

QUALITY ASSURANCE PROJECT PLAN

BROWNFIELDS PETROLEUM CLEANUP 116 MEMORIAL DRIVE HINESVILLE, GEORGIA

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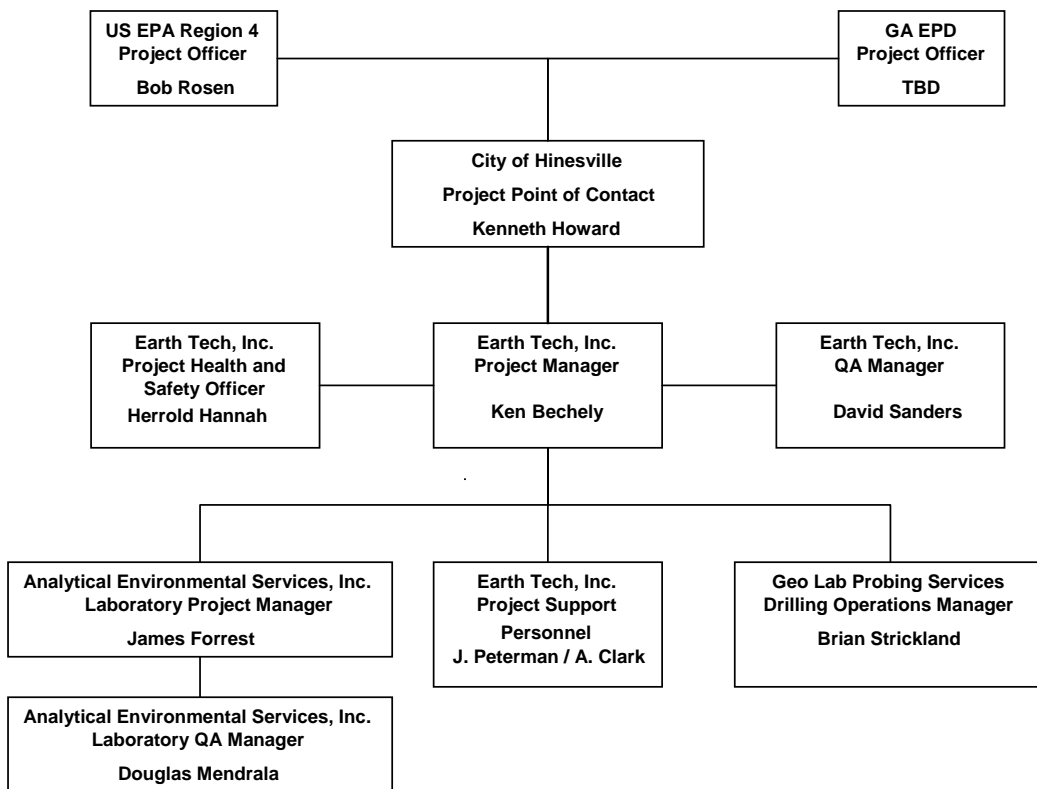
1.0 PROJECT MANAGEMENT

1.1 PROJECT ORGANIZATION

The Brownfields petroleum cleanup project team will include the site owner, the City of Hinesville; the prime consultant, Earth Tech, Inc.; subcontractors and regulators. These organizations have appropriate personnel with educational qualifications and work experiences on related projects to ensure that project objectives will be met.

Figure 1 presents the organizational chart for this project. The ultimate responsibility for data quality rests with Earth Tech's Project Manager. He is assisted by the Earth Tech QA Manager who is responsible for implementing the QA Project Plan (QAPP) and for proper sampling and documentation techniques.

Figure 1 Project Organizational Chart



The responsibilities and authorities of key project positions are discussed in the following paragraphs.

Project Point of Contact

The Project Point of Contact (POC) is the owner's representative responsible for overall coordination and direction of the project and administration of the Cooperative Agreement with the United States Environmental Protection Agency (US EPA). Responsibilities include:

- Final review and approval of project plans, project reports, and other deliverables on behalf of the owner
- Approval of project schedules and budgets and changes, if needed
- Overseeing coordination among US EPA, Georgia Environmental Protection Division (GA EPD), community organizations, and the contractor.

Project Manager

The Project Manager is Earth Tech's representative responsible for effective management of day-to-day project operations, technical adequacy of project work, and adherence to project schedules and budgets. Responsibilities include:

- Review and approval of project plans, including approval of sampling locations, chemical analysis parameters, cleanup techniques, schedules, and labor allocations;
- Implementation of quality control and health and safety standards required by the project plans;
- Management of funds for labor and materials procurement;
- Preparation of progress reports and other project deliverables with the assistance of project support personnel;
- Technical review of project deliverables; and
- Frequent communication with the POC with regard to day-to-day progress of the project.

Project Health and Safety Officer

The Project Health and Safety Officer is responsible for implementing the Health and Safety Program. Responsibilities include:

- Reviewing and monitoring compliance with the site-specific Health and Safety Plan (HASP);
- Implementing corrective measures for site-specific health and safety deficiencies;
- Ensuring required training and medical monitoring of project personnel; and
- Oversight of a site safety officer who will monitor the labeling, shipping, and control of hazardous or potentially hazardous samples and materials, and brief all personnel concerning health and safety requirements.

Project QA Manager

The Project QA Manager remains independent of the cost, scheduling, and other performance constraints that are the responsibility of the Project Manager. The Project QA Manager has the authority and responsibility to identify problems, initiate or provide solutions, verify implementation of solutions, and order work stoppage, if necessary. The Project QA Manager's primary functions and responsibilities include:

- Preparing, maintaining, and verifying compliance with the QAPP;
- Ensuring that quality control (QC) documentation is provided;
- Ensuring that all QC problems are handled in an expeditious manner;
- Auditing project activities to verify conformance with QA objectives;
- Informing the Project Manager of QA findings;
- Ensuring that all subcontractor activities are performed in accordance with QA requirements through review of subcontractor documents, laboratory data, and periodic audits; and
- Final data validation.

Project Support Personnel

Project support personnel include both project specialists, such as hydrogeologists, environmental engineers, chemists, and data validators, and site personnel, such as site geologists, site supervisors and helpers for excavation work, site safety officers. Project personnel shall have the required education, training, and experience commensurate with their responsibilities during the project. Personnel qualifications will be reviewed and evaluated by the Project Manager before being assigned to the project.

Laboratory Project Manager

Analytical Environmental Services, Inc. will provide subcontract laboratory analytical services for this project. The analytical laboratory's project manager will have ultimate responsibility for analytical performance, including adherence to contract QC requirements. The Laboratory Project Manager will serve as the primary laboratory contact person for Earth Tech. Any change in the scope of work will be processed through the Laboratory Project Manager, who will monitor the progress and timeliness of the work orders and laboratory reports.

The Laboratory Project Manager is responsible for ensuring that corrective action has been taken to address problems identified by QC sample results or QA audit findings.

Laboratory QA Manager

The Laboratory QA Manager has responsibility for developing and administering the project-specific QA program, including preparing written documents defining QC procedures, reviewing and approving laboratory QC procedures, supervising sample control operations, and

overseeing inter-laboratory testing programs and laboratory certifications. The QA Manager will submit control samples to the analysts, maintain control charts with warnings and control limits, and evaluate acceptability of control sample results, and will be responsible for spot-checking data sets to ensure that appropriate QC measures have been taken. The QA Manager will evaluate the effectiveness of the laboratory QA program through audits. Unacceptable findings will be reported to the Laboratory Project Manager for follow-up.

1.2 PROJECT BACKGROUND

The project site is located in Liberty County, Georgia at 116 Memorial Drive within the City of Hinesville (population 30,392), located approximately 40 miles southwest of Savannah. The Memorial Drive Site is owned by the City of Hinesville.

A June 2007 Phase II Investigation Report revealed evidence of subsurface contamination resulting from a release of petroleum products from old underground storage tanks (USTs) to groundwater originating from a former gasoline station / auto repair business at the project site. Groundwater samples also indicated the presence of chlorinated hydrocarbons which may be migrating on-site from an adjacent dry cleaning establishment.

Concentrations of ethylbenzene, toluene, xylenes, Methyl tert-butyl ether (MTBE), and tetrachloroethene (a/k/a perchloroethene, PCE) and associated breakdown products were detected in groundwater samples. Soil samples collected on site did not reveal the presence of volatile organic compounds (VOCs), benzene, toluene, ethylbenzene or xylenes (BTEX), or Poly-aromatic hydrocarbons (PAHs) at concentrations at or above the laboratory reporting limits. Several soil samples were analyzed for the presence of metals, and the results indicated that no metals were detected at concentrations at or above the Notification Criteria provided in the Georgia Rules for Hazardous Site Response (Chapter 391-3-19 - Appendix I).

1.3 PROJECT DESCRIPTION

This project will be performed in accordance with the Cooperative Agreement (BF-96432005-0) between US EPA and the City of Hinesville. The objective is to plan, perform, and complete a Brownfields petroleum cleanup at the Memorial Drive Site. The project tasks include source remediation by removal of three suspected underground storage tanks (USTs) and two hydraulic automobile lifts (if present on-site) and surrounding impacted soil, and groundwater remediation by monitored natural attenuation (MNA) or other means. Additional drilling, monitoring well installations, and sampling of soil and groundwater will be performed to establish sufficient monitoring of natural attenuation progress. Proposed groundwater sampling locations are indicated on Figure 2. If other means of remediation of groundwater become necessary, an analysis of cleanup alternatives will be prepared.

