URS

QUALITY ASSURANCE PLAN

PAS SITE INVESTIGATION

Oswego, N.Y.

DECEMBER 2, 1982

URS COMPANY, INC.
625 Delaware Ave.
Buffalo, N.Y. 14202

Submitted to:

URS Engineers, Inc.
Buffalo, NY

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1.0 INTRODUCTION

The investigation and evaluation of the PAS Oswego site will involve the combined efforts of the URS Company, Inc., Woodward-Clyde Consultants, GCA Corporation and Earth Dimensions, Inc. This project will involve a multidisciplined approach progressing from an initial evaluation of existing data and an onsite geophysical survey, to soil boring operations, monitoring well installation, sampling and analytical activities and final data evaluation and remedial action recommendations. The purpose of this document is to outline and define the specific test protocols to be utilized during the conduct of these tasks complete with precision and accuracy goals for all field and laboratory activities.

The remainder of this section contains a brief description of the overall project, delineating tasks associated with each individual contractor. In addition, both an overall project organization chart and a field specific organizational charts have been included.

1.1 PROJECT DESCRIPTION

Our overall approach to the investigation and evaluation of the PAS Owego site (see Figure 1) is to perform initial geophysical surveys to identify the probable extent of subsurface contaminant migration. The test program is developed such that the initial screening investigations will each supply information useful in defining the extent of the problem so that each subsequent test can be more specific (see Figure 2).

The initial efforts will consist of an investigation of the County Landfill and geophysical surveys downgradient of the PAS site. Once access to the site is permitted, detailed onsite geophysical surveys will be performed. These tests include terrain conductivity and surface resistivity surveys as well as seismic refraction evaluations. The extent of this preliminary information should reduce the number of ground disturbing tests necessary and insure the safe and proper placement of any test borings and ground water

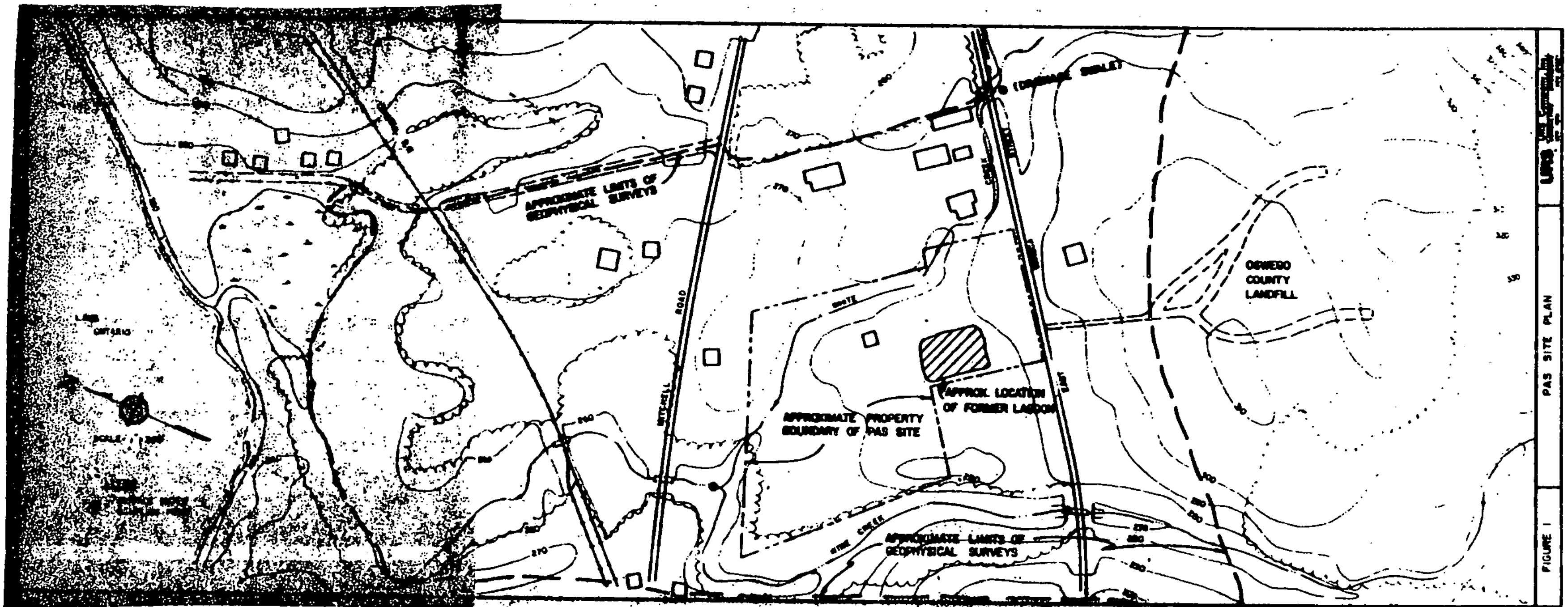

Figure 1. Site map from URS Technical Proposal.

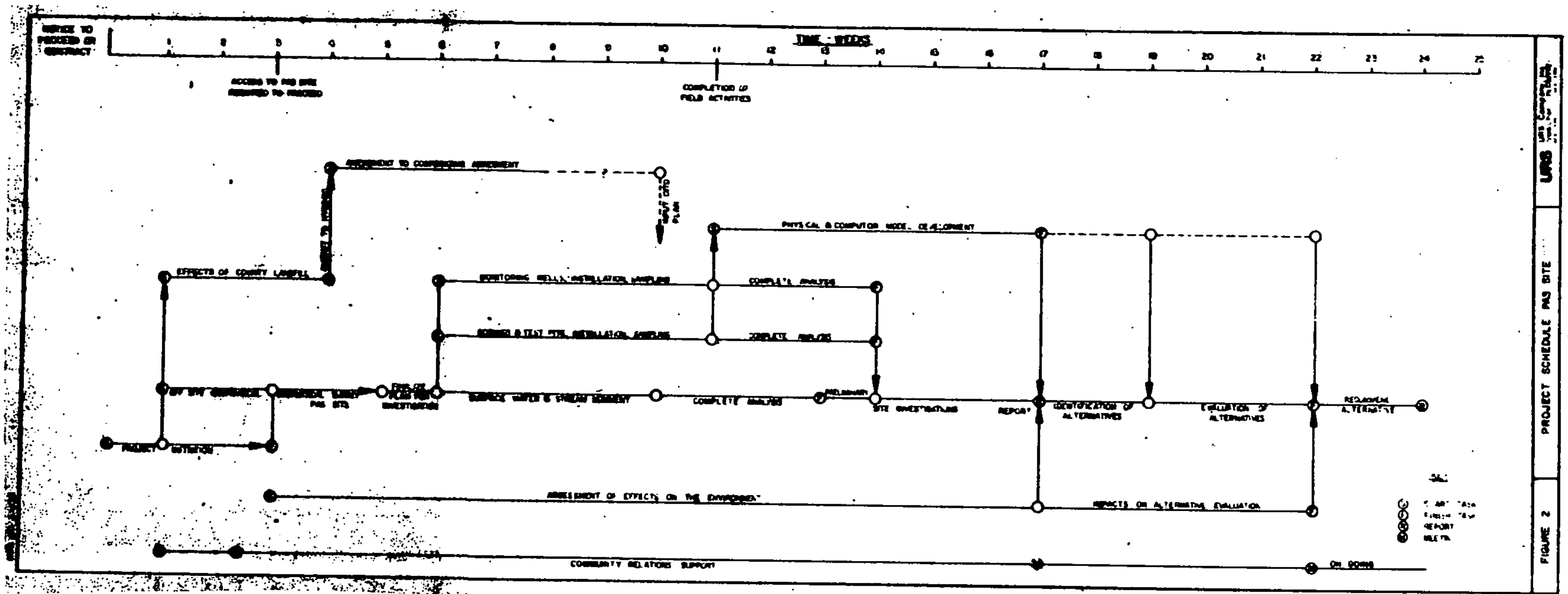

Figure 2. Project flow chart from URS Proposal.

monitoring wells. It is expected that approximately 15 test borings will be required as well as approximately 21 monitoring wells.

The information obtained from this field study as well as all associated analytical results will be evaluated to determine the available remedial alternatives. Our approach to identifying the most likely alternative is to utilize an Assessment Team consisting of the Principle Investigators from the Study Team.

1.2 PROJECT ORGANIZATION

The Project Organization Chart shown in Figure 3 represents the Principal Investigators which have been committed to this project. As indicated, the major channel of communication between NYSDEC and the URS Team will be through the Project Manager.

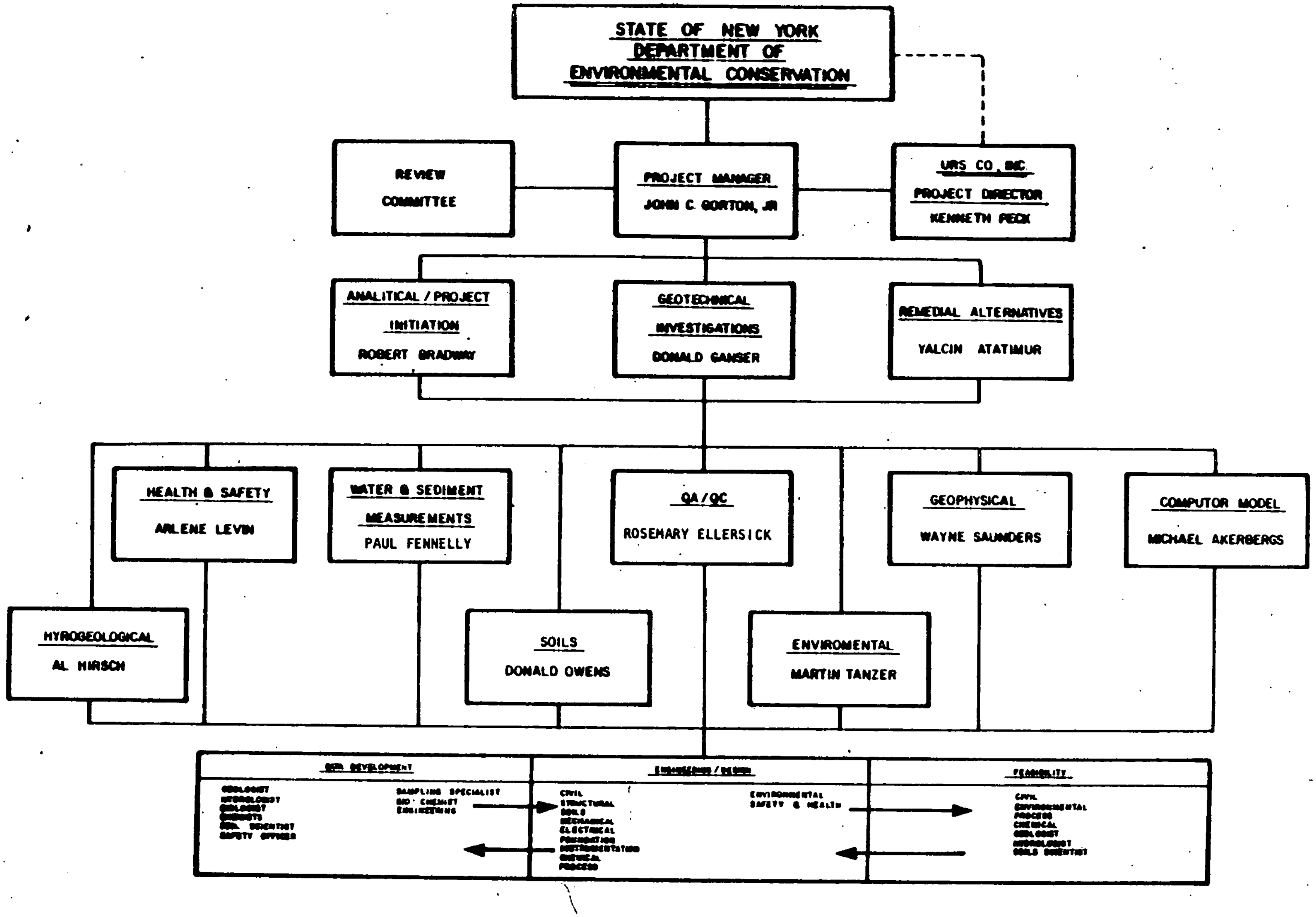

Figure 3. Project organization--PAS project.

2.0 GEOPHYSICAL SITE CHARACTERIZATION

Woodward-Clyde Consultants (WCC) has the responsibility as a member of the URS team to conduct the geophysical, geological, and hydrologic studies at the PAS site. A brief description of the geohydrology and contaminants present in the site is presented in the 1981 GCA study Information Evaluation for the Pollution Abatement Services, Inc. (PAS) Site, Oswego, New York.

