Quality Assurance Project Plan

for Remedial Investigation/ Alternatives Analysis Report Work Plan

1501 College Avenue Site
Niagara Falls, New York

September 2007 0140-001-103

Prepared For:

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Prepared By:

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QUALITY ASSURANCE PROJECT PLAN (QAPP)
FOR RI/AAR WORK PLAN
1501 College Avenue Site

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1.0 INTRODUCTION

This Quality Assurance Project Plan (QAPP) presents the organization, objectives, planned activities, and specific quality assurance/quality control (QA/QC) procedures associated with the proposed scope of work for the investigation described in the Remedial Investigation (RI) and Alternatives Analysis Report (AAR) Work Plan to be implemented at 1501 College Avenue in Niagara Falls, New York (see Figures 1 and 2). The RI/AAR is being performed by Benchmark Environmental Engineering & Science, PLLC (Benchmark) on behalf of Santarosa Holdings, Inc. in accordance with New York State Department of Environmental Conservation (NYSDEC) DER-10 guidance. A Sampling and Analysis Plan describing specific protocols for sample collection, sample handling and storage, chain-of-custody, and laboratory and field analyses to be performed as part of the RI/AAR is presented in Section 4.0 of this QAPP.

1.1 Background

The Site is a 13.0-acre portion of a parcel located on the College Avenue, between Hyde Park and Highland Avenue. The Site was used for heavy industrial manufacturing from at least 1910 to the mid 1980s, and at one time was part of the larger former Union Carbide Co. manufacturing complex. Previous investigations of the adjoining sites, which were also part of the same former Union Carbide Co. complex, have identified elevated semi-volatile organic compounds (SVOCs) and polychlorinated biphenyls (PCBs) as constituents of concern.

The Site is currently an abandoned industrial site that is generally in poor condition and disrepair. Evidence of illegal dumping is obvious across the site; various debris piles, automobile parts, abandoned automobiles, abandoned tanker trucks, drums of unknown liquid and solid contents, sacks of unknown granular or solid materials, aboveground storage tanks (ASTs), and household debris are located throughout the interior and exterior the site. Apparent illegal scrapping of on-site materials and automobiles was also evident during the site inspection.

A Phase I Environmental Site Assessment (ESA) was completed in August 2007 by Benchmark. The ESA revealed that the site was formerly portion of a former greater site operated by Union Carbide, which included the east adjacent site (i.e., former Hazorb site). Previous investigations and remediation of that site indicated that elevated SVOCs were present in soil/fill, sediment and debris piles above current NYSDEC Part 375 restricted-industrial soil cleanup objectives (SCOs). Furthermore, galbestos roofing/siding materials removed from the former Hazorb site contained hazardous concentrations of PCBs.

Historical records indicated the presence of USTs on the property and the past use of the Site as a heavy industrial Site since at least 1910, as well as records indicating contamination on nearby properties. Regulatory search information indicated a historic petroleum spill on the property, and several adjacent and nearby properties that have documented releases or potential releases of hazardous material and/or petroleum products. The areas of concern identified by Benchmark are illustrated on Figure 3.

Benchmark conducted a limited Preliminary Environmental Investigation at the 1501 College Avenue Site in August 2007. The Limited Preliminary Environmental Investigation involved collecting four surface soil samples, one galbestos roof-covering sample, two debris pile samples, and one paint chip sample. The samples indicated that PAHs, metals, and PCBs are present on-site above the NYSDEC 375 restricted-industrial SCOs (see Table 2).

In March 2001, URS Corporation prepared the "Site Investigation and Remedial Alternatives Report for the Hazorb Site, Niagara Falls, New York," for the City of Niagara Falls Department of Environmental Services. The study was completed with funding by a United States Environmental Protection Agency (USEPA) Brownfield Assessment Grant for the former Hazorb site, located immediately east adjacent to the subject site. The former Hazorb Site and the subject site were once part of a greater parcel operated by Union Carbide and its predecessors. Based on that report, elevated concentrations of semi-volatile organic compounds (SVOCs) in soil/fill, sediment and debris piles were present above current NYSDEC Part 375 restricted-industrial SCOs. Based on the similar historic operations at the Hazorb site and the subject site, it is possible that similar contaminants are present at the subject site.

Benchmark also reviewed a letter from the USEPA to Mr. Robert Marino, Director of the Bureau of Technical Support of the NYSDEC Division of Environmental Remediation dated November 2, 2003. According to that letter, the USEPA completed a removal action at the Hazorb site in 2003, which included "identification, stabilization, segregation, removal and disposal of all hazardous wastes found at the property." That letter indicated that galbestos siding/roofing materials with high PCB levels (up to 56,000 ppm) were identified and transported off-site. The USEPA letter made note that galbestos material will continue to be deposited on the former Hazorb site as long as the [subject site] building remains.

In June of 2007, the US Environmental Protection Agency (EPA) - Removal Support Team 2 (RST2) conducted additional sampling for ACM and PCBs related to the previously conducted remedial action at the abutting former Hazorb site. An EPA subcontractor collected soil and galbestos samples along the north and south sides of College Avenue adjacent to the Site. Preliminary sample results show that ACMs and PCBs (Galbestos) are present in the vicinity of the Site at levels that exceed the NYSDEC Part 375 Restricted-Industrial SCOs.

Santarosa Holdings, Inc. has elected to pursue cleanup and redevelopment of the 1501 College Avenue site under the New York State Brownfield Cleanup Program (BCP), and has applied for entrance into the BCP with the intent to execute a Brownfield Cleanup Agreement (BCA) as a non-responsible party (volunteer) per ECL§27-1405.

1.2 QAPP Preparation Guidelines

All QA/QC procedures described herein are structured in accordance with applicable technical standards, and NYSDEC's requirements, regulations, guidance, and technical standards. Specifically, this QAPP has been prepared in accordance with:

- *USEPA Requirements for Quality Assurance Project Plans for Environmental Data Operations* (EPA QA/R-5, October 1998)
- *Region II CERCLA Quality Assurance Manual*, Revision I, EPA Region II, dated October 1989.
- *NYSDEC Technical Assistance and Guidance Memorandum (TAGM) 3014 – Quality Assurance Project Plan*, dated 1991.
- *NYSDEC Draft DER-10, Technical Guidance for Site Investigation and Remediation*, dated December 2002.

1.3 Scope of the QAPP

This QAPP was prepared to provide quality assurance (QA) guidelines to be implemented during the RI/AAR activities. This document may be modified for subsequent phases of investigative work, as necessary. The QAPP provides:

- A means to communicate to the persons executing the various activities exactly what is to be done, by whom, and when.
- A culmination to the planning process that ensures that the program includes provisions for obtaining quality data (e.g., suitable methods of field operations).
- A historical record that documents the investigation in terms of the methods used, calibration standards and frequencies planned, and auditing planned.
- A document that can be used by the Project Manager and QA Officer to assess if the activities planned are being implemented and their importance for accomplishing the goal of quality data.
- A plan to document and track project data and results.
- Detailed descriptions of the data documentation materials and procedures, project files, and tabular and graphical reports.

The QAPP is primarily concerned with the QA/QC aspects of the procedures involved in the collection, preservation, packaging, and transportation of samples; field testing; record keeping; data management; chain-of-custody procedures; laboratory analyses; and other necessary matters to assure that the investigation activities, once completed, will yield data whose integrity can be defended.

QA refers to the conduct of all planned and systematic actions necessary to perform satisfactorily all task-specific activities and to provide information and data confidence as a result of such activities. The QA for task-specific activities includes the development of procedures, auditing, monitoring and surveillance of the performance.

QC refers to the activity performed to determine if the work activities conform to the requirements. This includes activities such as inspections of the work activities in the field (e.g., verification that the items and materials installed conform to applicable codes and design specifications). QA is an overview monitoring of the performance of QC activities through audits rather than first time inspections.

1.4 Project Description

1.4.1 Project Objectives

For sites entering the BCP at the point of investigation, NYSDEC requires completion of a RI/AAR. The primary objectives of the RI/AAR are to:

- Collect additional soil/fill and groundwater samples, under appropriate quality assurance/quality control criteria, to better delineate the nature and extent of contamination.
- Determine if the concentrations of constituents of concern in site soil/fill and/or groundwater pose potential unacceptable risks to human health and the environment.
- Delineate the nature and extent of environmental contamination necessary to determine the absence or presence of potential significant human health and/or environment risks and to form a basis for evaluating and estimating the cost of alternative remedial measures.

1.4.2 Project Overview

Field team personnel will collect environmental samples in accordance with the rationale and protocols described in Section 4.0 and Appendix A (Field Operating Procedures) of this QAPP. NYSDEC-approved sample collection and handling techniques will be used. Samples for chemical analysis will be analyzed in accordance with USEPA methodology to meet the definitive-level data requirements. Laboratory analyzed water quality parameters and/or samples analyzed for other non-characterization purposes (e.g., to facilitate evaluation of treatability) will be performed by a laboratory using NYSDEC/USEPA-approved standard methods as identified in USEPA Methods for Chemical Analysis of Water and Wastes (40 CFR Part 136) or USEPA (SW 846) protocols. Analytical results will be evaluated by a qualified third-party data validation expert.

1.5 Project Schedule

RI/AAR activities are expected to begin at the Site in December 2007. Figure 5 presents a tentative project schedule for the major tasks to be performed.

2.0 PROJECT ORGANIZATION AND RESPONSIBILITY

The principal organizations involved in verifying achievement of RI/AAR goals for Site include: the NYSDEC, the drilling subcontractor, the independent environmental laboratory, and the independent third-party data validator. Roles, responsibilities, and required qualifications of these organizations are discussed in the following subsections. Resumes for key management and QA personnel are included in Appendix C.

2.1 Management Responsibilities

2.1.1 NYSDEC and NYSDOH

It is the responsibility of the NYSDEC, in conjunction with the New York State Department of Health (NYSDOH), to review the RI/AAR Work Plan and supporting documents, including this QAPP, for completeness and conformance with the site-specific cleanup objectives and to make a decision to accept or reject these documents based on this review. The NYSDEC also has the responsibility and authority to review and approve all QA documentation collected during the remedial investigation and to confirm that the QA Plan was followed.

• *NYSDEC Representative(s):*	*Jeffrey Konsella, P.E., Project Manager*
• NYSDOH Representative:	*Matt Forcucci, Project Manager*

2.1.2 Benchmark Environmental Engineering and Science, PLLC

Benchmark Environmental Engineering and Science, PLLC (Benchmark) is the prime consultant on this project and is responsible for the performance of all services required to implement the RI/AAR Work Plan (hereafter referred to as the Work Plan) including, but not limited to, field operations, laboratory testing, data management, data analysis, and reporting. Any one member of Benchmark's staff may fill more than one of the identified project positions (e.g., field team leader and site safety and health officer). The various QA, field, laboratory and management responsibilities of key project personnel are defined below.

- *Benchmark Project Manager (PM):* *Michael Lesakowski*

  The Benchmark PM has the responsibility for ensuring that the project meets the Work Plan objectives. The PM will report directly to the NYSDEC/NYSDOH Project Managers and is responsible for technical and project oversight. The PM will:

  - Define project objectives and develop a detailed work plan schedule.
  - Establish project policy and procedures to address the specific needs of the project as a whole, as well as the objectives of each task.
  - Acquire and apply technical and corporate resources as needed to assure performance within budget and schedule constraints.
  - Develop and meet ongoing project and/or task staffing requirements, including mechanisms to review and evaluate each task product.
  - Review the work performed on each task to assure its quality, responsiveness, and timeliness.
  - Review and analyze overall task performance with respect to planned requirements and authorizations.
  - Review and approve all deliverables before their submission to NYSDEC.
  - Develop and meet ongoing project and/or task staffing requirements, including mechanisms to review and evaluate each task product.
  - Ultimately be responsible for the preparation and quality of interim and final reports.
  - Represent the project team at meetings.

- *FTL/SSHO:* *Bryan C. Hann*

  The Field Team Leader (FTL) has the responsibility for implementation of specific project tasks identified at the Site, and is responsible for the supervision of project field personnel, subconsultants, and subcontractors. The FTL reports directly to the Project Manager. The FTL will:

  - Define daily develop work activities.
  - Orient field staff concerning the project's special considerations.

- o Monitor and direct subcontractor personnel.
- o Review the work performed on each task to ensure its quality, responsiveness, and timeliness.
- o Assure that field activities, including sample collection and handling, are carried out in accordance with this QAPP.

For this project the FTL will also serve as the Site Safety and Health Officer (SSHO). As such, he is responsible for implementing the procedures and required components of the Site Health and Safety Plan (HASP), determining levels of protection needed during field tasks, controlling site entry/exit, briefing the field team and subcontractors on site-specific health and safety issues, and all other responsibilities as identified in the HASP (see Appendix C of the Work Plan).

2.2 Quality Assurance (QA) Responsibilities

The QA Officer will have direct access to corporate executive staff as necessary, to resolve any QA dispute. She is responsible for auditing the implementation of the QA program in conformance with the demands of specific investigations and Benchmark policies, and NYSDEC requirements. The QA Officer has sufficient authority to stop work on the investigation as deemed necessary in the event of serious QA issues.

- *Project QA Officer:* *Thomas H. Forbes, P.E.*

Specific function and duties include:

- o Performing QA audits on various phases of the field operations (see Section 10).
- o Reviewing and approving QA plans and procedures.
- o Providing QA technical assistance to project staff.
- o Reporting on the adequacy, status, and effectiveness of the QA program on a regular basis to the Project Manager for technical operations.
- o Responsible for assuring third party data review of all sample results from the analytical laboratory.

2.3 Field Responsibilities

Benchmark field personnel for this project are drawn from a pool of qualified resources. The Project Manager will use staff to gather and analyze data, and to prepare various task reports and support materials. All of the designated technical team members are experienced professionals who possess the degree of specialization and technical competence required to effectively and efficiently perform the required work.

2.4 Laboratory Responsibilities

Test America, the environmental laboratory retained by Benchmark located at 10 Hazelwood Drive, Amherst, New York 14228, is an independent, NY State Department of Health (NYSDOH) Environmental Laboratory Approval Program (ELAP)-certified facility approved to perform the analyses prescribed herein. Test America will report directly to the QA Officer, and will be responsible for immediately notifying the QA Officer of any problems with sample receipt, analysis or quality control.

- *Test America Client Services Manager:* *C. James Stellrecht*
  The Client Services Manager is responsible for the Client Services Department and will report directly to the Project Manager. The client services manager provides a complete interface with clients from initial project specification to final deliverables.

- *Test America Laboratory Director:* *Chris Spencer*
  The Laboratory Director is a technical advisor and is responsible for summarizing and reporting overall unit performance. Responsibilities of the Laboratory Director include:

  - Provide technical, operational, and administrative leadership.
  - Allocation and management of personnel and equipment resources.
  - Quality performance of the facility.
  - Certification and accreditation activities.
  - Blind and reference sample analysis.

- *Test America Quality Assurance Director (QA Director):* *Verl Preston*

The QA Director has the overall responsibility for data after it leaves the laboratory. The QA Director will be independent of the laboratory but will communicate data issues through the Laboratory Director. In addition, the QA Director will:

- Oversee laboratory QA.
- Oversee QA/QC documentation.
- Conduct detailed data review.
- Determine whether to implement laboratory corrective actions, if required.
- Define appropriate laboratory QA procedures.
- Prepare laboratory SOPs.

Independent QA review will be provided by the Laboratory Director and QA Director prior to release of all data to Benchmark.

- *Test America Sample Management Office:* *Ken Kinecki*

  The Sample Management Office will report to the Laboratory Director. Responsibilities of the Sample Management Office will include:

  - Receiving and inspecting the incoming sample containers.
  - Recording the condition of the incoming sample containers.
  - Signing appropriate documents.
  - Verifying chain-of-custody.
  - Notifying laboratory manager and laboratory supervisor of sample receipt and inspection.
  - Assigning a unique identification number and customer number, and entering each into the sample-receiving log.
  - With the help of the laboratory manager, initiating transfer of the samples to appropriate lab sections.
  - Controlling and monitoring access/storage of samples and extracts.

- *Test America Technical Staff (TS):*

  The TS will be responsible for sample analyses and identification of corrective actions. The staff will report directly to the Laboratory Director.

2.5 Other Subcontractor Personnel

2.5.1 Independent Third-Party Data Validator

Data Validation Services, Inc., the third-party data validator retained by Benchmark, will perform an independent data usability evaluation as recommended under NYSDEC's draft DER-10 guidance. The data usability evaluation will involve review of pertinent internal and external QC data as reported by the laboratory. QC parameters that will be evaluated in reference to compliance with the analytical methods, protocols, and deliverables requirements will include those items necessary to satisfy NYSDEC's requirements for preparation of a Data Usability Summary Report (DUSR). The specific data usability evaluation performed by the following key project personnel is defined below:

- Data Usability: *Judy Harry, Data Validation Services*

  The data validator has the responsibility for evaluating the data usability by examining the following:

  - Completeness of the data package.
  - Compliance with required holding times.
  - Sample chain-of-custody forms
  - QC analysis data, including blanks, instrument tunings, calibrations, spikes, surrogate recoveries, duplicates, laboratory controls and sample data.
  - Agreement between laboratory raw data and data summary sheets, with verification that correct data qualifiers were used where appropriate.

  The data usability summary will present the review findings with a discussion of any data deficiencies, analytical protocol deviations, and QC problems encountered. Data deficiencies, analytical method protocol deviations, and QC problems will be described and their effect on the data presented. Recommendations for resampling/reanalysis will be made where deemed necessary. Data qualifications will be documented for each parameter following the USEPA National Functional and Regional Data Validation Guidelines (most recent updates).

2.5.2 Drilling Subcontractor

TREC Environmental, the drilling subcontractor retained by Benchmark, will be responsible for assisting in performing well installation, sample collection, and investigation activities as directed by Benchmark.

- *Drilling Project Manager:* *Keith Hambley*

2.6 Special Training Requirements and Certifications

The purpose of this section is to address any specialized or non-routine training requirements necessary for completion of the subject investigation. Sufficient information shall be provided to ensure that special training skills can be verified, documented, and updated as necessary.

2.6.1 Training

Requirements for specialized training for non-routine field sampling techniques, field analyses, laboratory analyses, and data validation are specified below.

> Non-routine field sampling techniques: Currently there are no non-routine field sampling techniques that require specialized training.
>
> Non-routine field analyses: Currently there are no non-routine field analyses that require specialized training.
>
> Non-routine laboratory analyses: Currently there are no non-routine laboratory analyses techniques that require specialized training.
>
> Data validation: Selected analyses to be validated for all matrices sampled will be validated by Ms. Judy Harry of Data Validation Services. Data validation will be performed using the most current methods and quality control criteria from USEPA's Contract Laboratory Program (CLP) National Functional Guidelines for Organic and Inorganic Data Review and USEPA Region 2 guidelines.

2.6.2 *Data Validator Certification*

Ms. Harry has already attained certifications required for implementing this plan for Data Validation Services. The data validator resume is presented in Appendix C.

2.7 Contacts

The names, addresses, and telephone numbers of key project personnel are as follows:

Thomas O'Malley:

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Michael Lesakowski:
Project Manager

Benchmark Environmental Engineering and Science
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Thomas Forbes, P.E..:
Project Quality Assurance Officer

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Office: (716) 856-0599

Jim Stellrecht:
Laboratory Client Services Manager

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Jeffrey Konsella:
NYSDEC Project Manager

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Department of Environmental Remediation
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Matt Forcucci:
NYSDOH Project Manager

NYSDOH
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3.0 QUALITY ASSURANCE OBJECTIVES FOR MEASUREMENT DATA

The overall objectives and criteria for assuring quality for this effort are discussed below. This QAPP addresses how the acquisition and handling of samples and the review and reporting of data will be documented. The objectives of this QAPP are to address the following:

- The procedures to be used to collect, preserve, package, and transport groundwater samples.
- Field data collection.
- Record keeping.
- Data management.
- Chain-of-custody procedures.
- Precision, accuracy, completeness, representativeness, decision rules, comparability and level of quality control effort conformance for sample analysis and data management by Test America under NYSDEC CLP analytical methods.

Analytical methods and detection/reporting limits for chemical parameters to be analyzed during the RI/AAR for soil and groundwater are listed in Tables 1 and 2. Water levels and select water quality parameters (i.e., pH, turbidity, specific conductance, temperature) will be measured in the field as described in the FOPs (see Appendix A).

The goals for precision, accuracy, and completeness intended for use on this project are discussed in Sections 3.1 through 3.3 of this QAPP. Laboratory QA objectives are presented in the analytical laboratory's QA/QC Plan (see Appendix B). Test America is the analytical laboratory selected to analyze environmental samples for this RI.

All data will be reported completely. No data will be omitted unless an error occurred in the analyses or the run was invalidated because of QC sample recovery or poor precision.

3.1 Precision

Precision is a measurement of the degree to which two or more measurements are in agreement, which is quantitatively assessed based on the standard deviation. Precision in the laboratory is assessed through the calculation of relative percent difference (RPD) and calculation of relative standard deviations (RSD) for three or more replicate samples. The equations to be used to verify precision for this investigation are found in Section 12.1 of this QAPP. General precision goals are provided in Table 3.

Laboratory precision will be assessed through the analysis of matrix spike/matrix spike duplicate (MS/MSD) and field duplicate samples for organic parameters. For inorganic parameters, precision will be assessed through the analysis of matrix spike/ duplicates and field duplicate samples. Precision for field parameters, including pH, turbidity, specific conductance, and temperature will be determined through duplicate analysis of 1 in every 20 samples. Precision control limits for field measured parameters are provided in Table 4.

3.2 Accuracy

Accuracy is the degree of agreement between an observed value and an accepted reference of true value. Accuracy in the field is assessed through the use of field blanks and trip blanks, and through the adherence to all sample handling, preservation and holding times. One trip blank will accompany each batch of water matrix sample containers shipped to the laboratory for VOC analysis. Laboratory accuracy is assessed through the analysis of a MS/MSD samples (1 per 20), standard reference materials (SRM), laboratory control samples (LCS), and surrogate compounds, and the determination of percent recoveries. The equation to be used for accuracy for this investigation is found in Section 12.1 of this QAPP. Accuracy control limits for the laboratory are given in Table 3.

Accuracy for field measured parameters including pH, turbidity, specific conductance, and temperature will be assessed through instrument calibration standards discussed in instrument calibration and maintenance FOPs (see Section 4.0). Accuracy control limits for field measured parameters are provided in Table 4.

3.3 Completeness

Data completeness is a measure of the amount of valid data obtained from a prescribed measurement system as compared with that expected and required to meet the project goals. Laboratory and field completeness will be addressed by applying data quality checks and assessments described in Sections 3.1, 3.2, and 9.0 to ensure that the data collected are valid and significant.

As shown on Table 3, the laboratory completeness objectives for this investigation will be 90 percent or greater. A third-party data validator will follow procedures described in Section 9.2 to assess the completeness and validity of laboratory data deliverables. For this investigation, 100 percent of all laboratory analytical results will undergo third-party data review. The completeness of an analysis will be documented by including in the report sufficient information to allow the data validator to assess the quality of the results. A Category B deliverables package will be required in support of third-party data review.

3.4 Data Representativeness

Data representativeness expresses the degree to which data accurately and precisely represents a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition within a defined spatial and/or temporal boundary. All proposed field-testing and measurement procedures were selected to maximize the degree to which the field data will represent the conditions at the Site, and the matrix being sampled or analyzed.

Performance System Audits (see Section 10.0) and the proper execution of field activities are the main mechanisms for ensuring data representativeness. Representativeness in the laboratory is ensured through the use of proper analytical procedures, appropriate methods, meeting sample holding times, and analyzing and assessing field duplicate samples.

3.5 Comparability

Data comparability expresses the confidence with which one data set can be compared to another data set. Procedures for field measurements (see Appendix A) will assure that tests performed at various locations across the Site are conducted using accepted procedures, in a consistent manner between locations and over time, and including appropriate QA/QC procedures to ensure the validity of the data. Sampling procedures for environmental matrices are provided in Section 4.0 to ensure that samples are collected using accepted field techniques.

Analytical data will be comparable when similar sampling and analytical methods are used as documented in the QAPP. Comparability is also dependent on similar QA objectives. The field and laboratory parameter units to be used for this investigation are listed in Table 5.

3.6 Level of QC Effort for Sample Parameters

Field blank, method blank, trip blank, field duplicate, laboratory duplicate, laboratory control, standard reference materials (SRM) and matrix spike samples will be analyzed to assess the quality of the data resulting from the field sampling and analytical programs. QC samples are discussed below and summarized in Table 6.

- Field (equipment) blank samples are analyzed to check for potential cross-contamination if improperly cleaned/non-dedicated sampling equipment is used.
- Trip blanks are used to assess the potential for contamination of samples due to contaminant migration during sample shipment and storage.
- Method blank samples are generated within the laboratory and used to assess contamination resulting from laboratory procedures.
- Duplicate samples are analyzed to check for sampling and analytical reproducibility.
- MS/MSD and MS/Duplicate samples provide information about the effect of the sample matrix on the digestion and measurement methodology. Depending on site-specific circumstances, one MS/MSD or MS/Duplicate should be collected for every 20 or fewer investigative samples to be analyzed for organic and inorganic chemicals of a given matrix.

The general level of QC effort will be one field (blind) duplicate and one field blank (when non-dedicated equipment is used) for every 20 or fewer investigative samples of a given matrix. Additional sample volume will also be provided to the laboratory to allow one site-specific MS/MSD or MS/Duplicate for every 20 or fewer investigative samples of a given matrix. One trip blank consisting of distilled, deionized water will be included along with each sample delivery group of aqueous VOC samples.

4.0 SAMPLING AND ANALYSIS PLAN

The selection and rationale for the RI/AAR sampling program is discussed in the Work Plan. Methods and protocol to be used to collect environmental samples (i.e., soil and groundwater) for this investigation are described in the Benchmark Field Operating Procedures (FOPs) presented in Appendix A of this QAPP. Table 7 is a summary of the FOPs to be used during this investigation.

The number and type of environmental samples to be collected, parameter lists, required detection limits, and sample container requirements for each matrix (i.e., groundwater and soil samples) are summarized in Tables 1, 2, 6, and 8. The sampling program and related Site activities are discussed below. To the extent allowed by existing physical conditions at the facility, sample collection efforts will adhere to the specific methods presented herein. If alternative sampling locations or procedures are implemented in response to facility specific constraints, each will be selected on the basis of meeting data objectives. Such alternatives will be approved by NYSDEC before implementation and subsequently documented for inclusion in the project file.

4.1 Remedial Investigation Activities

The RI activities will include completion of test pits using a backhoe or similar equipment, completion of soil borings using a direct-push drill rig, installation of groundwater monitoring wells and sampling of various abandoned drums. Surface and subsurface soil samples will be collected across the Site from the test pits and/or soil borings. Groundwater samples will be collected from the newly installed monitoring wells. Additionally, samples of the roofing and siding material on the site building will be collected. These activities are described in greater detail below.

4.1.1 Supplemental Soil Investigation

4.1.1.1 Test Pit Excavations

Excavation of approximately 10 test pits across the property will allow for visual/olfactory/PID assessment of subsurface conditions and to obtain subsurface soil/fill samples for chemical characterization. Test pits will be field located, but will be focused toward areas of observed potential impact (areas suggestive of fill, surface staining, former transformers and automobile debris).

In general, test pits will be excavated from ground surface to native soils or groundwater, whichever is encountered first, using a small excavator. Test pit dimensions (i.e., depths and lengths) may vary depending on the vertical and horizontal extent of the soil/fill horizon, depth to groundwater, or encountered impacts (i.e., free-product, elevated PID readings, etc.). Test pit walls and excavated soil/fill will be examined by qualified Benchmark personnel and classified in accordance with the USCS. Excavated soil/fill and the test pit atmosphere will be field screened for the presence of VOCs using a field PID as a procedure for ensuring the health and safety of personnel at the Site and to identify potentially impacted soil/fill samples for laboratory analysis. The methodology for field soil/fill screening using a PID is discussed below and in the QAPP, presented under separate cover. Field measurements and observations will be documented in the project notebook by the Benchmark field scientist.

It is estimated that the test pits will be completed over a 2-day period, with surficial (0-6") and subsurface (6" to native soil/bedrock) will be collected for analysis of USEPA Target Compound List (TCL) semi-volatile organic compounds (SVOCs), Target Analytes List (TAL) metals, and polychlorinated biphenyls (PCBs). Additionally, at three test pit locations, samples will be analyzed for TCL volatile organic compounds (VOCs), herbicides and pesticides for Site characterization purposes. No VOC samples will be analyzed in the absence of elevated PID reading (i.e., greater than 5 ppm).

Soil/fill samples will be collected from the center of the excavator bucket using dedicated stainless steel sampling tools. Representative soil/fill samples will be placed in pre-cleaned laboratory supplied sample bottles, cooled to 4°C in the field, and transported under chain-of-custody command to Test America (formerly STL), located in Amherst, New York, a New York State Department of Health (NYSDOH) ELAP-certified analytical laboratory. Please refer to Table 1 for a summary of the soil/fill sampling and analysis plan. Please refer to Figure 4- RI sample locations.

4.1.2 Suspect Underground Storage Tank (USTs) Investigation

Excavation of up to four test pits in the vicinity of the suspect USTs will investigate whether USTs are present as well subsurface conditions in the area of the suspect USTs.

Excavated soil/fill and the test pit atmosphere will be field screened for the presence of VOCs using a field PID as a procedure for ensuring the health and safety of personnel at the Site and to identify potentially impacted soil/fill samples for laboratory analysis. Field measurements and observations will be documented in the project notebook by the Benchmark field scientist.

If USTs are encountered, up to four soil/fill samples will be collected and analyzed for TCL plus NYSDEC STARS List VOCs and SVOCs. Representative soil/fill samples will be placed in pre-cleaned laboratory supplied sample bottles, cooled to 4°C in the field, and transported under chain-of-custody command to Test America (formerly STL), located in Amherst, New York, a New York State Department of Health (NYSDOH) ELAP-certified analytical laboratory. Please refer to Table 1 for a summary of the soil/fill sampling and analysis plan. Please refer to Figure 4- RI sample locations.

4.1.3 Suspect Historic Transformers

The Phase I ESA performed on the Site identified suspect historic transformer pads, which may have contained PCB-laden oils. As such, surface sampling using either hand-held tools or a backhoe (if the areas are accessible with heavy equipment) will be conducted during the RI. Surface soil at up to three suspect transformer areas will be sampled for PCBs. Figure 4 shows areas of suspect transformer pads.

4.1.4 Drum/Container Sampling

The Phase I ESA performed on the Site identified numerous drums and ASTs, which contained unknown solid and liquid contents. As such, drums and AST sampling will be conducted during the RI for characterization purposes to determine proper handling and disposal of drums and ASTs and their contents.

If feasible, drums and other containers will be moved to a common staging area in a covered area of the building, preferably in a location that contains a competent concrete floor. Where several drums contain similar materials, composite samples will be collected across those drums/containers for representative analysis. The analytical protocol for drum sampling will largely be dictated by disposal facility requirements (the disposal facility has not yet been determined). In general, the solid materials will be analyzed for TCLP VOCs, TCLP metals, hazardous characterization (ignitability, reactivity, and pH), and total PCBs and liquid materials will be analyzed for TCLP VOCs, TCLP SVOCs, TCLP Metals, PCBs, and ignitability.

4.1.5 Roof and Siding Sampling

A previous study completed by Benchmark at the subject site identified elevated PCBs in galbestos roofing and siding material from the eastern portion of the building. As such, up to 10 additional roofing and siding material samples will be collected from the building to determine if elevated PCBs are present in roofing and siding materials in other areas of the site. Sample locations of the roofing and siding material will be determined in the field, with a bias toward weathered and/or damaged materials.

4.1.6 Supplemental Groundwater Investigation

Four groundwater monitoring wells will be installed on-site at the proposed locations shown on Figure 4. The new monitoring wells will provide groundwater flow information as well as groundwater quality information. Monitoring well installation, well development, and groundwater sample collection are discussed in the following sections.

4.1.6.1 Monitoring Well Installation

Four soil borings will be advanced to facilitate installation of four groundwater-monitoring wells, designated as BCP MW-1 through BCP MW-4 as shown on Figure 4. A GeoProbe 6620 DT direct-push drill rig capable of advancing hollow-stem augers will be employed to install 2-inch inside diameter (ID) monitoring wells.

Each boring location will be advanced approximately 10 fbgs into native soils or a minimum of 5 feet below the first encountered groundwater, whichever is greater, using hollow stem auger drilling methods. If groundwater is not encountered within 15 fbgs, a monitoring well will not be installed at that location. Recovered soil samples will be described in the field by qualified Benchmark personnel using the Unified Soil Classification System (USCS), scanned for total volatile organic vapors with a calibrated PID equipped with a 10.6 eV lamp (or equivalent), and characterized for impacts via visual and/or olfactory observations. Based on the field observations, one subsurface soil sample from each soil boring/monitoring well location will be collected for analysis of TCL SVOCs, TAL metals, and PCBs. All non-dedicated drilling tools and equipment will be decontaminated between boring locations using potable tap water and a phosphate-free detergent (e.g., Alconox).

Subsequent to boring completion, a 2-inch ID diameter flush-joint Schedule 40 PVC monitoring well will be installed at the boring locations. Each well will be constructed with a 5-foot flush-joint Schedule 40 PVC, 0.010-inch machine slotted well screen. Each well screen and attached riser will be placed at the bottom of each borehole and a silica sand filter pack (size # 0) will be installed from the base of the well to a maximum of 2 feet above the top of the screen. A bentonite chip seal will then be installed and allowed to hydrate sufficiently to mitigate the potential for downhole grout contamination. Cement/bentonite grout will be installed to approximately 1 fbgs via pressure tremie-pipe procedures. The newly installed monitoring wells will be completed with keyed-alike locks, a lockable J-plug, and an 8-inch diameter steel flush mounted road box anchored within a 2-foot by 2-foot by 1-foot square concrete pad.

4.1.6.2 Well Development

Upon installation, but not within 24 hours, newly installed monitoring wells will be developed in accordance with Benchmark and NYSDEC protocols. Development of the monitoring wells will be accomplished with dedicated disposable polyethylene bailers via surge and purge methodology. Field parameters including pH, temperature, turbidity and specific conductance will be measured periodically (i.e., every well volume or as necessary) during development. Field measurements will continue until they became relatively stable. Stability will be defined as variation between measurements of approximately 10 percent or less with no overall upward or downward trend in the measurements. A minimum of three well volumes will be evacuated from each monitoring well. Development water from the monitoring wells will be passed through a mobile granular-carbon treatment vessel, and discharged to ground.

4.1.6.3 Groundwater Sample Collection

Prior to sample collection, static water levels will be measured and recorded from all on-site monitoring wells. Following water level measurement, Benchmark personnel will purge and sample the monitoring wells using either a peristaltic pump with dedicated pump tubing following low-flow/minimal drawdown purge and sample collection procedures or using a dedicated polyethylene bailer. Prior to sample collection, groundwater will be evacuated from each well at a low-flow rate (typically less than 0.1 L/min). Field measurements for pH, specific conductance, temperature, turbidity, and water level as well as visual and olfactory field observations will be periodically recorded and monitored for stabilization. Purging will be considered complete when pH, specific conductivity and temperature stabilize and when turbidity measurements fall below 50 Nephelometric Turbidity Units (NTU), or become stable above 50 NTU. Stability is defined as variation between field measurements of 10 percent or less and no overall upward or downward trend in the measurements. Upon stabilization of field parameters, groundwater samples will be collected and analyzed as discussed below.

Upon arrival at each monitoring well, field personnel will visually inspect the monitoring well for defects and/or vandalism. Following location and inspection of each well, the static water level and total depth will be recorded and one standing well volume will be calculated.

Wells will be purged and sampled using a peristaltic pump and dedicated pump tubing following low-flow (minimal drawdown) purge and sample collection procedures in a manner similar to that described in the previous section. However, the pump will not require decontamination because all components are dedicated to each monitoring well.

Prior to and immediately following collection of groundwater samples, field measurements for pH, specific conductance, temperature, turbidity, dissolved oxygen and water level as well as visual and olfactory field observations will be recorded. All collected groundwater samples will be placed in pre-cleaned, pre-preserved laboratory provided sample bottles, cooled to 4°C in the field, and transported under chain-of-custody command to STL for analysis.

4.1.6.4 Groundwater Sample Analyses

Groundwater samples will be analyzed for TCL VOCs, TCL SVOCs, TAL Metals, PCBs, herbicides, and pesticides in accordance with USEPA SW 846 methodology with equivalent NYSDEC Category B deliverables to allow for independent third-party data usability assessment.

4.2 Investigation-Derived Waste Management

During installation of the monitoring wells, excess soil cuttings will be containerized in 55-gallon drums. Groundwater from well development and purging will be discharged to the ground surface. However, if field observations suggest groundwater impact, the water will be containerized in 55-gallon drums. Drums will be labeled with regard to contents, origin, and date of generation using a paint stick marker on two sides and the top of each drum. The drums will be staged on-site pending soil and groundwater analyses and remedial measures assessment.

4.3 Site Mapping

A site map will be developed during the field investigation. All sample points and relevant site features, including buildings, will be located on the site map. Benchmark will employ a Trimble GeoXT handheld GPS unit to identify the locations of all soil borings and newly installed wells relative to New York State planar grid coordinates. Monitoring well elevations will be measured by Benchmark's surveyor. An isopotential map showing the general direction of groundwater flow will be prepared based on water level measurements relative to USGS vertical datum. The maps will be provided with the RI report.

5.0 CUSTODY PROCEDURES

Sample custody is controlled and maintained through the chain-of-custody procedures. Chain of custody is the means by which the possession and handling of samples will be tracked from the source (field) to their final disposition, the laboratory. A sample is considered to be in a person's custody if it is in the person's possession or it is in the person's view after being in his or her possession or it was in that person's possession and that person has locked it in a vehicle or room. Sample containers will be cleaned and preserved at the laboratory before shipment to the Site. The following section and FOPs for Sampling, Labeling, Storage, and Shipment, located in Appendix A, describe procedures for maintaining sample custody from the time samples are collected to the time they are received by the analytical laboratory. Test America's laboratory chain-of-custody procedures are discussed in the Test America Quality Assurance Manual located in Appendix B.

5.1 Field Custody Procedures

Field logbooks provide the means of recording data collection activities performed during the investigation. As such, entries will be described in as much detail as possible so that persons going to the facility could reconstruct a particular situation without reliance on memory. Field logbooks are bound field survey books or notebooks. Logbooks are assigned to field personnel, but will be stored in the document control center when not in use. Each logbook will be identified by the project-specific document number. The title page of each logbook will contain the following:

- Person to whom the logbook is assigned.
- Logbook number.
- Project name.
- Project start date.
- End date

Entries into the logbook will contain a variety of information. At the beginning of each entry, the date, start time, weather, names of all sampling team members present, level of personal protection equipment being used, and the signature of the person making the entry will be entered. The names of visitors to the Site, field sampling or investigation team personnel and the purpose of their visit will also be recorded in the field logbook. Measurements made and samples collected will be recorded. All entries will be made in permanent ink, signed, and dated and no erasures will be made. If an incorrect entry is made, the information will be crossed out with a single strike mark that is signed and dated by the sampler. Whenever a sample location is surveyed, including compass and distance measurements or latitude/longitude information (e.g., obtained by using a global positioning system) the location information will be recorded. In the event that photographs are taken to document field activities, the number and brief description of the photographs taken will also be recorded. All equipment used to make measurements will be identified, along with the date of calibration.

Samples will be collected following the sampling procedures documented in Section 4.0 of this QAPP. The equipment used to collect samples will be noted, along with the time of sampling, sample description, depth at which the sample was collected, volume and number of containers. Sample identification numbers will be assigned prior to sample collection. Field duplicate samples, which will receive a separate sample identification number, will be noted under sample description.

The sample packaging and shipment procedures summarized below will ensure that the samples will arrive at the laboratory with the chain-of-custody intact. The protocol for specific sample numbering and other sample designations is included in an FOP provided in Appendix A of this QAPP. Examples of field custody documents and instructions for completion are also presented in Appendix A of this QAPP.

- The field sampler is personally responsible for the care and custody of the samples until they are transferred or properly dispatched. Field procedures have been designed such that as few people as possible will handle the samples.

- All bottles will be identified by the use of sample tags with sample numbers, sampling locations, date/time of collection, and type of analysis. The sample numbering system is presented in the FOP.

- Sample labels will be completed for each sample using waterproof ink unless prohibited by weather conditions. For example, a logbook notation would explain that a pencil was used to fill out the sample label because the ballpoint pen would not function in freezing weather.

- Samples will be accompanied by a properly completed chain-of-custody form (see FOP). The sample numbers and locations will be listed on the chain-of-custody form. When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the record. This record documents transfer of custody of samples from the sampler to another person, to a mobile laboratory, to the permanent laboratory, or to/from a secure storage area.

Samples will be properly packaged and cooled to 4°C (soil and groundwater samples) for shipment and dispatched to the appropriate laboratory for analysis, with a separate signed custody record enclosed in and secured to the inside top of each sample box or cooler. Shipping containers will be locked and secured with strapping tape and custody seals for shipment to the laboratory. The custody seals will be attached to the front right and back left of the cooler and covered with clear plastic tape after being signed by the field team leader. The cooler will be strapped shut with strapping tape in at least two locations.

5.2 Laboratory Custody Procedures

Laboratory custody procedures for sample receiving and log-in; sample storage and numbering; tracking during sample preparation and analysis; and storage of data are described in Appendix B, the Laboratory QA Manual.

5.2.1 Sample Receipt

A sample custodian is responsible for receiving samples, completing chain-of-custody (COC) records, determining and documenting the condition of samples received through the Cooler Receipt and Preservation Form (CRPF, see Laboratory QA Manual, Appendix B), logging samples into the LIMS system based upon the order of log-in, and storing samples in appropriate limited-access storage areas. Chain-of-custody documentation is also maintained for the transfer of samples between Test America, and for shipment of samples to subcontracted laboratories.

Upon sample receipt, an inventory of shipment contents is compared with the COC record, and any discrepancies, including broken containers, inappropriate container materials or preservatives, headspace in VOC samples, and incorrect or unclear sample identification, are documented and communicated to the appropriate project manager.

Each sample is given a unique laboratory code and an analytical request form is generated. The analytical request contains pertinent information for each sample, including:

- Client name
- Project number
- Task number
- Purchase order number
- Air bill number
- Chain-of-custody number
- Number of samples
- Sample descriptions
- Sample matrix type
- Date and time of sampling
- Analysis due dates
- Date and time of receipt by lab
- Client sample identification
- Any comments regarding special instructions or discrepancies

5.2.2 Sample Storage

Samples are stored in secure, limited-access areas. Walk-in coolers or refrigerators are maintained at 4°C, ± 2°C, or as required by the applicable regulatory program. The temperatures of all refrigerated storage areas are monitored and recorded a minimum of once per day. Deviations of temperature from the applicable range require corrective action, including moving samples to another storage location if necessary.

5.2.3 Sample Custody

Sample custody is defined by this document as an occurrence of any of the following:

- It is in someone's actual possession.
- It is in someone's view after being in his or her physical possession.

- It was in someone's possession and then locked, sealed, or secured in a manner that prevents unsuspected tampering.

- It is placed in a designated and secured area.

Samples are removed from storage areas by the sample custodian or analysts and transported to secure laboratory areas for analysis. Access to the laboratory and sample storage areas is restricted to laboratory personnel and escorted visitors only; all areas of the laboratory are therefore considered secure. If required by the applicable regulatory program, internal COC is documented in a log by the person moving the samples between laboratory and storage areas.

Laboratory documentation used to establish COC and sample identification may include the following:

- Field COC forms or other paperwork that arrives with the sample.

- The laboratory COC.

- Sample labels or tags are attached to each sample container.

- Sample custody seals.

- Sample preparation logs (i.e., extraction and digestion information) recorded in hardbound laboratory books that are filled out in legible handwriting, and signed and dated by the chemist.

- Sample analysis logs (e.g., metals, GC/MS, etc.) information recorded in hardbound laboratory books that are filled out in legible handwriting, and signed and dated by the chemist.

- Sample storage log (same as the laboratory COC).

- Sample disposition log, which documents sample disposal by a contracted waste disposal company.

5.2.4 Sample Tracking

All samples are maintained in the appropriate coolers prior to and after analysis. The analysts remove and return their samples as needed. Samples that require internal COC are relinquished to the analysts by the sample custodians. The analyst and sample custodian must sign the original COC relinquishing custody of the samples from the sample custodian to the analyst. When the samples are returned, the analyst will sign the original COC returning sample custody to the sample custodian. Sample extracts are relinquished to the instrumentation analysts by the preparatory analysts. Each preparation department tracks internal COC through their logbooks/spreadsheets.

Any change in the sample during the time of custody will be noted on the COC (e.g., sample breakage or depletion).

5.2.5 Sample Disposal

A minimum of 30 days following completion of the project, or after a period of time specified by any applicable project requirements, sample disposal is performed in compliance with federal, state, and local regulations. Alternatively, samples may be returned to the client by mutual agreement. All available data for each sample, including laboratory analysis results and any information provided by the client, are reviewed before sample disposal.

All samples are characterized according to hazardous/non-hazardous waste criteria and are segregated accordingly. All hazardous waste samples are disposed in accordance with formal procedures outlined in Test America's Standard Operating Procedure (SOP). It should be noted that all waste produced at the laboratory, including the laboratory's own various hazardous waste streams, is treated in accordance with all applicable local and Federal laws.

Complete Internal COC documentation is maintained for some samples from initial receipt through final disposal. This ensures that an accurate history of the sample from "cradle to grave" is generated. Internal Chain Documentation through disposal is in place at Test America.

5.3 Project File

The project file will be the central repository for all documents, which constitute evidence relevant to sampling and analysis activities as described in this QAPP. Benchmark is the custodian of the evidence file and maintains the contents of evidence files for the investigation, including all relevant records, reports, logs, field notebooks, pictures, subcontractor reports and data reviews in a secured, limited-access area and under custody of the Benchmark project manager. Information generated during this study by will be retained by Benchmark in the project file. The project file will include at a minimum:

- Field logbooks
- Field data and data deliverables
- Photographs
- Drawings
- Soil boring logs
- Laboratory data deliverables
- Data validation reports
- Data Assessment reports
- Progress reports, QA reports, interim project reports, etc.
- All custody documentation (tags, forms, air bills, etc.).

6.0 CALIBRATION PROCEDURES AND FREQUENCY

This section describes the calibration procedures and the frequency at which these procedures will be performed for both field and laboratory instruments.

6.1 Field Instrument Calibration

Quantitative field data to be obtained during groundwater sampling include pH, turbidity, specific conductance, temperature, and depth to groundwater. Quantitative water level measurements will be obtained with an electronic sounder or steel tape, which require no calibration. Quantitative field data to be obtained during soil sampling include screening for the presence of VOCs using a photoionization detector (PID).

FOPs located in Appendix A describe the field instruments used to monitor for these parameters and the calibration methods, standards, and frequency requirements for each instrument. Calibration results will be recorded in the Project Field Logbook.

6.2 Laboratory Instrument Calibration

All equipment and instruments used at Test America are operated, maintained and calibrated according to the manufacturer's guidelines and recommendations, as well as to criteria set forth in the applicable analytical methodology. Operation and calibration are performed by personnel who have been properly trained in these procedures. Documentation of calibration information is maintained in appropriate reference files. The frequency of calibration and concentration of calibration standards are determined by the manufacturer's guidelines, the analytical method, or the requirements of special contracts. Generally, purchased standards have a shelf life of 12-36 months and prepared standards have a shelf life of 1-12 months. Recalibration is required at anytime the instrument is not operating correctly or functioning at the proper sensitivity. Brief descriptions of the calibration procedures for major laboratory equipment and instruments are described in Test America's QA Manual (Appendix B).

7.0 ANALYTICAL PROCEDURES

Groundwater and soil samples collected during the RI activities will be analyzed by Test America, 10 Hazelwood Drive, Amherst, New York 14228, (716) 691-2600.

7.1 Field Analytical Procedures

Field procedures for collecting and preserving samples are described in FOPs located in Appendix A.

7.2 Laboratory Analytical Procedures

This section describes the analytical procedures to be followed in the laboratory. Laboratory analytical procedures will follow USEPA SW-846 methodology. Analytical methods, method detection limits, and reporting limits selected for use in this investigation are listed in Tables 1 (soil) and 2 (groundwater). Sample container, preservation and holding time requirements are presented in Table 8. Test America will provide analytical services; however, other laboratories may be used if necessary depending on project requirements. If a subcontract laboratory is required, the subcontracted laboratory's QA manual and copies of the State or Federal Certifications will be submitted to the NYSDEC prior to sample analysis. General laboratory analytical procedures and sample handling procedures are presented in Test America's QA Manual in Appendix B.

7.2.1 Sample Preparation and Analytical Methods

The laboratory named above will implement the method SOPs. The laboratory SOPs for sample preparation, cleanup and analysis are based on USEPA procedures. These SOPs provide sufficient details specific to the methods identified for this project.

7.2.2 Confirmation Analysis Methods

The laboratory SOPs presented in Appendix B identify the confirmatory analysis appropriate for this project. The basis for these SOPs is USEPA procedures. These protocols include second column confirmation for the gas chromatography methods.

In addition, confirmatory analysis may be performed by the evaluation of field duplicates and/or analytical results for split samples with the agency. Although analyte concentrations between duplicate analyses and split samples may vary, the target analytes present should be the same. This can be considered confirmation analysis.

7.2.3 Method Validation

In order to demonstrate that the laboratory is capable of detecting and quantifying analytes at specific levels required by regulatory agencies or clients, each laboratory establishes method detection limits (MDLs), instrument detection limits (IDLs), and practical quantitation limits (PQLs), as required by the specific method protocols. These limits, along with other related detection or quantitation limits, are defined as follows:

- *Method Detection Limit* (MDL) - the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero. The MDL is a theoretical, statistically derived value determined by preparing at least seven replicates of a low-level spiked matrix, which are taken through the entire sample preparation and analysis procedure; the standard deviation of the results is multiplied by the appropriate student's t value at the 99% confidence level to obtain the MDL. TEST AMERICA performs MDL studies using the procedure defined in 40 CFR Part 136, Appendix B, *Definition and Procedure for the Determination of the Method Detection Limit* - Revision 1.11. MDLs are determined for each method and instrument annually, at a minimum, or when significant modifications to the procedure or instrumentation have been made, as determined by laboratory manager.

- *Instrument Detection Limit* (IDL) - an estimate of the lowest concentration of a substance that can be reliably detected above background noise on an instrument. The IDL is a theoretical, statistically derived value, which is determined by analyzing seven replicates of a low-level standard on each of three non-consecutive days; the standard deviation of the results is multiplied by three to obtain the IDL.

- *Practical or Estimated Quantitation Limit* (PQL or EQL) - an estimate of the lowest concentration of a substance that can be reliably achieved within specified limits of precision and accuracy during routine laboratory operations. Typically, the PQL (EQL) is a nominal value selected at a level between 3 and 10 times the MDL.

- *Contract Required Quantitation Limit* (CRQL) – an estimate of the lowest concentration of a substance that can be reliably achieved as specified in the method. Typically, the CRQL is higher than PQL.

8.0 INTERNAL QUALITY CONTROL CHECKS

8.1 Field Quality Control Checks

The QC criteria for each field measurement are provided in Table 6 of this QAPP. Assessment of field sampling precision and bias will be made by collecting field duplicates and field blanks for laboratory analysis. Collection of the samples will be in accordance with the applicable FOPs described in Section 4.0 of this QAPP at the frequency indicated in Section 3.0 of this QAPP.

Blind Duplicate soil and groundwater samples will be collected to allow determination of analytical precision. One duplicate soil and groundwater sample will be collected for every 20 samples or per sampling event if less than 20 samples are collected. Duplicate sample aliquots for soil and groundwater will be collected sequentially as grab samples after collection of the initial sample aliquot. The sample location will not be disclosed to the analytical laboratory.

One equipment blank will be collected for each day of sampling activity if non-dedicated sampling equipment is used. These equipment blank samples will be used as a QC check of the decontamination procedures for sampling equipment. A VOC travel blank (a.k.a., "trip blank") will be included in each cooler containing water matrix samples to be analyzed for VOCs and sent to the laboratory for analysis.

8.2 Laboratory Quality Control Checks

The internal QC checks for laboratory analyses of soil and groundwater samples that will be collected during this investigation are covered in the laboratory's QA Manual located in Appendix B. Laboratory analytical internal QA/QC will be conducted in accordance with USEPA methodology. The checks include internal QC methods covering surrogate spikes, duplicates, preparation blanks, calibration, lab quality control samples and reagent checks. A site-specific MS/MSD sample will be analyzed as a further QC check. The matrix spike samples will be analyzed at the same frequency as the duplicate samples. The matrix spike samples will allow accuracy to be determined by using the percent recovery of the spiked compounds. The purpose of the MS/MSD samples is to monitor any possible matrix effects specific to samples collected from the Site. The specific sample location that will be used for matrix spikes may be chosen by the Project Manager or Project QA Officer.

9.0 DATA REDUCTION, VALIDATION, AND REPORTING

All data generated through field activities, or by the laboratory operation shall be reduced and validated prior to reporting. The laboratory shall disseminate no data until it has been subjected to the procedures summarized below.

9.1 Data Reduction

9.1.1 Field Data Reduction Procedures

Field measurements of pH, turbidity, temperature, specific conductance, water level and volatile organic vapor content (via the PID) are read directly in the units of final use, as discussed in Section 3.0 of this QAPP and listed in Table 5. Field personnel are responsible for monitoring the collection and reporting of field data. Field personnel will review field measurements at the time of measurement and will re-measure a parameter as necessary to assure quality and accuracy is maintained.

Field data will be recorded on appropriate field data record forms as they are collected and will be maintained in Benchmark's office project file. The Project QA Officer will review field procedures and compare field data to previous measurements to assess comparability and accuracy of the field data measurements.

9.1.2 Laboratory Data Reduction Procedures

Results of laboratory analyses will be reported in units of final use, as discussed in Section 3.0 and listed in Table 5. Laboratory calculations will be performed as prescribed for a given analytical method or in conformance with acceptable laboratory standards at the time the calculation is performed.

The laboratory will retain QA/QC records for at least five years. Original laboratory reports will be stored in the Benchmark project files. Copies of raw data will be available for review at the laboratory. Copies of raw data also may be requested as part of the QA/QC review. For this project, Benchmark has requested a complete validatable data package (Category B deliverables). The data package includes the following information:

- Transmittal letter.

- Sample number or numbers; matrix; date and time collected; date and time extracted/digested; date and time analyzed; chain of custody information; sample receipt information (e.g., container seals, cooler temperature); and field sampling log.
- Parameter requested.
- Results, including sample analytical results; duplicates; blanks; MS/MSDs; blank spikes; surrogate recoveries (if applicable); standard reference materials results; and low level matrix spike recoveries to confirm method detection limit.
- Surrogate recovery results for appropriate organic methods, including associated NYSDEC or Test America acceptance criteria.
- Chain of Custody documents.
- Case narrative.
- Supporting QA/QC. This includes sample preparation, analysis and cleanup methods, sample preparation and cleanup logs; analysis run logs; MDLs, IDLs and methods used to determine MDL in the matrix; calibration data; percent solids for non-water samples; example calculations; data validation procedures, results and checklists; and documentation illustrating how blank water is determined to be analyte free.

The Project Manager, Project QA Officer, or appropriate personnel assigned by the Project Manager will review the laboratory data. Section 12.0 outlines the procedures for evaluating the accuracy and precision of data. If comparison of data to previous measurements or known conditions at the Site indicates anomalies, the laboratory will be instructed to review the submitted data while Benchmark reviews the methods used to obtain the data. If anomalies remain, the laboratory may be asked to re-analyze selected samples provided that holding times have not been exceeded.

9.2 Data Usability Evaluation

Data usability evaluation procedures shall be performed for both field and laboratory operations as described below.

9.2.1 Procedures Used to Evaluate Field Data Usability

Procedures to validate field data for this project will be facilitated by adherence to the FOPs identified in Appendix A. The performance of all field activities, calibration checks on all field instruments at the beginning of each day of use, manual checks of field calculations, checking for transcription errors and review of field log books is the responsibility of the Field Team Leader.

9.2.2 Procedures Used to Evaluate Laboratory Data Usability

Data evaluation will be performed by the third-party data validator using the most current methods and quality control criteria from the USEPA's Contract Laboratory Program, (CLP) *National Functional Guidelines for Organic Data Review*, and *Contract Laboratory Program, National Functional Guidelines for Inorganic Data Review*, as well as corresponding USEPA Region 2 guidance. Also, results of blanks, surrogate spikes, MS/MSDs, and laboratory control samples will be reviewed/evaluated by the data validator. All sample analytical data for each sample matrix shall be evaluated. The third-party data validation expert will also evaluate the overall completeness of the data package. Completeness checks will be administered on all data to determine whether deliverables specified in Section 9.1.2 of this QAPP are present. The reviewer will determine whether all required items are present and request copies of missing deliverables. The data review will be presented in a Data Usability Summary Report (DUSR), prepared in accordance with Appendix 2B of NYSDEC's draft DER-10 guidance. Appropriate data qualifiers will be added to the data summary tables and analytical report Form 1. Any data that would be rejected under USEPA Region 2 Data Validation Guidelines will also be rejected in the DUSR.

