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Quality Assurance Project Plan

Lakewood DX (BRRTS No. 02-43-000105) Groundwater Assessment Project

15761 East Chain Lake Road,
Lakewood, Oconto County

Submitted to:
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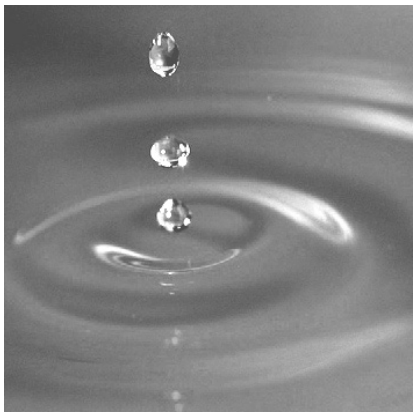

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QUALITY ASSURANCE PROJECT PLAN APPROVAL SHEET

Lakewood DX (BRRTS No. 02-43-000105) Groundwater Assessment Project
15761 East Chain Lake Road, Lakewood, Oconto County, WI
Wisconsin Department of Natural Resources

On behalf of the Wisconsin Department of Natural Resources (WDNR), this Quality Assurance Project Plan (QAPP) was prepared by GEI Consultants, Inc. (GEI) for the Lakewood DX site. The QAPP was developed in general conformance with ss. NR 716.13 and NR 716.09(2)(f)(5), Wis. Adm. Code.

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QUALITY ASSURANCE PROJECT PLAN DISTRIBUTION LIST

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ACRONYM LIST

ACM – Asbestos Containing Material

AHERA – Asbestos Hazard Emergency Response Act

AIHA– American Industrial Hygienists Association

ASTs – Aboveground Storage Tanks

ASTM – American Society for Testing and Materials

CFR – Code of Federal Regulations

CNS – Covenant Not to Sue

COC – Chain of Custody

DI – De-ionized

DQOs – Data Quality Objectives

DRO – Diesel-Range Organic Compounds

GEI – GEI Consultants, Inc.

GRO – Gasoline-Range Organic Compounds

HASP – Health and Safety Plan

HUD – U.S. Department of Housing and Urban Development

WDNR – 'State' Environmental Protection Agency

LCSs – Laboratory Control Samples

MDLs – Method Detection Limits

MS/MSD – Matrix Spike/Matrix Spike Duplicate

NELAP – National Environmental Lab Accreditation Program

NVLAP – National Voluntary Lab Accreditation Program

O&M – Operation and Maintenance

OSHA – Occupational Safety and Health Administration

PACE – Pace Analytical Services, Inc.

PAHs – Polynuclear Aromatic Hydrocarbons

PARCCS – Precision, Accuracy, Representativeness, Completeness, Comparability, and Sensitivity

PCBs – Polychlorinated Biphenyls

PE – Performance Evaluation

PID – Photoionization Detector

ACRONYM LIST (Continued)

PPE – Personal Protective Equipment

QA – Quality Assurance

QAPP – Quality Assurance Project Plan

QA/QC – Quality Assurance/Quality Control

QC – Quality Control

QLs – Quantitation Limits

REC- Recognized Environmental Condition

RPD – Relative Percent Difference

RSD – Relative Standard Deviation

SAP – Sampling and Analysis Plan

SOPs – Standard Operating Procedures

SVOCs – Semivolatile Organic Compounds

TPH – Total Petroleum Hydrocarbons

U.S. EPA – United States Environmental Protection Agency

USTs – Underground Storage Tanks

WDNR – Wisconsin Department of Natural Resources

VOCs – Volatile Organic Compounds

INTRODUCTION

The purpose of this document is to describe the personnel, procedures, and methods for ensuring the quality, accuracy, and precision of data associated with the Lakewood DX (BRRTS No. 02-43-000105) Groundwater Assessment Project at 15761 East Chain Lake Road, Lakewood, Oconto County, Wisconsin. Following the procedures outlined in this Quality Assurance Project Plan (QAPP) will help demonstrate that the data collected meets the project objectives. This QAPP will be valid for the duration of the project and, if the project duration extends beyond one year, will be reviewed at least annually (from the date of WDNR approval) so that it is up to date throughout the life of the project. An annual review would be documented and sent to all recipients of the QAPP with any updated materials (SOPs, etc.) to insert into the QAPP. If substantial changes are anticipated during the project (new laboratories, additional analyses, new field methods, etc.), a call will be arranged with the WDNR to determine how to revise this document.

1.0 PROJECT MANAGEMENT

1.1 Project Organization and Responsibilities

Figure 1 presents the organizational structure for the Lakewood DX (BRRTS No. 02-43-000105) Groundwater Assessment Project. All lines of communication, management activities, and technical direction within this project team will follow this organization arrangement. The WDNR project manager will be notified of any proposed changes in personnel.

Responsibilities of key project personnel are outlined below.

WDNR Project Manager

1. Direct, review, and approve the QAPP.
2. Provide technical consultation services to the GEI project manager.
3. Review progress reports detailing work accomplished.
4. Review all final reports.

GEI Project Manager

1. Responsible for directing project field activities, including planning, coordinating, monitoring, and evaluating.
2. Before sampling, meet with the team teader, quality assurance (QA) manager, and field staff to discuss and establish sampling purposes, sampling methodology, number of samples, size of samples, sample preservation methods, chain-of-custody (COC) requirements, analyses required, and which samples will be duplicated in the field.

3. Resolve technical problems.
4. Meet with team members to discuss and review analytical results prior to completion of reports.
5. Responsible for review and approval of project deliverables, development of project planning, and the overview of project strategies.
6. Review final report for consistency with project objectives.
7. Provide signature on final report.

GEI Project Quality Assurance Manager ***(this person should be independent of the assessment activities)***

1. Oversee assessment activities so that sampling methodology, sample preservation methods, and COC procedures are being followed.
2. Assist in any QA issues with field or laboratory questions, as needed.
3. Conduct Field Audits.
4. Maintain a record of samples submitted to the laboratory, the analyses being performed on each sample, the final analytical results, and data validation reports.
5. Prepare Data Assessment Report (DAR).
6. Annual review of QAPP.

GEI Data Manager

1. Maintain a record of all samples collected and the sample identification information on each sample.
2. Manage data acquired from field assessments and laboratory analyses.
3. Assemble data into computer format.

GEI Field Team Leader

1. Complete on-site Health and Safety Plan (HASP).
2. Be responsible for oversight of field activities so that procedures for the field activities related to the QAPP are executed and documented properly.
3. Submit data generated during field assessment to the data manager.
4. Procuring, coordinating and qualifying all subcontractors.

GEI Field Technical Staff

1. Before sampling, meet with GEI project manager to discuss and establish sampling purposes, sampling methodology, number of samples, size of samples, sample preservation methods, COC requirements, analyses required, and which samples will be duplicated in the field.
2. Be responsible for collection of equipment needed for property assessment work, which would include personal protective equipment (PPE), sampling equipment, sample containers and coolers, monitoring devices, and any other equipment deemed necessary.
3. Monitor hazardous conditions while conducting field operations.
4. Submit COC records and field paperwork to field team leader

PACE Laboratory Project Manager

1. Responsible for samples submitted to the laboratory, including those released to a subcontracted laboratory.
2. Responsible for summarizing quality assurance/quality control (QA/QC) requirements for the project, including those samples analyzed by subcontracted laboratories.
3. Maintain laboratory schedule so that technical requirements are understood by laboratory personnel.
4. Provide technical guidance to GEI project manager.
5. Maintain accuracy of the laboratory data.

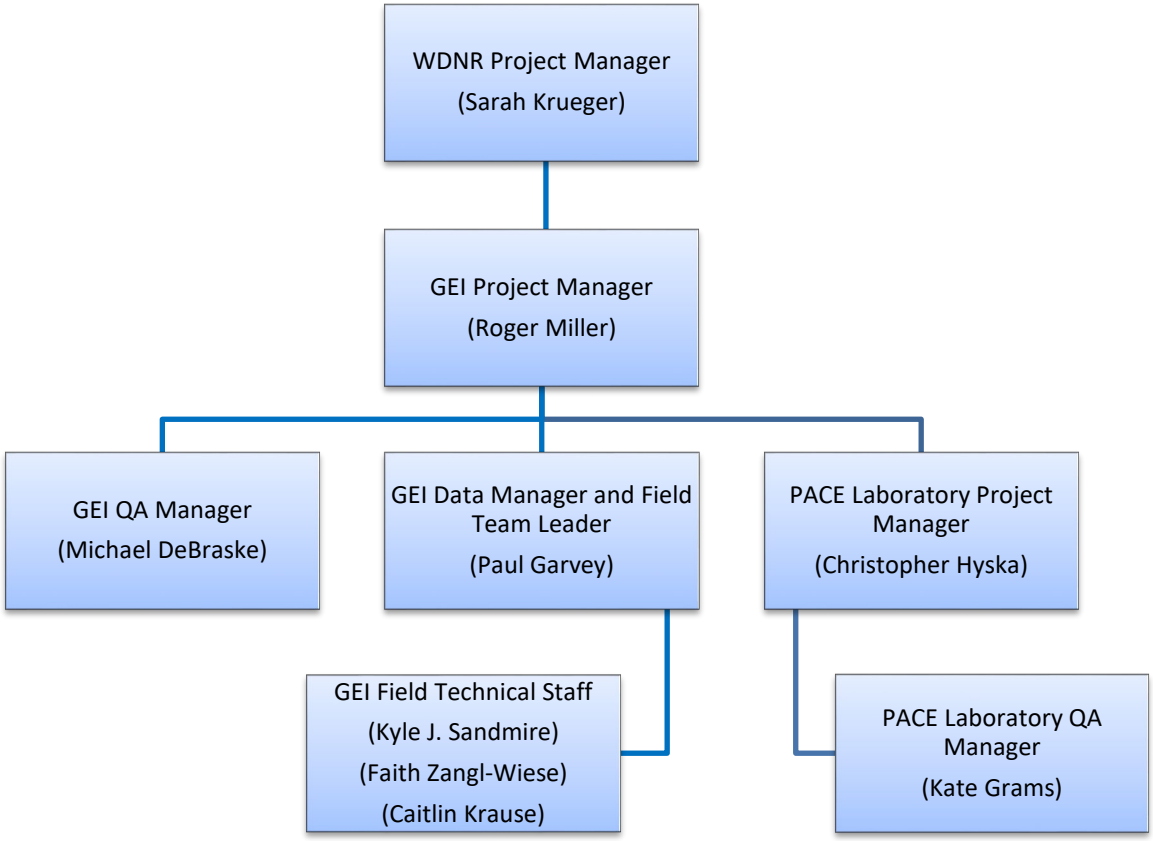
PACE Laboratory QA Manager

1. Responsible for evaluating adherence to policies and ensuring that systems are in place to provide QA/QC as defined in the QAPP.
2. Initiate and oversee audits of corrective action procedures.
3. Perform data reviews.
4. Maintain documentation of training.

FIGURE 1

PROJECT ORGANIZATIONAL CHART

Lakewood DX (BRRTS No. 02-43-000105) Groundwater Assessment Project



All GEI site personnel will be trained as mandated by the Occupational Safety and Health Administration (OSHA) Act regulations (29 Code of Federal Regulations [CFR] 1910.120). Additionally, all site personnel will be properly trained in the procedures for collecting, labeling, packaging, and shipping of liquid and solid environmental samples. The GEI project manager will maintain personnel training records. Field personnel will be trained to use all monitoring devices and other equipment used in the field.

Pace Analytical Services, Inc., a WDNR-certified laboratory has been selected for the analytical work required for this project, as listed in Table 1, *Lab Analysis Table*.

1.2 Facility History/Background Information

The Lakewood DX site was originally identified through sampling in the late 1980s and 1990s under a "traditional Superfund assessment" of a former gasoline station and repair garage that ceased operation in the early 1970s. Subsequent State-funded assessment included additional monitoring well installations and several rounds of groundwater sampling from 2002 through 2004. Available information suggests that 36 monitoring wells, including several well nests with water table wells and piezometers, and 17 private wells have been sampled for volatile organic compound (VOC) testing. Groundwater data has indicated contamination above NR 140, Wisconsin Administrative Code (WAC), groundwater quality standards for trichloroethylene (TCE); benzene, ethylbenzene, toluene, and xylenes (BTEX); naphthalene; and trimethylbenzenes (TMB).

The primary objective of the Lakewood DX (BRRTS No. 02-43-000105) Groundwater Assessment Project is to collect groundwater samples for laboratory analysis to determine whether groundwater contamination remains and, if so, whether the groundwater plume appears to have stabilized due to natural attenuation since the wells were last sampled in 2004.

1.3 Project Description and Schedule

State funding is being used to evaluate current groundwater conditions at the Lakewood DX site through completion of the following tasks:

- Development and use of this QAPP in conformance with ss. NR 716.13 and NR 716.09(2)(f)(5), Wis. Adm. Code, to describe the personnel, procedures, and methods for ensuring the quality, accuracy, and precision of data obtained. The WDNR will review and approve the QAPP prior to any sampling.
- Development and use of an on-site health and safety plan (HASP) to establish procedures designed to protect GEI personnel from the potential hazards posed by the groundwater sampling activities.
- Site reconnaissance, including locating private wells, if still in use, and private wells potentially at risk from site contamination; site mapping; scouting sample locations; obtaining and reviewing local historical land use records; and meeting with the WDNR. Sample locations will be selected in consultation with the WDNR.
- Groundwater sampling of seven (7) monitoring wells; five (5) potable water wells, with current treatment system, before and after treatment; and one (1) potable water well, before any treatment system; with a total of 18 samples being analyzed for VOCs.
- Preparation and submittal of a site investigation report in conformance with NR 716, Wis. Adm. Code, including data tables, laboratory reports, and field monitoring records, to summarize the methods and results of the groundwater assessment.

GEI anticipates it will take approximately 7 weeks to complete the Lakewood DX (BRRTS No. 02-43-000105) Groundwater Assessment Project. Generally, we anticipate the following schedule:

- Weeks 1-2 (April 29-May 10): WDNR review of QAPP.
- Week 3 (May 13-17): Amend QAPP to incorporate WDNR comments, as necessary. Work with WDNR project manager to schedule site reconnaissance and groundwater sampling.
- Week 4 (May 20-24): Complete site reconnaissance and groundwater sampling on prearranged date during this week.
- Weeks 5-6 (May 28-June 7): Subcontract laboratory analysis of collected samples.
- Week 7 (June 10-14): Review and tabulate data and prepare and submit site investigation report to WDNR.

1.4 Data Quality Objectives (DQOs)

DQOs are qualitative and quantitative statements that clearly state the objective of a proposed project, define the most appropriate type of data to collect, determine the appropriate conditions for data collection, and specify acceptable decision error limits that establish the quantity and quality of data needed for decision making. The DQOs are based on the use of the data that will be generated. Different data uses may require different quantities of data and levels of quality.

1.4.1 Analytical Quality Objectives

Analytical quality objectives are used so that the analysis will accurately and adequately identify the contaminants of concern, and so that the analysis selected will be able to achieve the quantitation limits less than or equal to the target cleanup levels.

1.4.1.1 Field Screening

Field-screening instruments provide a lower quality of analytical data compared to laboratory equipment in a controlled environment. However, field methods provide rapid "real-time" results for field personnel in order to help guide field decision-making processes. These techniques are often used for health and safety monitoring, initial site characterization to locate areas for detailed assessment, and preliminary comparison of remedial objectives. During sampling and other property assessment activities, the breathing space of site personnel will be monitored for the presence of VOCs using a photoionization detector (PID). The PID will also be used to perform field screening of potential vapors within the monitoring well casings immediately after well caps/plugs are removed.

1.4.1.2 WDNR Analyses

The laboratory listed on Table 1, *Lab Analyses Table*, is recognized by the WDNR, via Laboratory ID No. 405132750, as having a Wisconsin Certification under NR 149 to perform the environmental sample analyses required for this project. These certifications are 1 year in length, and the laboratory must maintain satisfactory performance in order to be issued new certificates after they expire.

