APPENDIX A

SAMPLING AND ANALYSIS PLAN

TITLE AND APPROVAL PAGE

This Sampling and Analysis Plan (SAP) describes requirements for site investigation/remediation activities at the NASA JPL Facility.

Title of the Project: Operable Unit 3 Remedial Investigation (RI) Addendum Work Plan

Organization Responsible for (insert Work Plan Name): Battelle

Effective Date of Plan: June 2004

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ACRONYMS AND ABBREVIATIONS

CFR	Code of Federal Regulations
CCl_4	carbon tetrachloride
CPR	cardiopulmonary resuscitation
DHS	Department of Health Services
DI	distilled
DO	dissolved oxygen
DOT	Department of Transportation
DQO	data quality objective
FID	flame ionization detector
HAZWOPER	Hazardous Waste Operations and Emergency Response
HCl	hydrochloric acid
HPLC	high-performance liquid chromatography
I.D.	inside diameter
IDW	investigation-derived waste
LAWC	Lincoln Avenue Water Company
LCS	laboratory control spike(s)
LCSD	laboratory control spike duplicate(s)
LOQ	limit of quantitation
LQAP	Laboratory Quality Assurance Plan
MCL	maximum contaminant level
MDL	method detection limit
MS	matrix spike(s)
MSD	matrix spike duplicate(s)
NA	not applicable
NEDTS	Navy Environmental Data Transfer Standards
NFESC	Naval Facilities Engineering Service Center
O_2	oxygen
O.D.	outside diameter
ORP	oxidation-reduction potential
OSHA	Occupational Safety and Health Administration
PPE	personal protective equipment
PVC	polyvinyl chloride
QA	quality assurance
QAO	Quality Assurance Officer
QAPP	Quality Assurance Project Plan
QA/QC	quality assurance/quality control
QC	quality control

RCRA	Resource Conservation and Recovery Act
RL	reporting limit
RPD	relative percent difference
RPM	Remedial Project Manager
RSD	relative standard deviation
SAP	Sampling and Analysis Plan
SHSP	Site Health and Safety Plan
SOQ	Statement of Qualifications
SWDIV	Southwest Division Naval Facilities Engineering Command
USA	Underground Services Alert
U.S. EPA	United States Environmental Protection Agency
VOA	volatile organic analysis
VOC	volatile organic compound

Section 1.0: PROJECT MANAGEMENT

This Sampling and Analysis Plan (SAP) has been provided as Appendix A in the Operable Unit 3 (OU-3) Remedial Investigation (RI) Addendum Work Plan for the NASA JPL facility. The SAP serves two functions: (1) it identifies the methods of sample collection and analysis during the assessment of soil and groundwater; and, (2) it documents how quality assurance (QA) and quality control (QC) activities will be implemented during the life cycle of the project to ensure that data are of sufficient quality for their intended purpose (i.e., to support decision making regarding remediation of the groundwater beneath NASA JPL). The SAP was prepared according to United States Environmental Protection Agency (U.S. EPA) Guidance (EPA QA/R-5; U.S. EPA, 2001) on preparation of Quality Assurance Project Plans (QAPPs); according to the U.S. EPA guidance, QAPPs are designed to describe both field sampling activities as well as quality assurance/quality control (QA/QC) activities.

The information presented in this SAP is organized into four groups according to their function as follows:

A. Project Management – this group is divided into elements that describe general areas of project management, project history and objectives, and roles and responsibilities of the participants.

B. Data Generation and Acquisition – this group is divided into elements that describe the sampling and analytical methods, sample handling, and QC requirements.

C. Assessment and Oversight – this group is divided into elements that describe activities for assessing the effectiveness of sample collection and analysis and associated QA/QC requirements.

D. Data Validation and Usability – this group is divided into elements that describe QA activities that occur after the data generation and acquisition phase of the project has been completed to ensure that data conform to the specified criteria and thus are useful for their intended purpose.

1.1 Title and Approval Page (A1)

The NASA JPL SAP Project Title and Approval sheet is provided as page ii of the SAP.

1.2 Table of Contents (A2)

The NASA JPL SAP Table of Contents is presented beginning on page iv of the SAP.

1.3 Distribution List (A3)

The NASA JPL SAP Distribution List is presented on page iii of the SAP.

1.4 Project Organization and Responsibilities (A4)

Figure A-1 provides a project organization chart for field work at the NASA JPL facility. Key personnel shown in the chart include the NASA Remedial Project Manager (RPM), NAVFAC Coordinator, NAVFAC Quality Assurance Manager, Battelle Project Manager, Battelle Project QAO, and the Battelle Project Team. Addresses and e-mail addresses for key personnel are provided in the Distribution List.

