Personnel participating in the work effort will review this document. All personnel are required to comply with procedures documented in this QAPP and supporting project documents to ensure usability of the data produced.

1. Project Management

1.1 Project

This section provides a description of the ARCADIS organizational structure of personnel involved with this project. The lines of authority are defined and key personnel identified for various activities of the project. The project organization is illustrated in Figure A-1. Table A-1 presents contact information for key ARCADIS personnel. The Project Manager will communicate with the client and regulatory agencies and oversee project execution. The Associate Project Manager and Site Managers will implement project tasks and coordinate with the technical personnel.

ARCADIS, Project Manager

Mr. Charles A. Bertz, P.E.. The ARCADIS Project Manager (PM) is responsible for the overall implementation of the project. The Project Manager is responsible for allocating resources to assure successful execution and completion of the scope of work (SOW). Other duties, as required, may include:

- Approving project-specific procedures and internally prepared plans, drawings, and reports;
- Ensuring technical, schedule, and budget requirements are met;
- Coordinating manpower and other necessary resources with ARCADIS Assistant Project Manager, Site Managers, and technical personnel;
- Reviewing project progress;
- Reviewing all final documents, plans, and drawings; and
- Coordinating document delivery and attaining project milestones.

ARCADIS, Associate Project Manager

Ms. Shelley Gibbons. The ARCADIS Assistant Project Manager (APM) will support the Project Manager in contract management as well as task implementation, document preparation, personnel coordination, and budget management. Ms. Gibbons will perform a key role in ensuring compliance with quality performance objectives. Other duties, as required, may include:

- Coordinating schedules and deliverables with the Site Managers and the Project Manager;
- Ensuring project budget and deliverable schedule compliance;
- Assisting with quality program implementation and coordinating document preparation and submittals;
- Serving as the "collection point" for the project staff reporting any changes or deviations from the project work plan;
- Determining the significance of these changes or deviations to specific work plans and the appropriateness of reporting such items to the corresponding regulatory and facility representatives;
- Arranging subcontractor services; and
- Preparing status update reports and revisions to the project work plan.

ARCADIS, Site Managers

Mr. Andy Davis, P.E. and Mr. Scott Bostian, P.E.. The ARCADIS Site Managers are principally responsible for overseeing day-to-day of task performance including all technical and administrative operations. Other duties required may include:

- Preparing the work plans;
- Selecting and monitoring technical staff;
- Assigning duties to the project staff and orienting the staff to the requirements of the project;
- Coordinating and scheduling field activity resources;

- Performing assessment and oversight duties as described in the PMP, Sampling and Analysis Plan (SAP), and QAPP;
- Reviewing and approving all final reports and other work products;
- Monitoring staff and subcontractor progress; and
- Distributing the QAPP to the ARCADIS technical staff.

ARCADIS, Quality Assurance Officer

Mr. Kurt Beil, P.E.. The ARCADIS Quality Assurance Officer (QAO) is responsible for oversight of all QA/QC activities. He will remain independent of day-to-day direct project involvement, but will have the responsibility for ensuring that all project and task-specific QA/QC requirements are met. He will have direct access to corporate staff, as necessary, to resolve any QA/QC problems, disputes, or deficiencies. The QA Officer's duties include:

- Reviewing and approving the Site-Wide QAPP and site-specific work plans;
- Reviewing and approving substantive changes to the QAPP, SAP, and work plans;
- Reviewing any new work orders with the Project Manager to determine if the QAPP requires modification;
- Providing external review of field and analytical activities by performance of assessment and oversight duties as described in the QCP; and
- Conducting or delegating responsibility for field audits in conjunction with the corporate QA office and maintaining written records of those audits.

ARCADIS, Health and Safety Officer

Mr. Sam Moyers. The ARCADIS Health and Safety Manager reviews and internally approves the Health and Safety Plan (HSP) that will be designed to the specific needs and operations associated with this project. In consultation with the PM, the Health and Safety Manager will ensure that an adequate level of personal protection exists for anticipated potential hazards for field personnel. Identify the Field Health and Safety Officer (FHSO) for each field operation. On-site health and safety will be the responsibility of the FHSO. The FHSO will work in coordination with the PM and the

project Health and Safety Manager to ensure that all activities are conducted safely and in accordance with the HSPA as well as facility requirements.

ARCADIS, Project Chemist

Ms. Jane Kennedy. The Project Chemist is responsible for laboratory selection and oversight, data validation and verification, and hard copy and electronic analytical data oversight. The Project Chemist's specific duties include:

- Developing the Site-Wide QAPP and QA aspects of site-specific work plans;
- Providing external review of analytical activities by performance of assessment and oversight duties;
- Coordinating with the Project Manager, Task Managers, and laboratory management to ensure that QA objectives appropriate to the project are set and that laboratory and field personnel are aware of these objectives;
- Recommending, implementing, and/or reviewing corrective actions taken in the event of QA/QC failures in the laboratory or field;
- Reporting nonconformance with either QC criteria or QA objectives (including an assessment of the impact on data quality or work assignment objectives) to the appropriate managers; and
- Assisting with preparation of reports summarizing data quality.

Technical Staff

The technical staff for this program will be drawn from a pool of technical resources within ARCADIS. The technical staff will implement project and site tasks, analyze data, and prepare reports/support materials. All technical personnel assigned will be experienced professionals who possess the degree of specialization and technical competence required to perform the required work effectively and efficiently. All technical staff will be familiar with the HASP and all relevant Work Plans, standard operating procedures (SOPs), and policies applicable to the field work performed.

Laboratories

Independent laboratories providing analytical services will be chosen as appropriate for the various project requirements including routine monitoring, confirmation sampling,

remedial system monitoring, air analyses, and pilot/benchscale studies. Geotechnical laboratories may be selected based on project requirements and will be identified in the site-specific work plans. Selection criteria for geotechnical laboratories will be based on previous performance on ARCADIS projects or satisfactory recommendations. Analytical chemistry laboratories shall be accredited under the National Environmental Laboratory Accreditation Program (NELAP) and in accordance with Georgia requirements for the project analytical parameters for which accreditation is available through the primary accrediting state. The laboratory QA programs will be reviewed by the ARCADIS Project Chemist, as appropriate. The laboratory will assign an experienced Project Manager to coordinate analytical support for field operations with the ARCADIS Field Operations Manager and Project Chemist.

The analytical chemistry laboratories will provide services under a specified SOW and contractual agreement with ARCADIS. This QAPP incorporates by reference the laboratory, reporting and detection limits, and quality control limits. SOPs will be evaluated by the project chemist to ensure that method performance is acceptable. Appropriate data will be uploaded to the electronic project database for use by the ARCADIS Project Manager and task managers.

The laboratory staff will include a qualified QA Manager, who reports directly to laboratory management independently of the technical operations of the laboratory, to oversee technical adherence to the laboratory QA programs and this QAPP.

The specific duties of the laboratory Project Manager and QA Manager include:

- Reviewing the QAPP and other project requirements to verify that analytical operations will meet project requirements as defined in the project documents;
- Documenting and implementing project QA/QC requirements in the laboratory and reviewing analytical data (10 percent for the QA Manager) to verify that the requirements were met;
- Reviewing receipt of all sample shipments and notifying the Project Chemist of any discrepancies within 1 day of receipt;
- Conducting internal laboratory audits to assess implementation of the laboratory Quality Assurance Manual (QAM) and procedures and providing written records of those audits;
- Rapidly notifying the Project Chemist regarding laboratory nonconformance with the QAPP or analytical QA/QC problems affecting project samples; and

- Coordinating with the project and laboratory management to implement corrective actions as required by the QAPP and internal laboratory QAM.

The principal contract laboratory QAM will be incorporated in this QAPP by reference when the laboratory subcontract is executed. Microseeps Laboratories, Inc. (Microseeps), will provide analytical support for the monitored natural attenuation (MNA) dissolved gas and biogeochemical parameters, and Air Toxics, Ltd. (Air Toxics), will provide analysis of air samples as required. The QAMs for these laboratories shall be retained by the ARCADIS Project Chemist. Ozark Underground Laboratories will provide dye tracer analyses associated with remedial system performance assessments.

Other Subcontractors

Other subcontractors will provide services under the direct supervision or direction of the ARCADIS Project Manager or Task Managers or appropriate designated staff. The drilling, surveying, geotechnical laboratory, and other subcontractors are responsible for performance in accordance with the individual subcontracts and applicable portions of the QAPP and Quality Control Plan (QCP) as defined in each subcontract package. Subcontractors are responsible for rapidly notifying the Site Manager regarding nonconformance with the QAPP or QA/QC problems encountered or observed. Subcontractors must coordinate with the Site Managers to implement corrective actions.

1.2 Problem Definition/Background

Detailed project information is included in the PMP, the SAP, and the PBA contract or, if necessary, will be included in the appropriate work plans that define a particular SOW to be completed.

1.3 Project Description

The field sampling program and field procedures are described in detail in the SAP, and therefore are not repeated in this QAPP. Additional work plans will be prepared as sampling and analytical requirements are defined. Any additional specific QA requirements will be included in specific plans.

The purpose of this QAPP is to provide field, laboratory, and quality assessment personnel with general instructions regarding activities to be performed before, during, and after each sampling effort to ensure generation of usable data. This QAPP

contains general and specific details regarding field sampling, laboratory analytical methods, and data management that apply to the Site. The collection and documentation of data will be performed as described in the following sections to ensure the quality of the collected data.

1.4 Data Quality Objectives for Measurement Data

Table A-2 presents the overall project Data Quality Objectives (DQOs). Additional analytical performance and data review DQOs include precision, accuracy, representativeness, completeness, and comparability (PARCC). These criteria represent qualitative and quantitative objectives that ensure the data are generated that are scientifically valid and usable for the intended purpose. As discussed in *USEPA Guidance on Systematic Planning Using the Data Quality Objectives Process; USEPA QA/G-4*, dated February 2006 and *USEPA Requirements for Quality Assurance Project Plans; USEPA QA/G-5*, dated March 2001, the DQOs are dependent on the intended uses of the data and are based on the premise that the ultimate use(s) of a particular data set should dictate the quantity and quality of these data. These DQOs in conjunction with criteria set forth in this QAPP will be used as a guide for data quality assessment by establishing analytical protocols and documentation requirements that will allow the analytical data to be collected, analyzed, and verified/validated in a consistent manner.

1.4.1 Precision, Accuracy, Representativeness, Completeness, and Comparability

The basis for assessing the elements of data quality is discussed in the following subsections. The contract analytical laboratory precision and accuracy QC limits will be incorporated into the QAPP and updated as appropriate.

Precision measures the reproducibility of repetitive measurements. It is strictly defined as the degree of mutual agreement among independent measurements as the result of repeated application of the same process under similar conditions.

Analytical precision is a measurement of the variability associated with duplicate (two) or replicate (more than two) analyses of the same sample in the laboratory and is determined by analysis of laboratory control samples/laboratory control sample duplicate (LCS/LCSD), matrix spikes/matrix spikes duplicate (MS/MSD), laboratory duplicates and field duplicates. If the recoveries of analytes in the LCS are comparable within established control limits, then laboratory precision is within limits. The contract laboratory control limits will be utilized to evaluate analytical precision.

Total precision is a measurement of the variability associated with the entire sampling and analysis process. It is determined by analysis of duplicate or replicate field samples and measures variability introduced by both the laboratory and field operations. Field duplicate samples and matrix duplicate spike samples are analyzed to assess field and analytical precision. Field duplicate samples will be collected at a minimum 5 percent frequency.

Duplicate results are assessed using the relative percent difference (RPD) between duplicate measurements. The formulas for the calculation of precision are provided in Table A-3 as RPD (used for two measurements), average RPD, relative standard deviation (RSD), and pooled RSD (used for more than two measurements). The proposed precision objective for soil and sediment field duplicates is an RPD of 70 percent and the precision objective for groundwater and surface water field duplicates is an RPD of 40 percent for all parameters analyzed.

Accuracy is a statistical measurement of correctness and includes components of random error (variability due to imprecision) and systematic error. It reflects the total error associated with a measurement. A measurement is accurate when the value reported does not differ from the true value or known concentration of the spike or standard. Analytical accuracy is measured by determining the percent recovery (%R) of known target analyses that are spiked into a LCS to a control limit. For organic parameters analyzed by GC and GC/MS surrogate compound recoveries are also used to assess accuracy and method performance for each sample analyzed.

