PHILIPS DISPLAY COMPONENTS COMPANY
SENECA FALLS, NEW YORK
RCRA FACILITY ASSESSMENT SAMPLING VISIT WORK PLAN / SUPPLEMENTAL SAMPLING VISIT WORK PLAN AND RCRA FACILITY INVESTIGATION OF THE MW-1 AREA

QAPjP

QUALITY ASSURANCE PROJECT PLAN (QAPjP)

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BUREAU OF HAZARDOUS
WASTE FACILITY MANAGEMENT
DIVISION OF
HAZARDOUS SUBSTANCES REGULATION

Prepared by:

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PROJECT NO. 288788

JULY 1992

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1.0 INTRODUCTION

The purpose of this Quality Assurance Project Plan (QAPjP) is to document the procedures and criteria that will be used to provide accurate, precise, comparable, representative and complete data during the performance of the RCRA Facility Assessment, Supplemental RCRA Facility Assessment, and RCRA Facility Investigation phases of work at the Philips Display Components Company site in Seneca Falls, New York.

The procedures and criteria that will be used to accomplish the work objectives will be responsive to requirements of the U.S. Environmental Protection Agency (U.S. EPA) and the New York State Department of Environmental Conservation (NYSDEC). The work objectives are summarized in Section 2 of this document. Requirements of the QAPjP are based on several sources including U.S. EPA and NYSDEC guidance documents [e.g. Interim Guidelines and Specifications For Preparing Quality Assurance Project Plans, QAMS-005/80, December 29, 1980; U.S. EPA Region III Quality Assurance Branch QAPjP Workshop Participant Workbook, February 27, 1990; and NYS Department of Environmental Conservation (Division of Hazardous Substances Regulation) RCRA Quality Assurance Project Plan Guidance, January 19, 1990].

In general, the QAPjP addresses: a) the quality assurance (QA) objectives of the project; b) specific QA and quality control (QC) procedures that will be implemented to achieve these objectives; and c) project organization and responsibility. These three areas are addressed in the QAPjP for the field work and laboratory analysis aspects of the project in accordance with requirements of the U.S. EPA which focus on the acquisition of environmental data of known and acceptable quality.

2.0 PROJECT DESCRIPTION

The primary objective of the investigation at the Philips Display Components Company's Seneca Falls, New York facility is to define the nature and extent, if any, of the potential constituent impact at the site. This investigation will be undertaken at 1) work areas described in the RCRA Facility Assessment Sampling Visit Work Plan prepared by Keystone Environmental Resources (Keystone), May 1990 (hereafter referred to as the RFA SVWP); work areas described in the RCRA Facility Assessment Supplemental Sampling Visit Work Plan prepared by Keystone, September 1990 (hereafter referred to as the RFA SSVWP); 2) the MW-1 area which has been identified as the primary target of the RCRA Facility Investigation Work Plan prepared by Keystone, July 1990 (hereafter referred to as the RFI WP) and the Primary Shortage Area which is to be closed in accordance with the Closure Plan prepared by the Chester Engineers, July 1986, Revised May 1987. Sections 2.1 and 2.2 describe the current site conditions and give some perspective on past operations at the facility. In addition, they provide the rationale for choosing sampling locations and analytical parameters of interest along with the number of samples to be taken. These will be summarized in Tables 2-1, 2-2, and 2-3 for the RFA SVWP, RFI WP, and RFA SSVWP, respectively.

2.1 Site Description

Philips Display Components Company operated a facility in the village of Seneca Falls, New York. A schematic plan view of the facility is shown in Figure 1 in the RFA SVWP, Volume I, Management Plan. The facility is bordered by Van Cleef Lake and the Seneca River/Barge Canal to the south, undeveloped and agricultural areas to the north and east, and residential area to the west.

The plant facility is underlain by glacial till, deposited as a result of Wisconsinian Glaciation, which ranges in depth from 21 to 37 feet beneath the surface. Site topography across the site is generally flat with ground surface decreasing in elevation towards the barge canal.

The facility was used to manufacture television picture tubes and served as headquarters for other Philips operations. Hazardous waste was generated in television glass and metal tube component fabrication, cleaning, finishing, coating, and tube salvage operations.

2.2 Site Conditions

Sylvania manufactured television picture tubes at this facility from 1948 to 1960. The facility was then sold to GTE in 1960, who in turn sold it to Philips in 1981. Philips stopped manufacturing at the facility in 1986 and sold it to the Seneca County Industrial Development Agency (IDA) in 1989. The original manufacturing by Sylvania was done in buildings 1 through 5. Through the years, the facility expanded to buildings 6 through 13. By 1972, GTE was conducting most manufacturing operations in buildings 8, 10, 10A, 11, and 13.

The closure plan for the facility includes the removal of all identified hazardous solid wastes from all units, in addition to liquids and materials which may have come into contact with the hazardous waste. Soil sampling is required beneath the sewers outside of the facility that may have contained hazardous process wastewaters and where releases may have occurred. Soil sampling is also required within the Primary and Interim Storage Areas, the Open Burning Area, the Former PCB Capacitor Area, at locations of the identified underground storage tanks, and in the area around MW-1.

Six monitoring wells were originally installed around the two hazardous waste management units as part of the RCRA monitoring program at the Seneca Falls facility. Because of the complex hydrogeology and natural geochemistry, the wells yielded insufficient water for proper monitoring under the RCRA program. The New York State Department of Environmental Conservation (NYSDEC) required Philips to install additional monitoring wells in order to provide for sufficient monitoring of the impoundments. As a result, 16 wells have been installed at the Seneca Falls facility under the RCRA monitoring program.

RCRA closure of the two impoundments and incinerator occurred in 1987. Final closure documents were submitted in January 1990. Groundwater monitoring has continued as part of the post closure requirements. The post-closure quarterly monitoring program includes determination of the groundwater flow pattern and sampling for common groundwater ions and heavy metals. At the request of the NYSDEC, volatile organic analysis is being performed on groundwater samples to provide background data under the Corrective Action Program. The data continues to support the conclusion that no hazardous constituents have entered the groundwater due to the RCRA regulated impoundments.

The underground sewers in the older manufacturing buildings may have received hazardous wastes prior to Philips' ownership. During Sylvania and GTE ownership and operation of the facility from 1948 to 1972, the facility sewers discharged directly to Van Cleef Lake or the Seneca River via several outfalls along the escarpment located south of the facility. During this time none of these outfalls were monitored. The sewers, sumps, and pits handled all of the process wastewaters during this period. Many of the original sumps, pits, and their drains in the original sewer system were filled with concrete and abandoned prior to Philips' ownership. However, there is not complete documentation on these old sumps, pits, and sewers. The segregated sewer systems which separated wastewater, including wastewaters which required treatment and those which did not, were installed in 1971 and 1972 during GTE ownership. Investigation of the original sewer system prior to segregation in 1972 is addressed in the RFA SSVWP.

All the existing sumps and pits in the facility and the industrial wastewater treatment plant (IWTP) were previously high pressure washed. The sumps, pits, and IWTP are visually clean, free of residue, and do not require additional washing. Philips flushed the underground sewers that handled hazardous wastewaters from the sumps in buildings 13 and 13A to the outside Lift Station No. 1 sump until analysis of the flush water samples collected at the Lift Station sump met the facilities SPDES permit requirements (Appendix A). Philips also static water pressure leak tested these underground sewers in buildings 13 and 13A and found no measurable leakage. The underground process sewers will be flushed to remove potential sediment and filled with cement. All flush water will drain to the outside

Table 2-1

lift station No. 1 sump, will be drummed, sampled, and analyzed for the parameters shown in Table 2-2. If the analyses reveal the water concentrations exceed SPDES permit levels, the sewer lines will be rerinsed and reanalyzed until the permit levels are met. In addition, the sewer line from the Lift Station sump to the IWTP, the 6 inch IWTP effluent line to the 36 inch interceptor line, and the Lift Station sump will be static water pressure leak tested, the water analyzed and the sewer rinsed and reanalyzed, as required.

These tests are further described in the Sewer Evaluation Report (Keystone, 1992).

In 1971 and 1972 GTE installed an interceptor pipe, as shown in Figure 2-1, south of the plant to tie in outfalls 2, 3, 4, 4A, and 5 and constructed the industrial wastewater treatment plant (IWTP) to treat plant effluent (figures depicting the approximate locations and configurations of the facility sewers are presented in the RFA SSVWP). Additionally, GTE constructed the outside lift station to collect wastewater drainage from outfalls 5A and 5B and pump it to the IWTP. In 1972, all non-treated plant effluent sewers were connected to the old outfall headers 2, 3, 4, 4A, and 5 and were tied into the new interceptor pipe. The treated effluent sewers were all connected to the IWTP and the IWTP discharge (monitored outfall 004) was also tied into the new interceptor pipe. The interceptor pipe continued to the Wastewater Effluent Settling Lagoon and to the new NYSPDES outfall 001, where the discharge was monitored prior to entering the canal. The remaining portions of the old outfalls 2, 3, 4, 4A, and 5 were abandoned. The old outfall 1, which handled roof drainage only, became NYSPDES outfall 002 and discharged to Van Cleef Lake approximately 15 feet below lake level. Outfalls 6 and 7 remained separate and their discharges to the canal were individually monitored until 1978. Outfall 8, which handled roof drainage only, had always been unmonitored. In 1978, GTE tied outfalls 6 and 7 into the interceptor pipe and abandoned the remainder of the 6 and 7 outfall pipe. No further significant changes were made to the plant sewers since that time. A more thorough description of the configurations and uses of the facility sewer system are presented in the Sewer Evaluation Report (Keystone, 1990).

Twelve underground storage tanks (USTs) have been identified at the Seneca Falls facility. Eight of these USTs are addressed in the SSVWP and are identified in Figures 1 and 2 in the RFA SSVWP. One 12,000 gallon #2 fuel oil UST, located adjacent to the southeast corner of Building 10, was removed in July 1985 and is addressed in Section 4.2.4 of the RCRA Facility Assessment Sampling Visit Work Plan, Volume II (Keystone, 1992). Two of the USTs (003 and 004) were part of the incinerator system and were included in the RCRA closure of the incinerator and impoundments, and are also not addressed in the Supplemental Site Visit Work Plan. Six USTs (1, 2, 5, 6, 7 and 11) addressed in the SSVWP were removed in 1986 and three USTs (8, 9, and 10) were closed in place and filled with inert material. A summary of the USTs, their locations, and the material each stored is presented in the RFA SSVWP.

Sampling under the RFA SVWP, RFA SSVWP, and RFI WP investigations will be covered in this document with regards to quality assurance/quality control procedures pertaining to field activities and laboratory analyses. Under the RFA SVWP, surface and subsurface soils will be evaluated in areas around and inside the facility where materials and waste were either produced, utilized, or stored including outside areas where wastes were collected for transfer to the IWTP. Additionally, the recleaning and rinse water sampling events will be evaluated under the RFA SVWP. Data obtained from the RCRA Facility Assessment will be used for site characterization. A tentative schedule for this investigation is presented in the RFA SVWP Management Plan (Vol. I), which highlights the benchmarks of progression of the investigation.

Activities outlined in the RFI Work Plan (Keystone, 1992) constitute assessments around the MW-1 monitoring well east of Building 13A and north of the former IWTP. Additional monitoring wells will be installed for a more in-depth evaluation of the surrounding groundwater and constituent impact. Data obtained from the RCRA Facility Investigation will be used for additional site characterization and for a preliminary evaluation of remedial alternatives. A tentative schedule for this investigation is presented in the RFI WP, which highlights the benchmarks of progression of the investigation.

Under the RFA SSVWP, surface and subsurface soils will be evaluated in areas around the facility sewers and their outfalls along the escarpment, the barrel storage area, and the site's UST locations to determine the impact, if any, of the soils beneath the facility based on potential spills or leaks of site-related constituents. The soils around the former outfalls, which were in operation from 1948 to 1972, will be sampled at predetermined locations adjacent to the sewer lines and along the escarpment where the sewers discharged. These soil samples will be analyzed for volatile organic constituents and the inorganic parameters which have been required to be monitored by the NYSDEC according to the Seneca Falls SPDES permit (Appendix A) since the sewers handled process wastewaters which may have contained solvents and/or lead, fluoride, and metal wastes. The soils in the barrel storage area will be analyzed for the inorganic site-related constituents. The soils around the USTs will be sampled at the tank bottom and 1 to 2 feet below the tank bottom and will be analyzed for either BETX (SW 8020) and semi-volatiles (SW 8270) or for methanol (methanol holding tanks) since the tanks were identified to contain either methanol, gasoline, diesel fuel, or #2 fuel oil. If any of these materials were to be found, the most significant levels would probably be directly beneath the USTs.

As part of the work completed for the RFA SSVWP, 10 monitoring wells will be installed around the plant buildings. A regularly schedule groundwater collection program will be initiated to monitor the groundwater quality. Soil samples will be collected from borings completed to accommodate monitoring wells and submitted to the analytical laboratory for analysis of fluoride, cadmium, chromium, lead, zinc, volatile organics and semivolatile organics. Groundwater samples will be collected quarterly and analyzed for site-related fluoride, cadmium, chromium, lead, zinc, volatile organics and semivolatile organics (second quarter only). ? in 3 of 10 wells only

Additionally, rinsate samples will be collected from process tanks and related equipment in the industrial wastewater treatment plant. The rinsate samples will be analyzed for fluoride, cadmium, chromium, lead and zinc. The rinsate sampling will be completed separately from the SSVWP, but will be completed in accordance with this QAPjP.

TABLE 2-1
RFA SVWP
ON-SITE SOIL AND UNDERGROUND SEWER LEAK TEST WATER SAMPLE ANALYSIS SUMMARY

Area/Matrix	Samples Per Location	No. of Locations	Parameter	Analytical Method (*2)	Detection Limit	Units	DQO Level	(*3) Duplicates	Rinsate Blanks	Trip Blanks (*3)	Total No. of Sample Analyses
Interim Storage Area/Soils	2	2	Chromium	EPA200.7	10	ug/L	III	-	-	1	5
			Lead	EPA239.2	5	ug/L					
			Aromatic Volatiles	SW8020	20-40	ug/Kg					
			Halogenated Volatiles	SW8010	2-50	ug/Kg					
Satellite Storage Area-Loading Dock/Soils	2	3	Chromium	EPA200.7	10	ug/L	III	-	-	1	7
			Lead	EPA239.2	5	ug/L					
			Aromatic Volatiles	SW8020	20-40	ug/Kg					
			Halogenated Volatiles	SW8010	2-50	ug/Kg					
Fuel Oil Tank/Soils	2	3	BETX(*1)	SW8020	20-30	ug/Kg	III	1	1	1	9
			Semivolatiles	SW8270	330-2600	ug/Kg					
Open Burning Area/Soils	4	6(*5)	Aromatic Volatiles	SW8020	20-40	ug/Kg	III	2	2	2	30
			Halogenated Volatiles	SW8010	2-50	ug/Kg					
PCB Capacitor Area/Soils	2	4	Polychlorinated Biphenyls	SW8080	80-160	ug/Kg	III	1	1	-	10
Underground (H_2O) Sewer Leak Test Water in the Lift Station, from the Lift Station to the WTP, 6" WTP Effluent Line to 36" Interceptor Pipe, 3" Return Line from outside Lift	2(*4)	4	Fluoride	EPA 340.2	100	ug/L	III	1	1	1	11
			Cadmium	EPA 200.7	5	ug/L					
			Chromium	EPA 200.7	10	ug/L					
			Lead	EPA 239.2	5	ug/L					
			Zinc	EPA 200.7	20	ug/L					
			pH	EPA 150.1	-						
			Trichloroethene	SW8010	0.10	ug/L					

TABLE 2-1
RFA SVWP
ON-SITE SOIL AND UNDERGROUND SEWER LEAK TEST WATER SAMPLE ANALYSIS SUMMARY

Area/Matrix	Samples Per Location	No. of Locations	Parameter	Analytical Method (*2)	Detection Limit	Units	DQO Level	(*3) Duplicates	Rinsate Blanks	Trip Blanks (*3)	Total No. of Sample Analyses
Background Sampling Soils	8	2	Fluoride	EPA 340.2	100	ug/L	III	1	1	-	18
			Cadmium	EPA 200.7	5	ug/L					
			Chromium	EPA 200.7	10	ug/L					
			Lead	EPA 239.2	5	ug/L					
			Zinc	EPA 200.7	20	ug/L					

(*1) Aromatic volatile compounds toluene,benzene,ethylbenzene,and total xylenes only.

(*2) All metals soil sample analyses will be extracted using SW1312 - Synthetic Precipitation Leaching Procedure prior to sample analyses.

(*3) The number of field QC samples to be taken per media is estimated as the exact number will be based on the number of samples taken per day and the groupings by media. Trip blanks will be analyzed for volatile organic sample analyses only. The overall one in twenty criteria will be met at a minimum per sample media and/or analysis type.

(*4) One leak and one flush water sample for each of the four sewer sections will be sampled.

(*5) Each of soil borings from the Open Burning Area will be field screened with an HNU. At least one sample per location will be analyzed by methods 8010 and 8020. All samples 5ppm over background will be submitted for fixed-base laboratory analysis.

TABLE 2-2
RFIWP
SAMPLE ANALYSIS SUMMARY FOR THE MW-1 RFI AREA

Area/Matrix	Samples Per Location	No. of (*1) Locations	Parameter	Analytical Method	Detection Limit	Units	DQO Level	(*5) Duplicates	Rinsate Blanks	(*5) Trip Blanks	Total No. of Sample Analyses
Area around MW-1/Groundwater	2 (*3)	22-28 (*3)	Volatile Organics	SW8240	5-10	ug/L	III	4 (*4)	4 (*4)	4 (*4)	56-68
			Semivolatiles (*2)	SW8270	10-80	ug/L					
Area around MW-1/Soils	1-5 (*6)	3-6 (*6)	Aromatic Volatiles	SW8020	20-40	ug/Kg	III	1-2	1-2	1-2	6-36
			Halogenated Volatiles	SW8010	2-50	ug/Kg					

(*1) The number of locations for the RFI WP are presently estimates. Definitive totals will be based on constituents detected in field screening.

(*2) Two rounds of semivolatile groundwater sampling are tentatively planned. Following the initial sampling round, the analytical results will be examined to determine the necessity for continuation of semivolatile organic analyses for this sampling program.

(*3) Groundwater samples will be taken in two sampling rounds from each of the installed monitoring wells as well as the 16 previous monitoring wells. Three to six well "nests" (1 shallow and 1 deep well) will be installed, based on constituents detected in the groundwater screening of the MW-1 area. Thus, the number of sample locations for the monitoring wells sampled during well construction will be between 22 and 28.

(*4) The number of duplicates and blanks for the monitoring wells is based on the two sampling rounds, with two duplicates, two rinsate blanks, and two trip blanks per sampling round.

(*5) The number of duplicates, field blanks, and trip blanks to be taken per media is estimated as the exact number will be based on the number of samples taken per day and the groupings of the media. Trip blanks will only be analyzed for volatile organic parameters, when applicable.

(*6) Only the shallow monitoring wells of the well "nest(s)" will be sampled for soils. Each of the samples taken in the test borings will be field screened with an HNU. At least one sample per location will be analyzed by methods 8010 and 8020. All samples 5 ppm over background will be submitted for fixed-base laboratory analysis.

TABLE 2-3
RFA SSVWP
ON-SITE SUPPLEMENTAL SOIL SAMPLE ANALYSIS SUMMARY

Area/Matrix	Samples Per Location	No. of Locations	Parameter	Analytical Method (*6)	Detection Limit	Units	DQO Level	(*3) Duplicates	Rinsate Blanks	Trip Blanks (*2)	Total No. of Sample Analyses
Underground Storage Tanks 5-9 & 11 Soils	2	20	BETX (*1) ok	SW8020	20-40	ug/Kg	III	2	2	2	46
			Semi-Volatiles	SW8270	330-2600	ug/Kg					
Underground Storage Tanks 1-2 Soils	2	6	Methanol ok	SW8015 (*4)	70	ug/Kg	III	1	1	-	14
Outfall Sewer Line Areas 1-7 Soils	2	27	Fluoride	EPA 340.2	100	ug/L	III	3	3	3	63
			Cadmium	EPA 200.7	5	ug/L					
			Chromium	EPA 200.7	10	ug/L					
			Lead	EPA 239.2	5	ug/L					
			Zinc	EPA 200.7	20	ug/L					
			pH	SW9045	-						
			Aromatic Volatiles	SW8020	20-40	ug/Kg					
			Halogenated Volatiles	SW8010	2-50	ug/Kg					
Barrel Storage Area South of Building 13 Soils	2	2	Fluoride	EPA 340.2	100	ug/L	III	1	1	-	6
			Cadmium	EPA 200.7	5	ug/L					
			Chromium	EPA 200.7	10	ug/L					
			Lead	EPA 239.2	5	ug/L					
			Zinc	EPA 200.7	20	ug/L					
			pH	SW9045	-						
Longterm Groundwater Monitoring System 1ST QTR	1	10	Fluoride	EPA 340.2	100	ug/L	III	1	1	1	13
			Cadmium	EPA 200.7	5	ug/L					
			Chromium	EPA 200.7	10	ug/L					
			Lead	EPA 239.2	5	ug/L					
			Zinc	EPA 200.7	20	ug/L					
			Volatile Organics	SW8240	5-10	ug/L					
2ND QTR (*5)	1	2	Fluoride	EPA 340.2	100	ug/L	III	1	1	1	5
			Cadmium	EPA 200.7	5	ug/L					
			Chromium	EPA 200.7	10	ug/L					
			Lead	EPA 239.2	5	ug/L					
			Zinc	EPA 200.7	20	ug/L					
			Volatile Organics	SW8240	5-10	ug/L					
			Semivolatile Organics	SW8270	10-80	ug/L					
	1	8	Fluoride	EPA 340.2	100	ug/L	III	1	1	1	11
			Cadmium	EPA 200.7	5	ug/L					
			Chromium	EPA 200.7	10	ug/L					
			Lead	EPA 239.2	5	ug/L					
			Zinc	EPA 200.7	20	ug/L					
			Volatile Organics	SW8240	5-10	ug/L					

See Jan 10. 91 letter #4

TABLE 2-3
RFA SSVWP
ON-SITE SUPPLEMENTAL SOIL SAMPLE ANALYSIS SUMMARY

Area/Matrix	Samples Per Location	No. of Locations	Parameter	Analytical Method (*6)	Detection Limit	Units	DQO Level	(*3) Duplicates	Rinsate Blanks	Trip Blanks (*2)	Total No. of Sample Analyses
3RD - 12TH QTRS	1	10	Fluoride	EPA 340.2	100	ug/L	III	1	1	1	13
			Cadmium	EPA 200.7	5	ug/L					
			Chromium	EPA 200.7	10	ug/L					
			Lead	EPA 239.2	5	ug/L					
			Zinc	EPA 200.7	20	ug/L					
			Volatile Organics	SW8240	5-10	ug/L					
Soil Borings For 10 New Monitoring Wells	2	10	Fluoride	EPA 340.2	100	ug/L	III	1	1	1	23
			Cadmium	EPA 200.7	5	ug/L					
			Chromium	EPA 200.7	10	ug/L					
			Lead	EPA 239.2	5	ug/L					
			Zinc	EPA 200.7	20	ug/L					
			Aromatic Volatiles	SW8020	20-40	ug/Kg					
			Halogenated Volatiles	SW8010	2-50	ug/Kg					
Rinsate Samples For Various Process Holding Tanks & Equipment	1	17	Fluoride	EPA 340.2	100	ug/L	III	1	1	-	19
			Cadmium	EPA 200.7	5	ug/L					
			Chromium	EPA 200.7	10	ug/L					
			Lead	EPA 239.2	5	ug/L					
			Zinc	EPA 200.7	20	ug/L					

(*1) Aromatic volatile compounds toluene, benzene, ethylbenzene, and total xylenes only.

(*2) Trip blanks are only analyzed for the volatile organic analyses.

(*3) The number of field QC samples to be taken per media is estimated as the exact number will be based on the number of samples taken per day and the groupings by media.

(*4) A summary of the methodology and instrumentation for methanol analysis is presented in Appendix E.

(*5) After the 2nd Quarterly Sampling, the analytical results will be examined to determine the possibility of reducing the frequency and/or analytical program for subsequent sampling.

(*6) All metals and fluoride analyses will be extracted using SW1312 - Synthetic Precipitation Leaching Procedure prior to sample analyses.

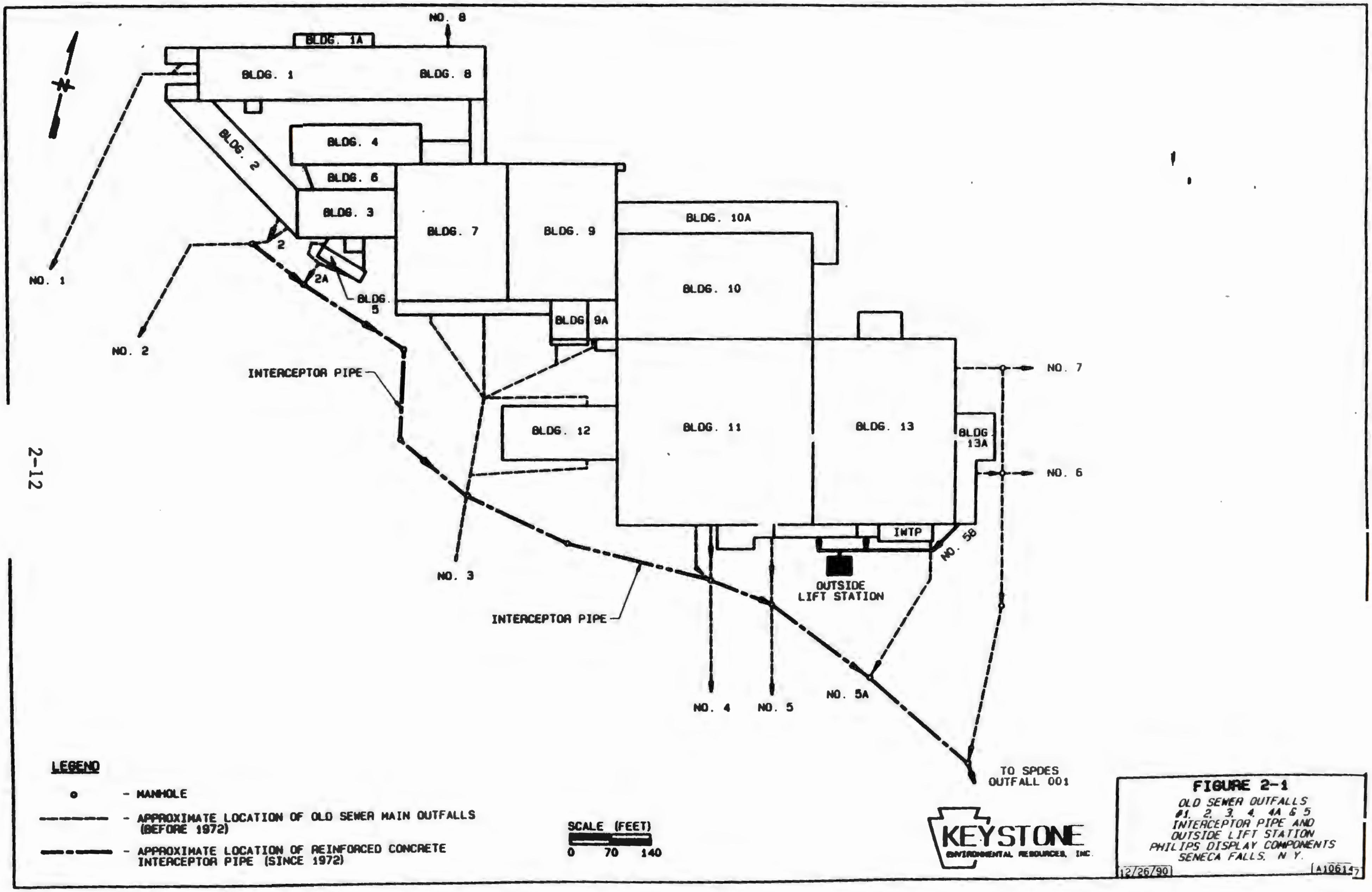

FIGURE 2-1

OLD SEWER OUTFALLS
#1, 2, 3, 4, 4A & 5
INTERCEPTOR PIPE AND
OUTSIDE LIFT STATION
PHILIPS DISPLAY COMPONENTS
SENECA FALLS, N.Y.

3.0 PROJECT ORGANIZATION AND RESPONSIBILITY

The following section describes the duties of key personnel assigned to the RCRA investigation at the Philips Display Components Company site Seneca Falls, New York.

Project Manager - Mr. Dennis Middleton (412) 825-9804

The Project Manager will be the primary point of contact and will have responsibility for technical, financial and scheduling matters for this project. His duties will include:

- Procurement, along with administrative personnel, and supervision of subcontractor services;
- Assignment of duties to, and orientation of the staff to, the needs and requirements of the project;
- Review of subcontractor work and approval of subcontract invoices;
- Establishment of a project record keeping system;
- Review of all major project deliverables for technical accuracy and completeness; and,
- Project closeout; and
- Responsibility for the project evidence file.

Team Leader/Sampling Coordinator - Mr. Michael Hursky (412) 825-9827

The Team Leader will be responsible for field activities and field data evaluation, including items as follows:

- Supervising the collection of the samples and providing for their proper documentation, handling and shipping;
- Maintaining a field log for all sampling activities;
- Maintaining a completion log for each borehole and monitoring well installed;
- Monitoring the drilling and sampling operations to verify that the drilling subcontractor and sampling team members adhere to the QAPjP;
- Coordinating activities with the Project Manager; and
- Preparing and presenting the relevant field investigation data.

Field Services Manager - Mr. James Gillespie (412) 825-9697

Responsibilities of the Field Services Manager include:

- Maintaining communications between the field Team Leader and the Project Manager;
- Scheduling and maintaining a field services crew to perform project specific objectives in a time and cost efficient manner; and
- Preparing field sampling procedures documentation for the associated work plans and/or QAPjP.

Laboratory Quality Assurance Manager - Mr. Merle Powell (412) 825-9771

The Laboratory Quality Assurance (QA) Manager is responsible for audits and monitors adherence to the laboratory QA objectives. The Laboratory QA Manager acts independently of the personnel performing analyses. His responsibilities include:

- Validating or assigning a designee who is independent of the analyst and the project to validate the data packages using review methods described in Section 9.0 of this document;
- Final review of the data package to ensure data is transcribed correctly and a complete and correct data package is reported to the user;
- Conducting laboratory performance and system audits on a monthly and quarterly basis, respectively; and,
- Initiation of systems corrective actions and review if corrective action taken appropriately resolved the identified problem.

Laboratory Director - Ms. Penny Gardner (412) 825-9767

Responsibilities of the Laboratory Director include:

- Collaborating with the project management in establishing sampling and testing programs;
- Serving as liaison between the laboratory and other project personnel;
- Serving as the "collection point" for reporting of nonconformances and changes in laboratory activities;
- Maintenance and releasing of laboratory testing data; and,
- Responsibility for laboratory activities by the analytical services staff.

4.0 QUALITY ASSURANCE OBJECTIVES

Data Quality Objectives (DQOs) are qualitative and quantitative statements to ensure that data of known and appropriate quality are obtained during investigative activities. Data obtained from the RCRA Facility Assessment and Supplemental RCRA Facility Assessment will be used for site characterization. Data obtained from the RCRA Facility Investigation will be used for additional site characterization and for a preliminary evaluation of remedial alternatives.

4.1 Data Quality Levels

There are five analytical levels of data quality available to accomplish the objectives of the investigation. They are:

- Level I - field screening
- Level II - field analysis
- Level III - SW-846 RAS methods
- Level IV - non-standard methods
- Level V - physical property and engineering material analysis

Level I and III procedures are planned for this project. The following section describes the differentiation between the levels and the selection of appropriate analytical levels.

4.2 Non-CLP Laboratory Methods

4.2.1 Level III Analyses

Level III analysis will be performed for those parameters where the rigid CLP reporting is not necessary to accomplish the objectives of the investigation. Level III analyses will still receive rigorous QA/QC protocols and documentation as described in the appropriate SW-846 methods (3rd Edition). In addition, for data validation purposes, all related raw data and chromatographs (when applicable) will be included in the data packages received by the laboratory. The following analyses will receive Level III analytical treatment.

Soils

Synthetic Precipitation Leaching Procedure	SW 1312
Cadmium	EPA 6010
Chromium	EPA 6010
Lead	EPA 6010
Zinc	EPA 6010
Fluoride	~~EPA 6010~~
Methanol	SW 340.2 ??
pH	SW 9045
Polychlorinated Biphenyls (see Table 4-3)	SW 8080
Aromatic Volatiles (see Table 4-3	SW 8020
Halogenated Volatiles (see Table 4-3)	SW 8010
Semi-Volatile Organics (See Table 4-2)	SW 8270

Aqueous (Groundwater, Leak Test Rinse, Process Tank & Equipment Rinse)

Fluoride	EPA 340.2
Cadmium	EPA 200.7
Chromium	EPA 200.7
Lead	EPA 239.2
Zinc	EPA 200.7
pH	EPA 150.1
Trichloroethene	EPA 8010
? Volatiles (see Table 4-3)	SW 8240
Semi-Volatiles (see Table 4-2)	SW 8270

4.2.2 Level I Analyses

Level I field screening for volatile organics (headspace analysis)/shallow monitoring will be performed on all soil samples collected from Shallow Monitoring Wells in the MW-1 area. If the headspace results indicate detected volatiles 5 part per million (ppm) greater than background, the sample will be submitted to the fixed base laboratory for analysis.

Soils

Total Volatile Organics	Field screening/headspace

4.3 Quality Control Parameters

The following sections define the detection limits and data precision, accuracy, and completeness criteria that will be maintained throughout the project to ensure data obtained will be of sufficient quality to achieve the project objectives:

- Detection limit - The minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero. Analytical methods to be utilized and their associated detection limits are listed on Tables 2-1, 2-2, and 2-3.

- Precision - A measure of the mutual agreement among individual measurements of the same property under prescribed similar conditions. Precision is determined based on the relative percent difference (RPD) of duplicate analyses or spikes, as appropriate. (See Section 12.1 for the method of calculation).

- Accuracy - The degree of agreement of a measurement with an accepted reference or true value. Accuracy is determined by calculating the percent recovery of spiked samples. (See Section 12.2 for the method of calculation).

- Representativeness - The sampling program is designed to ensure the analytical data obtained during the investigation represent conditions found at the site. Sample locations were selected to ensure soil, groundwater, and rinse water analytical data are suitable for their intended use and adequately characterize the site. A sufficient number of samples will be obtained to ensure site conditions are appropriately assessed. (A sample summary is presented on Tables 2-1, 2-2, and 2-3).

- Completeness - A measure of the amount of valid data obtained from a measurement system compared to the amount expected to be obtained under normal conditions. (See Section 12.3 for the method of calculation). The following rationale were used for developing the completeness objectives:

    - Level III analyses being used as general indicators for characterization that are specific for site assessment will have a minimum completeness objective of 100% as required by the NYSDEC RCRA Guidance Document.

    - Level I field screening is being used as a general indicator to determine the presence of volatile organics to verify the neccessity to submit samples for laboratory analyses, based on detected concentrations in the headspace.

- Comparability - One of the objectives of the investigation is to ensure analytical data are of comparable quality. The data collection mechanisms proposed are designed to produce comparable data. To ensure comparable data quality, standard recognized analytical methodologies will be followed.

To ensure comparability between samples over time, consideration will be given to seasonal conditions, flow or other environmental factors that may influence the analytical results.

Table 4-1 gives the target limits for all analyses in terms of precision, accuracy and completeness. For compounds analyzed by GC or GC/MS, precision and accuracy criteria are given only for selected analytes to be used in spiking for method control purposes.

TABLE 4-1 (Continued)

QUALITY ASSURANCE CRITERIA

Completeness Parameter	Method	Matrix	Matrix Spiking Level (ppb)	Precision (RPD)	Accuracy (%) ok	(%)
1,2,4-Trichlorobenz.	SW 8270	aqueous	50	28	39-98 ✓	100
Acenaphthene	SW 8270	aqueous	50	31	46-118 ✓	100
2,4-Dinitrotoluene	SW 8270	aqueous	50	38	24-96 ✓	100
Di-n-butylphthalate	SW 8270	aqueous	50	40	11-117	100
Pyrene	SW 8270	aqueous	50	31	26-127 ✓	100
n-Nitrosodi-n-propyl.	SW 8270	aqueous	50	38	41-116 ✓	100
1,4-Dichlorobenzene	SW 8270	aqueous	50	28	36-97 ✓	100
Pentachlorophenol	SW 8270	aqueous	100	50	9-103 ✓	100
Phenol	SW 8270	aqueous	100	42	12-89 ✓	100
2-Chlorophenol	SW 8270	aqueous	100	40	27-123 ✓	100
4-Chloro-3-methylph.	SW 8270	aqueous	100	42	23-97 ✓	100
4-Nitrophenol	SW 8270	aqueous	100	50	10-80 ✓	100
Total volatiles	HNU Screen	HNU Screen	soils	--	--	90

* Analytes for which method specified accuracy criteria are not established will be evaluated using the duplicate sample result RPD of 20% for aqueous samples.

** All metals and fluoride soil samples will be analyzed as aqueous samples since they will be extracted using Method SW1312 prior to analysis.

TABLE 4-2

LIST OF SEMI-VOLATILE ORGANIC COMPOUNDS

Acid Extractables

4-Chloro-3-Methylphenol
2-Chlorophenol
2,4 Dichlorophenol
2,4 Dimethylphenol
2,4 Dimethylphenol
2,4 Dinitrophenol
2-Methyl-4,6-dinitrophenol
2-Methylphenol
4-Methylphenol
2-Nitrophenol
4-Nitrophenol
Pentachlorophenol
Phenol
2,4,5-Trichlorophenol
2,4,6-Trichlorophenol

Base/Neutral Extractables

Acenaphthene
Acenaphthalene
Anthracene
Benzo(a)anthracene
Benzo(b)fluoranthene
Benzo(k)fluoranthene
Benzo(a)pyrene
Benzo(ghi)perylene
Benzoic Acid
Benzyl alcohol
Benzyl butyl phthalate
Bis(2-chloroethyl)ether
Bis(2-chloroethoxy)methane
Bis(2-chloroisopropyl)ether
4-Bromophenyl phenyl ether
4-Chloroaniline
2-Chloronaphthalene
4-Chlorophenyl phenyl ether
Chrysene
Dibenzo(ah)anthracene
Dibenzofuran
Di-n-butylphathalate
1,2-Dichlorobenzene
1,3-Dichlorobenzene
1,4-Dichlorobenzene
3,3'-Dichlorobenzidine
Diethyl phthalate
2,4-Dinitrotoluene
2,6-Dinitrotoluene
Di-n-octylphathalate
Fluoranthene
Hexachlorobenzene
Hexachlorobutadiene
Hexachlorocyclopentadiene
Hexachloroethane
Indeno(1,2,3-cd)pyrene
Isophorone
2-Methylnaphthalene
Naphthalene
2-Nitroaniline
3-Nitroaniline
4-Nitroaniline
Nitrobenzene
N-Nitrosodi-n-propylamine
N-Nitrosodiphenylamine
Phenanathrene
Pyrene
1,2,4-Trichlorobenzene

TABLE 4-3

LIST OF VOLATILE ORGANIC AND POLYCHLORINATED BIPHENYL COMPOUNDS

Volatile Organics (Method 8240)

Acetone
Dibromochloromethane
cis-1,3-Dichloropropene
trans-1,3-Dichloropropene
Bromoform
Bromomethane
Carbon tetrachloride
Chloroethane
Chloroform
Chloromethane
1,1,2,2-Tetrachloroethane
Toluene
1,1,2-Trichloroethane
Trichloroethene
trans-1,2-Dichloroethene
Vinyl Acetate
2-Butanone
2-Hexanone
1,1-Dichloroethene
1,2-Dichloropropane
Benzene
Bromodichloromethane
Ethyl benzene
Carbon disulfide
Chlorobenzene
Methylene chloride
4-Methyl-2-pentanone
Styrene
Tetrachloroethene
1,1,1-Trichloroethane
1,1-Dichloroethane
1,2-Dichloroethane
Vinyl Chloride
Xylenes
2-Chloroethylvinylether

Polychlorinated Biphenyls (Method 8080)

PCB - 1016
PCB - 1232
PCB - 1248
PCB - 1260
PCB - 1221
PCB - 1242
PCB - 1254

Aromatic Volatiles (Method 8010)

Chloromethane
Bromomethane
Vinyl Chloride
Chloroethane
Methylene Chloride

Halogenated Volatiles (Method 8020)

Benzene
Toluene
Chlorobenzene
Ethylbenzene
Styrene

TABLE 4-3 (Continued)

LIST OF VOLATILE ORGANIC AND POLYCHLORINATED BIPHENYL COMPOUNDS

Aromatic Volatiles (Method 8010)

Trichlorofluoromethane
1,1-Dichloroethene
Trans-1,2-dichloroethene
Chloroform
1,2-Dichloroethane
1,1,1-Trichloroethane
Carbon Tetrachloride
Bromodichloromethane
1,2-Dichloropropane
Cis-1,3-dichloropropane
Trichloroethene
dibromochloromethane
1,1,2-Trichloroethane
Trans-1,3-dichloropropene
2-Chloroethylvinyl ether
Bromoform
Tetrachloroethene
1,1,2,2-Tetrachloroethane
Chlorobenzene
1,3-Dichlorobenzene
1,2-Dichlorobenzene
1,4-Dichlorobenzene

Halogenated Volatiles (Method 8020)

Xylenes
1,3-Dichlorobenzene
1,2-Dichlorobenzene
1,4-Dichlorobenzene

5.0 SAMPLING EQUIPMENT AND PROCEDURES

In order to achieve the objectives of the RCRA Facility Closure work and obtain site specific information, the following matrices will be investigated at the Seneca Falls, New York site:

- soil sampling (as part of the RFA, RFI and the Supplemental RFA)
- underground sewer leak test water sampling (as part of the RFA)
- groundwater sampling (as part of the RFI and Supplemental RFA)
- rinsate sampling (as part of the Supplemental RFA)
- background soil sampling (as part of the RFA)

The number and location of the samples from each matrix are presented below as described in the SVWP, Vol. II, Section 4.0, the SSVWP, Section 4.0 and the RFIWP, Section 5.0 and as summarized from Tables 2-1, 2-2, and 2-3 of this document. The total number of samples presented below indicate the number of environmental samples for each matrix and sampling area, not counting related quality control samples (duplicates and blanks).

Area	Number of Samples	Matrix
SVWP		
Interim Storage Area - S01D	5	Soil
Open Burning Area	30**	Soil
PCB Capacitor Storage Area	10	Soil
Fuel Oil Loading Dock	7	Soil
Underground Fuel Oil Tank	9	Soil
Underground Sewer Leak Test Water in Outside Lift Station and Effluent Lines	11	Rinse Water
Background Soil Sampling	18	Soil

SSVWP		
Outfalls 1-7 Sewer Line Areas	63	Soil
Underground Storage Tanks (USTs) 1, 2, and 5-9 & 11 Previously Containing Methanol, Gasoline, Diesel Fuel, and #2 Oil	60	Soil
Rinsate Samples for Various Process Holding Tanks & Equipment	19	Rinse Water
Hydrofluoric Acid Barrel Storage Area	6	Soil
Long-Term Groundwater Monitoring	159*	Groundwater
Soil Borings for Long-Term Monitoring Wells	23	Soil
RFIWP		
Groundwater Investigation near MW-1	56-68*	Groundwater
Soil Investigation of Shallow MW-1 Monitoring Wells	6-36*	Soil

* Represents the maximum number of samples possible for this area and media.

The Primary Storage Areas are being closed in accordance with the Closure Plan developed for those areas. The Interim Storage Areas, Open Burning Area, PCB Capacitor Storage Area, Fuel Oil Loading Area, Underground Fuel Oil Tank and the Sewer Line and Sump Leak Tests are being evaluated during the RCRA Facility Assessment. The remaining 8 Underground Storage Tanks (USTs) Areas, the Outside Sewer Areas, the Hydrofluoric Acid Barrel Storage Area, the Groundwater Monitoring Background Sampling, and the Escarpment Outfall Areas are being evaluated during the Supplemental RCRA Facility Assessment. This document serves as the Quality Assurance Project Plan (QAPjP) for all three of these programs.

5.1 Sample Identification System

Each sample collected at the Philips site will be assigned a unique sample tracking number. The sample tracking number will consist of a three-segment alphanumeric code, which identifies the site or sampling area, the sample matrix, the sampling location, and the specific sample type. Any other pertinent information regarding sample identification will be recorded in field sampling logbooks. The alphanumeric code used in the sample identification system is explained in the following diagrams and subsequent designations.

(First Segment)		(Second Segment)		(Third Segment)	
AAA(A)	-	AAN	-	NN	A
Specific Location		Sample Matrix or Boring (if applicable)		sample event	sample qualifier (optional)

A - Alpha designation
N - Numeric designation

Specific Location:

The location of a given sample will be a unique abbreviation based on the name of the area sampled (i.e, OBA - Open Burning Area, etc.).

Sample Matrix:

SB - Soil boring
GW - Groundwater
SR - Sewer rinse test water
RB - Rinsate blank
TB - Trip blank
FB - Field blank

The numeric designation for sample matrix may apply to groundwater samples to designate the appropriate quarterly sampling round or to soil boring samples to designate the boring number for the sampling area.

Sampling Event:

Sampling events will be numbered in sequence beginning with "01". This also may indicate the number of samples taken from that location. For example, if soil boring samples are taken at two depths from the same boring SB1, they would be designated as SB1-01 and SB1-02.

Sample Qualifier:

A sample may have a qualifier "D" to indicate that the sample is a field duplicate (or split) of the original sample taken at a specific location.

An example of a sample identification number for a subsurface soil sample collected at area SO1D for the first time at the first boring is as follows:

SO1D-SB1-01

It's duplicate sample would be:

SO1D-SB1-O1D

A first sample from the same area but different boring would be identified as:

SO1D-SB2-01

Labeling a sample in this fashion allows for identification and sorting by data manipulating computer programs and easy identification by the end user.

5.1.1 Sample Labeling

Each sample container will be marked with a color coded label identifying the specific parameters of interest. The label will record the date of sample collection, alphanumeric identification, parameters to be analyzed, and preservatives, if applicable. Sample bottles will be prelabelled by the laboratory to avoid unnecessary delays.

5.2 Sample Container and Equipment Preparation

The following procedures for the sample container and equipment preparation (and decontamination) will be performed during all phases of each investigation. Quality assurance measures will be employed to ensure the cleanliness of the containers and equipment.

Demonstrated Analyte-Free Water

Water that will be used for the preparation of blanks and for decontaminating sampling equipment and containers must be ASTM II deionized water demonstrated to be analyte-free. The criteria for analyte-free water are the Method Detection Limits as stipulated in SW-846 for the most sensitive method to detect the analytes of concern. Specifically for the common laboratory contaminants (Methylene Chloride, Acetone, Toluene, 2-Butanone, and Phthalate esters), the limits are set at three times the respective MDLs determined by the most sensitive analytical method. This preparation and demonstration of analyte-free water will be performed by Keystone's Analytical Laboratory prior to the field team's departure for the site sampling visit.

5.2.1 Sample Container Preparation

All sample containers required for this project will be new and precleaned by the bottle vendor according to NYSDEC protocol (as outlined in Table 5-1), and will not be reused. Certification for the use of required cleaning procedures is presented in Appendix D.

The cleanliness of a batch of precleaned bottles is verified by the use of a trip blank. The trip blank is prepared by filling a batch of precleaned bottles with demonstrated analyte-free water. The bottles are transported to the site and returned to the laboratory in the same manner as the field samples. Any constituents found in the trip blank could be attributed to interaction between the sample and the container or a handling procedure which alters the sample. Trip blanks will only be collected with volatile organic analysis samples. The estimated number of trip blanks for the RFI investigation is presented in Table 2-2.

5.2.2 Equipment Cleaning Procedures

Equipment prepared in Keystone's laboratory will be cleaned following the procedures outlined below. Cleaning and/or decontamination performed in the field will comply with NYSDEC protocol. The field decontamination procedures will be outlined in the specific sub-sections of this section.

Stainless Steel Bailer and Funnel Preparation

1. All dedicated stainless steel bailers and porcelain buchner funnels are cleaned and prepared after each use by following the procedures below:

    A) Wash with tap water and non-phosphate detergent.
    B) Tap water rinsed, 3 times with hot water.
    C) Rinse with a 10% nitric acid solution.
    D) Rinse with tap water four times.
    E) * Rinse with pesticide grade methanol, acetone, and finally methanol again.
    F) Rinse with demonstrated analyte-free water.
    G) Heat for one hour at 800 degrees Fahrenheit.
    H) Wrap in aluminum foil.

    * If laboratory analyses of samples is to include methanol, then pesticide grade hexane will be substituted for the methanol in the equipment preparation procedure.

2. All miscellaneous equipment such as shovels, soil trowels, and stainless steel parts of other pieces of equipment are cleaned using the procedures A) through F) outlined above, air dried and wrapped with aluminum foil and polyethylene.

To verify that no contaminants are introduced from sampling equipment, an equipment rinsate blank is collected by filling or pumping distilled water demonstrated to be analyte-free through the sampling device and analyzing the water for the compounds of interest. One rinsate blank is collected each day sampling is performed on one piece of equipment per batch of equipment type cleaned.

5.3 Underground Sewer Leak Test Water Sampling

The Outside Lift Station No. 1 sump and the underground pipe lines connecting to the sump will be static leak tested. The 75 foot long and the 300 foot long sections of 6" RCP pipe from the Wastewater Treatment Plant (WTP) to the first manhole and from the first to the second manhole will be retested for static water leakage in accordance with the procedure in the Sewer Evaluation Report. The sewer lines from building 13 and 13A will be flushed, blocked, and then filled with cement to their respective outside lift station drain locations at the flange. A 6" fluid flange with a 2" pipe connection and ball valve will be installed in the eccentric position into the lift station end of the lines. The 6" RCP lines from the Wastewater Treatment Plant (WTP) to the first manhole and from the first manhole to second manhole will be blocked and fitted with a valve as described above at their respective manhole drains.

After the leak tests, the water drained from the sewer to the Outside Lift Station No. 1 sump and from the two 6" RCP pipe sections to the end manhole will be representatively sampled and submitted for analysis of the parameters listed in Table 2-2. The samples will be collected as grab samples from the ball valves as the lines are being drained.

The leak test will be securely contained until the analysis of the water are available and a disposal option can be chosen.

The sample containers for the sewer leak test rinse water will be precleaned and prepared according to the procedures outlined on Table 5-1. All samples will be handled and shipped in accordance with the sample handling and chain-of-custody procedures outlined in Sections 5.7 and 5.8.

5.4 Soil Sampling

Soil boring samples will be collected using split spoon sampling techniques following hollow-stem augering as described in Appendix C of this document (Standard Operating Procedure EXP-3, Soil and Borings; Standard Operating Procedure EXP-4, Soil and Rock Boring Sample Logging; or Standard Operating Procedure EXP-5, Subsurface Soil Sampling, as applicable). There is also provisions in SOP EXP-3 for hand drilling and sampling which may be applicable to these investigations. The soil samples will be collected from the areas shown in Section 5.0.

The number of samples to be collected, location and depth of sampling, and analytical parameters of interest for each sampling area will be in accordance with the procedures outlined in their respective work plans. The soil samples from each area will be analyzed for the parameters listed in Tables 2-1, 2-2, and 2-3.

All soil samples collected from the Open Burning Area for the RFA and from the Shallow Monitoring Wells in MW-1 will be field screened (DQO Level I Screening) for volatile organics detected in the head space. Samples will be split into a 40 ml vial to be sent to a fixed base laboratory for GC analysis of volatiles and into a pint-size glass jar for headspace analysis. Prior to sending samples to the fixed base laboratory, the headspace results will be examined. If the total volatile organics detected is not greater than or equal to 5 ppm over background levels, the sample will not be sent to the fixed base laboratory. However, at least one sample per location will be analyzed by methods 8010 and 8020. The selected sample will be the one that shows the highest reading during head space measurements. Therefore, the number of samples for the soils in the Open Burning Area may range from 6 to 24 (not counting QA samples) and the number of samples for the soils in the Shallow Monitoring Wells may range from 6 to 30 (not counting QA samples) based on results detected in the headspace and the maximum number of locations determined in the SVWP and RFIWP, respectively. The exact procedure for

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performing the headspace analysis is described in the respective work plans. Instrument calibration is included here in Appendix D.

The soil samples from the MW-1 area monitoring wells will be taken during installation of the well "nests". Each well will be sampled, as described in the RFIWP, at five intervals during construction in order to characterize soil quality and the potential horizontal and vertical extent of site-related constituents of the area around MW-1.

For selected soil sample locations that are beneath a solid cover, such as asphalt, the cover will be removed in order to expose the soils to be sampled. Seams or fractures in these surfaces would be the appropriate location of the surface removal especially if evidence to a potential release is visible (staining).

The containers used to collect the soil samples will be precleaned and prepared in accordance with the procedures outlined in Table 5-1. The sampling devices will be cleaned between sampling events using the following procedures if both organic and inorganic analyses will be performed for the successive sample taken:

1) Wash equipment with tap water and non-phosphate detergent.
2) Rinse with tap water.
3) Rinse with 10% nitric acid solution.
4) Rinse several times with tap water.
5) Rinse with pesticide grade methanol, acetone, then methanol again .
6) Rinse with distilled and demonstrated analyte-free water.
7) Air dry and wrap in aluminum foil.

The drilling equipment will be steam cleaned between test borings.

If soil samples to be collected are going to be analyzed for inorganics only, procedure 5) will be eliminated for decontamination. If soil samples to be collected are going to be analyzed for organics only, procedure 3) will be eliminated for decontamination.

The soils will be field classified and logged according to Standard Operating Procedure EXP-4, Soil and Rock Sample Boring Logging.

Soil samples will be contained in new glass containers with screw-type lids, labelled, and shipped to the appropriate analytical laboratory. Sample preservation, shipment, handling, and chain-of-custody procedures will be conducted in accordance with the methods outlined in Sections 5.7 and 5.8. If the borings are not used for monitoring well construction, they will be filled from the bottom to the surface with a neat cement grout mixture.

Excess soil generated as a result of soil boring and well installation activities will be containerized and stored on site. Upon receipt of the soil analytical results, the final disposition of the excess soil will be determined.

5.5 Groundwater Sampling

Upon determination from the previous data collected, two or more well "nest(s)" will be installed in the area of MW-1 under the RFIWP. The results of the previous data collected will assist in determining the exact location of the well "nest". The well "nest" will consist of several monitoring wells installed at intervals from shallow to deep wells to assist in characterizing the stratigraphy and hydrogeologic and hydrogeochemical regimes present beneath the site. Groundwater samples will also be collected from the monitoring wells installed under the supplemental sampling visit work plan. Additionally, all monitoring wells currently being sampled quarterly will be included in this sampling and analysis program. The estimated number of samples and analyses to be performed is summarized in Table 2-2 and Table 2-3. All procedures for accurate, precise, and representative groundwater sampling are described in Keystone Environmental Resources, Inc., Standard Operating Procedures, Groundwater Sample Collection From Monitoring Wells #201 (Appendix E). The NYSDEC QAPjP Guidance Document Procedures will take precedence over any procedures outlined in this SOP.

Prior to implementing a groundwater monitoring program, several tasks must be performed. Sample bottles are precleaned as described in Table 5-1 and equipment are cleaned and packaged for the required sampling according to the procedures outlined in Section 5.2. The laboratory is notified of incoming samples to prepare for holding times of specific samples. All of the sampling equipment required to collect, contain, preserve, and ship the samples is packaged and organized to allow efficient operation in the field. Field decontamination equipment is also prepared to enable this work to be performed when required. All groundwater samples will be preserved, handled, and shipped in accordance with the NYSDEC RCRA Quality Assurance Project Plan Guidance as described in Sections 5.7 and 5.8 and in Table 5-1.

5.5.1 Groundwater Sampling Equipment Preparation

Prior to performing a groundwater sampling project, the equipment used to collect groundwater samples will be prepared in Keystone's Monroeville, PA laboratory, in accordance with those procedures outlined above in Section 5.2.

5.5.2 Bladder Pump Preparation

1. Each tubing line set is dedicated for use on one well only. The sets of tubing are packaged securely and marked for future use on the corresponding dedicated wells.