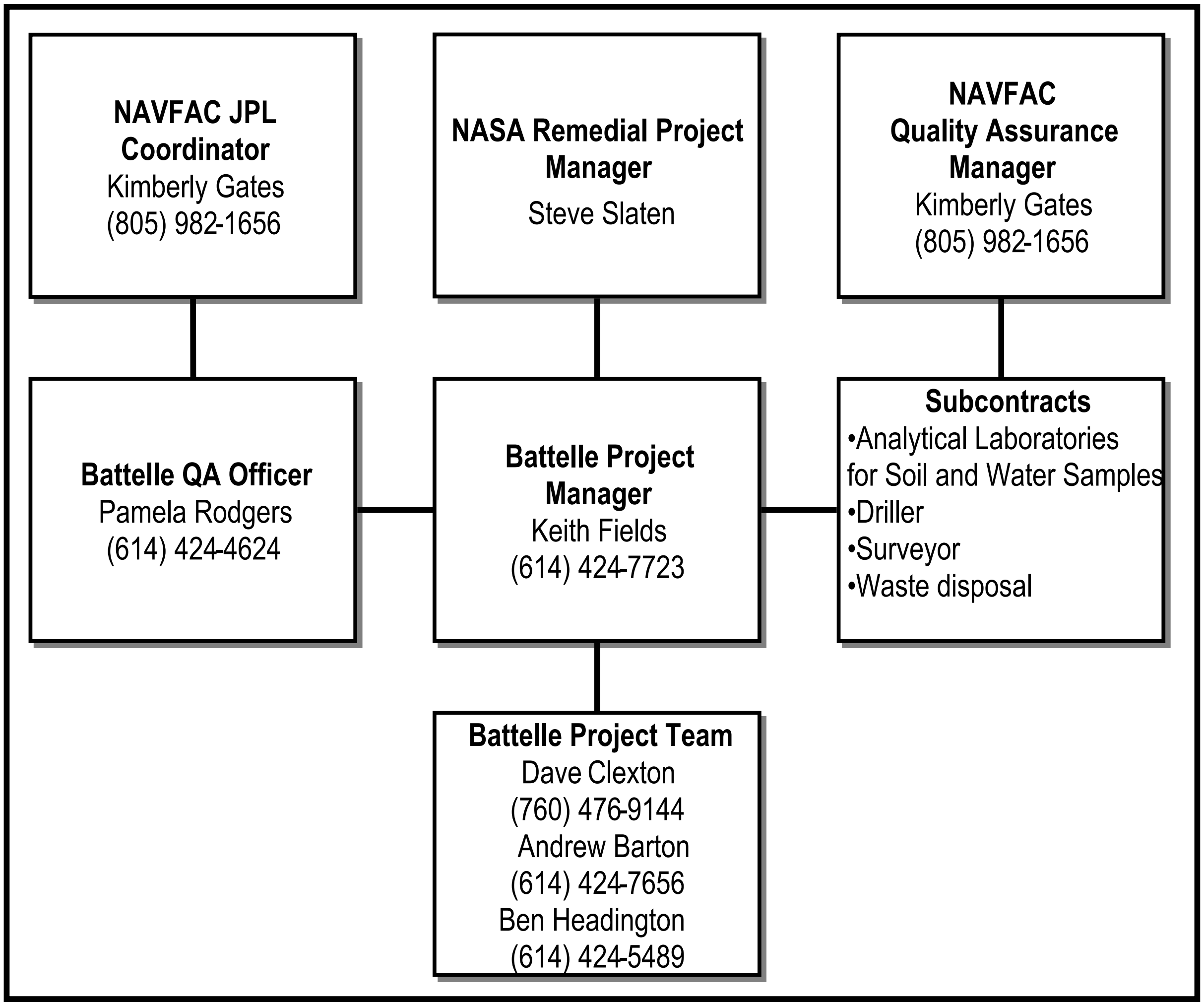

Figure A-1. Project Organization Chart for OU-3 Additional Remedial Investigation Activities at the NASA JPL Facility

Key subcontracted services are anticipated to include the following: analytical laboratories for analysis of soil and water samples, drilling company for installation and development of wells and collection of soil samples, surveyors for site layout and geophysical mapping, and a waste disposal company for handling and disposing of investigation-derived waste (IDW).

1.5 Problem Definition/Background (A5)

Perchlorate detections have been reported in municipal production wells located throughout the Raymond Basin, including the wells owned by the City of Pasadena and other purveyors. In addition, perchlorate detections in downgradient NASA JPL monitoring well MW-20 indicate the leading edge of the chemical plume originating at NASA JPL is not currently delineated. NASA JPL has assumed responsibility for the detections of VOCs and perchlorate in four City of Pasadena wells (Arroyo, Well 52, Ventura, and Windsor) and the two Lincoln Avenue Water Company (LAWC) wells (LAWC 3 and LAWC 5). An initial evaluation of available data was performed to evaluate NASA's responsibility for chemicals detected in other production wells and to identify uncertainties that will be addressed as part of the additional remedial investigation.

1.6 Project/Task Description (A6)

Additional investigation is proposed to delineate the leading edge of the perchlorate plume originating from the NASA JPL Facility and to improve the understanding of the relationship between water quality and perchlorate concentrations near the Sunset Reservoir. The additional investigation includes installation of two additional multi-port monitoring wells and collection of monitoring data from these wells in the form of groundwater-level elevations, chemical concentrations, and physical parameters.

1.7 Quality Objectives and Criteria for Measurement Data (A7)

This section presents the quality objectives for the project and the performance criteria necessary to meet these objectives. Included are discussions of the project data quality objectives (DQOs), the quantitative DQOs (precision, accuracy, and completeness), and the qualitative DQOs (comparability and representativeness). The overall QA objective is to generate data that are of known, documented, and defensible quality.

1.7.1 Data Quality Objectives. DQOs are statements that specify the quantity and quality of the data required to support project decisions. DQOs for this project were developed using the seven-step process *Guidance for the Data Quality Objectives Process* (U.S. EPA, 2000) and are presented in Table A-1. The QA procedures as well as the associated field sampling procedures contained in this SAP are focused on achieving these DQOs in a timely, cost-effective, and safe manner. Deviations from these objectives will require defining the cause or causes for noncompliance and will initiate the process of determining whether additional sampling and analyses will be required to attain project goals.

1.7.2 Quantitative Objectives: Precision, Accuracy, and Completeness. Precision quantifies the repeatability of a given measurement. Precision is estimated by calculating the relative percent difference (RPD) between laboratory or field duplicates, as shown in Equation (A-1).

$$\mathrm{RPD}\,(\%) = \frac{|\mathrm{Original} - \mathrm{Duplicate}|}{(\mathrm{Original} + \mathrm{Duplicate})/2} \times 100 \qquad \text{(A-1)}$$

The laboratory will review the QC samples to ensure that internal QC data lies within the limits of acceptability. Any suspect trends will be investigated and corrective actions taken. The analytical precision acceptability limits for all anlyses for this project will be:

- Water: 20%
- Vapor: 20%
- Soil: 30%.

Laboratory accuracy refers to the percentage of a known amount of analyte recovered from a given matrix. Percent recoveries for groundwater and soil samples are estimated by Equation (A-2).

$$\mathrm{Recovery}\,(\%) = \frac{(\mathrm{Spiked\ Sample}) - (\mathrm{Original\ Sample})}{(\mathrm{Amount\ of\ Spike\ Added})} \times 100 \qquad \text{(A-2)}$$

Table A-1. Data Quality Objective Steps for Assessment of Contaminated Soil and Groundwater

STEP 1 State the Problem	STEP 2 Identify the Decision(s)	STEP 3 Identify the Inputs to the Decisions	STEP 4 Define Study Boundaries	STEP 5 Develop Decision Rules	STEP 6 Specify Tolerable Limits on Errors	STEP 7 Optimize Sampling Design
The groundwater beneath NASA JPL has been found to contain elevated concentrations of perchlorate and other VOCs. Perchlorate detections in downgradient NASA JPL monitoring well MW-20 indicate the leading edge of the chemical plume originating at NASA JPL is not currently delineated.	Additional investigation is proposed to delineate the leading edge of the perchlorate plume originating from NASA JPL and to improve the understanding of the relationship between water quality and perchlorate concentrations near the Sunset Reservoir.	The primary type of information that needs to be obtained in order to resolve the decision statement is laboratory analyses of groundwater and soil samples collected from wells set in drilled boreholes. Depth-discrete ground-water samples will be analyzed for perchlorate, CCl_4, and several other VOCs. Soil samples will be analyzed for physical parameters to better understand the nature of the aquifer material.	A multi-port monitoring well will be installed in the vicinity of the City of Pasadena Atlanta well and in the northwestern portion of the Sunset Reservoir complex operated by Pasadena Water and Power.	Provide evidence that chemical concentrations and aerial extent of perchlorate and other VOCs in groundwater originating at NASA JPL is delineated and information to understand the relationship between water quality and perchlorate concentrations near the Sunset Reservoir. In addition, provide evidence that the groundwater sampling produces representative data that achieves monitoring objectives and supports project management decisions.	Statistical performance parameters have not been determined because limits on decision error will not be considered. Data validation will be performed by an in-house review.	The proposed sampling locations are based upon those presented in the Work Plan.

The recovery of most spiked organic compounds is expected to fall within a range of 70 to 130%. The recovery of spiked metals should be between 75 and 125%.

Completeness refers to the percentage of valid data received from actual testing done in the laboratory. Completeness is calculated as shown in Equation (A-3). The target completeness goal for all compounds is 90%.

$$\text{Completeness} = \frac{\text{Number of Measurements Judged Valid}}{\text{Total Number of Measurements}} \times 100 \qquad \text{(A-3)}$$

1.7.3 Qualitative Objectives: Comparability and Representativeness. Comparability is the degree to which one data set can be compared to another. To ensure comparability, samples will be collected at specified intervals and in a similar manner, and will be analyzed within the required holding times by accepted methods. All data and units used in reporting this project will be consistent with accepted conventions for groundwater and soil analyses. This approach will ensure direct comparison of results from projects using the methods presented in this SAP.