Both accuracy and precision are calculated for preparation or analytical batches, and the associated sample results are interpreted by considering these specific measurements. The formula for the calculation of accuracy is included in Table A-3 as %R from pure and sample matrices. Laboratory precision and accuracy control limits will be incorporated by reference into this QAPP upon selection of the contract laboratory.

Representativeness is achieved through use of the standard field, sampling, and analytical procedures. Representativeness is also determined or influenced by appropriate program design, with consideration of proper sampling locations and collection techniques.

Completeness is calculated for the aggregation of data for each analyte measured for any particular sampling event or other defined set of samples. The number of valid results divided by the number of possible individual analyte results, expressed as a percentage, determines the completeness of the data set. For completeness

requirements, valid results are all results not qualified with an "R" flag/reject or unusable data. For any instances of samples that could not be analyzed for any reason (e.g., holding time violations in which re-sampling and analysis were not possible, or samples spilled or broken), the numerator of this calculation becomes the number of valid results minus the number of possible results not reported.

The formula for calculation of completeness is presented, as follows:

$$\% \text{ completeness} = \frac{\text{number of valid results}}{\text{number of possible results}}$$

The completeness objective for sample matrices collected during these investigations will be at least 90 percent.

Comparability is the confidence with which one data set can be compared to another data set. The objective for this aspect of the QA/QC program is to produce data with the greatest possible degree of comparability. The number of matrices that are sampled and the range of field conditions encountered are considered in determining comparability. Comparability is achieved using standard methods for sampling and analysis, reporting data in standard units, and using standard and comprehensive reporting formats. Complete field documentation using standardized data collection forms shall support the assessment of comparability. Historical comparability is achieved through consistent use of methods throughout the project. EPA approved methods will be utilized for analytical chemistry determinations as available.

1.4.2 Objectives for Laboratory Analyses

The laboratory DQOs include method performance and reporting consistent with criteria presented in the USEPA document entitled "Test Methods for Evaluating Solid Waste-Physical/Chemical Methods," SW-846, Third Edition (as updated) the laboratory QAM and SOPs, this QAPP, and other applicable performance requirements published in EPA method guidance.

1.4.3 Objectives for Field Measurements

Field measurement DQOs for precision, accuracy, and completeness criteria presented in Table A-4 are consistent with the industry acceptance criteria.

Trip blanks (TBs) will accompany samples to be analyzed for volatile organic compounds (VOCs). Field duplicate samples will be collected at a frequency of 5 percent for each analysis and each sample matrix collected. Equipment blanks (EBs) and additional sample volume for MS analysis will be collected at a minimum five percent frequency for each analysis. Temperature blanks will be placed in each sample cooler and the temperature recorded upon laboratory receipt. Frequency for collection of field QC samples is presented in Table A-4.

The field sampling team will also be responsible for collecting additional sample quantities at a frequency of five percent for MS and MSD analyses.

1.5 Specialized Training and Certification

Training shall be provided to all project personnel to ensure compliance with the site specific Health and Safety Plan and technical competence in performing the work effort. Documentation of this training shall be maintained in the records of the contracted organizations. ARCADIS employees who participate in the types of activities defined in the Occupational Safety and Health Administration (OSHA) requirements under Code of Federal Regulations (CFR) 1910.120 complete the 40-hour health and safety training program. Each employee must successfully complete a minimum of 8 hours of refresher training annually to maintain the certification. Employee training records are maintained in the ARCADIS office where the employee resides. Any special requirements for personal possession of certification cards will be adhered to as program appropriate.

All analytical chemistry laboratories performing analyses will be required to maintain current NELAP accreditation for the parameters of interest if accreditation is available. Accreditation certificates, audit reports, and performance testing (PT) data will be reviewed by the Project Chemist, as appropriate to ensure that laboratory capabilities meet or exceed project requirements. Laboratories must also maintain internal training records for technical staff in accordance with standard laboratory practices and certification requirements. The laboratory will provide the applicable training records, including Initial Demonstration of Competence documentation, for review, as deemed necessary, by the ARCADIS Project Chemist.

All subcontractors and their employees will have current and applicable performance and certifications required to perform the assigned SOW. Subcontract agreements will include the specific training and certification requirements and applicable records will be reviewed as appropriate. Subcontractor training and certification documentation will be maintained at the subcontractors' offices.

1.6 Documents and Records

The primary documentation for the project includes field records, analytical data packages, and summary reports. This section describes the level of documentation and record keeping for the central project file that will be maintained by the ARCADIS office in Raleigh, North Carolina.

1.6.1 Document Control

All planning documents will be clearly identified by the document title, revision number, date, and page number in the header of each document page. Planning documents currently in use will be reviewed on an annual basis and any necessary revisions or updates will be amended and distributed to each participating party. Documents prepared in support of the PBA contract will be prepared and distributed as required.

Original field records and laboratory analytical data will be maintained in the ARCADIS Raleigh, NC office.

1.6.2 Field Documentation

Field documentation will include field logbook or daily logs, field sampling logs, instrument calibration logs, and data forms as necessary to provide sufficient information to allow review of field conditions, performance, and sample collection, to evaluate potential impacts to sample and data integrity, and to enable participants to reconstruct events that occurred during the field operations when necessary. Daily logs will also document any deviations from the SAP, QAPP, site or task specific work plans or other applicable planning documents and describe the rationale for the changes.

All entries will be made in waterproof ink, and the time of the entry will be recorded. The top of each page of the field documents will contain the date that the entries on that page were recorded. No pages will be removed from a bound logbook for any reason. Additional details on field documentation are provided in the SAP.

All documentation associated with field activities will be retained in the project file in accordance with the document retention policy stated in this QAPP and the QCP as applicable to the document type.

1.6.3.1 Corrections to Field Documentation

As with all bound data logbooks, no pages will be removed for any reason. If corrections are necessary on any field documentation, they will be made by drawing a single line through the original entry (so that the original entry can still be read) and writing the corrected entry alongside it. The correction must be initialed and dated. As necessary, corrected errors will include a footnote explaining the correction.

1.6.3.2 Photographs

Photographs will be taken as directed by the Site Manager. Documentation by a photograph will ensure the validity as a visual representation of an existing situation. A log will be developed to track the media that the photos are filed on (e.g., compact disc, floppy disk). Photographs, as developed or transferred to electronic media, shall be compiled into a photograph log and information recorded in field notebooks added to the log with appropriate photographs.

1.6.3 Laboratory Data Reporting/Record Retention

Analytical data reports for all samples will be prepared by the laboratory as a Level II Data Package. The Level II Data Packages will include a fully-executed COC Record, sample receipt checklist, cross-reference table of field samples with laboratory sample number, preparation and analytical batch numbers, analytical results, collection and analysis dates and times, reporting limits (RLs), dilution factors, surrogate recoveries, method blank data. Summary QC data will be provided for LCS, MS accuracy and precision, laboratory replicate precision, laboratory control limits. The analytical report shall include the method detection limits (MDL), and the quantitative RLs. Appropriate data flags identifying any QC result reported outside control limits and an explanation of all data flags applied by the laboratory. The case narrative will present an explanation of all QC results reported outside control limits and samples analyzed at dilutions where all results are non-detect.

Where detailed data validation is required, analytical data reports will include the following items in addition to the elements of the Level II data package, sample aliquots, final extract volumes, run logs, quantitation reports, ion spectra, chromatograms, batch identification report clearly linking all QC results to field sample results, and instrument calibration and tuning information. The laboratory report will include copies of any nonconformance or corrective action forms associated with data generation. This level of analytical report components will be defined as a Level IV data package.

The RLs will be corrected for percent moisture (soils only) and all dilution factors. Any compounds found less than the RL, but greater than the MDL will be reported and qualified with a "J" flag as estimated. Soils will be reported on a dry weight basis.

The laboratory will provide an electronic data deliverable (EDD) that matches all data reported on the hard copy analytical report. Electronic data report requirements are described in Section 2.12.

The laboratory is required to retain all information associated with the analytical operations for samples associated with this project for a minimum of 6 years.

1.6.4 Electronic Data Retention

Electronic data and media retention policies will correlate with hard copy data retention at the laboratories as well as other points of electronic data generation. Additionally, electronic data will be subject to back-up routines that will enable recovery of data that may become corrupted or lost due to instrument, computer, and/or power failures. Electronic media will be stored in climate-controlled areas to minimize potential for degradation. Storage areas will be access limited.

2. Data Generation and Acquisition Elements

2.1 Sampling Process Design

The sampling process design will be presented in future work plans and in the SAP.

2.2 Sampling Methods

The field sampling procedures, sampling methods and equipment are also discussed in detail in the associated SAP. Calibration will be documented on a Field Equipment Calibration form, where each instrumented calibrated is identified along with the date, time, calibration reading, and field staff initials. The field sampling methods are referenced in the following section.

2.3 Sample Handling and Custody

Procedures to insure the custody and integrity of the samples begin at the time of sampling and continue through transport, sample receipt, preparation, analysis and storage, data generation and reporting, and sample disposal. Records concerning the custody and condition of the samples are maintained in field and laboratory records. All samples will be uniquely identified, labeled, and documented in the field at the time of collection and recorded on the Chain-of-Custody (COC) form. Samples collected for laboratory QC will be clearly identified on the COC (e.g. MSs). Details for completing the COC are included in Section 4.2.17 of the SAP. Field custody procedures are presented in Section 4.3 of the SAP.

Samples collected in the field will be transported to the laboratory or field testing site as expeditiously as possible. Samples requiring preservation at 4 degrees +/- 2 degrees Celsius (^{o}C) will be packed in ice or chemical refrigerant to keep them cool during collection and transportation. Any concerns and/or deviations will be reported to the contractor immediately.

Once the samples reach the laboratory, they will be checked against information on the COC form for anomalies. The condition, temperature, and appropriate preservation of the samples will be recorded by the laboratory on a sample receipt checklist, and will be made part of the permanent project custody records. The occurrence of any anomalies in the received samples and their resolution shall be documented in laboratory records. All sample information shall then be entered into the laboratory tracking and data management system. The laboratory PM shall review the log-in for accuracy and compliance with project requirements. Procedures ensuring internal

laboratory COC shall also be implemented and documented by the laboratory. Specific instructions concerning the analysis specified for each sample shall be communicated to the analysts. Analytical batches shall be created, and laboratory QC samples shall be introduced into each batch.

While in the laboratory, samples shall be stored in limited access, temperature controlled areas. Refrigerators, coolers and freezers used for sample storage will be monitored for temperature 7 days a week. Acceptance criteria for the temperatures of the refrigerators and coolers are 4°C to 2°C. Acceptance criteria for the temperatures of the freezers shall be less than 0°C. All of the cold storage areas shall be monitored by thermometers that have been calibrated with a NIST traceable thermometer. As indicated by the findings of the calibration, correction factors shall be applied to each thermometer. Records that include acceptance criteria shall be maintained. Samples shall be stored separately from standards. Samples shall be stored after analysis until disposed of in accordance with applicable local, state, and federal regulations. Disposal records shall be maintained by the laboratory. SOPs describing sample control, custody, and disposal shall be maintained by the laboratory.

2.4 Sample Containers

The volumes and containers required for the sampling activities are listed in Table A-5. The laboratory will provide new, pre-cleaned sample containers. The laboratory shall use an approved specialty container supplier that prepares the containers in accordance with USEPA bottle preparation procedures. TBs will be transported to the site inside the same cooler/box as the VOC vials.

Sample container lids will not be mixed. All sample lids must stay with the original containers as provided by the supplier. Bottle lids (with any associated bottle) exhibiting cracks, splits, or chips shall be appropriately discarded.

2.5 Sample Preservation and Holding Times

New and pre-preserved (as appropriate) containers obtained from the laboratory shall be used for all samples requiring preservation. Chemicals used by the laboratory for preservation will be reagent-grade chemicals. The laboratory shall maintain traceability records for all preservatives in the event of potential contamination of samples. The laboratory must ensure that preservatives used in containers supplied will not expire within the anticipated time of sample collection completion. Each bottle received from the laboratory must be clearly labeled with the type of chemical preservative in the bottle and the test parameters that will be determined from the sample collected in the

container. Sample containers will not be stored at the site for longer than 30 days. Bottle orders and any additional preservative requirements will be submitted to the laboratory 5 working days prior to commencement of field operations to allow supplies of clean, fresh containers and preservatives to be shipped to the facility.

