NYSDEC SUPERFUND STANDBY CONTRACT
CONTRACT NUMBER D002472

DRAFT
QUALITY ASSURANCE PROGRAM PLAN

Submitted to:

New York State Department of Environmental Conservation
Albany, New York

Submitted by:

ABB Environmental Services
Portland, Maine

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APPROVED FOR
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QUALITY ASSURANCE PROGRAM PLAN

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1.0 PROGRAM DESCRIPTION

1.1 PURPOSE

The purpose of this Quality Assurance Program Plan (QAPP) is to define responsibilities and authorities for data quality, and to prescribe requirements for assuring that the field exploration activities under taken by ABB Environmental Services (ABB-ES), for the New York State Department of Environmental Conservation (NYSDEC) are planned and executed in a manner consistent with quality assurance (QA) objectives.

The QAPP provides guidance and specifications to ensure that:

- samples are obtained under controlled conditions using appropriate and documented procedures;
- samples are identified uniquely and controlled through sample tracking systems and chain-of-custody (COC) protocols;
- field determinations and laboratory analytical results are of known quality and are valid and consistent through using approved methods, preventive maintenance, calibrations, analytical protocols, quality control (QC) measurements, reviews, audits, and correcting out-of-control situations;
- calculations and evaluations are accurate, appropriate, and consistent throughout the project;
- data are validated and their use in calculations is documented; and
- records are retained as documentary evidence of the quality of samples, applied processes, equipment, and results.

1.2 SCOPE

This document has been prepared in support all work assignments issued under NYSDEC Contract No. D002472. The requirements of this QAPP apply to all ABB-ES and subcontractor activities undertaken, unless otherwise stipulated in the work-assignment specific Quality Assurance Project Plan (QAPjP).

The organizational responsibilities and interactions outlined in Section 2 of this document extend to quality-related controls and activities. The content and format of the QAPP is based on:

- *Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans - QAMS-005/80* prepared by the U.S. Environmental Protection Agency (USEPA) (USEPA, 1980) and

- NYSDEC Technical and Administrative Guidance Memos (TAGMs) including:

  - Phase II Investigation Generic Work Plan; TAGM HWR-88-4007 (NYSDEC, 1988).

  - Phase II Investigation Oversight Guidance; TAGM HWR-90-4008 (NYSDEC, 1990a).

  - Phase II Investigation Oversight Note Taking; TAGM HWR-90-4019 (NYSDEC, 1990b).

The QAPP consists of 14 sections, as described in QAMS 005/80, and is organized as follows:

Section 2	Organization and roles of the ABB-ES project team
Section 3	Quality assurance objectives
Section 4	Sampling procedures
Section 5	Sample custody
Section 6	Calibration procedures
Section 7	Analytical procedures
Section 8	Data reduction, validation, and reporting
Section 9	Internal quality control

Section 10	Audits
Section 11	Preventive maintenance
Section 12	Data assessment
Section 13	Corrective action
Section 14	Reports to management

The figures and tables are located at the end of each section they are first referenced in.

1.3 CONTRACT SUMMARY

ABB-ES has been retained by NYSDEC to conduct field investigation and remedial activities at various inactive hazardous waste sites in New York State (NYS). Under the contract, work assignments are issued that may require the performance of some, or all, of the following services:

- Preliminary Site Assessment (PSA)
- Remedial Investigation/Feasibility Study (RI/FS)
- Remedial Design (RD)
- Remedial Construction Management
- QA/QC Activities
- Site Response Activities
- Operation and Maintenance
- Citizen Participation Activities
- Health and Safety Plan Review

Particular sections of the QAPP will apply to the above work elements. Specific QAPP requirements that apply to a given work assignment will be identified in the a site-specific QAPjP to be developed for each unique site.

2.0 PROGRAM ORGANIZATION AND RESPONSIBILITIES

2.1 ORGANIZATION

ABB-ES operates using a multi-disciplinary team-based system. Under this system, personnel representing both engineering and scientific disciplines are assigned to teams and groups organized by similar client focus. The administrative personnel for the NYSDEC contract are members of the State Programs team, which is managed under the Government Operations group. Tasks leaders and key technical staff assigned to NYSDEC work assignments are generally either members of the State Programs team or the Government Operations group. However, additional resources are available from throughout the entire ABB-ES organization. Individuals with specialized skills assigned to other teams, groups, or offices within ABB-ES may join a NYSDEC project team as needed.

This portion of the QAPP addresses ABB-ES' NYSDEC Program organization and specifically outlines QC coordination and responsibilities. Those individuals assigned to a project or task are responsible for conducting project work by using the resources assigned to the project management organization. In this way, resources through ABB-ES are available to each project, but responsibility for initiating services and for ensuring acceptable results remains within the project organization. This responsibility carries with it the authority to initiate, modify, and stop activities, as appropriate. It is the Quality Review Board's (QRB) role to assist the Project Manager (PM), Task Leaders, and Site Managers in meeting project goals while providing an independent evaluation of product quality.

Figure 2-1 illustrates the overall program organization and principal lines of communication and authority.

2.2 SPECIFIC RESPONSIBILITIES

The responsibilities of the ABB-ES project positions and support organizations are summarized below.

Corporate Officer. The Corporate Officer is William R. Fisher, P.E., Vice President of ABB-ES. Mr. Fisher is responsible for establishing a contract for the services to be performed, for committing the corporate resources necessary to conduct the program work activities, and for supplying corporate-level input for problem resolution.

Program Manager. The New York State Superfund Standby Contract Program Manager is Robert E. Handy, Jr., P.E. The Program Manager has overall responsibility to organize and set operating procedures with NYSDEC.

Project Manager. The PM, named in the site-specific QAPjP or Work Plan, is responsible for day-to-day technical administration of the project and will be the primary technical contact for NYSDEC on most jobs. The PM will be responsible for:

- initiating project activities;
- identifying project staff, equipment, and other resource requirements;
- interfacing with NYSDEC on all cost, contractual, personnel, and other administrative matters;
- monitoring task activities, and adjusting efforts on resources, as required, to help assure that existing budgets, schedules, and work programs are maintained;
- providing regular briefings on the status of the project and preparation of monthly reports showing both technical progress and cost status;
- providing assurance that project technical and financial records are kept according to the requirements of NYSDEC and ABB-ES; and
- implementing subcontracting as required

Task Leaders and Site Managers. The Task Leaders and Site Managers are responsible for:

- the appropriateness, adequacy, and timeliness of the technical and engineering services provided;

- developing the technical approach and level of effort required to address each of task/subtask;
- the day-to-day conduct of the work, including the integration of the input of supporting disciplines and subcontractors (i.e., drilling or laboratory subcontractors);
- ongoing QC during performance of the work; and
- the technical integrity as well as the clarity and usefulness of all project work products.

Task Leaders and Site Managers will be identified in the site-specific Work Plan or QAPjP

Quality Review Board. A key component in the review process is the designation of a QRB for each project. The function of this group of senior technical and/or management personnel is to provide guidance on the technical aspects of the project. This is accomplished through periodic reviews of the services designed to incorporate the accumulated experience and corporate policy of the firm and to meet the objectives of the program as established by NYSDEC. The QRB provides input to project deliverables by conducting technical reviews while work is in progress. The QRB serves as a resource for the Quality Assurance Manager (QAM) in evaluating the magnitude of identified QC problems and supporting the development of appropriate corrective action.

Seven QRB members have been identified and are listed on Figure 2-1. For most work assignments, individuals from this group will be selected to serve as part of the project-specific QRB. If special technical issues are identified on a site- or project-specific basis, additional senior technical staff maybe assigned to the project-specific QRB to provide the appropriate technical guidance and review.

Quality Assurance Manager. The QAM, Clifford L. Colby, III, has responsibility for establishing, overseeing, and auditing specific procedures for documenting and controlling analytical and field data quality. Many of the procedures will be implemented by other individuals. The QAM works with the PM, Task Leaders, and Site Managers to verify that established ABB-ES and NYSDEC protocols are followed.

Responsibilities of the QAM include:

- monitoring the QA and QC activities of the laboratory for conformance with approved policies, procedures, and sound practices, and authorize improvements as necessary;
- informing the PM, Task Leaders, Site Managers, and/or subcontract laboratory management of nonconformance to the approved QC program;
- assuring that records, logs, standard procedures, project plans, and analytical results are complete and maintained in a retrievable fashion;
- distributing copies of standard procedures and project plans to all appropriate personnel involved in the project; and
- assuring that sampling is conducted in a manner consistent with the QC plan.

The QAM will delegate implementation of analytical QC functions as appropriate to the Laboratory Analytical Task Manager. The QAM will monitor the proper application of the program through review of all reports on a routine basis.

Contract Specialist. The Contract Specialist (CS), Ms. Theresa Martin, aids and assists the PM, Task Leaders, and Site Managers with compliance with contract terms and conditions, including cost allowability, invoicing, monitoring budgets, maintaining employee NSPE-grade lists, administering subcontracts, and meeting minority/women-owned business enterprise goals.

2.3 PERSONNEL QUALIFICATIONS AND TRAINING

The QAM reviews the assignment of technical staff and the project/program management plan with regard to appropriate qualifications in the technical areas relevant to the project and any associated QC techniques. This involves an assessment of individual qualifications and a resolution of training needs prior to the commencement of data generation/manipulation activities. Training typically consists of one or more of the following activities:

- general briefings covering all aspects of QA program and project plans;
- specific briefings on individual QAPjPs;
- specific briefings on individual QA and QC procedures or activities;
- required reading of pertinent QA-related documents; and
- participation in USEPA-approved and other training courses.

The QAM reassesses personnel training periodically with regard to the fulfillment of this QA program.

ABB-ES personnel involved with hazardous waste site investigations are required to attend an approved 40-hour health and safety course prior to working on hazardous waste sites. In addition, personnel are required to attend annual 8-hour, refresher health and safety training courses designed to review: (1) health and safety requirements and principles; (2) sampling procedures; (3) documentation procedures; (4) operational procedures; and (5) safety equipment use and function.

ABB-ES will staff projects with capable, trained personnel. ABB-ES typically uses a cross-section of junior-, middle-, and senior-level personnel to implement field sampling and investigation programs. By using this cross-section, personnel are placed in a position of responsibility to which they can respond.

2.4 SUPPORT SERVICES

To conduct certain Work Assignment, ABB-ES will retain subcontractors (selected considering price and technical qualifications) to perform specialized services, including sample analysis, drilling, surveying, and engineering consulting services. Before ABB-ES enters into a subcontract relationship, ABB-ES evaluates the potential subcontractor. Such evaluations may include visiting the subcontractors' business unit and conducting facility audits. ABB-ES may conduct pre-bid meetings to explain potential tasks, site conditions that may be encountered, and the importance of each task to the project. ABB-ES evaluates proposals both technically and financially, and then recommends selection to the NYSDEC.

Contract documents are thoroughly discussed with the subcontractor, and are complete and detailed, including scopes of work, payment terms and conditions, penalties for poor performance, and applicable prime contract flowdown clauses. Before awarding any work to a subcontractor, ABB-ES will confirm its ability to accomplish the work on the required schedule. As work is to be awarded, and as it continues, ABB-ES confirms schedules and commitments. ABB-ES requires periodic subcontractor progress reports (e.g., drillers' daily quantity sheets and documentation of internal technical reviews). Subcontractors must contact ABB-ES if they anticipate difficulty in adhering to scope, schedule, or budget. For technical issues, the subcontractor's primary point of contact within ABB-ES is the PM; for subcontract terms and conditions issues, it is the procurement specialists; and for payment issues, it is the CS. The procedural steps ABB-ES follows to effect subcontractor corrective action are listed in Table 2-1.

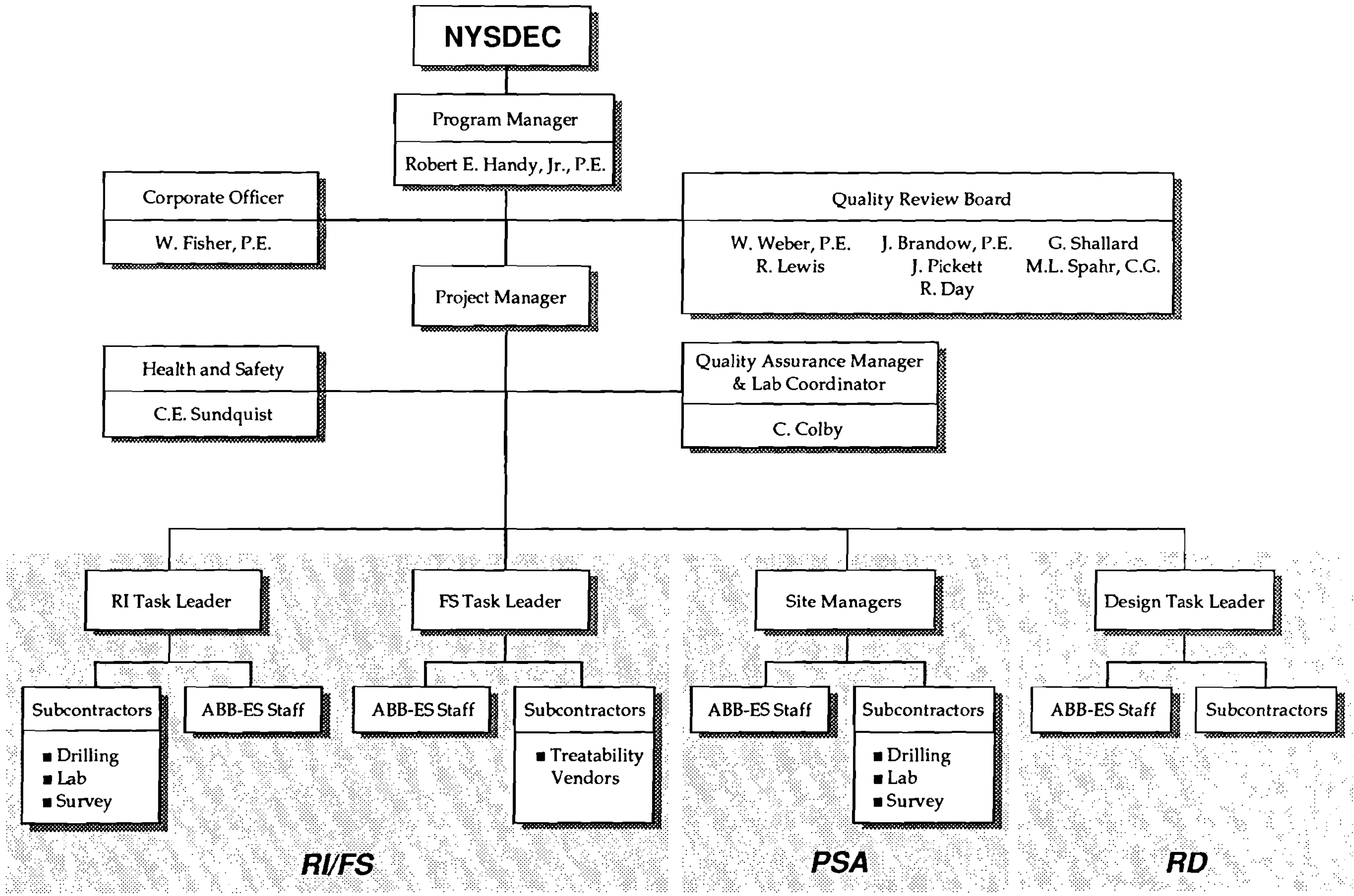

FIGURE 2-1
ORGANIZATION CHART
NYSDEC QUALITY ASSURANCE PROGRAM PLAN

ABB Environmental Services

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TABLE 2-1
SUBCONTRACTOR CORRECTIVE ACTION STEPS

NYSDEC QUALITY ASSURANCE PROGRAM PLAN

1.	ABB-ES visits subcontractors' facilities prior to initiating subcontract relationship
2.	CS and procurement staff develop, negotiate, and issue clear and concise subcontract agreement protecting the NYSDEC's and ABB-ES' interests
3.	CS and procurement staff communicate to the subcontractor assigned roles and responsibilities of the ABB-ES project team
4.	CS and PM maintain regular contact regarding subcontractor's technical performance and any deviations from scope and schedule
5.	CS and PM review subcontractor invoices for conformance to contract terms and conditions
6.	CS and PM attempt to resolve any issues with subcontractor's authorized representative
7.	CS and PM require subcontractor progress reports describing scope, schedule, and budget conformance
8.	CS and PM solicit Program Manager and other senior ABB-ES staff advice on non-routine issues
9.	CS and Program Manager involve subcontractors' senior management in unresolved issues
10.	CS and PM invoke applicable financial penalties
11.	CS and Program Manager consider subcontract termination if subcontract allows and performance problems are well-documented and unresolvable
12.	Refuse further subcontract associations

Notes:

ABB-ES = ABB Environmental Services
CS = Contract Specialist
NYSDEC = New York State Department of Environmental Conservation
PM = Project Manager

3.0 QUALITY ASSURANCE OBJECTIVES

3.1 DATA QUALITY OBJECTIVES

DQOs are qualitative and quantitative statements developed by the data user to specify the quality of data needed from a particular data activity to support specific decisions. The DQOs are the starting point in the design of the investigation. DQOs are based on the concept that the intended use of the data determines the quality of the data required. DQOs are established based on site conditions, project objectives, and available measurement systems. The DQO process matches sampling and analytical capabilities to the data targeted for specific uses and ensures that the quality of the data does not underestimate project requirements.

USEPA has identified five general levels of analytical data quality as being potentially applicable to field investigations conducted at potential hazardous waste sites under the Comprehensive Environmental Response, Compensation, and Liability Act. These levels are summarized as follows:

Level I - Field Screening. This level is characterized by the use of portable instrumentation that can provide real time data to assist in the optimization of sampling point locations and for health and safety monitoring. Data can be generated indicating the presence or absence of certain contaminants, especially volatiles, at sampling locations.

Level II - Field Analysis. This level is characterized by the use of portable analytical instruments that can be used on-site or in mobile laboratories stationed near a site. Depending on the types of contaminants, sample matrix, and personnel skills, qualitative and quantitative data can be obtained.

Level III - Laboratory Analysis. Laboratory-generated data obtained using USEPA-approved procedures, but using methods other than CLP Routine Analytical Services (RAS). These data are typically used for engineering studies (e.g., treatability testing) and site characterization. These data are both qualitative and quantitative. Level III data may include Toxicity Characteristic Leachate Procedure (TCLP) and Total Organic Carbon (TOC).

Level IV - CLP RAS. These data represent laboratory analytical results developed using CLP methods and supported by a rigorous QA program, supporting documentation, and data validation procedures. These data are typically used for definitive site characterization, risk assessment, engineering alternative selection and design, and enforcement/litigation activities. Level IV data can include Target Compound List (TCL) Volatile Organic Compounds (VOCs), semivolatile organic compounds (SVOCs), pesticides/polychlorinated biphenyls (PCBs), and Target Analyte List inorganics.

Level V - Non-standard Methods. This level is used for the analysis of non-standard sample matrices (i.e., biota, waste, etc.). The level also applies when non-conventional parameters, method-specific detection limits, or modification of existing methods are required. CLP Special Analytical Services are considered Level V. Level V data can be used for risk assessment, evaluation of alternatives, and engineering design.

3.2 Precision and Accuracy

Precision is defined as the agreement among individual measurements of the same chemical constituent in a sample, obtained under similar conditions. Field precision will be expressed as relative percent difference (RPD) of field duplicates:

$$RPD = \frac{|X1 - X2|}{(X1 \ x \ X2)/2} \ x \ 100$$

where,

RPD	=	relative percent difference between duplicate results
X1 and X2	=	results of duplicate analyses
|X1 - X2|	=	absolute difference between duplicates X1 and X2

Field duplicates take into account the level of error introduced by field sampling techniques, field conditions, and analytical variability. The RPD of field duplicates will be calculated by ABB-ES in order to evaluate the sample precision.

Accuracy is defined as the degree to which the analytical measurement reflects the true concentration level present. Accuracy will be measured as percent recovery for matrix spikes.

A matrix spike is a sample to which predetermined quantities of standard solutions of certain target analytes are added prior to sample extraction/digestion and analysis. Samples are split into replicates, one replicate is spiked and both aliquots are analyzed.

Accuracy can also be evaluated using the recovery of surrogate spikes in the organic analyses. These spikes consist of organic compounds which are similar to the analytes of interest in chemical composition, extraction, and chromatography, but which are not normally found in environmental samples. These compounds are spiked into all blanks, standards, and samples prior to analysis.

Percent recoveries of the surrogate, blank spike, and matrix spikes will be reported by the laboratory for all analytes associated with the samples. Variations from 100 percent recovery may be due to matrix interferences, laboratory spike handling procedures, or sample heterogeneities between replicates. The percent recovery of the spikes can be calculated from the following equation:

$$\%\ recovery = \left(\frac{X-B}{T}\right) x\ 100$$

where,

X	=	measured amount in sample after spiking
B	=	background amount in sample
T	=	amount of spike added

Accuracy is difficult to evaluate for the entire data collection activity, especially the sampling component. Field and trip blanks will be used in addition to the matrix and surrogate spiked samples to evaluate data accuracy in the investigations.

3.3 REPRESENTATIVENESS

Representativeness expresses the degree to which sample data depict existing site conditions. Measurements will be made so that analytical results are representative of the media (e.g., soil, water, and sediments) and conditions being measured, to the extent possible. Representative data are achieved through proper selection of sample location, sampling techniques, and collection of a sufficient number of samples. Sampling protocols are designed to collect representative samples of the media. Sample handling protocols (e.g., storage, transportation) are selected to protect the representativeness of the collected sample. Proper documentation will establish that protocols have been followed and sample identification and integrity are assured. Sample collection and handling will be in accordance with the standard procedures contained in this QAPP.

3.4 COMPLETENESS

The characteristic of completeness is a measure of the amount of valid data obtained compared to the amount that was expected to be obtained under normal conditions. The amount of valid data expected is established based on the measurements required to accomplish project objectives. Because sampling and waste characterization activities often rely on a field protocol, the site-specific Work Plan will provide an upper limit on the number of samples to be collected. For example, multiple depth soil sample collection from a boring may be specified, but the boring may be terminated for technical reasons prior to reaching the specified depth. In that case, it would not be possible to obtain a predetermined number of soil samples. The extent of completeness must therefore be reviewed on a relative basis for sample collection activities. Completeness for CLP data is estimated to be between 80-85% (USEPA, 1988).

3.5 COMPARABILITY

The characteristic of comparability reflects: (1) the internal consistency of measurements made at the site, (2) the expression of results in units consistent with other organizations reporting similar data, and (3) the confidence with which one data set can be compared to other similar measurements. Each value reported for a given measurement should be similar to other values within the same data set and other related data sets. Achieving this characteristic requires operating within the calibrated range of an instrument and utilizing analytical methodologies which produce comparable results.

4.0 SAMPLING PROCEDURES

4.1 Sample Labels and Records

Sample labels will be prepared, to the extent feasible prior to initiation of work, using a computerized labeling system. Each sample may require several labels for the different containers, depending on the analysis to be performed.

Identification of samples collected during the field investigation will be accomplished with an Integrated Site Information System (ISIS) code indicating sample type, sample identification, depth of sample (if applicable), and designation of duplicate samples. Soil, groundwater, and sediment samples will be labeled using a 14-digit system, as follows (ABB-ES, 1989):

Digits 1 & 2 — Site Code - two letter code to identify the site
Example: GS (Guterl Specialty Steel)

Digits 3, 4 — Sample Type - two letter code to identify sample media
BS - Test Boring Soil Sample
BW - Screened-auger Groundwater Sample
CD - Septic System/Sump Catch Basin Sludge Sample
CL - Septic System/Sump Catch Basin Liquid Sample
DL - Drum Liquid
DS - Drum Solids or Sludge
MW - Monitoring Well Groundwater Sample
PS - Test Pit Soil
PW - Test Pit Water
QD - Source Water Blank
QS - Sampler Blank (i.e., Rinsate Blank)
QT - Trip Blank
SD - Sediment Sample
SW - Surface Water
SS - Surface Soil
TS - TerraProbe℠ Soil Sample
TW - TerraProbe℠ Water Sample
WT - Waste Sample

Digits 5,6,7	Horizontal Sample Locator - three numbers to identify sample location. Example: 202
Digits 8,9,10	Depth of Sample Below Reference Surface - Example: XX1 foot, 125 feet. For BS samples, the depth indicated is assumed to be the top of a 2-foot, split-spoon sample. The designation XX0 will be used for BS samples collected from 0 to 2 feet below ground surface. All samples obtained from the ground surface or from drums and containers will be designated XXX.
Digits 11,12	Used as sampling event number when more than one round of sampling is required. If only one event is planned, the two letter code will be the year (e.g., 95 for samples obtained in 1995).
Digits 13,14	XD - duplicate sample XX - sample XF - sample collected for field laboratory analysis or a filtered groundwater sample collected for analytical laboratory analysis XS - laboratory split sample

Acceptable sample ISIS codes include GSMW101XXX95XX (a groundwater sample), GSQTXX1XXX94XX (a trip blank), and GSBS301X2993XX (a soil boring sample).

At the time the sample is obtained a sample data record sheet and field logbook entries will be completed. The sample records sheets for specific types of samples are discussed and illustrated in Subsection 4.5. The sample record documentation will include:

- a plan of the site with the sample location;
- sample label numbers;
- a description of the sample site;

- other physical descriptors of the sample site, if appropriate (e.g., stream width, groundwater depth, etc.);
- photographs of the sample site may be taken showing the sampling equipment and/or unusual conditions (orientation of photograph must be shown on sketch map, and photo number recorded in field notebook); and
- COC documentation (see Section 5).

4.2 Sample Container and Preservation Requirements

Sample integrity is maintained by using containers and preservation methods that are specific to the media sampled and analytical parameters. Sample containers and preservation methods specified in NYSDEC protocols are summarized in Table 4-1. Any project-specific variation or addition to the sample containers and preservation methods outlined in this table will be specified in the site-specific QAPjP.

4.2.1 Preparation of Sample Containers

Sample containers will be provided by the laboratory and are prepared according to USEPA protocols. The bottles will be equivalent to I-Chem series 300. QC records for the bottles used will be maintained by the laboratory. The procedures used by the vendor providing the laboratory with sample containers are detailed below.

4.2.1.1 Semivolatile Organic Compound Containers. (1-liter amber glass bottles and 4-ounce [oz] glass jars)

1. Wash containers, closures, and Teflon® liners in hot tap water with laboratory grade non-phosphate detergent.
2. Rinse three times with tap water.
3. Rinse with 1:1 nitric acid.
4. Rinse three times with American Society for Testing and Materials (ASTM) Type II water.

