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ALAMEDA POINT
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MAY 1989

**QUALITY ASSURANCE PROJECT PLAN (QAPP)
QUALITY ASSURANCE / QUALITY CONTROL PLAN (QA/QC)**

**REMEDIAL INVESTIGATION / FEASIBILITY STUDY
NAVAL AIR STATION ALAMEDA
ALAMEDA, CALIFORNIA**

VOLUME 3

**DEPARTMENT OF THE NAVY
WESTERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND
SAN BRUNO, CALIFORNIA 94066-0727**

QUALITY ASSURANCE PROJECT PLAN (QAPP)
QUALITY ASSURANCE/QUALITY CONTROL PLAN (QA/QC)

ALAMEDA NAVAL AIR STATION
ALAMEDA, CALIFORNIA

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May 4, 1989

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Transmittal
Quality Assurance Project Plan - Quality Assurance/Quality Control Plan
Remedial Investigation/Feasibility Study
Naval Air Station Alameda
Alameda, California

Dear Ms. Dizon:

Enclosed are three copies of the final Quality Assurance Project Plan - Quality Assurance/Quality Control Plan for the Remedial Investigation at the Naval Air Station Alameda. This report incorporates our responses to the comments made by the California Department of Health Services.

Seventeen additional copies of this report will be delivered to you on Friday, May 5, 1989.

This report completes a portion of the work authorized under Contract N62474-85-D-5620 Delivery Orders 001 and 002.

If you have any questions, please call us.

Respectfully submitted,

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Enclosures

FINAL QUALITY ASSURANCE PROJECT PLAN –
QUALITY ASSURANCE/QUALITY CONTROL PLAN
REMEDIAL INVESTIGATION/FEASIBILITY STUDY
(RI/FS)
VOLUME 3 OF 8

DATED 01 MAY 1989

THIS RECORD CONTAINS MULTIPLE VOLUMES
WHICH HAVE BEEN ENTERED SEPARATELY

VOLUME 1 OF 8 – FINAL SAMPLING PLAN, RI/FS
DATED 2/1/90 IS ENTERED IN THE DATABASE
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SOLID WASTE ASSESSMENT TEST PROPOSAL
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VOLUME 6 OF 8 – DATA MANAGEMENT PLAN,
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VOLUME 7 OF 8 – FINAL PRELIMINARY PUBLIC
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VOLUME 8 OF 8 – FINAL FEASIBILITY STUDY
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QUALITY ASSURANCE PROJECT PLAN (QAPP)
QUALITY ASSURANCE/QUALITY CONTROL PLAN (QA/QC)
ALAMEDA NAVAL AIR STATION
ALAMEDA, CALIFORNIA

1.0 PROJECT DESCRIPTION

The Work Plan for the Remedial Investigation/Feasibility Study (RI/FS) at NAS Alameda consists of the following planning documents:

- Volume 1 Sampling Plan
- Volume 1A Sampling Plan - SWAT Proposal Addendum
- Volume 1B Air Sampling Plan
- Volume 2 Health and Safety Plan
- Volume 3 Quality Assurance Project Plan - Quality Assurance/Quality Control Plan
- Volume 4 Community Relations Plan
- Volume 5 Project Management Plan/Schedule
- Volume 6 Data Management Plan
- Volume 7 Public Health and Environmental Evaluation Plan
- Volume 8 Feasibility Plan

1.1 Introduction

The purpose of the Quality Assurance Project Plan (QAPP) - Quality Assurance/Quality Control Plan (QA/QC) for the remedial investigation of the Alameda Naval Air Station (Alameda NAS) in Alameda County, California (herein referred to as the QAPP) is to indicate the prime responsibilities and prescribe the necessary procedures required to assure that the project is executed in a manner consistent with the National Oil and Hazardous Substance Contingency Plan, applicable U.S. Environmental Protection Agency (U.S. EPA) guidance documents, and with generally accepted and approved quality assurance objectives, and that data generated in the remedial investigation and feasibility study (RI/FS) is precise, accurate, representative, comparable, and complete so that a final decision on appropriate remedial action measures will be made on an informed and logical basis.

This QAPP provides guidance and specifications to assure that:

1. All field determinations and analytical results regarding sampling and analysis are valid through the implementation of preventive maintenance, equipment calibration, and approved analytical protocols;
2. Sampling is conducted using sample tracking systems and chain-of-custody procedures which properly identify samples being collected and control those samples from field collection through analysis and data reduction;
3. Records are produced and retained as documentary evidence of the quality of samples collected and analyzed, the validity of applied procedures, and the completeness of the remedial investigation in relation to the approved scope of the project;
4. Generated data is validated and appropriately used in calculations;
5. Calculations, evaluations, and decisions completed or deduced during the execution of the RI/FS plan are accurate, appropriate, and consistent with the objectives of this Plan and the Alameda Naval Air Station Remedial Investigation and Feasibility Study Work Plan (Alameda RI/FS).

The requirements of this QAPP are applicable to the activities of all participants in the RI/FS process at the Alameda NAS in Alameda County, California. This QAPP will address all anticipated activities necessary to execute the Alameda RI/FS and include sampling and analysis of environmental media, well installation, ground water monitoring, air monitoring, and surveying.

1.2 Project Summary: Alameda Naval Air Station

1.2.1 Project Location

The Alameda NAS occupies the western tip of the Island of Alameda and is located in Alameda County, California. Alameda Island is found along the eastern side of San Francisco Bay as shown on the General Location Map, presented as Figure 1-1 of the Site Investigation Work Plan. Alameda NAS occupies approximately 2,634 acres, with approximately 2,479 acres of the base owned by the government, and the remaining 155 acres leased from others. Approximately 1,526 acres of the air station are above water, and the remaining 1,108 acres is submerged.

The station is rectangular in shape, approximately two miles in length and one mile in width. The station is essentially flat, with typical relief ranging from 10 to 15 feet above sea level. Much of the dry land portion of the station, including all of the western portion of the station, is constructed on reclaimed marshes or open water areas which have been filled with dredge spoils. A substantial portion of the fill used in the reclamation of this western area resulted from dredging of San Francisco Bay and the so-called Oakland Estuary, which separates the island from the mainland just to the north (Wahler, 1985).

1.2.2 Project Objectives

The objectives of the Alameda RI/FS are to conduct a remedial investigation (RI) which will:

1. Define the sources, nature, extent, and distribution of chemical constituents at the sites;
2. Determine and quantify potential exposure pathways;

3. Assess the risk which the chemical constituents at the sites may have to public health and the environment;
4. Gather all necessary data to determine the feasibility of potential remedial actions;
5. Provide sufficient information to select a remedy and design the selected remedial responses.

The objectives of the Alameda RI/FS also include the completion of a feasibility study (FS) which will:

1. Review the applicability of various remedial technologies, including appropriate innovative technologies, to determine whether the technologies are appropriate remedies for the Alameda NAS sites;
2. Determine if each alternative, developed by combining technologies, is effective, by evaluating in the short and long term whether it:
 - o Protects human health and the environment;
 - o Meets and/or exceeds applicable or relevant and appropriate federal and state standards, requirements, criteria, and limitations (ARARs);
 - o To the extent required by Section 121 of CERCLA, results in permanent and significant reduction of toxicity, mobility, or volume of chemical constituents;
 - o Contains the best combination of complimentary technologies to meet the remedial objectives;

3. Assess the implementability of each alternative in terms of:
 - o Technical feasibility (short and long term);
 - o Administrative and institutional feasibility;
 - o Availability of materials and equipment;
4. Assess costs of each alternative in terms of:
 - o Short-term capital costs;
 - o Long-term operations and maintenance costs;
 - o Long-term replacement costs;
 - o Present value;
 - o Cost effectiveness;
5. Provide direction to the RI to ensure that sufficient data of the appropriate type is gathered to select a remedy based on the factors mentioned in the objectives listed above.

1.2.3 Major Task Summary

Implementation of the RI/FS work plan will involve numerous field activities related to investigation of existing data and gathering of new data from the field, analysis of samples to determine chemical species present and the concentration of chemicals, evaluation of data to determine the hydrogeologic setting of the Alameda NAS, the nature and extent of chemical constituent sources and the migration of the chemicals from the sources into soil, water, and air, the preparation of a report detailing the conclusions of the RI and the basis upon which the conclusions are

justified, and the evaluation and selection of appropriate remedial alternatives to meet the objectives of the RI/FS program.

Major activities, to be undertaken during the course of the RI/FS program, which will be covered by this QAPP include the following:

1. Sample collection, storage, shipment, and control;
2. Design and installation of monitoring wells to assess the vertical and horizontal extent of chemical constituent plumes;
3. Magnetic surveys to determine whether chemical constituent sources may be present in the subsurface in the form of buried drums or tanks, and to assess the nature and extent of sanitary leach fields;
4. Surveying of site features, including the location and elevation of soil samples, ground water monitoring wells, surface water and sediment sampling locations, air monitoring locations, topographic and piezometric contours, and the position of any waste sources;
5. Data management activities related to the entry, storage, analysis, and presentation of measurements, chemical analyses, and similar data which will be used to determine the nature and extent of the chemical constituents, and the appropriate alternative technologies to be implemented.

2.0 PROJECT ORGANIZATION AND RESPONSIBILITIES

2.1 Organization

Canonie Environmental Services Corp. (Canonie) operates under a matrix structure in which personnel belong to managerial departments and, at the same time, are assigned to special task forces. Managerial departments are responsible for the development of personnel in scientific training and for the review of work. Project Task Forces are responsible for the completion of specific, project-related objectives.

This QAPP addresses the project organization with respect to the activities to be performed during the RI/FS. Quality assurance and control activities must occur at all levels of the organization. The activities of the QAPP Team for the RI/FS project must remain independent of the activities of the Task Force in order to assure that procedures and protocols outlined in the RI/FS Work Plan are carried out.

The proposed Project Management Team of the Task Force for the implementation of the RI/FS Work Plan and the lines of communication between various key individuals are shown in Figure 1. The California Department of Health Services (DHS) will be notified of any changes in the project management team within two weeks of such change. The responsibilities of the Canonie task force and related managerial departments are summarized below.

- o The Project Manager is responsible for maintaining a clear definition of and adherence to the scope, schedule, and budget of the project. As a part of this responsibility, he will serve as the on-site communication link with the NavFac Project Officer, and support community relations efforts, provide immediate direction to staff, supervise all work by subcontractors, and maintain budgetary and schedule surveillance of the work.

- o The Technical Project Director is responsible for the staffing and overall administration of the project. As part of his QA/QC responsibilities, he will indicate QA/QC records to be retained, provide for QA/QC audits of the work of task force members, approve information released to the NavFac Project Officer, and approve task plans and operating procedures.
- o The Project Engineer is responsible for the implementation of RI/FS field activities, initial data acquisition, health and safety aspects of field activities, and for the proper selection and execution of procedures which have been accepted for use in the RI/FS program.
- o The Task Leaders within the project task force are responsible for specific engineering, scientific, and analytical operations required to accomplish identified project objectives.

The Quality Review Team reports directly to the corporate officer in charge. The team is responsible for on-going surveillance of project activities to ensure conformance to this plan and to evaluate the effectiveness of its requirements. As part of this responsibility, the team will monitor the correction of quality control problems, report to the corporate officer in charge concerning the quality of the services provided in relation to the stated objectives of the project, recommend changes, where appropriate, to improve the effectiveness of project procedures, and, review proposed additions and/or changes to this plan.

The Quality Review Team is directed by the Quality Assurance Coordinator, who is responsible for evaluating and approving this plan; scheduling and conducting QA/QC audits; providing QA/QC reports, and developing and initiating preventative and corrective actions.

Canonie's environmental laboratory will provide analytical services to the project. The laboratory is approved by the DHS with a reciprocal approval by the U.S. EPA to perform a variety of inorganic and organic analytical

services. The laboratory will also be responsible for the performance of all services related to the analysis of air monitoring samples, although actual analysis of samples will be performed by DHS certified and approved laboratories if discrete air monitoring is required.

3.0 QUALITY ASSURANCE OBJECTIVES

3.1 General

The quality of measurements made and data acquired during the RI/FS process will be determined by the following characteristics: accuracy, precision, representativeness, completeness, and comparability. Specific objectives for each characteristic are established to develop sampling protocols and identify applicable documentation, sample handling procedures, and measurement system procedures. These objectives are established based on site conditions, objectives of the project, and knowledge of available measurement systems. The subsequent use of these measurements in calculations and evaluations is also subject to aspects of this plan as described in the following sections.

Canonie will collect all samples and direct all field measurements in completing the work presented in the RI/FS Work Plan. Sample collection and field handling will be in accordance with the sampling and sample handling protocols established in this plan. All samples will be analyzed through Canonie's environmental laboratory, located at 212 Frank West Circle, Suite A, in Stockton, California. Analytical laboratory QA/QC information is specified for all anticipated analyses in Section 9. Recent analysis of EPA Quality Control check samples, containing the parameters of interest to this project using reagent grade water as the sample matrix and completed by Canonie's laboratory, are presented in Appendix A. The quality assurance program developed for and utilized at Canonie's laboratory is presented in Appendix B.

3.2 Representativeness

Measurements will be made so that analytical results are as representative of the actual field conditions as possible. Sampling protocols will be utilized to assure that samples collected are representative of the media

present in the field. Sample handling protocols, including such tasks as storage, transportation, and preservation, will be used to protect the representativeness of the samples gathered during the project. Proper documentation in the field and the laboratory will establish that protocols have been followed, and that sample identification as well as integrity have been preserved.

The Sampling Plan, presented in the RI/FS Work Plan, describes the samples which are currently planned for collection, the location of the sampling stations, the types of samples to be collected, and the types and number of analyses to be performed on the samples. The execution of the Sampling Plan should result in the collection of sufficient samples to determine the nature and extent of chemical constituents in the environment, to describe the hydrogeologic setting controlling the migration of chemical constituents through the soil and ground water, and to evaluate the technologies available for implementation during the remedial action.

3.3 Precision and Accuracy

Precision is the characteristic which reflects the ability to replicate a previously obtained value using identical testing procedures, while accuracy is the characteristic which reflects the ability to obtain a value which equals, or approaches within certain predetermined limits, the true value of a certain phenomenon. Each of these two characteristics are addressed in all data gathering and reporting conducted by Canonic. Data quality objectives for precision and accuracy are established for each major parameter to be measured during the project. These objectives are based upon prior experience in executing RIs or remedial activities for wastes similar to those present or anticipated at this site, on prior knowledge of the capabilities of the measurement system to be employed during activity at the site, and on the limitations which are presented in execution of the task. The precision and accuracy requirements for certain data gathering and reporting activities may vary based upon the anticipated use of the information. For example, the precision and accuracy

requirements of data gathered during surveying to locate ground water monitoring wells will not be as strict as the requirements imposed on analytical data, which is used to establish whether impacted soils or ground water will require remediation.

In general, the precision and accuracy requirements for the RI/FS program will met by assuring that at least ten percent of the samples gathered for analytical evaluation in each matrix type (i.e., soil, water, etc.) during each sampling episode are duplicates, so that field precision may be evaluated. Since standard sampling procedures are stipulated for all sampling episodes, no additional duplicates are required due to changes in sampling team composition. In the laboratory, ten percent of the samples of each matrix will be analyzed as replicates to evaluate laboratory precision. Duplicate and replicate samples will be chosen at random, unless the criticalness of the sampling would suggest duplicate sampling or replicate sampling to be appropriate. Section 6.0 of Appendix B discusses the use of approved methodologies, and Tables 2 through 27 identify detection limits typically achievable in the analysis of samples with low concentrations of chemical constituents. The analysis of data toward establishment of accuracy and precision levels obtained in the analytical work is discussed in Section 8.0.

Calculations performed with the data gathered or generated during the project are also checked for accuracy by the task leader or his designee, and precision, i.e., the comparability of calculation techniques between various tasks, is assured through review by the quality assurance team.

Portable field instruments, such as the organic vapor analyzers (OVAs), will be calibrated daily with standardized methane (standardization concentration to be within the range of 5 to 10 ppm) to establish the accuracy of the data collected.

Accuracy of field-measured pH will be evaluated through comparison of instrument readings taken on standard buffer solutions. Accuracy will be

established by obtaining readings which do not vary from the standardized solution value by + 0.05 pH units. Field measurements will be recorded to the nearest 0.05 pH units.

Accuracy of the conductivity meter will be assured by daily calibration verification with a standardized solution of potassium chloride, purchased from the manufacturer of the meter or from a laboratory chemical supply house. If instrument readings vary from the standardized value by more than five percent (5%), the conductivity meter will be recalibrated or replaced.

Instruments which are factory calibrated will be considered accurate if the most recent calibration occurred within the previous 12-month period and the instrument readings do not appear to be in obvious error. Periodic checks of the instruments against samples containing known concentrations will allow personnel to detect calibration drifting. Measurement precision for all field instrumentation will be estimated by periodically (1 per 10 samples) completing duplicate testing of samples in the field.

Precision and accuracy data for Canonie's laboratory is presented in Appendix B with the laboratory's quality assurance plan. Appendix C presents copies of the laboratory's certification of approval from the DHS.

3.4 Completeness

The characteristic of completeness is a measure of the amount of valid data obtained compared to the amount that was specified to be obtained under normal conditions. The amount of valid data specified is established based on the measurements required to accomplish project objectives. The extent of completeness must be reviewed on a relative basis for sample collection activities, since the required amount of valid data anticipated prior to sampling episodes may not accurately define the amount of data necessary to render a correct decision. Completeness of data handling systems is described in Sections 10, 12, and 14.

3.5 Comparability

The characteristic of comparability reflects both internal consistency of data collected with regard to a single parameter and an expression of data in units which are consistent with the units which data, gathered by other organizations measuring the same parameter, are presented. Comparability of data gathering and measuring procedures should also be addressed if data gathered is to be reliably compared. Thus, the characteristic of comparability implies the personnel involved in data acquisition and reduction must operate measurement systems within the calibrated range of the particular instrument as well as utilize analytical methodologies which produce comparable results.

When comparison of data sets indicates certain values within one or more sets are not consistent with the totality of the data acquired, these values, known as "outliers", must be reassessed prior to utilization in the decision-making process. Utilization of statistical analysis is often required to define whether the "outliers" represent significant values which require recognition in the decision-making process. Analysis methodologies which will be considered in reviewing data will include the three approved statistical procedures presented in 40 CFR 264. Since the number of verifiable sampling data points for the monitoring wells will be few, it may not be possible, however, to complete a time statistical analysis of data for all constituents at all locations.

3.6 Quality Assurance/Quality Control Objectives

The QA/QC objectives for the RI/FS activity contemplated in the RI/FS Work Plan include the following:

1. To collect sufficient field, sample blank, and trip blank samples as well as field duplicates to allow assessment of sample representativeness and sample collection protocol precision;

2. To analyze sufficient internal duplicates, blanks, reference standards, and matrix spike samples to allow an assessment of analytical precision and accuracy. Sufficiency of analytical QA/QC procedures is specified by the referenced methods in Section 9;
3. To produce documented, consistent, and technically defensible data and reports which accurately and completely define the nature and extent of chemical constituent presence at the site, the hydrogeologic environment controlling the migration of chemical species at the site and the flow of ground water in the area, and the concentration and distribution of any organic emissions which may impact adjacent property;
4. To develop an appropriate indicator parameter schedule for ground water and soils during the RI for use in economically evaluating the progress of remedial actions to be implemented at the site.

4.0 GROUND WATER MONITORING WELLS

4.1 General

The impacts to ground water quality, due to industrial activity, may result from surface spills, discharge of wastes or process waters into surface impoundments or leach fields, and from buried wastes or leaking tanks or pipes. Characterization of any resulting impacts to ground water quality and the transport of chemicals in the ground water requires that the hydrologic properties of the aquifer be determined. The direction of ground water flow can be determined by comparing static water level elevations in a series of wells completed in the same aquifer. Additionally, the flow rate can be calculated from the gradient of the ground water surface, hydraulic conductivity, and porosity.

The hydrogeologic conditions controlling transport of chemical constituents in the ground water are rarely defined in existing literature. Therefore, direct observation of subsurface conditions, through installation of ground water monitoring wells, is required to determine flow parameters such as permeability and hydraulic potential, and to assess the nature and extent of chemical constituent impacts to the local ground water quality. The sampling plan for the project describes the location where ground water monitoring wells are to be installed, the designation of the wells, and the depths or stratigraphy to be monitored. The sampling plan should be referenced for anticipated locations and the rationale for selection. This plan describes the procedures with which drillers are to comply in constructing monitoring wells. Well installation procedures and the quality control program controlling well construction are critical to the collection of data which accurately reflects the conditions existing in the subsurface soils and in the ground water. The following procedures will govern the installation of all monitoring wells during this project.

4.2 Cleaning of Equipment and Materials

The drill rig shall be in good condition, capable of efficiently accomplishing the designated work, and properly maintained so that chemical constituents are not introduced into the soil or the borehole during the construction of the well. Leaking seals or leaking tanks containing fluids other than approved drilling water shall not be permitted.

All equipment to be used in the construction of wells at the site shall be cleaned within the decontamination area designated in the health and safety plan. All drill rods, augers, samplers, and any other equipment necessary for the construction of the well shall be removed from the rig and steam cleaned utilizing water from a source approved by the project manager. A sample of the water used for steam cleaning the drill rig and equipment shall be collected during the first day of drilling, and analyzed for the chemical constituents known to be present at the site.

Drill rods, augers, casings, samplers, pipe wrenches, and other materials and tools shall be laid on saw horses or other supports and cleaned until all visible signs of grease, oil, mud, or other material are removed. Brushes shall be used as necessary to assist in the removal of extraneous materials or soil. New equipment shall be cleaned of all paint before utilization in well construction. Drillers shall utilize new, clean cotton work gloves in handling cleaned drill rig equipment. If the health and safety program for the site requires the donning of surgical or other protective gloves, these gloves may be worn beneath the cotton work gloves.

In addition to the cleaning of the equipment noted above, water tanks, pumps, mud pans, hoses, and transfer vessels shall be periodically cleaned to prevent the introduction of chemical constituents which would compromise the quality, representativeness, or use of the new well. Fittings on the drilling equipment may be greased and fluids may be added to equipment after cleaning, so long as extreme care is taken to avoid exposing cleaned equipment to the greases or fluids. When possible, vegetable oil-based

greases and lubricants shall be considered for use. Precautions shall be taken to prevent contamination of the well with petroleum oils and greases. Lubricants shall not be used on the drilling and sampling tools and fittings.

Only new materials shall be used in the construction of wells on the site. Well casings and screens shall, prior to cleaning, bear the manufacturer's label indicating the type of material and specification to which the material element was made. Grout, cement, bentonite, or other material to be used in construction of the well shall be brought to the site in unopened bags, pails, or other containers, and shall be clearly labeled as to type, manufacturer, and specification compliance.

When polyvinyl chloride (PVC) casing is utilized, the casing shall be cured and free of plasticizers. Only threaded casing and accessories shall be used. The factory threading operation for the casing shall be completed without the use of oils, and all burrs and shavings shall be cleaned from the casing. PVC casing with ink markings shall be sanded with fine sand paper until all ink has been removed from the entire casing. After steam cleaning the casings, workers shall always use clean cotton gloves when handling the casing.

All pumps to be used in development, purging, or pumping of wells at the site shall be steam cleaned and all wetted parts, hoses, and valves flushed thoroughly with water from the source approved by the project manager. Pumps which leak or otherwise may introduce chemical constituents into the well, sampled water, or aquifer shall not be used. Electrical lines to submersible pumps shall meet all applicable code standards. Electrical lines to submersible pumps may be attached to the discharge pipe or hose of the pump by stainless steel or plastic fasteners which grip by means of a mechanical action only. No electrical tape shall be used to attach electrical lines to the discharge pipe or hose.

Compressors utilized in the development, purging, or pumping of wells at the site shall be equipped with an operable oil trap and in-line air filter. The oil trap and filter shall be checked by the supervising geologist, geotechnical engineer, or technician prior to each day's use. The oil trap and filter must be capable of removing entrained oil from the compressed air to prevent introduction of chemical constituents into the sample water or the ground water.

If bladder pumps are utilized and powered by compressed nitrogen, the nitrogen gas shall be pressure regulated at the tank and shall pass through an in-line oil trap and filter before it enters the well or pump. The source of nitrogen gas shall be indicated in the daily log for the site activities.

4.3 Drilling Procedures and Steel Casing Installation

4.3.1 General Precautions and Restrictions

The addition of any drilling fluids which contain chemical additives or organic matter, such as Baroid or Revert, is strictly prohibited. The mixing of water or cuttings from upper soil zones with lower soil zones is prohibited, and any drilling method or activity which has the potential to cause such mixing is prohibited.

4.3.2 Preferred Drilling Procedures

Whenever feasible, wells shall be constructed using drilling procedures which do not require the introduction of water or drilling fluids into the well hole. In general, drilling with hollow-stem augers is preferable to rotary drilling; air rotary drilling is preferable to wet rotary drilling; and reverse-circulation drilling is preferable to wet rotary drilling. Wet rotary drilling with clear water and insertion of a temporary flush-joint casing is preferable to recirculation of drilling fluids and all methods are preferable to wet rotary drilling and the use of bentonite-based

drilling muds as a borehole stabilizer. Cable tool methods and other percussion tool drilling methods may be attempted in hard, consolidated formations, subject to approval by the project manager, and with particular consideration being given to the procedures used to prevent mixing of upper soil zones with lower soil zones.

Where conditions warrant, the use of a permanent steel casing installed to prevent mixing of upper soil zones with lower soil zones is encouraged. In some situations, several permanent casings may be required as the borehole is advanced to deeper soil zones. When required or utilized, installation of a permanent steel casing shall be completed prior to drilling into lower soil zones. When a steel casing is installed in a pre-drilled borehole and then driven into undisturbed soils at the base of the borehole, the pre-drilled borehole shall first be filled with grout (placed via a tremie pipe) prior to placing the steel casing into the borehole. The casing shall be inserted into the borehole and driven while the grout is still plastic. The length of permanent casing driven into the undisturbed soils beneath the grout-filled borehole shall be at least three feet. The grout inside the casing may subsequently be removed by washing or by drilling; however, the casing shall not be disturbed for the period between 1.5 hours and 48 hours after mixing of the grout.

4.3.3 Hollow-Stem Auger Drilling Procedure

Where a monitoring well screen is to be constructed in a saturated, permeable zone of soil under low or no artesian pressure, hollow-stem augers may be utilized to drill and stabilize the well hole. The inside diameter of the hollow-stem augers shall be at least 1.33 times the outside diameter of the well screen and riser scheduled to be placed in the borehole. Only hollow-stem augers with water-tight joints shall be utilized in constructing the well.

The borehole is created by rotating the hollow-stem augers and advancing the augers into the soil. The borehole is created as the soils are brought

to the surface by the action of the augers. When the augers have advanced to the designated depth, the augers are withdrawn. Soils which have not been pushed to the surface by the rotation of the auger are extracted when the augers are retrieved.

If heaving soils are encountered during the advancement of the borehole, the drilling crew may attempt to salvage the borehole by filling the hollow-stem augers with water from the approved source, and then cleaning out the hollow-stem auger using a clean split-spoon sampler or other tool. A roller bit shall not be used to remove the soil from within the auger, nor shall the augers be cleaned by jetting.

The borehole shall be advanced to the pre-determined depth or soil strata, as detailed in the project work plan, or advanced to a depth determined by the supervising geologist or geotechnical engineer. Sampling of the soil formation during advancement of the borehole shall conform to the sampling plan presented in the work plan and to the procedures set forth in Section 4.4.

4.3.4 Rotary Drilling using Temporary Flush Joint Steel Casing

Rotary drilling using temporary flush-joint steel casing may be used where the depth of the monitoring well exceeds the practical capability of hollow-stem auger drilling, where sandy, bouldery, or gravelly soils or weathered bedrock must be penetrated and cased to create an open well hole, or where artesian pressures in relatively shallow soils prevent the installation of a well using hollow-stem auger techniques. Rotary drilling shall utilize a temporary, flush-joint, steel casing to stabilize the well hole, while a bit is rotated within the driven casing to cut and pulverize the formation. Clean, clear water from an approved source shall be pumped into the casing to cool the bit and wash the cuttings from the well hole.

Rotary drilling requires a large source of clean water, approved by the project manager, drill rod with a large inside diameter, a drill with high

torque and weight, and a high-capacity, high-pressure pump. The roller or drag bit used shall create a borehole within the casing which is no more than 3/8-inch smaller in diameter than the inside diameter of the temporary casing.

The borehole for the well is created by driving the temporary casing into the soil approximately five feet. The drill bit is then inserted inside the casing and the soils are cut and pulverized while clean water is pumped into the borehole through the hollow stem of the drill rod. The pulverized soil is lifted to the surface of the borehole by the upward velocity of the water, with the cuttings forming into a slurry by mixing of the water with the soil. The soil slurry is removed from the borehole to a settling basin. As the driven portion of the casing is cleared of soil, the casing is again driven deeper into the formation, and then the drill bit is utilized to remove the soil within the casing.

Bentonite powder may be added at the surface, around the outside of the temporary casing, to lubricate the outside of the casing to facilitate removal after the well is constructed. However, bentonite shall not be added within the casing. Blow out may be counteracted by filling and maintaining the casing with water. The rotation and rate of bit feed shall be controlled to assure that the formation being drilled is ground to medium to fine sand-sized particles. Pump capacity shall be sufficient to cause the pulverized material to be washed from the borehole.

4.3.5 Air Rotary Method

This technique is similar to the rotary drilling technique discussed in Section 4.3.4. However, instead of utilizing water to cool the drill bit and wash the soils to the surface, compressed air is substituted as the medium to remove the cuttings from the hole. Air rotary drilling is not amenable to situations where artesian conditions are present. However, air rotary drilling is appropriate when medium to hard bedrock is to be drilled and recovery of a rock core sample is not required. Additionally, air

rotary drilling is appropriate in situations where hydrogeologic conditions are such that the loss of water through the borehole would affect the immediate ground water quality or could cause a ground water plume to be enlarged beyond its existing boundary.

4.3.6 Other Methods

The use of other drilling methods, including reverse circulation, percussion, and/or cable tool are not generally appropriate to the installation of monitoring wells. If the geology of the project site requires that one of these methods be utilized, the drilling program will be suspended and an alternative drilling program will be developed. The drilling program will include appropriate QA/QC directives.

4.4 Sampling of the Formation

4.4.1 General

The sampling of the formation is required to establish the nature of the soils at the location of the monitoring wells. Geologic samples, retrieved through split-spoon sampling or thin-walled tube sampling, are required to determine the strata thickness and soil type present at depth, and to provide the information necessary to develop an accurate log of the well hole. Where sampling is required for chemical characterization of the soils, sampling shall follow the procedures set forth in Section 5.3.2. All monitoring wells shall be properly logged, to provide a permanent record of the lithology encountered and the well constructed. The soils log for the well shall follow the format established in the Unified Soil Classification System (USCS). The field geologist or geotechnical engineer shall be responsible for obtaining all required information to fully and completely detail the lithology and well construction for each monitoring well installed at the site.

4.4.2 Sampling Interval and Type

Soils within the borehole shall be sampled at regular intervals, not to exceed five feet. At a minimum, two samples shall be retrieved from the soil strata in which a monitoring well screen is to be set. Sampling shall be performed in accordance with ASTM D1586, split-spoon sampling, or 1587, thin-walled tube sampling. Soil samples to be analyzed off-site for physical parameters shall be placed in 8-ounce paragon jars, sealed, and labeled. Labels shall include the name of the sampler, the date and time of collection, the borehole or well designation, the site name, and the preliminary classification of the soil under the USCS. Soils examined for logging of the hole, but not retained for subsequent analysis will be discarded with the cuttings.

Bedrock shall be continuously cored in the zone in which the well screen is to be set, if well screen is used in the bedrock, or in the zone which is to be finished as the monitored interval. Rock core shall be NX size or larger, and at least 80 percent of the core run shall be recovered when the RQD is equal to or greater than 25 percent. When the RQD is less than 25 percent, at least 60 percent of the core run shall be recovered. The core shall be placed in plastic, cardboard, or wooden core boxes, with core loss blocks provided as required, and properly identified and labeled.

Roller bit and percussion drill cuttings shall be sampled on at least ten-foot intervals, with the sampled cuttings placed in paragon jars, sealed, and labeled. Samples of the gravel pack, filter, and plastic grout shall also be collected, placed in separate glass jars, sealed, and labeled. When several wells are completed using gravel, filter media, or grout from the same bag or mix, only one sample of the common media needs to be retained. The log of the well shall note that a single sample was retained and is representative of the media in one or more additional wells.

4.5 Well Construction Materials

All materials utilized or incorporated into the construction of ground water monitoring wells shall be new, of sound condition, and free of hazardous or toxic chemical constituents which may leach into the ground water. All paint, coatings, or inks shall be removed prior to installation.

4.5.1 Well Screens

Well screens shall be continuously slotted PVC plastic well screen as manufactured by Johnson Well Screen, or equivalent, or if stainless steel screen is required due to special conditions, shall be continuously wound wire screens as manufactured by Johnson Well Screen, or equivalent. The diameter of the well screen shall meet the construction specification for the well designated in the work plan or determined by the field geologist or geotechnical engineer. Well screen shall be furnished in five-foot-long sections, or longer, except as specifically noted otherwise in the work plan. The bottom of each section shall be designed to accept a threaded bottom plug, which plug shall be designed to withstand all installation and well development pressures without becoming dislodged or damaged.

Slot size for the screen shall be determined by the field geologist or geotechnical engineer relative to the formation and gravel pack in which the screen is to be installed. Where prior information is available on the geology of the site, the work plan may stipulate a screen size for the monitoring wells. The field geologist or geotechnical engineer shall confirm that the slot size selected in the work plan is appropriate with field conditions observed during the drilling of the borehole.

4.5.2 Riser Pipe

Riser pipe shall consist of PVC plastic pipe meeting ASTM D1785, with flush-joint threads. Schedule 40 or 80 pipe, as designated in the work

plan, shall be utilized. Riser pipe shall be furnished in appropriate lengths, with all riser pipe having a minimum length of 5 feet and a maximum length of 20 feet. Threads shall be cut in accordance with DCDMA standards.

4.5.3 Casing

Permanent or temporary steel casing for cased wells shall have a minimum inside diameter which is 1.33 times the outside diameter of the well screen and riser pipe. The steel casing shall have a minimum wall thickness of 0.125 inches, and the ends of each casing section shall be threaded, or bevelled for welding. All casing shall be new black pipe which is free of interior coatings.

4.5.4 Grout Mix

Grout shall be mixed on-site, or delivered in ready-mix trucks where the volume of grout required exceeds the practical capability of portable mixing equipment or weather conditions prohibit effective mixing and temporary storage of the grout. Grout shall be composed of five to six gallons of water mixed with one bag of Portland cement. Hydrated lime may be substituted for up to 10 percent of the cement required. Bentonite shall be added to the mix at a rate of two to four pounds of bentonite powder per bag of cement.

The grout shall be thoroughly mixed and free of lumps. Cement used shall be Portland cement Type I, meeting ASTM C150, furnished in unopened bags weighing 94 pounds. Hydrated lime, if used, shall meet ASTM C207, Type S, furnished in unopened bags, and shall not contain additives which cause or enhance air entrainment. Bentonite shall be powdered sodium bentonite, supplied in full, unopened bags. Water shall be provided from a source approved by the project manager.

4.5.5 Gravel Pack

Gravel pack is the material placed in the annular space around the well screen. The pack shall be uniformly graded sand or gravel, comprised of hard, durable particles which have been washed and screened. The sizing of the particles shall be determined by the soil type encountered in the zone to be monitored. The particle size of the pack shall be at least 4 times the D15 size (15 percent of the soil is finer than this dimension) of the soil in the monitored zone and shall be no more than 4 times the D85 size (85 percent of the soil is finer than this dimension) of the soil in the monitored zone. The gravel pack shall be free of all organic matter and shall not contain detectable concentrations of any chemical constituents. The gravel pack shall be furnished in unopened bags or pails.

4.5.6 Bentonite Pellets for Seals

The seal between the filter and the borehole grout shall be constructed of sodium bentonite pellets and sand. The diameter of the bentonite pellets shall be less than one-half the width of the annular space into which they are placed. The pellets shall be furnished in unopened bags or pails and stored in a dry location prior to use.

4.6 Well Installation

Prior to installation of any material in a borehole, the supervising geologist or geotechnical engineer shall verify that the borehole is stable, vertical, unobstructed, and advanced to the depth indicated in the work plan or specified in the field orders. If the borehole tends to cave in or heave, the drill crew shall be instructed to take the necessary steps, consistent with the procedures described herein, to stabilize the borehole. Well installation shall not be permitted by driving or jetting the well screen, unless specifically authorized by the project manager through written authorization.

4.6.1 Well Component Assembly

The installation of the components of the well shall be as follows. All materials shall be cleaned in accordance with the procedures set forth in Section 4.2 prior to assembly. The well's screen and riser pipe shall be assembled by taping the male threaded portion of each component with Teflon; tape, and then inserting and tightening the components by hand. The bottom plug shall be inserted into the bottom of the last section of well screen. If more than one section of well screen is required, each section shall be joined and hand tightened after the joints have been taped with Teflon; tape. If necessary to assure a tight joint, pipe or chain wrenches may be utilized only if the wrenches have been thoroughly cleaned.

As the screen and riser pipes are assembled, the assembled sections (string) may be positioned into the borehole and held in place with a slip plate and ropes or wire cables attached to the boom of the drill rig. Precautions must be taken to prevent oil or greases on the ropes or cables from contacting the riser pipe. If oils or greases do contaminate the riser pipe through contact, the riser pipe must be removed and cleaned properly.

Once the string has been lowered to the depth of the zone to be monitored, the string shall be suspended in place, if necessary, and the screen and riser sections positioned in the center of the borehole and vertically aligned. The riser pipe shall extend at least two feet above grade, unless provision has been made to set the well in a Christy box within a paved area. The final trimming of the riser above grade shall occur after the grout is in place around the well. When long strings must be placed into a borehole, centralizers may be necessary or appropriate to assure that the string is properly centered in the borehole. Centralizers shall be thoroughly cleaned in accordance with the provisions of Section 4.2. Centralizers shall be constructed of PVC plastic or stainless steel.

4.6.2 Placement of Gravel Pack

After the string has been placed into the borehole, the volume of the gravel pack shall be computed and carefully measured. The gravel pack shall typically extend at least two feet above the uppermost row of slots in the well screen, except where relatively impermeable zones separating permeable strata of soil are thin and require that the gravel pack construction be limited to a shorter rise. The level of the gravel pack within the borehole will be confirmed by sounding with a weighted tape. When using hollow-stem augers, the gravel pack shall be placed by pouring the material into the annulus between the auger and the riser pipe. The auger shall be raised periodically, and an auger flight removed, to allow the gravel pack to fill the annulus between the well screen and the borehole wall. If the borehole is temporarily cased, the casing may be withdrawn to the top of the gravel pack after the calculated volume of gravel pack has been placed and sounded. After withdrawing the temporary casing to a level approximately three feet above the top of the gravel pack, the pack shall once again be sounded to determine whether the withdrawal of the casing disturbed the gravel pack, and whether the pack continues to extend at least two feet above the top of the well screen.

4.6.3 Placement of Bentonite Seal

After the gravel pack has been placed and sounded, a bentonite pellet seal shall be constructed above the gravel pack. Prior to placing the seal, the volume of pellets required to construct the seal shall be calculated and carefully measured. The seal shall be one to two feet in thickness, and the pellets shall be placed and sounded in the same manner as the gravel pack. If the bentonite seal is constructed above the water table, approximately five gallons of clean water shall be poured into the annulus between the riser pipe and borehole to wet the bentonite pellets. A seal tamper shall then be lowered down the borehole, and the wetted pellets shall be tamped into a cohesive mass.

4.6.4 Placement of Grout

After the bentonite grout has been placed, the borehole shall be grouted. The volume of grout required to fill the borehole shall be calculated and a volume shall be added to that calculated to account for losses. Grout shall be prepared in accordance with the procedure presented in Section 4.5, and then injected into the borehole via a tremie pipe. The discharge end of the tremie pipe shall be placed initially on the top of the bentonite seal. As the borehole is filled with the grout, the tremie pipe may be raised. The grout shall be pumped through the tremie pipe into the borehole until the grout flows out of the borehole at the surface. After the grout has been placed, the temporary casing shall be removed. Additional grout shall be added to maintain a continuous column of grout within the borehole which is filled completely to the surface. After the grout has set (approximately 48 hours), the riser pipe may be trimmed. Trimming of the riser shall proceed in a manner to prevent pipe cuttings from entering the well.

