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Woodward-Clyde Consultants

September 8, 1989
88C2221-1

Xerox Corporation
800 Phillips Road
Building 304-135
Webster, New York 14580

Attention: Eliott Duffney
Senior Environmental Engineer

REMEDIAL INVESTIGATION WORK PLAN
BLAUVELT FACILITY

Dear Eliott:

Woodward-Clyde Consultants (WCC) is pleased to submit the enclosed revised pages which were incorporated into the Xerox Blauvelt Site, Remedial Investigation Work Plan. The revisions were made in response to comment by the New York State Department of Environmental Conservation (NYSDEC) presented in their letter dated September 6, 1989. A summary of these revisions has also been attached to this letter for submittal to the NYSDEC.

WCC looks forward to the final resolution of changes to the Work Plan, and the subsequent initiation of the field investigation. Please do not hesitate to call if you have any questions or comments concerning these revisions.

Very truly yours,

WOODWARD-CLYDE CONSULTANTS

Steven L. Tanen
Assist Project Hydrogeologist

Robert G. Ehlenberger, C.P.G.
Project Manager

SLT/RGE/gmb/WM-16T
Enclosures

SUMMARY OF WORK PLAN MODIFICATIONS

Note: The following identifies changes made since the last version of the Work Plan, dated August 3, 1989. The items which follow are presented in the same order as the comments received from the NYSDEC in their letter of September 6, 1989.

Issue Number	Resolution
1	Addressed on page 26, 4th paragraph
2	Addressed on page 35, 1st paragraph
3	Addressed on page 46, item 4
4	Tables 2 and 3 updated
5	Tables 3 and 4 updated
6	Table 4 updated

Prior to sampling, a reconnaissance of the potential sampling locations will be made to survey the substrate types and general habitat characteristics (e.g., flow velocity, shade, presence of macrophytes). Four locations will be selected that have comparable habitat characteristics. By sampling from sites that have similar physical habitats, differences in the macroinvertebrate communities sampled are more apt to be attributable to the presence of contaminants in the surface water and/or sediments.

At each station, three quantitative benthic macroinvertebrate samples will be collected at relatively low flow conditions using appropriate sampling techniques. Sampling areas will be carefully selected so physical parameters are nearly identical for each sampling area. A 1-foot^2 Surber sampler will be used for sample collection. The sampling episode will be conducted at reasonably low-flow conditions and will be coordinated with the NYSDEC.

The initial sampling episode is intended to be a quantitative study and will yield information as to the need for additional sampling episodes. If warranted, additional sampling episodes will follow the procedures outlined in this section and/or be modified with NYSDEC concurrence.

Each sample collected will be labeled and preserved in 5 percent buffered form line. Benthic macroinvertebrates collected will be identified to the lowest practical level. Biological data will be examined relative to water and sediment analysis data. Attributes of the biological data from each station to be examined will include: species richness, similarity, equitability, overall abundance, distribution and species dominance, especially by pollutant-tolerant species. Diversity indices will be calculated based on the lowest taxonomic levels achievable. Macroinvertebrates will be identified to the species level as much as possible.

Based on the results of the benthic macroinvertebrate study and on the results of other field evaluations conducted in this RI, the need for further ecological studies will be considered. These potential studies may involve aquatic ecology, terrestrial ecology, bioaccumulation studies, etc. The wetlands north of the site will be considered in this evaluation.

6.2 DRILLING METHODS

Borings and wells completed in the overburden will be advanced by hollow-stem auger (HSA) techniques as described in WCC's Standard Operating Procedures (Appendix B). Soil samples will be taken continuously using a 2-inch O.D. split-spoon. If "boiling", running sands or plugs are encountered at any sampling interval, the augers will be cleaned via rotary techniques (minimizing the use of drilling additives). All drilling fluids will be recycled and containerized. If rotary drilling is to be used for overburden drilling, the first choice is to use water rotary, the second mud rotary, and the third choice air rotary. Any water used for drilling will be potable water. Drilling and split-spoon sampling will be conducted in accordance with ASTM D-1586. Hollow-stem augers will have a minimum nominal I.D. of 4-inches for the installation of 2-inch wells.

Monitoring wells (2-inch diameter) screened in the shallow bedrock will be drilled with HSA to the bedrock interface, cored with an NX core barrel (nominal O.D. of 3-inches) and then reamed to a nominal diameter of 4-inches. The deeper boreholes being advanced well into bedrock with open-hole completion, will be constructed with four inch stainless steel casing. Drilling tools creating an annulus of at least 6-inches will be used for the 4-inch wells. Figures 7 and 8 summarize well construction details.

Care will be taken to minimize the transportation of contaminants to the deeper zones (open-hole completion) by following the well installation procedures described in Appendix B.

In areas where well clusters have been proposed, the deepest location will be sampled and installed first. Subsequent wells (to be located approximately 10 feet from the initial well, or as close as logistically possible) will not require sampling. These boreholes will be advanced for the sole purpose of monitoring well installation, in accordance with the procedures in Appendix B.

D

top will then be unscrewed and the analytical probe punched through the aluminum foil for a headspace reading (the maximum reading will be recorded). If a sample is to be sent for analysis, a separate aliquot will be collected and not subjected to the warming process, but placed directly on ice.

8.4.3 GROUNDWATER SAMPLES

Groundwater samples will be collected from all monitoring wells installed at the plant site during this investigation. The procedures outlined below are the general steps that will be taken during all samplings:

1. Precleaned sample bottles will be received from the analytical laboratory in sealed sample shuttles.

2. At each well, water levels will be measured with a weighted measuring tape. Each tape will be cleaned prior to reuse in subsequent wells.

3. Each well to be sampled will be purged of three volumes (or until dry) of standing water. Purging will be accomplished by stainless steel or teflon bailer, centrifugal pump, or peristaltic pump. All pump hoses will be cleaned between uses.

4. The samples will be collected with a stainless steel or teflon bailer, centrifugal pump, or peristaltic pump for all wells.

5. During sampling, bottles for volatile organics analysis (VOAs) will be filled first. While filling the 40-ml VOA vials, extreme care will be taken to preclude the presence of bubbles in the vial after capping. After the vial is filled, invert the bottle and tap on the side to see if any air is included. If air bubbles are observed, the vial must be refilled. After the VOAs, the remaining sample bottles will be filled from the bailer. VOA pairs will be placed in a whirlpak type plastic bag and stored in a cooler maintained at 4° C by either ice or ice packs.

TABLE 2

REMEDIAL INVESTIGATION
SCOPE OF WORK SUMMARY

	Former Underground Storage Tank Area	CRC Area	Former Solvent Storage Room Area	Former Paint Spray Booth Area	Off-Site
Monitoring Wells					
Overburden Wells	9	4	1	-	16*
Shallow Bedrock Wells	1	2	-	-	13*
Deep Bedrock Wells	4	-	-	-	-
Soil Samples Collected for Analysis	24	13	3	-	32
Soil Borings					
Number of Borings	7	4*	-	2	-
Soil Samples Collected for Analysis	26	12*	-	6	-
Surface Water Samples	-	-	-	-	8
Sediment Samples	-	-	-	-	4**
Aquatic Biota Samples	-	-	-	-	3 - 4
Soil-Gas Survey					
Sample Points	-	10	-	4	50 - 70

* Locations contingent on soil-gas survey results

** Assumes half of surface water stations have sediments amenable to sampling

b

TABLE 3

SUMMARY OF SAMPLING AND ANALYTICAL CRITERIA

Media	Location/Type	No. of Locations	Sampling Criteria	No. Samples	Analyses
Soil-gas	Off-site survey	50 - 70	min. 10 percent	5 - 10	VO's, MS
Soil	CRC/borings	4	FS, WT, TD	12	VO's, MS
Soil	CRC/OB wells	3	FS, WT, TD	9	VO's, MS
Soil	CRC/BR wells	2	FS, WT	4	VO's, MS
Soil	Paint Booth/borings	2	FS, WT, TD	6	VO's, MS, Pb
Soil	Solvent Room/well	1	WT, TD, HS	3	VO's, MS, Pb
Soil	Tank Area/borings	7	see text	26	VO's, MS
Soil	Tank Area/wells	12	WT, HS	24	VO's, MS
Soil	Off-site wells	16	WT, HS (per cluster)	32	VO's, MS
Groundwater	Monitoring wells	73	all wells	73 (per quarter)	VO's, MS
Surface water	Off-site/stream	8	1 sample/station	8	VO's, MS
Sediment	Off-site/stream	8	same as above, where possible	4 (assumed)	VO's, MS

Key to Abbreviations:

VO's volatile organics (601/602)
MS mineral spirits
Pb lead

FS below floor slab
WT near water table
TD total depth of borehole
HS dependent on headspace readings

OB overburden
BR bedrock

TABLE 4

SUMMARY OF SAMPLE ANALYTICAL METHODS, CONTAINERS, PRESERVATIVES, AND HOLDING TIMES

PARAMETER	EPA ANALYTICAL METHOD/REFERENCE	CONTAINER	PRESERVATIVE	HOLDING TIME
Halogenated Volatile Organics	Method 601/40 CFR Part 136	Glass	Cool 4° C	7 days
Chloromethane				
Bromomethane				
Dichlorodifluoromethane				
Vinyl Chloride				
Chloroethane				
Methylene Chloride				
Trichlorofluoromethane				
1,1-Dichloroethene				
1,1-Dichloroethane				
1,2-Dichloroethene				
Chloroform				
1,2-Dichloroethane				
1,1,1-Trichloroethane				
Carbon Tetrachloride				
Bromodichloromethane				
1,2-Dichloropropane				
1,3 Dichloropropene (trans)				
Trichloroethene				
1,3-Dichloropropene (Cis)				
Dibromochloromethane				
1,1,2-Trichloroethane				
2-Chloroethylvinyl Ether				
Bromoform				
1,1,2,2-Tetrachloroethane				
Tetrachloroethene				
Chlorobenzene				
1,3-Dichlorobenzene (m)				
1,2-Dichlorobenzene (o)				
1,4-Dichlorobenzene (p)				

TABLE 4 (Continued)

PARAMETER	EPA ANALYTICAL METHOD/REFERENCE	CONTAINER	PRESERVATIVE	HOLDING TIME
Aromatic Volatile Organics	Method 602/40 CFR Part 136	Glass	Cool 4° C	7 days
Benzene Toluene Ethylbenzene Chlorobenzene 1,4-Dichlorobenzene 1,3-Dichlorobenzene 1,2-Dichlorobenzene				
Mineral Spirits	Method 8015/SW-846	Glass	Cool 4° C	14 days
Lead	Method 7420/SW-846	Glass	HNO_3 to pH 2	6 months

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August 3, 1989
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Xerox Corporation
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Webster, New York 14580

Attention: Eliott Duffney
Senior Environmental Engineer

REMEDIAL INVESTIGATION WORK PLAN
BLAUVELT FACILITY

Dear Eliott:

Woodward-Clyde Consultants (WCC) is pleased to submit the enclosed Revised Work Plan for the Remedial Investigation at Xerox Corporation's Blauvelt, New York facility. The Work Plan has been prepared for submittal to the New York State Department of Environmental Conservation (NYSDEC). This version of the Work Plan incorporates the comments made by Xerox and the NYSDEC on earlier versions. Specifically, this Revised Work Plan addresses comments of the NYSDEC in their letter of June 26, 1989. A Summary of Work Plan Modifications (as per the June 26, 1989 NYSDEC letter) has been attached to this letter for submittal to the NYSDEC.

Please do not hesitate to call with any questions or comments on this Work Plan.

Very truly yours,

WOODWARD-CLYDE CONSULTANTS

Steven L. Tanen
Assistant Project Hydrogeologist

Robert G. Ehlenberger, C.P.G
Project Manager

RGE/SLT/kcs/WM-16T
Enclosures

REMEDIAL INVESTIGATION
WORK PLAN

Prepared for:

XEROX CORPORATION

Blauvelt, New York

Prepared by:

WOODWARD-CLYDE CONSULTANTS

Plymouth Meeting, Pennsylvania

August 1989

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1.0 INTRODUCTION

This document presents a Work Plan for a Remedial Investigation (RI) of on-site and off-site areas at Xerox Corporation's Blauvelt, New York facility (Figure 1). Previous investigations performed within the plant boundaries have demonstrated the presence of groundwater and soil contamination, presumably a result of releases from underground solvent storage tanks. The tanks have been removed from the ground and all solvent use at the facility has been discontinued. The on-site groundwater and soil are contaminated by volatile and aliphatic organic compounds, as defined by the existing network of 23 monitoring wells, 10 recovery wells and 14 additional soil borings (Figure 2).

Analytical results from soil sampling carried out in December 1986 indicate that contamination has been observed in areas other than the area near and downgradient from the former storage tanks. Three soil borings drilled inside the existing building, located near former solvent spray booths, indicate that solvents may have leaked into the subsurface from the spray booth areas. Laboratory results confirm that groundwater is contaminated in this area.

As a result of the findings of previous investigations, and a need for additional information concerning the lateral and vertical extent of contaminant migration both on-site and off-site, Xerox Corporation has agreed with the New York State Department of Environmental Conservation (NYDEC) to complete remedial investigations under an Administrative Consent Order (ACO). This Work Plan will be an addendum to the ACO.

If field changes to the work Plan are required, they will be agreed upon by Xerox and the NYSDEC on-site representative. Any changes to the Work Plan will be summarized in a letter to the NYSDEC within two weeks of completing the field work, along with the reason for each change. The changes from the Work Plan, if any, will be summarized in the RI Report.

1.1 OBJECTIVES OF THE REMEDIAL INVESTIGATION

Based upon discussions with the NYDEC and Xerox personnel, WCC has identified work tasks that need to be performed to adequately address contamination both at

and around the Xerox facility. The primary goal of these tasks is to better define the lateral and vertical extent of contamination in several environmental media to allow a comprehensive Remedial Investigation (RI) of the area. This includes the investigation of all potential contaminant source areas on the Xerox site. Thus, some of the investigatory work will be performed on a confirmatory basis and will address all potential source areas, even those with minimal likelihood of contributing contaminants to the subsurface.

The purpose of the off-site investigations is to extend the existing on-site data to surrounding areas downgradient from the plant boundaries. Current data from existing on-site monitoring wells imply that contaminants may be migrating north/northwest off-site, towards a neighboring office and light industrial park.

Another objective of this RI is to satisfy the regulatory requirements. Although the Xerox site is not on the National Priority List (NPL), the New York State Superfund program is implemented by the NYDEC to follow the intent of the Comprehensive Environmental Response Compensation and Liability Act (CERCLA), the Superfund Amendments and Reauthorization Act (SARA) and the National Contingency Plan (NCP). Hence, the RI will be performed according to the standards of work in, and to meet the objectives of, CERCLA, SARA and the NCP.

The RI scope of work has been designed to supplement the data collected in previous investigations and to meet all objectives outlined for the RI. The objectives of the proposed investigation will include the following:

- Establishment of upgradient groundwater quality to provide a baseline for comparison to samples collected in zones of known or possible contamination;

- Investigation of additional on-site contamination sources such as the Former Paint Booths, Former Solvent Storage Room, and the Centralized Refurbishing Center (CRC) Area;

- Evaluation of the lateral and vertical extent of soil contamination by a soil-gas survey in order to define the extent of the groundwater contamination plume;

- Additional test borings to confirm soil conditions at selected locations;

- Delineation of the lateral and vertical extent of the groundwater contamination plume at the site by evaluating existing and newly installed monitoring wells;

- Development of data needed to support a feasibility study and evaluate the possible impacts of contamination on human health and the environment.

1.2 SUMMARY OF THE RI SCOPE OF WORK

WCC has prepared the RI scope of work to achieve the objectives of this study. The investigation involves a number of work tasks, in accordance with conversations and correspondence between the NYDEC, Xerox and WCC. The following section of the Work Plan summarizes the main RI tasks and provides a general overview; technical details of these tasks are described in subsequent sections and appendices.

1.2.1 PRELIMINARY DATA REVIEW

Prior to the onset of any field activities, WCC will perform a review of existing data to provide a preliminary understanding of both on-site and off-site conditions. The data gathered in this task will be used to evaluate any potential changes in the areas within the on-site study area and those areas outside the immediate site that may have been impacted by past activities. Figure 2 shows the general Blauvelt Facility layout with the areas monitored by existing wells.

1.2.2 INVESTIGATION OF ADDITIONAL SOURCES

In addition to the main source of contamination (releases from the former underground storage tanks), this work plan addresses other contaminant sources, known and potential, around the plant site. The areas of interest include:

- o The former paint booths, where solvent-based paints were used;
- o A former solvent storage room at the northeast corner of the building;
- o The CRC area, where subsurface contamination has already been identified.

1.2.3 SOIL INVESTIGATION

The soil contamination conditions, both on- and off-site, will be evaluated in a 3-step process. This first step will be to conduct a soil-gas survey. The on-site soil-gas survey will be conducted inside the building as a preliminary reconnaissance to optimize soil boring placement and to better identify the extent of contamination. This on-site soil gas survey will be extended to locations outside the building to provide area-wide coverage of the northern portion of the property.

The off-site soil-gas survey will be conducted to differentiate between the non-aqueous phase liquid (NAPL) contamination (if present) and the aqueous phase (this distinction has already been made on-site). The off-site survey will also be used to optimize off-site monitoring well placement, and identify the extent of contaminant migration.

Upon completion of the soil-gas survey, soil samples will be collected during both the soil boring and monitoring well installation portion of the subsurface exploration program. The final step of the soil investigation will be the submittal of selected samples for laboratory analysis for volatile organic compounds and for mineral spirits. Selection of samples for laboratory analysis will be based on headspace analysis for organic vapors. In addition, soil samples from the vicinity of the Former Paint Booths and Former Solvent Storage Room will also be analyzed for lead on the frequency of one sample per borehole.

1.2.4 GROUNDWATER INVESTIGATION

An extensive hydrologic and chemical investigation of groundwater is planned for both the on-site and off-site portions of the Remedial Investigation. Data collected will be used to establish groundwater gradients and flow rates, groundwater quality, and the lateral and vertical extent of contamination.

In order to fully incorporate the new wells into the groundwater investigation, analysis of groundwater for volatile organic compounds and mineral spirits will be conducted on both new and existing wells during the initial and subsequent groundwater sampling events. Water levels will be taken in all wells prior to the sampling events. Water level data will be used to generate piezometric contour maps of the water-bearing zones. Aquifer permeability tests ("slug" tests) will be performed to estimate hydraulic conductivity, or transmissivity, of the aquifer. Together, these data should define the rate, direction and extent of contaminant movement both on-and off-site.

1.2.5 SURFACE WATER AND SEDIMENT SAMPLING

Surface water and sediment sampling stations have been located as part of the off-site portion of the Remedial Investigation. The samples will evaluate the potential of groundwater and surface water interactions, and will evaluate surface water as a contaminant migration mechanism. Based upon results of the first sampling round, additional rounds of water/sediment sampling may be necessary to provide requisite data.

1.2.6 AQUATIC BIOLOGY STUDY

An aquatic biological survey will be performed to evaluate the stresses imposed upon local species due to the migration of the contaminant plume. The biological survey stations will correlate with surface water/sediment sampling stations. Their locations will be selected, along with surface water and sediment sampling stations, during the preliminary field reconnaissance; selected locations will have adequate flow and be suitable for both biological and chemical sampling. The initial macroinvertebrate study will be used to evaluate the need for additional sampling events and/or more detailed biological investigations.

1.2.7 UTILITIES INVESTIGATION

A review of local utilities and underground sewers, i.e., locations, elevations and construction details, will be performed to evaluate the potential hydraulic impact of the utilities on the local groundwater system. A large scale map will be included with the RI report which locates utilities which may impact local groundwater flow.

1.3 BACKGROUND INFORMATION

Three previous studies (Recra Research 1981, 1985; Dames and Moore, 1985) performed at Xerox Corporation's Blauvelt facility indicated the presence of organic solvents in the soil and groundwater. Contamination was identified as moving downgradient from the former tank area towards the north and northwest site boundaries. WCC was contracted by Xerox to continue the on-site evaluation, propose an off-site investigation, and to initiate an interim action to mitigate off-site migration. Technical details of WCC's previous on-site investigation and on-site interim action are included as Appendix A of this document. The proposed well locations for the on-site investigation (in addition to the existing wells) are shown on Figure 3. Figure 4 shows the locations of the proposed off-site monitoring wells in addition to the on-site locations, to illustrate the relationship of the on-site and off-site studies.

1.4 SUMMARY OF THE RI WORK PLAN

The Work Plan is divided into eight sections and four appendices, all of which are pertinent to the RI. A summary of the sections is given below.

- Section 1.0 outlines the purpose and scope of the remedial investigation, including an generalized summary of the technical tasks.

- Section 2.0 describes the site history and outlines both the geologic and hydrogeologic setting of the site.

- Section 3.0 presents a detailed discussion of the Remedial Investigation field activities.
- Section 4.0 contains a description of the interim actions being implemented and presents additional interim actions to be taken.
- Sections 5.0 and 6.0 discuss the analytical and drilling programs.
- Section 7.0 outlines the data analysis and report preparation.
- Section 8.0 is the Quality Assurance (QA) Project Management Plan for the Blauvelt Site.
- Appendix A presents a Technical Data Summary from previous WCC investigations.
- Appendix B details WCC Standard Operating Procedures (SOP's) for all field activities under the remedial investigation.
- Appendix C is the Health and Safety Plan developed specifically for the RI at the Blauvelt Site.
- Appendix D is a QA Plan for the analytical laboratory.
- Appendix E is the air monitoring program.

2.0 SITE HISTORY AND SETTING

2.1 WASTE MANAGEMENT PRACTICES

The underground solvent storage tanks and CRC area are the two main waste management units where soil and groundwater contamination has been identified. From 1970 to 1979, a portion of the Blauvelt plant was used for solvent spray cleaning of electrostatic copiers and associated parts. Table 1 summarizes the constituents included in the solvent

blends used at this facility. The solvents were stored in underground tanks and applied in the cleaning process within the CRC area. Solvent use ended in 1979; the underground tanks were subsequently drained and removed. Table 1 also presents those compounds detected at the Blauvelt Site as a result of soil and water analysis.

The two underground tanks, each 8 feet in diameter and 27 feet long, were located north of the existing building, approximately 100 feet south of Bradley Hill Road. The tanks were anchored on a concrete pad 30 feet long, 16 feet wide, and 2.5 feet thick. One tank was used for virgin solvent and the other for spent solvent.

Solvent materials were transported to the CRC area via an underground pipeline. The return flow of waste solvent was mixed with water and returned to the second tank through a separate buried pipeline. WCC will evaluate all readily available data regarding the underground solvent pipelines. This information will be incorporated into selection of exploration locations.

During the 1973 through 1980 period that the underground chlorinated solvent storage tanks were in operation at the Blauvelt facility, there were two recorded releases of solvent. The releases occurred on or about June 16, 1977 and June 7, 1979 and were the result of overflows from the waste solvent storage tank.

The material released is thought to have traveled overland following the slope of the land. This belief is supported by the defined NAPL plume and the location of puddles and collected samples downhill from the solvent storage areas as identified in reports from the 1979 release. The released material is believed to have been contained on Xerox property prior to its absorption into the soils. This is supported by the location of the defined NAPL plume and the large growth of healthy vegetation in the drainage culvert for the area at the northern property boundary noted during an inspection following the 1977 release. While exact figures for the amount of solvent released during these incidents is unknown, the potential for a larger quantity of solvent to be released was greater for the 1977 release.

There is currently no solvent or paint use at the Xerox facility. The entire plant is currently used for offices, telemarketing and warehousing.

2.2 POTENTIAL CONTAMINANT SOURCES

In addition to the underground storage tanks and CRC area, two other areas of the facility have been identified as solvent use or storage areas. They are the Former Paint Booths and the Former Solvent Storage Room.

Two paint booths existed in the area that is currently the maintenance shop (Figure 2). Solvent based paints were used in this area. Before the underground storage tanks were installed, solvents were stored in 55 gallon drums and small containers in an enclosed room in the northeast corner of the building (Figure 2).

2.3 GEOLOGIC AND HYDROGEOLOGIC SETTING

Site subsurface conditions in the vicinity of the Xerox Blauvelt site are characterized by a sequence of Pleistocene and Recent age unconsolidated deposits underlain by Triassic bedrock. The unconsolidated deposits are comprised of a thin surficial layer of brown organic-rich topsoil. The topsoil ranges from a clayey silt to a slightly coarser sandy silt. Underlying the topsoil is a heterogeneous sequence of glacial till. The glacial materials range in thickness from 12 to 23.5 feet and consist of fine-grained, clayey silts to coarse sandy/gravelly silts with sporadic cobbles and boulders.

The unconsolidated materials are underlain by red and brown sandstone, shale, and conglomerate of the Triassic age Brunswick Formation. At the plant, bedrock has been characterized as a reddish-brown and gray, fine-grained sandstone/siltstone and shale occurring in alternating layers of variable thickness. The predominant fracture orientations are parallel to bedding planes, however, locally the unit is highly fractured in both the horizontal and vertical directions.

Based on previous investigations, the unconsolidated deposits and shallow bedrock appear to behave as one hydrogeologic unit under water table conditions (Recra, 1980; Dames and Moore, 1985). However, there may be localized areas where the bedrock is semi-confined by the overburden. Groundwater flows to the north and northwest through the site

with a relatively small hydraulic gradient ranging from 0.0074 to 0.0128 (Dames and Moore, 1985). Data from monitoring wells screened in the overburden and shallow bedrock show similarities in flow direction and hydraulic gradient suggesting a good hydraulic connection between the two geologic units.

3.0 REMEDIAL INVESTIGATION FIELD ACTIVITIES

3.1 INTRODUCTION

3.1.1 OVERVIEW OF THE FIELD INVESTIGATION

The field investigation will be conducted in three phases. A soil-gas survey will be conducted prior to drilling activities, both on-site (inside selected building areas for monitoring well and soil boring placement) and off-site to optimize monitoring well placement and to differentiate between the NAPL (if present) and aqueous phases of contamination.

The second phase of investigation, drilling of soil borings and monitoring wells, will begin upon completion of the soil-gas surveys. Soil borings and monitoring well installation will continue simultaneously for both the on-site and off-site areas in order to optimize drill rig availability, and maintain consistency throughout the investigation. All solid and liquid spoils resulting from drilling and monitoring well installation will be contained in the appropriate drums (labeled "SOLIDS" and "LIQUIDS") for subsequent disposal by Xerox Corporation. All hazardous materials handling and disposal will be done in accordance with NYDEC hazardous waste regulations.

The final phase of work, evaluation of the aquifer for groundwater quality and aquifer flow characteristics, will begin at least two weeks following final well development. Groundwater samples will be collected prior to any aquifer testing. The initial sampling round for all new wells will be coordinated with the sampling of all the existing wells.

Off-site surface water and sediment sampling will be part of the initial groundwater sampling episode. An aquatic biological study will also be performed.

The entire RI program is summarized on Table 2. All activities will be performed in accordance with the Health and Safety Plan included with this detailed Work Plan as Appendix C.

This Work Plan describes the Remedial Investigation scope of work as agreed to by all parties involved. However, minor field changes may be required during the course of the field investigations. Approval of any such changes will be the responsibility of the NYSDEC on-site representative. Documentation of changes will be made by WCC within approximately 2 weeks of completion of field activities and in the final RI Report.

3.2 PRE-INVESTIGATION ACTIVITIES

3.2.1 DATA REVIEW/ON-SITE DATA UPDATE

Prior to initiating any field investigations, regional and on-site data will be used to help focus the off-site study. Regional information on geology, hydrogeology, hydrology, water supply and well inventories will be gathered from federal, state, local and university sources. On-site water level data will help refine the direction of groundwater flow, and analytical data will help refine the contaminant plume dimensions prior to migration off-site. It is recognized that the new recovery wells are designed to draw water simultaneously from the bedrock and overburden zones, hence, the analytical data from these wells may not correlate with other monitoring wells.

3.2.2 UTILITIES INVESTIGATION

Data will be collected from the Town of Orangeburg and the adjacent property owners (if possible) regarding the locations, elevations and construction details of underground sewers and other utilities. These data will be correlated with the on-site water level data (and with off-site data, when available) to evaluate the potential hydraulic impact of the utilities on the local groundwater system.

3.2.3 BASE MAP SURVEY

The area under investigation will be surveyed and mapped by a licensed surveyor using standard accepted surveying practices. The objective of the task is to prepare a base map which will incorporate previous survey information from the on-site hydrogeologic investigation with off-site survey information. The survey will include:

- Location of appropriate cultural features
- Update of all existing well locations to include those not already located
- Field survey of all off-site sample and monitoring well locations
- Development of a survey plot of the above identified points of concern and incorporating the on-site survey information

For vertical control, ground elevations will be surveyed to the nearest 0.1 foot, and top of well riser pipe elevations will be surveyed to the nearest 0.01 foot. Elevations will be referenced to a Standard Datum Base in terms of feet elevation (e.g., referenced to feet MSL).

In addition, the new on-site and off-site boring and monitoring well installation locations, all surface water and sediment sampling locations, as well as aquatic ecological survey stations, will be added to the base map upon completion of the initial sampling events.

3.3 SOIL-GAS SURVEY

Work conducted by WCC and others has indicated that volatile organic contamination in the subsurface can be identified using either an Organic Vapor Analyzer (OVA) or a Photo-ionization Detector (PID), such as an HNU. For a more detailed analysis, and to differentiate between the aqueous and non-aqueous phases of contamination, gas chromatographic (GC) analyses can be used for soil-gas analyses. Appendix B-10 (WCC's

Standard Operating Procedures, SOP) defines the procedures of the soil-gas survey. The soil gas survey will be used to help optimize well locations. Analytical results from the monitoring wells will be used for plume delineation.

3.3.1 ON-SITE SOIL-GAS SURVEY

Fourteen proposed soil-gas sample locations inside the Xerox building will be sampled (Figure 5). Ten samples will be taken in the CRC area adjacent to the former spray booths. The remaining four samples will be collected adjacent to the former paint booths. If necessary, additional probes will be installed to further define the contaminated zone. At each location, a small diameter hole will be drilled through the concrete floor slab of the building. A perforated steel probe will be inserted approximately 2 to 4 feet below the coarse subgrade underlying the slab. A soil-gas sample will be drawn from the probe and encapsulated in a pre-evacuated glass vial and pressurized. Samples will be flown to the laboratory daily, where they will be analyzed for non-halogenated (petroleum) hydrocarbons using a GC/FID and halogenated hydrocarbons using a GC/ECD instrument. Verbal results will be available within 24 hours of sample receipt so that sampling locations can be adjusted accordingly. Places where the concrete was penetrated will be repaired upon completion of sampling.

To delineate the contamination north of the building, a grid with 50-foot centers was developed (Figure 5). Using this grid, approximately 50 soil-gas samples would be collected in a manner similar to that described above. Additional samples using 25-foot centers could be collected at select locations to enhance plume delineation, if necessary. These additional sampling locations would be determined based on analytical results from the 50-foot center grid.

On-site information is available from several monitoring wells and borings installed between the parking area and Bradley Hill Road. Several soil-gas samples will be collected from the perimeter of this area. This soil-gas data can then be compared to existing groundwater data and the groundwater contaminant plume.

The soil gas survey will be performed by Target Environmental Services, Inc. of Columbia, Maryland. Target is a speciality company which provides services in soil gas surveying, sampling and analysis. Target's approach is to collect field samples using standard soil gas sampling techniques, with analysis of the samples performed at their Columbia, Maryland laboratory.

3.3.2 OFF-SITE SOIL-GAS SURVEY

There are two objectives to the off-site soil-gas survey at the Xerox site: (1) to locate (if present) and attempt to delineate the extent of the non-aqueous phase off-site and; (2) to attempt to delineate the presence and extent of aqueous phase contamination off-site. WCC will collect and analyze soil-gas samples at approximately 50 to 70 locations located on a grid pattern (Figure 6). If necessary, the survey will be extended to help locate monitoring wells that will adequately define the plume.

The procedure for collecting the soil-gas samples involves the insertion of a steel probe into the soil at a depth of approximately 3 to 5 feet. A sample of the soil gas is then drawn through perforations at the base of the probe with an oil-less vacuum pump. Samples are then analyzed using a field operable gas chromatograph (GC), which will enable quantitative and qualitative resolution of the plume(s). For the purpose of this study, two types of instrumentation will be utilized with the field GC. The two instruments, an electron capture detector (ECD) and a flame ionization detector (FID), differ in their ability to detect the contaminants present at the Xerox site. The ECD has the capability to detect halogenated organics but has poor detection of mineral spirits. The FID, on the other hand, is sensitive to mineral spirits and not the halogenated compounds. (Note that ECDs are not normally used on field instruments; if not available, a photo-ionization detector will be substituted.) Utilizing both these instruments, and knowing the constituents and relative concentrations of contaminants in the non-aqueous phase versus the aqueous phase, WCC will attempt to delineate the extent of both phases of contamination. In addition to the field analyses, a minimum of 10 percent of the samples will be sent to an analytical laboratory for QA/QC confirmation.

3.4 SOILS INVESTIGATION

Upon completion of the data analysis of both the on-site and off-site soil-gas survey, proposed soil boring and monitoring well locations will be reviewed. The data will be reviewed to optimize boring and well placement, as well as determining if additional borings and wells are required to identify the areal extent of contamination. Borings will be advanced as outlined in WCC's SOP (Appendix B-2). The following discussions present WCC's anticipated soil investigation program based on the currently available data; as new data become available, the numbers and locations of borings are subject to change. Substantive changes will be made with the concurrence of NYDEC's field representative(s).

3.4.1 CRC AREA

As part of the investigation of additional sources, soil borings are proposed inside the Xerox building to further delineate potential soil contamination. The lateral extent of soil contamination in the unsaturated zone in the CRC area needs to be defined in greater detail. In all, four locations have been identified for soil borings (Figure 5). Two borings will be advanced on either side of the former solvent spray booths. The actual locations of these borings will be dependent on the results from the OVA/PID soil-gas analyses.

The four borings will be advanced to the top of bedrock or to auger refusal. All borings will be drilled by hollow stem auger methods. Continuous split-spoon samples of the soils will be collected, allowing for detailed descriptions of the subsurface materials. All soil samples retained will be subjected to measurements of organic vapors in the headspace of the sample jars using an OVA or PID. Field procedures for performing headspace measurements are described in Section 8.4.2.

3.4.2 FORMER PAINT BOOTHS

Additional soil borings have been identified for the Former Paint Booths. Two paint booths existed in the area that is currently the maintenance shop. Solvent-based paints were used there, although there were no floor drains when the paint booths were in operation.

As a confirmatory check, two borings will be advanced in this area, one boring at each location of the former booths (Figure 3). There have been no known spills or leakage of solvents in this area.

3.4.3 FORMER UNDERGROUND TANK AREA

Soil samples for chemical analysis have been collected from most previous boreholes drilled throughout the on-site areas. Data from these samples have been used to help delineate the extent of contamination in the unsaturated zone. Additional soil samples will be collected in the Former Underground Tank Area as part of this investigation. These samples will further evaluate three-dimensional contamination trends in the unsaturated zone. The soil samples will be collected in a series of seven shallow borings (Figure 3) drilled to the water table. Soil samples will also be collected from selected borings drilled for well installation (see Table 2). For this task, continuous soil samples will be collected (at two foot intervals) from the surface to the water table. The number of soil samples from the unsaturated zone, of each borehole, to be submitted for laboratory analyses will depend on the location of the boring. Borings close to the center of the NAPL plume will have all unsaturated samples analyzed. At least two samples will be selected for analysis from borings further away from the NAPL plume axis. A minimum of two samples will be analyzed from each boring. Samples will be selected for laboratory analysis based on the depths of collection and headspace readings. For boring locations located away from the plume's axis, the samples with the highest organic levels will be selected.

3.4.4 SOIL SAMPLE ANALYSES

Soil samples collected for laboratory analysis from the soil borings (with the exception of borings advanced as part of Section 3.4.3) will be from the following intervals:

- One sample from immediately below the floor slab
- One sample from just above the water table, and

- o One sample from the saturated zone, preferably near the bottom of the boring.

Soil samples selected for laboratory analysis will be sent to General Testing Corporation (GTC). Table 3 includes a summary of the samples collected for analysis at each boring location. All soil samples will be collected and labeled as per WCC's SOP (Appendix B, Section B-2). Homogenization and manipulation of soil samples will be minimized to mitigate volatile loss during sample handling. Decontamination procedures are defined in Appendix B, Section B-8.

3.4.5 ADDITIONAL SOIL SAMPLES

In addition to the above soil borings drilled explicitly to collect soil samples for analysis, soil borings drilled for monitoring well installation (see Section 3.5.2) will also provide soil samples for laboratory analyses (Table 3). One to two soil samples from each well couplet location will be selected for laboratory analyses.

3.5 HYDROGEOLOGIC INVESTIGATION

Monitoring wells will be installed to define the hydrogeologic conditions and to define the three-dimensional extent of the contamination plume to the extent necessary to design remediation. The soil gas surveys will be used to select well locations. Additional wells beyond those indicated below may be required to define the plume.

3.5.1 ESTABLISHMENT OF UPGRADIENT GROUNDWATER QUALITY

Background water quality, as indicated in wells U-6 and U-6D (Figure 2), has consistently been below detection limits or in the low parts-per-billion range for the contaminants of interest, except on one occasion, when slightly elevated concentrations were detected. Data from sampling these wells in January and April 1987 confirms the concentrations at below detection limits. Based on WCC's review of sampling and analytical data, it is believed that the elevated concentrations are anomalous. To provide continued evidence of background quality, WCC will resample wells U-6 and U-6D. If concentrations

remain low, the high values will be discounted, and the long term trends will be accepted as indicators of background quality.

Prior to resampling, both wells will be throughly purged and sampled by the methods outlined in WCC's SOP (Appendix B). The re-sampling of these wells will occur during the early phases of the field investigation, with a high priority placed on the laboratory analysis, in order to take advantage of having drill rigs on-site should a new upgradient/background well cluster need to be installed. If a new background well cluster is to be installed, it would be at a separate location from U6/U6-D.

3.5.2 WELL INSTALLATION

3.5.2.1 ON-SITE MONITORING WELL INSTALLATION

The final location of the on-site overburden wells in the CRC area will be dependent on the OVA/PID soil-gas survey. Other on-site well locations are based on data collected from previous studies (see Figure 2).

CRC Area

Five locations have been identified for the installation of monitoring wells to better define the contamination previously identified in MW-17. Three of the locations are for overburden wells only, one is for a couplet of overburden and shallow bedrock, and one is for a shallow bedrock well (Figure 5).

The three locations for overburden wells only will be located so as to bound the lateral and upgradient sides of the plume.

The well couplet will be located near the previously-installed boring SP-12. This couplet will help delineate the vertical extent and magnitude of the contamination near the axis of the plume.

The shallow bedrock well will be installed outside the building, acting with MW-17 to serve as a couplet. The well is designed to be within approximately 10 feet of MW-17. However, final placement will be dependent on work space logistics due to the building wall. These wells will better define contamination along the plume axis.

Well Installation procedures are outlined in Section 5.0, and defined in Appendix B.

Former Solvent Storage Room

One well will be installed outside of the Former Solvent Storage Room on the northeast side of the building (Figure 3). This well will be a shallow overburden well. The well will be located to be close to the probable location of the former sump to which the storage room floor drain lines discharged. As the location and existence of this sump is unknown, a metal detection survey will be performed to attempt to locate it; if unsuccessful, the point where the drain line exits the building will be estimated and used to locate the well. If contamination is detected in this area, additional wells will be warranted to define the contamination plume.

Former Underground Tank Area

Contaminant migration in groundwater within the overburden and bedrock zones needs to be defined in greater detail in the northwest section of the plant site. Nine additional overburden wells, one additional shallow bedrock well, and four deep bedrock wells will be installed to provide this documentation. Locations for these monitoring wells (as well as the proposed wells discussed above for the CRC area) are shown on Figure 3.

Five overburden wells will be located within the Parking Area. One of these is located downgradient from the CRC area and upgradient from the former location of the storage tanks. This well will further differentiate contaminant migration from the spray booths from the contamination from the former storage tanks. Four of the wells in the parking area will be located northwest of the CRC area and west of the former storage tank

area. These wells will be installed in order to: 1) define the outer boundary of contamination in this area; and 2) distinguish the plume near the spray booth area from the plume at the former tank area.

Three overburden wells will be located east of the former storage tank area (north to northeast of well W-5). These wells are located in order to define the outer boundary of contamination in this area of the site.

One overburden well will be located in the far northwestern corner of the site. It will be part of well cluster designed to evaluate the vertical extent and distribution of contamination in this downgradient area.

A shallow bedrock well will be located in the well cluster in the northwestern corner of the site (Figure 3). This well is designed to further define the extent and magnitude of contamination in the shallow bedrock at a point downgradient from the source.

Four deep bedrock wells will be installed to define the vertical extent of contamination. Locations are indicated on Figure 3. The wells are located so they may be evaluated as part of a well cluster involving an overburden, shallow bedrock, and a deep bedrock well all in the same immediate area. The deep bedrock wells will be installed by drilling 20 feet below the bottom of the shallow bedrock wells in the cluster. The bedrock portion of the hole will be cored with NX core barrels. The bedrock wells will be constructed with a 10 foot section of open hole at the base.

WCC anticipates that the four deep bedrock wells discussed in the previous paragraph will be sufficient to delineate the vertical extent of contamination. If significant contamination is present in these wells, and the vertical extent is not defined, additional wells may be installed in a deeper zone. Xerox and WCC recognize the need to fully define the three-dimensional extent of the plume (in the bedrock and overburden) as part of this RI. If needed, deeper wells will be installed at locations adjacent to the wells described above; the depth of these wells would be 10 to 20 feet deeper than the next shallower wells, depending on fracture density in the bedrock and depending on the levels of contamination.

All wells will be completed with locking protective casings, either with or without casing stickups (Figure 7). Flush-mounted curb boxes (Figure 8) will be installed only if necessary at wells inside the existing building and in the parking lot. All wells will be developed following installation. If flush completions are used, curb boxes will be fitted with O-rings as necessary to make them water-tight. Provisions for drainage of the curb boxes to the vadose zone will be included to prevent collection of water within the curb box. All drilling, well installation and well development techniques are presented in WCC's SOP (Appendix B, Sections B-2, B-3.1 and B-3.2, respectively).

3.5.2.2 OFF-SITE MONITORING WELL INSTALLATION

It is anticipated that the off-site soil-gas survey may result in the delineation of a plume to the north of the site. Previous data indicate that plumes in the bedrock and overburden have similar trends with different concentration ranges. Thus, for the off-site work, most monitoring wells are to be installed in paired couplets -- one well in the overburden at each location, and one in the bedrock. However, WCC recognizes the possibility that the couplets may not be sufficient to delineate the vertical extent of contamination. If significant (defined in terms of WCC's ability to define the contaminant plume adequately for remedial purposes) contamination is found in the shallow bedrock wells, deeper wells will be required in the bedrock. Deeper wells, if needed, would be installed at selected locations described below (and shown on Figure 4) for couplets. If installed, the deeper wells will be installed so as to monitor zones similar to those proposed in WCC's on-site proposal.

Contingent on the off-site soil-gas survey results, sixteen locations for monitoring wells are identified for off-site wells (see Figure 4). Thirteen of these locations will be well couplets. Three of the well couplet locations and one overburden location are tentative locations. A decision concerning the installation of the tentative wells will be made based on site access, results from the soil-gas survey and sampling results from the other off-site well couplets, using 48-hour turnaround on laboratory results. Well locations are shown on Figure 4 and discussed briefly below.

Five well locations will be just north of Bradley Hill Road. Three of these locations will be well couplets; two will be overburden wells. These should: 1) aid in defining the vertical and lateral extent of contamination off-site; 2) aid in defining the extent of the NAPL off-site; and 3) evaluate the hydraulic significance of the creek northwest of the site.

One location for an overburden well is identified between Bradley Hill Road and the office building. This well is a tentative location, dependent on the results of the overburden wells to be installed immediately south. If installed, this well will be used to delineate the NAPL plume in the overburden zone.

Three well couplet locations will be approximately 200 feet north of Bradley Hill Road. These wells will aid in defining the vertical and lateral extent of contamination. One of the locations, located east of the pond, is tentative upon sampling results from the off-site well directly south and upon the results of the soil-gas survey.

Three well couplet locations will be approximately 500 feet north of Bradley Hill Road. One of the well couplet locations is tentative. A field decision concerning its installation will be made based on results of sampling in upgradient wells and results of the soil-gas survey. Flow rates derived for the overburden and for the bedrock during a previous on-site investigation indicate that these well locations will, in all likelihood, define the downgradient extent of the contaminant plume. If sample results and the soil-gas survey indicate that contaminants have migrated past these wells, two additional well couplets will be installed. The two additional well couplet locations will be approximately 1000 feet north of Bradley Road (Figure 4).

One well couplet will be installed between the New York Central Railroad tracks and the building, approximately 1000 feet north of Bradley Hill Road. This location is designed to help evaluate the sewer system as a potential contaminant conduit.

One well couplet will be installed west of the railroad, adjacent to the existing well MW-3. This well is to help evaluate the hydrologic significance of the stream.

3.5.3 MONITORING WELL DEVELOPMENT

Monitoring wells will be developed in 2-steps. Initially a stainless steel bailer will be used to agitate and remove any granular materials at the bottom of the well to minimize the possibility of clogging the pump; or destroying the impeller. The use of the stainless steel bailer is also effective in purging the well screen, gravel pack and borehole/aquifer interface; thus breaking up any materials which may clog the screen reduce communication between the well and the groundwater system. Once the bottom of the well has been cleared, the monitoring well will be pumped, with a centrifugal pump, for a minimum of one hour. Development will continue until the discharge water has a turbidity of 50 NTUs or less. In addition, development will proceed until a volume of groundwater is recovered which is equal to that lost in drilling the completion interval.

3.5.4 GROUNDWATER SAMPLING

At least two weeks after all the newly installed wells have been developed, groundwater samples will be collected from all existing and newly installed wells. The groundwater samples will be collected according to WCC's standard procedures (see Appendix B), which are in accordance with general guidelines established by the USEPA, as detailed in "RCRA Ground-Water Monitoring Technical Enforcement Guidance" document. Between three and five times the saturated well volume will be purged prior to sampling, using either stainless steel or Teflon bailers, or a centrifugal pump. All purged water will be drummed or otherwise containerized for appropriate disposal by Xerox Corporation. All purging equipment will be thoroughly decontaminated between uses to avoid cross-contamination between monitoring wells (as discussed in Appendix B-8). Groundwater samples will be obtained using dedicated Teflon or stainless steel bailers, with a minimum of agitation to avoid volatilizing mobile organic compounds.

All groundwater samples will be analyzed for volatile organic compounds and for mineral spirits. Wells located in the vicinity of the Former Paint Booths and Solvent Storage Rooms will be analyzed for total lead. The analyses at these and other wells will include lead in subsequent rounds if warranted by the results of the initial analyses. All

samples for lead will be preserved with a solution of nitric acid until the pH is lowered to at least 2. At the time of collection, all samples will be appropriately preserved (see Table 4) and transported to the analytical laboratory utilizing strict chain-of-custody procedures (see Section 8.0). Samples collected for metals analysis will not be filtered.

3.5.5 AQUIFER PERMEABILITY TESTING

All new off-site monitoring wells will be subjected to single hole aquifer permeability ("slug tests") to obtain in-situ permeability data throughout the area. Slug tests are performed by inserting (or removing) a metal slug of known volume and recording aquifer response to the change in water level within the well. Slug testing will allow for an assessment of aquifer permeabilities and groundwater flow rates. The slug will be decontaminated between wells as discussed in Appendix B. A detailed procedure for slug testing is presented in WCC's SOP (Appendix B, Section B-3.3).

3.6 SURFACE WATER AND SEDIMENT SAMPLING

Nine surface water sampling stations have been identified in the off-site area (see Figure 9). Eight of the surface water stations are downstream from the site, one is located upstream as a background sample. At each station, a surface water sample will be collected, and if possible, a sediment sample will also be collected. It is assumed that approximately half of the surface water stations will have bottom sediments amenable to sampling. Surface water and sediment sampling will be performed corresponding to rainfall and stream flow periods. Based on the results of the first round of surface water and sediment sampling, the need for multiple sampling events will be considered.

Surface water and sediment samples will be analyzed for USEPA volatile organic compounds and for mineral spirits. Surface water samples will be obtained by filling of bottles directly, thus avoiding cross-contamination and effects on representativeness from sampling devices. Sediment samples will be collected using an Eckman dredge or stainless steel spatulas. The sampling tool will be thoroughly decontaminated between locations by washing with a solution of alconox and water followed by potable water rinses. A detailed discussion for sampling, preservation and decontamination is included in Appendix B.

If possible, surface water samples will be collected during low flow conditions.

3.7 AQUATIC BIOLOGY STUDIES

A limited aquatic biology survey of the unnamed tributary to the pond adjacent to the Xerox site will be conducted to evaluate the potential effect of contaminated groundwater flow into the nearby surface waters.

The objective of this task is to evaluate benthic communities which occur in both upstream (background) and downstream (potentially impacted) areas nearby the Xerox site. The sampling data will be used to characterize and compare the communities to the maximum extent possible within the scope of the RI. The survey will be limited to the collection of benthic macroinvertebrates at four stations. A thorough reconnaissance will be performed prior to sampling to ensure that sites are as similar as possible regarding habitat, flow, depth, substrate type, etc. Selection of sample sites for macroinvertebrate sampling will be selected before surface water/sediment sampling locations. However, selected locations must meet criteria for collection of suitable samples for chemical analysis of these matrices. Stations will be located in conjunction with the surface water and sediment sampling locations (Figure 9). In general, sampling stations will be located as follows;

- o One control station in the tributary upstream from areas of potential impact from Xerox operations;
- o One station in the tributary adjacent to the site downstream of potential impact;
- o One downstream station in a small feeder tributary originating from a pond behind the office building; and
- o One station downstream of the junction of the feeder and the main tributary.

Prior to sampling, a reconnaissance of the potential sampling locations will be made to survey the substrate types and general habitat characteristics (e.g., flow velocity, shade, presence of macrophytes). Four locations will be selected that have comparable habitat characteristics. By sampling from sites that have similar physical habitats, differences in the macroinvertebrate communities sampled are more apt to be attributable to the presence of contaminants in the surface water and/or sediments.

At each station, three quantitative benthic macroinvertebrate samples will be collected at relatively low flow conditions using appropriate sampling techniques. Sampling areas will be carefully selected so physical parameters are nearly identical for each sampling area. A 1-foot^2 Surber sampler will be used for sample collection. The sampling episode will be conducted at reasonably low-flow conditions and will be coordinated with the NYSDEC.

The initial sampling episode is intended to be a quantitative study and will yield information as to the need for additional sampling episodes. If warranted, additional sampling episodes will follow the procedures outlined in this section and/or be modified with NYSDEC concurrence.

Each sample collected will be labeled and preserved in 5 percent buffered form line. Benthic macroinvertebrates collected will be identified to the lowest practical level. Biological data will be examined relative to water and sediment analysis data. Attributes of the biological data from each station to be examined will include: species richness, similarity, equitability, overall abundance, distribution and species dominance, especially by pollutant-tolerant species. Diversity indices will be calculated based on the lowest taxonomic levels achievable. Macroinvertebrates will be identified to the species level as much as possible. A similarity coefficient will be used to compare macroinvertebrate communities between and among stations (e.g. Whittaker's percent similarity coefficient).

Based on the results of the benthic macroinvertebrate study and on the results of other field evaluations conducted in this RI, the need for further ecological studies will be considered. These potential studies may involve aquatic ecology, terrestrial ecology, bioaccumulation studies, etc. The wetlands north of the site will be considered in this evaluation.

3.8 AIR MONITORING PROGRAM

An air monitoring program will be implemented to establish a baseline emissions estimate for the site. In addition, air monitoring will be conducted during the Remedial Investigation for protection of site workers, plant personnel and the community in the vicinity of site operations.

3.8.1 BASELINE EMISSIONS

An estimate would be made of the emission of volatile organic compounds at the site to provide baseline data for subsequent investigation/remediation programs. The baseline emissions would be estimated on the basis of a sorbent tube study. The study would be conducted at four locations to be finalized during the site reconnaissance. The locations would be selected to provide the following:

- o an upwind sampling site
- o a downwind sampling site
- o two sampling sites within the spill area.

A duplicate sample would be collected at each sampling site. The duplicate would be collected concurrently with the sample, and stored and analyzed in a manner identical to the sample.

The samples would be collected by drawing air through a sorbent tube by means of a portable air vacuum pump. A laboratory technically acceptable to the NYSDEC will be selected as the laboratory to conduct analyses of the absorption tubes. A Supelco Carbotrap 300 absortion tube, or its equivalent, will be utilized. The tubes will undergo thermal desorption, and be analyzed by GC/MS inaccordance with EPA Methods TO-1 and TO-2. Detection limits will be 10 percent of the Ambient Air Limits as established in the NYSDEC publication "Air Guide 1."

The samples would be collected at a flow rate of .1 liters per minute for a four to six hour period. The sampling point would be three to four feet above the ground surface. Sampling would be conducted during warm (greater than 70^{o}F), sunny days with calm

winds (less than 10 miles per hour). Meteorological data consisting of temperature, wind speed/direction, cloud cover and date and time of last rainfall would be recorded at an on-site weather station.

The air tube samples would be analyzed for specific volatile organic compounds. The compounds have been selected based upon a review of the compounds detected in soil and groundwater samples at the site to date. Compounds selected for incorporation into the sorbent tube study include:

Benzene
1,1-Dichloroethene
1,1-Dichloroethane
1,2-Dichloroethene
Ethylbenzene
Methylene Chloride
1,1,1-Trichloroethane
Tetrachloroethene
Toluene
Trichloroethene
Xylenes (m, p, and o)

3.8.2 REAL-TIME AIR MONITORING

WCC has prepared an air monitoring program for implementation during the remedial investigation field activities. The program has been included as Appendix E to this Work Plan. The real time monitoring program has been designed to respond to changing conditions and provide guidance for the safety of on-site workers and potential off-site receptors.

4.0 ADDITIONAL INTERIM ACTION

The purpose of the additional interim action is to remove a major portion of the NAPL prior to the pumping of groundwater to the groundwater recovery system. The

additional interim action (hereafter referred to as NAPL Recovery System) consists of the following elements.

1. Preliminary investigation leading to identification of the monitoring well(s) having maximum thickness and greatest recovery rate of NAPL;

2. Installation of NAPL recovery well(s) near the monitoring well(s) defined in (1);

3. Long term program for monitoring NAPL production in all wells located within the contamination zone;

4. Storage and disposal of recovered NAPL.

Details of the NAPL recovery system will be altered, as necessary, to meet the overall NAPL recovery objectives.

4.1 PRELIMINARY INVESTIGATION

A short-term monitoring program has been initiated to determine which wells within the contamination zone yield the greatest quantities of NAPL. This program is specifically aimed at monitoring wells MW-7, MW-10, MW-11, MW-12, and MW-13, which have been identified in the past as the only producers of NAPL. This program will continue through the remedial investigation.

Monitoring wells MW-7, MW-10, MW-11, MW-12, and MW-13 will continue to be sampled on a daily basis for a time period necessary to define the well(s) which produces the greatest quantity of NAPL during the remedial investigation. Any NAPL accumulations found in the wells will be recovered by hand bailer. The approximate volume of NAPL recovered from each well will be recorded. The cumulative volume of NAPL recovered from each well will also be recorded.

The thickness of NAPL in each of the recovery wells will be measured on a weekly basis during RI field operations. The accumulated NAPL will be removed by bailing; with records maintained of well numbers, dates, volumes removed etc.

4.2 INSTALLATION OF NAPL RECOVERY WELLS

Two additional wells, committed to NAPL recovery, will be installed adjacent to the wells identified as producing the most NAPL (Section 4.1). The additional wells (hereafter referred to as the NAPL recovery well(s)) will be constructed with a minimum diameter of 30 to 36 inches. The wells will be drilled using bucket auger techniques to the surface of the bedrock and will be screened from the bedrock surface to approximately 2 feet above the water table level. Figure 10 illustrates the typical NAPL recovery well construction.

Automatic NAPL skimmers, consisting of a level sensing probe and double diaphragm pneumatic pump, will be installed in the NAPL recovery wells. The skimmers are designed to remove NAPL on a continuous basis, all NAPL recovered by the skimmer will be stored temporarily in 55-gallon steel drums. The skimmer operation will be checked on a daily basis for proper operation. In the event the thickness of NAPL is too small for the automatic system to recover, the NAPL would be removed manually.

4.3 LONG-TERM NAPL MONITORING

A program for long-term monitoring of NAPL production in wells within the contaminated area will be instituted upon commencement of the NAPL recovery system.

Monitoring wells MW-7, MW-10, MW-11, MW-12, and MW-13 which have produced the NAPL in the past, will be checked on a daily basis initially and then weekly. Any NAPL found within a well will be removed manually using a bailer or other suitable device. The approximate volume of NAPL recovered from each well will be recorded.

4.4 NAPL STORAGE AND DISPOSAL

All NAPL recovered from wells within the contaminated area will be stored on-site in 55-gallon steel drums. Final disposal of the recovered NAPL will be in a manner consistent with NYDEC hazardous waste transportation and disposal regulations. Current plans are for the NAPL to be incinerated; Xerox has approvals with Frontier Chemical and Chemical Waste Management for the incineration of the NAPL.

5.0 ANALYTICAL PROGRAM

5.1 ANALYTICAL LABORATORY

General Testing Corporation (GTC), with facilities in Rochester, New York and Hackensack, New Jersey will provide the analytical laboratory services for the Remedial Investigation. GTC's Rochester facility is a "Technically Acceptable" laboratory under the New York State Superfund Program for the analysis of metals, volatile organic compounds (by gas chromatograph) and pesticides/PCB's (see New York State Department of Environmental Conservation Memorandum; From: Larry Bailey; Date: May 19, 1986 - Updated May 15, 1987; Subject: Technically Acceptable Laboratories). GTC is currently awaiting (or may have received by the time this Work Plan is approved) their NYSDEC accreditation for GC/MS analyses. In any event, only "Technically Acceptable" laboratories will be used for GC/MS work, if needed in this RI. Appendix D, the laboratory Quality Assurance (QA) Plan, presents an introduction to the management, organization and operations of GTC. GTC's Hackensack facility will be used as a point of coordination between WCC and the Rochester laboratory.

5.2 SOIL SAMPLING

Soil samples will be collected during the subsurface investigation. Tables 2 and 3 summarize the soil sampling events. The table identifies those samples to be sent for chemical analysis. All soil samples will be analyzed for volatile organic compounds, by USEPA Methods 8010 and 8020 and mineral spirits. Samples from borings in the vicinity of the Former Paint Booth and Former Solvent Storage Room will also be analyzed for total lead.

Soil sampling procedures, field headspace analysis and documentation procedures are discussed in Section 8.0 and Appendix B.

5.3 GROUNDWATER SAMPLING

WCC will conduct the initial groundwater sampling round in accordance with WCC's Standard Operating Procedures (Appendix B) which are based on the USEPA's "RCRA Ground-Water Monitoring Technical Enforcement Guidance Document". Wells will not be sampled for at least 2-weeks following development in order to allow the wells to stabilize with the local groundwater system.

All wells, new and existing, will be sampled during a single time interval (constituting a single sampling event). Prior to the purging and sampling the wells, static groundwater levels of all the wells will be recorded and referenced to the top of the riser pipe.

The wells will be analyzed for volatile organic compounds by USEPA Methods 8010 and 8020, and mineral spirits. Wells located in the area of the Former Paint Booths and Former Solvent Storage Areas will also be sampled for total lead (unfiltered). Based on the results of the initial analysis for lead, the analytical program may include lead in subsequent sampling rounds. Analysis for halogenated and purgeable compounds (by USEPA Methods 8010 and 8020), as well as mineral spirits, has been selected due to the nature of the solvent blend used in the past at the Blauvelt site. Table 2 is a summary of the groundwater and surface water/sediment sampling program.

Two rounds of analytical results for groundwater samples will be included in the RI report. The data from the initial round of groundwater sampling will be reviewed and evaluated. A sampling program for collection and analysis for a second round of sampling would be prepared based upon results of the first round. The second round of groundwater samples would be collected from selected wells and would be analyzed and reported using Contract Lab Protocol (CLP) for volatile organic compounds (Method 8010/8020). The CLP package will be submitted once a year, once groundwater sampling events conducted as part of the RI report have been conducted. Evaluations would also be made following the review of

the first round of sampling results. This review would determine whether testing of selected second round samples should include an expanded suite of analyses including contaminants on the Target Compound List (TCL).

All new wells (off-site and on-site) outside of the original study area will be analyzed for the full TCL. However, Xerox will petition the NYSDEC to waive this requirement on those wells with close proximity to those already analyzed for the TCL.

5.4 SURFACE WATER AND SEDIMENT SAMPLING

Surface water and sediment samples will be collected at the locations shown on Figure 9. The sampling episode for these locations will coincide, as close as possible, with the initial groundwater sampling event, such that samples can be collected during low flow conditions. It is assumed that approximately half of the surface water stations will have bottom sediment samples amenable to sampling.

The collection of surface water and sediment samples will be a one-time event, in order to evaluate the potential of groundwater and surface water interactions. The surface water and sediment samples will be analyzed for volatile organics compounds, by USEPA Methods 8010 and 8020, and mineral spirits. All samples will be collected in accordance with WCC's Standard Operating Procedures (Appendix B).

5.5 ANALYTICAL METHODOLOGIES

The analytical methodologies for volatile organic compounds used by GTC are based on USEPA document Test Methods for Evaluating Solid Wastes, Third Edition, (SW-846), which are consistent with the NYDEC's requirement for the analysis for Purgeable Halocarbons and Purgeable Aromatics by USEPA Methods 8010 and 8020 (see Appendix D). Analysis for mineral spirits, Method 8015 (aliphatic organic compounds), and lead, Methods 3005 and 7420, are also based on USEPA document SW-846. Routine laboratory deliverables will be provided by GTC; CLP or equivalent deliverables can be made available on a sample-by-sample basis upon request. Best efforts will be made to minimize laboratory contamination

of samples by routine laboratory artifacts. Appendix D contains the methodologies and QA/QC procedures to be implemented by GTC.

Low level detection limits will be provided for samples used to identify the extent of contamination. This will include samples from treatment unit effluent, surface water samples, and potable water supplies.

6.0 DRILLING AND WELL INSTALLATION

All drilling activities will be conducted under the direct supervision of a WCC geologist/hydrogeologist. The drilling subcontractor will be presented with a copy of the detailed work plan, and will be required to operate by the provisions of the plan. All drilling activities will be documented and logged as defined in WCC's Standard Operating Procedures (Appendix B) and the QA portion (Section 8.0) of this plan. The drilling operator will be licensed, or approved, by the State of New York for monitoring well installation.

6.1 DRILLING SUBCONTRACTOR

WCC will subcontract with a qualified drilling subcontractor to perform the soil borings, well installation, and related activities. A specific drilling company has not as yet been retained to provide these services. Rochester Drilling has been tentatively selected to conduct drilling and monitoring well construction services based on their qualifications and experience. However, if Rochester Drilling is not available due to scheduling conflicts, the following are tentatively identified as potential alternative subcontractors for consideration:

Empire Soils Investigations, Inc.
Warren-George, Inc.
Pennsylvania Drilling, Inc.

The drilling firm to be used would be selected on the basis of their experience on similar projects, rig availability, cost, compliance with health and safety requirements, and reputation for high quality workmanship and reliability. The NYSDEC will be notified of the final selection prior to the commencement of any drilling activities for confirmation of acceptability to the NYSDEC.

6.2 DRILLING METHODS

Borings and wells completed in the overburden will be advanced by hollow-stem auger (HSA) techniques as described in WCC's Standard Operating Procedures (Appendix B). Soil samples will be taken continuously using a 2-inch O.D. split-spoon. If "boiling", running sands or plugs are encountered at any sampling interval, the augers will be cleaned via rotary techniques (minimizing the use of drilling additives). All drilling fluids will be recycled and containerized. If overburden conditions prevent the use of hollow-stem augers at a specific drilling location, the first alternative will be to abandon the borehole (sealing the borehole via tremie grouting) and advance a new borehole offset five-feet from the original boring location. If obstructions are still encountered, other alternative drilling methods to be considered are cable tool drilling and a rotary technique (i.e., driving casing and clearing the borehole by water rotary). Prior to the implementation of any alternative drilling method, the NYSDEC will be contacted for concurrence with the changes and subsequent approval.

If rotary drilling is approved by the NYSDEC for overburden drilling, the first choice is to use water rotary, the second mud rotary, and the third choice air rotary. Any water used for drilling will be potable water. Drilling and split-spoon sampling will be conducted in accordance with ASTM D-1586. Hollow-stem augers will have a minimum nominal I.D. of 4-inches for the installation of 2-inch wells.

Monitoring wells (2-inch diameter) screened in the shallow bedrock will be drilled with HSA to the bedrock interface, cored with an NX core barrel (nominal O.D. of 3-inches) and then reamed to a nominal diameter of 4-inches. The deeper boreholes being advanced well into bedrock with open-hole completion, will be constructed with four inch stainless steel casing. Drilling tools creating an annulus of at least 6-inches will be used for the 4-inch wells. Figures 7 and 8 summarize well construction details.

Care will be taken to minimize the transportation of contaminants to the deeper zones (open-hole completion) by following the well installation procedures described in Appendix B.

In areas where well clusters have been proposed, the deepest location will be sampled and installed first. Subsequent wells (to be located approximately 10 feet from the initial well, or as close as logistically possible) will not require sampling. These boreholes will be advanced for the sole purpose of monitoring well installation, in accordance with the procedures in Appendix B.

6.3 WELL INSTALLATION

As discussed in Section 3.0 of the work plan, three types of monitoring well have been proposed for the Blauvelt Site: overburden wells, shallow bedrock wells and deep bedrock wells. All wells will be constructed in accordance with WCC's Standard Operating Procedures (Appendix B). All riser pipes and well screens will be decontaminated prior to installation by the methods described in Appendix B, Section B-8. All gravel pack material will be purchased in bags. Figures 7 and 8 summarize well construction details.

6.3.1 OVERBURDEN WELLS

The overburden monitoring wells will be drilled by advancing a soil boring to the top of bedrock. Continuous split-spoon soil samples will be collected during this drilling. The monitoring wells will be constructed of 2-inch I.D. stainless steel casing and screening (Type 304), with 10 feet of 0.010-inch slot screening. In some cases, 4-inch casing and screening will be used. All pipe will be new, with threaded flush-joints. The screen will be located so that the top 1 to 2 feet intercept the water table. The gravel pack used will be consistent with Jessie Morie No. 0 (see Figure 11 for gradation curve). The wells will be constructed and documented in accordance with the procedures outlined in WCC's Standard Operating Procedures (Appendix B).

6.3.2 SHALLOW BEDROCK WELLS

Shallow bedrock wells will be installed by drilling through the overburden to the top of competent bedrock. A temporary casing will then be inserted into the borehole and seated in the rock socket. A bentonite slurry will then be tremied around the annulus of the temporary casing. The casing will then be flushed with clean water and the borehole will be advanced to 10 to 12 feet below the bottom of the temporary casing by coring with an NX-core. Upon completion of coring the borehole will be reamed to a nominal diameter of at least 4-inches. The wells will be constructed with 2-inch I.D. stainless steel riser and screening (Type 304), with 10 feet of 0.010-inch stainless steel screen set to approximately 1 foot below the bedrock/overburden interface. All stainless steel pipe will be new threaded flush-joint.

The gravel pack will be consistent with Jessie Morie No. 0. The temporary casing will be removed after installation of the well, sand and bentonite. The wells will be constructed and documented in accordance with WCC's Standard Operating Procedures (Appendix B).

6.3.3 DEEP BEDROCK WELLS

The deep bedrock wells will be installed to a completion zone of approximately 20 feet below the bottom of the shallow bedrock wells. Drilling methods through the overburden and non-competent rock will be as described above, using temporary casing to protect deeper zones from cross-contamination. Open hole completions will be advanced to 10-feet below the cased interval.

7.0 DATA ANALYSIS/REPORTS AND PROJECT SCHEDULE

The preparation of the Remedial Investigation Report (RI) will conform to current USEPA guidelines with respect to the implementation of CERCLA 1985, the National Contingency Plan as amended (NCP, 74 FR 31180, July 16, 1982) and SARA 1986.

7.1 REMEDIAL INVESTIGATION REPORT

Upon completion of the field and analytical work, a Remedial Investigations report will be prepared for the study area which will include: a) a summary of the activities performed; b) a description of the site geology and hydrology; c) a location plan showing final locations of soil borings and groundwater monitoring wells, as well as surface water/sediment sampling locations; d) groundwater chemistry and soil headspace analyses; e) WCC's evaluation of existing groundwater quality in the RI study areas, f) an assessment of contaminant migration pathways (exposure routes) and potential receptors and g) definition of the contaminated groundwater plume (both areally and with depth). The extent of the plume will be defined where NYSDEC groundwater quality standards (6 NYCRR Part 703 and NYSDOH standards and guidelines) or other appropriate ARAR are no longer contravened. The report will document the methodologies and techniques used in this study, present data and interpretation of these data, and provide WCC's findings and conclusions. All drawings will include the revision number, the reviewers initials and a legend.

The final RI report will also include (based on previous and proposed investigations):

- All data collected from the site during past and current investigations;
- Representative cross sections or fence diagrams of the site geology which will illustrate local geologic and hydrogeologic conditions relative to soil/bedrock contamination;
- The lateral and vertical extent of groundwater contamination;
- Contours of groundwater elevations (with interpreted flow directions);
- Soil/bedrock contacts;
- The extent of selected chemical compounds in both the vadose zone and saturated units;
- Identification of data gaps and evaluation of the need for additional investigations;
- Boring logs (including blow counts and detailed classifications of the stratigraphy);
- As-built well construction diagrams;
- A list of acronyms;
- A summary of aquifer permeability tests (slug tests); and
- The delineation of the NAPL contamination.

Some of the information to be included in the RI in map form will include:

- All individual, municipal, commercial, and industrial water supply wells or intakes in the areas adjacent to and downgradient from the Blauvelt site, including identification of the source of water for the Oratim Swin Club (which is the Spring Valley Water Authority).

- Any other significant cultural or development features in the area.

- Area surface water hydrology and drainage patterns.

- Any other known or suspected sources of toxic or hazardous substance contamination in the surrounding areas including but not limited to any sites which have been listed on the Registry of Inactive Hazardous Waste Sites by the Bureau of Hazardous Site Control of the New York State Department of Environmental Conservation.

- Areas served by Municipal Water Supply and/or Municipal Waste Water Treatment Systems.

- Utility lines will be identified.

A preliminary screening of remedial alternatives will occur during the RI. To provide the information needed to accomplish this, the following tasks (at a minimum) will be conducted:

- Identification of probable ARAR's.

- Identification of preliminary remedial action goals.

- Estimation of the volumes of media for treatment, containment or removal.

- o Performance of a baseline risk assessment including identification of potential interim remedial actions.

7.2 RISK ASSESSMENT

Based on the data collected in the Remedial Investigation, a risk assessment will be conducted as part of the RI to combine the site evaluation, chemical anaiysis and transport evaluation, exposure assessment and basic toxicology into a description and quantification of actual and potential hazards associated with the site. The risk assessment will be in conformance with the Superfund Public Health Evaluation Manual (EPA/540/1-86/060). The objective of the risk assessment is to evaluate actual or potential threats on- or off-site to human health and the environment resulting the site and/or from the migration of the contaminant plume off the Blauvelt facility. This includes but may not be limited to pathways of soil, soil vapor, surface water/sediment, groundwater and biota. A detailed scope of the Risk Assessment will be included in the RI report.

The risk assessment will include, but may not be limited to the following tasks:

- o Characterization of environment setting;
- o Selection of indicator contaminants;
- o Identification of exposure pathways and receptors;
- o Exposure assessment; and
- o Comparison to standards and criteria.

The conclusion from the risk assessment will be coordinated with the feasibility study to indicate where remedial actions may be required.

7.3 FEASIBILITY STUDY

Upon conclusion of the Remedial Investigation, and developed concurrently with the Risk Assessment (if performed), a Feasibility Study (FS) addressing various alternatives for remediating the contamination at the Blauvelt site will be conducted. A detailed Work Plan for the FS will be included in the RI report. The general format of the FS will include the following tasks:

- Characterization of the study area and identification of problems (as defined in the RI);
- Identification of additional residential/commercial wells within the boundaries of groundwater contamination which may require sampling;
- Identification of alternatives;
- Screening of alternatives/technologies;
- Detailed analysis of alternative;
  - a. Environmental Effectiveness Analysis (intergraded with the Risk Assessment)
  - b. Cost Effectiveness Analysis
- Project and evaluate ambient air impacts from remedial activities;
- Describe control equipment proposed to mitigate emissions impacts; and
- Document calculations used in evaluations.

7.4 PROJECT SCHEDULE

The project schedule has been developed (Figure 12) to illustrate the sequencing of RI tasks. WCC anticipates that field work for this investigation can begin within approximately two weeks of authorization to proceed. Field work will commence with the off-site soil-gas survey, providing access to the property has been attained. The soil-gas survey and subsequent data analysis should take approximately three weeks to complete, at which time the drilling program should begin. Well installation will begin off-site and move to remaining on-site locations. The soil boring program will run concurrently with on-site well installation. The drilling program is anticipated to be performed through mobilizing two drilling rigs and crews and should require approximately ten weeks of field time. Groundwater sampling will take place one to two weeks following well installation and development, requiring an estimated four weeks field time. An additional four to six weeks can be expected for analytical laboratory turn around. The surface water/sediment sampling and aquatic biology studies will require several field days and will be scheduled contingent upon existing weather conditions. A draft Remedial Investigation Report will be submitted to Xerox within six weeks of receipt of the laboratory results. In summary, the investigation described herein will take approximately seven to eight months to complete.

8.0 QUALITY ASSURANCE PLAN

8.1 INTRODUCTION

This section of the Work Plan presents Quality Assurance/Quality Control (QA/QC) Plan for the investigations performed by WCC at the Xerox Corporation's Blauvelt Plant site. This document is not intended to be a detailed account of all field activities; rather, it presents a summary of the procedures and protocols to be followed by WCC to meet our QA/QC objectives. Briefly stated, the objective of the QA/QC program is the production of high-quality data.

This appendix is primarily concerned with QA/QC procedures for the field investigation aspects of this project. QA/QC concerns for the laboratory procedures are addressed extensively in Appendix D.

8.2 QA/QC OBJECTIVES

As stated above, the primary objective of WCC's field QA/QC program is to produce high-quality data. This means that all data generated during this study is to be scientifically representative of plant-site conditions, legally defensible, and have the required levels of precision and accuracy. These objectives hold true for data generated entirely by WCC (such as water levels) and for data for which WCC's involvement is only a part of the process (such as laboratory analysis of samples collected by WCC).

8.3 QA/QC RESPONSIBILITIES

While each WCC employee involved in the generation of data during an investigation is implicitly a part of the overall QA/QC program, certain individuals have specifically designated QA/QC responsibilities. For a project such as this investigation, these key personnel are, in order of decreasing authority, the QA Officer, the Project Manager, and the QA Manager.

Mr. Frank Waller, P.E., will serve as QA Officer for this project. His responsibilities include overseeing the QA/QC program from a management perspective.

Mr. Robert G. Ehlenberger, C.P.G., will serve as Project Manager for the site investigation. His QA/QC responsibilities include overseeing the day-to-day activities of all work on this project, including that of subcontractors. He will perform a detailed review of all data collected during this study to evaluate its ability to meet project and QA/QC objectives. Mr. Ehlenberger's responsibilities also include planning the appropriate field procedures and ensuring that project personnel are familiar with them.

The QA Manager is the individual responsible for implementing QA activities in the field. The QA Manager for this RI will be Mr. Steven Tanen. Mr. Tanen's responsibilities include such tasks as maintaining field notebooks, calibrating equipment, and maintaining chain-of-custody records.

8.4 SAMPLING PROCEDURES

As part of the site investigation, a large number and variety of environmental samples will be collected. These include: soil samples, sediment samples and groundwater and surface water samples. This section summarizes the procedures used during sample collection, equipment decontamination, field analyses, and sample preparation, preservation, and storage. The procedures outlined below have been modified for this project from detailed procedures described in WCC's Standard Operating Procedures (Appendix B).

8.4.1 DRILLING SPLIT-SPOON SOIL SAMPLING

1. Drill rigs will be steam-cleaned by the driller prior to moving onto the site.

2. The drill rig will be inspected by WCC for leaks of hydraulic fluids, fuel, etc. prior to moving onto the site.

3. All drilling will be performed under the direct technical supervision of a qualified WCC geologist or hydrogeologist.

4. Split-spoon soil samples will be taken in advance of auger flights and rotary drill bits.

5. Down-hole equipment will be steam-cleaned between holes; in addition, split-spoons will be washed between samples with a solution of alconox and water, followed by a potable water rinse.

6. Only non-petroleum lubricants will be allowed on drilling tools and augers.

7. Only clean, potable water will be used if it becomes necessary to clear the drilling equipment of debris or sediments.

8. Cleaned down-hole equipment and tools will be kept on wooden supports or plastic sheeting to minimize contact with the ground.

9. The drill rig, split-spoons, drill rods, and hand tools will be steam-cleaned between drilling locations except when offset is deemed necessary by the supervising geologist.

8.4.2 SAMPLE COLLECTION

1. Split-spoon samplers will be washed with alconox between samples.

2. The split-spoon samples will be taken in advance of the auger flights and rotary equipment.

3. The samples will be subjected to a minimum amount of agitation and handling to avoid losing contaminants. Jars for analysis of volatile organics will be filled immediately upon opening the split-spoon.

4. The split-spoons and samples will be placed on a clean surface.

5. The split-spoon samples will be transferred into clean glass jars.

6. Sample tags and labels will be completed clearly with indelible ink and affixed to the jar for sample storage. The tag information and all other appropriate data will be recorded in the sampling log.

7. The samples will be screened for volatile organic compounds in the headspace of the jar, using the following procedure:

Samples collected in jars will be immediately covered with aluminum foil, matte side up, and the top screwed on. Then the material will be allowed to come to room temperature, either by use of a water bath, a sterno, or by being kept in a warm location. The

top will then be unscrewed and the analytical probe punched through the aluminum foil for a headspace reading (the maximum reading will be recorded). If a sample is to be sent for analysis, a separate aliquot will be collected and not subjected to the warming process, but placed directly on ice.

8.4.3 GROUNDWATER SAMPLES

Groundwater samples will be collected from all monitoring wells installed at the plant site during this investigation. The procedures outlined below are the general steps that will be taken during all samplings:

1. Precleaned sample bottles will be received from the analytical laboratory in sealed sample shuttles.

2. At each well, water levels will be measured with a weighted measuring tape. Each tape will be cleaned prior to reuse in subsequent wells.

3. Each well to be sampled will be purged of three volumes (or until dry) of standing water. Purging will be accomplished by stainless steel or teflon bailer, centrifugal pump, or peristaltic pump. All pump hoses will be cleaned between uses.

4. All samples will be collected with a stainless steel or teflon bailer.

5. During sampling, bottles for volatile organics analysis (VOAs) will be filled first. While filling the 40-ml VOA vials, extreme care will be taken to preclude the presence of bubbles in the vial after capping. After the vial is filled, invert the bottle and tap on the side to see if any air is included. If air bubbles are observed, the vial must be refilled. After the VOAs, the remaining sample bottles will be filled from the bailer. VOA pairs will be placed in a whirlpak type plastic bag and stored in a cooler maintained at 4^{o} C by either ice or ice packs.

6. Preservatives will be added to the appropriate sample jars (Section 8.4.4).

7. Appropriate QA samples (field blanks, duplicates) will be filled concurrently with other samples (Section 8.4.5).

8. Samples will be shipped within 24 hours of collection. Analysis will occur within seven days of receipt by the laboratory.

8.4.4 SAMPLE PRESERVATION AND FILTERING

Preservative will be added to the lead sample jars as summarized in Table 4. Table 4 presents acceptable holding times and appropriate sample containers. Samples collected for metals analysis will not be filtered.

8.4.5 QUALITY ASSURANCE/QUALITY CONTROL SAMPLES

QA/QC samples will consist of duplicates, field blanks, trip blanks, and matrix spikes. A post-sampling performance audit will be performed based on the analytical results of the QA/QC samples.

One field blank will be taken for every twenty field samples collected. The field blanks will be prepared at the sampling location using distilled or deionized water routed through the bailer, split-spoon sampler, or other sampling equipment upon completion of normal decontamination procedures. Field blanks will be analyzed for volatile organics by USEPA Methods 8010 and 8020. The field blank serves as a check on the adequacy of decontamination procedures.

One field blank sample will be collected from each different source of water used in the drilling operations. Analysis of the drilling water, field, blank will be for volatile organics; mineral spirits and lead.

Duplicate samples are samples which are identical to those collected for analysis. These samples are obtained to perform as checks on the sampling and handling procedures. One duplicate sample will be collected for every twenty field samples, for each matrix. These samples will be collected at the same time, from the same location, and using the same sampling equipment and procedures. The duplicate samples will be collected in identical containers that have been similarly prepared, filled to approximately the same volume, preserved, and handled as the actual sample. Use of these quality control samples will allow WCC to evaluate the field sampling and handling procedures and their impact on obtaining representative samples.

Trip ("travel") blanks will consist of 40-ml VOA vials filled with distilled or deionized water. This blank serves as a check on potential volatile contamination sources in sample container preparation, method blank water, and sample transport. They will be prepared in the analytical laboratory, transported to the field and shipped with the other samples to the laboratory. The trip blank remains unopened throughout its travel from the laboratory to the field and back. One trip blank will be analyzed for each sampling episode. For example, one trip blank will be run for each groundwater sampling round and one will be run for each surface water sampling round. Trip blanks will be analyzed for volatile organics by USEPA Methods 8010 and 8020.

Matrix spike analysis shall be run by the analytical laboratory on one in twenty for all soil and water parameters. Methods requiring a greater rate of matrix spike analysis shall be followed exclusively.

Laboratory blank samples will be used to indicate any potential addition of contaminants to the samples as a result of the laboratory environment. The results of these samples are used as feedback to the laboratory personnel to indicate if excessive in-house contamination is occurring.

8.4.6 SAMPLE CUSTODY

The objective of chain-of-custody procedures is to document the history of each sample and its handling. An example chain-of-custody form is presented in Figure 13.

Custody records trace a sample from the jar's origin through collection and through all transfers of custody until it is transferred to an analytical laboratory. Internal laboratory records then document the custody of the sample through its final disposal.

8.4.7 SAMPLE VALIDITY

In order to establish sample validity, it is necessary to document measures taken to prevent or detect tampering.

Specific procedures to prevent or detect tampering are:

1. Precleaned sample containers will be received from the laboratory in sealed boxes. On receipt by the field personnel, the containers will be inspected for evidence of tampering.

2. An individual sample identifier will be affixed to each bottle or set of bottles comprising the containers(s) for a single sample and a chain-of-custody form completed for each individual sample.

3. Sample bottles will be stored in containers with custody seals until issued to sampling teams.

4. Decontaminated sampling equipment and sample containers in the hands of the sampling team will be kept under personal observation or under custody seals at all times.

5. The QA Manager will be responsible for samples turned in by the sampling teams and keep the samples under custody seals or personal observation until turned over to the designated carrier in sealed containers.

The QA Manager will be responsible for ensuring that custody procedures are followed and investigate any indication of tampering. The analytical laboratory General

Testing Corporation (GTC) maintains its own standard operating procedures for sample custody and security.

8.4.8 SAMPLE IDENTIFICATION

Sample identification will begin with the sample containers. Precleaned bottles will be received in sealed containers. The analytical laboratory will assign a serial number to each set. This serial number will be used as the first part of the identification assigned to an individual sample.

The assigned sample numbers will be used on the chain-of-custody form, sample log, and sample collection tags, which include all sampling information, such as sample location, time, sampling team, etc. The sample tag will be filled out in indelible ink and affixed to the sample container prior to the initiation of sampling.

8.5 SAMPLE TRANSFER PROCEDURES/CHAIN-OF-CUSTODY RECORDS

An individual chain-of-custody form will be generated for each individual sample at the time precleaned bottles are received and sample numbers assigned. The origination data and sample number will be entered at this time. The form consists of an original and two carbons.

The QA Manager will be responsible for shipping the collected samples. Sample tags will be rechecked against the chain-of-custody forms prior to shipment.

The samples will be packed and sealed with custody seals in numbered containers for shipment to the analytical laboratory. They will be accompanied by the original copy of the chain-of-custody form, which will be signed by the QA Manager as relinquisher. The second carbon of this form will be retained by the QA Manager.

On receipt of the samples, a laboratory representative will sign as having received the samples and return the original copy to the QA Manager.

8.5.1 SAMPLE SHIPMENT

Samples will be shipped from the Blauvelt plant site on the same day they are sampled either by overnight shipping services or by GTC courier. Regardless of the courier used, next day service to the analytical laboratory will be provided.

8.6 LABORATORY CUSTODY PROCEDURES

All samples received are entered into the tracking system utilized by the laboratory. After each sample has been logged in, it is referenced throughout the laboratory by the assigned identification number. All samples are maintained at $4^{o}C$ until analysis begins.

The laboratory is responsible for tracking samples throughout the laboratory and compiling the sample data files. All analysis reports generated in the laboratory are compiled for long-term storage in the sample files and for inclusion in the final report.

8.6.1 SECURITY IN THE LABORATORY

Strict security policies are maintained for the laboratory. Security policies augment chain-of-custody procedures and help maintain the integrity of all samples and sampling data. As a minimum, the following security measures are employed:

1. Use of locks on all refrigeration units for samples and extracts.

2. Restricted access to the laboratory by all unauthorized personnel.

3. Laboratory to be locked during non-business hours with access only by authorized personnel.

4. All computer data files to be read-write protected.

8.6.2 CHAIN-OF-CUSTODY PROCEDURES IN THE LABORATORY

The laboratory sample custodian is responsible for maintaining possession of the chain-of-custody samples and for maintaining all records documenting that possession. Upon receipt of samples, the sample custodian signs the shipping report accompanying each sample and records the date and time. All logging procedures are performed for each sample by the custodian. The samples are then locked in refrigerated storage.

After each extraction or analysis of a sample fraction, the laboratory worksheet for that sample is signed by the analyst, indicating the date of completion. By signing the laboratory worksheet, the individual affirms that he or she was completely responsible for the sample fraction during the period of time that it was not in the possession of the custodian.

8.7 CALIBRATION AND ANALYTICAL PROCEDURES

Calibration and Analytical Procedures for laboratory equipment are documented in Appendix D.

8.8. DATA ANALYSIS, VALIDATION, AND REPORTING

8.8.1 ANALYTICAL LABORATORY

The standard operating procedures used for laboratory data analysis, validation, and reporting are described in detail in Appendix D. If warranted, an annual audit of GTC's Rochester facility will be performed to verify compliance with QA/QC procedures and objectives.

8.8.2 PROJECT DATA

The analysis, validation, and reporting of data received from the analytical laboratories are the responsibility of the QA Officer and Project Manager.

The data from the laboratory that will be reviewed to evaluate the validity of the analyses are:

- o Contaminants in lab blanks
- o Agreement between samples and duplicates
- o Surrogate and spike recovery data

Levels of contaminants in laboratory and trip blanks are expected to be low enough to have little impact on the overall validity of the data. If any contaminants are found above detection limits in one of the field blanks, all of the sample data will be reviewed to see if comparable levels are present in some or all samples grouped by sample day, sample team, sampling equipment, etc. to assess the likely effect on overall sample validity.

8.9 INTERNAL QUALITY CONTROL CHECKS

8.9.1 ANALYTICAL LABORATORY

The internal quality control procedures of the analytical laboratory are described in Appendix D.

8.9.2 FIELD SAMPLING

A procedure for the use of trip and field blanks, duplicate samples, spiked samples, and surrogate recoveries has been established for assessing data precision and accuracy.

If field procedures are inadequate, the immediate corrective action will be taken to ensure that proper, approved procedures are implemented. If samples have been collected, these samples may be discarded and new samples taken. If samples have been sent for analysis, the laboratory may be contacted to terminate analysis.

8.10 PERFORMANCE AND SYSTEM AUDITS

8.10.1 ANALYTICAL LABORATORIES SYSTEM AUDITS

The system audits of the analytical laboratories are described in Appendix D.

8.10.2 FIELD SAMPLING SYSTEM AUDIT

The Project Manager and/or QA Manager will conduct a system audit prior to or during the first day of each sampling round. This on-site qualitative review will cover the following items, at a minimum:

1. Organization and Responsibility - Is the QA Organization operational?

2. Sample Collection - Are written procedures for collection available and are these followed as written?

3. Chain-of-Custody - Have the appropriate steps been followed in the traceability of sample origin and integrity?

4. Operational Procedures - Are the appropriate QC checks made in the field and are records maintained of these checks?

5. Equipment - Is the specified equipment available and in working order?

6. Training - Are field teams adequately trained?

7. Records - Are record keeping procedures operational?

8. Corrective Action - Is the appropriate chain of command followed when responding to situations? Are these situations properly reported on the Corrective Action Record Form?

9. Health and Safety - Are the proper precautions taken to protect the team during field operation?

8.10.3 FIELD SAMPLING PERFORMANCE AUDITS

The groundwater study at the Blauvelt site requires groundwater sample collection followed by sample analysis in the laboratory. Procedures for providing blanks, duplicate samples, and spiked samples have been established for assessing data precision and accuracy. These procedures offer the only opportunity for a postsampling performance audit.

8.11 PREVENTIVE MAINTENANCE

8.11.1 LABORATORY ANALYTICAL EQUIPMENT

Normal preventive maintenance procedures employed by the analytical laboratory are described in Appendix D.

8.11.2 FIELD ANALYTICAL INSTRUMENTS

The field analytical procedures include measurement of organic vapors in air, as well as in the headspace of sample jars. The following summarizes preventive maintenance procedures for the Foxboro Model 108/128 OVA.

Daily - Check battery and hydrogen gas supply

1. Clean primary filter and particle filter with forced air

2. Brush mixer/burner assembly filter

3. Solvent clean exhaust flame arrestor

4. Clean pickup fixtures with forced air

5. Inspect and recharge battery

Weekly - Inspect refiller valve, seals, and cylinder assembly

Every Six Months - Send out for factory maintenance, overhaul, and recalibration

Note: Refer to operating manual for procedure

8.12 CORRECTIVE ACTION AND FEEDBACK

To improve data quality and maintain it at an acceptable level, the QA system must be sensitive and timely in detecting out-of-control or unsatisfactory conditions. Two types of corrective actions can be implemented once a problem has been identified. On-the-spot or immediate corrective action is generally appropriate for inadequate procedures and malfunctioning or inadequate equipment. If on-the-spot corrective action is to be taken, it must be authorized by the QA Manager, put into effect, and recorded. If long-term corrective action is necessary, the Project Manager will initiate a corrective action request form, assign responsibility for investigation, determine the corrective action that is to be taken, assign responsibility for implementing the required action, and verify that the action has been effective.

8.13 DOCUMENT CONTROL

The purpose of document control is to ensure that all project documents will be accounted for when the project is complete. The Project Manager will maintain overall control for all items passing through project operations.

The QA Manager will also be responsible for issuing, controlling, and maintaining records of field-generated data. At the conclusion of field activity, all controlled documents and records shall be delivered to the Project Manager for inclusion in an overall project document inventory.