Representativeness is the degree to which a sample or group of samples is indicative of the population being studied. Over the course of this effort, samples will be collected in a manner such that they are representative of both the chemical composition and the physical state of the media at the time of sampling.

1.8 Special Training/Certification (A8)

All personnel performing fieldwork must comply with Occupational Safety and Health Administration (OSHA) requirements as specified in 29 CFR 1910. Personnel will have current records of Hazardous Waste Operations and Emergency Response (HAZWOPER) training and subsequent 8-hour refresher training. At least one person on the field team will be trained in first aid and certified in cardiopulmonary resuscitation (CPR).

Field team members will be adequately trained in field methods and sampling procedures outlined in this plan. Specifically, field team members will have training in the following field activities: drilling and well installation; well inspection; groundwater sampling; use of water-level indicators, and related field equipment; sample handling, packaging, and shipping; and handling of IDW. The Project Manager will maintain training records for all field personnel as part of the project file. Training records demonstrating compliance with OSHA requirements as specified above will be kept on site at all times.

1.9 Documentation and Records (A9)

The following general types of documents and records will be maintained for this project:

- SAP
- Site Health and Safety Plan (SHSP)
- Well construction diagrams
- Project logbooks
- Sample chain-of-custody forms
- General project correspondence
- Laboratory data reports
- Sampling and analysis reports.

The Project Manager is responsible for maintaining the above records to meet the requirements of this SAP. This requirement includes the maintenance of all records and data necessary for QA reports to management, corrective actions, and other associated documentation. Project documentation will be maintained for a minimum of five years following completion of the project.

Section 2.0: FIELD SAMPLING PLAN (DATA GENERATION AND ACQUISITION)

The SAP, in conjunction with the Work Plan, has been prepared to ensure that the DQOs specified for this project are met; the field sampling protocols are implemented, documented, and reviewed in a consistent manner; and the data collected are scientifically valid and defensible. The following sections describe field activities that may be performed as part of the CERCLA action at NASA JPL. These activities may include well installation, well development, geophysical logging of boreholes, sampling of environmental media and measurement of field parameters and groundwater levels.

2.1 Sampling Process Design (Experimental Design) (B1)

The proposed field activities and the rationale for their design are discussed in detail in the Work Plan.

2.2 Sampling and Analytical Requirements (B2)

The SAP has been prepared to ensure that DQOs specified for this project are met; the field sampling protocols are implemented, documented, and reviewed in a consistent manner; and the data collected are scientifically valid and defensible. This section addresses the sampling and analytical requirements for the continued remedial investigation.

2.2.1 Monitoring Well Installation. Selection of the proposed supplementary monitoring well locations was based on groundwater analytical data from existing wells, known groundwater flow patterns in the OU-3 area, and the objectives of this additional assessment. Two proposed monitoring well locations have been identified, each of which is located on property owned by the City of Pasadena. The first proposed location is downgradient of JPL monitoring well MW-20 (NASA's furthest downgradient monitoring well) near the City of Pasadena Atlanta well, which is located at 691 West Woodbury Road, near the intersection of Woodbury Road and Casitas Avenue. The second proposed location is slightly upgradient of the City of Pasadena Sunset Reservoir area Bangham and Copelin wells in the northwest corner of the PWP Sunset Reservoir complex near the intersection of Hammond Street and the Foothill Freeway. Although two additional monitoring wells are currently identified as part of this additional investigation, additional locations in OU-3 may be necessary depending on the groundwater monitoring results from these newly installed wells.

Prior to beginning drilling, all available utility maps will be reviewed and well locations will be strategically sited in the vicinity of the proposed location to avoid existing utilities. In addition, prior to performing any subsurface activities, the well locations will be scanned for underground utilities using geophysical methods. As required by California State law, Underground Services Alert (USA) will be notified of the planned drilling activities.

Similar to the existing JPL multi-port monitoring wells, the proposed monitoring wells have been designed to include five depth discrete monitoring points within one well casing, and will be equipped with the Westbay Instruments Ltd. multi-port casing monitoring system. Both new wells will be drilled to the top of the crystalline bedrock. Based on boring logs from nearby wells, it is anticipated that the proposed wells will extend to depths of approximately 700 to 1,000 ft. This design may be amended in the field if site-specific conditions warrant a modified construction. The wells will be installed using the mud rotary drilling technique and well construction will satisfy the requirements of the California Department of Water Resources, Water Well Standards, Bulletin 74-90, Supplement to Bulletin 74-81. The proposed screen depths will initially be chosen based on lithologic information from existing production and monitoring wells and existing groundwater level data. However, field changes to the proposed screen depths may occur as a result of information collected from lithologic logging during drilling and geophysical logging. Each monitoring well will be developed within 24 hours after being installed. Additional details regarding well drilling, multi-port casing system installation, testing, and well development can be found in Section 4.0 of the Work Plan and in NASA's regulator approved Work *Plan for Performing a Remedial Investigation/Feasibility Study at NASA JPL* (Ebasco, 1993a).

Groundwater samples will be collected from each of the sampling ports on the monitoring wells. In addition, a minimum of one saturated and one unsaturated soil sample will be collected from each soil boring during drilling.

2.2.2 Groundwater Sampling Procedures. The newly installed multi-port monitoring wells will be initially sampled from each screened interval within one week following well development according to the protocol described in this SAP. Groundwater chemical analyses will be performed by a California Department of Health Services (DHS)-certified laboratory using approved methods. Ambient air quality will be monitored and noted throughout field activities, including groundwater sampling.

2.2.2.1 Groundwater-Level Measurement Procedures. Groundwater-level measurements (potentiometric head) will be collected from each sampling port prior to sampling using a pressure transducer probe that was designed especially for use with the Westbay® multi-port casing system. The pressure transducer probe system typically installed in the wells is the Model 2521 MOSDAX Pressure Profiling System. Additional details regarding collection of groundwater-level measurements can be found in NASA's regulator approved *Field Sampling and Analysis for Performing a Remedial Investigation at Operable Unit 3: Off-Site Groundwater* (Ebasco, 1994).

2.2.2.2 Well Purging Procedures. Purging before sampling is not required in the multi-port monitoring wells because the groundwater is not exposed to the atmosphere. Only the first sampler volume of groundwater retrieved from each screened interval in the Westbay® multi-port wells is discarded prior to sampling. This volume of water is used as a rinse before samples are collected for analysis. Additional details regarding well purging procedures can be found in NASA's regulator approved *Field Sampling and Analysis for Performing a Remedial Investigation at Operable Unit 3: Off-Site Groundwater* (Ebasco, 1994).

2.2.2.3 Procedures for Collection of Groundwater Samples. Initial groundwater samples will be collected from each sampling port on the additional monitoring wells within one week after being developed. This time delay will maximize sample representativeness. Sampling the multi-port monitoring wells requires the use of specialized equipment provided by Westbay Instruments, Ltd. This equipment includes a sampler probe with a surface control unit (Model 2410 Sampler Probe System), whereby groundwater samples can be collected from each screened interval using dedicated tubing. The personnel using this equipment must be properly trained by Westbay Instruments, Ltd to ensure their proper use. Copies of the detailed operations manuals for the Westbay® sampling probe (including the required sampling equipment) and additional details regarding well sampling procedures are provided in NASA's regulator approved *Field Sampling and Analysis for Performing a Remedial Investigation at Operable Unit 3: Off-Site Groundwater* (Ebasco, 1994).