1.4.2 Project Quality Objectives

The project quality objectives process is a series of planning steps designed so that the type, quantity, and quality of environmental data used in decision making are appropriate for the intended application. There are five steps in the project quality objectives process that include problem statement, decision identification, decision inputs, assessment boundary, and the decision process. The details of these steps are provided in the following sections.

1.4.2.1 Problem Statement

Under this QAPP, the Lakewood DX site at 15761 East Chain Lake Road, Lakewood, Oconto County, Wisconsin, will be investigated to determine if previously identified groundwater contamination remains and if the groundwater plume has stabilized. Further WDNR action will be based on this investigation.

1.4.2.2 Decision Identification

Groundwater data will be used to determine if contamination remains and if further action is necessary. The following questions will be posed to make these determinations:

- Do contaminant levels exceed applicable standards such as WDNR limits?
- Can the contaminants be managed by eliminating exposure pathways through existing or additional engineering and institutional controls?
- Would the site require remediation prior to redevelopment?
- If remediation is too costly based on the expected land use, can the site be developed for another use?

1.4.2.3 Decision Inputs

Samples of groundwater will be collected for analysis as described in Appendix A, Environmental Standard Operation Procedures, to assess the current level of contamination. Samples will be collected to supplement data generated during previous assessments completed during and prior to 2004, as summarized on tables provided by the WDNR before this project was awarded.

1.4.2.4 Assessment Boundary

A site map showing the assessment boundary was provided by the WDNR before this project was awarded, and encompasses the locations of the groundwater and potable water wells planned to be sampled during the project.

1.4.2.5 Decision Process

Groundwater results will be compared with State standards for groundwater quality identified as NR 140 Enforcement Standards (ES) and NR 140 Preventive Action Limits (PAL). These standards are presented on Table 2, *Laboratory Data Quality Objectives for Groundwater*. If sample results exceed State standards, the WDNR may consider the following options:

- If contaminant levels exceed State standards, the WDNR may opt for resampling of specific locations associated with elevated contaminant levels. If any of the resample results confirm the original data, the second option listed below may be considered. If all sample and resample results are below standards, no further assessment or remedial action may be necessary.
- If contaminant levels exceeding State standards are associated only with a specific exposure pathway, pursuit of an exclusion of exposure pathways through the use of engineering and institutional controls may be considered.
- If an exposure pathway cannot be eliminated through engineering or institutional controls, development of a new Remedial Action Plan may be considered.

1.5 Quality Assurance Objectives for Measurement

The overall QA objective for the project is to develop and implement procedures for field sampling, COC, laboratory analysis, and reporting using WDNR protocol. Specific procedures for sampling, COC, laboratory instrument calibration, laboratory analysis, reporting of data, internal quality control, audits, preventative maintenance of field equipment, and corrective action are described in other sections of this QAPP.

Data quality objectives for measurements during this project will be addressed in terms of precision, accuracy, representativeness, completeness, comparability, and sensitivity (PARCCS). The numerical PARCCS parameters will be determined from the project DQOs so that they are met. The DQOs and resulting PARCCS parameters will require that the sampling be performed using standard methods with properly operated and calibrated equipment, and conducted by trained personnel.

1.5.1 Precision

Precision is the degree of agreement among repeated measurements of the same parameter under the same or similar conditions. Precision is reported as either relative percent difference (RPD) or relative standard deviation (RSD), depending on the end use of the data.

1.5.1.1 Field Precision Objectives

Field precision will be assessed through the collection and analysis of field duplicate samples. RPDs will be calculated for the detected analytes from investigative and field duplicate samples. Water matrix samples can be readily duplicated due to their homogeneous nature, and as such, a RPD of ±35 percent will be used as advisory limits for analytes detected in both investigative and field duplicate samples at concentrations greater than or equal to five times its quantitation limit. A summary of duplicate samples to be collected, along with the other quality control samples, is presented in Table 3, *Field and Lab QA/QC Sample Requirements*. Per WDNR requirements for this project, the minimum number of field duplicate samples required for each round of sampling is one for every 10 groundwater samples collected.

1.5.1.2 Laboratory Precision Objectives

Precision of laboratory analyses will be based upon laboratory matrix spike/matrix spike duplicate (MS/MSD) analyses. Precision is reported as RPD or RSD, and the equation to be used to determine precision is presented in Section 4.3.1. Per WDNR requirements for this project, MS/MSD analyses will be at a rate of 1 per 20 samples/matrix received by the laboratory. The MSD and RPDs used by the laboratory for the specific parameters being analyzed are presented in Table 3, *Field and Lab QA/QC Sample Requirements*.

1.5.2 Accuracy

Accuracy is the extent of agreement between an observed or measured value and the accepted reference, or true, value of the parameter being measured.

1.5.2.1 Field Accuracy Objectives

The objective for accuracy of the field sample collection procedures will be to demonstrate that samples are not affected by sources external to the sample, such as sample contamination by ambient conditions or inadequate equipment decontamination procedures. Sampling accuracy will be assessed by evaluating the results of equipment and trip blank samples for contamination.

Trip blanks will accompany sample containers and be subjected to the same handling procedures as the field samples, but will not be opened and will be shipped back to the laboratory with the samples. Trip blanks will be submitted at the rate of one trip

blank per shipping container containing field samples for laboratory analysis. The trip blank samples will provide a measure of potential cross contamination of samples by VOCs during shipment and handling.

Based on the expected use of disposable sampling equipment, only a trip blank is planned to be utilized. Otherwise, equipment and or fuel blanks will also be collected as described in Appendix A, Standard Operating Procedures.

Trip, equipment and /or field blanks will be analyzed during assessment activities in order to assess potential problems as they occur.

1.5.2.2 Laboratory Accuracy Objectives

Laboratory accuracy will be assessed by determining percent recoveries from the analysis of laboratory control samples (LCSs) or standard reference materials (SRMs). The analyses of MS/MSD samples are also utilized to determine laboratory accuracy by determining percent recoveries from the analysis of MS/MSD samples. MS/MSD samples will be collected for organic and inorganic analyses at a minimum frequency of 1 per 20 or fewer samples. The equation used to determine accuracy for this project is presented in Section 4.3.2.3.

The accuracy of the analyses also will be monitored through analysis of surrogate compounds. Surrogate compounds are added to each sample, standard, blank, and QC sample prior to sample preparation and analysis. Surrogate compounds are not expected to be found occurring naturally in the samples, but behave analytically similar to the compounds of interest. Consequently, surrogate compound percent recoveries will provide information on the effect that the sample matrix exhibits on the accuracy of the analyses.

1.5.3 Representativeness

Representativeness is a qualitative term that describes the extent to which a sampling design adequately reflects the environmental conditions of the site. It also reflects the ability of the sample team to collect samples and laboratory personnel to analyze those samples in such manners that the data generated accurately and precisely reflect the conditions at the site.

1.5.3.1 Measures for Representativeness of Field Data

Representativeness will be achieved by establishing the level of allowable uncertainty in the data and then statistically determining the number of samples needed to characterize the population through the DQO process. It will also be achieved by ensuring that sampling locations are properly selected. Representativeness is dependent upon the proper design of

the sampling program and will be accomplished by ensuring that this QAPP and the Environmental Standard Operation Procedures are followed. The QA goal will be to have all samples and measurements representative of the media sampled. Field testing for pH, temperature, and specific conductivity stabilization prior to groundwater sampling will help demonstrate that representative samples are collected.

1.5.3.2 Measures for Representativeness of Laboratory Data

Representativeness of laboratory data cannot be quantified. However, adherence to the prescribed analytical methods and procedures, including holding times, blanks, and duplicates, will help demonstrate that the laboratory data is representative.

1.5.4 Completeness

Completeness is defined as the measure of the quantity of valid data obtained from a measurement system compared to the quantity that was expected under normal conditions. While a completeness goal of 100 percent is desirable, an overall completeness goal of 90 percent may be realistically achieved under normal field sampling and laboratory analysis conditions.

1.5.4.1 Field Completeness Objectives

The field-sampling team will take measures to have data generated in the field be valid data. However, some samples may be lost or broken during handling and transit. Therefore, field completeness goals for this project will be to have 90 percent of all samples be valid data. The equation for calculating completeness is presented in Section 4.3.5.1.

1.5.4.2 Laboratory Completeness Objectives

Laboratory completeness will be a measure of the quantity of valid data measurements and analyses obtained from all the measurements and analyses completed for the project. The laboratory completeness goal is for 90 percent of the samples analyzed to be valid data. The procedure for determining laboratory data validity is provided in Section 4.2.2. The equation for calculating completeness is presented in Section 4.3.5.1.

1.5.5 Comparability

The confidence with which one data set can be compared to another is a measure of comparability. The ability to compare data sets is particularly critical when a set of data for a specific parameter is compared to historical data for determining trends.

1.5.5.1 Measures for Comparability of Field Data

Adhering to this QAPP and Environmental Standard Operation Procedures to properly handle and analyze sample will satisfy the comparability of field data. Additionally, efforts will be made to have sampling completed in a consistent manner by the same sampling team.

1.5.5.2 Measures for Comparability of Laboratory Data

Analytical data are comparable when the data are collected and preserved in the same manner followed by analysis with the same standard method and reporting limits. Data comparability is limited to data from the same environmental media. Analytical method quality specifications have been established so that the data will produce comparable results. The laboratory reporting limits are summarized on Table 2, *Laboratory Data Quality Objectives for Groundwater*.

1.5.6 Sensitivity

Sensitivity is the ability of a method or instrument to detect a parameter to be measured at a level of interest.

1.5.6.1 Measures for Field Sensitivity

The sensitivity of the field instruments selected to measure temperature, conductivity, and pH of groundwater for this project will be measured by analyzing calibration check solutions, where appropriate, that equate to the lower end of the expected concentration range. The sensitivity of the photoionization detector (PID) is relative to background readings in ambient air.

1.5.6.2 Measures for Laboratory Sensitivity

The sensitivity requirements for laboratory analyses are to be such to an extent as to meet WDNR standards for groundwater. If analytical methods are deemed to be insufficiently sensitive, alternative analytical methods may be utilized. Additionally, minimum laboratory detection limits which exceed WDNR standards will be evaluated in the following manner:

- Is the substance expected to be a chemical of concern, or, if the reporting limit exceeds WDNR groundwater standards, was the compound previously detected in groundwater or other media? If the substance is not an expected chemical of concern or previously detected in groundwater or other media, then the substance will be considered nondetect. If the substance is considered a chemical of concern or was detected previously,

the substance may be evaluated in a human health risk assessment using half the detection limit.

- If the reported detection limit exceeds WDNR groundwater standards, does the compound have an established Federal maximum contaminant level (MCL), and if so, does the reporting limit meet the MCL? If the reporting limit meets the MCL, the compound will be considered nondetect. If the reporting limit exceeds the MCL, the compound may be evaluated as part of a human health risk assessment using half the reported laboratory detection limit.

The laboratory reporting limits are summarized on Table 2, *Laboratory Data Quality Objectives for Groundwater*.

1.6 Documentation and Records

Records generated during project activities are a critical part of any property assessment. GEI will use select documents for recording information during project activities. Records to be used for project documentation include field forms, field books, laboratory data sheets, COC forms, and technical papers. Records generated during the project will be retained for a minimum of 10 years following the completion of the project. At a minimum, the data submittal will include the following:

- Figures showing site location, site boundaries, sampling locations, and summaries of impacted areas.
- Tables comparing laboratory data to the applicable standards.
- Laboratory data reports, including copies of all COC records.
- Copies of all sampling documentation, including groundwater development and sampling field forms.
- Data comments, as appropriate and per section 4 of this QAPP, that discuss and compares overall precision and accuracy data for each matrix, analytical parameter, and concentration level.

2.0 DATA GENERATION AND ACQUISITION

The purpose of the QAPP is to produce reliable data through procedures to maintain and demonstrate:

- The validity and integrity of the data;
- Mechanisms for ongoing control of data quality;
- Data quality in terms of PARCCS; and
- Usable, quantitative data for analysis, interpretation, and decision making.

2.1 Sampling Process Design

Sample locations, analytical parameters, and frequency of sampling for this project will be determined by the WDNR. The current sampling process design anticipated for the project is summarized in Section 1.3.

2.2 Analytical Methods Requirements

In order to preserve the integrity of samples both before and during analyses, specific analytical methods and requirements for those methods will be followed. Samples will be collected, prepared, and analyzed in accordance with laboratory SOPs for analyzed parameters. The laboratory listed on Table 1 will coordinate all analytical services for this assessment. The specific analytical method and reporting limits for each parameter for the laboratory is presented in Table 2.

Proper sample containers, preservation, holding times, and volumes for each analytical parameter are outlined in Table 4, *Sample Container, Preservation, and Holding Time Requirements*. The laboratory used will provide all sample containers and preservatives for this project.

All sample containers supplied by the laboratory will be cleaned according to U.S. EPA standards. QC documentation will be supplied with the sample containers and preservatives in order to verify their purity. The containers and preservatives can be traced back to their certificate of analysis from their lot number. The QC documentation/certificate of analysis shall be maintained on file with the laboratory. Additionally, the laboratory shall provide the field team with trip blanks for VOC analysis and laboratory-grade deionized (DI) water for rinsing field equipment and instruments.

2.3 Sample Handling and Custody Requirements

Proper sample handling and custody procedures are crucial to ensuring the quality and validity of data obtained through field and laboratory analyses. For example, the admissibility of environmental data as evidence in a court of law is dependent on the custody of the data. Custody procedure will be used to document the authenticity of data collected during this project. The data requiring custody procedures include field samples and data files that can include field books, logs, and laboratory reports. An item is considered in custody if it is:

- In a person's possession;
- In view of the person after being in their possession;
- Sealed in a manner that it cannot be tampered with after having been in physical possession; or
- In a secure area restricted to authorized personnel.

2.3.1 Sample Collection Documentation

Sample-handling procedures include field documentation, COC documentation, sample shipment, and laboratory sample tracking. Various aspects of sample handling and shipment, as well as the proposed sample identification system and documentation, are discussed in the following sections.

2.3.1.1 Field Books

Detailed records of the field activities will be maintained in a field book dedicated to this project. Entries will be dated and signed by personnel recording the data. The entries will be made in ink. Each field book will have a unique numerical identifier permanently attached, and each page will be numbered, permitting indexing of key data. At a minimum, information recorded in the field books will include documentation of sample locations, sampling times, types of samples collected, weather conditions, and any other information pertinent to the assessment.

2.3.1.2 Field Identification System

Each sample collected during the project will be given a unique identification code. Each unique sample identification will consist of the following:

- *Project Identification Code.* A three-letter alphabetic code will be used to identify the project site from which the sample was collected:

  LDX – Lakewood DX

- *Sample Matrix Code.* Each sample will be further identified by an alphabetic code corresponding to the sample matrix:

  MW – monitoring well sample

  PW – potable water sample

  TB – trip blank sample

  FD – field duplicate sample

- *Location Code.* Each groundwater sample will be identified by an alphanumeric location code as follows:

  MW-## – location of monitoring well

  Each potable water sample will be identified by an alphabetic location code as follows:

  PW-## – location of potable water sample

- *Treatment Status Code.* Each potable water sample will be further identified by an alphabetic code corresponding to its treatment status:

  BT – before treatment

  AT – after treatment

- *Examples.*

  LDX-MW-17B = groundwater sample from the Lakewood DX site at location 17B.

  LDX-PW-VD-BT = potable water sample from the Lakewood DX site at the Van Dyke residence before treatment.

Sample bottle labels appropriate for the size and type of containers shall be provided by PACE. The sample containers will be labeled in waterproof ink at the time of sample collection but prior to being filled. Each label will indicate at a minimum:

- Sample identification

- Date/time of sample collection
- Sampler's initials
- Required analyses
- Type of preservative.

2.3.1.3 Field Sample Handling

The possession and handling of samples will be documented from the time of collection to delivery to the laboratory. GEI field personnel are responsible for ensuring that COC procedures are followed. Field personnel will maintain custody of all samples until they are relinquished to another custodian, the laboratory, or to the freight shipper.

All samples must be catalogued on a COC form using sample identification codes. The date and time of collection will be recorded on the form, as well as the number of each type of sample, the method of preservation, and the type of analysis. The COC SOP is included in Appendix A.