Sample preservation will be verified on receipt at the laboratory with the exception of aqueous VOC samples. VOC sample preservation shall be verified prior to analysis. The preservation or pH check will be recorded on the sample receipt form or other appropriate logbook. If the samples are improperly preserved, a corrective action form will be submitted to the laboratory project manager for follow-up action. The laboratory will notify the ARCADIS Site Manager or Project Chemist to implement corrective actions in the field to ensure sufficient preservative is added at the time of sample collection.

Sample holding times will be based on published USEPA guidance and will be calculated for the date and time of collection. A list of preservatives and holding times for each type of analysis are presented in Table A-5. Additional preservation requirements and holding times for non-target analyses are listed in 40 CFR Part 136. Preservatives and holding times not listed in Table A-5 applicable to a specific task will be listed in the applicable SAP or work plan.

2.6 Analytical Methods

The primary analytical methods anticipated to be utilized for samples collected Table A-5. All methods will be USEPA approved/published. Additional USEPA approved methods, which may be utilized, are published in references listed below. Specific performance criteria, including QA protocols, for each analytical method, are documented in the published methods, laboratory SOPs, and the laboratory QAM. The QAM for each analytical laboratory performing work be reviewed as part of the procurement process and laboratory SOPs will be examined during onsite audits or as necessary. QAM is a generic term for the laboratory QA document, which describes the laboratory program to ensure data of known quality are generated. The contracted laboratory QAM will be incorporated by reference into this QAPP upon execution of the contract for analytical support.

2.6.1 Standard Laboratory Analytical Procedures

All standard analytical methods performed will be USEPA approved. The analytical methods are referenced in:

- *Test Methods for Evaluating Solid Waste, Physical Chemical Methods*, 3rd edition, SW-846, 1997.
- 40 CFR Part 136, *Guidelines Establishing Test Procedures for the Analysis of Pollutants under the Clean Water Act*; and
- *Methods for Chemical Analysis of Water and Wastes*, EPA-600/4-79-020, Revised March 1983.

The laboratory will perform all methods in accordance with the appropriate USEPA-approved methods and the laboratory specific SOPs for compliance with this QAPP and other project-specific requirements. The laboratory shall have method specific SOPs for all methods performed. The SOPs will detail method set-up, calibration, performance, and reporting criteria in accordance with SOP preparation under NELAP guidance and requirements. Method performance will be in strict compliance with the SOP and referenced method. Laboratory SOPs will include any modifications to the published method and will indicate actual performance protocols performed by the laboratory. The laboratory will update SOPs in accordance with NELAP requirements. The ARCADIS Project Chemist must approve any changes to the method performance acceptance criteria

The laboratory must notify the Project Chemist of any updated or revised RLs or performance control criteria prior to initiation of field operations. Required sample or extract dilutions to complete the analyses within method performance criteria may impact RLs. All required sample dilutions will be noted in the analytical report and explained in the case narrative. The laboratory shall make every effort to report all compounds/analytes at the lowest technically achievable limit to meet the risk screening standard requirements. The changes/elevations in limits will be evaluated to determine potential impact on DQOs. Any additional methods required for future projects will be specified in the SAP or Work Plan.

2.7 Elements of Quality Control

This section presents QC requirements relevant to analysis of environmental samples that shall be followed. The purpose of this QC program is to produce data of known quality that satisfy the project objectives and that meet or exceed the requirements of the standard methods of analysis. This program provides a mechanism for ongoing control and evaluation of data quality measurements through the use of QC materials.

Laboratory QC samples (e.g., blanks and LCSs) shall be included in the preparation batch with the field samples. Preparation batch is a number of samples (not to exceed 20 samples) similar in composition (matrix) and that are extracted or digested at the same time and with the same lot of reagents. MS and MSD samples do not count as environmental samples. The term analytical batch also extends to cover samples that do not need separate extraction or digestion (e.g., VOCs analysis by purge and trap). The identity of each preparation batch will be unambiguously reported with the analyses so that a reviewer can identify the QC samples and the associated environmental samples. The type of QC samples and the frequency of use of these samples are discussed in the following section. The laboratory will provide spike results from site-specific field samples of groundwater and soil, not from another client or site. Additional QC samples may be added to those required by the method to ensure accurate and precise data. The frequency of analysis of laboratory QC samples is presented in Table A-6.

2.7.1 Laboratory Control Samples

The LCS is analyte free water (aqueous samples) or clean sand (soil/sediment matrix) spiked with known concentrations of specific analytes. The LCS shall be carried through the complete sample preparation and analysis procedure. The LCS is used to evaluate each preparation batch and to determine if the method is in statistical control. One LCS will be included with every analytical batch. All target analytes will be spiked in the LCS.

In accordance with method criteria and laboratory SOPs, an LCS analyte outside the recovery acceptance limit mandates corrective action unless the out of control scenario does not impact data usability. Where corrective action is required and after the system problems have been resolved with system control re-established, all samples in the analytical batch will be reanalyzed for the out of control analyte(s). When an analyte in an LCS exceeds the upper or lower control limit and no corrective action is performed, the appropriate validation flag, as described in the data validation section, will be applied to all affected results. LCS results will be compared to the laboratory LCS control limits.

2.7.2 Matrix Spike and Matrix Spike Duplicate

An MS is an aliquot of sample spiked with known concentrations of specific compounds. The spiking occurs prior to sample preparation and analysis. The laboratory will provide the results at a minimum of one MS and one MSD sample for every 20 environmental samples. The MS and MSD samples will be designated on the

chain of custody (COC) form. Additional sample quantities will be collected so that MS and MSD analyses can be performed on the environmental samples collected at the Site. The full list of target analytes will be spiked into the samples utilized for the MS and MSD.

An MS is used to document the bias of a method in a given sample matrix. MS and MSD results are used to evaluate the matrix effect, not to control the analytical process. The recoveries of analytes in the MS/MSD will be compared to the laboratory QC acceptance limits 2. If the recoveries for the MS or the MSD are outside the QC acceptance limits, sample data will be evaluated by the Project Chemist to determine extent of impact.

2.7.3 Surrogates

Surrogates are organic compounds that are similar to the target analyte(s) in chemical composition and behavior in the analytical process, but that are not normally found in environmental samples. Surrogates are used to evaluate accuracy, method performance, and extraction efficiency. Surrogates are added to samples, controls, and blanks, in accordance with the method requirements.

When the recovery of a surrogate is outside the acceptance limits, corrective action steps must be taken. After the system problems have been resolved and system control has been re-established, the sample is re-prepared and re-analyzed. Re-preparation and re-analysis is not required if the laboratory is able to provide objective evidence with the case narrative of the final report documenting matrix interference (that is, unresolved co-eluting peaks on reconstructed ion chromatograms, or observations about visibly oily samples). If corrective actions are not performed or are ineffective, the appropriate validation flags are applied to the sample results. Re-extractions will be done within the holding times. Laboratory surrogate recovery limits will be included in each analytical report.

2.7.4 Internal Standards

Internal Standards (ISs) are measured amounts of certain compounds added after preparation or extraction of a sample. They are used in an IS calibration method to correct sample results affected by column injection losses, purging losses, or viscosity effects. ISs are added to samples, controls, and blanks, in accordance with the method requirements.

When the IS results are outside of the acceptance limits, corrective actions shall be performed. After the system problems have been resolved and system control has been re-established, samples analyzed while the system was malfunctioning are re-analyzed. If corrective actions are not performed, the appropriate validation flag, as described in the data validation section of this QAPP.

2.7.5 Retention Windows

Retention time windows are used in GC analysis for qualitative identification of analytes. They are calculated from replicate analyses of a standard on multiple days. The procedure and calculation method are given in SW-846 Method 8000A.

When the retention time is outside of the acceptance limits, corrective actions will be performed. After the system problems have been resolved and system control has been re-established, samples analyzed since the last acceptable retention time check are re-analyzed. If corrective actions are not performed, the appropriate validation flag, as described in the validation section, will be applied to the sample results.

2.7.6 Method Blank

A method blank is an analyte free matrix to which all reagents are added in the same volumes or proportions as used in sample processing. The method blank will be carried through the complete sample preparation and analytical procedure. The method blank is used to document contamination resulting from the analytical process. A method blank will be included in every analytical batch and representative for each sample matrix.

The presence of analytes in a method blank at concentrations greater than the MDL or RL for common laboratory contaminants indicates a need for corrective action. Corrective actions will be performed to eliminate the source of contamination prior to proceeding with analysis. After the source of contamination has been eliminated, all samples in the analytical batch will be re-prepared and re-analyzed. No analytical data will be corrected for the presence of analytes in blanks. When an analyte is detected in the method blank, but not in the associated samples, no corrective action is necessary. When an analyte is detected in the blank and in the associated samples and corrective actions are not performed, the appropriate validation flag, as described in the data validation section, will be applied to the sample results.

2.7.7 Equipment Blank

An EB is a sample of organic free water (for VOCs analyses) poured into, or over, or pumped through the sampling device, collected in the sample bottle, and transported to the laboratory for analysis. EBs are used to assess the effectiveness of equipment decontamination procedures.

EBs are collected immediately after the equipment has been decontaminated. The frequency requirements for collecting EBs are a minimum of five percent of the environmental samples. The blank shall be analyzed for all laboratory analyses requested for the environmental samples collected at the Site. When an analyte is detected in the EB the appropriate validation flag, as described in the data validation section, shall be applied to all sample results from samples collected. It should be noted that the laboratory will supply the organic free water. A sample aliquot of the organic free water will be submitted for the analysis of all parameters of interest.

2.7.8 Trip Blank

The TB consists of a VOC sample vial filled in the laboratory with ASTM Type II reagent grade water, transported to the sampling site, handled like an environmental sample and returned to the laboratory for analysis. TBs are not opened in the field. TBs are prepared only when VOC samples are taken and are analyzed only for VOC analytes. TBs are used to assess the potential introduction of contaminants from sample containers or during the transportation and storage procedures.

When an analyte is detected in the TB the appropriate validation flag as described in the validation section, shall be applied to all sample results from samples in the cooler with the affected TB. One TB of either soil or liquid matrix shall accompany each cooler of samples submitted to the laboratory for VOC analysis.

2.7.9 Field Duplicates

A field duplicate sample is a second sample collected at the same location as the original sample. Duplicate samples are collected simultaneously or in immediate succession, using identical recovery techniques, and treated in an identical manner during storage, transportation, and analysis. The sample containers are assigned an identification number in the field such that they cannot be identified (blind duplicate) as duplicate samples by laboratory personnel performing the analysis. Specific locations are designated for collection of field duplicate samples prior to the beginning of sample collection.

Field duplicate sample results are used to assess precision, including variability associated with both the laboratory analysis and the sample collection process. Field duplicates will be collected at a frequency of 5 percent of samples collected. Analytical results for field duplicate will be assessed during the data validation process. Specific locations will be designated for collection of field duplicate samples prior to the beginning of sample collection. Control limits for evaluation of precision for field duplicates will be 40 percent for aqueous samples and 70 percent for soil/sediment samples.

2.8 Instrument/Equipment Testing, Inspection, and Maintenance

Field equipment testing (calibration) and inspection will be completed daily and documented on the daily calibration form. Field equipment maintenance will be completed on an as needed basis.

Maintenance responsibilities for laboratory instruments are assumed by the respective Laboratory Facility Manager. The managers then establish maintenance procedures and schedules for each major equipment item. This responsibility may be delegated to field or laboratory personnel, although the managers retain responsibility for ensuring adherence to the prescribed protocols. All field instrument/equipment will be inspected prior to the project initiation.

2.8.1 Maintenance Schedules

The effectiveness of any maintenance program depends to a large extent on adherence to specific maintenance schedules for each major equipment item. Other maintenance activities are conducted as needed. Manufacturers' recommendations provide the primary basis for the established maintenance schedules, and manufacturers' service contracts provide the primary maintenance for many major instruments.

