FEASIBILITY STUDY
FOR THE BLAUVELT, NY SITE
XEROX CORPORATION

Prepared For:

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March 1993
File No. 70302-50

EXECUTIVE SUMMARY

This Feasibility Study (FS) for remediation of the Xerox Corporation (Xerox) site in Blauvelt, New York (Blauvelt Site) has been prepared in accordance with New York State Department of Conservation's (NYSDEC's) request, and addresses both the onsite and offsite areas of contamination that are attributable to Xerox as one unit for purposes of remediation planning. This document follows the feasibility study report format and content requested by NYSDEC in its 21 April 1992 correspondence. The NYSDEC format included a detailed summary of Interim Remediation Measures (IRMS) and treatability studies performed at the site, a Human Health Assessment (HHA), a Fish and Wildlife Impact Analysis (FWIA), and remediation cost sensitivity analyses.

Target cleanup levels were developed for groundwater, soil, surface water, and stream sediments. Tables ES-1 and ES-2 list the proposed target cleanup levels for groundwater and soils, respectively. Contaminant concentrations were compared to the corresponding target cleanup levels and were evaluated for potential impact to human health and the environment.

The FS addresses the groundwater contamination plumes and the two onsite soil contamination areas which will require remediation. Onsite soil contamination is present in a smaller area under the plant building, and in a larger area where the former USTs were located. Based on the media impact evaluations (see Section 1.6, Fish and Wildlife Impact Analysis), no unacceptable surface water or stream sediment contamination has been detected in the onsite or offsite areas. Groundwater contamination is present in two distinct plumes. One smaller plume is located within the overburden and shallow bedrock under the plant building. The larger plume is located within the overburden, shallow bedrock and deep bedrock units and extends onto adjacent properties.

The procedures used for detailed evaluation of remediation alternatives are consistent with those required by NYSDEC's HWR-90-4030 (1990) and USEPA's Draft Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA, November 1989. Remedial options were evaluated and screened according to seven specific criteria:

- Overall protection of human health and the environment
- Compliance with Applicable or Relevant and Appropriate Requirements (ARARS)
- Long-term effectiveness and permanence
- Reduction of toxicity, mobility and volume through treatment
- Short-term effectiveness
- Implementability
- Detailed cost

As a result of this evaluation, Alternative 2 has been identified as the most appropriate remediation alternative for the Blauvelt Site:

- Alternative 2 includes source control, and recovery and treatment of contaminated media. The source control consists of: (1) recovering NAPL and contaminated vapors from the water table and onsite soils, respectively, using 2-phase extraction; and 2) containing and recovering contaminated groundwater plumes using 2-phase extraction and conventional pumping wells.

- Prior to the design phase for the Blauvelt Site remediation, aquifer analyses and physical testing of onsite soils would be conducted to confirm the selection of the initial recovery well spacing, so that plume containment can be achieved in a cost effective and timely manner.

- Recovered contaminated groundwater would be treated using the technologies which have proven successful in the existing groundwater treatment system. Water collected from the offsite area would be treated by filration, oil/water separation (for NAPL removal), flow equalization, and carbon adsorption. Groundwater from the onsite area would be treated by a similar treatment train, but with the addition of UV/oxidation. Treated ground water would be discharged to the nearby tributary (at Outfall 001) of the Hackensack River under the State Pollutant Discharge and Elimination System (SPDES) permit issued to Xerox in September 1990.

- Vapors recovered by 2-phase extraction would be treated in vapor-phase carbon treatment units, or an equivalent treatment unit. The carbon treatment technology has already been proven successful and cost-effective for the current soil vapor extraction Interim Remediation Measure (IRM) currently being conducted at the Blauvelt Site. Treated vapors would be discharged to the atmosphere after treatment, as is currently allowed by New York State Department of Environmental Conservation (NYSDEC) discharge constraints.

- Monitoring would occur during installation of the remedial measures to ensure protection of the health and safety of remediation construction workers, Blauvelt site workers and the office park community adjacent to the site.

- The groundwater treatment and vapor-phase treatment systems would be monitored as stipulated under appropriate permits. Soil and groundwater sampling and analyses would be scheduled periodically throughout the remediation period, to confirm that the recovery well systems were reducing onsite and offsite groundwater and soils contamination.

- The estimated cost for implementing Alternative 2 is approximately $3,242,000.

TABLE ES-1

PROPOSED TARGET CLEANUP LEVELS FOR GROUNDWATER CONTAMINANTS OF CONCERN

Parameter	Proposed Cleanup Level (ug/l)	Detected Concentration Range (ug/l)
Bromodichloromethane	5[2]	ND-7.12
Bromoform	50[1]	ND-14.9
Chloroethane	5[2]	ND-2.48
Chloroform	7[1]	ND-33,300
Dibromochloromethane	5[2]	ND-39.1
1,1-Dichloroethane	5[2]	ND-5,400
1,2-Dichloroethane	5[2]	ND-4,380
1,1-Dichloroethene	5[2]	ND-2,000
1,2-Dichloroethene, total	5[2]	ND-327,000
Methylene chloride	5[2]	ND-6,690
Tetrachloroethene	5[2]	ND-72,400
1,1,1-Trichloroethane	5[2]	ND-57,000
Trichloroethene	5[2]	ND-43,700
Toluene	5[2]	ND-821
Vinyl chloride	2[1]	ND-987

Notes:

(1) New York State Drinking Water Standards, 6 NYCRR, Part 703, September 1991; and 10 NYCRR, Part 5.

(2) The New York State Department of Environmental Conservation's (NYSDEC's) Guidance Cleanup Level, per the October 1991 Guidance for Site Cleanup.

(3) Table modified from 1992 Draft Feasibility Study by Woodward-Clyde Consultants.

TABLE 1-12

PROPOSED TARGET CLEANUP LEVELS FOR GROUNDWATER CONTAMINANTS OF CONCERN

Parameter	Proposed Cleanup Level (ug/l)	Detected Concentration Range (ug/l)
Bromodichloromethane	5^2	ND-7.12
Bromoform	50^1	ND-14.9
Chloroethane	5^2	ND-2.48
Chloroform	7^1	ND-33,300
Dibromochloromethane	5^2	ND-39.1
1,1-Dichloroethane	5^2	ND-5,400
1,2-Dichloroethane	5^2	ND-4,380
1,1-Dichloroethene	5^2	ND-2,000
1,2-Dichloroethene, total	5^2	ND-327,000
Methylene chloride	5^2	ND-6,690
Tetrachloroethene	5^2	ND-72,400
1,1,1-Trichloroethane	5^2	ND-57,000
Trichloroethene	5^2	ND-43,700
Toluene	5^2	ND-821
Vinyl chloride	2^1	ND-987

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1.0 INTRODUCTION

The Blauvelt, New York facility of the Xerox Corporation (Xerox) is located in Rockland County, as indicated on Figure 1-1, Regional Site Map. Since 1980, Xerox has been conducting environmental investigations in the onsite and offsite areas of the Blauvelt, New York facility (Blauvelt Site). Figure 1-2 provides a plan view of the onsite and offsite areas of the Blauvelt Site. Xerox executed remedial investigations (RI) that have included monitoring well installations and groundwater sample analyses, as well as soil and ambient air sampling and analyses. Xerox installed and operates Interim Remedial Measures (IRMs) at the Blauvelt Site. The purposes of these IRMs have included recovery of nonaqueous-phase liquids (NAPL) and contaminated groundwater, granular activated carbon (GAC) treatment of contaminant vapors extracted during NAPL recovery, and groundwater treatment. This document is a Feasibility Study (FS), which details the results of an engineering evaluation of potential remediation process options for cleanup of the site, and which is based in part on the results of RI work and IRM program data. The above RI and FS programs have been conducted under the review of the New York State Department of Environmental Conservation (NYSDEC), per Consent Order No. Index No. W3-0007-82-04, dated April 16, 1990.

This FS has been prepared per the requirements of the June 25, 1992 Scope of Work for the Feasibility Study for the Blauvelt, New York Site, which conformed to the FS format and content requirements of NYSDEC in their April 21, 1992 letter to Xerox. This Scope of Work also incorporates revisions requested by NYSDEC after their review. The FS report was finalized by H&A of New York (H&A) at the request of Xerox Corporation based on the following sources of information:

- A report prepared by Woodward-Clyde Consultants of Plymouth Meeting, Pennsylvania (WCC), dated October 1992, entitled "Draft Feasibility Study for the Blauvelt, NY Site, Xerox Corporation" (WCC project no. 92C2193).

- A 20 January 1993 letter entitled "Response to Feasibility Study Comments, Xerox Corporation, Blauvelt Facility, Blauvelt, New York" (H&A file no. 70302-50) by H&A of New York. This document addressed NYSDEC comments provided to Xerox in Sections

C and D of a 21 December 1992 letter.

- Data acquired since WCC's submittal of the Draft FS report. Since that time, Interim Remedial Measures (IRMs) have been implemented both on-site and off-site, and three off-site bedrock wells have been installed and sampled.

The text, tables, and figures included in the Draft FS were modified as necessary by incorporating responses to NYSDEC's comments and by considering the recently-acquired data. Finalization of the Draft FS required modification of Figures 1-3 through 1-8, and Tables ES-1, ES-2, 1-4, 1-7, 1-8, 1-12, 1-13, 3-1, 4-1, and 4-9. Additionally, H&A modified the appendices contained in the Draft report by including a copy of the "Response to Feasibility Study Comments" document as Appendix A. Other figures, tables, and appendices appear here as they appeared in the Draft FS report, with the exception of Tables 1-16 and 1-17, and Appendix E (of the Draft FS) which were not referenced in the text of the Draft FS and were omitted from the final FS.

1.1 PURPOSE AND ORGANIZATION OF REPORT

Per the required FS format transmitted in NYSDEC's April 21, 1992 letter to Xerox, the FS has been subdivided into these five sections:

- Section 1 - Introduction
- Section 2 - Identification and Screening of Technologies
- Section 3 - Development of Alternatives
- Section 4 - Analysis of Alternatives
- Section 5 - Recommended Alterative

Section 1.0 provides introductory and site background information, characterizes and quantifies the nature and extent of contamination in the onsite and offsite areas, presents the known applicable, relevant and appropriate regulations (ARARs) and guidance documents to be considered (TBCs) in evaluating potential remediation methods, identifies appropriate remediation goals, and provides estimates of the volumes of contaminated environmental media requiring remediation. As requested by NYSDEC, Section 1.0 also provides the details of the

IRMs and treatability studies conducted by Xerox at the Blauvelt site, presents a summary of the Human Health Assessment (HHA) and thc Fish and Wildlife Impact Assessment (FWIA) for the site. The HHA is provided in Appendix D.

Section 2.0 of the FS presents the results of the screening of remediation technologies and process options, including an explanation of screening criteria. As per NYSDEC's April 21, 1992 FS format, technologies are defined as general remediation methods, such as in situ recovery of contaminated groundwater from the subsurface. Process options are defined as specific remediation methods, such as using conventional design pumping wells to achieve in situ recovery of contaminated groundwater. In Section 2.0, a generic description of technologies and site-specific concept designs of process options are presented for remediating the Blauvelt Site.

Section 3.0 identifies and develops appropriate remediation alternatives for the entire Blauvelt Site, including both the Onsite and Offsite Areas, and Section 4.0 presents the results and rationale for sitc-specific evaluation of individual alternatives according to the seven evaluation criteria which NYSDEC requested be used. Based on the results of the detailed IRM/treatability study evaluations presented in Section 1.0 and the remediation process options evaluations in Section 2.0, 5 cleanup alternatives (plus a No Action alterative) were identified. The 5 alternatives were evaluated in detail, and an alternatives screening step was not necessary. This approach is consistent with that offered in NYSDEC's April 21, 1992 letter. Section 4.0 also presents the results of a comparative analysis of all alternatives, again based on the seven criteria, as well as the results of remediation cost sensitivity analyses requested by NYSDEC. Factors evaluated in the sensitivity analyses included discount ratc, time to achieve remediation objectives, volume of materials to treat or dispose, and remediation system operation and maintenance requirements.

Section 5.0 concludes the FS by presenting Xerox's recommendation for the alterative most appropriate for remediation of the Onsite and Offsite Areas of the Blauvelt Site. This recommendation summarizes the components involved in this alterative and how the components would be implemented for the site. The recommendation details the rationale for concluding that the alterative best satisfies the remediation goals for the site.