9.3 Data Reporting

Data reporting procedures shall be carried out for field and laboratory operations as indicated below.

9.3.1 Field Data Reporting

All investigation field documents will be accounted for when they are completed. Accountable documents include items such as field notebooks, sample logs, field data records, photographs, data packages, computer disks, and reports.

9.3.2 Laboratory Data Reporting

Analytical data will be summarized in tabular format with such information as sample identification, sample matrix description, parameters analyzed and their corresponding detected concentrations, and the detection limit. Analytical results will be incorporated into reports as data tables, maps showing sampling locations and analytical results, and supporting text.

10.0 PERFORMANCE SYSTEM AUDITS AND FREQUENCY

Performance and system audits of both field and laboratory activities will be conducted to verify that sampling and analysis are performed in accordance with the procedures established in the FOPs and this QAPP. The audits of field and laboratory activities include two independent parts, internal and external.

10.1 Field Performance and System Audits

10.1.1 Internal Field Audits

The QA Officer will conduct internal audits of field activities including sampling and field measurements. These audits will verify that all established procedures are being followed. Internal field audits will be conducted at least once at the beginning of the Site sample collection activities. Project duration may warrant subsequent audits on a monthly basis.

The audit program consists of the following:

- Observation of field activities to confirm that procedures are performed in accordance with project protocols and standard accepted methods, as detailed in the FOPs located in Appendix A.

- Review daily field records, monitoring well sampling records, and any other data collection sheets during and after field measurements.

10.1.2 External Field Audits

The NYSDEC Site Project Coordinator may conduct external field audits. External field audits may be conducted any time during the field operations. These audits may or may not be announced and are at the discretion of the NYSDEC. External field audits will be conducted according to the field activity information presented in this QAPP.

10.2 Laboratory System Audits

The adequacy and implementation of Test America's QA plan are assessed on a continual basis through systems and performance audits. Systems audits evaluate practice against established quality system objectives and requirements. Performance audits measure the comparability and accuracy of laboratory data through the analysis of reference materials for which the true value is unknown to the analyst. Audits may be performed by Test America (internal), or by clients, regulatory agencies, or accreditation bodies (external).

10.2.1 Internal Laboratory Audits

The Test America QA Coordinator schedules internal systems audits such that the laboratory's quality system and range of test capabilities are audited annually. The audits are conducted to determine the following:

- Whether the procedures defined in the quality system are being followed.
- Whether the objectives defined in the quality system are being achieved.
- Identify opportunities for improvement.

The Test America QA Coordinator will conduct the laboratory audit. The QA Coordinator prepares an audit plan for each audit, which defines the scope of the audit, requirements that the audit will be conducted against, and the audit technique(s) to be used (observation, record review, interview). The internal system audits are scheduled as two auditing events and follow the audit plan.

The results of each audit are reported to the Laboratory Director and Supervisors for review and comment. Any deficiencies noted by the auditor are summarized in an audit report and corrective action is taken within a specified length of time to correct each deficiency. Should problems impacting data quality be found during an internal audit, any client whose data is adversely impacted will be given written notification if not already provided.

10.2.2 External Laboratory Audits

Upon client, regulatory agency, or accreditation body notification of intent to audit, the quality assurance officer notifies laboratory personnel and corporate quality assurance. During the audit, the quality assurance coordinator, or a designee, provides escort for the auditors, and participates in the pre-audit and post-audit conferences. Additional laboratory personnel are called upon as necessary during the course of the audit. An external audit will be conducted upon request by appropriate NYSDEC QA staff. These audits may or may not be announced and are at the discretion of the NYSDEC.

External audits may include any or all of the following:

- Review of laboratory analytical procedures.
- Laboratory on-site visits (see below).
- Submission of performance evaluation samples to the laboratory for analysis.

Failure of any or all audit procedures chosen can lead to laboratory disqualification, and the requirement that another suitable laboratory be chosen.

An external on-site review may consist of:

- Sample receipt procedures
- Custody and sample security and log in procedures
- Calibration records
- Instrument logs and statistics (number and type)
- Review of QA procedures
- Review of logbooks
- Review of sample preparation procedures
- Sample analytical SOP review
- Instrument (normal or extends quantitation report) reviews
- Personnel interviews
- Review of deadlines and glassware prep
- A close out to offer potential corrective action

It is common practice when conducting an external laboratory audit to review one or more data packages from sample lots recently analyzed by the laboratory. This review will most likely include but not be limited to:

- Comparison of resulting data to the laboratory SOP or method, including coding for deviations.
- Verification of initial and continuing calibrations within control limits.

- Verification of surrogate recoveries and instrument tuning results where applicable.

- Review of extended quantitation reports for comparisons of library spectra to instrument spectra, where applicable.

- Recoveries on control standard runs.

- Review of run logs with run times, ensuring proper order of runs,

- Review of spike recoveries/QC sample data.

- Review of suspected manually integrated GC data and its cause (where applicable).

- Assurance that samples are run within holding times.

All data will be reviewed while on the premises of Test America, so that any questionable data can be discussed with the staff.

Following the audit, the QA Officer provides a written summary of the audit to the laboratory manager, department supervisors, and corporate quality assurance. The summary includes the areas reviewed, and strengths and deficiencies identified during the audit.

The QA Coordinator initiates the corrective action process for each finding and is responsible for ensuring timely corrective action. The QA Coordinator prepares the audit report response, and prepares any follow-up responses as corrective actions are completed. The audit report and laboratory responses are copied to corporate quality assurance.

10.3 Laboratory Performance Audits

10.3.1 Internal Performance Audit

Internal performance audit samples are submitted at the discretion of the local QA Director as a supplement to the quality control checks run on a daily basis. The QA Director maintains a log of blind sample preparation in which the reference material used, preparation, and true value(s) are documented. The reference materials submitted should be independent of the laboratory's initial calibration standards.

Acceptance criteria for internal performance audit sample results are those provided with the reference material. If no criteria are provided, performance criteria listed in the reference method are used. Internal performance audit results are scored and corrective action is initiated in the same manner as external samples. The Laboratory Director is responsible for ensuring timely corrective action.

10.3.2 External Performance Audit

External performance audit samples are run at the frequency required to obtain and maintain desired certifications, accreditations, and approvals. Additional studies may be run at the discretion of corporate QA or the local laboratory manager.

The QA Director initiates the corrective action process for each performance audit result scored as "fail." The Laboratory Director is responsible for ensuring timely corrective action. The audit report and laboratory responses are copied to corporate quality assurance.

11.0 PREVENTATIVE MAINTENANCE

11.1 Field Instrument Preventative Maintenance

Each piece of field equipment is checked according to its routine maintenance schedule and before field activities begin. Field equipment planned for use during this investigation includes:

- Photoionization detector (PID).
- Water quality meters (includes pH, turbidity, temperature and specific conductance).
- Electric water level indicator.

Field personnel will report all equipment maintenance and/or replacement needs to the Project QA Officer and will record the information on the daily field record. Calibration and Maintenance FOPs are provided in Appendix A.

11.2 Laboratory Instrument Preventative Maintenance

As part of the QA Program Plan, a routine preventative maintenance program is conducted by Test America to minimize the occurrence of instrument failure and other system malfunctions. The analysts regularly perform instrument maintenance tasks (or coordinate with the vendor). All maintenance that is performed is in accordance with the manufacturer's specifications and is documented in the laboratory's maintenance logbooks. The maintenance logbooks used at Test America contain extensive information about the instruments used at the laboratory.

Preventative maintenance procedures, frequencies, and other pertinent information are available for each instrument used at Test America through SOPs and in the operating or maintenance manuals provided with the equipment. Responsibility for ensuring that routine maintenance is performed lies with the section supervisors. Each laboratory section maintains a critical parts inventory. The parts inventories include the items needed to perform the preventative maintenance procedures presented in Test America's QA Manual provided in Appendix B of this QAPP.

11.3 Inspection/Acceptance Requirements for Supplies and Consumables

11.3.1 Field Supplies and Consumables

For this investigation, Benchmark will track critical supplies in the following manner.

Item	Date Received	Condition	Responsible Individual
Tyvek suits			
Disposable bailers			
Pump tubing			
Latex gloves			
Respirator cartridges			
Sample containers			
Decon materials			
Alconox detergent			
pH buffer solutions			
Calibration gases			

Labels indicating the following information on receipt and testing are to be used for critical supplies and consumables.

- Unique identification number (if not clearly shown).
- Date received.
- Date opened.
- Date tested (if performed).
- Date to be retested (if applicable).
- Expiration date.

11.3.2 Laboratory Supplies and Consumables

Supplies and consumables used in the analytical process shall have traceable documentation (e.g., labels or logbooks) for date received, date opened, and date expired. Inspection, testing and acceptance criteria for critical supplies and consumables are identified below.

Critical Supplies & Consumables	Inspection/ Acceptance Testing Requirements	Acceptance Criteria	Testing Method	Frequency	Responsible Individual	Handling/ Storage Conditions
Standards	Refer to the Manufacturer's Certificate of Analysis.					
Acids	<RL's for common lab contaminants	<RL's all elements	SW-846	Each Lot	Receiving / Laboratory Personnel	Vented Acid Cabinets
Solvents	<RL's for common lab contaminants	<RL's for common lab contaminants	SW-846	Each Lot	Receiving / Laboratory Personnel	Vented Solvent Cabinets

12.0 DATA PRECISION, ACCURACY, AND COMPLETENESS EVALUATION

The purpose of this section is to indicate the methods by which it will be assured that the data collected for this investigation is in accordance with the data quality objectives (DQOs) for the Site. Factors considered during this investigation include:

- The chemical constituents known and/or suspected to be of concern, as they relate to the data quality level parameters chosen.
- The choice of analytical and sample preparation methods with method detection limits that meet the data quality level concentrations for chemical constituents of concern.
- The risk-based preliminary remediation goal parameters chosen based on conditions and possible receptors associated with the site (e.g., human health data quality levels, soil screening guidance, etc.).

Once these goals and objectives are evaluated and chosen, analytical data quality will be assessed to determine if the objectives have been met. In addition, the data will be reviewed for indications of interferences to results caused by sample matrices, cross contamination during sampling, cross contamination in the laboratory, and sample preservation and storage anomalies (i.e., samples holding time or analytical instrument problems).

As discussed in Section 3.0 of this QAPP, the validity of data will be evaluated in terms of precision, accuracy, and completeness. Described below are ways in which these three parameters will be evaluated. Evaluations will be performed upon completion of investigation field activities.

12.1 Accuracy Assessment

Data accuracy, which is assessed for laboratory data only, is based on recoveries, expressed as the percentage of the true (known) concentration, from laboratory spiked samples and QA/QC samples generated by the analytical laboratory.

Percent recovery (%R) for MS/MSD results is determined according to the following equation:

$$R\% = \frac{(A - B)}{T} \times 100$$

Where A = measured concentration after spiking
B = background concentration
T = known true value of spike

Percent recovery (%R) for LCS and surrogate compound results is determined according to the following equation:

$$R\% = \frac{\text{Experimental concentration}}{\text{Known amount added}} \times 100$$

This information is reviewed periodically by the Project Manager or Project QA Officer. The goals for the recovery of any constituent in a spiked or QA/QC sample are presented in Table 3.

12.2 Precision Assessment

For data generated by the laboratory, data precision is estimated by comparing analytical results from duplicate samples. The comparison is made by calculating the relative percent difference (RPD) given by:

$$RPD\% = \frac{2(S_1 - S_2)}{S_1 + S_2} \times 100$$

Where S_1 = sample result
S_2 = duplicate result

This information is calculated and reviewed periodically by the Project Manager and/or Project QA Officer. The goals for data precision for duplicate samples are presented in Table 3. For data generated in the field, the precision goals are summarized in Table 4.

12.3 Completeness Assessment

Data completeness will be evaluated by comparing the objectives of investigation efforts with the data obtained and determining whether there are any shortcomings in required information. A series of protocols, described below, will be used to evaluate data completeness. The purpose is to accomplish the following:

- Rigorously assess the quality and adequacy of data collected during the investigation.
- Review data collected during the investigation to evaluate if the study's objectives are being addressed and met.
- Ensure that the data collected are valid by applying the quality checks described in this and other sections of the QAPP.

Data generated during the investigation will be evaluated for completeness; that is, the amount of data meeting project QA/QC goals. If data generated during field operations or during analytical procedures appear to deviate significantly from previous trends, the Project Manager or Project QA Officer will review field or laboratory procedures with the appropriate personnel to evaluate the cause of such deviations. Where data anomalies cannot be explained, resampling may be performed. Completeness is defined as the percentage of valid results according to the equation below:

$$\%\ \text{completeness} = \frac{A}{B} \times 100$$

Where:
A = number of valid results;
B = total number of possible results

The goals for data completeness for laboratory measurements were presented previously in Table 3.

12.4 Assessment of Data

To assess the integrity of the data generated during this investigation, the Project Manager and QA Officer will review the laboratory analytical data and field data in accordance with procedures and protocols outlined in this QAPP. An assessment will be made to determine if the project objectives described in Section 1.0 have been achieved. Corrective Action described in Section 13.0 will be implemented, if necessary, to meet objectives for data integrity.

13.0 CORRECTIVE ACTION

Corrective action is the process of identifying, recommending, approving, and implementing measures to counter unacceptable procedures or out of QC performance that can affect data quality. Corrective action can occur during field activities, laboratory analyses, data validation, and data assessment. All corrective action proposed and implemented should be documented in the regular QA reports to management. Corrective action should be implemented only after approval by the Project Manager, or his/her designee. If immediate corrective action is required, approvals secured by telephone from the Project Manager should be documented in an additional memorandum.

For noncompliance problems, a formal corrective action program will be determined and implemented at the time the problem is identified. In the field, the person who identifies the problem is responsible for notifying the Field Team Leader, who will notify the Project Manager, who in turn will notify the NYSDEC Project Coordinator. If the problem is analytical in nature, information will be promptly communicated to the NYSDEC Project Coordinator via fax or telephone during that same day or the next business day. Implementation of corrective action will be confirmed in writing through the same channels. If noncompliance is observed in the laboratory or during data validation, the analyst or data validator will notify the Project Manager and communication will continue in the same manner as described above.

13.1 Field Corrective Action

If errors in field procedures are discovered during the observation or review of field activities by the Project QA Officer or his/her designee, corrective action will be initiated. Nonconformance to the QA/QC requirements of the FOPs will be identified by field audits or immediately by project staff who know or suspect that a procedure is not being performed in accordance with the requirements. The Project QA Officer or his designee will be informed immediately upon discovery of all deficiencies. Timely action will be taken if corrective action is necessary.

Corrective action in the field may be needed when the sample network is changed (i.e., more/less samples, sampling locations other than those specified in the Work Plan, etc.) or when sampling procedures and/or field analytical procedures require modification due to unexpected conditions. In general, the Project Manager and QA Officer may identify the need for corrective action. The Project Manager will approve the corrective measure that will be implemented by the field team. It will be the responsibility of the Project Manager to ensure that corrective action has been implemented.

If the corrective action will supplement the existing sampling plan (e.g., additional soil borings) using existing and approved procedures in the QAPP, corrective action approved by the Project Manager will be documented. If the corrective actions result in less samples (or analytical fractions), alternate locations, etc., which may result in non-achievement of project QA objectives, it will be necessary that all levels of project management, including the NYSDEC Project Coordinator, concur with the proposed action.

Corrective action resulting from internal field audits will be implemented immediately if data may be adversely affected due to unapproved or improper use of approved methods. The QA Officer will identify deficiencies and recommend corrective action to the Project Manager. The Project Manager and field team will implement corrective actions. Corrective action will be documented in QA reports to the entire project management.

Corrective actions will be implemented and documented in the project field record book. No staff member will initiate corrective action without prior communication of findings through the proper channels. If corrective actions are insufficient, work may be stopped by the NYSDEC Project Coordinator.

If at any time a corrective action issue is identified that directly impacts project DQOs, the NYSDEC Project Coordinator will be notified immediately.

13.2 Laboratory Corrective Action

Corrective actions may be initiated if the QA goals are not achieved. The initial step in a corrective action is to instruct the analytical laboratory to examine its procedures to assess whether analytical or computational errors caused the anomalous result. If no error in laboratory procedures or sample collection and handling procedures can be identified, then the Project Manager will assess whether reanalysis or resampling is required or whether any protocol should be modified for future sampling events.

13.3 Data Validation & Assessment Corrective Action

The need for corrective action may be identified during the data validation or assessment processes. Potential types of corrective action may include resampling by the field team, or reinjection/reanalysis of samples by the laboratory.

These actions are dependent upon the ability to mobilize the field team, whether the data to be collected is necessary to meet the QA objectives (e.g., the holding time for samples is not exceeded, etc.). If the data validator identifies a corrective action situation, the Project Manager will be responsible for approving the corrective action implementation. All required corrective actions will be documented by the laboratory QA Coordinator.

14.0 QUALITY ASSURANCE REPORTS TO MANAGEMENT

The deliverables associated with the tasks identified in the Work Plan and monthly progress reports will contain separate QA sections in which data quality information collected during the reporting period is summarized. Those reports will be the responsibility of the Project Manager and will include the QA Officer's input on the accuracy, precision, and completeness of the data, as well as the results of the performance and system audits, and any corrective action needed or taken during the project.

14.1 Contents of Project QA Reports

The progress reports will contain, on a routine basis, a QA section describing all results of field and laboratory audits, all information generated during the past month reflecting on the achievement of specific DQOs, and a summary of corrective action that was implemented, and its immediate results on the project. The status of the project with respect to the Project Schedule included in this QAPP will be determined. Whenever necessary, updates on training provided, changes in key personnel, anticipated problems in the field or laboratory for the coming month that could bear on data quality along with proposed solutions, will be reported. Detailed references to QAPP modifications will also be highlighted. All QA reports will be prepared in written, final format by the Project Manager or his designee. To the extent possible, assessment of the project should also be performed on the basis of available QC data and overall results in relation to originally targeted objectives.

In the event of an emergency, or in case it is essential to implement corrective action immediately, QA reports can be made by telephone to the appropriate individuals, as identified in the Project Organization and Corrective Action sections of this QAPP. However, these events, and their resolution will be addressed thoroughly in the next monthly progress report.

14.2 Frequency and Distribution of QA Reports

The QA reports will be completed for all months during which sample collection and/or analysis occurs and will be presented as part of the monthly progress report.

14.3 Individuals Receiving/Reviewing QA Reports

The QA reports will be delivered to all progress report recipients, which shall include all individuals identified in the Project Organization chart and other individuals identified by NYSDEC.

15.0 REFERENCES

1. New York State Department of Environmental Conservation. *Draft DER-10; Technical Guidance for Site Investigation and Remediation.* December 2002

2. U.S. Environmental Protection Agency. *Requirements for Quality Assurance Project Plans for Environmental Data Operations (EPA QA/R-5).* October 1998.

3. U.S. Environmental Protection Agency. *National Functional Guidelines for Organic Data Review(EPA-540/R-94-012).* 1994a.

4. U.S. Environmental Protection Agency. *National Functional Guidelines for Inorganic Data Review(EPA-540/R-94-013).* 1994b.

5. U.S. Environmental Protection Agency. *Test Methods for Evaluating Solid Waste, Physical/Chemical Methods. SW-846, Third Edition (Updates I, II and III).* 1991.

6. U.S. Environmental Protection Agency. *Region II, CERCLA Quality Assurance Manual, Revision I.* October 1989.

7. U.S. Environmental Protection Agency. *Methods for Chemical Analysis of Water and Wastes, EPA 600/4-70-020.* 1983b.

TABLES

TABLE 1

CONSTITUENTS OF PRIMARY CONCERN (COPCs)
FOR SOIL

RI / AAR QAPP
1501 College Avenue Site
Niagara Falls, New York

Analyte[1]	*CAS Number*	Analytical Method [2]	PQL	MDL
STARS Volatile Organic Compounds: (15 compounds) (ug/kg)				
Benzene	*71-43-2*	8021B	1	0.11
n-Butylbenzene	*104-51-8*	8021B	1	1.00
sec-Butylbenzene	*135-98-8*	8021B	1	0.08
tert-Butylbenzene	*98-06-6*	8021B	1	0.12
p-Cymene	*99-87-6*	8021B	1	0.41
Ethylbenzene	*100-41-4*	8021B	1	0.07
Isopropylbenzene	*98-82-8*	8021B	1	0.08
Methyl tert butyl ether	*1634-04-4*	8021B	1	0.06
n-Propylbenzene	*103-65-1*	8021B	1	0.11
Toluene	*108-88-3*	8021B	1	0.04
1,2,4-Trimethylbenzene	*95-63-6*	8021B	1	0.40
1,3,5-Trimethylbenzene	*108-67-8*	8021B	1	0.84
o-Xylene	*95-47-6*	8021B	1	0.01
p-Xylene	*106-42-3*	8021B	1	0.04
m-Xylene	*108-38-3*	8021B	1	0.04
TCL Volatile Organic Compounds (full list): (57 compounds) (ug/L) ***[includes STARS VOCs in blue]***				
Acetone	*67-64-1*	8260B	25	22.57
Benzene	*71-43-2*	8260B	5	0.81
Bromoform	*75-25-2*	8260B	5	1.13
Bromodichloromethane	*75-27-4*	8260B	5	0.72
Bromomethane (Methyl bromide)	*74-83-9*	8260B	5	1.47
2-Butanone (MEK)	*78-93-3*	8260B	25	3.49
n-Butylbenzene	*104-51-8*	8260B	5	1.95
sec-Butylbenzene	*135-98-8*	8260B	5	0.99
tert-Butylbenzene	*98-06-6*	8260B	5	1.03
Carbon disulfide	*75-15-0*	8260B	5	1.24
Carbon tetrachloride	*56-23-5*	8260B	5	0.84
Chlorobenzene	*108-90-7*	8260B	5	0.60
Chloroethane	*75-00-3*	8260B	5	0.84
Chloroform	*67-66-3*	8260B	5	1.26
Chloromethane (Methyl chloride)	*74-87-3*	8260B	5	0.73
Cyclohexane	*110-82-7*	8260B	5	0.23
p-Cymene (p-isopropyltoluene)	*99-87-6*	8260B	5	1.05
1,2-Dibromo-3-chloropropane	*96-12-8*	8260B	5	1.03

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Analyte[1]	*CAS Number*	Analytical Method [2]	PQL	MDL
TCL Volatile Organic Compounds (full list): (57 compounds) (ug/L) ***[includes STARS VOCs in blue]***				
1,2-Dibromoethane (EDB)	*106-93-4*	8260B	5	0.78
Dibromochloromethane	*124-48-1*	8260B	5	0.91
Dichlorodifluoromethane (Freon-12)	*75-71-8*	8260B	5	1.15
1,2-Dichlorobenzene	*95-50-1*	8260B	5	0.57
1,3-Dichlorobenzene	*541-73-1*	8260B	5	0.57
1,4-Dichlorobenzene	*106-46-7*	8260B	5	0.57
1,1-Dichloroethane	*75-34-3*	8260B	5	1.02
1,2-Dichloroethane (EDC)	*107-06-2*	8260B	5	0.88
1,1-Dichloroethylene (1,1-DCE)	*75-35-4*	8260B	5	0.61
trans-1,2-Dichloroethylene	*156-60-5*	8260B	5	1.43
cis-1,2-Dichloroethylene	*156-59-2*	8260B	5	1.19
cis-1,3-Dichloropropene	*10061-01-5*	8260B	5	0.79
trans-1,3-Dichloropropene	*10061-02-6*	8260B	5	0.96
1,2-Dichloropropane	*78-87-5*	8260B	5	0.95
Ethylbenzene	*100-41-4*	8260B	5	0.62
2-Hexanone	*591-78-6*	8260B	25	4.72
Isopropylbenzene (Cumene)	*98-82-8*	8260B	5	0.57
Methyl acetate	*79-20-9*	8260B	5	1.95
Methylene chloride	*75-09-2*	8260B	5	4.42
Methylcyclohexane	*108-87-2*	8260B	5	0.92
4-methyl-2-pentanone (MIBK)	*108-10-1*	8260B	25	4.21
Methyl tert butyl ether (MTBE)	*1634-04-4*	8260B	5	0.55
n-Propylbenzene	*103-65-1*	8260B	5	0.89
Styrene	*100-42-5*	8260B	5	1.20
1,1,1,2-Tetrachloroethane	*630-20-6*	8260B	5	1.12
Tetrachloroethylene (PCE)	*127-18-4*	8260B	5	0.80
Toluene	*108-88-3*	8260B	5	1.62
1,2,4-Trichlorobenzene	*120-82-1*	8260B	5	0.93
1,1,1-Trichloroethane	*71-55-6*	8260B	5	0.69
1,1,2-Trichloroethane	*79-00-5*	8260B	5	0.92
Trichloroethylene (TCE)	*79-01-6*	8260B	5	0.64
Trichlorofluoromethane (Freon-11)	*75-69-4*	8260B	5	0.77
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon	*76-13-1*	8260B	5	0.53
1,2,4-Trimethylbenzene	*95-63-6*	8260B	5	0.74

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TCL Volatile Organic Compounds (full list): (57 compounds) (ug/L) ***[includes STARS VOCs in blue]***				
1,3,5-Trimethylbenzene	*108-67-8*	8260B	5	0.65
Vinyl chloride	*75-01-4*	8260B	10	0.78
o-Xylene	*95-47-6*	8260B	5	1.12
p-Xylene	*106-42-3*	8260B	5	0.93
m-Xylene	*108-38-3*	8260B	5	0.93
TCL Semi-Volatile Organic Compounds (full list): (69 compounds) (ug/kg) ***[includes Base-Neutrals (black) and Acid Extractables (blue)]***				
Acenaphthene	*83-32-9*	8270C	330	11.00
Acenaphthylene	*208-96-8*	8270C	330	10.00
Anthracene	*120-12-7*	8270C	330	9.00
Benzo(a)anthracene	*56-55-3*	8270C	330	13.00
Benzo(a)pyrene	*50-32-8*	8270C	330	11.00
Benzo(b)fluoranthene	*205-99-2*	8270C	330	15.00
Benzo(g,h,i)perylene	*191-24-2*	8270C	330	10.00
Benzo(k)fluoranthene	*207-08-9*	8270C	330	17.00
Benzyl alcohol	*100-51-6*	8270C	330	14.00
bis(2-Chloroethoxy)methane	*111-91-1*	8270C	330	14.00
bis(2-Chloroethyl)ether	*111-44-4*	8270C	330	14.00
2,2'-oxybis(1-chloropropane); bis(2-chloroisopropyl)ether	*108-60-1*	8270C	330	14.00
bis(2-Ethylhexyl)phthalate	*117-81-7*	8270C	330	19.00
Butyl benzyl phthalate	*85-68-7*	8270C	330	17.00
4-Bromophenyl phenyl ether	*101-55-3*	8270C	330	11.00
4-Chloroaniline	*106-47-8*	8270C	330	18.00
4-Chloro-3-methylphenol	*59-50-7*	8270C	330	12.00
2-Chloronaphthalene	*91-58-7*	8270C	330	13.00
2-Chlorophenol	*95-57-8*	8270C	330	12.00
4-Chlorophenyl-phenylether	*7005-72-3*	8270C	330	12.00
Chrysene	*218-01-9*	8270C	330	10.00
Dibenzo(a,h)anthracene	*53-70-3*	8270C	330	13.00
Dibenzofuran	*132-64-9*	8270C	330	10.00
3,3'-Dichlorobenzidine	*91-94-1*	8270C	330	148.00
2,4-Dichlorophenol	*120-83-2*	8270C	330	15.00
1,2-Dichlorobenzene	*95-50-1*	8270C	330	15.00

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TCL Semi-Volatile Organic Compounds (full list): (69 compounds) (ug/kg) *[includes Base-Neutrals (black) and Acid Extractables (blue)]*				
1,3-Dichlorobenzene	*541-73-1*	8270C	330	14.00
1,4-Dichlorobenzene	*106-46-7*	8270C	330	13.00
Diethyl phthalate	*84-66-2*	8270C	330	9.00
2,4-Dimethylphenol	*105-67-9*	8270C	330	33.00
Dimethyl phthalate	*131-11-3*	8270C	330	10.00
Di-n-butyl phthalate	*84-74-2*	8270C	330	11.00
Di-n-octyl phthalate	*117-84-0*	8270C	330	31.00
4,6-Dinitro-2-methylphenol	*534-52-1*	8270C	1600	66.00
2,4-Dinitrophenol	*51-28-5*	8270C	1600	120.00
2,4-Dinitrotoluene	*121-14-2*	8270C	330	33.00
2,6-Dinitrotoluene	*606-20-2*	8270C	330	66.00
Fluoranthene	*206-44-0*	8270C	330	12.00
Fluorene	*86-73-7*	8270C	330	10.00
Hexachlorobenzene	*118-74-1*	8270C	330	11.00
Hexachlorobutadiene	*87-68-3*	8270C	330	13.00
Hexachlorocyclopentadiene	*77-47-4*	8270C	330	12.00
Hexachloroethane	*67-72-1*	8270C	330	14.00
Indeno(1,2,3-cd)pyrene	*193-39-5*	8270C	330	11.00
Isophorone	*78-59-1*	8270C	330	13.00
2-Methylnaphthalene	*91-57-6*	8270C	330	14.00
2-Methylphenol (o-Cresol)	*95-48-7*	8270C	330	33.00
4-Methylphenol (p-Cresol)	*106-44-5*	8270C	330	14.00
Naphthalene	*91-20-3*	8270C	330	14.00
2-Nitroaniline	*88-74-4*	8270C	1600	12.00
3-Nitroaniline	*99-09-2*	8270C	1600	17.00
4-Nitroaniline	*100-01-6*	8270C	1600	66.00
Nitrobenzene	*98-95-3*	8270C	330	12.00
2-Nitrophenol	*88-75-5*	8270C	330	66.00
4-Nitrophenol	*100-02-7*	8270C	1600	66.00
N-Nitrosodiphenylamine	*86-30-6*	8270C	330	29.00
N-Nitroso-di-n-propylamine	*621-64-7*	8270C	330	13.00
Pentachlorophenol	*87-86-5*	8270C	1600	50.00
Phenanthrene	*85-01-8*	8270C	330	11.00
Phenol	*108-95-2*	8270C	330	11.00

TABLE 1

CONSTITUENTS OF PRIMARY CONCERN (COPCs) FOR SOIL

RI / AAR QAPP
1501 College Avenue Site
Niagara Falls, New York

Analyte[1]	*CAS Number*	Analytical Method [2]	PQL	MDL
TCL Semi-Volatile Organic Compounds (full list): (69 compounds) (ug/kg) *[includes Base-Neutrals (black) and Acid Extractables (blue)]*				
Pyrene	*129-00-0*	8270C	330	11.00
1,2,4-Trichlorobenzene	*120-82-1*	8270C	330	18.00
2,4,5-Trichlorophenol	*95-95-4*	8270C	800	14.00
2,4,6-Trichlorophenol	*88-06-2*	8270C	330	13.00
TAL Metals (modified): (12 compounds) (mg/L) *[site specific metals in blue]*				
Antimony	*7440-38-2*	6010B	15	0.69
Arsenic	*7440-38-2*	6010B	2	0.37
Barium	*7440-39-3*	6010B	0.5	0.05
Cadmium	*7440-43-9*	6010B	0.2	0.06
Chromium	*7440-47-3*	6010B	0.5	0.14
Lead	*7439-92-1*	6010B	1	0.19
Mercury	*7439-97-6*	7471A	0.02	0.0071
Nickel	*7440-02-0*	6010B	0.5	0.12
Potassium	*7440-09-7*	6010B	30	8.4
Selenium	*7782-49-2*	6010B	4	0.48
Silver	*7440-22-4*	6010B	0.5	0.15
Thallium	*7440-28-0*	6010B	6	0.66
Wet Chemistry: (1 compound) (mg/kg)				
Cyanide (total)	*57-12-5*	9012.0	1.0	0.35
PCBs: (7 compounds) (mg/kg)				
Aroclor 1016	*12674-11-2*	8082	16.66	3.26118
Aroclor 1221	*11104-28-2*	8082	16.66	6.95672
Aroclor 1232	*11141-16-5*	8082	16.66	3.12131
Aroclor 1242	*53469-21-9*	8082	16.66	2.90256
Aroclor 1248	*12672-29-6*	8082	16.66	3.98752
Aroclor 1254	*11097-69-1*	8082	16.66	8.66085
Aroclor 1260	*11096-82-5*	8082	16.66	6.57138
TCL Pesticides: (21 parameters) (ug/kg)				
4,4'-DDD	72-54-8	8081	1.67	0.31
4,4'-DDE	72-55-9	8081	1.67	0.21
4,4'-DDT	50-29-3	8081	1.67	0.38
Aldrin	309-00-2	8081	1.67	0.4
alpha-BHC	319-84-6	8081	1.67	0.4
alpha-Chlordane	5103-71-9	8081	1.67	0.83
beta-BHC	319-85-7	8081	1.67	0.5

TABLE 1

CONSTITUENTS OF PRIMARY CONCERN (COPCs) FOR SOIL

RI / AAR QAPP
1501 College Avenue Site
Niagara Falls, New York

Analyte[1]	*CAS Number*	Analytical Method [2]	PQL	MDL
TCL Pesticides: (21 parameters) (ug/kg)				
delta-BHC	319-86-8	8081	1.67	0.4
Dieldrin	60-57-1	8081	1.67	0.4
Endosulfan I	959-98-8	8081	1.67	0.3
Endosulfan II	33213-65-9	8081	1.67	0.3
Endosulfan Sulfate	1031-07-8	8081	1.67	0.311
Endrin	72-20-8	8081	1.67	0.54
Endrin aldehyde	7421-93-4	8081	1.67	0.68
Endrin ketone	53494-70-5	8081	1.67	0.41
gamma-BHC	58-89-9	8081	1.67	0.4
gamma-Chlordane	5103-74-2	8081	1.67	0.4
Heptachlor	76-44-8	8081	1.67	0.83
Heptachor epoxide	1024-57-3	8081	1.67	0.43
Methoxychor	72-43-5	8081	1.67	0.38
Toxaphene	8001-35-2	8081	33.00	9.7
Herbicides: (19 compounds) (mg/kg)				
2,4-D	*94-75-7*	8151A	17	1.958
Dalapon	*75-99-0*	8151A	17	2.425
Dichloroprop	*120-36-5*	8151A	17	2.293
Dinoseb	*88-85-7*	8151A	17	1.808
4-Nitrophenol	*100-02-7*	8270	330	40.92
Pentachlorophenol	*87-86-5*	8151A	17	2.328
Picloram	*1918-02-1*	8151A	17	7.180
2,4,5-T	*93-76-5*	8151A	17	2.155
2,4,5-TP	*93-72-1*	8151A	17	1.852

Notes:

1. Analytes as per NYSDEC and USEPA list of parameters.
2. Analytical methods per USEPA publication, SW-846, "Test Methods for Evaluating Solid Waste", Third Edition.

Acronyms/Abbreviations:

CAS = Chemical Abstracts Service registry number.
MDL = Method Detection Limit provided by STL
PQL = Practical Quantitation Limit
mg/kg = milligrams per kilogram
ug/kg = micrograms per kilogram

TABLE 2

CONSTITUENTS OF PRIMARY CONCERN (COPCs) FOR GROUNDWATER

RI / AAR QAPP
1501 College Avenue Site
Niagara Falls, New York

Analyte[1]	*CAS Number*	Analytical Method [2]	PQL	MDL
STARS Volatile Organic Compounds: (15 compounds) (ug/L)				
Benzene	*71-43-2*	8021B	0.2	0.02
n-Butylbenzene	*104-51-8*	8021B	0.4	0.03
sec-Butylbenzene	*135-98-8*	8021B	0.4	0.02
tert-Butylbenzene	*98-06-6*	8021B	0.4	0.03
p-Cymene	*99-87-6*	8021B	0.4	0.28
Ethylbenzene	*100-41-4*	8021B	0.2	0.03
Isopropylbenzene	*98-82-8*	8021B	0.2	0.03
Methyl tert butyl ether	*1634-04-4*	8021B	0.4	0.23
n-Propylbenzene	*103-65-1*	8021B	0.2	0.03
Toluene	*108-88-3*	8021B	0.2	0.04
1,2,4-Trimethylbenzene	*95-63-6*	8021B	0.2	0.03
1,3,5-Trimethylbenzene	*108-67-8*	8021B	0.2	0.17
o-Xylene	*95-47-6*	8021B	0.2	0.09
p-Xylene	*106-42-3*	8021B	0.4	0.25
m-Xylene	*108-38-3*	8021B	0.4	0.25
TCL Volatile Organic Compounds (full list): (57 compounds) (ug/L) ***[includes STARS VOCs in blue]***				
Acetone	*67-64-1*	8260B	5	2.48
Benzene	*71-43-2*	8260B	1	0.35
Bromoform	*75-25-2*	8260B	1	0.26
Bromodichloromethane	*75-27-4*	8260B	1	0.39
Bromomethane (Methyl bromide)	*74-83-9*	8260B	1	0.28
2-Butanone (MEK)	*78-93-3*	8260B	5	2.49
n-Butylbenzene	*104-51-8*	8260B	1	0.28
sec-Butylbenzene	*135-98-8*	8260B	1	0.30
tert-Butylbenzene	*98-06-6*	8260B	1	0.30
Carbon disulfide	*75-15-0*	8260B	1	0.48
Carbon tetrachloride	*56-23-5*	8260B	1	0.27
Chlorobenzene	*108-90-7*	8260B	1	0.32
Chloroethane	*75-00-3*	8260B	1	0.32
Chloroform	*67-66-3*	8260B	1	0.34
Chloromethane (Methyl chloride)	*74-87-3*	8260B	1	0.35
Cyclohexane	*110-82-7*	8260B	1	0.53
p-Cymene (p-isopropyltoluene)	*99-87-6*	8260B	1	0.31
1,2-Dibromo-3-chloropropane	*96-12-8*	8260B	1	0.47
1,2-Dibromoethane (EDB)	*106-93-4*	8260B	1	0.42
Dibromochloromethane	*124-48-1*	8260B	1	0.32
Dichlorodifluoromethane (Freon-12)	*75-71-8*	8260B	1	0.29

TABLE 2

CONSTITUENTS OF PRIMARY CONCERN (COPCs) FOR GROUNDWATER

RI / AAR QAPP
1501 College Avenue Site
Niagara Falls, New York

Analyte[1]	*CAS Number*	Analytical Method [2]	PQL	MDL
TCL Volatile Organic Compounds (full list): (57 compounds) (ug/L) *[includes STARS VOCs in blue]*				
1,2-Dichlorobenzene	*95-50-1*	8260B	1	0.40
1,3-Dichlorobenzene	*541-73-1*	8260B	1	0.33
1,4-Dichlorobenzene	*106-46-7*	8260B	1	0.37
1,1-Dichloroethane	*75-34-3*	8260B	1	0.27
1,2-Dichloroethane (EDC)	*107-06-2*	8260B	1	0.46
1,1-Dichloroethylene (1,1-DCE)	*75-35-4*	8260B	1	0.29
trans-1,2-Dichloroethylene	*156-60-5*	8260B	1	0.33
cis-1,2-Dichloroethylene	*156-59-2*	8260B	1	0.37
cis-1,3-Dichloropropene	*10061-01-5*	8260B	1	0.36
trans-1,3-Dichloropropene	*10061-02-6*	8260B	1	0.37
1,2-Dichloropropane	*78-87-5*	8260B	1	0.33
Ethylbenzene	*100-41-4*	8260B	1	0.34
2-Hexanone	*591-78-6*	8260B	5	2.39
Isopropylbenzene (Cumene)	*98-82-8*	8260B	1	0.32
Methyl acetate	*79-20-9*	8260B	1	0.45
Methylene chloride	*75-09-2*	8260B	1	0.44
Methylcyclohexane	*108-87-2*	8260B	1	0.50
4-methyl-2-pentanone (MIBK)	*108-10-1*	8260B	5	2.34
Methyl tert butyl ether (MTBE)	*1634-04-4*	8260B	1	0.48
n-Propylbenzene	*103-65-1*	8260B	1	0.35
Styrene	*100-42-5*	8260B	1	0.31
1,1,1,2-Tetrachloroethane	*630-20-6*	8260B	1	0.35
Tetrachloroethylene (PCE)	*127-18-4*	8260B	1	0.36
Toluene	*108-88-3*	8260B	1	0.35
1,2,4-Trichlorobenzene	*120-82-1*	8260B	1	0.41
1,1,1-Trichloroethane	*71-55-6*	8260B	1	0.26
1,1,2-Trichloroethane	*79-00-5*	8260B	1	0.42
Trichloroethylene (TCE)	*79-01-6*	8260B	1	0.32
Trichlorofluoromethane (Freon-11)	*75-69-4*	8260B	1	0.36
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon	*76-13-1*	8260B	1	0.55
1,2,4-Trimethylbenzene	*95-63-6*	8260B	1	0.33
1,3,5-Trimethylbenzene	*108-67-8*	8260B	1	0.36
Vinyl chloride	*75-01-4*	8260B	1	0.24
o-Xylene	*95-47-6*	8260B	1	0.27
p-Xylene	*106-42-3*	8260B	1	0.66
m-Xylene	*108-38-3*	8260B	1	0.66

TABLE 2

CONSTITUENTS OF PRIMARY CONCERN (COPCs) FOR GROUNDWATER

RI / AAR QAPP
1501 College Avenue Site
Niagara Falls, New York

Analyte[1]	*CAS Number*	Analytical Method [2]	PQL	MDL
TCL Semi-Volatile Organic Compounds (full list): (69 compounds) (ug/L) *[includes Base-Neutrals (black) and Acid Extractables (blue)]*				
Acenaphthene	*83-32-9*	8270C	10	0.15
Acenaphthylene	*208-96-8*	8270C	10	0.09
Anthracene	*120-12-7*	8270C	10	0.10
Benzo(a)anthracene	*56-55-3*	8270C	10	0.16
Benzo(a)pyrene	*50-32-8*	8270C	10	0.09
Benzo(b)fluoranthene	*205-99-2*	8270C	10	0.17
Benzo(g,h,i)perylene	*191-24-2*	8270C	10	0.12
Benzo(k)fluoranthene	*207-08-9*	8270C	10	0.12
Benzyl alcohol	*100-51-6*	8270C	20	1.79
bis(2-Chloroethoxy)methane	*111-91-1*	8270C	10	2.10
bis(2-Chloroethyl)ether	*111-44-4*	8270C	10	2.44
2,2'-oxybis(1-chloropropane); bis(2-chloroisopropyl)ether	*108-60-1*	8270C	10	1.77
bis(2-Ethylhexyl)phthalate	*117-81-7*	8270C	10	2.80
Butyl benzyl phthalate	*85-68-7*	8270C	10	7.47
4-Bromophenyl phenyl ether	*101-55-3*	8270C	10	2.50
4-Chloroaniline	*106-47-8*	8270C	10	1.05
4-Chloro-3-methylphenol	*59-50-7*	8270C	10	2.73
2-Chloronaphthalene	*91-58-7*	8270C	10	1.94
2-Chlorophenol	*95-57-8*	8270C	10	1.00
4-Chlorophenyl-phenylether	*7005-72-3*	8270C	10	2.42
Chrysene	*218-01-9*	8270C	10	0.17
Dibenzo(a,h)anthracene	*53-70-3*	8270C	10	0.12
Dibenzofuran	*132-64-9*	8270C	10	0.12
3,3'-Dichlorobenzidine	*91-94-1*	8270C	20	7.43
2,4-Dichlorophenol	*120-83-2*	8270C	10	2.13
1,2-Dichlorobenzene	*95-50-1*	8270C	10	2.50
1,3-Dichlorobenzene	*541-73-1*	8270C	10	2.43
1,4-Dichlorobenzene	*106-46-7*	8270C	10	2.45
Diethyl phthalate	*84-66-2*	8270C	10	2.99
2,4-Dimethylphenol	*105-67-9*	8270C	10	1.60
Dimethyl phthalate	*131-11-3*	8270C	10	2.53
Di-n-butyl phthalate	*84-74-2*	8270C	10	6.64
Di-n-octyl phthalate	*117-84-0*	8270C	10	6.95
4,6-Dinitro-2-methylphenol	*534-52-1*	8270C	50	7.62
2,4-Dinitrophenol	*51-28-5*	8270C	50	10.51
2,4-Dinitrotoluene	*121-14-2*	8270C	10	3.52
2,6-Dinitrotoluene	*606-20-2*	8270C	10	2.67

TABLE 2

CONSTITUENTS OF PRIMARY CONCERN (COPCs) FOR GROUNDWATER

RI / AAR QAPP
1501 College Avenue Site
Niagara Falls, New York

Analyte[1]	*CAS Number*	Analytical Method [2]	PQL	MDL
TCL Semi-Volatile Organic Compounds (full list): (69 compounds) (ug/L) *[includes Base-Neutrals (black) and Acid Extractables (blue)]*				
Fluoranthene	*206-44-0*	8270C	10	0.14
Fluorene	*86-73-7*	8270C	10	0.10
Hexachlorobenzene	*118-74-1*	8270C	10	1.14
Hexachlorobutadiene	*87-68-3*	8270C	10	3.50
Hexachlorocyclopentadiene	*77-47-4*	8270C	45	23.67
Hexachloroethane	*67-72-1*	8270C	10	3.47
Indeno(1,2,3-cd)pyrene	*193-39-5*	8270C	10	0.13
Isophorone	*78-59-1*	8270C	10	2.51
2-Methylnaphthalene	*91-57-6*	8270C	10	0.09
2-Methylphenol (o-Cresol)	*95-48-7*	8270C	10	2.07
4-Methylphenol (p-Cresol)	*106-44-5*	8270C	10	1.09
Naphthalene	*91-20-3*	8270C	10	0.11
2-Nitroaniline	*88-74-4*	8270C	50	4.50
3-Nitroaniline	*99-09-2*	8270C	50	3.50
4-Nitroaniline	*100-01-6*	8270C	50	3.14
Nitrobenzene	*98-95-3*	8270C	10	2.27
2-Nitrophenol	*88-75-5*	8270C	10	2.00
4-Nitrophenol	*100-02-7*	8270C	50	15.00
N-Nitrosodiphenylamine	*86-30-6*	8270C	10	2.29
N-Nitroso-di-n-propylamine	*621-64-7*	8270C	10	1.66
Pentachlorophenol	*87-86-5*	8270C	50	9.54
Phenanthrene	*85-01-8*	8270C	10	0.14
Phenol	*108-95-2*	8270C	10	1.10
Pyrene	*129-00-0*	8270C	10	0.17
1,2,4-Trichlorobenzene	*120-82-1*	8270C	10	2.45
2,4,5-Trichlorophenol	*95-95-4*	8270C	10	3.21
2,4,6-Trichlorophenol	*88-06-2*	8270C	10	1.92
TAL Metals (modified): (12 compounds) (mg/L) *[site specific metals in blue]*				
Antimony	*7440-38-2*	6010B	0.02	0.0055
Arsenic	*7440-38-2*	6010B	0.01	0.00338
Barium	*7440-39-3*	6010B	0.002	0.00017
Cadmium	*7440-43-9*	6010B	0.001	0.00034
Chromium	*7440-47-3*	6010B	0.004	0.0009
Lead	*7439-92-1*	6010B	0.005	0.0016
Mercury	*7439-97-6*	7470A	0.0002	0.00015
Nickel	*7440-02-0*	6010B	0.01	0.0011
Potassium	*7440-09-7*	6010B	0.5	0.039

TABLE 2

CONSTITUENTS OF PRIMARY CONCERN (COPCs) FOR GROUNDWATER

RI / AAR QAPP
1501 College Avenue Site
Niagara Falls, New York

Analyte[1]	*CAS Number*	Analytical Method [2]	PQL	MDL
TAL Metals (modified): (12 compounds) (mg/L) *[site specific metals in blue]*				
Selenium	*7782-49-2*	6010B	0.015	0.0061
Silver	*7440-22-4*	6010B	0.003	0.0009
Thallium	*7440-28-0*	6010B	0.02	0.0066
Wet Chemistry: (1 compound) (mg/L)				
Cyanide (total)	*57-12-5*	9012.0	1.0	0.005
PCBs: (7 compounds) (mg/L)				
Aroclor 1016	*12674-11-2*	8082	0.5	0.176
Aroclor 1221	*11104-28-2*	8082	0.5	0.1764
Aroclor 1232	*11141-16-5*	8082	0.5	0.3647
Aroclor 1242	*53469-21-9*	8082	0.5	0.31
Aroclor 1248	*12672-29-6*	8082	0.5	0.1055
Aroclor 1254	*11097-69-1*	8082	0.5	0.0786
Aroclor 1260	*11096-82-5*	8082	0.5	0.25
Field Parameters: (5 compounds) (units as identified below)				
pH (units)	*NA*	field	NA	NA
Temperature (°C)	*NA*	field	NA	NA
Specific Conductance (uS/mS)	*NA*	field	NA	NA
Turbidity (NTU)	*NA*	field	NA	NA
Dissolved Oxygen	*NA*	field	NA	NA

Notes:

1. Analytes as per NYSDEC and USEPA list of parameters.
2. Analytical methods per USEPA publication, SW-846, "Test Methods for Evaluating Solid Waste", Third Edition.

Acronyms/Abbreviations:

CAS = Chemical Abstracts Service registry number.
MDL = Method Detection Limit provided by STL
mg/L = milligrams per liter
mS = milli-Siemans
ug/L = micrograms per liter
uS = micro-Siemans
NA = not applicable
NTU = nephelometric turbidity unit
PQL = Practical Quantitation Limit

TABLE 3

PROJECT GOALS FOR PRECISION, ACCURACY & COMPLETENESS FOR LABORATORY MEASUREMENTS

RI / AAR QAPP
1501 College Avenue Site
Niagara Falls, New York

Analytical Method	Precision Goal [1] (RPD) [2]	Accuracy Goal (% R) [3]		Completeness Goal (%)
	Soil & Water	Soil	Water	
STARS 8021B or EPA 8260B	± 30	± 50	± 30	90
EPA 8270C	± 30	± 50	± 30	90
EPA 6010B and EPA 7470A/7471A	± 30	± 50	± 30	90
EPA 8082	± 30	± 50	± 30	90
Water Quality Parameters	± 30	NA	± 30	90

Notes:

1. Precision goals vary depending on the compound being analyzed; the precision goals presented are general in nature.
2. RPD = Relative Percent Difference
3. %R = Percent Recovery

TABLE 4

PROJECT GOALS FOR PRECISION, ACCURACY & COMPLETENESS FOR FIELD MEASUREMENTS

RI / AAR QAPP
1501 College Avenue Site
Niagara Falls, New York

Measurement	Units	Precision Goal	Accuracy Goal	Completeness Goal
pH	pH units	± 0.2 unit	± 0.2 unit	90%
Eh	milli-volts (mV)	± 1.0 mV	± 1.0 mV	90%
Temperature	degrees Celsius (°C)	± 0.2 deg. C	± 0.4 deg. C	90%
Turbidity	NTU	± 0.05 NTU	± 0.05 NTU	90%
Specific Conductance	mS/cm at 25°C mS/cm at 25oC	± 100 uS/cm ± 0.1 mS/cm	± 100 uS/cm ± 0.1 mS/cm	90%
Dissolved Oxygen	ppm	± 0.3 ppm	± 0.3 ppm	90%
Water Level	fbTOR	± 0.01 unit	± 0.01 unit	90%

Acronyms/Abbreviations:

fbTOR = feet below top of riser
mS = milli-Siemans
NTU = nephelometric turbidity unit
ug/L = micrograms per liter

TABLE 5

DATA MEASUREMENT UNITS FOR FIELD & LABORATORY PARAMETERS

RI / AAR QAPP
1501 College Avenue Site
Niagara Falls, New York

Parameter	Units
Water Level	feet below top of riser (fbTOR)
pH	pH units
Eh	milli-volts (mV)
Temperature	degrees Celsius (°C)
Turbidity	Nephelometric Turbidity Unit (NTU)
Specific Conductance	microsiemens per centimeter at 25°C (mS/cm) millisiemens per centimeter at 25°C (mS/cm)
Dissolved Oxygen (DO)	parts per million (ppm)
Concentration of parameter in soil sample	micrograms per kilogram (mg/kg) organic milligrams per kilogram (mg/kg) inorganic
Concentration of parameter in groundwater sample	micrograms per liter (mg/L) organic milligrams per liter (mg/L) inorganic
Hydraulic Conductivity	centimeters per second (cm/sec)
Photoionization Detector (PID)	parts per million by volume (ppmv)

TABLE 6

RI / AAR QAPP

Analytical Program Quality Assurance/Quality Control Summary

1501 College Avenue Site
Niagara Falls, New York

Matrix/Area	Parameter[1]	No. Samples	Estimated Number of QC Samples					Total
			Trip Blank[2]	Matrix Spike[3]	Matrix Spike Duplicate[3]	Equipment Blank[4]	Blind Duplicate[3]	
Exterior Surface Soil/Fill [5]	TCL + STARS VOCs	3	1	1	1		1	7
	TCL SVOCs	10		1	1		1	13
	TAL Metals	10		1	1		1	13
	PCBs	13		1	1		1	16
	Pesticides	3		1	1		1	6
	Herbicides	3		1	1		1	6
Exterior Subsurface Soil/Fill [5]	TCL + STARS VOCs	3	1	1	1		1	7
	TCL SVOCs	10		1	1		1	13
	TAL Metals	10		1	1		1	13
	PCBs	10		1	1		1	13
	Pesticides	3		1	1		1	6
	Herbicides	3		1	1		1	6
Suspect UST Area	TCL + STARS List VOCs	4						4
	TCL + STARS List SVOCs	4						4
Galbestos Roofing	PCBs	10		1	1		1	13
Drum Characterization Sampling [6] (solids)	TCLP VOCs	15						15
	TCLP Metals	15						15
	Total PCBs	15						15
	Hazardous Characterisites							
	Ignitability	15						15
	Reactivity	15						15
	Corrosivity	15						15
Drum/Tank Characterization Sampling [6] (liquids)	Flashpoint	5						5
	Total PCBs	5						5
	RCRA Metals	5						5
	TCL VOCs	5						5
	TCL SVOCs	5						5
Groundwater	TCL + STARS VOCs	4	1	1	1		1	8
	TCL SVOCs	4		1	1		1	7
	TAL Metals	4		1	1		1	7
	PCBs	4		1	1		1	7
	Herbicides	4		1	1		1	7
	Pesticides	4		1	1		1	7
	Field Parameters: DO, pH, Turbidity, Conductance, Temperature	4						4

Notes:

1. Analyses will be perfomed via USEPA SW-846 methodology w/ equivalent Category B deliverables package.
2. Trip blanks will be submitted to the laboratory each day aqueous volatile organic samples are collected.
3. Blind duplicate and MS/MSD samples will be collected at a frequency of 1 per 20 samples collected.
4. Dedicated sampling equipment will be used for groundwater and soil/fill sample collection.
5. Ten test-pits will be excavtaed, with one surface, and one sub-surface series of soil/fill samples being collected from each test-pit.
6. Number of samples is estimated; similar materials will be composited, final number of samples will be determined in the field

TABLE 7

SUMMARY OF FIELD OPERATING PROCEDURES

QAPP for RI/AAR Work Plan
1501 College Avenue Site
Niagara Falls, New York

QAPP FOP No.	BM FOP No.	Procedure
1	001.0	Abandonment of Borehole Procedures
2	008.0	Calibration and Maintenance of Portable Field pH, Eh Meter
3	009.0	Calibration and Maintenance of Portable Field Turbidity Meter
4	011.0	Calibration and Maintenance of Portable Photoionization Detector (PID)
5	012.0	Calibration and Maintenance of Portable Specific Conductance Meter
6	015.0	Documentation Requirements for Drilling and Well Installation
7	017.0	Drill Site Selection Procedure
8	018.0	Drilling and Excavation Equipment Decontamination Procedures
9	020.0	Electromagnetic (EM) Survey Procedure
10	022.0	Groundwater Level Measurement
11	023.0	Groundwater Purging Procedures Prior to Sample Collection
12	024.0	Groundwater Sample Collection Procedures
13	026.0	Hollow Stem Auger Drilling Procedures
14	031.0	Low-Flow (Minimal Drawdown) Groundwater Purging & Sampling Procedures
15	032.0	Management of Investigative-Derived Waste
16	033.0	Monitoring Well Construction for HSA Boreholes
17	036.0	Monitoring Well Development Procedures
18	040.0	Non-Disposable and Non-Dedicated Sampling Equipment Decontamination
19	041.0	Overburden Casing Installation Procedure
20	073.0	Real-Time Air Monitoring During Intrusive Activities
21	046.0	Sample Labeling, Storage and Shipment Procedures
22	047.0	Screening of Soil Samples for Organic Vapors During Drilling Activities
23	055.0	Soil Gas Survey Procedure (Active and Passive)
24	054.0	Soil Description Procedures Using the USCS
25	058.0	Split-spoon Sampling
26	063.0	Surface and Subsurface Soil Sampling Procedures
27	070.0	Well/Piezometer Construction Materials and Design

TABLE 8

SAMPLE CONTAINER, VOLUME, PRESERVATION & HOLDING TIME REQUIREMENTS

QAPP for RI/AAR Work Plan
1501 College Avenue Site
Niagara Falls, New York

Matrix	Parameter [1]	Container Type	Minimum Volume	Preservation (Cool to 4 °C for all samples)	Holding Time
Soil/Fill	TCL + STARS VOCs (if elevated PID) [5]	glass	4 oz.	Cool to 4°C, Zero Headspace	Analyze within 14 days of VTSR
	TCL SVOCs	glass	16 oz.	Cool to 4°C	Extract within 14 days of VTSR Analyze within 40 days of VTSR
	TAL Metals	glass	16 oz.	Cool to 4°C	Mercury - 28 Days VTSR Others - 180 Days VTSR
	TCL PCBs	glass	16 oz.	Cool to 4°C	Extract within 14 days of VTSR Analyze within 40 days of VTSR
	Pesticides	glass	16 oz.	Cool to 4°C	Extract within 14 days of VTSR Analyze within 40 days of VTSR
	Herbicides	glass	16 oz.	Cool to 4°C	Extract within 14 days of VTSR Analyze within 40 days of VTSR
Groundwater	TCL + STARS VOCs	glass	2-40 ml	HCl to pH<2, Zero Headspace	Analyze within 10 days of VTSR
	TCL SVOCs	glass	1L	Cool to 4°C	Extract within 7 days of VTSR Analyze within 40 days of VTSR
	TCL PCBs	glass	1L	Cool to 4°C	Extract within 7 days of VTSR Analyze within 40 days of VTSR
	Pesticides	glass	1L	Cool to 4°C	Extract within 7 days of VTSR Analyze within 40 days of VTSR
	Herbicides	glass	1L	Cool to 4°C	Extract within 7 days of VTSR Analyze within 40 days of VTSR
	TAL Metals	Plastic/glass	16 oz.	HNO_3 to pH<2	Mercury - 28 Days VTSR Others - 6 months VTSR

Notes:

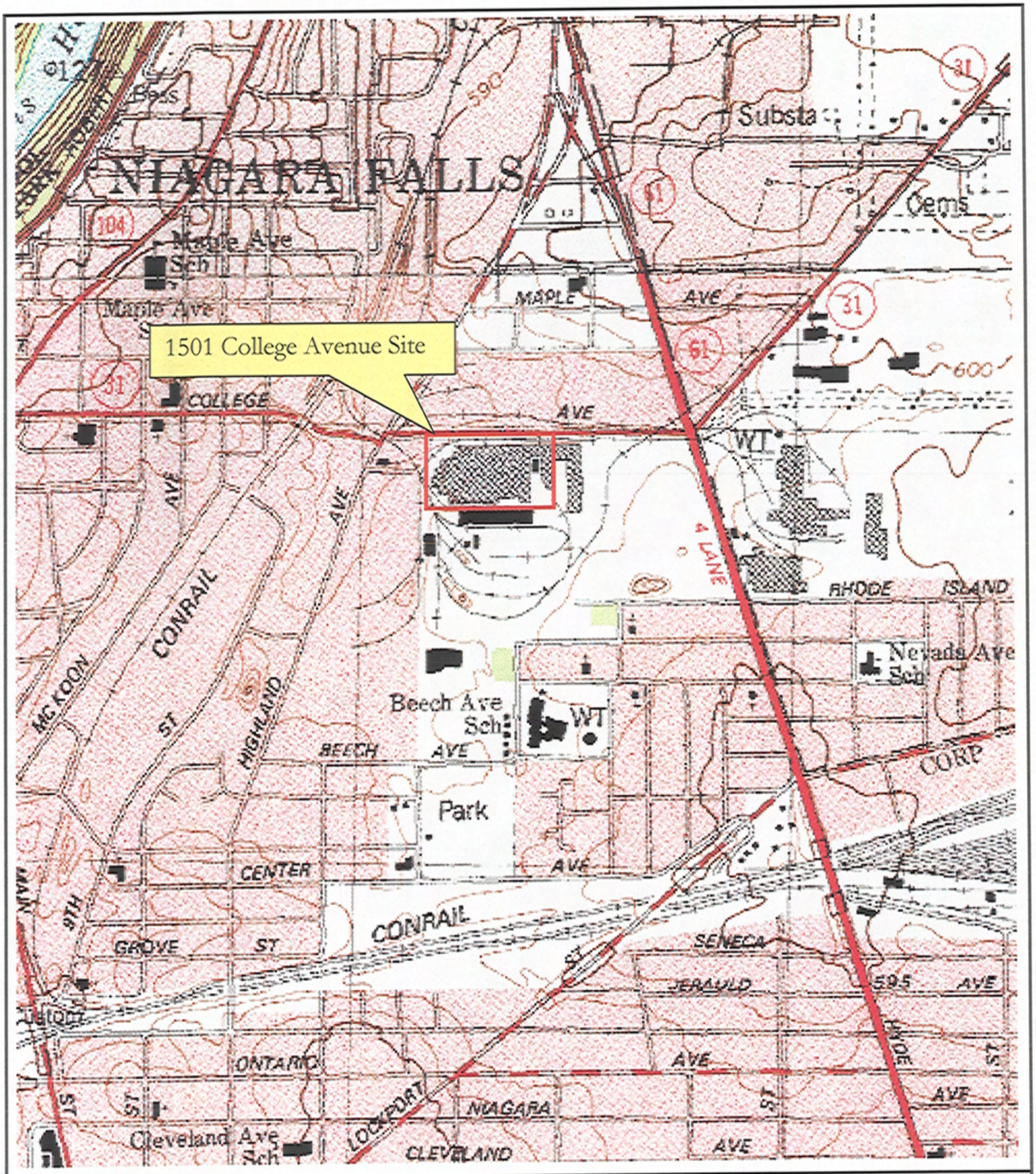
1. USEPA SW-846 methodology. The list of analytes, laboratory method and the method detection limit for each parameter are included in Tables 1 and 2.