The scope of work is divided into the following major tasks:

- Preparation of plans required by the Brownfields program for City of Hinesville and US EPA approval;
- Source remediation including excavation of petroleum USTs, removal of a fuel dispenser island and associated piping, and excavation of surrounding impacted soil;
- Groundwater cleanup using corrective action plans to be submitted to City of Hinesville and Georgia Environmental Protection Division (GA EPD) for approval; and,
- Reporting of cleanup progress and completion.

These tasks are addressed in greater more detail in the project schedule on Figure 2. Proposed sample types, recommended analyses, and proposed analytical methods as prescribed by GA EPD guidance documents for UST closure and corrective action are listed in Table 1. The locations of confirmatory soil samples that will determine how much soil will be removed from the tank excavation are described in Section 2.1.1. Descriptions of field sampling equipment and onsite field analytical instruments are provided throughout Sections 3, 4, and 5 of the Sampling and Management Plan (SAMP). Detailed information about documents and records is provided in Section 1.6. Specialized training is discussed in Section 1.5.

Table 1 – Sample Types, Recommended Analysis, and Analytical Methods

Sample Source	Sample Purpose	Recommended Analysis	Analytical Methods
Tank Excavation	Soil for Disposal Characterization	Ignitability	1010
		Corrosivity pH	9040B
		Reactivity	SW-846 7.3.3.2, 7.3.4.2
		TCLP Volatiles	1311/8260B
		TCLP Semivolatiles	1311/8270C
		TCLP Metals	1311/6010B/7000/7470
Tank Excavation	Soil for Confirmation Sampling	BTEX	5035-8260B
		PAHs	8270C
Potential Hydraulic Lift Excavation	Soil for Confirmation Sampling	PCBs	8082
Water Well	Groundwater Monitoring	BTEX / VOCs	5030-8260B
		PAHs	8270C
Lake or Stream	Surface Water Monitoring	BTEX	5030-8260B
		PAHs	8270C

1.4 QUALITY OBJECTIVES AND CRITERIA

Data quality objectives (DQOs) are qualitative and quantitative statements developed by data users to specify the quality of data from field and laboratory data collection activities to support specific decision or regulatory actions. The DQOs describe what data are needed, why the data are needed, and how the data will be used to address the problem being investigated. DQOs also establish numeric limits for data to allow the user (or reviewers) to determine whether data collected are of sufficient quality for use in the intended application. EPA Documents QA/G-4 (*Guidance for the Data Quality Objectives Process*) and QA/G-4HW (*Guidance for the Data Quality Objectives Process for Hazardous Waste Sites*) were used in developing the DQOs for this project. Table 2 below outlines the project specific DQOs.

Table 2 – Project Specific Data Quality Objectives for the Memorial Drive Site

Data Quality Objective	Project Specific Action
1. Problem statement	<p>Previous assessment revealed contamination resulting from a release of petroleum products from USTs to groundwater originating from a former gasoline station at the project site. Groundwater at the site and surrounding parcels has been impacted. Concentrations of ethylbenzene, toluene, and xylenes were detected, as well as other VOCs that may be related to an off-site source. Soil impacts in the immediate area of the USTs are unknown and must be investigated upon removal of the USTs. Cleanup of the site will facilitate mixed-use redevelopment already underway in the neighborhood.</p> <p>The objective is to plan, perform, and complete a Brownfields petroleum cleanup at the Memorial Drive Site. The site material will be characterized for disposal. Soil and groundwater analytical data will be generated to support cleanup actions at the site.</p> <p>This project is a joint effort between the US EPA, the City of Hinesville, and Earth Tech. Thus, the planning team members are the representatives from these organizations.</p>

Data Quality Objective	Project Specific Action
2. Identify the decisions	<p>Evaluate potential health risks and environmental impacts that resulted from the underground release of petroleum products and determine compliance of soil and groundwater to GA EPD cleanup standards. The anticipated clean-up levels for this site are as follows:</p> <p>Benzene: Soil 120 micrograms per kilogram ($\mu\text{g}/\text{Kg}$), Groundwater 5 micrograms per liter ($\mu\text{g}/\text{L}$), Surface Water 71 $\mu\text{g}/\text{L}$</p> <p>Toluene: Soil 500,000 $\mu\text{g}/\text{Kg}$, Groundwater 1,000 $\mu\text{g}/\text{L}$</p> <p>Ethylbenzene: Soil 140,000 $\mu\text{g}/\text{Kg}$, Groundwater 700 $\mu\text{g}/\text{L}$</p> <p>Xylenes: Soil 700,000 $\mu\text{g}/\text{Kg}$, Groundwater 10,000 $\mu\text{g}/\text{L}$</p>
3. Identify inputs to the decision	<p>Samples used to characterize materials for disposal will be analyzed to determine if concentrations of analytes exceed regulatory limits for hazardous waste characteristics. Data from soil and groundwater sampling events will be compared to GA EPD cleanup standards to verify that the site is remediated.</p>
4. Define boundary of project	<p>All three tanks are 1000-gallons. The size of this tank pit leads us to estimate that up to but not exceeding 14 soil samples and 7 groundwater samples will be collected and analyzed by US EPA methods for the tank excavation. It was discovered that the hydraulic lifts have already been removed, so no sampling is necessary in the lift areas. If the target clean-up levels are not met and additional excavation is deemed necessary, as many as 12 soil samples may be collected for re-confirmatory analysis purposes. Vertical soil sampling will continue (above the water table) until levels meet the applicable criteria in the Georgia UST Regulations. If the water table is encountered before soil contamination is vertically delineated to the target clean-up levels, excavation will be discontinued.</p> <p>Figure 3 indicates the approximate boundaries of the Memorial Drive Site, the location of the USTs, and the proposed monitoring well locations.</p>

Data Quality Objective	Project Specific Action
5. Develop the decision rule	<p>A review of analytical results will be performed to determine if materials characterized for disposal are subject to RCRA. If the material is determined to be a hazardous waste then it should be managed under Subtitle C. If the material is non-hazardous then it should be managed as a non-RCRA hazardous waste.</p> <p>If any one soil sample result exceeds GA EPD cleanup standards, then additional soil remediation will be warranted. If any groundwater sample result exceeds GA EPD cleanup standards, then additional groundwater remediation will be warranted.</p>
6. Specify limits on decision errors	<p>The null hypothesis is that the site is contaminated. The probability of false positive decision errors (erroneously rejecting the null hypothesis or deciding that the site is clean when it is not) will be minimized as much as possible. Errors that increase the probability of leaving soils in place when they contain substances at levels greater than the action level – false positive decision errors – will be considered acceptable no more than 10% of the time. Errors that increase the probability of cleaning up soils when that action is not required – false negative decision errors – will be considered acceptable only 10% of the time.</p> <p>Measurement errors can occur during sample collection, handling, preparation, and analysis when standard procedures as described in the QAPP are not followed. These will be minimized through the use of standard operating procedures and non-conformance reporting as addressed in Section 3.1 titled “Assessments and Response Actions”.</p>
7. Optimize the Design for Obtaining Data	<p>The one sample t-test will be used to compare the overall sample results to the applicable action level. If any result exceeds the action level then the sample will be considered a hazardous waste and disposed of appropriately. If the results are below the action level then the sample will be disposed of as non-hazardous.</p> <p>The PARCC for this project are detailed in this QAPP in Section 1.4.2, titled “Measurement of Data Quality”.</p>

1.4.1 General Description of DQOs

The usability of the data is matched to the DQOs. A number of factors relate to the quality of data and sample collection methods and are as important to consider as methods used for sample analysis. Following the project SAMP for both sample collection and analysis reduces sampling and analytical error. Complete chain-of-custody documentation, and adherence to required sample preservation techniques, holding times, and proper shipment methods ensure sample integrity. Earth Tech employs trained, experienced technicians capable of all forms of sampling techniques.

By utilizing trained personnel and following detailed site-specific sampling procedures, Earth Tech will maintain the data quality at the site level. Obtaining valid and comparable data also requires adequate QA/QC procedures and documentation, as well as established detection and control limits.

Valid data is defined as results that are generated when the instrument and quality controls are within the designated limits. Data validation procedures are designed to systematically review data quality and to assign qualifiers that indicate limited usability of other data.

1.4.2 Measurement of Data Quality

Earth Tech’s QA objective is to ensure that environmental monitoring data of known and acceptable quality are collected to sufficiently characterize materials for disposal and to support cleanup actions at the site. To meet this goal, the following quality control parameters will be evaluated: precision, accuracy, representativeness, comparability and completeness (PARCC).

These parameters will be evaluated by the laboratory during analyses and will be evaluated by Earth Tech during the final data validation. The precision and accuracy criteria listed in Appendix A will be used if the laboratory has not generated in house precision and accuracy criteria. Table 3 lists the frequency of field/laboratory control samples to be collected for analysis.