2.3.1.4 Field Sample Packaging and Shipping

Samples will be packaged and transported in a manner that maintains the integrity of the sample and permits the analysis to be performed within the prescribed holding time. Prior to shipment, each sample container will be inspected for a label with the proper sample identification code.

Samples will be either couriered or shipped via overnight mail to the laboratory that will be performing the analyses. The laboratory will be contacted in advance to expect shipment so that holding times of the samples will be conserved. The COC forms will be sealed in a plastic bag and transported inside the sample cooler. In addition, any shipping receipts will be incorporated into the COC documentation. Samples will be packed in the cooler using bubble-wrap packing materials and ice will be sealed in a Ziploc®-type bag. Any samples suspected of being highly contaminated will additionally be sealed in a Ziploc®-type bag. The cooler will be taped closed using two custody seals provided by the laboratory to prevent tampering during transport. Upon relinquishing the sample cooler to the laboratory, GEI field personnel will sign custody of the samples over to the laboratory by signing and dating the bottom of the COC form. One copy of the COC documentation will be retained by the GEI data manager and a second copy will be retained by the laboratory. The integrity of the custody seals shall be noted by PACE on the COC form upon arrival. In addition, the shipping label will be included with the COC form retained by the GEI data manager.

2.3.1.5 Field Documentation

Field COC procedures will help deomstrate the proper documentation of each sample from collection in the field to delivery at the laboratory. Custody of samples shall be maintained and documented at all times. The documentation for each sample will include the following information:

- COC form
- Sample label with sample identification code
- Shipping documents.

This documentation will allow for proper identification and verification of all samples upon arrival at the laboratory.

2.3.2 Laboratory Chain of Custody

The laboratory used in this project will perform custody procedures for sample receiving and log-in, sample storage, tracking during sample preparation and analysis, and storage of data in accordance with their SOPs. The laboratory project manager will be responsible for ensuring that laboratory custody protocol is maintained.

2.3.3 Final Evidence Files Custody Procedure

GEI will be responsible for the custody of the evidence files and maintain and update the contents of the files during the project. The evidence files will include all records relevant to sampling and analysis activities such as boring logs, field books, photographs, subcontractor reports, laboratory data deliverables, COC forms, and data reviews. GEI will retain this file for a period of 10 years after completion of the project.

2.4 Quality Control Requirements

The quality control requirements help demonstrate that the environmental data collected is of the highest standard feasible as appropriate for the intended application. Facets of the quality control requirements are provided in the following sections.

2.4.1 Field Quality Control Requirements

Where applicable, QC checks will be strictly followed during the assessment through the use of replicate measurements, equipment calibration checks, and data verification by GEI field personnel. Field-sampling precision and data quality will be evaluated through the use of sample duplicates, equipment blanks, and trip blanks. Sample duplicates provide precision information regarding homogeneity, handling, transportation, storage, and analysis. Equipment blanks will be used so that proper contamination procedures have been performed and that no cross contamination has

occurred during sampling or transportation. Trip blanks will be used with VOCs only, to demonstrate that transportation of samples has not contaminated the samples. If there is any discrepancy in the sample data, the GEI project manager will be notified and, if deemed necessary, re-sampling of the questionable point scheduled. Requirements for field QA/QC samples are listed in Table 3.

2.4.2 Laboratory QC Requirements

The laboratory QA manager will be responsible for ensuring that the laboratory's data precision and accuracy are maintained in accordance with specifications. Internal laboratory duplicates and calibration checks are performed on one of every 20 samples submitted for analysis. Other internal laboratory QA/QC is performed according to laboratory SOPs. Soil samples that are submitted for laboratory MS/MSD or spike and duplicate analyses will have an additional set of samples collected from the sample locations. In the case of VOCs, double the amount will be collected. Typically, laboratories require two to three sample containers for each sample location, therefore, four to six sample containers will be collected for laboratory MS/MSD analyses.

2.5 Instrument Calibration and Frequency

The calibration procedures to be employed for both the field and laboratory instruments used during this project are referenced in this section. Measuring and test equipment used in the field and laboratory will be subjected to a formal calibration program. The program will require equipment of the proper type, range, accuracy, and precision to provide data compatible with the specified requirements and the desired results. Calibration of measuring and test equipment may be performed internally using in-house reference standards, or externally by agencies or manufacturers.

The responsibility for the calibration of laboratory equipment rests with the laboratory. GEI field personnel are responsible for the calibration of GEI field equipment and field equipment provided by subcontractors.

Documented and approved procedures will be used for calibrating measuring and testing equipment. Widely accepted procedures, such as those published by U.S. EPA and American Society for Testing and Materials (ASTM), or procedures provided by manufacturers in equipment manuals will be adopted.

Calibrated equipment will be uniquely identified by the manufacturer's serial number, a GEI equipment identification number, or by other means. This identification, along with a label indicating when the next calibration is due (only for equipment not requiring daily calibration), will be attached to the equipment. If this is not possible, records traceable to the equipment will be readily available for reference. It will be the responsibility of all equipment operators to check the calibration status from the due date labels or records prior to using the equipment.

Measuring and testing equipment will be calibrated at prescribed intervals and/or as part of operational use. Frequency will be based on the type of equipment, inherent stability, manufacturer's recommendations, values given in national standards, intended use, and experience. Equipment will be calibrated whenever possible using reference standards having known relationships to nationally recognized standards or accepted values of physical constants. If national standards do not exist, the basis for calibration will be documented.

Physical and chemical reference standards will be used only for calibration. Equipment that fails calibration or becomes inoperable during use will be removed from service, segregated to prevent inadvertent use, and tagged to indicate the fault. Such equipment will be recalibrated and repaired to the satisfaction of the laboratory personnel or GEI field personnel, as applicable. Equipment that cannot be repaired will be replaced.

Records will be prepared and maintained for each piece of calibrated measuring and test equipment to document that established calibration procedures have been followed. Records for subcontractor field equipment and GEI equipment used only for this specific project will be kept in the project files. The laboratory will maintain laboratory calibration records.

2.5.1 Field Instrument Calibration

Instruments used to gather, generate, or measure field environmental data will be calibrated with sufficient frequency and in such manner that accuracy and reproducibility of results are consistent with the manufacturer's specifications. Field measurement instruments will include PID units used to detect VOC. As applicable, field instruments will be calibrated daily prior to use and the calibration will be verified by analyzing a calibration check standard. The calibration will be consistent with the standard procedure. The field calibration procedures are presented in the field SOPs located in Appendix A.

Calibration procedures will be documented in the field logbook and field sampling sheets. Documentation will include the following:

- Date and time of calibration
- Identity of the person performing the calibration
- Reference standard used, if applicable
- Reading taken and adjustments to attain proper reading
- Any corrective action.

Trained personnel will operate field measurement equipment in accordance with the appropriate standard procedures or manufacturer's specifications. GEI field technical staff members will examine field measurement equipment used during field sampling to verify that they are in operating condition. The GEI field team leader will periodically audit the calibration and field performance of the field equipment to document that the system of field calibration meets the manufacturer's specifications.

2.5.2 Laboratory Instrument Calibration

The proper calibration of laboratory equipment is a key element in the quality of the analysis done by the laboratory. Each type of instrumentation and each U.S. EPA-approved method have specific requirements for the calibration procedures, depending on the analytes of interest and the sample medium.

The calibration procedures and frequencies of the equipment used to perform the analyses will be in accordance with requirements established in the laboratory SOPs. The laboratory QA managers will be responsible for ensuring that the laboratory instrumentation is maintained in accordance with specifications. Individual laboratory SOPs will be followed for corrective actions and preventative maintenance frequencies.

2.6 Data Management

GEI field technical staff members will manage raw data during field activities. The GEI data manager will periodically collect data gathered during assessment activities in order to maintain results. As appropriate, the GEI data manager will coordinate transfer of raw data to computer formats such as Microsoft® Excel or Microsoft® Access to better organize and track incoming data. This will enable the GEI data manager to identify any data gaps. Any flaws in field QA/QC will be brought to the attention of the GEI QA manager.

The PACE project manager will be responsible for laboratory data management. PACE will follow data review and data reporting procedures in their QA Manual. Analytical data reports generated by PACE will present all sample results, including all QA/QC samples. The data reports will include a laboratory narrative for the data set describing any out of control analyses and their effect on sample results, explanation of all lab applied qualifiers; all sample results including the % moisture content for soil samples, the spike and duplicate analysis results (or MS/MDS results) including the % recoveries and RPDs. The following data must be available upon request from the lab on a case by case basis, if data issues arise: summaries of daily calibration check samples (including notation of any outliers), calibration blank results, surrogate results including % recoveries (as applicable per analysis), the method blank results, lab control sample (LCS) results including % recoveries. All data, including QA/QC results, will become

part of the project files and will be maintained by the GEI data manager. Upon report delivery, GEI personnel will analyze laboratory data in accordance with accepted statistical methodologies and will be supervised by the GEI data manager.

3.0 ASSESSMENT/OVERSIGHT

Performance and system audits may be completed to document that the field sampling activities and laboratory analyses are performed following the procedures established in this QAPP, including the attached SOPs. The audits may be both internally and externally led, as further described below.

3.1 Technical Systems Audits

Generally, system audits are a qualitative measure of adherence to sampling QA measures overall, including sample collection handling, decontamination procedures, COC, and recording requirements in the field, as well as sample receiving, log-in, and instrument operating records in the laboratory.

3.1.1 Field Data

A GEI scientist will be present at the site during sampling activities. The scientist will provide the on-site supervision required during the project. The scientist will be in daily contact with the GEI field team leader, who will then review compliance with the project objectives and sampling protocol outlined in this QAPP. Any anticipated modifications to the sampling or measuring procedures will be reported to the Project Manager and U.S. EPA project manager. GEI field technical staff members will report modifications to the GEI project manager, and document the modification in the field logbook.

Sample data precision will be determined by the collection and subsequent analysis of sample duplicates, equipment blanks, and trip blanks to verify reproducibility.

3.1.2 Field Screening Instruments

GEI field technical staff members will audit and maintain the performance field-screening instruments. Instruments will be calibrated according to the standard procedures located in Appendix A, and regular preventative maintenance will be performed as described in Table 5, *Field Equipment Preventive Maintenance*.

3.1.3 Report Preparation

Prior to submittal to the WDNR, all reports will undergo a peer review conducted by a project team within GEI. All components of the report will be checked and initialed by a designated team member. The WDNR will also review all reports prior to final submittal.

3.1.4 Laboratory Data

Laboratory results will be reviewed for compliance against the DQO criteria for the level of reporting required.

3.2 Performance Evaluation Audits

Generally, performance audits are a quantitative measure of field sample collection and laboratory analyses quality.

3.2.1 Field Audits

The GEI QA manager may conduct audit of field activities. The WDNR may also conduct an independent field audit. If a second phase of field activities is necessary and the second phase starts more than 6 months following the initial phase, then a second field audit may be completed. The field audit will include the following checklist:

Item	Description of Field Audit Activities	QA Manager Initials
1.	Review of field-sampling records	
2.	Review of field-measurement procedures	
3.	Examination of the application of sample identifications following the specified protocol	
4.	Review of field instrument calibration records and procedures	
5.	Recalibration of field instruments to verify calibration to the manufacturer's specifications	
6.	Review of the sample handling and packaging procedures	
7.	Review of COC procedures	

If deficiencies are observed during the audit, the deficiency shall be noted in writing and a follow-up audit may be completed if deemed necessary by the project QA manager. Corrective action procedures may need to be implemented due to the findings from the audit. Such actions will be documented in the field logbook.

3.2.2 Laboratory Audits

PACE is a WDNR-certified laboratory and will perform all of the analytical services required during the project. The PACE QA manager will be responsible for ensuring that the laboratory data precision and accuracy are maintained in accordance

with specifications and laboratory SOPs. As a WDNR-certified lab, PACE is routinely audited by the State of Wisconsin.

3.3 Reports to Management

For the duration of the project, monthly reports will be prepared by the GEI project manager and submitted to the WDNR project manager. These reports will serve to inform the WDNR project manager of the project progress and any significant interim findings that have been identified. This will streamline the process of addressing issues as they arise and adjusting the program to better define the environmental concerns. At the completion of the assessment, draft and final site investigation project reports will be issued.

4.0 DATA VALIDATION/USABILITY

This section describes the QA activities that will be performed so that the collected data are scientifically defensible, properly documented, and of known quality, and meet project objectives. All analytical data collected for the project will be validated.

The following three steps will be followed so that project data quality needs are met.

1. **Data Verification** – Data verification is a process of evaluating the completeness, correctness, and contractual compliance of a data set against the method standard, SOP, or contract requirements. Data verification will be performed internally by the analytical group or laboratory generating the data. Additionally, data may be checked by an entity external to the analytical group or fixed laboratory. Data verification may result in accepted, qualified, or rejected data.

2. **Data Validation** – Data validation is an analyte- and sample-specific process that extends the qualification of data beyond method, procedural, or contractual compliance (i.e., data verification) to determine the analytical quality of specific data sets. Data validation criteria are based on the measurement performance criteria of the project QAPP. The group that generates the data will perform data validation. Data validation results are accepted, qualified, or rejected data.

3. **Data Usability Assessment** – Data usability assessment is the process of evaluating validated data to determine if the data can be used for purpose of the project (i.e., to answer the environmental questions or to make environmental decisions). Data usability will include the following sequence of evaluation:

    - First, individual data sets will be evaluated to identify the measurement performance/usability issues or problems affecting the ultimate achievement of project DQOs.
    - Second, an overall evaluation of all data generated for the project will be performed.
    - Finally, the project-specific measurement performance criteria and data validation criteria will be evaluated to determine if they were appropriate for meeting project DQOs.

In order to perform the data evaluation steps above, the reported data will be supported by complete data packages which include sample receipt and tracking information, COC records, tabulated data summary forms, and raw analytical data for all field samples, standards, QC checks and QC samples, and all other project-specific documents that are generated.

4.1 Instructions for Data Review, Validation, and Verification Requirements

This section describes the process for documenting the degree to which the collected data meet the project objectives, individually and collectively. GEI will estimate the potential effect that each deviation from this QAPP may have on the usability of associated data items, its contribution to the quality of reduced and analyzed data, and its effects on the decision.

The following procedures will be implemented to verify and validate data collected during the project:

- *Sampling Design* – How closely a measurement represents the actual environment at a given time and location is a complex issue. Each sample will be checked for compliance with the specifications, including type and location. GEI will note deviations from the specifications, and discuss them with the WDNR project manager.

- *Sample Collection Procedures* – Sample collection procedures identified in this QAPP will be followed. If field conditions require deviations, they will be discussed with the WDNR project manager.

- *Sample Handling* – Deviations from the planned sample handling procedures will be noted on the COC forms and in the field logbooks. Data collection activities will indicate the events that occur during sample handling affecting the integrity of the samples.

  GEI field technical staff members will evaluate the sample containers and the preservation methods used and so that they are appropriate to the nature of the sample and the type of data generated from the sample. Checks on the identity of the sample will be made so that the sample continues to be representative of its native environment as it moves through the analytical process.

- *Analytical Procedures* – Each sample will be verified so that the procedures used to generate the data were implemented as specified. Data validation activities will be used to determine how seriously a sample deviated beyond the acceptance limit so that the potential effects of the deviation can be evaluated.

- *Quality Control* – QC checks that are to be performed during sample collection, handling, and analysis are specified in an earlier section of this

QAPP. For each specified QC check, the procedures, acceptance criteria, and corrective action should be specified. During data validation, the corrective actions that were taken, which samples were affected, and the potential effect of the actions on the validity of the data will be documented.

- *Calibration* – Field and laboratory instrument calibrations will be documented so that calibrations:

    - Were performed within an acceptance time prior to generation of measurement data;
    - Were performed in proper sequence;
    - Included the proper number of calibration points;
    - Were performed using a standard that bracketed the range of reported measurement results; and
    - Had acceptable linearity checks and other checks so that the measurement system was stable when calibration was performed.

  When calibration problems are identified, any data produced between the suspect calibration event and any subsequent recalibration will be flagged to alert data users.