Tables

TABLE 1

INLAND CHEMICAL SOLVENT BLENDS
USED AT XEROX, BLAUVELT
AND SUMMARY OF DETECTED COMPOUNDS

Trade Name	Major Components	Approximate Concentration
I) Solvent Blends		
AP-66	1,1,1-Trichloroethane	58%
	Aliphatic Hydrocarbons	29%
	Tetrachloroethene	7%
	Trichloroethene	6%
AP-67	Aliphatic Hydrocarbons	50%
	1,1,1-Trichloroethane	20%
	Trichloroethene	15%
	Tetrachloroethene	10%
	Methylene Chloride	5%
AP-71	Aliphatic Hydrocarbons	65%
	Tetrachloroethene	25%
	Trichloroethane	5%
	Methylene Chloride	5%
AP-72	Aliphatic Hydrocarbons	60%
	Tetrachloroethene	5%
	Trichloroethene	5%
	1,1,1-Trichloroethane	5%
	Methylene Chloride	12.5%
	n-Heptane	12.5%
II) Detected Compounds		
A) Aliphatics	Mineral Spirits	
	n-Heptane	
	n-Octane	
	n-Nonane	
	n-Decane	

TABLE 1 (Continued)

Trade Name	Major Components
B) Volatile Organics	Vinyl Chloride
	Methylene Chloride
	1,1-Dichloroethene
	1,1-Dichloroethane
	1,2-Dichloroethene
	Chloroform
	1,2-Dichloroethane
	1,1,1-Trichloroethane
	Trichloroethene
	Tetrachlorethene
	Benzene
	Toluene
	Ethylbenzene
	Chlorobenzene
	1,4-Dichlorobenzene
	1,3-Dichlorobenzene
	Xylenes
C) Inorganics	Lead*

*Potential concern due to activities associated with Paint Booths

TABLE 2

REMEDIAL INVESTIGATION
SCOPE OF WORK SUMMARY

	Former Underground Storage Tank Area	CRC Area	Former Solvent Storage Room Area	Former Paint Spray Booth Area	North of Building	Off-Site
Monitoring Wells						
Overburden Wells	9	4	1	-	-	16*
Shallow Bedrock Wells	1	2	-	-	-	13*
Deep Bedrock Wells	4	-	-	-	-	-
Soil Samples Collected for Analysis	24	13	3	-	-	32
Soil Borings						
Number of Borings	7	4*	-	2	-	-
Soil Samples Collected for Analysis	26	12*	-	6	-	-
Surface Water Samples	-	-	-	-	-	8
Sediment Samples	-	-	-	-	-	4**
Aquatic Biota Samples	-	-	-	-	-	3 - 4
Soil-Gas Survey						
I) Off-Site						
Sample Points	-	-	-	-	-	50 - 70
II) On-Site						
Sample Points	-	10	-	4	50 - 60	-

* Locations contingent of soil-gas survey results
** Assumes half of surface water stations have sediments amendable to sampling

TABLE 3

SUMMARY OF SAMPLING AND ANALYTICAL CRITERIA

Media	Location/Type	No. of Locations	Sampling Criteria	No. Samples	Analyses
Soil-gas	Off-site survey	50 - 70	All sample points	50 - 70	VO's, MS
Soil-gas	On-site survey	50 - 70	All sample points	50 - 70	VO's, MS
Soil	CRC/borings	4	FS, WT, TD	12	VO's, MS
Soil	CRC/OB wells	3	FS, WT, TD	9	VO's, MS
Soil	CRC/BR wells	2	FS, WT	4	VO's, MS
Soil	Paint Booth/borings	2	FS, WT, TD	6	VO's, MS, Pb
Soil	Solvent Room/well	1	WT, TD, HS	3	VO's, MS, Pb
Soil	Tank Area/borings	7	see text	26	VO's, MS
Soil	Tank Area/wells	12	WT, HS	24	VO's, MS
Soil	Off-site wells	16	WT, HS (per cluster)	32	VO's, MS
Groundwater	Monitoring wells	73	all wells	73 (per quarter)	VO's, MS
Surface water	Off-site/stream	8	1 sample/station	8	VO's, MS
Sediment	Off-site/stream	8	same as above, where possible	4 (assumed)	VO's, MS

Key to Abbreviations:

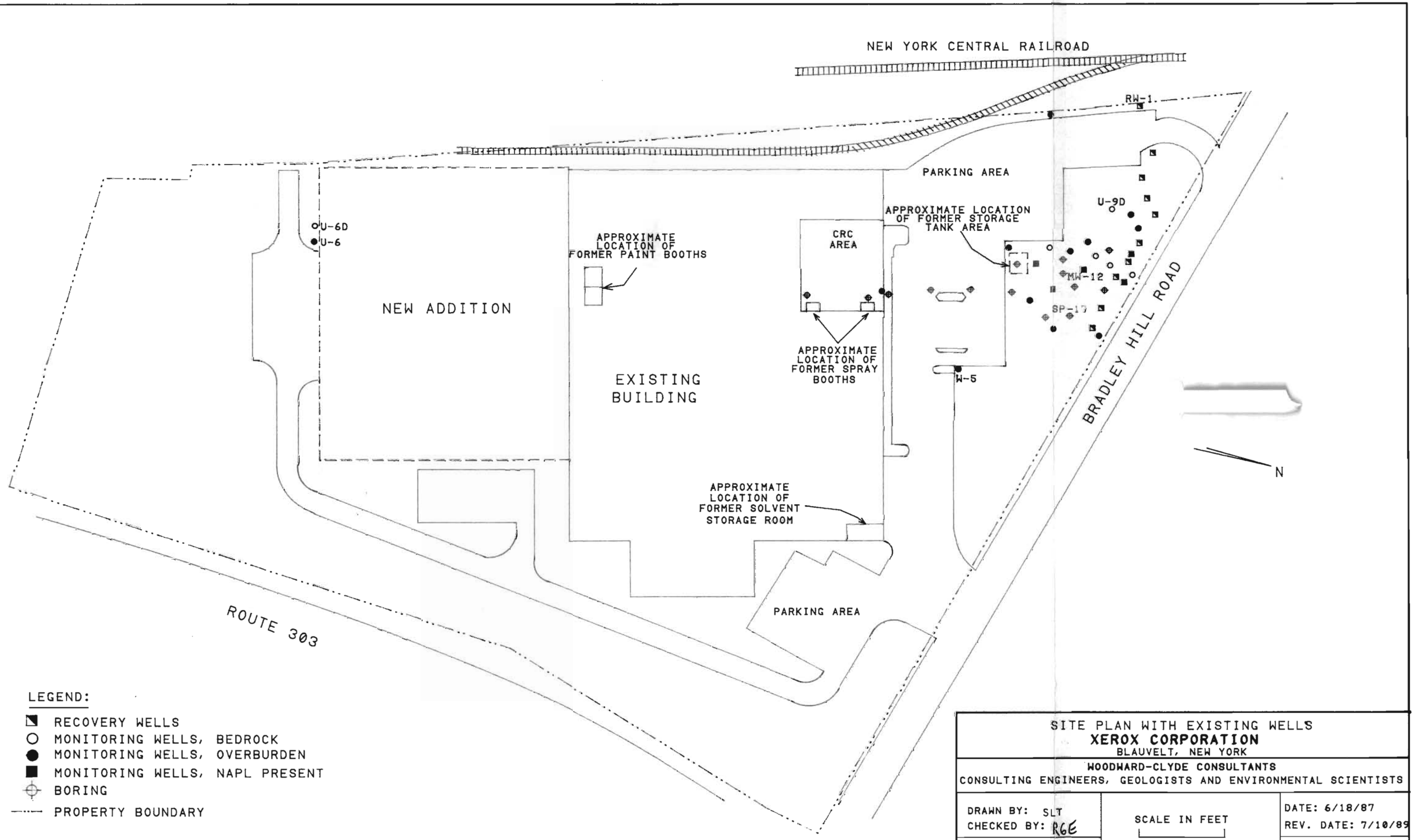
VO's	volatile organics (8010/8020)
MS	mineral spirits
Pb	lead
FS	below floor slab
WT	near water table
TD	total depth of borehole
HS	dependent on headspace readings
OB	overburden
BR	bedrock

TABLE 4

SUMMARY OF SAMPLE ANALYTICAL METHODS,
CONTAINERS, PRESERVATIVES, AND HOLDING TIMES

PARAMETER	EPA ANALYTICAL METHOD/REFERENCE	CONTAINER	PRESERVATIVE	HOLDING TIME
Halogenated Volatile Organics	Method 5030/SW-846 Method 8010/SW-846	Glass	Cool 4 °C	7 days
Chloromethane Bromomethane Dichlorodifluoromethane Vinyl Chloride Chloroethane Methylene Chloride Trichlorofluoromethane 1,1-Dichloroethene 1,1-Dichloroethane 1,2-Dichloroethene Chloroform 1,2-Dichloroethane 1,1,1-Trichloroethane Carbon Tetrachloride Bromodichloromethane 1,2-Dichloropropane 1,3-Dichloropropene (trans) Trichloroethene 1,3-Dichloropropene (Cis) Dibromochloromethane 1,1,2-Trichloroethane 2-Chloroethylvinyl Ether Bromoform 1,1,2,2-Tetrachloroethane Tetrachloroethene Chlorobenzene 1,3-Dichlorobenzene (m) 1,2-Dichlorobenzene (o) 1,4-Dichlorobenezene (p)				
Aromatic Volatile Organics	Method 5030/SW-846 Method 8020/SW-846	Glass	Cool 4 °C	7 days
Benzene Toluene Ethylbenzene Chlorobenzene 1,4-Dichlorobenzene 1,3-Dichlorobenzene 1,2-Dichlorobenzene				
Mineral Spirits	Method 8015/SW-846	Glass	Cool 4 °C	14 days
Lead	Method 7420/SW-846	Glass	HNO3 to pH 2	6 months

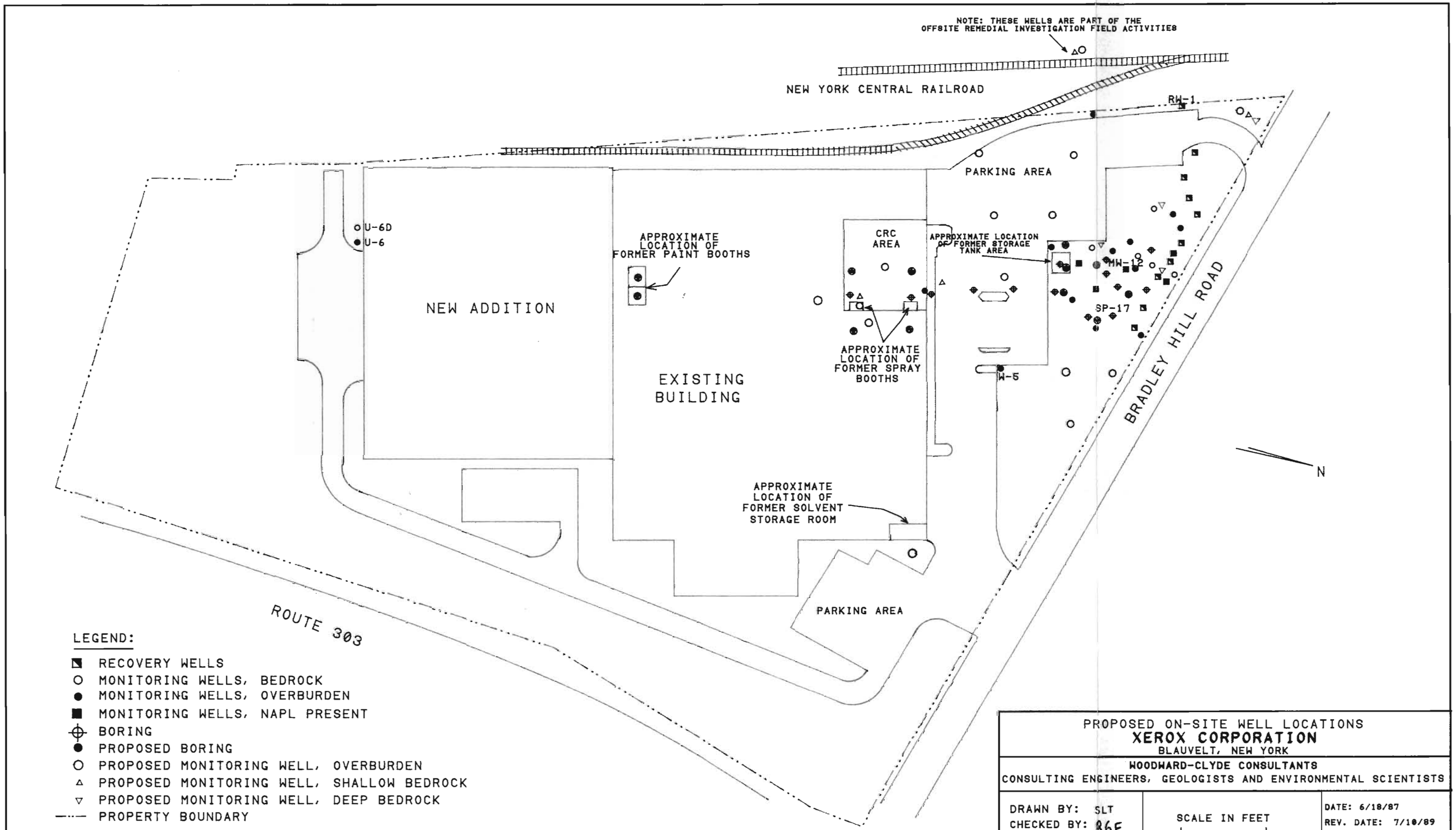
Figures



SITE PLAN WITH EXISTING WELLS
XEROX CORPORATION
BLAUVELT, NEW YORK

WOODWARD-CLYDE CONSULTANTS
CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

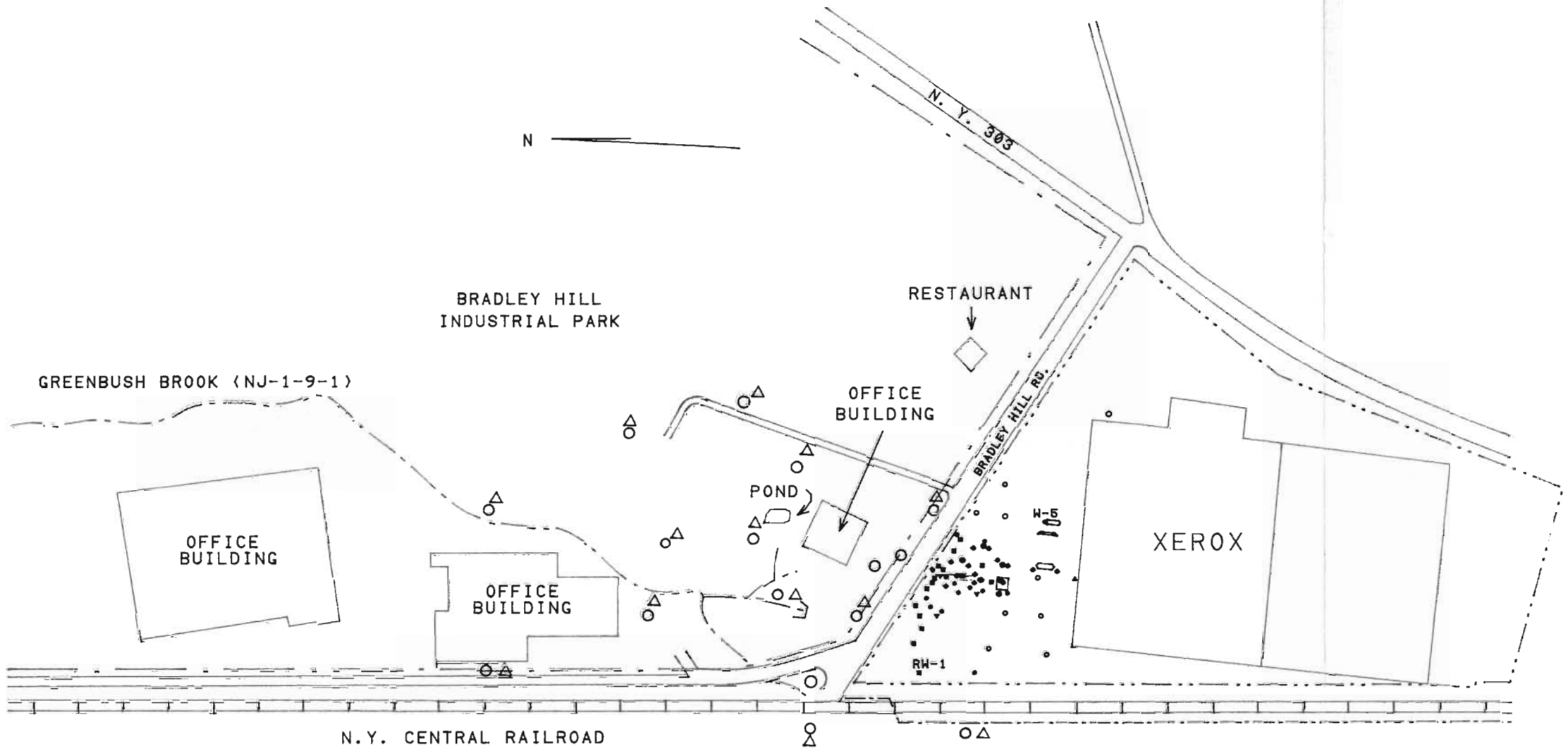
DRAWN BY: SLT CHECKED BY: RGE	SCALE IN FEET 0 100	DATE: 6/18/87 REV. DATE: 7/10/89
JOB: 88C2221-1		FIGURE 2



PROPOSED ON-SITE WELL LOCATIONS
XEROX CORPORATION
BLAUVELT, NEW YORK

WOODWARD-CLYDE CONSULTANTS
CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

DRAWN BY: SLT CHECKED BY: RGE	SCALE IN FEET 0 100	DATE: 6/18/87 REV. DATE: 7/10/89
JOB: 88C2221-1		FIGURE 3



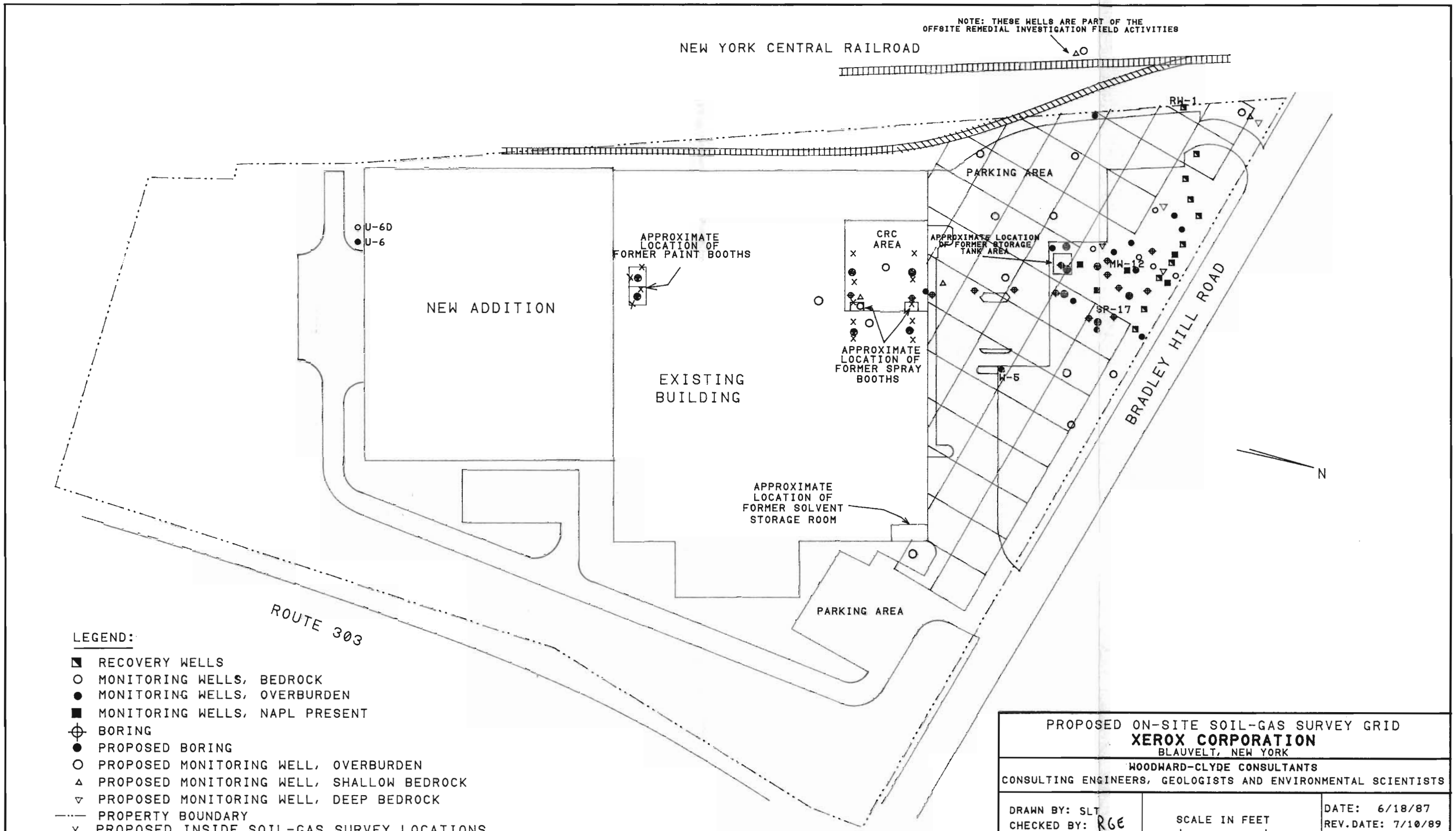
LEGEND:

- ○ PROPOSED MONITORING WELL, OVERBURDEN
- △ PROPOSED MONITORING WELL, SHALLOW BEDROCK
- ·—·— XEROX PROPERTY BOUNDARY
- —·— BRADLEY HILL INDUSTRIAL PARK PROPERTY BOUNDARY

PROPOSED OFF-SITE WELL LOCATIONS
XEROX CORPORATION
BLAUVELT, NEW YORK

WOODWARD-CLYDE CONSULTANTS
CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

DRAWN BY: SLT CHECKED BY: RGE	SCALE IN FEET 0 — 300	DATE: 6/18/87 REV.DATE: 7/10/89
JOB: 87C2662-2		FIGURE 4



PROPOSED ON-SITE SOIL-GAS SURVEY GRID

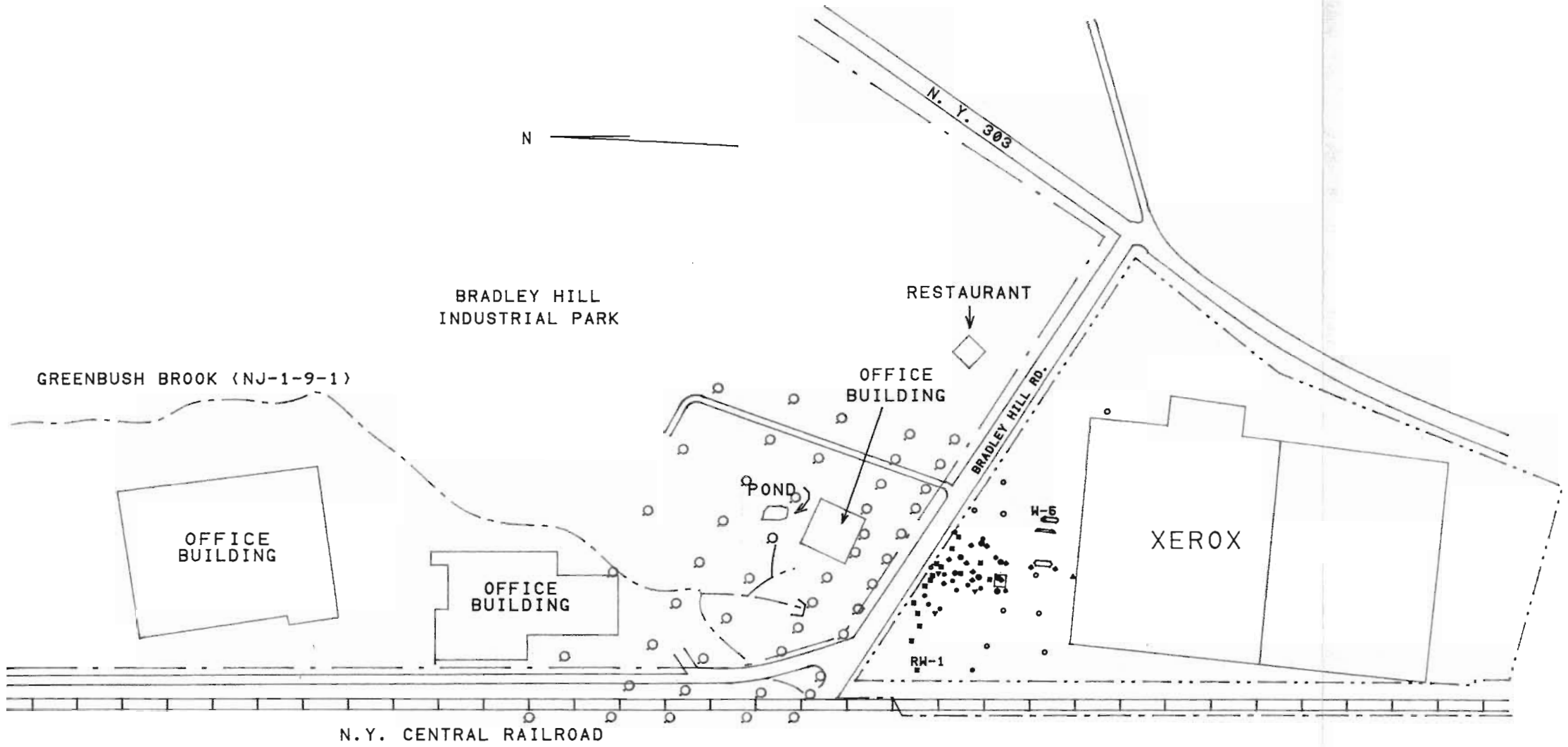
XEROX CORPORATION

BLAUVELT, NEW YORK

WOODWARD-CLYDE CONSULTANTS

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

DRAWN BY: SLT CHECKED BY: RGE	SCALE IN FEET 0 100	DATE: 6/18/87 REV.DATE: 7/10/89
JOB: 88C2221-1		FIGURE 5



LEGEND:

- APPROXIMATE SAMPLING LOCATIONS
- XEROX PROPERTY BOUNDARY
- BRADLEY HILL INDUSTRIAL PARK PROPERTY BOUNDARY

SOIL-GAS SURVEY OFF-SITE AREAS

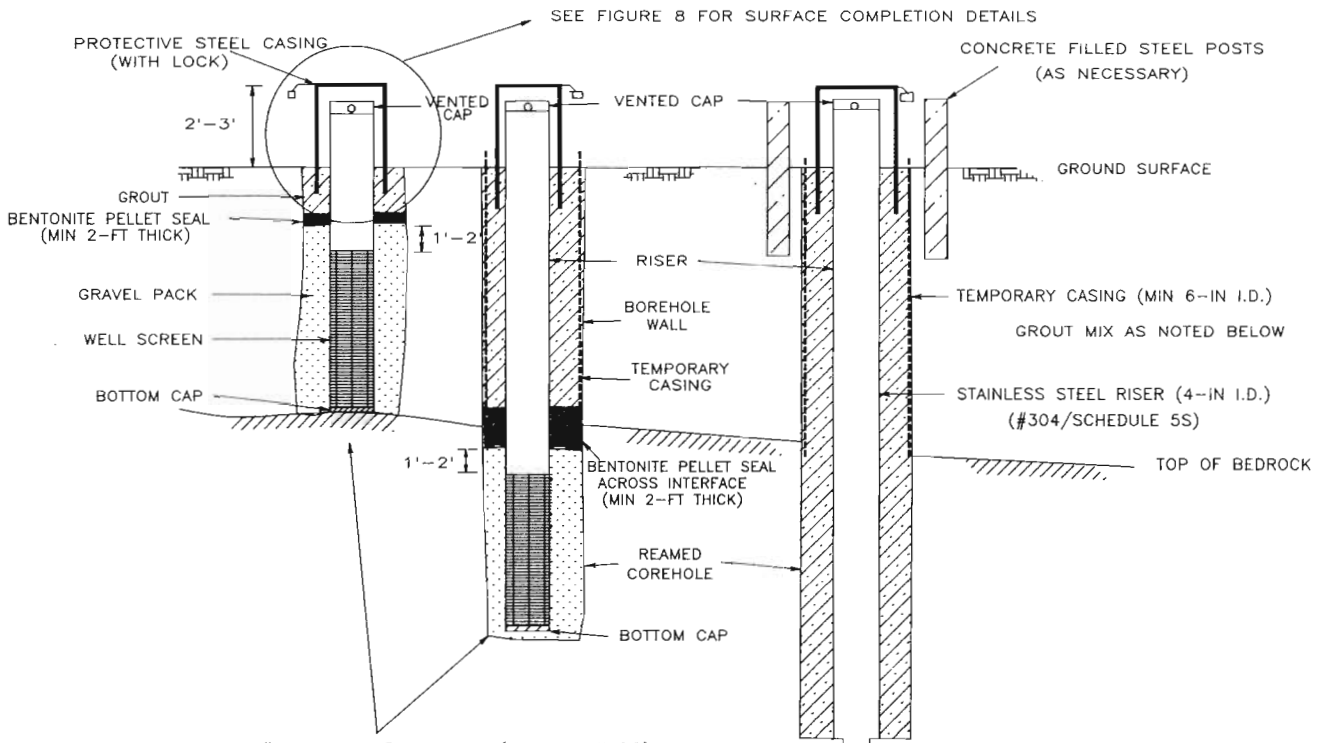
XEROX CORPORATION

BLAUVELT, NEW YORK

WOODWARD-CLYDE CONSULTANTS

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

DRAWN BY: SLT CHECKED BY: RGE	SCALE IN FEET 0 — 300	DATE: 6/18/87 REV.DATE: 7/10/89
JOB: 88C2221-1		FIGURE 6



CASING MATERIALS: #304 STAINLESS STEEL (SCHEDULE 5S)

SCREEN SLOT SIZE: .010" CONTINOUS SLOT

CASING AND SCREEN DIAMETER: 2-INCH I.D.

SAND PACK: JESSIE MORIE NO. 0

SCREEN LENGTH: 10-FEET

GROUT MIX: PORTLAND TYPE I CEMENT
3% BENTONITE
6-7 GAL. WATER PER 100 LBS CEMENT/BENTONITE

WELL CONSTRUCTION SUMMARY
XEROX CORPORATION
BLAUVELT, NEW YORK

WOODWARD-CLYDE CONSULTANTS
CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

DRAWN BY: SLT CHECKED BY: RGE	NOT TO SCALE	DATE: 6/18/87 REV.DATE: 7/24/89
JOB: 88C2221-1		FIGURE 7

SURFACE COMPLETIONS

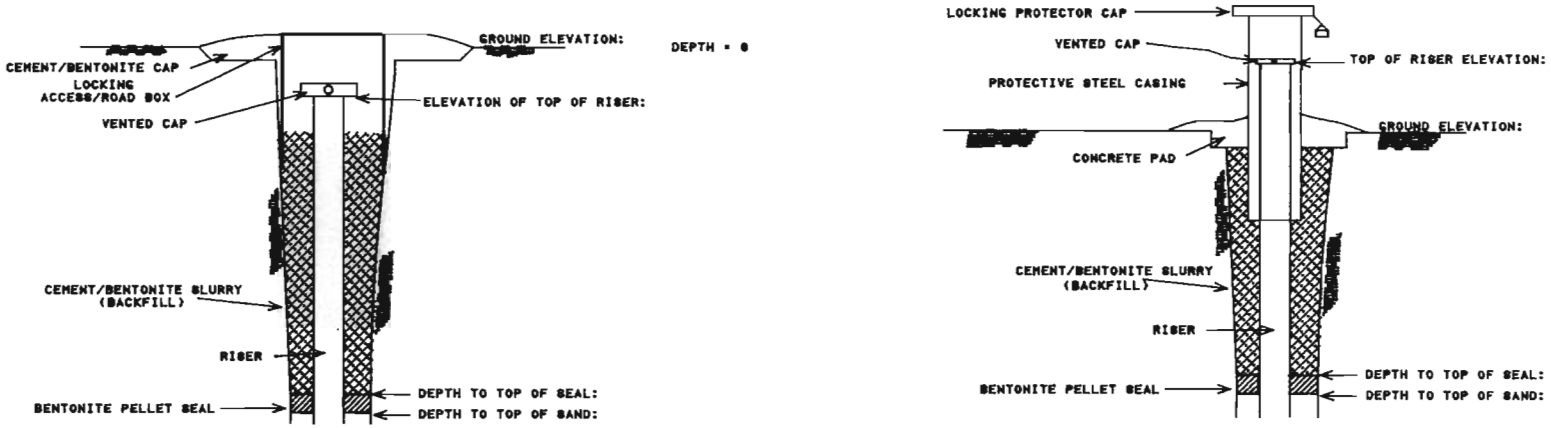
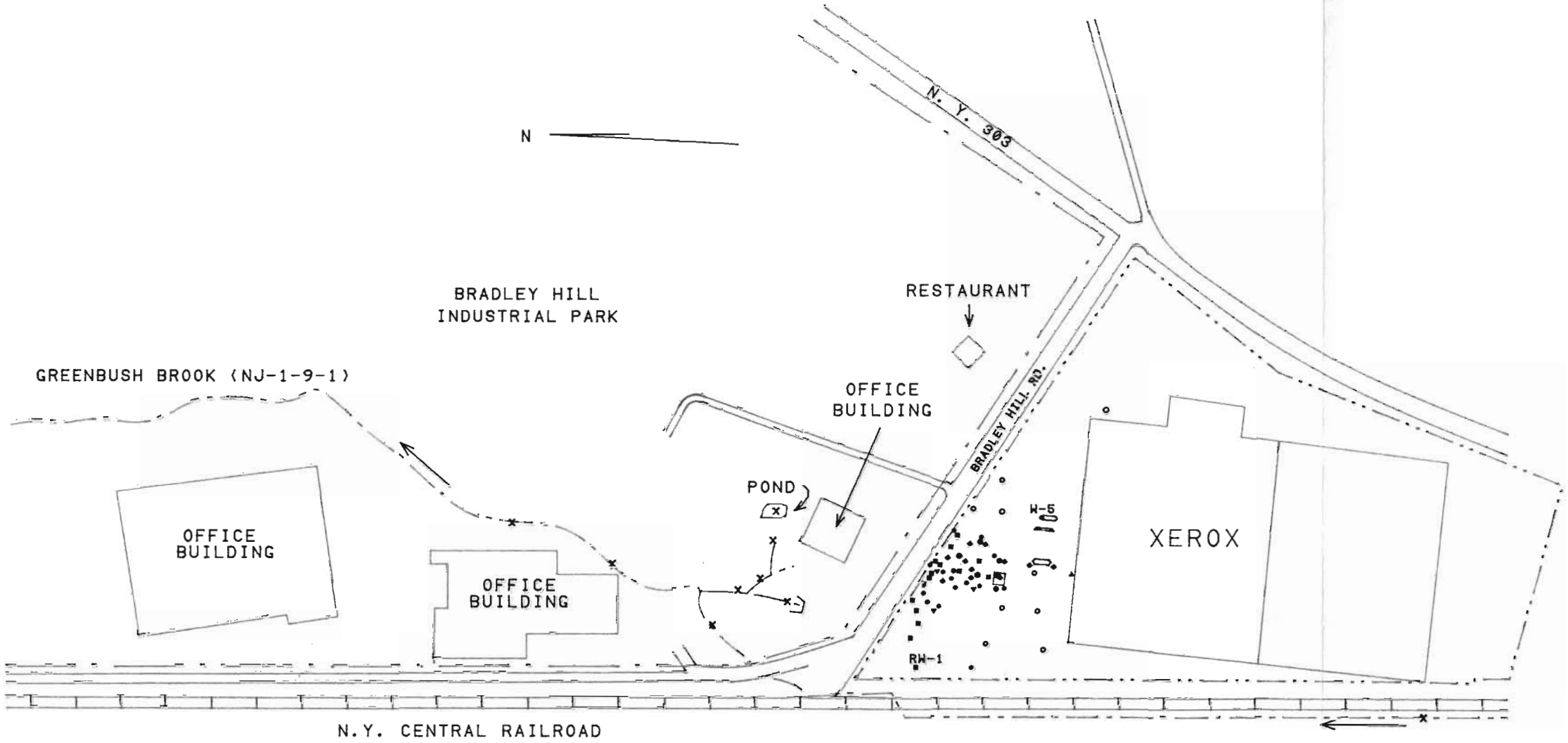


FIGURE 8



LEGEND:

- × PROPOSED OFF-SITE SURFACE WATER/SEDIMENT/BIOTA SAMPLING STATIONS
- ← FLOW DIRECTION
- —··— XEROX PROPERTY BOUNDARY
- —·—·— BRADLEY HILL INDUSTRIAL PARK PROPERTY BOUNDARY

OFF-SITE SURFACE WATER/SEDIMENT/BIOTA SAMPLING STATIONS

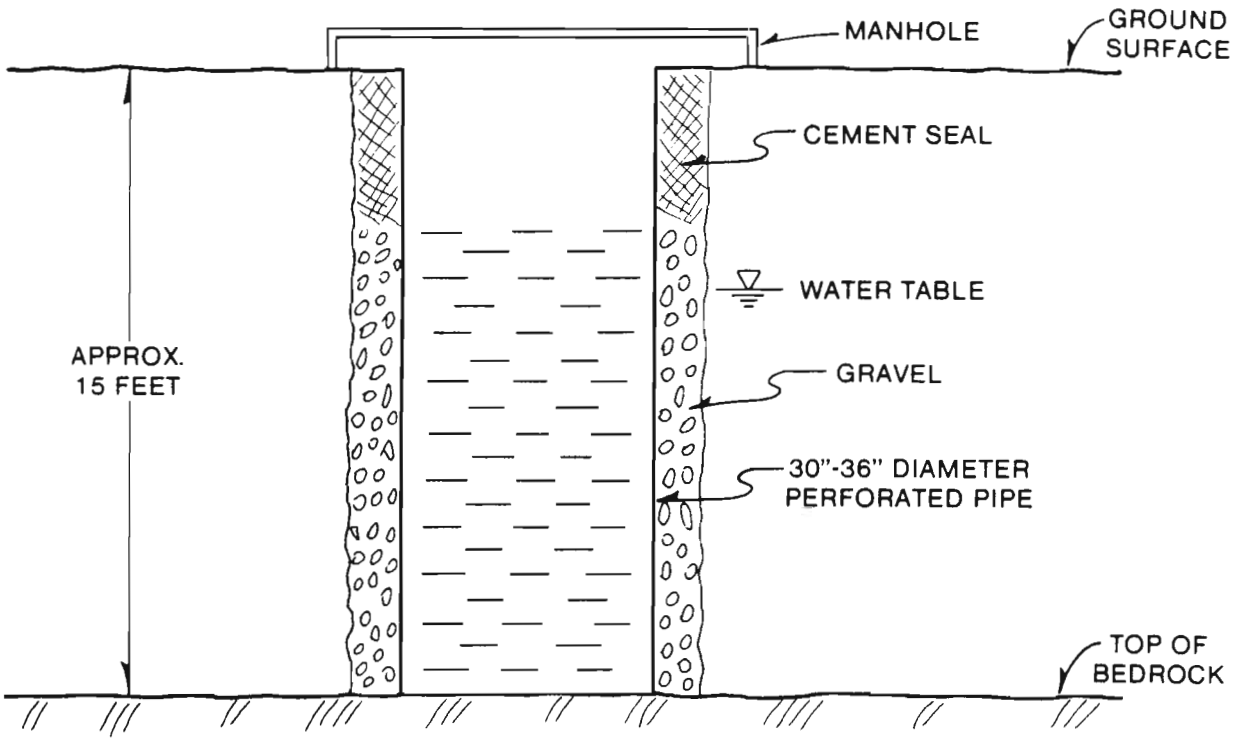
XEROX CORPORATION

BLAUVELT, NEW YORK

WOODWARD-CLYDE CONSULTANTS

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

DRAWN BY: SLT CHECKED BY: RGE	SCALE IN FEET 0 — 300	DATE: 6/18/87 REV. DATE: 7/10/89
JOB: 88C2221-1		FIGURE 9



TYPICAL NAPL RECOVERY WELL CONSTRUCTION
XEROX CORPORATION
BLAUVELT, NEW YORK

FIGURE 10

St. Paul, Minn. 55165

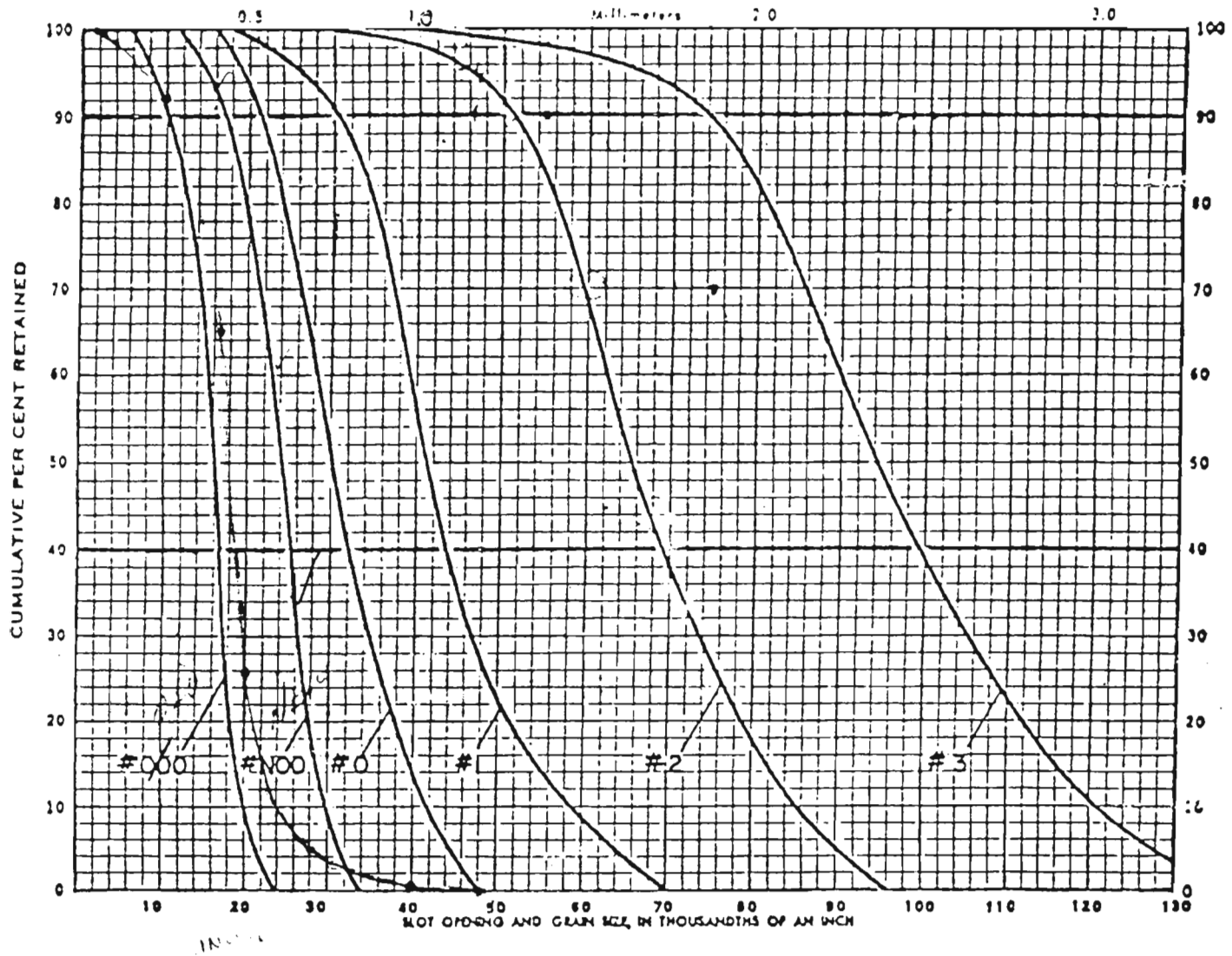
Johnson Division
Universal Oil Products Co.
1950 Old Highway 8
Saint Paul, Minnesota

Sample sent in by Jesse S. Morie & Son, Inc.

Town Maurice Town State N. J. Date 16 Nov. 1971

From Cape May Well gravel

Remarks test # 1 (No 00 GRAVEL PACK)



SIEVE OPENINGS	CUMULATIVE PER CENT RETAINED					
	000	00	0	1	2	3
.132						2
.094					1	50
.066				3	47	95
.047			1	30	95	99
.033		1	36	85	99	
.023	1	81	85	97		
.018	52	93	100			
.012	84	99				
.008	95					
.006	100					

Notes:

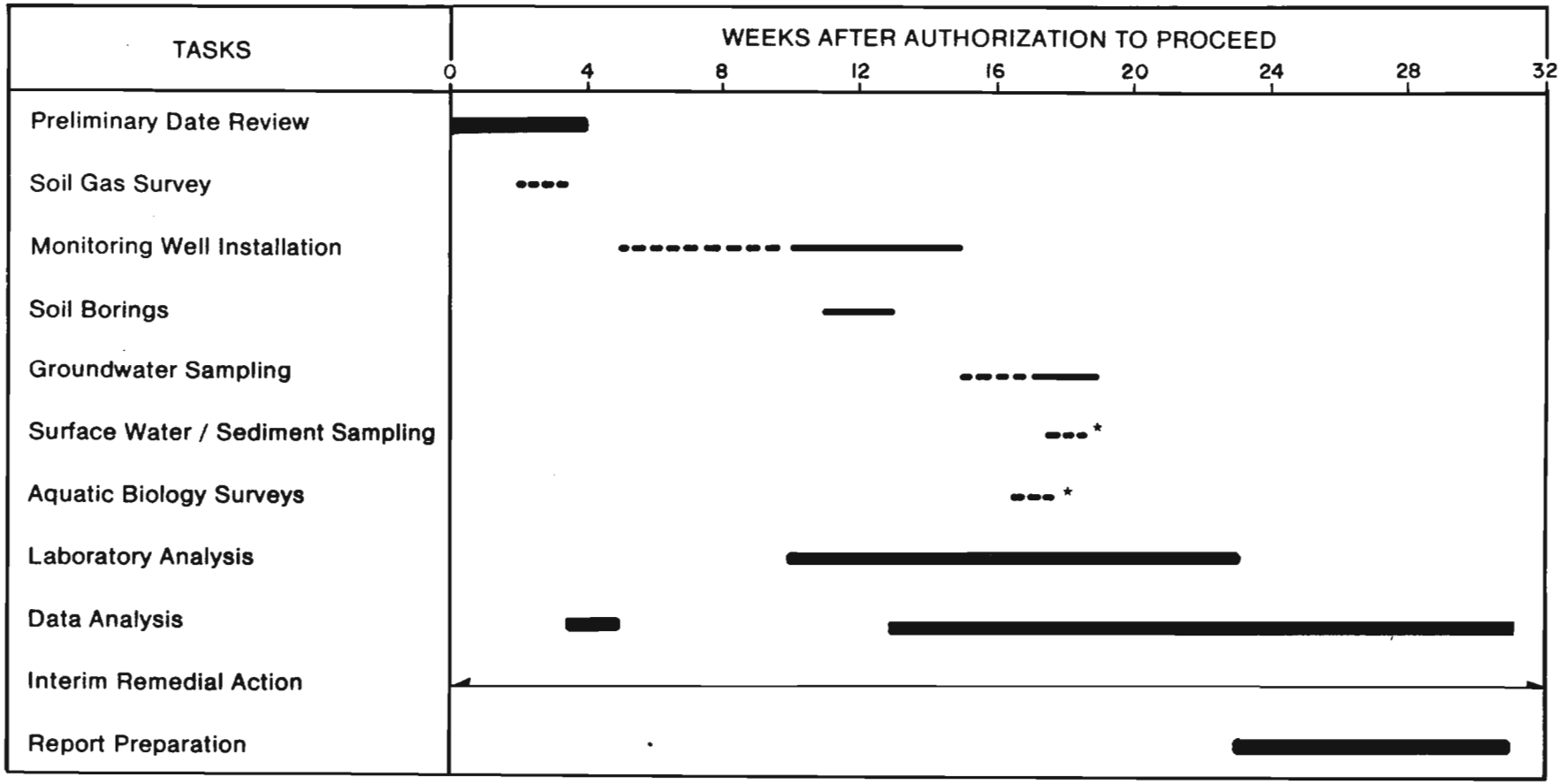
Recommended Slot Opening:

Recommended Screen: Dia. in. Length Ft.

By:

SO MANY CONSIDERATIONS ENTER INTO THE MAKING OF A GOOD WELL THAT, WHILE WE BELIEVE SLOT SIZES FURNISHED OR RECOMMENDED FROM SAND SAMPLES ARE CORRECT WE ASSUME NO RESPONSIBILITY FOR THE SUCCESSFUL OPERATION OF JOHNSON WELL SCREENS

FIGURE 11



PROJECT SCHEDULE
REMEDIAL INVESTIGATION
XEROX CORPORATION
BLAUVELT, NEW YORK

FIGURE 12

GENERAL TESTING CORPORATION/CHAIN-OF-CUSTODY RECORD

710 Exchange Street 85 Trinity Place
Rochester, NY 14608 Hackensack, NJ 07601

GTC Job No. _____
Client Project No. _____
_____

Sample Origination & Shipping Information

Collection Site _____

Address _____
Street City State Zip

Collector _____
Print Signature

Bottles Prepared by _____ Rec'd by _____
Bottles Shipped to Client via _____ Seal/Shipping # _____
Samples Shipped via _____ Seal/Shipping # _____

Sample(s) Relinquished by:	Received by:	Date/Time
1. Sign	1. Sign	/ /
for	for	:
2. Sign	2. Sign	/ /
for	for	:
3. Sign	3. Sign	/ /
for	for	:

Sample(s) Received in Laboratory by _____ / / @ :

	Client I.D.# / Lab#	Sample Location / Date/Time	★	Analyte or Analyte Group(s) Required (see below for additional)	Sample Prep Preserved Y	Preserved N	Filtered Y	Filtered N	Bottle Set(s) (see below)	Rec'd at GTC
1		/ / :								
2		/ / :								
3		/ / :								
4		/ / :								
5		/ / :								

Use Bottle No. for indicating type bottles used in each bottle set and fill in box with # of bottles used for each type.

Bottle No.	1	2	3	4	5	6	7	8	9	10	11
Bottle Type	40 ml Vial	Pint Glass	Qt. Glass	4 oz. Plastic	8 oz. Plastic	16 oz. Plastic	Qt. Pl.	Gal. Pl.	Steril. Pl.		
# of each											

Additional Analytes _____

Shaded area for Lab use only; bottom copy for client; maximum of 5 samples per page.

★ Source Codes: Monitoring Well (W), Soil (S), Treatment Plant (T), Drinking Water (D), Leachate (L), Hazardous Waste (H), River or Stream (R), Pond (P), Industrial Discharge (I), _____(X), _____(Y).

FIGURE 13

Appendix A

APPENDIX A

SUMMARY OF PREVIOUS DATA

APPENDIX A
INTRODUCTION

This Appendix contains a technical data summary for work performed at the Xerox Corporation facility in Blauvelt, New York. Most of the work described in this report was performed by Woodward-Clyde Consultants (WCC); however, some data presented herein were collected by others.

The purpose of this Appendix is to provide a compilation of field and laboratory data for tasks performed during WCC's involvement in this project. Data from previous investigations have been provided in earlier reports generated by other consultants (Recra Research 1981, 1985; Dames and Moore, 1985). This report covers work performed by WCC from approximately August 1986 through January 1987.

Note that it is not the intent of this Appendix to provide interpretations or draw conclusions based on the data. Such analyses will be made in a forthcoming Remedial Investigations report, to be completed at the conclusion of on- and off-site studies. In the meantime, the data described herein is to provide a basis for understanding the technical scope of work presented by WCC for additional on-site investigations, off-site investigations and additional interim action. These scopes of work are presented in the body of this Work Plan.

The data described in this Appendix covers six main tasks, each detailed in a separate subsection. These tasks are:

Appendix A-1)	Recovery Well Installation
Appendix A-2)	Non-Aqueous Phase Liquid (NAPL) Investigation
Appendix A-3)	Investigation of Potential Alternate Sources
Appendix A-4)	NAPL Recovery Testing
Appendix A-5)	Soil Gas Sampling
Appendix A-6)	Groundwater Monitoring Data

For each task, the appropriate subsection presents a description of the task objectives, a summary of field methodologies, and a compilation of field and laboratory data.

APPENDIX A-1

RECOVERY WELL INSTALLATION

APPENDIX A-1
RECOVERY WELL INSTALLATION

Task Description: Ten groundwater recovery wells were installed at the Blauvelt facility during late September and early October 1986. The wells are part of the on-site interim remedial action described in WCC's Conceptual Interim Action plan, dated February 20, 1986.

Task Objective: The recovery wells were installed as part of an interim system to mitigate the environmental impact of organic solvents detected in the subsurface following the excavation of two solvent storage tanks. The primary purpose of the interim system is to control off-site contaminant migration. Locations of the recovery wells are plotted on Figure A-1.1, denoted as the RW-series. When in operation, the wells are designed to be pumped at a nominal rate of 3 to 4 gallons per minute (gpm).

Work Performed: The ten recovery wells were installed using mud rotary techniques. Soil samples were collected from the overburden zone by split spoons; selected samples were submitted for laboratory analysis. The wells are screened with 20 feet of screen, half in the overburden and half in the upper portion of the bedrock. Casing and screening diameter is 4". Casing material is stainless steel. Logs of borings and well construction details follow this discussion. Table A-1.1 is a summary of well construction details.

Upon completion of the well installation, the recovery wells were developed with a surge block and centrifugal pump. Development for each well ranged in duration from 1 to 3.5 hours, with an average of approximately 1.25 hours per well. Development records for these wells follow the well logs. All cuttings, mud and development water from each drilling location were placed in drums for off-site disposal. Groundwater elevation measurement and groundwater sampling from the wells was carried out soon after well installation and development. Groundwater elevation data are given in Table A-1.2. Groundwater samples were collected on November 7, 1986 by Recra Research, Inc., who also performed the laboratory analyses. Sampling results are and summarized in Table A-1.3.

TABLE A-1.1

SUMMARY OF WELL CONSTRUCTION DETAILS
XEROX CORPORATION
BLAUVELT, NEW YORK

Well No.	Installed By	Date Installed	Intent of Well Design and Location	Total Depth of Boring (ft)*	Screened Interval (ft)*	Zone Monitored	Casing Material	Casing Diameter	Ground Elevation (ft, msl)	Top of Protective Casing Elev. (ft, msl)	Comments
W-1	Recra	9/80	monitoring	20	6.4-16.4	overburden	galvanized	2"	109.62	113.60	Bedrock at 18'
W-2	Recra	9/80	monitoring	18	4-14	overburden	galvanized	2"	104.82	106.80	Bedrock at 16.5'
W-3	Recra	9/80	monitoring	24	8.5-18.5	overburden	galvanized	2"	109.39	111.98	Bedrock at 20.7'
W-4	Recra	9/80	monitoring	22	4.5-14.5	overburden	galvanized	2"	109.92	111.81	Bedrock at 22'
W-5	Recra	9/80	monitoring	31	5-15	overburden	galvanized	2"	113.10	115.15	
U-6	Recra	8/84	monitoring	10.5	4.5-9.5	overburden	galvanized	2"	115.88	119.04	
W-7	Recra	8/84	monitoring	17.5	3.5-13.5	overburden	galvanized	2"	107.52	110.99	Bedrock at 15.8', NAPL present
W-8	Recra	8/84	monitoring	15	4.5-14.5	overburden	galvanized	2"	108.03	111.66	Bedrock at 23.6'
U-6D	Recra	8/84	monitoring	27.5	19-23	bedrock	galvanized	2"	115.48	118.43	Bedrock at 14'
W-7D	Recra	8/84	monitoring	29.5	23-28	bedrock	galvanized	2"	107.32	111.14	Bedrock at 18'
W-9D	Recra	8/84	monitoring	27	19-24	bedrock	galvanized	2"	105.62	108.80	Bedrock at 15'
OW-1	Dames & Moore	8/85	pump test obs.	34	22-33	bedrock	galvanized/ stainless	2"	110.24	113.27	Bedrock at 15'
OW-2	Dames & Moore	7/85	pump test obs.	30	19-30	bedrock	galvanized/ stainless	2"	107.16	110.98	Bedrock at 15'
PW-1	Dames & Moore	7/85	pumping	31	19.5-30.5	bedrock	galvanized/ stainless	4"	107.80	110.87	Bedrock at 18.5'
PW-2	Dames & Moore	8/85	pumping	18.4	11.1-16.7	overburden	galvanized/ stainless	4"	107.62	110.90	
RW-1	WCC	9/86	pumping	32	5-25	OB/SBR	stainless	4"	106.54	109.36	Bedrock at 15'
RW-2	WCC	9/86	pumping	36	9.5-29.5	OB/SBR	stainless	4"	105.89	107.94	Bedrock at 19.5'
RW-3	WCC	9/86	pumping	34	9-29O	OB/SBR	stainless	4"	105.54	107.86	Bedrock at 18'
RW-4	WCC	10/86	pumping	33.5	7-27	OB/SBR	stainless	4"	102.84	105.34	Bedrock at 12.5'
RW-5	WCC	10/86	pumping	33	7-27	OB/SBR	stainless	4"	104.56	106.95	Bedrock at 14'
RW-6	WCC	10/86	pumping	33	6.5-26.5	OB/SBR	stainless	4"	106.43	108.81	Bedrock at 16.5'
RW-7	WCC	10/86	pumping	34.5	8-28	OB/SBR	stainless	4"	106.81	109.40	Bedrock at 18'
RW-8	WCC	10/86	pumping	34	8-28	OB/SBR	stainless	4"	107.80	110.15	Bedrock at 18'
RW-9	WCC	10/86	pumping	35	9-29	OB/SBR	stainless	4"	108.01	110.30	Bedrock at 19'
RW-10	WCC	9/86	pumping	38	12-32	OB/SBR	stainless	4"	108.64	110.08	Bedrock at 22'
MW-10	WCC	11/86	monitoring	15	3.5-13.5	overburden	stainless	2"	106.43	109.43	Bedrock at 15', NAPL present
MW-11	WCC	11/86	monitoring	14	4-14	overburden	stainless	2"	110.13	112.64	Bedrock at 14', NAPL present
MW-12	WCC	11/86	monitoring	18	3.5-13.5	overburden	stainless	2"	108.69	111.72	Bedrock at 18', NAPL present
MW-13	WCC	11/86	monitoring	16	4-14	overburden	stainless	2"	111.58	114.28	Bedrock at 16', NAPL present
MW-14	WCC	12/86	monitoring	21.5	2.25-12.25	overburden	stainless	2"			Bedrock at 21.5'
MW-15	WCC	12/86	monitoring	14	2.8-12.8	overburden	stainless	2"			
MW-16	WCC	12/86	monitoring	23.5	7-17	overburden	stainless	2"			Bedrock at 23.5'
MW-17	WCC	12/86	monitoring	22	10-20	overburden	stainless	2"			Bedrock at 22'

* Below ground surface
OB = Overburden
SBR = Shallow Bedrock

TABLE A-1.2

SUMMARY OF GROUNDWATER ELEVATIONS
XEROX CORPORATION
BLAUVELT, NEW YORK

Well Number	9/80	10/80	8/25/84	9/19/84	11/28/84	6/17/85	7/23/85	7/24/85	7/31/85
W-1	101.85	101.64	103.29	102.52	101.44	102.24	101.32	101.67	101.84
W-2	101.42	101.17	102.05	101.50	100.72	101.51	101.71	100.70	101.11
W-3	104.74	104.53	102.78	102.45	102.13	102.58	101.81	101.73	102.33
W-4	102.60	101.93	103.74	103.02	101.77	103.78	101.71	101.59	102.27
W-5	104.38	103.34	105.34	104.37	102.83	104.12	102.98	102.90	103.63
U-6	--	--	111.86	111.60	110.83	111.62	110.88	110.84	111.52
W-7	--	--	102.42	101.70	98.48	--	--	--	--
W-8	--	--	103.19	102.41	101.30	105.18	101.25	101.21	101.82
U-6D	--	--	111.96	111.54	111.18	111.89	111.33	111.26	112.05
W-7D	--	--	102.38	101.78	100.97	101.51	100.84	100.74	101.18
W-9D	--	--	101.99	101.46	100.62	101.36	100.53	100.53	101.04
OW-1	--	--	--	--	--	--	--	--	--
OW-2	--	--	--	--	--	--	--	--	--
PW-1	--	--	--	--	--	--	--	--	--
PW-2	--	--	--	--	--	--	--	--	--
RW-1	--	--	--	--	--	--	--	--	--
RW-2	--	--	--	--	--	--	--	--	--
RW-3	--	--	--	--	--	--	--	--	--
RW-4	--	--	--	--	--	--	--	--	--
RW-5	--	--	--	--	--	--	--	--	--
RW-6	--	--	--	--	--	--	--	--	--
RW-7	--	--	--	--	--	--	--	--	--
RW-8	--	--	--	--	--	--	--	--	--
RW-9	--	--	--	--	--	--	--	--	--
RW-10	--	--	--	--	--	--	--	--	--
MW-10	--	--	--	--	--	--	--	--	--
MW-11	--	--	--	--	--	--	--	--	--
MW-12	--	--	--	--	--	--	--	--	--
MW-13	--	--	--	--	--	--	--	--	--
MW-14	--	--	--	--	--	--	--	--	--
MW-15	--	--	--	--	--	--	--	--	--
MW-16	--	--	--	--	--	--	--	--	--
MW-17	--	--	--	--	--	--	--	--	--

TABLE A-1.2
(Continued)

Well Number	8/3/85	8/8/85	8/12/85	8/14/85	12/16/85	10/16/86	11/3/86	11/12/86	1/8/87
W-1	101.89	101.77	101.68	101.66	102.7	--	101.65	101.59	102.70
W-2	101.22	100.92	100.95	100.96	101.84	--	100.90	101.00	101.90
W-3	102.32	102.33	102.18	102.08	105.19	--	--	105.25	--
W-4	102.31	102.39	102.20	102.06	013.55	--	101.91	101.93	103.81
W-5	103.47	103.48	103.30	103.15	104.38	--	103.00	--	105.15
U-6	111.49	111.71	--	111.24	112.31	--	110.89	--	111.84
W-7	--	--	--	--	100.80	--	101.19	101.22	102.09
W-8	101.82	102.49	101.61	--	102.86	--	--	101.60	102.96
U-6D	112.00	111.97	--	111.43	111.70	--	111.48	--	113.53
W-7D	101.30	101.47	101.29	101.23	101.99	--	100.99	100.93	102.14
W-9D	101.15	100.88	101.05	100.83	101.74	--	100.85	100.92	101.70
OW-1	--	102.60	101.69	101.68	102.77	--	101.75	101.67	103.27
OW-2	--	103.94	101.53	101.55	102.51	--	101.36	101.28	102.48
PW-1	--	101.70	101.60	101.58	102.54		101.35	101.32	102.57
PW-2	--	101.40	101.30	101.41	101.36	--	101.38	101.28	102.50
RW-1	--	--	--	--	--	101.21	101.11	--	--
RW-2	--	--	--	--	--	100.69	100.59	100.72	--
RW-3	--	--	--	--	--	100.91	100.76	100.78	--
RW-4	--	--	--	--	--	100.94	100.79	100.93	--
RW-5	--	--	--	--	--	100.95	100.80	100.76	--
RW-6	--	--	--	--	--	100.86	100.71	100.72	--
RW-7	--	--	--	--	--	100.95	100.80	100.78	--
RW-8	--	--	--	--	--	101.45	101.25	101.25	--
RW-9	--	--	--	--	--	101.90	101.50	101.42	--
RW-10	--	--	--	--	--	100.85	100.63	100.52	--
MW-10	--	--	--	--	--	--	--	100.92	--
MW-11	--	--	--	--	--	--	--	101.85	--
MW-12	--	--	--	--	--	--	--	101.73	--
MW-13	--	--	--	--	--	--	--	101.89	--
MW-14	--	--	--	--	--	--	--	--	--
MW-15	--	--	--	--	--	--	--	--	--
MW-16	--	--	--	--	--	--	--	--	--
MW-17	--	--	--	--	--	--	--	--	--

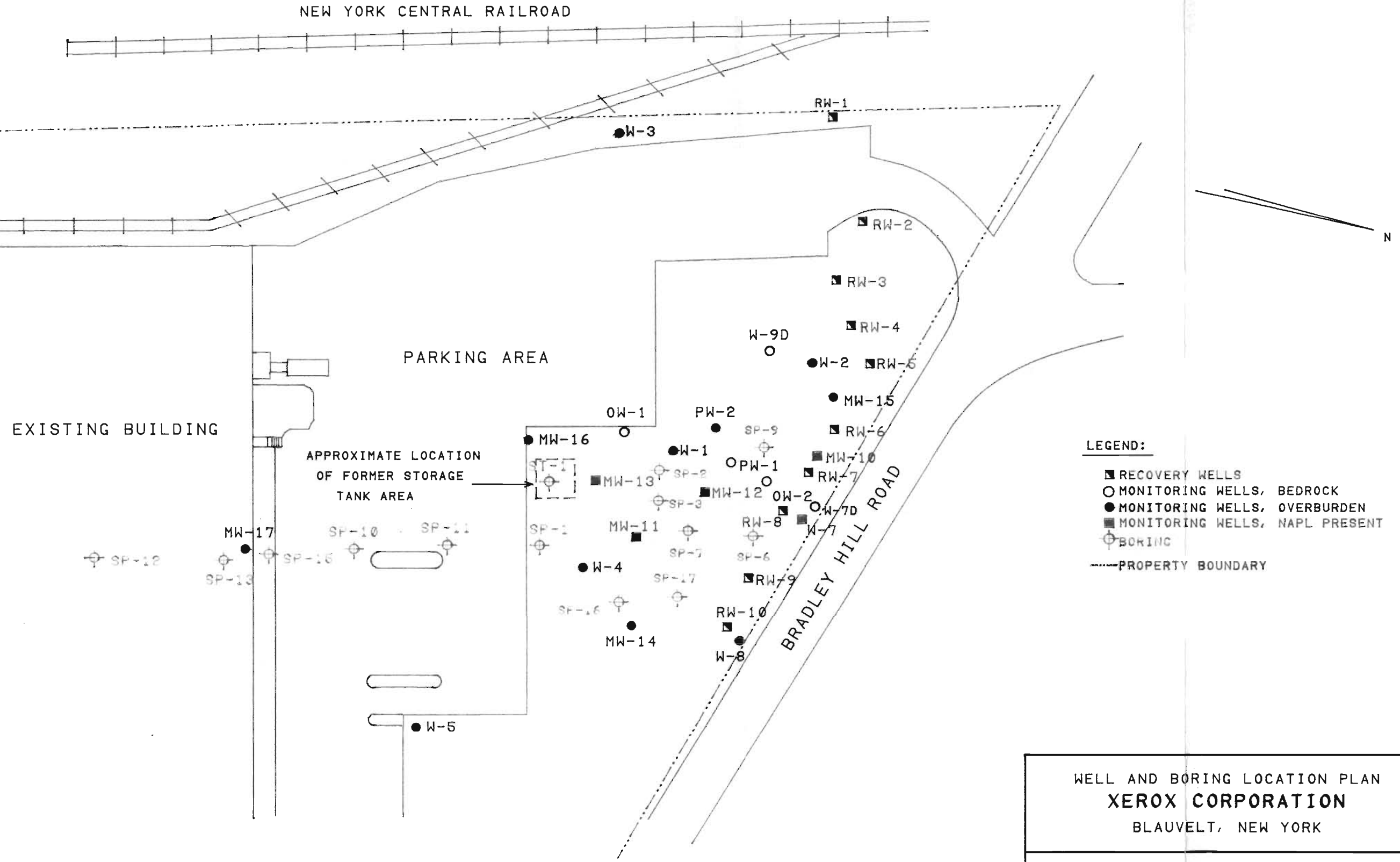
Observations/Discussion: Depth to bedrock ranges from 12.5 feet below the surface in RW-4 to 22 feet in RW-10. Significant variability in pumping rates from individual recovery wells are expected based on the development records. The intermittent well yields ranged from approximately 1 to 5 gpm during development, apparently due to localized permeability changes in subsurface materials. Well yields during development are summarized below. Well yields may be increased slightly with a more vigorous development program. As mentioned previously, the recovery wells and are screened to intercept the overburden and the shallow bedrock; hence, analytical results and water levels reflect a contribution from both zones. Total organic (TVO) concentrations range from 301.7 ppb in RW-1 to 59,422.1 ppb in RW-6.

Recovery Well No.	Estimated Well Yield During Development (gpm)
1	1.7
2	0.8
3	3
4	--
5	4 - 5
6	3 - 4
7	5
8	1
9	5
10	2 - 3

TABLE A-1.3

SUMMARY OF VOLATILE ORGANICS CONCENTRATIONS (ppb)
RECOVERY WELLS

Well Number	11/7/86
RW-1	301.7
RW-2	4,336
RW-3	3,295.9
RW-4	15,295
RW-5	1,530.5
RW-6	47,422.1
RW-7	34,419.4
RW-8	28,670.9
RW-9	7,645.2
RW-10	1,646



WELL AND BORING LOCATION PLAN

XEROX CORPORATION

BLAUVELT, NEW YORK

WOODWARD-CLYDE CONSULTANTS

CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

DRAWN BY: SLT CHECKED BY: RGE	SCALE IN FEET 0 — 50	DATE: 2/26/87 REV. DATE: 7/10/89
JOB: 85C2667-7		FIGURE A-1.1

APPENDIX

WELL DEVELOPMENT INFORMATION

WELL DEVELOPMENT NOTES

All depths, including drawdown levels, are in feet below the top of the outer steel casing.

WELL R-1

10/8/86	9:30	static level 8.2 ft
	2:00	static level 8.1 ft
	2:10	pump for 15 min, then pump break down
10/9/86		pump 10 min, drawdown about 25 ft
		allow recovery to 8.2 ft
		pump 10 min, drawdown to 30 ft
		allow recovery and take recovery levels (see below)
		surge 10 min
	1:30	pump 11 min, water looks pretty muddy
		allow recovery
		surge 10 min
	3:02	pump at 1 to 3 gpm, water still pretty muddy
	3:15	water level at 29 ft, stop pump
		allow recovery
	4:10	pump 10 min
10/15/86	4:02	start pump
	4:06	water level 13.5
	4:11	Q ~ 1.7 gpm, looks very slightly cloudy
	4:14	water level 20 to 21 ft
	4:21	water level 22.5 ft, stop pump
	4:22:50	water level 21.0
	4:22:50	water level 16.5

Recovery Levels, Well R-1, 10/9/86

Elapsed Time After Stopped Pumping (min)	Depth to Water
30 sec	28.2
50 sec	27.6
1:15	27.0
2:15	25.8
3:30	24.2
4:30	23.2
5:45	21.9
7:15	20.5
9:00	19.0
10:00	18.2
12:00	16.9
13:30	15.9
15:00	15.0
16:30	14.25
18:00	13.5
19:30	12.9
21:00	12.3
22:30	11.8
24:00	11.45
25:30	11.2
27:00	10.95
28.30	10.7
30:00	10.45

WELL R-2

10/8/86	4:05	start pump	
	4:12	stop pump, take recovery readings	
		0:30	15.6
		1:00	15.7
		2 min	15.1
		3 min	14.6
		6 min	13.8
		10.5 min	13.0
	4:30	surge 10 min	
10/9/86	9:30	static level 7.2	
		surge 3 min	
	9:34	start pump	
	9:38	water level 17 ft	
	9:41	water level 18.6 ft	
	9:46	water level 16 ft, stop pump (already had stopped pumping), take recovery readings	
		0:30	15.1
		2 min	14.7
		4 min	14.3
		7 min	13.7
		10 min	13.2
		15 min	12.4
	10:45	surge 10 min	
	11:43	start pump	
	11:56	stop pump	
	1:42	start pump	
	1:55	stop pump	
	3:25	start pump - water looks pretty muddy still	
	3:50	stop pump	

10/15/86	3:17	start pump
	3:18	water level 13 ft
	3:19	water level 13.9 ft
	3:27	water level 15.9 ft, increase Q
	3:33	Q ~ 0.8 gpm
	3:35	water level 20.3 ft, looks very slightly cloudy to clear
	3:44	water level 23.2 ft
	3:50	stop pump

WELL R-3

10/9/86		static level 6.9 ft
	12:05	start pump
	12:15	stop pump (out of gas) - water looked much clearer than R-1 or R-2, must have blown out water with air for longer time/higher yield
	1:00	pump
	1:10	stop pump
	1:45	surge 10 min
	1:58	water level 6.2 ft, start pump
	2:06	water level 22.8 ft
	2:17	water level 23.3 ft
	2:33	water level 23 ft
	2:37	Q ~ 3 gpm
	2:40	stop pump, measure recovery (see below)
	2:55	surge 10 min

Recovery Levels, Well R-3, 10/9/86

Elapsed Time After Stopped Pumping (min.)	Depth to Water
0:30	20.5
1:00	18.9
1:25	17.3
1:45	16.1
2:14	14.6
2:40	14.1
3:05	13.5
3:18	13.0
4:00	12.0
4:33	11.3
5:00	10.8
5:30	9.8
6:15	8.8
6:30	8.5
6:50	8.2
7:25	7.8
7:55	7.5
8:45	7.2
10:35	7.0

WELL R-4

10/14/86

pump for 30 to 40 min

drawdown 19 ft

measure recovery levels (min:sec)

0:10	18.2	4:20	10.7
0:30	17.3	5:00	9.9
1:00	16.1	6:00	8.8
1:45	14.4	6:30	8.4
2:00	14.0	7:00	7.9
2:20	13.2	7:30	7.6
2:45	12.7	8:00	7.3
3:30	11.7	9:00	6.7

surge 10 min

pump 30 min - water looks clear

WELL R-5

10/15/86	9:58	start pump
		Q ~ 3 to 4 gpm, looks cloudy
	10:33	water level 11.5, stop pump
		surge 10 min
	11:29	start pump
	11:34	water level 11.8, Q ~ 4 to 5 gpm
	11:45	stop pump (out of gas)
	11:55	start pump
	12:15	stop pump - water looks clear

pump ~ 45 min at Q ~ 5 gpm
water looks slightly cloudy
recovery levels:

1 min	12.1
1:30	11.1
2:15	10.3
3:00	9.6
4:15	8.8
6:45	8.3

10:10 surge 15 min

10:39 start pump

Q ~ 3 to 4 gpm, water still slightly cloudy

surge 10 min

11:36 start pump

Q ~ 3 to 4 gpm, water level 11 to 11.5

water still slightly cloudy, smells of product, slightly foamy

12.03 stop pump

WELL R-7

10/10/86		static level 8.5
	2:24	start pump
		Q ~ 5 gpm, looks pretty clear
	2:35	water level 10.4
	2:42	water level 10.2, pump had stopped discharging
		allow recovery
	3:01	start pump
	3:17	water level 10.4
	3:24	water pretty clear to very clear
	3:48	stop pump
10/13/86		static level 8.5
		surge 10 min

WELL R-8

10/10/86		static level 8.8
	2:12	start pump
	2:15	water level ~ 25
approx.	2:18	stop pump, take recovery levels (see below)
10/13/86		static level 8.7
	1:23	start pump
	1:29	water level 17.3, Q <1gpm, looks pretty muddy
approx.	2:00	pump out of gas, water level ~ 23
	3:00	water level 13.5
	3:45	bail well for 30 min (~ 20 gal) into barrel
10/14/86		continue to bail about 35 gal
		becoming less muddy, looks cloudy now
		surge 10 min
		bail out 10 more gal
	2:16	static level 8.7
		surge 10 min
	2:41	start pump
		Q ~ 1 to 2 gpm, still muddy
	2:47	pump stopped
	2:58	start pump
		Q ~ 1 to 1.5 gpm
	3:15	water level 16.2, becoming less muddy, beginning to look cloudy
	3:20	water level 16.6
	3:21	water level 15.7, Q ~ 0.8 gpm, cloudy
	3:36	increase Q, looks cloudy
	3:55	water level 29

10/14/86	3:58	stop pump, measure recovery:
	4:06	17
	4:09	14.7
	4:13	12.9
	4:16	start pump
		water very cloudy to slightly muddy
	4:37	water looks cloudy
	4:45	stop pump
10/15/86	1:51	start pump
		Q ~ 1 gpm, looks muddy
	2:06	water level 12.2
	2:07	increase Q
	2:10	water level 19
		Q ~ 1.7 gpm, looks cloudy
	2:17	water level 24
	2:24	water level 25
	2:32	Q ~ 1.0 gpm, water level 25, looks cloudy to very cloudy
	2:41	water level 25.4
	2:59	water level 25.4
		Q ~ 0.8 gpm, water looks clear to very slightly cloudy
	3:05	stop pump

Recovery levels, Well R-8, 10/10/86

Approx. Elapsed Time After Stopped Pumping (min:sec)	Depth To Water (ft)
0.50	26.4
2:00	26.2
15	22.6
19	21.2
21	20.6
25	19.6
27	19.1
33	17.8
37	17.0
45	15.6
56	14.1
66	12.8
92	10.9

WELL R-9

10/10/86		static level 9.5
	11:06	start pump
	11:10	water level 10.8
	11:16	water looks clear
	11:19	water level 11.8
	11:29	water level 10.5
	11:36	water level 10.5, Q ~ 5 gpm
	11:37	stop pump
		surge 10 min
	11:48	start pump
	12:18	stop pump
10/13/86		static level 8.45
		surge 10 min

WELL R-10

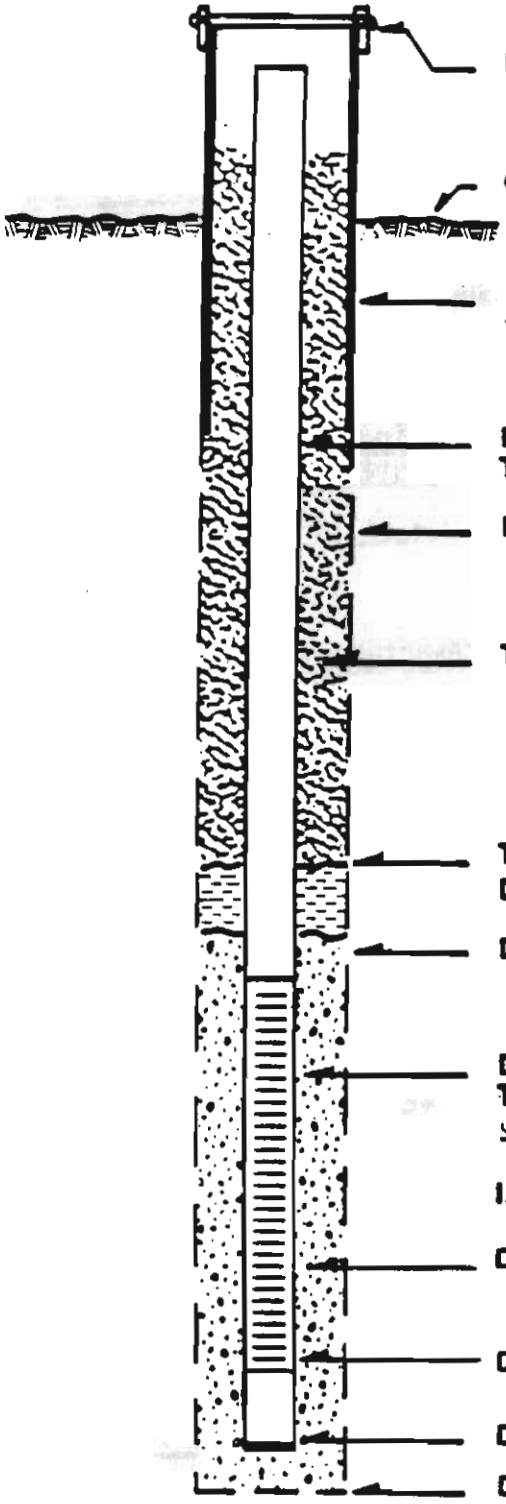
10/10/86		static level 9.3
		pump 12 min, looks pretty muddy, water level 28.4
		take recovery readings (see below)
	10:32	start pump
	10:44	stop pump
		surge 10 min
	1:32	start pump
	1:36	water level 17.5
	1:46	water level 20.3
	1:50	stop pump
10/13/86		static level 9.25
		surge 10 min
	10:17	start pump
	10:24	water level 23 ft, Q ~ 2 to 3 gpm
	10:45	stop pump, water pretty muddy, recovery levels:
		10:58 13.5
		11:02 11.1
		11:09 9.7
	11:10	start pump
	11:43	stop pump - water clearing up, looks cloudy
	12:48	start pump
	1:15	stop pump - water slightly cloudy
10/15/86		surge 10 min
	12:35	start pump
	12:39	water level 25 ft, so decrease Q, water looks moderately cloudy, Q ~ 2 to 3 gpm
	12:46	water level 25.5, decrease Q
	12:48	water level 24.5, Q ~ 1 to 1.3 gpm, cloudy

10/15/86	12:56	water level 20
	1:05	water level 20, Q ~ 1.5 gpm, slightly cloudy
	1:20	water level 20.5, Q ~ 1.25 gpm
	1:21	increase Q, very slightly cloudy to clear
	1:22	water level 23.5
	1:23	water level 25.5
	1:26	water level 27
	1:27	stop pumping, take recovery levels:

1:28:00	25.0
1:28:22	24.0
1:28:53	23.0
1:29:22	22.0
1:30:35	20.0
1:31:25	18.7
1:31:58	18.0
1:32:47	17.0
1:33:52	16.0
1:35:26	14.0
1:37:50	11.5

Recovery levels, Well R-10, 10/10/86

Elapsed Time After Stop Pumping (min:sec)	Depth to Water
0:35	27.0
2:20	25.2
3:15	24.1
4:00	23.3
4:50	22.4
5:45	21.7
6:30	21.2
8:35	19.9
9:45	19.2
11:40	18.1
13:20	17.3
15:05	16.4
16:50	15.7
17:50	15.2
18:55	14.7
21:10	13.6
22:15	13.2
23:55	12.6
25:30	12.1
26:45	11.7
28:50	11.1



Elevation of top of riser pipe 109.36

Ground Elevation 106.54'

I.D. of surface casing 6 in
Type of surface casing steel

I.D. of riser pipe 4 in
Type of riser pipe stainless steel

Diameter of borehole 8 in

Type of backfill cement-bentonite grout

Type of seal bentonite pellets
Depth to top of seal 1.5'

Depth to top of sand pack 4'

Depth to top of screen 5'
Type of screened section
Johnson stainless steel No. 20 Slot

I.D. of screened section 4 in

Depth to top of bedrock 15'

Depth to bottom of screen 25'

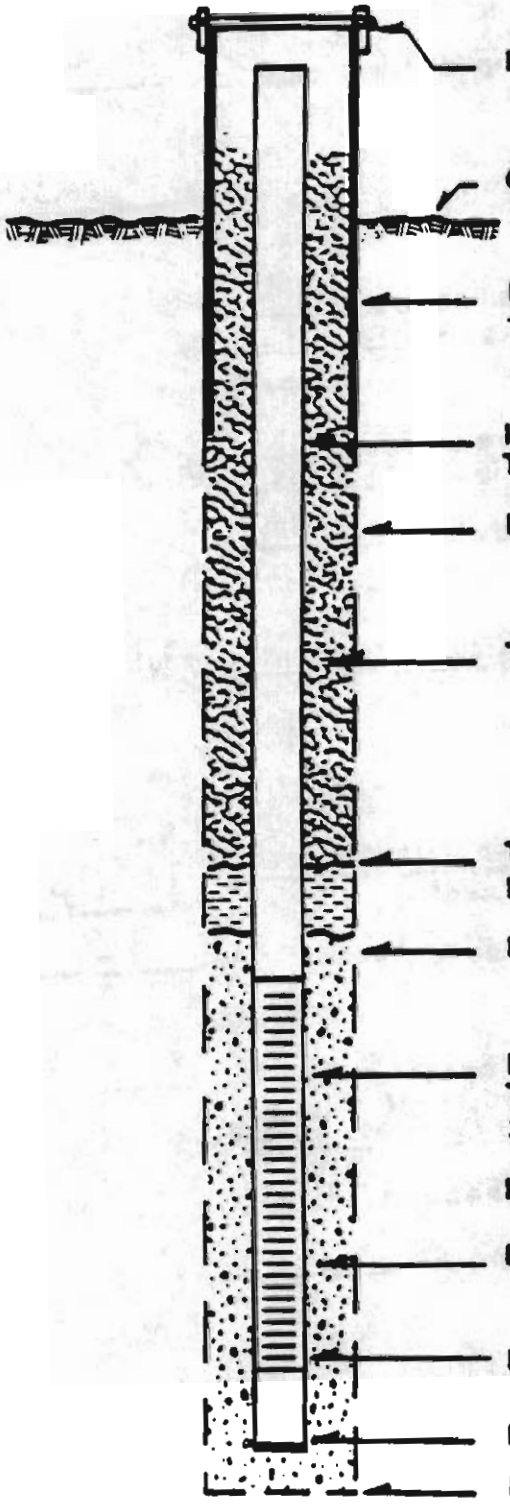
Depth to bottom of sump 30'

Depth of borehole 32'

Report of Recovery Well RW-1

DRAWN BY:	CHECKED BY: GWC	PROJECT NO.: 85C2667-3	DATE: 9/24/86	FIGURE NO.