Table 3 – Field Sampling Summary

Analytical Parameters	Matrix	Subtotal Samples	Trip Blanks *	Field Blanks	Equipment Blanks **	Duplicate Samples	MS/MSD Samples	Total Field Samples
VOC (8260B)	Water and soil	21 or more	1 per cooler	1 per day	1 per day	1 per 20	1 per 20	28 or more
PAHs (8270C)	Water and soil	21 or more	NA	1 per day	1 per day	1 per 20	1 per 20	28 or more
PCBs (8082)	Soil	10 or more	NA	1 per day	1 per day	1 per 20	1 per 20	14 or more
TCLP-VOC (1311/8260B)	Soil	1	NA	NA	NA	NA	NA	1

Analytical Parameters	Matrix	Subtotal Samples	Trip Blanks *	Field Blanks	Equipment Blanks **	Duplicate Samples	MS/MSD Samples	Total Field Samples
TCLP-BNA (1311/8270C)	Soil	1	NA	NA	NA	NA	NA	1
TCLP-Total Metals	Soil	1	NA	NA	NA	NA	NA	1

* Trip blanks will be required for environmental samples but not for waste samples

** Rinsate blanks will be performed at a rate of one per day per piece of equipment that has been decontaminated. If dedicated equipment is utilized, there will not be a need for a rinsate blank.

Precision

Precision is a measure of mutual agreement among individual measurements of the same property under prescribed and similar conditions.

Precision of the measurement data for this project will be based upon duplicate analyses (replicability), control sample analyses (repeatability), and results for duplicate field samples (sample replicability). A field duplicate is defined as a sample that is divided into two equal parts for the purpose of analysis. Field duplicates will be collected for all sample matrices and analyzed for all parameters. Discretely sampled field duplicates are useful in determining sampling variability. However, greater than expected differences between duplicates may occur because of variability in the sample material. Field duplicates shall be used as a quality control measure to monitor precision relative to sample collection activities.

Analytical precision shall be evaluated by using matrix spike/matrix spike duplicates (MS/MSDs), laboratory control samples (LCSs) or by using sample duplicates. Precision is calculated in terms of Relative Percent Difference (RPD).

RPDs must be compared to the laboratory-established RPD for the analysis. Precision of duplicates may depend on sample homogeneity. The analyst or his/her supervisor must investigate the cause of data outside stated acceptance limits. Corrective action may include recalibration, re-analysis of QC samples, sample re-analysis, or flagging the data as suspect if problems cannot be resolved.

Accuracy

Accuracy is the degree of agreement of a measurement or average of measurements with an accepted reference or "true" value. Accuracy is a measure of bias in the system.

Accuracy of the measurement data will be assessed and controlled as follows. Results for blanks, matrix, laboratory control, and surrogate spikes will be the primary indicators of accuracy. These results will be used to control accuracy within acceptable limits by requiring

that they meet specific criteria. As spiked samples are analyzed, spike recoveries will be calculated and compared to pre-established acceptance limits.

Acceptance limits will be based upon previously established laboratory capabilities for similar samples using control chart techniques. In this approach, the control limits reflect the minimum and maximum recoveries expected for individual measurements for an in-control system. Recoveries outside the established limits indicate some assignable cause, other than normal measurement error, and the need for corrective action. This includes recalibration of the instrument, re-analysis of the QC sample, re-analysis of the samples in the batch, or flagging the data as suspect if the problem cannot be resolved. Recovery of matrix spikes may depend on sample homogeneity.

Representativeness

Representativeness expresses the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition. The characteristics of representativeness are usually not quantifiable. Subjective factors to be taken into account are as follows:

- Degree of homogeneity of a site
- Degree of homogeneity of a sample taken from one point in a site
- Available information on which a sampling plan is based

Field duplicates, as defined under precision, are also used to assess representativeness. Two samples collected at the same location and at the same time are considered to be equally representative of this condition, at a given point in space and time. To maximize representativeness of results, sampling techniques, sample size, and sample locations will be carefully chosen to provide laboratory samples representative of the site and the specific area. For instance, soil samples are likely to be less homogenous than liquid waste samples, and thus it is important for the sampler and analyst to follow Standard Operating Procedures (SOPs) when collecting soil samples. Samples exhibiting obvious stratification or lithologic changes should not be used as replicates.

Within the laboratory, precautions are taken to extract from the sample container an aliquot representative of the whole sample. However, samples requiring analysis of volatile organic compounds should not be mixed.

Comparability

Comparability expresses the confidence with which one data set can be compared to another data set measuring the same property. Comparability is ensured through the use of established and approved sample collection techniques and analytical methods, consistency in the basis of analysis, consistency in reporting units, and analysis of standard reference materials.

The use of standard methods to collect and analyze samples, along with instruments calibrated against Standard Analytical Reference Materials which are National Institute for Standards and Technology traceable standards, will also ensure comparability.

Comparability also depends on the other data quality characteristics. Only when data are judged to be representative of the environmental conditions, and when precision and accuracy are known, can data sets be compared with confidence.

Completeness

Completeness is a measure of the amount of valid data obtained from a measurement system compared to the amount expected to be obtained under controlled laboratory conditions.

Data completeness is a measure of the extent to which the database resulting from a measurement effort fulfills objectives for the amount of data required. Completeness is defined as the valid data percentage of the total tests requested.

Valid analyses are defined as those where the sample arrived at the laboratory intact, properly preserved, in sufficient quantity to perform the requested analyses, and accompanied by a completed chain-of-custody form. Furthermore, the sample must be analyzed within the specified holding time and in such a manner that analytical QC acceptance criteria are met.

1.5 SPECIAL TRAINING REQUIREMENTS/CERTIFICATION

Personnel assigned to the project, including field personnel and subcontractors, will be qualified to perform the tasks to which they are assigned. An OSHA-designated competent person must be onsite to perform the required daily inspections of equipment and/or operations. The competent person may be an Earth Tech or subcontractor employee. Each staff member will have the education, training, technical knowledge, and experience to perform assigned functions. In addition, all personnel performing field activities at the site will be trained in accordance with Earth Tech procedure SH&E 114, *Safety Training Programs*. For this project, training will include the requirements specified in the following:

1. SH&E 202, *Safety Meetings*
2. SH&E 112, *Respiratory Protection Program*
3. SH&E 115, *Hazard Communication Program*
4. SH&E 301, *Hazardous Waste Operations (HAZWOPER)*

Earth Tech personnel and subcontractors must have successfully completed training meeting the provisions established in 29 CFR 1910.120 (e)(2) and (e)(3) (40-hour initial training). As appropriate, personnel also must have completed annual refresher training in accordance with 29 CFR 1910.120 (e)(8); each person's most recent training course must have been completed within the previous 365 days. Personnel must also have completed a physical exam in accordance with the requirements of 29 CFR 1910.120 (f), where the medical evaluation

includes a judgment of the employee's ability to use respiratory protective equipment and to participate in hazardous waste site activities. Training documentation for Earth Tech personnel is kept in personnel files maintained by the Human Resource Representative in the Roswell office. Subcontractors will be required to provide training documentation to Earth Tech. This documentation will be kept by the site manager during field activities and in the project file.

Training will be provided, as needed, to achieve initial proficiency; maintain proficiency; and adapt to changes in technology, methods, or job responsibilities. The site-specific training will be performed prior to the worker performing the subject task or handling the impacted materials and on an as-needed basis thereafter. Training will be conducted by the SSO (or his/her designee) and will be documented on the form attached to SH&E 202, *Safety Meetings*. In addition, field personnel will receive an orientation to the appropriate work plans, including this QAPP and the health and safety plan, as appropriate to their responsibilities before participation in site activities.

Training of field personnel will be provided by the Earth Tech Project Manager or a qualified designee. Training of laboratory personnel will be the responsibility of the subcontractor laboratory. Copies of personnel training and qualification records will be kept on file in the form of resumes and training and orientation records. Subcontractor records will be reviewed during audits. Earth Tech records maintenance is the responsibility of the Project Manager.

1.6 DOCUMENTATION AND RECORDS

Earth Tech is committed to providing scientifically sound and, where necessary, legally defensible data of known and documentable quality. Legally defensible data are data which will stand against reasonable adversarial inquiry. Data must be documented so the entire process can be reconstructed. Project files must be organized so the project events can be reconstructed. This includes field reports, field and analytical documentation, data management, and validation. The Project Manager and field personnel are responsible for the completeness and preservation of site records. Each individual who handles a working document in the course of performing an assigned activity shall protect the records against destruction, loss, or defacement.

1.6.1 Field Documentation

Information pertaining to environmental samples will be recorded in the field. Documentation shall consist of field logbooks, field data sheets, sample labels and chain-of-custody records. Field logbooks, data sheets, photographs, and chain-of-custody procedures are discussed in the SAMP.

Daily Logs and Data Sheets

All information pertinent to a field survey and/or sampling will be recorded on appropriate data sheets and/or in a project logbook which will be a waterproof, bound book with consecutively numbered pages. Entries in the logbook will be made in waterproof ink, and will include the following:

- Name and address of field contact (on logbook cover)
- Names and affiliations of personnel on site
- Date and time
- General description of each day's field activities
- Documentation of weather conditions during sampling
- Location of sampling

For each sample the following information will be provided, as appropriate:

- Sample distribution
- Observations of sample or collection environment, if needed
- Identification of sample device
- Field measurements made such as air monitoring, etc.
- Sequence of collection
- Type of sample matrix
- Estimated volume of liquid
- Date and time of collection
- Field sample identification number
- Sampler's name
- Preservatives used

Unused portions of the logbook will be crossed out. The bottom of each page in the logbook will be signed and dated by the person making the entries.