- *Data Reduction and Processing* – Checks on data integrity will be performed to evaluate the accuracy of raw data and include the comparison of important events and duplicate rekeying of data to identify data entry errors. The laboratory will follow data reduction procedures in their QA Manual.

4.2 Instructions for Validation and Verification Methods

This section describes the process that will be followed to verify and validate the project data.

4.2.1 Verification

Field data will be verified by the GEI QA manager by reviewing field documentation and chain-of-custody records. Data from direct-reading instruments used to measure conductivity and pH will be internally checked by reviewing calibration and operating records. The laboratory data will be verified in respect to the COC, units of measure, and citation of analytical methods. Data verification procedures followed by the laboratory, per their QA Manual, will include reviewing and documenting sample receipt, sample preparation, sample analysis (including internal QC checks), data reduction, and reporting. Any deviations from the acceptance criteria corrective actions

taken, and data determined to be of limited usability (i.e., laboratory-qualified data) will be noted in the case narrative of the laboratory report. The QA manager will also verify the use of blanks and duplicates. All applicable reference and identification codes and numbers will be reviewed as part of the documentation.

4.2.2 Validation

Data validation will be conducted by GEI consistent with the procedure identified in Section 1.5 of this QAPP. The data verification/validation procedure will identify data as being acceptable, of limited usability qualified or estimated, or rejected. The conditions that result in data being qualified or estimated or rejected are identified in Section 1.5 of this QAPP. The results of the data verification/validation will be provided in data validation memoranda that are provided to GEI's Project Manager and are included in the Quality Assurance Management Reports. All sampling, handling, field analytical data, and fixed-laboratory data will be validated by entities external to the data generator. The validation procedure will specify the verification process of every quality control measure used in the field and laboratory.

Each analytical report will be reviewed for compliance with the applicable method and for the quality of the data reported.

Data determined to be unusable may require that corrective action be taken. Potential types of corrective action may include resampling by the field team or reanalysis of the samples by the laboratory. The corrective actions taken are dependent upon the ability to mobilize the field team and whether the data are critical for the project DQOs to be achieved. Should GEI's QA Officer identify a situation requiring corrective action during data verification/validation, GEI's Project Manager will be responsible for approving the implementation of the corrective action.

4.3 Instructions for Reconciliation with Data Quality Objectives

This section describes the scientific and statistical procedures/methods that will be used to determine whether data are of the right type, quality, and quantity to support environmental decision making for the project.

The Data Quality Assessment (DQA) process is described in *Guidance for the Data Quality Assessment Process: Practical Methods for Data Analysis*, EPA QA/G-9, July 1996. EPA QA/G-9 will be used to guide the data assessment on this project. The DQA process will consist of five steps:

1. Review DQOs and sampling design
2. Conduct preliminary data review
3. Select statistical test

4. Verify assumptions
5. Draw conclusions from the data.

While the formal DQA process presented in the guidance may not be followed in its entirety, a systematic assessment of the data quality will be performed. This process will include a preliminary data review. Data will be presented in tables and figures to identify the trends, relationships, and anomalies.

The overall usability of the data for the project will be assessed by evaluating the PARCCS of the data set to the measurement performance criteria in Section 1.5 of this QAPP using statistical quantities as applicable. The procedures and statistical formulas to be used for these evaluations are presented in the following sections.

4.3.1 Precision

In order to meet the needs of the project, data must meet the measurement performance criteria for precision. Project precision will be evaluated by assessing the RPD data from the field duplicate samples. Analytical precision will be evaluated by assessing the RPD data from either duplicate spiked sample analyses or duplicate sample analyses.

The RPD between two measurements is calculated using the following simplified formula:

$$RPD = \frac{\left| R_1 - R_2 \right|}{(R_1 + R_2)/2} \quad X \quad 100$$

where: R_1 = value of first result

R_2 = value of second result.

Overall precision for the sampling programs will be determined by calculating the mean RPD for all field duplicates in a given sampling program. This will provide an evaluation of the overall variability attributable to the sampling procedure, sample matrix, and laboratory procedures in each sampling program.

The overall precision requirement will be the same as the project precision. It should be noted that the RPD of two measurements can be very high when the data approach the quantitation limit of an analysis. The calculation of the mean RPD will include only the RPD values for field duplicate sample analyte data that are greater than or equal to five times the quantitation limit for an analysis.

Poor overall precision may be the result of one or more of the following:

- Field instrument variation
- Analytical measurement variation
- Poor sampling technique
- Sample transport problems
- Heterogeneous matrices.

In order to identify the cause of the imprecision, the field-sampling design rationale and sampling techniques should be evaluated by the reviewer, and both field and analytical duplicate/replicate sample results should be reviewed. If poor precision is indicated in both the field and analytical duplicates/replicates, then the laboratory may be the source of error. If poor precision is limited to the field duplicate/replicate results, then the sampling technique, field instrument variation, sample transport, or heterogeneous sample matrices may be the source of error.

If the Data Validation Report indicates that analytical imprecision exists for a particular data set, then the impact of that imprecision on data usability must be discussed in the Data Assessment Report. It should be noted that the Data Validation Report is considered to be the QA/QC report supplied by the analytical laboratory, and the Data Assessment Report will be prepared by GEI and submitted as part of the site investigation report.

When project-required precision is not achieved and project data are not usable to adequately address environmental questions and to support project decision making, then the Data Assessment Report should address how this problem will be resolved and discuss the need for resampling.

4.3.2 Accuracy/Bias

In order to meet the needs of the data users, project data will follow the measurement performance criteria for accuracy/bias established in Section 1.5.2.

4.3.2.1 Sample Contamination

QC check samples data will be reviewed to evaluate the accuracy and potential bias of sample results. If field contamination exists, then the impact of field contamination on data usability will be discussed in the Data Assessment Report, and the GEI project manager and field team leader should be notified. Differentiate field sample collection and transport contamination from contamination introduced at the time of sample preparation and analysis. Note that sample contamination may result in either negative or positive bias. For example, improperly cleaned sample containers for metals analysis may result in the retention of metals on interior container walls. This would result in lower metals concentrations being reported than are actually present in the environmental sample, which is a negative bias. A positive bias would occur when sample container contamination results in an additive effect, meaning that reported analyte concentrations are higher than the true sample concentrations for that analyte.

4.3.2.2 Analytical Accuracy/Bias

The data from method/preparation blank samples, field blank samples, trip blank sample, surrogate spikes, MS/MSD samples, and LCSs will be used to determine accuracy and potential bias of the sample data. If the Data Validation Reports indicate that contamination and/or analytical inaccuracies/bias exist for a particular data set, then the impact of that contamination and/or analytical inaccuracies/bias on data usability will be discussed on the Data Assessment Report.

4.3.2.3 Overall Accuracy/Bias

The data from the method/preparation blank samples provide an indication of laboratory contamination that may result in bias of sample data. Sample data associated with method/preparation blank contamination will have been identified during the data verification/validation process. Sample data associated with method/preparation blank contamination are evaluated during data validation procedure to determine if analytes detected in the samples and the associated method/preparation blanks are “real” or are the result of laboratory contamination. The procedure for this evaluation involves comparing the concentration of the analyte in the sample to the concentration of the method/preparation blank, taking into account adjustments for sample dilution and dry-weight reporting. In general, the sample data are qualified as not detected if the sample concentration is less than five times (ten times for common laboratory contaminants) the method/preparation blank concentration. Typically, the common quantitation limit for the affected analyte is elevated to the concentration detected in the sample.

The data from the field blanks and trip blanks provide an indication of field and transportation conditions that may result in bias of sample data. Sample data associated with contaminated field and trip blank samples have been identified during the data verification/validation process. The evaluation procedure and qualification of sample

data associated with field blank and trip blank contamination is performed in the same manner as the evaluation procedure for method blank sample contamination, taking into account the difference in units for aqueous field blank samples collected during soil sampling programs.

Surrogate spike recoveries provide information regarding the accuracy/bias of the organic analyses on an individual sample bias. Surrogate compounds are not expected to be found in the samples and are added to every sample prior to sample preparation/purging. The percent recovery data provide an indication of the effect that the sample matrix may have on the preparation and analysis procedure. Sample data exhibiting matrix effects will have been identified during data verification/validation process.

Matrix spike sample data can provide information regarding the accuracy/bias of the analytical methods relative to the sample matrix. Matrix spike samples are field samples that have been fortified with target analytes prior to sample preparation and analysis. The percent recovery data provide an indication of the effect that the sample matrix may have on the preparation and analysis procedure. Sample data exhibiting matrix effects will have been identified during data verification/validation process.

Analytical accuracy/bias will be determined by evaluating the percent recovery data of LCSs. LCSs are artificial samples prepared in the laboratory using a blank matrix that is fortified with analytes from a standard reference material that is independent of the calibration standards. LCSs are prepared and analyzed in the same manner as the field samples. The data from LCS analyses will provide an indication of the accuracy and bias of the analytical method for each target analyte.

Percent recovery is calculated using the following formula:

$$\%R = \frac{SSR - SR}{SA} \times 100$$

where: SSR = Spiked Sample Result
SR = Sample Result or Background
SA = Spike Added.

The percent recovery of LCSs is determined by dividing the measured value by the true value and multiplying by 100.

Overall accuracy/bias for the sampling events will be determined by calculating the percent accuracy measurements that meet the measurement performance criteria specified in Section 1.5.2 of this QAPP. Overall accuracy will be considered acceptable if the surrogate percent recoveries are met for at least 75 percent of the samples and the

LCS percent recoveries are met for all samples and the MS/MSD percent recoveries are met for at least 75 percent of the samples.

The Data Assessment Report will discuss and compare overall contamination and accuracy/bias data from multiple data sets collected for the project for each matrix, analytical parameter, and concentration level. The Data Assessment Report will describe the limitations on the use of the project data if extensive contamination and/or inaccuracy/bias exists or when it is limited to a specific sampling or laboratory analytical group, data set, analytical parameter, or concentration level. The Data Assessment Report will identify qualitative and/or quantitative bias trends in multiple performance evaluation (PE) sample results for each matrix, analytical parameter, and concentration level. The impact of any qualitative and/or quantitative trends in bias on the sample data will be discussed. Any PE samples that have false positive and/or false negative results should be reported and the impact on data usability will be discussed in the Data Assessment Report.

When project-required accuracy/bias is not achieved and project data are not usable to adequately address environmental questions and to support project decision making, then the Data Assessment Report will address how this problem will be resolved and the potential need for resampling.

4.3.3 Sample Representativeness

In order to meet the needs of the data users, project data must meet the measurement performance criteria to sample representativeness specified in Section 1.5.3.

Representativeness of the samples will be assessed by reviewing the results of field audits and the data from field duplicate samples. If field duplicate precision checks indicate potential spatial variability, then this may trigger additional scoping meetings and subsequent resampling in order to collect data that are more representative of a nonhomogeneous site. Overall sample representativeness will be determined by calculating the percent of field duplicate sample data that achieved the RPD criteria specified in Section 1.5.3 of this QAPP. Overall sample representativeness will be considered acceptable if the results of the field audits indicate that the approved sampling methods or alternate acceptable sampling methods were used to collect the samples, and the field duplicates RPD data are acceptable for at least 75 percent of the samples.

The Data Assessment Report will discuss and compare overall representativeness for each matrix, parameter, and concentration level. Data Assessment Reports will describe the limitations on the use of project data when overall non-representative sampling has occurred or when non-representative sampling is limited to a specific sampling group, data set, matrix, analytical parameter, or concentration level. If data are not usable to adequately address environmental questions and/or support project decision

making, then the Data Assessment Report will address how this problem will be resolved and discuss potential need for resampling.

4.3.4 Sensitivity and Quantitation Limits

In order to meet the needs of the data user, project data must meet the measurement performance criteria for sensitivity as specified. Low point calibration standards should produce a signal at least ten times the background noise levels and should be part of a linear calibration curve. Document the procedures for calculating method detection limits (MDLs) and quantitation limits (QLs).

4.3.4.1 Overall Sensitivity and Quantitation Limits

The quantitation limits for the sample data will be reviewed so that the sensitivity of the analyses was sufficient to achieve WDNR standards. The method/preparation blank sample data and LCSs percent recovery data will be reviewed to assess compliance with the measurement performance criteria specified in Section 1.5.6 of this QAPP.

Overall sensitivity will be assessed by comparing the sensitivity for each monitoring program to the detectability requirements for the analyses. Overall sensitivity will be considered acceptable if quantitation limits for samples are less than the acceptable evaluation criteria (i.e., WDNR standards).

It should be noted that quantitation limits may be elevated as a result of high concentrations of target compounds, nontarget compounds, and matrix interferences (collectively known as sample matrix effects). In these cases, the sensitivity of the analyses will be evaluated on an individual sample basis relative to the applicable evaluation criteria. The need to investigate the use of alternate analytical methods may be required if the sensitivity of the analytical methods identified in this QAPP cannot achieve the evaluation criteria because of sample matrix interference.

If Data Validation Reports indicate that sensitivity and/or QLs were not achieved, then the impact of that lack of sensitivity and/or higher QLs on data usability will be discussed in the Data Assessment Report.

The Data Assessment Report will discuss and compare overall sensitivity and QLs from multiple data sets collected for the project for each matrix, analytical parameter, and concentration level. The Data Assessment Report will describe the limitations on the use of the project data if project-required sensitivity and QLs were not achieved for all project data or when it is limited to a specific sampling or laboratory/analytical group, data set, matrix, analytical parameter, or concentration level.

When project-related QLs are not achieved and project data are not usable to adequately address environmental questions and to support project decision making, then the Data Assessment Report will address how this problem will be resolved and discuss the potential need for resampling. In this case, the Data Assessment Report will clearly differentiate between usable and unusable data for the users.

4.3.5 Completeness

In order to meet the needs of the data users, project data will follow the measurement performance criteria for data completeness outlined in Section 1.5.4.

4.3.5.1 Overall Completeness

Completeness will be assessed by comparing the number of valid (usable) sample results to the total possible number of results within a specific sample matrix and/or analysis. Percent completeness will be calculated using the following formula:

$$\% \text{ Completeness} = \frac{\text{Number of Valid (usable) measurements}}{\text{Number of Measurements Planned}} \text{ X } 100$$

Overall completeness will be assessed by calculating the mean percent completeness for the entire set of data obtained for each sampling program. The overall completeness for the project will be calculated when all sampling and analysis is concluded. Overall completeness will be considered acceptable if at least 90 percent of the data are determined to be valid.

The Data Assessment Report will discuss and compare overall completeness of multiple data sets collected for the project for each matrix, analytical parameter, and concentration level. The Data Assessment Report will describe the limitation on the use of the project data if project-required completeness was not achieved for the overall project or when it is limited to a specific sampling or laboratory/analytical group, data set, analytical parameter, or concentration level.

When project-required completeness is not achieved and sufficient data are not available to adequately address environmental questions and support project decision making, then the Data Assessment Report will address how this problem will be resolved and discuss the potential need for additional resampling.

4.3.6 Comparability

In order to meet the needs of the data users, project data will follow the measurement performance criteria for comparability outlined in Section 1.5.5.

The comparability of data sets will be evaluated by reviewing the sampling and analysis methods used to generate the data for each data set. Project comparability will be determined to be acceptable if the sampling and analysis methods specified in this QAPP and any approved QAPP revisions or amendments are used for generating the soil, groundwater, sediment, and surface water data.

The Data Assessment Report will discuss and compare overall comparability between multiple data sets collected for the project for each matrix, analytical parameter, and concentration level. The Data Assessment Report will describe the limitation on the use of project data when project-required data comparability is not achieved for the overall project or when it is limited to a specific sampling or laboratory/analytical group, data set, matrix, analytical parameter, or concentration level.

For long-term monitoring projects, data comparability is extremely important. Project data will be compared to previously generated data to determine the possibility of false positives and/or false negatives. Variations detected in the data may reflect a changing environment or indicate sampling and/or analytical error. Comparability criteria will be established to evaluate these data sets in order to identify statistical outliers to trigger resampling as verified.