2.1 RELEVANT BACKGROUND INFORMATION

The PAS site encompasses an area of about 70 acres near Oswego, New York. The area is bounded by Wine and White Creeks and E. Seneca Streets. The predominant surficial material is artificial fill which ranges from 5 to 10 feet in thickness, but lacustrine silts and clays occupy the western third of the PAS site. These surficial materials are underlain by cobble and boulder till locally referred to as the Lodgement and Ablation Tills. Bedrock (Oswego sandstone) occurs at a depth of about 30 feet at the site.

The principal factors that may influence water contaminant flow at the PAS site include:

- a potential upgradient source of ground water contamination from a municipal landfill,
- preferential flow in the higher permeability fill materials,
- second phase flow of some contaminants along top of fill topographic lows, and
- flow of contaminants into or through the tills through possible higher permeable zones.

2.1.1 General Approach

To assess ground water contaminant flow at the PAS site WCC will conduct geophysical surveys including terrain conductivity, earth resistivity and refraction seismic survey. The objectives of these surveys are to identify contaminant plumes and stratigraphic changes with respect to depth. These data then will be used to plan the exploratory borings and monitor well installation program. The surveys will be conducted in accordance with approved safety and decontamination programs.

2.2 GEOPHYSICAL SURVEYS

It is anticipated that the following geophysical instruments will be utilized for the subsurface investigation at, and in the vicinity of the PAS site to conduct terrain conductivity, earth resistivity, and refraction seismic surveys.

Geonics EM 34-3 Terrain Conductivity Meter
Geonics EM 31 Terrain Conductivity Meter
Bison 2390 Earth Resistivity Meter
Nimbus ES-120 Multichannel Signal Enhancement Seismograph

2.2.1 Techniques

All surveys will be conducted by experienced WCC personnel who have conducted many similar surveys utilizing the in-house equipment identified previously. Survey lines will be located in the field by placing a surveyors stake or hub into the ground. The lines will be based on tape and compass survey techniques. The distance between lines and measurement intervals will vary and depend on the type of survey conducted, the detail required, and the existing subsurface conditions. The location of the stake (i.e., survey line) will be referenced on appropriate site maps and aerial photographs. Direction of survey lines will be initiated and maintained by Brunton Compass with the proper magnetic declination. Distances between measurement stations will be maintained by a "hip-chain" device. Where detailed survey work is warranted by any geophysical apparatus, a grid-type pattern will be established by placing four (4) surveyor stakes on hubs into the ground at right angles with the appropriate measurement stations.

All geophysical equipment will be calibrated on a daily basis in conformance with manufacturers guidelines. The operating manuals will be available on-site for all operations personnel and are attached as Appendix A. Because the surveys will be conducted during winter months, it is anticipated that cold temperatues will be normal. Therefore, all batteries will be checked for their power output at least twice daily. To assure that all instruments are working properly, a test site with similar geohydrologic conditions not affected by contamination at the site will be used daily to make measurements and assure repeatability.

2.2.2 Safety

All geophysical equipment being utilized is of a non-destructive nature and poses little or no threat to individuals or the environment. All gephysical equipment which is taken on the PAS site proper will be decontaminated in accordance with on-site procedures. No equipment will leave the PAS site until approved by the on-site safety officer.

2.3 BOREHOLE, MONITOR WELL AND TEST PIT INSTALLATION

About 15 exploratory boreholes and 21 monitoring wells are planned to be installed at and in the vicinity of the PAS site. The locations of boreholes and monitoring wells will be based in part on the results of geophysical surveys, which are to be conducted prior to the boring and monitoring well installation programs. In order to optimize the location and depths of monitoring wells, information of the exploratory boring program will be used in conjunction with the results of the geophysical surveys. In addition, on-site monitoring will be utilized to develop a safety program for the installation of the exploratory borings.

2.3.1 Exploratory Borings

Fifteen soil borings will be advanced to the top of bedrock which is estimated to occur at a depth of about 30 feet. The borings will be advanced utilizing hollow stem augers or driven casing utilizing a roller bit and compressed air to remove cuttings from the hole. Soil samples will be retrieved continuously utilizing a split-spoon sampler in advance of the auger or the driven casing. Upon refusal the samples will be collected utilizing diamond coring techniques. At the completion of the boring, each borehole will be grouted to the surface utilizing a cement slurry with ten percent bentonite.

An organic vapor analyzer (OVA) will be used to monitor air quality in the vicinity of the drill hole during operations and to measure the organic vapor content of individual soil samples after they have been extruded and logged. Information on the OVA will be used to determine the safety requirements that are required, as well as to estimate the extent of soil contamination. This is routine practice by WCC and will be conducted along the other routine air safety checks to be made by URS.

(in 30° weather)

Samples collected during the soil boring program will be logged by an experienced geologist/soil scientist and a boring log of the strata encountered will be developed (Figures 4 and 5). The depth to the water table will be measured on several occasions before the boring is grouted. As required by the soil sampling program, the geologist/soil scientist will provide soil samples to GCA for chemical analyses. The sample will be collected utilizing a brass cork borer to subsample the core. The contents of the cork borer will be placed into a 40 ml glass vial then capped with a septum seal. The vial will be labeled with the bore hole designation and the depth of the sample. The vial will then be delivered to the GCA Mobile Lab and the corer will be soap and water washed using a stiff brush then rinsed with deionized water before reuse. The remaining samples will be retained by WCC for possible physical property testing if required at a later date. The samples will be segregated as hazardous waste soil samples and stored for a period of six months, unless specifically requested otherwise by URS. Physical property tests of the soils would be conducted by WCC in their hazardous waste materials testing laboratory. These tests would be conducted in accordance with the requests of URS to identify soil properties relevant to remedial action programs on Borehole geophysics.

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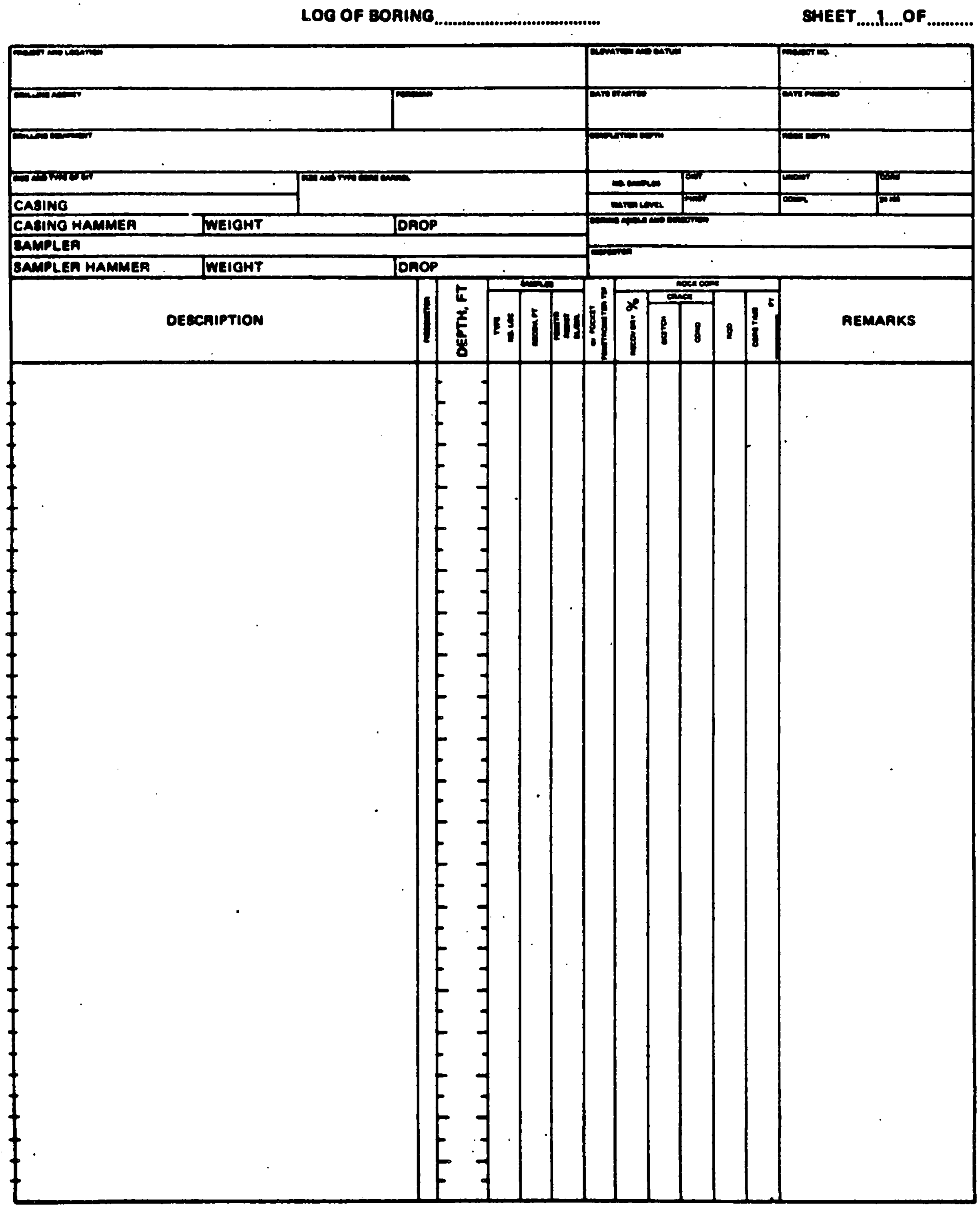
Should also be solvent rinsed, e.g. hexane/acetone

2.3.2 Installation of Monitor Wells

About 21 monitoring wells will be installed at or in the vicinity of the PAS site. About half of these will be installed about 10 feet into bedrock



LOG OF BORING.. SHEET....1....OF..........

CASING		
CASING HAMMER	WEIGHT	DROP
SAMPLER		
SAMPLER HAMMER	WEIGHT	DROP

DESCRIPTION		DEPTH, FT					%					REMARKS

Figure 4. Test boring log.

INSPECTION REPORT

WOODWARD–CLYDE CONSULTANTS
CONSULTING ENGINEERS, GEOLOGISTS AND
ENVIRONMENTAL SCIENTISTS

201 WILLOWBROOK BLVD., WAYNE, NEW JERSEY 07470 201–785–0700

DATE ____________________

PROJECT NO. ____________________

LOCATION ____________________

PROJECT ____________________

CLIENT'S REPR. ____________________

CONTRACTOR'S REPR. ____________________

WEATHER ____________________

PROGRESS OF WORK ____________________

INSPECTOR ____________________

Figure 5. Inspection report.

which is estimated to occur at a depth of 30 feet below ground level, and the other half completed into the till near the top of the water table in the till, estimated to occur at a depth of about 15 feet.

2.3.2.1 Method of Installation--

Dependent upon the record of the exploratory boring program, holes in the surface till will be advanced utilizing either 6 x 12' hollow stem auger or by driving 6 inch ID flush joint casing. Soil samples will be collected continuously utilizing a split-spoon sampler or by coring. Dependent upon site conditions, much or all of a hole will be advanced utilizing driven casing. Thus, at depths exceeding auger refusal or throughout the length of the hole, the procedure will entail the collection of a soil sample by split spoon or coring, the reaming of the hole to sample depth utilizing a roller bit with compressed air to remove cuttings, and then driving casing in the reamed hole. The casing will be advanced after reaming to the depth equivalent to the previous sampling depth, thus, soil or rock samples will be collected from undisturbed materials.

Solvent washed

During drilling, an OVA will be used to monitor at frequent intervals the quality of air emanating from the hole and the quality of air emanating from soil samples. Soil samples will be identified in accordance with the Unified Soil Classification System by an experienced geologist/soil scientist and a log of the borehole will be prepared as requested. Soil samples will be delivered to GCA for priority pollutant analysis as requested. Other samples will be retained by WCC for a period of six months. Physical property tests of these soils or cores will be conducted in the WCC hazardous soils testing laboratory as requested by URS.

Screen and riser pipes will be installed in each hole. Dependent upon anticipated chemical water quality, the screens will either be PVC or stainless steel slotted screens with PVC or black iron rise pipe, respectively. PVC casings and screens will be flush joint. Given the higher costs of stainless steel screens and black iron rise pipe, these will be used only if adverse chemical water quality requires these materials. A 3 inch ID well screen that is 5 to 10 feet long will be installed in each well. A filter pack comprised of well graded sand and consistent with the slot size of the screen (0.01-0.02 inches) will be installed around the screen. The filter pack will extend no further than two feet above the top of the screened interval. A bentonite seal with a minimum thickness of two feet then will be installed. The annular space around the riser pipe will be grouted utilizing a cement slurry with ten percent bentonite. The grout will be installed utilizing a tremie. A protective steel casing with locking cap will be installed around the surface pipe if a PVC rise pipe is utilized. Otherwise, a protective cap will be installed on the 3 inch ID black iron riser pipe. A sample monitor well installation report is provided as Figure 6.