In addition to the information entered into the logbook, data sheets developed by Earth Tech for specific field procedures will be completed, as appropriate. These include Borehole Log, Well Completion Log, Potentiometric Level Measurement Form, Well Development/Purge Log, Groundwater Sampling Record, Dissolved Oxygen Measurement, Slug Test Data Sheet, Soil/Sediment Sampling Record, Decontamination Record, and Equipment Calibration Daily Logs. All data sheets will be completed, signed and dated by personnel entering the information and checked for completeness and accuracy by the Project QA Manager or his/her designee.

Corrections to Documentation

All original data recorded in field logbooks, or in custody records, as well as other data entries, will be written with waterproof ink. If an error is made on the document, corrections will be

made simply by crossing a single line through the error and entering the correct information. All corrections will be initialed and dated.

Photographs

Photographs, if taken, will be recorded in the appropriate logbook section or in additional sections, as needed. Information to be recorded includes:

- Roll and frame number
- Time and date
- Photographer
- Location
- Subject
- Significant features
- Names of any personnel included in the photograph

When photographs are developed, all pertinent information will be transferred to the back of the photographs.

If a digital camera is used to take photographs then the following information should be included in the logbook and on the back of any digital prints:

- Time and date
- Photographer
- Location
- Subject
- Significant features
- Names of any personnel included in the photograph

1.6.2 Laboratory Documentation and Records

To provide scientifically sound, legally defensible data of known and documentable quality, data must be documented so that the analytical process can be reconstructed, and project files must be organized so that project events can be reconstructed if necessary. The laboratory is accountable for the completeness and accuracy of information, including data that demonstrate the laboratory's ability to perform specific analyses.

Documentation

Data reduction calculations used for this project are typically included on standard reporting forms developed by the laboratories and associated with each individual method or groups of methods.

Calculations not covered on the standard reporting forms include computer-based data reduction programs. The laboratory is responsible for maintaining a listing of these data reduction programs and for being able to demonstrate their validity.

All data will be calculated and reported in units consistent with other organizations reporting similar data to allow comparability of data sets.

All QC information will be recorded in notebooks and printouts in the same format used for sample results. It is the analyst's responsibility to check the QC information against limits for the analysis. When analysis of a QC sample shows that the analysis of that batch of samples is not in control, the analyst will immediately bring the matter to the attention of the supervisor. The supervisor will, if necessary, consult with the Project QA manager and/or Project Manager to determine whether the analysis can proceed, selected samples should be rerun, or specific corrective action needs to be taken before analyzing additional samples. Out-of-control analyses must be documented by the supervisor. The analyst or supervisor will file a corrective action report with the Project QA manager.

Earth Tech will require documentation that includes sample results, sample specific detection limits, calibration checks, response factors, surrogate recoveries, internal standard areas, duplicates, and matrix spike recoveries, as applicable to a specific analytical method.

1.6.3 Data Management

Laboratory reports will be reviewed by the analyst, the analytical supervisor, and the Laboratory Project Manager. Analytical and field QC will be documented, reviewed by the Project Manager and Project QA manager, and included in the final report. Final laboratory reports are expected to be turned around within 10 business days of sample receipt.

Data Integrity

Data integrity during collection and reporting of data will be assured through use of approved data forms and bound logbooks. The forms and logbooks will be signed and dated and checked by another equally competent person. Changes to documentation must be dated and initialed and files of data secured. The same principles will be followed for both field and laboratory data. The integrity of databases will be assured by limited access. Corrective actions will be implemented and documented when data or instrumentation does not meet criteria.

Data Archive

Data storage and documentation will be maintained using logbooks and data sheets that will be kept on file. All computer-acquired/generated raw data are stored on magnetic tape, floppy disk, or other required media and the paper hard copies are kept on file in job folders at the

laboratories for 5 years. The central file for the sampling and analytical effort will be maintained by Earth Tech for a period of 10 years after the final report.

1.6.4 Data Reporting

Field data reporting includes bound notebooks and data sheets, such as borehole logbooks, well completion logs, and field parameter stabilization forms. Field personnel record all on-site measurements and field observations, including all pertinent sampling information, equipment calibration, etc. Use of chain-of-custody forms ensures that the sample is controlled at all times and transfer of control is properly documented.

Laboratory data reporting is an extensive activity beginning with a report of reviewed data compiled into a complete data package and finalized by the laboratory project manager and QA manager review and approval. Upon completion of data review at all levels and subsequent clerical preparation and final typographical review, reports are signed by the laboratory project manager and/or designate. Reports from the laboratory will include the following:

- The original signed chain-of-custody form and cooler receipt form documenting receipt in laboratory;
- A cross-reference of field sample number to laboratory sample number;
- A cross-reference to correlate all applicable laboratory QC samples with the appropriate field sample(s);
- A glossary to define the symbols and terms used in the laboratory report;
- Sample collection, extraction or preparation, and analysis dates for each sample;
- Practical quantitation limits and dilution factors for each sample;
- A sample data summary (the analytical results for the sample) reporting all analytes as a detected concentration or as less than the detection limit;
- Results of initial and continuing calibrations clearly correlating the sample analyses with the calibration check samples;
- A QC summary report, providing data on any method blanks, check samples, surrogate recoveries, laboratory duplicates, matrix spikes, matrix spike duplicates, and laboratory control samples applicable to the particular method. The QC summary report will also list laboratory control limits; and
- A case narrative, which shall discuss the corrective actions taken whenever laboratory control limits are exceeded, and any other problems that impact data quality.

2.0 MEASUREMENT/DATA ACQUISITION

2.1 SAMPLING PROCESS DESIGN

The sampling program for the site is designed to properly characterize excavated soil and monitor groundwater to support the Brownfields petroleum cleanup. Design of the sampling program is based on recommendations in GA EPD guidance documents for UST closure and corrective action.

The type and number of samples expected to be collected per sampling location are provided in Table 3 (Field Sampling Summary) of this QAPP along with analytical method numbers. Method detection limits and QC acceptance criteria for each analytical method are provided in Appendix A (Precision and Accuracy Criteria). Requirements for sample containers, preservation techniques, holding times, and minimum volume requirements are presented in Table 2 of the SAMP.

2.1.1 Soil Samples from UST and Potential Hydraulic Lift Excavation

The following soil samples will be collected from the tank and lift removal areas:

- One tank bottom sample per tank from approximately 2 feet below the estimated tank bottom at the fill-port end of the excavation;
- One lift bottom sample per lift from approximately 2 feet below the estimated lift bottom at the end of the excavation;
- One side sample every 30 linear feet along the base of the sides after overexcavation (within 1 foot of the bottom of the excavation);
- One bottom sample per 200 square feet along the bottom of the overexcavated area; and
- One waste characterization sample from the stockpile of excavated soil.

The following soil samples will be collected from the piping trench and former dispenser area:

- One trench sample every 25 linear feet of piping from worst-case locations such as elbows and other line fittings; and
- One dispenser sample every 25 linear feet of dispenser island.

2.1.2 Groundwater Samples

Monitoring wells for groundwater sample collection will be installed to adequately determine the progress of groundwater cleanup and determine the source of other VOCs previously detected. One “worst-case” monitoring well will be installed within 2 feet of the UST pit in the estimated downgradient direction of groundwater flow. Because the dispenser island is within 25 feet of the anticipated location of the “worst-case” monitoring well, it is expected that one monitoring well will be sufficient to characterize the immediate source area. Two monitoring wells will be

installed at up gradient locations, and three additional monitoring wells will be installed in the estimated downgradient direction of groundwater flow to determine the potentiometric surface at the site and cleanup progress.

Samples will be collected from the six monitoring wells semiannually for 2 years to observe the trend of natural biodegradation effects associated with a monitored natural attenuation petroleum cleanup of groundwater.

2.2 SAMPLING METHODS

Sampling methods and requirements are described in the SAMP prepared separately for this project. The SAMP includes procedures for sample handling and custody, analytical methods, QC activities, instrument testing, inspection, and maintenance, and instrument calibration and frequency.

On-site support facilities are not needed for each sampling method.

2.3 SAMPLE HANDLING AND CUSTODY

Detailed descriptions of sample handling and chain-of-custody procedures are provided in Section 2.2 of the SAMP.

2.4 QUALITY CONTROL

Quality control acceptance criteria for each analyte are provided in Appendix A of this QAPP. Acceptance criteria are provided for accuracy and precision in water and soil samples. Comparability, completeness, and representativeness requirements for field samples and analytical results are discussed in Section 1.4.2 of this QAPP.

Corrective actions to be implemented if quality control criteria are not met during the course of the project are provided in the next to last paragraph of Section 1.6.2 on page 19 of this QAPP.

2.5 INSTRUMENT/EQUIPMENT TESTING, INSPECTION, MAINTENANCE, AND CALIBRATION

Field equipment and instruments will be tested and inspected at the beginning of each workday by the field team to which the equipment/instruments have been assigned. Calibrations will be performed according to the manufacturer's instructions, as set forth in the instruction manual provided with each piece of equipment. The general calibration procedures are as follows.

Organics vapor monitoring equipment will be calibrated twice daily (prior to use in the morning and afternoon) at a minimum, and more frequently if necessary, to obtain reliable

measurements of potential monitoring well emissions. Calibration will be performed using certified isobutylene (100 ppm) and zero air span gases supplied in disposable containers.