If it is determined that long-term monitoring data are not comparable, the Data Assessment Report will address whether the data indicate a changing environment or the anomalies are a result of sampling and/or analytical error. If data are not usable to adequately address environmental questions and/or support project decision making, then the Data Assessment Report will address how this problem will be resolved.

Overall comparability of data from split samples (samples that are collected at the same time from the same location and split equally between two parties using sample containers from the same source or vendor) will be evaluated by determining the RPD of detected analytes in both samples following data verification/validation. Analytes that are detected in only one of the two samples will be assessed by reviewing the data verification/validation reports for both data sets and determining the cause of the discrepancy. Overall comparability of split sample data will be considered acceptable if the RPD for detected analytes with concentrations greater than or equal to five times their respective quantitation limits does not exceed RPD acceptance criteria for field duplicate samples.

If screen/confirmatory comparability criteria are not met, then this will be documented in the Data Assessment Report and the effect on data usability will be discussed. If oversight split-sampling comparability criteria are not met, then this will be documented in the Data Assessment Report and the effect on data usability will be discussed. If data are not usable to adequately address environmental questions and/or

support project decision making, then the Data Assessment Report will address how this problem will be resolved and discuss potential need for resampling.

Overall comparability of data from the groundwater monitoring program will be assessed by evaluating analyte concentrations over time. The data from monitoring events will be evaluated for trends, if necessary, using the Mann-Kendall test described in Section 4.3.4.1 of EPA QA/G-9. Suspected outliers will be assessed using the Extreme Value Test described in Section 4.4.3 of EPA QA/G-9. As the groundwater database becomes larger, it may be necessary to use different statistical methods to determine trends and outliers. Any changes to the statistical methods used for this project will be communicated to the WDNR prior to initiating the change.

4.3.7 Data Limitations and Actions

Sources of sampling and analytical error will be identified and corrected as early as possible to the onset of sample collection activities. An ongoing data assessment process will be incorporated during the project, rather than just as a final step, to facilitate the early detection and correction of problems, ensuring that project quality objectives are met.

Data that do not meet the measurement performance criteria specified in this QAPP will be identified and the impact on the project quality objectives will be assessed and discussed within the final report. Specific actions for data that do not meet the measurement performance criteria depend on the use of the data and may require that additional samples are collected or the use of the data to be restricted.

5.0 REFERENCES

United States Environmental Protection Agency. 2006. *EPA Requirements for Quality Assurance Project Plans*. EPA QA/R-5, Office of Research and Development, Washington DC.

United States Environmental Protection Agency. 1993. *Data Quality Objectives Process for Superfund: Interim Final Guidance*. EPA 540-R-93-071, Office of Research and Development, Washington DC.

United States Environmental Protection Agency. 1994. *Guidance for Data Quality Assessments*. EPA QA/G-5, Office of Research and Development, Washington DC.

United States Environmental Protection Agency. 1996. *Guidance for the Data Quality Assessment Process: Practical Methods for Data Analysis*. EPA QA/G-9, Office of Research and Development, Washington DC.

LIST OF TABLES

Table 1 - Laboratory Analyses by Laboratory
Marathon County Area-Wide Brownfield Assessment Project

Laboratory Name	Analyses to be Performed	Method Number	Media
PACE Analytical Green Bay, WI	VOCs	SW-846 8260	Groundwater

SM - Standard Methods for Analysis of Water and Wastewater

Table 2

Laboratory Data Quality Objectives for Groundwater
Lakewood DX Groundwater Assessment Project

	NR 140 Standards		Federal	Laboratory Objectives						Acceptance Criteria	
				Analytical Methods/Limits						MS/MSD	
Parameters (units) [Laboratory]	**ES**	*PAL*	MCL/MCLG	Prep/Extraction	Analysis	MDL	PQL	LCS	RPD	Recovery	RPD
VOCs (ug/L) [PACE]											
1,1,1,2-Tetrachloroethane	**70**	*7*	--	5030	8260B	0.92	1.0	70-130	20	70-130	20
1,1,1-Trichloroethane	**200**	*40*	200	5030	8260B	0.9	1.0	70-132	20	70-130	20
1,1,2,2-Tetrachloroethane	**0.2**	*0.02*	--	5030	8260B	0.2	1.0	69-130	20	67-130	20
1,1,2-Trichloroethane	**5**	*0.5*	5	5030	8260B	0.42	1.0	70-130	20	70-130	20
1,1-Dichloroethane	**850**	*85*	--	5030	8260B	0.75	1.0	70-130	20	69-131	20
1,1-Dichloroethene	**7**	*0.7*	7	5030	8260B	0.57	1.0	70-130	20	70-130	20
1,1-Dichloropropene	**--**	--	--	5030	8260B	0.75	1.0	70-130	20	70-130	20
1,2,3-Trichlorobenzene	**--**	--	--	5030	8260B	0.74	1.0	70-130	20	70-130	20
1,2,3-Trichloropropane	**60**	*12*	--	5030	8260B	0.99	1.0	70-130	20	70-130	20
1,2,4-Trichlorobenzene	**70**	*14*	--	5030	8260B	0.97	1.0	70-130	20	70-130	20
1,2,4-Trimethylbenzene[1]	**480**	*96*	--	5030	8260B	0.97	1.0	70-130	20	70-130	20
1,2-Dibromo-3-chloropropane	**0.2**	*0.02*	0.2	5030	8260B	1.68	5.0	50-150	20	70-130	20
1,2-Dibromoethane	**0.05**	*0.005*	0.05	5030	8260B	0.56	1.0	70-130	20	70-130	20
1,2-Dichlorobenzene	**600**	*60*	600	5030	8260B	0.83	1.0	70-130	20	70-130	20
1,2-Dichloroethane	**5**	*0.5*	5	5030	8260B	0.36	1.0	70-134	20	70-130	20
1,2-Dichloropropane	**5**	*0.5*	5	5030	8260B	0.49	1.0	70-130	20	70-130	20
1,3,5-Trimethylbenzene[1]	**480**	*96*	--	5030	8260B	0.83	1.0	70-130	20	70-130	20
1,3-Dichlorobenzene	**600**	*120*	--	5030	8260B	0.87	1.0	70-130	20	70-130	20
1,3-Dichloropropane	**--**	--	--	5030	8260B	0.61	1.0	70-130	20	70-130	20
1,4-Dichlorobenzene	**75**	*15*	75	5030	8260B	0.95	1.0	70-130	20	70-130	20
2,2-Dichloropropane	**--**	--	--	5030	8260B	0.62	1.0	70-130	20	70-130	20
2-Chlorotoluene	**--**	--	--	5030	8260B	0.85	1.0	70-130	20	70-130	20
4-Chlorotoluene	**--**	--	--	5030	8260B	0.74	1.0	70-130	20	70-130	20
Benzene	**5**	*0.5*	5	5030	8260B	0.41	1.0	70-131	20	69-130	20
Bromobenzene	**--**	--	--	5030	8260B	0.82	1.0	70-130	20	70-130	20
Bromochloromethane	**--**	--	--	5030	8260B	0.97	1.0	70-130	20	70-130	20
Bromodichloromethane	**0.6**	*0.06*	--	5030	8260B	0.56	1.0	70-130	20	70-130	20
Bromoform	**4.4**	*0.44*	--	5030	8260B	0.94	1.0	70-130	20	68-130	20
Bromomethane	**10**	*1*	--	5030	8260B	0.91	1.0	23-200	20	22-200	20
Carbon tetrachloride	**5**	*0.5*	5	5030	8260B	0.49	1.0	70-130	20	70-130	20
Chlorobenzene	**100**	*20*	100	5030	8260B	0.41	1.0	70-130	20	70-130	20
Chlorodibromomethane	**60**	*6*	--	5030	8260B	0.81	1.0	70-130	20	70-130	20
Chloroethane	**400**	*80*	--	5030	8260B	0.97	1.0	70-136	20	66-136	20
Chloroform	**6**	*0.6*	--	5030	8260B	1.3	5.0	70-130	20	70-130	20
Chloromethane	**30**	*3.0*	--	5030	8260B	0.24	1.0	54-148	20	45-143	20

Table 2

Laboratory Data Quality Objectives for Groundwater
Lakewood DX Groundwater Assessment Project

Parameters (units) [Laboratory]	NR 140 Standards ES	NR 140 Standards *PAL*	Federal MCL/MCLG	Laboratory Objectives: Analytical Methods/Limits Prep/Extraction	Analysis	MDL	PQL	LCS	RPD	Acceptance Criteria: MS/MSD Recovery	RPD
VOCs (ug/L) [PACE]											
cis-1,2-Dichloroethene	**70**	*7*	70	5030	8260B	0.83	1.0	70-130	20	70-130	20
cis-1,3-Dichloropropene [2]	**0.2**	*0.02*	--	5030	8260B	0.2	1.0	70-130	20	70-130	20
Dibromomethane	**--**	--	--	5030	8260B	0.6	1.0	70-130	20	70-130	20
Dichlorodifluoromethane	**1000**	*200*	--	5030	8260B	0.99	1.0	70-130	20	70-130	20
Diisopropyl ether	**--**	--	--	5030	8260B	0.76	1.0	70-130	20	70-130	20
Ethylbenzene	**700**	*140*	700	5030	8260B	0.54	1.0	70-130	20	70-130	20
Fluorotrichloromethane	**3490**	*698*	--	5030	8260B	0.79	1.0	70-130	20	70-130	20
Hexachlorobutadiene	**--**	--	--	5030	8260B	0.67	5.0	70-130	20	70-130	20
Isopropylbenzene	**--**	--	--	5030	8260B	0.59	1.0	70-130	20	70-130	20
Methylene chloride	**5**	*0.5*	--	5030	8260B	0.43	1.0	66-130	20	64-130	20
Methyl-tert-butyl-ether	**60**	*12*	--	5030	8260B	0.61	1.0	70-130	20	70-130	20
Naphthalene	**100**	*10*	--	5030	8260B	0.89	5.0	70-130	20	70-130	20
n-Butylbenzene	**--**	--	--	5030	8260B	0.93	1.0	70-130	20	70-130	20
n-Propylbenzene	**--**	--	--	5030	8260B	0.81	1.0	70-130	20	70-130	20
p-Isopropyltoluene	**--**	--	--	5030	8260B	0.67	1.0	70-130	20	70-130	20
sec-Butylbenzene	**--**	--	--	5030	8260B	0.89	5.0	70-130	20	70-130	20
Styrene	**100**	*10*	100	5030	8260B	0.86	1.0	70-130	20	43-130	20
tert-Butylbenzene	**--**	--	--	5030	8260B	0.97	1.0	70-130	20	70-130	20
Tetrachloroethene	**5**	*0.5*	5	5030	8260B	0.45	1.0	70-130	20	70-130	20
Toluene	**800**	*160*	1000	5030	8260B	0.67	1.0	70-130	20	70-130	20
trans-1,2-Dichloroethene	**100**	*20*	100	5030	8260B	0.89	1.0	70-130	20	70-130	20
trans-1,3-Dichloropropene [2]	**0.2**	*0.02*	--	5030	8260B	0.19	1.0	70-130	20	70-130	20
Trichloroethene	**5**	*0.5*	5	5030	8260B	0.48	1.0	70-130	20	70-130	20
Vinyl chloride	**0.2**	*0.02*	2	5030	8260B	0.18	1.0	63-141	20	70-130	20
Xylene, -o [3]	**2,000**	*400*	10	5030	8260B	0.83	1.0	70-130	20	70-130	20
Xylenes, -m & -p [3]	**2,000**	*400*	10	5030	8260B	1.8	2.0	70-130	20	70-130	20

Notes:

VOCs = Volatile Organic Compounds

MCL/MCLG = Maximum Contaminant Level/Maximum Contaminant Level Goal - National Primary Drinking Water Standards-Federal

[1] Standards are for 1,2,4- and 1,3,5-Trimethylbenzene combined.

[2] Standards are for cis and trans 1,3-dichloropropene.

[3] Standards are for Total Xylenes (-m, -p and -o).

-- No NR 140 ES or PAL established.

Table 3
Field and Lab QA/QC Sample Requirements
Lakewood DX (BRRTS No. 02-43-000105) Groundwater Assessment Project

	QC Sample Type	Frequency of Sample/Analysis	Details
Field Samples	Duplicate Samples	Groundwater: 1 duplicate per 10 samples, or 1 duplicate if fewer than 10 samples	Duplicate sample to be collected by the same methods at the same time as the original sample. Used to verify sample and analytical reproducibility.
	Equipment Blanks	1 equipment blank per 20 samples, if matrix is sampled with reusable equipment. Sample after decontamination is performed.	Distilled water placed into contact with sampling equipment. Used to assess quality of data from field sampling and decontamination procedures.
	Trip Blanks	1 trip blank per cooler containing samples for VOC analysis for water samples	Laboratory prepared organic-free blank to assess potential contamination during sample container shipment and storage.
Lab Samples	Matrix Spike/Matrix Spike Duplicate	1 MS/MSD per 20 or fewer samples per matrix	Laboratory spiked sample to evaluate matrix and measurement methodology.
	Method Blanks	1 method blank per lab SOP	Laboratory blank sample to assess potential for contamination from laboratory instruments or procedures.
	Laboratory Control Samples and Duplicates	Analyzed as per method requirements and laboratory SOPs	Evaluates laboratory reproducibility.

Table 4
Sample Container, Preservation, and Holding Time Requirements
Lakewood DX (BRRTS No. 02-43-000105) Groundwater Assessment Project

Parameter	Bottle Requirements	Preservation Requirements	Holding Time (1)
Water Samples			
VOCs	3-40ml glass vials with Teflon lined septum	4°C; HCl pH <2	14 days

(1) Holding times are based on time of sample collection.

Table 5
QA Objectives for Field Measurements
Lakewood DX (BRRTS No. 02-43-000105) Groundwater Assessment Project

Measurement Parameter	Equipment[1]	Instrument Range	Precision[2]	Accuracy[3]	Completeness
Water					
Water Levels	Slope Indicator or Solinist	0-100 feet	±0.01 foot	0.005 foot	95%
Oil/Water Interface	Heron Interface Sm. Oil Meter	0-60 feet	±0.01 foot	0.005 foot	95%
Temperature	Orion	-5 to 45°C	±0.1°C	±0.15°C	95%
Conductivity		0-200 mS/cm	±1mS/cm	±0/5%	95%
pH		0-14 pH units	±0.1 pH units	±0 pH units	95%
ORP	Hanna Instruments	±999mV	±1 mV	±5mV	95%
Dissolved Oxygen	YSI	0-50 feet	0.1%	±2%	95%
Vapor					
Headspace/organic vapor	MiniRae 2000 PID	0-999ppm [4]	0.1 ppm		95%
	Photovac 2020 PID	0.1-2000 ppm [4]	0.1 ppm	±2 ppm	95%

Notes:
[1] The above list of field instruments constitutes those that are anticipated to be used for the project. It should be noted that certain GEI standard operating procedures (SOPs) may include discussion of additional field instruments beyond what is anticipated for the project.
[2] Expressed as the acceptable deviation from the Scale.
[3] Expected based on equipment manufacturer specifications.
[4] Instrument units as calibrated to isobutylene
ORP - Oxidation reduction potential
PID - Photoionization Detector

Table 6
Field Equipment Preventive Maintenance
Lakewood DX (BRRTS No. 02-43-000105) Groundwater Assessment Project

Instruments	Maintenance Procedures/Schedule	Spare Parts in Stock
Photoionization Detectors Including MiniRae 2000 or Photovac 2020	1. Calibrate at the beginning of each day and as necessary during use. 2. Check battery, and recharge when low. 3. Replace dust filter every 240 hours of operation or as needed.	1. Battery charger 2. Spare filter cartridges
Water Level Meters Interface Probes	1. Check battery and response to water prior to field work. 2. Replace battery when light/sound are weak or low. 3. Clean immediately after use and again prior to field work to minimize potential for cross contamination.	1. Batteries
Dissolved Oxygen	1. Calibrate at the beginning of field event (and daily for multiple day events), and as necessary during use. 2. Replace electrodes as needed.	1. Calibration solution 2. Batteries
pH Meter/temperature	1. Calibrate at the beginning of field event (and daily for multiple day events), and as necessary during use. 2. Replace electrodes as needed.	1. pH buffers 2. Batteries 3. Spare electrodes
Conductivity Meter/temperature	1. Calibrate at the beginning of field event (and daily for multiple day events), and as necessary during use. 2. Check redline and replace batteries if does not calibrate.	1. Calibration solution 2. Batteries
ORP	1. Calibrate at the beginning of field event (and daily for multiple day events), and as necessary during use. 2. Replace electrodes as needed.	1. Calibration solution 2. Batteries

APPENDIX A

Appendix A GEI Field SOPs

FD-001 Field Notebook

FD-003 Sample Management and Chain of Custody

GW-003 Low Flow (low stress) Groundwater Sampling

GW-004 pH and Temperature Measurement

GW-006 Specific Conductance Measurement

GW-009 Potable Well Sampling

QA-002 Field Quality Control Samples

Note: Standard Operating Procedures (SOPs) provide guidance for sampling and are not intended to match all project-specific procedures. Some procedures may be modified in the field to adapt more closely to Wisconsin Department of Natural Resources (WDNR) sampling guidance and/or based on consultation with the WDNR Project Manager.