5. Rinse with pesticide-grade methylene chloride.

6. Oven dry.

7. Remove containers, closures, and Teflon® liners from oven.

8. Place Teflon liners in closures and place closures on containers. The attendant must wear gloves and the containers cannot be removed from the preparation room until sealed.

4.2.1.2 Elemental Parameter, Cyanide, and Miscellaneous Parameter Containers. (1-liter, 500, 250, 120 and 60-milliliter (mL) clear and 1-liter amber polyethylene bottles)

1. Wash bottles, closures, and Teflon® liners in hot tap water and laboratory grade non-phosphate detergent.

2. Rinse three times with tap water.

3. Rinse with 1:1 nitric acid.

4. Rinse three times with ASTM Type II water.

5. Air dry in contaminant-free environment.

6. Place liners in closures and place closures on bottles. The attendant must wear gloves and the bottles cannot be removed from the preparation room until sealed.

4.2.1.3 Volatile Organic Compound Containers. (40-mL amber glass vials and 2-oz or 4-oz glass jars)

1. Wash vials, septa, and closures in hot tap water with laboratory grade non-phosphate detergent.

2. Rinse three times with tap water.

3. Rinse three times with ASTM Type II water.

4. Oven dry vials, septa, and closures.

5. Remove vials, septa, and closures from oven.

6. Place septa in closures, Teflon® side down, and place on vials. The attendant must wear gloves and the vials cannot be removed from the preparation room until sealed.

4.2.2 Sample Preservation

Unless the proper sample container preparation and sample preservation measures are taken in the field, sample composition can be altered by contamination, degradation, biological transformation, chemical interactions, and other factors during the time between sample collection and analysis. Steps to maintain the in situ characteristics required for analysis may include storage of samples at 4 degrees Celsius, pH adjustment, and chemical fixation. Specific sample and container preservation requirements are summarized in Table 4-1. Where pH adjustment is performed, the pH will be checked in the field with pH paper to assure the required pH level is achieved. If pre-preserved sample containers are provided by the laboratory, extra preservation material should be available in the field in cases where additional material is needed to achieve the necessary pH.

4.3 DECONTAMINATION PROCEDURES

Equipment to be decontaminated during the project may include: (1) drill rig, TerraProbe℠, backhoe, truck, or trailer; (2) tools; (3) monitoring equipment; (4) sample containers; and (5) sample collection equipment.

All decontamination will be done by personnel in protective gear appropriate for the level of decontamination as determined in the site-specific Health and Safety Plan (HASP). The site-specific Work Plan will designate where equipment decontamination will be performed on site (e.g., at a central decontamination station established at the site or at individual exploration locations).

4.3.1 Large Equipment

ABB-ES anticipates that large equipment such as drill rigs, TerraProbes℠, backhoes, trucks, and trailers may potentially be contaminated during field activities. Large equipment requiring decontamination will be cleaned with a portable, high-pressure steam cleaner. Personnel performing this activity will use the same level of health and safety personal protection required for invasive exploration activities plus splash protection.

4.3.2 Tools and Sampling Equipment

Contaminated tools and sampling equipment will be dropped into a plastic pail, tub or other container. The tools will be brushed off, rinsed, and transferred into a second pail to be carried to further decontamination stations where they will be washed with a Liquinox ®, or equivalent soap and water solution, rinsed with clean potable water, and finally rinsed with deionized water. Tools such as wrenches, split-spoons, etc., may be decontaminated between exploration locations with a high-pressure steam cleaner instead of washing. Sampling equipment, such as bailers, will be wrapped in aluminum foil after cleaning to prevent contamination before next use.

4.3.3 Monitoring Equipment

When monitoring equipment is being used under conditions where it may become contaminated, the equipment will be protected as much as possible from contamination by draping, masking or otherwise covering as much of the instrument as possible with plastic without hindering the operation of the unit. For example, the photoionization detector (PID) can be placed in a clear plastic bag which allows reading of the scale and operation of the knobs. The sensor on the PID can be partially wrapped, keeping the sensor tip and discharge port clear.

Any contaminated equipment will be taken from the drop area and the protective coverings removed and disposed of in the appropriate containers. Any direct or obvious contamination will be brushed or wiped with a disposable paper wipe. The units will then be wiped off with damp disposable wipes and dried. The units will be checked, standardized, and recharged, as necessary, for the next day's operation. They will then be prepared with new protective coverings.

4.3.4 Sample Handling/Shipping Areas

Sample containers will be wiped clean at the sample site, taken to the decontamination area to be further cleaned, as necessary, and transferred to a clean carrier. The samples will be checked off against the COC record. The samples will then be stored on ice in a secure area prior to shipment.

Sample handling areas will be cleaned/wiped down daily using disposable wipes. Disposable wipes will not be used on any equipment that comes in contact with samples. For final cleanup, all equipment will be disassembled and decontaminated. Any equipment which cannot be satisfactorily decontaminated will be disposed (e.g., glassware, covers for surfaces).

The management of disposal of liquid and solid wastes generated during decontamination is presented in Subsection 4.10.

4.4 FIELD INVESTIGATION TECHNIQUES AND PROCEDURES

4.4.1 Geophysical Methods

Geophysical methods are remote-sensing techniques that provide information about subsurface conditions. Geophysical surveys can be used to identify buried objects or features such as utility lines/pipes, former disposal trenches or pits, buried debris and/or waste material. This information is used to plan locations of explorations including test pits, borings, and monitoring wells. Geophysical techniques commonly used as part of field investigations include (but not limited to) ground penetrating radar (GPR), magnetometry, and terrain conductivity (TC). Using more than one individual survey technique in a given area provides for correlation of anomalous features and lends for a more comprehensive interpretation. The principles, instrumentation, methodology, and techniques of data evaluation of GPR, magnetometry, and TC are presented in the following subsections.

4.4.1.1 Ground Penetrating Radar. GPR uses high frequency radio waves to investigate the presence of subsurface objects and structures by measuring reflections from any interface where there is a significant change in the dielectric constant. Typical applications for GPR include delineating the boundaries of buried waste materials and perimeters of abandoned landfills; finding steel reinforcement bars and voids in concrete structures; recording the depth of geological interfaces, bedrock, and coal seams; locating and mapping buried utilities; profiling lake bottoms; and determining glacial ice stratification and thickness.

Principles. Energy is radiated downward into the subsurface from an antenna that is pulled slowly across the ground at speeds varying from about 0.25 to 5 miles per hour, depending on the amount of detail desired and the nature of the target. The radio wave energy is reflected from surfaces where there is a contrast in the electrical properties of subsurface materials. These surfaces may be naturally occurring geologic horizons (e.g., soil layers, changes in moisture content, voids and fractures in bedrock) or manmade (e.g., buried utilities, tanks, drums). The reflected energy is processed and displayed on a continuous strip chart recording of distance versus time (i.e., where time can be thought of as proportional to depth).

The time required for the electromagnetic (EM) pulse to traverse the path down to and back from the reflecting medium is measured in nanoseconds (one nanosecond = 1×10^{-9} seconds). The two-way travel time is proportional to the depth of burial of the reflecting medium and is dependent on the dielectric properties of the medium through which the EM pulse travels. The dielectric properties of a medium are related to the moisture content and composition of a material. Figure 4-1 depicts the relationship between a single EM pulse generated by the controller and the resulting strip chart recording that would result from many such EM pulses.

The depth of penetration of a GPR system is highly site-specific, and depends on (1) the soil types at the site, (2) moisture conditions, and (3) the frequency of the antenna (i.e., lower frequencies penetrate deeper resulting in less resolution).

Instrumentation. The radar system consists of a control unit, an antenna assembly (i.e., transmitter/receiver), and a recording device for analog field recordings. A digital recording unit may also be present for further data processing after field activities are completed. The antenna transmits EM pulses of short duration into the ground. The pulses are reflected from geologic or manmade surfaces and are picked up by the receiver, which transmits the signals to the control unit for processing and display. Shallow objects appear near the top of the strip chart recording (i.e., less time elapsed between the outgoing pulse and the return of reflected energy), whereas deeper objects appear farther down the recording (i.e., more time elapsed). ABB-ES generally uses a GSSI (Geophysical Survey Systems, Inc., North Salem, N.H.) SIR System III unit.

Methodology. GPR surveys are usually performed by establishing a grid of parallel lines across a site and towing the radar antenna along each of these survey lines, usually in the same direction. The spacing and orientation of the grid lines depends on the orientation, if any, of the target features and the required resolution, factors that will be specified in the site-specific Work Plan. For determination of geologic features or to detect large targets, surveys are typically performed with line spacing ranging from 5 to 20 feet, or greater.

The position of the antenna along the survey lines is annotated by vertical marks (i.e., "tick marks") placed on the instrument output by a device controlled by the operator. The tick marks correspond with distance along a cloth measuring tape, pin flags, or other physical markers at the site.

Data Evaluation. The propagation velocity of the EM pulse depends upon the relative dielectric permitivity of the material through which the pulse travels. The relative dielectric permitivity is a measure of the degree to which a medium can resist the flow of the EM pulse -- the higher the relative permitivity, the lower the resistance to flow, and vice versa. For most earth materials and rocks, the relative dielectric permitivity does not exceed 10 and is always greater than unity, the value for a vacuum. Table 4-2 gives typical permitivity values for commonly encountered materials. The dielectric permitivity is related to the propagation velocity by the formula:

$$e_r = (c/V_m)^2$$

where,

c = propagation velocity in free space ($3x10^8$ meters per second or approximately 1 foot per nanosecond)

V_m = the propagation velocity through a material.

It follows that

$$(e_r)^{1/2} = c/V_m \text{ or } 1/V_m = (e_r)^2/c$$

Since c is approximately equal to 1 ft/ns, then $1/V_m$ is approximately equal to $(e_r)^{1/2}$.

Final results are values of nanoseconds per foot (one-way travel time). These formulas give a method for estimating the propagation velocity for a medium; therefore, the depth to a reflecting horizon if the soil conditions are known. If soil condition are unknown or their properties cannot be estimated accurately enough, a reflector of known depth can often be used to calibrate the GPR recordings to site conditions.

4.4.1.2 Magnetometry. Magnetometry uses local variations in the earth's magnetic field to locate buried ferromagnetic objects such as drums, tanks, pipes, and cables. Typically a single 55-gallon drum can be detected at depths of up to 15 feet and large drum deposits or large tanks can be detected at depths of 65 feet or more assuming minimal magnetic interference in the vicinity of the target(s). Calculations of the mass or size of detected objects generally yield only approximate results.

Magnetic surveys are impractical in areas where metal pipes, fences, railroad tracks, metal buildings, and other ferrous metal artifacts are abundant. Proper selection of equipment and survey techniques can alleviate some of these problems.

Principles. All materials subjected to a magnetic field, including the magnetic field of the earth, will develop an induced magnetization, the intensity of which is proportional to the applied magnetic field and the magnetic susceptibility of the material. Ferromagnetic materials, such as iron or steel, have high magnetic susceptibilities.

Induced magnetization in an object produces a local magnetic field which either reinforces (i.e., positive magnetic susceptibility) or reduces (i.e., negative magnetic susceptibility) the external applied field. The variations in an otherwise uniform magnetic field caused by the presence of an object are called magnetic anomalies. Observations of such anomalies can be used to infer the presence of such objects.

In magnetometry, one measures local variations in the earth's magnetic field along a traverse or across an area on the surface. Because the intensity of the earth's magnetic field depends in part on the magnetic susceptibility of subsurface materials, a knowledge of variations in field intensity provides an indication of variations in the distribution of materials with different magnetic susceptibilities. In particular, magnetometry can detect the anomalies caused by buried ferromagnetic objects and other natural features which may be of interest in hydrogeologic site investigations.

Instrumentation. Magnetometer surveys will be conducted using a proton precession magnetometer with vertical gradiometer capability. A vertical gradiometer has a dual sensor mounted on a vertically oriented staff which simultaneously measures the total field at each sensor. The gradient is the difference between the values recorded at the upper and lower sensors divided by the distance between them, typically one-half of one meter. In a proton precession magnetometer, a strong magnetic field is applied to a proton-rich fluid (e.g., kerosene) which realigns the protons. The field is then turned off and the frequency of the signal generated by the protons as they realign themselves with the earth's magnetic field is dependent upon, and thus a measure of, the strength of the field at that point.

Methodology. Magnetic measurements are generally made along a grid pattern or in a series of parallel lines across the survey area. The spacing of the grid or lines depends on the size and depth of the objects sought and will be specified in the site-specific Work Plan. Because of the phenomena of temporal magnetic drift, a magnetic survey usually includes establishing a base station at which magnetic measurements are made at regular intervals. These measurements may later be used to correct all total field survey data for temporal differences due to drift and also act as a QA/QC check on the function of the instrument. Theoretically, it is not necessary to correct vertical gradient measurements for temporal drift because any variation affects the two sensors equally.

In the field, the operator should avoid any sources of high magnetic gradients such as power lines, buildings, and any large iron or steel objects. The operator should also avoid carrying any unnecessary metal articles.

Data evaluation. Field data are recorded in the instrument as a series of data blocks which can be transferred to a computer for processing and evaluation. Each data block contains the total field values for each sensor, the "X" and "Y" coordinates for the measurement are input by the user, the date and time, and several parameters that permit an evaluation of data quality. The total field values are recorded in gammas. The intensity of the earth's magnetic field is approximately 60,000 gammas at the poles and 30,000 gammas at the equator.

For typical manmade iron or steel objects, one may quantify the approximate depth of burial and the amount of metal that produces an observed magnetic anomaly. The intensity or size of the anomaly (I) can be expressed as:

$$I = M/r^n$$

where,

M	=	magnetic moment of the source
r	=	depth to the source and,
n	=	is a measure of the rate of decay with distance, n = 3 for a dipole source and 2 for a monopole source.

Assuming a dipole source, the weight of a metal object in pounds, can be expressed as:

$$(Ir^3)/M$$

where,

M	=	magnetic moment per pound of iron, varying from approximately 175 to 1,750
r	=	depth in feet below the sensor
I	=	anomaly amplitude in gammas.

4.4.1.3 Terrain Conductivity. TC surveys use measurements of the electrical conductivity of a hydrogeologic section to (1) characterize the conductivity of subsurface materials, (2) delineate the extent of contaminant plumes with high concentrations of dissolved electrolytes, and (3) map large concentrations of buried wastes with a degree of saturation, containerization, or inherent electrical properties distinct from the surrounding soil matrix.

Principles. The instrumentation consists of a transmitter and receiver. When a measurement is made, the transmitter is energized by an alternating current that produces a magnetic field, designated as the primary field, H_p. This artificial magnetic field induces small electric currents to flow in the earth which, in turn, produce a secondary magnetic field, H_s, which is made up of two components, quadrature and in-phase components.

The secondary magnetic field is related to the transmitter/receiver separation and to the operating frequency of the transmitter, both of which are selected by the operator. The ratio of the quadrature phase of the secondary field to the primary field (H_s/H_p) is linearly proportional to the terrain conductivity under most conditions. This ratio is measured by the receiver and converted into conductivity values in units of milliohms per meter.

Field measurements may be recorded on a digital data logger, which is capable of recording simultaneously both the quadrature phase and in-phase components of the induced magnetic field. The quadrature phase component gives the ground conductivity value in milliohms per meter. The in-phase component is more sensitive to metallic objects and hence is useful for looking for buried tanks and drums. Data from the in-phase component may be thought of as being equivalent to a metal detector survey.

Instrumentation. Three instruments are available for EM surveying: an EM-31 or EM 34-3, EM-61, all manufactured by Geonics, Ltd., of Mississauga, Ontario. These instruments are rapid-reconnaissance exploration tools used to assess the conductivity values for soil, rock, and waste materials.

The most commonly used instrument, the Geonics EM-31, is a single-piece model operable by one person, with a fixed coil spacing of 12 feet. This provides an effective sampling depth of up to 18 feet. The Geonics EM 34-3 is a dual coil model, operable by two people, with variable coil spacings of 33, 66, and 321 feet. This provides for an effective sampling depth of up to nearly 200 feet. Each instrument can be used in either the horizontal dipole or vertical dipole mode. Selection of the operational dipole mode depends on the depth of sampling desired and the desired sensitivity of the instrument to materials at various depths, relative to the transmitter-receiver coil separation. The EM-61 is a time domain metal detector which detects both ferrous and non-ferrous materials.

Methodology. TC surveys are generally conducted on a grid system of parallel lines across the site area. Measurements are taken at grid points. The spacing of the lines depends on the resolution required and will be specified in the site-specific Work Plan. At each grid point the meter reading is recorded and the apparatus is moved to the next site grid location.

For the dual coil method (Model EM-34), the selected inter-coil spacing must be achieved prior to recording the data. In addition, the two coils must be coplanar. In the horizontal dipole mode, the coils are oriented vertically, where as in the vertical dipole mode, the coils are oriented horizontally.

Data Evaluation. Although it is difficult to define the thickness and "true" conductivity of individual subsurface layers, the instrument measures very precisely the "apparent" conductivity of a volume of underlying earth materials. The apparent conductivity value is made up of the sum of the contributions from each layer that is "sampled" by the transmitter-receiver array. The volume, therefore the depth, of earth materials sampled increases with increasing separation between the transmitter and receiver.

A comparison of the relative responses for vertical and horizontal dipoles is illustrated in Figure 4-2. The vertical axis describes the relative contribution to the secondary magnetic field, arising from a thin layer at a given depth, z. The horizontal axis shows how this response varies as a function of the ratio (z/s), where "z" is the depth of the thin layer described previously and "s" is the transmitter/receiver separation.

As illustrated in Figure 4-2, in the vertical dipole mode, the contribution to the secondary magnetic field from near-surface materials is very small but reaches a maximum at a depth "z" of approximately 0.4. The contribution is significant, although diminished, at a depth of 1.5. This depth represents the effective depth of exploration in the vertical dipole mode.

In the horizontal dipole mode, the contribution to the secondary magnetic field arising from near-surface materials is a maximum and decreases with increased depth. The contribution is also significant at a depth of about 0.75s. This depth represents the effective depth of exploration in the horizontal dipole mode.

4.4.2 Test Pits

Test pits or trenches are designed to allow exploration of subsurface contamination and the nature of near-surface soils. The locations of test pits will be planned in advance and rationale presented in the site-specific Work Plan, with provisions for the field geologist to modify plans in response to unanticipated site conditions. Test pitting will be conducted at the levels of personal protection specified in the site-specific HASP.

Test pits will be excavated using a backhoe. The field geologist will record the following information on the Test Pit Record (see Figure 4-3) and in the field logbook:

- site name and location;
- names of contractor, backhoe operator, and sampler;
- date and time of excavation;
- depth, width, length, and orientation of trench;
- sample number, depth, and type for all samples;
- approximate water level, after stabilization;
- soil description;
- results of any field screening;
- list of any photographs taken;
- date and type of backfill; and
- any other pertinent observations (staining, odor, etc.).

Test pit samples will be collected from the middle of the backhoe bucket, without requiring the field geologist to enter the excavation. Samples will be collected using the following procedures:

1. Excavate to the dimensions required by the field geologist.

2. Test pit excavation may be terminated due to groundwater seepage into the excavation or encountering obstructions, utility lines, or waste containers. Depending on the conditions encountered, it may be possible to continue excavating more slowly and carefully, rather than to terminate the exploration.

3. The backhoe operator will remove the material from the test pit, under the direction of the field geologist, and deposit excavated soil on plastic sheets in order to minimize contamination of surface soils.

4. When the bucket is brought to the surface, the contents will be screened for VOCs with a PID and examined for visible signs of contamination.

5. Samples will be obtained from the middle of the bucket and placed in the appropriate jars using a clean stainless steel trowel or spatula. Samples may also be collected from the test pit walls by using an extendable hand tool.

6. Excavated soils will be back-filled into the excavation and tapped down into place with the backhoe bucket.

Sample containers will be checked for complete and accurate labeling and COC procedures will be initiated.

The test-pitting subcontractor will decontaminate his backhoe bucket between excavations following the procedures described in Subsection 4.3.1.

4.4.3 Exploratory Drilling

A geologist will be present during the drilling of borings and installation of monitoring wells. The geologist will maintain drilling logs and collect appropriate samples. A qualified drilling subcontractor will supply the necessary type and number of drilling rigs capable of performing drilling techniques appropriate for the existing subsurface conditions. The boring methods employed at a given site are selected based on known subsurface conditions. ABB-ES has prepared detailed drilling specifications that govern the drilling subcontractor's effort. These specifications are modified and issued on a site-specific basis to reflect the needs of each project.

4.4.3.1 Auger Borings. One of the most commonly used drilling methods use of hollow-stem augers (HSA), utilizing coupled lengths of continuous flight augers to bring cuttings upward as the auger string is rotated and advanced into the ground. ABB-ES routinely specifies 4.25-inch inside-diameter (ID) HSA drilling at sites where overburden is composed of sand or silt, and cobbles, boulders, or rubble are not expected to be encountered. The hollow-stem allows for collection ahead of the augers using a split-spoon sampler or other device, and is large enough for installation of 2-inch ID monitoring wells inside the annular space of the casing. Auger sections are usually 5 feet in length and are attached directly to each other with bolts or with bolted collars. During drilling, the open end of the auger can be blocked as it advances to prevent soil from entering the hollow stem. No drilling fluids are used under normal circumstances. More commonly, the soil is allowed to pack into the open end a few inches. After the auger is advanced to the desired sampling level, the sampling tool is inserted through the hollow stem and driven. Techniques for subsurface soil sampling are presented in Subsection 4.5.1.2.

The advantages of the HSA technique include:

- simplicity of procedure;
- low risk of personnel exposure;
- can be used to obtain soil samples from a wide range of subsurface conditions;
- drilling fluids are generally not required; and
- availability of equipment.

The disadvantages of the HSA technique are:

- difficulty in penetrating excessively cobbled or bouldered soils; and
- difficulty in sampling granular soil below the water table since, without drill fluids, there is no practical means to maintain hydrostatic equilibrium in the borehole. When the plug is withdrawn, water and sediment from outside the augers may enter the borehole, potentially causing contamination and difficulty in sampling undisturbed soil below the bottom of the augers.

4.4.3.2 Cased Borings. In washed casing methods (driven or spun), the boring is advanced by first driving or spinning the casing (i.e., smooth sided, threaded, flush joint pipe) into the soil to the desired depth and then clearing out to a maximum depth of three inches below the bottom of the casing using a rollerbit and rod through which water is pumped as the bit is advanced. Where driven casing is used, the lead casing is equipped with a bit called the drive shoe. Spun casing uses a spin shoe. ABB-ES commonly specifies 4-inch ID washed casing in tight, heavy soils such as clay, soil containing cobbles, boulders, or rubble through which augers could not be advanced, or in borings that are planned to be advanced through the overburden into bedrock.

Driven casing is advanced using the blows of a 300-pound hammer falling 24-inches. Hammer blows are recorded for each 12 inches of penetration. In cohesive soils, the inner bit may be advanced further than 3-inches ahead of the casing, and then the casing advanced. During washing of the casing and advance of the roller bit and rod, water will not be recirculated, to prevent cross-contamination unless specified in the site-specific Work Plan. Management and disposal of the wash water and soil cuttings will be in accordance with Subsection 4.10 or specified in the site-specific Work Plan. As washed borings are advanced, special care shall be taken to note and record the depth where drilling fluid is lost if this occurs, the depth of an apparent change in soil type, consistency, or color, as can be detected practically while advancing the boring, or other details about the progress of the boring.

The advantages of this drilling technique are:

- simplicity of procedure;
- low risk of personnel exposure;
- can be used to obtain soil samples from a wide range of subsurface conditions;
- can be used to obtain samples from depths greater than 100 feet; and
- availability of equipment.

This disadvantages of cased borings arise from the need to use a drilling fluid. When sampling pervious soils, drilling fluids can permeate ahead of the casing. This can result in contamination of the underlying pervious soils if drilling fluids are recirculated.

4.4.4.3 Rock Coring. Some rock core drilling may be required to complete monitoring well installations at specific sites. Bedrock drilling will be conducted with 4.0-inch ID flush joint casing. Continuous rock core will be collected using H rock coring equipment. The H rock coring device consists of a diamond drilling bit and core tube with inner core barrel. After a length of core drilling is complete, the core barrel is retrieved from the borehole. The core is extruded directly into wooden core boxes for description and storage.

The field geologist will take custody of the rock core after it is extruded from the core barrel. The length of rock core will be described using the procedures outlined below and recorded on the Rock Coring Log (Figure 4-4) and in the field logbook.

1. Scan the core with a PID and record any measurements.

2. Determine the percent recovery from measurement of length of core retrieved versus the length of drill bit advancement (i.e., the core run).

3. Visually examine the core and record its characteristics (including: lithology, petrography, color (wet), layering, fracture spacing, joints, presence of fossils, visual evidence of possible contamination.

4. Determine rock quality data (RQD). RQD is determined as the total length of rock core segments greater than four inches in length versus the total length of drill bit advancement. RQD is calculated in percent.

4.4.4.4 Monitoring Well/Piezometer Installation. The objectives for each monitoring well and/or piezometer may vary from site to site and from well to well. The objectives will be clearly defined in the site-specific Work Plan before the monitoring system is designed. Monitoring wells serving different purposes require different types of construction. The objectives for installing monitoring wells may include:

- determining groundwater flow direction and velocity;
- sampling or monitoring for contaminants;
- determining aquifer characteristics (e.g., hydraulic conductivity testing); and
- performing site remediation (e.g., injection or recovery wells).

In cases where only groundwater flow or velocities are to be determined, piezometers, cluster wells, or well points may be used.

Well Materials. Well riser pipe materials are specified by diameter, type of materials, and thickness of pipe. Well screens require an additional specification of slot size. Well specifications will be presented in the site-specific Work Plan and/or QAPjP.

The selection of well material depends on the method of drilling, the type of contamination expected, natural water quality, and anticipated depth. Cost may also be a consideration. The two most-commonly used materials are polyvinyl chloride (PVC) and stainless steel. PVC is generally preferred to stainless steel because it is light-weight, less expensive, non-corrosive, and generally easier to work with. However, PVC may deteriorate in the presence of ketones, aromatics, alkyl sulfides, and some chlorinated hydrocarbons. In such cases stainless steel may be preferred.