Wells will be developed utilizing one of several techniques. These techniques could include bailing, utilization of a submersible or suction pump, or surge block. No ground water samples will be collected for analysis until the wells have rested for two weeks following development.

2.3.2.2 Aquifer Testing--

Aquifer testing to estimate transmissivity of the strata can be accomplished either by a pump test or a single hole test. The pump test is a more extensive test because water is pumped for a long period of time from one well and water level changes are measured in adjacent wells. The pump or aquifer test, however, produces relatively large volumes of pump water which may be contaminated and would require treatment prior to disposal. The test, therefore, is not recommended by WCC at this time.

A falling head permeability tests will be conducted in each exploratory boring and a "slug" test in each monitoring well. A borehole permeability test log is provided as Figure 7. These methods are rapid means by which the permeability in the immediate vicinity of a boring or monitoring well can be approximated, and when conducted at numerous locations allows WCC to estimate the permeability of saturated strata through much of the site area. The tests do not involve pumping of potentially contaminated water.

2.3.3 Test Pits

Ten test pits will be excavated with a back hoe to a 15 to 20 foot maximum depth to support the exploratory soil borings and to describe the soil micro variability on site. Each test pit will be first excavated to a 5 foot depth prior to going any deeper to allow for shallow examination and

MONITOR WELL INSTALLATION REPORT

Monitor Well No. ____________

Project ______________________________ Location ____________

Project No. __________ Installed By __________ Date ________ Time ________

Method of Installation ______________________________

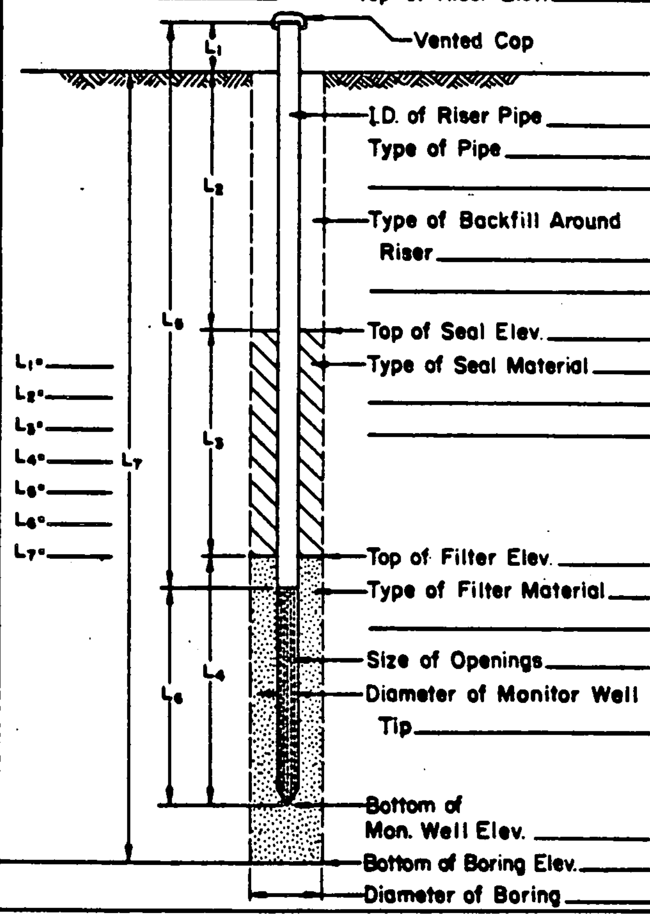
____

____

____

LOG OF MONITOR WELL

BORING			MONITOR WELL
Depth in ft.	Description	Symbol	Type of Monitor Well ____________
			Ground Elev. ________ Top of Riser Elev. ________



Remarks ______________________________

____

____

____

Inspected By ____________

Figure 6. Monitor well installation report.

BOREHOLE PERMEABILITY TEST LOG

BORING ______________ DIAMETER ________________ INSPECTOR ____________________ DATE __________

GROUNDSURFACE ELEVATION __________ FT DEPTH TO GROUNDWATER (D_G) ________ FT

DIAMETER OF CASING OR RISER ____________________ IN. DEPTH OF CASING ________ FT

			L_A			T	H_1	H_2	H_A			Q	Q			
TEST NUMBER	TYPE TEST (1)	SECTION OF BORING TESTED	AVERAGE LENGTH OF TEST SECTION	START TIME	STOP TIME	ELAPSED TIME	START AVERAGE HEAD	STOP AVERAGE HEAD	AVERAGE HEAD	START METER READ	STOP METER READ	GALLONS USED	FLOW RATE (GPM)	Q/H_A	C_p	K(2) (FT/YR)

(1) FALLING HEAD = FH; CONSTANT HEAD = CH

(2) CONVERSION FACTORS: K $\left(\frac{FT/YR}{365}\right)$ = K (FT/DAY) K (FT/YR) x 9.67 x 10^{-7} = K (cm/sec) CHECKED BY: ____________________

REFERENCE: EARTH MANUAL, U.S. BUREAU OF RECLAMATION, 1974, p. 541

Figure 7. Borehole permeability test log.

description. At least two people will be present during logging of any test pits, and no person will be allowed in or near an open test pit if the cut side walls are unstable. Also, no person will be allowed into an unshored pit deeper than 5 feet.

Fill and soil samples will be obtained from each significant fill layer or soil horizon-strata. Any test pit encountering visually contaminated material will be stopped after penetrating 5 feet of original glacial till to prevent further vertical flow of liquid contaminants. Should any drums or barrels be encountered, excavation will be terminated. The excavated soil material will be carefully backfilled into the test pit. An organic vapor analyzer (OVA) will be used to monitor air quality during the excavation, logging and backfilling of the test pits.

2.3.4 Decontamination

This section describes the decontamination procedures that will be used on the drilling equipment when the drilling rig is moved to a new location at the PAS site and prior to leaving the PAS site at the completion of the drilling program. Decontamination procedures for personnel are described by GCA in the Addendum to the Health and Safety Plan. The objectives of these procedures will be to reduce the potential for cross-hole contamination and for contaminants to leave the PAS site upon completion of the job.

The drilling rigs and accessories will be precleaned in the following manner:

- Residual oils, grit, rust and soil, will be removed from all parts of the drilling rig in close proximity to the bore hole, with a stiff wire brush.

- Thorough washing with detergent and steam cleaning utilizing scrub brushes.

The drilling rigs, augers and drilling accesories shall be cleaned between bore hole/monitoring well locations.

- Residual oils, grit, rust and soil will be removed from all parts of the drilling rig in close proximity to the bore hole, with a stiff wire brush.

- Thorough washing with detergent and steam cleaning utilizing scrub brushes.

- Collect, store and securely dispose of all waste, rinse and washwater.

- All personnel cleaning field equipped shall follow the safety plan.

During the period of drilling, the drill rigs will not leave the PAS site, thereby, preventing contaminant loss from the site by egress of the drilling vehicles. Prevention of cross-hole contamination will be achieved by passive and active means. Passively, the potential for cross-contamination will be reduced by sequencing drilling operations from areas of presumed low contamination to areas of higher contamination. Upon completion of a boring or installation of a monitoring well, all drilling equipment that penetrates the borehole will be cleaned. Drill stem, bits, and casing will be steam cleaned before the equipment is utilized on the following hole.

The split spoon and monitoring well hardware shall be cleaned in the following manner:

- Residual oils, grit, rust and soil will be removed from all parts of the drilling rig in close proximity to the bore hole, with a stiff wire brush.

- Thorough washing with detergent and steam cleaning utilizing scrub brushes.

- Rinse with deionized water.

- Rinse with acetone
- Rinse with hexane
- Second rinse with acetone
- Final rinse with deionized water
- Air dry
- Initiate chain of custody if necessary
- Collect, store and securely dispose of all waste, rinse and washwater

At the completion of the drilling and geophysical program, all drilling equipment, drill rigs, compressors as well as the backhoe and bulldozer will be steam cleaned. Cleaning will occur just prior to departure of the vehicles from the PAS site.

Trip Blanks

3.0 SOIL AND WATER TESTING

3.1 TASK DESCRIPTION

GCA is responsible for the following tasks:

- Surface Water Sampling and Analysis: four locations collected twice and analyzed at GCA's Bedford, MA laboratory for Priority Pollutants.

- Stream Sediment Sampling and Analysis: five locations including one at each of the four surface water sampling locations as well as one at a former lagoon site. Each location will be sampled once and analyzed at GCA's Bedford, MA laboratory for specific suspected priority pollutants.

- Onsite soil sample analysis: Soil samples from borehole installations and test pit excavation will be delivered to GCA's onsite laboratory for hydrocarbon screening analysis.

- Off-site soil sample analysis: 10 soil samples will be delivered to GCA's laboratory in Bedford, MA. The samples will be analyzed for the priority pollutants.

- Ground water sampling analysis: each of the 21 installed monitoring wells will be sampled once and analyzed at GCA's Bedford, MA laboratory for priority pollutants.

3.2 PROJECT ORGANIZATION AND RESPONSIBILITY

Figure 8 presents GCA's organization chart for their part of the project showing the individuals responsible for each key element of the sampling and analyses task.

3.3 QUALITY ASSURANCE OBJECTIVES IN TERMS OF PRECISION, ACCURACY, COMPLETENESS, REPRESENTATIVENESS AND COMPARABILITY

3.3.1 Sampling Procedures

All sampling will be conducted by personnel experienced in the techniques described. Field blanks and duplicates will be collected for each type on sample as a means of evaualting representativeness.

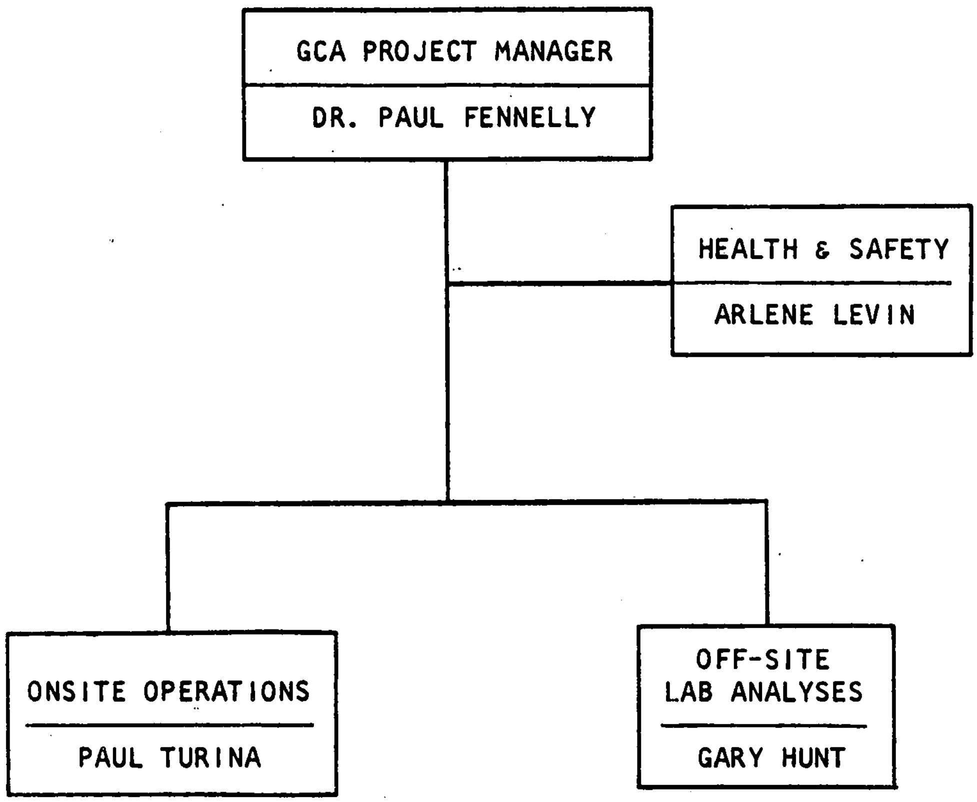


Figure 8. GCA Corporation Task Organization Chart.

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3.3.2 Onsite Soil Analysis

mobile lab

The techniques employed for the onsite analysis of the soil samples is designed to supply a rapid assessment of the likelihood of volatile organic contamination. This information will assist the geologists in decisions regarding further drilling progress as well as insuring a high degree of safety for the drilling crews. Therefore QA objectives will be based on providing maximum analytical sensitivity within the constraints of expediency.

3.3.3 Off-Site Analysis

Precision, accuracy and completeness objectives are given in Figure 9 for those analysis conducted by GCA's laboratory in Bedford, MA.