Woodward-Clyde Consultants



Elevation of top of riser pipe 107.94'

Ground Elevation 105.89'

I.D. of surface casing 6 in
Type of surface casing steel

I.D. of riser pipe 4 in
Type of riser pipe stainless steel

Diameter of borehole 8 in

Type of backfill cement-bentonite grout

Type of seal bentonite pellets
Depth to top of seal 6.0'

Depth to top of sand pack 8.2'

Depth to top of screen 9.5'
Type of screened section
Johnson stainless steel No. 20 Slot

I.D. of screened section 4 in

Depth to top of bedrock 19.5'

Depth to bottom of screen 29.5'

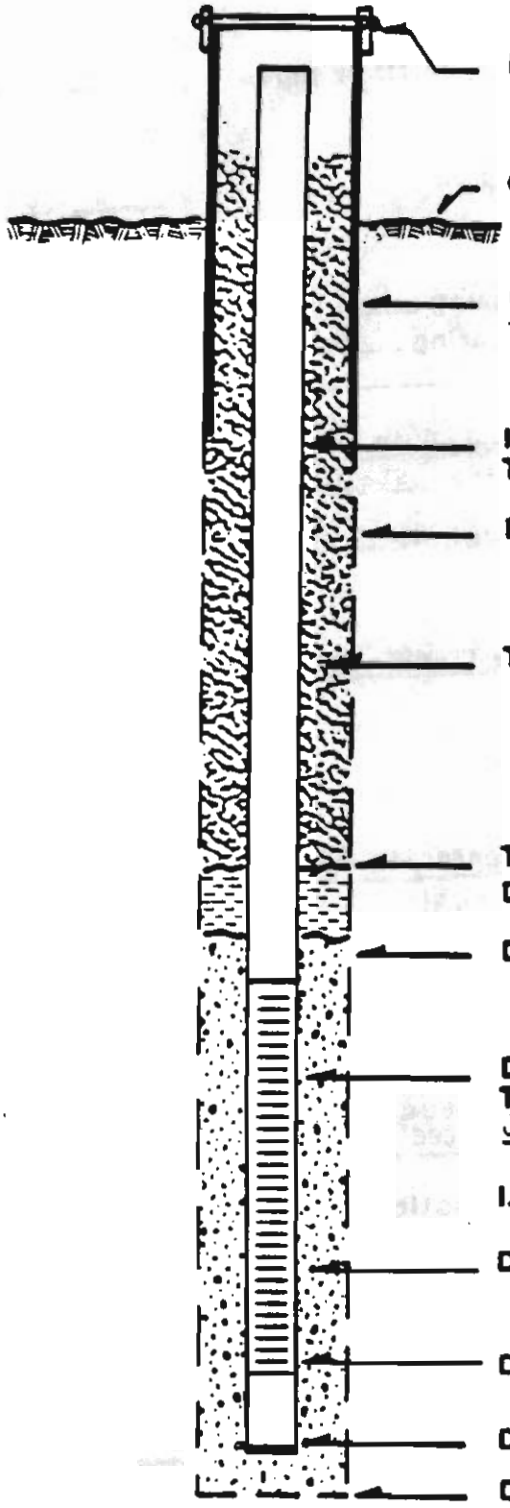
Depth to bottom of sump 34.5'

Depth of borehole 36'

Report of Recovery Well RW-2

DRAWN BY:	CHECKED BY: GWC	PROJECT NO.: 85C2667-3	DATE: 9/26/86	FIGURE NO:

Woodward-Clyde Consultants



Elevation of top of riser pipe 107.86'

Ground Elevation 105.54'

I.D. of surface casing 6 in
Type of surface casing steel

I.D. of riser pipe 4 in
Type of riser pipe stainless steel

Diameter of borehole 8 in

Type of backfill cement-bentonite grout

Type of seal bentonite pellets
Depth to top of seal 5'

Depth to top of sand pack 7.5'

Depth to top of screen 9'
Type of screened section
Johnson stainless steel No. 20 Slot

I.D. of screened section 4 in

Depth to top of bedrock 18'

Depth to bottom of screen 29'

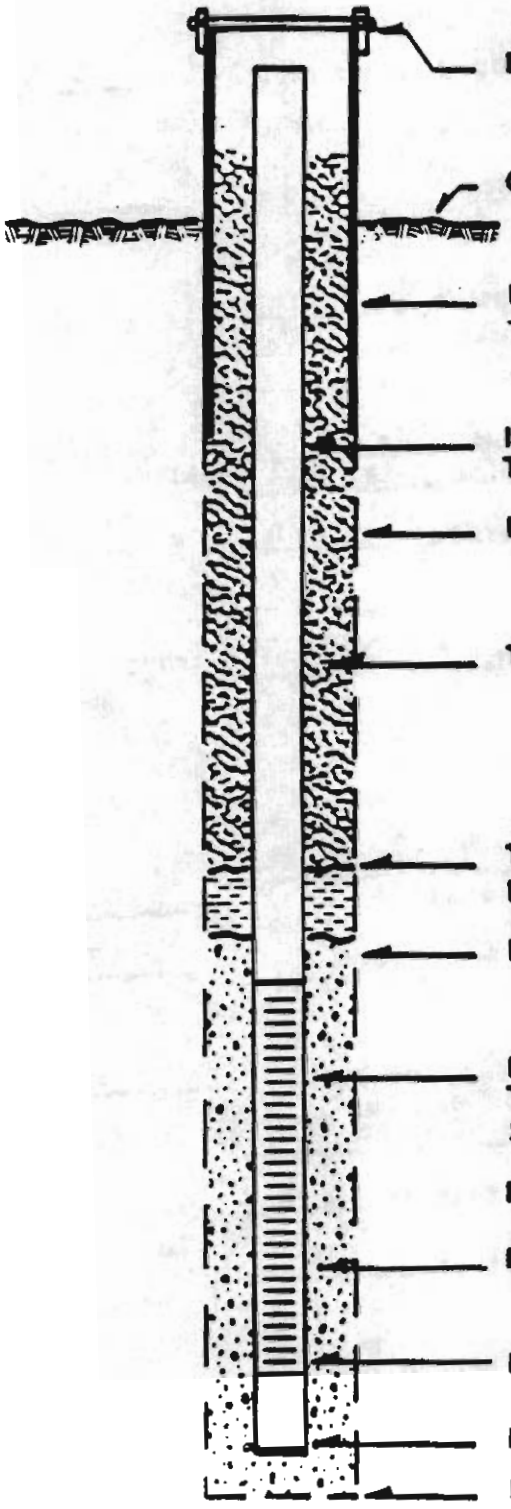
Depth to bottom of sump 34'

Depth of borehole 34'

Report of Recovery Well RW-3

DRAWN BY:	CHECKED BY: GWC	PROJECT NO.: 85C2667-3	DATE: 9/26/86	FIGURE NO:

Woodward-Clyde Consultants



Elevation of top of riser pipe 105.34'

Ground Elevation 102.84

I.D. of surface casing 6 in
Type of surface casing steel

I.D. of riser pipe 4 in
Type of riser pipe stainless steel

Diameter of borehole 8 in

Type of backfill cement-bentonite grout

Type of seal bentonite pellets
Depth to top of seal 3.5'

Depth to top of sand pack 5.5'

Depth to top of screen 7'
Type of screened section
Johnson stainless steel No. 20 Slot

I.D. of screened section 4 in

Depth to top of bedrock 12.5'

Depth to bottom of screen 27'

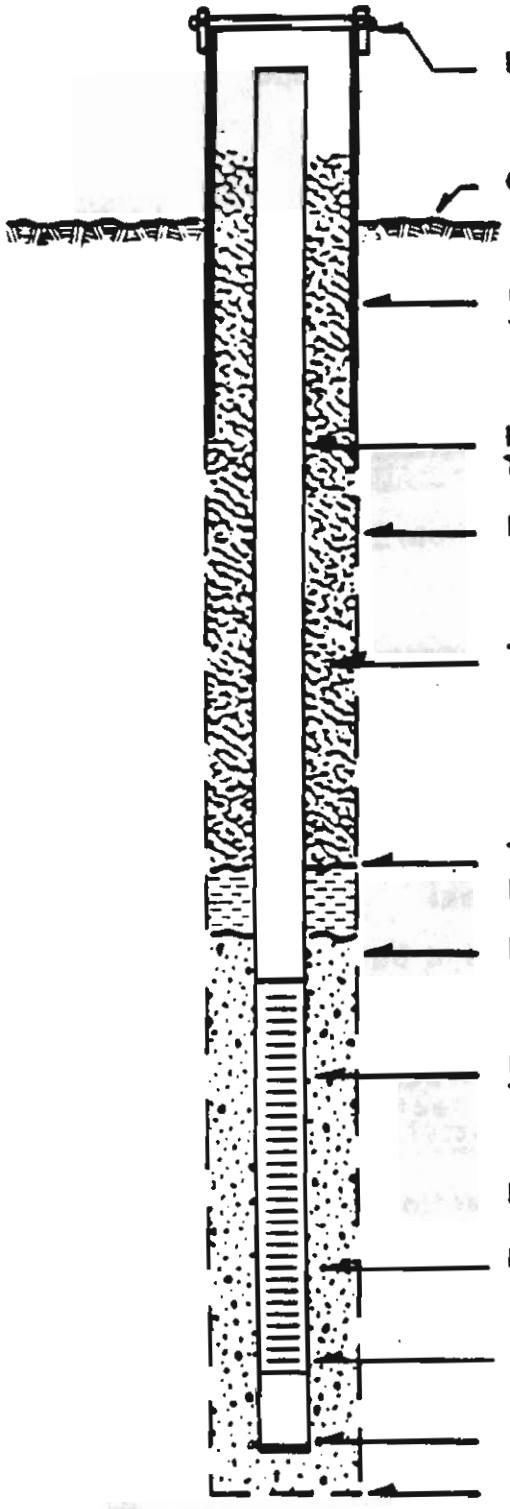
Depth to bottom of sump 32'

Depth of borehole 33.5'

Report of Recovery Well RW-4

DRAWN BY:	CHECKED BY: GWC	PROJECT NO.: 85C2667-3	DATE: 10/9/86	FIGURE NO

Woodward-Clyde Consultants



Elevation of top of riser pipe 106.95'

Ground Elevation 104.56'

I.D. of surface casing 6 in
Type of surface casing steel

I.D. of riser pipe 4 in
Type of riser pipe stainless steel

Diameter of borehole 8 in

Type of backfill cement-bentonite grout

Type of seal bentonite pellets
Depth to top of seal 4.2'

Depth to top of sand pack 6.1'

Depth to top of screen 7'
Type of screened section
Johnson stainless steel No. 20 Slot

I.D. of screened section 4 in

Depth to top of bedrock 14'

Depth to bottom of screen 27'

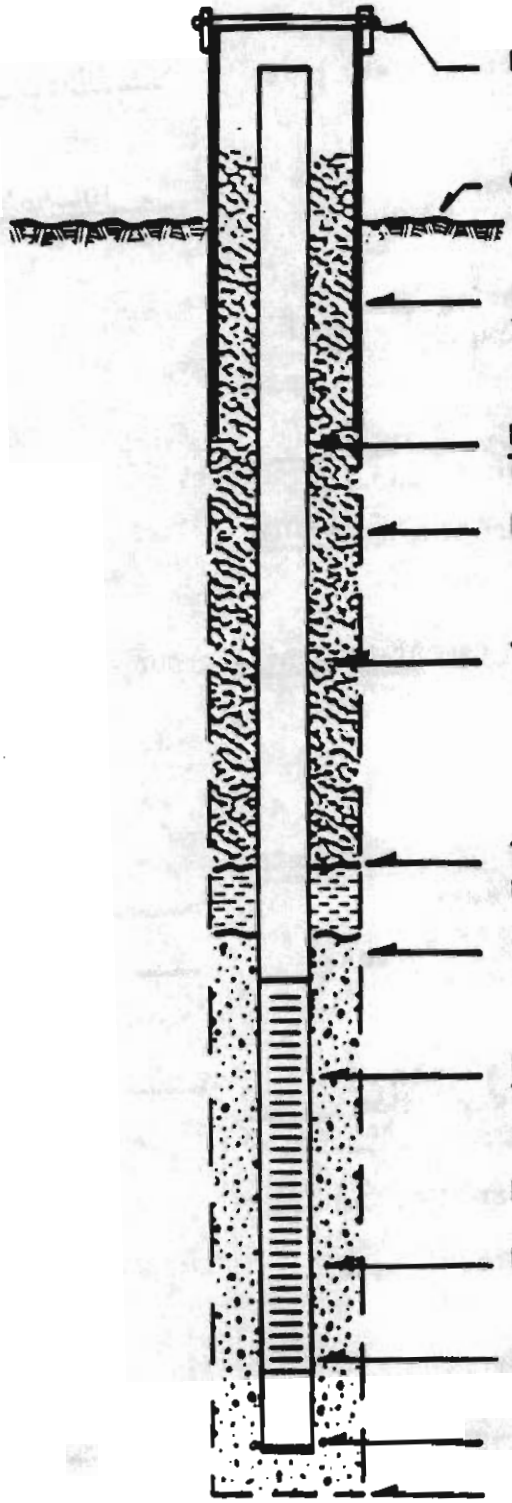
Depth to bottom of sump 32'

Depth of borehole 33'

Report of Recovery Well RW-5

DRAWN BY:	CHECKED BY: GWC	PROJECT NO.: 85C2667-3	DATE: 10/14/86	FIGURE NO:

Woodward-Clyde Consultants



Elevation of top of riser pipe 108.81'

Ground Elevation 106.43'

I.D. of surface casing 6 in
Type of surface casing steel

I.D. of riser pipe 4 in
Type of riser pipe stainless steel

Diameter of borehole 8 in

Type of backfill cement-bentonite grout

Type of seal bentonite pellets
Depth to top of seal 2.5'

Depth to top of sand pack 4.5'

Depth to top of screen 6.5'
Type of screened section
Johnson stainless steel No. 20 Slot

I.D. of screened section 4 in

Depth to top of bedrock 16.5'

Depth to bottom of screen 26.5'

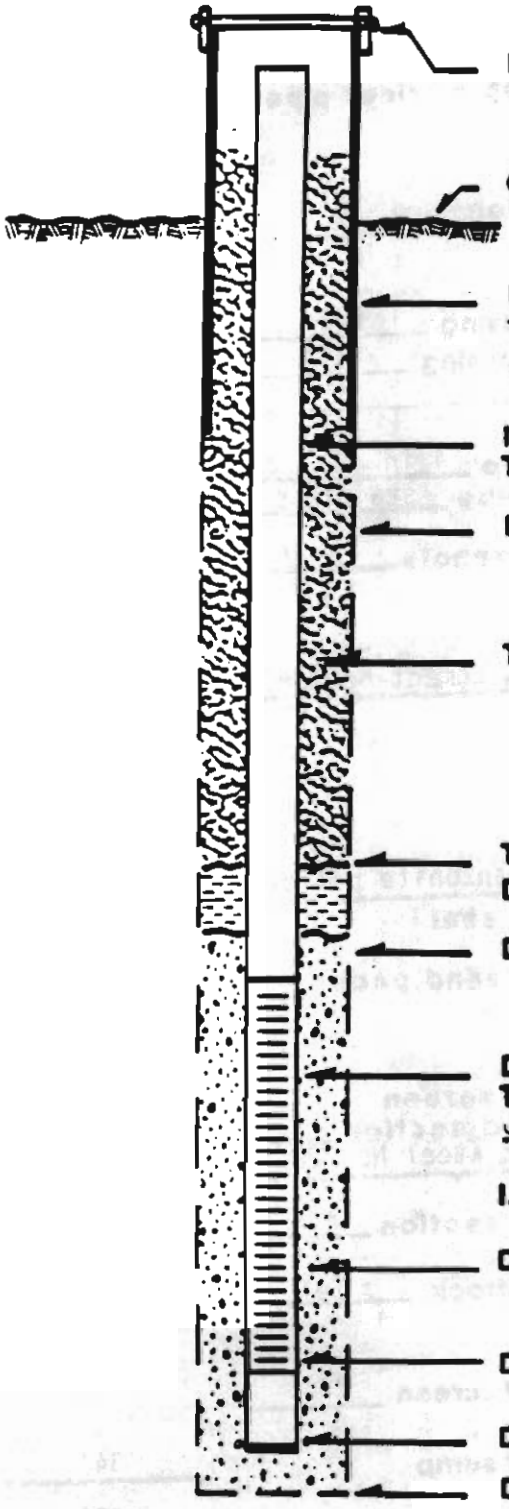
Depth to bottom of sump 31.5'

Depth of borehole 33'

Report of Recovery Well RW-6

DRAWN BY:	CHECKED BY: GWC	PROJECT NO.: 85C2667-3	DATE: 10/8/86	FIGURE NO

Woodward-Clyde Consultants



Elevation of top of riser pipe 110.08'

Ground Elevation 108.64'

I.D. of surface casing 6 in
Type of surface casing steel

I.D. of riser pipe 4 in
Type of riser pipe stainless steel

Diameter of borehole 8 in

Type of backfill cement-bentonite grout

Type of seal bentonite pellets
Depth to top of seal 7.5'

Depth to top of sand pack 10'

Depth to top of screen 12'
Type of screened section
Johnson stainless steel No. 20 Slot

I.D. of screened section 4 in

Depth to top of bedrock 22'

Depth to bottom of screen 32'

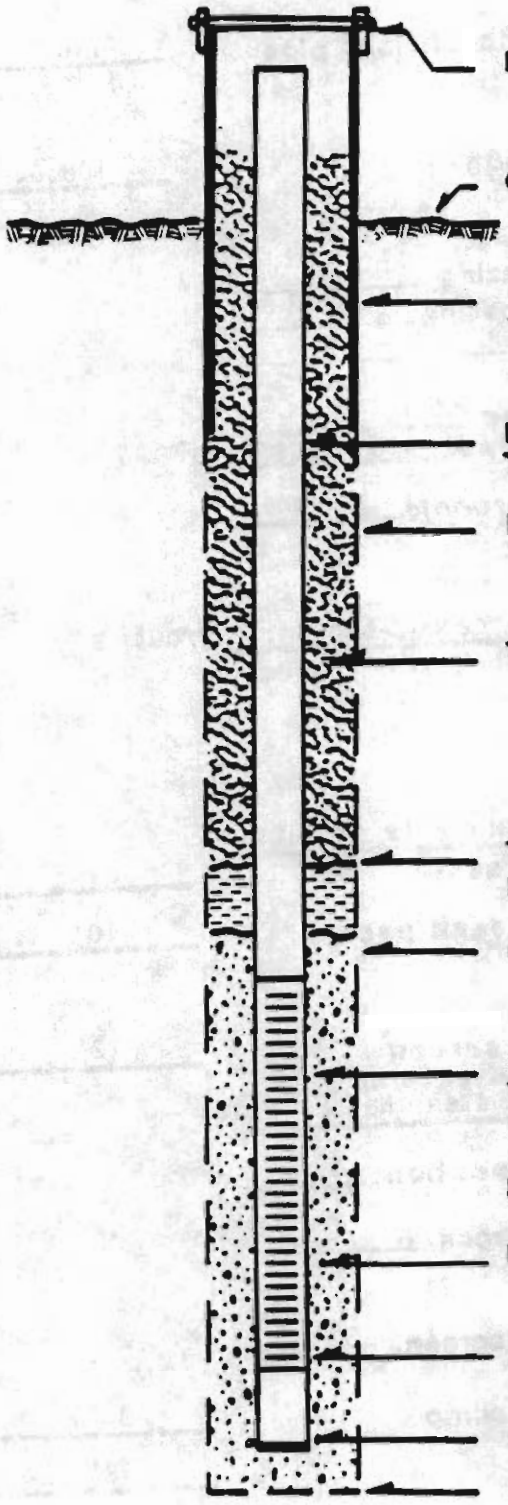
Depth to bottom of sump 37'

Depth of borehole 38'

Report of Recovery Well RW-10

DRAWN BY:	CHECKED BY: GWC	PROJECT NO.: 85C2667-3	DATE: 9/30/86	FIGURE NO

Woodward-Clyde Consultants



Elevation of top of riser pipe 110.30

Ground Elevation 108.01'

I.D. of surface casing 6 in
Type of surface casing steel

I.D. of riser pipe 4 in
Type of riser pipe stainless steel

Diameter of borehole 8 in

Type of backfill cement-bentonite grout

Type of seal bentonite pellets
Depth to top of seal 5.5'

Depth to top of sand pack 7'

Depth to top of screen 9'
Type of screened section
Johnson stainless steel No. 20 Slot

I.D. of screened section 4 in

Depth to top of bedrock 19'

Depth to bottom of screen 29'

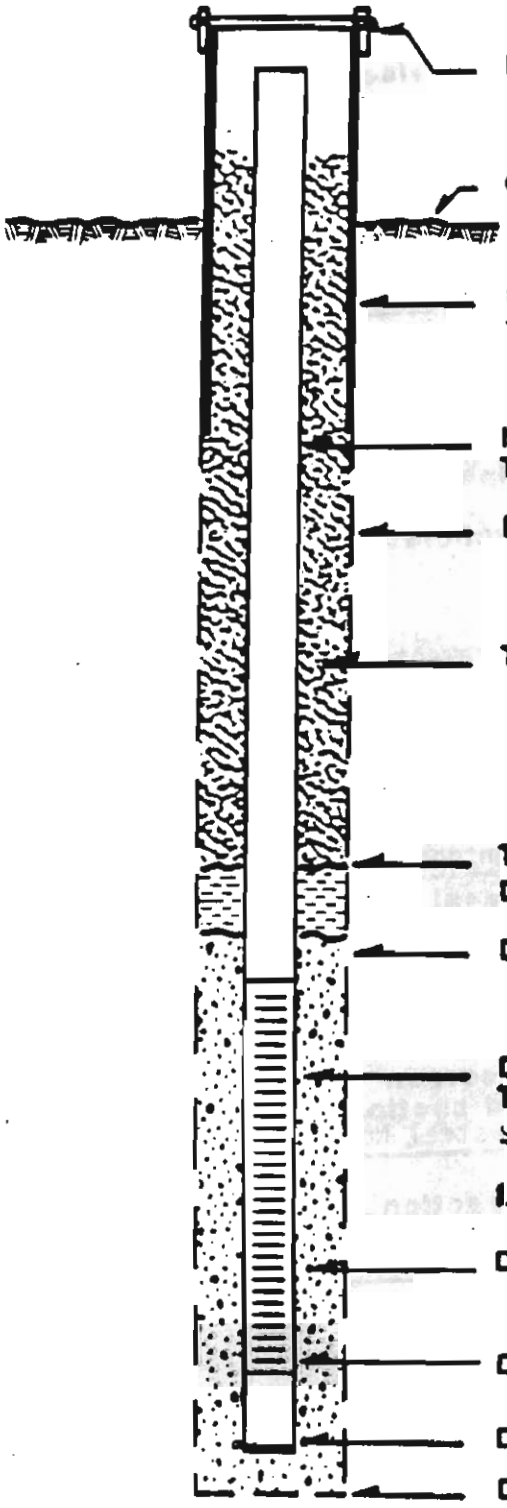
Depth to bottom of sump 34'

Depth of borehole 35'

Report of Recovery Well RW-9

DRAWN BY:	CHECKED BY: GWC	PROJECT NO.: 85C2667-3	DATE: 10/2/86	FIGURE NO

Woodward-Clyde Consultants



Elevation of top of riser pipe 110.15'

Ground Elevation 107.80'

I.D. of surface casing 6 in
Type of surface casing steel

I.D. of riser pipe 4 in
Type of riser pipe stainless steel

Diameter of borehole 8 in

Type of backfill cement-bentonite grout

Type of seal bentonite pellets
Depth to top of seal 5'

Depth to top of sand pack 6.2'

Depth to top of screen 8'
Type of screened section
Johnson stainless steel No. 20 Slot

I.D. of screened section 4 in

Depth to top of bedrock 18'

Depth to bottom of screen 28'

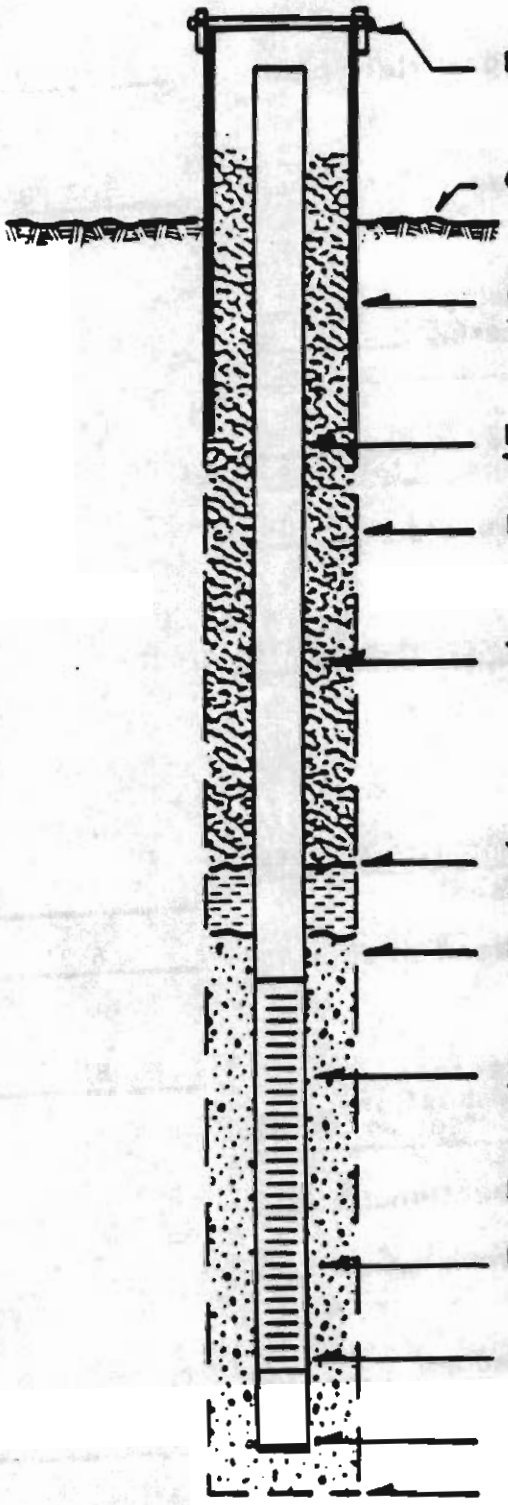
Depth to bottom of sump 33'

Depth of borehole 34'

Report of Recovery Well RW-8

DRAWN BY:	CHECKED BY: GWC	PROJECT NO.: 85C2667-3	DATE: 10/3/86	FIGURE NO:

Woodward-Clyde Consultants



Elevation of top of riser pipe 109.40'

Ground Elevation 106.81'

I.D. of surface casing 6 in
Type of surface casing steel

I.D. of riser pipe 4 in
Type of riser pipe stainless steel

Diameter of borehole 8 in

Type of backfill cement-bentonite grout

Type of seal bentonite pellets
Depth to top of seal 4'

Depth to top of sand pack 6'

Depth to top of screen 8'
Type of screened section
Johnson stainless steel No. 20 Slot

I.D. of screened section 4 in

Depth to top of bedrock 18'

Depth to bottom of screen 28'

Depth to bottom of sump 33'

Depth of borehole 34.5'

Report of Recovery Well RW-7

DRAWN BY:	CHECKED BY: GWC	PROJECT NO.: 85C2667-3	DATE: 10/6/86	FIGURE NO

Woodward-Clyde Consultants

LOG of BORING No. RW-1

DATE 9/23/86 SURFACE ELEVATION 1065.4 LOCATION See Figure

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	DESCRIPTION	ELEVATION	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OVA SOIL (ppm)
5		31	Red brown silty SAND with trace clay and gravel					<0.1
		21						<0.1
		26						<0.1
10			- red brown silty sand with clay and shale fragments					
		45						<0.1
		77		91.54				<0.1
15		100/1'	Red brown SHALE					<0.1
20								
25								
30								
35								
40								

Completion Depth 32 Feet Water Depth 8.5 Feet Date 9/23/86

Project Name Xerox Corp. - Blauvelt, NY Project Number 85C2667-4

WCC - RP 1

LOG of BORING No. RW-2

DATE 9/25/86 SURFACE ELEVATION 105.89 LOCATION See Figure

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	DESCRIPTION	ELEVATION	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OVA SOIL (ppm)
		5	- Brown to red brown FILL; mix of sand, gravel, clay, silt					< 0.1
		11						< 0.1
				100.89				
5		14	Brown TILL; silty SAND					< 0.1
			- brown silty sand with little gravel					
		15	- brown to red brown clayey sand with little gravel					< 0.1
		11						< 0.1
10			- red brown sand and gravel					
		13		93.89				< 0.1
		13	Red brown clayey SILT with little sand and trace gravel					< 0.1
								< 0.1
15		20						
		73						<0.1
		100/3"		86.39				< 0.1
20			Red brown SHALE					
25								
30								
35								
40								

Completion Depth 36 Feet Water Depth 7.5 Feet Date 9/26/86

Project Name Xerox Corp. - Blauvelt, NY Project Number 85C2667-4

Woodward-Clyde Consultants

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LOG of BORING No. RW-3

DATE 9/26/86 SURFACE ELEVATION 105.54 LOCATION See Figure

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	DESCRIPTION	ELEVATION	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OVA SOIL (ppm)
		7	Red brown SILT with trace clay, roots					<0.1
		8						<0.1
5		10	- red brown clayey silt with trace sand, gravel					<0.1
		19	- red brown sandy silt with trace clay, gravel					<0.1
		15	- red brown clayey silt with trace sand, gravel					<0.1
10		14						<0.1
		13						<0.1
15		23		89.54				<0.1
		100/3"	Weathered SHALE					<0.1
20			- red brown shale					
25								
30								
35								
40								

Completion Depth 34 Feet Water Depth 7.0 Feet Date 9/29/86

Project Name Xerox Corp. - Blauvelt, NY Project Number 85C2667-4

Woodward-Clyde Consultants

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LOG of BORING No. RW-4

DATE 10/9/86 SURFACE ELEVATION 102.84 LOCATION See Figure

DEPTH, ft. / SAMPLES	SAMPLING RESISTANCE	DESCRIPTION	ELEVATION	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OVA SOIL (ppm)
	2	Dark brown TOPSOIL with roots	101.84				0
	8	Red brown sandy CLAY	98.84				60
5	33	Red brown silty SAND					45
	44	- red brown clayey sand with trace gravel, cobbles					20
	62	- red brown silty sand					70
10	52	Red brown clayey SILT with weathered shale fragments	92.84				30
		SHALE					
15							
20							
25							
30							
35							
40							

Completion Depth 33.5 Feet Water Depth 4.5 Feet Date 10/9/86

Project Name Xerox Corp. - Blauvelt, NY Project Number 86C2667-4

Woodward-Clyde Consultants

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LOG of BORING No. RW-5

DATE 10/13/86 SURFACE ELEVATION 104.56 LOCATION See Figure

DEPTH, ft. / SAMPLES	SAMPLING RESISTANCE	DESCRIPTION	ELEVATION	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OVA SOIL (ppm)
	4	Brown silty clay with roots	102.56				<0.1
	20	Red brown sandy silt with trace gravel					<0.1
5	28	- red brown clayey silt with sand					<0.1
	24	- red brown clayey silt with sand; soft, wet					13
10	24	- red brown sandy silt with trace gravel					12
	49	- red brown clayey silt with shale and gravel	89.56				15
15		Red brown SHALE					
20							
25							
30							
35							
40							

Completion Depth 33 Feet Water Depth 6.0 Feet Date 10/14/86

Project Name Xerox Corp. - Blauvelt, NY Project Number 85C2667-4

WCC - RP 1

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LOG of BORING No. RW-6

DATE 10/8/86 SURFACE ELEVATION 106.43 LOCATION See Figure

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	DESCRIPTION	ELEVATION	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OVA SOIL (ppm)
		6	Brown to dark brown clayey SILT with roots					0
		12	- Red brown clayey silt with gravel	102.43				0
5		7	Red brown clayey SAND with trace gravel	100.43				0.2
		14	Red brown clayey silt with trace sand, gravel	98.43				0.4
		18	Red brown silty SAND					0.6
10		15	- red brown silty sand, wet					7.5
		18	- red brown sand and silt					20
15		41						70
		100/3'		89.93				
			SHALE					
20								
25								
30								
35								
40								

Completion Depth 33 Feet Water Depth 8.0 Feet Date 10/8/86

Project Name Xerox Corp. - Blauvelt, NY Project Number 85C2667-4

Woodward-Clyde Consultants

LOG of BORING No. RW-7

DATE 10/6/86 SURFACE ELEVATION 106.81 LOCATION See Figure

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	DESCRIPTION	ELEVATION	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OVA SOIL (ppm)
		8	Red brown clayey SILT with trace gravel and roots					
		12						
5		26	- red brown clayey silt with trace gravel	100.81				
		14	Red brown silty SAND with trace gravel	98.81				>100
		9	Red brown clayey SILT with trace sand					40
10		6		94.81				140
		13	Red brown clayey SAND					20
15		100/4"	- red brown silty sand	88.81				
			Red brown SHALE					
20								
25								
30								
35								
40								

Completion Depth 34.5 Feet Water Depth 8.5 Feet Date 10/6/86

Project Name Xerox Corp. - Blauvelt, NY Project Number 85C2667-4

Woodward-Clyde Consultants

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LOG of BORING No. RW-8

DATE 10/3/86 SURFACE ELEVATION 107.80 LOCATION See Figure

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	DESCRIPTION	ELEVATION	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OVA SOIL (ppm)
		6	Brown silty CLAY with roots	105.80				< 0.1
		14	Red brown clayey SILT with trace sand					< 0.1
5		16						< 0.1
		19	- red brown clayey silt with sand and gravel	99.80				1.6
		19	Red brown silty SAND with clay and gravel					25
10		16		95.80				> 80
		11	Sandy SILT with clay					160
		13	- red brown sandy silt					16
15		58		90.30				< 10
			SHALE					
20								
25								
30								
35								
40								

Completion Depth 34 Feet Water Depth 9.0 Feet Date 10/3/86

Project Name Xerox Corp. - Blauvelt, NY Project Number 85C2667-4

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LOG of BORING No. RW-9

DATE 10/1/86 SURFACE ELEVATION 108.01 LOCATION See Figure

DEPTH, ft. / SAMPLES	SAMPLING RESISTANCE	DESCRIPTION	ELEVATION	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OVA SOIL (ppm)
	8	Red brown silty CLAY with roots	106.01				< 0.1
	18	Red brown SAND with gravel	104.01				< 0.1
5	13	Red brown clayey SILT with little sand and gravel					< 0.1
	9	- red brown clayey SILT with trace sand and gravel					< 0.1
	9		98.01				< 0.1
10	5	Red brown silty SAND with gravel					< 0.1
15	4	- red brown clayey SAND with silt and gravel	91.01				< 0.1
	100/4"	SHALE					< 0.1
20							
25							
30							
35							
40							

Completion Depth 35 Feet Water Depth 8.8 Feet Date 10/2/86

Project Name Xerox Corp. - Blauvelt, NY Project Number 85C2667-4

WCC - RP 1

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LOG of BORING No. RW-10

DATE 9/29/86 SURFACE ELEVATION 108.64 LOCATION See Figure

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	DESCRIPTION	ELEVATION	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OVA SOIL (ppm)
		9	Brown SILT with sand, gravel and little clay					< 0.1
		69		104.64				< 0.1
5		10	Red brown silty SAND	100.64				0.6
		10	Red brown clayey SILT					< 0.1
10								
15				92.64				
		84	Red brown silty SAND with little gravel					< 0.1
		69						< 0.1
20		100/4"		88.64				< 0.
			Red brown SHALE					
25								
30								
35								
40								

Completion Depth 38 Feet Water Depth 9.5 Feet Date 9/30/86

Project Name Xerox Corp. - Blauvelt, NY Project Number 85C2667-4

WCC - RP 1

APPENDIX A-2

NON-AQUEOUS PHASE LIQUID INVESTIGATION

APPENDIX A-2
NON-AQUEOUS PHASE LIQUID (NAPL) INVESTIGATION

Task Description: Eleven soil borings (ST-1, ST-2, SP-1 through SP-9) were drilled in early November 1986 as part of an investigation of a floating non-aqueous phase liquid (NAPL) present at the Blauvelt site. Two additional soil borings (SP-16 and SP-17) were drilled in December 1986 as part of this task. Seven monitoring wells (MW-10 through MW-16), four of which are at locations of previous borings, were installed during November and December as part of the same investigation.

Task Objective: Prior to this task, NAPL had only been detected in MW-7. Additional NAPL investigations were initiated to determine if the NAPL layer was more extensive than a localized zone around MW-7. The purpose of the NAPL investigation is to evaluate the distribution, magnitude, and constituents of NAPL present on-site and to delineate the direction of NAPL migration.

Work Performed: Locations of soil borings and wells are shown in Figure A-1.1. Logs of borings and well construction details follow this discussion. Table A-1.1 summarizes well construction details for the well installed in this, and other, tasks.

All borings for this task were drilled using hollow-stem auger techniques. Continuous split spoon samples of the soils were collected and were subjected to measurements of organic vapors in the headspace of the sample jars. OVA headspace readings are included on the boring logs. In addition, soil samples were collected from each boring and submitted for laboratory analysis. Laboratory results of soil sampling are summarized in Table A-2.1. All boreholes were backfilled with cuttings and grouted with a cement-bentonite grout to the surface when completed.

The monitoring wells were also drilled using hollow-stem auger techniques. All NAPL investigation wells are installed in the overburden, with 10-foot screens set to intercept the water table. As with the soil borings, continuous split spoon samples were collected, some of which were submitted for laboratory analysis. The

monitoring wells were developed following completion of well installation. All cuttings and development water from these locations were placed in drums for off-site disposal. Groundwater samples and elevations were taken soon after well installation. A summary of groundwater elevations is presented in Table A-1.2. Appendix A-6 lists the analytical results of groundwater sampling. Total volatile organics concentrations are summarized in Table A-2.2. Analytical results derived from samples of the non-aqueous phase liquid are presented in Table A-2.3.

Note that monitoring wells MW-10, 11, 12 and 13 are at the former locations of borings SP-8, SP-4, SP-5, and ST-2, respectively.

Observations/Discussion: NAPL presence in soil borings was identified visually and served as the basis for field decisions regarding the numbers and locations of subsequent borings and wells, and for delineation of the NAPL plume. In wells, NAPL was identified, where present, by use of a clear, bottom-loading bailer and/or an electro-optical probe. Figure A-2.1 is a location plan showing the approximate extent of the non-aqueous phase as delineated by the wells and borings described above. The map indicates that the NAPL has migrated to the north from the former storage tank area. Wells known to contain a floating non-aqueous phase were checked for the possible presence of a dense or sinking phase. A dense phase was not observed in any of the wells.

TABLE A-2.1

SUMMARY OF SOIL SAMPLING RESULTS
XEROX CORPORATION
BLAUVELT, NEW YORK

Boring No.	Parameter	Sample Interval (ft) 0-2	2-4	4-6	6-8	8-10	10-12
ST-1	Mineral Spirits (ppm)	--	--	--	--	422	--
	Total Volatiles (ppb)	--	--	--	--	96,300	--
ST-2	Mineral Spirits (ppm)	--	--	50	--	--	--
	Total Volatiles (ppb)	--	--	27,900	--	--	--
SP-1	Mineral Spirits (ppm)	--	--	--	--	33	--
	Total Volatiles (ppm)	--	--	--	--	ND	--
SP-2	Mineral Spirits (ppm)	--	--	198	--	--	--
	Total Volatiles (ppb)	--	--	3,500	--	--	--
SP-3	Mineral Spirits (ppm)	--	--	--	--	--	10
	Total Volatiles (ppb)	--	--	--	--	--	29,340
SP-4	Mineral Spirits (ppm)	--	--	--	--	--	--
	Total Volatiles (ppb)	--	--	--	--	--	--
SP-5	Mineral Spirits (ppm)	--	--	--	--	11,780	--
	Total Volatiles (ppb)	--	--	--	--	174,000	--
SP-6	Mineral Spirits (ppm)	--	--	--	123 (6-10)	--	--
	Total Volatiles (ppb)	--	--	--	90,577 (6-10)	--	--
SP-7	Mineral Spirits (ppm)	--	--	--	--	2,130	--
	Total Volatiles (ppb)	--	--	--	--	1,752,000	--
SP-8	Mineral Spirits (ppm)	--	--	--	--	8,000	--
	Total Volatiles (ppb)	--	--	--	--	127,000	--
SP-9	Mineral Spirits (ppm)	--	--	--	--	6,060	--
	Total Volatiles (ppb)	--	--	--	--	160,300	--
SP-10	Mineral Spirits (ppm)	--	--	20	--	--	--
	Total Volatiles (ppb)	--	--	ND	--	--	--
SP-11	Mineral Spirits (ppm)	--	--	20	--	--	--
	Total Volatiles (ppb)	--	--	14	--	--	--
SP-12	Mineral Spirits (ppm)	7,660	--	--	--	--	--
	Total Volatiles (ppb)	3,899,000	--	--	--	--	433.8
SP-13	Mineral Spirits (ppm)	4.6	--	--	--	--	233
	Total Volatiles (ppb)	6.2	--	--	--	--	60,160
SP-15	Mineral Spirits (ppm)	--	--	--	--	11,800	.1 (10-11) 4.6 (10-12)
	Total Volatiles (ppb)	--	--	--	--	412	7.9 (10-11) 34.5 (11-12)
SP-16	Mineral Spirits (ppm)	--	--	--	--	ND	--
	Total Volatiles (ppb)	--	--	--	--	ND	--
SP-17	Mineral Spirits (ppm)	--	--	ND	--	ND	--
	Total Volatiles (ppb)	--	--	ND	--	ND	--
MW-14	Mineral Spirits (ppm)	--	--	.1	--	--	--
	Total Volatiles (ppb)	--	--	ND	--	--	--
MW-15	Mineral Spirits (ppm)	--	--	--	.1	--	--
	Total Volatiles (ppb)	--	--	--	32	--	--
MW-16	Mineral Spirits (ppm)	--	--	--	--	.1	--
	Total Volatiles (ppb)	--	--	--	--	ND	--
MW-17	Mineral Spirits (ppm)	10,800	--	--	--	--	677
	Total Volatiles (ppb)	46,410	--	--	--	--	29,950
RW-1	Mineral Spirits (ppm)	--	--	--	--	--	--
	Total Volatiles (ppb)	--	--	--	--	--	--
RW-2	Mineral Spirits (ppm)	--	--	--	--	--	--
	Total Volatiles (ppb)	--	--	--	--	--	--
RW-3	Mineral Spirits (ppm)	--	--	--	--	--	--
	Total Volatiles (ppb)	--	--	--	--	--	--
RW-4	Mineral Spirits (ppm)	--	--	--	--	--	50
	Total Volatiles (ppb)	--	--	--	--	--	205.8
RW-5	Mineral Spirits (ppm)	--	--	--	--	--	50
	Total Volatiles (ppb)	--	--	--	--	--	16 (10-14)
RW-6	Mineral Spirits (ppm)	--	--	--	--	--	50
	Total Volatiles (ppb)	--	--	--	--	--	1,274.2
RW-7	Mineral Spirits (ppm)	--	--	--	828	--	--
	Total Volatiles (ppb)	--	--	--	1,278	--	--
RW-8	Mineral Spirits (ppm)	--	--	--	66 (6-12)	--	--
	Total Volatiles (ppb)	--	--	--	1,427 (6-12)	--	--
RW-9	Mineral Spirits (ppm)	--	--	--	--	--	--
	Total Volatiles (ppb)	--	--	--	--	--	--
RW-10	Mineral Spirits (ppm)	--	--	--	--	--	--
	Total Volatiles (ppb)	--	--	--	--	--	--

TABLE A-2.1
(Continued)

Boring No.	Parameter	Sample Interval (ft) 12-14	14-16	16-18	18-20	20-22	22-24
ST-1	Mineral Spirits (ppm)	--	--	--	--	--	--
	Total Volatiles (ppb)	--	--	--	--	--	--
ST-2	Mineral Spirits (ppm)	--	--	--	--	--	--
	Total Volatiles (ppb)	--	--	--	--	--	--
SP-1	Mineral Spirits (ppm)	--	10	--	--	--	--
	Total Volatiles (ppb)	--	ND	--	--	--	--
SP-2	Mineral Spirits (ppm)	--	10	--	--	--	--
	Total Volatiles (ppb)	--	29,240	--	--	--	--
SP-3	Mineral Spirits (ppm)	--	2,230	--	--	--	--
	Total Volatiles (ppb)	--	335,700	--	--	--	--
SP-4	Mineral Spirits (ppm)	11,100	--	--	--	--	--
	Total Volatiles (ppb)	2,594,500	--	--	--	--	--
SP-5	Mineral Spirits (ppm)	--	--	1,340 (16-17)	--	--	--
	Total Volatiles (ppb)	--	--	171,600 (16-17)	--	--	--
SP-6	Mineral Spirits (ppm)	--	--	--	--	--	--
	Total Volatiles (ppb)	--	--	--	--	--	--
SP-7	Mineral Spirits (ppm)	--	164	--	--	--	--
	Total Volatiles (ppb)	--	54,800	--	--	--	--
SP-8	Mineral Spirits (ppm)	--	20 (14-15)	--	--	--	--
	Total Volatiles (ppb)	--	1,534 (14-15)	--	--	--	--
SP-9	Mineral Spirits (ppm)	--	20	--	--	--	--
	Total Volatiles (ppb)	--	ND	--	--	--	--
SP-10	Mineral Spirits (ppm)	--	--	--	--	--	--
	Total Volatiles (ppb)	--	--	--	--	--	--
SP-11	Mineral Spirits (ppm)	--	--	--	--	--	--
	Total Volatiles (ppb)	--	--	--	--	--	--
SP-12	Mineral Spirits (ppm)	--	--	--	--	--	--
	Total Volatiles (ppb)	--	--	11	--	--	--
SP-13	Mineral Spirits (ppm)	--	--	--	--	--	--
	Total Volatiles (ppb)	--	--	--	--	--	--
SP-15	Mineral Spirits (ppm)	--	--	--	--	--	.1
	Total Volatiles (ppb)	--	--	--	--	--	ND
SP-16	Mineral Spirits (ppm)	--	--	--	--	--	--
	Total Volatiles (ppb)	312,000	--	--	--	--	--
SP-17	Mineral Spirits (ppm)	--	--	--	--	--	--
	Total Volatiles (ppb)	--	--	--	--	--	--
MW-14	Mineral Spirits (ppm)	.1	--	--	--	.1	--
	Total Volatiles (ppb)	ND	--	--	--	ND	--
MW-15	Mineral Spirits (ppm)	.1	--	--	--	--	--
	Total Volatiles (ppb)	ND	--	--	--	--	--
MW-16	Mineral Spirits (ppm)	--	--	.1	--	--	--
	Total Volatiles (ppb)	--	--	ND	--	--	--
MW-17	Mineral Spirits (ppm)	--	--	--	--	.1	--
	Total Volatiles (ppb)	--	--	--	--	ND	--
RW-1	Mineral Spirits (ppm)	--	--	--	--	--	--
	Total Volatiles (ppb)	--	--	--	--	--	--
RW-2	Mineral Spirits (ppm)	--	--	--	--	--	--
	Total Volatiles (ppb)	--	--	--	--	--	--
RW-3	Mineral Spirits (ppm)	--	--	--	--	--	--
	Total Volatiles (ppb)	--	--	--	--	--	--
RW-4	Mineral Spirits (ppm)	--	--	--	--	--	--
	Total Volatiles (ppb)	--	--	--	--	--	--
RW-5	Mineral Spirits (ppm)	--	--	--	--	--	--
	Total Volatiles (ppb)	--	--	--	--	--	--
RW-6	Mineral Spirits (ppm)	--	--	--	--	--	--
	Total Volatiles (ppb)	--	--	--	--	--	--
RW-7	Mineral Spirits (ppm)	--	--	--	--	--	--
	Total Volatiles (ppb)	--	--	--	--	--	--
RW-8	Mineral Spirits (ppm)	--	--	--	--	--	--
	Total Volatiles (ppb)	--	--	--	--	--	--
RW-9	Mineral Spirits (ppm)	--	--	--	--	--	--
	Total Volatiles (ppb)	--	--	--	--	--	--
RW-10	Mineral Spirits (ppm)	--	--	--	50	--	--
	Total Volatiles (ppb)	--	--	--	16.7	--	--

TABLE A-2.2
SUMMARY OF GROUNDWATER QUALITY IN ON-SITE WELLS
TOTAL VOLATILE ORGANICS (ppb)

WELL NUMBER	9/11/80	9/20/84	11/28/84	8/19/85	12/16/85	7/2/86	9/30/86	11/7/86	1/9/87	1/16/87	1/31/89	4/18/89	5/15/89	AVERAGE
W-1	35,700	260,078	145,600	--	247,671	255,390	132,700	--	276,700	--	223,600	110,400	--	187,538
W-2	25,300	57,268	52,768	--	110,310	86,390	70,100	--	34,200	--	108,936	76,626	--	69,100
W-3	320	2,344	1,111	--	1,680	--	--	--	--	--	80	--	--	1,107
W-4	106,500	23,002	61,224	--	13,680	33,810	53,900	--	27,280	--	13,604	18,180	--	39,020
W-5	32	2	ND	--	25	271	25	--	ND	--	ND	5	--	40
W-6	--	ND	ND	121	5	17	2	--	ND	--	15	6	--	5
W-7	--	80,050	116,658	101,773	124,690	73,630	87,310	205,035	197,320	--	114,810	126,870	--	122,815
W-8	--	1,863	2,700	--	151	2,662	1,996	--	775	--	39	10	--	1,274
U-6D	--	10	ND	20	10	2	5	--	ND	--	14	9	--	8
W-7D	--	1,260	4,360	19,418	10,302	3,551	6,021	--	1,370	--	17,784	5,137	--	7,689
W-9D	--	4,645	9,471	--	9,500	22,860	18,870	--	13,660	--	31,594	17,465	--	16,007
OW-1	--	--	--	506	142	4,250	326	--	398	--	2,133	48,781	--	8,076
OW-2	--	--	--	5,433	12,785	3,399	2,899	--	80	--	17,723	5,796	--	6,874
PW-1	--	--	--	2,375	13,720	--	3,955	--	3,294	--	28,258	5,278	--	9,480
PW-2	--	--	--	82,510	99,866	--	106,450	--	67,500	--	155,782	112,588	--	104,116
RW-1	--	--	--	--	--	--	--	302	--	--	--	--	--	302
RW-2	--	--	--	--	--	--	--	4,336	--	--	--	--	--	4,336
RW-3	--	--	--	--	--	--	--	3,296	--	--	--	--	--	3,296
RW-4	--	--	--	--	--	--	--	15,295	--	--	--	--	--	15,295
RW-5	--	--	--	--	--	--	--	1,531	--	--	--	--	--	1,531
RW-6	--	--	--	--	--	--	--	47,422	--	--	--	--	--	47,422
RW-7	--	--	--	--	--	--	--	34,419	--	--	--	--	--	34,419
RW-8	--	--	--	--	--	--	--	28,671	--	--	--	--	--	28,671
RW-9	--	--	--	--	--	--	--	7,645	--	--	--	--	--	7,645
RW-10	--	--	--	--	--	--	--	1,646	--	--	--	--	--	1,646
MW-10	--	--	--	--	--	--	--	--	--	314,600	120,890	55,700	--	163,730
MW-11	--	--	--	--	--	--	--	--	--	144,520	133,200	93,300	126,690	124,428
MW-12	--	--	--	--	--	--	--	--	--	85,720	75,373	21,777	--	60,957
MW-13	--	--	--	--	--	--	--	--	--	232,420	126,600	221,100	290,750	217,718
MW-14	--	--	--	--	--	--	--	--	88	--	7	3	--	33
MW-15	--	--	--	--	--	--	--	--	16,060	--	21,587	3,038	--	13,562
MW-16	--	--	--	--	--	--	--	--	173,500	--	241,432	119,900	--	178,277
MW-17	--	--	--	--	--	--	--	--	68,430	--	--	32,630	--	50,530

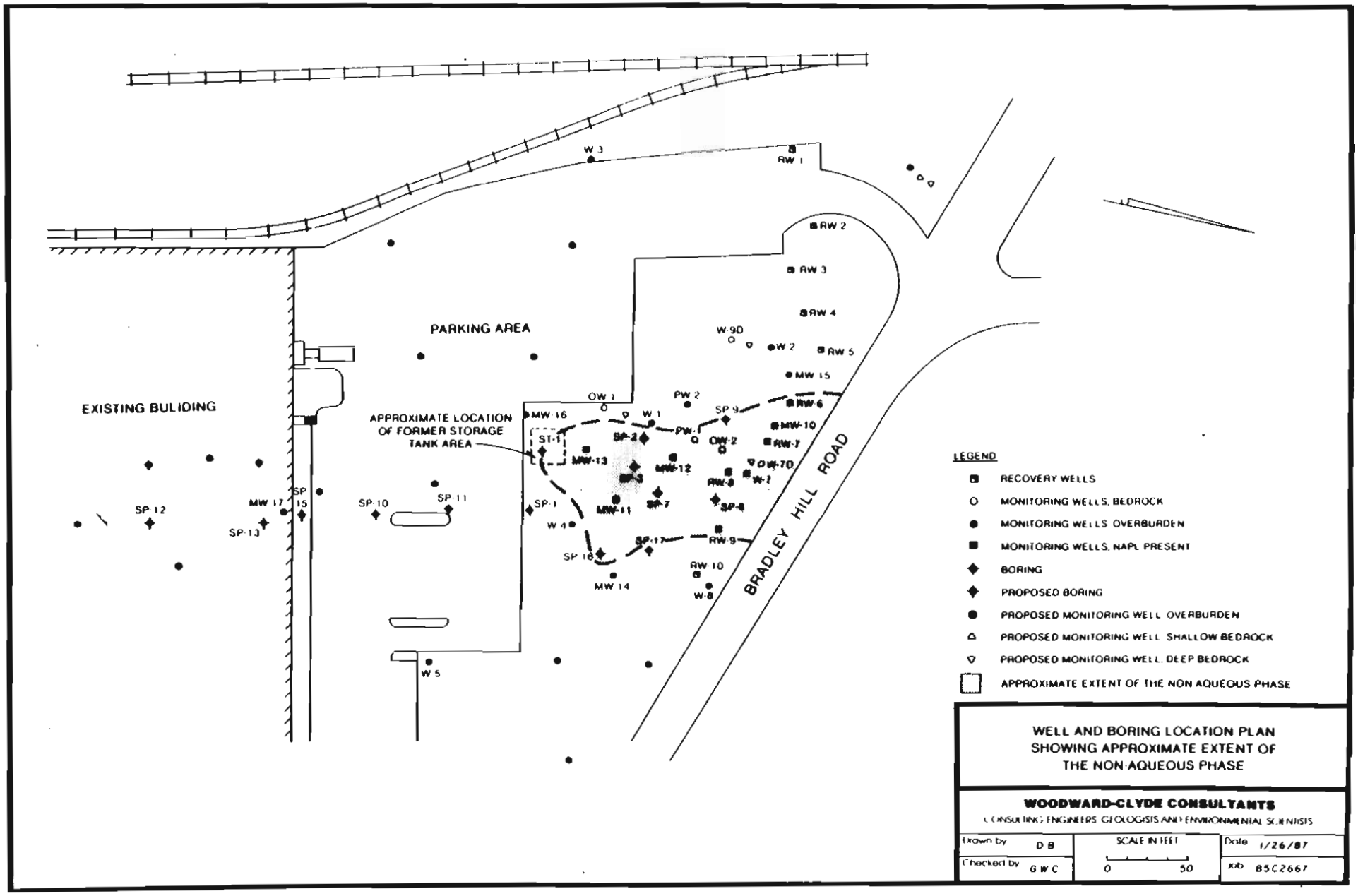
ppb = parts per billion
ND = NOT DETECTED
-- = NOT SAMPLED

TABLE A-2.3

ANALYTICAL RESULTS FROM NON-AQUEOUS PHASE LIQUID
XEROX CORPORATION
BLAUVELT, NEW YORK

Well Number	Parameter	Concentration (ppm) 12/16/85	11/7/86	1/16/87	1/30/89	4/17/89
W-7	1,1,1-trichloroethane	6,500	13,000	--	10,900	14,000
	trichloroethene	16,000	7,600	--	13,800	13,600
	tetrachloroethene	130,000	260,000	--	369,000	308,000
W-11	1,1,1-trichloroethane	--	--	27,400	--	--
	trichloroethene	--	--	28,400	--	--
	tetrachloroethene	--	--	280,000	--	--
	toluene	--	--	4,040	--	--
MW-13	1,2-dichloroethene(Cis&Trans)	--	--	--	26,000	8,630
	1,1,1-trichloroethane	--	--	--	57,900	16,400
	trichloroethene	--	--	--	66,700	18,600
	tetrachloroethene	--	--	--	565,000	238,000
MW-10	1,1,1-trichloroethane	--	--	--	5,070	--
	trichloroethene	--	--	--	8,260	--
	tetrachloroethene	--	--	--	493,000	--

-- Not Sampled



WELL AND BORING LOCATION PLAN
SHOWING APPROXIMATE EXTENT OF
THE NON-AQUEOUS PHASE

WOODWARD-CLYDE CONSULTANTS
CONSULTING ENGINEERS GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

Drawn by	D B	SCALE IN FEET	Date 1/26/87
Checked by	G W C	0 50	Job 85C2667

FIGURE A-2.1

LOG of BORING No. ST-1

DATE 10/15/86 SURFACE ELEVATION 111.80 LOCATION See Figure

DEPTH, ft. / SAMPLES	SAMPLING RESISTANCE	DESCRIPTION	ELEVATION	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OVA SOILS (ppm)
	4	Brown organic clayey SILT					0
	9	- brown clayey silt with little sand, trace gravel					80
5	4	- brown sandy silt					50
	4	- brown clayey SAND with trace gravel					350
	4						400
10		Refusal at 9'					
15							
20							
25							
30							
35							
40							

Completion Depth 9 Feet Water Depth _____ Feet Date 10/15/86

Project Name Xerox Corp. - Blauvelt, NY Project Number 85C2667--4

WCC - AP 1

Woodward-Clyde Consultants

LOG of BORING No. ST-2 (MW-13)

DATE 10/15/86 SURFACE ELEVATION 111.58 LOCATION See Figure

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	DESCRIPTION	ELEVATION	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OVA SOILS (ppm)
		12	Brown sandy SILT with trace gravel					18
		10						400
5		38						> 1000
		21	-red brown sandy silt					350
		46	-red brown clayey silt with dark brown					950
10		26	-red brown clayey silt					350
		39						700
15		70	-red brown silt					600
			SHALE					
20								
25								
30								
35								
40								

Completion Depth 16 Feet Water Depth _____ Feet Date 10/15/86

Project Name Xerox Corp. - Blauvelt, NY Project Number 85C2667-4

Woodward-Clyde Consultants

WCC - RP 1

LOG of BORING No. SP-1

DATE 11/3/86 SURFACE ELEVATION 111.97 LOCATION See Figure

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	DESCRIPTION	ELEVATION	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OVA SOILS (ppm)
		7	Dark brown TOPSOIL					0
		28	Brown and gray clayey SAND with trace gravel					1.0
5		72	-brown silty sand with little gravel					1.5
		18						100
10		18						4
		10	-red brown clayey sand with little gravel					4.5
		12						
15		14						
		100/1"	SHALE					
20								
25								
30								
35								
40								

Completion Depth 16 Feet Water Depth 12 Feet Date 11/3/86

Project Name Xerox Corp. - Blauvelt, NY Project Number 85C2667-4

Woodward-Clyde Consultants

WCC - RP

LOG of BORING No. SP-2

DATE 11/3/86 SURFACE ELEVATION 109.40 LOCATION See Figure

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	DESCRIPTION	ELEVATION	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OVA SOILS (ppm)
		4	Dark brown TOPSOIL					13
		19	Gray and yellow brown clayey SILT					250
5		10	Red brown clayey SAND with trace gravel					250
		7	-red brown silty sand with trace gravel, dry					300
		9	-red brown clayey sand with little gravel, wet					250
10		9						250
		5						250
15		10						200
			SHALE					80
20								
25								
30								
35								
40								

Completion Depth 16 Feet Water Depth 8 Feet Date 11/3/86

Project Name Xerox Corp. - Blauvelt, NY Project Number 85C2667-4

Woodward-Clyde Consultants

WCC - RP 1

LOG of BORING No. SP-3

DATE 11/3/86 SURFACE ELEVATION 109.15 LOCATION See Figure

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	DESCRIPTION	ELEVATION	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OVA SOILS (ppm)
		4	Dark brown TOPSOIL					210
		20	Yellow brown and gray clayey SILT -red brown and gray silt with little sand and gravel					200
5		12						275
		7	Red brown clayey SAND, moist					275
		8						300
10		4	-red brown clayey sand, moist to wet, non-aqueous phase present					75
		7						275
15		11						300
			SHALE					
20								
25								
30								
35								
40								

Completion Depth 16 Feet Water Depth 8 Feet Date 11/3/86

Project Name Xerox Corp. - Blauvelt, NY Project Number 85C2667-4

Woodward-Clyde Consultants

WCC - RP 1

LOG of BORING No. SP-4 (MW-11)

DATE 11/4/86 SURFACE ELEVATION 110.13 LOCATION See Figure

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	DESCRIPTION	ELEVATION	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OVA SOILS (ppm)
		2	Brown and yellow brown organic clayey SILT					40
		5	-brown, yellow brown and gray clayey silt with trace sand					70
5		38	Brown SAND with gravel and cobbles					200
		13	Red brown clayey SILT with sand					220
		12	Red brown silty SAND					200
10		11						200
15			SHALE					
20								
25								
30								
35								
40								

Completion Depth 14 Feet Water Depth _____ Feet Date 11/4/86

Project Name Xerox Corp. - Blauvelt, NY Project Number 85C2667-4

Woodward-Clyde Consultants

WCC - AP 1

LOG of BORING No. SP-5 (MW-12)

DATE 11/4/86 SURFACE ELEVATION 108.69 LOCATION See Figure

DEPTH, ft. / SAMPLES	SAMPLING RESISTANCE	DESCRIPTION	ELEVATION	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OVA SOILS (ppm)
	2	Brown and gray SAND with brown silty clay					160
	13	-Brown clayey SILT with gray sand					200
5	6	Red brown clayey SAND with clayey SAND with little gravel					220
	8						220
	9	- red brown sand with little silt; saturated with dark brown product					200
10	9	- red brown clayey sand					200
	4						200
15	12						200
	30						200
20		SHALE					
25							
30							
35							
40							

Completion Depth 18 Feet Water Depth _____ Feet Date 11/4/86

Project Name Xerox Corp. -- Blauvelt, NY Project Number 85C2667-4

Woodward-Clyde Consultants

WCC - RP

LOG of BORING No. SP-6

DATE 11/4/86 SURFACE ELEVATION 107.31 LOCATION See Figure

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	DESCRIPTION	ELEVATION	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OVA SOILS (ppm)
		3	Red brown clayey SILT and SAND					220
		11						230
5		3						280
		3						280
10		9						260
		19						
15								
20								
25								
30								
35								
40								

Completion Depth 12 Feet Water Depth _____ Feet Date 11/4/86

Project Name Xerox Corp. - Blauvelt, NY Project Number 85C2667

Woodward-Clyde Consultants

WCC - AP 1

LOG of BORING No. SP-7

DATE 11/4/86 SURFACE ELEVATION 108.27 LOCATION See Figure

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	DESCRIPTION	ELEVATION	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OVA SOILS (ppm)
		6	Dark brown TOPSOIL					10
		10	Gray and red brown clayey SILT					110
5		5	Brown and red brown silty SAND					280
		3	-red brown clayey sand with trace gravel					260
		9						280
10		12	-red brown clayey sand					260
		5						260
15		15						240
			SHALE					
20								
25								
30								
35								
40								

Completion Depth 16 Feet Water Depth _____ Feet Date 11/4/86

Project Name Xerox Corp. - Blauvelt, NY Project Number 85C2667-4

WCC - AP-1

Woodward-Clyde Consultants

LOG of BORING No. SP-8 (MW-10)

DATE 11/5/86 SURFACE ELEVATION 106.43 LOCATION See Figure

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	DESCRIPTION	ELEVATION	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OVA SOILS (ppm)
5		5	Brown to dark brown clayey SILT with trace silt and sand					11
		8	-red brown clayey silt and brown loose sand					280
		7						220
		4	Red brown clayey SAND, moist to wet					260
10		5	-red brown clayey sand, observed dark brown free product					240
		9						270
		10	-red brown clayey sand with little shale fragments					200
15		65						280
			Red brown SHALE					
20								
25								
30								
35								
40								

Completion Depth 15 Feet Water Depth _____ Feet Date 11/5/86

Project Name Xerox Corp. - Blauvelt, NY Project Number 85C2667-4

Woodward-Clyde Consultants

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LOG of BORING No. SP-9

DATE 11/5/86 SURFACE ELEVATION 106.65 LOCATION See Figure

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	DESCRIPTION	ELEVATION	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OVA SOILS (ppm)
		6	Dark brown TOPSOIL					12
		7	Yellow brown clayey SILT with trace gravel					160
5		3						
		6	Red brown silty SAND with little clay					250
		6	red-brown silty sand with trace gravel					280
10		9	red-brown silty sand with little clay					260
		6						250
15		14	Red brown SILT, SAND, and GRAVEL					120
			SHALE					
20								
25								
30								
35								
40								

Completion Depth 16 Feet Water Depth _____ Feet Date 11/5/86

Project Name Xerox Corp. - Blauvelt, NY Project Number 85C2667-4

Woodward-Clyde Consultants

WCC - RP

LOG of BORING No. SP-10

DATE 11/5/86 SURFACE ELEVATION 113.98 LOCATION See Figure

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	DESCRIPTION	ELEVATION	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OVA SOILS (ppm)
			6" ASPHALT and gravel					5
		7	Brown clayey SAND					9
		8	-brown to red brown clayey sand and silt					
5		27	-sand and gravel					8
		16						8
		9						4
10		8	-red brown clayey sand with little gravel					9
		60						6
15			SHALE, dry					

Completion Depth 13 Feet Water Depth _____ Feet Date 11-5-86

Project Name Xerox Corp. - Blauvelt, NY Project Number 85C2667-4

Woodward-Clyde Consultants

WCC - RP 1

LOG of BORING No. SP-11

DATE 11-5-86 SURFACE ELEVATION 113.13 LOCATION See Figure

DEPTH, ft. / SAMPLES	SAMPLING RESISTANCE	DESCRIPTION	ELEVATION	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OVA SOILS (ppm)
		6" Asphalt Concrete					
		Red brown SAND with little gravel, clay					0
5	34						2
	22						2
	5	Red-brown clayey SILT with little sand and gravel					2
10	14						4
		SHALE, dry					
15							
20							
25							
30							
35							
40							

Completion Depth 13 Feet Water Depth _____ Feet Date 11/5/86

Project Name Xerox Corp. - Blauvelt, NY Project Number 85C2667-4

WCC - RP 1

Woodward-Clyde Consultants

LOG of BORING No. SP-12

DATE 12/15/86 SURFACE ELEVATION _____ LOCATION See Figure

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	DESCRIPTION	ELEVATION	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OVA SOILS (ppm)
			8" CONCRETE and gravel					
		5	Red brown SAND and silt with little gravel, odor					500
		30	- red brown sand with some silt and trace gravel, loose, dry					110
5		14	- red brown sand with some silt and little gravel					400
		10	- red brown sand with some silt, trace gravel; 2" lens of gray clay					450
		44	- dark red brown sand and silt with little gravel, odor, patches of green staining					70
10		62	- red brown sand, little silt					600
		35	- red brown sand and silt with little gravel, odor, damp					20
15		38	- red brown sand and silt, little gravel, odor, saturated					10
		50	Red-brown clayey SILT with little sand and trace gravel, saturated					10
		29						<1
20		62						3
		30						6
25		32						< 1
		120/5"	Red brown SILTSTONE					
30								
35								
40								

Completion Depth 26.5 Feet Water Depth _____ Feet Date 12/15/86

Project Name Xerox Corp. - Blauvelt, NY Project Number 85C2667-9

Woodward-Clyde Consultants

WCC - RP 1

LOG of BORING No. SP-13

DATE 12/16/86 SURFACE ELEVATION _____ LOCATION See Figure

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	DESCRIPTION	ELEVATION	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OVA SOILS (ppm)
			8" CONCRETE and gravel					
		4	Red brown silty SAND with little clay and trace gravel, odor					750
		28						250
5		20						>1000
		16						
		29	- red brown silty sand, trace silt, trace gravel, odor					>1000
10		100	- red brown sand, little silt, odor					>1000
			Refusal at 11'					
15								

Completion Depth 11 Feet Water Depth _____ Feet Date 12/16/86

Project Name Xerox Corp. Blauvelt, NY Project Number 85C2667-9

WCC - AP

Woodward-Clyde Consultants

LOG of BORING No. SP-14 (MW-17)

DATE 12/16/86 SURFACE ELEVATION _____ LOCATION See Figure

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	DESCRIPTION	ELEVATION	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OVA SOILS (ppm)
		8	Red brown sandy SILT, trace gravel, odor					250
		4	Red brown silty SAND, trace clay, odor					500
5		14	- red-brown silty sand, trace clay and gravel, odor					100
		4	- dark red brown silty sand with little clay, trace gravel, odor					100
		15						600
10		18	- red brown silty sand					700
			- dark red brown silty sand, little clay trace gravel, odor, moist					>1000
15		24	- dark red brown silty sand, little clay trace gravel, odor, saturated					900
		17	- red brown silty sand, trace clay and gravel, black patches, odor					600
		10	- red brown silty sand and siltstone fragments					250
20		15	Red brown sandy SILT with little clay siltstone fragments					10
		110/2"	SILTSTONE					
25								

Completion Depth 22 Feet Water Depth 13.5 Feet Date 12/16/86

Project Name Xerox Corp. - Blauvelt, NY Project Number 85C2667-9

Woodward-Clyde Consultants

WCC - RP 1.

LOG of BORING No. SP-15

DATE 12/17/86 SURFACE ELEVATION _____ LOCATION See Figure

DEPTH, ft. / SAMPLES	SAMPLING RESISTANCE	DESCRIPTION	ELEVATION	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OVA SOILS (ppm)
		Note: Bottom of sump at 8'					
5							
	6	Medium to fine black SAND, some silt, moist					
10	7	-black silty sand grading to red brown silty sand with some pebbles, wet					
	10	-red brown silty sand, black staining at top					100
	19	-red brown coarse to medium sand with some gravel andsome fine sand and silt					12
15	10	-reddish brown silty coarse to medium sand					1
	6						< 1
20	36						< 1
	50						< 1
		Gray SHALE					
25							
30							
35							
40							

Completion Depth 23 Feet Water Depth _____ Feet Date 12/17/86

Project Name Xerox Corp. - Blauvelt, NY Project Number 85C2667-9

Woodward-Clyde Consultants

WCC - AP

LOG of BORING No. SP-16

DATE 12/12/86 SURFACE ELEVATION _____ LOCATION See Figure

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	DESCRIPTION	ELEVATION	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OVA SOILS (ppm)
		2	Light brown silty SAND, moist					0
		43	Light to medium brown sandy gravelly FILL, contains concrete fragments					0
5		39	Highly mottled light to dark brown fine to medium SAND, trace silt, gravel					0
		11	-light to medium brown coarse to medium sand					0
		15	-gray/green coarse to fine sand, slight odor					100
10		13	-red brown silty fine sand, wet at bottom					200
		21	-reddish brown fine sand and silt, black non-aqueous phase liquid present					
15		14						
		9	-red brown medium to fine sand, trace silt, wet					60
		19	-red brown coarse to medium silty sand, trace clay, gravel, wet					10
20		65						7
			SHALE					
25								
30								
35								
40								

Completion Depth 22 Feet Water Depth 5.1 Feet Date 12/13/86

Project Name Xerox Corp. - Blauvelt, NY Project Number 85C2667-9

Woodward-Clyde Consultants

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LOG of BORING No. SP-17

DATE 12/17/86 SURFACE ELEVATION _____ LOCATION See Figure

DEPTH, ft. / SAMPLES	SAMPLING RESISTANCE	DESCRIPTION	ELEVATION	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OVA SOILS (ppm)
	2	Gray/buff silty SAND					0
	12	-reddish brown silty sand with trace gravel					0
5	20	-brown silty medium sand, wet					110
	20	-reddish brown to medium brown fine sand with little silt, trace clay					75
	5	-Reddish brown sandy, silty GRAVEL, wet					7
10	7	Gravelly SAND with little silt					7
	13	-silty coarse to fine sand, trace clay					8
	14	-red brown to dark brown coarse to medium sand with little gravel					2
15	9	-red brown silty sand					12
	70	-red brown silty sand					8
20		SHALE					
25							
30							
35							
40							

Completion Depth 19.5 Feet Water Depth 2.75 Feet Date 12/15/86

Project Name Xerox Corp. - Blauvelt, NY Project Number 85C2667-9

WCC - RP

Woodward-Clyde Consultants

LOG of BORING No. MW-14

DATE 12/16/86 SURFACE ELEVATION _____ LOCATION See Figure

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	DESCRIPTION	ELEVATION	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OVA SOILS (ppm)
		4	Topsoil					< 1
		11	Buff-Medium gray silty fine SAND					< 1
			-reddish brown medium to fine sand with little silt, trace gravel					
5		30	-silty medium to fine sand, trace coarse sand, wet					1
		16	-medium to red brown coarse to fine sand, some silt, trace clay, wet					1
		7	-red brown silty sand with some clay					< 1
10		10						< 1
		9	-reddish brown fine sand and silt					< 1
15		10	-medium to coarse sand with fine sand and silt, dense					10
		14						12
		26						16
20		60	-medium to coarse sand with fine sand and silt, some black staining					70
			SHALE					
25								
30								
35								
40								

Completion Depth 21.5 Feet Water Depth _____ Feet Date 12/16/86

Project Name Xerox Corp. - Blauvelt, NY Project Number 85C2667-9

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LOG of BORING No. MW-15

DATE 12/17/86 SURFACE ELEVATION _____ LOCATION See Figure

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	DESCRIPTION	ELEVATION	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OVA SOILS (ppm)
		2	Medium to dark brown clayey SILT and fine sand					< 1
		13	Reddish brown coarse to medium SAND with some silt, moist					4
5		11	-reddish brown coarse to medium sand, trace gravel, moist					1
		7	-reddish brown clayey silty sand with thin medium sand lenses, moist					< 1
		13	-silty medium to fine, reddish brown sand, trace gravel					8
10		15	-reddish brown medium to fine sand with some silt					30
		10	-reddish brown coarse to medium sand, trace silt					20
15								
20								
25								
30								
35								
40								

Completion Depth 14 Feet Water Depth _____ Feet Date 12/17/86

Project Name Xerox Corp. - Blauvelt, NY Project Number 85C2667-9

WCC - RP

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LOG of BORING No. MW-16

DATE 12/18/86 SURFACE ELEVATION _____ LOCATION See Figure

DEPTH, ft.	SAMPLES	SAMPLING RESISTANCE	DESCRIPTION	ELEVATION	WATER CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	OVA SOILS (ppm)
		7	Brown sandy SILT, trace gravel and clay, roots present					20
		14	-brown to dark brown sandy silt with little clay and gravel					100
5		61						150
		39	-red brown sandy silt with little sand and gravel					100
		11						>1000
10		36						500
		35						400
15		35	-red brown sandy silt with little clay and gravel					120
		21	-red brown sandy silt with little clay and gravel, trace siltstone fragments					150
		13						250
20		85						NS 30
25			SILTSTONE					

Completion Depth 23.5 Feet Water Depth _____ Feet Date 12/19/86

Project Name Xerox Corp. - Blauvelt, NY. Project Number 85C2667-9

Woodward-Clyde Consultants

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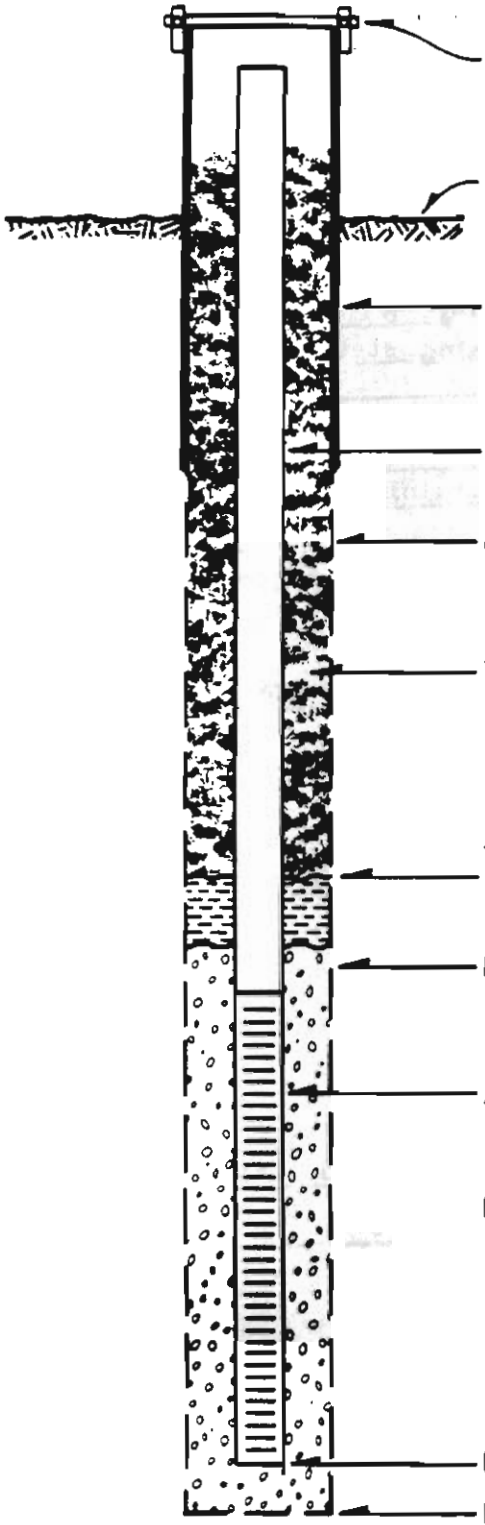


Elevation of top of riser pipe 109.43'

Ground Elevation 106.43'

I.D. of surface casing 6"
Type of surface casing steel

I.D. of riser pipe 2"
Type of riser pipe stainless steel

Diameter of borehole 8"

Type of backfill Cement-Bentonite Grout

Type of seal Bentonite pellets
Depth to top of seal 2.0'

Depth to top of sand pack 3.0'

Depth to top of screen 3.5'
Type of screened section
Johnson stainless steel #10 slot

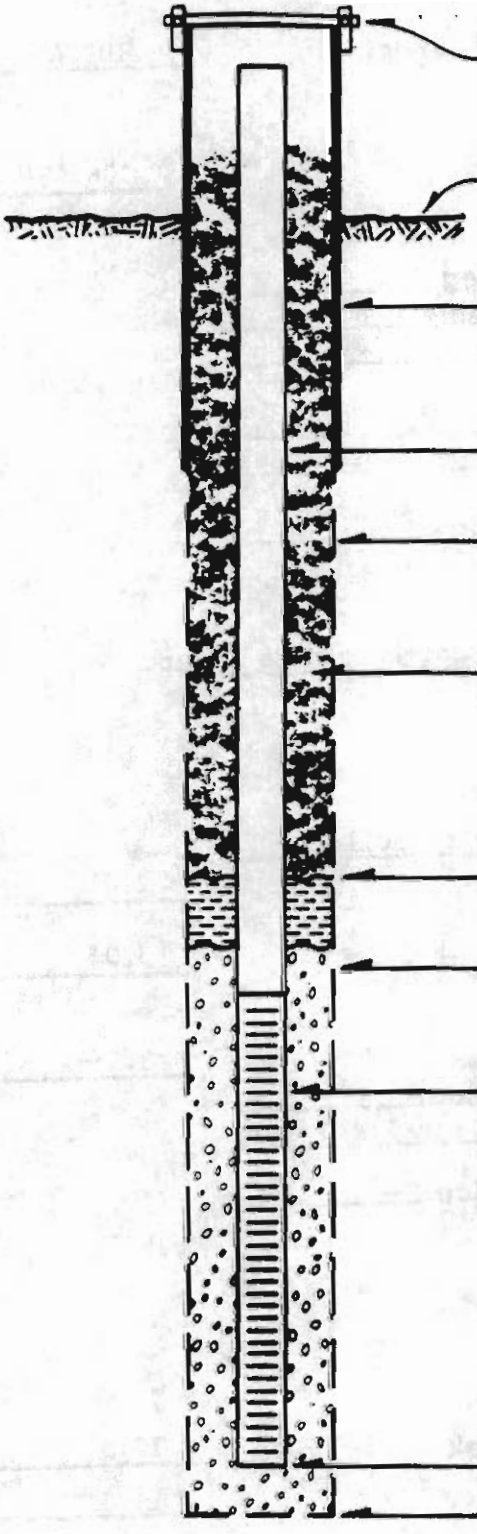
I.D. of screened section 2"

Depth to bottom of well 13.5'

Depth of borehole 13.5'

REPORT OF MONITORING WELL NO. MW-10

DRAWN BY: D.B.	CHECKED BY: GWC	PROJECT NO: 85C2667-3	DATE: 11/5/86	FIGURE NO:



Elevation of top of riser pipe 112.64'

Ground Elevation 110.13'

I.D. of surface casing 6"
Type of surface casing steel

I.D. of riser pipe 2"
Type of riser pipe stainless steel

Diameter of borehole 8"

Type of backfill Cement-Bentonite Grout

Type of seal Bentonite pellets
Depth to top of seal 2.5'

Depth to top of sand pack 3.5'

Depth to top of screen 4'
Type of screened section
Johnson stainless steel #10 slot

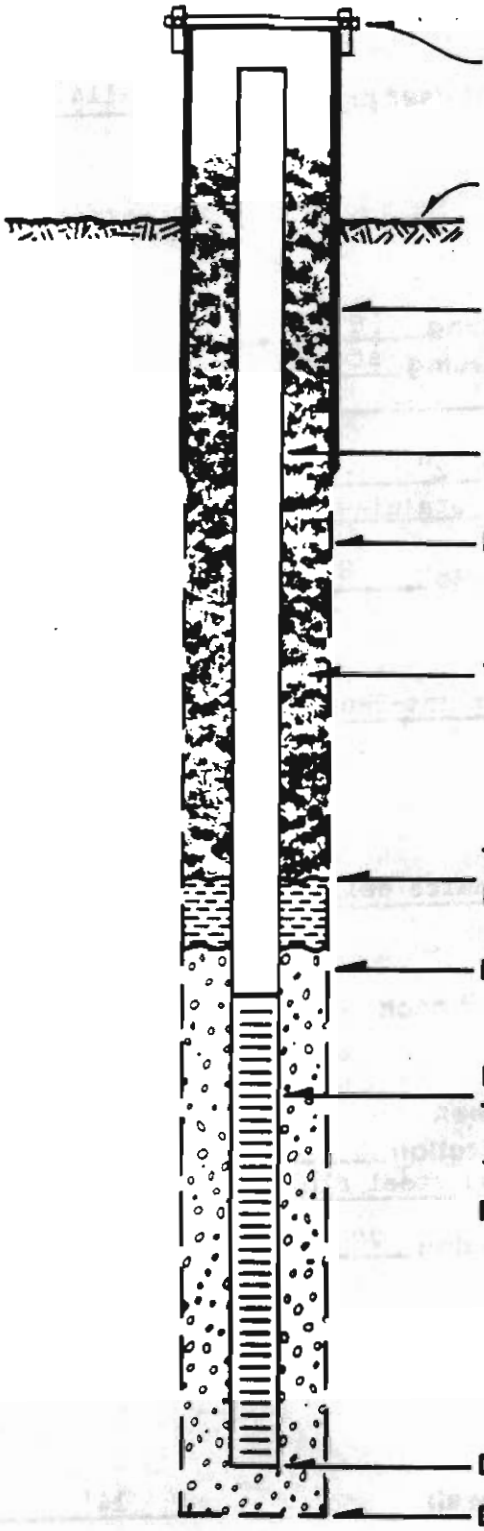
I.D. of screened section 2"

Depth to bottom of well 14'

Depth of borehole 14'

REPORT OF MONITORING WELL NO. MW-11

DRAWN BY: D.B.	CHECKED BY: GWC	PROJECT NO: 85C2667-3	DATE: 11/6/86	FIGURE NO:



Elevation of top of riser pipe: 111.72'

Ground Elevation: 108.69'

I.D. of surface casing: 6"
Type of surface casing: steel

I.D. of riser pipe: 2"
Type of riser pipe: stainless steel

Diameter of borehole: 8"

Type of backfill: Cement-Bentonite Grout

Type of seal: Bentonite pellets
Depth to top of seal: 2.0'

Depth to top of sand pack: 3.0'

Depth to top of screen: 3.5'
Type of screened section: Diedrich stainless steel #10 slot

I.D. of screened section: 2"

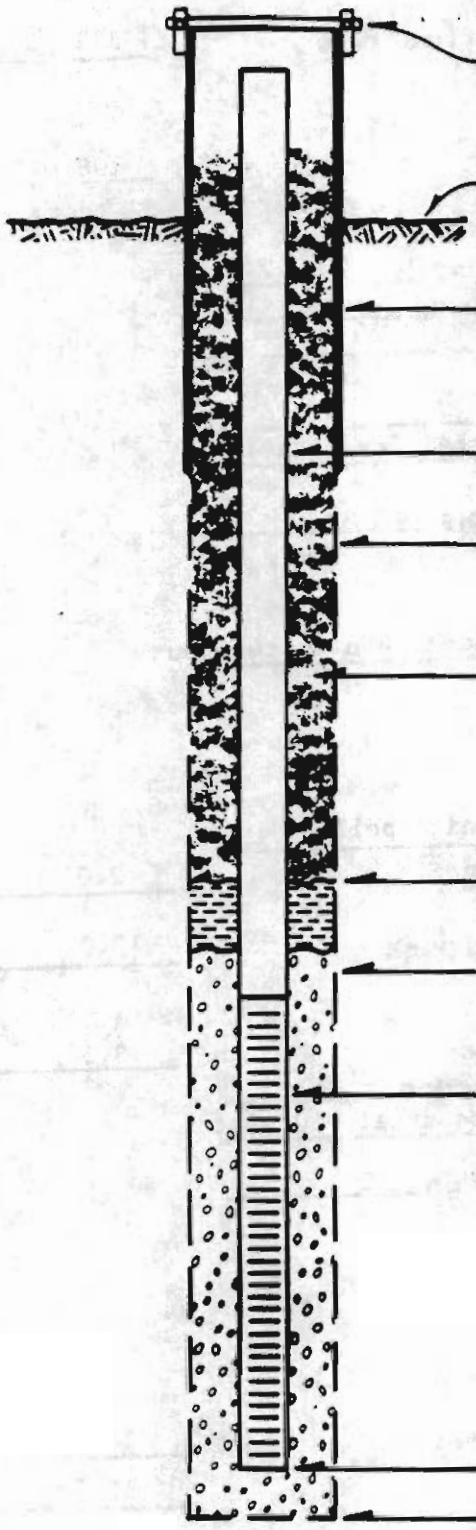
Depth to bottom of well: 13.5'

Depth of borehole: 13.5'

REPORT OF MONITORING WELL NO. MW-12

DRAWN BY: D.B.	CHECKED BY: GWC	PROJECT NO: 85C2667-3	DATE: 11/7/86	FIGURE NO:

Woodward-Clyde Consultants



Elevation of top of riser pipe 114.28'

Ground Elevation 111.58'

I.D. of surface casing 6"
Type of surface casing steel

I.D. of riser pipe 2"
Type of riser pipe stainless steel

Diameter of borehole 8"

Type of backfill Cement-Bentonite Grout

Type of seal Bentonite pellets
Depth to top of seal 2.5'

Depth to top of sand pack 3.5'

Depth to top of screen 4'
Type of screened section
Johnson stainless steel #10 slot

I.D. of screened section 2"

Depth to bottom of well 14'

Depth of borehole 14'

REPORT OF MONITORING WELL NO. MW-13

DRAWN BY: D.B.	CHECKED BY: GWC	PROJECT NO: 85C2667-3	DATE: 11/7/86	FIGURE NO:

Elevation of top of riser pipe _____

Ground Elevation _____

I.D. of surface casing 6"
Type of surface casing steel

I.D. of riser pipe 2"
Type of riser pipe stainless steel

Diameter of borehole 8"

Type of backfill Cement Grout

Type of seal Bentonite pellets
Depth to top of seal 1.5'

Depth to top of sand pack 2.0'

Depth to top of screen 2.25'
Type of screened section
Johnson stainless steel #10 slot

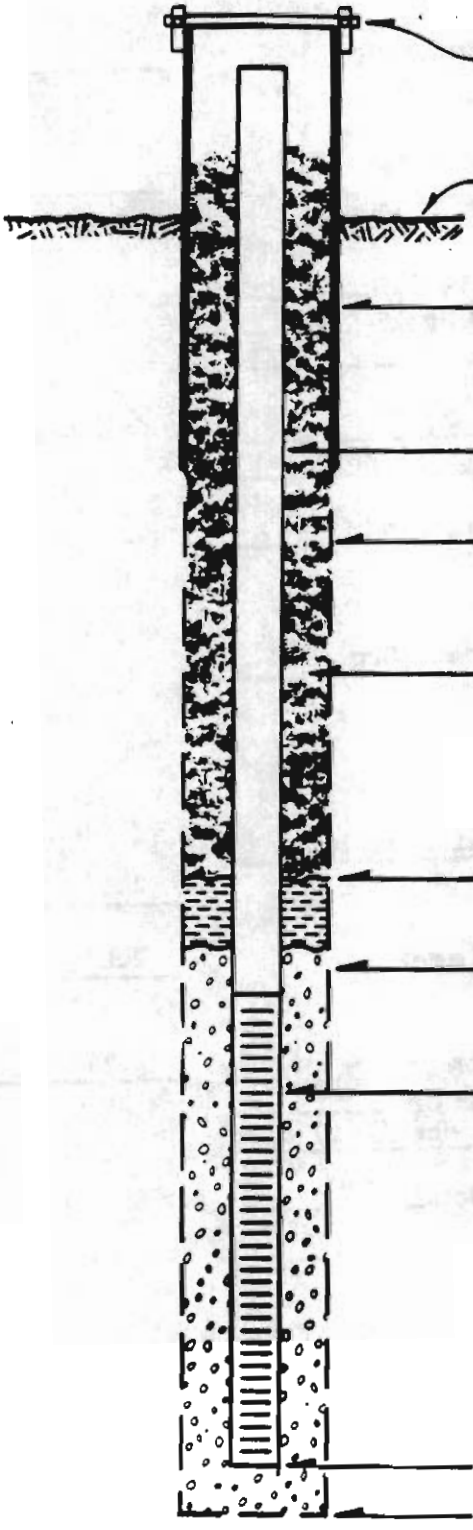
I.D. of screened section 2"

Depth to bottom of well 12.25'

Depth of borehole 18'

REPORT OF MONITORING WELL NO. MW-14

DRAWN BY: D.B.	CHECKED BY: GWC	PROJECT NO: 85C2667-9	DATE: 12/16/86	FIGURE NO:



Elevation of top of riser pipe _____

Ground Elevation _____

I.D. of surface casing 6"
Type of surface casing steel

I.D. of riser pipe 2"
Type of riser pipe stainless steel

Diameter of borehole 8"

Type of backfill Cement Grout

Type of seal Bentonite pellets
Depth to top of seal 1.8'

Depth to top of sand pack 2.3'

Depth to top of screen 2.8'
Type of screened section
Johnson stainless steel #10 slot

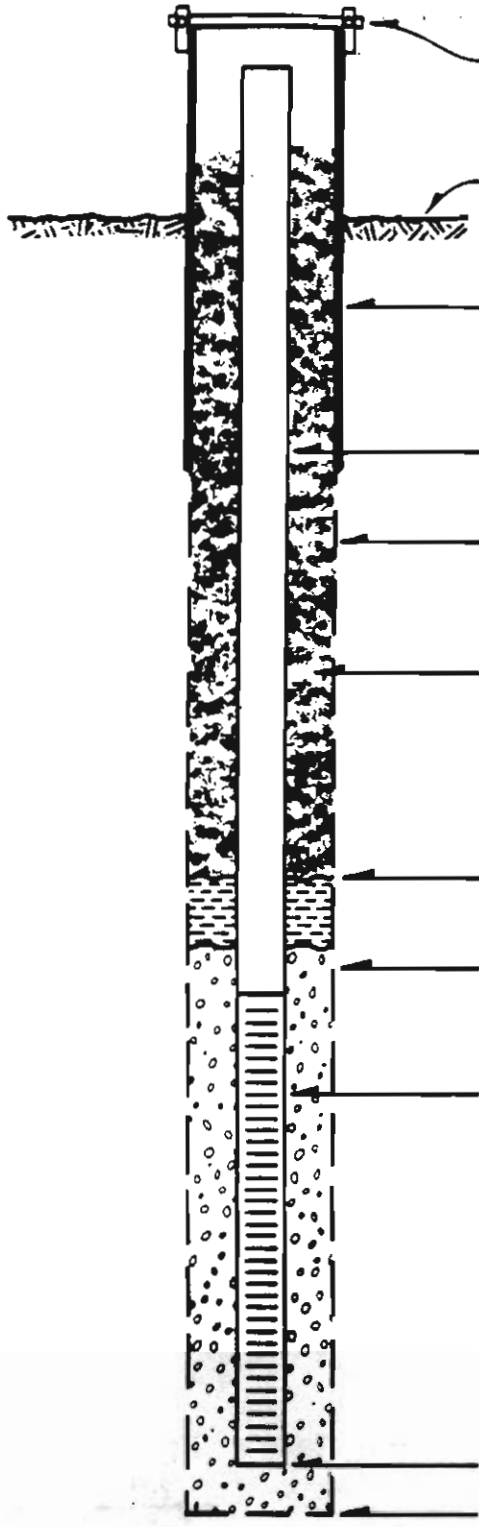
I.D. of screened section 2"

Depth to bottom of well 12.8'

Depth of borehole 14'

REPORT OF MONITORING WELL NO. MW-15

DRAWN BY: D.B.	CHECKED BY: GWC	PROJECT NO: 85C2667-9	DATE: 12/17/86	FIGURE NO:



Elevation of top of riser pipe _____

Ground Elevation _____

I.D. of surface casing 6"
Type of surface casing steel

I.D. of riser pipe 2"
Type of riser pipe stainless steel

Diameter of borehole 8"

Type of backfill Cement Grout

Type of seal Bentonite pellets
Depth to top of seal 4'

Depth to top of sand pack 5'

Depth to top of screen 7'
Type of screened section
Johnson stainless steel #10 slot

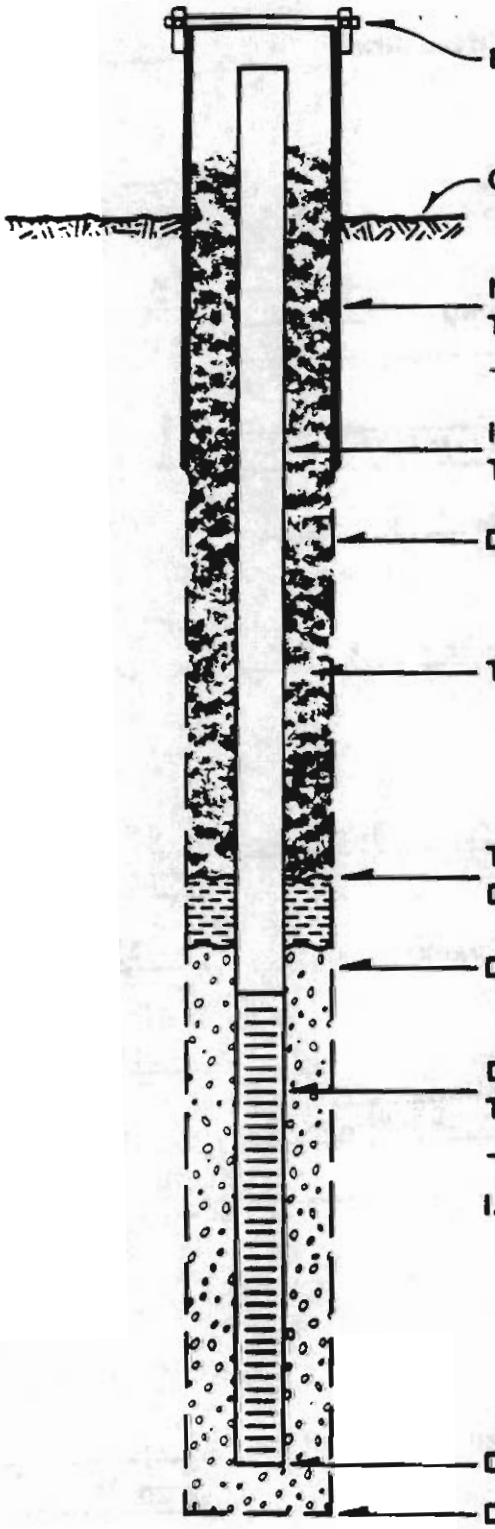
I.D. of screened section 2"

Depth to bottom of well 17'

Depth of borehole 20'

REPORT OF MONITORING WELL NO. MW-16

DRAWN BY: D.B.	CHECKED BY: GWC	PROJECT NO: 85C2667-9	DATE: 12/18/86	FIGURE NO:



Elevation of top of riser pipe: Flush Mount (same as ground elevation)

Ground Elevation: _____

I.D. of surface casing: 6"

Type of surface casing: steel flush mount

I.D. of riser pipe: 2"

Type of riser pipe: stainless steel

Diameter of borehole: 8"

Type of backfill: Cement Grout

Type of seal: Bentonite pellets

Depth to top of seal: 5.5'

Depth to top of sand pack: 7'

Depth to top of screen: 10'

Type of screened section: Johnson stainless steel #10 slot

I.D. of screened section: 2"

Depth to bottom of well: 20'

Depth of borehole: 22'

REPORT OF MONITORING WELL NO. MW-17

DRAWN BY: D.B.	CHECKED BY: GWC	PROJECT NO: 85C2667-9	DATE: 12/19/86	FIGURE NO:

APPENDIX A-3

INVESTIGATION OF POTENTIAL ALTERNATE SOURCES

APPENDIX A-3
INVESTIGATION OF OTHER POTENTIAL CONTAMINATION SOURCES

Task Description: Six soil borings (SP-10 through SP-15) were drilled in November and December 1986 as part of an investigation of other potential sources of contamination at the Blauvelt site. One of the borings (SP-14) was converted into a monitoring well (MW-17).

Task Objective: As an outgrowth of investigations related to the former underground storage tanks, WCC initiated an investigation of other solvent-use facilities at the site. The six borings and one well were installed to help evaluate potential contaminant sources upgradient from the former tank area. The areas of interest in this task included the former drain and fill pipelines for the tanks, a sump adjacent to the building, and the former solvent spray booths inside the building.

Work Performed: Locations of the soil borings and the monitoring well are shown on Figure A-1.1. Logs of borings and well construction details are given in Appendix A-2. Two of the borings (SP-10 and SP-11) were drilled in the vicinity of former solvent pipelines running from the building to the former underground storage tanks. One boring (SP-15) was drilled in a sump immediately adjacent to the existing building, near the point where the former pipelines exited the building. Three borings (SP-12, SP-13, and SP-14) were advanced inside the existing building near former solvent spray booths. One of these borings, SP-14, was converted to a monitoring well (MW-17) in order to evaluate groundwater quality near the spray booths.

All borings were drilled using hollow-stem auger techniques. Continuous split spoon samples of the soils were collected and were subjected to measurements of organic vapor in the headspace of the sample jars; OVA headspace readings are included on the boring logs. In addition, selected soil samples were collected from each boring and submitted for laboratory analysis. Results of soil analyses are given in Table A-2.1. All boreholes were backfilled with cuttings and grouted with a cement-bentonite grout to the surface when completed. Cuttings from SP-14, which was converted to MW-17, were drummed for off-site disposal. MW-17 was developed following completion of well

installation. Well development water was also contai d in drums. Groundwater sampling and measurement of groundwater elevations were carried out soon after well installation; results are tabulated in Appendix A-6. Total volatile organics concentration in the groundwater from MW-17 is summarized on Table A-2.2.

Observations/Discussion: Soil sample headspace readings and laboratory results, along with groundwater samples from MW-17, confirm that the former solvent spray booth area has been a source of contamination to the subsurface. Sample headspace readings and laboratory analyses indicate that the former pipeline is apparently not a source of contamination, and that the area has not been impacted by contamination.

APPENDIX A-4

NAPL RECOVERY TESTING

APPENDIX A-4
NAPL RECOVERY TESTING

Task Description: As part of the investigation of non-aqueous phase liquid (NAPL) occurrence and remediation at the Blauvelt site, a limited recovery testing program was carried out on five wells.

Task Objective: The purpose of the NAPL recovery testing is to evaluate the existing shallow monitoring wells to prioritize specific locations to act as long-term NAPL recovery points. This work was only performed on wells MW-7, MW-10, MW-11, MW-12, and MW-13, as these are the only wells where NAPL has consistently been detected.

Work Performed: Work prior to this task had been performed to identify the general occurrence of NAPL in the area around the former underground storage tanks (see "NAPL Investigation" section). NAPL was detected in MW-7, MW-10, MW-11, MW-12, and MW-13. The recovery test program was implemented on these five wells to measure recovery rates and yields. This task was implemented by General Testing Corporation, by pumping NAPL from the five wells, as available, on approximately a daily basis between December 10 and 23, 1986.

The wells were pumped with a suction hose connected to a diaphragm pump on the surface. Prior to pumping, the thickness of NAPL in each well was measured using a clean bailer. Only wells with a measurable thickness of NAPL were pumped. The suction pump was implemented in a manner that would allow for pumping predominately NAPL, with minimal water pumped. All NAPL and contaminated water pumped during this effort was containerized in a 55-gallon drum.

Observations/Discussion: Table A-4.1 presents a summary of the NAPL thickness and recovery records. The greatest amount of NAPL was recovered from MW-10, followed by MW-11 and MW-12. Product recovery from MW-7 and MW-13 was insignificant. Figure A-4.1 presents a record of cumulative volumes recovered during this program.