When the aquifer is bedrock, a well screen may not be necessary, the well is simply an open hole in bedrock. Unconsolidated materials such as sands, clay, and silts, require a well screen. The screen slot size should be selected to retain 90 percent of the filter pack material or in-situ aquifer material, after development (Driscoll, 1989). The gradation of the filter pack material will be selected based on the gradation of the native soils within the screened interval. A screen slot size of 0.010-inches is generally used when a screen is necessary and site conditions are not known.

The thickness of pipe depends on the strength required for the well. In general, larger diameter pipe requires greater thickness to maintain adequate strength. Similarly, driven well points require greater strength, and therefore greater thickness, than wells installed inside drilled borings.

Well Design. The well depth and diameter are tailored to the specific monitoring needs of each site and generally depends on the purpose of the monitoring system and the geologic setting. The decision concerning the depth of placement and length of the well screen is based on the following information:

- aquifer depth, thickness, and characteristics (e.g., permeability and specific yield);
- anticipated depth, thickness, and characteristics (e.g., density relative to water) of the contaminant plume;
- head distribution and estimated flow in the aquifer; and

- fluctuation in groundwater levels.

In most situations, screen lengths are 5 to 10 feet.

Standard well IDs are 2, 4, 6, or 8 inches. For most groundwater monitoring and sampling programs, a 2-inch ID well is preferred. Pumping tests for determining aquifer characteristics may require larger diameter wells; however, in situ hydraulic conductivity testing can be performed during drilling or after well installation in small diameter wells. Other considerations in selecting well diameters include the types and size of the sampling equipment, and any in situ instrumentation that may be used in the well. In general, the borehole diameter should be at least 4 inches larger than the well riser pipe diameter to provide an annular space of at least 2 inches for placement of filter pack, seal, and grout or backfill.

Well Installation. Monitoring well installation details will be recorded in the field logbook and on an Overburden or Bedrock Monitoring Well Construction Diagram (Figures 4-5 and 4-6).

Materials placed in the annular space between the borehole and the riser include filter pack, bentonite seal, and grout. In general, all of these materials may be installed using a tremie pipe placed in the annular space. In shallow wells, these materials may be emplaced from the ground surface, but the rationale and procedures must be described in the site-specific Work Plan and/or site-specific QAPjP.

The filter pack is usually a fine to medium uniform sand. The exact filter pack gradation should be chosen to retain approximately 60 percent of the aquifer material after well development (Driscoll, 1989). The filter pack is installed around the well screen and extending 2 to 3 feet above the top of the screen. At least 2 feet of bentonite pellets will be placed above the filter pack.

The bentonite expands by absorbing water and serves to isolate the screened interval from the rest of the annular space and the formation. If the bentonite seal is above the water table, care must be taken to adequately hydrate the pellets before proceeding with well construction. If the seal is below the water table the bentonite slurry may be tremied into place.

Grout is placed from the top of the bentonite to the ground surface. Grout generally consists of a cement-bentonite mixture or Portland cement. The grout minimize the possibility of surface run-off reaching the screened interval and replaces material removed from the boring during drilling thereby minimizing hole collapse and subsidence around the well.

In certain cases, the borehole may be drilled to a depth greater than the well installation depth. For these cases, the well is backfilled to the desired depth with bentonite and sand is placed between the bottom of the well and the bentonite.

Well sections and all materials coming in contact with the well must be cleaned before installation. The screen and well-riser pipe can be placed in the boring either manually or using the rig to hold the pipe, depending on the weight of the well. The pipe is lowered and sections added until desired screen depth is reached. No glues or solvent-cement will be used in well construction monitoring wells. When the screen and riser are in place, the filter pack, bentonite seal, and grout are installed using tremie pipes. The well is completed with a vented PVC cap.

When the well is completed and grouted to the surface, a protective steel casing is often placed over the top of the well. This casing generally has a hinged cap and must be able to be locked to prevent vandalism. The protective casing is larger in diameter than the well and is set over the well into the wet grout or is concreted in place. Protective casings can be above ground or flush-mounted. Above ground protective casings will have weep holes to allow drainage. Special care must be taken with flush-mounted installations to ensure that surface drainage does not enter the well. The protective casing and surface cement should extend below the frost line to prevent heaving.

Well Development. Well development is a process of pumping or purging a new monitoring well, designed to stabilize and increase the permeability of the filter pack around the well screen and to restore the permeability of the formation which may have been reduced by drilling operations. The selection of the well development method will be made by the site hydrogeologist based on the drilling methods, well construction and installation details, and the site geology. Monitoring wells should be allowed to set for a minimum of 24 hours before well development to allow for the seal and grout to set (NYSDEC, 1988). Any equipment introduced into the well will be decontaminated in accordance with the procedures presented in the HASP. Water levels will be taken from each well before and after development. To avoid aeration of the filter pack, the water level will not be allowed, to the extent feasible, to fall below the top of the filter pack during development.

Well development may be accomplished using one of several methods including:

- Overpumping, which uses a pump (e.g., submersible or peristaltic) or compressed air (i.e., air lift) to remove water from the well.

- Surge block which uses a plunger, the approximate diameter of the well, to agitate water in and out of the screen. No water is removed from the well.

- Compressed air which develops a well by either backwashing (i.e., forcing water out of the well and reducing pressure to let water flow back in) or surging (i.e., releasing a large volume of air suddenly into an open well below the water table producing a strong surge due to resistance of water head, friction, and inertia). Water is pumped from the well using airlift.

Well development will continue until the turbidity of the discharge water is 50 nephelometric units (NTUs) or less. Field measurements of turbidity, temperature, pH, and specific conductivity will be recorded for each well volume removed. If the turbidity of the development water is not less than 50 NTUs within a reasonable amount of time, 2 to 3 hours or as specified in the site-specific Work Plan, field personnel will provide the field data to the FOL or PM who will contact the NYSDEC Project Manager for guidance on how to proceed. An average of two weeks should be allowed between development and subsequent sampling or water level measurements to allow the aquifer to re-equilibrate.

Well development will be documented in the field notebook and on the Well Development Record (Figure 4-7).

4.5 Sampling Techniques

The rationale for each sampling site location will be identified in the site-specific Work Plan. For meaningful evaluation of the sample analytical results, it is important that the actual location of the samples be properly documented. If possible, sampling sites will be marked in the field with stakes or flagging. All sampling site locations will be referenced on a base map and on sampling records.

The location and distribution of contaminants at a given site are a function of many factors, including but not limited to:

- site operation or waste disposal practices;
- site design;
- site closure;
- waste characteristics;
- site topography and surface drainage;
- climate; and
- site hydrogeology.

The development of a sampling program requires consideration of the factors listed above and the scope and objectives of the project.

4.5.1 General Soil Sampling Methodology

Development of a soil/sediment sampling plan to evaluate the distribution and magnitude of contamination at a specific site requires at a minimum:

- an assessment of the site conditions;
- evaluation of the methodology and results of any previous sampling and analysis programs which may have been completed at the site; and
- definition of the scope and objectives of the project.

A number of techniques have been developed to obtain samples from various depths below the ground surface. The techniques described herein are those normally employed by ABB-ES. They have been selected to provide a practical and efficient means of obtaining samples in a manner consistent with safety protocols and QA/QC requirements. Additionally, they employ equipment that is normally available for use.

The selection of sampling techniques to be employed at a given site is based upon the depth from which samples must be obtained, the types of exploration, and/or the nature of the soils to be sampled. The sampling techniques are categorized by the depths or the types of explorations from which they are obtained:

- shallow soil samples, from depths of less than 6 inches;
- subsurface soil samples from test borings and TerraProbe℠ explorations at variable depths; and
- sediment samples from depths of less than 6 inches (see Subsection 4.5.3).

All soil samples collected will be logged in the field at the time of sampling by the field geologist. Soils shall be classified in accordance with the Unified Soil Classification System (USCS), Figure 4-8. Soil samples will be described fully on the appropriate sampling logs.

At the time samples are obtained, the following must be recorded by the sampler in the field logbook and on sample data sheets:

- sample site location (e.g., grid coordinates baseline station and offset, or the location plotted on a map or aerial photograph);
- sample type and depth;
- date and time of sampling;
- project and sample designations;
- sample identification; and
- analyses requested.

For laboratory samples, the sampler must initiate COC procedures and describe the sample site in adequate detail to allow the analytical results to be properly interpreted and, if necessary, to allow collection of additional samples from the same sample location. ABB-ES uses preprinted labels and standardized record forms to expedite this process and ensure uniformity of records. The sampling protocols and recordkeeping requirements for the types of samples described in the following pages vary according to the sampling techniques. Additional requirements may also be established on a site-specific basis. The entire soil sampling process should be designed and conducted in a manner that provides properly documented samples suitable for the intended analyses.

4.5.1.1 Surface Soil Sampling. Shallow soil sampling provides samples of surface and near surface soils suitable for chemical analysis. Shallow soil samples are usually obtained by using one of the following devices:

- split-spoon sampler;
- hand auger or corer;
- trowel or spoon; or
- spade.

The split-spoon sampler is described in detail in Subsection 4.5.1.2. Two distinct types of hand augers are available: a cup-type auger and a screw-type auger. Use of either device is generally limited to the upper portion of the soil profile (i.e., less than 5 feet). These augers are best suited for obtaining composite samples from relatively shallow depths and in relatively loose soils. Use of trowels or spades is straightforward but usually limited to sampling very shallow depths (i.e., less than 18 inches).

Soil samples can be either grab or composite, depending on the objective of the sampling program. In grab sampling, the soil jar is filled directly. In composite sampling, several methods are available:

- Samples can be composited over depth at a single spot.

- Samples can be composited laterally, in which one sample comprises several, usually three or four, soil specimens from the same depth in the vicinity of the sampling site.

During composite sampling, several depths or locations are selected and a stainless steel bucket is filled with samples from all locations. The material is then mixed and put into appropriate containers. Samples for VOCs are **not** mixed. A specific location is chosen and the sample is placed immediately in the appropriate containers with as little agitation or disturbance as possible.

Immediately after taking a sample, COC procedures are initiated and the Surface Soil Sample Data Record (Figure 4-9) is completed. Any special observations (staining, odor, etc.) will be recorded in the "Notes" portion of the Record.

4.5.1.2 Subsurface Soil Sampling. Sampling during soil boring allows collection of soil samples from depths greater than 5 feet below ground surface. Borings are advanced using a variety of methods including HSA, drive-and-wash casing, or spun-and-wash casing methods. The boring method chosen is based on subsurface conditions and the method will be specified in the site-specific Work Plan.

Split-spoon Soil Sampling. Soil boring samples are taken from undisturbed soil at the bottom of the boring with a split-spoon sampler. This sampler consists of a split steel tube or sample barrel threaded at both ends. A sharpened drive shoe secures the bottom of the barrel and an adaptor secures the top. The adaptor is threaded to connect directly to the drill rods and contains a check valve (Figure 4-10). The split-spoon is driven into undisturbed soil below the casing using the standard penetration test (ASTM-D-1586-84) (ASTM, 1990) (Figure 4-11). The standard penetration test consists of driving a 1⅜-inch ID, 2-foot split spoon 18 inches into the soil at the end of the drilling rods using a 150-pound hammer dropped 30-inches. Blows per foot are recorded as a SPT-N value defined as total blows for the penetration from 6 to 18 inches. If the split-spoon is to be driven greater than 18 inches, or will be larger than 1⅜-inch ID, this will be specified in the site-specific Work Plan.

After the sampler has been driven, it is withdrawn from the borehole and the sampler is opened by removing the drive shoe and adaptor. The field geologist will take custody of the sampling device as soon as it is withdrawn from the borehole. The sample will be collected and documented in the field logbook and on the Test Boring Log (Figure 4-12) in accordance with the following procedures:

1. Scan the soil with a PID and record any measurements.

2. Visually examine the sample and record its characteristics (e.g., texture, color, consistency, moisture content, layering and other pertinent data) and classify using the USCS (ASTM-D-2488-84) (ASTM, 1990), Figure 4-8.

3. Remove the portion(s) of the sample selected for chemical analysis and place into appropriate containers using a clean spatula. Soil intended for VOC

analysis should be placed in the appropriate wide-mouth glass jar and capped as quickly as possible. The containers should be filled as near to capacity as possible to minimize volatilization of the sample into the container headspace. Soil intended for other types of analyses should be placed in appropriate containers and capped.

4. Place the remainder of the sample in an 8- or 16-oz reference jar. This sample portion will be used for headspace PID measurement and for any physical materials testing that is required.

5. Discard any excessively disturbed or loose material found in the sampler which may not be representative of the interval sampled. This material will be discarded in the same manner as the drill cutting at each boring location.

6. Decontaminate the sampling device in accordance with the procedures specified in Subsection 4.3.2.

In some instances, there may be no analytical samples collected from a given boring. In these instances, steps 2 and 3 of the procedure listed above are omitted and the sample is placed in one or more reference jars.

Immediately after the samples are collected, all sample containers are checked for completeness and COC procedures are initiated. The boring log is also updated by the geologist. Boring logs may be completed by the driller but for purposes of completeness and documentation a separate boring log is also compiled by the ABB-ES geologist. The boring log includes interpretations of subsurface materials and conditions encountered, sample locations, PID readings, and other notes pertinent to how the boring was conducted or conditions encountered during sampling, such as staining, odor, etc. The geologist's boring log will be completed in a site field logbook and on a Test Boring Log (Figure 4-12).

The sampler must exercise considerable care while collecting samples for analysis. Some methods for sample collection are described below.

1. Obtain samples from undisturbed soil below the casing or auger. This is accomplished by monitoring or checking the drill crew's measurements, observing the sampling process and examining the sample once it is retrieved.

2. Carefully remove and discard portions of the sample that are suspected to be contaminated by contact with the casing, auger, or drilling fluids.

3. Conserve sample volume since under certain soil conditions it may be difficult or impossible to achieve good sample recovery with split-spoons.

Procedures employed to minimize cross-contamination during test boring sampling operations include the following:

- Samples are taken immediately after the boring is advanced to the desired sampling depth.

- The sampling tools are decontaminated prior to taking each sample.

- The drilling contractor is not permitted to use oil, grease or other petroleum-based lubricants on the drill rods, casing or sampling tools. Use of any other lubricants will be documented.

- The drilling technique and procedures to be utilized, particularly the use of drilling fluids, are carefully evaluated for each site.

4.5.2 General Water Sampling Methodology

The location and distribution of contaminants at a given site are governed by many factors, including:

- site operation or waste disposal practices;
- site design;
- site closure;
- waste characteristics;
- site topography and surface drainage;
- climate; and
- site hydrogeology.

Development of a water sampling plan that will effectively reveal the distribution and magnitude of contamination at a specific site requires:

- an assessment of the factors listed above;

- evaluation of the methodology and results of any previous sampling and analysis program which have been completed at the site; and

- definition of the scope and objectives of the project.

4.5.2.1 Surface Water Sampling. The technique for surface water sampling must be selected after addressing such items as:

- depth of water body;
- flow rate;
- stratification;
- specific gravity/solubility of anticipated analytical parameters;
- seasonal variations; and
- analytical parameters of interest.

The exact location of each surface water sample will be established in the field at the time of sampling. General sampling areas will be presented in the site-specific Work Plan. Surface water samples will be collocated with sediment samples. Surface water samples should always be collected before the sediment sample. The sample site will be noted on a site plan or aerial photograph and marked in the field with flagging and a wooden stake. The stake will be labeled with the sample site number.

The sample will be taken in the following manner:

1. Collect the sample from the surface water body by immersing a clean sample bottle. If a stream is being sampled, collect the sample while facing upstream with the opening of the sampling device oriented upstream but avoiding floating debris.

2. Or, directly fill the appropriate sample containers from a sampling device if one is needed.

3. Measure the following parameters, if possible, in the water body, not the sample:

   - PID reading;
   - temperature;
   - pH;

- specific conductance;
- elevation of significant surface water bodies; and
- any other site-specific field measurements required.

If direct measurement is not possible, measure these parameters from water remaining in the sampling device or another sample bottle. This information will be recorded on the Surface Water and Sediment Field Data Record (Figure 4-13), sample labels will be completed, and COC procedures will be initiated.

4. Complete the sample data record and field logbook entry. Include any observations of special conditions such as color, odor, etc.

4.5.2.2 Groundwater Sampling. Sampling of groundwater monitoring wells will proceed from the upgradient or background wells to the downgradient or potentially contaminated wells, as best as can be determined. The sampling procedure is detailed below:

1. Check the well for proper identification and location.

2. Measure and record the height of the protective casing above ground surface.

3. After unlocking the well and removing any well caps, measure and record the ambient and well-mouth organic vapor levels using a PID.

4. Measure and record the distance between the top of the well and the top of the protective casing.

5. Using the electronic water level meter, measure and record the static water level in the well and the depth to the well bottom to the nearest 0.01 foot. Measurements will be referenced from the top of the well riser as opposed to the protective casing, when feasible. The point of measurement and the depth to water will be recorded in the logbook and Groundwater Sample Data Record (Figure 4-14). The water level meter is decontaminated upon removal as described in Subsection 4.3.3. In areas where light non-aqueous phase liquids (LNAPLs) are anticipated, an interface probe will be used to measure the thickness of free product present.

6. Calculate the volume of water in the well. Volume in gallons for a 2-inch ID well equals 0.041 times the square of the inside diameter of the well riser, in inches, times the depth of water, in feet. Volume calculations are detailed on the Groundwater Sample Data Record.

Upon completion of the measurements and calculations described above, sampling will commence in the sequence listed below, utilizing the appropriate purging technique (1a, 1b, or 1c):

1. Lower the pump intake into the well. For shallow groundwater situations, the pump intake will be lowered to the top of the well screen to begin purging (see Step No. 2). Modifications to this setup may be utilized in certain situations:

   a. If the well screen is very large, and pumping from the top is impractical, the pump intake will be lowered to the approximate mid-point of the screened portion of the well.

   b. If the well is situated in tight formations such as tills, clays or rock, the purging of the well will be performed from near the top of the well screen. As the water level in the well is lowered by purging, the pump is also lowered.

   c. If the well is in a highly productive aquifer, purging will progress by purging at intervals in the well screen, from the top of the water column downward, to avoid leaving stagnant water in the well.

   To avoid aeration of the sandpack, the water level will not be allowed, to the extent feasible, to fall below the top of the filter pack during purging except possibly in tight formations (see 1b above), where purging the well (and sandpack) dry can be unavoidable. The selection of the pump to be used for well purging will be presented in site-specific Work Plan and/or site-specific QAPjP, and approved in advance by NYSDEC.

   Considerations in pump selection are depth to water, the level of contamination anticipated, site access, and cost. Readily available choices include peristaltic pumps (shallow groundwater), disposable submersible pumps, such as a Whale® pump (good for moderate groundwater depths and contamination), and stainless steel/Teflon® submersible pumps, such as the Redi-Flow® (good for most applications).

2. Purge the well. Monitor the field parameters, pH, temperature, turbidity, and specific conductivity, and measure the volume of groundwater being pumped. In situ parameters may be monitored in a beaker filled from the pump discharge or in-line with the pump discharge. Purging of the standing well water is considered complete when any of the following is achieved:

   - a minimum of three well volumes has been purged, field parameters have stabilized, (within 10 percent) and turbidity is less than 50 NTUs; or

   - five well volumes have been purged and parameters have stabilized (within 10 percent); or

   - the well has been pumped dry and allowed to recharge

3. Record the in situ parameters, temperature, pH, specific conductivity, and turbidity in the field logbook and Groundwater Sample Data Record (Figure 4-14).

4. After purging, lower the bailer to the middle of the screened interval or mid-point of the static water level. If the analysis to be performed is for LNAPLs, then the bailer will be lowered to the top of the water column for sample collection.

5. Collect the sample(s). VOC samples are filled directly from a bailer with as little agitation as possible. Other samples can be placed directly into the appropriate container from the bailer or pump discharge.

6. Remove the pump or bailer from the well and decontaminate the pump, tubing or bailer by flushing with the decontamination fluid specified in Subsection 4.3.3, or dispose.

7. Complete the Groundwater Sample Data Record after each well is sampled. Include any observations made during sampling such as color, odor, etc., in the field logbook and field sample data record.

8. Secure the well cap and lock.

The following collection steps apply only to VOC samples:

1. Uncap the sample bottle, taking care not to touch the Teflon-faced septum. If the septum is contaminated in any way, it should be replaced.

2. If a chlorine residual is potentially present, check for chlorine content of the water to be sampled with potassium iodide paper or a chlorine residual comparator. If a residual chlorine content is detected, use the tip of a stainless steel spatula to add a few grains of sodium thiosulfate (American Chemical Society grade) to the sample container prior to filling the bottle.

3. Fill the sample vial slowly from the bailer until the vial just begins to overflow.

4. Place the cap on the convex meniscus taking care not to touch the Teflon-faced silicon rubber septum and screw cap on.

5. Invert the bottle, tap lightly, and check for air bubbles.

6. If air bubbles are present, open the bottle, add sample to eliminate air bubbles, and reseal. Repeat this procedure until the bottle is filled and no air bubbles are detected.

4.5.2.3 Domestic Well Sampling. Domestic wells will be sampled using the same procedures described for groundwater monitoring wells, with the exception of using in-place plumbing equipment. Prior to any sampling, ABB-ES personnel will contact the well owner and complete a Groundwater Usage Survey (Figure 4-15). The information provided on the survey will be used to identify downgradient domestic wells.

The sampling point at each domestic well location will be determined at the time of sampling and will be as close to the pump as practical. When possible, samples will be taken up-line from aerators, softeners, or filtering systems. If there is no outlet available up-line from the water treatment system, attempts will be made to by-pass the system, if possible.

When the necessary information is available, the purge volume will be calculated to ensure purging of one storage volume, based on pressure tank volume, before sampling. The tap will be opened and the water will be allowed to run until pH and temperature stabilize or as long as necessary to remove estimated purge water volume. Sample containers will be filled directly from the tap or faucet. Samples will be collected as described for monitoring well samples, except that samples collected for inorganic analyses will not be filtered so that the samples will accurately represent the quality of water ingested by residents.

4.5.3 General Sediment Sampling Methodology

Sediment sampling procedures are designed to obtain representative samples of the sediment from streams, lakes, ponds, wetlands, and lagoons for chemical analysis.

The exact location of each sediment sample will be established in the field at the time of sampling. Sediment sampling points are often collocated with surface water samples. Sediment samples should always be collected after the surface water sample.

Sediment samples will be collected in the following manner:

1. Unless otherwise specified, grab or composited samples will be obtained from the surface of the sediment.

2. The sampler will photograph the sample site (if specified for the project), complete the required records and initiate COC procedures.

Sediment sampling information is recorded on the Surface Water Sediment Sample Field Data Record Figure 4-13 and in the logbook.

The recommended sediment collection devices are stainless steel spoons or trowels, Teflon® or glass coring tubes for shallow wadeable water, and gravity corers in deeper waters.

In shallow, wadeable waters, the direct use of a core liner or tube (five-inch) is recommended. The tube is pushed into the substrate until approximately 1 inch (2.5 centimeters) or less of the tube is above the sediment-water interface. When hard or coarse substrates are sampled, a gentle rotation of the tube while it is pushed will facilitate greater penetration and reduce core compaction. The tube is then capped with a Teflon® plug or a sheet of Teflon® held in place by a rubber stopper or cork. After capping, the tube is slowly extracted, the negative pressure and adherence of the sediment keeping the sample in the tube. Before the bottom part of the core is pulled above the water surface, it too is capped. Caution should be exercised not to disturb the area to be sampled. The sampler should always stand downstream from the sample location when wading in shallow water.

To help prevent contamination from direct contact between the sampler's hands and the upper part of the tube, a collar-type device can be constructed of wood and should have a circular recess to accept the top of the tube. The recess will have a hole in it to allow water to pass through when the tube is pushed in, and will be lined with a sheet of Teflon. Handles will be attached to the sides of the collar. After the tube is driven in, a wide circular motion will be used to help loosen the core for easy removal; the collar device is removed; the top of the tube is capped (as described above); the tube is pulled out of the sediment layer; and the bottom of the tube capped before removing it from the water.

Another method of obtaining sediments in shallow, wadeable waters with a core tube is to use the tube as a horizontal scoop. The tube is placed on its side on the sediment surface and carefully inserted into the sediment so that the top inside surface is just at the sediment/water interface. It is important to disturb the fines as little as possible. After the tube is filled, both ends will be capped with a Teflon plug, as described above, before the tube is removed from the sediment. If this method is used with a tube having an outer diameter of 2 inches and wall thickness of 1/8-inch, only the top 2 inches of sediment will be sampled.

For calculating the amount of sample that will be collected using different tube sizes and core lengths, the number of tubes necessary can be calculated by using the formula for the volume of a cylinder ($\pi r^2 L$). Additional material may be required if duplicate analyses are performed on individual samples.

When the sediment is difficult to penetrate with a Teflon or glass tube, a commercially available hand coring device can be used. These devices are equipped with a metal barrel, a handle, and a core liner. The liner is inserted and then held in place by a screw-on core cutter, usually manufactured of stainless steel. The core cutter, along with the handle attached to the core barrel, increases the efficiency of sediment penetration. After the sample has been obtained, the cutting head is removed and the liner is carefully withdrawn and immediately capped, as previously described.

When coarse grained deposits such as sand are sampled, the use of a core retainer will increase the efficiency of sample retention. Only retainers manufactured of stainless steel should be used in order to minimize the risk of trace metal contamination and eliminate corrosion. When several samples are to be obtained, it is advisable to carry extra core liners to the sample site. This eliminates the need to conduct time-consuming extrusions and permits the use of the core liners as sample containers for shipment to the laboratory.

4.6 TERRAPROBE℠/FIELD LABORATORY ANALYSIS

The TerraProbe℠ System provides the means to collect and analyze soil, water, and vapor samples for site characterization in the field during contamination assessments to depths of approximately 25 feet below ground surface. The TerraProbe℠ is commonly used by ABB-ES in assessing the extent of contamination at a site in combination with field analytical procedures. The TerraProbe℠ System uses hydraulics to push and/or hammer rods, specialized 3/4-inch diameter rods, and probe tips into the subsurface for sample collection. The entire system is mounted on a standard cargo van. The procedures for the collection of soil, water, and vapor samples are detailed below.

The procedures for sample collection are:

1. Obtain clearance for all underground utilities.

2. Clear all hydraulic lines and unfold the probe system from the rear van doors.

3. Set up and configure the TerraProbe℠ unit over the sample location.

4. Attach the appropriate sampling probe to the rods; securely fasten the piston stop for soil sampling. The sample tubes, sample probes, rods, piston stops, and piston rods should be decontaminated prior to beginning the exploration.