1.2 BACKGROUND INFORMATION

Figure 1-2 is a plan view of the onsite and offsite areas of the Blauvelt Site; in general, the demarcation between the onsite and offsite areas is the Xerox property line at Bradley Hill Road. Six studies investigating the Blauvelt Site (RECRA Research, between 1981 and 1985; Dames and Moore, 1985; Woodward-Clyde Consultants, spanning between 1986 and 1992; and H&A of New York in 1992 and 1993) have indicated the presence of organic solvents in the soil and groundwater. A Remedial Investigation in the offsite area has evaluated contaminant migration from the Blauvelt Site to the groundwater, as well as the potential for contaminant migration to surface water and stream sediment. Contamination has been identified as moving down gradient from the former underground storage tank (UST) locations toward the north and northwest site boundaries. Contamination also is present under the former Central Refurbishing Center (CRC) of the Blauvelt plant building.

Section 1.2.1 below briefly summarizes known history of site operations, solvent use and storage, and solvent spills and leaks that occurred at the site. Section 1.2.2 summarizes the known characteristics of the hydrogeology and soils in the onsite and offsite areas, as determined from remedial investigations. In addition, Section 1.2.3 presents preliminary analyses of groundwater pumping requirements for containment and recovery of contaminated groundwater plumes in the onsite and offsite areas. These preliminary analyses were used as the basis for selecting the spacing, number and preliminary locations for proposed groundwater plume contaminant and recovery wells for the various remediation alternatives evaluated in the FS. Section 1.3 summarizes the nature and extent of contamination. Section 1.9 provides the known details of IRMs and treatability studies conducted by Xerox at the site. A Remedial Investigation (RI) report was previously prepared by Woodward Clyde Consultants.

1.2.1 Site History

Xerox Corporation has been leasing the Blauvelt Site property for purposes of refurbishing and distributing copier machines. Beginning in 1970, a variety of blended solvents were used for solvent spray cleaning of electrostatic copiers and associated parts. Various blends of solvents were supplied by Inland Chemical. The constituents of these blends have been reported to

NYSDEC in previous submittals, including the December 1980 Investigative Program Report prepared by RECRA Research, Inc. Currently, Xerox's operations at the site have been restricted to distribution activities. During the period of time Xerox was refurbishing copiers at the site, a specially formulated blend of cleaning solvents was used inside the plant and stored as fresh solvent in an underground storage tank (UST) on the north side of the plant. Waste solvent from plant activities was piped to and stored in a second UST, next to the fresh solvent UST. These USTs were reported to be 8 feet in diameter and 27 feet in length.
There were reported releases of solvent on or about June 16, 1977 and June 7, 1979. The releases were reportedly the result of overflows from the waste solvent storage tank. In addition, it has been assumed by NYSDEC that some additional solvent blend may have spilled or leaked at other times (including the time of tank removal), and seeped into soils and groundwater. Based on the observed impacts to soil and groundwater, it is also apparent that operations in the CRC introduced solvent blend into the environment under the plant building. The two USTs were removed in December 1979, and the soils excavated during the tank removal placed back in the excavation pit.

1.2.2 Site Description

Monitoring well data has indicated that the subsurface, in both the onsite and offsite areas of the Blauvelt site, is divided into three distinct water-bearing zones: overburden soils, shallow bedrock, and deep bedrock. Water level monitoring and in-situ permeability testing (slug testing) were conducted to determine basic aquifer characteristics for each zone. While these three zones are distinct, they are hydraulically connected (as shown by similarities in flow direction and hydraulic gradient), except for some located areas of low-permeability lenses. Groundwater in the overburden, shallow bedrock, and deep bedrock zones all flow generally in a north direction under moderate to low flow gradients. Overburden and shallow bedrock flow gradients are similar at approximately 0.026 ft/ft. Deep bedrock groundwater flows under a low gradient of approximately 0.012 ft/ft.

The overburden zone consists of a sequence of low-permeability glacial till soils and unconsolidated rock fragments, as well as some sandy layers. Estimated characteristics of the overburden zone include an average depth of about 18 feet ranging to a maximum depth of approximately 40 feet. The overburden zone has a primary porosity of about 15 percent, and permeabilities ranging from 7.9 x 10^{-2} ft/min to 2.4 x 10^{-3} ft/min. The depth to the water table in the overburden zone ranges between about 4 to 8 feet in the onsite areas and from at the surface (intersecting the ground surface at the pond behind the Bradley Corporate Park building), to in excess of 15 feet in the offsite areas. The set of IRM groundwater recovery wells installed on site have provided sustainable water yields averaging between 3 and 4 gpm; water yields may maximize at about 5 gpm where sandy layers are intercepted.

The bedrock at the site generally consists of sandstones, shales, siltstones, and occasional conglomerates. The bedrock is fractured and weathered in the shallow zone, with decreasing degrees of weathering with increasing depth. The vertical extent of the weathered zone is approximately 15 to 20 feet. Estimated characteristics of the shallow bedrock zone include an average secondary porosity of about 10 percent and permeabilities ranging from 4.8 x 10^{-2} ft/min to 1.6 x 10^{-3} ft/min. The depth to the top of the shallow bedrock zone averages about 18 feet, and the thickness of this zone averages about 28 feet in the onsite area and 25 feet in the offsite area. The estimated sustainable yield for a single well in the shallow bedrock in the onsite and offsite areas is about 3 to 10 gpm. Estimated characteristics of the deep bedrock zone include an average secondary porosity of about 10 percent and permeabilities ranging from 9.0 x 10^{-3} ft/min to 4.9 x 10^{-3} ft/min.

A review of groundwater level information was conducted on data collected from nearby monitoring wells at the Xerox, Blauvelt New York site to evaluate the influence of the existing onsite groundwater recovery system on offsite groundwater levels. Water level data collected during periods when the groundwater recovery system was on line (December 1991 and January 1992) were compared to water level data collected during periods when the groundwater recovery system was off line (April and July 1992). In general, water levels in monitoring wells nearby the recovery wells (i.e., MW-OS-2 and 2R, MW-OS-3, and MW-OS-4 and -4R) were approximately one to four feet lower during the period when the groundwater recovery system was operating.

1.2.3 Conceptual Design of Groundwater Recovery System

Existing groundwater pumping data (Dames & Moore, 1985) has been utilized for the conceptual design of a groundwater recovery/plume containment system. The goal of the conceptual design was to estimate preliminary well spacings to control groundwater flow within the observed contaminant plume. For the conceptual design of well spacings, the Theis method was used as described by Todd in "Groundwater Hydrology", 2nd Edition, John Wiley, 1991. Appropriate well spacing for the containment of the plume can be developed based on calculated drawdowns using the Theis equation. The drawdowns at various locations are contoured over a site to evaluate if groundwater control has been achieved (i.e., gradient reversals and changes in groundwater flow patterns).

The method allows for multiple wells to be simulated at varying pumping rates, with the total drawdown at any point being the summation of the predicted drawdown from all the pumping wells.

The conceptual design is based on the following assumptions:

- The Theis method can be used for a fractured bedrock system if:
    - The bedrock system behaves like a confined aquifer
    - Observed drawdowns are significantly less than the saturated thickness of the aquifer
- Bedrock - T ranged from 1,000 gallons/day/foot (gpd/ft) to 8,900 gpd/ft
  Sy ranged from 0.0089 (for T = 1,000 gpd/ft) to 0.001 (for T = 8,900 gpd/ft)
  Average pumping rate of 5 gallons/minute (gpm)
  Radius of Influence extending to approximately 280 feet
- Overburden - T ranged from 600 gpd/ft to 2,900 gpd/ft
  Sy ranged from 0.04 (for 600 gpd/ft) to 0.056 (for 2,900 gpd/ft).
  Average pumping rate of 2 gpm
  Radius of influence extending to approximately 125 feet

Bedrock characteristics were used because the bedrock represents the most likely media in which offsite migration of contaminants would occur and due to the greater lateral extent of contamination observed in the shallow bedrock. Table 1-1 lists the aquifer characteristics assumed for the preliminary groundwater pumping analyses, which were used for the development of remediation alternatives in Section 3.0 of this FS.

Input to the Theis method (based on the data generated by D&M) included the following:

- at value of 8,900 gpd/ft
- sy of 0.001
- 5 gpm/well pumping rate
- 4 wells were simulated, spaced at 100-foot intervals oriented in an east-west direction
- a 24 hour simulation period

The Theis analysis included presumed recharge boundaries which were 400 feet away from the pumping wells. The 400-foot distance resulted in an observed radius of influence (from a single pumping well) of approximately 280 feet, as observed in the D&M pump test. The total recharge volume introduced along recharge boundaries equaled the total volume being withdrawn by the pumping wells. The distribution of simulated drawdown was incorporated into estimated layouts for containment wells (see Figure 1-3) and for recovery wells (see Figure 1-4) within the groundwater contamination plumes. The conceptual well layout was designed to allow for the required groundwater control and recovery and minimize disruption to offsite properties. The radius of influence of each of the actual recovery well lines must be sufficient to recover the groundwater within the area of contamination.

1.3 NATURE AND EXTENT OF CONTAMINATION

The following four subsections summarize the nature and extent of contamination as defined by the Remedial Investigation conducted for groundwater, soils, surface water, and stream sediments in the onsite and offsite areas. Further details of the nature and extent of contamination are provided under separate cover in the Final Remedial Investigation Report.

1.3.1 Soils and Air

Table 1-2 summarizes the analytical data for soils in the onsite and offsite areas. A range of volatile organics have been detected in varying concentrations in some onsite soils, but only extremely low or nondetectable contaminant concentrations have been detected in the offsite area. The areal extent of onsite soils contamination was defined based on a comparison between the analytical data and the target soils cleanup levels proposed for this site (see Section 1.7), . The areal extent is shown in Figure 1-5 as two distinct contamination areas: one smaller area associated with former activities in the plant building which is located completely below the building; and a second, larger area coinciding with the former location of the USTs at the site. Based on the proposed target cleanup levels, there is no contaminated offsite soil area associated with past or present site activities. Per NYSDEC's request, Section 1.8 provides estimated volumes and areas of contaminated soils to be remediated in the onsite area.

One round of ambient air sampling was performed in May 1992 by WCC and is summarized in Appendix C. In general, airborne site contaminants are present at very low concentrations. Only two volatile organic compounds, benzene and trichloroethane, exceeded the Draft New York State Air Guide-1 (1991 Edition) Annual Guideline Concentrations (AGCs). Contaminants detected during the air sampling analysis were significantly lower than the Short-Term (one hour) Guideline Concentrations (SGCs). Additional monitoring will be conducted to further characterize the ambient air quality at the site. Based on the results of this monitoring, the extent of ambient air remediation will be determined.

1.3.2 Onsite Groundwater

Table 1-3 summarizes the analytical data for groundwater in the onsite area. A range of volatile organics have been detected in varying concentrations in groundwater along with lead. The areal extent of the onsite groundwater contamination was defined as shown on Figures 1-6 through 1-8 based on a comparison between analytical data and the target groundwater cleanup levels proposed for this site (see Section 1.7).

Figure 1-6 shows the areal extent of the two identified contaminant plumes in the overburden zone; Figure 1-7 shows the areal extent of these plumes in the shallow bedrock zone; and Figure 1-8 shows the areal extent of the larger plume in the deep bedrock zone. The vertical extent of contamination has been assessed by the deep bedrock wells installed at the site as part of the Remedial Investigation. The exact vertical interval to which the groundwater has been contaminated in the area illustrated on Figures 1-6 through 1-8 has not been defined, but the vertical flow conditions indicated in Figure 1-9 indicate the existing monitoring well network adequately defines site conditions. In addition, because of the upward gradient from the deep to shallow bedrock in the offsite portions of the plume, it is likely that the contamination is not substantially deeper than the existing deep bedrock monitoring wells. Available analytical data do not indicate that the smaller onsite plume extends into the deep bedrock zone. Section 1.8 provides estimated volumes and areas of contaminated groundwater to be remediated in the onsite area.

1.3.3 Offsite Groundwater

Table 1-4 summarizes the analytical data for groundwater in the offsite area. Volatile organics and lead have been detected in varying concentrations in offsite groundwater. Based on a comparison with target groundwater cleanup levels proposed for this site (see Section 1.7), the areal extent of the offsite groundwater contamination has been defined as shown on Figures 1-6 through 1-8.

Although the vertical extent of the contamination in the deeper bedrock is not fully defined, the vertical flow conditions depicted in Figure 1-9 restrict the downward migration of contaminants to the approximate depth of the existing deep monitoring wells. Section 1.8 provides estimated volumes and areas of contaminated groundwater to be remediated in the offsite area.

