time, the laboratory will provide CLP Form 1s to TtEMI within 10 days of sample receipt.

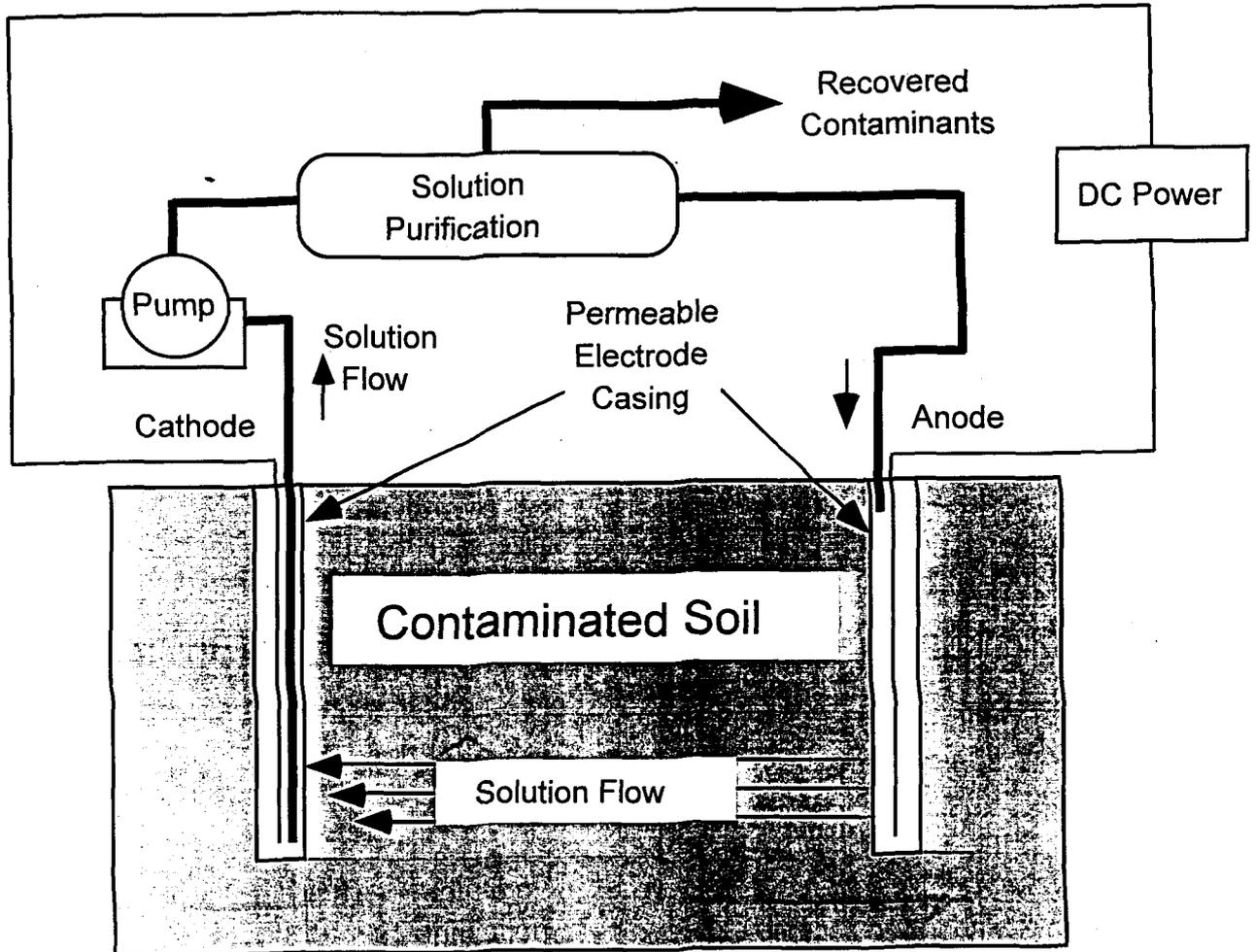
### **A10.3 DISPOSITION OF RECORDS AND DOCUMENTS**

Four copies of all records and documents produced during this demonstration will be archived. One copy will remain with each the EFA West project manger, the Geokinetics project manager, and the TtEMI project manager. The retention time for these archives will be determined by the organizational requirements of each individual manager.

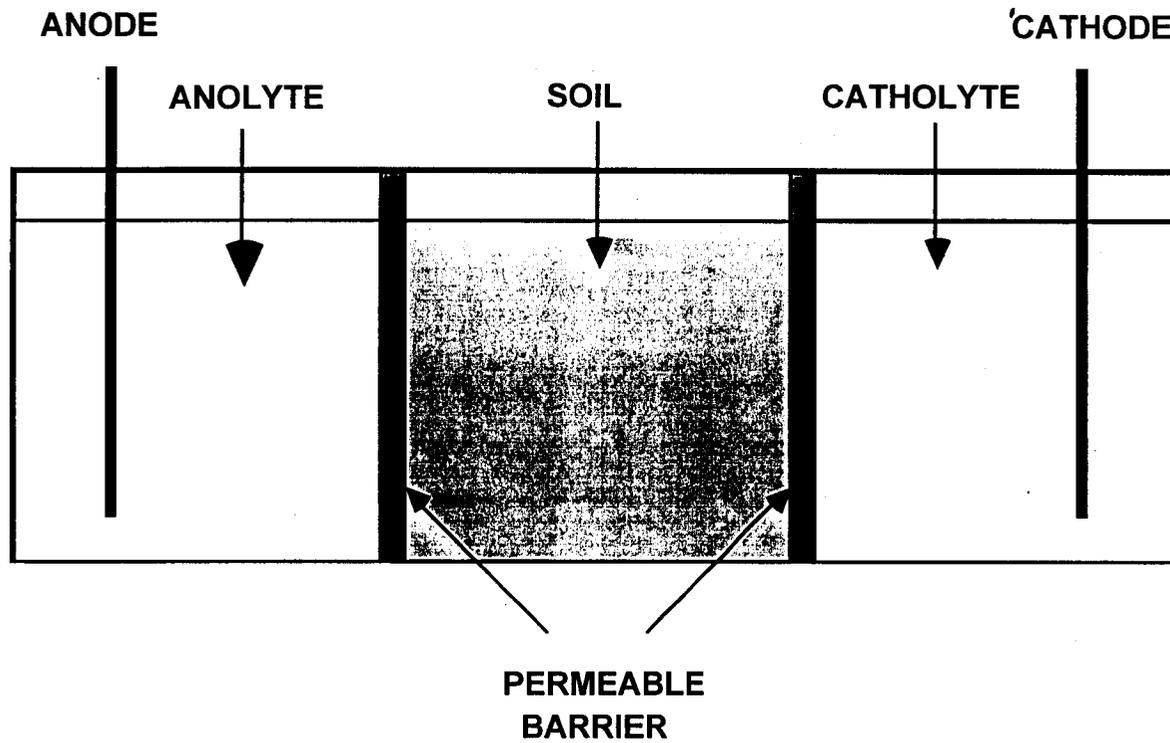
All reports, data sheets, memoranda, etc., will be supplied to the individuals on the appropriate distribution list. The document distribution lists will be constructed at the beginning of the demonstration by the project managers listed in the previous paragraph.



**FIGURE A5-1**  
**Alameda Point, Building 5**  
**Plating Shop Layout**



**FIGURE A5-2**  
**Schematic Diagram of Electokinetic**  
**Soil Remediation System**



**FIGURE A5-3**  
Longitudinal Section  
Through Turbo Cell

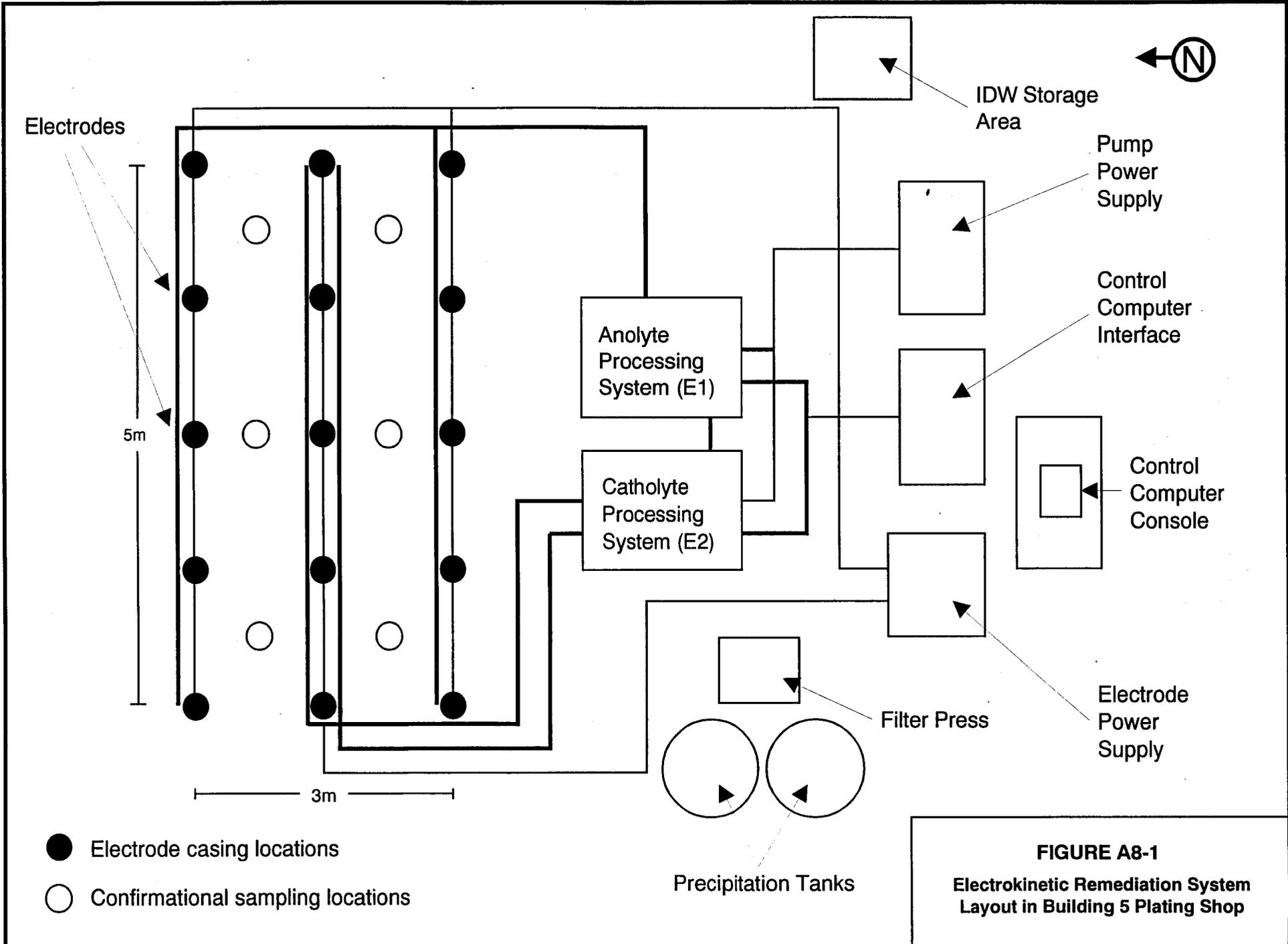


TABLE A5-1

PRIMARY AND SECONDARY OBJECTIVES OF  
ELECTROKINETIC REMEDIATION DEMONSTRATION  
ALAMEDA POINT

Objective	Means of achieving objective
<b>Primary Objectives</b>	
P1. Assess the ability of the technology to treat soils contaminated with chromium to levels of U.S. Environmental Protection Agency (EPA) Region IX Preliminary Remedial Goals (PRG) for residential soils.	Determine initial and final concentrations of chromium through the collection of discrete soil samples of the untreated and remediated soils. The samples will be analyzed using EPA CLP Methods.
<b>Secondary Objectives</b>	
S1. Determine the effectiveness of the process to remove other heavy metals from the soil being treated. Also evaluate the movement of other cations within the process.	Determine initial and final concentrations of total metals through the collection of discrete soil samples of the untreated and remediated soils. The samples will be analyzed using EPA CLP Methods.
S2. Report specific operating and maintenance concerns that may affect the long-term reliability of the system observed during the demonstration.	Through assessment and oversight measures, problems with the EK process will be identified and corrective actions will be taken. All problems will be documented accordingly.
S3. Determine chromium removal rate and specific operating conditions for the system.	Data will be collected from process control sensors used to continuously monitor electrical conductivity, pH, and temperature of the electrolytes during system operation.
S4. Perform a mass balance for chromium and other metals over entire process system.	Determine initial and final concentrations of total metals in the soil, electrolytes, and solid precipitate through sampling and analysis. Also measure total mass and volumes of all process streams.
S5. Approximate costs of capital equipment, operations, and maintenance.	Costs for labor, capital equipment, site preparation, startup, consumables and supplies, utilities, IDW disposal, analytical services, maintenance, and demobilizing will be evaluated.

TABLE A5-2

DEPTH OF SAMPLES COLLECTED FOR CHEMICAL ANALYSIS  
ALAMEDA POINT

Sample	Depth (meters) <sup>a</sup>
Core 1 - Sample 1	1.8
Core 1 - Sample 2	2.9
Core 2 - Sample 1	2.3
Core 2 - Sample 2	3.3

Note: a Depth measured from the wooden floor of the Building 5 plating shop (=0.0 meters).

TABLE A5-3

RESULTS FROM ELEMENTAL ANALYSIS OF  
BUILDING 5 CORE SAMPLES (MG/KG) (HUNTINGDON 1995)  
ALAMEDA POINT

Analyte	Core 1 - Sample 1	Core 1 - Sample 2	Core 2 - Sample 1	Core 2 - Sample 2
Aluminum	4,260	5,190	4,060	4,700
Arsenic	1.5	1.2	1.3	1.9
Barium	33.5	42.0	31.1	35.5
Beryllium	0.12	0.14	0.12	0.14
Cadmium	0.89	0.74	0.78	0.81
Calcium	4540	2310	1590	1830
Chromium	65.4	96.4	492	155
Cobalt	4.1	4.8	4.0	4.6
Copper	6.0	6.4	10.9	16.1
Iron	8760	9310	8970	8900
Lead	2.8	2.5	2.1	2.2
Magnesium	4560	2580	2600	2540
Manganese	104	94.3	131	107
Nickel	25.6	29.2	27.3	28.7
Potassium	704	1130	774	1000
Sodium	219	199	78.9	227
Vanadium	18.0	21.7	16.9	19.3
Zinc	16.2	17.9	16.9	18.9

TABLE A5-4

**RESULTS FROM ORGANIC ANALYSIS OF  
BUILDING 5 CORE SAMPLES (MG/KG) (HUNTINGDON, 1995)  
ALAMEDA POINT**

Analyte	Core 1 - Sample 1	Core 1 - Sample 2	Core 2 - Sample 1	Core 2 - Sample 2
Methylene Chloride	ND	ND	1.25	ND
2-Butanone	ND	ND	7.13	16.37
1,1,1-Trichloroethane	5.65	ND	ND	ND
4-Methyl-2-penta-none	ND	ND	7.58	11.23
2-Hexanone	ND	ND	12.4	13.5
Octahydro-1-methyl-pentalene	ND	ND	ND	35.79
1,2,3-Trimethyl-benzene	ND	ND	ND	74.08
Undecane	ND	ND	ND	18.45
Isomer of C <sub>8</sub> H <sub>16</sub>	ND	ND	6.63	ND
Isomers (3) of C <sub>9</sub> H <sub>12</sub>	ND	ND	29.67	ND
Isomer of C <sub>11</sub> H <sub>14</sub>	ND	ND	ND	17.87
Isomer of Trimethyl-benzene	ND	ND	ND	18.88
Unknown(s) <sup>a</sup>	ND	6.76 (1)	41.17 (4)	235.9 (6)

Note:

ND Not Detected.

<sup>a</sup> Figure in parentheses following unknown concentration is number of unknowns detected in sample.