Water quality monitors, such as the Horiba U-22 and U-10, will be calibrated daily at a minimum, and more frequently if necessary, to obtain reliable measurements. Calibration will be performed according to the manufacturers' instructions while also using the appropriate AutoCal calibration solution with the following standards: pH 4.0, turbidity 0 NTU, and conductivity 4.46 mS/cm.

Water level indicators and oil/water interface probes are not calibrated in the field, but will be maintained in a clean condition and good working order and should be tested twice daily (prior to use in the morning and the afternoon) at a minimum.

Field maintenance of instruments will only consist of cleaning, drying, and light repair. Instruments needing more than that level of maintenance/repair will be returned to the instrument supplier, and a properly working replacement will be obtained in a timely manner.

Documentation of field calibration and testing for all field measurement instruments will consist of recording the instrument model number and serial number in the field team logbook for each calibration. The lot number and expiration dates of calibration standards will be recorded in the field logbook when documenting instrument calibration. This information includes date, time of day, person/persons performing the calibration, and general weather conditions which might affect the instrument performance. Table 4 provides lists of solvents, reagents, buffer solutions and other consumable supplies required for the project.

Table 4 – List of Consumable Supplies and Field Equipment

Decontamination	Sampling Activities
Alconox®	AutoCal Solution
Liquinox®	Horiba U-10 or U-22
Isopropanol	AutoCal Solution for Horiba Calibration
Distilled Water	Stainless Steel Bowls/Spoons
Plastic Sheetting	Electric submersible and /or peristaltic pump
Aluminum Foil	Polyethylene tubing for sample purging
Organic Free Water	Polyethylene bailers and nylon rope
Brushes	HCL, methanol, NaOH preserved 40ml sample vials
Buckets	Nitric acid preserved plastic containers
	Amber liter sample containers
	Gasoline powered generator for pumps
	Gasoline for generator
	Coolers

	Miscellaneous: Packing tape, forms, field notebooks, tags, seals, resealable baggies, and ice Camera
Field Screening	Health and Safety
Isobutylene gas Lab Grade Zero Air Photovac 2020 Minirae OVA 128	Nitrile gloves Hard Hat Safety glasses Tyvek Overalls and Tape Leather/Rubber Boots Respirators

2.6 DATA ACQUISITION REQUIREMENTS (NON-DIRECT MEASUREMENTS)

Previously obtained data, published or unpublished, may be available in computer databases, literature files, or from other sources. The acceptance of the data for use on the project must be preceded by an evaluation as to the validity of the data. This evaluation must be based on information regarding the data validation procedures used on the data, and any qualifiers assigned; or, if no data validation was performed, a review of available documentation in regards to the data. Based on available information, a determination will be made as to the usability of the data and any limitations on its use.

3.0 ASSESSMENT AND OVERSIGHT

3.1 ASSESSMENT AND RESPONSE ACTIONS

The Project Manager, field supervisors and sampling team members will ensure that procedures are followed as specified in project plans and that measurement data meet the prescribed acceptance criteria. In the event a problem arises, it is imperative that prompt action be taken to correct the problem.

A nonconformance exists if there is a deviation from or noncompliance with contract specifications, the QA program, approved procedures, or project plans. Nonconformances also include major errors in documented analysis, data or results, and deficiencies in documentation or any other aspect of the project that affects quality. Personnel who identify a nonconformance should report the condition on a Nonconformance Report (NCR) and distribute the NCR to the Project Manager. The sample numbers of the samples affected by the nonconformance should be noted on the NCR. The Project Manager and the Project QA Manager will review the NCR to determine if ongoing work should be stopped; and if the nonconformance involves a major deviation from the contract or approved project plans, or may significantly impact the cost or schedule of the work, in which case the nonconformance will be reported to the City of Hinesville; and if the nonconformance has any impact on previously obtained data or reports submitted to City of Hinesville. If impacted, the Project Manager will note the impact in the "Remarks" section of the NCR and notify in writing all individuals and organizations that may be affected by the nonconformance and resulting data. The evaluation will be documented on the NCR.

The Project Manager will recommend corrective action to resolve the nonconformance and the recommended corrective action will be reviewed and approved by the Project QA Manager. The approved corrective action will be implemented by appropriate personnel, and reviewed and approved by the Response Manager and QA Manager. A copy will also be forwarded to the POC.

System Audits

There are no planned periodic audits and surveillance activities scheduled during field operations because of the short duration of actual onsite activities. However, the project manager, project safety, and QA manager may perform unannounced field inspections to verify that project requirements such as the following are being met:

- site health and safety procedures;
- equipment decontamination;
- specific field procedure methods (i.e., sampling protocols, equipment calibration, decontamination, etc.);
- field documentation;

- field measurements;
- sample collection/documentation (i.e., COC); and
- sample packing/shipping.

External audits of operations may be performed by regulatory agencies and the City of Hinesville at the discretion of the organizations. Earth Tech QA personnel will assist in all external audits of field and office activities.

There are no planned audits scheduled for the contract laboratory because of the short duration of the project. However, the Project QA manager may perform unannounced inspections to verify that project requirements are being met. Upon receipt of each laboratory data package, the Project QA Manager will review each package for completeness and adherence to the quality control protocol established for each type of analysis.

3.2 REPORTS TO MANAGEMENT

Upon receipt of each laboratory data package, the Project QA Manager will review each package for completeness and adherence to the quality control protocol established for each type of analysis. A Quality Assurance Summary Report (QASR) detailing the sampling and analysis status and any QA/QC problems will be prepared by the Project QA Manager after receipt of the field and laboratory reports and review of the analytical data reports. The QASR will be submitted to the Project Manager. As appropriate, each QASR shall contain information on the status of the project and any quality problem. This may include:

- Activities and general program status;
- Calibration and QC data problems;
- Unscheduled maintenance activities;
- Corrective action activities;
- Status of any unresolved problems;
- Assessment and summary of data completeness; and
- Any significant QA/QC problems and recommended and/or implemented solutions not included above.

4.0 DATA VALIDATION AND USABILITY

This section presents the methods for data validation, documentation, and report format. All analytical data generated by the laboratory will be extensively reviewed prior to report generation, to assure the validity of the reported data. This internal data review process will consist of data generation, reduction and a minimum of three levels of data review. In each stage, the review process will be documented using an appropriate checklist form that is signed and dated by the reviewer. The analyst who generates the analytical data has the prime responsibility for data correctness and completeness. Each step of this review process involves evaluation of data quality based on both results of the QC data and the professional judgment of those conducting the review. This application of technical knowledge and experience to the evaluation of data is essential in ensuring that data of known quality are generated consistently. All data generated and reduced shall follow well documented in-house laboratory protocols.

4.1 DATA REVIEW, VALIDATION, AND VERIFICATION REQUIREMENTS

4.1.1 Level 1, Technical Data Review

Each laboratory analyst will review his/her work. The review at a minimum will include the following:

- sample preparation information is correct and complete;
- analysis information is correct and complete;
- the appropriate SOPs have been followed;
- analytical results are correct and complete;
- QC samples are within established control limits;
- special sample preparation and analytical requirements have been met; and
- documentation is complete (any abnormalities have been documented and forms complete, holding times documented, etc.).

Level 1 data review will be documented by using a checklist, signed and dated by the reviewer.

4.1.2 Level 2, Technical Review

The Level 2 review will be performed by a supervisor or data review specialist, whose function is to provide an independent review of the data package. This review will be conducted according to established procedures as follows:

- all appropriate laboratory SOPs have been followed;
- calibration data are scientifically sound, appropriate to the method, and completely documented;
- QC samples are within established guidelines;
- qualitative identification of sample components is correct;
- quantitative results are correct;

- documentation is complete and accurate (any anomalies have been documented and forms completed, etc.);
- the data are ready for incorporation into the final report; and
- the data package is complete and ready for data archive.

Level 2 review will be structured so all calibration data and QC sample results are reviewed and all of the analytical results from at least 10% of the samples are checked back to the sample preparation and analytical bench sheets. If no problems are found with the data package, the review is complete. If any problems are found with the data package, an additional 10% of the sample results will be checked back to the sample preparatory and analytical bench sheets. This cycle then repeats until either no errors are found in the data checked or all data has been checked. All errors and corrections noted will be documented. Level 2 data review will also be documented on a checklist with the signature of the reviewer and date of review.

4.1.3 Level 3, Administrative Data Review

Level 3 review is performed by the Laboratory QA Manager at the laboratory. This review will be similar to the review as provided in Level 2 except that it will provide a total overview of the data package to ensure its consistency and compliance with project objectives. All errors noted will be corrected and documented. Level 3 data review will also be documented on a checklist with the signature of the reviewer and date of the review.

4.1.4 Laboratory Data Reports

Definitive data are generated using rigorous analytical methods, such as approved US EPA reference methods. Data are analyte-specific, with confirmation of analyte identification and concentration. Methods produce tangible raw data in the form of printouts or computer-generated electronic files. Waste characterization laboratory reports will be required to contain a results summary for each sample. The following QA/QC elements will be included with the laboratory report:

- Sample results summary;
- Cross reference sample ID (laboratory/client);
- Sample holding times;
- Detection limits and qualifiers;
- Internal and external chain of custody documentation;
- Initial and continuing calibration data;
- Interference check sample (ICP);
- ICP serial dilution;
- Initial and continuing blank data (inorganics);
- Method blanks (instrument, extraction, etc.);
- Surrogate spike data with control limits;
- Matrix spike/matrix spike duplicate with control limits (organics);
- Matrix spike and duplicate with control limits (inorganics);
- Laboratory Control Sample with control limits;

- Internal standard area count and retention time;
- GC/MS tuning criteria;
- Second column confirmation data;
- Raw data;
- A case narrative to include cleanup and dilution procedures and interference's encountered; and
- Performance Evaluation samples (when required).