2. Each pump should be disassembled according to the manufacturer's manual.

3. The stainless steel parts of each pump are cleaned using the methods outlined in Section 5.2.

4. The remaining parts of each pump are washed with non-phosphate detergent, and rinsed with distilled water.

5. Each pump is reassembled, wrapped in aluminum foil (shiny side out), covered with plastic, and stored for future use.

5.5.3 Water Level Measurement

Water levels in monitoring wells must be measured before the wells are purged and sampled. There are several methods used by Keystone when measuring the water levels of wells. The following methods are listed in order of preference. Preferred methods will obtain accurate water level and depth measurements, will be easy to decontaminate, and will eliminate the chance of cross contamination.

Regardless of the method of water level measurement, the upgradient well(s) should be measured prior to the downgradient. When performed in conjunction with decontaminating the measuring device between wells, the potential for cross contamination will be further reduced.

Prior to water level measurement, the following steps should be performed to ensure uncontaminated, reproducible and accurate water level measurements are taken.

a. Unlock and/or open the monitoring well. Enter a description of condition of the security system and protective casing in the field notebook or on the field data sheet.

b. Cut a slit in one side of a plastic sheet and slip it over and around the well, creating a clean surface onto which the sampling equipment can be placed. This clean work area should be a minimum of eight square feet. Care should be taken not to kick, transfer, drop, or in any way let soil or other materials fall onto this sheet unless it comes from inside the well.

c. Establish the measuring point for the well. The measuring point location should be clearly marked on the well casing or identified in previous sample collection records. The measuring point should be a point which is, or can easily be transposed vertically to the survey control point for the well. Record the measuring point location on the field data sheet or in the field notebook.

d. Measure the static water level to the nearest 0.01 foot using the applicable method, as described in the QAPjP.

Interface Probe Method

Interface probes are commonly used to detect the presence of any floating or sinking immiscible layers. However, they can also be used to detect the water levels inside wells. The following procedures describe the interface probe method.

1. The probe should be lowered slowly inside each well. When water is detected the probe will make a beeping noise to signify the beginning of the water level. When the beeping noise is heard, observe the calibrated drop line to determine the water level.

   If a solid tone is heard, continue lowering the probe (observing the calibrated drop line) until the steady tone stops. The measurement on the drop line between when the steady tone began and when it stopped will determine the thickness of the light phase immiscible layer.

   The procedure as described above can be used to determine the presence (and thickness) of dense phase (sinking) immiscible layers.

2. All measurements should be recorded to the nearest one hundredth of a foot.

3. The probe is decontaminated between each well by rinsing with distilled water demonstrated to be analyte-free.

Electric Probe Method

The following procedures describe the electric probe method of water level measurement.

1. Lower the weighted probe into the well casing (when the probe contacts water it will send a pulse to the above ground gauge which will be recorded by a movement of the gauge stick) and observe the calibrated drop line to determine the water level.

2. Mark the point on the cable at the surveyed point on the well, when the probe is touching the water. Measure the distance from the mark to the last foot mark and add this measurement to it to determine the water level.

3. The probe is decontaminated between each well by rinsing with distilled water demonstrated to be analyte-free.

5.5.4 Well Purging

All monitoring wells are purged prior to sample collection. Purging of each well will be performed from the top of the water column, using pumps or top filling stainless steel bailers. Wells will be purged until at least three casing volumes of water are removed from each well or until the pH, conductivity and temperature of the purge water has stabilized prior to sampling. The pH, conductivity and temperature field measurements will be recorded for each well included in the sampling program. The final measurement recorded during the purging process, to verify the stabilization of the water, shall be considered the record for the well. Low yielding wells should be purged to dryness once and allowed to recover sufficiently. Except for low yielding wells which may require additional time to recover, wells will be sampled within three hours of purging.

To calculate the amount of water to purge from each well the depth of standing water must be measured using one of the above noted procedures. In addition, the casing diameter of each well must be known. These measurements, along with the following appropriate numbers, must be inserted into Formula 1.0, to determine the specific conversion factor to be used on each size well.

Gallons of Water per Linear Foot of Casing Diameter:

1.5" = 0.1057
2.0" = 0.1623
4.0" = 0.6613
6.0" = 1.5003

Top Filling Stainless Steel Bailer Volume (per ft of bailer)

1 1/8" = 300 mls
1 1/2" = 425 mls
3.0" = 1850 mls

Formula 1.0

$$\frac{\text{Gallons of Water/linear ft. of casing diameter} \times 3785\ (\text{mls/gal})}{\text{volume of bailer}} \times 3$$

= conversion factor for each well being sampled

The conversion factor must be multiplied times the depth of standing water in each well to determine the number of bails which must be purged from each well. The following conversion factors are listed for the well diameters listed below:

Well Diameter	3 Casing Volumes Conversion
1.5"	4.007
2.0"	4.3363
4.0"	4.0589
6.0"	9.2086

5.5.4.1 Purging and Sampling Methods

Wells are purged and sampled by either hand bailing or pumping. The determination to purge a well using pumps or bailers is influenced by the amount of water to be removed from each well.

When possible, all samples are collected using bailers. Hand bailing for sample collection is preferred because bailers can be decontaminated much more carefully and readily than pumps. Also, since pumping rates are difficult to control and since most pumps operate through a pulsating action, the potential degassing of volatile organic concentrations may occur. Normally, pumps are used as sampling devices when bailers cannot be used as a result of well obstruction or the installation of submersible pumps. When a number of sampling rounds will take place, the same type of sampling equipment will be used to eliminate potential variability in sample collection technique.

5.5.4.2 Bailing

The following procedures are followed when wells are purged and samples are extracted using hand bailers.

1. Place plastic sheeting (or garbage bags) around the well casing to create a clean working surface.

2. Use a separate laboratory cleaned stainless steel bailer on each well for the required purging and sampling.

3. Follow Health and Safety Plan for Personal Protective Equipment.

4. Use a minimum of 10 feet of either stainless steel wire, teflon-coated stainless steel wire or polypropylene monofilament cord. Nylon cord may be used following a ten foot leader of the previously described materials.

    - Make sure the bailer is securely fastened.

- After removing the protective foil wrapping from the bailer, lower it into the well until it touches the bottom.
- Remove an additional length of cord and tie it securely to the well head to serve as a safety line for the bailer.

5. When raising the bailer, the cord is collected by hand, over the plastic sheeting.

6. Purged groundwater will be collected and drummed and stored on-site until groundwater analysis is completed.

7. As indicated, a separate laboratory-cleaned stainless steel bailer is used to collect samples from each monitoring well.

   - Samples are collected when the well recharges after purging.
   - All samples are collected according to their order of volatilization (see Table 5-2).
   - All volatile organic samples will be collected with laboratory cleaned bottom filling stainless steel bailers in conjunction with an emptying device, whenever analyzing for volatiles.
   - When sampling, all bailers should be gently lowered into the well to prevent degassification of volatile organic constituents which may be present in the well water.

5.5.4.3 Pumping

As noted above, when possible, pumps are not used to sample wells. However, there are circumstances when pumps are more effective purging devices than bailers. Also, in some instances pumps are the only means by which samples can be extracted from monitoring wells.

There are several pumps which Keystone uses to perform field work.

Peristaltic Pump:

Peristaltic pumps must be operated above ground next to the well being purged and are limited to purging depths of about 20.0 to 30.0 feet below ground surface. The following describes the appropriate procedures for using a peristaltic pump.

1. New nalgene suction line is used on each well being purged.

2. If a peristaltic pump is used to collect a sample, e.g., the well casing is bent preventing the passage of a bailer, new medical grade silicon pump head tubing and teflon tubing is used to collect the sample.

3. The suction line should be lowered to a depth in the water column to assure continued collection should drawdown of the water column occur.

4. To determine the proper amount of water to be purged, the pumping rate will be measured in gallons per minute by recording the time required to fill a selected volume of a calibrated bucket (see above Section 5.6.4 on Well Purging). Flow measurements should be performed three times on each well to obtain an average rate.

5. The pumping is monitored to ensure proper pump operation and assure continuous discharge. If drawdown occurs, the tubing will be lowered deeper into the water column.

6. When the required amount of water is purged from each well, allow for sufficient recovery before sampling.

7. Contain all purge water, as appropriate, in labelled containers for future testing, treatment and/or disposal. All tubing is disposed of after each use.

Bladder Pumps:

The bladder pump is a gas operated positive displacement submersible well pump that uses inert compressed gas, e.g., nitrogen, to inflate an internal bladder which pumps water up the polyethylene discharge line.

These pumps are used when large volumes of water must be purged from monitoring wells. Usually these pumps are used on wells with diameters greater than 2.0" and wells with depths up to 150 feet.

The line assembly is dedicated for use on one well only. After use, the polyethylene tubing is wrapped in a spool, marked, and stored for future use in the specific well to which it is dedicated.

The bladder pumps are primarily used to remove the required amount of water from the monitoring well prior to sampling. When this is accomplished, the well water is sampled using a laboratory cleaned stainless steel bailer. The following describes the appropriate procedure for using a bladder pump.

1. Connect the line assembly to the pump by first attaching the cable and then connecting the sample and gas lines.
2. Lower the pump down the well by unrolling the line off of the spool until the pump touches bottom. Raise the pump to the desired position inside the well allowing sufficient room for drawdown of the water column.
3. Secure the cable to hold the pump at the desired depth.
4. Connect the gas line to the control box. The discharge line should be placed in a container (e.g. 55-gallon drum) to collect the purged water.
5. Connect the gas supply to the control box and adjust the pressure according to the manufacturer's manual.

6. Turn on the control box and adjust the inflate delay to obtain the best pumping cycle.

7. The pumping rate should be calculated to determine the length of time the pump should run to purge the well. Field measurements of pH and specific conductance, or the calculation of three casing volumes (see Formula 1.0), may be used to determine when a sufficient amount of water has been purged.

8. When the required amount of water has been purged, the well should be sampled using a laboratory cleaned stainless steel bailer.

9. As noted, the tubing is used on one well only and after each sampling it is packed, sealed, and stored for future use on that well.

Submersible Pumps:

When wells are encountered with depths greater than 150 feet, stainless steel submersible pumps are used to purge the required amount of well water. When possible, the submersible pumping apparatus is pulled to allow for sampling with a laboratory cleaned stainless steel bailer. If this is not feasible, the submersible pump will remain intact and will be used to collect the sample.

When economically feasible, the submersible pumps will be dedicated to each well. However, in some cases this is not economically feasible and the same pump must be used in several wells. Every effort will be made to ensure that these pumps are used in wells containing similar constituent concentrations.

When the pumps must be reused, they will be steam cleaned between wells. If possible, the pumps will also be taken apart and cleaned. The stainless steel parts will be cleaned following procedures outlined above in Section 5.2. The remaining parts will be washed with non-phosphate detergent and rinsed with distilled water. The pumps will be reassembled and covered until the next use. The following describes the appropriate procedures for using the submersible pump.

1. The submersible pump and discharge line should be lowered to a depth in each well between the middle to bottom screened portion of each monitoring well. The nylon safety line should be secured to the well casing.

2. Connect the power cord to the power source (generator) and turn on the pump.

3. Continue to monitor the pumping rate and lower the line if drawdown of the water column occurs.

4. If the well is pumped to dryness, allow sufficient time for the well to recover. This time will vary depending on the characteristics of each well and the time required for recharging the well.

5. After this period the pump should be re-started and the total discharge volume should be measured to determine the rate of recharge.

6. Collect and contain all purged water, as appropriate, in labelled containers for future testing, treatment, and/or disposal.

5.6 Sample Preservation and Holding Times

All samples will be preserved and handled according to procedures described in Tables 5-1 and 5-3 in order to preserve accurate representativeness of the environmental samples. Sample preservation will be performed immediately after sample is placed in the appropriate container before it is sealed. Documentation of preservation will be entered in the field log book.

5.7 Shipment Documentation

The following sections describe appropriate procedures and/or uses of the chain-of-custody record, the chain-of-custody tag, and sample shipment.

5.7.1 Chain-of-Custody Record

A chain-of-custody record will be prepared for each ice chest containing samples. The chain-of-custody record will record all of the necessary information pertaining to the specific samples in that individual ice chest. This information includes: date and time of sample collection, sample location, parameters to be analyzed, and notes specific to the laboratory. When complete, the chain-of-custody records will be signed and relinquished by the designated field team leader. The original copy will be sealed in a plastic envelope and taped to the inside of the lid of the specific ice chest and will be sent to the laboratory performing the analyses and a copy of the chain-of-custody will be maintained by the field team. See Figure 5-2 for a copy of the chain-of-custody record used by Keystone Environmental Resources, Inc.

5.7.2 Chain-of-Custody Tag

After each ice chest containing samples is properly sealed, a metal chain-of-custody tag shall be fastened to the cooler opening to prevent potential sample tampering. The metal tag is numbered, and this number and the ice chest number will be written on the chain-of-custody record to document the sealing of the cooler. Evidence tape will be used to seal the opening of ice chests that are not equipped with straps to hold the metal chain-of-custody tags. These procedures shall be performed to document and ensure the integrity of the samples as they are shipped from the project site to the laboratory performing the analyses. Upon receipt at the lab, the integrity of each cooler will be examined and the chain-of-custody records will be reviewed. A copy of the chain-of-custody will be maintained by the field team and the original will always accompany the current custodial designee.

5.7.3 Sample Shipment

The samples will be packaged and shipped according to procedures described in Keystone Environmental Resources, Inc., Standard Operating Procedure, Packaging and Shipping of Samples #502 (Appendix F) via a commercial carrier if the laboratory performing the analyses is not in the vicinity of the project site. The shipping carrier and the determination to ship air freight (overnight or 2-day air) versus shipment via ground transportation is made by the field team designee. The decision will be based on the holding times of the samples, project deadlines, and efforts to reduce project costs.

5.8 Field Quality Assurance

One rinsate blank will be collected for the project specific parameters during the collection of the soil samples, the rinse water samples and the groundwater samples. The rinsate blank will be collected to determine whether any sampling device influenced the analytical results. The rinsate blank for the soil sample will be collected by pouring demonstrated analyte-free water over a laboratory cleaned hand trowel into the designated sampling containers. The rinsate blank for the rinse water will be collected by running demonstrated analyte-free water through new teflon tubing and into project specific sampling containers. The rinsate blank for the groundwater sampling event will be collected by pouring demonstrated analyte-free water into a laboratory cleaned stainless steel bailer and transferring the water into the designated sampling containers. The blank samples will be collected in the appropriate containers prepared according to specifications outlined in Table 5-1. Each blank will be analyzed for the parameters specific to the sampling event. Sample handling, preservation, and shipping will be identical to the procedures for their associated environmental samples as outlined in Sections 5.7 and 5.8.

One rinsate blank will be collected each day on one piece of equipment for each equipment type used. The number of rinsate blanks shown on Tables 2-1, 2-2, and 2-3 are only estimates. The actual number of rinsate blanks will be dependent on the type and number of samples collected per day.

One trip blank will accompany each shipment of vials to the laboratory for analysis of volatile organics for the groundwater sampling. The trip blank will be analyzed for the same parameters as the sample containers which they are accompanying. The trip blank containers will be prepared according to the procedures outlined in Table 5-1. The containers will be filled with demonstrated analyte-free water at Keystone's laboratory. The containers will be taken to the field where they will remain sealed. The trip blank samples will be placed first in the ice chest, then the project samples, and then the cooler will be delivered to the laboratory for analysis. This blank will determine whether proper container preparation and handling of the samples to be analyzed for volatile organics have occurred.

Trip blanks will be collected at a rate of 1 trip blank in 20 environmental samples or one per shipment or cooler, whichever is greater. The number of trip blanks shown on Tables 2-1, 2-2 and 2-3 are estimates based on the tentative number of samples to be taken for the groundwater screening and on the number of groundwater sampling rounds scheduled.

5.9 Safety Precautions

Site and media specific sampling health and safety requirements for all investigations at the Seneca Falls site are outlined in detail in the SVWP, Vol. III - Health and Safety Plan, May 1990. These requirements should be strictly adhered, whenever applicable.

Whenever sampling conditions are not specifically addressed in the Health and Safety Plan, all personnel performing field sampling work will comply with the EPA established minimum level D safety precautions, unless advised by the site's Health and Safety Officer. Level D protection includes wearing long sleeve shirts, long pants, goggles or safety glasses, hardhats, steel toe boots, and safety gloves. In addition, Keystone's Health and Safety officer will determine in advance, if additional safety equipment is required, for example tyvek suits and/or respirators.

5.10 Documentation

A number of documents must be completed before, during, and after each sampling project. These documents include analytical request forms, chain of custody sheets, any project notes pertaining to the sampling work, and sampling equipment checklists/pre-field punch list (when applicable). Additional documented information are used as reference during each phase of a project and they include sample holding times and sample preservation and containment records.

TABLE 5-1
SAMPLE CONTAINER CLEANING PROCEDURES AND SAMPLE PRESERVATION METHODS (OR PROCEDURES)

Parameter	Matrix	Preservative	Sample Container	Cleaning Procedure
Metals	water	HNO_3 to pH <2 and cool to 4°C	1 liter plastic	1
Volatile Organics	water	cool to 4°C	40 ml glass vial with teflon septum	2
Fluoride	water	cool to 4°C	500 ml plastic	3
Semi-Volatiles/ PCBs	water	cool to 4°C	1 liter amber glass	4
Metals	soil	none required	8 oz. glass container	1
Volatile Organics	soil	cool to 4°C	40 ml glass vial with teflon septum	2
Methanol	soil	cool to 4°C	4 oz. glass container	2
Fluoride	soil	cool to 4°C	8 oz. glass container	3
Semi-Volatiles/ PCBs	soil	cool to 4°C	8 oz. glass container	4

1. Use new bottle; wash container and closure with hot water using non-phosphate detergent; rinse 3 times with hot tap water; rinse with 1:1 nitric acid and drain; rinse with demonstrated analyte-free water and drain thoroughly; air dry; and cap.

2. Use new bottle; wash containers and closure with hot tap water using non-phosphate detergent; rinse, three times with hot tap water; rinse three times again with demonstrated analyte-free water; oven dry containers, septa and liners at 105 °C for one hour; air dry caps; and cap while hot.

3. No cleaning required. Use new bottle depending on quantities required by the laboratory for analysis.

4. Use new 1 liter amber glass or 80 oz. jar for water and 8 oz jar for soils; wash container and closure with hot tap water using non-phosphate detergent; hot tap water rinse three times; rinse jar and teflon lined closure with pesticide grade acetone followed by a hexane rinse; rinse three times with demonstrated analyte-free water; oven dry for one hour at 105 °C (containers); air dry caps, and cap when dry.

NYSDEC. RCRA Quality Assurance Project Plan Guidance Document. January 19, 1990.

Federal Register, Vol. 49, No. 29, 1984, p. 43260.

U.S. EPA. 1982. Test Methods for Evaluating Solid Waste. 3rd ed.SW-846.

TABLE 5-2

ORDER OF VOLATILIZATION

Water samples are collected according to the following order of volatilization as referenced in the September, 1986 RCRA TEGD:

- Volatile Organic Compounds (VOCs) - No air bubbles
- Semivolatile Organic / Polychlorinated Biphenyls
- Fluoride / Metals

There is not an order of preference for the collection of any remaining miscellaneous parameters. However, pH and specific conductance measurements should be performed to check the stability of the water sampled.

TABLE 5-3

HOLDING TIMES

Parameter	Holding Time*
Volatile Organics / Methanol	Within 7 days of collection for soils, Within 7 days of collection for waters, unless acidified, then 14 days.
Semi-volatiles / PCBs	Within 7 days of collection (for extraction) of water, Within 40 days of extraction (for analysis) of water. Within 14 days of collection (for extraction) of soils, Within 40 days of collection (for analysis) of soils.
Metals	Within 180 days of collection
Fluoride	Within 28 days of collection
pH, Specific Conductance	Immediately after sample collection

* (Federal Register, Vol. 49, No. 29, 1984, p. 43260)

U.S. Environmental Protection Agency. 1986. Test Methods for Evaluating Solid Waste. 3rd ed. SW-846.

U.S. Environmental Protection Agency. September, 1986. RCRA Technical Enforcement Guidance Document.

NYSDEC. January 19, 1990. RCRA Quality Assurance Project Plan Guidance.

FIGURE 5-1

ANALYTICAL REQUEST FORM

Request Taken By: ______________________ Request Date: ______________

Client: ______________________ Project Manager: ______________

Client Contact: ______________________ Telephone: ______________

Address: ______________________

____

______________________ Start Date: ______________

____

Telephone: ______________________

NO. OF SAMPLES	MATRIX	ANALYTICAL PARAMETERS	TURNAROUND TIME, DAYS

APPLICATION : ☐ NPDES ☐ SDWA ☐ RCRA ☐ Superfund ☐ Other

Special Instructions: ____

____

____

____

____

____

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[illegible]

KEYSTONE
ENVIRONMENTAL RESOURCES, INC.

CHAIN OF CUSTODY RECORD

PLANT CODE	PROJECT NAME
SAMPLERS *(Signature)*	

STA. NO.	DATE	TIME	COMP	GRAB	WELL	STATION LOCATION	NUMBER OF CONTAINERS									CONDUCTIVITY	pH	REMARKS OR OBSERVATIONS

Relinquished by: ***(Signature)***	**Date**	**Time**	**Received by:** ***(Signature)***	**Reliquished by:** ***(Signature)***		**Date**	**Time**	**Received by:** ***(Signature)***
Relinquished by: ***(Signature)***	**Date**	**Time**	**Received by:** ***(Signature)***	**Reliquished by:** ***(Signature)***		**Date**	**Time**	**Received by:** ***(Signature)***
Reliquished by: ***(Signature)***	**Date**	**Time**	**Received for Laboratory by:** ***(Signature)***	**Date**	**Time**	Ice Chest Temp °C	Ice Chest #	Chain of Custody Tag #

***DISTRIBUTION: Original accompanies shipment; Copy to Coordinator Field Files.**

PAGE ____ OF ____

FIGURE 5-2

FIGURE 5-3

Revised: EXAMPLE
Plant Name: ABCDE
Charge #: 111111-11-11
Wells: R-1, R-7, R-8, R-8B, R-9, R-9C, R-9D, R-10, SF-1, SF-2, SF-3, SF-4
Copy Reports To: X. Smith, Y. Smith, Z. Smith
Turnaround: Normal
Sampling Dates: Quarterly

The following is a list of parameters for which samples are analyzed:

Field Meas.

pH(4X)
Cond.(4X)

Other

EPA 8310
EPA 8040
Tox(4X)

NaHSO4

TOC(4X)

NOTES: TOC, TOX, pH, and Cond. get replicated 4x for all wells.
* prepare an additional TOX bottle for all wells being replicated 4x.

DO NOT FILTER ANY PARAMETERS.

THIS IS AN EXAMPLE COPY OF A COMPUTER GENERATED PRINTOUT.

KEYSTONE ENVIRONMENTAL RESOURCES, INC.

FIELD DATA SHEET FOR GROUNDWATER SAMPLING

PLANT:

PROJECT:

DATE OF WATER LEVELS:

DATE OF SAMPLING:

SAMPLING METHOD:

SAMPLED BY:

WEATHER:

Site No.	Time	Well Dia. (in.)	Depth of Well (ft) (including stickup)	Depth to H₂O in Well (ft)	Depth of H₂O in Well (ft)	Number of Bails Removed	Dry at Number of Bails Removed	In-situ Measurements								
								pH (units)				Conductivity (umhos/cm)				Temp. (C°)

SITE NO.	OBSERVATIONS

Page____of____

FIGURE 5-4

Figure 5-5

SAMPLING VISIT - SAMPLING EQUIPMENT CHECKLIST

PHILIPS DISPLAY COMPONENTS CORPORATION
SENECA FALLS, NEW YORK

SAMPLING AND TESTING EQUIPMENT

Out In

___ ___ Water level meter with spare batteries (1)

___ ___ pH meter with spare batteries and spare electrode, buffers (1)

___ ___ Conductivity meter with spare batteries (1), standard solution

___ ___ Hnu meter, fully charged and calibrated

___ ___ Camera (35mm) wth film

___ ___ Field thermometers (2)

___ ___ Six foot folding rule

___ ___ Squeeze bottles (2)

___ ___ Plastic bucket, calibrated (2)

___ ___ Containers (wide mouth) for pH, specific conductance (8)

___ ___ Plastic Sheets

___ ___ Soil Sampling Knife

___ ___ Spare bailer with rope (200 feet) (Note: Philips has Dedicated Bailers)

STATIONERY SUPPLIES

___ ___ Field log book

___ ___ Field Log Forms (12)

___ ___ Field Punch List (1)

___ ___ Chain of Custody Forms

___ ___ Analyses Request Sheets

___ ___ Project Site Maps

___ ___ Plastic Leakproof Bags

MISCELLANEOUS

___ ___ Tyvek Coveralls (30 Pair)

___ ___ Gloves (latex)

___ ___ Gloves (nitrile)

___ ___ Custody Seals (10)

___ ___ Permanent Ink Markers (3)

___ ___ Calculator

___ ___ Rain Gear

___ ___ Rubber Boots

___ ___ Tools

___ ___ Flashlight

___ ___ Watch

___ ___ Well Keys

___ ___ Ice (obtain near site)

___ ___ Distilled Water (Demonstrated to be analyte-free by analytical laboratory)

___ ___ Methanol and Acetone Rinses (2 bottles each)

___ ___ Nitric Acid (10%) Rinse (2 botles)

___ ___ Paper towels

___ ___ Personnel protective equipment (including hard hat, steel toed boots, safety glasses, respirator, etc.)

SUBCONTRACTOR SUPPLIED EQUIPMENT

Drilling equipment

Soil gas survey equipment

____
Team Leader Date

Figure 5-6

OFFICE PUNCH LIST

PROJECT: ____________________

SAMPLING DATES: ____________________

	PRE-TRIP TASKS	**INITIALS**	**DATE**
1.	Review Site Specific Field Sampling Manual........	______	______
2.	Review Site Specific Health & Safety Plan or Other Approved Document................................	______	______
3.	Notify Analytical Laboratory....................................	______	______
4.	Notify Designated Plant Personnel of Sampling Event..	______	______
5.	Prepare Sample Bottles and Shipping Containers (See Field Information Sheet)................................	______	______
6.	Identify Quality Assurance Samples and Locations..	______	______
7.	Assemble Sampling Equipment and Completed Equipment Checklist (See Equipment Checklist)......................................	______	______
8.	Perform Laboratory Calibrations and Precision of Field Meters...	______	______
	a. pH Meter..	______	______
	b. Conductivity Meter..	______	______
	c. Field Calibration Solutions............................	______	______
9.	Assemble Necessary Forms	______	______
	a. Field Log Book..	______	______
	b. Field Punch List	______	______
	c. Chain of Custody	______	______
	d. Copy of Analytical Request Sheet (Approved)	______	______
	e. Field Information Sheet (Approved)............	______	______
10.	Review Sampling Procedures with Project Team.	______	______

Approved By ______ Date ______

	POST-TRIP TASKS	**INITIALS**	**DATE**
1.	Complete Field Notes...	______	______
2.	Complete Trip Report..	______	______
3.	Deliver Trip Report and Field Notes to Project Mgr.	______	______

Approved By ______ Date ______

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6.0 SAMPLE CUSTODY

The primary objective of sample custody is to create an accurate written verified record, which can be used to trace the possession and handling of the samples from the moment of collection through data analysis and reporting. A sample is under a person's custody if:

a. it is in the person's possession, or

b. it is in the person's view, after being in the person's possession, or

c. it was in the person's possession and the person locked it up, or

d. it is in a designated secure area.

6.1 Field Sample Documentation

The Team Leader will be personally responsible for the care and custody of the samples until they are properly transferred or dispatched. Samples will be accompanied by the Chain-of-Custody Record (see Figure 5-2). When transferring possession of the samples, the individuals relinquishing and receiving will sign, date, and note the time on the Record, with a separate Chain-of-Custody Record accompanying each shipping container.

In cases where samples leave the originator's immediate control, such as shipment to the laboratory by a common carrier (e.g., Federal Express) a seal is provided on the shipping container to document the integrity of the samples during transportation. Any shipping containers that do not arrive at the laboratory with the seal intact will not be considered to have been in valid custody. Before each container is sealed for shipment, it is packed with ice or coolant so that the temperature inside the container is 4°C. The temperature is checked in the field and is recorded on the Chain-of-Custody Record.

6.2 Laboratory Sample Documentation

Upon arrival at the laboratory, samples will be checked in by the Sample/Analysis Coordinator or his designate utilizing Keystone's Sample Shipment Checklist (Figure 6-1). The following procedures will be followed:

a) The Sample/Analysis coordinator will first examine whether the shipping container seals are intact or broken. Containers with broken seals will not be accepted for analysis.

b) Coolers will be opened and it shall be determined if proper temperature has been maintained during shipment. The temperature is recorded on the Chain-of-Custody Record upon receipt.

c) If samples have been damaged during shipment, the remaining samples shall be carefully examined to determine whether they were affected. Any affected samples also shall be considered damaged. It will be noted on the Chain-of-Custody Record that specific samples were damaged and that the samples were removed from the sampling program. Field personnel will be notified as soon as possible that samples were damaged and that they must be resampled, or the testing program changed.

d) The identity of the samples received will be compared against those listed on the Chain-of-Custody Record. Verification of sample holding times will be done and samples will be checked to assure that holding times have not been exceeded. Individual parameters' holding times are presented in Table 5-3. Results from analyses performed after the appropriate holding times should be considered suspect.

e) The Sample/Analysis Coordinator will sign and date the Chain-of-Custody Record and attach any waybill to the Chain-of-Custody Record.

Keystone's Analytical Division's LIMS (Laboratory Information Management System) computer is an integral part of the sample custody procedure. Upon verification of sample receipt at the laboratory, the Sample/Analysis Coordinator will assign a unique nine character laboratory ID number to the sample for entry into the LIMS computer.

The first character, an alphanumeric, designates either the Keystone Monroeville (M) or Houston (H) analytical laboratory. The next two characters reference the year, the next two characters indicate the month, the next the sequential work order (by cooler) received by the laboratory in that month, and the last three characters represent the number of samples received from that site in the individual cooler. For example:

M	90	-	08	■	1	001
lab designation	year		month		work order sequence	sample number

Once samples have been logged-in and transferred to the proper storage areas, the laboratory department manager is responsible for their proper storage and condition.

Each department manager shall be given Laboratory Sample Chronicles (see Figures 6-2 and 6-3 for examples of inorganic chronicles used by the Keystone-Monroeville Laboratory) which lists the laboratory sample identification, matrix, parameters for analysis, and required completion date. These forms will be used to document sample custody while the samples are in-house. All Chain-of-Custody Records and Sample Chronicles will be kept on file by the Manager of Quality Assurance.

Whenever data are transferred to the data user, along with the analytical data is a log indicating the laboratory tracking identification number and the corresponding field identification number for each sample (as described in Section 5.1).

FIGURE 6-1
KEYSTONE

☐ Houston ☐ Monroeville ☐ Ontario

sample shipment checklist

CLIENT: ______________ DATE SHIPPED: ______________
CLIENT CONTACT: ______________ DATE RECEIVED: ______________
TELEPHONE NO.: ______________ SHIPPED VIA: ______________
CHECKED BY: ______________

NUMBER OF SHIPPING CONTAINERS (COOLERS, BOXES, ETC.): ______________

CONTAINER ID	CUSTODY TAPE		TEMPERATURE C	NO. OF SAMPLE CONTAINERS	AGREE WITH COC? (Y/N)
	PRESENT? (Y/N)	INTACT? (Y/N)			

IRREGULARITIES

SAMPLE ID	SUB SAMPLE ID	IRREGULARITY

CHECKER SIGNATURE: ______________ DATE: ______________

RESOLUTION OF IRREGULARITIES WITH CLIENT

CLIENT REPRESENTATIVE: ______________ KEYSTONE REPRESENTATIVE: ______________
TELEPHONE NO.: ______________ DATE ______________ TIME ______________
WRITTEN FOLLOWUP (Y/N) ______________ DATE ______________
DECISION: ______________

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SIGNATURE ______________

FIGURE 6-2

ICP ANALYSES

CLIENT____________________ SAMPLE NUMBER____________________

WORK ORDER____________ MATRIX____________ WT/VOL DIGESTED____________

Analyses Requested		Due Dates	Samples Analyzed (X if all) Initials, Date	Rechecks, Comments
Aluminum				
Antimony				
Arsenic				
Barium				
Beryllium				
Cadmium				
Calcium				
Chromium				
Cobalt				
Copper				
Iron				
Lead				
Magnesium				
Manganese				
Mercury				
Nickel				
Potassium				
Selenium				
Silver				
Sodium				
Thallium				
Vanadium				
Zinc				
Other				

Comments:____

____

____

FIGURE 6-3

GRAPHITE FURNACE ANALYSIS

CLIENT__________________ SAMPLE NUMBERS________________

WORK ORDER______________ MATRIX_______________________

ANALYSES	DUE DATE	DATE OF ANALYSES, RECHECKS, DILUTIONS, MSA's,etc.
ARSENIC		
LEAD		
SELENIUM		
THALLIUM		
OTHER:		

COMMENTS:

7.0 ANALYTICAL PROCEDURES

All analyses will be performed using analytical procedures from either "Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods" (SW-846), Third Edition, 1986, incorporating any applicable latest available updates or "Methods for Chemical Analysis of Water and Wastes", March, 1983 except for the methanol analysis for soils and the leachate extractions of fluoride and metals in all soil samples collected utilizing Method 1312, Synthetic Precipitation Leaching Procedure from Update II of SW-846. The methanol analytical method for soil samples is a modified SW 8015 method and the summary of methodology and instrumentation is presented in Appendix G. The TPH Scan analytical method for soil samples is based on the New York State Department of Health method 310-13. The exact analytical procedures to be used are presented by media and analysis in Tables 2-1, 2-2, and 2-3. ok

The analytical procedures specified and detection limits from Keystone's Analytical Laboratory meet all requirements specified in the NYSDEC Quality Assurance Project Plan. As requested in comments by NYSDEC from Mr. Paul R. Counterman, P.E., Director of Bureau of Hazardous Waste Facility Management, in a letter dated December 22, 1989, soil sample instrument detection limits were evaluated for capability of comparison with U.S. EPA health based standards for carcinogens and systemic toxicants. All instrument detection limits were below standards except for Aroclor-1254 and Aroclor-1260, both of which were 100 ug/kg compared to the 91 ug/kg carcinogenic standard for soil ingestion, as submitted by NYSDEC. However, these are the lowest instrument detection limits available from Keystone Laboratory. In conversation with Mr. Victor Valaitis (NYSDEC) of May 4, 1990, Mr. Valaitis stated these will be reviewed and should be acceptable. ok All procedures for environmental sample analysis, handling, storage, preparation, and documentation while in the laboratory's custody and deliverable requirements upon delivery of the data to the user will be followed by Keystone personnel as stated in the Keystone Environmental Resources, Inc., Standard Operating Procedure, 10/85, Laboratory Standard Operating Procedures.

8.0 CALIBRATION CONTROLS AND FREQUENCY

All field and laboratory equipment is calibrated before use to ensure proper operating conditions. The following procedures are utilized for this purpose.

8.1 Field Instrumentation

For the headspace analysis of volatiles in soil samples collected in the Open Burning Area, an Organic Vapor Analyzer will be used to screen the samples. Associated calibration controls and frequency are described in Appendix D.

pH Meter

The initial calibration is performed with three standard buffer solutions reading pH 4.0, 7.0, and 9.0. The calibration is checked after every ten samples. In addition, the meter is checked with an outside calibration reference standard, and a post calibration is performed at the end of each day. If the check sample is out of range, the instrument is recalibrated and the frequency of checks is increased.

The pH meter is calibrated at least twice each day using two different pH buffer solutions. Rinse the probe thoroughly between buffer measurements with demonstrated analyte-free water and again after calibration is completed. Record on the field log the buffer used. To check the pH meter standardization, select a third pH buffer solution in the expected pH range of the well water samples and take a measurement. If the reading differs by more than 0.1 pH units from the standard, recalibrate the instrument. If unacceptable deviations still occur, consult the operating manual for a remedial course of action. At each well, check pH reading by measuring the pH value of a buffer solution in the expected range of the well water. If the reading deviates from the known value by more than 0.1 standard units, recalibrate the instrument as described above.

Conductivity Meter

The conductivity meter used does not have a designated calibration knob. The meter is checked prior to use with an outside calibration standard. If the standard is not within 10% of the true value, the instrument is not in calibration and a backup unit must be employed. The backup meter is also checked prior to use with an outside calibration standard.

The specific conductance/thermistor meter should not exhibit random fluctuations and will only require daily "red lining" and checks against a known KCl solution, which should be chosen to be within the expected conductivity range. Specific conductance is temperature-dependent and therefore the meter readings must be corrected for reporting to 25 degrees C based upon the temperature of the standard solution. Thoroughly rinse the probe with distilled water after immersing in KCl standard solution. In addition to daily standardization of the conductivity readings, the termistor readings also must be checked daily. This is accomplished by taking a temperature reading of the KCl standard solution with both the conductivity probe and a mercury thermometer.

All field instrument calibrations are recorded on a field instrument calibration sheet (Figure 8-1 is an example of a pH calibration sheet).

8.2 Laboratory Instrumentation - Inorganics

Atomic Absorption Spectrophotometer

The instrument is calibrated before each use with a reagent blank and three calibration standards. The first standard must be at the method detection limit. In order to verify the linearity of the curve, the regression coefficient must be at least 0.995. The calibration is next checked by the analysis of an Initial Calibration Verification (ICV). The results must be within 10% of the true value for the initial calibration to be verified. After every 10 analytical samples, and at the end of the run, a Continuing Calibration Verification (CCV) and Continuing Calibration Blank (CCB) are analyzed. If the CCB shows a result greater than the method detection limit, or if the reference standard differs from the true value by more than 10%, the previous samples are invalidated and must be reanalyzed. If an undiluted sample gives a response greater than the highest standard, the sample must be diluted and reanalyzed. If the diluted sample gives a response less than twice the method detection limit, the sample must be reanalyzed at a lesser dilution.

Inductively Coupled Plasma Spectrophotometer

The entrance slit to the photomultiplier tube is aligned by a monochrometer on a mercury line. The instrument is calibrated before each use with a reagent blank and a calibration standard containing all of the desired elements. The initial calibration is checked by the analysis of an ICV. The results must be within 10% of the true value for the initial calibration to be verified. In order to verify linearity near the detection limit, a standard containing the elements of interest at twice the method detection limit is analyzed at the beginning and end of each run. After every 10 analytical samples, and at the end of the run, the CCV and a CCB are analyzed. If the CCB shows a response greater than the method detection limit, or if the CCV differs from the true value by more than 10%, the previous samples are invalidated and must be reanalyzed. In order to verify the absence of interelement and background interferences, an interference check sample is analyzed at the beginning and end of each run. A list of the elements present in the interference check sample is given in Table 8-1.

8.3 Laboratory Instrumentation - Organics

Gas Chromatographic / Mass Spectrometry

The GC/MS system will be calibrated with a minimum of five concentration levels of calibration standard for each parameter to be analyzed in the sample. One of the concentrations of each standard will be slightly above the method detection limit . The other concentrations in the samples will be in the linear working range of the GC/MS system. Within each 12 hour period, calibration check standards will be analyzed to confirm the validity of the original five-point calibration curve for each constituent being analyzed. Calibration check compounds, concentrations, and procedures will confirm the applicable provisions of the latest protocol employed.

Gas Chromatographic / Liquid Chromatographic

These instruments are calibrated for the components of interest with a solvent blank and 3 or 5 calibration standards. The first standard must be at the method detection limit. In order to verify the linearity of the curve, the regression coefficient must be at least 0.995. The calibration is next checked by the analysis of an outside reference standard. If a supplied standard (NBS or EPA) is not available, an in-house solution containing a concentration different than those used to prepare the curve is used. The results obtained on the check standard must be within 20% of the true value for the initial calibration to be verified. After every ten samples, and at the end of the run, the mid-point standard is analyzed.

If the mid-point standard differs from the true value by more than 15%, the previous samples are invalidated and must be reanalyzed. If an undiluted sample gives a response greater than the highest standard, the sample must be diluted and reanalyzed. If the diluted sample gives a response less than twice the method detection limit, the sample must be reanalyzed at a lesser dilution.

8.4 Laboratory Instrumentation - Conventional Chemistries

Electrochemical Methods

An outside reference standard is analyzed with each batch of samples. Results must be within the value supplied with the standard. If acceptable results are not obtained on the reference sample, the previous samples are invalidated and must be reanalyzed.

8.5 Preparation of Standards

All analytical methods at some point must be validated by the use of calibration standards. A calibration standard is made by the appropriate dilution of a pure substance, the purity of which is traceable to NBS or EPA standard. Because of the high sensitivity of many analytical instruments, the calibration standard is an extremely dilute version of the pure compound. Because of the high dilution required, in order to be within the linear range of the instrument, the preparation of the calibration standard is frequently made by serial dilution rather than in a single step. In order to provide standard solutions at sufficiently low concentration, a miniscule amount of the pure substance will be required, the measurement of which is subject to extreme error. Thus, it is preferable to deal with potential dilution errors, rather than with the large error associated with the measurement of a vary small amount of the pure substance.

The initial standard is usually obtained either as a pure material or as a prepared certified solution of a given concentration of the pure compound or compounds. In preparing the stock solution of the calibration standard, great care must be exercised in measuring weights and volumes as accurately as possible, since all the analyses following the calibration will be based on the accuracy of the calibration, and the accuracy of the analytical data is dependent on the calibration curve. Table 8-2 summarizes the valid lifetime of primary and secondary standards used in many tests. These lifetimes should be taken as a guide only. It is the analyst's responsibility to assure that all standards used are within the standard solution holding time, and to prepare fresh standard solutions, whenever necessary. In preparing working solutions, or using working solutions, the analyst must check for signs of deterioration of the standard, such as the cloudiness, precipitation, or discoloration. The standard must also be periodically compared with previous runs of standards, and with independently prepared standards to assure that response factors fall within an historically accepted range.

All standards and standard solutions of organic compounds will be maintained in glass containers, and will be protected from light. The position of the meniscus in each container will be marked after each time that the container is opened, so that changes due to evaporation can be detected.

Metals and fluoride working solutions and stock solutions will be kept in polyethylene containers at room temperature. The position of the meniscus will be marked each time a solution is used to insure that concentration changes due to evaporation are detected.

Before using any standard solution, the analyst will examine it for signs of precipitation and changes in color. If precipitation has occurred, the solution will be discarded and a new standard prepared. Discoloration frequently is only a warning sign, but will not affect the results. If a solution is discolored, the analyst will compare the results with historically established response factors, to assure that the solution is still within the operating range of the method, and within experimental error of its original concentration.

For each stock standard solution that is prepared, accurate records will be kept in a special logbook used only for the maintenance of standards data. The following information will be entered in the logbook at the time of stock standard preparation:

a. Date of the standard preparation;
b. Application for which the standard is being prepared;
c. For each compound, the supplier of the primary standard, the batch number, and the amount taken;
d. The solvent identification (compound, supplier, batch number);
e. The final volume of the stock standard;
f. The identification number assigned to the stock standard preparation; and
g. The name of the analyst preparing the standard.

In preparing the diluted working standards, it is the analyst's responsibility to make sure that the stock standard is of valid vintage. The preparation of all working standards is also recorded in the logbook. The same information as the stock standard is recorded in the logbook.

The working standards for organic analysis will be stored in a freezer in the work area. No other samples or extracts will be stored in the same freezer. The working standards for metals will be stored in the work area in a cabinet or shelf designated for standards only. The metals standards do not need refrigeration. For other parameters, the working standards will be maintained in either a refrigerator or at room temperature in the work area, but at specifically designated cabinets or shelves, where no other materials are being stored.

8.6 Corrective Action

There are many laboratory functions which may require corrective action. The decision to undertake corrective action, and the ensuing action must be documented so that traceability can be maintained. The point of originating the corrective action varies, depending upon the mode of detection that such action is necessary. It is generally the role of either the QA/QC Manager or the Department Section Manager to initiate such action. Those actions that affect the quality of the data will be recorded and the record maintained by the QA/QC Manager. The procedures for appropriate corrective actions is detailed in Section 14.

8.7 Identification of Potential Problems

The QA/QC Manager will be responsible for informing the Section Manager and the Laboratory Director that a problem appears to exist in a particular type of analysis, and the data of that type of analysis will not be accepted until the problem is isolated and corrected. It will be the responsibility of the Section Manager to address the identification of the source of the problem, and the responsibility of the Laboratory Director to assure that the Section Manager is acting upon the need for corrective action.

In some situations, the need to correct an operation is apparent to the analyst, and does not originate from the data validation process. For example, instrumental failures are determined by the analyst, and the corrective action is taken in the form of repairing the instrument either through a service call or through the laboratory personnel. Such action must be recorded in the instrument maintenance log, and the QA/QC Manager will be informed of such action so that close scrutiny can be paid to the analyses preceding the instrumental failure. If these analyses met the required acceptance criteria, no further action will be taken relative to that data.

TABLE 8-1

INTERFERENT AND ANALYTE ELEMENTAL CONCENTRATIONS USED FOR ICP INTERFERENCE CHECK SAMPLE

Analytes	(mg/l)	Interferents	(mg/l)
Ag	1.0	Al	500
Ba	0.5	Ca	500
Cd	1.0	Fe	200
Co	0.5	Mg	500
Cr	0.5		
Cu	0.5		
Mn	0.5		
Ni	1.0		
Pb	1.0		
V	0.5		
Zn	1.0		

TABLE 8-2

STANDARDS AND SOLUTIONS HOLDING TIMES

MATERIAL	HOLDING TIME		
	Pure Compound	Stock Solution	Working Solution
Volatile organic compounds for GC or GC/MS analysis	1 Yr @ -10°C	2 Mo @ -10°C	1 Wk @ -10°C
Semivolatile organic compounds for GC or GC/MS analysis	1 Yr @ 4°C	1 Yr @ 4°C	6 Mo @ -10°C
Pesticide/PCBs	1 Yr @ 4°C	1 Yr @ 4°C	6 Mo @ -10°C
Metals for ICP analysis	Indef. @ RT	1 Yr @ RT	6 Mo @ RT
Metals for GFAA analysis	Indef. @ RT	1 Yr @ RT	6 Mo @ RT
Fluoride	Indef. @ RT	1 Yr @ 4°C	6 Mo @ 4°C

FIGURE 8-1

CALIBRATION SHEET

pH METER

Project: ______________________ Date: ______

Meter: ______________________

	Meter Reading	Buffer Solutions				Operator Initials
		4	7	9	Standard 6.5	
Initial Calibration	unadjusted					
	adjusted					
Calibration Check	unadjusted	■		■		
	adjusted	■		■		
	unadjusted	■		■		
	adjusted	■		■		
	unadjusted	■		■		
	adjusted	■		■		
Final Calibration	unadjusted					
	adjusted					

Calibration checks should be made after every 10 readings using the pH 7 buffer solution (unadjusted reading). If readings are within .1 unit of the solution no calibration adjustment is made, if greater than .1 a complete calibration is necessary (adjusted reading), if greater than .2 do a complete calibration and increase the frequency of calibration checks.

Operator Signature: ______________________

9.0 DATA REDUCTION, VALIDATION AND REPORTING

Data transfer and support are essential functions in summarizing information to support conclusions. It is essential that these processes are performed accurately and, in the case of data reduction, accepted statistical techniques are used.

9.1 Data Reduction

For most analyses, data reduction involves the comparison of samples to a standard reference curve. Samples (or extracts) are diluted within the concentration range of the curve. To verify the linearity of the curve, the linear regression coefficient is calculated according to the following equation:

$$r = \frac{N \Sigma X_i Y_i - (\Sigma X_i)(\Sigma Y_i)}{([N\Sigma X_i^2 - (\Sigma X_i)^2][N \Sigma Y_i^2 - (\Sigma Y_i)^2])^{1/2}}$$

The acceptable values for the regression coefficient were given in Section 8. The sample results are calculated according to the following formula:

$$y = mx + b$$

where y is the ordinate, x is the abscissa, m is the slope, and b is the y intercept.

Results from analyses that do not make use of a standard curve are calculated by the appropriate formula given in the method, taking the number of significant figures into account.

The digits in a number that are "significant" are comprised of those that are known with certainty, plus the first digit whose value is in doubt. For example, if three successive weighings of a sample yield the values 0.656, 0.658, and 0.662, the calculated average weight would be 0.658666. Obviously the weighings are not reliable in the third decimal place, so that the measurement contains three significant figures (two certain digits and one about which there is some doubt). The average, therefore, should contain the same number of significant figures and should be rounded off to 0.659. This rounding off is done according to the following rule: if the digit following the last significant figure is greater than 5, the significant figure is raised by 1; if less than 5, no change is made; if equal to 5, the last significant figure should be rounded up, if odd, and rounded down, if even. For example, 0.66050 would be 0.660 (three significant figures). Zeros following a number after the decimal are counted as significant figures (4.250 has four significant figures). Zeros preceding a number, or following a number before the decimal, are not counted. Thus, both 0.066 and 66,000 have only two significant figures, but 166.0, and 660.0 have four.

When making calculations involving measured values, results must be expressed so that they contain only the number of significant figures justified by the certainty of the original measurement. For example, addition or subtraction results are rounded off to the position of the number containing the least accurately known value: 13.4 + 1478.224 = 1491.624, rounded off to 1491.6. Multiplication or division results are expressed with the same number of significant figures as the least certain original value used in the calculation: 31 x 350.1 = 10,853.1, rounded off to 11,000.

All concentrations for analytical measurements, except for pH, will be reported in appropriate units of part per billion for solids (ug/kg) and liquids (ug/l) depending on the individual analytical instrument detection limits.

Some groundwater analyses will be performed using mass spectroscopic methods. The laboratory will utilize a library mass spectrum matching for verification of the accurate identification of individual analytes. If the data validator has the appropriate mass spectroscopic experience and can identify inaccurate library identifications, then action will be taken to accurately identify unknown or misidentified analytes.

Another potential problem for reduction of results pertains to the case of outlier values (reported outside the "expected" range of concentrations). Since many factors could potentially cause an outlier, including an actual real extreme result, any attempt to correct or remove outlier data values must be accompanied by validated documentation to prove that the data is not correct as presented.

9.2 Data Validation

All data obtained will be validated in four steps. First, during the field operations, field measures will be validated at the time of collection by the Team Leader by following standard procedures and using QC checks. Second, all laboratory analytical results will be validated by the laboratory designee who is the specific analytical task leader. Third, a laboratory designee, other than the analyst, who is independent of the analysis and the project will validate the data. Last, as requested by NYSDEC, twenty-five percent of all one-time collected analytical data collected will be validated by an independent third party.

ok

Field Data Validation

Validation of field obtained data as well as ongoing QA/QC checks of environmental samples being taken is performed on two levels. First, all data is reviewed during the time of collection and second, all data is reviewed by secondary field personnel. If the Team Leader is performing the initial review, a designee will do the secondary review. Otherwise, the Team Leader will perform the secondary review. In review of the field data, care will be taken to ensure correct codes, units, sample locations, as well as other pertinent information is included and correct. Any inconsistencies discovered will be resolved immediately, if possible.

Additionally, the Team Leader will be responsible for ensuring that accurate and correct data and representative samples are obtained by following field objectives as they are described in the respective work plans. It is important that the Team Leader makes sure the field team adheres to the approved work plans and follows QA/QC measures as outlined in this document including the proper calibration of instruments, sampling according to standard operating procedures, and taking of sufficient sample volume.

Laboratory Data Validation

The respective Laboratory Department Manager will validate all laboratory data, prior to reporting, originating from his or her section. Some of the following QA/QC measures are reviewed or procedures are used:

1) A standard curve is prepared prior to sample analysis.
2) The standard regression coefficient is within the acceptable range.
3) Standard reference materials are analyzed at proper frequencies and acceptable results are obtained.
4) The reagent blanks are analyzed at the proper frequency.
5) Precision requirements of this plan are met.
6) Accuracy requirements of this plan are met.
7) Completeness requirements of this plan are met.
8) Samples are analyzed within the proper sample holding times.
9) All calculations are verified as correct.
10) Proper units are reported.
11) The proper methodologies were used.

Besides this review of analytical results and project specific precision, accuracy, and completeness requirements, the Laboratory Department Manager will perform unannounced audits of report forms and other data sheets as well as daily reviews of instrument logs, performance test results, and analyst performance. Any review of analytical results or internal QA/QC checks that indicate problems, immediate corrective actions will be taken and all data collected since the previous approved QC audits will be reviewed for validity.

Independent Data Validation

All raw data is validated before reporting by the Laboratory Quality Assurance Manager or his designee, who is independent of the analyst and the project. The Laboratory QA Manager can be shown to be independent of the project as the data reviewed is only identified to laboratory personnel, except those who assemble data for reporting, by the laboratory's sample identification numbers. Thus, the Laboratory QA Manager or his designee will not know the identity of the site or sample locations and could not knowingly influence what was reported.

The Laboratory QA Manager must be independent of the analyst to preserve the integrity of the quality assurance review. However, additional steps are taken to ensure this integrity by the use of performance and system audits which are documented and reviewed by the Laboratory QA Manager and by the Laboratory Department Manager.

The validation performed by the independent data validator will be based on QA/QC and analytical results which are dependent on the analysis performed. Generally, these QA/QC checks include criteria such as holding times, instrument performance, calibrations, blanks, surrogate recoveries, and matrix spike/matrix spike duplicate recoveries to determine if problems exist with interferences or instrument problems which could affect accuracy and precision of the reported data.

Third Party Data Validation

The procedures to be followed for the required third party data validation are defined in Appendix H. Twenty-five percent of all one-time collected analytical data from the RFAWP, RFIWP, and RFA SSVWP will be independently validated by a qualified and experienced validation/subcontractor.

9.3 Data Reporting

Once the data have been validated by laboratory personnel, the results are entered into the LIMS system where they are stored prior to reporting. The data entered into the LIMS system is backed-up on cassette memory tapes approximately every 36 hours. In the event of a system failure or accident the data is re-entered from the validated reports. When all analyses are completed, the laboratory will issue a final report including the results of the validation reviews. The Laboratory QA Manager will check the final report to ensure that no errors have been made in transcription from the raw data. He will then issue the report to the Laboratory Manager for distribution. All applicable QC data (as shown in Section 10) are included with the final report. From there, the CLP-type analytical data packages will be submitted, as required to meet the 25% overall frequency, to the independent third party validator. The representative 25% will be arbitrarily selected, making sure all one-time sampling event analyses and sampling media are adequately represented.

As is specified in the NYSDEC QAPjP Guidance Document, only sample analyses collected under RFI and RFA investigations which are planning a one time sampling event require 3rd party data validation to ensure the validity of data collected. These one time events include soil sampling for the storage and open burning areas under the RFAWP, the soil borings around MW-1 under the RFIWP, and the UST soil borings and rinsate sampling under the RFA SSVWP.

The third party validators will return the data packagers with individual unbiased narratives reporting problems noted (including QC limit violations) and data usability recommendations. Any significant problems noted will be examined for the potential affect on other unvalidated data packages. If deemed necessary, other potentially affected data packages will be validated by the third party validators.

10.0 QUALITY CONTROL PROCEDURES

Quality control (QC) procedures and checks are used to verify the accuracy of investigation data. Field QC checks are used to identify potential problems with sampling procedures such as inconsistent use of standard operating procedures or field introduced sample or water supply contamination and/or problems with sample homogeneity or representativeness.

10.1 Field QC Checks

To check the quality of data from field sampling efforts, blanks and duplicate samples will be collected for analysis. These samples will be treated as separate samples for identification, logging, and shipping. Analytical results on blanks and duplicates will be reported with the appropriate field sample data.

Rinsate and Trip Blanks

All field blanks (trip and rinsate) are used to check for constituent contamination introduced by the bottle or the sampling environment (trip) or by the sampling equipment (rinsate). These QC checks are used to verify the validity of the field sampling effort. Their use was described in Section 5.9.

Duplicate (Split) Sample Collection and Analysis

A minimum of one of every 20 samples will be collected and analyzed in duplicate to evaluate the precision of both the collection and analytical procedures as described in the NYSDEC QAPjP Guidance. Duplicate samples (splits) will be collected by field personnel and submitted to the laboratory for analysis. The relative percent difference will be calculated from the duplicate analysis for the particular compounds of interest. Should the relative percent difference be excessive for the material analyzed and method used, other quality control parameters will be evaluated to determine whether the duplicates or the entire set needs to be reanalyzed.