1.3.4 Surface Water

To document the nature and extent of site-related contaminants in aquatic habitats near the Blauvelt Site, surface water and sediment samples were collected at one up-gradient location (Station No. 9) to provide background information and at eight down-gradient locations that receive surface runoff and groundwater from the Site. The locations of the sampling stations are illustrated in Figure 1-10.

Stations 1, 2, 8 and 9 were located in a small first-order stream that has seasonally intermittent flow. At the time of sampling the stream discharge was low and field estimated at less than 2 cfs. Stations 3, 4 and 5 were located in the outlet from a small landscape pond located behind a commercial building less than 0.1 mile north of the Site. Station 6 was located in the pond. Station 7 was located in a stormwater ditch that drains part of the Site and discharges to the small stream that drains the area.

Water sampling was conducted during the low flow conditions when the potential contaminant inputs from groundwater may be most easily detected, sincc dilution by surface water runoff is minimal. The water samples were collected on June 5, 1991 and submitted for analysis of USEPA volatile organic compounds (VOCs) and for mineral spirits. Water samples were obtained at all stations except Station 7 which was in the drainage ditch. The ditch was dry at the time of sampling. The results of the water sample analysis showed the presence of 5 VOCs in water samples from the down gradient stations 1, 2, 3, 4, 5 and 6 (Table 1-5). The detected VOCs were: 1,1-Dichloroethane; 1,2-Dichloroethane (total);Tetrachloroethane; 1,1,1-Trichloroethane; and Trichloroethene. No mineral spirits were detected at any stations. The concentrations of total VOCs measured nearest the Site in the pond and the outlet (Stations 4, 5, 6) ranged from about 50 to 100 ppb, while levels at locations further downstream (Stations 1, 2 and 3) ranged from about 2 to 30 ppb.

Station 8 located only slightly down gradient from the Site and at the western perimeter of any potential down gradient contaminant transport, had no detectable VOCs or mineral spirits. Likewise, the upstream background location (Station 9) showed no detectable VOCs or mineral spirits.

1.3.5 Stream and Pond Sediment

Sediment samples were collected at the same stations utilized for surface water collections. The sediment samples from Stations 1, 2, 3, 4, 7, 8 and 9 consisted primarily of fine to coarse sandy material with some organic detritus. The sediment from Station 5 consisted of fine sandy material with a high concentration of organic detritus such as twigs and leaf fragments. The pond sediment from Station 6 consisted of a fine-grained, anaerobic, black mud intermixed with organic detritus, and had a strong sulfur odor.

The results of the sediment sample analysis showed the presence of the same 5 VOCs as detected in the surface water samples. In addition to these VOCS, methylene chloride was also detected in all samples except those from Stations 6 and 9. Mineral spirits was not detected in any sediment samples (Table 1-6).

Total VOCs among sediment samples from all down gradient stations ranged from a low of about 10 ppb at Station 8 located along the western perimeter of the Site to a maximum of about 88 ppb at Station 7 located in the Site stormwater runoff ditch. No detectable VOCs were identified in the sediment sample from the upstream background Station 9.In addition to these findings, the sediment sampler rinsate blank did have a low but detectable level of chloroform. Chloroform was not detected in any of the sediment or water samples and is unlikely to be a site-related contaminant of concern.

1.4 ARARS, TBC CRITERIA AND NEW YORK STATE SCGs

Remediation of the Blauvelt Site will conform with the NYSDEC requirements for protection of human health and the environment. This FS presents the results of evaluating whether remediation alternatives being considered will comply with any and all "applicable or relevant and appropriate requirements," or ARARS, identified for the site remediation. A requirement may be "applicable" or "relevant and appropriate," but not both. USEPA defines "applicable" requirements as, "those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or State law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstances at a CERCLA site."

"Relevant and appropriate" requirements are "those ... standards, requirements, criteria or limitations promulgated under Federal or State law that, while not applicable ... address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site." There are three types of ARARS: chemical-, action-, and location-specific. Table 1-7 summarizes the list of sources of ARARs identified for the site. The ability of a remediation alterative to meet ARARs is considered a threshold criteria in the evaluation of the alterative.

To-be-considered (TBC) criteria are nonpromulgated advisories or guidances issued by Federal or State governments that are not legally binding and do not have the status of potential ARARS. In situations where there are no identifiable ARARS, cleanup criteria may be selected by consideration of TBCS.

1.4.1 Types of ARARs

The ARARs are divided into three major categories: chemical-specific requirements, location-specific requirements, and action-specific requirements, as defined below:

- Chemical-specific ARARs are health- or risk-based numerical values or methodologies which, when applied to site-specific conditions, result in the establishment of numerical values. These values establish the acceptable amount or concentration of a chemical that may be found in, or discharged to, the ambient environment. Generally, if a chemical has more than one ARAR, the more stringent value should be complied with.
- Location-specific ARARs are restrictions placed on the concentration of hazardous substances or the conduct of activities solely because they occur in a particular location.
- Action-specific ARARs are usually technology- or activity-based requirements or limitations on actions taken with respect to hazardous wastes.

1.4.2 Chemical-Specific ARARs

The ARAR-based chemical-specific remediation criteria for the site are presented in Table 1-8. The values shown are regulatory limits for surface water, and groundwater; and guideline values for air for site-specific indicator parameters. Criteria for soils are addressed in the TBCs section.

To meet ARARS, the remediation must comply with the following three criteria:

- Surface water cleanup criteria within intermittent drainageways must be met within each drainageway, downstream of each area of concern and prior to its confluence with the offsite stream.

- Groundwater cleanup criteria must be applied at the boundaries of each waste management unit. For the Blauvelt Site; the location of the former underground storage tank (UST) for waste solvents would be the only applicable waste management unit.

- Air quality criteria must be maintained at the Xerox site boundaries.

1.4.3 Action-Specific ARARs

Action-specific ARARs are usually technology- or activity-based requirements or limitations on actions taken with respect to hazardous wastes. Most of the action specific ARARs identified on Table 1-7 are related to the remedies requiring excavation, removal, or onsite treatment of hazardous waste. For example, RCRA regulations regarding the construction of an onsite hazardous waste landfill would be relevant and appropriate. Waste transportation to a commercial facility for treatment or disposal would have to meet Hazardous Waste Manifest System requirements.

1.4.4 Location-Specific ARARs

Location-specific ARARs are restrictions placed on the concentration of hazardous substances or the conduct of activities because they are in specific locations. The location-specific ARARs listed in Table 1-7 are related to the existence of a stream near the Blauvelt Site, and the potential for impact on endangered species which may be dependent on the site. As stated later in Section 1.6.1.4 Documented Fish and Wildlife Resources, none of the historical locations for endangered, threatened or rare species or species of special concern (as identified by NYSDEC's Natural Heritage Database) are within a two-mile radius of the Blauvelt Site.

1.4.5 TBCs

Remediation goals based on " to-be-considered" criteria (TBCS) are summarized in Table 1-8. These criteria are from a draft NYSDEC document entitled "Cleanup Policy and Guidelines" dated October 1991. It is understood that, in the absence of promulgated standards and guidelines, these criteria can be negotiated with NYSDEC. Such negotiation is recommended for contaminants where this condition exists.

1.4.6 New York State SCGs

New York State has issued Standards, Criteria and Guidelines (SCGS) which include any promulgated hazardous waste management regulations or cleanup levels concerning groundwater contamination, as well as draft or final guidelines for soils cleanup levels.These SCGs are the same as the chemical-, action-, and location-specific ARARs and TBCs as cited in earlier in Section 1.4 and provided in Tables 1-7 through 1-9.

1.5 SUMMARY OF RESULTS OF HUMAN HEALTH RISK ASSESSMENT

A Human Health Risk Assessment (HHA) has been developed by Woodward-Clyde Consultants (WCC) for the Xerox Corporation site in Blauvelt, New York (Blauvelt Site). The objective of the HHA was to ascertain whether unacceptable health risks are posed to humans by current site conditions. The assessment examined potential health impacts that could be incurred by humans currently in or near the site, as a result of exposure to site-related chemicals under current and plausible future site use. Section 1.2 provides information on the Blauvelt Site history and site conditions. The HHA followed guidance developed by the USEPA for performing a baseline risk assessment under CERCLA. The full text of the HHA is provided in Appendix D of this FS.

The available chemical data for groundwater, soils, surface water, and sediments were examined for applicability to selecting contaminants (or chemicals) of concern and evaluating health risks in the HHA. To select a list of chemicals of concern, criteria such as frequency of detection were applied; for other chemicals, there was insufficient information on comparability of detected concentrations to background sample concentrations, and information on the presence of the chemical in quality control blanks, to include the chemical on the list. However, few chemicals were removed from consideration as a chemical of concern as a result of the selection process.

Next, four groups of potential receptors were examined for their potential exposure; onsite workers, offsite workers, offsite residents and trespassers. Of these receptor groups, only trespassers were identified as having an opportunity for exposure to site related contaminants (i.e., identified as having complete exposure pathways). Potential exposure of adult and youth trespassers to chemicals contained in surface water and sediments (from a stream which crosses the Blauvelt Site property) was assessed for reasonable maximum exposures (RME), as well as more typical exposures. Dermal and incidental exposure were considered. The resultant upper bound cancer risk estimates were all at or below the acceptable risk range identified by USEPA as 1×10^{-8} to 1×10^{-6}. The resultant noncarcinogenic Hazard Indices were all below the comparison threshold value of 1.0. This indicates that unacceptable health risks are not posed by exposure to chemicals at the site.

The above conclusion is limited by several assumptions made in the assessment. These assumptions include the following:

- Site-related chemicals in groundwater have not migrated past Bradley Industrial Park into residential areas north of the site, and no or limited private wells exist in these northern residential areas. The estimated furthest extent of chemical migration was defined per site data available to date. Available well information does not completely identify the location, operating history, or depth of private wells in the vicinity of the site. Available information does indicate any wells are in operation immediately downgradient of the site. For purposes of this FS, exposure to groundwater was not assessed. However, the assessment did examine the concentrations of chemicals found in groundwater on or downgradient of the site, and identified the presence of multiple chemicals at concentrations which exceeded these chemicals' Maximum Contaminant Levels (MCLs) as defined per the Safe Drinking Water Act. Therefore, if this water were to be regularly consumed, it is likely that adverse health effects would be incurred.

- Exposure to subsurface soils would not occur under normal circumstances to the potential receptor groups considered, so all exposure pathways for subsurface soils were identified as incomplete. It was recognized that future construction workers may excavate or otherwise disturb subsurface soils, but it was assumed any subsurface disturbance would be performed under the protection of an appropriate Health and Safety Plan (HSP), which would adequately protect all workers from exposure.

- Exposure to subsurface soil chemicals that have migrated to the overlying atmosphere was not assessed because the pathway was anticipated to be minimal for all receptor groups. Some limited available ambient air data were available, with which to examine this assumption; this ambient air quality data generally confirmed that exposure via ambient air would not pose unacceptable health risks. However, data from an additional sampling episode will be used to strengthen this conclusion.

- Exposure to surface soils was not assessed because the site history suggests that chemical releases occurred solely to the subsurface or directly below the Xerox plant building foundation. However, analysis of one surface soil sample collected by Xerox at a location north of the building detected a lead concentration of 4,520 mg/kg, which is above the EPA's recommended soil lead level (500 to 1,000 mg/kg) for the protection of children. This suggests that, at least in this area, unacceptable health risks may be posed by surface soils.

Finally, recommendations were made for investigating potential additional risk issues for the Blauvelt Site. These recommendations included, 1) additional sampling of groundwater to confirm the extent of chemical migration in the offsite area; 2) an additional drinking water well survey that includes interviewing owners of all previously identified wells to obtain pertinent groundwater use data; 3) sampling of water from any drinking water wells located within the area potentially impacted by site-related contaminants (if the suggested survey identifies any) a resampling of the area of surface soil in which a lead concentration of 4,520 mg/kg was conducted and confirmed the reported value. This area will be addressed during remedial activities.