Acronyms/Abbreviations:

VOCs = Volatile Organic Compounds
SVOCs = Semi-Volatile Organic Compounds
TAL = Target Analyte List
TCL = Target Compound List
COD = Chemical Oxygen Demand
VTSR = Validated Time of Sample Receipt; required within 2 days of collection

FIGURES

FIGURE 1



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PROJECT NO.: 0140-001-103

DATE: SEPTEMBER 2007

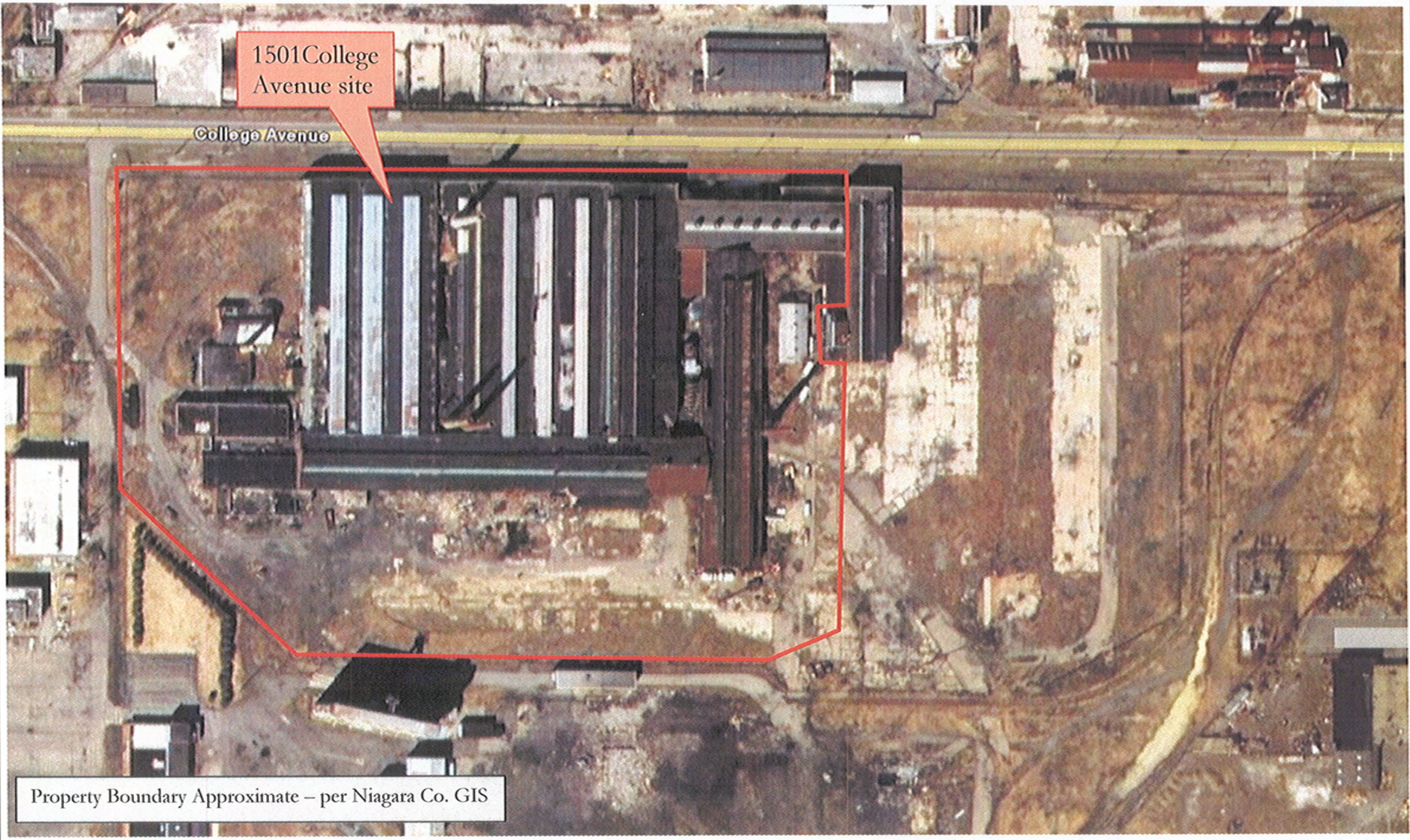
DRAFTED BY: NTM

SITE LOCATION AND VICINITY MAP

REMEDIAL INVESTIGATION WORK PLAN

1501 COLLEGE AVENUE SITE
NIAGARA FALLS, NEW YORK

PREPARED FOR
SANTAROSA HOLDINGS, INC.



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SITE PLAN MAP

REMEDIAL INVESTIGATION WORK PLAN

1501 COLLEGE AVENUE SITE
NIAGARA FALLS, NEW YORK

PREPARED FOR
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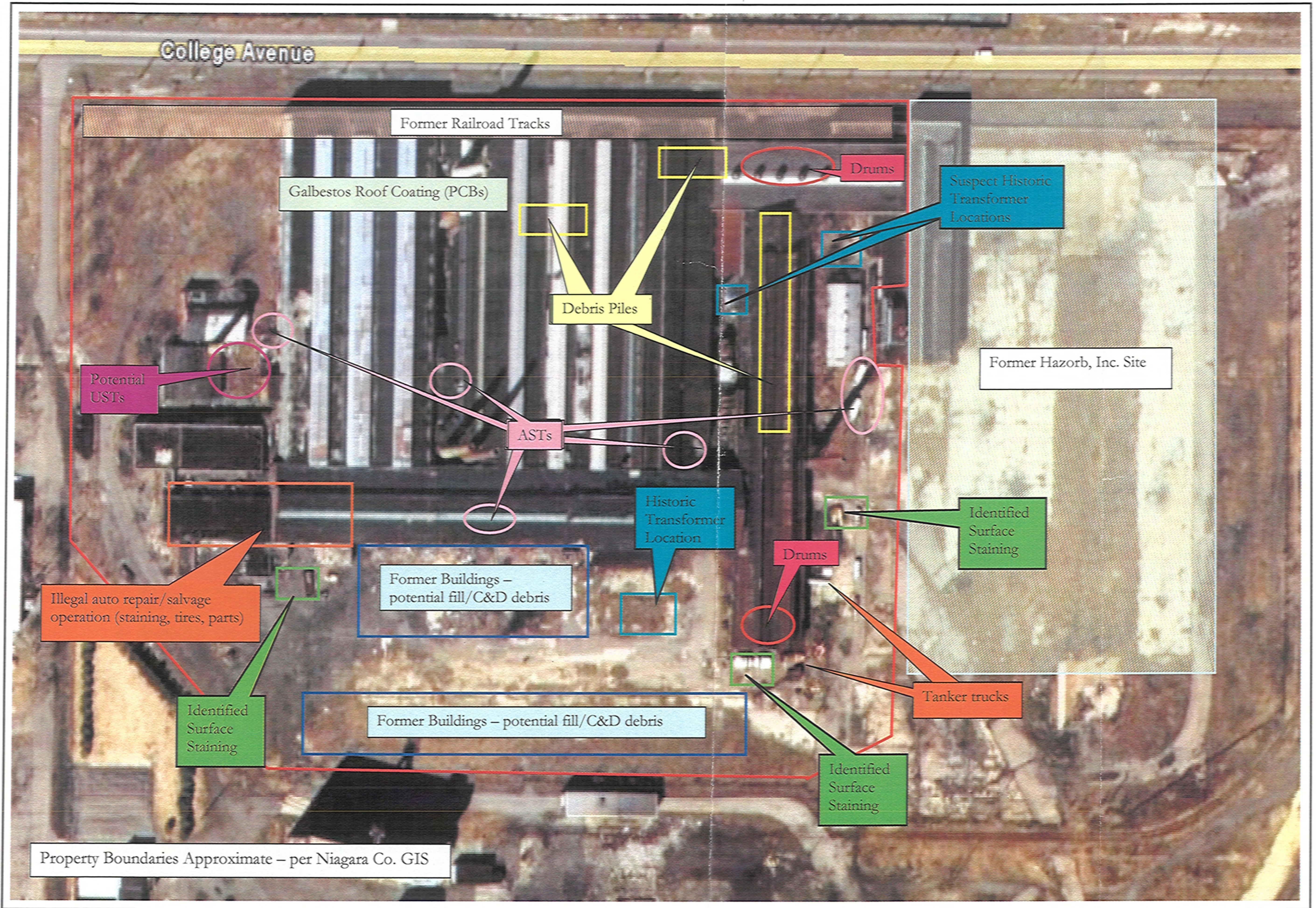
FIGURE 2

FILEPATH: f:\cad\benchmark\buffalo fuel\ri wp\figure 2: site plan map.dwg



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RECOGNIZED ENVIRONMENTAL CONDITIONS

REMEDIAL INVESTIGATION WORK PLAN

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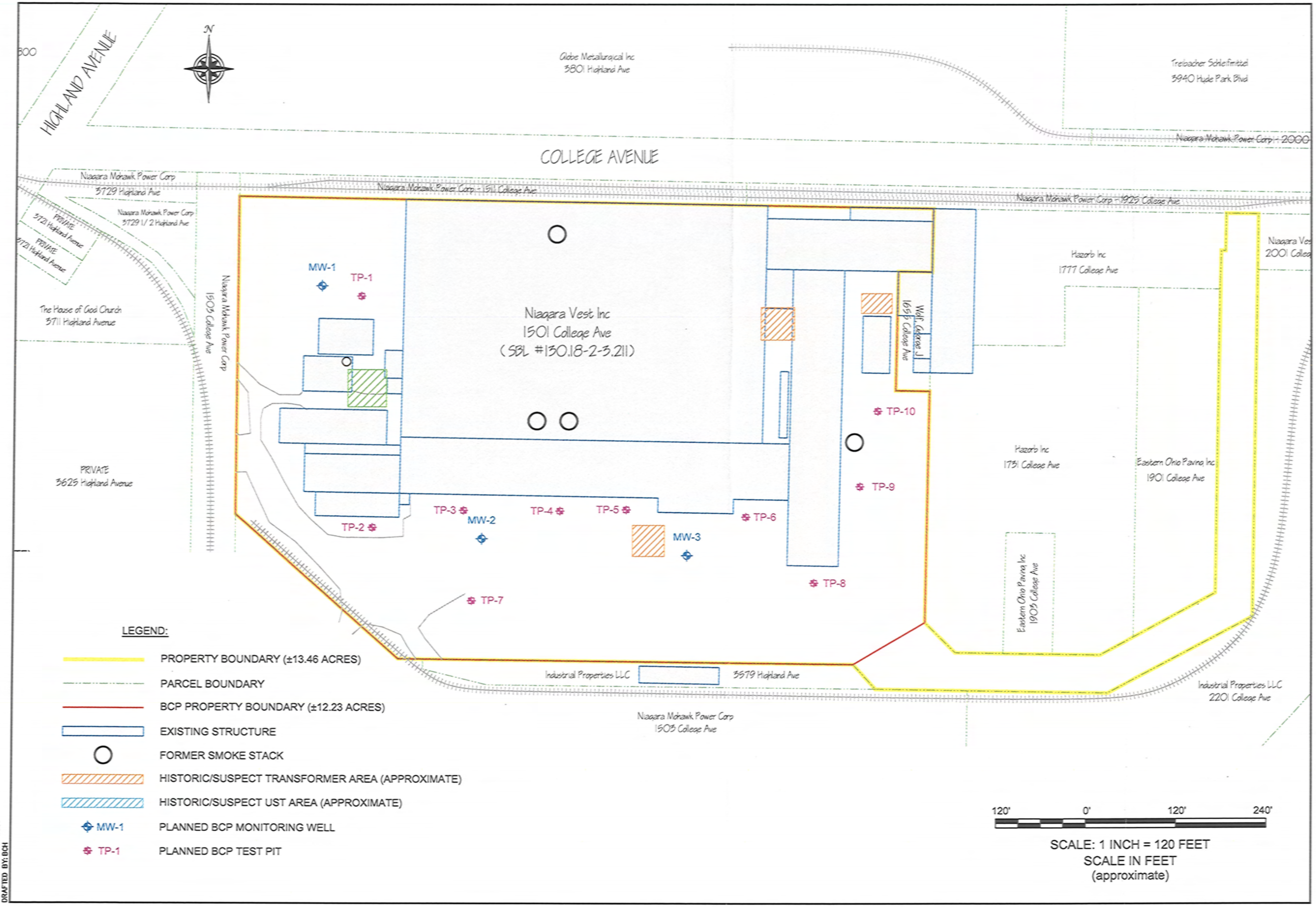
FIGURE 3



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PROPOSED SAMPLE LOCATIONS

RI / AAR WORK PLAN

1501 COLLEGE AVENUE SITE
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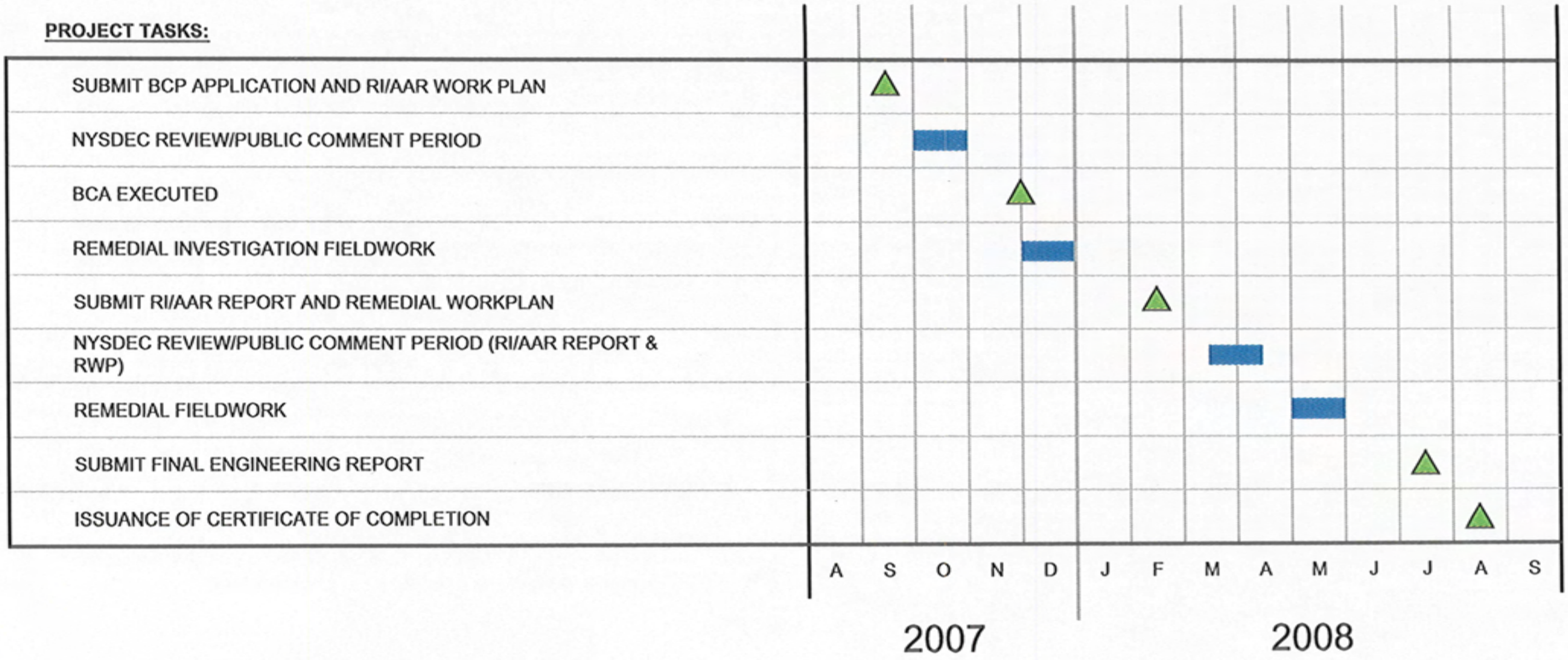
FIGURE 4



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PROJECT SCHEDULE

1501 COLLEGE AVENUE SITE
NIAGARA FALLS, NEW YORK

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FIGURE 5

APPENDIX A

FIELD OPERATING PROCEDURES (FOPS)

FOP 001.0

ABANDONMENT OF BOREHOLE PROCEDURE

PURPOSE

Soil borings that are not completed as monitoring wells will be plugged by filling the holes with a cement/bentonite grout. Field staff will calculate the borehole volume and compare it to the final installed volume of grout to evaluate whether bridging or loss to the formation has occurred. These calculations and the actual volume placed will be noted on the Boring Log.

PROCEDURE

1. Determine most suitable seal materials. Grout specifications generally have mixture ratios as follows:

   <u>Grout Slurry Composition (% Weight)</u>

   1.5 to 3.0% - Bentonite (Quick Gel)
   40 to 60 % - Cement (Portland Type I)
   40 to 60 % - Potable Water

2. Calculate the volume of the borehole base on the bit or auger head diameter plus 10% and determine the volume of grout to be emplaced. Generally, the total mixed volume is the borehole volume plus 20%.

3. Identify the equipment to be used for the preparation and mixing of the grout. Ensure the volume of the tanks to be used for mixing has been measured adequately. Document these volumes on the **Field Borehole Log** (sample attached).

4. Identify the source of the water to be used for the grout and determine its suitability for use. In particular, water with high sulfate, or chloride levels or heated water should not be used. These types of waters can cause operational difficulties or modify the set-up for the grout.

5. Identify the equipment to be used for emplacing the grout. Ensure that the pump to be used has adequate pressure to enable complete return to surface.

6. Identify the volumes to be pumped at each stage or in total if only one stage is to be used.

7. Prepare the borehole abandonment plan and discuss the plan and activities with the drilling contractor prior to beginning any mixing activities.

8. Begin mixing the grout to be emplaced.

9. Record the type and amount of materials used during the mixing operation. Ensure the ratios are within specifications tolerance.

10. Begin pumping the grout through the return line bypass system to confirm all pump and surface fittings are secure.

11. Initiate downhole pumping from the bottom of the borehole. Record the times and volumes emplaced on the Field Borehole Log (sample attached).

12. Document the return circulation of grout. This may be facilitated by using a colored dye or other tagging method if a mudded borehole condition exists prior to grout injection.

13. Identify what procedures will be used for grouting in the upper 3 feet. When casing exists in the borehole, decisions are required as to the timing for removal and final disposition of the casing. Generally, it will not be removed prior to grouting because of the potential for difficult access and loss of circulation in the upper soil or rock layers. Accordingly, when cement return is achieved at surface, the casing is commonly removed and the borehole is topped off with grout or soils. If casing removal is not possible or not desired, the casing left in place should be cut off at a depth of 5 feet or greater below ground surface. If casing is not present during grouting, the grout level in the borehole is topped off after the rods or tremie pipe is removed.

14. Clear and clean the surface near the borehole. Level the ground to above the pre-existing grade. Add grout or cement as necessary to the area near the borehole. (Note: On occasion, the grout may settle over several days. If settling occurs, the

natural soils from the immediate vicinity can be used to level to settled area to match the existing grade.

15. A follow-up check at each site should be made within one week to 10 days of completion. Document the visit and describe any action taken on a Field Activity Daily Log.

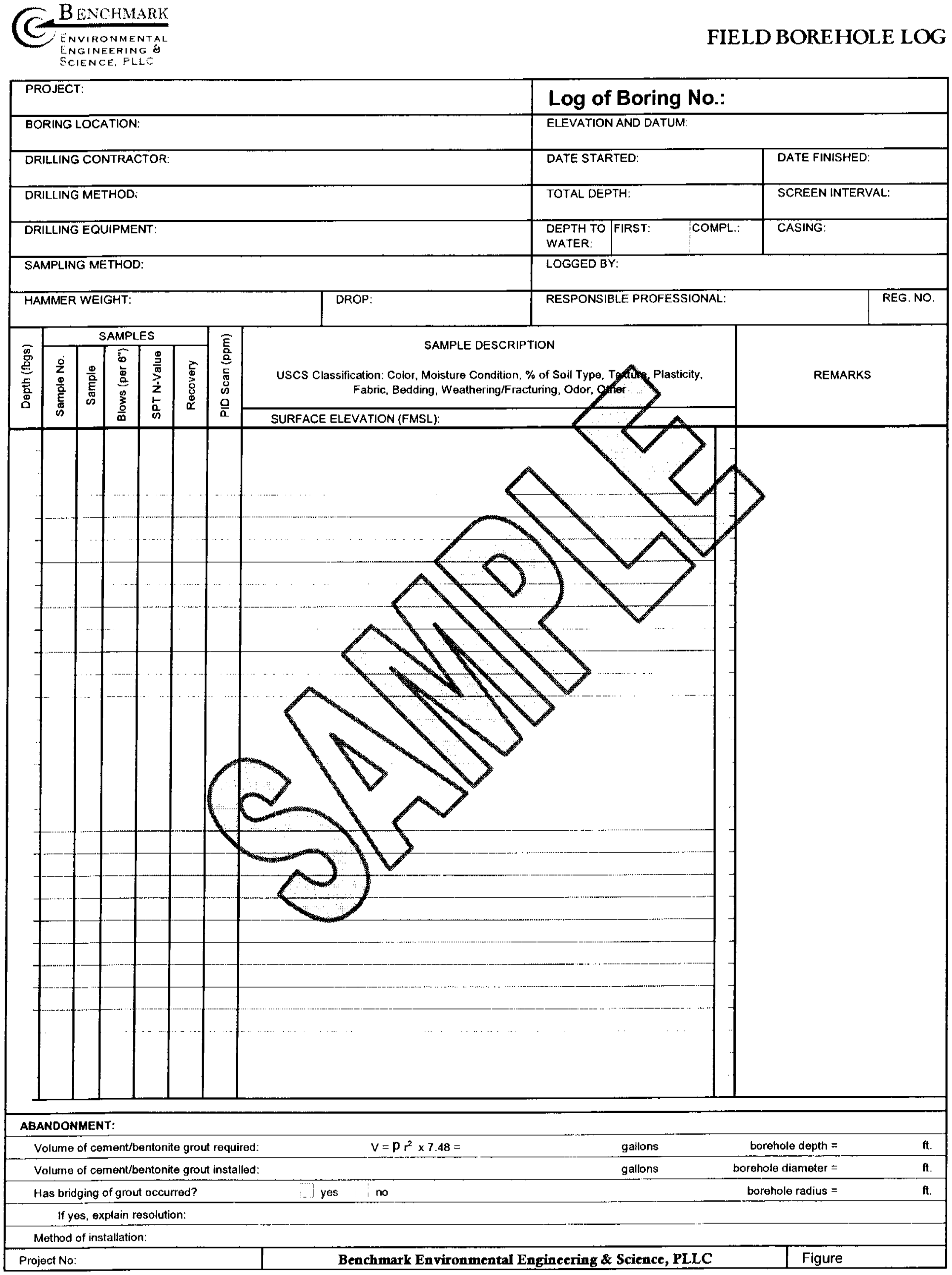
ATTACHMENTS

Field Borehole Log (sample)

REFERENCES

New York State Department of Environmental Conservation, July 1988, Drilling and Monitoring Well Installation Guidance Manual.

Driscoll, F.G., 1987, Groundwater and Wells, Johnson Division, St. Paul, Minnesota, 1089 p.



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FIELD BOREHOLE LOG

PROJECT:		**Log of Boring No.:**	
BORING LOCATION:		ELEVATION AND DATUM:	
DRILLING CONTRACTOR:		DATE STARTED:	DATE FINISHED:
DRILLING METHOD:		TOTAL DEPTH:	SCREEN INTERVAL:
DRILLING EQUIPMENT:		DEPTH TO WATER: FIRST: COMPL.:	CASING:
SAMPLING METHOD:		LOGGED BY:	
HAMMER WEIGHT:	DROP:	RESPONSIBLE PROFESSIONAL:	REG. NO.

Depth (fbgs)	SAMPLES					PID Scan (ppm)	SAMPLE DESCRIPTION USCS Classification: Color, Moisture Condition, % of Soil Type, Texture, Plasticity, Fabric, Bedding, Weathering/Fracturing, Odor, Other	REMARKS
	Sample No.	Sample	Blows (per 6")	SPT N-Value	Recovery		SURFACE ELEVATION (FMSL):	

ABANDONMENT:

Volume of cement/bentonite grout required: $V = p r^2$ x 7.48 = gallons borehole depth = ft.

Volume of cement/bentonite grout installed: gallons borehole diameter = ft.

Has bridging of grout occurred? ☐ yes ☐ no borehole radius = ft.

If yes, explain resolution:

Method of installation:

Project No:	**Benchmark Environmental Engineering & Science, PLLC**	Figure

FOP 008.0

CALIBRATION AND MAINTENANCE OF PORTABLE FIELD pH/Eh METER

PURPOSE

This guideline describes a method for calibration of a portable pH/Eh meter. The pH/Eh meter measures the hydrogen ion concentration or acidity of a water sample (pH function), and the oxidation/reduction potential of a water sample (Eh function). Calibration is performed to verify instrument accuracy and function. All field instruments will be calibrated, verified and recalibrated at frequencies required by their respective operating manuals or manufacturer's specifications, but not less than once each day that the instrument is in use. Field personnel should have access to all operating manuals for the instruments used for the field measurements. This procedure also documents critical maintenance activities for this meter.

ACCURACY

The calibrated accuracy of the pH/Eh meter will be:

pH	± 0.2 pH unit, over the temperature range of ± 0.2 C.
Eh	± 0.2 millivolts (mV) over the range of ± 399.9 mV, otherwise ± 2 mV.

PROCEDURE

Note: Meters produced by different manufacturers may have different calibration procedures. These instructions will take precedence over the procedure provided herein. This procedure is intended to be used as a general guideline, or in the absence of available manufacturer's instructions.

1. Obtain and active the meter to be used. As stated above, initial calibrations will be performed at the beginning of each sampling day.

2. Immerse the sensing probe in a container of certified pH 7.0 buffer solution traceable to the National Bureau of Standards.

3. Measure the temperature of the buffer solution, and adjust the temperature setting accordingly.

4. Compare the meter reading to the known value of the buffer solution while stirring. If the reading obtained by the meter does not agree with the known value of the buffer solution, recalibrate the meter according to the manufacturer's instructions until the desired reading is obtained. This typically involves accessing and turning a dial or adjustment screw while measuring the pH of the buffer solution. The meter is adjusted until the output agrees with the known solution pH.

5. Repeat Steps 2 through 5 with a pH 4.0 and 10.0 buffer solution to provide a three-point calibration. Standards used to calibrate the pH meter will be of concentrations that bracket the expected values of the samples to be analyzed, especially for two-point calibrations (see note below).

Note: Some pH meters only allow two-point calibrations. Two-point calibrations should be within the suspected range of the groundwater to be analyzed. For example, if the groundwater pH is expected to be approximately 8, the two-point calibration should bracket that value. Buffer solutions of 7 and 10 should then be used for the two-point calibration.

6. Document the calibration results and related information in the Project Field Book and on an **Equipment Calibration Log** (see attached sample). Information will include, at a minimum:

    - Time, date, and initials of the field team member performing the calibration
    - The unique identifier for the meter, including manufacturer, model, and serial number
    - The brand and expiration dates of buffer solutions
    - The instrument readings
    - The instrument settings (if applicable)

- Pass or fail designation in accordance with the accuracy specifications presented above
- Corrective action taken (see Maintenance below) in the event of failure to adequately calibrate

MAINTENANCE

- When not in use, or between measurements, keep the pH/Eh probe immersed in or moist with buffer solutions.

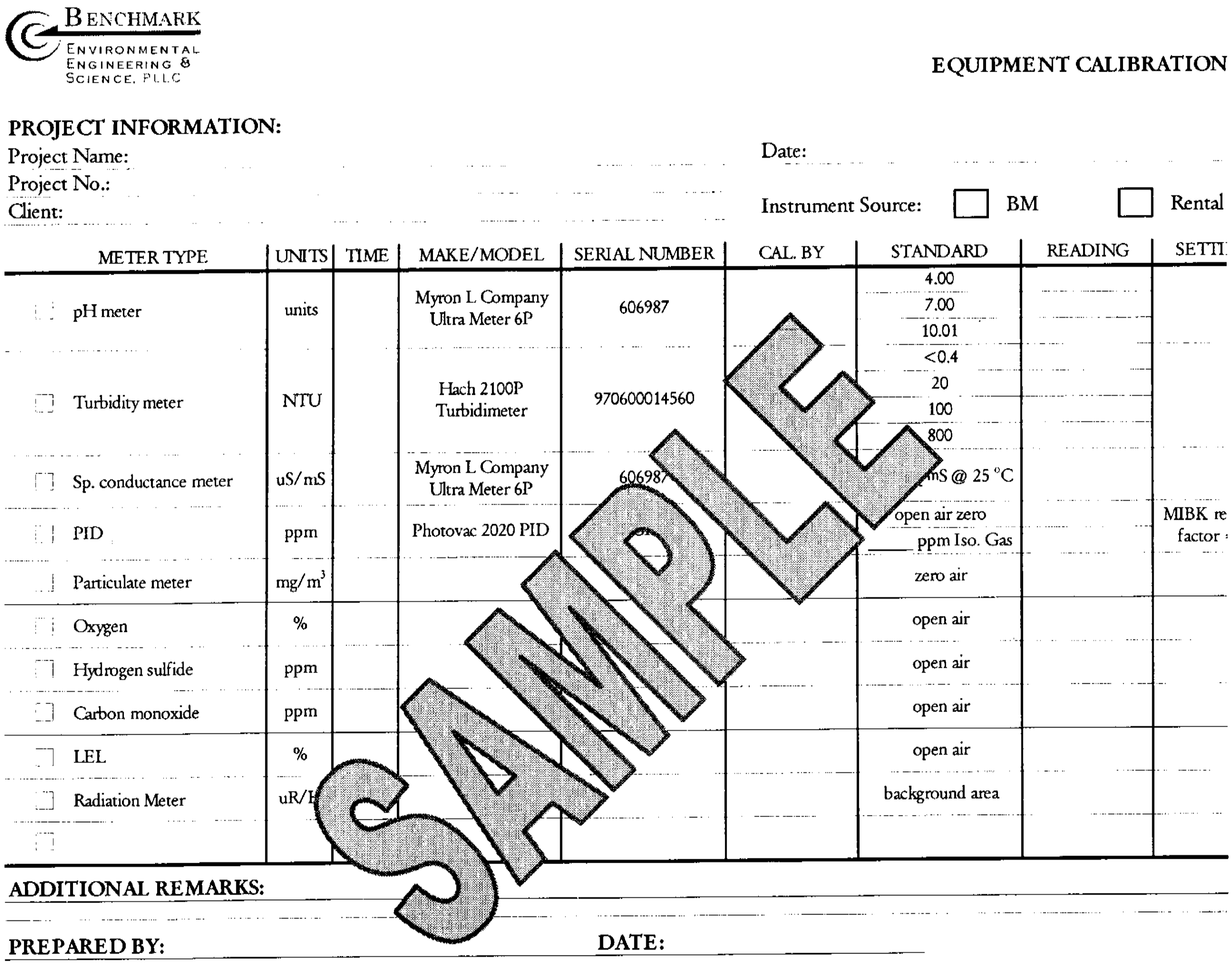
- Check the meter batteries at the end of each day and recharge or replace as needed.

- Replace the pH/Eh probe any time that the meter response time becomes greater than two minutes or the meeting system consistently fails to retain its calibrated accuracy for a minimum of ten sample measurements.

- If a replacement of the pH/Eh probe fails to resolve instrument response time and stability problems, obtain a replacement instrument (rental instruments) and/or order necessary repairs/adjustment.

ATTACHMENTS

Equipment Calibration Log (sample)



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EQUIPMENT CALIBRATION

PROJECT INFORMATION:

Project Name:

Project No.:

Client:

Date:

Instrument Source: ☐ BM ☐ Rental

METER TYPE	UNITS	TIME	MAKE/MODEL	SERIAL NUMBER	CAL. BY	STANDARD	READING	SETTI
☐ pH meter	units		Myron L Company Ultra Meter 6P	606987		4.00 7.00 10.01		
☐ Turbidity meter	NTU		Hach 2100P Turbidimeter	970600014560		<0.4 20 100 800		
☐ Sp. conductance meter	uS/mS		Myron L Company Ultra Meter 6P	60698		mS @ 25 °C		
☐ PID	ppm		Photovac 2020 PID			open air zero ___ ppm Iso. Gas		MIBK re factor
☐ Particulate meter	mg/m^3					zero air		
☐ Oxygen	%					open air		
☐ Hydrogen sulfide	ppm					open air		
☐ Carbon monoxide	ppm					open air		
☐ LEL	%					open air		
☐ Radiation Meter	uR/					background area		
☐								

ADDITIONAL REMARKS:

PREPARED BY: **DATE:**

FOP 009.0

CALIBRATION AND MAINTENANCE OF PORTABLE FIELD TURBIDITY METER

PURPOSE

This guideline describes the method for calibration of the HACH 2100P portable field turbidity meter. Turbidity is one water quality parameter measured during purging and development of wells. Turbidity is measured as a function of the samples ability to transmit light, expressed as Nephelometric Turbidity Units (NTUs). The turbidity meter is factory calibrated and must be checked daily prior to using the meter in the field. Calibration is performed to verify instrument accuracy and function. This procedure also documents critical maintenance activities for this meter.

ACCURACY

Accuracy shall be ± 2% of reading below 499 NTU or ± 3% of reading above 500 NTU with resolution to 0.01 NTU in the lowest range. The range key provides for automatic or manual range selection for ranges of 0.00 to 9.99, 0.0 to 99.9 and 0 to 1000 NTU. Another key provides for selecting automatic signal averaging. Pressing the key shall toggle signal averaging on or off.

PROCEDURE

Calibration of the 2100P Turbidimeter is based on formazin, the primary standard for turbidity. The instrument's electronic and optical design provides long-term stability and minimizes the need for frequent calibration. The two-detector ratioing system compensates for most fluctuations in lamp output. **A formazin recalibration should be performed at least once every three months,** more often if experience indicates the need. During calibration, use a primary standard such as StablCal™ Stabilized Standards or formazin standards.

Note: Meters produced by different manufacturers may have different calibration check procedures. These manufacturers' instructions will take precedence over the procedure provided here. This procedure is intended to be used as a general guideline, or in the absence of available manufacturer's instructions.

Note: Because the turbidity meter measures light transmission, it is critical that the meter and standards be cared for as precision optical instruments. Scratches, dirt, dust, etc. can all temporarily or permanently affect the accuracy of meter readings.

Preparing StablCal Stabilized Standards in Sealed Vials

Sealed vials that have been sitting undisturbed for longer than a month must be shaken to break the condensed suspension into its original particle size. Start at *step 1* for these standards. If the standards are used on at least a weekly interval, start at *step 3.*

Note: These instructions do not apply to <0.1 NTU StablCal Standards; <0.1 NTU StablCal Standards should not be shaken or inverted.

1. Shake the standard vigorously for 2-3 minutes to re-suspend any particles.
2. Allow the standard to stand undisturbed for 5 minutes.
3. Gently invert the vial of StablCal 5 to 7 times.
4. Prepare the vial for measurement using traditional preparation techniques. This usually consists of oiling the vial (see *Section 2.3.2 on page 11 of the manual*)

and marking the vial to maintain the same orientation in the sample cell compartment (see *Section 2.3.3 on page 12 of the manual*). This step will eliminate any optical variations in the sample vial.

5. Let the vial stand for one minute. The standard is now ready for use in the calibration procedure.

Calibration Procedure

1. Turn the meter on.

2. Shake pre-mixed formazin primary standards in accordance with the above procedure.

3. Wipe the outside of the <0.1 NTU standard and insert the sample cell in the cell compartment by aligning the orientation mark on the cell with the mark on the front of the cell compartment.

4. Close the lid and press **I/O**.

5. Press the **CAL** button. The **CAL** and **S0** icons will be displayed and the 0 will flash. The four-digit display will show the value of the S0 standard for the previous calibration. If the blank value was forced to 0.0, the display will be blank. Press the right arrow key (→) to get a numerical display.

6. Press **READ**. The instrument will count from 60 to 0, read the blank and use it to calculate a correction factor for the 20 NTU standard measurement. If the dilution water is ≥ 0.5 NTU, E 1 will appear when the calibration is calculated (*see Section 3.6.2.3 on page 31 of the manual*). The display will automatically increment to the next standard. Remove the sample cell from the cell compartment

Note: The turbidity of the dilution water can be "forced" to zero by pressing → rather than reading the dilution water. The display will show "S0 NTU" and the ↑ key must be pressed to continue with the next standard.

7. Repeat steps 1 through 7 for the 20, 100 and 800 standards.
8. Following the 800 NTU standard calibration, the display will increment back to the S0 display. Remove the sample cell from the cell compartment.
9. Press **CAL** to accept the calibration. The instrument will return to measurement mode automatically.
10. Document the calibration results and related information in the Project Field Book and on an **Equipment Calibration Log** (see attached sample). Information will include, at a minimum:
    - Time, date, and initials of the field team member performing the calibration
    - The unique identifier for the meter, including manufacturer, model, and serial number
    - The brand of calibration standards
    - The instrument readings
    - The instrument settings (if applicable)
    - Pass or fail designation in accordance with the accuracy specifications presented above
    - Corrective action taken (see Maintenance below) in the event of failure to adequately calibrate.

Note: Pressing CAL completes the calculation of the calibration coefficients. If calibration errors occurred during calibration, error messages will appear after CAL is pressed. If E 1 or E 2 appear, check the standard preparation and review the calibration; repeat the calibration if necessary. If "CAL?" appears, an error may have

occurred during calibration. If "CAL?" is flashing, the instrument is using the default calibration.

NOTES

- If the **I/O** key is pressed during calibration, the new calibration data is lost and the old calibration will be used for measurements. Once in calibration mode, only the **READ, I/O,** ↑ , and →keys function. Signal averaging and range mode must be selected before entering the calibration mode.
- If **E 1** or **E 2** are displayed, an error occurred during calibration. Check the standard preparation and review the calibration; repeat the calibration if necessary. Press **DIAG** to cancel the error message (**E 1** or **E 2**). To continue without repeating the calibration, press **I/O** twice to restore the previous calibration. If "**CAL?**" is displayed, an error may have occurred during calibration. The previous calibration may not be restored. Either recalibrate or use the calibration as is.
- To review a calibration, press **CAL** and then ↑ to view the calibration standard values. As long as **READ** is never pressed and **CAL** is not flashing, the calibration will not be updated. Press **CAL** again to return to the measurement mode.

MAINTENANCE

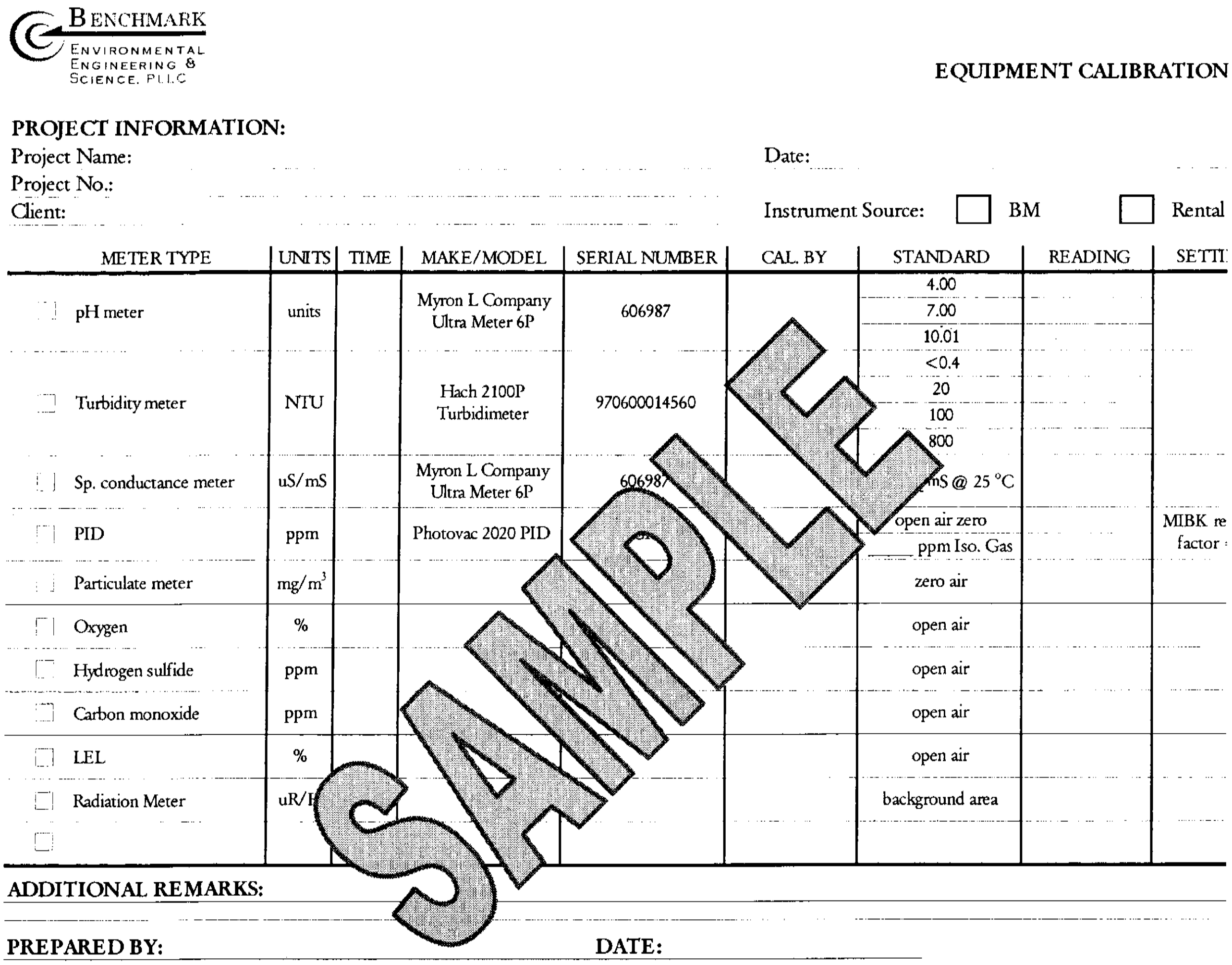
- **Cleaning:** Keep the turbidimeter and accessories as clean as possible and store the instrument in the carrying case when not in use. Avoid prolonged exposure to sunlight and ultraviolet light. Wipe spills up promptly. Wash sample cells with non-abrasive laboratory detergent, rinse with distilled or demineralized water, and air dry. Avoid scratching the cells and wipe all moisture and fingerprints off the cells before inserting them into the instrument. Failure to do so can give inaccurate readings. See *Section 2.3.1 on page 11 of the manual* for more information about sample cell care.
- **Battery Replacement:** AA alkaline cells typically last for about 300 tests with the signal-averaging mode off, about 180 tests if signal averaging is used. The "battery" icon flashes when battery replacement is needed. Refer to *Section 1.4.2 on page 5 of the manual* for battery installation instructions. If the batteries are changed within 30

seconds, the instrument retains the latest range and signal average selections. If it takes more than 30 seconds, the instrument uses the default settings. If, after changing batteries, the instrument will not turn off or on and the batteries are good, remove the batteries and reinstall them. If the instrument still won't function, contact Hach Service or the nearest authorized dealer.

- **Lamp Replacement:** The procedure in *Section 4.0 on page 49 of the manual* explains lamp installation and electrical connections. Use a small screwdriver to remove and install the lamp leads in the terminal block. The instrument requires calibration after lamp replacement.

ATTACHMENTS

Equipment Calibration Log (sample)



BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

EQUIPMENT CALIBRATION

PROJECT INFORMATION:

Project Name:

Date:

Project No.:

Client:

Instrument Source: ☐ BM ☐ Rental

METER TYPE	UNITS	TIME	MAKE/MODEL	SERIAL NUMBER	CAL. BY	STANDARD	READING	SETTI
☐ pH meter	units		Myron L Company Ultra Meter 6P	606987		4.00		
						7.00		
						10.01		
☐ Turbidity meter	NTU		Hach 2100P Turbidimeter	970600014560		<0.4		
						20		
						100		
						800		
☐ Sp. conductance meter	uS/mS		Myron L Company Ultra Meter 6P	606987		mS @ 25 °C		
☐ PID	ppm		Photovac 2020 PID			open air zero		MIBK re
						_____ ppm Iso. Gas		factor
☐ Particulate meter	mg/m^3					zero air		
☐ Oxygen	%					open air		
☐ Hydrogen sulfide	ppm					open air		
☐ Carbon monoxide	ppm					open air		
☐ LEL	%					open air		
☐ Radiation Meter	uR/					background area		
☐								

ADDITIONAL REMARKS:

PREPARED BY: **DATE:**

FOP 011.0

CALIBRATION AND MAINTENANCE OF PORTABLE PHOTOIONIZATION DETECTOR

PURPOSE

This procedure describes a general method for the calibration and maintenance of a portable photoionization detector (PID). The PID detects and initially quantifies a reading of the volatile organic compound (VOC) concentration in air. The PID is used as a field-screening tool for initial evaluation of soil samples and for ambient air monitoring of compounds with ionization potentials (IP) less than the PID lamp electron voltage (eV) rating. The IP is the amount of energy required to move an electron to an infinite distance from the nucleus thus creating a positive ion plus an electron. It should be noted that all of the major components of air (i.e., carbon dioxide, methane, nitrogen, oxygen etc.) have IP's above 12 eV. As a result, they will not be ionized by the 9.5, 10.2, 10.6 or 11.7 eV lamps typically utilized in field PIDs. The response of the PID will then be the sum of the organic and inorganic compounds in air that are ionized by the appropriate lamp (i.e., 9.5, 10.2, 10.6 or 11.7 eV). Attached to this FOP is a table summarizing common organic compounds and their respective IPs.

Calibration is performed to verify instrument accuracy and function. All field instruments will be calibrated, verified and recalibrated at frequencies required by their respective operating manuals or manufacturer's specifications, but not less than once each day that the instrument is in use. Field personnel should have access to all operating manuals for the instruments used for the field measurements. This procedure also documents critical maintenance activities for this meter.

Note: The information included below is equipment manufacturer- and model-specific, however, accuracy, calibration, and maintenance procedures for this type of portable equipment are typically similar. The information below pertains to the Photovac 2020 photoionization detector equipped with a 10.6 eV lamp. The actual equipment to be used in the field will be equivalent or similar. The previously mentioned attached table indicates the compounds that cannot be detected by a standard 10.6 eV lamp.

Note: The PID indicates <u>total</u> VOC concentration readings that are normalized to an isobutylene standard, so actual quantification of individual compounds is not provided. In addition, the PID response to compounds is highly variable, dependent on ionization potential of the compound, and the presence or absence of other compounds.

ACCURACY

The Photovac 2020 is temperature compensated so that a 20 °C change in temperature corresponds to a change in reading of less than two percent full-scale at maximum sensitivity. The useful range of the instrument is from 0.5 – 2000 ppm isobutylene with an accuracy of ± 10% or ± 2 ppm. Response time is less than three seconds to 90 percent of full-scale. The operating temperature range is 0 to 40° C and the operating humidity range is 0 to 100 % relative humidity (non-condensing).

PROCEDURE

1. Calibrate all field test equipment at the beginning of each sampling day. Check and recalibrate the PID according to the manufacture's specifications.
2. Calibrate the PID meter using a compressed gas cylinder containing a 100-ppm isobutylene standard, a flow regulator, and a tubing assembly. In

addition, a compressed gas cylinder containing zero air ("clean" air) may be required if ambient air conditions do not permit calibration to "clean air".

3. Fill two Tedlar bags equipped with a one-way valve with zero-air (if applicable) and 100-ppm isobutylene gas.

4. Assemble the calibration equipment and actuate the PID in its calibration mode. Connect the PID probe to the zero air calibration bag (or calibrate to ambient air if conditions permit) and wait for a stable indication.

5. Change the response factor of the PID to the Methyl Isobutyl Ketone (MIBK) setting, which is a response factor of 1.0 for the Photovac 2020.

6. Connect the PID probe to the 100-ppm isobutylene standard calibration bag. Measure an initial reading of the isobutylene standard and wait for a stable indication.

7. Keep the PID probe connected to the 100-ppm isobutylene standard calibration bag, calibrate to 100-ppm with the isobutylene standard and wait for a stable indication.

8. Document the calibration results and related information in the Project Field Book and on an **Equipment Calibration Log** (see attached sample), indicating the meter readings before and after the instrument has been adjusted. This is important, not only for data validation, but also to establish maintenance schedules and component replacement. Information will include, at a minimum:
    - Time, date and initials of the field team member performing the calibration
    - The unique identifier for the meter, including manufacturer, model, and serial number
    - The brand and expiration date of the isobutylene gas
    - The instrument readings: before and after calibration
    - The instrument settings (if applicable)

- Pass or fail designation in accordance with the accuracy specifications presented above
- Corrective action taken (see Maintenance below) in the event of failure to adequately calibrate.

MAINTENANCE

- The probe and dust filter of the PID should be checked before and after every use for cleanliness. Should instrument response become unstable, recalibration should be performed. If this does not resolve the problem, access the photoionization bulb and clean with the manufacturer-supplied abrasive compound, then recalibrate.

- The PID battery must be recharged after each use. Store the PID in its carrying case when not in use. Additional maintenance details related to individual components of the PID are provided in the equipment manufacturer's instruction manual. If calibration or instrument performance is not in accordance with specifications, send the instrument to the equipment manufacturer for repair.

- Maintain a log for each monitoring instrument. Record all maintenance performed on the instrument on this log with date and name of the organization performing the maintenance.