TABLE A5-5

BUILDING 5 PLATING SHOP TREATABILITY STUDY RESULTS  
ALAMEDA POINT

Acid	Chromium Removal (%)	Energy Used (Kwh/m <sup>3</sup> )
Acetic	58	120
Nitric	57	40
Phosphoric	73	40
Hydrochloric	67	35
Citric	26	160

TABLE A7-1

PRECISION AND ACCURACY GOALS FOR  
ELECTROKINETIC TREATABILITY STUDY  
ALAMEDA POINT

Analyte	Water		Soil		Blank Spike	
	MS % Recovery	MD % RPD	MS % Recovery	MD % RPD	LCS % Recovery	LCSD % RPD
CLP Metals	75 - 125	20	75 - 125	35	80 - 120	25
pH	NA	20	NA	35	NA	NA
Major Anions	75 - 125	20	50 - 150	50	80 - 120	25

Notes:

- MS Matrix spike
- MD Matrix duplicate
- RPD Relative percent difference
- LCS Laboratory check sample
- LCSD Laboratory check sample duplicate
- CLP Contract Laboratory Program
- NA Not applicable

TABLE A7-2

**CONTRACT LABORATORY PROGRAM METALS CONTRACT-REQUIRED DETECTION  
LIMITS FOR ELECTROKINETIC TREATABILITY STUDY  
ALAMEDA POINT**

Analyte	Water Contract Required Detection Limit <sup>a</sup> (mg/L)	Soil Contract Required Detection Limit <sup>a</sup> (mg/kg)
Aluminum	50	40
Antimony	6	2
Arsenic	10	2
Barium	200	40
Beryllium	4	0.4
Cadmium	1	0.5
Calcium	5,000	1,000
Chromium	10	2
Cobalt	50	5
Copper	4	0.4 <sup>b</sup>
Iron	100	20
Lead	3	0.05 <sup>b</sup>
Magnesium	5,000	1,000
Manganese	15	3
Mercury	0.025 <sup>b</sup>	0.003 <sup>b</sup>
Molybdenum	10	1
Nickel	8 <sup>b</sup>	1 <sup>b</sup>
Potassium	5,000	1,000
Selenium	5	1
Silver	2	0.2
Sodium	5,000	1,000
Thallium	2	0.5

Notes:

- <sup>a</sup> Laboratory will report all analytes detected above the instrument detection limit (IDL) whether or not the detected value is above the contract-required detection limit (CRDL)
- <sup>b</sup> Required detection limits are lower than current state-of-the-art instrumentation is capable of producing.

TABLE A7-2 (Continued)

CONTRACT LABORATORY PROGRAM METALS CONTRACT-REQUIRED DETECTION  
LIMITS FOR ELECTROKINETIC TREATABILITY STUDY  
ALAMEDA POINT

Analyte	Water Contract Required Detection Limit (mg/L)	Soil Contract Required Detection Limit (mg/kg)
Vanadium	50	10
Zinc	20	4
Chloride	0.1	5
Fluoride	0.1	5
Sulfate	0.2	10
Nitrate/Nitrite	0.05	0.2

Notes:

- <sup>a</sup> Laboratory will report all analytes detected above the instrument detection limit (IDL) whether or not the detected value is above the contract-required detection limit (CRDL)
- <sup>b</sup> Required detection limits are lower than current state-of-the-art instrumentation is capable of producing.

TABLE A8-1

ELECTROKINETIC REMEDIATION TECHNOLOGY DEMONSTRATION  
 BASIC OPERATING PARAMETERS  
 SITE 5, ALAMEDA POINT

Electrolyte Parameters	
Electrolyte	Dilute Hydrochloric acid
Electrolyte pH	2.5 - 4.0
Electrolyte Flow Rate	1.7 gpm
Electrode Parameters	
Electrode number and arrangement	15 electrodes placed on a 3-meter x 5-meter grid
Power Requirement, Initial	18 Amps at approximately 500 volts DC
Final	250 Amps at approximately 70 Volts DC
Energy Requirement	2000 - 4000 Kwh/m <sup>3</sup>
Electrode Casing	
Diameter	3.4 inches
Length	2 meters

Notes:

gpm                      gallons per minute  
 Kwh/m<sup>3</sup>                kilowatt-hour per cubic meter  
 DC                        direct current

## GROUP B. MEASUREMENT / DATA ACQUISITION

This section presents a detailed sampling plan, analysis, measurement, operation and data handling that will be followed during the EK demonstration at Site 5.

### **B1.0 SAMPLING PROCESS DESIGN**

The objective of this sampling plan is to provide representative data in sufficient quantities to allow the Navy and TtEMI to evaluate the effectiveness of the EK remediation system in treating soils with characteristics and contamination profiles present at Alameda Point Site 5. Technology performance will be evaluated based on meeting the primary and secondary project objectives presented in Table A5-1. The following sections provide the detailed sampling program.

#### **B1.1 SAMPLING OBJECTIVES AND LOCATIONS**

This section describes the sampling objectives of the demonstration and identifies specific sampling and measurement locations based upon those objectives.

##### **B1.1.1 Sampling Objectives**

Sampling objectives are a necessary part of the effort to produce well-documented, defensible data of a known and reproducible quality, and of sufficient quantity, to properly evaluate the remediation technology. Specific sampling objectives for the demonstration of the EK remediation system are listed below:

- Collect representative samples of each matrix that will reflect the true concentration of the analytes of interest
- Collect samples in sufficient quantities to enable a thorough evaluation of the process.
- Obtain necessary physical and chemical characterizations of the samples to determine the performance of the EK remediation technology.
- Collect samples in sufficient volume using proper sample handling techniques so that they can be appropriately analyzed.

### B1.1.2 Sampling and Measurement Locations

Sampling locations are selected based upon the configuration of the treatment system and sampling objectives. Samples to be collected during the EK demonstration include the following: (1) untreated soil, (2) treated soil, (3) electrolyte solutions, and (4) solid precipitate. The process locations to be sampled, analytical parameters, and selection rationale are presented in Table B1-1.

Untreated Soil Sampling Locations. Untreated soil samples will be collected by TtEMI from the area of the EK demonstration defined by the electrode grid shown in Figure B1-1. During the drilling of the 15 borings for the electrode casing installation, discrete soil samples will be obtained from three different depths from each of the sampling locations U1 through U15. Untreated soil samples will be analyzed to determine the initial chromium concentrations, soil pH, and percent moisture in the EK demonstration area. In addition to chromium, samples from locations U7 through U9 will be analyzed for total metals, cyanide, and major anions. Soil density will also be determined on these samples to support mass balance calculations. Split samples will be archived on site until the demonstration is completed.

Treated Soil Sampling Locations. Following completion of the demonstration, treated soil samples will also be collected by TtEMI. Six confirmation borings will be drilled within the electrode grid as shown in Figure B1-2. At the locations marked C1 through C6, discrete soil samples will be collected from the same three depths as the untreated soil samples. Treated soil samples will be analyzed to determine final chromium concentrations, soil pH, and percent moisture in the EK demonstration area. Samples from C3 and C4 will also be analyzed for total metals and major anions. In addition to these locations, based on the analytical results from the untreated soil samples, three additional confirmation borings, C7 through C9, will be drilled in the most contaminated area of the grid in an effort to profile the chromium concentrations across the anode/cathode grid. Results from these samples will be used to determine whether the chromium was mobilized completely across the grid or whether any in situ precipitation occurred. Split samples of the confirmation borings will be archived on site.

Electrolyte Solution Sampling Locations. Before the system is started, the electrolyte solutions (anolyte and catholyte) will be sampled by TtEMI to provide baseline concentrations of total metals, major anions, and pH. These samples will be collected from the electrolyte piping before system startup. During the demonstration, pH, conductivity, and temperature will be continuously monitored and

recorded by the process computer using electronic sensors located in the electrolyte reservoirs. These measurements will be used to determine when the electrolyte solutions need regenerating. Samples of both the catholyte and anolyte will be collected by Geokinetics on a daily basis and archived as backup samples to the real-time process measurements. The electrolyte samples will be collected from the return piping near the reservoirs (Figure B1-3), which will each contain the respective electrolyte after it has been pumped from the electrode casings.

At the completion of the demonstration, the stripped electrolytes will be pumped into IDW tanks for storage. Samples of the stripped electrolytes will be collected by TtEMI from the storage tanks for analysis to support mass balance calculations and for waste disposal purposes.

Solid Precipitate Sampling Locations. During system operation, the electrolyte solutions will become loaded with chromium and other heavy metals. The solutions will be regenerated at specified times based on the real-time process measurements. The regeneration process includes shutting down the system and then stripping the chromium and other heavy metals from the electrolyte solutions using chemical precipitation. After the precipitation process, the electrolyte solutions will be filtered through a plate and frame filter press to remove the metal hydroxide precipitate. Fresh acid will then be added to the solutions to maintain ionic strength and pH. At this point, the solutions are regenerated and the system is ready to be restarted. The resulting filter cakes will be combined in an IDW drum for storage. At the completion of the demonstration, a composite sample of the solid filter cake will be collected by TtEMI for analysis to support mass balance calculations and for waste disposal purposes.

## **B1.2 NUMBER OF SAMPLES AND FREQUENCY OF COLLECTION**

The number of samples of the untreated and treated soil is based on the sampling objectives, number of borings, and three depth intervals. For each of the 15 untreated soil borings, three samples at specified depth intervals will be collected for a total of 45 samples. For each of the 9 treated soil borings, three samples at specified depth intervals will be collected for a total of 27 samples.

The electrolyte solutions will be sampled once before the demonstration and once after the demonstration. During the demonstration, samples of the electrolyte solutions will be collected daily and archived as backup samples to the real-time process measurement equipment.

At the end of the demonstration, a composite sample of the resulting solid metal hydroxide precipitate will be collected. The EK demonstration sample collection program is summarized in Tables B1-2 and B1-3. Table B1-2 includes sampling and measurement location, sample type and matrix, analytical parameters, and total number of samples and field measurements. Table B1-3 includes sample identification numbers (field and laboratory), analyses, matrix, and specified samples for QC purposes.

## **B2.0 SAMPLING METHODS REQUIREMENTS**

This section describes the procedures for collecting representative samples or taking measurements at each sampling location. The following subsection describes the soil boring drilling method and sampling requirements for each medium of interest. Sample containers, preservatives, and holding times for each analysis are discussed in Section B3.2.

### **B2.1 SOIL BORING DRILLING METHODS**

A total of 24 soil borings will be installed to approximately 8 feet below ground surface (bgs). After a hole is drilled through the concrete floor in each of the specified locations, soil borings will be drilled using the hollow-stem auger (HSA) method. The HSA drilling method employs a hollow helical steel drill tool that is rotated to advance the boring and cuttings to the surface. A cutter head is attached to the lead auger to cut the hole. During drilling, a center bit inserted into the hollow area of the cutter head prevents cuttings from entering the hollow portion of the auger. The center bit connects through the auger flights by small diameter drill rods and is attached to the top-head drive unit of the drill rig. The top-head drive is powered by a truck-mounted engine that mechanically rotates the entire flight of augers. The hollow opening allows for the insertion of sampling tools and well completion materials with the augers in place to support the boring. The borings will be installed using an auger with an inside diameter of 3-3/4 inches (7-1/8 inch outside diameter) to allow the insertion of the 3.4-inch diameter electrode casing.

#### **B2.1.1 Soil Sampling Methods**

Subsurface soil samples will be collected using split-spoon sampling techniques. The preferred method, the surface drop hammer, will be used to drive the split-spoon sampling device into the soil for sample

collection. The surface drop hammer system will use an 18-inch long split-spoon sampler to collect the soil samples.

To collect a subsurface soil sample, the auger is advanced to the top of the predetermined sampling depth. At this point, the center bit, which is attached to the drill rods, is pulled out of the hole. The split-spoon sampler is then attached to a small diameter, flush threaded pipe and lowered to the bottom of the hole. The 140-pound surface drop hammer mounted on the drill rig is dropped repeatedly onto the sampling pipe to drive the sampler into the ground.

The 18-inch split-spoon sampler holds three brass sleeves 6 inches in length. The outside casing of the sampler opens longitudinally to insert or remove the sleeves. After the sampler has been driven to the desired depth, it is removed from the hole at which time the brass sleeves are removed. The middle sleeve will be prepared for shipment to the laboratory, and the bottom sleeve will be prepared for storage at the site. Both ends of each sleeve will be covered and capped with polyvinyl chloride caps. The caps will be held in place with duct tape. The capped sleeves will then be labeled and placed in Ziploc bags to prevent cross-contamination. Sample sleeves being sent to the laboratory for analysis will be stored in a cooler filled with ice and maintained at a temperature of 4° C, and the middle sleeves will be placed in a 55-gallon IDW storage barrel for archival purposes. The soil in the remaining bottom sleeves will be knocked out into another 55-gallon IDW storage container, and the brass sleeves will be decontaminated and reused during the sampling process.

While the sampler is driven with the surface drop hammer, blow counts are measured every 6 inches to determine the physical characteristics of the material encountered. Fifty blow counts without significant penetration is considered formation refusal. If 100 blows are counted for a 6-inch interval, the sampler is removed, and the drill stem is again advanced through the material. The soil beneath Building 5, however, is known to be fill material residing within the vadose and saturated zones. No refusal is anticipated at this site. It is more likely that unconsolidated soil deposits may pose a problem during sampling at this location.

For sampling of unconsolidated soil deposits, a split-spoon sampler equipped with a sample catcher is used to prevent sample loss. The catcher is placed in the lower portion of the sampler. As the sampler is pulled to the surface, the catcher prevents unconsolidated material from falling out the bottom of the

sampler. The catcher will be decontaminated in the same manner used to decontaminate the split- spoon sampler.

### **B2.1.2 Soil Boring Abandonment**

At the completion of the demonstration, all borings will be abandoned in accordance with California regulations. A Volclay or equivalent bentonite-grout mixture will be used to fill the borings. In these shallow borings, the entire drill string will be pulled from the boring as long as the formation is stable, and a tremie pipe will be lowered to near the bottom of the boring. As the grout is pumped, the tremie will be positioned such that it is below the top of the grout in the boring. The boring will be filled with grout to seal it.

### **B2.2 UNTREATED SOIL**

Untreated soil samples will be collected with a split-spoon sampler at three different depths from each of 15 borings. The top of the 6-inch thick concrete floor will be the reference elevation for all drilling and sampling activities. Starting from the top of the concrete floor, 1.5-foot sections of soil will be collected at the sampling depths of 1 to 2.5 feet, 4 to 5.5 feet, and 6.5 to 8 feet bgs. Each 1.5-foot section will be contained within a three column sample core using brass sleeves. A total of 45 soil samples will be collected from the 15 borings for laboratory analysis to characterize the contamination before the demonstration. The middle 6-inch sleeve of each 1.5-foot sample section will be sent to the laboratory for analysis, and the bottom 6-inch sleeve will be archived at the site. The samples will be properly sealed, labeled, and stored on ice until shipment to the laboratory. The remaining 6-inch sleeve will be emptied into an IDW waste container. The analyses performed at the laboratory will include chromium, soil pH, and percent moisture on all 45 samples, and additional analyses of total metals, cyanide, major anions, and soil density will be performed on nine samples.

Cyanide analysis will be performed by the laboratory on a rush basis. If cyanide is found in any of the samples, a possibility exists that the process could produce small amounts of cyanide gas as the water in the soil migrates to the acidic anolyte solution during the process. Prior to process startup, additional environmental controls will be implemented at the site if cyanide is detected in the untreated soil.

For the purposes of determining a mass balance for chromium over the entire process, the total volume of soil within the EK demonstration grid will be calculated and then converted to mass units using the soil density results.

### **B2.3 TREATED SOIL**

Treated soil samples will be collected with a split-spoon sampler at three different depth intervals from each of six borings. Starting from the top of the concrete floor, 1.5-foot sections of soil will be collected at the sampling depths of 1 to 2.5 feet, 4 to 5.5 feet, and 6.5 to 8 feet bgs. A total of 18 soil samples will be collected from the six borings for laboratory analysis to characterize the soil after to the demonstration. The analyses performed at the laboratory will include chromium, soil pH, and percent moisture on all 18 samples, and additional analyses of total metals and major anions will be performed on six samples.

### **B2.4 PROCESS CONTROL MONITORING**

During system operation, the concentration of chromium (as  $\text{Cr}^{+3}$ ) and other cations will increase in the catholyte solution, and the concentration of anions will increase in the anolyte solution. Conductivity, pH, and temperature measurements of the electrolytes will be monitored on a real-time basis to indicate when the solutions are becoming saturated with contaminants and are no longer viable. Based on these data, Geokinetics will determine when to strip the electrolytes of chromium and other cations and when to replenish the electrolytes with fresh acid. These measurements will be monitored and recorded by the process computer.

### **B2.5 ELECTROLYTE SOLUTION SAMPLING**

At the start of the demonstration, after the electrolyte processing systems have been charged with the proper solutions, but before power is applied to the electrodes, the anolyte and catholyte processing systems will be sampled to provide baseline contaminant concentrations of the electrolytes. Four 500-mL samples will be collected in properly preserved high density polyethylene (HDPE) sample bottles from each of the anolyte and catholyte processing systems. Sampling stopcocks will be located on the return piping of each electrolyte processing systems close to the reservoirs. Sample bottles will be filled from these stopcocks. After filling, the sample bottles will be sealed, labeled, and stored on

ice until shipment to the laboratory. Two of each of the electrolyte samples will be sent to the laboratory for analysis of total metals, major anions, and pH. The remaining two samples of each electrolyte solution will be archived at the site as backup samples.