10.2 Internal Laboratory QC Checks

The following internal laboratory QC checks are performed for most analyses to ensure the measurement systems are under control:

a) Initial and continuing calibration
b) Calibration check compounds and reagent blanks
c) Preparation blanks
d) Matrix spike and matrix spike duplicate analysis
e) Quality control charts
f) Surrogate spike standard performance evaluation

Initial and Continuing Calibration

Each measurement system must be calibrated immediately prior to use and be shown to maintain the calibration throughout the course of the analysis. Calibration procedures were discussed in Section 8 and are described in more detail in the respective analytical methodologies.

Calibration Check Compounds and Reagent Blank

The respective calibration check compounds and reagent blanks are analyzed periodically throughout the course of the analysis, depending on the required analysis. The exact frequencies and methods of use are described in more detail in the respective analytical methodologies.

Preparation Blanks

A preparation blank is run with each batch of samples received for analysis, depending on the analysis. Compound responses observed in the blank at levels above the reportable detection limit are reviewed for possible laboratory contamination. If high blank values are observed, laboratory glassware and reagents will be checked for contamination and the analysis of future samples halted until the system can be brought under control. A high blank value is defined as a value

- Recalculate or reinject/repurge the sample or extract or re-extract and reanalyze the sample.

If any of these measures listed above fails to correct the problem, the analytical system will be considered out of control and the problem must be corrected before continuing.

10.3 Organic Analyses - Gas Chromatographic (GC)

This section outlines the minimum quality control operations necessary to satisfy the analytical requirements associated with the determination of organic parameters using gas chromatographic techniques.

Initial Calibration Verification

In order to verify the linearity of the initial five point calibration curve (Section 8.3), the percent relative standard deviation (%RSD) between calibration factors must not differ by more than 20%. Alternatively, the linear regression coefficient must be at least 0.995.

Continuing Calibration Verification

The working calibration curve or calibration factor must be verified after every eight samples by the analysis of a continuing calibration verification solution (CCV). If the response for any analyte varies from the predicted response by more than ±15%, a new calibration curve must be prepared and all samples after the last good CCV reanalyzed.

Surrogate Spike Standard Performance Evaluation

Surrogate standards will be used for gas chromatographic procedures as described previously in Section 10.2. Surrogate compounds and recovery levels are given in the applicable methods.

Reagent Blank

Each batch of samples will be accompanied by a reagent blank. The reagent blank will be carried throughout the entire analytical procedure including sample preparation or extraction, as applicable, to check contamination introduced by exposure to the laboratory environment.

Matrix Spike/Matrix Spike Duplicate Analysis

These parameters will be run at the frequency as stated previously in Section 10.2 and will follow the procedures as shown in the applicable methods.

10.4 Organic Analyses - GC/Mass Spectrometry (GC/MS)

This section outlines the minimum quality control operations necessary to satisfy the analytical requirements associated with the determination of TCL volatile organics by GC/MS. At all times, the most current versions of the required protocol will be employed by the laboratory.

Tuning and GC/MS Mass Calibration

Prior to initiating data collection, it is necessary to establish that a given GC/MS meets the standard mass spectral abundance criteria. This is accomplished through the analysis of tuning compounds. The ion abundance criteria for each calibration compound should be met before any samples, blanks, or standards can be analyzed.

GC/MS Initial System Calibration

Prior to the analysis of samples and after tuning criteria have been met, the GC/MS system must be initially calibrated at a minimum of five concentrations to determine the linearity of response utilizing TCL compound standards. Once the system has been calibrated, the calibration must be verified each 12 hour time period for each GC/MS system.

A minimum of five different concentrations plus the three designated internal standards at constant concentrations will be used to develop the calibration curve. Once the initial calibration is validated, the average response factors and percent relative standard deviations for all TCL organic compounds will be calculated and reported.

System Performance Check Compound Response

A system performance check will be performed on the calibration curve before it is used. Performance check compounds are used to check compound instability and check for degradation caused by contaminated lines or active sites in the system and are usually the first to show poor performance and tend to decrease in response as the chromatographic system or the standard material begins to deteriorate. Therefore, they must meet the minimum requirements when the system is calibrated.

GC/MS Continuing System Calibration

Each 12 hours during sample analysis a continuing calibration standard will be run. The response factor data from the standards for each 12 hours will be compared with the average response factors from the initial calibration for each instrument. If the minimum response factors for individual compounds in the verification standard fall outside acceptable quality control criteria, appropriate corrective action will be taken prior to further sample analysis.

Calibration Check Compounds

After the system performance check is met, calibration check compounds are used to check the validity of the initial calibration. If the response for any calibration check compound varies from the calibrated response by more than the criteria limits, corrective action will be taken.

10.5 Metals by Inductively Coupled Plasma (ICP)

This section outlines the minimum quality assurance operations necessary to satisfy the analytical requirements associated with the determination of metals by ICP. At all times, the most current revisions of the applicable protocol will be implemented by the laboratory.

Initial Calibration and Continuing Calibration Verification

At the start of instrumental operation, the ICP will be calibrated according to the manufacturer's instructions and current protocol. Immediately after the ICP system has been calibrated, the accuracy of the initial calibration shall be verified and documented for every analyte by the analysis of EPA Initial Calibration Verification (ICV) Solution(s) at each wavelength used for analysis. When measurements exceed the control limits for inorganic analyses, the analysis must be terminated, the problem corrected, the instrument recalibrated, and the initial calibration reverified.

During continued analysis of metals by ICP a Continuing Calibration Verification (CCV) Solution(s) will be analyzed at each wavelength after every tenth sample. Each CCV analyzed must reflect the conditions of analysis of all associated analytical samples (the preceding 10 analytical samples or the preceding analytical samples up to the previous CCV).

If the deviation of the continuing calibration verification is greater than the control limits specified, the analysis must be stopped, the problem corrected, the instrument must be recalibrated, the continuing calibration verified and the reanalysis of the preceding 10 analytical samples or all analytical samples analyzed since the last good calibration verification must be performed for the analytes affected.

Preparation Blank Analysis

At least one preparation (or reagent) blank consisting of deionized distilled water processed through each sample preparation procedure (i.e., water, solids) will be analyzed with every 20 samples, or with each group of samples digested, whichever is more frequent. Specific procedures are detailed in the current protocol.

ICP Interference Check Sample Analysis

To verify inter-element and background correction factors, an ICP Interference Check Sample, Quality Control Sample and Linear Range Verification Sample, will be analyzed at least twice per eight hours of operation, or once during and again at the end of analysis. If these monitoring checks fall outside the allowable criteria, appropriate corrective action will be taken according to current protocol.

Matrix Spike Sample Analysis

Matrix spiked sample analysis is designed to provide information about the effect of sample matrix on the digestion and measurement methodology. The spike is added before the digestion and prior to any distillation steps. At least one spiked sample analysis will be performed on each group of samples of a similar matrix type (i.e., water, soil) and concentration (i.e., low, medium) for every 20 samples. Samples identified as field blanks cannot be used for spike sample analysis. Spike recovery limits range from 75-125 percent for metals as defined in the current protocol. If these limits are not obtained, appropriate action will be taken.

Duplicate Sample Analysis

At least one duplicate sample will be analyzed from each group of samples of a similar matrix type (i.e., water, soil) and concentration (i.e., low, medium) for every 20 samples. Samples identified as field blanks cannot be used for duplicate sample analysis. A control limit of 20% Relative Percent Difference shall be used for aqueous original and duplicate values greater than or equal to five times the detection limit. A control limit of (+/-) the detection limit must be used for sample values less than five times the detection limit.

10.6 Metals by Graphite Furnace Atomic Absorption (GFAA)

Graphite Furnace Atomic Absorption (GFAA) analysis will be performed on metals not amenable to analysis by ICP. These metals include arsenic, lead, selenium and thallium. The analysis of these metals by GFAA will be in accordance to current protocol.

All furnace analyses, except during Full Methods of Standard Addition (MSA), will require duplicate injections for which the average absorbance or "concentration" will be reported. All analyses will fall within the calibration range. The raw data package will contain both absorbance or "concentration" values, the average value and the relative standard deviation (%RSD) or coefficient of variance (CV). For concentrations greater than the CRDL, duplicate injection readings will agree within 20 percent RSD or CV, or the sample will be rerun once, as specified in current protocol.

All furnace analyses for each sample will require at least a single analytical spike to determine if the MSA will be required for quantification. The spike will be analyzed and prepared in accordance to current protocol. The quality assurance/quality control (QA/QC) procedures defined by the current protocol will be followed when performing the specified analysis.

An initial calibration curve will be established using a blank and a minimum of four standards of different concentrations. The calibration curve will be confirmed with a standard and reagent blank before sample analysis.

To assure instrumental stability, a calibration check will be run every 10 samples. If these instrument calibration checks should fall outside allowable criteria, the instrument will be recalibrated and all preceding samples, to a prior good calibration, will be reanalyzed.

The GFAA analysis will include at least one reagent blank, before the digestion sample spike and sample duplicate, for every 20 samples of similar matrices.

10.7 General Chemistry Parameters

Matrix spikes, duplicates and reagent blanks will be run at the same frequency as described in the current protocol or as described previously in general terms in Section 10.2.

11.0 PERFORMANCE AND SYSTEM AUDITS

Two types of audit procedures are conducted during this project: performance and system audits. These audits will be performed on laboratory activities as well as field activities.

11.1 Performance Audits

Laboratory Performance Audits

Laboratory performance audits are conducted by the Laboratory Quality Assurance Manager on a monthly basis. Each laboratory analyst is given a performance evaluation sample containing analytes for the parameters which he/she usually performs. These audit samples are used to identify problems in technique or methodologies which could lead to future analytical problems.

Additionally, the laboratory performance audits include verification of each analyst's record keeping, proper use and understanding of procedures, and appropriate analytical documentation. Corrective action will be taken for any deficiencies noted during the audit.

Field Performance Audits

Field performance audits are performed directly by the Team Leader and indirectly by the performance of field QC samples. All field obtained data will be reviewed by the Team Leader, as they are generated, for accuracy and clarity in order to ensure their reproducibility after completion of field activities. The analytical results of the field blanks and replicate samples are indirect audits of the level of performance of field activities.

- Level of QA conducted per each field team;
- Contingency plans in case of equipment failure or other events preventing the planned activity from proceeding;
- Decontamination procedures;
- Level of efficiency with which each team conducts planned activities at one site and proceeds to the next; and
- Sample packaging and shipment.

Any discrepancies discovered during the field system audit, and corrective actions taken, will be noted in the field log book by the team leader and a supplemental report will be filed with the project manager.

11.3 Corrective Actions

Corrective actions will be taken by the field team leader or audit team immediately upon discovering any discrepancy in the system that might affect the data being collected. The need for corrective actions may be identified by system or performance audits or by standard quality control procedures. The important aspects of the corrective action are outlined below:

- Identification and definition of the problem;
- Assignment of responsibility for investigation of the problem;
- Investigation and determination of the cause of the problem;
- Determination of a corrective action to eliminate the problem;
- Assigning and accepting responsibility for implementing the corrective action;
- Implementing the action and evaluating its effectiveness; and

- Verifying that the action has eliminated the problem.

Once a corrective action is initiated the Quality Assurance Manager should review the problem, the corrective action taken, the results of that action, and ensure that the action has resolved the problem.

12.0 ASSESSMENT PROCEDURES FOR LABORATORY DATA ACCEPTABILITY

The following describes the procedures that will be employed to evaluate the precision, accuracy, completeness, representativeness, and comparability of the generated data.

12.1 Precision

Precision is a measure of agreement among individual measurements of the same property under prescribed similar conditions. Precision is assessed by calculating the relative percent difference (RPD) of replicate spike samples or replicate sample analyses according to the following equation:

$$RPD = \frac{|R1 - R2|}{(R1 + R2)/2} \times 100 \qquad \text{where } R1 = \text{result 1}$$
$$R2 = \text{result 2}$$

12.2 Accuracy

Accuracy is a measure of the closeness of an individual measurement to the true value. Accuracy is measured by calculating the percent recovery (%R) of known levels of spike compounds as follows:

$$R = \frac{\text{determined value of spiked sample}}{\text{theoretical value of spiked sample}} \times 100$$

12.3 Completeness

Completeness is a measure of the amount of valid data obtained from a measurement system, expressed as a percentage of the number of valid measurements that should have been collected. It is calculated as follows:

$$\text{Completeness (\%)} = \frac{\text{number of valid samples reported}}{} \times 100$$

total number of samples analyzed

12.4 Representativeness

Representativeness is the degree to which data accurately and precisely represents a characteristic population, a process control, or an environmental condition. Appropriate sampling procedures will be implemented so that the samples are representative of the environmental matrices from which they were obtained. The sampling procedures are described in the respective work plans.

12.5 Comparability

Comparability refers to the degree to which one data set can be compared to another. Appropriate sampling and analytical processes will be implemented so that the samples of similar matrices may be compared.

12.6 Quality Control Charts

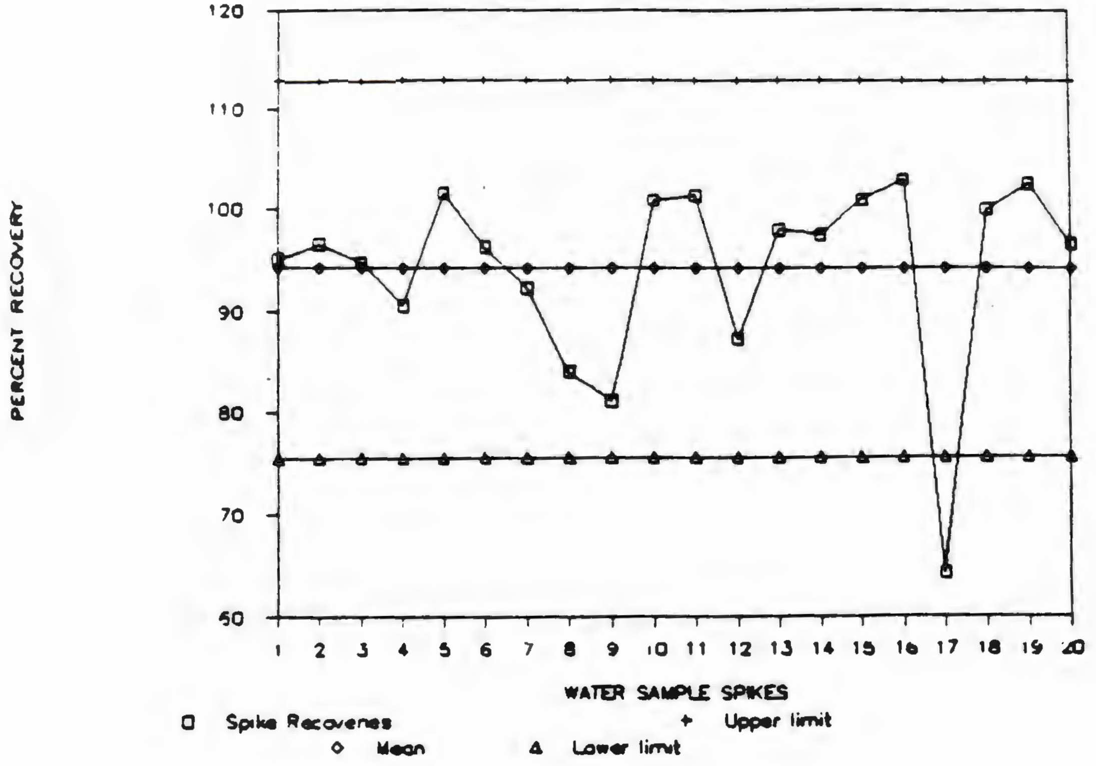
Quality control charts are prepared after every 20 determinations of precision and accuracy. The charts are prepared by determining the mean value of the determinations and setting control limits at ± 2 standard deviations from that mean. The following equations are used:

$$\text{mean} = \bar{x} = \sum_{i\ 1}^{n} \chi_i/\eta$$

$$\text{standard deviation} = \sqrt{\frac{1}{n-1} \sum_{i\ 1}^{n} (x_i-\bar{x})^2}$$

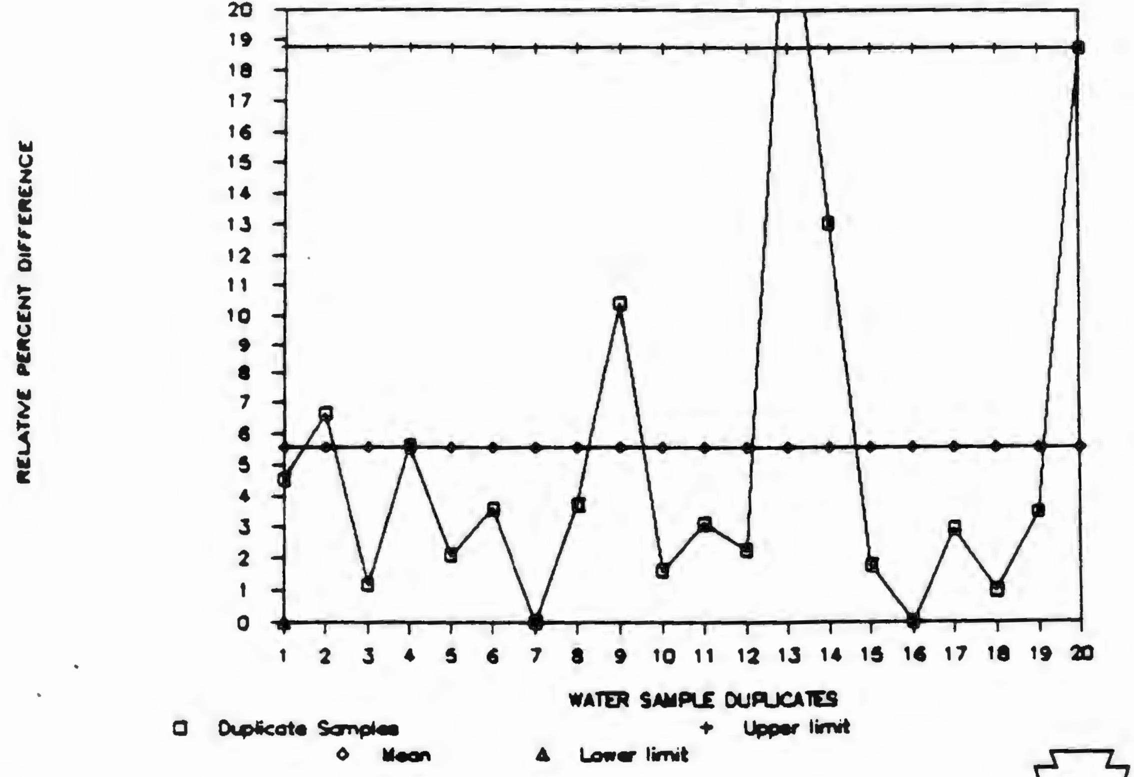
The control limits should approximate the values given in Table 4-1. If the limits are found to be outside these values, the measurement system is examined to determine if possible problems exist. Example control charts are shown in Figure 12-1.

FIGURE 12-1



MATRIX SPIKE ACCURACY PLOT

ZINC 01/19/89–06/04/89



DUPLICATE SAMPLE PRECISION PLOT

ZINC 6/13/89–11/10/89

13.0 PREVENTIVE MAINTENANCE

Periodic preventive maintenance is required for equipment whose performance can affect results. Most analytical instruments require periodic maintenance in order to prevent inaccurate results. Instrument manuals are kept on file for reference if equipment needs repair. Troubleshooting sections of manuals are often useful in assisting personnel in performing maintenance tasks.

All major laboratory instruments are under service contract so that trained professionals are available on call to minimize instrument downtime.

13.1 Glassware Preparation

Glassware used for analysis is thoroughly cleaned by laboratory personnel immediately after each use. Special cleaning procedures are described in detail based on analysis in Table 5-1 as required by the NYSDEC RCRA QAPjP Guidance Document.

13.2 Routine Preventive Maintenance (Field and Laboratory Equipment)

Routine preventive maintenance for laboratory equipment shown in this section are as described in Keystone Environmental Resources, Inc., Laboratory Standard Operating Procedures.

Gas Chromatographs

1) Change septa daily
2) Periodically clean detectors
3) Replace columns when instrument response deteriorates

Mass Spectrometers

1) Periodically dismantle and clean the ionizing source

Inductively Coupled Plasma Spectrophotometers

1) Change pump tubing every 4 days of operation or as needed
2) Clean nebulizer daily or as needed
3) Periodically clean and replace torch and chimney extension

Atomic Absorption Spectrophotometers

1) Clean contact cylinders daily
2) Check pyrolytic tube and platform daily
3) Replace contact cylinders every 3 months or as needed.

Analytical Balance

1) Check daily with class S weights
2) Clean and calibrate once per year

pH Meters

1) Store electrodes in pH 7 buffer when not in use
2) Keep hole for filling solution plugged to prevent evaporation of filling solution when not in use
3) Replace filling solution as needed

Conductivity Meter

1) Keep battery fully charged
2) Replatinize cell when response becomes erratic or platinum backing has flaked off the cell

14.0 CORRECTIVE ACTION

Corrective action procedures are divided into two subgroups: methods corrective action and systems corrective action. These corrective actions are implemented whenever system or performance audits note deficiencies or when QC procedures indicate a potential analytical problem.

14.1 Methods Corrective Action

Methods corrective action is initiated by the Analyst and Department Section Manager at the time of analysis. Recoveries that fall outside the acceptable window limits established by the laboratory or the supplier of the control sample is an example of a reason to initiate methods corrective action. Poor response or poor sensitivity check response are other causes that require methods corrective action.

The analyst is required to terminate analysis when any of the above problems are noted, locate the problem and correct it. This may take the form of recalibration of standards, reanalyzing a sample or in extreme cases, general maintenance of the instrument hardware. Documentation of the latter is done in the instruments log book. Satisfactory methods corrective action will be the proper response that corrects the problem for which the action was taken.

14.2 System Corrective Action

The Laboratory Quality Assurance Manager initiates the systems corrective action. A memo is generated which is addressed to the Section Manager responsible. A copy of the memo is filed in a folder designated for such. The Section Manager then assigns the responsibility of the required corrective action to the appropriate analyst. Systems corrective action is initiated as a result of any of the following: 1) Poor result in a performance audit (internal or external) or 2) Poor result in an interlaboratory performance test program.

When satisfactory progress has been achieved on each requested action, the analyst describes the nature of the problem and the action that was taken to resolve it on the Notification of Invalid Analysis and/or Data Form (See Figure 14-1). Action here may involve extensive study of extraction solvents, digestion acids, standards from more than one source, etc. The Section Manager reviews the process to verify that the corrective action implemented has resolved the problem, then signs and dates the form. This form is given to the Laboratory Quality Assurance Manager . The Laboratory Quality Assurance Manager evaluates the corrective steps taken, and if satisfied that no further action is required, signs the Notification of Invalid Analysis and/or Data Form and files it in a folder designated as such. If more corrective steps should be taken, the Laboratory Quality Assurance Manager sends the form back to the Section Manager with comments, suggestions, etc. and the corrective process starts again.

Figure 14-1

NOTIFICATION OF INVALID ANALYSIS AND/OR DATA

WORK ORDER # ____________________ DATE ANALYZED ____________________

SAMPLE #(s) ____

CLIENT ____________________ PARAMETER ____________________

ORIGINATING DEPARTMENT:

_______ GC, HPLC _______ METALS _______ EXTRACTIONS

_______ GC/MS _______ WET CHEMISTRY _______ OTHER __________

Invalid data submitted to Data Management(i.e. "finalized"): YES ____ NO ____

ACTION

I. State the analysis and/or reporting problem recognized: Analyst or Manager ______________ Date __________

____

____

____

II. State what action was taken to correct the problem:

____

____

____

Individual completing the necessary corrective action ____________________ Date __________

APPROVALS

I. MANAGER OF ORIGINATING DEPARTMENT

The problem appears _____ laboratory (e.g. procedure, instrument) related. Signature ______________ Date ________
_____ sample (e.g. matrix, volume) related.

II. PROJECT MANAGER

The client _____ was contacted. Signature ____________________ Date __________
_____ was not.

III. QC MANAGER

Additional follow-up ______ is necessary. Signature ____________________ Date __________
______ is not.

COMMENTS

____

____

____

____

____

1. HOW TO USE: Use only one notification Sheet to track and document one common problem related to samples associated with a single work order.
2. WHEN TO USE: Always initiate everytime invalid data is submitted to Data Management (or "finalized" within LIMS), AND
Always initiate everytime the problem cannot be characterized as obviously laboratory-related.
Should not be initiated for procedure or instrument related problems positively isolated and corrected prior to reporting results (the invalid work being marked "void" on instrument or bench sheets).
3. DISTRIBUTION: Once initiated, complete this sheet with approvals, and submit with data to Data Management.

KEYSTONE
ENVIRONMENTAL RESOURCES LTD.

15.0 QA REPORTS TO MANAGEMENT

This QAPjP provides a documentable mechanism for the assurance of quality work performed for the Seneca Falls site. Audit reports (Section 11.0) will be provided to management by the Laboratory Manager as a means of tracking program performance. Additionally, periodic assessments of measurement data accuracy, precision, and completeness and significant QA/QC problems will be provided to management by the Laboratory QA Officer and independent data validator.

Field QA reports will be submitted periodically during field activities to report the daily field progress, compiled field data sets, and corrective actions documentation. Any situations requiring immediate corrective action measures will be brought to the attention of the Project Manager.

REFERENCES

Federal Register, Vol. 49, No. 29, 1984, p. 43260

Keystone Environmental Resources Standard Operating Procedures. Laboratory Standard Operating Procedure.

Keystone Environmental Resources Standard Operating Procedures. Packaging and Shipping of Samples. Number 502.

Keystone Environmental Resources Standard Operating Procedures. Groundwater Sample Collection From Monitoring Wells. Number 201.

Standard Operating Procedure. Soil and Rock Borings. Number EXP-3. April, 1990.

Standard Operating Procedure. Soil and Rock Boring Sample Logging. Number EXP-4. April, 1990.

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Keystone Environmental Resources. June, 1992. Philips Display Components Company Management Plan. Vol. I.

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Keystone Environmental Resources. June, 1992. Philips Display Components Company Supplemental Site Visit Work Plan.

New York State Department of Environmental Conservation. Official Communication from P. Counterman (NYSDEC) to E. Chase (Philips Display Components Company). December 22, 1989.

New York State Department of Environmental Conservation, Division of Hazardous Substances Regulation. RCRA Quality Assurance Project Plan Guidance. January 19, 1990.

Scalf, M.R., J.A. McNabb, W.J. Dunlap, R.L. Cosby and J. Fryberger. 1981 Manual of Groundwater Sampling Procedures. U.S. EPA. Robert S. Kerr. Environmental Research Laboratory. Ada, OK: NWWA/WPA Series 1981.

U.S. Environmental Protection Agency. 1982. Test Methods for Evaluating Solid Waste. 2nd ed. SW-846.

U.S. Environmental Protection Agency. Revised March, 1983. Methods for Chemical Analysis of Water and Wastes. EPA-600/4-79-020.

U.S. Environmental Protection Agency. 1984. Characterization of Hazardous Waste Sites, A Methods Manual. Volume II. 2nd ed. EPA-600/4-84-076.

U.S. Environmental Protection Agency. 1986. Test Methods for Evaluating Solid Waste. 3rd ed. SW-846 including Update II.

U.S. Environmental Protection Agency. September, 1986. RCRA Technical Enforcement Guidance Document.

U.S. Environmental Protection Agency Region III Quality Assurance Branch. February, 1990. QAPjP Workshop Participant Workbook.

U. S. Environmental Protection Agency. December, 1980. Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans. QAMS-005/80.

Valaitis, Victor. Personal conversation. May 4, 1990. Regarding instrument detection limits for Aroclor-1254 and Aroclor-1260 below carcinogenic standard for soil ingestion.

TABLE 8-1

INTERFERENT AND ANALYTE ELEMENTAL CONCENTRATIONS USED FOR ICP INTERFERENCE CHECK SAMPLE

Analytes	(mg/l)	Interferents	(mg/l)
Ag	1.0	Al	500
Ba	0.5	Ca	500
Cd	1.0	Fe	200
Co	0.5	Mg	500
Cr	0.5		
Cu	0.5		
Mn	0.5		
Ni	1.0		
Pb	1.0		
V	0.5		
Zn	1.0		

TABLE 8-2

STANDARDS AND SOLUTIONS HOLDING TIMES

MATERIAL	HOLDING TIME		
	Pure Compound	Stock Solution	Working Solution
Volatile organic compounds for GC or GC/MS analysis	1 Yr @ -10°C	2 Mo @ -10°C	1 Wk @ -10°C
Semivolatile organic compounds for GC or GC/MS analysis	1 Yr @ 4°C	1 Yr @ 4°C	6 Mo @ -10°C
Pesticide/PCBs	1 Yr @ 4°C	1 Yr @ 4°C	6 Mo @ -10°C
Metals for ICP analysis	Indef. @ RT	1 Yr @ RT	6 Mo @ RT
Metals for GFAA analysis	Indef. @ RT	1 Yr @ RT	6 Mo @ RT
Fluoride	Indef. @ RT	1 Yr @ 4°C	6 Mo @ 4°C

TABLE 4-2

LIST OF SEMI-VOLATILE ORGANIC COMPOUNDS

Acid Extractables

4-Chloro-3-Methylphenol
2-Chlorophenol
2,4 Dichlorophenol
2,4 Dimethylphenol
2,4 Dimethylphenol
2,4 Dinitrophenol
2-Methyl-4,6-dinitrophenol
2-Methylphenol
4-Methylphenol
2-Nitrophenol
4-Nitrophenol
Pentachlorophenol
Phenol
2,4,5-Trichlorophenol
2,4,6-Trichlorophenol

Base/Neutral Extractables

Acenaphthene
Acenaphthalene
Anthracene
Benzo(a)anthracene
Benzo(b)fluoranthene
Benzo(k)fluoranthene
Benzo(a)pyrene
Benzo(ghi)perylene
Benzoic Acid
Benzyl alcohol
Benzyl butyl phthalate
Bis(2-chloroethyl)ether
Bis(2-chloroethoxy)methane
Bis(2-chloroisopropyl)ether
4-Bromophenyl phenyl ether
4-Chloroaniline
2-Chloronaphthalene
4-Chlorophenyl phenyl ether
Chrysene
Dibenzo(ah)anthracene
Dibenzofuran
Di-n-butylphathalate
1,2-Dichlorobenzene
1,3-Dichlorobenzene
1,4-Dichlorobenzene
3,3'-Dichlorobenzidine
Diethyl phthalate
2,4-Dinitrotoluene
2,6-Dinitrotoluene
Di-n-octylphathalate
Fluoranthene
Hexachlorobenzene
Hexachlorobutadiene
Hexachlorocyclopentadiene
Hexachloroethane
Indeno(1,2,3-cd)pyrene
Isophorone
2-Methylnaphthalene
Naphthalene
2-Nitroaniline
3-Nitroaniline
4-Nitroaniline
Nitrobenzene
N-Nitrosodi-n-propylamine
N-Nitrosodiphenylamine
Phenanathrene
Pyrene
1,2,4-Trichlorobenzene

TABLE 4-3

LIST OF VOLATILE ORGANIC AND POLYCHLORINATED BIPHENYL COMPOUNDS

Volatile Organics (Method 8240)

Acetone
Dibromochloromethane
cis-1,3-Dichloropropene
trans-1,3-Dichloropropene
Bromoform
Bromomethane
Carbon tetrachloride
Chloroethane
Chloroform
Chloromethane
1,1,2,2-Tetrachloroethane
Toluene
1,1,2-Trichloroethane
Trichloroethene
trans-1,2-Dichloroethene
Vinyl Acetate
2-Butanone
2-Hexanone
1,1-Dichloroethene
1,2-Dichloropropane
Benzene
Bromodichloromethane
Ethyl benzene
Carbon disulfide
Chlorobenzene
Methylene chloride
4-Methyl-2-pentanone
Styrene
Tetrachloroethene
1,1,1-Trichloroethane
1,1-Dichloroethane
1,2-Dichloroethane
Vinyl Chloride
Xylenes
2-Chloroethylvinylether

Polychlorinated Biphenyls (Method 8080)

PCB - 1016
PCB - 1232
PCB - 1248
PCB - 1260
PCB - 1221
PCB - 1242
PCB - 1254

Aromatic Volatiles (Method 8010)

Chloromethane
Bromomethane
Vinyl Chloride
Chloroethane
Methylene Chloride

Halogenated Volatiles (Method 8020)

Benzene
Toluene
Chlorobenzene
Ethylbenzene
Styrene

TABLE 4-3 (Continued)

LIST OF VOLATILE ORGANIC AND POLYCHLORINATED BIPHENYL COMPOUNDS

Aromatic Volatiles (Method 8010)

Trichlorofluoromethane
1,1-Dichloroethene
Trans-1,2-dichloroethene
Chloroform
1,2-Dichloroethane
1,1,1-Trichloroethane
Carbon Tetrachloride
Bromodichloromethane
1,2-Dichloropropane
Cis-1,3-dichloropropane
Trichloroethene
dibromochloromethane
1,1,2-Trichloroethane
Trans-1,3-dichloropropene
2-Chloroethylvinyl ether
Bromoform
Tetrachloroethene
1,1,2,2-Tetrachloroethane
Chlorobenzene
1,3-Dichlorobenzene
1,2-Dichlorobenzene
1,4-Dichlorobenzene

Halogenated Volatiles (Method 8020)

Xylenes
1,3-Dichlorobenzene
1,2-Dichlorobenzene
1,4-Dichlorobenzene

TABLE 5-1
SAMPLE CONTAINER CLEANING PROCEDURES AND SAMPLE PRESERVATION METHODS (OR PROCEDURES)

Parameter	Matrix	Preservative	Sample Container	Cleaning Procedure
Metals	water	HNO_3 to pH <2 and cool to 4°C	1 liter plastic	1
Volatile Organics	water	cool to 4°C	40 ml glass vial with teflon septum	2
Fluoride	water	cool to 4°C	500 ml plastic	3
Semi-Volatiles/ PCBs	water	cool to 4°C	1 liter amber glass	4
Metals	soil	none required	8 oz. glass container	1
Volatile Organics	soil	cool to 4°C	40 ml glass vial with teflon septum	2
Methanol	soil	cool to 4°C	4 oz. glass container	2
Fluoride	soil	cool to 4°C	8 oz. glass container	3
Semi-Volatiles/ PCBs	soil	cool to 4°C	8 oz. glass container	4

1. Use new bottle; wash container and closure with hot water using non-phosphate detergent; rinse 3 times with hot tap water; rinse with 1:1 nitric acid and drain; rinse with demonstrated analyte-free water and drain thoroughly; air dry; and cap.

2. Use new bottle; wash containers and closure with hot tap water using non-phosphate detergent; rinse, three times with hot tap water; rinse three times again with demonstrated analyte-free water; oven dry containers, septa and liners at 105 °C for one hour; air dry caps; and cap while hot.

3. No cleaning required. Use new bottle depending on quantities required by the laboratory for analysis.

4. Use new 1 liter amber glass or 80 oz. jar for water and 8 oz jar for soils; wash container and closure with hot tap water using non-phosphate detergent; hot tap water rinse three times; rinse jar and teflon lined closure with pesticide grade acetone followed by a hexane rinse; rinse three times with demonstrated analyte-free water; oven dry for one hour at 105 °C (containers); air dry caps, and cap when dry.

NYSDEC. RCRA Quality Assurance Project Plan Guidance Document. January 19, 1990.

Federal Register, Vol. 49, No. 29, 1984, p. 43260.

U.S. EPA. 1982. Test Methods for Evaluating Solid Waste. 3rd ed.SW-846.

TABLE 5-2

ORDER OF VOLATILIZATION

Water samples are collected according to the following order of volatilization as referenced in the September, 1986 RCRA TEGD:

- Volatile Organic Compounds (VOCs) - No air bubbles
- Semivolatile Organic / Polychlorinated Biphenyls
- Fluoride / Metals

There is not an order of preference for the collection of any remaining miscellaneous parameters. However, pH and specific conductance measurements should be performed to check the stability of the water sampled.

TABLE 5-3

HOLDING TIMES

Parameter	Holding Time*
Volatile Organics / Methanol	Within 7 days of collection for soils, Within 7 days of collection for waters, unless acidified, then 14 days.
Semi-volatiles / PCBs	Within 7 days of collection (for extraction) of water, Within 40 days of extraction (for analysis) of water. Within 14 days of collection (for extraction) of soils, Within 40 days of collection (for analysis) of soils.
Metals	Within 180 days of collection
Fluoride	Within 28 days of collection
pH, Specific Conductance	Immediately after sample collection

* (Federal Register, Vol. 49, No. 29, 1984, p. 43260)

U.S. Environmental Protection Agency. 1986. Test Methods for Evaluating Solid Waste. 3rd ed. SW-846.

U.S. Environmental Protection Agency. September, 1986. RCRA Technical Enforcement Guidance Document.

NYSDEC. January 19, 1990. RCRA Quality Assurance Project Plan Guidance.

APPENDICES

APPENDIX A

SPDES PERMIT
PHILIPS DISPLAY COMPONENTS COMPANY
SENECA FALLS, NEW YORK

[illegible] (7/84)

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

State Pollutant Discharge Elimination System (SPDES)
DISCHARGE PERMIT
Special Conditions (Part 1)

Industrial Code 3672
Discharge Class (CL) 03
Toxic Class (TX) 02
Major D.B. 07
Sub D.B. 05

Facility IDNumber: NY· 0001228
UPA Tracking Number:
Effective Date (EDP): June 1, 1985
Expiration Date (ExDP): June 1, 1990
Modification Date(s):
Attachment(s): *General Conditions (Part II,* 2/85)

This SPDES permit is issued in compliance with Title 8 of Article 17 of the Environmental Conservation Law of New York State and in compliance with the Clean Water Act, as amended, (33 U.S.C. §1251 et. seq.) (hereinafter referred to as "the Act").

Attn: Mr. A. R. Covell

Permittee Name: Philips ECG, Inc.
Street: 50 Johnson St.
City: Seneca Falls State: NY Zip Code: 13148

is authorized to discharge from the facility described below:

Facility Name:
Location (C,T,[✓ V]) Seneca Falls County: Seneca
Mailing Address (Street): Johnson Street
Mailing Address (City) Seneca Falls State: New York Zip Code: 13148

from Outfall No. 001 at: Latitude 76° 46' 51" & Longitude 42° 54' 59"
into receiving waters known as: Seneca River/Barge Canal, Class C
and: (list other Outfalls, Receiving Waters & Water Classification)

in accordance with the effluent limitations, monitoring requirements and other conditions set forth in this permit.

This permit and the authorization to discharge shall expire on midnight of the expiration date shown above and the permittee shall not discharge after the expiration date unless this permit has been renewed, or extended pursuant to law. To be authorized to discharge beyond the expiration date, the permittee shall apply for permit renewal as prescribed by Sections 17-0803 and 17-0804 of the Environmental Conservation Law and Parts 621, 752, and 755 of the Departments' rules and regulations.

PERMIT ADMINISTRATOR	DATE ISSUED	ADDRESS
Albert W. Butkas	5/2/85	6274 E. Avon-Lima Road Avon, NY 14414

Distribution: Region 8 Water Division
Mr. Hannaford, BWFD
Seneca County Health Department
Dr. Baker, USEAP/Region II
Dr. Spear, USEPA/NJ

Albert W. Butkas

.-20-2a (7/84)

Facility ID # NY 0001228
Part 1, Page 2 of 4

FINAL EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

During the Period Beginning June 1, 1985,

and lasting until June 1, 1990,

the discharges from the permitted facility shall be limited and monitored by the permittee as specified below:

Outfall Number & Effluent Parameter	Discharge Limitations		Units	Minimum Monitoring Requirements	
	Daily Avg.	Daily Max.		Measurement Frequency	Sample Type
001 (Process Wastewater)					
Flow	Monitoring requirement only		MGD	Continuous	Recorder
Temperature		90*	°F	2/Month	Grab
pH (Range)	6.0 - 9.0		SU	Continuous	Recorder
Solids, Suspended		404	#/Day	2/Month	24-Hour Composite
BOD_5	270	404	#/Day	2/Month	24-Hour Composite
Fluoride, Total		52	#/Day	2/Month	24-Hour Composite
Cadmium, Total		1.1	#/Day	2/Month	24-Hour Composite
Chromium, Total		4.2	#/Day	2/Month	24-Hour Composite
Zinc, Total		6.7	#/Day	2/Month	24-Hour Composite
Trichloroethylene		4.2	#/Day	2/Month	Grab

* If the influent temperature from Vancleef Lake is greater than 90°F, no net increase is permitted.

001 B (Process Wastewater, 2 March - 31 Dec.)					
Lead, Total		3.4	#/Day	2/Month	24-Hour Composite
001 C (Process Wastewater, 1 Jan. - 1 March)					
Lead, Total		2.3	#/Day	2/Month	24-Hour Composite

91-20-2e (7/84)

Facility ID # NY 0001228
Part 1, Page 3 of 4

Definition of Daily Average and Daily Maximum

The daily average discharge is the total discharge by weight or in other appropriate units as specified herein, during a calendar month divided by the number of days in the month that the production or commercial facility was operating. Where less than daily sampling is required by this permit, the daily average discharge shall be determined by the summation of all the measured daily discharges in appropriate units as specified herein divided by the number of days during the calendar month when the measurements were made.

The daily maximum discharge means the total discharge by weight or in other appropriate units as specified herein, during any calendar day.

Monitoring Locations

Permittee shall take samples and measurements to meet the monitoring requirements at the location(s) indicated below: (Show locations of outfalls with sketch or flow diagram as appropriate). Normally samples should be taken from effluent flow prior to discharge to the Barge Canal.

At flows greater than 700 GPM, samples shall also be taken from the holding lagoon influent i.e. the fluoride and heavy metals waste treatment effluent.

-20-2f (7/84)

Facility ID # NY 0001228
Part 1, Page 4 of 4

MONITORING, RECORDING AND REPORTING

a) The permittee shall also refer to the General Conditions (Part II) of this permit for additional information concerning monitoring and reporting requirements and conditions.

b) The monitoring information required by this permit shall be:

☐ Summarized, signed and retained for a period of three years from the date of sampling for subsequent inspection by the Department or its designated agent.

☒ Summarized and reported by submitting completed and signed Discharge Monitoring Report forms once every 3 month(s) to the locations specified below. Blank forms available at department offices listed below. The first report will be due no later than September 28, 1985.
Thereafter, reports shall be submitted no later than the 28th of the following month(s): December, March, June, September.

Department of Environmental Conservation
Regional Water Engineer - Region 8
6274 E. Avon-Lima Road
Avon, New York 14414

Department of Environmental Conservation
Water Division
50 Wolf Road,
Albany, New York 12233

☒ (applicable only if checked)
Dr. Richard Baker, Chief
Permit Administration Branch
Planning & Management Division
USEPA Region II, 26 Federal Plaza
New York, New York 10278

c) If so directed, Monthly Wastewater Treatment Plant Operator's Reports should be submitted to the Regional Engineer and County Health Department or County Environmental Control Agency specified above.

d) Monitoring must be conducted according to test procedures approved under 40 CFR Part 136, unless other test procedures have been specified in this permit.

e) If the permittee monitors any pollutant more frequently than required by the permit, using test procedures approved under 40 CFR 136 or as specified in the permit, the results of this monitoring shall be included in the calculations and recording of the data on the Discharge Monitoring Reports.

f) Calculations for all limitations which require averaging of measurements shall utilize an arithmetic mean unless otherwise specified in this permit.

g) Unless otherwise specified, all information recorded on the Discharge Monitoring Report shall be based upon measurements and sampling carried out during the most recently completed reporting period.

h) On or after April 1, 1984, any laboratory test or sample analysis required by this permit for which the State Commissioner of Health issues certificates of approval pursuant to section five hundred two of the Public health Law shall be conducted by a laboratory which has been issued a certificate of approval. Inquires regarding laboratory certification should be sent to the Laboratory Certification/Quality Assurance Group, New York State Health Department Center for Laboratories and Research, Division of Environmental Sciences, The Nelson A. Rockefeller Empire State Plaza, Albany, New York 12201.

Attachments: General Conditions Part II (Renewal-RW)

Copies:
SPDES File
Region 8 (2 copies)
Mr. Crandall - BMS
Mr. Adamczyk - BIP
Dr. Baker - EPA Region II
Dr. Spear - EPA N.J.

Facility ID No. : NY 000 1228

Effective Date : March 1, 1980

Expiration Date : June 30, 1981

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION
STATE POLLUTANT DISCHARGE ELIMINATION SYSTEM (SPDES)
DISCHARGE PERMIT

Special Conditions
(Part I)

This SPDES permit is issued in compliance with Title 8 of Article 17 of the Environmental Conservation Law of New York State and in compliance with the provisions of the Federal Water Pollution Control Act, as amended by the Federal Water Pollution Control Act Amendments of 1972, P.L. 92-500, October 18, 1972, (33 U.S.C. §1251 <u>et. seq.</u>) (hereinafter referred to as "the Act").

GTE Products Corp.
Johnston Street
Seneca Falls, New York 13148

Attn: Alan R. Covell
Environmental Quality Engineer

is authorized to discharge from the facility described below:

Electronic Tube Division
Johnston Street
Seneca Falls, New York 13148

Lat. 42° 54' 58"
Long. 76° 47' 16"

Seneca Falls (V), Seneca County

into receiving waters known as:

Seneca River - Barge Canal Class C

in accordance with the effluent limitations, monitoring requirements and other conditions set forth in this permit.

This permit and the authorization to discharge shall expire on midnight of the expiration date shown above and the permittee shall not discharge after the expiration date unless this permit has been renewed, or written authorization is given by the Department. In order to receive authorization to discharge beyond the expiration date, the permittee shall submit such information, forms, and fees as are required by the Department of Environmental Conservation no later than 180 days prior to the expiration date.

By Authority of George K. Hansen, P.E., Chief, P.D.E.S. Permit Section
Designated Representative of Commissioner of the
Department of Environmental Conservation

JAN 24 1980
Date

Signature

FINAL EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS
(March 1, 1980)

During the period beginning EDP and lasting until June 30, 1981 the discharges from the permitted facility shall be limited and monitored by the permittee as specified below:

		Net Discharge Limitations				Monitoring Reqmts.	
		kg/day (lbs/day)		Other Units (Specify)			
Outfall Number	Effluent Parameter	Daily Avg.	Daily Max.	Daily Avg.	Daily Max.	Measurement Frequency	Sample Type
001 (Wastewater Holding Lagoon)	5-day BOD	136(300)	204(450)	N/A	54 mg/l	Weekly	Composite
	Suspended Solids	34(75)	98(215)	N/A	100 mg/l	Weekly	Composite
	Total Zinc	0.68(1.5)	2.3(5.0)	N/A	0.6 mg/l	Weekly	Composite
	Fluorides	15.9(35)	23.6(52)	N/A	6.2 mg/l	2/month	Composite
	Total Lead	0.21(0.47)	0.42(0.94)	N/A	0.15mg/l	2/month	Composite
	Total Chromium	0.96(2.1)	1.92(4.2)	N/A	0.5 mg/l	2/month	Composite
	Total Hex.Chromium	0.27(0.6)	0.55(1.2)	N/A	0.15 mg/l	2/month	Composite
	Total Copper	0.14 (0.3)	0.68(1.5)	N/A	0.2 mg/l	Monthly	Composite
	Total Cadmium	0.25(0.55)	0.5(1.1)	N/A	0.15mg/l	Monthly	Composite
	Cyanides	0.045(0.1)	0.09(0.2)	N/A	0.03mg/l	Monthly	Composite
	Sulfides	5.3(11.6)	7.9(17.4)	N/A	2.0 mg/l	Monthly	Composite
	Settleable Solids	N/A	N/A	0.2 ml/l	0.4 ml/l	Weekly	Grab
	Temperature	N/A	N/A	N/A	90°F	Weekly	Grab
	Flow	N/A	N/A	N/A	N/A	Continuous	Metered

002 (Warehouse Drain) - No discharge permitted, except for storm drainage and surface runoff. No monitoring required.

003 (Van Cleef Lake Intake) -Monitoring requirements shall be identical to these which apply to 001, except that pH monitoring is not required.

(1) - Mass limits apply only when the flow through the holding pond Parshall flume is less than 700 gpm. Concentration limits apply only when the aforementioned flow exceeds 700 gpm. The settleable solids limitations apply when mass limits are in effect.

(2) - If the intake temperature is equal to or greater than 90°F, no net increase shall be allowed.

The pH shall not be less than 6.5 standard units nor greater than 9.0 standard units and shall be monitored as follows: continuously recorded in 001.

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): on outfall 001 prior to discharge and from 003 influent prior to conditioning.

The daily average discharge is the total discharge by weight or in other appropriate units as specified herein, during a calendar month divided by the number of days in the month that the production or commercial facility was operating. Where less than daily sampling is required by this permit, the daily average discharge shall be determined by the summatio of all the measured daily discharges in appropriate units as specified herein divided by th number of days during the calendar month when the measurements were made.

The daily maximum discharge means the total discharge by weight or in other appropriate uni as specified herein, during any calendar day.

FINAL EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS
(March 1, 1980)

During the period beginning EDP and lasting until June 30, 1981 the discharges from the permitted facility shall be limited and monitored by the permittee as specified below:

		Discharge Limitations				Monitoring Reqmts.	
		kg/day (lbs/day)		Other Units (Specify)			
Outfall Number	Effluent Parameter	Daily Avg.	Daily Max.	Daily Avg.	Daily Max.	Measurement Frequency	Sample Type
004	Waste Treatment Plant Effluent						
	Fluorides	13.6(30)	N.A.	---	---	Weekly	Composite
	Total Cadmium	0.11(0.24)	N.A.	---	---	"	"
	Total Lead	0.16(0.36)	0.33(0.72)	---	---	"	"
	Total Zinc*	---	---	---	---	"	"
	Total Copper*	---	---	---	---	"	"
	Total Chromium*	---	---	---	---	"	"
	Total Hex. Chromium*	---	---	---	---	"	"
	Suspended Solids *	---	---	---	---	"	"
	Settleable Solids*	---	---	---	---	"	Grab
	Cyanide*	---	---	---	---	Monthly	Composite
	Flow	---	---	---	---	Continuous	Metered
005	Grease & Oil Separator						
	Oil and Grease	---	---	---	15 mg/l	Monthly**	Grab

* Monitoring requirements only.

**A grab sample shall be taken of the grease & oil separator effluent within the first half hour of a discharge occurrence.

The pH shall not be less than N.A. standard units nor greater than NA standard units and shall be monitored as follows:

Samples taken in compliance with the monitoring requirements specified above shall be taken at the following location(s): on each individual effluent above 004 & 005 prior to discharge to wastewaters lagoon identified with 001

The daily average discharge is the total discharge by weight or in other appropriate units as specified herein, during a calendar month divided by the number of days in the month that the production or commercial facility was operating. Where less than daily sampling is required by this permit, the daily average discharge shall be determined by the summation of all the measured daily discharges in appropriate units as specified herein divided by the number of days during the calendar month when the measurements were made.

The daily maximum discharge means the total discharge by weight or in other appropriate units as specified herein, during any calendar day.

MONITORING, RECORDING AND REPORTING

a) The permittee shall also refer to the General Conditions (Part II) of this permit for additional information concerning monitoring and reporting requirements and conditions.

b) The monitoring information required by this permit shall be summarized and reported by submitting a completed and signed Discharge Monitoring Report form once every 1 months to the Department of Environmental Conservation and other appropriate regulatory agencies at the offices specified below. The first report will be due no later than March 28, 1980 . Thereafter, reports shall be submitted no later than the 28th of the following month(s): Each month.

Chief, Waste Source Monitoring Section
New York State Department of Environmental Conservation
Room 300 - 50 Wolf Road - Albany, New York 12233

Regional Engineer
New York State Department of Environmental Conservation
Regional Office #8, 6274 East Avon-Lima Road, Avon, N.Y. 14414

Dr. Richard Baker, Chief, Permits Administration Branch
Planning & Management Division, USEPA Region II
26 Federal Plaza, New York, New York 10007

c) If so directed by this permit or by previous request, Monthly Wastewater Treatment Plant Operator's Reports shall be submitted to the DEC Regional Office and county health department or county environmental control agency specified above.

d) Each submitted Discharge Monitoring Report shall be signed as follows:

1. If submitted by a corporation, by a principal executive officer of at least the level of vice president, or his duly authorized representative, if such representative is responsible for the overall operation of the facility from which the discharge described in the Discharge Monitoring Report originates;

2. If submitted by a partnership, by a general partner;

3. If submitted by a sole proprietor, by the proprietor;

4. If submitted by a municipality, State or Federal agency, or other public entity; by a principal executive officer, ranking elected official, commanding officer, or other duly authorized employee.

e) Unless otherwise specified, all information submitted on the Discharge Monitoring Form shall be based upon measurements and sampling carried out during the most recently completed reporting period.

f) Blank Discharge Monitoring Report Forms are available at the above addresses.

APPENDIX B

CERTIFICATION FOR DOCUMENTATION OF USE OF APPROPRIATE BOTTLE PRECLEANING REQUIREMENTS FROM SAMPLE BOTTLE VENDOR

All-Pak

All-Pak, Inc., 2260 Roswell Drive
Chartiers Valley Industrial Park
Pittsburgh, Pennsylvania 15205

412/922-7525

June 11, 1990

Keystone Environmental
3000 Tech Center Drive
Monroeville, PA 15146

Attn: Keith Stang
Subject: Bottle Pre-cleaning requirements
NY State Dept. of Environmental Conservation

Dear Keith,

Pursuant to our meeting of June 1, 1990, in regard to the above subject, listed below please find a summary of our cleaning procedures as compared to the Jan. 17, 1990 NYSDEC QAPJP Guidance document.

A. <u>Demonstrated Analyte - Free Water</u>
We are in total compiance.

B. <u>Pre-cleaning for Metals, Cyanide, and Sulfide Analyses</u>
Item 3 - We will use reagent grade nitric acid.
All other points remain the same.

C. <u>Pre-cleaning for Purgeable Organic Analyses</u>
We are in total compliance.

D. <u>Pre-cleaning for Extractable Organic Analyses</u>
Item 3 - We rinse with either nitric or sulfuric acid
vs. acetone or methanol.
All other items are in compliance.

We will certify that our bottles have been cleaned to certification Level 3 and a certificate of analysis will be sent with each case. Each case will have a lot number assigned for quality control purposes.

If I can be of any further service to you, please do not hesitate to contact me.

Yours Truly,

Karen L. Brooks

Karen L. Brooks
Manager
Pre-Cleaned Bottle Sales

KLB/tlm

CC: R. Tamborino - All-Pak
Meryl Powell - Keystone

APPENDIX E
SUMMARY OF METHANOL METHODOLOGY AND INSTRUMENTATION

HOUSTON LAB

SUMMARY OF METHODOLOGY AND INSTRUMENTATION

The soil sample received on February 26, 1990 was analyzed for methanol according to a procedure based on Method 8015 in Fed. Methods for Evaluating Solid Waste (SW-846) Vol. 1, Sec. C., US Environmental Protection Agency, 1986.

The sample (2.00 grams) was weighed into a 10-ml screw capped vial. Two mls of deionized water was added and the vial was sealed. The sample was dispersed in water and then agitated at high speed for one minute with a vortex mixer. After 30-60 minutes sufficient supernatant had separated for analysis. The soil extract was analyzed by direct injection into a Perkin-Elmer 3920B FID gas chromatograph. The gas chromatograph was fitted with a glass column (6′ x 1/4" x 2 mm ID) packed with 5% carbowax 20 m on 80/120 mesn carbopack BAW. The oven temperature was 70 degrees C isothermal. The detector response was measured with a Hewlett-Packard 3390-A Reporting Integrator.

METHODOLOGY SUMMARY

PARAMETER	METHOD NO.	DETECTION LIMIT
METHANOL	8015	7.00 mg/kg

AIHA Accrediation: 171

APPENDIX C

STANDARD OPERATING PROCEDURE EXP-3,
SOIL AND BORINGS
STANDARD OPERATING PROCEDURE EXP-4,
SOIL AND ROCK BORING
SAMPLE LOGGING
STANDARD OPERATING PROCEDURE EXP-7,
MONITORING WELL CONSTRUCTION, INSTALLATION AND DEVELOPMENT

STANDARD OPERATING PROCEDURE
SOP: EXP-3

KEYSTONE
ENVIRONMENTAL RESOURCES, INC.