2.2.2.4 Groundwater Samples for Field Measurement of Water Quality Parameters. Because purging is not required in the Westbay® multi-port monitoring wells, temperature, pH, specific conductivity and turbidity of the groundwater will be measured at each sampling port using flow through cells before and after each sample is collected. An attempt also will be made to collect dissolved oxygen (DO) and oxidation reduction potential (ORP) measurements. The instruments used to measure the water quality parameters will meet the measurement standards specified in the *Quality Assurance Program for Performing a Remedial Investigation at the NASA Jet Propulsion Laboratory* (Ebasco, 1993b).

2.2.3 Soil Sampling Procedures. A minimum of one saturated and one unsaturated soil sample will be collected from each monitoring well for use in determining selected physical parameters, such as hydraulic conductivity, porosity, and bulk density. Soil analyses will be performed by a California DHS-certified laboratory using approved methods. Ambient air quality will be monitored and noted throughout field activities, including soil sampling. Soil sampling will be conducted as follows:

1. The downhole drilling equipment will be tripped from the borehole.
2. The modified split-spoon sampler and all associated sampling equipment will be decontaminated using the decontamination procedures for field equipment described in Section 2.2.4.
3. A modified split-spoon sampler attached to a 300-pound hammer will be inserted down the well for sample collection. After reaching the desired depth, the 2.6-inch-I.D., 18-inch-long split-spoon sampler containing stainless steel sleeves will be driven into the soil.
4. The sampler will be retrieved from the borehole, and one-half of the split spoon will be removed so that the soil in the sleeves rests in the remaining half of the barrel.
5. The sleeve to be used for laboratory analysis will be removed from the lower end of the split-spoon sampler. Each end of the sleeve will be capped with a Teflon™ sheet, sealed with a polyethylene lid, and labeled.
6. All soil samples will be immediately sealed in a plastic bag and placed in an ice chest or refrigerator, where they will be maintained at approximately 4°C until shipment for analyses.
7. All remaining soil samples will be disposed of with the soil cuttings.

2.2.4 Decontamination Procedures. All nondisposable field equipment will be decontaminated as described below before each use to avoid cross-contamination between samples and to ensure the health and safety of the field crews.

Commercially available distilled (DI) water and reagent-grade methanol will be used as intermediate rinses. The final rinse will use high-performance liquid chromatography (HPLC)-grade water (or equivalent). The following sequence will be used to clean all field equipment and sampling devices:

- Wash the samplers with Liquinox™ detergent and DI water and clean them with a stiff-bristle brush.
- Rinse with DI water.
- Rinse with methanol.
- Rinse with HPLC-grade water (or equivalent).
- Place the sampling equipment on a clean surface and air dry.

Any non-dedicated Westbay® sampling equipment will be decontaminated according to the procedures outlined in the *Quality Assurance Program for Performing a Remedial Investigation at the NASA Jet Propulsion Laboratory* (Ebasco, 1993b).

2.2.5 Disposal of Contaminated Materials. Several waste streams will result from the execution of this SAP. Wastes will be periodically sampled and analyzed for the organic and inorganic constituents noted in Table A-2 so that the ultimate disposal method for the wastes can be identified. NASA will be

Table A-2. Sampling and Analytical Requirements for Investigation Derived Waste [(a)]

Waste Type	Sampling/Analysis Frequency	Analysis
Drill cuttings and soil sampling residuals	As drums are filled	Perchlorate, organics and metals listed in Table A-3.
Development water from wells, drilling fluids, and decontamination water	As drums are filled	Perchlorate, organics, and metals listed in Table A-3.

(a) All analyses to be performed at an off-site laboratory.

responsible for the ultimate disposal of both hazardous and non-hazardous wastes. A description of each waste stream is presented below.

2.2.5.1 Soils. Soils associated with sampling operations have the potential of containing some level of chemicals. Soil cuttings and any residual materials associated with sampling activities will be stored temporarily in 55-gallon drums or lined roll-off bins prior to transportation and disposal at an off-site licensed facility. Analytical results characterizing the contents of each drum will be obtained to determine whether the materials will require disposal in either a hazardous or non-hazardous facility. Copies of the manifests for all containers of soil removed from the project site will be retained in the project files.

2.2.5.2 Groundwater, Drilling Fluids, and Decontamination Wastewater. Groundwater from well development activities, drilling fluids and decontamination water generated during field sampling efforts will be stored temporarily in Baker tanks, polyethylene tanks, and/or 55-gallon drums in an appropriate storage area. Analytical results from the streams that constituted the wastewater will be obtained prior to transportation of the water off-site, and used to determine the proper method of disposal.

2.2.5.3 Used Personal Protective Equipment. The field activities will be performed in Level D personal protective equipment (PPE) and/or modified Level D PPE. Used PPE (if applicable) will be stored temporarily in 55-gallon drums prior to transportation and disposal at an off-site licensed facility.

2.2.5.4 Waste Transport, Disposal, and/or Treatment. Loading and transporting soil, groundwater/decontamination water, and used PPE (if applicable) will be coordinated with a specified NASA representative. Original copies of the manifest and disposal notification forms will be provided to the transporter for shipment. Copies of waste manifests and receipts for the disposal of wastes will be retained.

2.3 Sample Handling and Custody (B3)

This section presents sample handling and custody procedures for the remediation activities. These procedures will ensure proper handling, custody, and documentation of the samples from field collection through laboratory analyses.

2.3.1 Sample Handling. Groundwater samples are to be collected and containerized in order of decreasing volatility of parameters. The preferred collection order for groundwater samples is:

1. VOCs
2. Perchlorate, nitrates, etc.
3. Metals

A sufficient sample volume will be collected from each location sampled to serve the needs of all analyses (including matrix spikes, matrix spike duplicates, and field duplicates). All samples to be analyzed for VOCs will be collected and capped with zero headspace. The sample containers will be inverted, shaken, tapped, and visually inspected for air bubbles by the sample team prior to leaving the sample site. If air bubbles are observed, the entire sample collection process will be repeated. All other sample containers for water samples will be filled to approximately 90% capacity. Groundwater will be analyzed for the parameters listed in Table A-3.

Table A-3. Summary of Monitored Parameters and Analytical Methods

Constituent	Units	Method Number	PQL
Perchlorate	µg/L	314.0[(a)]	2
Sodium	µg/L	200.7	2,000
Potassium	µg/L	200.7	400
Calcium	µg/L	200.7	200
Magnesium	µg/L	200.7	100
Chloride	mg/L	300.0	0.2
Nitrate-Nitrogen (NO_3-N)	mg/L	300.0	0.4
Sulfate	mg/L	300.0	0.5
Bicarbonate	mg/L	310.1	2
Total Lead	µg/L	200.8	1
Total Arsenic	µg/L	200.9	5
Total Chromium	µg/L	200.8	5
Hexavalent Chromium	mg/L	7196	0.01
Total Dissolved Solids	mg/L	160.1	10
Alkalinity	mg/L	310.1	2
1,4-Dioxane	µg/L	8270	3
Nitrosamines (including NDMA)	µg/L	1625M	Various
1,2,3-Trichloropropane	µg/L	504.1	0.005
VOCs	µg/L	524.2	Various

(a) Ten percent of samples also will be analyzed using an LC/MS/MS method. Results from the two methods will be evaluated against each other.
PQL = practical quantitation limit
NDMA = n-nitrosodimethylamine

2.3.2 Sample Containers, Holding Times, and Preservation and Turnaround Times. Table A-4 presents sample container, holding time, and preservation requirements for the listed analytical parameters based on U.S. EPA SW-846 requirements. New, pre-cleaned sample containers will be used. The laboratory selected to receive the samples will supply containers.