3.4 SAMPLING PROCEDURES

The sampling procedures for each matrix are listed below. Sample containers and preservation will be in accordance with the procedures described in the Federal Register December 18, 1979, Vol. 44, NO. 244.

3.4.1 Surface Waters

Four locations will be selected to represent the surface water flow associated with the PAS site. These will include one location on each of both White and Wine Creek, just upstream of the PAS site, as well as a location immediately after their convergence and just before their discharge to Lake Ontario. In order to allow for a historical interpretation of the results the sampling sites will be located at points previously sampled and described by the USGS in March of 1980. Similar locations were also employed by other investigators including the U.S. EPA (1977), Galson Technical Services (1976, 1977), Fred C. Hart Associates (1981) and the Oswego County Public Health Department.

Each location will be sampled twice, during the study. The samples will be collected as a 24 hour composite of at least 8 grabs utilizing an ISCO Model 2100 Hazardous Waste Sampler. Should severe cold prevent their

	Precision (relative standard deviation)	Accuracy	Completeness
Volatile Organics			
Sediment/Soil	25%	±25%	95
Water	20%	±20%	95
Extractable Organics			
Sediment/Soil	25%	±25%	95
Water	20%	±20%	95
Trace Elements			
Sediment/Soil	15%	±15%	95
Water	10%	±10%	95
CN/5			
Sediment/Soil	15%	±15%	95
Water	10%	±10%	90

Figure 9. QA objectives for precision, accuracy and completeness.

operation, samples will be collected and composited by hand on 4-hour intervals. Samples for volatile organic analysis will be collected as single grabs in septum sealed vials.

3.4.2 Sediments

Five locations will be selected to represent the surface water sediments associated with the PAS site. These will include the four locations previously mentioned for surface water sampling as well as a fifth location at the site of an old concrete abutment used to dam the area for ice formation. Historical data also exists for sediment samples at these locations.

Each location will be sampled once. The samples will be collected as the composite of at least four distinct core penetrations. A hand-operated piston corer will be used for collection and will be capable of collecting the first 6 inches of sediments.

3.4.3 Ground Water

The 21 monitoring wells installed during this project will be sampled once each for priority pollutants. Each well will be fully purged of all stagnant water and allowed to recover prior to actual sampling. The purged water will be continuously monitored for conductivity and the purging will be considered sufficient when the conductivity level remains stable for three well volumes or the well runs dry. The purged water will be collected and properly disposed.

If samples are positive a followup sampling and analyses should be necessary.

Samples for volatile organic analysis will be collected with a teflon bailer as soon as the well begins to recover. Samples for all other analysis will be collected with a peristaltic pump or a Teflon bailer. bailing is preferred.

if pump is used will tubing be changed at each well?

3.5 SAMPLE CUSTODY PROCEDURES

3.5.1 Sample Identification

Each sample will be labeled with a tag of the type shown in Figure 10. Each sample will be assigned a field identification number and will be listed

Sample Code						DATE	TIME	N 1000
	CONTRACT NO:							
	DESIGNATE		TEMPERATURE	pH	PRESERVATIVE			
	COMP	GRAB						
Seq. No.	SOURCE			SAMPLER (Signature):				

Control No.			Phosphate	Br⁻, F⁻, Color	Sulfide	Sulfite, Surfactants	Nitrate, Nitrite	NH_3, Org. N	COD, TOC	Radioactivity	Bacteria	BOD	Solids	Oil and Grease	Phenols	Cyanide	Trace Elements	Pesticides/PCBs	Extractable Org.	Volatile Organics	ANALYSES

Figure 10. Sample collection tag.

on the tag with all other pertinent information. This information as well as a description of the site location and any additional comments will be listed in a bound field logbook.

3.5.2 Onsite Laboratory Procedures

Properly labeled samples will be delivered to the GCA mobil lab. Upon arrival all samples will be entered into a bound laboratory notebook by field identification number. As the samples are analyzed the corresponding injection, numbers as assigned by the GC integrator will be entered in the lab notebook.

Volatile analysis in mobile lab? If so will they be reanalyzed in Bedford?

3.5.3 Transfer to GCA Laboratory, Bedford, MA

Samples designated for analysis at GCA Corporations laboratory in Bedford, MA will be maintained under strict chain of custody protocols.

Each container will be sealed and checked for proper labeling. The samples are then packed into lockable metal coolers with blue-ice freeze paks. A chain of custody form (Figure 11) is completed for each shipment, signed by the task leader and a copy placed into the cooler. The cooler is then locked, sealed with custody tape and delivered to GCA's lab by overnight express courier.

time involved?

3.6 ANALYTICAL PROCEDURES

3.6.1 Onsite Procedures

As the primary goal of onsite analysis is the definition of areas contaminated by material from the site, a scheme to provide this information by using a headspace technique for analyzing for volatile organic material (boiling points 35° to 140°C) has been devised. This method is derived from methods utilizing headspace measurement techniques designed to allow the measurement of volatile organic species in solid waste, specifically Method 5020 (Headspace Method) and Method 8015 (Non Halogenated Volatile Organics) as described in Test Methods for Evaluating Solid Waste (EPA-SW-846,

CHAIN OF CUSTODY RECORD

Project Code	Project Name		REMARKS
SAMPLERS (Signature)			

Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Relinquished by: (Signature)	Date/Time	Received by: (Signature)	Relinquished by: (Signature)	Date/Time	Received by: (Signature)
Relinquished by: (Signature)	Date/Time	Received for Laboratory by: (Signature)	Date/Time	Remarks	

N 1000

Figure 11. Chain of-custody form.

July 1982). Since these methods do not, however, address the primary needs of this program, modifications have been made to allow suitable data to be obtained from the method. A description of the method to be utilized in this screening analysis is given below.

Approximately 10 grams of sample (wet weight) will be placed in a 40 ml septum capped vial and brought to the GCA onsite laboratory for analysis. Since the number of samples to be analyzed and the screening nature of the program do not warrant a precise weight on each sample, an averaged tare weight will be subtracted from the sample container weight to obtain an approximate sample weight. Sample weights should be precise to within ±10 percent. Since volumes of the vials may also vary, an average vial volume will also be obtained for use in concentration calculations.

After return to the onsite laboratory, the vials will be weighed, then heated to 90°C for 1 hour. After this period, the sample will be maintained at 90°C and a 1.0 ml aliquot of the vial headspace will be withdrawn and injected into a gas chromatograph for analysis. GC analytical conditions are shown in Table 1.

Calibration standards to be used in this program will be prepared by injecting a carbon disulfide solution of C_5 (pentane, B.P. 36°C) through C_9 (nonane, B.P. 151°C) hydrocarbons through the septum of an empty vial and heating the vial to 90°C. Three such vials, prepared at varying concentrations, will serve as the initial calibration curve. Calibrations will be checked on each subsequent day of running by injection of a midpoint on the curve. As each peak is eluted, an integrated area count will be measured, and the summation of peak areas used for a calibration curve consisting of a plot of total amount of C_5-C_9 standard injected versus total integrated area of the eluting peaks.

Is preparation of std. the same as samples? Std should be absorbed on soil? Run first curve every day instead one point

Quantitation of the resultant chromatographic data will be achieved by summation of the total integrated areas of all peaks eluted and comparison of this summation to the established calibration curve using the following equation:

$$\text{Concentration} = ((A \times m) + b) \times V \times 1/W$$

TABLE 1. ANALYTICAL CONDITIONS FOR HEADSPACE ANALYSIS

Instrument	Perkin Elmer 3920 GC equipped with two Flame Ionization Detectors (FID)
Column	8 ft stainless steel packed with 1% SP 1000 on Carbopack B 60/80 mesh
Flow Rate	40 mls/min
Temperature Program	60°C held for 2 minutes, then 10°C per minute to 220°C and held
Injection Volume	1 cc

FID for potential VHO scan. will pick up only BTX compounds where

A = sum of all integrated areas of eluting peaks

m = slope of calibration curve

b = y intercept

V = approximate volume of vial minus sample volume

W = approximate weight of sample in vial.

The obtained quantitative value will then be supplied to onsite personnel. Quantitation of peaks within specific boiling point ranges will be possible at a later time, if necessary, by examination of elution times of sample peaks in relation to those of standards.

Prior to sampling, all vials will be baked in a 90°C oven for 1 hour to remove potential contamination. Calibration curves are to be checked on every day of analysis to confirm validity of the curve as well as acceptable operation of the analytical system. Where possible, duplicate analysis of specific samples will be conducted to confirm quantitations.

3.6.2 Off-Site Analysis

In addition to the onsite monitoring program, analyses will be conducted on samples returned to the GCA Laboratory in Bedford, MA. Numbers of samples and parameters are shown in Table 2:

Sample preservation?

A brief description of the analytical procedures to be utilized as follows:

Organic Analyses--Priority pollutant analyses of water samples will proceed in accordance with EPA protocols dated December 3, 1979 (40 CFR Part 136). Volatile organics will be analyzed via purge and trap GC/MS techniques as stated in EPA Method 624. Extractable organics will be analyzed according to EPA Method 625 using a fused silica capillary column in place of the conventional packed column. Pesticides and PCBs will be analyzed according to EPA Method 608 using a gas chromatograph fitted with an electron capture

TABLE 2. OFF-SITE ANALYSES OF SOLID AND AQUEOUS SAMPLES

Sample type	Number to be analyzed of GCA	Analyses to be performed	Sample container	Volume per analysis	Preservative*
AQUEOUS					
- Surface water	8	Volatile organic carbon	VOA vials	40 ml/	
		Base neutral extractable compounds	Glass	1000 ml/	
- Ground water	21	Acid extractable compounds	Glass	1000 ml/	
		Metals	LPE	500 ml/	pH_2 HNO_3
		Cyanide	LPE	500 ml/	pH_{12} NaOH
		Sulfide	LPE	200 ml/	Zinc acetate
SOLID					
- Soils	10	Volatile organic carbon	VOA vials	/10g	
		Base neutral extractable compounds	Glass	/10g	
- Sediments	5	Acid extractable compounds	Glass	/10g	
		Metals	LPE	/10g	
		Cyanide	LPE	/10g	
		Sulfide	LPE	/10g	

*All samples stored and shipped at 4°C.

detector. All sediment samples will be prepared in accordance with procedures described in the "Chemistry Laboratory Manual for Bottom Sediments and Elutriate Testing (EPA-905/4-79-014 March 1979). Subsequent analyses will be performed as designated in the procedures noted above.

Trace Metals--Analysis of water samples for the priority pollutant metals, with the exception of mercury, will be performed in accordance with the procedures outlined in "Inductively Coupled Plasma-Atomic Emission Spectrometric Method for Trace Element Analysis of Water and Wastes," U.S. Environmental Protection Agency, Cincinnati, Ohio, November 1980. Mercury analysis will be done by the cold vapor procedure contained in "Methods for Chemical Analysis of Water and Wastes" (EPA-600/4-79-020 March 1979).

All sediment samples will be analyzed for the priority pollutant metals in accordance with the procedures contained in "Chemistry Laboratory Manual for Bottom Sediments and Elutriate Testing" (EPA-905/4-79-014, March 1979).

3.8 GCA'S OVERALL QUALITY ASSURANCE PROGRAM

3.8.1 Introduction

The objective of the quality assurance program is to ensure that complete, precise, accurate and representative data are provided. The key individual responsible for quality assurance on all projects is the Division QA Manager who reports directly to the Division General Manager. Specific internal quality control measures for this program will be the responsibility of the Laboratory Quality Control Coordinator.

3.8.2 Sample Custody and Storage

The purpose of chain-of-custody procedures is to document the identity of the sample, and its handling, from its first existence as a sample until analysis and data reduction are completed.

All samples submitted to the GCA/Technology Division Analytical Laboratory are brought to the Sample Bank Manager, who establishes or continues the chain-of-custody by assigning a GCA Control Number to each sample on receipt; this number identifies the sample through all further handling. The sample is recorded in the bound Master Sample Log under its GCA Control Number; the control number is also permanently affixed to the sample container. Each page of the Master Log contains the following information:

- GCA Control Number
- Sample description
- Sample condition
- Signature of person completing sample record
- Date of sample receipt

GCA/Technology Division maintains large, locked, refrigerated and nonrefrigerated storage areas with provision for hazardous material storage. After necessary preservation or subdivision, the Sample Bank Manager stores each sample in the appropriate area under its GCA Control Number. Only the Sample Bank Manager or her assistant have access to the sample storage area.

The Sample Bank Manager initiates a page for each sample in the Custody Book and ensures that each handling of the sample is appropriately documented. Each analyst working with the sample first goes to the Sample Bank Manager and records in the Custody Book all actions taken on the sample, thereby maintaining the chain-of-custody of the original sample.