SOP: EXP-3. SOIL AND ROCK BORINGS

1. SCOPE AND PURPOSE

1.1 The purpose of this guideline is to describe the methods, the sequence of operations and the equipment necessary to perform soil and rock borings.

1.2 This guideline addresses most of the accepted and standard drilling techniques, their benefits and drawbacks. It should be used generally to determine what type of drilling techniques would be most successful depending on site-specific geologic conditions and the type of samples required.

2. DEFINITIONS

Bedrock - The rock, usually solid but may be highly weathered and friable, that underlies soil, or other unconsolidated, surficial material.

Boulders - Rounded, semirounded or naturally angular particles of rock larger than 12 inches in size.

Clay - Fine grained soil or portions of soil having certain physical properties, composition and texture. Clay exhibits plastic properties within a range of water contents and exhibits considerable strength when air dried. Clay consists usually of fragments of hydrous aluminum or magnesium silicate minerals, and it consists predominantly of grains with diameters of less than 0.005 mm.

Cobbles - Rounded, semirounded or naturally angular particles of rock between 3 inches and 12 inches in size.

Gravel - Rounded or semirounded particles of rock that will pass a 3 in. sieve and be retained on a No. 4 US standard sieve (4.76 mm). Coarse gravel is larger than 3/4-inches, while fine gravel is finer than 3/4-inches.

Stone - Crushed or naturally angular particles of rock that will pass a 3 in. sieve and be retained on a No. 4 US standard sieve (4.76 mm).

Rock - Any consolidated or coherent and relatively hard, naturally formed mass of mineral matter.

Sand - Particles of rock that will pass a No. 4 US standard sieve (4.76 mm) and be retained on a No. 200 US standard sieve (0.074 mm). Coarse sand is larger than a No. 10 sieve (2.0 mm), medium sand is between the No. 40 and No. 10 sieves, and fine sand is finer than a No. 40 sieve (0.42 mm).

Silt - Material passing the No. 200 US standard sieve (0.074 mm) that is nonplastic or very slightly plastic and that exhibits little or no strength when air dried.

Soil - Sediments or other unconsolidated accumulations of solid particles that are produced by the physical and chemical disintegration of rock and that may contain organic matter.

Undisturbed Sample - A soil sample that has been obtained by methods in which every precaution has been taken to minimize disturbance to the sample. (See SOP: EXP-5B).

Water Table - A surface in an aquifer where ground water pressure is equal to atmospheric pressure.

3. RESPONSIBILITIES

Project Manager - In consultation with the Project Geologist, the Project Manager shall be responsible for evaluating the drilling requirements for the site and specifying drilling techniques that will be successful given the study objectives and geologic conditions at the site. He should also determine the disposal methods for products generated by drilling, such as drill cuttings and well development water, as well as any specialized supplies or logistical support required for the drilling operations. The Project Manager is responsible for overall supervision and scheduling of drilling activities.

Site Geologist/Rig Geologist - Responsible for insuring that standard and approved drilling procedures are followed. The Site Geologist will generate a detailed boring log for each test hole. This log shall include a description of materials, samples, method of sampling, blow counts, down pressure and other pertinent drilling and testing information that may be obtained during drilling (See SOP:EXP-4). Often this position for inspecting the drilling operations may be filled by other geotechnical personnel, such as soils and foundation engineers, civil engineers, etc. having appropriate training.

The general area in which the borings are to be located will be shown on a site map included in the project specific work plan. The boring locations shown or implied in the work plan are approximate. Determination of the exact location for borings is the responsibility of the Site Geologist. The final location for drilling must be properly documented on the boring log.

Drilling Subcontractors - Responsible for obtaining all drilling permits and clearances, and supplying all services (including labor), equipment and material required to perform the drilling, testing, and well installation program, as well as maintenance and quality control of such required equipment.

The driller must report any major technical or analytical problems encountered in the field to the Site Geologist or Project Manager within 24 hours, and must provide advance written notification for any changes in field procedures describing and justifying such changes. No such changes shall be made unless requested and authorized in writing by the Project Manager.

The Drilling Subcontractor will be responsible for following decontamination procedures specified in the Decontamination SOP:Decon-1. Upon completion of the work, the Drilling Subcontractor will be responsible for demobilizing all equipment, cleaning up specified materials deposited on site during drilling operations, and properly backfilling or abandoning any open borings.

4. GENERAL APPLICATION

4.1 The purpose of drilling test holes is:

- To determine the type, thickness, and certain physical properties of the soil and rock strata which underlie the site, and/or
- To accommodate monitoring wells.

4.2 The drilling rig, including all attachments, will be steam cleaned prior to the commencement of each boring. All drilling and sampling equipment will be cleaned using appropriate decontamination procedures between borings and samples respectively. Unless otherwise specified, it is generally advisable to drill borings at "clean" locations first, and at the most contaminated locations last, to reduce the risk of spreading contamination between locations. All borings must be logged by the rig geologist unless the project work plan specifically states that logging is not required. Situations where logging would not be required would include installation of multiple well points within a small area, or a "second attempt" boring adjacent to a boring that could not be continued through resistant material. In the latter case, the boring log can be resumed 5 feet above the depth at which the initial boring was abandoned, although the rig geologist should still confirm that the stratigraphy at the redrilled location conforms essentially with that encountered at the original location. If significant differences are seen, each hole should be logged separately.

5. DRILLING METHODS

The methods described below apply to drilling in subsurface materials, including but not limited to, sand, gravel, clay, silt, cobbles, boulders, rock and man-made fill. Drilling methods should be selected after studying the site geology and terrain, purpose of drilling, waste conditions at the site, and the overall subsurface investigation program proposed for the site. The full range of different drilling methods applicable to the proposed program should be identified with final selection based on relative cost, availability, time - constraints, and how well each method meets the sampling and testing requirements of the individual drilling program.

5.1 Continuous-Flight Hollow-Stem Auger Drilling

This method of drilling consists of screwing augers with a hollow stem into the ground. Cuttings are brought to the surface by the rotating action of the auger. This method is relatively quick and inexpensive. Additional advantages of this type of drilling include:

- o Samples can be obtained without pulling the augers out of the hole by collecting samples from the auger flight returns. However, this is a poor method for obtaining samples from thin, discrete formations because of mixing of soils which occurs as the material is brought to the surface. Sampling of such formations will require the use of split-barrel (split-spoon) or thin-wall (Shelby) tube samplers advanced through the hollow core of the auger.

- No drilling fluids are required.
- A well can be installed inside the auger stem and backfilled as the augers are withdrawn.

Disadvantages and limitations of this method of drilling include:

- Augering can only be done in unconsolidated materials.
- The inside diameter of hollow stem augers used for well installation should be at least four inches greater than the well casing. Use of such large diameter hollow stem augers is more expensive than the use of smaller diameter augers in boreholes not used for well installation. Furthermore, the density of unconsolidated materials and depths becomes more of a limiting factor. More friction is produced with the larger diameter auger and subsequently greater torque is needed to advance the boring.
- The maximum effective depth for drilling is 150 feet or less, depending on site conditions, the size of augers used, and size of the drill rig.
- In augering through clean sand formations below the water table, the sand will tend to flow into the hollow stem when the plug is removed for soil sampling or well installation. This will require either drilling while maintaining a positive head of water inside the auger (to retard sand inflow) and/or washing out any sand inflow prior to proceeding with sampling or well installation.

The procedures for performing hollow stem auger soil investigation shall conform with the applicable ASTM

Standards: D1452-80 and D1586-84. The hollow stem auger may be advanced by any power operated drilling machine having sufficient torque and ram range to rotate and force the auger to the desired depth. The machine must, however, be equipped with the accessory equipment needed to perform required sampling.

When taking soil samples for chemical analysis, the hollow-stem auger shall be plugged until the desired sampling depth is reached. Samples can be taken using split-spoon or Shelby tube samplers pressed into the formation in advance of the auger. If the sample is to be taken at a relatively deep point, the auger may be advanced without a plug to within five feet of the sample depth. Then clean out the auger stem, insert a plug and continue to the sampling depth. The plug is then removed and samples taken as specified by the rig geologist. Samples should be taken according to the specifications of the sampling plan. Any required sampling shall be performed by rotation, pressing, or driving in accordance with the standard or approved method governing use of the particular sampling tool. The sequence shall be repeated for each sample desired.

The hollow stem auger may be used without the plug, when boring for geotechnical examination, for well installation, or when operating below the water table or in other water containing formations. In such cases the hollow stem auger shall be advanced to the desired sampling depth and the hole shall be cleaned out in the same manner prescribed for casing cleanout (see Section 7.0 of this guideline). Sampling will be performed as in any cased hole.

When drilling below the water table, it may be necessary to keep the hollow stem auger full of water, at least to the level of the water table, to prevent blowback and plugging of the auger. If water is added to the hole, it may be required to be sampled and analyzed to determine if it is free from contaminants prior to use. Alternately, specially designed plugs which allow passage of formation water but not solid material may be used (see Reference 1 of this guideline). This method also prevents blowback and plugging of the auger when the plug is removed for sampling. If gravelly or hard material is encountered which prevents advancing the auger, augering should be halted and either driven casing or hydraulic rotary methods should be attempted. If refusal of drilling is encountered, a five foot core run should be conducted to confirm bedrock (See Section 5.9 of this guideline).

At the option of the Project Manager and Site Geologist, when resistant materials prevent the advancement of the auger, a new boring can be attempted. The original boring must be properly backfilled and abandoned, and the new boring started a short distance away at a location determined by the site geologist. If multiple water bearing strata were encountered, the original boring must be grouted closed. In some formations it may be prudent to also grout borings which only penetrate the water table aquifer, since loose backfill in the boring would still provide a preferred pathway for surface liquids to reach the water table.

5.2 Continuous-Flight Solid-Stem Auger Drilling

This method operates in a similar manner as hollow-stem augers. Practical application of this method is severely restricted as compared with hollow stem augers. Split barrel (split-spoon) sampling cannot be done without pulling the augers which may allow the hole to collapse. The method is therefore very time consuming and is not cost effective. Also, augers would have to be withdrawn before installing a monitoring well, which again, may allow the hole to collapse. Furthermore, geologic logging by examining the soils brought to the surface is unreliable as in the case of the hollow stem auger, and depth to water may be difficult to determine while drilling.

There would be very few situations where use of a solid stem auger would be preferable to other drilling methods. The only practical applications of this method would be to drill boreholes for well installation where no lithologic information is desired and the soils are such that the borehole can be expected to remain open after the augers are withdrawn. Alternatively, the technique can be used to find depth to bedrock in an area when no other information is required from drilling.

5.3 Hydraulic Rotary Drilling

Hydraulic drilling includes air-rotary and fluid-rotary drilling.

5.3.1 Air-Rotary Drilling

Air-rotary drilling is a method of drilling where the borehole is advanced by rapid rotation of the drilling bit, which cuts, chips, and grinds the material at the bottom of the hole into small particles. The bit is cooled and the cuttings are removed by pumping air from a compressor down through the drill rods and bit and up the annulus between the borehole wall and the drill rods. Air rotary rigs are available throughout much of the United States and are well suited for many drilling applications. A variation of the air rotary method is the air hammer method, which uses a pneumatic or percussion hammer that pulverizes rock and uses air to return cuttings to the surface.

Air rotary rigs operate best in hard rock formations. Formation water is blown out of the hole along with the cuttings, so it is possible to determine when the first water-bearing zone is encountered. After filtering water blown from the hole, collection and field analysis may provide preliminary information regarding changes in water quality for some parameters. Where significant water inflow is encountered, foaming agents may be added to enhance the ability of the air stream to remove cuttings from the wellbore. Formation sampling ranges from excellent in hard, dry formations to nonexistent when circulation is lost in cavernous limestones and other formations with cavities.

Casing is required to keep the borehole open when drilling in soft, caving formations below the water table. When more than one water-bearing zone is encountered and where the hydrostatic pressures are different, flow between zones will occur between the time the drilling is done and the time the hole can be properly cased and one zone grouted off. Multiple casing strings can be used to rectify this problem, if necessary. Synthetic drilling aids are not usually used in air rotary drilling. If the air is filtered to capture compressor lubricants, contamination can be minimized more effectively than with other methods. In badly contaminated subsurface situations, air rotary drilling must be used carefully to minimize the exposure of drilling personnel to potentially hazardous materials.

Air rotary methods are conductive to drilling in hard rock and other consolidated formations where a mud or water lining is unnecessary to support the walls against caving. An important advantage of using the air rotary method is that contamination of the water zone is not a factor since no drilling fluid is used.

5.3.2 Fluid-rotary Drilling

Fluid-rotary drilling operates in a similar manner to air rotary drilling except that a drilling fluid ("mud") or clean water is used in place of air. In this case, the bit is cooled and the cuttings are removed by pumping water or drilling fluid from a sump down through the drill rods and bit and up the annulus between the borehole wall and the drill rods. The water or "mud" flows first into a settling pit and ultimately back to the main pit for recirculation. Water alone may be used when the depth is small and the soil is stable. Drilling mud is sometimes preferred, since the required flow is smaller and the mud serves to stabilize the hole; however, the mud may clog permeable soil units. A sample should be collected of any material introduced into the well (water, drilling mud, additives, etc.). The sample should be retained for future analysis if any question of contamination arises. A section of casing is used to start the hole, but the remaining part of exploratory boreholes advanced by rotary drilling is usually uncased except in soft soils.

When rotary drilling is used for exploratory borings, items such as motors, rotary driving mechanisms, winches, and pumps, are generally assembled as a unit, with a folding mast mounted on a truck or tractor. The unit also may be mounted on intermediate skids so that it can be placed on a raft or moved into places inaccessible to motor vehicles. Skid mounted drilling machines can also be used for rotary drilling.

Many types of rotary drilling bits are used, depending on the character of the material to be penetrated. Fishtail bits and two-bladed bits are used in relatively soft soils and three-to-four-bladed bits in firmer soils and soft rock. The cutting edges are surfaced with tungsten carbide alloys or are formed by special hard metal inserts. The bits used in rock have several rollers with hard-surfaced teeth. The two-cone bits are used in soft or broken formations, but the tri-cone and roller bits provide smoother operation and are more efficient in harder rocks. The number of rollers and the number and shape of the teeth are varied in accordance with the character of the rock. Relatively few and large teeth are used in soft rock, and the teeth are interfitting so that the bit will be self-cleaning. The teeth in all bits are flushed by drilling fluid flowing out of vents in the base of the bit.

Boreholes produced by rotary drilling may be cased to provide stability. The drill rod and bit can be removed from the borehole, and a sampler can be lowered through the casing to remove soil from the bottom of the boring.

Uncased boreholes are often filled with water to stabilize the hole and to remove material ground up by the boring tools. Water will exert a stabilizing effect on the parts of the hole that extend below groundwater level; however, above the water table, the water may result in a loss of soil strength and a collapse of the hole. Water alone generally prevents neither caving of borings in soft or cohesionless soils nor a gradual squeezing-in of a borehole in plastic soils. Uncased boreholes filled with the water are generally used in rock and are often used in stiff, cohesive soils.

An uncased borehole can be stabilized by filling it with a properly proportioned drilling fluid or "mud," which, when circulated, also serves to remove ground-up material from the bottom of the hole. A satisfactory drilling fluid can occasionally be obtained by mixing locally available fat clays with water, but is is usually advantageous and often necessary to add commercially prepared drilling mud additives. When suitable native clays are not available, the drilling fluid is prepared with commercial products alone. These mud-forming products consist of highly colloidal, gel-forming, thixotropic clays - primarily bentonite - with various chemicals added to control dispersion, thixotropy, viscosity, and gel strength. A sample of the drilling fluid should be analyzed to eliminate the possibility of introducing contamination into the borehole.

The stabilizing effect of the drilling fluid is caused in part by its higher specific gravity (in comparison with water alone) and in part by the formation of a relatively impervious lining or "mudcake" on the side walls of the borehole. This lining prevents sloughing of cohesionless soils and decreases the rate of swelling of cohesive materials. The drilling fluid also facilitates removal of cuttings from the hole. The required velocities and volume of circulation are smaller than for water alone, and the problem of uncontrolled erosion at the bottom of the hole is decreased. Furthermore, the drilling fluid is thixotrophic; that is, it stiffens and forms a gel when agitation is stopped, and it can be liquified again by resuming the agitation. Drilling mud is, therefore, better able than water to keep the cuttings in suspension during the time required for withdrawal and reinsertion of boring and sampling tools. It also reduces abrasion and retards corrosion of these tools.

There are a variety of fluids that can be used with this drilling method. If a drilling fluid other than water/cuttings is used, a "background" sample of the fluid should be taken for analysis of possible organic or inorganic contaminants.

The use of synthetic slurries must be avoided at any location where chemical samples are to be collected, since they contain synthetic organic compounds. However, there is also widespread concern that bentonite muds may absorb volatile organics and other potential contaminants from the groundwater. Extensive well development may therefore be required to remove this mud. One method of avoiding these concerns is to drill, with mud, to a depth of approximately 10 feet above the required groundwater sampling depth, followed by hollow stem auger drilling down to the desired depth before well placement. In this manner, a groundwater sample unaffected by the drilling fluid can be obtained.

Some synthetic drilling fluids which are designed to dissipate in the boring in several days (e.g., "REVERT") have been reported to foster the growth of bacteria in the borehole, and thus should be avoided in drilling borings where subsurface microbial and chemical data is to be collected.

Advantages to this drilling method include:

- The ability to drill in many types of formations.
- Relatively quick and inexpensive.
- Split barrel (split-spoon) or Shelby tube samples can be obtained without removing drill rods.
- In some borings casing may not be needed as the drilling fluids may keep the borehole open.
- Drill rigs are readily available in most areas.

Disadvantages to this method include:

- Formation logging is unreliable if split barrel (split-spoon) samples are not taken (i.e., the depths of materials logged from cuttings delivered to the surface are approximate).

- Drilling fluids reduce permeability of the formation adjacent to the boring to some degree, and require more extensive well development than "dry" techniques (augering, air-rotary).
- No information on depth to water is obtainable while drilling.
- Fluids are needed for drilling, and there is some question about the effects of the drilling fluids on water samples obtained. For this reason as well, extensive well development may be required.
- In very porous materials (i.e., rubble fill, boulders, coarse gravel) drilling fluids will be continuously lost into the formation. This will require either constant replenishment of the drilling fluid, or the use of casing through this formation.
- Drill rigs are large and heavy, and must be supported with supplied water.

The procedures for performing hydraulic rotary soil investigations and sampling shall conform with the applicable ASTM standards: D2113-83, D1587-83,and D1586-84.

For air or fluid-rotary drilling, the rotary drill may be advanced to the desired depth by any power operated drilling machine having sufficient torque and ram range to rotate and force the bit to the desired depth. The drilling machine must, however, be equipped with any accessory equipment needed to perform required sampling, or coring. Prior to sampling, any settled drill cuttings in the borehole must be removed.

Soil samples shall be taken as specified by the Field Sampling and Analysis Plan, or more frequently, if requested, by the rig geologist. Any required sampling shall be performed by rotation, pressing, or driving in accordance with the standard or approved governing use of the particular sampling tool.

5.4 Reverse Circulation Rotary Drilling

The common reverse circulation rig is a water or mud rotary rig with a large diameter drill pipe which circulates the drilling water down the annulus and up the inside of the drill pipe (reverse flow direction from direct mud rotary). This type of rig is used for the construction of large capacity production water wells and is not suited for small, water quality sampling wells because of the use of drilling muds and the large diameter hole which is created. A few special reverse circulation rotary rigs are made with double-wall drill pipe. The drilling water or air is circulated down the annulus between the drill pipes and up inside the inner pipe.

Advantages of the latter method include:

- The formation water is not contaminated by the drilling water.
- Formation samples can be obtained, from known depths.
- When drilling with air, immediate information is available regarding the water bearing properties of formations penetrated.
- Collapsing of the hole in unconsolidated formations is not as great a problem as when drilling with the normal air rotary rig.

Disadvantages include:

- Double-wall, reverse circulation drill rigs are very rare and expensive to operate.

- Placing cement grout around the outside of the well casing above a well screen often is difficult, especially when the screen and casing are placed down through the inner drill pipe before the drill pipe is pulled out.

5.5 Drilling by the Driven-Casing Method

The driven-casing method consists of alternately driving casing (fitted with a sharp, hardened casing shoe) into the ground using a hammer lifted and dropped by the drill rig and cleaning out the casing using a rotary chopping bit and air or water to flush out the materials. The casing is driven down in stages (usually 5 feet per stage). A continuous record is kept of the blows per foot in driving the casing. The casing is normally advanced by a three hundred (300) pound hammer falling freely through a height of thirty (30) inches. Simultaneous washing and driving of the casing is not recommended. If this procedure is used, the elevations between which water is used in driving the casing should be recorded.

The driven casing method is used in unconsolidated formations only. When the boring is to be used later for well installation, the driven casing used should be at least four inches larger in diameter than the well casing to be installed. Advantages to this method of drilling include:

- Split barrel (split spoon) sampling can be conducted while drilling.
- Well installation is easily accomplished.
- Drill rigs used are relatively small and mobile.
- The use of casing minimizes flow into the hole from upper water bearing layers; therefore multiple aquifers can be penetrated and sampled for rough field determinations of some water quality parameters.

- The method is useful in formations which are unstable and prone to collapse, such as coarse gravels.

Some of the disadvantages include:

- This method can only be used in unconsolidated formations.
- The method is slower than other methods (average drilling progress is 30 to 50 feet per day).
- Maximum depth of the borehole varies with the size of the drill rig and casing diameter used, and the nature of the formations drilled.
- The cost per hour or per foot of drilling may be substantially higher than other drilling methods.
- It is difficult and time consuming to pull back the casing if it has been driven very deep (deeper than 50 feet in many formations).

5.6 Cable Tool Drilling

A cable tool rig uses a heavy, solid-steel, chisel-type drill bit ("tool") suspended on a steel cable, which when raised and dropped chisels or pounds a hole through the soils and rock. Drilling progress may be expedited by the use of "slip-jars" which serve as a cable-activated down hole percussion device to hammer the bit ahead.

When drilling through the unsaturated zone, some water must be added to the hole. The cuttings are suspended in the water and then bailed out periodically. When below the water table, after sufficient groundwater is entering the borehole to replace the water removed by bailing, no further water may be added.

When soft caving formations are encountered, it is necessary to drive casing as the hole is advanced to prevent collapse of the hole. Often the drilling can be only a few feet below the bottom of the casing. Because the drill bit is lowered through the casing, the hole created by the bit is smaller than the casing. Therefore, the casing (with a sharp, hardened casing shoe on the bottom) must be driven into the hole (see Section 5.5 of this guideline).

Advantages of the cable-tool method include the following:

- Information regarding water-bearing zones is readily available during the drilling. Even relative permeabilities and rough water quality data from different zones penetrated can be obtained by skilled operators.
- The cable-tool rig can operate satisfactorily in all formations, but is best suited for caving, boulder, cable or coarse gravel type formations (e.g., glacial till) or formations with large cavities above the water table (such as limestones).
- When casing is used, the casing seals formation water out of the hole, preventing down-hole contamination and allowing sampling of deeper aquifers for field-measurable water quality parameters.
- Split barrel (split spoon) or Shelby tube samples can be collected through the casing.

Disadvantages include:

- Drilling is slow compared with rotary rigs.
- The necessity of driving the casing in unconsolidated formations requires that the casing be pulled back if exposure of selected water-bearing zones is desired. This process complicates the well completion process and often increases costs. There is also a chance that the casing may become stuck in the hole.

- The relatively large diameters required (minimum of 4-inch casing) plus the cost of steel casing result in higher costs compared to rotary drilling methods where casing is not required, such as use of a hollow stem auger.

- Cable-tool rigs have largely been replaced by rotary rigs. In some parts of the U.S., availability may be difficult.

5.7 Jet Drilling (Washing)

Jet drilling consists of pumping water or drilling mud down through a small diameter (1/2 to 2-inch) standard pipe (steel or PVC). The pipe may be fitted with a chisel bit or a special jetting screen. Formation materials dislodged by the bit and jetting action of the water are brought to the surface through the annulus around the pipe. As the pipe is jetted deeper, additional lengths of pipe may be added at the surface.

Jet percussion is a variation of the jetting method, in which the casing is driven with a drive weight. Normally, this method is used to place 2-inch diameter casing in shallow, unconsolidated sand formations but has been used to install 3 to 4-inch diameter casings to 200 feet.

Jetting is acceptable in very soft formations, usually for shallow sampling, and when introduction of drilling water to the formation is acceptable. Such conditions would occur during rough stratigraphic investigation or installation of piezometers for water level measurement.

Advantages of this method include:

- Jetting is fast and inexpensive.

- Because of the small amount of equipment required, jetting can be accomplished in locations where access by a normal drilling rig would be very difficult. For example, it would be possible to jet down a well point in the center of a lagoon at a fraction of the cost of using a drill rig.

- Jetting numerous well points just into a shallow water table is an inexpensive method for determining the water table contours, hence flow direction.

Disadvantages include the following:

- A large amount of foreign water or drilling mud is introduced above and into the formation to be sampled.
- Jetting is usually done in very soft formations which are subject to caving. Because of this caving, it is often not possible to place a grout seal above the screen to assure that water in the well is only from the screened interval.
- The diameter of the casing is usually limited to two inches; therefore, samples must be obtained by methods applicable to small diameter casings.
- Jetting is only possible in very soft formations that do not contain boulders or coarse gravel, and the depth limitation is shallow (about 30 feet without jet percussion equipment).
- Large quantities of water are often needed.

5.8 Drilling with a Hand Auger

This method is applicable wherever the formation, total depth of sampling, and the site and groundwater conditions are such as to allow hand auger drilling. Hand augering can also be considered at locations where drill rig access is not possible. All hand auger borings will be performed according to ASTM D1452-80.

Samples should be taken continuously unless otherwise specified by the Site Specific Sampling Protocol. Any required sampling is performed by rotation, pressing, or driving in accordance with the standard or approved method governing use of the particular sampling tool. Typical equipment used for sampling and advancing shallow "hand auger" holes are Iwan samplers (which are rotated) or post hole diggers (which are operated like tongs). This technique is slow but effective where larger pieces of equipment do not have access and where very shallow holes are desired (less than 5 feet). Surficial soils must be composed of relatively soft and non-cemented formations to allow penetration by the auger.

5.9 Rock Drilling and Coring

When soil borings cannot be continued using augers or rotary methods due to the hardness of the soil, or when rock or large boulders are encountered, drilling and sampling can be performed using a diamond bit corer in accordance with ASTM D2113. These procedures are addressed in a separate protocol, SOP:EXP-6, Rock Core Drilling, Coring and Rock Core Handling.

5.10 Drilling & Support Vehicles

In addition to the drilling method required to accomplish the objectives of the field program, the type of vehicle carrying the drill rig and/or support equipment, and its suitability for the site terrain, will often be an additional deciding factor in planning the drilling program. The types of vehicles available are extensive, and depend upon the particular drilling subcontractor's fleet. Most large drilling subcontractors will have a wide variety of vehicle and drill types suited for most drilling assignments in their particular region, while smaller drilling subcontractors will usually have a fleet of much more limited diversity. The weight, size, and means of locomotion (tires, tracks, etc.) of the drill rig must be selected to be compatible with the site terrain, to assure adequate mobility between borehole locations. Such considerations also apply to necessary support vehicles used to transport water and/or drilling materials to the drill rigs at the borehole locations. When the drill rigs or support vehicles do not have adequate mobility to easily traverse the site, provisions must be made for assisting equipment such as bulldozers, winches, timber planking, etc., to maintain adequate progress during the drilling program.

5.11 Equipment Sizes

In planning subsurface exploration programs, care must be taken in specifying the various drilling components, so they will fit properly in the boring or well.

For drilling open boreholes using rotary drilling equipment, tri-cone drill bits are employed with air, water or drilling mud to remove cuttings and cool the bit. Tri-cone bits are slightly smaller than the holes they drill (i.e., 5 7/8" or 7 7/8" bits will nominally drill 6" and 8" holes, respectively.

For obtaining split-barrel samples of a formation, samplers are manufactured in sizes ranging from 2-inches to 4-1/2 inches in outside diameter. However, the most commonly used size is the 2-inch O.D., 1-3/8-inch I.D. split-barrel sampler. When this sampler, is used, and driven by a 140-lb hammer dropping 30-inches, the procedure is called a Standard Penetration Test, and the blows per foot required to advance the sampler into formation can be correlated to the formation's density or strength.

In planning the drilling of boreholes using hollow stem augers or casing, in which Shelby tube samples or diameter core drilling will be performed, refer to the various sizes and clearances provided in EXP-3T1 of this guideline.

5.12 Estimated Drilling Progress

To estimate the anticipated rates of drilling progress for a site the following must be considered:

- The speed of the drilling method employed.
- Applicable site conditions (e.g., terrain, mobility between borings, difficult drilling conditions in

bouldery soils, rubble fill or broken rock, etc.)

- Project imposed restrictions (e.g., drilling while wearing personal protective equipment, decontamination of drilling equipment, etc.).

Based on recent experience in drilling average soil conditions (no boulders) and taking samples at 5' intervals, for moderate depth (30 to 50') boreholes (not including installation or development of wells), the following daily rates of total drilling progress may be anticipated for the following drilling methods:

Drilling Method	Avg. Daily Progress (linear feet)
Hollow stem augers	75
Solid stem augers	50
Mud Rotary Drilling	100
Reverse Circulation Rotary	100
Skid Rig with Driven Casing	30
Rotary with Driven Casing	50
Cable Tool	30
Hand Auger	Varies
Continuous Rock Coring	50

This rate will vary depending upon level of personnel protective equipment required for the specific site.

6. TELESCOPING BELOW A CONFINING LAYER

A telescoping technique minimizes the potential for the migration of contaminated groundwater to lower strata below a confining layer. The telescoping technique consists of drilling to a confining layer utilizing a spun casing method with a diamond cutting or augering shoe, (a method similar to the rock coring method described in SOP:EXP-6, except that larger casing is used) or a driven casing method (see Section 5.5 of this guideline), and installing a specified diameter steel well casing. The operation consists of three separate steps. Initially, a drilling casing usually of 8" diameter is installed followed by installation of the well casing (6" diameter is common). This well casing is driven into the confining layer to insure a tight seal at the bottom of the hole. The well casing is sealed at the bottom of the hole with a bentonite-cement slurry. The remaining depth of the boring is drilled utilizing a narrower diameter spun or driven casing technique within the outer well casing. A smaller diameter well casing with an appropriate length of slotted screen on the lower end is installed to the surface.

Clean sand is placed in the annulus around and to a point about 2 ft above the screen prior to withdrawal of the drilling casing. The annular space above the screen and to a point 2 ft above the bottom of the outer well casing is sealed with a tremied cement-bentonite slurry which is pressure-grouted or displacement-grouted into the hole. The remaining casing annulus is backfilled with clean material and grouted at the surface, or it is grouted all the way to the surface.

7. CLEANOUT OF CASING PRIOR TO SAMPLING

The boring must be completely cleaned of disturbed soil, segregated coarse material and clay adhering to the inside walls of the casing. The cleaning must extend to the bottom edge of the casing and, if possible, a short distance further (1 or 2 inches) to bypass disturbed soil resulting from the advancement of the casing. Loss of wash water during cleaning should be recorded.

For disturbed samples both above and below the water table and where introduction of relatively large volumes of wash water is permissible, the cleaning operation is usually performed by washing the material out of the casing with water; however, the cleaning should never be accomplished with a strong, downward directed jet which will disturb the underlying soil. When clean out has reached the bottom of the casing or slightly below (as specified above), the string of tools should be lifted one foot off the bottom with the water still flowing, until the wash water coming out of the casing is clear of granular soil particles. In formations where the cuttings contain gravel and other larger particles, it is often useful to repeatedly raise and lower the drill rods and wash bit while washing out the hole, to force these large particles upward out of the hole. As a time saver, the drilling Contractor may be permitted to use a split barrel (split-spoon) sampler with the ball check valve removed as the clean out tool, provided the material below the spoon is not disturbed and the shoe of the spoon is not damaged. However, because the ball check valve has been removed, in some formations it may be necessary to install a flap valve or spring sample retainer in the split-spoon drive head, to prevent the sample from falling out as the sampler is withdrawn from the hole. The use of jet-type chopping bits is discouraged except where large boulders and cobbles or hard cemented soils are encountered. If water markedly softens the soils above the water table, clean out should be performed dry with an auger.

For undisturbed samples below the water table, or where wash water must be minimized, clean out is usually accomplished with an appropriate diameter clean out auger. This auger has cutting blades at the bottom to carry loose material up into the auger, and up turned water jets just above the cutting blades to carry the removed soil to the surface. In this manner there is a minimum of disturbance at the top of the material to be sampled. If any gravel material washes down into the casing and cannot be removed by the clean out auger, a split-barrel sample can be taken to remove it. Bailers and sandpumps should not be used. For undisturbed samples above the groundwater table, all operations must be performed in a dry manner.

If all of the cuttings created by drilling through the overlying formations are not cleaned from the borehole prior to sampling, some of the problems which may be encountered during sampling include:

- When sampling is attempted through the cuttings remaining in the borehole, all or part of the sampler may become filled with the cuttings. This limits the amount of sample from the underlying formation which can enter and be retained in the sampler, and also raises questions on the validity of the sample.
- If the cuttings remaining in the borehole contain coarse gravel and/or other large particles, these may block the bit of the sampler and prevent any materials from the underlying formation from entering the sampler when the sampler is advanced.
- In cased borings, should sampling be attempted through cuttings which remain in the lower

portion of the casing, these cuttings could cause the sampler to become bound into the casing, such that it becomes very difficult to either advance or retract the sampler.

- When sampler blow counts are used to estimate the density or strength of the formation being sampled, the presence of cuttings in the borehole will usually give erroneously high sample blow counts.

To confirm that all cuttings have been removed from the borehole prior to attempting sampling, it is important that the rig geologist measure the "stickup" of the drill string. This is accomplished by measuring the assembled length of all drill rods and bits or samplers (the drill string) as they are lowered to the bottom of the hole, below some convenient reference point of the drill string; then to measure the height of this reference point above the ground surface. The difference of these measurements is the depth of the drill string (lower end of the bit or sampler) below the ground surface, which must then be compared with the depth of sampling required (installed depth of casing or depth of borehole drilled). If the length of drill string below grade is more than the drilled or casing depth, the borehole has been cleaned too deeply, and this deeper depth of sampling must be recorded on the log. If the length of drill string below grade is less than the drilled or casing depth, the difference represents the thickness of cuttings which remain in the borehole. In most cases, an inch or two of cuttings may be left in the borehole with little or no problem. However, if more than a few inches for cuttings are encountered, the borehole must be recleaned prior to attempting sampling.

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TABLE EXP-3T1

(2 OF 2)
DRILLING EQUIPMENT SIZES

Drilling Component	Designation or Hole Size (in)	O.D. (in)	I.D. (in)	Coupling I.D. (in)
Flushed Coupled Casing	RX	1 7/16	1 3/16	1 3/16
	EX	1 13/16	1 5/8	1 1/2
	AX	2 1/4	2	1 29/32
	BX	2 7/8	2 9/16	2 3/8
	NX	3 1/2	3 3/16	3
	HX	4 1/2	4 1/8	3 15/16
Flushed Joint Casing	RW	1 7/16	1 3/16	
	EW	1 13/16	1 1/2	
	AW	2 1/4	1 29/32	
	BW	2 7/8	2 3/8	
	NW	3 1/2	3	
	HW	4 1/2	4	
	PW	5 1/2	5	
	SW	6 5/8	6	
	UW	7 5/8	7	
	ZW	8 5/8	8	
Diamond Core Barrels	EWM	1 1/2	7/8 **	
	AWM	1 7/8	1 1/8 **	
	BWM	2 3/8	1 5/8 **	
	NWM	3	2 1/8 **	
	HWG	3 7/8	3	
	2 3/4 x 3 7/8	3 7/8	2 11/16	
	4 x 5 1/2	5 1/2	3 15/16	
	6 x 7 3/4	7 3/4	5 15/16	
	AQ (wireline)	1 57/64	1 1/16	
	BQ (wireline)	2 23/64	1 7/16 **	
	NQ (wireline)	2 63/64	1 7/8	
	HQ (wireline)	3 25/32	2 1/2	

** Because of the fragile nature of the core and the difficulty to identify rock details, use of small diameter core (1 3/8") is not recommended.

TABLE EXP-3T1

(1 OF 2)
DRILLING EQUIPMENT SIZES

Drilling Component	Designation or Hole Size (in)	O.D. (in)	I.D. (in)	Coupling I.D. (in)
Hollow-Stem Augers	6 1/4	5	2 1/4	-
	6 3/4	5 3/4	2 3/4	-
	7 1/4	6 1/4	3 1/4	-
	13 1/4	12	6	-
Thin Wall Tube Samplers	-	2	1 7/8	-
	-	2 1/2	2 3/8	-
	-	3	2 7/8	-
	-	3 1/2	3 3/8	-
	-	4 1/2	4 3/8	-
	-	5	4 3/4	-
Drill Rods	RW	1 3/32	23/32	13/32
	EW	1 3/8	15/16	7/16
	AW	1 3/4	1 1/4	5/8
	BW	2 1/8	1 3/4	3/4
	NW	2 5/8	2 1/4	1 3/8
	HW	3 1/2	3 1/16	2 3/8
	E*	1 5/16	7/8	7/16
	A	1 5/8	1 1/8	9/16
	B	1 7/8	1 1/4	5/8
	N	2 3/8	2	1
				Wall Thickness (in
Driven External Coupled Extra Strong Steel* Casing	2 1/2	2.875	2.323	0.276
	3	3.50	2.90	0.3
	3 1/2	4.00	3.36	0.318
	4	4.50	3.83	0.337
	5	5.63	4.81	0.375
	6	6.625	5.76	0.432
	8	8.625	7.63	0.5
	10	10.750	9.750	0.5
	12	12.750	11.750	0.500

*Add twice the casing wall thickness to casing O.D. to obtain the approximate O.D. of the external pipe couplings.

STANDARD OPERATING PROCEDURE
SOP: EXP-4

KEYSTONE
ENVIRONMENTAL RESOURCES, INC.

SOP: EXP-4. SOIL AND ROCK BORING SAMPLE LOGGING

1. SCOPE AND PURPOSE

This SOP will provide descriptions of the standard classifications and methods for the logging of soil/rock samples and the geophysical logging of boreholes. These techniques should be used during each borehole advancement in order to obtain a uniform description of the subsurface lithology. It is particularly important that each person logging boreholes does so in a consistent fashion to insure that strata and contaminant distribution can be correlated from borehole to borehole.

Borehole logs provide information which is used in the determination of geological conditions (stratification, relative permeability, etc.) and ultimately in the assessment of contaminant distribution and in evaluations of remedial actions. Borehole logging is also performed to assure that each well is constructed according to specifications.

2. RESPONSIBILITIES

The Project or Site Geologist is responsible for overseeing all boring activities and assuring that each borehole is logged accurately and completely. If more than one rig is being used on site, he/she must ascertain that each Rig Geologist is properly trained in logging procedures and that these geologists will produce consistent logs. A brief review session to standardize classifications may be warranted when the first boring is completed. Although this guideline indicates that geologists will be performing the logging, other qualified geoscience personnel (geotechnical engineers, civil engineers) may perform this work in most cases.

3. SOIL BORING FIELD LOGS AND DOCUMENTATION

- Each boring will be fully described on a boring log (See Form EXP-4BL1) by the rig geologist as the boring is being drilled. Data which will be included in the logs, when applicable, are listed below:

- Identifying number and location of each boring will be recorded.

- Depths recorded in feet and tenths of feet.

- Soil classification in accordance with the Unified Soil Classification System (USCS), (See Section 4 and Figure EXP-4BL2 of this guideline). These classifications will be prepared in the field by the geologist and will be subject to revision based on laboratory tests or subsequent review.

- A full description of soil samples. For split-spoon, solid tube, thin wall, soil core, or otherwise intact samples, the description will include but not be limited to the USCS two-letter classification, plus a more complete verbal description following the Burmister system of color, consistency, grain size and size distribution (See Attachment EXP-4A1).

- Depth limits, type and number of each sample taken. All samples shall be numbered consecutively.

- The number of blows required for each six inch penetration of split-spoon sampler and for each twelve inch penetration of casing; hammer weight and length of fall for split-spoon or driven samplers; hydraulic pressure used to push Shelby tubes. If Shelby tubes are pushed manually, that will be indicated.

- The estimated interval for each sample.

- Depth to water as first encountered during drilling, along with the method of determination. Any distinct water-bearing zones below the first zone also will be noted.

- If drilling fluid is used the fluid losses, interval over which they occur and the quantity lost will be recorded.

  - A general description of the drilling equipment used. This description, including such information as rod size, bit type, pump type, rig manufacturer, and model, may be provided in a general legend.

  - Dates and times of start and completion.

  - Names of Contractor, driller and rig geologist.

  - Size and length of casing used in each borehole.

  - HNU and/or OVA meter readings and related signs of visible contamination for each sample or from cuttings that appear contaminated.

- As the boring is drilled, the rig geologist will evaluate samples recovered, together with observation of the drill cuttings, wash water (if any), drill performance, etc., to determine appropriate stratigraphic definitions or distinctions within the soil column. Such contacts or breaks between strata must be determined by the rig geologist and indicated on the boring log. If such information is not provided, the "log" is nothing more than a listing of individual sample descriptions. In general, a stratigraphic unit contains only similar soils which can be classified within the same two-letter USCS classification category symbol. In some cases, significant differences in soil color, grain size distribution, strength, etc., would be sufficient to classify soils having the same two-letter USCS classification category symbol, into two or more distinct strata.

- After the rig geologist has indicated the appropriate stratigraphic breaks on the log, he/she should develop and record an appropriate description for each defined stratigraphic unit. Each description should contain information about the color, grain size distribution, consistency, moisture, etc., and the appropriate two-letter USCS classification category symbol. The descriptions should be entered on the log in underlined capital letters.

- Each sample collected for chemical or geotechnical analysis (See SOP:EXP-5) will be labeled according to the specific sampling SOP, Sampling Packaging and Shipment Procedures, and proper chain-of-custody procedures will be initiated. For those borings drilled employing the mud rotary method, a sample of the mud shall be taken before it is used in the boring. This sample will be used for chemical analysis of the mud.

4. CLASSIFICATION OF SOILS

All soil classification data should be written directly on the boring log and in a field notebook. The method of deriving the classification should be described, or referenced to this guideline. Handling of samples during soil classification should be coordinated with chemical sampling activities.

4.1 USCS Classification

Soils are to be classified according to the Unified Soil Classification System (USCS). This method of classification is detailed in Figure EXP-4BL2. This method of classification identifies soil types on the basis of grain size and liquid limits, and categorizes them by two-letter symbols.

In the USCS system, fine-grained soils, or fines, are classified as those which will pass through a No. 200 U.S. standard sieve (0.074 mm) and are of two types: silt (M) and clay (C). Some classification systems define size ranges for these soil particles, but for field classification purposes, they are identified by their respective behaviors only. Organic material (O) is a common component of soil but has no size range, and is recognized by its composition. Highly organic fibrous materials containing a predominance of undecomposed plant or woody fiber are root mat, peat, humus and lignite.

Coarse-grained soils are divided into two types, rock fragments and sand or gravel. The terms sand and gravel not only refer to the size of the soil particles but also to their depositional history.

Gravelly soils are identified by a (G) as the first letter in the two-letter symbol, whereas sandy soils are identified with an (S). The term rock fragments should be used to indicate granular materials resulting from the breakup of rocks. These materials are normally angular, indicating little or no transport from their source. When the term "rock fragments" is used it should be followed by a size designation such as "(1/4-1/2" diameter)" or "course-sand size" either immediately after the entry or in the remarks column. The USCS classification would not be affected by this variation in terms.

The second letter in the two-letter USCS symbol provides information about the grain size distribution of granular soils, or the plasticity characteristics of fine-grained soils. These second-letter modifiers are (P) poorly graded/well sorted, (W) well graded/poorly sorted, (c) clayey, (M) silty, (L) low plasticity, or (H) high plasticity.

Well graded granular soils, within the limited definition of USCS (SW or GW), do not frequently occur in nature. Therefore, while a sample may appear to contain all of the sizes for granular soil (fine, medium and coarse), it is not likely to contain them in the proper proportions to meet the USCS definitions for well graded soil. Thus, field classifying such soils as poorly graded (SP or GP) is more likely to be correct in most cases.

4.2 Burmister Classification System

This system deals with rather precise identification of soil components and proportions. A proper identification allows construction of a grain size curve within a very narrow range. The system requires considerable laboratory and field practice before accurate identifications can be made. An accurate identification tells much about a soil's characteristics; e.g., plasticity, permeability, frost heave potential, compactibility, etc. Slight variations in the identification could indicate appreciable changes in some of the soil properties. Thus every sample is carefully identified in order to detect the potential changes. Many of the other systems of soil classification are more general and may therefore give only general impressions rather than specific impressions (See Table EXP-4BL3 and Attachment EXP-4A1).

4.3 Grain Size Classification

The names of soils, such as "silt" or "clay" are commonly assigned to different grain-size fractions. The most widely accepted size classifications are shown in graphic form in Figure EXP-4BL4. With few exceptions natural soils consist of a mixture of two or more different grain-size fractions. The designation of soils by the names of their principal constituents is facilitated by triangular diagrams where the three coordinates represent the percentage of sand, silt and clay. A mixed-grained soil is located on this diagram based on the fraction of each constituent it contains. Where this point is located determines the type to which the soil belongs (See Figure EXP-4BL5).

A classification system based on size alone can be misleading because the physical properties of the finest soil fractions depend on many factors other than grain size. Therefore, if the words "silt" or "clay" are used to express grain size it should be described in that manner, such as "clay-size particle".

4.4 Soil Descriptors

In nature, soils are comprised of particles of varying size and shape and are combinations of the various soil types. Figure EXP-4BL4 lists grain size classifications to be used in describing soils or rocks. The following terms are useful in the description of soil:

Terms Identifying Proportion of the Component	Defining Range of Percentages by Weight
trace	0-10%
little	11-20%
some	21-35%
"and"	36-50%

These descriptions are adopted from the Burmister Classification System, and are more completely described in Attachment EXP-4A1.

5. CONDITION AND STRUCTURE OF SOILS

5.1 Relative Density and Consistency

To classify the relative density and/or consistency of a soil, the geologist must first identify the soil type. Granular soils contain predominantly sands and gravels. They are noncohesive (particles do not adhere well when compressed). Finer grained soils (silts and clays) are cohesive (particles will adhere together when compressed).

- The density of noncohesive, granular soils is classified according to standard penetration resistances obtained from split barrel sampling methods detailed in SOP:EXP-5A. Those designations are:

Designation	Relative Density	Standard Penetration Resistance (blows per foot)
Very loose	0-15%	0 to 5
Loose	15-40%	6 to 10
Medium dense	40-70%	11 to 30
Dense	70-85%	31 to 50
Very dense	85-100%	Over 50

Standard penetration resistance is the number of blows required to drive a split-barrel sampler with a 2-in. outside diameter 12 in. into the material using a 140-lb hammer falling freely through 30 in. The sampler is driven through an 18-in. or 24-in. sample interval and the number of blows is recorded for each 6-in. increment. Relative density can be rated from the standard penetration resistance in accordance with modified USBR criteria as shown on Figure EXP-4BL6 as a function of overburden pressure. It is important to note that if gravel or rock fragments are broken by the sampler or if rock fragments are lodged in the tip, the resulting blow count will be erroneously high, reflecting a higher density than actually exists. This should be noted on the log and referenced to the sample number.

- The consistency of cohesive soils is determined by performing field tests and identifying the consistency as shown in Figure EXP-4BL7. The consistency of cohesive soils is determined either by blow counts or most accurately by a pocket penetrometer or field Torvane device. The pocket penetrometer method is conducted on a selected sample of the soil, preferably the lowest 0.5 ft of the sample in the split-barrel sampler. The sample should be broken in half and the penetrometer pushed into the end of the sample to determine the consistency. Do not determine consistency by attempting to penetrate a rock fragment. If the sample is decomposed rock, it is classified as a soft decomposed rock rather than a hard soil. Consistency should not be determined solely by blow counts. The pocket penetrometer or Torvane should be used in conjunction with blow counts.

5.2 Moisture

Moisture content is estimated in the field according to four categories: dry, moist, wet, and saturated. In dry soil, there appears to be little or no water. Saturated samples obviously have all the water they can hold. Moist and wet classifications are somewhat subjective and often are determined by the individual's judgement. A suggested parameter for judging this in a fine-grained soil would be calling a soil wet if rolling it in the hand or on a porous surface liberates water, i.e., dirties or muddies the surface. Whatever method is adopted for describing moisture, it is important that the method used by an individual remains consistent throughout an entire drilling job.

Laboratory or field tests for water content should be performed if the natural water content is important.

5.3 Color

Soil colors should be described utilizing a single color descriptor preceded, when necessary, by a modifier to denote variations in shade or color mixtures. A soil could therefore be referred to as "gray" or "light gray" or "blue-gray". Since color can be utilized in correlating units between sampling locations, it is important that color descriptions be kept consistent throughout the field operations.

Colors must be described while the sample is still fresh and moist. Soil samples should be broken or split vertically to describe colors. Soil sampling devices tend to smear the sample surface creating color differences between the sample interior and exterior. Adjectives such as mottled and variegated should be used where applicable.

Soil Color Charts should be used and the type of color chart used should be noted in the field notebook and boring log.

5.4 Stratification

Stratification can only be determined after the sample barrel is opened. The stratification or bedding thickness for soil is dependent on grain size and composition. The classification to be used for stratification description is shown in Figure EXP-4BL8.

5.5 Texture, Fabric and Structure

The texture, fabric, bedding, and structure of the soil should be described. Texture is described as the relative angularity of the particles (for sand-sized grains or larger): rounded, subrounded, subangular, and angular. Fabric should be noted as to whether the particles are flat or bulky and whether there is a particular relation between particles (i.e., stratified, laminated, banded, heterogeneous varved). It is important to recognize defects in a soil structure. The following are often observed: slickensides, rootholes, fissures, weathering and inclusions.

5.6 Mineral/Rock Constituent and Depositional Origin

- The type and condition of mineral and rock constituents should be noted on the boring log and/or fieldbook. Examples are quartz, shale, micaceous, feldspathic, decomposed, friable, etc.

- The depositional origin of the soils will be identified where possible. Alluvial, colluvial, glacial till, outwash and marine are a few of the environments where the soils may have been deposited.

6. TYPICAL IDENTIFICATION OF SOILS

In the description of the soil, its color shall be described first, followed by texture, composition, structure, consistency and moisture, as shown in Table EXP-4BL3. Visual contamination, if any, will be noted in the remarks column of the boring log, and located on the diagram of the lithologic column.

7. FIELD AIDS FOR IDENTIFICATION OF SOILS

In addition to visual observation of the soils recovered in sampling devices, certain field tests may be performed to assist in classifying these soils. Since many of these field tests require some additional handling of the samples, they should only be used in cases where doing so will not be hazardous. Some of these visual aids in soil identification are:

- To evaluate plasticity to distinguish between clay and silts, dry a pat of soil quickly by placing it on a hot surface (i.e., exhaust pipe of the drill rig). Attempt to crumble the fully dried pat in the hand. Clays will tend to break into fragments, with increasing strength displayed by clays of greater plasticity (CH soils). Conversely, pure silt will have virtually no internal cohesion and will very easily pulverize to a very fine powder (Dry Strength Test).

- When a pat of wet silt is held in the hand and shaken (by taping one hand against the other), free water will appear on the surface of the soil, which when touched will recede back into the pat of soil (Shaking Test).

- Clays are sticky to the touch, while silts give no such sticky feeling. Highly plastic clays (CH) will exhibit a greasy feeling.

- Organic soils are usually dark in color (dark brown or black), have an organic (earthy) odor, and often contain remnants of the vegetable matter from which they were formed. When hydrogen peroxide is applied to organic soils, it will bubble and fizz; however, this same reaction can also be caused by certain metals (e.g., iron) in the soil.

- With experience, the percentage of fines in granular soils can be judged by the degree to which handling the wet soil dirties or stains one's hand or gloves. Relatively clean (<5% fines) soils (SP, GP, SW, GW) leave little or no stain, while soils with more than 12% fines (SC, SM, GC, GM) will leave a noticeable stain when handled wet (Smear Test).

- The ability to roll a "thread" of a fine grained soil is an indication of its plasticity. In a moist state highly plastic soils (CH) can be rolled to a very thin (1/16-inch) diameter without breaking, while non-cohesive pure silt cannot be rolled to a thread without crumbling (Thread Test).

- To aid in identifying the grain size distribution of granular soils, samples of each fraction (fine, medium, coarse) can be prepared in the laboratory and used in the field for comparison against the sample. Such comparative samples can either be contained in individual vials or glued on a piece of cardboard.

8. FIELD ROCK DESCRIPTION LOG

A blank log is illustrated in Form EXP-4BL1 and will be used to provide "detailed" geologic rock classification data described in the following sections. In some cases EXP-4BL1 may be sufficient for logging general rock descriptive information. The degree of required rock descriptive information and log format will be determined by the Project Geologist and Project Manger. Each log will be completed by the rig geologist who shall also record the information listed below:

- Names of contractor, driller and rig geologist.
- Number and location of each boring.
- Date and depth of hole at start and end of working day shift.
- Depth and size of any casing at start and end of each core run.
- Depth of start and finish of each core run.
- Core diameter and changes in core size.
- Type and condition of bit.
- Time required to drill each foot of core.
- Total core recovery with information as to possible location of core losses.
- Details of delays and breakdowns.
- A general description of the drilling equipment used.
- Depth to water as first encountered during drilling, along with the method of determination. Any distinct water-bearing zones below the first zone also will be noted.
- Gain or loss of water or mud; type of cuttings.
- Standing water-level at start and end of each working period.
- Description of strata.
- Depth, type and number of each sample taken.
- Details of in-situ tests and instrumentation installed.
- HNu and/or OVA meter readings and related signs of visible contamination for each core or from cuttings that appear contaminated.
- Backfilling and grouting.

9. CLASSIFICATION OF ROCKS

Rocks are grouped into three main divisions: sedimentary, igneous, and metamorphic. Sedimentary rocks are by far the most predominant type exposed at the earth's surface. The following basic names are applied to the type of rocks found in sedimentary sequences:

- Sandstone - Made up predominantly of granular materials ranging between 1/16 and 2 mm in diameter.
- Siltstone - Made up of granular materials less than 1/16 mm in diameter. Fractures irregularly. Medium thick to thick bedded.
- Claystone - Very fine grained rock made up of clay and silt-size materials. Fractures irregularly.
- Shale - A very fine grained, fissile rock. Fractures along bedding planes.
- Limestone - Rock made up of predominantly of calcite ($CaCO_3$). Effervesces upon the application of dilute hydrochloric acid.
- Coal - Rock consisting mainly of organic remains.
- Others - Numerous other rock types are present in the geologic section. Their overall abundance is dependent upon the geographic locations.

In classifying a sedimentary rock the following hierarchy should be noted: rock type, color, stratification, hardness, fracturing, weathering, and other characteristics. All classification data should be written directly on the boring log and in a field notebook. The method of deriving the classification should be described or reference to this guideline or other manuals used should be included.

9.1 Rock Type

As described above, there are numerous names for sedimentary rocks. In most cases a rock will be a combination of several rock types, therefore a modifier such as a sandy siltstone or a silty sandstone can be used. The modifier indicates that a significant portion of the rock type is composed of the modifier. Other modifiers can include carbonaceous, calcareous, siliceous, etc.

Details as to lithology, mineralogy, decomposition and sedimentary structures should be noted.

Grain diameters are used for the classification of clastic sedimentary rocks. Figure EXP-4BL9 is the Udden-Wentworth classification that will be assigned to sedimentary rocks. The individual boundaries are slightly different that the USCS subdivision for soil classification. For field determination of grain sizes, a scale can be used for the coarse grained rocks.

The division between very fine sandstone and siltstone is probably not measurable in the field. The boundary should be determined by use of a hand lens. If the grains cannot be seen with the naked eye but are distinguishable with a hand lens, the rock is a siltstone. If the grains are not distinguishable with a hand lens, the rock is a claystone.

9.2 Color

The color of a rock can be determined in the same manner as for soil samples. Rock core samples should be classified while wet, when possible, and air cored samples should be scraped clean of cuttings and wetted prior to color classification.

If Rock Color Charts are used the chart type must be recorded in the field notebook.

9.3 Stratification

The bedding thickness designations applied to soil classification will also be used for rock classification. The boring log can be used as a graphic log in which standard rock symbols are used and to indicate major stratigraphic changes. Minor changes and related details will be described in the written description.