TABLE A-4.1

THICKNESS AND RECOVERY OF NON-AQUEOUS PHASE LIQUID
XEROX CORPORATION
BLAUVELT, NEW YORK

Well No.	11/12/86 Product Thick. (ft)	11/12/86 Product Recovered (gal)	12/10/86 Product Thick. (ft)	12/10/86 Product Recovered (gal)	12/11/86 Product Thick. (ft)	12/11/86 Product Recovered (gal)	12/12/86 Product Thick. (ft)	12/12/86 Product Recovered (gal)	12/15/86 Product Thick. (ft)	12/15/86 Product Recovered (gal)
MW-7	.44	0	--	0	0	0	.1	.065	0	0
MW-10	.61	0	.7	.456	.3	.195	.35	.228	.55	.359
MW-11	1.50	0	.4	.261	.15	.098	.1	.065	.15	.098
MW-12	.77	0	.1	.065	.15	.098	.1	.065	.1	.065
MW-13	.18	0	.1	.065	.1	.065	.1	.065	.1	.065

Well No.	12/16/86 Product Thick. (ft)	12/16/86 Product Recovered (gal)	12/18/86 Product Thick. (ft)	12/18/86 Product Recovered (gal)	12/22/86 Product Thick. (ft)	12/22/86 Product Recovered (gal)	12/23/86 Product Thick. (ft)	12/23/86 Product Recovered (gal)	1/07/87 Product Thick. (ft)	1/07/87 Product Recovered (gal)
MW-7	0	0	0	0	0	0	0	0	.15	0
MW-10	.4	.261	.2	.130	.25	.163	.15	.098	.45	0
MW-11	.15	.098	.15	.098	.1	.065	.2	.130	.3	0
MW-12	--	0	.1	.065	.1	.065	.1	.065	.1	0
MW-13	.1	.065	0	0	.1	.065	0	0	.05	0

-- = Not measured

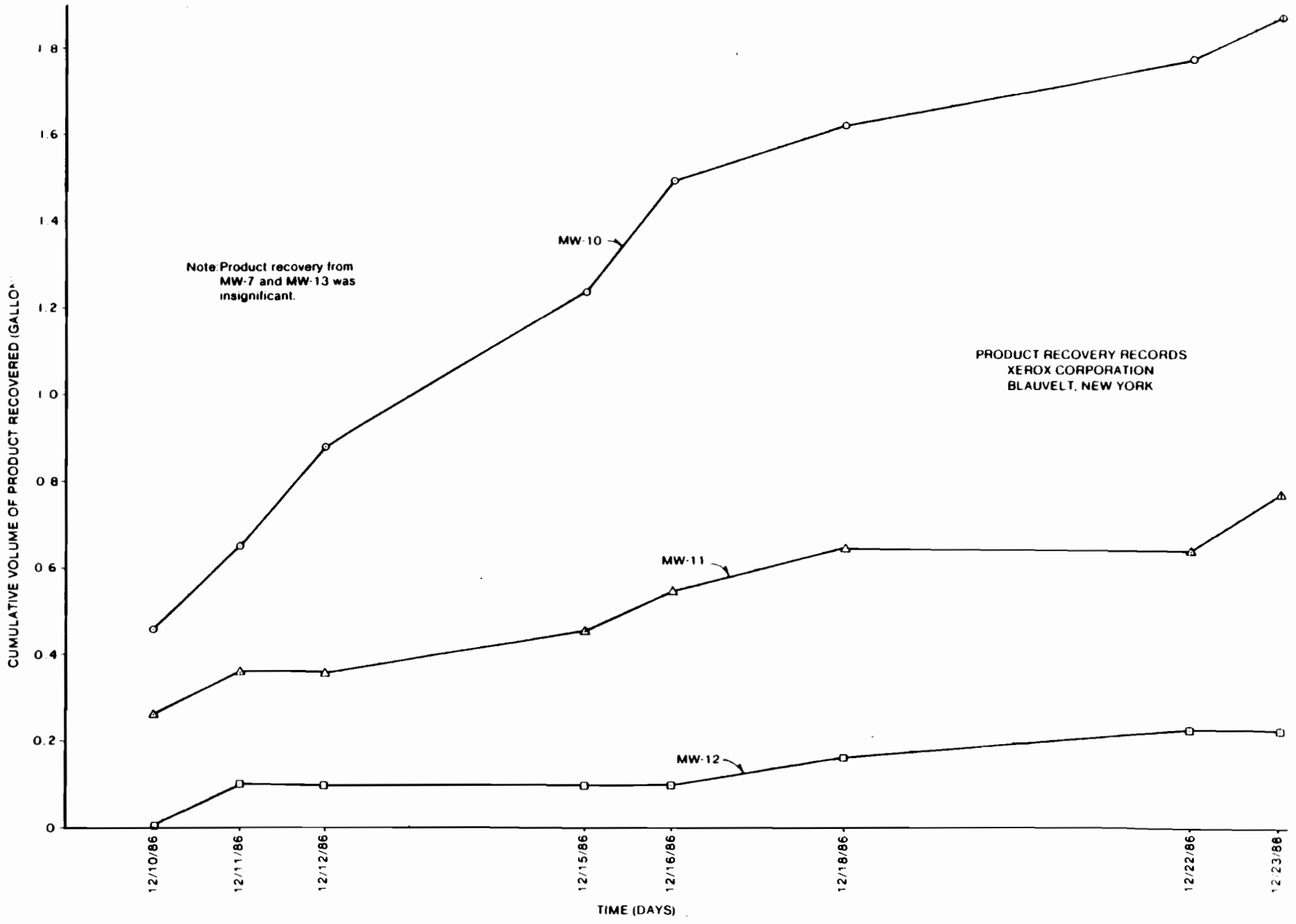

CUMULATIVE VOLUME OF PRODUCT RECOVERED (GALLO
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0
Note: Product recovery from MW-7 and MW-13 was insignificant.
MW-10
MW-11
MW-12
PRODUCT RECOVERY RECORDS
XEROX CORPORATION
BLAUVELT, NEW YORK
12/10/86
12/11/86
12/12/86
12/15/86
12/16/86
12/18/86
12/22/86
12/23/86
TIME (DAYS)

FIGURE A-4.1

APPENDIX A-5

SOIL GAS SAMPLING

APPENDIX A-5
SOIL GAS SAMPLING

Task Description: WCC performed a reconnaissance - level survey of selected on-site areas by sampling soil gas from the unsaturated zone.

Task Objective: The purpose of the soil gas sampling was to evaluate the applicability of this field technique to the contaminants and soils at this site. The work was not performed to delineate an on-site plume, but rather to use the existing on-site data to determine if the technique would be applicable to other upgradient and downgradient areas.

Work Performed: Soil gas samples were collected from eight stations near the former underground tanks (Figure A-5.1). A total of ten samples were collected, two samples being duplicates at selected sites. Sample locations were selected to be adjacent to soil and/or groundwater sampling points. The samples were collected from a depth of three feet below grade and analyzed in the field with an HNu organic vapor meter with an 11.7 ev lamp. Two samples were also collected in air bags for laboratory QA/QC confirmation.

At each station, a steel probe with a perforated tip was driven to a depth of three feet (Figure A-5.2). Probes were decontaminated with an acetone rinse and steam cleaning prior to use. Soil gas samples were withdrawn from the subsurface using a Metalbellows oil-less vacuum pump allowing several minutes to evacuate the probe before sampling. After evacuating the probe, the HNu intake was attached to the top of the probe, allowing the sample to be drawn into the HNu by its own internal pump. HNu readings were recorded as the peak value over a three to four minute period. Duplicate readings were taken by installing a second probe within three feet of the first and following procedures as outlined above. Air bag samples were collected from the discharge of the Metalbellows pump after taking the HNu readings.

Observations/Discussions: Table A-5.1 summarizes the HNu readings from the ten soil gas probes. Also shown on Table A-5.1 are data from nearby soil and groundwater

analyses, where available, to indicate the degree of correlation between the soil gas and other analyses.

Table A-5.2 summarizes the results of the laboratory analyses for the two soil gas samples collected in air bags. These data indicate a general correlation trend between field and laboratory results, considering the overall sensitivity of the HNu.

TABLE A-5.1

SUMMARY OF ON-SITE SOIL GAS SAMPLING RESULTS
November 3 through 5, 1986

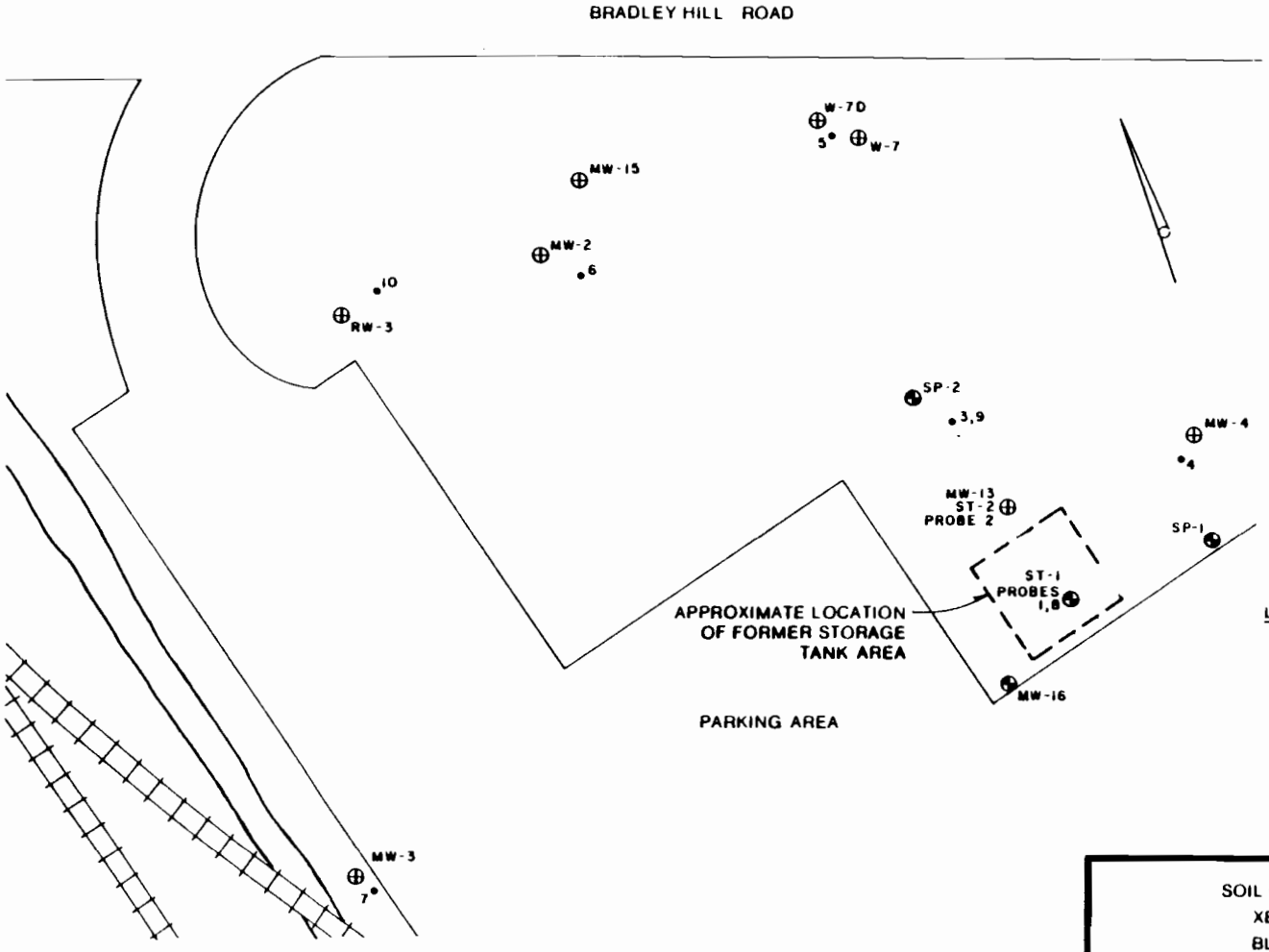
Soil Gas Probe No.	HNu Reading, ppm	Nearby Soil Analysis*	Nearby Groundwater Analysis*	Comments
1	10	96.3 (ST-1; 8-10 ft)	173.5 (MW-16; 1/9/87)	Prior to standardizing methods
2	200	27.9 (ST-2; 4-6 ft)	232.4 (MW-13; 1/9/87)	
3	305	3.5 (SP-2; 4-6 ft)	85.7 (MW-12; 1/9/87)	
4	3.0	33 (SP-1; 8-10 ft)	32.3 (MW-4; 1/9/87)	
5	25	1.4 (RW-8; 6-12 ft)	197.1 (MW-7; 1/9/87)	
6	75	0.032 (MW-15; 6-8 ft)	34.2 (MW-2; 1/9/87)	
7	7.5	ND	1.7 (MW-3; 12/16/85)	
8	145	96.3 (ST-1; 8-10 ft)	173.5 (MW-16; 1/9/87)	Duplicate of Probe 1
9	250	3.5 (SP-2; 4-6 ft)	85.7 (MW-12; 1/9/87)	Duplicate of Probe 3
10	162	ND	3.3 (RW-3; 11/7/86)	

* Soil and groundwater analyses given as total volatile organics, ppm

TABLE A-5.2

SUMMARY OF LABORATORY CONFIRMATION ANALYSES
QA/QC SOIL GAS SAMPLES

Probe No.	Field HNu Reading, ppm	Laboratory Analyses	
		Total Volatiles, ppb	Mineral Spirits, ppm
3	305	4316	2200
6	75	16.9	500



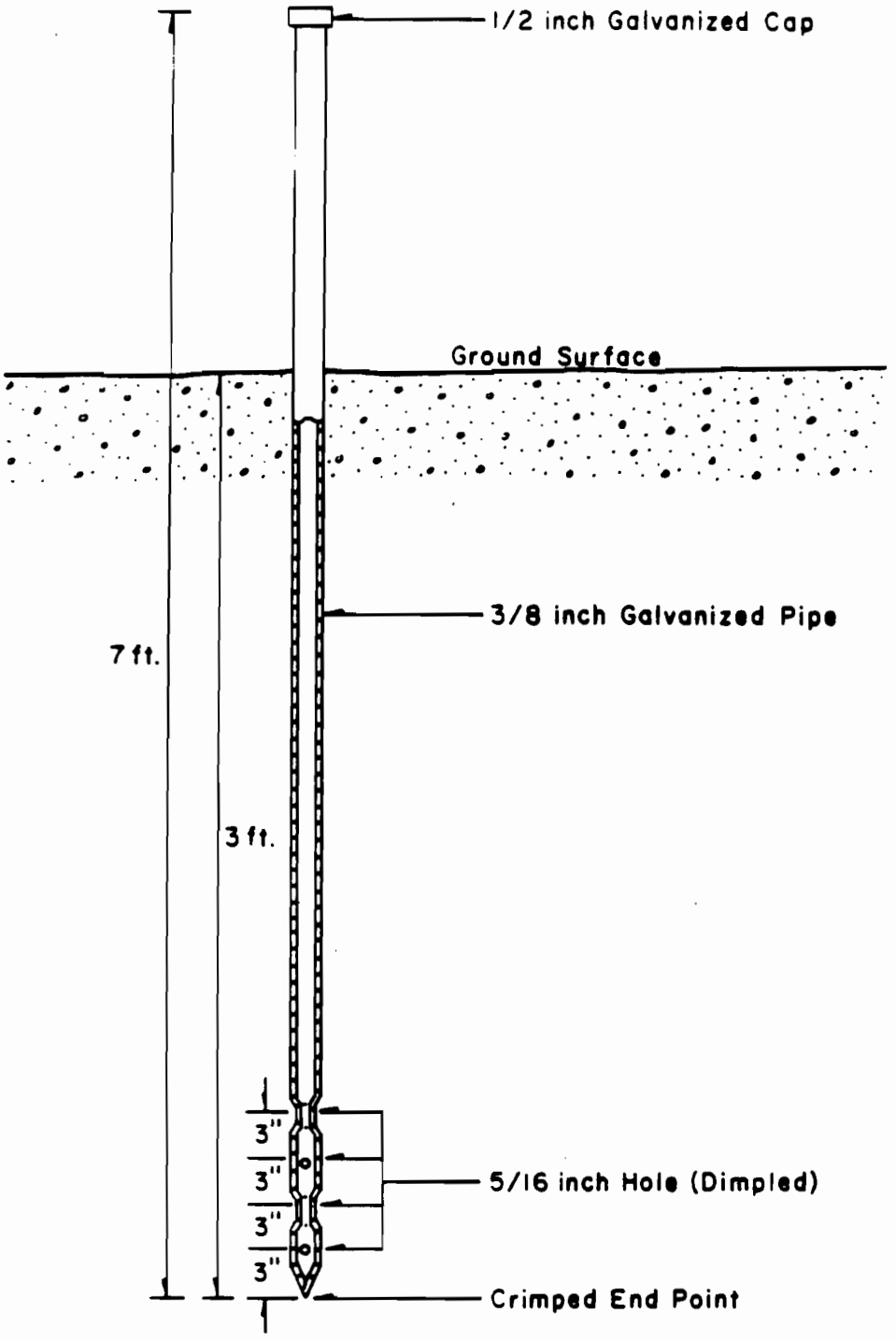
NOTE: ONLY WELLS AND BORINGS LOCATED NEAR SOIL GAS PROBES SHOWN

SOIL GAS PROBE LOCATIONS
XEROX CORPORATION
BLAUVELT, NEW YORK

WOODWARD-CLYDE CONSULTANTS
CONSULTING ENGINEERS GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

Drawn by: D B	Scale: 0 30	Date: 2/16/87	
Checked by: P R J		Job: 85C2667.10	

FIGURE A-5.1



SOIL GAS SAMPLING
PROBE CONSTRUCTION
XEROX CORPORATION
BLAUVELT, NEW YORK

FIGURE A-5.2

APPENDIX A-6

GROUNDWATER MONITORING DATA

APPENDIX A-6

GROUNDWATER MONITORING DATA

This Appendix presents a summary of all available data from various sampling episodes of on-site monitoring and recovery wells. The data presented herein represent samples collected by Dames & Moore, Recra Environmental and General Testing Corporation.

The abbreviations for NS and ND, included in this Appendix are defined as follows:

NS: Not scheduled for analysis (equivalent to Not Analyzed)

ND: Not detected

In response to the NYSDEC's inquiry regarding lead analysis for the March 16, 1989[1] data submission (first quarter analysis) General Testing Corporation (GTC) attributed differences in results due to variability in the sample sets as a result of slow well recharge, variability in the sample sets as a result of slow well recharge, traces of NAPL, and field sampling technique. A copy of GTC's letter is attached to the end of this Appendix.

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(1) (It appears the NYSDEC comments incorrectely referenced the April 18, 1989 report since TCL analyses and lead, furnance analysis were run simulataneously only during the first quarter sampling event date March 16, 1989.

WELL NUMBER MW-10

CATEGORY	PARAMETER	UNITS	DATE 01/16/87 CONCENTRATION	DATE 01/31/89 CONCENTRATION	DATE 04/18/89 CONCENTRATION
ALIPHATICS					
	MINERAL SPIRITS	ppb	NS	9730.0	19600.0
	N-HEPTANE	ppb	NS	NS	NS
	N-OCTANE	ppb	NS	NS	NS
	N-NONANE	ppb	NS	NS	NS
	N-DECANE	ppb	NS	NS	NS
VOLATILES					
	CHLOROMETHANE	ppb	<500.0	<2500.0	<5000.0
	BROMOMETHANE	ppb	<500.0	<2500.0	<5000.0
	DICHLORODIFLUOROMETHANE	ppb	<500.0	NS	NS
	VINYL CHLORIDE	ppb	<500.0	<1000.0	<2000.0
	CHLOROETHANE	ppb	<500.0	<1000.0	<2000.0
	METHYLENE CHLORIDE	ppb	<100.0	<500.0	<1000.0
	TRICHLOROFLUOROMETHANE	ppb	<100.0	<1000.0	<2000.0
	1,1-DICHLOROETHENE	ppb	<100.0	<500.0	<1000.0
	1,1-DICHLOROETHANE	ppb	<100.0	<500.0	<1000.0
	1,2-DICHLOROETHENE	ppb	1500.0	10900.0	2700.0
	CHLOROFORM	ppb	<100.0	<500.0	<1000.0
	1,2-DICHLOROETHANE	ppb	<100.0	<500.0	<1000.0
	1,1,1-TRICHLOROETHANE	ppb	22500.0	8790.0	<1000.0
	CARBON TETRACHLORIDE	ppb	<100.0	<500.0	<1000.0
	BROMODICHLOROMETHANE	ppb	<100.0	<500.0	<1000.0
	1,2-DICHLOROPROPANE	ppb	<100.0	<500.0	<1000.0
	1,3-DICHLOROPROPENE (TRANS)	ppb	<100.0	<1000.0	<2000.0
	TRICHLOROETHENE	ppb	23000.0	12800.0	1200.0
	1,3-DICHLOROPROPENE (CIS)	ppb	<200.0	<500.0	<1000.0
	DIBROMOCHLOROMETHANE	ppb	<200.0	<1000.0	<2000.0
	1,1,2-TRICHLOROETHANE	ppb	<200.0	<1000.0	<2000.0
	2-CHLOROETHYLVINYL ETHER	ppb	<200.0	<1000.0	<2000.0
	BROMOFORM	ppb	<200.0	<1000.0	<2000.0
	1,1,2,2-TETRACHLOROETHANE	ppb	<100.0	<1000.0	<2000.0
	TETRACHLOROETHENE	ppb	260000.0	88400.0	51800.0
	CHLOROBENZENE	ppb	<200.0	<1000.0	<2000.0
	1,3-DICHLOROBENZENE (M)	ppb	<200.0	NS	NS
	1,2-DICHLOROBENZENE (O)	ppb	<200.0	NS	NS
	1,4-DICHLOROBENZENE (P)	ppb	<200.0	NS	NS
	BENZENE	ppb	2900.0	<1000.0	<2000.0
	TOLUENE	ppb	3300.0	<1000.0	<2000.0
	ETHYLBENZENE	ppb	1400.0	<1000.0	<2000.0
	CHLOROBENZENE	ppb	<200.0	<1000.0	<2000.0
	1,4-DICHLOROBENZENE	ppb	<200.0	<1000.0	<2000.0
	1,3-DICHLOROBENZENE	ppb	<200.0	<1000.0	<2000.0
	1,2-DICHLOROBENZENE	ppb	<200.0	<1000.0	<2000.0
	P-XYLENE	ppb	<1000.0	<1000.0	<2000.0
	M-XYLENE	ppb	<1000.0	<1000.0	<2000.0
	O-XYLENE	ppb	<1000.0	<1000.0	<2000.0
	TOTAL VOLATILES	ppb	314600.0	120890.0	55700.0

WELL NUMBER MW-12

CATEGORY	PARAMETER	UNITS	DATE 01/16/87 CONCENTRATION	DATE 01/31/89 CONCENTRATION	DATE 04/18/89 CONCENTRATION
ALIPHATICS					
	MINERAL SPIRITS	ppb	NS	<100.0	9670.0
	N-HEPTANE	ppb	NS	NS	NS
	N-OCTANE	ppb	NS	NS	NS
	N-NONANE	ppb	NS	NS	NS
	N-DECANE	ppb	NS	NS	NS
VOLATILES					
	CHLOROMETHANE	ppb	<500.0	<1000.0	<500.0
	BROMOMETHANE	ppb	<500.0	<1000.0	<500.0
	DICHLORODIFLUOROMETHANE	ppb	<500.0	NS	NS
	VINYL CHLORIDE	ppb	<500.0	<400.0	<200.0
	CHLOROETHANE	ppb	<500.0	<400.0	<200.0
	METHYLENE CHLORIDE	ppb	<100.0	220.0	<100.0
	TRICHLOROFLUOROMETHANE	ppb	<100.0	<400.0	<200.0
	1,1-DICHLOROETHENE	ppb	<100.0	<200.0	<100.0
	1,1-DICHLOROETHANE	ppb	<100.0	<200.0	<100.0
	1,2-DICHLOROETHENE	ppb	5700.0	50000.0	8530.0
	CHLOROFORM	ppb	<100.0	<200.0	<100.0
	1,2-DICHLOROETHANE	ppb	<100.0	<200.0	<100.0
	1,1,1-TRICHLOROETHANE	ppb	5300.0	2163.0	925.0
	CARBON TETRACHLORIDE	ppb	<100.0	<200.0	<100.0
	BROMODICHLOROMETHANE	ppb	<100.0	<200.0	<100.0
	1,2-DICHLOROPROPANE	ppb	<100.0	<200.0	<100.0
	1,3-DICHLOROPROPENE (TRANS)	ppb	<100.0	<400.0	<200.0
	TRICHLOROETHENE	ppb	13000.0	1490.0	822.0
	1,3-DICHLOROPROPENE (CIS)	ppb	<200.0	<200.0	<100.0
	DIBROMOCHLOROMETHANE	ppb	<200.0	<400.0	<200.0
	1,1,2-TRICHLOROETHANE	ppb	<200.0	<400.0	<200.0
	2-CHLOROETHYLVINYL ETHER	ppb	<200.0	<400.0	<200.0
	BROMOFORM	ppb	<200.0	<400.0	<200.0
	1,1,2,2-TETRACHLOROETHANE	ppb	<100.0	<400.0	<200.0
	TETRACHLOROETHENE	ppb	57400.0	21500.0	11500.0
	CHLOROBENZENE	ppb	<200.0	<400.0	<200.0
	1,3-DICHLOROBENZENE (M)	ppb	<200.0	NS	NS
	1,2-DICHLOROBENZENE (O)	ppb	<200.0	NS	NS
	1,4-DICHLOROBENZENE (P)	ppb	<200.0	NS	NS
	BENZENE	ppb	3000.0	<400.0	<200.0
	TOLUENE	ppb	560.0	<400.0	<200.0
	ETHYLBENZENE	ppb	<100.0	<400.0	<200.0
	CHLOROBENZENE	ppb	<200.0	<400.0	<200.0
	1,4-DICHLOROBENZENE	ppb	<200.0	<400.0	<200.0
	1,3-DICHLOROBENZENE	ppb	<200.0	<400.0	<200.0
	1,2-DICHLOROBENZENE	ppb	<200.0	<400.0	<200.0
	P-XYLENE	ppb	NS	<400.0	<200.0
	M-XYLENE	ppb	500.0	<400.0	<200.0
	O-XYLENE	ppb	260.0	<400.0	<200.0
	TOTAL VOLATILES	ppb	85720.0	75373.0	21777.0

WELL NUMBER MW-14

CATEGORY	PARAMETER	UNITS	DATE 01/09/87 CONCENTRATION	DATE 01/31/89 CONCENTRATION	DATE 04/18/89 CONCENTRATION
ALIPHATICS					
	MINERAL SPIRITS	ppb	NS	<100.0	<100.0
	N-HEPTANE	ppb	NS	NS	NS
	N-OCTANE	ppb	NS	NS	NS
	N-NONANE	ppb	NS	NS	NS
	N-DECANE	ppb	NS	NS	NS
VOLATILES					
	CHLOROMETHANE	ppb	<5.0	<5.0	<5.0
	BROMOMETHANE	ppb	<5.0	<5.0	<5.0
	DICHLORODIFLUOROMETHANE	ppb	<5.0	NS	NS
	VINYL CHLORIDE	ppb	<5.0	<2.0	<2.0
	CHLOROETHANE	ppb	<5.0	<2.0	<2.0
	METHYLENE CHLORIDE	ppb	<1.0	<1.0	<1.0
	TRICHLOROFLUOROMETHANE	ppb	<1.0	<2.0	<2.0
	1,1-DICHLOROETHENE	ppb	<1.0	<1.0	<1.0
	1,1-DICHLOROETHANE	ppb	3.6	<1.0	<1.0
	1,2-DICHLOROETHENE	ppb	<1.0	<1.0	<1.0
	CHLOROFORM	ppb	<1.0	<1.0	<1.0
	1,2-DICHLOROETHANE	ppb	<1.0	<1.0	<1.0
	1,1,1-TRICHLOROETHANE	ppb	<1.0	<1.0	<1.0
	CARBON TETRACHLORIDE	ppb	<1.0	<1.0	<1.0
	BROMODICHLOROMETHANE	ppb	<1.0	<1.0	<1.0
	1,2-DICHLOROPROPANE	ppb	<1.0	<1.0	<1.0
	1,3-DICHLOROPROPENE (TRANS)	ppb	<1.0	<2.0	<2.0
	TRICHLOROETHENE	ppb	35.0	<1.0	<1.0
	1,3-DICHLOROPROPENE (CIS)	ppb	<2.0	<1.0	<1.0
	DIBROMOCHLOROMETHANE	ppb	<2.0	<2.0	<2.0
	1,1,2-TRICHLDROETHANE	ppb	<2.0	<2.0	<2.0
	2-CHLOROETHYLVINYL ETHER	ppb	<2.0	<2.0	<2.0
	BROMOFORM	ppb	<2.0	<2.0	<2.0
	1,1,2,2-TETRACHLOROETHANE	ppb	<1.0	<2.0	<2.0
	TETRACHLOROETHENE	ppb	49.0	7.1	3.0
	CHLOROBENZENE	ppb	<2.0	<2.0	<2.0
	1,3-DICHLOROBENZENE (M)	ppb	<2.0	NS	NS
	1,2-DICHLOROBENZENE (O)	ppb	<2.0	NS	NS
	1,4-DICHLOROBENZENE (P)	ppb	<2.0	NS	NS
	BENZENE	ppb	<1.0	<2.0	<2.0
	TOLUENE	ppb	<1.0	<2.0	<2.0
	ETHYLBENZENE	ppb	<1.0	<2.0	<2.0
	CHLOROBENZENE	ppb	<2.0	<2.0	<2.0
	1,4-DICHLOROBENZENE	ppb	<2.0	<2.0	<2.0
	1,3-DICHLOROBENZENE	ppb	<2.0	<2.0	<2.0
	1,2-DICHLOROBENZENE	ppb	<2.0	<2.0	<2.0
	P-XYLENE	ppb	<1.0	<2.0	<2.0
	M-XYLENE	ppb	<1.0	<2.0	<2.0
	O-XYLENE	ppb	<1.0	<2.0	<2.0
	TOTAL VOLATILES	ppb	87.6	7.1	3.0

WELL NUMBER MW-16

CATEGORY	PARAMETER	UNITS	DATE 01/09/87 CONCENTRATION	DATE 01/31/89 CONCENTRATION	DATE 04/18/89 CONCENTRATION
ALIPHATICS					
	MINERAL SPIRITS	ppb	NS	2105.0	1520.0
	N-HEPTANE	ppb	NS	NS	NS
	N-OCTANE	ppb	NS	NS	NS
	N-NONANE	ppb	NS	NS	NS
	N-DECANE	ppb	NS	NS	NS
VOLATILES					
	CHLOROMETHANE	ppb	<500.0	<2500.0	<2500.0
	BROMOMETHANE	ppb	<500.0	<2500.0	<2500.0
	DICHLORODIFLUOROMETHANE	ppb	<500.0	NS	NS
	VINYL CHLORIDE	ppb	<500.0	<1000.0	<1000.0
	CHLOROETHANE	ppb	<500.0	<1000.0	<1000.0
	METHYLENE CHLORIDE	ppb	<100.0	642.0	<500.0
	TRICHLOROFLUOROMETHANE	ppb	<100.0	<1000.0	<1000.0
	1,1-DICHLOROETHENE	ppb	1700.0	1090.0	<500.0
	1,1-DICHLOROETHANE	ppb	1900.0	<500.0	<500.0
	1,2-DICHLOROETHENE	ppb	9800.0	17300.0	18900.0
	CHLOROFORM	ppb	<100.0	<500.0	<500.0
	1,2-DICHLOROETHANE	ppb	<100.0	<500.0	<500.0
	1,1,1-TRICHLOROETHANE	ppb	83000.0	85700.0	22200.0
	CARBON TETRACHLORIDE	ppb	<100.0	<500.0	<500.0
	BROMODICHLOROMETHANE	ppb	<100.0	<500.0	<500.0
	1,2-DICHLOROPROPANE	ppb	<100.0	<500.0	<500.0
	1,3-DICHLOROPROPENE (TRANS)	ppb	<100.0	<1000.0	<1000.0
	TRICHLOROETHENE	ppb	64000.0	75500.0	39700.0
	1,3-DICHLOROPROPENE (CIS)	ppb	<200.0	<500.0	<500.0
	DIBROMOCHLOROMETHANE	ppb	<200.0	<1000.0	<1000.0
	1,1,2-TRICHLOROETHANE	ppb	<200.0	<1000.0	<1000.0
	2-CHLOROETHYLVINYL ETHER	ppb	<200.0	<1000.0	<1000.0
	BROMOFORM	ppb	<200.0	<1000.0	<1000.0
	1,1,2,2-TETRACHLOROETHANE	ppb	<100.0	<1000.0	<1000.0
	TETRACHLOROETHENE	ppb	11000.0	61200.0	39100.0
	CHLOROBENZENE	ppb	<200.0	<1000.0	<1000.0
	1,3-DICHLOROBENZENE (M)	ppb	<200.0	NS	NS
	1,2-DICHLOROBENZENE (O)	ppb	<200.0	NS	NS
	1,4-DICHLOROBENZENE (P)	ppb	<200.0	NS	NS
	BENZENE	ppb	<100.0	<1000.0	<1000.0
	TOLUENE	ppb	2100.0	<1000.0	<1000.0
	ETHYLBENZENE	ppb	<100.0	<1000.0	<1000.0
	CHLOROBENZENE	ppb	<200.0	<1000.0	<1000.0
	1,4-DICHLOROBENZENE	ppb	<200.0	<1000.0	<1000.0
	1,3-DICHLOROBENZENE	ppb	<200.0	<1000.0	<1000.0
	1,2-OICHLOROBENZENE	ppb	<200.0	<1000.0	<1000.0
	P-XYLENE	ppb	<100.0	<1000.0	<1000.0
	M-XYLENE	ppb	<100.0	<1000.0	<1000.0
	O-XYLENE	ppb	<100.0	<1000.0	<1000.0
	TOTAL VOLATILES	ppb	173500.0	241432.0	119900.0

WELL NUMBER MW-3

CATEGORY	PARAMETER	UNITS	DATE 04/18/89 CONCENTRATION	DATE 05/15/89 CONCENTRATION
ALIPHATICS				
	MINERAL SPIRITS	ppb	<100.0	NS
	N-HEPTANE	ppb	NS	NS
	N-OCTANE	ppb	NS	NS
	N-NONANE	ppb	NS	NS
	N-DECANE	ppb	NS	NS
VOLATILES				
	CHLOROMETHANE	ppb	<5.0	<5.0
	BROMOMETHANE	ppb	<5.0	<5.0
	DICHLORODIFLUOROMETHANE	ppb	NS	NS
	VINYL CHLORIDE	ppb	<2.0	<2.0
	CHLOROETHANE	ppb	<2.0	<2.0
	METHYLENE CHLORIDE	ppb	<1.0	<1.0
	TRICHLOROFLUOROMETHANE	ppb	<2.0	<2.0
	1,1-DICHLOROETHENE	ppb	<1.0	<1.0
	1,1-DICHLOROETHANE	ppb	<1.0	<1.0
	1,2-DICHLOROETHENE	ppb	<1.0	<1.0
	CHLOROFORM	ppb	<1.0	<1.0
	1,2-DICHLOROETHANE	ppb	<1.0	<1.0
	1,1,1-TRICHLOROETHANE	ppb	<1.0	<1.0
	CARBON TETRACHLORIDE	ppb	<1.0	<1.0
	BROMODICHLOROMETHANE	ppb	<1.0	<1.0
	1,2-DICHLOROPROPANE	ppb	<1.0	<1.0
	1,3-DICHLOROPROPENE (TRANS)	ppb	<2.0	<2.0
	TRICHLOROETHENE	ppb	<1.0	<1.0
	1,3-DICHLOROPROPENE (CIS)	ppb	<1.0	<1.0
	DIBROMOCHLOROMETHANE	ppb	<2.0	<2.0
	1,1,2-TRICHLOROETHANE	ppb	<2.0	<2.0
	2-CHLOROETHYLVINYL ETHER	ppb	<2.0	<2.0
	BROMOFORM	ppb	<2.0	<2.0
	1,1,2,2-TETRACHLOROETHANE	ppb	<2.0	<2.0
	TETRACHLOROETHENE	ppb	1.1	<1.0
	CHLOROBENZENE	ppb	<2.0	<2.0
	1,3-DICHLOROBENZENE (M)	ppb	NS	NS
	1,2-DICHLOROBENZENE (O)	ppb	NS	NS
	1,4-DICHLOROBENZENE (P)	ppb	NS	NS
	BENZENE	ppb	<2.0	<2.0
	TOLUENE	ppb	<2.0	<2.0
	ETHYLBENZENE	ppb	<2.0	<2.0
	CHLOROBENZENE	ppb	<2.0	<2.0
	1,4-DICHLOROBENZENE	ppb	<2.0	<2.0
	1,3-DICHLOROBENZENE	ppb	<2.0	<2.0
	1,2-DICHLOROBENZENE	ppb	<2.0	<2.0
	P-XYLENE	ppb	<2.0	<2.0
	M-XYLENE	ppb	<2.0	<2.0
	O-XYLENE	ppb	<2.0	<2.0
	TOTAL VOLATILES	ppb	1.1	ND

WELL NUMBER OW-2

CATEGORY	PARAMETER	UNITS	DATE 08/19/85 CONCENTRATION	DATE 12/16/85 CONCENTRATION	DATE 07/02/86 CONCENTRATION	DATE 09/30/86 CONCENTRATION	DATE 01/09/87 CONCENTRATION	DATE 01/31/89 CONCENTRATION	DATE 04/18/89 CONCENTRATION
ALIPHATICS									
	MINERAL SPIRITS	ppb	NS	NS	<2000.0	<100.0	NS	<100.0	<100.0
	N-HEPTANE	ppb	ND	<5.0	NS	NS	NS	NS	NS
	N-OCTANE	ppb	ND	<5.0	NS	NS	NS	NS	NS
	N-NONANE	ppb	ND	<5.0	NS	NS	NS	NS	NS
	N-DECANE	ppb	ND	1.7	NS	NS	NS	NS	NS
VOLATILES									
	CHLOROMETHANE	ppb	NS	<50.0	<5.0	<100.0	<50.0	<250.0	<125.0
	BROMOMETHANE	ppb	NS	<50.0	<5.0	<100.0	<50.0	<250.0	<125.0
	DICHLORODIFLUOROMETHANE	ppb	NS	NS	<5.0	<100.0	<50.0	NS	NS
	VINYL CHLORIDE	ppb	NS	55.0	<5.0	<100.0	<50.0	<100.0	<50.0
	CHLOROETHANE	ppb	NS	<10.0	20.0	<100.0	<50.0	<100.0	<50.0
	METHYLENE CHLORIDE	ppb	ND	260.0	<1.0	54.0	<10.0	55.1	<25.0
	TRICHLOROFLUOROMETHANE	ppb	NS	NS	<1.0	<20.0	<10.0	<50.0	<50.0
	1,1-DICHLOROETHENE	ppb	NS	240.0	55.0	35.0	<10.0	231.0	54.7
	1,1-DICHLOROETHANE	ppb	297.0	530.0	134.0	230.0	<10.0	302.0	<25.0
	1,2-DICHLOROETHENE	ppb	2012.0	4200.0	490.0	770.0	260.0	8384.0	2690.0
	CHLOROFORM	ppb	NS	280.0	<1.0	<20.0	<10.0	<50.0	<25.0
	1,2-DICHLOROETHANE	ppb	NS	<20.0	<1.0	<20.0	<10.0	<50.0	<25.0
	1,1,1-TRICHLOROETHANE	ppb	2323.0	2700.0	460.0	190.0	280.0	5640.0	1970.0
	CARBON TETRACHLORIDE	ppb	NS	<20.0	<1.0	<20.0	<10.0	<50.0	<25.0
	BROMODICHLOROMETHANE	ppb	NS	<20.0	<1.0	<20.0	<10.0	<50.0	<25.0
	1,2-DICHLOROPROPANE	ppb	NS	<20.0	<1.0	<20.0	<10.0	<50.0	<25.0
	1,3-DICHLOROPROPENE (TRANS)	ppb	NS	<20.0	<1.0	<20.0	<10.0	<100.0	<50.0
	TRICHLOROETHENE	ppb	ND	3600.0	1270.0	1440.0	110.0	1370.0	459.0
	1,3-DICHLOROPROPENE (CIS)	ppb	NS	<40.0	<2.0	<40.0	<20.0	<50.0	<25.0
	DIBROMOCHLOROMETHANE	ppb	NS	<40.0	<2.0	<40.0	<20.0	<100.0	<50.0
	1,1,2-TRICHLOROETHANE	ppb	NS	<40.0	<2.0	<40.0	<20.0	<100.0	<50.0
	2-CHLOROETHYLVINYL ETHER	ppb	NS	<500.0	<2.0	<40.0	<20.0	<100.0	<50.0
	BROMOFORM	ppb	ND	<100.0	<2.0	<40.0	<20.0	<100.0	<50.0
	1,1,2,2-TETRACHLOROETHANE	ppb	ND	NS	<1.0	<40.0	<10.0	<100.0	<50.0
	TETRACHLOROETHENE	ppb	786.0	920.0	970.0	180.0	220.0	1741.0	622.0
	CHLOROBENZENE	ppb	NS	<50.0	<2.0	<40.0	<20.0	<100.0	<50.0
	1,3-DICHLOROBENZENE (M)	ppb	NS	NS	<2.0	<40.0	<20.0	NS	NS
	1,2-DICHLOROBENZENE (O)	ppb	NS	NS	<2.0	<40.0	<20.0	NS	NS
	1,4-DICHLOROBENZENE (P)	ppb	NS	NS	<2.0	<40.0	<20.0	NS	NS
	BENZENE	ppb	ND	<20.0	<2.0	<20.0	<10.0	<100.0	<50.0
	TOLUENE	ppb	15.0	<10.0	<2.0	<20.0	<10.0	<100.0	<50.0
	ETHYLBENZENE	ppb	ND	<2.0	<2.0	<20.0	<10.0	<100.0	<50.0
	CHLOROBENZENE	ppb	NS	<2.0	<2.0	<40.0	<20.0	<100.0	<50.0
	1,4-DICHLOROBENZENE	ppb	ND	<5.0	<2.0	<40.0	<20.0	<100.0	<200.0
	1,3-DICHLOROBENZENE	ppb	NS	<5.0	<2.0	<40.0	<20.0	<100.0	<50.0
	1,2-DICHLOROBENZENE	ppb	NS	<5.0	<2.0	<40.0	<20.0	<100.0	<50.0
	P-XYLENE	ppb	ND	NS	<2.0	<20.0	<10.0	<100.0	<50.0
	M-XYLENE	ppb	ND	NS	<2.0	<20.0	<10.0	<100.0	<50.0
	O-XYLENE	ppb	ND	NS	<2.0	<20.0	<10.0	<100.0	<50.0
	TOTAL VOLATILES	ppb	5433.0	12785.0	3399.0	2899.0	398.0	17723.0	5795.7

WELL NUMBER PW-2

CATEGORY	PARAMETER	UNITS	DATE 08/19/85 CONCENTRATION	DATE 12/16/85 CONCENTRATION	DATE 09/30/86 CONCENTRATION	DATE 01/09/87 CONCENTRATION	DATE 01/31/89 CONCENTRATION	DATE 04/18/89 CONCENTRATION
ALIPHATICS								
	MINERAL SPIRITS	ppb	NS	NS	2350.0	0.0	<100.0	<100.0
	N-HEPTANE	ppb	ND	<7000.0	NS	NS	NS	NS
	N-OCTANE	ppb	ND	<700.0	NS	NS	NS	NS
	N-NONANE	ppb	ND	<300.0	NS	NS	NS	NS
	N-DECANE	ppb	ND	<1000.0	NS	NS	NS	NS
VOLATILES								
	CHLOROMETHANE	ppb	NS	<500.0	<2500.0	<2500.0	<1000.0	<1000.0
	BROMOMETHANE	ppb	NS	<500.0	<2500.0	<2500.0	<1000.0	<1000.0
	DICHLORODIFLUOROMETHANE	ppb	NS	NS	<2500.0	<2500.0	NS	NS
	VINYL CHLORIDE	ppb	NS	<500.0	<2500.0	<2500.0	<400.0	<400.0
	CHLOROETHANE	ppb	NS	<5000.0	<2500.0	<2500.0	<400.0	<400.0
	METHYLENE CHLORIDE	ppb	899.0	4300.0	2800.0	<500.0	312.0	418.0
	TRICHLOROFLUOROMETHANE	ppb	NS	NS	<500.0	<500.0	<400.0	<400.0
	1,1-DICHLOROETHENE	ppb	NS	1900.0	850.0	<500.0	1400.0	1070.0
	1,1-DICHLOROETHANE	ppb	653.0	1800.0	4000.0	3500.0	3570.0	3400.0
	1,2-DICHLOROETHENE	ppb	20892.0	16000.0	26900.0	14000.0	42000.0	34800.0
	CHLOROFORM	ppb	NS	<500.0	<500.0	<500.0	<200.0	<200.0
	1,2-DICHLOROETHANE	ppb	NS	<200.0	<500.0	<500.0	<200.0	<200.0
	1,1,1-TRICHLOROETHANE	ppb	33396.0	26000.0	30300.0	16000.0	37000.0	31800.0
	CARBON TETRACHLORIDE	ppb	NS	<200.0	<500.0	<500.0	<200.0	<200.0
	BROMODICHLOROMETHANE	ppb	NS	<200.0	<500.0	<500.0	<200.0	<200.0
	1,2-DICHLOROPROPANE	ppb	NS	<200.0	<500.0	<500.0	<200.0	<200.0
	1,3-DICHLOROPROPENE (TRANS)	ppb	NS	<200.0	500.0	<500.0	<400.0	<400.0
	TRICHLOROETHENE	ppb	17110.0	37000.0	27600.0	21000.0	39900.0	12100.0
	1,3-DICHLOROPROPENE (CIS)	ppb	NS	<400.0	<1000.0	<1000.0	<200.0	<200.0
	DIBROMOCHLOROMETHANE	ppb	NS	<400.0	<1000.0	<1000.0	<400.0	<400.0
	1,1,2-TRICHLOROETHANE	ppb	NS	<400.0	<1000.0	<1000.0	<400.0	<400.0
	2-CHLOROETHYLVINYL ETHER	ppb	NS	2300.0	<1000.0	<1000.0	<400.0	<400.0
	BROMOFORM	ppb	ND	<1000.0	<1000.0	<1000.0	<400.0	<400.0
	1,1,2,2-TETRACHLOROETHANE	ppb	ND	NS	<500.0	<500.0	<400.0	<400.0
	TETRACHLOROETHENE	ppb	9437.0	10000.0	14000.0	13000.0	31600.0	29000.0
	CHLOROBENZENE	ppb	NS	<500.0	<1000.0	<1000.0	<400.0	<400.0
	1,3-DICHLOROBENZENE (M)	ppb	NS	NS	<1000.0	<1000.0	NS	NS
	1,2-DICHLOROBENZENE (O)	ppb	NS	NS	<1000.0	<1000.0	NS	NS
	1,4-DICHLOROBENZENE (P)	ppb	NS	NS	<1000.0	<1000.0	NS	NS
	BENZENE	ppb	123.0	<200.0	<500.0	<500.0	<400.0	<400.0
	TOLUENE	ppb	ND	480.0	<500.0	<500.0	<400.0	<400.0
	ETHYLBENZENE	ppb	ND	24.0	<500.0	<500.0	<400.0	<400.0
	CHLOROBENZENE	ppb	NS	<20.0	<1000.0	<1000.0	<400.0	<400.0
	1,4-DICHLOROBENZENE	ppb	ND	30.0	<1000.0	<1000.0	<400.0	<400.0
	1,3-DICHLOROBENZENE	ppb	NS	32.0	<1000.0	<1000.0	<400.0	<400.0
	1,2-DICHLOROBENZENE	ppb	NS	<5.0	<1000.0	<1000.0	<400.0	<400.0
	P-XYLENE	ppb	<75.0	NS	<500.0	<500.0	<400.0	<400.0
	M-XYLENE	ppb	<75.0	NS	<500.0	<500.0	<400.0	<400.0
	O-XYLENE	ppb	<75.0	NS	<500.0	<500.0	<400.0	<400.0
	TOTAL VOLATILES	ppb	82510.0	99866.0	106450.0	67500.0	155782.0	112588.0

WELL NUMBER RM-10

CATEGORY	PARAMETER	UNITS	DATE 11/07/86 CONCENTRATION
ALIPHATICS			
	MINERAL SPIRITS	ppb	NS
	N-HEPTANE	ppb	<2.0
	N-OCTANE	ppb	<2.0
	N-NONANE	ppb	<2.0
	N-DECANE	ppb	<2.0
VOLATILES			
	CHLOROMETHANE	ppb	<10.0
	BROMOMETHANE	ppb	<20.0
	DICHLORODIFLUOROMETHANE	ppb	NS
	VINYL CHLORIDE	ppb	<10.0
	CHLOROETHANE	ppb	<20.0
	METHYLENE CHLORIDE	ppb	<80.0
	TRICHLOROFLUOROMETHANE	ppb	NS
	1,1-DICHLOROETHENE	ppb	49.0
	1,1-DICHLOROETHANE	ppb	15.0
	1,2-DICHLOROETHENE	ppb	240.0
	CHLOROFORM	ppb	16.0
	1,2-DICHLOROETHANE	ppb	<10.0
	1,1,1-TRICHLOROETHANE	ppb	480.0
	CARBON TETRACHLORIDE	ppb	<20.0
	BROMODICHLOROMETHANE	ppb	<10.0
	1,2-DICHLOROPROPANE	ppb	<10.0
	1,3-DICHLOROPROPENE (TRANS)	ppb	<10.0
	TRICHLOROETHENE	ppb	430.0
	1,3-DICHLOROPROPENE (CIS)	ppb	<20.0
	DIBROMOCHLOROMETHANE	ppb	<20.0
	1,1,2-TRICHLOROETHANE	ppb	<20.0
	2-CHLOROETHYLVINYL ETHER	ppb	<80.0
	BROMOFORM	ppb	<20.0
	1,1,2,2-TETRACHLOROETHANE	ppb	NS
	TETRACHLOROETHENE	ppb	360.0
	CHLOROBENZENE	ppb	<20.0
	1,3-DICHLOROBENZENE (M)	ppb	NS
	1,2-DICHLOROBENZENE (O)	ppb	NS
	1,4-DICHLOROBENZENE (P)	ppb	NS
	BENZENE	ppb	56.0
	TOLUENE	ppb	<1.0
	ETHYLBENZENE	ppb	<1.0
	CHLOROBENZENE	ppb	<1.0
	1,4-DICHLOROBENZENE	ppb	<2.0
	1,3-DICHLOROBENZENE	ppb	<2.0
	1,2-DICHLOROBENZENE	ppb	<2.0
	P-XYLENE	ppb	NS
	M-XYLENE	ppb	NS
	O-XYLENE	ppb	NS
	TOTAL VOLATILES	ppb	1646.0

WELL NUMBER RW-3

CATEGORY	PARAMETER	UNITS	DATE 11/07/86 CONCENTRATION
ALIPHATICS			
	MINERAL SPIRITS	ppb	NS
	N-HEPTANE	ppb	<2.0
	N-OCTANE	ppb	<4.0
	N-NONANE	ppb	<2.0
	N-DECANE	ppb	<2.0
VOLATILES			
	CHLOROMETHANE	ppb	<2.0
	BROMOMETHANE	ppb	<2.0
	DICHLORODIFLUOROMETHANE	ppb	NS
	VINYL CHLORIDE	ppb	<1.0
	CHLOROETHANE	ppb	<2.0
	METHYLENE CHLORIDE	ppb	<7.0
	TRICHLOROFLUOROMETHANE	ppb	NS
	1,1-DICHLOROETHENE	ppb	180.0
	1,1-DICHLOROETHANE	ppb	36.0
	1,2-DICHLOROETHENE	ppb	240.0
	CHLOROFORM	ppb	1.3
	1,2-DICHLOROETHANE	ppb	8.3
	1,1,1-TRICHLOROETHANE	ppb	800.0
	CARBON TETRACHLORIDE	ppb	<30.0
	BROMODICHLOROMETHANE	ppb	<10.0
	1,2-DICHLOROPROPANE	ppb	<10.0
	1,3-DICHLOROPROPENE (TRANS)	ppb	<10.0
	TRICHLOROETHENE	ppb	1100.0
	1,3-DICHLOROPROPENE (CIS)	ppb	<10.0
	DIBROMOCHLOROMETHANE	ppb	NS
	1,1,2-TRICHLOROETHANE	ppb	73.0
	2-CHLOROETHYLVINYL ETHER	ppb	<80.0
	BROMOFORM	ppb	<20.0
	1,1,2,2-TETRACHLOROETHANE	ppb	NS
	TETRACHLOROETHENE	ppb	850.0
	CHLOROBENZENE	ppb	<20.0
	1,3-DICHLOROBENZENE (M)	ppb	NS
	1,2-DICHLOROBENZENE (O)	ppb	NS
	1,4-DICHLOROBENZENE (P)	ppb	NS
	BENZENE	ppb	7.3
	TOLUENE	ppb	<1.0
	ETHYLBENZENE	ppb	<1.0
	CHLOROBENZENE	ppb	<1.0
	1,4-DICHLOROBENZENE	ppb	<2.0
	1,3-DICHLOROBENZENE	ppb	<2.0
	1,2-DICHLOROBENZENE	ppb	<2.0
	P-XYLENE	ppb	NS
	M-XYLENE	ppb	NS
	O-XYLENE	ppb	NS
	TOTAL VOLATILES	ppb	3295.9

WELL NUMBER RM-5

CATEGORY	PARAMETER	UNITS	DATE 11/07/86 CONCENTRATION
ALIPHATICS			
	MINERAL SPIRITS	ppb	NS
	N-HEPTANE	ppb	<2.0
	N-OCTANE	ppb	<4.0
	N-NONANE	ppb	<2.0
	N-DECANE	ppb	<2.0
VOLATILES			
	CHLOROMETHANE	ppb	<1.0
	BROMOMETHANE	ppb	<2.0
	DICHLORODIFLUOROMETHANE	ppb	NS
	VINYL CHLORIDE	ppb	<1.5
	CHLOROETHANE	ppb	<2.0
	METHYLENE CHLORIDE	ppb	<10.0
	TRICHLOROFLUOROMETHANE	ppb	NS
	1,1-DICHLOROETHENE	ppb	2.0
	1,1-DICHLOROETHANE	ppb	4.2
	1,2-DICHLOROETHENE	ppb	83.0
	CHLOROFORM	ppb	6.8
	1,2-DICHLOROETHANE	ppb	<2.0
	1,1,1-TRICHLOROETHANE	ppb	350.0
	CARBON TETRACHLORIDE	ppb	<3.0
	BROMODICHLOROMETHANE	ppb	<1.0
	1,2-DICHLOROPROPANE	ppb	<1.0
	1,3-DICHLOROPROPENE (TRANS)	ppb	<1.0
	TRICHLOROETHENE	ppb	400.0
	1,3-DICHLOROPROPENE (CIS)	ppb	NS
	DIBROMOCHLOROMETHANE	ppb	NS
	1,1,2-TRICHLOROETHANE	ppb	9.2
	2-CHLOROETHYLVINYL ETHER	ppb	<8.0
	BROMOFORM	ppb	<2.0
	1,1,2,2-TETRACHLOROETHANE	ppb	NS
	TETRACHLOROETHENE	ppb	610.0
	CHLOROBENZENE	ppb	<2.0
	1,3-DICHLOROBENZENE (M)	ppb	NS
	1,2-DICHLOROBENZENE (O)	ppb	NS
	1,4-DICHLOROBENZENE (P)	ppb	NS
	BENZENE	ppb	61.0
	TOLUENE	ppb	4.3
	ETHYLBENZENE	ppb	<1.0
	CHLOROBENZENE	ppb	<1.0
	1,4-DICHLOROBENZENE	ppb	<2.0
	1,3-DICHLOROBENZENE	ppb	<2.0
	1,2-DICHLOROBENZENE	ppb	<2.0
	P-XYLENE	ppb	NS
	M-XYLENE	ppb	NS
	O-XYLENE	ppb	NS
	TOTAL VOLATILES	ppb	1530.5

WELL NUMBER RW-7

CATEGORY	PARAMETER	UNITS	DATE 11/07/86 CONCENTRATION
ALIPHATICS			
	MINERAL SPIRITS	ppb	NS
	N-HEPTANE	ppb	<40.0
	N-OCTANE	ppb	<80.0
	N-NONANE	ppb	<4.0
	N-DECANE	ppb	<4.0
VOLATILES			
	CHLOROMETHANE	ppb	<100.0
	BROMOMETHANE	ppb	<200.0
	DICHLORODIFLUOROMETHANE	ppb	NS
	VINYL CHLORIDE	ppb	<100.0
	CHLOROETHANE	ppb	<200.0
	METHYLENE CHLORIDE	ppb	<1000.0
	TRICHLOROFLUOROMETHANE	ppb	NS
	1,1-DICHLOROETHENE	ppb	500.0
	1,1-DICHLOROETHANE	ppb	250.0
	1,2-DICHLOROETHENE	ppb	740.0
	CHLOROFORM	ppb	<200.0
	1,2-DICHLOROETHANE	ppb	<100.0
	1,1,1-TRICHLOROETHANE	ppb	8600.0
	CARBON TETRACHLORIDE	ppb	<300.0
	BROMODICHLOROMETHANE	ppb	<100.0
	1,2-DICHLOROPROPANE	ppb	<100.0
	1,3-DICHLOROPROPENE (TRANS)	ppb	<100.0
	TRICHLOROETHENE	ppb	7200.0
	1,3-DICHLOROPROPENE (CIS)	ppb	<300.0
	DIBROMOCHLOROMETHANE	ppb	<300.0
	1,1,2-TRICHLOROETHANE	ppb	<300.0
	2-CHLOROETHYLVINYL ETHER	ppb	<800.0
	BROMOFORM	ppb	<100.0
	1,1,2,2-TETRACHLOROETHANE	ppb	NS
	TETRACHLOROETHENE	ppb	14000.0
	CHLOROBENZENE	ppb	<200.0
	1,3-DICHLOROBENZENE (M)	ppb	NS
	1,2-DICHLOROBENZENE (O)	ppb	NS
	1,4-DICHLOROBENZENE (P)	ppb	NS
	BENZENE	ppb	2800.0
	TOLUENE	ppb	320.0
	ETHYLBENZENE	ppb	9.4
	CHLOROBENZENE	ppb	<1.0
	1,4-DICHLOROBENZENE	ppb	<2.0
	1,3-DICHLOROBENZENE	ppb	<2.0
	1,2-DICHLOROBENZENE	ppb	<2.0
	P-XYLENE	ppb	NS
	M-XYLENE	ppb	NS
	O-XYLENE	ppb	NS
	TOTAL VOLATILES	ppb	34419.4

WELL NUMBER RW-9

CATEGORY	PARAMETER	UNITS	DATE 11/07/86 CONCENTRATION
ALIPHATICS			
	MINERAL SPIRITS	ppb	NS
	N-HEPTANE	ppb	<4.0
	N-OCTANE	ppb	<4.0
	N-NONANE	ppb	<2.0
	N-DECANE	ppb	<2.0
VOLATILES			
	CHLOROMETHANE	ppb	<10.0
	BROMOMETHANE	ppb	<20.0
	DICHLORODIFLUOROMETHANE	ppb	NS
	VINYL CHLORIDE	ppb	22.0
	CHLOROETHANE	ppb	<20.0
	METHYLENE CHLORIDE	ppb	<70.0
	TRICHLOROFLUOROMETHANE	ppb	NS
	1,1-DICHLOROETHENE	ppb	170.0
	1,1-DICHLOROETHANE	ppb	35.0
	1,2-DICHLOROETHENE	ppb	2300.0
	CHLOROFORM	ppb	<80.0
	1,2-DICHLOROETHANE	ppb	<40.0
	1,1,1-TRICHLOROETHANE	ppb	2500.0
	CARBON TETRACHLORIDE	ppb	<100.0
	BROMODICHLOROMETHANE	ppb	<40.0
	1,2-DICHLOROPROPANE	ppb	<40.0
	1,3-DICHLOROPROPENE (TRANS)	ppb	<40.0
	TRICHLOROETHENE	ppb	1300.0
	1,3-DICHLOROPROPENE (CIS)	ppb	<80.0
	DIBROMOCHLOROMETHANE	ppb	<80.0
	1,1,2-TRICHLOROETHANE	ppb	<80.0
	2-CHLOROETHYLVINYL ETHER	ppb	<300.0
	BROMOFORM	ppb	<80.0
	1,1,2,2-TETRACHLOROETHANE	ppb	NS
	TETRACHLOROETHENE	ppb	820.0
	CHLOROBENZENE	ppb	<80.0
	1,3-DICHLOROBENZENE (M)	ppb	NS
	1,2-DICHLOROBENZENE (O)	ppb	NS
	1,4-DICHLOROBENZENE (P)	ppb	NS
	BENZENE	ppb	490.0
	TOLUENE	ppb	7.0
	ETHYLBENZENE	ppb	1.2
	CHLOROBENZENE	ppb	<1.0
	1,4-DICHLOROBENZENE	ppb	<2.0
	1,3-DICHLOROBENZENE	ppb	<2.0
	1,2-DICHLOROBENZENE	ppb	<2.0
	P-XYLENE	ppb	NS
	M-XYLENE	ppb	NS
	O-XYLENE	ppb	NS
	TOTAL VOLATILES	ppb	7645.2

WELL NUMBER U-6D

CATEGORY	PARAMETER	UNITS	DATE 09/20/84 CONCENTRATION	DATE 11/28/84 CONCENTRATION	DATE 08/19/85 CONCENTRATION	DATE 12/16/85 CONCENTRATION	DATE 07/02/86 CONCENTRATION	DATE 09/30/86 CONCENTRATION	DATE 01/09/87 CONCENTRATION	DATE 01/31/89 CONCENTRATION	DATE 04/18/89 CONCENTRATION
ALIPHATICS											
	MINERAL SPIRITS	ppb	NS	NS	NS	NS	<2000.0	<100.0	NS	<100.0	<100.0
	N-HEPTANE	ppb	<5.0	<0.1	ND	<60.0	NS	NS	NS	NS	NS
	N-OCTANE	ppb	NS	NS	ND	<3.0	NS	NS	NS	NS	NS
	N-NONANE	ppb	NS	NS	ND	1.8	NS	NS	NS	NS	NS
	N-DECANE	ppb	NS	NS	ND	6.4	NS	NS	NS	NS	NS
VOLATILES											
	CHLOROMETHANE	ppb	NS	NS	NS	<1.0	<5.0	<5.0	<5.0	<5.0	<5.0
	BROMOMETHANE	ppb	NS	NS	NS	<1.0	<5.0	<5.0	<5.0	<5.0	<5.0
	DICHLORODIFLUOROMETHANE	ppb	NS	NS	NS	NS	<5.0	<5.0	<5.0	NS	NS
	VINYL CHLORIDE	ppb	NS	NS	NS	<1.0	<5.0	<5.0	<5.0	<2.0	<2.0
	CHLOROETHANE	ppb	NS	NS	NS	<1.0	<5.0	<5.0	<5.0	<2.0	<2.0
	METHYLENE CHLORIDE	ppb	4.0	<1.0	<10.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
	TRICHLOROFLUOROMETHANE	ppb	NS	NS	NS	NS	<1.0	<1.0	<1.0	<2.0	<2.0
	1,1-DICHLOROETHENE	ppb	NS	NS	NS	<0.5	<1.0	<1.0	<1.0	<1.0	<1.0
	1,1-DICHLOROETHANE	ppb	<1.0	<1.0	ND	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
	1,2-DICHLOROETHENE	ppb	<1.0	<1.0	ND	<0.5	<1.0	<1.0	<1.0	<1.0	<1.0
	CHLOROFORM	ppb	3.0	<1.0	NS	2.9	<1.0	1.6	<1.0	2.3	1.7
	1,2-DICHLOROETHANE	ppb	NS	NS	NS	<0.5	<1.0	<1.0	<1.0	<1.0	<1.0
	1,1,1-TRICHLOROETHANE	ppb	<1.0	<1.0	ND	0.7	<1.0	<1.0	<1.0	<1.0	<1.0
	CARBON TETRACHLORIDE	ppb	NS	NS	NS	<0.5	<1.0	<1.0	<1.0	<1.0	<1.0
	BROMODICHLOROMETHANE	ppb	NS	NS	NS	<5.0	<1.0	<1.0	<1.0	<1.0	<1.0
	1,2-DICHLOROPROPANE	ppb	NS	NS	NS	<0.5	<1.0	<1.0	<1.0	<1.0	<1.0
	1,3-DICHLOROPROPENE (TRANS)	ppb	NS	NS	NS	<0.5	<1.0	<1.0	<1.0	<2.0	<2.0
	TRICHLOROETHENE	ppb	2.0	<1.0	<10.0	<0.5	1.8	<1.0	<1.0	<1.0	<1.0
	1,3-DICHLOROPROPENE (CIS)	ppb	NS	NS	NS	<1.0	<2.0	<2.0	<2.0	<1.0	<1.0
	DIBROMOCHLOROMETHANE	ppb	NS	NS	NS	<1.0	<2.0	<2.0	<2.0	<2.0	<2.0
	1,1,2-TRICHLOROETHANE	ppb	NS	NS	NS	<1.0	<2.0	<2.0	<2.0	<2.0	<2.0
	2-CHLOROETHYLVINYL ETHER	ppb	NS	NS	NS	<10.0	<2.0	<2.0	<2.0	<2.0	<2.0
	BROMOFORM	ppb	NS	NS	ND	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
	1,1,2,2-TETRACHLOROETHANE	ppb	NS	NS	ND	NS	<1.0	<2.0	<1.0	<2.0	<2.0
	TETRACHLOROETHENE	ppb	1.0	<1.0	20.0	6.0	<1.0	3.7	<1.0	11.6	7.1
	CHLOROBENZENE	ppb	NS	NS	NS	<1.0	<2.0	<2.0	<2.0	<2.0	<2.0
	1,3-DICHLOROBENZENE (M)	ppb	NS	NS	NS	NS	<2.0	<2.0	<2.0	NS	NS
	1,2-DICHLOROBENZENE (O)	ppb	NS	NS	NS	NS	<2.0	<2.0	<2.0	NS	NS
	1,4-DICHLOROBENZENE (P)	ppb	NS	NS	NS	NS	<2.0	<2.0	<2.0	NS	NS
	BENZENE	ppb	<1.0	<1.0	ND	<0.2	<2.0	<1.0	<1.0	<2.0	<2.0
	TOLUENE	ppb	<1.0	<1.0	<10.0	<0.2	<2.0	<1.0	<1.0	<2.0	<2.0
	ETHYLBENZENE	ppb	NS	NS	ND	<0.2	<2.0	<1.0	<1.0	<2.0	<2.0
	CHLOROBENZENE	ppb	NS	NS	NS	<0.2	<2.0	<2.0	<2.0	<2.0	<2.0
	1,4-DICHLOROBENZENE	ppb	NS	NS	ND	<0.5	<2.0	<2.0	<2.0	<2.0	<2.0
	1,3-DICHLOROBENZENE	ppb	NS	NS	NS	<0.5	<2.0	<2.0	<2.0	<2.0	<2.0
	1,2-DICHLOROBENZENE	ppb	NS	NS	NS	<0.5	<2.0	<2.0	<2.0	<2.0	<2.0
	P-XYLENE	ppb	NS	NS	ND	NS	<2.0	<1.0	<1.0	<2.0	<2.0
	M-XYLENE	ppb	<1.0	<1.0	ND	NS	<2.0	<1.0	<1.0	<2.0	<2.0
	O-XYLENE	ppb	<1.0	<1.0	ND	NS	<2.0	<1.0	<1.0	<2.0	<2.0
	TOTAL VOLATILES	ppb	10.0	ND	20.0	9.6	1.8	5.3	ND	13.9	8.8

WELL NUMBER W-2

CATEGORY	PARAMETER	UNITS	DATE 09/11/80 CONCENTRATION	DATE 09/20/84 CONCENTRATION	DATE 11/28/84 CONCENTRATION	DATE 12/16/85 CONCENTRATION	DATE 07/02/86 CONCENTRATION	DATE 09/30/86 CONCENTRATION	DATE 01/09/87 CONCENTRATION	DATE 01/31/89 CONCENTRATION	DATE 04/18/89 CONCENTRATION
ALIPHATICS											
	MINERAL SPIRITS	ppb	NS	NS	NS	NS	<2000.0	120.0	NS	643.0	<100.0
	N-HEPTANE	ppb	<300.0	650.0	240.0	<10000.0	NS	NS	NS	NS	NS
	N-OCTANE	ppb	NS	<30.0	<3.0	<700.0	NS	NS	NS	NS	NS
	N-NONANE	ppb	NS	<30.0	<3.0	<5.0	NS	NS	NS	NS	NS
	N-DECANE	ppb	NS	<30.0	<3.0	<10.0	NS	NS	NS	NS	NS
VOLATILES											
	CHLOROMETHANE	ppb	NS	NS	NS	<1000.0	<500.0	<2500.0	<500.0	<1000.0	<500.0
	BROMOMETHANE	ppb	NS	NS	NS	<1000.0	<500.0	<2500.0	<500.0	<1000.0	<500.0
	DICHLORODIFLUOROMETHANE	ppb	NS	NS	NS	NS	<500.0	<2500.0	<500.0	NS	NS
	VINYL CHLORIDE	ppb	NS	NS	NS	<1000.0	<500.0	<2500.0	<500.0	<400.0	<200.0
	CHLOROETHANE	ppb	NS	NS	NS	<1000.0	<500.0	<2500.0	<500.0	<400.0	<200.0
	METHYLENE CHLORIDE	ppb	2300.0	<2000.0	<2000.0	<2000.0	1300.0	1300.0	<100.0	255.0	103.0
	TRICHLOROFLUOROMETHANE	ppb	NS	NS	NS	NS	NS	<500.0	<100.0	<200.0	<200.0
	1,1-DICHLOROETHENE	ppb	NS	NS	NS	1100.0	610.0	<500.0	<100.0	411.0	335.0
	1,1-DICHLOROETHANE	ppb	NS	<2000.0	<2000.0	<1000.0	370.0	1700.0	<100.0	1670.0	588.0
	1,2-DICHLOROETHENE	ppb	NS	3000.0	3700.0	2000.0	7200.0	4900.0	2000.0	20800.0	14500.0
	CHLOROFORM	ppb	NS	NS	NS	710.0	<100.0	<500.0	<100.0	<200.0	<100.0
	1,2-DICHLOROETHANE	ppb	NS	NS	NS	<500.0	<100.0	<500.0	<100.0	<200.0	<100.0
	1,1,1-TRICHLOROETHANE	ppb	<80.0	19000.0	15000.0	8500.0	21700.0	13600.0	2300.0	12400.0	13100.0
	CARBON TETRACHLORIDE	ppb	NS	NS	NS	<500.0	<100.0	<500.0	<100.0	<200.0	<100.0
	BROMODICHLOROMETHANE	ppb	NS	NS	NS	<1000.0	<100.0	<500.0	<100.0	<400.0	<100.0
	1,2-DICHLOROPROPANE	ppb	NS	NS	NS	<500.0	<100.0	<500.0	<100.0	<200.0	<100.0
	1,3-DICHLOROPROPENE (TRANS)	ppb	NS	NS	NS	<500.0	<100.0	<500.0	<100.0	<400.0	<200.0
	TRICHLOROETHENE	ppb	9000.0	17000.0	15000.0	21000.0	19700.0	19700.0	9400.0	23600.0	13300.0
	1,3-DICHLOROPROPENE (CIS)	ppb	NS	NS	NS	<2000.0	<200.0	<1000.0	<200.0	<200.0	<100.0
	DIBROMOCHLOROMETHANE	ppb	NS	NS	NS	<2000.0	<200.0	<1000.0	<200.0	<400.0	<200.0
	1,1,2-TRICHLOROETHANE	ppb	NS	NS	NS	<2000.0	450.0	<1000.0	<200.0	<400.0	<200.0
	2-CHLOROETHYLVINYL ETHER	ppb	NS	NS	NS	<10000.0	<200.0	<1000.0	<200.0	<400.0	<200.0
	BROMOFORM	ppb	NS	NS	NS	<1000.0	<200.0	<1000.0	<200.0	<400.0	<200.0
	1,1,2,2-TETRACHLOROETHANE	ppb	NS	NS	NS	NS	<100.0	<500.0	<100.0	<400.0	<200.0
	TETRACHLOROETHENE	ppb	14000.0	18000.0	19000.0	77000.0	35600.0	28900.0	20500.0	49800.0	34700.0
	CHLOROBENZENE	ppb	NS	NS	NS	<1000.0	<200.0	<1000.0	<200.0	<400.0	<200.0
	1,3-DICHLOROBENZENE (M)	ppb	NS	NS	NS	NS	<200.0	<1000.0	<200.0	NS	NS
	1,2-DICHLOROBENZENE (O)	ppb	NS	NS	NS	NS	<200.0	<1000.0	<200.0	NS	NS
	1,4-DICHLOROBENZENE (P)	ppb	NS	NS	NS	NS	<200.0	<1000.0	<200.0	NS	NS
	BENZENE	ppb	NS	25.0	22.0	<200.0	<200.0	<500.0	<100.0	<400.0	<200.0
	TOLUENE	ppb	NS	150.0	46.0	<40.0	<200.0	<500.0	<100.0	<400.0	<200.0
	ETHYLBENZENE	ppb	NS	<100.0	<10.0	<40.0	<200.0	<500.0	<100.0	<400.0	<200.0
	CHLOROBENZENE	ppb	NS	<200.0	<20.0	<20.0	<200.0	<1000.0	<200.0	<400.0	<200.0
	1,4-DICHLOROBENZENE	ppb	NS	<300.0	<20.0	<100.0	<200.0	<1000.0	<200.0	<400.0	<200.0
	1,3-DICHLOROBENZENE	ppb	NS	NS	NS	<100.0	<200.0	<1000.0	<200.0	<400.0	<200.0
	1,2-DICHLOROBENZENE	ppb	NS	NS	NS	<100.0	<200.0	<1000.0	<200.0	<400.0	<200.0
	P-XYLENE	ppb	NS	<200.0	<20.0	NS	<200.0	<500.0	<100.0	<400.0	<200.0
	M-XYLENE	ppb	NS	40.0	<10.0	NS	<200.0	<500.0	<100.0	<400.0	<200.0
	O-XYLENE	ppb	NS	53.0	<10.0	NS	<200.0	<500.0	<100.0	<400.0	<200.0
	TOTAL VOLATILES	ppb	25300.0	57268.0	52768.0	110310.0	86930.0	70100.0	34200.0	108936.0	76626.0

WELL NUMBER W-4

CATEGORY	PARAMETER	UNITS	DATE 09/11/80 CONCENTRATION	DATE 09/20/84 CONCENTRATION	DATE 11/28/84 CONCENTRATION	DATE 12/16/85 CONCENTRATION	DATE 07/02/86 CONCENTRATION	DATE 09/30/86 CONCENTRATION	DATE 01/09/87 CONCENTRATION	DATE 01/31/89 CONCENTRATION	DATE 04/18/89 CONCENTRATION
ALIPHATICS											
	MINERAL SPIRITS	ppb	NS	NS	NS	NS	<2000.0	150.0	NS	<100.0	697.0
	N-HEPTANE	ppb	<300.0	260.0	230.0	<10000.0	NS	NS	NS	NS	NS
	N-OCTANE	ppb	NS	13.0	<4.0	<20.0	NS	NS	NS	NS	NS
	N-NONANE	ppb	NS	6.2	3.8	<5.0	NS	NS	NS	NS	NS
	N-DECANE	ppb	NS	4.8	<2.0	<5.0	NS	NS	NS	NS	NS
VOLATILES											
	CHLOROMETHANE	ppb	NS	NS	NS	<500.0	<500.0	<1000.0	<1000.0	<250.0	<500.0
	BROMOMETHANE	ppb	NS	NS	NS	<500.0	<500.0	<1000.0	<1000.0	<250.0	<500.0
	DICHLORODIFLUOROMETHANE	ppb	NS	NS	NS	NS	<500.0	<1000.0	<1000.0	NS	NS
	VINYL CHLORIDE	ppb	NS	NS	NS	<500.0	<500.0	<1000.0	<1000.0	<100.0	<200.0
	CHLOROETHANE	ppb	NS	NS	NS	<500.0	<500.0	<1000.0	<1000.0	<100.0	<200.0
	METHYLENE CHLORIDE	ppb	500.0	<2000.0	<1000.0	<1000.0	<100.0	<200.0	<200.0	<50.0	<100.0
	TRICHLOROFLUOROMETHANE	ppb	NS	NS	NS	NS	<100.0	<200.0	<200.0	<100.0	<200.0
	1,1-DICHLOROETHENE	ppb	NS	NS	NS	<200.0	<100.0	<200.0	<200.0	<50.0	<100.0
	1,1-DICHLOROETHANE	ppb	NS	<2000.0	1800.0	<200.0	310.0	2100.0	<200.0	244.0	<100.0
	1,2-DICHLOROETHENE	ppb	NS	<2000.0	2300.0	1200.0	13000.0	19000.0	5000.0	2290.0	2160.0
	CHLOROFORM	ppb	NS	NS	NS	280.0	<100.0	<200.0	<200.0	<50.0	<100.0
	1,2-DICHLOROETHANE	ppb	NS	NS	NS	<200.0	<100.0	<200.0	<200.0	<50.0	<100.0
	1,1,1-TRICHLOROETHANE	ppb	<60.0	9700.0	16000.0	1400.0	7100.0	12000.0	3100.0	1570.0	4200.0
	CARBON TETRACHLORIDE	ppb	NS	NS	NS	<200.0	<100.0	<200.0	<200.0	<50.0	<100.0
	BROMODICHLOROMETHANE	ppb	NS	NS	NS	<200.0	<100.0	<200.0	<200.0	<50.0	<100.0
	1,2-DICHLOROPROPANE	ppb	NS	NS	NS	<200.0	<100.0	<200.0	<200.0	<50.0	<100.0
	1,3-DICHLOROPROPENE (TRANS)	ppb	NS	NS	NS	<200.0	<100.0	<200.0	<200.0	<50.0	<200.0
	TRICHLOROETHENE	ppb	45000.0	9100.0	16000.0	1900.0	7100.0	9800.0	5480.0	2080.0	3280.0
	1,3-DICHLOROPROPENE (CIS)	ppb	NS	NS	NS	<200.0	<200.0	<400.0	<400.0	<50.0	<100.0
	DIBROMOCHLOROMETHANE	ppb	NS	NS	NS	<200.0	<200.0	<400.0	<400.0	<100.0	<200.0
	1,1,2-TRICHLOROETHANE	ppb	NS	NS	NS	<200.0	<200.0	<400.0	<400.0	<100.0	<200.0
	2-CHLOROETHYLVINYL ETHER	ppb	NS	NS	NS	<5000.0	<200.0	<400.0	<400.0	<100.0	<200.0
	BROMOFORM	ppb	NS	NS	NS	<200.0	<200.0	<400.0	<400.0	<100.0	<200.0
	1,1,2,2-TETRACHLOROETHANE	ppb	NS	NS	NS	NS	<100.0	<200.0	<200.0	<100.0	<200.0
	TETRACHLOROETHENE	ppb	61000.0	3900.0	25000.0	8900.0	6300.0	11000.0	13700.0	6880.0	8540.0
	CHLOROBENZENE	ppb	NS	NS	NS	<500.0	<200.0	<400.0	<400.0	<100.0	<200.0
	1,3-DICHLOROBENZENE (M)	ppb	NS	NS	NS	NS	<200.0	<400.0	<400.0	NS	NS
	1,2-DICHLOROBENZENE (O)	ppb	NS	NS	NS	NS	<200.0	<400.0	<400.0	NS	NS
	1,4-DICHLOROBENZENE (P)	ppb	NS	NS	NS	NS	<200.0	<400.0	<400.0	NS	NS
	BENZENE	ppb	NS	<30.0	<30.0	<50.0	<200.0	<200.0	<200.0	<100.0	<200.0
	TOLUENE	ppb	NS	140.0	76.0	<10.0	<200.0	<200.0	<200.0	<100.0	<200.0
	ETHYLBENZENE	ppb	NS	<30.0	<10.0	<10.0	<200.0	<200.0	<200.0	<100.0	<200.0
	CHLOROBENZENE	ppb	NS	<40.0	48.0	<10.0	<200.0	<400.0	<400.0	<100.0	<200.0
	1,4-DICHLOROBENZENE	ppb	NS	100.0	<20.0	<30.0	<200.0	<400.0	<400.0	<100.0	<200.0
	1,3-DICHLOROBENZENE	ppb	NS	NS	NS	<30.0	<200.0	<400.0	<400.0	<100.0	<200.0
	1,2-DICHLOROBENZENE	ppb	NS	NS	NS	<30.0	<200.0	<400.0	<400.0	<100.0	<200.0
	P-XYLENE	ppb	NS	<40.0	<10.0	NS	<200.0	<200.0	<200.0	<100.0	<200.0
	M-XYLENE	ppb	NS	62.0	<10.0	NS	<200.0	<200.0	<200.0	<100.0	<200.0
	O-XYLENE	ppb	NS	<200.0	<10.0	NS	<200.0	<200.0	<200.0	<100.0	<200.0
	TOTAL VOLATILES	ppb	106500.0	23002.0	61224.0	13680.0	33810.0	53900.0	27280.0	13604.0	18180.0

WELL NUMBER W-7

CATEGORY	PARAMETER	UNITS	DATE 09/20/84 CONCENTRATION	DATE 11/28/84 CONCENTRATION	DATE 08/19/85 CONCENTRATION	DATE 12/16/85 CONCENTRATION	DATE 07/02/86 CONCENTRATION	DATE 09/30/86 CONCENTRATION	DATE 11/07/86 CONCENTRATION	DATE 01/09/87 CONCENTRATION	DATE 01/31/89 CONCENTRATION	DATE 04/18/89 CONCENTRATION
ALIPHATICS												
	MINERAL SPIRITS	ppb	NS	NS	NS	NS	450000.0	2800.0	NS	NS	13470.0	16900.0
	N-HEPTANE	ppb	<70.0	<400.0	ND	5000.0	NS	NS	<2000.0	NS	NS	NS
	N-OCTANE	ppb	<60.0	<20.0	ND	<5000.0	NS	NS	130000.0	NS	NS	NS
	N-NONANE	ppb	31.0	<20.0	ND	13000.0	NS	NS	170000.0	NS	NS	NS
	N-DECANE	ppb	210.0	15.0	ND	120000.0	NS	NS	520000.0	NS	NS	NS
VOLATILES												
	CHLOROMETHANE	ppb	NS	NS	NS	<1000.0	<100.0	<1000.0	<200.0	<1000.0	<2500.0	<5000.0
	BROMOMETHANE	ppb	NS	NS	NS	<1000.0	<100.0	<1000.0	<400.0	<1000.0	<2500.0	<5000.0
	DICHLORODIFLUOROMETHANE	ppb	NS	NS	NS	NS	<100.0	<1000.0	NS	<1000.0	NS	NS
	VINYL CHLORIDE	ppb	NS	NS	NS	<1000.0	<100.0	<1000.0	<200.0	<1000.0	<1000.0	<2000.0
	CHLOROETHANE	ppb	NS	NS	NS	<1000.0	<100.0	<1000.0	<400.0	<1000.0	<1000.0	<2000.0
	METHYLENE CHLORIDE	ppb	<2000.0	<100.0	464.0	<1000.0	<100.0	430.0	<1000.0	1520.0	<500.0	<1000.0
	TRICHLOROFLUOROMETHANE	ppb	NS	NS	NS	NS	<100.0	<200.0	NS	<200.0	<1000.0	<2000.0
	1,1-DICHLOROETHENE	ppb	NS	NS	NS	1200.0	110.0	<200.0	1600.0	9060.0	<500.0	<1000.0
	1,1-DICHLOROETHANE	ppb	<2000.0	1200.0	813.0	3500.0	120.0	1800.0	530.0	10030.0	1440.0	<1000.0
	1,2-DICHLOROETHENE	ppb	<2000.0	140.0	144.0	2300.0	3900.0	1400.0	4800.0	33400.0	3370.0	9270.0
	CHLOROFORM	ppb	NS	NS	NS	720.0	<100.0	<200.0	<200.0	<200.0	<500.0	<1000.0
	1,2-DICHLOROETHANE	ppb	NS	NS	NS	<400.0	<100.0	<200.0	<200.0	<200.0	<500.0	<1000.0
	1,1,1-TRICHLOROETHANE	ppb	23000.0	44000.0	46000.0	44000.0	15700.0	7180.0	47000.0	27700.0	15100.0	15700.0
	CARBON TETRACHLORIDE	ppb	NS	NS	NS	<400.0	<100.0	<200.0	<2000.0	<200.0	<500.0	<1000.0
	BROMODICHLOROMETHANE	ppb	NS	NS	NS	<400.0	<100.0	<200.0	<1000.0	<200.0	<500.0	<1000.0
	1,2-DICHLOROPROPANE	ppb	NS	NS	NS	<400.0	<100.0	<200.0	<1000.0	<200.0	<500.0	<1000.0
	1,3-DICHLOROPROPENE (TRANS)	ppb	NS	NS	NS	<400.0	<100.0	<200.0	<1000.0	<200.0	<1000.0	<2000.0
	TRICHLOROETHENE	ppb	21000.0	23000.0	51000.0	49000.0	15000.0	10800.0	36000.0	28100.0	20800.0	23600.0
	1,3-DICHLOROPROPENE (CIS)	ppb	NS	NS	NS	<1000.0	<200.0	<200.0	<2000.0	<200.0	<500.0	<1000.0
	DIBROMOCHLOROMETHANE	ppb	NS	NS	NS	<1000.0	<200.0	<200.0	<2000.0	<200.0	<1000.0	<2000.0
	1,1,2-TRICHLOROETHANE	ppb	NS	NS	NS	<1000.0	<200.0	<200.0	<2000.0	1170.0	<1000.0	<2000.0
	2-CHLOROETHYLVINYL ETHER	ppb	NS	NS	NS	<10000.0	<200.0	<200.0	<8000.0	2140.0	<1000.0	<2000.0
	BROMOFORM	ppb	NS	NS	ND	<2000.0	<200.0	<200.0	<2000.0	<200.0	<1000.0	<2000.0
	1,1,2,2-TETRACHLOROETHANE	ppb	NS	NS	ND	NS	<100.0	<200.0	NS	<200.0	<1000.0	<2000.0
	TETRACHLOROETHENE	ppb	36000.0	47000.0	ND	20000.0	37700.0	65700.0	110000.0	68800.0	74100.0	78300.0
	CHLOROBENZENE	ppb	NS	NS	NS	1000.0	<200.0	<400.0	<2000.0	<400.0	<1000.0	<2000.0
	1,3-DICHLOROBENZENE (M)	ppb	NS	NS	NS	NS	<200.0	<400.0	NS	<400.0	NS	NS
	1,2-DICHLOROBENZENE (O)	ppb	NS	NS	NS	NS	<200.0	<400.0	NS	<400.0	NS	NS
	1,4-DICHLOROBENZENE (P)	ppb	NS	NS	NS	NS	<200.0	<400.0	NS	<400.0	NS	NS
	BENZENE	ppb	13.0	<70.0	ND	<200.0	<200.0	<200.0	1600.0	<200.0	<1000.0	<2000.0
	TOLUENE	ppb	<70.0	1100.0	3352.0	1400.0	1100.0	<200.0	1500.0	15400.0	<1000.0	<2000.0
	ETHYLBENZENE	ppb	37.0	78.0	ND	800.0	<200.0	<200.0	580.0	<200.0	<1000.0	<2000.0
	CHLOROBENZENE	ppb	<90.0	<80.0	NS	620.0	<200.0	<400.0	1400.0	<400.0	<1000.0	<2000.0
	1,4-DICHLOROBENZENE	ppb	<300.0	<100.0	ND	160.0	<200.0	<400.0	<40.0	<400.0	<1000.0	<2000.0
	1,3-DICHLOROBENZENE	ppb	NS	NS	NS	990.0	<200.0	<400.0	25.0	<400.0	<1000.0	<2000.0
	1,2-DICHLOROBENZENE	ppb	NS	NS	NS	<100.0	<200.0	<400.0	<20.0	<400.0	<1000.0	<2000.0
	P-XYLENE	ppb	<90.0	<80.0	ND	NS	<200.0	<200.0	NS	<200.0	<1000.0	<2000.0
	M-XYLENE	ppb	<400.0	140.0	ND	NS	<200.0	<200.0	NS	<200.0	<1000.0	<2000.0
	O-XYLENE	ppb	<400.0	<100.0	ND	NS	<200.0	<200.0	NS	<200.0	<1000.0	<2000.0
	TOTAL VOLATILES	ppb	80050.0	116658.0	101773.0	124690.0	73630.0	87310.0	205035.0	197320.0	114810.0	126870.0

WELL NUMBER M-8

CATEGORY	PARAMETER	UNITS	DATE 09/20/84 CONCENTRATION	DATE 11/28/84 CONCENTRATION	DATE 12/16/85 CONCENTRATION	DATE 07/02/86 CONCENTRATION	DATE 09/30/86 CONCENTRATION	DATE 01/09/87 CONCENTRATION	DATE 01/31/89 CONCENTRATION	DATE 04/18/89 CONCENTRATION
ALIPHATICS										
	MINERAL SPIRITS	ppb	NS	NS	NS	<2000.0	<100.0	NS	<100.0	<100.0
	N-HEPTANE	ppb	14.0	1.2	<20.0	NS	NS	NS	NS	NS
	N-OCTANE	ppb	<2.0	<0.1	<80.0	NS	NS	NS	NS	NS
	N-NONANE	ppb	<1.0	<0.1	<3.0	NS	NS	NS	NS	NS
	N-DECANE	ppb	<1.0	<0.1	4.1	NS	NS	NS	NS	NS
VOLATILES										
	CHLOROMETHANE	ppb	NS	NS	<5.0	<50.0	<50.0	<50.0	<5.0	<5.0
	BROMOMETHANE	ppb	NS	NS	<5.0	<50.0	<50.0	<50.0	<5.0	<5.0
	DICHLORODIFLUOROMETHANE	ppb	NS	NS	NS	<50.0	<50.0	<50.0	NS	NS
	VINYL CHLORIDE	ppb	NS	NS	<5.0	<50.0	<50.0	<50.0	<2.0	<2.0
	CHLOROETHANE	ppb	NS	NS	<5.0	<50.0	<50.0	<50.0	<2.0	<2.0
	METHYLENE CHLORIDE	ppb	<200.0	<100.0	<1.0	39.0	<10.0	<10.0	<1.0	<1.0
	TRICHLOROFLUOROMETHANE	ppb	NS	NS	NS	<10.0	<10.0	<10.0	<2.0	<2.0
	1,1-DICHLOROETHENE	ppb	NS	NS	<2.0	<10.0	<10.0	<10.0	<1.0	<1.0
	1,1-DICHLOROETHANE	ppb	<200.0	<100.0	<20.0	<10.0	<10.0	<10.0	<1.0	<1.0
	1,2-DICHLOROETHENE	ppb	200.0	<100.0	<2.0	130.0	41.0	<10.0	3.7	<1.0
	CHLOROFORM	ppb	NS	NS	<1.0	<10.0	<10.0	<10.0	<1.0	<1.0
	1,2-DICHLOROETHANE	ppb	NS	NS	<2.0	<10.0	<10.0	<10.0	<1.0	<1.0
	1,1,1-TRICHLOROETHANE	ppb	550.0	<100.0	6.6	43.0	33.0	<10.0	<1.0	<1.0
	CARBON TETRACHLORIDE	ppb	NS	NS	<2.0	<10.0	<10.0	<10.0	<1.0	<1.0
	BROMODICHLOROMETHANE	ppb	NS	NS	<2.0	<10.0	<10.0	<10.0	<1.0	<1.0
	1,2-DICHLOROPROPANE	ppb	NS	NS	<2.0	<10.0	<10.0	<10.0	<1.0	<1.0
	1,3-DICHLOROPROPENE (TRANS)	ppb	NS	NS	<2.0	<10.0	<10.0	<10.0	<2.0	<1.0
	TRICHLOROETHENE	ppb	440.0	200.0	4.7	340.0	150.0	45.0	10.7	1.4
	1,3-DICHLOROPROPENE (CIS)	ppb	NS	NS	<4.0	<20.0	<20.0	<20.0	<1.0	<1.0
	DIBROMOCHLOROMETHANE	ppb	NS	NS	<4.0	<20.0	<20.0	<20.0	<2.0	<2.0
	1,1,2-TRICHLOROETHANE	ppb	NS	NS	<4.0	<20.0	<20.0	<20.0	<2.0	<2.0
	2-CHLOROETHYLVINYL ETHER	ppb	NS	NS	<50.0	<20.0	<20.0	<20.0	<2.0	<2.0
	BROMOFORM	ppb	NS	NS	<2.0	<20.0	<20.0	<20.0	<2.0	<2.0
	1,1,2,2-TETRACHLOROETHANE	ppb	NS	NS	NS	<20.0	<20.0	<10.0	<2.0	<2.0
	TETRACHLOROETHENE	ppb	670.0	2500.0	140.0	2110.0	1710.0	730.0	24.5	8.9
	CHLOROBENZENE	ppb	NS	NS	<1.0	<20.0	<20.0	<20.0	<2.0	<2.0
	1,3-DICHLOROBENZENE (M)	ppb	NS	NS	NS	<20.0	<20.0	<20.0	NS	NS
	1,2-DICHLOROBENZENE (O)	ppb	NS	NS	NS	<20.0	<20.0	<20.0	NS	NS
	1,4-DICHLOROBENZENE (P)	ppb	NS	NS	NS	<20.0	<20.0	<20.0	NS	NS
	BENZENE	ppb	3.4	<1.0	<2.0	<20.0	<10.0	<10.0	<2.0	<2.0
	TOLUENE	ppb	<1.0	<1.0	<1.0	<20.0	62.0	<10.0	<2.0	<2.0
	ETHYLBENZENE	ppb	<1.0	<1.0	<1.0	<20.0	<10.0	<10.0	<2.0	<2.0
	CHLOROBENZENE	ppb	<1.0	<1.0	<1.0	<20.0	<20.0	<20.0	<2.0	<2.0
	1,4-DICHLOROBENZENE	ppb	<1.0	<1.0	<2.0	<20.0	<20.0	<20.0	<2.0	<2.0
	1,3-DICHLOROBENZENE	ppb	NS	NS	<2.0	<20.0	<20.0	<20.0	<2.0	<2.0
	1,2-DICHLOROBENZENE	ppb	NS	NS	<2.0	<20.0	<20.0	<20.0	<2.0	<2.0
	P-XYLENE	ppb	<1.0	<1.0	NS	<20.0	<10.0	<10.0	<2.0	<2.0
	M-XYLENE	ppb	<1.0	<1.0	NS	<20.0	<10.0	<10.0	<2.0	<2.0
	O-XYLENE	ppb	<1.0	<1.0	NS	<20.0	<10.0	<10.0	<2.0	<2.0
	TOTAL VOLATILES	ppb	1863.4	2700.0	151.3	2662.0	1996.0	775.0	38.9	10.3

INORGANIC ANALYSIS (LEAD)
ON-SITE WELLS
XEROX - BLAUVELT SITE
BLAUVELT, NEW YORK

Location	Concentration (ppm) 1/31/89*	1/31/89**	4/18/89*
W-1	.0946	.0851	.0157
W-2	.0215	--	.0057
W-3	.0316	--	--
W-4	.0434	--	.0053
W-5	.386	--	.005
U-6	.0656	.0272	.005
W-7	.0786	--	.0282
W-8	.0157	.0381	.0454
U-6D	.0484	.98	.0198
W-7D	.115	.0573	.0312
W-9D	.0575	--	.0560
OW-1	.0682	--	.0265
OW-2	.0962	--	.0527
PW-1	.0058	--	.0055
PW-2	.0786	--	.0254
MW-10	.005	--	.005
MW-11	.005	--	.005
MW-12	.005	--	.005
MW-13	.0084	--	.005
MW-14	.005	--	.005
MW-15	.0116	--	.0061
MW-16	.009	--	.005
MW-17	--	--	.0102

* By Method 7421
** TCL Analysis
ppm Parts per million
-- Not Sampled

general testing corporation

water and wastewater testing specialists

710 Exchange Street
Rochester, NY 14608
(716) 454-3760

85 Trinity Place
Hackensack, NJ 07601
(201) 488-5242

LABORATORY REPORT

Job No: R89/00276 Date: MAR. 14 1989

Client:
Mr. Eliott Duffney
Xerox Corporation
800 Phillips Road
Webster, New York 14580

Sample(s) Reference

Blauvelt Facility

Collected : 01/31/89 P.O. #:

METALS - HSL — ANALYTICAL RESULTS - mg/l

Sample:	-001	-002	-003	-004	-005	-006		
Location:	U-6	U-60	W-1	W-70	W-70 Dup	W-8		
Date Collected:	01/31/89	01/31/89	01/31/89	01/31/89	01/31/89	01/31/89		
Time Collected:	10:50	10:55	11:30	12:35	12:40	13:00		
Aluminum	0.86	0.85	1.16	1.03	1.06	0.94		
Antimony	<0.20	<0.20	<0.20	<0.20	<0.20	0.20		
Arsenic	<0.0020	<0.0020	0.0140	<0.0020	<0.0020	<0.0020		
Barium	0.22	0.21	0.49	0.70	0.69	0.14		
Beryllium, Furnace	<0.0050	0.0090	<0.0050	<0.0050	<0.0050	<0.0050		
Cadmium, Furnace	0.0621	0.0024	0.0058	0.0026	0.0022	<0.0010		
Calcium, Total	48.3	62.5	218	87.4	86.4	26.4		
Chromium, Furnace	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	0.0147		
Cobalt, Total	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050		
Copper, Total	<0.020	0.124	0.031	<0.020	<0.020	0.029		
Iron, Total	39.7	0.926	17.2	3.89	7.16	123		
Lead, Total	0.0272	0.9800	0.0851	0.0573	0.0909	0.0381		
Magnesium, Total	8.25	7.10	22.5	12.6	12.5	3.54		
Manganese, Total	0.462	0.034	6.16	0.147	0.159	0.886		
Mercury, Total	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020	<0.00020		
Nickel, Total	<0.040	<0.040	<0.040	<0.040	<0.040	<0.040		
Potassium, Total	1.20	1.21	1.58	1.72	2.46	0.473		
Selenium, Total	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050	<0.0050		
Silver, Total	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010		
Sodium, Total	16.5	7.83	17.0	11.1	11.6	44.2		
Thallium, Furnace	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010		
Tin, Total	<0.010	<0.010	<0.010	<0.010	<0.010	<0.010		
Vanadium, Furnace	<0.050	<0.050	<0.050	<0.050	<0.050	<0.050		
Zinc, Total	3.77	4.04	11.6	6.41	6.89	1.31		

*EPA 40 CFR Part 136 10/84
NY LABORATORY CERTIFICATION ID#: 10145
NJ ID#: 73331 in Rochester; NJ ID#: 02317 in Hackensack

Analytical procedures in accordance with Standard Methods for the Examination of Water and Wastewater, 15th Edition and Methods for Chemical Analysis of Water and Wastes, EPA. (<) indicates lowest detectable concentration with procedure used. Data on quality control performed with above sample(s) is available upon request.