ATTACHMENTS

Table 1; Summary of Ionization Potentials
Equipment Calibration Log (sample)

TABLE 1

SUMMARY OF IONIZATION POTENTIALS

Chemical Name	Ionization Potential (eV)	Cannot be Read by 10.6 eV PID
A		
2-Amino pyridine	8	
Acetaldehyde	10.21	
Acetamide	9.77	
Acetic acid	10.69	X
Acetic anhydride	10	
Acetone	9.69	
Acetonitrile	12.2	X
Acetophenone	9.27	
Acetyl bromide	10.55	
Acetyl chloride	11.02	X
Acetylene	11.41	X
Acrolein	10.1	
Acrylamide	9.5	
Acrylonitrile	10.91	X
Allyl alcohol	9.67	
Allyl chloride	9.9	
Ammonia	10.2	
Aniline	7.7	
Anisidine	7.44	
Anisole	8.22	
Arsine	9.89	
B		
1,3-Butadiene (butadiene)	9.07	
1-Bromo-2-chloroethane	10.63	X
1-Bromo-2-methylpropane	10.09	
1-Bromo-4-fluorobenzene	8.99	
1-Bromobutane	10.13	
1-Bromopentane	10.1	
1-Bromopropane	10.18	
1-Bromopropene	9.3	
1-Butanethiol	9.14	
1-Butene	9.58	
1-Butyne	10.18	
2,3-Butadione	9.23	
2-Bromo-2-methylpropane	9.89	
2-Bromobutane	9.98	
2-Bromopropane	10.08	

TABLE 1

SUMMARY OF IONIZATION POTENTIALS

Chemical Name	Ionization Potential (eV)	Cannot be Read by 10.6 eV PID
2-Bromothiophene	8.63	
2-Butanone (MEK)	9.54	
3-Bromopropene	9.7	
3-Butene nitrile	10.39	
Benzaldehyde	9.53	
Benzene	9.25	
Benzenethiol	8.33	
Benzonitrile	9.71	
Benzotrifluoride	9.68	
Biphenyl	8.27	
Boron oxide	13.5	X
Boron trifluoride	15.56	X
Bromine	10.54	
Bromobenzene	8.98	
Bromochloromethane	10.77	X
Bromoform	10.48	
Butane	10.63	X
Butyl mercaptan	9.15	
cis-2-Butene	9.13	
m-Bromotoluene	8.81	
n-Butyl acetate	10.01	
n-Butyl alcohol	10.04	
n-Butyl amine	8.71	
n-Butyl benzene	8.69	
n-Butyl formate	10.5	
n-Butyraldehyde	9.86	
n-Butyric acid	10.16	
n-Butyronitrile	11.67	X
o-Bromotoluene	8.79	
p-Bromotoluene	8.67	
p-tert-Butyltoluene	8.28	
s-Butyl amine	8.7	
s-Butyl benzene	8.68	
sec-Butyl acetate	9.91	
t-Butyl amine	8.64	
t-Butyl benzene	8.68	
trans-2-Butene	9.13	
C		

TABLE 1

SUMMARY OF IONIZATION POTENTIALS

Chemical Name	Ionization Potential (eV)	Cannot be Read by 10.6 eV PID
1-Chloro-2-methylpropane	10.66	X
1-Chloro-3-fluorobenzene	9.21	
1-Chlorobutane	10.67	X
1-Chloropropane	10.82	X
2-Chloro-2-methylpropane	10.61	X
2-Chlorobutane	10.65	X
2-Chloropropane	10.78	X
2-Chlorothiophene	8.68	
3-Chloropropene	10.04	
Camphor	8.76	
Carbon dioxide	13.79	X
Carbon disulfide	10.07	
Carbon monoxide	14.01	X
Carbon tetrachloride	11.47	X
Chlorine	11.48	X
Chlorine dioxide	10.36	
Chlorine trifluoride	12.65	X
Chloroacetaldehyde	10.61	X
α -Chloroacetophenone	9.44	
Chlorobenzene	9.07	
Chlorobromomethane	10.77	X
Chlorofluoromethane (Freon 22)	12.45	X
Chloroform	11.37	X
Chlorotrifluoromethane (Freon 13)	12.91	X
Chrysene	7.59	
Cresol	8.14	
Crotonaldehyde	9.73	
Cumene (isopropyl benzene)	8.75	
Cyanogen	13.8	X
Cyclohexane	9.8	
Cyclohexanol	9.75	
Cyclohexanone	9.14	
Cyclohexene	8.95	
Cyclo-octatetraene	7.99	
Cyclopentadiene	8.56	
Cyclopentane	10.53	
Cyclopentanone	9.26	
Cyclopentene	9.01	

TABLE 1

SUMMARY OF IONIZATION POTENTIALS

Chemical Name	**Ionization Potential (eV)**	Cannot be Read by 10.6 eV PID
Cyclopropane	10.06	
m-Chlorotoluene	8.83	
o-Chlorotoluene	8.83	
p-Chlorotoluene	8.7	
D		
1,1-Dibromoethane	10.19	
1,1-Dichloroethane	11.12	X
1,1-Dimethoxyethane	9.65	
1,1-Dimethylhydrazine	7.28	
1,2-Dibromoethene	9.45	
1,2-Dichloro-1,1,2,2-tetrafluoroethane (Freon 114)	12.2	X
1,2-Dichloroethane	11.12	X
1,2-Dichloropropane	10.87	X
1,3-Dibromopropane	10.07	
1,3-Dichloropropane	10.85	X
2,2-Dimethyl butane	10.06	
2,2-Dimethyl propane	10.35	
2,3-Dichloropropene	9.82	
2,3-Dimethyl butane	10.02	
3,3-Dimethyl butanone	9.17	
cis-Dichloroethene	9.65	
Decaborane	9.88	
Diazomethane	9	
Diborane	12	X
Dibromochloromethane	10.59	
Dibromodifluoromethane	11.07	X
Dibromomethane	10.49	
Dibutylamine	7.69	
Dichlorodifluoromethane (Freon 12)	12.31	X
Dichlorofluoromethane	12.39	X
Dichloromethane	11.35	X
Diethoxymethane	9.7	
Diethyl amine	8.01	
Diethyl ether	9.53	
Diethyl ketone	9.32	
Diethyl sulfide	8.43	
Diethyl sulfite	9.68	
Difluorodibromomethane	11.07	X

TABLE 1

SUMMARY OF IONIZATION POTENTIALS

Chemical Name	Ionization Potential (eV)	Cannot be Read by 10.6 eV PID
Dihydropyran	8.34	
Diiodomethane	9.34	
Diisopropylamine	7.73	
Dimethoxymethane (methylal)	10	
Dimethyl amine	8.24	
Dimethyl ether	10	
Dimethyl sulfide	8.69	
Dimethylaniline	7.13	
Dimethylformamide	9.18	
Dimethylphthalate	9.64	
Dinitrobenzene	10.71	X
Dioxane	9.19	
Diphenyl	7.95	
Dipropyl amine	7.84	
Dipropyl sulfide	8.3	
Durene	8.03	
m-Dichlorobenzene	9.12	
N,N-Diethyl acetamide	8.6	
N,N-Diethyl formamide	8.89	
N,N-Dimethyl acetamide	8.81	
N,N-Dimethyl formamide	9.12	
o-Dichlorobenzene	9.06	
p-Dichlorobenzene	8.95	
p-Dioxane	9.13	
trans-Dichloroethene	9.66	
E		
Epichlorohydrin	10.2	
Ethane	11.65	X
Ethanethiol (ethyl mercaptan)	9.29	
Ethanolamine	8.96	
Ethene	10.52	
Ethyl acetate	10.11	
Ethyl alcohol	10.48	
Ethyl amine	8.86	
Ethyl benzene	8.76	
Ethyl bromide	10.29	
Ethyl chloride (chloroethane)	10.98	X
Ethyl disulfide	8.27	

TABLE 1

SUMMARY OF IONIZATION POTENTIALS

Chemical Name	Ionization Potential (eV)	Cannot be Read by 10.6 eV PID
Ethyl ether	9.51	
Ethyl formate	10.61	X
Ethyl iodide	9.33	
Ethyl isothiocyanate	9.14	
Ethyl mercaptan	9.29	
Ethyl methyl sulfide	8.55	
Ethyl nitrate	11.22	X
Ethyl propionate	10	
Ethyl thiocyanate	9.89	
Ethylene chlorohydrin	10.52	
Ethylene diamine	8.6	
Ethylene dibromide	10.37	
Ethylene dichloride	11.05	X
Ethylene oxide	10.57	
Ethylenelmine	9.2	
Ethynylbenzene	8.82	
F		
2-Furaldehyde	9.21	
Fluorine	15.7	X
Fluorobenzene	9.2	
Formaldehyde	10.87	X
Formamide	10.25	
Formic acid	11.05	X
Freon 11 (trichlorofluoromethane)	11.77	X
Freon 112 (1,1,2,2-tetrachloro-1,2-difluoroethane)	11.3	X
Freon 113 (1,1,2-trichloro-1,2,2-trifluororethane)	11.78	X
Freon 114 (1,2-dichloro-1,1,2,2-tetrafluoroethane)	12.2	X
Freon 12 (dichlorodifluoromethane)	12.31	X
Freon 13 (chlorotrifluoromethane)	12.91	X
Freon 22 (chlorofluoromethane)	12.45	X
Furan	8.89	
Furfural	9.21	
m-Fluorotoluene	8.92	
o-Fluorophenol	8.66	
o-Fluorotoluene	8.92	
p-Fluorotoluene	8.79	
H		
1-Hexene	9.46	

TABLE 1

SUMMARY OF IONIZATION POTENTIALS

Chemical Name	Ionization Potential (eV)	Cannot be Read by 10.6 eV PID
2-Heptanone	9.33	
2-Hexanone	9.35	
Heptane	10.08	
Hexachloroethane	11.1	X
Hexane	10.18	
Hydrazine	8.1	
Hydrogen	15.43	X
Hydrogen bromide	11.62	X
Hydrogen chloride	12.74	X
Hydrogen cyanide	13.91	X
Hydrogen fluoride	15.77	X
Hydrogen iodide	10.38	
Hydrogen selenide	9.88	
Hydrogen sulfide	10.46	
Hydrogen telluride	9.14	
Hydroquinone	7.95	
I		
1-Iodo-2-methylpropane	9.18	
1-Iodobutane	9.21	
1-Iodopentane	9.19	
1-Iodopropane	9.26	
2-Iodobutane	9.09	
2-Iodopropane	9.17	
Iodine	9.28	
Iodobenzene	8.73	
Isobutane	10.57	
Isobutyl acetate	9.97	
Isobutyl alcohol	10.12	
Isobutyl amine	8.7	
Isobutyl formate	10.46	
Isobutyraldehyde	9.74	
Isobutyric acid	10.02	
Isopentane	10.32	
Isophorone	9.07	
Isoprene	8.85	
Isopropyl acetate	9.99	
Isopropyl alcohol	10.16	
Isopropyl amine	8.72	

TABLE 1

SUMMARY OF IONIZATION POTENTIALS

Chemical Name	Ionization Potential (eV)	Cannot be Read by 10.6 eV PID
Isopropyl benzene	8.69	
Isopropyl ether	9.2	
Isovaleraldehyde	9.71	
m-Iodotoluene	8.61	
o-Iodotoluene	8.62	
p-Iodotoluene	8.5	
K		
Ketene	9.61	
L		
2,3-Lutidine	8.85	
2,4-Lutidine	8.85	
2,6-Lutidine	8.85	
M		
2-Methyl furan	8.39	
2-Methyl napthalene	7.96	
1-Methyl napthalene	7.96	
2-Methyl propene	9.23	
2-Methyl-1-butene	9.12	
2-Methylpentane	10.12	
3-Methyl-1-butene	9.51	
3-Methyl-2-butene	8.67	
3-Methylpentane	10.08	
4-Methylcyclohexene	8.91	
Maleic anhydride	10.8	X
Mesityl oxide	9.08	
Mesitylene	8.4	
Methane	12.98	X
Methanethiol (methyl mercaptan)	9.44	
Methyl acetate	10.27	
Methyl acetylene	10.37	
Methyl acrylate	9.9	
Methyl alcohol	10.85	X
Methyl amine	8.97	
Methyl bromide	10.54	
Methyl butyl ketone	9.34	
Methyl butyrate	10.07	
Methyl cellosolve	9.6	
Methyl chloride	11.28	X

TABLE 1

SUMMARY OF IONIZATION POTENTIALS

Chemical Name	Ionization Potential (eV)	Cannot be Read by 10.6 eV PID
Methyl chloroform (1,1,1-trichloroethane)	11	X
Methyl disulfide	8.46	
Methyl ethyl ketone	9.53	
Methyl formate	10.82	X
Methyl iodide	9.54	
Methyl isobutyl ketone	9.3	
Methyl isobutyrate	9.98	
Methyl isocyanate	10.67	X
Methyl isopropyl ketone	9.32	
Methyl isothiocyanate	9.25	
Methyl mercaptan	9.44	
Methyl methacrylate	9.7	
Methyl propionate	10.15	
Methyl propyl ketone	9.39	
α -Methyl styrene	8.35	
Methyl thiocyanate	10.07	
Methylal (dimethoxymethane)	10	
Methylcyclohexane	9.85	
Methylene chloride	11.32	X
Methyl-n-amyl ketone	9.3	
Monomethyl aniline	7.32	
Monomethyl hydrazine	7.67	
Morpholine	8.2	
n-Methyl acetamide	8.9	
N		
1-Nitropropane	10.88	X
2-Nitropropane	10.71	X
Naphthalene	8.12	
Nickel carbonyl	8.27	
Nitric oxide, (NO)	9.25	
Nitrobenzene	9.92	
Nitroethane	10.88	X
Nitrogen	15.58	X
Nitrogen dioxide	9.78	
Nitrogen trifluoride	12.97	X
Nitromethane	11.08	X
Nitrotoluene	9.45	
p-Nitrochloro benzene	9.96	

TABLE 1

SUMMARY OF IONIZATION POTENTIALS

Chemical Name	Ionization Potential (eV)	Cannot be Read by 10.6 eV PID
O		
Octane	9.82	
Oxygen	12.08	X
Ozone	12.08	X
P		
1-Pentene	9.5	
1-Propanethiol	9.2	
2,4-Pentanedione	8.87	
2-Pentanone	9.38	
2-Picoline	9.02	
3-Picoline	9.02	
4-Picoline	9.04	
n-Propyl nitrate	11.07	X
Pentaborane	10.4	
Pentane	10.35	
Perchloroethylene	9.32	
Pheneloic	8.18	
Phenol	8.5	
Phenyl ether (diphenyl oxide)	8.82	
Phenyl hydrazine	7.64	
Phenyl isocyanate	8.77	
Phenyl isothiocyanate	8.52	
Phenylene diamine	6.89	
Phosgene	11.77	X
Phosphine	9.87	
Phosphorus trichloride	9.91	
Phthalic anhydride	10	
Propane	11.07	X
Propargyl alcohol	10.51	
Propiolactone	9.7	
Propionaldehyde	9.98	
Propionic acid	10.24	
Propionitrile	11.84	X
Propyl acetate	10.04	
Propyl alcohol	10.2	
Propyl amine	8.78	
Propyl benzene	8.72	
Propyl ether	9.27	

TABLE 1

SUMMARY OF IONIZATION POTENTIALS

Chemical Name	Ionization Potential (eV)	Cannot be Read by 10.6 eV PID
Propyl formate	10.54	
Propylene	9.73	
Propylene dichloride	10.87	X
Propylene imine	9	
Propylene oxide	10.22	
Propyne	10.36	
Pyridine	9.32	
Pyrrole	8.2	
Q		
Quinone	10.04	
S		
Stibine	9.51	
Styrene	8.47	
Sulfur dioxide	12.3	X
Sulfur hexafluoride	15.33	X
Sulfur monochloride	9.66	
Sulfuryl fluoride	13	X
T		
o-Terphenyls	7.78	
1,1,2,2-Tetrachloro-1,2-difluoroethane (Freon 112)	11.3	X
1,1,1-Trichloroethane	11	X
1,1,2-Trichloro-1,2,2-trifluoroethane (Freon 113)	11.78	X
2,2,4-Trimethyl pentane	9.86	
o-Toluidine	7.44	
Tetrachloroethane	11.62	X
Tetrachloroethene	9.32	
Tetrachloromethane	11.47	X
Tetrahydrofuran	9.54	
Tetrahydropyran	9.25	
Thiolacetic acid	10	
Thiophene	8.86	
Toluene	8.82	
Tribromoethene	9.27	
Tribromofluoromethane	10.67	X
Tribromomethane	10.51	
Trichloroethene	9.45	
Trichloroethylene	9.47	
Trichlorofluoromethane (Freon 11)	11.77	X

TABLE 1

SUMMARY OF IONIZATION POTENTIALS

Chemical Name	Ionization Potential (eV)	Cannot be Read by 10.6 eV PID
Trichloromethane	11.42	X
Triethylamine	7.5	
Trifluoromonobromo-methane	11.4	X
Trimethyl amine	7.82	
Tripropyl amine	7.23	
V		
o-Vinyl toluene	8.2	
Valeraldehyde	9.82	
Valeric acid	10.12	
Vinyl acetate	9.19	
Vinyl bromide	9.8	
Vinyl chloride	10	
Vinyl methyl ether	8.93	
W		
Water	12.59	X
X		
2,4-Xylidine	7.65	
m-Xylene	8.56	
o-Xylene	8.56	
p-Xylene	8.45	

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EQUIPMENT CALIBRATION

PROJECT INFORMATION:

Project Name: Date:

Project No.:

Client: Instrument Source: ☐ BM ☐ Rental

METER TYPE	UNITS	TIME	MAKE/MODEL	SERIAL NUMBER	CAL. BY	STANDARD	READING	SETTI
☐ pH meter	units		Myron L Company Ultra Meter 6P	606987		4.00 7.00 10.01		
☐ Turbidity meter	NTU		Hach 2100P Turbidimeter	970600014560		<0.4 20 100 800		
☐ Sp. conductance meter	uS/mS		Myron L Company Ultra Meter 6P	606987		mS @ 25 °C		
☐ PID	ppm		Photovac 2020 PID			open air zero ____ ppm Iso. Gas		MIBK re factor
☐ Particulate meter	mg/m^3					zero air		
☐ Oxygen	%					open air		
☐ Hydrogen sulfide	ppm					open air		
☐ Carbon monoxide	ppm					open air		
☐ LEL	%					open air		
☐ Radiation Meter	uR/					background area		
☐								

ADDITIONAL REMARKS:

PREPARED BY: **DATE:**

FOP 012.0

CALIBRATION AND MAINTENANCE OF PORTABLE SPECIFIC CONDUCTANCE METER

PURPOSE

This guideline describes a method for calibration of a portable specific conductance meter. This meter measures the ability of a water sample to conduct electricity, which is largely a function of the dissolved solids within the water. The instrument has been calibrated by the manufacturer according to factory specifications. This guideline presents a method for checking the factory calibration of a portable specific conductance meter. A calibration check is performed to verify instrument accuracy and function. All field test equipment will be checked at the beginning of each sampling day. This procedure also documents critical maintenance activities for this meter.

ACCURACY

The calibrated accuracy of the specific conductance meter will be within ± 1 percent of full-scale, with repeatability of ± 1 percent. The built-in cell will be automatically temperature compensated from at least 32° to 160° F (0° to 71°C).

PROCEDURE

Note: The information included below is equipment manufacturer- and model-specific, however, accuracy, calibration, and maintenance procedures for this type of portable equipment are typically similar. The information below pertains to the Myron L Company Ultrameter Model 6P. The actual equipment to be used in the field will be equivalent or similar.

1. Calibrate all field test equipment at the beginning of each sampling day. Check and recalibrate the specific conductance meter according to the manufacture's specifications.

2. Use a calibration solution of known specific conductivity and salinity. For maximum accuracy, use a Standard Solution Value closest to the samples to be tested.

3. Rinse conductivity cell three times with proper standard.

4. Re-fill conductivity cell with same standard.

5. Press **COND** or **TDS**, then press **CAL/MCLR**. The "CAL" icon will appear on the display.

6. Press the **↑/MS** or **MR/↓** key to step the displayed value toward the standard's value or hold a key down to cause rapid scrolling of the reading.

7. Press CAL/MCLR once to confirm new value and end the calibration sequence for this particular solution type.

8. Repeat steps 1 through 7 with additional new solutions, as necessary.

9. Document the calibration results and related information in the Project Field Book and on an **Equipment Calibration Log** (see attached sample), indicating the meter readings before and after the instrument has been adjusted. This is important, not only for data validation, but also to establish maintenance schedules and component replacement. Information will include, at a minimum:
    - Time, date and initials of the field team member performing the calibration
    - The unique identifier for the meter, including manufacturer, model, and serial number
    - The brand and expiration date of the calibration standards
    - The instrument readings: before and after calibration

- The instrument settings (if applicable)
- The overall adequacy of calibration including the Pass or fail designation in accordance with the accuracy specifications presented above.
- Corrective action taken (see Maintenance below) in the event of failure to adequately calibrate.

MAINTENANCE

NOTE: Ultrameters should be rinsed with clean water after use. Solvents should be avoided. Shock damage from a fall may cause instrument failure.

Temperature Extremes

Solutions in excess of 160°F/71°C should not be placed in the cell cup area; this may cause damage. Care should be exercised not to exceed rated operating temperature. Leaving the Ultrameter in a vehicle or storage shed on a hot day can easily subject the instrument to over 150°F voiding the warranty.

Battery Replacement

Dry Instrument THOROUGHLY. Remove the four bottom screws. Open instrument carefully; it may be necessary to rock the bottom slightly side to side to release it from the RS-232 connector. Carefully detach battery from circuit board. Replace with 9-volt alkaline battery. Replace bottom, ensuring the sealing gasket is installed in the groove of the top half of case. Re-install screws, tighten evenly and securely.

NOTE: Because of nonvolatile EEPROM circuitry, all data stored in memory and all calibration settings are protected even during power loss or battery replacement.

Cleaning Sensors

The conductivity cell cup should be kept as clean as possible. Flushing with clean water following use will prevent buildup on electrodes. However, if very dirty samples — particularly scaling types — are allowed to dry in the cell cup, a film will form. This film reduces accuracy. When there are visible films of oil, dirt, or scale in the cell cup or on the electrodes, use a foaming non-abrasive household cleaner. Rinse out the cleaner and your Ultrameter is ready for accurate measurements.

NOTE: Maintain a log for each monitoring instrument. Record all maintenance performed on the instrument on this log with date and name of the organization performing the maintenance.

ATTACHMENTS

Equipment Calibration Log (sample)

Benchmark Environmental Engineering & Science, PLLC

EQUIPMENT CALIBRATION

PROJECT INFORMATION:

Project Name:

Project No.:

Client:

Date:

Instrument Source: ☐ BM ☐ Rental

METER TYPE	UNITS	TIME	MAKE/MODEL	SERIAL NUMBER	CAL. BY	STANDARD	READING	SETTI
☐ pH meter	units		Myron L Company Ultra Meter 6P	606987		4.00 7.00 10.01		
☐ Turbidity meter	NTU		Hach 2100P Turbidimeter	970600014560		<0.4 20 100 800		
☐ Sp. conductance meter	uS/mS		Myron L Company Ultra Meter 6P	606987		mS @ 25 °C		
☐ PID	ppm		Photovac 2020 PID			open air zero _____ ppm Iso. Gas		MIBK re factor
☐ Particulate meter	mg/m^3					zero air		
☐ Oxygen	%					open air		
☐ Hydrogen sulfide	ppm					open air		
☐ Carbon monoxide	ppm					open air		
☐ LEL	%					open air		
☐ Radiation Meter	uR/H					background area		
☐								

ADDITIONAL REMARKS:

PREPARED BY: **DATE:**

FOP 015.0

DOCUMENTATION REQUIREMENTS FOR DRILLING AND WELL INSTALLATION

PURPOSE

The purpose of these documentation requirements is to document the procedures used for drilling and installing wells in order to ensure the quality of the data obtained from these operations. Benchmark field technical personnel will be responsible for developing and maintaining documentation for quality control of field operations. At least one field professional will monitor each major operation (e.g. one person per drilling rig) to document and record field procedures for quality control. These procedures provide a description of the format and information for this documentation.

PROCEDURE

Project Field Book

Personnel assigned by the Benchmark Field Team Leader or Project Manager will maintain a Project Field Book for all site activities. These Field Books will be started upon initiation of any site activities to document the field investigation process. The Field Books will meet the following criteria:

- Permanently bound, with nominal 8.5-inch by 11-inch gridded pages.
- Water resistant paper.
- Pages must be pre-numbered or numbered in the field, front and back.

Notations in the field book will be in black or blue ink that will not smudge when wet. Information that may be recorded in the Field Book includes:

- Time and date of all entries.

- Name and location of project site and project job number.
- Listing of key project, client and agency personnel and telephone numbers.
- Date and time of daily arrivals and departures, name of person keeping the log, names and affiliation of persons on site, purpose of visit (if applicable), weather conditions, outline of project activities to be completed.
- Details of any variations to the procedures/protocols (i.e., as presented in the Work Plan or Field Operating Procedures) and the basis for the change.
- Field-generated data relating to implementation of the field program, including sample locations, sample descriptions, field measurements, instrument calibration, etc.
- Record of all photographs taken in the field, including date, time, photographer, site location and orientation, sequential number of photograph, and roll number.

Upon completion of the site activities, all Field Books will be photocopied and both the original and photocopied versions placed in the project files. In addition, all field notes except those presented on specific field forms will be neatly transcribed into Field Activity Daily Log (FADL) forms (sample attached).

Field Borehole/Monitoring Well Installation Log Form

Examples of the Field Borehole Log and Field Borehole/Monitoring Well Installation Log forms are attached to this Field Operating Procedure. One form will be completed for every boring by the Benchmark field person overseeing the drilling. At a minimum, these forms will include:

- Project name, location, and number.
- Boring number.

- Rig type and drilling method.
- Drilling dates.
- Sampling method.
- Sample descriptions, to meet the requirements of the Unified Soil Classification System (USCS) for soils and the Unified Rock Classification System (URCS) for rock.
- Results of photoionization evaluations (scan and/or headspace determinations).
- Blow counts for sampler penetration (Standard Penetration Test, N-Value).
- Drilling rate, rig chatter, and other drilling-related information, as necessary.

All depths recorded on Boring/Monitoring Well Installation Log forms will be expressed in increments tenths of feet, and not in inches.

__Well Completion Detail Form__

An example of this form is attached to this Field Operating Procedure. One form will be completed for every boring by the Benchmark field person overseeing the well installation. At a minimum, these forms will include:

- Project name, location, and number.
- Well number.
- Installation dates.
- Dimensions and depths of the various well components illustrated in the Well Completion Detail (attached). These include the screened interval, bottom caps or plugs, centralizers, and the tops and bottoms of the various annular materials.

- Drilling rate, rig chatter, and other drilling related information.

All depths recorded on Field Borehole/Monitoring Well Installation Logs will be expressed in tenths of feet, and not in inches.

Daily Drilling Report Form

An example of this form is attached to this Field Operating Procedure. This form should be used to summarize all drilling activities. One form should be completed for each rig for each day. These forms will include summaries of:

- Footage drilled, broken down by diameter (e.g. 200 feet of 6-inch diameter hole, 50 feet of 10-inch diameter hole).
- Footage of well and screen installed, broken down by diameter.
- Quantities of materials used, including sand, cement, bentonite, centralizers, protective casings, traffic covers, etc. recorded by well or boring location.
- Active time (hours), and activity (drilling, decontamination, development, well installation, surface completions, etc.)
- Down-time (hours) and reason.
- Mobilizations and other events.
- Other quantities that will be the basis for drilling invoices.

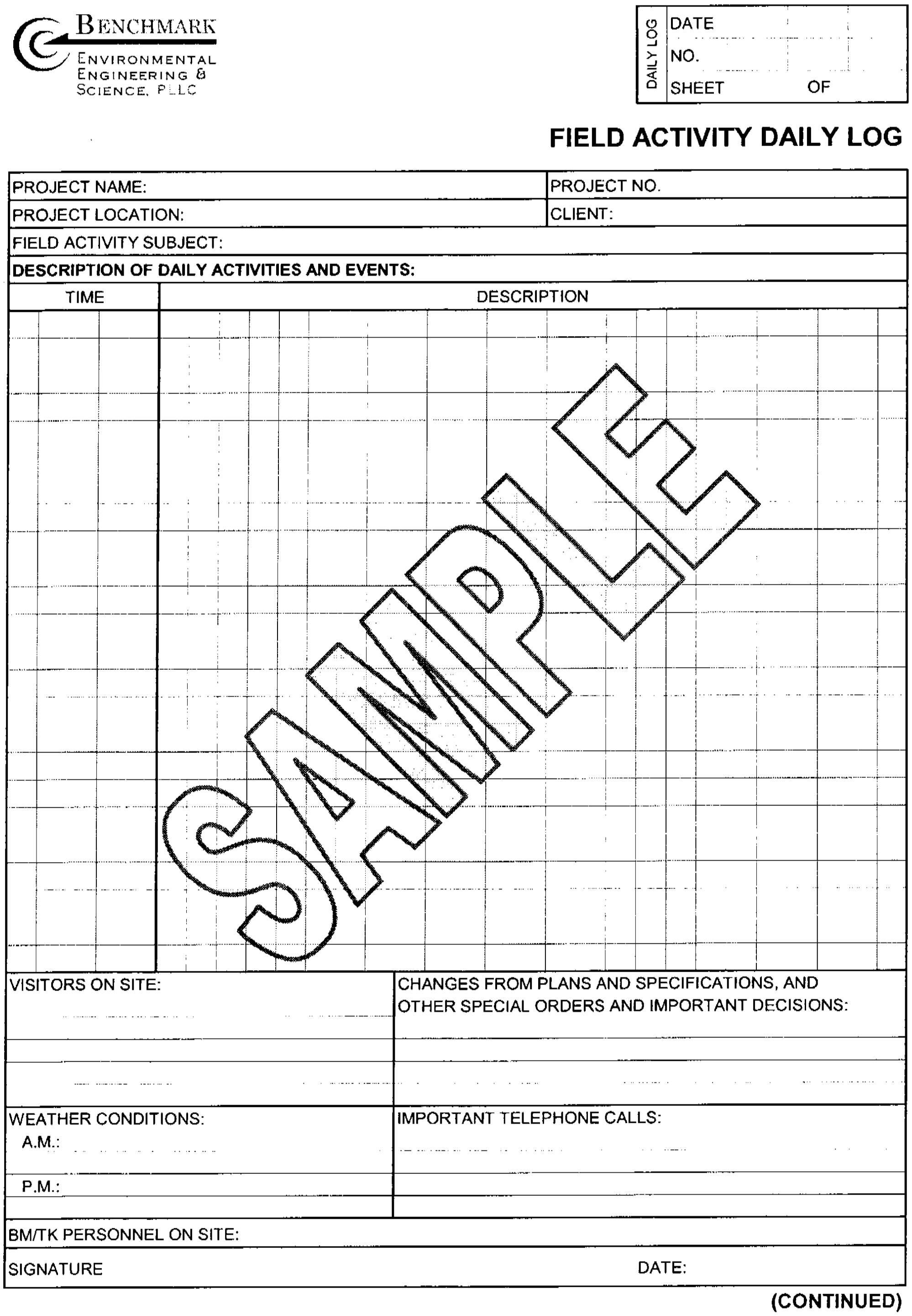
The form should be signed daily by both the Benchmark field supervisor and the driller's representative, and provided to the Benchmark Field Team Leader.

Other Project Field Forms

Well purging/well development forms, test pit logs, environmental sampling field data sheets, water level monitoring forms, and well testing (slug test or pumping test) forms. Refer to specific guidelines for form descriptions.

ATTACHMENTS

Field Activity Daily Log (FADL) (sample)
Field Borehole Log (sample)
Field Borehole/Monitoring Well Installation Log (sample)
Stick-up Well/Piezometer Completion Detail (sample)
Flush-mount Well/Piezometer Completion Detail (sample)
Daily Drilling Report (sample)



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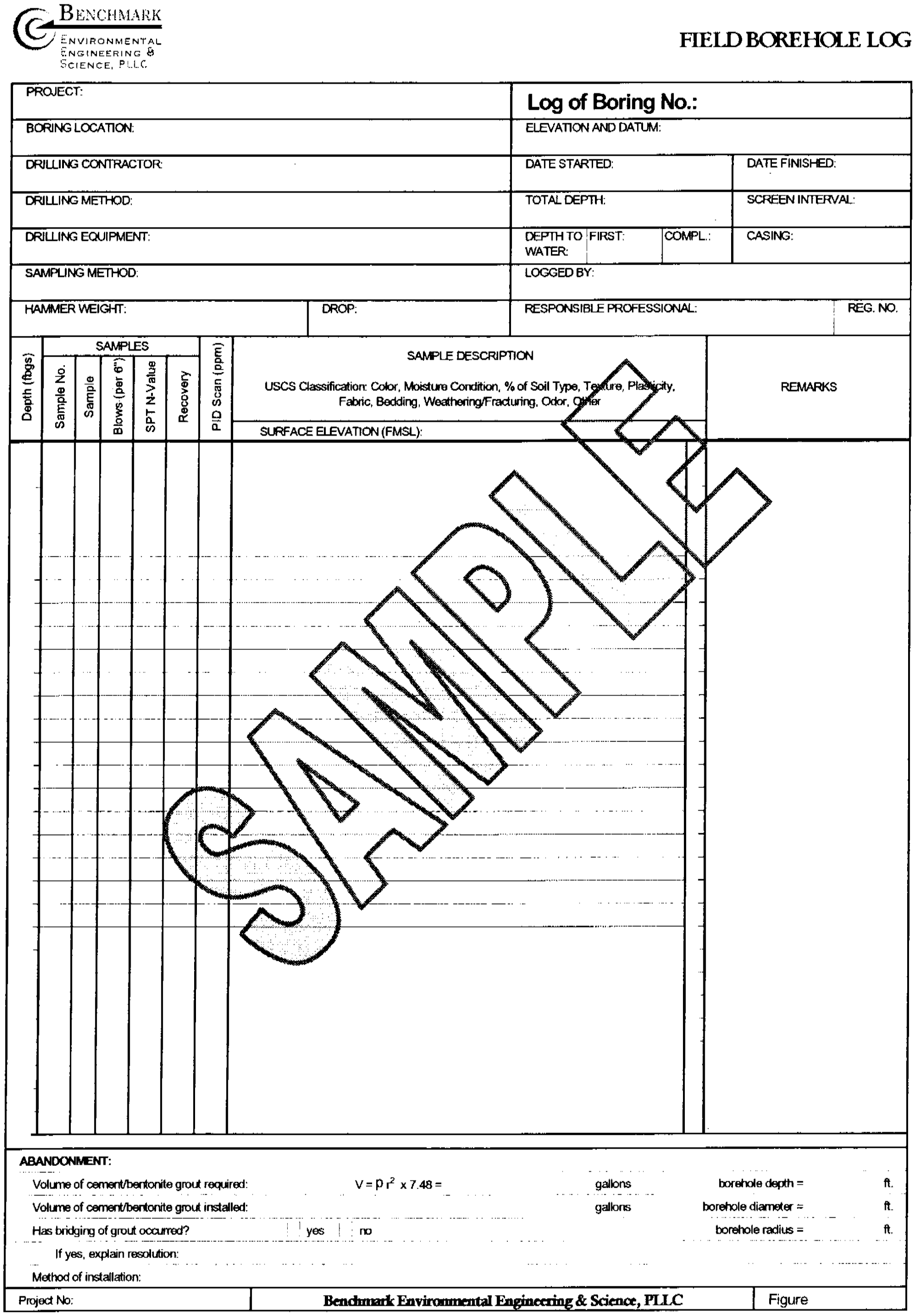
DAILY LOG	
	DATE
	NO.
	SHEET OF

FIELD ACTIVITY DAILY LOG

PROJECT NAME:	PROJECT NO.
PROJECT LOCATION:	CLIENT:
FIELD ACTIVITY SUBJECT:	
DESCRIPTION OF DAILY ACTIVITIES AND EVENTS:	
TIME	DESCRIPTION

VISITORS ON SITE:	CHANGES FROM PLANS AND SPECIFICATIONS, AND OTHER SPECIAL ORDERS AND IMPORTANT DECISIONS:
WEATHER CONDITIONS: A.M.:	IMPORTANT TELEPHONE CALLS:
P.M.:	
BM/TK PERSONNEL ON SITE:	
SIGNATURE	DATE:

(CONTINUED)



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FIELD BOREHOLE LOG

PROJECT:	**Log of Boring No.:**	
BORING LOCATION:	ELEVATION AND DATUM:	
DRILLING CONTRACTOR:	DATE STARTED:	DATE FINISHED:
DRILLING METHOD:	TOTAL DEPTH:	SCREEN INTERVAL:
DRILLING EQUIPMENT:	DEPTH TO WATER: FIRST: COMPL.:	CASING:
SAMPLING METHOD:	LOGGED BY:	
HAMMER WEIGHT: DROP:	RESPONSIBLE PROFESSIONAL:	REG. NO.

Depth (fbgs)	SAMPLES					PID Scan (ppm)	SAMPLE DESCRIPTION USCS Classification: Color, Moisture Condition, % of Soil Type, Texture, Plasticity, Fabric, Bedding, Weathering/Fracturing, Odor, Other SURFACE ELEVATION (FMSL):	REMARKS
	Sample No.	Sample	Blows (per 6")	SPT N-Value	Recovery			

ABANDONMENT:

Volume of cement/bentonite grout required: $V = p\, r^2 \times 7.48 =$ gallons borehole depth = ft.

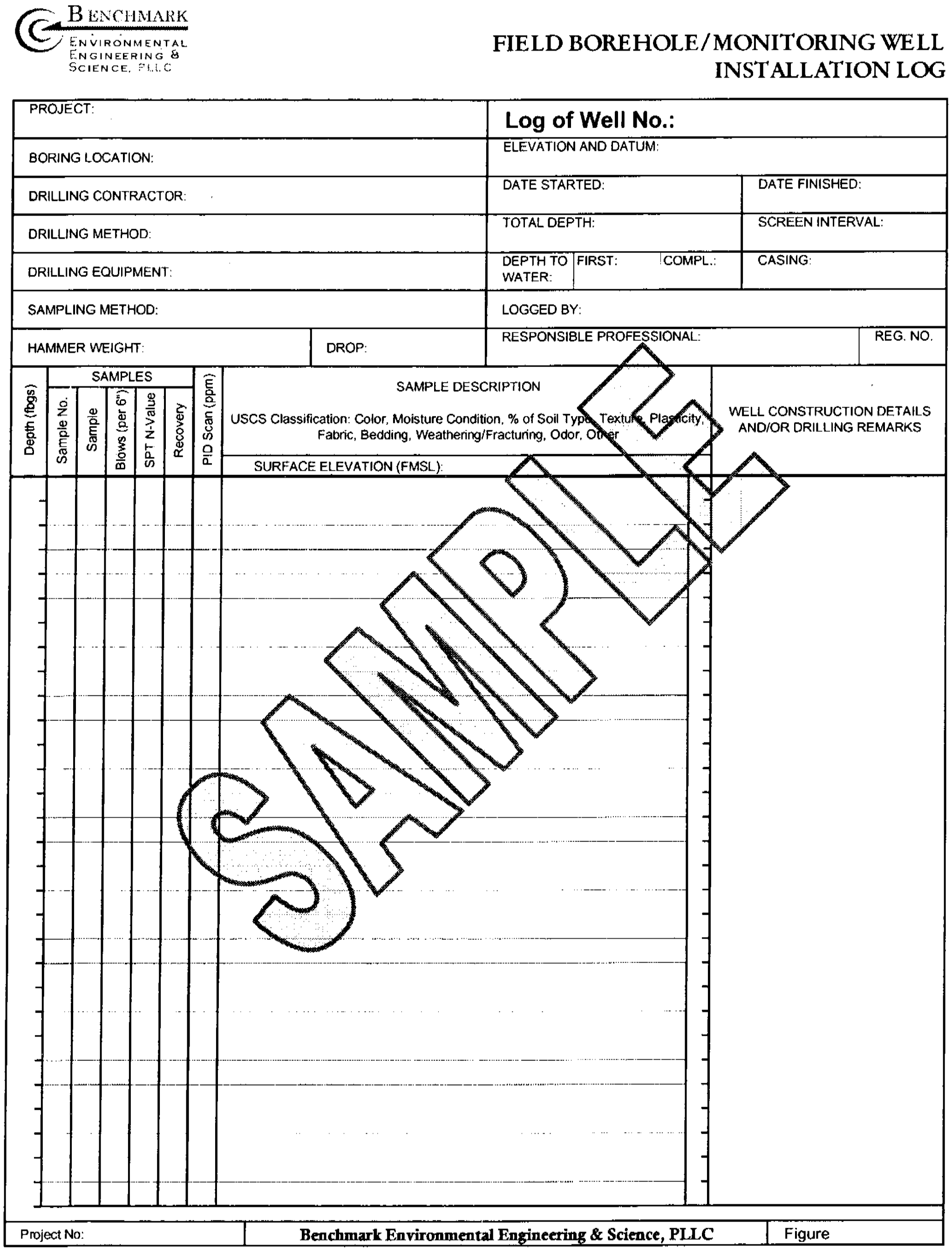
Volume of cement/bentonite grout installed: gallons borehole diameter = ft.

Has bridging of grout occurred? ☐ yes ☐ no borehole radius = ft.

If yes, explain resolution:

Method of installation:

Project No:	**Benchmark Environmental Engineering & Science, PLLC**	Figure



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FIELD BOREHOLE/MONITORING WELL INSTALLATION LOG

PROJECT:		**Log of Well No.:**		
BORING LOCATION:		ELEVATION AND DATUM:		
DRILLING CONTRACTOR:		DATE STARTED:		DATE FINISHED:
DRILLING METHOD:		TOTAL DEPTH:		SCREEN INTERVAL:
DRILLING EQUIPMENT:		DEPTH TO WATER: FIRST:	COMPL.:	CASING:
SAMPLING METHOD:		LOGGED BY:		
HAMMER WEIGHT:	DROP:	RESPONSIBLE PROFESSIONAL:		REG. NO.

Depth (fbgs)	SAMPLES					PID Scan (ppm)	SAMPLE DESCRIPTION USCS Classification: Color, Moisture Condition, % of Soil Type, Texture, Plasticity, Fabric, Bedding, Weathering/Fracturing, Odor, Other	WELL CONSTRUCTION DETAILS AND/OR DRILLING REMARKS
	Sample No.	Sample	Blows (per 6")	SPT N-Value	Recovery		SURFACE ELEVATION (FMSL):	

Project No:	**Benchmark Environmental Engineering & Science, PLLC**	Figure	

STICK-UP WELL/PIEZOMETER COMPLETION DETAIL

Project Name:

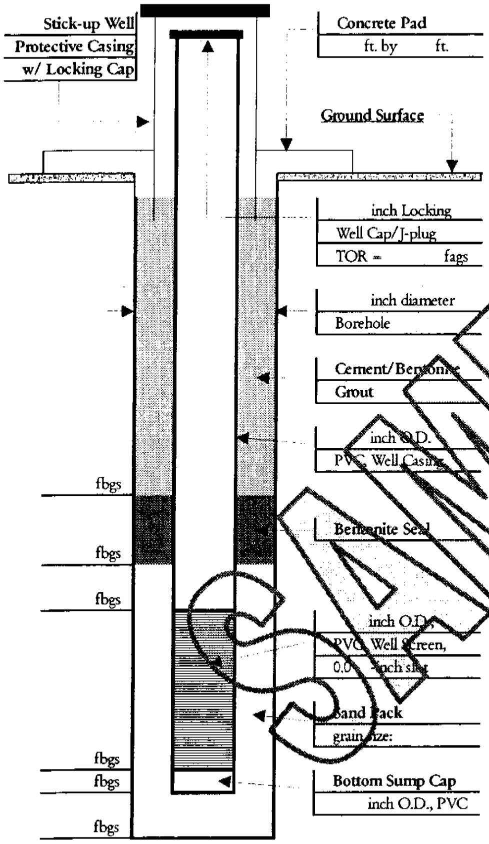
WELL NUMBER:

Client:

Date Installed:

Boring Location:

Project Number:



Driller Information

Company:

Driller:

Helper:

Permit Number:

Drill Rig Type:

Well Information

Land Surface Elevation: fmsl (approximate)

Drilling Method:

Soil Sample Collection Method:

Drilling Fluid:

Fluid Loss During Drilling: gallons (approximate)

Material of Well Construction

Casing:

Screen:

Sump:

Sand Pack:

Annular Seal:

Well Development

Well Purpose:

Techneque(s):

Date Completed:

BM/TK Personnel:

Total Volume Purge: gallons

Static Water Level: fbTOR

Pump Depth:

Purge Duration: minutes

Yeild: gpm

Specific Capacity: gpm/ft

Comments:

PREPARED BY:

DATE:

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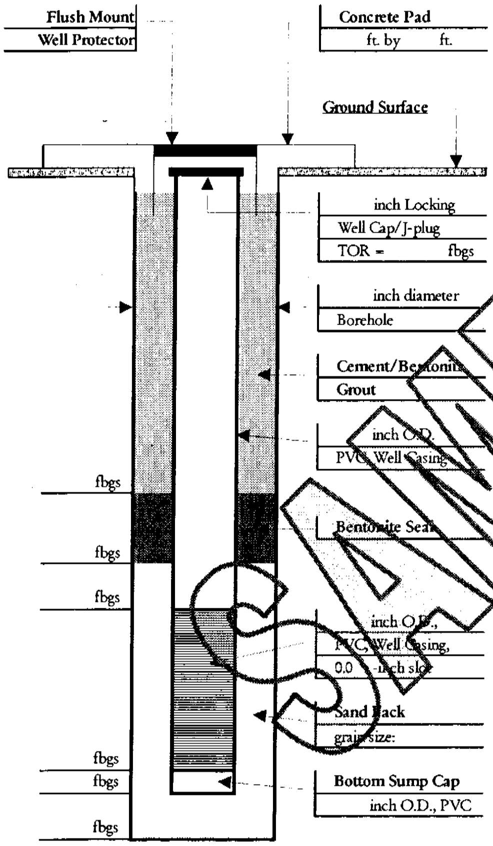
FLUSHMOUNT WELL/PIEZOMETER COMPLETION DETAIL

Project Name:	WELL NUMBER:
Client:	Date Installed:
Boring Location:	Project Number:



Driller Information	
Company:	
Driller:	
Helper:	
Permit Number:	
Drill Rig Type:	

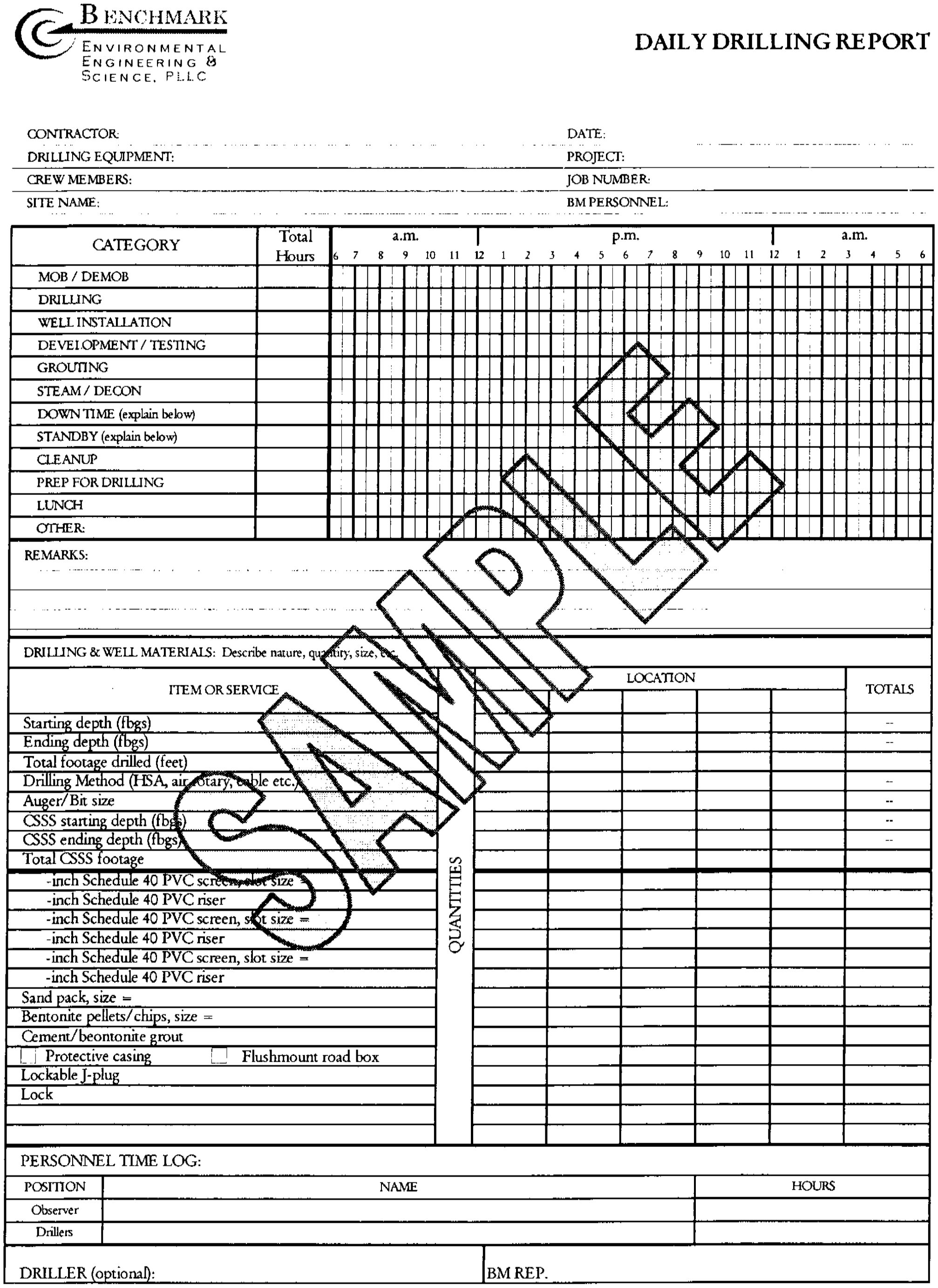
Well Information	
Land Surface Elevation:	fmsl (approximate)
Drilling Method:	
Soil Sample Collection Method:	
Drilling Fluid:	
Fluid Loss During Drilling:	gallons (approximate)

Material of Well Construction	
Casing:	
Screen:	
Sump:	
Sand Pack:	
Annular Seal:	

Well Development	
Well Purpose:	
Techneque(s):	
Date Completed:	
BM/TK Personnel:	
Total Volume Purge:	gallons
Static Water Level:	fbTOR
Pump Depth:	
Purge Duration:	minutes
Yeild:	gpm
Specific Capacity:	gpm/ft

Comments:

PREAPRED BY: DATE:



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DAILY DRILLING REPORT

CONTRACTOR:
DATE:
DRILLING EQUIPMENT:
PROJECT:
CREW MEMBERS:
JOB NUMBER:
SITE NAME:
BM PERSONNEL:

CATEGORY	Total Hours	a.m. 6	7	8	9	10	11	p.m. 12	1	2	3	4	5	6	7	8	9	10	11	a.m. 12	1	2	3	4	5	6
MOB / DEMOB																										
DRILLING																										
WELL INSTALLATION																										
DEVELOPMENT / TESTING																										
GROUTING																										
STEAM / DECON																										
DOWN TIME (explain below)																										
STANDBY (explain below)																										
CLEANUP																										
PREP FOR DRILLING																										
LUNCH																										
OTHER:																										

REMARKS:

DRILLING & WELL MATERIALS: Describe nature, quantity, size, etc.

ITEM OR SERVICE	QUANTITIES	LOCATION					TOTALS
Starting depth (fbgs)							--
Ending depth (fbgs)							--
Total footage drilled (feet)							
Drilling Method (HSA, air rotary, cable etc.)							--
Auger/Bit size							--
CSSS starting depth (fbgs)							--
CSSS ending depth (fbgs)							--
Total CSSS footage							
-inch Schedule 40 PVC screen, slot size =							
-inch Schedule 40 PVC riser							
-inch Schedule 40 PVC screen, slot size =							
-inch Schedule 40 PVC riser							
-inch Schedule 40 PVC screen, slot size =							
-inch Schedule 40 PVC riser							
Sand pack, size =							
Bentonite pellets/chips, size =							
Cement/beontonite grout							
☐ Protective casing ☐ Flushmount road box							
Lockable J-plug							
Lock							

PERSONNEL TIME LOG:

POSITION	NAME	HOURS
Observer		
Drillers		

DRILLER (optional):
BM REP.

FOP 017.0

DRILL SITE SELECTION PROCEDURE

PURPOSE

This procedure presents a method for selecting a site location for drilling. Drill site selection should be based on the project objectives, ease of site access, freedom from obstructions and buried metallic objects (drums) and site safety (appropriate set backs from overhead and buried services).

PROCEDURE

The following procedure outlines procedures prior to drilling activities:

1. Review project objectives and tentatively select drilling locations that provide necessary information for achieving objectives (i.e., Work Plan).
2. Clear locations with property owner/operator to ensure that drilling activities will not interfere with site operations and select appropriate access routes.
3. Stake locations in the field, measure distance from locations to recognizable landmarks, such as building or fence lines and plot locations on site plan. Ensure location is relatively flat, free of overhead wires and readily accessible. Survey location if property ownership is in doubt.
4. Obtain clearances from appropriate utilities and if buried waste/metallic objects are suspected, screen location with appropriate geophysical method.
5. Establish a secure central staging area for storage of drilling supplies and for equipment decontamination. Locate a secure storage area for drilling samples, as necessary.

ATTACHMENTS

none

FOP 018.0

DRILLING AND EXCAVATION EQUIPMENT DECONTAMINATION PROCEDURES

PURPOSE

This procedure is to be used for the decontamination of drilling and excavation equipment (i.e., drill rigs, backhoes, augers, drill bits, drill rods, buckets, and associated equipment) used during a subsurface investigation. The purpose of this procedure is to remove chemical constituents associated with a particular drilling or excavation location from this equipment. This prevents these constituents from being transferred between drilling or excavation locations, or being transported out of controlled areas.

PROCEDURE

The following procedure will be utilized prior to the use of drilling or excavation equipment at each location, and prior to the demobilization of such equipment from the site:

1. Remove all loose soil and other particulate materials from the equipment at the survey site.

2. Wrap augers, tools, plywood, and other reusable items with a plastic cover prior to transport from the site of use to the decontamination facility.

3. Transport equipment to the decontamination facility. All equipment must be decontaminated at an established decontamination facility. This facility will be placed within a controlled area, and will be equipped with necessary features to contain and collect wash water and entrained materials.

4. Wash equipment thoroughly with pressurized low-volume water or steam, supplied by a pressure washer or steam cleaner.

5. If necessary, use a brush or scraper to remove visible soils adhering to the equipment, and a non-phosphate detergent to remove any oils, grease, and/or hydraulic fluids adhering to the equipment. Continue pressure washing until all visible contaminants are removed.

6. Allow equipment to air dry.
7. Store equipment in a clean area or wrap the equipment in new plastic sheeting as necessary to ensure cleanliness until ready for use.
8. Manage all wash waters and entrained solids as described in the Benchmark Field Operating Procedure for Management of Investigation-Derived Waste.

ATTACHMENTS

none

FOP 020.0

ELECTROMAGNETIC (EM) SURVEY

PURPOSE

This procedure describes a method for EM geophysical surveys to map the lateral extent of conductive waste material.

PROCEDURE

An Electromagnetic (EM) survey will be performed over approximately 15 acres at the site. This survey will map the variations in electrical conductivity of the near subsurface across the survey area. The Geonics EM31 and solid state data logger will be used to map the lateral extent of conductive fill material. This device has a depth of exploration of approximately 12 feet. The instrument simultaneously records the quadrature and in-phase components of the electromagnetic fields generated by the device's transmitter. The quadrature component data are measurements of the apparent terrain conductivity. A terrain conductivity map of the study site should provide information concerning variations in conductive fill material, lithology and/or pore fluid. The EM31 device also records the in-phase component of the EM field. The in-phase component is sensitive to the presence of highly conductive material and is generally considered the metal detection mode. Buried metal within 12 below surface such as steel drums, storage tanks or metallic pipes can be mapped in this mode.

The profile lines will be spaced 25 feet apart across the entire accessible area of the site. EM data points will be measured and recorded every 2.0 to 3.0 feet along the profiles. Terrain conductivity and in-phase data are recorded and stored on portable digital logging equipment. The data logger is then interfaced to a laptop computer where data are stored and backed-up on floppy disks. Data analysis requires the use of a variety of software programs where data are interpreted in both profile and plan format. The results of the EM survey will be color-contoured and presented in plan view. Two color-contoured maps will be provided of the EM31 survey results; a map of terrain conductivity and a map of in-phase (metal detection) results.

FOP 022.0

GROUNDWATER LEVEL MEASUREMENT

PURPOSE

This procedure describes the methods used to obtain accurate and consistent water level measurements in monitoring wells, piezometers and well points. Water levels will be measured at monitoring wells and, if practicable, in supply wells to estimate purge volumes associated with sampling, and to develop a potentiometric surface of the groundwater in order to estimate the direction and velocity of flow in the aquifer. Water levels in monitoring wells will be measured using an electronic water level indicator (e-line) that has been checked for operation prior to mobilization.

PROCEDURE

1. Decontaminate the e-line probe and a lower portion of cable following the procedures referenced in the Benchmark Field Operating Procedure for Non-Disposable and Non-Dedicated Sampling Equipment Decontamination. Store the e-line in a protected area until use. This may include wrapping the e-line in clean plastic until the time of use.

2. Unlock and remove the well protective cap or cover and place on clean plastic.

3. Lower the probe slowly into the monitoring well until the audible alarm sounds. This indicates the depth to water has been reached.

4. Move the cable up and down slowly to identify the depth at which the alarm just begins to sound. Measure this depth against the mark on the lip of the well riser used as a surveyed reference point (typically the north side of the riser).

5. Read depth from the graduated cable to the nearest 0.01 foot. Do not use inches. If the e-line is not graduated, use a rule or tape measure graduated in 0.01-foot increments to measure from the nearest reference mark on the e-line cable.

6. Record the water level on a Water Level Monitoring Record (sample attached).
7. Remove the probe from the well slowly, drying the cable and probe with a clean paper wipe. Be sure to repeat decontamination before use in another well.
8. Replace well plug and protective cap or cover. Lock in place as appropriate.