4.6.5 Placement of Well Protector

A steel pipe, having an inside diameter of at least 1.33 times the outside diameter of the riser pipe, shall be set concentrically around the riser pipe and into the plastic grout. The bottom of the well protector shall be submerged at least three feet into the grout, and shall extend at least six inches above the top of the riser pipe. The grout which is forced out of the borehole due to the placement of the well protector shall be carefully removed so as to prevent "mushrooming" of the grout, which tends to promote heaving of the well casing and the well protector during frost conditions. The well protector shall be maintained plumb and concentric with the riser pipe until the grout has set. Temporary braces may be required to maintain the well protector in the proper position. A locking cap shall be secured to the top of the well protector pipe to prevent unauthorized entry into the well.

4.7 Well Development

All new monitoring wells shall be developed, by pumping or other means of evacuating the well casing, in order to remove trapped soil fines in the gravel pack and soil formation just outside the pack and to produce a representative sample of the water in the formation. Well development shall be completed as soon as possible after the well construction has been completed and prior to sampling for any water quality characteristics.

Well development may be accomplished through the use of submersible, bladder, jet, or suction pumps. Pumps must be fully operational, meet applicable electrical or other code provisions, and must be thoroughly cleaned in accordance with procedures set forth in Section 4.2. Pump capacity shall generally be rated at three to five gallons per minute. Pumps shall be operated to remove water from the well casing continuously for at least five minutes without pumping the well dry. As an alternative to pumping, an air lift may be utilized to evacuate and surge the well. Where the nature of the formation makes development of the well infeasible using pumps, bailers may be utilized.

Well development shall continue until representative formation water, free of the effects of well construction, is obtained. Representative formation water shall be defined as water which is generally free of sediment, and has stable pH, temperature, and conductivity readings when measured during a period of ten minutes. In general, well development shall proceed for at least four hours, unless prior experience suggests that a shorter well development period results in the production of formation water which is representative. Well development water will be discharged onto the ground near the well, or piped to the on-site storage tanks for storage and eventual disposal or treatment.

5.0 SAMPLING

5.1 General

The quality of sample collection techniques is assured by keying the techniques utilized in each sampling episode to both the media to be sampled and the analytes of interest to the investigation. The source of a particular environmental sample, whether it be water, soil, air, or other material, as well as the particular analyte to be tested (i.e., heavy metal, volatile organic, etc.), influence the decision of which specialized collection technique is required to preserve the integrity of the sample and ensure that a representative portion of the source is collected. Further, unless proper sample container preparation and handling measures are taken prior to sample acquisition, the sample composition may be altered by contamination, degradation, biological transformation, chemical interactions, or other processes during the time between sample collection and laboratory analysis. The resultant inaccuracy in the data may have profound effects on the comparability of analytical data from the sampling episode with the results of other episodes or other organizations, as well as tainting decisions related to such data.

Sample containers are generally filled directly from the source or sampling device without special considerations. However, certain analytical procedures require the sample obtained to be preserved by altering the pH of the sample to some predetermined value in order to maintain the in-situ characteristics of a particular analyte during transport and storage. Media-specific sample collection and preservation techniques are presented below. Adherence to approved protocols enhances the integrity of the data obtained from the sampling, and allows comparison of the data with standards and references established by regulatory agencies.

Table 1 of Canonie's laboratory quality assurance plan (Appendix B) presents the currently accepted sample volume, handling, and preservation requirements for hazardous materials sampling projects.

Unless otherwise specified in this plan, sampling procedures outlined in "Samplers and Sampling Procedures for Hazardous Waste Streams", EPA-600/2-80-018, will be followed in the collection of samples from various media at the site. A copy of this plan will be available at the site for reference by site personnel. Split or duplicate samples in appropriate containers accompanied by a sample tag and chain-of-custody form will be provided to the Navy Project Coordinator, and/or applicable regulatory agencies when approved by the Navy Project Coordinator, upon request.

5.2 Sample Container Preparation

Objective: To prepare appropriate sample containers for pre-selected analyses prior to the sampling episode.

Approach: The following procedures outline the basic steps required in preparing sample bottles for the indicated analysis. The blank water used in the procedures outlined below is identical to the reagent water (ASTM Type II or better) used to prepare sample blanks.

5.2.1 Elements Containers

1. Wash the glass bottles and caps thoroughly in hot detergent water.
2. Rinse the glass bottles and caps thoroughly with hot tap water.
3. Rinse the glass bottles and caps with 1:1 nitric acid.
4. Rinse the glass bottles and caps with blank water three times.

If soil samples are being collected using a split-spoon sampler, samples may be collected in brass tubes, inserted in the split-spoon as a liner. If brass tubes are used, the procedure stated above shall be used, except that the acid rinse shall be omitted.

5.2.2 Semi-Volatile Organic Analytes and Sample Blank Containers

1. Wash the bottles and Teflon;-lined caps, or brass tubes if used, thoroughly in hot detergent water.
2. Rinse the bottles and caps thoroughly with hot tap water.
3. Rinse the bottles and caps thoroughly with blank water.
4. Rinse the bottles and caps with ACS acetone and pesticide-grade hexane, and then air dry.
5. For trip blank water bottles, fill the one-liter bottles with blank water in the laboratory.

5.2.3 Volatile Organic Analytes

1. Wash the containers (bottles and Teflon;-lined caps, or brass tubes if used) thoroughly in hot detergent water.
2. Rinse the containers thoroughly with hot tap water.
3. Rinse the containers thoroughly with blank water.
4. Heat the containers at 100 degrees Celsius for one hour.
5. Allow containers to cool where they are protected from sources of contamination.

6. After the containers have cooled, cap the containers to prevent contamination.
7. For trip blank water bottles, fill the 40 ml VOA bottles with blank water in the laboratory.

5.2.4 Solid Sorbent Tubes

Appendix D presents a description of the methodologies employed in the preparation and subsequent sampling of Tenax tubes. Canonie will provide to the NavFac Project Officer a list of the constituents of interest with the detection limit for the constituent, and the NIOSH analytical reference methods applicable thereto, prior to the collection of samples.

5.3 Sampling Procedures

5.3.1 Air Monitoring Procedures

Monitoring of the ambient atmosphere may be accomplished successfully through the application of various techniques, ranging from the very simple (using colormetric tubes and a hand pump) to the sophisticated (using complex traps and absorbent media with real-time analysis employing gas chromatographic instruments). While the type and precision of monitoring data generally is directly related to the sophistication of the instrumentation utilized, valuable data concerning atmospheric impacts of chemical constituents may be accessed through application of monitoring methods which use low to moderate cost equipment. Further, these methods provide data which is of acceptable quality to assess public health impacts created by the presence of chemical constituents at a particular site.

The techniques described below are generally employed by Canonie in the collection of air quality data. These techniques are widely accepted and in general use throughout the field. The techniques selected provide practical, efficient means of obtaining samples in a manner consistent with

health and safety considerations and QA/QC requirements. Selection of a particular method for use in monitoring air quality will be accomplished in the Air Monitoring Plan (Volume 1B). A decision to use one method over another will be dependent on a weighing of several factors, including the precision required, the time period in which validated results will be returned, the interest in knowing whether specific chemical constituents are present, and the cost effectiveness of the method in relation to the intended usage of the data.

The sampling of ambient air quality requires that proper records be maintained during the sample collection process. Sampling must be designed and conducted in a manner that provides samples suitable for the intended analyses and are properly documented to assure comparability at a later date. At the time atmospheric sampling (and analysis) occurs, the following information must be recorded by the sampling team:

1. Sample site location (e.g., baseline station and offset or address);
2. Date and time of sampling;
3. Weather conditions, including prevailing wind direction, temperature, cloud cover, approximate humidity, and precipitation occurrence;
4. Sample identification number, if analysis does not occur contemporaneously with sample collection;
5. Identification of sampler;
6. Analyses requested, or analytical result obtained if analysis occurs contemporaneously with sample collection.

In addition to preserving pertinent information regarding the sampling, the sample team must initiate chain-of-custody procedures, describe the sample site in adequate detail to allow analytical results to be properly interpreted, and provide additional replicate samples to allow for evaluation of precision and representativeness. Canonie will utilize preprinted labels and standardized record forms to expedite this documentation effort in the field and ensure uniformity of records. The sampling protocols and recordkeeping requirements for the techniques described in this plan vary according to sampling techniques. Additional requirements may also be established on a site-specific basis based upon information obtained during sampling episodes.

5.3.1.1 Century 128 Organic Vapor Analyzer

Organic compounds which volatilize into the ambient air during site activity will be monitored periodically using a Century 128 Organic Vapor Analyzer (OVA), which operates on a flame ionization detection principle. The OVA is a hydrogen flame ionization instrument with sensitivity in the parts per million (V/V) range. The instrument measures organic vapor concentrations by producing a response to an unknown vapor sample, through ionization of the inputted vapor, which can be related to a gas of known composition to which the instrument has previously been calibrated. During normal operation, a continuous vapor sample is drawn into the probe and transmitted to the detection chamber by an internal pumping system. The sample flow rate is metered, calibrated, and passed through a particle filter before reaching the detection chamber. The vapor sample is ionized in the detection chamber, creating a current which is measured with a linear electrometer preamplifier. The preamplifier signal is conditioned and the resulting signal is transmitted for subsequent meter or external recorder display. Preamplifier signal settings allow detection ranges of 0 to 10 ppm, 0 to 100 ppm, and 0 to 1,000 ppm total organic concentration in the vapor samples analyzed.

During activities at the site, an OVA will be utilized by a field engineer or technician to sample ambient atmospheric conditions related to organic constituents. Air monitoring will occur after the OVA has been calibrated in accordance with procedures set forth in Section 7.2.4. Samples are drawn from specified locations, such as downwind of drilling activities or in the headspace above a soil sample, to determine the ambient concentrations which exist in the air. Sampling, once the instrument is operating and calibrated, only requires that the instrument handler place the inlet tube on the OVA probe at the location where vapor samples are to be accessed. The instrument readout is then monitored by the instrument handler, and notes on readout values are recorded in the daily log for the site work.

5.3.1.2 Solid Sorbent Tube Sampling

Procedures for solid sorbent sampling apply to Tenax tubes, polyurethane foam tubes, Chromosorb tubes, charcoal tubes, and florsil tubes. Sampling locations for tube sampling will be selected on the day sample collection is to occur. Sampling will generally involve collection of one or more samples at upwind, on-site, and downwind locations. General sampling locations for this project are discussed in the Air Monitoring Plan (Volume 1B).

At each sampling location, a calibrated Gilian pump will be installed at an elevation approximately five feet above ground, and generally away from trees or obstructions, such as buildings. A prepared solid sorbent tube will be labeled with a unique sampling number and the identification number of the Gilian pump to which the tube will be connected. The ends of the charcoal tube will then be broken off, and the tube placed into the sample tube holder. The flow direction arrow on the tube shall point toward the sampling pump. The ends of the tube holder shall then be evenly tightened to seal the holder.

When the tube holder is set with the new charcoal tube, the pump shall be turned on, and a notation made in the sample log book or field notes of the time sampling commenced. Periodically, during the sample period, the pump shall be checked to assure continued operation. If pump failure occurs, the digital readout of the pump clock shall be activated and the time of operation observed and recorded in the field notes, together with the pump number and solid sorbent tube sample number.

For pumps which properly operate for the entire sampling episode, the pumps shall be collected and turned off as close to the conclusion of the 480-minute sampling time period as possible. The digital readout of each sampling pump shall be activated and the time of operation for each pump observed and recorded in the field notes adjacent to the recorded sampling start time for the pump.

Each solid sorbent tube shall then be removed from its holder, the ends of the tube sealed with the plastic caps provided with the tube, the sealed tube placed in an individual zip-lock plastic bag, the samples placed in an iced cooler. A blank sample shall then be prepared by breaking the ends of a clean, fresh solid sorbent tube, sealing the ends with the red, plastic caps accompanying the tube, placing a label on the tube, and sealing the tube in a zip-lock plastic bag, and placing it with the other tubes in an iced cooler.

The sampled air volume is then calculated for each pump based on the air flow rate applicable to each pump and the time each pump operated. The total volume of air sampled by each tube shall then be entered on the chain-of-custody form accompanying the sample container.

5.3.1.3 Particulate Sampling

The media to be used for this particulate sampling are pre-weighed, mixed cellulose ester filter cassettes. The media will be obtained from the analytical laboratory. Sampling locations will be selected on the day

sample collection is to occur, and in many instances will correspond to the solid sorbent tube sampling locations. A discussion of the proposed areas for particulate sampling is in the Air Monitoring Plan (Volume 1B).

At each sampling location, a calibrated Gilian pump will be installed at an elevation approximately five feet above ground, and generally away from trees or obstructions, such as buildings. A pre-weighed filter cassette will be labeled with a unique sampling number and the identification number of the Gilian pump to which it is connected by tygon tubing.

When the sampling train is assembled and the pump started, a notation will be made in the sample log book. Periodically during the sample period, the pump flowrate shall be checked to ensure a continuous flow of air is being drawn through the filter. If a pump failure occurs, the digital readout of the pump clock should be noted and the time of operation observed. This information should be noted in the sample log book together with the pump number and the filter sample number.

For pumps which properly operate for the entire sampling period, the sample shall be collected and the pump turned off at the end of the designated sampling period. The digital readout of the pump should be noted along with the time of operation in the field notes adjacent to the start time.

Each filter cassette shall then be disconnected from the pump, the plugs replaced and sealed. The cassettes can be stored with other samples awaiting shipment. A blank cassette sample shall then be prepared. The plugs of the cassette shall be removed, no air will be drawn through the cassette, the plugs shall be replaced and sealed. A label shall be placed on the cassette and the cassette shall be placed with the other samples awaiting shipment.

The sample air volume is then calculated for each pump, based on the applicable flowrate for each pump and the time of collection for each pump.

The total volume of air sampled by each cassette shall then be entered on the chain-of-custody form accompanying the sample container.

5.3.1.4 Oxygen Content Monitoring

Portable oxygen monitors are invaluable when initially responding to hazardous material spills or waste site situations. The monitors are useful in screening ambient air, in locations such as unventilated room, tanks, or storage areas where oxygen levels may not be sufficient to support life. When used properly, the portable oxygen monitor will indicate the percent oxygen present in the atmosphere sampled. Normal oxygen concentration required for respiration is 20.9 percent.

The portable oxygen monitor has three principle components for operation: the airflow system, the oxygen sensing device, and the microamp meter. Typically the air is drawn into the instrument and through the oxygen sensor with a built-in pump or aspirator bulb, although some instruments employ a passive cell system. The sensor analyzes the sampled air and emits an electronic signal which is translated by the microamp meter and transmitted to a readout. Most monitors employ a light-emitting diode (LED) readout system which indicates oxygen content within a range of 0 to 25 percent. Many instruments also are equipped with programmable alarms which can be set to activate at specific oxygen levels.

When ambient atmospheres are monitored for oxygen level, the sampling technician or engineer will check the operation of the instrument in accordance with the procedures set forth in this plan. The technician or engineer will then position the intake of the instrument in close proximity to the area being sampled. Caution must be exercised to avoid exposure to atmospheres where oxygen levels are deficient. Sampling for oxygen levels may require sampling personnel to operate in teams. Readings from within areas surveyed by the technician or engineer are then logged in the sampling logbook, with a notation of the time and the technician or engineer completing the survey.

5.3.1.5 Combustible Gas Monitoring

In general, combustible gas detectors are used to determine the potential for combustion or explosion in unknown atmospheres. These instruments, in combination with oxygen detectors and radiation survey instrumentation, should be the first monitors used when entering a hazardous area. These measurements of ambient conditions obtained from these instruments provide a general indication of the degree of immediate hazard to personnel and permit the health and safety officer to make informed decisions on levels of protection required at the site. However, the instruments are typically not sufficiently sensitive to trace levels of hazardous or toxic compounds which may represent significant health threats to workers, and therefore must not be relied upon exclusively by personnel to determine the appropriateness of protective equipment or attire.

A combustible gas indicator consists of three primary components: the sensor (hotwire, catalytic, solid state, etc.), signal processor and readout display. Typically, the sample is introduced to the sensor either by diffusion into a passive sensor or by pumping the sampled gas through an active sensor. The sensor produces a signal in response to combustible gases in the sampled air, which signal is processed and displayed as the ratio of the combustible gas present to the total required to reach the lower explosion limit (LEL).

The lower explosive limit (also LFL, lower flammability limit) is defined as the lowest concentration of gas or vapor in air which can be ignited by an ignition source and cause an explosion or flame propagation. Conversely, the upper explosive limit or UEL (also UFL, upper flammability limit) is the concentration of gas in air above which there is insufficient oxygen available to support combustion, and an explosion is unlikely. A flame, however, may burn at the gas-air interface or, should additional air enter the mixture, a very explosive atmosphere may develop. In general, the instruments respond in the following manner:

The meter indicates 50 LEL (50 percent). This means that 50 percent of the concentration of combustible gas needed to reach an unstable combustible situation is present. If the LEL of the gas is 5 percent in air, then the instrument indicates a 2.5 percent mixture is present.

The meter needle stays above 100 LEL (100 percent). This means that the concentration of combustible gas is greater than the LEL and less than the UEL and, therefore, immediately combustible and explosive.

The meter needle rises above the 100 LEL (100 percent) mark and then returns to zero. This response indicates the ambient atmosphere has a combustible gas concentration greater than the UEL.

Of the many instruments commercially available for detecting combustible or explosive gas, some are not certified safe for operation within the atmospheres indicated. Only those monitors that are certified safe for use in atmospheres greater than 25 percent of the LEL should be utilized.

Some combustible gas monitors provide readouts in units of percent LEL, while some instruments provide a readout in percent combustible gases by volume. Several instruments are available which provide dual scaled readouts. Many situations may occur where the types of combustible gases to be encountered are unknown. In such instances the more explosive the calibration gas (the lower the LEL) the more sensitive the indication of explosivity and thus the greater the margin of safety. The operator should be familiar with the LEL concentrations for specific gases to effectively use instruments that provide data in percent combustible (by volume) only.

Although monitors can be purchased that are factory calibrated using gases such as butane, pentane, natural gas, or petroleum vapors, methane calibration is the most common. The LEL of methane is 5 percent by volume in air, therefore, an air mixture containing 5 percent methane will be read as 100 percent LEL and will be explosive if a source of ignition is

present. When combustible gases other than methane are sampled, the relative response of the detector for these other gases must be considered. Recalibration to other gases may be possible; the manufacturer's recommendations should be consulted prior to adjusting the calibration of the instrument. The relative sensitivity of the detector and the differences in LEL for different gases are typically set forth in the literature accompanying the instrument. Actual correlation equations that will convert the percent LEL (based on methane) read by the unit to a percent LEL for another combustible gas can usually be found in the operating manual. Many units also have alarm systems which can be adjusted for various LELs and several are available that incorporate analyzers.

5.3.2 Soil Sampling Procedures

A number of techniques have been developed to obtain samples from various depths below ground surface or in media such as sediment or sludge. Techniques described herein are those normally employed by Canonie. These techniques have been selected to provide practical, efficient, and representative means of obtaining samples in a manner consistent with health and safety considerations and QA/QC requirements. Additionally, these techniques employ equipment and methodologies which are normally utilized in geotechnical work.

The selection of sampling techniques to be employed at a given location or under particular conditions is based upon the depth from which samples must be obtained and the nature of the soils (or sediment or sludge) to be sampled. The sampling techniques are categorized by the depths at which samples are to be taken or the conditions prevailing at the time sampling is initiated, as listed below:

1. In-situ surface or shallow sampling;
2. In-situ deep sampling;

3. Sediment sampling;
4. Sludge sampling.

Maintaining proper records is a significant aspect of the sample collection program. The entire sampling process is designed and conducted in a manner that provides samples suitable for the intended analyses and are properly documented to assure comparability at a later date. At the time samples are obtained, the following information must be recorded by the sampling team:

1. Sample site location (e.g., baseline station and offset, or process or equipment item);
2. Depth or position;
3. Date and time of sampling;
4. Sample identification number;
5. Identification of sampler;
6. Analyses requested.

In addition to preserving pertinent information regarding the sampling, the sample team must initiate chain-of-custody procedures, describe the sample site in adequate detail to allow analytical results to be properly interpreted, collect necessary duplicate samples to allow evaluation of precision and representativeness, and provide sufficient information for samplers to return to collect additional replicate samples at a later date, if necessary. Canonie will utilize pre-printed labels and standardized record forms to expedite this documentation effort in the field and ensure uniformity of records. The sampling protocols and recordkeeping requirements for the techniques described in this Plan vary according to

sampling techniques. Additional requirements may also be established on a site-specific basis based upon information obtained during sampling episodes.

5.3.2.1 In-Situ Surface or Near-Surface Sampling

Objective: To obtain in-situ surface or near-surface samples suitable for chemical analysis.

Approach: In-situ surface or shallow soil sampling will be conducted by pushing prepared brass tubes into the soil by hand or with the aid of a push rod. Samples may also be acquired by manually driving a split-spoon sampler containing a brass tube insert into the soil to the depth desired, and then withdrawing the sampler.

Detailed Description:

Generally, a four-inch-long brass tube, which has been cleaned with an Alconox wash and rinsed with distilled water and with electronic-grade methanol and allowed to air dry, will be advanced into the media to be sampled, at locations designated in the Sampling Plan, to retrieve a sample for analysis. If the sample is to be obtained from the surface, the sampler will remove the upper one to two inches of media just prior to the insertion of the brass tube into the media. This final removal of surficial media just prior to sampling will assure that concentrations of volatile organics in the sample are representative of the in-situ media.

When the tube has been driven and filled with the media to be sampled, the sampler will withdraw the tube, cover the ends with aluminum foil or Teflon; tape, cap each end with a fitted plastic cap, and then tape the ends of the tube to secure the caps to the tube for shipment. The sample will then be labeled in accordance with QA/QC protocols given in this plan and finally stored in an iced cooler for transport to the laboratory.

5.3.2.2 In-Situ Shallow Sampling

Objective: To obtain soil samples which reflect in-situ soil conditions in the upper soil zones which are suitable for chemical analysis.

Approach: Samples representative of conditions which exist between surface and 6 to 10 feet below existing ground surface will be obtained by advancing a hand-operated auger into the soil to the depth from which samples are required. A system consisting of an auger bit, a series of drill rods, a "T" handle, and a thin-walled tube corer are utilized to remove overburden and then extract the soil sample. The auger bit, drill rods, and "T" handle are used to bore a hole to the desired sampling depth and then withdrawn. The auger bit is then replaced with the tube corer, the corer and drill rods are lowered into the borehole, and the corer is advanced into the soil to the depth of completion desired. The corer and drill rods are then withdrawn from the borehole and the sample recovered from the tube corer.

Detailed Description:

Upper soils may be sampled through the use of a drill rig using a procedure similar to that discussed below in Section 5.3.2.3, In-situ Deep Sampling. However, certain conditions may prohibit the mobilization of a drill rig into an area to be sampled, or samples may be obtained more economically by sampling personnel using hand augers. Sampling devices may vary, depending on the type of soil conditions anticipated or the depth to which sampling must be completed. Sampling equipment may include of several types of augers, such as a bucket type or continuous flight auger, or may include posthole augers. Bucket type augers are useful in direct sample recovery and provide a large sample volume. Continuous flight augers can be used to collect samples from deeper zones, however, the soil sample is frequently "disturbed", having been mixed with soil from several intervals in the

borehole. Samples can be taken directly from the flights, and continuous augers are useful when a sample from the entire soil column is desired. Posthole augers have limited utility for purposes of sample acquisition, though posthole augers are particularly useful when the borehole must be advanced through fibrous or heavily rooted soil zones. Where soil conditions affect borehole stability, a temporary casing may be useful in maintaining the open borehole to the sampling depth desired.

Typically, a hand-powered sampling system will be composed of various auger bits, several drill rods, a "T" handle, and a tube corer. The auger bit will be attached to one end of a drill rod and the "T" handle attached to the opposite end. The auger assembly will then be advanced through the soil at an identified soil sampling location. As the assembly is advanced, the "T" handle may be detached, an additional length of drill rod added to the first section of rod, and the "T" handle reattached to the assembly. It may be advisable to remove the upper four to six inches of soil from around the borehole to prevent this loose soil from falling into the borehole. As soil is extracted from the borehole, the accumulated soils should be removed to prevent it from accidentally re-entering the borehole.

After the assembly has been advanced to the desired depth, the entire assembly is carefully removed from the borehole. The auger bit is removed from the drill rod assembly, and the tube corer, thin walled tube sampler, or split-spoon sampler is attached to the rods. The assembly is then carefully lowered into the borehole and the sampler is advanced into the soil to obtain the soil sample. The assembly is then removed from the borehole, and the soil sample is retrieved from the sampler and placed into an appropriate sample container. Soil samples may be placed in brass tubes or 8-ounce glass jars. The openings of the container are covered with aluminum foil or with Teflon; and the container then sealed and cooled to 4 degrees Celsius.

5.3.2.3 In-Situ Deep Sampling

Objective: To obtain soil samples which reflect in-situ soil conditions and are suitable for chemical analysis from depths where health and safety prohibit the collection of samples by individuals entering the excavation, or where the soil is inaccessible to sampling personnel.

Approach: Samples representative of conditions which exist at depth in the subsurface will be obtained by advancing prepared brass tubes into the media. The brass tubes will be inserted into the split-spoon sampler in the instance where soils are being sampled, and may be placed into a handheld sampling rod when samples are to be retrieved from tank bottoms or test pits.

Detailed Description:

Generally four-inch-long brass tubes, which have been cleaned with an Alconox wash and rinsed with distilled water and with electronic-grade methanol and allowed to air dry, will be placed inside a split-spoon sampler prior to assembly of the sampler and attachment of the sampler to the drill rod. The sampler will then be advanced through the soils in the borehole as described in ASTM D1586. Upon retrieval of the split-spoon sampler from the borehole, the sampler is opened, and the brass tubes, now filled with soil, are quickly removed from the sampler, the ends of the tube covered with aluminum foil or Teflon; tape, cap the covered ends with clean, fitted plastic caps, and then tape the ends of the tube to secure the caps to the tube for shipment. The sample will then be labeled in accordance with QA/QC protocols given in this plan and finally stored in an iced cooler for transport to the laboratory.

Where handheld sampling rods are utilized, the brass tube may be clamped or secured to the rod, and then the tube lowered to the location from which the sample is to be acquired. After the tube has been advanced into the

media being sampled, the tube is retrieved and the sample secured inside the tube by covering the ends with aluminum foil or Teflon; tape, capping the ends with tight-fitting plastic caps, and then taping the caps to the tube. The sample is then labeled in accordance with QA/QC protocols and finally stored in an iced cooler for transport to the laboratory.

5.3.2.4 Sediment Sampling

Objective: To obtain sediment samples from a pipe, stream bed, or bottom of a non-flowing body of water which are suitable for chemical analyses.

Approach: Samples representative of the sediment are collected through direct access to the sediment, with collection utilizing handheld tools, or through indirect access using long-handled gravity corers, thin-walled piston sampler, or small, clam-shell samplers. Samplers are placed in brass tubes or appropriate glass jars or vials.

Detailed Description:

Where surficial sediment samples are required for chemical analysis, several methods may be employed to retrieve the samples, depending on the location of the sediment and the depth of water overlying the sediment. In the case of sediment in pipelines, the pipe may be entered (under applicable health and safety guidelines), and the sediment scraped from the pipe invert and placed in appropriate sample containers. Where access to the sampling location is not directly accessible, a collapsible, long-handled tool may be utilized, or a dragline arrangement employed to collect the sample and retrieve it to a location where access has been made.

For streams and smaller bodies of water, sediments may be accessed by wading into the water downstream of the sampling point and scooping up the sediment sample with a trowel or grabbing a sample with a clamshell

arrangement. After the sample has been removed from the bottom, the sample is quickly placed into the appropriate sample container and capped.

In instances where sediments are to be sampled in areas directly inaccessible to the reach of the sampler, sediments may be gathered using small clamshell-type devices, corers, or piston samplers attached to extended handles. Sampling technicians or field engineers may have to utilize rafts or boats to safely access the sampling location. Sample retrieval may have to occur slowly to prevent the sediment from washing out of the sampling device. After bringing the sample out of the water, the sampler must quickly transfer the sample to the appropriate sample container.

Gravity corers usually consist of a metal tube with a replaceable, tapered nosepiece on the lead end of the sampler and a ball or flap-type check valve on the trailing end of the sampler. The check valve allows liquids to pass through the corer on descent of the sampler, but prevents washout of the sample when the device is raised during recovery of the sample. The tapered nosepiece facilitates cutting of material and reduces core disturbance during penetration. Gravity corers are generally useful in collecting essentially undisturbed samples which represent the profile of sediment or sludge strata present. Depending on the density of the sediment or sludge and the weight of the corer, penetration depths of up to 30 inches may be attained.

A Ponar grab sampler may also be useful in sampling sediments or sludges. The Ponar grab sampler is a clamshell-type scoop which is activated by a counter lever system. The shell is opened and latched in place and then slowly lowered to the depth from which samples are desired. The latching device is then released, and the clamshell closes to enclose the sample. The sampling device is then raised and the sample transferred to a sample container. Ponar samplers are available in several sizes, some of which may require a winch to raise and lower the sampler. Penetration depths are again dependent on the density of the media to be sampled and the weight of

the sampler. Ponar samplers collect "disturbed" samples, and thus are not useful when stratification or profiling information is desired. Additionally, the sampling action of the Ponar sampler may cause a suspension of sediment or sludge in the overlying liquid matrix. Therefore, it is advisable to complete sampling of the overlying liquid matrix prior to sampling the sediments or sludges.

Usually, the use of the gravity corers or Ponar samplers will require that the sample be released into a container other than the final sample container. A stainless steel tray is typically used. The sample is placed into a clean tray and then a stainless steel spoon or trowel is utilized to select an aliquot of the material and place the aliquot into the sample container. In all cases, when sufficient sample volume has been retrieved to fill the appropriate sample container or to complete the requested analysis, the sample container must then be capped or closed, properly labeled, and then stored in an iced cooler for transport to the laboratory. Where sampling locations are difficult to describe, photographs of the location may be appropriate to allow others to understand the position from which samples were collected. Stakes and/or buoys may also be useful in temporarily marking the locations of sampling activity.

5.3.2.5 Sludge Sampling

Objective: To obtain samples of sludge from tanks, lagoons, or surface impoundments which are suitable for chemical analysis.

Approach: Samples representative of the sludge are collected through direct access to the sludge, with collection utilizing hand-held tools, or through indirect access using long-handled gravity corers, thin-walled piston samplers, or small, clamshell samplers. Samples are placed in brass tubes or appropriate glass jars or vials.

Detailed Description:

Sludge sampling, in general, utilizes techniques which are identical or similar to those utilized in sediment sampling. The detailed description set forth above should be consulted, with field modifications instituted, to obtain the desired sample.

5.3.3 Ground Water Sampling

Ground water monitoring wells are placed to define the extent of a chemical constituent plume, to monitor the natural background quality of the ground water for purposes of recording the quality of the resource, or to measure the effects on water level which production, extraction, or injection well pumping may cause. New monitoring wells are often installed to provide supplemental data to an existing database so that further conclusions may be drawn about existing conditions or the appropriateness of potential future actions. The rationale for deciding where the new monitoring wells should be located is based upon the hydrogeologic information available, the need for more precise data in a particular area, the relative concentrations exhibited in the subsurface through analysis of previous data, the necessity to further refine the areal extent of various concentrations, and the need to closely monitor the effects of remediation activities upon the ground water.

Monitoring wells will be installed consistent with the program set forth in the RI/FS Work Plan and approved by regulatory agencies having jurisdiction over the project. Ground water samples will be obtained from the new and existing monitoring wells, in accordance with the program set forth in the Sampling Plan, to determine the impact which past activities have had on the local environment and to monitor future impacts which remediation activities will have on the hydrogeologic environment. Pre-printed labels will be prepared for all ground water samples. Containers appropriate to the type of analyses to be performed will be utilized, and the samples will be analyzed for parameters selected and denoted in the Sampling Plan.

Information regarding preservation, sample container, and minimum volume requirements is presented in Table 1 in Appendix B.

5.3.3.1 Well Sampling Sequence

Where more than one well within a specific well field or site is to be sampled, the sampling sequence will begin with the well having the smallest analyte concentration. Successive samples will be obtained from wells of increasing analyte concentration.

If the relative degree of suspected contamination at each well cannot be reasonably assumed, sampling will proceed from the perimeter of the site towards the center of the site. The sampling sequence will be arranged such that wells are sampled in order of increasing proximity to the suspected analyte source.

5.3.3.2 Equipment Cleaning

Sample bottles, bottle caps, and septums will be thoroughly washed with detergent, rinsed extensively with tap water, and then rinsed again with high-purity deionized water. After washing and rinsing, sample bottles and components will be dried at a temperature of 105 degrees Centigrade for a period of one hour. Sample bottles, bottle caps, and septums will be protected from all forms of solvent contact between the time of drying and actual usage at the sample site.

Prior to purging or sampling each well, all equipment surfaces which will be placed in the well or may come in contact with the ground water will be cleaned to prevent the introduction of spurious contaminants. Cleaning will be accomplished by flushing, washing, or wiping equipment components with pesticide-grade acetone and hexane and then thoroughly rinsing the components with fresh deionized water. Care will be exercised to assure that normally wetted interior surfaces of pumps, bailers, hoses, tubes, or other components are properly cleaned. A sample of clean wash solvent will

be obtained during each day's sampling from each container of solvent used. The solvent will be sampled in the manner described for ground water and included within the ground water sampling sequence. Health and safety requirements appropriate for the use of acetone and hexane will be rigorously enforced. Reagent rinse waters will be collected and retained in drums at the site. The drum contents will either be treated and discharged, combined with collected trench water for disposal, or held on-site and addressed during interim or final remedial measures.

In lieu of using acetone and hexane, purging and sampling equipment can be cleaned with hot water and steam. Interior surfaces will be flushed with fresh deionized water heated to 60 degrees Centigrade (140 degrees Fahrenheit) or higher. The interior flushing water will fully traverse the same circuit of hoses, tubes, valves, or other equipment components as that followed by the well water during purge and sampling. The volume of hot water used for flushing interior surfaces will equal or exceed 10 times the physical volume of the equipment piece based on outside (exterior) dimensions, excluding attached hoses, cables, or wires. Samples of the final interior flushing water will be obtained from a random 10 percent or more of the wells sampled each day. Exterior surfaces will be cleaned with steam generated from fresh deionized water. Thorough steam cleaning will be performed immediately prior to initiation of the interior flushing procedure and again prior to insertion of the equipment piece into the well. As with all purging and sampling equipment, access to and use of the steam generator will be controlled to prevent extraneous contamination. Health and safety requirements appropriate for the use of heating elements, fuels, hot water, and steam will be initiated and rigorously observed.

Stainless steel wire, which can be properly cleaned after repeated usage, should be used for lowering and raising equipment in the wells. Bailers used in the purging or sampling of wells shall be manufactured of Teflon™ or stainless steel. In the event that absorbent materials (i.e., rope or cord) are placed in the wells, they will be stored in dust-tight containers until usage and the used portion will be discarded after completion of

sampling at each well. Similarly, disposable surgical-type gloves will be worn while sampling and discarded after each well sample is completed.

All equipment components and critical openings (i.e., bailer slots, pump valves, etc.) will be visually inspected to assure they are free of soil particles or other solid material which may become dislodged during purging or sampling operations.

5.3.3.3 Well Purging and Sampling

Immediately prior to purging each well, the depth from top of well casing to top of water surface will be determined to the nearest 0.1 foot and recorded as a portion of the well sample data. The top of well casing elevation will be determined to the nearest 0.1 foot by conventional survey methods.

Jetting methods will not be used for purging the monitoring wells. The preferred method for purging and sampling of the monitoring wells is with a submersible bladder-type pump providing a uniform rate of discharge. Pumps causing aeration or agitation of the water are not to be used for sampling purposes. Teflon™ tubing will be used for intake/discharge lines as required for pump operation. The pump intake or suction end will be lowered to the well bottom and then raised one foot before starting the pump. In small diameter, low purging volume monitoring wells, purging and sampling can be effected with a bailer constructed of stainless steel, glass, Teflon™, or Teflon™-coated materials. If required, all monitoring wells will be purged and sampled using a Teflon™ bailer. Purge waters will be discharged onto the ground surface near the well, or purge waters will be collected and stored for later disposal or treatment. All monitoring wells will be capped and locked to prevent unauthorized access to the well and the possible contamination of the well between sampling episodes.

Initially, monitoring wells will be purged by removing the minimum quantity of ground water (V_w) determined by one of the following equations:

$$V_w = 0.017 (d*d) W \text{ cubic feet}$$

or $V_w = 0.12 (d*d) W \text{ gallons}$

Where d is the well casing diameter in inches and W is the depth of water in the well casing measured in feet. Note that W must be calculated by subtracting the measured depth to water in the well from the total well casing length reported on the well installation details or boring log. Recognizing the variabilities of well size and depth, water depth, and aquifer characteristics, it is intended for pumping rates to be such that the specified purge values are removed in a time period not exceeding 90 minutes. If a well is evacuated during the purge, it will be allowed to recharge for a period not exceeding 24 hours before sampling. An evacuated well which has not recovered sufficiently to allow sampling after 24 hours of recharge time will be deleted from the sampling sequence.

Operating recovery wells with in-place pumps will be purged prior to sampling by allowing a full free flow of water from the sampling point for a time period of 30 minutes or for one-half of the volume (V_w) calculated by the preceding formulas, whichever occurs first.

At each well to be sampled, purged waters will be monitored for temperature, pH, and conductivity as a function of time. This data will be accurately recorded such that the variation of parameters can be related to elapsed purging time. These relationships, along with sample data from selected purge evaluation wells, will be used to modify the purging volumes at each specific well.

Purging methods, volumes, times, and any other pertinent information will be recorded and reported by the sampling team. The sampling team will discharge purged waters from the monitoring wells onto the ground near the

wells. Purged waters will not be discharged in a manner which will allow direct runoff of the waters into surface water courses.

Prior to initiating a well field sampling sequence, one or more specific wells will be selected for evaluating the purging effort. The selected well(s) will be sampled at the beginning and approximately midway through the purging volume previously described in addition to normal sampling at the completion of purging. Selection of the purge evaluation well(s) will be from those wells suspected of containing solvent concentrations higher than the statistical mean for the site. To the degree possible, different wells will be used for purge evaluation from one sampling period to the next. The number of purge evaluation wells will be 1, if 9 or fewer wells are to be sampled, and 2, if 10 or more wells are to be sampled. The purge evaluation wells will be sampled in their normal order within the sampling sequence. The samples collected in this manner will be analyzed for the same chemical constituents as other samples; however, the analytical results will not be included in the analysis of ground water quality.

The ground water samples will be placed in glass bottles fitted with caps having Teflon™-faced silicon seals. The sample bottles will be 40 ml or larger in size. Each sample bottle will be labeled with a selected numerical or alpha-numerical designation which allows the sampling team to identify the sample for tracking purposes and allows the engineering staff to collate results of the continuing monitoring effort, evaluate the hydrogeologic conditions at the site, determine the spatial extent of chemical constituents, and/or analyze the effectiveness of remediation activities.

Additional information to be shown on the bottle label will include:

1. General site name, identification, or location;
2. Sampling location (i.e. well number, stream station);

3. Sampling date and time;
4. Name of the person collecting the sample.

The water sample, when collected, will totally fill the sample bottle in such a manner as to prevent air bubbles from passing through the sample as well as eliminating the entrapment of any air in the bottle. The sample bottles will be capped immediately after filling, inverted, and tapped to test for air bubbles. If any bubbles are observed, the sample will be discarded and a fresh sample obtained from the monitoring well. Samples will be placed in an ice chest or similar container capable of maintaining a temperature of 4 degrees Centigrade while the samples are transported via overnight package delivery service to the laboratory. Unavoidable vacuum bubbles may form during storage as a result of sample contraction from cooling; however, the formation of these bubbles in the sample will not void the sample for analysis purposes. Three separate sample bottles of ground water will be collected at each monitoring well as the sample set, so that duplicate samples are available for analysis if required.