STANDARD OPERATING PROCEDURE

FD-001 Field Notebook

1. Objective

Describe methods for documentation of field activities.

Documentation of site activities is a crucial part of the field investigation process. The field notebook serves as the record of field activities performed or observed during the project. It provides a factual basis for preparing field observation reports, if required, and reports to clients and regulatory agencies. Example field notes are provided in Attachment A.

2. Execution

- Use a separate all-weather bound notebook for each site/location/project number. Spiral notebooks should not be used because pages can be easily removed.
- Write neatly using black or blue pen, preferably a waterproof pen. Use of pencil is also acceptable only with approval of the project manager, such as in but not limited to, certain field conditions [e.g., cold or wet weather].
- Write the project name, project number, book number (i.e., 1 of 3), and date on the front cover. On the inside cover, identify the project name, project number, and "Return Book To:" the office address of the project manager.
- Number all of the pages of the field book starting with the first entry.
- Record activities as they occur. Record only facts and observations, regardless of whether they appear to be relevant at that time.
- Identify conditions or events that could affect/impede your ability to observe conditions (e.g. snow-covered ground surface, inability to access areas of interest).
- Neatly cross out mistakes using a single line and initial them. Erasures are not permitted.
    - If an error is made on an entry in the field notebook, the individual who made the entry should make the corrections. The corrections must be initialed and dated by the person making the correction.
- Sign or initial and date the bottom of every page with an entry if the project requires such documentation.
- Place a diagonal line through unused portions of a page.
- Record the following information upon each arrival at the site:
    - Date/time/weather.
    - GEI personnel.
    - Purpose of visit/daily objectives.
    - People (client, contractor, landowners, etc.) present upon GEI arrival.

- Record the following information during the course of the day:
  - Conversations with contractors/subcontractors, clients, visitors, GEI staff, landowners (site or abutters). If possible, record complete names, titles, and affiliations.
  - Time of arrival and departure of individuals.
  - Activities as they occur.

- Additional examples of observations to record may include and are not limited to:
  - Type and quantity of monitoring well construction materials used.
  - Use of field data sheets or electronic logging equipment (e.g. boring logs, monitoring well sampling logs, etc.).
  - Ambient air monitoring data.
  - Field equipment calibration information.
  - Locations and descriptions of sampling points.
  - Contractor/Subcontractor progress.
  - Sample media (soil, sediment, groundwater, etc.).
  - Sample collection method.
  - Number and volume of sample(s) collected and sample bottle preservatives used.
  - Sample identification number (s) and date and time of sample collection.
  - Approximate volume of groundwater removed before sampling.
  - Any field observations made such as pH, temperature, turbidity, conductivity, water level, etc.
  - References for maps and photographs of the sampling site(s).
  - Information pertaining to sample documentation: bottle lot numbers/ dates, method of sample shipments, chain-of custody record numbers, and overnight shipping numbers.
  - Surveying data (including sketches with north arrows).
  - Changes in weather.
  - Rationale for critical field decisions.
  - Recommendations made to the client representative and GEI Project Manager.
  - Site sketch of conditions at the end of the day.
  - Summary of work completed/work remaining.
  - Allow time at the end of the day to complete entries in the notebook.

3. References

New Jersey DEP Field Sampling Procedures Manual, August 2005.

ASFE Daily Field Report for Geotechnical Field Observation, 2nd Edition (2001), ASFE, Inc.

4. Attachments

Attachment A - Example Field Notes

5. Contact

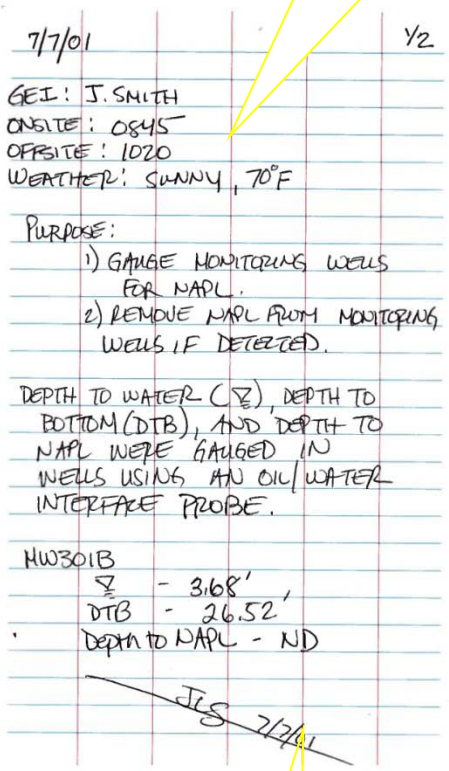
Melissa Felter
Leslie Lombardo

SOP FD-001

Attachment A – Example Field Notes

Start of each day includes:
- **Date**
- **Project Number**
- **People on site**
- **Purpose of Work**
- **Weather Conditions**

Each page is numbered



7/7/01 1/2

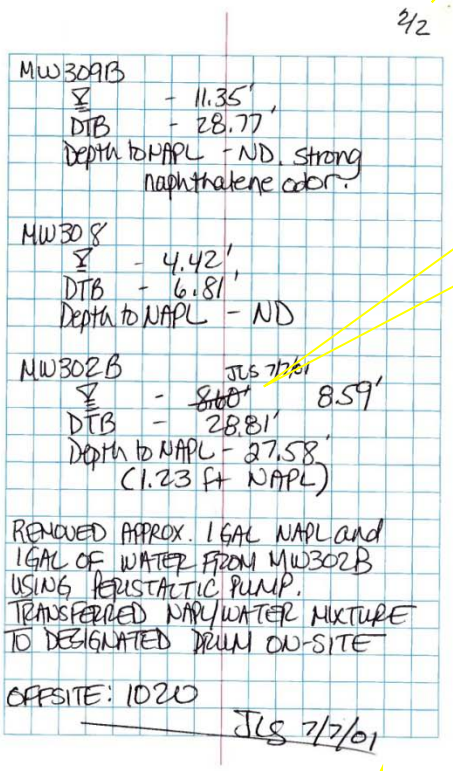
GEI: J. SMITH
ONSITE: 0845
OFFSITE: 1020
WEATHER: SUNNY, 70°F

PURPOSE:
1) GAUGE MONITORING WELLS FOR NAPL.
2) REMOVE NAPL FROM MONITORING WELLS IF DETECTED.

DEPTH TO WATER (▽), DEPTH TO BOTTOM (DTB), AND DEPTH TO NAPL WERE GAUGED IN WELLS USING AN OIL/WATER INTERFACE PROBE.

MW301B
▽ - 3.68'
DTB - 26.52'
Depth to NAPL - ND

JLS 7/7/01



2/2

MW309B
▽ - 11.35'
DTB - 28.77'
Depth to NAPL - ND. Strong naphthalene odor.

MW308
▽ - 4.42'
DTB - 6.81'
Depth to NAPL - ND

MW302B JLS 7/7/01
▽ - ~~8.60'~~ 8.59'
DTB - 28.81'
Depth to NAPL - 27.58'
(1.23 ft NAPL)

REMOVED APPROX. 1 GAL NAPL and 1 GAL OF WATER FROM MW302B USING PERISTALTIC PUMP. TRANSFERRED NAPL/WATER MIXTURE TO DESIGNATED DRUM ON-SITE

OFFSITE: 1020

JLS 7/7/01

Errors are single line crossed out and initialed

Blank Space crossed out and initialed

Bottom of each page signed and dated

GEI Consultants

STANDARD OPERATING PROCEDURE

FD-003 Sample Management and Chain of Custody

1. Objective

Describe methods to label sample containers, manage the samples, and prepare Chain of Custody documentation for the samples. Sample transport is also addressed.

2. Project Setup

When setting up a sampling event, inform the recipients of the samples (laboratories) and recipients of laboratory results (data group and project managers). Discuss with the laboratory the sampling media, turnaround times, and reporting limits for appropriate regulatory criteria for the site. Include the data group on correspondence so that turnaround times, data validation, and project deliverable schedules can be tracked successfully.

- Laboratory - Number of samples, analyses needed: bottle orders and holding times, turnaround times needed, reporting limits needed for regulatory criteria.
- Data group - Number of samples, analyses requested, turnaround times and reporting limits requested, data validation needed, regulatory criteria to use for tabulating results, deliverables needed, and project name and number.
- Schedule - Inform the laboratory and Data Group of schedule delays, changes to analyses, and expediting.

3. Sampling Execution

- Review the work plan prior to sampling to determine the following:
  - Sample matrix and sampling method.
  - Required analysis and sample volumes.
  - Sample container type and preservative requirements.
  - Required analysis methods and/or report formats.
  - The turnaround time required by the project.
  - If the data will be sent directly from the laboratory to the data validator, Project Manager, or Data Group.
  - Holding time restrictions for sampling media and analytical methods.
  - Sample naming convention used for this project site.
- Sample labels should be filled out using a waterproof or permanent marker or pen. Required information includes:
  - Sample ID.
  - Date and time (military time) of sample collection.
  - Project number.
  - Sample preservatives.
  - Sampler's initials.
  - Laboratory analytical methods.

- Place the label on the jar or bottle, not on the cap. Sample custody begins at this time.
- Record the above information in the field notebook.
- Individually wrap sample jars with packing material, if needed. See SOP SC-002 for guidance on packaging samples for shipment to the laboratory by way of common carrier. Place samples in a cooler with bagged ice or freezer packs (blue ice) immediately after collection. Add sufficient ice or freezer packs to cool samples to approximately 4°C.
- Complete a chain of custody (COC) for the samples as described below. GEI or laboratory COCs may be used as long as they contain fields for all required sample information as described in Section 2.1.

3.1. Chain-of-Custody (COC) Completion

- Fill out COC neatly and in permanent ink. Alternatively, an Excel version of the GEI COC is available and can be filled out electronically.
- Certain analyses (i.e. air analysis by TO-15) require specialized, laboratory issued COCs. Make sure any specialized COCs are available before sample collection.
- Record the project name and number, the sampler's name(s) and the state where the samples were collected.
- For each sample, enter the sample identification number, date and time (military time) collected, the number of sample containers, and any additional information to fulfill project, client or regulatory requirements.
- Record the type of analysis (including laboratory method; e.g. EPA-SW846 Method XX) requested and the preservative (if appropriate) in the vertical boxes.
- Field duplicates should be anonymous to the laboratory, but must be recorded for use by the Data Group. To keep track of this information, link the field duplicate with the proper sample in the field notebook. If required by the Project Manager or Data Group, also document this information on or attach a note to the GEI copy of the COC.
- Trip blanks for large sites should be named similar to the samples they are collected with so that there are not two of the same sample name for the same site. For example, "OU1TB-122509" and "OU3TB-122509" would avoid any mistakes.
- Strike incorrect entries on the COC with a single line, followed by the initials of the person making the correction, the date, and the correct entry.
- When sample custody is ready to be relinquished, complete the bottom of the form with date and time (military time) and signatures of relinquisher and receiver of samples as indicated. The sample collector is always the first signature while the analytical laboratory is the final signature. Theoretically, all individuals handling the samples between collection and laboratory should sign the form; however, if a common carrier (i.e., Federal Express, UPS) is used for shipping, GEI must identify the carrier in the 'Received by' box on the

COC. If the sampler hand delivers the samples to the laboratory, the received box must be signed by the laboratory.

- If the samples are placed in a designated secure area (e.g. GEI sample fridge), note this location in the "Received by" box on the COC.
- GEI uses both single sheet and triplicate COCs. If using the triplicate COCs (white, yellow, and pink copies), the pink copy should be retained by the sampling personnel and provided to the Data Group for proper filing. The white and yellow copies should accompany the samples to the laboratory.
- If you are using the single sheet COC, make a copy of the COC after it has been signed by the lab courier and forward it to the Data Group.
- Prior to sample shipment by common carrier, the COC must be placed inside the cooler in a Ziplock bag or other watertight package.
- If a common carrier such as FedEx is used to transport the samples to the laboratory, include the carrier tracking number and identify the carrier in the "Received by" box on the COC.
- If a courier is used to transport samples to the laboratory (lab courier or GEI personnel), the courier signs the COC in the "Received by" box.
- Place a custody seal on the cooler if shipping via common carrier.
- Transport samples to the laboratory as soon as possible. It is preferable to transport the samples directly to the laboratory from the field. Samples brought back to the office for storage prior to submission to the laboratory must be kept cold (4° C).
- Unused sampling containers/media that are sent back to the lab should be included on a separate COC.
- After the samples are sent to the laboratory, the GEI copy of the COC must be forwarded to the Data Group: datagroup@geiconsultants.com.

4. Limitations

- Keep the number of people involved in handling samples to a minimum.
- Where practical, only allow people associated with the project to handle the samples.
- Always document the transfer of samples from one person to another on the COC.
- The COC should always accompany the samples.
- Give samples positive identification at all times that is legible and written with waterproof or permanent ink.
- When sending samples via a common carrier, use one COC per package.
- Where practical, avoid sending samples from more than one site with separate COCs in a single package.

5. References

New Jersey Department of Environmental Protection, Field Sampling Procedures Manual, August 2005.

Connecticut Department of Environmental Protection, Guidance for Collecting and Preserving Soil and Sediment Samples for Laboratory

6. Attachments

Attachment A - Example Chains of Custody
Attachment B - Shipping Info Pics

7. Contact

Brian Skelly
Leslie Lombardo

Chain of Custody Record

STL Connecticut
128 Long Hill Cross Road
Shelton, CT 06484
Tel: 203-929-8140

Example COC

SEVERN TRENT **STL**
Severn Trent Laboratories, Inc.

STL-4124 (0901)

Client	Project Manager	Date	Chain of Custody Number
GEI	Dave Terry	12-31-07	00452

Address	Telephone Number (Area Code)/Fax Number	Lab Number	Page
455 Winding Brook Dr	860 368 5300 / 860 368 5307		1 of 1

City	State	Zip Code	Site Contact	Lab Contact
Glastonbury	CT	06033	M. Felter	Paul Mobart

Project Name and Location (State)	Carrier/Waybill Number
Carroll Gardens NY	FedEx 9383 7603 0879

Contract/Purchase Order/Quote No.