ATTACHMENTS

Water Level Monitoring Record (sample)

REFERENCES

Benchmark FOPs:

040 Non-Disposable and Non-Dedicated Sampling Equipment Decontamination

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WATER LEVEL MONITORING RECORD

Project Name:
Client:
Project No.:
Location:
Field Personnel:
Date:
Weather:

Well No.	Time	Top of Riser Elevation (fmsl)	Static Depth to Water (fbTOR)	Groundwater Elevation (fmsl)	Total Depth (fbTOR)	Last Total Depth Measurement (fbTOR)

Comments/Remarks:

PREAPRED BY:
DATE:

FOP 023.0

GROUNDWATER PURGING PROCEDURES PRIOR TO SAMPLE COLLECTION

PURPOSE

This procedure describes the methods for monitoring well/piezometer purging prior to groundwater sample collection in order to collect representative groundwater samples. The goal of purging is to remove stagnant, non-representative groundwater from the well and/or prevent stagnant water from entering collected samples. Purging involves the removal of at least three to five volumes of water in wells with moderate yields and at least one well volume from wells with low yields (slow water level recovery).

Purge and sample wells in order of least-to-most contaminated (this is not necessary if dedicated or disposable equipment is used). If you do not know this order, sample the upgradient wells first, then the furthest down-gradient or side-gradient wells, and finally the wells closest to, but down-gradient of the most contaminated area. Sampling should commence immediately following purging or as soon as the well has adequately recharged and not more than 24-hours following end time of evacuation.

PROCEDURE

1. Prepare the electronic water level indicator (e-line) in accordance with the procedures referenced in the Benchmark Field Operating Procedure for Groundwater Level Measurement and decontaminate the e-line probe and a lower portion of cable following the procedures referenced in the Benchmark Field Operating Procedure for Non-disposable and Non-dedicated Sampling Equipment Decontamination. Store the e-line in a protected area until use. This may include wrapping the e-line in clean plastic until the time of use.

2. Inspect the interior and exterior of the well/piezometer for signs of vandalism or damage and record condition on the Groundwater Well Purge & Sample Collection Log and/or Groundwater Well Inspection Form (samples

attached). Specifically, inspect the integrity of the following: concrete surface seal, lock, protective casing and well cover, well riser and J-plug/cap. Report any irregular findings to the Project Manager.

3. Unlock and remove the well protective cap or cover and place on clean plastic to avoid introducing foreign material into the well.

4. Calibrate the photoionization detector (PID) in accordance with the Benchmark Field Operating Procedure for Calibration and Maintenance of Portable Photoionization Detector.

5. Monitor the well for organic vapors using a PID, as per the Work Plan. If a reading of greater than 5 ppm is recorded, the well should be allowed to vent until levels drop below 5 ppm before proceeding with purging.

6. Lower the e-line probe slowly into the monitoring well and record the initial water level in accordance with the procedures referenced in the Benchmark Field Operating Procedure for Groundwater Level Measurement.

7. Following static water level determinations, slowly lower the e-line to the bottom of the well/piezometer. Record the total depth to the nearest 0.01-foot and compare to the previous total depth measurement. If a significant discrepancy exists, re-measure the total depth. Continue with purging activities observing purge water to determine whether the well/piezometer had become silted due to inactivity or damaged (i.e., well sand within purge water). Upon confirmation of the new total depth and determination of the cause (i.e., siltation or damage), notify the Project Manager following field activities.

8. Calculate the volume of water in the well based on the water level below the top of riser and the total depth of the well using the following equation:

$$V = 0.0408[(B)^2 \times \{(A) - (C)\}]$$

Where,

A = Total Depth of Well (feet below measuring point)
B = Casing diameter (inches)
C = Static Water Level (feet below measuring point)

9. **For wells where the water level is 20 feet or less below the top of riser,** a peristaltic pump may be used to purge the well. Measure the purged volume using a calibrated container (i.e., graduated 5-gallon bucket) and record measurements on the attached Groundwater Well Development and Purge Log. Use new and dedicated tubing for each well. During the evacuation of shallow wells, the intake opening of the pump tubing should be positioned just below the surface of the water. As the water level drops, lower the tubing as needed to maintain flow. For higher yielding wells, the intake level should not be lowered past the top of the screen. Pumping from the top of the water column will ensure proper flushing of the well. Continue pumping until the required volumes are removed (typically three well volumes). For higher yielding wells, adjust the purging rate to maintain the water level above the screen. For lower yielding wells or wells where the screen straddles the water table, maintain purging at a rate that matches the rate of recovery of the well (well yield). If the well purges to dryness and is slow to recharge (greater than 15 minutes), terminate evacuation.

10. **For wells where the water level is initially below 20 feet,** or drawn down to this level because of slow recharge rate, conduct purging using one of three devices listed below:

    - <u>Bailer</u> – A bottom filling dedicated polyethylene bailer attached to a length of dedicated hollow-braid polypropylene rope. Purging a well utilizing a bailer should be conducted smoothly and slowly as not to agitate the groundwater or damage the well.

    - <u>Well Wizard Purge Pump (or similar)</u> – This pneumatic bladder pump uses compressed air to push water to the surface. Groundwater is not in contact with the drive air during the pumping process, therefore the pump may be used for sample collection.

- Waterra™ Pump – This manually operated pump uses dedicated polyethylene tubing and a check valve that can be used as an optional method for purging deeper wells. The pump utilizes positive pressure to evacuate the well, therefore the pump may be used for sample collection, and however over-agitation groundwater should be avoided.

Prior to use in a well, non-dedicated bailers, exterior pump bodies and pump tubing should be cleaned in accordance with the Benchmark Field Operating Procedure for Non-Disposable and Non-Dedicated Sampling Equipment Decontamination. Dedicated and/or disposable equipment should be contained within the sealed original manufacturers packaging and certified pre-cleaned by the manufacturer with a non-phosphate laboratory detergent and rinsed using de-ionized water.

8. Purging will continue until a predetermined volume of water has been removed (typically three well volumes) or to dryness. Measurements for pH, temperature, specific conductance, dissolved oxygen (optional), Eh (optional) and turbidity will be recorded following removal of each well volume. Purge the well to dryness or until the readings for indicator parameters listed above (or well-specific indicator parameters) stabilize within the following limits for each parameter measured:

Field Parameter	Stabilization Criteria
Dissolved Oxygen	± 0.3 mg/L
Turbidity	± 10 %
Specific Conductance	± 3 %
Eh	± 10 mV
PH	± 0.1 unit

Stabilization criteria presented within the project Work Plan will take precedence.

DOCUMENTATION AND SAMPLE COLLECTION

This section pertains to the documentation of collected field data during and following purging activities and sample collection.

1. Record all data including the final three stable readings for each indicator parameter on the attached Groundwater Well Purge & Sample Log.
2. Record, at a minimum, the "volume purged," "purging stop-time," "purged dry (Y/N)," "purged below sand pack (Y/N)," and any problems purging on the attached Groundwater Well Purge & Sample Log.
3. Collect groundwater samples in accordance with the Benchmark Field Operating Procedure for Groundwater Sample Collection. Record "sample flow rate" as an average, "time sample collected," and any other pertinent information related to the sampling event on the attached Groundwater Well Purge & Sample Log.
4. Restore the well to its capped/covered and locked condition.

ALTERNATIVE METHODS

Alternative purging and sampling methods and equipment, other than those described herein are acceptable if they provide representative groundwater samples. The purging and sampling method and equipment must not adversely affect sample integrity, chemistry, temperature and turbidity. In addition, alternative equipment must have minimal or no effect on groundwater geochemistry, aquifer permeability and well materials. Equipment materials must also minimize sorption and leaching. The field team is responsible for documenting and describing any alternative equipment and procedures used to purge a well and collect samples.

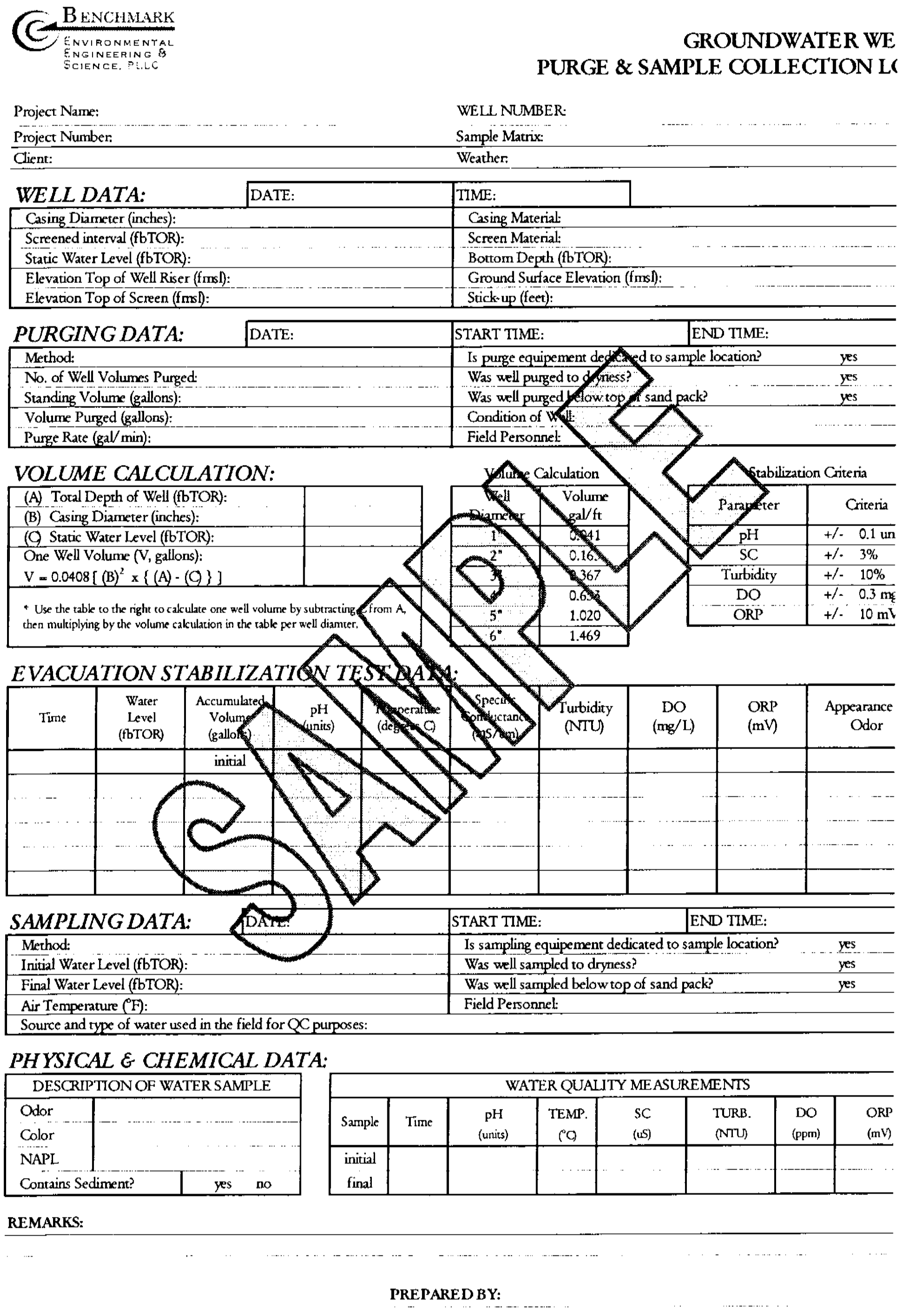
ATTACHMENTS

Groundwater Well Purge & Sample Collection Log
Groundwater Well Inspection Form

REFERENCES

Benchmark FOPs:

011	*Calibration and Maintenance of Portable Photoionization Detector*
022	*Groundwater Level Measurement*
024	*Groundwater Sample Collection Procedures*
040	*Non-disposable and Non-dedicated Sampling Equipment Decontamination*



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GROUNDWATER WE
PURGE & SAMPLE COLLECTION L

Project Name:
Project Number:
Client:
WELL NUMBER:
Sample Matrix:
Weather:

WELL DATA:

DATE:		TIME:	
Casing Diameter (inches):		Casing Material:	
Screened interval (fbTOR):		Screen Material:	
Static Water Level (fbTOR):		Bottom Depth (fbTOR):	
Elevation Top of Well Riser (fmsl):		Ground Surface Elevation (fmsl):	
Elevation Top of Screen (fmsl):		Stick-up (feet):	

PURGING DATA:

DATE:	START TIME:	END TIME:	
Method:		Is purge equipement dedicated to sample location?	yes
No. of Well Volumes Purged:		Was well purged to dryness?	yes
Standing Volume (gallons):		Was well purged below top of sand pack?	yes
Volume Purged (gallons):		Condition of Well:	
Purge Rate (gal/min):		Field Personnel:	

VOLUME CALCULATION:

(A) Total Depth of Well (fbTOR):	
(B) Casing Diameter (inches):	
(C) Static Water Level (fbTOR):	
One Well Volume (V, gallons): $V = 0.0408 [(B)^2 \times \{ (A) - (C) \}]$	

* Use the table to the right to calculate one well volume by subtracting C from A, then multiplying by the volume calculation in the table per well diamter.

Volume Calculation

Well Diameter	Volume gal/ft
1"	0.041
2"	0.163
3"	0.367
4"	0.653
5"	1.020
6"	1.469

Stabilization Criteria

Parameter	Criteria
pH	+/- 0.1 un
SC	+/- 3%
Turbidity	+/- 10%
DO	+/- 0.3 mg
ORP	+/- 10 mV

EVACUATION STABILIZATION TEST DATA:

Time	Water Level (fbTOR)	Accumulated Volume (gallons)	pH (units)	Temperature (degrees C)	Specific Conductance (uS/cm)	Turbidity (NTU)	DO (mg/L)	ORP (mV)	Appearance Odor
		initial							

SAMPLING DATA:

DATE:	START TIME:	END TIME:	
Method:		Is sampling equipement dedicated to sample location?	yes
Initial Water Level (fbTOR):		Was well sampled to dryness?	yes
Final Water Level (fbTOR):		Was well sampled below top of sand pack?	yes
Air Temperature (°F):		Field Personnel:	

Source and type of water used in the field for QC purposes:

PHYSICAL & CHEMICAL DATA:

DESCRIPTION OF WATER SAMPLE		
Odor		
Color		
NAPL		
Contains Sediment?	yes	no

WATER QUALITY MEASUREMENTS

Sample	Time	pH (units)	TEMP. (°C)	SC (uS)	TURB. (NTU)	DO (ppm)	ORP (mV)
initial							
final							

REMARKS:

PREPARED BY:

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GROUNDWATER WELL INSPECTION FORM

Project:	WELL I.D.:
Client:	
Job No.:	
Date:	
Time:	

EXTERIOR INSPECTION

Protective Casing:
Lock:
Hinge/Lid:
Concrete Surface Seal:
Bollards:
Label/I.D.:
Other:

INTERIOR INSPECTION

Well Riser:
Annular Space:
Well Cap:
Water Level (fbTOR):
Total Depth (fbTOR):
Other:

Comments/Corrective Actions:

PREPARED BY: DATE:

FOP 024.0

GROUNDWATER SAMPLE COLLECTION PROCEDURES

PURPOSE

This procedure describes the methods for collecting groundwater samples from monitoring wells and domestic supply wells following purging and sufficient recovery. This procedure also includes the preferred collection order in which water samples are collected based on the volatilization sensitivity or suite of analytical parameters required.

PROCEDURE

Allow approximately 3 to 10 days following well development before performing purge and sample activities at any well location. Conversely, perform sampling as soon as practical after sample purging at any time after the well has recovered sufficiently to sample, or within 24 hours after evacuation, if the well recharges slowly. If the well does not yield sufficient volume for all required laboratory analytical testing (including quality control), a decision should be made to prioritize analyses based on contaminants of concern at the site. If the well takes longer than 24 hours to recharge, the Project Manager should be consulted. The following two procedures outline sample collection activities for monitoring and domestic type wells.

Monitoring Wells

1. Purge the monitoring well in accordance with the Benchmark FOPs for Groundwater Purging Procedures Prior to Sample Collection or Low Flow (Minimal Drawdown) Groundwater Purging & Sampling Procedures. Perform sampling as soon as practical after purging at any time after the well has recovered sufficiently to sample, or within 24 hours after evacuation, if the well recharges slowly. If the well does not yield sufficient volume for all required laboratory analytical testing (including quality control), a decision should be made to prioritize analyses based on contaminants of concern at the site. Analyses will be prioritized in the order of the parameters volatilization sensitivity. After volatile organics have been collected, field parameters

must be measured from the next sample collected. If a well takes longer than 24 hours to recharge, the Project Manager should be consulted.

2. Sampling equipment that is not disposable or dedicated to the well will be decontaminated in accordance with the Benchmark Field Operating Procedure for Non-Disposable and Non-Dedicated Sampling Equipment Decontamination.

3. Calibrate all field meters (i.e., pH/Eh, turbidity, specific conductance, dissolved oxygen, PID etc.) in accordance with the Benchmark Field Operating Procedure for Calibration and Maintenance of the specific field meter.

4. Prepare the electronic water level indicator (e-line) in accordance with the procedures referenced in the Benchmark Field Operating Procedure for Groundwater Level Measurement and decontaminate the e-line probe and a lower portion of cable following the procedures referenced in the Benchmark Field Operating Procedure for Non-disposable and Non-dedicated Sampling Equipment Decontamination. Store the e-line in a protected area until use. This may include wrapping the e-line in clean plastic until the time of use.

5. Inspect the well/piezometer for signs of vandalism or damage and record condition on the Groundwater Well Purge & Sample Collection Log (sample attached). Specifically, inspect the integrity of the following: concrete surface seal, lock, protective casing and well cover, well casing and J-plug/cap. Report any irregular findings to the Project Manager.

6. Unlock and remove the well protective cap or cover and place on clean plastic to avoid introducing foreign material into the well.

7. Calibrate the photoionization detector (PID) in accordance with the Benchmark Field Operating Procedure for Calibration and Maintenance of Portable Photoionization Detector.

8. Monitor the well for organic vapors using a PID, as per the Work Plan. If a reading of greater than 5 ppm is recorded, the well should be allowed to vent until levels drop below 5 ppm before proceeding with purging. Record PID measurements on a well-specific Groundwater Well Purge & Sample Collection Log (sample attached).

9. Lower the e-line probe slowly into the monitoring well and record the measurement on a well-specific Groundwater Well Purge & Sample Collection Log (sample attached).

10. Groundwater samples will be collected directly from the sampling valve on the flow through cell (low-flow), discharge port of a standard pump assembly (peristaltic, pneumatic, submersible, or Waterra™ pump) or bailer (stainless steel, PVC or polyethylene) into appropriate laboratory provided containers. In low-yielding wells at which the flow through cell is not used, the samples may be collected using a disposable bailer.

11. If disposable polyethylene bailers are used, the bailer should be lowered *slowly* below the surface of the water to minimize agitation and volatilization. For wells that are known to produce turbid samples (values greater than 50 NTU), the bailer should be lowered and retrieved at a rate that limits surging of the well.

12. Sampling data will be recorded on a Groundwater Well Purge & Sample Collection Log (sample attached).

13. Pre-label all sample bottles in the field using a waterproof permanent marker in accordance with the Benchmark Sample Labeling, Storage and Shipment FOP. The following information, at a minimum, should be included on the label:

    - Project Number;
    - Sample identification code (as per project specifications);
    - Date of sample collection (mm, dd, yy);
    - Time of sample collection (military time only) (hh:mm);
    - Specify "grab" or "composite" sample type;
    - Sampler initials;
    - Preservative(s) (if applicable); and
    - Analytes for analysis (if practicable).

14. Collect a separate sample of approximately 200 ml into an appropriate container prior to collecting the first and following the last groundwater sample collected to measure the following field parameters:

Parameter	Units
Dissolved Oxygen	parts per million (ppm)
Specific Conductance	mmhos/cm or mS or mS
pH	pH units
Temperature	°C or °F
Turbidity	NTU
Eh (*optional*)	mV
PID VOCs (*optional*)	ppm

Record all field measurements on a Groundwater Well Purge & Sample Collection Log (sample attached).

15. Collect samples into pre-cleaned bottles provided by the analytical laboratory with the appropriate preservative(s) added based on the volatilization sensitivity or suite of analytical parameters required, as designated in the **Sample Collection Order** section below.

16. Lower the e-line probe slowly into the monitoring well and record the measurement on a well-specific Groundwater Well Purge & Sample Collection Log (sample attached).

17. The samples will be labeled, stored and shipped in accordance with the Benchmark Field Operating Procedure for Sample Labeling, Storage and Shipment Procedures.

Domestic Supply Wells

1. Calculate or estimate the volume of water in the well. It is desirable to purge at least one casing volume before sampling. This is controlled, to some extent, by the depth of the well, well yield and the rate of the existing pump. If the volume of water in the well cannot be calculated, the well should be purged continuously for no less than 15 minutes.

2. Connect a sampling tap to an accessible fitting between the well and the pressure tank where practicable. A hose will be connected to the device and the hose discharge located 25 to 50 feet away. The well will be allowed to pump until the lines and one well volume is removed. Flow rate will be measured with a container of known volume and a stopwatch.

3. Place a clean piece of polyethylene or Teflon™ tubing on the sampling port and collect the samples in the order designated below and in the sample containers supplied by the laboratory for the specified analytes. *DO NOT* use standard garden hose to collect samples.

4. Sampling results and measurements will be recorded on a Groundwater Well Purge & Sample Collection Log (sample attached) as described in the previous section.

5. Collect samples into pre-cleaned bottles provided by the analytical laboratory with the appropriate preservative(s) added based on the volatilization sensitivity or suite of analytical parameters required, as designated in the **Sample Collection Order** section below.

6. The samples will be labeled, stored and shipped in accordance with the Benchmark Field Operating Procedure for Sample Labeling, Storage and Shipment Procedures.

SAMPLE COLLECTION ORDER

All groundwater samples, from monitoring wells and domestic supply wells, will be collected in accordance with the following.

1. Samples will be collected preferentially in recognition of volatilization sensitivity. The preferred order of sampling if no free product is present is:
    - Field parameters
    - Volatile Organic Compounds (VOCs)
    - Purgeable organic carbons (POC)
    - Purgeable organic halogens (POH)
    - Total Organic Halogens (TOX)
    - Total Organic Carbon (TOC)

- Extractable Organic Compounds (i.e., BNAs, SVOCs, etc.)
- Total petroleum hydrocarbons (TPH) and oil and grease
- PCBs and pesticides
- Total metals (Dissolved Metals)
- Total Phenolic Compounds
- Cyanide
- Sulfate and Chloride
- Turbidity
- Nitrate (as Nitrogen) and Ammonia
- Preserved inorganics
- Radionuclides
- Unpreserved inorganics
- Bacteria
- Field parameters

2. Document the sampling procedures and related information in the Project Field Book and on a Groundwater Well Purge & Sample Collection Log (sample attached).

DOCUMENTATION

The three words used to ensure adequate documentation for groundwater sampling are accountability, controllability, and traceability. Accountability is undertaken in the sampling plan and answers the questions who, what, where, when, and why to assure that the sampling effort meets its goals. Controllability refers to checks (including QA/QC) used to ensure that the procedures used are those specified in the sampling plan. Traceability is documentation of what was done, when it was done, how it was done, and by whom it was done, and is found in the field forms, Project Field Book, and chain-of-custody forms. At a minimum, adequate documentation of the sampling conducted in the field consists of an entry in the Project Field Book (with sewn binding), field data sheets for each well, and a chain-of-custody form.

As a general rule, if one is not sure whether the information is necessary, it should nevertheless be recorded, as it is impossible to over-document one's fieldwork. Years may go by before the documentation comes under close scrutiny, so the documentation must be capable of defending the sampling effort without the assistance or translation of the sampling crew.

The minimum information to be recorded daily with an indelible pen in the Project Field Book and/or field data sheets includes date and time(s), name of the facility, name(s) of the sampling crew, site conditions, the wells sampled, a description of how the sample shipment was handled, and a QA/QC summary. After the last entry for the day in the Project Field Book, the Field Team Leader should sign the bottom of the page under the last entry and then draw a line across the page directly under the signature.

PRECAUTIONS/RECOMMENDATIONS

The following precautions should be adhered to prior to and during sample collection activities:

- Field vehicles should be parked downwind (to avoid potential sample contamination concerns) at a minimum of 15 feet from the well and the engine turned off prior to PID vapor analysis and VOC sample collection.
- Ambient odors, vehicle exhaust, precipitation, or windy/dusty conditions can potentially interfere with obtaining representative samples. These conditions should be minimized and should be recorded in the field notes. Shield sample bottles from strong winds, rain, and dust when being filled.

- The outlet from the sampling device should discharge below the top of the sample's air/water interface, when possible. The sampling plan should specify how the samples will be transferred from the sample collection device to the sample container to minimize sample alterations.

- The order of sampling should be from the least contaminated to the most contaminated well to reduce the potential for cross contamination of sampling equipment (see the Sampling Plan or Work Plan).

- Samples should not be transferred from one sampling container to another.

- Sampling equipment must not be placed on the ground, because the ground may be contaminated and soil contains trace metals. Equipment and supplies should be removed from the field vehicle only when needed.

- Smoking and eating should not be allowed until the well is sampled and hands are washed with soap and water, due to safety and possibly sample contamination concerns. These activities should be conducted beyond a 15-foot radius of the well.

- No heat-producing or electrical instruments should be within 15 feet of the well, unless they are intrinsically safe, prior to PID vapor analysis.

- Minimize the amount of time that the sample containers remain open.

- Do not touch the inside of sample bottles or the groundwater sample as it enters the bottle. Disposable gloves may be a source of phthalates, which could be introduced into groundwater samples if the gloves contact the sample.

- Sampling personnel should use a new pair of disposable gloves for each well sampled to reduce the potential for exposure of the sampling personnel to contaminants and to reduce sample cross contamination. In addition, sampling personnel should change disposable gloves between purging and sampling operations at the same well.

- Sampling personnel should not use perfume, insect repellent, hand lotion, etc., when taking groundwater samples. If insect repellent must be used, then sampling personnel should not allow samples or sampling equipment to contact the repellent, and it should be noted in the documentation that insect repellent was used.
- Complete the documentation of the well. A completed assemblage of paperwork for a sampling event includes the completed field forms, entries in the Project Field Book (with a sewn binding), transportation documentation (if required), and possibly chain-of-custody forms.

ATTACHMENTS

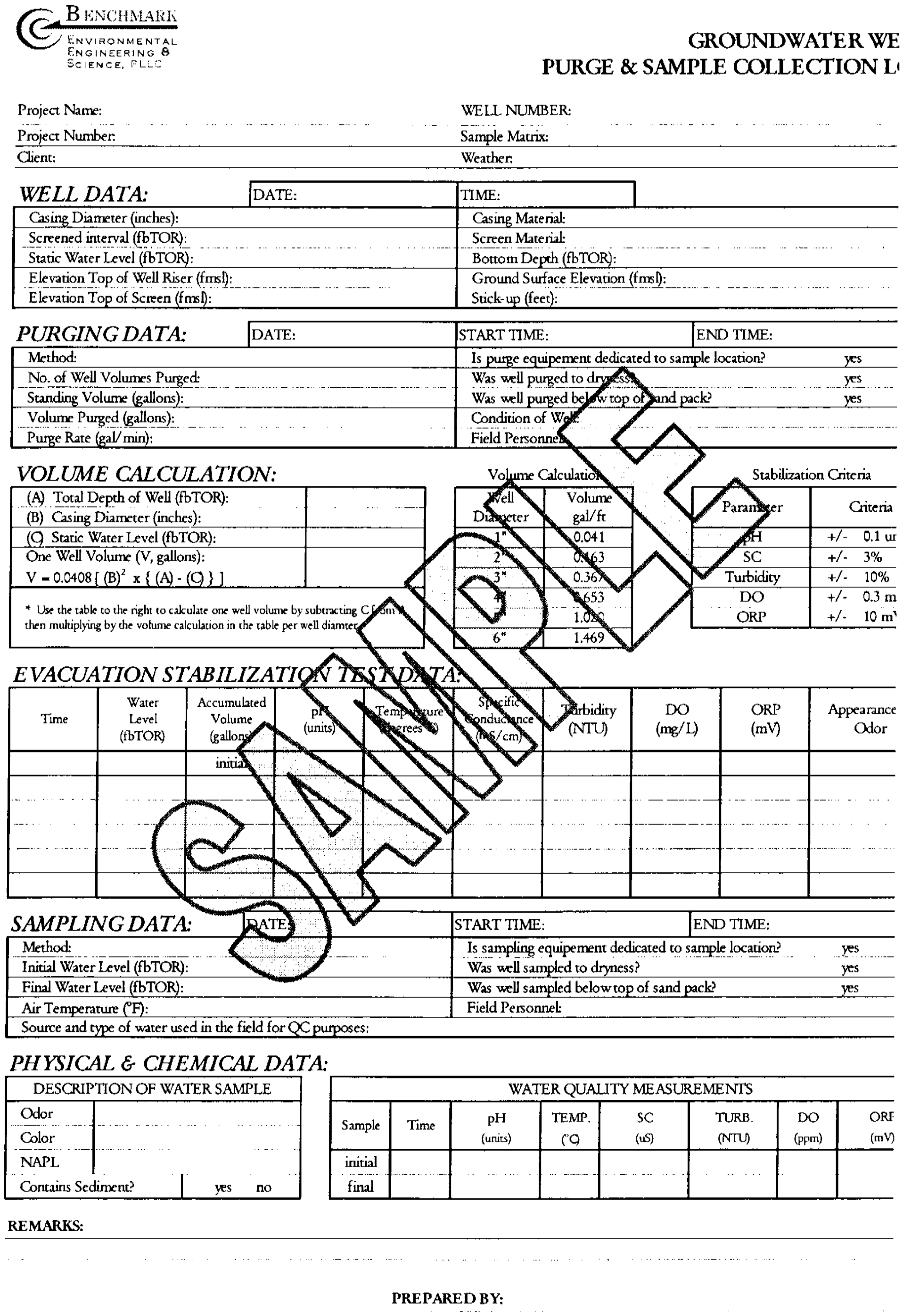
Groundwater Well Purge & Sample Collection Log (sample)

REFERENCES

1. Wilson, Neal. *Soil Water and Ground Water Sampling*, 1995

Benchmark FOPs:

007 Calibration and Maintenance of Portable Dissolved Oxygen Meter
008 Calibration and Maintenance of Portable Field pH/Eh Meter
009 Calibration and Maintenance of Portable Field Turbidity Meter
011 Calibration and Maintenance of Portable Photoionization Detector
012 Calibration and Maintenance of Portable Specific Conductance Meter
022 Groundwater Level Measurement
023 Groundwater Purging Procedures Prior to Sample Collection (optional)
031 Low Flow (Minimal Drawdown) Groundwater Purging & Sampling Procedures (optional)
040 Non-Disposable and Non-Dedicated Sampling Equipment Decontamination
046 Sample Labeling, Storage and Shipment Procedures



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Project Name:	WELL NUMBER:
Project Number:	Sample Matrix:
Client:	Weather:

WELL DATA: DATE: TIME:

Casing Diameter (inches):	Casing Material:
Screened interval (fbTOR):	Screen Material:
Static Water Level (fbTOR):	Bottom Depth (fbTOR):
Elevation Top of Well Riser (fmsl):	Ground Surface Elevation (fmsl):
Elevation Top of Screen (fmsl):	Stick-up (feet):

PURGING DATA: DATE: START TIME: END TIME:

Method:	Is purge equipement dedicated to sample location?	yes
No. of Well Volumes Purged:	Was well purged to dryness?	yes
Standing Volume (gallons):	Was well purged below top of sand pack?	yes
Volume Purged (gallons):	Condition of Well:	
Purge Rate (gal/min):	Field Personnel:	

VOLUME CALCULATION:

(A) Total Depth of Well (fbTOR):	
(B) Casing Diameter (inches):	
(C) Static Water Level (fbTOR):	
One Well Volume (V, gallons): $V = 0.0408 [(B)^2 \times \{ (A) - (C) \}]$	

* Use the table to the right to calculate one well volume by subtracting C from A then multiplying by the volume calculation in the table per well diamter.

Volume Calculation

Well Diameter	Volume gal/ft
1"	0.041
2"	0.163
3"	0.367
4"	0.653
5"	1.020
6"	1.469

Stabilization Criteria

Parameter	Criteria
pH	+/- 0.1 u
SC	+/- 3%
Turbidity	+/- 10%
DO	+/- 0.3 m
ORP	+/- 10 m

EVACUATION STABILIZATION TEST DATA:

Time	Water Level (fbTOR)	Accumulated Volume (gallons)	pH (units)	Temperature (degrees C)	Specific Conductance (mS/cm)	Turbidity (NTU)	DO (mg/L)	ORP (mV)	Appearance Odor
		initial							

SAMPLING DATA: DATE: START TIME: END TIME:

Method:	Is sampling equipement dedicated to sample location?	yes
Initial Water Level (fbTOR):	Was well sampled to dryness?	yes
Final Water Level (fbTOR):	Was well sampled below top of sand pack?	yes
Air Temperature (°F):	Field Personnel:	
Source and type of water used in the field for QC purposes:		

PHYSICAL & CHEMICAL DATA:

DESCRIPTION OF WATER SAMPLE		
Odor		
Color		
NAPL		
Contains Sediment?	yes	no

WATER QUALITY MEASUREMENTS

Sample	Time	pH (units)	TEMP. (°C)	SC (uS)	TURB. (NTU)	DO (ppm)	ORP (mV)
initial							
final							

REMARKS:

PREPARED BY:

FOP 026.0

HOLLOW STEM AUGER (HSA) DRILLING PROCEDURES

PURPOSE

This guideline presents a method for drilling a borehole through unconsolidated materials, including soils or overburden, and consolidated materials, including bedrock.

PROCEDURE

The following procedure will be used to drill a borehole for sampling and/or well installation, using hollow-stem auger methods and equipment.

1. Follow Benchmark's Field Operating Procedure for Drill Site Selection Procedure prior to implementing any drilling activity.
2. Perform drill rig safety checks with the driller by completing the Drilling Safety Checklist form (sample attached).
3. Conduct tailgate health and safety meeting with project team and drillers by completing the Tailgate Safety Meeting Form.
4. Calibrate air-monitoring equipment in accordance with the appropriate Benchmark's Field Operating Procedures or manufacturers recommendations for calibration of field meters.
5. Ensure all drilling equipment (i.e., augers, rods, split-spoons) appear clean and free of soil prior to initiating any subsurface intrusion. Decontamination of drilling equipment should be in accordance with Benchmark's FOP: Drilling and Excavation Equipment Decontamination Procedures.
6. Mobilize the auger rig to the site and position over the borehole.
7. Level and stabilize the rig using the rig jacks, and recheck the rig location against the planned drilling location. If necessary, raise the jacks and adjust the rig position.

8. Place a metal or plywood auger pan over the borehole location to collect the auger cuttings. This auger pan will be equipped with a 12-inch nominal diameter hole for auger passage. As an alternative, a piece of polyethylene tarp may be used as a substitute.

9. Advance augers into the subsurface. For sampling or pilot-hole drilling, nominal 8-inch outside diameter (OD) augers should be used. The boring diameter will be approved by the Benchmark field supervisor.

10. Collect soil samples via split spoon sampler in accordance with Benchmark's Field Operating Procedure for Split Spoon Sampling.

11. Check augers periodically during drilling to ensure the boring is plumb. Adjust rig position as necessary to maintain plumb.

12. Continue drilling until reaching the assigned total depth, or until auger refusal occurs. Auger refusal is when the drilling penetration drops below 0.1 feet per 10 minutes, with the full weight of the rig on the auger bit, and a center bit (not center plug) in place.

13. Plug and abandon boreholes not used for well installation in accordance with Benchmark's Field Operating Procedure for Abandonment of Borehole.

OTHER PROCEDURAL ISSUES

- Slip rings may be used for lifting a sampling or bit string. The string will not be permitted to extend more than 15 feet above the mast crown.

- Borings will not be over drilled (rat holed) without the express permission of the Benchmark field supervisor. All depth measurements should be accurate to the nearest 0.1 foot, to the extent practicable.

- Potable water may be placed in the auger stem if critically necessary for borehole control or to accomplish sampling objectives. This will be performed only with the express permission of the Benchmark field supervisor.

ATTACHMENTS

Drilling Safety Checklist (sample)
Tailgate Safety Meeting Form (sample)

REFERENCES

Benchmark FOPs:

001	*Abandonment of Borehole Procedures*
010	*Calibration and Maintenance of Portable Flame Ionization Detector*
011	*Calibration and Maintenance of Portable Photoionization Detector*
017	*Drill Site Selection Procedure*
018	*Drilling and Excavation Equipment Decontamination Procedures*
058	*Split Spoon Sampling Procedures*

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DRILLING SAFETY CHECKLIST

Project: **Supplemental Phase II RFI/ICMs**
Date:
Project No.: 0041-009-500
Drilling Company:
Client: **RealCo., Inc.**
Drill Rig Type:

ITEMS TO CHECK	OK	ACTION NEEDED
"Kill switches" installed by the manufacturer are in operable condition and all workers at the drill site are familiar with their location and how to activate them?		
"Kill switches" are accessible to workers on both sides of the rotating stem? NOTE: Optional based on location and number of switches provided by the manufacturer.		
Cables on drill rig are free of kinks, frayed wires, "bird cages" and worn or missing sections?		
Cables are terminated at the working end with a proper eye splice, either swaged Coupling or using cable clamps?		
Cable clamps are installed with the saddle on the live or load side? Clamps should not be alternated and should be of the correct size and number for the cable size to which it is installed. Clamps are complete with no missing parts?		
Hooks installed on hoist cables are the safety type with a functional latch to prevent accidental separation?		
Safety latches are functional and completely span the entire throat of the hook and have positive action to close the throat except when manually displaced for connecting or disconnecting a load?		
Drive shafts, belts, chain drives and universal joints shall be guarded to prevent accidental insertion of hands and fingers or tools.		
Outriggers shall be extended prior to and whenever the boom is raised off its cradle. Hydraulic outriggers must maintain pressure to continuously support and stabilize the drill rig even while unattended.		
Outriggers shall be properly supported on the ground surface to prevent settling into the soil.		
Controls are properly labeled and have freedom of movement. Controls should not be blocked or locked in an action position.		
Safeties on any device shall not be bypassed or neutralized.		
Controls shall be operated smoothly and cables and lifting devices shall not be jerked or operated erratically to overcome resistance.		
Slings, chokers and lifting devices are inspected before using and are in proper working order? Damaged units are removed from service and are properly tagged?		
Shackles and clevises are in proper working order and pins and screws are fully inserted before placing under a load?		
High-pressure hoses have a safety (chain, cable or strap) at each end of the hose section to prevent whipping in the event of a failure?		
Rotating parts of the drill string shall be free of sharp projections or hooks, which could entrap clothing or foreign objects?		
Wire ropes should not be allowed to bend around sharp edges without cushion material.		
The exclusion zone is centered over the borehole and the radius is equal or greater than the boom height?		

ITEMS TO CHECK	OK	ACTION

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DRILLING SAFETY CHECKLIST

Project: **Supplemental Phase II RFI/ICMs**
Date:
Project No.: 0041-009-500
Drilling Company:
Client: **RealCo., Inc.**
Drill Rig Type:

ITEMS TO CHECK	OK	ACTION NEEDED
The work area around the borehole shall be kept clear of trip hazards and walking surfaces should be free of slippery material.		
Workers shall not proceed higher than the drilling deck without a fall restraining device and must attach the device in a manner to restrict fall to less than 6 feet.		
A fire extinguisher of appropriate size shall be immediately available to the drill crew. The drill crew shall have received annual training on proper use of the fire extinguisher.		
29 CFR 1910.333 © (3) Except where electrical distribution and transmission lines have been de-energized and visibly grounded, drill rigs will be operated proximate to, under, by, or near power lines only in accordance with the following: .333 © (3) (ii) 50 kV or less -minimum clearance is 10 ft. For 50 kV or over - 10ft. Plus ½ in. For each additional kV **Benchmark Policy: Maintain 20 feet clearance**		
29 CFR 1910.333 © (3) (iii) While the rig is in transit with the boom in the down position, clearance from energized power lines will be maintained as follows: Less than 50 kV - 4 feet 50 to 365 kV - 10 feet 365 to 720 kV - 16 feet		

Name: ______________________ (printed)

Signed: ______________________ Date: ______________

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TAILGATE SAFETY MEETING FORM

Project Name: Date: Time:
Project Number: Client:
Work Activities:

HOSPITAL INFORMATION:

Name:
Address: *City* *State:* *Zip:*
Phone No.: *Ambulance Phone No.*

SAFETY TOPICS PRESENTED:

Chemical Hazards:

Physical Hazards: Slips, Trips, Falls

PERSONAL PROTECTIVE EQUIPMENT:

Activity *PPE Level:* A B C D
Activity *PPE Level:* A B C D
Activity *PPE Level:* A B C D
Activity *PPE Level:* A B C D
Activity *PPE Level:* A B C D

New Equipment:

Other Safety Topic(s): Environmental Hazards (aggressive fauna)
Eating, drinking, use of tobacco products is prohibited in the Exclusion Zone (EZ)

ATTENDEES

Name Printed	Signatures

Meeting conducted by:

FOP 031.0

LOW FLOW (MINIMAL DRAWDOWN) GROUNDWATER PURGING & SAMPLING PROCEDURES

PURPOSE

This procedure describes the methods used for performing low flow (minimal drawdown) purging, also referred to as micro-purging, at a well prior to groundwater sampling to obtain a representative sample from the water-bearing zone. This method of purging is used to minimize the turbidity of the produced water. This may increase the representativeness of the groundwater samples by avoiding the necessity of filtering suspended solids in the field prior to preservation of the sample.

Well purging is typically performed immediately preceding groundwater sampling. The sample should be collected as soon as the parameters measured in the field (i.e., pH, specific conductance, dissolved oxygen, Eh, temperature, and turbidity) have stabilized.

PROCEDURE

1. Water samples should not be taken immediately following well development. Sufficient time should be allowed to stabilize the groundwater flow regime in the vicinity of the monitoring well. This lag time will depend on site conditions and methods of installation but may exceed one week.

2. Prepare the electronic water level indicator (e-line) in accordance with the procedures referenced in the Benchmark's Groundwater Level Measurement FOP and decontaminate the e-line probe and a lower portion of cable following the procedures referenced in the Benchmark's Non-disposable and Non-dedicated Sampling Equipment Decontamination FOP. Store the e-line in a protected area until use. This may include wrapping the e-line in clean plastic until the time of use.

3. Calibrate all sampling devices and monitoring equipment in accordance with manufacturer's recommendations, the site Quality Assurance Project Plan (QAPP) and/or Field Sampling Plan (FSP). Calibration of field

instrumentation should be followed as specified in Benchmark's Calibration and Maintenance FOP for each individual meter.

4. Inspect the well/piezometer for signs of vandalism or damage and record condition on the Groundwater Well Purge & Sample Collection Log form (sample attached). Specifically, inspect the integrity of the following: concrete surface seal, lock, protective casing and well cover, well casing and J-plug/cap. Report any irregular findings to the Project Manager.

5. Unlock and remove the well protective cap or cover and place on clean plastic to avoid introducing foreign material into the well.

6. Monitor the well for organic vapors using a PID, as per the Work Plan. If a reading of greater than 5 ppm is recorded, the well should be allowed to vent until levels drop below 5 ppm before proceeding with purging.

7. Lower the e-line probe slowly into the monitoring well and record the initial water level in accordance with the procedures referenced in Benchmark's Groundwater Level Measurement FOP. Refer to the construction diagram for the well to identify the screened depth.

8. Decontaminate all non-dedicated pump and tubing equipment following the procedures referenced in the Benchmark's Non-disposable and Non-dedicated Sampling Equipment Decontamination FOP.

9. Lower the purge pump or tubing (i.e., low-flow electrical submersible, peristaltic, etc.) <u>slowly</u> into the well until the pump/tubing intake is approximately in the middle of the screened interval. Rapid insertion of the pump will increase the turbidity of well water, and can increase the required purge time. This step can be eliminated if dedicated tubing is already within the well.

   Placement of the pump close to the bottom of the well will cause increased entrainment of solids, which may have settled in the well over time. Low-flow purging has the advantage of minimizing mixing between the overlying stagnant casing water and water within the screened interval. The objective of low-flow purging is to maintain a purging rate, which minimizes stress (drawdown) of the water level in the well. Low-flow refers to the velocity with which water enters the pump intake and that is imparted to the formation pore water in the immediate vicinity of the well screen.

10. Lower the e-line back down the well as water levels will be frequently monitored during purge and sample activities.

11. Begin pumping to purge the well. The pumping rate should be between 100 and 500 milliliters (ml) per minute (0.03 to 0.13 gallons per minute) depending on site hydrogeology. Periodically check the well water level with the e-line adjusting the flow rate as necessary to stabilize drawdown within the well. If possible, a steady flow rate should be maintained that results in a stabilized water level (drawdown of 0.3 feet or less). If the water level exceeds 2 feet below static and declining, slow the purge rate until the water level generally stabilizes. Record each pumping rate and water level during the event.

    The low flow rate determined during purging will be maintained during the collection of analytical samples. At some sites where geologic heterogeneities are sufficiently different within the screened interval, high conductivity zones may be preferentially sampled.

12. Measure and record field parameters (pH, specific conductance, Eh, dissolved oxygen (DO), temperature, and turbidity) during purging activities. In lieu of measuring all of the parameters, a minimum subset could be limited to pH, specific conductance, and turbidity or DO.

    Water quality indicator parameters should be used to determine purging needs prior to sample collection in each well. Stabilization of indicator parameters should be used to determine when formation water is first encountered during purging. In general, the order of stabilization is pH, temperature, and specific conductance, followed by Eh, DO and turbidity. Performance criteria for determination of stabilization should be based on water-level drawdown, pumping rate and equipment specifications for measuring indicator parameters. An in-line flow through cell to continuously measure the above parameters may be used. The in-line device should be disconnected or bypassed during sample collection.

13. Purging will continue until parameters of water quality have stabilized. Record measurements for field indicator parameters (including water levels) at regular intervals during purging. The stability of these parameters with time can be used to guide the decision to discontinue purging. Proper adjustments must be made to stabilize the flow rate as soon as possible.

14. Record well purging and sampling data in the Project Field Book or on the attached Groundwater Well Purge & Sample Collection Log (sample attached). Measurements should be taken approximately every three to five minutes, or as merited given the rapidity of change.

15. Purging is complete when field indicator parameters stabilize. Stabilization is achieved after all field parameters have stabilized for three successive readings. Three successive readings should be within ± 0.1 units for pH, ± 3% for specific conductance, ± 10 mV for Eh, and ± 10% for turbidity and dissolved oxygen. These stabilization guidelines are provided for rough estimates only, actual site-specific knowledge may be used to adjust these requirements higher or lower.

    An in-line water quality measurement device (e.g., flow-through cell) should be used to establish the stabilization time for several field parameters on a well-specific basis. Data on pumping rate, drawdown and volume required for parameter stabilization can be used as a guide for conducting subsequent sampling activities.

16. Collect all project-required samples from the discharge tubing at the flow rate established during purging in accordance with Benchmark's Groundwater Sample Collection Procedures FOP. **If a peristaltic pump and dedicated tubing is used, collect all project-required samples from the discharge tubing as stated before, however volatile organic compounds should be collected in accordance with the procedure presented in the next**

section. Continue to maintain a constant flow rate such that the water level is not drawn down as described above. Fill sample containers with minimal turbulence by allowing the ground water to flow from the tubing along the inside walls of the container.

17. If field filtration is recommended as a result of increased turbidity, an in-line filter equipped with a 0.45-micron filter should be utilized.

18. Replace the dedicated tubing down the well taking care to avoid contact with the ground surface.

19. Restore the well to its capped/covered and locked condition.

20. Upon purge and sample collection completion, slowly lower the e-line to the bottom of the well/piezometer. Record the total depth to the nearest 0.01-foot and compare to the previous total depth measurement. If a significant discrepancy exists, re-measure the total depth. Record observations of purge water to determine whether the well/piezometer had become silted due to inactivity or damaged (i.e., well sand within purge water). Upon confirmation of the new total depth and determination of the cause (i.e., siltation or damage), notify the Project Manager following project field activities.

PERISTALTIC PUMP VOC SAMPLE COLLECTION PROCEDURE

The collection of VOCs from a peristaltic pump and dedicated tubing assembly shall be collected using the following procedure.

1. Once all other required sample containers have been filled, turn off the peristaltic pump. The negative pressure effects of the pump head have not altered groundwater remaining within the dedicated tubing assembly and as such, this groundwater can be collected for VOC analysis.

2. While maintaining the pressure on the flexible tubing within the pump head assembly, carefully remove and coil the polyethylene tubing from the well; taking care to prevent the tubing from coming in contact with the ground

surface and without allowing groundwater to escape or drain from the tubing intake.

3. Once the polyethylene tubing is removed, turn the variable speed control to zero and reverse the pump direction.

4. Slowly increase the pump rate allowing the groundwater within the polyethylene tubing to be "pushed" out of the intake end (i.e., positive displacement) making sure the groundwater within the tubing is not "pulled" through the original discharge end (i.e., negative displacement). Groundwater pulled through the pump head assembly CANNOT be collected for VOC analysis.

5. Slowly fill each VOC vial by holding the vial at a 45-degree angle and allowing the flowing groundwater to cascade down the side until the vial is filled with as minimal disturbance as possible. As the vial fills, slowly rotate the vial to vertical. **DO NOT OVERFILL THE VIAL, AS THE PRESERVATIVE WILL BE LOST.** The vial should be filled only enough so that the water creates a slight meniscus at the vial mouth.

6. Cap the VOC vials leaving no visible headspace (i.e., air-bubbles). Gently tap each vial against your hand checking for air bubbles.

7. If an air bubble is observed, slowly remove the cap and repeat Steps 5 and 6.

ATTACHMENTS

Groundwater Well Purge & Sample Collection Log (sample)

REFERENCES

United States Environmental Protection Agency, 540/S-95/504, 1995. *Low Flow (Minimal Drawdown) Ground-Water Sampling Procedures.*

Benchmark FOPs:

007	*Calibration and Maintenance of Portable Dissolved Oxygen Meter*
008	*Calibration and Maintenance of Portable Field pH/Eh Meter*
009	*Calibration and Maintenance of Portable Field Turbidity Meter*
011	*Calibration and Maintenance of Portable Photoionization Detector*
012	*Calibration and Maintenance of Portable Specific Conductance Meter*
022	*Groundwater Level Measurement*
024	*Groundwater Sample Collection Procedures*
040	*Non-Disposable and Non-Dedicated Sampling Equipment Decontamination*
046	*Sample Labeling, Storage and Shipment Procedures*

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LOW FLOW METHOD GROUNDWATER PURGE & SAMPLE COLLECTION LOG

Project Name:	WELL LOCATION:
Project Number:	Sample Matrix: groundwater
Client:	Weather:

WELL DATA:

	DATE:	TIME:
Casing Diameter (inches):	Casing Material:	
Screened interval (fbTOR):	Screen Material:	
Static Water Level (fbTOR):	Bottom Depth (fbTOR):	
Elevation Top of Well Riser (fmsl):	Ground Surface Elevation (fmsl):	
Elevation Top of Screen (fmsl):	Stick-up (feet):	
Standing volume in gallons: [(bottom depth - static water level) x vol calculation in table per well diameter]:		

Volume Calculation

Well Diameter	Volume gal/ft
1"	0.041
2"	0.163
3"	0.367
4"	0.653
5"	1.020
6"	1.469

PURGING DATA:

Pump Type:

Is equipment dedicated to location? yes no	Is tubing dedicated to location? yes no
Depth of Sample (i.e. Level of Intake) (fbTOR):	Approximate Purge Rate (gal/min):

Time	Water Level (fbTOR)	Accumulated Volume (gallons)	pH (units)	Temperature (degrees C)	Specific Conductance (mS/cm)	Turbidity (NTU)	DO (mg/L)	ORP (mV)	Appearance & Odor
	Initial								

SAMPLING DATA:

DATE:	START TIME:	END TIME:
Method: low-flow with dedicated tubing	Was well sampled to dryness? yes no	
Initial Water Level (fbTOR):	Was well sampled below top of sand pack? yes no	
Final Water Level (fbTOR):	Field Personnel:	

PHYSICAL & CHEMICAL DATA:

	WATER QUALITY MEASUREMENTS					
Appearance:	pH (units)	TEMP. (°C)	SC (uS)	TURB. (NTU)	DO (ppm)	ORP (mV)
Color:						
Odor:						
Sediment Present?						

REMARKS:

PREPARED BY:

MANAGEMENT OF INVESTIGATION-DERIVED WASTE (IDW)

PURPOSE

The purpose of these guidelines is to ensure the proper holding, storage, transportation, and disposal of materials generated from field investigation activities that may contain hazardous wastes. Investigation-derived waste (IDW) include the following:

- Drill cuttings, discarded soil samples, drilling mud solids, and used sample containers.
- Well development and purge waters and discarded groundwater samples.
- Decontamination waters and associated solids.
- Soiled disposable personal protective equipment (PPE).
- Used disposable sampling equipment.
- Used plastic sheeting and aluminum foil.
- Other equipment or materials that either contain or have been in contact with potentially impacted environmental media.

Because these materials may contain regulated chemical constituents, they must be managed as a solid waste. This management may be terminated if characterization analytical results indicate the absence of these constituents.

PROCEDURE

1. Contain all investigation-derived wastes in Department of Transportation (DOT)-approved 55-gallon drums, roll-off boxes, or other containers suitable for the wastes.

2. Contain wastes from separate borings or wells in separate containers (i.e. do not combine wastes from several borings/wells in a single container, unless it is a container used specifically for transfer purposes, or unless specific permission to do so has been provided by the Benchmark Field Team Leader. Unused samples from surface sample locations within a given area may be combined.

3. To the extent practicable, separate solids from drilling muds, decontamination waters, and similar liquids. Place solids within separate containers.

4. Transfer all waste containers to a staging area. Access to this area will be controlled. Waste containers must be transferred to the staging area as soon as practicable after the generating activity is complete.

5. Pending transfer, all containers will be covered and secured when not immediately attended.

6. Label all containers with regard to contents, origin, date of generation, using Benchmark's IDW container label (sample attached). Use indelible ink for all labeling.

7. Complete the Investigative Derived Waste Container Log (sample attached) as waste containers are labeled in order to track and inventory project waste. Leave a copy of the log with the site manager or fax copy to the owner/operator as necessary.

8. Collect samples for waste characterization purposes, or use boring/well sample analytical data for characterization.

9. For wastes determined to be hazardous in character, **be aware of accumulation time limitations**. Coordinate the disposal of these wastes with the plant manager/owner/operator, if applicable.

10. Dispose of investigation-derived wastes as follows:
    - Soil, water, and other environmental media for which analysis does not detect organic constituents, and for which inorganic constituents are at

levels consistent with background, may be spread on the Property or otherwise treated as a non-waste material as directed by the plant manager/owner/operator or Project Manager.

- Soils, water, and other environmental media in which organic compounds are detected or metals are present above background will be disposed as industrial waste. Alternate disposition must be consistent with applicable State and Federal laws.
- Personal protective equipment, disposable bailers, and similar equipment may be disposed as municipal waste, unless waste characterization results mandate disposal as industrial wastes.

WASTE STORAGE MANAGEMENT

Hazardous materials generated on site should be temporarily stored in a secure location that is under the control of the owner/operator or does not allow for vandalism (i.e., within a locked building structure or within a locked fenced in area). A waste-staging area should be designated on-site by the Project Manager in conjunction with the owner/operator.

ATTACHMENTS

Investigation Derived Waste Container Log (sample)
Investigation Derived Waste Container Label (sample)

REFERENCES

None

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INVESTIGATION DERIVED WASTE CO

Project Name:
Project Number:
Location:
Personnel:

Container		Contents	Date		Staging Location	Date Sampled	C
Number	Description		Started	Ended			

Prepared By:
Signed:

IDW Container Label (sample):

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Project Name:
Project Number:

Container I.D.:
Contents/Matrix:
Estimated Quantity:
Date of Generation:
Date of Sample Collection:

Contact Name:
Contact Phone Number:

FOP 033.0

MONITORING WELL CONSTRUCTION FOR HOLLOW STEM AUGER BOREHOLES

PURPOSE

Wells will be installed within selected boreholes for the purpose of evaluating groundwater characteristics. Well installation procedures depend upon the drilling method. This procedure describes well construction and installation for boreholes drilled using the hollow stem auger method. Refer to the Benchmark's Hollow Stem Auger Drilling Procedures FOP. Nominal dimensions and materials for the well are shown in the attached well construction diagram.

PROCEDURE

1. Advance borehole in accordance with the Benchmark's Hollow Stem Auger Drilling Procedure FOP to the required depth. The nominal inside diameter (ID) of the auger stem used should be at least 2 inches larger than the outside diameter (OD) of the riser and screen selected for the well installation. Record the monitoring well construction on the Field Borehole/Monitoring Well Installation Log (sample attached) (see Documentation Requirements for Drilling and Well Installation FOP).
2. Remove the drill rods and center bit/plug from the auger stem and verify borehole depth using weighted measuring tape.
3. In the event of an over drill (i.e. borehole depth is more than one foot greater than desired base of screen depth), use bentonite chips poured through the auger stem to seal the over drilled portion of the borehole. Be sure to note bentonite chip thickness on Field Borehole/Monitoring Well Installation Log.
4. Add a maximum of 6 inches of filter pack material through the auger stem to the base of the borehole. (Note: This step may be avoided if dense non-aqueous phase liquids are suspected to be present and it is desirable to have the screen and/or sump at the base of the borehole.)