1.6 FISH AND WILDLIFE IMPACT ANALYSIS

The Fish and Wildlife Impact Analysis (FWIA) for the Xerox site in Blauvelt, New York (Blauvelt Site) was conducted in accordance with the NYSDEC draft guidance, "Fish and

Wildlife Impact Analysis for Inactive Hazardous Waste Sites" (NYSDEC, 1992). The objectives of the analysis are identified in the following five-step process:

- Step 1 - characterize the habitat and ecological resources and their value at and around the Site
- Step 2 - identify contaminant-specific impacts to fish and wildlife receptors and food chain pathways
- Step 3 - evaluate the ecological effects of the remediation alternatives
- Step 4 - provide ecological design criteria for implementation of the selected alterative
- Step 5 - provide a monitoring program plan that evaluates compliance with the selected remediation design and evaluates the efficacy of the remedial actions

The FWIA is a comprehensive, but flexible, five-step process which provides a set of guidelines that may be applied in their entirety or limited to specific steps. Steps may be eliminated where sufficient information supports the decision of no further action. The FWIA for the Blauvelt Site has been conducted within this flexible framework and the guidance was used to "focus" specific elements of the analysis on the important site specific issues and ecological resources at the Site.

1.6.1 Step I - Site Description

The objectives of Step I of the FWIA are to identify if fish and wildlife resources that may be affected by site-related contaminants are present or were present prior to contaminant introduction and to provide appropriate information for designing a remedial investigation of those resources. In this section, a description of terrestrial and aquatic wildlife resources and their value is presented.

The Site description consists of a general discussion of the Site's setting, followed by a more detailed evaluation of terrestrial and aquatic resources. The terrestrial and aquatic resources discussion is limited to habitat descriptions for each covertype within a one half-mile radius of the Site. The Site description in Step I also includes an evaluation of significant habitats such as

Wild and Scenic Rivers and Endangered Species present within a two-mile radius of the Site.

1.6.1.1 Site Setting

The Blauvelt Site is located in Rockland County in southeastern New York State in the Town of Blauvelt, about two miles west of the Hudson River (Figure 1-1). The Site is located at the upland apex of a small "V"-shaped valley that slopes downward from the apex at the southern end of the valley (elevation 130 feet above National geodetic vertical datum (NGVD)) toward the north where the valley floor becomes flatter and wider (elevation 75 feet above NGVD). This valley is an upland extension of the Hackensack River Valley that runs north to south and is located about 0.75 mile west of the Blauvelt Site. Surface water in the upland valley drains into two first-order' streams that combine on the valley floor, turn southward, and discharge into the Hackensack River. The altitude range within a one-half-mile radius from the Site varies from about 75 to 250 feet above NGVD.

Numerous man-made features occupy the land within a one-half-mile radius of the Site, while the remainder of the area consists of small sections of the natural habitats interspersed between the man-made features (Figure 1-10). The sections of natural habitat that remain within the one-half-mile radius include forest, brushland, wetlands, a small stream, and a pond. On the upland slopes, some deciduous forest community is present and early succession stages of herb and shrub communities exist in areas where the trees have been removed. Surface water runoff from these upland areas collects in both man-made ditches and a small natural stream that flows from south to north through the Site area. A small landscape pond (less than 50 feet in diameter) is located behind one of the commercial buildings near the Site. Overflow water from the pond discharges via a ditch to the small, natural stream that traverses the Site area. The natural stream becomes dendritic north of the Site and flows into a small wetland located about 0.6 mile north of the Site.

In accordance with the NYSDEC guidance, terrestrial and aquatic habitats and their associated wildlife and fish resources are described separately below. Included in this characterization are the identification of any significant wildlife (e.g., endangered species) and habitats (e.g., Wild and Scenic Rivers) within a two-mile radius of the Site, a covertype-based description of the fish and wildlife within a one-half-mile radius of the Site, and a qualitative assessment of the value of the habitats and wildlife resources in each covertype. In accordance with the FWIA guidance, field verification of the covertype map has been performed, and a description of the flora within the one-half nine radius, along with a listing of the fauna expected within each covertype are provided in the following sections. Fieldwork to identify wildlife species will be performed in the Spring of 1993).

1.6.1.2 Terrestrial Resources and Covertypes

In accordance with FWIA guidance, Step I - Site Description, a covertype map of the area within one-half-mile of the Blauvelt Site was prepared (Figure 1-11). The major covertypes that are described below include man-made features, terrestrial covertypes, and wetlands. Terrestrial covertypes and wetlands are discussed in terms of physical features, wildlife resources, stress related to volatile organic compounds, and a qualitative description of each habitat's value. A discussion of the aquatic resources is provided in Section 1.6.1.3. Covertypes were identified from a review of a recent aerial photograph and the Nyack, New York 7.5 minute USGS quadrangle map. The covertypes were field verified by a qualified biologist. The plant species identified at the Site are listed for all covertypes and are discussed at the end of Section 1.6.1.2.

<u>**Man-Made Features**</u>

An aerial photograph of the Site that includes the area within a one-half-mile radius was reviewed. The aerial photograph was taken in the winter of 1989, and the scale is one inch equals 100 feet. Significant man-made features north of the Site include a drive-in theater and 11 large, light industrial buildings. The land east of the Site is predominantly forested parkland. There is a set of CONRAIL railroad tracks west of the Site and a four-lane boulevard (State Route 303) on the east side of the Site. A debris disposal area is located approximately 300 feet west of the Site. The disposal area includes approximately 100 acres of native vegetation, about 30 acres of which has been disturbed by debris piles. Disjunct sections of natural habitat are also present, and

each covertype is discussed separately below.

Deciduous Forest Covertype

Physical Features - As can be seen on Figure 1-12, some of the land on the north, south, and west sides of Bradley Hill Road is composed of the forest covertype. Because the majority of the land in the immediate vicinity of the Site has been dedicated to manmade made features, no large (> 5 acres) contiguous forest habitat is available for terrestrial wildlife to inhabit. The forested covertype in the vicinity of the Site is interspersed with large buildings and manicured grass, and does not provide any uninterrupted vegetated corridors for vertebrate movement through the area. The largest uninterrupted area of forest inside the one-half-mile radius is a small patch (approximately 3 acres). The forest in this area is relatively old (greater than 50 years) and does not have a dense understory or herbaceous layer. This feature may also limit wildlife use of this area.

Wildlife Resources - Wildlife species that inhabit forested areas require large, uninterrupted tracts of forest to meet their habitat requirements. The small patch of forest may provide resting areas for a few transient individuals from time to time, but due to the nature of its size, it lacks the resources to support any more than a few individuals at one time. The species that may possibly use the forested area within the offsite area are ones that would normally use the canopy layer in a forest for forage and nesting sites (e.g., squirrels, birds). The vertebrate species (e.g., white tailed deer) that may inhabit the large tracts of forested land within the boundaries of the parkland (east of the Site), would seek water and forage in lower elevation areas (wetlands) from time to time. There are substantial wetland resources west and north of the Site which these animals would probably seek out. The migration route that would be preferred by most of these vertebrate species is down a densely vegetated drainageway. There is a drainageway north of the Site that would be well-suited to this type of animal movement. The numerous man-made features in the Site vicinity probably serve to deter vertebrate movement through the Site area. The preferred pathway for movement and the adequate resources, both being located north of the Site should limit the use of the forested portion of the offsite area to only a few transient species.

Observations of Stress - No volatile organic compounds were detected in the surface soils in the forested offsite area (see Section 1.3.1), and no stressed vegetation was observed in this area during the field reconnaissance.

Habitat Value - The small size and the man-made features surrounding the forested areas near the site make them relatively low value habitat for wildlife in the area. In general, forested areas that lack developed understory and herbaceous layers do not provide desirable habitat for most terrestrial mammals. The other forested areas nearby provide habitat that is more capable of sustaining wildlife populations. The large area of parkland east of the Site provides less disturbed habitat for wildlife species commonly associated with deciduous forests. The large forested wetlands west and north of the Site also provide habitat for populations of vertebrate species.

Scrub/Shrub Covertype

Physical Features - The scrub/shrub covertype in the Site area is located north of the Xerox building, in narrow bands along the banks of the stream, in small landscaped areas around the nearby buildings, and along the edge of the forested area north of Bradley Hill Road. The two large wetland areas north and west of the Site have some relatively large areas of scrub/shrub vegetation. The scrub/shrub covertype is not one of the predominant covertypes within the one-half-mile radius of the Blauvelt Site. The majority of the land in the immediate vicinity of the site is composed of a mixture of man-made features and forest, and there is limited scrub/shrub habitat available for terrestrial wildlife. The scrub/shrub areas near the Site occur primarily as narrow bands of vegetation along the borders of other covertypes. These narrow bands are broken up by roads and buildings which results in only short corridors of scrub/shrub vegetation for vertebrate movement within the area.

Wildlife Resources - The scrub/shrub areas in the vicinity of the Site occur primarily as narrow bands of vegetation along the borders of other covertypes. In general, wildlife species that would use scrub/shrub habitat require larger tracts than those present in the Site area to meet their habitat requirements. The species that may possibly use the scrub/shrub habitat are ones that may wander up the stream channel foraging for food (e.g., raccoon, opossum). Many of the scrub/shrub areas around the Site have been disturbed recently (within the last 10 years) and are vegetated primarily with non-native plant species (e.g., Phragmites australis). The majority of the plant species that have been planted in the landscaped areas are horticultural varieties of native plants that are of little value to wildlife.

Observations of Stress - No volatile organic compounds were detected in the surface soils in the scrub/shrub areas in the offsite area, and no evidence of stressed vegetation was observed.

Habitat Value - The native scrub/shrub habitat in the vicinity of the Site is generally of low resource value for wildlife in the area. The narrow and disjunct bands of scrub/shrub covertype near the Site have low capacity to support a vertebrate population. The scrub/shrub areas may provide resting areas for a few transient individuals, but they lack the resources to support any more than a few individuals. Some of the landscaped areas around the buildings can be considered as scrub/shrub habitat. However, the horticultural varieties of plants in the landscaped areas are a poor resource for wildlife and generally do not provide wildlife with forage or cover.

Herbaceous Cover

Physical Features - The herbaceous covertype in the Site area is located primarily north of the Xerox building, along the banks of the stream that flows through the Site, in small landscaped areas around the buildings, and along the edges of Bradley Hill Road and the CONRAIL railroad tracks. The herbaceous covertype is one of the minor covertypes within the one-half-mile radius of the Site. Because the majority of the land in the vicinity of the offsite area is composed of man-made features and forest, there are few areas with herbaceous vegetation.

Wildlife Resources - The herbaceous covertype is in close proximity to the scrub/shrub covertype and has similar characteristics (i.e., disturbed and short broken corridors). The majority of the plant species that have been planted in the landscaped areas are horticultural varieties of native plants (e.g., cultivated grasses). In general, the wildlife species that would use the herbaceous areas require larger tracts with different species composition than those present in the Site area to meet their habitat requirements.

Observations of Stress - No volatile organic compounds were detected in the surface soils in the herbaceous areas near the Site. There are no visible indications that the herbaceous vegetation experienced stress related to the volatile organics in the shallow groundwater.

Habitat Value - The herbaceous habitat is of relatively minimal value as a resource to wildlife in the area. The disjunct nature and limited species composition of the herbaceous covertype at the Site lowers its ability to provide a forage base for vertebrate populations of herbivores. The herbaceous areas may provide some forage and resting areas for a few transient individuals, but they lack the resources to support any more than a few individuals.

Wetland Cover

Physical Features - The USGS and NYSDEC maps show a wetland approximately 40 acres in area (labeled on Figure 1-12 as the NA-4) approximately 0.6 mile north of the Site. The maps also show a large wetland approximately 330 acres in area (labeled on Figure 1-12 as the NA-5) approximately 0.6 mile west of the Site. The wetland north of the Site is hydrologically downgradient from the Site, and the larger wetland to the west also is hydrologically downgradient from the Site (approximately 1.6 mile).

The wetland covertype within one-half mile of the Site consists of a thin band (2 to 15 feet wide) along each bank of the creek, the pond, and the pond outlet drainageway. This is the only wetland covertype within the one-half-mile radius. The wetland covertype is one of the minor covertype, because the land in the vicinity of the Site is predominantly forest and man-made features.

Wildlife Resources - No mammals that would be expected to use the stream-side wetland habitat were observed during the Site visits, nor were there any secondary indications of their presence (e.g., tracks, scat, dwellings). Mammals that may be expected to use these areas include raccoon, opossum, muskrat, rats, mice, and shrews.The apparent paucity of wildlife in the stream-side wetlands is probably due to the physical conditions of the stream in this area. The wetlands habitat is interrupted numerous times by culverts for roads crossing the stream. The stream has high (12+ feet) man-made, rock wall banks in many areas and generally supports only a narrow, interrupted band of emergent wetland vegetation along the channel. In general, wildlife species that inhabit wetlands areas require larger and more diverse populations of emergent plant species than those that occur within the one-half-mile radius to meet their habitat requirements. The wetlands in the area are small, discontinuous, and narrow, which limits their ability to support a vertebrate population of any significant size.