Sample I.D. No. and Description (Containers for each sample may be combined on one line)	Date	Time	Matrix: Air	Aqueous	Sed.	Soil	Containers & Preservatives: Unpres.	H2SO4	HNO3	HCl	NaOH	ZnAc/NaOH	Analysis: VOC 8260B	SVOC 8270C	TO-15 + NAPHTHALENE	Special Instructions/ Conditions of Receipt
CGSB-01 (0-2)	12-31-07	1130				X	X						X	X		
CGSB-02 (3-4)	12-31-07	1250				X	X						X	X		
CGSB-02 (3-4) MS	12-31-07	1250				X	X						X	X		
CGSB-02 (3-4) MSD	12-31-07	1250				X	X						X	X		
CGSB-XX (5-6)	12-31-07	0800				X	X						X	X		
CGTB-123107	12-31-07	1400				TB				X			X			
CGGW-01	12-31-07	1430		X			X			X			X	X		
CGSG-01	12-31-07	0700-1500	X												X	CANISTER# 2013 REGULATOR# 779

For New Jersey: "CLP data package deliverables"

Possible Hazard Identification
☐ Non-Hazard ☐ Flammable ☐ Skin Irritant ☐ Poison B ☒ Unknown

Sample Disposal
☐ Return To Client ☒ Disposal By Lab ☐ Archive For _____ Months (A fee may be assessed if samples are retained longer than 1 month)

Turn Around Time Required
☐ 24 Hours ☐ 48 Hours ☐ 7 Days ☐ 14 Days ☐ 21 Days ☒ Other see contract

QC Requirements (Specify) Send EDD to datagroup@geiconsultants.com NYS Cat B ASP deliverable send to Lorie Mackinnon

1. Relinquished By	Date	Time	1. Received By	Date	Time
Melissa J Felter	12-31-07	1600	FedEx Waybill 923117-4432	12-31-07	
2. Relinquished By	Date	Time	2. Received By	Date	Time
3. Relinquished By	Date	Time	3. Received By	Date	Time

Comments
USED FLOW CONTROLLER FOR AIR SAMPLE INCLUDED

DISTRIBUTION: WHITE - Returned to Client with Report; CANARY - Stays with the Sample; PINK - Field Copy

EXAMPLE COC

Chain-of-Custody Record

Laboratory: Accutest

Laboratory Job # (Lab use only)

GEI Consultants
400 Unicorn Park Dr.
Woburn, MA 01801
PH: 781.721.4000
FX: 781.721.4073

Project Information

Project Name: MWRA - Low Service Storage Tank

Project Location: Stoneham, MA

Project Number: 093400

Project Manager: D. Aghjayan

Send Report to: rseigener@geiconsultants.com

Send EDD to: labdata@geiconsultants.com

MCP PRESUMPTIVE CERTAINTY REQUIRED – YES NO

If Yes, Are MCP Analytical Methods Required? YES NO NA

If Yes, Are Drinking Water Samples Submitted? YES NO NA

If Yes, Have You Met Minimum Field QC Requirements? YES NO NA

Sample Handling

Samples Field Filtered
YES NO NA

Sampled Shipped With Ice
YES NO

Lab Sample Number	GEI Sample ID	Collection Date	Collection Time	Matrix	No. of Bottles	Sampler(s) Initials	Preservative	Preservative	Preservative	Preservative	Preservative	Preservative	Preservative	Preservative	Sample Specific Remarks
							None	MeOH	None	None	MeOH	None	None	None	
							Analysis								
							PCBs	VPH Fractions Only	EPH Fractions Only	SVOCs	VOCs, % Solids**	Conductivity	RCRA 8 Metals*	TPH by GC/FID DRO	
	093400-LS6-S5(19'-21')	12/29/2009	9:30	SO	3	JMR		x			x				
	093400-LS6-COMP (FILL)	12/29/2009	9:30	SO	1	JMR	x		x	x		x	x	x	
	093400-LS6-COMP (NATIVE)	12/29/2009	15:00	SO	1	JMR	x		x	x		x	x	x	
	093400-LS8-COMP	12/29/2009	14:00	SO	1	JMR	x		x	x		x	x	x	
	093400-LS9-S4 (8'-8'-5")	12/30/2009	14:30	SO	3	JMR		x			x				
	093400-LS9-COMP	12/30/2009	15:00	SO	1	JMR	x		x	x		x	x	x	

MCP Level Needed: GEI requires the most stringent Method 1 MCP standard be met for all analytes whenever possible.

Relinquished by sampler: (signature)	Date:	Time:	Received by: (signature)
1. Joseph M. Reyes	12/30/09	16:30	1. GEI FRIDGE
Relinquished by: (signature)	Date:	Time:	Received by: (signature)
2. GEI FRIDGE	1/4/10	1310	2. Naomi Hagopian
Relinquished by: (signature)	Date:	Time:	Received by: (signature)
3. Naomi Hagopian	1/4/10	1310	3. [illegible]
Relinquished by: (signature)	Date	Time	Received by: (signature)
4.			4.

Turnaround Time (Business days):

Normal _X_ Other ____

10-Day ____ 7-Day ____

5-Day ____ 3-Day ____

Before submitting rush turnaround samples, you must notify the laboratory to confirm that the TAT can be achieved.

Additional Requirements/Comments/Remarks:

Please use MA Landfill List

* Please run TCLP analysis for RCRA 8 Metals results that exceed the 20 times rule.

** Please use % solids sample for VOC and VPH analysis of 093400-LS6-COMP (FILL), 093400-LS6-COMP (NATIVE), 093400-LS8-COMP, and 093400-LS9-COMP

Chain-of-Custody Record

Laboratory:

Laboratory Job # (Lab use only)

GEI Consultants
455 Winding Brook Drive, Suite 201
Glastonbury, CT 06033
PH: 860.368.5300
FX: 860.368.5307

Project Information

Project Name/Number:

Project Location:

Project Contact:

Phone Number:

Page __ of __

Send Report to:

Send EDD to: datagroup@geiconsultants.com

Preservative

Analysis

Sample Handling

Samples Field Filtered

YES NO NA

Samples Shipped With Ice

YES NO

Deliverables:

If Yes, Have You Met Minimum Field QC Requirements? YES NO NA

Lab Sample Number	GEI Sample ID	Collection		Matrix	No. of Bottles	Sampler(s) Initials	Sample Specific Remarks
		Date	Time				

Relinquished by sampler: (signature)	Date :	Time:	Received by: (signature)
1.			1.
Relinquished by: (signature)	Date :	Time:	Received by: (signature)
2.			2.
Relinquished by: (signature)	Date :	Time:	Received by: (signature)
3.			3.
Relinquished by: (signature)	Date :	Time:	Received by: (signature)
4.			4.

Turnaround Time (Business days):

Normal _____ **Other** _____

10-Day _____ **7-Day** _____

5-Day _____ **3-Day** _____

Before submitting rush turnaround samples, you **must** notify the laboratory to confirm that the TAT can be achieved.

Additional Requirements/Comments/Remarks:

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

PACKING SAMPLES FOR SHIPMENT BACK TO THE LABORATORY

A. Line cooler with bubble wrap and large plastic bag. Use absorbent pad inside the bag if bottles contain preservatives.

B. Wipe outside of bottles and put glass in individual bubble bags & seal. Place bottles & the temperature blank into cooler. Leave room for ice in between bottles & on top.

C. Place double bagged or loose ice randomly around bottles throughout the cooler.

D. Place large bag of ice or loose ice on top of the bottles. In warm weather, the cooler should be packed with as much ice as possible.

E. Close outer bag, compress excess air out of bag, twist top and knot. If necessary, use more bubble wrap to fill the dead air spaces. Place chain of custody (COC) and other paperwork in plastic bag and seal. Place on top of cooler.

F. Close cooler, place signed and dated Custody Seals over opening. Tape over the Custody Seal and seal cooler securely. Fill out overnight shipping waybill and attach to the top or handle of the cooler. Attach Saturday delivery stickers if needed. Ship according to DOT regulations.

TestAmerica
THE LEADER IN ENVIRONMENTAL TESTING

PACKING SAMPLES FOR SHIPMENT BACK TO THE LABORATORY

A. Line cooler with bubble wrap and large plastic bag. Use absorbent pad inside the bag if bottles contain preservatives.

B. Wipe outside of bottles and put glass in individual bubble bags & seal. Place bottles & the temperature blank into cooler. Leave room for ice in between bottles & on top.

C. Place double bagged or loose ice randomly around bottles throughout the cooler.

D. Place large bag of ice or loose ice on top of the bottles. In warm weather, the cooler should be packed with as much ice as possible.

E. Close outer bag, compress excess air out of bag, twist top and knot. If necessary, use more bubble wrap to fill the dead air spaces. Place chain of custody (COC) and other paperwork in plastic bag and seal. Place on top of cooler.

F. Close cooler, place signed and dated Custody Seals over opening. Tape over the Custody Seal and seal cooler securely. Fill out overnight shipping waybill and attach to the top or handle of the cooler. Attach Saturday delivery stickers if needed. Ship according to DOT regulations.

STANDARD OPERATING PROCEDURE

GW-003 Low Flow (Low Stress) Groundwater Sampling

1. Objective

Describe methods to collect groundwater samples most likely to produce results that represent aquifer conditions.

Low-flow purging is limited to wells that, with sustained pumping, exhibit no continuous drawdown.

2. Execution

- Prior to groundwater sampling consult with the project manager to confirm that the type of pump is appropriate and consistent with the approved work plan.
- Record activities in the field notebook (see SOP FD-001 Field Notebook) and on a Monitoring Well Sampling Record such as the examples in Attachment A. Use a separate form for each sampling location and event. You may forego the forms and record all information in the field notebook if the Project Manager approves.
- Calibrate pH, temperature, Specific Conductance (SC), turbidity, Dissolved Oxygen (DO), and Oxidation-Reduction Potential (ORP) on the meter(s). Use calibration methods provided by the manufacturer of the equipment. Note that appropriate calibration for dissolved oxygen requires a water saturated air environment, along with measured temperature and barometric pressure.
- Begin with the monitoring well believed to have the least contaminated groundwater and proceed systematically to the well with the most contaminated groundwater. Check the well, the lock, and the locking cap for damage or evidence of tampering.
- Slowly and gently measure the depth to water with a water level probe and/or oil-water interface probe. Do not measure depth to well bottom at this time (wait until sampling has been completed). Measure water level in accordance with SOP GW-001 Water Level Measurement.
- Attach new polyethylene or Teflon lined tubing to the sampling pump and the flow-through cell that contains the meter probes.
- Slowly and gently insert new polyethylene or Teflon lined tubing to the pump intake (or use dedicated tubing that remains in the well) and to the middle of the saturated screened interval or to the pre-determined sampling depth.
- The tubing intake should be kept at least two (2) feet above the bottom of the well to prevent disturbance or suspension of any sediment or Non-Aqueous Phase Liquid (NAPL) present in the bottom of the well. Record the depth of the pump intake.

- If possible, position your sampling equipment and tubing so that it is in the shade. The goal is to minimize the effect of sunlight raising the temperature of water being collected.
- Start the pump on the lowest setting and increase slowly until flow begins. Adjust the pumping rate so that drawdown in the well is minimal (0.3 feet or less, is desirable but not mandatory). Use a pumping rate between 100 to 1,000 milliliters per minute (mL/min) (or approximately 0.1 to 1 quarts per minute). Measure flow rate on the pump or using a graduated container every 3 to 5 minutes and record. The minimum purge volume will be twice the combined volumes of the sampling string (i.e. pump, tubing, and flow-through cell).
- While purging, record water levels every 3 to 5 minutes and monitor and record the water quality indicator parameters: pH, temperature, specific conductance (SC), dissolved oxygen (DO), and turbidity. If specified in the field sampling plan also include ORP.
- Purging is complete when, after three consecutive measurements, the water quality parameters have stabilized as follows:

    - pH (+/- 0.1 standard units)
    - temperature (+/- 3%)
    - SC (+/- 3%)
    - turbidity (+/- 10% if >5 NTU; if 3 values are <5 NTU, consider the values as stabilized)
    - DO (+/-10% if >0.5 mg/L; if 3 values are <0.5 mg/L, consider the values as stabilized)
    - ORP (+/- 10 mV)

- Dispose of purge water according to the field plan.

Sample Collection:

- Following purge, remove the discharge tubing from the flow-through cell. Do not disturb pump and tubing between stabilization and sample collection.
- Fill sample containers directly from the sampling device in order of decreasing volatility (i.e., Volatile Organic Compounds (VOC) samples are collected first; see SOP SC-002 Sampling Handling). Fill all containers from the discharge end of the tubing. Collect samples at a flow rate equal to the steady state purge rate.
- If not using a dedicated pump, remove sampling device and decontaminate (see SOP QA-001 Equipment Decontamination). Discard used tubing.
- Store samples in a cooler on ice for transport to the laboratory.
- Measure depth to bottom of well.

- Secure the well cap.

3. Limitations

- Prior to departure for the field, obtain available information on well construction for use in field investigation (i.e., screen and riser material, well diameter and depth, screened interval, optimum sampling depth, etc.).
- If possible, when using dedicated equipment, install equipment into well at least 24 hours before sample collection to minimize disturbance of the water column and/or suspension of sediments or NAPL on bottom.
- If water quality indicator parameters do not stabilize after removing 3 to 5 well volumes or 2 hours, contact the Project Manager. Three options will be available: 1) continue purging until stabilization; 2) discontinue purging and do not sample; or 3) discontinue purging and sample.
- The key indicator parameter for VOCs is DO. The key indicator parameter for all other samples is turbidity.
- Fill all sample containers with minimal turbulence by allowing the groundwater to flow from the tubing gently down the inside of the container.
- Consult with the project manager before field filtering samples for metals if using low-flow sampling.
- Be aware of any preservatives in the sample bottles and handle with care, in accordance with the Health and Safety Plan.

4. References

Standard Reference for Monitoring Wells (April 19, 1991), Massachusetts DEP, DEP Publication No. WSC-310-91.

Reproducible Well-Purging Procedures and VOC Stabilization Criteria for Ground Water Sampling (1994), M.J. Barcelona, H. A. Wehram, and M.D. Varljen, Ground Water, Vol. 32, No. 1, 12-22.

Low-Flow Purging and Sampling of Ground Water Monitoring Wells with Dedicated Systems (1995), R.W. Puls, and C.J. Paul, Groundwater Monitoring and Review, Summer 1995 116-123.

Low Stress (Low Flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells (2010), EQASOP-GW 001 Low Stress (Low Flow) SOP, Revision 3, U.S. Environmental Protection Agency, Region I, January 19, 2010.

Ground Water Sampling Procedure Low Stress (Low Flow) Purging and Sampling, (1998), Ground-Water Sampling SOP, Final, U.S. Environmental Protection Agency, Region II, March 16, 1998.

RCRA Ground-Water Monitoring: Draft Technical Guidance, (1993), U.S. Environmental Protection Agency, EPA/530-R-93-001.

To Filter, or Not to Filter, That is the Question, (1997), Special Topics Subcommittee Letter Report EPA-SAF-EEC-LTR-97-011, April 29, 1997, Meeting, U.S. Environmental Protection Agency, Science Advisory Board Environmental Engineering Committee, September 5, 1997.

Should Filtered or Unfiltered Groundwater and Surface Water Samples be Collected for the Risk Assessment?, (1995), MCP Q&A: Subparts I and J, Special #4, Bureau of Waste Site Cleanup, Massachusetts Department of Environmental Protection (DEP), February, 1995.

5. Attachments

Attachment A - Monitoring Well Sampling Record

6. Contacts

Brian Conte
Saskia Oosting

MONITORING WELL SAMPLING RECORD

PID Reading _____ Job Name _____

Job Number _____ By _____ Date _____

Location _____ Measurement Datum _____

Well Number _____

Pre-Development Information Time (start) _____

Water Level _____ Total Depth of Well _____

One Purge Vol _____ Three Well Volume _____

Water Characteristics

Color _____ _____ Clear _____ Cloudy

Odor _____ None _____ Weak _____ Moderate _____ Strong

Any films or immiscible material _____

***Volume* (gal)**	**Time**	**pH**	**Temp (°C)**	**Spec. Conductance (µS/cm)**	**Turbidity (NTU)**	**DO Conc. (mg/L)**	**ORP (mV)**	**TDS**

Total Volume Removed (gal) _____ pH _____

Temperature (°C) _____ Specific Conductance (µS/cm) _____

DO Concentration (mg/L) _____ ORP (mV) _____

TDS _____

Post Development Information

Time (Finished) _____

Water Level _____ Total Depth of Well _____

Approximate Volume Removed (gal) _____

Water Characteristics

Color _____ ____ Clear ____ Cloudy

Odor ____ None ____ Weak ____ Moderate ____ Strong

Any films or immiscible material _____

Comments

Low-Flow Groundwater Sampling Form

Project number and name ______________________ Sampling personnel ______________________ Sample date ____________ Well ID ____________

Well location description: ______________________

Well Construction

Well diameter ____________

Well measurement point ____________

Roadbox condition ____________

Well screen interval ____________

Well depth ____________

Sampling Information

Initial depth to water ____________ Time: ____________

Sample intake depth ____________

Pump type and ID ____________

Stabilized flow rate ____________

Stabilized flow rate = flow rate with no further drawdown

Samples Collected

VOCs 8260	☐
SVOCs 8270	☐
VPH	☐
EPH	☐
Metals	☐
PCBs	☐
Other	☐

Field values at time of sample collection:

Time: ____________ Depth to water: ____________

Sp.Cond. ____________ mS/cm

DO ____________ mg/L

ORP ____________ mV

pH ____________ s.u.