4.2 DATA VALIDATION AND VERIFICATION METHODS

Data review is performed both on field data sheets and laboratory data packages. Field data are checked for documentation of completeness in data sheets and in logbooks, adherence to sample collection and testing procedures, inclusion of required field QC samples, correct preservation of samples, and complete and correct chain-of-custody forms with signature and date at each transfer of custody.

Analytical laboratory data are checked for completeness of analysis as requested, inclusion of required frequency of QC samples, conformance to acceptance criteria for QC samples, adherence to holding times requirements, and second column confirmation where required. Nonconformances will be reviewed for acceptable corrective action for any out-of-control events.

Results from field duplicates are compared and RPD calculated, where possible. If one or both results are non-detects, the RPD cannot be calculated. For values less than five times the detection limit, RPDs will not be calculated. Results are evaluated based on whether corresponding values are close. RPDs below 40 percent for soils and 30 percent for waters represent good agreement. For higher RPDs or otherwise notable disagreement between the duplicates, nonhomogeneous samples are generally the cause. If every duplicate pair shows larger differences, sampling or analytical procedures need to be re-evaluated.

All laboratory and field blanks will be reviewed for blank contamination, and the sample results qualified in the event that the contamination level multiplied by five (10 for common laboratory contaminants) exceeds the sample result. In instances where more than one blank is associated with a given sample, qualifications should be based upon a comparison with the associated blank having the highest concentration of a contaminant. The results must not be corrected by subtracting any blank value.

Data validation is a systematic process of reviewing data, to ensure that the data is adequate for its intended use. Data will be reviewed and/or validated by the QA Manager. Data review and validation will be documented on special forms. The following bullets illustrate some of the parameters that will be utilized when determining the usability of the collected data:

- were the samples collected in the correct locations;
- were the samples collected using the appropriate sample containers and preservatives;

- were the samples handled properly and did they arrive at the laboratory at 4° C or less;
- were the samples recorded properly on the chain-of-custody form;
- was the correct digestion/extraction and analysis performed;
- were the QA/QC results within the established limits;
- were any problems noted by the laboratory; and
- were there any problems noted from the data validation?

Data validation guidelines specified in the following EPA documents will be followed as applicable to the requested report format:

- Quality Assurance/Quality Control Guidance For Removal Activities-Sampling, QA/QC Plan and Data Validation Procedures Interim Final, April 1990, OSWER Directive 9360.4-01
- EPA National Functional Guidelines for Organic Data Review; October 1999, EPA-540/R-99-008
- EPA National Functional Guidelines for Inorganic Data Review, February 1994b, EPA-540/R-94-013

Results will be annotated, as necessary, with the following qualifiers in accordance with the National Functional Guidelines:

- U The constituent was analyzed for, but was not detected above the level of the associated analytical reporting limit.
- J The analyte was positively identified; the associated numerical value is the approximate concentration of the analyte in the sample.
- UJ The analyte was not detected above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately and precisely measure the analyte in the sample.
- R The sample results are rejected due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the analyte cannot be verified.
- B The analyte was detected in the associated method blank; the associated numerical value is the approximate concentration of the analyte in the sample.

For projects where electronic data deliverables have been provided by the laboratory, the electronic data will be evaluated against the hard copy by the laboratory.

4.3 RECONCILIATION WITH USER REQUIREMENTS

Reconciliation of the data to the project specific DQOs is the process by which the data is assessed as to whether it answers the relevant questions concerning site conditions. The questions that will be addressed in the final site report are:

- Has the site been remediated?
- Is the disposal material considered hazardous or non-hazardous?

Data quality and validity will be assessed routinely during the project and upon completion of the project to ensure that the DQOs are achieved. The five data quality indicators that will be utilized to assess the usability of the analytical data are accuracy, precision, representativeness, comparability, and completeness.

Precision and accuracy measure the reproducibility of analytical results and the bias of a measurement method, respectively. QC limits for the precision and accuracy parameters have been established under EPA SW-846 method-specific QC requirements. These QC limits must be met by the laboratory for the data to be considered of acceptable quality.

4.3.1 Precision

Quality control procedures, such as control sample analyses and replicate analyses, represent the primary mechanism for evaluating measurement data variability or precision. Replicate analyses will be used to define analytical replicability, while results for replicate samples may be used to define the total variability (replicability) of the sampling/analytical system as a whole.

Control limits for control sample analyses, acceptability limits for replicate analyses, and response factor criteria are based upon precision in terms of RSD or RPD. The standard deviation is a measure of the average distance of an individual observation from the mean. It is usually denoted "s" and defined as:

$$SD = s = \sqrt{\frac{\sum_{i=1}^n x_i^2 - \left[\sum_{i=1}^n x_i\right]^2 / n}{n - 1}}$$

In this equation, n is the number of observations and x_i is the i th observation. The percent RSD is a measure of variability that is adjusted for the magnitude of the values in the sample:

$$\% RSD = \frac{\text{Standard Deviation}}{\text{Sample Mean}} \times 100$$

The percent RSD is used when the size of the standard deviation changes with the size of the mean. RPD is another measure of variability that is adjusted for the magnitude of the measured values. It is used only when the sample contains two observations, and is calculated as follows:

$$RPD = \frac{|X_1 - X_2|}{(X_1 + X_2)/2} \times 100$$

where X_1 and X_2 are duplicate sample measurement results. RPD is directly related to RSD for duplicate results by:

$$RPD = \sqrt{2 \text{ RSD}}$$

RSD is used for calculating precision of response factors in calibration procedures and acceptability of the calibration. RPD is calculated on sample duplicates or spike duplicates. RPDs cannot be calculated in the instance one or both values are non-detects. In these cases an evaluation will be made during data validation on the replication.

4.3.2 Accuracy

For surrogate compounds, laboratory control samples, and continuing calibration check standards, the calculation formula for percent recovery is:

$$\% \text{ Recovery} = \frac{\text{Concentration found}}{\text{Concentration spiked}} \times 100$$

A similar calculation used to determine the recovery of a spike concentration added to a sample. The percent spike recovery:

$$\% \text{ Spike recovery} = \frac{\text{Value of sample plus spike} - \text{Value of unspiked sample}}{\text{Value of spike added}} \times 100$$

The percent recovery is compared with the established control limits. For matrix spikes the assignable cause for recoveries outside acceptable limits may be, and often is, due to matrix interference.

If a matrix effect is confirmed by acceptable performance on the LCS, the data will be flagged. LCSs will be analyzed routinely to demonstrate that the analytical system is performing within acceptable limits. These LCS results will provide another measure of accuracy of the measurement data.

Blanks will make up one other group of QC checks that will address measurement bias. Instead of assessing and controlling overall accuracy, field and laboratory blanks will be used to control

bias due to sample contamination and to assess the extent to which this source of bias impacts the measurement results. Since sample contamination generally occurs at relatively low concentrations, contamination effects are most pronounced, in terms of relative error, for low-concentration samples.

The control limits for precision and accuracy established under SW-846 and EPA methodology guidelines will be used to identify outliers (data results outside the specific control limits). If outliers occur, the samples in question will be re-analyzed, if possible, or carefully evaluated on a case-by-case basis.

4.3.3 Representativeness

Representativeness expresses the degree to which sample data accurately and precisely reflect site conditions. Representativeness of the data is determined by:

- Comparing actual sampling procedures to those delineated in the field sampling plan;
- Comparing analytical results of field duplicates to determine the spread in the analytical results; and
- Examining the results of QC blanks for evidence of contamination - contamination may be cause for qualification of the affected samples.

The data validation process will determine whether any results will be classified as questionable or qualified by any of these criteria.

4.3.4 Comparability

Comparability expresses the confidence with which one set of analytical data may be compared with another. Comparability is maintained by being aware of previous analytical work and through the use of standard analytical methods and units such as:

- Demonstrating traceability of standards to NIST or EPA sources;
- Use of Standard and Approved methodologies;
- Standardized units of measure; and
- Participation in interlaboratory studies to demonstrate laboratory performance.

The laboratory will use all of these measures to ensure the data produced are of the highest quality and comparable to that of other quality laboratories in the industry.

4.3.5 Completeness

Completeness is a measure of the valid data obtained from an analysis expressed as the percentage of the total data that should have been obtained.

$$\% \text{ Completeness} = \frac{\text{Amount of valid data obtained}}{\text{Total amount of valid data expected}} \times 100$$

During data assessment, an evaluation will be made of whether restrictions on data usability will permit the use of the data for specific purposes identified during the DQO process. If DQOs state that the data will only be used for screening purposes, estimated values can be used without restrictions, and even unusable data may provide useful information. If DQOs indicate that a portion of the data will be used for confirmation of clean-up goals, any restrictions on the data would seriously impact their usability.