After the demonstration, samples of the stripped electrolyte solutions will be collected to measure the concentrations of the contaminants for mass balance and waste disposal purposes. Samples will be collected from a sampling port on the top of the IDW storage tanks using a dip tube sampling device. From each electrolyte solution, four 500-ml samples will be collected in properly preserved HDPE sample bottles. After the sample bottles are filled, they will be sealed, labeled, and stored on ice until shipment to the laboratory. Two of each of the electrolyte samples will be sent to the laboratory for analysis of total metals, major anions, and pH. The remaining two samples of each electrolyte solution will be archived at the site as backup samples. In addition, for mass balance calculations, the total final volume of the electrolytes used in the process will be measured using the volumetric graduations on the sides of the IDW storage tanks.

During system operation, samples of the anolyte and catholyte will be collected once per day by Geokinetics and archived as backup samples to the real-time process measurements. These samples will be collected from the stopcocks in the return piping close to the reservoirs. One sample of 250-ml volume will be collected in properly preserved HDPE containers from each of the process solutions. These samples will be properly sealed, labeled, and stored for possible analysis in case of a failure of any of the real-time measurement equipment. Analysis of these samples would be performed by Geokinetics at its discretion.

## **B2.6 SOLID PRECIPITATE SAMPLING**

At the completion of the demonstration, a composite sample of the metal precipitate filter cake will be collected by TtEMI. Using a stainless steel stirring spoon, the filter cake in the IDW storage barrel will be mixed until a homogenous mixture is obtained. Two 12-ounce glass jars of the precipitate will be collected. These samples will be properly sealed and labeled. One of these samples will be sent directly to the laboratory for the analysis of total metals and percent moisture. The remaining sample will be archived as a backup sample. The results of these analyses will be used in the mass balance calculations for chromium and for disposal purposes. In addition, the mass of the precipitate will be measured or estimated based on the volume and density of the precipitate.

Five types of QA/QC samples will be collected during the field treatability study activities: matrix spike (MS) and MD samples, field duplicate aqueous samples, equipment rinsate samples, and field blank samples.

#### Matrix Spike and Matrix Duplicate Samples

Samples requiring MS and MD analyses will be required as specified in Table B1-3. MS and MD analyses will be performed on a minimum of 5 percent of each matrix, or one in every batch of up to 20 samples. Outside of the sample volumes specified in Table B2-1, no additional sample volume is necessary to perform these analyses on soils. Water samples will be sampled in triplicate for MS and MD analyses. Samples specified for MS and MD analyses are identified in Table B1-3.

#### Field Duplicate Samples

Field duplicate samples will be collected on aqueous samples at the rate of 10 percent, or one for every 10 samples collected, as specified in Table B1-3. Water samples will be sampled in triplicate for field duplicate analyses. Field duplicate samples will be collected at the same time, from the same source, and using the same sampling procedures as the original sample. Field duplicate results will be used to evaluate the overall precision of the sampling and analytical systems. Because of the nonhomogenous nature of soils, field duplicate precision for soils provides no additional information affecting the evaluation of data quality; therefore, no field duplicate soil samples will be collected.

#### Equipment Rinsates

For the soil sampling events, equipment rinsate samples will be collected to determine whether cross-contamination may be introduced by use of inadequately decontaminated sampling equipment. The samples will be collected by rinsing the decontaminated split-spoon sampling device with distilled, deionized water, and collecting this water in properly preserved containers. The frequency of collection will be one equipment rinsate for each day of soil sampling. As specified in Table B1-3, the analyses to be performed are total metals, major anions, and pH.

#### Field Blank Samples

Field blank samples will be collected to determine the background concentrations of the analytes of interest in the water used to decontaminate sampling equipment and to prepare equipment rinsate

samples. For this treatability study, one field blank sample will be submitted to the laboratory for each sampling event. A total of two samples will be collected, one for the sampling of the untreated soil and one for the sampling of the treated soil. The results will be used in the evaluation of the decontamination process. As specified in Table B1-3, the analyses to be performed are total metals, major anions, and pH.

### **B3.0 SAMPLE HANDLING AND CUSTODY REQUIREMENTS**

This section discusses the sample integrity requirements of labeling, containerization, preservation, handling, shipment, and holding times that will be followed during the treatability study.

#### **B3.1 SAMPLE LABELING**

Each sample container will be labeled with a unique field and laboratory sample identification numbers. The label will also identify the date and time of collection and analyses to be performed. Figure B3-1 is an example of the sample labels that will be used. Table B2-1 summarizes the field and laboratory sample identification numbers.

#### **B3.2 CONTAINERIZATION, PRESERVATION, AND HOLDING TIMES**

Table B3-1 presents proper containers, preservatives, and holding time requirements for each analytical parameter to be analyzed. Container sizes have been selected to allow for adequate sample volume for the required analyses. All containers will be obtained from the selected laboratory.

Holding time is the duration a sample can be held from the time it is collected until the time it is analyzed and still produce acceptable results. The holding times were determined from those presented in the reference literature on analytical methods. In some cases, reference literature does not specifically state holding times for a particular analyte. In these instances, a conservative estimate was used, based on holding times for similar analytical methods.

### B3.3 SAMPLE HANDLING AND SHIPMENT

The field team will follow standard EPA COC procedures for each sample as it is collected. The COC form provides defensible documentation of the sample identification and location, sample type and matrix, date and time of collection, and sampling personnel (Figure B3-2). A copy of all COC forms will be compiled at the site as a permanent record of sampling activities. A copy will accompany each set of samples sent to the laboratory, and a final copy of all COC forms will be sent to the TtEMI QA manager. Samples will be retained at all times in the field crew's custody until they are shipped to the laboratory. Samples will be shipped at the end of each day's activities by the field crew to the laboratory via Federal Express. Sample custody will begin when the samples collected are placed into an iced cooler in the possession of the designated field personnel. A line item on the field COC form will be filled out and initialed by the field sample custodian.

When all line items are completed or when the samples are picked up, the field sample custodian will sign and date the COC form, list the time, and confirm the completeness of all descriptive information contained on the form. Each individual who subsequently assumes responsibility for the sample will sign the COC form and list the reason for assuming custody. The field sample custodian will retain a copy of the COC form for program files.

All samples will be packaged and labeled for shipment in compliance with current regulations. In addition, soil samples collected in brass tubes will be bagged in Ziploc freezer bags to minimize the possibility of cross contamination. Plastic coolers will be used for shipping hazardous waste samples. Each cooler will be lined with two plastic bags. Styrofoam or bubble wrap will be used to absorb shock. The cooler must be able to withstand a 1-meter drop on solid concrete in the position most likely to cause damage.

After the containers are packaged, the inner plastic bag around the samples will be sealed by twisting the top and securely taping the bag closed to prevent leaks. A COC seal will then be placed on the plastic bag closure. When preservation requirements dictate, ice will be placed between the inside plastic bag and the outside one, and the outside bag will be taped shut. COC forms and any other shipping and sample documentation will accompany the shipment. These documents will be enclosed in a waterproof plastic bag and taped to the underside of the cooler lid.

Each cooler prepared for shipment will be securely taped shut. Reinforced or other suitable tape (such as duct tape) will be wrapped at least twice around the cooler near each end with hinges. Additionally, a custody seal will be placed across the cooler so that if it is opened, the seal will be broken.

Sample shipping containers will be marked in accordance with U.S. Department of Transportation regulations. In addition to showing complete mailing addresses, each cooler will be clearly marked with "this end up" arrows on all four sides, a label on each side of the container indicating the proper shipping name of the samples, and a sticker containing the originator's address.

Field personnel will ensure that the sample will not exceed allowable holding times during shipment. All samples will be shipped for overnight delivery. The laboratory sample custodian or designated alternate will receive and assume custody of samples until the samples have been properly logged into the laboratory and stored in a secured area. When a sample shipment is received, the cooler will be inspected for warning labels and security breaches before it is opened. The sample custodian will open the cooler and carefully check the contents for evidence of breakage or leaking. The temperature of the water in the cooler will be measured and the presence of ice noted. The contents of the cooler will be inspected for COC forms and other information or instructions. The temperature will be noted on the COC form, along with the date and signature of the person making the entry. The sample custodian will verify that all the information on the sample bottle labels is correct and that it correlates with the information on the COC form and will acknowledge sample receipt.

The samples will be logged into the laboratory's information management system (LIMS) in groups of 20 samples or less that will be referred to as sample delivery groups (SDG). COC forms and SDG assignment sheets will be sent to the TtEMI QA manager to verify receipt. Any discrepancy between the samples and the COC information, any broken or leaking sample bottles, or any other abnormal situation will be documented on a deficiency report (DR) form and be reported to the laboratory project manager. The TtEMI QA manager will be informed of any problem, and corrective action options will be discussed and implemented. The problem and its resolution will be noted on the DR form and will be initialed and dated by the sample custodian.

## **B4.0 ANALYTICAL METHODS REQUIREMENTS**

Selection of the appropriate methods to prepare and analyze the EK treatability study samples is dependent upon the specific analytes of interest, the sample matrix, and the minimum detectable concentrations needed for the project. Because the analytical results from this treatability study will be incorporated into the RI/FS report document, fully defensible definitive data that can be used for risk assessment purposes are required for all soil samples. In addition, to evaluate the effectiveness of the EK technology to remove chromium and other heavy metals from Site 5 soils, definitive data are necessary for all process streams.

Where applicable, EPA CLP procedures were selected for all matrices. For analyses in which no CLP method is available, alternative EPA and ASTM methods were selected. In addition, the laboratory will be required to submit full data packages to the TtEMI QA manager for the purpose of performing third party data validation on the data. The analytical methods are presented in Table B3-1. Any failures in the analytical systems that may compromise these methods and procedures will be reported immediately to the TtEMI QA manager. Alternate analytical methods and subcontracting of samples to other laboratories will not be allowed unless the TtEMI QA manager is consulted and approves such changes.

## **B5.0 QUALITY CONTROL REQUIREMENTS**

Internal QC consists of the checks and procedures performed within the project to ensure that the QA objectives are met. These checks and procedures verify compliance with the objectives or indicate the need for corrective action. Internal QC consists of: (1) checks controlling field activities, such as sample collection and shipping, and (2) checks controlling laboratory activities, such as extraction and analysis. These checks are discussed below.

### **B5.1 FIELD QUALITY CONTROLS**

Field QC checks include those measures necessary to ensure that quality data are generated during the field sampling operations. For this treatability study, equipment rinsate blanks, field duplicate samples, and field blanks will provide the data necessary to evaluate field QC.

### **B5.1.1 Equipment Rinsate Blanks**

Equipment rinsate samples are used to evaluate the decontamination procedures and the resulting cleanliness of the sampling equipment. The rinsate samples will be collected after a sample collection device is subjected to standard decontamination procedures. Distilled/deionized source water will be poured over or through the sampling device after decontamination and will be collected in the appropriate containers for analysis. The equipment rinsate samples will be packaged along with the field samples and shipped blind to the laboratory for the specified analyses. One equipment rinsate sample per sampling device per day will be collected and submitted for the appropriate analyses.

### **B5.1.2 Field Duplicate Samples**

Field duplicate samples will be collected on aqueous samples at the rate of 10 percent, or one for every 10 samples collected. Field duplicate samples will be collected at the same time, from the same source, and using the same sampling procedures as the original sample. Field duplicate results will be used to evaluate the overall precision of the sampling and analytical systems. Because of the nonhomogenous nature of soils, field duplicate precision for soils provides no additional information affecting the evaluation of data quality; therefore, no field duplicate soil samples will be collected.

### **B5.1.3 Field Blank Samples**

Field blank samples will be submitted to the laboratory to determine the background concentrations of the analytes of interest in the water used to decontaminate sampling equipment and to prepare equipment rinsate samples. For this treatability study, one field blank sample will be submitted to the laboratory for each sampling event. A total of two samples will be collected, one for the sampling of the untreated soil and one for the sampling of the treated soil. The results will be used in the evaluation of the decontamination process.

## **B5.2 LABORATORY QUALITY CONTROL CHECKS**

The following internal analytical laboratory QC measures will be taken, where appropriate, to ensure a high degree of precision and accuracy. Laboratory QC samples and procedures will be performed at the frequency specified in the referenced method, and as required by the laboratory's QA/QC program.

- Method blanks
- MS samples
- MD samples
- Laboratory control samples (LCS)
- Calibration standards
- Continuing calibration check standards
- Instrument performance check standards
- Detection limit check standards
- Analyte interference check samples
- Postdigestion spike samples

In addition to these QC parameters, the laboratory will be required to maintain QC control charts for all analyses being performed. MS and LCS accuracy and MD precision will be monitored based on the current control chart for each method. Control charts should be updated every 3 months or after 30 QC measurements have been performed.

#### **B6.0 INSTRUMENT AND EQUIPMENT TESTING, INSPECTION, AND MAINTENANCE REQUIREMENTS**

Instrumentation and equipment operation is discussed in the following sections.

##### **B6.1 FIELD PROCEDURES AND EQUIPMENT**

The HSA drill rig and associated equipment will be operated by a certified driller according to standard drilling procedures.

Geokinetics personnel will perform testing, inspection, and maintenance for the demonstration equipment such as pumps, piping, electrical supplies, computer control equipment, and process sensors. Field instrument calibration is described in Section B7.1.

##### **B6.2 LABORATORY PROCEDURES AND ANALYTICAL EQUIPMENT**

The laboratory will follow its own QA/QC plan for the testing, inspection, and maintenance of all analytical testing equipment and procedures. Standard operating procedures (SOP) for each analytical method and laboratory procedure will define all QC parameters and the frequency at which each parameter is performed. SOPs will be made available to all laboratory personnel for review and

reference purposes. Laboratory personnel following laboratory procedures and operating high-tech instrumentation, along with performing the inspections, testing, and maintenance on these methods and equipment, will be properly trained and supervised by qualified staff.

## **B7.0 INSTRUMENT CALIBRATION AND FREQUENCY**

An important function in maintaining data quality is the proper operation and calibration of the source measurement and sampling equipment. Using referenced procedures, the equipment will be calibrated before field sampling begins, and the results will be properly documented and retained. Standard reference calibration techniques will be used where applicable, and in all cases, the manufacturer's recommendations will be followed.

### **B7.1 FIELD MEASUREMENT AND SAMPLING EQUIPMENT CALIBRATION**

The calibration frequency of field measurement and sampling equipment is presented in Table B7-1. The procedures used to calibrate this equipment are discussed below.

#### **B7.1.1 Conductivity Meter Calibration**

Conductivity sensors and meters used in this project will be calibrated with certified standard solutions provided from a reputable supplier such as Fisher Scientific or Baxter Scientific analytical supply companies. Conductivity sensors and meters will be calibrated as per manufacturer's recommendations, and the results of the calibration activities will be logged in a field logbook.

#### **B7.1.2 Pressure Gauge Calibration**

Gauges used during this project to measure differential and static pressures during sampling will be calibrated according to the technique described in Section 3.1.2 of EPA document 600/4-77-027b (EPA 1977). This technique requires that pressure readings of the gauge be compared directly to that of a oil gauge manometer. The gauges will be calibrated before field sampling and checked following the field sampling. Before the field sampling activities, the gauges will be inspected in the laboratory and documented as meeting EPA specifications before shipping to the field. All calibration activities will be documented in a field logbook.

### **B7.1.3 Temperature Sensor Calibration**

Thermocouple temperature sensors will be calibrated using the procedure described in Section 3.4.2 of EPA document 600/4-77-027b (EPA 1977). Each temperature sensor will be calibrated at a minimum of three points over the anticipated range of use (if possible) against a National Bureau of Standards-traceable, mercury-in-glass thermometer. All sensors will be calibrated before field sampling. Before the field sampling activities, the thermocouple temperature sensors will be inspected in the laboratory. After passing the inspection, the sensors will be documented as meeting EPA specifications and shipped to the field. All calibration activities will be documented in a field logbook.

### **B7.1.4 pH Meter Calibration**

pH sensors and meters will be calibrated using certified pH buffer solutions with values of 4.00, 7.00, and 10.00. Certified calibration standards will be obtained from a reputable supplier of analytical supplies. pH sensors and meters will be calibrated in accordance with manufacturer's recommendations, and the results of the calibration activities will be logged in a field logbook.

### **B7.1.5 Analytical Balance Calibration**

During the field measurement program, the analytical balance will be calibrated over the expected range of use with certified standard weights (traceable to National Institute of Standards and Technology [NIST] standards) before use and then checked on a daily basis. All calibration activities will be logged in a field log book.

## **B7.2 LABORATORY INSTRUMENT CALIBRATION**

Specific calibration procedures for standard EPA and ASTM methods are described in the published method protocols that are referenced in Section A7.1. Also, a summary of calibration procedures and the internal QC requirements including frequency of calibration checks, acceptance criteria, and corrective action requirements, are provided in Section A7.0.

Calibration standards are prepared from standard reference materials obtained from EPA or other approved sources. Calibration check samples are prepared from sources other than those used for calibration. Standards must be traceable to their source throughout analysis.