9.4 Hardness

The hardness of a rock is a function of the compaction, cementation, and mineralogical composition of the rock. A relative scale for sedimentary rock hardness is as follows:

<u>Soft</u> - Weathered, considerable erosion of core, easily gouged by knife blade, scratched by fingernail. Soft rock crushes or deforms under pressure of a pressed hammer. This term is always used for the hardness of the saprolite (decomposed rock which occupies the zone between the lowest soil horizon and firm bedrock).

<u>Medium Soft</u> - Slight erosion of core, slightly gouged by knife blade, or breaks with crumbly edges from single hammer blow.

<u>Medium Hard</u> - No core erosion, easily scratched by knife blade or breaks with sharp edges from single hammer blow.

<u>Hard</u> - Requires several hammer blows to break and has sharp breaks. Cannot be scratched with knife blade.

Note the difference in usage here of the words "scratch" and "gouge". A scratch should be considered a slight depression in the rock (do not mistake the scraping off of rock flour from drilling with a scratch in the rock itself), while a gouge is much deeper.

9.5 Fracturing

The degree of fracturing of a rock is described by measuring the fractures or joint spacing. After eliminating drilling breaks, the average spacing is calculated and the fracturing is described by the following terms:

- Massive: >3′ (May contain hairline cracks)
- Slightly fractured: 1′-3"
- Moderately fractured: 0.5′-1′
- Closely fractured: 0.1′-0.5′
- Intensely fractured: 0.05′-0.1′
- Crushed: <0.05′ (Approx. 0.6")

The structural integrity of the rock can be approximated by calculating the Rock Quality Designation (RQD) of cores recovered. The RQD is determined by adding the total lengths of all pieces exceeding four inches and dividing by the total length of the coring run, to obtain a percentage:

$$RQD = (r/l) \times 100$$

where:

r = Total length of all pieces of the lithologic unit being measured, which are greater than 4 inches in length, and have resulted from natural breaks. Natural breaks include slickensides, joints, compaction slicks, bedding plane partings (not caused by drilling), friable zones, etc., and

l = Total length of the coring run.

Figure EXP-4BL10 provides qualitative descriptive terminology for rock quality (decomposition, consistency, and fracturing), relative hardness and RQD.

9.6 Weathering

The degree of weathering is a significant parameter that is important in determining weathering profiles and is also useful in engineering designs. The following terms can be applied to distinguish the degree of weathering.

Fresh - Rock shows little or no weathering effect. Fractures or joints have little or no staining and rock has a bright appearance.

Slight- Rock has some staining (i.e., discoloration along joints, cracks or exposed surfaces) which may penetrate several centimeters into the rock. Clay fillings of joints may occur. Feldspar grains may show some alteration.

Moderate - Most of the rock, with exception of quartz grains, is stained. Rock is weakened due to weathering and can be easily broken with hammer.

Severe - All rock, including quartz grains, is stained. Some of the rock is weathered to the extent of becoming a soil. The rock is very weak and crumbly.

Decomposed - All minerals are completely altered.

9.7 Other Characteristics

The following items should be included in the rock description:

- Description of contacts between two rock units. These can be sharp or gradational.
- Description of any filled cavities or vugs.
- Description of any joints or open fractures.
- Notation of joints with depth, approximate angle to vertical, any mineral filling or coating, and degree of weathering.
- The angle of bedding or other planar features shall be written in degrees. The preferred angular measurement is made from the perpendicular to the core axis with a protractor. Thus, a bedding feature which is horizontal in the core would be measured as a 0° angle.

Additional information should be provided, including an estimation of the degree of cementation and type of cement for granular sedimentary rocks; a description of the texture and fabric of the rock (i.e., the shape and relationship of component particles or crystals); and the structure or macroscopic features of the rock mass. Generally, rock structure is best seen in the outcrop rather than the hand specimen, but some indications of structure (e.g., horizontal or dipping beds, open joints) can be obtained from core samples.

All information shown on the field classification sheets should be neat to the point where it can be reproduced photographically for report presentation. Sections should be drawn daily by the rig geologist or site geologist. The data should be kept current to provide control of the drilling program and to indicate various areas requiring special consideration and sampling.

9.8 Additional Terms Used in the Description of Rock

The following terms are used to further identify rocks:

Seam - Thin (12 in. or less), probably continuous layer.

Some - Indicates significant (15 to 40 percent) amounts of the accessory material. For example, rock composed of seams of sandstone (70 percent) and shale (30 percent) would be "sandstone -- some shale seams".

Few - Indicates small (0 to 15 percent) amounts of the accessory material. For example, rock composed of seams of sandstone (90 percent) and shale (10 percent) would be "sandstone -- few shale seams".

Interbedded - Used to indicate thin or very thin alternating seams of material occurring in approximately equal amounts. For example, rock composed of seams of sandstone (50 percent and shale (50 percent) would be "interbedded sandstone and shale".

Interlayered - Used to indicate thick alternating seams of material occurring in approximately equal amounts.

10. DATA COLLECTION

Data gathered in the examination of soil and/or rock samples should include all the characteristics listed in Sections 4 through 7 for soil samples, and Sections 8 and 9 for rock samples. Actual sampling of soils or rock for chemical or geotechnical analysis is described in other technique-specific SOP's.

In addition to gathering data on the sample obtained, the geologist should gather additional data by observing the physical features of the study area. Rock outcrops can provide information on lithology, stratigraphy, structure, and degree and orientation of fracturing. Examining the geomorphological features of an area can provide additional insight into the geology of the area. Exposed soils can provide information on the origin of the soils (residual, alluvial etc.) and help in defining the area's geology.

All the above information should be obtained wherever possible and documented in field logbooks and notes. A map of the study area should be carried along on any reconnaissance and any important features found plotted on the map for reference purposes.

Unified Soil Classification

(The No.200 sieve size is about the smallest partical visible to the naked eye)

Field Identification (Excluding particles larger than 3 inches and basing fractions on estimated weights)				Group Symbols	Typical Names	Information Required For Describing Soils	Laboratory Classification Criteria				
Coarse Grained Soils More than half of material is larger than No. 200 sieve size	**Gravels** More than half of coarse fraction is larger than No. 4 sieve size	**Clean Gravels** Little or No fines	Wide range of grain size and substantial amounts of all intermediate particle sizes	GW	Well graded gravels, gravel-sand mixtures, little or no fines.	Give typical name; indicate approximate percentages of sand and gravel, max size; angularity, surface condition, and hardness of the coarse grains; local or geologic name and other pertinent descriptive information; and symbol in parentheses. For undisturbed soils add information on stratification, degree of compactness, cementation, moisture conditions and drainage characteristics. **Example: –** Silty sand, gravelly; about 20% hard, angular gravel particles ½-in. maxium size; rounded and subangular sand grains coarse to fine; about 15% non-plastic fines with low dry strength; well compacted and moist in place; alluvial sand; (SM)	Use grain size curve in identifying the fractions as given under field identification	Determine percentages of gravel and sand from grain size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size) coarse grained soils are classified as follows:	Less then 5% GW,GP,SW,SP. More than 12% GM,GC,SM,SC. 5% to 12% Borderline cases requiring use of dual symbols	$C_u = \frac{D_{60}}{D_{10}}$ Greater than 4 $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between one and 3	
			Predominantly one size or a range of sizes with some intermediate sizes missing	GP	Poorly graded gravels, gravel-sand mixtures, little or no fines					Not meeting all gradation requirements for GW	
		Gravels with fines Appreciable amount of fines	Non-plastic fines (for identification procedures see ML below	GM	Silty gravels, poorly graded sand-gravel-clay mixture					Atterberg limits below "A" line or PI less than 4	Above "A" line with PI between 4 and 7 are borderline cases requiring use of dual symbols.
			Plastic fines (for identification procedures see CL below	GC	Clayey gravels, poorly graded gravel-sand-clay mixtures					Atterberg limits above "A" line with PI greater than 7	
	Sands More than half of coarse fraction is smaller than No. 4 sieve size	**Clean Sands** Little or fines	Wide range in grain sizes and substantial amounts of all intermediate particle sizes	SW	Well graded sands, gravelly sands, little or no fines					$C_u = \frac{D_{60}}{D_{10}}$ Greater than 6 $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between one and 3	
			Predominantly one size or a range of sizes with some intermediate sizes missing	SP	Poorly graded sands, gravelly sands, little or no fines					Not meeting all gradation requirements for SW	
		Sands with Fines Appreciable amount of fines	Non-plastic fines (for identification procedures see ML below)	SM	Silty sands, poorly graded sand-silt mixtures					Atterberg limits below "A" line, with PI less then 4	Above "A" line with PI between 4 and 7 are borderline cases requiring use of dual symbols.
			Plastic fines (for identification procedures see CL below)	SC	Clayey sands, poorly graded sand-clay mixtures					Atterberg limits above "A" line, with PI greater then 7	

IDENTIFICATION PROCEDURES ON FRACTION SMALLER THAN No. 40 SEIVE SIZE

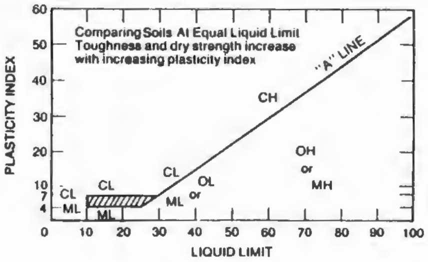
		Dry Strength (Crushing Characteristics)	Dilatancy (Reaction to Shaking)	Toughness (Consistency near plastic limit)	Group Symbols	Typical Names	Information Required For Describing Soils	Laboratory Classification Criteria
Fine Grained Soils More than half of material is smaller than No. 200 sieve size	**Silts and Clays** Liquid limit less than 50	None to slight	Quick to slow	None	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands with slight plasticity	Give typical name; indicate degree and character of plasticity, amount and maximum size of of coarse grains; color in wet condition, odor if any, local or geologic name, and other pertinent descriptive information; and symbol in parentheses. For undisturbed soils add information on structure, stratification, consistency in undisturbed and remolded states, moisture and drainage conditions. **Example: –** Clayey silt, brown; slightly plastic; small percentage of fine sand; numerous vertical root holes; firm and dry in place; loess; (ML)	 Plasticity Chart
		Medium to high	None to very slow	Medium	CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays		
		Slight to medium	Slow	Slight	OL	Organic silts and organic silt-clays of low plasticity		
	Silts and Clays Liquid limit greater than 50	Slight to medium	Slow to none	Slight to medium	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts		
		High to very high	None	High	CH	Inorganic clays of high plasticity, fat clays		
		Medium to high	None to very slow	Slight to medium	OH	Organic clays of medium to high plasticity		
Highly Organic Soils		Readily identified by color, odor, spongy feel and frequently by fibrous texture			Pt	Peat and other highly organic soils		

Figure: EXP-4BL2
Unified Soil Classification System

Figure: EXP-4BL2
Date: 6/88

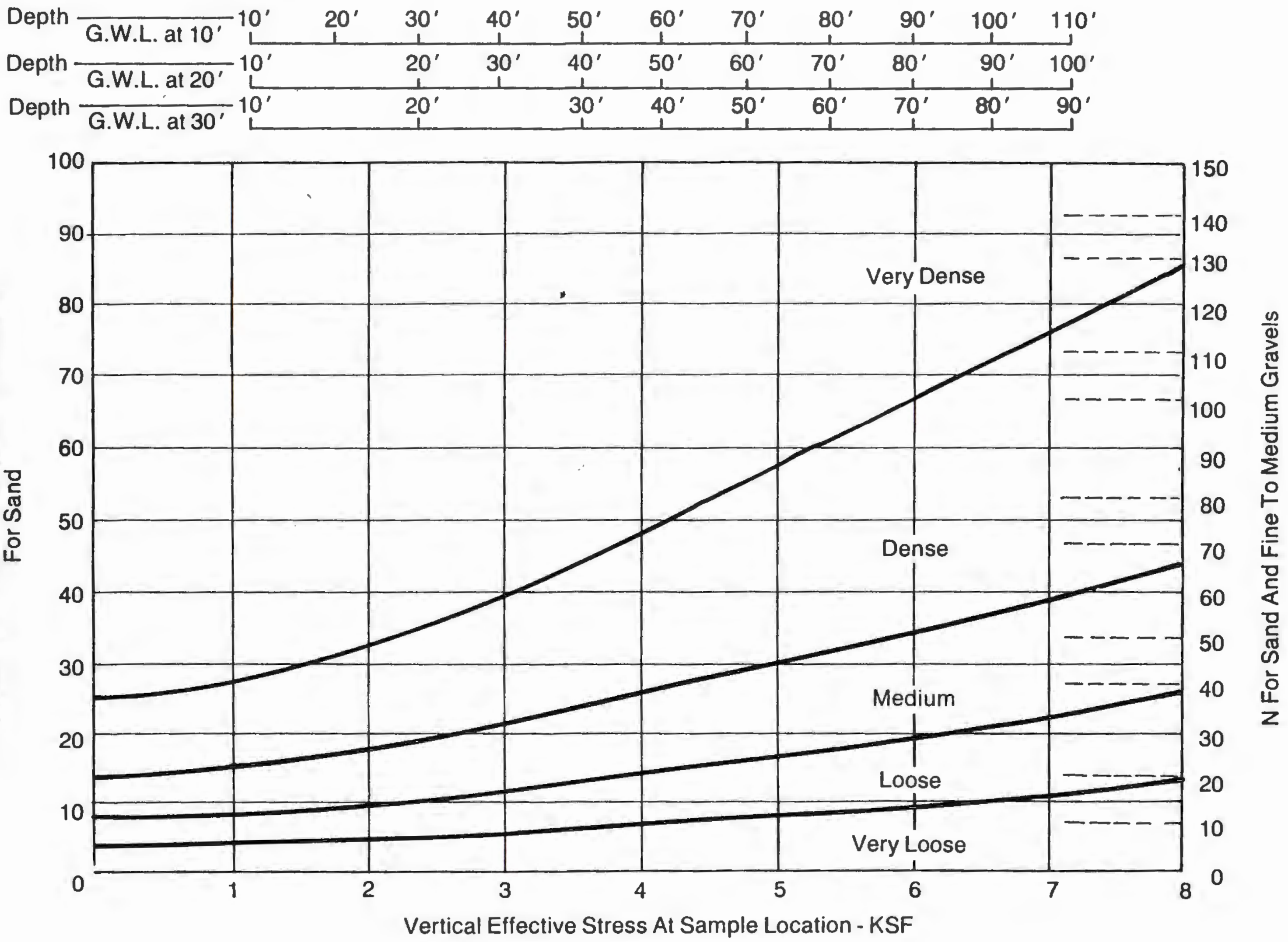


Figure: EXP-4BL6: Relative Density Of Sand From Standard Penetration Test

Figure: EXP-4BL6
Date: 6/88

Figure 2-5
Burmister System

Main Features

Modifiers

Major Component*

Minor Component (S)*

Color

Fractions

Proportion

(Minor Comp.)

Abbreviated
Verson:

Grbr m (-) f S, l (-) m G ; lyr; occ lns c S"

(Not to Be Used
On Boring Logs)

As Identified
in Field. First
Letter of First
Work Capitalized

Identifies
Grain Size (s)
(−) = Major Fraction
(−) = Minor Fraction

Identifies Quanty,
Acts as a Conjunction:
35-50% = a (and)
20-35% = s (some)
10-20% = l (little)
1-10% = t (trace)
(+) = upper third
(−) = lower third

*Abbreviation Capitalized

Unabbreviated
Verson:

Gray brown medium (−) to fine SAND, little (−) medium Gravel;
layered; occasional lens coarse Sand (SP).

Unified Soil Classification
Adequuate for a Generalized
Stratum Description

Upon Approval, The Chester Engineers May Use a Modified BURMISTER SYSTEM For Detailed Identification of Soil Components, Fractions and Proportions. The UNIFIED SOIL CLASSIFICATION,** Based Upon Field Data, Is Also Presented.

FIGURE EXP-4BL7

CONSISTENCY OF COHESIVE SOILS

Consistency	Blows per Foot	Unconfined Compressive Strength (tons per square foot by pocket penetration	Field Identification
Very Soft	0 to 3	Less than 0.25	Easily penetrated several inches by fist. Tall core will sag or slump under its own weight.
Soft	4 to 5	0.25 to 0.50	Easily penetrated several inches by thumb. Core can be pinched in two between thumb and forefinger.
Medium Stiff (Firm)	6 to 10	0.50 to 1.0	Can be penetrated several inches by thumb with moderate effort.
Stiff	11 to 15	1.0 to 2.0	Readily indented by thumb but penetrated only with great effort.
Very Stiff	16 to 30	2.0 to 4.0	Readily indented by thumb nail; penetrated very slightly by thumb.
Hard	Over 30	More than 4.0	Indented by thumb nail. Core cannot be penetrated by thumb; can be pierced with pencil.

* Note: Slickensided and fissured clays may have lower unconfined compressive strengths than shown above, because of planes of weakness or cracks in the soil. The consistency ratings of such soils are based on penetrometer readings.

FIGURE EXP - 4BL 9

GRAIN CLASSIFICATION FOR ROCKS

Particle Name	Grain Size Diameter
Cobbles	> 64 mm
Pebbles	4 - 64 mm
Granules	2 - 4 mm
Very Coarse Sand	1 - 2 mm
Coarse Sand	0.5 - 1 mm
Medium Sand	0.25 - 0.5 mm
Fine Sand	0.125-0.25 mm
Very Fine Sand	0.0625-0.125 mm
Silt	0.0039-0.0625 mm
Clay	<0.0039 mm

(After Wentworth, 1922)

FIGURE EXP-4BL10
ROCK CORE DESCRIPTIVE TERMINOLOGY

GUIDE FOR ROCK DESCRIPTIONS IN FIELDLOG PREPARATION

- Rock Type - Gneiss, Basalt, etc.
- Color - Gray, pink, green, etc.
- Hardness - (See Hardness chart)
- Bedding - Stratification (See Bedding Chart), foliation, etc.
- Weathering - (See weathering chart)
- Composition - Percentage of dominant and accessory minerals
- Miscellaneous - Calcareous, vuggy, cementing material, incusions, ets.
- Discontinuities - Joints, faults, fractures, etc. with descriptions to include coatings, infilling, inclination, etc.

BEDDING

• Thinly laminated	3 mm
• Thickly laminated	3-10 mm
• Very thin bedded	1-3 cm
• Thin bedding	3-10 cm
• Medium bedding	10-30 cm
• Thick bedding	3-1 m
• Very thick bedding	> 1 m

HARDNESS

- Very Hard - Cannot be scratched with knife blade.
- Hard - Can be scratched by knife blade but only with great difficulty.
- Medium hard - Can be scratched by knife blade.
- Medium soft - Easily scratched by knife blade.
- Soft - Can be gouged 1/8" to 1/4" with knife blade.
- Very soft - Can be cut in half or nearly so with knife blade.

FRACTURING (AVERAGE SIZE OF PIECES)

- Massive - >3' (May contain hairline cracks)
- Slightly fractured - 1'-3"
- Moderately fractured - 0.5'-1'
- Closely fractured - 0.1'-0.5'
- Intensely fractured - 0.05'-0.1'
- Crushed - <0.05' (Approx. 0.6")

ROCK QUALITY DESIGNATION (R.Q.D) is based on a modified core logging procedure which, in turn, is based indirectly on the number of fractures and the amount of softening or alteration in the rock mass as observed in the rock cores. Instead of counting the fractures, an indirect measure is obtained by summing up the total length of core recovered - but counting only those pieces of core which are four inches (10 cm) in length or longer, and which are hard and sound.

This procedure obviously penalizes the rock where recovery is poor. This is appropriate, because poor core recovery usually indicates poor quality rock.

It has been found that there is a good relationship between the numerical values of the R.Q.D. and the general quality of the rock for engineering purposes. This relationship is as follows:

R.Q.D	Description of Rock Quality
0 - 25%	Very Poor
25 - 50%	Poor
50 - 75%	Fair
75 - 90%	Good
90 - 100%	Excellent

Example: Gneiss, dark green, medium soft, thin bedded, strong foliation parallel to bedding, slight weathering, fracture at 46.3' with thin clay filling. Contains 50% feldspar, 30% quartz, and 20% biotite mica, scattered garnet inclusions.

NOTE: Grain size classification for rocks will follow the Wentworth Designations.

STANDARD OPERATING PROCEDURE
SOP: EXP-5

KEYSTONE
ENVIRONMENTAL RESOURCES, INC.

SOP: EXP-5 SUBSURFACE SOIL SAMPLING

1. General Application

Subsurface soil samples are obtained for identification of soil grain-size distributions, stratigraphic correlations, and chemical analysis (if required). The characterization can indicate the potential for migration of chemical contaminants from hazardous substance sites. In addition, definition of the actual migration of contaminants can be obtained through chemical analysis of the soil samples. Subsurface soil samples are obtained in conjunction with soil boring and monitoring well installation programs and provide direct information as to the physical and chemical makeup of the subsurface environment. Where the remedial activities may include in-situ treatment or the excavation and removal of the contaminated soil, the depth and areal extent of contamination must be known as accurately as possible.

Surface soil samples serve to characterize the extent of surface contamination. These samples may be collected during initial site screening to determine gross contamination levels and levels of personal protection required, as part of the Remedial Investigation field sampling activities, to gather more detailed site data during Remedial Design, or to determine the need for or success of cleanup during Remedial Construction.

Site construction activities may require that engineering and physical properties of soil and rock be determined. Soil types, bearing strength, compressibility, permeability, plasticity, and moisture content are some of the geotechnical characteristics that may be determined by laboratory tests of soil samples to design and construct deep foundations or remedial components.

Two soil sampling methods have been addressed. These include one procedure for obtaining disturbed soil samples and soils penetration resistance information and one procedure from which one can obtain relatively undisturbed soil samples:

- o Split Barrel (Split-Spoon) Sampling
- o Thin-Wall (Shelby) Tube Sampling

SOP: EXP-5A. SUBSURFACE SOIL SAMPLING

SPLIT BARREL (SPLIT-SPOON) SAMPLING

1. Scope and Purpose

This SOP covers soil sampling by split-barrel only, as this is the means most often used for obtaining samples from unconsolidated deposits. This method provides a representative disturbed soil sample for classification purposes and a record of the soil penetration resistance. A split-barrel sampler is a steel tube, split in half lengthwise, with the halves held together by threaded collars at each end of the tube. Also called a split-spoon sampler, this device can be driven into resistant (consolidated) materials using a drive weight mounted on the drilling string.

A standard split spoon sampler (used for performing Standard Penetration Tests) is 2-inches O.D. and 1 3/8-inches I.D. This standard spoon typically is available in two common lengths providing either 20" or 26" internal longitudinal clearance for obtaining 18" or 24" long samples, respectively.

Details of the implementation of this procedure for a particular project shall be described in a project work plan which shall include a detailed description of the work to be performed and identification of field equipment to be used.

2. Responsibilities

It shall be the responsibility of the Contract Driller to provide the necessary equipment for obtaining subsurface soil samples. This includes the split-barrel sampler and sample containers (sized according to project requirements). It is the Contract Driller's responsibility to maintain a complete set of boring logs for contract purposes. Standard Penetration Tests (SPT) (ASTM: 1586-84) will be conducted by the Contract Driller if required by the project. Equipment decontamination shall also be the responsibility of the Driller.

It shall be the responsibility of the Project Geologist/Engineer to observe all activities pertaining to subsurface soil sampling to ensure that all the standard procedures are followed properly, and to record all pertinent data on a boring log, which includes but is not limited to the blow counts per every advanced six-inch increment. It is also the Geologist/Engineer's responsibility to indicate to the Contract Driller at what specific depth samples shall be collected. The Geologist/Engineer will maintain custody of all samples until they are shipped to their appropriate destination.

3. General Procedures

The sampling depth interval is typically one (1) sample every five (5) vertical feet with additional samples taken, at the discretion of the project geologist/engineer, when significant textural, visual or odor changes are encountered.

The following are the standard procedures to be used in advancing casing and obtaining soil samples.

Specific requirements described in a project's task plan may call for deviations in the standard procedures but these will be taken into account on a project by the project basis.

3.1 Standard Procedures-Advancing Casing

- Casing shall be advanced in the overburden by a series of operations which consist of driving the casing to the elevation at which the sample is to be taken, and cleaning out the hole to the bottom of the casing without disturbing the material to be sampled.
- For advancing the boring in holes requiring rock coring, casing shall be drilled or driven in 5-foot increments and seated in the top of the bedrock. For dense soils such as glacial till, the boring may be advanced by drilling the casing into the soil. In this case, the casing shoe is replaced with a casing drill bit. Hollow stem augers or solid flight augers with casings may be used to advance the hole. On borings requiring rock coring, the augers must be removed and casing firmly seated in rock prior to coring. Depending upon field conditions, drilling mud may be used in lieu of casing.

- If boulders or obstructions are encountered during the progress of the boring, the casing shall be advanced past or through the obstacles either by drilling, mechanically fracturing, or blasting.

- Casing shall consist of the flush joint or flush coupled type. With the approval of the site geologist/engineer or his delegate a heavy duty drive pipe may be used depending on the nature of the overburden or drilling method. The size of the casing shall be sufficient to allow soil sampling, rock coring, or the use of instrumentation where applicable. The casing, casing shoe, and casing bit shall be straight. The inside of the casing shall be clean and free of any obstructions.

- The casing shall generally be advanced in 5-foot intervals or to the designated sampling interval. In cohesive soils such as clay or plastic silt, where the hole remains open and clear, the boring may be advanced uncased. For such open holes, which are advanced by the use of a chopping bit, roller bit, and/or drilling mud, the casing may be advanced after drilling (for rock drilling, casing is required for the full depth of the overburden). The use of water shall not be permitted to facilitate driving of the casing except when directed by the inspecting geologist/engineer. This shall apply to dense soils in which soil sampling is not required. Such "washing and driving" of casing shall be recorded on the field boring log.

- The casing shall be cleaned out before sampling and care shall be taken to avoid sampling of material partly within the casing. Any equipment which is not specially designed for obtaining soil samples shall be considered unsatisfactory. The holes in the chopping bits used for cleaning shall be drilled so that the stream of water will not be directed downward. The amount of water shall be the minimum required to clean the casing and to raise the soil particles to the surface. When the casing cannot be cleaned by washing, augers shall be used for cleaning the drill hole preparatory to sampling. The sample spoon should not be used to remove excess material or to clean out the casing. The bottom of the boring shall be thoroughly cleaned to the required sampling depth.

- In certain borings where the hollow stem auger serves as the casing, the augers shall be advanced to the sampling depth which will normally occur at 5-foot intervals. The hollow stem auger should be equipped with a plug to prevent soil from entering into the bottom of the auger. If soil enters the auger, it shall be necessary to clean the auger out prior to sampling.

3.2 Sampling

- Drive samples of the materials encountered shall be obtained by the use of a split spoon sampler having a 2-inch O.D. and 1 3/8-inch I.D., and a clear inside length of at least 18 inches. The spoon shall be equipped with a properly fitting ball check valve and a flap valve or basket retainer shall be used when sampling in loose soils. Drill rods used for driving the sample shall have as a minimum 1 5/8-inch O.D. (AW).

- Drive samples shall be taken at every change of material or stratification and at 5-foot intervals, or as directed by the inspecting geologist/engineer.

- The inspecting geologist/engineer shall make an independent determination of depth measurements and check his determinations with those made by the drilling foreman. Any discrepancy shall be resolved in the field as soon as it is discovered. All depth measurements shall be made in feet and tenths of feet.

- The change in soil strata should be established by the inspecting geologist/engineer and the driller from sampling and observation of the wash material and driving resistance during the progress of the boring. Drive samples shall be obtained by driving the sampling spoon into the material below the bottom of the casing so as to fully fill its chamber without compressing the material. A representative sample of the material, not affected by the washing out process, shall be obtained from the sampling spoon.

- Standard penetration tests, as described below, shall be performed to facilitate the determination of the relative resistance of the various strata. The sampler shall be driven with a hammer weighing 140 pounds and falling 30 inches. The hammer shall be raised and dropped with one turn of the rope around the cathead. The use of wire or cable in driving the sampling spoon shall not be permitted. The number of blows for each six inches of penetration of the sampler shall be recorded on the boring log Form EXP-4BL1.

- The hammer weight shall be certified by an independent testing laboratory as weighing 140 pounds ±5 pounds. The 30 inches shall be so marked on the drive pipe.

- In case of poor sample recovery, a second attempt may be required by the inspecting geologist/engineer. For this attempt, the inspecting geologist/engineer may require alternate methods of obtaining samples. These methods include:

    - the use of the casing hammer to drive the split-spoon sample;
    - the use of an open-end rod driven with the casing hammer;
    - the use of an oversized spoon driven with the casing hammer;
    - the use of a core barrel which has been approved by the inspecting geologist to core the soil;
    - the use of traps or flap valves;
    - overdriving of the sample;
    - any combination of the above, or;

- other methods approved by the inspecting geologist.

- The use of any of the methods detailed in Section 3.2.7 shall be recorded on the inspector's and contractor's logs and on the sample jar or core box. Should any of these methods fail to secure a sample, the casing may be advanced to the maximum depth of the previous sample attempt and a third and final attempt may be made, at the discretion of the inspecting geologist/engineer. The third attempt, however, shall not exceed the top of the next 5-foot sampling interval.

- When sampling in fine sands below the water table, which have a tendency to flow up into the casing during various stages of the drilling operations, special precautions shall be taken. The casing shall be maintained full of water at all times. Water shall be pumped into the casing when withdrawing the wash rods after cleaning the casing. A sample of this water must be collected and analyzed prior to use in order to qualify and quantify any potential contamination of the sample. The casing shall be maintained full of water also during withdrawal of the sampler spoon to minimize the hydrostatic head in the drill rods which would tend to drive the sample out of the bottom of the spoon. A perforated section of drill rod or adapter shall be attached to the top of the sampling spoon to facilitate drainage of the drill water after sampling. The drill rods shall be withdrawn slowly to avoid losing the sample.

4. Documentation

4.1 The inspecting geologist/engineer shall prepare a field boring log of each boring (See Form EXP-4BL1). The boring log shall be kept current. All applicable portions of the log shall be filled out. In addition to the data entries noted, the inspecting geologist/engineer should be careful to observe and note any of the following:

- support of hole walls, i.e., mud, or casing;

- any unusual action of the drill rods, such as rapid drop of rods, or rods advancing under their own weight;
- the depth of casing at each soil sampling interval when casing is used during soil sampling;
- the names of the drilling crew;
- the type and make of drill rig.

4.2 The inspecting geologist/engineer shall identify the borehole by marking the identification number of the borehole on the casing.

4.3 The geologist/engineer shall complete all sample logs, chain-of-custody forms and shipping forms required for the project.

5. References

Acker, III, W.L., 1974. Basic Procedures for Soil Sampling and Core Drilling. Acker Drilling Co., Inc., Scranton, PA.

American Society for Testing and Materials, 1986. ASTM Standards D1586-84. ASTM Book of Annual Standards, ASTM, Philadelphia, PA.

Earth Manual. United States Bureau of Reclamation, "Designation E-2", second edition, 1974.

Hvorslev, J.M., Subsurface Exploration and Sampling of Soils for Civil Engineering Purposes. The Engineering Foundation, New York, 1949.

STANDARD OPERATING PROCEDURE
SOP: EXP-7

KEYSTONE
ENVIRONMENTAL RESOURCES, INC.

SOP: EXP-7. MONITORING WELL CONSTRUCTION, INSTALLATION, AND DEVELOPMENT

1. SCOPE AND PURPOSE

This Standard Operating Procedure (SOP) is concerned with the construction, installation, and development of groundwater monitoring wells. Monitoring wells provide for the measurement of groundwater elevations and the monitoring of groundwater elevation fluctuations, the collection of groundwater samples, the monitoring of contaminant concentrations, and the detection of light- and dense-phase organic contaminants. In addition, monitoring well networks are used to define site-specific characteristics such as: the hydrogeologic regime, aquifer characteristics (such as hydraulic conductivity, head distribution, transmissivity, etc.), groundwater flow directions and velocities, vertical and horizontal migration of possible contaminant plumes, contaminant plume geometry and velocity of migration. Additionally, monitoring well networks can be used to develop a data base for evaluation and designing remedial measures, determine the effects of possible remedial measures, and to assist in performing remedial work, such as functioning as recovery or injection wells.

2. RESPONSIBILITIES

2.1 The Project Manager or Project Geologist will have the responsibility to oversee and ensure that all monitoring well construction, installation, and development activities are performed in accordance with the project-specific plan, and this SOP. In most states, there are regulations related to the construction of wells. These must be accounted for during monitoring well design.

2.2 The Project Manager or the Project Geologist will have the responsibility to oversee and ensure that:

1) the objectives of the well installation and use are clearly defined and integrated before the monitoring system is designed. For each site, each monitoring well installation is unique, and the design must be based on the

specific set of conditions present and its intended use.

2) the location, depth, and construction details of monitoring wells are important considerations when planning a water-quality monitoring program. These parameters are equally important when observation wells are installed, since there is often a need to sample wells that were originally designed only for measuring water levels. The hydrogeologic conditions may require a phased approach or a flexible schedule in monitoring well installation to allow information to be evaluated prior to well placement.

2.3 The Site Geologist must ensure that all Field Geologists understand this SOP, the site-specific plan, and the technical specifications developed for the particular job. A Field Geologist will be responsible for observing all subcontractor activities involved in the construction, installation, and development of monitoring wells.

3. MONITORING WELL DESIGN

Many factors influence the design of a monitoring well. The design of a well depends upon the intended application. Of critical importance are: 1) the location and depth of the monitoring well (including the depth of the screened interval, 2) the diameter of the well, and 3) the selection of materials of construction (including screen slot size selection and sand pack sizing).

3.1 Location and Depth

Siting of monitoring wells should be performed after a preliminary estimation of the general groundwater flow direction. In most cases these can be determined through review of geologic data and the site terrain. In addition, production wells or other monitoring wells in the area may be used to determine the flow direction. If these methods cannot be used, piezometers may have to be installed to determine the gradient. This requires a minimum of three piezometers.

When monitoring for specific objectives, the location of the well and depth of the screen are determined according to the purpose of the system.

For example, at a new site where the objective is early warning, the wells should be located as close as possible to the source; alternatively, where contamination is discovered, determining the extent of contamination is the objective and the wells may be needed to define the flow characteristics, the area involved, and the vertical distribution of water quality.

The depth interval covered by the well screen is important for determining not only the vertical distribution of the hydraulic heads, but also the levels at which contaminants are present. The quality of the groundwater may vary with the depth due to several factors, including the density of the contaminant-water solution, lenses or layers of varying permeability, and geologic features that may form barriers diverting the flow. A well that is screened for the entire depth of the aquifer at that location will be affected by several water-bearing strata and may only reflect the presence or probable absence of contamination and provide composite water levels. Therefore, a fully penetrating well cannot be used to quantify or vertically locate a contamination plume. If the vertical distribution of hydraulic heads or contaminant level is desired, multilevel sampling wells or several wells, screened at different depths, at the same location, may have to be constructed.

3.1.1 Multilevel Monitoring

Multilevel monitoring can be accomplished by installing conventional screen and riser pipe wells in either separate boreholes or a single, large-diameter borehole.

Gas-lift sampling devices have proven advantageous as alternatives to conventional monitoring wells. These devices are essentially screened samplers installed in a borehole with only one or two small-diameter tubes extending to the surface. Manufacturers of these types of samplers claim that four samplers can be installed in a 3-in. diameter borehole. This reduces drilling costs, decreases the volume of stagnant water to be purged, and provides a sampling system that minimizes cross contamination from sampling equipment. These samplers also perform well when the water table is below 25 ft (the typical range of suction pumps). Two manufacturers of these samplers are Timco Manufacturing Company, Inc., of Prairie du Sac, Wisconsin, and BARCAD Systems, Inc., of Concord, Massachusetts. Each offers various construction materials.

Two additional types of multilevel sampling systems have been developed. Both employ individual screened openings through a small-diameter casing. One of these systems (marketed by Westbay Instruments Ltd. of Vancouver, British Columbia, Canada) uses a screened port and a sampling probe to obtain samples and head measurements or perform permeability tests. This system allows sampling ports at intervals as close as 5 ft, if desired, in boreholes from 3 to 4.8 in. in diameter.

The other system, developed at the University of Waterloo at Waterloo, Ontario, Canada, requires field assembly of the individual sampling ports and tubes that actuate a simple piston pump and force the samples to the surface. Where the depth of ground water is less than 25 ft. the piston pumps are not required. The assembly is made of easily obtained materials; however, the cost of labor to assemble these monitoring systems may not be cost-effective.

3.2 Diameter of the Well

In determining well diameter, the following needs must be considered:

- Adequate water volume for sampling
- Installation method
- Type of sampling device to be used
- Costs

The volume required for organic and inorganic analysis is approximately 1-1/2 to 2 gal, plus a split sample (often requested by state or owner). A total of 4 gallons of water is the minimal volume for a typical sampling program.

Casing Inside Diameter, in.	Standing Water Column Depth to Obtain 1 gal Water, ft	Total Water Column Depth of Standing Water to Obtain for 4 gal,(ft)
2	6.13	25
4	1.53	6
6	0.68	3

For most monitoring programs, either a 2-in. or 4-in. diameter well is preferred. The volume of stagnant water in the well is minimized, the costs are reduced, and the water table stabilizes more readily than in large diameter wells, while providing representative samples. Pumping tests for determining aquifer characteristics may require large-diameter wells; however, in situ permeability tests can be performed during drilling or after well installation in small-diameter wells.

3.3 Construction Materials

Well materials are specified by casing diameter, type of material, and sand pack size and size distribution. The selection of well diameter was discussed in Section 3.2.

3.3.1 Type of Material

The selection of the type of well construction materials depends on the method of drilling, the type of contamination expected, and natural water quality and depth. The cost and level of accuracy required are also important selection factors. The materials generally available are Teflon, stainless steel, PVC, galvanized steel, and mild steel. Each has advantages and limitations. The two most commonly used materials are PVC and steel. Table EXP-7T1 compares these. When expense is not limited or trace-metals or organic sampling is required, stainless steel may be preferred. Teflon materials are extremely expensive, but considered inert. PVC has many advantages, including low cost, excellent availability, light weight, and ease of manipulation;

however, there are also some questions about organic chemical sorption and leaching that are being researched. Indications currently are that these problems are minimal. The crushing strength of PVC may limit the depth of installation, but Schedule 80 materials may overcome some of the problems associated with depth. An added factor to consider when using PVC pipe is that Schedule 80 PVC pipe has an inner diameter slightly smaller than that of Schedule 40 pipe, due to the greater thickness of schedule 80 pipe. This may be an important factor when considering the size of bailers or pumps to be used for sampling or testing. Screens and casing of mild steel can be very good for organic chemical determinations when properly cleaned. Cleaning is required because oil-based preservatives and oil used during thread cutting may contaminate samples. Metal pipe, however, may corrode and release metal ions or chemically react with organic constituents. This is considered by some to be less of a problem than the problem associated with PVC material. Galvanized steel is not recommended for metal analyses, as zinc and cadmium levels may be elevated from the zinc coating. Table EXP-7T2 presents compatibility of several plastics with contaminants.

Where compatibility of well construction materials and suspected contaminants is questionable, field-blank wells could be constructed upgradient in an uncontaminated area and directly downgradient in the contaminated zone. Two wells of different material such as PVC and stainless steel would be installed next to each other at each location. Analytical results would be compared to determine the influence of construction materials.

3.3.2 Thickness

Thickness of pipe is referred to as "schedule" for polyvinyl chloride (PVC) casing and is usually Schedule 40 or 80. Steel casing thickness is often referred to as "Strength" and Standard Strength is usually adequate for monitoring well purposes. The larger the diameter of the casing, the thicker the casing may need to be to maintain adequate strength.

Design of Sand Packs and Well Screen Slot Size

The physical nature of aquifers and chemistry of water in aquifers vary extensively. A properly designed well screen must accommodate these varied physical and chemical characteristics. Types of materials for well screen construction in various chemical environments were discussed in Section 3.3.1. Various types of perforations of well screen exist. Most are manufactured, however others are hand perforated from casing or other materials. A few of these screens may be adequate in some geologic formations, but may provide marginal success under other geologic conditions. A description of each of the major types is presented on Table EXP-7T3 for information only. The preferred well screens for use are either continuous slot or machine slotted.

Slot Openings in Well Screens are designated by numbers which correspond to the width of the slot openings in thousandths of an in. For example, a No. 20 slot has an opening of 0.020 inches.

Well screen slots are usually machined on PVC and Teflon screens. On stainless steel screens, wire-wound screens are preferred, because screen geometry prevents screen plugging by sediments.

The following steps are to be taken to design an effective sand pack around the screen and size the well screen to prevent the influx of sediment from the monitored formation:

3.3.3.1 Construct grain size curves from sieve analysis of all strata comprising the aquifer to be monitored. Determine the stratum composed of the finest material and select the grading of the sand pack on the basis of the sieve analysis of this material.

3.3.3.2 Multiply the 70 percent size of the sediment by a factor of between 4 and 9. Use 4 as the multiplier if the sediments are fine and uniform in size distribution; use 6 if the sediments are coarser and non-uniform in size distribution; and use a factor between 6 and 9 where the sediments have highly non-uniform gradation and includes silt.

3.3.3.3 Place the result of this multiplication on a graph of cumulative per cent retained vs grain size (in thousandths of an inch) (See Figure EXP-7F4) at the 70 per cent size of the sand. This is the first point on the curve that represents the grading of the sand pack required to properly construct the well.

3.3.3.4 Through the initial point on the sand pack curve, draw a smooth curve representing a material with a uniformity coefficient of 2.5 or less. This must be done by trial and error.

3.3.3.5 Prepare specifications for the sand pack by first selecting 4 or 5 sizes that cover the spread of the curve and then set down a permissible range for the per cent retained on each of the selected sieve sizes. This permissible range may be percentage points above or below the per cent retained at any point on the curve.

3.3.3.6 As a final step, select a size for the well screen openings that will retain 90 per cent or more of the sand pack material.

A pack having such a ratio of size, when compared to the formation, will provide mechanical retention of the formation sediments and prevent the sediments from moving into the sand envelope and into the well itself.

Sand pack material should be clean, with well-rounded grains that are smooth and uniform. These characteristics increase the permeability and porosity of the sand pack material. With uniform material, less hydraulic separation of the particles occurs while the material is being placed or allowed to settle through a considerable depth of water.

Sand pack material consisting mostly of siliceous, rather than calcareous particles is preferred. Up to about 5 per cent calcareous material is a common allowable limit. This is important because of the possibility of calcareous sand affecting the chemistry of the groundwater in the immediate vicinity of the well.

4. EQUIPMENT AND MATERIALS

4.1 Equipment

Drilling equipment as supplied by the drilling subcontractor (See SOP:EXP-3). Well development will require additional equipment such as:

1) Water pumps of sufficient size to remove excessive fines from the well,

2) Air compressor, or compressed air tanks (certified breathable),

3) Tygon tubing or teflon tubing of sufficient length to extend from the water or air source to the bottom of the well, and

4) Surge blocks.

4.2 Materials

The list below identifies the types of materials which may be used for a range of sites requiring the construction, installation, and development of monitoring wells. From this list, a project-specific list will be selected based upon project objectives, accessibility to the site, and project funding. The types of materials required include:

1) PVC (Schedule 40 or 80) flush-jointed riser casing of pre-determined diameter.

2) PVC (Schedule 40 or 80) flush-jointed machined slotted well screen.

or,

3) Stainless steel (304, 316, or 2205) flush-joint threaded riser casing of pre-determined diameter.

4) Stainless steel (304, 316, or 2205) flush-joint threaded slotted well screen (machine slotted or wirewound) of the same diameter as specified above.

5) Silica Sand (such as Ottawa) appropriately sized.

6) Cement-bentonite grout.

7) Bentonite pellets for installing seals, and powder for mixing with cement to form grout.

8) Steel protective casing, either flush mounted type in areas of high traffic, or five foot high in no traffic areas, with locking cap.

5. WELL INSTALLATION

5.1 General Background

A typical monitoring well set in unconsolidated materials consists of a slotted or perforated section of pipe designed to allow the inflow of water while supporting the earth materials surrounding the screen. Attached to the screen is casing or riser pipe that extends to the surface. A protective steel casing is generally used at ground surface with PVC pipe. The protective pipe or casing is fitted with a ventilated cap that is lockable to prevent damage and vandalism to the well. Bedrock wells are usually open holes drilled into the rock with a casing set into the bedrock surface to maintain the hole through the overburden and seal out upper groundwater bearing zones from the well. Figure EXP-7F5 shows cross sections of typical monitoring wells.

If an aquifer to be sampled lies below a contaminated zone, proper well installation techniques must be applied to avoid cross contamination between aquifers. Under most conditions, this can be accomplished by installing double-cased wells. This is accomplished by drilling a large diameter boring through the contaminated aquifer, into the underlying confining layer, and setting and grouting an outer casing into the confining layer. A smaller diameter boring should then be drilled through the confining layer, into the aquifer to be sampled, for installation of the monitoring well. A proper seal is required between aquifers in order to obtain representative hydrogeologic information.

The installation of the screen and riser pipe is usually accomplished by assembling and lowering the well screen and riser pipe within an open hole or in a cased hole. Casing, mud, or hollow-stem augers are commonly used to keep the hole open in unconsolidated materials. The slotted screen is installed to monitor a specific horizon or zone. The decision concerning placement and slot size is based on the following information:

- Aquifer thickness
- Head distribution and estimated flow in the aquifer

- Permeability and physical characteristics of the formation, such as grain size, thickness, and uniformity
- Specific yield of existing wells
- Anticipated depth and thickness of contaminant plume
- Physical and chemical characteristics of pollutants
- Fluctuation in groundwater level
- Volatile organic scan of soil samples
- Borehole geophysical logs

In common situations, depending on the purpose of the well and the site conditions, screen lengths are often 5 to 10 ft. The slot size selected will govern the quantity of water and natural materials or sand pack materials entering the well. The screen should pass approximately 10 percent of the pack material, or in situ aquifer material. The assembled well should be placed in the borehole and suspended several inches off the bottom of the boring to ensure that the well casing is not bowed during installation. A centralizer could be used on the riser to ensure the well is centered in the borehole. After the screen and riser pipe are in place, a sand or gravel pack is placed around and two feet above the screen, or the natural materials are allowed to collapse around the well screen.

A bentonite seal must be placed above the top of the screen (on top of the gravel pack) to maintain a discrete sampling interval. It is important to seal the annulus to prevent water flow along the well casing within a higher permeability zone within the annulus. This flow could alter the measured contamination or allow cross contamination of aquifers. Typically, seals are constructed of bentonite pellets or a bentonite slurry. (Bentonite is a clay of volcanic origin that has swelling properties and, therefore, a very low permeability). The seal may extend to the ground surface, or a suitable backfill may be used around the riser pipe above the seal. Installing sand packs and seals is difficult and must be performed in holes with adequate space between the casing and the screen and riser pipe. The temporary casing or borehole should be at least 4 in. larger in diameter than the screen and riser pipe. A flush-jointed, threaded riser pipe facilitates the implacement of these materials. A tremie pipe could also be utilized under certain circumstances to install the sand pack, bentonite seal, and grout to prevent bridging and ensure a competent grout seal.

As backfill materials (gravel pack, bentonite pellets, grout, etc.) are being placed in the annular space around the monitoring well, the drilling casing or augers in the hole should be simultaneously withdrawn, to prevent backfill materials from becoming jammed (bridged) between the well casing and drilling tools. If these backfill materials become wedged between the casings, the well may be pulled out of the hole along with the drilling tools. Also, the depths of backfill materials should be checked at frequent intervals with a weighted tape or similar device to insure that the backfill materials are placed to the proper depths and are the proper thicknesses. All details of well installation should be carefully documented for later reference.

Flowing wells should be equipped with a pressure gauge and tap for sampling. The well casing would be capped to prevent water from flowing from such wells.

Protection for the well is generally provided by a large-diameter steel pipe with a locking cap, extending below the ground surface and set into a concrete collar. The protective pipe restricts access to the well, and the concrete seal is designed to route water due to precipitation away from the well. Additional protection is often needed in areas of high traffic. In some instances, the use of manholes or depressed boxes with covers instead of pipes projecting above the ground may be required.

After the monitoring system is completed, a survey should be performed. The elevation of the top of the well casing, the ground surface, and the horizontal coordinates of each well must be determined. Surveyors are usually asked to plot the location of each well on the site map and to provide elevations (to within 0.01 feet) of both the top of casing and the ground surface. The location on the well which is surveyed should be marked. An identification number should be placed on each monitoring well.

5.2 Procedures for Well Installation

5.2.1 Emplace sand below the proposed base of the wellscreen approximately one foot (1') thick by using a tremie pipe while withdrawing the drilling tools in one foot (1') increments. Measure and record the depth of the sand cushion.

5.2.2 Assemble and install the observation well pipe and screen. In areas where potential undissolved, floating product is anticipated, install the well screen so as to extend a minimum of one (1) foot above maximum anticipated water table level. The bottom of the well screen must be fitted with a threaded or pinned plug. All pipe sections shall be connected by dry threading of the joints.

No glued, solvents, or lubricating compound shall be used to make up the connections. The well pipe assembly must be carefully lowered into the borehole to ensure centering of the well in the hole. After installation, the Chester field geologist and the drilling contractor will carefully measure the depth to the well tip from the top of the well and record the measurement on the well log.

5.2.3 Install a sand pack in the annulus around the well screen, while withdrawing the augers or casing in increments to at least two feet (2') above the screen. Grain size of the sand shall be appropriate to the formation characteristics while the slot size of the screen shall be consistent with filter pack grain size.

5.2.4 Withdraw the casing or augers in increments and install a bentonite clay pellet seal approximately two feet (2') thick above the sand pack. If a seal exceeding two feet (2') in thickness is installed, the casing or tools will be withdrawn in one foot (1') increments as Bentonite pellets are added.

5.2.5 Insert a tremie pipe and backfill the remainder of the hole with bentonite-cement grout until it flows at the ground surface. At all times, the bottom of the tremie pipe shall be below the top of the grout in the annulus.

5.2.6 After the well installation is complete, mark the top of the well to indicate water level measuring point for future reference. If the riser is not cut evenly, the measuring point should be marked on the highest point of the riser. Place a threaded or slip cap on the riser, and vent the cap.

5.2.7 If well head completions must be flush with the ground surface, a street box or lockable valve gage box may be installed in lieu of the metal pipe. Installation consists of finishing the riser pipe two inches (2") below grade and cement grouting the box in place. If protective casing is used, secure the casing in place using cement pad of approximately 2 foot by 2 foot finished to below frost layer.

5.2.8 Paint the well protective pipe or box to inhibit rust formation and increase visibility. Paint the well number in one inch (1") block numerals of a contrasting color.

5.2.9 Following the completion of the monitoring well, the well will be developed according to SOP:EXP-7 Section 6 in order to restore the natural hydraulic conductivity of the formation and remove excessive fines from the sand pack. The development process shall employ the use of surge blocks and water pumps (submersible and/or centrifugal). Development will continue until turbidity of the water is reduced. In areas with high percentages of clay and silt sized particles, development to clay and silt-free conditions may not be possible. In these cases, development will continue until turbidity has been "significantly" reduced. Temperature, pH, and conductivity measurements will be taken and recorded and development will continue until turbidity has been "significantly" reduced and/or the physical/chemical measurements remain consistent.

5.2.10 Following the installation of the monitoring wells, the vertical elevation of the wells will be determined. Casing height and adjacent ground surface elevation will be determined to an accuracy of 0.01 feet. A mark will be placed on the casing for use as a measuring point. Elevations will be determined relative to the plant datum, or, if available, mean sea level.

6. WELL DEVELOPMENT

Well development is one of the most important steps in the procedure of well installation. Every type of drilling operation reduces the permeability of the water-bearing zones in the vicinity of the borehole. The purpose of well development is to increase the permeability of the formation after drilling operations and to stabilize the sand formation around the well screen. Well development can be accomplished by any of several methods. The selection of the well development method to be used should be made by a qualified geologist and is based on the drilling methods, well construction and installation details, and the characteristics of the formation in which the well is screened. The primary methods of well development are summarized below.

6.1 Overpumping and Backwashing - This method of development consists of alternately pumping or bailing the well at a high rate to draw the water level down and then "backwashing" - reversing the flow direction so that water is passing from the well into the formation. This back and forth movement of water through the well screen and gravel pack serves to remove fines from the formation while preventing bridging (wedging) of sand grains. Backwashing can be accomplished by several methods including, pouring water into the well and then bailing, starting and stopping a pump intermittently to change water levels (rawhiding), and backwashing under pressure, which consists of alternately pumping or bailing the well and then forcing water into the well under pressure, through a water tight fitting. Care should be taken when backwashing under pressure not to apply too much pressure, which could damage or destroy the well screen and bentonite seal.

6.2 Surging with a Surge Plunger - A Surge Plunger is essentially a plunger nearly the same diameter as the well casing which is moved up and down inside the well casing to agitate the water, causing it to move in and out of the screens. This movement of water pulls fines into the well where they may be removed by any of several methods and prevent bridging of sand particles in the gravel pack. There are two basic types of surge plungers - solid and valved surge plungers. In formations with relatively high water yields, a solid plunger is most effective as the surging action is greater. In formations with low yields, a valved surge plunger may be preferred, as solid plungers tend to force water out of the well at a greater rate than it will flow back in. Valved plungers are designed to produce a greater inrush than outrush of water during surging.

6.3 Compressed Air - Compressed air can be used to develop a well by either of two methods - Backwashing or Surging. Backwashing is done by forcing water out through the screens, using increasing air pressure inside a sealed well, then releasing the pressurized air to allow the water to flow back into the well. Care should be taken when using this method so that the water level does not drop below the top of the screen, thus air logging the formation and reducing well yield.

Surging, or the open well method, consists of alternately releasing large volumes of air suddenly into an open well to produce a strong surge by virtue of the resistance of water head, friction, and inertia, and then pumping the well with the air lift method.

6.4 High Velocity Jetting - The most effective all-around well development method available is the high velocity jetting method. In this method, water is forced out at high velocities through openings in a plunger type device against and through the well screen to loosen fine particles from the sand pack and surrounding formation. The jetting tool is slowly rotated and raised and lowered the length of the wellscreen to develop the entire screened area. The fines washed into the screen during this process can then be bailed or pumped from the well.

The above is a short summary of available well development techniques. A thorough review of the procedures for the individual method to be used should be conducted prior to supervising the development of monitoring wells at a site.

7. DOCUMENTATION

Well installations will be recorded on Form EXP-7F6. All measurements should be made from ground surface. Installation details to be recorded include the following, where appropriate:

- Date/time of construction
- Drilling method and drilling fluid used (if any)
- Well location (± 0.5 ft)
- Borehole diameter and well casing diameter
- Well depth (± 0.1 ft)
- Drilling and lithologic logs
- Casing materials
- Screen materials and design
- Casing and screen joint type
- Screen slot size/length
- Filter pack material/size, grain analysis
- Filter pack volume calculations
- Filter pack placement method
- Sealant materials (percent bentonite)
- Sealant volume (lbs/gallon of cement)
- Sealant placement method (tremie, etc.)
- Surface seal design/construction

- Well development procedure
- Type of protective well cap
- Ground surface elevation (± 0.01 ft)
- Top of monitoring well casing elevation (± 0.01 ft)
- Top of protective steel casing elevation (± 0.01 ft)
- Detailed drawing of well (include dimensions)

8. REFERENCES

Johnson Division UOP Inc., Groundwater and Wells, Edward E. Johnson, Inc. 1975.

Schalle and Oberlander, 1983 (May), Water Well Journal.

U.S. Environmental Protection Agency, Procedures Manual for Groundwater Monitoring at Solid Waste Disposal Facilities, SW-611, December 1980.

U.S. Environmental Protection Agency, September 1986, RCRA Groundwater Monitoring Technical Enforcement Guidance Document.

TABLE EXP-7T1

COMPARISON OF STEEL AND PVC CASINGS

Stainless Steel Well Casing

In deep wells, should be used to prevent compression and closing of the casing and screen.

Has a short life in corrosive water.

Oxides may sorb organic substances.

Should be steam cleaned when used on projects involving certain types of organic contamination.

Is expensive but most reliable organic sampling.

Difficult to adjust size and length, and to work with in the field.

PVC Well Casing

Use when sheer strength is not critical.

Is easy to handle.

More susceptible to collapse than steel.