Once collected, each containerized sample will be labeled and placed into a matrix-specific sample cooler. The sample cooler will serve as the shipping container and will be provided by the laboratory with the sample containers. The sample cooler will be packed with ice to cool samples to 4°C during shipment. Samples are to be transported to the laboratory promptly in order to provide ample time for analyses to be conducted within the established maximum holding times. The maximum interval between sample collection and shipment is to be one business day.

Table A-4. Sample Containers, Holding Times, and Preservation Methods for Groundwater Samples

Constituent	Method No.	Sample Container	Preservation Method	Max. Holding Times
Perchlorate	314.0[a]	125-mL amber or plastic	Cool, 4°C	28 days
Sodium	200.7	125-mL poly	Cool, 4°C	6 months
Potassium	200.7	125-mL poly	Cool, 4°C	6 months
Calcium	200.7	125-mL poly	Cool, 4°C	6 months
Magnesium	200.7	125-mL poly	Cool, 4°C	6 months
Chloride	300.0	125-mL poly	Cool, 4°C	28 days
Nitrate-Nitrogen (NO_3-N)	300.0	125-mL poly	Cool, 4°C	48 hours
Sulfate	300.0	125-mL poly	Cool, 4°C	28 days
Bicarbonate	310.1	125-mL poly	Cool, 4°C	14 days
Total Lead	200.8	125-mL poly	Cool, 4°C, pH<2 HNO_3	6 months
Total Arsenic	200.9	125-mL poly	Cool, 4°C, pH<2 HNO_3	6 months
Total Chromium	200.8	125-mL poly	Cool, 4°C, pH<2 HNO_3	6 months
Hexavalent Chromium	7196	100-mL poly	Cool, 4°C	24 hours
Total Dissolved Solids	160.1	500-mL poly	Cool, 4°C	7 days
Alkalinity	310.1	200-mL poly	Cool, 4°C	14 days
1,4-Dioxane	8270	1,000-mL amber glass	Cool, 4°C	7 days
1,2,3-TCP	504.1	3 x 40-mL glass	Cool, 4°C	14 days
Nitrosamines (including NDMA)	1625M	2 x 1000-mL glass	Cool, 4°C	7 days
VOCs	524.2	3 x 40-mL glass	Cool, 4°C, No headspace, pH<2 HCl	14 days

(a) A certain percentage of samples also will be analyzed using an LC/MS/MS method. Results from the two methods will be evaluated against each other.

The Project Manager or designee is responsible for coordinating with the laboratory for sample shipment via laboratory pick-up or overnight delivery service. U.S. Department of Transportation (DOT) regulations concerning the shipment of environmental samples to a laboratory for analysis will be followed.

2.3.3 Sample Packaging and Shipping. Immediately after samples are collected and labeled for off-site laboratory analysis, they will be placed in a matrix-specific ice chest or cooler. The samples will be packed with shock-absorbent materials, such as bubble wrap, to prevent movement or breakage of the sample jars during transport. The ice chest will be filled with wet ice in order to meet the 4°C preservative requirement. A temperature blank will accompany each cooler.

The chain-of-custody will be placed in a zip-lock bag and taped to the inside of the cooler. The ice chest will be banded with packaging tape and custody seals will be placed along the ice chest lid in order to prevent or indicate tampering. The cooler containing the environmental samples will be picked up by the laboratory or arrangements can be made to have the cooler delivered to the laboratory by an overnight delivery service such as FedEx. If an overnight delivery service is used, the package must be scheduled for priority overnight service so that the temperature preservative requirement is not exceeded.

2.3.4 Sample Documentation. Sample documentation includes sample designation, sample labeling, field notes, and chain-of-custody forms. Sample designation provides that each sample will be uniquely identified, labeled, and documented in the field at the time of collection. Each sample container will have a sample label affixed to the outside of the container in an obvious location. Example labels are presented in Figures A-2 and A-3. Information will be recorded on the label with water-resistant ink. The sample label will specify:

- Sample identification number
- Date and time of sample
- Preservation used
- Analytical methods
- Project name.

The field notebook will be used to provide daily records of significant events, observations, and measurements during field investigations. The field logbook also will be used to document all sampling activities. All notebook entries will be made with indelible ink to provide a permanent record. Logbooks will be kept in the possession of the field technician during the on-site work and all members of the field team will have access to the notebook. These notebooks will be maintained as permanent records.

The field notebooks are intended to provide sufficient data and observations to reconstruct events that occurred during installation and sampling. All notebooks will be given a unique label and multiple notebooks will be assigned serial numbers. The following items will be recorded in the field logbook.

- Name, date, and time of entry
- Names and responsibilities of field crew members
- Name and titles of any site visitors
- Descriptions of drilling and sampling procedures, and problems encountered
- Number and amount of samples taken at each location
- Details of sampling location

Client/Project Name: ____

Sample ID: ____

Date/Time: ____

Analysis:____

Preservative: ____

Sampler's Name: ____

Figure A-2. Sample Label for Water Samples

Client Name: ____

Sample ID: ____

Date/Time: ____

Analysis: ____

Sampler's Name: ____

Sample Type: **Grab** **Composite** **Other**

Figure A-3. Sample Label for Soil Samples

- Identification numbers of all samples collected
- Date and time of collection
- Sample collection method
- Decontamination procedures
- Field measurements (e.g., DO, ORP, temperature, pH, and conductivity) and general observations.

Each sample container is to be logged using a chain-of-custody form prior to shipment or pickup by the laboratory. The chain-of-custody form will be signed by the individual responsible for custody of the sample containers and will accompany the samples to the laboratory. An example chain-of-custody form is presented in Figure A-4. Information to be recorded on the chain-of-custody form should include:

- Sample matrix
- Sample collector's name

- Dates/times of sample collection
- Sample identification numbers
- Number and type of containers for each sample aliquot
- Type of preservation
- QC sample designation
- Analysis method
- Special handling instructions
- Destination of samples
- Name, date, time, and signature of each individual releasing the shipping container.

The laboratory will designate a sample custodian. This individual is responsible for inspecting and verifying the correctness of the chain-of-custody records upon sample receipt. The sample custodian will accept the samples by signing the chain-of-custody form and noting the condition of the samples in writing on the chain-of-custody or other receipt form. The sample custodian will notify the Project Team Leader of any discrepancies.

Samples received by the laboratory will be entered into a sample management system, which must include:

- Laboratory sample number
- Field sample designation
- Analytical batch numbers
- List of analyses requested for each sample container.

Immediately after receipt, the samples will be stored in an appropriate secure storage area. The analytical laboratory will maintain written records showing the chronology of sample handling during the analysis process by various individuals at the laboratory.