#### **B8.0 INSPECTION AND ACCEPTANCE REQUIREMENTS FOR SUPPLIES AND CONSUMABLES**

All supplies and consumable materials will be obtained from reputable vendors. In the case of reagents used to calibrate instrumentation, standards will either be supplied by the instrument manufacturer, or a certified reference material will be obtained from a reputable supply company. No certified reference material will be used past its date of expiration.

Process chemicals will also be obtained from a reputable supply company. All shipments of chemicals will be inspected before they are used. Any chemical containers that are not completely sealed with the original wrappings or sealing materials, or appear to have been tampered with, will be returned to the supplier for replacement. Process chemicals will also be stored in such a way as to prevent contamination. Containers will be kept sealed and away from direct sunlight and moisture.

Sample containers will come prepreserved according to EPA requirements from the laboratory. Any containers that are broken, visibly contaminated, or otherwise appear to have been tampered with will be discarded. Sample containers will be kept sealed and stored in such a way as to prevent contamination.

Distilled/deionized water for the use of sampling equipment decontamination and for equipment rinsate preparation will be obtained from reputable suppliers. A sample of the water will be submitted to the laboratory for analysis to determine baseline concentrations of the contaminants of interest. The water will be obtained in 5-gallon carboys and will be stored in such a way that will prevent contamination before and during use. Potable water used for the preparation of the electrolytes will be obtained from water outlets within Building 5 at Alameda Point. The water is supplied by East Bay Municipal Utilities District. Since all process streams will be analyzed for baseline contaminants before system startup, it will not be necessary to analyze the potable water.

## **B9.0 DATA ACQUISITION REQUIREMENTS (NONDIRECT MEASUREMENTS)**

Not applicable.

## **B10.0 DATA MANAGEMENT**

The following sections outline the project data management scheme.

### **B10.1 FIELD DATA MANAGEMENT**

Field data collected by the process control computer system will be stored electronically and downloaded onto diskettes for permanent storage. Hard copy reports of the data will be generated and compiled for review. The Geokinetics field operations manager will be responsible for the review, transfer, and storage of all data collected for the duration of the demonstration.

Field activities that include the preparation of chemical solutions, sampling and measurements of process parameters, and any changes made to the operating conditions of the process equipment, will be documented by the operations manager in a daily field operations logbook.

TtEMI personnel responsible for the sampling and analysis of process streams for the purpose of submittal to the laboratory will follow the documentation requirements detailed in Section B3.0.

### **B10.2 LABORATORY DATA MANAGEMENT**

Upon the receipt of the samples to the laboratory, the laboratory sample control personnel will reconcile the information on the COC forms with the sample bottles received. Sample control will document any anomalies and report these to the laboratory project manager. The information on the COC forms will then be entered into the LIMS along with the analyses being requested, and proper sample bottle labels will be generated and attached to the bottles.

Data that are acquired through the sample preparation, analysis, and reporting processes are tracked using the LIMS. Data are either transferred from the instrumentation electronically to the LIMS, or qualified personnel enter the data through terminals. The laboratory is responsible to track all QC

measurements along with the specific sample results as a batch process. Any QC measurements that exceed the specified QC limits for the project are documented, and the TtEMI QA manager is notified. After all data are collected, reviewed, and approved, the laboratory will generate an electronic deliverable from the LIMS. A hard copy data package is generated for the TtEMI QA manager as is a copy of the electronic deliverable.

The laboratory project manager is responsible for proper sample handling and documentation that will allow for the tracking of individual samples from the time of receipt to the submittal of the final data package and electronic deliverable to the TtEMI QA manager. Laboratory login deficiency reports and laboratory nonconformance memoranda will be used by the laboratory to document and disseminate nonconformance information to the TtEMI QA manager. The laboratory is required to maintain the analytical records for a period of 10 years. Data can be stored in a number of ways usually including a combination of hard copy and computer tape backups.

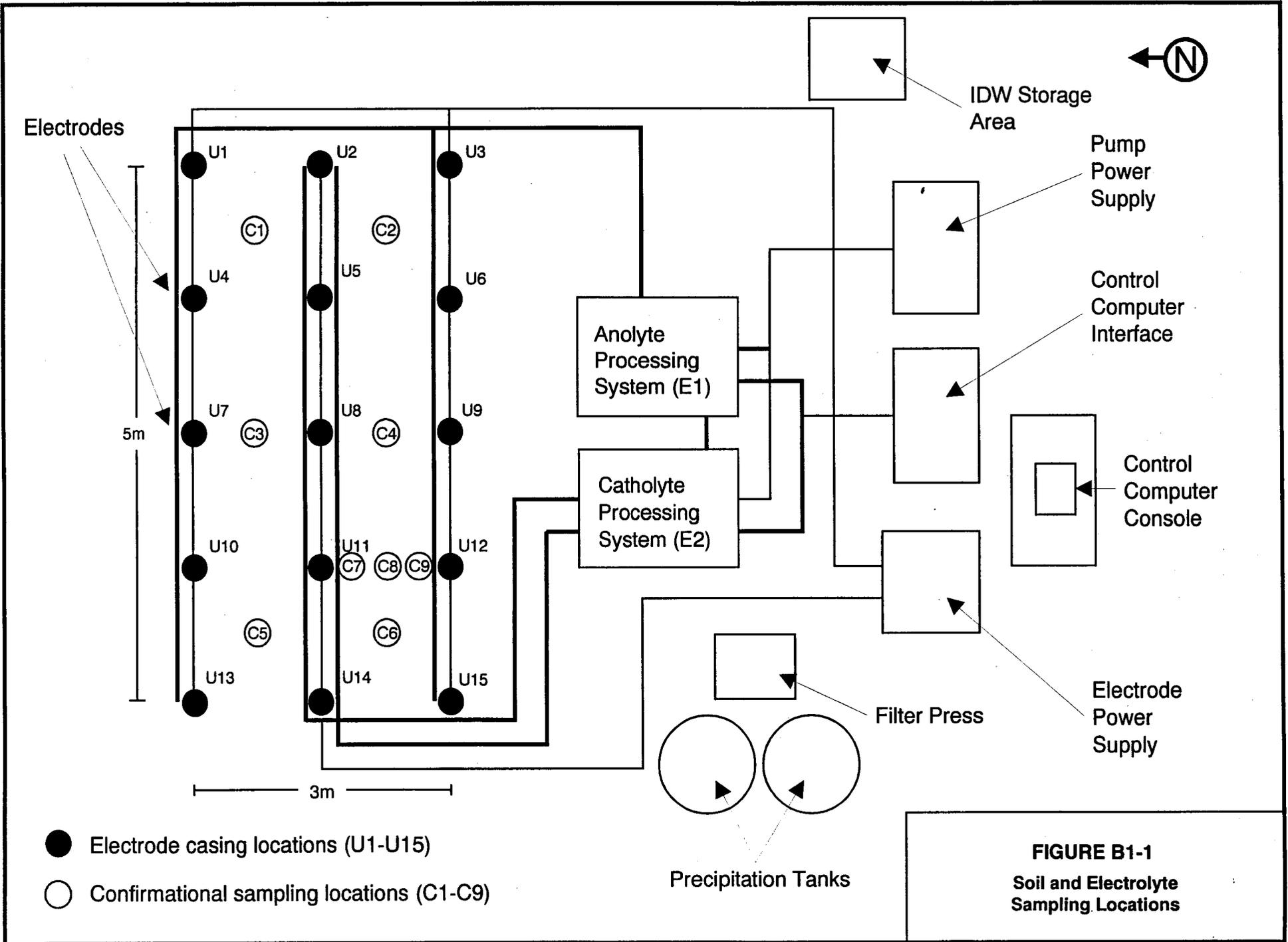
### **B10.3 TETRA TECH EM INC. DATA MANAGEMENT**

The laboratory is responsible for sending a hard copy of the entire data package and an electronic deliverable on computer diskette to the TtEMI QA manager. After the receipt of the data package, the electronic deliverable will be imported into TtEMI's database. The importing program has a system of checks that are performed to determine whether any of the requested fields have not been properly filled. It checks for problems with detection limits, analyte concentrations, analyte nomenclature, analytical test name nomenclature, sampling and analysis dates, duplicate records, and many other checks that could possibly indicate a problem with the electronic deliverable. Any errors reported by the importing program are thoroughly investigated. If necessary, the laboratory is requested to regenerate the deliverable. The hard copy is also checked for completeness. If any sections have been omitted by the laboratory, these sections are requested.

Data tables are printed from the database, and a copy of both the data tables and the hard copy data package are sent to an outside party for validation. The validator scrutinizes every aspect of the data package and reconciles any discrepancies found in the data with the laboratory. The validator then applies qualifiers to any anomalies in the data and marks the electronic data tables for correction. The validator prepares a data validation report based on the thorough review and then returns the data package, marked tables, and data validation report to the TtEMI QA manager.

At this point, the TtEMI QA manager reviews the data validation report and the marked tables for technical correctness. The data validation report is then edited for technical content, and the data tables are submitted to a data entry person for changes. The final version of the data validation report and the updated tables are reviewed for completeness by a technical reviewer. When complete, the data are ready for distribution to the user.

The TtEMI QA manager is responsible for the proper handling of the data. At the conclusion of the project, the TtEMI QA manager will prepare a QC summary report in support of the RI/FS report, to summarize the overall quality of the data and determine whether the data quality objectives were met. All hard copy data packages are stored in an off-site storage facility, and the final version of the electronic data tables are downloaded onto electronic data diskettes for permanent storage.



- Electrode casing locations (U1-U15)
- Confirmational sampling locations (C1-C9)

**FIGURE B1-1**  
Soil and Electrolyte  
Sampling Locations

PRC Environmental Management Inc.  
916-852-8300  
10670 White Rock Road, Suite 100  
Rancho Cordova, CA 95670

SAMPLE ID: 107-TDS-

PROJECT NUMBER: 044-0107IRRIF2

INSTALLATION: NAS ALAMEDA

FIELD LOCATION:

MATRIX: SOIL / AQUEOUS / SOLID

ANALYSIS:

PRESERVATIVE:  
FILTERED YES / NO

DATE: TIME:

SAMPLER'S INITIALS:

FIGURE B3-1  
Sample Label

TABLE B1-1

SAMPLING OVERVIEW  
ALAMEDA POINT

Sampling Location	Analytical Parameter	Selection Rationale
EK demonstration grid untreated soil (U1-U15)	Chromium	To determine baseline contaminant concentrations and to compare to regulatory limits
	Total metals, cyanide, major anions, Soil pH, percent moisture	To determine physical and chemical characteristics of soil
	Soil density, soil volume	For mass balance determination
EK demonstration grid treated soil (C1-C9)	Chromium	To determine removal efficiency of chromium and to compare to regulatory limits
	Total metals, major anions, Soil pH, percent moisture	To determine removal efficiency of metals and to determine physical and chemical characteristics of soil
Anolyte and catholyte solutions prestartup (E1 and E2)	Total metals, major anions, pH	To determine background contaminant concentrations
Anolyte and catholyte solutions during process operation (E1 and E2)	Analyses at the desecration of Geokinetics	Backup for process control measurements
Stripped electrolyte solutions postshutdown (E3 and E4)	Total metals, major anions, pH	To compare to regulatory limits for disposal purposes
	Chromium, volume	For mass balance determination
Filter cake from precipitation process postshutdown (P1)	Total Metals, Soil pH	To compare to regulatory limits for disposal purposes
	Chromium, mass, percent moisture	For mass balance determination

TABLE B1-2

SAMPLE COLLECTION AND FIELD MEASUREMENT REQUIREMENTS  
ALAMEDA POINT

Sample Location	Analytical Parameter	Sampling Method	Sample Matrix	No. of Samples
Untreated soil (U1-U15)	Chromium	G	Soil	45
	Total metals	G		9
	Cyanide	G		9
	Major anions	G		9
	Percent moisture	G		45
	Soil pH	G		45
	Soil density	G		9
	Volume	M		1
	Mass	CA		1
Treated soil (C1-C9)	Chromium	G	Soil	27
	Total metals	G		6
	Major anions	G		6
	Percent moisture	G		27
	Soil pH	G		27
Anolyte (E1) prestartup	Total metals	G	Aqueous	1
	Major anions	G		1
	pH	G		1
Catholyte (E2) prestartup	Total metals	G	Aqueous	1
	Major anions	G		1
	pH	G		1
Anolyte (E1) during process operation	pH	M	Aqueous	1,440
	Conductivity	M		1,440
	Temperature	M		1,440
	Samples on hold	G		30
Catholyte (E2) during process operation	pH	M	Aqueous	1,440
	Conductivity	M		1,440
	Temperature	M		1,440
	Samples on hold	G		30
Stripped Electrolyte Solutions (E3 and E4) post-shutdown	Total metals	G	Aqueous	2
	Major anions	G		2
	pH	G		2
	Volume	M		2
Precipitate filter cake post-shutdown (P1)	Total metals	G	Solid	1
	Percent moisture	G		1
	Mass	M		1

TABLE B1-3

FIELD AND LABORATORY IDENTIFICATION NUMBERS  
FOR ELECTROKINETIC TREATABILITY STUDY SAMPLES  
ALAMEDA POINT

Sample Identification	Field Identification	Matrix	MS and MD Analyses	METALS	CHROME	CYANIDE	ANIONS	PH	% MOIST	DENSITY
107-TSD-001	U1-1	Soil	X		X			X	X	
107-TSD-002	U1-4	Soil			X			X	X	
107-TSD-003	U1-8	Soil			X			X	X	
107-TSD-004	U2-1	Soil			X			X	X	
107-TSD-005	U2-4	Soil			X			X	X	
107-TSD-006	U2-8	Soil			X			X	X	
107-TSD-007	U3-1	Soil			X			X	X	
107-TSD-008	U3-4	Soil			X			X	X	
107-TSD-009	U3-8	Soil			X			X	X	
107-TSD-010	U4-1	Soil			X			X	X	
107-TSD-011	U4-4	Soil			X			X	X	
107-TSD-012	U4-8	Soil			X			X	X	
107-TSD-013	U5-1	Soil			X			X	X	
107-TSD-014	U5-4	Soil			X			X	X	

TABLE B1-3 (Continued)

FIELD AND LABORATORY IDENTIFICATION NUMBERS  
FOR EK TREATABILITY STUDY SAMPLES  
ALAMEDA POINT

Sample Identification	Field Identification	Matrix	MS and MD Analyses	METALS	CHROME	CYANIDE	ANIONS	PH	% MOIST	DENSITY
107-TSD-015	U5-8	Soil			X			X	X	
107-TSD-016	U6-1	Soil			X			X	X	
107-TSD-017	U6-4	Soil			X			X	X	
107-TSD-018	U6-8	Soil			X			X	X	
107-TSD-019	U7-1	Soil		X		X	X	X	X	X
107-TSD-020	U7-4	Soil	X	X		X	X	X	X	X
107-TSD-021	U7-8	Soil		X		X	X	X	X	X
107-TSD-022	U8-1	Soil		X		X	X	X	X	X
107-TSD-023	U8-4	Soil		X		X	X	X	X	X
107-TSD-024	U8-8	Soil		X		X	X	X	X	X
107-TSD-025	U9-1	Soil		X		X	X	X	X	X
107-TSD-026	U9-4	Soil		X		X	X	X	X	X
107-TSD-027	U9-8	Soil		X		X	X	X	X	X
107-TSD-028	U10-1	Soil			X			X	X	

TABLE B1-3 (Continued)

FIELD AND LABORATORY IDENTIFICATION NUMBERS  
FOR EK TREATABILITY STUDY SAMPLES  
ALAMEDA POINT

Sample Identification	Field Identification	Matrix	MS and MD Analyses	M E T A L S	C H R O M E	C Y A N I D E	A N I O N S	P H	% M O I S T	D E N S I T Y
107-TSD-029	U10-4	Soil			X			X	X	
107-TDS-030	U10-8	Soil			X			X	X	
107-TDS-031	U11-1	Soil			X			X	X	
107-TDS-032	U11-4	Soil			X			X	X	
107-TDS-033	U11-8	Soil			X			X	X	
107-TDS-034	U12-1	Soil			X			X	X	
107-TDS-035	U12-4	Soil			X			X	X	
107-TDS-036	U12-8	Soil			X			X	X	
107-TDS-037	U13-1	Soil			X			X	X	
107-TDS-038	U13-4	Soil			X			X	X	
107-TDS-039	U13-8	Soil			X			X	X	
107-TDS-040	U14-1	Soil	X		X			X	X	
107-TDS-041	U14-4	Soil			X			X	X	
107-TDS-042	U14-8	Soil			X			X	X	

TABLE B1-3 (Continued)