Samples for inorganic analyses will be obtained using the bladder pump. The samples for inorganic analyses will be field filtered as appropriate using a noncontaminating 0.45 micron filtration apparatus. The filters will be changed as needed during filtration and prior to sampling. The filtered water will be poured into the appropriate bottles which will contain the preservatives supplied by the analytical laboratory.

Methods and materials for sample preservation are specified within the U.S. EPA sampling and handling section of the analytical methodology. The applicable sample preservation techniques will be followed based upon U.S. EPA recommendations, and these techniques are incorporated by U.S. EPA reference.

5.3.4 Surface Water Sampling

Surface water may be impacted by chemical constituents through direct contact with the chemical stock, through contact with impacted soils, through discharge of process waters or wastes to the water, or through the discharge of ground water to the surface water. Surface water impacts may result in exposure of biota and human populations through consumption of the surface water. Sampling of surface waters adjacent to or on the property of sites impacted by chemical constituents is therefore warranted.

5.3.4.1 Stream, Pond, or Lake Water Sampling

Objective: To collect water samples for analysis, which will permit characterization of the water, establish the background water quality relevant to the body of water sampled, and determine the degree to which chemical constituents have impacted the natural water quality.

Approach: The location from which the sample is to be gathered is accessed through appropriate equipment, including in some instances rafts or boats, and samples are obtained using pumps, bailers, sampling containers capable of obtaining and enclosing discrete volumes of water from specific locations and depths, and/or other sampling hardware.

Detailed Description:

The sampling of surface waters is undertaken after appropriate evaluation of site factors, including the depth of water, flow rate, stratification of the water body, seasonal variations in water quality, and chemical characteristics of the analytes of interest. Samplers may be able to access the sampling location by donning hip waders and walking out into a stream to collect the samples, or may have to utilize small boats or rafts to obtain the desired samples. Appropriate health and safety precautions

must be observed in working in or on water to prevent loss of equipment and/or injury or death to members of the sampling team.

Sampling locations for the project will be defined in the project sampling plan. When surface water sampling locations cannot be surveyed conveniently to land-based survey points, photographs will be taken during the sampling episode to document the location from which the sample was obtained. Labeling and chain-of-custody procedures for surface water samples shall follow the same format established for soil and ground water samples.

Samples will be collected in accordance with the following guidelines.

1. The sampler shall enter the body of water downstream of the sampling point so as to avoid entraining sediment into the water at the intended sampling point.
2. The sampler shall immerse a clean beaker, or alternatively the sample container itself, into the water. The opening of the sample container should be oriented generally toward the upstream, with the water sample flowing into the container. The sampler collecting the water sample should attempt to keep floating debris from entering the sample bottle, unless the presence of such debris is necessary to the establishment of representativeness.
3. Sufficient sample volume for each analysis should be collected from the same location and within a reasonably short period of time to maintain comparability between the samples collected at each sampling location. If required for specific analyses, the appropriate preservatives must be added prior to sealing the sample bottle for shipment. Preservatives required for analysis are presented in Appendix B.

4. Additional data to be collected at each surface water sampling location shall include temperature, pH measurement, specific conductance measurement, and the measurement of any other characteristic which might reasonably affect the comparability or representativeness of samples. If a reusable transfer bottle is used to collect the sample from the liquid stream, the transfer bottle must be thoroughly cleaned and rinsed prior to further sampling.

5.3.5 Ground Water Level Measurements

Objective: To determine the piezometric surface elevation of ground water at identified locations, in order to evaluate ground water flow direction, probable direction of migration of chemical constituents, and the effect which withdrawal wells may have on the hydrogeologic environment.

Approach: Measurement of the surface of the ground water in monitoring and residential wells, in relation to known elevations, and conversion of the measurements to elevations keyed to the U.S.G.S. survey elevations established for the locale.

Detailed Description:

Water level measurements will be taken using an electric water level probe, Soil Test Model No. DR-760A, or equivalent. The instrument indicates that the water surface in the well has been contacted when the weighted probe tip is submerged by approximately two centimeters, thus completing an electronic circuit and illuminating a light on the water level meter. The depth of the water in the well is then measured by noting the point on the probe lead wires which corresponds to the top of the well casing when the electronic circuit is first completed. The accuracy of the probe is generally considered to be ± 0.01 feet. If the probe lead wires are not graduated to permit direct reading of the depth, the probe may be withdrawn

and the length, from probe tip to the point on the wire corresponding to the top of the well casing, measured and recorded.

Water level readings shall be recorded on a form which notes the date and time the level readings are taken, the individuals accomplishing the task, the well identification number or designation, the elevation of the top of the well casing, the elevation of the adjacent ground, the condition of the well casing, the serial number or other identification number of the water level meter being utilized, and the depth to water level, recorded as the depth from the top of the casing to water level surface and as elevation of the water level. The reporting form shall be signed by each person on the sampling crew with a designation of the crew chief and individual actually taking the measurement.

In order to prevent cross-contamination of monitoring wells, the probe shall be thoroughly cleaned by flushing, washing, or wiping equipment components with pesticide-grade acetone and hexane, and then thoroughly rinsing the components with deionized water. Health and safety requirements appropriate to the use of acetone and hexane shall be strictly enforced. If absorbent materials (i.e., cotton rope or cord) are placed in the well to assist in lowering or raising the probe, the materials shall be stored in dust-tight containers until usage and then the used portion shall be discarded after completion of sampling at each well.

Reports of the water level measurement results shall be prepared and forwarded to appropriate individuals and agencies in the progress reports specified for the program.

To assure that water level measurements are accurate, the instrument shall be checked each day by immersing the probe tip into a beaker of clean water. The individual taking the measurements shall observe the meter light as the probe is immersed, and verify that the meter light is illuminated when the probe first breaks the surface of the water. If the meter does not function properly when tested, the meter shall either be

repaired and retested prior to further use, or the meter shall be returned to the manufacturer for repairs and another meter substituted.

5.4 Remote Survey Procedures

5.4.1 Horizontal and Vertical Control

Horizontal and vertical control points will be established on site for documentation of sampling elevations and locations. Primary reference control points will be established by a registered land surveyor. Primary vertical control will be to a tolerance of + 0.01 feet using near sea level (MSL) as datum. Measurements of sample locations will be by qualified field personnel. Permanent structures such as buildings, and roads may be used as horizontal references in addition to the primary control points.

5.4.2 Ground Penetrating Radar

Ground penetrating radar (GPR) may be used for characterization of subsurface features or to enhance the subsurface profiles. A record of the location, date, and time of each GPR transect will be kept to allow future use of the data and integration with soil conductivity data.

5.4.3 Soil Conductivity and Resistivity

Soil conductivity will be measured with a ground conductivity meter capable of investigating to a depth of eighteen feet. If required, soil resistivity surveys will be conducted where the depth capabilities of the conductivity meter are exceeded. At this time it is anticipated that the resistivity survey will follow the Schlumberger methods. The surveys will extend to outside of the potential anomalous area in order to ascertain the background conductivity of the unaffected soil. A record of the location, data, and time of each conductivity and resistivity survey will be kept.

5.4.4 Soil Gas Sampling

Soil gas sampling is used to determine the presence of hydrocarbon vapors in the subsurface soils, and to acquire data which will allow the plotting of hydrocarbon vapor concentrations in the soil gas with respect to a surveyed area. The presence and concentration of hydrocarbon vapors in the soil gas is useful in selecting locations for ground water monitoring wells and/or soil borings, and thereby to define the horizontal extent of organic chemical impacts in the subsurface.

Several areas at a site may be impacted by organic compounds due to spills or leaks. The use of a drill rig and split-spoon sampling, or other soil sampling method, followed by chemical analysis of the soil samples by approved U.S. EPA laboratory methods, may be prohibitively expensive or inappropriate during a preliminary investigation. In such cases, soil gas monitoring may be useful in delineating the boundaries of a suspected or known spill area. After delineating the approximate boundaries, further sampling using drill rigs or other methods may be conducted to more precisely define the extent of impacts.

Soil gas monitoring is conducted using an organic vapor analyzer, such as a Century 128 Organic Vapor Analyzer (OVA), which employs a flame ionizing detector (FID), or an HNU meter, which employs a photoionization detection (PID) system for evaluating the organic content in the sampled air. The procedure requires the sampling engineer or technician to create a borehole or annulus in the soil to the depth where soil gas monitoring is to be conducted. Typically, the sampling technician will drive a metal rod into the soil at the sampling location selected. After creating the sampling hole, the metal rod is carefully removed from the hole. The sampling port, or a long tube connected to the sampling port, of the instrument is placed into the sampling hole. The readout of the organic vapor analyzer is then observed, and the level of organics detected in the soil gas is recorded.

Soil gas monitoring may be conducted randomly, though sampling on an established grid system yields more useful data. When conducted on a grid system, the recorded organic vapor readings may be plotted and iso-contours of organic concentrations created to assist in defining the extent of organic impacts.

5.4.5 Radiation Surveys

The purpose of radiation surveys is to detect and quantify the presence of radioactive sources within a particular area, so that protective equipment may be properly specified for workers, and appropriate tests performed to determine the extent of impact.

Potential sources of radioactive material exist in the form of discarded instrument dials and medical wastes. Because the potential for radioactive contamination exists, field monitoring for radioactivity will be established. The instrument used for this monitoring will have the ability to detect gamma and beta particles at levels greater than 0.02 millirems per hour, and to average these emissions over a preselected time period.

Prior to conducting field investigations and sampling, the background levels of radiation will be investigated at random locations both on-site and off-site. Background radiation levels will also be monitored and recorded at each borehole and sampling site where radioactive material may be present. If, during sampling, either the soil sample or the equipment show enhanced radiation levels of greater than five times background level (three measurements at a 10 second time constant) the sample or equipment will be considered to be contaminated. Such soil samples will be analyzed for radioisotope composition. All contaminated soil will be removed from the equipment by steam cleaning. In addition to the radioactivity meter, all personnel will be required to wear personal film badges when working in areas where there is potential for exposure to radioactive material.

5.5 Decontamination Procedures

The decontamination of equipment is necessary to safeguard worker health, minimize the possibility of spreading of contamination, and ensure the accuracy of analytical results of samples collected with the equipment. All personnel and hand-held monitoring and sampling equipment will be decontaminated at each site (refer to the Health and Safety Plan for decontamination procedures).

After the collection of each sample, the sampling equipment will be decontaminated prior to reuse.; The primary decontamination process will be steam cleaning. An alternative decontamination process consists of placing the sampler into a wash tub containing Alconox detergent and tap water, and cleaning the sampler with a brush. Next, the sampler will be rinsed with tap water to remove all soap, and rinsed with hexane to remove any residual contaminants. The waste hexane will be collected and containerized for proper disposal. The sampler will be thoroughly rinsed with deionized water and allowed to air dry.

The waste waters used for decontamination will be collected and stored in Department of Transportation (DOT) approved 55-gallon drums for later disposal. These drums will be stored either in the controlled equipment storage area or at a hazardous waste storage generator accumulation point designated by the Navy. The choice of the appropriate storage area is subject to Naval approval. Samples of wash water will be analyzed to determine whether the liquids can be disposed of on-site or whether they will require offsite disposal.

Any downhole equipment used in a boring must be decontaminated before reuse. Where possible the recommended decontamination procedure is to clean all equipment at the site where it is used. Many of the sites to be investigated, however, are in high-traffic work areas. Most of these areas are paved and the areas of soil disrupted are extremely small. It is, therefore, believed that the danger posed by introducing contaminants into

the air during soil investigation activities is minimal. In addition, the construction of a decontamination station at each site large enough to clean the heavy equipment would prove to be costly and time consuming, and cause major disruptions to ongoing work. While personnel decontamination and portable monitoring and sampling equipment decontamination can be conducted at each site, the decontamination of the truck and associated downhole equipment can be done a centralized decontamination stations. One such station can be constructed near the mobile command center in a restricted area of the parking lot. Another decontamination station should be constructed on the western side of the base to allow the decontamination of equipment used during the 1943-1956 Disposal Area and West Beach Landfill studies.

When all downhole equipment has been used at a site, all equipment used can be removed (by pick-up) to a decontamination area to be cleaned for reuse. If the work at a site is completed before all downhole equipment is used, then the drill truck will be loaded with the downhole equipment and driven to the decontamination area where it and all downhole equipment will be cleaned before use at another site.

6.0 SAMPLE CUSTODY

An established program of sample chain-of-custody procedures, that is followed during sample collection and handling activities in both the field and laboratory operations, is required to assure that sample integrity is maintained and data generated through the analysis of the samples is applicable to evaluation of the site. The program is designed to assure that each sample is accounted for at all times. To maintain the highest degree of control in sample handling, pre-printed labels will be utilized so that all necessary information is retained with the sample, and chain-of-custody records and shipping manifests will be employed to maintain control over access to and destination of samples after shipment from the location of sample collection. Additionally, proper completion of field sample logs, accession books, tracking sheets, and extraction logs by appropriate field and laboratory personnel provide for thorough monitoring of the samples from collection through analysis and final report generation.

The objective of sample identification, custody, and monitoring procedures is to assure that:

1. All samples collected are uniquely labeled for identification purposes throughout the analytical process;
2. Samples are correctly analyzed and results are traceable to field records;
3. Important sample characteristics are preserved;
4. Samples are protected from loss, damage, or tampering;
5. Any alteration of samples (e.g., filtration, preservation, or damage due to shipment or other processes) is documented;

6. A record of sample integrity and analytical fate is established for legal purposes.

6.1 Sample Monitoring Forms

The use of the indicated forms listed above accomplishes one or more of the specific objectives of sample custody, identification, or control. The use of each of the listed forms is discussed below.

6.1.1 Sample Log

The sample log is completed in the field by the individual physically in charge of the sample collection. The sample log correlates the assigned sample bottle designation to a specific well or sample location or other distinguishing feature or attribute (i.e., dummy sample, replicate sample, purge evaluation sample, etc.). The sample log also contains information concerning day and time of sampling, type, location, and depth for wells, water depth in the well, purge volume, purge water temperature, pH, conductivity as a function of time, procedures utilized to preserve the sample for analysis, and the sequence in which sampling was completed. Other relevant information, such as weather conditions, may also be included. The sample log is attached to the chain-of-custody record and shipped with the samples to the laboratory.

6.1.2 Chain-of-Custody Record

The chain-of-custody record is completed in the field by the individual physically in charge of the sample collection. The chain-of-custody record may be completed contemporaneously with the sample log or prior to the shipment of samples to the laboratory. The chain-of-custody record contains information on the date of sample collection, the sampler, the project name and number, laboratory project number, the number of containers of each sample being shipped, and an itemization of the analyses requested for each sample, together with any remarks about the sample prior

to shipment. The chain-of-custody record is enclosed with the samples after it has been signed by the sampler. The record is then signed each time possession of the samples changes, with the signature of the person relinquishing and receiving the sample, as well as the time of exchange being indicated on the record. A sample copy of a chain-of-custody form is set forth on Figure 3 of Appendix B.

6.1.3 Accession Book

The accession book is maintained at the receiving laboratory by the sample custodian. When samples arrive from the field, each container is assigned a laboratory number, which is then logged into the accession book. Other important information entered into the accession book includes the name of the shipping firm or person who delivered the samples to the laboratory, the date received and the individual taking custody, the container size and any comments related to possible mishandling, abuse, or obvious damage to the shipping container or contents, the name of the client, the date and time of sample collection, the sampler's initials, and the site from which the samples originated. The accession book becomes the permanent record of all samples received by the laboratory for analysis. A sample page from the accession book is presented on Figure 6 of Appendix B.

6.1.4 Tracking Sheets

The tracking sheets are developed at the time the samples are logged into the accession book. Each sample received at the laboratory has its own unique tracking sheet. The tracking sheet contains the date the sample was taken, received by the laboratory, prepared for analysis, and finally analyzed. Results of analysis, as well as dilution of the sample or any other conditions used, are also noted. Tracking sheets are utilized for presumptive as well as confirming analysis. Final reports are generated from the information on the tracking sheets. The tracking sheet for each sample, as well as any notes, chromatographic charts, and atomic absorption

printouts are permanently filed in the records of the laboratory. A sample tracking sheet is presented on Figure 5 of Appendix B.

6.1.5 Extraction Log

Various types of analyses require that sample extraction and subsequent volume reduction occur. Each sample which undergoes this process is recorded in the extraction log with information on all conditions which existed during the creation of the final extract. Typical information includes the sample number, initial volume, final volume, date the extraction/volume reduction was produced, analyst performing the work, the methodology utilized, and any comments about the nature of the sample. The extraction log is a permanent record maintained by the laboratory.

The flow of samples and analytical data within the Canonie laboratory is illustrated on Figure 2. Omitted for clarity are procedures which involve calibration of instrumentation for each analytical run and verification of instrument detection limits, which are conducted on a quarterly basis.

6.2 Reagent Documentation

Written documentation of reagents utilized in the laboratory is maintained in a reagent record book. Information maintained includes the date the stock is made, the analyst preparing the stock, the weight or volume of all materials used in the creation of the stock, the source of the chemical, and the source lot number. The record includes information for stock standards, intermediate stock, and quality assurance stock. U.S. EPA protocols are followed in the creation and testing of all stock. All stock bottles are clearly labeled with the exact contents of the bottle, the concentration, the date of creation, the expiration date, and the analyst who created the stock. Reagents are stored at conditions appropriate for each stock, and are discarded after standard permissible holding times have been exceeded or if contamination or decomposition of the stock is evident.

For general inorganic analysis, Analytical Reagent (AR) grade reagents are utilized. Metal analysis performed via atomic absorption spectroscopy employs reagents and solvents of spectroquality. For organic analysis, the minimum purity used is AR grade. For high-pressure liquid chromatography (HPLC), HPLC-grade solvents are used. Where requested analysis requires more stringent grades of reagents, those reagents are utilized. All base stock for the creation of reagents in the laboratory are purchased from reputable suppliers and are of the requisite standard purity. Typical commercial suppliers utilized by the laboratory for the purchase of base stock and standards include Supelco and Chem Service, along with Foxboro, J. T. Baker, Fisher Scientific, Aldrich, and American Scientific. Several sources are used so that a contamination or defect in one source can be detected, by comparison against another source, before a great deal of false analytical results are reviewed and published. The use of multiple source in stocking the laboratory's chemical needs, therefore, promotes additional quality assurance throughout the analytical process. Stock and standard solutions are tracked in a manner illustrated on the forms presented as Figures 7, 8, and 9 of Appendix B.

6.3 Packing and Shipping

In addition to sample collection and preservation requirements, especially the maintenance of sample temperature at four degrees Centigrade until extraction or analysis, samples should be packed and shipped properly to maintain the health and safety of sample transporters. Guidelines for packing and shipping of samples are included in Appendix E.

7.0 CALIBRATION PROCEDURES AND FREQUENCY

7.1 Calibration Procedures for Laboratory Equipment

Equipment at Canonie's laboratory in Stockton, California, is routinely calibrated in accordance with the methodology-specific protocols, and meets the minimum requirements established by U.S. EPA laboratory protocols. Analysis of air monitoring samples will be performed by DHS certified and approved laboratories, and calibration standards should meet the appropriate requirements.

7.2 Calibration Procedures and Frequency for Field Instruments

Equipment utilized in the field will be calibrated prior to each day's use. The procedures for each piece of equipment which Canonie anticipates will be utilized are set forth below. If other instruments are used, the manufacturer's calibration procedures will be followed.

7.2.1 Thermometer

Using a National Bureau of Standards (NBS)-approved thermometer, immerse both the field thermometer and NBS-approved thermometer into a beaker of water and note any differences for the field probe.

Recalibrate the field probe as necessary.

7.2.2 Specific Conductance Meter

Calibrate meter and probe using the calibration control and the conductance calibration line on the meter dial.

Turn the function switch to read "conductivity x 10" and then depress the cell test button, noting the deflection. If the needle falls more than two percent of the reading, clean the probe and retest.

Using at least two potassium chloride buffer solutions which will most likely bracket the range of expected conductivity, note accuracy of the water and probe and clean probe if necessary.

7.2.3 pH Meter

Place electrodes and the manufacturer's supplied buffer solutions in a water bath at the temperature of the water to be sampled. After temperature equilibrium has been established, measure the temperature and adjust the temperature compensation knob for the temperature indicated.

If refillable electrode probes are used, remove the electrode cap and check that probe solution is above the full mark.

Immerse the probe in the pH 7 buffer solution and adjust the calibration control to read pH 7.

Remove the probe, rinse with distilled water and then immerse in either the pH 4 or pH 10 buffer solution, depending on the expected pH of the sample solution.

If the pH meter does not register the correct pH for the buffer solution tested, adjust the calibration knob on the back of the instrument so that the meter reads the correct pH as defined by the buffer solution tested.

After rinsing the probe, insert the probe into the sample to be tested and allow the probe to come to equilibrium with the sample water prior to recording the readout.

7.2.4 Century Organic Vapor Analyzer

Calibration of an OVA when the instrument is used in the survey mode is accomplished according to the following protocol:

1. The "Gas Select" control is preset to the desired dial indication prior to turning on the instrument. The instrument is factory set to read out directly in terms of methane in air.
2. Move the INSTRUMENT Switch to ON and allow five minutes for warm up.
3. To set the audible alarm to a predetermined level, first turn the PUMP switch to ON, then adjust the meter pointer to the desired alarm level, using the CALIBRATE ADJUST (zero) knob. Turn the Alarm Level Adjust Knob on the back of the Readout Assembly until the alarm is just audible. Adjust the speaker volume with the VOLUME Knob. If the earphone is used, plug in and readjust the volume as desired. The instrument is then preset to activate the alarm when the level exceeds that of the setting.
4. Move the CALIBRATE Switch to X10 and adjust the meter reading to zero with the CALIBRATE ADJUST (zero) Knob.
5. Check that the PUMP Switch is ON and observe the SAMPLE FLOW RATE Indicator. Indication should be approximately 2 units.
6. Open the H2 TANK VALVE one turn and observe the reading on the H2 TANK PRESSURE Indicator. (Approximately 150 psi of pressure is required for each hour of operation.)
7. Open the H2 SUPPLY VALVE one-half to one turn and observe the reading on the H2 SUPPLY PRESSURE Indicator.

8. Confirm that the meter is still reading zero (readjust if required).
9. Depress the igniter button. There will be a slight "pop" as the hydrogen ignites and the meter pointer will move upscale of zero. Immediately after ignition, release the igniter button. Do not depress igniter button for more than six seconds. If burner does not ignite, let instrument run for several minutes and try again. After ignition, the meter pointer will indicate the background level of the organic vapor to which it is calibrated. This background level is nulled out using the CALIBRATE ADJUST (zero) Knob.

The OVA is calibrated daily using specially obtained calibration gases purchased from compressed gas manufacturers. A certified cylinder of organic-free air and a certified cylinder of an organic vapor, such as methane, at a known concentration, are purchased for calibration purposes. Each gas is used to fill separate calibration gas bags.

After the OVA has warmed up at the start of each day's use, the OVA is first calibrated to the zero gas standard. The zero gas bag is filled with a quantity of the organic-free gas, and the calibration gas bag is filled with a quantity of the known concentration organic gas. Each bag has a valved sampling tube, allowing the OVA operator to control the flow of the gas from the bag. The OVA is calibrated to the organic-free gas by connecting the tube of the gas bag to the inlet port of the OVA. The valve to the bag is opened, and the OVA meter reading is monitored. The CALIBRATE ADJUST knob is adjusted until the OVA meter reads 0.0. The zero gas is sampled for an additional 15 seconds to verify the zero calibration.

After the zero calibration is established, the zero gas bag valve is closed and the bag detached from the OVA. The known standard gas bag is connected to the inlet port of the OVA, and the valve to the bag is opened. After the meter reading has stabilized, the meter reading is adjusted to read the

known concentration of the organic gas by adjusting the GAS SELECT knob on the OVA. The OVA meter reading is observed for 15 seconds to verify that the calibration is maintained. The gas bag valve is then shut, and the gas bag tube disconnected from the OVA.

After completing the calibration with the known standard, the OVA is again connected to the organic-free gas bag, and the zeroing of the OVA meter is checked. The OVA meter should read between 0.0 and 0.2 if calibration has been maintained. If the reading is within this range, a final check is performed by closing the valve to the organic-free gas bag. If the reading on the OVA meter is between 1.0 and 1.8, the OVA may now be used to monitor organic vapors. If either of the readings is not observed, the OVA must be re-calibrated, as described above.

Maintenance of the GC Unit

Maintenance of the GC unit will be conducted in accordance with the manufacturer's instructions. These instructions will be kept on file at the base office for the OVA GC unit and will be strictly observed. Additional copies of the instructions will be included with the OVA GC when shipment is made to the field.

7.2.5 Gilian Pump Sampling

Gilian pumps are used during solid sorbent, particulate, and metal monitoring. The calibration procedure to be utilized will be the same for all sampling media used during an integrated sampling period. The Gilian pump is calibrated by attaching the pump with the sampling media in-line to a thin film bubble meter via a tygon tube. The pump is started and allowed to operate for five minutes. The pump draws a thin film through a known volume in the test chamber. The time it takes to displace the known volume is used to electronically determine the flow rate at which the pump is operating. The flow rate is shown on a digital readout on the face of the thin film bubble meter. The desired flow rate can be achieved by adjusting

the flow valve on the pump. When the desired flow rate is obtained, at least three additional readings, without any further adjustment of the valve will be obtained. These flow rates must remain within five percent of the set flow rate. The in-line sample media can be retained for additional calibrations.

7.2.6 Combustible Gas Indicator

Calibration of a combustible gas indicator is accomplished according to the following protocol:

1. Make sure instrument is clean and serviceable, especially sample lines and detector surfaces. Check battery charge level. If in doubt, charge battery as described in operating manual. Some units have charge level meters, while others have only low-charge alarms.
2. Turn unit to ON position, and allow instrument sufficient warm-up time. Verify that sample pump is operable (if so equipped) when analyzer is ON.
3. With the intake assembly in combustible gas-free ambient air, zero the meter by rotating the zero control until the meter reads 0 percent LEL. Calibrate unit against known concentration of a calibration gas by rotating the calibration control (span or gain) until the meter reads the same concentration as the known standard. For those instruments with internal or non-adjustable span, a calibration curve should be prepared, using concentrations in the range expected to be encountered. If necessary, adjust alarm setting to appropriate combustibility setting.
4. Position intake assembly or cell in close proximity to area in question to get accurate reading. If alarm occurs, or if readings reach the action levels designated in the safety plan, personnel

should evacuate area. If instrument malfunction occurs, personnel should evacuate area.

Some important factors to keep in mind during use are:

- o Slow sweeping motions of intake or cell assembly will help assure that problem atmospheres are not bypassed. Cover an area from floor (ground) to ceiling, or above breathing zone.
- o Operation of unit in temperatures outside of recommended operating range may compromise accuracy of readings or damage the instrument.
- o Platinum filament detectors may be poisoned (reduced in sensitivity) by gases such as leaded gasoline vapors (tetraethyl lead), sulfur compounds (mercaptans and hydrogen sulfide), and silicon compounds.
- o Many combustible gas detectors are not designed for use in oxygen-enriched or depleted atmospheres. If this condition is encountered or suspected, personnel should evacuate the area. Specially designed units are available for operation in such atmospheres.
- o An oxygen detector should always be used in conjunction with explosimeters.
- o Accurate data depends on regular calibration and battery charging. See operating manual.
- o More than any other factor, effective utilization of unit requires operator with full understanding of operating principles and procedures for the specific instrument in use.

7.2.7 Oxygen Meter

Calibration of an oxygen meter is accomplished according to the following protocol:

1. Make sure instrument is clean and serviceable, especially sample lines and detector surfaces. Consult records on instrument maintenance to determine if detector solution should be changed. Some instruments will need this service after as little as 1 to 2 weeks of use.
2. Check battery charge level. If in doubt, charge battery as detailed in operating manual. Some units have charge level indicators while others have alarms that will indicate a low charge.
3. Verify that sample pump is operable (if so equipped) when analyzer is on. Turn instrument on and, using calibration knob on instrument, calibrate against fresh air (20.9 percent O₂) by aligning meter needle at 20.9 percent. If unit is equipped with alarm mode, set alarm at desired level.
4. A quick field check can be accomplished by exhaling into the sensor, this should cause a definite drop in O₂ readings and activate any alarms. Allow for instrument warm-up, if necessary, before entering site to take readings.
5. Position intake assembly or sensor in close proximity to area in question to get accurate reading. If alarm occurs, personnel should evacuate area, unless equipped with supplied air equipment suitable for use in an IDLH atmosphere.

Some important factors to keep in mind during use are:

- o Slow sweeping motions may assist in the prevention of bypassing problem areas.
- o Operation of instrument in temperatures outside of manufacturer-specified operating range may compromise accuracy of readings or damage unit.
- o Presence of known interfering gases, especially oxidants, can affect readings (for example the Edmont Model 60-400 Oxygen Monitor has interferences of the following gases in concentrations greater than 0.25 percent or 2,500 ppm: SO₂, fluorine, chlorine, bromide, iodines and nitrogen oxides). See the operating manual for unit being used.
- o The oxygen detector can also be poisoned (decrease in sensitivity) by exposure to various gases. Some detectors are poisoned by concentration of mercaptans and hydrogen sulfide greater than or equal to 1 percent. See operating manual for unit being used.
- o When relying on alarm mode for warnings of oxygen deficient atmospheres, a manual check of the alarm function at regular intervals is recommended.
- o Wherever applicable, protect instrument with a disposable cover to prevent contamination.
- o Most units will have rechargeable battery packs that provide continuous operation for 8 to 12 hours. Recharging batteries prior to expiration of the specified interval will insure operation while on a site.

- o More than any other factor, effective utilization of unit requires operator with full understanding of operating principles and procedures for the specific instrument in use.

7.2.8 Radiation Meter

Calibration of a radiation meter is accomplished in accordance with the following generalized procedures. The specific protocols presented in the instruction manuals accompanying the instrument must be consulted for particular calibration procedures.

1. Choose an instrument or interchangeable detector tube which is correlated to the radioactive constituents anticipated by the investigation work plans for the project.
2. Turn the selector switch to standby or to the warm-up position and allow the instrument to warm-up for one to two minutes. After warm-up, turn the instrument selector switch to the battery check position and check the battery strength.
3. Turn the range selector switch to the appropriate scale factor (e.g., 100X, 10X, 1X, 0.1X) and check or calibrate instrument with a radioactive check source. Evaluate the instrument response in relation to the calibration source, and tune the instrument response to match the calibration. Note: At a minimum, Coleman-type lantern mantles may be used as a check source, since the mantles are coated with radioactive thorium oxide.
4. Turn audio switch on, if an audio warning signal is desired. Choose a needle response action (fast/slow), and turn the range selector to the most sensitive setting. The instrument is now ready to utilize in radiation surveys.

8.0 ANALYTICAL PROCEDURES

8.1 Selection of Parameters

The selection of parameters for the project is made through an evaluation of existing data and an analysis of data needs with respect to the project objectives. The parameters of interest are designated in the Sampling Plan, and particular parameters to be addressed in each sample are noted.

8.2 Selection of Procedures

Procedures to be utilized in accomplishing the activity described in the work plan are those practices, methods, protocols, and procedures set forth in U.S. EPA SW-846 Test Methods for Evaluating Solid Waste: Physical/Chemical Methods - Third Edition (1987), and relevant materials testing methods approved by the American Society of Testing and Materials (ASTM), including the following:

ASTM D422	Method for Particle-Size Analysis of Soils
ASTM D1586	Method for Penetration Test and Split-Barrel Sampling of Soils
ASTM D1587	Practice for Thin-Walled Tube Sampling of Soils
ASTM D2113	Practice for Diamond Core Drilling for Site Investigation
ASTM D2434	Test Method for Permeability of Granular Soils
ASTM D4220	Practices for Preserving and Transporting Soil Samples

The analytical procedures to be used in accomplishing the work plan include those summarized in Tables 2 through 27 of Appendix B. Detection limits stated in these tables are those normally achievable by the laboratory.

9.0 DATA REDUCTION, VALIDATION, AND REPORTING

Data reduction is the process of converting measurement system outputs to an expression of the parameter which is consistent with the comparability objective identified in Section 5 of this plan. Calculations completed during data reduction of analytical results are described in the U.S. EPA analytical methods and procedures.

Field data collection and validation will follow the process illustrated on Figure 3. Prior to data collection, determinations are made regarding the data which is required and the methodology to be used. Once the data is obtained, it is reviewed and assessed for overall adequacy by the Operations Coordinator. If it is determined that the initial data collection activity, or a portion thereof, did not provide adequate data, the activity will be repeated.

Calculations performed during data reduction are reviewed by the chemist performing the analysis, by the engineer/scientist/technician collecting data in the field, or by the engineer/scientist evaluating data in the office, prior to the release of any data reporting, thus assuring that reporting errors are kept to a minimum. Laboratory review of data reduction is illustrated on Figure 2.

Analytical results reported for each sample are verified to assure proper identification by comparing the original sample collection logs with the chain-of-custody forms and the various laboratory log books. Based upon the results of this validation procedure, the laboratory certifies that the results are in compliance with the quality assurance objectives for accuracy and precision. Upon certification by the laboratory manager, the reported values are received and reviewed by the technical staff and the Quality Assurance Coordinator, if deemed necessary. Analytical data is presented in a format illustrated on Figure 4.

Field or analytical data entered into the corporate computer database for storage, analysis, or report generation is initially submitted to the Manager of Data Processing, or his designee. Data submitted for entry has been checked and verified by the engineer, scientist, chemist, or technician as being accurate and complete, and meeting the quality assurance criteria established for the phase of work in which the data was developed. Data is then entered into the computer by data entry operators using standardized entry forms developed especially for the type of data under consideration.

After entry of the data into the computer, a hard copy printout of the data is generated and the printout is compared directly with the original data sheets. A data entry operator who was not involved in the original entry of the data to the computer reviews the hardcopy printout. Each entry is reviewed, and inaccurate entries are highlighted. After review is complete, the hardcopy printout is returned to the original data entry operator and the noted inaccuracies are corrected. A final printout of the data is generated by the computer and the corrected version of the database is reviewed. After all corrections have been made to the database, the original data sheets are stamped "POSTED", and filed in the office's central file.

Data, information, or designs submitted to the drafting department for development are initially prepared by the engineer or scientist charged with the responsibility for creation of a graphical representation. The sketch or graphic representation is then reviewed by the engineer or scientist originating the material and the chief draftsman for format, intent, and consistency with prior work. The drawing is then assigned a unique project drawing number, the number and title of the drawing is entered into the drafting department log, and a draftsman is assigned to formally develop the drawing. After completing the initial presentation of the drawing on mylar, a paper check print is produced for review by the originating engineer or scientist. All information on the check print is reviewed and approved information is highlighted with a yellow highlighter

marker, while incorrect information, changes, or additions are noted in red ink. The check print is then returned to the draftsman for correction, and a final check print is issued for review. Upon approval of the final check print, the originating engineer or scientist signs and dates the mylar original. The drawing is then reviewed by the task leader or project manager for consistency with project objectives, and then the task leader or project manager signs and dates the original mylar.

Revisions to previously approved mylar drawings are submitted to the drafting department on paper prints of the original mylar. Revisions are made to the mylar, with a review process occurring as noted above for original work. When the revisions are finally approved, a notation of the revision scope is noted in the margin of the drawing, and the dated, revised drawing is then signed by the individual approving the revision as presented.

Data presentation in reports submitted through this RI/FS will be developed at the time of report preparation and will be dictated by factors such as the number of constituents observed above detection limits, ease of understanding, and clarity of presentation. The final format shall be determined by the author(s) of the report. Periodic presentation of finalized data to the NavFac Project Officer will be in accordance with a format which is mutually acceptable to the NavFac Project Officer and Canonie.

10.0 INTERNAL QUALITY CONTROL

10.1 Measurement Systems

Quality control procedures are established for laboratory and field activities. Canonie routinely follows the quality control procedures established for all field activities such as sample blank collection, duplicate sample collection, field verification of measurements, and comparison of the number of samples submitted for analysis compared to the number indicated prior to the initiation of the sampling episode as a check on sampling completeness. For analytical work, the procedures set forth in the U.S. EPA publication SW-846, "Test Methods for Evaluating Solid Waste: Physical/Chemical Methods" - Third Edition (1987), the NIOSH Manual of Analytical Methods, and 40 CFR 136 are followed.

Field quality control activities include the use of calibration standards and blanks for pH, specific conductance, temperature, and organic vapor analysis. Special samples are routinely sent to the laboratory, including trip blanks, blind replicates, sample blanks, and filtration blanks. These samples provide the quantitative basis for validating the data reported. These samples are explained in greater detail below.

10.1.1 Trip Blanks

Trip blanks are required for assessing volatile organic priority pollutants in water samples. The trip blanks consist of a volatile organic analysis (VOA) sample container filled with reagent water which is shipped to the site with the other VOA sample containers. A minimum of four percent of the samples included in a shipment to the laboratory for analysis are trip blanks.

10.1.2 Replicates

Replicates of soil and water samples will be submitted for analysis of all parameters specified for those samples. Unless otherwise indicated by analytical results or other factors, a minimum of 10 percent of all samples will be replicates. The identity of the replicate samples will not be revealed to the laboratory until completion of the analyses.

True replicates of soil samples are not typically possible because chemical constituents are rarely distributed uniformly in the media, even within small distances within the soil matrix. This is especially true for samples collected for volatile organic analysis, since mixing is not appropriate and the length of time between extraction of the sample from the soil matrix and final capping and sealing of the sample for shipment must be minimized to prevent volatilization of organics from the sample. Therefore, some differences can be expected from "replicate" soil samples taken for volatile organic analysis.

10.1.3 Sample Blanks

A minimum of 10 percent of the water samples sent to the laboratory for volatile or semi-volatile organic analysis will be sample blanks composed of the reagent water passed through the sampling pump and tubing assembly prior to monitoring well sampling. Volatile or semi-volatile organics present within the pump or tubing are assessed by collecting a sample of reagent water passed through the sampling apparatus after completion of all preparatory washing and rinsing activities.

10.1.4 Filtration Blanks

Ground water samples scheduled for analysis of inorganic parameters may require filtration. In order to assess filtration apparatus cleaning procedures and potential cross-contamination, as well as any contamination contribution by the filter itself, a filtration blank is collected for

every 10 to 20 samples filtered. The filtration blank is prepared by passing reagent water through a freshly cleaned filtration apparatus.

10.1.5 Blind Samples

Approximately 10 percent of the samples sent to the laboratory shall be blind samples. Certified blind samples are prepared in the laboratory using concentrations of organic solvents not uncharacteristic of actual ground water samples from the site. The 10 percent requirement for blind samples is not to be construed as "every tenth sample" or a rigorous "1 in 10 samples", but rather as a randomly spaced addition of samples which numerically approximate 10 percent or more of the actual ground water samples collected. The blind samples assess the precision and accuracy of the analyst in the performance of the analytical methods.

10.2 Quality Review of Studies and Report Preparation

The purpose of quality reviews through the course of analytical work and remediation activities is to assure that the services rendered and the documentation produced meet currently accepted standards of professional conduct. The level of effort for each project will vary depending on the type of project undertaken, the duration of the project, and the relative size and complexity of the work. Small projects may require only periodic discussions among task force personnel and department managers to meet minimum review standards. Quality control on larger projects may require that a specially selected review team be assembled for more frequent meetings and discussions. Quality control reviews would then be scheduled on a regular basis, with the opportunity to hold other reviews when the need arose, remaining as an option for the task force and the review team.

The following outline identifies applicable review phases, timing, and personnel involved in quality control reviews. The outline has direct application to large projects as well as small tasks, with appropriate adjustments to reflect the scope of work. The time to plan, schedule, and

conduct quality control reviews should always be considered part of design, construction, and documentation phases of the project.

Each project is divided into phases for quality control reviews. At each phase, the review should include assessment of the work in relation to client goals and regulatory restrictions, contractual commitments, technical merit, project scheduling, budget, assignment of appropriate personnel, department and intra-company coordination, project problem resolution, documentation, and consistency with overall corporate and client policy. Key elements to success of any quality control review are the identification of problem areas, maintenance of communication toward implementation of solutions, and follow-up analysis and documentation.