2.8.2 Spare Parts

Along with a schedule for maintenance activities, an adequate inventory of spare parts is required to minimize equipment downtime. The inventory includes those parts (and supplies) that are subject to frequent failure, have limited useful lifetimes, or cannot be obtained in a timely manner should failure occur.

Field sampling task leaders and the respective laboratory managers are responsible for maintaining an adequate inventory of spare parts. In addition to spare parts and

supply inventories, the contractor shall maintain an in house source of backup equipment and instrumentation.

2.9 Instrument/Equipment Calibration and Frequency

Field equipment will be calibrated at the frequency recommended by the manufacturer's specifications and/or described by the analytical method.

Analytical instruments will be calibrated in accordance with the procedure specified in the analytical methods. All analytes that are reported shall be present in the initial and continuing calibrations, and these calibrations must meet the acceptance criteria specified in the analytical method. Records of standard preparation and instrument calibration will be maintained by the laboratory. Records shall unambiguously trace the preparation of standards and their use in calibration and quantitation of sample results. Instrument calibration will be checked using all of the analytes. All calibration criteria will satisfy SW-846 requirements at a minimum. The initial calibration will be checked at the frequency specified in the methods using materials prepared independently of the calibration standards.

2.10 Inspection/Acceptance of Supplies and Consumables

The laboratory will inspect supplies and consumables prior to their use in analysis. The materials description in the methods of analysis shall be used as a guideline for establishing the acceptance criteria for these materials. Introduction of interfering compounds into the analytical process will be monitored by analysis of method blanks. Purity and efficiency of reagents shall be monitored by analysis of LCSs. An inventory and storage system for these materials will assure use before manufacturers' expiration dates and storage under safe and chemically compatible conditions.

Sample containers will be laboratory supplied. All containers will be certified clean and the certificates will be retained by the laboratory. Containers are stored in clean areas to prevent exposure to fuels, solvents, and other contaminants.

2.11 Non-Direct Measurements

Non-direct measurement data will be entered into the project file. Data will be entered from forms, tables and data packages as presented in the documents/reports. All data entry will be peer reviewed prior to finalization.

2.12 Data Management

The data reduction, review, reporting, and validation procedures described in this section will ensure that (1) complete documentation is maintained, (2) transcription and data reduction errors are minimized, (3) the data are reviewed and documented, and (4) the reported results are qualified, as necessary. Laboratory data reduction and verification procedures are required to ensure that the overall objectives of analysis and reporting meet method and project specifications.

2.12.1 Electronic Data Management

Data management protocols track samples and results from work plan implementation to the final report. The field data include approved work planning tables, labels, field sampling forms, COC, and logbooks. Geographic coordinates will be generated for all sample locations in electronic format. The Field Operations Leader or designee will review all field data for accuracy. Field data will be collected using portable data acquisition (PDA) devices or manually entered into a database or spreadsheet.

The laboratory will provide an EDD for all analytical reports. The EDD will be in the format required for the project environmental database and include, at a minimum, the following information:

- Laboratory information – Laboratory name, client name, laboratory work order, client project number, and date received;
- Sample information – Laboratory project number, sample identification, laboratory sample identification, date sampled, time sampled, matrix;
- Analytical Data – Sample Delivery Group (SDG), test code, test name, analyte, analyte type, sample type, CAS number, date and time prepared, date and time analyzed, preparation batch identification, analytical batch identification, result, laboratory qualifier, MDL, RL, and dilution factor; and
- QC Data – All fields provided for analytical data will also be populated for method blanks, surrogates for all samples, LCS, MS/MSD, and laboratory replicates. QC sample data will also include QC Sample Type, recoveries, RPDs, control limits, and any associated qualifiers. Calibration data are not required.

The Project Chemist, Data Manager, or designee will review approximately 5 percent of electronic laboratory and field data to verify the results against the hard copy and check for transcription errors. A greater than 15 percent discrepancy rate in two consecutive datasets will require additional review and verification. Electronic data will match the hard copy data for all results. Significant figures and rounding routines may differ slightly based on the program utilized to generate hard copy reports and electronic files, but may not differ to the point of impacting data integrity or usability. The results will be transferred to a centralized database. The ARCADIS Data Manager or data validator will add any data qualifiers. The Data Manager will generate data tables for the project team as required. The Project Chemist and Site Manager will resolve discrepancies between the planned activities and actual data collected and document the findings in the data report. The central database will be stored in a secure area with access limited to data management specialists designated by the Project Manager. The central database will be electronically linked to a geographic information system/computer-aided design (GIS/CAD) systems, risk assessment programs, and other final data user models and statistical programs. Data users may enter additional electronic data such as risk-based criteria for comparison of the results. This data will be stored in separate tables in the database and linked to the actual results. Any data from outside sources will include a description of the data, a reference to the source, and the date updated. The outside data will be checked prior to use in order to verify that the most current values are used.

2.12.2 Field Data Review

All field data and the required forms will be reviewed by the author prior to submittal to the Site Manager or designee for review. Any field forms or documentation requiring amendments and/or corrections will be clearly documented on the corresponding day's field form or logs and initialed. Corrections will be made by a single line, followed by initials. The Site Manager or designee will verify the field review then submit the documents for data entry and/or retention in the project file.

2.12.3 Laboratory Data Review

The analytical laboratory will perform a series of internal reviews/audits prior to submittal of the final data package.

2.12.3.1 Laboratory Internal Review

In each laboratory analytical section, the analyst performing the tests shall review 100 percent of the data. After the analyst's review has been completed, 100 percent of the data shall be reviewed independently by a senior analyst or by the supervisor of the respective analytical section using the same criteria.

Data qualifiers shall be added by the laboratory supervisor of the respective analytical section, after the first and second level of laboratory data reviews have been performed. Analytical batch comments shall be added to the first page/Case Narrative of the data report packages to explain any non-conformance or other issues. When data are qualified, the laboratory supervisor shall apply a final qualifier to any data that have been affected by multiple qualifiers. This final qualifier shall reflect the most severe qualifier that was applied to the data, that is, all data will have only one data qualifying flag associate with it.

The laboratory QA section shall review 10 percent of the completed data packages, and the laboratory project manager shall perform a sanity check review on all the completed data packages. The laboratory shall apply appropriate data qualifying flags to any impacted field sample including field QC samples.

The laboratory will submit the analytical data package and EDD to ARCADIS via email and on compact disk. The analytical report will be complete and signed and submitted in portable document format (pdf). The EDD shall be prepared in accordance with the protocols defined by ARCADIS for input into the electronic data management system.

2.12.3.2 Analytical Report and Data Management

Upon submittal of the data package (report and EDD), the data will be logged in by the data manager as received and the EDD loaded into the project database. The Data Manager will forward the analytical data to the Project Chemist or designee for review and validation in accordance with Section 3 of this QAPP. The data package, at a minimum, will be reviewed to assure completeness and that the EDD matches the report. Once the analytical data package is determined to be final and complete and as validated, the data with any applicable data qualifiers will be added to the project database. Any data validation reports will be submitted to the Data Manager archiving with the analytical report. The data will then be available for distribution to the project team. Upon completion, the analytical data package, EDD, and validation report will be submitted to the project file.

2.12.4 Archiving

The laboratory shall maintain electronic and hardcopy records sufficient to re-create each analytical event conducted for a minimum of 6 years. Data will be accessible within 7 working days upon request. ARCADIS will retain the project files for at least 6 years.

3. Assessment and Oversight

3.1 Assessment and Response Actions

Assessment activities include management and assessments, technical systems audits, and performance evaluations. Management assessments include routinely scheduled meetings and conference calls to evaluate staff utilization. Assignment of qualified personnel to projects, maintenance of schedules and budgets, and quality of project deliverables are verified as part of these assessments. Performance evaluations are used to ensure that trained and qualified staff is utilized for the project. Technical assessment activities include peer review, data quality reviews, and technical system audits (i.e., laboratory and field). Technical systems audits include review and evaluation of field and laboratory performance to assess the implementation of quality programs and directives specifically for the project. Procedures for assessment and audit of data quality are described in Section 4 of this QAPP. Procedures for peer review and technical assessments are summarized briefly below. Both the overall and direct technical assessment activities may result in the need for corrective action. The procedure for corrective action response is summarized below.

3.1.1 Peer Review

All project deliverables including work plans, SAPs, draft and final reports, and technical memoranda will be peer reviewed by ARCADIS. The peer review process provides for a critical evaluation of the deliverable by an individual or team to determine whether the deliverable will meet the established criteria, DQOs, technical standards, and contractual obligations. The PM or APM will assign peer reviewers, depending on the nature and complexity of the project, when the publication schedule is established. The PM will be responsible for ensuring all peer reviewers participate in the review process and approve all final deliverables. The QA Manager is responsible for verifying that project documents were generated in accordance with the project requirements.

3.2 Corrective Action

Corrective actions will be implemented as necessary to insure that project activities are performed and data are generated in accordance with the project quality documents. In conjunction with the QA Manager and Project Chemist, the Project Manager and Site Managers are responsible for initiating and implementing corrective action in the field and in the office. The laboratory project manager, in conjunction with the laboratory technical staff and QA manager, is responsible for implementing corrective action in

the laboratory. It is the combined responsibility to insure that all analytical procedures are followed as specified and that the data generated meet the prescribed acceptance criteria. Specific corrective actions necessary will be clearly documented in the logbooks or analytical reports.

In all cases in which corrective actions of field procedures are required, a written report describing the nature of the problem, an evaluation of the cause, if known, and the action taken will be prepared by the ARCADIS Site Manager or the ARCADIS QAO. The report will be distributed to the ARCADIS PM, the ARCADIS QAO (if not preparing the report), and the ARCADIS Project Director.

Any corrective actions taken by the contract laboratory will be reported to the ARCADIS Project Chemist. The laboratory will include in each data package a discussion of the problems encountered and corrective actions taken. In addition, the laboratory will maintain a file that documents all corrective actions taken. Reports of corrective actions undertaken during laboratory analysis will be documented, as appropriate, in the Data Validation Report.

3.3 Performance and Data Quality Reports

Data Validation Reports - Data validation reports will be completed by the Project Chemist as soon as possible after receipt of the data from the laboratory (i.e., the goal is within 3 weeks). Impacts on the usability of the data will be tracked by adding qualifiers to individual data points as described in Section 4.

Serious analytical problems will be reported immediately to the ARCADIS Project Chemist by the laboratory PM. The ARCADIS Project Chemist will notify the ARCADIS Site Manager and PM to evaluate necessity for resampling or additional sample collection. Time and type of corrective action (if needed) will depend on the severity of the problem and will be related to overall project importance of the data points. Corrective actions may include altering procedures in the field, conducting an audit, resampling or modifying laboratory protocol.

Project Status Reports - Project status reports are completed by the PM to document the overall assessment of the project on a monthly basis. The Project Status Report tracks the overall quality of performance relative schedule, budgets and other issues.

4. Data Validation and Usability

The general procedures for data validation and usability are described below. These procedures will be adapted, if necessary, to meet project-specific or activity-specific requirements. Data validation and usability criteria set forth in this QAPP shall be followed unless otherwise amended in the SAPs or Work Plans which will address any modifications to data review criteria not included in this QAPP.

4.1 Data Review, Verification, and Validation

Data generated will be reviewed for conformance with the QAPP, SAP and other applicable work plans, as well as specific project requirements. QA information provided by the laboratory will be evaluated relative to the methods performed, the laboratory SOPs, the laboratory QAM, COC requests, Laboratory Task Orders (LTOs) or similar directive document, and this QAPP, as appropriate. The laboratory will be responsible for internal review of all calibrations, raw data, and calculations. The final analytical report will be reviewed by the laboratory PM and other appropriate laboratory management personnel for compliance with the above listed documents including peer and supervisory review prior to releasing data to ARCADIS.

The ARCADIS Project Chemist and data validation team will perform additional verification and validation of laboratory data to assess the quality and usability of the data generated. Field record review will include instrument calibration logs, sampling logs, COC records, field notes, and field parameter results. The field information assessment will evaluate the potential for impact to sample integrity and chemical data quality.