5. Push and/or hammer the sample probe to the desired sample depth; release piston stop for soil sampling.

6. Push sampling probe 10 to 12 inches to collect a soil sample. Lower a small diameter bailer down the inside of the drive rods to collect a water sample. Apply a vacuum to the drive rods to collect a vapor sample.

7. Remove the rods and sampling probe from the exploration.

8. Place the sample into the appropriate container(s).

All sample information will be recorded, along with the date and time of sample collection, in the field notebook and on the TerraProbe℠ Field Data Record Figure 4-16.

The samples collected using the TerraProbe℠ System can be analyzed in the field by gas chromatography (GC) or other methods to assess the extent of contamination. The method used on any given site depends upon the data quality objectives and the specific contamination or compounds present. The data quality can range from simple compound group identification to single analyte risk assessment quantification, depending upon the data quality objectives of the program. DQOs for TerraProbe℠ data will be specified in site-specific QAPjP.

Routine QC during field analysis episodes can include the following:

- method detection limits for the instrument on-site;
- multi-point calibration curve generation for quantitation, 3 point typical;
- reagent blanks;
- duplicate sample analysis;

- spiked sample analysis;
- system blank analysis;
- matrix spike analysis; and

- container blank analysis.

The above QC methodology will vary depending upon the data quality objectives; however, most field analysis techniques employed are a modification of USEPA SW-846 laboratory methodology. Field analysis for total petroleum hydrocarbons (TPH), PCBs, selected VOCs and SVOCs, inorganics, and selected pesticides can be performed.

The field methods available for these analyses include: purge and trap analysis of VOCs, infrared spectroscopy analysis of petroleum hydrocarbons, field screening of SVOCs by GC/mass spectrometry, and field screening of pesticides/PCBs via micro-extraction followed by direct GC-electron capture detector analysis. These methods are detailed in the following ABB-ES Standard Operating Procedures (SOPs):

- *Purge and Trap Analysis of Volatile Organic Compounds by Field Gas Chromatography*; FGCPT-001-01 (ABB-ES, 1991a);

- *Infrared Spectroscopy Analysis of Petroleum Hydrocarbons*; FANIR-001-01 (ABB-ES, 1991b);

- *Field Screening of Semivolatile Organic Compounds by GC/MS*; FMSSV-001-01 (ABB-ES, 1991c); and

- *Field Screening of Pesticides/PCBs by GC/ECD*; FGCPP-001-01. (ABB-ES 1991d).

Each SOP contains information on the analysis requirements, conventions, calibration, sample preparation, target compound identification and quantitation, field documentation procedures, QC procedures, and data review and deliverables.

The field analysis will be summarized and presented in a report that will include:

- data summary sheets, field analysis summaries, field sample collection information and logbooks from field analysts;

- graphical summaries of site data; and

- raw analytical data such as chromatograms.

4.7 Drum Sampling

Sampling personnel will develop an exclusion zone at the drum location in accordance with the site-specific HASP. The work area will be cleared of all physical hazards. Plastic sheeting will be used around the drums to protect the ground surface during sampling. Sample jars will be labeled in accordance with the site-specific QAPjP. Sampling will be performed at the level of personal protection specified in the site-specific HASP. Due to the potential release of hazardous gases, ABB-ES will only sample drums already open to the atmosphere and will not open drums or perform remote sampling. The ambient air conditions in and around the drums will be monitored using a PID.

Documentation in the field logbook should begin with a visual inspection of the drum, noting any holes, markings and weak spots. Any readings detected with the PID should be recorded. A description of the drum contents should be recorded (color, consistency, etc.).

Solids can be sampled from the drums using several methods: a bucket auger, hand auger, or hand scoop; if the drums are open to the atmosphere. When the drum has been sampled, all sampling equipment should be decontaminated as described in the site-specific HASP.

4.8 Aquifer Characterization

Aquifer testing activities include water level measurements and in situ hydraulic conductivity testing. These tests are designed to characterize groundwater flow patterns and to assess aquifer characteristics.

4.8.1 Water Level Measurements

Groundwater level measurements can be made in monitoring wells, private or public drinking water wells, piezometers, or open boreholes. Water level measurements in monitoring wells should be made before purging and evacuation for groundwater sampling.

The procedures for water level measurements are:

1. Check the well for proper identification and location.

2. Measure and record the height of protective casing from ground surface to check for settlement or heave.

3. After unlocking the well and removing any well caps, measure and record the ambient and well-mouth organic vapor levels using a PID. This level will be recorded in the field notebook and the appropriate health and safety actions taken, in accordance with the site-specific HASP.

4. Measure and record the distance between the top of the well riser and the top of the protective casing to check for heave or settling.

5. Using an electronic water level meter (or similar measuring device), measure and record the static water level in the well and the depth to the well bottom to the nearest 0.01 foot. Measurements will be referenced from the top of the well riser, as opposed to the protective casing, when feasible. An interface probe will be used in areas where LNAPLs are anticipated. (The water level meter should be decontaminated after use according to the procedures specified in Subsection 4.3.3).

All well measurements will be recorded, along with the date and time of measurement, in the field notebook. Every well will have a clearly established reference point of known elevation, normally a painted mark on the upper edge of the riser pipe.

4.8.2 Hydraulic Conductivity Testing

In situ hydraulic conductivity testing is designed to provide information about aquifer characteristics by measuring aquifer response to stress, such as a sudden fall or rise in water levels. The most common form of hydraulic conductivity (K) testing is called a slug test. Slug tests yield approximate values for K, representative of the portion of aquifer within a small radius directly adjacent to the well boring that is stressed.

There are two kinds of slug tests, rising-head and falling-head tests. In a falling-head test, the operator induces a rise in the water level and records the water level return to static. In a rising-head test, the water level in the well is suddenly lowered and the water level rise to static is recorded. Rising-head tests are preferred in wells with screens that straddle the water table. Either rising- or falling-head tests may be performed in wells completed below the water table. The type of tests to be run will be specified in the site-specific Work Plan.

Prior to beginning the test, the static water level will be measured and recorded using the procedures for obtaining water levels presented in Subsection 4.8.1.

To begin the test, there are several ways to induce a rise or fall in water levels including:

- introduction of a cylindrical mass, or slug, into the well that displaces a volume of water and raises the water level above static;
- removal of the slug, after aquifer equilibration, effectively lowering the water level below static level;
- addition of a volume of water to the well raising the water level; or
- removal of a volume of water by pumping and lowering the water level.

Choice of a method depends on several factors, most concerning the level of contaminants in the well. Pumping to lower the water level is less desirable if the purged water will require containerization due to contaminant concentrations. In such cases, introduction of a slug is preferred, taking proper precautions to minimize cross-contamination between wells. The purpose of the well is also important in choosing a method. Water should not be added to a well that will be sampled for chemical analysis. Well design also should be considered. The method of inducing stress in the aquifer will be specified in the site-specific Work Plan.

The water level return to static can be measured using an electronic water level meter or a pressure transducer connected to a data logger. Readings should be taken at least every half minute for the first 10 minutes, every 5 minutes for the period of 10 to 50 minutes, every 10 minutes for the period 50 to 100 minutes, every

30 minutes for the period of 100 minutes to 5 hours, and every hour for the period 5 to 24 hours. The pressure transducer with data logger is the preferred method and is required for wells with high K values and short recovery times. The data logger can be set to record data several times a second. Recovery data should be recorded until the well recovers 90 percent of its static water level.

When using a pressure transducer and data logger, all input parameters for equipment operation will be recorded in the field notebook and on an Aquifer Testing Completion Checklist (Figure 4-17). Test data from the data logger will be downloaded to a computer disk either in the field or upon return to the office.

The following additional information is required to reduce the test data and derive a value for the hydraulic conductivity:

- initial drawdown (i.e., difference between static water level and the level after stressing);
- well screen and riser diameter;
- effective length of the screened interval; and
- borehole diameter.

In water table wells where the head changes occur in the sandpack/screen interval during aquifer testing or where permeability of the sandpack is much greater than the formation, the riser radius (r) approaches the borehole radius (R) and the length (L) varies over the duration of the test. In order to avoid selection of an inappropriate value of riser radius and resulting permeability underestimates, compensation for the extra void space is necessary. The "effective radius (r_e)", derived from the radii of the borehole (R) and riser (r), and the porosity of the sandpack (n), should be considered as:

$$r_e = [r^2 (1-n) + nR^2]^{1/2}$$

The value of L (length of sandpack) should also be adjusted accordingly (Bouwer, et al., 1976; Palmer and Paul, 1987).

The data will be reduced using the AQTESOLV software package (Geraghty & Miller, 1991). This program utilizes either Bouwer and Rice (1976) or Cooper, Bredehoeft, and Papadopulos (1976) methodologies for slug test data reduction. The output of the AQTESOLV program is a graph of data with a fitted curve and hydraulic conductivity or transmissivity value. Any other data reduction method to be used will be specified in the site-specific Work Plan.

4.8.3 Packer Testing

Water pressure tests or "packer tests" are in situ tests performed to measure the permeability of a specific zone in a bedrock borehole. Water pressure tests are used to estimate bedrock permeabilities for hydrogeologic studies and in estimating grouting and dewatering requirements for construction purposes.

Packer tests may be done during the advancement of the borehole or after drilling is completed. Packer tests are usually conducted in NW-size (i.e., 3-inch) boreholes, but can be conducted in boreholes of a larger size. The test involves placing expandable packers, either mechanical or pneumatic in a borehole. A pneumatic packer assembly is preferred because it is easier to use and provides a more positive seal. A section of the borehole, usually five feet in length, is sealed off with the packers. Water is then pumped through the zone between the packers at a known pressure. The rate of flow into the formation is measured with a flow meter. The apparent gross permeability of the test zone is calculated using the data obtained in the test.

Methodology.

1. Flush the borehole with clean water to remove cuttings. Measure the depth of the borehole, and check for caving. Be sure that an adequate reserve of water is available to avoid running out of water during a test.

2. Determine the test zone. The test section length should be a minimum of 5 times the diameter of the borehole. Avoid placing the packer in a zone of fractured rock or in the bottom of the casing because leakage will occur. Keep the rock core or drilling logs handy to refer to during the test.

3. Determine Maximum Allowable Gauge Pressure (MGP) according to the formula below (U.S. Bureau of Reclamation, 1977). In order to avoid

hydrofracturing (i.e., loosening) the rock mass, do not exceed MGP during testing.

$$MGP\ (psi) = (Z)(K)$$

where,

Z	=	depth in feet from top of the upper packer to ground surface
K	=	0.5 pounds per square inch (psi)/ft

4. Prior to the start of actual permeability testing, the packer system should be tested for leakage by installing the packer in a piece of steel casing and conducting the test as if it were being done in the borehole. The water pressure must not exceed maximum packer inflation pressure. Check the hose for leaks. Check the water meter to assure that it is working properly.

5. If possible, determine the static water level in the borehole prior to the installation of the packer.

6. Assemble and install the packer equipment in the borehole. Measure each rod and top of coupling as it goes into the hole. Be sure rods are tightened to prevent leakage at the joints, teflon tape may be helpful. Number the rods for easy tracking of the packer location for sequential tests. Lower the equipment to the location of the deepest test. Figures 4-17, 4-18, and 4-19 depict arrangement of equipment.

7. Before performing the first test, bleed air out of the lines by forcing water through the packer system assembly before the packers are inflated. Inflate both packers to at least 150 pounds per square inch (psi). Double packers are usually spaced five feet apart, but spacing can be varied to meet specific test requirements.

8. Before starting the test, record the following information in the field logbook and Packer Test Log (Figure 4-21).

   - test number;

- test section;
- hole size;
- height of pressure gauge above ground surface;
- ground surface elevation; and
- depths to rock surface, groundwater, bottom of boring, bottom of upper packer to top of lower packer.

9. Test should be conducted in three steps: The first at one-half the MGP with packers at 150 psi; the second at full MGP with packers at 150 psi; and the third at full MGP with the packers at 170 psi.

   Step 1, One-half MGP at 150 psi on Packers. Pump water into the system and record observations of gauge pressure and water meter at 30 second intervals until a constant rate of flow is reached.

   Step 2, Full MGP at 150 psi on Packers. Pump water into system and record observations of gauge psi pressure and water meter at 30 second intervals until a constant rate of flow is reached

   Step 3, Full MGP at 170 psi on Packers. Increase pressure on packers by 20 psi. Pump water into the system and record observations of gauge pressure and water meter at 30 second intervals until a constant rate of flow is reached. The results of Steps 2 and 3 should be similar. If they are not, Step 3 should be repeated, increasing the packer pressure by an additional 20 psi until consistent results are achieved. Do not exceed the maximum packer pressure (220 psi).

   For all test steps, record water levels in the casing during test, if the water level rises during the test, the packers may not be sealed and the test results may be suspect. Measurements of doubtful accuracy must be noted, along with a description of the questionable aspects. If possible, testing should be continued until accurate data is obtained. It may be necessary to move the packer assembly a short distance to obtain an adequate seal.

10. If leakage of water from the packed section into the surrounding rock is so great that the MGP cannot be reached, run the pump at its full capacity with the bypass valve closed. Record the amount of water pumped into the test section, at 30-second intervals, with associated pressure readings.

11. Upon completion of the test, deflate the packers and move to the next test depth. Complete log sheets (Figure 4-21).

12. The same test methodology may be used with a single packer. Single packer tests are conducted as the borehole is advanced using the bottom of the borehole in place of the second packer.

Resolution of Common Packer Test Problems.

Packers move up out of the hole at the start of the test. Occasionally, particularly in low permeability rocks, the packer assembly may lift out of the hole due to the water pressure. Observers should stay clear of the top of the borehole to avoid injury. It may be helpful to deflate and re-inflate the packers to obtain a more positive seal in the borehole. Also, the rig drive head can be placed over the top of the swivel to help to hold the packers in place during the testing.

Pumping excessive amounts of water into the formation. In certain types of hydrogeologic or contaminant investigations, large quantities of water should not be pumped into the aquifer as this may impact local groundwater quality. If this is a concern, packer tests should be avoided. Alternatively, falling or rising head tests may be performed or geophysical borehole data may be obtained.

Jamming of the packers in the borehole. Packers may become caught in the borehole for two reasons: (1) caving of the formation amount the packers, or (2) failure of the packers to deflate. In the later case, it is generally advisable to re-inflate and deflate the packers a second time to try and remedy the problem. Forcibly removing the packers from the hole should be avoided as they may become permanently lodged or damaged. In some instances it may be helpful to pump water through the system to help lubricate the equipment for removal. Packer tests in soft, broken or cavernous formations should be attempted with great caution.

Malfunctioning water meter. Water meters are sensitive instruments and are subject to malfunctions due to clogging by debris or mechanical failure. It is important to check the water meter prior to use to be certain that it is working properly. Generally, it is best to place the water meter in a horizontal position, particularly for low flow measurements. It is also important to determine what the units of the meter dial are prior to use, as they are often poorly marked.

Data Evaluation. Compute the rock mass hydraulic conductivity. Additional data required for each test are as follows: (1) depth of hole at time of each test; (2) depth to bottom of top packer; (3) depth to top of bottom packer; (4) depth to water level in borehole at frequent intervals; (5) elevation of piezometric level; (6) length of test section; (7) radius of hole; (8) length of packer; (9) height of pressure gauge above ground surface; (10) height of water swivel above ground surface; and (11) description of material tested. Item 4 is important since a rise in water level in the borehole may indicate leakage from the test section.

The formulas used to compute the hydraulic conductivity from pressure test data are:

$$K = C\frac{Q}{2(\Pi)LH} \ln \frac{L}{r} \qquad L \geq 10r$$

$$K = C\frac{Q}{2(\Pi)LH_T} \sin \frac{L}{2r} \qquad 10r > L > r$$

where,

K	=	hydraulic conductivity (feet/day)
Q	=	constant rate of flow into the hole (gallons per minute)
L	=	length of the test section (feet)
H_T	=	differential head on the test section (H_g + H_p in feet)
r	=	radius of the borehole (feet)
C	=	Conversion factor for hydraulic conductivity in units of feet/day C equals 1.928×10^2

Note: Hg is equal to elevation head (distance from swivel to static water level). Hp is equal to pressure head calculated in feet from pressure gauge. For the unsaturated condition (i.e., static water is below bottom of lower packer), Hg is equal to distance in feet from swivel to center of test section.

These formulas provide only approximate values of K since they are based on several simplifying assumptions and do not take into account the flow of water from the test section back to the borehole (U.S. Bureau of Reclamation, 1968). Because of the heterogenous and anisotropic nature of water bearing rock formations, K value is referred to as apparent gross hydraulic conductivity. However, they give values of the correct magnitude and are suitable for practical purposes. The following listing provides a general grouping of rock mass hydraulic conductivity.

ROCK MASS HYDRAULIC CONDUCTIVITY

Hydraulic Conductivity Grouping	Range of Results
Very Low, equivalent to clay	Less than $1x10^{-4}$ feet/day
Low, equivalent to silt	$1x10^{-4}$ to $1x10^{-2}$ feet/day
Medium, equivalent to fine sand	$1x10^{-2}$ to 10^{-1} feet/day
High, equivalent to sand	$1x10^{-1}$ to $1x10^{1}$ feet/day
Very High, equivalent to clean sand or gravel	More than $1x10^{1}$ feet/day

4.9 SURVEYS

4.9.1 Elevation and Location Survey

Elevation and location surveys will be conducted by a New York-registered professional land surveyor.

Elevations will be referenced to mean sea level, 1929 General Adjustment and will be measured at 0.01 feet for monitoring well casings and 0.1 feet for ground surfaces. Horizontal locations will be tied into the New York State Plane Coordinate system, to the nearest 0.1 feet.

The actual surveying techniques and the required equipment to be employed, and the required accuracy and precision, are dependant upon the field conditions and the nature of the sampling stations and/or techniques to be employed. All field measurements shall be performed at least once and remeasured (i.e., checked) at least once. All survey observations and measurements shall be properly recorded by the designated member of the survey crew in bound field books, in accordance with the requirements of these guidelines.

Any calibrations performed upon surveying equipment in connection with this work shall be properly documented with regard to personnel, date, instrument number, calibration readings, procedures and standards employed, adjustments made, comments and/or observations, etc.

All analysis employed in the reduction of field data, calculations, production of maps, etc. shall follow commonly-accepted professional survey practices which are appropriate for the task at hand, including all appropriate procedures for QC to check and review the work. Where a computer is used to reduce data, the program employed shall have first been certified to yield repeatable results within the required limits of accuracy. All office calculations, data reduction, map making, etc. shall be performed in a neat, sequential, and logical order to facilitate future review.

The installed locations of all benchmarks, baselines and monuments shall be appropriately documented on a base map to indicate their relative locations. Benchmarks will be described with respect to their construction and location, on map, in addition to their grid coordinates.

If required, final maps will be submitted as an original or Mylar, in the specified map size. If one sheet is not sufficient, the mapped area may be divided into sections, one per sheet, and appropriate references and match lines provided. Maps shall be of a suitable scale to show appropriate detail clearly. Although this varies with the size of the site mapped, appropriate map scales generally range from 1 inch = 50 feet to 1 inch = 200 feet. The scale utilized will be clearly shown on the map both graphically (e.g., bar scale) and numerically (e.g., 1 inch = 50 feet). Each map will also indicate a true north meridian, preferably oriented toward the top of the page, and will be provided with appropriate borders, legends, title boxes, notes, data references and means of identifying author, checkers, etc.

The following paragraphs summarize specific surveying requirements appropriate to various sampling locales.

Borings and Test Pits. Horizontal locations and ground surface elevations for borings and test pits are indicated on boring/test pit logs and may be used to construct geologic sections or profiles. Horizontal locations should be staked to the nearest foot, and ground surface elevations measured to 0.1 feet.

Monitoring Wells and Piezometers. In general, horizontal location, well riser elevation, and ground surface elevation criteria for wells and piezometers are similar to those of test pits or borings. However, the surveyor should measure and mark the elevation of the top of the riser to 0.01 feet as this point will be used as a reference to measure precise groundwater elevations. For monitoring wells, pumping wells, and piezometers, a permanent mark will be made on the riser, protective casing, or other point of reference both for surveying purposes and to enable reproducible depth to water measurements.

Surface Water Sampling. When grab samples are obtained from the edges of surface water bodies, the samplers should install a location stake at the shoreline marked with the station number and coordinates, if appropriate. This stake may also be used as a reference point for measuring the water surface elevation (to the nearest 0.01 feet). In certain cases, this may not be required, since the sampler can estimate and mark the appropriate location and elevation directly on a Site Topographic Map. Such locations do not require great location accuracy (within several feet), since they are usually only indicated graphically on the Site Map.

When samples are to be taken within the surface water body away from the shoreline, better horizontal control is usually required. Sampling locations are determined by the sampler using on-shore baselines or ranges.

Surface Soil/Waste Sampling. Measurement and layout requirements for obtaining a single grab sample of soil or waste are comparable to those for obtaining surface water grab samples from the shoreline. Where a composited sample is to be collected from a sampling grid, the surveyors must stake out the grid, and indicate the station number(s), coordinates or orientation of the grid, and ground elevation(s) on the stakes. Generally, a precision of no better than the nearest foot for location, and 0.1 feet for elevation will suffice from grab or grid surface sampling.

4.9.2 Global Positioning Survey

Global Positioning System (GPS) is a geographic data collection system which uses satellites to locate positions and log time. GPS is an all weather, 24 hour, world wide service maintained by the Department of Defense. The system can be used as a data capture or in navigation mode to assist in geographic referencing for returning to points previously entered. GPS used at environmental sites has shown to be a low cost, accurate tool for rapid surveys.

GPS systems typically consists of a portable receiver, a base station receiver, data loggers, processing software, and a field computer. Data can be collected in point, line, or area format. The datum and coordinate system used can be specified to the nature of the job and application. For differential correction, used to correlate a known steady position relative to the rover - mobile data collection unit, a fixed community base station within 300 miles of the survey can be employed or a field operated base station unit can be used.

Accuracy is determined by several factors including the type of equipment. Sub-meter accuracy systems are most often used. A few constraints for acquiring sub-meter accuracy are based on the satellite geometry - the arrangement and number of satellites in 'view' of the position, the altitude of the satellites, and the satellite's health. Signal strength can be affected by buildings blocking the satellite's signal or a dense tree canopy that can weaken the signal will also limit the accuracy of the survey. Another consideration is PDOP (i.e., Position Dilution of Precision) which needs to be within a specified range to acquire high accuracy. The amount of time at each position increases the accuracy of the fix by allowing more positions to be logged. Timing and careful planning can remedy or limit the affects to most signal strength problems (Trimble, 1994).

The Department of Defense purposely degrades GPS accuracy through selective availibility. Post processing of collected GPS data is necessary to remove the effects of selective availibility in order to tranform data to a usable format (Trimble, 1994). Data can then be transferred onto an existing CAD map or used to construct a site map. Typical environmental applications include generating real time site maps, wetland delineation, mapping soil boring locations, TerraProbe locations, and mapping surface water/sediment sampling locations.

4.10 Management of Investigation-Derived Wastes

Specific procedures for handling contaminated environmental materials and contaminated, disposable, personal safety equipment will be presented in the site-specific Work Plan and/or HASP. In general, ABB-ES is responsible for collecting, controlling, and staging hazardous materials generated during field investigations. Manifest signature and ultimate disposal are the responsibility of NYSDEC; however, ABB-ES may assist in the planning and coordination of these activities, if required.

Contaminated soil and water will be handled in accordance with NYSDEC guidance documents unless otherwise specified in the site-specific QAPjP (NYSDEC, 1989 and no date).

4.10.1 Soil Disposal

NYSDEC TAGM 4032, Disposal of Drill Cuttings, distinguishes between soils from Class 2 inactive hazardous waste sites and soils from investigations near or adjacent to Class 2 sites (NYSDEC, 1988). Class 2 site soils are presumed to be hazardous while soils from areas off-site are presumed to be non-hazardous.

Alternatives for on-site disposal of non-hazardous soils include:

- backfill inside test borings not completed as monitoring wells;
- collect and dispose on-site;
- temporarily store on-site for dewatering prior to off-site disposal;
- transport from off-site areas to site (without need to manifest or contract with licensed hauler)

Non-hazardous waste can also be transported off-site to a solid waste management facility.

Hazardous soils can be transported off-site to a Resource Conservation and Recovery Act (RCRA)-permitted treatment, storage, or disposal facility. Prior to shipping for off-site disposal, representative samples of waste material will be analyzed to establish requirements for the proper management and disposal of wastes. These materials will be transported by a licensed hauler and accompanied by the proper manifests.

All of these disposal alternatives are subject to precautions listed in TAGM 4032, including the general requirement that the soils "be handled and disposed of in a manner that does not pose a threat to health and the environment." Overall, handling and disposal of drill cuttings and other soil will be identified and addressed in the site-specific Work Plan.