Observations of Stress - Although a few volatile organic compounds were detected in the stream sediment, none were detected in the surface soils from the stream-side wetland area. There were also no visible indications of stress in the shallow rooted species (i.e., Salix sp. and the emergent vegetation). Moreover, the deeper-rooted tree species (i.e., Acer rubrum and Fraxinus pennsylvania) along the stream showed no visible indications of stress related to volatile organics in the shallow groundwater.

Habitat Value - The stream-side wetland habitat within the one-half-mile radius area is of relatively low value as a resource to wildlife. These wetlands areas may occasionally provide forage and resting areas for a few transient individuals, but these areas lack the resources to support any more than a few individuals. The wetlands areas may be used by herbivores and carnivores from the larger wetland area north of the Site while foraging for food. The large emergent and forested wetlands north and west of the Site should provide better habitat and support a relatively diverse population of vertebrate species that would commonly be associated with wetlands.

Value of Terrestrial Covertypes to Humans

In accordance with the FWIA guidance, the value of resources and covertypes to the human population in the area was evaluated. The value of the terrestrial resources in the vicinity of the Site to the humans is as a passive recreation area for the nearby work force to use during breaks. As discussed above, the habitat in the Site vicinity has limited value to wildlife; therefore, the wildlife resources in the Site vicinity would provide very little opportunity to the surrounding human population for observation of wildlife. No hunting would be permitted in the forest, scrub/shrub, herbaceous, or wetland habitat in the offsite area because there are buildings in close proximity to this area.

Plant Sites Identified in the Site Area

The plant species identified in the vicinity of the Blauvelt Site are listed in Table 1-9. There are seven areas identified in the table. The areas are divided by either physical barriers or covertypes. Area A consists of the portion of the Site where the underground storage tanks were. Area B consists of the forested area onsite south of Bradley Hill Road. Area C is the offsite forested area north of Bradley Hill Road. Areas D, E, F, and G are all sections of the stream. They are separated by physical barriers (culverts), and the plant populations in each area are slightly different. Area D is located west, adjacent to the Site's western boundary. Area E is located north of the Site and is downstream from Area D. The next stretch of stream, downgradient, is Area F, which is located west of the wooded area (Area C). Area G is located farthest north of the Site on the west side of the drive-in movie theater. The landscape plant species identified in the Site area are listed under Area H.

1.6.1.3 Aquatic Ecological Resources

Freshwater Streams

Two small, freshwater streams drain the area within a one-half-mile radius of the Site. The larger of the two streams drain an area northeast of the Site. Since this stream is not exposed to site-related constituents, ecological characteristics of this stream are not addressed in this FS. The smaller stream does receive drainage from the Blauvelt Site and is characterized.

The smaller stream is an unnamed, first-order stream that flows past the west side of the site and north through the one-half-mile area. Since site-related compounds have the potential for coming into contact with aquatic biota that inhabit the stream, it is one of the primary focal points of the FS. The geomorphology, hydrology, substrate conditions, water chemistry and biota for this stream are discussed below.

Physical Features

The drainage basin area upstream from the Site is small and the stream is identified on the topographic map as having intermittent flow. This drainage basin area contains no major springs that sustain flow during dry periods, but smaller groundwater seeps likely provide some of the base flow in the stream. Although some of the basin area has deciduous forest covertype, most of the basin is composed of man-made features that induce rapid runoff of storm waters. Field observations confirm that storms induce extremely abrupt changes in water flow rates in the stream and it is subject to "flash flooding" during major rain events under normal flow conditions, the stream discharge at the Site is unlikely to exceed 5 cfs. Discharge at the time of field sampling (June 5, 1991) was estimated at less than 2 cfs.

The stream channel is roughly "V"-shaped and incised into the surrounding land surface in most areas. The top of the stream channel, where it passes through the Site area, varies in width from about 5 to 10 feet, while the channel bottom varies from about 2 to 4 feet. The channel depth ranges from about 3 to 6 feet, while the water depth during low flow is only a few inches. The stream flows down-slope through the area, from about 110 feet to 70 feet NGVD in a distance of 0.6 mile. The average stream gradient is about 1 foot/80 feet. The combination of the narrow and incised channel and this steep gradient act to produce rapid flow of water through the channel, particularly during runoff of major storm events.

The rapid flow of storm runoff has eroded the stream channel, and the stream bottom consists of gravel, cobbles, boulders, and some exposed bedrock in the numerous riffle areas. Some occasional pools are present and the substrate here consists mainly of coarse sands, gravels and cobble. Limited amounts of fine-grained sediments are present in the pools or elsewhere in the stream substrate, which are indicative of the strong erosion forces present in the stream.The water chemistry of the upland streams in this area of New York are characterized by relatively low dissolved mineral content, near saturation levels of dissolved oxygen, and nearly neutral Ph values (Perlmutter, 1959). The water chemistry reflects the local Newark Group sandstone geology. Since groundwater discharge supports the flow in these streams, the groundwater and surface water chemistry are similar, especially during low flow conditions.

Water hardness and alkalinity in the Hackensack River about 1.5 miles upstream from the Site were 69 ppm and 54 ppm, respectively (Perlmutter, 1959). At the Site, high dissolved oxygen levels are likely due to the turbulent flow in the stream. The annual water temperature cycle will reflect air temperature since no major cold-water springs discharge into the stream. A daily temperature cycle will also occur since limited shading allows water warming from the sun.

<u>Wildlife Resources</u> - The fish and wildlife resources in small intermittent stream of this type are

probably limited by these physical extremes described above. Desiccation (drying) of the stream substrate occurs during periods of low and intermittent flow. Conversely, strong substrate scouring occurs during periods of flash flooding. These extreme conditions probably restrict the development of aquatic biota in the stream to organisms specifically adapted for survival in this type of environment.

A field reconnaissance was conducted on June 5, 1991 by two WCC aquatic ecologists to survey the stream biota. The survey confirmed that wildlife resources in this reach of the stream were limited. No submerged aquatic vegetation or fish were observed in the stream during the survey. However, benthic-dwelling macro invertebrates were abundant and appeared to dominate the biota in the stream.

The benthic organisms can burrow into the streams sand and gravel substrate to escape both the desiccation during low flow and the scouring action during flash flooding. Therefore, the FWIA for this stream will focus primarily on the benthic macroinvertebrate community. However, other stream organisms and trophic levels also are discussed briefly below.

Periphyton - Primary production in the stream appears to be limited. No evidence of submerged aquatic macrophytes was present on the stream substrate in June, and macrophyte populations were probably limited by periodic desiccation and scouring. Likewise, the periphyton algal growth on the stream substrate was sparse and limited to unshaded areas of the stream. The lack of macrophytes and periphyton suggests that little of the organic matter required to support growth of benthic macroinvertebrate communities is provided by primary production of plants in the stream. The majority of the organic matter necessary to support these organisms is likely provided by terrestrial leaf litter inputs from the local deciduous forests and riparian vegetation. Some of the sediment and benthic samples collected in the stream had an abundance of this leaf litter, particularly those samples collected at stations where the deciduous forest canopy covers the stream (Stations 3, 4 and 5, Figure 1-10).

Fish - Fish were not present in the portion of the stream located near the site area. Repeated kick-net trials by the NYSDEC aquatic ecologist failed to collect any fish from the protective cover areas along the stream margin, and no fish were observed by the field team in the clear water of deeper pool areas.

The field reconnaissance was conducted farther downstream on two separate occasions for a distance of one-half mile north of the Site to search for fish. During these efforts, one small school of juvenile minnows and two unidentified adult minnows were observed in the stream at about 0.5 mile down stream from the Site. Adult minnow observations will be confirmed and characterized during fieldwork performed in the Spring of 1993. At this location, the stream has a much lower gradient and appears to have been moved and channelized to accommodate the construction of an industrial building. The channelization process appears to have created a long, deep perennial pool that can support the reproduction and development of a small population of minnows. At the downstream end of this channel, the stream becomes much shallower and discharges through a series of smaller dendritic channels into the wetland area north of the offsite area.

Upstream migration of minnows from this area toward the vicinity of the Site are restricted by low and intermittent flow and by the high water velocities encountered during high flow events. A second evaluation of the possible restriction of upstream migration will be completed during high runoff conditions in the Spring of 1993. Moreover, several natural and man-made obstructions occur in the stream channel that also physically limit upstream migration. Occasional bedrock outcrops along the stream bottom have resulted in small natural waterfalls and steep cascade areas that, during low flow, are barriers to upstream migration. Similarly, the stream passes through several culverts below the Site, and small waterfalls exist at some of these culvert outlets during low flow.

This combination of factors probably accounts for the lack of fish in the portion of the stream that traverses the site area. However, the water and sediment chemical analysis data from the site area was compared to the NYSDEC Water Quality Standards (Section 1.3.5) and to the NYSDEC "Cleanup Criteria for Aquatic Sediments" to document the potential for site-related exceedance in contaminant concentrations that also may account for the lack of fish in this area. These issues are discussed below in the Step II, Containment-Specific Impact Analysis, of the FS.

Benthic Macroinvertebrates - Benthic macroinvertebrates are the primary fauna that inhabit the stream near the Site. A benthic survey was included as part of the stream sampling program conducted on June 5, 1991. The objectives of the benthic survey were as follows:

1. Characterize and compare benthic communities upstream and downstream of the Site

2. Generate data to evaluate possible impacts of the Site on the environment as part of the Draft Feasibility Study

Benthic macroinvertebrates were collected at four stations in the drainageways adjacent to the Blauvelt Site (Figure 1-10). Station 9 (the control station) was located upstream of the Site where the drainageway runs parallel to the railroad tracks. Station 8 was located just downstream of the Site, east of Bradley Hill Road. Station 5 was located in the small feeder tributary which originates in a pond behind the Xerox office building. Station 2 was located downstream of the junction of the feeder and the main tributary. These sampling stations were selected by WCC and NYSDEC aquatic ecologists based on the similarity of the habitat characteristics such as flow velocity, shade, substrate conditions and other features as noted in the approved Work Plan.Water and sediment chemistry samples also were collected at these four stations, and all biological and chemical sampling was conducted on the same day (June 5, 1991).

Three replicate samples were collected at each of the four stations using a Surber stream bottom sampler with a sampling area of one square foot. Replicate sampling locations were carefully selected so that physical parameters were kept as similar as possible among the replicates. Results of the benthic macroinvertebrate data collection effort are presented in the attached Table J-10. A total of 56 different taxa were collected in a study area. Taxa collected include turbellarians (flatworms), nematodes (roundworm), nematomorphans (horsehair worm), annelids (segmented worms), isopods (aquatic sowbugs), amphipods (scuds), cambrids (crayfish), Hydracarina (water mite), insects, and molluscs (clams and snails). The five most common taxa collected in the study area were the isopod Caecidotea communes, the caddisfly larvae Hydrophyche sp., the fly larvae Antocha sp., the black fly larvae Simulium sp., and the family of midge fly larvae Chironomidae. These taxa were present in all samples. The oligochaete worm family Tubificidae was also present in all but one sample.
The species sensitivity ranking system presented in the "Rapid Bioassessment Protocols For Use

in Streams and Rivers" (USEPA, 1989) was used to characterize the sensitivity of these organisms to environmental stress. None of the genera are considered to be particularly sensitive taxa. These taxa can dominate or exclude more sensitive taxa in stressed environments. The fact that they occur in conjunction with other more sensitive taxa, and comprise only portions of the communities observed, suggests that overall, the drainageways in the vicinity of the Site provide moderate quality habitat for benthic macroinvertebrates. While most of the taxa recovered occur in "clean" to moderately altered habitats, some of the fauna such as the Plecoptera (stoneflies) are more typical of habitats which have not been effected by development.

Taxa richness (total number of different taxa) per station ranges from a mean of 21 at Stations 5 and 9, to a mean of 16 at Station 2. It should be noted that since the oligochaetes and chironomids were identified to family only, the actual number of species per station may be as much as double these values, and the differences in taxa richness is not thought to be significant.

Density (number of individuals per unit area) ranges from a mean high of 2,146 individuals per square meter (indiv./m^2) at Station 5, to a mean low of 494 indiv./m^2 at Station 2. In most cases, C. communis, the caddisfly family Hydrophychidae, and the midge larvae family Chironomidae are the most abundant in terms of number of individuals at these stations. Molluscs also comprise a numerically important component of the fauna recovered at Stations 5 and 9.