Chemical analytical data collected will be reviewed and, as appropriate, qualified using guidelines established in the USEPA National Functional Guidelines (NFGs) modified to incorporate method and project-specific requirements. The analytical data review will be performed under either of two levels: Tier 2 or Tier 3. The frequency and components included in each tier are defined in Sections 4.2.2.1 and 4.2.2.2.

4.2 Verification and Validation Methods

The data review scheme for analytical results from the receipt of the analytical data through the validated report is described below. The laboratory is responsible for performing internal data review. The data review by the analytical laboratory will include 100 percent analyst review, 100 percent peer review, and 100 percent review by the laboratory project manager to verify that all project-specific requirements are

met. The laboratory QA Officer will perform a review on 10 percent of the data packages. All levels of laboratory review will be fully documented and available for review if requested or if a laboratory audit is performed.

After receipt from the laboratory, project data will be verified and validated by ARCADIS or experienced contract personnel using the following steps.

4.2.1 Evaluation of Completeness

The Project Chemistry Team will verify the following report content for all data, as appropriate, for the required level of data validation:

- Laboratory information matches the field information;
- Fully executed COC records;
- Report completeness and conformance with COC, LTO, QAPP, Site-Specific Work Plan, and other project requirements;
- Case narrative describing any out-of-control events and summarizing analytical observation or non-conformances;
- Sample receipt information;
- Data report forms;
- QA/QC summary data;
- Initial and continuing calibration information (Tier 3 validation);
- Instrument tuning data (Tier 3 validation);
- Quantitation reports (Tier 3 validation);
- Batch and/or run logs (Tier 3 validation);
- Chromatograms (Tier 3 validation); and
- Documentation of any QC problems.

If the data package is incomplete, the Project Chemist will contact the laboratory, which must provide all missing information within a reasonable timeframe (i.e., 1 to 2 days).

4.2.2 Evaluation of Compliance

The data validation procedures are briefly outlined below:

- Electronic checking routines (Tier I validation) will be utilized to check 100 percent of the field and laboratory QC data (LCS, MS/MSD, blanks) to verify that holding times and acceptance and performance criteria were met and to note any anomalous values. Appropriate data qualifiers (Section 4.3) will be applied to the data where deficiencies are identified;

- All chemistry data generated with the exception of waste characterization, storm water discharge, and remedial system operational monitoring will undergo a Tier 2 validation. Initially, one SDG for each matrix will undergo the detailed Tier 3 validation to ensure laboratory performance;

- All data will be checked to ensure all analytical problems and corrections are reported in the case narrative and that appropriate laboratory qualifiers are added; and

- For any problems identified, review concerns with the laboratory, obtain additional information if necessary, and check all related data to determine the extent of the error. Data qualifiers will be applied to the analytical results to indicate potential limitations on data usability.

The data validation team will follow qualification guidelines in USEPA *Contract Laboratory Program (CLP) National Functional Guidelines for Organic Data Review*, EPA 540/R-99/008, October 1999; USEPA *Contract Laboratory Program National Functional Guidelines for Inorganic Data Review*, EPA 540/R-01/008, July 2002; USEPA *Contract Laboratory Program National Functional Guidelines for Inorganic Data Review*, EPA 540/R-04/004, October 2004; Laboratory QAM; Laboratory Methods; and the QAPP with performance criteria based on the published analytical methods and laboratory established control limits.

4.2.2.1 Tier 2 Verification

Tier 2 data verification includes a review of all sample documentation coupled with electronic data screening and manual review. The analytical report will be assessed for completeness and for compliance with COC requests, LTO, SAP, and any additional work plan documents. The electronic data compliance will be conducted utilizing the EQuIS Data Qualification Module (DQM), a module within the Earthsoft suite of environmental data management products. All analytical data will be managed within

the EQuIS Chemistry database via electronic uploading of laboratory data. The DQM is written in Visual Basic for the EQuIS database and checks for the following parameters:

- Blank contamination;
- MS and MSD recoveries;
- MS/MSD RPD;
- LCS and LCSD recoveries;
- LCS/LCSD RPDs (when available);
- Surrogate recoveries;
- Field duplicate RPDs; and
- Holding times.

The DQM routines apply appropriate qualifiers to the data. Select manual reviews will verify appropriate qualifier application. Data Qualifiers will not be manually applied to original hard copy analytical reports. The validation reports will be included with any submittal of analytical reports to agencies or other required party

4.2.2.2 Tier 3 Validation

One SDG for each matrix collected during the initial phases of the project will undergo a detail data validation which will include the complete Tier 2 assessment and review of the additional following information relative to target compounds/analytes:

- Instrument tune;
- Initial calibration;
- Continuing calibration;
- Interference check standards (metals only);
- Serial dilutions (metals only);
- Quantitation reports;

- Internal standard area (organics only);
- Retention times (as applicable by method);
- Chromatograms (as applicable by method);
- Ion spectra for compound identification;
- Data transcription from instrument report to hard copy report; and
- A subset of calculations will be verified for each sample.

4.2.3 Data Validation Reporting

The Project Chemist will perform the following reporting functions:

- Alert the QA Manager and the Site Manager to any QC problems, obvious anomalous values, or discrepancies between the field and laboratory data and resolve any issues;
- Discuss QC problems in a data validation memo for each laboratory report;
- Review the laboratory EDD and electronic field data, enter the data qualifiers into the database, and oversee preparation of analytical data summary tables. The tables will summarize those samples and analytes for which detectable concentrations were exhibited as well as complete analytical summary tables. The tables will include field QC samples; and
- Prepare a summary of the quality control information at the completion of all field and laboratory efforts for the site. The report will summarize planned versus actual field and laboratory activities and data usability concerns.

The Project or Task Manager provides the final Data Quality Assessment during the technical review of the data report.

4.2.4 Validation Reports

Reports will be generated for each data package or combination of data packages for a single sampling event to record the results of the validation effort. The reports will identify all deficiencies and the impact on the results. The data validator or the Database Manager will append qualifiers generated during the verification/validation

process to the EQuIS database and a summary table of the data qualifiers will be included with the analytical report.

4.3 Reconciliation with Data Usability Requirements

For routine assessments of data quality, ARCADIS will implement the data verification/validation procedures described in Section 4.2 and assign appropriate data qualifiers to indicate limitations on the data. The Project Chemist will be responsible for evaluating precision, accuracy, representativeness, comparability, and completeness of the data using procedures described in Section 1.4. Any deviations from the analytical DQOs for the project will be documented in the data verification/validation memo and provided to the data users for the project. The Project Chemist will work with the final users of the data in performing data quality assessments. The data quality assessment may include some or all the following steps:

- Data that are determined to be incomplete or not usable for the project will be discussed with the project team. If critical data points are involved which impact the ability to complete the project objectives, the data users will report immediately to the Site Manager. The Site Manager will discuss the resolution of the issue with the ARCADIS Project Manager and implement the necessary corrective actions (for example, resampling);

- Data that are non-detect but have RLs elevated due to blank contamination or matrix interference will be compared to screening values (see Appendices B and C). If RLs exceed the screening values, then the results will be handled as appropriate for data use; and

- Data qualified as estimated will be utilized if it is determined that the data are useable for their intended purpose. If an estimated result is close to a screening value, then there is uncertainty in any conclusions as to whether the result exceeds the screening value. The data user must evaluate the potential uncertainty in developing recommendations for the site. If estimated results become critical data points in making final decisions on the site, the Site Manager should evaluate the use of the results and may consider the data point incomplete.

In the validation process there are two types of data validation codes that may be applied, those related to identification (confidence concerning the presence or absence of compounds) and those related to quantitation. Each of the standard data validation codes is defined below:

R	Data point is unusable due to serious deficiencies in analytical and QC criteria. The presence or absence of the analyte/compound cannot be verified
UB	Not detected substantially above the level reported in laboratory or field blanks. For organics - 5X (10X for common lab contaminants) or for metals - 10X. Data point considered non-detect at the value qualified.
U	Analyte/Compound not detected. The associated value indicates the concentration above which the result would be considered a quantitative value.
J	Reported value is considered an approximate concentration.
UJ	Analyte/compound not detected above the quantitation limit. However, the reported quantitation limit is approximate.

The ultimate data assessment process involves comparing analytical results to screening values and background concentrations to determine whether the contamination present is site related (i.e., above background levels) or significant (i.e., above screening values). Additional data assessment may be performed on site-by-site basis. Any additional procedures for data quality assessment will be provided in the OU-Specific Work Plan.

5. References

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USEPA. 2004. USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review, Office of Superfund Remediation and Technology Innovation, EPA 540-R-04-004 (OSWER 9240.1-45), October.

USEPA. 2006. Guidance on Systematic Planning and Using the Data Quality Objectives Process; EPA /240/B-06 QA/G-4.

ARCADIS

Tables

Table 1: ARCADIS Technical Team Contact Information

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Table A-2. Data Quality Objectives for Site Characterization.

Data Quality Objective	Project Specific Action
Problem statement	Historical activities have contributed to environmental impacts to surface and subsurface soil, surface water and groundwater at the military facilities. The project goals include delineation of environmental impacts and achieving remedy in place or response complete in accordance with the timeline set forth in the performance based contract. To achieve these goals, characterization activities shall be performed in accordance with the sampling and analysis plans, implementation of remedial actions, monitoring of remedial performance, and confirmation of attainment of clean-up goals.
Identify the decisions	• Do constituent concentrations exceed the screening criteria? • Has the Site been delineated? • What remedial system will be used to reduce constituent concentrations? • Does the remedial system meet the performance goals?
Identify the inputs to the decision	• Complete additional delineation sampling and compare identified CoC data to screening levels; and define extent of contamination. • Design and implement remedial systems • Monitor remedial system performance • Confirm reduction in contaminant levels to below clean-up goals.
Develop the decision rule	• If soil and groundwater quality data indicate concentrations above screening levels, the affected media will be addressed by additional site investigation to delineate the nature and extent of impact to the affected media. • When the Site is delineated, the soil and groundwater quality data will be evaluated to determine if an active remediation is required to reduce the concentrations below the clean-up goals. • If the remedial system does not meet the performance goals, modifications to the existing system and/or an additional or alternative remedial system will be implemented.
Specify limits on decision errors	Data quality and usability will be determined in accordance with the criteria set forth in the QAPP. Rejected data will not be used for decision-making purposes.

CoC Constituent of Concern.
QAPP Quality Assurance Project Plan.

Table A-3 Statistical Calculations

Statistical	Symbol	Formula	Definition	Uses
Mean	X	$\frac{\left(\sum_{i=1}^{\eta} x_i\right)}{n}$	Measure of central tendency	
Standard Deviation	S	$S_x = \left(\frac{n\Sigma\chi 2 - (\Sigma\chi)^2}{n(n-1)}\right)^{1/2}$	Measure of relative scatter of the data	
Relative Standard Deviation		$(S / \overline{X}) \times 100$	Relative standard deviation, adjusts for magnitude of observations	Used to assess precision for replicate results
Pooled RSD	RSD_p	$\left(\frac{\sum_{i=1}^{\eta} (RSDi)^2 \, dfi}{\sum_{i=1}^{\eta} dfi}\right)^{1/2}$	Measure of overall variability of a series	Used to assess overall performance for compounds with multiple measurements
Relative Percent Difference	RPD	$\left(\frac{(X_1 - X_2)}{(X_1 + X_2)/2}\right) \times 100$	Measure of variability that adjusts for the magnitude of observations	Used when there are only two observations; mathematically related to RSD

Table A-3 Statistical Calculations

Statistical	Symbol	Formula	Definition	Uses
Average Relative Percent Difference	RPD	$\frac{\text{RPD}}{n}$	Average relative percent difference - analogous to pooled RSD for duplicate measurements	Used to assess overall performance for compounds with multiple measurements
Confidence Interval	CI	$\frac{X \pm t\langle \alpha, n-1 \rangle^{S}}{n^{1/2}}$	Interval about X that contains the true value, with probability α	Assign intervals or error bars to measurement data
Percent Recovery	R	$\left(\frac{X_{meas}}{X_{true}}\right) \times 100$	Recovery of spiked compound in pure matrix	Recovery of Quality Control check sample, method spikes
Percent Recovery	R	$\frac{\begin{pmatrix}\text{value of} & \text{value of}\\ \text{spiked} & \text{unspiked}\\ \text{sample} & \text{sample}\end{pmatrix}}{\text{Value of added spike}} \times 100$	Recovery of spiked compound in sample matrix	Matrix spike and matrix spike/matrix spike duplicate recovery

X = Observation (concentration)
n = Number of observations
df = Degrees of freedom, usually
t = Statistical from students' "t" distribution

Table A-4. Field Quality Control Sample Collection Guidelines.