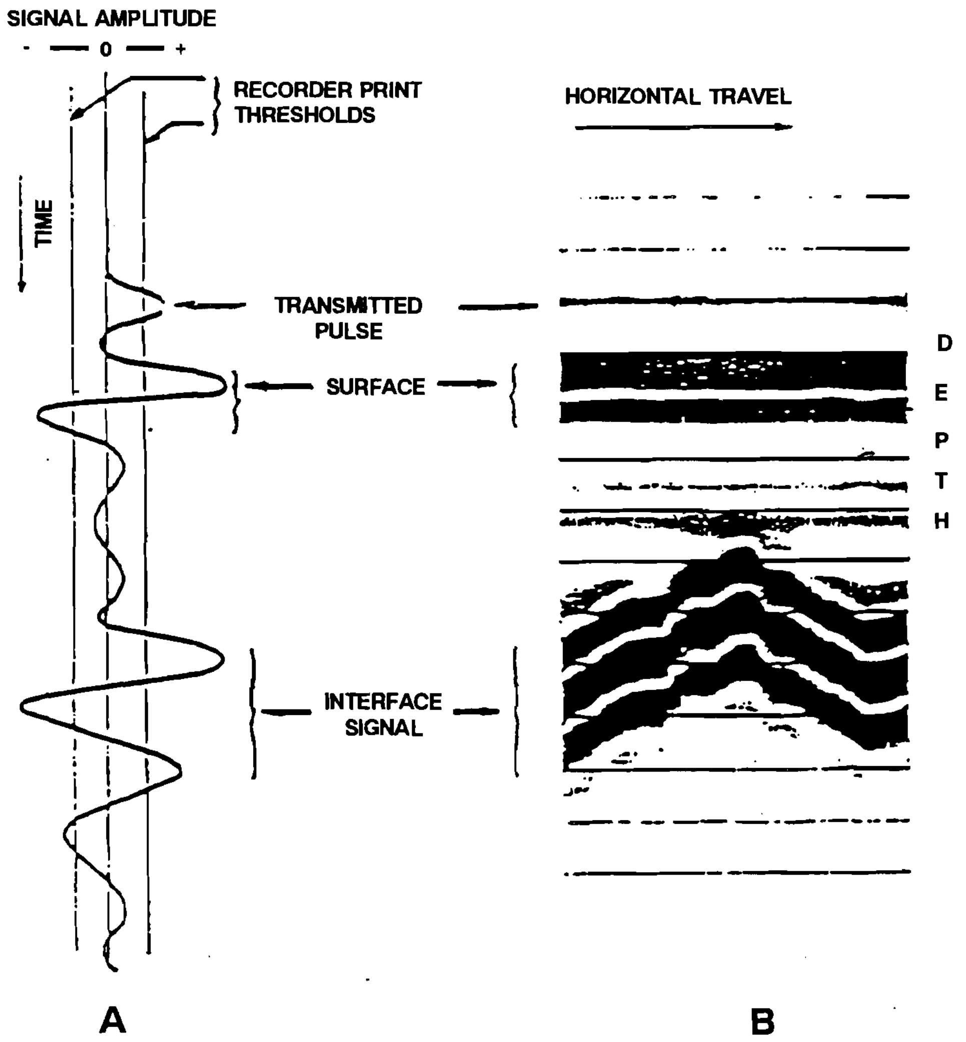
4.10.2 Water Disposal

NYSDEC guidance for the control and management of contaminated groundwater presents five alternatives for the disposal of groundwater generated during investigations at hazardous waste sites, including:

- transportation off-site to an RCRA-permitted treatment facility;
- discharge to a sanitary sewer for treatment at a publicly-owned treatment works (POTW);
- on-site treatment and discharge to a storm sewer or receiving stream;
- transport by truck to a POTW; or
- on-site disposal by allowing water to infiltrate into the ground (NYSDEC, no date).

Interim storage and implementation of these disposal alternatives are subject to further conditions and procedures as required by NYSDEC.

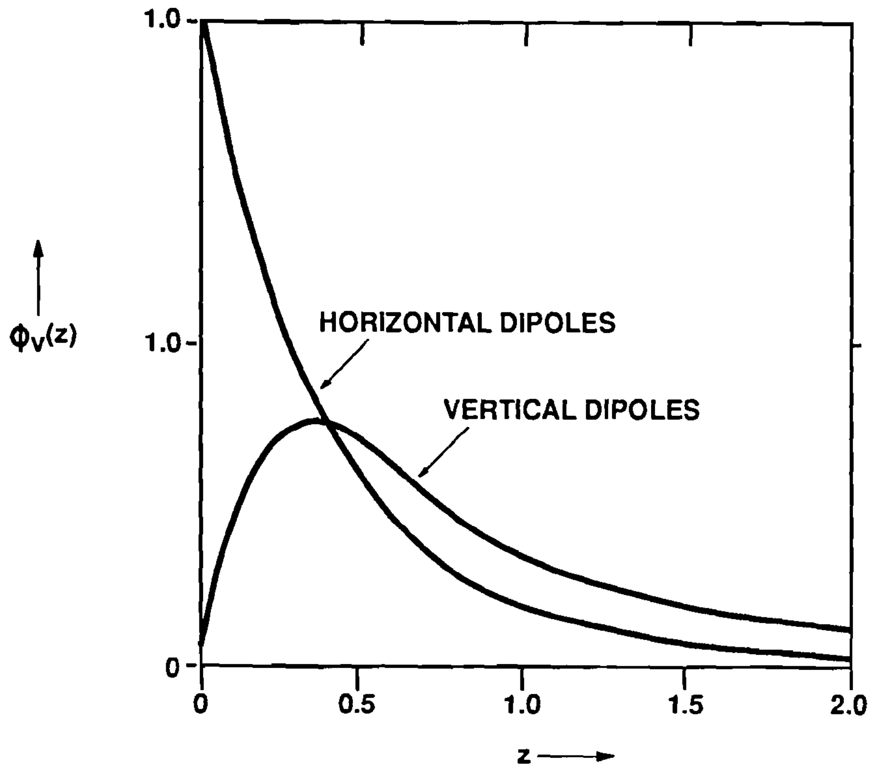
In order to determine if groundwater is non-hazardous, representative samples must be sent to an approved laboratory for analysis. Non-hazardous groundwater may be discharged to the ground, a sanitary sewer, or a surface water body; subject to conditions as required by NYSDEC. Overall, the management and disposal of groundwater will be specified in the site-specific Work Plan.



(A) SKETCH OF A SINGLE PULSE AND REFLECTIONS AS SEEN BY THE RECEIVER.

(B) EXAMPLE OF PROFILE INFORMATION AS DISPLAYED BY THE GRAPHIC RECORDER TIME.

FIGURE 4-1
GPR SYSTEM DATA
NYSDEC QUALITY ASSURANCE PROJECT PLAN



Note: "$\Phi_V(z)$" is the relative contribution to the secondary magnetic field intensity from material in a thin layer (dz) located at (normalized) depth "z".

"z" is the depth of the thin layer (dz) divided by the intercoil spacing between transmitter and receiver

FIGURE 4-2
TERRAIN CONDUCTIVITY SURVEY COMPARISON OF
RELATIVE RESPONSES FOR VERTICAL AND HORIZONTAL DIPOLES
NYSDEC QUALITY ASSURANCE PROGRAM PLAN

TEST PIT RECORD

Site: ______________________ Project No.: ______________

Location No.: ______________ Date: ________ Time: ________ End: ________

Coordinates: ______________________ Excavated by: ______________

SKETCH MAP OF TEST PIT SITE

N

WIND

SCALE 1" = ________ FT.

NOTES: ______________________

Crew Members:

1.

2.

3.

4.

5.

6.

Monitor Equipment:

PI Meter	Y	N
Explosive Gas	Y	N
Avail. Oxygen	Y	N
OVA	Y	N

Other ______________

Photographs, Roll ______________

Exposure ______________

FIGURE 4-3
TEST PIT RECORD
NYSDEC QUALITY ASSURANCE PROGRAM PLAN

TEST PIT RECORD

Profile Along Test Pit: ______________________ Project No.: __________

Site: ______________________ Date: __________

SKETCH MAP OF TEST PIT PROFILE

SCALE 1" = __________ FT.

NOTES: ______________________

No.	Sample ID	Depth (Ft.)	HD. SP. PID (PPM)
S-1			
S-2			
S-3			
S-4			
S-5			
S-6			
S-7			
S-8			

REFERENCE: FIELD BOOK #: __________

Page #: __________

SIGNATURE: __________

FIGURE 4-3 (CONT.)
TEST PIT RECORD
NYSDEC QUALITY ASSURANCE PROGRAM PLAN

ROCK CORING LOG

Project:	Site:	Exploration/Well No.:		Project No.:
Client:	Driller's Name:	Logged by:	Checked by:	Ground Elev.:
Drilling Contractor:	Protection Level:	Rig Type:	Start Date:	Finish Date:
Drilling Method:		P.I.D. (eV):	Casing Size:	Auger Size:

Bit type/size:	Bit Use:	Core Interval (to/from)(ft):

Depth (feet) Below GRD Sort.	Sample No. & Penetration/ Recovery (feet)	Graphic Log	Natural Cove Breaks		Weathered Condition	Rock Quality			Drilling Rate min/ft	Color	Rock Description and Comments on Drilling
			Type/Dip	Surface Condition		Total 4" Core	RQD (%)	Rock Quality Description			

FIGURE 4-4
ROCK CORING LOG
NYSDEC QUALITY ASSURANCE PROGRAM PLAN

ABB Environmental Services

9506009D L4

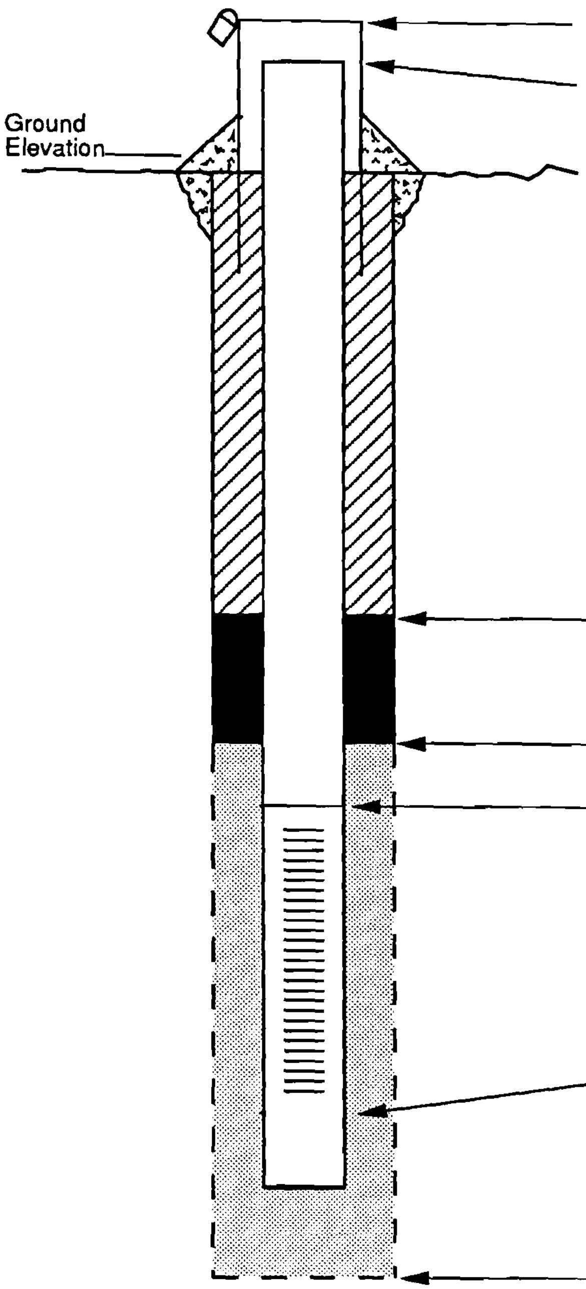
OVERBURDEN MONITORING WELL CONSTRUCTION DIAGRAM

Project: ______________ Site Area: ______________ Driller: ______________

Project No.: ______________ Boring No.: ______________ Drilling Method: ______________

Date Installed: ______________ Development Method: ______________

Field Geologist: ______________



Elevation of Top of Surface Casing: ______________

Stick-up of Casing Above Ground Surface: ______________

Elevation of Top of Riser Pipe: ______________

Type of Surface Seal: ______________

Type of Surface Casing: ______________

ID of Surface Casing: ______________

Diameter of Borehole: ______________

Riser Pipe ID: ______________

Type of Riser Pipe: ______________

Type of Backfill: ______________

Elevation of Top of Seal: ______________

Depth of Top of Seal: ______________

Type of Seal: ______________

Elevation of Top of Sand: ______________

Depth of Top of Sand: ______________

Elevation of Top of Screen: ______________

Depth of Top of Screen: ______________

Type of Screen: ______________

Slot Size x Length: ______________

ID of Screen: ______________

Type of Sandpack: ______________

Elevation of Bottom of Screen: ______________

Depth of Bottom of Screen: ______________

Depth of Sediment Sump with Plug: ______________

Elevation of Bottom of Borehole: ______________

Depth of Bottom of Borehole: ______________

FIGURE 4-5
OVERBURDEN MONITORING WELL CONSTRUCTION DIAGRAM
NYSDEC QUALITY ASSURANCE PROGRAM PLAN

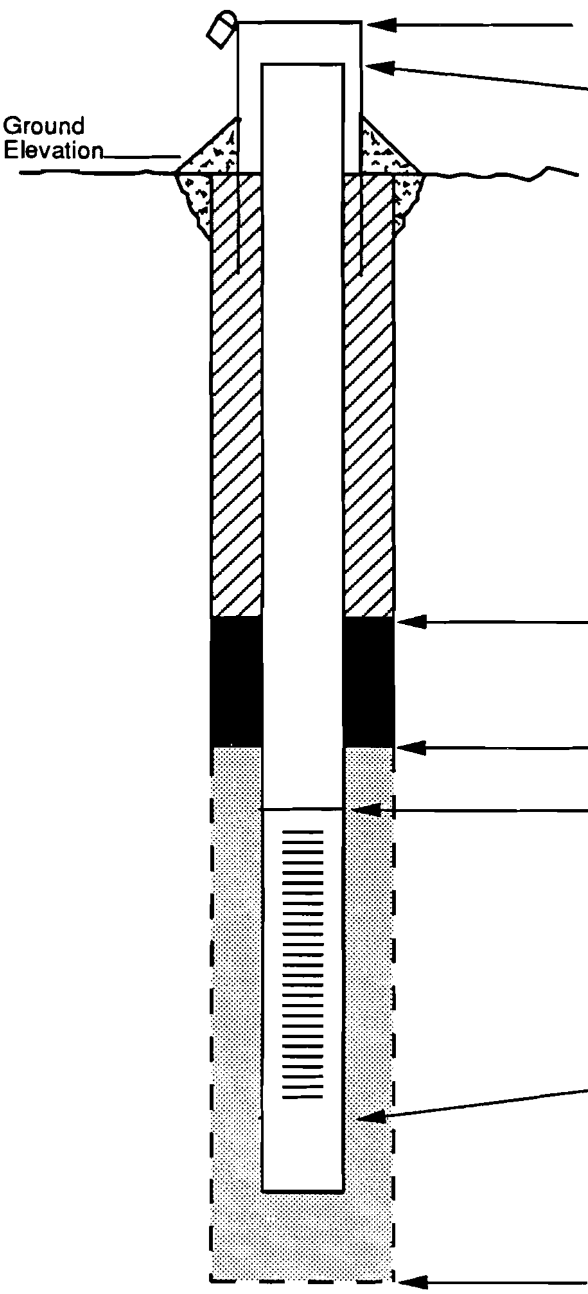
BEDROCK MONITORING WELL CONSTRUCTION DIAGRAM

Project: ______________ Site: ______________ Driller: ______________

Project No.: ______________ Boring No.: ______________ Coring Method: ______________

Date Installed: ______________ Development Method: ______________

Field Geologist: ______________



Elevation of Top of Surface Casing: ______________

Stick-up of Casing Above Ground Surface: ______________

Elevation of Top of Riser Pipe: ______________

Type of Surface Seal: ______________

Type of Surface Casing: ______________

ID of Surface Casing: ______________

Diameter of Corehole: ______________

Riser Pipe ID: ______________

Type of Riser Pipe: ______________

Type of Backfill: ______________

____

Bedrock Elevation/Depth: ______________

Elevation of Top of Seal: ______________

Depth of Top of Seal: ______________

Type of Seal: ______________

Elevation of Top of Sand: ______________

Depth of Top of Sand: ______________

Elevation of Top of Screen: ______________

Depth of Top of Screen: ______________

Type of Screen: ______________

Slot Size x Length: ______________

ID of Screen: ______________

Type of Sandpack: ______________

Elevation of Bottom of Screen: ______________

Depth of Bottom of Screen: ______________

Depth of Sediment Sump with Plug: ______________

Elevation of Bottom of Corehole: ______________

Depth of Bottom of Corehole: ______________

FIGURE 4-6
BEDROCK MONITORING WELL CONSTRUCTION DIAGRAM
NYSDEC QUALITY ASSURANCE PROGRAM PLAN

WELL DEVELOPMENT RECORD

Project:	Well Installation Date:		Project No.
Client:	Well Development Date:	Logged by:	Checked by:
Well/Site I.D.:	Weather:	Start Date:	Finish Date:
Initial Water Level (ft):		Start Time:	Finish Time:

Water Level during Initial Pumping/Purging (ft):

Water Level at Termination of Pumping/Purging (ft):

Number of Well Volumes	TIME	TEMP.	pH	Conductivity	Approximate Pumping Rate (gal/min)	Turbidity (NTU's)

NOTES:

Well Developer's Signature ______________________

FIGURE 4-7
WELL DEVELOPMENT RECORD
NYSDEC QUALITY ASSURANCE PROGRAM PLAN

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS			GROUP SYMBOLS	TYPICAL NAMES
COARSE-GRAINED SOILS (More than half of material is larger than no. 200 sieve size)	GRAVELS (more than half of coarse fraction is larger than no. 4 sieve size)	CLEAN GRAVELS (Little of no fines)	GW	Well -graded gravels, gravel-sand mixtures, little or no fines
			GP	Poorly-graded gravels, gravel-sand mixtures, little or no fines
		GRAVELS WITH FINES (Appreciable amount of fines)	GM	Silty gravels, gravel-sand-silt mixtures
			GC	Clayey gravels, gravel-sand-clay mixture
	SANDS (more than half of coarse fraction is larger than no. 4 sieve size)	CLEAN SANDS (Little of no fines)	SW	Well-graded sands, gravelly sands, little or no fines
			SP	Poorly-graded sands, gravelly sands, little or no fines
		SANDS WITH FINES (Appreciable amount of fines)	SM	Silty sands, sand-silt mixture
			SC	Clayey sands, sand-clay mixtures
FINE-GRAINED SOILS (More than half of material is smaller than no. 200 sieve size)	SILTS AND CLAYS (Liquid limit less than 50)		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
			OL	Organic silts and organic silty clays of low plasticity
	SILTS AND CLAYS (Liquid limits greater than 50)		MW	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts
			CH	Inorganic clays of high plasticity, fat clays
			OH	Organic clays of medium to high plasticity, organic silts
	HIGHLY ORGANIC SOILS		Pt	Peat and other highly organic soils

TERMS DESCRIBING DENSITY/CONSISTENCY

COARSE-GRAINED SOILS (major portion retained on No. 200 sieve): Includes (1) clean gravels; (2) silty or clayey gravels; and (3) silty, clayey or gravelly sands. Relative density is rated according to standard penetration resistance.

DESCRIPTIVE TERM	STANDARD PENETRATION RESISTANCE, SPT, N, BLOWS/FT
Very loose	0 to 4
Loose	4 to 10
Medium dense	10 to 30
Dense	30 to 50
Very dense	Over 50

FINE-GRAINED SOILS (major portion retained on No. 200 sieve): Includes (1) inorganic and organic silts and clays; (2) gravelly, sandy, or silty clays; and (3) clayey silts. Consistency is rated according to standard penetration resistance or field guidelines

DESCRIPTIVE TERM	FIELD GUIDELINES	SPT, N BLOWS/FT
Very soft	Fist easily penetrates	<2
Soft	Thumb easily penetrates	2-4
Medium stiff	Thumb penetrates with moderate effort	4-8
Stiff	Indented by thumb with great effort	8-15
Very stiff	Indented by thumbnail	15-30
Hard	Indented by thumbnail with difficulty	>30

SIZE PROPORTIONS

DESIGNATION	PERCENT BY WEIGHT
Trace	0 to 10
Little	10 to 20
Some	20 to 35
Clayey, silty, sandy or gravelly	35 to 50

Color (light brown, yellowish orange, gray, greenish gray, dark gray, etc.)
Name (sand, silty sand, clay, etc. including proportions, trace, little, etc.)
Gradation (well graded, poorly graded)
Density/Consistency (from above)
Plasticity (non-plastic, sl. plastic, mod. plastic, highly plastic)
Moisture (dry, damp, moist, saturated)
Structure (layering, cracks, fractures, etc.)
Unified Soil Classification Designation
Geological Origin (till, marine clay, alluvium, etc.)

FIGURE 4-8
KEY TO SOIL DESCRIPTIONS
NYSDEC QUALITY ASSURANCE PROGRAM PLAN

SURFACE SOIL SAMPLE FIELD DATA RECORD

Project: ______________________ Site: ______________________
Project Number: ______________________ Date: ______________________
Sample Location ID: [ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ][ ] Time: Start: __________ End: __________
Signature of Sampler: ______________________

SOIL SAMPLE

DEPTH OF SAMPLE ______________

EQUIPMENT USED FOR COLLECTION:
[ ] HAND AUGER
[ ] S.S. SPLIT SPOON
[ ] SHOVEL
[ ] HAND SPOON
[ ] ALUMINUM PANS
[ ] SS BUCKET
[ ] ______________

TYPE OF SAMPLE COLLECTED:
[ ] DISCRETE
[ ] COMPOSITE

SAMPLE OBSERVATIONS:
[ ] ODOR ______________
[ ] COLOR ______________
[ ] ______________

DECONTAMINATION FLUIDS USED:
✓ ALL USED
[ ] ETHYL ALCOHOL
[ ] 25% METHANOL/ 75% ASTM TYPE II WATER
[ ] DEIONIZED WATER
[ ] LIQUINOX SOLUTION
[ ] HEXANE
[ ] HNO_3 SOLUTION
[ ] POTABLE WATER
[ ] NONE

SOIL TYPE:
[ ] CLAY
[ ] SAND
[ ] ORGANIC
[ ] GRAVEL

FIELD GC DATA: [ ] FIELD DUPLICATE COLLECTED
DUPLICATE ID: ______________

SAMPLE LOCATION SKETCH:
[ ] YES
[ ] NO

SAMPLES COLLECTED

✓ IF REQUIRED AT THIS LOCATION	MATRIX: SURFACE WATER	MATRIX: SEDIMENT	✓ IF PRESERVED WITH ACID-BASE	VOLUME REQUIRED	✓ IF SAMPLE COLLECTED	SAMPLE BOTTLE IDS
[ ] VOC	[ ]	[ ]	[ ]	______	[ ]	___/___/___/___
[ ] SVOC	[ ]	[ ]	[ ]	______	[ ]	___/___/___/___
[ ] PEST/PCB	[ ]	[ ]	[ ]	______	[ ]	___/___/___/___
[ ] INORGANICS	[ ]	[ ]	[ ]	______	[ ]	___/___/___/___
[ ] TPH	[ ]	[ ]	[ ]	______	[ ]	___/___/___/___
[ ] TCLP	[ ]	[ ]	[ ]	______	[ ]	___/___/___/___
[ ]	[ ]	[ ]	[ ]	______	[ ]	___/___/___/___

NOTES/SKETCH

FIGURE 4-9
SURFACE SOIL SAMPLE DATA RECORD
NYSDEC QUALITY ASSURANCE PROGRAM PLAN

SURFACE SOIL SAMPLE DATA RECORD

Site: ______________________ Project No.: ______________

Location No.: ______________ Date: __________ Start: __________ End: __________

Coordinates: ______________________

SKETCH MAP OF SAMPLING SITE

N

WIND

SCALE 1" = __________ FT.

SOIL PROFILE

SCALE IN FEET

0

1

2

No.	Sample No.	Depth (ft.)
S-1		
S-2		
S-3		

Sampling Equipment:

Decon. Materials:

Crew Members:

1.

2.

3.

4.

5.

6.