Overall, the types of organisms found reflect predominant characteristics of the habitat. Many of the forms recovered are typical of moderately well-aerated, flowing water with an abundant food supply in the form of leaf litter and other detritus. Subtle differences among the faunal constituents observed in the Site vicinity may reflect other features such as sediment type or surface water chemistry.

Community analysis was utilized to provide a further comparison of the benthic communities present at the upstream, background station versus the downstream stations located in the offsite area. These results are presented below in Step II, Contaminant Specific Impact Analysis, of this FWIA (see Section 1.6.2).

Observations of Stress - The stream habitat within 0.5 mile downstream from the Site shows no obvious indications of stress potentially related to site contaminants. The stream water has no obvious surface sheen or odor. No groundwater seeps containing visible product were observed and the stream sediment samples had no noticeable solvent odor. The biological community showed no evidence of stress and there are no reported incidences of fish or wildlife mortalities for the stream.

Habitat Value - The value of this stream within 0.5 mile of the Site was qualitatively assessed. The value of the aquatic habitat to wildlife is primarily limited to the indigenous benthic macroinvertebrate community that occupies the stream sediments. Downstream at about 0.5 mile from the Site, the stream habitat provides food, refuge, and breeding sites for a limited population of minnows. The minnows may provide occasional forage for fish-eating birds, but the area is small, and the resource is limited and may not be sufficient to sustain a breeding population of birds. Ducks are unlikely users of this stream, since little or no aquatic vegetation is present for forage. Ample alterative stream habitat exists for aquatic birds in the larger Hackensack River Basin area within 0.75 mile of the Site.

The stream provides no opportunity for human recreational uses such as swimming, boating, hunting, fishing, and little opportunity for wildlife observation. The stream also provides little opportunity for wading or stream-side picnicking since within one-half mile of the Site, the stream is primarily surrounded by industrial and commercial buildings that detract from the streams aesthetic appeal. Downstream from the Site, within the 2.0-mile radius, there is some stream and adjacent wetland habitat that may provide opportunities for the viewing of wildlife, but it is unlikely these areas are potentially affected by Site contaminants.

Freshwater Pond

Physical Features - The freshwater pond near the site area is a man-made landscape pond that has no obvious inlet, spring, stream or ditch and apparently little fresh water flow through. Surface water runoff and, potentially, some seepage of groundwater probably provide the input water to the pond. The pond outlet is a concrete dam and spillway. Water flows over the spillway and passes through a forested area for about 250 feet before joining the small stream that traverses the Site. The pond diameter is less than 50 feet, and the depth at the point that sediment was sampled at the dam, presumably the deepest point, was approximately 4 feet. The pond outlet discharge was small and field-estimated at less than 0.1 cfs at the time of field sampling.

During the reconnaissance, the pond water appeared stagnant, dark and slightly tea-colored due to oak leaf litter from surrounding trees. Water chemistry variables were not measured in the pond water, but the water chemistry probably is low in dissolved minerals with nearly neutral pH. The dissolved oxygen levels probably show substantial seasonal variation. In summer, the surface water oxygen level probably approaches saturation while the bottom water remains low. The pH and dissolved oxygen levels will be measured during fieldwork to be performed in the Spring of 1993. Under winter ice-cover, oxygen likely declines to extremely low levels, due to the bacterial decomposition of leaf litter. The bottom sediment sample from the pond substantiates this assertion. This sediment consisted of a black, anaerobic, fine-grained mud containing a large quantity of decomposing leaves and twigs. This sediment had a very strong hydrogen sulfide odor, a condition consistent with anaerobic conditions.

Wildlife Resources - Although biota were not sampled in the pond, field observations showed there were no submerged or emergent macrophytes present and no native fish were observed. The dam at the pond and stream obstructions downstream probably limit any upstream migration of native fish into the pond.

Observations of Stress - The pond habitat shows no obvious indications of stress potentially related to site contaminants. The pond water has no obvious surface sheen or odor. No seeps were observed around the pond. The pond sediment had a strong hydrogen sulfide (rotten egg) odor, which is characteristic of anaerobic sediments but not an organic solvent odor characteristic of the site-related contaminants. Size and other natural restrictions probably limit wildlife use of this pond and therefore, no observations of stressed or unstressed biota could be made.

Habitat Value - This pond habitat is of minimal value to native fish and wildlife resources. It does not provide refuge, food, breeding, or roosting sites for any significant local populations. Likewise, the pond provides no opportunities for human recreational uses such as swimming, boating, hunting, fishing wildlife observation or other recreational or economic activities. The only apparent value of this pond is that it provides an aesthetically pleasing view for occupants of the adjacent office building.

1.6.1.4 Documented Fish and Wildlife Resources

The objective of this section is to document wildlife resources within a two-mile radius of the Site (Figure 1-12) and to identify any NYSDEC Significant habitats located in this area. Data were obtained from the NYSDEC and Department of the State (DOS) on regulated wetlands, Wild and Scenic Rivers, Coastal Zone Areas, and Significant Habitats within two miles of the Site.

NYSDEC Significant Habitats

There are no NYSDEC designated Significant Habitats within two miles of the Blauvelt Site.

Endangered, Threatened, or Rare Species and Species of Special Concern

According to the NYSDEC Natural Heritage Database, one federally listed endangered species, three state-listed endangered species, one state-listed threatened species, three state-listed rare species, and two state-listed species of special concern occur in the area covered by the Nyack, New York USGS quadrangle. The coordinate locations given for the historical occurrence of these species were plotted on the Nyack, New York 7.5 minute quadrangle. None of the historical locations listed in the Natural Heritage Database occur within the two-mile radius of the Blauvelt Site.

Regulated Wetlands

There are four regulated wetlands within the two-mile radius shown on Figure 1-12. The wetlands are all north and west of the Site. The closest regulated wetland (NA-4) is approximately 3,200 feet north of the Site. The other three regulated wetlands within the two-mile radius are 3,200 feet west (NA-5), 8,000 feet north (NA-11), and 8,100 feet southwest (NA-12) of the Site. Wetlands NA-4, NA-5, and NA-12 are hydrologically downgradient from the Site.

Wild and Scenic Rivers

There are no designated Wild and Scenic Rivers within two miles of the Site.

Coastal Zone Areas

The maps provided by New York State's Department of State, Division of Coastal Resources and Waterfront Revitalization indicate the presence of a Coastal Area within two miles of the Site that is under the regulation of the New York State Coastal Zone Management Plan. At its closest point, the Coastal Area boundary is approximately 1,700 feet from the Site. The Coastal Area encompasses Blauvelt State Park, Rockland County Park, and two small municipal parks east of the Site.

Rivers, Streams, and Lakes

The Blauvelt Site is entirely within the headwater area of the Hackensack River drainage basin. The area within the two-mile radius of the Site delineated on Figure 1-12 is drained by two rivers, one brook, and a creek. The two rivers are: (1) the Hackensack, west of the Site, and (2) the Hudson, east of the Site. A tertiary reach of the Hackensack River which flows toward the southwest, is approximately 4,200 feet west of the Site. The lower reach of the Hudson River which flows toward the south, is approximately 9,300 feet east of the Site.

The stream which drains the area along the western edge of the two-mile radius is Nauraushaun Brook. The stream draining the southern portion of the two-mile radius is Sparkill Creek. There are eight lakes of varying size scattered throughout the two mile radius that are not shown to be connected to any of the surface water bodies described above. None of them are named on the USGS quadrangle map and all have surface areas of less than nine acres.

Lake Tappan, where the Hackensack River empties into the lake, lies approximately 9,900 feet southwest of the Site. Lake Tappan is a man-made reservoir and is part of the Hackensack

Water Company's (a New Jersey water supply company) reservoir system. DeForest Lake and the beginning of the Hackensack River are approximately 11,100 feet north of the Site. The lake is a man-made reservoir and part of the Hackensack Water Company's reservoir system. There is a small, rectangular reservoir approximately 8,000 feet north of the Site (ownership unknown).

Park Land/Open Space

Four parks are within the two-mile radius: Blauvelt State Park; Rockland County Park; and two small municipal parks. The Blauvelt State Park boundary is approximately 1,800 feet east from the Site at its closest point. One of the municipal parks is approximately 3,700 feet to the northeast and the other, approximately 4,600 feet to the southeast. Rockland County park is approximately 6,600 feet southeast of the Site.

1.6.2 Step II - Contaminant-Specific Impact Analysis

Within the one-half-mile radius area around the Blauvelt Site, a much smaller land area may potentially have been exposed to site-related contaminants. A delineation of this area was conducted to more clearly document the extent of natural habitat that may have been exposed to site contaminant releases. This zone of potential exposure is hydrologically downgradient and is confined to the area north of the Site. Surface water runoff from the Site would follow the land surface contour and transport any surface contamination downgradient toward the stream and the covertypes described above. Likewise, the subsurface geological features mirror the surface transport of contaminants and would also transport contaminants to this area. These transport mechanisms likely combined to direct contaminants toward the north. These features probably confined the contaminant transport primarily to the central portion of the valley floor and parallel to the stream channel.

The stream surface water and sediment chemical data from this area confirmed the presence of contaminants in the stream channel. In addition, the groundwater contaminants plumes show that contaminants were also transported downgradient to the north and parallel to the stream channel. The perimeter of the overburden groundwater plume is coincident with this area of potential contaminant exposure.

This area of potential contaminant exposure in the Bradley Corporate Park corresponds to the offsite area previously described in Section 1.2, Site Description. It is located downgradient and adjacent to the onsite area. It is approximately 750 feet wide on an east-west axis by approximately 1250 feet long on a north-south axis, an area of about 21.5 acres. An examination of a recent aerial photograph shows that about 65 percent of this offsite area consists of man-made features while the remainder consists of natural covertypes.

A portion of this offsite area consists of mainly natural covertypes that is about 400 feet wide by about 800 feet long, an area of about 7.35 acres. This area of mainly natural covertypes contains some deciduous forest habitat, with some stream and pond habitat and some early succession stage herbaceous and shrub habitat. These natural covertypes within the offsite area are the main focal points of the FWIA and each is assessed separately below.

A contaminant-specific impact analysis was conducted for each of the natural covertypes represented in the offsite area. To initiate this process, the contaminants of concern were identified and a conceptual ecological model for each habitat was utilized to identify potential pathways of contaminant transport from source area to ecological receptors. Where a contaminant pathway was found to be incomplete or ecological receptors were not present, the impact was considered minimal and no further analysis was conducted. Where completed pathways to ecological receptors are identified, the potential impacts were assessed using criteria-specific analysis and analysis of toxicological effects.

Contaminants of Concern - Among the contaminants released from the Blauvelt Site, five volatile organic compounds (VOCS) were found in surface water samples downgradient from the Site. The same five VOCs and one additional compound (methylene chloride) were found in the surface water sediment samples collected down gradient from the Site. These six VOCs are considered the contaminants of concern (COCs) for the aquatic media of water and sediment: 1,1-Dichloroethane; 1,2-Dichloroethane (total); Tetrachloroethane; 1,1,1-Trichloroethane; Trichloroethane; and Methylene Chloride.

These VOCs are all chlorinated alkane solvents of low molecular weight (ranging between 84.9 to 165.8 grams) and low boiling point (ranging between 4O°C to 121°C). Their densities, ranging between 1.1 to 1.6, are slightly greater than that of water, and they have poor water solubility (ranging from slightly soluble to insoluble).

The first two of these physicochemical properties of the VOCs would encourage their rapid volatilization. This may limit their persistence in the surface water and sediment of the stream habitat in the offsite area. Turbulent mixing in the riffle areas of the stream and during high flow "flash flooding" also may encourage loss of the contaminants from the stream water and sediments by volatilization. It is unlikely these contaminants are transported for any great distance down stream and their in-stream residence times are probably short.

Transport Pathways - Despite the above phenomena, there are contaminants being transported into the stream from the Site area. There are two environmental transport pathways that may potentially transport the contaminants into the stream habitat from the Site. Surface water run off from the Site can transport contaminants into the stream in both dissolved and particle-bound phases. However, the contaminants are highly volatile and contaminant releases to onsite surface soils no longer occur at the Site, so surface water runoff is probably not the most important current pathway to the stream. Presently, the major source area of site contaminants is located in the shallow groundwater zone downgradient from the Site. Groundwater seepage from this source area is probably the most important current natural pathway of contaminant transport into the stream, in addition to the permissible inputs from the Site treatment plant discharge.