QC Sample	Description
Field Duplicate	One per matrix per 20 samples for each analysis.
Equipment Rinsate Blank	One per equipment set per 20 samples collected for each analysis. Only equipment sets that are dedicated or disposed of do not require equipment blanks.
Trip Blank	One per shipment for each cooler in which samples for volatile analysis are shipped. Trip blanks are analyzed for all volatile methods designated for the samples. Trip blanks are shipped for both solid and aqueous matrices.
Field Blank	One per 20 samples collected for each analysis if/when field conditions warrant evaluation of air borne contaminants. Collection decision by the Site Manager.

Field Analyses Data Quality Objectives

Parameter	Method	Precision	Accuracy % Recovery	Completeness %
pH	150.1	0.05 units	±0.2 units	95
Conductivity	120.1	7.6 umhos/cm	±2%	95
Temperature	--	0.1°C	±2°C	95

Calibration Frequency

Analysis	Initial Calibration	Calibration Check	Sample Duplicate
pH	Daily	Every 4 Hours	Daily
Conductivity	Daily	Every 4 Hours	Daily
Turbidity	Daily	Every 4 Hours	Daily

QA Quality Assurance
umhos/cm micromhos per centimeter

Table A-5. Summary of Methods, Containers, Preservatives, and Holding Times.

Parameter	Matrix	Preparation Method	Analytical Method [a]	Container [b]	Preservative	Holding Time [c]
Organic and Metals Methods						
VOCs	Water	5030, 5032	8260	4 x 40-mL vial with Teflon-lined septum	pH < 2 with HCl, Cool 4°C	14 days
	Water	5030, 5032	8260	4 x 40-mL vial with Teflon-lined septum	If effervescence is observed, eliminate HCl preservative and Cool 4°C	7 days
	Solid	5035	8260	3 x Encore™ OR 2 x Sodium Bisulfate vial and 1 x Methanol vial	Cool 4°C	48 hours to preservation for Encore™, then 14 days to analysis
SVOCs	Water	3510, 3520 [d]	8270 (Low Level)	2 x 1-L amber G	Cool 4°C [e]	7 days to extraction and 40 days to analysis
	Solid	3540, 3550 [d]	8270 (Low Level)	1 x 4-oz or 8-oz G	Cool 4°C	14 days to extraction and 40 days to analysis
PAHs	Water	3510, 3520 [d]	8270 SIM)	2 x 1-L amber G	Cool 4°C [e]	7 days to extraction and 40 days to analysis
	Solid	3540, 3525 [d]	8270 SIM	2 x 1-L amber G	Cool 4°C [e]	7 days to extraction and 40 days to analysis
Organochlorine Pesticides	Water	3510, 3520 [d]	8081/608	2 x 1-L amber G	Cool 4°C [e]	7 days to extraction and 40 days to analysis
	Solid	3540, 3550 [d]	8081	1 x 4-oz or 8-oz G	Cool 4°C	14 days to extraction and 40 days to analysis
Organochlorine Herbicides	Water	8151 [d]	8151	2 x 1-L amber G	Cool 4°C [e]	7 days to extraction and 40 days to analysis
	Solid	8151 [d]	8151	1 x 4-oz or 8-oz G	Cool 4°C	14 days to extraction and 40 days to analysis
Metals (except Mercury)	Water	3005, 3010	6010/6020	1 x 500mL HDPE	pH < 2 with HNO_3, Cool 4°C	6 months
	Solid	3050, 3051	6010	1 x 8-oz G	Cool 4°C	6 months
Mercury	Water	NA	7470	1 x 500mL HDPE	pH < 2 with HNO_3, Cool 4°C	28 days
	Solid	NA	7471	1 x 8-oz G	Cool 4°C	28 days

Table A-5. Summary of Methods, Containers, Preservatives, and Holding Times.

Parameter	Matrix	Preparation Method	Analytical Method [a]	Container [b]	Preservative	Holding Time [c]
Total Petroleum Hydrocarbons as GRO	Water	5030, 5032	8015 Modified	4 x 40-mL vial with Teflon-lined septum	pH < 2 with HCl, Cool 4°C	14 days
	Solid	5035	8015 Modified	3 x Encore™ OR 2 x Sodium Bisulfate vial and 1 x Methanol vial	Cool 4°C	48 hours to preservation for Encore™, then 14 days to analysis
Total Petroleum Hydrocarbons as DRO/ORO	Water	3510, 3520 [d]	8015 Modified	2 x 1-L amber G	Cool 4°C [e]	7 days to extraction and 40 days to analysis
	Solid	3540, 3550 [d]	8015 Modified	1 x 4-oz or 8-oz G	Cool 4°C	14 days to extraction and 40 days to analysis
Waste Characterization Parameters						
TCLP Metals [f] (including Mercury)	Solid Waste Material	1311 for Leach/ 3005, 3010	6010 and 7470 (for Leachate)	1 x 8-oz wide-mouth G	Cool 4°C	28 days from collection to Leach; 28 days to analysis of Leachate
TCLP VOCs [f]	Solid Waste Material	1311 for Leach/ 5030	8260 for Leachate	1 x 4-oz G packed full	Cool 4°C	14 days from collection to Leach; 14 days to analysis of Leachate when preserved with HCl to pH < 2
TCLP SVOCs [f]	Solid Waste Material	1311 for Leach/ 3510, 3520	8270 for Leachate	1 x 8-oz wide-mouth G	Cool 4°C	14 days from collection to Leach; 40 days to analysis of Leachate
TCLP Pesticides [f]	Solid Waste Material	1311 for Leach/ 3510, 3520	8081 for Leachate	1 x 8-oz wide-mouth G	Cool 4°C	14 days from collection to Leach; 40 days to analysis of Leachate
TCLP Herbicides [f]	Solid Waste Material	1311 for Leach/ 8151	8151 for Leachate	1 x 8-oz wide-mouth G	Cool 4°C	14 days from collection to Leach; 40 days to analysis of Leachate
Ignitability	Aqueous Waste	NA	1010	500 mL G	NA	NA
	Solid Waste Material	NA	ASTM D-92	1 x 8-oz wide-mouth G	NA	NA

Table A-5. Summary of Methods, Containers, Preservatives, and Holding Times.

Parameter	Matrix	Preparation Method	Analytical Method [a]	Container [b]	Preservative	Holding Time [c]
Reactivity	Aqueous Waste	NA	USEPA Region 4 Guidance for Sulfide	500 mL HDPE	pH > 9 with 2 mL ZnAc and NaOH, Cool 4°C	7 days
	Aqueous Waste	NA	9010/9012/9014 for Cyanide	1 x 120 mL HDPE	pH > 12 with NaOH	14 days
	Solid Waste Material	NA	USEPA Region 4 Guidance for Sulfide	1 x 8-oz wide-mouth G	Cool 4°C	7 days
	Solid Waste Material	NA	9010/9012/9014 for Cyanide	1 x 1-L HDPE	Cool 4°C	Sulfide 7 days
Corrosivity (pH)	Aqueous Waste	NA	9040	120 mL HDPE	NA	24 hours
	Solid Waste Material	NA	9045	1 x 8-oz wide-mouth G	NA	24 hours
General Chemistry Parameters						
Alkalinity	Water	NA	SM 2320 B	500 mL HDPE	Cool 4°C	14 days
Ammonia	Water	NA	SM 4500-NH3 D	500 mL HDPE	pH < 2 with H_2SO_4, Cool 4°C	28 days
Biochemical Oxygen Demand (BOD)	Water	NA	405.1	1 x 1-L HDPE	Cool 4°C	48 hours
Chloride	Water	NA	SM4500-CL/300.0/9056	500 mL HDPE/ 2 x 40 mL vial	Cool 4°C	28 days
Cyanide	Water	NA	9010/9012/9014	1 x 120 mL HDPE	pH > 12 with NaOH, Cool °4C	14 days
	Solid	NA	9010/9012/9014	1 x 4-oz or 8-oz G	Cool 4°C	14 days
Hardness	Water	NA	SM 2340B/6010	500 mL HDPE	Cool 4°C for 130.2/ pH < 2 with HNO_3, Cool 4°C for 6010	6 months
Nitrate	Water	NA	353.2/300.0/9056	120 mL HDPE/	Cool 4°C	2 days
Nitrite	Water	NA	353.2/300.0/9056	120 mL HDPE/	Cool 4°C	2 days
Nitrate/Nitrite	Water	NA	353.2	500 mL HDPE	pH < 2 with H_2SO_4	28 days

Table A-5. Summary of Methods, Containers, Preservatives, and Holding Times.

Parameter	Matrix	Preparation Method	Analytical Method [a]	Container [b]	Preservative	Holding Time [c]
Phosphate	Water	NA	365.3/300.0/9056	500 mL HDPE/ 2 x 40 mL vial	pH < 2 with H_2SO_4	28 days
Sulfate	Water	NA	ASTM 516-90/300.0/9056	500 mL HDPE/ 2 x 40 mL vial	Cool 4°C	28 days
Sulfide	Water	NA	SM 4500-SULFIDE	1-L HDPE	2 mL ZnAc and NaOH to pH > 9, Cool 4°C	7 days
Total Dissolved Solids (TDS)	Water	NA	SM 2540C	500 mL HDPE	Cool 4°C	7 days
Total Suspended Solids (TSS)	Water	NA	SM 2540D	1-L HDPE	Cool 4°C	7 days
Total Organic Carbon (TOC)	Water	NA	415.2/9060	500 mL HDPE	pH < 2 with HCl or H_2SO_4, Cool 4°C	28 days
Dissolved Organic Carbon (DOC)	Water	NA	415.2/9060	500 mL HDPE	AFTER FILTRATION: pH < 2 with HCl or H_2SO_4, Cool 4°C	28 days
Chemical Oxygen Demand	Water	NA	410.4	500 mL HDPE	pH <2 with H_2SO_4	28 days

(a) The 8000 series methods will be used for assessment and remediation; the 600 series methods will be used only for wastewater.
(b) Sample volumes may be combined for parameters where preservatives are the same and adequate sample volume is supplied to the laboratory. Volumes listed are based on sample containers and not minimum volumes required for some of the General Chemistry Parameters listed. All other volumes are minimum volumes required to be submitted to the laboratory.
(c) Maximum holding time allowed from date of collection.
(d) Cleanup methods may be applicable if matrix interference is encountered. Cleanup methods may include alumina (Method 3610), florisil (Method 3620), silica gel (Method 3630), gel permeation chromatography (GPC) (Method 3640), and sulfur (Method 3660). Selection of appropriate method is based on nature of interference and target compounds.
(e) If residual chlorine is present, requires sodium thiosulfate in each sample container.
(f) Waste Characterization addresses solid (soils, drilling mud) material analysis for waste disposal purposes. Liquid (aqueous or organic) wastes will be characterized using the appropriate methods for determination of total constituent concentrations in accordance with waste disposal requirements under the Resource Conservation and Recovery Act (RCRA). TCLP analyses will be performed as required on wastes containing > 0.5% solids in accordance with RCRA waste characterization and disposal requirements.

°C – Degrees Centigrade.
DRO – Diesel Range Organics
GRO – Gasoline Range Organics
H_2SO_4 – Sulfuric acid.
HCl – Hydrochloric acid.
HDPE – High Density Polyethylene.
HNO_3 – Nitric acid.
L – Liter.
mL – Milliliter.

NA – Not Applicable.
NaOH – Sodium hydroxide.
ORO – Oil Range Organics
PAHs – Polycyclic Aromatic Hydrocarbons
SVOCs – Semivolatile Organic Compounds.
TAL – Target Analyte List.
TCL – Target Compound List.
TCLP – Toxicity Characteristic Leaching Procedure.
VOCs – Volatile Organic Compounds.
ZnAc – Zinc acetate.