2.4 Analytical Methods (B4)

This section presents minimum criteria for laboratory selection and discusses methods to be used for analyses of soil, groundwater, and investigation derived waste samples.

2.4.1 Laboratory Selection. An analytical laboratory that has successfully completed the Navy evaluation process through the Naval Facilities Engineering Service Center (NFESC) will perform all analyses, unless specified otherwise by the NASA. Aqueous and soil samples for this task order will be analyzed by a California-certified laboratory.

Battelle's Project Manager will communicate sampling and analysis schedules to the laboratory with sufficient lead-time to meet contractual agreements with the laboratory.

CHAIN OF CUSTODY

EMAX Laboratories, Inc.	1835 W. 205th Street, Torrance, CA 90501 Tel #: 310-618-8889 Fax #: 310-618-0818 Email: info@emaxlabs.com	PO NUMBER: SAMPLE STORAGE	EMAX CONTROL NO. * PROJECT CODE:

	MATRIX CODE	PRESERVATIVE CODE	ANALYSIS REQUIRED	TAT
CLIENT				
PROJECT	DW=Drinking Water	IC = Ice		☐ Rush ____hrs.
COORDINATOR TEL FAX EMAIL	GW=Ground Water	HC = HCl		☐ Rush ____days
	WW=Waste Water	HN=HNO3		☐ 7 days
SEND REPORT TO	SD=Solid Waste SL=Sludge	SH=NaOH		☐ 14 days
COMPANY	SS=Soil/ Sediment	ST=Na2S2O3		☐ 21 days
ADDRESS	WP=Wipes PP=Pure Products	ZA=Zinc Acetate		☐ 30 days
	AR=Air	HS=H_2SO_4		☐ ____days
EMAX PM	O=			☐

SAMPLE ID		SAMPLING			CONTAINER			MATRIX CODE	QC	PRESERVATIVE CODE	COMMENTS
LAB	CLIENT	LOCATION	DATE	TIME	NO.	SIZE	TYPE				
• 1											
• 2											
• 3											
• 4											
• 5											
• 6											
• 7											
• 8											
• 9											
• 0											

Instructions				Cooler #	Temp. (°C)	Sample #s
SAMPLER			COURIER/AIRBILL			
RELINQUISHED BY	Date	Time	RECEIVED BY			

NOTICE: Turn-around-time (TAT) for samples shall not begin until all discrepancies have been resolved. For samples received and discrepancies resolved after 1500 hrs, TAT shall start at 0800 hrs the next business day. The client is responsible for all cost associated with sample disposal. Samples shall be disposed of as soon as practical (but not prior to fifteen (15) calendar days) after issuance of analytical report unless a different sample disposal schedule is pre-arranged with EMAX. Disposal fee for samples defined by CA Title 22 as non-hazardous shall be $5.00 per sample. EMAX will return hazardous samples to the client at the client's expense unless directed in writing otherwise.

Figure A-4. Sample Chain of Custody for Water and Soil Samples

2.4.2 Laboratory Analytical Methods. Laboratory analytical methods were selected based on the project DQOs and in consideration of the method detection limits achievable for each parameter. Each laboratory analytical method was chosen to address the intended use of the sampling data. Table A-3 presents the laboratory analytical methods that are to be used during the field activities.

2.4.3 Quantitative Reporting Limits. Factors that influence the quantitative reporting limits of analytical methods include the analytical method itself, sample matrix interference, and high concentrations of the target analyte. Actual reporting limits may vary from sample to sample in accordance with standard laboratory practices. Table A-3 provides the reporting limits for the analytical methods used for soil and groundwater.

2.5 Quality Control Requirements (B5)

QA can be described as an integrated system of activities in the area of quality planning, assessment, and improvement to provide the project with a measurable assurance that the established standards of quality are met. QC checks, including both field and laboratory, are the specific operational techniques and activities used to fulfill the QA requirements. Proper sample acquisition and handling procedures are necessary to ensure the integrity of the analytical results. All procedures will be followed in both the field and the laboratory.

2.5.1 Field Quality Control Checks. The collection frequency for each field QC sample is listed in Table A-5. The field QC samples will be assigned unique sample numbers and will be submitted to the analytical laboratory. If abnormalities are detected in field QC checks, the data associated with the QC checks will be flagged and appropriate actions will be taken to rectify issues.

Table A-5. QC Sampling Collection Frequency

Type of Sample	Number of Samples
Field Duplicates	10%; if <10 per day, one sample will be collected
Equipment Rinsate[(a)]	1 per day
Trip Blank	1 per cooler
Field Blank	1 per day
Laboratory Quality Assurance[(b)]	5%

(a) Required to verify decontamination between samples where non-dedicated equipment is used.
(b) For MS/MSD analyses.

2.5.1.1 Field Duplicate Samples. For all water samples, duplicate samples will be collected by retaining consecutive samples from the sample pump. Field duplicate samples will be collected at a rate of 10% of the total number of samples during a sampling event. If fewer than 10 samples are collected, one duplicate sample will be collected.

2.5.1.2 Equipment Rinsate Blanks. Equipment rinsate blanks will be collected daily to ensure that non-dedicated sampling devices have been decontaminated effectively. Equipment rinsate blanks will consist of the final HPLC-grade (or equivalent) rinsewater used in the final step of the sampling equipment decontamination procedure. Rinsate samples will be collected at a frequency of one per day during sampling events. The rinsate QA samples for the split-spoon samplers used to collect soil samples will be obtained prior to collection of the samples by rinsing through the decontaminated split-spoon sampler containing sleeves with HPLC-grade water (or equivalent). The water will be collected in a 40-mL VOA vial and returned to the laboratory for analysis. Equipment rinsate blanks on the non-dedicated

Westbay® equipment (if any) will be collected according to the procedures outlined in the *Quality Assurance Program for Performing a Remedial Investigation at the NASA Jet Propulsion Laboratory* (Ebasco, 1993b). Equipment rinsate blanks will be analyzed for VOCs only.

2.5.1.3 Trip Blanks. Trip blank samples will accompany each cooler that contains samples being submitted for volatile parameter analysis. Trip blanks will be prepared at the laboratory by filling 40-mL VOA vials with HPLC-grade water. Trip blanks are not to be opened in the field.

2.5.1.4 Field Blanks. Field blanks for groundwater sampling will be collected daily and will consist of three 40-mL VOA vials. The vials will be filled with HPLC-grade water prior to collection of a groundwater sample, and the uncapped vials will be placed upwind of the well during collection of the groundwater sample. Following groundwater sample collection, the vials will be acidified, capped, labeled, and recorded in the field logbook. The purpose of this type of blank is to detect possible contamination of the sample from airborne hydrocarbons during sample collection.

2.5.1 Laboratory Quality Control Checks. Laboratory QC is addressed through the analysis of laboratory QC samples, documented internal and external laboratory QC practices, and laboratory audits. Three types of laboratory QC samples will be used in this project: laboratory blank samples, matrix/matrix spike duplicate (MS/MSD) samples, and laboratory control samples (LCS). Definitions of each type of laboratory QC sample are listed below. Analytical results for these samples will become the quantitative focus of the laboratory QC activities. For laboratory measurements, if any of the QC checks are outside the acceptance criteria, corrective actions will be taken. The laboratory QC checks, acceptance criteria, and corrective actions are listed in Table A-6.