Monitor Equipment:

PI Meter	Y	N
Explosive Gas	Y	N
Avail. Oxygen	Y	N
OVA	Y	N
Other		

Photographs, Roll __________

Exposure __________

References: __________

Field Book #: __________

Page #: __________

Attachments:

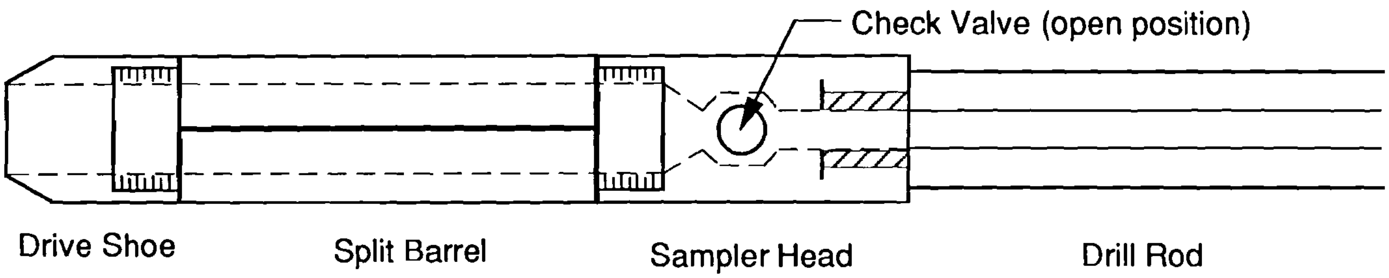
Signature: __________

SAMPLE DESCRIPTION:

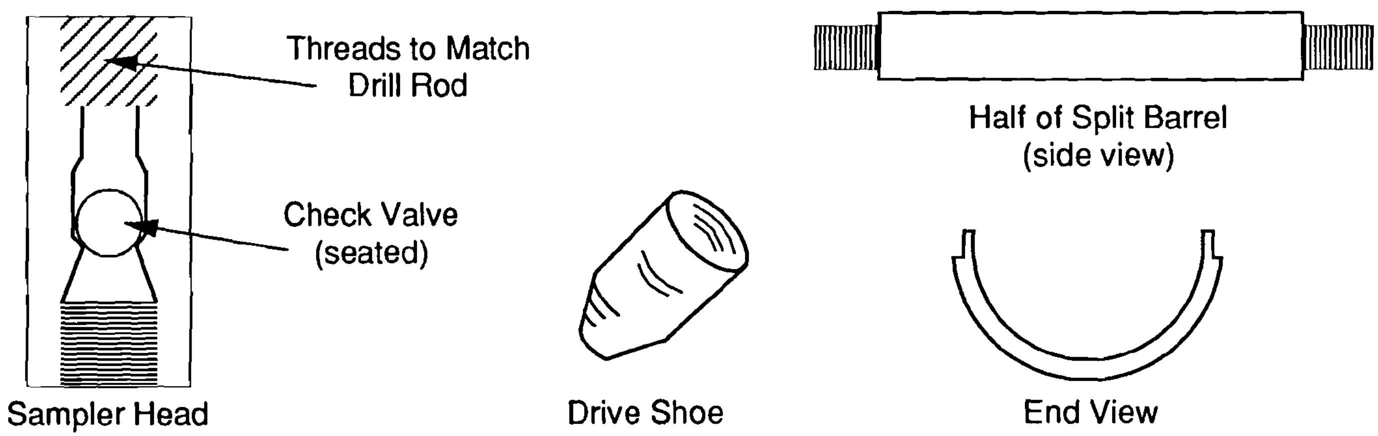
NOTES:

FIGURE 4-9 (CONT.)
SURFACE SOIL SAMPLE DATA RECORD
NYSDEC QUALITY ASSURANCE PROGRAM PLAN

SPLIT-SPOON SAMPLER



SPLIT-SPOON SAMPLER DISASSEMBLED



NOT TO SCALE

FIGURE 4-10
SPLIT-SPOON SAMPLER
NYSDEC QUALITY ASSURANCE PROGRAM PLAN

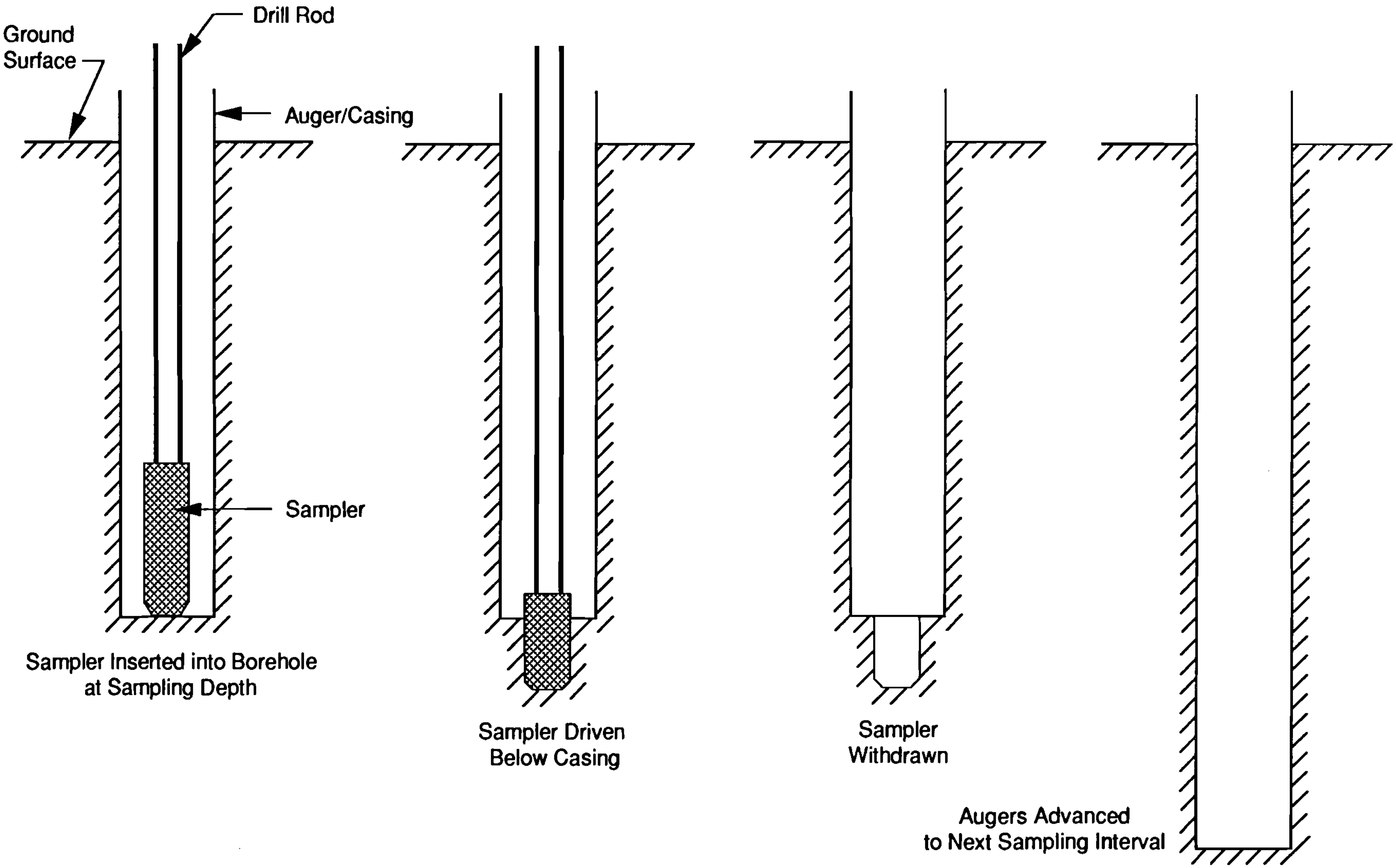


FIGURE 4-11
STEPS IN SAMPLING A TEST BORING
NYSDEC QUALITY ASSURANCE PROGRAM PLAN

ABB Environmental Services

9404014D(P)

TEST BORING LOG

Project	Boring/Well No.	Project No.

Client	Site	Sheet No. ______ of ______

Logged By	Ground Elevation	Start Date	Finish Date

Drilling Contractor	Driller's Name	Rig Type

Drilling Method	Protection Level	P.I.D. (eV)	Casing Size	Auger Size

Soil Drilled	Rock Drilled	Total Depth	Depth to Groundwater/Date	Piez ☐ Well ☐ Boring ☐

Depth(Feet)	Sample No. & Penetration/ Recovery (Feet)	Sample Type	SPT Blows/6" or Core Rec./Rqd. %	SPT-N (Blows/Ft.)	Graphic Log	Sample Description	USCS Group Symbol	Notes on Drilling	Monitoring (ppm) PI Meter Field Scan	PI Meter Head Space		Lab Tests

FIGURE 4-12
TEST BORING LOG
NYSDEC QUALITY ASSURANCE PROGRAM PLAN

ABB Environmental Services

9404014D(z) L33

SURFACE WATER AND SEDIMENT SAMPLE FIELD DATA RECORD

Project: ______________________ Site: ______________________
Project Number: ______________________ Date: ______________________
Sample Location ID: [| | | | | | | | | | | | |] Time: Start: __________ End: __________
Signature of Sampler: ______________________

SURFACE WATER INFORMATION

TYPE OF SURFACE WATER:
[ ] STREAM [ ] RIVER
[ ] POND/LAKE [ ] SEEP

WATER DEPTH AT SAMPLE LOCATION __________ (ft)

DEPTH OF SAMPLE
FROM TOP OF WATER ______________ (ft)

EQUIPMENT USED FOR COLLECTION:
[ ] NONE, GRAB INTO BOTTLE
[ ] BOMB SAMPLER
[ ] PUMP ______________

DECONTAMINATION FLUIDS USED:
✓ ALL USED
[ ] ETHYL ALCOHOL
[ ] 25% METHANOL/ 75% ASTM TYPE II WATER
[ ] DEIONIZED WATER
[ ] LIQUINOX SOLUTION
[ ] HEXANE
[ ] HNO_3 SOLUTION
[ ] POTABLE WATER
[ ] NONE

VELOCITY MEASUREMENTS OBTAINED? [ ] YES, SEE FLOW MEASUREMENT DATA RECORD ______________

TEMPERATURE __________ Deg. C. SPEC. COND. __________ µmhos/cm pH __________ Units DISS. O_2 __________ ppm

[ ] FIELD DUPLICATE COLLECTED
DUPLICATE ID: [| | | | | | | | | | | | |]

SAMPLE LOCATION SKETCH:
[ ] YES
[ ] NO

METHOD USED:
[ ] WINKLER
[ ] PROBE

SEDIMENT INFORMATION

DEPTH OF SEDIMENT SAMPLE __________ (ft)

EQUIPMENT USED FOR COLLECTION:
[ ] GRAVITY CORER
[ ] S.S. SPLIT SPOON
[ ] DREDGE
[ ] HAND SPOON
[ ] ALUMINUM PANS
[ ] SS BUCKET
[ ] ______________

TYPE OF SAMPLE COLLECTED:
[ ] DISCRETE
[ ] COMPOSITE

SAMPLE OBSERVATIONS:
[ ] ODOR ______________
[ ] COLOR ______________
[ ] ______________

DECONTAMINATION FLUIDS USED:
✓ ALL USED
[ ] ETHYL ALCOHOL
[ ] 25% METHANOL/ 75% ASTM TYPE II WATER
[ ] DEIONIZED WATER
[ ] LIQUINOX SOLUTION
[ ] HEXANE
[ ] HNO_3 SOLUTION
[ ] POTABLE WATER
[ ] NONE

SEDIMENT TYPE:
[ ] CLAY
[ ] SAND
[ ] ORGANIC
[ ] GRAVEL

[ ] FIELD DUPLICATE COLLECTED
DUPLICATE ID: [| | | | | | | | | | | | |]

SAMPLES COLLECTED

✓ IF REQUIRED AT THIS LOCATION	MATRIX: SURFACE WATER	MATRIX: SEDIMENT	✓ IF PRESERVED WITH ACID-BASE	VOLUME REQUIRED	✓ IF SAMPLE COLLECTED	SAMPLE BOTTLE IDS
[ ] VOC	[ ]	[ ]	[ ]	______	[ ]	____/____/____/____
[ ] SVOC	[ ]	[ ]	[ ]	______	[ ]	____/____/____/____
[ ] PEST/PCB	[ ]	[ ]	[ ]	______	[ ]	____/____/____/____
[ ] INORGANICS	[ ]	[ ]	[ ]	______	[ ]	____/____/____/____
[ ] TPH	[ ]	[ ]	[ ]	______	[ ]	____/____/____/____
[ ] TCLP	[ ]	[ ]	[ ]	______	[ ]	____/____/____/____
[ ]	[ ]	[ ]	[ ]	______	[ ]	____/____/____/____

NOTES/SKETCH

FIGURE 4-13
SURFACE WATER AND SEDIMENT SAMPLE FIELD DATA RECORD
NYSDEC QUALITY ASSURANCE PROGRAM PLAN

ABB Environmental Services

GROUNDWATER SAMPLE FIELD DATA RECORD

Project: ______________ Site: ______________
Project Number: ______________ Date: ______________
Time: Start: ________ End: ________
Sample Location ID: ______________ Signature of Sampler: ______________

Water Level/Well Data

Well Depth ____ Ft. ___ Measured ___ Historical ___ Top of Well ___ Top of Protective Casing ___ ____ Well Riser Stick-up ____ Ft. (from ground) Protective ____ Ft. Casing/Well Difference Protective ____ Ft. Casing

Depth to Water ____ Ft.

Well Material: ___ PVC ___ SS ______

Well Locked?: ___ Yes ___ No

Well Dia. ___ 2 inch ___ 4 inch ___ 6 inch ___ ______

Water Level Equip. Used: ___ Elect. Cond. Probe ___ Float Activated ___ Press. Transducer ___ ______

Height of Water Column ____ Ft. X ___ .16 Gal/Ft. (2 in.) ___ .65 Gal/Ft. (4 in.) ___ 1.5 Gal/Ft. (6 in.) ___ ___ Gal/Ft. (__in.) = [______ Gal/Vol. ______ Total Gal Purged]

Well Integrity:	Yes	No
Prot. Casing Secure	___	___
Concrete Collar Intact	___	___
Other ______	___	___

Equipment Documentation

Purging/Sampling Equipment Used:

(✓ If Used For)

Purging	Sampling		Equipment ID
___	___	Peristaltic Pump	______
___	___	Submersible Pump	______
___	___	Bailer	______
___	___	PVC/Silicon Tubing	______
___	___	Teflon/Silicon Tubing	______
___	___	Airlift	______
___	___	Hand Pump	______
___	___	In-line Filter	______
___	___	Press/Vac Filter	______
___	___		______

Decontamination Fluids Used:

(✓ All That Apply at Location)

- ___ Methanol (100%)
- ___ 25% Methanol/75% ASTM Type II water
- ___ Deionized Water
- ___ Liquinox Solution
- ___ Hexane
- ___ HNO_3/D.I. Water Solution
- ___ Potable Water
- ___ None
- ___ ______
- ___ ______

Field Analysis Data

PID: Ambient Air ____ ppm Well Mouth ____ ppm

Purge Data Collected ___ In-line ___ In Container

Sample Observations: __ Turbid __ Clear __ Cloudy __ Colored __ Odor

Purge Data	@ ____ Gal.	@ ____ Gal.	@ ____ Gal.	@ ____ Gal.	@ ____ Gal.
Temperature, Deg. C					
pH, units					
Specific Conductivity (µmhos/cm)					
Turbidity (NTUS)					
Oxidation - Reduction, +/- mv					
Dissolved Oxygen, ppm					

Sample Collection Requirements

(✓ If Required at this Location)

Analytical Parameter	✓ If Sample Collected	Preservation Method	Volume Required	Sample Bottle /Lot Nos.
__ VOCs	______	4°C	2x40 ml	______
__ SVOCs	______	4°C	2x1 liter AG	______
__ Inorganics	______	HNO_3,4°C	1x1 liter P	______
__ Cyanide	______	NaOH,4°C	1x500ml P	______
__ Nitrate/Sulfate	______	H_2SO_4,4°C	1x1 liter P	______
__ Nitrate/Phosphate	______	H_2SO_4,4°C	1x1 liter P	______
__ Pest/PCB	______	4°C	3x1 liter AG	______
__ TPH	______	H_2SO_4,4°C	2x1 liter AG	______
__ TOC	______	H_2SO_4,4°C	1x1 liter P	______
	______			______

Notes: ______________

FIGURE 4-14
GROUNDWATER SAMPLE DATA RECORD
NYSDEC QUALITY ASSURANCE PROGRAM PLAN

ABB Environmental Services

9404014D L22

GROUNDWATER USAGE SURVEY

Name: ____________________

Address: ____________________

____

Telephone Number: (   ) ____________________

DOMESTIC WATER SOURCE: (Circle One)   **Private Well**   **City Water Supply**

Do you foresee any changes in this source in the future ? ____________________

If so, what ? ____________________

If you have a private well:

How deep ? ________ **How old ?** ______ **Diameter ?** ______ **Drilled or Dug ?** ______

Plumbing material (Circle One)   **PVC** (Plastic)   **Copper**

Is the line connected to a Water Softening or other Treatment System ? ____________________

____

Any problems ? (color, odor, taste, staining, inadequate supply) ____________________

____

____

SEWAGE SYSTEM: (Circle One)   **Private Septic System**   **City Sewer Line**

Any problems ? ____________________

____

____

Please sketch Well location, and Septic system with approximate distances to each other.

FIGURE 4-15
GROUNDWATER USAGE SURVEY
NYSDEC QUALITY ASSURANCE PROGRAM PLAN

TERRAPROBE FIELD DATA RECORD

Project: ______________________________ **Logged by:** ______________________________

Job No.: ______________________________ **TerraProbe Operator:** ______________________________

Exploration Location	Sample ID (ISIS)	Matrix	Date	Time	Depth	Collection Method
		❑ Water ❑ Soil/Sed			❑ Inches ❑ Feet	❑ Soil Probe ❑ Surface Soil ❑ Bail for Water

Observations (Texture, Color, Odor, Etc.)

Sample Collected for:
❑ Laboratory Analysis
❑ Field Analysis

Exploration Location	Sample ID (ISIS)	Matrix	Date	Time	Depth	Collection Method
		❑ Water ❑ Soil/Sed			❑ Inches ❑ Feet	❑ Soil Probe ❑ Surface Soil ❑ Bail for Water

Observations (Texture, Color, Odor, Etc.)

Sample Collected for:
❑ Laboratory Analysis
❑ Field Analysis

Exploration Location	Sample ID (ISIS)	Matrix	Date	Time	Depth	Collection Method
		❑ Water ❑ Soil/Sed			❑ Inches ❑ Feet	❑ Soil Probe ❑ Surface Soil ❑ Bail for Water

Observations (Texture, Color, Odor, Etc.)

Sample Collected for:
❑ Laboratory Analysis
❑ Field Analysis

Exploration Location	Sample ID (ISIS)	Matrix	Date	Time	Depth	Collection Method
		❑ Water ❑ Soil/Sed			❑ Inches ❑ Feet	❑ Soil Probe ❑ Surface Soil ❑ Bail for Water

Observations (Texture, Color, Odor, Etc.)

Sample Collected for:
❑ Laboratory Analysis
❑ Field Analysis

FIGURE 4-16
TERRAPROBE FIELD DATA RECORD
NYSDEC QUALITY ASSURANCE PROGRAM PLAN

AQUIFER TEST COMPLETION CHECKLIST

SETUP	DATE	AQUIFER TEST NO. ______ PERFORMED BY: ______
MONITORING WELL ID		
DATE OF TEST		
TYPE OF TEST		
HERMIT TYPE/SERIAL#		
TEST #		
DATA COLLECTION RATE		
TRANSDUCER		
SERIAL #		
PSIG		
SCALE FACTOR		
OFFSET		
INPUT CHANNEL		
TEST DATA		
INPUT MODE (TOC/SUR)		
STATIC WATER LEVEL (FT./TOC)		
WELL DEPTH (FT./TOC)		
XD DEPTH (FT.TOC)		
INITIAL XD REFERENCE		
SLUG DEPTH (FT./TOC)		
TIME OF SLUG PLACEMENT		
TIME OF WL EQUILIBRATION		
NEW XD REFERENCE		
START TIME OF TEST		
END TIME OF TEST		

NOTES:

FIGURE 4-17
AQUIFER TEST COMPLETION CHECKLIST
NYSDEC QUALITY ASSURANCE PROGRAM PLAN

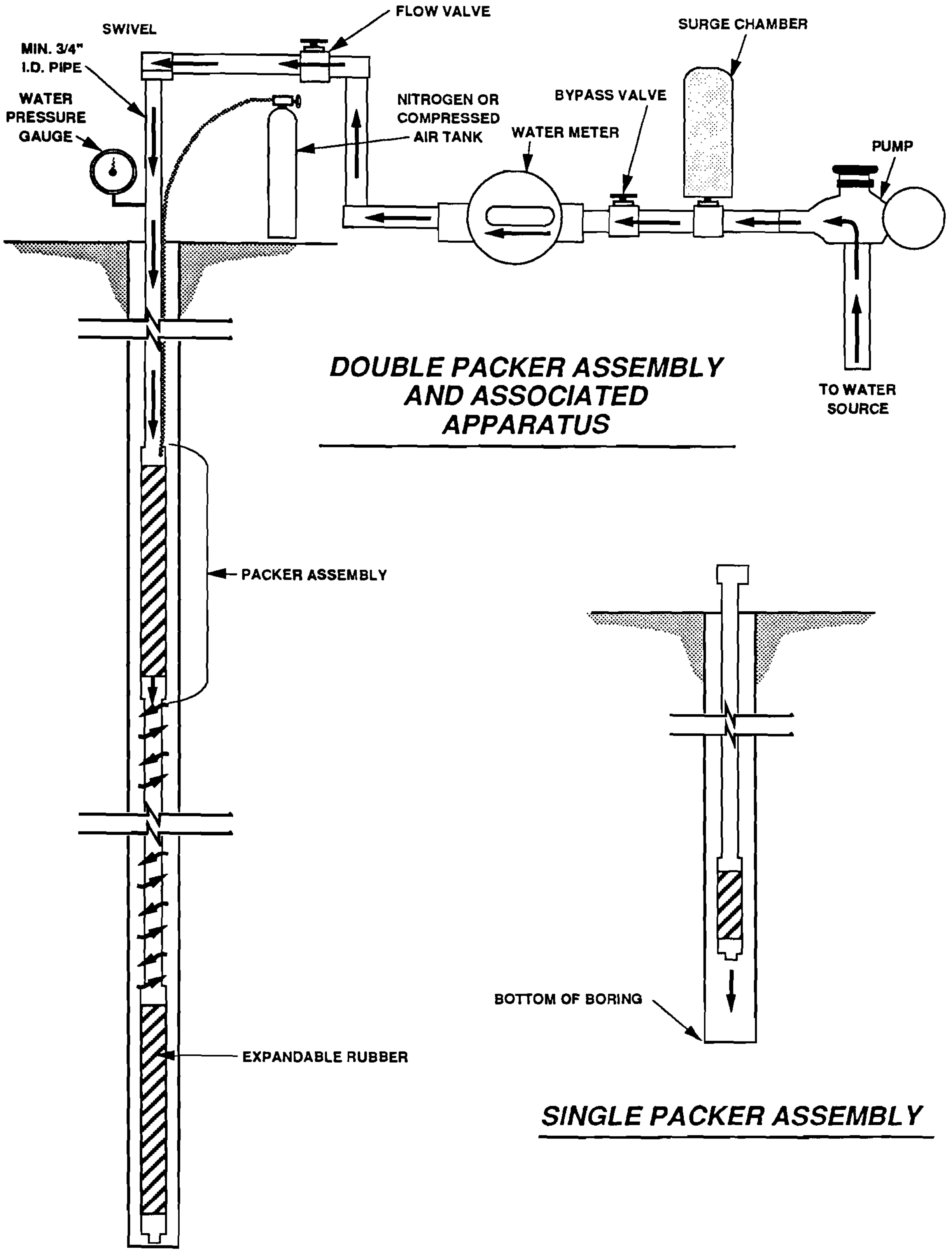


FIGURE 4-18
EXAMPLE OF PACKER TEST SET UP
NYSDEC QUALITY ASSURANCE PROGRAM PLAN

ABB Environmental Services

9404014D(A)

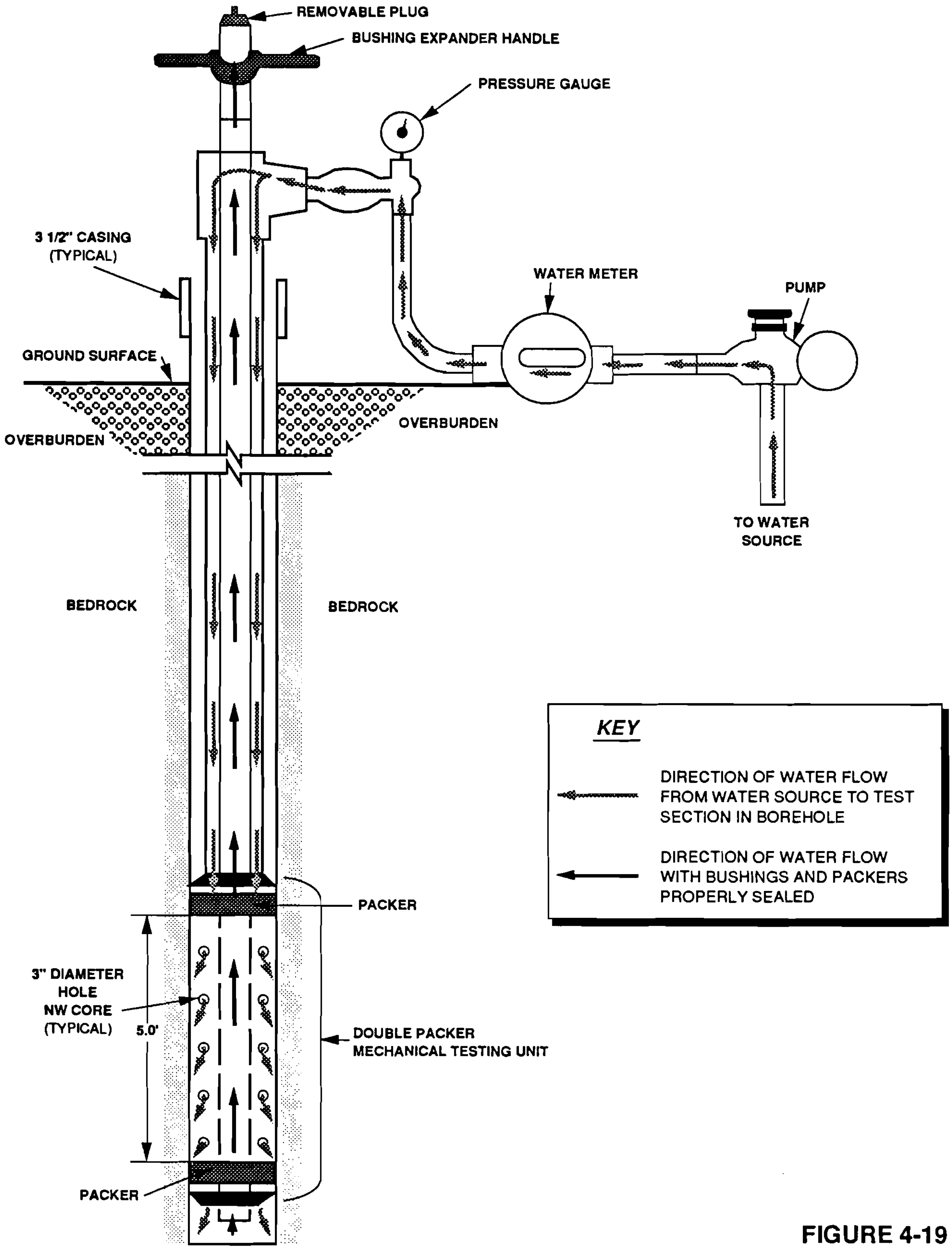


FIGURE 4-19
SCHEMATIC OF MECHANICAL PACKER PRESSURE TEST AND RELATED EQUIPMENT
NYSDEC QUALITY ASSURANCE PROGRAM PLAN

NOT TO SCALE

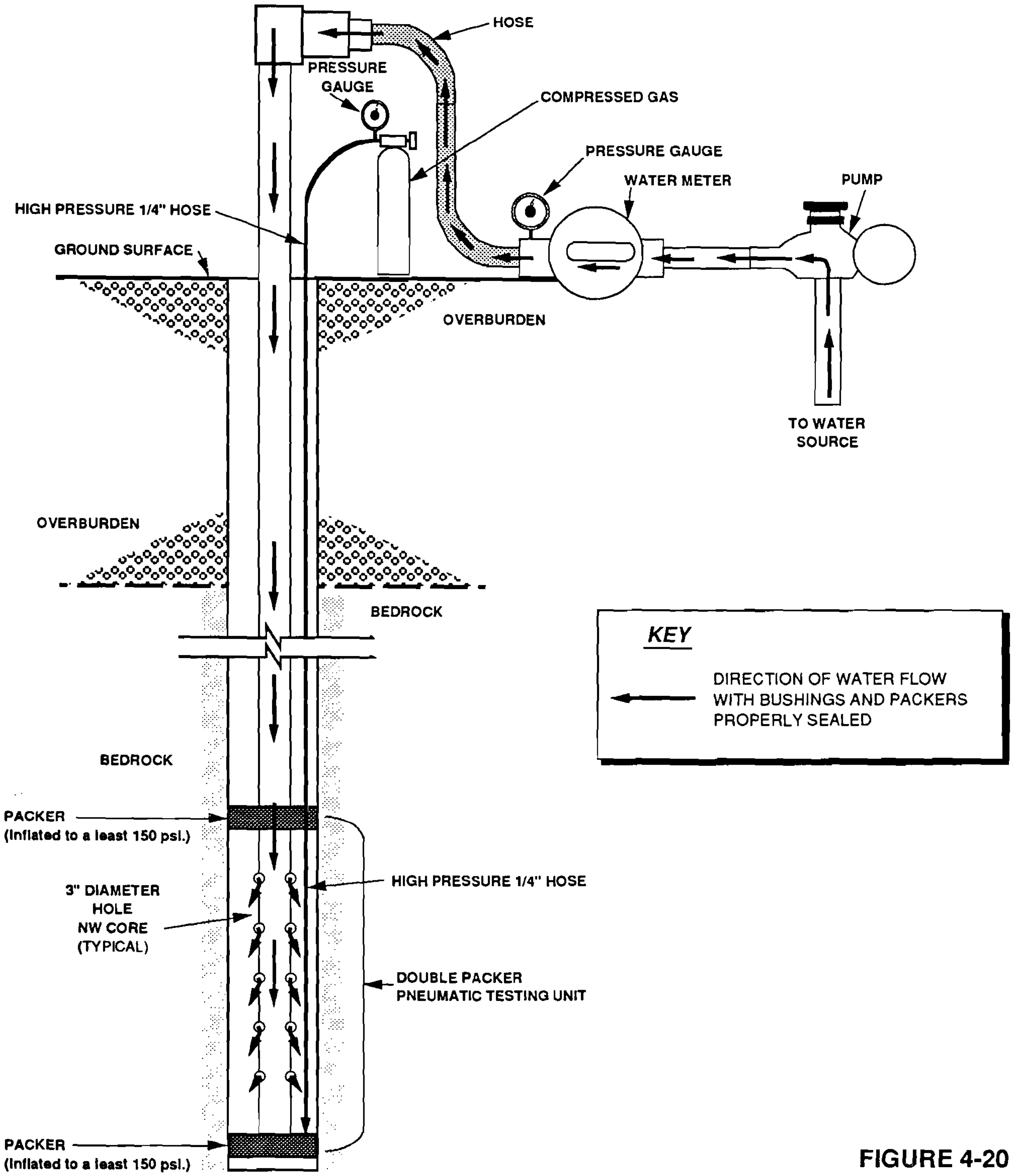


FIGURE 4-20
SCHEMATIC OF PNEUMATIC PACKER
PRESSURE TEST AND RELATED EQUIPMENT
NYSDEC QUALITY ASSURANCE PROGRAM PLAN

NOT TO SCALE

PACKER TEST LOG

Project: ______________________ Page 1 of ___

Client: ______________________ Contractor: ______________________

	Packer System	Water Meter	Water Gauge	Surge Chamber
Type:				
Manufacturer:				
Model Number:				