FIELD AND LABORATORY IDENTIFICATION NUMBERS  
FOR EK TREATABILITY STUDY SAMPLES  
ALAMEDA POINT

Sample Identification	Field Identification	Matrix	MS and MD Analyses	METALS	CHROME	CYANIDE	ANIONS	PH	% MOIST	DENSITY
107-TDS-043	U15-1	Soil			X			X	X	
107-TDS-044	U15-4	Soil			X			X	X	
107-TDS-045	U15-8	Soil			X			X	X	
107-TDS-046	C1-1	Soil			X			X	X	
107-TDS-047	C1-4	Soil			X			X	X	
107-TDS-048	C1-8	Soil			X			X	X	
107-TDS-049	C2-1	Soil			X			X	X	
107-TDS-050	C2-4	Soil			X			X	X	
107-TDS-051	C2-8	Soil			X			X	X	
107-TDS-052	C3-1	Soil		X			X	X	X	
107-TDS-053	C3-4	Soil		X			X	X	X	
107-TDS-054	C3-8	Soil		X			X	X	X	
107-TDS-055	C4-1	Soil		X			X	X	X	
107-TDS-056	C4-4	Soil		X			X	X	X	

TABLE B1-3 (Continued)

FIELD AND LABORATORY IDENTIFICATION NUMBERS  
FOR EK TREATABILITY STUDY SAMPLES  
ALAMEDA POINT

Sample Identification	Field Identification	Matrix	MS and MD Analyses	M E T A L S	C H R O M E	C Y A N I D E	A N I O N S	P H	% M O I S T	D E N S I T Y
107-TDS-057	C4-8	Soil		X			X	X	X	
107-TDS-058	C5-1	Soil			X			X	X	
107-TDS-059	C5-4	Soil			X			X	X	
107-TDS-060	C5-8	Soil	X		X			X	X	
107-TDS-061	C6-1	Soil			X			X	X	
107-TDS-062	C6-4	Soil			X			X	X	
107-TDS-063	C6-8	Soil			X			X	X	
107-TDS-064	C7-1	Soil			X			X	X	
107-TDS-065	C7-4	Soil			X			X	X	
107-TDS-066	C7-8	Soil			X			X	X	
107-TDS-067	C8-1	Soil			X			X	X	
107-TDS-068	C8-4	Soil			X			X	X	
107-TDS-069	C8-8	Soil			X			X	X	
107-TDS-070	C9-1	Soil			X			X	X	

TABLE B1-3 (Continued)

FIELD AND LABORATORY IDENTIFICATION NUMBERS  
FOR EK TREATABILITY STUDY SAMPLES  
ALAMEDA POINT

Sample Identification	Field Identification	Matrix	MS and MD Analyses	METALS	CHROMIUM	CYANIDE	ANIONS	PH	% MOIST	DENSITY
107-TDS-071	C9-4	Soil			X			X	X	
107-TDS-072	C9-8	Soil			X			X	X	
107-TDS-073	E1-1	Aqueous		X			X	X		
107-TDS-074	E2-1	Aqueous		X			X	X		
107-TDS-075	E3-1	Aqueous	X	X			X	X		
107-TDS-076	E4-1	Aqueous		X			X	X		
107-TDS-077	E4-1DUP	Aqueous		X			X	X		
107-TDS-078	P1-1	Solid	X		X		X	X		
107-TDS-079	Equipment Rinsate (ER)-1	Aqueous		X			X	X		
107-TDS-080	ER-2	Aqueous		X			X	X		
107-TDS-081	ER-3	Aqueous		X			X	X		
107-TDS-082	ER-4	Aqueous		X			X	X		
107-TDS-083	ER-5	Aqueous		X			X	X		
107-TDS-084	ER-6	Aqueous		X			X	X		

TABLE B1-3 (Continued)

FIELD AND LABORATORY IDENTIFICATION NUMBERS  
FOR EK TREATABILITY STUDY SAMPLES  
ALAMEDA POINT

Sample Identification	Field Identification	Matrix	MS and MD Analyses	METALS	CHROME	CYANIDE	ANIONS	PH	% MOIST	DENSITY
107-TDS-085	Field Blank (FB)-1	Aqueous		X			X	X		
107-TDS-086	FB-2	Aqueous		X			X	X		
107-TDS-087	Auxiliary Sample #									
107-TDS-088	Auxiliary Sample #									
107-TDS-089	Auxiliary Sample #									
107-TDS-090	Auxiliary Sample #									
107-TDS-091	Auxiliary Sample #									
107-TDS-092	Auxiliary Sample #									
107-TDS-093	Auxiliary Sample #									
107-TDS-094	Auxiliary Sample #									
107-TDS-095	Auxiliary Sample #									
107-TDS-095	Auxiliary Sample #									

Notes:

MS Matrix spike

MD Matrix duplicate

DUP Duplicate

TABLE B3-1

ANALYTICAL METHOD, CONTAINER, PRESERVATION, AND HOLDING TIME  
 REQUIREMENTS FOR ELECTROKINETIC TREATABILITY STUDY SAMPLES  
 ALAMEDA POINT

Parameter		Water Methods	Sample Container	Minimum Volume	Preservative	Holding Time
Chromium and Total Metals		CLP <sup>a</sup>	High density polyethylene	500 mL	HNO <sub>3</sub> to pH < 2	Mercury 28 days all others 6 months
Cyanide		CLP <sup>a</sup>	High density polyethylene	500 mL	NaOH to pH > 12	14 days
Major anions	Chloride, Fluoride, Sulfate	EPA 300.0 <sup>b</sup>	High density polyethylene	500 mL	Cool, 4° C	28 days
	Fluoride (alternate method)	EPA 340.2 <sup>c</sup>				28 days
	Nitrate/nitrite	EPA 353.2 <sup>c</sup>				28 days
pH		EPA 150.1 <sup>c</sup>				immediate
Parameter		Soil Methods	Sample Container	Sample Tube Size	Preservative	Holding Time
Chromium and total metals		CLP <sup>a</sup>	Brass sampling tube	2 by 6 inches	Cool, 4 C	6 months
Soil pH		CLP <sup>a</sup>				3 days
Percent moisture		CLP <sup>a</sup>				14 days
Major anions <sup>d</sup>		EPA 300.0 <sup>b</sup>				28 days
Soil density		ASTM <sup>e</sup>				28 days

Notes:

- <sup>a</sup> Contract Laboratory Program Statement of Work for Inorganic Analyses, ILM04.0, (EPA 1995 )
- <sup>b</sup> The Determination of Inorganic Anions in Water by Ion Chromatography Method 300.0, (EPA1984)
- <sup>c</sup> Methods for Chemical Analysis of Water and Wastes, (EPA 1983)
- <sup>d</sup> EPA Method 300.0 applied to a D.I. water extract of soil sample
- <sup>e</sup> American Standards of Testing and Materials

TABLE B7-1

CALIBRATION FREQUENCY FOR FIELD MEASUREMENT AND SAMPLING EQUIPMENT  
ALAMEDA POINT

Sampling Equipment	Initial Calibration Frequency		Calibration Check Frequency	
	Before Sampling	Weekly	After Sampling	Daily
Conductivity meter	X			
Pressure gauge	X		X	
Thermocouple temperature sensors	X			
pH meter	X		X	
Analytical balance		X		X

## GROUP C. ASSESSMENT / OVERSIGHT

### **C1.0 PERFORMANCE AND SYSTEM AUDITS**

A QA audit is an independent assessment of a measurement system. QA audits may consist of performance or system audits and may be conducted internally or externally. Internal audits are conducted by the project QA manager and may be functionally independent of the sampling and analysis teams. External audits are conducted by an independent organization, such as EPA.

The laboratory will maintain an internal QA audit program of annual performance and system audits. The laboratory will also participate in external QA audits, including site inspections by government agencies, certification testing, and participation in EPA interlaboratory comparison studies. The laboratory coordinator keeps results for these, as well as the laboratory's internal and project specific audit activities, on file for each laboratory. The laboratory will participate in project-specific external audits as requested by the TtEMI QA manager.

### **C1.1 PERFORMANCE AUDITS**

Performance audits of sampling and analysis procedures will be conducted at the discretion of the TtEMI QA manager. The audits will consist of the following:

- Performing field operation audits which review and document field sampling efforts
- Issuing blind QC samples to the analytical laboratory and requiring analysis of specified critical parameters
- Preparing a QA report that will include the results of the blind QC samples

### **C1.2 SYSTEM AUDITS**

System audits will be conducted at the direction of the TtEMI QA manager. The audits will include the following, as appropriate:

- Review the demonstration organization to determine the functional operation of the QA program
-

- Determine whether SOPs are available and implemented as written
- Assess traceability of samples and data
- Determine whether appropriate QC checks are being made and that appropriate documentation is maintained
- Determine whether the equipment specified in the QAPP is available, calibrated, and in proper working condition
- Determine whether record keeping procedures, including notebooks, logsheets, bench sheets, and tracking forms are properly maintained
- Prepare a report to be submitted to the project manager

### **C1.3 CORRECTIVE ACTION**

If problems are detected during any performance or system audit, the laboratory project manager or the field team leader will immediately notify the TtEMI QA manger of the problem. A course of action will be decided on based on a thorough discussion of the problem, and immediate action will be taken to correct the problem. The laboratory project manager or the field team leader will then prepare and send a corrective action memorandum to the TtEMI QA manager and other appropriate personnel, as needed.

During the demonstration, corrective actions will be taken any time problems are identified in the program that affect either data quality or the proper operation of the demonstration equipment. The appropriate project manager is responsible for identifying the cause of the problem and developing a solution. The effects of the solution will be examined to determine whether or not the action eliminates the problem and associated concerns. If the corrective action is initially successful, the demonstration project manager, field team leader, or laboratory project manager will prepare a corrective action memorandum for the TtEMI QA manager describing the corrective action, the timeframe and method for implementation, and the expected results. If the corrective action is not initially successful, the appropriate manager will submit a corrective action memorandum identifying the problem and the initial measures taken to correct the problem. A copy of the memorandum will also be sent to the EFA West project manager. The project managers will be responsible for implementing corrective measures and will assess their effectiveness after implementation.

## **C2.0 REPORTS TO MANAGEMENT**

Effective management of environmental measurement efforts requires timely assessment and review. This assessment and review requires interaction and feedback between the team members. Weekly status reports from the EK demonstration team will be required to provide ongoing evaluation of the demonstration operation and resulting data quality. Such reports may include the following information:

- A summary of project activities and general QA program status
- A summary of any changes to the process or to operating procedures
- A summary of scheduled and unscheduled maintenance activities
- A summary of corrective action activities
- System and performance audit results

Weekly status reports will be prepared by the EK demonstration team and will include input from TtEMI oversight personnel, the Geokinetics field manager, and the Geokinetics project manager. Computerized reports will be prepared and sent to both the TtEMI QA manager and the EFA West project manager.

## **GROUP D. DATA VALIDATION AND USABILITY**

### **D1.0 DATA REVIEW, VALIDATION, AND VERIFICATION REQUIREMENTS**

Accurate data reduction, validation, and reporting are essential to summarize the data that will be used to support the treatability study conclusions. The following sections describe the reduction, validation, and reporting procedures to be used for field and laboratory data.

#### **D1.1 DATA REDUCTION**

Wherever possible, the initial data reduction will be computerized. This reduces the frequency of transcription and calculation errors. Where data reduction is not computerized, calculations will be performed in permanently bound laboratory notebooks or on preprinted data reduction pages. The data reduction for some analyses may include the analysts' interpretations of the raw data and manual calculations. When this is required, the analysts' decisions will be written in ink on the raw data

sheets. Any corrections to data sheets will be made by lining out inaccurate information, initialing the lined-out entry, and adding the revised information next to the lined-out entry.

The laboratory will evaluate all of the raw data generated before, during, and after the sample analyses for correctness, completeness, and adherence to specific QC guidelines. The data reduction process may include some or all of the following procedures:

- Review of initial QC checks including method detection limits and analyte sensitivity checks, method blanks, calibrations, matrix interference check standards, and instrument performance checks
- Review and interpretation of raw data including quantitation reports, chromatograms, mass spectral data matches, and instrument readings from the sample and QC analyses
- Computation of analyte concentrations including all preparatory and dilution factors
- Computation of QC data including surrogate and internal standard recoveries, spike recoveries, and duplicate precision
- Comparison of QC results to established control limits.
- Reanalysis of samples or the qualification of specific analytes as a result of QC problems

For each method, specific criteria must be performed and evaluated on a per batch and per sample basis. For this project, the reduction of analytical data will be performed using the format specified in the appropriate EPA or CLP method. Documentation of the data reduction process will include the generation of CLP data packages and electronic data deliverables in compliance with the TtEMI laboratory services SOW (PRC 1995).

## **D1.2 DATA VALIDATION AND VERIFICATION METHODS**

Data validation is the process through which the laboratory data package or SDG, is technically evaluated by a third party independent of the laboratory. Through the data validation process, the data will be evaluated for acceptable quality and quantity, based on the critical indicator parameters of PARCC (EPA 1987). These parameters are discussed in detail in Section A7.0 of the QAPP.

Samples will be analyzed by the laboratory in SDGs that consist of no more than 20 samples each. All analytical methods for each SDG will be validated based on the criteria in the "Laboratory Data

Validation Functional Guidelines for Evaluating Inorganics Analyses" (EPA, 1988). A validation narrative will be prepared for each SDG by the validation reviewer. Each validation narrative will contain a list of the samples in the SDG, the analyses performed, the identity of the samples receiving full validation, and the results of validation for each methodology. All samples in each SDG will receive a cursory validation review, and initially 10 percent of the samples for each of the analyses performed will receive a full validation review. The cursory validation and the full validation criteria are listed below.

All items listed are evaluated in a full validation review. Cursory review items are indicated by a single asterisk (\*).

#### CLP Inorganics (Functional Guidelines for Evaluating Inorganics Analyses)

- \* Holding times
- \* Calibration (initial and continuing)
- \* Blanks (method, instrument, and preparation blanks)
- Inductively coupled plasma (ICP) interference check sample
- \* LCS
- \* Duplicate sample analysis
- \* MS sample analysis
- GFAA (graphite furnace) quality control (QC)
- \* ICP serial dilution
- Sample result verification
- \* Field duplicates
- \* Overall assessment of data for a SDG

#### Non-CLP Inorganic Parameters

- \* Method compliance
- \* Holding times
- \* Calibration (initial and continuing)
- \* Blanks (method, instrument, and preparation blanks)
- \* Sample duplicates, MS, blank spikes
- \* Other laboratory QC specified by the method
- \* Field duplicates
- Detection limits
- Compound identification
- Compound quantitation
- Sample result verification
- \* Overall assessment of data for an SDG

During the process of data validation, validators will complete worksheets that document the criteria reviewed. These worksheets will be used to generate the validation narrative. The worksheets are part of the complete data validation report which will be kept on file in TtEMI's Sacramento office.

Once the data are reviewed, data validation qualifiers will be applied to the analytical results. Data validation qualifiers are alphabetic characters placed adjacent to each reported value that correspond to definitions specified by the functional guidelines. The functional guidelines data validation qualifiers and their definitions are listed below.

#### Data Qualifiers

- U - Indicates the compound was analyzed for, but was not detected above the concentration listed. The value listed is the sample quantitation limit.
- J - Indicates an estimated concentration value. The result is considered qualitatively acceptable but quantitatively unreliable.
- UJ - Indicates an estimated quantitation limit. The compound was analyzed for, but was considered nondetected.
- JN - The analysis indicates the presence of an analyte that has been "tentatively identified," and the associated numerical value represents its approximate concentration.
- R - The data are unusable (compound may or may not be present). Resampling and reanalysis is necessary for verification.

No qualifier - Indicates that the data are acceptable both qualitatively and quantitatively.

#### TtEMI Comment Codes

- a - Surrogate spike recovery problems
- b - Blank contamination problems
- c - Matrix spike recovery problems
- d - Duplicate (precision) problems
- e - Internal standard problems
- f - Calibration problems
- g - Quantification below the reporting limit
- h - Other problems, refer to data validation narrative

Note: Data qualifiers are from Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analyses (EPA 1988).

### **D1.3 REPORTING**

The laboratory will submit analytical reports in hard copy and electronic formats. Both hard copy reports and the electronic database reports will be submitted with laboratory qualifiers that are defined by either the EPA CLP SOW, TtEMI's SOW, or the laboratory's own SOPs. Data submitted with laboratory-defined qualifiers identify such items as nondetected values, values below the contract required quantitation limit (considered estimated values), and values with problems during the analysis. Through the process of data validation, these laboratory-defined data qualifiers are evaluated for appropriateness and replaced as deemed necessary with the functional guidelines data validation qualifiers to inform the data user of the validity of the data. A database program created at TtEMI will be used to transfer data from the laboratory via an ASCII-formatted diskette. This database allows (1) the data validation qualifiers to be substituted as necessary for the original laboratory qualifiers, (2) corrections of detected data errors, (3) other software to be interfaced, and (4) tables to be printed with the validated results in various formats.

In addition to the analytical results with the associated qualifiers, the printed tables will also include a comment column. The comment column is used to provide an explanation for any assigned qualifiers. The alphabetic letters "a" through "h," as defined by TtEMI, are used to reference different QC issues that may have impacted the analytical results. The associated definitions for these comment codes are provided in Table D2-2. The comment codes on the analytical tables will provide the reader with an immediate explanation for the qualifier attached to the result. The comment code also will allow the reader to locate detailed discussion of the QC issue in the appropriate data validation narrative.