Table A-6. Quality Control, Acceptance Criteria, and Corrective Action

QC Sample Type	Acceptance Criteria	Corrective Action
Procedural blank	<5 × MDL	Results examined by analyst. Corrective action (re-extraction, reanalysis) or justification document.
Blank spike	80-120%	
Calibration	5-point calibration curve (RSD≤ ± 20%); mid-range NIST standard solution (RSD≤ ± 20%) (Battelle SOP, Appendix H)	Investigate the problem, resolve the problem, and recalibrate.
Calibration check	Mid-range calibration solution (RSD≤ ± 30%) (every 10 samples)	Investigate the problem, resolve the problem, recalibrate, and re-analyze affected samples.

MDL = Minimum detection limit is estimated from the lowest calibration standard solution. Samples below the MDL will be reported as not detected (ND)
RSD = relative standard deviation.

In addition to the QC checks discussed above, the laboratory must provide data to demonstrate that laboratory glassware, reagents and solutions are free from contamination by perchlorate, such as may occur through use of certain detergents used to clean laboratory glassware.

2.5.2.1 Laboratory Blank Samples. Laboratory blank samples are designed to detect contamination of routine samples that occurs in the laboratory. Laboratory blanks verify that method interference caused by contaminants in solvents, reagents, glassware, and other sample processing hardware are known and minimized. Laboratory blanks are deionized water for aqueous samples. A minimum of one laboratory blank will be analyzed each day that routine samples are analyzed. The concentration of the target compounds in the laboratory blank sample must be less than or equal to the reporting limit. If the blank is not under the specified limit, the source contamination is to be identified and corrective actions taken.

2.5.2.2 Matrix Spike Samples. MS and MSD samples are designed to check the precision and accuracy of the analytical methods through the analysis of a normal sample with a known amount of analyte added. Additional sample volume for MS and MSD samples will be collected in the field in the same manner as field duplicate samples. In the laboratory, two portions of the sample are spiked with a standard solution of target analytes. MS and MSD samples will be analyzed for the same parameters as the routine samples, and analytical results will be evaluated for precision and accuracy of the analytical method and effects of the sample matrix. The MS and MSD samples will be collected from 5% of all routine samples.

2.5.2.3 Laboratory Control Samples. Laboratory control samples include blank spikes and blank spike duplicates. Blank spike samples are designed to check the accuracy of the analytical method by measuring a known concentration of an analyte in the blank spike samples. Blank spike duplicate samples are designed to check the accuracy and precision of the analytical method by measuring a known concentration of an analyte in the blank spike duplicate sample. Blank spike and blank spike duplicate samples are prepared by the laboratory using clean laboratory matrices spiked with the same spiking compounds used for matrix spikes at levels approximately 10 times greater than the method detection limit.

2.6 Instrument/Equipment Testing, Inspection, and Maintenance (B6)

Various field instruments may be used during the field activities. Such instrumentation may include flow meters for measuring groundwater quality and a FID for measuring VOCs in breathing zones. A list of field instruments that may be used during field work at NASA JPL is provided in Table A-7.

Table A-7. Field Meters

Matrix	Parameter	Instrument
Groundwater	Water quality parameters (temperature/conductivity/conductivity/ salinity/turbidity/pH)	Orion Model SA520 pH meter, Yellow Springs Instrument Company Model 33 conductivity and salinity meter, Hach Model 16800 turbidimeter
Groundwater	Groundwater-level	Electric water level indicator or pressure transducer system (MOSDAX Model 2521)
Soil/Breathing Zone	Organic vapors	Photovac FID

Field instrument maintenance will be documented in the field logbook for each field instrument used during field activities. Field equipment will be maintained when routine inspections indicate the need for maintenance. In the event that a piece of equipment needs repair, a list of the field equipment manufacturers' addresses, telephone numbers, and points of contact will be maintained on site during field activities. Field equipment routine maintenance may include the following:

- Calibrating equipment according to manufacturers directions
- Removing surface dirt and debris

- Replacing/cleaning filters when needed
- Ensuring proper storage of equipment
- Inspecting instruments prior to use
- Charging battery packs when not in use
- Maintaining spare and replacement parts in field to minimize down time.

Laboratory instrument maintenance including standard preventive maintenance procedures and schedules are contained in, and will be performed in accordance with, the method documentation.

2.7 Instrument/Equipment Calibration and Frequency (B7)

Methods for calibration of field instruments will follow the specific instrument manufacturers' recommendations. All field instruments will be calibrated before each day of use; and a calibration check at the end of the day will be performed to verify that the instrument remained in good working condition throughout the day. If the calibration check at the end of the day does not meet acceptance criteria, then that day's data will be flagged and the instrument calibration checks will increase to the operator's satisfaction that the instrument remains true to the initial calibration.

Laboratory instrument calibration will be performed as specified in the method documentation. Specific laboratory calibration techniques are established for the U.S. EPA methods to demonstrate that the analytical instrument is operating within the design specifications and that the quality of the data generated can be replicated.

2.8 Inspection/Acceptance Requirements for Supplies and Consumables (B8)

Any supplies and consumables used in the sample collection process or instrument calibration, such as sample bottles, deionized water, calibration gases, etc., will be inspected upon receipt and prior to use. The sample tubing should also come with a certificate of acceptance. At a minimum, the Project Manager or a field team member will inspect the tubing upon receipt for damage or broken seals.

2.9 Non-direct Measurements/Data Acquisition Requirements (B9)

Non-direct measurement data (obtained from such sources as computer data bases, programs, literature files and historical data bases) are not anticipated as part of the field implementation or field decision-making aspects of this project.

2.10 Data Management (B10)

The purpose of the data management section of this SAP is to briefly describe the procedures that will be used to maintain data quality throughout the project. These operations include, but may not be limited to data recording, data reduction, and data reporting.

2.10.1 Data Recording. All field observations and laboratory results will be linked to a unique sample location through the use of the sample identification system. Field observations and measurement data will be recorded on the field forms and in a field notebook to provide a permanent record of field activities. All data that are hand-entered will be subjected to a review by a second person to minimize data entry errors. A check for completeness of field records (logbooks, field forms, databases, electronic spreadsheets) will ensure that all requirements for field activities have been fulfilled, complete records exist for each activity, and the procedures specified in this SAP have been implemented. Field documentation will ensure sample integrity and provide sufficient technical information to recreate each field event.

2.10.2 Data Reduction. The data will be reviewed by the contractor to determine if the qualitative parameters of representativeness and comparability have been achieved. In general, the review will be accomplished by comparing the chain-of-custody and field notebook entries with the data for the sample. If the reported concentrations of a field sample from a specific location do not reflect historical data, then efforts will be made to determine if the data reflect an actual change in environmental conditions at that sampling point, or if the integrity of the sample was compromised during collection, preservation, shipping, or analysis. Conversely, if some level of analyte historically present in samples from a specific location is no longer present, then similar efforts will be made to confirm that change in concentration. QA/QC requirements that bracket questionable data again will be reviewed to confirm the performance of instrumentation during the time when questionable data were generated. Any deviations will be documented, and corrective actions will be taken to determine if the data meet project goals. If the data do not meet project goals, then the need for additional sampling and analysis will be determined.