Is noncorrosive and lightweight.

May sorb some organic substances, but soon reaches equilibrium.

Glue should be never used for connecting lengths of pipe.

Should be threaded or pressure-fitted when used with organic contamination studies.

Chemical deterioration of PVC casing is possible when either ketones, aromatics, alkyl sulfides, or specific chlorinated hydrocarbons are present.

TABLE EXP-7T2

RESISTANCE OF WELL CASING THERMOPLASTICS TO COMMON MATERIALS UNDER EXPECTED USE CONDITIONS*

	ABS	PVC	SR
Mineral Acids			
Hydrochloric (Muriatic) Acid-30%	+	+	+
Sulfuric Acid-50%	+	+	+
Sulfamic Acid-30%	+	+	+
Alkalies			
Ammonium Hydroxide-30%	+	+	+
Calcium Hydroxide-30%	+	+	+
Sodium Hydroxide-30%	+	+	+
Salts			
Calcium Chloride	+	+	+
Potassium Chloride	+	+	+
Sodium Bicarbonate	+	+	+
Sodium Chloride (Salt)	+	+	+
Sodium Phosphate	+	+	+
Sodium Sulfite	+	+	+
Oxidizing Agents/Disinfectants			
Sodium Hypochlorite (Bleach soln.-12%	+	+	+
Chlorine Water	+	+	+
Calcium Hypochlorite-Soln.-18%	+	+	+
Organic Acids			
Acetic Acid-10%	+	+	+
Stearic Acid	+	+	+
Hydroxy Acetic Acid, 10%	+	+	+
Oils & Derived Products			
Crude Oil-Sour	+	+	+
Diesel Fuel	+	+	+
Gasoline	+	+	+
Lubricating & Thread Cutting Oils	+	+	+
Motor Oil	+	+	+
Solvents			
Acetone	-	-	-
Methyl Ethyl Ketone	-	-	-
Toluene	-	-	-
Trichloroethylene	-	-	-
Turpentine	-	+	-
Xylene	+	+	+
Soaps and Detergents	+	+	+
Gases			
Ammonia	+	+	+
Carbon Dioxide	+	+	+
Hydrogen Sulfide	+	+	+
Natural Gas	+	+	+
Oxygen	+	+	+

Key: + denotes resistant
- not resistant

TABLE EXP-7T2

RESISTANCE OF WELL CASING THERMOPLASTICS TO COMMON MATERIALS UNDER EXPECTED USE CONDITIONS*
(Continued)

For materials not included in the Table, the well casing manufacturer should be consulted. An expanded table on chemical resistance of thermoplastic piping materials is also available from the Plastic Pipe Institute.

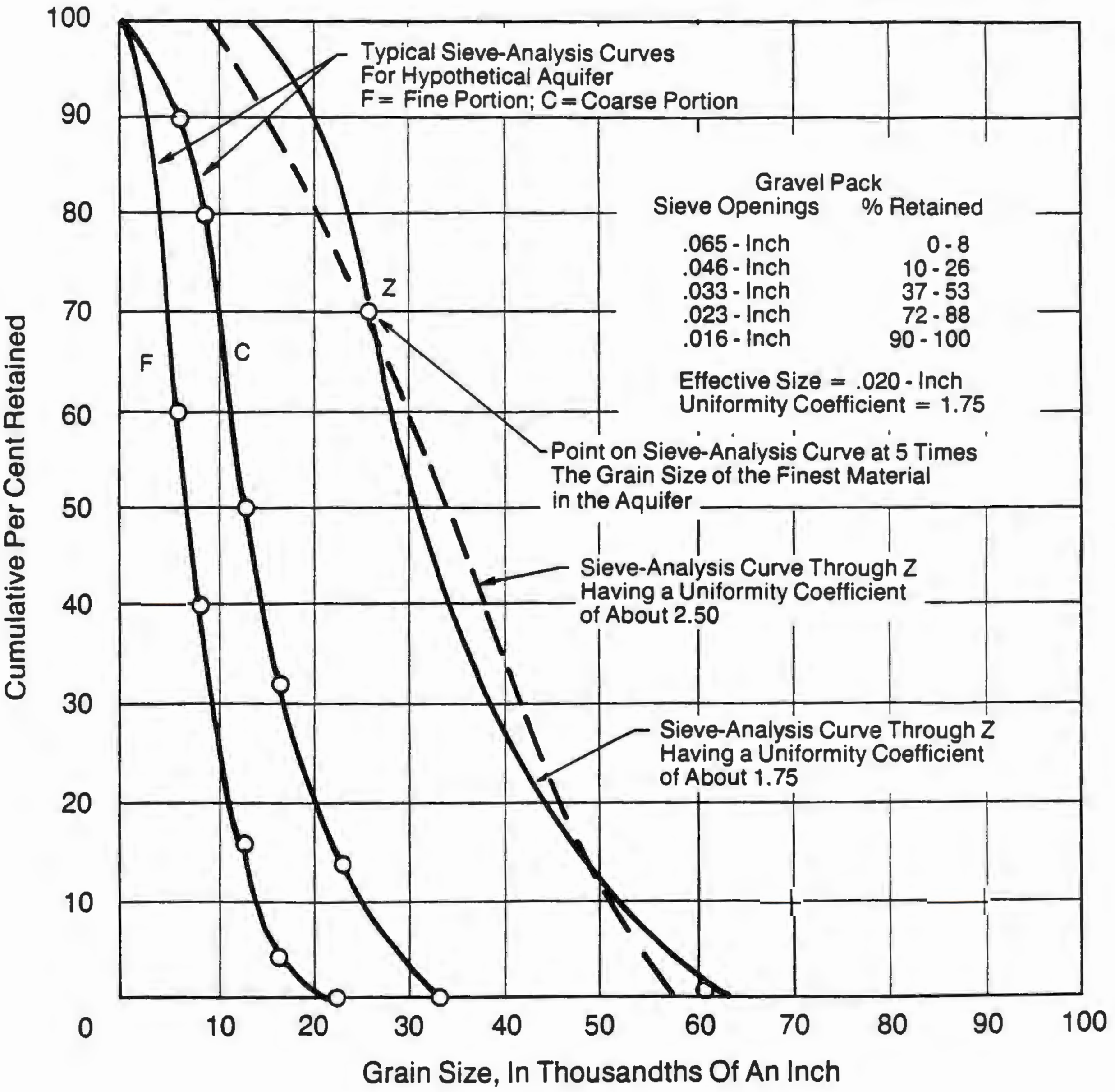
* The indicated extent of chemical resistance is for guidance purposes only for conditions of expected usage. As chemical resistance is not necessarily applicable to all conditions.

TABLE EXP-7T3

MAJOR TYPES OF WELL SCREENS

Type	Description
Continuous-Slot	Constructed by winding cold-rolled wire or plastic, triangular in cross section, around a circular array of longitudinal rods. As a result of the triangular wire, each slot opening adjacent to the wires is V-shaped. This type of well screen provides more intake area per unit area of screen surface than any other type of screen.
Louvered and Bride-Slot	Constructed by punching slots either parallel or perpendicular to the axis of the screen. This type of well screen requires an artificial gravel pack. This type of well screen provides limited intake area per unit area of screen surface.
Pipe-Base Screens	Constructed by winding a trapezoid-shaped wire either directly onto a pipe having openings, or winding the wire over a series of longitudinal rods spaced around the circumference of the pipe. This type of well screen is subject to rapid corrosion of the steel pipe and is usually low in efficiency; however, it has very high strength and can be retrieved from great depths.
Slotted Metal Pipe	Constructed by cutting or punching slots in metal pipe. While relative cost is low, several characteristics limit their use: 1) openings are not closely spaced, 2) percentage of open area is low, 3) size of the openings varies considerably, and 4) openings fine enough to control fine sand are difficult or impossible to produce.
Slotted PVC	Constructed by machining uniform-sized slots in PVC pipe. While slotted PVC has less than half the open area of continuous slot plastic screens and is about one tenth as strong as stainless steel screens, they are easy to install, are not affected by corrosive water, and are relatively inexpensive.

Figure: - EXP-7F4



Gravel Pack

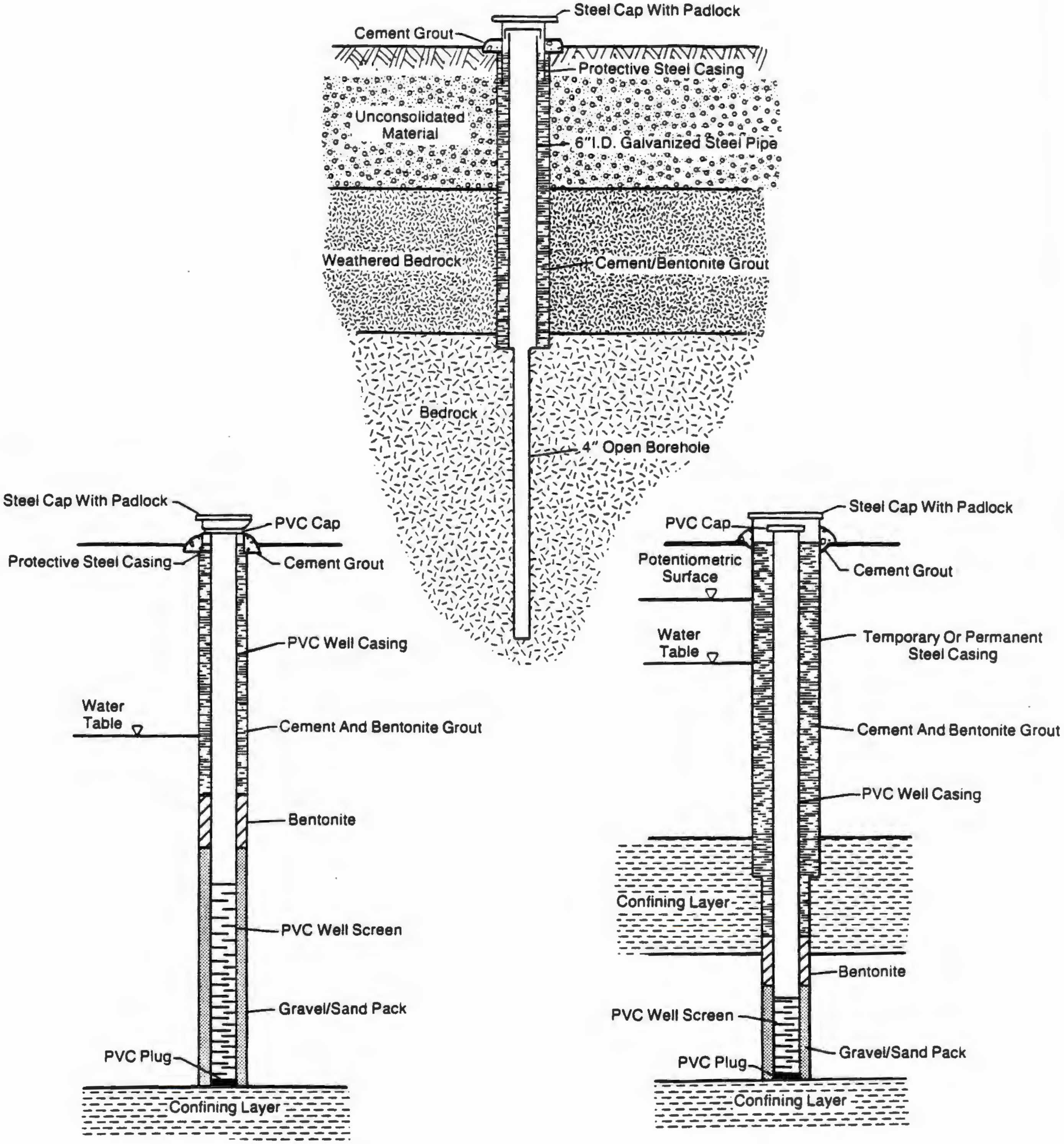
Sieve Openings	% Retained
.065 - Inch	0 - 8
.046 - Inch	10 - 26
.033 - Inch	37 - 53
.023 - Inch	72 - 88
.016 - Inch	90 - 100

Effective Size = .020 - Inch
Uniformity Coefficient = 1.75

Grain-size curves for aquifer sand and corresponding curve for properly selected sand pack material.

(Johnson, Inc., 1975)

Figure: EXP-7F5



Bedrock Monitoring Well Construction

Single Monitoring Well Construction In An Unconfined Aquifer

Single Monitoring Well Construction In A Confined Aquifer

Typical Monitoring Wells
(USEPA, 1980 & 86)

APPENDIX D

ORGANIC VAPOR ANALYZER (FID/HNu) CALIBRATION PROCEDURES

KEYSTONE ENVIRONMENTAL RESOURCES, INC.
STANDARD OPERATING PROCEDURES
PHILLIPS DISPLAY COMPONENTS

TITLE: **OPERATION/CALIBRATION**
HNu PHOTOIONIZATION ANALYZER

1.0 GENERAL APPLICABILITY

This SOP describes the operation and techniques used for the Model PI 101 Photoionization Analyzer (PID), manufactured by HNU Systems, Inc. This instrument has been adjusted to measure organic vapor levels. There are three direct reading ranges: 0-2 ppm, 0-20 ppm, 0-200 ppm at a minimum gain. The detection limit is 0.1 ppm. The response is less than 5 seconds to 90% of full scale. Keystone Environmental Resources Inc. Air Quality Department uses a lamp of 10.9 eV strength. The PI 101 is capable of operating either from a rechargeable battery for more than 10 hours or continuously from the AC battery charger.

2.0 RESPONSIBILITIES

2.1 The Health and Safety Officer or his/her designee will be responsible for the calibration, operation and maintenance of the instrument.

2.2 The Health and Safety Officer or his/her designee will be responsible for the documentation which applies to the various procedures performed with the instrument.

3.0 SUPPORTING MATERIALS

3.1 Traceable span gas cylinder

3.1.1 Isobutylene

3.2 Tedlar Bags

3.3 Tubing used for gas transferred from cylinder to bag.

3.4 AC Battery Charger

4.0 METHODS OR PROTOCOL FOR USE

4.1 Standard Procedure

4.1.1 Operation and calibration of the instrument should be done in a controlled environment, i.e., in the office, interior of a vehicle, etc. This is done in order to control working temperature and to protect from vehicle exhaust, etc.

4.1.2 The probe nozzle, electrode case handle and cable are stored within the instrument cover. To assemble, the handle must be screwed to the opposite end of the electrode casing. The 12 pin connector at the end of the cable must then be attached to the rest of the unit by twisting it downwards until a distinct snap and lock is felt. The unit is now ready to be used.

4.1.3 Prior to calibration or use of the instrument, the unit should be allowed to warm up. In this time, check to see if the UV light source is working. DO NOT LOOK DIRECTLY AT THE LIGHT SOURCE. Also, check to see if the intake is working properly. It is within the electrode casing and will give off a distinct hum when the unit is turned on.

4.1.4 Check to make sure the level of charge is high enough to ensure accurate readings. When the instrument is switched to the Battery Check position, the needle should deflect upscale to well within the green area (battery level) on the face of the meter. If not, the unit should be charged using the AC charger. A 3-hour charge will bring the unit up to 90% full charge.

With continuous use, (e.g., unit left on a full day), the unit should be recharged overnight for 10-14 hours.

4.2 Calibration and Maintenance

4.2.1 Calibration should be done at the beginning of each day the instrument is used, to ensure accurate readings over the full range of scale that is to be needed.

4.2.2 The instrument should be zeroed before and after each calibration. To zero the instrument, turn the function switch to the standby position and rotate the zero adjustment knob until the meter reads zero (wait for a stable response and then adjust the zero adjustment knob until a zero reading is obtained).

4.2.3 Actual calibration is done by first filling an evacuated Tedlar Bag with n-Hexane or 1,3-Butadiene calibration gas. This is done by connecting to the outlet side of the regulator on the calibration gas cylinder a flexible hose and the other side connected to the inlet valve of the Tedlar bag. Fill bag. Be absolutely sure the Tedlar bag has been evacuated before filling it with gas. Otherwise the calibration gas will be diluted and its concentration will not be known.

4.2.4 The appropriate analyzer scale shall be used on the known concentration of Isobutylene calibration gas. Attach the probe nozzle to the Tedlar bag and allow it to sample the gas until a stable, unchanging reading is reported by the analyzer. Adjust the span control knobs so that the instrument reading agrees exactly with the concentration of the calibration gas. Whenever the span setting is changed, the zeroing procedure (Section 4.2.2) should be repeated.

4.2.5 All calibration checks must be documented on appropriate forms.

4.3 Standard Operation

4.3.1 After the instrument is fully calibrated, it is ready to be used. To obtain the most accurate reading, use the 0-20 scale. To analyze a sample, the probe nozzle should be placed at the (1) breathing zone, and (2) the ground zone (about knee high) taking care not to contaminate the probe with any materials.

4.3.2 All readings should be documented on the appropriate forms.

4.3.3 Meter calibration should be checked by methods in 4.2 at the end of the day and any appropriate changes made and documented. This check should be done periodically.

5.0 DOCUMENTATION

5.1 Field/Lab Equipment Status Forms

5.2 HNU Pl 101 Recalibration Form Rev. 1

5.3 All documentation shall be retained in project files.

6.0 REFERENCES

Instruction Manual for PI 101 Photoionization Analyzer, printed by HNU Systems, Inc. 1975.

Standard Operating Procedure, Title: Operation/Calibration HNU Photoionization Analyzer, Date: 1st. Qtr. 1984, Number: 7315, Revision 1.

HNU PI 101 RECALIBRATION FORM

SN:__________

Project Name/No.______________

Recalibration Date ____/____/____

Time______________________________

By Whom___________________________

Calibration Gases: Cylinder ID Number Concentration

1.________________________________ppm

2.________________________________ppm

Where Calibrated: ________________________________
(Office Field Lab)

Battery Check: (Y,N) ________

Recharge Time:__________hrs

Zero Adjust: (Y,N) ________

First Calibration:

Designated Reading________ppm

Observed Reading________ppm

Span Setting: Initial ________

Final ________

Post Span Observed Reading______________________ppm

Post Calibration Zero Adjust: (Y,N) ________

Instruction

MI
611-132
December 1985

Model OVA 128
CENTURY Organic Vapor Analyzer

FIGURE 1
PORTABLE ORGANIC VAPOR ANALYZER

FOXBORO®

INTRODUCTION

The Model OVA 128 CENTURY Organic Vapor Analyzer (OVA 128) is manufactured in three configurations. These are:

- Basic Flame Ionization Detector for monitoring total hydrocarbons
- Gas chromatograph supplied with two columns
- Gas chromatograph tri-column for Benzene Analysis.

A battery charger can be ordered for either 120 V ac, 60 Hz or for 220 V ac, 50 Hz. Classifications are:

- FM certified for use in Class I, Groups A, B, C, and D, Division 1 hazardous environments.
- BASEEFA certified intrinsically safe, Ex ib, for IIC, Zone 1, Temperature Class T6. BASEEFA No. 76002/B std. SFA 3007.

Accessories for the OVA 128 are:

- Strip Chart Recorder - either FM or BASEEFA certified.
- Activated Charcoal Filter Assembly - used for zeroing the analyzer in a contaminated environment. Also used with dessicant as a moisture trap.
- Sample Dilutor Assembly for 10:1, 25:1, or 50:1 sample dilution.
- Septum Adapter for direct, online injection with the GC.
- Portable Isothermal Pack (PIP) for temperature control of GC columns.

The OVA 128 is a sensitive instrument designed to measure trace quantities of organic materials in air. It is essentially a flame ionization detector such as utilized in laboratory gas chromatographs and has similar analytical capabilities. The flame ionization detector is an almost universal detector for organic compounds with the sensitivity to measure in the parts per million range (V/V) in the presence of atmospheric moisture, nitrogen oxides, carbon monoxide, and carbon dioxide.

The instrument has broad application since it has a chemically resistant air sampling system and can be readily calibrated to measure almost all organic vapors. It has a single linearly scaled readout from 0 ppm to 10 ppm with a X1, X10, and X100 range switch. This range expansion feature provides accurate readings across a wide concentration range with either 10, 100 or 1000 ppm full scale deflection. Designed for use as a portable survey instrument, it can also be readily adapted to fixed remote monitoring or mobile installations. It is ideal for the determination of many organic air pollutants and for monitoring the air in potentially contaminated areas.

The OVA 128 is certified by Factory Mutual Research Corporation (FM) for use in Class I, Groups A, B, C, & D, Division I hazardous locations. Similar foreign certifications have been obtained, including BASEEFA. This requirement is especially significant in industries where volatile flammable petroleum or chemical products are manufactured or used and for instruments which are used in portable surveying or for analyzing concentrations of gases and vapors. Such instruments must be incapable, under normal or abnormal conditions, of causing ignition of hazardous mixtures in the air. In order to maintain the certified safety, it is important that the precautions outlined in this manual be practiced and that no modifications be made to these instruments.

It is highly recommended that the entire manual be read before operating the instrument. It is essential that all portions relating to safety of operation and maintenance be thoroughly understood.

Reference Literature

MI 611-101	Operation of Tri-Column GC Option
MI 611-102	Operation of Dilutor Kit
MI 611-105	Operation of Portable Isothermal Pack

GENERAL DESCRIPTION

The OVA 128 Analyzer is designed to detect and measure hazardous organic vapors and gases found in most industries. It has broad application since it has a chemically resistant sampling system and can be calibrated to almost all organic vapors. It can provide accurate indication of gas concentration in one of three ranges: 0 to 10 ppm; 0 to 100 ppm; or 0 to 1000 ppm. While designed as a lightweight portable instrument, it can be permanently installed to monitor a fixed point.

The instrument utilizes the principle of hydrogen flame ionization for detection and measurement of organic vapors. The instrument measures organic vapor concentration by producing a response to an unknown sample, which can be related to a gas of known composition to which the instrument has previously been calibrated. During normal survey mode operation, a continuous sample is drawn into the probe and transmitted to the detector chamber by an internal pumping system.

The sample stream is metered and passed through particle filters before reaching the detector chamber. Inside the detector chamber, the sample is exposed to a hydrogen flame which ionizes the organic vapors. When most organic vapors burn, they leave positively charged carbon-containing ions. An electric field drives the ions to a collecting electrode. As the positive ions are collected, a current corresponding to the collection rate is generated. This current is measured with a linear electrometer preamplifier which has an output signal proportional to the ionization current. A signal conditioning amplifier is used to amplify the signal from the preamp and to condition it for subsequent meter or external recorder display. The display is an integral part of the Probe/Readout Assembly and has 270° scale deflection.

In general, the hydrogen flame ionization detector is more sensitive for hydrocarbons than any other class of organic compounds. The response of the OVA varies from compound to compound, but gives repeatable results with all types of hydrocarbons; i.e., saturated hydrocarbons (alkanes), unsaturated hydrocarbons (alkenes and alkynes) and aromatic hydrocarbons.

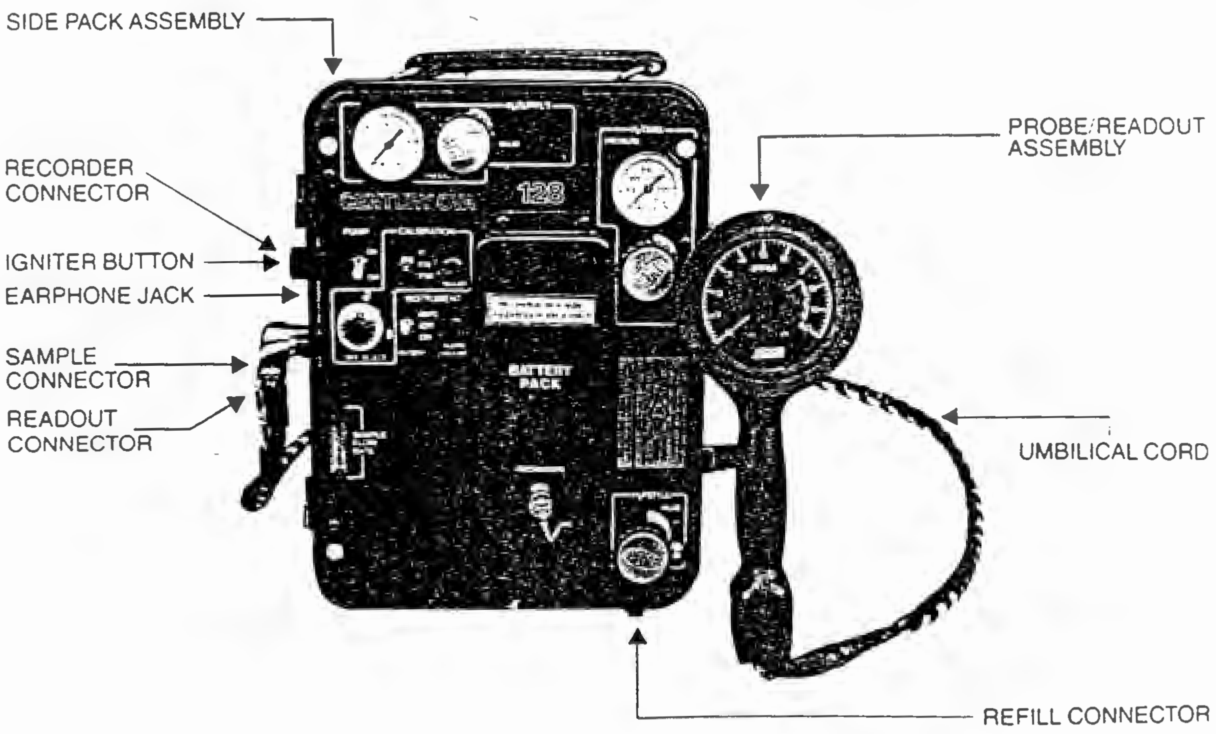


FIGURE 2
PORTABLE ORGANIC VAPOR ANALYZER
Model OVA 128

Typical response of various hydrocarbons, relative to methane is as follows:*

Compound	Relative Response (percent)
Methane	100 (reference)
Hexane	70
Propane	64
N-butane	61
N-pentane	100
Ethylene	85
Acetylene	200
Benzene	150
Toluene	120
Ethane	90

Compounds containing oxygen, such as alcohols, ethers, aldehydes, carbolic acid and esters give a lower response than that observed for hydrocarbons. This is particularly noticeable with compounds having a high ratio of oxygen to carbon such as the lower members of each series which have one, two or three carbons. With compounds containing higher numbers of carbons, the effect is diminished to such an extent that the response is similar to that of the corresponding hydrocarbons.

Nitrogen-containing compounds (i.e., amines, amides, and nitriles) respond in a manner similar to that observed for oxygenated materials. Halogenated compounds also show a lower relative response as compared with hydrocarbons. Materials containing no hydrogen, such as carbon tetrachloride, give the lowest response; the presence of hydrogen in the compounds results in higher relative responses. Thus, $CHCl_3$ gives a much higher response than does CCl_4. As in the other cases, when the carbon to halogen ratio is 5:1 or greater, the response will be similar to that observed for simple hydrocarbons.

The OVA has negligible response to carbon monoxide and carbon dioxide which, due to their structure, do not produce appreciable ions in the detector flame. Thus, other organic materials may be analyzed in the presence of CO and CO_2.

Applications

(1) Measurement of most toxic organic vapors present in industry for compliance with Occupational Safety and Health Administration (OSHA) requirements.

(2) Evaluation and monitoring applications in the air pollution field.

(3) Source identification and measurement for fugitive emissions (leaks) as defined by EPA.

(4) Forensic science applications.

(5) Controlling and monitoring atmospheres in manufacturing and packaging operations.

(6) Leak detection related to volatile fuel handling equipment.

(7) Monitoring the background level of organic vapors at hazardous waste sites.

(8) Quality control procedures geared to leak checking, pressurized system checks, combustion efficiency checks, etc.

Major Features

The basic instrument consists of two major assemblies, the Probe/Readout Assembly and the Side Pack Assembly (See Figure 2). The recorder is optional on all models, but is normally used with all instruments which incorporate the GC Option. The output meter and alarm level adjustments are incorporated in the Probe/Readout Assembly.

The Side Pack Assembly contains the remaining operating controls and indicators, electronic circuitry, detector chamber, hydrogen fuel supply, and electrical power supply.

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*NOTE: Each OVA detector will have slightly different responses for organic vapors relative to methane. The user should determine responses for his individual instrument. The typical response of various compounds relative to methane is as follows:

KETONES	
Acetone	60
Methyl ethyl ketone	80
Methyl isobutyl ketone	100
ALCOHOLS	
Methyl alcohol	15
Ethyl	25
Isopropyl	65
HALOGEN COMPOUNDS	
Carbon tetrachloride	10
Chloroform	65
Trichloroethylene	70
Vinyl chloride	35

Other major features are: linear scale readout, approximately two second response time and portable operating time of 8 hours for fuel supply and battery pack. A battery test feature allows charge condition to be read on the meter. Hydrogen flame-out is signified by an audible alarm plus a visual indication on the meter. The instrument contains a frequency modulated detection alarm which can be preset to sound at a desired concentration level. The frequency of the detection alarm varies as a function of detected level giving an audible indication of organic vapor concentration. An earphone is provided to allow the operator to hear the alarm in noisy areas or to avoid disturbing workers.

During use, the Side Pack Assembly can be carried by the operator on either his left or right side or as a back pack. The Probe/Readout Assembly can be detached from the Side Pack Assembly and disassembled for transport and storage.

Standard Accessories

A variety of sampling fixtures can be used. In addition, small diameter tubing can be used for remote sampling or electrically insulated flexible extensions can be used for places that are difficult to reach.

Telescoping Probe

Probe length can be increased or decreased over a 22 to 30 inch range to suit the individual user. A knurled locking nut is used to lock the probe at the desired length. The probe is attached to the Readout Assembly. When appropriate, the probe is replaced with a Close Area Sampler, which is supplied as a standard accessory.

Sampling Accessories

Part Number	Description
510125-1	Close area sampler - Connects directly to the readout assembly.
510035-1	Telescoping wand - Adjustable length - accommodates the probe listed below.
510126-1	Tubular area sampler - Used with the telescoping wand.

Particulate Filters

The primary filter of porous stainless steel is located behind the sample inlet connector (see Side Pack Assembly drawing). In addition, a replaceable porous metal filter is installed in the "close area" sampler.

Carrying Case

An instrument carrying case is provided to transport, ship and store the disassembled Probe/Readout Assembly, the Side Pack Assembly and other equipment.

Specifications

READOUT: 0 to 10, 0 to 100, 0 to 1000 ppm (linear)
SAMPLE FLOW RATE: 1 1/2 to 2 1/2 litre per minute at 22°C, 760 mm, using close area sampler
RESPONSE TIME: Approximately 2 seconds for 90% of final reading.
PRIMARY ELECTRICAL POWER: 12 volt (nominal) battery pack.
FUEL SUPPLY: Approximately 75 mL volume tank of pure hydrogen, maximum pressure 2400 psig, fillable in case.
HYDROGEN FLOW RATE: Factory set 12.5 ±0.5 mL/min (minus GC option) 11.0 ±0.5 mL/min (GC models)
PORTABLE OPERATING TIME: Minimum 8 hours with battery fully charged, hydrogen pressure at 1800 psig.
PHYSICAL DIMENSIONS: 9" x 12" x 5" (229 mm x 305 mm x 127 mm) Sidepack only.
WEIGHT: 12 pounds (5.5 kg) (sidepack and hand-held probe assembly)
DETECTION ALARM: Audible alarm plus meter indication. User preset to desired level.
FLAME-OUT ALARM: Audible alarm plus meter indication (needle drops off scale in negative direction).
BATTERY TEST: Battery charge condition indicated on readout meter. Upon activation of momentary contact switch, a meter reading above the indicator line means that there is 4 hours minimum service life remaining (at 22°C).
FILTERS: In-line sintered metal filters will remove particles larger than 10 microns.
OPERATING TEMPERATURE RANGE: 10°C to 40°C.
MINIMUM AMBIENT TEMPERATURE: 15°C for Flame Ignition (coldstart).
ACCURACY: Based on the use of a calibration gas for each range:

Calibration Temp. °C	Operating Temp. °C	Accuracy in % of Individual Full Scale		
		X1	X10	X100
20 to 25	20 to 25	±20	±10	±10
20 to 25	10 to 40	±20	±20	±20

RELATIVE HUMIDITY: 5% to 95%, Effect on accuracy: ±20% of individual full scale
RECORDER OUTPUT: 0 to 5 volts
MINIMUM DETECTABLE LIMIT (METHANE): 0.2 ppm
STANDARD ACCESSORIES:

1. Instrument carrying and storage case
2. Hydrogen fuel filling hose assembly
3. Battery charger
4. Earphone
5. Various sampling fixtures
6. Maintenance tool kit
7. Operators manual (2 each)
8. Padded leather carrying straps

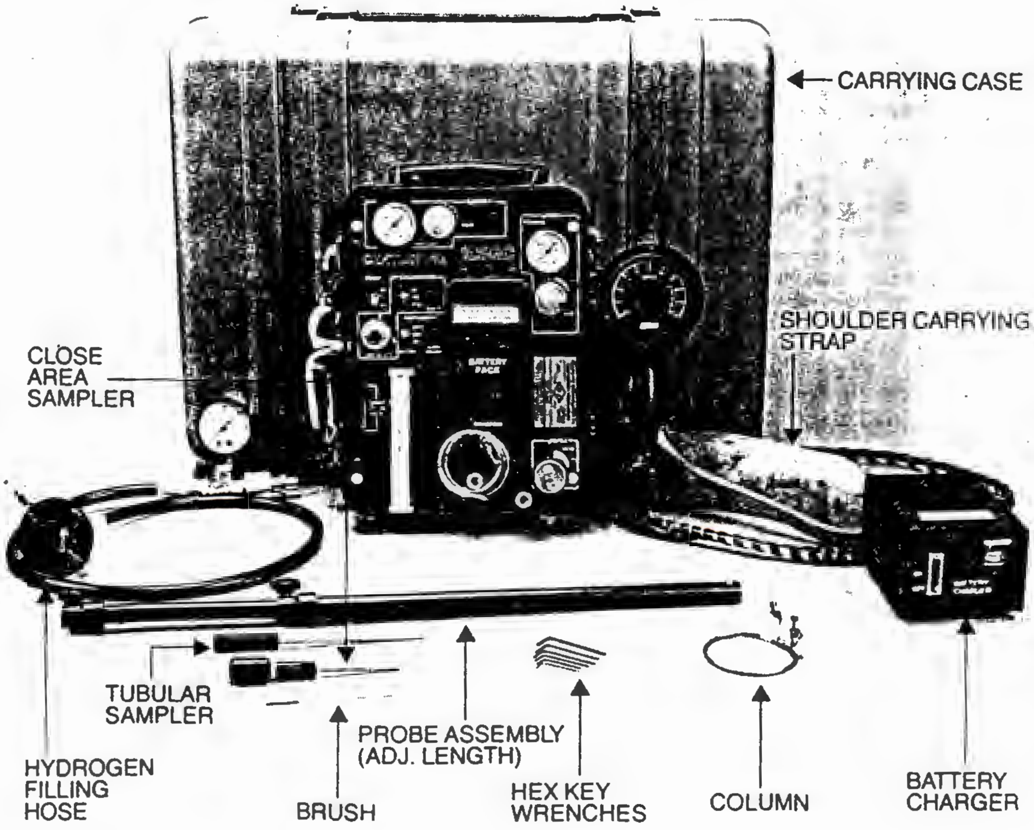


FIGURE 3
OVA-128 ANALYZER COMPONENTS
(Gas Chromatograph Model Shown)

OPERATING PROCEDURES

Controls and Indicators

Sidepack Assembly

1) INSTR/BATT Test Switch* - Three position toggle switch controls all instrument electrical power except the pump and alarm power. It also permits display of the battery charge condition on the readout meter.

2) PUMP (ON/OFF) Switch* - Toggle switch controls power to the internal pump and audio alarms.

3) Igniter Switch - Momentary push button switch connects power to the igniter coil in the detector chamber and simultaneously disconnects power to pump.

4) CALIBRATE Switch (range selector) -Selects the desired range: X1 (0 to 10 ppm); X10 (0 to 100 ppm); X100 (0 to 1000 ppm).

5) CALIBRATE ADJUST (zero) Knob -Potentiometer used to "zero" the instrument.

6) GAS SELECT KNOB (span control) - Ten-turn dial readout potentiometer sets the gain of the instrument (commonly referred to as span control).

7) Recorder Connector - Five-pin connector used to connect the instrument to an external recorder with the following pin connections:

   Pin E - + 12 V dc
   Pin H - Ground
   Pin B - Signal 0 to 5 V dc

8) Charger Connector - BNC connector used to connect the battery pack to the battery charger.

9) HYDROGEN TANK VALVE - Valve used to supply or close off the fuel supply from the hydrogen tank.

10) HYDROGEN TANK PRESSURE Indicator - High pressure gauge measures pressure in the hydrogen fuel tank which is an indication of fuel supply.

11) HYDROGEN SUPPLY VALVE - Valve used to supply or close off hydrogen fuel to the detector chamber.

12) HYDROGEN SUPPLY PRESSURE Indicator - Low pressure gauge used to monitor hydrogen pressure at the capillary restrictor.

13) SAMPLE FLOW RATE Indicator - Indicator to monitor the sample flow rate.

14) REFILL CONNECTION - ¼ in AN fitting to connect the hydrogen refill hose to the instrument.

15) REFILL VALVE - Valve to open one end of the instrument fuel tank for refilling with hydrogen.

16) EARPHONE JACK - Used to connect the earphone; speaker is disabled when earphone is used.

17) VOLUME Knob - Potentiometer adjusts the volume of the internal speaker and earphone.

18) Readout and Sample Connectors - Used to connect the sample hose and umbilical cord from the Probe/Readout to the Side Pack.

Controls and Indicators

Probe/Readout Assembly

1) Meter - Linear scaled 270° meter displays the output signal level in ppm.

2) Alarm Level Adjust Knob - Potentiometer (located on the back of the Readout Assembly) is used to set the concentration level at which the audible alarm is actuated.

*Special Switch - switch handle must be pulled to change position. This prevents accidental movement.

Startup Procedure

a) Connect the Probe/Readout Assembly to the Sidepack Assembly by attaching the sample line and electronic jack to the Sidepack.

b) Select the desired sample probe (close area sampler or telescoping probe) and connect the probe handle. Before tightening the knurled nut, check that the probe accessory is firmly seated against the flat seals in the probe handle and in the tip of the telescoping probe.

c) Move the Instr/Batt Switch to the test position. The meter needle should move to a point beyond the white line, indicating that the integral battery has more than 4 hours of operating life before recharging is necessary.

d) Move the Instr/Batt Switch to the "ON" position and allow a 5 minute warm-up.

e) Turn the Pump Switch on.

f) Use the Calibrate Adjust knob to set the meter needle to the level desired for activating the audible alarm. If this alarm level is other than zero, the Calibrate Switch must be set to the appropriate range.

g) Turn the Volume Knob fully clockwise.

h) Using the Alarm Level Adjust knob, turn the knob until the audible alarm is activated.

i) Move the Calibrate Switch to X1 and adjust the meter reading to zero using the Calibrate Adjust (zero knob).

j) Open the hydrogen Tank Valve 1 or 2 turns and observe the reading on the Hydrogen Tank Pressure Indicator. (Approximately 150 psi of pressure is required for each hour of operation).

k) Open the Hydrogen Supply Valve 1 or 2 turns and observe the reading on the Hydrogen Supply Pressure Indicator. The reading should be between 8 and 12 psi.

Note: With GC instrument, a column or jumper must be installed.

l) After approximately one minute, depress the Igniter Button until the hydrogen flame lights. The meter needle will travel upscale and begin to read "Total Organic Vapors". Caution: Do not depress igniter for more than 6 seconds. If flame does not ignite, wait one minute and try again.

m) The instrument is ready for use. NOTE: If the ambient background organic vapors are "zeroed out" using the Calibrate Adjust knob, the meter needle may move off-scale in the negative direction when the OVA is moved to a location with lower background. If the OVA is to be used in the 0 to 10 ppm range, it should be "zeroed" in an area with very low background. A charcoal filter (Part No. 510095-1) can be used to generate the clean background sample.

Operating Procedures

The following procedure describes operation of the OVA in the "Survey Mode" to detect total organic vapors.

a) Set the CALIBRATE Switch to the desired range. Survey the areas of interest while observing the meter and/or listening for the audible alarm indication. For ease of operation, carry the Side Pack Assembly positioned on the side opposite the hand which holds the Probe/Readout Assembly. For broad surveys outdoors, the pickup fixture should be positioned several feet above ground level. When making quantitative readings or pinpointing, the pickup fixture should be positioned at the point of interest.

b) When organic vapors are detected, the meter pointer will move upscale and the audible alarm will sound when the setpoint is exceeded. The frequency of the alarm will increase as the detection level increases.

If the flame-out alarm is actuated, check that the pump is running, then press the igniter button. Under normal conditions, flame-out results from sampling a gas mixture that is above the lower explosve level which causes the hydrogen flame to extinguish. If this is the case, reignition is all that is required to resume monitoring. Another possible cause for flame-out is restriction of the sample flow line which would not allow sufficient air into the chamber to support combustion. The normal cause for such restriction is a clogged particle filter.

It should be noted that the chamber exhaust port is on the bottom of the case and blocking this port with the hand will cause fluctuations and/or flame-out.

Shut Down Procedure

The following procedure should be followed for shut down of the equipment:

A. Close HYDROGEN TANK VALVE
B. Close HYDROGEN SUPPLY VALVE
C. Move INSTR Switch to OFF
D. Wait 5 seconds and move PUMP Switch to OFF. INSTRUMENT IS NOW IN A SHUT DOWN CONFIGURATION.

Fuel Refilling

NOTE: Use PREPURIFIED or ZERO grade hydrogen (certified total hydrocarbons as methane <0.5 ppm recommended).

a) The instrument and the charger should be completely shut down during hydrogen tank refilling operations. Refilling should be done in a ventilated area. THERE SHOULD BE NO POTENTIAL IGNITERS OR FLAME IN THE AREA.

b) If you are making the first filling on the instrument or if the filling hose has been allowed to fill with air, the filling hose should be purged with hydrogen prior to filling the instrument tank. This purging is not required for subsequent fillings.

c) The filling hose assembly should be left attached to the hydrogen supply tank when possible. Ensure that the FILL/BLEED Valve on the instrument end of the hose is in the OFF position. Connect the hose to the refill connection on the Side Pack Assembly.

d) Open the hydrogen supply bottle valve slightly. Open the REFILL VALVE and the HYDROGEN TANK VALVE on the instrument panel and place the FILL/BLEED Valve on the filling hose assembly in the FILL position. The pressure in the instrument tank will be indicated on the HYDROGEN TANK PRESSURE Indicator.

e) After the instrument fuel tank is filled, close the REFILL VALVE on the panel, the FILL/BLEED Valve on the filling hose assembly and the hydrogen supply bottle valve.

f) The hydrogen trapped in the hose should now be bled off to atmospheric pressure. CAUTION should be used in this operation as described in Step (g) below, since the hose will contain a significant amount of hydrogen at high pressure.

g) The hose is bled by turning the FILL/BLEED Valve on the filling hose assembly to the BLEED position. After the hose is bled down to atmospheric pressure, the FILL/BLEED Valve should be turned to the FILL position to allow the hydrogen trapped in the connection fittings to go into the hose assembly. Then, again, turn the FILL/BLEED Valve to the BLEED position and exhaust the trapped hydrogen. Then turn the FILL/BLEED Valve to OFF to keep the hydrogen at one atmosphere in the hose so that at the time of the next filling there will be no air trapped in the filling line.

h) Close the HYDROGEN TANK VALVE.

i) With the HYDROGEN TANK VALVE and the HYDROGEN SUPPLY VALVE closed, a small amount of HYDROGEN at high pressure will be present in the regulators and plumbing. As a leak check, observe the HYDROGEN TANK PRESSURE Indicator while the remainder of the system is shut down and ensure that the pressure reading does not decrease rapidly (more than 350 psi/h) which would indicate a significant leak in the supply system.

Battery Charging

WARNING: Never charge in a hazardous environment.

a) Plug charger connector into mating connector on battery cover and insert ac plug into 115 V ac wall outlet.

b) Move the battery charger switch to the ON position. The lamp above the switch button should illuminate.

c) Battery charge condition is indicated by the meter on the front panel of the charger; meter will deflect to the left when charging. When fully charged, the pointer will be in line with "charged" marker above the scale.

d) Approximately one hour of charging time is required for each hour of operation. However, an overnight charge is recommended. The charger can be left on indefinitely without damaging the batteries. When finished, move the battery charger switch to OFF and disconnect from the Side Pack Assembly.

THE FOLLOWING ARE SPECIAL INSTRUCTIONS FOR RECHARGING BATTERIES WHICH HAVE BEEN COMPLETELY DISCHARGED.

It has been established that the above battery charging procedures may not be effective when the operator has allowed the battery to COMPLETELY discharge.

When this happens and the above procedures fail to charge the battery, perform the following additional steps:

e) Remove the battery from the instrument case.

f) Connect to any variable dc power supply.

g) Apply 40 volts at ½ ampere maximum.

h) Observe the power supply meter. As soon as the battery begins to draw current, gradually reduce the power maintaining ½ A maximum until the meter reads approximately 15 volts.

NOTE: The time required to reach the 15 volt reading will depend on degree of discharge.

i) Repeat steps (a), (b), (c), and (d) above to complete the charging cycle.

SUMMARY OF OPERATING PROCEDURES

Start Up

a) Check battery condition by moving the INSTR Switch to the BATT position.

b) Move INSTR Switch to ON and allow five (5) minutes to warm-up.

c) Use the Calibrate Adjust knob to set the meter needle to the level desired for activating the audible alarm. If this alarm level is other than zero, the Calibrate Switch must be set to the appropriate range.

d) Turn the Volume Knob fully clockwise.

e) Using the Alarm Level Adjust knob, turn the knob until the audible alarm is activated.

f) Set CALIBRATE Switch to X1 position, use CALIBRATE Knob and set meter to read 0.

g) Move PUMP Switch to ON position, then place instrument panel in vertical position and check SAMPLE FLOW RATE indication. The normal range is 1.5 to 2.5 units. If less, check filters.

h) Open the HYDROGEN TANK VALVE and the HYDROGEN SUPPLY VALVE. Wait one minute for hydrogen to purge the system.

i) Depress Igniter Button until burner lights. Do not depress Igniter Button for more than six seconds. (If burner does not ignite, let hydgrogen flow for one minute and again attempt ignition.)

j) Use CALIBRATE Knob to "zero" out ambient background. For maximum sensitivity below 10 ppm, set CALIBRATE Switch to X1 and readjust zero on meter. To avoid false flame-out alarm indication, set meter to 1 ppm with CALIBRATE Knob and make differential readings from there.

Shut Down

a) Close the HYDROGEN SUPPLY VALVE

b) Close the HYDROGEN TANK VALVE

c) Move the INSTR Switch and PUMP Switch to OFF

d) Instrument is now in shut down configuration

CALIBRATION

Recalibration to Various Organic Vapors

The OVA 128 is capable of responding to nearly all organic compounds. At the time of manufacture, the analyzer is calibrated to mixtures of methane in air. For precise analysis it is necessary to recalibrate with the specific compound of interest. The GAS SELECT control is used to set the electronic gain for a particular compound.

The instrument is recalibrated using a mixture of a specific vapor in air, with known concentration. After the instrument is in operation and the normal background is zeroed, draw a sample of the calibration gas into the instrument. The GAS SELECT Knob on the panel is then used to set the readout meter indication to correspond to the concentration of the calibation gas mixture.

The instrument has now been calibrated to the vapor mixture being used. After this adjustment, the setting on the "digidial" should be recorded for that particular organic vapor compound. This exercise can be performed for a large variety of compounds, thereby generating a "library" which can be used for future reference without need for additional calibration standards.

To read a particular compound, the GAS SELECT control is turned to the predetermined setting for the compound. Calibration on any one range automatically calibrates the other two ranges.

Using Empirical Data

Relative response data can be used to estimate the concentration of a vapor without need to recalibrate the analyzer. With the instrument calibrated to methane, obtain the concentration reading for a calibration sample of the test vapor. The response factor (R) in percent, for that vapor is:

$$R = \frac{\text{Actual Concentration}}{\text{Measured Concentration}}$$

To determine the concentration of an unknown sample of that vapor, multiply the measured concentration by R.

Calibration Standards

Commercial Standards

Commercially available standard samples offer the most convenience and are recommended for the most precise analyses. Always remember to obtain the desired vapor in an air background. Samples should be drawn from the cylinder into a collapsed sample bag, then drawn from the bag by the instrument to prevent a pressure or vacuum at the sample inlet.

Preparation of Standards

The following procedure is for generating calibration standards as an alternative to using commercial mixtures.

Obtain a five (5) gallon glass bottle and determine its volume by measuring the volume of water needed to fill it (use of a 1000 mL graduated cylinder is convenient). Another approach is to weigh the empty bottle, fill it with water and weigh again. The difference between the two values is the weight of water. By multiplying the weight of water in pounds by 0.455, obtain the volume of the bottle in liters. Empty the water and allow the bottle to dry. Place a one-foot piece of Teflon tubing in the flask to aid in mixing the vapors uniformly with the air. The volume of such a bottle should be about 20 liters, which is 20,000 mL. If the volume were 20,000 mL, then a 2 mL sample of a gas would be equivalent to 200 mL per 2 million mL or 100 ppm (V/V). Use of a gas tight Syringe, readable in 0.01 mL, allows the preparation of mixtures in the 1-2 ppm range, which are sufficient for the quantitative estimation of concentrations. A plastic stopper is loosely fitted to the tip of the bottle. The needle of the syringe is placed inside the jug neck and the stopper squeezed against the needle to decrease leakage during sample introduction. Inject the sample into the bottle and withdraw the needle without removing the stopper. Tighten the stopper and shake the bottle for a few minutes with sufficient vigor that the plastic tubing in the bottle moves around to ensure good mixture of the vapors with the air.

Calculations

$$\text{Injection} = \frac{\text{Volume Concentration X Molecular Weight X System Volume}}{\text{Density X Molar Volume at STP*}}$$

$$= \frac{(C)\ (MW)\ (V)}{(D)\ (V)}$$

Using the Ideal Gas Law, PV=RT, the molar volume of any gas at STP (25°C and 1 atm) is:

$$V = \frac{RT}{P} = \frac{\text{Universal Gas Constant x Temperature}}{\text{Pressure}}$$

$$= \frac{\left[\left(0.08206\ \frac{\text{litre atm}}{\text{mol K}}\right)\right] (298.15\ \text{K})}{1\ \text{atm}}$$

$$= (24.47\ \text{L})\ (\text{mol}^{-1})$$

Therefore, the injection volume necessary to prepare 1 liter of a 100 ppm sample of hexane would be:

$$\text{Injection Volume} = \frac{(100\ \text{ppm})\ [(86.18\ \text{g})\ (\text{mol}^{-1})]\ (1\ \text{liter})}{[(0.659\ \text{g})\ (\text{mL}^{-1})]\ [(24.47\ \text{L})\ (\text{mol}^{-1})]\ [(1000\ \text{mL})\ (\text{l}^{-1})]}$$

$$= 0.534\ \mu\text{L}$$

* STP - Standard Temperature and Pressure

Primary Calibration for Methane

Internal electronic adjustments are provided to calibrate and align the circuits. After initial factory calibration, it should not be necessary to repeat the calibration unless the analyzer undergoes repairs which affect calibration. If the OVA 128 will be extensively used for analysis of a sample other than methane, recalibration of the electronics (after resetting the GAS SELECT CONTROL) may result in better accuracy. See Recalibration to Various Organic Vapors above.

Primary calibration of this instrument is accomplished at the factory using methane-in-air, sample gases.

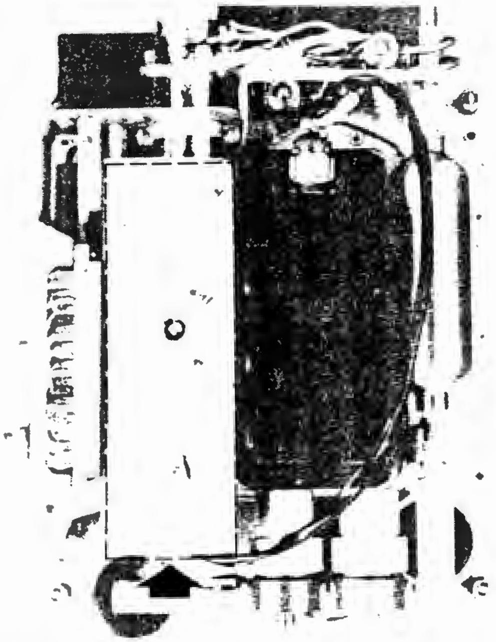


FIGURE 4
LOCATION OF ELECTRONIC ADJUSTMENTS

Calibration Using Known Samples for Each Range *(Refer to Figure 4)*

The accuracy stated under Specifications is obtained when the instrument is calibrated with known concentrations for each range. Prepare separate samples of methane-in-air in these concentration ranges: 7 to 10 ppm, 90 to 100 ppm, and 900 to 1000 ppm. Calibrate the instrument as follows:

a) Place the instrument in normal operation and allow a minimum of 15 minutes for warm-up and stabilization.

b) Set the GAS SELECT control to 300.

c) Set the CALIBRATE Switch to X1.

d) Set the CALIBRATE ADJUST (Zero) Knob so that the meter reads zero.

e) Check that the meter reads zero on the X10 and X100 ranges.

f) Set the CALIBRATE Switch to X1 and introduce the sample with known concentration in the 7 to 10 ppm range.

g) Adjust R31 so that the meter reading corresponds to the sample concentration.

h) Set the CALIBRATE Switch to X10 and introduce the sample with known concentration in the 90 to 100 ppm range.

i) Adjust R32 so that the meter reading corresponds to the sample concentration.

j) Set the CALIBRATE Switch to X100 and introduce the sample with known concentration in the 900 to 1000 ppm range.

k) Adjust R33 so that the meter reading corresponds to the sample concentration.

l) The instrument is now calibrated for methane and ready for service.

Calibration Using a Single Sample Calibration *(Refer to Figure 4)*

Calibration may be accomplished using a single known sample of methane in air in the range of 90 to 100 ppm. This may not provide the accuracy stated under specifications but is adequate for field survey work.

a) Place instrument in normal operation with CALIBRATE Switch set to X10 and GAS SELECT control set to 300.

b) Use the CALIBRATE ADJUST (zero Knob to adjust the meter reading to zero.

c) Introduce a methane sample of a known concentration (between 90 and 100 ppm not to exceed 100 ppm) and adjust trimpot R-32 so the meter reading corresponds to the known sample.

d) This sets the instrument gain for methane with the panel mounted gain adjustment (GAS SELECT) set at a reference number of 300.

e) Turn off HYDROGEN SUPPLY VALVE to put out flame.

f) Leave CALIBRATE Switch on X10 position and use CALIBRATE ADJUST (zero) Knob to adjust meter reading to 4 ppm.

g) Place CALIBRATE Switch in X1 position and using trimpot R-31 adjust meter reading to 4 ppm.

h) Move CALIBRATE Switch to X10 position again. Use CALIBRATE ADJUST (zero) Knob to adjust meter to a reading of 40 ppm.

i) Move CALIBRATE Switch to X100 position and use trimpot R-33 to adjust meter reading to 40 ppm.

j) Move CALIBRATE ADJUST (zero) Knob to adjust meter reading to zero.

k) Unit is now balanced from range to range, calibrated to methane, and ready to be placed in normal service.

SAFETY PRECAUTIONS

The OVA 128 has been tested and certified by Factory Mutual Research Corporation (FM) as safe for use in Class I, Division 1, Groups A, B, C and D hazardous atmospheres. Similar foreign certifications have been obtained, including BASEEFA. Special restrictions must be strictly adhered to, to ensure the certification is not invalidated by actions of operating or service personnel.

All flame ionization hydrocarbon detectors are potentially hazardous since they use hydrogen or hydrogen mixtures in the detector cell. Mixtures of hydrogen and air are flammable over a wide range of concentrations whether an inert gas such as nitrogen is present or not. Therefore, the recommended precautions and procedures should be followed for maximum safety. Safety considerations were a major factor in the design of the Organic Vapor Analyzer (OVA).

All connections are of the permanent type as opposed to quick disconnect. To protect against external ignition of flammable gas mixtures, the flame detection chamber has porous metal flame arrestors on the sample input and the exhaust ports as well as on the hydrogen inlet connector. The standard battery pack and other circuits are internally current limited to an intrinsically safe level.