Michael K. Pang
Laboratory Director

general testing corporation

water and wastewater testing specialists

710 Exchange Street
Rochester, NY 14608
(716) 454-3760

85 Trinity Place
Hackensack, NJ 07601
(201) 488-5242

July 31, 1989

Mr. Eliott Duffney
Xerox Corporation
800 Phillips Road
Webster, NY 14580

Dear Mr. Duffney:

As requested on July 25, a data check was conducted for the report dated March 16, 1989 from the Blauvelt Facility.

Quality control and data transcription was checked. All data is correct as reported. Differences in lead values between the two Job Numbers R89/275 and 276 are attributable to the variability in sample composition.

The samples taken required volumes of two to four liters depending on the location. Slow well recharge, trace NAPL, and sampling technique could have provided a non-uniform sample. Confirmation of the above is not possible since most sample has been discarded.

Please review this information and call should any questions arise.

Sincerely,

GENERAL TESTING CORPORATION

Sue Toscano

Sue Toscano
Client Representative

msw

Enc.

Appendix B

APPENDIX B

Appendix B contains the Woodward-Clyde Consultants Standard Operating Procedures. The material includes:

B-1.0 PRELIMINARY INVESTIGATIVE PROCEDURES

Planning is a vital element in any site investigation. Most hazardous waste investigations and monitoring programs require detailed and comprehensive written explanations of the tasks to be performed, quality assurance and quality control measures and safety precautions. Only with this planning phase can the effective and safe performance of tasks and the retrieval of high quality data be assured.

A major part of this planning involves research of background information and general site surveys which are used to develop the site safety plan and the site sampling plan.

B-1.1 REVIEW OF EXISTING DATA

The review of existing data is an integral part of the preparation phase for all projects and is a basic technique of professional practice. Planning for hazardous waste site investigations typically requires the review of existing hydrogeologic and geotechnical information. Guidelines for the type of information to be obtained and reviewed prior to the development of the site Health and Safety Plan and the Field Sampling Plan are described below. Sources would typically include municipal, state and federal agencies including, but not limited to, natural resources, environmental and health agencies, the client's and well drillers files and Woodward-Clyde Consultants (WCC) library files.

B-1.2 FACILITY OPERATIONS

Information should be obtained on present and past operational practices at the site under investigation. This includes information on facility construction, disposal practices, spills and cleanups, results of previous health or environmental studies, and itemized lists of wastes known or expected to be found on the site.

B-1.3 CHEMICAL DATA

Available chemical data for the site and vicinity should be reviewed to assess the potential for known or suspected contaminants in various environmental media. The toxicological or general health effects of known or suspected contaminants at the site should

be defined. The chemical data may be tabulated and/or plotted to facilitate analysis and interpretation.

B-1.4 SITE SURVEYS

A site survey provides information about site facilities and processes, topography, access of equipment, and location of monitoring wells, borings and sampling locations. This information is necessary for preparation of the site sampling and safety plans. The site is the area of controlled access and activity as defined by the project Manager. Aerial photos, if available, should be reviewed and any construction or topography changes noted.

B-1.5 OFF-SITE SURVEY

A reconnaissance of the site vicinity (off-site survey) will usually provide valuable preliminary information and can be conducted before legal permission to enter a site is obtained. The survey will produce notes on visual observations, hand sketches, and photographs. If there are no reliable data about potential safety hazards on a site, off-site surveys are recommended until the site Health and Safety Plan has been completed and approved.

B-1.6 ON-SITE SURVEY

On-site surveys should generally be performed only when adequate data to define the potential threat to health is available. Appropriate protective equipment must be worn during the on-site survey. If an on-site survey is considered necessary to obtain information for the site safety plan, and no reliable data exist, personnel should wear safety gear capable of protecting them from an undefined type of exposure.

Methods used to obtain data are the same as for off-site surveys. Elevation and boundary surveys may also be useful in establishing control points for mapping locations of proposed site activities. During the on-site survey, potential contaminant sources are

inspected and probable locations and access for borings and monitoring wells identified. An air quality survey using equipment such as an Organic Vapor Analyzer (OVA) or an HNU photoionization meter will be performed.

B-1.7 SITE HEALTH AND SAFETY PLAN

All activities on a site are subject to the provisions of the site Health and Safety Plan (HASP). This site-specific document is prepared before site work begins.

In general, the site HASP should as a minimum provide information on known or suspected contaminants, their effects on health (i.e., symptoms of exposure), required protective gear and its limitations, emergency medical and evacuation procedures, and names and phone numbers of local medical facilities, physicians, fire, police and ambulance agencies.

Common sense and good judgment are important parts of an effective HASP. Employees are not expected to place themselves in a situation where they believe their safety is compromised.

B-1.8 FIELD SAMPLING PLAN

The Field Sampling Plan is the section of the Work Plan which details each task to be performed in the field during the hazardous waste site investigation. Number, location of sampling points and types of analyses at each point are described. Any variances of field procedures from those stipulated in the sampling plan must be approved by the Site Manager, in consultation with the Project Manager, and possibly outside enforcement agencies or the client. Work should not begin at a site until the Field Sampling Plan has been completed and approved by the Project Manager and Client. Site-specific details for the Field Sampling Plan are discussed in the Remedial Investigation Field Activities Section of the Work Plan.

B-2.0 BORING INSTALLATION

Borings will be installed to: (1) define the stratigraphy and structure beneath the site; (2) obtain representative samples of subsurface soil and/or obtain rock core; (3) provide access for aquifer test equipment; and (4) install piezometers or monitoring wells. Borings are usually advanced using power drilling systems such as truck, trailer, crawler, or skid-mounted drilling rigs, although manual techniques may also be used.

B-2.1 DRILLING PROCEDURES FOR SPLIT-SPOON AND ROCK CORE SAMPLING

B-2.1.1 GENERAL PROCEDURES

- The field geologist will locate and stake each boring location.
- The Project Manager will review the scope of work with the drilling subcontractor to assure that proper equipment is available, and that the field operations and health and safety requirements are understood.
- Underground cable and power line locations will be determined before boring activity begins.
- Drill rigs and tools (samplers, augers, wrenches, etc.) will be steam cleaned by the drilling contractor prior to entering the site (see Section B-8.0).
- All water trucks will be flushed with potable water prior to moving into the site.
- The drill rig will be inspected for leaks of hydraulic fluids, fuel, etc., prior to moving into the site. All visible leaks in hoses and/or seals will be corrected.

- A WCC geologist will be on-site during all drilling operations to inspect soil samples and to maintain an accurate geologic log for each boring. The inspector will be responsible for ensuring that the drilling performed by the contractor is in accordance with project specifications. All information regarding the boring activities will be recorded in a field notebook.

- The Inspector shall instruct the driller to position the drill rig over the staked location of the boring. If the actual location of the drill hole is changed from the stake, the displacement shall be indicated on the boring log and the boring location plan.

- All depths and lengths shall be measured and recorded to the nearest 0.1 foot. The Inspector shall not rely completely on the driller's measurements, and shall periodically check these measurements on his/her own.

- The geologist will describe any changes in lithology, color, or odor of subsurface materials (if respiratory protection is not required as per the HASP) and will note encountered, and if possible overnight, groundwater level data on boring log forms.

- Air quality monitoring will be performed continuously during drilling as described in WCC's Health and Safety Plan (HASP).

- Hollow stem augers (HSA) or rotary techniques will be used to advance the borehole. (The drilling technique to be used for each location has been defined in Remedial Investigation Field Activities section of the Work Plan). If a monitoring well is being installed upon completion of soil/rock sampling:

  The I.D. of the HSA, or the outside diameter (O.D.) of the rotary tool will be at least 2-inches greater than the O.D. of the riser pipe/screen being installed.

- A mud (recycling) tub will be used for any rotary technique required to advance the borehole in order to minimize the loss of drilling fluids to the ground surface.

- Two-inch (I.D.) split-spoon soil samples will be taken in advance of the drilling tool. NX core-barrels will be used to collect bedrock samples.

- Connection of drilling tools will not be lubricated with petrochemical lubricants. Threaded connections will be cleaned using wire brushes and a string gasket may be used at connections.

- Only clean potable water will be used if it becomes necessary to clear the hollow stem of debris or sediments.

- In wet or muddy conditions, the tires of the rig will be covered with plastic to minimize tracking potentially contaminated spoils from the work area to the decon pad.

- All downhole tools will be steam cleaned inside and outside between boring locations.

- All drilling fluid recycling tools will be flushed as described in Section B-8 upon completion of tasks such as:

  a) Completion of borehole

  b) Conversion from rotary techniques for soil sampling to rock coring

  c) Prior to bedrock open-hole completion after the setting of riser pipe

- Cleaned augers and tools will be kept on either plastic sheeting, pallets or raised blocks.

- At the end of each boring (if a monitoring well has not been designated for that location):
  - The hole will be backfilled with a soil portland cement (ASTM C150) bentonite mix to within 3 feet of the ground surface. The remaining 3 feet will be backfilled with a portland cement (ASTM C150) bentonite slurry (3 pounds bentonite, 94 pound bag cement, 8 gallons water to provide a hardened cap. Any remaining auger spoils and the plastic tire cover, if used, will be placed in a 55 gallon drum labeled "SOLIDS" and the borehole designation.
  - All drilling and downhole tools will be decontaminated as outlined in Section B-8.

The following discussion is divided into two sections: procedures specific to soil borings and procedures specific to rock drilling.

B-2.1.2 SOIL BORINGS

Standard Penetration Tests will be performed, and split-spoon samples collected in accordance with ASTM-D-1586-84 when boreholes are advanced through unconsolidated deposits.

B-2.1.2.1 PREPARATION OF SOIL BORING LOGS

A legible, concise and complete record of all significant information pertaining to drilling and sampling operations within each borehole must be maintained concurrent with the advancement of the hole. This information shall be recorded on the field boring log. A sample soil boring log is shown in Figure B-2.1. In general, there are two types of boring logs used in WCC's Plymouth Meeting Office - soil data logs and rock data logs. It is the responsibility of the Inspector to make certain that the selection of logs is consistent with

project needs and approved by the project manager. The format contained in Figure B-2.1 should be followed closely so that completed boring logs look consistent in presentation of data. The source of description, if not based on the recovered soil sample, shall be noted on the boring log.

Required information on the boring log shall include the following:

- Description of soil samples;
- Drilling technique (i.e.) HSA, rotary, etc.
- Sampling device (i.e.,) 2-inch 10 split-spoon sampler, shelby tube, etc.
- Depth or elevation of strata changes;
- Number of blows per 6-inch of penetration of the split-spoon during the Standard Penetration Test;
- Number of blows per 6-inch or one foot of penetration of steel casing;
- Location and number of split-spoon and undisturbed tube samples;
- Length of recovered sample.

In addition to the required information indicated on the boring log, the remarks section of the boring log will include such pertinent information as:

- Offset (magnitude and direction) of as-drilled location from staked location;
- Depth and condition of casing;
- Depth of introduction of drilling fluid and type of drilling fluid;

- Loss of samples;
- Change in color of drilling fluid and characteristics of soil cuttings;
- Upward boiling of bottom of borehole;
- Loss of drilling fluid;
- Change in resistance to rotary or HSA drilling
- Artesian conditions noting flow water, duration flow observed
- Occurrence and depth of obstructions, including cobbles and boulders;
- Stoppage and resumption of drilling operations; and
- Conditions of undisturbed samples.

Separating lines between different soil strata shall be drawn as follows:

- A solid line if a change is observed in the split-spoon;
- A dashed line at an intermediate location between samples or based on the depth of observed change in soil cuttings with drilling fluid, or change in drilling effort if soil change is not observed in the split-spoon.

Separating lines shall be drawn only when changes in major soil component occur.

B-2.1.2.2 SOIL SAMPLING

- Split-spoon samples will be collected in accordance with ASTM-D-1586-84. Jars for chemical laboratory analysis will be filled first.

- Shelby tube samples will be collected where appropriate at the discretion of the Project Manager. Shelby tube samples will be collected in accordance with ASTM-D-1587-83. A sample from the top and bottom of the shelby tube will be collected, classified and stored separate jars prior to sealing the top and bottom of the tube with a non-petroleum based wax (such as bees wax).

- Soil samples will be identified in the field using the Burmister System and ASTM-2488 outlined on Table B-2.1. Figure B-2.2 is a guide for classifying relative densities for granular materials based on Standard Penetration Tests.

- Samples will be examined and stored in air-tight glass sample jars with screw-cap lids. One soil sample will be collected from each split-spoon except when changes in soil type are observed within the sample interval. When this occurs, soils of each type will be stored in separate jars. All sample jars will be labelled.

- The split-spoon sampler will be decontaminated before each use as described in Section B-8.

- Soil sample swill be transferred from the split-spoon sampler to the sample jar using a stainless steel spoon, which will be decontaminated before each sample.

- Headspace analysis of organic vapors within samples jars will be measured with either an OVA or HNU as described in Section B-2.2. Samples for laboratory analysis will be collected first, followed by samples for headspace analysis. Samples for laboratory analysis will be collected in the appropriate jar as designated in the Field Sampling Section of the Work Plan.

The Site Manager will ensure that the inspection, drilling, decontamination, and sampling procedures identified are allowed.

B-2.1.2.3 LABELING OF SOIL SAMPLES

After soil samples are retrieved and classified, the samples will be preserved in either glass jar containers (split-spoon samples) or tube containers (undisturbed samples). The sample containers and jar boxes shall be marked and labeled as shown in Figure B-2.3. Jar samples of representative trimmings from undisturbed samples should be identified in such a way as to readily indicate their association with tube samples. All soil samples being collected for laboratory analysis will be collected first, and placed in the appropriate glassware as described in the Field Sampling Section of the Work Plan.

B-2.1.2.4 CLASSIFICATION OF SOIL SAMPLES

Soil samples shall be classified in the field in accordance with the Burmister System and ASTM-2488. Table B-2.1 is helpful for field soil classification.

Soil descriptions shall be based on visual/manual observations of the soil in split-spoon, soil cuttings, or trimming from tube samples. In general, split-spoon samples shall be sliced in half before preserving in jars in order to observe and measure stratification and inclusions.

The sequence of describing a soil sample in the field boring log is as follows:

1. Condition of soil, i.e., compactness, granular soils (see Figure B-2.2), or consistency cohesive soils (see Table B-2.1).

2. Color.

3. Descriptive adjective for main soil component.

4. Main soil component.

5. Descriptive adjective for minor soil component.

6. Minor soil component.

7. Miscellaneous descriptions.

8. Water content descriptive term.

9. Geological name, if known, or other names (in parenthesis).

B-2.1.2.5 DISPOSAL OF DRILLING SPOILS/FLUIDS

Upon completion of HSA test borings, all auger spoils will be collected and containerized in 55 gallon drums labeled "SOLIDS" and with the borehole designation. Upon completion of all borings advanced by rotary techniques, all excess fluids collected in the mud (recycling) tub shall be pumped into a 55 gallon drums labeled "LIQUIDS." All drums will be properly disposed of as outlined in the Remedial Investigation Field Activities Section of the Work Plan.

B-2.1.2.6 DECONTAMINATION OF SAMPLING JARS

All field sample jars (for both headspace and chemical analyses) will be decontaminated as described in Section B-8.

B-2.1.2.7 CHAIN-OF-CUSTODY-RECORD

Each sample set requiring laboratory analysis will be accompanied by a chain-of-custody record. When transferring the possession of samples, the individuals relinquishing and receiving will sign, date, and note the time on the chain-of-custody record. This record documents transfer of custody of samples from the sampler to the shipper, or to an analytical laboratory, etc. The record must contain the following minimum information:

a. The sample container identification number;

b. Signature of collector;

c. Date and time of collection;

d. Place of collection;

e. Sample type;

f. Signatures of persons involved in the chain of possession;

g. Inclusive dates of possession.

B-2.1.2.8 BOUND FIELD LOG ENTRY

All sampling information will be recorded in ink in a bound field log book. Entries will include sufficient detail to reconstruct site activities, if necessary. Information recorded in the notebook should include but not be limited to the following: place or site of investigation or interest; exact location; date and time of arrival and departure; affiliation of persons contacted; name of person keeping log; names of all persons on-site; purpose of visit; all available information on site; field instrument calibration information; location of sampling points; number of samples taken; method of sample collection; date and time of sample collection; name of collector; all sample identification numbers; description of samples; weather conditions on the day of sampling and any field observations.

B-2.1.3 ROCK DRILLING

The following procedures describe methods for inspection of core and non-core rock drilling, handling and labeling of core, preparation of boring logs, and rock description.

As with soil boring logs, rock boring logs should be as comprehensive as possible under field conditions, yet be terse and precise. The level of detail should be keyed to the purpose of the investigation as well as to the intended user of the prepared logs. Although the same basic information should be presented on all rock boring logs, an appropriate level of detail should be determined by the project manager based on project needs.

B-2.1.3.1 NON-CORE DRILLING

Non-core rock drilling may be used when an intact rock sample is not required and a borehole is to be advanced relatively quickly and inexpensively. Types of non-core drilling include air-track drilling, down-the-hole percussive drilling, rotary tricone (roller bit) drilling, rotary drag bit drilling, and, in very soft rocks, augering. Drilling fluid may be water, mud, or compressed air.

The following information pertaining to drilling characteristics should be recorded in the remarks section of the rock coring log, (or where designated by the project manager):

- Changes in penetration rate or drilling speed in minutes or seconds per foot;
- Dropping of rods;
- Changes in drill operation by driller (down pressures, rotation speeds, etc.);
- Changes in drill bit condition;
- Unusual drilling action (chatter, bouncing, binding, etc.)

When drilling with compressed air, there may or may not be return water depending on depth to the water table, rate of recharge, and heat generated by the drilling process. When drilling with water, characteristics of the return water can provide valuable information concerning subsurface conditions. The following information concerning fluid characteristics should be recorded in the remarks section of the boring log:

- o Depth to static water level measure every morning before start of drilling;
- o Absence of return water;
- o Color and clarity of return water;
- o Changes in flow rate of return water, including loss of circulation and artesian flow.

B-2.1.3.2 CORE DRILLING

Core barrels may be single tube or more commonly, double tube, which offer better recovery by isolating the rock core from the water stream. For particularly friable or broken rock, triple tube barrels may be used. Double and triple tube core barrels may have split inner tubes to allow observation and removal of core with reduced disturbance.

Wire line drilling equipment allows the inner tube to be uncoupled from the outer tube and raised to the surface by means of a wire line passing through the drill rods. This equipment usually produces better recovery as well as better production rates.

Although NX (2-1/8-inch core diameter) is the size most frequently used for engineering investigations, larger and smaller sizes are in use. Generally, a larger core size will produce greater recovery. Because of their effect on core recovery, the size and type of coring equipment used should be carefully recorded in the appropriate places on the boring log. It should be noted that most standard correlations for RQD are based on measurements made on NX-size core.

Observations of drilling characteristics and fluid characteristics (including water levels) should be recorded in the remarks section of the boring log as described for non-core drilling.

All excess fluids resulting from the coring operation will be pumped into a drum labeled "LIQUIDS." All drums will be properly disposed of as outlined in the Remedial Investigation Field Activities Section of the Work Plan.

The cores should be handled carefully during transfer from barrel to box to preserve mating across factures and fracture-filling materials. Deliberate breaks in the core should be avoided unless absolutely necessary. Any deliberate or mechanical breaks should be logged with the symbol -M- at the appropriate interval.

An example of recommended core box markings is given in Figure B-2.4 Wooden blocks should be used to mark the drilled depth of the top and bottom of each run. Depths should also be marked at each end of the box's divided intervals. The core box lid should have identical markings both inside and at least one end of the box should be marked as shown.

Rock core may be photographed as directed by the project manager.

For angled borings, depths marked on core boxes and boring logs should be "non-vertical depths," i.e., measured along the borehole's long axis.

B-2.1.3.3 LOGGING PROCEDURES FOR CORE DRILLING

Rock descriptions should use technically correct geologic terms, although local terms in common general use may be acceptable if they help describe distinctive characteristics. Rock core should be logged when wet for consistency of color description and greater visibility of rock features. An example of a core boring log is given in Figure B-2.5. A minimum of one complete rock description should be given per page. Otherwise, "as above" with one or two modifications is acceptable.

Descriptive terms should be precisely defined, either as described in these procedures or as noted on the boring log (e.g. "thin" bedding, "moderately" fractured, etc.).

Non-standard abbreviations should also be defined, with reference either to a standard list or as noted on the log itself.

It is very important to record on the log any change in color of drilling fluids or changes in drilling rates in order to estimate the depth recovered are if less than 100 percent core recovery is achieved.

The following terms refer to column headings given in the sample coring log in Figure B-2.5.

- Recovery - The ratio of the length of core recovered to the total length of core drilled on a given run, expressed as both a fraction and as a percentage. Core length should be measured along centerline. Non-recovery should be assumed to be at the end of the run unless there is reason to suspect otherwise (e.g. weathered zone, drop of rods, etc.). Non-recovery should be marked on the boring log, and entries should not be made for bedding, fracturing, or weathering in that interval.

  Recoveries greater than 100 percent may occur if core which was not recovered during a run is subsequently recovered by a later run. These should be recorded as such; adjustments to data should not be made in the field.

- RQD (Rock Quality Designation) - The ratio of the total length of core pieces 4-inches or longer to the total length drilled on a given run, recorded on the log as both as a fraction and as a percentage. Core length should be measured along centerline.

- Bed - Stratification, foliation, and other significant non-fracture structural features should be sketched in this column. Veins, stringers, seams, etc. may be considered significant if they are parallel to fractures, planar,

differentially weathered, repeated, or otherwise unusual. Stratification and foliation may be shown schematically, but indistinct structure should be so labeled on the log. Dip angles of the features should be measured down from the horizontal using a protractor or dipmeter, and marked on the log. For non-vertical borings, the angle should be measured and marked as if the boring were vertical.

- o Fracture Dip - Fractures should be sketched at the depth at which they are inferred to occur. Dip angles should be measured and marked as for bedding and foliation. If the rock is broken in many pieces less than one-half to one-inch long, the log may be cross hatched in that interval, or factures may be shown schematically.

Table B-2.2 should be used as a standard to determine the degree of weathering, hardness, and joint classifications.

B-2.2 HEADSPACE ANALYSES

Soil samples obtained during the course of exploratory drilling will be screened for volatile organic compounds in the headspace of the non-chemical analysis sample jar using the following procedure:

1. Samples collected in jars will be immediately covered with aluminum foil, matte side up, and the top screwed on.

2. The sample will then be brought to room temperature by being kept in a warm location.

3. The top will then be unscrewed (15 minutes to 1 hour after sample collection) and the OVA/PID probe will be punched through the aluminum foil for a headspace reading.

4. The maximum reading will be recorded.

TABLE B-2.1

FIELD DETERMINATION OF SOIL COMPONENTS*

Component	Characteristic	Determination
Granular Soil	Feel/smear test	Pinch of soil is handled between thumb and finger to obtain an impression - grittiness or softness
Gravel		
Coarse	Dia. 3/4 in - 3 in	Measurable
Fine	Dia. 4.7 in - 3/4 in	Measurable
Sand		
Coarse	Dia. 2 - 4.7 mm	Visible to eye, measurable
Medium	Dia. 0.4 - 2 mm	Visible to eye
Coarse to Medium (C-M)		Very harsh/gritty feel and smear
Fine	Dia. 0.074 - 0.4 mm	Barely discernible to unaided eye, soft feel, slighly gritty smear
Coarse to Fine (C-F)		Less harsh than C-M, but very gritty smear
Medium to Fine (M-F)		Less gritty smear than C-F/C-M and softer feel
Silt	Dia. 0.02 - 0.074 mm	Distinguisable with hand lens. 10 percent identified by a slight discoloration of finger tips. Increasing silt increase discoloration and softness
	Sedimentation Test	Small sample of soil shaken in glass container (8 oz. jar)
	For a 4-inch fall in jar - a) 4-inches in approximately 1/2 minute for particle sizes coarser than SILT b) 4-inches in approximately 50 minutes for particles .005 mm: "clay size"	
Sand - Silt Mixtures	Apparent cohesion	Measured by ball test (Burmister 1949) Form ball in hand by compacting moist soil to diameter 1-1/2 in (37 mm)
		Medium to fine sand forms weak ball with difficulty; cannot be picked up between thumb and forefinger without crushing.
		Ball can be picked up with difficulty; 20 percent silt
		Ball readily picked up: 35 to 50 percent silt.
Silt vs. Clay	Dia. 0.074 mm	
	Strength	Air dry, then crush between fingers
	Dilatancy Test	Mixed with water to thick paste consistency.
	Thread Test	Rolls into thin threads in wet state but threads break when picked up by one end.

Note: "Feel" tests not to be performed on contaminated soils. Contaminated samples will be evaluated by cutting core with a knife and evaluating the smear.

IDENTIFICATION OF COMPOSITE CLAY SOILS ON AN OVERALL PLASTICITY BASIS

Degree of Overall Plasticity	PI	Identification (Burmister System)	Smallest Diameter of Rolled Threads, mm
Nonplastic	0	SILT	None
Slight	1 - 5	Clayey Silt	6
Low	5 - 10	SILT and CLAY	3
Medium	10 - 20	CLAY and SILT	1.5
High	20 - 40	Silty CLAY	0.8
Very High	40	CLAY	0.4

TABLE B-2.1 (Continued)

IDENTIFICATION OF FINE-GRAINED SOIL FRACTIONS FROM MANUAL TESTS

Material	Dry Strength	Dilatency Reaction	Toughness of Plastic Thread	Plasticity Description	Smear
Sandy silt	None - very low	Rapid	Weak, soft	None - low	Rough, gritty
Silt	Very low - low	Rapid	Weak, soft	None - low	Rough
Clayey silt	Low - medium	Rapid - slow	Medium stiff	Slight - medium	Dull and rough
Sandy clay	Low - high	Slow - none	Medium stiff	Slight - medium	Gritty, shiney
Silty clay	Medium - high	Slow - none	Medium stiff	Slight - medium	Shiney, waxy and smooth
Clay	High - very high	None	Very stiff	High	Very slick, slimey, waxy and smooth
Organic silt	Low - medium	Slow	Weak, soft	Slight	Rough
Organic clay	Medium - very high	None	Medium stiff	Medium - high	Dull, may appear silty

CONSISTENCY OF FINE-GRAINED SOIL FRACTIONS

	Consistency Classification	Unconfined Compressive Strength (tons/sq. ft.) Pocket Penetrometer	Remarks
Silts and Clays	Very soft	less than 0.25	Sag under own weight
	Soft	0.25 to 0.50	Core can be pinched in two
	Firm	0.50 to 1.00	Core easily imprinted with fingers
	Stiff	1.00 to 2.00	Core imprinted with considerable finger pressure
	Very stiff	2.00 to 4.00	Core only slightly imprinted with fingers
	Hard	4.00 and higher	Core cannot be imprinted with fingers

SOIL COMPONENTS RANGES

Descriptive Term	Abbreviation	Percentage Range
Trace	t	1 - 10
Little	l	10 - 20
Some	s	20 - 35
And	a	35 - 50

Descriptive terms used to denote the estimated percentage, by dry weight of each soil component. Refinements can be made by using (+) or (-) for upper and lower limits respectively.

* After Burmister (1949, 1951) and ASTM 2488

TABLE B-2.2

DESCRIPTION OF ROCK PROPERTIES

I - WEATHERING

CRITERIA	DEEPLY (D)	MODERATELY (M)	SLIGHTLY (S)	FRESH (F)
Physical Condition	Decomposed, friable to low hardness, friable to weak strength	Moderately decomposed, low to moderate hardness and weak to moderate strength	Slightly decomposed, moderately hard to hard, moderately strong to strong	Unaffected by weathering agents. No decomposition of minerals, no disintegration, no discoloration, no alterations on fracture surfaces, no physical decomposition, usually very hard and very strong.
Minerals	Completely decomposed	Moderate decomposition; extensively stained (particularly iron-rich minerals)	Slight decomposition; some surficial staining	
Disintegation	Disintegrated	Most of the cement is moderately disintegrated	Slight to no effect	
Rock Discoloration	Deep and thorough	Moderate or localized; may be intense	Slight, Intermittent, or localized	
Fractures	All are coated extensively with clay or silt, or stained with oxides or sulfides, or contain a carbonate or siliceous crust	± 50% are coated with varying amounts of clay or silt, or stained with oxides or sulfides, or contain a carbonate or siliceous crust	± 10% are slightly stained	

II - HARDNESS

Very Hard	Cannot be scratched with knife or sharp pick. Breaking of hand specimens requires several hard blows of geologists' pick.
Hard	Can be scratched with knife or pick only with difficulty. Hard blow of hammer required to detach hand specimen.
Moderately Hard	Can be scratched with knife or pick. Gouges or grooves to 1/4-inch deep can be excavated by hard blow of point of geologists' pick. Hand specimens can be detached by moderate blow.
Medium	Can be grooved or gouged 1/16-inch deep by firm pressure onknife or pick point. Can be excavated in small chips to pieces about 1-inch maximum size by hard blows of the point of a geologists' pick.
Soft	Can be gouged or grooved readily with knife or pick point. Can be excavated in chips to pieces several inches in size by moderate blows of a pick point. Small thin pieces can be broken by finger pressure.
Very Soft	Can be carved with knife. Can be excavated readily with point of pick. Pieces an inch or more in thickness can be broken by finger pressure. Can be scratched readily by finger nail.

III - JOINT BEDDING AND FOLIATION SPACING IN ROCK

Spacing	Joints	Bedding and Foliation
Less than 2-inches	Very close	Very thin
2 inches to 1 foot	Close	Thin
1 foot to 3 feet	Moderately close	Medium
3 feet to 10 feet	Wide	Thick
More than 10 feet	Very wide	Very thick

Note: Joint spacing refers to the distance normal to the plane of the joints of a single system or "set" of joints which are parallel to each other or nearly so. The spacing of each "set" should be described, if possible to establish.

FIELD BORING LOG

Woodward-Clyde Consultants
Consulting Engineers
Geologists and Environmental Scientists

GROUND WATER OBSERVATION

At _____ ft, after _____ hrs.

At _____ ft, after _____ hrs.

At _____ ft, after _____ hrs.

JOB _____ No. _____

DRILLING RIG _____

OPERATOR _____

ENG. / TECHNICAN _____

BORING NUMBER _____

BORING OFFSET _____

SURFACE ELEVATION _____

DATE START _____ FINISH _____

DEPTH BELOW SURF.	SAMPLE DEPTH FROM	SAMPLE DEPTH TO	TYPE of SAMPLE	BLOWS/6", CASE, CORE RECOVERY	DRILLING METHOD & RESIST.	STRATA CHANGE DEPTH	FIELD IDENTIFICATION, REMARKS INCL. COLOR, DENSITY, LOSS WASH WATER, SEAMS IN ROCK, etc.	SAMPLE PRESERVED NO.	SAMPLE PRESERVED FROM	SAMPLE PRESERVED TO

GENERAL NOTES:

TOTAL DEPTH _____

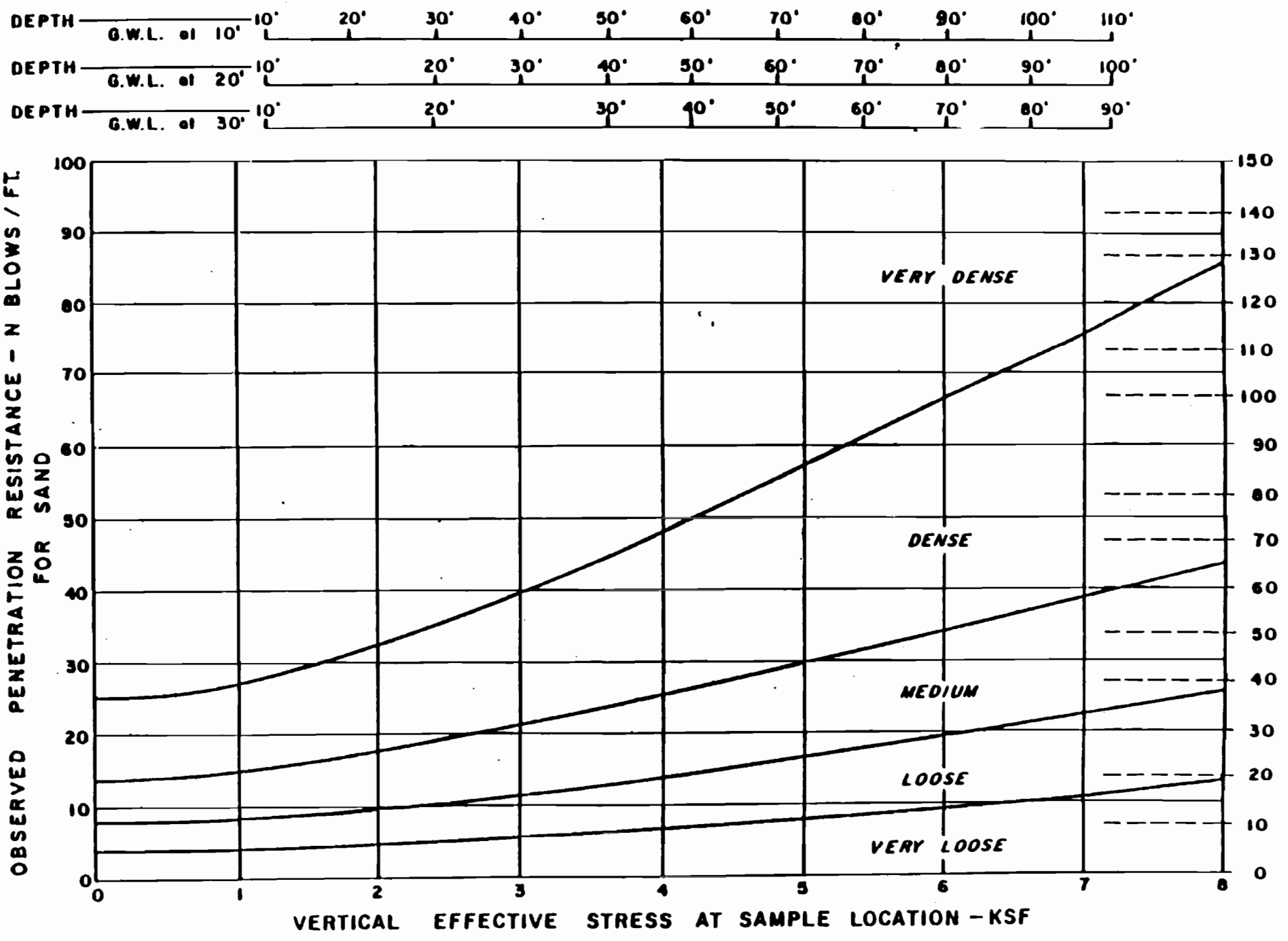
ROCK DRILLING _____

Proportions used: trace = 0 - 10%, little = 10 - 20%, some = 20 - 35%, and = 35 - 50%

HOLE No

WGA 1-7

Figure B-2.1

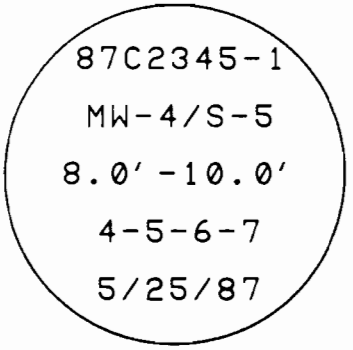


RELATIVE DENSITY OF SAND FROM STANDARD PENETRATION TEST

(FROM EARTH MANUAL U.S. BUREAU OF RECLAMATION 1968)

LABELING OF SAMPLE CONTAINERS

SAMPLE JAR LABEL



WCC PROJECT #
BORING/SAMPLE #
SAMPLE INTERVAL
BLOWS/6 IN.
DATE SAMPLE COLLECTED

SAMPLE JAR LABEL

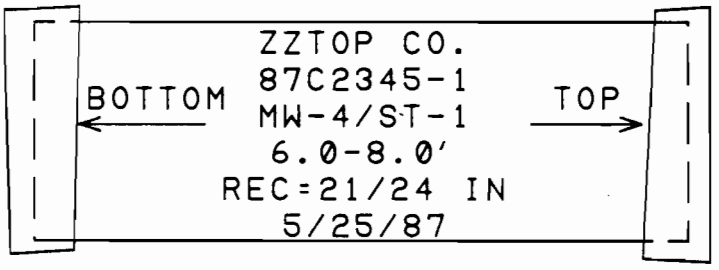
Project: ZZTOP Co. Job:87C2345-1
Boring #: MW-4 Date: 5/25/87
Sample #: S-5 Depth: 8.0-10.0'
WCC Blows: 4-5-6-7

SAMPLE JAR BOX

LABEL AT LEAST TWO SIDES OF THE BOX AND THE TOP →

ZZTOP CO.
87C2345-1
MW-3:S-1 TO S-10
MW-4:S-1 TO S-8
BOX 2/9
WCC

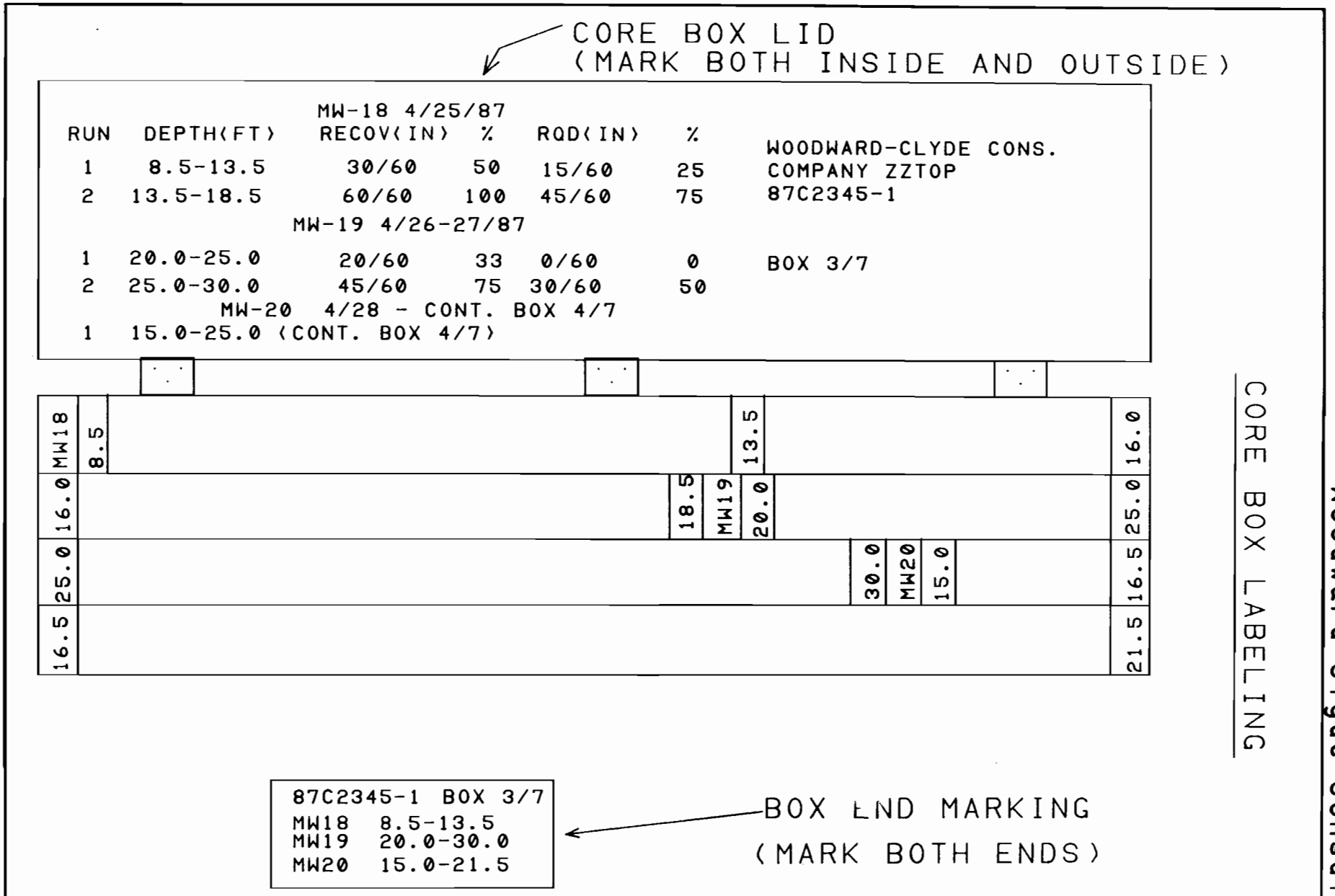
SHELBY TUBE (ST) LABEL



SAMPLE JARS FROM THE TOP AND BOTTOM OF THE TUBE SHOULD BE MARKED:

MW-4/ST1-TOP
MW-4/ST1-BOT

Figure B-2.3



CORE BOX LABELING

Figure B-2.

Woodward-Clyde Consultants

FIELD ROCK DESCRIPTION LOG

Sheet _____ of _____

GROUND WATER OBSERVATION		
At _____ Ft. at Completion	JOB _____ NO. _____	BORING NUMBER _____
At _____ Ft. after _____ hrs.	DRILLING RIG _____	BORING OFFSET _____
At _____ Ft. after _____ hrs.	OPERATOR _____	SURFACE ELEVATION _____
At _____ Ft. after _____ hrs.	INSPECTOR _____	DATE START _____ FINISH _____

DEPTH	CORE RUN		RQD		RECOVERY		Core Type & Resist.	STRATA CHANGE DEPTH	FIELD IDENTIFICATION, TYPE AND COLOR WEATHERING, SEAMS IN ROCK, etc.	FRACTURES		BED
	From	To	Inch	%	Inch	%				No./Ft.	DIP	DIP

GENERAL NOTES:

Total Depth _____

'ROCK' Drilling _____

Proportions used: trace 0-10%, little 10-20%, some 20-35%, and 35-50%

HOLE NO.

Figure B-2.5

B-3.0 GROUNDWATER MONITORING WELL INSTALLATION AND DEVELOPMENT PROCEDURES

B-3.1 MONITORING WELL INSTALLATION

Monitoring wells are installed to determine the hydrologic characteristics of aquifers underlying the site, and to obtain samples of groundwater that can be considered representative of the chemical quality of groundwater in the underlying aquifers. Boreholes for the monitoring wells will be drilled in accordance with the procedures outlined in Section B-2.

B-3.1.1 GENERAL CONSIDERATIONS

Factors that will be considered in determining the method of well installation and particulars of well design include:

1) The expected nature of the materials to be encountered.

2) Diameter and depth of well casing.

3) Expected transmissivity and storage coefficient of the aquifers.

4) Water level conditions and trends.

5) Water quality, and type and concentrations of contaminants.

Monitoring well design will meet two basic criteria: (1) water must move freely into the well, and (2) vertical migration of surface water or undesired groundwater to the well intake zone must be minimized. The well construction and dimensions will conform to the specifications described in the Remedial Investigation Field Activities section of the Work Plan.

Materials used in the construction of monitoring wells must remain essentially chemically inert with respect to the contaminants in the groundwater for the duration of the monitoring program. Newly packaged well casing and screens will be used in all monitoring wells. Casing sections will have flush, threaded, joints to insure that a well-developed seal can be obtained. Only non-petrochemical greases, if any, will be used during drilling. A water sample will be obtained from each source of water used for drilling. The sample(s) will be analyzed for halogenated volatile organics, mineral spirits, aromatic volatile organics and lead (Methods 8010, 8015, 8020, and 3005).

B-3.1.2 WELL CONSTRUCTION SPECIFICATIONS

A large diameter boring is drilled in accordance with the procedures outlined in Section B-2. The diameter of the borehole workspace (being the I.D. for hollow stem augers and casing; the O.D. of the rotary tool) shall be at least 2-inches greater than the O.D. of the riser/screen being installed.

Monitoring well construction materials will be selected so as not to react with contaminants suspected to be in the subsurface system. Well construction materials and drilling techniques for each well installation are defined in the Remedial Investigation Field Activities section of the Work Plan.

B-3.1.3 WELL INSTALLATION PROCEDURE

Upon completion of the borehole two types of monitoring wells may be installed; a) a monitoring well with slotted screen completion in the overburden or severely fractured bedrock or, b) a monitoring well with open-hole completion in competent bedrock. The monitoring well completion criteria for each location is summarized in the Remedial Investigation Field Activities section of the Work Plan.

B-3.1.3.1 SCREENED MONITORING WELL COMPLETION

The procedure for installing a monitoring well with slotted screen completion is as follows:

- Upon completion of the test boring the borehole will be sounded to verify completion depth and to check for caved-in materials

- If the borehole has caved, the materials will be flushed from the borehole using a jetting or rotary technique with potable water. Drilling additives such as drilling mud should be minimized or used as a last resort. Casing will be advanced to the approximated depth of cave-in to insure an open work space.

- Once the borehole has been cleaned the screen and riser pipe (all connections will be new threaded flush joints) will be lowered to design depth and held stationary by either a pull plug, or wrench resting atop the auger/casing. Each well shall have a threaded plug on the screen bottom. The riser pipe will have a stick-up of at least 2-feet above the ground surface.

- A gravel pack shall be placed around and at least 1-foot above the screen. Continuous measurements should be taken to insure the gravel pack has not bridged inside the casing. The gravel pack should be dropped slowly in order to develop even distribution around the screen.

- The riser pipe should be rotated slowly or vibrated while the gravel pack is being dropped to minimize bridging. (If the gravel pack should bridge either slowly raise and lower the augers/casing or add clean potable water inside the riser to displace the bridge.)

- While the gravel pack is being dropped the augers/casing should be backed out of the borehole, with at least 6- to 12-inches of sand remaining inside the augers/casing.

- When the gravel pack is approximately one-foot above the well screen, the depth to sand should be recorded (measurements should be taken completely around the annulus to verify even distribution of the gravel pack). A one-foot thick (minimum) bentonite pellet seal shall then be placed above the gravel pack.

- Careful measurements should be taken to verify at least one foot of bentonite pellets have been placed. The augers/casing should be backed out to the top of the bentonite seal and a measurement taken to verify the depth of the seal. Allow 15 - 20 minutes for the pellets to swell.

- Above the bentonite seal, a grout-bentonite slurry (the slurry shall consist of a mixture of portland cement-ASTM C 150 and water in the proportion of approximately seven gallons of clean water per bag of cement, one cubic foot or 94 pounds, and 2 percent bentonite powder) shall be pumped through a tremmie pipe from the bottom to the top. Grout must discharge from the annulus before the seal is considered complete.

- After the auger/casing is removed, a protective steel casing, with padlock will be placed over the riser pipe. The outer casing shall extend at least 2-feet below the ground surface and will be temporarily blocked to allow at least 2- to 3-inches of open space between the outer casing and riser pipe.

- A protective casing, with padlock, will be placed over the riser pipe. The outer casing shall extend at least 2-feet below the ground surface and will be temporarily blocked until the grout sets to allow at least 2- to 3-inches of open space between the outer casing and riser pipe. Flush mounted curb boxes will only be used when no practical alternative is available. Their use must be approved by the NYSDEC on a case by case basis. Curb boxes must meet the following criteria to the extent practicable:

  a. The box "manhole" cover must be equipped with a rubber "O" ring so as to be water tight;

  b. The box must open to the vadose zone below to allow any water that inadvertently enters the box to drain away and to allow the well to be in approximate equilibrium with the barometric pressure; and

c. The box must be placed in an area that drains readily. If the chosen location is in a low area, the surface must be built up so it is no longer in an area of potential ponding.

- All riser pipes will have snug fitting, or threaded, vented caps.

Figure B-3.1 is a typical log for a monitoring well with a screened completion.

B-3.1.3.2 OPEN-HOLE MONITORING WELL COMPLETION

To protect the open-hole completion from cross contamination, the following drilling sequence is proposed.

- Drill through overburden materials using hollow stem auger or tri-cone rotary bit and casing.

- The overburden will be sealed off from the bedrock with temporary casing before drilling proceeds into unweathered rock. (If augers were used they will be backed out and temporarily will be advanced.)

- Core through bedrock to the top of the open-hole completion interval using an NX double tube core barrel to collect samples for lithologic classification and analysis of fracture density.

- A four-inch diameter stainless steel riser casing will be installed above the completion interval. Ream the borehole a diameter at least 2-inches greater than the outside diameter of the riser pipe to be installed; the casing will be steam-cleaned prior to insertion. Optionally, at least 12 hours prior to well installation set a 6-inch grout plug at the bottom of the casing to minimize the amount of grout entering the riser pipe during the sealing of the borehole annulus.

- Sound the boring depth with a weighted tape to verify no materials collapsed into the borehole.

- Lower the casing to the bottom of the hole, adding water to the riser pipe to keep the plug from moving.

- Grout will be installed via tremie pipe from the bottom of the borehole to the ground surface to seal off the upper contaminated zone. The slurry mix will be of the same proportions as for a screened monitoring well (see Section B-3.1.3.1).

- A protective casing, with padlock, will be placed over the riser pipe. The outer casing shall extend at least 2-feet below the ground surface and will be temporarily blocked until the grout sets to allow at least 2- to 3-inches of open space between the outer casing and riser pipe. Flush mounted curb boxes will only be used when no practical alternative is available. Their use must be approved by the NYSDEC on a case by case basis. Curb boxes must meet the following criteria to the extent practicable:

  a. The box "manhole" cover must be equipped with a rubber "O" ring so as to be water tight;

  b. The box must open to the vadose zone below to allow any water that inadvertently enters the box to drain away and to allow the well to be in approximate equilibrium with the barometric pressure; and

  c. The box must be placed in an area that drains readily. If the chosen location is in a low area, the surface must be built up so it is no longer in an area of potential ponding.

- All riser pipes will have snug fitting, or threaded, vented caps.

Figure B-3.2 presents construction details on a step-by-step basis. Figure B-3.3 is a typical log for documenting monitoring well construction with open-hole completion.

Upon completion of grouting, no work shall be permitted on the hole for a period of at least 12-hours, or overnight, to allow the grout to cure.

- Decontaminate all downhole and recycling equipment as discussed in Section B-8 prior to open-hole completion.

- Core below the bottom of the casing using an NX double tube core barrel. This section will be utilized as an open-hole well completion. Ten feet of open borehole, and no more, will be advanced as the open hole completion.

Upon completion of the monitoring well installation for either the open-hole or screened monitoring wells, a cement pad will be constructed to at least the perimeter of the borehole, and sloped such that any surface or rainwater is diverted away from the monitoring well.

B-3.2 WELL DEVELOPMENT

Well development is performed following monitoring well installation to improve the hydraulic communication between the formation and monitoring wells and to assure representative groundwater samples. Wells should be developed for at least one-hour or until there is a turbid-free discharge from the well.

During the drilling process the side of the borehole may become smeared with clays or other fine sediments. This plugging action substantially reduces the permeability of the aquifer in the zone of the boring and retards the movement of water into the well. In addition, sediment may enter the filter pack or clog the well screen slots during installation of the well materials.

Well development is the process of flushing the aquifer interface with the well and cleaning the filter pack and the well or piezometer screen slots to permit groundwater to flow into the monitoring well. Development is required: (1) to restore the natural permeability of the formation adjacent to the borehole, (2) to remove clay, silt and other fines from the filter pack and well screen so that subsequent water samples will not be abnormally turbid or contain undue suspended matter, and (3) to remove remnant drilling fluids from the well, filter pack and aquifer and contaminants introduced during the time of drilling.

The various methods that may be used to develop a well are discussed below. An appropriate method for developing the wells will be determined following completion of monitoring well installation.

The well should not be developed until the grout slurry is allowed to cure overnight, or for at least 12 to 24 hours.

B-3.2.1 METHODS OF DEVELOPING WELLS

The development process is best accomplished by causing the natural formation water collected inside the well screen to be moved vigorously in and out through the screen in order to agitate the clay and silt and move these fines into the well where they can be removed. Use of water other than the natural formation water is not recommended due to the possibility of contributing contaminant or atypical water quality to the groundwater. Any equipment used for well development must be thoroughly cleaned before use to prevent possible contamination of the well. Wells should not be sampled for at least 2 weeks following development, in order to allow the system to stabilize. All discharged materials from the well will be pumped into 55-gallon drums labeled "Liquids." The monitoring wells will be developed until the discharge water has a turbidity equal to or less than 50 NTU's. In addition, development will proceed until a volume of groundwater is removed which is equal to that lost in drilling the completion interval.

The following procedures are available for developing monitoring wells.

B-3.2.1.1 SURGE BLOCK

A surge block is a round plunger with pliable edges (constructed of a material such as rubber belting) that will not catch on the well screen. Moving the surge block forcefully up and down inside the well screen causes the water to surge in and out through the screen accomplishing the desired cleaning action. Close monitoring of the amount of pressure generated must be made to prevent damaging the well casing or screen. If the surge block method is used, samples should not be taken less than two weeks after development of the well.

After approximately one-hour of surging the well should be evacuated into a drum labeled "Liquids". If the discharge remains turbid after five well volumes have been removed, continue surging for another hour followed by removing approximately five well volumes. This sequence should continue until the discharge is relatively free of fine materials (turbidity of less than 50 NTU's).

If the discharge is cloudy and the well yield is low, resulting in the well being "pumped dry", allow the fine fraction in the discharge to settle out in the drum and re-introduce the well discharge to the system so development can continue.

B-3.2.1.2 AIR LIFT

The air lift method involves pumping compressed air into a pipe placed inside the well casing (see Figure B-3.4). Pressure applied intermittently and for short periods causes the water to surge up and down inside the casing. Once the desired washing is accomplished, continuously applied air pressure is used to blow water and suspended sediments upward out of the well. (A threaded, or clamped, fixture with fittings for air and discharge lines should be affixed to the top of the well casings to direct the discharged water into a drum or other container.

Considerable care must be exercised to avoid injecting air directly through the well screen. Air can become trapped in the formation outside the well screen and affect

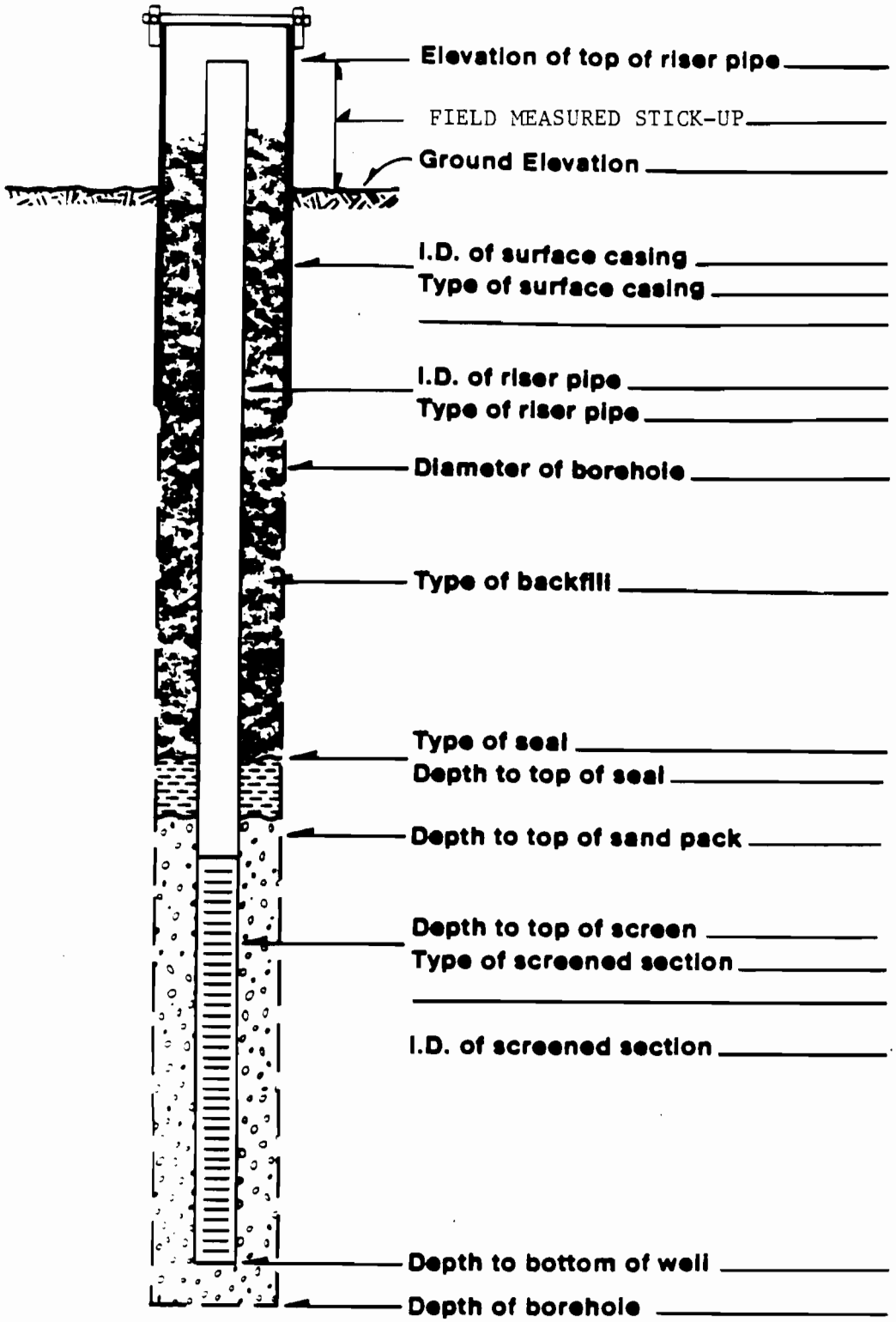
subsequent chemical analyses of water samples and hydraulic conductivity measurements. The bottom of the air pipe should not be placed below the top of the screened section of casing.

Another restriction on the use of air is the submergence factor. Submergence is defined as the height of the water column above the bottom of the air pipe (in feet) divided by the total length of the air pipe. To result in efficient air lift operation, the submergence should be at least 20 percent. This may be difficult to achieve in shallow monitoring wells or wells which contain small volumes of water.

B-3.2.1.3 BAILER AND PUMPING

A bailer which is heavy enough to sink rapidly through the water can be raised and lowered through the water column to produce an agitating action that is similar to that caused by a surge block. The bailer, however, has the added capability of removing turbid water and fines each time it is brought to the surface. Bailers can be custom-made and can be hand operated in shallow wells.

Pumping can be used effectively in wells where recharge is rapid. The type and size of the pump used is contingent upon the well design.



Well Construction Materials

Screen Length	ft
Riser Pipe	ft
Bottom Cap	
Vented Cap	
Gravel Pack	lb/bags
Pellets	lb/buck
Powder	lb/bags
Cement	lb/bags

REPORT OF MONITORING WELL NO. _____

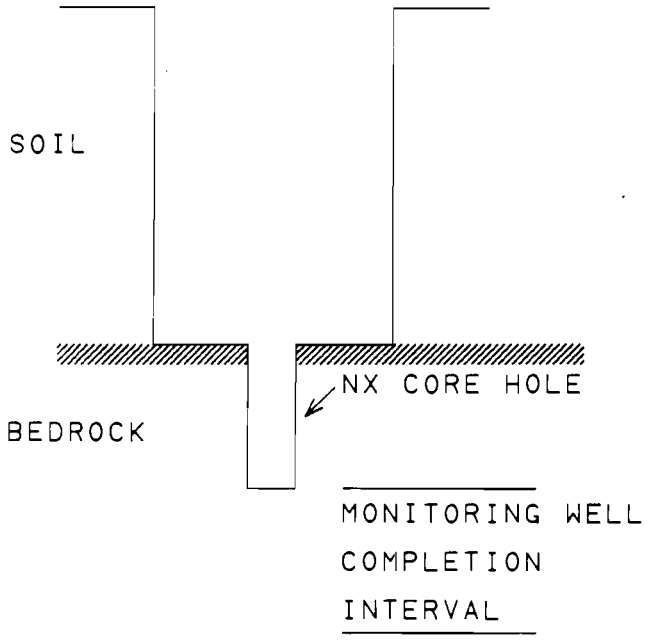
DRAWN BY:	CHECKED BY:	PROJECT NO:	DATE:	FIGURE NO

Woodward-Clyde Consultants

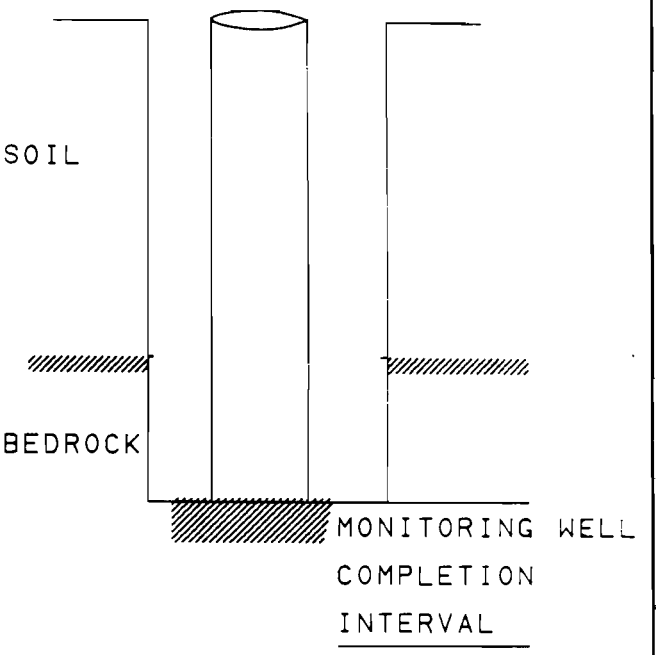
Figure B-3.1

MONITORING WELL
OPEN-HOLE COMPLETION
DRILLING SEQUENCE

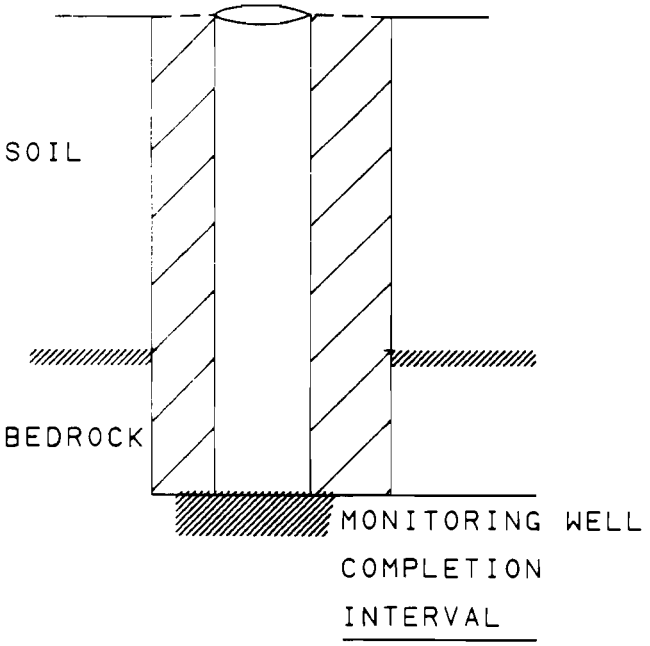
1) DRILL THROUGH OVERBURDEN;
IF AUGERS USED, PULL AUGERS;
SET TEMP CASING (AT LEAST 6" ID);
(CASING TO SEAL OVERBURDEN FROM BEDROCK);
CORE TO TOP OF COMPLETION INTERVAL.



2) REAM BOREHOLE TO DIAM 2-IN GREATER THAN RISER; AND THEN INSTALL RISER PIPE.



3) INSTALL GROUT VIA TREMIE PIPE, AND ALLOW GROUT TO SET-UP



4) DECONTAMINATE DOWNHOLE TOOLS AND WATER RECYCLING EQUIPMENT, THEN CORE COMPLETTION INTERVAL.

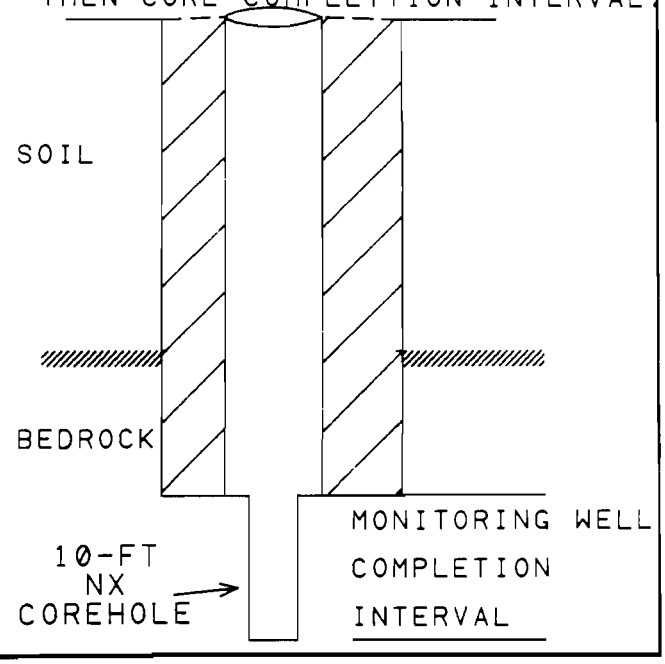
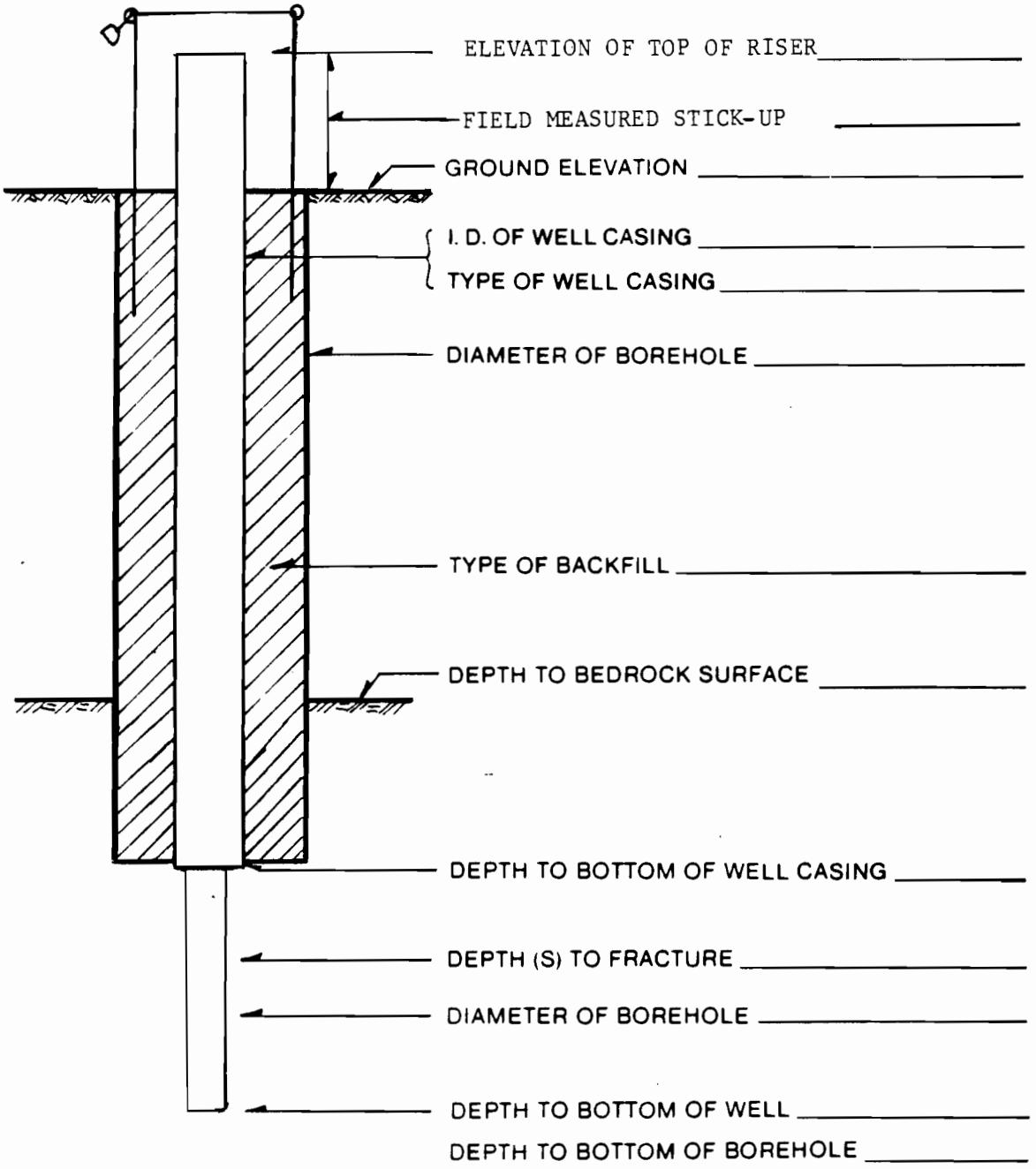


Figure B-3.2



Well Construction Materials

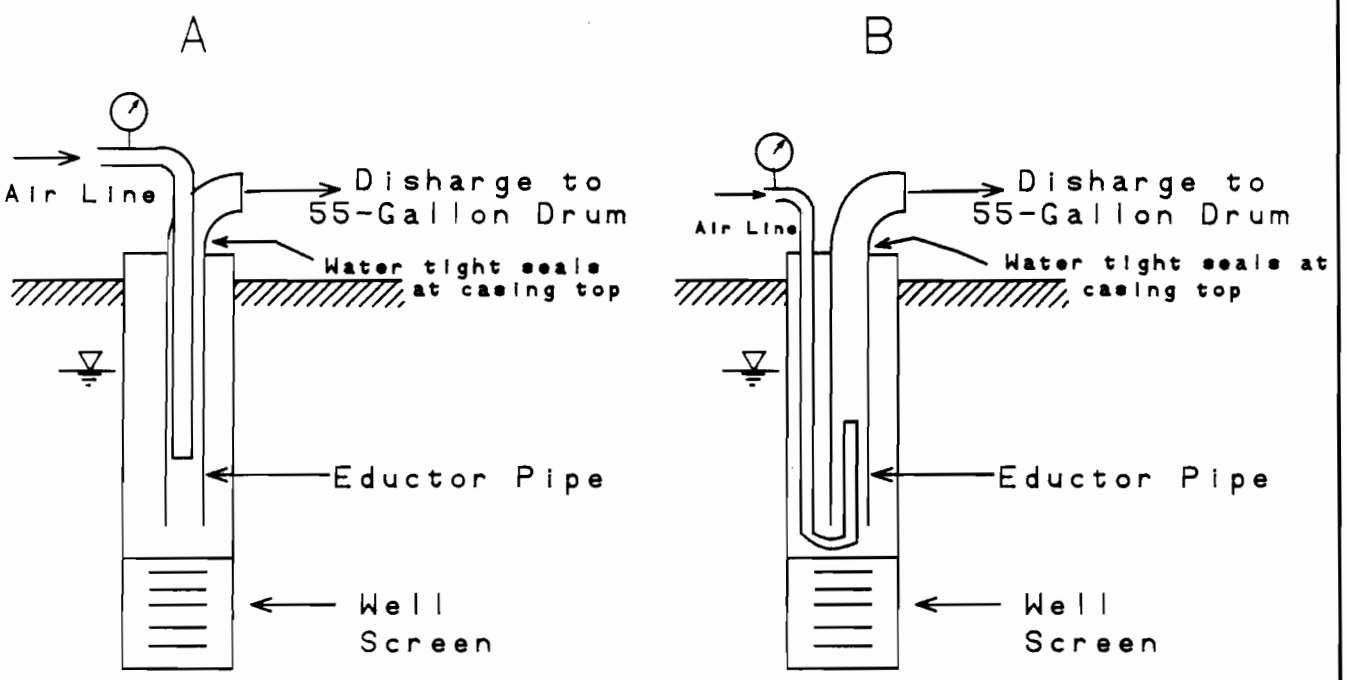
Screen Length	ft	Gravel Pack	lb/bags
Riser Pipe	ft	Pellets	lb/buckets
Bottom Cap		Powder	lb/bags
Vented Cap		Cement	lb/bags

REPORT OF MONITORING WELL

Drawn by:	Checked by:	Project No.:	Date:	Figure No.:

Figure B-3.3

SETUP FOR AIR-LIFT DEVELOPMENT



Setup:

Schematic A: Eductor Pipe ID: Air Line ID
3 or 4: 1

Schematic B: Eductor Pipe ID: Air Line ID
2: 1

Figure B-3.4

B-4.0 SLUG TESTING

Single-well permeability tests (slug tests) will be performed on selected monitoring wells (see the Remedial Investigation Activities section of the Work Plan). The purpose of these tests is to estimate the permeability of the materials in the near-well vicinity. Slug tests are inexpensive and rapidly performed, and will give a reasonable estimation of aquifer permeability if the well is properly developed.

B-4.1 OPERATION OF FIELD RECORDER

The slug test procedure is given for two types of equipment set-up a) a strip chart recorder coupled to a transducer and b) a digital data logger coupled to a transducer.

Before beginning the slug test, the following information will be recorded:

- Well or well bore identification number or letter
- Location and elevation of reference point from which water depth measurements are made
- Elevation of groundwater with respect to the reference point
- Date and time of test
- Well depth, screen length, riser pipe radius, well screen radius, radius of the gravel pack and borehole depth
- Aquifer or groundwater zone being tested
- Volume of water added or withdrawn, or volume of solid cylinder
- Type of measuring device used

o Names of personnel conducting test

B-4.1.1 SET-UP: WCC TRANSDUCER INTERFACE/DRUCK TRANSDUCER

The following procedure is for the use of the WCC Transducer Interface and Druck Transducer.

A. Set Up

1. On the back of the recorder, place the cone function switch in the off position (up) and the power switch in the "battery" position (up).

2. On the front of the recorder set the paper speed switch on cm/min and the selector above it on 30. Turn the power switch on. Remove the plastic cap from the pen tip.

   With the span switch, "off", take a screwdriver and adjust the zero control until the pen is in the middle of the paper (50). Set the span select knob on 10. Now put the span switch on MV.

3. Plug the two pin banana plug from the interface (Black Box) into the recorder just below the zero control with the ground tab on the plug to the right. Plug the transducer into the interface socket. Turn the interface power switch to "Battery" and adjust the "Zero Adjust" knob on the interface until the pen is back on 50 or as close as possible.

4. Measure the static water level in the well with a clean tape and record.

5. Lower the transducer slowly into the well, watching the recorder pen as you do. When the transducer reaches the water surface the pen will move to the

left. Make a note of this depth and now lower the transducer another 10 or 15 feet. The transducer can be damaged if it is lowered more than 20 feet below the water surface. Readjust the zero knob on the interface to bring the pen back to 50.

6. To calibrate the system, turn the chart switch on, make a final zero adjustment to get the pen on 50 and then lower the transducer one foot, return the transducer to its original position and then raise it one foot. Repeat this procedure with the span switch on 5 and then 20. Turn chart switch off and write the span and paper speed settings on the test record. Now secure the transducer cable to keep the transducer at this level.

7. Slowly lower the slug to the water surface, watching for motion of the pen. Raise the slug an inch or two above water and hold it there with one hand. Turn the chart switch on and then with your free hand grab the slug rope a little more than one slug length above the other hand. Allow the slug to drop this distance, but not to the transducer as you could damage the transducer.

8. Examine the resulting trace on the recorder chart. The trace should go to about 100 and return slowly to 50. If not, readjust the span and try again. If the trace only goes to 60 to 70, set the span on 5. If the trace goes off scale, set the span on 20.

9. When the proper scale has been determined, run the test by dropping the slug with the chart switch on, as described above, wait for the trace to return to 50 (or very close) and then pull the slug up out of the water as quickly as possible. The pen will then go to the right. Let this chart run until the pen returns to 50. Be sure to note paper speed span setting and slug dimensions, on all records.

B-4.1.2 SET-UP: IN-SITU HERMIT DATA LOGGER

The operation of an In-Situ Hermit Data Logger (model SE1000B-a 2 channel unit) is as follows:

I. INITIAL SET-UP

Press any key to wake the unit up.

A) General Functions:

Hold **ENTER** and press **DATA**

press **ENTER** to go into test number

press **SCAN DOWN** and then **ENTER** to go into sample rate

press **SCAN DOWN** and then **ENTER** to go into number of inputs

press **SCAN DOWN** and then **ENTER** to go into transducer type

B) Test Number

press **ENTER, SEL** will appear on display

press **SCAN DOWN** or **SCAN UP** to modify the Test Number start at 0, press

ENTER to lock it in

press **SCAN DOWN** to go to rate

C) **Sample Rate**

press **ENTER** **RATE** will appear on display

set unit for **LOG** or **LIN** (use scan up or scan down) to pick rate (pick log for slug test)

press **ENTER** to set sampling interval; use **000.00** for slug test

(to change reading press **STOP NEXT** to move to the desired decimal place then use scan up and scan down to set the number, press **ENTER** when all the changes have been made)

D) **Number of Inputs**

Scan down to go to number of inputs; **INP 1** will appear on display

press **ENTER** to change the number

INP 1 the 1 will begin to blink use the scan up or scan down to increase the number of inputs. Use 1 for slug test.

press **ENTER** to lock it in

scan down to go to type

E) **Type**

Leave type at Level

press **STOP NEXT** to get out of this mode

II. TRANSDUCER SET UP

Hold Enter and press XD

A) **Water Level Reference Datum**

REF will appear on display

press **ENTER;** 000.00 will appear with the first 0 blinking. Do not set this number until after the transducer is connected and at the proper depth. For slug tests, set this to 000.00. The procedure for changing the number is the same as (sample rate) see previous section

press **ENTER** to complete the data input

B) **Scale**

press **SCAN DOWN** to get to scale

press **ENTER** 010.0? will appear with the ? being 7, 4, or 9. Check the transducer's real on the little plate for the right scale for this transducer

Set the number as for the Ref.

press **ENTER** to complete the data input

E) **Display**

press **SCAN DOWN** to get DSP.

press **ENTER** EniTOC will appear. Leave as is press **ENTER** to complete the data input

press **STOP NEXT** to get out of this mode

III. CALIBRATION

To verify the calibration of the unit, raise the transducer off the bottom of the well and mark the cable and top of casing

press any button to wake up unit

press **DATA** and record level
raise cable/transducer two foot

press **DATA** and record level

lower cable/transducer two foot (to original mark)

press **DATA** and record level

readings should show a two foot change (if not, the error will be incorporated into data reduction).

IV. TO START TEST

press **START** button

the test number will appear

start will appear (note the test has not started it is already to start) (you have 90 seconds)

press **ENTER**

LOG 1 will appear. (This will be followed by LOG 2, LOG 3, etc. to LOG 10.) You cannot get into the unit for 10 minutes

After 10 minutes Run will appear on the display

To check on the test, press any key to wake the unit up.

- Press **DATA;** DSP "#" will appear with "#" flashing ("#" will be the current test number).

- Scan to the desired test number to be viewed and press **ENTER** to lock it in

- The unit then displays the elapsed time in minutes of the last sample point, then the sample point value in the selected units

- Use the scan down key to view earlier points and scan up to view later points

- To view data from the start of the test, press the **START** key. The display shows the start date, followed by the start time, moves to time TEO, then displays the data at TEO.

  (NOTE: Elapsed time values for the first two seconds of log mode data will appear somewhat ambiguous due to the display's inability to show small decimal values. Elapsed time up to two minutes cannot be displayed with full resolution. Use Table B-4.1 to convert the displayed times to their full resolution).

To Stop the Test:

- Press **(ENTER)** key

- o the unit will display 8:8 8.88
- o The unit will then display RUN
- o Hold **(ENTER)** key down then press **(STOP/NEXT)** key
- o The unit will display **STOP** with the blinking
- o Press **(ENTER)** key
- o Test is now shut-down

* For multiple tests, remember to change the test number even for the same hole (all other parameters can stay as is).

B-4.2 SLUG TEST DATA REDUCTION

Once the slug test data has been collected, the test results will be reduced and permeabilities estimated by the methods described in Cooper et. al. (1967), Bouwer and Rice (1976), and Earlougher (1977).

TABLE B-4.1

LOG MODE ELAPSED TIME VALUES FOR THE HERMIT SE1000B

Sample Number	Display (min)	Actual (min)
0	0.00	0.0000
1	0.00	0.0033
2	0.00	0.0066
3	0.00	0.0099
4	0.01	0.0133
5	0.01	0.0166
6	0.02	0.0200
7	0.02	0.0233
8	0.02	0.0266
9	0.03	0.0300
10	0.03	0.0333
11	0.05	0.0500
12	0.06	0.0666
13	0.08	0.0833
14	0.10	0.1000
15	0.11	0.1166
16	0.13	0.1333
17	0.15	0.1500
18	0.16	0.1666
19	0.18	0.1833
20	0.20	0.2000
21	0.21	0.2166
22	0.23	0.2333
23	0.25	0.2500
24	0.26	0.2666
25	0.28	0.2833
26	0.30	0.3000
27	0.31	0.3166
28	0.33	0.3333
29	0.41	0.4167
30	0.50	0.5000
31	0.58	0.5833
32	0.66	0.6667
33	0.75	0.7500
34	0.83	0.8333
35	0.91	0.9167
36	1.00	1.0000
37	1.08	1.0833
38	1.16	1.1667
39	1.25	1.2500
40	1.33	1.3333
41	1.41	1.4166
42	1.50	1.5000
43	1.58	1.5833
44	1.66	1.6667
45	1.75	1.7500
46	1.83	1.8333
47	1.91	1.9167
48	2.00	2.0000
49	2.50	2.5000
50	3.00	3.0000

B-5.0 SURFACE WATER SAMPLING

Surface water samples will be taken at the locations indicated in the Work Plan. Surface water samples will be obtained by filling of bottles directly, thus avoiding cross-contamination and effects on representatives from sampling devices.

- With proper protective garment and gear, take grab samples by slowly submerging the sample bottles with minimal surface disturbance.

- Continue delivery of the sample until the bottle is almost completely filled (leave approximately 10 percent of top void since bottles have been preset) except for VOA samples.

- Retrieve the sample bottles from the surface water with minimal disturbance.

- Fill volatile organic bottles first, followed by other bottles.

- All samples for VOA must be filled very slowly and completely to avoid trapping any air. After VOA vial is capped, invert and tap lightly to see if any air is trapped. If so, refill and recap.

- Place sample bottle in cooler/container maintained at 4^{O} C until sample bottle can be properly decontaminated and transported to laboratory.

B-6.0 SURFACE SOIL AND SEDIMENT SAMPLING

B-6.1 SURFACE SOIL SAMPLES

Surface soil samples will be collected which are representative of the nature of the local soil at the sample site. The sampling locations and discussion of the choice of sampling locations are documented in the work plan.

The sampling procedure will depend to some extent on the competence and grain size of the top six inches to one foot of surface material at each sample point. The sample procedure below applies equally to all types of surface samples regardless of the actual sampling tool employed.

The sampling point will be located and identified on a detailed site map and in the field. Using stainless steel equipment, a hole six inches deep will be cut or excavated. A relatively undisturbed near surface grab sample will be placed in the sample containers. Headspace analysis of organic vapors within sample jars will be measured between 15 minutes and 1 hour after placement in sample jars.

The samples will be documented and handled according to WCC's procedures for sample quality assurance and documentation which are discussed in the Quality/Assurance Plan. The stainless steel equipment will be cleaned between samples according to WCC's decontamination procedures (B-8.0).

B-6.2 SEDIMENT SAMPLING

Sediment samples associated with surface water will be collected using a stainless steel spatula or Eckman dredge. The samples will be transferred to the appropriate sample containers. To ensure the retention of volatile components, sediment samples should not be mixed in the field. Homogenization or compositing, if necessary, will be performed by the analytical laboratory.

Care should be taken to exclude vegetation or large (2 mm) non-sediment particles from the sample. Native water on the sample should not be removed.

B-7.0 MONITORING WELL SAMPLING

B-7.1 INITIAL ACTIVITIES

While obtaining access to the well to be sampled, note the condition of the well, particularly with respect to the possibility of security breaches, tampering, or lack of well integrity. Perform appropriate air monitoring in accordance with the HASP while opening the well cap.

Measure the depth to water using an electronic probe, weighted measuring tape, or steel tape with chalk. If the as-built well specifications are not available, measure the total depth of the well. Measuring equipment should be decontaminated before and after use in each well, in accordance with Section B-8.

Calculate the volume of standing water in the well using the formula:

$V = (7.48)(S)(\ r^2)$

where:

v = volume of standing water, gallons

s = saturated thickness of water column in well, feet

r = radius of well, feet

Well volumes for commonly-sized wells are provided on Table B-7.1.

Calculate the total volume to be purged by multiplying the volume present by the number of volumes required for purging by the Work Plan (typically 3 to 5).

B-7.2 WELL PURGING

A submersible or centrifugal pump or a bailer will most likely be used to purge each well prior to sampling. A minimum of three well volumes will be removed by this means. If, however, the well recovery rate is very low, a reduced pumping rate may be used to purge as much water as possible (up to three volumes). If purging a slowly-recharging well, sampling can usually be performed after recharge has occurred to 75 percent of the original height of water, following complete well evacuation. Discharge water generated during purging will be discharged at least 10 feet downgradient of the well location or containerized for appropriate disposal. Water samples will be collected within 24 hours of well purging.

After purging each well, the outside of the pump will be washed with detergent water and then rinsed with potable water. Then, the pump will be operated and a sufficient amount of potable water will be pumped through it to rinse the inside of the pump. Hoses used for purging may be discarded after use. Bailers used for purging will be decontaminated according to Section B-8.

B-7.3 WELL SAMPLING

A PVC, stainless steel, or teflon bailer with a check valve assembly will be used to collect the groundwater samples. The choice of bailer type will be dependent upon site conditions. Bailers will be decontaminated according to the procedures outlined in B-8.0. If conditions warrant, a dedicated PVC, stainless steel, or teflon bailer with a check valve assembly will be used to collect the groundwater samples. The suspension line attached to each bailer will consist of nylon cord or a stainless steel leader attached to nylon or polypropylene cord which will be kept from excessively contacting groundwater.

The method of sampling is to lower the bailer smoothly into the well to a point approximately opposite the middle of the well screen. Substantial agitation of the water column is to be avoided as this could result in volatilization of volatile organic compounds. The number of bails used to fill the sample bottles should be minimized.

The first one or two bailers of water retrieved should be used to: (1) fill VOA vials, and (2) provide a sample for the field measurements to be conducted. Subsequent bailers should be used to fill the remaining sample bottles. To minimize the effect of any potential constituent stratification in the water column of the well, a small portion of water should be discharged from the bailer into each sample bottle, except VOAs, alternately until all of the bottles are full.

The field blank will be obtained by pouring laboratory pure water (deionized and organic-free water) through one of the decontaminated sampling devices that is to be used for sample collection that day. As the laboratory water cascades off the sampling device it will be collected in the appropriate container for analyses.

When well sampling has been completed, the suspension cord will be removed from the bailer and disposed of, except with dedicated bailers. The bailer will then be decontaminated and sealed in a plastic bag.

All samples for dissolved metals analysis will not be filtered in the field prior to preservation; no other samples should be filtered. In case turbid water is encountered in any of the wells, aliquots for analysis in the laboratory should be taken from the clear water after the sediment has settled in the sample bottles.

TABLE B-7.1

WELL VOLUMES IN GALLONS

Diameter of Well in Inches

		1	2	3	4	6	8
	1	.04	.16	.37	.65	1.47	2.61
	5	.2	.82	1.84	3.26	7.34	13.06
	10	.41	1.63	3.67	6.53	14.69	26.11
	15	.61	2.45	5.51	9.79	22.03	39.17
	20	.82	3.26	7.34	13.06	29.38	52.23
	25	1.02	4.08	9.18	16.32	36.72	65.28
	30	1.22	4.90	11.02	19.59	44.07	78.34
	35	1.43	5.71	12.85	22.85	51.41	91.40
Height	40	1.63	6.53	14.69	26.11	58.76	104.45
of	45	1.84	7.34	16.53	29.38	66.10	117.51
Water	50	2.04	8.16	18.36	32.64	73.44	130.57
Column,	55	2.24	8.98	20.20	35.91	80.79	143.62
Feet	60	2.45	9.79	22.03	39.17	88.13	156.68
	65	2.65	10.61	23.87	42.43	95.48	169.74
	70	2.86	11.42	25.71	45.70	102.82	182.80
	75	3.06	12.24	27.54	48.96	110.17	195.85
	80	3.26	13.06	29.38	52.23	117.51	208.91
	85	3.47	13.87	31.21	55.49	124.86	221.97
	90	3.67	14.69	33.05	58.76	132.20	235.02
	95	3.88	15.50	34.89	62.02	139.54	248.08
	100	4.08	16.32	36.72	65.28	146.89	261.14

B-8.0 DECONTAMINATION PROCEDURES

Equipment and personnel decontamination areas will be set up in an area determined to be uncontaminated but as near as possible to the work site. Determination of the decontamination area will be made by using an Organic Vapor Analyzer (OVA or HNU), site reconnaissance, or other determinative procedures.

B-8.1 DRILLING EQUIPMENT

Large equipment, such as drill rigs and ancillary equipment will be decontaminated at the beginning of the field work and prior to leaving the site after work is completed with high pressure hot water/detergent or steam spray and brushing to remove encrusted material. When contamination is apparent, or when working in messy conditions, the back end of the drill rig (including drillers platform and derrick) will be decontaminated between each hole location. The back end off the drilling rig may be locally cleaned with soap and water and a brush. If mud or her contamination remains visible the back end of the rig will be steam cleaned. The augers will be thoroughly steam cleaned and staged on heavy plastic to prevent contact with the ground.

Field cleaning of well casing and well screening as specified in the Work Plan, will consist of steam cleaning to remove oil and grease.

Any of the drill rig tools that may have contacted contamination will be pressure cleaned after the completion of each well to minimize the potential for cross-contamination. Special attention should be given to decontaminating downhole sampling devices prior to each use. Split-spoon, core barrels, or specialized samplers should be thoroughly cleaned under the supervision of the WCC inspector. Enough split-spoons for use on each borehole should be decontaminated by steam cleaning. If split-spoons must be decontaminated for reuse in a borehole, they must be decontaminated in accordance with USEPA Region II protocol (subsequently discussed).

B-8.2 SAMPLING EQUIPMENT

All hand operated water sampling equipment (e.g., bailers) and sampling equipment (e.g., trowels, spoons, and split-spoons within boreholes) will be decontaminated prior to each use. Decontamination between samplings will include the following procedures:

1. Wash and scrub with low phosphate detergent.

2. Tap water rinse.

3. Rinse with 10 percent nitric acid, ultrapure.

4. Tap water rinse.

5. Acetone rinse or methanol followed by hexane rinse (pesticide grade or better).

6. Deionized demonstrated analyte free water rinse.

7. Air dry.

8. Wrap in foil, shiny side out for transport

If metals are not analyzed, the 10 percent nitric rinse may be omitted. If organic samples are not being taken, the solvent rinse may be omitted.