5. Measure the length of the well string (i.e. riser and screen), and lower the well string into the well assembly to the desired depth. All measurements during the well installation process will be accurate to 0.1 foot.

6. Surface pour filter pack material into the annulus between the well and the auger stem as the augers are gradually withdrawn from the borehole. Use a weighted tape to confirm that the level of sand is maintained within the augers at all times. Record material volumes used.

7. After filter pack materials are brought to the required level, surface pour bentonite chips or pellets into the annulus between the well and the auger stem to form the filter pack seal. If necessary to avoid bridging, delayed hydration (coated) pellets may be used. Record the volume of material used.

8. Allow the bentonite chips/pellets to adequately hydrate for approximately 30 to 45-minutes. Cap or cover the well top of riser.

9. Mix cement/bentonite grout to a smooth consistency using a centrifugal or reciprocating pump. Do not hand mix. All water used must be potable quality. Record the volume of water used.

10. Fill the remaining annulus between the well and the auger stem with grout by surface pouring or pumping, and begin withdrawal of the auger string. Periodically top the auger string off with additional grout. If groundwater is present within the annulus above the bentonite chip/pellet seal, cement/bentonite grout will be pressure tremie grouted from bottom to top in order to displace groundwater from the borehole.

11. When the auger string is withdrawn, center the upper portion of the well riser within the borehole, and place drums or barricades around the well for protection while the grout cures. Place and lock a security cap (i.e., J-plug) in the opening of the well riser.

12. Leave the well undisturbed for at least 24 hours to allow the grout to cure. If excessive grout fallback occurs, top off as necessary with bentonite chips or additional grout.

13. Construct the surface completion as shown in the attached Typical Monitoring Well Detail (Figure 1). Select flush completions for all locations in active operational or high traffic areas, or in other areas where an above grade completion would be undesirable. Use aboveground completions in all other areas.

14. Place a dedicated lock on the well or protective casing, and keep well locked when not actively attended.

15. Permanently label the well with the appropriate well identifier as determined by the Project Manager or specified in the Work Plan.

16. Permanently mark a survey location on the north side at the top of the casing with a saw cut. Survey all wells for horizontal location and elevation, using a surveyor licensed by the State of New York. Coordinates and elevations will be provided in a coordinate system consistent with previous well surveys at the Site. Information obtained will include location (*x* and *y*) of the well, and elevation (*z*) of the ground surface, the pad, and the top of riser.

17. Develop the well as described in the Benchmark Field Operating Procedure for Monitoring Well Development.

18. Manage all waste materials generated during well installation and development as described in the Benchmark Field Operating Procedure for Management of Investigation Derived Waste.

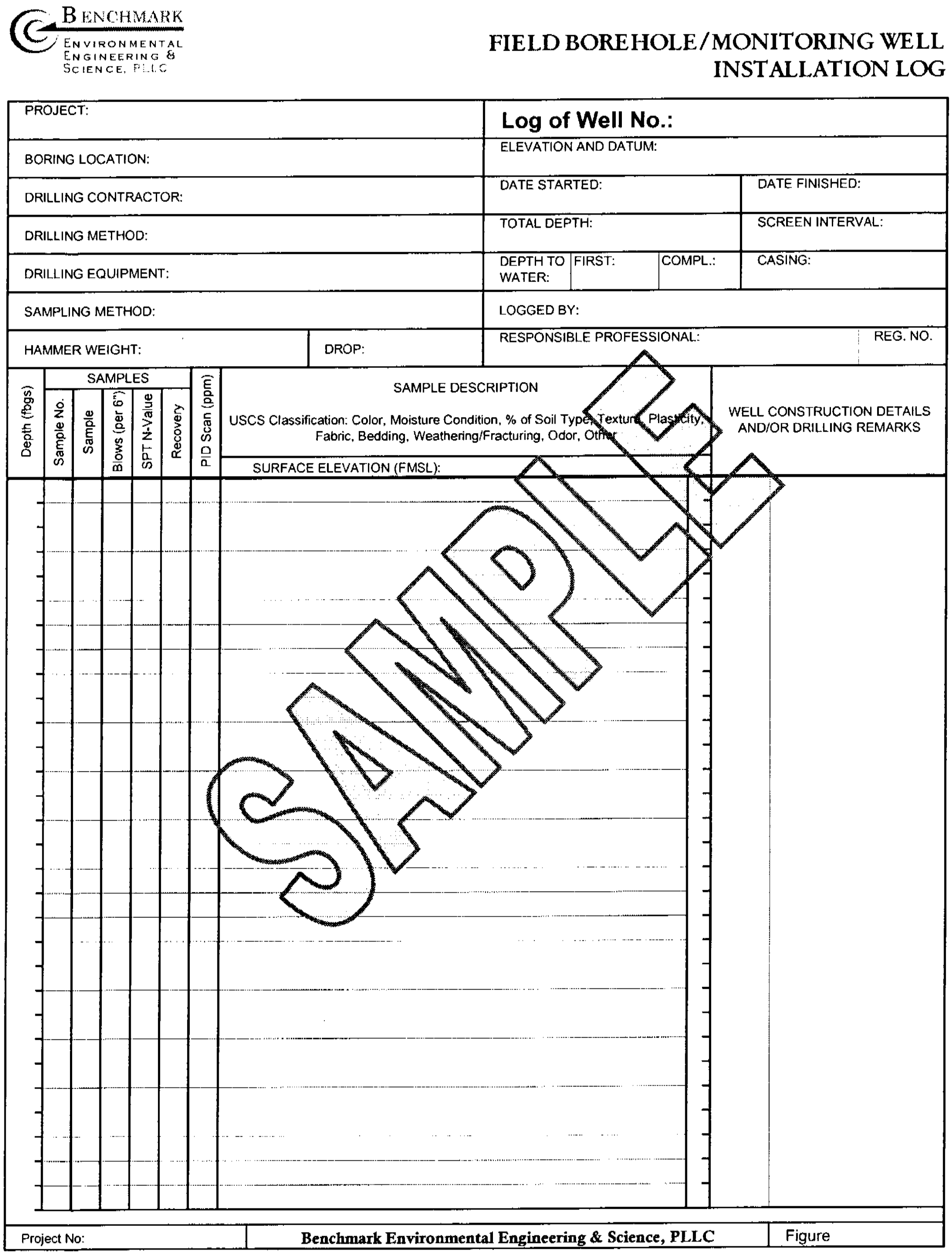
ATTACHMENTS

Field Borehole/Monitoring Well Installation Log (sample)
Typical Monitoring Well Detail (Figure 1)

REFERENCES

Benchmark FOPs:

015 *Documentation Requirements for Drilling and Well Installation*
026 *Hollow Stem Auger Drilling Procedures*
032 *Management of Investigation Derived Waste*
036 *Monitoring Well Development Procedures*



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FIELD BOREHOLE/MONITORING WELL INSTALLATION LOG

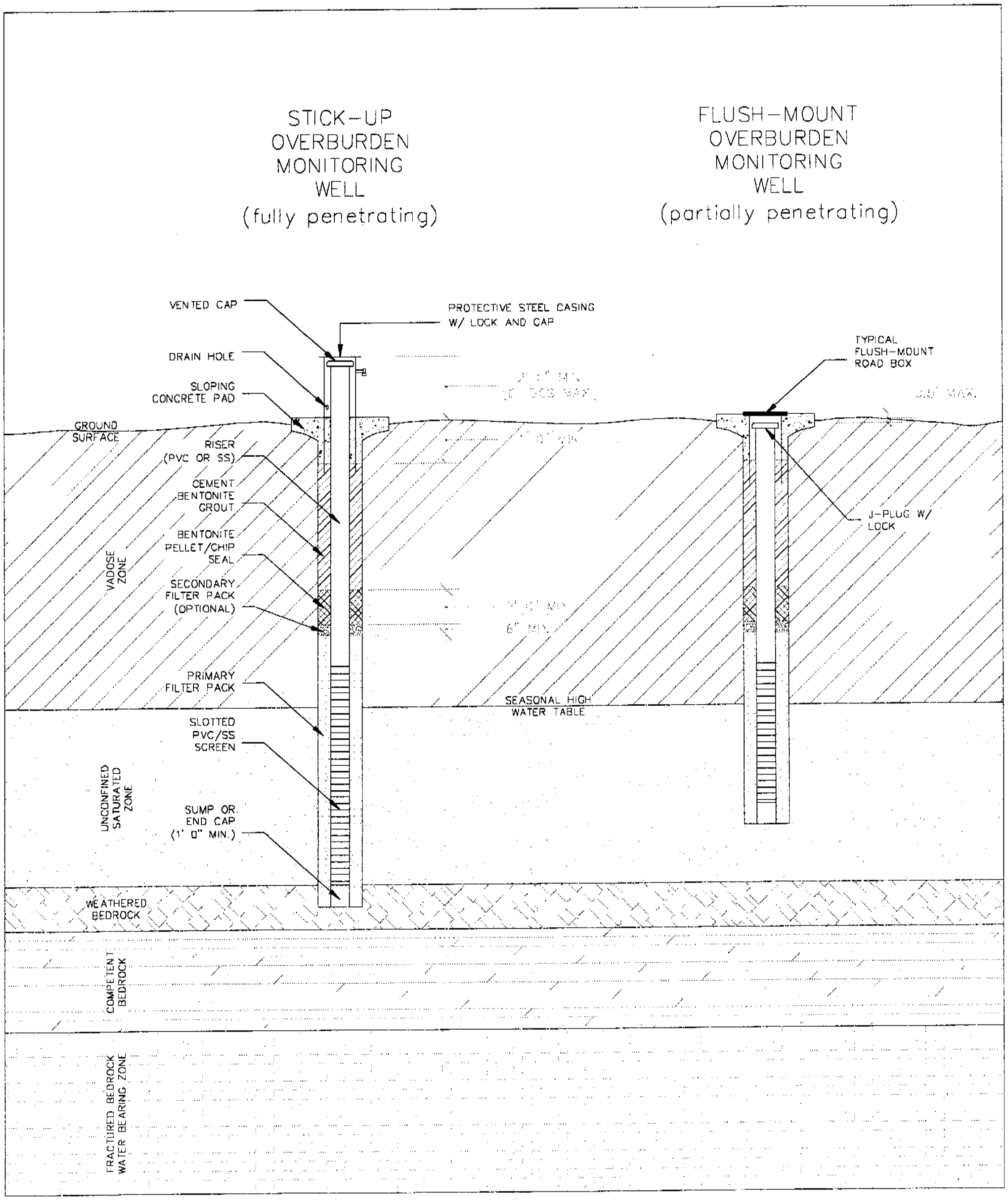
PROJECT:		**Log of Well No.:**		
BORING LOCATION:		ELEVATION AND DATUM:		
DRILLING CONTRACTOR:		DATE STARTED:		DATE FINISHED:
DRILLING METHOD:		TOTAL DEPTH:		SCREEN INTERVAL:
DRILLING EQUIPMENT:		DEPTH TO WATER: FIRST:	COMPL.:	CASING:
SAMPLING METHOD:		LOGGED BY:		
HAMMER WEIGHT:	DROP:	RESPONSIBLE PROFESSIONAL:		REG. NO.

Depth (fbgs)	SAMPLES					PID Scan (ppm)	SAMPLE DESCRIPTION USCS Classification: Color, Moisture Condition, % of Soil Type, Texture, Plasticity, Fabric, Bedding, Weathering/Fracturing, Odor, Other	WELL CONSTRUCTION DETAILS AND/OR DRILLING REMARKS
	Sample No.	Sample	Blows (per 6")	SPT N-Value	Recovery		SURFACE ELEVATION (FMSL):	

Project No:	**Benchmark Environmental Engineering & Science, PLLC**	Figure

MONITORING WELL CONSTRUCTION FOR HOLLOW STEM AUGER BOREHOLES

FIGURE 1



FOP 036.0

MONITORING WELL DEVELOPMENT PROCEDURES

PURPOSE

This procedure describes the methods for the development of newly installed monitoring wells and re-development of existing monitoring wells that have been inactive for an extended period of time (i.e., one year or more). Monitoring wells are developed after installation in order to remove introduced water and drilling fluids, reduce the turbidity of the water, and improve the hydraulic communication between the well and the water-bearing formation. Well development will not commence until the annular grout seal has cured, but will be performed within ten calendar days of well installation.

PROCEDURE

1. All well development will include surge blocking or false bailing with one or more of the following fluid removal methods. Well development activities may include:
    - Bailing
    - Air Lifting
    - Submersible Pumping
    - Other methods as approved by the Benchmark Field Team Leader.
    - The appropriate water removal method will be selected based on water level depth and anticipated well productivity.
2. Assemble and decontaminate equipment (if necessary), and place in the well. Reference the Benchmark Field Operating Procedure for Non-Disposable and Non-Dedicated Sampling Equipment Decontamination.
3. Alternate the use of agitation methods with water removal methods, using the former to suspend solids in the well water, and the latter to remove the turbid water. For example, use a vented surge block to agitate the well, moving up and down within the screened interval and then use a pump to clear the well. A bailer may be used for both purposes, by surging with the bailer (false

bailing) for a period within the screened interval, then bailing a volume of water from the well.

4. When using surging methods, initiate this activity gradually, with short (2 to 3 feet) strokes. After several passes across the screened interval, increase the speed and length of the surge strokes.

5. Continue development until the following objectives are achieved:

    - Field parameters stabilize to the following criteria:
        - o Dissolved Oxygen: ± 0.3 mg/L
        - o Turbidity: ± 10%
        - o Specific Conductance: ± 3%
        - o ORP: ± 10 mV
        - o pH: ± 0.1 units
    - The well will generate non-turbid water during continued pumping typically less than 50 NTU.
    - A minimum of 10 well volumes has been evacuated from the well.
    - In the case of lost water during drilling activities, the volume of water removed exceeds twice the volume of water lost to the formation during the drilling process, as indicated by the water balance.

6. Document the development methods, volumes, field parameter measurements, and other observations on the attached Benchmark Groundwater Well Development Log (sample attached).

ATTACHMENTS

Groundwater Well Development Log (sample)

REFERENCES

Benchmark FOPs:

040 Non-Disposable and Non-Dedicated Sampling Equipment Decontamination

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GROUNDWATER WELL DEVELOPMENT LOG

Project Name: WELL NUMBER:

Project Number: Sample Matrix:

Client: Weather:

WELL DATA:

DATE: TIME:

Casing Diameter (inches):	Casing Material:
Screened interval (fbTOR):	Screen Material:
Static Water Level (fbTOR):	Bottom Depth (fbTOR):
Elevation Top of Well Riser (fmsl):	Datum Ground Surface: Mean Sea Level
Elevation Top of Screen (fmsl):	Stick-up (feet):

PURGING DATA:

DATE: START TIME: END TIME:

VOLUME CALCULATION:

(A) Total Depth of Well (fbTOR):	
(B) Casing Diameter (inches):	
(C) Static Water Level (fbTOR):	
One Well Volume (V, gallons): $V = 0.0408 [(B)^2 \times \{ (A) - (C) \}]$	

*Use the table to the right to calculate one well volume.

Field Personnel:

Volume Calculation

Well Diameter	Volume gal/ft
1"	0.041
2"	0.163
3"	0.367
4"	0.653
5"	1.020
6"	1.469
8"	2.611

Stabilization Criteria

Parameter	Criteria
DO	+/- 0.3 mg/L
Turbidity	+/- 10%
SC	+/- 3%
ORP	+/- 10 mV
pH	+/- 0.1 unit

EVACUATION STABILIZATION TEST DATA:

Time	Water Level (fbTOR)	Accumulated Volume (gallons)	pH (units)	Temperature (degrees C)	Specific Conductance (mS/cm)	Turbidity (NTU)	DO (mg/L)	ORP (mV)	Appearance & Odor

REMARKS:

PREPARED BY:

FOP 040.0

NON-DISPOSABLE AND NON-DEDICATED SAMPLING EQUIPMENT DECONTAMINATION

PURPOSE

This procedure is to be used for the decontamination of non-disposable and non-dedicated equipment used in the collection of environmental samples. The purpose of this procedure is to remove chemical constituents from previous samples from the sampling equipment. This prevents these constituents from being transferred to later samples, or being transported out of controlled areas.

HEALTH AND SAFETY

Nitric acid is a strong oxidizing agent as well as being extremely corrosive to the skin and eyes. Solvents such as acetone, methanol, hexane and isopropanol are flammable liquids. Limited contact with skin can cause irritation, while prolonged contact may result in dermatitis. Eye contact with the solvents may cause irritation or temporary corneal damage. Safety glasses with protective side shields, neoprene or nitrile gloves and long-sleeve protective clothing must be worn whenever acids and solvents are being used.

PROCEDURE – GENERAL EQUIPMENT

Bailers, split-spoons, steel or brass split-spoon liners, Shelby tubes, submersible pumps, soil sampling knives, and similar equipment will be decontaminated as described below.

1. Wash equipment thoroughly with non-phosphate detergent and potable-quality water, using a brush where possible to remove any particulate matter or surface film. If the sampler is visibly coated with tars or other phase-separated hydrocarbons, pre-wash with acetone or isopropanol, or by steam cleaning. Decontamination will adhere to the following procedure:

a. Rinse with potable-quality water;

b. Rinsed with 10% nitric acid (HNO_3) solution [1];

c. Rinse with potable-quality water;

d. Rinse with pesticide grade acetone or methanol [2];

e. Rinse with pesticide grade hexane [2];

f. Rinse with deionized water demonstrated analyte-free, such as distilled water;

g. Air dry; and

h. Store in a clean area or wrap in aluminum foil (shiny side out) or new plastic sheeting as necessary to ensure cleanliness.

2. All non-dedicated well evacuation equipment, such as submersible pumps and bailers, which are put into the well, must be decontaminated following the procedures listed above. All evacuation tubing must be dedicated to individual wells (i.e., tubing cannot be reused). However, if submersible pump discharge tubing must be reused, the tubing and associated sample valves or flow-through cells used in well purging or pumping tests will be decontaminated as described below:

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[1] Omit this step if metals are <u>not</u> being analyzed. For carbon steel split spoon samplers, a 1% rather than 10% HNO_3 solution should be used.

[2] This solvent rinse can be omitted if organics are <u>not</u> being analyzed. Alternatively, if approval from the NYSDEC has been granted, use pesticide grade isopropanol as the cleaning solvent. Isopropanol is better suited as a cleaning solvent that acetone, methanol and hexane for the following reasons:

- Acetone is a parameter analyzed for on the Target Compound List (TCL); therefore the detection of acetone in samples collected using acetone rinsed equipment is suspect;
- Almost all grades of methanol contain 2-butanone (Methyl Ethyl Ketone, MEK) contamination. As for acetone, 2-butanone is a TCL compound. Thus, the detection of 2-butanone in samples collected using methanol rinsed equipment is suspect. In addition, methanol is much more hazardous than either isopropanol or acetone.
- Hexane is not miscible with water (hydrophobic) and therefore, is not an effective rinsing agent unless the sampling equipment is dry. Isopropanol is extremely miscible in water (amphoteric), making it an effective rinsing agent on either wet or dry equipment.

a. Pump a mixture of potable water and a non-phosphate detergent through the tubing, sample valves and flow cells, using the submersible pump.

b. Steam clean or detergent wash the exterior of the tubing, sample valves, flow cells and pump.

c. Pump potable water through the tubing, sample valve, and flow cell until no indications of detergent (e.g. foaming) are observed.

d. Double rinse the exterior of the tubing with potable water.

e. Rinse the exterior of the tubing with distilled water.

f. Store in a clean area or wrap the pump and tubing assembly in new plastic sheeting as necessary to ensure cleanliness until ready for use.

3. All unused sample bottles and sampling equipment must be maintained in such a manner that there is no possibility of casual contamination.

4. Manage all waste materials generated during decontamination procedures as described in the Benchmark Field Operating Procedure for Management of Investigation Derived Waste.

PROCEDURE – SUBMERSIBLE PUMPS

Submersible pumps used in well purging or purging tests will be decontaminated thoroughly each day before use as well as between well locations as described below:

Daily Decontamination Procedure:

1. Pre-rinse: Operate the pump in a basin containing 8 to 10 gallons of potable water for 5 minutes and flush other equipment with potable water for 5 minutes.

2. Wash: Operate the pump in 8 to 10 gallons of non-phosphate detergent solution (i.e., Alconox) for 5 minutes and flush other equipment with fresh detergent solution for 5 minutes.
3. Rinse: Operate the pump in a basin of potable water for 5 minutes and flush other equipment with potable water for 5 minutes.
4. Disassemble pump.
5. Wash pump parts with a non-phosphate detergent solution (i.e., Alconox). Scrub all pump parts with a test tube brush or similar device.
6. Rinse pump with potable water.
7. Rinse the inlet screen, the shaft, the suction interconnection, the motor lead assembly, and the stator housing with distilled/deionized water.
8. Rinse the impeller assembly with 1% nitric acid (HNO_3).
9. Rinse the impeller assembly with isopropanol.
10. Rinse the impeller assembly with distilled/deionized water.

Between Wells Decontamination Procedure:

1. Pre-rinse: Operate the pump in a basin containing 8 to 10 gallons of potable water for 5 minutes.
2. Wash: Operate the pump in 8 to 10 gallons of non-phosphate detergent solution (i.e., Alconox) for 5 minutes.
3. Rinse: Operate the pump in a basin of potable water for 5 minutes.
4. Final rinse the pump in distilled/deionized water.

ATTACHMENTS

None

REFERENCES

<u>Benchmark FOPs:</u>
032 Management of Investigation-Derived Waste

FOP 041.0

OVERBURDEN CASING INSTALLATION PRCEDURES

PURPOSE

This guideline presents a method for the installation of casing to prevent downhole contamination of hazardous compounds from shallow overburden material. This method is particularly applicable where contaminated strata overlie uncontaminated strata of lower permeability. The method can be used with hollow stem auger drilling or rotary wash drilling (where temporary casing is used). This guideline also presents a method for the evaluation of the integrity of the grout seal around an overburden casing, which has been positioned into a confining layer.

CASING INSTALLATION PROCEDURE

1. Advance boring by appropriate drilling methods, through the contaminated strata a short distance (1 to 2 feet) into an underlying lower permeable unit.
2. Calculate the volume of the borehole base on the bit/auger head or steel casing diameter plus 10% and determine the volume of grout to be emplaced. Generally, the total mixed volume is the borehole volume plus 20%.
3. Identify the equipment to be used for the preparation and mixing of the grout. Ensure the volume of the tanks to be used for mixing has been measured adequately. Document these volumes on the Field Borehole/Monitoring Well Installation Log (sample attached).
4. Identify the source of the water to be used for the grout and determine its suitability for use. In particular, water with high sulfate, or chloride levels or heated water should not be used. These types of waters can cause operational difficulties or modify the set-up for the grout.
5. Identify the equipment to be used for emplacing the grout. Ensure that the pump to be used has adequate pressure to enable complete return to surface.

6. Identify the volumes to be pumped at each stage or in total if only one stage is to be used.

7. Begin mixing the grout to be emplaced. Grout specifications generally have mixture ratios as follows:

Grout Slurry Composition (% Weight)		
1.5 to 3.0%	-	Bentonite (Quick Gel)
40 to 60 %	-	Cement (Portland Type I)
40 to 60 %	-	Potable Water

8. Record the type and amount of materials used during the mixing operation. Ensure the ratios are within specifications tolerance.

9. Begin pumping the grout through the return line bypass system to confirm all pump and surface fittings are secure.

10. Remove drill rods and center plug (or clean out temporary casing) and insert a tremie pipe to the bottom of the boring. Pump the cement/bentonite grout slurry through the tremie pipe until grout return is observed at grade and no bridging of the slurry is evident. Slowly withdraw the augers (or casing) from the boring while maintaining the grout level at grade. Record the times and volumes emplaced on the Field Borehole/Monitoring Well Installation Log (sample attached).

11. Document the return circulation of grout. This may be facilitated by using a colored dye or other tagging method if a mudded borehole condition exists prior to grout injection.

12. Place a drillable plug (preferably untreated wood) at the downhole end of black steel or other appropriate casing, insert the casing through the slurry, and seat it into the underlying formation.

13. Allow grout to set for 24 to 48 hours.

HYDROSTATIC TESTING OF CASING PROCEDURE

1. Following adequate setting time for the grout, drill through the grout inside the casing until the top of the confining layer has been reached (refer to Field Borehole/Monitoring Well Installation Log during casing installation).

2. Fill the casing with potable water and measure the water level within the casing with a water level indicator to the nearest 0.01-foot and record the measurement on the Pipe Leakage Testing Log (sample attached).

3. Monitor the water level for 30 minutes and record the final water level within the casing with a water level indicator to the nearest 0.01-foot and record the measurement on the Pipe Leakage Testing Log (sample attached).

4. Should the water level drop more than the allowable volume calculated using the following equation, the seal shall be regrouted at the Subcontractor's expense.

   $Q_{(allowable)} = 2.75\ DKH$

   Where:
   $Q_{(allowable)}$ = Flow rate during a 30 minute test
   D = Inside diameter of overburden casing
   K = Confining layer hydraulic conductivity (see Table 1)
   H = Head of water applied

   Note: Be sure to use consistent units of measure.

ATTACHMENTS

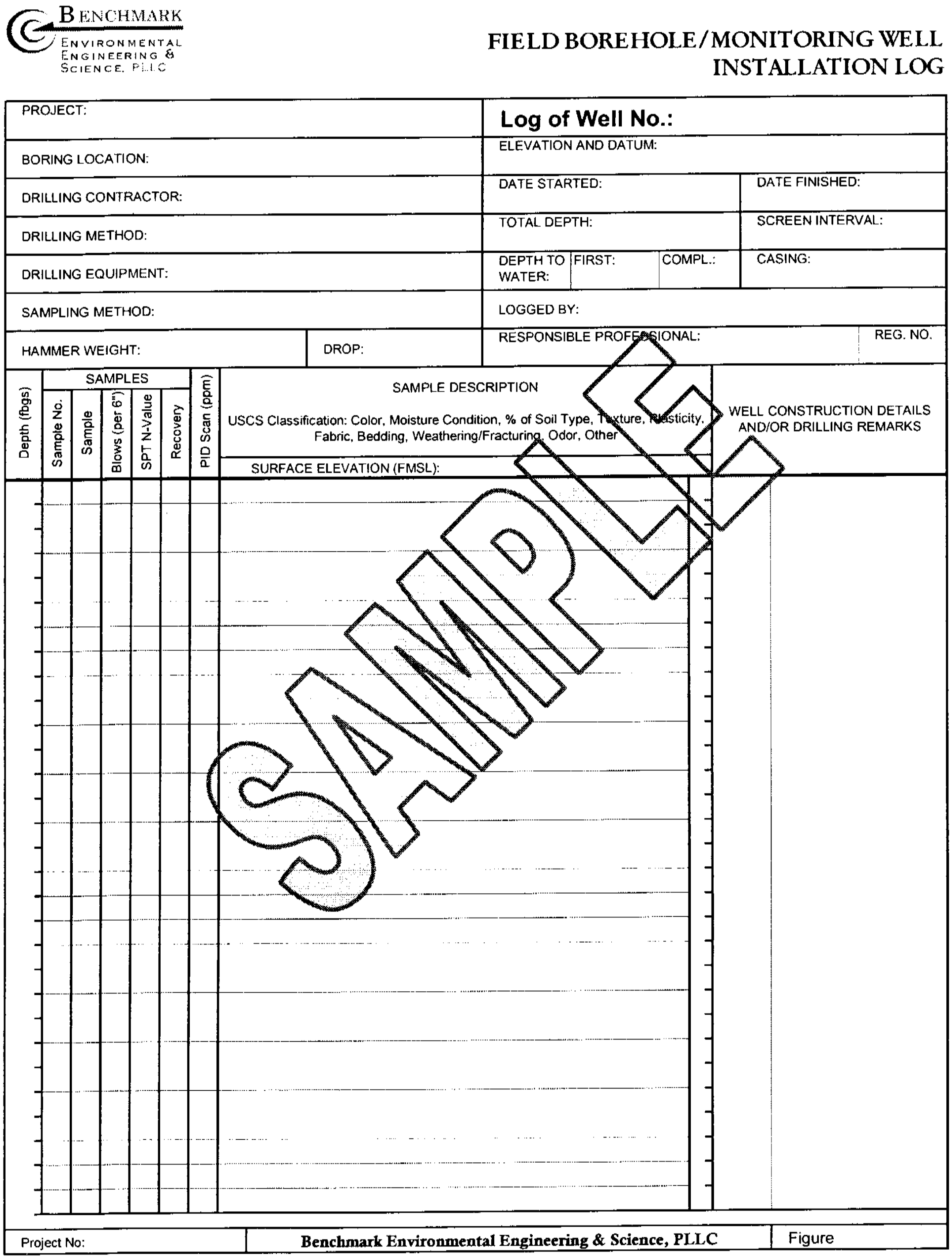
Field Borehole/Monitoring Well Installation Log (sample)
Pipe Leakage Testing Log (sample)

Table 1 – Range of Values of Hydraulic Conductivity and Permeability

REFERENCES

Freeze, R.A. and J.A. Cherry. 1979. *Groundwater*. Prentice-Hall, Inc., Englewood, New Jersey, 604 p.

Benchmark FOPs:
018 Drilling and Excavation Equipment Decontamination Protocols



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FIELD BOREHOLE/MONITORING WELL INSTALLATION LOG

PROJECT:		**Log of Well No.:**			
BORING LOCATION:		ELEVATION AND DATUM:			
DRILLING CONTRACTOR:		DATE STARTED:			DATE FINISHED:
DRILLING METHOD:		TOTAL DEPTH:			SCREEN INTERVAL:
DRILLING EQUIPMENT:		DEPTH TO WATER:	FIRST:	COMPL.:	CASING:
SAMPLING METHOD:		LOGGED BY:			
HAMMER WEIGHT:	DROP:	RESPONSIBLE PROFESSIONAL:			REG. NO.

Depth (fbgs)	SAMPLES						SAMPLE DESCRIPTION USCS Classification: Color, Moisture Condition, % of Soil Type, Texture, Plasticity, Fabric, Bedding, Weathering/Fracturing, Odor, Other	WELL CONSTRUCTION DETAILS AND/OR DRILLING REMARKS
	Sample No.	Sample	Blows (per 6")	SPT N-Value	Recovery	PID Scan (ppm)	SURFACE ELEVATION (FMSL):	

Project No:	**Benchmark Environmental Engineering & Science, PLLC**	Figure

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PIPE LEAKAGE TESTING LOG

Project: Location:

Client: Date:

Job No: BM Personnel:

Location Description	Test Procedure (Air or Hydrostatic)	QC Initials	Readings				Elapsed Time (minutes)	Change in Pressure/ Water Level (psi/fbMP)	Pass/Fail	Passing Retest Date	Comments/Notes
			Start		End						
			Pressure or Water Level	Time	Pressure or Water Level	Time					

Prepared By: Date:

TABLE 1: (From Freeze and Cherry, page 29.)

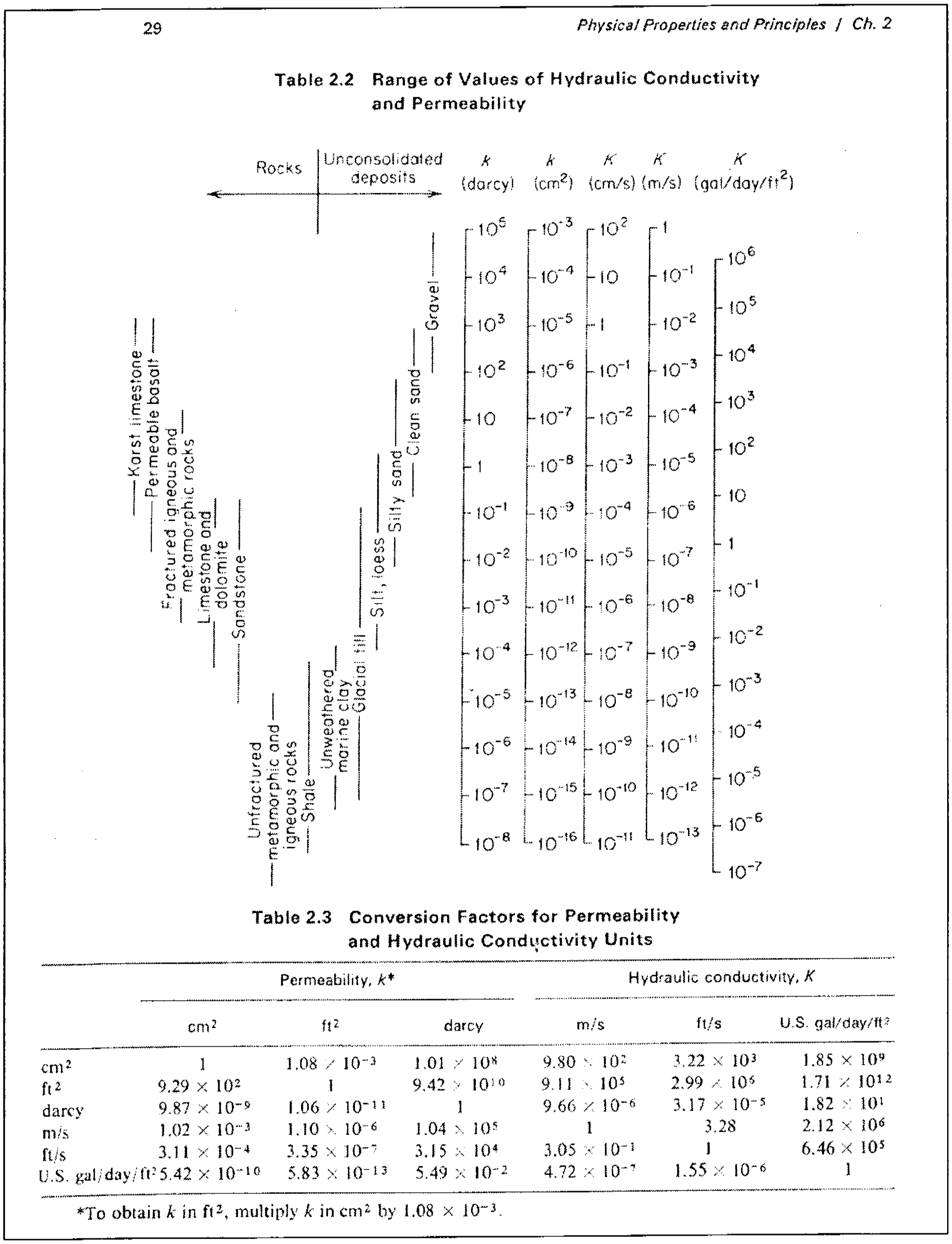

Table 2.2 Range of Values of Hydraulic Conductivity and Permeability

Table 2.3 Conversion Factors for Permeability and Hydraulic Conductivity Units

	Permeability, *k**			Hydraulic conductivity, *K*		
	cm²	ft²	darcy	m/s	ft/s	U.S. gal/day/ft²
cm²	1	1.08×10^{-3}	1.01×10^{8}	9.80×10^{2}	3.22×10^{3}	1.85×10^{9}
ft²	9.29×10^{2}	1	9.42×10^{10}	9.11×10^{5}	2.99×10^{6}	1.71×10^{12}
darcy	9.87×10^{-9}	1.06×10^{-11}	1	9.66×10^{-6}	3.17×10^{-5}	1.82×10^{1}
m/s	1.02×10^{-3}	1.10×10^{-6}	1.04×10^{5}	1	3.28	2.12×10^{6}
ft/s	3.11×10^{-4}	3.35×10^{-7}	3.15×10^{4}	3.05×10^{-1}	1	6.46×10^{5}
U.S. gal/day/ft²	5.42×10^{-10}	5.83×10^{-13}	5.49×10^{-2}	4.72×10^{-7}	1.55×10^{-6}	1

*To obtain *k* in ft², multiply *k* in cm² by 1.08×10^{-3}.

FOP 046.0

SAMPLE LABELING, STORAGE & SHIPMENT PROCEDURES

PURPOSE

The collection and analysis of samples of environmental media, including soils, groundwater, surface water, and sediment, are the central activities of the field investigation. These samples must be properly labeled to preserve its identity, and properly stored and shipped in a manner that preserves its integrity and chain of custody. This procedure presents methods for these activities.

SAMPLE LABELING PROCEDURE

1. Assign each sample retained for analysis a unique 9-digit alphanumeric identification code or as indicated in the Project Work Plan. Typically, this code will be formatted as follows:

Sample I.D. Example: GW051402047	
GW	**Sample matrix** GW = groundwater; SW = surface water; SUB = subsurface soil; SS = surface soil; SED = sediment; L = leachate; A = air
05	Month of sample collection
14	Day of sample collection
02	Year of sample collection
047	Consecutive sample number

2. Consecutive sample numbers will indicate the individual sample's sequence in the total set of samples collected during the investigation/sampling event. The sample number above, for example, would indicate the 47th sample retained for analysis during the field investigation, collected on May 14, 2002.

3. Affix a non-removable (when wet) label to each sample container. The following information will be written on the label with black or blue ink that will not smudge when wet:

   - Project number
   - Sample ID (see Step 1 above)
   - Date of sample collection
   - Time of sample collection (military time only)
   - Specify "grab" or "composite" sample with an "X"
   - Sampler initials
   - Preservative(s) (if applicable)
   - Analytes for analysis (if practicable)

4. Record all sample label information in the Project Field Book and on a Sample Summary Collection Log (see attached samples), keyed to the sample identification number. In addition, add information regarding the matrix, sample location, depth, etc. to provide a complete description of the sample.

SAMPLE STORAGE PROCEDURE

1. Immediately after collection, placement in the proper container, and labeling, place samples to be retained for chemical analysis into resealable plastic bags.

2. Place bagged samples into an ice chest filled approximately half-full of double bagged ice. Blue ice is not an acceptable substitute for ice.

3. Maintain samples in an ice chest or in an alternative location (e.g. sample refrigerator) as approved by the Benchmark Field Team Leader until time of shipment. Periodically drain melt-water off coolers and replenish ice as necessary.

4. Ship samples on a daily basis, unless otherwise directed by the Benchmark Field Team Leader.

5. Maintain appropriate custody procedures on coolers and other sample storage containers at all times. These procedures are discussed in detail in the Project Quality Assurance Project Plan, Monitoring Plan or Work Plan.

6. Samples shall be kept in a secure location locked and controlled (i.e., locked building or fenced area) so that only the Project Field Team Leader has access to the location or under the constant visual surveillance of the same.

SAMPLE SHIPPING PROCEDURE

1. Fill out the chain-of-custody form completely (see attached sample) with all relevant information. The white original goes with the samples and should be placed in a resealable plastic bag and taped inside the sample cooler lid; the sampler should retain the copy.

2. Place a layer of inert cushioning material such as bubble pack in the bottom of cooler.

3. Place each bottle in a bubble wrap sleeve or other protective wrap. To the extent practicable, then place each bottle in a resealable plastic bag.

4. Open a garbage bag (or similar) into a cooler and place sample bottles into the garbage bag (or similar) with volatile organic analysis (VOA) vials near the center of the cooler.

5. Pack bottles with ice in plastic bags. At packing completion, cooler should be at least 50 percent ice, by volume. Coolers should be completely filled, so that samples do not move excessively during shipping.

6. Duct tape (or similar) cooler drain closed and wrap cooler completely in two or more locations to secure lid, specifically covering the hinges of the cooler.

7. Place laboratory label address identifying cooler number (i.e., 1 of 4, 2 of 4 etc.) and overnight delivery waybill sleeves on cooler lid or handle sleeve (Federal Express).

8. Sign the custody seal tape with an indelible soft-tip marker and place over the duct tape across the front and back seam between the lid and cooler body.

9. Cover the signed custody seal tape with an additional wrap of transparent strapping tape.

10. Place "Fragile" and "This Side Up" labels on all four sides of the cooler. "This Side Up" labels are yellow labels with a black arrow with the arrowhead pointing toward the cooler lid.

11. For coolers shipped by overnight delivery, retain a copy of the shipping waybill, and attach to the chain-of-custody documentation.

ATTACHMENTS

Soil/Sediment Sample Summary Collection Log (sample)
Groundwater/Surface Water Sample Summary Collection Log (sample)
Wipe Sample Summary Collection Log (sample)
Air Sample Summary Collection Log (sample)
Chain-Of-Custody Form (sample)

REFERENCES

None

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SOIL/SEDIMENT
SAMPLE COLLECTION SUMMARY LOG

Field ID	Location	QC Type	Depth (feet)		Analytical Parameters	Containers	Date	Time	Sampler Initials	Comments (e.g. problems encountered, ref. to variance, location changes, depth changes, important matrix observations or description, gravel thickness, etc.)
			from	to						

Equipment Rinsate Blanks - *Pour clean deionized water over or through decontaminated sampling equipment into sample container. Collect at a frequency of 1 per sampling method per day. Analyze for all those parameters analyzed for in the samples collected the same day. HSL Metals can be substituted by only the Metals analyzed for that day (except Hexavalent Chromium which needs a separate container). Match equipment used for constituents of concern to rinsate analyte. Note deionzied water lot # or distilled water manufacturers info & date.*

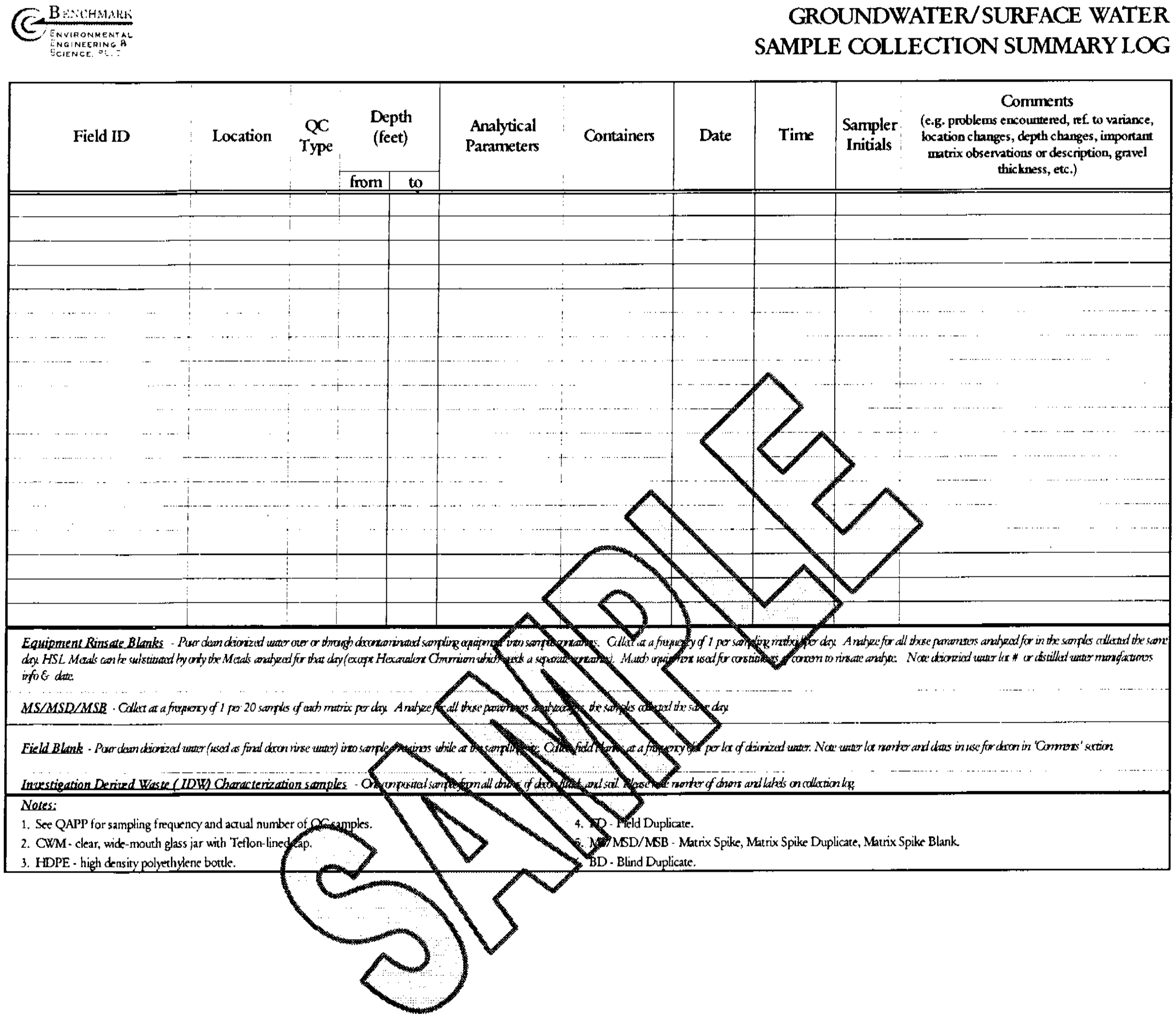
MS/MSD/MSB - *Collect at a frequency of 1 per 20 samples of each matrix per day. Analyze for all those parameters analyzed for the samples collected the same day.*

Field Blank - *Pour clean deionized water (used as final decon rinse water) into sample container while at the sampling site. Collect field blanks at a frequency of 1 per lot of deionized water. Note water lot number and dates in use for decon in 'Comments' section.*

Investigation Derived Waste (IDW) Characterization samples - *One composited sample from all drums of decon fluids and soil. Please note number of drums and labels on collection log.*

Notes:

1. See QAPP for sampling frequency and actual number of QC samples.
2. CWM - clear, wide-mouth glass jar with Teflon-lined cap.
3. HDPE - high density polyethylene bottle.
4. MS/MSD/MSB - Matrix Spike, Matrix Spike Duplicate, Matrix Spike Blank.
5. BD - Blind Duplicate - indicate location of duplicate.



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GROUNDWATER/SURFACE WATER
SAMPLE COLLECTION SUMMARY LOG

Field ID	Location	QC Type	Depth (feet)		Analytical Parameters	Containers	Date	Time	Sampler Initials	Comments (e.g. problems encountered, ref. to variance, location changes, depth changes, important matrix observations or description, gravel thickness, etc.)
			from	to						

Equipment Rinsate Blanks - *Pour clean deionized water over or through decontaminated sampling equipment into sample containers. Collect at a frequency of 1 per sampling method per day. Analyze for all those parameters analyzed for in the samples collected the same day. HSL Metals can be substituted by only the Metals analyzed for that day (except Hexavalent Chromium which needs a separate container). Match equipment used for constituents of concern to rinsate analyte. Note deionized water lot # or distilled water manufactures info & date.*

MS/MSD/MSB - *Collect at a frequency of 1 per 20 samples of each matrix per day. Analyze for all those parameters analyzed for the samples collected the same day.*

Field Blank - *Pour clean deionized water (used as final decon rinse water) into sample containers while at the sampling site. Collect field blanks at a frequency of 1 per lot of deionized water. Note water lot number and dates in use for decon in 'Comments' section.*

Investigation Derived Waste (IDW) Characterization samples - *One composited sample from all drums of decon fluids and soil. Please note number of drums and labels on collection log.*

Notes:

1. See QAPP for sampling frequency and actual number of QC samples.
2. CWM - clear, wide-mouth glass jar with Teflon-lined cap.
3. HDPE - high density polyethylene bottle.
4. FD - Field Duplicate.
5. MS/MSD/MSB - Matrix Spike, Matrix Spike Duplicate, Matrix Spike Blank.
6. BD - Blind Duplicate.

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WIPE SAMPLE COLLECTION SUMMARY LOG

Field ID	Location	QC Type	Analytical Parameters	Containers	Date	Time	Sampler Initials	Comments (e.g. problems encountered, ref. to variance, location changes, important observations or descriptions, etc.)

Notes:

1. See QAPP for sampling frequency and actual number of QC samples.
2. CWM - clear, wide-mouth glass jar with Teflon-lined cap.
3. FD - Field Duplicate.
4. FB - Field Blank.
5. RS - Rinsate.
6. No Matrix Spike, Matrix Spike Duplicate or Matrix Spike Blanks for wipe samples.
7. Rinsates should be taken at a rate of 1 per day during wipe sampling. Only take when reusable equipment is used.
8. Wipe sample FB collected by wiping unused glove (and any other sampling equipment coming into contact with sampled surface) with prepared gauze pad and place in sample jar. Take at a rate of 1 FB per 20 samples.
9. Wipe sample FDs taken adjacent to original sample at a rate of 1 FD per 20 samples.
10. **EH** : Extract and Hold

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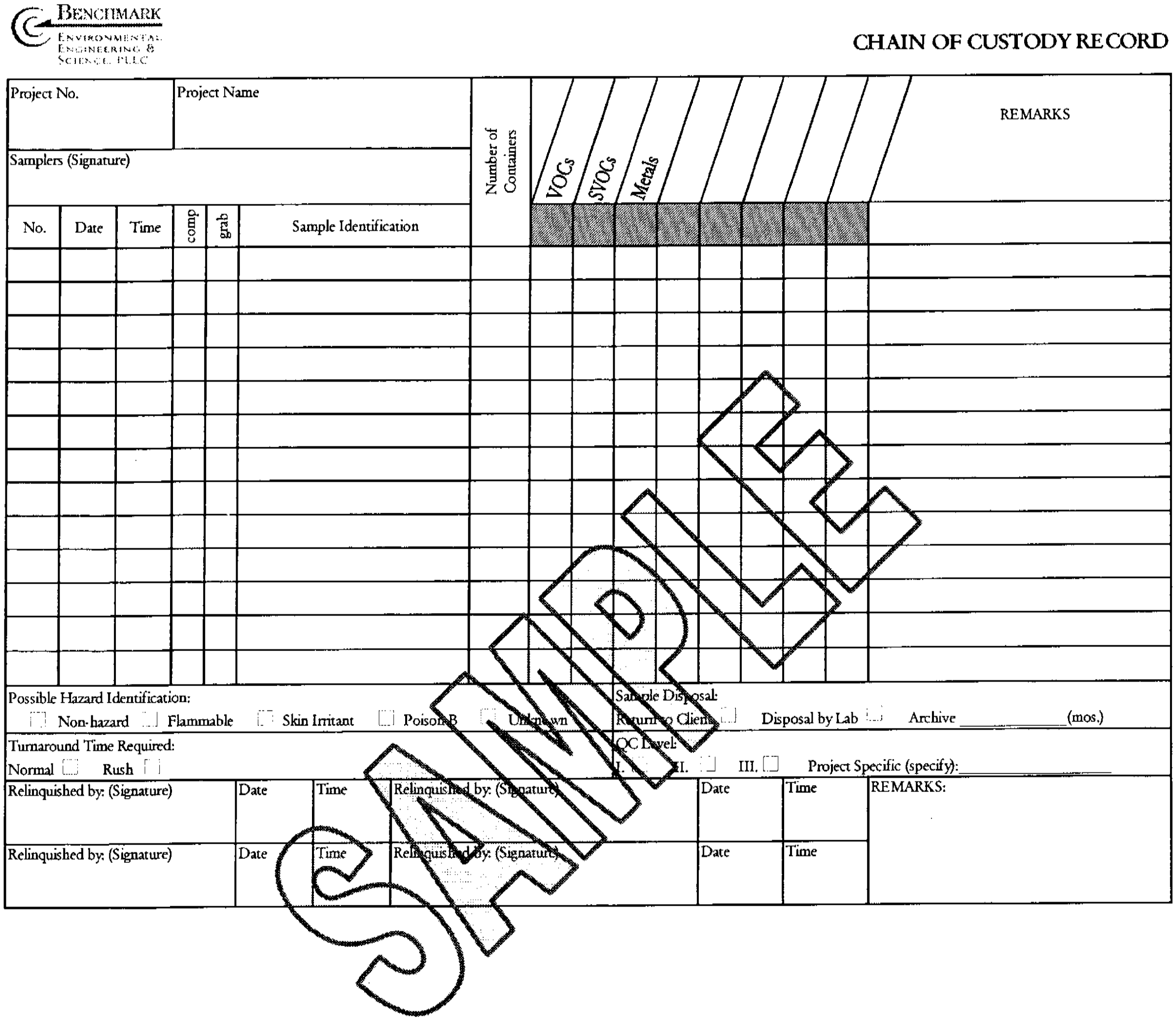
AIR SAMPLE COLLECTION SUMMARY LOG

Field ID	Location	QC Type	Analytical Parameters	Containers	Date	Time	Sampler Initials	Comments (e.g. problems encountered, ref. to variance, location changes, important observations or descriptions, etc.)

Notes:
1. See QAPP for sampling frequency and actual number of QC samples.
2. SC - Summa Canister.
3. TB - Tedlar Bag (quantity).
4. No Matrix Spike, Matrix Spike Duplicate, Matrix Spike Blanks, Field Duplicates, Field Blanks or Rinsates collected for air samples.



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CHAIN OF CUSTODY RECORD

Project No.	Project Name
Samplers (Signature)	

No.	Date	Time	comp	grab	Sample Identification	Number of Containers	VOCs	SVOCs	Metals						REMARKS
							▨	▨	▨	▨	▨	▨	▨	▨	

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

Sample Disposal:
Return to Client ☐ Disposal by Lab ☐ Archive ____________(mos.)

Turnaround Time Required:
Normal ☐ Rush ☐

QC Level:
I. ☐ II. ☐ III. ☐ Project Specific (specify):________________

Relinquished by: (Signature)	Date	Time	Relinquished by: (Signature)	Date	Time	REMARKS:
Relinquished by: (Signature)	Date	Time	Relinquished by: (Signature)	Date	Time	

FOP 047.0

SCREENING OF SOIL SAMPLES FOR ORGANIC VAPORS DURING DRILLING ACTIVITIES

PURPOSE

This procedure is used to screen soil samples for the presence of volatile organic constituents (VOCs) using a field organic vapor meter. These meters will be either photoionization detector (PID) or flame-ionization detector (FID) type. This screening is performed at the drilling and sampling location as a procedure for ensuring the health and safety of personnel at the site and to identify potentially contaminated soil samples for laboratory analysis. All soil samples will be field screened to provide a vertical profile of soil contamination by volatile organic substances.

PROCEDURE

1. Calibrate air-monitoring equipment in accordance with the appropriate Benchmark's Field Operating Procedures or manufacturers recommendations for calibration of field meters.

2. Collect split-spoon (or other sampler) samples in accordance with Benchmark's Split Spoon Sampling Procedure FOP.

3. When the split-spoon or other sampler is opened or accessed, shave a thin layer of material from the entire length of the core.

4. Scan the core visually and with the PID or FID noting stratification, visible staining, or other evidence of contamination.

5. Based on this initial scan of the sample, collect approximately 100 milliliters (ml) of soil using a decontaminated or dedicated stainless steel spatula, scoop, or equivalent. Place this soil into a labeled wide-mouth glass jar approximately ½ to ¾ full and seal with aluminum foil and a screw top cap. Alternatively, the soil may be placed into a clean, re-sealable plastic bag and sealed. Be sure to leave some headspace above the soil sample within the sealed container.

6. Place field screening sample (i.e., jar or bag) in a location where the ambient temperature is at least 70° Fahrenheit.

7. Leave the field screening sample bag for at least 30 minutes, but no more than 60 minutes.

8. Carefully remove the screw top cap from the jar and slowly insert the tip of the organic vapor meter (PID or FID) through the aluminum foil seal making the smallest hole possible. Alternatively, unseal a portion of the plastic bag just big enough to insert the probe of a calibrated PID.

9. Record the maximum reading in parts per million by volume (ppmv) on the Field Borehole Log or Field Borehole/Monitoring Well Installation Log form (see attached samples) (see Documentation Requirements for Drilling and Well Installation FOP), at the depth interval corresponding to the depth of sample collection.