Quality control during the preparation of designs 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 is derived from many sources (i.e., the database is comprised of secondary measurements). Documentation of secondary data typically is accomplished via data verification/ tracking checklists with accompanying written criteria describing "acceptable" data to insure consistency in data selection. This allows all database components to be traced to the primary generator and forces a review of the data quality as the database is assembled. All project personnel are responsible for utilization and monitoring of this process; compliance is audited by the Quality Assurance Coordinator. Upon completion of the database, data interpretation, evaluation, and report preparation commence. Interpretation may require consultation with individuals versed in statistical analysis or use of computerized statistical routines. Data evaluations incorporate peer review to provide broad-based insight to data correlations and interactions.

11.0 AUDITS

Quality assurance audits are performed to assure and document that quality control measures are being utilized to provide data of acceptable quality and that subsequent calculations, interpretation, and other project outputs are checked and validated. The Quality Assurance Coordinator or a member of the Quality Assurance Review Team will visit the site periodically and unannounced to assure that the designated control procedures set forth in this document are practiced.

System and performance audits may be conducted by the Quality Assurance Coordinator. The Quality Review Team will conduct project audits of calculations, interpretations, and reports which are based on the measurement system outputs.

11.1 Systems Audit

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

11.1.1 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 to the requirements of the project. The Technical Project Director will maintain firsthand knowledge of his/her team's capabilities and will discuss the organization's efficiency with the Quality Assurance Coordinator. Assigned personnel may be interviewed by the Quality Assurance Coordinator during an audit.

11.1.2 Facilities and Equipment

The audit will address whether field tools, analytical instruments, and construction equipment are selected and used to meet requirements specified by the project objectives stated in this Plan and other project work plans. Equipment and facilities provided for personnel health and safety will also be evaluated. Calibration and documentation procedures for instruments used in the field will receive special attention.

11.1.3 Analytical Methodology

Routine external performance evaluations, as well as blind internal performance evaluations, are generally conducted in cooperation with standard procedures of the U.S. EPA. A review of analytical methodology in regard to the data requirements for the project will also be performed. An on-site observation of analyst technique, data reduction, and recordkeeping may be performed, if determined necessary. Periodic review of the precision and accuracy of data is essential.

11.1.4 Sampling and Sample Handling Procedure

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

11.1.5 Data Handling

During a systems audit, the Quality Assurance Coordinator will review data handling procedures with the Technical Project Director and Task Leaders. Accuracy, consistency, documentation, and appropriate selection of methodologies will be discussed.

11.2 Performance Audit

These audits are intended primarily for analytical and data generation systems. Canonie's laboratory regularly participates in, and successfully completes, U.S. EPA Performance Evaluations (WS and WP series). Ongoing performance evaluations include duplicates, matrix spikes, QC check samples, etc.

11.3 Project Audit

Project audits encompass the aspects of both the systems audit and the performance audit. The project audit typically occurs at least twice for a short-term project and more often during long-term projects. Timing is keyed to the systems involved and the project objectives.

11.4 QA Audit Report

A written report of the Quality Assurance audit may be prepared to include:

1. An assessment of task force's status in each of the major project areas.
2. Clear statements of areas requiring improvement or problems to be corrected. Recommendation 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.
3. A timetable for any corrective action required.
4. A follow-up to assure that recommendations have been implemented.

12.0 PREVENTIVE MAINTENANCE

Preventive maintenance of all field equipment proceeds routinely before each sampling event; more extensive maintenance is performed on the basis of hours in use.

Laboratory equipment is maintained on a regular, scheduled basis. This maintenance is documented in the laboratory records book for each instrument. Emergency repair or scheduled manufacturer's maintenance is provided under repair and maintenance contracts with factory representatives.

13.0 DATA ASSESSMENT

The purpose of data quality assessment is to assure that data generated under the program is accurate and consistent with project objectives. The quality of data will be assessed based on the precision, accuracy, consistency, and completeness of the data that is measured or generated.

Data quality assessment will be conducted in three phases.

13.1 Phase 1

Prior to data collection, sampling and analytical procedures will be evaluated in regard to their ability to generate the appropriate technically acceptable information required to achieve project objectives. This Quality Assurance/Quality Control Plan meets this requirement by establishing project objectives defined in terms of parameters, analytical methods, and required performance levels.

13.2 Phase 2

During data collection, results will be assessed to assure that the selected procedures are efficient and effective, and that the data generated provides sufficient information to achieve project objectives. Precision and accuracy of measurement systems will also be evaluated. In general, evaluation of data will be based on performance audits and review of completeness objectives.

Documentation will include:

1. Number of replicate samples collected;
2. Number of replicate, spike, and field blank samples analyzed;

3. Use of historical data and its reference;
4. Identification of analytical method used;
5. Evaluation of the data package, which will include:
 - o Initial calibration and calibration verification,
 - o Continuing calibration verification after every 20 samples for elemental parameters and daily for semi-volatiles,
 - o Spiked sample analysis after every 10 samples for elemental parameters and after every 20 samples for semi-volatiles,
 - o 10 percent preparation blank analysis,
 - o One duplicate sample analysis for every 10 samples.

The technical director of Canonie's laboratory will be responsible for any additional evaluation required of analytical data packages.

13.3 Phase 3

Throughout the data collection activities, an assessment of the adequacy of the database generated in regard to completing the project objectives will be undertaken. Recommendations for improved quality control will be developed, if appropriate. In the event that data gaps are identified, the Quality Assurance Coordinator or Quality Review Team may recommend the collection of additional raw data to fully support the project's findings and recommendations.

14.0 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 could 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 and the Quality Assurance Coordinator. The written communication will identify the condition and explain how it may affect data quality or quantity. Corrective action in the field is the responsibility of each individual of the on-site staff, with review of procedures to be used occurring prior to sampling episodes and a check of the procedures implemented taking place after the sampling episode is completed.

Corrective actions with regard to laboratory analyses are the responsibility of the designated laboratory. In general, situations which may require corrective action are identified through the analysis of travel blanks and blanks retained in the laboratory, which would show any potential contamination of samples by incorrect laboratory preparation procedures or through the shipping phase, if it existed. These blanks are included in each sample set shipped to the laboratory, providing a constant check on these two potential sources of error. During analysis, the typical procedure which the chemist utilizes in testing the samples involves the analysis of a laboratory blank, a calibration sample, a laboratory blank, several field samples, a live spike, a spiked laboratory blank, and several duplicates and/or replicates. Overall quality control in the laboratory is maintained by utilizing quality control standards which are prepared independently from calibration standards. Preparation of quality control standards may be by a chemist not directly involved in the preparation of the calibration standards, by an outside laboratory, or by a manufacturer/supplier of laboratory supplies. The acceptance or rejection of analytical data is contingent upon the results of analysis

presented for the quality control and calibration standards. The plotting of quality control data on a chart allows for continued tracking of quality control procedures and results, with this information, as well as all analytical results retained in the files for future reference and review.

14.1 Immediate Corrective Action

This type of 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 his/her supervisor. The supervisor and the appropriate task leader 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 Project Manager, the client, and the Quality Assurance Coordinator. These individuals will collectively decide on a course of action to correct the deficiencies while the project continues to proceed. If the problem is limited in scope, the Task Leader will decide on the corrective action measure, document the solution in the appropriate workbook, and notify the Project Manager, the client, and the Quality Assurance Coordinator in memorandum form.

14.2 Long-term Corrective Action

Long-term corrective action procedures are devised and implemented to prevent the recurrence of a potentially serious problem. The Quality Assurance Coordinator will be notified of the problem and will conduct an investigation to determine the severity and extent of the problem. The Quality Assurance Coordinator will then file a corrective action request with the Project Manager and Quality Review Team. In case of dispute between the Quality Review Team and the Project Manager, the Responsible Corporate Officer will make a final determination for the company.

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

- o Performance Audits;
- o System Audits;
- o Laboratory/field comparison studies;
- o Quality Assurance/Quality Control program audits conducted by the Quality Review Team.

The Quality Assurance Coordinator will be responsible for documenting all notifications, recommendations, and final decisions. The Project Manager and the Quality Assurance Coordinator will be jointly responsible for notifying program staff and implementing the agreed upon course of action. The Quality Assurance Coordinator will be responsible for verifying the efficiency of the implemented actions. The development and implementation of preventative and corrective actions will be timed, to the extent possible, to minimize any adverse impact on project schedules and subsequent data generation/processing activities. However, scheduling delays will not override the decision to correct the data collection deficiencies or inaccuracies before proceeding with additional data collection. The Quality Assurance Coordinator will also be responsible for developing and implementing routine program controls to minimize the need for corrective action.

15.0 REPORTS TO MANAGEMENT

Periodic summary reports will be prepared to inform management of project status. The reports will include:

1. Periodic assessment of measurement data accuracy, precision, and completeness;
2. Results of performance audits and/or systems audits;
3. Significant QA/QC problems and recommended solutions;
4. Status of solutions to any problems previously identified.

Additionally, any incidents requiring corrective action will be fully documented. Procedurally, the Quality Assurance Coordinator will prepare the reports to management. These reports will be addressed to the Project Manager and the Quality Review Team. The summary of findings shall be factual, concise, and complete. Any required supporting information will be appended to the report.

REFERENCES

FINAL
QUALITY ASSURANCE PROJECT PLAN (QAPP)
QUALITY ASSURANCE/QUALITY CONTROL PLAN
(QA/QC)

THE ABOVE IDENTIFIED SECTION IS NOT
AVAILABLE.

EXTENSIVE RESEARCH WAS PERFORMED BY
SOUTHWEST DIVISION TO LOCATE THIS
SECTION. THIS PAGE HAS BEEN INSERTED AS A
PLACEHOLDER AND WILL BE REPLACED
SHOULD THE MISSING ITEM BE LOCATED.

QUESTIONS MAY BE DIRECTED TO:

DIANE C. SILVA
RECORDS MANAGEMENT SPECIALIST
NAVAL FACILITIES ENGINEERING COMMAND
SOUTHWEST
1220 PACIFIC HIGHWAY
SAN DIEGO, CA 92132

TELEPHONE: (619) 532-3676

TABLES

TABLE 1

CHARCOAL TUBE SAMPLING

<u>Constituent of Interest</u> ¹	<u>Detection Limit</u> ²		<u>NIOSH Analytical Method Reference</u>
	<u>(mg)</u>	<u>(ml/l)</u>	
Ethyl Benzene	1.0	2.4	S29
Methyl Ethyl Ketone	1.0 - 2.0	3.5 - 7.1	S3
Methylene Chloride	1.0	3.0	S329
Tetrachloroethylene	2.0	3.1	S335
1,1,1-Trichloroethane	2.0	3.8	S328
Trichloroethylene	2.0	3.9	S336
Toluene	1.0	2.8	S343
Xylene	4.0	9.6	S318

Notes:

¹Constituents selected based on current information. Initial results of Phase IA will provide additional information prompting review of this list.

²Detection limit based on sampling for 480 minutes at 200 cc/min.

These eight compounds represent the constituents found on-site in soils, ground water, or surface water in concentrations greater than 20 ppm. As such, these constituents are likely to be present in the ambient air at the greatest concentrations. The list may be amended after soil and ground water monitoring is completed in Phase IA to include compounds which may pose equal or greater risks, based on toxicity, than those presented here.

FIGURES

REMEDIAL INVESTIGATION/FEASIBILITY STUDY

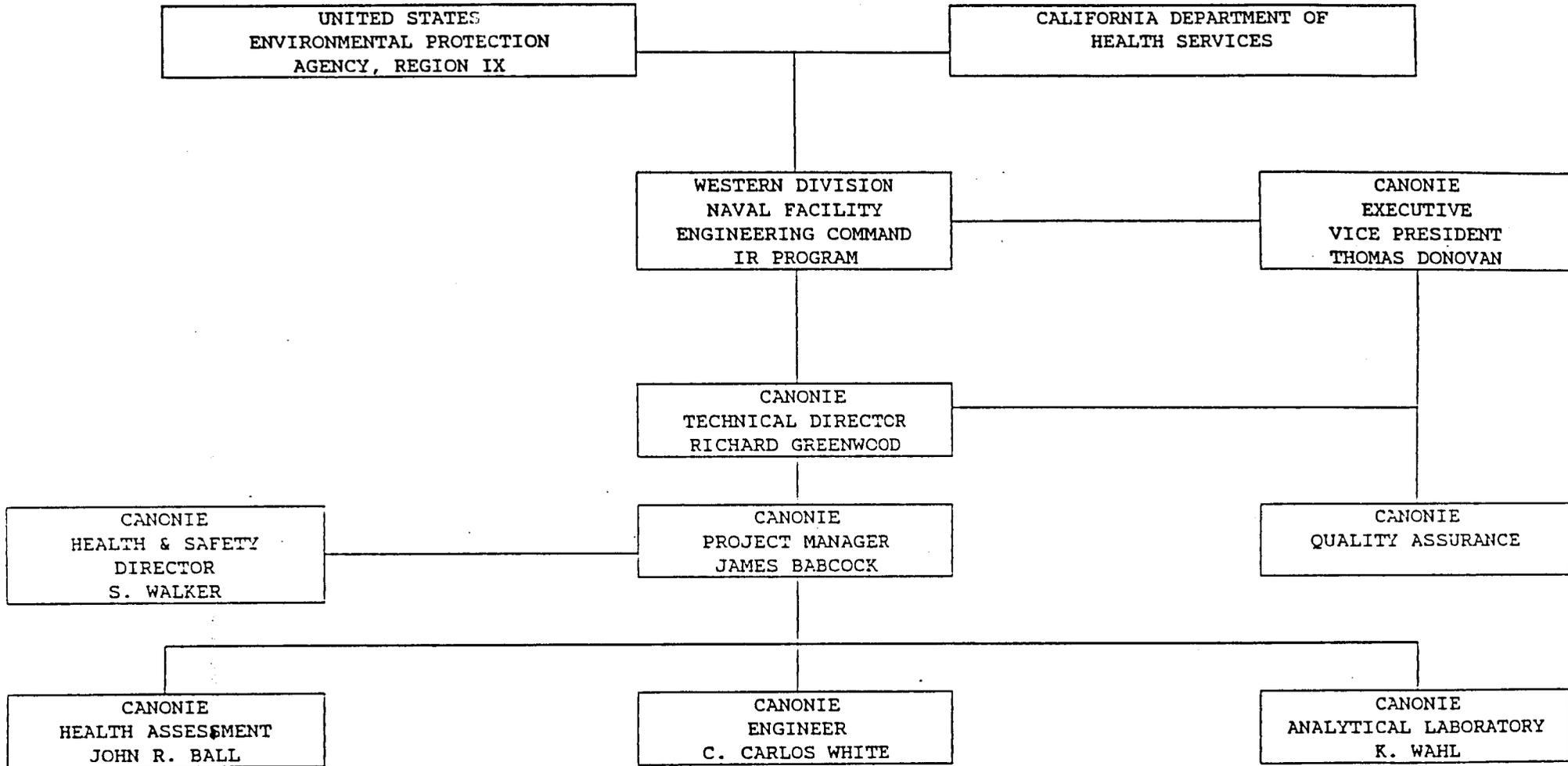


FIGURE 1
RI/FS PROJECT MANAGEMENT TEAM
NAS ALAMEDA SITE

DRAWING NUMBER 87-072-B21

CHECKED BY [Signature] 12/15/87

APPROVED BY [Signature] 12/15/87

JVA 12-15-87

DRAWN BY [Signature]

REVISIONS

NO. DATE

MARKETING/SALES

CLIENT

SAMPLES RETURNED TO CLIENT

SAMPLES PREPARED FOR SHIPPING

SAMPLE ID TO SAMPLE CONTROL

SEND CONTAINERS TO CLIENT

SCHEDULE INCOMING WORK

INVOICE CLIENT

ARCHIVE REPORT AND RAW DATA

FINAL REPORT

ARE SAMPLE CONTAINERS REQUESTED?

LOG SAMPLES INTO LP BOOK

REPORT VALID AND COMPLETE?

ARE SAMPLES ACCEPTABLE?

CORRECTIONS?

REPORT REVIEWED BY SECTION CHIEF

INSTRUMENTATION CALIBRATION

ANALYSIS

SAMPLE PREPARATION

TRACKING SHEETS TO APPROPRIATE SECTIONS

DATA ENTRY

INSTRUMENTATION OPERATING WITHIN LIMITS?

BLANK ANALYSIS

BLANK ACCEPTABLE?

SAMPLE ANALYSIS

QC ACCEPTABLE?

DATA REDUCTION

DATA REVIEW BY ANALYST

DATA REVIEW BY SECTION CHIEF

DATA VALID?

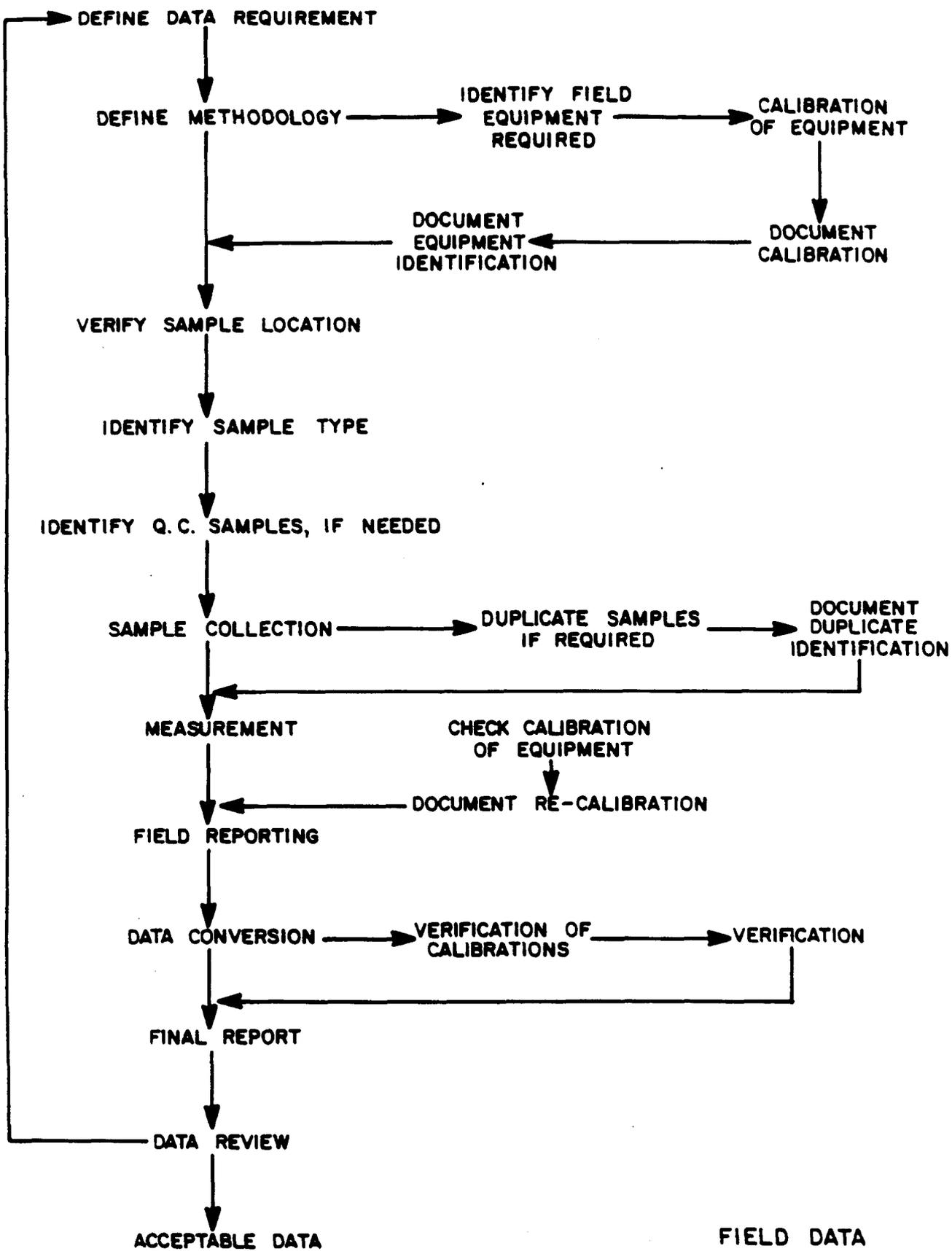
LABORATORY SAMPLE AND DATA FLOW CHART

Canonie Environmental

DATE: 12-15-87
SCALE: NTS

FIGURE 2

DRAWING NUMBER 87-072-B21



FIELD DATA
COLLECTION AND VALIDATION
FIGURE 3

Table 2
 Results of EP Toxicity Metals Analysis on Soil
 Samples Received From Fairchild, McKin
 Results in mg/l leachate

01-09-1987
 84-130-1514
 Page 4

Sampler ID:	A1-10	A1-12	A1-2	A1-3	A1-4
Lab ID#:	616611	616613	616603	616604	616605
Analyte(s)					
Arsenic	ND 0.5				
Barium	ND 10.				
Cadmium	ND 0.10				
Chromium (Total)	ND 0.5				
Mercury	ND 0.02				
Lead	ND 0.5				
Selenium	ND 0.1				
Silver	ND 0.5				

Note:

ND X denotes none detected to a level of X

#ND X denotes none detected to a level of X due to an interfering peak

FIGURE 4

Canonie Environmental

APPENDIX A

U.S. ENVIRONMENTAL PROTECTION AGENCY
WATER POLLUTION PERFORMANCE EVALUATIONS

PERFORMANCE EVALUATION REPORT
WATER POLLUTION STUDY NUMBER MP017

DATE: 11/19/86

LABORATORY: CA040

ANALYTES	SAMPLE NUMBER	REPORT VALUE	TRUE VALUE*	ACCEPTANCE LIMITS	WARNING LIMITS	PERFORMANCE EVALUATION
TRACE METALS IN MICROGRAMS PER LITER:						
ALUMINUM	1	646	390	303.- 517.	331.- 490.	NOT ACCEPTABLE
	2	148	156	109.- 211.	121.- 198.	ACCEPTABLE
ARSENIC	1	141	260	189.- 326.	207.- 309.	NOT ACCEPTABLE
	2	75.9	78.0	55.2- 99.4	60.8- 93.9	ACCEPTABLE
BERYLLIUM	1	103	108	90.0- 128.	94.9- 123.	ACCEPTABLE
	2	32.6	32.4	25.9- 39.1	27.6- 37.4	ACCEPTABLE
CADMIUM	1	140	100	82.7- 115.	86.7- 111.	NOT ACCEPTABLE
	2	43.7	50.0	40.4- 57.1	42.5- 55.0	ACCEPTABLE
COPALT	1	218	204	170.- 239.	179.- 230.	ACCEPTABLE
	2	104	67.9	53.6- 81.5	57.2- 77.9	NOT ACCEPTABLE
CHROMIUM	1	81.7	90.0	69.5- 107.	74.2- 103.	ACCEPTABLE
	2	54.9	60.0	44.6- 72.6	48.1- 69.1	ACCEPTABLE
COPPER	1	266	224	194.- 249.	201.- 242.	NOT ACCEPTABLE
	2	21.6	22.4	15.9- 28.8	17.5- 27.2	ACCEPTABLE
IRON	1	723	672	572.- 738.	593.- 718.	CHECK FOR ERROR
	2	113	67.2	49.4- 82.5	53.6- 78.4	NOT ACCEPTABLE
MERCURY	1	5.07	4.80	3.23- 6.48	3.64- 6.07	ACCEPTABLE
	2	0.824	0.600	.231- .977	.325- .883	ACCEPTABLE
MANGANESE	1	232	252	220.- 277.	227.- 270.	ACCEPTABLE
	2	78.0	63.0	51.9- 72.5	54.5- 69.9	NOT ACCEPTABLE
NICKEL	1	271	245	205.- 284.	215.- 274.	ACCEPTABLE
	2	41.3	49.0	37.1- 61.3	40.1- 58.3	ACCEPTABLE
LEAD	1	289	315	260.- 365.	273.- 352.	ACCEPTABLE
	2	96.9	84.0	65.9- 103.	70.5- 98.2	ACCEPTABLE

* BASED UPON THEORETICAL CALCULATIONS, OR A REFERENCE VALUE WHEN NECESSARY.

PERFORMANCE EVALUATION REPORT

DATE: 11/19/86

WATER POLLUTION STUDY NUMBER WP017

LABORATORY: CA040

ANALYTES	SAMPLE NUMBER	REPORT VALUE	TRUE VALUE*	ACCEPTANCE LIMITS	WARNING LIMITS	PERFORMANCE EVALUATION
TRACE METALS IN MICROGRAMS PER LITER:						
SELENIUM	1	102	100	90.2- 119.	85.1- 114.	ACCEPTABLE
	2	54.0	60.0	43.5- 75.1	47.5- 71.1	ACCEPTABLE
VANADIUM	1	129	155	120.- 192.	130.- 182.	CHECK FOR ERROR
	2	37.8	31.0	12.0- 50.9	17.2- 45.6	ACCEPTABLE
ZINC	1	281	304	255.- 348.	267.- 337.	ACCEPTABLE
	2	20.4	19.0	13.4- 25.7	14.9- 24.2	ACCEPTABLE
ANTIMONY	3	107	108	70.6- 152.	81.5- 142.	ACCEPTABLE
	4	43.1	28.8	15.7- 44.5	19.5- 40.8	CHECK FOR ERROR
SILVER	3	9.98	10.4	7.67- 13.1	8.36- 12.4	ACCEPTABLE
	4	7.31	6.24	4.51- 7.99	4.95- 7.55	ACCEPTABLE
THALLIUM	3	49.4	50.0	34.4- 67.9	38.9- 63.4	ACCEPTABLE
	4	17.7	15.0	10.1- 20.6	11.5- 19.1	ACCEPTABLE
MOLYBDENUM	3	50.5	41.5	25.3- 57.0	29.8- 52.5	ACCEPTABLE
	4	26.4	23.3	11.1- 34.1	14.2- 30.9	ACCEPTABLE
MINERALS IN MILLIGRAMS PER LITER: (EXCEPT AS NOTED)						
PH-UNITS	3	8.88	8.96	8.63- 9.10	8.69- 9.04	ACCEPTABLE
	4	4.40	4.39	4.31- 4.50	4.33- 4.47	ACCEPTABLE
SPEC. COND. (UMHDS/CM AT 25 C)	1	378	373	335.- 410.	344.- 401.	ACCEPTABLE
	2	619.	611	540.- 669.	556.- 653.	ACCEPTABLE
TDS AT 180 C	1	228	252	154.- 390.	183.- 360.	ACCEPTABLE
	2	334	315	280.- 385.	293.- 372.	ACCEPTABLE
TOTAL HARDNESS (AS CaCO3)	1	118	118	110.- 130.	112.- 128.	ACCEPTABLE
	2	138.	142	132.- 155.	135.- 152.	ACCEPTABLE

* BASED UPON THEORETICAL CALCULATIONS, OR A REFERENCE VALUE WHEN NECESSARY.

PERFORMANCE EVALUATION REPORT

DATE: 11/19/86

WATER POLLUTION STUDY NUMBER WP017

LABORATORY: CA040

ANALYTES	SAMPLE NUMBER	REPORT VALUE	TRUE VALUE*	ACCEPTANCE LIMITS	WARNING LIMITS	PERFORMANCE EVALUATION
MINERALS IN MILLIGRAMS PER LITER: (EXCEPT AS NOTED)						
CALCIUM	1	45.5	46.0	40.0- 51.4	41.4- 50.0	ACCEPTABLE
	2	16.0	16.0	14.2- 19.2	14.9- 18.6	ACCEPTABLE
MAGNESIUM	1	0.919	0.910	.759- 1.12	.804- 1.07	ACCEPTABLE
	2	23.7	25.0	21.1- 28.3	22.0- 27.4	ACCEPTABLE
SODIUM	1	13.3	13.2	11.3- 15.1	11.8- 14.6	ACCEPTABLE
	2	55.2	56.2	48.3- 62.8	50.1- 61.0	ACCEPTABLE
POTASSIUM	1	4.80	5.00	3.95- 5.94	4.20- 5.69	ACCEPTABLE
	2	12.8	13.0	10.8- 15.3	11.4- 14.7	ACCEPTABLE
TOTAL ALKALINITY (AS CaCO ₃)	1	13.2	9.99	7.28- 14.5	8.17- 13.6	ACCEPTABLE
	2	75.0	75.0	67.4- 80.2	69.0- 78.6	ACCEPTABLE
CHLORIDE	1	87.0	84.0	77.6- 93.3	79.5- 91.4	ACCEPTABLE
	2	103	101	93.1- 109.	95.1- 107.	ACCEPTABLE
FLUORIDE	1	3.13	3.20	2.69- 3.66	2.81- 3.54	ACCEPTABLE
	2	0.525	0.531	.430- .642	.457- .615	ACCEPTABLE
NUTRIENTS IN MILLIGRAMS PER LITER:						
ORTHOPHOSPHATE	1	0.016	0.020	.0036-.0363	.0076-.0324	ACCEPTABLE
	2	0.600	0.600	.514- .688	.535- .667	ACCEPTABLE
PCB'S IN MICROGRAMS PER LITER:						
PCB-AROCOR 1016	1	2.08	1.83	.829- 2.58	1.05- 2.36	ACCEPTABLE
PCB-AROCOR 1254	2	2.12	2.34	.937- 3.25	1.23- 2.95	ACCEPTABLE
* BASED UPON THEORETICAL CALCULATIONS, OR A REFERENCE VALUE WHEN NECESSARY.						

PERFORMANCE EVALUATION REPORT

DATE: 11/19/86

WATER POLLUTION STUDY NUMBER WP017

LABORATORY: CA040

ANALYTES	SAMPLE NUMBER	REPORT VALUE	TRUE VALUE*	ACCEPTANCE LIMITS	WARNING LIMITS	PERFORMANCE EVALUATION
PESTICIDES IN MICROGRAMS PER LITER:						
ALDRIN	1	0.313	0.590	.0478- .900	.157- .791	ACCEPTABLE
	2	0.067	0.125	.0060- .190	.0295- .166	ACCEPTABLE
DIELDRIN	1	0.647	0.852	.371- 1.25	.486- 1.14	ACCEPTABLE
	2	0.233	0.232	.118- .316	.144- .290	ACCEPTABLE
DDD	1	0.700	0.932	.393- 1.42	.524- 1.29	ACCEPTABLE
	2	0.240	0.266	.125- .379	.158- .347	ACCEPTABLE
DDE	1	0.381	0.539	.174- .852	.261- .765	ACCEPTABLE
	2	0.091	0.095	.0452- .166	.0607- .151	ACCEPTABLE
DDT	1	1.21	1.31	.457- 2.09	.665- 1.88	ACCEPTABLE
	2	0.321	0.261	.0935- .378	.130- .342	ACCEPTABLE
4E) .CHLOR	1	0.455	0.571	.160- .837	.247- .751	ACCEPTABLE
	2	0.232	0.238	.0858- .329	.117- .298	ACCEPTABLE
HEPTACHLOR EPOXIDE	1	0.374	0.511	.205- .738	.274- .670	ACCEPTABLE
	2	0.102	0.120	.0379- .192	.0577- .173	ACCEPTABLE
CHLORDANE	3	7.95	8.64	4.07- 11.7	5.04- 10.7	ACCEPTABLE
	4	1.60	2.35	1.09- 3.21	1.36- 2.94	ACCEPTABLE
VOLATILE HALOCARBONS IN MICROGRAMS PER LITER:						
1,2 DICHLORDETHANE	1	101.4	90.2	49.8- 139.	61.1- 127.	ACCEPTABLE
	2	24.2	15.7	9.54- 24.1	11.4- 22.3	NOT ACCEPTABLE
CHLOROFORM	1	69.0	60.4	41.7- 83.1	47.0- 77.8	ACCEPTABLE
	2	32.6	24.2	18.5- 33.6	20.4- 31.7	CHECK FOR ERROR
1,1,1 TRICHLORJETHANE	1	99.9	73.8	46.2- 104.	53.5- 96.4	CHECK FOR ERROR
	2	19.4	11.8	5.32- 20.6	7.28- 18.7	CHECK FOR ERROR

* BASED UPON THEORETICAL CALCULATIONS, OR A REFERENCE VALUE WHEN NECESSARY.

PERFORMANCE EVALUATION REPORT
WATER POLLUTION STUDY NUMBER WP017

DATE: 11/19/86

LABORATORY: CA040

ANALYTES	SAMPLE NUMBER	REPORT VALUE	TRUE VALUE*	ACCEPTANCE LIMITS	WARNING LIMITS	PERFORMANCE EVALUATION
VOLATILE HALOCARBOHS IN MICROGRAMS PER LITER:						
TRICHLOROETHENE	1	62.6	55.1	35.1- 78.3	40.7- 72.8	ACCEPTABLE
	2	13.4	12.5	6.25- 20.3	8.05- 18.5	ACCEPTABLE
CARBONTETRACHLORIDE	1	107.2	92.7	59.4- 129.	68.4- 120.	ACCEPTABLE
	2	8.6	7.94	1.97- 14.9	3.62- 13.3	ACCEPTABLE
TETRACHLOROETHENE	1	49.0	48.0	29.3- 64.1	33.7- 59.7	ACCEPTABLE
	2	6.6	8.47	4.77- 13.5	5.88- 12.3	ACCEPTABLE
BROMODICHLOROMETHANE	1	106.7	84.5	60.2- 116.	67.2- 108.	ACCEPTABLE
	2	21.2	15.6	10.3- 22.8	11.9- 21.2	ACCEPTABLE
DIBROMOCHLOROMETHANE	1	87.0	71.7	47.0- 113.	55.4- 104.	ACCEPTABLE
	2	20.4	16.7	10.6- 25.8	12.5- 23.9	ACCEPTABLE
BROMOFORM	1	109.0	97.8	57.5- 157.	70.1- 144.	ACCEPTABLE
	2	30.3	27.0	16.5- 39.8	19.5- 36.8	ACCEPTABLE
METHYLENE CHLORIDE	1	69.1	98.0	44.6- 146.	57.6- 133.	ACCEPTABLE
	2	16.9	13.7	7.43- 23.3	9.45- 21.2	ACCEPTABLE
CHLOROBENZENE	1	91.0	79.1	42.2- 114.	51.3- 105.	ACCEPTABLE
	2	14.6	13.6	8.33- 19.7	9.77- 18.2	ACCEPTABLE
VOLATILE AROMATICS IN MICROGRAMS PER LITER:						
BENZENE	1	11.5	7.78	4.67- 11.7	5.57- 10.8	CHECK FOR ERROR
	2	44.2	51.8	34.3- 69.5	38.9- 64.9	ACCEPTABLE
ETHYLBENZENE	1	12.6	10.5	5.33- 16.4	6.74- 15.0	ACCEPTABLE
	2	104.7	78.6	50.1- 105.	57.3- 98.3	CHECK FOR ERROR
TOLUENE	1	23.2	18.2	11.3- 25.0	13.1- 23.3	ACCEPTABLE
	2	149.7	99.0	63.8- 133.	72.8- 124.	NOT ACCEPTABLE

* BASED UPON THEORETICAL CALCULATIONS, OR A REFERENCE VALUE WHEN NECESSARY.

PERFORMANCE EVALUATION REPORT
WATER POLLUTION STUDY NUMBER WPO17

DATE: 11/19/86

LABORATORY: CA040

ANALYTES	SAMPLE NUMBER	REPORT VALUE	TRUE VALUE*	ACCEPTANCE LIMITS	WARNING LIMITS	PERFORMANCE EVALUATION
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VOLATILE AROMATICS IN MICROGRAMS PER LITER:

1,2-DICHLOROBENZENE	1	15.2	14.0	5.73- 23.2	8.03- 20.9	ACCEPTABLE
	2	85.6	72.9	37.6- 110.	47.1- 101.	ACCEPTABLE
1,3-DICHLOROBENZENE	1	21.9	20.6	5.39- 33.2	9.24- 29.3	ACCEPTABLE
	2	81.2	77.4	20.0- 121.	34.0- 107.	ACCEPTABLE
1,4-DICHLOROBENZENE	1	7.2	5.46	1.84- 9.79	2.90- 8.73	ACCEPTABLE
	2	53.6	54.6	28.1- 89.7	36.2- 81.5	ACCEPTABLE

MISCELLANEOUS PARAMETERS:

NON-FILTERABLE RESIDUE (IN MG/L)	1	14.8	16.0	10.2- 18.2	11.2- 17.2	ACCEPTABLE
	2	56.0	60.5	49.6- 63.4	51.3- 61.7	ACCEPTABLE

* BASED UPON THEORETICAL CALCULATIONS, OR A REFERENCE VALUE WHEN NECESSARY.

PERFORMANCE EVALUATION REPORT
 WATER POLLUTION STUDY NUMBER WPC18

DATE: 05/22/97

LABORATORY: CAJ40

ANALYTES	SAMPLE NUMBER	REPORT VALUE	TRUE VALUE*	ACCEPTANCE LIMITS	WARNING LIMITS	PERFORMANCE EVALUATION
TRACE METALS IN MICROGRAMS PER LITER:						
ARSENIC	1	98.1	150	111.- 186.	121.- 177.	NOT ACCEPTABLE
	2	33.0	20.1	12.5- 27.4	14.4- 25.5	NOT ACCEPTABLE
BERYLLIUM	1	727	725	621.- 822.	547.- 797.	ACCEPTABLE
	2	369	332	289.- 330.	300.- 359.	ACCEPTABLE
CADMIUM	1	63.5	55.0	46.6- 63.2	48.5- 61.2	NOT ACCEPTABLE
	2	474	445	378.- 501.	393.- 436.	ACCEPTABLE
COBALT	1	140	142	118.- 165.	124.- 159.	ACCEPTABLE
	2	609	610	520.- 694.	543.- 672.	ACCEPTABLE
CHROMIUM	1	514	514	400.- 606.	425.- 581.	ACCEPTABLE
	2	200	191	154.- 227.	163.- 213.	ACCEPTABLE
COPPER	1	957	953	959.-1020.	880.-1030.	ACCEPTABLE
	2	544	492	440.- 536.	452.- 524.	NOT ACCEPTABLE
IRON	1	1100	1096	947.-1210.	980.-1190.	ACCEPTABLE
	2	1350	1352	1500.-2060.	1660.-2010.	ACCEPTABLE
MERCURY	1	0.433	0.317	.472- 1.40	.589- 1.29	NOT ACCEPTABLE
	2	4.85	4.55	3.09- 6.09	3.47- 5.71	ACCEPTABLE
MANGANESE	1	395	381	337.- 419.	348.- 409.	ACCEPTABLE
	2	998	989	884.-1080.	909.-1060.	ACCEPTABLE
NICKEL	1	824	762	670.- 853.	693.- 831.	ACCEPTABLE
	2	354	320	273.- 364.	284.- 352.	CHECK FOR ERROR
LEAD	1	736	685	584.- 773.	608.- 753.	ACCEPTABLE
	2	420	392	331.- 450.	345.- 435.	ACCEPTABLE
SELENIUM	1	22.5	20.0	12.5- 26.1	14.2- 24.4	ACCEPTABLE
	2	46.9	42.3	30.9- 51.7	33.5- 49.1	ACCEPTABLE

* BASED UPON THEORETICAL CALCULATIONS, OR A REFERENCE VALUE WHEN NECESSARY.