### **D2.0 RECONCILIATION WITH DATA QUALITY OBJECTIVES**

After all of the data have been received from the laboratory and validated, the TtEMI QA manager will prepare a quality control summary report (QCSR). The QCSR will document and summarize how well the analytical data support the data quality objectives (DQO) determined for the treatability study as discussed in Section A7.0 of this QAPP. The methods and techniques that will yield analytical data of acceptable quality and quantity to support the DQOs are also stated in Section B4.0 of this QAPP. Acceptability of data, evaluated by the critical indicator PARCC parameters, is determined through the process of data validation. The PARCC parameters are discussed in Section A7.0, and the data validation process is discussed in Section D1.2 of this QAPP. The results of the data validation process

for the treatability study will be summarized in the QCSR and will include a discussion of general QC issues. Specific QC issues will be discussed in the individual data validation narratives which will be attached to the QCSR as an appendix. An appendix will also be prepared containing the tabulated validated analytical data for water and soil. The tabulated data will include the appropriate validation qualifiers and comment codes to explain the qualifications. All original analytical data packages from the laboratory will be bound and archived at the TtEMI Sacramento office.

## REFERENCES

- U.S. Environmental Protection Agency (EPA). 1983. "Methods for Chemical Analysis of Water and Waste." Prepared by Environmental Monitoring and Support Laboratory. March.
- EPA. 1987. "Data Quality Objectives for Remedial Response Activities Development Process." Prepared by the Office of Emergency Response and Office of Waste Programs Enforcement. March.
- EPA. 1988. "Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analyses." July.
- EPA. 1990. "Statement of Work for Inorganic Analyses Multi-Media Multi-Concentration." EPA Contract Laboratory Program. March.
- EPA. 1994. "EPA Requirements for Quality Assurance Project Plans for Environmental Data Operations." EPA QA/R-5. Interim Final. May.
- PRC Environmental Management, Inc. 1993. "Remedial Investigation/ Feasibility Study Work Plan Addendum for Naval Air Station, Alameda, California, Draft." September.
- PRC. 1995. "Navy CLEAN II Laboratory Services Statement of Work." June.
- PRC. 1996. "Remedial Investigation/Feasibility study Data Transmittal Memorandum for Sites 4, 5, 8, 10A, 12, and 14 for Naval Air Station, Alameda, California, Final." Volume 1 of 2. April.

**ATTACHMENT A**

**STATEMENT OF WORK  
SITE 5 ELECTROKINETIC TREATABILITY STUDY**

**(15 pages)**

**ATTACHMENT A**  
**STATEMENT OF WORK**  
**SITE 5 ELECTROKINETIC TREATABILITY STUDY**  
*Revised August 6, 1997*

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**Prime Contractor:** PRC Environmental Management, Inc.  
**Technical Contact:** Neal Hutchison (916) 853-4501

**PRC's Client:** Department of the Navy, Naval Facilities  
Engineering Command, Engineering Field  
Activity, West

**Prime Contract Number:** N62474-94-D-7609, Contract Task Order No. 057

**Project Title:** Electrokinetic Treatability Study

**Site Name:** Building 5, NAS Alameda, Alameda, CA

**Subcontract Term:** June 25, 1997 through June 22, 1998

**1.0 INTRODUCTION**

PRC Environmental Management, Inc. (PRC) was requested by the Navy to conduct a pilot-scale treatability study at Naval Air Station Alameda (NAS Alameda) which would demonstrate the capabilities of an electrokinetic separation (EK) technology to treat in situ soils for metals contamination. For this project, PRC requires a subcontractor (vendor) that is capable of performing the design, implementation, operation, and evaluation of the EK technology on bench- and pilot-scales. Based on previous work performed for the Navy under the U.S. Environmental Protection Agency's (U.S. EPA) Superfund Innovative Technology Evaluation (SITE) program, Geokinetics International, Inc. of Berkeley, California (GII) has been chosen to be the sole-source technology vendor for the NAS Alameda Site 5 electrokinetic bench-scale and pilot-scale treatability studies. This statement of work (SOW) has been prepared to clarify GII's role in the performance of this demonstration.

The vendor, GII, shall first be required to perform a bench-scale treatability study on a portion of metals-contaminated soil taken from the Building 5 Plating Shop at NAS Alameda. GII shall prepare a detailed report with appended analytical data documenting the results of the bench-scale study. The report should describe tests performed, analytical results, and an interpretation of these results. PRC

and the Navy shall use the results from the bench-scale study to evaluate the potential effectiveness of the EK technology to treat in situ soils at the site. Acceptable bench-scale results demonstrating the capability of the EK technology to meet the treatment objective for chromium will be required prior to beginning pilot-scale activities.

Based on acceptable bench-scale results demonstrating the capability of the EK technology to meet the treatment objective for chromium, GII shall design, implement, and operate a pilot-scale EK treatability study on approximately 45 cubic yards of metals-contaminated soil located beneath a portion of the concrete slab in the Plating Shop of Building 5 at NAS Alameda. GII will allow for a complete technical evaluation of the treatment system at all stages of the treatability study. Evaluation will include, but will not be limited to (1) the reliability and function of the process equipment; (2) capital, labor, operational, and maintenance costs; (3) process operating parameters; (4) vendor sampling and analytical procedures; (5) ability to meet treatment objectives; (6) daily operation and problems encountered; (7) deviations from project plans; (8) process waste handling procedures and requirements; and (9) health and safety. GII shall be responsible for the collection of appropriate samples at various process points to demonstrate the effectiveness of the treatment system in treating the in situ soil. In addition, GII must also be willing to allow the collection of split samples by PRC during all activities.

## 2.0 SITE HISTORY

NAS Alameda is located on the western end of Alameda Island, in Alameda and San Francisco Counties. Alameda Island lies along the eastern side of the San Francisco Bay, adjacent to the city of Oakland. The base, roughly rectangular in shape, is approximately 2 miles long and 1 mile wide, and occupies 1,636 acres of dry land and 998 acres of submarine land. Under the installation restoration (IR) program, 23 sites have identified as being contaminated with some form of environmental contaminant. IR Site 5 (Site 5) is of particular importance because of the abundance of environmental contaminants that have been identified throughout the site. Site 5, which consists of Building 5 and the surrounding parking areas, is located near the south central part of the base and occupies approximately 18.5 acres. Site 5 is bordered by Avenue C on the north, Avenue F on the south, Second street on the east, and First street on the West.

APPENDIX A – STATEMENT OF WORK SITE 5  
ELECTROKINETIC TREATABILITY STUDY

PAGE 3

FINAL  
QUALITY ASSURANCE PROJECT PLAN  
ELECTROKINETIC REMEDIATION DEMONSTRATION  
REVISION 1

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NAVFAC SOUTHWEST TO LOCATE THIS PAGE.  
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**DIANE C. SILVA**  
**RECORDS MANAGEMENT SPECIALIST**  
**NAVAL FACILITIES ENGINEERING COMMAND**  
**SOUTHWEST**  
**1220 PACIFIC HIGHWAY**  
**SAN DIEGO, CA 92132**

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technology to meet the treatment objective for chromium, GII shall be required to perform a pilot-scale treatability study on approximately 45 cubic yards of contaminated soil located below the concrete floor of the Building 5 Plating Shop. The pilot-scale treatability study is expected to continue until the entire 45 cubic yards of soil has been treated.

The 45 cubic yards of soil being treated is only a small portion of the metals-contaminated soil located beneath the Plating Shop. In order to mimic the results of a full-scale electrokinetic remediation process, GII shall operate the pilot-scale treatability study in the same manner as if this treatment were being applied to the entire area of metals-contaminated soil under the Building 5 Plating Shop.

The EK technology must be able to treat soils contaminated with chromium to levels below the U.S. EPA's Region IX preliminary remediation goal (PRG) for residential soils. Therefore, the primary cleanup goal for chromium is 210 milligrams per kilogram (mg/kg) for total chromium (1/6 ratio of Cr VI/Cr III), and 30 mg/kg for chromium VI. Although no secondary cleanup goals for other heavy metals detected at the site have been defined, the results of the treatability study for these metals will also be compared to federal PRGs.

For the pilot-scale treatability study, the Navy is not required to obtain regulatory permits under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA); however, GII will be required to comply with Resource Conservation and Recovery Act (RCRA) requirements for all soil handling and liquid and solid waste storage. GII must also comply with California and Federal Department of Transportation regulations for transport of equipment and materials to and from the site.

During the operation of the treatment system, GII shall be responsible for implementing engineering controls to reduce explosive and toxic gases including hydrogen, oxygen, and hydrogen cyanide. GII shall monitor the surface of the treatment area for these hazards during system operation to insure that the treatment system is operating in a safe manner. If air monitoring results indicate the exceedence of Occupational Safety and Health Administration (OSHA) or California (Cal)/OSHA levels for these gases, GII will immediately shut the system down. Operation of the treatment system will not continue until GII has corrected the problem.

Soil and treated wastes generated during the demonstration will be handled as investigation derived waste (IDW) by PRC. GII shall be responsible for the analysis of any process waste streams being discharged to the sanitary sewer. If sample analysis indicates the exceedence of regulatory levels for site specific contaminants or process reagents, GII shall be responsible for the treatment of all process streams prior to discharge. The Navy maintains a permit through East Bay Municipal Utilities District (EBMUD) for wastewater discharge to the sanitary sewer. All discharges must follow the requirements described in EBMUD's permit.

Electricity for the pilot-scale treatment system will be supplied by the Alameda Bureau of Electricity. GII shall be responsible for the cost of the electricity to operate the treatment system and the installation of the required metering system to measure the amount of electricity used. Sanitary facilities and potable water are available within Building 5. Costs for all other utilities shall be the responsibility GII. PRC shall maintain a security fence around the treatment area to limit access to the treatment area and process equipment. With the exception of the raised wooden floor and filling the borings with grout, GII shall be responsible for returning the treatment site to its original condition prior to demobilizing off the site. PRC shall be responsible for grouting the bore-holes and replacing the raised floor in the Plating Shop.

GII shall be responsible for documenting all activities associated with the pilot-scale study. This includes computer acquisition of all necessary process parameters, maintaining daily log books, and maintaining photographic or video tape logs. GII shall also assist the Navy in the organization of "Visitor's Day" activities.

### **3.2 SPECIFIC TASKS FOR THE BENCH-SCALE TREATABILITY STUDY**

GII shall perform a bench-scale treatability study on a portion of the contaminated soils located in the Plating Shop at Site 5. The goal of the bench-scale treatability study is to determine the appropriate operating conditions for the EK treatment system with respect to treating heavy metals-contaminated soils at Site 5. The bench-scale study should be designed so that data of sufficient quality and quantity are obtained so that an evaluation can be made as to whether the pilot-scale treatability system will be capable of removing chromium to a level below EPA's Region IX PRG. GII shall provide PRC and

the Navy with a short technical memo detailing the bench-scale treatability study prior to performing the bench-scale study. GII shall also provide PRC and the Navy with a detailed report of the bench-scale study which includes the following information:

- Setup and operation of the bench-scale study
- Process operating parameters
- Analytical procedures
- Analytical results
- Evaluation of the EK technology based on treatment objectives

GII shall use methods for analysis that provide data of definitive quality. That is, data that are generated using SW846 or EPA CLP methods from a laboratory certified in the state of California by the California Department of Health Services.

### **3.3 SPECIFIC TASKS FOR THE PILOT-SCALE TREATABILITY STUDY**

Based on acceptable results from the bench-scale treatability study, GII shall perform a pilot-scale treatability study on the in situ soils located in the Plating Shop at Site 5. The goal of the pilot-scale treatability study is to demonstrate the effectiveness of the EK technology for treating in situ soils at Site 5, and possibly other Navy sites, for heavy metals contamination. The pilot-scale study should be a scaled-down version of what GII would employ to clean up a much larger site; however, the pilot-scale study should be conducted in a manner that is as similar as possible to the operation of a full-scale system. The pilot-scale study should be designed so that data of sufficient quality and quantity are obtained so that a detailed evaluation can be made of the EK technology to treat the Site 5 soils. In addition, the pilot-scale study should be designed in a manner to provide sufficient data so that an accurate estimate of operating costs can be obtained, within the constraints of generating excessive process waste and also for optimizing the energy usage of the system.

GII shall provide a best estimate of direct labor, equipment, operating, and other direct costs for the bench-scale and pilot-scale treatability studies. The following sections describe specific tasks to be performed by GII.

### **3.3.1 Pilot-Scale Treatability Study Work Plan**

For the pilot-scale treatability study, GII shall be required to prepare a work plan to be used with the Site 5 Electrokinetic Remediation Demonstration Quality Assurance Project Plan (QAPP) (PRC 1996). The treatability study work plan should include the following information:

- Description and results of the bench-scale treatability study
- Description of the pilot-scale process equipment, materials, and power requirements
- Detailed process and instrument diagram (p&id) including sampling locations
- Full site diagram incorporating the p&id
- Provisions for secondary containment
- Pilot plant installation and startup
- Pilot plant operation and maintenance procedures
- Process monitoring parameters and measurements
- Health and safety procedures (may be attached as an addendum)
- Analysis and discharge procedures for process waste
- Procedures for concentration and recovery of heavy metals

As an appendix to the final pilot-scale treatability study work plan, GII shall include the detailed bench-scale report outlined in Section 3.2. GII shall submit the pilot-scale treatability study work plan to PRC and the Navy for review as part of the procurement process. GII shall be required to address comments to the work plan and make appropriate changes prior to mobilization.

### **3.3.2 Mobilization**

GII shall supply and transport all necessary materials, equipment, and personnel to and from the site from GII's facility. This task includes all lodging, meals and similar costs for maintaining personnel in Alameda while performing the work described in this SOW. Once field work begins, costs for all materials, equipment, and personnel that must be procured to maintain operability are also included. This task also includes site preparation for secondary containment, health and safety monitoring, and

electrical power. GII shall photo log or video tape site preparation, mobilization, and equipment setup activities for community relations efforts.

The Alameda Bureau of Electricity will provide the source of electrical power for the treatment site; however, GII shall provide a licensed and bonded electrician for the installation of a metering control device and connection of electrical power for the treatment system. GII shall be responsible for the measurement and the cost of electrical power usage for the duration of the project.

GII shall be required to maintain secondary containment for all process flows for the duration of the treatability study. Secondary containment shall consist of a water proof/acid proof geotextile liner, fiber reinforced, of a thickness no less than 40 mils (Reef Industries TX2150G or equivalent). The liner shall be installed on the concrete floor of the treatment area and secured at a height of 24 inches at the perimeter of the containment area. Holes made in the liner for the electrode casings shall be sealed using duct tape. All liquid process/storage tanks and process piping shall be installed within this secondary containment area.

Prior to system startup, in accordance with GII's approved health and safety plan (see Section 6.0), GII shall install appropriate health and safety monitoring equipment to monitor the treatment area for toxic and explosive gases. Upon system startup, GII shall maintain constant monitoring for toxic and explosive gases until adequate data have been collected to document that the system can be safely operated without additional engineering safety controls. If at any time the system is determined to be operating in a manner that is considered to be hazardous to human health or poses an explosion hazard based on OSHA or Cal/OSHA regulations, GII shall be required to shut the system down and install appropriate engineering controls to eliminate or reduce the hazard to acceptable levels.

### **3.3.3 Operation and Maintenance of Pilot-Scale Treatability Study**

The electrokinetic pilot-scale treatability study shall be conducted in accordance with GII's approved demonstration work plan and PRC's QAPP. GII shall be responsible for the system's operation, maintenance, and real-time monitoring of process flows. GII shall also be responsible for performing the concentration of heavy metals from the process streams. GII shall maintain the on-site storage of

the concentrated metals solutions (final product) in 55 gallon plastic barrels. GII shall also be responsible for daily site visits to maintain the system and perform safety checks. In addition, GII shall be responsible for sampling, analysis, storage, and pretreatment of any process wastewater, prior to its discharge to the sanitary sewer system. For the duration of the project, PRC and GI shall maintain a locked security gate controlling access to the treatment site.

#### **3.3.4 Demobilization**

GII shall be responsible for the disassembly and removal of all treatment equipment. GII shall also be responsible for the analysis and disposition of all process wastewater. After disassembly and removal of the treatment equipment, PRC shall be responsible for filling the borings with grout and replacing the raised wooden floor in the Plating Shop. GII shall be responsible for all other aspects of returning the treatment area to its original condition. PRC will be responsible for the disposal of the concentrated metals solution as IDW.