Temp. ____________ °C

Turb. ____________ NTU

Cumulative Time (min.)	**Volume (gal)**	**Water depth (ft)**	**Temp. (°C)**	**Sp.Cond. (mS/cm)**	**D.O. (mg/L)**	**pH (s.u.)**	**ORP (mV)**	**Turb. (NTU)**
Typical Groundwater Values			5 to 15	0.05 to 5	0 to 4	5 to 7	-100 to +500	aim for <10

Notes: ______________________

Sample Information:

Sample ID ____________

Sample Time: ____________

Color: ____________

Turbidity: ____________

Field Filtered YES / NO Analyses: ____________

Filter type: ____________

Odor/Sheen/NAPL ____________

Duplicate Collected YES / NO

If yes, duplicate ID: ____________

Purge water disposal? to ground drummed other:

Well Volume Conversion:

Diam. (in)	Factor (gal/ft)
1	0.04
1.5	0.09
2	0.16
4	0.65
6	1.50

well volume =
3.14 x (r)^2 x 7.48 gal/ft
where r = 1/2 diameter in ft

Stabilization Criteria:
Sp.Cond. +/- 3%
DO +/- 10%
ORP +/- 10 mV
pH +/- 0.1 Std Units
Temp. +/- 3%
Turb. +/- 10% if values >1 NTU

Guidance:

1 Position tubing at midpoint of saturated screened interval

2 Minimize drop in water level and purge until parameters are stable

3 Disconnect flow thru cell during sampling

4 Call Project Manager if issues arise (e.g. stabilization takes more than 2 hrs, well goes dry, odd data).

5 For VPH and VOC samples, if stabilization flow rate is less than 200 ml/min, contact PM

STANDARD OPERATING PROCEDURE

GW-004 pH and Temperature Measurement

1. Objective

Describe methods for measuring the pH and temperature of liquids using a combination pH/temperature meter.

2. Execution

Calibration

- Calibrate the meter according to the equipment manufacturer's instructions at the beginning of each day of use. Calibration for pH shall be performed using at least two buffer solutions. Solutions chosen should be similar to the expected pH of the liquids tested (pH 7 and 4 buffer solutions are preferred in most cases for groundwater or surface water measurements).
- Check calibration at the end of the day by reading the two solutions used in calibration. Also perform additional field checks as needed based on observed readings (i.e., inconsistent readings). Record measurements and time of measurement in the field book or sample sheet. If the readings are outside +/– 0.2 pH units, recalibrate the meter.

Sample Measurement

- Immediately prior to testing a sample, decontaminate testing container and probe assembly with one rinse of distilled water. Do not use methanol to rinse the probe. Methanol rinses could damage the probe.
- Gently dry the probe with a paper towel and shake beaker to remove excess solution. Visually inspect the bottom of the probe to ensure that liquid or sediment is not trapped between outer casing and probe.
- Pour the sample into the testing container and insert both temperature and pH probe. Stir sample for 30 seconds using both probes. Let the probes equilibrate in the sample solution for another 30 seconds. Measure and record the temperature. Measure and record pH reading after stabilization or 60 seconds, whichever is sooner. A reading has stabilized if pH units have not changed +/– 0.1 pH units during a 30 second period.
- Record pH to the nearest 0.1 unit and temperature to the nearest whole number.

3. Limitations

- Coatings and particulates may affect the response of the probe; more thorough cleaning using a weak alconox solution and distilled water rinse

and gently wiping the probe surface with a paper towel may be required to clean the surface of the probe.

- Temperature affects both the response of the instrument to pH and the actual pH of the sample. The Automatic Temperature Compensation (ATC) function compensates for the variation in the response of the meter only. Therefore, the pH must always be reported with temperature.
- The probe is a fragile thin glass bulb surrounded on three sides by a plastic casing. Care must be taken in handling the probe to avoid breakage.
- Do not use buffer solutions past their expiration date.

4. References

Standard Methods for the Examination of Water and Wastewater, 18th Edition, Method 4500-H. American Public Health Association (1992).

5. Contacts

Brian Conte
Saskia Oosting

STANDARD OPERATING PROCEDURE

GW-006 Specific Conductance Measurement

1. Objective

Describe standard methods to measure conductivity of water using a field conductivity meter.

2. Execution

- Calibrate the meter according to equipment manufacturer's instructions at the beginning of each day of use. Calibration shall be performed using a standard KCl or other solution recommended by the manufacturer.
- Record the make, model, and serial or identification number of the instrument and calibration information in the field notebook.
- Check calibration at the end of the day by measuring the standard used in calibration and record in field book. Also perform additional field checks as needed based on observed readings (i.e., inconsistent readings). If the readings are outside +/- 0.02 mS/cm, the meter must be recalibrated. Initial calibration should be conducted under the same conditions (i.e., temperature, and location) of field testing.
- Immediately prior to testing a sample, decontaminate testing container and probe assembly with distilled water.
- Gently dry the probe with a paper towel and shake container to remove excess solution.
- Pour sample into the container and insert probe. Stir sample with the probe for approximately 10 seconds. Let the probe equilibrate in the sample solution for another 30 seconds. Measure conductivity and record in the field notebook.
- Record conductivity to the nearest whole number.

3. Limitations

- Oily coatings and particulates may affect the probe's response; more thorough cleaning using a weak alconox solution and distilled water rinse and gently wiping the probe surface may be required to clean the surface of the probe.
- If sample liquid is contaminated, (e.g. stained, conductance >0.75 mS/cm), rinse probe with distilled water immediately after measuring sample to minimize fouling of probe.
- Do not use calibration solutions past their expiration date.

4. References

Standard Methods for the Examination of Water and Wastewater, 18th Edition, Method 4500-H. American Public Health Association (1992).

5. Contact

Brian Conte
Saskia Oosting

STANDARD OPERATING PROCEDURE

GW-009 Potable Well Sampling

1. Objective

Describe methods to collect a drinking water supply sample and to reduce the bias of system related variables (pumps, piping, holding tanks, etc.).

2. General Information

- Inquire if any treatment units are used on the system. Softening (pH adjustment), iron removal, turbidity removal, and chlorination are often used; these may give misleading results depending upon the parameters of interest. Consult with the project manager if these treatment units may affect the sample to be collected.
- Home carbon filters used for the removal of organics have become increasingly popular. Basement and outside faucets may by-pass such treatment systems.
- Important considerations to record in the field book, if available, are:
    - Well driller and date drilled
    - Construction of well and casing depth
    - Well and pump location
    - Well depth and pump capacity (if available)
    - Storage tank capacity
    - Treatment or conditioning unit (if any)
    - Plumbing arrangement
    - Possible sample collection points
    - Distance of well to any septic systems or underground storage tanks
    - Aesthetic information (color, odor, observed suspended material)
- If possible, obtain the name(s) of the resident or water supply owner/operator, the resident's mailing address, and the resident's home and work telephone numbers. The information is needed so that the residents or water supply owner/operators can be informed of the results of the sampling program.
- For long term monitoring projects a specific tap or faucet should be designated as the target sample access point for consistency and data comparability of future samples.

3. Execution

- If possible, collect the sample from a tap or spigot located at or near the well head or pump house and before the water supply is introduced into any storage tanks or treatment units.
- It may not be possible to collect the sample at or near the well head or pump house.
- If the sample must be collected at the downstream side water tanks/system equipment, calculate the volume of water in the system prior to the sampling point. For example, if the closest sampling point follows a 30-gallon pressure

tank and four gallons of water in the piping then a 34 gallon volume should be recorded.

- If possible, purge at least three volumes of water in the system prior to the sampling point. Purge a minimum of one-volume. This allows a complete exchange of fresh water where the sample is collected and avoids sampling stagnant water.
- If the volume of water cannot be determined or the owner prohibits purging of the full one-volume, then a 15-minute purge time should be used. The project manager should be informed that the sample was collected in this manner and the information should be recorded in the field book.
- Home faucets, particularly kitchen faucets, usually have a screen (aerator) installed on the discharge. The screen must be removed prior to sampling for bacteria or for volatile organics, since the screen tends to aerate the water and some organics may be lost. Also, when sampling for bacteria, do not take a sample from a swivel faucet since the joint may harbor a significant bacterial population.
- Open several taps during the purge to ensure a rapid and complete exchange of water in the tanks and reduce system backflow.
- After purging for several minutes, measure the turbidity, pH, specific conductivity, and temperature of the water. Continue to monitor these parameters until three consistent readings are obtained. Consistent readings means:
    - pH remains constant within 0.1 standard units.
    - Specific conductance and turbidity does not vary more than 10 percent. Turbidity readings should be below 10 Nephelometric Turbidity Units (NTUs).
    - Temperature remains constant.
- After three consistent readings have been obtained, collect the sample.
- If consistent readings cannot be attained, but adequate volume has been purged, collect the sample.

4. Limitations

- When sampling for bacterial content, the sample container should not be rinsed before use due to possible contamination of the sample container or removal of the thiosulfate dechlorinating agent (if used).
- Homeowners' plumbing systems should not be tampered with in any way except for removal of the faucet screen (aerator) with permission of the homeowner.
- When filling any sample container, care should be taken that no splashing drops of water from the ground or sink enter into either the bottle or cap.
- When sampling at a water treatment plant, samples are often collected from the raw water supply and the treated water after chlorination.
- Do not remove the pump from a homeowner's well unless the removal is authorized by the homeowner and is performed by a licensed pump installer.
- Continually running wells do not require purging and can be sampled immediately.

5. References

Potable Water Supply Sampling, United States Environmental Protection Agency, Region 4, SESDPROC-305-R1, November 1, 2007.

Standard Methods for the Examination of Water and Wastewater, 18th Edition, Method 4500-H. American Public Health Association (1992).

Ground Water and Wells. Johnson Division, UOP Inc.; St. Paul, Minn. 1982. p277-294.

Ground Water Manual - A Water Resources Technical Publication; U.S. Dept. of Interior, Bureau of Reclamation. Government Printing Office, Washington DC 1977.

6. Contacts

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STANDARD OPERATING PROCEDURE

QA-002 Field Quality Control Samples

1. Objective

Field Quality Control (QC) samples are used to monitor the reproducibility and representativeness of field sampling. The QC samples are handled, transported, and analyzed in the same manner as the associated field samples. QC samples may include trip blanks, equipment blanks, and field duplicates.

2. Execution

2.1. Trip blanks

- Used to monitor possible sources of contamination from transport, storage, inadequate bottle cleaning, or laboratory methodologies.
- Sample containers filled at the laboratory with analyte-free water are transported to and from the site, and are not opened until time of analysis.
- Trip blanks are stored with the sample containers prior to and after field activities and remain with the collected samples until analyzed.
- Generally, one trip blank per volatiles analysis (e.g. volatile organic compounds) shipment.
- Consider submitting a trip blank when sample shipment is by Fed Ex or other large carrier, or laboratory courier.
- Trip blanks should be recorded in the field notebook and on the chain-of-custody that same as all other samples.

2.2. Equipment blanks

- Equipment blanks (also known as equipment rinsate blanks) are used to monitor possible sources of contamination associated with sample collection. Monitors on-site sampling environment, sampling equipment decontamination, sample container cleaning, the suitability of sample preservatives and analyte-free water, and sample transport and storage conditions
- Equipment blanks are collected by pouring laboratory supplied or distilled or deionized water over sampling tools that have been decontaminated per the work plan, into sample containers.
- Equipment blanks are stored with the associated field samples until submitted for analysis.
- Generally collected when site conditions indicate site related contamination is a concern. Check project-specific work plan and/or quality assurance project plan for required frequency.
- Prepare equipment blanks immediately after the equipment is cleaned in the field and before leaving the sampling site.
- Prepare equipment blanks by rinsing the decontaminated sampling equipment set with the appropriate type of analyte-free water and collecting the rinse water in appropriate sample containers.

- If a potable water rinse is the typical final step, collect the equipment blank with analyte-free water after the potable water rinse.
- Equipment blanks should be recorded in the field notebook and on the chain-of-custody that same as all other samples.

2.3. Field Duplicates

- Used to evaluate the precision and representativeness of the sampling procedures.
- Field duplicates are two samples collected from the same location using the same procedures. Both samples are submitted to the laboratory as individual samples with different sample identification.
- Field duplicates from groundwater sampling for all analyses except volatiles analysis are collected by alternating filling sample containers from the same sampling device. Field duplicates for volatiles analysis are filled sequentially.
- Soil or sediment field duplicates are collected by homogenizing the sample for all analyses except volatiles. The homogenized sample is then divided into two equal portions and placed in separate sample containers. Field duplicates for volatile analysis are collected at two adjacent sampling locations.
- Each sample is assigned different sample identifications.
- Field duplicates are generally collected at frequency of 1/20 samples. Check project-specific work plan and/or quality assurance project plan for required frequency.
- All field QC samples should be labeled in the field and submitted “blind” to the laboratory – as if they are separate, primary samples.
- Field duplicates should be recorded in the field notebook and on the chain-of-custody that same as all other samples.
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2.4. Matrix-Spike samples (MS/MSD)

- Matrix spike and matrix spike duplicate samples (MS/MSDs) are environmental samples that are spiked in the laboratory or in the field with a known concentration of a target analyte(s) to verify percent recoveries.
- Matrix spike and matrix spike duplicate samples are primarily used to check sample matrix interferences. They can also be used to monitor error due to laboratory bias and poor precision. However, a data set of at least three or more results is necessary to statistically distinguish between laboratory performance and matrix interference.
- Generally, the laboratory is required to extract and analyze MS or MS / MSDs at a minimum frequency of 5% of samples being analyzed for the target analyte(s). If the project or client criteria require an MS or MS/MSD, collect sufficient volume in the appropriate containers, and designate the sample to be used as the MS or MS/MSD on the chain of custody.
- Calculate the percent recovery for all spiked analytes for both the MS and MSD. For MS/MSDs also calculate the relative percent difference (RPD). The

RPD for each spiked analyte is calculated using the amount detected not percent recovery. If your data will be subjected to validation, the % recovery and the RPD will generally be determined by the validator.

2.5. Typical QA/QC Frequency

- QA/QC frequency is determined by project, client or regulatory criteria and should be verified prior to sample collection. Generally, QA/QC samples are collected according to the frequency described below:

Duplicate Samples	One per sampling event, one per 10 samples collected, or one every two weeks, whichever comes first.
Equipment Blanks	For each equipment type that is not dedicated or disposable - one per sampling event, one per 20 samples collected, or one every two weeks, whichever comes first.
Trip Blanks	One per sample delivery group, or in each cooler containing VOC soil or aqueous samples, depending on project.
MS or MS / MSDs	One MS or MS/MSD per sampling event, one per 20 samples collected, or one every two weeks, whichever comes first.

3. Limitations

- Trip blanks must never be opened in the field.
- Trip blanks are usually for VOCs only because less volatile compounds are not likely to cross-contaminate other samples by simply being in close proximity.
- Laboratory-grade water must be used during the collection of equipment blanks.
- Field duplicates must have different sample identifications.

4. References

Test Methods for Evaluating Solid Waste, Physical/Chemical Methods (November 1986), U.S. Environmental Protection Agency Department of Solid Waste, Washington, D.C.

U.S. Environmental Protection Agency Office of Emergency and Remedial Response, 1990, Quality assurance/quality control guidance for removal activities: EPA/540/G-90/004, Sampling QA/QC Plan and Data Validation Procedures Interim Final, April, 1990.

5. Contact

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