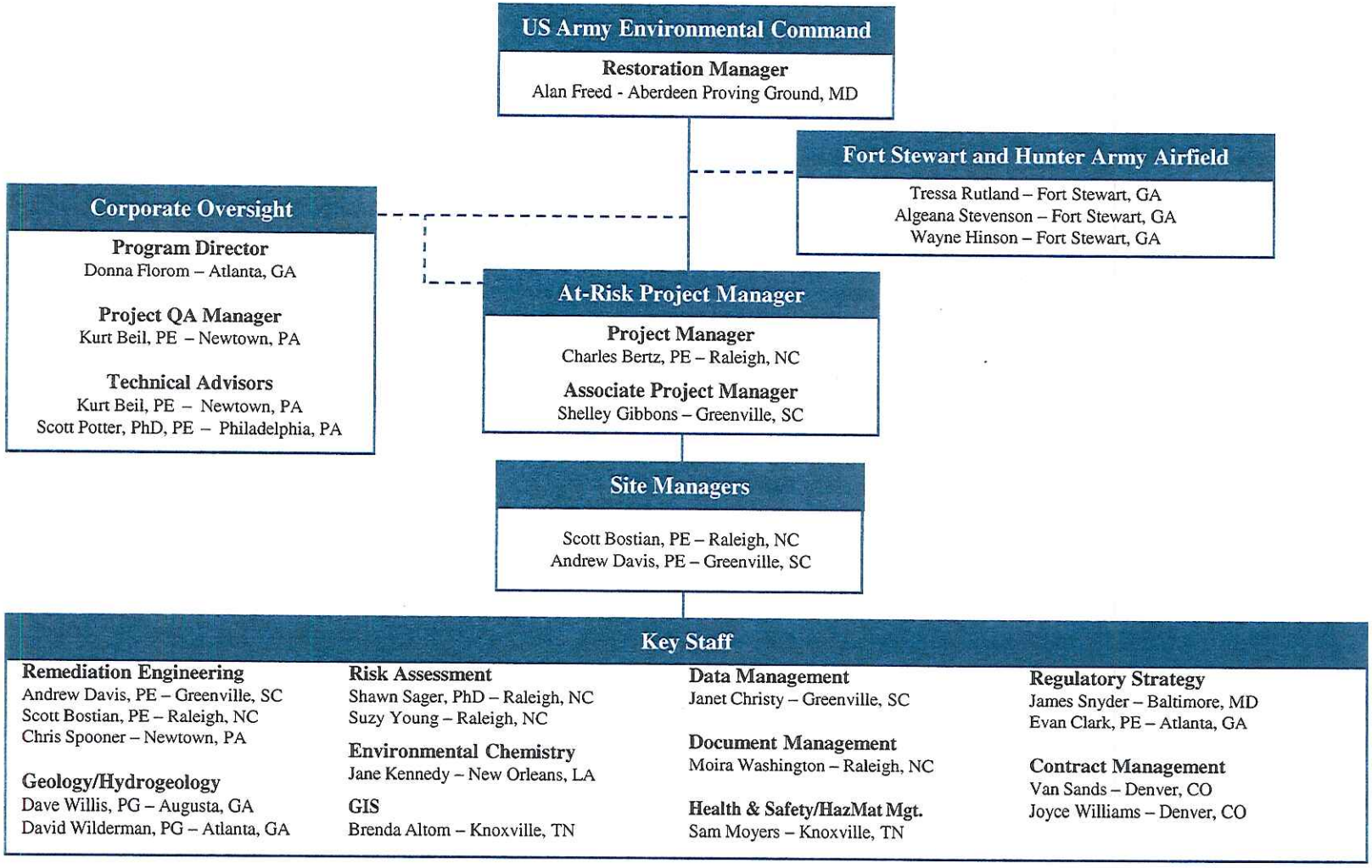
Table A-6. Laboratory Quality Control Sample Analysis Guidelines.

QC Sample	Description
Method Blank	One per matrix per preparation batch for each analysis.
Lab Replicate	One per matrix per preparation batch for each analysis.
Laboratory Control Sample/ Laboratory Control Sample Duplicate (LCS/LCSD)	One LCS per matrix per preparation batch for each analysis. LCSD performance is optional.
Surrogate Spiking	All samples analyzed for organic methods as method and Standard Operating Procedure (SOP) appropriate.
Matrix Spike/Matrix Spike Duplicate (MS/MSD)	One pair per matrix per preparation batch for each analysis. The spike solution will contain a broad range of the analytes of concern, but may not contain all due to incompatibility, interaction, breakdown, availability, or multi-component compounds. The overall frequency of MS/MSD on the project samples must be at least 1 set per 20 samples.

ARCADIS

Figures

Figure A-1
Project Organization
Environmental Restoration PBA
Fort Stewart and Hunter Army Airfield
Georgia



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Appendix B

Field Forms

ARCADIS

Utilities and Structures Checklist

Project: Fort Stewart / Hunter Army Airfield

Prepared By: _____

Location: _____

Date: _____

Instructions: This checklist must be completed by an ARCADIS staff member as a safety measure to insure that all underground utility lines, other underground structures, as well as aboveground power lines are clearly marked out in the area selected for boring or excavation. **DRILLING OR EXCAVATION WORK MAY NOT PROCEED UNTIL LINES ARE MARKED AND THIS CHECKLIST HAS BEEN COMPLETED.** Arrangements for underground utility markouts are best made at the time of the preliminary site visit to allow client and/or utility company sufficient time. Keep completed checklist and maps onsite; send copy to Project Manager.

Assignment of Responsibility: ARCADIS is responsible for having underground utilities and structures located and marked. Preferably, the utilities themselves should mark out the lines.

Emergency Procedures: Follow emergency procedures outlined in site-specific Health and Safety Plan.

Utilities and Structures

Type	Not Present	Present	How Marked? (flags, paint, wooden stakes, etc.)
Natural Gas Line			
Electric Power Line			
Telephone Cable			
Sewer Line			
Storm Drain			
Water Line			
Steam Line			
Petroleum Product Lines			
Product Tank			
Septic Tank/Drain Field			
Overhead Power Line			

Name and Affliation of person who marked or cleared underground lines or structures

ORGANIZATION	NAME	PHONE

Comments:

ARCADIS

Location Sketch

Well(s) _____ Project No. GP08HAFS Page _____ of _____

Site Location _____

Prepared by _____

(Locate all wells, borings, etc. with reference to three permanent reference points: tape all distances: clearly label all wells, roads, and permanent features)

ARCADIS

Boring/Well Construction Log

JOB NUMBER	CLIENT	LOCATION	WELL NO.	PAGE 1 OF ____	WELL LOCATION
GP08HAFS	Fort Stewart / HAAF				N

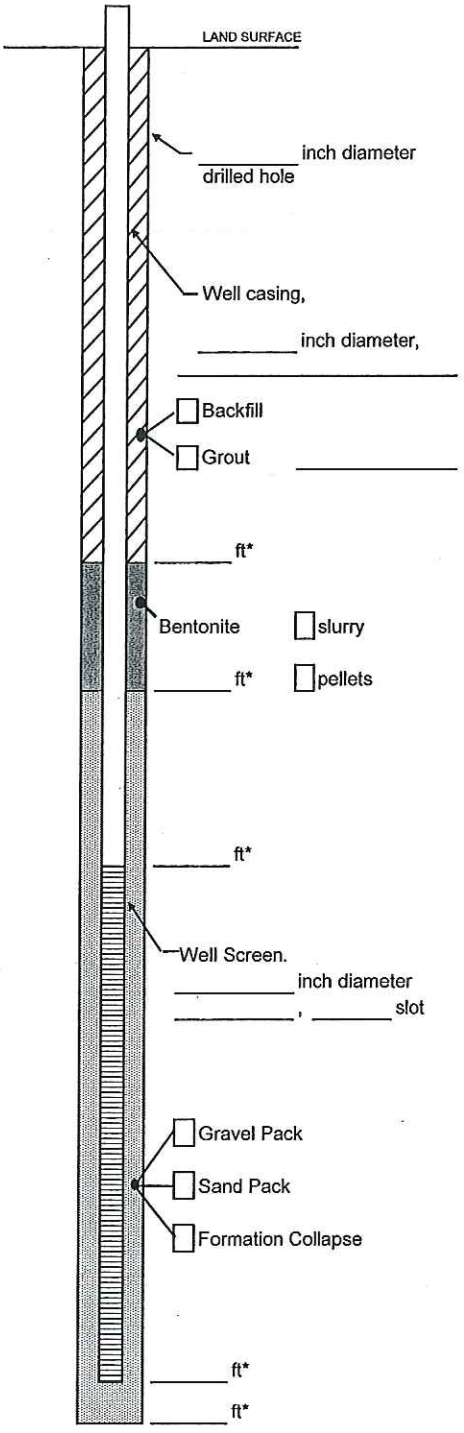
RILLING METHOD	SAMPLING METHOD
DRILLING START / FINISH	DEVELOP START / FINISH
STATIC DTW / DTO — TIME / DATE	DRILLED BY
ELEVATION TOC / GL	LOGGED BY

WELL CONSTRUCTION	DEPTH FEET	CLASS	NAME	COLOR	DESCRIPTION: GRADATION, SECONDARY CHARACTERISTICS, ODOR, REMARKS.	M.C.	PID/FID (PPM)	SAMPLE NO.	SAMPLE DEPTH	BLOWS	RECOV %	TYPE
	1											
	2											
	3											
	4											
	5											
	6											
	7											
	8											
	9											
	10											
	11											
	12											
	13											
	14											
	15											
	16											
	17											
	18											
	19											
	20											

ARCADIS

Well Construction Log

(Unconsolidated)



Measuring Point is
Top of Well Casing
Unless Otherwise Noted.

* Depth Below Land Surface

Project GP08HAFS Well _____

Town/City _____

County _____ State GA

Permit No. _____

Land-Surface (LS) Elevation and Datum:

_____ feet ☐ Surveyed

☐ Estimated

Installation Date(s) _____

Drilling Method _____

Drilling Contractor _____

Drilling Fluid _____

Development Technique(s) and Date(s)

Fluid Loss During Drilling _____ gallons

Water Removed During Development _____ gallons

Static Depth to Water _____ feet below M.P..

Pumping Depth to Water _____ feet below M.P.

Pumping Duration _____ hours

Yield _____ gpm Date _____

Specific Capacity _____ gpm/ft

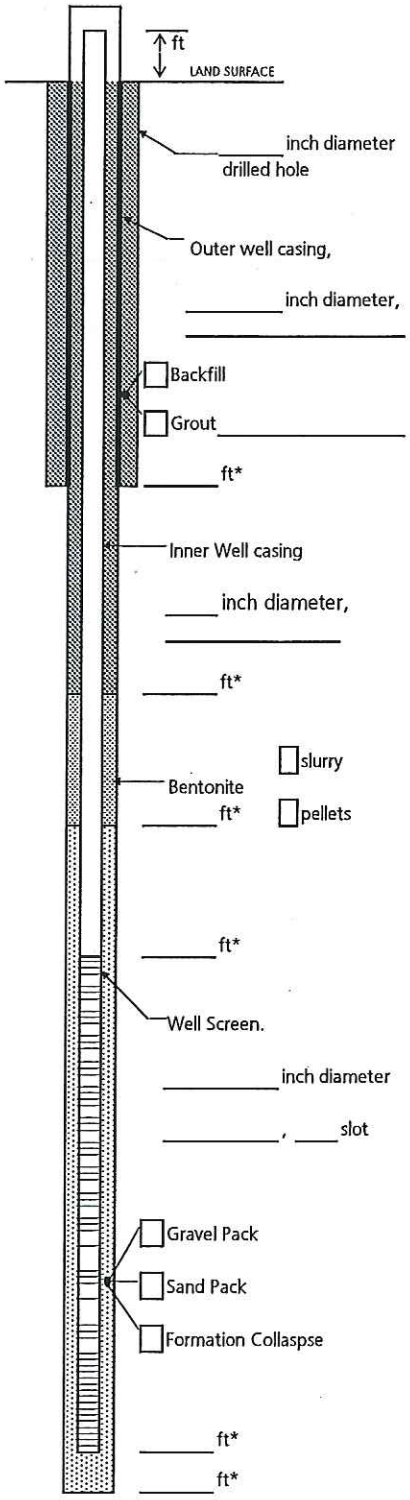
Well Purpose Monitoring

Remarks _____

Prepared by _____

ARCADIS

WELL CONSTRUCTION LOG- TELESCOPING



Measuring Point is
Top of Well Casing
Unless Otherwise Noted.