#### **3.3.5 Preparation of a Pilot-Scale Treatability Study Report**

GII shall prepare a report documenting the results of the electrokinetic pilot-scale treatability study. The following information shall be included in the evaluation of the treatability study:

- Reliability and function of process equipment
- Capital, labor, operational, and maintenance costs
- Process operating parameters
- Vendor sampling and analytical procedures
- Ability to meet treatment objectives
- Daily operation and problems encountered
- Deviations from project plans
- Process waste handling procedures and requirements
- Health and safety concerns

PRC shall evaluate the effectiveness of the EK technology used for this site based on information from

GII's report, analytical results obtained through the sampling of process streams during operation, and also sampling and analysis of the final concentrated metals solution. PRC will also perform an estimated mass balance calculation for the metals removed by the electrokinetic process.

#### **4.0 PRC SUPPORT AND OVERSIGHT**

For the bench-scale treatability study, PRC will supply enough contaminated soil from the Plating Shop at Site 5 so that GII can perform all required tests. PRC will review GII's bench-scale report and make a recommendation to the Navy on whether to proceed with the pilot-scale study.

Based on acceptable bench-scale results demonstrating the capability of the EK technology to meet the treatment objective for chromium, GII shall perform the pilot-scale treatability study. During initial mobilization and startup of the pilot-scale system, PRC's field oversight manager will provide technical support to GII which will consist of providing access to the treatment site and coordination of involved parties including PRC, GII, NAS Alameda Caretaker Site Office, and Engineering Field Activities West staff. PRC shall also coordinate access to 120-volt (and/or 240-volt) electricity for the treatment equipment as specified in GII's demonstration work plan; however, as mentioned in Section 3.1, GII shall be responsible for the connection, measurement, and cost of all electrical power for the treatment system.

For the duration of the project, PRC shall visit the site several times a week during GII's daily site visits. During some of these site visits, PRC will be performing sampling of process streams for use in the evaluation of the process, as specified in the QAPP. In addition, throughout the project PRC will have a staff member present when GII performs any major modifications to the system, including times when GII is regenerating the process solutions and/or stripping and concentrating the metals from the process streams.

## 5.0 SCHEDULE OF TASKS AND DELIVERABLES

The vendor must be able to perform each task and prepare each deliverable within the schedule outlined below.

<u>Task</u>	<u>Activity Period</u>
Bench-Scale Treatability Study	August 11, 1997 - September 12, 1997
Mobilization of Pilot-Scale System	October 13, 1997 to October 17, 1997
<u>Task</u>	<u>Activity Period</u>
Operation of Pilot-Scale System	October 20, 1997 to April 24, 1998
Demobilization of Pilot-Scale System	April 27, 1998 to May 1, 1998

<u>Deliverable</u>	<u>Delivery Date</u>
Bench-Scale Treatability Study Technical Memo	June 25, 1997
Bench-Scale Treatability Study Report	September 19, 1997
Draft Pilot-Scale Treatability Study Work Plan	September 19, 1997
Final Pilot-Scale Treatability Study Work Plan	October 10, 1997
Draft Pilot-Scale Treatability Study Report	May 18, 1998
Final Pilot-Scale Treatability Study Report	June 22, 1998

## 6.0 HEALTH AND SAFETY

**Health and Safety Plan.** A base-wide health and safety plan (HSP) has been prepared for NAS Alameda (PRC 1993). This plan establishes the minimum health and safety program requirements for work under this subcontract. GII's authorized representative shall read the plan and develop any necessary interface between the NAS Alameda HSP and GII's health and safety program. GII's authorized representative shall sign the plan acknowledgment and agreement and return it to PRC prior to the start of work. All GII staff proposed to work at NAS Alameda shall also read and sign the plan prior to starting work.

GII shall prepare and submit a site-specific HSP for work at the site, including any necessary supplements to PRC's base-wide HSP. GII shall be required to incorporate both Navy and PRC comments into its HSP before any field work is performed. All applicable health and safety standard operating procedures referenced in GII's HSP shall be made available to PRC upon demand.

**Other Applicable Health and Safety Requirements.** GII shall maintain and implement its own health and safety program pursuant to OSHA general industry standards and Cal/OSHA general industry safety orders and/or the OSHA construction industry standards and the Cal/OSHA construction industry safety orders applicable to its industry, and comply with applicable requirements set forth in the above. GII shall also comply with requirements contained in the U.S. Army Corps of Engineers Safety and Health Requirements Engineer Manual (EM) 385-1-1, dated October 1992.

**Medical Surveillance Program.** All on-site personnel will meet the medical surveillance requirements set forth in the applicable HSP. All on-site personnel will have been fit-tested for use of an air-purifying respirator within the last six months.

**Training Requirements.** All personnel will meet the training requirements set forth in the applicable HSP.

**Safety Meetings.** GII shall hold a weekly on-site safety meeting of at least 15 minutes duration. The safety meeting shall discuss health and safety monitoring, site hazards, and all other relevant safety concerns pertaining to the operation of the treatment system.

**Provision of Company Health and Safety Officer and Designation of Site Safety Coordinator.** GII will identify a company health and safety officer (HSO) who shall be the point-of-contact for health and safety matters for this project. All GII personnel performing field work associated with this SOW will be under the supervision of the HSO. The HSO will evaluate compliance with PRC's base-wide HSP and applicable Federal, state, and local regulations. GII will also identify a site safety coordinator who shall be directly accountable to the HSO and will direct health and safety matters at the site. The site safety coordinator will oversee all field work and monitor the health and safety of all field personnel.

The site safety coordinator has the authority to alter, cease, or redirect any activities and/or health and safety measures being implemented during all field activities.

**First Aid.** GII shall maintain sufficient personnel current in standard industrial first aid and cardiopulmonary resuscitation (CPR) (American Red Cross or U.S. Bureau of Mines standard) and provide a minimum of one qualified person per work crew.

**Equipment.** GII shall maintain a minimum of one fire extinguisher (15 pound or 3A:40BC) at the site (in addition to any specific requirements in the site-specific HSP).

**Site Specific Training.** GII shall make employees available for a site orientation meeting at a designated time and location. GII shall provide an equivalent site orientation to all replacement workers. As described in **Safety Meetings**, GII shall provide a minimum of one toolbox safety meeting per week for its employees and maintain on-site records of those meetings.

**Employee Safety Orientations.** GII shall provide safety orientations to all new employees and newly promoted supervisors assigned to this contract. GII shall provide a training program description with a copy of GII's company safety program.

**Equipment Inspections.** GII shall provide the PRC on-site representative certification of inspection and safe operating condition for each heavy vehicle (greater than 8,000 pounds gross vehicle weight), drill rig, crane, or other machinery prior to use, and will maintain these certifications on site. GII shall also maintain on site, written documentation of regular inspection of all equipment and vehicles, in accordance with manufacturers' recommendations, industry standards, GII's written program and/or GII's HSP.

**Notification for Rental Equipment.** GII will be required to provide written notification to rental agencies whose rental equipment will be used on a hazardous waste site. Written notification shall describe the intended use of the equipment, that there is a possibility of contamination of the rental equipment, and the steps GII will take to decontaminate the equipment prior to return. A written acceptance of the terms of GII's notification shall be obtained from the rental agency.

**Personal Protective Equipment (PPE) Requirements.** The following are the minimum requirements for each PPE level as specified for this project, unless modified in the GII HSP:

- Level C: Level D modified plus full-face respirator with combination high-efficiency particulate and organic vapor cartridge
- Level D Modified: Level D plus chemical protective (CP) tyvek(™), polyethylene coated tyvek(™), or saranex(™) coveralls; CP gloves (nitrile, neoprene, or viton construction); and CP over boots
- Level D: Hard hat; American National Standards Institute (ANSI) approved safety glasses; steel toe and shank leather work boot; long pants; sleeved shirt

GII shall plan to perform the majority of work in Level D and Level D Modified PPE.

**Documentation.** The following table is a list of documents GII must prepare and submit to PRC's health and safety coordinator (or maintain in the field) for this project.

Document	Document Type	Schedule	Action	PRC Verification
Designation in writing of company health and safety officer	O	A	1	
Accident prevention plan and code of safe practices according to OSHA, Cal/OSHA, and U.S. Army Corp. of Engineers	P	A	1	
Medical surveillance program requirements from HSP	P	A	1	
Training program description according to HSP	P	A	1	
HSP acknowledgment and agreement form	O	A	1,2	
Designation in writing of site safety coordinator	O	A	1,2	

Document	Document Type	Schedule	Action	PRC Verification
License and training certifications	P	M	2	
Vehicles registration and proof of insurance	P	M	2	

Notes:

<u>Document</u>	<u>Schedule</u>	<u>Action</u>
O-original signed	A-five days prior to scheduled start of field work	1-submit to PRC health and safety coordinator
P-print/copy	M-maintain on site	2-submit to on-site safety coordinator

### 7.0 OTHER LICENSES, PERMITS, AND REGULATIONS

GII must have appropriate insurances including workers' compensation, and other valid permits applicable to this project. Insurance certification evidencing the required insurance coverage shall be delivered to PRC prior to commencing work. GII is expected to comply with the provisions of the NAS Alameda base-wide HSP, GII's approved HSP, and general safe work practices.

### 8.0 REFERENCES

- Lockheed Martin Research and Development Division. 1995. Treatability Results, NAS Alameda, Building 5 Plating Shop. October 12.
- PRC Environmental Management, Inc. (PRC). 1993. Remedial Investigation/Feasibility Study Work Plan Addendum, NAS Alameda, California, Draft. September.
- PRC and Montgomery Watson. 1995. Data Summary Report, Background and Tidal Influence Studies and Additional Work at Sites 4 and 5, NAS Alameda, Volume 1 of 2, Final. October 16.
- PRC. 1996. Quality Assurance Project Plan, Electrokinetic Remediation Demonstration, NAS Alameda, Final. March.
- Reef Industries, Inc. P.O. Box 750250, Houston, Texas, 77275. (713) 943-0070.
- U.S. Army Corps of Engineers. 1992. Safety and Health Requirements Manual, EM 385-1-1. October.

**ATTACHMENT B**  
**STATEMENT OF WORK**  
**SITE 5 SUBSURFACE DRILLING**

(11 pages)

## ATTACHMENT B

### STATEMENT OF WORK SITE 5-SUBSURFACE DRILLING *Revised April 9, 1996*

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**Prime Contractor** : PRC Environmental Management, Inc.  
**Technical Contact** : Joe Mollusky (206) 587-4650

**PRC's Client** : Department of the Navy, Western Division  
Engineering Field Activity, West

**Prime Contract Number** : N62474-88-D-5086, Contract Task Order 0107

**Project Title** : Borehole Drilling, Soil Sampling, Electrode Casing  
Installation, and Borehole Abandonment

**Site Name** : Naval Air Station Alameda, Site 5, Alameda, California

**Subcontract Term** : May 8 - 11, 1996 and July 1 -3, 1996

#### A. INTRODUCTION

PRC Environmental Management, Inc. (PRC) requires a subcontractor to perform various drilling tasks associated with an electrokinetic remediation demonstration at Naval Air Station (NAS) Alameda. The overall objective of the work is to advance boreholes, collect soil samples, install electrode casings, conduct an electrokinetic remediation demonstration, advance additional borings, and collect confirmational soil samples after the demonstration. Casings installed by the subcontractor will be used to house electrodes necessary to conduct the electrokinetic remediation demonstration at NAS Alameda Site 5 (Figure 1). This demonstration will allow the Navy to evaluate the ability of the electrokinetic process to remediate soils contaminated with heavy metals. The demonstration will be conducted at Site 5 to determine the effectiveness of electrokinetic remediation to reduce chromium concentrations in soils. The data collected during the demonstration will be used to develop performance and cost data of the innovative technology.

The general requirements of this statement of work (SOW) are as follows:

- Access the work area inside of Building 5 through a door way 10 feet 9 inches high by 10 feet 4 inches wide. Vertical clearance at the work area is greater than 30 feet. A trailer mounted drill rig may be required to access the work area.
- Position drill rig on a wood floor in the work area. The wood floor is approximately 3 feet above a concrete floor. The wooden floor boards (3-inch by 6-inch) are supported by 10-inch by 12-inch beams that are spaced 5 feet apart. The beams rest on piers that are spaced 8 feet apart. Sections of the wooden floor boards will be removed by others to access the concrete floor. Holes will be cored through the concrete floor by others at all 24 drilling locations.

- Advance a total of 24 borings in two separate phases. The first phase consists of 15 borings advanced for the purposes of collecting untreated soil samples and installing electrode casing. The second phase includes 9 borings advanced after the demonstration for the purpose of collecting treated soil samples. After a hole is drilled by others through the concrete floor at each of the 24 boring locations, the subcontractor will advance soil borings using the hollow stem auger drilling method to a depth of 8 feet below the top of the concrete floor.

The rig will need to turn augers as follows:

- Minimum of 4-inch and maximum of 6.25-inch outside diameter auger to allow (1) insertion of 3.4-inch diameter electrode casings in open boreholes at 15 boring locations and (2) collection of subsurface soil samples using split-spoon sampling techniques from all 24 borings.

And/Or

- If the borings collapse, contingency plans to use a minimum of 3.75-inch inside diameter auger to allow (1) insertion of 3.4-inch diameter electrode casings in the initial 15 boreholes and (2) collection of subsurface soil samples using split-spoon sampling techniques from all 24 boreholes.

Or

- Propose and use alternate drilling method that achieves objectives of soil sampling and electrode casing installation.
- Collect split-spoon soil samples at 3 depths for all 24 borings.
- Install 15 electrode casings. Electrode casings, including end caps and heads, will be provided by Lockheed Martin Missiles and Space Company. The electrode casings, including end caps and heads, will be installed as follows:
  - Fifteen 3.4-inch diameter, perforated electrode casings equipped with semipermeable liners will be installed to a depth of 8 feet below the top of the concrete floor. A sand pack will be installed only if the larger diameter auger is used to insure continuous contact between the electrode casing and surrounding soil matrix.

Remainder of electrokinetic remediation equipment will be provided and installed by Lockheed Martin Missiles and Space Company.

- Electrokinetic remediation demonstration will be conducted by Lockheed Martin Missile and Space Company personnel.
- Soil boring abandonment. After completion of the demonstration, all borings will be abandoned in accordance with California regulations. A Volclay 7 or equivalent bentonite-grout mixture will be used to fill the borings.

The subcontractor shall provide ALL materials, equipment, and qualified personnel to complete all of the tasks described in this SOW, unless otherwise specified. In addition, the subcontractor shall provide backup equipment within 24 hours if equipment failure should occur during field activities.

## B. TASKS

The work to be performed under this SOW has been divided into three tasks:

- **Task 1:** Advance 24 soil borings to a depth of 8 feet below the top of the concrete floor for a total of 192 feet of drilling. Containerize drill cuttings in 55-gallon drums.

Starting from the top of the concrete floor, collect 1.5-foot split-spoon samples of soil at the sampling depths of 1 to 2.5 feet, 4 to 5.5 feet, and 6.5 to 8 feet. Each 1.5-foot section will be contained within a three column sample core using brass sleeves. Soil in one of the 6-inch sleeves will be emptied into an investigation-derived waste container.

Collect a total of 72 soil samples from the 24 borings. Forty-five untreated soil samples will be collected from the 15 borings (U1 through U15) advanced prior to the demonstration. Twenty-seven treated soil samples will be collected from 9 borings (C1 through C9) advanced after the demonstration.

- **Task 2:** Install 15 electrode casings. An electrode casing will be installed at about 8 feet below the top of the concrete floor in each of soil borings U1 through U15.
- **Task 3:** Abandon all 24 soil borings. Electrode casings will need to be removed and soil borings will need to be abandoned according to California regulations.
- **Task 4:** Decontaminate equipment and supplies, and containerize decontamination equipment and supplies.

Location of utilities under the concrete floor and underground will be identified by Navy personnel prior to any drilling activities by the subcontractor.

Tasks 1, 2, and 3 are described in more detail below and summarized in Table 1. Figure 1 shows the layout of soil borings and electrode casing placement.

### TASK 1 - SOIL BORING ADVANCEMENT AND SOIL SAMPLING

1. **Target Depths:** Total depths of all 24 soil borings are 8 feet below the top of the concrete floor.
2. **Drilling and Installation Method:** Twenty-four soil borings will be advanced using the hollow-stem auger method. An approximate total of 192 feet of boring will be advanced. Table 1 summarizes the boring and electrode casing installation program. The rig will need to turn augers as follows:

Minimum of 4-inch and maximum of 6.25-inch outside diameter auger to allow (1) insertion of 3.4-inch diameter electrode casings in open boreholes at 15 boring locations and (2) collection of subsurface soil samples using split-spoon sampling techniques from all 24 borings.

And/Or

If the borings collapse, contingency plans to use a minimum of 3.75-inch inside diameter auger to allow (1) insertion of 3.4-inch diameter electrode casings in the initial 15 boreholes and (2) collection of subsurface soil samples using split-spoon sampling techniques from all 24 boreholes.

Or

Use alternate drilling method that achieves objectives of soil sampling and electrode casing installation.