The presence of contaminants in the stream and pond water and sediment samples confirm that these transport pathways are complete. The presence of receptor organisms in the stream confirms the potential for exposure, and therefore, this potential for impact was assessed as follows. The primary receptor organisms identified in the stream during Step I, Description of Fish and Wildlife Resources, are a limited periphyton community on the stream substrate, a benthic macroinvertebrate community, and a small population of minnows located about 0.5 mile downstream from the Site.

1.6.2.1 Criteria-Specific Impact Analysis: Water

A criteria-specific impact analysis was conducted to evaluate the potential impacts to the receptor organisms identified above. Since the receptors can be exposed to both contaminated water and sediment, the stream and pond water and sediment chemical data were compared to NYSDEC's Water Quality Standards (NYSDEC, 1991) and the Cleanup Criteria for Aquatic Sediments (NYSDEC, 1989). The NYSDEC's Ambient Water Quality Standards and Guidance Values (AWQS/GV) for fresh surface water VOCs were evaluated for the contaminants of concern at the Blauvelt Site. Review of the guidance values reflects exceedances for exposures for trichloroethene and tetrachloroethene.

An additional reference was made to the USEPA Water Quality Criteria. This effort showed that, in general, the toxicity of the low molecular weight chlorinated alkanes solvents to aquatic biota is very low, and no WQC for the protection of aquatic life have been promulgated for the solvents identified as the contaminants of concern (COC) at the Blauvelt Site. However, some aquatic organism toxicity-based guidance values are available in the USEPA WQC and were evaluated for use in this impact analysis. These toxicity-based guidance values are presented in Table 1-11. They are referred to by USEPA as the lowest observed effects level (LOEL). LOELs are presented in lieu of criteria because there are insufficient toxicological data to promulgate criteria. Table 1-11 compares the acute level and, where available, the chronic LOEL for each of the site COCs (or their nearest chemical relative) with the site surface water maximum concentration (Table 1-5).

This comparison shows that the site COCs are, as a group of compounds, not particularly toxic to aquatic biota. Generally, the chronic LOEL values for the low molecular weight chlorinated alkanes range from about 2,500 to 20,000 ppb. Secondly, the comparison shows that the maximum concentration levels in surface waters are from about two to four orders of magnitude below the LOEL values, thus providing a safety factor of between 50 and 10,000 times. These observations suggest that the risks to aquatic biota in the stream from the current levels of contaminants are minimal.

This assessment should be considered as an estimated "worst possible case," since the surface water data were collected during low-flow conditions when the proportional contribution of contaminated groundwater to surface water flow in the stream was near a maximum, and presumably the COC levels were also maximal. During periods of normal to high flow, the risks to biota would be lower because of the greater dilution of the groundwater by less contaminated or "clean" surface water inputs from upstream.

1.6.2.2 Criteria-Specific Impact Analysis: Sediment

The NYSDEC's Cleanup Criteria for Aquatic Sediments (NYSDEC, 1989) were searched for the COCs at the Blauvelt Site. The document shows that no sediment criteria for the protection of aquatic life have been developed for the site contaminants, either on an aquatic toxicity basis or a wildlife residue basis. The NYSDEC sediment criteria does provide for the calculation of site-specific criteria based on the USEPA guidance for establishing sediment criteria from equilibrium partitioning (USEPA, 1989). This calculation requires numerical values for the water quality criteria, the octanol/water partition coefficient (K_{ow}), and the site-specific total organic content in the sediment. However, lack of available water quality criteria for the Site COCs and lack of the sediment total organic matter content preclude the use of this technique to calculate site-specific sediment criteria.

Since no sediment cleanup criteria for site COCs are presented for the protection of aquatic life, no analysis of risk can be conducted on this basis. However, some insight into the potential risk to aquatic biota exposed to the stream and pond sediment can be gained by comparing the sediment COC levels (Table 1-6) to the USEPA LOEL values (Table 1-11) for the low molecular weight chlorinated alkanes. A direct comparison of these values cannot be made since the sediment data are presented in μ/kg (wet weight) of sediment, while the LOEL data are presented as μg/l of water. However, if it is assumed that all of the mass of each contaminant in one kilogram of sediment is present primarily in the sediment pore water in a bioavailable form and then transferred to one liter of pore water, then a comparison can be made between the LOEL value and the sediment levels. This would represent a worst-case conservative assumption. Since the sediment data are presented on a wet-weight basis and the organic content of these sediments is low, the above assumption of high constituent bioavailability is probably correct and the comparison to the LOEL is reasonable. Moreover, the NYSDEC sediment criteria document indicates that virtually all of the sediment content of non-polar organic compounds with low K_{ow} values of about 2.0 or less is present in a bioavailable form in the pore water. Since the K_{ow} values for the sediment COCs are all less than 2.5, the above assumption is further corroborated.This comparison shows that all of the sediment COC levels are about two to four orders of magnitude below the LOEL values. This suggests that risks for toxic effects to aquatic biota exposed to the stream and pond sediments are minimal. The natural disturbances to the macroinvertebrate stream biota due to the effects of desiccation during low flow and the effects of severe substrate scouring during "flash flood" events probably exceed the risks presented by either the sediment or surface water levels of site contaminants.

In conclusion, the water and sediment criteria-specific impact analysis demonstrate that impacts to fish and wildlife resources in the offsite areas of the stream and pond located downgradient from the Site are minimal, with little or no risk of toxic effects. These results also suggest that potential impacts to fish and wildlife located downstream near the wetlands or the Hackensack River are minimal.

1.6.2.3 Analysis of Toxicological Effects to Benthic Macroinvertebrates

The NYSDEC guidance requires that an analysis of toxicological effects be conducted where no numerical criteria exist. Since there are no promulgated sediment quality criteria for the COCs that are based on toxicity to aquatic fauna, benthic community level analyses have been performed in the site vicinity to determine whether or not benthic communities have been altered as a result of exposure to site-related contaminants. The methodology and results of the benthic investigation have already been presented in Section 1.6.13.

In general, the types of benthic macroinvertebrates recovered in the study area reflect the natural physicochemical features of the habitat. Many of the forms found are typical of moderately well aerated, flowing water, with an abundant food supply in the form of leaf litter and other detritus. Some subtle differences were observed among the faunal assemblages in the offsite area that vicinity may reflect other natural features, such as sediment type or surface water chemistry.
To qualitatively evaluate the benthic macroinvertebrate data for evidence of site-related toxicological impacts, the benthic macroinvertebrates collected were assigned tolerance values (TV) presented in the Rapid Bioassessment Protocol (USEPA, 1989). This EPA protocol assigns a (TV) ranging from 0 to 10 to each macroinvertebrate family, based on their

environmental tolerances. A value of 0 represents the most sensitive, or least tolerant families.

Most of the taxa recovered at the Site are members of families to which tolerance values have been assigned. These taxa and their respective tolerance values are presented in Table 1-10. The TVs have been used qualitatively along with density (number of individuals per unit area) and richness (number of taxa) as a means of evaluating the benthic macroinvertebrate data collected at the Site. Predominant forms were characterized as sensitive (TV = 0-3); moderately tolerant (TV = 4-7) or tolerant (TV = 8-10).

Reference Stations 9 and 5 (located downstream of the pond) had the highest mean taxa richness of all four locations sampled. While Station 9 had the second highest mean density, it also had the greatest incidence of pollution-sensitive forms. According to the tolerance values presented in the Protocol, the four most sensitive forms found in the study area are the Chloroperlidae (TV = 1), Attenella sp. (TV = 1), Gomphus sp. (TV = 1), and Glossosoma sp. (TV = 0), all of which occur at Station 9. The taxa recovered at reference Station 9 include approximately 26% sensitive forms, 48% moderately tolerant forms and 26% tolerant forms. The higher macroinvertebrate density at Station 5 is attributable to dominance by the midge Family Chironomidae (TV = 6), the black fly Family Simulidae (TV = 6) and the fingernail clam Family Sphaeriidae (TV = 8). The taxa recovered at this station include approximately 12% sensitive forms, 65% moderately tolerant forms and 23% tolerant forms.

Stations 2 and 8 were similar to each other in terms of density and richness, but generally had lower densities and richness than the communities observed at reference Station 9. The low mean density at Station 2 is largely due to one replicate with a community density of only 184 indiv./ft, which probably represents an outlier. The taxa collected at Station 2 include about 13% sensitive forms, 62% moderately tolerant forms, and 25% tolerant forms. The taxa found at Station 8 includes 21% sensitive forms, 47% moderately tolerant forms and 32% tolerant forms.

In general, benthic density and richness at the sampling stations did not vary consistently with sediment or surface water chemistry measured in the vicinity of the Site. While concentrations of VOCs were higher at Station 5, this station had the highest benthic macroinvertebrate density. It is more likely that subtle differences in the natural physical features of the habitats at the different stations account for the slight differences observed in the biota. The fact that Station 5 had the highest density in the study area is probably due to the nature of the sediment at this station compared to the other stations. Sediment at Station 5 was composed largely of fine sand, compared to fine to coarse sand at the other stations. This sediment is more suitable for colonization by oligochaetes and chironomids, which were found in higher densities at this station than any other station sampled.

In summary, benthic macroinvertebrate communities collected at stations downstream of the Site are generally similar in terms of faunal assemblages. Differences in density and the types of organisms collected are probably due to subtle physical differences in habitat, since these parameters do not vary consistently with sediment or surface water chemistry. Benthic fauna collected are typical of moderately well aerated, flowing waters.

The types of taxa at all stations sampled were dominated by moderately tolerant forms. None of the stations are dominated by tolerant taxa; however, tolerant taxa occur at all stations sampled, in conjunction with other sensitive and moderately tolerant forms.

1.6.3 Step III - Ecological Effects of Remediation Alternatives

The third step in the FWIA is conducted to document both the contaminant-related and non-contaminant-related ecological effects of each of the five remediation alternatives evaluated in this Draft Feasibility Study (Section 3.0). Remediation Alterative 1 is a no action alterative. Alternatives 2 through 5 prescribe containment of contaminated groundwater in the overburden, shallow bedrock and deep bedrock zones in both the on- and offsite areas. Alternatives 2, 3 and 4 also prescribe recovery of the contaminated groundwater plumes in these three water-beaning zones in the on- and offsite areas (see Section 3.0 for details).

Conventional pumping recovery wells and 2-phase extraction recovery wells would be used to collect groundwater. 2-phase extraction recovery wells would be used to collect groundwater and contaminated soil vapors, and NAPL in Alternatives 2 and 3. For the alternatives evaluated network of pipes will be installed to collect the groundwater and vapors for treatment at onsite treatment facilities. The ten existing groundwater recovery wells would continue to operate in the overburden and shallow bedrock zones in the onsite area in Alternatives 2 through 5. In Alternative 4, a bituminous concrete cap would be placed over 0.29 acre of maintained lawn to cover contaminated soils in the area of the two former underground storage tanks (USTS) at the Site.

The exact specifications of each of these alternatives (No. 1 through 5) are detailed in Section 3.0, Development of Alternatives, and illustrated in Table 3-1.

1.6.3.1 Contaminant-Related Effects

Aquatic Habitats - Minimal negative impacts of site contaminants on the fish and wildlife resources in the aquatic habitat onsite or offsite were documented in the Step II, Contaminant-Specific Impact Analysis. However, contaminant concentrations in some stream water and sediment samples downgradient from the Site showed that the quality of these media are minimally, but measurably, impacted. Implementation of remediation Alternatives 2 through 4 (and Alterative 5 to a lesser degree) would be expected to significantly reduce the concentrations of contaminants in these media by lowering the concentrations in groundwater that seeps into the stream. Alterative 1 (No Action) would not be expected to significantly reduce contaminant concentrations in stream water and sediment samples. Therefore, Alternatives 2 through 5 would be preferable to Alterative 1.

Four of the five alternatives would utilize groundwater recovery wells to reduce the concentrations of site-related contaminants in the groundwater. Since the surface water stream and pond habitat probably receive contaminants via groundwater inputs, any reductions in groundwater contaminant levels would have a positive effect on the water and sediment quality in the aquatic habitat by reducing the contaminant concentrations in both of these media. The improvements in groundwater quality, and hence surface water contaminant levels, would depend on the amount of water recovered by the well pumping and water treatment systems utilized. Presumably, from an ecological perspective, the alternatives with the greatest number and more extensive array of wells would more quickly improve surface water quality conditions downgradient from the Site. Paving of the onsite area determined to contain soil contamination would be effective in limiting the erosion and subsequent runoff of contaminants to the downgradient stream habitat and the leaching of contaminants to the groundwater. Therefore, Alterative 4 (which includes such paving) would likely have a positive effect by reducing contaminant levels in the water and sediment of the aquatic habitat.