M.GP. = (0.566 to 1.0) x Z

Computed Maximum Gauge Press (mgp): ______________________

Computed Internal Friction: ______________________

Rock Type: ______________________

Hole Radius (Feet): ______________________

Boring Number: ______________________

Test Numbers: ______________________

Job Number: ______________________

Location: ______________________

Elevation: ______________________

Date Start: ______________________

Date Finish: ______________________

Driller: ______________________

Geologist: ______________________

Depths (all distances measured from ground surface in feet)

To Top of Rock: ______________________

To Bottom of Boring: ______________________

To Water Table: ______________________

To Top of Lower Packer: ______________________

To Bottom of Upper Packer: ______________________

Length of Test Section: ______________________

Height of Water Pressure Gauge Above Ground Surface: ______________________

Test Interval (feet)	Test Number	Start Time	Elapsed Time (min)	Packer Pressure (psi)	Gauge Pressure (HP) (psi)	Meter Reading (gals)	Volume of Flow (Q) (gals/min)	Permeability (K) (feet/day)

Formula to Compute Permeability: $k = C \frac{Q}{2\pi L H_T} \text{ IN } \frac{L}{r}$

Assumptions:
$L \geq 10r$
$H_T = (Hp \times 2.307) + Hg$
$C = 1.928 \times 10^2$

k = Permeability (feet/day)
Q = Constant Flow Rate (gallons per minute)
L = Length of Test Section (feet)
H_T = Differential Head on Test Section (feet)
r = Radius of Borehole (feet)
C = Conversion Factor to Obtain k in units of feet/day

FIGURE 4-21
PACKER TEST LOG
NYSDEC QUALITY ASSURANCE PROGRAM PLAN

ABB Environmental Services

W9506009D(A)

TABLE 4-1
SAMPLE CONTAINER, PRESERVATION AND HOLD TIME REQUIREMENTS

NYSDEC QUALITY ASSURANCE PROGRAM PLAN

PARAMETER	MEDIUM	CONTAINER	VOLUME REQUIREMENTS	PRESERVATION	HOLDING TIMES[1]
Volatile Organics					
TCL VOCs	Soil/Sediment	Glass, Teflon® lined cap or septa	20 g	Cool, 4°C	7 days
	Groundwater/Liquid	Glass, Teflon® lined septa	(2) 40 mL	Cool, 4°C	7 days
Extractable Organics					
TCL SVOCs, TCL	Soil/Sediment	Glass, Teflon® lined lid	100 g	Cool, 4°C	5 days extract/40 days analyze
Pesticides/PCBs	Groundwater/Liquid	Glass, Teflon® lined cap	(2) l-L	Cool, 4°C	5 days extract/40 days analyze
Inorganics					
TAL Inorganics	Soil/Sediment	Glass	2g	Cool, 4°C	6 months
Mercury		Glass	1g	Cool, 4°C	26 days
Cyanide		Glass	10g	Cool, 4°C	12 days
Hexavalent Chromium		Glass	2g	Cool, 4°C	24 hrs.
TAL Inorganics	Groundwater/Liquid	Glass or Polyethylene	450 mL	HNO_3 to pH<2, 4°C	6 months
Mercury		Glass or Polyethylene	200 mL	HNO_3 to pH<2, 4°C	26 days
Cyanide		Glass or Polyethylene	1 L	NaOH to pH>12, 4°C	12 days
Hexavalent Chromium		Glass or Polyethylene	500 mL	Cool, 4°C	24 hrs.
TCLP					
VOCs	Soil/Sediment	Glass, Teflon® lined lid	3x100g	Cool, 4°C	7 days extraction/7 days analyze
SVOCs	Soil/Sediment	Glass, Teflon® lined lid	200g	Cool, 4°C	5 days extraction/7 days preparative extraction/40 days analyze
Mercury	Soil/Sediment	Glass, Teflon® lined lid	200g	Cool, 4°C	5 days extraction/28 days analyze
Inorganics	Soil/Sediment	Glass, Teflon® lined lid	200g	Cool, 4°C	180 days extraction/180 days analyze
Pesticides	Soil/Sediment	Glass, Teflon® lined lid	200g	Cool, 4°C	5 days extraction/40 days analyze
Herbicides	Soil/Sediment	Glass, Teflon® lined lid	200g	Cool, 4°C	5 days extraction/40 days analyze
Ignitability	Soil/Sediment	Glass, Teflon® lined lid	25g	Cool, 4°C	28 days
Reactivity	Soil/Sediment	Glass, Teflon® lined lid	40g	Cool, 4°C	28 days
Corrosivity	Soil/Sediment	Glass, Teflon® lined lid	30g	Cool, 4°C	28 days

Notes:

[1] All holding times are from verified time of sample receipt at the laboratory.

°C = Celsius
g = gram
Hg = mercury
HNO_3 = nitric acid
L = liter
mL = milliliter
NaOH = sodium hydroxide
PCB = polychlorinated biphenyls
SVOC = semivolatile organic compound
TAL = Target Analyte List
TCL = Target Compound List
VOC = volatile organic compound

TABLE 4-2
APPROXIMATE ELECTROMAGNETIC PROPERTIES OF VARIOUS MATERIALS

MATERIAL	RELATIVE DIELECTRIC PERMITIVITY	PULSE VELOCITY (ns/ft)
Air	1	1
Freshwater	81	9
Seawater	81	9
Sand (dry)	4 - 6	2.1 - 2.4
Sand (saturated)	30	5.5
Silt (saturated)	10	3.1
Clay (saturated)	8 - 12	2.8 - 3.3
Average "dirt"	16	4
Dry sandy coastal land	10	3.1
Marshy forested flat land	12	3.5
Rich agricultural land	15	3.9
Pastoral land, hilly, forested	13	3.6
Freshwater ice	4	2.0
Permafrost	4 - 8	2.0 - 2.9
Granite (dry)	5	2.2
Limestone	7 - 9	2.6
Concrete	6.4	2.5
Asphalt	3 - 5	1.7 - 2.5

Notes:

ns/ft = nanoseconds per foot

5.0 SAMPLE CUSTODY

5.1 GENERAL

ABB-ES has established a program of sample COC that is followed during analytical sample handling activities in both field and laboratory operations. This program is designed to assure that each sample is accounted for at all times. To maintain this level of sample monitoring, computer-generated sample container labels and shipping manifests are normally employed. Field data sheets, COC records, and analytical request forms (ARFs) must be completed by the appropriate sampling and laboratory personnel for each sample. The objectives of the ABB-ES COC program are to ensure:

- samples are uniquely identified;
- samples are collected for all scheduled analyses;
- the correct samples are analyzed for requested analyses and are traceable to their records;
- descriptions of important sample characteristics and field observations are recorded;
- samples are protected from loss or and area identified if damaged;
- alteration of samples (e.g., filtration, preservation) is documented;
- a forensic record of sample integrity is established;
- sample security is maintained; and
- relevant field information is recorded including location, sample number, date and time, identification of field samples, and individuals collecting the samples.

The COC protocol followed by the sampling crews involves the following steps:

- documenting procedures and amounts of reagents added to the sample during sample preparation and sample preservation;
- recording sampling locations, sample bottle identification, and specific sample collection procedures on the appropriate forms;
- using pre-prepared sample labels that contain all information necessary for effective sample tracking; and
- completing standard field data record forms to establish analytical sample custody in the field before sample shipment (see Subsection 4.5).

Prepared labels are normally developed for each sample to be collected. Each label is numbered to correspond with the appropriate sample(s) to be collected.

The COC record is used to document sample-handling information (i.e., sample location, sample identification, and number of containers corresponding to each sample number). The following information is recorded on the COC record:

- project reference;
- the site location code, sample identification number, date of collection, time of collection, sample bottle number, preservation, and sample type, number of containers, sample matrix;
- the names of the sampler(s) and the person shipping the samples;
- serial number of custody seals and shipping cases;
- the date and time that the samples were delivered for shipping;
- analyses required; and
- the names of those responsible for receiving the samples at the laboratory.

An example of a COC and an ARF are shown in Figures 5-1 and 5-2. Field sample data records, which also include pertinent data relative to COC procedures were presented in Section 4 (see Figures 4-9, 4-13, and 4-14). The COC and ARF are completed in quadruplicate. Two copies accompany the analytical samples to the laboratory, another is kept by the sample crew chief and is transferred to the QAM, and the last copy is maintained in the project file. Additional copies can be provided if needed for the project.

5.2 ANALYTICAL SAMPLE TRACKING

Tracking of samples commences at the time of sample collection. A site-specific database of anticipated sample collection is created as ARFs and COCs are received from the field. A letter of receipt from the laboratory provides information to verify:

- analytical program;
- turnaround time;
- laboratory internal identification numbers; and
- COC for shipped samples

ABB-ES prints weekly reports in formats organized by (1) sample ISIS code and (2) due date. Missing information is pursued by the QAM.

As analytical data are received, the database is updated. Data receipt dates are compared to contracted turnaround times. Weekly reports submitted to the QAM provide a means of identifying and initiating pursuit of missing data packages or missing results within a package.

In addition, the laboratories will complete the NYSDEC tracking, sample preparation, and analysis summary forms (Figures 5-3 through 5-7), to be included with the case narrative.

5.3 ANALYTICAL SAMPLE SHIPPING

Packing. Sample containers are generally packed in metal or hard plastic, insulated coolers for shipment. Bottles are packed tightly to minimize motion. Styrofoam, vermiculite, and "bubble pack" are suitable packing material for most instances. Ice is placed in double Ziploc® bags and added to the cooler along with all paperwork which is sealed in a separate Ziploc® bag. The cooler top is then taped shut. The samples are shipped to the laboratory together with the COC documents and the ARFs.

Shipping. The standard procedure for shipping environmental samples to the analytical laboratory is as follows:

1. All shipping of environmental samples collected by ABB-ES personnel must be done through FedEx, or equivalent overnight delivery service. Receipts are retained as part of the COC documentation. Samples will be shipped to the laboratory within 24 to 48 hours of sampling.

2. Prior to leaving for the field, the person responsible for sample collection must notify the QAM of the number, type, and collection and shipment dates for the samples. If the number, type, or date of shipment changes due to site constraints or program changes, the Task Leader or Site Manager must notify the QAM of the changes. This notification from the field also needs to occur when sample shipments will arrive on Saturdays. The QAM will coordinate sample pick-up with the laboratory.

3. If prompt shipping and laboratory receipt of the samples can not be guaranteed, (e.g., Sunday arrival), the samplers will be responsible for proper storage and custody of the samples until adequate shipping arrangements can be made.

The QAM keeps the laboratory informed of all field sampling activities. This communication is critical to allow the laboratory enough time to prepare for the sample shipment arrival.

CHAIN OF CUSTODY RECORD

Page ___ of ___

PROJECT NO.	PROJECT NAME
FIELD SAMPLE CUSTODIAN	

STATION NUMBER	DATE	TIME	COMP.	GRAB	STATION LOCATION	NUMBER OF CONTAINERS	SAMPLE CONTAINER TYPE/PRESERVATION REQUIRED											REMARKS INDICATE SOIL/WATER/AIR SEDIMENT/SLUDGE

RELINQUISHED BY: (SIGNATURE)	DATE/TIME	RECEIVED BY: (SIGNATURE)	RELINQUISHED BY: (SIGNATURE)	DATE/TIME	RECEIVED BY: (SIGNATURE)
RELINQUISHED BY: (SIGNATURE)	DATE/TIME	RECEIVED BY: (SIGNATURE)	RELINQUISHED BY: (SIGNATURE)	DATE/TIME	RECEIVED BY: (SIGNATURE)
RELINQUISHED BY: (SIGNATURE)	DATE/TIME	RECEIVED FOR DISPOSAL BY: (SIGNATURE)	DATE/TIME	REMARKS	

ABB Environmental Services, Inc.
Portland Office: P. O. BOX 7050
Portland, ME 04112

FIGURE 5-1
CHAIN-OF-CUSTODY RECORD
NYSDEC QUALITY ASSURANCE PROGRAM PLAN

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

SAMPLE IDENTIFICATION AND ANALYTICAL REQUIREMENT SUMMARY

Customer Sample Code	Laboratory Sample Code	Analytical Requirements*					
		*VOA GC/MS	*BNA GC/MS	*VOA GC	*PEST PCB	*Metals	*Other

** Check Appropriate Boxes*

** CLP, Non-CLP (Please indicate year of protocol)*
** HSL, Priority Pollutant*

FIGURE 5-2
SAMPLE IDENTIFICATION AND ANALYTICAL REQUIREMENT SUMMARY
NYSDEC QUALITY ASSURANCE PROGRAM PLAN

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

SAMPLE PREPARATION AND ANALYSIS SUMMARY
B/N-A
ANALYSES

Laboratory Sample ID	Matrix	Date Collected	Date Rec'd at Lab	Date Extracted	Date Analyzed

FIGURE 5-3
B/N-A ANALYSES SUMMARY
NYSDEC QUALITY ASSURANCE PROGRAM PLAN

ABB Environmental Services

9404014D(H)

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

SAMPLE PREPARATION AND ANALYSIS FORM
B/N-A
ORGANIC ANALYSES

Sample ID	Matrix	Analytical Protocol	Extraction Method	Auxilary Clean Up	Dil/Conc Factor

FIGURE 5-4
B/N-A ORGANIC ANALYSES SUMMARY
NYSDEC QUALITY ASSURANCE PROGRAM PLAN

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

SAMPLE PREPARATION AND ANALYSIS SUMMARY
PESTICIDE/PCB
ANALYSES

Laboratory Sample ID	Matrix	Date Collected	Date Rec'd at Lab	Date Extracted	Date Analyzed

FIGURE 5-5
PESTICIDE/PCB ANALYSES SUMMARY
NYSDEC QUALITY ASSURANCE PROGRAM PLAN

ABB Environmental Services

9404014D(I)

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

SAMPLE PREPARATION AND ANALYSIS SUMMARY
VOC
ANALYSES

Laboratory Sample ID	Matrix	Date Collected	Date Rec'd at Lab	Low Level Med.Level	Date Analyzed

FIGURE 5-6
VOLATILE ORGANIC COMPOUND ANALYSES SUMMARY
NYSDEC QUALITY ASSURANCE PROGRAM PLAN

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

SAMPLE PREPARATION AND ANALYSIS SUMMARY
INORGAMIC
ANALYSES

Sample ID	Matrix	Metals Requested	Date Rec'd	Date Analyzed

FIGURE 5-7
INORGANIC ANALYSES SUMMARY
NYSDEC QUALITY ASSURANCE PROGRAM PLAN

ABB Environmental Services

9404014D(K)

6.0 CALIBRATION PROCEDURES

6.1 Calibration Procedures for Laboratory Equipment

The calibration procedures used by the contract laboratories are specified by the NYSDEC Analytical Services Protocols (ASP) (NYSDEC, 1993) and are addressed in the QA documents for the laboratory subcontractor.

6.2 Control of Measuring and Test Equipment

Inspection, measurement, and test equipment shall be controlled, calibrated, adjusted, and maintained at prescribed intervals. Critical spare parts will be kept on inventory to minimize downtime. Calibration shall be performed against certified equipment having known valid relationships to nationally recognized standards. If no national standard exists, the basis for calibration shall be documented.

The method and interval of calibration for each item shall be defined and shall be based on equipment type, stability characteristics, required accuracy, and other considerations affecting measurement control. Special calibration shall be performed when accuracy of the equipment becomes suspect. When inspection, measurement, or test equipment are found to be out of tolerance, an evaluation shall be made of the validity and acceptability of previous inspection or test results. If any inspection, measurement, or test equipment is consistently found to be out of calibration, it shall not be made available for use. Records shall be maintained and equipment shall be suitably marked to indicate calibration status.

6.3 Field Instrument Calibration

Each piece of equipment will be calibrated daily prior to use or as specified by the manufacturer. Calibration data are recorded on a Field Instrumentation Quality Assurance Record (Figure 6-1). The manufacturer and lot number of all standards will be noted on the field instrument QA record. The types of field measurements that may be made include but are not limited to the following:

- pH;

- specific conductance;
- temperature;
- dissolved oxygen;
- organic vapors; and
- turbidity.

FIELD INSTRUMENTATION & MATERIAL QUALITY ASSURANCE RECORD

Project ______________ Site ______________________________

Project No. ____________ Sampler Signature ______________________________

Date ______________

Field Instrumentation Calibration Data

Equipment Type/I.D.	Battery Condition	Calibration Information
______________	________	pH 4 _____ pH 7 _____ pH 10_____
______________	________	pH 4 _____ pH 7 _____ pH 10_____
______________	________	pH 4 _____ pH 7 _____ pH 10_____
______________	________	Cond. Std. ______/______ Cond. Std. ______/______meter value
______________	________	Cond. Std. ______/______ Cond. Std. ______/______meter value
______________	________	Cond. Std. ______/______ Cond. Std. ______/______meter value
Dissolved Oxygen		
______________	________	Avg. Winkler Value______ ppm Meter Value_____ ppm
Redox		
______________	________	Zobell Sol. Value ______ Meter Value____
Photoionization Meter		
______________	________	Zero/Zero Air? ❑Yes ❑No Span Gas Value___ ppm Equiv.
		Meter Value ___ ppm Equiv.
______________	________	Zero/Zero Air? ❑Yes ❑No Span Gas Value___ ppm Equiv.
		Meter Value ___ ppm Equiv.
Other		
______________	________	______________________________

Fluids/Materials Record

Deionized Water Source: _____ ABB-ES FOS ____ Portable System ____ Other

Trip Blank Water Source: _____ Lab; Lot No. __________

_____ Other; Type ____________________ ID__________

Decontamination Fluids: Type ____________________ ID__________

Filtration Paper ID: (In Line) Manuf/Type ______________ Lot No. __________ / __________

(Vacuum) Manuf/Type ______________ Lot No. __________ / __________

Chemicals Used: HNO_3 Lot No. ______________ ZnAOC Lot No. ______________

H_2SO_4 Lot No. ______________ Other Lot No. ______________

HCL Lot No. ______________ Other Lot No. ______________

NaOH Lot No. ______________

FIGURE 6-1
FIELD INSTRUMENTATION AND MATERIAL QUALITY ASSURANCE RECORD
NYSDEC QUALITY ASSURANCE PROGRAM PLAN

ABB Environmental Services

9506009D L17

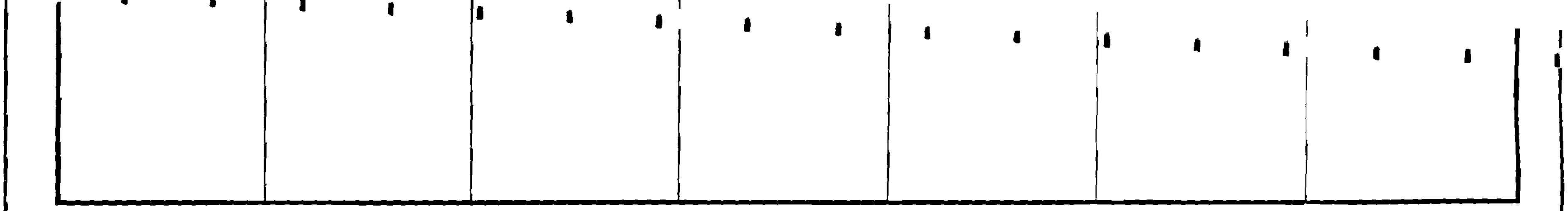


FIGURE 7-1
VOLATILE ORGANIC ANALYSES
WEEKLY QUALITY CONTROL SUMMARY
NYSDEC QUALITY ASSURANCE PROGRAM PLAN

ANALYTICAL LABORATORY WEEKLY QUALITY CONTROL SUMMARY

VOLATILE ORGANICS ANALYSES

Project: ____________________ SDG No.: ____________________

Laboratory: ____________________ Week Ending: ____________________

Sample I.D.	Dilution Required	Holding Time Met (y/n)	Surrogate Recoveries		Matrix Spike Recoveries	
			Acceptable (y/n)	<10% (y/n)	Acceptable (y/n)	<10% (y/n)

FIGURE 7-1
VOLATILE ORGANIC ANALYSES
WEEKLY QUALITY CONTROL SUMMARY
NYSDEC QUALITY ASSURANCE PROGRAM PLAN

ANALYTICAL LABORATORY WEEKLY QUALITY CONTROL SUMMARY

SEMIVOLATILE ORGANICS ANALYSES

Project: ______________________________ SDG No.: ______________________________

Laboratory: ______________________________ Week Ending: ______________________________

Sample I.D.	Dilution Required	Holding Time Met (y/n)	Surrogate Recoveries		Matrix Spike Recoveries	
			Acceptable (y/n)	<10% (y/n)	Acceptable (y/n)	<10% (y/n)

FIGURE 7-2
SEMIVOLATILE ORGANIC ANALYSES
WEEKLY QUALITY CONTROL SUMMARY
NYSDEC QUALITY ASSURANCE PROGRAM PLAN

ANALYTICAL LABORATORY WEEKLY QUALITY CONTROL SUMMARY

PESTICIDES/PCBs ANALYSES

Project: ______________________ SDG No.: ______________________

Laboratory: ______________________ Week Ending: ______________________

Sample I.D.	Dilution Required	Holding Time Met (y/n)	Surrogate Recoveries		Matrix Spike Recoveries	
			Acceptable (y/n)	<10% (y/n)	Acceptable (y/n)	<10% (y/n)

FIGURE 7-3
PESTICIDE/PCBs ANALYSES
WEEKLY QUALITY CONTROL SUMMARY
NYSDEC QUALITY ASSURANCE PROGRAM PLAN

ANALYTICAL LABORATORY WEEKLY QUALITY CONTROL SUMMARY

INORGANICS ANALYSES

Project: ____________________ SDG No.: ____________________

Laboratory: ____________________ Week Ending: ____________________

Sample I.D.	Dilution Required	Holding Time Met (y/n)	Surrogate Recoveries		Matrix Spike Recoveries	
			Acceptable (y/n)	<10% (y/n)	Acceptable (y/n)	<10% (y/n)

FIGURE 7-4
INORGANICS ANALYSES
WEEKLY QUALITY CONTROL SUMMARY
NYSDEC QUALITY ASSURANCE PROGRAM PLAN

ABB Environmental Services

8.0 DATA REDUCTION, VALIDATION AND REPORTING

ABB-ES will perform data reduction, validation, and reporting unless otherwise stated in the site-specific Work Plan and/or QAPjP.

8.1 REDUCTION

Data reduction is the process of converting measurement system outputs to an expression of the parameter which is consistent with the comparability objective. Calculations made during data reduction are described in the referenced analytical methods and in the participating laboratory QA Program.

Upon receipt, analytical data packages are turned over to the data management staff for reduction to standard data tabulations. This reduction may occur in one of three ways:

- data are manually entered into data table templates;
- data are downloaded directly from the laboratory computer; or
- data are downloaded from magnetic media supplied with the data package by the laboratory.

In all cases, the electronic version of the standard data tabulation is checked against the hardcopy data package.

Completed data tabulations are provided to the data validation staff along with the original data packages. The original data, tabulations, and magnetic media are stored in a secure and retrievable fashion.

8.2 VALIDATION

Validation of measurements is a systematic process of reviewing a body of data to check that the data are adequate for their intended use. Validation of laboratory data will be performed in accordance with *National Functional Guidelines for*

Organics Review, (USEPA, 1991) and *Laboratory Data Validation, Functional Guidelines for Evaluating Inorganics Analyses* (USEPA, 1989), as well as the appropriate USEPA Region II revisions to these protocols. In addition, the validation protocols will be modified to include requirements specified in the NYSDEC ASP. The process includes the following activities:

- auditing measurement system calibration and calibration verification;
- auditing QC activities;
- screening data sets for outliers;
- reviewing data for technical credibility versus the sample site setting;
- auditing field sample data records and COC;
- checking intermediate calculations; and
- documenting the overall validation process;

These guidelines provide criteria for data validation to evaluate the QC data deliverables accompanying the different analytical procedure outputs.

Field data collection and interpretation will follow the process illustrated in Figure 8-1. Prior to data collection, determinations are made regarding the data to be gathered in the field and the methodology to be used. Once the data are obtained, they will be reviewed and assessed as to their adequacy.