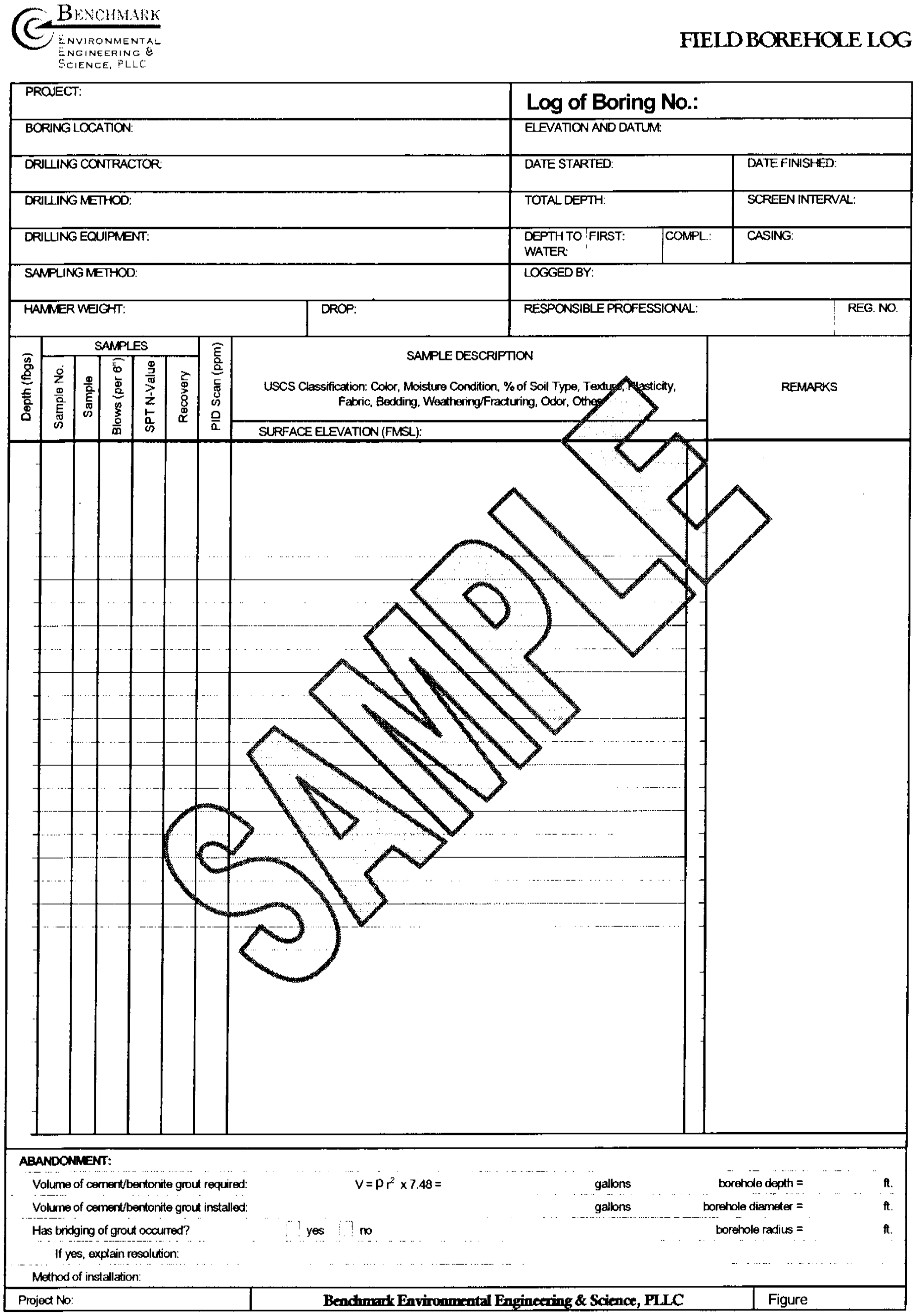
ATTACHMENTS

Field Borehole Log (sample)
Field Borehole/Monitoring Well Installation Log (sample)

REFERENCES

<u>Benchmark FOPs:</u>

010	*Calibration and Maintenance of Portable Flame Ionization Detector*
011	*Calibration and Maintenance of Portable Photoionization Detector*
015	*Documentation Requirements for Drilling and Well Installation*
058	*Split Spoon Sampling Procedures*



BENCHMARK ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

FIELD BOREHOLE LOG

PROJECT:	**Log of Boring No.:**
BORING LOCATION:	ELEVATION AND DATUM:
DRILLING CONTRACTOR:	DATE STARTED: / DATE FINISHED:
DRILLING METHOD:	TOTAL DEPTH: / SCREEN INTERVAL:
DRILLING EQUIPMENT:	DEPTH TO WATER: FIRST: / COMPL.: / CASING:
SAMPLING METHOD:	LOGGED BY:
HAMMER WEIGHT: / DROP:	RESPONSIBLE PROFESSIONAL: / REG. NO.

Depth (fbgs)	SAMPLES					PID Scan (ppm)	SAMPLE DESCRIPTION USCS Classification: Color, Moisture Condition, % of Soil Type, Texture, Plasticity, Fabric, Bedding, Weathering/Fracturing, Odor, Other SURFACE ELEVATION (FMSL):	REMARKS
	Sample No.	Sample	Blows (per 6")	SPT N-Value	Recovery			

ABANDONMENT:

Volume of cement/bentonite grout required: $V = p r^2$ x 7.48 = gallons borehole depth = ft.

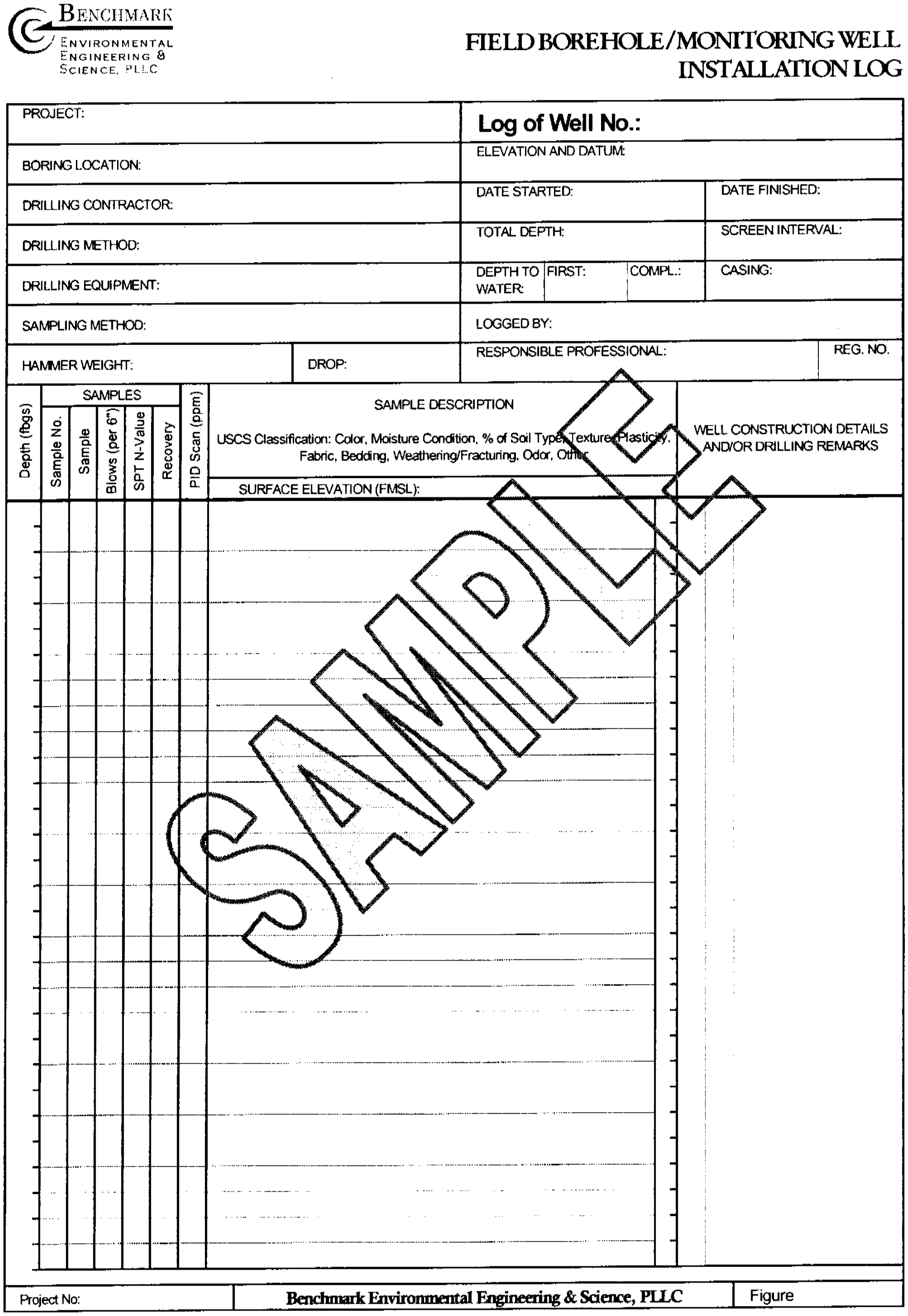
Volume of cement/bentonite grout installed: gallons borehole diameter = ft.

Has bridging of grout occurred? ☐ yes ☐ no borehole radius = ft.

If yes, explain resolution:

Method of installation:

Project No:	**Benchmark Environmental Engineering & Science, PLLC**	Figure



Benchmark Environmental Engineering & Science, PLLC

FIELD BOREHOLE/MONITORING WELL INSTALLATION LOG

PROJECT:		**Log of Well No.:**	
BORING LOCATION:		ELEVATION AND DATUM:	
DRILLING CONTRACTOR:		DATE STARTED:	DATE FINISHED:
DRILLING METHOD:		TOTAL DEPTH:	SCREEN INTERVAL:
DRILLING EQUIPMENT:		DEPTH TO WATER: FIRST: COMPL.:	CASING:
SAMPLING METHOD:		LOGGED BY:	
HAMMER WEIGHT:	DROP:	RESPONSIBLE PROFESSIONAL:	REG. NO.

Depth (fbgs)	SAMPLES Sample No.	Sample	Blows (per 6")	SPT N-Value	Recovery	PID Scan (ppm)	SAMPLE DESCRIPTION USCS Classification: Color, Moisture Condition, % of Soil Type, Texture, Plasticity, Fabric, Bedding, Weathering/Fracturing, Odor, Other SURFACE ELEVATION (FMSL):	WELL CONSTRUCTION DETAILS AND/OR DRILLING REMARKS

Project No:	**Benchmark Environmental Engineering & Science, PLLC**	Figure

FOP 054.0

SOIL DESCRIPTION PROCEDURES USING THE UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)

PURPOSE

This guideline presents a means for insuring consistent and proper field identification and description of collected soils during a project (via, split-spoon (barrel) sampler, hand auger, test pit etc.). The lithology and moisture content of each soil sample will be physically characterized by visual observation in accordance with Bureau of Reclamation Standards as modified from the Unified Soil Classification System (USCS). This method of soil characterization describes soil types based on grain size and liquid and plastic limits and includes moisture content. This FOP is fairly consistent with ASTM Designation: D 2488 "Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)." When using this FOP to classify soil, the detail of description provided for a particular material should be dictated by the complexity and objectives of the project. However, more often than not, "after the fact" field information is required later in the project, therefore, every attempt to describe the soil as completely as possibly should be made.

Intensely weathered or decomposed rock that is friable and can be reduced to gravel size or smaller by normal hand pressure should be classified as a soil. The soil classification would be followed by the parent rock name in parenthesis. Projects requiring depth to bedrock determinations should always classify weathered or decomposed bedrock as bedrock (i.e., landfill siting). The project manager should always be consulted prior to making this determination.

PROCEDURE

Assemble necessary equipment and discuss program requirements with drilling contractor.

1. Calibrate air-monitoring equipment in accordance with the appropriate Benchmark's Field Operating Procedures or manufacturers recommendations for calibration of field meters.

2. Collect desired soil sample in accordance with appropriate Benchmark FOP (i.e., split-spoon sampling, hand augering, test pitting etc.).

3. Shave a thin layer off the entire length of the sample to expose fresh sample.

4. Photograph and scan the sample with a photoionization detector (PID) at this time, if applicable, in accordance with Benchmark's Screening of Soil Samples for Organic Vapors During Drilling Activities FOP.

5. Describe the sample using terminology presented in the Descriptive Terms section below.

6. Record all pertinent information in the Project Field Book and Field Borehole Log (sample attached) or Field Borehole/Monitoring Well Installation Log (sample attached).

7. After the sample has been described, place a representative portion of the sample in new, precleaned jars for archival purposes. Label the jar with a sample identification number, sample interval, date, project number and store in a secure location.

8. If the soil is to be submitted to a laboratory for analysis, collect the soil sample with a dedicated stainless steel sampling tool, place the sample into the appropriate laboratory-supplied containers, and store in an ice-chilled cooler staged in a secure location in accordance with Benchmark's Sample Labeling, Storage and Shipment Procedures FOP.

9. All remaining soil from soil sample collection activities shall be containerized in accordance with Benchmark's Management of Investigative-Derived Waste (IDW) FOP and/or the Project Work Plan.

DESCRIPTIVE TERMS

All field soil samples will be classified in accordance with the Unified Soil Classification System (USCS) (modified from ASTM D2488) presented in Figures 1 and 2 (attached) and using the descriptive terms detailed in this section. It is desirable to supplement the USCS classification with a geologic interpretation of the soil sample that is supported by the soil descriptive terms presented in this section as well as the attached Figures.

Use the following descriptive terms when classifying soils:

- **Group Name** (USCS, see Figure 2)
- **Group Symbol** (USCS, see Figure 2)
- **Angularity** (ASTM D2488; Table 1)
    - Angular – particles have sharp edges and relatively planar sides with unpolished surfaces
    - Subangular – particles are similar to angular description but have rounded edges
    - Subrounded – particles have nearly planar sides but have well-rounded corners and edges
    - Rounded – particles have smoothly curved sides and no edges
- **Particle Shape** (ASTM D2488; Table 2)
    - Flat – particles with width/thickness >3
    - Elongated – particles with length/width >3
    - Flat and Elongated – particles meet criteria for both flat and elongated
- **Moisture Condition** (ASTM D2488; Table 3)
    - Dry – absence of moisture, dusty, dry to the touch
    - Moist – damp, but no visible water

  - Wet – visible free water, usually soil is below water table
- **Reaction with Hydrochloric Acid (HCl)** (ASTM D2488; Table 4)
  - None – no visible reaction
  - Weak – some reaction, with bubbles forming slowly
  - Strong – violent reaction, with bubbles forming immediately
- **Consistency of Cohesive Soils** (ASTM D2488; Table 5)
  - Very soft – squeezes between fingers when fist is closed; easily penetrated several inches by fist
  - Soft – easily molded by fingers; easily penetrated several inches by thumb
  - Firm – molded by strong pressure of fingers; can be penetrated several inches by thumb with moderate effort
  - Stiff – dented by strong pressure of fingers; readily indented by thumb but can be penetrated only with great effort
  - Very stiff – readily indented by thumbnail
  - Hard – indented with difficultly by thumbnail
- **Cementation** (ASTM D2488; Table 6)
  - Weak – crumbles or breaks with handling or slight finger pressure
  - Moderate – crumbles or breaks with considerable finger pressure
  - Strong – will not crumble or break with finger pressure
- **Structure (Fabric)** (ASTM D2488; Table 7)
  - Varved – alternating 1 mm to 12 mm (0.04 – 0.5 inch) layers of sand, silt and clay
  - Stratified – alternating layers of varying material or color with the layers less than 6 mm (0.23 inches) thick; note thickness
  - Laminated – alternating layers of varying material or color with the layers less than 6 mm (0.23 inches) thick; note thickness
  - Fissured – contains shears or separations along planes of weakness

  - Slickensided – shear planes appear polished or glossy, sometimes striated
  - Blocky – cohesive soil that can be broken down into small angular lumps which resist further breakdown
  - Lensed – inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay; note thickness
  - Homogeneous – same color and appearance throughout
- **Inorganic Fine-Grained Soil Characteristics** (ASTM D2488; Table 12)
  - Dry Strength (ASTM D2488; Table 8)
    - None – the dry specimen crumbles with the slightest pressure of handling
    - Low – the dry specimen crumbles with some finger pressure
    - Medium – the dry specimen breaks into pieces or crumbles with considerable finger pressure
    - High – the dry specimen cannot be broken with finger pressure. The specimen will break into pieces between the thumb and a hard surface.
    - Very High – the dry specimen cannot be broken between the thumb and a hard surface
  - Dilatency (ASTM D2488; Table 9)
    - None – no visible change in the specimen
    - Slow – water slowly appears on the surface of the specimen during shaking and does not disappear or disappears slowly upon squeezing
    - Rapid – water quickly appears on the surface of the specimen during shaking and disappears upon squeezing
  - Toughness (ASTM D2488; Table 10)
    - Low – only slight pressure is required to roll the thread near the plastic limit. The thread and the lump are weak and very soft.
    - Medium – medium pressure is required to roll the thread to near the plastic limit. The thread and the lump are soft.

        - High – considerable pressure is required to roll the thread to near the plastic limit. The thread and the lump are firm.

- **Plasticity** (ASTM D2488; Table 11)
    - Nonplastic – a 3 mm (0.12 inches) thread cannot be rolled at any water content
    - Low Plasticity – the thread can barely be rolled, and crumbles easily
    - Medium Plasticity – the thread is easy to roll and not much time is required to reach the plastic limit before crumbling
    - High Plasticity – it takes considerable time rolling and kneading to reach the plastic limit; the thread can be rolled several times before crumbling
- **Relative Density of Cohesionless (Granular) Soils**
    - Very loose – easily penetrated 30 cm (1.2 inches) with 13 mm (0.5 inch) rebar pushed by hand
    - Loose – easily penetrated several cm with 13 mm (0.5 inch) rebar pushed by hand
    - Medium dense – easily to moderately penetrated with 13 mm (0.5 inch) rebar driven by 2.3 kg (6 pound) hammer
    - Dense – penetrated 0.3 m (1 foot) with difficulty using 13 mm (0.5 inch) rebar driven by 2.3 kg (6 pound) hammer
    - Very dense – penetrated only a few cm with 13 mm (0.5 inch) rebar driven by 2.3 kg (6 pound) hammer
- **Color** (use Munsel® Color System)
- **Particle Size** (see Figure 3)
    - Boulder – larger than a basketball
    - Cobble – grapefruit, orange, volleyball
    - Coarse Gravel – tennis ball, grape
    - Fine Gravel – pea
    - Coarse Sand – rock salt

  - Medium Sand – opening in window screen
  - Fine Sand – sugar, table salt
  - Fines (silt and clay) – cannot visually determine size (unaided)
- **Gradation**
  - Well Graded (GW, SW) – full range and even distribution of grain sizes present
  - Poorly-graded (GP, SP) – narrow range of grain sizes present
  - Uniformly-graded (GP, SP) – consists predominantly of one grain size
  - Gap-graded (GP-SP) – within the range of grain sizes present, one or more sizes are missing
- **Organic Material** – Organic soils usually have a dark brown to black color and may have an organic odor. Often, organic soils will change color, for example, black to brown, when exposed to the air. Some organic soils will lighten in color significantly when air-dried. Organic soils normally will not have a high toughness or plasticity. The thread of the toughness test will be spongy.
  - PEAT – 50 to 100 percent organics by volume, primary constituent
  - Organic (soil name) – 15 to 50 percent organics by volume, secondary organic constituent
  - (Soil name) with some organics – 5 to 15 percent organics by volume, additional organic constituents
- **Fill Materials** – All soils should be examined to see if they contain materials indicative of man-made fills. Man-made fill items should be listed in each of the soil descriptions. Common fill indicators include glass, brick, dimensioned lumber, concrete, pavement sections, asphalt, metal, plastics, plaster etc. Other items that could suggest fill include buried vegetation mats, tree limbs, stumps etc. The soil description for a fill material should be followed by the term "FILL", i.e., for a sandy silt with some brick fragments the description would be "SANDY SILT (ML), with brick fragments (Fill)". The size and distribution of fill indicators should be noted. The limits (depth range) of fill material should be determined and identified at each exploration location.

- **Other Constituents/Characteristics**
  - Additional constituents and/or pertinent soil characteristics not included in the previous categories should be described depending on the scope and objectives of the project. Observations that may be discussed include:
    - Oxide staining
    - Odor
    - Origin
    - Presence of root cast
    - Presence of mica
    - Presence of gypsum
    - Presence of calcium carbonate
    - Percent by volume of cobbles & boulders with size description and appropriate rock classification
  - Other pertinent information from the exploratory program should be recorded, if it would be useful from a biddability/constructability perspective. The conditions that should be listed include caving or sloughing, difficulty in drilling and groundwater infiltration.

SOIL DESCRIPTIONS

Generally, soil descriptions presented in this FOP are not intended for civil engineering (construction) purposes, but rather for hydrogeologic and contaminant transport purposes. As such, the visual-manual tests performed are somewhat limited in that they are only performed in order to indicate important information about potential hydraulic properties of a soil. Therefore, at a minimum, soil descriptions should include:

- Color (using Munsell® charts) at moist condition, include mottling
- Field moisture condition;

- Percentage estimates of various grain sizes present (fines, sand, gravel);
- Plasticity (see Descriptive Terms section of this FOP);
- Consistency/Density (see Descriptive Terms section of this FOP);
- Other important geologic information such as consolidation, gravel size and shape, visible internal structure, root holes, mica, odors, etc.

Based on these data, and in conjunction with the flow charts provided in the ASTM Standard (see Figure 2), the soil is given a USCS group name and a two-letter symbol. If fill is identified, indicate the word FILL after the soil description (parenthetically).

The first step in this FOP is to determine if the sample is predominantly fine-grained or predominantly coarse-grained (see Figure 3). Coarse-grained soils are relatively easy to identify, however descriptions of fine-grained soils can be more difficult, requiring additional field tests to assist the field geologist arrive at the proper soils classification. These tests are explained in detail in the ASTM Standard. Generally, the differentiation between silt and clay is based on plasticity and "texture". However, tests for dry strength and dilatency, along with plasticity, can be very helpful and are recommended in the ASTM Standard. If additional tests are performed, in addition to plasticity, to classify the fines, record them with the soil description on the logs. Doing this will assist the reader (i.e., Project Manager) to follow the logic used to describe a soil (e.g., medium plasticity, <u>low</u> dry strength = elastic silt [MH]; not a lean clay [CL]).

Fines described in the classification should be modified by the plasticity (e.g., nonplastic fines, low plasticity fines, etc.) reserving the words "silt" and "clay" for the USCS group name. This applies to fine-grained and coarse-grained soils.

According to a note in the ASTM Standard, percentage of grain size can be estimated in ranges using the words "few", "little", "some" and "mostly". This FOP discourages the use of these modifiers based on practical reasons: (1) the range of percentages in a given word may cross a name designation on the flow charts used for classification, and (2) these words are meaningless to someone who does not have the obscure table in front of them for reference. Accordingly, this FOP encourages estimating grain sizes in percentages or range of percentages (e.g., "about or approximately 10% fine sand"; or "20-25% nonplastic fines). When estimating percentages of grain sizes, make sure that all of the estimates add up to 100%. Keep in mind, the "break over" percentages for fines in a coarse-grained soil and for sand or gravel in a fine-grained soil (refer to Figure 2). For example, do not say "10 to 20% nonplastic fines" when the "break over" occurs into a new USCS group name at 15% fines.

In summary, adhering to the ASTM Standard and the guidelines outlined in this FOP will provide uniformity in soil descriptions of field personnel. Pertinent criteria and their appropriate order are provided at the top of each boring log field sheet. Prior to mobilization to the field, field staff should make sure to have laminated copies of the ASTM Standard flow charts and tables as well as this FOP (as necessary). Some examples of complete soil descriptions are as follows:

Coarse-grained Soil

CLAYEY GRAVEL with SAND (GC): dark olive gray (5Y 3/2), wet, about 50% fine to coarse gravel, about 30% fine sand, about 20% low plasticity fines, subrounded gravel to 2-inch diameter of greenstone and chert.

Fine-grained Soil

LEAN CLAY with SAND (CL): dark olive gray (5Y 3/2), moist, about 80% fines, about 20% fine to medium sand, trace fine gravel, medium plasticity, firm, root holes.

BORING AND MONITORING WELL INSTALLATION LOGS

One of the most important functions of a boring/monitoring well installation log, besides transmitting the soil description, is to show where the "data" (soil samples) were collected, giving the reader an idea of how reliable or representative the description is. An example of a completed boring and monitoring well installation log is attached to this FOP.

On the example and sample logs, depths of attempted and recovered or non-recovered interval are shown. Do not include the "water level" symbol (inverted triangle) on the logs; instead, indicate the depth at which groundwater was first encountered and, as necessary, the depth to water at borehole/monitoring completion in the space provided on the log header. Also shown on the example and sample logs is the symbol for samples collected for chemical analysis and PID scan measurements. Odor, if noted, will be shown on the logs in the soil description; however, odor, if noted, is subjective and not necessarily indicative of specific compounds or concentrations. Also attached to this FOP is a disclaimer and log symbols used, which should be provided with each set of logs within the project final report.

Remember: field borehole/monitoring well installation logs should be NEAT, ACCURATE, and LEGIBLE. Don't forget that the well completion diagram completed for each well requires details of the surface completion (i.e., flush-mount, stick-up etc.). It is the responsibility of the field staff to double-check each log (i.e., percentages, classifications, well construction details etc.) prior to implementing into a final report. A registered professional (i.e., professional engineer, PE or professional geologist, PG) must review each log and will be ultimately responsible for its content and accuracy.

REQUIRED EQUIPMENT

- Knife
- Engineer's rule/measuring tape
- Permanent marker
- Pre-cleaned wide-mouth sample jars (typically provided by the driller)
- Pre-cleaned wide-mouth laboratory sample jars (provided by the laboratory)
- Stainless steel sampling equipment (i.e., spoons, spatulas, bowls etc.)
- 10x hand lens
- Hydrochloric acid
- ASTM D2488 flow charts (preferably laminated)
- ASTM D2488 test procedures (Tables 1 through 12) (preferably laminated)
- Camera (disposable, 35 mm or digital)
- Munsell soil color chart
- Project Field Book/field forms

ATTACHMENTS

Figure 1; Field Guide for Soil and Stratigraphic Analysis
Figure 2; USCS Soil Classification Flow Chart (modified from ASTM D2488)
Figure 3; Illustration of Particle Sizes

Field Borehole Log Explanation
Field Borehole Log (sample)
Field Borehole Log (completed example)
Field Borehole/Monitoring Well Installation Log Explanation
Field Borehole/Monitoring Well Installation Log (sample)
Field Borehole/Monitoring Well Installation Log (completed example)

REFERENCES

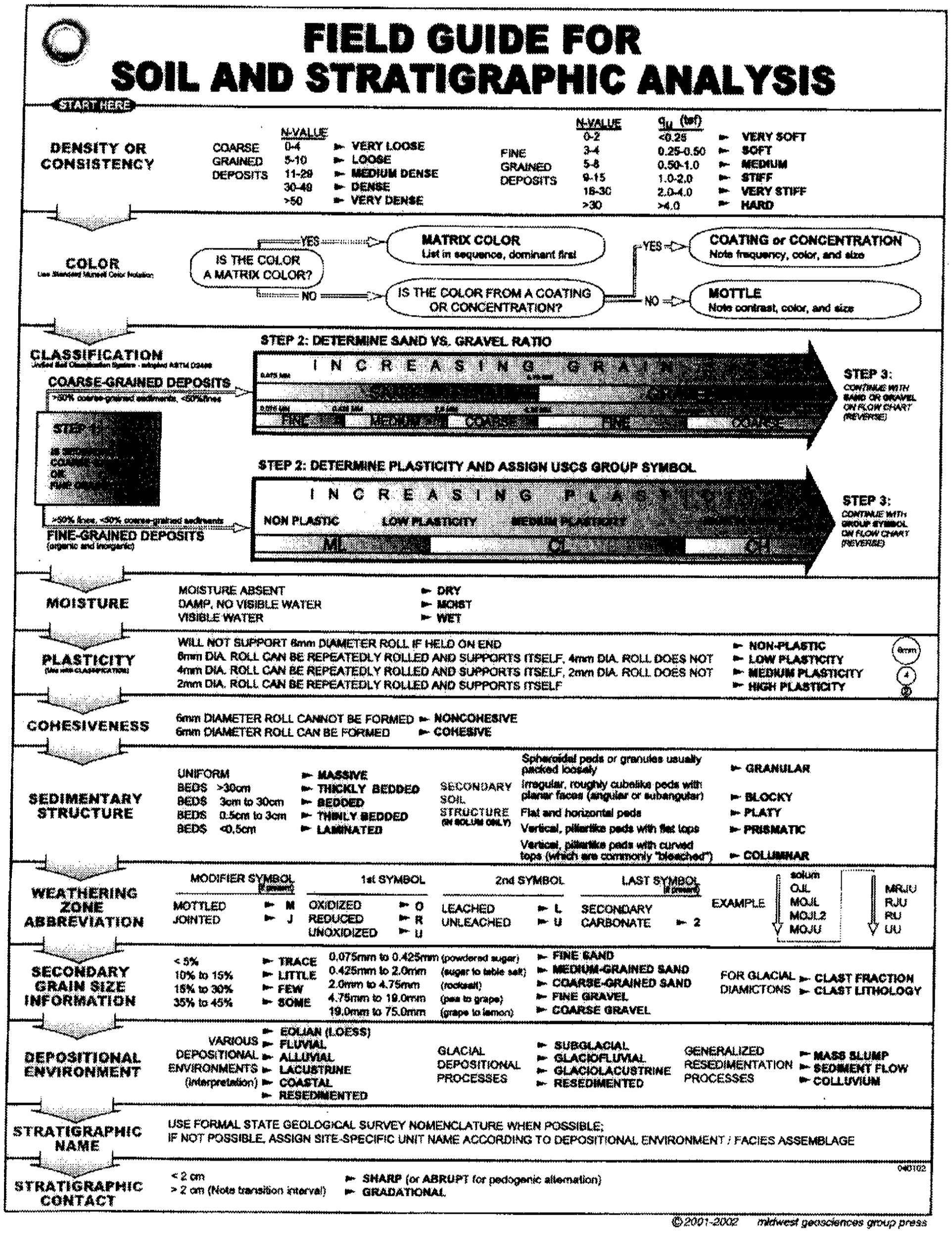
American Society for Testing and Materials, 2000. *ASTM D2488: Standard Practice for Description and Identification of Soils (Visual-Manual Procedure).*

State of California, Department of Transportation, Engineering Service Center, Office of Structural Foundations, August 1996. *Soil & Rock Logging Classification Manual (Field Guide), by Joseph C. de Larios.*

Benchmark FOPs:
010 *Calibration and Maintenance of Portable Flame Ionization Detector*
011 *Calibration and Maintenance of Portable Photoionization Detector*
015 *Documentation Requirements for Drilling and Well Installation*
025 *Hand Augering Procedures*
032 *Management of Investigation-Derived Waste*
046 *Sample Labeling, Storage and Shipment Procedures*
047 *Screening of Soil Samples for Organic Vapors During Drilling Activities*
058 *Split-Spoon Sampling Procedures*
065 *Test Pit Excavation and Logging Procedures*

FIGURE 1

FIELD GUIDE FOR SOIL AND STRATIGRAPHIC ANALYSIS



FIELD GUIDE FOR SOIL AND STRATIGRAPHIC ANALYSIS

START HERE

DENSITY OR CONSISTENCY

COARSE GRAINED DEPOSITS N-VALUE	
0-4	► VERY LOOSE
5-10	► LOOSE
11-29	► MEDIUM DENSE
30-49	► DENSE
>50	► VERY DENSE

FINE GRAINED DEPOSITS N-VALUE	q_u (tsf)	
0-2	<0.25	► VERY SOFT
3-4	0.25-0.50	► SOFT
5-8	0.50-1.0	► MEDIUM
9-15	1.0-2.0	► STIFF
16-30	2.0-4.0	► VERY STIFF
>30	>4.0	► HARD

COLOR
Use Standard Munsell Color Notation

IS THE COLOR A MATRIX COLOR?
YES ⇒ MATRIX COLOR — List in sequence, dominant first
NO ⇒ IS THE COLOR FROM A COATING OR CONCENTRATION?
YES ⇒ COATING or CONCENTRATION — Note frequency, color, and size
NO ⇒ MOTTLE — Note contrast, color, and size

CLASSIFICATION
Unified Soil Classification System - adapted ASTM D2488

COARSE-GRAINED DEPOSITS
>50% coarse-grained sediments, <50% fines

STEP 2: DETERMINE SAND VS. GRAVEL RATIO
INCREASING GRAIN
FINE MEDIUM COARSE FINE COARSE
STEP 3: CONTINUE WITH SAND OR GRAVEL ON FLOW CHART (REVERSE)

STEP 1:

FINE-GRAINED DEPOSITS
(organic and inorganic)
>50% fines, <50% coarse-grained sediments

STEP 2: DETERMINE PLASTICITY AND ASSIGN USCS GROUP SYMBOL
INCREASING PLASTICITY
NON PLASTIC LOW PLASTICITY MEDIUM PLASTICITY
ML CL CH
STEP 3: CONTINUE WITH GROUP SYMBOL ON FLOW CHART (REVERSE)

MOISTURE

MOISTURE ABSENT	► DRY
DAMP, NO VISIBLE WATER	► MOIST
VISIBLE WATER	► WET

PLASTICITY
Use with CLASSIFICATION

WILL NOT SUPPORT 6mm DIAMETER ROLL IF HELD ON END	► NON-PLASTIC
6mm DIA. ROLL CAN BE REPEATEDLY ROLLED AND SUPPORTS ITSELF, 4mm DIA. ROLL DOES NOT	► LOW PLASTICITY
4mm DIA. ROLL CAN BE REPEATEDLY ROLLED AND SUPPORTS ITSELF, 2mm DIA. ROLL DOES NOT	► MEDIUM PLASTICITY
2mm DIA. ROLL CAN BE REPEATEDLY ROLLED AND SUPPORTS ITSELF	► HIGH PLASTICITY

6mm 4 2

COHESIVENESS

6mm DIAMETER ROLL CANNOT BE FORMED	► NONCOHESIVE
6mm DIAMETER ROLL CAN BE FORMED	► COHESIVE

SEDIMENTARY STRUCTURE

UNIFORM	► MASSIVE
BEDS >30cm	► THICKLY BEDDED
BEDS 3cm to 30cm	► BEDDED
BEDS 0.5cm to 3cm	► THINLY BEDDED
BEDS <0.5cm	► LAMINATED

SECONDARY SOIL STRUCTURE (IN SOLUM ONLY)

Spheroidal peds or granules usually packed loosely	► GRANULAR
Irregular, roughly cubelike peds with planar faces (angular or subangular)	► BLOCKY
Flat and horizontal peds	► PLATY
Vertical, pillarlike peds with flat tops	► PRISMATIC
Vertical, pillarlike peds with curved tops (which are commonly "bleached")	► COLUMNAR

WEATHERING ZONE ABBREVIATION

MODIFIER SYMBOL (if present)		1st SYMBOL		2nd SYMBOL		LAST SYMBOL (if present)	
MOTTLED	► M	OXIDIZED	► O	LEACHED	► L	SECONDARY CARBONATE	► 2
JOINTED	► J	REDUCED	► R	UNLEACHED	► U		
		UNOXIDIZED	► U				

EXAMPLE
solum
OJL
MOJL
MOJL2
MOJU

MRJU
RJU
RU
UU

SECONDARY GRAIN SIZE INFORMATION

< 5%	► TRACE
10% to 15%	► LITTLE
15% to 30%	► FEW
35% to 45%	► SOME

0.075mm to 0.425mm	(powdered sugar)	► FINE SAND
0.425mm to 2.0mm	(sugar to table salt)	► MEDIUM-GRAINED SAND
2.0mm to 4.75mm	(rocksalt)	► COARSE-GRAINED SAND
4.75mm to 19.0mm	(pea to grape)	► FINE GRAVEL
19.0mm to 75.0mm	(grape to lemon)	► COARSE GRAVEL

FOR GLACIAL DIAMICTONS
► CLAST FRACTION
► CLAST LITHOLOGY

DEPOSITIONAL ENVIRONMENT

VARIOUS DEPOSITIONAL ENVIRONMENTS (interpretation)
► EOLIAN (LOESS)
► FLUVIAL
► ALLUVIAL
► LACUSTRINE
► COASTAL
► RESEDIMENTED

GLACIAL DEPOSITIONAL PROCESSES
► SUBGLACIAL
► GLACIOFLUVIAL
► GLACIOLACUSTRINE
► RESEDIMENTED

GENERALIZED RESEDIMENTATION PROCESSES
► MASS SLUMP
► SEDIMENT FLOW
► COLLUVIUM

STRATIGRAPHIC NAME

USE FORMAL STATE GEOLOGICAL SURVEY NOMENCLATURE WHEN POSSIBLE;
IF NOT POSSIBLE, ASSIGN SITE-SPECIFIC UNIT NAME ACCORDING TO DEPOSITIONAL ENVIRONMENT / FACIES ASSEMBLAGE

STRATIGRAPHIC CONTACT

< 2 cm	► SHARP (or ABRUPT for pedogenic alteration)
> 2 cm (Note transition interval)	► GRADATIONAL

040102

FIGURE 2

USCS SOIL CLASSIFICATION FLOW CHART (MODIFIED FROM ASTM D2488)

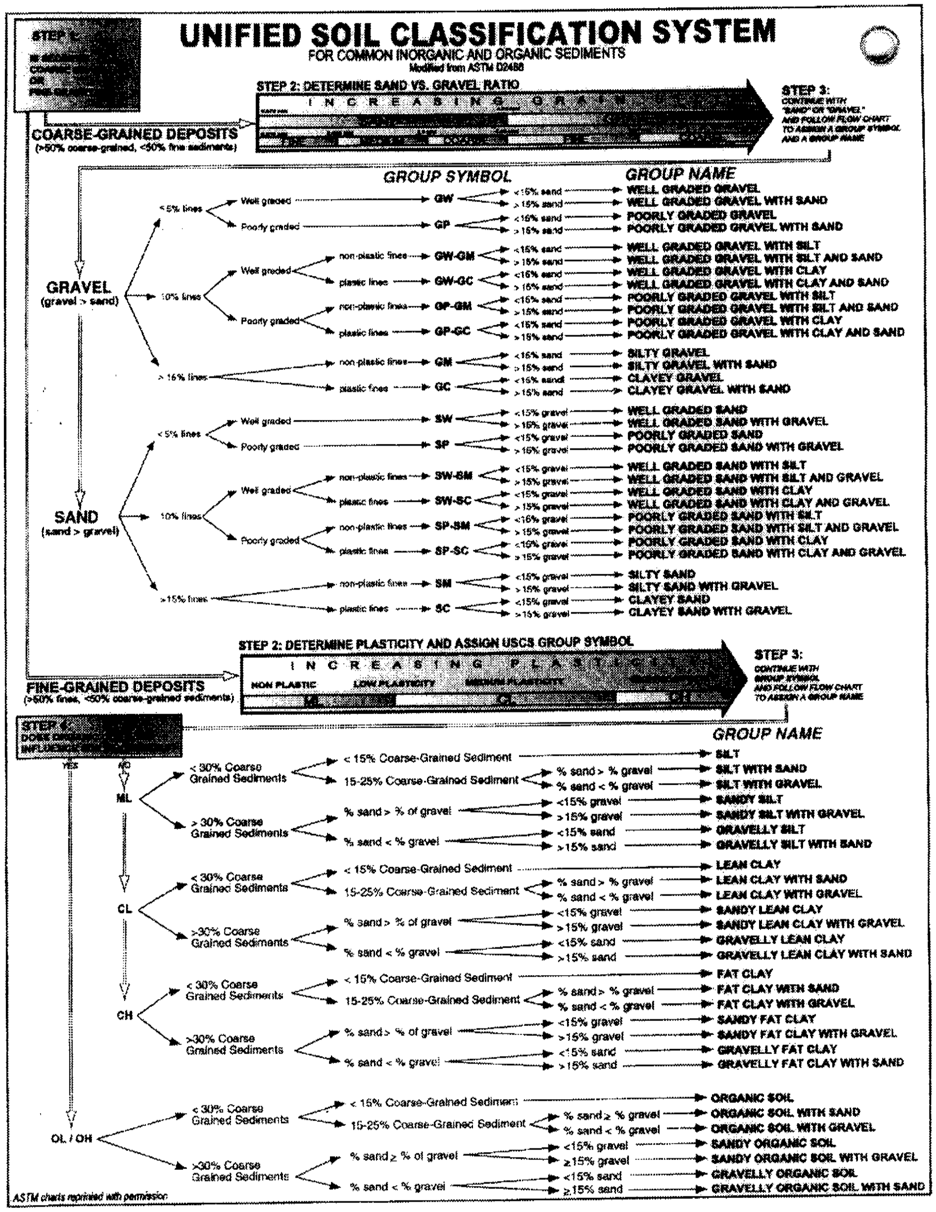
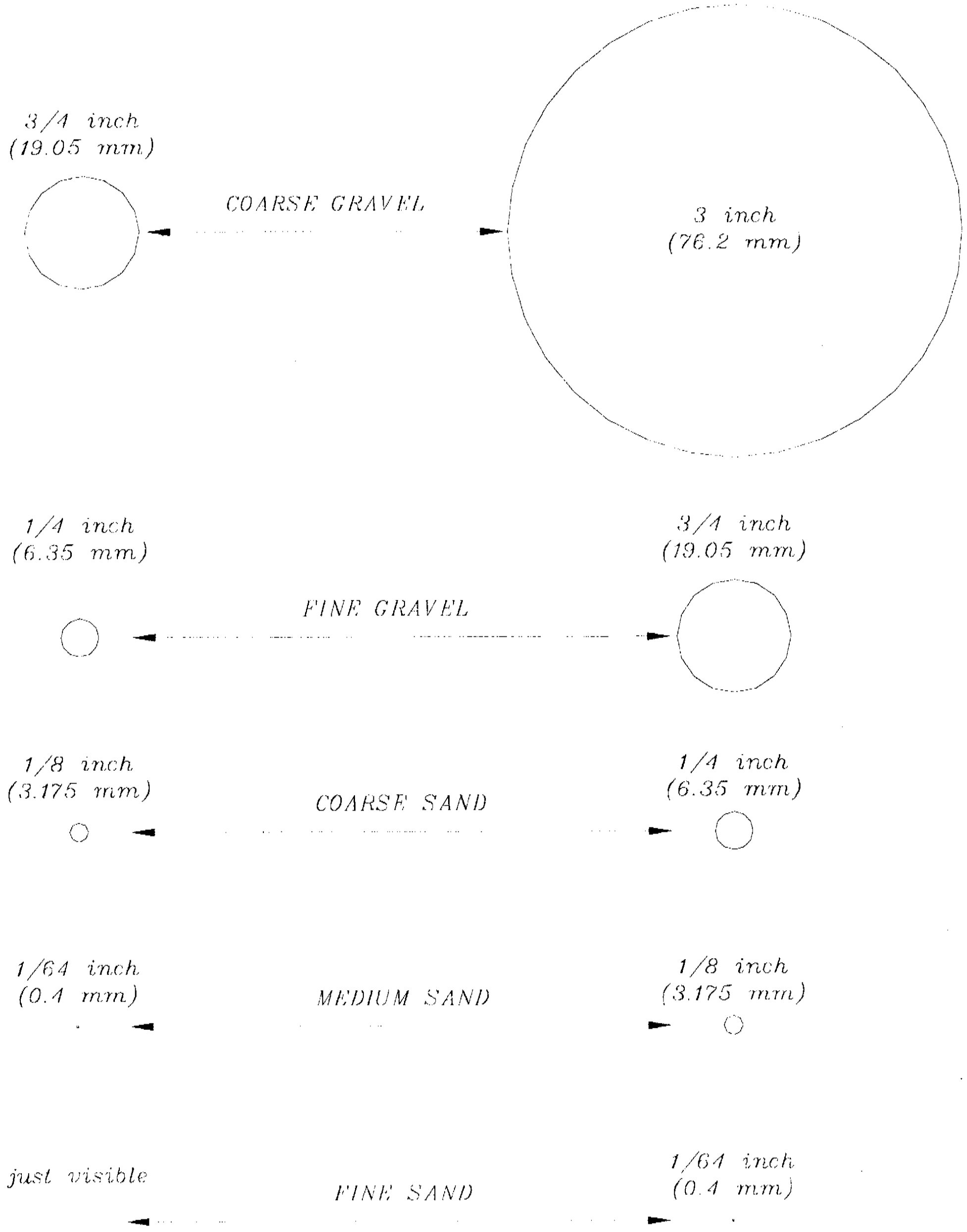
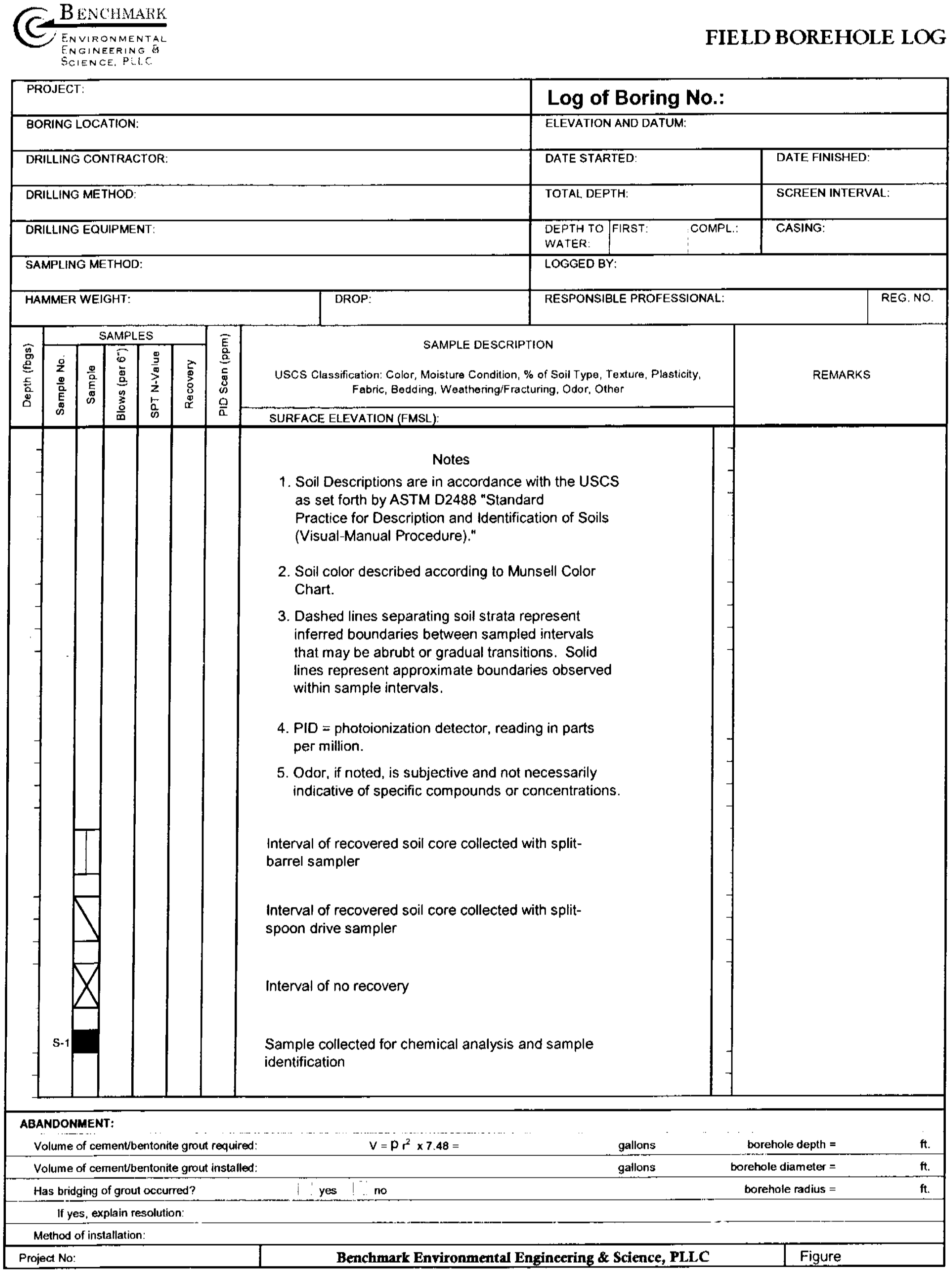


FIGURE 3

ILLUSTRATION OF PARTICLE SIZES





BENCHMARK
ENVIRONMENTAL ENGINEERING & SCIENCE, PLLC

FIELD BOREHOLE LOG

PROJECT:	**Log of Boring No.:**		
BORING LOCATION:	ELEVATION AND DATUM:		
DRILLING CONTRACTOR:	DATE STARTED:	DATE FINISHED:	
DRILLING METHOD:	TOTAL DEPTH:	SCREEN INTERVAL:	
DRILLING EQUIPMENT:	DEPTH TO WATER: FIRST: COMPL.:	CASING:	
SAMPLING METHOD:	LOGGED BY:		
HAMMER WEIGHT: DROP:	RESPONSIBLE PROFESSIONAL:		REG. NO.

Depth (fbgs)	SAMPLES					PID Scan (ppm)	SAMPLE DESCRIPTION USCS Classification: Color, Moisture Condition, % of Soil Type, Texture, Plasticity, Fabric, Bedding, Weathering/Fracturing, Odor, Other SURFACE ELEVATION (FMSL):	REMARKS
	Sample No.	Sample	Blows (per 6")	SPT N-Value	Recovery			

Notes

1. Soil Descriptions are in accordance with the USCS as set forth by ASTM D2488 "Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)."
2. Soil color described according to Munsell Color Chart.
3. Dashed lines separating soil strata represent inferred boundaries between sampled intervals that may be abrupt or gradual transitions. Solid lines represent approximate boundaries observed within sample intervals.
4. PID = photoionization detector, reading in parts per million.
5. Odor, if noted, is subjective and not necessarily indicative of specific compounds or concentrations.

Interval of recovered soil core collected with split-barrel sampler

Interval of recovered soil core collected with split-spoon drive sampler

Interval of no recovery

S-1 Sample collected for chemical analysis and sample identification

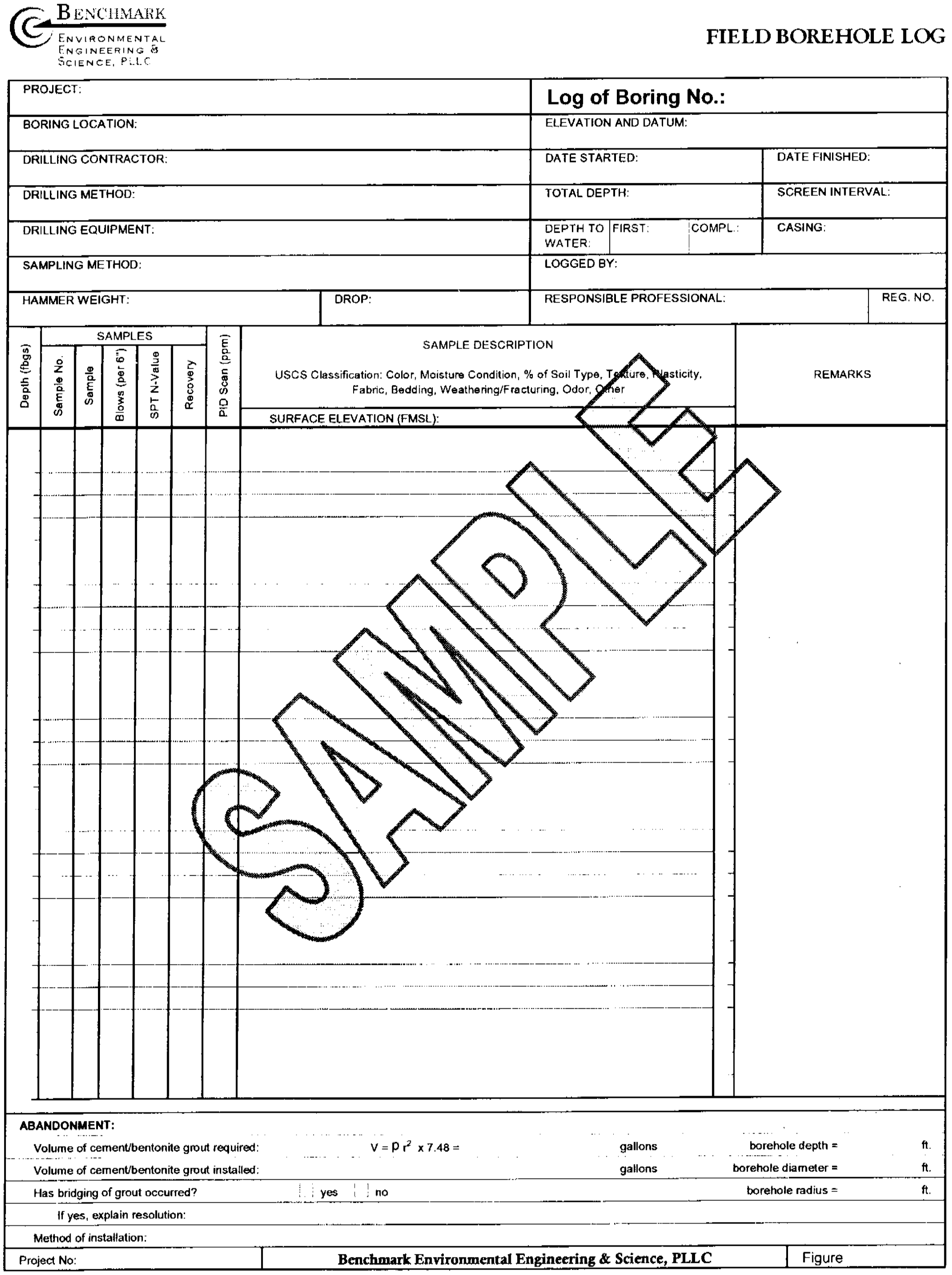
ABANDONMENT:

Volume of cement/bentonite grout required:	V = p r² x 7.48 =	gallons	borehole depth = ft.
Volume of cement/bentonite grout installed:		gallons	borehole diameter = ft.
Has bridging of grout occurred?	☐ yes ☐ no		borehole radius = ft.

If yes, explain resolution:

Method of installation:

Project No:	**Benchmark Environmental Engineering & Science, PLLC**	Figure



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FIELD BOREHOLE LOG

PROJECT:		**Log of Boring No.:**	
BORING LOCATION:		ELEVATION AND DATUM:	
DRILLING CONTRACTOR:		DATE STARTED:	DATE FINISHED:
DRILLING METHOD:		TOTAL DEPTH:	SCREEN INTERVAL:
DRILLING EQUIPMENT:		DEPTH TO WATER: FIRST: COMPL.:	CASING:
SAMPLING METHOD:		LOGGED BY:	
HAMMER WEIGHT:	DROP:	RESPONSIBLE PROFESSIONAL:	REG. NO.

Depth (fbgs)	SAMPLES Sample No.	Sample	Blows (per 6")	SPT N-Value	Recovery	PID Scan (ppm)	SAMPLE DESCRIPTION USCS Classification: Color, Moisture Condition, % of Soil Type, Texture, Plasticity, Fabric, Bedding, Weathering/Fracturing, Odor, Other SURFACE ELEVATION (FMSL):	REMARKS

ABANDONMENT:

Volume of cement/bentonite grout required: $V = \rho r^2 \times 7.48 =$ gallons borehole depth = ft.

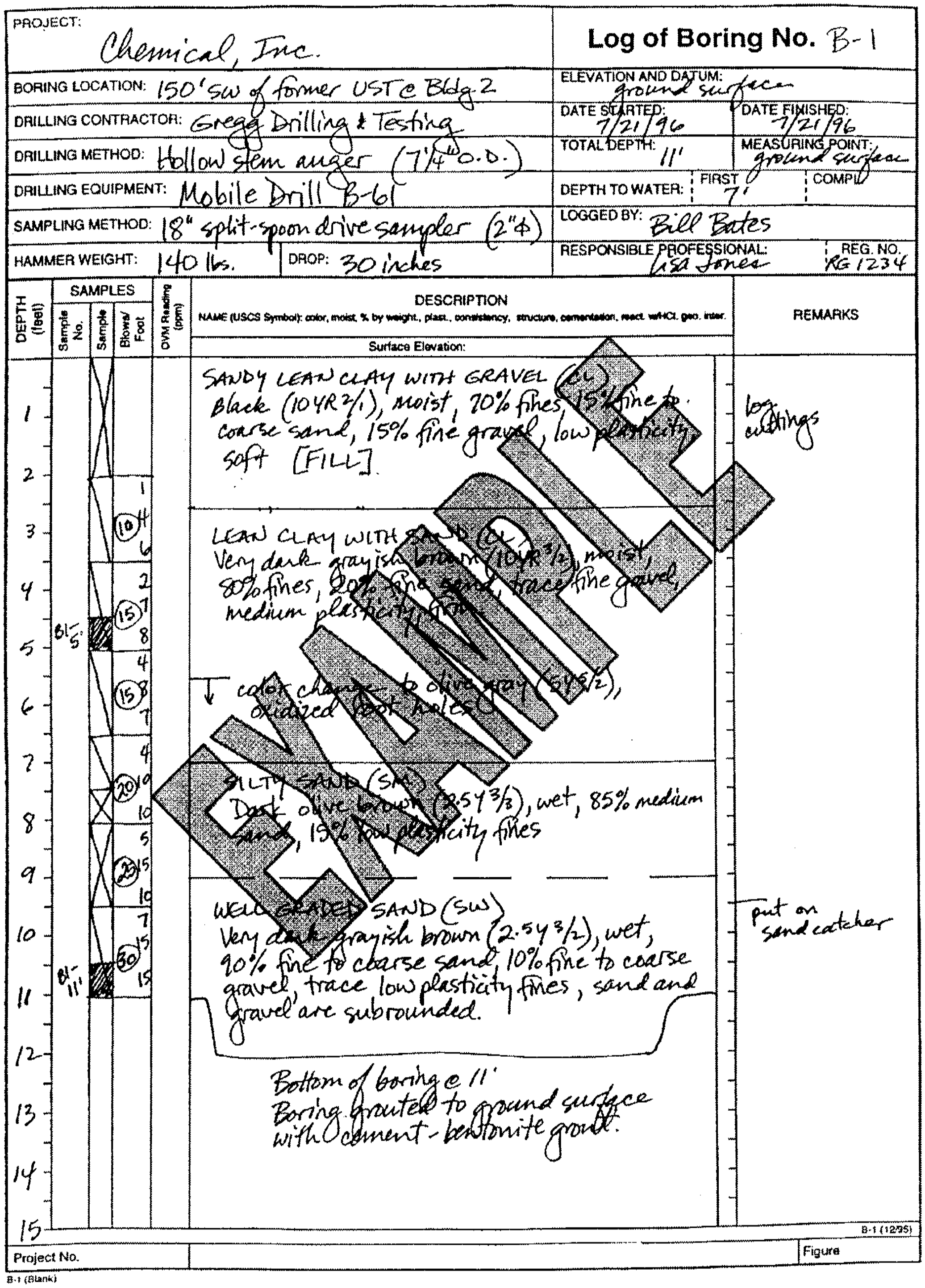
Volume of cement/bentonite grout installed: gallons borehole diameter = ft.