When sample preparation and analysis procedures necessitate the transfer of samples between two analysts within the laboratory, a Sample Custody Transfer form is used. This document becomes part of the permanent project file and serves as a supplement to the Custody Notebook record of handling.

3.8.3 Quality Control

Quality Control (QC) for this program will involve the use of blind spikes, laboratory control samples and, where sample size permits splitting, blind duplicates. Quality control samples prepared by the Laboratory QC Coordinator will constitute approximately 10 to 15 percent of the sample total. A more detailed discussion of quality control procedures specific to this program is presented in the following sections.

"Blind" Quality Control Samples--Quality control samples which have been coded to resemble actual samples and inserted into the sample flow at the time samples are logged in at the Sample Bank are termed "blind" QC samples; these samples are prepared by the Laboratory Quality Control Coordinator. Some or all of the following may be used as "blind" QC samples in this program.

- Laboratory (deionized) water spiked with an EPA or NBS concentrate.
- Duplicate sample - split an actual sample into two equal portions; neither portion is spiked.
- Spiked duplicate - split an actual sample into two equal portions; one portion is spiked using EPA or NBS concentrates.

All quality control data will be reported as percent recovery of the spiked compound or percent difference between duplicates.

Laboratory Control Samples--These samples are used routinely in the laboratory to identify systematic method and operator errors. A laboratory control sample (LCS) is prepared by the analyst, carried through all sample preparation steps, and analyzed prior to the analysis of actual samples. If the results of these analyses are within established limits, sample analysis may proceed. The following types of laboratory control samples will be used in this program:

- Laboratory (deionized) water spiked with an EPA or NBS concentrate.
- Spiked Duplicate--split a sample into two equal portions; spike one portion using EPA or NBS concentrates.

One LCS will be processed with each set of samples prepared in a day. Data from the analysis of laboratory control samples are normally reported as percent recovery of the spike.

Blanks--Blanks provide valuable information regarding contamination or interferences introduced during sampling and analytical operations. Two types of blanks will be used routinely during this program:

1. Method Blanks--The method blank is a sample of laboratory (deionized) water which is carried through the sample preparation and analysis procedures to account for contamination introduced by reagents and glassware. A method blank is normally prepared with each set of samples processed.

2. Calibration Blank--A calibration blank is prepared in the same manner as the standards used for instrument calibration; it contains all the reagents used in the preparation of standards except the parameter of interest. A calibration blank is prepared daily with each set of standards.

Same as std every day?

Instrument Calibration and Maintenance--Log books are maintained for all analytical instrumentation; information regarding instrument operating conditions and maintenance procedures must be recorded in these logbooks and signed by the analyst. Detailed calibration procedures for most laboratory instrumentation can be found in Part 3 of the GCA/Technology Division Quality Assurance Manual.

? where is QA's

In general, instruments are calibrated daily. Prior to beginning sample analysis, an instrument check sample, which is laboratory (deionized) water spiked with an EPA or NBS concentrate, is analyzed to verify instrument calibration and standard preparation. If each component of the instrument check sample is within the established control limits ($\pm$ 3 standard deviations), the analysis may proceed. If any component is outside the established control limits, the analysis is stopped until the problem is located and solved.

Precision and Accuracy--The laboratory has established control limits for the analysis of representative volatile and extractable organic compounds and metals in deionized water. Since it is not possible to establish control limits for these parameters in all the matrices one might encounter in the analysis of environmental samples, the precision and accuracy for each method used in this program will be established through the analysis of replicate and spiked samples.

The standard deviation of replicate measurements will be used to estimate their precision. The following equation will be used:

$$S = \sqrt{\frac{\sum_{i=1}^{N} X_i^2 - \frac{1}{N}\left(\sum_{i=1}^{N} X_i\right)^2}{N-1}}$$

where S = standard deviation

X_i = result of individual measurement

N = number of measurements

Relative standard deviation may also be reported; this is calculated in the following manner:

$$RSD = 100 \frac{S}{\bar{X}}$$

where RSD = relative standard deviation expressed in percent

S = standard deviation

$\bar{X}$ = arithmetic mean of replicate measurements

The accuracy of the analytical methods used in this program will be estimated through the use of reference materials such as NBS SRM 1566, Oyster Tissue, or spiking of replicate samples. Accuracy will be expressed as percent recovery or relative error according to the equations shown below:

$$\text{Percent Recovery} = 100 \frac{\text{measured value}}{\text{true value}}$$

$$\text{Relative Error} = 100 \frac{\text{measured value} - \text{true value}}{\text{true value}}$$

Quality Control Reports--The Laboratory Quality Control Coordinator is required to prepare monthly reports of QC activities for the Laboratory Manager and Division QA Manager. These reports detail the number of QC samples submitted and the precision and accuracy achieved, as well as any corrective action initiated during the reporting period.

The Final Report will detail the preparation of quality control samples and contain all QA/QC data generated during the program. In addition, the Final Report will describe the manner in which control limits for each analysis were established and applied. Copies of all audit reports pertaining to this program will also be included.

APPENDIX A

OPERATOR MANUALS--FIELD INSTRUMENTATION

GEONICS LIMITED

1745 Meyerside Drive, Unit 8, Mississauga, Ontario, Canada L5T 1C5 Tel. (416) 676-9580 Cables: Geonics

Feb.1980

EM34-3 OPERATING INSTRUCTIONS

The following is the set-up and operating procedure for the EM34-3 Terrain Conductivity Meter.

1. Initial Set-up: At the beginning of the survey select an area free of "cultural interference" and man-made conductors such as buried pipes, buildings, power lines and steel reinforced concrete, etc.

1.1 Having determined the coil separation to be used for the survey, lay the instrument out on the ground accordingly. Connect the reference cable (10,20 or 40 meters) - one end to the 8-pin connector on the transmitter (Tx) coil and the other end to the "REFERENCE" connector on the receiver console.

1.2 Connect the transmitter console to the transmitter coil using the appropriate short cable.

1.3 Put the "LEVEL" switch on the transmitter console to the "NORMAL" position (see section 6).

1.4 Set the receiver and transmitter coils to the selected coil separation with red circles on the coils both facing in the same direction.

1.5 Set transmitter "SEPARATION" switch to selected value and turn on transmitter ("POWER/OFF" switch to "POWER" position).

1.6 Check to see that Battery Monitor Meter indicator is in the black area of the scale. If not, batteries are low or are not making proper contact to the battery clips.

1.7 Check condition of receiver battery by rotating receiver "SEPARATION" switch to "BATT" position with "POWER/OFF" switch in "OFF" position (see section 5.2).

1.8 Set receiver "SEPARATION" switch to selected value.

2. Electronic Nulling: to remove any offsets in the output (DC) circuitry.

2.1 Prior to turning receiver on insure that meters read zero by adjusting mechanical meter zero control.

2.2 Turn on receiver ("POWER/OFF" switch to "POWER" position).

2.3 With receiver coil disconnected depress "NULL MODE" push button switch. Both meter needles should go to zero.

2.4 If either needle is not at zero reading, release the lock on the appropriate "NULL" control potentiometer. With "NULL MODE" switch still depressed adjust the "NULL" control to zero the meter.

2.5 Lock the "NULL" control.

2.6 Connect the receiver coil to the receiver console "COIL" connector via the appropriate short cable.

3. Receiver Compensation and Gain Check

3.1 Maintaining the receiver and transmitter coils in the same plane adjust the coil separation to obtain zero reading (centre of green area) on the "COIL SEPARATION" meter. (Insure that red circles on coils face in the same direction). The coil separation should now measure the selected value and allow from 2-4 meters of slack reference cable between the hooks which attach to the console leather cases.

3.2 With the "SENSITIVITY RANGE" switch set to the 300 millimho/meter position move the receiver coil toward the transmitter until the "COIL SEPARATION" meter deflects to full scale mark.

3.3 Measure the distance that the receiver coil has moved. This distance should be 10.4% of intercoil spacing.

4. Taking a Reading : the instrument is now operational, reading apparent terrain conductivity directly in millimhos/meter in either the horizontal or vertical dipole mode.

4.1 At each measurement station the transmitter operator positions himself and remains stationary. The receiver operator should position the receiver coil such that the "COIL SEPARATION" meter is in the green area.

4.2 The "SENSITIVITY RANGE" switch should be set to the position which positions the "CONDUCTIVITY" Meter in the upper 70% of the scale. The meter reading should then be recorded in millimhos/meter. (The "SENSITIVITY RANGE" switch setting indicates full scale meter reading).

NOTE: In order to minimize reading errors particularly on the most sensitive settings it is necessary to keep the receiver and transmitter consoles separated from their respective coils by 0.7 - 1.0 meter.

5. Periodic Daily Checks

5.1 Nulling: To make sure that any possible drift is kept under control, we suggest that you repeat the electronic nulling procedure (steps 2.1 to 2.6) at least once per day during the survey.

5.2 Receiver Battery Check: The receiver battery test is done simply by switching the "SEPARATION" switch to "BATT" position and power switch to "OFF" position. The meters will indicate the condition of the two sets of receiver batteries. If the indicator is below the markings replace the batteries, or see that the battery contacts are clean.

With new batteries, meter reading could be on the upper limit of the scale.

5.3 Transmitter Batteries: With the Tx coil connected and the "LEVEL" switch in the "HIGH" position, needle of the Battery Monitor Meter should be in the black area of the scale. Keeping the transmitter batteries warm in cold weather will improve battery lifetime.

6. Transmitter Output Power

As earlier mentioned transmitter output power should be kept at the "NORMAL" level for increased battery life. Under very noisy conditions (power line or spherics) the transmitter power should be increased by switching the "LEVEL" switch to "HIGH" position.

7. Instrument Calibration

Prior to leaving the factory, the instrument is calibrated to read correctly but due to its high sensitivity fine adjustment of the instrument in the field may be helpful, particularly in regions of low conductivity and where the conductivity values are known to a good degree of confidence.

NOTE: As a precautionary move the readings and exact location should be recorded prior to making any adjustments so that if the correction is found to be unsatisfactory the original settings can be recovered without returning the instrument to the factory.

7.1 Having decided what the new reading should be the instrument "zero" can be adjusted by controls inside the receiver console. To gain access to these controls remove the receiver chassis from its metal cover by undoing the two side screws and battery lid.

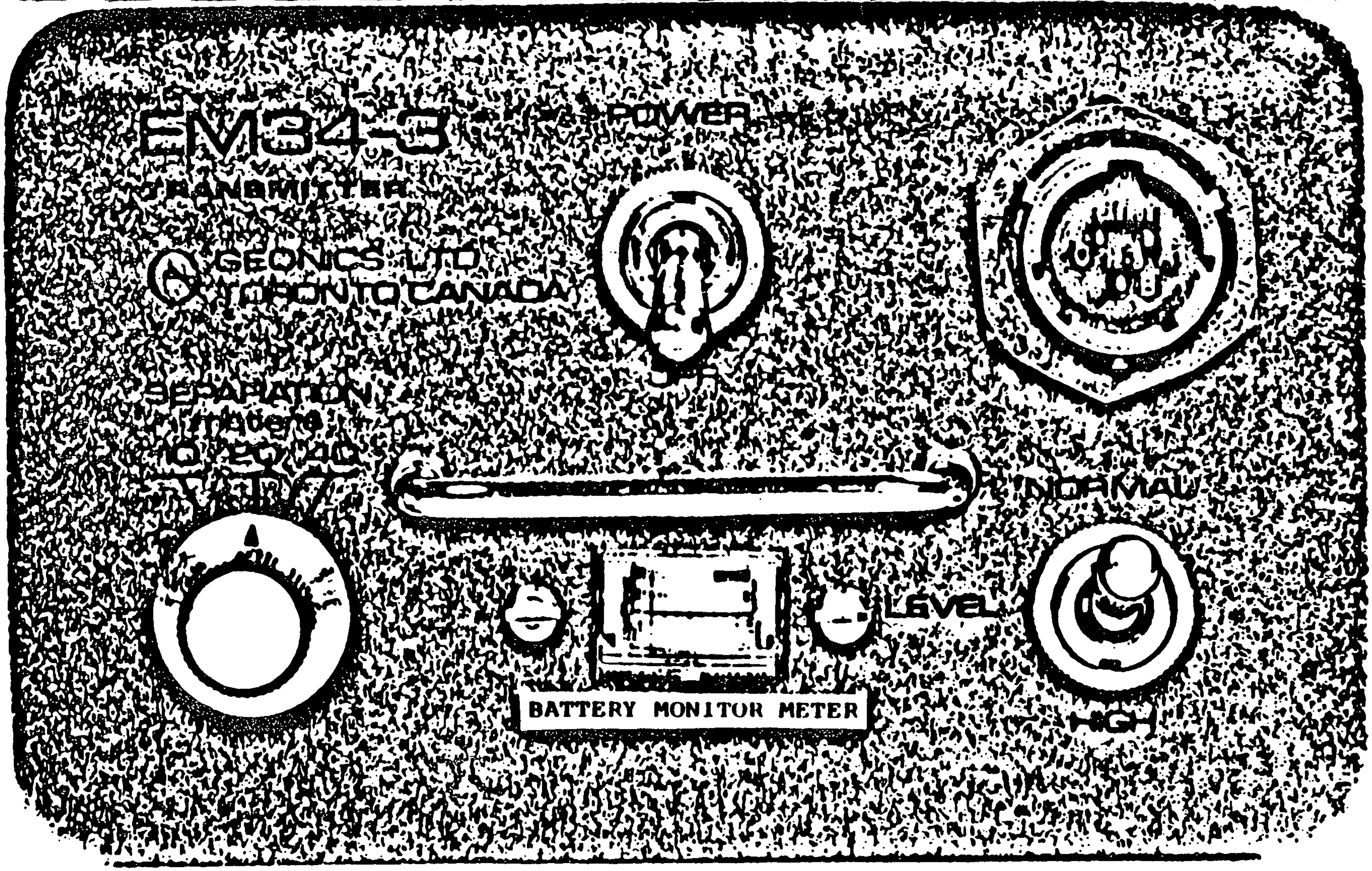
7.2 The "zero" adjustment potentiometers are located on printed circuit board No.5 - one potenicmeter for each coil separation.