2.10.3 Data Reporting. Following the data review process, the sample results will be entered into an electronic database. This electronic database will be submitted to NASA in a format compatible with the Navy Environmental Data Transfer Standards (NEDTS). Data will be compiled with spatial and temporal qualifiers so that it will be possible to rapidly plot or review changes in the concentrations of target analytes at each sampling point over time. Hard copies of the data reports received from the laboratories will be filed chronologically in three-ringed binders and will be stored separately from the electronic files. Hard copies of data signed by a representative of the analytical laboratory will be compared to any electronic versions of the data to confirm that the conversion process has not modified the reported results. Any additional reporting formats will be completed, and electronic and hard copies will be stored in different locations at the contractor's facilities.

Section 3.0: ASSESSMENT AND OVERSIGHT

This section describes the activities for assessing the effectiveness of project implementation and associated QA and QC activities. The purpose of assessment is to ensure that the SAP is implemented as prescribed.

3.1 Assessment and Response Actions (C1)

Assessments that may be performed during continued site assessment activities at NASA JPL include, but are not limited to the following: technical system audits, audits of data quality, and data quality assessments.

3.1.1 Performance and System Audits. Technical systems audits and audits of data quality will be conducted periodically during site assessment activities by the Battelle QAO. In addition, the Battelle Project Manager/QAO will conduct regular audits of the field and laboratory data as they are generated as well as data/sample collection procedures. This schedule of QA checks will require the cooperation of the laboratory regarding timely delivery of reports. However, it will ensure that data quality issues are identified early, rather than at the end of the investigation.

If significant variances are found during the audit, the Battelle QAO may, at his or her discretion, conduct additional audits. Additional audits may include a visit to the field and to the laboratory, if required and if determined to be necessary by the Battelle QAO. The Battelle QAO will review the SAP and the final report.

For those audits resulting in variances, the Project Team Leader or the laboratory coordinator will submit a response in writing to the Battelle QAO. Reports will be submitted to NASA through the RPM.

3.1.2 Corrective Action. Corrective actions may be initiated by any of the participants of the data generation (field technician or laboratory analyst), reporting (laboratory director or field team leader), and validation process (Battelle Project Manager or QAO). Note that it is important to generate corrective actions early in the process so that the problem has a greater chance of being resolved in a timely and cost-effective manner. An example Corrective Action Report is presented in Figure A-5.

For field measurements, if the final calibration check is outside acceptable limits, then the associated data collected that day will be flagged. On the following day, a single point continuing calibration check will be run after every five wells monitored (or samples analyzed) to determine how long the initial calibration holds. Calibration frequencies will be adjusted accordingly.

For laboratory measurements, if any of the QC checks (MS, MSD, laboratory control samples, or laboratory blank) are outside the acceptance criteria (for accuracy, precision, and cross-contamination), the laboratory will follow the corrective actions that are outlined in the LQAP.

3.2 Reports to Management (C2)

Project reports prepared by Battelle will be submitted to NASA through the RPM. The schedule and additional recipient list for submission of these reports following completion of remedial activities will be decided accordingly.

CORRECTIVE ACTION REPORT	
SECTION A: STATEMENT OF PROBLEM (TO BE COMPLETED BY INITIATOR)	
(a) Item of nonconformance:	(b) Number:
(c) Location of nonconforming item:	(d) Date:
(e) Name, organization, and telephone number of person initiating NCR	(f) Date nonconformance found:
(g) Individual/organization responsible for the resolution of the nonconformance:	
(h) Reference:	
(i) Description of nonconformance: (1) identification of nonconforming item or service; (2) requirements, including the specific reference documented by title, revision, and its unique identification number; and (3) as found conditions:	
(j) Signature of initiator:	Date:
(k) QA Manager concurrence:	Date:
(l) STOP WORK order required YES NO	

Figure A-5. Sample Corrective Action Report

SECTION B: PROBLEM RESOLUTION (TO BE COMPLETED BY THE RESPONSIBLE INDIVIDUAL/ORGANIZATION)	
(a) Responsible individual/organization:	
(b) Proposed resolution:	
(c) Root cause:	
(d) Actions taken to prevent recurrence:	
Responsible individual:	Date:

Figure A-5. Sample Corrective Action Report (Continued)

Section 4.0: DATA VALIDATION AND USABILITY

This section is divided into three elements that describe the QA activities that occur after the data collection phase of the project has been completed to ensure that data conform to the specified criteria and thus satisfy monitoring objectives.

4.1 Data Review and Verification (D1)

The data generated for this project will be reviewed and verified by the Battelle QAO and either an independent outside review or in-house review.

4.2 Verification Methods (D2)

Data verification involves the process of generating qualitative and quantitative sample information through observations, field procedures, analytical measurements and calculations. The data verification and reporting process for the field data involves ensuring that calibration of instruments, field blanks, and field duplicates are within the acceptance criteria. The verification process for the laboratory data involves ensuring that the holding times, precision, accuracy, laboratory blanks, and detection limits are within the acceptance criteria outlined in this SAP.

The field and laboratory personnel will provide the Battelle QAO with all the data. The Battelle QAO then will send the laboratory data either to an outside independent review company or to in-house review for data verification. The Battelle QAO will be responsible for overall review of the data verification results, for compliance with the specified DQOs. After this QA procedure is complete, the Battelle Project Manager will incorporate the verified data into the site assessment investigation reports.

4.3 Reconciliation with Data Quality Objectives (D3)

Data collected during the field efforts will be reconciled with the DQOs by preparing summary tables, charts, figures, or performing other types of data analyses that facilitate direct comparison of data collected during the baseline through the entire extent of the project. Comparisons will be made on a parameter-specific basis, concentrating on the contaminants of concern. Comparisons also will facilitate an analysis of contaminant concentration trends through time and space.

Section 5.0: REFERENCES

Ebasco. 1993a. *Work Plan for Performing a Remedial Investigation/Feasibility Study (RI/FS) at NASA JPL.* Prepared for the National Aeronautics and Space Administration Jet Propulsion Laboratory. December.

Ebasco. 1993b. *Quality Assurance Program for Performing a Remedial Investigation at the NASA Jet Propulsion Laboratory.* Prepared for the National Aeronautics and Space Administration Jet Propulsion Laboratory. December.

Ebasco. 1994. *Field Sampling and Analysis for Performing a Remedial Investigation at Operable Unit 3: Off-Site Groundwater.* Prepared for the National Aeronautics and Space Administration Jet Propulsion Laboratory. May.

Puls, R. W. and Barcelona M. J. 1996. *Low-Flow (Minimal Drawdown) Ground-Water Sampling Procedures*. EPA/540/S-95/504. April.

San Diego County DEH, see San Diego County Department of Environmental Health.

San Diego County Department of Environmental Health. 2002. *Site Assessment and Mitigation Manual.* Site Assessment and Mitigation Division.

United States Environmental Protection Agency. 2000. *Data Quality Objectives Process for Hazardous Waste Site Investigations (EPA QA/G-4HW)*. EPA/600/R00/007. Prepared by the U.S. EPA's Office of Environmental Information. January. Available at: http://www.epa.gov/quality/qa_docs.html.

United States Environmental Protection Agency. 2001. *EPA Requirements for Quality Assurance Project Plans (EPA QA/R-5).* EPA/240/B-01/003. Prepared by the U.S. EPA's Office of Environmental Information. March. Available at: http://www.epa.gov/quality/qa_docs.html.

U.S. EPA, see United States Environmental Protection Agency.