APPENDIX A

PRECISION AND ACCURACY CRITERIA

Estimated Reporting Limits for Method 8260B

Analyte Volatile Organic Compounds SW-8260B	Aqueous Samples		Soil Samples
	Estimated Reporting Limit (µg/L) 5 ml purge	Estimated Reporting Limit (µg/L) 25 ml purge	Estimated Reporting Limit (µg/kg) Low level Soil/sediment
Dichlorodifluoromethane	5	1	5
Chloromethane	5	1	5
Vinyl chloride	5	1	5
Bromomethane	5	1	5
Chloroethane	5	1	5
Trichlorofluoromethane	5	1	5
1,1-Dichloroethene	5	1	5
Methylene chloride	5	1	5
trans-1,2-Dichloroethene	5	1	5
1,1-Dichloroethane	5	1	5
2,2-Dichloropropane	5	1	5
cis-1,2-Dichloroethene	5	1	5
Chloroform	5	1	5
Bromochloromethane	5	1	5
1,1,1-Trichloroethane	5	1	5
Carbon tetrachloride	5	1	5
1,1-Dichloropropene	5	1	5
Benzene	5	1	5
1,2-Dichloroethane	5	1	5
Trichloroethene	5	1	5
1,2-Dichloropropane	5	1	5
Bromodichloromethane	5	1	5
Dibromomethane	5	1	5
cis-1,3-Dichloropropene	5	1	5
Toluene	5	1	5
Trans-1,3-Dichloropropene	5	1	5
1,1,2-Trichloroethane	5	1	5
Tetrachloroethene	5	1	5
1,3-Dichloropropane	5	1	5
Dibromochloromethane	5	1	5
1,2-Dibromoethane	5	1	5
1-Chlorohexane	5	1	5
Chlorobenzene	5	1	5
1,1,1,2-Tetrachloroethane	5	1	5
Ethyl benzene	5	1	5
p-Xylene	5	1	5
m-Xylene	5	1	5
o-Xylene	5	1	5
Styrene	5	1	5
Bromoform	5	1	5
Isopropylbenzene	5	1	5
1,1,2,2-Tetrachloroethane	5	1	5
Bromobenzene	5	1	5
1,2,3-Trichloropropane	5	1	5

Analyte Volatile Organic Compounds SW-8260B	Aqueous Samples		Soil Samples
	Estimated Reporting Limit (µg/L) 5 ml purge	Estimated Reporting Limit (µg/L) 25 ml purge	Estimated Reporting Limit (µg/kg) Low level Soil/sediment
n-Propylbenzene	5	1	5
2-Chlorotoluene	5	1	5
1,3,5-Trimethylbenzene	5	1	5
4-Chlorotoluene	5	1	5
tert-Butylbenzene	5	1	5
1,2,4-Trimethylbenzene	5	1	5
sec-Butylbenzene	5	1	5
p-Isopropyltoluene	5	1	5
1,3-Dichlorobenzene	5	1	5
1,4-Dichlorobenzene	5	1	5
n-Butylbenzene	5	1	5
1,2-Dichlorobenzene	5	1	5
1,2-Dibromo-3-chloropropane	5	1	5
1,2,4-Trichlorobenzene	5	1	5
Hexachlorobutadiene	5	1	5
Naphthalene	5	1	5
1,2,3-Trichlorobenzene	5	1	5

QC Acceptance Criteria for Method 8260B

Analyte Volatile Organic Compounds SW-8260B	Accuracy Water (%R)	Precision Water (% RPD)	Accuracy Soil (%R)	Precision Soil (% RPD)
Dichlorodifluoromethane	75-125	< 20	65-140	< 30
Chloromethane	75-125	< 20	65-140	< 30
Vinyl chloride	40-125	< 20	30-145	< 30
Bromomethane	75-125	< 20	65-140	< 30
Chloroethane	60-125	< 20	50-140	< 30
Trichlorofluoromethane	65-125	< 20	55-140	< 30
1,1-Dichloroethene	75-125	< 20	65-140	< 30
Methylene chloride	75-125	< 20	65-140	< 30
trans-1,2-Dichloroethene	75-125	< 20	65-140	< 30
1,1-Dichloroethane	75-125	< 20	65-140	< 30
2,2-Dichloropropane	75-125	< 20	65-140	< 30
cis-1,2-Dichloroethene	75-125	< 20	65-140	< 30
Chloroform	75-125	< 20	65-140	< 30
Bromochloromethane	75-125	< 20	65-140	< 30
1,1,1-Trichloroethane	75-125	< 20	65-140	< 30
Carbon tetrachloride	60-125	< 20	50-140	< 30
1,1-Dichloropropene	75-125	< 20	65-140	< 30
Benzene	75-125	< 20	65-140	< 30
1,2-Dichloroethane	65-125	< 20	65-140	< 30
Trichloroethene	75-125	< 20	65-140	< 30
1,2-Dichloropropane	75-125	< 20	65-140	< 30
Bromodichloromethane	75-125	< 20	65-140	< 30
Dibromomethane	65-125	< 20	55-140	< 30
cis-1,3-Dichloropropene	75-125	< 20	65-140	< 30
Toluene	75-125	< 20	65-140	< 30
Trans-1,3-Dichloropropene	65-125	< 20	55-140	< 30
1,1,2-Trichloroethane	75-125	< 20	65-140	< 30
Tetrachloroethene	75-125	< 20	65-140	< 30
1,3-Dichloropropane	75-125	< 20	65-140	< 30
Dibromochloromethane	70-125	< 20	60-140	< 30
1,2-Dibromoethane	75-125	< 20	65-140	< 30
1-Chlorohexane	75-125	< 20	65-140	< 30
Chlorobenzene	75-125	< 20	65-140	< 30
1,1,1,2-Tetrachloroethane	75-125	< 20	65-140	< 30
Ethyl benzene	75-125	< 20	65-140	< 30
p-Xylene	75-125	< 20	65-140	< 30
m-Xylene	75-125	< 20	65-140	< 30
o-Xylene	75-125	< 20	65-140	< 30
Styrene	75-125	< 20	65-140	< 30
Bromoform	75-125	< 20	65-140	< 30
Isopropylbenzene	75-125	< 20	65-140	< 30
1,1,2,2-Tetrachloroethane	75-125	< 20	65-140	< 30
Bromobenzene	75-125	< 20	65-140	< 30
1,2,3-Trichloropropane	75-125	< 20	65-140	< 30
n-Propylbenzene	75-125	< 20	65-140	< 30
2-Chlorotoluene	75-125	< 20	65-140	< 30
1,3,5-Trimethylbenzene	70-125	< 20	60-140	< 30

Analyte	Accuracy	Precision	Accuracy	Precision
Volatile Organic Compounds SW-8260B	Water (%R)	Water (% RPD)	Soil (%R)	Soil (% RPD)
4-Chlorotoluene	75-125	< 20	65-140	< 30
tert-Butylbenzene	75-125	< 20	65-140	< 30
1,2,4-Trimethylbenzene	75-125	< 20	65-140	< 30
sec-Butylbenzene	75-125	< 20	65-140	< 30
p-Isopropyltoluene	75-125	< 20	65-140	< 30
1,3-Dichlorobenzene	75-125	< 20	65-140	< 30
1,4-Dichlorobenzene	75-125	< 20	65-140	< 30
n-Butylbenzene	75-125	< 20	65-140	< 30
1,2-Dichlorobenzene	75-125	< 20	65-140	< 30
1,2-Dibromo-3-chloropropane	55-125	< 20	40-140	< 30
1,2,4-Trichlorobenzene	75-125	< 20	65-140	< 30
Hexachlorobutadiene	75-125	< 20	65-140	< 30
Naphthalene	75-125	< 20	65-140	< 30
1,2,3-Trichlorobenzene	75-125	< 20	65-140	< 30
Surrogates				
Dibromofluoromethane	75-125		65-140	
Toluene-d8	75-125		65-140	
4-Bromofluorobenzene	75-125		65-140	
1,2-Dichloroethane-d4	60-140		50-150	

Estimated Reporting Limits for Method 8270C

Analyte Semi-volatile Organic Compounds SW-8270C	Aqueous Samples	Soil Samples
	Estimated Reporting Limit (µg/l)	Estimated Reporting Limit (µg/kg) Low level Soil/sediment
Acenaphthene	10	660
Acenaphthylene	10	660
Anthracene	10	660
Benzo(a)anthracene	10	660
Benzo(b)fluoranthene	10	660
Benzo(k)fluoranthene	10	660
Benzoic acid	50	3300
Benzo(g,h,i)perylene	10	660
Benzo(a)pyrene	10	660
Benzyl alcohol	20	1300
bis(2-Chloroethoxy) methane	10	660
bis(2-Chloroethyl) ether	10	660
bis(2-Chloroisopropyl) ether	10	660
4-Bromophenyl phenyl ether	10	660
Butyl benzyl phthalate	10	660
4-Chloroaniline	20	1300
4-Chloro-3-methylphenol	20	1300
2-Chloronaphthalene	10	660
2-Chlorophenol	10	660
4-Chlorophenyl phenyl ether	10	660
Chrysene	10	660
Dibenz(a,h)anthracene	10	660
Dibenzofuran	10	660
Di-n-butylphthalate	10	660
1,2-Dichlorobenzene	10	660
1,3-Dichlorobenzene	10	660
1,4-Dichlorobenzene	10	660
3,3'-Dichlorobenzidine	20	1300
2,4-Dichlorophenol	10	660
Diethylphthalate	10	660
2,4-Dimethylphenol	10	660
Dimethyl phthalate	10	660
4,6-Dinitro-2-methylphenol	50	3300
2,4-Dinitrophenol	50	3300
2,4-Dinitrotoluene	10	660
2,6-Dinitrotoluene	10	660
Di-n-octyl phthalate	10	660
bis(2-Ethylhexyl)phthalate	10	660
Ethyl methanesulfonate	20	ND
Fluoranthene	10	660
Fluorene	10	660
Hexachlorobenzene	10	660
Hexachlorobutadiene	10	660
Hexachlorocyclopentadiene	10	660