PERFORMANCE EVALUATION REPORT

DATE: 05/22/87

WATER POLLUTION STUDY NUMBER WP019

LABORATORY: CA040

ANALYTES	SAMPLE NUMBER	REPORT VALUE	TRUE VALUE*	ACCEPTANCE LIMITS	WARNING LIMITS	PERFORMANCE EVALUATION
TRACE METALS IN MICROGRAMS PER LITER:						
VANADIUM	1	1090	1129	954.-1310.	1000.-1260.	ACCEPTABLE
	2	912	919	776.-1070.	815.-1030.	ACCEPTABLE
ZINC	1	1102	1059	926.-1160.	955.-1130.	ACCEPTABLE
	2	1754	1656	1440.-1820.	1490.-1780.	ACCEPTABLE
ANTIMONY	3	114	90.0	60.9- 126.	69.6- 117.	ACCEPTABLE
	4	31.8	43.6	33.2- 63.6	37.9- 63.9	NOT ACCEPTABLE
SILVER	3	14.5	13.0	9.66- 16.0	10.5- 15.2	ACCEPTABLE
	4	11.7	9.36	6.85- 11.8	7.47- 11.2	CHECK FOR ERROR
THALLIUM	3	59.6	80.0	56.2- 109.	63.4- 101.	CHECK FOR ERROR
	4	3.47	10.0	6.09- 14.1	7.11- 13.0	ACCEPTABLE
MINERALS IN MILLIGRAMS PER LITER: (EXCEPT AS NOTED)						
PH-UNITS	3	5.08	5.20	5.06- 5.30	5.09- 5.27	CHECK FOR ERROR
	4	8.66	8.50	8.04- 8.99	8.15- 8.79	ACCEPTABLE
SPEC. COND. (UMHOS/CM AT 25 C)	1	753	752	677.- 864.	701.- 841.	ACCEPTABLE
	2	406	448	421.- 509.	431.- 497.	NOT ACCEPTABLE
TDS AT 180 C	1	572	460	326.- 574.	357.- 543.	CHECK FOR ERROR
	2	274	257	203.- 315.	217.- 301.	ACCEPTABLE
TOTAL HARDNESS (AS CaCO3)	1	240	229	217.- 247.	221.- 243.	ACCEPTABLE
	2	107	103	94.2- 112.	96.4- 110.	ACCEPTABLE
CALCIUM	1	33.3	24.3	71.9- 97.0	75.0- 93.8	ACCEPTABLE
	2	7.14	6.67	5.59- 8.23	5.92- 7.90	ACCEPTABLE
MAGNESIUM	1	4.57	4.50	3.79- 5.24	3.97- 5.06	ACCEPTABLE
	2	21.3	21.0	18.0- 24.0	18.7- 23.3	ACCEPTABLE

* BASED UPON THEORETICAL CALCULATIONS, OR A REFERENCE VALUE WHEN NECESSARY.

PERFORMANCE EVALUATION REPORT
 WATER POLLUTION STUDY NUMBER WPC13

DATE: 05/22/97

LABORATORY: CA340

ANALYTES	SAMPLE NUMBER	REPORT VALUE	TRUE VALUE*	ACCEPTANCE LIMITS	WARNING LIMITS	PERFORMANCE EVALUATION
MINERALS IN MILLIGRAMS PER LITER: (EXCEPT AS NOTED)						
SODIUM	1	61.6	57.6	51.7- 63.1	53.1- 61.7	ACCEPTABLE
	2	30.3	29.2	25.8- 32.9	26.7- 32.0	ACCEPTABLE
POTASSIUM	1	1.59	1.60	1.08- 2.32	1.24- 2.17	ACCEPTABLE
	2	23.0	28.0	23.2- 32.0	24.3- 30.8	ACCEPTABLE
TOTAL ALKALINITY (AS CaCO ₃)	1	117	110	99.2- 117.	101.- 115.	CHECK FOR ERROR
	2	12.2	15.0	11.4- 19.0	12.4- 15.1	CHECK FOR ERROR
CHLORIDE	1	152	162	152.- 179.	155.- 175.	ACCEPTABLE
	2	72.0	73.1	65.7- 80.2	67.5- 79.4	ACCEPTABLE
FLUORIDE	1	2.64	2.65	2.29- 2.93	2.37- 2.35	ACCEPTABLE
	2	0.440	0.412	.333- .487	.357- .468	ACCEPTABLE
SULFATE	1	8.92	10.0	6.96- 12.6	7.67- 11.9	ACCEPTABLE
	2	72.3	80.0	67.4- 90.7	70.3- 87.8	ACCEPTABLE
NUTRIENTS IN MILLIGRAMS PER LITER:						
NITRATE-NITROGEN	1	4.08	4.00	3.25- 4.69	3.43- 4.52	ACCEPTABLE
	2	5.49	7.50	6.33- 8.78	6.63- 8.49	CHECK FOR ERROR
ORTHOPHOSPHATE	1	0.356	0.358	.739- .976	.768- .947	ACCEPTABLE
	2	0.370	0.349	.310- .441	.325- .425	ACCEPTABLE
DEMANDS IN MILLIGRAMS PER LITER:						
COD	1	46.3	54.4	37.4- 64.4	40.8- 61.1	ACCEPTABLE
	2	50.5	148	113.- 171.	120.- 164.	NOT ACCEPTABLE

* BASED UPON THEORETICAL CALCULATIONS, OR A REFERENCE VALUE WHEN NECESSARY.

PERFORMANCE EVALUATION REPORT

DATE: 05/22/87

WATER POLLUTION STUDY NUMBER WPO18

LABORATORY: CA040

ANALYTES	SAMPLE NUMBER	REPORT VALUE	TRUE VALUE*	ACCEPTANCE LIMITS	WARNING LIMITS	PERFORMANCE EVALUATION
PCB'S IN MICROGRAMS PER LITER:						
PCB-AROCOR 1232	2	1.146	1.74	.481- 2.82	.795- 2.51	ACCEPTABLE
PCB-AROCOR 1260	1	0.725	1.16	.705- 1.44	.795- 1.35	CHECK FOR ERROR
PESTICIDES IN MICROGRAMS PER LITER:						
ALDRIN	1	0.433	0.760	.132- 1.07	.249- .951	ACCEPTABLE
	2	0.163	0.213	.0350- .317	.0704- .281	ACCEPTABLE
DIELDRIN	1	0.172	0.206	.0934- .301	.120- .275	ACCEPTABLE
	2	0.630	0.746	.396- 1.02	.475- .936	ACCEPTABLE
DDO	1	0.294	0.146	.0527- .237	.0753- .214	NOT ACCEPTABLE
	2	0.929	0.487	.217- .734	.282- .669	NOT ACCEPTABLE
DDE	1	0.263	0.338	.158- .444	.194- .408	ACCEPTABLE
	2	0.730	0.845	.602- 1.15	.495- 1.05	ACCEPTABLE
DDT	1	0.090	0.396	.145- .588	.203- .533	NOT ACCEPTABLE
	2	0.307	0.929	.447- 1.40	.569- 1.23	NOT ACCEPTABLE
HEPTACHLOR	1	0.187	0.332	.112- .463	.156- .419	ACCEPTABLE
	2	0.573	0.872	.224- 1.24	.352- 1.11	ACCEPTABLE
HEPTACHLOR EPOXIDE	1	0.271	0.316	.147- .449	.184- .411	ACCEPTABLE
	2	0.790	0.877	.506- 1.15	.589- 1.07	ACCEPTABLE
CHLORDANE	3	5.81	9.28	3.69- 13.3	4.90- 12.1	ACCEPTABLE
	4	0.927	1.24	.549- 1.73	.700- 1.58	ACCEPTABLE

* BASED UPON THEORETICAL CALCULATIONS, OR A REFERENCE VALUE WHEN NECESSARY.

PERFORMANCE EVALUATION REPORT

DATE: 05/22/87

WATER POLLUTION STUDY NUMBER WPO13

LABORATORY: CA060

ANALYTES	SAMPLE NUMBER	REPORT VALUE	TRUE VALUE*	ACCEPTANCE LIMITS	WARNING LIMITS	PERFORMANCE EVALUATION
VOLATILE HALOCARBOANS IN MICROGRAMS PER LITER:						
1,2 DICHLOROETHANE	1	12.6	9.13	3.01- 16.5	4.70- 14.3	ACCEPTABLE
	2	62.5	73.1	43.2- 105.	51.0- 97.7	ACCEPTABLE
CHLOROFORM	1	67.0	63.5	46.4- 90.9	52.1- 85.2	ACCEPTABLE
	2	2.43	1.96	D.L.- 4.97	.565- 4.34	ACCEPTABLE
1,1,1 TRICHLOROETHANE	1	3.90	4.08	2.12- 6.99	2.73- 6.38	ACCEPTABLE
	2	48.3	53.0	23.3- 30.7	34.3- 74.1	ACCEPTABLE
TRICHLOROETHENE	1	4.61	6.03	2.97- 9.00	3.74- 8.23	ACCEPTABLE
	2	51.5	63.3	39.2- 92.7	45.9- 86.0	ACCEPTABLE
CARBONTETRACHLORIDE	1	5.12	5.45	1.35- 9.93	2.45- 8.93	ACCEPTABLE
	2	53.3	59.0	34.1- 88.3	40.9- 81.5	ACCEPTABLE
TETRACHLOROETHENE	1	4.79	3.30	1.72- 5.13	2.15- 4.70	CHECK FOR ERROR
	2	74.5	53.6	33.1- 69.9	37.8- 65.2	NOT ACCEPTABLE
BROMODICHLOROMETHANE	1	4.69	3.62	1.61- 6.29	2.19- 5.71	ACCEPTABLE
	2	52.3	48.2	34.4- 69.3	38.7- 64.9	ACCEPTABLE
DIBROMOCHLOROMETHANE	1	9.80	8.12	4.45- 11.3	5.30- 10.4	ACCEPTABLE
	2	77.7	54.1	35.3- 78.9	40.9- 73.3	CHECK FOR ERROR
BROMOFORM	1	3.82	11.1	6.32- 15.6	7.49- 14.5	NOT ACCEPTABLE
	2	33.0	45.2	27.3- 68.4	32.4- 63.2	ACCEPTABLE
METHYLENE CHLORIDE	1	7.26	7.11	3.19- 12.0	4.30- 10.9	ACCEPTABLE
	2	73.3	67.5	44.1- 94.9	50.5- 89.5	ACCEPTABLE
CHLOROBENZENE	1	7.06	7.71	4.96- 10.3	5.63- 9.59	ACCEPTABLE
	2	46.3	46.2	35.6- 60.0	39.5- 56.9	ACCEPTABLE
VOLATILE AROMATICS IN MICROGRAMS PER LITER:						
BENZENE	1	26.4	33.0	21.1- 44.7	24.1- 41.7	ACCEPTABLE
	2	2.57	2.31	.909- 3.94	1.29- 3.55	ACCEPTABLE

* BASED UPON THEORETICAL CALCULATIONS, OR A REFERENCE VALUE WHEN NECESSARY.
D.L. STANDS FOR DETECTION LIMIT

PERFORMANCE EVALUATION REPORT

DATE: 05/22/87

WATER POLLUTION STUDY NUMBER WP018

LABORATORY: CA040

ANALYTES	SAMPLE NUMBER	REPORT VALUE	TRUE VALUE*	ACCEPTANCE LIMITS	WARNING LIMITS	PERFORMANCE EVALUATION
VOLATILE AROMATICS IN MICROGRAMS PER LITER:						
ETHYLBENZENE	1	41.4	48.9	31.3- 65.4	35.7- 61.0	ACCEPTABLE
	2	2.57	3.26	1.37- 5.29	1.88- 4.78	ACCEPTABLE
TOLUENE	1	52.3	62.4	41.6- 82.3	46.9- 77.0	ACCEPTABLE
	2	3.84	4.46	2.16- 6.98	2.77- 6.37	ACCEPTABLE
1,2-DICHLOROBENZENE	1	43.6	47.0	20.8- 69.5	27.6- 62.7	ACCEPTABLE
	2	5.88	7.23	1.77- 12.5	3.26- 11.0	ACCEPTABLE
1,3-DICHLOROBENZENE	1	42.4	49.1	16.2- 75.3	24.4- 67.1	ACCEPTABLE
	2	8.04	9.53	2.73- 15.9	4.55- 14.1	ACCEPTABLE
1,4-DICHLOROBENZENE	1	36.6	41.7	27.6- 61.8	32.0- 57.4	ACCEPTABLE
	2	7.88	9.94	3.21- 14.8	4.82- 13.2	ACCEPTABLE
MISCELLANEOUS PARAMETERS:						
TOTAL CYANIDE (IN MG/L)	1	76.0	0.070	.0278- .0976	.0365- .0928	NOT ACCEPTABLE
	2	27.0	0.225	.110- .298	.134- .274	NOT ACCEPTABLE
NON-FILTERABLE RESIDUE (IN MG/L)	1	78.2	83.9	62.1- 87.0	65.2- 84.0	ACCEPTABLE
	2	23.5	25.1	16.4- 28.0	17.9- 26.6	ACCEPTABLE
OIL AND GREASE (IN MG/L)	1	22.0	9.00	1.34- 12.8	2.77- 11.4	NOT ACCEPTABLE
	2	15.0	25.0	13.6- 31.6	15.8- 29.4	CHECK FOR ERROR

* BASED UPON THEORETICAL CALCULATIONS, OR A REFERENCE VALUE WHEN NECESSARY.

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LABORATORY QUALITY ASSURANCE MANUAL

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APPENDIX B

LABORATORY QUALITY ASSURANCE/
QUALITY CONTROL MANUAL

1.0 INTRODUCTION

The purpose of this Quality Assurance/Quality Control (QA/QC) Program Manual is to ensure that the data generated by Canonie Environmental Services Corp. (Canonie), in the analysis of environmental samples, are accurate and precise. Additionally, Canonie's goal also includes the proper documentation of sample handling and analysis, so that the data generated are acceptable for introduction into evidence in enforcement actions or other legal proceedings. This QA/QC Program Manual was developed by Canonie laboratory personnel, and is consistent with U.S. Environmental Protection Agency (U.S. EPA) guidance documents, U.S. EPA Publication SW-846, and U.S. EPA Contract Laboratory Program criteria.

Canonie's QA/QC Program is designed to produce reliable data in the identification and measurement of chemical and physical parameters, while meeting or exceeding prescribed standards of performance in the completion of the analysis of samples. The program details to produce this data are presented in the following sections of this manual, together with standardized procedures for the collection and preservation of samples, sample control, instrument calibration and maintenance, and analytical methodologies.

2.0 LABORATORY PERSONNEL

The QA/QC Program is not only the responsibility of the laboratory manager, staff supervisors, and the QA officer, but the entire Canonie staff of technicians and chemists are responsible for the consistent and continuous provision of quality analytical work. The provision of quality analytical data is dependent on staff working as a team, with each team member positively contributing to the completion of the work in accordance with approved procedures. Quality data is the result of qualified personnel performing their tasks in accordance with approved procedures. The qualifications of personnel to perform the work is the result of thorough and on-going in-house training as well as the attendance of staff at external seminars and training courses which address instrumentation, analytical methodologies, and sampling techniques.

Consistent performance requires continuous attention to work habits, staffing, and anticipated work load. Weekly staff meetings provide opportunities to discuss new ideas, relate problems and discuss solutions, and to review safety considerations. Periodic, in-house seminars, where staff are introduced to unfamiliar instrumentation or analytical methodologies, expand the competence of the laboratory staff and provide for staffing flexibility during periods when several staff are ill or absent, or when the analytical load in one or more departments is increased temporarily.

The Canonie laboratory is staffed with 30 experienced chemists, biologists, and technical assistants. A brief resume of the supervisory personnel is provided in the Resumes section of this appendix. Figure 1 is an organizational chart for the laboratory, indicating lines of communication and responsibilities. Each section chief within the laboratory is responsible for verifying all analytical work performed within his/her section. The QA officer is responsible for the overall laboratory QA Program, and for directing corrective action required in response to deficiencies noted during data reviews.

3.0 SAMPLING PROCEDURES

The provision of quality analytical data, while the object of the laboratory, is of no value to a remedial investigation or other inquiry unless sampling procedures, employed in the collection of the sample, are designed and implemented to obtain representative samples of the media of concern. In order to obtain data which accurately define the character of the sampled media, sampling procedures and sample preservation techniques must be followed to assure that the sample received by the laboratory is representative of the media sampled. Sampling procedures and preservation techniques are detailed in several publications, including the following:

- o Test Methods for Evaluating Solid Waste - Physical/Chemical Methods, SW-846 (3rd Edition, 1986);
- o Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020;
- o Standard Methods for the Examination of Water and Wastewater, APHA-AWWA-WPCF (16th Edition, 1985).

Preservation techniques are dependent on sample type and the analytical procedure to be followed in the laboratory. Usually, maintaining the sample on ice after sampling and during transport to the laboratory is sufficient to maintain sample integrity. Table 1 presents the recommended sampling type, preservation techniques, container size and type, and sample volume for most commonly analyzed compounds. If chemical compounds are anticipated for which no sampling and preservation information is available, the laboratory QA officer should be contacted for instructions.

4.0 SAMPLE CUSTODY

4.1 Sample Scheduling and Coordination

Coordination of sample custody, sample analysis, and data reduction and reporting is required if the data provided are to meet the laboratory's quality assurance goals as well as the time constraints placed upon the project are to be met. These goals can be met if sufficient time is allotted for sample preparation and analysis and if proper attention is given to the accurate tracking of samples from collection through final reporting. Laboratory scheduling to meet particular deadlines is crucial, and therefore, prior notification to the laboratory of sampling, required analysis, and reporting restraints is important. Field personnel should notify the laboratory prior to sampling episodes, and relay the following information:

1. The anticipated number of samples, the sample matrix to be analyzed, and the analysis requested;
2. The number and type of sampling containers required to complete the sampling;
3. The sample volume which the field personnel anticipate collecting.

Upon receipt of notification, the laboratory will assign a laboratory project number to the work. This number will then be entered on the Laboratory Project Sheet (LP Sheet), together with information on the project, the client for whom the work is performed, and invoicing information. A sample LP Sheet is presented as Figure 2. Other information required by the laboratory to schedule the work and control sample tracking and costs includes the following:

- o The number of samples anticipated;

- o The sample matrices and the analyses to be performed;
- o The number and type of sampling containers to be supplied by the laboratory;
- o The date when sampling is scheduled;
- o The date when the final laboratory report is due;

When requested, the laboratory will provide chain-of-custody forms and sample labels to clients utilizing the laboratory. A sample chain-of-custody form is presented as Figure 3, and representative sample labels are presented on Figure 4.

4.2 Sample Collection

When sampling actually occurs, the laboratory should be notified that samples will be transported to the laboratory as scheduled. If sampling must be cancelled for any reason, the laboratory should be notified of the delay and of the new date when sampling is to occur. Prompt notification will assure that staffing and analytical work loads are adjusted to meet the demands of other clients.

During sampling, the field engineers or technicians should note any characteristics which may provide information to the staff chemists about the type or concentration of chemical constituents in the sampled matrix. It is of particular importance that characteristics, such as low flash point, explosivity, or high toxicity, be noted on the chain-of-custody forms to alert laboratory personnel of potential health and safety concerns in handling the samples.

Additionally, all sample collection and preservation procedures designed for the sampling project should be followed to assure sample representativeness and integrity. The sample label on each sample container should be completed in its entirety to assure that all pertinent information accompanies the sample to the laboratory. Complete information on each label is necessary so that if the sample container is separated from the

rest of the shipment in the laboratory, sufficient information is available on the label to ascertain the scheduled work required on the sample. The chain-of-custody form should reflect the identification of each sample for which laboratory results are requested. If samples are to be held at the laboratory pending further instructions, an appropriate comment should be made on the chain-of-custody form. Each sample must be uniquely identified. The administrative sample tracking system maintained by the laboratory allows each sample batch to be identified with a alpha-numeric label containing a maximum of 20 characters.

4.3 Sample Receipt

Sample receipt is the first contact which the laboratory has with the sampled media. Proper control and documentation of all samples within the laboratory begins with the procedures instituted during receipt. When samples are received, the sample custodian checks each shipping container for the chain-of-custody form, and then verifies the presence of each sample indicated on the chain-of-custody form and the condition in which the sample is found. Missing samples or samples which have broken or compromised during shipment are noted on the chain-of-custody form. If no chain-of-custody form is found in the shipping container, an inventory of the samples is taken and the person from whom the samples received is immediately contacted. A chain-of-custody form is then completed by the sample custodian in accordance with the instructions of the sampler/client. After checking the chain-of-custody form against the samples received, the sample custodian then obtains a number from the data control section and assigns the number to the chain-of-custody form.

After checking the samples and the chain-of-custody form for consistency, the sample custodian assigns a unique, six digit, laboratory identification number (ID number) to each sample for tracking control purposes. Each ID number begins with a number which indicates the year in which the sample was received by the laboratory. Samples received in 1986 are assigned an ID number which begins with the number 6. The samples are then logged into

the computer-based laboratory tracking system, and the computer generates the tracking sheets and accession sheets for the samples. A sample tracking sheet is presented as Figure 5, and a sample accession page is presented as Figure 6.

After completing the sample receipt activities described, the sample custodian places the samples into one of the laboratory refrigerators to maintain the preservation of the samples, and the custodian then enters the sample numbers into the sample control book for the refrigerator. If the sample custodian is unsure of the proper preservation procedure for the samples, the section chief in charge of the analysis requested on the sample is contacted for instructions. Any preservation involving the addition of chemical preservatives, such as hydrochloric acid, is completed by the appropriate chemist and is noted on the chain-of-custody form at the time of the addition.

The project folder, containing the laboratory project work request form, the chain-of-custody form and the tracking sheets, is then given to the section chief in charge of the analysis requested. When the section chief, or his/her designee is prepared to analyze the samples, the samples are requested from the sample custodian, who obtains the samples from the refrigerator and relinquishes possession to the chemist. The transfer of the samples to the chemist is then noted in the sample control book for the refrigerator. When the samples have been analyzed, the samples are returned to the sample custodian, who either returns them to the refrigerator pending further analysis, disposes of the sample after a holding period of two weeks, or returns the samples to the client. The disposition of the sample is noted in the sample control book for the refrigerator. A sample page from the sample control book is presented as Figure 7.

5.0 MAINTENANCE AND CALIBRATION PROCEDURES

5.1 Maintenance Procedures

The laboratory staff maintains complete records of all maintenance performed on each analytical instrument owned or operated by Canonie. The routine performance of maintenance assures that the availability of Canonie's analytical instruments will be maximized, unscheduled maintenance will be minimized, and clients will be assured of receiving quality data on a timely basis. When unscheduled maintenance is required, an appropriately trained staff member or the manufacturer's representative is called to repair the faulty instrument. All maintenance is performed in accordance with the manufacturer's written specifications. Whenever maintenance is completed on any instrument, an entry is made into the maintenance log for the instrument, noting the date and time, the person completing the maintenance work, the reason for maintenance, the work accomplished, and the results obtained.

5.2 Calibration of Instrumentation

5.2.1 Gas and Liquid Chromatographs

The chromatographs are calibrated daily for each type of analysis performed. Calibration of each instrument is completed upon initial start-up and additional calibrations are completed during the day in accordance with prescribed statistical procedures. In general, as the number of samples to be analyzed increases, the number of calibration checks increase. As a general rule within the laboratory, the calibration of the instrument is checked after 10 samples have been analyzed. Further, quality assurance is maintained by including a quality control (QC) sample, having a known concentration of one or more chemical constituents of interest, within the 10 sample batch and comparing the instrument response to the known value for the QC sample.

Calibration is accomplished by analyzing standardized samples which have concentrations falling within the middle of the linear detection range of the instrument. The response of the instrument to the standardized samples is utilized to prepare a calibration curve for the instrument. The initial calibration of the instrument is based upon a five-point curve. Using the five-point calibration curve, an average response factor (ARF), computed by dividing the reported concentration by the area under the chromatogram, is determined from the five points.

Once the instrument is calibrated and a linear calibration curve has been generated based upon the analysis of five known concentrations, daily calibrations are completed by generating a three-point curve, calculating the daily response factor RF, and then comparing the daily RF with the initial, five-point ARF. The calibration of the instrument is assumed to be acceptable if the daily RF is within 10 percent of the initial RF. If the daily RF is 10 percent more or less than the initial RF, the daily calibration must be repeated. If the daily RF continues to fall outside the limits for acceptability, then appropriate maintenance or other action must be taken to rectify the performance of the instrument.

5.2.2 Gas Chromatograph/Mass Spectrometer Calibration

Gas chromatograph/mass spectrometer (GC/MS) systems must be hardware-tuned to meet certain minimum criteria prior to any analyses. The criteria applicable to the initial and daily calibration of the GC/MS system is method-specific. The calibration procedures are set forth in "Test Methods for Evaluating Solid Waste, Physical/Chemical Methods", SW-846, with the criteria for U.S. EPA Method 8240 appearing in Section 7.0 and following of the method description, the criteria for U.S. EPA Method 8250 appearing in Section 7.0 and following of the method description, the criteria for U.S. EPA Method 8270 appearing in Section 7.0 and following of the method description, and the criteria for U.S. EPA Method 8280 appearing in Section 6.0 and following of the method description. Analyses must not begin

until these criteria are met. In addition, the minimum performance criteria established for each method must be demonstrated for each 12-hour shift. The instrument calibration must be acceptable prior to the initiation of analyses during each shift, as post-acquisition manipulation of ion abundances which are inconsistent with applicable criteria is not permitted.

5.2.3 Atomic Absorption Spectrophotometer

The atomic absorption spectrophotometer is calibrated using a minimum of three standards and a blank for each parameter to be analyzed. After calibration, analysis may proceed with the intermediate concentration standard included in the sampling cycle. The intermediate standard should be analyzed within a frequency of once for every ten samples tested. Analysis of samples may continue if the value for the intermediate standard is reported within ten percent of the known value for said standard. When instrument drift causes the value reported for the intermediate standard to vary more than ten percent, the instrument shall be recalibrated using the three standards. Samples which were analyzed during the period when reported value of the intermediate standard was not within acceptable limits, must be analyzed again with reference to the recalibrated instrument.

For each analyte tested by atomic absorption spectrophotometry, the response factor (RF), determined by dividing the concentration by the absorbance, for high concentration and low concentration standards, are monitored. If the RFs deviate from the typical values recorded for each analyte during the course of analysis, then a fresh standard is prepared and the instrument is calibrated to the new standard. Additionally, deviations in RFs from typically reported values may be the result of instrument drift related to physical aspects of the instrument, such as lamps, or the tubes in the graphite furnace. These instrument-related factors shall be investigated when RFs deviate. If the preparation and utilization of newly prepared standards and the replacement of lamps or furnace tubes does not result in the re-establishment of acceptable RFs, then maintenance of the instrument is required.

5.2.4 Inductively-Coupled Plasma Spectrometer

The inductively-coupled plasma spectrometer (ICP) is calibrated using a batch of six standards. These standards include:

1. Calibration blank solution;
2. Calibration standard solution;
3. Initial calibration verification standard solution;
4. Interference check standard solution;
5. Linear check standard solution;
6. Quality control standard solution.

The analytical curve is generated by the calibration blank and calibration standard solution. After generation of the analytical curve, the initial calibration verification standard solution is analyzed. The recovery of this standard solution must be 90 to 110 percent of the expected value. The interference check standard solution is analyzed next. The recovery of the standard solution must fall within a 80 to 120 percent of the expected value. The linear check standard solution is analyzed next, and its value must be twice the detection limit. Finally, the quality control standard solution, received from an outside source such as the U.S. EPA, is analyzed. The value reported for the quality control standard solution must be within 90 to 110 percent of the expected value. If, in the analysis of the calibration solutions, any of the recovery criteria for the four last-mentioned solutions are not met, then the instrument performance must be evaluated and the source of the instrument deficiencies determined. After correction of any noted deficiencies, the instrument must be recalibrated in accordance with the procedures set forth above.

5.2.5 Analytical Balances

The calibration of analytical balances shall be checked daily, or with each use (whichever is less frequent), by analyzing a single class S weight and recording the value determined by the balance. The class S weight selected

shall be typical of the mass of samples to be analyzed. Should the reported value of the class S weight deviate from the known value of the weight by more than 0.5 percent, the balance shall be inspected to determine if obstructions hinder the free movement of the balance pan, or if residue remains on the pan and causes an error in the analysis. After careful inspection of the balance, the class S weight shall be analyzed again.

If the balance reading continues to deviate by more than 0.5 percent, the selected class S weight shall be analyzed on a second balance. If the second balance reports an acceptable value, the first balance shall be taken out of service and repaired by a certified technician. If the second balance also reports an unacceptable value, the class S weight shall be replaced with another class weight to determine if the weight or the balances require replacement. Appropriate action shall be taken to correct the deficiencies detected. Balances shall be inspected annually and certified as to their accuracy by qualified technicians.

5.2.6 Thermometers

All thermometers, used by Canonie's laboratory, are calibrated annually by submerging each thermometer in three separate temperature baths and noting the temperature reading of each thermometer in comparison with that of a National Bureau of Standards-certified thermometer. Each thermometer maintained at the laboratory is given an unique identification tag in order to monitor the performance of the instrument. Thermometers found to deviate more than one degree Celcius for a given range are used for non-critical work, or discarded.

5.2.7 pH Meters

The laboratory pH meters are calibrated, using a pH 7.0 buffer solution and either a pH 4.0 or pH 10.0 buffer solution, to create a two-point calibration of the electronic meter. The second buffer solution is chosen based upon the anticipated pH range of the sample to be tested. In addition to

the calibration of the pH meter, the instrument is also examined for any physical damage, and the pH probe is checked to assure that the probe tip is in good condition. Any notations with respect to damage are made in the calibration log for the instrument.

5.2.8 Conductivity Meter

Each conductivity meter is carefully inspected for damage or physical wear prior to calibration. If the coating of the electrode appears to be damaged, the electrode shall be re-platinized in accordance with the manufacturer's guidelines prior to use. The conductivity meter does not require daily calibration. However, periodically, the conductivity calibration is checked by analyzing five separate standardized solutions of potassium chloride. The calibration check is performed in accordance with Method 205.1, presented in "Standard Methods for the Examination of Water and Wastewater", 16th Edition.

5.2.9 Turbidimeter

The calibration of the turbidimeter shall be checked daily, or with each use (whichever is less frequent), by analyzing a 4 nephelometric turbidity units (NTU) formazin standard and a 40 NTU formazin standard and recording the reported readings. When the reported reading for the standards varies by more than 5 percent, the turbidimeter shall be recalibrated in accordance with Method 214 A, presented in "Standard Methods for the Examination of Water and Wastewater", 16th Edition.

5.2.10 Repeating Pipets

Repeating pipets, which are furnished and calibrated "to deliver" (TD) a specified volume of liquid shall be checked periodically for accuracy by weighing the water dispensed by the pipet during five fill-and-dispense cycles. The reported weight of the dispensed water is then compared with the theoretical weight of five pipet volumes of water. If the dispensed

weight varies by more than 0.1 percent from the theoretical, the pipets shall be removed from service in critical analytical operations.

5.2.11 Refrigerators

Since most samples received by the laboratory must be preserved at specified temperatures, it is imperative that the true operating temperature of the refrigerator is known. Each refrigerator shall be inspected daily and the temperature of the interior of the refrigerator noted and recorded in a bound notebook. The temperature of the refrigerators shall be maintained within two degrees of the required temperature, and any corrective measures required to bring the temperature of the refrigerators into compliance shall be immediately implemented.

5.2.12 Ovens

Ovens used in the analysis of samples for total suspended solids and total dissolved solids shall be checked daily for temperature. Ovens shall maintain the proper temperature, and deficiencies in temperature shall be noted and corrected. Ovens not used in the direct analysis of samples shall be monitored every six months to assure that the operating temperature range is accurate.

5.3 Preparation of Laboratory Equipment and Supplies

The calibration of instrumentation and associated equipment is useless without the provision of clean glassware and accurately prepared distilled water and reagents. Quality assurance requires that the reagents and the containers used to hold samples and reagents are free of any contamination which would compromise the integrity and representativeness of the samples. In order to track the performance of equipment and supplies and document activities related to these critical items, Canonic maintains instrumentation and reagent log books. Each day an instrument is used in the analysis of environmental samples, an entry is made in the log book of the analyses

completed, including analysis of blanks, calibrations standards, QC control samples, and environmental sample ID numbers. Additionally, any maintenance required on the equipment is noted within the instrument log book. The log book, therefore, provides a complete history of the instrument's use, performance, and maintenance record.

Additional log books are maintained on non-critical equipment which is tangentially related to the analytical work performed by the laboratory. These logs generally contain quarterly entries describing the physical condition of the equipment, and whether repair or replacement of the item is required.

The following information relates to the preparation and maintenance of laboratory equipment and stock solutions which will assure accurate, quality data.

5.3.1 Glassware

Prior to use, all glassware shall be checked for damage, such as "stars", cracks, and scratches. All laboratory glassware shall be kept scrupulously clean to assure that there will be no contamination of samples or sample extracts. Specific cleaning procedures for glassware are designated based upon the intended use of the glassware during analysis. The procedures are as follows:

5.3.1.1 Volatile Organic Compounds (VOCs)

Glassware used in VOC analysis shall be soaked in a basin of cleaning solution containing no chlorides. Palmolive dish soap is an acceptable cleaning solution. After soaking, the glassware shall be transferred to a second basin and washed using the same detergent utilized in the first basin. After thoroughly washing the glassware, the glassware shall be rinsed with tap water followed by organic-pure water. The glassware shall

then be placed into an oven and baked to ensure that all volatile compounds are removed.

5.3.1.2 Non-Volatile Organic Compounds

Glassware used in non-volatile organic compound analysis shall be soaked in a basin of cleaning solution containing no chlorides. Palmolive dish soap is an acceptable cleaning solution. After soaking, the glassware shall be rinsed and then transferred to a second basin and washed using the same detergent utilized in the first basin. After thoroughly washing the glassware, the glassware shall be rinsed with tap water, followed by a rinse using de-ionized water, followed by a rinse using a one percent solution of nitric acid, followed by a final rinse using de-ionized water. The rinsed glassware shall be inverted on a rack and allowed to air dry. After drying, the cleaned glassware shall be placed in the proper storage locations.

5.3.1.3 Inorganic Compounds

Glassware used in inorganic analyses is first rinsed with a one percent solution of nitric acid. Following the rinse, the glassware is washed with a phosphorus-free detergent, usually Alconox. Following the washing, the glassware is rinse with tap water, followed by a rinse using deionized water, followed by a rinse using a one percent solution of nitric acid, followed by a final rinse using deionized water. The glassware is then placed on a rack to air dry, and then placed in the proper storage locations.

5.3.2 Preparation of Parent Solutions

The preparation of parent solutions must be properly documented to assure that, if errors or incongruities are detected in analytical results, the source of the errors may be traced through the laboratory to all potential sources. When parent solutions are prepared, all relevant information shall be included in the Parent Solution Preparation Log maintained for the

laboratory. A sample page from this log book is included as Figure 8. Each newly prepared parent solution shall be assigned a unique code number, and all code numbers for parent solutions shall begin with the letter "P". The information pertinent to the preparation of the parent solution, including the code number, the date of preparation, the analyst's name, the code numbers of the standards and reagents utilized in the preparation, and all weights and volumes used, shall be recorded in the log book.

During the preparation of any parent solution, the calibration of any balance used in the weighing of any component shall be checked prior to utilization of the balance, regardless of previous calibration checks. After preparation of the parent solution is complete, a label shall be prepared and affixed to the bottle holding the parent solution which indicates the code number, exact contents, date of preparation, solvent, analyst's name, and expiration date. Also, a mark shall be placed on the outside of the bottle which indicates the level of solvent in the bottle. Thereafter, as significant aliquots of the parent solution are removed from the bottle, a new mark shall be placed on the bottle denoting the level of solution remaining in the bottle. The primary purpose in marking the bottle is to determine if significant losses of solution are occurring due to evaporation.

5.3.3 Preparation of Stock Standards and Quality Control Stock

Stock standards and quality control stock reagents are prepared by the laboratory using chemical stock produced commercially and certified by the manufacturer. Canonic purchases certified stock from a variety of sources to permit quality assurance testing of a particular reagent from one source against another. Commercially-certified stock mixtures are also utilized by the laboratory. All stock mixtures are periodically checked by analyzing quality assurance test samples supplied by the U.S. EPA.

A log book shall be maintained on all aspects of the purchase and preparation of stock solutions. Where laboratory staff prepare stock solutions,

the pertinent information to the preparation of the stock shall be recorded in the log book. A sample page from the Stock Standards Log Book is presented as Figure 9. After preparation of the stock solution is complete, a label shall be prepared and affixed to the bottle holding the stock solution which indicates the code number, exact contents, date of preparation, stock solution, analyst's name, and expiration date.

5.3.4 Preparation of Deionized Water

The laboratory is equipped with equipment to produce sufficient quantities of deionized water for use in all analytical work. The quality assurance program maintained for the production of deionized water includes resistivity analysis on each batch of water produced, and quarterly analysis of the water for pH, conductivity, silica content, total solids, and total organic carbon. The results of these analyses are recorded in a log book for the equipment.

5.4 General Storage and Stock Control

Proper storage of referenced standards and samples is an essential part of the analytical process. As indicated above, samples are stored, in general, in refrigerators and control of the stored samples is maintained by the sample custodian. Samples required for analysis are removed from the refrigerators through documented procedures, and after analyses are completed, the samples are returned to the sample custodian. Upon the conclusion of all analytical work, the sample custodian either contacts the client for instructions regarding the disposition of the samples, disposes of the samples in accordance with applicable regulations, or returns the samples to the originating site. The final disposition of the sample is noted in the laboratory's permanent record file for the sample.

For stock solutions used in the analysis of samples, the analyst or technician should always allow a container to come up to room temperature prior to opening the bottle. Once opened, the analyst or technician should

carefully, but expeditiously, remove the aliquot needed for purposes of analysis, and then replace the cap. After obtaining the required stock, the analyst or technician shall return the stock to storage immediately.

Since each stock solution may require special handling, the following descriptive information on stock handling is subject to modification for particular solutions.

5.4.1 Purity, Undiluted Standards

Purity, undiluted standards shall be stored in proper containers only. Preferably, each container shall contain a desiccant to absorb free water. All standards shall be stored in explosion-proof refrigerators.

5.4.2 Concentrated "Stock" Solutions

All concentrated stock solutions shall be stored at approximately 4 degrees Celsius. Stable compounds, such as organochlorines and triazines, shall be replaced semi-annually, or when degradation of solution integrity is apparent. Compounds which degrade only when exposed to ambient temperatures shall be replaced semi-annually, or when degradation of solution integrity is apparent. Unstable compounds, such as butylate, CDED, and disulfotan, shall be replaced monthly. For stock solutions of DDT and Endrin, or similar compounds, degradation analyses shall be performed in accordance with schedules established in U.S. EPA's Contract Laboratory Program protocol.

5.4.3 Dilute "Working" Solutions

Stable compounds shall be stored in refrigerators if the solutions are not in daily use. Periodically, new working solutions shall be prepared by dilution of "stock" solutions. If significant solvent evaporation is noted, the working solutions shall be discarded, and a new working solution

prepared. Stable solutions which are permanently maintained at the laboratory bench shall be replaced with fresh dilutions of "stock" solutions on a quarterly basis, or replaced with previously unopened working solutions taken from refrigerator storage. When solvent evaporation is evident, the working solution shall be discarded.

Compound solutions which are known to be unstable at ambient temperatures shall be stored in refrigerators at all times. When these solutions are required for analysis, the analyst or technician shall remove the solution from the refrigerator for only such time as is required to obtain the needed aliquot. Unstable solutions shall be replaced bimonthly, unless loss of solvent is evident and requires replacement on a more timely basis. Solutions which are unstable at any temperatures shall be stored in refrigerators between uses and shall be replaced weekly.

Solvents used in organic analyses shall be checked for purity on a periodic basis. Purity checks shall be performed by concentrating 200 ml to 1 ml and analyzing the composition. Solvents which show interferences shall not be used in analytical work.

6.0 ANALYTICAL PROCEDURES

Canonie's laboratory employs only U.S. EPA-approved methods in the analysis of environmental samples, or, when required by particular agencies to which the client is responsible, approved methodologies published by the particular agency involved. Most of the procedures utilized by Canonie's laboratory are taken from the following publications:

- o Test Methods for Evaluating Solid Waste - Physical/Chemical Methods, SW-846 (3rd Edition, 1986);
- o Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020;
- o Standard Methods for the Examination of Water and Wastewater, APHA-AWWA-WPCF (16th Edition, 1985).

Additional procedures are received from the clients served by the laboratory or from state regulatory agencies. Tables 2 through 27 list the more common methods utilized for analysis of soils and water, together with the detection limits typically achieved in the analysis of samples with low concentrations of chemical constituents. Also included with each table are details on appropriate sample containers, shipping requirements, acceptable holding times, and the method of analysis.

7.0 DATA REVIEW AND REPORTING

All data generated by Canonie's laboratory are reviewed to assure that appropriate quality assurance objectives are met in the performance of the requested analysis. The quality assurance program at the laboratory requires that all analytical data are reviewed by at least two chemists within each of the various analytical sections within the laboratory. If a second chemist is unavailable to review the work, the QA officer shall complete the second review. In addition to this mandatory data review, the QA officer shall randomly review work from each analytical section to verify that the documentation is complete and the reported results comply with applicable quality assurance criteria.