As an alternative to the above procedures, sampling equipment may be steam-cleaned, as described in Section B-8.1, if steam cleaning is readily available.

All water-contact well tubing will be factory cleaned and wrapped. If on-site inspection reveals that it has not been properly wrapped or cleaned or has been soiled during transport, cleaning on-site will be done by high-pressure hot water/detergent. Well tubing used for purging will be dedicated for each well.

B-8.3 PERSONNEL

Decontamination of personnel will be in accordance with the project specific HASP and will consist of soap (Alconox or equivalent) and water washing of exterior protective gear followed by removal of the clothing. The procedure is as follows:

1. Place equipment and/or samples in area designated

2. Wash boots and outer gloves using (a) soap (Alconox or equivalent) in water solution and (b) potable water rinse. Store gloves in appropriate place

3. Remove respirator, if used, and store in appropriate place, if still usable

4. Remove outer coveralls, and booties and dispose in appropriate containers

5. Remove inner gloves, if used, and wash hands and face

6. Check all reusable equipment for serviceability. Red-tag if contaminated. Mark for repair or disposal if damaged or inoperative.

B-9.0 SOIL GAS SURVEY

B-9.1 INTRODUCTION

Volatile organic compounds (VOCs) in groundwater and soils can often be identified by analyzing trace gases in soil just below the ground surface. This technique is possible because many VOCs including perchloroethylene (PCE), trichloroethylene (TCE), methylene chloride (MeCl), and others, will volatilize from groundwater and move by molecular diffusion away from source areas towards regions of lower concentration in the surrounding soil profile. At sites where groundwater containing VOCs has migrated away from source areas, the concentration of VOCs found in the gaseous component of the vadose zone may be correlated, in a general way, to the concentration of VOCs found in the aqueous phase below. Soil gas sampling is used to attempt to identify areas of high soil gas concentrations, surrounded by lower soil gas concentrations as a means of broadly delineating the zone of subsurface materials containing elevated concentrations of volatile constituents. Used in this way, soil gas sampling is an effective, relatively non-disruptive technique to quickly identify the general extent of groundwater containing elevated levels of VOCs. This information can then be used to more effectively locate the placement of groundwater monitoring wells and borings.

B-9.2 PRE-INSTALLATION PROCEDURES

The pipes are steam cleaned and thoroughly rinsed before arrival at the site. Upon arrival at the site at least one pipe from each pipe lot is connected to the sampling system and checked for contamination using the GC. Pipe lot size is defined as the number of probes identically prepared for a given emplacement session. This number generally varies between 5 and 20 probes. If any sizable contamination is found - greater than double the ambient air - every pipe in a lot is checked to identify whether residual contamination is excessive.

Small amounts of residue are not unusual when it is considered that the oils, used in processing and handling the pipe, must often be removed with solvents. Other

contributions may result from adsorption during temporary storage in solvent enriched air sometime during processing or transit. Pipes with greater than double the ambient level of contamination for a constituent are not used (none were found). Lower concentrations, when they occur, are noted and are later subtracted from the readings if they are significant.

B-9.3 INSTALLATION PROCEDURES

Probes are installed by hammering to the required depth using a 95-lb pneumatic fence post driver. This is accomplished by manually holding the probe upright while using a sledge hammer to "set" the probe. After setting the probe, at about the 6-inch depth, the driver is mounted and the probe is installed.

B-9.4 SOIL GAS SAMPLING PROCEDURES DESCRIPTION OF SAMPLING SYSTEMS

The sampling system consists of an oil-less vacuum pump connected up-flow from the vacuum gauge, the flow meter, the flow control valve and the sampling bulb. Sampling is accomplished by extracting samples through a septum on the pipe head. For samples intended for laboratory analysis, standard 500 ml gas sampling bulbs, with septums and Teflon stopcocks at both ends, were connected to a probe at the tapped hole using a stainless steel tube 1-1/2-feet long.

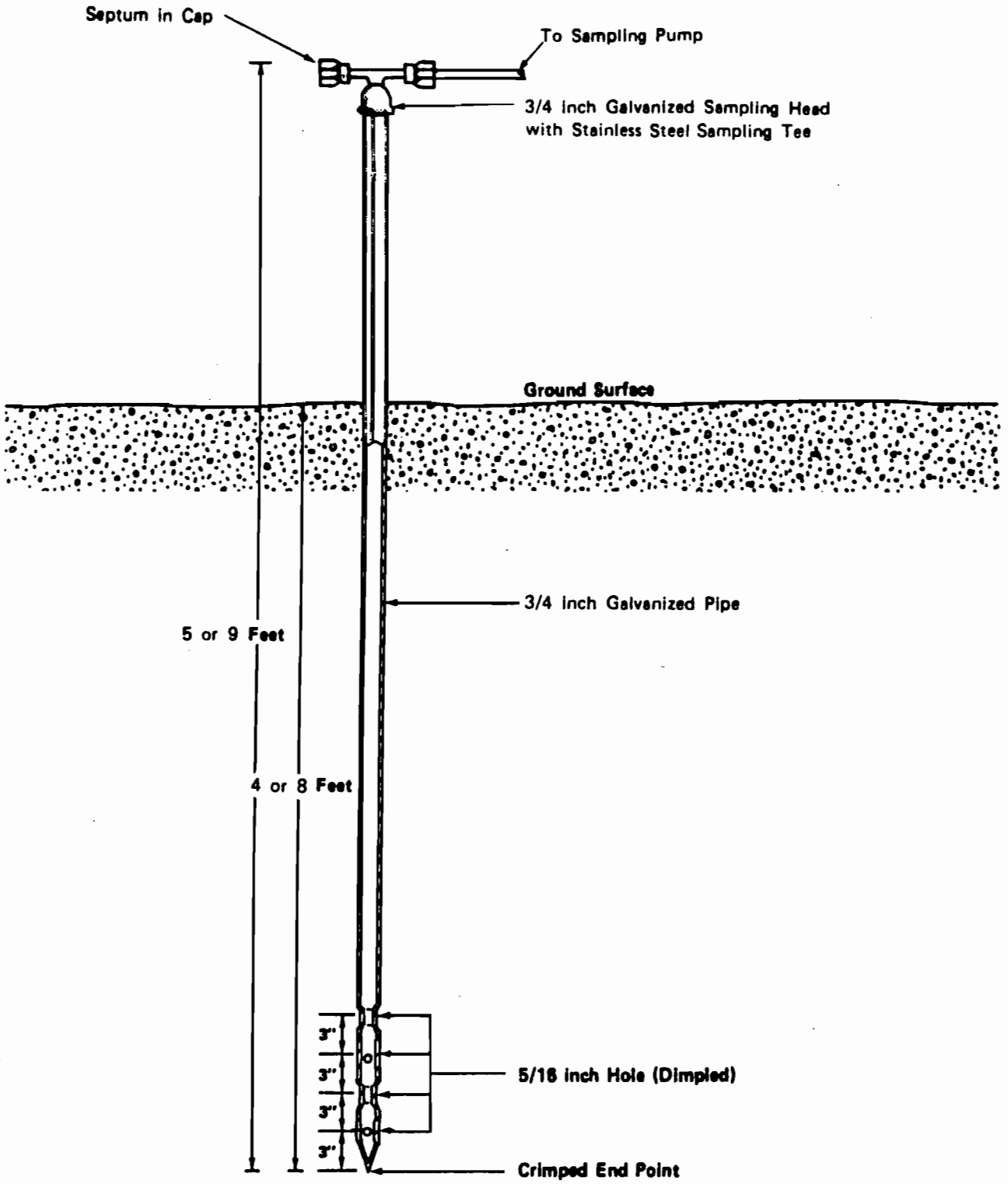
B-9.5 PRESAMPLING PROCEDURES

At the beginning and end of each day the joints of the sampling system are visually checked for leakage. After probe installation, the soil gas sampling system is connected, the pump is turned on, and all the joints are again visually checked for possible leakage. The flow rate is adjusted to approximately one liter per minute, and the vacuum gauge reading is noted for indications of relatively high vacuum conditions (greater than 10 inches of Hg) which may result from the placement into an impermeable clay or the saturated zone. After removing at least two pipe volumes of air (approximately 300 ml 5-foot section of probe), sampling can begin.

B-9.6 SAMPLING PROCEDURES

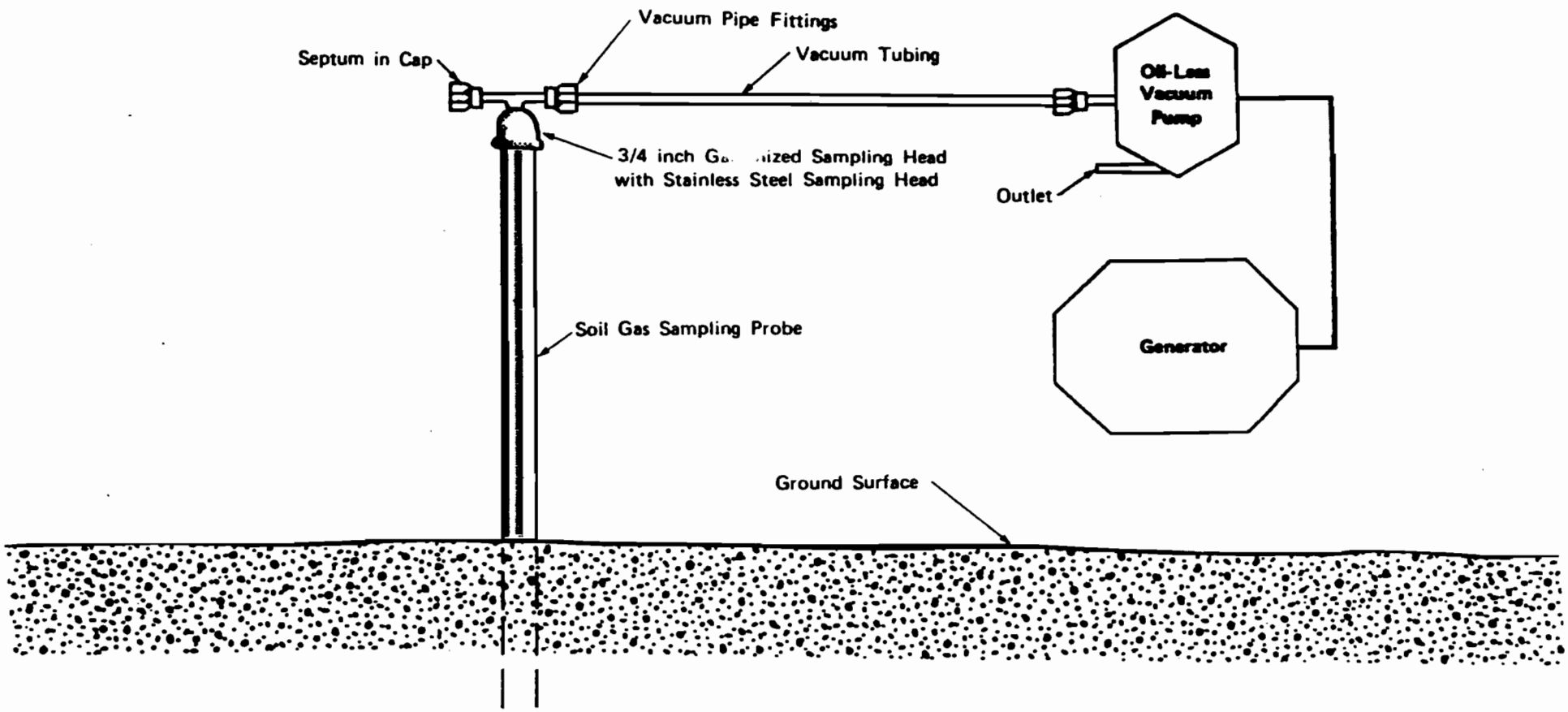
After performing background and residual contamination checks, 0.1 cc to 1.0 cc soil gas samples are collected with a glass barreled syringe through the septum on the sampling line and are analyzed on-site by injection directly into the GC. This is always followed by at least one replicate sample taken several minutes after the first. If the gas removal process was at steady state, these injections should be within 20 percent of each other. Occasionally, because of the imperfect nature of the samples (dirt, variable soil moisture, etc.), variations greater than 20 percent may be observed. Differences greater than 20 percent typically require at least one other injection to establish trends. In any case, the maximum concentration found is reported.

Probes are left in place and are generally not reused without a thorough steam cleaning. Probes that show no detectable organic constituents may be pulled and reused, on the same site, without cleaning, after a residual contamination check is performed on each one.



Project: Project No.	SOIL GAS SAMPLING PROBE CONSTRUCTION	Fig.

WOODWARD–CLYDE CONSULTANTS



Project: Project No.	SOIL GAS SAMPLING SYSTEM	Fig.

B-10.0 EQUIPMENT CALIBRATION PROCEDURES

Equipment calibration procedures have been excerpted from the appropriate Operations Manuals for the specific equipment to be used on the subject project. The following equipment calibration procedures are included herein:

B-10.1 Century Systems Portable Organic Vapor Analyzer (OVA)
(calibrated with methane in air)

B-10.2 HNu Organic Vapor Meter
(calibrated with isobutylene with calibration to benzene)

B-10.3 AID Organic Vapor Meter
(calibrated with isobutylene)

B-10.1 CENTURY SYSTEMS PORTABLE ORGANIC VAPOR ANALYZER (OVA)

OPERATING AND SERVICE MANUAL

for

CENTURY SYSTEMS'

Portable Organic Vapor Analyzer (OVA)
Model OVA-128
and Optional Accessories

REVISION C

CENTURY SYSTEMS CORPORATION
P. O. Box 818
Arkansas City, Kansas 67005
Telephone: (316) 447-3311
TWX NO. 910-740-6740

damaging the batteries. When finished, move the battery charger switch to OFF and disconnect from the Side Pack Assembly.

The following are special instructions relative to batteries which have been allowed to completely discharge.

It has been established that the above battery recharging procedures may not be sufficient when the operator of the instrument has inadvertently left the INSTR Switch ON for a period of time without recharging and allowed the battery to completely discharge.

When this happens and the above procedures fail to recharge the battery, the following should be accomplished:

1) Remove the battery from the instrument case.
2) Connect to any variable DC power supply.
3) Apply 40 volts at 1/2 amp maximum.
4) Observe the meter on the power supply frequently and as soon as the battery begins to draw current, reduce the voltage on the power supply at a slow rate until the meter reads approximately 15 volts. NOTE: The time required to reach the 15 volt reading will depend on degree of discharge.
5) Repeat steps a), b), c), and d) above to continue charging.

2.7.2 DC CHARGER

a) The optional DC charger is designed to both charge the battery and to provide power for operating the instrument from a 12 volt DC source, such as vehicle power.
b) Connect the DC charger cord to the connector on the battery cover of the Side Pack Assembly. Plug the line cord into the vehicle cigarette lighter or other power source connection.
c) In mobile applications, the DC charger is used to supply vehicle power to the instrument. Therefore, it may be left connected at all times.

2.8 CHARCOAL FILTERING

When it is desired to preferentially remove the heavier hydrocarbons, such as those associated with automobile exhaust, gasoline, etc., simply remove the pickup fixture from the end of the probe and install the optional charcoal filter assembly.

This same charcoal filter assembly can be installed directly into the Readout Assembly by using the adapter provided.

2.9 MOISTURE FILTERING

Filtering of moisture in the sample is not normally required. However, when moving in and out of buildings in cold weather, excessive condensation can form in the lines and detector chamber. In this case, the charcoal filter adapter can be filled with a desiccant such as "Drierite" which will filter out the moisture contained in the sample.

SECTION 3

SUMMARIZED OPERATING PROCEDURES

3.1 GENERAL

The procedures presented in this section are intended for use by personnel generally familiar with the operation of the instrument. Section 2 presents the comprehensive detailed operating procedures.

It is assumed that, prior to start up the positions of all switches and valves are in shut down configuration as described in paragraph 3.3.

3.2 START UP

a) Move PUMP Switch to ON and check battery condition by moving the INSTR Switch to the BATT position.
b) Move INSTR Switch to ON and allow five (5) minutes for warm-up.
c) Set Alarm Level Adjust Knob on back of Readout Assembly to desired level.
d) Set CALIBRATE Switch to X10 position, use CALIBRATE Knob and set meter to read 0.
e) Move PUMP Switch to ON position then place instrument panel in vertical position and check SAMPLE FLOW RATE indication.
f) Open the H2 TANK VALVE and the H2 SUPPLY VALVE.
g) Depress Igniter Button until burner lights. Do not depress Igniter Button for more than six (6) seconds. (If burner does not ignite, let instrument run for several minutes and again attempt ignition.)
h) 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.

3.3 SHUT DOWN

a) Close the H2 SUPPLY VALVE and the H2 TANK VALVE.
b) Move the INSTR Switch and PUMP Switch to OFF.
c) Instrument is now in shut down configuration.

SECTION 4

CALIBRATION

4.1 GENERAL

The OVA is capable of responding to nearly all organic compounds. For precise analyses it will be necessary to calibrate the instrument with the specific compound of interest. This is especially true for materials containing elements other than carbon and hydrogen.

The instrument is factory calibrated to a methane in air standard. However, it can be easily and rapidly calibrated to a variety of organic compounds. A GAS SELECT control is incorporated on the instrument panel which is used to set the electronic gain to a particular organic compound.

Internal electronic adjustments are provided to calibrate and align the electronic circuits. There are four (4) such adjustments all located on the electronics board. One adjustment potentiometer, R-38, is used to set the power supply voltage and is a one-time factory adjustment. The remaining three adjustments, R-31, R-32 and R-33 are used for setting the electronic amplifier gain for each of the three (3) calibrate ranges. Access to the adjustments is accomplished by removing the instrument from its case. Figure 4-1 indicates the location of the adjustments.

4.2 ELECTRONIC ADJUSTMENTS

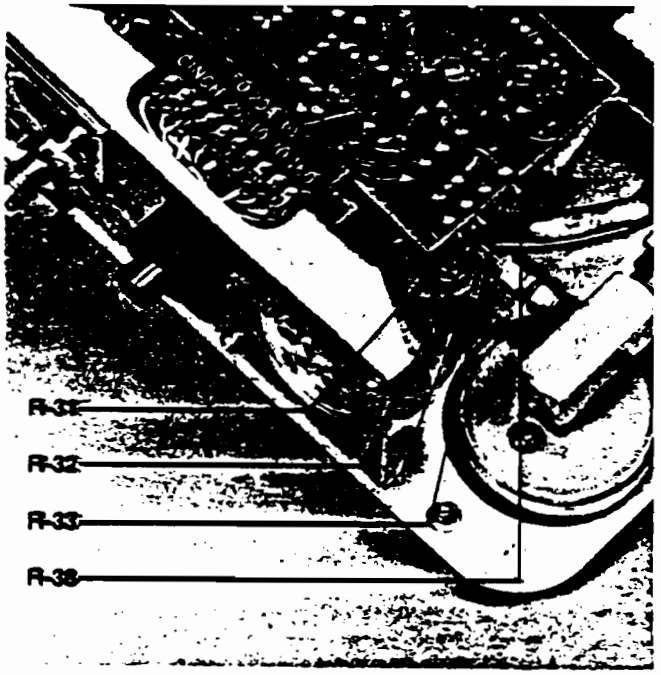
Primary calibration of this instrument is accomplished at the factory using methane in air sample gases.

.2.1 GAIN ADJUSTMENT

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 and adjust the meter reading to zero.
c) Introduce a methane sample of a known concentration (near 100 ppm) and adjust trimpot R-32 on circuit board (see Figure 4-1 for location) so that meter reads equivalent 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 H2 SUPPLY VALVE to put out flame.

4.2.2 BIAS ADJUSTMENT

a) Leave CALIBRATE Switch on X10 position and use CALIBRATE ADJUST (zero) Knob to adjust meter reading to 4 ppm.
b) Place CALIBRATE Switch in X1 position and, using trimpot R-31 on circuit board, adjust meter reading to 4 ppm. (See Figure 4-1)
c) Move CALIBRATE Switch to X10 position again. Use CALIBRATE ADJUST (zero) Knob to adjust meter to a reading of 40 ppm.
d) Move CALIBRATE Switch to X100 position and use trimpot R-33 on circuit board to adjust meter reading to 40 ppm.
e) Move CALIBRATE Switch to X10 position and use CALIBRATE ADJUST (zero) Knob to adjust meter reading to zero.
f) Unit is now balanced from range to range, calibrated to methane, and ready to be placed in normal service.



'GURE 4-1. LOCATION OF ELECTRONIC
DJUSTMENTS
(Model OVA-118 shown; location typical to OVA-128)

4.3 CALIBRATION TO OTHER ORGANIC VAPORS

4.3.1 SETTING GAS SELECT CONTROL (Span)

Primary calibration of the instrument is accomplished using a known mixture of a specific organic vapor compound. After the instrument is in operation and the "normal background" is "zeroed out", draw a sample of the calibration gas into the instrument. The GAS SELECT Knob on the panel is then used to shift the readout meter indication to correspond to the concentration of the calibration gas mixture.

The instrument is then calibrated for the vapor mixture being used. After this adjustment, the setting on the "digidial" is read and recorded for that particular organic vapor compound. This exercise can be performed for a large variety of compounds and when desiring 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.

4.3.2 USING EMPIRICAL DATA

Relative response data may be obtained, which can then be used to estimate concentrations of various vapors. With the instrument calibrated to methane, obtain the concentration reading for a calibration sample of the test vapor. The relative response, in percent, for that test vapor would then be the concentration read/concentration of the calibrated sample X 100.

4.3.3 PREPARATION OF CALIBRATION STANDARDS

4.3.3.1 COMMERCIAL SAMPLES

Commercially available standard samples offer the most convenient and reliable calibration standards and are recommended for the most precise analyses. Always remember to obtain the cylinder with the desired sample and the "balance as air". Sample 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.

4.3.3.2 PURE GASEOUS SAMPLES

Obtain a large collapsible sample bag, preferably polyethylene such as a 40 gallon trash can liner. Insert a tube into the bag opening and tie shut around the tube. The tubing should have a shut-off valve or plug and be suitable for connecting the OVA input tube. Determine the volume of the bag by appropriate means (i.e., wet-test meter, dimensions of the bag, etc.). Forty gallon polyethylene bags provide a volume of approximately 140-160 liters. For gas samples, flush a 10 cc hypodermic syringe with the compound to be tested and then inject a 10 cc sample through the wall of the air-filled bag. Immediately after withdrawing the needle, cover the hole with a piece of plastic tape. Allow a few minutes for the sample to completely diffuse throughout the bag. Agitation will ensure complete diffusion. Connect the outlet tube to the OVA and take a reading. To verify repeatability of sampling technique, disconnect the bag and inject a second sample of the gas into the bag without emptying. Since only 2 or 3 liters will have been removed, the overall volume change will be small and the instrument reading should now be twice that of the

original. The concentration in ppm (V/V) will be equal to the sample size in cc divided by the volume of the bag in liters times 1000. For example, a 10 cc gas sample when placed in a 160 liter bag will provide a sample of 63 ppm, i.e., 10 X 1000/160 equals 63 ppm.

4.3.3.3 GASEOUS AND LIQUID SAMPLES (Alternate Method)

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, obtainable from scientific supply houses, 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, you obtain the volume of the bottle in liters. Empty the water out and allow the bottle to dry. Place a one-foot piece of plastic 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 placed in the bottle 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 rubber stopper is loosely fitted to the top of the bottle and the needle of the syringe 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. Put the stopper in tight 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.

For liquid samples, use of the following equation will allow the calculation of the number of microliters of organic liquid needed to be placed into the bottle to make 100 ppm (V/V) of vapor.

V1 equals V2 X Mw/244D

- V1 - Volume of liquid in microliters needed to make an air mixture of 100 ppm (V/V)
- V2 - Volume of bottle in liters
- Mw - Molecular weight of substance
- D - Density of substance

This procedure has the advantage that you can see when all of the organic liquid has vaporized and the volume can be determined readily.

For liquid samples, an alternate procedure involves the use of a diffusion dilution device such as that described by Desty, Geach and Goldup in "Gas Chromatography", R.P.W. Scott, ed., Academic Press, New York, 1961.

4.4 THEORY

Theoretical background and empirical data related to the Century Organic Vapor Analyzer is presented in 4.4.1 and 4.4.2.

4.4.1 HYDROCARBONS

In general, a 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 excellent repeatable results with all types of hydrocarbons; i.e., saturated hydrocarbons (alkanes), unsaturated hydrocarbons (alkenes and alkynes) and aromatic hydrocarbons.

The typical relative response of various hydrocarbons to methane is as follows:

Compound	Relative Response (percent)
Methane	100 (reference)
Propane	64
N-butane	61
N-pentane	100
Ethylene	85
Acetylene	200
Benzene	150
Toluene	120
Ethane	90

4.4.2 OTHER ORGANIC COMPOUNDS

Compounds containing oxygen, such as alcohols, ethers, aldehydes, carbolic acid and esters give a somewhat lower response than that observed for hydrocarbons. This is particularly noticeable with those compounds having a high ratio of oxygen to carbon such as found in the lower members of each series which have only one, two or three carbons. With compounds containing higher numbers of carbons, the effect of the oxygen 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 typical relative response of various compounds to methane is as follows:

Methane	100 (calibration sample)
Ketones	
Acetone	60
Methyl ethyl ketone	60
Methyl isobutyl ketone	100
Alcohols	
Methyl alcohol	15
Ethyl	25
Isopropyl	65

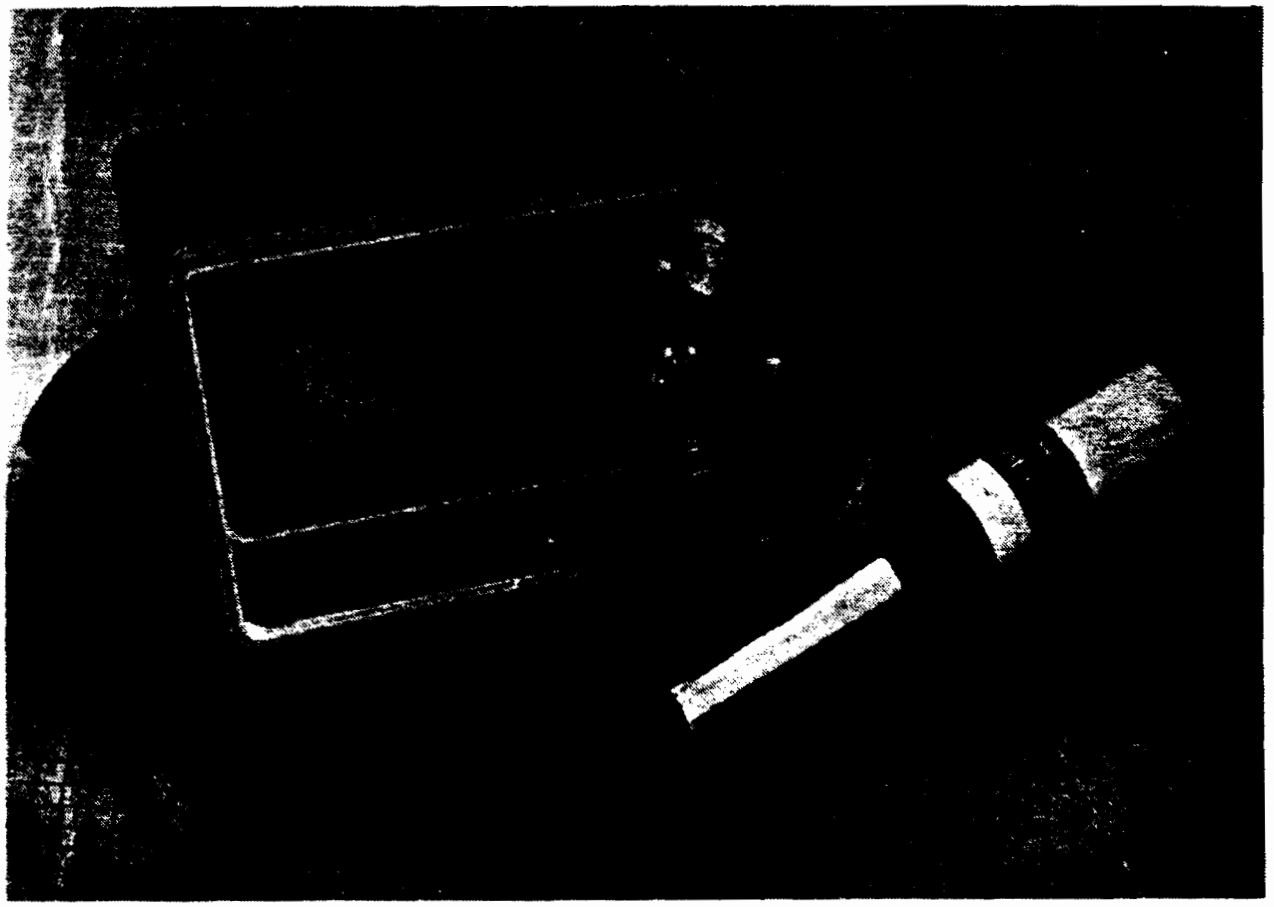
Halogen compounds

Carbon tetrachloride	10
Chloroform	65
Trichloroethylene	70
Vinyl chloride	35

The OVA has negligible response to carbon monoxide and carbon dioxide which evidently, due to their structure, do not product appreciable ions in the detector flame. Thus, other organic materials may be analyzed in the presence of CO and CO_2.

B-10.2 HNU ORGANIC VAPOR METER

INSTRUCTION MANUAL 601348



MODEL PI 101

Portable Photoionization Analyzer

hnu

SECTION 3

CALIBRATION

3.1 INTRODUCTION

The PI 101 Analyzer is designed for trace gas analysis in ambient air and is calibrated at HNU with certified standards of benzene, vinyl chloride and isobutylene. Other optional calibrations are available (e.g., ammonia, ethylene oxide, H2S, etc.). Calibration data is given in the data sheet. If a special calibration has been done, the data is given in the Application Data Sheet, which notes the sample source, type of calibration (see Section 8, Appendix), and other pertinent information.

Good instrumentation practice calls for calibration on the species to be measured in the concentration range to be used. This procedure assures the operator that the analyzer is operating properly and will generate reliable data.

Some general points to consider when calibrating the PI 101 are that the analyzer is designed for operation at ambient conditions and therefore the gas standards used for calibration should be delivered to the analyzer at ambient temperatures and pressure and at the proper flow rates.

WARNING:

The PI 101 is a non-destructive analyzer; calibrations using toxic or hazardous gases must be done in a hood.

The frequency of calibration should be dictated by the usage of the analyzer and the toxicity of the species measured. If the analyzer has been serviced or repaired, calibration should be done to verify operation and performance. It is recommended that calibration be checked frequently at first (daily or every other day) and then regularly based on the confidence level developed.

The normal meter scaleplate is 0 to 20. If the scaleplate is different, refer to the Application Data Sheet. If there are questions, consult the HNU representative before proceeding with calibration check.

An accurate and reliable method of calibration check is to use an analyzed gas cylinder in a test setup as shown in Figure 3-1 and described below. Additional material on calibration is given in Section 8, Appendix.

3.2 ANALYZED GAS CYLINDER

a. Concentration - The calibration gas cylinder is to contain the species of interest made up in an air matrix at or near the concentration to be analyzed. If the component is unstable in air, another matrix is to be used. The final calibration mixture should be similar to the sample the PI 101 will analyze. If the expected concentration is not known then a concentration should be chosen that will cause a scale displacement of 50 to 80% on the X10 range. Calibration on X10 range will provide accurate values on the X1 range as well.

For use on the 0-2000 range, a two-standard calibration is preferred: one at 70 to 85% of the linear range and the other at 25 to 35% of the linear range. With the linear range of approximately 600 ppm for most compounds these points would lie between 420 to 510 ppm and 150 to 210 ppm, respectively.

b. Stability - The calibration gas must be stable within the cylinder during the period of use. If the calibration is required in the field, then use of a small cylinder is recommended. In addition, the choice of cylinder material in contact with the gas must be considered (steel, aluminum or teflon). If there are any questions, the operator should request stability and usage information from the gas supplier.

WARNING

Extreme care must be taken in the handling of gas cylinders. Contents are under high pressure. In some cases, the contents may be hazardous. Many gas suppliers will provide data sheets for the mixtures upon request.

c. Delivery - The cylinder containing the calibration mixture must be connected to a proper regulator.

WARNING

Never open the valve on a gas cylinder container without a regulator attached.

Leak test all tank/regulator connections as well as the main cylinder valve to prevent toxic or hazardous materials from leaking into the work area. Care must be taken that the materials of construction of the regulator will not interact with the calibration gas.

One method of sampling the calibration gas is illustrated in Figure 3-1. Connect the cylinder to one leg of the tee, a flow meter to the opposite leg, and the probe to the third leg. The flow meter does not require a valve. If there is a valve, it must be left wide open. the flowmeter is only to indicate excess flow. Adjust the flow from the regulator such that only a little excess flow is registered at the flowmeter.

This insures that the PI 101 sees the calibration gas at atmospheric pressure and ambient temperature.

d. Usage - Generally, a gas cylinder should not be used below 200-300 psi as pressure effects could cause concentration variations. The cylinder should not be used past the recommended age of the contents as indicated by the manufacturer. In case of difficulty, verify the contents and concentration of the gas cylinder.

e. Alternate means of calibration are possible. For more information, contact the HNU Service Department.

3.3 PROBE

a. Identify the probe by the lamp label. If a question exists, disassemble the probe and inspect the lamp. The energy of the lamp is etched into the glass envelope.

b. Connect the probe to the readout assembly, making sure the red interlock switch is depressed by the ring on the connector.

c. Set the SPAN pot to the proper value for the probe being calibrated. Refer to the calibration memo accompanying the probe.

d. Check the Ionization Potential (IP) of the calibration gas to be used. The IP of the calibration gas must be at or below the IP of the lamp.

e. Proceed with the calibration as described in Section 3.4. Check the calibration memo for specific data. If any questions develop, call the HNU representative.

f. NOTE: The 11.7eV lamp has a special cleaning compound. Do not use water or any other cleaning compound with the 11.7 eV lamp. Do not interchange ion chambers, amplifier boards or lamps between probes. (See Section 5.2).

3.4 PROCEDURE

a. Battery check - Turn the function switch to BATT. The needle should be in the green region. If not, recharge the battery.

b. Zero set - Turn the function switch to STANDBY. In this position the lamp is OFF and no signal is generated. Set the zero point with the ZERO set control. The zero can also be set with the function switch on the X1 position and using a "Hydrocarbon-free" air. In this case "negative" readings are possible if the analyzer measures a cleaner sample when in service.

c. 0-20 or 0-200 range - For calibrating on the 0-20 or 0-200 range only one gas standard is required. Turn the function switch to the range position and note the meter reading. Adjust the SPAN control setting as required to read the ppm concentration of the standard. Recheck the zero setting (step b.). If readjustment is needed, repeat step c. This gives a two-point calibration; zero and the gas standard point. Additional calibration points can be generated by dilution of the standard with zero air if desired (see Section 8).

d. 0-2000 range - For calibrating on the 0-2000 range, use of two standards is recommended as cited in Section 3.2a. First calibrate with the higher standard using the SPAN control for setting. Then calibrate with the lower standard using the ZERO adjustment. Repeat these several times to ensure that a good calibration is obtained. The analyzer will be appoximately linear to better than 600 ppm, (see Figure 3-2). If the analyzer is subsequently to be used on the 0-20 or 0-200 range, it must be recalibrated as described in steps b. and c. above.

e. Lamp cleaning - If the span setting resulting from calibration is 0.0 or if calibration cannot be achieved, then the lamp must be cleaned (see Section 5.2).

f. Lamp replacement - If the lamp output is too low or if the lamp has failed, it must be replaced (see Section 5.3).

3.5 CALIBRATION CHECKING

Rapid calibration checking in the field can be accomplished by use of a small disposable cylinder containing isobutylene. Immediately after a calibration has been completed, a reading is taken on a special isobutylene standard. This provides a reference concentration measurement for later checking in the field. This can be done at any time with a portable cylinder containing this same special standard, using this reference reading as a check, and making adjustments to the analyzer if necessary. In effect, this is an indirect method of calibration, one maintaining the calibration to give direct readings for the original gas mixture, but using the portable isobutylene cylinder. Details are given in Section 8.2 of the Appendix.

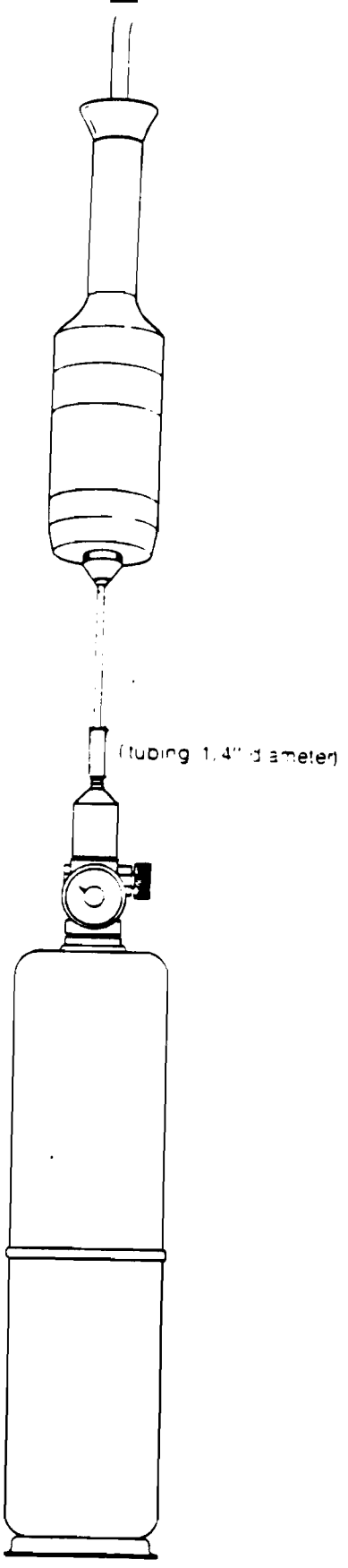
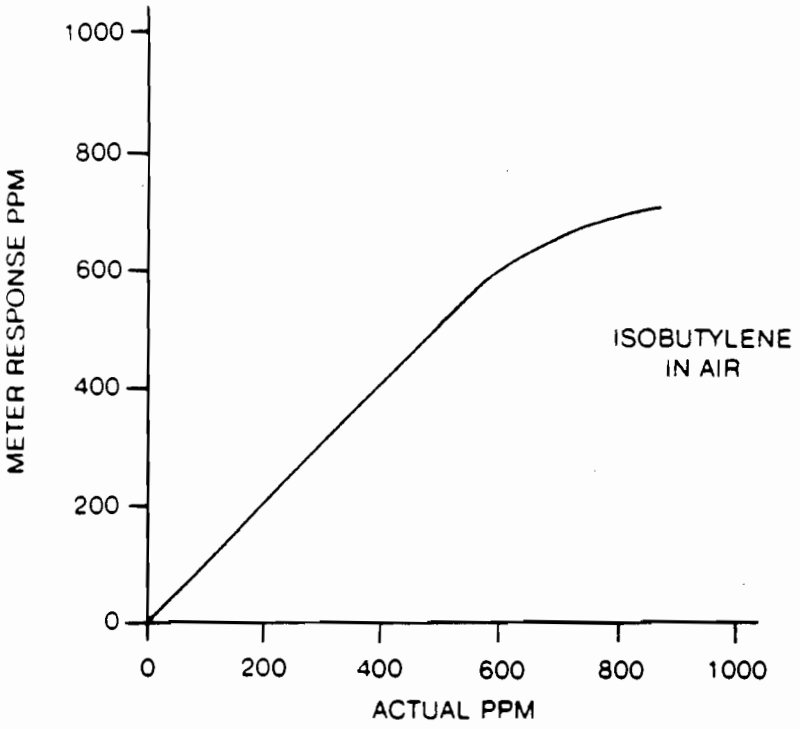


FIGURE 3-1
CALIBRATION TEST SET UP



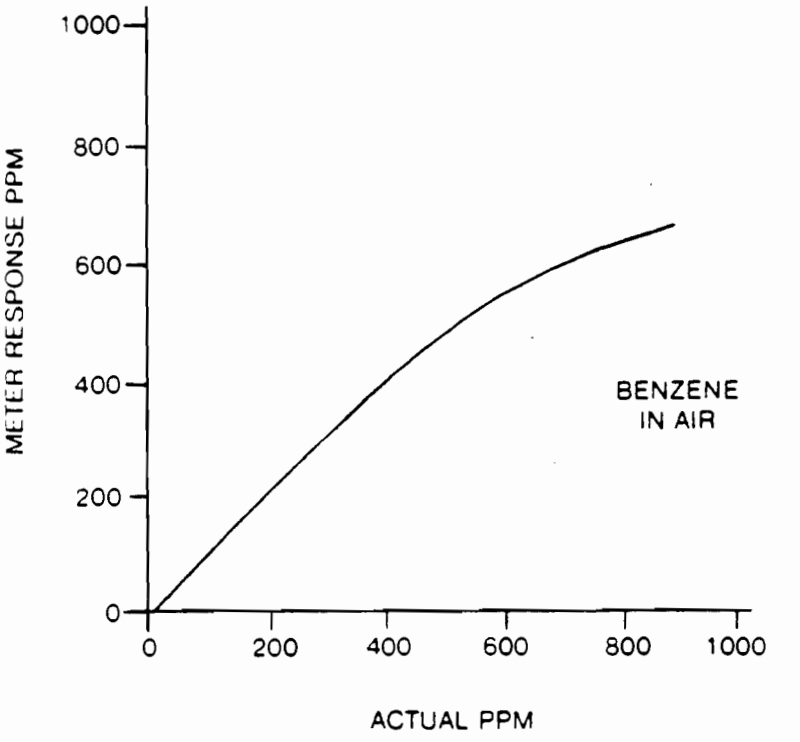
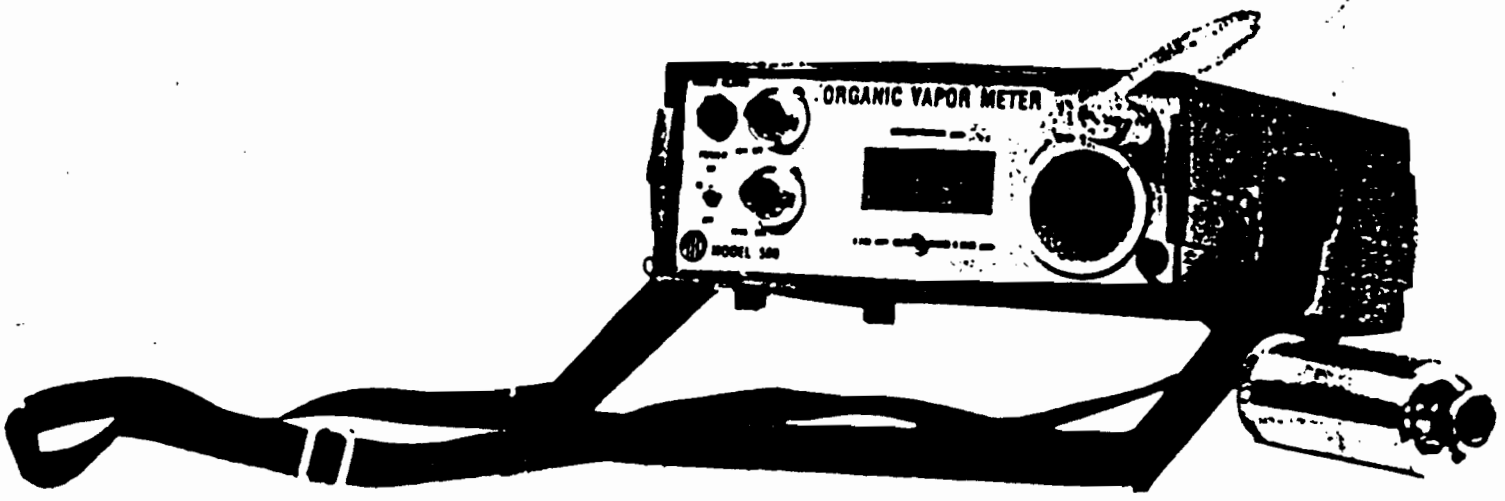


FIGURE 3-2
TYPICAL CALIBRATION CURVES (10.2 eV)

B-10.3 AID ORGANIC VAPOR METER

PORTABLE
ORGANIC VAPOR METER
MODEL 580

ANALYTICAL INSTRUMENT DEVELOPMENT, INC.
ROUTE 41 & NEWARK ROAD AVONDALE, PA. 19311
(215) 268-3181 TLX 835441



SECTION III

CALIBRATION

3-1 GENERAL

The Model 580 Organic Vapor Meter is indeed a quantitative instrument and can certainly be used as such. It makes use of the Photoionization Detection System using a lamp with an ionization energy of 10.0 eV which is standard in the Model 580. Almost all organic materials will be ionized at this energy level. There are some organic materials, such as a few of the freons, methane, ethane and propane that are not ionized and thus will not be detected. The ionization potentials for the various organic materials will simply tell whether the material will be detected by the the Photoionization Detector. It does not give any clue as to the sensitivity of that detector for that particular material. Certainly, different organic vapors will have different sensitivities. It is important to understand that the Model 580 does indeed sense most organic vapors and that its response to these different organic vapors will indeed be different.

In this section of the manual, the aspects of calibrating the Model 580 for various vapors will be discussed. In the following section discussing applications, various ways of using the features of the Model 580 will be explained along with the various methods for calibration of the 580. There will also be applications of the Model 580 in specific instances where the organic vapors or the mixtures of organic vapors are completely unknown. The 580 can be an extremely useful tool, even in areas such as those.

3-2 FACTORY CALIBRATION OF THE MODEL 580

To complete testing and operation in AID's checkout area, each Model 580 has been calibrated and linearity checked at the factory. The particular gas chosen for this calibration is butadiene. The Model 580 has good response for butadiene. Butadiene standards prepared in air are relatively stable with time, undergoing no serious adsorption or reaction problems.

After the Model 580 has been completely checked electrically and the unit balanced, it is then operated with zero air being used as a sample. This zero air is allowed to flow into an elongated chamber. The probe from the Model 580 is then inserted into this chamber. The zero air flow rate is adjusted in significant excess of the sampling rate of the Model 580, which is at the rate of 500 ml/min. This means that the standards and zero air made available to the Model 580 should be in excess of 600 ml/min. Drawing zero air as a sample, the zero adjustment on the rear of the instrument is then set so that the digital readout on the front panel is zero.

Standards of various concentrations of butadiene in air are then made available to the 580 in the same fashion as zero air. The Sensitivity/Calibrate Pot on the front of the Model 580 is adjusted to read 200. This adjustment will be explained in the next section. With a known standard made available to the Model 580 at a flow rate in excess of the sampling rate of the 580, the span pot on the rear of the Model 580 is adjusted such that the digital readout corresponds to the value of the butadiene standard being presented to the 580. Other concentrations of butadiene are then presented to the instrument. The readout on the front panel for each of these should correspond to the concentration being presented to the 580. This provides our linearity check of the Model 580.

The instrument is now calibrated for butadiene. For different materials other than butadiene that have different sensitivities in the Phtoionization Detector, the readout will not correspond to the exact concentration of these materials. Methods of handling this will also be discussed in a future section.

3-3 THE SENSITIVITY/CALIBRATE POT

The Sensitivity/Calibrate Pot is located on the front panel of the Model 580 to the left of the digital readout and below a similar looking dial for the alarm pot. These duodials are for 10-turn pots. In the calibration of the Model 580 using butadiene, this particular pot was adjusted to 200. This means it is exactly two revolutions from one end. This potentiometer is in the output circuit of the detector amplifier. It functions as a voltage divider network. The voltage on the slider is some fraction of the total voltage on the pot. It is the voltage on the divider that is presented to the digital readout circuit that provides the readout in the LCD. The lower the setting on this potentiometer, the less sensitive or the lower the reading that one obtains on the front panel for a given concentration. Conversely the higher the setting on this pot, the higher will be the reading. It is not a linear relationship, but it is a reproducible relationship.

The function of this potentiometer is to increase or decrease the sensitivity of the Model 580 in a defined and reproducible fashion. The setting of 200 that was used for butadiene is simply a convention and was arbitrarily chosen. Certainly a setting of 300 could have been used just as well. However, this would mean by using simply the Sensitivity/Calibrate Pot for adjustment, only approximately 3 times greater sensitivity could be obtained for various materials versus approximately 5 times the sensitivity increase obtainable with a setting of 200. The main purpose of the Sensitivity/Calibrate Pot is to allow relationships to be established for the sensitivity of particular gases and vapors of interest to the user to be determined for a given Model 580. Once these settings have been determined, the user need only calibrate the instrument against a single standard such as butadiene maintaining the same set number for butadiene on this Sensitivity/Calibrate Pot.

The use of the Sensitivity/Calibrate Pot is best illustrated by an example. The problem at hand is to measure the concentration at low levels of benzene in a working environment. OSHA has established the TLV for benzene at 10 ppm. If it is known that the area is free of virtually all other organic materials other than benzene, the Model 580 can be calibrated to benzene for actual reading of the ppm level of benzene in that environment. For calibration, one would proceed in the following manner: The Model 580 would be calibrated with butadiene as a reference standard, as done by the factory check procedure. That is, the Sensitivity/Calibrate Pot would be set at 200. A known amount of butadiene in air would be presented to the 580 and the span pot on the rear of the instrument would be adjusted to provide the proper reading on the digital display for the concentration being used. Then a known amount of benzene vapor in air is presented to the Model 580. The Sensitivity/Calibrate Pot would be adjusted such that the front panel digital display read the correct concentration for benzene. Let us assume that the setting on the Sensitivity/Calibrate Pot to obtain the correct reading for benzene in air was 125. The Model 580 now has been calibrated and a sensitivity established for benzene. This would mean that in the future, only the reference standard of butadiene would be needed to be used to correct for any slight changes in the instrument sensitivity, perhaps due to lamp aging or some small electronic change. For these calibrations in the future, the Sensitivity/Calibrate Pot would be set to 200. The 580 would be presented with a known concentration of butadiene in air and the span pot at the rear of the unit adjusted to give a correct reading. Then the Sensitivity/Calibrate Pot would be set to 125 and the digital display would read the correct concentration for benzene in the sample drawn into the Model 580. Standards of benzene in air are not stable at the ppm level due to adsorption of benzene on the surfaces of the container. This means that if one wanted to calibrate the instrument with a benzene standard each time calibration was needed, a new standard would have to be prepared for this purpose. The Sensitivity/Calibrate Pot allows the user to prepare this standard only once and relate it to the reference standard of butadiene, via the setting on the Sensitivity/Calibrate Pot. This setting will stay constant for a given lamp in a given Model 580. This then permits any future calibration of the Model 580 to be accomplished by the reference standard of butadiene in air which is significantly more stable than the benzene in air standard would be.

In like fashion, the Model 580 can be calibrated with a large number of known vapors in air with a record being maintained of the Sensitivity/Calibrate Pot setting for the proper reading of each of these individual vapors. These settings will remain constant for a given Model 580 with a given lamp installed. Complete calibration of the Model 580 can then be accomplished simply by using the reference standard of butadiene in air with the Sensitivity/Calibrate Pot set at 200 and correct reading obtained using the Span Pot on the rear of the instrument. Notice that in the above calibration procedures, the Span Pot is adjusted only for the reference standard. The Sensitivity/Calibrate Pot is set to the appropriate setting for other calibrations.

It is certainly possible to calibrate the Model 580 directly for a given vapor or gas in air. In the above case, one could use an arbitrary setting

of 100 and present the Model 580 with a known benzene concentration and the Span Pot at the rear of the instrument could be adjusted such that the Model 580 read directly the proper concentration of the benzene standard. In this instance, benzene has become the reference standard.

When records are being made of the various settings for the Sensitivity/Calibrate Pot for various materials, it is important that that list be accompanied by the reference standard that was used and setting of the Sensitivity/Calibrate Pot used for that reference standard. Examples will be shown in the application section again of how the Sensitivity/Calibrate Pot is used in this particular instrument.

3-4 METHODS OF GENERATING CONCENTRATIONS OF VARIOUS MATERIALS IN AIR.

This section is not intended to be exhaustive as far as the preparation of gas and vapor standards in air are concerned. Only those methods that have been found most practical for the calibration of the 580 are discussed here. There are basically two types of standards. Static standards in which a known volume of the gas or vapor is mixed with a known volume of air and the concentration of the gas or vapor in air calculated from knowing these volumes. The second method used is what is called a dynamic standard. Dynamic standard preparation involves mixing gases or vapors with air under a flowing condition whereby the flow rate of both gases are known prior to their mixing. The concentration then is calculated from flow rates.

Certainly commerically available standard cylinders of gaseous materials in air offer the most convenient method of calibration. However, these are static standards. Standards prepared in this fashion in air for vapors of various organic liquids often show concentration reduction with time due to adsorption problems. In general, gases when mixed with air will maintain their concentrations with time since adsorption is generally not a problem. However, some gases are sufficiently reactive that chemical reaction of the gas will cause a reduction of it in air. These precautions must be observed when using commercially prepared standards for calibration of the Model 580. It is for this reason that butadiene in air was chosen as a reference standard for factory calibration. Static standards can be prepared in a laboratory and in general are reasonable ways of calibrating the Model 580. However, it is important that these standards be used shortly after their preparation to reduce the significance of any adsorption problems. Static standards prepared for calibration of the Model 580 are best prepared in collapsible plastic bags. This is opposed to a fixed volume container. The sampling rate of the 580, which is 500 ml/min, requires an appreciable amount of sample. Even one minute's sampling out of a fixed container will remove 500 ml/min from it. This should not significantly reduce the pressure inside the container. Thus, the collapsible bag provides the best means as opposed to a fixed volume. A 5 gallon polyethylene bag is a convenient size to use of the preparation of static standard.

A tube is inserted into the opened end of the bag and the bag opening then sealed around the tube. The tube should have a cutoff valve or some means of closing the volume of the bag. The volume of air introduced

into the bag must be measured. This is most conveniently measured by a wet test meter. However, a source of air flowing through a flow meter can be used if the flow can be held constant, then time is a measure of the volume of the air placed into the bag. All air is expelled from the bag by completely collapsing it prior to connection to the source of air. It can then be connected to a wet test meter or flow meter via a short length of rubber tubing hooked to the plastic tube of the bag. The air flow is started into the bag at a rate of approximately 5 l/min. A total of 10 liters is a convenient volume for a 5 gallon bag. This would mean approximately 2 minutes for filling the bag.

For gaseous samples, the trace organic will be added via a glass hypodermic syringe. The 1 cc Tuberculin syringe is a convenient size. For a butadiene standard, the 1 cc syringe is flushed with pure butadiene and then filled to the 1 cc mark. While the air is flowing into the plastic bag, the short piece of rubber tubing is pierced by the needle from the 1 cc syringe and the plunger slowly depressed such that the 1 cc of butadiene is added to the air flowing into the plastic bag. When 10 liters of air have been added to the plastic bag, the flow is immediately stopped and the valve on the tube or the closing clamp is applied to contain the air and butadiene within the plastic bag. It is best at this stage of the procedure not to rely solely on the diffusion of butadiene to form a uniform mixture inside the plastic bag. Slight kneeding of the plastic bag will hasten the mixing of the butadiene in air. The plastic tube from the bag is then connected to the probe on the Model 580 via a short length of rubber tubing and the valve on the plastic tube immediately opened. The Model 580 withdraws a sample from the bag at the sampling rate of 500 ml/min. Thus, 10 liters of sample in the bag will provide approximately 20 minutes. Certainly the calibration of the 580 can be accomplished in a shorter period of time. One should wait until the reading, as displayed on the digital readout, remains constant before any span adjustment is made with butadiene. The concentration of butadiene in ppm by volume will be equal to the sample size, which was 1 cc, divided by the volume of the bag in liters, which would be 10 liters, times 1000. In this particular instance, the concentration would be:

$$\text{Conc (ppm by Vol)} - \frac{1\text{cc Butadiene} \times 1000}{10\text{ L Air}} = 100 \text{ ppm}$$

For organic materials, which are normally liquids at room temperature, the procedure is essentially the same except that an extremely small liquid sample is injected into the flowing air stream rather than the gas sample. This technique works well only for relatively volatile organic materials. The flowing air stream must vaporize all of the material or the calculation will be off. If the material is not rapidly volatile in that flowing air stream, the liquid should be injected through the surface of the plastic bag. Immediately after withdrawing the needle, the hole in the plastic bag should be covered with a piece of plastic tape.

Again significant kneeding of the bag will hasten the evaporation of the sample and mixing of the vapor into the air to provide homogeneous samples. The introduction of this sample into the 580 is the same as

before. The calculation of the concentration of the vapor in air is a two-step procedure whereby the small volume of liquid injected into the air stream or into the plastic bag is converted to a volume of vapor. This volume of vapor is then used in the same manner as the volume of gas in the case of butadiene. The following equations apply:

$$\text{Volume Vapor (cc)} = \frac{\text{Liquid Volume (ul)} \times \text{Liquid Density} \times 24.45}{\text{Molecular Weight}}$$

The above equation gives the vapor volume at atmospheric pressure (760 torr) and 25°C (77°F).

Then:

$$\text{Concentration (ppm by Volume)} = \frac{\text{Vapor Volume (cc)} \times 1000}{\text{Air Volume (liters)}}$$

The following is a sample calculation for benzene.

$$\text{Liquid Volume} = 2 \text{ ul}$$

$$\text{Benzene Density} = 0.879 \text{ g/cc}$$

$$\text{Molecular Weight Benzene} = 78.1$$

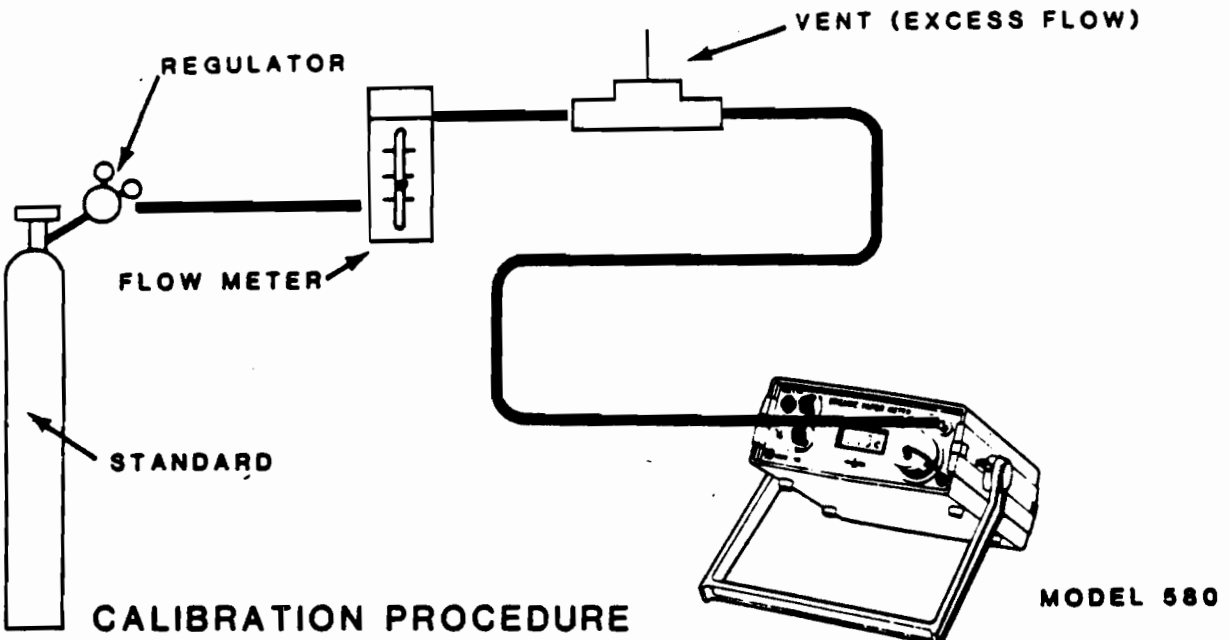
$$\text{Air Volume} = 10 \text{ liters}$$

$$\text{Vapor Volume} = \frac{2 \times 0.879 \times 24.45}{78.1} = 0.55 \text{ cc Benzene Vapor}$$

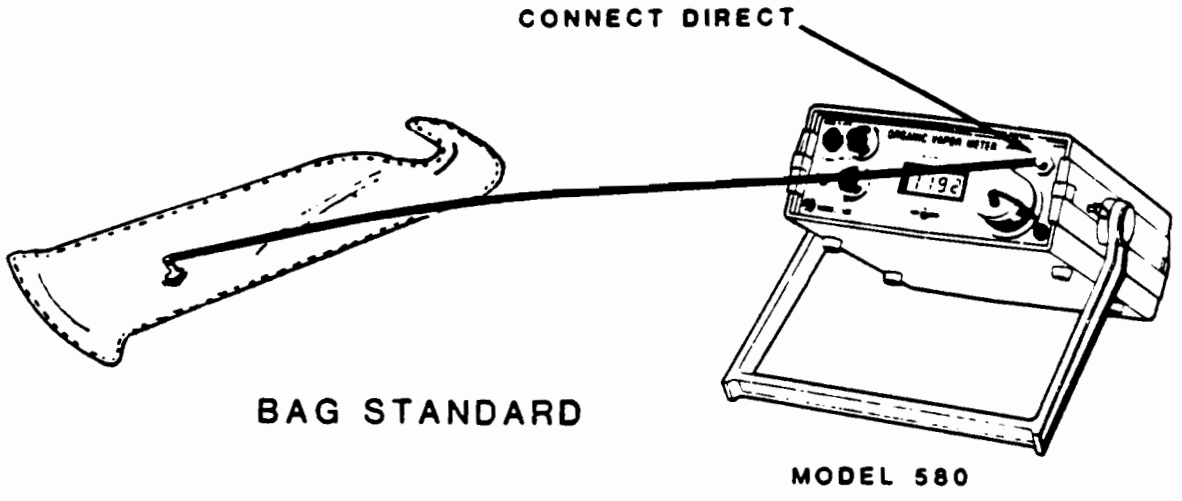
$$\text{Conc} = \frac{0.55 \times 1000}{10} = 55 \text{ ppm (vol)}$$

The syringe used for the measurement of liquids in this particular instance is a small volume-type such as those manufactured by the Hamilton Company. A convenient size syringe is the 10 microliter volume.

Dynamic standards can be prepared of both gases and vapors by using the techniques of either permeation tubes for gases or diffusion tubes for vapors. These permeation or diffusion devices supply a very small flow of either the gas or vapor. This is mixed with a known flow rate of air providing a flowing stream that has a known amount of either gas or vapor in the air stream. These are probably the most reliable and accurate standards available for low level concentrations of gases and vapors in air. However, the techniques require some additional instrumentation in order to implement the use of these devices. The reader is referred to AID's Calibration Standards Notebook for the use of these techniques in the dynamic generation of standards.



CALIBRATION PROCEDURE
PRESSURIZED STANDARD



BAG STANDARD

Appendix C

APPENDIX C

Appdendix C is the site-specific Health and Safety Plan for the field investigation activities at the Xerox Corporation, Blauvelt, New York facility.

HEALTH AND SAFETY PLAN

PROJECT NUMBER: 88C2221-2

PROJECT NAME: Remedial Investigation
Xerox Corporation
Blauvelt, New York

PROJECT MANAGER: Robert G. Ehlenberger

INTRODUCTION

This Safety Plan established guidelines and requirements for worker safety and conduct during field and laboratory (geotechnical) work associated with the Remedial Investigation at Xerox Corporation's Blauvelt, New York facility. Employees of Woodward-Clyde Consultants (WCC) and its subcontractors are required to read the Plan and sign the Compliance Agreement attached to the plan.

SITE DESCRIPTION

The Xerox facility is located in Blauvelt, New York. The areas of interest for this investigation include some level ground in and near a parking area of the plant inside the Xerox building, and off-site areas in a small industrial park. This site contains some small brush and low trees, some of which need to be cleared before drilling begins. Figure 1 shows the regional location of the site and Figure 2 shows the plant site vicinity. The site is located on unconsolidated overburden materials overlying bedrock, which consists of red shales and siltstones. Overburden consists of glacial till which ranges in thickness from 14 to 23.5 feet.

WORK DESCRIPTION

The work to be performed in this Remedial Investigation includes several tasks to fully characterize the geologic, hydrologic, and contamination conditions in on-site and off-site areas of the plant. Major tasks include:

- o Off-site soil gas survey using a field GC
- o On-site soil gas studies using an OVA
  (primarily restricted to locations in the building):
- o Soil borings
- o Well installation
- o Groundwater sampling
- o Aquifer testing
- o Aquatic biological studies
- o Surface water and sediment sampling

Field work is expected to begin in August 1987, and it is anticipated that approximately 4 to 8 weeks will be necessary to complete operations. Drilling will be performed using hollow-stem augers and mud rotary techniques, with continuous split-spoon sampling to the bedrock surface. Sampling of the bedrock will be by cuttings in the return mud; bedrock coring will also be performed in some locations. For a more detailed presentation of the scope of work and technical approach, please refer to WCC's Work Plan.

WCC will observe and document the quality of all subcontractual work. All drilling and well installation will be conducted by a qualified drilling subcontractor. An exploration location plan is included in Figure 2.

HAZARD ASSESSMENT

The primary hazard associated with the scheduled field and laboratory work is exposure to volatile and aliphatic compounds. The principal volatile and aliphatic organic compounds present at the site, based on information concerning types of solvents used at the site are listed in Table 1. The Threshold Limit Values (TLV) for employee exposure to the listed compounds are also given in Table 1.

Any of the compounds in Table 1 can affect the body if they are inhaled, ingested, or if they come in contact with the eyes or skin. The principal route of exposure at the site will be from inhalation and skin contact. Personal protective methods recommended by the National

Institute for Occupational Safety and Health (NIOSH) will be met or exceeded during work at the site. Organic vapor twin cartridge respirators will be worn when the working area organic vapor concentration exceeds 5 parts per million (ppm). Skin and eye protection will be required at all times while drilling and sampling in the plant site.

GENERAL HEALTH AND SAFETY REQUIREMENTS

1. Before commencing field or laboratory work, all WCC personnel must take a WCC-approved medical examination. This requirement is waived for individuals who have taken the examination during the past 12 months. Contractors that routinely perform work for WCC at hazardous waste sites must provide a similar examination for their employees.

2. WCC personnel must have completed a 40-hour Health and Safety Training Course (WCC Basic Health and Safety Training, REM II Training or equivalent) to work on this project in the field. Subcontractor personnel must have received training to include the use and limitations of protective equipment including respirators.

3. The Project Manager and/or Site Safety Officer shall hold a meeting of all field and laboratory personnel (including subcontractor personnel assigned to field work) before work commences. During the meeting, all personnel shall be provided with a copy of this Safety Plan; the Plan shall be reviewed and discussed and questions answered. Signed Compliance Agreement forms shall be collected by the Project Manager and filed. Individuals refusing to sign the form will not be allowed to work on the project.

4. The personal protective equipment specified in this Plan must be provided to all field personnel. If respirators are specified, personnel shall be informed that facial hair that interferes with proper fit of respirators must be removed. The facial hair requirements comply with OSHA regulations. Subcontractors must provide acceptable equipment to their personnel.

5. All field personnel must inform the Project Manager or his/her designated representative before commencing work at the site. At least two members of the field crew must be on-site whenever drilling, sampling, or other invasive work is to be performed.

6. A daily log shall be used to record entry and exit dates and times of all WCC and subcontractor personnel and of project site visitors, accidents, illnesses, incidences of safety infractions by field personnel, air quality and personal exposure monitoring data, and other safety-related matters. In case of an accident, injury, or illness occurring during site operations, the Incident/Accident Report form included as part of this Plan must be completed.

7. Smoking, eating, drinking, and open fires (including matches, lighters, etc.) shall not be permitted while working, or in any portion of the site restricting such activities.

8. Whenever possible, field personnel should work from a position upwind of borings, wells, pits, and trenches during construction and while samples are being collected.

9. Work in the area (drilling and sampling) will be performed in zones restricted to working personnel only. These zones will extend approximately 25 feet in all directions from the working area of the drill rig.

10. A safety station containing at least one First Aid Kit, fire extinguisher, and eyewash station shall be available.

PROTECTION LEVEL

Work activities and locations will span a wide range of conditions with correspondingly different health and safety risks. For example, surface water sampling, groundwater sampling in upgradient wells, or drilling in far downgradient areas represent relatively low levels of risk. Drilling and sampling in areas contaminated with non-aqueous materials or drilling inside the building, represent higher risk levels. Previous site data, combined with an active monitoring program during this study, should be used to select the appropriate protection levels.

Work will be started at Level D protection. Level D will include wearing coveralls/overalls or Tyvek suits along with boots, chemically-resistant gloves, a hardhat, and safety glasses. The level of protection will be raised to Level C if air quality monitoring in the work (breathing zone) space indicates organic vapors present in excess of approximately 5 ppm. At this time, half-face respirators will be donned. Respirators will be equipped with cartridges rated for organic vapor and acid gas. If the concentration of organic vapors in the air exceeds 50 ppm, Level B protection (SCBAs) will be used. Based on data from previous work at the site, it is not likely that Level B protection will be required. Should level B protection be required, field personnel must have attended WCC Advanced Health and Safety Training or be approved by the Business Unit Health and Safety Officer based upon experience.

PROTECTIVE EQUIPMENT

Protective equipment for field personnel is listed below. The donning of respirators is based on levels of organic vapors as indicated by air monitoring equipment.

1. A hardhat must be worn by all personnel working within 25 feet of any heavy equipment.

2. Safety goggles or glasses must be worn by all personnel working within 25 feet of any heavy equipment. Chemical splash goggles will be worn during well development, groundwater sampling, and surface water and sediment sampling.

3. Waterproof gloves (Nitrile outer gloves with PVC or latex inner gloves) must be worn by all project personnel engaged in drilling and sampling at the plant site. Drillers should wear heavy-duty, acid- and oil-resistant gloves.

4. Chemically-resistant boots must be worn by all project personnel engaged in drilling and sampling at the plant site.

5. Tyvek disposable coveralls shall be worn by all personnel engaged in drilling and sampling in the plant site area. Tyvek suits should be taped to gloves and boots with duct tape to limit the possibility of direct skin contact with waste materials.

6. Half-face respirators, with organic vapor/acid gas rated air-purifying cartridges shall be available to all personnel while working at the plant site. Drilling company personnel are required to provide equivalent respirators and cartridges. Personnel must be fit-tested with their specific respirator or have fit-test documentation on file in Plymouth Meeting Health and Safety files. Subcontractors must supply fit-test documentation upon request.

7. An emergency eye wash package shall be available at all times. The location of the nearest on-site emergency shower will be indicated to all personnel not familiar with the site. WCC field personnel will be briefed on the location of the nearest emergency telephones.

Geotechnical laboratory personnel must wear waterproof gloves and laboratory coats whenever samples or parts of samples are directly handled and during cleanup of materials and equipment that have come in contact with the samples.

Personnel protective equipment will be disposed of at the plant site in containers approved by plant personnel. No contaminated equipment will be carried off-site. The equipment will be placed in drums and properly disposed of. Gloves and other reusable items (boots) will be thoroughly washed with a solution of water and alconox with a potable water rinse upon exiting work locations. All non-disposable equipment used during drilling and development operations will be decontaminated by steam-cleaning and, if necessary, an alconox and water scrub, at a designated decontamination area located on the plant site. Equipment decon will be performed at a level of protection equal to or greater than that used during drilling/sampling. Monitoring will be performed during steam cleaning as the steam will mobilize volatile contaminants.

AIR QUALITY AND PERSONNEL EXPOSURE MONITORING

Air quality monitoring in the work space will be performed using a Century Model 128 Organic Vapor Analyzer (OVA) or AID Organic Vapor Meter (OVM). Air quality monitoring will be performed on a continuous basis, so that the Site Safety Officer can determine when to change protection levels, in accordance with action levels detailed in this Health and Safety Plan.

SAMPLE HANDLING, TRANSPORT, AND SHIPMENT

To ensure that vehicles used to transport samples to the analytical chemistry and geotechnical laboratories do not become contaminated during transport, all sample jars will be decontaminated with a solution of water and alconox prior to placement in plastic coolers, which shall be sealed after receiving samples. Chain-of-custody procedures will be followed for all samples identified for analytical laboratory work. If the samples are shipped by commercial carrier, Department of Transportation requirements must be observed.

EMERGENCIES

In the event of a major accident or life-threatening situation, the Site Safety Officer or designated alternate shall direct another member of the field crew (if available) to contact appropriate local emergency response authorities. Personnel not required to assist must move to a safe area. The Site Safety Officer must notify the office Health and Safety Officer, Mr. Robert Ehlenberger, and EOG Health and Safety Officer, Mr. Martin Kemplin, or Mr. Phillip Jones of any such occurrence.

Illnesses and minor injuries occurring on-site or in the laboratory must be reported to the Project Manager and attended to immediately. An Incident/Accident Report must be completed if injuries or incidents result from the presence of contaminated materials at the site.

PROJECT SAFETY PERSONNEL

Personnel responsible for implementing this Health and Safety Plan are the Project Manager and Site Safety Officer. A Site Safety Officer will be named later pending approval by the Corporate Health and Safety Officer and the Business Unit Health and Safety Officer. Their specific responsibilities and authority are described in the WCC Hazardous Waste Health and Safety Manual.

Emergency phone numbers to be called in the event of an emergency are the following:

(716) 422-5825	Eliott Duffney Environmental Engineer Xerox Corporation Webster, New York Facility
(914) 358-6200	Nyack General Hospital North Midland Avenue
(914) 359-0240	Village of Piermont Police Department Emergency Number
(914) 359-3500	Ambulance Service

Xerox Blauvelt personnel may be reached on any plant phone by dialing just the last four digits. A road map to the Nyack Hospital is provided as Figure 3.

SAFETY PLAN APPROVALS

Robert G. Ehlenberger
Project Manager

8/3/89
Date

Phil Jones
Corporate Health and Safety Officer

8/3/89
Date

These signatures are for the Xerox, Blauvelt Facility, Blauvelt, New York (88C2221-2) Health and Safety Plan.

Tables

TABLE 1

HAZARDOUS COMPOUNDS
XEROX CORPORATION
BLAUVELT, NEW YORK SITE

Chemical Name	TLV (ppm)	IDLH (ppm)	Highest Concentration In Soil/Water (ppm)	Acute Symptoms
Benzene	10	2,000	.04	Irritated Eyes, Nose Respiratory System, Giddiness, Nausea, Staggered Gait
Bromoform	.50	---	2.20	Irritated Eyes, Respiratory System, CNS Depression
1,4 - Dichlorobenzene	75	1,000	.30	Headache, Eye Irritation, Nausea
1,1 - Dichloroethane	100	4,000	1.80	CNS Depression, Skin Irritation, Drowsiness
Trans 1,2 Dichloroethane	10	1,000	22.00	Eye Irritation, Nausea, Vomiting, Dermatitis, CNS Depression
Ethylbenzene	100	2,000	.09	Headache, Irritated Eyes and Mucous Membranes, Dermatitis
Methylene Chloride	100	5,000	2.30	Dizziness, Nausea, Vomiting, Visual Distortion, Staggered Gait, Slurred Speech
N-Decane	---	---	.21	No specific toxicity effect (a simple asphyxiant). Produces rapid respirations and air hunger, diminished mental alertness & impaired muscular coordination

TABLE 1
(continued)

HAZARDOUS COMPOUNDS
XEROX CORPORATION
BLAUVELT, NEW YORK SITE

Chemical Name	TLV (ppm)	IDLH (ppm)	Highest Concentration In Soil/Water (ppm)	Acute Symptoms
N-Heptane	400	4,250	2.00	Light Headed, Giddiness, Nausea, Dermatitis
N-Nonane	200	---	.03	Respiratory Irritation, Narcotic in High Concentrations
N-Octane	300	3,750	.10	Eye and Nose Irritation, Drowsiness, Drowsiness,
1,1,1 - Trichloroethane	350	1,000	120.00	Headache, Eye Irritation, CNS Depression
Trichloroethene	50	1,000	100.00	Headache, Dizziness, Visual Distortion, Eye Irritation, Nausea, Vomiting
Tetrachloroethene	50	500	47.00	Eye, Nose, and Throat Irritation, Headache, Nausea, Dizziness
Toluene	100	2,000	1.60	Headache, Dizziness, Dilated Pupils, Fainting, Weakness, Dermatitis
Total Xylenes	100	10,000	.25	Eye, Nose, and Throat Irritation, Dizziness, Drowsiness, Staggered Gait

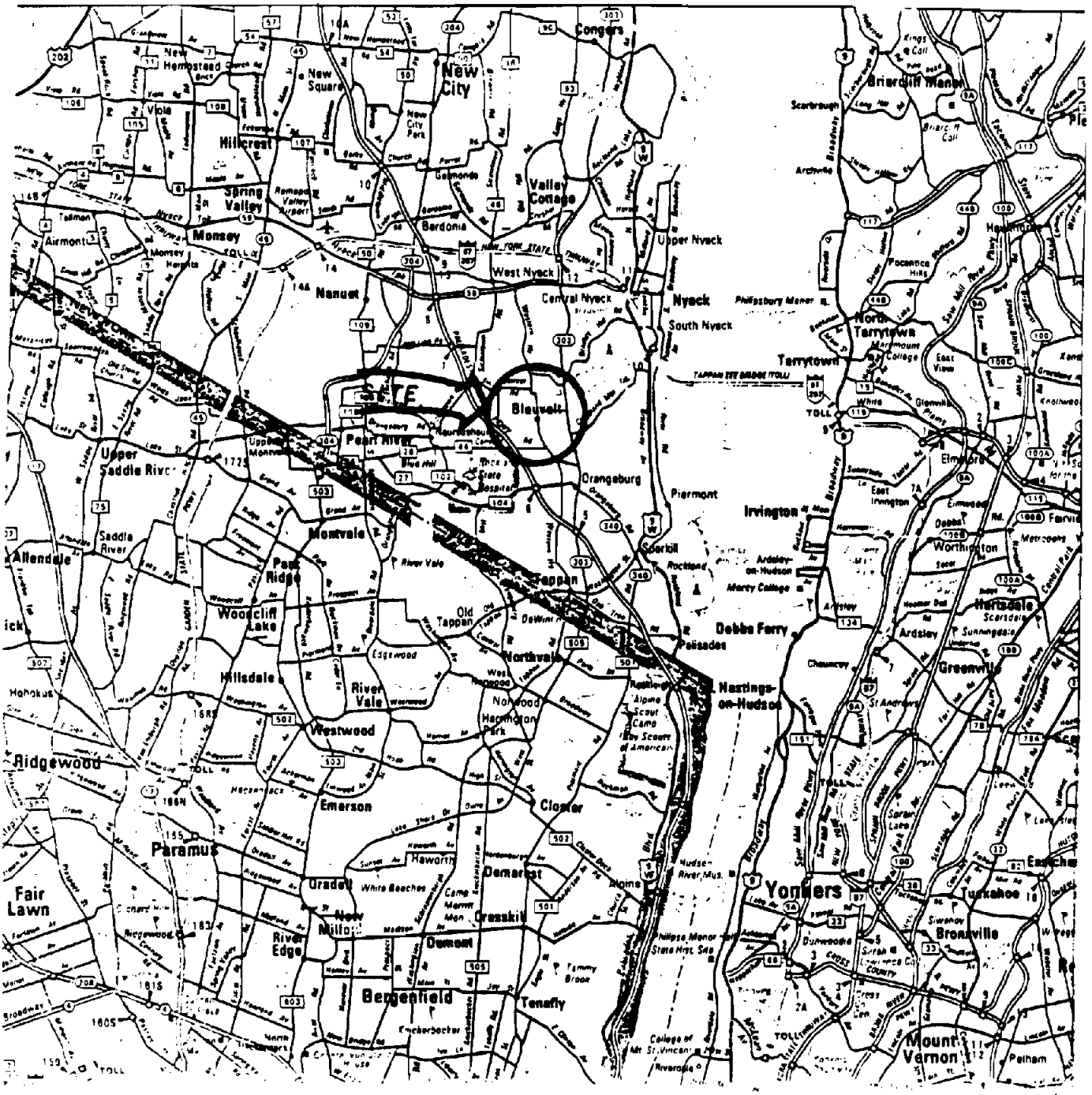
/WM-16R

TABLE 2

NAPL CONCENTRATIONS (VOLATILE ORGANICS)
XEROX CORPORATION
BLAUVELT, NEW YORK SITE

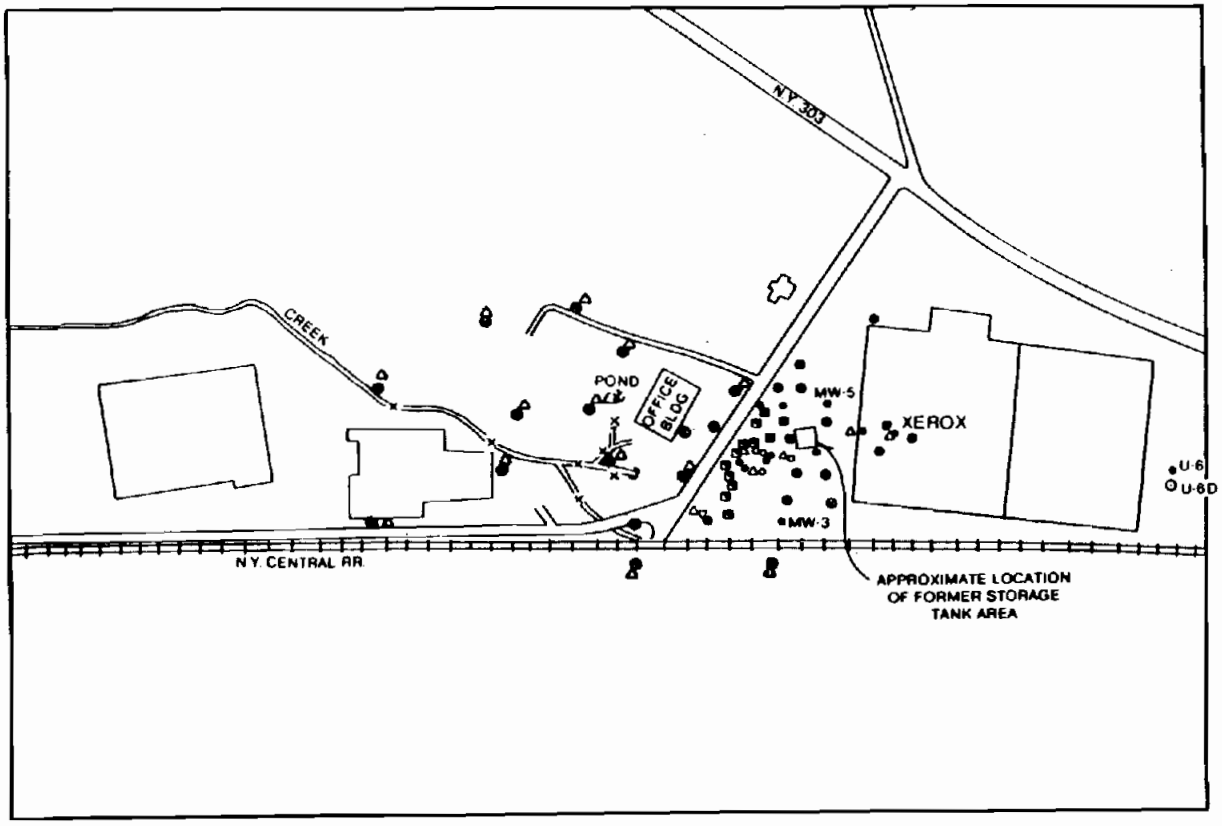
Chemical Name	Highest Concentration in Water (ppm)
1,1,1-Trichloroethane	57,900
Trichloroethene	66,700
Tetrachloroethene	565,000
1,2-Dichloroethene(Cis&Trans)	26,000

Figures



REGIONAL
SITE MAP

FIGURE 1



LEGEND

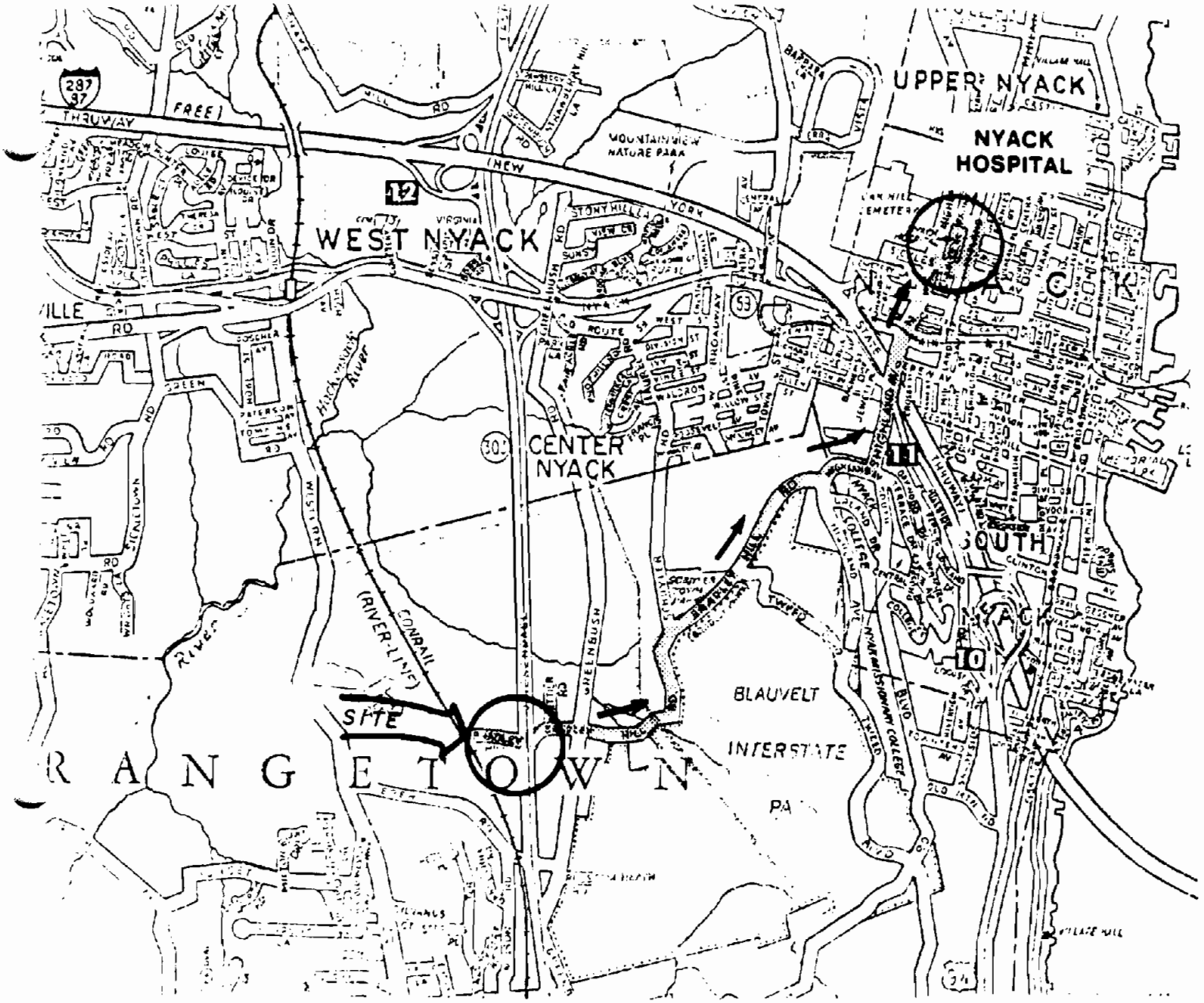
- PROPOSED MONITORING WELL OVERBURDEN
- PROPOSED MONITORING WELL, SHALLOW BEDROCK
- PROPOSED MONITORING WELL DEEP BEDROCK
- PROPOSED SURFACE WATER SAMPLING LOCATIONS
- MONITORING WELLS, OVERBURDEN
- RECOVERY WELLS
- MONITORING WELLS, BEDROCK
- MONITORING WELLS, NAPL PRESENT
- DEFINITE WELL LOCATION
- TENTATIVE WELL LOCATION

PROPOSED OFF-SITE MONITORING WELL
LOCATION PLAN
XEROX CORPORATION
BLAUVELT, NEW YORK

WOODWARD-CLYDE CONSULTANTS
CONSULTING ENGINEERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

Drawn by J.C.	SCALE IN FEET 0 300	Date 2/5/87
Checked by P.R.J.		Job 85C2667

FIGURE 2



HOSPITAL
ROUTE
MAP

FIGURE 3

Attachments

HEALTH AND SAFETY PLAN
COMPLIANCE AGREEMENT FORM

PROJECT: Xerox Corporation, Interim Remediation Plan

CLIENT: Xerox Corporation

LOCATION: Xerox Plant, Blauvelt, New York

PROJECT NO: 88C2221-2

I, _____, have received a copy of the Health and Safety Plan for the above-referenced project. I have read the plan, understand it, and agree to comply with all its provisions. I understand that I can be prohibited from working on the project for violating any of the safety requirements specified in the plan.

Signed:

_____ _____

Signature Date

_____

Company

/WM-16R

FORM HS-502
HAZARDOUS WASTE INCIDENT REPORT

DATE _____ PROJECT/ LOCATION _____ BUSINESS UNIT _____

DESCRIPTION OF INCIDENT, INCLUDING INJURIES, PROPERTY DAMAGE AND EMERGENCY ACTION TAKEN AND PERSONNEL INVOLVED (use additional sheets if needed):

_____

_____

_____

_____

_____

WITNESS OF INCIDENT:

_____

_____

_____

POSSIBLE OR KNOWN CAUSES:

_____

_____

_____

WHAT ACTIONS ARE NEEDED TO PREVENT A SIMILAR INCIDENT?

_____

_____

_____

_____ _____

REPORTER BUSINESS UNIT SAFETY OFFICER

_____ _____

PROJECT MANAGER CORPORATE HEALTH & SAFETY OFFICER

Appendix D

APPENDIX D

Appendix D presents the Methodologies and QA/QC Plan of General Testing Corporation.

Note: Only General Testing Corporation's Rochester facility will be used for analytical work on this project; their Hackensack facility will be used only for logistical coordination between WCC's field operations and the Rochester laboratory. GTC will only be used for analysis of parameter groups for which they have been certified by the NYDEC as technically acceptable. In addition, any subcontract work required for this project will be performed by laboratories certified as technically acceptable by the NYDEC.

CHAPTER 1

MANAGEMENT ORGANIZATION AND FACILITIES

1.1 Introduction

General Testing Corporation (GTC) has extensive laboratory facilities at both Hackensack, New Jersey (4,400 square feet) and Rochester, New York, (10,000 square feet). General Testing shares ownership in these facilities with HydroQual, Inc., and functions both independently and as HydroQual's laboratory services group.

The General Testing Laboratories are capable of analyzing for virtually every pertinent water quality parameter using Standard Methods and USEPA procedures. A full complement of advanced analytical instrumentation is employed in these determinations. These include, but are not limited to:

- ten gas chromatographs, including flame ionization, electron capture, nitrogen/phosphorus, thermal conductivity, photoionization, and Hall cell detectors

- two autoinjection GC samplers, one Varian, and one Hewlett Packard

- two GC data management systems, including one Varian Vista 402 and one HP 3362. These systems control and integrate data from eight separate detectors

- one total carbon analyzer, OI Model 700 a fully automated high temperature persulfate digestion/purge and trap system

- two dual channel IL-751 atomic absorption spectrophotometers;

- one HP 5970B Mass Selective Detector coupled to HP 5980 GC

- one Varian 975 atomic absorption spectrophotometer. This system is fully automated in either the flame or furnace mode, for the sequential analysis of up to 12 metals on 60 samples

- one Varian Spectra 30 automated atomic absorption spectrophotometer

- eight autoanalyzer channels including auto distillation for phenols and fluorides. Autoanalyzers are microprocessor controlled;

- one Lachat four channel Quickchem Automated Ion Analyzer system capable of running four chemistries at 100 samples per hour.

- two Infrared scanning spectrophotometers, one, a Bechman MX 600 with microprocessor control, and the other a double beam Perkin Elmer.

The firm has a full complement of in-house sampling equipment to respond to any situation, ranging from sewer monitoring to large scale surface and groundwater sampling programs. These include more than 20 automatic samplers (discrete and compositing modes), 8 automatic flow meter systems, 2 velocity meters, 10 Van Dorn and Kemmerer samplers, dredges, pvc and stainless steel bailers, trash and submersible purging pumps, and pressurized well cap systems. The firm has six vehicles for field services; an 18 foot inboard boat and two 10 foot outboard boats; 10 conductivity, 3 salinity, 10 pH, and 10 dissolved oxygen meters available for field survey work.