* Depth Below Land Surface

Project _____ Well _____

Town/City _____

County _____ State _____

Permit No. _____

Land-Surface Elevation and Datum:

_____ feet ☐ Surveyed

☐ Estimated

Installation Date(s) _____

Drilling Method _____

Drilling Contractor _____

Drilling Fluid _____

_____

Development Technique(s) and Date(s)

_____

_____

_____

Fluid Loss During Drilling _____ gallons

Water Removed During Development _____ gallons

Static Depth to Water _____ feet below M.P.

Pumping Depth to Water _____ feet below M.P.

Pumping Duration _____ hours

Yield _____ gpm Date _____

Specific Capacity _____ gpm/ft

Well Purpose _____

_____

_____

Remarks _____

_____

_____

_____

_____

Prepared by _____

ARCADIS
Well Development Form

Page ____ of ____

Project/No. GP08HAFS / Fort Stewart/HAAF

Well ID _____

Date _____

Screened Interval _____

Measuring Point Description _____

Well Materials: ___ PVC ___ St. Steel

Static Water Level _____

Casing Diameter (in) _____

Pump On _____

Pump Off _____

Total depth _____

Boring Diameter (in) _____

Pump Intake _____

Water Column _____

Development Method:

Volume Purged (g) _____

Gallons Per Foot _____

Centrifugal _____
Submersible _____
Surge Block _____
Bailed _____
Other _____

Development Criteria: X Boring Vol. ___ Casing Vol. X Parameters

Gallons in Casing/Boring _____

Developed By: _____

Time	Minutes Relapsed	Rate (gpm) or (ML)	DTW (ft)	Gallons Purged	pH	Cond. (umhos) (ms/cm)	Turb (NTUs)	Redox (mV)	Diss. O2 (mg/L)	TEMP. (C) or (F)	Remarks

Boring/Casing Volumes
2" = 0.16 3" = 0.37 4" = 0.65 6" = 1.47 8" = 2.61 10 " = 4.08 12" = 5.88

ARCADIS

Geoprobe Groundwater Sampling Form

Project No. GP08HAFS **Boring ID:** DP-

Site Location: Fort Stewart / Hunter Army Airfield Date Sampled

Site Description

Weather

Duplicate/QA/QC:

Purging/Sample Collection Information

Casing Material: St. Steel Geoprobe rods Purge Method:(circle one) Bailer Peristaltic Check Valve

Casing Diameter: Geoprobe rods Sample Method: (circle one) Slotted Rods Retractable Screen

Sample ID Boring ID-GW (depth)	Sample Time	Water Column	Gallons/ Foot	Volume Purged	Turbidity	Color	Odor	Lab	Other

Lab Analysis

Constituents Sampled	Container Description	Preservative

Remarks

Sample Personnel

urge volume = Water Column (ft) x 0.02
Water Column = Sample Depth - Depth to Water

WELL SAM[illegible]NG SUMMARY

ARCADIS Project Number: GP08HAFS Project Name: Fort Stewart / HAAF Sampler:		Collection Date (mm/dd/yy)	Collection Time (hr.min)	Initial Depth to Water (ft btoc)	Well Volume (gallons)	Total Depth (ft)	Total Volume Removed (gallons)	Final							Comment
Sample ID	Location ID							pH	Cond. (umhos)	Temp. (oC)	Turb. (NTU)	ORP	DO	TDS	

( ) = Enter the collection date within the parenthesis (ie. 011904)

ARCADIS

Water Level Measurement Form

Project No: GP08HAFS
Location: Fort Stewart / Hunter Army Airfield

Date: _____
Recorded By: _____

Well Number	Time	TOC Elevation (ft)	Static Depth to Water (ft btoc)	Duplicate Reading (ft btoc)	GW Elevation (ft msl)	Total Depth (ft btoc)	Comments

ft btoc Feet below top of casing.

ARCADIS

Water Level/Pumping Test Record

Page ____ of ____

Project _____ Well _____ Site _____

Screen Setting _____ Measuring Point Description _____ Height Above Ground Surface _____

Static Water Level _____ Measured With _____ Date/Time _____

Drawdown ☐ Start of Test _____ Pumping Well _____

Recovery ☐ End of Test _____

Distance From Well Measured To Pumping Well® _____ Discharge Rate _____ Orifice _____

Date & Time	Well Or t (mins)	Held (ft)	Wet (ft)	Depth to Water (ft)	s (ft)	Dewatering Correction (ft)	Artesian s' (2) (ft)	Q (gpm)	Mano-meter (in)	Remarks (3)

1) Dewatering Correction 2) Equivalent Artesian Drawdown 3) pH, Spec. Cond., Temp., Weather, Sand, Turbidity, etc.

ARCADIS Project Number: GP08HAFS				Analysis/Parameters																					
Project Name: Fort Stewart / Hunter Army Airfield				Lab															Field						
Sampler:																									
Laboratory:																									
Sample ID	Location ID	Collection Date (mm/dd/yy)	Collection Time (hr:min)	TOC (9060)	Aluminum (6010B)	Metals (App IX) (6010B)	SVOCs (8270C)	VOCs (8260B)	Alkalinity (310.1)	Pesticides (8081A)	Hex Chrome (7196A)	Total Iron (6010)	Carbon Dioxide (AM20G)	Sulfate (9056)	Nitrate and Nitrite (9056)	Chlorides (9056)	Methane, Ethane, and Ethene (AM20G)	pH	DO,ORP,temp., turbidity, conductivity	Sample Type	Matrix Code	Location Description	Chain of Custody	Parent Sample ID	Comment

( ) = Enter the collection date within the parenthesis (ie. 011904)

* If more than one TB is colleced in one day then name the Trip Blanks sequentially (ie. TB1( ), TB2( ), etc.)

**The time on the COC needs to be the same for MS/MSD as the parent sample.

SAMPLING LOCATION SURVEY SUMMARY

ARCADIS Project Number: GP08HAFS							
Project Name: Fort Stewart / Hunter Army Airfield							
Sampler:							
Laboratory:							
				Top of Casing Elevation			
Location	*Easting**	*Northing**	*Ground Elevation (ft. AMSL)*	*Inner (ft. AMSL)*	*Protective/Outer (ft. AMSL)*	*Depth-to-Water Reference Elevation (ft. AMSL)*	*Comment*

* - Please provide reference for the coordinate system used.

ARCADIS

Soil/Sediment Sample Log

Project/Site Location: Fort Stewart / Hunter Army Airfield Project No.: GP08HAFS

Sample No.: _____ Duplicate/QA/QC: _____

Date: _____ Weather: _____

Site Description: _____

Sampling Method and Material: Geoprobe MacroCore with liner, stainless steel sampling spoon

Sample ID Boring ID-SO (depth)	Sample Time	Soil Class.	Soil Description (Color, description, moisute, odor, etc.)	PID/FID Reading	Offsite Lab Analysis?

Lab Analysis

Constituents Sampled	Container Description	Preservative

Remarks: _____

Sample Personnel: _____

SOIL SAMPLING SUMMARY

ARCADIS Project Number: GP08HAFS							
Project Name: Fort Stewart / HAAF							
Sampler:							
Laboratory:							
Sample ID	*Location ID*	*Collection Date (mm/dd/yy)*	*Collection Time (hr.min)*	*Estimated Ground Elevation (ft. AMSL)*	*Sample Start Depth (ft bgs)*	*Sample End Depth (ft bgs)*	*Comment*

Note: Sample ID = Location ID(Sample Start Depth-Sample End Depth)

11/7/2008

ARCADIS

Groundwater Sampling Form

Site Location: Fort Stewart/HAAF Project No. GP08HAFS **Well ID:** _____

Date: _____ Sampled By: _____

Sampling Time: _____ Recorded By: _____

Weather: _____ Duplicate/QA/QC: _____

Instrument Identification

Instrument:	PID	Water Quality Meter(s)
Serial #:		

Purging Information

Casing Material: _____

Casing Diameter: _____

Total Depth: _____

Depth to Water: _____

Water Column: _____

Gallons/Foot: _____

Gallons in Well: _____

Purge Method: (circle one) Submersible Centrifugal Bladder Bailer Peristaltic

Screen Interval: From: _____ To: _____

Pump Intake Setting: _____

Volumes to be Purged: _____

Total Volume Purged: _____ _____

Pump On: _____ Off: _____

Field Parameter Measurements During Purging

Time	Minutes Elapsed	Rate (gpm or ml)	Volume Purged	Depth to Water	Turbidity (NTUs)	pH (SI Units)	Conductivity (µmhos/cm)	Temp (°C or °F)	Diss. Oxygen	Comments

Observations During Sampling

Well Condition: _____

Color: _____

Odor: _____

Purge Water Disposal: _____

Turbidity(qualitative): _____

Other (OVA, HNU,etc.): _____

Constituents Sampled	Container Description: From Lab _____ ARCADIS _____	Preservative

Boring/Casing Volumes

2" = 0.16 4" = 0.65

ARCADIS

SURFACE WATER SAMPLE LOG

Sample ID _____ Project/No. _____

Date _____ Sampling Personnel _____

Time _____ _____

Weather _____

DESCRIPTION OF SAMPLE LOCATION:

Name of Water Body _____

Depth of Water _____ Velocity _____

Other Comments _____

Substrate Description _____

Location _____

_____

Description of Nearby Vegetation _____

FIELD PARAMETERS:

Sample Method _____

Sample Description _____

_____

Temperature (°C/°F) _____ pH _____

Dissolved Oxygen _____ SC _____

Salinity _____

CONTAINER DESCRIPTION: From _____ Lab _____

Bottle Type	Analysis	Preservative

ARCADIS
CALIBRATION FORM
PHOTOIONIZATION DETECTOR

Project: Fort Stewart / Hunter Army Airfield

Location: _____

PID Model: Multi Rae

Pre-Use Calibration

Date:_____ Time:_____am/pm

5 minute (minimum) warm up in ambient air: YES ☐ NO ☐

Battery indicator reading (e.g., 10 through +20): _____

Instrument zeroed (ambient air): YES ☐ NO ☐

Span gas pressure (e.g., 30 psi minimum to 300 psi):

Calibration gas used is 100 ppm Isobutylene/air: YES ☐ NO ☐

Benzene Referenced: YES ☐ NO ☐

Calibration Value: _____

Post-Use Calibration

Date:_____ Time:_____am/pm

Ambient air reading (e.g., 0 ppm): _____ppm

Battery indicator reading (e.g., 10 through +20): _____

Calibration Value: _____

Comments and description of work activities performed during monitoring:

_____

_____

_____

Calibrated by:_____

ARCADIS

Field Instrument Calibration Log

Project Name/Number _____ Date _____

Calibrating Personnel _____ Instrument _____

Time of Initial Calibration _____ Weather _____

Calibrant	Initial Reading	Adjusted Reading	Final Reading	Time	Temperature

ARCADIS

Daily Log

Well(s) _____ Project No. GP08HAFS Page _____ of _____

Site Location Fort Stewart / Hunter Army Airfield

Prepared by _____

Date/Time	Description of Activities

CADIS

Laboratory Task Order No./P.O. No. _____ **CHAIN-OF-CUSTODY RECORD** Page ____ of ____

Project Number/Name _____

Project Location _____

Laboratory _____

Project Manager _____

Sampler(s)/Affiliation _____

Sample ID/Location	Matrix	Date/Time Sampled	Lab ID	ANALYSIS / METHOD / SIZE						Remarks	Total

Sample Matrix: L = Liquid; S = Solid; A = Air

Total No. of Bottles/ Containers

Relinquished by: _____	Organization: _____	Date ___/___/___ Time _____	Seal Intact?
Received by: _____	Organization: _____	Date ___/___/___ Time _____	Yes No N/A
Relinquished by: _____	Organization: _____	Date ___/___/___ Time _____	Seal Intact?
Received by: _____	Organization: _____	Date ___/___/___ Time _____	Yes No N/A

Special Instructions/Remarks: _____

Delivery Method: ☐ In Person ☐ Common Carrier _____ ☐ Lab Courier ☐ Other _____