Has bridging of grout occurred? ☐ yes ☐ no borehole radius = ft.

If yes, explain resolution:

Method of installation:

Project No:	**Benchmark Environmental Engineering & Science, PLLC**	Figure



PROJECT: Chemical, Inc.	**Log of Boring No.** B-1
BORING LOCATION: 150' SW of former UST @ Bldg. 2	ELEVATION AND DATUM: ground surface
DRILLING CONTRACTOR: Gregg Drilling & Testing	DATE STARTED: 7/21/96 DATE FINISHED: 7/21/96
DRILLING METHOD: Hollow stem auger (7¼" O.D.)	TOTAL DEPTH: 11' MEASURING POINT: ground surface
DRILLING EQUIPMENT: Mobile Drill B-61	DEPTH TO WATER: FIRST 7' COMPL.
SAMPLING METHOD: 18" split-spoon drive sampler (2"φ)	LOGGED BY: Bill Bates
HAMMER WEIGHT: 140 lbs. DROP: 30 inches	RESPONSIBLE PROFESSIONAL: Lisa Jones REG. NO. RG 1234

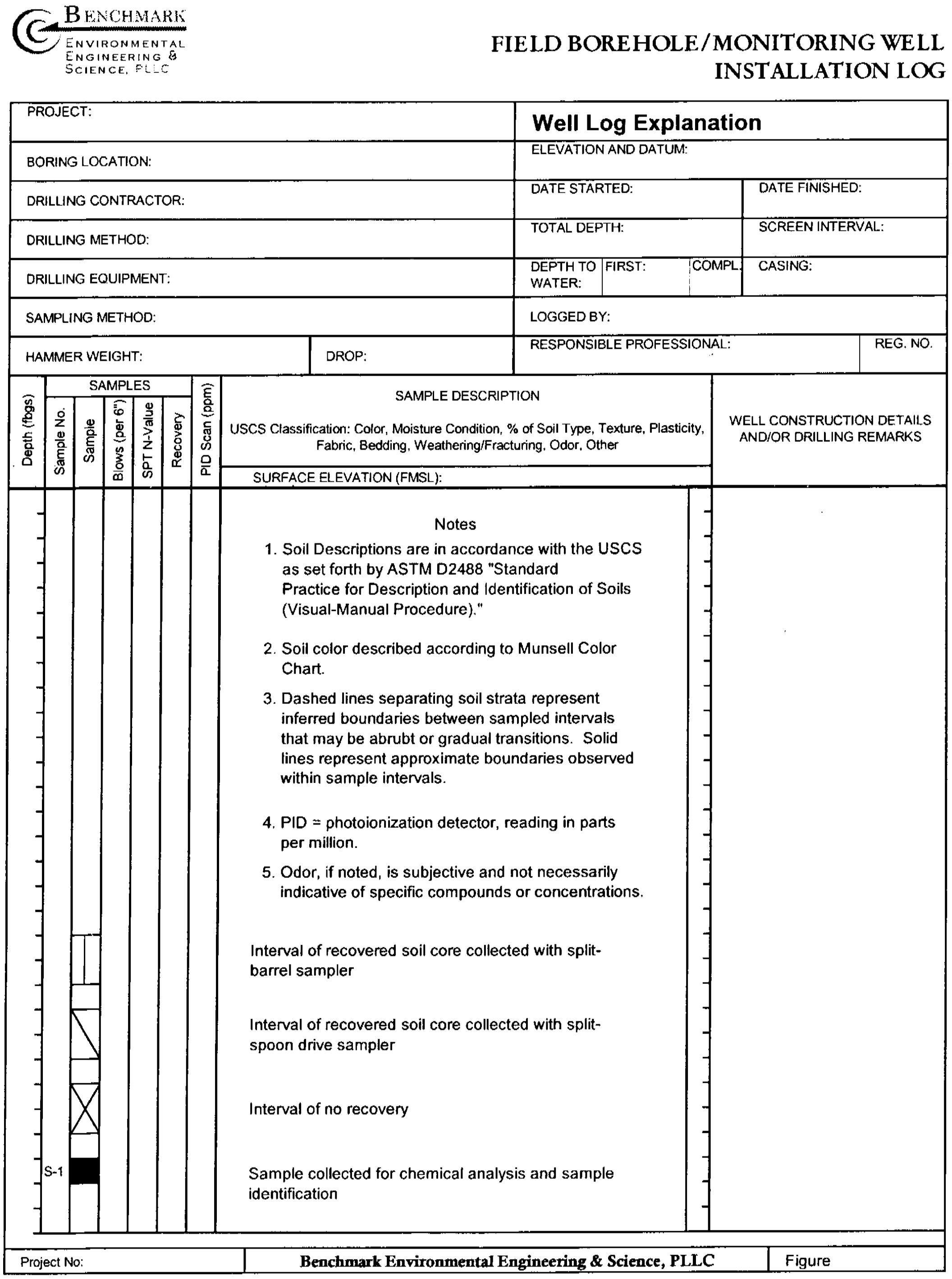
DEPTH (feet)	SAMPLES: Sample No.	SAMPLES: Blows/ Foot	OVM Reading (ppm)	DESCRIPTION NAME (USCS Symbol): color, moist, % by weight., plast., consistency, structure, cementation, react. w/HCl, geo. inter. Surface Elevation:	REMARKS
1 2				SANDY LEAN CLAY WITH GRAVEL (CL) Black (10YR 2/1), moist, 70% fines, 15% fine to coarse sand, 15% fine gravel, low plasticity, soft [FILL]	log cuttings
3 4 5 6 7	B1-5'	1 ⑩ 4 6 2 ⑮ 7 8 4 ⑮ 8 7		LEAN CLAY WITH SAND (CL) Very dark grayish brown (10YR 3/2), moist, 80% fines, 20% fine sand, trace fine gravel, medium plasticity, firm ↓ color change to olive gray (5Y 5/2), oxidized root holes	
8 9		4 ⑳ 10 10 5 ㉕ 15 10		SILTY SAND (SM) Dark olive brown (2.5Y 3/3), wet, 85% medium sand, 15% low plasticity fines	
10 11	B1-11'	7 ㉚ 15 15		WELL GRADED SAND (SW) Very dark grayish brown (2.5Y 3/2), wet, 90% fine to coarse sand, 10% fine to coarse gravel, trace low plasticity fines, sand and gravel are subrounded.	put on sand catcher
12 13 14 15				Bottom of boring @ 11' Boring grouted to ground surface with cement-bentonite grout.	

B-1 (12/95)

Project No.

Figure

B-1 (Blank)



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FIELD BOREHOLE/MONITORING WELL INSTALLATION LOG

PROJECT:		**Well Log Explanation**			
BORING LOCATION:		ELEVATION AND DATUM:			
DRILLING CONTRACTOR:		DATE STARTED:		DATE FINISHED:	
DRILLING METHOD:		TOTAL DEPTH:		SCREEN INTERVAL:	
DRILLING EQUIPMENT:		DEPTH TO WATER:	FIRST:	COMPL.	CASING:
SAMPLING METHOD:		LOGGED BY:			
HAMMER WEIGHT:	DROP:	RESPONSIBLE PROFESSIONAL:			REG. NO.

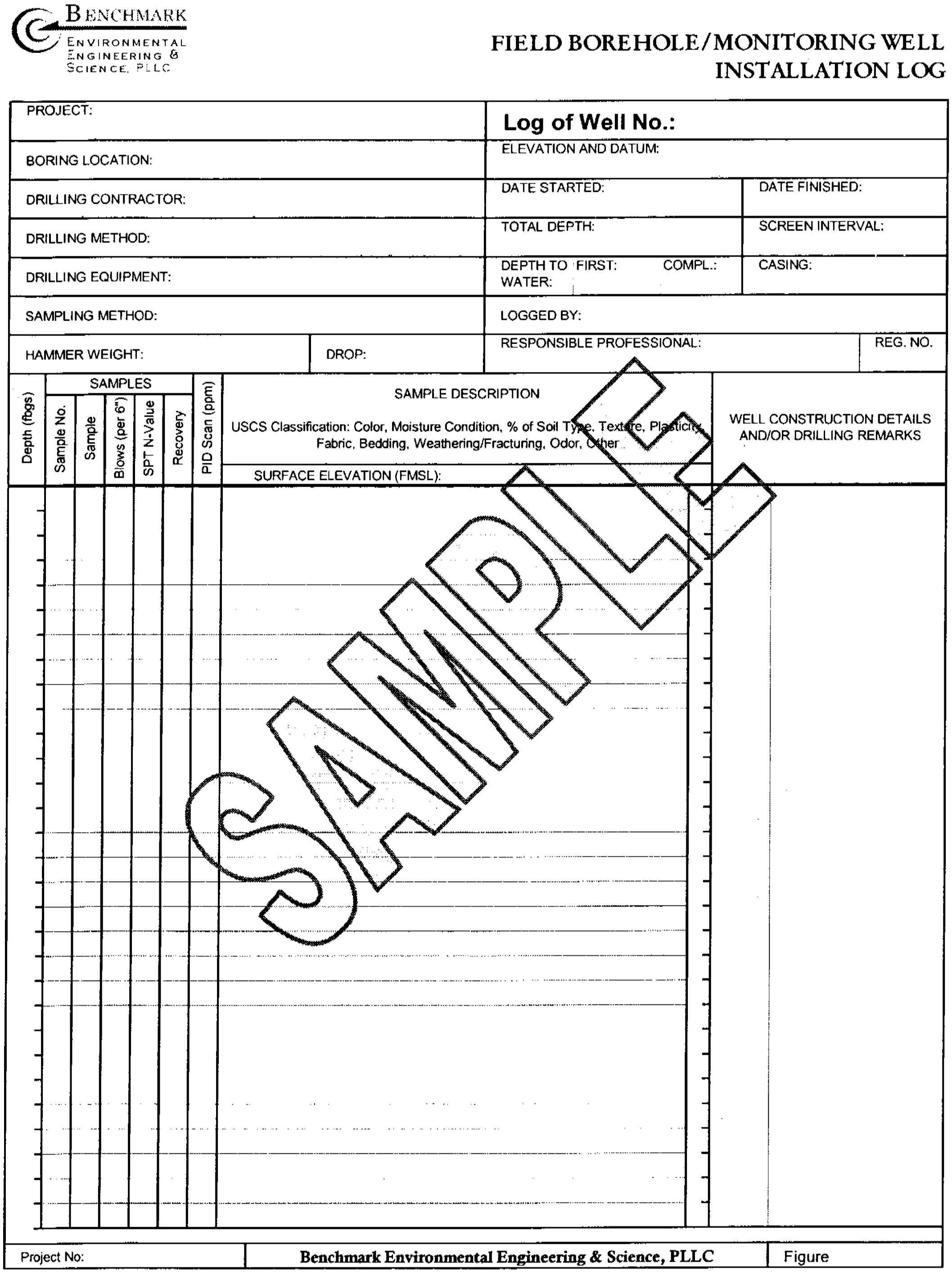
Depth (fbgs)	SAMPLES					PID Scan (ppm)	SAMPLE DESCRIPTION USCS Classification: Color, Moisture Condition, % of Soil Type, Texture, Plasticity, Fabric, Bedding, Weathering/Fracturing, Odor, Other SURFACE ELEVATION (FMSL):	WELL CONSTRUCTION DETAILS AND/OR DRILLING REMARKS
	Sample No.	Sample	Blows (per 6")	SPT N-Value	Recovery			

Notes

1. Soil Descriptions are in accordance with the USCS as set forth by ASTM D2488 "Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)."
2. Soil color described according to Munsell Color Chart.
3. Dashed lines separating soil strata represent inferred boundaries between sampled intervals that may be abrupt or gradual transitions. Solid lines represent approximate boundaries observed within sample intervals.
4. PID = photoionization detector, reading in parts per million.
5. Odor, if noted, is subjective and not necessarily indicative of specific compounds or concentrations.

Sample No.	Sample	
	▯	Interval of recovered soil core collected with split-barrel sampler
	⧅	Interval of recovered soil core collected with split-spoon drive sampler
	☒	Interval of no recovery
S-1	■	Sample collected for chemical analysis and sample identification

Project No:	**Benchmark Environmental Engineering & Science, PLLC**	Figure



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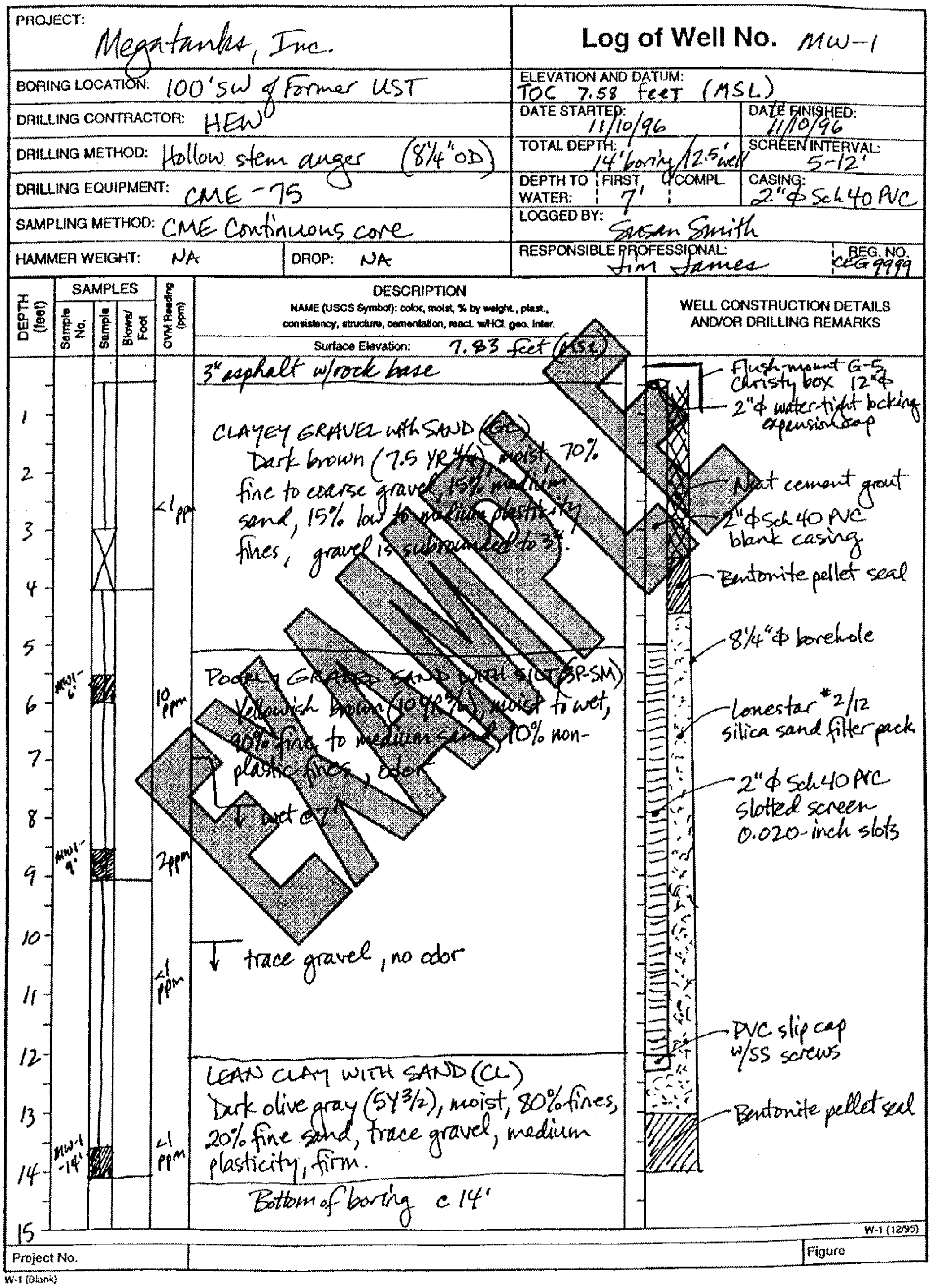
FIELD BOREHOLE/MONITORING WELL INSTALLATION LOG

PROJECT:
Log of Well No.:
BORING LOCATION:
ELEVATION AND DATUM:
DRILLING CONTRACTOR:
DATE STARTED:
DATE FINISHED:
DRILLING METHOD:
TOTAL DEPTH:
SCREEN INTERVAL:
DRILLING EQUIPMENT:
DEPTH TO WATER: FIRST: COMPL.:
CASING:
SAMPLING METHOD:
LOGGED BY:
HAMMER WEIGHT:
DROP:
RESPONSIBLE PROFESSIONAL:
REG. NO.

Depth (fbgs)	SAMPLES					PID Scan (ppm)	SAMPLE DESCRIPTION USCS Classification: Color, Moisture Condition, % of Soil Type, Texture, Plasticity, Fabric, Bedding, Weathering/Fracturing, Odor, Other	WELL CONSTRUCTION DETAILS AND/OR DRILLING REMARKS
	Sample No.	Sample	Blows (per 6")	SPT N-Value	Recovery		SURFACE ELEVATION (FMSL):	

Project No:
Benchmark Environmental Engineering & Science, PLLC
Figure



PROJECT: Megatanks, Inc.

Log of Well No. MW-1

BORING LOCATION: 100' SW of Former UST

ELEVATION AND DATUM: TOC 7.58 feet (MSL)

DRILLING CONTRACTOR: HEW

DATE STARTED: 11/10/96

DATE FINISHED: 11/10/96

DRILLING METHOD: Hollow stem auger (8¼" OD)

TOTAL DEPTH: 14' boring/12.5' well

SCREEN INTERVAL: 5-12'

DRILLING EQUIPMENT: CME-75

DEPTH TO WATER: FIRST 7' COMPL.

CASING: 2"Φ Sch 40 PVC

SAMPLING METHOD: CME Continuous core

LOGGED BY: Susan Smith

HAMMER WEIGHT: NA

DROP: NA

RESPONSIBLE PROFESSIONAL: Jim James

REG. NO. CEG 9999

DEPTH (feet)	SAMPLES Sample No.	OVM Reading (ppm)	DESCRIPTION NAME (USCS Symbol): color, moist, % by weight, plast., consistency, structure, cementation, react. w/HCl, geo. inter. Surface Elevation: 7.83 feet (MSL)	WELL CONSTRUCTION DETAILS AND/OR DRILLING REMARKS
			3" asphalt w/rock base	Flush-mount G-5 Christy box 12"Φ 2"Φ water-tight locking expansion cap
1			CLAYEY GRAVEL with SAND (GC) Dark brown (7.5 YR 4/4), moist, 70% fine to coarse gravel, 15% medium sand, 15% low to medium plasticity fines, gravel is subrounded to 3".	
2		<1 ppm		Neat cement grout 2"Φ Sch 40 PVC blank casing
3				
4				Bentonite pellet seal
5				8¼"Φ borehole
6	MW1-6'	10 ppm	POORLY GRADED SAND WITH SILT (SP-SM) Yellowish brown (10YR 5/6), moist to wet, 90% fine to medium sand, 10% non-plastic fines, odor	Lonestar #2/12 silica sand filter pack
7			↓ wet @ 7'	
8				2"Φ Sch40 PVC slotted screen 0.020-inch slots
9	MW1-9'	2ppm		
10			↓ trace gravel, no odor	
11		<1 ppm		
12				PVC slip cap w/SS screws
13			LEAN CLAY WITH SAND (CL) Dark olive gray (5Y 3/2), moist, 80% fines, 20% fine sand, trace gravel, medium plasticity, firm.	Bentonite pellet seal
14	MW-1-14'	<1 ppm	Bottom of boring @ 14'	
15				

W-1 (12/95)

Project No.

Figure

W-1 (Blank)

FOP 055.0

SOIL GAS SURVEY PROCEDURES (ACTIVE & PASSIVE)

PURPOSE

This guideline presents a method to identify concentrations (ppm) of total volatile organic contaminants (VOCs) in the shallow subsurface. Prior to initiating the soil gas survey, a survey grid system is established for location control. The grid system typically consists of equally spaced stakes or pin flags placed at 50-foot nodes across the site. However, the soil gas survey is typically conducted at a 25-foot spacing and can easily be conducted within the 50-foot spaced site grid. The soil gas survey can be conducted with a photoionization detector (PID), flame-ionization detector (FID), explosimeter (LEL) and/or passive soil gas techniques (viz. Gore-Sorber®) depending on the requirements presented in the Project Work Plan.

ACTIVE SOIL GAS SURVEY PROCEDURES

1. Conduct tailgate health and safety meeting with project team by completing the Tailgate Safety Meeting Form (sample attached).
2. Calibrate air-monitoring equipment in accordance with the appropriate Benchmark's Field Operating Procedures or manufacturers recommendations for calibration of field meters.
3. Establish sampling grid at 25-foot spacing by marking each node with a stake or pin flag over the entire area of concern. Larger or smaller grids may be established as required by the Project Work Plan.
4. At each grid node/sample point, advance a test hole to a maximum depth of 36-inches using a slam hammer and steel rod (i.e., slam bar) approximately 0.75-inches in diameter. Obstructions may prevent maximum penetration so several attempts may be required.

5. Withdraw the slam bar and insert a Teflon® intake probe to approximately 24-inches below ground surface making sure not to touch the bottom or contact shallow/perched groundwater.

6. Plug the top of the hole with a rubber or cork stopper attached to the intake probe to prevent escape of soil gases.

7. Activate the PID/FID/LEL meter and connect to the Teflon® intake probe with tygon (or similar) tubing. Draw soil gas into the instrument and record the highest value observed on the Soil Gas Survey Log (sample attached). This may take several minutes, as the meter will have to purge ambient air from the tubing.

8. Remove the intake probe from the test hole and flush the meter with clean ambient air until readings return to the background level.

9. Repeat Steps 4 through 8 until all sample locations have been analyzed.

PASSIVE SOIL GAS SURVEY PROCEDURES

Passive soil gas techniques provide a more sensitive and representative means of measuring soil gases. Typically, passive methods involve integrated sampling over time and collection of the sample on an adsorbent material. This combination provides high sensitivity to volatile as well as semi-volatile organics, allows for success on sites with low soil permeability and minimizes fluctuations in soil gas availability due to changing ambient and subsurface conditions. Also, passive soil gas sampling does not disrupt the natural equilibrium of vapors in the subsurface, as is the case with active sampling methods. This procedures utilizes Gore-Sorber® modules installed in a grid pattern and left in place for a recommended time.

1. Conduct tailgate health and safety meeting with project team by completing the Tailgate Safety Meeting Form (sample attached).

2. Establish sampling grid at 25-foot spacing by marking each node with a stake or pin flag over the entire area of concern. Larger or smaller grids may be established as required by the Project Work Plan.

3. Inventory the Gore-Sorber® modules' making sure that each grid node has a sample module.

4. At each grid node/sample point, advance a pilot hole to a maximum depth of 36-inches using a slam hammer and steel rod (i.e., slam bar) approximately 0.75-inches in diameter. Obstructions may prevent maximum penetration so several attempts may be required.

5. Withdraw the slam bar from the pilot hole.

6. Remove each Gore-Sorber® module from its sample container and record the serial number and site identification number on the Chain-of-Custody, Project Field Book and site map.

7. Take the insertion rod provided by Gore, place into the pocket at the bottom of the module and insert the module into the pilot hole.

8. Seal the pilot hole at the surface with the provided cork, which is secured to the insertion/retrieval cord to prevent escape of soil gases and mark the location with a pin flag or stake.

9. Plug the top of the hole with a rubber or cork stopper attached to the intake probe to prevent escape of soil gases.

10. Repeat Steps 4 through 9 until all sample modules have been installed.

11. Wait the prescribed time recommended by Gore. Retrieve each module and return each to their original sample container and place into a cooler and ship back to Gore's laboratory for analysis with the Chain-of-Custody.

ATTACHMENTS

Tailgate Safety Meeting Form (sample)
Soil Gas Survey Log (sample)

REFERENCES

Benchmark FOPs:
006 *Calibration and Maintenance of Combustible Gas/Oxygen Meter*
010 *Calibration and Maintenance of Portable Flame Ionization Detector*
011 *Calibration and Maintenance of Portable Photoionization Detector*

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TAILGATE SAFETY MEETING FORM

Project Name: Date: Time:
Project Number: Client:
Work Activities:

HOSPITAL INFORMATION:

Name:
Address: *City:* *State:* *Zip:*
Phone No.: *Ambulance Phone No.*

SAFETY TOPICS PRESENTED:
Chemical Hazards:

Physical Hazards: Slips, Trips, Falls

PERSONAL PROTECTIVE EQUIPMENT:

Activity: *PPE Level:* A B C D
Activity: *PPE Level:* A B C D
Activity: *PPE Level:* A B C D
Activity: *PPE Level:* A B C D
Activity: *PPE Level:* A B C D

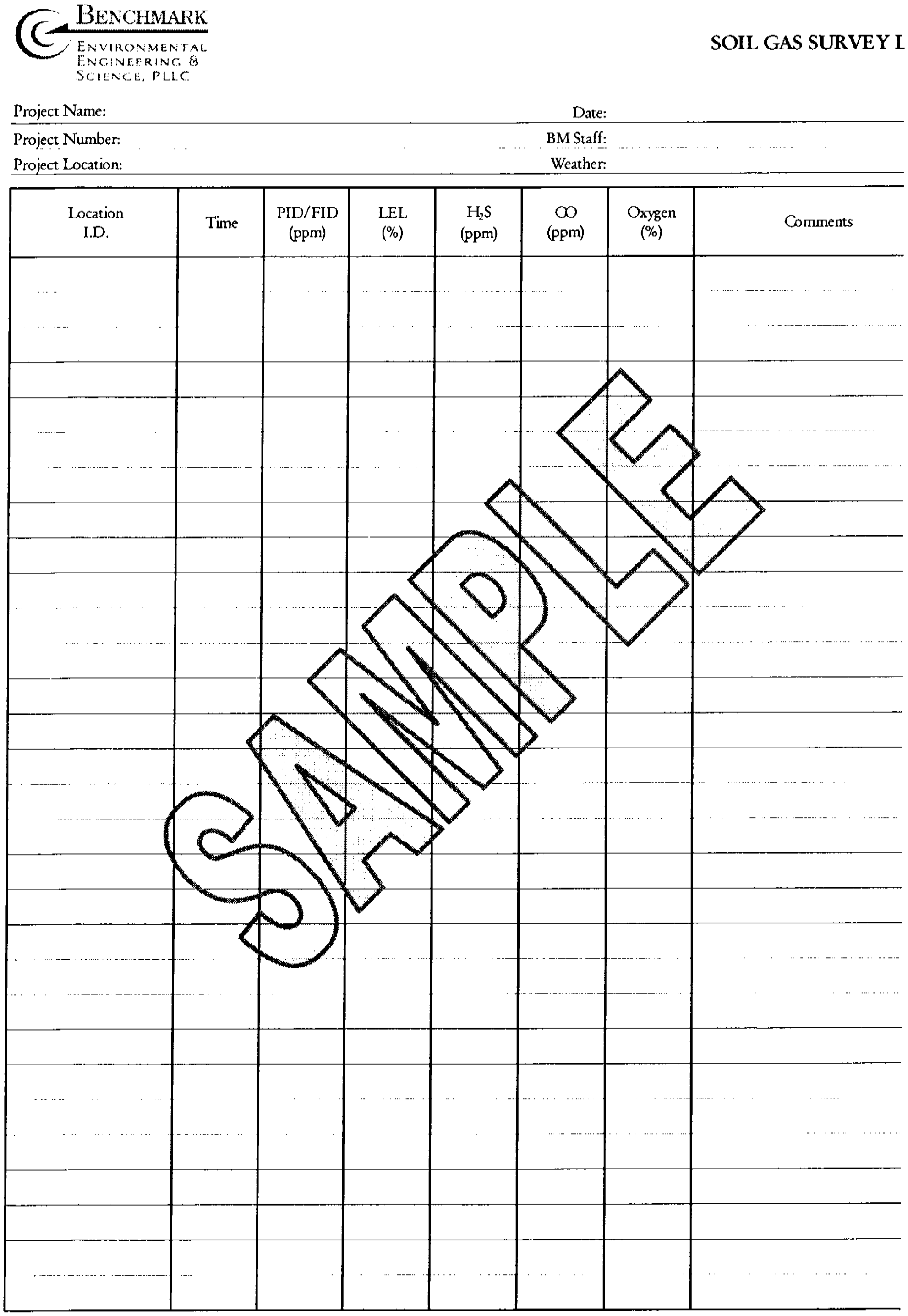
New Equipment:

Other Safety Topic(s): Environmental Hazards (aggressive fauna)
Eating, drinking, use of tobacco products is prohibited in the Exclusion Zone (EZ)

ATTENDEES

Name Printed	Signatures

Meeting conducted by:



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SOIL GAS SURVEY L

Project Name: Date:
Project Number: BM Staff:
Project Location: Weather:

Location I.D.	Time	PID/FID (ppm)	LEL (%)	H_2S (ppm)	CO (ppm)	Oxygen (%)	Comments

FOP 058.0

SPLIT-SPOON SAMPLING PROCEDURES

PURPOSE

This guideline presents the methods for using a split-spoon sampler for collecting soil samples from a boring and for estimating the relative in-situ compressive strength of subsurface materials (ASTM D 1586). Representative samples for lithologic description, geochemical analysis, and geotechnical testing will be collected from the subsurface materials using the split-spoon sampler.

PROCEDURE

1. Place plastic sheeting on a sturdy surface to prevent the split-spoon and its contents from coming in contact with the surface (several layers of sheeting may be placed on the surface so that they may be removed between each sample or as needed).

2. Lower the sampling string to the base of the borehole. Measure the portion of the sampling string that extends above surrounding grade (i.e. the stickup). The depth of sampling will equal the total length of the string (sampler plus rods) minus the stickup length.

3. Measure sampling depths to an accuracy of 0.1 feet. If field measurements indicate the presence of more than 0.3 feet of disturbed materials in the base of the borehole (i.e. slough), the sampler will be used to remove this material, after which a second sampling trip will be made.

4. Select additional sampler components as required (i.e., leaf spring core retainer for clays or a sand trap for non-cohesive sands). If a retainer or trap is not used, a spacer ring will be used to hold the liners in position inside the sampler.

5. For driving samples, attach the drive head sub and hammer to the drill rods without the weight resting on the rods. For pushing samples using the rig hydraulics, skip to Step 9.

6. Mark four 6-inch intervals on the drill rods relative to a reference point on the drill rig. With the sampler resting on the bottom of the hole, drive the sampler with the 140 lb. hammer falling freely over a 30-inch fall until 24 inches have been penetrated or 50 blows applied.

7. Record the number of blows per 6 inches. Determine the "N" value by adding the blows for the 6 to 12-inch and 12 to 18-inch intervals of each sample drive.

8. After penetration is complete, remove the sampling string. Avoid removing sampling string by hitting up on the string with the hammer as this can cause the sample to fall from the bottom of the split-spoon sampler. The sampling string should be removed via cable lifting or rig hydraulics. If sample retention has been poor, let the sampling string rest in place for at least 3 minutes, then rotate clockwise at least 3 times before removing from the borehole.

9. For pushed samples (i.e., using rig hydraulics), mark four 6-inch intervals on the drill rods relative to a reference point on the rig. Use the rig pull-down to press the sampler downward until 24 inches have been penetrated or no further progress can be made with the full weight of the rig on the sampler.

10. Remove the split-spoon sampler from the sampling string and place on the plastic-covered surface.

11. Open the split-spoon sampler only when the Benchmark field geologist is prepared to describe and manage the sample.

12. Describe the sample in accordance with the Unified Soil Classification System in accordance with the Benchmark FOP: Soil Description Procedures Using the Unified Soil Classification System (USCS).

13. Record all information in accordance with Benchmark's FOP: Documentation Requirements for Drilling and Well Installation.

14. Collect a portion of the sample for field screening as described in the Benchmark FOP: Screening of Soil Samples for Organic Vapors During Drilling Activities.

15. If applicable, collect soil samples for volatile organic constituents (VOCs). If applicable, collect sample for semi-volatile, metals, geotechnical, or other off-site analysis.

16. The samples will be labeled, stored and shipped in accordance with the Benchmark's FOP: Sample Labeling, Storage and Shipment Procedures.

ATTACHMENTS

none

REFERENCES

<u>Benchmark FOPs:</u>
015 Documentation Requirements for Drilling and Well Installation
046 Sample Labeling, Storage and Shipment Procedures
047 Screening of Soil Samples for Organic Vapors During Drilling Activities
054 Soil Description Procedures Using the Unified Soil Classification System (USCS)

FOP 063.1

SURFACE AND SUBSURFACE SOIL SAMPLING PROCEDURES

PURPOSE

This procedure describes the methods for sampling surface soil and subsurface soil samples for physical and chemical laboratory analysis during intrusive activities such as test pitting, hand augering, drilling, surface soil sampling etc. Typical health and safety related issues should be addressed in the Project Health and Safety Plan.

PRE-SAMPLING PROCEDURES

1. Review project objectives and the Project Health and Safety Plan (HASP).
2. Commence intrusive activities in accordance with specific Benchmark FOPs (test pitting, hand augering, drilling etc.) or as directed by the Project Work Plan.
3. Conduct tailgate health and safety meeting with project team and/or subcontractor(s) by completing the Tailgate Safety Meeting Form (sample attached).
4. Calibrate air-monitoring equipment in accordance with the appropriate Benchmark's Field Operating Procedures or manufacturers recommendations for calibration of field meters.
5. Conduct air monitoring as required by the HASP, Project Work Plan or Benchmark's FOP Real-Time Air Monitoring During Intrusive Activities. Record all results on the Real Time Air Monitoring Log (sample attached).
6. Decontaminate all <u>non-dedicated</u> stainless steel (or Pyrex glass) equipment in accordance with Benchmark's Non-disposable and Non-dedicated Sampling Equipment Decontamination procedures.
7. Collect soil samples in accordance with the following sections.

SURFACE SOIL/FILL SAMPLING PROCEDURES

Collection of surface soil/fill samples facilitates the evaluation of potential health risks to current site receptors that may be exposed to soil/fill via direct contact, incidental ingestion, or inhalation of airborne particulates. The following procedure is in accordance with NYSDEC sampling protocol of surface soil/fill material. Volatile organic analysis of surface soil/fill utilizing this method will yield negatively biased results and should not be performed.

1. Collect all soil samples using dedicated (or decontaminated non-dedicated) sampling tools (i.e., spoons, trowels, bowls etc.), preferably constructed of stainless steel.

2. If the sample area is vegetated, then collect the surface soil sample from 0 to 2 inches below ground surface (bgs) following removal of the sod.

3. If there is no soil present within the sample area (i.e., only slag, concrete, mixed with fines), excavate an area 12 inches by 12 inches by 6 inches deep, screen the material to less than 1/8 inch (No. 4 sieve), and submit the screened material for analysis. If there is not enough material to completely fill the sample jar, then expand the excavation 3 inches in all four directions screening the additional material. Expand the excavation in this manner until sufficient sample volume is obtained.

SURFACE/SUBSURFACE SOIL SAMPLING PROCEDURES

1. Collect all soil samples using dedicated (or decontaminated non-dedicated) sampling tools (i.e., spoons, trowels, bowls etc.), preferably constructed of stainless steel.

   Surface soil samples are typically collected from 0 to 6 inches below ground surface (bgs). Subsurface soils are typically sampled from varying depths greater than 6-inches bgs based on field observations and as directed by the Project Work Plan.

2. Transfer samples for chemical (VOC, SVOC, Metals etc.) and physical (i.e., Atterberg Limits, Grain Size, Permeability etc.) analytical testing by direct grab (i.e., directly from the bucket of the excavation equipment, split-spoon sampler, hand auger etc.) using the dedicated (or decontaminated non-dedicated) sampling tools into appropriate laboratory-supplied containers and seal. The chemical or physical laboratory selected to perform the analysis should determine minimum sample volume for analysis.

3. Prepare collected samples in accordance with Benchmark's FOP: Sample Labeling, Storage and Shipment Procedures. Do not allow the chemical soil samples to freeze during storage and shipping. It should be noted, ice is not required for physical soil samples and all physical soil samples should be kept at the collected soil moisture by securing with a tight sealing lid. Do not allow physical soil samples to gain or lose moisture from the collected soil moisture prior to analysis.

4. Record all sampling details (i.e., depth and location) in the Project Field Book; appropriate Benchmark log sheets depending on method of intrusion (i.e., drilling, test pitting, hand augering etc.); and on the Soil/Sediment Sample Collection Summary Log (sample attached).

PARAMETER-SPECIFIC PROCEDURES

1. Volatile Organic Compound (VOCs): Transfer sufficient soil volume to fill the laboratory-supplied container (typically 4 ounces) by packing the soil sample with the sampling tool to the top of the container leaving no headspace. At no time should a gloved hand (i.e., latex, nitrile etc.) be used to pack the sample into the sample container as the sample may be compromised via cross-contamination.

2. All Other Parameters: All other parameters include, but are not limited to, Semi-VOCs (SVOCs), polychlorinated biphenyls (PCBs), herbicides,

pesticides, total metals etc. Transfer sufficient soil volume to fill the laboratory-supplied container by packing the soil sample with the sampling tool to the top of the container. Unless otherwise indicated by the laboratory or the Project Work Plan, the sample jar for all other parameters does not have to be packed completely leaving no headspace as with the VOC containers.

ATTACHMENTS

Tailgate Safety Meeting Form (sample)
Soil/Sediment Sample Collection Summary Log (sample)
Real Time Air Monitoring Log (sample)

REFERENCES

Benchmark FOPs:

006	*Calibration and Maintenance of Combustible Gas/Oxygen Meter*
010	*Calibration and Maintenance of Portable Flame Ionization Detector*
011	*Calibration and Maintenance of Portable Photoionization Detector*
040	*Non-disposable and Non-dedicated Sampling Equipment Decontamination*
046	*Sample Labeling, Storage and Shipment Procedures*
073	*Real-Time Air Monitoring During Intrusive Activities*

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TAILGATE SAFETY MEETING FORM

Project Name: Date: Time:
Project Number: Client:
Work Activities:

HOSPITAL INFORMATION:

Name:
Address: *City:* *State:* *Zip:*
Phone No.: *Ambulance Phone No.*

SAFETY TOPICS PRESENTED:

Chemical Hazards:

Physical Hazards: Slips, Trips, Falls

PERSONAL PROTECTIVE EQUIPMENT:

Activity: *PPE Level:* A B C D
Activity: *PPE Level:* A B C D
Activity: *PPE Level:* A B C D
Activity: *PPE Level:* A B C D
Activity: *PPE Level:* A B C D

New Equipment:

Other Safety Topic(s): Environmental Hazards (aggressive fauna)
Eating, drinking, use of tobacco products is prohibited in the Exclusion Zone (EZ)

ATTENDEES

Name Printed **Signatures**

Meeting conducted by:

Benchmark Environmental Engineering & Science, PLLC

SOIL/SEDIMENT

SAMPLE COLLECTION SUMMARY LOG

Field ID	**Location**	**QC Type**	**Depth (feet)**		**Analytical Parameters**	**Containers**	**Date**	**Time**	**Sampler Initials**	**Comments** (e.g. problems encountered, ref. to variance, location changes, depth changes, important matrix observations or description, gravel thickness, etc.)
			from	**to**						

__Equipment Rinsate Blanks__ - Pour clean deionized water over or through decontaminated sampling equipment into sample containers. Collect at a frequency of 1 per sampling method per day. Analyze for all those parameters analyzed for in the samples collected the same day. HSL Metals can be substituted by only the Metals analyzed for that day (except Hexavalent Chromium which needs a separate container). Match equipment used for constituents of concern to rinsate analyte. Note deionized water lot # or distilled water manufacturers info [illegible]

__MS/MSD/MSB__ - Collect at a frequency of 1 per 20 samples of each matrix per day. Analyze for all those parameters analyzed for the samples collected the same day.

__Field Blank__ - Pour clean deionized water (used as final decon rinse water) into sample containers while at the sampling site. Collect field blanks at a frequency of 1 per lot of deionized water. Note water lot number and dates in use for decon in 'Comments' section.

__Investigation Derived Waste (IDW) Characterization samples__ - One composite sample from all drums of decon fluids and soil. Please note number of drums and labels on collection log.

Notes:

1. See QAPP for sampling frequency and actual number of QC samples.
2. CWM - clear, wide-mouth glass jar with Teflon-lined cap.
3. HDPE - high density polyethylene bottle.
4. MS/MSD/MSB - Matrix Spike, Matrix Spike Duplicate, Matrix Spike Blank.
5. BD - Blind Duplicate - indicate location of duplicate.

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REAL TIME AIR MONITORING LOG

Date:
Project Name:
Project Number:
Project Location:
Client:
Purpose of Air Monitoring:

WEATHER CONDITIONS:

Time of Day:	A.M.	P.M.
Ambient Air Temp.:		
Wind Direction:		
Wind Speed:		
Precipitation:		

Date	Personnel	Time	Air Monitoring Meter Measurement (Units)							Location/Activity/Comments
			PID (ppm)	LEL (%)	H_2S (ppm)	O_2 (%)	CO (ppm)	Particulates (mg/m^3)	Other	

NOTE: SEE EQUIPMENT CALIBRATION LOG FOR DESCRIPTION OF EQUIPMENT TYPE.

Prepared By: Date:

FOP 070.0

WELL/PIEZOMETER CONSTRUCTION MATERIALS AND DESIGN

PURPOSE

This guideline presents construction materials and design requirements for monitoring well/piezometer installations in accordance with NYSDEC recommended specifications (6NYCRR Part 360).

CONSTRUCTION MATERIALS

1. Well Screen and Riser – Only new flush threaded screen and riser materials will be used. Screen and riser materials, well dimensions, screen slot opening size and length to be determined based on formation characteristics and suspect water quality or as specified by the project geologist/hydrogeologist. A vented cap or J-plug should be placed over the riser. A V-slot cut in the riser or permanent marking, both placed on the north side of the riser, will act as a monitoring reference point.

2. Bentonite Well Seal – The bentonite should be from a commercial source free of chemical additives (granular or powdered for grout and pelletized for seal).

3. Concrete – Low heat of hydration concrete should be used for grout and cementing protective casing if well construction materials are composed of PVC (ASTM Type II or Type IV Portland Cement).

4. Water – Water should be from a potable source of known chemistry and free of chemical constituents which may compromise integrity of installation.

5. Grout – Mixture of bentonite, cement and water in accordance with the following specifications. Premix bentonite and water prior to adding cement.

<u>Grout Slurry Composition (% Weight)</u>

1.5 to 3.0% - Bentonite (Quick Gel)
40 to 60 % - Cement (Portland Type I)
40 to 60 % - Potable Water

6. Filter Pack – The filter pack should consist of clean, inert, siliceous, rounded to subrounded particles. Filter pack particle size is dependent on the formation and the slot size of the screen.

   A secondary filter about 6-inches thick may be placed between filter pack and the bentonite seal and potentially between the bentonite seal and the grout backfill, to minimize grout penetration of the seal. A uniformly graded fine sand (100% passing No. 30 sieve) should be used as a secondary filter.

7. Protective Casing, Locking Cap and Lock – Protective casing with a lockable cap should be cemented in place around the riser. The inside diameter of the protective casing should be a minimum of 2-inches larger than the outside diameter of the well riser. The annular space between the casing and the riser should be filled with pea gravel or coarse sand. A weep hole should be drilled near the base of the casing to facilitate drainage of standing water. If more than one well is installed, all locks should be keyed alike.

8. A sample of all cement, bentonite and sand used in well construction should be saved in a labeled, Teflon-sealed, precleaned glass jar.

REFERENCES

New York State Department of Environmental Conservation, July 1988, *Drilling and Monitoring Well Installation Guidance Manual.*

Driscoll, F.G., 1987, *Groundwater and Wells*, Johnson Division, St. Paul, Minnesota, p. 1089.

Sara, M. N., *Proposed Recommended Practice for Design and Installation of Ground Water Monitoring Wells in Aquifers: ASTM Subcommittee D18.21.*

FOP 073.0

REAL-TIME AIR MONITORING DURING INTRUSIVE ACTIVITIES PROCEDURE

PURPOSE

This guideline presents requirements for real-time community air monitoring and required responses during all project required intrusive activities, such as drilling, test pitting, earthwork construction etc. This procedure is consistent with the requirements for community air monitoring for all intrusive projects, including projects conducted at remediation sites, as established by the New York State Department of Health (NYSDOH) and the New York State Department of Environmental Conservation (NYSDEC). Accordingly, this Field Operating Procedure (FOP) follows procedures and practices outlined under the NYSDOH's generic Community Air Monitoring Plan dated June 20, 2000 and NYSDEC Technical Assistance and Guidance Memorandum (TAGM) 4031: Fugitive Dust Suppression and Particulate Monitoring Program at Inactive Hazardous Waste Sites.

This FOP requires real-time monitoring for constituents of concern (COC) (i.e., volatile organic compounds (VOCs), lower explosive limit (% LEL), particulates (i.e., dust) etc.) at the upwind and downwind perimeter as well as the exclusion zone of a project site during all intrusive activities. This FOP is not intended for use in establishing action levels for worker respiratory protection (see Project Health and Safety Plan (HASP) for worker protection action levels). Rather, its intent is to provide a measure of protection for the surrounding community from potential airborne contaminant releases as a direct result of investigative and remedial work activities. The community, as referenced in this document, includes any off-site residences, public buildings/grounds and commercial or industrial establishments adjacent to the project site. The action levels specified herein require increased monitoring, corrective actions to abate emissions, and/or work shutdown. Additionally, this FOP helps to confirm that work activities did not spread contamination off-site through via air transport mechanisms. Community air monitoring shall be integrated with the construction worker personal exposure-monitoring program contained in the project and site-specific HASP.

MONITORING & MITIGATION PROCEDURE

Real-time air monitoring for COC levels at the upwind and downwind perimeter as well as the exclusion zone of the project site will be required. The perimeter locations of monitoring stations will be established based on the location of the exclusion zone (i.e., immediate work area) and wind direction. Where wind direction is shifting or winds are calm, the downwind monitoring location will default to the perimeter location nearest the most sensitive receptor (i.e., residential property). All downwind receptors being equal, the downwind monitoring location will default to the perimeter location downwind of the prevailing winds at the site. Real-time air monitoring will be required for all ground intrusive activities at a minimum of 30-minute intervals. Ground intrusive activities include, but are not limited to, soil/fill excavation and handling, test pitting or trenching, borehole advancement and monitoring well installation. Although additional site specific COCs may be monitored during real-time air monitoring activities, the most common COCs are discussed in this FOP, including organic vapors (i.e., VOCs), airborne particulates (i.e., fugitive dust) and combustible gases (i.e., methane) and oxygen.

ORGANIC VAPORS

Ambient organic vapor concentrations should be measured prior to commencing intrusive activities each workday and a minimum of every 30-minutes thereafter. Air monitoring activities should be performed using equipment appropriate to measure the types of COCs known or suspected to be present. The equipment should be calibrated daily for the COCs or for an appropriate surrogate. All organic vapor readings must be recorded in the Project Field Book and/or Real-Time Air Monitoring Logs (sample attached) and, if applicable, be made available for State (DEC and DOH) personnel to review.

Mitigation upon the detection of various action levels of organic vapors are presented below:

- If the sustained ambient air concentration of total organic vapors at the downwind perimeter of the site exceeds a reading of 5 parts per million (ppm) above background, work activities must be temporarily halted and monitoring continued. If the total organic vapor level readily decreases (per instantaneous readings) below 5 ppm over background, work activities can resume with continued monitoring.

- If sustained total organic vapor levels at the downwind perimeter of the site persist at levels in excess of 5 ppm over background but less than 25 ppm, work activities must be halted, the source of vapors identified, corrective actions taken to abate emissions and monitoring continued. Following organic vapor mitigation, work activities can resume provided that the sustained total organic vapor level 200 feet downwind of the exclusions zone or half the distance to the nearest potential receptor or residential/commercial structure, whichever is less, (but in no case less than 20 feet) is below a sustained value of 5 ppm over background.

- If the sustained organic vapor level is above 25 ppm at the downwind perimeter of the site, the designated Site Safety and Health Officer must be notified and work activities shut down. The Site Safety and Health Officer will determine when re-entry of the work zone is possible and will implement downwind air monitoring to ensure vapor emissions do not impact the nearest off-site residential or commercial structure at levels exceeding those specified under the Major Vapor Emission Monitoring program described below.

Major Vapor Emission Monitoring

- If the sustained organic vapor level is greater than 5 ppm over background 200 feet downwind from the site or half the distance to the nearest off-site receptor (residential or commercial structure), whichever is less, all work activities must be halted. If, following the cessation of the work activities or as the result of an emergency, organic levels persist above 5 ppm above background 200 feet downwind or half the distance to the nearest off-site residential or commercial structure from the site perimeter, then the air quality must be monitored within 20 feet of the perimeter of the nearest off-site receptor (20-foot zone).

- If efforts to abate the emission source are unsuccessful and if organic vapor levels approach or exceed 5 ppm above background within the 20-foot zone for more than 30 minutes, or are sustained at levels greater than 10 ppm above background for longer than one minute, then the Major Vapor Emission Response Plan will automatically be placed into effect (see next section).

Major Vapor Emission Response Plan

Upon activation of Major Vapor Emission Response Plan, the following activities will be undertaken:

1. All Emergency Response Contacts as listed below and in the Site-Specific Health and Safety Plan will be contacted.

2. The local police authorities will immediately be contacted by the Site Safety and Health Officer and advised of the situation.

3. Frequent air monitoring will be conducted at 30-minute intervals within the 20-foot zone. If two successive readings below action levels are measured, air

monitoring may be halted or modified by the Site Safety and Health Officer.

4. The Site Safety and Health Officer will determine if site workers can safely undertake source abatement measures. Abatement measures may include covering the source area with clean fill or plastic sheeting, or consolidating contaminated materials to minimize surface area. The Site Safety and Health Officer will adjust worker personal protective equipment as necessary to protect workers from over-exposure to organic vapors.

The following personnel are to be notified by the Site Safety and Health Officer in the listed sequence if the Major Vapor Emission Response Plan is activated:

Contact	**Phone**
Police/Fire Department	911
New York State Dept. of Health	(716) 847-4502
New York State Dept. of Environmental Conservation	(716) 851-7220
State Emergency Response Hotline	(800) 457-7362

In addition, the Site Safety and Health Officer will provide these authorities with a description of the apparent source of the contamination and abatement measures being taken by the contractor, if any.

AIRBORNE PARTICULATES

Fugitive dust suppression and airborne particulate monitoring shall be performed during any intrusive activities involving disturbance or handling of site soil/fill materials. Fugitive dust suppression techniques will include the following minimum measures:

- Excavated stockpiles will be seeded or covered with clean soil or synthetic materials (e.g., tarps, membranes, etc.) whenever stockpiling activities cease for a period of longer than 90 days.
- Spraying potable water on all excessively dry work areas and roads.
- All fill materials leaving the site will be hauled in properly covered containers or haul trailers.
- Additional dust suppression efforts may be required as discussed below.

Particulate concentrations should be measured prior to commencing intrusive activities each workday and a minimum of every 30-minutes thereafter. The particulate monitoring should be performed using equipment capable of measuring particulate matter less than 10 micrometers in size (PM-10) for comparison to the airborne particulate action level. The equipment must be equipped with an audible alarm to indicate exceedance of the action level and calibrated daily. In addition, fugitive dust migration should be visually assessed during all work activities. All air borne particulate readings must be recorded in the Project Field Book and/or Real-Time Air Monitoring Logs (sample attached) and, if applicable, be made available for State (DEC and DOH) personnel to review. Mitigation upon the detection of various action levels of airborne particulates are presented below:

- If the sustained downwind PM-10 particulate level is 100 micrograms per cubic meter (ug/m^3) greater than background (upwind perimeter) or if airborne dust is observed leaving the work area, then dust suppression techniques must be employed. Work may continue with dust suppression techniques provided that downwind PM-10 particulate levels do not exceed 150 ug/m^3 above the upwind level and provided that no visible dust is migrating from the work area.

- If, after implementation of dust suppression techniques, sustained downwind PM-10 particulate levels are greater than 150 ug/m³ above the upwind level, work must be stopped and a re-evaluation of activities initiated. Work can resume provided that dust suppression measures, such as those described the Supplemental Dust Suppression section below are employed and are successful in reducing the downwind PM-10 particulate concentration to within 150 ug/m³ of the upwind level and in preventing visible dust migration.

Visual Assessment

In conjunction with the real-time monitoring program, Benchmark personnel and any subcontractors thereof will be responsible for visually assessing fugitive dust migration from the site. If airborne dust is observed leaving the site, the work will be stopped until supplemental dust suppression techniques are employed in those areas.

Supplemental Dust Suppression

Supplemental dust suppression techniques may include but are not necessarily limited to the following measures:

- Reducing the excavation size, number of excavations or volume of material handled.
- Restricting vehicle speeds.
- Applying water on buckets during excavation and dumping.
- Wetting equipment and excavation faces.
- Wetting haul roads.
- Restricting work during extreme wind conditions.

- Use of a street sweeper on paved haul roads, where feasible.

Work can resume using supplemental dust suppression techniques provided that the measures are successful in reducing the sustained downwind particulate concentration to below 150 ug/m^3 above background, and in preventing visible dust migration off-site.

COMBUSTIBLE GASES & OXYGEN

Ambient combustible gas and oxygen concentrations should be measured prior to commencing intrusive activities each workday and a minimum of every 30-minutes thereafter. Air monitoring activities should be performed using equipment appropriate to measure combustible gases in percent lower explosive limit (LEL) and percent oxygen and calibrated daily. All combustible gas and oxygen readings must be recorded in the Project Field Book and/or Real-Time Air Monitoring Logs (sample attached) and, if applicable, be made available for State (DEC and DOH) personnel to review.

Mitigation upon the detection of various action levels of organic vapors are presented below:

Combustible Gas:

- If the sustained ambient air concentration of combustible gas at the downwind perimeter of the site exceeds a reading of 10 to 25% LEL, work activities must be temporarily halted and monitoring continued. If the total organic vapor level readily decreases (per instantaneous readings) below 10% LEL, work activities can resume with continued monitoring.

- If sustained combustible gas levels at the downwind perimeter of the site persist at levels in excess of 25% LEL, work activities must be halted, the source of explosion hazards identified, corrective actions taken to abate emissions and monitoring continued. Following combustible gas mitigation, work activities can resume provided that the sustained total organic vapor level 200 feet downwind of the exclusions zone or half the distance to the nearest potential receptor or residential/commercial structure, whichever is less, (but in no case less than 20 feet) is below a sustained value of 10% LEL.

Oxygen:

- If the sustained ambient oxygen concentration at the downwind perimeter of the site measures a reading between 19.5% - 21% oxygen, work activities can continue with extreme caution, however attempts to determine the potential source of oxygen displacement must be conducted.

- If the sustained oxygen level readily decreases below 19.5% LEL, work activities should be discontinued and all personnel must leave the area immediately.

- If the sustained oxygen level at the downwind perimeter of the site persists at levels between 21-25%, work activities can resume with caution.

- If the sustained oxygen level at the downwind perimeter of the site persists at levels exceeding 25% (fire hazard potential), work activities should be discontinued and all personnel must leave the area immediately.

ATTACHMENTS

Real-Time Air Monitoring Log (sample)

REFERENCES

Benchmark FOPs:

006	*Calibration and Maintenance of Combustible Gas/Oxygen Meter*
010	*Calibration and Maintenance of Flame Ionization Detector*
011	*Calibration and Maintenance of Portable Photoionization Detector*
xxx	*Calibration and Maintenance of Portable Particulate Meter (as per Manufacturers Specifications)*

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REAL TIME AIR MONITORING LOG

Date:
Project Name:
Project Number:
Project Location:
Client:
Purpose of Air Monitoring:

WEATHER CONDITIONS:

Time of Day:	A.M.	P.M.
Ambient Air Temp.:		
Wind Direction:		
Wind Speed:		
Precipitation:		

Date	Personnel	Time	Air Monitoring Meter Measurement (Units)							Location/Activity/Comments
			PID (ppm)	LEL (%)	H_2S (ppm)	O_2 (%)	CO (ppm)	Particulates (mg/m³)	Other	

NOTE: SEE EQUIPMENT CALIBRATION LOG FOR DESCRIPTION OF EQUIPMENT TYPE.

Prepared By: Date:

APPENDIX B

LABORATORY CERTIFICATIONS & QUALITY ASSURANCE MANUAL

(*PROVIDED UPON REQUEST*)

APPENDIX C

RÉSUMÉS

(*PROVIDED UPON REQUEST*)