In reviewing the work selected at random, the QA officer shall evaluate whether:

1. The calculations, identification, and reported units are correct;
2. All results obtained for the samples were within the working calibration range of the instrument, or were diluted properly and then analyzed within the working calibration range;
3. The QC results meet acceptance criteria established for the analysis.

If the data and/or QC results are unacceptable, the analyst must determine the cause for the unacceptability of the data prior to performing any further analysis, and prior to releasing the results of analysis. In the event that the QC results fall outside the control limits established for the analysis, a QA/QC comment sheet, presented as Figure 10, shall be completed and signed by the section chief, analyst, and the QA officer, with notations from each on the cause for the unacceptable QC results.

If the data and QC results are acceptable, the analyst performing the work shall initial the tracking sheets, bench sheets, and/or other generated data. The complete data package shall then be transferred to the chemist completing the second data review for his/her evaluation and approval. Upon completion of the review by the second chemist, the data package shall be assembled for final review. All analytical results from each section shall be assembled into one data package, and the full package shall be reviewed by the Laboratory Supervisor to assure that all information, resulting conclusions, and reported data for the project are properly documented, statistically valid, and meet the requirements of the client.

After final approval by the Laboratory Supervisor, the package shall be sent to the data control section to be typed. After typing, the report is proofread by the administrator, and returned to the chemists performing the analyses and reviewing the data for final signature. Only after these review and approval procedures have been completed may the report issue to the client and appropriate regulatory agencies. Finally, the accounting department receives the report and prepares an invoice covering the work.

8.0 QUALITY CONTROL

The quality control program is the most essential element in the laboratory quality assurance program for evaluating the performance of analytical measurements. The quality control program involves the analysis of blank, duplicate, and spiked samples in conjunction with the analysis of environmental samples. Since the analyst knows that blank samples should not contain any chemical constituents and that spiked samples have a known concentration of a selected constituent, the performance of the analysis can be measured by comparing the reported values for the blanks and spiked samples with the known values. Duplicate samples allow the analyst to assess the consistency of the work, since duplicate samples, by definition, should yield identical values. In general, a blank, duplicate, and spiked sample is included in each set of ten samples analyzed.

8.1 Blank Sample Analysis

There are several types of blank samples which may be included with an analytical sample set. These blank sample types include reagent blanks, travel or trip blanks, and field blanks. Each type of blank is used to determine whether sample integrity has been compromised through the introduction of extraneous constituents. The preparation and analysis of these blanks are described below.

8.1.1 Reagent Blank

A reagent blank is prepared using deionized water, purified soil, solvents, acids, or other reagents used in the preparation and analysis of the environmental samples. All analyses are completed with at least one reagent blank in the analytical sample set in order to verify that any positive results reported in the analysis are not due to contamination from the laboratory. Reported concentrations of any constituent above minimal

detection levels indicates that process contamination has occurred and that immediate corrective action is warranted.

8.1.2 Travel Blank

A travel blank is prepared by the laboratory and transported to the field with the shipment of empty sampling containers, or separately if sampling containers are obtained locally. The travel blank is handled at the site in the same manner as the samples originating from the site, e.g., the sample is placed in the cooler at the during sampling, and is labeled and recorded on the chain-of-custody form. The purpose of the travel blank is to determine whether sample integrity is compromised during transportation. Travel blanks, therefore, allow the analyst to determine the nature of the environment in which the samples were transported, and whether any contamination of the samples occurred during shipment. If contamination is noted in the travel blanks, the procedures for handling samples during packing and the means of transport for the samples must be evaluated. This may require monitoring or altering transport methods in order to eliminate the source of the contamination.

8.1.3 Field Blank

A field blank is prepared at the sampling site and returned to the laboratory with the other environmental samples. The labeling of the field blank should not disclose that the sample is a field blank. Since the field blank is exposed to the same handling and field conditions as all other samples, the field blank allows an evaluation of the procedures followed by sampling personnel. If the field blank shows contamination, field personnel must re-evaluate the performance of their work or the procedures being followed.

8.2 Spiked Samples

In order to assure the accuracy of the analytical procedures, an environmental sample is randomly selected, from each sample shipment received at the laboratory, and spiked with a known amount of the analyte, or analytes, to be evaluated. In general, a sample spike should be included in every set of ten samples tested on each instrument. The spike sample is then analyzed. The increase in concentration of the analyte observed in the spiked sample, due to the addition of a known quantity of the analyte, compared to the reported value of the same analyte in the unspiked sample determines the percent recovery. Daily control charts are plotted for each commonly analyzed compound and kept on instrument-specific, matrix-specific, and analyte-specific bases. Figure 11 illustrates a daily control chart form for maintaining this information. The percent recovery for a spike sample is calculated according to the following formula:

$$\text{Percent Recovery} = \frac{\text{Amount in Spiked Sample} - \text{Amount in Sample}}{\text{Known Amount Added}} \times 100$$

8.3 Duplicate Analysis

The preferred method of duplication at Canonie's laboratory is the analysis of a duplicate spike sample. Additionally, U.S. EPA method protocol requires that a duplicate analysis of all spiked samples be incorporated into the analysis of environmental samples. Spiked samples are prepared by choosing a sample at random from each sample shipment received at the laboratory, dividing the sample into equal aliquots, and then spiking each of the aliquots with a known amount of analyte. For water samples, the analyst spikes each aliquot separately; however, for soils analysis, the extract of the soil sample is spiked and the spiked extract is then divided into equal aliquots for subsequent analysis. The duplicate samples are then included in the analytical sample set. The splitting of the sample allows the analyst to determine the precision of the preparation and analytical techniques associated with the duplicate sample. The relative percent difference (RPD) between the spike and duplicate spike are calculated

and plotted in a form as shown on Figure 12. The relative percent difference is calculated according to the following formula:

$$\text{RPD} = \frac{\text{Amount in Spike 1} - \text{Amount in Spike 2}}{[0.5(\text{Amount in Spike 1} - \text{Amount in Spike 2})]} \times 100$$

8.4 Measurement of Method Detection Limits

The laboratory re-evaluates, periodically, the method detection limits (MDLs) achievable for each matrix type and each method commonly utilized in analytical work. The MDL is defined as the minimum concentration of a substance that can be identified, measured, and reported with 99 percent confidence. To determine the MDLs, the methods prescribed by the U.S. EPA are employed for each analytical method and matrix type. In general the procedure to be used is as follows:

1. If the MDL is to be determined for aqueous samples, a laboratory standard, with a concentration of 1 to 5 times that of the estimated MDL, is prepared and analyzed. For other matrices, a laboratory standard, with a concentration of 5 to 10 times that of the estimated MDL, is prepared and analyzed.
2. The prepared standard is analyzed six additional times.
3. The MDL for the method and matrix is calculated by determining the standard deviation of the results of all seven analyses, and multiplying the standard deviation by a factor of 3.143.

9.0 ESTABLISHMENT OF ACCEPTABLE LIMITS

In addition to establishing the accuracy and precision of the analysis of various analytes in various matrices, quality control requires that the overall, continuing ability of the analysts to produce quality data be assessed. The historical capability of the laboratory to produce quality data is determined through trend analysis on the relative percent differences and percent recoveries reported for the laboratory. In general, the trend analysis requires that at least 20 spike and duplicate samples be analyzed for each analyte and in each matrix. However, when an analyte is not encountered consistently or is analyzed during only one project, a trend analysis may be completed using as few as five data points.

The trend analysis for quality control is completed by constructing a control chart or \bar{X} chart. The simple, statistical methods utilized in the construction of the charts enable the QA officer to detect trends in sample analysis, and thereby determine whether analyst errors, standards degradation, and/or instrument drift may be affecting the quality of data produced by the laboratory. The following information presents the accepted method of constructing a control chart, and the method which Canonie's laboratory utilizes in its quality assurance program.

9.1 Procedure for the Construction of a Control Chart

When a quality control sample of known concentration is analyzed a number of times, a series of analytical results are received which should bracket the known concentration in a Gaussian, or normal, distribution. To assess this distribution, several simple, statistical calculations must be completed. These calculations are defined as follows:

- o The average (\bar{X}) is the sum of the results divided by the number of results, n.

$$\bar{X} = [\Sigma (x)]/n$$

- o The standard deviation (σ) is an indication of the spread of the results from the mean, i.e., the precision of the analysis. The standard deviation is defined as the square root of the sum of the differences between the average and each result, squared, divided by one less than the number of analyses completed.

$$\sigma = [\Sigma(x-\bar{x})^2/(n-1)]^{0.5}$$

If the results of analysis are normally distributed, the proportion of the results lying within any given range is related to the standard deviation. That is, 68 percent of the observations lie within $\bar{X} \pm \sigma$, 95 percent of the observations lie within $\bar{X} \pm 2\sigma$, and 99 percent of the observations lie within $\bar{X} \pm 3\sigma$, for large numbers of samples. This relationship becomes more precise as the number of samples, n , increases, but is suitable for smaller populations as well (approximately 20 or more).

Once at least 20 quality control samples have been analyzed, and the mean and standard deviation calculated, the QA officer should be able to predict the limits within which any further analysis of quality control samples will fall, if the analysis is performed under identical conditions. For example, if a quality control sample contains a particular analyte in a concentration of 10.0 ppb, 20 analyses of the sample may produce an average value of 9.9 ppb, and a standard deviation of 1.0 ppb. Further analysis of the quality control sample should yield results which fall within the range of 9.9 ± 2.0 , or from 7.9 to 11.9, for 95 percent of the analyses. Similarly, 99 percent of the results should fall within the range of 9.9 ± 3.0 , or from 6.9 to 12.9. These two ranges, defined as the 95 percent confidence range and the 99 percent confidence range, are used as limits. The upper and lower warning limits are $\bar{X} \pm 2.0\sigma$, and the upper and lower control limits are defined by $\bar{X} \pm 3.0\sigma$.

These limits can be used to construct a chart defining when an analysis is "in control". Figure 12 presents a typical control chart produced by the laboratory. In order to construct a control chart, the analyst must complete the following steps:

1. Analyze a quality control sample, of known concentration and analyte composition, at least 20 times. This analysis does not normally occur separately, but rather, the analyst utilizes the reported results from quality control samples included in environmental sample sets.
2. Collate the results, and compute the mean (\bar{X}), and the standard deviation, σ .
3. Set the upper warning limit at $\bar{X} + 2.0\sigma$ and the lower warning limit at $\bar{X} - 2.0\sigma$.
4. Set the upper control limit at $\bar{X} + 3.0\sigma$ and the lower control limit at $\bar{X} - 3.0\sigma$.
5. Draw a control chart which delineates the average and the four limits determined in steps 3 and 4, above.
6. Plot each subsequently obtained quality control sample result on the chart to demonstrate the precision of the analysis.

The precision and accuracy data for Methods 8240, 8270, 8010, 8020, 8080, and for total priority pollutant metals are presented in Tables 28 through 33.

10.0 ACCEPTANCE CRITERIA AND PROBLEMS

When an analysis is being performed, the analyst must verify immediately that the results generated for the quality control samples falls within the acceptance limits for that analysis.

The quality control sample indicates acceptable analysis values when it falls between the lower warning limit (LWL) and the upper warning limit (UWL). As long as the quality control sample falls within these limits, the analysis will continue and results will be released to the client. If the quality control sample value falls between the control limit and warning limit (UCL and UWL or LCL and LWL), the analysis should be scrutinized as possibly out-of-control. The sample results are still acceptable at this point, however, if the control sample value remains between the control limit and warning limit for 5 consecutive days, the analysis is stopped and no data is released until the problem is resolved.

If the quality control sample value falls outside the control limits (UCL or LCL), this indicates an out-of-control situation. The analysis is stopped and no data is released until the reason for the problem has been identified and resolved. When an out-of-control situation occurs, the analyst is required to fill out a QA/QC comment sheet (see Figure 10) and submit it to both their immediate supervisor and the Quality Assurance Officer. After the problem has been corrected and shown that acceptable results are once again produced, samples will once again be analyzed and the data will be released. Depending on the type of problem encountered, the problem and its solution will be documented.

Not only are the control charts used to monitor the performance of the laboratory, the Quality Assurance Officer also monitors the laboratory performance by releasing blind quality assurance samples and by randomly reviewing particular analysis. In the event that the Quality Assurance Officer spots unacceptable practices, a formal notice (Figure 10) is issued

to the laboratory manager and the section supervisor in which the corrective actions must be implemented. The section supervisor must respond to the formal notice and correct any deficiencies.

Precision, Accuracy and Relative Error:

Precision refers to the reproducibility of a method when it is repeated on a homogeneous sample under controlled conditions.

The precision or reproducibility of a method shall be expressed on a percentage of the mean and is termed the relative standard deviation or coefficient of variation:

$$C_v = \frac{100\sigma}{\bar{x}}$$

Where: C_v = Relative standard deviation or coefficient of variation

σ = standard deviation

\bar{x} = mean

Relative error expresses the difference between the measured and the actual amounts:

$$\text{relative error} = \frac{X - TV}{\bar{x}}$$

Where: X = observed value

TV = true value

\bar{x} = mean

Therefore, relative error represents the measure of accuracy of a method.

11.0 PERFORMED AND SYSTEM AUDITS

Canonie Environmental Services Laboratory routinely analyzes performance audit samples from New York State Department of Health, for potable and non-potable water, and U.S. EPA, for both the drinking water (WS series) and wastewater (WP series) samples.

Certified reference materials are purchased from the National Bureau of Standards for metals in sediment-like matrixes. Additional reference material is acquired from the U.S. EPA Quality Assurance Materials Book. Current laboratory certification include:

1. California DOHS certification for the analysis of Hazardous Waste.
2. California Department of Health Service, Sanitation and Radiation, approved water laboratory certification for General Chemical and Organic Chemical.
3. New York State Department of Health certification for potable water and non-potable water analysis.

12.0 REVIEW OF ANALYTICAL RESULTS BY THE QUALITY ASSURANCE OFFICER

The function of the Quality Assurance Officer is to assure that the quality of the service delivered to the client meets the highest possible standard of quality, through the control of handling and analytical procedures performed on the samples. Should the acquired data be of suspect quality, it is the duty of the Quality Assurance Officer to halt its release.

Outlined is the functions and responsibilities performed by the Quality Assurance Officer:

1. Coordinate proficiency testing for laboratory approval programs.
2. Coordinate any on-site QA/QC inspections.
3. Prepare and update QA/QC plans.
4. Assist in the development of new analytical methods and techniques.
5. Assist in the development and planning of QA/QC documents and programs with the Project Engineer on a project-by-project basis.
6. With the QC committee continue to develop and implement a QC program.
7. Monitor the sections for compliance to the QA/QC program by:
 - a. Reviewing standard storage and preparation.
 - b. Reviewing instrument log books.
 - c. Reviewing QC documentation for completeness.
 - d. Reviewing sample storage.

8. Analyze data generated from in-house QC check samples.
9. Advise personnel on laboratory procedures.
10. Advise personnel when problems are encountered with an analysis.
11. Respond to inquiries made regarding laboratory QA/QC related activities.

Responsibilities: The Quality Assurance Officer will:

1. Identify and refer any instances in which QC objectives are not being met to the section heads and laboratory manager for remedial actions.
2. Assure that suspect data are not included in laboratory reports.
3. Follow up on the remedial actions undertaken in response to the above referrals to assure that QC objectives are once again being met.
4. Inspect corrective action reports for out-of-control events.
5. Prepare a monthly QA report summarizing any warning sheets issued, corrective actions taken, unresolved problems, and overall QC activities of the laboratory.

A monthly QA report is then submitted to the Manager of Laboratory Services, Ken Wahl. He reviews the progress of the laboratory, makes his recommendations and goals for the next month. The monthly QA report is submitted to the Executive Vice President, Phillip E. Antommara.

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TABLES

FINAL
QUALITY ASSURANCE PROJECT PLAN (QAPP)
QUALITY ASSURANCE/QUALITY CONTROL PLAN
(QA/QC)

DATED 01 MAY 1989

Parameter	Collection Technique	Container	Volume (ml)	Preservation	Holding Time	Method Technique	Method	Detection Limit PPM
Acidity	Grab or Composite	P,G	100	Cool, 4 degrees C	14 days	Potentiometry	305.2	1.0
Alkalinity	Grab or Composite	P,G	100	Cool, 4 degrees C	14 days	Potentiometry	310.1	1.0
Ammonia	Grab or Composite	P,G	400	H2SO4 to pH <2	28 days	Spectrophotometry	SM 417B	0.1
BOD	Grab only	P,G	1000	Cool, 4 degrees, C	48 hours	Membrane Electraclac	405.1	1.0
Bacteria	Grab only	P,G	200	Cool, 4 degrees C, 10% Na2S2O3, EDTA	6 hours	5 tube MPN	SM 908	2.2
Bicarbonate/Carbonate	Grab only	P,G	100	Determine onsite	No holding	Titrimetry	ASTM D513C	5.0
Boron	Grab or Composite	P,G	100	Cool, 4 degrees C	7 days	Spectrophotometry	ASTM 3082	0.1
Bromide	Grab or Composite	P,G	100	None required	28 days	Spectrophotometry	320.1	1.0
COD	Grab only	P,G	50	H2SO4 to pH <2; Cool 4 degrees C	28 days	Digestion	410	10.
Calorimetry	Grab or Composite	P,G	100	Cool, 4 degrees C		Parr Bomb		
Carbon dioxide	Grab only	P,G	100	Cool, 4 degrees C	24 hours	Titrimetry	ASTM D513C	1.0
Chloride	Grab or Composite	P,G	50	None required	28 days	Titrimetry	325.3	1.0
Color	Grab or Composite	P,G	50	Cool, 4 degrees C	48 hours	Visual Comparison	110.2	1.0
Conductance	Grab or Composite	P,G	100	Cool, 4 degrees C	28 days	Conductivity, Meter	120.1	
Corrosivity	Grab or Composite	G	1000	Cool, 4 degrees C		Corrosivity toward Steel	1110	

* Note: P = Plastic Container, G = Glass Container

TABLE 1

Parameter	Collection Technique	Container	Volume (ml)	Preservation	Holding Time	Method Technique	Method	Detection Limit PPM
Cyanide	Grab or Composite	P,G	500	NaOH to pH>12, 0.6g Ascorbic Acid	14 days	Distillation	9010	0.02
Fluoride	Grab or Composite	P	300	None Required	28 days	Specific Ion Electrode	340.2	0.1
Hardness	Grab or Composite	P,G	100	HNO3 to pH <2	6 months	Titrimetry	130.2	1.0
Hexavalent Chromium	Grab or Composite	P,G	100	Cool, 4 degrees C	24 hours	Spectrophotometry	SM 312.3	0.005
Hydroxide	Grab or Composite	P,G	100	Cool, 4 degrees C	14 days	Titrimetry	ASTM D 514	1.0
Ignitability (Flash Point)	Grab or Composite	G	200	Cool, 4 degrees C		Closed Cap	1010	
Metals Suspended (except Cr VI)	Grab or Composite	P,G	1000	Filter onsite	6 months, except Hg--28 days	Atomic Absorption	200.	See pg. 32-34
Metals, Dissolved (except Cr VI)	Grab or Composite	P,G	1000	Filter onsite, HNO3 to pH <2	6 months, except Hg--28 days	Atomic Absorption	200.	See pg. 32-34
Metals, Total (except Cr VI)	Grab or Composite	P,G	1000	HNO3 to pH <2	6 months, except Hg--28 days	Atomic Absorption	200.	See pg. 32-34
Nitrate	Grab or Composite	P,G	100	Cool, 4 degrees C H2SO4 to pH < 2	48 hours 28 days	Spectrophotometry	353.3	0.05
Nitrite	Grab or Composite	P,G	50	Cool, 4 degrees C	48 hours	Spectrophotometry	354.1	0.005
Nitrogen, Kjeldahl (total)	Grab or Composite	P,G	500	HNO3 to pH <2	28 days	Distillation, Titrimetry	351.3	0.1
Odor	Grab only	G	200	Cool, 4 degrees C	24 hours	Sensory Detection	140.1	1.0
Oil & Grease	Grab only	G	1000	Cool 4 degrees C H2SO4 to pH <2	28 days	Extraction, Gravimetry	413.1	1.0

* Note: P = Plastic Container, G = Glass Container

TABLE 1
(Continued)

Parameter	Collection Technique	Container	Volume (ml)	Preservation	Holding Time	Method Technique	Method	Detection Limit PPM
Organic Lead	Grab or Composite	G	1000	Cool, 4 degrees C		MIBX Extraction		
Oxygen (dissolved)	Grab only	G	300	None	Analyze Immediately	Membrane Electrode	360.1	0.1
Percent Moisture	Grab or Composite	P,G	50 gms	Cool, 4 degrees C		Oven drying		
pH	Grab only	P,G	25	None	Analyze Immediately	pH Meter	150.1	---
Phosphates, Ortho	Grab or Composite	P,G	50	Cool, 4 degrees C	48 hours	Spectrophotometry	365.2	0.01
Phosphorus, Total	Grab or Composite	P,G	50	H2SO4 to pH <2	28 days	Spectrophotometry	365.4	0.01
Salinity	Grab or Composite	P,G	500	Cool, 4 degrees C	28 days	Hydrometer	SM 210 B	
Silica	Grab or Composite	P	50	Cool, 4 degrees C	28 days	Spectrophotometry	370.1	0.05
Solids Total Dissolved	Grab or Composite	P,G	100	Cool, 4 degrees C	7 days	Gravimetry	160.1	1.0
Solids Total Settleable	Grab or Composite	P,G	1000	Cool, 4 degrees C	48 hours	Gravimetry	160.5	0.5
Solids Total	Grab or Composite	P,G	100	Cool, 4 degrees C	7 days	Gravimetry	160.3	1.0
Solids Total Suspended	Grab or Composite	P,G	100	Cool, 4 degrees C	7 days	Gravimetry	160.2	1.0
Specific Gravity	Grab only	P,G	100	None	28 days	Pycnometer	ASTM D1429	---
Sulfate	Grab or Composite	P,G	50	Cool, 4 degrees C	28 days	Nephelometry	375.4	1.0

TABLE 1
(Continued)

* Note: P = Plastic Container, G = Glass Container

Parameter	Collection Technique	Container	Volume (ml)	Preservation	Holding Time	Method Technique	Method	Detection Limit PPM
Sulfide	Grab or Composite	P,G	500	Cool, 4 degree C, 2ml zinc acetate & NaOH	7 days	Titrimetry	376.1	1.0
Sulfite	Grab or Composite	P,G	50	Determine onsite	No holding	Titrimetry	377.1	2.0
Surfactants (MBAS)	Grab or Composite	P,G	250	Cool, 4 degrees C	48 hours	Extraction Spectrophotometry	425.1	0.05
Total Organic Carbon (TOC)	Grab or Composite	G, Teflon-lined cap	25	Cool, 4 degrees C HCl to pH <2	28 days	Combustion-Infrared	SM 505	1.0
Total Organic Halogens (TOX)	Grab or Composite	G, Amber Teflonline	100	Cool, 4 degrees C add 1ml 0.1M Na sulfite	7 days	TOX Instrumentation		
Tannins & Lignins	Grab or Composite	P,G	100	None	48 hours	Spectrophotometry	SM 513	0.1
Turbidity	Grab or Composite	P,G	100	Cool, 4 degrees C	48 hours	Nephelometry	180.1	0.01

TABLE 1
(Continued)

* Note: P = Plastic Container, G = Glass Container

TABLE 2
Purgeable Halocarbons

<u>Analytes</u>	<u>Detection Limits</u>	
	<u>Water (mg/l)</u>	<u>Soil (mg/kg)</u>
✓ Bromodichloromethane	0.0005	0.02
✓ Bromoform	0.0005	0.02
✓ Bromomethane	0.0005	0.02
✓ Carbon tetrachloride	0.0005	0.02
Chlorobenzene	0.0005	0.02
Chloroethane	0.0005	0.02
2-Chloroethylvinyl ether	0.0005	0.02
✓ Chloroform	0.0005	0.02
Chloromethane	0.0005	0.02
Dibromochloromethane	0.0005	0.02
1,2-Dichlorobenzene	0.0005	0.02
1,3-Dichlorobenzene	0.0005	0.02
1,4-Dichlorobenzene	0.0005	0.02
Dichlorodifluoromethane	0.0005	0.02
✓ 1,1-Dichloroethane	0.0005	0.02
✓ 1,2-Dichloroethane	0.0005	0.02
✓ 1,1-Dichloroethene	0.0005	0.02
trans-1,2-Dichloroethene	0.0005	0.02
✓ 1,2-Dichloropropane	0.0005	0.02
cis-1,3-Dichloropropene	0.0005	0.02
✓ trans-1,3-Dichloropropene	0.0005	0.02
1,1,2,2-Tetrachloroethane	0.0005	0.02
Tetrachloroethene	0.0005	0.02
1,1,1-Trichloroethane	0.0005	0.02
✓ 1,1,2-Trichloroethane	0.0005	0.02
✓ Trichloroethene	0.0005	0.02
Trichlorofluoromethane	0.0005	0.02
✓ Vinyl chloride	0.0005	0.02
Methylene chloride	0.0005	0.02

TABLE 2
(Continued)
Purgeable Halocarbons

<u>Other analytes available upon request</u>	<u>Additional increase per analyte</u>
Freon	10%
cis-1,2-Dichloroethene	10%
EDB	10%

Water

Analysis: Method 601

Sampling container: Specially prepared 40 ml volatiles vials, taken in triplicate.

Reference: Method for Organic Chemical Analysis of Municipal and Industrial Wastewater, PB83-201798, Method 601, U. S. Environmental Protection Agency, Cincinnati, Ohio, July 1982.

Soil

Analysis: Method 8010

Sampling Container: Air tight completely full brass tube, or 40 ml vial

Reference: Test Method for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, Method 8010, U. S. Environmental Protection Agency, 1982.

Shipping requirements: Packed in an iced cooler, with chain-of-custody.

Acceptable holding time to analysis: 14 days.

Method of analysis: Gas Chromatography.

TABLE 3
Purgeable Aromatics

<u>Analytes</u>	<u>Detection Limits</u>	
	<u>Water (mg/l)</u>	<u>Soil (mg/kg)</u>
Benzene	0.005	0.2
Chlorobenzene	0.005	0.2
1,2-Dichlorobenzene	0.005	0.2
1,3-Dichlorobenzene	0.005	0.2
1,4-Dichlorobenzene	0.005	0.2
Ethylbenzene	0.005	0.2
Toluene	0.005	0.2
Xylene	0.005	0.2
<u>Other analytes available upon request</u>		
	<u>Additional increase per analyte</u>	
Acetone	10%	
Isopropyl Alcohol	10%	
Other Volatile Hydrocarbons (PID detector)	10%	
Other Volatile Hydrocarbons (FID detector)	50%	

Water

Analysis: Method 602

Sampling container: Specially prepared acidified 40 ml volatiles vials, taken in triplicate.

Reference: Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater, PB83-201798, Method 602 and 624, U. S. Environmental Protection Agency, Cincinnati, OH, July 1982.

Soil

Analysis: Method 8020

Sampling container: Air tight completely full brass tube, or 40 ml vial

Reference: Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, Method 8020, U. S. Environmental Protection Agency, 1982.

Shipping requirements: Packed in an iced cooler, with chain-of-custody.

Acceptable holding time to analysis: 14 days.

Method of analysis: Gas Chromatography

TABLE 4
Phenols

<u>Analytes</u>	<u>Detection Limits</u>	
	<u>Water (mg/l)</u>	<u>Soil (mg/kg)</u>
4-Chloro-3-methylphenol	0.001	10.
2-Chlorophenol	0.008	10.
2,4-Dichlorophenol	0.008	10.
2,4-Dimethylphenol	0.008	10.
2,4-Dinitrophenol	0.005	10.
2-Methyl-4,6-dinitrophenol	0.003	10.
2-Nitrophenol	0.005	10.
4-Nitrophenol	0.005	10.
Pentachlorophenol	0.005	10.
Phenol	0.008	10.
2,4,6-Trichlorophenol	0.001	10.
<u>Other analytes available upon request</u>	<u>Additional increase per analyte</u>	
Tetrachlorophenol	10%	

Water

Analysis: Method 604

Sampling container: Specially prepared one liter bottle, taken in triplicate.

References: Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater, PB83-201798, Method 604, U. S. Environmental Protection Agency, Cincinnati, OH, July 1982.

Varian Liquid Chromatography Procedure #96, Determination of Trace Levels of Phenols in Water, Varian Instruments, Walnut Creek, California.

Soil

Analysis: Method 8040

Sampling container: Specially prepared mason jar or brass tube (200 g. required).

References: Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, Method 8040, U. S. Environmental Protection Agency, 1982.

Varian Liquid Chromatography Procedure #96, Determination of Trace Levels of Phenols in Water, Varian Instruments, Walnut Creek, California.

TABLE 4
(Continued)
Phenols

Shipping requirements: Packed in an iced cooler, with chain-of-custody.
Samples are extracted within 7 days and completely analyzed within 30 days of collection.

Method of analysis: Liquid and Gas Chromatography.

TABLE 5
Organochlorine Pesticides

<u>Analytes</u>	<u>Detection Limits</u>	
	<u>Water (ug/l)</u>	<u>Soil (mg/kg)</u>
Aldrin	0.05	0.01
Alpha-BHC	0.05	0.01
Beta-BHC	0.05	0.01
Delta-BHC	0.05	0.01
Gamma-BHC	0.05	0.01
Chlordane	0.5	0.05
4,4'-DDD	0.05	0.01
4,4'-DDE	0.05	0.01
4,4'-DDT	0.05	0.01
Dieldrin	0.05	0.01
Endosulfan I	0.05	0.01
Endosulfan II	0.05	0.01
Endosulfan sulfate	0.05	0.01
Endrin	0.05	0.01
Endrin aldehyde	0.05	0.01
Heptachlor	0.05	0.01
Heptachlor epoxide	0.05	0.01
Toxaphene	5.	0.5
PCB-1016	0.5	0.01
PCB-1221	0.5	0.01
PCB-1232	0.5	0.01
PCB-1242	0.5	0.01
PCB-1248	0.5	0.01
PCB-1254	0.5	0.01
PCB-1260	0.5	0.01
<u>Other analytes available upon request</u>	<u>Additional increase per analyte</u>	
DBCP	10%	
Methoxychlor	10%	

TABLE 5
(Continued)
Organochlorine Pesticides

Water

Analysis: Method 608

Sampling container: Specially prepared one liter sample bottles, taken in triplicate.

Reference: Method for Organic Chemical Analysis of Municipal and Industrial Wastewater, PB 83-201796, Method 608, U. S. Environmental Protection Agency, Cincinnati, OH, July 1982.

Soil

Analysis: Method 8080

Sampling container: Specially prepared mason jar or brass tube (200 g soil required).

Reference: Test Method for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, Method 8080, U. S. Environmental Protection Agency, 1982.

Shipping requirements: Packed in an iced cooler, with chain-of-custody.

Samples are extracted within 7 days and completely analyzed within 30 days of collection.

Method of analysis: Gas Chromatography.

TABLE 6
PCB's (Polychlorinated Biphenyls)

<u>Analytes</u>	<u>Detection Limits</u>	
	<u>Water (ug/l)</u>	<u>Soil (mg/kg)</u>
PCB-1016	0.5	0.05
PCB-1221	0.5	0.05
PCB-1232	0.5	0.05
PCB-1242	0.5	0.05
PCB-1248	0.5	0.05
PCB-1254	0.5	0.05
PCB-1260	0.5	0.05

Water

Analysis: Method 608.3

Sampling container: Specially prepared one liter sample bottles, taken in triplicate.

Reference: Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater, PB83-201796, Method 608, U. S. Environmental Protection Agency, Cincinnati, OH, 1982.

Soil

Analysis: Method 8080.3

Sampling container: Specially prepared mason jar or brass tube (200 g soil required).

Reference: Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, Method 8080, U. S. Environmental Protection Agency, 1982.

Shipping requirements: Packed in an iced cooler, with chain-of-custody.

Samples are extracted within 7 days and completely analyzed within 30 days of collection.

Method of analysis: Gas Chromatography.

TABLE 7
PCB'S in Oil

<u>Analytes</u>	Detection Limits
	<u>Oil (mg/kg)</u>
PCB-1016	5.
PCB-1221	5.
PCB-1232	5.
PCB-1242	5.
PCB-1248	5.
PCB-1254	5.
PCB-1260	5.

Oil

Analysis: Method PCB Oil

Sampling container: Two 20-40 ml Vials, teflon or foil lined cap (provide at least 15 ml volume).

Reference: EPA Test Method for the Determination of Polychlorinated Biphenyls in Transformer Fluid and Waste Oils, EPA-600/4-81-045, U. S. Environmental Protection Agency, Cincinnati, OH, September 1982.

Shipping requirements: Securely packed in a leak proof container with chain-of-custody.

Acceptable holding time to analysis: 28 days.

Method of analysis: Gas Chromatography.

TABLE 3
Polynuclear Aromatic Hydrocarbons

<u>Analytes</u>	<u>Detection Limits</u>	
	<u>Water (mg/l)</u>	<u>Soil (mg/kg)</u>
Acenaphthene	0.01	1.
Acenaphthylene	0.01	1.
Anthracene	0.01	1.
Benzo (a) anthracene	0.01	1.
Benzo (a) pyrene	0.01	1.
Benzo (b) fluoranthene	0.01	1.
Benzo (g,h,i) perylene	0.01	1.
Benzo (k) fluoranthene	0.01	1.
Chrysene	0.01	1.
Dibenzo (a,h) anthracene	0.01	1.
Fluoranthene	0.01	1.
Fluorene	0.01	1.
Indeno (1,2,3-cd) pyrene	0.01	1.
Naphthalene	0.01	1.
Phenanthrene	0.01	1.
Pyrene	0.01	1.

Water

Analysis: Method 610

Sampling container: Specially prepared one liter sample bottles, taken in triplicate.

Reference: Method for Organic Chemical Analysis of Municipal and Industrial Wastewater, PB 83-201798, Method 610, U. S. Environmental Protection Agency, Cincinnati, OH, July 1982.

Soil

Analysis: Method 8100

Sampling container: Specially prepared mason jar or brass tube (200 g soil required).

Reference: Test Method for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, Method 8100, U. S. Environmental Protection Agency, 1982.

TABLE 8
(Continued)

Polynuclear Aromatic Hydrocarbons

Shipping requirements: Packed in an iced cooler, with chain-of-custody.
Samples are extracted within 7 days and completely analyzed within 30 days of collection.

Method of analysis: Gas and Liquid Chromatography.

TABLE 9
Chlorinated Hydrocarbons

<u>Analytes</u>	<u>Detection Limits</u>	
	<u>Water (mg/l)</u>	<u>Soil (mg/kg)</u>
2-Chloronaphthalene	0.001	0.1
1,2-Dichlorobenzene	0.0015	0.15
1,3-Dichlorobenzene	0.0015	0.15
1,4-Dichlorobenzene	0.0015	0.15
Hexachlorobenzene	0.0005	0.1
Hexachloroethane	0.0005	0.1
1,2,4-Trichlorobenzene	0.0005	0.1
Hexachlorocyclopentadiene	0.001	0.1
Hexachlorobutadiene	0.001	0.1

Water

Analysis: Method 612

Sampling container: Specially prepared one liter sample bottles, taken in triplicate.

Reference: Method for Organic Chemical Analysis of Municipal and Industrial Wastewater, PB 83-201798, Method 612, U. S. Environmental Protection Agency, Cincinnati, OH, July 1982.

Soil

Analysis: Method 8120

Sampling container: Specially prepared mason jar or brass tube (200 g soil required).

Reference: Test Method for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, Method 8120, U. S. Environmental Protection Agency, 1982.

Shipping requirements: Packed in an iced cooler, with chain-of-custody.

Samples are extracted within 7 days and completely analyzed within 30 days of collection.

Method of analysis: Gas Chromatography.

TABLE 10
Chlorinated Herbicides

<u>Analytes</u>	<u>Detection Limits</u>	
	<u>Water (mg/l)</u>	<u>Soil (mg/kg)</u>
2,4-D	0.02	0.02
2,4,5-TP	0.02	0.02
<u>Other analytes available upon request</u>		
2,4,5-T	Additional increase per analyte 10%	
Dinoseb	10%	

Water

Analysis: Method 615

Sampling container: Specially prepared one liter sample bottles (amber), taken in triplicate.

Reference: Determination of Chlorinated Herbicides in Industrial and Municipal Wastewater, EPA-600/4-82-005, Method 615, EMSL, U. S. Environmental Protection Agency, Cincinnati, OH, July 1982.

Varian Liquid Chromatography Procedure #88, Reverse Phase Separation of 2,4-D and Silvex in Waste Water, Varian Instruments, Walnut Creek, California.

Soil

Analysis: Method 8150

Sampling container: Specially prepared mason jar or brass tube (200 g soil required).

Reference: Test Method for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, Method 8150, U. S. Environmental Protection Agency, 1982.

Varian Liquid Chromatography Procedure #88, Reverse Phase Separation of 2,4-D and Silvex in Waste Water, Varian Instruments, Walnut Creek, California.

Shipping requirements: Packed in an iced cooler, with chain-of-custody.

Samples are extracted within 7 days and completely analyzed within 30 days of collection.

Method of analysis: Gas and Liquid Chromatography.

TABLE 11

Organophosphorus Pesticide

<u>Analytes</u>	<u>Detection Limits</u>	
	<u>Water (ug/l)</u>	<u>Soil (mg/kg)</u>
DEF	1.	1.
Delnav	1.	1.
Diazinon	1.	1.
Dimethoate	1.	1.
Disulfoton	1.	1.
Ethion	1.	1.
Ethyl parathion	1.	1.
Malathion	1.	1.
Methyl parathion	1.	1.
Methyl trithion	1.	1.
Phorate	1.	1.

Water

Analysis: Method 622

Sampling container: Specially prepared one liter sample bottles, taken in triplicate.

Reference: Determination of Organophosphorus Pesticides in Industrial and Municipal Wastewater, EPA-600/4-82-008, Method 622, EMSL, U. S. Environmental Protection Agency, Cincinnati, OH, July 1982.

Soil

Analysis: Method 8140

Sampling container: Specially prepared mason jar or brass tube (200 g soil required).

Reference: Test Method for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, Method 8140, U. S. Environmental Protection Agency, 1982.

Shipping requirements: Packed in an iced cooler, with chain-of-custody.

Samples are extracted within 7 days and completely analyzed within 14 days of collection.

Method of analysis: Gas Chromatography.

TABLE 12

Volatile Organics (GC/MS)

<u>Analytes</u>	<u>Detection Limits</u>	
	<u>Water (mg/l)(1)</u>	<u>Soil (mg/kg)(2)</u>
Benzene	0.005	0.125
Bromodichloromethane	0.005	0.125
Bromoform	0.005	0.125
Bromomethane	0.010	0.250
Carbon tetrachloride	0.005	0.125
Chlorobenzene	0.005	0.125
Chloroethane	0.010	0.250
2-Chloroethylvinyl ether	0.010	0.250
Chloroform	0.005	0.125
Chloromethane	0.010	0.250
Dibromochloromethane	0.005	0.125
1,2-Dichlorobenzene	0.005	0.125
1,3-Dichlorobenzene	0.005	0.125
1,4-Dichlorobenzene	0.005	0.125
Dichlorodifluoromethane	0.005	0.125
1,1-Dichloroethane	0.005	0.125
1,2-Dichloroethane	0.005	0.125
1,1-Dichloroethene	0.005	0.125
trans-1,2-Dichloroethene	0.005	0.125
1,2-dichloropropane	0.005	0.125
cis-1,3-Dichloropropene	0.005	0.125
trans-1,3-Dichloropropene	0.005	0.125
Ethylbenzene	0.005	0.125
Methylene chloride	0.005	0.125
1,1,2,2-Tetrachloroethane	0.005	0.125
Tetrachloroethene	0.005	0.125
Toluene	0.005	0.125
1,1,1-Trichloroethane	0.005	0.125
1,1,2-trichloroethane	0.005	0.125
Trichloroethene	0.005	0.125
Trichlorofluoromethane	0.005	0.125
Vinyl chloride	0.010	0.250

TABLE 12
(Continued)
Volatile Organics (GC/MS)

Other analytes available upon request

Secondary Quantitation List (optional at extra charge), analytes and detection limits subject to change.