No Modifications Permissible

It is imperative that operation and service procedures described in this manual be carefully followed in order to maintain the intrinsic safety which is built into the OVA. NO MODIFICATION TO THIS INSTRUMENT IS PERMISSIBLE. Therefore, component replacement must be accomplished with approved parts.

Electrical Protection

The 12 V battery power supply circuit is current limited to an instrinsically safe level. Fuses are not utilized and all current limiting resistors and other components which are critical to the safety certification are encapsulated to prevent inadvertent replacement with components of the wrong value or specification. Under no circumstances should the encapsulation be removed.

Fuel Supply System

The OVA fuel tank has a volume of approximately 75 cm which, when filled to the maximum rated pressure of 2300 psig, holds approximately 5/8 ft of gas. The fuel used in the OVA should be PREPURIFIED or ZERO grade hydrogen (certified total hydrocarbons as methane <.5 ppm recommended.)

Hydrogen gas gains heat when expanding and, therefore, should not be rapidly released from a high pressure tank to a low pressure environment. Flow restrictors are incorporated in the hydrogen refill fitting and hydrogen is restricted on the output side of the tank by the low flow rate control system. In addition, a special flow restrictor is incorporated in the FILL/BLEED valve of the hydrogen filling hose assembly. These precautions limit the flow rate of the hydrogen to prevent ignition due to self-heat from expansion.

Precautions should be taken during hydrogen filling or hydrogen emptying operations to ensure that there are no sources of ignition in the immediate area. Since the instrument tank at 2300 psig holds only 5/8 ft of hydrogen, the total quantity, if released to the atmosphere, would be quickly diluted to a non-flammable level. There is, however, the possibility of generating flammable mixtures in the immediate vicinity of the instrument during filling or emptying operations if normal care is not exercised.

Detector Chamber

The input and output ports of the flame ionization chamber have sintered metal flame arrestors. The chamber is ruggedly constructed of Teflon such that even if highly explosive mixtures of hydrogen and air are inadvertently created in the chamber and ignited, the chamber would NOT rupture.

MAINTENANCE

This section describes the routine maintenance schedule and provides procedures for trouble-shooting an instrument malfunction.

CAUTION: Maintenance personnel should be thoroughly familiar with instrument operation before performing maintenance. It is essential that all portions of this manual relating to safety of operation, servicing and maintenance, be thoroughly understood. There should be no potential igniters or flame in the area when filling, emptying or purging the hydrogen system and the instrument should be turned off.

Extreme care should be exercised to ensure that required parts replacement is accomplished with the parts specified by Foxboro. NO MODIFICATIONS ARE PERMITTED. DISASSEMBLE INSTRUMENT ONLY IN A NON-HAZARDOUS ATMOSHPHERE.

Routine Maintenance *(Refer to Figure 5)*

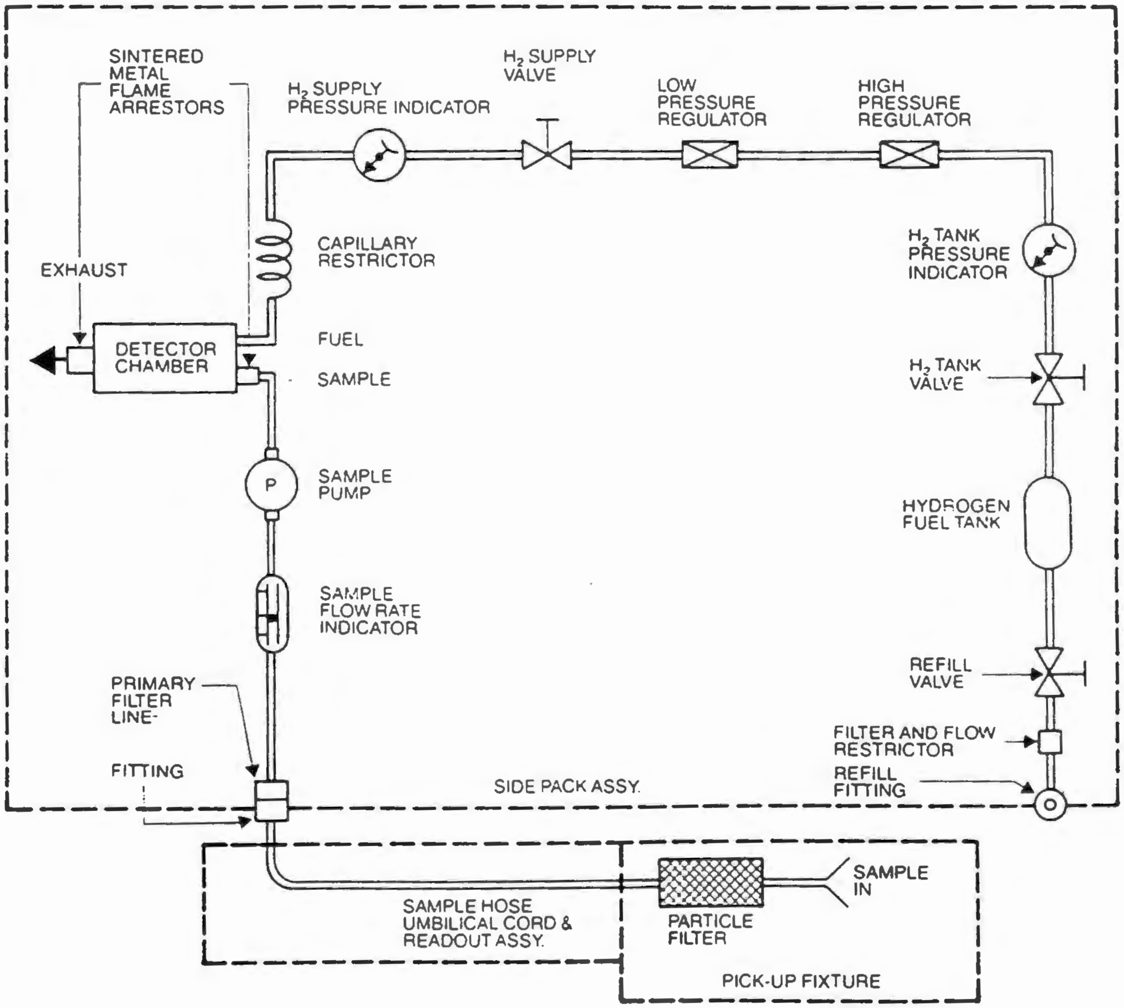


FIGURE 5
BLOCK DIAGRAM - GAS HANDLING SYSTEM

Primary Filter

This filter is located behind the sample inlet connector (Fitting Assembly) on the Side Pack Assembly and is removed for cleaning by using a 7/16 inch thin wall socket to unscrew the Fitting Assembly. The filter cup, "O" ring and loading spring will then come out. The porous stainless filter cup can be cleaned by blowing out or washing in solvent. If a solvent is used, care should be taken to ensure that all solvent is removed by blowing out or heating the filter. Reassemble in reverse order ensuring that the "O" ring seal on the Fitting Assembly is intact.

Secondary Filter

A particle filter is located in each pick-up fixture. One of these filters must be in the sample line whenever the instrument is in use. The OVA 128 uses a porous metal filter which can be replaced or cleaned.

Mixer/Burner Assembly Filter

A porous metal particle filter is incorporated in the Mixer/Burner Assembly which screws into the Preamp Assembly. This filter is used as the sample mixer and inlet flame arrestor in the chamber. The filter should not become contaminated under normal conditions but can be cleaned or the assembly replaced if necessary.

Access to this filter or output surface does not require removing the instrument from the case. For access, remove the safety cover using a hex key wrench (supplied) then unscrew the exhaust port. The Filter Assembly can now be seen on the side of the chamber (Preamp Assembly) and can be cleaned with a small wire brush.

Exhaust Flame Arrestor

A porous metal flame arrestor is located in the exhaust port of the detector chamber (Preamp Assembly). It acts as a particle filter on the chamber output and restricts foreign matter from entering the chamber. This filter may be cleaned by removing the exhaust port. For access, see Mixer/Burner section above. Note that the filter is captive to the exhaust port. Clean the filter with a solvent or detergent and ensure that it is dry and completely baked out at 120°F before reinstalling.

Sampling Fixtures

Sampling fixtures should be periodically cleaned with an air hose and/or detergent water to eliminate foreign particle matter.

If a solvent is used, the fixture should be subsequently cleaned with detergent and baked out at 120°F to eliminate residual hydrocarbons from the solvent.

Hydrogen Tank Supply & Refill Valves

After some time, the Teflon washers under each valve packing nut can "cold flow" (move with pressure) and allow hydrogen to leak. Leakage can be determined by using Leak-Tec, Snoop or a soap solution around the valve stems. This leakage can usually be stopped by tightening the compression nut (adapter) as outlined below.

a) Unscrew the packing nut with a 7/16 inch wrench
b) Unscrew the valve
c) Replace the compression rings

This compression is against soft material and only a small amount of force is necessary to sufficiently compress the Teflon washers. If, after tightening, leakage still occurs, it would be advisable to replace the two Teflon washers, as follows:

a) Drain hydrogen system slowly and to the extent necessary to work on the leaking valve(s). Observe safety precautions. There should be no potential igniters in the area.

b) Remove all three (3) knob screws and knobs.

c) Remove the compression nut on the valve that is not sealing properly. Remove the stem by unscrewing it from the valve body. Observe the sandwich of metal and Teflon washers and note their order.

d) Visually check the Kel-F™ seat on the stem for cracks or foreign material. Wipe clean, if necessary, with a lint free cloth (no solvents or oils) and replace if damaged.

e) Remove the washers and replace the Teflon washers (the factory procedure is a light wipe of HYDROCARBON FREE silicone grease).

f) Replace the stem assembly in the valve body and tighten lightly.

g) Push the washers down into the compression area in the same order as noted upon removal. Replace the compression nut and tighten snuggly.

h) Close the low pressure valve and fill the tank assembly. Check valves for leaks. Tighten again, if necessary, and reassemble the unit.

Air Sampling System Maintenance

A potential problem associated with the OVA instrument is that leaks can develop in the air sample pumping system. These leaks can result in dilution or loss of sample, causing low reading of vapor concentration and slow response.

The OVA is equipped with a flow gauge that provides a method to check for air leaks. Assemble the pickup probe selected for use to the readout assembly and then position the sidepack vertically so the flow gauge may be observed. Cover the end of the pickup probe with your finger and observe that the ball in the flow gauge goes to the bottom, indicating no air flow (if ball has slight chatter while on bottom, this is acceptable). Cover the center of the chamber exhaust port with your thumb and again observe the ball going to the bottom. Another simple check is to expose the pickup probe to cigarette smoke or a light vapor (butane) and observe that the meter responds in approximately 2.0 seconds. It should be noted that slow meter response may also indicate a restriction in the air sampling system.

Failure of the ball to go to the bottom when the inlet is blocked indicates a leak in the system between the probe and the pump inlet or the inlet check valve. To isolate the problem, remove parts, one at a time, and again block off the air inlet. Remove the pickup probe(s) and cover the air inlet at the Readout Assembly. If the ball goes to the bottom, check that the "readout to probe" seal washer is in place and replace the probes, holding them back against this seal while tightening the nut. Recheck, and if leakage is still present, it is probably in the probe (pickup fixture), which should be repaired or replaced.

If leakage is indicated as being past the readout handle when the connection to the sidepack is tight, disconnect the sample line at the fitting on the sidepack and cover this inlet with your finger. If the flow gauge ball goes to the bottom, the problem should be a leak in the umbilical cord/Readout Assembly, which should be investigated and repaired. There is also the possibility of a leaking check valve in the pump which would not show up on this test. If the leakage is not found in the umbilical cord, it is most likely in the pump check valve. The pump should be replaced.

If the ball does not go to the bottom, the leak will be either in the flow gauge or it's connecting tubing. Visually check that the tubing is connected and if so, the flow gauge should be repaired or replaced. Check the "O" ring installation in the sample inlet connector (Fitting Assembly).

As an alternate approach, leaks on the inlet side of the pump can be detected by using alcohol on a "Q" Tip and lightly swabbing the connections one at a time or by directing organic vapor or smoke at the potential leakage points and observing the meter response or audible alarm.

Leaks (beyond the pump) are easier to locate, as any of the commercially available leak detection solutions can be used. Cover the exhaust port, which will place the exhaust system under pressure, and check each connection, one at a time. Replace the Teflon tubing or retape the threaded connections with Teflon joint tape. Check the igniter and Mixer/Burner Assembly where they screw into the detector, the high voltage terminal screw on the side of the Mixer/Burner and exhaust port itself. If after these checks, the flow gauge ball still will not go to the bottom with the exhaust blocked, the problem is likely a leaking exhaust check valve in the pump, which should be repaired or replaced.

Contaminating Control

On occasion, the background reading may be relatively high under normal ambient conditions. Ambient background readings will vary somewhat depending on the geographical location where the instrument is being used. However, the background reading normally should be in the range of 3 to 5 ppm as methane. The acceptable background reading consists of 1 to 1½ ppm of methane which is present in the normal air environment. In addition to the measurement of a normal methane background, there will normally be 2 to 4 ppm of equivalent methane background caused by acceptable levels of contamination in the hydrogen fuel and/or hydrogen fuel handling system resulting in a total equivalent methane reading of 3 to 5 ppm in clean air.

If the background reading goes above 5 ppm to 6 or 7 ppm, this is normally still acceptable since any measurement is additive to that background reading, i.e., 2 ppm on top of 5 or 2 ppm on top of 7 provides the same differential reading, however, the lower background is obviously desirable.

The background reading is zeroed out or nulled - even though in reality the background still exists. The background reading is measured by zeroing the meter with the flame out and noting the meter indication after the flame is on.

The cause for a high background reading is usually associated with contamination in the hydrogen fuel system. This will, of course, cause a background reading since this is the function of the basic detector "to measure contamination entering the detector chamber". In addition, contamination present in the hydrogen will many times leave a small unobservable deposit on the burner face which can continue to generate a background reading when the detector is in operation and the burner assembly is heated.

Another possible cause of contamination is the Mixer/Burner Assembly when the contamination is trapped in the porous bronze sample filter. This is not a common problem and usually only happens when an unusually high level of contaminant is drawn into the assembly. Another possible cause of high background reading is contamination in the air sample line to the detector. This is uncommon but can be the source of the problem.

NOTE: An OVA that has the Chromatograph Option can have high background caused by saturation or contamination of the activated charcoal filter, which is in the line during chromatograph analysis, or of the column which is in the hydrogen line at all times.

Analysis and Correction

Prior to analyzing the problem, the OVA should be checked for proper electronic operation. It should be ensured that the instrument is calibrated to methane as referenced.

If, after checking that the OVA is properly calibrated, the background is still higher than normal for ambient conditions, the following procedure should be followed to isolate the cause of the problem:

a) Let the OVA run for a period of time (15 to 30 minutes) and see if the background level decreases as a function of time. The background could go down as a result of clearing line contamination which is removable simply by the normal flow of air through the sample line.

b) Take a reading in a known, relatively clean air environment. Normally, outside air environment is clean enough to assess by comparison whether the background reading is internal to the instrument or is present in the location where the instrument is being used.

c) If the OVA has the Gas Chromatograph Option, depress the sample inject valve, so that the activated charcoal is in the line, and observe whether the background reading goes down and stays steady after elution of the air peak. The reading should always go down or stay the same but never increase when the sample valve is depressed, since the charcoal filter will remove trace elements of organic vapors in the air sample heavier than C_2. If another activated charcoal filter is available, this may be attached to the end of the probe to scrub the air so that a clean air sample is supplied to the detector. The external activated charcoal filter can be used on any instrument, with or without chromatograph, for providing a clean air sample to assess background level.

d) If the background cannot be reduced by any of the previous steps, remove the safety cover and the exhaust port of the detector chamber (on the bottom of the case) and clean the cavity and the electrode using the small wire brush supplied with the analyzer. This will remove any small quantities of contamination which could be the source of the background vapor. After cleaning, replace the exhaust port and safety cover and reignite the OVA. If detector contamination was the cause, the problem should be immediately resolved and the ambient back ground will drop to an acceptable level.

e) If the high background is still present, the various parts of the sample flow line such as pickup probes, umbilical cord to the instrument, etc., should be investigated by the process of elimination to see if the contamination can be isolated.

Serious contamination in the air sample line is very uncommon, however, if very large doses of low vapor pressure compounds are sampled, there is a possibility of residual contamination. This would eventually clear itself out but may take a considerable period of time. A typical cause for high background from the sample line is a contaminated Mixer/Burner Assembly. If heavy contamination of the Mixer/Burner is indicated, replace the Mixer/Burner Assembly.

f) In the event of contamination in the pump or other internal parts of the sample flow lines which cannot be removed, the sample flow components have to be disassembled and cleaned. This is normally a factory operation, however, components such as the pump can be replaced in the field along with any contaminated tubing.

g) High background readings on OVA's which include the Gas Chromatograph Option can be caused by other sources of contamination. If the charcoal filter mounted on the instrument panel is saturated, contaminated air would be supplied to the detector and raise the ambient level background. To check for this, refill the cartridge with fresh charcoal, Foxboro P/N CSC004. This would determine if the charcoal was the source of the background reading. It is also possible that a high background reading could be due to contamination in the column. This could be caused by compounds slowly eluting from a column which has become contaminated. The easiest way to check for column contamination is to replace the column with a clean column or a short empty piece of column tubing and see if the high background reading drops.

h) If the above steps do not correct the high background, the cause will normally be contamination in the hydrogen fuel system.

Contamination in the hydrogen fuel system is usually the direct result of contaminated hydrogen gas or contamination introduced during the filling operation. Filling hose contamination can be caused by storing the hose in a contaminated area.

To remove contamination, the fuel system should be purged with hydrogen. Effective purging is accomplished by disconnecting the capillary tube fitting to the manifold block which has the low pressure gauge (Hydrogen Supply Pressure Gauge and Hydrogen Supply Valve). This disconnects the capillary tubing from the hydrogen line so that hydrogen may be purged at a reasonable rate from the tank assembly through the regulators, gauges and valves. After disconnecting the capillary, the hydrogen tank can be filled in the normal manner. The tank valve and hydrogen supply valve can then be opened which will bleed the hydrogen from the tank through the hydrogen fuel system, purging contamination which is in vapor form. There is the possibility that contamination has been introduced into the hydrogen fuel system which is not readily purged by the hydrogen gas, but this is unlikely. After purging with clean hydrogen two or three times, the capillary tube should be reconnected and the background again checked. Five or ten minutes should be allowed before assessing the background reading, since contaminated hydrogen can be trapped in the capillary tube.

If another clean instrument is available, the fuel system from the clean instrument can be connected to the contaminated instrument to verify whether the problem is associated with the hydrogen fuel supply system. The interconnection should be made to the capillary tube of the contaminated instrument.

Troubleshooting

Table 1 presents a summary of field troubleshooting procedures. If necessary, the instrument can be easily removed from the case by unlocking the four (4) ¼ turn fasteners on the panel face and removing the refill cap. The battery pack is removed by taking out the four (4) screws on the panel and disconnecting the power connector.

Factory Maintenance

To ensure continuous trouble-free operation, a periodic factory maintenance, overhaul, and recalibration is recommended. The recommended schedule is every six to nine months. This maintenance program includes replacement of plastic seals and parts as required, pump overhaul, motor check, sample line cleaning, hydrogen leak check, recalibration, and detailed examination of the unit for any other required maintenance and repair.

Recommended Spare Parts

Item	Description	Part Number	Recommended Quantity
1	Igniter	510461-1	2
2	Pump Assembly	510223-6	1
3	Cup, Filter (3/8 inch OD, ss)	510318-1 (5/pkg.)	1
4	Mixer/Burner Assembly	510513-1	1
5	Wafer, Teflon, H_2 Valve	510160-1 (10/pkg.)	1
6	Washer, Brass, H_2 Valve	510160-2 (10/pkg.)	1
7	Exhaust Port Assembly	510530-1	1
8	Battery Pack Assembly	510542-1	1
9	Sample Line Assembly	510316-1	1
10	Particle Filters	510116-1	1

TABLE 1

PROBLEM	TROUBLE SHOOTING PROCEDURE	REMEDY
1) Low sample flow rate on flow indicator. Nominally 2 units on flow gauge. (See also 6 below)	a) Check primary filter in sidepack and particle filters in the pickup assembly.	Replace or clean filter if clogged.
	b) Determine assembly containing restriction by process of elimination, i.e., remove probe, remove Readout Assembly, remove primary filter, etc.	Investigate the assembly containing this restriction to determine cause of blockage. Clean or replace as required.
	c) If the restriction is in the Side Pack Assembly, further isolate by disconnecting the sample flow tubing at various points, i.e., pump output chamber, etc. NOTE: The inherent restrictions due to length of sample line, flame arrestors, etc., must be taken into account when troubleshooting.	If in the detector chamber, remove and clean or replace porous metal flame arrestors. If pump is found to be the problem, remove and clean or replace.
2) Hydrogen flame will not light. (See also 6 below)	a) Check sample flow rate (see 1 above)	If sample flow rate is low, follow procedure 1 above.
	b) Check igniter by removing the chamber exhaust port and observing the glow when the IGNITE BUTTON is depressed.	If igniter does not light up, replace the plug. If igniter still does not light, check the battery and wiring.
	c) Check for rated Hydrogen Supply Pressure. (Listed on calibration plate on pump bracket).	If low, remove battery pack and adjust to proper level by turning the allen wrench adjustment on the low pressure regulator cap.
	d) Check hydrogen flow rate by observing the psi decrease in pressure on the Hydrogen Tank Pressure gauge. The correct flow rate will cause about 130 psi decrease in pressure per hour. (Approximately 12 cm^3/min at detector).	The most likely cause for hydrogen flow restriction would be a blocked or partially blocked capillary tube. If flow rate is marginally low, attempt to compensate by increasing the Hydrogen Supply Pressure by one-half or one psi. If flow rate cannot be compensated for, replace capillary tubing.
	e) Check all hydrogen plumbing joints for leaks using soap bubble solution. Also, shut off all valves and note pressure decay on hydrogen tank gauge. It should be less than 350 psi per hour.	Repair leaking joint.

TABLE 1

PROBLEM	TROUBLE SHOOTING PROCEDURE	REMEDY
	f) Check to see if hydrogen supply system is frozen up by taking unit into a warm area.	If there is moisture in the hydrogen supply system and the unit must be operated in subfreezing temperatures, purge the hydrogen system with dry nitrogen and ensure the hydrogen gas used is dry.
	g) Remove exhaust port and check for contamination.	If the chamber is dirty, clean with ethyl alcohol and dry by running pump for approximately 15 minutes. If hydrogen fuel jet is misaligned, ensure the porous metal flame arrestor is properly seated.
	h) Check spacing between collecting electrode and burner tip. Spacing should be 0.1 to 0.15 inches.	Adjust by screwing Mixer/Burner Assembly in or out. This spacing problem should only occur after assembling a Mixer/Burner Assembly to a Preamp Assembly.
3) Hydrogen flame lights but will not stay lighted.	a) Follow procedures 2(a), (c), (d), (e), (g) and (h) above. Also refer to 5 below.	
4) Flame-out alarm will not go on when hydrogen flame is out.	a) Check instrument calibration setting and GAS SELECT control setting.	Readjust as required to proper setting. Note that the flame-out alarm is actuated when the meter reading goes below zero.
	b) Remove exhaust port and check for leakage current path in chamber (probably moisture or dirt in chamber).	Clean contamination and/or moisture from the chamber using a swab and alcohol, dry chamber by running pump for approximately 15 minutes.
	c) If above procedures do not resolve the problem, the probable cause is a malfunction in the preamp or power board assemblies.	Return preamp chamber or power board assembly to the factory for repair.
	d) Check that volume control knob is turned up.	Adjust for desired volume.

TABLE 1

PROBLEM	TROUBLE SHOOTING PROCEDURE	REMEDY
5) False flame-out alarm.	a) Flame-out alarm is actuated when signal goes below electronic zero (with flame on). This can be due to inaccurate initial setting, drift, or a decrease in ambient concentration. Verify if this is the problem by zeroing meter with flame out and reigniting.	When using the X1 range adjust meter to 1 ppm, rather than zero, be sure instrument has been zeroed to "lowest expected ambient background level".
6) Slow response, i.e., time to obtain response after sample is applied to input is too long.	a) Check to ensure that probe is firmly seated on the rubber seal in the readout assembly.	Reseat by holding the probe firmly against the rubber seat and then lock in position with the knurled locking nut.
	b) Check sample flow rate per procedure 1 above.	See 1 above.
7) Slow recovery time, i.e., too long a time for the reading to get back to ambient after exposure to a high concentration or organic vapor.	a) This problem is normally caused by contamination in the sample input line. This requires pumping for a long period to get the system clean of vapors. Charcoal in the lines would be the worst type of contamination. Isolate through the process of elimination. (See 1(b)).	Clean or replace contaminated sample line or assembly as required.
	b) Check flame chamber for contamination.	Clean as required.
8) Ambient background reading in clean environment is too high.	a) A false ambient background reading can be caused by hydrocarbons in the hydrogen fuel supply system. Place finger over sample probe tube restricting sample flow and if meter indication does not go down signficantly the contamination is probably in the hydrogen fuel.	Use a higher grade of hydrocarbon free hydrogen. Check for contaminated fittings on filling hose assembly.
	b) A false ambient background reading can also be caused by a residue of sample building up on the face of the sample inlet filter. If the test in 8(a) above produces a large drop in reading, this is usually the cause.	Remove the exhaust port (it is not necessary to remove instrument from case). Use the small wire brush from the tool kit or a knife blade and lightly scrub surface of sample inlet filler.

TABLE 1

PROBLEM	TROUBLE SHOOTING PROCEDURE	REMEDY
	c) A false ambient background reading can also be caused by hydrocarbon contamination in the sample input system. The most likely cause would be a contaminant absorbed or condensed in the sample line. NOTE: It should be emphasized that running the instrument tends to keep down the buildup of background vapors. Therefore, run the unit whenever possible and store it with the carrying case open in clean air.	Clean and/or replace the sample input lines. Normally the false reading will clear up with sufficient running.
9) Pump will not run.	a) Check that there is no short circuit in wiring.	If no short circuit, pump motor is defective.
10) No power to electronics but pump runs.	a) Short circuit in electronics.	There is a short in the electronics assembly. Return OVA to factory or authorized repair facility.
11) No power to pump or electronics	a) Place battery on charger and see if power is then available. Recharge in a non-hazardous area only.	If power is available, battery pack is dead or open. Recharge battery pack. If still defective, replace battery pack.

GAS CHROMATOGRAPH (GC) OPTION

The Model OVA 128 CENTURY Organic Vapor Analyzer provides efficient and accurate indication of total organic compound concentrations on a continuous sampling basis. However, in areas where mixtures of organic vapors are present, it often becomes necessary to determine the relative concentration of the components and/or to make quantitative analysis of specific compounds.

To provide this capability, a gas chromatograph (GC) option is available. See Figure 6 for the location of the major components and controls associated with the GC option. When the GC option is used, the capability of the OVA includes both qualitative and on-the-spot quantitative analysis of specific components present in the ambient environment. The Recorder, which is used with the GC option, is described separately.

This section is applicable only to an OVA with the optional gas chromatograph system.

Modes of Operation

The OVA with GC option has two modes of operation. The first mode is the measurement of total organic vapors in the same manner as described for the basic OVA instrument. This mode is referred to as the "Survey Mode". The OVA is in the "Survey Mode" of operation whenever the Sample Inject Valve is in the "out" position.

The second mode of operation is called the "GC Mode". The OVA is in this mode of operation any time a sample has been injected into the GC system and the sample is being transported through the GC column. This section provides a brief description of how a gas chromatograph (GC) operates and specifically, how the model OVA 128 performs the required operations. A comprehensive discussion of gas chromatography theory, column selection, and data analysis is beyond the scope of this manual.

The OVA with GC option can be utilized for many types of analysis in the outdoor or indoor ambient environment or for specific laboratory type analysis. The OVA was not designed to compete with the research or process gas chromatograph but to compliment these instruments or eliminate their need in field applications.

This manual is intended to provide the operator with information to operate and maintain the OVA. Foxboro publishes Application/Technical Notes to assist the operators in applying the instrument to field monitoring situations.

All flame ionization detector (FID) gas chromatographs require certain elements for their operation. These elements include three flow regulated gas supplies as follows: 1) A carrier gas to transport the sample through the column; 2) Hydrogen gas for operation of the FID; 3) A clean air supply to support combustion to the FID. In addition, a method for injecting a known volume of sample air (aliquot) to be analyzed is required.

In standard gas chromatographs these three (3) flow regulated gases are individually supplied from pressurized cylinders equipped with regulators and flow control apparatus. The Model 128 GC system differs in that the hydrogen fuel for the FID is also used as the carrier gas. The clean air supply is simply the normal air sample pumped to the FID. During the GC analysis, this air is scrubbed in a charcoal filter to provide the clean air supply. The end result is that no additional gas supplies are required to add the GC option to the basic OVA instrument.

A valving arrangement is incorporated to provide a method for transferring a fixed volume of air into the GC system for analysis. The sample air injected into the GC column is the same sample being analyzed by the OVA for total organic vapor concentration. Therefore, the instrument provides the unique capability to observe the total organic vapor concentration of the sample prior to injecting it into the GC system. This operating feature is invaluable in field work where the environment is continually changing and where valuable GC analysis time must be expended only on the sample of concern.

OVA Columns

Columns are available in 4, 8, 12, 24, 36 and 48 inch lengths as standard offerings with any of the column packings listed below. Longer lengths are available in 12-inch increments on a non-standard basis. To order a column simply use the general part number for a column which is 510454 followed by a dash (-), the Foxboro packing material designation, a second dash and the desired length in inches. A sample column designation is 510454-G-24. This would represent a 24 inch column with 10% OV 101 on chromosorb W, HP 60/80 mesh. If a specific application arises which calls for a column material not listed below, please contact Foxboro. We will be happy to check on its availability.

Foxboro Designation	Material
A	20% Dioctyl Phthalate on Chromosorb-P, AW 60/80 Mesh
C	Chromosorb 101, 60/80 Mesh
D	20% Ucon 50 HB 280 on Chromosorb-P, AW 60/80 Mesh
E	20% Carbowax 400 on Chromosorb-P, AW 60/80 Mesh
F	5/1.75% Diethylhexyl Sebecate/Bentone 34 on Chomosorb W, AW 60/80 Mesh
G	10% OV-101 on Chromosorb W, HP 60/80 Mesh
T	10% 1,2,3-Tris (2-cyanoethoxy) Propane on Chromosorb P, AW 60/80 Mesh
B	3% Diisodecyl Phthalate on Chromosorb W, AW 60/80 Mesh
PT	Poropak T, 60/80 Mesh
Q	Poropak Q, 60/80 Mesh
H	20% Carbowax 20M on Chromosorb P, AW 60/80 Mesh
J	n-Octane on Porasil C, 80/100 Mesh
N	Porapak N, 60/80 Mesh

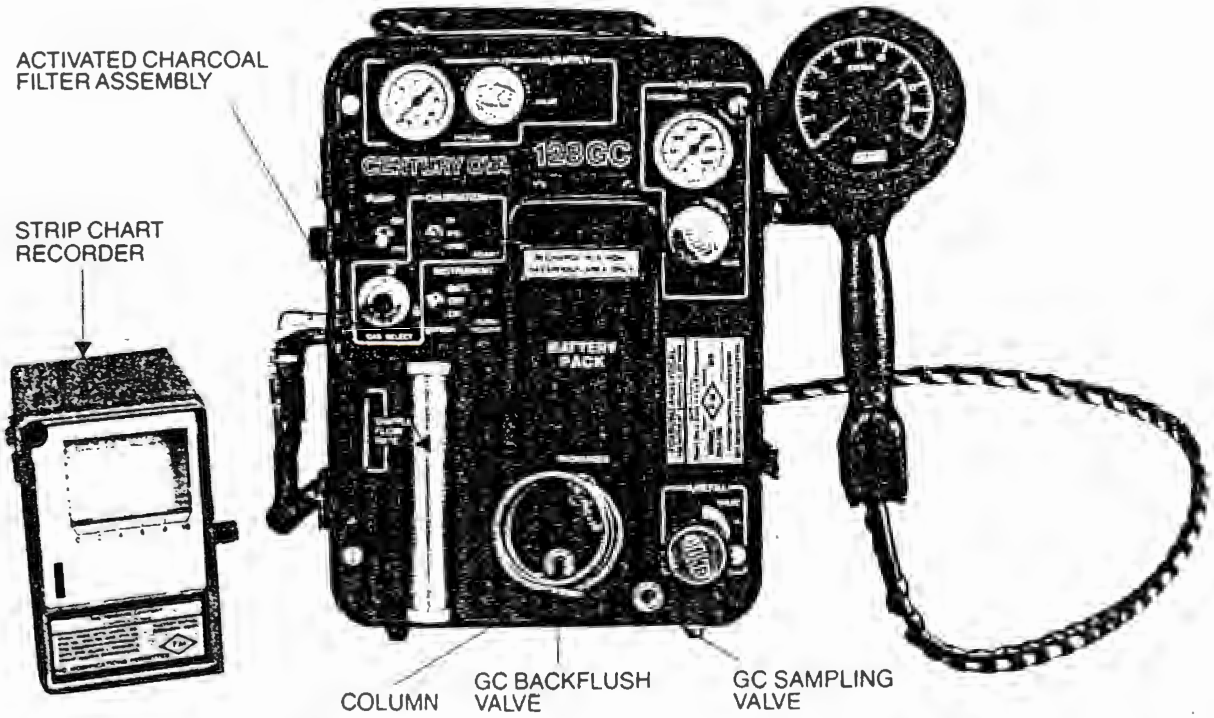


FIGURE 6
ADDITIONAL CONTROLS & COMPONENTS - GC OPTION

Sample Flow

Figure 7 is a flow diagram illustrating the flow paths of the hydrogen fuel, sample air supply, and GC injected sample aliquot.

Two push-pull valves are used in the GC system; the Sample Inject Valve and the Backflush Valve.

Block D illustrates the flow paths with the Sample Inject Valve in the "out" position. With this valve in the "out" position, the OVA functions in its normal manner as a total organic vapor analyzer.

Block C illustrates the flow paths after the Sample Inject Valve is moved to the "in" position to initiate the GC Mode.

The hydrogen flow path is now through the sample loop which enables hydrogen to sweep the air sample from the loop and carry it through the GC column.

Also note that the sample air going to the FID chamber is now routed through the activated charcoal filter where essentially all organic vapor contamination is removed from the air. The activated charcoal filter will effectively absorb most organic vapors with the exception of methane and ethane. The functions of the Sample Inject Valve are, therefore, to transfer a fixed volume sample of the air being monitored into the hydrogen stream and to reroute the sample air supply through a filter (scrubber).

The Backflush Valve has no prepositioning requirement to function. It can be in either the "in" or "out" position at the time a sample is injected into the GC system for analysis. The Backflush Valve simply reverses the direction of the hydrogen flow through the GC column.

Regardless of the operating mode, hydrogen always flows through the column to the FID detector and the sample air supply always flows to the FID detector to provide oxygen for the hydrogen flame.

The recommended hydrogen flow rate is 12 cm /min for proper FID operation and as a standard flow rate for generating GC reference/calibration data. This hydrogen flow rate is adjusted by varying the Hydrogen Supply Pressure, which is the hydrogen pressure at the input of the flow control capillary tube of the OVA. The pressure is changed by adjusting the set screw in the bonnet of the low pressure regulator, accessible by removing the battery pack from the instrument panel. To monitor the hydrogen flow rate, connect a bubble flowmeter to an end of the GC column which has been disconnected from the panel fitting and move the Backflush Valve so that hydrogen is flowing out of the column. Primary hydrogen flow control is accomplished by the capillary tube of the OVA. However, the flow restriction of a GC column will also affect the hydrogen rate and the effect will vary with column length, type of packing and packing methods. The nominal Hydrogen Supply Pressure is around 10 psig and the pressure drop across a typical 24 inch long column packed with 60/80 mesh material is approximately 1 to 1.5 psig. Normally, when the hydrogen flow rate is set at 12 cm^3/min with a standard 24 inch long column, no adjustment needs to be made when using columns from four (4) inches to four (4) feet long. Longer columns may require hydrogen flow adjustment for proper operation. Adjustment would be required if and when precisely controlled analysis was being conducted or when the hydrogen flow was too low to keep the flame burning.

The sample air flow rate is not adjustable and is nominally 1.0 liter/minute. This flow rate should remain relatively constant. A sample flow gauge is provided on the OVA panel to monitor the sample flow rate. (Note: Panel gauge is not calibrated in L/min). When the Sample Inject Valve is in the "in" position, there may be a slight increase or decrease in sample air flow rate (0 to 15%). This change will normally not affect operation of the instrument as long as the flow rate is consistent from analysis to analysis. Basically, if the flow rate is consistent between calibration and end usage, there will be suitable precision in the measurements.

GC Analysis

1) SAMPLE INJECTION

When the Sample Injection Valve is depressed, the air in the sample loop is injected into the hydrogen stream which transports the sample through the column for separation of its components and to the flame chamber for analysis. This small volume of injected sample is qualitatively analyzed based on the retention time of the individual components of that sample while passing through the column. Quantitative analysis can then be accomplished by peak height or peak area analysis methods.

2) THE COLUMN

The column consists of tubing packed with a material which physically interacts with organic vapors and retards the passage of the vapors through the column. Since the packing material has a different attraction for each organic substance, each component in a mixture of gases will be slowed down to a different extent.

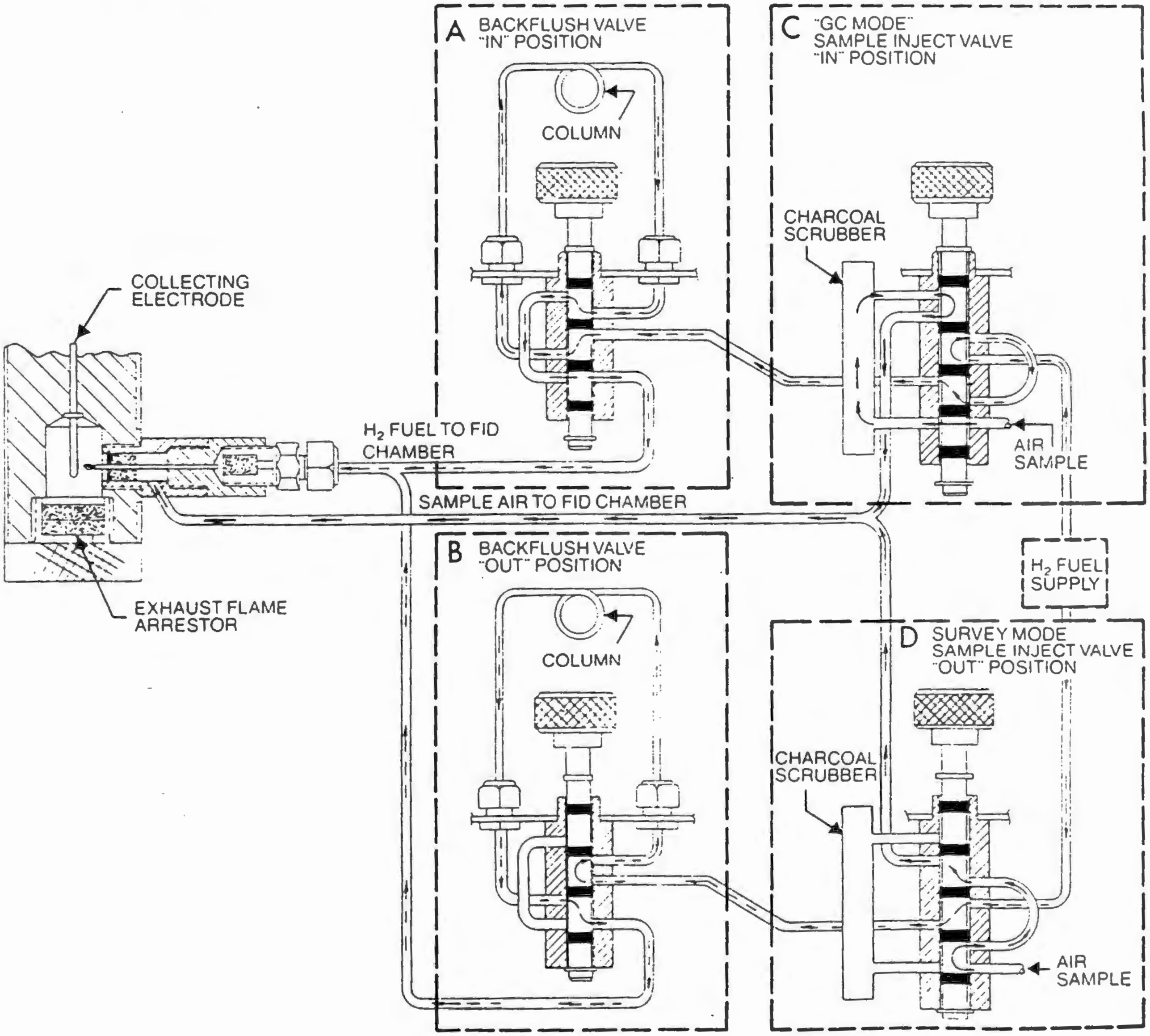


FIGURE 7
FLOW DIAGRAM - GC OPTION

The net effect is that each component elutes from the column at a different time. The components are then fed to the detector which gives a response to the meter or to an external strip chart recorder.

A portable isothermal pack (PIP) can be used for temperature control and/or isothermal analysis. This is described further under PIP kit option.

3) QUALITATIVE ANALYSIS

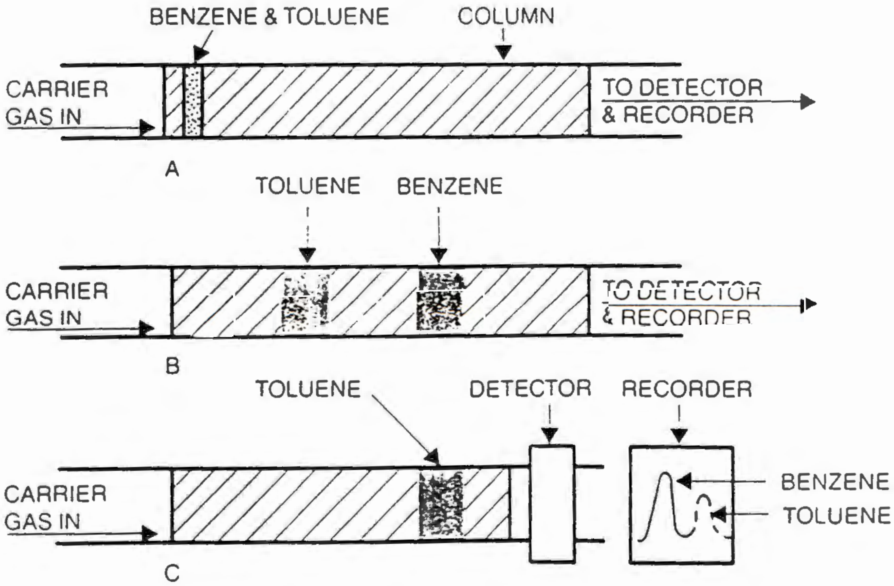
As each organic substance has a unique interaction with the column packing material, the time that the substance is retained on the column is also unique and thus characteristic of that particular substance. The "retention time" (RT) is primarily dependent on the type of packing material, the length of the column, the flow rate of the gas carrying the mixture through the column and the temperature range of the system.

When these variables are controlled, the retention times can be used to identify each of the components in a mixture. Because of these variables, it is usually necessary to establish retention times for each instrument by making a test with the pure substances of interest or to refer to established time data charts prepared in advance for that specific instrument. In those cases where retention times of the components are too close together for a good analysis, an adjustment in one or more of the operating variables will effect a sufficient difference in retention times to enable meaningful analysis.

4) QUANTITATIVE ANALYSIS

The detector response to any organic component is proportional to the quantity of material passing through the detector at a given time. For an eluted component, a plot of concentration vs. time forms a bell-shaped curve.

When using a strip chart recorder, the curve drawn on the paper is triangularly shaped and the area under the peak is related to the amount of substance being analyzed.



PICTORIAL SEPARATION OF BENZENE AND TOLUENE – "A" AT BEGINNING OF SEPARATION; "B" DURING SEPARATION; "C" BENZENE HAS ALREADY PASSED THE DETECTOR AND IS RECORDED. TOLUENE (DOTTED LINES) WILL APPEAR ON RECORDER AS IT PASSES THE DETECTOR.

FIGURE 8
TYPICAL COLUMN SEPARATION SEQUENCE

5) BACKFLUSH

The column Backflush Valve is provided to reverse the flow of the carrier gas (hydrogen) through the column. It is necessary that the column be backflushed after each individual analysis except under certain special conditions. The primary purpose of the backflush function is to clear the column of heavy compounds (with long retention times) which would contaminate the column and cause interferences to future GC analysis. The Backflush Valve has no prepositioning requirement; it is reversed from either position it was in during GC analysis. The Backflush Valve should be actuated immediately after the peak of the last compound of interest elutes. Figure 8 illustrates the function of the Backflush Valve.

In the GC system, the backflush is "to the detector". This is possible because the carrier gas and detector fuel are the same, i.e., hydrogen. It provides a convenient means of quantifying the total compounds in the backflush by simply recording the peak that elutes during the backflush operation. For field instruments, this quantitative backflush information is valuable since it provides a direct means of observing the condition of the column and seeing when the column is clean and the detector response has returned to baseline. The time required for the backflush is usually 1.2 to 1.5 times the GC analysis time.

6) SURVEY TO GC MODE

There is an inherent advantage to integrating the GC system to the basic total Organic Vapor Analyser (OVA). The OVA provides a direct reading of total organic vapors in the air being sampled, which gives the operator information about the sample being injected into the GC system. This information can be used to predict and verify the peaks that result during the GC analysis, including the backflush peak.

This feature eliminates expending valuable GC analysis time where there is no contamination of concern (comparable to taking noise measurements in quiet corners). It also enables the operator to select the most appropriate location to conduct an analysis, normally the area of highest concentration.

GC MODE OPERATING PROCEDURES

The gas chromatographic analysis mode (GC Mode) of operation can be initiated at any time during a survey by simply depressing the Sample Inject Valve. After completion of the analysis and backflush operations, the Sample Inject Valve is pulled out and the survey continued or another sample injected. Note that when the Sample Inject Valve is in the survey mode (out position) the OVA operates in the same manner as an OVA which does not incorporate the GC option.

Controls/Indicators

Refer to Figure 6.

1) Sample Inject Valve - This two (2) position valve (shown schematically in Figure 7) is used to select either Survey Mode (valve out) or GC Mode (valve in).

2) Backflush Valve - This two (2) position valve (shown schematically in Figure 7) is used to reverse the flow of hydrogen through the column to:

    a) Backflush the column for cleaning.

    b) Quantitatively measure total compounds after a selected point. Example: Separation of methane from non-methane hydrocarbons to read total non-methane hydrocarbon level.

3) Column - Separates components of a gas mixture so that each component of the mixture elutes from the column at a different time.

4) Activated Charcoal Filter Assembly - This assembly functions only in the GC Mode (Sample Inject Valve "in") as shown schematically in Figure 7). It removes organic compounds (except methane and ethane) by absorption from the sample air supply.

Turn on Procedure

Place the Sample Inject Valve in the "out" position and put the OVA instrument in operation per "Operating Procedures" for the survey mode. NOTE: Leave the hydrogen fuel and pump "on" for three (3) to four (4) minutes before attempting ignition to allow time for hydrogen purging of the column.

Survey Mode

When using the OVA in the Survey Mode, ensure that the Sample Inject Valve remains in the full "out" position and that the Backflush Valve is either full "in" or full "out". Note that when changing from the GC Mode to the Survey Mode, the OVA output reading will continue to change until all compounds have been eluted from the GC column. Therefore, under normal field conditions, the GC column should be backflushed for clearing, which takes approximately 1.2 to 1.5 times the forward analysis time. The backflush peak may be observed returning to baseline, after which the Sample Inject Valve may be moved to the Survey Mode (out) position.

When the compound(s) being analyzed are known to be the only compound(s) present in the air sample, backflushing may be omitted.

GC Mode Operation

In normal GC analysis, a strip chart recorder is used to record the output concentration from the OVA as a function of time. This record, called a chromatogram, is utilized for interpretation of the GC data.

a) OPERATION

    1) Turn on recorder and push Sample Inject Valve "in" with a fast, positive motion. This starts the GC analysis which is automatic up to the point of backflushing. NOTE: Rapid and positive motion should be used when moving either the Sample Inject or Backflush Valves. On occasion, the flame in the FID detector may go out, which would be indicated by a sharp and continued drop of the concentration level. If this occurs, reignite the flame and continue the analysis. NOTE: A negative "air" peak typically occurs shortly after sample injection and should not be confused with flame-out.

    2) The negative air peak and various positive compound peaks indicated on the OVA readout meter and the strip chart recorder represent the chromatogram.

3) After the predetermined time for the analysis has elapsed (normally immediately after the peak of the last compound of concern), rapidly move the Backflush Valve to its alternate position (in or out). Leave the instrument in this condition until the backflush peak returns to baseline, then pull the Sample Inject Valve to the "out" position. If no backflush peak appears, pull the Sample Inject Valve out after being in the backflush condition for a period at least twice as long as the analysis time. The OVA is now in the Survey Mode and ready for survey or injection of another sample into the GC system.

b) INTERPRETATION OF RESULTS

The OVA 128 with GC option is intended for applications where there are a limited number of compounds of interest and the compounds are normally known. Under these conditions, the operator must know the retention time and peak height characteristics of the compounds under specific operating conditions. To calibrate the OVA in the GC Mode, determine, by test, the retention time and peak area (using peak height analysis) for the compounds of concern. These tests should be conducted on the column to be utilized and over the concentration and temperature range of concern. When representative characteristic data is available, such as in the Application/Technical Notes, a spot calibration check is normally all that is required.

It should be noted that under normal field conditions, the vapor concentrations vary continually as a function of time, location, and conditions. Field measurements for industrial hygene work are normally associated with a threshhold level around a pre-established concentration. Surveys for locating fugitive emission sources present a continually varying situation. Under these conditions, it is desirable to have a simple method of interpreting the GC data for on-the-spot analysis and decision making. High precision is normally not a requirement for these type analyses since the environment is continually changing. The methods presented in this section are designed to provide a means for typical field analysis. When the OVA is used under laboratory conditions, standard laboratory methodology may be used for greater precision.

Technical Discussion

The chromatogram is a chart recorder trace of the organic vapor concentration from the Organic Vapor Analyzer (OVA) as a function of time. A typical chromatogram is illustrated in Figure 9 and is a series of triangular shaped peaks originating from and returning to a fixed baseline. Qualitative interpretation of a chromatogram involves identifying a peak by analyzing the time it took for the peak to appear after initial injection [referred to as retention time (RT)] and comparing this RT to reference data. Quantitative interpretation involves analyzing the area under the peak and relating this area to calibration data of peak area versus concentration for that specific compound under the conditions present during the GC analysis.

It can be seen that interpretation of a chromatogram requires the use of calibration reference data. GC reference data is always generated empirically, i.e., through tests. Foxboro Application/Technical Notes may be used as a reference for selecting columns and interpreting chromatograms. However, simple tests must be conducted to obtain the required reference data.

a) QUALITATIVE ANALYSIS

Under a given set of operating conditions the retention time is characteristic of that particular substance and can be used to identify specific compounds. It will be necessary to calibrate retention times by making tests with the pure compounds of interest.

The retention time (RT) is defined as that period of time from injection until the time of maximum detector response for each substance. Retention time is measured from the time of sample injection to the time the apex of the triangle shaped curve is obtained on the strip chart recorder. (See Figure 9). The strip chart recorder operates on a clock mechanism such that the distance along the baseline is proportional to time. While retention times are characteristic for each compound, it is possible that two materials could have the same retention times. Thus, if there is any question as to the identity of the vapor, it may be necessary to verify identification by retention times on different columns.

Use of a longer column will increase the retention times of those components it is capable of separating. The time between peaks will also be increased. This is especially useful if a component comes through too fast or if desired peaks are so close that they overlap.

b) COLUMN SELECTION

Two columns are supplied with the instrument. These are general purpose columns which are useful in a wide variety of applications. If they do not achieve separations for a particular application, it may be necessary to select other packing materials or longer columns. Foxboro will assist in this selection or prepare a custom column if necessary.

If columns are made by the user or purchased from other sources, ensure that the packing density does not create too large a pressure drop. A large pressure drop can result in flame-out problems.

c) TEMPERATURE EFFECT ON RETENTION TIME

An increase in temperature will decrease column retention time (RT) and vice versa. Normally retention time (RT), as a function of temperature, changes linearly over the range of 0 to 40°C. For complex qualitative analysis, a calibration plot of RT versus temperature will be required. In typical usage, such as inside a factory, the effect of temperature can be compensated for during chromatogram interpretation. A single component tracer compound can be sampled at any time to provide a "key" for other compound identification.

d) CARRIER GAS FLOW RATE AFFECT ON RETENTION TIME

An increase in carrier gas flow rate will decrease retention time. For reproducible data, the carrier gas (hydrogen) flow rate must be recorded in association with a chromatogram. Primary control of the hydrogen flow rate is accomplished in the OVA by regulating the hydrogen pressure across a capillary tube. The hydrogen flow rate is also affected by the restriction of the GC column but most columns have a limited effect. The hydrogen flow rate is factory set at 12 cm /minute with a typical 24 inch column.

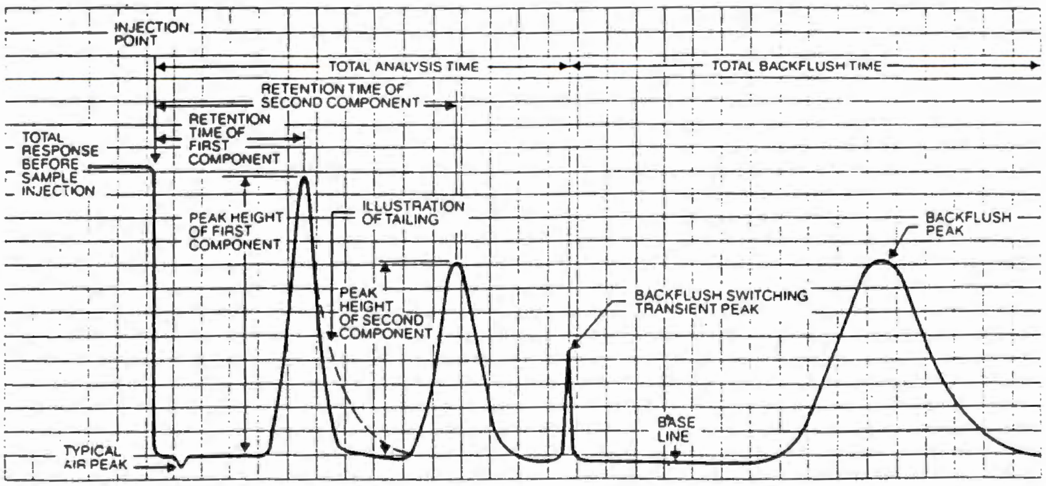


FIGURE 9
TYPICAL CHROMATOGRAM

TABLE 2

PROBLEM		TROUBLE SHOOTING PROCEDURE	REMEDY
1) Low sample flow rate on flow indicator.	a)	Check Teflon tubing on valve assembly for kinks, etc.	Straighten or replace teflon tubing.
	b)	Check flow rate with valve in down position.	Check for over restriction of charcoal filter.
2) Hydrogen flame will not light.	a)	Check column connections on top of unit to make sure they are tight.	Tighten fittings.
	b)	Check column for sharp bends or kinks. (Hydrogen flows through this column at all times and a sharp bend will compact packing too tightly for proper hydrogen flow).	Replace column.
	c)	Check charcoal filter fittings to make sure they are tight.	Tighten fittings.
	d)	Check hydrogen flow rate from the column.	Adjust hydrogen pressure to obtain 12 cm^3/min flow rate.
	e)	Check that the Inject and Backflush Valves are both completely in or out. A partially activated valve will block the hydrogen and air flow paths.	Ensure both valves are either completely in or out.
	f)	If a new column was installed prior to problem identification, check for proper hydrogen flow rate through the column (should be approximately 12 cm /min).	Increase hydrogen pressure to obtain proper hydrogen flow rate or if column is excessively restrictive, replace or repack the column.
3) Ambient background reading in clean environment is too high.	a)	Check for contamination in charcoal filter assembly. This can be detected if ambient reading increases when going in to the chromatographic mode.	Replace activated charcoal in charcoal filter assembly.
	b)	Check for contamination in column.	Replace or clean column.
	c)	Check for contamination in column valve assembly.	Remove valve stems and wipe with clean lint-free cloth. Heat valve assembly during operation to vaporize and remove contaminants.
4) Flame-out when operating either valve.	a)	Ensure valves are being operated with a quick, positive motion.	Operate valve with a positive motion.