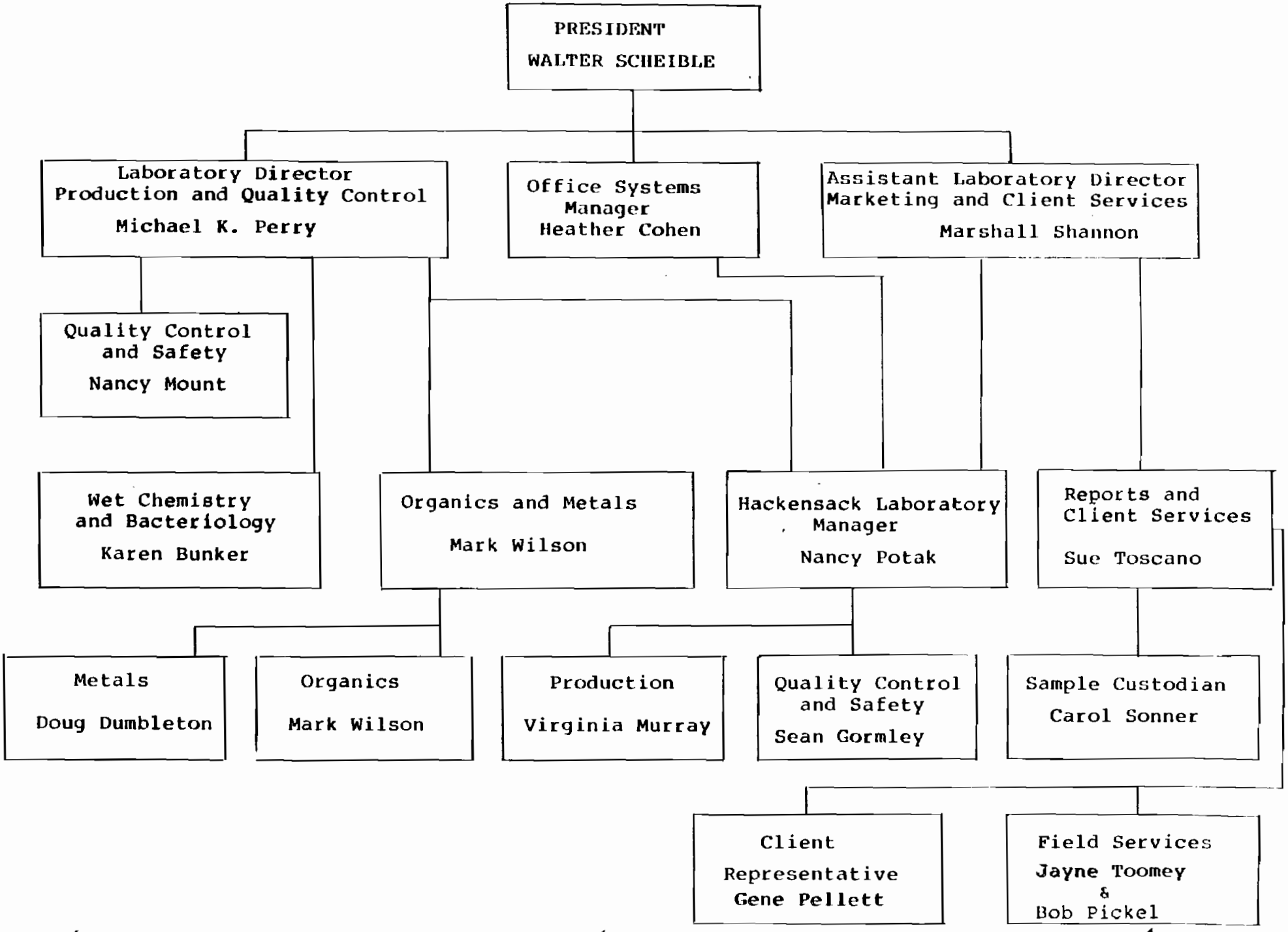
General Testing has elected to build an extensive GC laboratory dedicated to analysis of known compounds, including all of the priority pollutants, and limited GC/MS instrumentation for confirmation and limited analysis. The procedures are accepted, accurate and precise, with sufficient equipment to allow for high volume work. There are sufficient columns and detectors to confirm specific compound identification through the published alternate column techniques. All of these procedures are extremely cost-effective for routine monitoring needs. Where many gas chromatography/mass spectrum (GC/MS) analyses are required, such as large projects where initial full spectrum screening programs or for more complete isomer identification are needed, General Testing relies on several reputable GC/MS service groups. Strict Chain of Custody records are kept for all subcontractor work.

Services in the area of hazardous waste sampling, testing, site investigations, groundwater, and landfill monitoring have emerged in the past five years as a major segment of our business, comprising nearly half our sales volume. Equipment for proper protocols for sampling and analytical services are available and in sufficient quantity to perform large numbers of analyses promptly. When necessary, mobile laboratories can be brought on-site quickly. Two trailers, one 40 foot long and one 28 foot long, are available. Both are fully outfitted with lab benches, safety showers, hoods, sinks, and other common laboratory needs. GTC's laboratories also have all of the requisite equipment to collect, analyze, preserve and ship samples in accordance with current USEPA protocols. GTC has extensive experience in strict Chain of Custody procedures in support of litigation.

General Testing is certified by the New York State Department of Health and the New Jersey Department of Environmental Protection. The laboratory maintains a quality assurance/quality control (QA/QC) program which accounts and documents all handling procedures from the time of sample receipt to final report. General Testing has undergone extensive and successful state and USEPA monitoring for QA/QC procedures and results, through several major projects in recent years. These included the Belleville, New Jersey emergency response, the Blue Spruce Site Investigations, the Passaic River water quality survey, the Grand Calumet/Indiana Harbo Ship Canal water quality survey, the New York City Landfill closure survey, the Necco Park site investigation in Niagara Falls, and the Paerdegat Basin Study in New York City. General Testing is also approved as a New York State Superfund support laboratory and participates in numerous industry sponsored proficiency programs such as those of Xerox, DuPont, 3M, Waste Management, Ford, and General Motors.

1.2 Organization

As an independent laboratory, the management system of General Testing flows from the Laboratory Director, Mike Perry, and his Assistant Laboratory Director, Marshall Shannon, to the area managers and supervisors. The responsibilities are clearly defined to ensure efficient sample analysis and data review. The quality control system depends on bench data review by the managers and report reviews by the directors. A separate quality control department, under the direction of Nancy Mount, compiles all quality control data, updates charts and provides each area supervisor with his or her daily acceptance limits.


PRESIDENT
WALTER SCHEIBLE
Laboratory Director
Production and Quality Control
Michael K. Perry
Office Systems
Manager
Heather Cohen
Assistant Laboratory Director
Marketing and Client Services
Marshall Shannon
Quality Control
and Safety
Nancy Mount
Wet Chemistry
and Bacteriology
Karen Bunker
Organics and Metals
Mark Wilson
Hackensack Laboratory
Manager
Nancy Potak
Reports and
Client Services
Sue Toscano
Metals
Doug Dumbleton
Organics
Mark Wilson
Production
Virginia Murray
Quality Control
and Safety
Sean Gormley
Sample Custodian
Carol Sonner
Client
Representative
Gene Pellett
Field Services
Jayne Toomey
&
Bob Pickel

All personnel are trained in their direct responsibilities for accurate quality control procedures. Figure 1.1 details the management responsibilities for the company.

1.3 Facilities

The firm is divided into two basic functions, Engineering Services, and the Central Analytical Group.

The Rochester facility comprises the main analytical services group. All major analytical systems are located here, with centralized areas for specific groups of parameters. These include:

1.) A 20' x 30' room for receiving and storing samples, including glovebox areas for screening hazardous waste samples.

2.) Two walk-in refrigerators for routine sample storage.

3.) Two locked refrigerator/freezers for hazardous and litigation type samples.

4.) A 15' x 30' sample preparation area for organic analyses. A negative pressure is maintained in this room to prevent possible air contamination into other laboratory areas.

5.) A 20' x 15' metals preparation room. Contains preparation hood systems for all metals anlayses.

6.) A 60' x 20' room for metals and organics instrumentation. At present, the instruments in the room include:

Organics-Volatiles - Five systems are available.

a.) 3 automated purge and trap analysis system for waters, each including:

- Tekmar LSC-2 coupled to a Tekmar 10 place Autopurge system
- Tracor 540 GC, equipped with a packed column to a split detector system, PID and Hall cell
- Varian Vista 402 DMS with real time plotting on 2 channels
- HP 3362 DMS - 2 channels

b.) 2 automated purge and trap analysis system for soils, each including:

- Tekmar 4000 trap unit/controller coupled to a 10 place Tekmar 4200 automated purge system, heated to 105°C on each unit.
- Tracor 560 GC equipped with a packed column with a split detector system, PID and Hall cell
- HP 3362A DMS with real time plotting on two channels.

Organics, Pesticides and PCBs - Two systems are available.

a.) 1 Varian 3700 GC, equipped with:

- Ni^{63} EC detector
- Capillary and packed columns
- HP 3380 recorder/integrator
- Varian 99 place autosampler
- HP 3362 DMS

b.) 1 HP 5730 GC, equipped with:

- Ni^{63} EC detector
- Capillary and packed columns
- HP 3392 recorder/integrator
- HP 7672-99 place autosampler
- HP 3362 DMS

Organics - back up and miscellaneous systems.

- Varian 3700 GC with Thermionic Detector
- HP 5730 GC with FID detectors
- HP 5710 GC with FID detectors
- Varian 1400 GC with Chromolytics PT unit
- 2-HP 3380 recorder/integrators
- Altex HPLC System
- Tekmar LSC-2 P & T Unit
- Tekmar LSC-1 P & T Unit

- 2 MCI - TOX Analyzers
- O.I. 700 TOC Analyzer

Metals - Four analysis systems are available.

a.) Varian 975 AAS equipped with:

- 12 lamp turret
- PSC 55 autosampler
- GTA 95 graphite tube system
- HP 86B microcomputer

b.) IL-751 AAS, equipped with:

- Autosampler
- Varian VGA-76 hydride sampler

c.) IL-751 AAS, dedicated to mercury analysis

- Autosampler
- Mercury cold vapor assembly

d.) Varian Spect AA 30, equipped with:

- Auto sampler
- PSC56 Auto Sampler
- DS15 Micro processor

7.) A 20' x 20' room for an autoanalysis system including a Lab-Mate V computerized control and data management system. Autoanalyzer systems include:

- 1 Technicon AA1 dedicated to cyanide analysis
- 1 Technicon dual channel AA2 system dedicated to nutrients
- 1 AlpKem multi analysis system equipped with 5 analysis loops and microdistillation unit
- 1 Labmate V microcomputer for control and analysis of autoanalyzers.

Note: This area is presently being expanded by about 100% to accomodate a 4 channel automated Quickchem system by Lachat.

8.) A 30' x 20' wet chemical laboratory for all distillations, reflux, titration, etc. A 5' x 5' x 8' walk-in bocubator is also in this room.

9.) A 15' x 80' office area functioning as the Central Office system for GTC.

10.) Two TCLP Extractors for toxicity testing.

The Hackensack Laboratory routinely services its own clients for sampling and analyses for routine monitoring. Their other function is to provide a centralized engineering services group, under the direction of Hydroqual, they can provide complete and professional management for major treatability and pilot studies. The laboratory facility has been designed around this type program and includes;

1.) Sampling systems for pilot studies and water quality surveys.

2.) Large fume hoods areas.

3.) A complete microbiology laboratory with a 12 FT3 Autoclave and 15 incubators, and sufficient bench space for large quantities of samples.

4.) Specialized equipment for bench scale treatability studies.

5.) A 6' x 12' walk-in bocubator capable of holding 4000 BOD bottles.

6.) A 8' x 6' walk-in refrigerator for sample storage.

7.) TOC, UV/VIS and infrared analysis systems.

8.) 400 linear feet of bench space.

9.) Personnel trained in treatability and pilot studies.

10) A 40' x 10' mobile laboratory facility with all utilities. The laboratory can be equipped and staffed for particular project requirements.

11) Analytical systems for those parameters with 24 hours or less holding time and for quick analytical support for special projects.

A Central HP Data Management System is being installed. The system will communicate with both laboratories, give access to all managers and directors to continuously track all work in the company, and generate all final reports from data received automatically from the various laboratory sections.

IV. GENERAL QUALITY ASSURANCE PRACTICES

A. Introduction:

The function of quality control is to ensure that data measurements are precise and accurate. The quality assurance program at General Testing has been developed to provide personnel, facilities, and equipment that will meet this goal.

The analyst performing routine analysis is aware that the company's reputation is dependent upon the quality of the data generated. With this in mind, each analyst is provided with reliable quality control tools.

The most important of these tools are tables and charts used to monitor past and present levels of analytical quality. From these tables, quality control objectives are determined which allow the analyst to evaluate his work and accept or reject the data obtained.

Charts and tables are maintained for each analytical procedure for both precision and accuracy.

B. Precision

Precision is defined as the scattering about a single point and is generated from replicate values obtained from the analysis of a single sample. Precision is calculated as percent relative error, and is defined as the difference between the values, divided by their average, multiplied by 100.

Tables for percent relative error are maintained at defined intervals not exceeding more than a ten fold change in values. As an example, Nitrate is analyzed in the range of .05 to 2.0 ppm, and precision is monitored for the intervals .05 to .50 ppm, and .50 to 2.0 ppm. Quality control limits for precision are calculated by adding the percent relative error values from the previous six months, and obtaining an average percent relative error and its associated standard deviation for that interval. The limit is set by adding two standard deviations to the average relative error. Our current control limits are in Appendix A.

C. Accuracy

Accuracy is defined as the deviation of data from a known point. Both spiked recovery, and USEPA check sample recovery are monitored in terms of percent recovery of the known value. Spikes are added to deionized water as a check on the analyst, instruments, and method used. Spikes to samples check on all these also, with the added feature of providing information on the effects of the sample matrix (constituents which may cause positive or negative bias to the value).

The USEPA check samples provide an independent (not controlled by laboratory) audit of all components of the analysis. Tables are maintained for blank spikes, sample spikes, and each USEPA check sample independently and used to calculate control limits for each from the past six months data. Control limits are set by adding the percent recovery for each category, and calculating the average percent recovery along with its associated standard deviation. The upper and lower control limits are set by multiplying the standard deviation by two, and adding or subtracting this value from the average percent recovery, respectively. See Appendix A for our current control limits.

D. Use of Quality Control Charts and Limits

Quality Control charts are used to detect trends in the quality of data generated. When a trend is noticed, either higher or lower than the average, the analyst can decide to investigate the cause by isolating the problem to the method used (the instruments used, or the analyst himself). The control limits are used to evaluate the quality of the data generated in that run. In general, any analysis which fails to meet the control limits in precision, spiked recovery, or USEPA check samples will not be accepted. Each run is evaluated first by the analyst himself, and then by that analyst's manager, and/or the quality assurance officer, who also keeps up to date records of all QC data. Decisions to accept or reject a run are made by the manager or QA officer.

E. Quality Control Packages

General Testing will at any time include quality control data for each parameter analyzed on a given job. A quality control run is generated by randomly picking 10% of the samples analyzed for duplicate and spike analysis. In addition, we tailor a specific quality control package for larger projects such as DuPont's samples from Necco Park and the Plant Site. This includes field blanks, field duplicates, laboratory duplicates, and laboratory spikes on each set of samples from a site.

F. GLOSSARY OF TERMINOLOGY

1.) Method Detection Limits are based on Instrument Detection Limit studies as stated in EPA protocol in the Federal Register - 40 DFR Part 136 - 10/84. Basically, a known standard at approximately 5X the sensitivity is anlayzed 7 - 10 times on 3 non-consecutive days. The standard deviation is calculated and the MDL is equal to 3X the average standard deviation for the analysis.

2.) Sensitivity is normally defined as that concentration required for a 1% absorption or at least three times the noise level. Where two working ranges are listed, the sensitivity applies only to the lower range.

3.) Working ranges are analysis range of the standard sets. Samples exceeding these ranges must be diluted to the standard range. Analytical systems are often split into two working ranges, e.g., auto analyzers. Analyses are first screened at the upper range and repeated at the lower range if better sensitivities are required.

4.) Accuracy is defined using three recovery methods.

A.) Matrix Recovery - Standard amounts of analyte is added to a replicate sample. Spike recovery is calculated as:

$$\% \text{ Recovery} = \frac{(\text{Sample} + \text{Spike mg/l}) - (\text{Sample mg/l})}{\text{Spike mg/l}} \times 100$$

B.) Method Recovery - Same as matrix, except the analyte is added to distilled water digestion.

C.) EPA Recovery - Standard reference solutions are made in distilled water from standards provided by EPA's EMSL laboratory, Cincinatti, Ohio. Recoveries are compared to the reported true values.

5.) Precision - Precision values are determined from replicate analysis or real samples. Precision values are listed as the % Relative Error (RE).

Precision control limits used for control purposes are defined as 2 RE. Precision values must fall within 2 RE for acceptable data. All RE values used for control are based on historical data.

$$\% \text{ RE} = \frac{|A-B|}{A+B/2} \times 100 \text{ or } \% \text{ RE} = \frac{\text{difference}}{\text{average}} \times 100$$

The listed RE are simple objectives which must be met as a minimum and can be used for control chart purposes.

III. ANALYTICAL PROCEDURES: ORGANICS

A. Instrumentation

The sensitivity of the instrumentation used in trace organic chemical analysis and the low concentration of organic compounds being investigated dictate that special attention must be given to analytical protocols. Contamination of the sample from any possible source must be diligently guarded against and interferences in the sample must be carefully controlled. The following is our current list of gas chromatographic systems in use.

1.) Tracor 540 GC with a Hall 700A electrolytic conductivity detector and a Tracor 703 photoionization detector and a Tekmar LSC II with a 10 port ALS purge/trap.

2.) Varian 3400 with a Hall 700A electrolytic conductivity detector, a Tracor 703 PID, and a Tekmar LSC II purge/trap system with a 10 port ALS.

3.) Tracor 540 with Hall 700A electrolytic conductivity detector, a HNU photoionization detector and a Tekmar LSC II purge/trap system with a 10 port ALS.

THE ABOVE THREE SYSTEMS ARE OPERATED USING AN HP SERIES 200 MICROCOMPUTER WITH NELSON ANALYTIC SERIES 701 SOFTWARE FOR PROCESSING CHROMATOGRAPHIC RUNS.

4.) Tracor 560 GC with 700 A HECD and 703 PID and a Tekmar LSC II and a 10 place Dynamic Headspace Analyzer. Also, a second

700A HECD and a FID detector are available with this instrument.

5.) Tracor 560 with 700A HECD and HNU PID and a 10 place Tekmar 4000 Dymanic Headspace analyzer.

THESE TWO TRACOR SYSTEMS ARE OPERATED WITH A VARIAN VISTA 402 CHROMATOGRAPHIC SYSTEM.

6.) HP 5730 with two Flame Ionization detectors and one electron capture detector. An HP 3392 integrator is used with this system and a model 7672 auto sampler.

7.) HP 5710 with two Flame Ionization detectors and a HP 3390 integrator.

8.) Varian 1400 with 1-FID, a Tekmar LSC I purge/trap and HP 3380 integrator.

9.) Altex HPLC system dedicated to the analysis of aromatic compounds.

10.) Varian 3700 with an electron capture detector and a model 8000 autosampler. Also equipped with a thermionic specific detector for Nitrogen/Phosphorous analysis.

11.) HP GC/MS system with a 5880 GC and 5970 MSD, equipped with an HP series 300 computer with NBS library search capabilities (just developing methodologies at this time; will be submitted at a later date).

B. Supplies and Reagents

Reference compounds of materials must be assayed and of 98 percent purity or higher (if less than 98 percent, an appropriate correction factor must be used). The reference is cataloged, dated and stored in a refrigerator, if necessary. Stock solutions of these reference materials are prepared in a high-boiling, inert solvent, when possible, to minimize errors due to evaporation or solvent induced decomposition. Stock standards of approximately 1000 ppm are prepared by accurately weighing the reference material to 0.1 mg on an analytical balance and diluting to an appropriate volume. An accurate record of solvent, date, and concentration is kept on the preparation of all stock standards. Smaller stock standards and working standards are prepared when the need arises. Working standards prepared in water (i.e. for volatiles) must be prepared immediately before use, then discarded. Stock standards for volatiles are kept in a freezer in methanol and replaced at the maximum every three months or sooner if necessary. All other stock standards are kept until signs of problems arise. Instrument response factors are compared against previous standards each time new standards are prepared.

Pesticide quality solvents or equivalent must be used in the preparation of standards and for extraction of samples. A preliminary lot check of each solvent using 10 percent more sample than required in the extraction and routine solvent blanks are run to ensure the purity of solvents. In addition, diethylether must be shown to be free of peroxides by using one of the available methods. As stated before, anhydrous sodium sulfate must be solvent rinsed and stored in glass at 130°C. Florisil must be purchased activated at 630°C and transferred to a glass container with a foil lined lid and stored in a 130°C oven, for a minimum of five hours before use. Clean-up methods using florisil require that a lauric acid value be determined for each lot of florisil used.

Carrier gases are a very important part of a chromatographic system and only high purity or equivalent grades are used. All gases are filtered through molecular sieve 5A traps to remove traces of water and oxygen which can adversely affect the performance of columns and detectors. These traps are changed every 2 to 3 cylinders of gas or earlier if symptoms of bad carrier gas arise. All gases are regulated using two stage regulators with an additional signal stage regulator in the gas line just before the gas enters the GC.

C. Procedures for Cleaning Glassware

C.1. Laboratory Glassware

a. Clean all glassware as soon as possible after use by rinsing with the last solvent used (example - Pesticide analysis rinse with methylene chloride).
b. Wash with detergent in hot water.
c. Rinse with tap water.
d. Rinse with distilled (or deionized water).
e. Rinse with acetone.
f. Rinse with pesticide grade hexane.
g. Dry at 180°C.
h. Store in clean environment inverted or sealed with a stopper or aluminum foil.

C.2. Sample Containers for Extractable Organics Analysis

a. For the USEPA Methods 604, 606, 608, 610, 612, PCB's, B/N.

1.) Use amber glass - 1 liter volume
2.) Wash container - rinse with tap and DI water - and rinse with suitable solvent (Hexane) and dry at 105°C (optional).
3.) Bake bottles at 180°C for one hour.
4.) Bottle caps must be lined with teflon or aluminum foil. Store bottles in clean separate storage area.

b. For USEPA Methods 601, 602, and 603.

1.) Use 40 ml glass vial with screw cap. Detergent wash and rinse with tap and deionized water. Dry at 180°C.
2.) Septums - teflon faced silicon, detergent wash and rinse with tap and distilled water, dry at 180°C.
3.) Cool and cap immediately. Store all vials in clean separate storage area.

D. Sample Acceptance - Organics

The laboratory must share responsibility for the preservation and shipment of all samples that it will accredit with concentration values, and therefore, has adopted a policy of sample rejection based on sample identification, age, condition and preservation. It is the responsibility of the laboratory to: (a) coordinate the sampling, preservation and shipment of samples, (b) supply clean sample containers, (c) provide adequate sample identification and compositing instructions, and (d) arrange for duplicates and blanks as requird by the laboratory. Additional pre-arrangements are to be made for sample splitting, phase anlaysis, or if calculations should be based on a wet weight or dry weight basis. General Testing Corporation policy for all sludge sediments and soils is to report all results on a dry weight basis, together with percent solids.

Bottles and caps are supplied by the laboratory because a rigorous cleaning is required. For water samples that are to be analyzed by solvent extraction, 1 liter or 32 ounce amber glass bottles with a narrow-mouth and a teflon or foil lined screw cap are preferred. For sediment samples, clear wide mouth, 1 liter or 32 ounce bottles are preferred. Bottles used for collecting water samples for solvent extraction should not be overfilled or pre-rinsed with sample before filling because oil and other material remaining in the bottle after rinsing can cause erroneously high results. Sampling for purgeable organics requires 40 ml screw cap vials with teflon lined silicon septums. All samples should be taken in duplicate because of leakage and once a vial is opened it should be filled quickly. All vials should have proper identification and are filled to overflowing and sealed with no air space or air bubbles in them, making sure the teflon side of the septum is facing the sample.

All samples for organic analysis must arrive as soon as possible after shipping and must be maintained at 4°C or less during shipping in an insulated ice chest. Upon arrival, they are checked for all the above criteria and if not met, should only be accepted if resampling is impossible. When both dry weight and wet weight results are required for sediments or sludges, a percent solids is initiated as soon as possible after receipt of the sample. Note: GTC's policy is to determine the percent of solids and report all results as dry weight.

Chain of Custody forms accompany all samples. This program starts when sample containers leave the laboratory. Each time a sample is collected, the form is initiated stating where and when the sample was collected and cross referenced to the actual sample identification on the container. When the samples are returned to the laboratory, the person receiving the samples signs and dates the form and immediately places the samples in a 4°C refrigerator. In this manner, full documentation of sample handling is maintained from sample collection through completion of analysis.

E. Quality Control

A formal quality control program for each type of analysis is established. The minimum requirements of this program consist of an initial demonstration of laboratory capability, the continuing analysis of spiked and duplicate samples and the analysis of the USEPA reference standards as a continuing check on performance. These ongoing performance checks are compared to established performance criteria to determine if the results of anlaysis are within accuracy and precision limits. In addition, method and/or reagent blanks and field blanks are analyzed to demonstrate the procedure and system to be interference free.

1.) Before performing any analyses, the ability to generate acceptable accurate and precise data is demonstrated by analyzing clean water spikes for liquid - liquid extractions and gas purge extractions for all compounds of interest. These data are used for baseline precision and accuracy criteria for a particular method. Method performance criteria is calculated from this data and upper and lower control limits for accuracy are set as follows:

Upper Control Limit (UCL) = R + 2S

Lower Control Limit (LCL) = R - 2S

Where R = the average percent recovery and S = the standard deviation of the percent recovery.

2.) A continuous accuracy check is done by spiking a minimum of 10 percent of all samples and checking to see if it falls within the range of $R \pm 2S$. Control charts are used for this purpose, which are periodically updated to include all data recorded. If the recoveries fall outside the limits established, the system is checked for problems, which must be resolved before continuing.

3.) A continuing precision check is done by analyzing 10 percent of all samples in duplicate and checking to see if the % Relative Error (RE) falls within the specified range of control charts. Precision control charts are established with the upper limit UCL = D_4RE where D_4 equals the Shewart factor which is 3.27 and % RE = the percent relative error = 1A-B1/(A+B) x 200. These charts are revised and updated as more data becomes available.

4.) Other quality assurance techniques are practiced including the analysis of the USEPA quality control samples as a check on accuracy. When doubt exists over the identification of a peak on a chromatogram, confirmatory techniques such as chromatographs with a dissimilar column are employed. In addition, the method detection limit is established based on a series of at least five replicate spiked samples and the MDL = t(n-1)S, where MDL = method detection limit, t n-1 = student "t" test at the 99% level, S = the standard deviation.

5.) Surrogate spiking standards are added to all samples before analysis by purge/trap techniques or liquid/liquid extractions. These compounds are similar to the organics to be analyzed for and are a check on the efficiency, accuracy and reproducibility of the results. Again, control charts are established based on historical data.

6.) In summary, we employ a 30% quality control program:

(a) 10% of the samples are spiked
(b) 10% of the samples are run in duplicate, and
(c) 10% of the time a method or field blank is analyzed.
(d) Analysis of EPA check samples are analyzed with each batch of samples.
(e) Surrogate spiking standards are added to all samples where applicable.

Acceptance Criteria for organics analysis is based on the use of control charts as stated above. The duplicates,EPA recovery, spiked sample recoveries, and surrogate spikes must fall within specified limits or the analysis is repeated, if possible. If it is impossible to repeat the analysis, the appropriate data is flagged to indicate this. See QC acceptance limits in Appendix A.

METHOD 5030

PURGE-AND-TRAP

1.0 SCOPE AND APPLICATION

1.1 This method describes sample preparation and extraction for the analysis of volatile organics by a purge-and-trap procedure. The gas chromatographic determinative steps are found in Methods 8010, 8015, 8020, and 8030. Although applicable to Method 8240, the purge-and-trap procedure is already incorporated into Method 8240.

1.2 Method 5030 can be used for most volatile organic compounds that have boiling points below 200°C (vapor pressure is approximately equal to mm Hg @ 25°C) and are insoluble or slightly soluble in water. Volatile water-soluble compounds can be included in this analytical technique; however, quantitation limits (by GC or GC/MS) are approximately ten times higher because of poor purging efficiency. The method is also limited to compounds that elute as sharp peaks from a GC column packed with graphitized carbon lightly coated with a carbowax. Such compounds include low-molecular-weight halogenated hydrocarbons, aromatics, ketones, nitriles, acetates, acrylates, ethers, and sulfides.

1.3 Water samples can be analyzed directly for volatile organic compounds by purge-and-trap extraction and gas chromatography. Higher concentrations of these analytes in water can be determined by direct injection of the sample into the chromatographic system.

1.4 This method also describes the preparation of water-miscible liquids, solids, wastes, and soil/sediments for analysis by the purge-and-trap procedure.

2.0 SUMMARY OF METHOD

2.1 The purge-and-trap process: An inert gas is bubbled through the solution at ambient temperature, and the volatile components are efficiently transferred from the aqueous phase to the vapor phase. The vapor is swept through a sorbent column where the volatile components are adsorbed. After purging is completed, the sorbent column is heated and backflushed with inert gas to desorb the components onto a gas chromatographic column.

2.2 If the above sample introduction techniques are not applicable, a portion of the sample is dispersed in methanol to dissolve the volatile organic constituents. A portion of the methanolic solution is combined with water in a specially designed purging chamber. It is then analyzed by purge-and-trap GC following the normal water method.

3.0 INTERFERENCES

3.1 Impurities in the purge gas and from organic compounds out-gassing from the plumbing ahead of the trap account for the majority of contamination problems. The analytical system must be demonstrated to be free from contamination under the conditions of the analysis by running laboratory reagent blanks. The use of non-TFE plastic coating, non-TFE thread sealants, or flow controllers with rubber components in the purging device should be avoided.

3.2 Samples can be contaminated by diffusion of volatile organics (particularly methylene chloride and fluorocarbons) through the septum seal of the sample vial during shipment and storage. A field reagent blank prepared from reagent water and carried through sampling and handling protocols serves as a check on such contamination.

3.3 Contamination by carryover can occur whenever high-level and low-level samples are analyzed sequentially. Whenever an unusually concentrated sample is analyzed, it should be followed by an analysis of reagent water to check for cross-contamination. The trap and other parts of the system are subject to contamination; therefore, frequent bake-out and purging of the entire system may be required.

3.4 The laboratory where volatile analysis is performed should be completely free of solvents.

4.0 APPARATUS AND MATERIALS

4.1 Microsyringes: 10-uL, 25-uL, 100-uL, 250-uL, 500-uL, and 1,000 uL: These syringes should be equipped with a 20-gauge (0.006-in I.D.) needle having a length sufficient to extend from the sample inlet to within 1 cm of the glass frit in the purging device. The needle length will depend upon the dimensions of the purging device employed.

4.2 Syringe valve: Two-way, with Luer ends (three each), if applicable to the purging device.

4.3 Syringe: 5-mL, gas-tight with shutoff valve.

4.4 Balance: Analytical, capable of accurately weighing 0.0001 g, and a top-loading balance capable of weighing 0.1 g.

4.5 Glass scintillation vials: 20-mL, with screw-caps and Teflon liners or glass culture tubes with a screw-cap and Teflon liner.

4.6 Volumetric flasks: 10-mL and 100-mL, class A with ground-glass stoppers.

4.7 Vials: 2-mL, for GC autosampler.

4.8 Spatula: Stainless steel.

4.9 Disposable pipets: Pasteur.

4.10 Purge-and-trap device: The purge-and-trap device consists of three separate pieces of equipment: the sample purger, the trap, and the desorber. Several complete devices are commercially available.

4.10.1 The recommended purging chamber is designed to accept 5-mL samples with a water column at least 3 cm deep. The gaseous headspace between the water column and the trap must have a total volume of less than 15 mL. The purge gas must pass through the water column as finely divided bubbles with a diameter of less than 3-mm at the origin. The purge gas must be introduced no more than 5 mm from the base of the water column. The sample purger, illustrated in Figure 1, meets these design criteria. Alternate sample purge devices may be used, provided equivalent performance is demonstrated.

4.10.2 The trap must be at least 25 cm long and have an inside diameter of at least 0.105 in. Starting from the inlet, the trap must contain the following amounts of adsorbents: 1/3 of 2,6-diphenylene oxide polymer, 1/3 of silica gel, and 1/3 of coconut charcoal. It is recommended that 1.0 cm of methyl silicone-coated packing be inserted at the inlet to extend the life of the trap (see Figures 2 and 3). If it is not necessary to analyze for dichlorodifluoromethane or other fluorocarbons of similar volatility, the charcoal can be eliminated and the polymer increased to fill 2/3 of the trap. If only compounds boiling above 35°C are to be analyzed, both the silica gel and charcoal can be eliminated and the polymer increased to fill the entire trap. Before initial use, the trap should be conditioned overnight at 180°C by backflushing with an inert gas flow of at least 20 mL/min. Vent the trap effluent to the hood, not to the analytical column. Prior to daily use, the trap should be conditioned for 10 min at 180°C with backflushing. The trap may be vented to the analytical column during daily conditioning; however, the column must be run through the temperature program prior to analysis of samples.

4.10.3 The desorber should be capable of rapidly heating the trap to 180°C for desorption. The polymer section of the trap should not be heated higher than 180°C, and the remaining sections should not exceed 220°C during bake-out mode. The desorber design illustrated in Figures 2 and 3 meet these criteria.

4.10.4 The purge-and-trap device may be assembled as a separate unit or may be coupled to a gas chromatograph, as shown in Figures 4 and 5.

4.10.5 **Trap Packing Materials**

4.10.5.1 2,6-Diphenylene oxide polymer: 60/80 mesh, chromatographic grade (Tenax GC or equivalent).

4.10.5.2 Methyl silicone packing: OV-1 (3%) on Chromosorb-W, 60/80 mesh or equivalent.

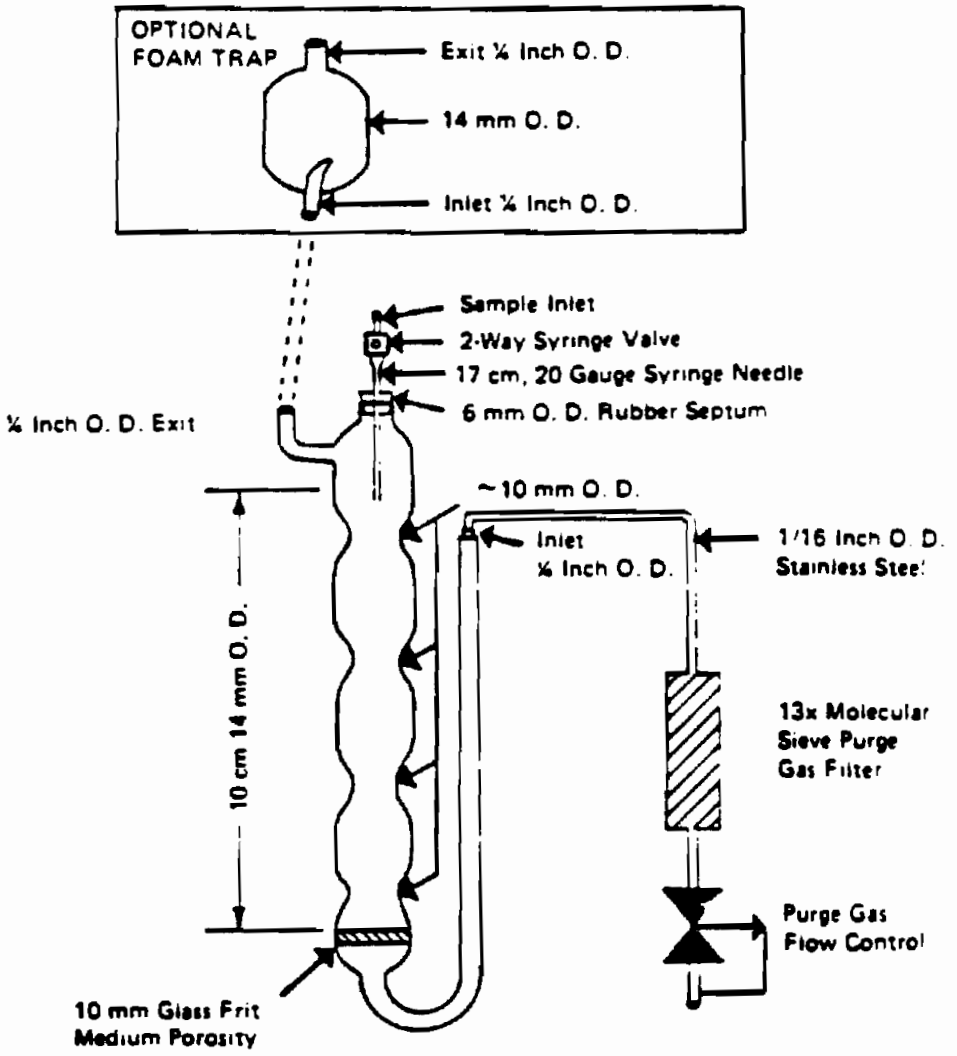


Figure 1. Purging chamber.

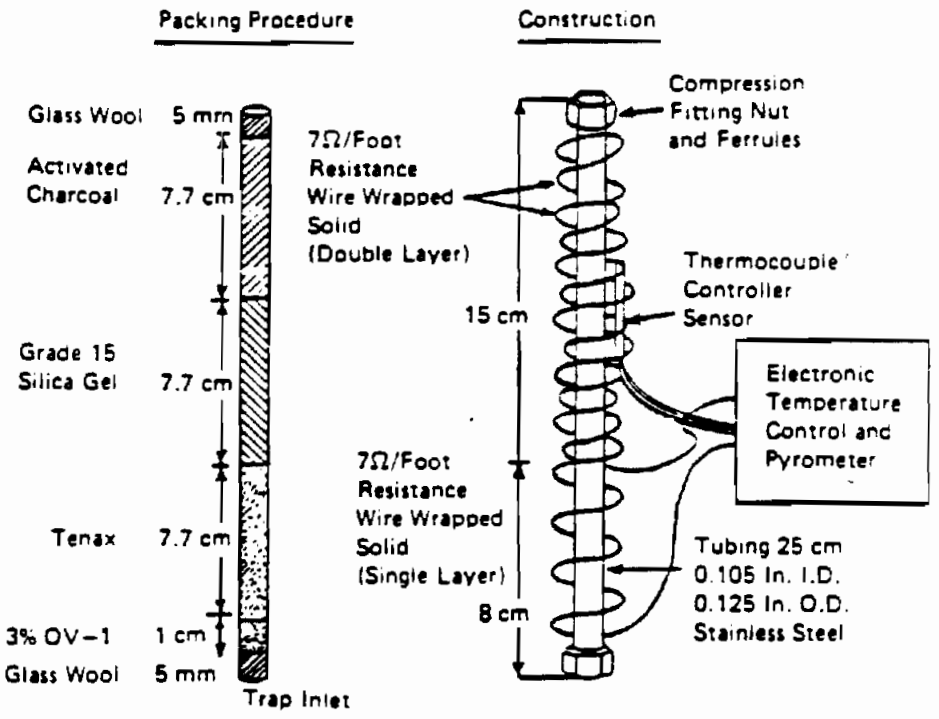


Figure 2. Trap packings and construction for Method 8010.

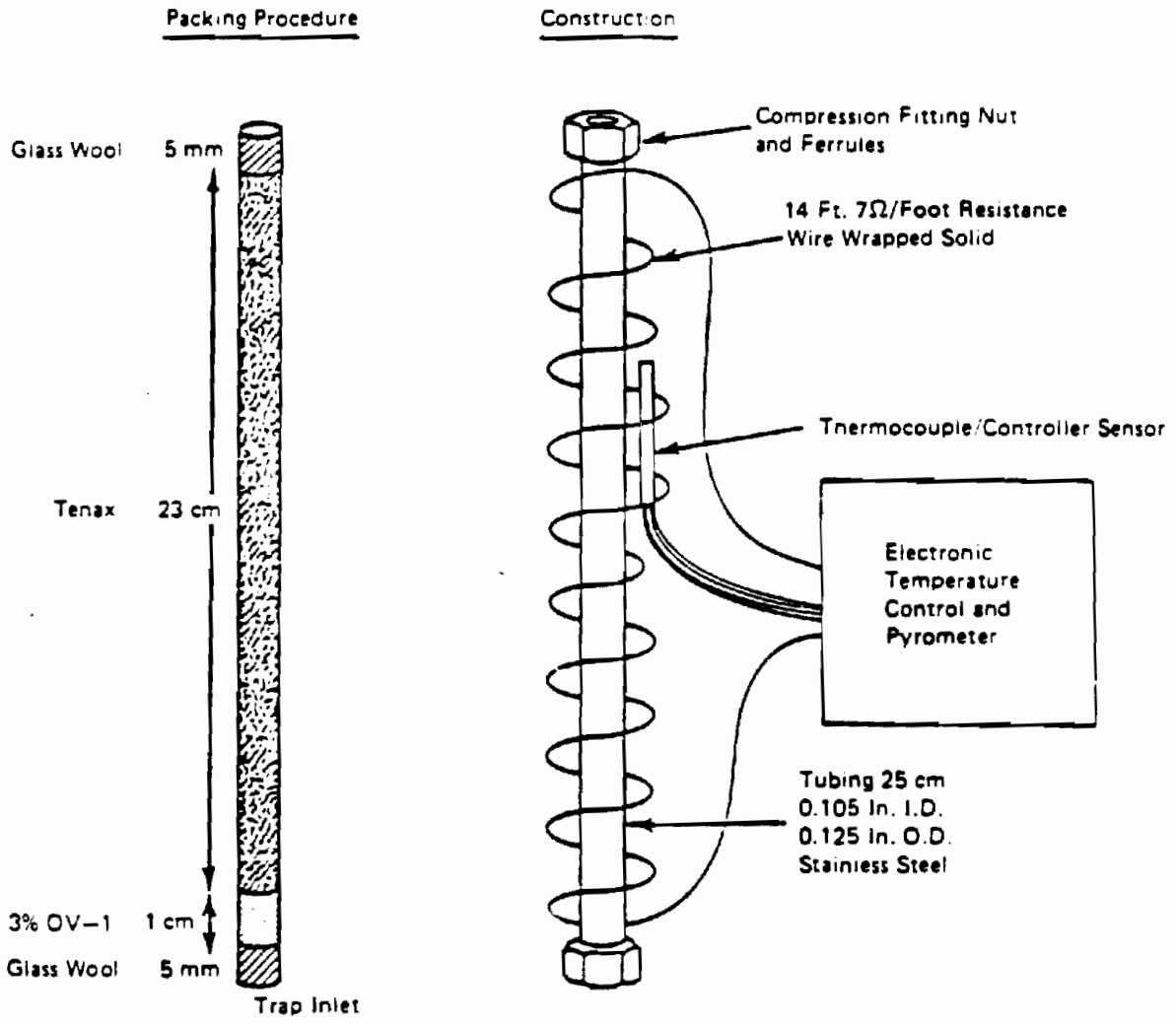


Figure 3. Trap packing and construction for Methods 8020 and 8030.

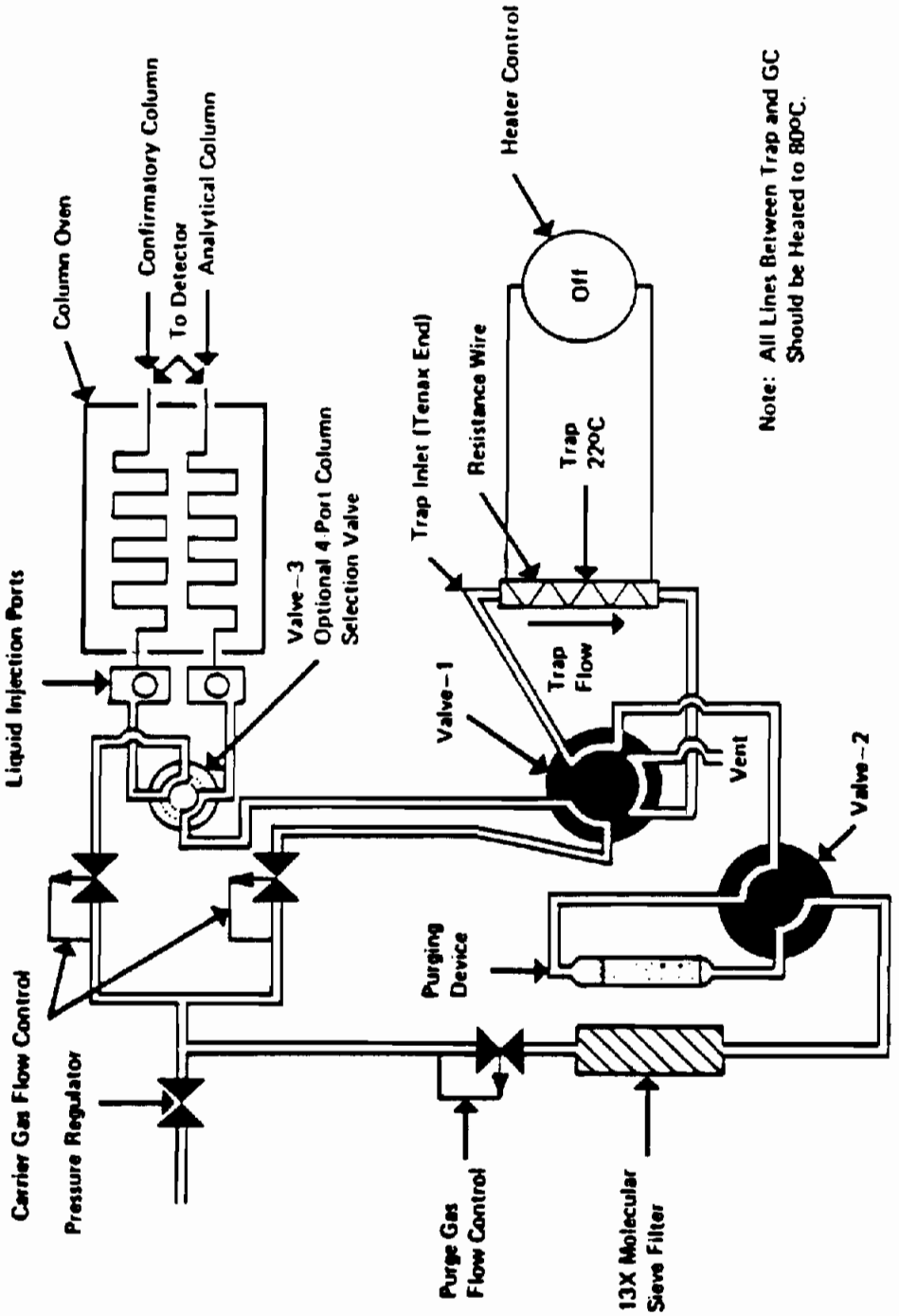


Figure 4. Purge-and-trap system, purge-sorb mode, for Methods 8010, 8020, and 8030.

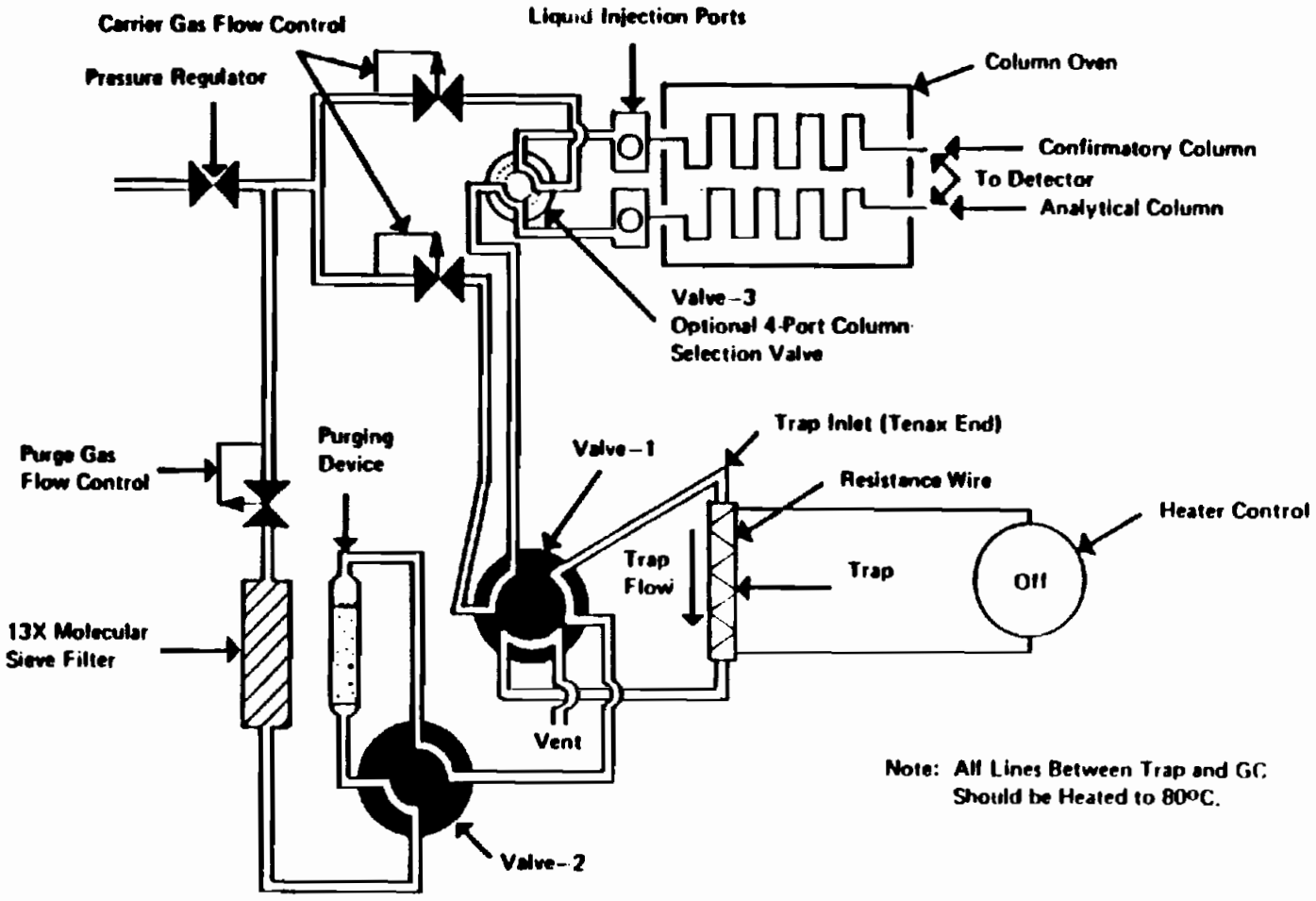


Figure 5. Purge-and-trap system, desorb mode, for Methods 8010, 8020, and 8030.

4.10.5.3 Silica gel: 35/60 mesh, Davison, grade 15 or equivalent.

4.10.5.4 Coconut charcoal: Prepare from Barnebey Cheney, CA-580-26 lot #M-2649, by crushing through 26 mesh screen.

4.11 Heater or heated oil bath: Should be capable of maintaining the purging chamber to within 1°C over a temperature range from ambient to 100°C.

5.0 REAGENTS

5.1 Reagent water: Reagent water is defined as water in which an interferent is not observed at the method detection limit of the compounds of interest.

5.1.1 Reagent water may be generated by passing trap water through a carbon filter bed containing about 500 g of activated carbon (Calgon Corp., Filtrasorb-300 or equivalent).

5.1.2 A water purification system (Millipore Super-Q or equivalent) may be used to generate reagent water.

5.1.3 Reagent water may also be prepared by boiling water for 15 min. Subsequently, while maintaining the water temperature at 90°C, bubble a contaminant-free inert gas through the water for 1 hr. While still hot, transfer the water to a narrow-mouth screw-cap bottle and seal with a Teflon-lined septum and cap.

5.2 Methanol: Pesticide quality or equivalent. Store away from other solvents.

6.0 SAMPLE COLLECTION, PRESERVATION, AND HANDLING

6.1 Refer to the introductory material to this chapter, Organic Analytes, Section 4.1.

7.0 PROCEDURE

7.1 Initial calibration: Prior to using this introduction technique for any GC method, the system must be calibrated. General calibration procedures are discussed in Method 8000, Section 7.4, while the specific determinative methods and Method 3500 give details on preparation of standards.

7.1.1 Assemble a purge-and-trap device that meets the specification in Section 4.10. Condition the trap overnight at 180°C in the purge mode with an inert gas flow of at least 20 mL/min. Prior to use, condition the trap daily for 10 min while backflushing at 180°C with the column at 220°C.

7.1.2 Connect the purge-and-trap device to a gas chromatograph.

7.1.3 Prepare the final solutions containing the required concentrations of calibration standards, including surrogate standards, directly in the purging device. Add 5.0 mL of reagent water to the purging device. The reagent water is added to the purging device using a 5-mL glass syringe fitted with a 15-cm 20-gauge needle. The needle is inserted through the sample inlet shown in Figure 1. The internal diameter of the 14-gauge needle that forms the sample inlet will permit insertion of the 20-gauge needle. Next, using a 10-uL or 25-uL microsyringe equipped with a long needle (Paragraph 4.1), take a volume of the secondary dilution solution containing appropriate concentrations of the calibration standards. Add the aliquot of calibration solution directly to the reagent water in the purging device by inserting the needle through the sample inlet. When discharging the contents of the microsyringe, be sure that the end of the syringe needle is well beneath the surface of the reagent water. Similarly, add 10 uL of the internal standard solution. Close the 2-way syringe valve at the sample inlet.

7.1.4 Carry out the purge-and-trap analysis procedure using the specific conditions given in Table 1.

7.1.5 Calculate response factors or calibration factors for each analyte of interest using the procedure described in Method 8000, Section 7.4.

7.1.6 The average RF must be calculated for each compound. A system performance check should be made before this calibration curve is used. If the purge-and-trap procedure is used with Method 8010, the following five compounds are checked for a minimum average response factor: chloromethane; 1,1-dichloroethane; bromoform; 1,1,2,2-tetrachloroethane; and chlorobenzene. The minimum acceptable average RF for these compounds should be 0.300 (0.250 for bromoform). These compounds typically have RFs of 0.4-0.6 and are used to check compound instability and check for degradation caused by contaminated lines or active sites in the system. Examples of these occurrences are:

7.1.6.1 Chloromethane: This compound is the most likely compound to be lost if the purge flow is too fast.

7.1.6.2 Bromoform: This compound is one of the compounds most likely to be purged very poorly if the purge flow is too slow. Cold spots and/or active sites in the transfer lines may adversely affect response.

7.1.6.3 Tetrachloroethane and 1,1-dichloroethane: These compounds are degraded by contaminated transfer lines in purge-and-trap systems and/or active sites in trapping materials.

7.2 On-going calibration: Refer to Method 8000, Sections 7.4.2.3 and 7.4.3.4 for details on continuing calibration.

TABLE 1. PURGE-AND-TRAP OPERATING PARAMETERS

	Analysis Method			
	8010	8015	8020	8030
Purge gas	Nitrogen or Helium	Nitrogen or Helium	Nitrogen or Helium	Nitrogen or Helium
Purge gas flow rate (mL/min)	40	20	40	20
Purge time (min)	11.0 ± 0.1	15.0 ± 0.1	12.0 ± 0.1	15.0 ± 0.1
Purge temperature (°C)	Ambient	85 ± 2	Ambient	85 ± 2
Desorb temperature (°C)	180	180	180	180
Backflush inert gas flow (mL/min)	20-60	20-60	20-60	20-60
Desorb time (min)	4	1.5	4	1.5

7.3 Sample preparation:

7.3.1 Water samples:

7.3.1.1 Screening of the sample prior to purge-and-trap analysis will provide guidance on whether sample dilution is necessary and will prevent contamination of the purge-and-trap system. Two screening techniques that can be utilized are: the use of an automated headspace sampler (modified Method 3810), interfaced to a gas chromatograph (GC), equipped with a photo ionization detector (PID), in series with an electrolytic conductivity detector (ECD); and extraction of the sample with hexadecane (Method 3820) and analysis of the extract on a GC with a FID and/or an ECD.

7.3.1.2 All samples and standard solutions must be allowed to warm to ambient temperature before analysis.

7.3.1.3 Assemble the purge-and-trap device. The operating conditions for the GC are given in Section 7.0 of the specific determinative method to be employed.

7.3.1.4 Daily GC calibration criteria must be met (Method 8000, Section 7.4) before analyzing samples.

7.3.1.5 Adjust the purge gas flow rate (nitrogen or helium) to that shown in Table 1, on the purge-and-trap device. Optimize the flow rate to provide the best response for chloromethane and bromoform, if these compounds are analytes. Excessive flow rate reduces chloromethane response, whereas insufficient flow reduces bromoform response.

7.3.1.6 Remove the plunger from a 5-mL syringe and attach a closed syringe valve. Open the sample or standard bottle, which has been allowed to come to ambient temperature, and carefully pour the sample into the syringe barrel to just short of overflowing. Replace the syringe plunger and compress the sample. Open the syringe valve and vent any residual air while adjusting the sample volume to 5.0 mL. This process of taking an aliquot destroys the validity of the liquid sample for future analysis; therefore, if there is only one VOA vial, the analyst should fill a second syringe at this time to protect against possible loss of sample integrity. This second sample is maintained only until such time when the analyst has determined that the first sample has been analyzed properly. Filling one 20-mL syringe would allow the use of only one syringe. If a second analysis is needed from a syringe, it must be analyzed within 24 hr. Care must be taken to prevent air from leaking into the syringe.

7.3.1.7 The following procedure is appropriate for diluting purgeable samples. All steps must be performed without delays until the diluted sample is in a gas-tight syringe.

7.3.1.7.1 Dilutions may be made in volumetric flasks (10-mL to 100-mL). Select the volumetric flask that will allow for the necessary dilution. Intermediate dilutions may be necessary for extremely large dilutions.

7.3.1.7.2 Calculate the approximate volume of reagent water to be added to the volumetric flask selected and add slightly less than this quantity of reagent water to the flask.

7.3.1.7.3 Inject the proper aliquot of samples from the syringe prepared in Paragraph 7.3.1.5 into the flask. Aliquots of less than 1-mL are not recommended. Dilute the sample to the mark with reagent water. Cap the flask, invert, and shake three times. Repeat the above procedure for additional dilutions.

7.3.1.7.4 Fill a 5-mL syringe with the diluted sample as in Paragraph 7.3.1.5.

7.3.1.8 Add 10.0 uL of surrogate spiking solution (found in each determinative method, Section 5.0) and, if applicable, 10 uL of internal standard spiking solution through the valve bore of the syringe; then close the valve. The surrogate and internal standards may be mixed and added as a single spiking solution. Matrix spiking solutions, if indicated, should be added (10 uL) to the sample at this time.

7.3.1.9 Attach the syringe-syringe valve assembly to the syringe valve on the purging device. Open the syringe valves and inject the sample into the purging chamber.

7.3.1.10 Close both valves and purge the sample for the time and at the temperature specified in Table 1.

7.3.1.11 At the conclusion of the purge time, attach the trap to the chromatograph, adjust the device to the desorb mode, and begin the gas chromatographic temperature program and GC data acquisition. Concurrently, introduce the trapped materials to the gas chromatographic column by rapidly heating the trap to 180°C while backflushing the trap with inert gas between 20 and 60 mL/min for the time specified in Table 1.

7.3.1.12 While the trap is being desorbed into the gas chromatograph, empty the purging chamber. Wash the chamber with a minimum of two 5-mL flushes of reagent water (or methanol followed by reagent water) to avoid carryover of pollutant compounds into subsequent analyses.

7.3.1.13 After desorbing the sample, recondition the trap by returning the purge-and-trap device to the purge mode. Wait 15 sec; then close the syringe valve on the purging device to begin gas flow

through the trap. The trap temperature should be maintained at 180°C for Methods 8010 and 8020, and 210°C for Methods 8015 and 8030. Trap temperatures up to 220°C may be employed; however, the higher temperature will shorten the useful life of the trap. After approximately 7 min, turn off the trap heater and open the syringe valve to stop the gas flow through the trap. When cool, the trap is ready for the next sample.

7.3.1.14 If the initial analysis of a sample or a dilution of the sample has a concentration of analytes that exceeds the initial calibration range, the sample must be reanalyzed at a higher dilution. When a sample is analyzed that has saturated response from a compound, this analysis must be followed by a blank reagent water analysis. If the blank analysis is not free of interferences, the system must be decontaminated. Sample analysis may not resume until a blank can be analyzed that is free of interferences.

7.3.1.15 All dilutions should keep the response of the major constituents (previously saturated peaks) in the upper half of the linear range of the curve. Proceed to Method 8000 and the specific determinative method for details on calculating analyte response.

7.3.2 **Water-miscible liquids:**

7.3.2.1 Water-miscible liquids are analyzed as water samples after first diluting them at least 50-fold with reagent water.

7.3.2.2 Initial and serial dilutions can be prepared by pipetting 2 mL of the sample to a 100-mL volumetric flask and diluting to volume with reagent water. Transfer immediately to a 5-mL gas-tight syringe.

7.3.2.3 Alternatively, prepare dilutions directly in a 5-mL syringe filled with reagent water by adding at least 20 uL, but not more than 100-uL of liquid sample. The sample is ready for addition of surrogate and, if applicable, internal and matrix spiking standards.

7.3.3 **Sediment/soil and waste samples:** It is highly recommended that all samples of this type be screened prior to the purge-and-trap GC analysis. These samples may contain percent quantities of purgeable organics that will contaminate the purge-and-trap system, and require extensive cleanup and instrument downtime. See Paragraph 7.3.1.1 for recommended screening techniques. Use the screening data to determine whether to use the low-level method (0.005-1 mg/kg) or the high-level method (>1 mg/kg).

7.3.3.1 Low-level method: This is designed for samples containing individual purgeable compounds of <1 mg/kg. It is limited to sediment/soil samples and waste that is of a similar consistency (granular and porous). The low-level method is based on

purging a heated sediment/soil sample mixed with reagent water containing the surrogate and, if applicable, internal and matrix spiking standards. Analyze all reagent blanks and standards under the same conditions as the samples.

7.3.3.1.1 Use a 5-g sample if the expected concentration is <0.1 mg/kg or a 1-g sample for expected concentrations between 0.1 and 1 mg/kg.

7.3.3.1.2 The GC system should be set up as in Section 7.0 of the specific determinative method. This should be done prior to the preparation of the sample to avoid loss of volatiles from standards and samples. A heated purge calibration curve must be prepared and used for the quantitation of all samples analyzed with the low-level method. Follow the initial and daily calibration instructions, except for the addition of a 40°C purge temperature for Methods 8010 and 8020.

7.3.3.1.3 Remove the plunger from a 5-mL Luerlock type syringe equipped with a syringe valve and fill until overflowing with reagent water. Replace the plunger and compress the water to vent trapped air. Adjust the volume to 5.0 mL. Add 10 uL each of surrogate spiking solution and internal standard solution to the syringe through the valve. (Surrogate spiking solution and internal standard solution may be mixed together.) Matrix spiking solutions, if indicated, should be added (10 uL) to the sample at this time.

7.3.3.1.4 The sample (for volatile organics) consists of the entire contents of the sample container. Do not discard any supernatant liquids. Mix the contents of the sample container with a narrow metal spatula. Weigh the amount determined in Paragraph 7.3.3.1.1 into a tared purge device. Note and record the actual weight to the nearest 0.1 g.

7.3.3.1.5 In certain cases, sample results are desired based on a dry-weight basis. When such data is desired, a portion of sample for moisture determination should be weighed out at the same time as the portion used for analytical determination. Immediately after weighing the sample for extraction, weigh 5-10 g of the sample into a tared crucible. Determine the percent moisture by drying overnight at 105°C. Allow to cool in a desiccator before weighing:

$$\frac{\text{g of sample - g of dry sample}}{\text{g of sample}} \times 100 = \% \text{ moisture}$$

7.3.3.1.6 Add the spiked reagent water to the purge device, which contains the weighed amount of sample, and connect the device to the purge-and-trap system.

NOTE: Prior to the attachment of the purge device, steps 7.3.3.1.4 and 7.3.3.1.6 must be performed rapidly and without interruption to avoid loss of volatile organics. These steps must be performed in a laboratory free of solvent fumes.

7.3.3.1.7 Heat the sample to 40°C ± 1°C (Methods 8010 and 8020) or to 85°C ± 2°C (Methods 8015 and 8030) and purge the sample for the time shown in Table 1.

7.3.3.1.8 Proceed with the analysis as outlined in Paragraphs 7.3.1.11-7.3.1.15. Use 5 mL of the same reagent water as in the reagent blank. If saturated peaks occurred or would occur if a 1-g sample were analyzed, the high-level method must be followed.

7.3.3.2 High-level method: The method is based on extracting the sediment/soil with methanol. A waste sample is either extracted or diluted, depending on its solubility in methanol. An aliquot of the extract is added to reagent water containing surrogate and, if applicable, internal and matrix spiking standards. This is purged at the temperatures indicated in Table 1. All samples with an expected concentration of >1.0 mg/kg should be analyzed by this method.

7.3.3.2.1 The sample (for volatile organics) consists of the entire contents of the sample container. Do not discard any supernatant liquids. Mix the contents of the sample container with a narrow metal spatula. For sediment/soil and waste that are insoluble in methanol, weigh 4 g (wet weight) of sample into a tared 20-mL vial. Use a top-loading balance. Note and record the actual weight to 0.1 gram and determine the percent moisture of the sample using the procedure in Paragraph 7.3.3.1.5. For waste that is soluble in methanol, weigh 1 g (wet weight) into a tared scintillation vial or culture tube or a 10-mL volumetric flask. (If a vial or tube is used, it must be calibrated prior to use. Pipet 10.0 mL of methanol into the vial and mark the bottom of the meniscus. Discard this solvent.)

7.3.3.2.2 Quickly add 9.0 mL of methanol; then add 1.0 mL of the surrogate spiking solution to the vial. Cap and shake for 2 min.

NOTE: Steps 7.3.3.2.1 and 7.3.3.2.2 must be performed rapidly and without interruption to avoid loss of volatile organics. These steps must be performed in a laboratory free from solvent fumes.

7.3.3.2.3 Pipet approximately 1 mL of the extract to a GC vial for storage, using a disposable pipet. The remainder may be disposed of. Transfer approximately 1 mL of reagent methanol to a separate GC vial for use as the method blank for each set of samples. These extracts may be stored at 4°C in the dark, prior to analysis.

7.3.3.2.4 The GC system should be set up as in Section 7.0 of the specific determinative method. This should be done prior to the addition of the methanol extract to reagent water.

7.3.3.2.5 Table 2 can be used to determine the volume of methanol extract to add to the 5 mL of reagent water for analysis. If a screening procedure was followed, use the estimated concentration to determine the appropriate volume. Otherwise, estimate the concentration range of the sample from the low-level analysis to determine the appropriate volume. If the sample was submitted as a high-level sample, start with 100 uL. All dilutions must keep the response of the major constituents (previously saturated peaks) in the upper half of the linear range of the curve.

7.3.3.2.6 Remove the plunger from a 5.0-mL Luerlock type syringe equipped with a syringe valve and fill until overflowing with reagent water. Replace the plunger and compress the water to vent trapped air. Adjust the volume to 4.9 mL. Pull the plunger back to 5.0 mL to allow volume for the addition of the sample extract and of standards. Add 10 uL of internal standard solution. Also add the volume of methanol extract determined in Paragraph 7.3.3.2.5 and a volume of methanol solvent to total 100 uL (excluding methanol in standards).

7.3.3.2.7 Attach the syringe-syringe valve assembly to the syringe valve on the purging device. Open the syringe valve and inject the water/methanol sample into the purging chamber.

7.3.3.2.8 Proceed with the analysis as outlined in the specific determinative method. Analyze all reagent blanks on the same instrument as that used for the samples. The standards and blanks should also contain 100 uL of methanol to simulate the sample conditions.

7.3.3.2.9 For a matrix spike in the high-level sediment/soil samples, add 8.0 mL of methanol, 1.0 mL of surrogate spike solution and 1.0 mL of matrix spike solution. Add a 100-uL aliquot of this extract to 5 mL of water for purging (as per Paragraph 7.3.3.2.6).

TABLE 2. QUANTITY OF METHANOL EXTRACT REQUIRED FOR ANALYSIS OF HIGH-LEVEL SOILS/SEDIMENTS

Approximate Concentration Range	Volume of Methanol Extract[a]
500-10,000 ug/kg	100 uL
1,000-20,000 ug/kg	50 uL
5,000-100,000 ug/kg	10 uL
25,000-500,000 ug/kg	100 uL of 1/50 dilution [b]

Calculate appropriate dilution factor for concentrations exceeding this table.

[a]The volume of methanol added to 5 mL of water being purged should be kept constant. Therefore, add to the 5-mL syringe whatever volume of methanol is necessary to maintain a volume of 100 uL added to the syringe.

[b]Dilute an aliquot of the methanol extract and then take 100 uL for analysis.

7.4 Sample analysis:

7.4.1 The samples prepared by this method may be analyzed by Methods 8010, 8015, 8020, 8030, and 8240. Refer to these methods for appropriate analysis conditions.

8.0 QUALITY CONTROL

8.1 Refer to Chapter One for specific quality control procedures and Method 3500 for sample preparation procedures.

8.2 Before processing any samples, the analyst should demonstrate through the analysis of a reagent water method blank that all glassware and reagents are interference free. Each time a set of samples is extracted, or there is a change in reagents, a method blank should be processed as a safeguard against chronic laboratory contamination. The blank samples should be carried through all stages of the sample preparation and measurement.

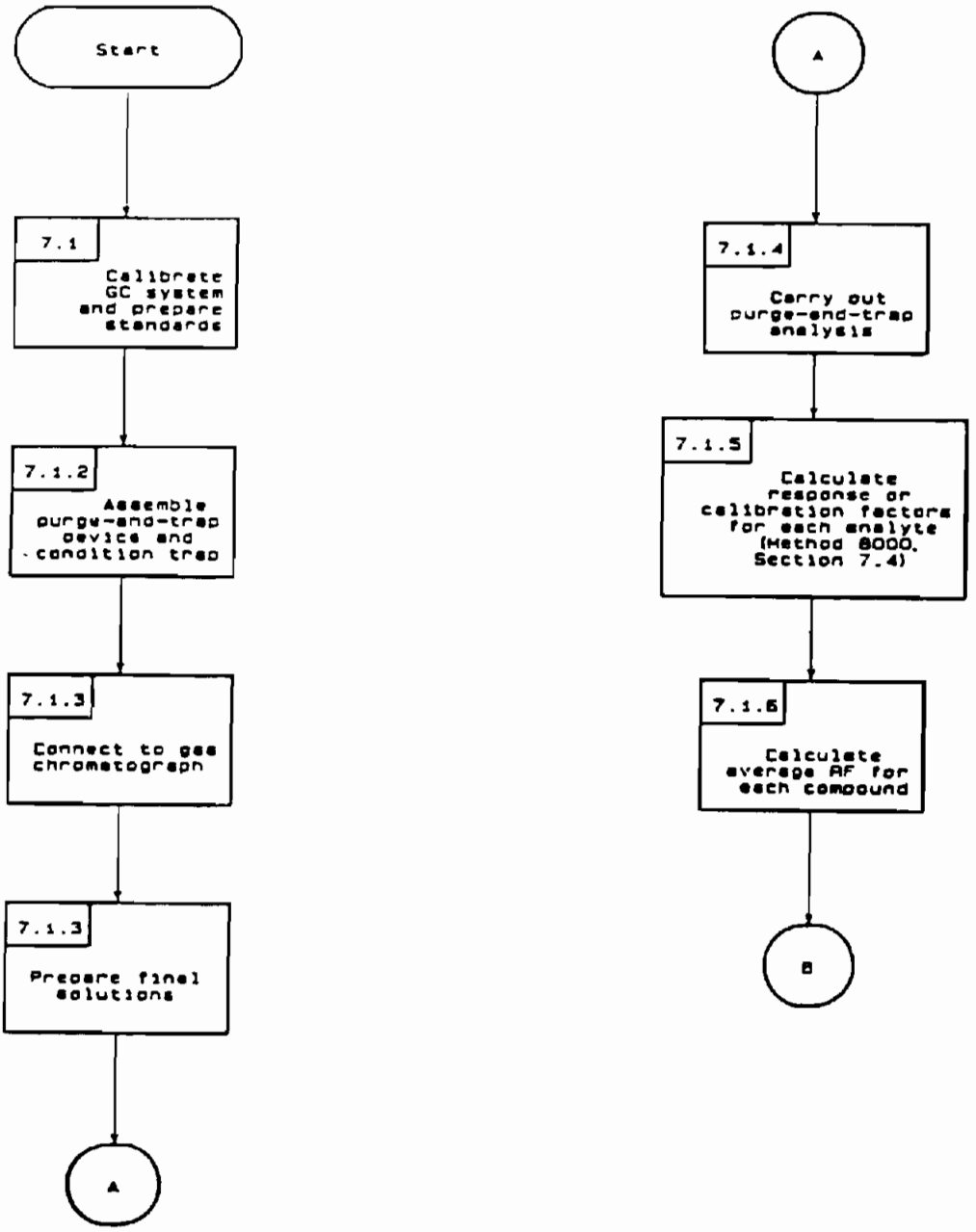
8.3 Standard quality assurance practices should be used with this method. Field replicates should be collected to validate the precision of the sampling technique. Laboratory replicates should be analyzed to validate the precision of the analysis. Fortified samples should be carried through all stages of sample preparation and measurement; they should be analyzed to validate the sensitivity and accuracy of the analysis. If the fortified samples do not indicate sufficient sensitivity to detect <1 ug/g of the analytes in the sample, then the sensitivity of the instrument should be increased, or the sample should be subjected to additional cleanup.

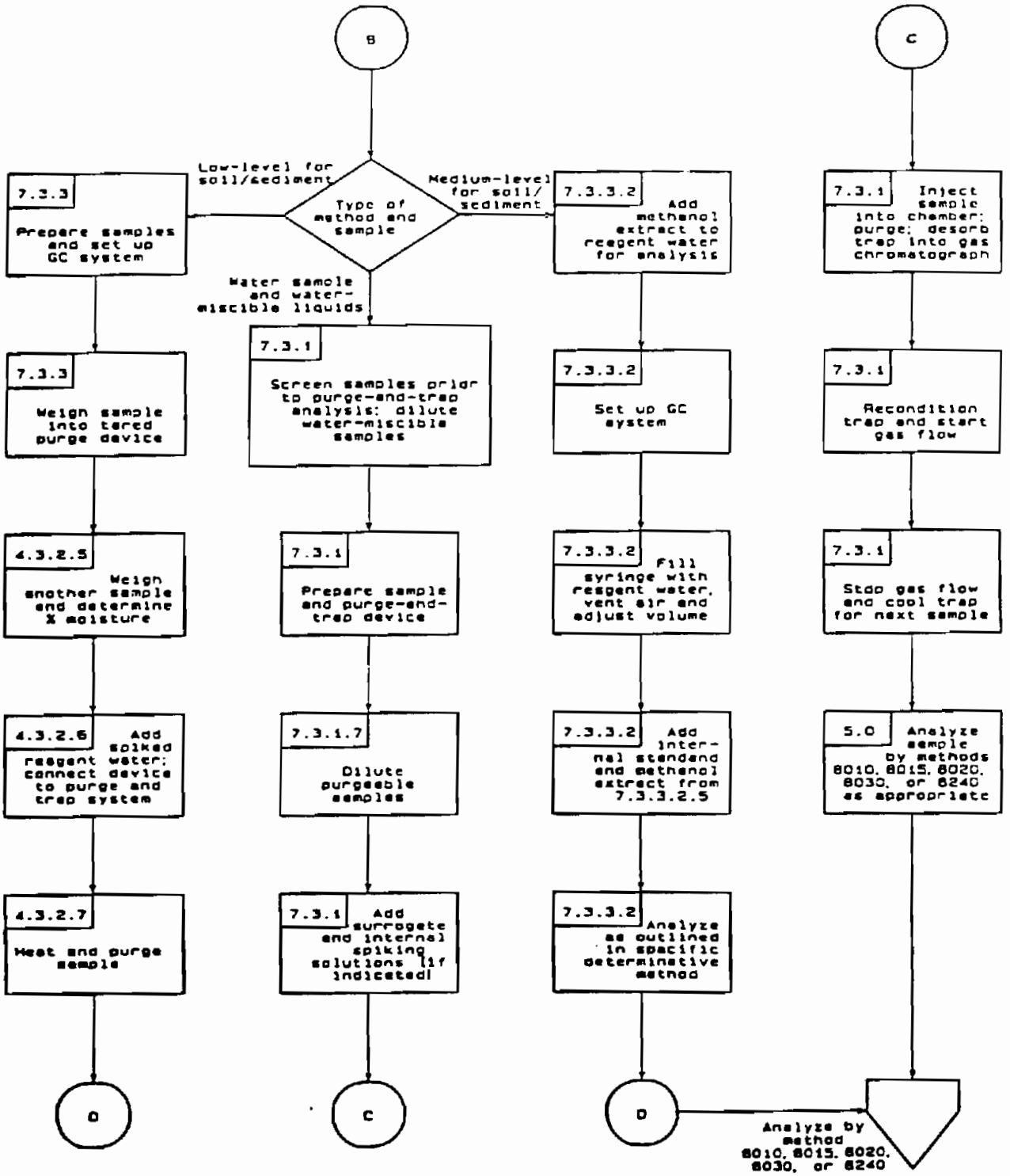
9.0 METHOD PERFORMANCE

9.1 Refer to the determinative methods for performance data.

10.0 REFERENCES

1. U.S. EPA 40 CFR Part 136, "Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act; Final Rule and Interim Final Rule and Proposed Rule," October 26, 1984.


Start
7.1
Calibrate GC system and prepare standards
7.1.2
Assemble purge-and-trap device and condition trap
7.1.3
Connect to gas chromatograph
7.1.3
Prepare final solutions
A
A
7.1.4
Carry out purge-and-trap analysis
7.1.5
Calculate response or calibration factors for each analyte (Method 8000, Section 7.4)
7.1.6
Calculate average RF for each compound
B


B
C
Type of method and sample
Low-level for soil/sediment
Medium-level for soil/sediment
Water sample and water-miscible liquids
7.3.3 Prepare samples and set up GC system
7.3.3 Weigh sample into tared purge device
4.3.2.5 Weigh another sample and determine % moisture
4.3.2.6 Add spiked reagent water; connect device to purge and trap system
4.3.2.7 Heat and purge sample
D
7.3.1 Screen samples prior to purge-and-trap analysis; dilute water-miscible samples
7.3.1 Prepare sample and purge-and-trap device
7.3.1.7 Dilute purgeable samples
7.3.1 Add surrogate and internal spiking solutions (if indicated)
C
7.3.3.2 Add methanol extract to reagent water for analysis
7.3.3.2 Set up GC system
7.3.3.2 Fill syringe with reagent water, vent air and adjust volume
7.3.3.2 Add internal standard and methanol extract from 7.3.3.2.5
7.3.3.2 Analyze as outlined in specific determinative method
D
7.3.1 Inject sample into chamber; purge; desorb trap into gas chromatograph
7.3.1 Recondition trap and start gas flow
7.3.1 Stop gas flow and cool trap for next sample
5.0 Analyze sample by methods 8010, 8015, 8020, 8030, or 8240 as appropriate
Analyze by method 8010, 8015, 8020, 8030, or 8240

METHOD 8010

HALOGENATED VOLATILE ORGANICS

1.0 SCOPE AND APPLICATION

1.1 Method 8010 is used to determine the concentration of various volatile halogenated organic compounds. Table 1 indicates compounds that may be analyzed by this method and lists the method detection limit for each compound in reagent water. Table 2 lists the practical quantitation limit for other matrices.

2.0 SUMMARY OF METHOD

2.1 Method 8010 provides gas chromatographic conditions for the detection of halogenated volatile organic compounds. Samples can be analyzed using direct injection or purge-and-trap (Method 5030). Ground water samples must be analyzed using Method 5030. A temperature program is used in the gas chromatograph to separate the organic compounds. Detection is achieved by a halogen-specific detector (HSD).

2.2 The method provides an optional gas chromatographic column that may be helpful in resolving the analytes from interferences that may occur and for analyte confirmation.

3.0 INTERFERENCES

3.1 Refer to Methods 5030 and 8000.

3.2 Samples can be contaminated by diffusion of volatile organics (particularly chlorofluorocarbons and methylene chloride) through the sample container septum during shipment and storage. A field sample blank prepared from reagent water and carried through sampling and subsequent storage and handling can serve as a check on such contamination.

4.0 APPARATUS AND MATERIALS

4.1 Gas chromatograph:

4.1.1 **Gas Chromatograph:** analytical system complete with gas chromatograph suitable for on-column injections or purge-and-trap sample introduction and all required accessories, including detector, analytical columns, recorder, gases, and syringes. A data system for measuring peak heights and/or peak areas is recommended.

TABLE 1. CHROMATOGRAPHIC CONDITIONS AND METHOD DETECTION LIMITS FOR HALOGENATED VOLATILE ORGANICS

Compound	Retention time (min) Col. 1	Retention time (min) Col. 2	Method detection limit[a] (ug/L)
Benzyl chloride			
Bis(2-chloroethoxy)methane			
Bis(2-chloroisopropyl)ether			
Bromobenzene			
Bromodichloromethane	13.7	14.6	0.10
Bromoform	19.2	19.2	0.20
Bromomethane			
Carbon tetrachloride	13.0	14.4	0.12
Chloroacetaldehyde			
Chlorobenzene	24.2	18.8	0.25
Chloroethane	3.33	8.68	0.52
Chloroform	10.7	12.1	0.05
1-Chlorohexane			
2-Chloroethyl vinyl ether	18.0		0.13
Chloromethane	1.50	5.28	0.08
Chloromethylmethyl ether			
Chlorotoluene			
Dibromochloromethane	16.5	16.6	0.09
Dibromomethane			
1,2-Dichlorobenzene	34.9	23.5	0.15
1,3-Dichlorobenzene	34.0	22.4	0.32
1,4-Dichlorobenzene	35.4	22.3	0.24
Dichlorodifluoromethane			
1,1-Dichloroethane	9.30	12.6	0.07
1,2-Dichloroethane	11.4	15.4	0.03
1,1-Dichloroethylene	8.0	7.72	0.13
trans-1,2-Dichloroethylene	10.1	9.38	0.10
Dichloromethane			
1,2-Dichloropropane	14.9	16.6	0.04
trans-1,3-Dichloropropylene	15.2	16.6	0.34
1,1,2,2-Tetrachloroethane	21.6		0.03
1,1,1,2-Tetrachloroethane			
Tetrachloroethylene	21.7	15.0	0.03
1,1,1-Trichloroethane	12.6	13.1	0.03
1,1,2-Trichloroethane	16.5	18.1	0.02
Trichloroethylene	15.8	13.1	0.12
Trichlorofluoromethane	7.18		
Trichloropropane			
Vinyl chloride	2.67	5.28	0.18

[a] Using purge-and-trap method (Method 5030).

TABLE 2. DETERMINATION OF PRACTICAL QUANTITATION LIMITS (PQL) FOR VARIOUS MATRICES[a]

Matrix	Factor[b]
Ground water	10
Low-level soil	10
Water miscible liquid waste	500
High-level soil and sludge	1250
Non-water miscible waste	1250

[a]Sample PQLs are highly matrix-dependent. The PQLs listed herein are provided for guidance and may not always be achievable.

[b]PQL = [Method detection limit (Table 1)] X [Factor (Table 2)]. For non-aqueous samples, the factor is on a wet-weight basis.

4.1.2 **Columns:**

4.1.2.1 Column 1: 8-ft x 0.1-in I.D. stainless steel or glass column packed with 1% SP-1000 on Carbopack-B 60/80 mesh or equivalent.

4.1.2.2 Column 2: 6-ft x 0.1-in I.D. stainless steel or glass column packed with chemically bonded n-octane on Porasil-C 100/120 mesh (Durapak) or equivalent.

4.1.3 **Detector:** Electrolytic conductivity (HSD).

4.2 Sample introduction apparatus: Refer to Method 5030 for the appropriate equipment for sample introduction purposes.

4.3 Syringes: 5-mL Luerlok glass hypodermic and a 5-mL, gas-tight with shutoff valve.

4.4 Volumetric flask: 10-, 50-, 100-, 500-, and 1,000-mL with a ground-glass stopper.

4.5 Microsyringe: 10-, 25-uL with a 0.006-in I.D. needle (Hamilton 702N or equivalent) and a 100-uL.

5.0 REAGENTS

5.1 Reagent water: Reagent water is defined as a water in which an interferent is not observed at the method detection limit (MDL) of the parameters of interest.

5.2 Stock standards: Stock solutions may be prepared from pure standard materials or purchased as certified solutions. Prepare stock standards in methanol using assayed liquids or gases, as appropriate. Because of the toxicity of some of the organohalides, primary dilutions of these materials of the toxicity of these materials should be prepared in a hood.

5.2.1 Place about 9.8 mL of methanol in a 10-mL tared ground-glass-stoppered volumetric flask. Allow the flask to stand, unstoppered, for about 10 min or until all alcohol-wetted surfaces have dried. Weigh the flask to the nearest 0.1 mg.

5.2.2 Add the assayed reference material, as described below.

5.2.2.1 **Liquids:** Using a 100-uL syringe, immediately add two or more drops of assayed reference material to the flask; then reweigh. The liquid must fall directly into the alcohol without contacting the neck of the flask.

5.2.2.2 **Gases:** To prepare standards for any compounds that boil below 30°C (e.g., bromomethane, chloroethane, chloromethane, dichlorodifluoromethane, trichlorofluoromethane, vinyl chloride), fill a 5-mL valved gas-tight syringe with the reference standard to the 5.0-mL mark. Lower the needle to 5 mm above the methanol

meniscus. Slowly introduce the reference standard above the surface of the liquid. The heavy gas rapidly dissolves in the methanol. This may also be accomplished by using a lecture bottle equipped with a Hamilton Lecture Bottle Septum (#86600). Attach Teflon tubing to the side-arm relief valve and direct a gentle stream of gas into the methanol meniscus.

5.2.3 Reweigh, dilute to volume, stopper, and then mix by inverting the flask several times. Calculate the concentration in micrograms per microliter (ug/uL) from the net gain in weight. When compound purity is assayed to be 96% or greater, the weight may be used without correction to calculate the concentration of the stock standard. Commercially prepared stock standards may be used at any concentration if they are certified by the manufacturer or by an independent source.

5.2.4 Transfer the stock standard solution into a Teflon-sealed screw-cap bottle. Store, with minimal headspace, at -10°C to -20°C and protect from light.

5.2.5 Prepare fresh standards every 2 months for gases or for reactive compounds such as 2-chloroethylvinyl ether. All other standards must be replaced after 6 months, or sooner if comparison with check standards indicates a problem.

5.3 Secondary dilution standards: Using stock standard solutions, prepare in methanol secondary dilution standards, as needed, that contain the compounds of interest, either singly or mixed together. The secondary dilution standards should be prepared at concentrations such that the aqueous calibration standards prepared in Section 5.4 will bracket the working range of the analytical system. Secondary dilution standards should be stored with minimal headspace for volatiles and should be checked frequently for signs of degradation or evaporation, especially just prior to preparing calibration standards from them.

5.4 Calibration standards: Calibration standards at a minimum of five concentration levels are prepared in reagent water from the secondary dilution of the stock standards. One of the concentration levels should be at a concentration near, but above, the method detection limit. The remaining concentration levels should correspond to the expected range of concentrations found in real samples or should define the working range of the GC. Each standard should contain each analyte for detection by this method (e.g., some or all of the compounds listed in Table 1 may be included). In order to prepare accurate aqueous standard solutions, the following precautions must be observed.

5.4.1 Do not inject more than 20 uL of alcoholic standards into 100 mL of reagent water.

5.4.2 Use a 25-uL Hamilton 702N microsyringe or equivalent (variations in needle geometry will adversely affect the ability to deliver reproducible volumes of methanolic standards into water).

5.4.3 Rapidly inject the alcoholic standard into the filled volumetric flask. Remove the needle as fast as possible after injection.

5.4.4 Mix aqueous standards by inverting the flask three times only.

5.4.5 Fill the sample syringe from the standard solution contained in the expanded area of the flask (do not use any solution contained in the neck of the flask).

5.4.6 Never use pipets to dilute or transfer samples or aqueous standards.

5.4.7 Aqueous standards are not stable and should be discarded after 1 hr, unless properly sealed and stored. The aqueous standards can be stored up to 24 hr, if held in sealed vials with zero headspace.

5.5 Internal standards (if internal standard calibration is used): To use this approach, the analyst must select one or more internal standards that are similar in analytical behavior to the compounds of interest. The analyst must further demonstrate that the measurement of the internal standard is not affected by method or matrix interferences. Because of these limitations, no internal standard can be suggested that is applicable to all samples. The compounds recommended for use as surrogate spikes (Paragraph 5.6) have been used successfully as internal standards, because of their generally unique retention times.

5.5.1 Prepare calibration standards at a minimum of five concentration levels for each parameter of interest as described in Section 5.4.

5.5.2 Prepare a spiking solution containing each of the internal standards using the procedures described in Sections 5.2 and 5.3. It is recommended that the secondary dilution standard be prepared at a concentration of 15 ug/mL of each internal standard compound. The addition of 10 uL of this standard to 5.0 mL of sample or calibration standard would be equivalent to 30 ug/L.

5.5.3 Analyze each calibration standard according to Section 7.0, adding 10 uL of internal standard spiking solution directly to the syringe.

5.6 Surrogate standards: The analyst should monitor both the performance of the analytical system and the effectiveness of the method in dealing with each sample matrix by spiking each sample, standard, and reagent water blank with surrogate halocarbons. A combination of bromochloromethane, 2-bromo-1-chloropropane, and 1,4-dichlorobutane is recommended to encompass the range of the temperature program used in this method. From stock standard solutions prepared as in Section 5.2, add a volume to give 750 ug of each surrogate to 45 mL of reagent water contained in a 50-mL volumetric flask, mix, and dilute to volume for a concentration of 15 ng/uL. Add 10 uL of this surrogate spiking solution directly into the 5-mL syringe with every sample and reference standard analyzed. If the internal standard calibration procedure is used, the surrogate compounds may be added directly to the internal standard spiking solution (Paragraph 5.5.2).

5.7 Methanol: pesticide quality or equivalent. Store away from other solvents.

6.0 SAMPLE COLLECTION, PRESERVATION, AND HANDLING

6.1 See the introductory material to this chapter, Organic Analytes, Section 4.1.

7.0 PROCEDURE

7.1 Volatile compounds are introduced into the gas chromatograph either by direct injection or purge-and-trap (Method 5030). Method 5030 may be used directly on ground water samples or low-level contaminated soils and sediments. For medium-level soils or sediments, methanolic extraction, as described in Method 5030, may be necessary prior to purge-and-trap analysis.

7.2 Gas chromatography conditions (Recommended):

7.2.1 **Column 1:** Set helium gas flow at 40 mL/min flow rate. Set column temperature at 45°C for 3 min; then program an 8°C/min temperature rise to 220°C and hold for 15 min.

7.2.2 **Column 2:** Set helium gas flow at 40 mL/min flow rate. Set column temperature at 50°C for 3 min; then program a 6°C/min temperature rise to 170°C and hold for 4 min.

7.3 Calibration: Refer to Method 8000 for proper calibration techniques. Use Table 1 and especially Table 2 for guidance on selecting the lowest point on the calibration curve.

7.3.1 Calibration must take place using the same sample introduction method that will be used to analyze actual samples (see Paragraph 7.4.1).

7.3.2 The procedure for internal or external calibration may be used. Refer to Method 8000 for a description of each of these procedures.

7.4 Gas chromatographic analysis:

7.4.1 Introduce volatile compounds into the gas chromatograph using either Method 5030 (purge-and-trap method) or the direct injection method (see Paragraph 7.4.1.1). If the internal standard calibration technique is used, add 10 uL of internal standard to the sample prior to purging.

7.4.1.1 Direct injection: In very limited applications (e.g., aqueous process wastes) direct injection of the sample into the GC system with a 10-uL syringe may be appropriate. The detection limit is very high (approximately 10,000 ug/L) therefore, it is only

permitted where concentrations in excess of 10,000 ug/L are expected or for water-soluble compounds that do not purge. The system must be calibrated by direct injection (bypassing the purge-and-trap device).

7.4.2 Follow Section 7.6 in Method 8000 for instructions on the analysis sequence, appropriate dilutions, establishing daily retention time windows, and identification criteria. Include a mid-level standard after each group of 10 samples in the analysis sequence.

7.4.3 Table 1 summarizes the estimated retention times on the two columns for a number of organic compounds analyzable using this method. An example of the separation achieved by Column 1 is shown in Figure 1.

7.4.4 Record the sample volume purged or injected and the resulting peak sizes (in area units or peak heights).

7.4.5 Calculation of concentration is covered in Section 7.8 of Method 8000.

7.4.6 If analytical interferences are suspected, or for the purpose of confirmation, analysis using the second GC column is recommended.

7.4.7 If the response for a peak is off-scale, prepare a dilution of the sample with reagent water. The dilution must be performed on a second aliquot of the sample which has been properly sealed and stored prior to use.

8.0 QUALITY CONTROL

8.1 Refer to Chapter One for specific quality control procedures and Method 8000 for gas chromatographic procedures. Quality control to ensure the proper operation of the purge-and-trap device is covered in Method 5030.

8.2 Mandatory quality control to validate the GC system operation is found in Method 8000, Section 8.6.

8.2.1 The quality control check sample concentrate (Method 8000, Section 8.6) should contain each parameter of interest at a concentration of 10 ug/mL in methanol.

8.2.2 Table 3 indicates the calibration and QC acceptance criteria for this method. Table 4 gives method accuracy and precision as functions of concentration for the analytes of interest. The contents of both Tables should be used to evaluate a laboratory's ability to perform and generate acceptable data by this method.

8.3 Calculate surrogate standard recovery on all samples, blanks, and spikes. Determine if recovery is within limits (limits established by performing QC procedure outlined in Method 8000, Section 8.10).

8.3.1 If recovery is not within limits, the following is required.

- Check to be sure there are no errors in calculations, surrogate solutions and internal standards. Also, check instrument performance.
- Recalculate the data and/or reanalyze the extract if any of the above checks reveal a problem.
- Reextract and reanalyze the sample if none of the above are a problem or flag the data as "estimated concentration."

9.0 METHOD PERFORMANCE

9.1 This method was tested by 20 laboratories using reagent water, drinking water, surface water, and three industrial wastewaters spiked at six concentrations over the range 8.0-500 ug/L. Single operator precision, overall precision, and method accuracy were found to be directly related to the concentration of the parameter and essentially independent of the sample matrix. Linear equations to describe these relationships are presented in Table 4.

9.2 The accuracy and precision obtained will be determined by the sample matrix, sample introduction technique, and by the calibration procedure used.

10.0 REFERENCES

1. Bellar, T.A., and J.J. Lichtenberg, J. Amer. Water Works Assoc., 66(12), pp. 739-744, 1974.

2. Bellar, T.A., and J.J. Lichtenberg, "Semi-Automated Headspace Analysis of Drinking Waters and Industrial Waters for Purgeable Volatile Organic Compounds," in Van Hall, ed., Measurement of Organic Pollutants in Water and Wastewater, ASTM STP 686, pp. 108-129, 1979.