<u>Analytes</u>	<u>Detection Limits</u>	
	<u>Water (mg/l) (1)</u>	<u>Soil (mg/kg) (2)</u>
Freon 113	0.005	0.125
Acetone	0.005	0.125
Isopropyl Alcohol	0.005	0.125
Ethylene Dibromide (EDB)	0.005	0.125

Water

Analysis: Method 624

Sampling container: Specially prepared 40 ml volatile vial, taken in triplicate.

Reference: Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater, PB83-201798, Method 624, U.S. Environmental Protection Agency, Cincinnati, OH, July 1982

Soil

Analysis: Method 8240

Sampling container: Air tight completely full brass tube.

Reference: Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, Method 8240, U.S. Environmental Protection Agency, 1982.

Shipping requirements: Packed in an iced cooler with chain-of-custody.

Acceptable holding time to analysis: 14 days.

Method of analysis: Gas Chromatography/Mass Spec.

(1) Specific detection limits are highly matrix dependent. The detection limits listed herein are provided for guidance and may not always be achievable. Lower detection levels are possible with additional work at an increased price.

(2) Detection limits listed for soil/sediment are based on wet weight.

TABLE 13

Semivolatile Organics (GC/MS)

<u>Analytes</u>	<u>Detection Limits</u>	
	<u>Water (mg/l)(1)</u>	<u>Soil (mg/kg)(2)</u>
Acenaphthene	0.010	0.330
Acenaphthylene	0.010	0.330
Aldrin	0.010	0.330
Anthracene	0.010	0.330
Benzo(a)anthracene	0.010	0.330
Benzo(b)fluoranthene	0.010	0.330
Benzo(k)fluoranthene	0.010	0.330
Benzo(ghi)perylene	0.010	0.330
Benzo(a)pyrene	0.010	0.330
Benzidine	0.040	1.32
Butyl benzyl phthalate	0.010	0.330
alpha-BHC	0.010	0.330
beta-BHC	0.010	0.330
delta-BHC	0.010	0.330
gamma-BHC	0.010	0.330
Bis (2-chloroethoxy)methane	0.010	0.330
Bis (2-chloroethyl) ether	0.010	0.330
Bis (2-chloroisopropyl)ether	0.010	0.330
Bis (2-ethylhexyl)phthalate	0.010	0.330
4-Bromophenyl phenyl ether	0.010	0.330
Chlordane	0.100	3.30
4-Chloro-3-methylphenol	0.010	0.330
2-Choronaphthalene	0.010	0.330
2-Chlorophenol	0.010	0.330
4-Chlorophenyl phenyl ether	0.010	0.330
Chrysene	0.010	0.330
4,4'-DDD	0.010	0.330
4,4'-DDE	0.010	0.330
4,4'-DDT	0.010	0.330
Dibenzo(a,h)anthracene	0.010	0.330
Dibutyl phthalate	0.010	0.330
1,2-Dichlorobenzene	0.010	0.330
1,3-Dichlorobenzene	0.010	0.330

TABLE 13
(Continued)

Semivolatile Organics (GC/MS)

<u>Analytes</u>	<u>Detection Limits</u>	
	<u>Water (mg/l)(1)</u>	<u>Soil (mg/kg)(2)</u>
1,4-Dichlorobenzene	0.010	0.330
3,3'-dichlorobenzidine	0.20	6.60
2,4-Dichlorophenol	0.010	0.330
Dieldrin	0.010	0.330
Diethylphthalate	0.010	0.330
2,4-Dimethylphenol	0.010	0.330
Dimethylphthalate	0.010	0.330
2,4-Dinitrophenol	0.050	1.65
2,4-Dinitrotoluene	0.010	0.330
2,6-Dinitrotoluene	0.010	0.330
Di-n-octylphthalate	0.010	0.330
Endosulfan I	0.010	0.330
Endosulfan II	0.010	0.330
Endosulfan sulfate	0.020	0.660
Endrin	0.010	0.330
Endrin aldehyde	0.020	0.660
Fluoranthene	0.010	0.330
Fluorene	0.010	0.330
Heptachlor	0.010	0.330
Heptachlor epoxide	0.010	0.330
Hexachlorobenzene	0.010	0.330
Hexachlorobutadiene	0.010	0.330
Hexachlorocyclopentadiene	0.010	0.330
Hexachloroethane	0.010	0.330
Indeno(1,2,3-cd)pyrene	0.010	0.330
Isophorone	0.010	0.330
2-Methyl-4,6-dinitrophenol	0.050	1.65
Naphthalene	0.010	0.330
Nitrobenzene	0.010	0.330
4-Nitrophenol	0.010	0.330
2-Nitrophenol	0.010	0.330
N-Nitrosodimethylamine	0.010	0.330
N-Nitrosodi-n-propylamine	0.010	0.330
N-Nitrosidiphenylamine	0.010	0.330

TABLE 13
(Continued)
Semivolatile Organics (GC/MS)

<u>Analytes</u>	<u>Detection Limits</u>	
	<u>Water (mg/l)(1)</u>	<u>Soil (mg/kg)(2)</u>
PCB-1016	0.050	1.65
PCB-1221	0.050	1.65
PCB-1232	0.050	1.65
PCB-1242	0.050	1.65
PCB-1248	0.050	1.65
PCB-1254	0.050	1.65
PCB-1260	0.050	1.65
Pentachlorophenol	0.050	1.65
Phenanthrene	0.010	0.330
Phenol	0.010	0.330
Pyrene	0.010	0.330
Toxaphene	0.5	16.5
1,2,4-Trichlorobenzene	0.010	0.330
2,4,6-Trichlorophenol	0.010	0.330

Water

Analysis: Method 625

Sampling container: Specially prepared one liter bottle taken in triplicate.

Reference: Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater, PB83-201796, Method 625, U.S. Environmental Protection Agency, Cincinnati, OH, July 1982

Soil

Analysis: Method 8270

Sampling container: Specially prepared mason jar, 200 g soil required.

Reference: Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, Method 8270, U.S. Environmental Protection Agency, 1982.

Shipping requirements: Packed in an iced cooler with chain-of-custody.

Samples are extracted within 7 days and completely analyzed within 30 days of collection.

Method of analysis: GC/MS

TABLE 13
(Continued)
Semivolatile Organics (GC/MS)

(1) Specific detection limits are highly matrix dependent. The detection limits listed herein are provided for guidance and may not always be achievable. Lower detection levels are possible with additional work at an increased price.

(2) Detection limits listed for soil/sediment are based on wet weight.

TABLE 14

Carbamates

<u>Analytes</u>	<u>Detection Limits</u>	
	<u>Water (mg/l)</u>	<u>Soil (mg/kg)</u>
Aldicarb	0.05	1.
Carbaryl	0.05	1.
Carbofuran	0.05	1.
Diuron	0.05	1.
Linuron	0.05	1.
Methomyl	0.05	1.
Oxamyl	0.05	1.

Water

Analysis: Method 632

Sampling container: Specially prepared one liter sample bottles, taken in triplicate.

Reference: Method of Organic Chemical Analysis of Municipal and Industrial Wastewater, PB83-201798, Method 632, U. S. Environmental Protection Agency, Cincinnati, OH, July 1982.

Soil

Analysis: Method 632Mod

Sampling container: Specially prepared mason jar or brass tube (200 g soil required).

Reference: Modified Method 632 Test Method for Evaluating Solid Waste, Physical/Chemical Methods, adapted for soil.

Shipping requirements: Packed in an iced cooler, with chain-of-custody.

Samples are extracted within 7 days and completely analyzed within 30 days of collection.

Method of analysis: Liquid Chromatography.

TABLE 15

Fumigants

<u>Analytes</u>	<u>Detection Limits</u>	
	<u>Water (mg/l)</u>	<u>Soil (mg/kg)</u>
DBCP (Dibromochloropropane)	0.01	1.0
EDB (Ethylene Dibromide)	0.1	1.0

WaterAnalysis: Method 2000

Sampling container: Specially prepared one liter sample bottles, taken in triplicate, for EDB only, use 40 ml vial (purge & trap technique).

Reference: Analysis of 1,2-dibrom -3- chloropropane in Water, California Department of Health Services Methods, p. 215.

Reference: Method for Organic Chemical Analysis of Municipal and Industrial Wastewater, PB83-201798, Method 601, U. S. Environmental Protection Agency, Cincinnati, Ohio, July 1982 (EDB only).

Soil: Method 2010

Sampling container: Air tight completely full brass tube.

Reference: Analysis of 1,2-dibrom -3- chloropropane in Water, California Department of Health Services Methods, p. 215.

Reference: Test Method for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, Method 8010, U. S. Environmental Protection Agency, 1982 (EDB only).

Shipping requirements: Packed in an iced cooler, with chain-of-custody.

Samples are extracted within 7 days and completely analyzed within 30 days of collection. EDB only using purge & trap technique, 14 days to analysis.

Method of analysis: Gas Chromatography.

TABLE 16
Benzene, Toluene, Xylene
 (Gasoline components)

<u>Analytes</u>	<u>Detection Limits</u>	
	<u>Water (mg/l)</u>	<u>Soil (mg/kg)</u>
Benzene	0.005	0.2
Xylene	0.005	0.2
Toluene	0.005	0.2
Other Hydrocarbons	0.005	0.2
<hr/>		
<u>Other analytes available upon request:</u>	<u>Additional increase per analyte</u>	
EDB	80%	

Water

Analysis: Method 2500

Sampling container: Specially prepared acidified 40 ml volatiles vials, taken in triplicate.

Reference: Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater, PB83-201798, Method 602, U. S. Environmental Protection Agency, Cincinnati, OH, July 1982.

Soil

Analysis: Method 2510

Sampling container: Air tight completely full brass tube, or 40 ml vial

Reference: Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, Method 8020, U. S. Environmental Protection Agency, 1982.

Shipping requirements: Packed in an iced cooler, with chain-of-custody.

Acceptable holding time to analysis: 14 days.

Method of analysis: Gas Chromatography with FID detector.

TABLE 17

Total Extractable Hydrocarbons
(Diesel/Fuel Oil Components)

<u>Analytes</u>	Detection Limits	
	<u>Water (mg/l)</u>	<u>Soil (mg/kg)</u>
Total Extractable Hydrocarbons	1.	10.

WaterAnalysis: Method 2515

Sampling container: Specially prepared one liter sample bottles, taken in triplicate.

Reference: Method for Organic Chemical Analysis of Municipal and Industrial Wastewater, PB 83-201798, Method 602 modified, U. S. Environmental Protection Agency, Cincinnati, OH, July 1982.

SoilAnalysis: Method 2520

Sampling container: Air tight completely full brass tube or 40 ml vial

Reference: Analytical Procedures for the Detection and Quantitation of Total Petroleum Fuel Hydrocarbons and Fuel Constituents California Regional Water Quality Control Board, 11/8/1985.

Shipping requirements: Packed in an iced cooler, with chain-of-custody.

Samples are extracted within 7 days and completely analyzed within 30 days of collection.

Method of analysis: Solvent extraction, Gas Chromatography with FID detector.

TABLE 13
EP Toxicity Pesticides

<u>Analytes</u>	<u>Maximum Contaminant Level</u> (mg/l leachate)	<u>Detection Limit</u>
Endrin	0.02	All detection limit
Lindane	0.4	are one-tenth or
Methoxychlor	10.0	less of the
Toxaphene	0.5	maximum contaminant
2,4-D	10.0	level
2,4,5-TP	1.0	

Analysis: Method EPTP

Samples are extracted with acetic acid and the leachate is examined for the pesticides listed.

Sampling container: Specially cleaned mason jars for solids and sludges sample size 400 g, and liter containers for liquids.

Reference: Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, EP Toxicity, U. S. Environmental Protection Agency, 1982.

Varian Liquid Chromatography Procedure #88, Reverse Phase Separation of 2,4-D and Silvex in Waste Water, Varian Instruments, Walnut Creek, California

Shipping requirements: Packed in an iced cooler, with chain-of-custody.

Samples are extracted within 7 days and completely analyzed within 30 days collection.

Method of analysis: Gas and Liquid Chromatography.

TABLE 19

Title 22 Pesticides/Herbicides

<u>Analytes</u>	<u>Detection Limit</u> <u>Water (mg/l)</u>
Endrin	0.00005
Lindane	0.00005
Methoxychlor	0.001
Toxaphene	0.005
2,4-D	0.01
2,4,5-TP (Silvex)	0.001

Water

Analysis: Method T22P

Sampling container: Specially prepared one liter bottles taken in triplicate.

Reference: Methods for Organic Chemical Analysis of Municipal and Industrial Wastewater, PB 83-201796, Method 608, U. S. Environmental Protection Agency, Cincinnati, OH, July 1982. Determination of Chlorinated Herbicides in Industrial and Municipal Wastewater, EPA-600/4-82-005, Method 615, EMSL, U. S. Environmental Protection Agency, Cincinnati, OH, July 1982.

Shipping requirements: Packed in an iced cooler, with chain-of-custody.

Samples are extracted within 7 days and completely analyzed within 30 days of collection.

Method of analysis: Gas Chromatography.

TABLE 20

TITLE 22

DRINKING WATER ANALYSES - PRIMARY

Drinking water samples can be analyzed for the parameters specified in the California Administrative Code (Title 22) to assure potability.

<u>Analysis</u>	<u>Price per Sample</u>
<u>Inorganics:</u>	
Arsenic, Barium, Cadmium, Chromium, Lead, Mercury, Nitrate, Selenium, Silver, Fluoride	85.00
<u>General Minerals:</u>	
Bicarbonate, Carbonate, Hydroxide, Alkalinity, Calcium, Chloride, Copper, Foaming Agents (MBAS), Iron, Magnesium, Manganese, pH, Sodium, Sulfate, Specific Conductance, Total Dissolved Solids, Total Hardness, Zinc	75.00
<u>General Physical:</u>	
Color, Odor, Turbidity (See pgs. 35-38).	15.00
<u>Bacteriological:</u>	
Total Coliform - 5 tube & Fecal Coliform - 5 tube (see page 35).	15.00
<u>Organics (Pesticides):</u>	
Endrin, Lindane, Methoxychlor, Toxaphene, 2,4-D, 2,4,5-TP (Refer to Title 22 Pesticides).	110.00
<u>Trihalomethanes:</u>	
Chloroform, Bromoform, Dibromochloromethane, Bromodichloromethane (Refer to Purgeable Halocarbons).	100.00

TABLE 21
Priority Pollutant Metals
Metals

<u>Analytes</u>	<u>Detection Limits</u>	
	<u>Water (mg/l)</u>	<u>Soil (mg/kg)</u>
Antimony	0.02	5.
Arsenic	0.01	5.
Beryllium	0.005	0.75
Cadmium	0.005	1.
Chromium	0.005	5.
Copper	0.05	5.
Lead	0.005	5.
Mercury	0.001	0.2
Nickel	0.05	5.
Selenium	0.005	1.
Silver	0.01	5.
Thallium	0.01	5.
Zinc	0.01	5.

Samples are digested and analyzed for the 13 metals, according to EPA criteria, Federal Register, December 3, 1979.

Sampling container: Special acid-washed mason jars for solids and sludges sample size 400 g, and special acid-washed liter containers for liquids.

Reference: California Assessment Manual, January 1984, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, Individual Metals Analysis, U. S. Environmental Protection Agency, 1982.

Shipping requirements: Packed in an iced cooler, with chain-of-custody.

Method of analysis: Atomic Absorption Spectrophotometry.

TABLE 22
California Assessment Manual Metals

<u>Analytes</u>	<u>Regulatory Limits</u>		<u>Detection Limits</u>	
	<u>TTLIC (mg/kg)</u>	<u>STLC (mg/l)</u>	<u>TTLIC (mg/kg)</u>	<u>STLC (mg/l)</u>
Arsenic	500	5	5.	0.1
Antimony	500	15	5.	0.1
Barium	10,000	100	5.	0.1
Beryllium	75	0.75	0.75	0.1
Cadmium	100	1	1.	0.1
Chromium III/VI*	2,500/500	560/5	5/5	0.1/0.1
Cobalt	8,000	80	5.	0.1
Copper	2,500	25	5.	0.1
Lead	1,000	5	5.	0.1
Mercury	20	0.2	0.2	0.1
Molybdenum	3,500	350	5.	0.1
Nickel	2,000	20	5.	0.1
Selenium	100	1	1.	0.1
Silver	500	5	5.	0.1
Thallium	700	7	5.	0.1
Vanadium	2,400	24	5.	0.1
Zinc	5,000	250	5.	0.1

Samples are either acid digested for total metal content (to be compared to TTLIC regulatory values) or extracted with citrate buffer (to be compared to STLC regulatory values).

*Chromium values are reported as total chromium, the sum of the III and VI species.

Sampling container: Special acid-washed mason jars for solids and sludges (400 g sample size), and special acid-washed liter containers for liquids.

Reference: California Assessment Manual, January 1984, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, Individual Metals Analysis as per, U. S. Environmental Protection Agency, Methods listed on pp. 28, 30.

Shipping requirements: Packed in an iced cooler, with chain-of-custody.

Method of analysis: Atomic Absorption Spectrophotometry.

TABLE 23
EP Toxicity Metals

<u>Analytes</u>	<u>Maximum Contaminant Level</u> (mg/l leachate)	<u>Detection Limit</u>
Arsenic	5.0	0.1
Barium	100.0	0.1
Cadmium	1.0	0.1
Chromium (total)	5.0	0.1
Mercury	0.2	0.1
Lead	5.0	0.1
Selenium	1.0	0.1
Silver	5.0	0.1

Samples are extracted with acetic acid, and the leachate is examined for the eight metals listed.

Sampling container: Specially cleaned mason jars for solids and sludges, and 1 liter containers for liquids.

Reference: Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846, EP Toxicity, U. S. Environmental Protection Agency, 1982.

Shipping requirements: Packed in an iced cooler, with chain-of-custody.

Method of analysis: Atomic Absorption Spectrophotometry.

TABLE 24
EPA Methods
Atomic Absorption Analysis
Metals in Water

<u>Element</u>	<u>Flame</u>	<u>Graphite Furnace</u>	<u>Hydride Generation</u>	<u>Cold Vapor</u>	<u>ICP</u>
Aluminum	EPA 202.1	EPA 202.2			EPA 200.7
Antimony	EPA 204.1	EPA 204.2			EPA 200.7
Arsenic		EPA 206.2	EPA 206.3		
Barium	EPA 208.1	EPA 208.2			EPA 200.7
Beryllium	EPA 210.1	EPA 210.2			EPA 200.7
Cadmium	EPA 213.1	EPA 213.2			EPA 200.7
Calcium	EPA 215.1				EPA 200.7
Chromium (Total)	EPA 218.1	EPA 218.2			EPA 200.7
Cobalt	EPA 219.1	EPA 219.2			EPA 200.7
Copper	EPA 220.1	EPA 220.2			EPA 200.7
Iron	EPA 236.1	EPA 236.2			EPA 200.7
Lead	EPA 239.1	EPA 239.2			EPA 200.7
Magnesium	EPA 242.1				EPA 200.7
Manganese	EPA 243.1	EPA 243.2			EPA 200.7
Mercury				EPA 245.1	
Molybdenum	EPA 246.1	EPA 246.2			EPA 200.7
Nickel	EPA 249.1	EPA 249.2			EPA 200.7
Potassium	EPA 258.1				EPA 200.7
Selenium		EPA 270.2	EPA 270.3		
Silver	EPA 272.1	EPA 272.2			EPA 200.7
Sodium	EPA 273.1				EPA 200.7
Strontium*	303A				EPA 200.7
Thallium	EPA 279.1	EPA 279.2			EPA 200.7
Vanadium	EPA 286.1	EPA 286.2			EPA 200.7
Zinc	EPA 289.1	EPA 289.2			EPA 200.7

Reference: Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020, EMSL, U. S. Environmental Protection Agency, 1979.

* Reference: Standard Methods for the Examination of Water and Wastewater, 16th Edition, 1985.

Method of Analysis: Atomic Absorption Spectrophotometry.

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TABLE 25

Minimum Detection Limits
Atomic Absorption Analysis
Metals in Water
mg/l

<u>Element</u>	<u>Flame</u>	<u>Graphite Furnace</u>	<u>Hydride Generation</u>	<u>Cold Vapor</u>
Aluminum	0.5	0.02		
Antimony	0.02	0.005	0.005	
Arsenic		0.01	0.003	
Barium	0.2	0.05		
Beryllium	0.04	0.0005		
Cadmium	0.02	0.0005		
Calcium	0.05			
Chromium (Total)	0.1	0.003		
Cobalt	0.05	0.005		
Copper	0.05	0.003		
Iron	0.05	0.01		
Lead	0.4	0.002		
Magnesium	0.02	0.001		
Manganese	0.01			
Mercury				0.001
Molybdenum	0.1	0.005		
Nickel	0.2	0.005		
Potassium	0.05			
Selenium		0.005	0.004	
Silver	0.02	0.001		
Sodium	0.05			
Strontium	0.02	0.002		
Thallium	0.1	0.003		
Vanadium	0.5	0.005		
Zinc	0.03	0.005		

TABLE 26
EPA Methods
Atomic Absorption Analysis
Metals in Soil

<u>Element</u>	<u>Flame</u>	<u>Graphite Furnace</u>	<u>Hydride Generation</u>	<u>Cold Vapor</u>
Aluminum				
Antimony	EPA 7040	EPA 7041		
Arsenic		EPA 7060	EPA 7061	
Barium	EPA 7080	EPA 7081		
Beryllium	EPA 7090	EPA 7091		
Cadmium	EPA 7130	EPA 7131		
Calcium				
Chromium (Total)	EPA 7190	EPA 7191		
Cobalt				
Copper	EPA 7210	EPA 7211		
Iron	EPA 7380	EPA 7381		
Lead	EPA 7420	EPA 7421		
Magnesium				
Manganese	EPA 7460	EPA 7461		
Mercury				EPA 7471
Molybdenum				
Nickel	EPA 7520	EPA 7521		
Potassium				
Selenium		EPA 7740	EPA 7741	
Silver	EPA 7760	EPA 7761		
Sodium	EPA 7770			
Strontium				
Thallium	EPA 7840	EPA 7841		
Vanadium	EPA 7910	EPA 7911		
Zinc	EPA 7950	EPA 7951		

Reference: California Assessment Manual, January 1984, Test Methods for Evaluating Solid Waste, Physical/Chemical Methods, SW-846.

Method of analysis: Atomic Absorption Spectrophotometry.

TABLE 27

Minimum Detection Limits
Atomic Absorption Analysis
Metals in Soil
mg/kg

<u>Element</u>	<u>Flame</u>	<u>Graphite Furnace</u>	<u>Hydride Generation</u>	<u>Cold Vapor</u>
Aluminum	50.	2.		
Antimony	20.	1.	1.	
Arsenic		1.	0.5	
Barium	20.	5.		
Beryllium	20.	0.5		
Cadmium	4.	0.5		
Calcium	20.			
Chromium (Total)	20.	0.5		
Cobalt	20.	0.5		
Copper	20.	0.5		
Iron	20.	1.		
Lead	40.	0.5		
Magnesium	20.			
Manganese	4.	0.2		
Mercury				0.2
Molybdenum	40.	0.5		
Nickel	20.	0.5		
Potassium	20.			
Selenium		1.	1.	
Silver	4.	0.2		
Sodium	20.			
Strontium	4.	0.2		
Thallium	20.	0.5		
Vanadium	80.	0.5		
Zinc	5.	0.5		

TABLE 28

PRECISION AND ACCURACY DATA
U.S. EPA METHOD 8240

<u>Compound</u>	<u>Precision (Average Percent Recovery)</u>	<u>Lower Accuracy Range (Percent Recovery)</u>	<u>Upper Accuracy Range (Percent Recovery)</u>
Chloromethane	84.88	0.00	168.98
Bromomethane	107.70	21.90	193.50
Vinyl chloride	102.90	0.00	209.26
Chloroethane	102.97	0.00	222.61
Methylene chloride	91.08	60.35	121.80
Acetone	93.61	0.00	333.11
Carbon disulfide	44.42	0.00	104.08
1,1-Dichloroethene	63.70	6.46	120.93
1,1-Dichloroethane	90.18	37.64	142.71
Total 1,2-Dichloroethene	99.80	45.88	188.16
Chloroform	97.25	39.63	154.87
1,2-Dichloroethene	105.30	71.56	139.03
1,1,1-Trichloroethane	107.86	34.96	180.76
Carbon tetrachloride	94.55	58.93	130.17
Bromodichloromethane	104.66	66.57	142.75
1,2-Dichloropropane	100.16	67.31	133.01
cis-1,3-Dichloropropene	104.86	90.12	119.60
trans-1,3-Dichloropropene	101.61	75.32	127.89
Trichloroethene	99.28	56.38	142.17
Benzene	112.28	54.27	170.29
Dibromochloromethane	114.63	48.85	180.41
1,1,2-Trichloroethane	112.79	53.79	171.78
Bromoform	140.04	60.28	219.80
4-Methyl-2-pentanone	108.22	12.12	204.31
1,1,2,2-Tetrachloroethane	111.77	61.81	161.72
Tetrachloroethene	100.91	35.23	166.59
Toluene	100.02	22.88	177.15
Chlorobenzene	103.61	72.80	134.42
Ethylbenzene	111.58	33.05	190.10
Total xylenes	108.60	56.44	160.75
Styrene	106.53	81.82	131.24
Trichlorofluoromethane	60.31	0.00	129.05
Freon 113	100.08	22.35	177.81
1,2-Dibromoethane	95.63	63.39	127.87
2-Chloroethyl vinyl ether	96.81	75.15	118.48
1,3-Dichlorobenzene	108.90	52.42	165.37
1,2-Dichlorobenzene	112.59	104.14	121.04
1,4-Dichlorobenzene	110.89	62.76	159.01

TABLE 29

PRECISION AND ACCURACY DATA
U.S. EPA METHOD 8270

<u>Compound</u>	<u>Precision (Average Percent Recovery)</u>	<u>Lower Accuracy Range (Percent Recovery)</u>	<u>Upper Accuracy Range (Percent Recovery)</u>
Phenol	92.87	81.77	103.96
Bis(2-Chloroethyl) ether	95.28	86.89	103.67
2-Chlorophenol	96.87	90.31	103.42
1,3-Dichlorobenzene	104.35	88.11	120.59
1,2-Dichlorobenzene	104.01	83.10	124.92
1,4-Dichlorobenzene	98.12	92.31	103.92
Bis(2-chloroisopropyl)ether	93.38	42.98	143.80
N-Nitroso-di-N-Propylamine	91.22	78.93	103.51
Hexachloroethane	94.34	79.96	108.71
N-Nitrosodimethylamine	101.00	69.30	132.70
2-Fluorophenol	100.16	89.11	111.21
d5-phenol	94.18	85.01	103.35
d6-Nitrobenzene	91.88	87.40	96.36
Nitrobenzene	93.19	86.59	99.78
Isophorone	92.83	85.97	99.69
2-Nitrophenol	104.93	92.51	117.34
2,4-Dimethylphenol	88.11	78.60	97.61
2,4-Dichlorophenol	91.07	55.08	127.05
Bis(2-chloroethoxy)methane	95.70	88.93	102.47
1,2,4-Trichlorobenzene	90.25	67.05	113.44
Naphthalene	95.91	86.25	105.57
Hexachlorobutadiene	85.41	76.81	94.00
Hexachlorocyclopentadiene	80.89	70.48	91.30
2,4,6-Trichlorophenol	77.48	60.25	94.66
2-Fluorobiphenyl	95.76	81.32	110.20
2-Chloronaphthalene	95.40	72.94	117.86
Dimethyl Phthalate	96.00	78.80	113.20
Acenaphthylene	98.54	85.41	111.67
2,6-Dinitrotoluene	92.21	50.62	133.79
Acenaphthene	96.07	79.22	112.91
2,4-Dinitrophenol	86.60	62.23	110.97
4-Nitrophenol	72.84	61.25	84.43
2,4-Dinitrotoluene	92.04	79.71	104.36
Diethylphthalate	98.99	88.50	109.48
4-Chlorophenyl-phenylether	85.86	71.15	100.52
Fluorene	94.42	85.08	103.77
2,4,6-Tribromophenol	84.87	71.97	97.76
Anthracene	96.45	81.63	11.27
Benzo(a)anthracene	98.25	89.57	106.93
Benzo(b)fluoranthene	95.82	81.03	110.61
Benzo(k)fluoranthene	93.90	65.68	122.11
Benzo(ghi)perylene	102.84	79.92	125.75
Benzo(a)pyrene	94.85	87.62	102.08
Benzidine	98.15	75.65	120.65
Butyl benzyl phthalate	94.36	89.41	99.31
4-Chloro-3-Methylphenol	92.60	74.73	110.46

TABLE 29

PRECISION AND ACCURACY DATA
U.S. EPA METHOD 8270
(Continued)

<u>Compound</u>	<u>Precision (Average Percent Recovery)</u>	<u>Lower Accuracy Range (Percent Recovery)</u>	<u>Upper Accuracy Range (Percent Recovery)</u>
Bis(2-ethylhexyl)phthalate	91.49	72.61	110.36
4-Bromophenyl phenyl ether	97.25	75.32	119.17
Chrysene	95.52	88.98	102.05
dibenzo(a,h)anthracene	100.49	79.74	121.23
Dibutyl phthalate	107.66	94.11	121.21
3,3'-dichlorobenzidine	91.82	70.14	113.49
Di-n-octylphthalate	79.89	40.91	118.87
Fluoranthene	92.05	79.25	104.85
Hexachlorobenzene	100.68	90.56	110.79
Indeno(1,2,3-cd) pyrene	101.08	76.71	125.44
2-Methyl-4,6-dinitrophenol	85.35	47.41	123.29
N-Nitrosodiphenylamine	102.25	94.47	110.02
Pentachlorophenol	55.98	30.06	81.89
Phenanthrene	100.97	93.16	108.78
Pyrene	91.64	71.31	111.96

TABLE 30

PRECISION AND ACCURACY DATA
U.S. EPA METHOD 8020

<u>Compound</u>	<u>Precision (Average Percent Recovery)</u>	<u>Lower Accuracy Range (Percent Recovery)</u>	<u>Upper Accuracy Range (Percent Recovery)</u>
Acetone	145.25	66.74	223.76
Benzene	96.25	74.08	118.42
Toluene	81.25	57.68	104.82
Chlorobenzene	97.75	89.69	105.81
Ethylbenzene	110.75	84.30	137.20
Total xylenes	75.85	54.05	97.65
Isopropyl alcohol	110.00	69.70	150.30
1,3-Dichlorobenzene	100.00	91.84	108.16
1,2-Dichlorobenzene	106.00	98.88	113.12
1,4-Dichlorobenzene	102.50	94.42	110.58

TABLE 31

PRECISION AND ACCURACY DATA
U.S. EPA METHOD 8010

<u>Compound</u>	<u>Precision (Average Percent Recovery)</u>	<u>Lower Accuracy Range (Percent Recovery)</u>	<u>Upper Accuracy Range (Percent Recovery)</u>
Chloromethane	93.75	5.31	182.19
Bromomethane	105.00	67.51	142.49
Vinyl chloride	81.00	40.96	121.04
Chloroethane	102.25	50.14	154.36
Methylene chloride	106.25	63.59	148.91
1,1-Dichloroethene	101.00	53.45	148.55
1,1-Dichloroethane	110.50	71.36	149.64
Total 1,2-Dichloroethene	99.50	64.95	134.05
Chloroform	92.00	63.86	120.14
1,2-Dichloroethane	130.00	101.48	158.52
1,1,1-Trichloroethane	89.00	67.40	110.60
Carbon tetrachloride	102.25	70.95	133.55
Bromodichloromethane	131.50	108.73	154.27
1,2-Dichloropropane	101.25	74.70	127.80
cis-1,3-Dichloropropene	119.75	103.47	135.03
trans-1,3-Dichloropropene	104.50	79.33	129.67
Trichloroethene	141.50	113.72	169.28
Dibromochloromethane	104.50	79.33	129.67
1,1,2-Trichloroethane	104.50	79.33	129.67
Bromoform	70.02	62.04	78.00
1,1,2,2-Tetrachloroethane	74.00	50.49	97.51
Tetrachloroethene	74.00	50.49	97.51
Chlorobenzene	97.75	89.69	105.81
Dichlorodifluoromethane	81.00	40.96	121.04
Trichlorofluoromethane	102.75	52.38	153.12
Freon 113	138.75	90.93	186.57
1,2-Dibromoethane	89.50	82.11	96.89
2-Chloroethyl vinyl ether	185.50	129.44	241.56
1,3-Dichlorobenzene	100.00	91.84	108.16
1,2-Dichlorobenzene	106.00	98.88	113.12
1,4-Dichlorobenzene	102.50	94.42	110.58

TABLE 32

PRECISION AND ACCURACY DATA
U.S. EPA METHOD 8080 (PESTICIDES)

<u>Compound</u>	<u>Precision (Average Percent Recovery)</u>	<u>Lower Accuracy Range (Percent Recovery)</u>	<u>Upper Accuracy Range (Percent Recovery)</u>
Alpha-BHC	92.46	68.14	116.77
Beta-BHC	88.37	62.57	114.18
Delta-BHC	95.76	78.88	112.63
Gamma-BHC	91.62	70.44	112.80
Heptachlor	96.10	73.96	118.25
Aldrin	93.94	75.31	112.57
Heptachlor epoxide	87.24	56.72	117.75
Endosulfan I	89.69	61.79	117.59
Endosulfan II	102.30	84.44	120.15
4,4'-DDD	81.11	75.20	107.02
4,4'-DDE	97.60	81.47	113.74
4,4'-DDT	116.14	108.53	123.75
Dieldrin	79.13	5.89	152.38
Endrin	86.16	29.71	142.62
Endrin aldehyde	101.44	100.08	102.80
Endosulfan sulfate	93.60	64.88	122.32

TABLE 33

PRECISION AND ACCURACY DATA
TOTAL PRIORITY POLLUTANT METALS

<u>Compound</u>	<u>Precision (Average Percent Recovery)</u>	<u>Lower Accuracy Range (Percent Recovery)</u>	<u>Upper Accuracy Range (Percent Recovery)</u>
<u>ICP</u>			
Beryllium	104	90.4	111.4
Barium	102	97.4	107.0
Cadmium	93.4	80.2	107.0
Chromium	98.9	91.9	105.9
Copper	97.6	92.6	102.6
Lead	98.9	77.9	120.0
Nickel	103	90.6	109.0
Silver	103.9	72.5	135.0
Zinc	104	87.8	120.0
<u>Cold Vapor</u>			
Mercury	100.9	90.4	111.4
<u>Graphite Furnace</u>			
Thallium	91.8	60.8	123.0
Arsenic	96.1	82.5	110.0
Selenium	99.1	77.1	121.0
Antimony	90.4	76.6	104.0

APPENDIX B
FIGURES

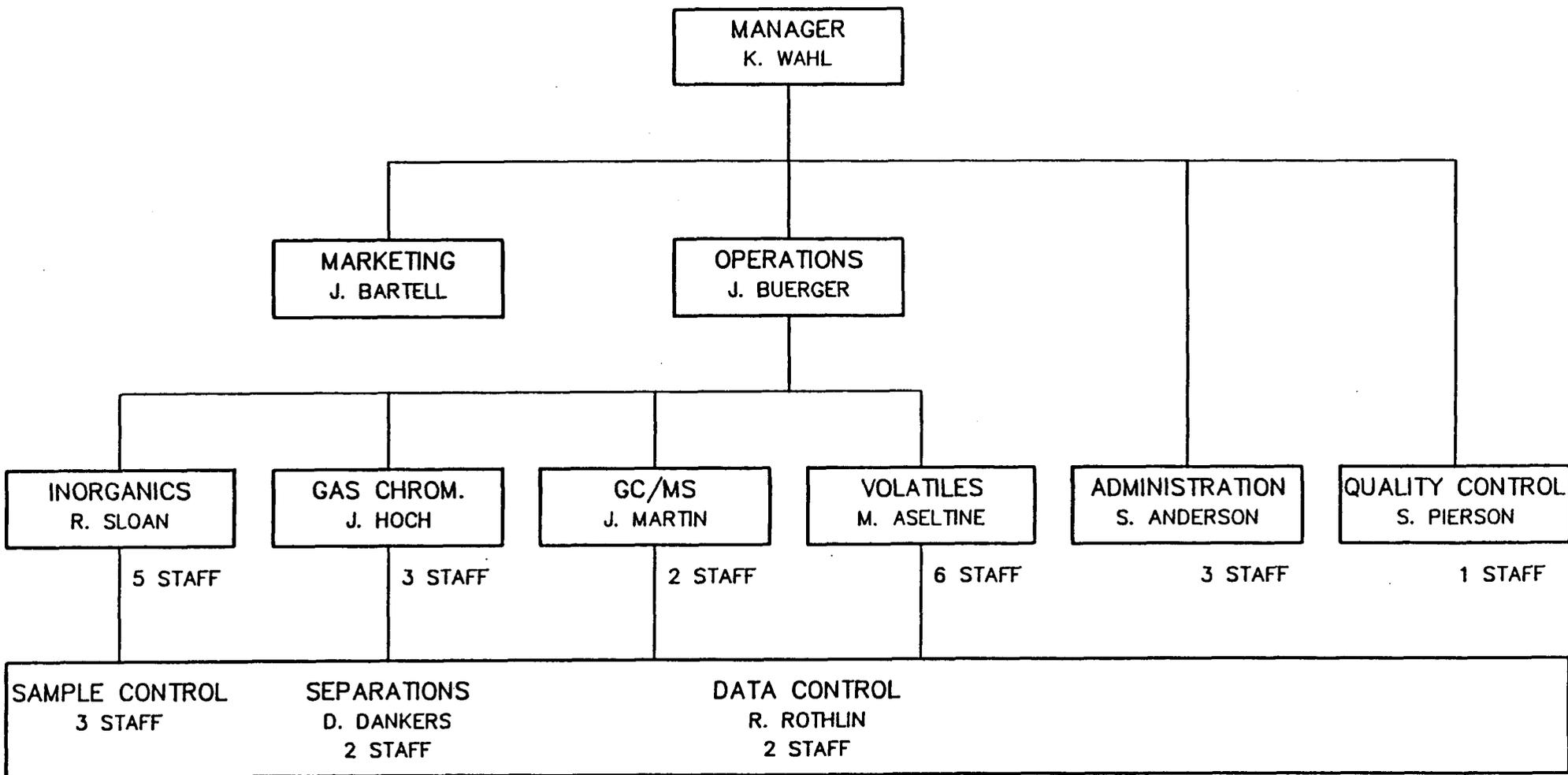


FIGURE 1
ADMINISTRATIVE ORGANIZATION
STOCKTON LABORATORY

CANONIE ENVIRONMENTAL LABORATORY SAMPLE TRACKING SHEET

LP #:

CLIENT:
PROJECT #:

SAMPLER I.D.

LAB. I.D.

CONTAINER

ANALYSIS:
X:

DATE SAMPLED:
DATE RECEIVED:
COST:

COMMENTS:

COLUMN

SAMPLE
VOL/WGT:

FINAL
EXTRACT VOL:

DATE

SAMPLE I.D.: LINE 1

LINE 2

DILUTION

LAB I.D.:

DATE PREP'D:

WORKER

UNITS:

DATE ANAL:

LAB I.D.