Data validation results are used to evaluate data utility. Minimum data evaluation includes:

- trip blanks, field blanks, and method blanks for potential laboratory or field sampling contamination;

- matrix spike duplicate recoveries for assessment of analytical precision and accuracy; and

- field duplicates for assessment of sampling and analysis precision and environmental matrix heterogeneity.

An example spreadsheet summarizing the validation results for each sample is included in Figure 8-2.

8.3 Reporting

Two presentations of the analytical data will be prepared by ABB-ES' data validation team. The data tables will represent:

1. The raw data as received from the laboratory, tabulated by medium and analytical fraction.

2. The annotated data resulting from the validation process, tabulated in the same format (Figure 8-2).

The validated data table, Table 2, is the formal presentation of analytical data and includes the following information in a format suitable for review:

- sample number;
- date sampled;
- sample numbers of associated analyses (field, trip, and equipment blanks);
- analyte name;
- reporting units;
- detection limit;
- analytical results;
- validation qualifiers; and
- any required footnotes.

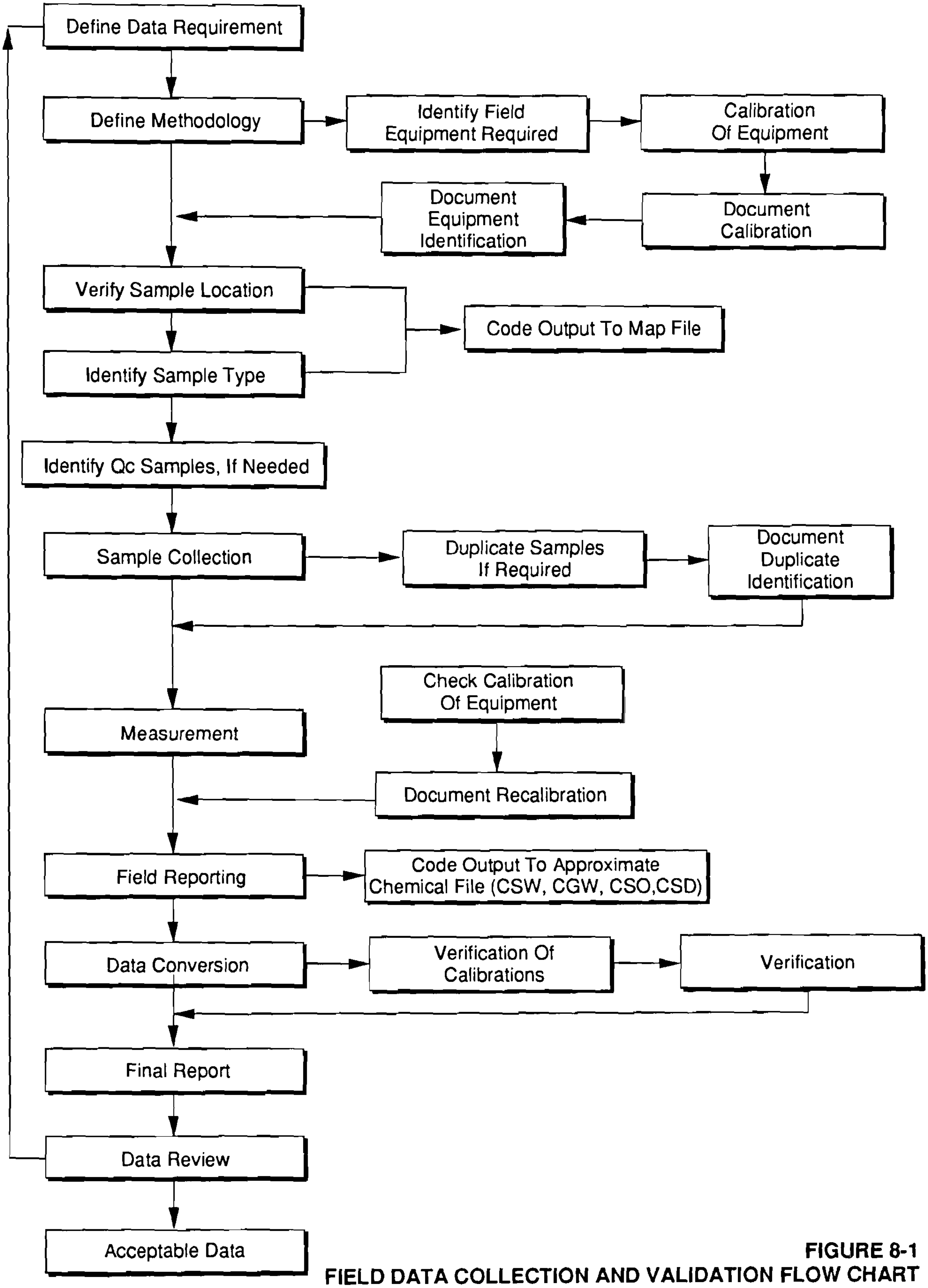


FIGURE 8-1
FIELD DATA COLLECTION AND VALIDATION FLOW CHART
NYSDEC QUALITY ASSURANCE PROGRAM PLAN

PROJECT: Semivolatile Organic Soil Analysis (ug/kg)

Table 2
Validation / Summary Table

ANALYTE	SOW-3/90 - II CRQL	SS-101 DUP	SS-101	SS-102	SS-103	SS-104	SS-105
ISIS ID:		DCSS101XX094XD	DCSS101XX094XX	DCSS102XX094XX	DCSS103XX094XX	DCSS104XX094XX	DCSS105XX094XX
LAB NUMBER:		950195-2	950195-3	950206-7	950206-8	950206-9	950206-10
DATE SAMPLED:		10/24/94	10/24/94	10/26/94	10/26/94	10/26/94	10/26/94
DATE EXTRACTED:		10/26/94	10/26/94	10/28/94	10/28/94	10/28/94	10/28/94
DATE ANALYZED:		11/21/94	11/21/94	11/22/94	11/22/94	11/22/94	11/22/94
3-Nitroaniline	800	51000 U	25000 U	43000 U	1700 U	3500 U	3600 U
Acenaphthene	330	21000 U	10000 U	18000 U	700 U	1500 U	1500 U
2,4-Dinitrophenol	800	51000 U	25000 U	43000 U	1700 U	3500 U	3600 U
4-Nitrophenol	800	51000 U	25000 U	43000 U	1700 U	3500 U	3600 U
Dibenzofuran	330	21000 U	10000 U	18000 U	700 U	1500 U	1500 U
2,4-Dinitrotoluene	330	21000 U	10000 U	18000 U	700 U	1500 U	1500 U
Diethylphthalate	330	21000 U	10000 U	18000 U	700 U	1500 U	1500 U
4-Chlorophenyl-phenylether	330	21000 U	10000 U	18000 U	700 U	1500 U	1500 U
Fluorene	330	21000 U	10000 U	18000 U	700 U	1500 U	1500 U
4-Nitroaniline	800	51000 U	25000 U	43000 U	1700 U	3500 U	3600 U
4,6-Dinitro-2-methylphenol	800	51000 U	25000 U	43000 U	1700 U	3500 U	3600 U
N-Nitrosodiphenylamine	330	21000 U	10000 U	18000 U	700 U	1500 U	1500 U
4-Bromophenyl-phenylether	330	21000 U	10000 U	18000 U	700 U	1500 U	1500 U
Hexachlorobenzene	330	21000 U	10000 U	18000 U	700 U	1500 U	1500 U
Pentachlorophenol	800	51000 U	25000 U	43000 U	1700 U	3500 U	3600 U
Phenanthrene	330	1900 J	10000 U	18000 U	370 J	580 J	140 J
Anthracene	330	21000 U	10000 U	18000 U	68 J	1500 U	1500 U
Carbazole	330	21000 U	10000 U	18000 U	700 U	1500 U	1500 U
Di-n-butylphthalate	330	21000 U	10000 U	18000 U	700 U	1500 U	1500 U
Fluoranthene	330	4900 J	820 J	18000 U	900	1200 J	460 J
Pyrene	330	4400 J	870 J	18000 U	740	970 J	380 J
Butylbenzylphthalate	330	150000 J	72000 J	110000 J	3600	8300	9400
3,3'-Dichlorobenzidine	330	21000 U	10000 U	18000 U	700 U	1500 U	1500 U
Benzo(a)Anthracene	330	3700 J	800 J	18000 U	470 J	590 J	300 J
Chrysene	330	4200 J	990 J	18000 U	470 J	660 J	380 J
bis(2-Ethylhexyl)phthalate	330	21000 U	10000 U	18000 U	700 U	1500 U	2200
Di-n-octylphthalate	330	21000 U	10000 U	18000 U	700 U	1500 U	1500 U
Benzo(b)Fluoranthene	330	5400 J	1700 J	18000 U	430 J	590 J	410 J
Benzo(k)Fluoranthene	330	3400 J	1700 J	18000 U	340 J	450 J	420 J
Benzo(a)Pyrene	330	4900 J	1500 J	18000 U	390 J	510 J	400 J
Indeno(1,2,3-c,d)Pyrene	330	4800 J	2500 J	18000 U	300 J	390 J	400 J
Dibenz(a,h)Anthracene	330	1700 J	10000 U	18000 U	100 J	140 J	110 J
Benzo(g,h,i)perylene	330	4700 J	2700 J	18000 U	260 J	360 J	370 J
Dilution Factor:		50.0	25.0	50.0	2.00	4.00	4.00
Percent Solids:		78	80	93	94	91	89
Sample Volume\Weight (ml\g):		30.0	30.0	30.0	30.0	30.0	30.0
Associated Method Blank:		K0890	K0890	K1112	K1112	K1112	K1112
Associated Equipment Blank:		DCQSXX2XXX94XX	DCQSXX2XXX94XX	DCQSXX2XXX94XX	DCQSXX2XXX94XX	DCQSXX2XXX94XX	DCQSXX2XXX94XX
Associated Field Blank:		-	-	-	-	-	-

Site: SURFACE SOILS
U = not detected J = estimated

FIGURE 8-2
EXAMPLE OF VALIDATED DATA TABLE
NYSDEC QUALITY ASSURANCE PROGRAM PLAN

9.0 INTERNAL QUALITY CONTROL

9.1 FIELD QUALITY CONTROL

QC procedures have been established for ABB-ES' field activities. Field QC activities include the use of calibration standards for pH, specific conductance, temperature, and PIDs. Field QC samples to be submitted to the laboratory include:

- trip blanks;
- field duplicates; and
- equipment blanks

These samples provide a quantitative basis for evaluating the data reported. The site-specific Work Plan will specify the number and type of QC samples to be obtained during field activities.

Trip Blanks. Trip blanks are required for assessing the potential for contaminating aqueous VOC samples during sample shipment. The trip blank consists of a VOC sample container filled by the laboratory with reagent water and is shipped to the site with other VOC sample containers. A trip blank is included with each shipment of water samples scheduled for VOC analysis and will be analyzed with the other VOC samples. Soil samples do not require trip blanks.

Field Duplicates. Field duplicates of soil and water samples will be submitted for analysis of all site-specific parameters at a rate of 5 percent of the samples collected. These duplicates are intended to assess the homogeneity of the sampled media and the precision of the sampling protocol. True duplicates of soil, sediment, and waste samples are not possible because chemicals are typically not uniformly distributed in these materials.

Equipment Blanks. Equipment blanks (i.e., rinsate blanks) for the bailer, sampling pump, and/or tubing assembly are scheduled during monitoring well sampling at a rate of 5 percent of the samples collected. VOCs and SVOCs or inorganics present within the bailer, pump apparatus, or discharge tubing are assessed by collecting a sample of reagent water passed through the sampling apparatus after washing with the decontamination solution followed by at least one rinse with reagent water.

Soil equipment blanks are collected during each field event at a rate of 5 percent of the samples collected. VOC, SVOC, or inorganics present within or on the sampling apparatus where intimate contact with the sample occurs (i.e., split-spoon, trowel), are assessed by rinsing the sampling apparatus with ASTM Type II water following decontamination. Rinsate blanks are collected directly into the appropriate water container.

Matrix Spike/Matrix Spike Duplicates (MS/MSD). The NYSDEC ASP requires the laboratory to analyze MS/MSDs for organic analyses at a frequency of 5 percent. To meet this requirement the ABB-ES FOL will select samples for MS/MSD analyses and will provide additional sample volume to the laboratory.

Completeness. Completeness of scheduled sample collection will be controlled in the field by comparing a summary of samples scheduled for collection with samples actually collected each day. Daily checking of field data sheets and comparison to COC and shipment records provides further control of documentation and completeness.

9.2 Quality Review of Studies and Report Preparation

Quality reviews are performed during the course of a project to ensure that all project deliverables meet currently accepted professional standards. The level of effort for each assignment will vary depending on type of assignment, project objectives and goals, duration, and size. Review of the project will entail periodic discussions between technical staff, Task Leaders, Site Managers, QRB, PM, and Program Manager.

QC reviews are routine scheduled, but the option of holding a QC review at any time is always possible. The time required to plan, schedule, and required to conduct QC reviews will be planned into the overall effort required to conduct of all other design, writing, and checking phases of a project.

Each assignment is normally divided into phases for internal QC reviews. At each phase, the review should evaluate client goals, contractual commitments, technical merit, timing, budget, assignment of appropriate personnel, department coordination, project problem resolution, documentation, and consistency with company policy.

Important elements to the success of any QC review are identification of problem areas, communication to implement solutions, and follow-up.

QC during the preparation of studies and reports relies on documentation of data utilized and peer review of conclusions drawn from the assembled database. The comparability objective established for the project is of particular importance when data are derived from many sources (i.e., the database is comprised of secondary measurements).

Documentation of secondary data typically is accomplished through completion of data verification/tracking checklists with accompanying written criteria describing "acceptable" data for consistency in data selection. This allows all database components to be traced to the primary generator and forces a review of data quality as the database is developed. Project personnel are responsible for utilization and monitoring of this process; compliance is audited by the QAM. Upon completion of the database, data interpretation, evaluation, and report preparation commence. Interpretation may require consultation with ABB-ES' statistician and/or use of computerized statistical routines.

Documentation is also prepared for statistical manipulation methodologies. Data evaluation incorporates peer review to provide broad-based insight to data correlations and interactions.

To enhance the professional quality of the company's studies and reports, the PM and Program Manager will:

- require that reports refer to and are consistent in scope with the project proposal and contract; and

- require that the report be organized and written so that (1) NYSDEC understands the risks and uncertainties associated with the report and (2) facts are distinguished from opinion, and risks and limitations are identified.

Implementation of QC for reports involves the use of a technical review routing and sign-off forms. Figure 9-1 illustrates the Deliverable Review Tracking Form. The PM and Program Manager provide final review and release for all deliverables.

NSSC PROGRAM
DELIVERABLE REVIEW TRACKING FORM

PROJECT TITLE:	
PROJECT NO.:	
DELIVERABLE TITLE:	
AUTHOR(S):	
DATE TO BE SHIPPED:	
DATE DUE TO CLIENT:	
DRAFT	FINAL

REVIEWERS	REVIEWED BY	DATE	SECOND REVIEW NEEDED (Y/N)
PROJECT MANAGER			
TECHNICAL REVIEWER			
SITE CHEMIST			
DOCUMENT COORDINATOR			
PROGRAM MANAGER			

DOCUMENT CAN BE RELEASED TO NYSDEC (Y/N)		
	PROGRAM MANAGER	DATE

NOTES:

TRACKING FORM MUST ACCOMPANY DELIVERABLE TO PROJECT FILE

FIGURE 9-1
DELIVERABLE REVIEW TRACKING FORM
NYSDEC QUALITY ASSURANCE PROGRAM PLAN

10.0 AUDITS

QA audits are performed to document that QC measures are being utilized to provide data of acceptable quality and that subsequent calculations, interpretation and other project outputs are checked and validated. Both scheduled and unscheduled audits are provided for in the QA program.

The QRB may conduct project audits of calculations, interpretations and reports which are based on the measurement system outputs, and system and performance audits.

10.1 PROJECT SYSTEMS AUDIT

A project systems audit may be conducted on all components of measurement systems to determine proper selection of procedures and utilization of resources. The systems audit includes evaluation of both field and laboratory procedures.

Organization and Personnel. The project organization is reviewed for compliance with the proposed organization and for clarity of assigned responsibility. Personnel assigned to the project will be reviewed to determine that assigned responsibility, skill, and training of the personnel are properly matched. The PM maintains firsthand knowledge of the project-team's capabilities and will discuss the organization's efficacy with the QRB. Assigned personnel may be interviewed by the QRB during an audit.

Facilities and Equipment. The audit will address whether field equipment and analytical instruments are selected and used to meet requirements specified by the project objectives stated in the site-specific Work Plan. Equipment and facilities provided for personnel health and safety may also be evaluated. Calibration and documentation procedures for instruments used in the field are also reviewed.

Analytical Methodology. A review of analytical methodology relative to data requirements for the project will be performed. An on-site observation of analyst technique, data reduction, and record keeping may be performed, if necessary. Periodic review of precision and accuracy of data will be performed.

Sampling and Sample Handling Procedure. An audit of scheduled samples versus samples collected versus samples received for analysis may be performed. Field documentation may be reviewed. If deemed necessary, a site visit will be made to document that designated control procedures are practiced during sampling activities.

Data Handling. During a system audit, the QRB will review data handling procedures with the Task Leaders and Site Managers. Accuracy, consistency, documentation, and appropriate selection of methodologies will be discussed.

10.2 Project Review

Project reviews are scheduled and conducted monthly by the Program Manager. The intent of project reviews are to assess scope and contractual compliance and overall technical quality of the contracted services. Documentation of the project review, including the identification of action items and associated follow-up, is essential to maximizing the utility of these reviews.

10.3 Quality Assurance Audit Report

A written report of the QA project/system audit is prepared to include:

- an assessment of project team status in each of the major project areas;
- clear statements of areas requiring improvement or problems to be corrected;
- recommendations and assistance will be provided regarding proposed corrective actions or system improvements. (If no action is required, the report will state that the QA audit was satisfactorily completed); and
- a timetable for any corrective action required.

11.0 PREVENTIVE MAINTENANCE

11.1 ANALYTICAL INSTRUMENTATION

Preventive maintenance of analytical instrumentation is addressed by the subcontract laboratories SOPs that are presented in the Laboratory QA documents.

11.2 FIELD INSTRUMENTS

Preventive maintenance of field equipment is performed by field chemists and field operations support staff and routinely precedes each sampling event. More extensive maintenance is performed on the basis of hours in use. Sampling crews report on the performance of the equipment after each sampling event. Critical spare parts are kept in stock.

12.0 DATA ASSESSMENT

12.1 GENERAL

The purpose of data quality assessment is to document that data generated under the program are accurate and consistent with project objectives. The quality of data will be assessed based on the precision, accuracy, representativeness, comparability, and completeness of the data that are generated. Data quality assessment will be conducted in three phases:

Phase 1. Prior to data collection, sampling and analysis procedures are evaluated in regard to their ability to generate the appropriate, technically acceptable information required to achieve project objectives. This QAPP meets this requirement by establishing project objectives defined in terms of parameters, analytical methods, and required sampling protocols.

Phase 2. During data collection, results will be reviewed to assess whether procedures are efficient and effective and that the data generated provide sufficient information to achieve project objectives. The precision and accuracy of selected measurement systems will be evaluated. In general, evaluation of data will be based on performance audits, results of duplicate and spiked sample analyses, and review of completeness objectives.

Documentation may include:

- number and identity of duplicate samples collected;
- number and identity of duplicate, spike, and field blank samples analyzed;
- identification of statistical techniques, if used, to measure central tendency, dispersion, or testing for outliers;
- use of historical data and its reference;
- identification of analytical method; and

- data validation results.

Phase 3. Following completion of data collection activities, an assessment of the adequacy of the database generated in regard to completing project objectives will be undertaken by the QRB and PM. Recommendations for improved QC will be developed, if appropriate. In the event that data gaps are identified, the auditor may recommend the collection of additional raw data to fully support the project's findings and recommendations.

Each phase of the assessment will be conducted in conjunction with appropriate project staff.

12.2 Procedures to Assess Precision and Accuracy

Assessment of precision and accuracy of analytical data is accomplished via review of duplicate analyses (precision) and surrogate/matrix spike recovery (accuracy), both in reagent water and sample matrices. Precision is generally expressed as the RPD. Accuracy of a reported value is reflected as percent recovery. Precision of methodologies must be assessed for each matrix since distribution of contaminants may be non-homogeneous, especially in non-water matrices. Precision in samples must be reviewed with knowledge of the matrix and level of analyte present. Corrective action or documentation of substandard precision is a laboratory responsibility. Accuracy of methodologies must also recognize the impact of matrix interferences. Surrogate/matrix spike recoveries are generally specified by the analytical method under defined conditions. Each method which provides QC requirements and acceptance criteria also specifies the method of generating the data to be reviewed. Precision and accuracy of instrumental analyses is further addressed in the NYSDEC ASP and the Laboratory QAPP. It is the laboratory's responsibility to attempt to identify the source of substandard recoveries and either take corrective action or document the cause as required by the NYSDEC ASP.

Calculations are presented below:

$$\%R = \frac{observed\ value}{theoretical\ value} \times 100$$

$$RPD = \frac{C_1 - C_2}{(C_1 + C_2)/2 \times 100}$$

where,

%R	=	percent recovery
C_1	=	concentration of the original sample
C_2	=	concentration of the duplicate sample

Completeness is generally assessed as a percentage of data intended to be generated and is most often utilized in Phase 3 of the data assessment process.

13.0 CORRECTIVE ACTION

Corrective or preventive action is required when potential or existing conditions are identified that may have an adverse impact on data quantity or quality. Corrective action can be immediate or long-term. In general, any member of the program staff who identifies a condition adversely affecting quality can initiate corrective action by notifying in writing his or her supervisor, the QAM, or the QRB. The written communication will identify the condition and explain how it may affect data quality or quantity.

13.1 IMMEDIATE CORRECTIVE ACTION

Immediate corrective action is usually applied to spontaneous, non-recurring problems, such as an instrument malfunction. The individual who detects or suspects nonconformance to previously established criteria or protocol in equipment, instruments, data, methods, etc., will immediately notify their supervisor. The supervisor and the appropriate Task Leader, Site Manager, or PM will then investigate the extent of the problem and take the necessary corrective steps. If a large quantity of data is affected, the Task Leader must prepare a memorandum to the PM, QAM, and the QRB. These individuals will collectively decide how to proceed. If the problem is limited in scope, the Task Leader or Site Manager will decide on the corrective action measure, document the solution and notify the PM, QRB, and the QAM in memorandum form.

13.2 LONG-TERM CORRECTIVE ACTION

Long-term corrective action procedures are devised and implemented to prevent the recurrence of a potentially serious problem. The QRB will be notified of the problem and will conduct an investigation to determine the severity and extent of the problem. They will then file a corrective action request with the PM and QAM.

In case of dispute between the QRB and the PM, the Company Officer will make a final determination for the company.

Corrective actions may also be initiated as a result of other activities, including:

- performance audits;
- systems audits;
- laboratory/field comparison studies; and
- QA project audits conducted by the QRB.

The QAM will be responsible for documenting all notifications, recommendations, and final decisions. The PM and the QRB will be jointly responsible for notifying program staff and implementing the agreed upon course of action. The QRB will be responsible for verifying the efficacy of the implemented actions. The development and implementation of preventive and corrective actions will be timed, to the extent possible, so as not to adversely impact either project schedules or subsequent data generation/processing activities. The QRB will also be responsible for developing or identifying and implementing routine program controls to minimize the need for corrective action.

14.0 REPORTS TO MANAGEMENT

Management personnel at all levels receive QA reports appropriate to their level of responsibility. The PM receives copies of all QA documentation. QC documentation is retained within the department which generated the product or service (e.g., field data documentation) except where this documentation is a deliverable for a specific contract. QC documentation is also submitted to the QAM for review and approval. Previous sections detailed the QA activities which are integral to ABB-ES' QA Program and the reports which they generate. A final audit report for each project may also be prepared. The reports would include:

- periodic assessment of measurement data accuracy, precision and completeness;
- results of performance audits and/or systems audits;
- significant QA problems and recommended solutions for future projects; and
- status of solutions to any problems previously identified.

Additionally, any incidents requiring corrective action will be fully documented. Procedurally, the PM will prepare the reports to management. These reports will be addressed to the Task Leader, or Site Manager, QAM, and the QRB. The summary of findings shall be factual, concise, and complete. Any required supporting information will be appended to the report.

ABB-ES	ABB Environmental Services
ASTM	American Society for Testing and Materials
ARF	analytical request form
ASP	Analytical Services Protocols
°C	degree Celcius
CLP	Contract Laboratory Program
COC	chain-of-custody
CS	Contract Specialist
DQO	data quality objective
EM	electromagnetic
FOL	Field Operations Leader
FS	Feasibility Study
g	gram
GC	gas chromatography
GPR	ground-penetrating radar
GPS	global positioning system
HASP	Health and Safety Plan
Hg	mercury
HNO_3	nitric acid
HSA	hollow-stem auger
ID	inside diameter
ISIS	Integrated Site Information System
K	hydraulic conductivity
L	liter
LNAPL	light non-aqueous phase liquid

MGP	maximum allowable gauge pressure
mL	milliliter
MS/MSD	matrix spike/matrix spike duplicate
NaOH	sodium hydroxide
ns/ft	naroseconds per feet
NTUs	nephelometric turbidity units
NYS	New York State
NYSDEC	New York State Department of Environmental Conservation
oz	ounce
PARCC	precision, accuracy, representativeness, completeness, and comparability
PCB	polychlorinated biphenyl
PID	photoionization detector
PM	Project Manager
POTW	publicly-owned treatment works
PSA	Preliminary Site Assessment
psi	pounds per square inch
PVC	polyvinyl chloride
QA	Quality Assurance
QAM	Quality Assurance Manager
QAPjP	site-specific Quality Assurance Project Plan
QAPP	Quality Assurance Program Plan
QC	Quality Control
QRB	Quality Review Board
RAS	Routine Analytical Services
RCRA	Resource Conservation and Recover Act
RD	Remedial Design
RI	Remedial Investigation
RPD	Relative Percent Difference
RQD	rock quality data

SOP	Standard Operating Procedure
SVOC	semivolatile organic compound
TAGM	Technical and Administrative Guidance Memo
TAL	Target Analyte List
TC	Terrain Conductivity
TCL	Target Compound List
TCLP	Toxicity Characteristics Leaching Procedure
TOC	Total Organic Carbon
TPH	total petroleum hydrocarbons
USCS	Unified Soil Classification System
USEPA	U.S. Environmental Protection Agency
VOC	volatile organic compound

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