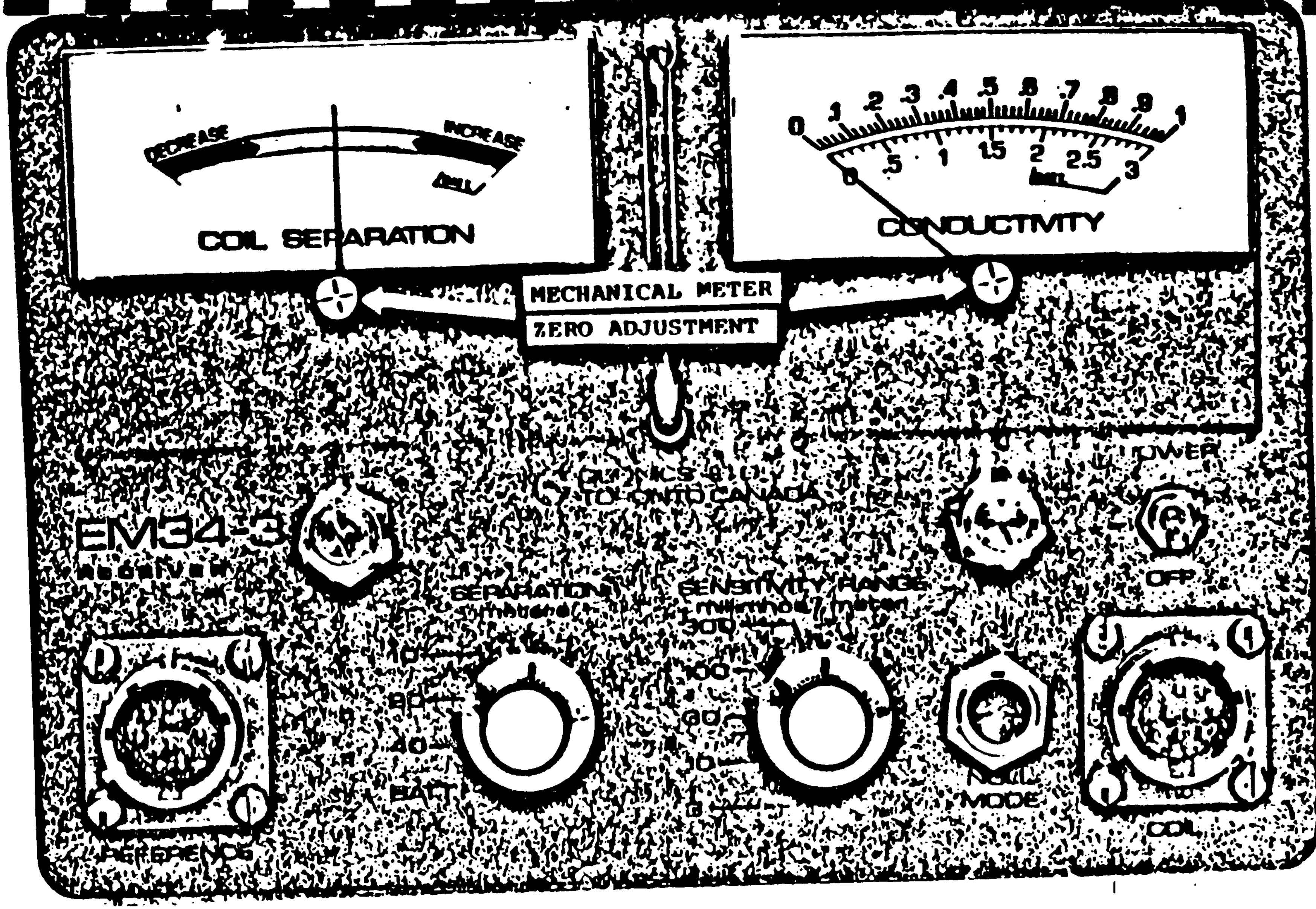
10 meters - R15
20 meters - R14
40 meters - R13

7.3 The appropriate potentiometer should then be adjusted to give the desired meter reading.

NOTE: Each control should be adjusted only with the corresponding coil separation.

7.4 After adjusting any of the "zero" controls check the Electronic Null (section 2). Re-Null if necessary and repeat "zero" adjustment.


EM34-3
TRANSMITTER
POWER
GEONICS LTD
TORONTO CANADA
SEPARATION
10 20 40
NORMAL
LEVEL
BATTERY MONITOR METER
HIGH


DECREASE
INCREASE
COIL SEPARATION
0 .1 .2 .3 .4 .5 .6 .7 .8 .9 1
0 .5 1 1.5 2 2.5 3
CONDUCTIVITY
MECHANICAL METER
ZERO ADJUSTMENT
EM34-3
POWER
OFF
SEPARATION
SENSITIVITY RANGE
100
40
BATT
MODE
COIL

GEONICS LIMITED
1745 Meyerside Drive, Unit 8, Mississauga, Ontario, Canada L5T 1C5 Tel. (416) 676-9580 Cables: Geonics

OPERATING MANUAL

for

EM31

NON-CONTACTING

TERRAIN CONDUCTIVITY METER

Revised June 1979

3.2 Instrument Calibration

Absolute instrument calibration is easily achieved if an area of ground is available of known and constant conductivity down to the depth of penetration of the instrument. The procedure is simple; the instrument is simply located over the known area at the usual operating height (approximately 1m) and the "QF" compensation control is adjusted until the meter reads the correct terrain conductivity. If the ground conductivity is high Fig. 3 must be used to correctly set the instrument reading.

It is wise to maintain such an area as a calibration check area even if the variation of the conductivity with depth at that area is not accurately known. The instrument is simply operated over that area and a note is made of the instrument's conductivity reading for cross checking with future measurements.

Note:
"QF" control and "NULL" control are located under the front panel. Battery pack should be removed to have access to the controls.

Check that the "COARSE" switch has been left in its original position by switching the mode switch to the "COMP" position as for (a) above and insuring that the meter still reads zero.

c) To approximately check the sensitivity of the instrument set the mode switch to the "COMP" position, and rotate the "COARSE" switch clock-wise for one step. Needle should deflect for about 75% to 85% of full scale (inside black mark) reading. It is unlikely that the sensitivity of the instrument will vary however it may be useful to record the actual meter reading for comparison at a later date.

d) For ground of conductivity higher than 30 millimhos per meter, the functional checks should be carried out with the range switch set at the position corresponding to the conductivity of the ground over which the functional checking is performed.

In such a case the needle deflection indicated in Section 3.1c and 3.1d should still be 22 to 26 millimhos per meter (which will now be a smaller percentage of the full scale deflection).

e) This completes the functional checks of the instrument.

3. CALIBRATION OF THE INSTRUMENT

Prior to shipping, the instrument is calibrated in the factory to read properly. If necessary, certain checking procedures are easily carried out as described below.

IMPORTANT. The most critical adjustment is the "QF" (quadrature fine) potentiometer which has been precisely adjusted at the factory. Before any adjustments are made it is strongly recommended that the instrument first be set up at a fixed height over a known location and the ground conductivity carefully noted. If this adjustment is misaligned the instrument will have to be recalibrated over ground of known conductivity as described below (Section 3.2)

The functional checks are normally carried out over ground of conductivity less than thirty millimhos per meter.

For higher ground conductivity see note on Section 3.1d.

3.1 Equipment Functional Checks

a) Set the instrument for normal operation as indicated in the operating instructions (Section 2).

Put the range switch to the 30 position (30 millimhos per meter full scale) for all the following tests. Set the Mode switch to the "COMP" position, and adjust the meter needle to read zero using the "COARSE" switch and the "FINE" compensation potentiometer.

b) To check the phasing of the instrument set the mode switch to the "PHASE" position. Rotate the "COARSE" switch clockwise one step.
If there is a change in the reading adjust the "PHASE" potentiometer until there is no change in the reading for the one step change in the "COARSE" control setting.

2. OPERATING INSTRUCTIONS (cont'd)

f) second to which the operator should adjust his walking speed for the greatest accuracy.

Alternatively, to extend battery life, the instrument can be switched on at each measurement station. The operator will notice that the type of integrator used results in a slight initial overshoot of the needle, which is normal, and that approximately two seconds after switch-on the measurement can be recorded.

2. OPERATING INSTRUCTIONS

a) Using the identifying labels on the tubes align the transmitter coil tube with respect to the main tube and fix it with the clamp.

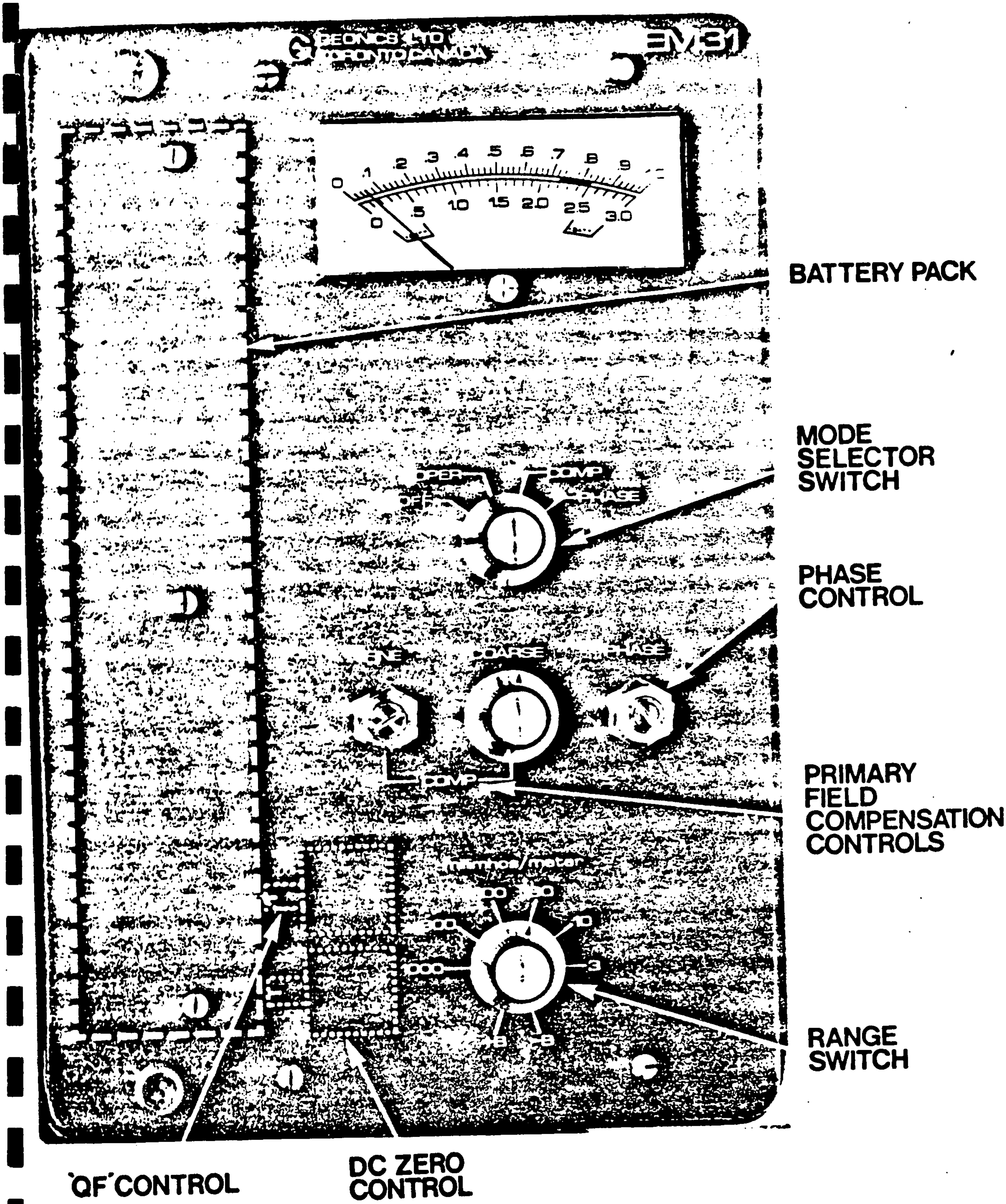
b) Check battery condition, plus and minus, by setting the mode switch to the "OPER" position and the range switch to the "+B" and "-B" positions respectively. If needle reads inside the "BATT" mark on the meter, batteries are in good condition, otherwise replace the batteries with a fresh set of "C" size alkaline batteries.