MDL

ANALYTE(S)

FINAL

CANONIE ENVIRONMENTAL

QA/QC COMMENT SHEET

METHOD _____

DATE ANALYZED _____

INSTRUMENT ID _____

LP NUMBER _____

ANALYST _____

CLIENT _____

PROBLEM: _____

CORRECTIVE ACTIONS: _____

SECTION CHIEF _____ DATE _____

ANALYST _____ DATE _____

COMMENTS _____

QA/QC DEPT. _____ DATE _____

COMMENTS: _____

Canonie Environmental Analytical Laboratory

Duplicate Percent Difference - 1,2-Dichlorobenzene, Inst.#2

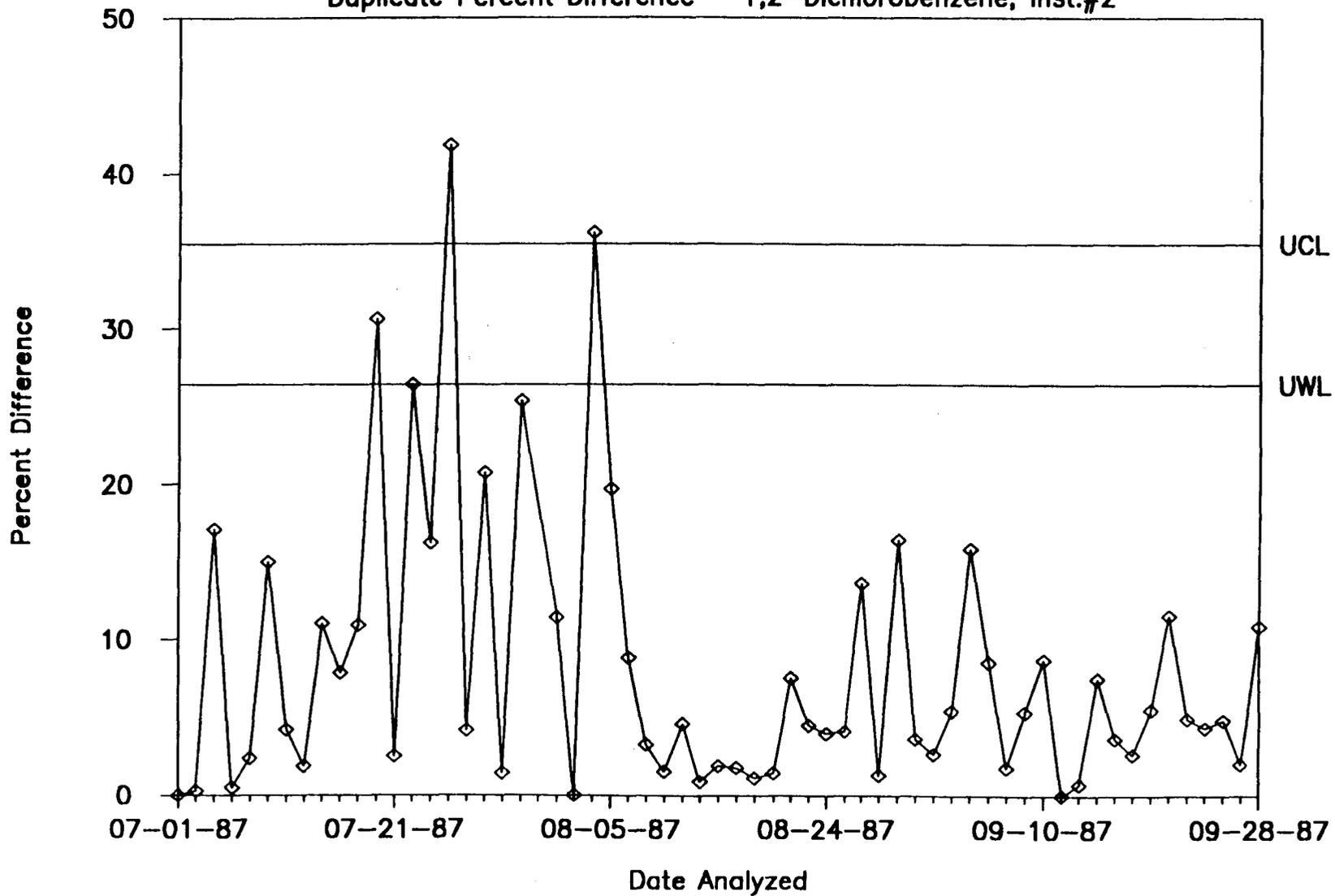


FIGURE 12

RESUMES

APPENDIX B
RESUMES

KENNETH C. WAHL

Project Manager/Manager of Laboratory Services

Education

M.S., Chemistry, Xavier University, 1975
B.S., Chemistry, Canisius College, 1968

Certifications

Diplomate of the American Board of Forensic Toxicology

Affiliations

American Academy of Forensic Science
American Chemical Society

Specialty Areas

Trace Organic Analysis of Water, Soil, and Other Environmental
Matrices
Microcomputer Data Base Management Systems

Experience and Background

At Canonie Environmental Services Corp.'s (Canonie's) analytical laboratory, Mr. Wahl is responsible for managing the laboratory. His duties also include administrative operation of the laboratory. The laboratory employs 12 chemists and 11 laboratory technicians in the analysis of water, soil, oil, hazardous waste, and other environmental samples utilizing EPA protocols. Each week the laboratory analyzes hundreds of samples for all types of trace organics, metals, and inorganics. Samples are accepted for other consulting engineering firms in California and throughout the United States.

Prior to joining Canonie, Mr. Wahl was employed by Occidental Chemical Company at its Lathrop facility for 12 months. There, he was responsible for establishing the environmental laboratory, the quality assurance system, and the microcomputer-based data management system. He was responsible for certifying the laboratory under the California Department of Health Services, and maintaining the analysis and data management of environmental samples at the facility. With a staff of one chemist and four technicians, samples of water were analyzed daily for various pesticides, fumigants, herbicides, and industrial chemicals using EPA protocols.

At Hooker (Occidental) Chemical Research Center near Niagara Falls, New York, Mr. Wahl supervised four technicians in an organic analytical section for 13 months. The section was

(Kenneth C. Wahl)

primarily involved in the analysis of all types of environmental samples for toxic chemicals. Samples from Occidental's North American locations were analyzed according to EPA protocols, or in-house developed procedures where there were no EPA protocols. He was also responsible for the daily analysis and data management of a long-term priority pollutant project at an Occidental site in Michigan. Mr. Wahl developed GC methods for the analysis of volatile compounds in blood and semi-volatile compounds in urine for monitoring workers at toxic waste cleanup sites.

As supervisor for two years in the Environmental Chemistry section of Erie County Public Health Laboratory, Mr. Wahl was responsible for directing two chemists and three technicians in the analysis of hazardous waste, soil, oil, leachates, water, and other matrices for toxic chemicals and other chemical parameters using EPA protocols. He was responsible for establishing a quality assurance program, and for certifying the laboratory by the New York State Department of Public Health. He prepared analytical reports for the appropriate government agencies such as the New York State Department of Public Health, the Erie County Department of Public Health, the New York State Department of Environmental Conservation, and the U.S. EPA. Mr. Wahl was responsible for defending the analytical results of the laboratory in court, if necessary.

Mr. Wahl worked as a chemist for six years with the Erie County Public Health Laboratory, Toxicology Section, in Buffalo, New York. He was responsible for the analysis of samples for drugs, toxic chemicals, and poisons. Samples included both bulk specimens such as liquids and solids, and biological samples such as blood, urine, organs, etc. Analyses included work utilizing gas chromatography (GC), infrared spectrophotometry (IR), ultraviolet/visible spectrophotometry (UV/VIS), thin layer chromatography (TLC), and atomic absorption spectrophotometry (AA). Mr. Wahl testified in court as an expert witness regarding the results of the tests he conducted. He developed a derivitization procedure for the analysis of acetaminophen using a GC with and FID detector. He was also responsible for the development of Diazepam analysis using GC. Mr. Wahl developed a thin layer chromatography technique for the analysis of drugs of abuse in urine.

Publications

Wahl, K. C., November 1975, "Toxicology: Basic Procedures for Rural Laboratories and Small Hospitals", Medical Technology, Audio Tape/Slide Program, Communications in Learning, Inc., Buffalo, New York.

(Kenneth C. Wahl)

Rejent, T. A. and K. C. Wahl, 1976, "Diazepam Abuse: Incidence, Rapid Screening and Confirming Methods", Clinical Chemistry, Vol. 22, No. 6, pp. 889-891.

Wahl, K. C., February 1977, "Determination of Acetaminophen Using Derivatization Versus Colorimetric Techniques", 29th Annual Meeting of the American Academy of Forensic Sciences, San Diego, California.

Wahl, K. C. and T. A. Rejent, 1978, "Quantitative Gas Chromatographic Determination of Acetaminophen Using Trimethylanilinium Hydroxide as the Derivatizing Agent", Journal of Forensic Sciences, Vol. 23, No. 1, pp. 14-20.

Wahl, K. C. and T. A. Rejent, September/October 1979, "Identification of Drugs of Abuse in Urine Using Single Development Thin-Layer Chromatography", Journal of Analytical Toxicology, Vol. 3, pp. 216-217.

Wahl, K. C., April 1985, "The Advantages of Gas Chromatographic Volatiles Analysis When Using an Effluent Splitter, Dual Detectors, and a Computerized Data System", Lab Con West 85, San Mateo, California.

Antommara, P. E., B. M. Bell, and K. C. Wahl, July 1985, "Pesticide Rinse Water Treatment and Analysis", presented to the U.S. EPA Research Workshop on Treatment/Disposal of Aqueous Pesticide Wastes, Cincinnati, Ohio.

JON M. BARTELL

Project Supervisor (Senior Chemist)

Education

M.B.A., Business Administration, California State University,
1983

B.S., Chemistry/Biology, California State University, 1976

Affiliations

Association of Official Analytical Chemists
Association of Soil and Foundation Engineers
American Chemical Society
American Society of Testing and Materials
American Water Works Association
Society for Marketing Professional Services

Specialty Areas

Quality Assurance
Inorganic Analysis

Experience and Background

Mr. Bartell is experienced in a variety of fields dealing with the analysis of environmental samples and material analysis. He is responsible for the day-to-day operations of the inorganic section of the laboratory, and he oversees the entire laboratory quality control program. In addition to these responsibilities, Mr. Bartell provides technical advice to clients as well as other branches of the company in areas of environmental monitoring, sampling, and analysis to ensure compliance with government regulations. His primary responsibility is to coordinate and oversee the activities of the inorganic section and to provide results of the highest quality in the shortest turnaround time.

To ensure the high standards set by the laboratory, Mr. Bartell coordinates the organic and inorganic quality control program. This includes participation in internal audit samples as well as interlaboratory and EPA quality assurance programs. The results of these analytical cross-checks are used to monitor laboratory performance.

Mr. Bartell was the senior chemist for the city of Sacramento's water department. In this capacity, he supervised two chemists and three technicians in the organic and inorganic analysis of water and waste for Title 22 as well as priority pollutant components.

(Jon M. Bartell)

During this time Mr. Bartell developed liquid/liquid extraction and gas chromatographic techniques which were instrumental in the identification and quantitation of low levels of rice herbicides which were contributing to a taste problem in the city's water supply. He was involved on a corrosion monitoring and inhibition project to reduce corrosion rates. He also worked to develop alternative disinfection procedures to chlorine. This project was designed to reduce or to eliminate trihalomethane formation. Mr. Bartell also developed a project to identify and enumerate bacterial regrowth types present in attenuated condition within the distribution system.

Mr. Bartell designed and set up an environmental engineering laboratory for Met-Chem Engineering. As a senior chemist at Met-Chem, he supervised one chemist and three technicians and was responsible for establishing the laboratory and certifying it under the California Department of Health Services. During this time the laboratory was involved with a number of hazardous waste management contracts which involved the analysis of PCBs, solvents, pesticides, and herbicides using EPA methods. The laboratory was eventually expanded to include the analysis of fuels and oils as well as material testing for a number of large contractors. Extensive metals analysis utilizing atomic absorption spectroscopy comprised a major portion of the workload.

As a chemist with Cordova Chemical in Sacramento, Mr. Bartell had experience with stack gas monitoring using methods approved by regulatory agencies, as well as determining stack effluent spread. He was also involved with testing of monitoring wells used to check the spread of pollutants on the Acrojet property. In this position Mr. Bartell gained experience with various air pollution monitoring systems and with a wide variety of NIOSH analytical methods.

JOHN M. BUERGER

Project Supervisor (Chemist)

Education

B.S., Chemistry, San Jose State University, 1983

Affiliations

American Chemical Society

Specialty Areas

Organic Analysis
Microcomputer Data Base Management Systems

Experience and Background

Mr. Buerger is a staff chemist for Canonie Environmental Services Corp.'s (Canonie's) analytical laboratory. His primary responsibilities include the development and implementation of automated, organic analytical procedures which conform to EPA protocol for Canonie's microprocessor-based, dual channel gas chromatographs. He is responsible for the daily routine analysis of a variety of trace organic constituents such as halogenated hydrocarbons, organochlorine pesticides, organophosphorus pesticides, herbicides, fumigants, acid extractables, and base/neutral extractables employing both packed column and capillary column gas chromatographic techniques.

Mr. Buerger participated in implementing the volatile organic analysis of water and soil samples for the Fairchild Semiconductor project, employing a purge and trap technique and column splitter coupled to both flame ionization detectors and Hall detectors.

Mr. Buerger has set up a gas chromatography system utilizing dual capillary columns in a single injector coupled to an electron capture detector and flame photometric detector. This system is presently used in the standard analysis of organophosphorus pesticides, herbicides, fumigants, PCBs, and other organics.

In addition to Mr. Buerger's chemical background, he has programmed and established the laboratory's computer data base system. The system operates on an IBM personal computer and integrates professional software with custom, in-house developed programs. The data base is used to store all analytical results and to generate all project and client reports as well as internal office reports.

JERRY D. MARTIN

Project Scientist/GCMS Supervisor

Education

B.S., Environmental Science, Sam Houston State, 1977

Affiliations

American Chemical Society
American Society of Mass Spectrometry

Specialty Areas

GC/MS Analysis of Water, Soil, Air, and Petroleum Samples

Experience and Background

At Canonie Environmental Services Corp.'s (Canonie's) analytical laboratory, Mr. Martin is responsible for the supervision of the GC/MS systems operation and the interpretation of the results.

Prior to joining Canonie, Mr. Martin was employed at California Water Labs, Inc., in Modesto, California. He was responsible for the management of the organic laboratory and the supervision of seven chemists. His duties included scheduling analyses, purchasing equipment, and some bidding on projects. He was also responsible for developing new methods and maintaining quality control throughout the laboratory as well as daily operation of a Finnigan GC/MS.

Mr. Martin's experience includes three years with Lockheed Engineering and Management Services Company as a scientist. His responsibilities included verification of purity of repository standards using GC/MS, GCFID, and HPLC, verification of composition and concentration of standard solutions made by other contractors, and maintaining computerized records of pesticide inventory and analysis results. He also modified and upgraded the mass spectra data system hardware and software.

Mr. Martin's education includes the following courses: Finnigan 4000/4500 GC/MS Advanced Operators Course, Finnigan Mass Spectral Interpretator's Course, and Finnigan Mass Spectral Interpretator's Application Course.

Publications

Shore, F. L., J. D. Martin, and L. R. Williams, 1986, "Mass Spectrometric Quantification of Polychlorinated Biphenyl Congeners Using Multiple Carbon-13 Internal Standards", Biomedical and Environmental Mass Spectrometry, Vol. 13, pp 15-19.

ROY L. SLOAN

Project Scientist

Education

B.S., Chemistry, Marshall University, 1975

Experience and Background

Mr. Sloan brings to Canonie Environmental Services Corp. approximately ten years of laboratory analysis and supervisory experience. His most recent employment was with California Water Labs, Inc., as a Lab Manager. His duties included supervising the inorganic lab, negotiating lab procurement contracts, performing AAS, DCP, ion chromatography, and wet chemical analyses. He also developed a quality assurance program for the inorganic lab.

For approximately eight years prior, Mr. Sloan was employed by FMC Corporation, first as an Associate Chemist and later as a Chief Chemist. His responsibilities included supervision and training of technicians, performing special analytical work for chlorine, caustic hydrogen peroxide, and ammonia, and providing direct customer services such as consulting, trouble-shooting, and coordinating modifications to product specifications. He also recommended, developed, and implemented new practices, methods, and procedures to improve laboratory efficiency and developed and maintained a quality assurance program.

SHARON K. PIERSON

Quality Control Officer/Assistant Project Scientist

Education

B.S., Biology, University of the Pacific, 1978

Affiliations

American Association for the Advancement of Science

Specialty Areas

Quality Control
Hazardous Waste Laws
Analysis of Volatile Organics
GC/MS Operator

Experience and Background

Ms. Pierson is currently the Quality Control (QC) Officer with Canonie Environmental Services Corp.'s (Canonie's) analytical laboratory. She is responsible for ensuring that the data generated by the laboratory is technically sound and statistically correct. Her duties as QC Officer include monitoring instrument performance, ensuring accurate standards and quality control checks for standard methods, and stopping the release of data which does not meet with the prescribed quality standards.

She is also responsible for the use and application of safety equipment for workers in the field. Ms. Pierson is involved in keeping abreast of state and federal hazardous waste regulations.

Other areas that Ms. Pierson has been responsible for at Canonie include the analysis of volatile organics using an automated purge and trap sampler connected to a GC with Hall/FID/PID detectors. Her duties included the actual analysis of samples and manipulation of the GC data via the computerized data system. Ms. Pierson was responsible for the maintenance of the instrumentation, including the GC, Hall/FID/PID detectors, and computer system, and their associated minor repairs. She was involved in the writing of reports and summaries based on laboratory analytical results.

ARLEN G. NECKELS

Assistant Project Scientist (Chemist)

Education

Agribusiness, San Joaquin Delta College, 1963

Specialty Areas

Trace Organic, Pesticide Analysis
Inorganic and Metals Analysis

Experience and Background

Mr. Neckels is involved in the analysis of organochlorine and organophosphorus pesticides by gas chromatographic methods. He is responsible for the packed and capillary column analysis of those compounds utilizing electron capture, flame photometric, and nitrogen/phosphorus detectors. He performs the analysis of PCBs, herbicides, fumigants, and organonitrogen compounds in water, soil, oil, solid waste, and other types of matrices. His duties also include the analysis of the compounds, the data manipulation, and the final reporting of results.

Mr. Neckels was involved in the setup, implementation, and Department of Health Services' (DOHS) certification of the automated EPA 601 volatiles analysis utilizing computer-controlled auto-sampler purge and trap instrumentation, a chromatograph with packed column and effluent splitter, and two detectors attached to a computerized data system for data reduction.

Mr. Neckels performs maintenance and routine repair of the gas chromatography instrumentation, associated detectors such as Hall electroconductivity, flame photometric, thermionic specific (N/P), flame ionization, photoionization, and electron capture, and for the associated autosampler equipment, both liquid and volatile.

As a chemist in the environmental laboratory for Occidental Chemical Company (Best Products, now Simplot Company), Mr. Neckels was involved with the daily routine gas chromatographic analyses of organochlorine and organophosphorus pesticides, fumigants, and herbicides of samples taken from the facility's carbon unit remedial system. He was responsible for the packed and capillary column analysis of those compounds utilizing electron capture, flame photometric, and nitrogen/phosphorus detectors. His duties included the analysis of PCBs, various industrial chemicals and organonitrogen compounds in water, soil, oil, solids, and other types of matrices when requested by the environmental department of the facility. He was directly responsible for the analysis of the samples and the data manipulation via computerized data systems. All methods used were EPA methods or modifications approved by the state of California DOHS.

(Arlen G. Neckels)

Previously, Mr. Neckels was a product development chemist, a position in which he conducted research in the development of new formulations and the evaluation of established formulations for pesticide products. This involved both gas and liquid chromatographic analysis with various columns and detectors. He was responsible for the analytical work and the final report generation.

As a senior technician, Mr. Neckels was responsible for the air and water pollution sampling and analysis programs on the facility property. Methods that were used were EPA- and NIOSH-approved methods utilizing both gas and liquid chromatographic analysis with various columns and detectors. He was also involved in product development for the fertilizer department. For four years he operated the laboratory at the Hanford Satellite plant, an agricultural chemicals complex. His duties included quality and air pollution control analysis. He was responsible for the development of new methods of analysis for agricultural chemicals manufactured at the facility.

As a technician, Mr. Neckels conducted over 100 different procedures for chemical and physical analysis for quality and process control of agricultural chemicals production. These methods ranged from wet chemical to advanced automated instrumentation.

MICHAEL ASELTINE

Assistant Project Scientist

Education

B.A., Environmental Biology, University of the Pacific, 1982

Experience and Background

Prior to joining Canone Environmental Services Corp., Mr. Aseltine was employed with California Water Labs where he was responsible for the volatile organic analysis of soil, water, and air, and analysis of total organic halides.

Mr. Aseltine is proficient with all stages of volatile organic analysis, from collection to data analysis. He has experience with FID, PID, and HECO detectors combined with purge and trap and DANU headspace concentrators, and is knowledgeable of federal and state analysis methods.

S. JACK SHIMASAKI

Assistant Project Scientist

Education

B.A., Chemistry, University of California, 1951

Affiliations

American Chemical Society

Experience and Background

Prior to joining Canonic Environmental Services Corp., Mr. Shimasaki was head chemist for Nelson Laboratories in Stockton, California. He was responsible for supervising the performance of chemical analysis of various agriculturally related products and trace metal determinations in soils and wastewaters. He also compiled the data for reporting to the clients. Mr. Shimasaki established and maintained Nelson Laboratories' quality assurance program for generated data and was responsible for the certification of the lab under the California Department of Health Services for chemical analysis of drinking and wastewaters, and for bacteriological testing of drinking waters.

Publications

Parrette, R., A. J. Hammond, and S. J. Shimasaki, "High Effective Impulse of High Density Zirconium Propellants", JANAF meeting.

JAMES M. HOCH

Assistant Project Scientist

Education

B.S., Chemistry, Bucknell University, 1982

Ph.D., Organic Chemistry, University of the Pacific (in progress)

Experience and Background

Mr Hoch's background includes four years as a graduate teaching assistant and research assistant in the chemistry department at the University of the Pacific. Topics of research during this time included the mechanism of rhodium catalyzed decarboxylation and the synthesis of the biologically active constituent of *Anemopsis Californica*, 1-methyl-4-isopropyl-hydroxy bicyclo (3.1.0) hexane.

Mr. Hoch was previously employed as a bench top chemist for Citation Circuits, a circuit board production plant, in Stockton, California. His duties included chemical analysis for titrations, pH, and colorimetry.

As a technical consultant for California Cooler in Stockton, California, Mr. Hoch was responsible for the setup and operation of an HPLC system for preservative monitoring.

DONNA M. ALLSUP

Chemist

Education

B.S., Chemistry, Southeast Missouri University, 1977

Affiliations

American Petroleum Institute

Experience and Background

Ms. Allsup brings to Canonic Environmental Services Corp. a strong background in chemical analysis. She is experienced in the chemical analysis of drilling fluids used in drilling oil, gas, and geothermal wells. She has been responsible for maintaining the physical and chemical properties of the fluid during the drilling process and making daily recommendations for optimum efficiency and economics.

As a water research assistant for the U.S. Army Corps. of Engineers, Ms. Allsup designed equipment and experiments necessary to perform water research.

DALE E. GIMBLE

Chemist

Education

B.S., Biochemistry, University of California, 1982

Experience and Background

Mr. Gimble was previously employed as a laboratory technician with Morse Laboratories, Inc. He is experienced in:

- o Pesticide residue analysis;
- o Organic extraction procedures;
- o Ion exchange chromatography;
- o Preparation of reagents;
- o EPA water analysis;
- o Sample preparations;
- o Gel Electrophoresis;
- o Enzyme assays and kinetics.

GAIL ROBERTS-ADAMS

Chemist

Education

B.S., Forensic Sciences/Chemistry, California State University,
1982

A.A., General Education, Rio Hondo Community College, 1978

Specialty Areas

Inorganic Analysis

Metals Analysis

Volatile Organics Analysis

Instrument Maintenance and Repair

Experience and Background

At Canonie Environmental Services Corp.'s laboratory, Ms. Roberts-Adams has been involved in the analysis of soil, water, and other matrices for volatile and semi-volatile organics using EPA protocols calling for gas chromatography with Hall and Flame ionization detectors. She is responsible for setting up the computerized data system to operate the instrumentation, collect the data, and finally produce the quantified reports.

Previously, Ms. Roberts-Adams was involved in inorganics analysis and the operation of a computer-driven atomic absorption spectrophotometer. She performed physical parameter testing and wet chemical tests.

SHAKOORA AZIMI

Chemist

Education

B.S., Biology, Kabul University, 1979
B.S., Chemistry, Kabul University, 1979

Experience and Background

Ms. Azimi is experienced in gas chromatography following EPA Methods 601 and 602 for volatile organics using a flame ionization detector, a photoionization detector, and a Hall electrolytic conductivity detector. She is knowledgeable in SW-846 Methods 5030, 8010, 8015, and 8020 for solid waste analysis.

Ms. Azimi has also worked in Canonie Environmental Services Corp.'s inorganics laboratory, performing all wet chemistry analysis according to SW-846 methods. She is capable in all areas of sample preservation, preparation, and analysis.

B. MARK TRAXLER

Chemist

Education

B.S., Biochemistry, 1987

A.A., Chemistry, Delta College, 1982

Specialty Areas

Inorganic Analysis of Waters, Soils and Other Media
Analysis of Volatile Organics
Background in Biochemistry and Food Science
Computer Programming

Experience and Background

Since joining Canonie Environmental Services Corp., (Canonie) Mr. Traxler has been responsible for analysis of inorganics and metals in waters, wastewaters, soils, and hazardous wastes.

His duties include compiling and interpreting data regarding chemical quality of waters and hazardous wastes. He is also involved in the development of methods for analytical analyses and development of computer programs for quality control.

Prior to joining Canonie, Mr. Traxler was employed for five years with a private laboratory. He was responsible for inorganic chemical analyses of waters, wastewaters, soils, feeds, fertilizers, plant tissues, and miscellaneous items. He was also responsible for data interpretation and quality control. He became highly proficient in the use of the atomic absorption spectrophotometer, as well as other analytical instruments used in an inorganic laboratory.

His education includes upper division work in biochemistry and food science as well as a strong background in inorganic chemistry.

APPENDIX C
LABORATORY CERTIFICATES

STATE OF CALIFORNIA
DEPARTMENT OF HEALTH SERVICES

HAZARDOUS WASTE TESTING LABORATORY CERTIFICATE

is hereby granted to

CANONIE ENVIRONMENTAL

to conduct analysis of hazardous waste in the following test categories:

PARTIAL ORGANIC CHEMICAL ANALYSIS
FULL INORGANIC CHEMICAL ANALYSIS
PHYSICAL PROPERTY TESTING
CALIFORNIA WASTE EXTRACTION TEST

This Certificate is granted in accordance with provisions of Article 8.5,
Chapter 6.5, Division 20 of the Health and Safety Code.

Certificate No. 155

Expiration Date SEPTEMBER 8, 1988



Issued at Berkeley, on SEPTEMBER 9, 1986

by

Chief, Hazardous Materials Laboratory Section

EXPIRES:
June 30, 1990

STATE OF CALIFORNIA
DEPARTMENT OF HEALTH SERVICES
LABORATORY SERVICES
SANITATION AND RADIATION LABORATORY
APPROVED WATER LABORATORY

Canonie Engineers, Inc.
Stockton

is hereby approved as awater laboratory
for the performance of analytical examinations as follows:

General Chemical
Organic Chemical

Issued at Berkeley, September 12, 1983

Amended November 26, 1984

April 29, 1985

By B. R. Tamplin
Chief, Sanitation and Radiation Laboratory

*This approval is subject to revocation
or suspension for good cause*

FORM 245-302A (REV. 1-1-71)
00041-000 10-70 2M DUP 08P

NEW YORK STATE DEPARTMENT OF HEALTH

DAVID AXELROD, M.D. COMMISSIONER



INTERIM CERTIFICATE OF APPROVAL FOR LABORATORY SERVICE

(Issued in accordance with the Laws of New York State)
pursuant to Section 502 of the Public Health Law
Expires 12:01 AM April 1, 1988
ISSUED April 1, 1987

Laboratory ID. Number 10798

Laboratory Name: Canonie Engineers
Number & Street: 212 Frank West Circle, Suite A
City, State, Zip: Stockton CA 95206

Director: Mr. Kenneth C Wahl

is hereby APPROVED as an Environmental Laboratory for the category

POTABLE WATER

NON-POTABLE WATER

All approved subcategories and analytes are listed on the attached addendum

Herbert W. Dickerman, M.D. PhD.
~~David Axelrod, M.D.~~
Director
Wadsworth Center for Laboratories and Research

APPENDIX D

DISCUSSION OF CHARCOAL AND TENAX™
SAMPLE TUBE PREPARATION AND ANALYSIS
CLAYTON ENVIRONMENTAL CONSULTANTS, INC.
NOVI, MICHIGAN

Clayton Environmental Consultants, Inc.

25711 Southfield Road, Southfield, Michigan 48075. Telephone (313) 424-8860

February 18, 1986

Ms. Irene Fanelli
CANONIE ENGINEERS, INC.
P.O. Box 1019
Gray, ME 04039

Dear Ms. Fanelli:

In response to our telephone conversation of February 14, the following describes our qualifications, methods, and quality assurance practices for the sampling program discussed.

The Clayton laboratory is accredited by the American Industrial Hygiene Association (AIHA) and participates in the National Institute for Occupational Safety and Health (NIOSH) Proficiency Analytical Testing (PAT) program for organic solvents, metals, silica, and asbestos. A copy of our accreditation certificate and recent PAT round summary is provided.

The laboratory has extensive experience in analysis of organic solvents using both gas chromatography and gas chromatography/mass spectrometry (GC/MS). We employ standard accepted methods of analysis referenced in the NIOSH Manual of Analytical Methods and by the Environmental Protection Agency (EPA).

As discussed, we recommend that the samples for the nine organic solvents be collected on activated charcoal. The analysis would be performed by gas chromatography using a flame ionization detector after desorption with carbon disulfide (CS₂). A listing of the NIOSH analytical method references is compiled below.

<u>Analyte</u>	<u>Method No.</u>
Dichlorobenzene	S135
Ethyl benzene	S29
Ethylene dichloride	S122
Fluorotrichloromethane	S102
Tetrachloroethane	S124
Tetrachloroethylene	S335
Toluene	S343
Trichloroethylene	S336
Xylene	S318

Copies of the NIOSH validation sheets for each of the above are enclosed, with the exception of fluorotrichloromethane (S102), which will be forwarded to you shortly.

Clayton Environmental Consultants, Inc.

Ms. Irene Fanelli
CANONIE ENGINEERS, INC.

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The Clayton laboratory maintains a rigorous quality assurance program, including chain of custody, sample tracking, and analysis. Our program is consistent with both AIHA and EPA requirements.

Quality Assurance practices specific to the sampling program for Canonie Engineers are listed below.

- 4-point calibration curve
- blanks
- duplicate desorption efficiency determination for each compound. (A more rigorous program can be performed upon request.)
- analysis of standard samples throughout the analysis sequence

We would be happy to incorporate additional quality assurance procedures, as specified by Canonie Engineers.

We look forward to working with Canonie Engineers, Inc. Please call if you have any questions.

Sincerely,



Robert Lieckfield Jr., C.I.H.
Manager, Laboratory Services

RL:kf
Enclosures

Clayton Environmental Consultants, Inc.

25711 Southfield Road, Southfield, Michigan 48075, Telephone (313) 424-8860

February 19, 1986

Ms. Irene Fanelli
CANONIE ENGINEERS, INC.
P.O. Box 1019
Gray, ME 04039

Subject: Clayton Job No. 31536-17

Dear Ms. Fanelli:

The following is the information you requested in our conversation of February 18 regarding the analyses of charcoal tubes and Tenax tubes.

Modifications to NIOSH Methods

The only modification from the quoted NIOSH methods was the use of a 60-meter DB-5 capillary column in place of the column listed in the methods. All samples were analyzed under the following conditions:

Instrument: Hewlett Packard 5880
Column: 60-meter DB-5 capillary
Oven Program: 50 °C for 7 minutes
5 °C/minute to 100 °C; hold for 6 minutes
10 °C/minute to 130 °C; hold for 6 minutes
Injection Port: 250 °C
Detector: 275 °C
Head Pressure: 24 PSIG
Injection: 1 microliter split ratio 18:1
Desorption: 1 milliliter CS₂

Desorption Efficiencies

Desorption efficiencies run with Canonie charcoal tube samples submitted on February 12, 1986 are listed below.

<u>Compound</u>	<u>Spike Level (ug)</u>	<u>Desorption Efficiency (%)</u>
Ethylene dichloride	3.1 13	97, 100 96, 97
Tetrachloroethylene	4.1 16	102, 101 97, 99
m-xylene	2.2 8.6	97, 94 94, 97

Ms. Irene Fanelli
CANONIE ENGINEERS, INC.

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<u>Compound</u>	<u>Spike Level (ug)</u>	<u>Desorption Efficiency (%)</u>
o-dichlorobenzene	3.3	90, 82
	13	84, 85
	261	88, 66
Fluorotrichloromethane (Freon 11)	7.5	89, 92
	30	92, 95
	1490	112, 109
Ethyl benzene	2.2	98, 94
	8.7	96, 98
	173	96, 97
1,1,2,2-tetrachloroethane	4.0	73, 72
	16	74, 72
	317	95, 90
Trichloroethylene	3.7	123, 118
	15	112, 112
Toluene	2.2	100, 95
	8.7	95, 97

Please note that desorption efficiencies were run at two levels in duplicate on parameters for which we have a larger data base (perchloroethylene, xylene, ethylene dichloride, toluene, and trichloroethylene).

On the other parameters (1,1,2,2-tetrachloroethane, ethyl benzene, Freon 11, o-dichlorobenzene), we have desorption efficiencies run at three levels in duplicate. Note that in all cases, at least one of the desorption efficiencies was at a level no greater than 3 times the reported limit of detection (LOD).

LOD's are determined by the level of the lowest standard injected and detected with the samples.

Preparation of Tenax for Gas Chromatography/Mass Spectrometry (GC/MS) Thermal Desorption

The tenax tubes are prepared by the following Clayton proprietary method:

The Tenax is sequentially extracted (Soxhlet) for 6-hour periods with pentane and then methanol. It is then dried, and packed into a large bore (one-half inch) GC column and conditioned overnight at 270 °C with nitrogen or helium flowing through the column. The Tenax (200 mg per tube) is then packed into eight-inch lengths of precleaned (methylene chloride wash and bake dry) 9-mm OD purex tubing, and held in place with precleaned glass wool. The tubes are immediately flame sealed.

Ms. Irene Fanelli
CANONIE ENGINEERS, INC.

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GC/MS Thermal Desorption Method

Tenax tubes are analyzed by heating the tube to 250 °C while back-flushing the tube onto a cryogenically (liquid-nitrogen) cooled capillary trap and then rapidly heating the trap to inject the material onto the GC/MS. The GC oven of the GC/MS instrument is held at a subambient temperature with liquid nitrogen to help form a narrower band of injected material on the column. The instrument is then scanned while the GC program runs. Typically, 45 minutes of scans are collected at .75-second intervals. The data is analyzed by forward search of the combined Wiley-NBS-NIH-EPA database when analyzing for total unknowns. When the parameters of interest are known in advance, reverse search against authentic standards is the method of analysis.

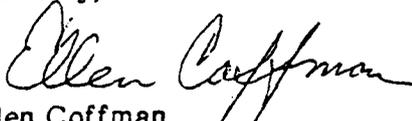
Enclosed is information regarding recommended sampling rates and exposure times for the Tenax tubes.

Limits of Detection for Nine Organic Compounds on the GC/MS

Although absolute LOD's for the nine compounds are not known, it has been our experience that we can detect 100 nanograms (ng) of most compounds spiked onto Tenax tubes and thermally desorbed. These detection limits are supported by work done by Edo Pellizzari under U.S. EPA Contract #68-02-2262. In addition, we have established instrument LOD's (GC/MS) for these compounds around the 20 ng/injection level. The only compound on the list that may cause a problem, because of its volatility, is the Freon 11.

We hope that this information satisfies your requirements. If you have any further questions, please call.

Sincerely,



Ellen Coffman
Technical Supervisor

EC:kf
Enclosure

GC/MS TENAX TUBE COLLECTION PROCEDURE

Enclosed are the Tenax tubes you requested for qualitative organic determination by gas chromatography/mass spectrometry (GC/MS).

The tubes are six inches long and contain 200 mg of Tenax which has been carefully conditioned to minimize interferences.

The tube will be thermally desorbed in our laboratory upon return to us, and the entire sample will be injected into the GC/MS for analysis. To avoid "overloading" the GC/MS with too much sample, it is important that the sample size, or the amount of contaminant collected on the Tenax tube, be controlled. We recommend the following sample volumes depending on the type of environment being sampled. Please also note that we are unable to adequately analyze a sample of insufficient size (one with a sample volume less than shown below).

<u>Environment</u>	<u>Total Sample Volume (liters)</u>
Very Clean (no odor)	100 to 200
Clean (no odor but something expected, or very faint odor)	50 to 100
Moderately Dirty (some noticeable odor, not intolerable)	20 to 50
Dirty (very noticeable odor)	10 to 20
Very Dirty (bad odor, noticeable smoke, etc.)	1 to 10

The flowrate of the sampling pump may vary from 50 to 200 cc/min.

If you are unsure about the sample size that you should collect, we recommend that two side-by-side samples be taken. Collect 10 times more sample on one tube than the other. At your direction, we will hold one of the samples, pending the results of the other.

Please retain the blank tube (the tube which has been broken) and return it to us with the other Tenax tubes for analysis. We will analyze the blank together with the others to determine background contamination.

APPENDIX E
PACKING AND SHIPPING GUIDELINES

Packing and Shipping Guidelines

I. INTRODUCTION

The Federal Regulations set forth by the Department of Transportation (DOT) for the packaging, labeling, and shipping of hazardous materials are extensive and broadly applicable. Therefore, a copy of the DOT requirements as described in the Code of Federal Regulations, 49 CFR 171-177, is an essential reference for those anticipating the need to ship samples of hazardous materials. What follows are generalized guidelines for compliance with DOT standards, along with references to the applicable sections in the Federal Register. It may be prudent to check with state and local agencies for any additional requirements or restrictions they may have.

II. SAMPLE TYPES

In selecting the proper shipping procedures, it should first be decided which of the two basic categories the sample falls into: Environmental Sample or Hazardous Substance Sample. An additional need for this distinction is to provide bases for selecting health and safety precautions for the laboratory personnel receiving and handling the samples.

- A. Environmental Samples - These are samples of soil, water, or air usually collected off-site of a hazardous waste dump or chemical spill, and are therefore not expected to be contaminated with high concentrations of toxic materials. The function of "environmental sample" collection is usually to monitor the extent of contamination and/or the off-site transport of contaminated materials. If there is doubt as to the suitability of a sample to this classification, it should be placed in the Hazardous Substance category.
- B. Hazardous Substances - Samples falling into this group are known or expected to be contaminated at concentrations that are potentially harmful; including, but not limited to, on-site samples of soil or water, samples from drums or bulk storage tanks, contaminated pools, lagoons, etc., and leachates from hazardous waste sites.

These are operational definitions intended to aid in making decisions concerning sample handling and shipping. The specifics of the DOT definitions are found in 40 CFR 261.3, and 261.4.

III. ENVIRONMENTAL SAMPLES

Although packaging and shipping requirements for environmental samples (associated with hazardous waste situations) are not as stringent as for hazardous waste samples, it is recommended that the following general packing procedure be utilized to ensure safe delivery and maintain sample integrity. This becomes especially important when samples are being transported by common carrier. If sufficient information is available concerning the nature of the sampled material, the following may be relaxed accordingly.

SHIPPING OF ENVIRONMENTAL SAMPLES

When a sample is shipped to the laboratory, it must be packaged in a proper shipping container to avoid leakage and/or breakage. A cardboard box that will provide at least 10 cm (4 inches) of tight packing around the sample container must be used. Acceptable packing materials include sawdust, crumpled newspaper, vermiculite, polyurethane chips, etc. Other samples that require refrigeration must be packed with reusable plastic packs or cans of frozen freezing gels in molded polyurethane boxes with sturdy fiberboard protective case. The boxes must be taped closed with masking tape or fiber plastic tape.

All packages must be accompanied by a sample analysis sheet and chain-of-custody record. Complete address of the sender and the receiving laboratory must legibly appear on each package. When sent by mail, register the package with return receipt requested. When sent by common carrier, obtain a copy of the bill of lading. Post office receipts and bill of lading copies may be used as part of the chain-of-custody documentation.

It should be noted that the addition of the following "hazardous" compounds as preservatives to environmental samples will not alter the Environmental classifications provided the following criteria are met:

1. Hydrochloric acid solutions at concentrations 0.04 percent (w/w) or less;
2. Mercuric chloride in water solutions at concentrations less than or equal to 0.004 percent (w/w);
3. Nitric acid in water, concentrations less than or equal to 0.15 percent (w/w);
4. Sulfuric acid solutions, concentrations less than or equal to 0.035 percent (w/w);
5. Sodium hydroxide in water, concentrations less than or equal to 0.080 percent (w/w);
6. Phosphoric acid in water, concentrations yielding a pH range between 4 and 2.