3. Development and Application of Test Procedures for Specific Organic Toxic Substances in Wastewaters: Category 11 - Purgeables and Category 12 - Acrolein, Acrylonitrile, and Dichlorodifluoromethane, Report for EPA Contract 68-03-2635 (in preparation).

4. U.S. EPA 40 CFR Part 136, "Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act; Final Rule and Interim Final Rule and Proposed Rule," October 26, 1984.

5. Provost, L.P. and R.S. Elder, "Interpretation of Percent Recovery Data," American Laboratory, 15, pp. 58-63, 1983.

6. "EPA Method Validation Study 23, Method 601 (Purgeable Halocarbons)," Report for EPA Contract 68-03-2856 (in preparation).

TABLE 3. CALIBRATION AND QC ACCEPTANCE CRITERIA[a]

Parameter	Range for Q (ug/L)	Limit for s (ug/L)	Range for $\bar{X}$ (ug/L)	Range P, P_s (%)
Bromodichloromethane	15.2-24.8	4.3	10.7-32.0	42-172
Bromoform	14.7-25.3	4.7	5.0-29.3	13-159
Bromomethane	11.7-28.3	7.5	3.4-24.5	D-144
Carbon tetrachloride	13.7-26.3	5.6	11.8-25.3	43-143
Chlorobenzene	14.4-25.6	5.0	10.2-27.4	38-150
Chloroethane	15.4-24.6	4.4	11.3-25.2	46-137
2-Chloroethylvinyl ether	12.0-28.0	8.3	4.5-35.5	14-186
Chloroform	15.0-25.0	4.5	12.4-24.0	49-133
Chloromethane	11.9-28.1	7.4	D-34.9	D-193
Dibromochloromethane	13.1-26.9	6.3	7.9-35.1	24-191
1,2-Dichlorobenzene	14.0-26.0	5.5	1.7-38.9	D-208
1,3-Dichlorobenzene	9.9-30.1	9.1	6.2-32.6	7-187
1,4-Dichlorobenzene	13.9-26.1	5.5	11.5-25.5	42-143
1,1-Dichloroethane	16.8-23.2	3.2	11.2-24.6	47-132
1,2-Dichloroethane	14.3-25.7	5.2	13.0-26.5	51-147
1,1-Dichloroethene	12.6-27.4	6.6	10.2-27.3	28-167
trans-1,2-Dichloroethene	12.8-27.2	6.4	11.4-27.1	38-155
1,2-Dichloropropane	14.8-25.2	5.2	10.1-29.9	44-156
cis-1,3-Dichloropropene	12.8-27.2	7.3	6.2-33.8	22-178
trans-1,3-Dichloropropene	12.8-27.2	7.3	6.2-33.8	22-178
Methylene chloride	15.5-24.5	4.0	7.0-27.6	25-162
1,1,2,2-Tetrachloroethane	9.8-30.2	9.2	6.6-31.8	8-184
Tetrachloroethene	14.0-26.0	5.4	8.1-29.6	26-162
1,1,1-Trichloroethane	14.2-25.8	4.9	10.8-24.8	41-138
1,1,2-Trichloroethane	15.7-24.3	3.9	9.6-25.4	39-136
Trichloroethene	15.4-24.6	4.2	9.2-26.6	35-146
Trichlorofluoromethane	13.3-26.7	6.0	7.4-28.1	21-156
Vinyl chloride	13.7-26.3	5.7	8.2-29.9	28-163

Q = Concentration measured in QC check sample, in ug/L.

s = Standard deviation of four recovery measurements, in ug/L.

$\bar{X}$ = Average recovery for four recovery measurements, in ug/L.

P, P_s = Percent recovery measured.

D = Detected; result must be greater than zero.

[a]Criteria from 40 CFR Part 136 for Method 601 and were calculated assuming a QC check sample concentration of 20 ug/L.

TABLE 4. METHOD ACCURACY AND PRECISION AS FUNCTIONS OF CONCENTRATION[a]

Parameter	Accuracy, as recovery, x' (ug/L)	Single analyst precision, s_r' (ug/L)	Overall precision, S' (ug/L)
Bromodichloromethane	1.12C-1.02	0.11$\bar{X}$+0.04	0.20$\bar{X}$+1.00
Bromoform	0.96C-2.05	0.12$\bar{X}$+0.58	0.21$\bar{X}$+2.41
Bromomethane	0.76C-1.27	0.28$\bar{X}$+0.27	0.36$\bar{X}$+0.94
Carbon tetrachloride	0.98C-1.04	0.15$\bar{X}$+0.38	0.20$\bar{X}$+0.39
Chlorobenzene	1.00C-1.23	0.15$\bar{X}$-0.02	0.18$\bar{X}$+1.21
Chloroethane	0.99C-1.53	0.14$\bar{X}$-0.13	0.17$\bar{X}$+0.63
2-Chloroethyl vinyl ether[b]	1.00C	0.20$\bar{X}$	0.35$\bar{X}$
Chloroform	0.93C-0.39	0.13$\bar{X}$+0.15	0.19$\bar{X}$-0.02
Chloromethane	0.77C+0.18	0.28$\bar{X}$-0.31	0.52$\bar{X}$+1.31
Dibromochloromethane	0.94C+2.72	0.11$\bar{X}$+1.10	0.24$\bar{X}$+1.68
1,2-Dichlorobenzene	0.93C+1.70	0.20$\bar{X}$+0.97	0.13$\bar{X}$+6.13
1,3-Dichlorobenzene	0.95C+0.43	0.14$\bar{X}$+2.33	0.26$\bar{X}$+2.34
1,4-Dichlorobenzene	0.93C-0.09	0.15$\bar{X}$+0.29	0.20$\bar{X}$+0.41
1,1-Dichloroethane	0.95C-1.08	0.08$\bar{X}$+0.17	0.14$\bar{X}$+0.94
1,2-Dichloroethane	1.04C-1.06	0.11$\bar{X}$+0.70	0.15$\bar{X}$+0.94
1,1-Dichloroethene	0.98C-0.87	0.21$\bar{X}$-0.23	0.29$\bar{X}$-0.04
trans-1,2-Dichloroethene	0.97C-0.16	0.11$\bar{X}$+1.46	0.17$\bar{X}$+1.46
1,2-Dichloropropane[b]	1.00C	0.13$\bar{X}$	0.23$\bar{X}$
cis-1,3-Dichloropropene[b]	1.00C	0.18$\bar{X}$	0.32$\bar{X}$
trans-1,3-Dichloropropene[b]	1.00C	0.18$\bar{X}$	0.32$\bar{X}$
Methylene chloride	0.91C-0.93	0.11$\bar{X}$+0.33	0.21$\bar{X}$+1.43
1,1,2,2-Tetrachloroethene	0.95C+0.19	0.14$\bar{X}$+2.41	0.23$\bar{X}$+2.79
Tetrachloroethene	0.94C+0.06	0.14$\bar{X}$+0.38	0.18$\bar{X}$+2.21
1,1,1-Trichloroethane	0.90C-0.16	0.15$\bar{X}$+0.04	0.20$\bar{X}$+0.37
1,1,2-Trichloroethane	0.86C+0.30	0.13$\bar{X}$-0.14	0.19$\bar{X}$+0.67
Trichloroethene	0.87C+0.48	0.13$\bar{X}$-0.03	0.23$\bar{X}$+0.30
Trichlorofluoromethane	0.89C-0.07	0.15$\bar{X}$+0.67	0.26$\bar{X}$+0.91
Vinyl chloride	0.97C-0.36	0.13$\bar{X}$+0.65	0.27$\bar{X}$+0.40

x' = Expected recovery for one or more measurements of a sample containing a concentration of C, in ug/L.

s_r' = Expected single analyst standard deviation of measurements at an average concentration of $\bar{X}$, in ug/L.

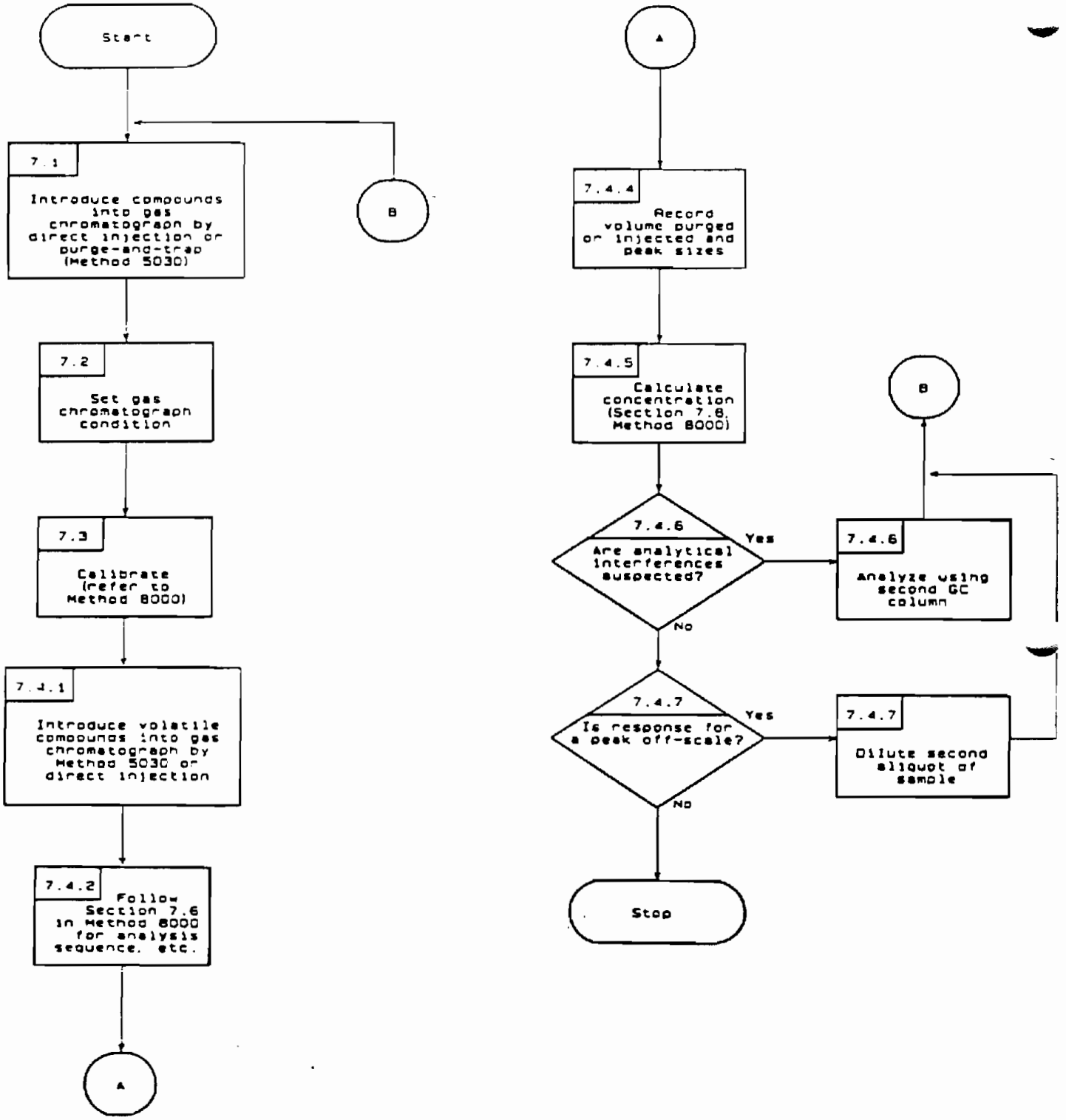
S' = Expected interlaboratory standard deviation of measurements at an average concentration found of $\bar{X}$, in ug/L.

C = True value for the concentration, in ug/L.

$\bar{X}$ = Average recovery found for measurements of samples containing a concentration of C, in ug/L.

[a]From 40 CFR Part 136 for Method 601.

[b]Estimates based upon the performance in a single laboratory.


Start
7.1
Introduce compounds into gas chromatograph by direct injection or purge-and-trap (Method 5030)
B
7.2
Set gas chromatograph condition
7.3
Calibrate (refer to Method 8000)
7.4.1
Introduce volatile compounds into gas chromatograph by Method 5030 or direct injection
7.4.2
Follow Section 7.6 in Method 8000 for analysis sequence, etc.
A
A
7.4.4
Record volume purged or injected and peak sizes
7.4.5
Calculate concentration (Section 7.8, Method 8000)
B
7.4.6
Are analytical interferences suspected?
Yes
7.4.6
Analyze using second GC column
No
7.4.7
Is response for a peak off-scale?
Yes
7.4.7
Dilute second aliquot of sample
No
Stop

NONHALOGENATED VOLATILE ORGANICS

1.0 SCOPE AND APPLICATION

1.1 Method 8015 is used to determine the concentration of various nonhalogenated volatile organic compounds. Table 1 indicates the compounds that may be investigated by this method.

2.0 SUMMARY OF METHOD

2.1 Method 8015 provides gas chromatographic conditions for the detection of certain nonhalogenated volatile organic compounds. Samples may be analyzed using direct injection or purge-and-trap (Method 5030). Ground water samples must be analyzed by Method 5030. A temperature program is used in the gas chromatograph to separate the organic compounds. Detection is achieved by a flame ionization detector (FID).

2.2 If interferences are encountered, the method provides an optional gas chromatographic column that may be helpful in resolving the analytes from interferences that may occur and for analyte confirmation.

3.0 INTERFERENCES

3.1 Refer to Method 5030 and 8000.

3.2 Samples can be contaminated by diffusion of volatile organics (particularly chlorofluorocarbons and methylene chloride) through the sample container septum during shipment and storage. A field sample blank prepared from reagent water and carried through sampling and subsequent storage and handling can serve as a check on such contamination.

4.0 APPARATUS AND MATERIALS

4.1 Gas chromatograph:

4.1.1 **Gas Chromatograph:** Analytical system complete with gas chromatograph suitable for on-column injections or purge-and-trap sample introduction and all required accessories, including detectors, column supplies, recorder, gases, and syringes. A data system for measuring peak heights and/or peak areas is recommended.

4.1.2 **Columns:**

4.1.2.1 Column 1: 8-ft x 0.1-in I.D. stainless steel or glass column packed with 1% SP-1000 on Carbopack-B 60/80 mesh or equivalent.

TABLE 1. NONHALOGENATED VOLATILE ORGANICS

Acrylamide
Diethyl ether
Ethanol
Methyl ethyl ketone (MEK)
Methyl isobutyl ketone (MIBK)
Paraldehyde (trimer of acetaldehyde)

4.1.2.2 Column 2: 6-ft x 0.1-in I.D. stainless steel or glass column packed with n-octane on Porasil-C 100/120 mesh (Durapak) or equivalent.

4.1.3 **Detector:** Flame ionization (FID).

4.2 Sample introduction apparatus: Refer to Method 5030 for the appropriate equipment for sample introduction purposes.

4.3 Syringes: A 5-mL Luerlok glass hypodermic and a 5-mL, gas-tight with shutoff valve.

4.4 Volumetric flask: 10-, 50-, 100-, 500-, and 1,000-mL with a ground-glass stopper.

4.5 Microsyringe: 10- and 25-uL with a 0.006-in I.D. needle (Hamilton 702N or equivalent) and a 100-uL.

5.0 REAGENTS

5.1 Reagent water: Reagent water is defined as a water in which an interferent is not observed at the method detection limit (MDL) of the analytes of interest.

5.2 Stock standards: Stock solutions may be prepared from pure standard materials or purchased as certified solutions. Prepare stock standards in methanol using assayed liquids.

5.2.1 Place about 9.8 mL of methanol in a 10-mL tared ground-glass-stoppered volumetric flask. Allow the flask to stand, unstoppered, for about 10 min or until all alcohol-wetted surfaces have dried. Weigh the flask to the nearest 0.1 mg.

5.2.2 Using a 100-uL syringe, immediately add two or more drops of assayed reference material to the flask; then reweigh. The liquid must fall directly into the alcohol without contacting the neck of the flask.

5.2.3 Reweigh, dilute to volume, stopper, and then mix by inverting the flask several times. Calculate the concentration in micrograms per microliter (ug/uL) from the net gain in weight. When compound purity is assayed to be 96% or greater, the weight may be used without correction to calculate the concentration of the stock standard. Commercially prepared stock standards may be used at any concentration if they are certified by the manufacturer or by an independent source.

5.2.4 Transfer the stock standard solution into a Teflon-sealed screw-cap bottle. Store, with minimal headspace, at -10°C to -20°C and protect from light.

5.2.5 Standards must be replaced after 6 months, or sooner if comparison with check standards indicates a problem.

5.3 Secondary dilution standards: Using stock standard solutions, prepare in methanol secondary dilution standards, as needed, that contain the compounds of interest, either singly or mixed together. The secondary dilution standards should be prepared at concentrations such that the aqueous calibration standards prepared in Section 5.4 will bracket the working range of the analytical system. Secondary dilution standards should be stored with minimal headspace for volatiles and should be checked frequently for signs of degradation or evaporation, especially just prior to preparing calibration standards from them.

5.4 Calibration standards: Calibration standards at a minimum of five concentration levels are prepared in reagent water from the secondary dilution of the stock standards. One of the concentration levels should be at a concentration near, but above, the method detection limit. The remaining concentration levels should correspond to the expected range of concentrations found in real samples or should define the working range of the GC. Each standard should contain each analyte for detection by this method (e.g., some or all of the compounds listed in Table 1 may be included). In order to prepare accurate aqueous standard solutions, the following precautions must be observed.

5.4.1 Do not inject more than 20 uL of alcoholic standards into 100 mL of reagent water.

5.4.2 Use a 25-uL Hamilton 702N microsyringe or equivalent (variations in needle geometry will adversely affect the ability to deliver reproducible volumes of methanolic standards into water).

5.4.3 Rapidly inject the alcoholic standard into the filled volumetric flask. Remove the needle as fast as possible after injection.

5.4.4 Mix aqueous standards by inverting the flask three times only.

5.4.5 Fill the sample syringe from the standard solution contained in the expanded area of the flask (do not use any solution contained in the neck of the flask).

5.4.6 Never use pipets to dilute or transfer samples or aqueous standards.

5.4.7 Aqueous standards are not stable and should be discarded after 1 hr, unless properly sealed and stored. The aqueous standards can be stored up to 24 hr, if held in sealed vials with zero headspace.

5.5 Internal standards (if internal standard calibration is used): To use this approach, the analyst must select one or more inter$l standards that are similar in analytical behavior to the compounds of interest. The analyst must further demonstrate that the measurement of the internal standard is not affected by method or matrix interferences. Because of these limitations, no internal standard can be suggested that is applicable to all samples.

5.5.1 Prepare calibration standards at a minimum of five concentration levels for each parameter of interest as described in Section 5.4.

5.5.2 Prepare a spiking solution containing each of the internal standards using the procedures described in Sections 5.2 and 5.3. It is recommended that the secondary dilution standard be prepared at a concentration of 15 ug/mL of each internal standard compound. The addition of 10 uL of this standard to 5.0 mL of sample or calibration standard would be equivalent to 30 ug/L.

5.5.3 Analyze each calibration standard according to Section 7.0, adding 10 uL of internal standard spiking solution directly to the syringe.

5.6 Surrogate standards: The analyst should monitor both the performance of the analytical system and the effectiveness of the method in dealing with each sample matrix by spiking each sample, standard, and reagent water blank with one or two surrogate compounds recommended to encompass the range of temperature program used in this method. From stock standard solutions prepared as in Section 5.2, add a volume to give 750 ug of each surrogate to 45 mL of reagent water contained in a 50-mL volumetric flask, mix, and dilute to volume for a concentration of 15 ng/uL. Add 10 uL of this surrogate spiking solution directly into the 5-mL syringe with every sample and reference standard analyzed. If the internal standard calibration procedure is used, the surrogate compounds may be added directly to the internal standard spiking solution (Paragraph 5.5.2).

5.7 Methanol: pesticide quality or equivalent. Store away from other solvents.

6.0 SAMPLE COLLECTION, PRESERVATION, AND HANDLING

6.1 See the introductory material to this chapter, Organic Analytes, Section 4.1.

7.0 PROCEDURE

7.1 Volatile compounds are introduced into the gas chromatograph either by direct injection or purge-and-trap (Method 5030). Method 5030 may be used directly on ground water samples or low-level contaminated soils and sediments. For medium-level soils or sediments, methanolic extraction, as described in Method 5030, may be necessary prior to purge-and-trap analysis.

7.2 Gas chromatography conditions (Recommended):

7.2.1 **Column 1:** Set helium gas flow at 40 mL/min flow rate. Set column temperature at 45°C for 3 min; then program an 8°C/min temperature rise to 220°C and hold for 15 min.

7.2.2 Column 2: Set helium gas flow at 40 mL/min flow rate. Set column temperature at 50°C for 3 min; then program a 6°C/min temperature rise to 170°C and hold for 4 min.

7.3 Calibration: Refer to Method 8000 for proper calibration techniques.

7.3.1 Calibration must take place using the same sample introduction method that will be used to analyze actual samples (see Section 7.4.1).

7.3.2 The procedure for internal or external calibration may be used. Refer to Method 8000 for a description of each of these procedures.

7.4 Gas chromatographic analysis:

7.4.1 Introduce volatile compounds into the gas chromatograph using either Method 5030 (purge-and-trap method) or the direct injection method. If the internal standard calibration technique is used, add 10 uL of internal standard to the sample prior to purging.

7.4.1.1 Direct injection: In very limited applications (e.g., aqueous process wastes), direct injection of the sample into the GC system with a 10 uL syringe may be appropriate. One such application is for verification of the alcohol content of an aqueous sample prior to determining if the sample is ignitable (Methods 1010 or 1020). In this case, it is suggested that direct injection be used. The detection limit is very high (approximately 10,000 ug/L); therefore, it is only permitted when concentrations in excess of 10,000 ug/L are expected or for water-soluble compounds that do not purge. The system must be calibrated by direct injection (bypassing the purge-and-trap device).

7.4.2 Follow Section 7.6 in Method 8000 for instructions on the analysis sequence, appropriate dilutions, establishing daily retention time windows, and identification criteria. Include a mid-level standard after each group of 10 samples in the analysis sequence.

7.4.3 Record the sample volume purged or injected and the resulting peak sizes (in area units or peak heights).

7.4.4 Calculation of concentration is covered in Section 7.8 of Method 8000.

7.4.5 If analytical interferences are suspected, or for the purpose of confirmation, analysis using the second GC column is recommended.

7.4.6 If the response for a peak is off-scale, prepare a dilution of the sample with reagent water. The dilution must be performed on a second aliquot of the sample which has been properly sealed and stored prior to use.

8.0 QUALITY CONTROL

8.1 Refer to Chapter One for specific quality control procedures and Method 8000 for gas chromatographic procedures. Quality control to ensure the proper operation of the purge-and-trap device is covered in Method 5030.

8.2 Mandatory quality control to validate the GC system operation is found in Method 8000, Section 8.6.

8.3 Calculate surrogate standard recovery on all samples, blanks, and spikes. Determine if recovery is within limits (limits established by performing QC procedure outlined in Method 8000, Section 8.10).

8.3.1 If recovery is not within limits, the following is required.

- Check to be sure there are no errors in calculations, surrogate solutions and internal standards. Also, check instrument performance.
- Recalculate the data and/or reanalyze the extract if any of the above checks reveal a problem.
- Reextract and reanalyze the sample if none of the above are a problem or flag the data as "estimated concentration."

9.0 METHOD PERFORMANCE

9.1 The accuracy and precision obtained will be determined by the sample matrix, sample introduction technique, and calibration procedures used.

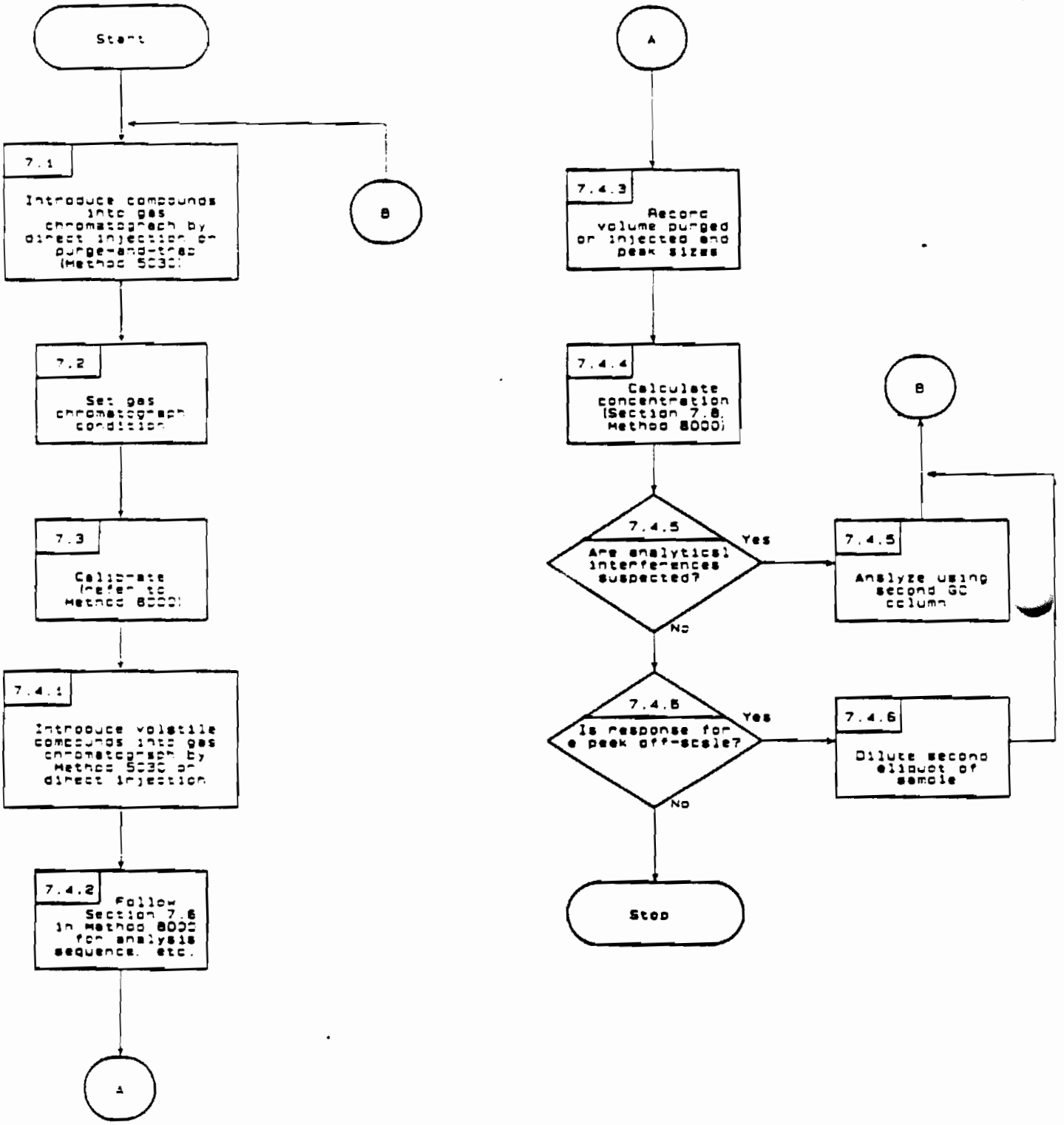
9.2 Specific method performance information will be provided as it becomes available.

10.0 REFERENCES

1. Bellar, T.A., and J.J. Lichtenberg, J. Amer. Water Works Assoc., 66(12), pp. 739-744, 1974.

2. Bellar, T.A., and J.J. Lichtenberg, Semi-Automated Headspace Analysis of Drinking Waters and Industrial Waters for Purgeable Volatile Organic Compounds, in Van Hall, ed., Measurement of Organic Pollutants in Water and Wastewater, ASTM STP 686, pp. 108-129, 1979.

3. Development and Application of Test Procedures for Specific Organic Toxic Substances in Wastewaters: Category 11 - Purgeables and Category 12 - Acrolein, Acrylonitrile, and Dichlorodifluoromethane, Report for EPA Contract 68-03-2635 (in preparation).


Start
7.1
Introduce compounds into gas chromatograph by direct injection or purge-and-trap (Method 5030)
B
7.2
Set gas chromatograph condition
7.3
Calibrate (refer to Method 8000)
7.4.1
Introduce volatile compounds into gas chromatograph by Method 5030 or direct injection
7.4.2
Follow Section 7.6 in Method 8000 for analysis sequence, etc.
A
A
7.4.3
Record volume purged or injected and peak sizes
7.4.4
Calculate concentration (Section 7.8, Method 8000)
7.4.5
Are analytical interferences suspected?
Yes
No
7.4.5
Analyze using second GC column
B
7.4.6
Is response for a peak off-scale?
Yes
No
7.4.6
Dilute second aliquot of sample
Stop

METHOD 8020

AROMATIC VOLATILE ORGANICS

1.0 SCOPE AND APPLICATION

1.1 Method 8020 is used to determine the concentration of various aromatic volatile organic compounds. Table 1 indicates compounds which may be determined by this method and lists the method detection limit for each compound in reagent water. Table 2 lists the practical quantitation limit (PQL) for other matrices.

2.0 SUMMARY OF METHOD

2.1 Method 8020 provides chromatographic conditions for the detection of aromatic volatile compounds. Samples can be analyzed using direct injection or purge-and-trap (Method 5030). Ground water samples must be determined using Method 5030. A temperature program is used in the gas chromatograph to separate the organic compounds. Detection is achieved by a photo-ionization detector (PID).

2.2 If interferences are encountered, the method provides an optional gas chromatographic column that may be helpful in resolving the analytes from the interferences and for analyte confirmation.

3.0 INTERFERENCES

3.1 Refer to Method 5030 and 8000.

3.2 Samples can be contaminated by diffusion of volatile organics (particularly chlorofluorocarbons and methylene chloride) through the sample container septum during shipment and storage. A field sample blank prepared from reagent water and carried through sampling and subsequent storage and handling can serve as a check on such contamination.

4.0 APPARATUS AND MATERIALS

4.1 Gas chromatograph:

4.1.1 **Gas Chromatograph:** Analytical system complete with gas chromatograph suitable for on-column injections or purge-and-trap sample introduction and all required accessories, including detectors, column supplies, recorder, gases, and syringes. A data system for measuring peak heights and/or peak areas is recommended.

TABLE 1. CHROMATOGRAPHIC CONDITIONS AND METHOD DETECTION LIMITS FOR AROMATIC VOLATILE ORGANICS

Compound	Retention time (min) Col. 1	Retention time (min) Col. 2	Method detection limit[a] (ug/L)
Benzene	3.33	2.75	0.2
Chlorobenzene	9.17	8.02	0.2
1,4-Dichlorobenzene	16.8	16.2	0.3
1,3-Dichlorobenzene	18.2	15.0	0.4
1,2-Dichlorobenzene	25.9	19.4	0.4
Ethyl Benzene	8.25	6.25	0.2
Toluene	5.75	4.25	0.2
Xylenes			

[a] Using purge-and-trap method (Method 5030).

TABLE 2. DETERMINATION OF PRACTICAL QUANTITATION LIMITS (PQL) FOR VARIOUS MATRICES[a]

Matrix	Factor[b]
Ground water	10
Low-level soil	10
Water miscible liquid waste	500
High-level soil and sludge	1250
Non-water miscible waste	1250

[a]Sample PQLs are highly matrix-dependent. The PQLs listed herein are provided for guidance and may not always be achievable.

[b]PQL = [Method detection limit (Table 1)] X [Factor (Table 2)]. For non-aqueous samples, the factor is on a wet-weight basis.

4.1.2 Columns:

4.1.2.1 Column 1: 6-ft x 0.082-in I.D. #304 stainless steel or glass column packed with 5% SP-1200 and 1.75% Bentone-34 on 100/120 mesh Supelcort or equivalent.

4.1.2.2 Column 2: 8-ft x 0.1-in I.D. stainless steel or glass column packed with 5% 1,2,3-Tris(2-cyanoethoxy)propane on 60/80 mesh Chromosorb W-AW or equivalent.

4.1.3 Detector: Photoionization (PID) (h-Nu Systems, Inc. Model PI-51-02 or equivalent).

4.2 Sample introduction apparatus: Refer to Method 5030 for the appropriate equipment for sample introduction purposes.

4.3 Syringes: A 5-mL Luerlok glass hypodermic and a 5-mL, gas-tight with shutoff valve.

4.4 Volumetric flask: 10-, 50-, 100-, 500-, and 1,000-mL with a ground-glass stopper.

4.5 Microsyringe: 10- and 25-uL with a 0.006-in I.D. needle (Hamilton 702N or equivalent) and a 100-uL.

5.0 REAGENTS

5.1 Reagent water: Reagent water is defined as a water in which an interferent is not observed at the method detection limit (MDL) of the parameters of interest.

5.2 Stock standards: Stock solutions may be prepared from pure standard materials or purchased as certified solutions. Prepare stock standards in methanol using assayed liquids. Because of the toxicity of benzene and 1,4-dichlorobenzene, primary dilutions of these materials should be prepared in a hood.

5.2.1 Place about 9.8 mL of methanol in a 10-mL tared ground-glass-stoppered volumetric flask. Allow the flask to stand, unstoppered, for about 10 min or until all alcohol-wetted surfaces have dried. Weigh the flask to the nearest 0.1 mg.

5.2.2 Using a 100-uL syringe, immediately add two or more drops of assayed reference material to the flask; then reweigh. The liquid must fall directly into the alcohol without contacting the neck of the flask.

5.2.3 Reweigh, dilute to volume, stopper, and then mix by inverting the flask several times. Calculate the concentration in micrograms per microliter (ug/uL) from the net gain in weight. When compound purity is assayed to be 96% or greater, the weight may be used without correction

to calculate the concentration of the stock standard. Commercially prepared stock standards may be used at any concentration if they are certified by the manufacturer or by an independent source.

5.2.4 Transfer the stock standard solution into a Teflon-sealed screw-cap bottle. Store, with minimal headspace, at 4°C and protect from light.

5.2.5 All standards must be replaced after 6 months, or sooner if comparison with check standards indicates a problem.

5.3 Secondary dilution standards: Using stock standard solutions, prepare in methanol secondary dilution standards, as needed, that contain the compounds of interest, either singly or mixed together. The secondary dilution standards should be prepared at concentrations such that the aqueous calibration standards prepared in Paragraph 5.4 will bracket the working range of the analytical system. Secondary dilution standards should be stored with minimal headspace for volatiles and should be checked frequently for signs of degradation or evaporation, especially just prior to preparing calibration standards from them.

5.4 Calibration standards: Calibration standards at a minimum of five concentration levels are prepared in reagent water from the secondary dilution of the stock standards. One of the concentration levels should be at a concentration near, but above, the method detection limit. The remaining concentration levels should correspond to the expected range of concentrations found in real samples or should define the working range of the GC. Each standard should contain each analyte for detection by this method (e.g., some or all of the compounds listed in Table 1 may be included). In order to prepare accurate aqueous standard solutions, the following precautions must be observed.

5.4.1 Do not inject more than 20 uL of alcoholic standards into 100 mL of reagent water.

5.4.2 Use a 25-uL Hamilton 702N microsyringe or equivalent (variations in needle geometry will adversely affect the ability to deliver reproducible volumes of methanolic standards into water).

5.4.3 Rapidly inject the alcoholic standard into the filled volumetric flask. Remove the needle as fast as possible after injection.

5.4.4 Mix aqueous standards by inverting the flask three times only.

5.4.5 Fill the sample syringe from the standard solution contained in the expanded area of the flask (do not use any solution contained in the neck of the flask).

5.4.6 Never use pipets to dilute or transfer samples or aqueous standards.

5.4.7 Aqueous standards are not stable and should be discarded after 1 hr, unless properly sealed and stored. The aqueous standards can be stored up to 24 hr, if held in sealed vials with zero headspace.

5.5 Internal standards (if internal standard calibration is used): To use this approach, the analyst must select one or more internal standards that are similar in analytical behavior to the compounds of interest. The analyst must further demonstrate that the measurement of the internal standard is not affected by method or matrix interferences. Because of these limitations, no internal standard can be suggested that is applicable to all samples. The compound, alpha,alpha,alpha-trifluorotoluene recommended for use as a surrogate spiking compound (Paragraph 5.6) has been used successfully as an internal standards.

5.5.1 Prepare calibration standards at a minimum of five concentration levels for each parameter of interest as described in Section 5.4.

5.5.2 Prepare a spiking solution containing each of the internal standards using the procedures described in Sections 5.2 and 5.3. It is recommended that the secondary dilution standard be prepared at a concentration of 15 ug/mL of each internal standard compound. The addition of 10 uL of this standard to 5.0 mL of sample or calibration standard would be equivalent to 30 ug/L.

5.5.3 Analyze each calibration standard according to Section 7.0, adding 10 uL of internal standard spiking solution directly to the syringe.

5.6 Surrogate standards: The analyst should monitor both the performance of the analytical system and the effectiveness of the method in dealing with each sample matrix by spiking each sample, standard, and reagent water blank with surrogate compounds (e.g, alpha,alpha,alpha-trifluorotoluene) recommended to encompass the range of the temperature program used in this method. From stock standard solutions prepared as in Section 5.2, add a volume to give 750 ug of each surrogate to 45 mL of reagent water contained in a 50-mL volumetric flask, mix, and dilute to volume for a concentration of 15 ng/uL. Add 10 uL of this surrogate spiking solution directly into the 5-mL syringe with every sample and reference standard analyzed. If the internal standard calibration procedure is used, the surrogate compounds may be added directly to the internal standard spiking solution (Paragraph 5.5.2).

5.7 Methanol: pesticide quality or equivalent. Store away from other solvents.

6.0 SAMPLE COLLECTION, PRESERVATION, AND HANDLING

6.1 See the introductory material to this chapter, Organic Analytes, Section 4.1.

7.0 PROCEDURE

7.1 Volatile compounds are introduced into the gas chromatograph either by direct injection or purge-and-trap (Method 5030). Method 5030 may be used directly on ground water samples or low-level contaminated soils and sediments. For medium-level soils or sediments, methanolic extraction, as described in Method 5030, may be necessary prior to purge-and-trap analysis.

7.2 Gas chromatography conditions (Recommended):

7.2.1 **Column 1:** Set helium gas flow at 36 mL/min flow rate. The temperature program sequences are as follows: For lower boiling compounds, operate at 50°C isothermal for 2 min; then program at 6°C/min to 90°C and hold until all compounds have eluted. For higher boiling range of compounds, operate at 50°C isothermal for 2 min; then program at 3°C/min to 110°C and hold until all compounds have eluted. Column 1 provides outstanding separations for a wide variety of aromatic hydrocarbons. Column 1 should be used as the primary analytical column because of its unique ability to resolve para-, meta-, and ortho-aromatic isomers.

7.2.2 **Column 2:** Set helium gas flow at 30 mL/min flow rate. The temperature program sequence is as follows: 40°C isothermal for 2 min; then 2°C/min to 100°C and hold until all compounds have eluted. Column 2, an extremely high-polarity column, has been used for a number of years to resolve aromatic hydrocarbons from alkanes in complex samples. However, because resolution between some of the aromatics is not as efficient as with Column 1, Column 2 should be used as a confirmatory column.

7.3 Calibration: Refer to Method 8000 for proper calibration techniques. Use Table 1 and especially Table 2 for guidance on selecting the lowest point on the calibration curve.

7.3.1 Calibration must take place using the same sample introduction method that will be used to analyze actual samples (see Section 7.4.1).

7.3.2 The procedure for internal or external calibration may be used. Refer to Method 8000 for a description of each of these procedures.

7.4 Gas chromatographic analysis:

7.4.1 Introduce volatile compounds into the gas chromatograph using either Method 5030 (purge-and-trap method) or the direct injection method. If the internal standard calibration technique is used, add 10 uL of internal standard to the sample prior to purging.

7.4.1.1 Direct injection: In very limited applications (e.g., aqueous process wastes), direct injection of the sample into the GC system with a 10 uL syringe may be appropriate. The detection limit is very high (approximately 10,000 ug/L); therefore, it is only permitted when concentrations in excess of 10,000 ug/L are expected or for water-soluble compounds that do not purge. The system must be calibrated by direct injection (bypassing the purge-and-trap device).

7.4.2 Follow Section 7.6 of Method 8000 for instructions on the analysis sequence, appropriate dilutions, establishing daily retention time windows, and identification criteria. Include a mid-level standard after each group of 10 samples in the analysis sequence.

7.4.3 Table 1 summarizes the estimated retention times and detection limits for a number of organic compounds analyzable using this method. An example of the separation achieved by Column 1 is shown in Figure 1. Figure 2 shows an example of the separation achieved using Column 2.

7.4.4 Record the sample volume purged or injected and the resulting peak sizes (in area units or peak heights).

7.4.5 Calculation of concentration is covered in Section 7.8 of Method 8000.

7.4.6 If analytical interferences are suspected, or for the purpose of confirmation, analysis using the second GC column is recommended.

7.4.7 If the response for a peak is off-scale, prepare a dilution of the sample with reagent water. The dilution must be performed on a second aliquot of the sample which has been properly sealed and stored prior to use.

8.0 QUALITY CONTROL

8.1 Refer to Chapter One for specific quality control procedures and Method 8000 for gas chromatographic procedures. Quality control to ensure the proper operation of the purge-and-trap device is covered in Method 5030.

8.2 Mandatory quality control to validate the GC system operation is found in Method 8000, Section 8.6.

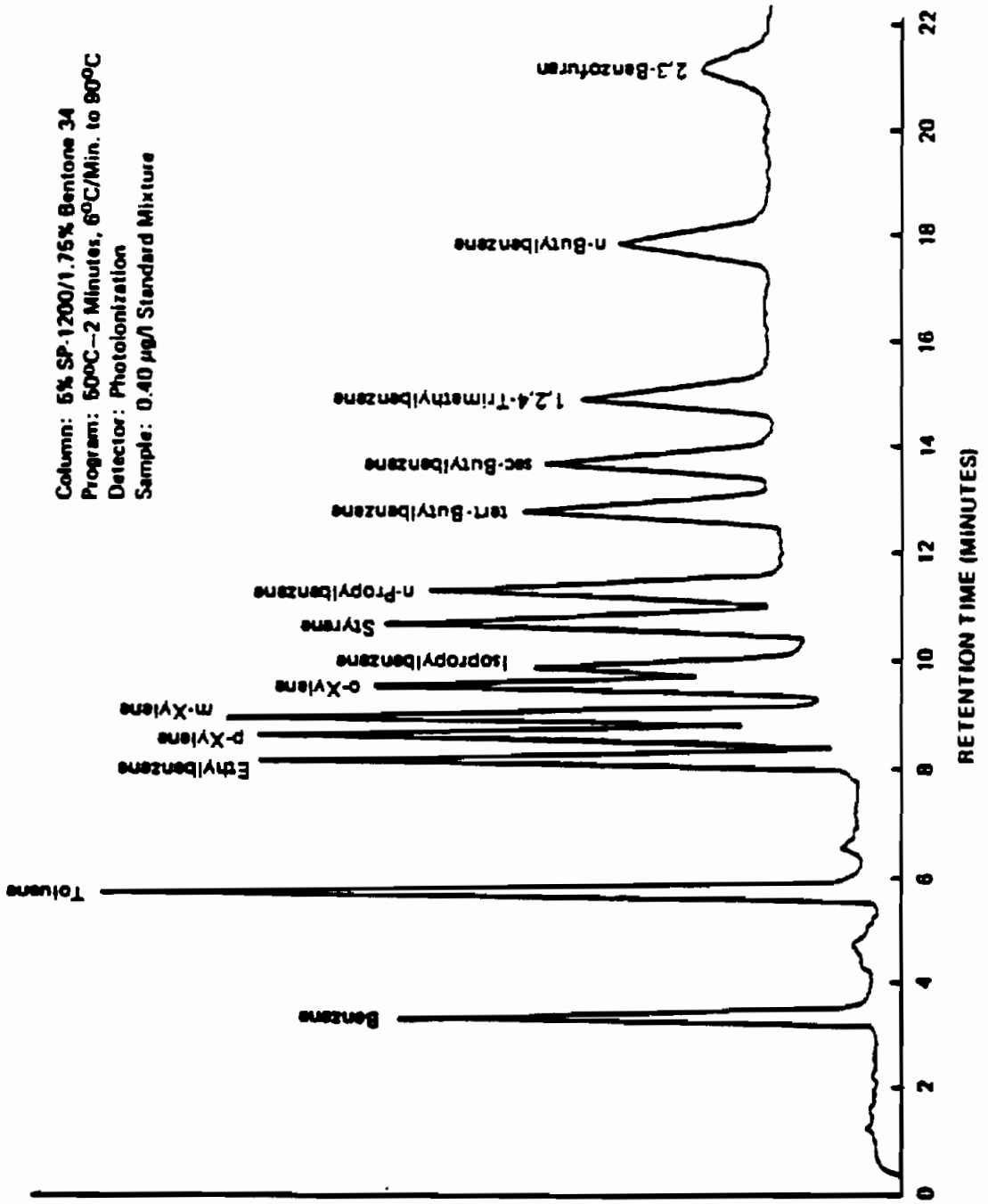


Figure 1. Chromatogram of aromatic volatile organics (column 1 conditions).

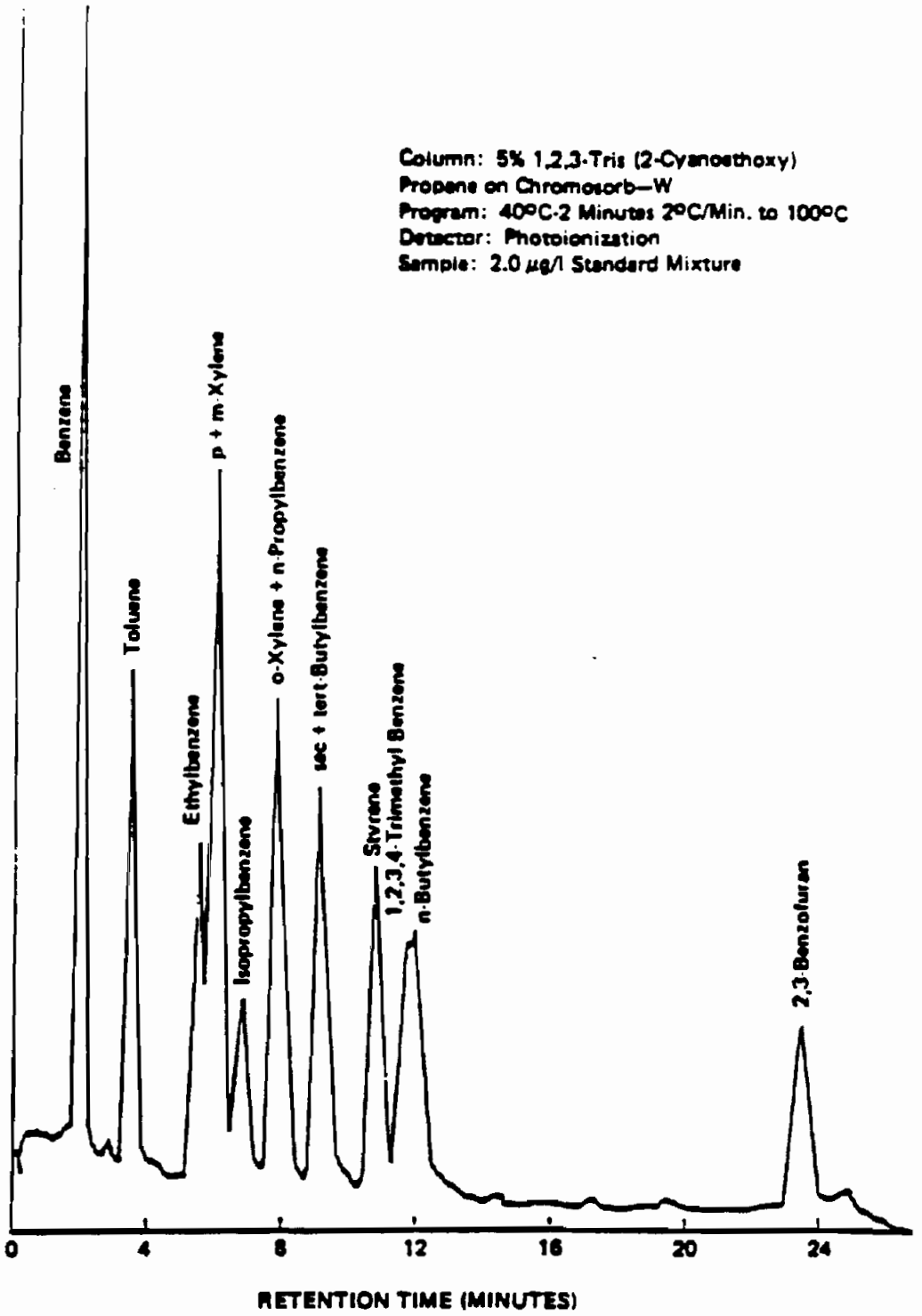


Figure 2. Chromatogram of aromatic volatile organics (column 2 conditions).

8.2.1 The quality control check sample concentrate (Method 8000, Section 8.6) should contain each parameter of interest at a concentration of 10 ug/mL in methanol.

8.2.2 Table 3 indicates the calibration and QC acceptance criteria for this method. Table 4 gives method accuracy and precision as functions of concentration for the analytes of interest. The contents of both Tables should be used to evaluate a laboratory's ability to perform and generate acceptable data by this method.

8.3 Calculate surrogate standard recovery on all samples, blanks, and spikes. Determine if recovery is within limits (limits established by performing QC procedure outlined in Method 8000, Section 8.10).

8.3.1 If recovery is not within limits, the following is required.

- Check to be sure there are no errors in calculations, surrogate solutions and internal standards. Also, check instrument performance.
- Recalculate the data and/or reanalyze the extract if any of the above checks reveal a problem.
- Reextract and reanalyze the sample if none of the above are a problem or flag the data as "estimated concentration."

9.0 METHOD PERFORMANCE

9.1 This method was tested by 20 laboratories using reagent water, drinking water, surface water, and three industrial wastewaters spiked at six concentrations over the range 2.1-500 ug/L. Single operator precision, overall precision, and method accuracy were found to be directly related to the concentration of the parameter and essentially independent of the sample matrix. Linear equations to describe these relationships are presented in Table 4.

9.2 The accuracy and precision obtained will be determined by the sample matrix, sample introduction technique, and by the calibration procedure used.

10.0 REFERENCES

1. Bellar, T.A., and J.J. Lichtenberg, J. Amer. Water Works Assoc., 66(12), pp. 739-744, 1974.

2. Bellar, T.A., and J.J. Lichtenberg, Semi-Automated Headspace Analysis of Drinking Waters and Industrial Waters for Purgeable Volatile Organic Compounds, in Van Hall (ed.), Measurement of Organic Pollutants in Water and Wastewater, ASTM STP 686, pp. 108-129, 1979.

3. Dowty, B.J., S.R. Antoine, and J.L. Laseter, "Quantitative and Qualitative Analysis of Purgeable Organics by High Resolution Gas Chromatography and Flame Ionization Detection," in Van Hall, ed., Measurement of Organic Pollutants in Water and Wastewater. ASTM STP 686, pp. 24-35, 1979.

4. Development and Application of Test Procedures for Specific Organic Toxic Substances in Wastewaters. Category 11 - Purgeables and Category 12 - Acrolein, Acrylonitrile, and Dichlorodifluoromethane. Report for EPA Contract 68-03-2635 (in preparation).

5. "EPA Method Validation Study 24, Method 602 (Purgeable Aromatics)," Report for EPA Contract 68-03-2856 (in preparation).

6. U.S. EPA 40 CFR Part 136, "Guidelines Establishing Test Procedures for the Analysis of Pollutants Under the Clean Water Act; Final Rule and Interim Final Rule and Proposed Rule," October 26, 1984.

7. Provost, L.P., and R.S. Elder, "Interpretation of Percent Recovery Data," American Laboratory, 15, pp. 58-63, 1983.

TABLE 3. CALIBRATION AND QC ACCEPTANCE CRITERIA[a]

Parameter	Range for Q (ug/L)	Limit for s (ug/L)	Range for $\bar{X}$ (ug/L)	Range P, P_s (%)
Benzene	15.4-24.6	4.1	10.0-27.9	39-150
Chlorobenzene	16.1-23.9	3.5	12.7-25.4	55-135
1,2-Dichlorobenzene	13.6-26.4	5.8	10.6-27.6	37-154
1,3-Dichlorobenzene	14.5-25.5	5.0	12.8-25.5	50-141
1,4-Dichlorobenzene	13.9-26.1	5.5	11.6-25.5	42-143
Ethylbenzene	12.6-27.4	6.7	10.0-28.2	32-160
Toluene	15.5-24.5	4.0	11.2-27.7	46-148

Q = Concentration measured in QC check sample, in ug/L.

s = Standard deviation of four recovery measurements, in ug/L.

$\bar{X}$ = Average recovery for four recovery measurements, in ug/L.

P, P_s = Percent recovery measured.

[a]Criteria are from 40 CFR Part 136 for Method 602 and were calculated assuming a QC check sample concentration of 20 ug/L. These criteria are based directly upon the method performance data in Table 4. Where necessary, the limits for recovery have been broadened to assure applicability of the limits to concentrations below those used to develop Table 1.

TABLE 4. METHOD ACCURACY AND PRECISION AS FUNCTIONS OF CONCENTRATION

Parameter	Accuracy, as recovery, x' (ug/L)	Single analyst precision, s_r' (ug/L)	Overall precision, S' (ug/L)
Benzene	0.92C+0.57	0.09$\bar{X}$+0.59	0.21$\bar{X}$+0.56
Chlorobenzene	0.95C+0.02	0.09$\bar{X}$+0.23	0.17$\bar{X}$+0.10
1,2-Dichlorobenzene	0.93C+0.52	0.17$\bar{X}$-0.04	0.22$\bar{X}$+0.53
1,3-Dichlorobenzene	0.96C-0.04	0.15$\bar{X}$-0.10	0.19$\bar{X}$+0.09
1,4-Dichlorobenzene	0.93C-0.09	0.15$\bar{X}$+0.28	0.20$\bar{X}$+0.41
Ethylbenzene	0.94C+0.31	0.17$\bar{X}$+0.46	0.26$\bar{X}$+0.23
Toluene	0.94C+0.65	0.09$\bar{X}$+0.48	0.18$\bar{X}$-0.71

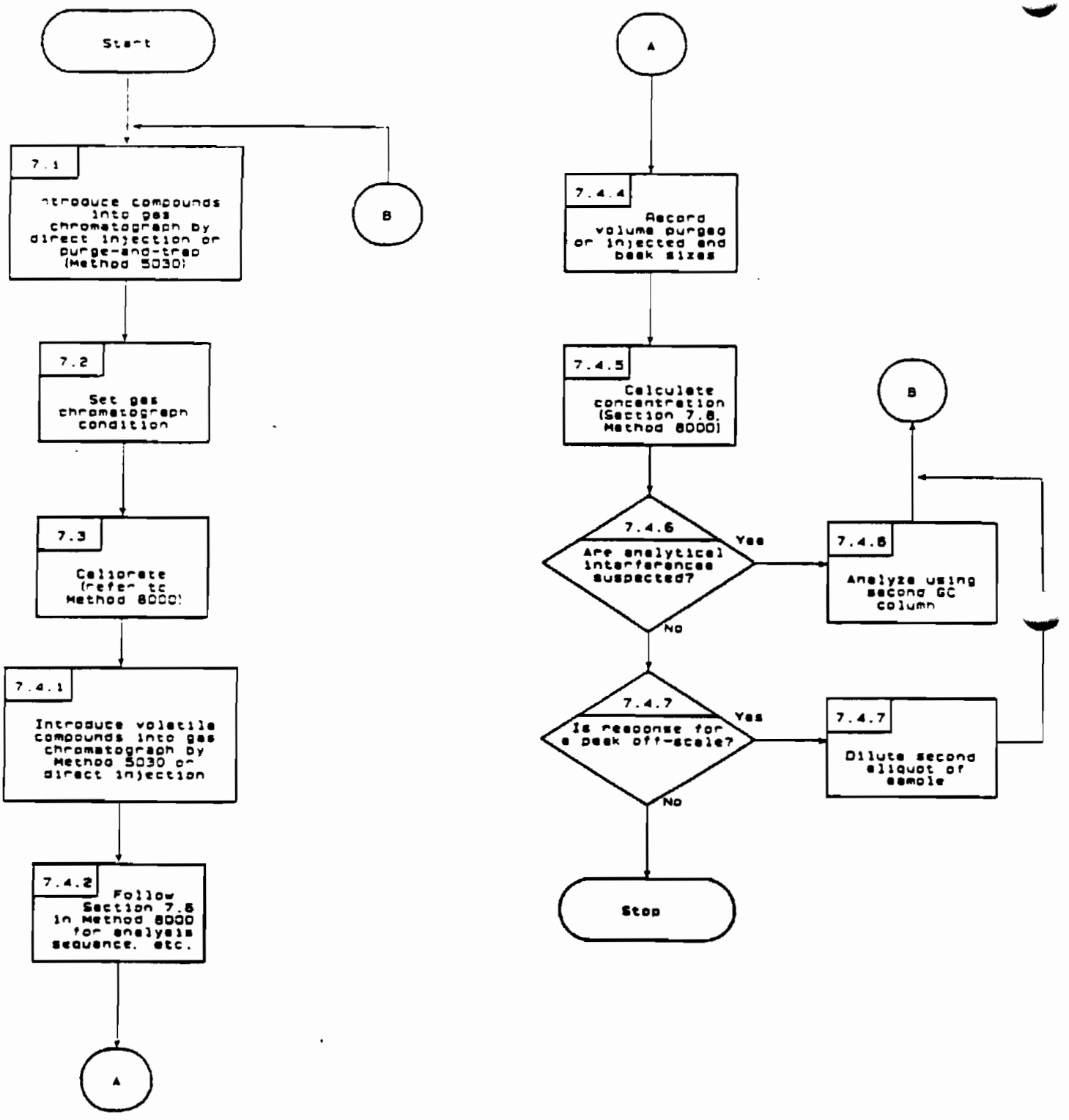
x' = Expected recovery for one or more measurements of a sample containing a concentration of C, in ug/L.

s_r' = Expected single analyst standard deviation of measurements at an average concentration of $\bar{X}$, in ug/L.

S' = Expected interlaboratory standard deviation of measurements at an average concentration found of $\bar{X}$, in ug/L.

C = True value for the concentration, in ug/L.

$\bar{X}$ = Average recovery found for measurements of samples containing a concentration of C, in ug/L.


Start
7.1
Introduce compounds into gas chromatograph by direct injection or purge-and-trap (Method 5030)
B
7.2
Set gas chromatograph condition
7.3
Calibrate (refer to Method 8000)
7.4.1
Introduce volatile compounds into gas chromatograph by Method 5030 or direct injection
7.4.2
Follow Section 7.5 in Method 8000 for analysis sequence, etc.
A
A
7.4.4
Record volume purged or injected and peak sizes
7.4.5
Calculate concentration (Section 7.8, Method 8000)
B
7.4.6
Are analytical interferences suspected?
Yes
7.4.8
Analyze using second GC column
No
7.4.7
Is response for a peak off-scale?
Yes
7.4.7
Dilute second aliquot of sample
No
Stop

METHOD 3005

ACID DIGESTION OF WATERS FOR TOTAL RECOVERABLE OR DISSOLVED METALS FOR ANALYSIS BY FLAA OR ICP SPECTROSCOPY

1.0 SCOPE AND APPLICATION

1.1 Method 3005 is an acid digestion procedure used to prepare surface water and ground water samples for analysis by flame atomic absorption spectroscopy (FAA) or by inductively coupled argon plasma spectroscopy (ICP). Samples prepared by Method 3005 may be analyzed by AAS or ICP for the following metals:

Aluminum	Magnesium
Antimony	Manganese
Arsenic*	Molybdenum
Barium	Nickel
Beryllium	Potassium
Cadmium	Selenium*
Calcium	Silver
Chromium	Sodium
Cobalt	Thallium
Copper	Vanadium
Iron	Zinc
Lead	

*ICP only

1.2 For the analysis of total dissolved metals, the sample is filtered at the time of collection, prior to acidification with nitric acid.

2.0 SUMMARY OF METHOD

2.1 Total recoverable metals: The entire sample is acidified at the time of collection with nitric acid. At the time of analysis the sample is heated with acid and substantially reduced in volume. The digestate is filtered and diluted to volume, and is then ready for analysis.

2.2 Dissolved metals: The sample is filtered through a 0.5 um filter at the time of collection and the liquid phase is then acidified at the time of collection with nitric acid. At the time of analysis the sample is heated with acid and substantially reduced in volume. The digestate is again filtered (if necessary) and diluted to volume and is then ready for analysis.

3.0 INTERFERENCES

3.1 The analyst should be cautioned that this digestion procedure may not be sufficiently vigorous to destroy some metal complexes.

4.0 APPARATUS AND MATERIALS

4.1 Griffin beakers of assorted sizes.

4.2 Watch glasses.

4.3 Qualitative filter paper and filter funnels.

5.0 REAGENTS

5.1 ASTM Type II water (ASTM D1193): Water should be monitored for impurities.

5.2 Concentrated nitric acid, reagent grade (HNO_3): Acid should be analyzed to determine level of impurities. If method blank is <MDL, then acid can be used.

5.3 Concentrated hydrochloric acid, reagent grade (HCl): Acid should be analyzed to determine level of impurities. If method blank is <MDL, then acid can be used.

6.0 SAMPLE COLLECTION, PRESERVATION, AND HANDLING

6.1 All samples must have been collected using a sampling plan that addresses the considerations discussed in Chapter Nine of this manual.

6.2 All sample containers must be prewashed with detergents, acids, and Type II water. Plastic and glass containers are both suitable.

6.3 Sampling:

6.3.1 **Total recoverable metals:** All samples must be acidified at the time of collection with HNO_3 (5 mL/L).

6.3.2 **Dissolved metals:** All samples must be filtered through a 0.5 um filter and then acidified at the time of collection with HNO_3 (5 mL/L).

7.0 PROCEDURE

7.1 Transfer a 100-mL aliquot of well-mixed sample to a beaker.

7.2 For metals that are to be analyzed by FLAA or ICP, add 2 mL of concentrated HNO_3 and 5 mL of concentrated HCl. The sample is covered with a ribbed watch glass and heated on a steam bath or hot plate at 90 to 95°C until the volume has been reduced to 15-20 mL.

CAUTION: **Do not boil. Antimony is easily lost by volatilization from hydrochloric acid media.**

7.3 Remove the beaker and allow to cool. Wash down the beaker walls and watch glass with Type II water and, when necessary, filter or centrifuge the sample to remove silicates and other insoluble material that could clog the nebulizer. Filtration should be done only if there is concern that insoluble materials may clog the nebulizer; this additional step is liable to cause sample contamination unless the filter and filtering apparatus are thoroughly cleaned and prerinsed with dilute HNO_3.

7.4 Adjust the final volume to 100 mL with Type II water.

8.0 QUALITY CONTROL

8.1 For each analytical batch of samples processed, blanks (Type II water and reagents) should be carried throughout the entire sample preparation and analytical process. These blanks will be useful in determining if samples are being contaminated.

8.2 Duplicate samples should be processed on a routine basis. A duplicate sample is a sample brought through the whole sample preparation and analytical process. Duplicate samples will be used to determine precision. The sample load will dictate the frequency, but 20% is recommended.

8.3 Spiked samples or standard reference materials should be employed to determine accuracy. A spiked sample should be included with each group of samples processed and whenever a new sample matrix is being analyzed.

9.0 METHOD PERFORMANCE

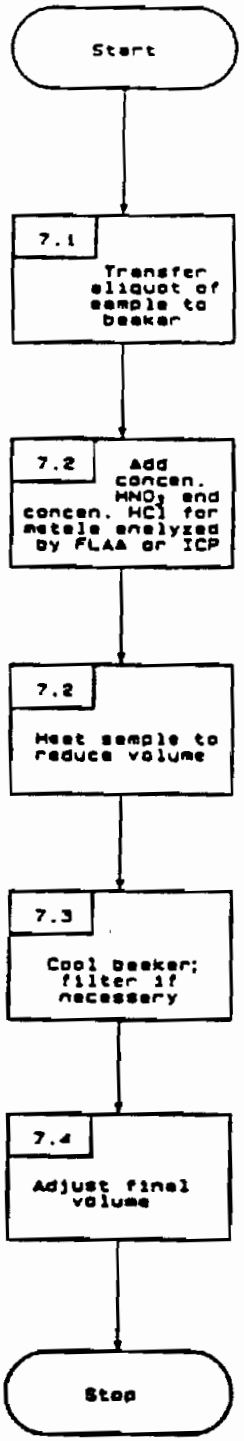
9.1 No data provided.

10.0 REFERENCES

10.1 None required.

METHOD 3005

ACID DIGESTION OF WATERS FOR TOTAL RECOVERABLE OR DISSOLVED METALS FOR ANALYSIS BY FLAA OR ICP SPECTROSCOPY



Revision 0
Date September 1986

METHOD 3050

ACID DIGESTION OF SEDIMENTS, SLUDGES, AND SOILS

1.0 SCOPE AND APPLICATION

1.1 This method is an acid digestion procedure used to prepare sediments, sludges, and soil samples for analysis by flame or furnace atomic absorption spectroscopy (FLAA and GFAA, respectively) or by inductively coupled argon plasma spectroscopy (ICP). Samples prepared by this method may be analyzed by ICP for all the listed metals, or by FLAA or GFAA as indicated below (see also Paragraph 2.1):

FLAA		GFAA
Aluminum	Magnesium	Arsenic
Barium	Manganese	Beryllium
Beryllium	Molybdenum	Cadmium
Cadmium	Nickel	Chromium
Calcium	Potassium	Cobalt
Chromium	Sodium	Iron
Cobalt	Thallium	Molybdenum
Copper	Vanadium	Selenium
Iron	Zinc	Thallium
Lead		Vanadium

2.0 SUMMARY OF METHOD

2.1 A representative 1- to 2-g (wet weight) sample is digested in nitric acid and hydrogen peroxide. The digestate is then refluxed with either nitric acid or hydrochloric acid. Dilute hydrochloric acid is used as the final reflux acid for (1) the ICP analysis of As and Se, and (2) the flame AA or ICP analysis of Al, Ba, Be, Ca, Cd, Cr, Co, Cu, Fe, Mo, Pb, Ni, K, Na, Tl, V, and Zn. Dilute nitric acid is employed as the final dilution acid for the furnace AA analysis of As, Be, Cd, Cr, Co, Pb, Mo, Se, Tl, and V. A separate sample shall be dried for a total solids determination.

3.0 INTERFERENCES

3.1 Sludge samples can contain diverse matrix types, each of which may present its own analytical challenge. Spiked samples and any relevant standard reference material should be processed to aid in determining whether Method 3050 is applicable to a given waste.

4.0 APPARATUS AND MATERIALS

4.1 Conical Phillips beakers: 250-mL.
4.2 Watch glasses.
4.3 Drying ovens: That can be maintained at 30°C.
4.4 Thermometer: That covers range of 0 to 200°C.
4.5 Whatman No. 41 filter paper (or equivalent).
4.6 Centrifuge and centrifuge tubes.

5.0 REAGENTS

5.1 ASTM Type II water (ASTM D1193): Water should be monitored for impurities.

5.2 Concentrated nitric acid, reagent grade (HNO_3): Acid should be analyzed to determine level of impurities. If method blank is <MDL, the acid can be used.

5.3 Concentrated hydrochloric acid, reagent grade (HCl): Acid should be analyzed to determine level of impurities. If method blank is <MDL, the acid can be used.

5.4 Hydrogen peroxide (30%) (H_2O_2): Oxidant should be analyzed to determine level of impurities.

6.0 SAMPLE COLLECTION, PRESERVATION, AND HANDLING

6.1 All samples must have been collected using a sampling plan that addresses the considerations discussed in Chapter Nine of this manual.

6.2 All sample containers must be prewashed with detergents, acids, and Type II water. Plastic and glass containers are both suitable. See Chapter Three, Section 3.1.3, for further information.

6.3 Nonaqeuous samples shall be refrigerated upon receipt and analyzed as soon as possible.

7.0 PROCEDURE

7.1 Mix the sample thoroughly to achieve homogeneity. For each digestion procedure, weigh to the nearest 0.01 g and transfer to a conical beaker a 1.00- to 2.00-g portion of sample.

7.2 Add 10 mL of 1:1 HNO_3, mix the slurry, and cover with a watch glass. Heat the sample to 95°C and reflux for 10 to 15 min without boiling. Allow the sample to cool, add 5 mL of concentrated HNO_3, replace the watch glass, and reflux for 30 min. Repeat this last step to ensure complete oxidation.

Using a ribbed watch glass, allow the solution to evaporate to 5 mL without boiling, while maintaining a covering of solution over the bottom of the beaker.

7.3 After Step 7.2 has been completed and the sample has cooled, add 2 mL of Type II water and 3 mL of 30% H_2O_2. Cover the beaker with a watch glass and return the covered beaker to the hot plate for warming and to start the peroxide reaction. Care must be taken to ensure that losses do not occur due to excessively vigorous effervescence. Heat until effervescence subsides and cool the beaker.

7.4 Continue to add 30% H_2O_2 in 1-mL aliquots with warming until the effervescence is minimal or until the general sample appearance is unchanged.

NOTE: Do not add more than a total of 10 mL 30% H_2O_2.

7.5 If the sample is being prepared for (a) the ICP analysis of As and Se, or (b) the flame AA or ICP analysis of Al, Ba, Be, Ca, Cd, Cr, Co, Cu, Fe, Pb, Mg, Mn, Mo, Ni, K, Na, Tl, V, and Zn, then add 5 mL of concentrated HCl and 10 mL of Type II water, return the covered beaker to the hot plate, and reflux for an additional 15 min without boiling. After cooling, dilute to 100 mL with Type II water. Particulates in the digestate that may clog the nebulizer should be removed by filtration, by centrifugation, or by allowing the sample to settle.

7.5.1 **Filtration:** Filter through Whatman No. 41 filter paper (or equivalent) and dilute to 100 mL with Type II water.

7.5.2 **Centrifugation:** Centrifugation at 2,000-3,000 rpm for 10 min is usually sufficient to clear the supernatant.

7.5.3 The diluted sample has an approximate acid concentration of 5.0% (v/v) HCl and 5.0% (v/v) HNO_3. The sample is now ready for analysis.

7.6 If the sample is being prepared for the furnace analysis of As, Be, Cd, Cr, Co, Pb, Mo, Se, Tl, and V, cover the sample with a ribbed watch glass and continue heating the acid-peroxide digestate until the volume has been reduced to approximately 5 mL. After cooling, dilute to 100 mL with Type II water. Particulates in the digestate should then be removed by filtration, by centrifugation, or by allowing the sample to settle.

7.6.1 **Filtration:** Filter through Whatman No. 41 filter paper (or equivalent) and dilute to 100 mL with Type II water.

7.6.2 **Centrifugation:** Centrifugation at 2,000-3,000 for 10 min is usually sufficient to clear the supernatant.

7.6.3 The diluted digestate solution contains approximately 5% (v/v) HNO_3. For analysis, withdraw aliquots of appropriate volume and add any required reagent or matrix modifier. The sample is now ready for analysis.

7.7 Calculations:

7.7.1 The concentrations determined are to be reported on the basis of the actual weight of the sample. If a dry weight analysis is desired, then the percent solids of the sample must also be provided.

7.7.2 If percent solids is desired, a separate determination of percent solids must be performed on a homogeneous aliquot of the sample.

8.0 QUALITY CONTROL

8.1 For each group of samples processed, preparation blanks (Type II water and reagents) should be carried throughout the entire sample preparation and analytical process. These blanks will be useful in determining if samples are being contaminated.

8.2 Duplicate samples should be processed on a routine basis. Duplicate samples will be used to determine precision. The sample load will dictate the frequency, but 20% is recommended.

8.3 Spiked samples or standard reference materials must be employed to determine accuracy. A spiked sample should be included with each group of samples processed and whenever a new sample matrix is being analyzed.

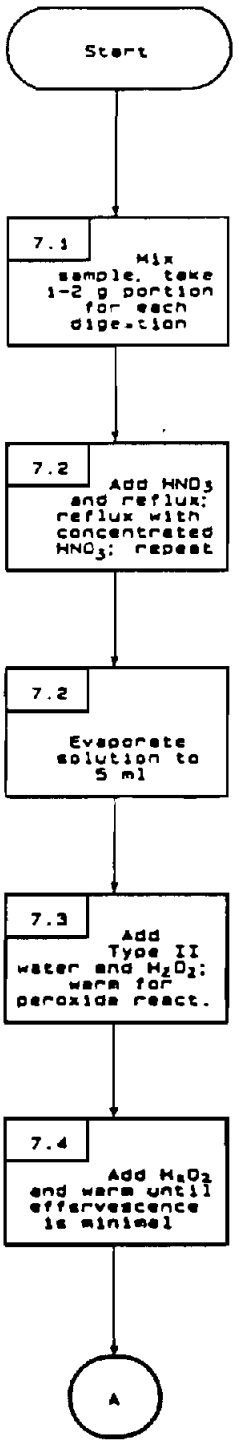
8.4 The concentration of all calibration standards should be verified against a quality control check sample obtained from an outside source.

9.0 METHOD PERFORMANCE

9.1 No data provided.

10.0 REFERENCES

10.1 None required.


Start
7.1
Mix sample, take 1-2 g portion for each digestion
7.2
Add HNO_3 and reflux: reflux with concentrated HNO_3; repeat
7.2
Evaporate solution to 5 ml
7.3
Add Type II water and H_2O_2: warm for peroxide react.
7.4
Add H_2O_2 and warm until effervescence is minimal
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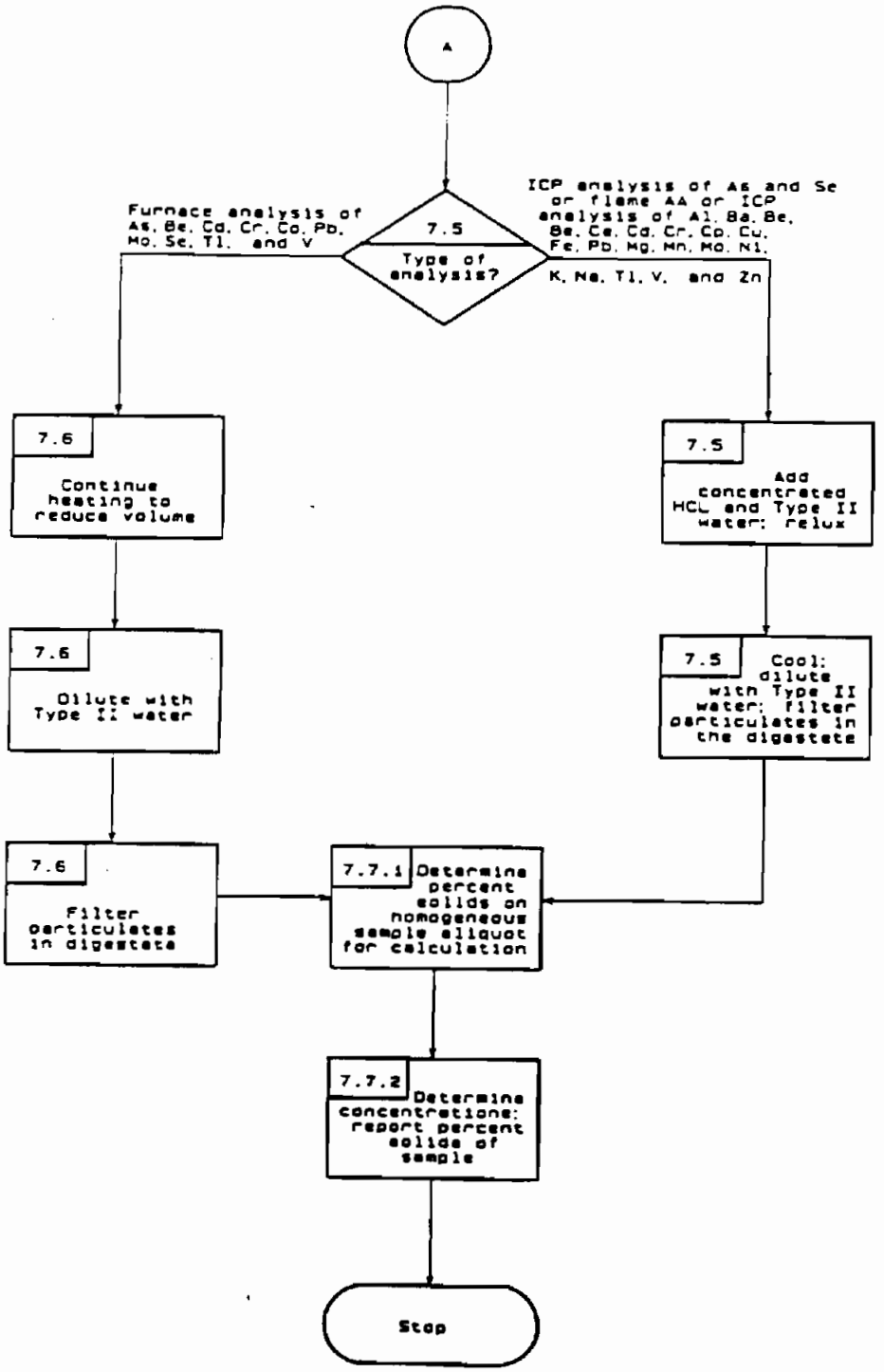
A
7.5
Type of analysis?
Furnace analysis of As, Be, Cd, Cr, Co, Pb, Mo, Se, Tl, and V
ICP analysis of As and Se or flame AA or ICP analysis of Al, Ba, Be, Be, Ca, Cd, Cr, Co, Cu, Fe, Pb, Mg, Mn, Mo, Ni, K, Na, Tl, V, and Zn
7.6 Continue heating to reduce volume
7.6 Dilute with Type II water
7.6 Filter particulates in digestate
7.5 Add concentrated HCL and Type II water; relux
7.5 Cool; dilute with Type II water; filter particulates in the digestate
7.7.1 Determine percent solids on homogeneous sample aliquot for calculation
7.7.2 Determine concentrations; report percent solids of sample
Stop

METHOD 7420

LEAD (ATOMIC ABSORPTION, DIRECT ASPIRATION)

1.0 SCOPE AND APPLICATION

1.1 See Section 1.0 of Method 7000.

2.0 SUMMARY OF METHOD

2.1 See Section 2.0 of Method 7000.

3.0 INTERFERENCES

3.1 See Section 3.0 of Method 7000 if interferences are suspected.

3.2 Background correction is required at either wavelength.

4.0 APPARATUS AND MATERIALS

4.1 For basic apparatus, see Section 4.0 of Method 7000.

4.2 Instrument parameters (general):

4.2.1 **Lead hollow cathode lamp.**
4.2.2 **Wavelength:** 283.3 nm (primary); 217.0 nm (alternate).
4.2.3 **Fuel:** Acetylene.
4.2.4 **Oxidant:** Air.
4.2.5 **Type of flame:** Oxidizing (fuel lean).
4.2.6 **Background correction:** Required.

5.0 REAGENTS

5.1 See Section 5.0 of Method 7000.

5.2 Preparation of standards:

5.2.1 **Stock solution:** Dissolve 1.599 g of lead nitrate, $Pb(NO_3)_2$ (analytical reagent grade), in Type II water, acidify with 10 mL redistilled HNO_3, and dilute to 1 liter with Type II water. Alternatively, procure a certified standard from a supplier and verify by comparison with a second standard.

5.2.2 Prepare dilutions of the stock solution to be used as calibration standards at the time of analysis. The calibration standards should be prepared using the same type of acid and at the same concentration as will result in the sample to be analyzed after processing.

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Date September 1986

6.0 SAMPLE COLLECTION, PRESERVATION, AND HANDLING

6.1 See Chapter Three, Section 3.1.3, Sample Handling and Preservation.

7.0 PROCEDURE

7.1 Sample preparation: The procedures for preparation of the sample are given in Chapter Three, Section 3.2.

7.2 See Method 7000, Paragraph 7.2, Direct Aspiration.

8.0 QUALITY CONTROL

8.1 See Section 8.0 of Method 7000.

9.0 METHOD PERFORMANCE

9.1 The performance characteristics for an aqueous sample free of interferences are:

Optimum concentration range: 1-20 mg/L with a wavelength of 283.3 nm.
Sensitivity: 0.5 mg/L.
Detection limit: 0.1 mg/L.

9.2 For concentrations of lead below 0.2 mg/L, the furnace technique (Method 7421) is recommended.

9.3 Precision and accuracy data are available in Method 239.1 of Methods for Chemical Analysis of Water and Wastes.

9.4 The data shown in Table 1 were obtained from records of state and contractor laboratories. The data are intended to show the precision of the combined sample preparation and analysis method.

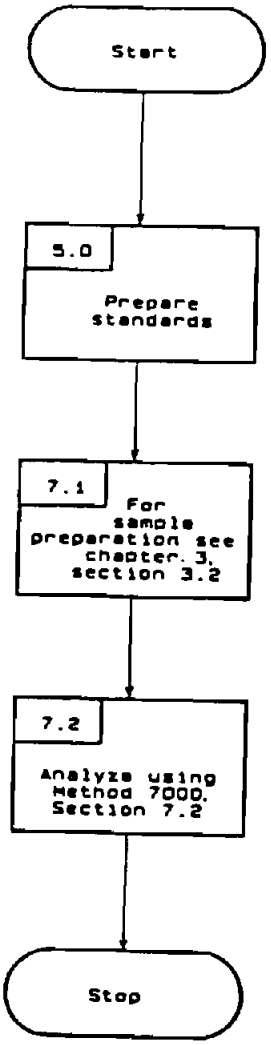
10.0 REFERENCES

1. Methods for Chemical Analysis of Water and Wastes, EPA-600/4-82-055, December 1982, Method 239.1.

2. Gaskill, A., Compilation and Evaluation of RCRA Method Performance Data, Work Assignment No. 2, EPA Contract No. 68-01-7075, September 1986.

TABLE 1. METHOD PERFORMANCE DATA

Sample Matrix	Preparation Method	Laboratory Replicates
Wastewater treatment sludge	3050	450, 404 ug/g
Emission control dust	3050	42,500, 63,600 ug/g


Start
5.0
Prepare standards
7.1
For sample preparation see chapter 3, section 3.2
7.2
Analyze using Method 7000, Section 7.2
Stop

METHOD 7421

LEAD (ATOMIC ABSORPTION, FURNACE TECHNIQUE)

1.0 SCOPE AND APPLICATION

1.1 See Section 1.0 of Method 7000.

2.0 SUMMARY OF METHOD

2.1 See Section 2.0 of Method 7000.

3.0 INTERFERENCES

3.1 See Section 3.0 of Method 7000 if interferences are suspected.

3.2 Background correction is required.

3.3 If poor recoveries are obtained, a matrix modifier may be necessary. Add 10 uL of phosphoric acid (Paragraph 5.3) to 1 mL of prepared sample in the furnace sampler cup and mix well.

4.0 APPARATUS AND MATERIALS

4.1 For basic apparatus, see Section 4.0 of Method 7000.

4.2 Instrument parameters (general):

4.2.1 **Drying time and temp:** 30°sec at 125°C.
4.2.2 **Ashing time and temp:** 30°sec at 500°C.
4.2.3 **Atomizing time and temp:** 10 sec at 2700°C.
4.2.4 **Purge gas:** Argon.
4.2.5 **Wavelength:** 283.3 nm.
4.2.6 **Background correction:** Required.
4.2.7 Other operating parameters should be set as specified by the particular instrument manufacturer.

NOTE: The above concentration values and instrument conditions are for a Perkin-Elmer HGA-2100, based on the use of a 20-uL injection, continuous-flow purge gas, and nonpyrolytic graphite. Smaller sizes of furnace devices or those employing faster rates of atomization can be operated using lower atomization temperatures for shorter time periods than the above-recommended settings.

5.0 REAGENTS

5.1 See Section 5.0 of Method 7000.

5.2 Preparation of standards:

5.2.1 **Stock solution:** Dissolve 1.599 g of lead nitrate, $Pb(NO_3)_2$ (analytical reagent grade), in Type II water, acidify with 10 mL redistilled HNO_3, and dilute to 1 liter with Type II water. Alternatively, procure a certified standard from a supplier and verify by comparison with a second standard.

5.2.2 Prepare dilutions of the stock solution to be used as calibration standards at the time of analysis. The calibration standards should be prepared using the same type of acid and at the same concentrations as in the sample after processing (0.5% v/v HNO_3).

5.3 Phosphoric acid: Reagent grade.

6.0 SAMPLE COLLECTION, PRESERVATION, AND HANDLING

6.1 See Chapter Three, Section 3.1.3, Sample Handling and Preservation.

7.0 PROCEDURE

7.1 Sample preparation: The procedures for preparation of the sample are given in Chapter Three, Section 3.2.

7.2 See Method 7000, Paragraph 7.3, Furnace Procedure. The calculation is given in Method 7000, Paragraph 7.4.

8.0 QUALITY CONTROL

8.1 See Section 8.0 of Method 7000.

9.0 METHOD PERFORMANCE

9.1 Precision and accuracy data are available in Method 239.2 of Methods for Chemical Analysis of Water and Wastes.

9.2 The performance characteristics for an aqueous sample free of interferences are:

Optimum concentration range: 5-100 ug/L.
Detection limit: 1 ug/L.

9.3 The data shown in Table 1 were obtained from records of state and contractor laboratories. The data are intended to show the precision of the combined sample preparation and analysis method.

10.0 REFERENCES

1. Lead by Flameless Atomic Absorption with Phosphate Matrix Modification, Atomic Spectroscopy, 1 (1980), no. 3, pp. 80-81.

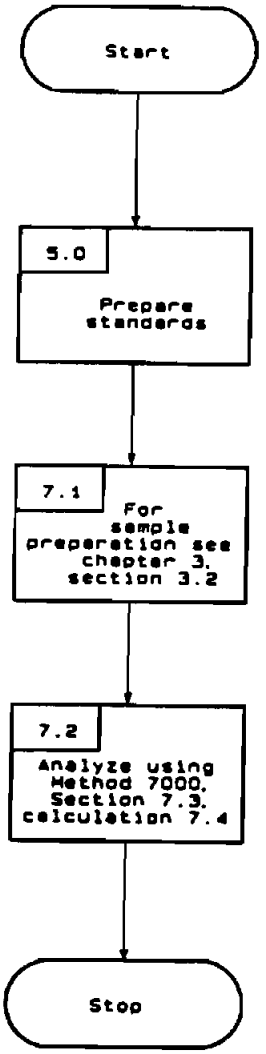
2. Gaskill, A., Compilation and Evaluation of RCRA Method Performance Data, Work Assignment No. 2, EPA Contract No. 68-01-7075, September 1986.

TABLE 1. METHOD PERFORMANCE DATA

Sample Matrix	Preparation Method	Laboratory Replicates
Contaminated soil	3050	163, 120 mg/g
Paint primer	3050	0.55, 0.63 mg/g
Lagoon soil	3050	10.1, 10.0 ug/g
NBS SRM 1646 Estuarine sediment	3050	23.7 ug/g[a]
NBS SRM 1085 Wear metals in lubricating oil	3030	274, 298 ug/g[b]
Solvent extracted oily waste	3030	9, 18 ug/L

[a]Bias of -16% from expected.

[b]Bias of -10 and -2% from expected, respectively.


Start
5.0
Prepare standards
7.1
For sample preperation see chapter 3, section 3.2
7.2
Analyze using Method 7000, Section 7.3, calculation 7.4
Stop

Appendix E

APPENDIX E

Appendix E presents the Air Monitoring Program, Blauvelt, New York Report.

March 22, 1989
88C2221-2

Xerox Corporation
800 Phillips Road, Building 304
Webster, New York 14580

Attention: Mr. Eliott Duffney
Environmental Manager

Re: Air Monitoring Program
Blauvelt, New York

Dear Eliott:

Woodward-Clyde Consultants (WCC) is pleased to respond to your request for a suggested air monitoring program for implementation during the remedial investigation at your Blauvelt, New York facility. As you requested, this program is limited to real time air monitoring instrumentation. WCC has suggested the use of total volatile organics such as the HNu or Foxboro OVA.

Thank you for the opportunity to assist you with this request. If you wish to discuss the program, please do not hesitate to call.

Very truly yours,

WOODWARD-CLYDE CONSULTANTS

Robert G. Ehlenberger
Senior Project Hydrogeologist

for Peter R. Jacobson
Senior Project Hydrogeologist

RGE/PRJ/vbg/WM-16R

AIR MONITORING PROGRAM

The drilling operations will generate soils cuttings and drilling fluids which may be contaminated with volatile organic compounds. Release of these compounds to the atmosphere depends on the level of contamination, weather conditions, and work procedures. Real-time air monitoring (i.e., direct reading instruments) is needed because of the regularly changing conditions and the potential for off-site migration. The real time monitoring should consist of a total organic vapor monitor such as an HNu (photo-ionization detector - PID) or an organic vapor analyzer (flame-ionization detector - FID). This method is preferable to collection of discrete grab samples as grab samples may not be representative of actual field conditions. Action levels based on the air monitoring results will be used to initiate emission control procedures.

POTENTIAL CONTAMINANTS

The soil contaminants include a mixture of chlorinated and aromatic hydrocarbons. As the contaminated soils or drilling fluids are brought to the surface, the air temperature and increased surface area cause the compounds to change from a liquid state to a vapor state, depending on the vapor pressure of the individual compounds.

A review of the key site contaminants may be seen as follows:

	ACGIH TLV (ppm)	Vapor Pressure (mm Hg)
Tetrachloroethene	50	15
Trichloroethene	50	100
Benzene	10	100
Toluene	100	36
Xylene	100	6
1,1,1-Trichloroethane	350	100
Ethyl Benzene	100	10
1,1-Dichloroethene	5	600
1,1-Dichloroethane	200	234
1,2-Dichloroethane	10	64

Based on a combination of vapor pressure and concentration, the key air contaminants would be trichloroethlene, 1,1,1-trichloroethane, 1,1-Dichloroethane, and 1,1-Dichloroethene.

AIR MONITORING INSTRUMENTS

Direct reading air monitoring instruments provide a quantitative indication of the total organic vapor concentration in the air. The instrument response depends on the method of detection, calibration, and the relative response to the compounds of interest.

ACTION LEVELS

Action levels are based on concentrations at the edge of the exclusion zone which extends approximate 25 from the working area of the drilling rigs. Three action levels have been developed.

	Organic Vapor Concentration	Action
Action Level One	Background to 1 ppm	Increase monitoring frequency to every 10 minutes
Action Level Two	1 ppm to 5 ppm	Reduce surface area of spoils and drilling mud by foam or drumming cuttings, or covering the mud tub.
Action Level Three	greater than 5 ppm	Stop work, reduce surface area of spoils, contact project manager

AIR MONITORING PROCEDURES

An initial survey shall be performed with an OVA or HNu to determine the typical organic vapor background level. Background levels shall be determined on a daily basis upwind of the exclusion zone. All action levels are based on concentration above background.

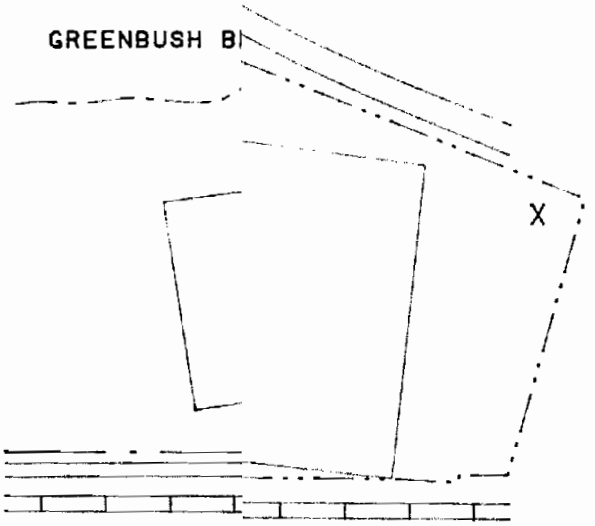
Readings shall be taken at the upwind and downwind edge of the exclusion zone at least twice per hour. Exclusion zones will consist of the area within 50 feet of the drill rig. If structures or potential receptors are located within a 50-foot radius of the drilling rig, the exclusion zone will be reduced to not include the potential receptor. The frequency of measurements may be increased or measurement stations changed based upon organic vapor concentrations at the exploration location and/or wind direction. The area where local exclusion zones will be established during site operations is shown on Figure E-1. Generally, the highest concentrations will be directly downwind of the operations area. Readings shall be recorded in the field log book.

The OVA or HNu shall be calibrated daily with the standard calibration gas. (Methane for the OVA, isobuthylene for the HNu). Only individuals that are properly trained in the use of the air monitoring equipment shall perform the monitoring.

In addition, monitoring stations will be established in the field prior to the start of field operations. Four on-site and six off-site monitoring stations will be established, as shown on Figure E-1. Total organic vapor concentrations in the air will be measured at these locations as follows:

- prior to the start of field activities,
- every Friday at the conclusion of field activities, and
- at the conclusion of the field program.

These monitoring stations are being proposed to assure that site activities are not resulting in an impact to the surrounding community.



LEGEND:

- ○ PROPOSED MONITORING WI
- △ PROPOSED MONITORING WI
- ·-·-· XEROX PROPERTY BOUNDA
- ⬠ EXCLUSION ZONE PERIMET DRILLING OPERATIONS
- X PROPOSED AIR-MONITORIN
- ·-·-· BRADLEY HILL INDUSTRI PROPERTY BOUNDARY

IR-MONITORING/EXCLUSION ZONES
XEROX CORPORATION
BLAUVELT, NEW YORK

HOODHARD-CLYDE CONSULTANTS
EERS, GEOLOGISTS AND ENVIRONMENTAL SCIENTISTS

E

SCALE IN FEET
0 300

DATE: 6/18/87
REV. DATE: 2/22/89

1-2

FIGURE E-1