c) Electronic nulling of the instrument, if necessary, is done by setting the Mode switch to the "OPER" position, setting the range switch to the least sensitive position (1000 millimhos/meter), and then adjusting the "NULL" control to obtain zero reading. (See note Section 3.2)

d) Align and connect the receiver coil tube to the main tube. Ensure that the mode switch is set to the "OPER" position.

e) Wearing the instrument as shown in the data sheet with the shoulder strap adjusted so that the instrument rests comfortably on the hip, switch the Mode switch to the "OPER" position and rotate the range switch so that the meter reads in the upper two thirds of the scale. The full scale deflection is now indicated by the range switch and the instrument is reading the terrain conductivity directly in millimhos per meter.

f) In moving to the next measurement station the Mode switch may be left in the "OPER" position to provide a continuous reading of the terrain conductivity. The instrument has a time constant of approximately one



GEONICS LTD
TORONTO CANADA
EM31
BATTERY PACK
MODE SELECTOR SWITCH
PHASE CONTROL
PRIMARY FIELD COMPENSATION CONTROLS
RANGE SWITCH
'QF' CONTROL
DC ZERO CONTROL

EG&G GEOMETRICS

NIMBUS ES-1210
MULTICHANNEL
SIGNAL ENHANCEMENT
SEISMOGRAPH

3.0 OPERATION

3.1 INTRODUCTION

Despite the formidable appearance of the ES-1210 Seismograph, operation is relatively straightforward. Most of the controls are duplicates (on the amplifiers) or are self-explanatory (for display and plotter). There are a few special operations due to the great flexibility of the instrument, which are easily mastered. Past experience has been that it is worthwhile to make a trial run in comfortable working conditions to become familiar with the instrument before attempting a field survey. It is suggested that the operator go through the following step-by-step procedure with the instrument in the laboratory or nearby field.

3.2 CONTROL FAMILIARIZATION

Connect a spread cable to the signal connector. The spread cable should be laid out for a short distance, and geophones connected. With the power off, connect the battery pack to the instrument using the power cable supplied with the instrument.

Connect a hammer switch to the start input. If work is being performed in a laboratory, it is best to use only the switch assembly without a hammer. The switch bracket itself makes a small impact when tapped on the table, and the energy level is acceptable.

Set all the controls for a normal operation to give a starting point in this procedure. Set the GAIN controls to 24 db, TRACE SIZE to 5, MODE to AP, MEMORY FREEZE down (in), NOTCH down (in), RECORD TIME to 500, DELAY TO 0000, VARIABLE AREA to NORMAL, RECORD LENGTH to SHORT, BRIGHTNESS at midrange and depressed DISPLAY to ALL, and SELECT to BAT.

Turn on the power switch; the voltmeter should read battery voltage, around 12 volts. Rotate the switch and measure the other voltages +5, +V, -V, MOT and STY (MOT and STY will not indicate correctly except during printing). Return the SELECT switch to BAT position and depress the VOLTAGE/GEOPHONE switch. The panel meter should now indicate the resistance of the first geophone. Rotate the switch around and check the resistance of the other geophones, waiting a few moments at each position for the meter to settle. Leave the switch in the BAT position to monitor the battery voltage.

Adjust the BRIGHTNESS control until the CRT displays properly. The displayed signal may be a random pattern. This is caused by the fact that the memory contains a random signal when the instrument is first turned on. Depress the CLEAR MEMORY button and hold it down. Push the READ-TEST toggle switch to—the left toward READ. The STATUS light should come on and stay lit for about one second, then turn off automatically. Release the CLEAR MEMORY switch. This operation will clear the memory. Straight lines should be visible across the CRT display.

Depress the NOISE MONITOR and tap on the ground or table. The traces on the CRT should wiggle up and down from the vibrations. The vibrations are being sensed by the geophones and fed to the CRT display. Change the GAIN on some of the channels to see that the vibration traces grow larger or smaller.

Push the READ-TEST switch toward TEST. The status light should come on for half a second and turn off. The geophone signal has been stored in the memory. Depending on the gain used and the background noise, the signal may appear on the CRT display. To assure this, erase the signal just stored, and repeat TEST operation. This time, hit the table or ground midway during the cycle. The CRT should now display the 12 traces with an obvious signal toward the middle of the record.

Set RECORD TIME down to 50 milliseconds, clear the memory and repeat the experiment using the real hammer switch or sledgehammer instead of the TEST switch. There should be a nice seismic waveform on the CRT. If the signals seem excessively small or large, adjust the TRACE SIZE to get a better appearance. If a good picture cannot be obtained, change the GAIN, and try again. Using the NOISE MONITOR while you tap the ground should help get the approximate value.

If a copy of the record is desired, depress the PRINT switch momentarily. After a short delay, the oscillograph will turn on and paper will come out of the circular slot. (If no paper comes out, see instructions under "Changing Paper" in Chapter 6.0 of this manual to load the recorder with paper). The paper copy should be almost identical with the CRT display, except that there will be time lines on the record.

To become familiar with the multiple display opportunities of the instrument, make a few more records in different modes. A longer record can be obtained by switching RECORD LENGTH to LONG. The CRT display will expand horizontally and show only the first half of the record. Depressing the PRINT switch will produce a new paper copy which will be twice as long as the previous one (about 14 inches [36 cm]). Pull out on the BRIGHTNESS control. Timing lines will show on the CRT display. Make a new copy of the paper record and notice that it will now have the high resolution timing lines (more of them, closer together). When testing for variable area, notice that the tops of the signal displayed on the CRT will be shaded in white. The paper record will have the same shading. Changing the position of the DISPLAY SELECT control will produce 6-channel displays and paper records.

All of the front panel controls have now been exercised except the delay and filter adjustments.

To test the use of enhancement, hit the ground or table twice in the same place without clearing the memory. The waveforms on the CRT (and paper records) should grow larger with each successive impact. Pull up on the TRACE SIZE controls on the first three channels (1, 2, and 3). Hit the ground some more, and notice that the remaining channels continue to grow, while 1, 2, and 3 do not. By selecting the MEMORY FREEZE, these channels are prevented from further stacking. Clear the memory in the usual fashion. Notice that channels 1, 2, and 3 did not erase, but are still on the screen. Thus, were able to "save" them while starting over with the others.

To experiment with the DELAY switch, try setting the record time back at 500 ms. Dial in delay of 2000 on the DELAY switch. Impact the ground and watch the STATUS light. Notice that it waits for exactly two seconds, then comes on for one-half second. If the ground is hit again during the on time, you can make a record of an impact which occurred over two seconds after hammer time. More experimenting with shorter delays, using a record time of 50 milliseconds may be beneficial. Notice that the waveform stored on the CRT will move left in time by the amount of delay. For example, if the signal arrived at 25 milliseconds before, and you used a 10 ms delay (0010 on the DELAY switch), the new signal will appear at 15 milliseconds on the CRT and the paper record.

The filters in the ES-1210F are more subtle in their operation, since their function is to eliminate unwanted frequencies from the signal. A good way to experiment is to group all the geophones closely together and set up the controls to produce a normal record. The waveforms should be about the same on all channels. Select different combinations of filter settings on channels 2 through 12, leaving channel 1 as a reference. Try selecting bandpass, lowpass, highpass, and bandreject on various channels, and select different frequencies like 30, 50, 100, and 300. Erase and store a new record in the memory and make a paper copy. Write the filter settings on the paper record and compare the appearance of the signals. Notice that highpass will remove the low frequency components, lowpass will remove the high frequency components, and similar effects will appear on the other samples.

A similar test with the notch filters can be made if there is some 50 or 60 Hz interference from a power line. Normally this will not occur unless you are using long cables near a power line.

INSTRUCTION MANUAL
BISON INSTRUMENTS

SIGNAL ENHANCEMENT EARTH RESISTIVITY SYSTEM
MODEL 2390

OPERATING INSTRUCTIONS

V
OPERATING INSTRUCTIONS

A. Instrument Operation

NOTE: Some of the panel toggle switches have a protective locking mechanism. They must be pulled out to operate.

NOTE: A dummy-load test box may be supplied as an optional external accessory. This may be connected to the system at any time to check overall operation.

The preliminary planning starts with the selection of an electrode configuration. The 2390 system operates with any of the standard resistivity configurations, but normally the preference will be for·

—Schlumberger or Wenner for shallow (to 100 meters depth, say) resistivity sounding

—Dipole for deeper sounding

—Wenner for shallow resistivity profiling

—Dipole or Wenner for deeper resistivity profiling.

A useful first step is to make a rough estimate of the expected voltages, by using the formulas given in Figure 1 or by deriving similar formulas for other electrode configurations. This will provide guidance in the choice of current setting, or provide an indication that a different electrode configuration would be preferable. The normal current setting is 20 milliamperes. If the expected voltages are only a few hundred microvolts or less, the 50 milliampere or even the 100 milliampere setting is recommended. If the expected voltages are a few hundred millivolts, the 10 millampere setting is recommended.

The following preliminary settings on the instrument controls should be made before proceeding with the survey:

Transmitter: Set Frequency and Decade (see below)
Set Current Range

Receiver: Set Frequency and Decade to be identical with Transmitter settings.
Set Voltage Range (see below)
Set R-SP switch to R for resistivity measurements, or to SP for self potential measurements (or for Battery Test).

A frequency settings of 1.0 Hz and 1x is normally used. Lower frequencies are reserved for deeper investigations where the expected voltage levels are very small. Higher frequencies may be used for shallow investigations. On the transmitter a current setting of 20 milliamperes is recommended. A higher current value may be required if the measured voltages become undesirably small, as for example at large electrode spacings. A lower current value may become necessary under very dry conditions, where the electrode resistance is high. The latter limitation can often be overcome by wetting down the soil around the electrodes, or by emplacing several electrodes connected electrically in parallel.

The choice of voltage range on the Receiver is based on the following considerations. Normally, one of the two intermediate settings will be used to start with. If the voltage is so high that it exceeds the measuring range, the display numbers will blank off as a warning. The Range switch should then be turned to a higher setting. On the other hand, if the number which is displayed contains only 1 or 2 significant digits, a lower setting for the range switch is called for. In general, a lower setting should be used whenever the displayed digits are less than 0199. (The decimal point is changed automatically as the Range switch is changed).

NOTE: Changes in the Voltage Range setting can be made at anytime.

The first step in taking field measurements is to synchronize the waveforms on the Transmitter or Receiver. This step must be taken whenever the power has been turned off on either Transmitter or Receiver. Proceed as follows:

1) Connect the two units together by the Synchronization Cable. This plugs into the outlets labelled Sync Input/Snych Output.

2) Turn on Main Power on both units. Do not turn on Transmit Power as yet.

3) Observe the Out-of Sync Indicator light on the Receiver. It should be lighted, showing that synchronization does not as yet exist. If it fails to light, turn the Receiver Power off and on one or more times until the light remains lighted. If it still fails to light, check battery condition on both units. Beyond this, contact the manufacturer.

4) Depress the Sync pushbutton on the Transmitter until the Out Of Sync light on the Receiver goes out. This should take a maximum of one operating cycle (1 second at 1 hertz setting, 10 seconds at 0.1 hertz setting, etc). If the light fails to remain out or blinks on and off, check that the Frequency and Decade settings on Transmitter and Receiver are the same, and then repeat the process. If the system fails to synchronize, contact the manufacturer.

The Synchronizing Cable may be removed after synchronization has been completed. The Transmitter and Receiver can be operated in complete isolation from each other, up to hundreds of meters apart, if desired. The system will retain synchronization for up to 24 hours, although a wise precaution would be to re-synchronize after 8-10 hours.