TABLE 2

PROBLEM	TROUBLE SHOOTING PROCEDURE	REMEDY
	b) Either hydrogen or air may be leaking around one or more of the valve quad rings. Assess by tests and "O" ring inspection.	Remove stems and lightly coat with silicone grease, only on contact surface of the "O" ring. Wipe off excess (do not remove quad rings).
	c) Damaged or worn quad rings causing leak.	Replace quad rings and grease as above.
5) Excessive peak tailing	a) Change or clean GC; see if problem disappears.	Ensure columns are clean prior to use. If one of the same type of column tails are worse than others, repack the column or discard.
	b) Inspect GC valves for excessive silicone grease or contamination.	Excessive lubricant or foreign matter in the valve assembly can cause excessive tailing. Clean valve assemblies and lightly relubricate as required. Lubricant should be put only on the outside contact surface of the "O" ring. Do not get grease into the "O" ring grooves.

Recommended Spares

The following spare parts and supplies are recommended to support the GC system and recorder. These are an addition to the spare parts list for the basic OVA described in the "OVA MAINTENANCE" section.

ITEM DESCRIPTION	PART NO.
1) Quad Rings	510496-1 (10/pkg.)
2) Tubing, .148 in ID .020 wall	12942
3) Tubing, Teflon .120 in ID .030 wall	12941
4) Activated Charcoal	CSC-004
5) "O" Ring for Charcoal Scrubber	U0118CE
6) Chart Paper (linear)	CSC-008 (6/rls/pkg)

ACCESSORIES

Recorder Accessory

A portable Strip Chart Recorder is available for use with the OVA (reference Figure 11). The recorder is powered from the OVA battery pack and the output can be scaled to match the OVA readout meter, thereby providing a permanent record for subsequent analysis or reference. P/N 510445-4 is FM certified intrinsically safe. P/N 510445-6 is BASEEFA certified.

The recorder can be used with the OVA to provide a long term monitoring profile of total hydrocarbon or can be used with the Gas Chromatograph Option to provide a chromatogram.

Features

The recorder prints dry (no ink) on pressure sensitive chart paper. The recorder is equipped with two gain ranges and an electronic zero adjustment. The HIGH gain position is normally used to provide a means of scale expansion.

Controls and Connections

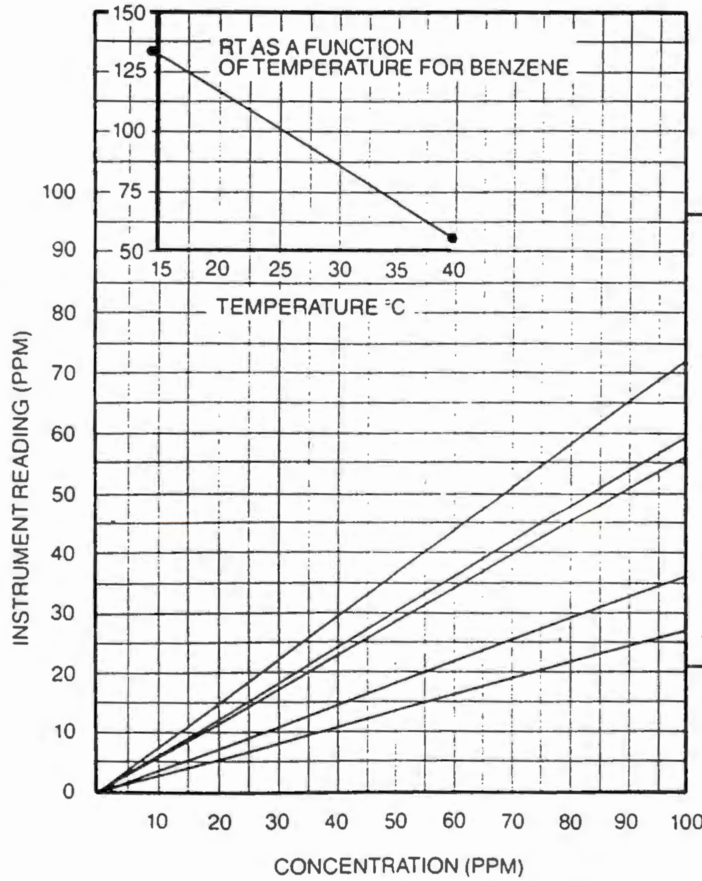
Described below are the functions of recorder controls and connectors.

1) HIGH-LOW Switch - This switch, located on the right hand side of the recorder, provides 2 ranges. The LOW range is set for the same full scale reading as the OVA readout meter. The HIGH range can be set to give an increased sensitivity to the recorder without effecting the OVA calibration.

2) ZERO ADJUST Knob - This potentiometer, located on the right hand side of the recorder, permits "nulling" of the background reading on the recorder without affecting the calibration of the OVA displayed on the OVA readout. In the full clockwise position, the recorder will display the same reading as the OVA meter. Counterclockwise rotation will reduce the reading on the recorder.

3) POWER CONNECTOR - This 126 series, 5 pin connector provides power and signal to the recorder, as follows:

PIN	FUNCTION
B	Input Signal
E	pos. 12VDC input
H	Ground

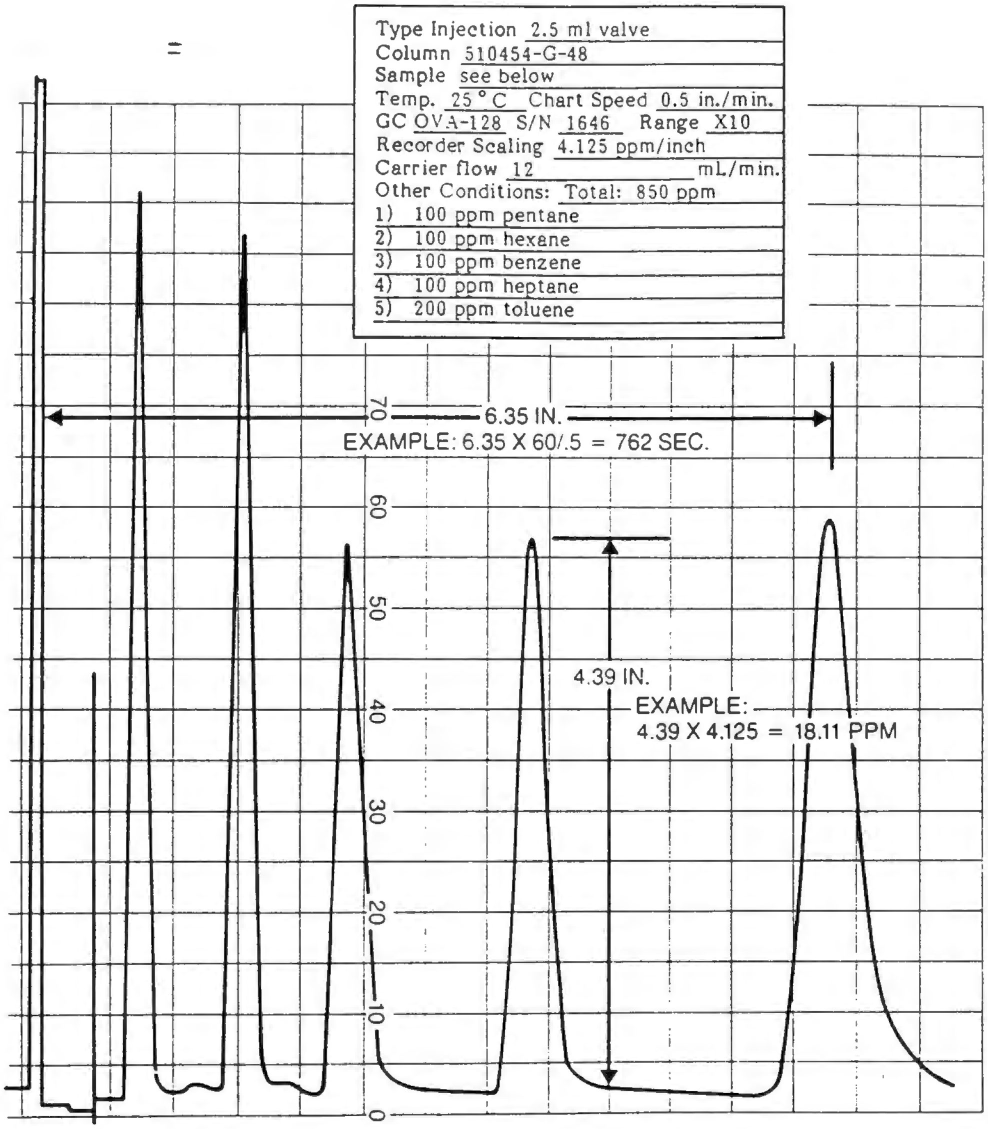


Column G-48 Chromatograph OVA-128
Temperature 25°C Carrier Flow 12 mL/sec.
Injection: Volume 2.5 mL Type valve

X	Compound	R.R (%)	RT (sec)	TLV (ppm)
X4	Heptane	80	471	400
X2	Pentane	100	90	1000
X2	Hexane	90	198	100
X2	Benzene	150	291	1
X3	Toluene	120	762	200

NOTE:
1. Concentration used for test is 100 ppm or as indicated.
2. X = Concentration multiplier

FIGURE 10A
CALIBRATION CHART



Type Injection 2.5 ml valve
Column 510454-G-48
Sample see below
Temp. 25 ° C Chart Speed 0.5 in./min.
GC OVA-128 S/N 1646 Range X10
Recorder Scaling 4.125 ppm/inch
Carrier flow 12 mL/min.
Other Conditions: Total: 850 ppm
1) 100 ppm pentane
2) 100 ppm hexane
3) 100 ppm benzene
4) 100 ppm heptane
5) 200 ppm toluene

FIGURE 10B
CHROMATOGRAM

Calibration

Electronic and mechanical adjustments, other than the operational adjustments on the side panel, are provided to calibrate and align the recorder. (See Figure 11).

MECHANICAL ZERO ADJUSTMENT

A) Snap out the front panel nameplate using a small blade screwdriver in the left hand slot) for access to mechanical zero adjust screw, place HIGH-LOW Switch in OFF position.

B) Unscrew knurled fastener at top of front panel to open recorder. Pull down plastic chassis latch on right side to release sticker bar tension on paper and adjust mechanical zero as required. Replace nameplate, chassis latch and resecure front panel.

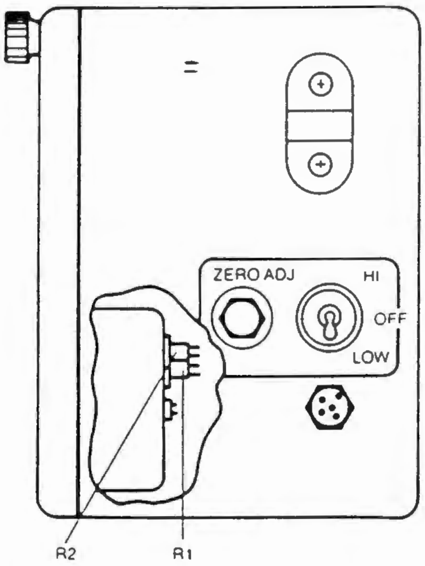


FIGURE 11
RECORDER CONTROLS AND ADJUSTMENTS

GAIN ADJUSTMENT

Separate adjustments are provided for the HIGH and LOW ranges on the recorder. (Refer to Figure 11 for location).

a) Connect recorder to OVA and adjust OVA for full scale reading on readout (about 5 VDC).
b) Loosen knurled fastener on upper left of the front panel and pull front panel down.
c) Place HIGH-LOW Switch in LOW and adjust R1 until recorder prints full scale.
d) Place HIGH-LOW Switch in HIGH and adjust OVA to read the desired full scale with front panel CALIBRATE ADJUST Knob, typically half scale on the readout. Adjust R2 until recorder reads full scale. NOTE: Full scale adjustment of the recorder for 1/2 scale on the OVA gives a gain increase of two (2) in the height of the peak on the chromatograms. This is the factory set point for the HIGH gain range; however, other points can be set as desired with a gain of three being the maximum obtainable without amplifier loading.

Maintenance and Routine Operations

Refer to the manufacturer's (Gulton) manual on the recorder which is enclosed with each recorder when shipped.

Changing Chart Speeds

The recorder is equipped with a 16 RPM motor which gives a writing speed of four (4) strikes per second. The chart advance speed is determined by the gear train assembly number used. The inches per hour for each gear train is given in the table on page 9 of the Gulton recorder manual. Refer to the bottom line of the chart adjacent to drive motor 16 and note for example that a number 1 gear train has a chart speed of 8"/hour.

a) To change the paper speed, open the recorder, remove gear box spring (on left side), move gear box in direction of arrow on its case and lift out from top. Do not force out from bottom. Insert new gear, bottom first, slide into position against arrow direction. Replace gear box spring.

Activated Charcoal Filter Accessory

The Activated Charcoal Filter Assembly is an accessory which can be installed on the OVA Readout Assembly or attached at the end of the telescoping probe. The filter is typically filled with activated charcoal which acts as an absorbent and effectively filters out organic vapors other than methane or ethane.

A screw cap on the probe end is removed for refilling the filter with activated charcoal or other filtering media.

Applications of the filter include:

1) Obtaining a clean air sample for zero baseline check and adjustment.

2) Running "blank" chromatograms to assess instrument contamination.

3) Rapid screening of methane and non-methane organic vapors.

4) Selective screening for natural gas surveys.

5) As a moisture filter when filled with a desiccant such as silica gel.

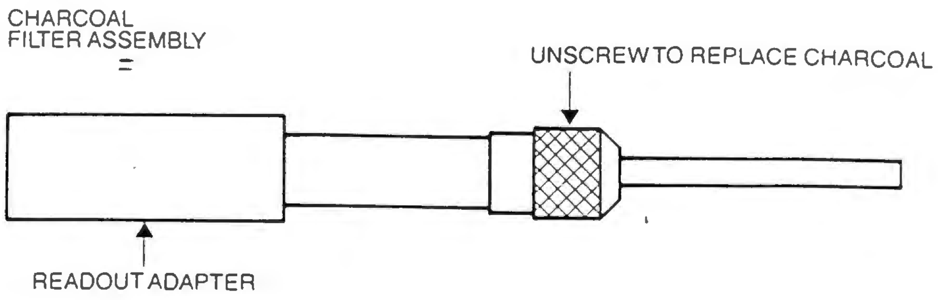


FIGURE 12
ACTIVATED CHARCOAL FILTER ASSEMBLY

A press fit adapter on the back of the filter assembly is removed when installing the unit on the telescoping probe. When replacing the cap end after refilling, one wrap of ½ inch teflon tape should be used to seal the threads.

The life of the filter will depend on the time in use and the concentrations of the compounds being filtered. Under typical industrial air monitoring conditions, the filter will last for many days of continuous sampling. See Figure 12.

Sample Dilutor Accessory

An adjustable sample dilutor assembly, P/N 511745-1 is an accessory. The dilutor is supplied with a 10:1 dilution orifice as standard. Orifices for 25:1, P/N 511770-2, and 50:1, P/N 511770-3, dilution are also available.

In operation, the dilutor is attached to the end of the telescoping probe or connected by external tubing to the input fitting of the OVA side pack. Dilution of the air being monitored is accomplished by stream splitting through the use of a needle valve on the sample input. An activated charcoal scrubber is inserted in the main air supply line to the OVA and scrubs the air of organic vapors. It also creates a slight vacuum at its output side of the scrubber and the vacuum at this point draws the sample air through the needle valve where it mixes with the main air supply going to the OVA detector.

The dilution valve provides a means of sampling vapor levels above the lower explosive level (LEL) and in oxygen deficient atmospheres. These conditions can occur in normal leak or source survey as the operator gets close to the leak or vapor source or in monitoring various manufacturing or material handling processes. Approximately 14% oxygen is required to sustain operation of the FID in the OVA.

Setting Dilution Rate

Prepare a sample in a bag at a high level, typically 1,000 to 5,000 ppm. Any suitable gas can be used, such as butane from a cigarette lighter; however, a compound similar to those to be measured provides greater accuracy. The actual concentration of the gas does not have to be known, since the dilution rate is simply a relative level.

Obtain an OVA reading on the vapor sample with the dilution valve removed. Then install the valve, loosen the jam nut and turn the needle valve until the meter reading corresponds to the original reading divided by the dilution factor desired. Retighten the jam nut.

It should be noted that when the dilution valve is used for natural gas leak survey and pinpointing, the charcoal filter will not remove the methane from the dilution air supply. Care should be taken so that natural gas is not allowed to enter the main air inlet. (See Figure 13.)

OVA Septum Adapter Accessory

A Septum Adapter, P/N 510645-1, is available for direct on-line sample injection to the GC column inlet. The Septum Adapter mounts directly on the OVA front panel and sample injections from .025 to 2.5 cm may be made using a gas tight syringe.

This provides a range of sensitivity of approximately 10% to 1000% of the OVA standard valve, which has a sample loop volume of approximately 0.25 cm . Syringe injection can cause flame-out, however, the OVA may be reignited after the injection is made. The air in the sample must elute from the column before reignition. The time for the air peak to elute is a function of the column length and the volume of the sample injected. For example, a 1 cm sample into a 12" column will require approximately 5 seconds; and, a 2.5 cm sample into a 48" column will require approximately 20 seconds.

The Septum Adapter also provides a means whereby samples from oxygen deficient atmospheres or process streams can be injected directly into the chromatograph. Headspace analysis may also be accomplished using the Septum Adapter and a syringe.

OVA Portable Isothermal Pack (PIP) Accessory

A column can separate an exceptionally wide variety of components if the separations are made at different temperature ranges. In addition, peak heights and retention times can vary with column temperature. The PIP option was developed to control column temperature, without affecting the analyzer's intrinsic safety specifications and without compromising the analyzer's portability.

When the Septum Adapter is installed on the OVA, the normal GC sample valve may still be used alternatively with the syringe injection. In addition to variable sample size and sensitivity, syringe injections will normally provide greater symmetry and reduce tailing of chromatogram peaks as compared with the standard valve injection.

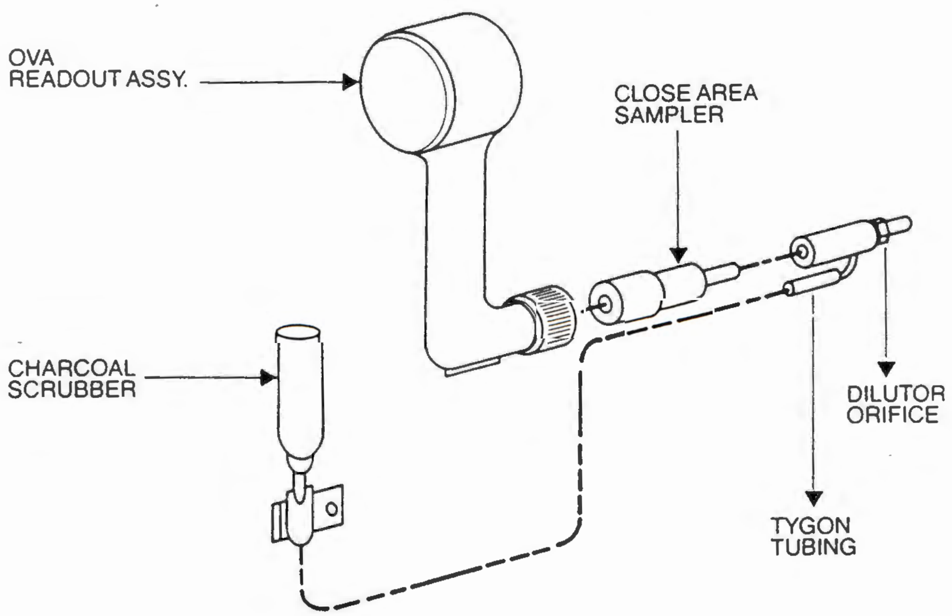


FIGURE 13
OVA SAMPLE DILUTOR

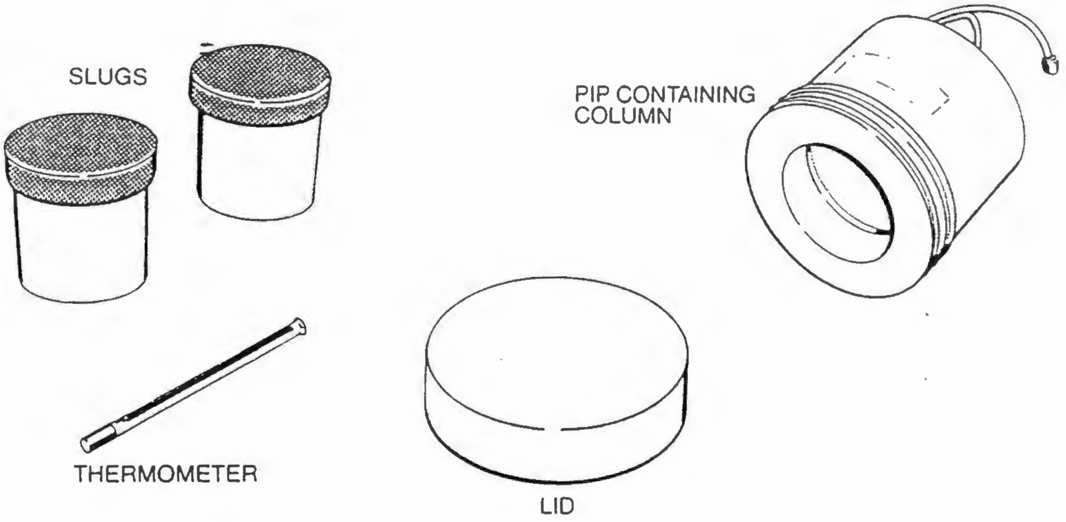


FIGURE 14
PORTABLE ISOTHERMAL PACK

PIP Components & Spare Parts

511800-1	PIP Kit
511805-1	PIP Assembly (specify column length and packing material)
511810-1	40°C Slug (phase-change material)
511830-1	Seeder for 40°C Slug
511815-1	Aluminum Slug
511820-1	Empty Bottles (package of six)
511825-1	Insulating Cover
511826-1	Thermometer

PIP columns can be prepared with any standard column packing material. A temperature control slug is inserted into the PIP slug cavity which has exterior foam insulation. For field operation in extreme ambient temperatures, an additional sheepskin jacket can be installed. The period of temperature control depends upon the temperature difference between ambient and the slug. For a 0°C ice pack and ambient temperature of 27°C, a control period of approximately 10 hours is typical. Additional information on the PIP system will be found in Foxboro document TI611-105.

CENTURY is a trademark of The Foxboro Company.

Teflon is a trademark of E.I. duPont de Nemours and Company.

Snoop is a trademark of The Nupro Company.

Kel-F is a trademark of M.W. Kellog Company.

Chromosorb is a trademark of Johns-Manville.

Carbowax is a trademark of Union Carbide Corporation.

Poropak is a trademark of Waters Associates.

Porasil is a trademark of Waters Associates.

APPENDIX E

KEYSTONE ENVIRONMENTAL RESOURCES STANDARD OPERATING PROCEDURES, GROUNDWATER SAMPLE COLLECTION FROM MONITORING WELLS

KEYSTONE ENVIRONMENTAL RESOURCES, INC.
STANDARD OPERATING PROCEDURE

TITLE: GROUNDWATER SAMPLE COLLECTION FROM MONITORING WELLS

1.0 PURPOSE AND APPLICABILITY

This standard operating procedure (SOP) describes methods performed by Keystone Environmental Resources (Keystone) personnel for the collection of groundwater samples from monitoring wells. The scope of this SOP is limited to field operations and protocols.

This SOP provides general guidance in the collection of groundwater samples from monitoring wells. Several methods, e.g., bailing and pumping can be used to collect groundwater samples. The method of choice is dependent on such factors as parameters to be analyzed and depth to groundwater. In general, bailing is preferred over pumping for several reasons. Some of the more important ones are (i) pumping rates can agitate well water and alter volatile component concentrations, (ii) pumps are not easily dedicated to a given well, and (iii) pumps are more difficult to decontaminate after use than bailers. In either case, the project engineer/scientist should stipulate in the sampling plan which method should be used in the field on each project.

2.0 RELATED DOCUMENTS

- Keystone Environmental Resources Standard Operating Procedure. 1986. Quality Assurance/Quality Control for Groundwater Sampling. Number 504.

- Keystone Environmental Resources Standard Operating Procedure. 1986. Packaging and Shipping of Samples. Number 502.

- Scalf, M.R., J.A. McNabb, W.J. Dunlap, R.L. Cosby and J. Fryberger. 1981. Manual of Groundwater Sampling Procedures. U.S. EPA. Robert S. Kerr. Environmental Research Laboratory. Ada, OK: NWWA/WPA Series 1981.

- U.S. Environmental Protection Agency. September, 1986. RCRA Technical Enforcement Guidance Document.
- U.S. Environmental Protection Agency. 1982. Test methods for Evaluating Solid Waste. 3rd ed. SW-846.
- U.S. Environmental Protection Agency. 1984. Characterization of Hazardous Waste Sites, A Methods Manual. Volume 2.2nd ed. EPA-600/4-84-076.

3.0 RESPONSIBILITIES

The field team leader or his/her designee is responsible for ensuring that all groundwater sampling is performed in accordance with the project specific sampling plan, this SOP, and the appropriate QA/QC SOP. In addition the field team leader must ensure that all field workers fully understand the applicable SOP's. The project engineer/scientist should be contacted for specific instructions.

4.0 REQUIRED MATERIALS

The list below identifies typical pieces of equipment that may be used for a wide range of groundwater sampling applications. From this list, specific project equipment should be selected based upon project objectives, the depth to groundwater, purge volumes, analytical requirements and well construction.

- Purging/Sample Collection Equipment

  Bailers (Bottom Filling)
  Centrifugal pump
  Submersible pump
  Peristaltic pump

Bladder pump

- Related Sampling and Field Measurement Equipment

Thermometer
pH meter
Specific conductance meter
Filtration apparatus (vacuum, or disposable)
Water-level measurement equipment

- General Equipment

Goggles or equivalent eye protection
Distilled water and dispenser bottle
Decontamination liquids
Field data sheets and log book
Sample preservation solutions
Sample containers
Buckets and intermediate containers
Ice chests
First aid Kit
Key (s) for well locks
Stopwatch

- Disposable Materials

Plastic sheeting/bags
Pumping tubing
Bailer cord
Gloves
Filters

Chemical-free paper towels
Protective coverall, e.g., Tyvek

5.0 SAFETY PRECAUTIONS

When in the field performing sampling work all personnel will comply with the EPA established level D safety precautions. This includes wearing long sleeve shirts, long pants, goggles or safety glasses, hardhats, steel toe boots, and safety gloves. In addition Keystone's Health and Safety officer will determine, in advance, if additional safety equipment is required i.e. tyvek suits, respirators, etc...

6.0 PREPARATION PROCEDURES

6.1 Sample Bottle Preparation

Three general types of analyses are performed on groundwater samples; (i) conventional pollutants, (ii) metallic pollutants, (iii) volatile organic and semi-volatile organics. The protocols for preparing the bottles for each type of analysis are discussed below.

6.1.1 Conventional Pollutants

1. Use new bottles with screw-type lids.

2. Prelabel and preserve (where appropriate) all bottles prior to shipment. Measurement of the preserved samples' pH will be done to insure proper preservation (where appropriate).

3. Place bottles in suitable shipping packages, for example, ice chests with adequate packing to reduce bottle breakage (see SOP 502).

6.1.2 Metallic Pollutants

1. New polyethylene containers are used with plastic screw type polyethylene lined lids.

2. The cleaning procedures for each new container are as follows:

    - Rinse container with 1:1 nitric acid
    - Rinse container with distilled water two times.
    - Rinse container with 1:1 HCL.
    - Rinse container thoroughly with distilled water four times.
    - Each container is thoroughly dryed, capped and stored for use.

3. All containers are prelabeled prior to shipment.

4. Once samples are collected, nitric acid is added to preserve the sample at a pH of 2.0 or less. Measurement of the preserved samples' pH will done to insure proper preservation.

5. The preserved samples are then placed in ice chests and cooled to a temperature of 4 degrees Celsius.

6. Before the cooler is sealed a chain of custody sheet is completed for each cooler containing samples.

7. Each cooler is sealed, with chain-of-custody tape or tag, and shipped overnight to Keystone's analytical laboratories for analysis.

6.1.3 Semi-Volatiles

1. New narrow neck amber bottles are used with a teflon lined lid.

2. The cleaning procedure for each new bottle is as follows:

   * Rinse with pesticide grade isopropanol.
   * Air dry in laboratory hood.
   * Dry with pure nitrogen.

3. Prelabel Sample Containers.

4. Pack all bottles securely in ice chests.

5. Each cooler containing samples must have a completed chain-of-custody sheet for the bottles contained inside.

6. The coolers should then be sealed, with chain-of-custody tape or tag, and shipped overnight to Keystone's laboratories for analysis.

6.1.4 Volatile Organics

1. New 40 ml vials and teflon septa will be used.

2. The cleaning procedure for each new vial and septa is as follows:

   * Wash vials and septa with non-phosphate detergent and hot tap water.

   * Rinse three times with tap water.

- Rinse again with ASTM Type I deionized water.
- Oven dry containers and closures at 105° Centigrade for one hour.
- Re-assemble bottles and closures.

3. Prelabel sample container.
4. Pack all vials securely in ice chests.
5. Each cooler containing samples must have a completed chain-of-custody sheet for the bottles contained inside.
6. The coolers should then be sealed, with chain-of-custody tape or tag, and shipped overnight to Keystone's laboratories for analysis.

6.2 Equipment Preparation Procedures

6.2.1 Bailer and Funnel Preparation

1. All stainless steel bailers and porcelain buchner funnels are laboratory cleaned and prepared after each use by following the procedures outlined below:

A) Wash with non phosphate detergent.
B) Rinse with tap water three times.
C) Soak for five minutes in a 10% nitric acid solution.
D) Rinse with distilled water four times.
E) Rinse with pesticide grade acetone.
F) Rinse with pesticide grade hexane.

G) Dry using pure nitrogen.
H) Heat for one hour at 800 degrees Fahrenheit.
I) Cool to room temperature.
J) Wrap with aluminum foil (shiny side out).

2. A separate laboratory-cleaned stainless steel bailer is used to purge and sample each well. All miscellaneous equipment such as shovels, soil trowels, and stainless steel parts of other pieces of equipment are cleaned using the procedures A) through F) outlined above, and wrapped with aluminum foil and plastic.

6.2.2 Bladder Pump Preparation

1. Each tubing line set is dedicated for use on one well only. The sets of tubing are packaged securely and marked for future use on the corresponding dedicated wells.

2. Each pump should be disassembled according to the manufacturer's manual.

3. The stainless steel parts of each pump are cleaned using the methods outlined in section 6.2.1 A) through F).

4. The remaining parts of each pump are washed with non-phosphate detergent, and rinsed with distilled water.

5. Each pump is reassembled, wrapped in aluminum foil (shiny side out), covered with plastic, and stored for future use.

6.3 Water Level Measurement

Water levels in monitoring wells must be measured before the wells are purged and sampled. There are several methods used by Keystone when measuring the water levels of wells. The following methods are listed in order of preference. Preferred methods will obtain accurate water level and depth measurements, will be easy to decontaminate, and will eliminate the chance of cross contamination.

Regardless of the method of water level measurement, the upgradient well(s) should be measured prior to the downgradient. When performed in conjunction with decontaminating the measuring device between wells, the potential for cross contamination will be further reduced.

All water level measurements are taken from surveyed points on each well casing and measured to an accuracy of .01 feet.

6.3.1 Interface Probe

Interface probes are commonly used to detect the presence of any floating or sinking immiscible layers. However they can also be used to detect the water levels inside wells.

1. The probe should be lowered slowly inside each well. When water is detected the probe will make a beeping noise to signify the beginning of the water level. When the beeping noise is heard observe the calibrated drop line to determine the water level.

   If a solid tone is heard, continue lowering the probe (observing the calibrated drop line) until the steady tone stops. The measurement on the drop line between when the steady tone began and when it stopped will determine the thickness of the light phase immiscible layer.

The procedure as described above can be used to determine the presence (and thickness) of layers of dense phase (sinking) immiscible layers.

2. All measurements should be recorded to the nearest one hundredth of a foot (.01).

3. The probe is decontaminated between each well by wiping it with a cloth containing distilled water.

6.3.2 Electric Probe Method

1. Lower the weighted probe into the well casing (when the probe contacts water it will send a pulse to the above ground gauge which will be recorded by a movement of the gauge stick) and observe the calibrated drop line to determine the water level.

2. Mark the point on the cable at the surveyed point on the well, when the probe is touching the water. Measure the distance from the mark to the last foot mark and add this measurement to it to determine the water level.

3. Decontaminate the probe between each well by wiping the line with a cloth containing distilled water.

6.5 Well Purging

All monitoring wells are purged prior to sample collection to assure collection of representative groundwater samples. Wells will be purged until at least three casing volumes of water are removed from each well or until the pH, conductivity and temperature of the purge water has stabilized prior to sampling. If a well is purged dry, sufficient time must be allowed for recovery.

To calculate the amount of water to purge from each well the depth of standing water must be measured using one of the above noted procedures. In addition the casing diameter of each well must be known. These measurements, along with the following appropriate numbers, must be inserted into formula 1.0 on page 10, to determine the specific conversion factor to be used on each size well.

Gallons of H_2O per Linear Foot of Casing Diameter:

1.5" = 0.1057
2.0" = 0.1623
4.0" = 0.6613
6.0" = 1.5003

Top Filling Stainless Steel Bailer Volume (per ft of bailer)

1 1/8" = 300 mls
1 1/2" = 425 mls
3.0" = 1850 mls

Formula 1.0

$$\frac{\text{Gallons of H2O/linear ft. of casing diameter x 3785 (mls/gal)}}{\text{volume of bailer}} \times 3$$

= conversion factor for each well being sampled

The conversion factor must be multiplied times the depth of standing water in each well to determine the number of bails which must be purged from each well. The following conversion factors are listed for the well diameters listed below:

Well Diameter	3 Casing Volume Conversion
1.5"	4.007
2.0"	4.3363
4.0"	4.0589
6.0"	9.2086

To verify the removal of the required well volumes during purging, a graduated bucket will be used to measure purge water quantities.

6.5.1 Purging and Sampling Methods

Wells are purged and sampled by either hand bailing or pumping.

When possible all samples are collected using bailers. Hand bailing for sample collection is preferred because bailers can be decontaminated much more carefully than pumps. Also since pumping rates are difficult to control and since most pumps operate through a pulsating action the degassing of volatile organic concentrations may occur.

6.5.2 Bailing

The following procedures are followed when wells are purged and samples are extracted using hand bailers.

1. Place plastic sheeting (or garbage bags) around the well casing to create a clean surface for the placement of sampling cord and equipment.

2. Use a separate laboratory cleaned stainless steel bailer on each well for the required purging and sampling.

3. Use new surgical or nitrile gloves when working on each well.

4. Use a minimum of 10 feet of either stainless steel wire, teflon coated stainless steel wire or polypropylene monofilament cord. Nylon cord may be used following a ten foot leader of the previously described materials.

    - Make sure the bailer is securely fastened.
    - After removing the protective foil wrapping from the bailer, lower it into the well until it touches the bottom.
    - Remove an additional length of cord and tie it securely to the well head to serve as a safety line for the bailer.

5. When raising the bailer the cord is collected on the plastic sheeting.

6. Unless authorized otherwise, all purged groundwater is collected and when possible, dumped into the on site treatment system.

7. Separate laboratory-cleaned stainless steel bailer is used to collect samples from each monitoring well.

    - Samples are collected when the well recharges after purging.
    - All samples are collected according to their order of volatilization (see Table 1).
    - All volatile organic samples will be collected with laboratory cleaned bottom filling stainless steel bailers in conjunction with an emptying device.
    - When sampling all bailers should be gently lowered into the well to prevent degassification of volatile organic constituents which may be present in the well water.

8. The remaining sample containers will be filled according to their order of volatilization.

6.5.3 Pumping

As noted above, when possible, pumps are not used to sample wells. However, there are circumstances when pumps are more effective purging devices than bailers. When pumps are used to purge wells, pumping will be done from the top of the water column and flow will be checked to ensure removal of the proper volume of water. Also, in some instances pumps are the only means by which samples can be extracted from monitoring wells.

There are several pumps which are used frequently to perform field work.

Peristaltic Pump:

Peristaltic pumps must be operated above ground next to the well being purged and are limited to purging depths of 20.0 to 30.0 feet below ground surface.

1. New nalgene suction line is used on each well being purged. New silicon pump head tubing will also be used if the pump is utilized for sampling.

2. If a peristaltic pump is used to collect a sample, e.g., the well casing is bent preventing the passage of a bailer, the choice of tubing used to collect the sample will be contingent on the parameters of interest.

   * For example, if conventional parameters are being analyzed then standard nalgene tubing is sufficient to collect the sample.
   * If volatile, semi-volatile, or metals parameters are the constituents of interest, teflon tubing is used to collect the sample.

3. The suction line should be lowered to a depth in the water column to assure continued collection should drawdown of the water column occur.

4. To determine the proper amount of water to be purged, the pumping rate should be measured in gallons per minute by recording the time required to fill a selected volume of a calibrated bucket (see Section 6.5 on Well Purging). Flow measurements should be performed three times on each well to obtain an average rate.

5. Monitor the pumping to ensure proper pump operation and assure continuous discharge. If drawdown occurs lower the tubing deeper into the water column.

6. When the required amount of water is purged from each well allow for sufficient recovery before sampling.

7. All purge water is disposed of in the plant wastewater treatment system if available. All tubing is disposed of after each use.

Bladder Pumps:

The bladder pump is a gas operated positive displacement submersible well pump that uses inert compressed gas, e.g., nitrogen, to inflate an internal bladder which pumps water up the discharge line.

These pumps are used when large volumes of water must be purged from monitoring wells. Usually these pumps are used on wells with diameters greater than 2.0" and wells with depths up to 150 feet.

The line assembly is dedicated for use on one well only. After use the tubing is wrapped, marked, and stored for future use in the well to which it is dedicated.

The bladder pumps are primarily used to remove the required amount of water from the monitoring well prior to sampling. When this is accomplished the well water is sampled using a laboratory cleaned stainless steel bailer.

1. Connect the line assembly to the pump by first attaching the cable and then connecting the sample and gas lines.

2. Lower the pump down the well by unrolling the line off of the spool until the pump touches bottom. Raise the pump to the desired position inside the well allowing sufficient room for drawdown of the water column.

3. Secure the cable to hold the pump at the desired depth.

4. Connect the gas line to the control box. The discharge line should be placed in a container (e.g. 55 gallon drum) to collect the purged water.

5. Connect the gas supply to the control box and adjust the pressure according to the manufacturer's manual.

6. Turn on the control box and adjust the inflate delay to obtain the best pumping cycle.

7. The pumping rate should be calculated to determine the length of time the pump should run to purge the well. Field measurements of pH and specific conductance, or the calculation of three casing volumes (Formula #1), may be used to determine when a sufficient amount of water has been purged.

8. When the sufficient amount of water has been purged the well should be sampled using a laboratory cleaned stainless steel bailer.

---

9. As noted, the tubing is used on one well only and after each sampling it is packed, sealed, and stored for future use on that well.

Submersible Pumps:

When wells are encountered with depths greater than 150 feet, submersible pumps are used to purge the required amount of well water. When possible the submersible pumping apparatus is pulled to allow for sampling with a laboratory cleaned stainless steel bailer. If this is not feasible the submersible pump will remain intact and will be used to collect the sample.

When economically feasible the submersible pumps will be dedicated to each well. However, in some cases this is not economically feasible and the same pump must be used in several wells.

When this must be done the pumps will be steam cleaned between wells. Also, the pumps will be used on wells known to contain similar constituent levels.

1. The submersible pump should be lowered to a depth in each well between the middle to bottom screened portion of each monitoring well. The safety line should be secured to the well casing.

2. Connect the power cord to the power source (generator) and turn on the pump.

3. Continue to monitor the pumping rate and lower the line if drawdown of the water column occurs.

4. If the well is pumped to dryness allow ten minutes for the well to recover.

5. After this period the pump should be re-started and the total discharge volume should be measured to determine the rate of recharge.

6. Collect all purged water and if available dispose of in an on-site wastewater treatment system.

6.5.4 Sample Filtration

As outlined in the 1986 RCRA Technical Enforcement Guidance Document, filtering will not be performed on samples to be analyzed for organics. Only inorganics will be filtered and metals will be sampled in unfiltered and filtered portions using .45 micron filter paper. Each Keystone project manager is responsible for determining the inorganic parameters to be filtered for each specific project. However, all sampling programs are subject to change depending on the various state and EPA regional regulations pertaining to specific plant sites.

Filtering is performed using either vacuum pumps with funnels, or peristaltic pumps with disposable funnels/filters. If using the vacuum pump method a laboratory cleaned funnel is used for each well. Funnels are decontaminated in the laboratory using the procedures outlined in section 6.2.1. If using the peristaltic pump method, new medical grade silicone tubing is used in the pump head for each sample filtered and new teflon tubing is used from the pump head to the filter. Whether using the vacuum pump or peristaltic pump methods all samples are filtered through .45 micron filter paper. After filtering, samples requiring preservatives are preserved and all containers are securely placed in coolers and chilled to a temperature of 4 degrees Celsius. Each cooler containing samples will contain a completed chain-of-custody form or tag.

7.0 DOCUMENTATION

A number of documents must be completed before, during, and after each sampling project. These documents include; analytical request forms, chain of custody sheets, field data sheets and any project notes pertaining to the sampling work. Additional documents are used as reference information during each phase of a project and they include; holding time sheets, and sample preservation and containment sheets.

Analytical Request Form:

The analytical request forms (See attachment 1) are completed by the project engineer/scientist and submitted to the sampling team when requesting sampling work. These sheets contain the specific parameters of interest for which the collected samples will be analyzed. The field team coordinator sends the request forms directly to the sample control department to notify the laboratory of the incoming samples. If the field team is not used to collect the samples then the engineer or scientist requesting the work is responsible for providing this information to the laboratory.

Chain of Custody Sheets:

When the field team sends samples to Keystone's analytical laboratories, each ice chest containing samples must be accompanied by a chain of custody form (see attachment 2). These forms contain information pertaining to the samples such as: the project name, the name of the people collecting the samples, the site of collection, the date and time of collection, the parameters of interest for each sample, remarks or observations of samples if appropriate, the signature of the person relinquishing control of the samples and the name of the carrier shipping the samples to the laboratory (e.g. Federal Express, Purolator, etc.). The original chain of custody sheet is sent with the samples, one copy is kept with the client and the other copy is stored in Keystone's field team files.

Field Data Sheets:

The field data sheets (See attachment 3) serve as a field logbook for information pertaining to each specific project. The basic project information such as the name of the project, the date of sampling and the name of the people collecting the samples is contained on these forms. These forms are specifically designed for the collection of samples from groundwater monitoring wells. Information pertaining to the wells being sampled is recorded on these forms. Observations are made on the integrity of the wells being sampled and the physical characteristics of the water in the wells. If representatives are on site to observe sampling activities and or to split samples, the names, positions and departments of these people is noted on the sheet. The original copy of the field sheets is stored in the project files of Keystone's field team. One copy is kept with the client and the remaining copies are sent to the Keystone personnel involved with the project.

Project Notes:

Information specific to each project is written on computer generated printouts (See attachment 4). These sheets are used by the field team members to prepare for and to perform the work required to successfully complete the sampling project.

Additional Documents:

Attachments 5a, b, c, contain the holding times, and protocol for proper preservation and containment of water and soil samples (Reference September 1986, RCRA TEGD, and EPA SW-846 3rd Edition 1982).

This information enables the field team to properly preserve samples and it provides the field team with a time table of when samples must be received by the laboratory for analysis within the recommended EPA holding times.

ATTACHMENT 1

ANALYTICAL REQUEST FORM

Client: ____________________

Client Contact: ____________________

Address: ____________________

____

____

____

Telephone: ____________________

Request Taken By: ____________________

Request Date: ____________________

Project Manager: ____________________

Telephone: ____________________

Start Date: ____________________

NO. of SAMPLES	MATRIX	ANALYTICAL PARAMETERS	TURNAROUND TIME, DAYS

APPLICATION: ( ) NPDES ( ) SDWA ( ) RCRA ( ) SUPERFUND ( ) OTHER

Special instructions: ____________________

____

____

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____

____

FIGURE 5-1

KEYSTONE
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CHAIN OF CUSTODY RECORD

PLANT CODE	PROJECT NAME
SAMPLERS *(Signature)*	

STA. NO.	DATE	TIME	COMP.	GRAB	WELL	STATION LOCATION	NUMBER OF CONTAINERS									CONDUCTIVITY	pH	REMARKS OR OBSERVATIONS

Relinquished by: *(Signature)*	Date	Time	Received by: *(Signature)*	Reliquished by: *(Signature)*	Date	Time	Received by: *(Signature)*
Relinquished by: *(Signature)*	Date	Time	Received by: *(Signature)*	Reliquished by: *(Signature)*	Date	Time	Received by: *(Signature)*

Reliquished by: *(Signature)*	Date	Time	Received for Laboratory by: *(Signature)*	Date	Time	Ice Chest Temp °C	Ice Chest #	Chain of Custody Tag #

*DISTRIBUTION: Original accompanies shipment; Copy to Coordinator Field Files.

PAGE _____ OF _____

ATTACHMENT 2

KEYSTONE ENVIRONMENTAL RESOURCES, INC.

FIELD DATA SHEET FOR GROUNDWATER SAMPLING

PLANT:

PROJECT:

DATE OF WATER LEVELS:

DATE OF SAMPLING:

SAMPLING METHOD:

SAMPLED BY:

WEATHER:

Site No.	Time	Well Dia. (in.)	Depth of Well (ft) (including stickup)	Depth to H_2O in Well (ft)	Depth of H_2O in Well (ft)	Number of Bails Removed	Dry at Number of Bails Removed	In-situ Measurements								
								pH (units)				Conductivity (umhos/cm)				Temp. (C°)

SITE NO.	OBSERVATIONS

Page____of____

ATTACHMENT 3

ATTACHMENT 4

Revised: EXAMPLE
Plant Name: ABCDE
Charge #: 111111-11-11
Wells: R-1, R-7, R-8, R-8B, R-9, R-9C, R-9D, R-10, SF-1, SF-2, SF-3, SF-4
Copy Reports To: X. Smith, Y. Smith, Z. Smith
Turnaround: Normal
Sampling Dates: Quarterly

The following is a list of parameters for which samples are analyzed:

Field Meas.	**Other**
pH(4X)	EPA 8310
Cond.(4X)	EPA 8040
	Tox(4X)

NaHSO4

TOC(4X)

NOTES: TOC, TOX, pH, and Cond. get replicated 4x for all wells.
* prepare an additional TOX bottle for all wells being replicated 4x.

DO NOT FILTER ANY PARAMETERS.

THIS IS AN EXAMPLE COPY OF A COMPUTER GENERATED PRINTOUT.

DCC #433

KEYSTONE
ENVIRONMENTAL RESOURCES, INC.

ATTACHMENT 5A

I CONVENTIONAL PARAMETERS

PARAMETER	COLLECTION VOLUME (ml)	PRESERVATIVE	HOLDING TIME
acidity	300	cool to $4^{\circ}C$	14 days
alkalinity	300	cool to $4^{\circ}C$	14 days
ammonia	1000	H_2SO_4 to pH<2	28 days
BOD5	1000	cool to $4^{\circ}C$	48 hours
carbon (TOC)	250	HCL to pH<2	28 days
chloride	300	cool to $4^{\circ}C$	28 days
COD	100	H_2SO_4 to pH<2	28 days
color	100	cool to $4^{\circ}C$	48 hours
cyanate	1000	H_2SO_4 to pH<2	28 days
cyanide (total)	1000	NaOH to pH<12	14 days
cyanide (free)	1000	NaOH to pH<12	14 days
cyanide (ammenable)	1000	NaOH to pH<12	14 days
fluoride	300	HNO_3 to pH<2	28 days
formaldehyde	40	cool to $4^{\circ}C$	48 hours
hardness	300	HNO_3 to pH<2	6 months
iron (+2)	150	2 drops conc HCl	24 hours
nitrate	100	H_2SO_4 to pH<2	28 days
nitrite	100	cool to $4^{\circ}C$	24 hours
nitrogen (TKN)	100	H_2SO_4 to pH<2	28 days
oil and grease	1000	H_2SO_4 to pH<2	28 days
phenols	1000	H_2SO_4 to pH<2	28 days
phosphorus	300	H_2SO_4 to pH<2	28 days
solids, suspended	300	cool to $4^{\circ}C$	7 days
solids, dissolved	300	cool to $4^{\circ}C$	7 days
sulfate	600	cool to $4^{\circ}C$	28 days
sulfide	500	NaOH to pH 9+Zn acetate	7 days
sulfite	300	cool to $4^{\circ}C$	24 hours
surfactants	1000	cool to $4^{\circ}C$	48 hours
thiocyanate	150	NaOH to pH>12	14 days
thiosulfate	300	cool to $4^{\circ}C$	28 days
TOX	250	cool to $4^{\circ}C$	7 days
turbidity	100	cool to $4^{\circ}C$	48 hours

a) Soil samples should be in 32 oz. glass jars and stored at $4^{\circ}C$ until analyzed.

b) TOC, TOX, and formaldehyde must be taken with no head space.

c) $NaHSO_4$ may be used for H_2SO_4 since the acid is formed upon the addition of water.

d) Fluoride must be collected in plastic.

ATTACHMENT 5B

II METALS

PARAMETER	COLLECTION VOLUME	PRESERVATIVE	HOLDING TIME
Chromium VI	400	Cool to 4°C	24 hours
Mercury	400	HNO_3 to pH<2	26 days
Metals	600	HNO_3 to pH<2	6 months

a) dissolved metals must be filtered on site and require the same sample volumes as total metals.

b) soil samoles must be at least 200 grams and require no preservation other than storing at 4°C until analyzed.

c) either plastic or glass containers may be used.

cleaning procedure - detergent, tap water, 1:1 nitric acid, tap water, 1:1 hydrochloric acid, tap water, deionized water.

ATTACHMENT 5C

III ORGANICS

PARAMETER	COLLECTION VOLUME	PRESERVATIVE	HOLDING TIME
volatile organics (8010,8020,8240)	2 40ml vials	4 drops conc. HCl, cool to $4^{O}C$	14 days
acrolein & acrylonitrile (8030)	2 40ml vials	adjust to pH 4-5, cool to $4^{O}C$	14 days

a) Soil samples should be collected in 4 oz. (120ml) widemouth glass jars with teflon liners and stored at $4^{O}C$ until analyzed.

b) Cleaning procedures for volatile containers - wash vials and septa with soap and water and rinse with distilled deionized water, dry at $105^{O}C$ for one hour.

PARAMETER	COLLECTION VOLUME	PRESERVATIVE	HOLDING TIME
Semivolatile organics (8040,8060,8070,) (8080,8090,8310,) (8110,8120,8140,) (8150,82708280)	1 gallon (amber) or 2 1/2 gallon (amber)	cool to $4^{O}C$	7 days until extraction 40 days following extraction

a) includes pesticides and herbicides.

b) phenols (8040) and PAHs (8310) can be analyzed from the same container.

c) soil samples should be collected in 8 oz. widemouth glass jars with teflon liners.

d) cleaning procedure for semivolatile containers - wash with soap and water, rinse with deionized distilled water, rinse with pesticide grade isopropanol, dry at $105^{O}C$ for one hour.

e) the holding time for soils is 14 days until extraction and 40 days following extraction.

APPENDIX F

KEYSTONE ENVIRONMENTAL RESOURCES STANDARD OPERATING PROCEDURES, PACKAGING AND SHIPPING OF SAMPLES

TITLE: PACKAGING AND SHIPPING OF SAMPLES

1.0 PURPOSE AND APPLICABILITY

This Standard Operating Procedure (SOP) is concerned with the packaging and shipping of samples, including groundwater, surface water, soil, and waste from the time of the field collection to the arrival at the receiving laboratory.

The purpose of this SOP is to identify general procedures to minimize sample loss through breakage, spillage and leakage.

EPA regulations [40 CFR Sec. 261.4(d)] specify that samples collected for the sole purpose of testing are exempt from RCRA regulations when the following conditions are applicable.

- Samples are being transported to a laboratory for analysis;
- Samples are being transported to the collector from the laboratory after analysis;
- Samples are being stored (i) by the collector prior to shipment for analysis, (ii) by the analytical laboratory prior to analysis, (iii) by the analytical laboratory after testing but prior to return of sample to the collector or pending the conclusion of a court case.

2.0 RELATED DOCUMENTS

- U.S. Environmental Protection Agency. 1984. Characterization of hazardous waste sites, a methods manual. Volume 2. 2nd ed. EPA-600/4-84-076.

3.0 RESPONSIBILITIES

It is the responsibility of the field team leader or his designee to assure that the proper sample packaging and shipping procedures are implemented.

4.0 REQUIRED MATERIALS

- Shipping containers e.g., cardboard boxes, ice chests
- Shipping labels and chain-of-custody forms
- Packing tape
- Chain-of-custody tape or tags
- Packing material, e.g., styrofoam, vermiculite
- Ice, cold packs or other suitable cooling agents
- Marking pens

5.0 SAFETY PRECAUTIONS

No special safety precautions are necessary. Be careful when handling potentially hazardous materials and when lifting sample packages.

6.0 PROCEDURE

1. Place plastic-bubble wrap matting or other suitable material on bottom and in corners of shipping container, e.g., ice chest, shipping cartons.

2. Complete chain-of-custody form(s) for each packaged container.

3. Wrap each sample container with plastic-bubble wrap matting or other suitable material and secure with rubber band.

4. Place wrapped sample containers upright in ice chest.

5. Place styrofoam material or other suitable packaging material throughout the voids in the ice chest to restrict sample container movement.

6. Keep sample shipment cool by placing ice or cold packs in ice chests. If ice is used avoid breaking ice bags or place ice in Ziplock bags. The purpose of this is to reduce free water in the ice chests.

7. Add additional styrofoam or other suitable material to completely fill the ice chest.

8. Place original copy of chain-of-custody form(s) in ice chest or place in a chain-of-custody envelope on the side of the chest and retain carbon copy. Chain-of-custody form(s) may also be placed in a Ziplock bag for protection.

9. Close ice chest, check to see if samples are tightly packed and add packaging material if necessary. Wrap ice chest with packing tape then seal with chain-of-custody tape or tag.

10. Use air-express overnight delivery service if immediate sample delivery to the laboratory is required and samples cannot be driven to the receiving laboratory. Obtain copies of shipment records from all couriers.

7.0 DOCUMENTATION

Record in the field notebook a description of the packaging and shipping procedures used for each sample package or group of packages. Complete chain-of-custody records and retain carbon copies. Obtain copies of shipment records from all handlers/couriers of sample packages. This documentation should be forwarded to the project engineer/scientist.

APPENDIX G

SUMMARY OF METHANOL METHODOLOGY AND INSTRUMENTATION

HOUSTON LAB

SUMMARY OF METHODOLOGY AND INSTRUMENTATION

The soil sample received on February 26, 1990 was analyzed for methanol according to a procedure based on Method 8015 in Fed. Methods for Evaluating Solid Waste (SW-846) Vol. 1, Sec. C., US Environmental Protection Agency, 1986.

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The sample (2.00 grams) was weighed into a 10-ml screw capped vial. Two mls of deionized water was added and the vial was sealed. The sample was dispersed in water and then agitated at high speed for one minute with a vortex mixer. After 30-60 minutes sufficient supernatant had separated for analysis. The soil extract was analyzed by direct injection into a Perkin-Elmer 3920B FID gas chromatograph. The gas chromatograph was fitted with a glass column (6′ x 1/4" x 2 mm ID) packed with 5% carbowax 20 m on 80/120 mesh carbopack BAW. The oven temperature was 70 degrees C isothermal. The detector response was measured with a Hewlett-Packard 3390-A Reporting Integrator.

METHODOLOGY SUMMARY

PARAMETER	METHOD NO.	DETECTION LIMIT
METHANOL	8015	7.00 mg/kg

AIHA Accrediation: 171