Analyte Semi-volatile Organic Compounds SW-8270C	Aqueous Samples	Soil Samples
	Estimated Reporting Limit (µg/l)	Estimated Reporting Limit (µg/kg) Low level Soil/sediment
Hexachloroethane	10	660
Indeno(1,2,3-cd)pyrene	10	660
Isophorone	10	660
2-Methylnaphthalene	10	660
2-Methylphenol	10	660
4-Methylphenol	10	660
Naphthalene	10	660
2-Nitroaniline	50	3300
3-Nitroaniline	50	3300
4-Nitroaniline	20	3300
Nitrobenzene	10	660
2-Nitrophenol	10	660
4-Nitrophenol	50	3300
N-Nitrosodiphenylamine	10	660
N-Nitroso-di-n-propylamine	10	660
Pentachlorophenol	50	3300
Phenanthrene	10	660
Phenol	10	660
Pyrene	10	660
1,2,4-Trichlorobenzene	10	660
2,4,5-Trichlorophenol	10	660
2,4,6-Trichlorophenol	10	660

QC Acceptance Criteria for Method 8270C

Analyte Semi-volatile Compounds SW-8270C	Organic	Accuracy Water (%R)	Precision Water (% RPD)	Accuracy Soil (%R)	Precision Soil (% RPD)
Acenaphthene		45-125	< 20	35-135	< 30
Acenaphthylene		45-125	< 20	35-135	< 30
Anthracene		45-165	< 20	35-175	< 30
Benzo(a)anthracene		50-135	< 20	40-145	< 30
Benzo(b)fluoranthene		35-125	< 20	25-135	< 30
Benzo(k)fluoranthene		35-125	< 20	25-135	< 30
Benzoic acid		25-160	< 20	20-170	< 30
Benzo(g,h,i)perylene		35-150	< 20	25-160	< 30
Benzo(a)pyrene		40-125	< 20	30-135	< 30
Benzyl alcohol		35-125	< 20	25-135	< 30
bis(2-Chloroethoxy) methane		45-125	< 20	35-135	< 30
bis(2-Chloroethyl) ether		45-125	< 20	30-135	< 30
bis(2-Chloroisopropyl) ether		35-170	< 20	25-175	< 30
4-Bromophenyl phenyl ether		50-130	< 20	40-140	< 30
Butyl benzyl phthalate		25-125	< 20	25-135	< 30
4-Chloroaniline		45-140	< 20	35-150	< 30
4-Chloro-3-methylphenol		40-125	< 20	40-145	< 30
2-Chloronaphthalene		60-125	< 20	50-135	< 30
2-Chlorophenol		40-125	< 20	30-135	< 30
4-Chlorophenyl phenyl ether		50-130	< 20	30-135	< 30
Chrysene		55-135	< 20	45-145	< 30
Dibenz(a,h)anthracene		50-125	< 20	40-135	< 30
Dibenzofuran		50-125	< 20	40-135	< 30
Di-n-butylphthalate		30-130	< 20	25-140	< 30
1,2-Dichlorobenzene		40-160	< 20	30-135	< 30
1,3-Dichlorobenzene		30-125	< 20	25-135	< 30
1,4-Dichlorobenzene		30-125	< 20	25-135	< 30
3,3'-Dichlorobenzidine		25-175	< 20	25-175	< 30
2,4-Dichlorophenol		45-125	< 20	35-135	< 30
Diethylphthalate		35-125	< 20	25-135	< 30
2,4-Dimethylphenol		45-140	< 20	35-150	< 30
Dimethyl phthalate		25-175	< 20	25-175	< 30
4,6-Dinitro-2-methylphenol		25-135	< 20	25-145	< 30
2,4-Dinitrophenol		30-150	< 20	25-160	< 30
2,4-Dinitrotoluene		35-140	< 20	25-150	< 30
2,6-Dinitrotoluene		50-125	< 20	40-135	< 30
Di-n-octyl phthalate		35-130	< 20	25-140	< 30
bis(2-Ethylhexyl)phthalate		30-140	< 20	25-140	< 30
Fluoranthene		45-125	< 20	35-135	< 30
Fluorene		45-140	< 20	35-150	< 30
Hexachlorobenzene		45-135	< 20	35-145	< 30
Hexachlorobutadiene		25-125	< 20	25-135	< 30
Hexachlorocyclopentadiene		40-125	< 20	30-135	< 30
Hexachloroethane		25-135	< 20	25-160	< 30
Indeno(1,2,3-cd)pyrene		25-160	< 20	25-170	< 30
Isophorone		25-175	< 20	25-175	< 30

Analyte Semi-volatile Compounds SW-8270C	Organic	Accuracy Water (%R)	Precision Water (% RPD)	Accuracy Soil (%R)	Precision Soil (% RPD)
2-Methylnaphthalene		40-125	< 20	30-135	< 30
2-Methylphenol		25-125	< 20	25-135	< 30
4-Methylphenol		30-125	< 20	25-135	< 30
Naphthalene		50-125	< 20	40-135	< 30
2-Nitroaniline		50-125	< 20	40-135	< 30
3-Nitroaniline		50-125	< 20	40-135	< 30
4-Nitroaniline		40-145	< 20	30-155	< 30
Nitrobenzene		45-135	< 20	35-145	< 30
2-Nitrophenol		40-125	< 20	35-135	< 30
4-Nitrophenol		25-135	< 20	25-140	< 30
N-Nitrosodiphenylamine		25-125	< 20	25-135	< 30
N-Nitroso-di-n-propylamine		35-125	< 20	25-135	< 30
Pentachlorophenol		25-140	< 20	35-150	< 30
Phenanthrene		50-125	< 20	40-135	< 30
Phenol		25-125	< 20	25-135	< 30
Pyrene		45-140	< 20	35-150	< 30
1,2,4-Trichlorobenzene		40-140	< 20	30-150	< 30
2,4,5-Trichlorophenol		25-175	< 20	25-175	< 30
2,4,6-Trichlorophenol		35-130	< 20	25-140	< 30
Surrogates:					
2,4,6-Tribromophenol		25-135		25-145	
2-Fluorobiphenyl		40-125		30-135	
2-Fluorophenol		25-125		25-135	
Nitrobenzene-d5		30-125		25-135	
Phenol-d5		25-125		25-135	
Terphenyl-d14		40-130		30-140	

Estimated Reporting Limits for Method 6010B

Analyte Inorganic Metals SW-6010B	Aqueous Samples	Soil/Sediment Samples
	Estimated Reporting Limit (µg/l)	Estimated Reporting Limit (mg/kg)
Aluminum	200	10
Antimony	60	3
Arsenic	10	0.5
Barium	200	10
Beryllium	5	0.25
Cadmium	5	0.25
Calcium	5000	250
Chromium	10	0.5
Cobalt	50	2.5
Copper	10	0.5
Iron	100	5
Lead	3	0.15
Magnesium	5000	250
Manganese	15	0.75
Nickel	40	2
Potassium	5000	250
Selenium	5	0.25
Silver	10	0.5
Sodium	5000	250
Thallium	10	0.5
Vanadium	50	2.5
Zinc	20	1.0

QC Acceptance Criteria for Method 6010B

Analyte Inorganic Metals SW-6010B	Accuracy Water (%R)	Precision Water (% RPD)	Accuracy Soil (%R)	Precision Soil (% RPD)
Aluminum	75-125	< 20	60-140	< 35
Antimony	75-125	< 20	60-140	< 35
Arsenic	75-125	< 20	60-140	< 35
Barium	75-125	< 20	60-140	< 35
Beryllium	75-125	< 20	60-140	< 35
Cadmium	75-125	< 20	60-140	< 35
Calcium	75-125	< 20	60-140	< 35
Chromium	75-125	< 20	60-140	< 35
Cobalt	75-125	< 20	60-140	< 35
Copper	75-125	< 20	60-140	< 35
Iron	75-125	< 20	60-140	< 35
Lead	75-125	< 20	60-140	< 35
Magnesium	75-125	< 20	60-140	< 35
Manganese	75-125	< 20	60-140	< 35
Nickel	75-125	< 20	60-140	< 35
Potassium	75-125	< 20	60-140	< 35
Selenium	75-125	< 20	60-140	< 35
Silver	75-125	< 20	60-140	< 35
Sodium	75-125	< 20	60-140	< 35
Thallium	75-125	< 20	60-140	< 35
Vanadium	75-125	< 20	60-140	< 35
Zinc	75-125	< 20	60-140	< 35

Estimated Reporting Limits for Method SW7470A/SW7471A

Analyte SW-7470A/7471A	Aqueous Samples	Soil Samples
	Estimated Reporting Limit (mg/L)	Estimated Reporting Limit (mg/Kg)
Mercury	0.001	0.1

QC Acceptance Criteria for Method SW7470A/SW7471A

Analyte SW-7470A/7471A	Accuracy Water (%R)	Precision Water (% RPD)	Accuracy Soil (%R)	Precision Soil (% RPD)
Mercury	75-125	< 25	70-130	< 30