If the system should go out of synch at any time, the Out-of-Sync Indicator Light on the Receiver will go on, provided the Synchronizing Cable is connected between the two units. To check for sync when operating with the Transmitter and Receiver isolated, they must be temporarily reconnected through the Synchronizing Cable.

To proceed with the field measurements, the first step is to emplace the electrodes and connect them to the instruments. In general the electrodes should be driven into the ground sufficiently far to ensure contact with moist soil. In some areas, this may be only a few centimeters or tens of centimeters. Elsewhere, penetration up to a meter may be required. One test for quality of the electrode contact is the amount of current flow. If the Current Under-Range Indicator Light remains off when the Transmit Power switch is turned on, the electrode contacts are satisfactory for the current electrodes. Contact quality for the potential electrodes can be confirmed by removing them temporarily from the receiver and connecting them briefly to the C1-C2 current output connectors. Again, if the current flow is adequate, the electrode contacts are satisfactory. Usually this latter step is not required, however. If the current electrode contacts are satisfactory and if the potential measurements are repeatable and reasonable, we may assume that the potential electrode contacts are also satisfactory.

With all of the preliminary settings and connections made, the Transmitter current may be turned on by means of the Transmit Power control. (NOTE: The current circuit and current electrodes have high voltage on them during transmission. Make certain that no person is in contact with them).

The Milliamperes Meter should display a reading which is roughly (within 1%) equal to the setting on the Current selector. The actual current flow is controlled electronically through a precision feedback circuit. It equals the Current value appearing on the Milliamperes Meter. The Frequency Indicator lights should now be pulsing in time with the frequency selected.

If the Current Under-Range Indicator Light comes on, check the Milliamperes reading. If the meter reads 0, one of the current electrodes is probably disconnected somewhere between the Transmitter and the earthing point at the electrode. Check the connections. If the meter reads a value which is less than the Current Selector setting, one or both of the current electrodes is making poor electrical contact with the earth. One solution is to turn the Range switch to a lower current setting. A better solution is to improve the electrical contact at the electrodes by (1) driving them in deeper, or (2) pouring water or salt water around them, or (3) driving additional electrodes nearby and connecting them in electrical parallel.

If all systems are working satisfactorily up to this point, the voltage output can be read from the Receiver Millivolts display. This quantity equals the number ΔV, in the expressions in Figure 1. The Current, I, in these expressions equals the number on the Milliamperes Meter on the Transmitter.

The voltage reading on the Receiver will be displayed continually as long as the Transmitter Current is flowing The voltage reading will be updated, however, at the conclusion of every 10 cycles of the Current waveform For example, the updating will occur every 10 seconds at the 1.0 hertz Frequency setting, and every 100 seconds at the 0.1 hertz Frequency setting. This display period will give the operator sufficient time to write down the readings as they appear.

It is important to remember that a wait of 10 full cycles of Transmitter current is required before a valid Receiver reading will appear. Any reading prior to this is meaningless. The operator may prefer to eliminate this meaningless preliminary reading by pushing the Clear pushbutton on the Receiver. This will set the display at 0 until the first valid reading appears After this, the successive readings will appear automatically every 10 cycles.

If at any time the numerals on the display go blank, the Range switch on the Receiver must be changed to a higher setting, after which depress the Clear Test button.

The operator will naturally wish to confirm at all times that he is getting valid readings. The Transmitter current is continually monitored through the Current Under-Range Indicator Light and the Milliamperes Meter. The validity of the Potential readings on the Receiver can be established through the following checks: (1) the reading should be repeatable within a few percent from one 10 cycle count on the Transmitter Current waveform to the next count (except possibly for the first reading, as explained two paragraphs earlier). (2) The reading should be plausible, based on the computation described in the first paragraph above of the Operating Instructions. (3) Successive readings should vary smoothly from one electrode spacing to another (although geologic factors can produce erratic variations here).

If the Potential readings appear questionable, confirm that all of the cables are properly connected and that the electrodes are making good connection with the earth. A visual inspection should be carried out.

One final aspect of the Operating Instructions relates to use of the Transmit Power switch on the Transmitter. This switch must be on during the full time that measurements are being carried out at the Receiver, yet it should be left off as much as possible to conserve battery power The recommended procedure is to turn it on at the start of the measurement and to turn it off immediately after measurements are completed. If the two units are being operated side by side or separated up to a few tens of meters, this can be carried out by one person. At greater separations, individual operators for Transmitter and Receiver will be required. They may communicate by voice or walkie-talkie radio or other signal systems.

A separate Test Box is available, which permits system check with a standard load. This may be connected at any time that a question arises as to validity of readings. It may also be used for instruction in instrument operation.

B. Battery Maintenance.

The battery voltages should be kept at 11.5 volts or higher. If the voltage falls below this level, erratic operation may result. The solution is to recharge the battery or to use an external 12 volt power source.

Complete battery recharge will require about 16 hours with the Bison battery charger supplied. In normal field operation the system is placed on recharge overnight. Longer charging times will not damage the battery, however excessive charging times should be avoided.

Battery life in the field is dependent upon the following: (1) Time Transmit Power is on and, most significantly (2) Current Range position. The higher positions use significantly more power and more quickly discharge the batteries

C. Use of Test Load

The 2390 system maybe supplied with an optional accessory called the Test Load. This is a small box containing a resistive network which simulates the resistive load of the four electrodes in the earth.

The Test Load has several possible uses. 1) It may be used for instruction. Simulated field measurements can be taken in the office, with demonstrations of the functions for the various panel controls. 2) It may be used for self-instruction by following the Operating Instructions of Section V. 3) It may be used to confirm that the instrument is operating correctly. Questionable readings may occasionally appear during field operations. By replacing the electrode connections with the Test Load connections, instrument operation can be checked. As an example, the current flow might be zero instead of the expected value of 10 or 20 milliamperes. The most probably cause would be a broken cable or defective electrode connection, but the Test Load could be used to quickly eliminate the instrument as the source of trouble. 4) It may be used to trouble shoot the instrument.

The resistive network consists of large resistors at the current output in series with a very small resistor across the potential input. The exact values are selected by the factory to provide convenient measurements. The operator should establish these values as soon as convenient after receiving the instrument and make a note of them. (The values will be one potential reading for each of two or three current settings).

To use the Test Load, simply plug the four connectors into the 2390 panel sockets and proceed with the measurement.

EG&G GEOMETRICS

NIMBUS ES-1210
MULTICHANNEL
SIGNAL ENHANCEMENT
SEISMOGRAPH

3.0 OPERATION

3.1 INTRODUCTION

Despite the formidable appearance of the ES-1210 Seismograph, operation is relatively straightforward. Most of the controls are duplicates (on the amplifiers) or are self-explanatory (for display and plotter). There are a few special operations due to the great flexibility of the instrument, which are easily mastered. Past experience has been that it is worthwhile to make a trial run in comfortable working conditions to become familiar with the instrument before attempting a field survey. It is suggested that the operator go through the following step-by-step procedure with the instrument in the laboratory or nearby field.

3.2 CONTROL FAMILIARIZATION

Connect a spread cable to the signal connector. The spread cable should be laid out for a short distance, and geophones connected. With the power off, connect the battery pack to the instrument using the power cable supplied with the instrument.

Connect a hammer switch to the start input. If work is being performed in a laboratory, it is best to use only the switch assembly without a hammer. The switch bracket itself makes a small impact when tapped on the table, and the energy level is acceptable.

Set all the controls for a normal operation to give a starting point in this procedure. Set the GAIN controls to 24 db, TRACE SIZE to 5, MODE to AP, MEMORY FREEZE down (in), NOTCH down (in), RECORD TIME to 500, DELAY TO 0000, VARIABLE AREA to NORMAL, RECORD LENGTH to SHORT, BRIGHTNESS at midrange and depressed DISPLAY to ALL, and SELECT to BAT.

Turn on the power switch; the voltmeter should read battery voltage, around 12 volts. Rotate the switch and measure the other voltages +5, +V, -V, MOT and STY (MOT and STY will not indicate correctly except during printing). Return the SELECT switch to BAT position and depress the VOLTAGE/ GEOPHONE switch. The panel meter should now indicate the resistance of the first geophone. Rotate the switch around and check the resistance of the other geophones, waiting a few moments at each position for the meter to settle. Leave the switch in the BAT position to monitor the battery voltage.

Adjust the BRIGHTNESS control until the CRT displays properly. The displayed signal may be a random pattern. This is caused by the fact that the memory contains a random signal when the instrument is first turned on. Depress the CLEAR MEMORY button and hold it down. Push the READ-TEST toggle switch to the left toward READ. The STATUS light should come on and stay lit for about one second, then turn off automatically. Release the CLEAR MEMORY switch. This operation will clear the memory. Straight lines should be visible across the CRT display.

Depress the NOISE MONITOR and tap on the ground or table. The traces on the CRT should wiggle up and down from the vibrations. The vibrations are being sensed by the geophones and fed to the CRT display. Change the GAIN on some of the channels to see that the vibration traces grow larger or smaller.

Push the READ-TEST switch toward TEST. The status light should come on for half a second and turn off. The geophone signal has been stored in the memory. Depending on the gain used and the background noise, the signal may appear on the CRT display. To assure this, erase the signal just stored, and repeat TEST operation. This time, hit the table or ground midway during the cycle. The CRT should now display the 12 traces with an obvious signal toward the middle of the record.

Set RECORD TIME down to 50 milliseconds, clear the memory and repeat the experiment using the real hammer switch or sledgehammer instead of the TEST switch. There should be a nice seismic waveform on the CRT. If the signals seem excessively small or large, adjust the TRACE SIZE to get a better appearance. If a good picture cannot be obtained, change the GAIN, and try again. Using the NOISE MONITOR while you tap the ground should help get the approximate value.

If a copy of the record is desired, depress the PRINT switch momentarily. After a short delay, the oscillograph will turn on and paper will come out of the circular slot. (If no paper comes out, see instructions under "Changing Paper" in Chapter 6.0 of this manual to load the recorder with paper). The paper copy should be almost identical with the CRT display, except that there will be time lines on the record.

To become familiar with the multiple display opportunities of the instrument, make a few more records in different modes. A longer record can be obtained by switching RECORD LENGTH to LONG. The CRT display will expand horizontally and show only the first half of the record. Depressing the PRINT switch will produce a new paper copy which will be twice as long as the previous one (about 14 inches [36 cm]). Pull out on the BRIGHTNESS control. Timing lines will show on the CRT display. Make a new copy of the paper record and notice that it will now have the high resolution timing lines (more of them, closer together). When testing for variable area, notice that the tops of the signal displayed on the CRT will be shaded in white. The paper record will have the same shading. Changing the position of the DISPLAY SELECT control will produce 6-channel displays and paper records.

All of the front panel controls have now been exercised except the delay and filter adjustments.

To test the use of enhancement, hit the ground or table twice in the same place without clearing the memory. The waveforms on the CRT (and paper records) should grow larger with each successive impact. Pull up on the TRACE SIZE controls on the first three channels (1, 2, and 3). Hit the ground some more, and notice that the remaining channels continue to grow, while 1, 2, and 3 do not. By selecting the MEMORY FREEZE, these channels are prevented from further stacking. Clear the memory in the usual fashion. Notice that channels 1, 2, and 3 did not erase, but are still on the screen. Thus, were able to "save" them while starting over with the others.

To experiment with the DELAY switch, try setting the record time back at 500 ms. Dial in delay of 2000 on the DELAY switch. Impact the ground and watch the STATUS light. Notice that it waits for exactly two seconds, then comes on for one-half second. If the ground is hit again during the on time, you can make a record of an impact which occurred over two seconds after hammer time. More experimenting with shorter delays, using a record time of 50 milliseconds may be beneficial. Notice that the waveform stored on the CRT will move left in time by the amount of delay. For example, if the signal arrived at 25 milliseconds before, and you used a 10 ms delay (0010 on the DELAY switch), the new signal will appear at 15 milliseconds on the CRT and the paper record.

The filters in the ES-1210F are more subtle in their operation, since their function is to eliminate unwanted frequencies from the signal. A good way to experiment is to group all the geophones closely together and set up the controls to produce a normal record. The waveforms should be about the same on all channels. Select different combinations of filter settings on channels 2 through 12, leaving channel 1 as a reference. Try selecting bandpass, lowpass, highpass, and bandreject on various channels, and select different frequencies like 30, 50, 100, and 300. Erase and store a new record in the memory and make a paper copy. Write the filter settings on the paper record and compare the appearance of the signals. Notice that highpass will remove the low frequency components, lowpass will remove the high frequency components, and similar effects will appear on the other samples.

A similar test with the notch filters can be made if there is some 50 or 60 Hz interference from a power line. Normally this will not occur unless you are using long cables near a power line.

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