3. **Management of Drill Cuttings:** The subcontractor will containerize all the drill cuttings in 55-gallon steel drums and transfer the drums to a nearby decontamination and staging area designated by PRC. The subcontractor will provide the drums and equipment necessary to move the drums.
4. **Subsurface Soil Sampling:** The subcontractor will collect representative subsurface soil samples prior to and after the demonstration to properly evaluate the performance of the remediation technology.

Split-spoon samples will be collected at the sampling depths of 1 to 2.5 feet, 4 to 5.5 feet, and 6.5 to 8 feet below the top of the concrete floor. A total of 45 untreated soil samples will be collected from the 15 borings (U1 through U15) advanced prior to the demonstration. A total of 27 treated soil samples will be collected from 9 borings (C1 through C9) advanced after the demonstration. A total of 72 soil samples will be collected from a total of 24 soil borings. Table 1 summarizes the samples to be collected.

Samples will be collected with a 1.5-foot long standard split-barrel sampler. Split-spoon sample liners will be supplied by the subcontractor. At least three samplers will be made available for use during sampling activities. Split-spoon samples will be collected using the method described in ASTM Standard D-1586.

5. **Drilling Water:** If subsurface conditions require the addition of water to maintain an open borehole, the source of the water must be approved by PRC's on-site field manager. Adding water to the borings must be avoided if at all possible.

## TASK 2 - ELECTRODE CASING INSTALLATION

Fifteen soil borings (U1 through U15) will be advanced as discussed under Task 1 and then electrode casings will be installed. Table 1 summarizes the drilling, soil sampling, electrode casing installation, and abandonment activities.

## Procedure:

Installation of electrode casings should be conducted as follows:

1. **Verify Depth:** Upon reaching the total depth of the borehole, verify the depth using a weighted measuring tape.
2. **Placement of Electrode Casing:** Remove the small diameter auger from the boring and place the provided electrode casing in the borehole. If the borehole collapses, use larger diameter auger and place the provided electrode casing into the augers.
3. **Placement of Annulus Materials (only if larger diameter auger is used):** Simultaneously withdraw the augers during placement of annulus materials (sand pack). The weighted measuring device shall be used at regular intervals to ensure that the augers are never above the top of the annulus materials during construction.
4. **Sand Pack (only if larger diameter auger is used):** Install the sand pack, if necessary, as directed by PRC. The sand pack shall be introduced at a uniform rate in a manner that will allow even placement of the sand as approved by PRC. Every precaution shall be taken to ensure placement of the sand pack continuously from the bottom of the electrode casing to the top of the electrode casing without separation or bridging of the materials as they are introduced into the annulus.
5. **General.** The subcontractor shall take all necessary precautions to prevent contaminated water, hydraulic fluid, or other substances from entering the borehole, either through the opening or by seepage through the ground surface of the boring.

## Materials:

1. **Electrode Casing, Including End Cap and Head (provided by others):** Fifteen 3.4-inch diameter, perforated polyvinyl chloride (PVC) electrode casings, including end cap and head, will be provided by Lockheed Martin Missiles and Space Company. Each casing will have a semipermeable liner.

Subcontractor should bring device to cut PVC casing, if needed.

No glues or solvents shall be used during any part of electrode casing installation.

2. **Sand Pack:** If the larger diameter auger is used, the subcontractor shall provide and install a layer of 10-20 Colorado, Monterey, or equivalent silica sand in the annular space between the electrode casing and borehole. Subcontractor shall be able to procure other sand sizes on short notice, if required.
3. **55-Gallon Drums:** The subcontractor shall provide 55-gallon drums to containerize drill cuttings and pallets on which to store the drums in an investigation-derived waste area.
4. **Plastic Sheeting:** The subcontractor shall provide plastic sheeting to cover the entire work area and materials to construct a temporary berm for the plastic sheeting.

### TASK 3 - DECONTAMINATION PROTOCOL

This section covers the labor, materials, and equipment necessary for decontaminating all personnel, drilling and driving equipment, sampling equipment, and construction materials.

The subcontractor shall provide containment apparatus for decontaminating equipment. This could be in the form of a decontamination trailer with built-in tank and hood for containing fluids and racks for cleaning equipment. No liquids will be allowed to escape from areas used to decontaminate equipment.

Racks should be provided to ensure that all sides of the drilling equipment can be effectively decontaminated. Pumps should be provided to transfer liquids from the containment area to the water holding drums or tanks. The subcontractor shall cooperate with PRC during any testing and/or sampling required to assess the adequacy of equipment decontamination. All decontaminating will occur at the decontamination and staging area. All rig and equipment decontaminating will also be done in this area. Other requirements include the following:

1. **Personnel Decontamination:** The subcontractor shall provide all protective clothing and the equipment necessary for its own personnel to comply with the decontamination procedures as specified in PRC's health and safety plan. All personnel shall be decontaminated before leaving the drilling site and decontamination area. Decontamination shall be required before breaks, when picking up tools, equipment, or materials in the drilling zone, or any other activities where the potential exists for contaminant transfer.
2. **Equipment and Supplies:** The subcontractor shall provide all equipment and supplies necessary for the decontamination of all drilling equipment, supplies, and construction materials. This includes high pressure cleaning equipment, phosphate-free cleaning detergent (Alconox™), decontamination solution, buckets, brushes, and materials necessary to construct a decontamination station.
3. **Decontamination, Drilling Equipment:** Equipment decontamination shall consist of thorough steam cleaning at a minimum. For cleaning very oily drilling equipment, it may be necessary to inject a detergent solution into the steam cleaner. If a trisodiumphosphate (TSP) solution is used, the equipment shall be "rinsed" with pure hot water or steam before decontamination is complete. No detergent other than a phosphate-free cleaning detergent shall be used unless accepted by PRC before use.

The subcontractor shall decontaminate the drilling auger, bits, drill pipe, and other drilling equipment before arriving at the site. The subcontractor will decontaminate all equipment that enters the borehole after each boring to the satisfaction of PRC in the following manner:

- (1) Scrape and remove all earthen materials from the equipment.
- (2) Steam clean all equipment.
- (3) Collect rinsate and scrapings and place in approved containers.

4. **Decontamination, Soil Sampler:** Between each sample collection sequence at individual borings, the subcontractor will decontaminate all tools used for soil sampling and packaging, including split-barrel samplers within a decontamination area supplied or constructed by the subcontractor.
5. **Decontamination, Drill Rig:** The drilling end of the drill rig, the drill pipe which enters the borehole, and the pipe truck sections where drill pipe is stored shall be cleaned at the equipment staging area.
6. **Decontamination, Casing Installation Completion Supplies:** The subcontractor shall follow the same decontamination procedures on all casing installation completion supplies and equipment.
7. **Decontamination, Containerizing Fluids, Cuttings, and Disposable Materials:** The subcontractor shall containerize all decontamination fluids, earthen material, and personal protection material in 55-gallon drums. The fluids shall be placed in 55-gallon drums and may be transferred to the on-site storage tank. Other materials should be drummed and transferred to the decontamination and staging area.

#### Task 4 - SOIL BORING ABANDONMENT

At the completion of the demonstration, all 24 soil borings will be abandoned according to California regulations. The electrode casings will be removed from borings U1 through U15. If the casing cannot be removed the subcontractor will cut off the casing extending above the concrete floor and abandon the casing in place. A Volclay 7 or equivalent bentonite-grout mixture will be used to fill the borings. In these shallow borings, the entire drill string will be pulled from the boring as long as the formation is stable and a tremie pipe will be lowered to near the bottom of the boring. As the grout is pumped, the tremie will be positioned such that it is below the top of the grout in the boring. The boring will be filled with grout to seal it.

#### C. SCHEDULE OF TASKS

PRC expects the entire SOW to be completed no later than July 3, 1996, regardless of schedule conflicts.

The proposed schedule of tasks is as follows:

<u>Task</u>	<u>Schedule</u>
Mobilization, orientation, passes, setup	May 8, 1996
Drilling, Soil Sampling and Casing Installation at borings U1 through U15	May 8 - 11, 1996
Drilling and Soil Sampling at C1 through C9	July 1 - 3, 1996
Abandonment of all 24 borings	

#### D. HEALTH AND SAFETY

The subcontractor shall follow all federal, state, and local Occupational Safety and Health Administration (OSHA) requirements for general industry, hazardous waste site operations, and

construction during all field work. Subcontractor employees also will comply with all other regulatory and U.S. Navy environmental health and safety requirements including, but not necessarily limited to, fire protection, ionizing radiation protection, hazardous and nonhazardous waste disposal, and traffic safety.

The subcontractor will be required to perform all field work in conformance with a written site-specific health and safety plan (HSP). The subcontractor may develop an HSP that complies with PRC's Navy CLEAN Health and Safety Program or adopt PRC's site-specific HSP as its own if after review of the plan the subcontractor determines that PRC's site-specific HSP meets all of the subcontractor's requirements. If the subcontractor adopts PRC's site-specific HSP, the subcontractor must provide a certification that it has reviewed PRC's site-specific HSP and has determined that the plan meets all of the subcontractor's requirements.

All subcontractor personnel participating in field activities will be required to read the site-specific HSP and sign an HSP acceptance form before beginning work on the site. Subcontractor personnel engaged in field work involving hazardous and/or radioactive material must meet the training and medical surveillance requirements of Title 29 of the Code of Federal Regulations (29 CFR) 1910.120, "Medical Surveillance, " and requirements of 29 CFR 1910.120(e), "Training."

All subcontractor personnel performing field work associated with this SOW will be under the supervision of an on-site health and safety officer (OHSO). The OHSO will oversee all field work; evaluate compliance with PRC's site-specific HSP and applicable federal, state, and local regulations; and monitor the health and safety of all PRC and subcontractor field personnel. The OHSO has the authority to alter, cease, or redirect any activities and/or health and safety measures being implemented during all field activities.

Level D personal protection is expected to be suitable for all activities described in this SOW. The subcontractor shall provide and use protective glasses, ear protection, boots with steel toes and shanks, gloves, and coveralls or dedicated clothing as a minimum for Level D activities. Nevertheless, unforeseen conditions may occur that would require an upgrade to Level C personal protection, and the subcontractor should be prepared to upgrade if necessary. The subcontractor shall be prepared to upgrade to Level C at any time, and all equipment required for a Level C upgrade shall be available and provided by the subcontractor. The PRC OHSO shall check for subcontractor compliance to PRC's site-specific HSP (including appropriate training and documentation of items such as 40-hour OSHA training).

#### E. PERSONNEL

Because of security requirements at NAS Alameda facilities, all subcontractor personnel shall be U.S. citizens or permanent residents. Proof of personnel citizenship or permanent resident status is a requirement for fulfillment of this SOW. The successful bidder will be required to provide a list of ALL potential personnel to work at the NAS Alameda facilities with appropriate training and citizenship documentation before beginning work on this SOW. The subcontractor personnel will also be required to obtain a personal badge and vehicle passes the morning the work begins. PRC will coordinate pass requests and will meet subcontractor personnel to lead them through the process.

## F. MEASUREMENT AND PAYMENT

Measurement will be for lump-sum items, unit costs, and hourly rates. Attachment B is a cost spreadsheet that lists items included to execute this contract. Measurement of items for payment will be based on the unit of measurement for each item as presented in Attachment B. Standby time is defined as any portion of a normal work day when PRC orders work to cease or when other activities at the site dictate shutdown as approved by PRC, except and unless PRC has issued, verbally or in writing, a Stop Work Order, a Notice of Unsafe Conditions, or a Nonconformance Report. Time during the period any of the three orders mentioned above are in effect shall be regarded as downtime.

An example of standby time would be a shutdown of drilling activities awaiting a field decision from the PRC office. Minor interruptions caused by minor field decisions will not be considered standby time.

Downtime is defined as time, other than standby time, during which drilling could occur but does not or when machinery is broken down, materials or equipment are not available, or the subcontractor elects not to drill or the contractor (PRC) has issued and not withdrawn a Stop Work Order, a Notice of Unsafe Conditions, or a Nonconformance Report.

All downtime initiated by the subcontractor resulting from equipment failure, availability of materials and supplies, and other unforeseen conditions shall be at the sole expense of the subcontractor.

## G. DAILY LOG

The driller shall provide the PRC site manager with a log on a daily basis to report the progress made and quantities used for the purposes of billing and payment. The driller's log shall show only those items found on the schedule of prices (Attachment B) and shall be reported using only those units of measurements found on the schedule of prices. These include lump sum items, material quantities, and hourly charges. No other units of measurement shall be presented by the driller. The daily log will be completed and signed by the driller and approved by the PRC site manager.

## H. STANDARDS AND REFERENCES

The following are incorporated by reference:

ASTM Standard D-1586: Standard Method for Penetration Test and Split-Barrel Sampling of Soils.

Federal Register: 29 CFR 1910.120.

**TABLE 1**

**SUBSURFACE SOIL SAMPLES TO BE COLLECTED AND  
ELECTRODE CASINGS TO BE INSTALLED**

Site	Soil Boring Identification Number	Target Depth (feet bcf)	Subsurface Soil Sampling Depths (feet bcf)	Number of Samples	Borings in which Electrode Casings to be Installed	Target Depth (feet bcf)	Soil Borings to be Abandoned <sup>c</sup>
5	U1 through U15 <sup>a</sup>	8	1 to 2.5	45	U1 through U15	8	U1 through U15
			4 to 5.5				
			6.5 to 8				
	C1 through C9 <sup>b</sup>	8	1 to 2.5	27	Not Applicable		C1 through C9
			4 to 5.5				
			6.5 to 8				

Notes:

- a Advancement, collection of subsurface soil samples, and installation of electrode casings at soil borings U1 through U15 will be conducted between April 23 and 26, 1996.
- b After the demonstration, advancement and collection of subsurface soil samples at soil borings C1 through C9 will be conducted between June 3 and 7, 1996.
- c After the demonstration, electrode casings will be removed and soil borings U1 through U15 and soil borings C1 through C9 will be abandoned following California regulations between June 3 and 7, 1996.
- bcf below the top of the concrete floor

**ATTACHMENT B**  
**SCHEDULE OF PRICES**  
**Drilling, Soil Sampling, and Electrode Casing Installation**  
**NAS Alameda**

Description	Unit	Quantity	Unit Price	Total
<b>1. Mobilization/Demobilization</b>				
a. Phase 1: Moving equipment, tools, supplies, and personnel to and from the project site area. Includes providing equipment for Level D and Level C personal protection.	Lump Sum	2		
<b>2. Drill Soil Borings and Subsurface Soil Sampling</b>				
a. Minimum 4-inch and maximum 6.25-inch outside diameter auger drilling for 3.4-inch electrode casings at 15 boring locations and sampling using split spoon sampler	Foot	120		
b. Minimum 3.75-inch inside diameter auger drilling for 3.4-inch electrode casings at 15 boring locations and sampling using split spoon sampler	Foot	0		
c. 3.75-inch inside diameter auger drilling and sampling using split spoon sampler	Foot	72		
d. Alternate drilling method for 3.4-inch electrode casings at 15 boring locations and sampling using split spoon sampler at 24 boring locations	Foot	0		
<b>3. Installation of Electrode Casing including all supplies, except as specified in SOW</b>				
a. 3.4-inch diameter electrode casings equipped with end caps, heads, and liners	Foot	120		
<b>4. Decontamination</b>				
a. Decontamination after each boring	Boring	24		
<b>5. Soil Boring Abandonment</b>				
a. Pull electrode casings from borings and fill borings with bentonite-grout mixture	Boring	15		
b. Fill borings with bentonite-grout mixture	Boring	9		
<b>6. Waste Handling</b>				
a. Transfer cuttings to 55-gallon drums at staging area	Boring	24		
b. Cleaning, labeling, and transferring drums to drum storage area	Drum	20		
<b>7. Materials</b>				
a. 55-gallon drums	Drum	20		
b. Silica sand	Bag	30		
c. Concrete	Bag	24		
<b>8. Miscellaneous</b>				
a. Standby time	Hour	1		-0-
b. Level C upgrade	Day	1		-0-
<b>TOTAL:</b>				

**ATTACHMENT C**

**GEOKINETICS DEMONSTRATION WORK PLAN**

**THIS DOCUMENT IS CONSIDERED CONFIDENTIAL BUSINESS INFORMATION AND HAS BEEN OMITTED. REQUESTS FOR THIS ATTACHMENT SHOULD BE MADE TO TEMI AND MAY BE PERMITTED WITH PRIOR, WRITTEN APPROVAL OF GEOKINETICS INTERNATIONAL, INC.**

**ATTACHMENT D**

**GEOKINETICS BENCH-SCALE  
TREATABILITY STUDY REPORT (1997)**

**THIS DOCUMENT IS CONSIDERED CONFIDENTIAL BUSINESS INFORMATION  
AND HAS BEEN OMITTED. REQUESTS FOR THIS ATTACHMENT SHOULD BE MADE  
TO TEMI AND MAY BE PERMITTED WITH PRIOR, WRITTEN APPROVAL OF  
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