Terrestrial Habitats - Minimal negative impacts of site-related contaminants on wildlife resources in the terrestrial covertypes offsite were documented in Step II, Contaminant-Specific Impact Analysis. No contaminants were detected in the surface soils of the offsite terrestrial habitats. Therefore, none of the remediation alternatives are expected to result in any contaminant-related impacts to the wildlife resources in the offsite area.

In the onsite area, a small area of soil contamination is present in an area of maintained lawn at the south end of the Site. Alterative 4 would cover this area with a bituminous concrete cap, thus destroying this vegetative cover type while simultaneously eliminating the risk of contaminant exposure to any wildlife species that may utilize the lawn area for forage. This small area of lawn is neither natural habitat, unique habitat, or critical habitat for the continued support of wildlife resources in the area and, therefore, the loss constitutes a minimal impact.

1.6.3.2 Non-Contaminant Related Effects

Aquatic habitats - The non-contaminant-related effects of the remediation alternatives to the fish and wildlife resources in the aquatic habitat onsite and offsite would be primarily associated with the construction and installation of the groundwater recovery wells and with the pumping system required to transport groundwater to the onsite treatment plant. Clearing and grubbing of access roads for the wells and pipelines may result in a greater opportunity for soil erosion and stream siltation and, thus, a greater opportunity for adverse impacts on the benthic macroinvertebrate community in the stream. Appropriate erosion control strategies would be employed to mitigate these risks and, if properly applied, these impacts would be minimal. Recovery well locations would also be modified, where necessary, to limit risks to the aquatic habitat. Pumping rates will be low because of aquifer characteristics and impacts to surface water flow in the stream are not considered to be significant. Alterative 1 (which proposes no new wells) would have the least potential for erosion related impacts, while Alternatives 2, 3, and 4 may have the greatest potential. Construction-related impacts associated with the installation of the bituminous concrete cap (under Alterative 4) are considered minimal.

Well drilling and well development-related impacts were also considered minimal, since neither the drilling fluids (if used) or water pumped during the well development process would be discharged to the ground surface or to the local stream. These fluids would be collected and treated in the onsite treatment system prior to SPDES-permitted discharge. In addition, solids from drill cuttings would be containerized and shipped offsite for proper disposal. There would be no onsite disposal of these well installation by-products.

Terrestrial Habitats - The non-contaminant-related effects of the remediation alternatives to the wildlife resources in the terrestrial cover types onsite and offsite would be primarily related to the construction and installation of the groundwater recovery wells and the pipeline network. The majority of the recovery wells in the onsite area would be located in man-made areas such as parking lots and lawn. Therefore, impacts to wildlife resources on site would be minimal. The recovery wells in the offsite area would be installed within the estimated perimeters of the overburden, shallow bedrock, and deep bedrock groundwater contaminant plumes (see Section 3.0, Development of Alternatives). An area of about 7.4 acres would contain the proposed recovery wells and of this, about 3.1 acres in natural habitat. Therefore, about 85 percent of the area is covered with manmade features and about 15 percent is deciduous forest and herbaceous covertypes. Since the recovery wells would not be located in buildings, the well locations would primarily fall within the deciduous forest covertype or the roadways.

Timber cutting, land clearing and excavating for access roads, drilling operations and pipeline installations would disturb varying amounts of this habitat, depending on the number and locations of wells described in the remediation alternatives. Alterative 1, with no offsite wells proposed, would have the least impact on this deciduous forest area. Alternatives 2 through 5 would locate new wells in this area and would require the partial removal of the natural vegetation to provide access roads for drilling and excavation machinery.

These activities would also kill some less-mobile wildlife species and displace the more-mobile species. These impacts would be most evident during the construction phase, but vegetation in the disturbed areas would eventually become re-established and the wildlife return. The displaced wildlife may migrate to similar, adjacent deciduous forest habitat that is abundant less than 1800 feet east of the Site, in Blauvelt State Park. Some displaced species would eventually occupy the recovering vegetation in the previously excavated area. Although some of the original habitat would be permanently lost for access roads to service the wells, in other areas the impacts would be temporal in nature. The description of the wildlife resources in this covertype showed that this habitat is not unique or critical habitat for the support of any significant species or population. Therefore, the potential impacts to the terrestrial community associated with Alternatives 2 through 5 are considered minor. These factors should not restrict the selection of a preferred remediation alterative.

In conclusion, the level of negative impact associated with both the contaminant-related and non-contaminant-related effects of the remediation alternatives on aquatic systems and the terrestrial covertype do not outweigh the positive impacts. Therefore, the minimal negative ecological effects associated with these alternatives should not outweigh the beneficial effects of implementing the remediation, or restrict the selection of a preferred remediation alterative at the Blauvelt Site.

1.6.4 Step IV - Ecological Considerations in Implementation of Selected Alternatives

Implementation of the selected remediation alterative would be conducted in a manner protective of the aquatic resources in the on- and offsite areas of the Blauvelt Site. Routine protection against erosion-induced stream siltation would be specified for all recovery/containment well drilling operations. Erosion control plans would be developed prior to the start of remediation, and followed during remediation. Treated discharges to the stream would comply with the New York SPDES permit conditions.

Any land-clearing activities in the terrestrial covertypes (if required to construct the site remediation) would be conducted to minimize loss of the deciduous forest community, and a buffer zone would be provided between the stream and the placement of upland recovery wells. No recovery wells would be located in the stream basin or wetlands, and all drilling fluids and cuttings would be contained for proper offsite disposal.

1.6.5 Step V - Monitoring Program

As part of implementing the remediation alternative selected for the Blauvelt Site, a surface water sampling program will be implemented to monitor the efficacy of the remedial alterative. Yearly surface water samples will be collected from the stream at an upstream and a downgradient location from the remediation activities. The downgradient sample will be collected during low-flow conditions when the proportional contribution of groundwater to the stream is high and any site-related contaminant inputs most easily detected. The downgradient surface water sample will be collected at Station 2. An upgradient surface water sample will be collected at Station 9 to ensure that no COCs are entering the stream from nonsite-related sources. These surface water samples will be analyzed for VOCs and mineral spirits and the results reported to the NYSDEC.

The monitoring will proceed for a period of three years and be reviewed to evaluate the need for continued monitoring. The data will be compared to the data presented in this study to identify any significant changes in the type of contaminants or the concentrations of the COCS. The data will also be compared to NYSDEC AWQS/GV and the USEPA LOELs to document any exceedances. If exceedances occur or concentration levels increase, additional control measures will be instituted during implementation of the remediation alterative.

1.6.6 Conclusions of the FWIA

The results of the FWIA provide the following conclusions:

- Five site-related VOCs were identified in surface water samples collected downgradient from the Blauvelt Site.

- The same five site-related VOCS, plus one additional compound (methylene chloride), were identified in stream and pond sediment samples collected downgradient from the Blauvelt Site.

- No VOCs were identified in surface water or sediment samples collected upgradient from the Blauvelt Site.

- None of the VOCs concentrations in the surface water or sediment samples exceed the Lowest Observed Effect Levels LOELs documented by USEPA (Water Quality Criteria, 1991) in toxicity tests on freshwater organism.

- No Contaminants of Concern (COCS) were detected in surface soils in the offsite area, and risks to terrestrial wildlife and habitats are minimal.

- The lack of native fish resources at the Site is probably the result of intermittent stream flow and physical barriers to upstream migration, and not due to site-related toxic effects of COCS.

- Natural assemblages of benthic macroinvertebrate organisms dominate the stream faunal biota and do not appear to be impacted by site-related, toxic effects of cocs.

- No impacts of the remediation alternatives or their implementation were identified for the aquatic habitat onsite or offsite.

- Non-contaminant-related aspects of the implementation of the remediation Alternatives 2 through 5 would result in minor negative impacts to the terrestrial habitat onsite and offsite, but the positive effects to water quality associated with remediation exceed and offset the negative impacts.

- A surface water monitoring program win be implemented to document the efficacy of the chosen remedial alternatives.

The issues presented in the above summary show that no remediation of surface water habitats (including stream and pond water, sediment or biota) are required at the Blauvelt Site. Remediation of the groundwater, and prevention of contaminated surface runoff, which are proposed by the recommended Alterative 2 (Section 3.0), will likely provide adequatic protection of the terrestrial and aquatic fish and wildlife resources at the Blauvelt Site.

1.7 REMEDIATION GOALS

1.7.1 Overall Goals

Remediation goals specify the objectives for managing concentrations of contaminants in various environmental media and/or minimizing or eliminating the pathways of human and environmental exposure to these contaminants. The main objective of remediation of the Blauvelt Site is to protect human health and the environment, by limiting the exposure of potential human and environmental receptors to site-related chemicals. This FS has considered controlling exposure to site-related contaminants and controlling further migration of contaminants (both "source control measures"), as well as contaminated media recovery and treatment measures (or "active remediation measures"). Source control and active remediation measures are described and evaluated in Section 2.0.

The selected alterative must take into account the unique site conditions, and the level of development, effectiveness, and implementability of the specific remediation methods making up the alternative.

Per NYSDEC, all regulated contaminants (i.e., the "Xerox Blend" of solvents and mineral spirits) are to be considered "contaminants of concern" for the purposes of the site cleanup.

There is both an onsite and an offsite area at the Blauvelt Site that require remediation. Of the environmental media at the Blauvelt Site, onsite and offsite groundwater contaminant plumes and onsite area soils have been determined to contain sufficient concentrations of contaminants to require remediation. However, evaluation of soil sample analytical data indicates that offsite area soils do not require remediation. Similarly, sample analytical data for surface water and stream sediments indicate that these two media do not require remediation for any areas at the Blauvelt Site.

The remedial goals for the environmental media of concern are listed below:

Soil:

- Reduce soil contamination to prevent soils from releasing contaminants to groundwater resulting in exceedances of groundwater quality standards through partitioning, leaching, or other mechanisms.

- Reduce soil contamination so that contaminants are not released to ambient air resulting in exceedances of ambient air standards or risk based guidance values.

- Reduce soil contamination to levels that do not exceed health-based exposure levels for reasonable worst case direct exposure scenarios.

Groundwater:

- Reduce the concentration of groundwater contaminants to the higher of background or water quality standards.

- Reduce the concentration of contaminants in groundwater that discharges to surface water and sediments to prevent exceedances of surface water/sediment quality standards and/or guidance values.

Surface Water/Sediments:

- Indirectly reduce the concentration of contaminants in surface/sediments to levels below standards and/or guidance values by treating groundwater.

Air/Soil Gas:

- Indirectly reduce the concentration of contaminants in air to the higher of background or ambient air standards/guidance values by treating groundwater.

Tables 1-1 through 1-3 summarize the analytical data for soils, onsite groundwater, and offsite groundwater, respectively. Section 1.4 summarizes New York State and US Environmental

Protection Agency USEPA values for Appropriate and Relevant and Applicable Regulations (i.e., standards) and To-Be-Considered values (i.e., guidance values). The following sections present the proposed cleanup goals for Blauvelt Site groundwater and soils.

1.7.2 PROPOSED GROUNDWATER CLEANUP LEVELS

Analytical data for groundwater from the -onsite and offsite areas have been evaluated, and compared to available NYS and USEPA regulations and guidance for cleanup of these media. As a result, the contaminants (or parameters) listed in the left-hand column of Table 1-12 have been compared to the NYS drinking water standards (as per NYS Drinking Water Standards, 6 NY CRR, Part 703, September 1991; and 10 NY CRR, Part 5, which is included in Part 703 as an appendix). The Table 1-12 contaminants are identified as the parameters of concern for the groundwater remediation (onsite and offsite areas combined). It should be noted that one parameter, chloroethane, has been detected in the groundwater only at a level (up to 2.48 μg/l) below the proposed target level (5 μg/l).

Per NYSDEC mandate, the NYS drinking water standards will be the target cleanup levels for onsite and offsite groundwater; these standards are provided in the second column of Table 1-12 for each contaminant of concern. Exceptions will be for any contaminant for which the average background groundwater level was higher than the NYS drinking water standard. The third column of Table 1-12 provides the range of detected groundwater contaminants for the Blauvelt Site. The groundwater target cleanup levels discussed above were used to determine the extent of groundwater contamination for the Blauvelt Site (see Section 1.3).Remediation goals for the site include cleanup of the extent of onsite and offsite groundwater contamination as defined in Section 1.3 and Figures 1-5 through 1-7.

Tables in Sections 1.3.2 and 1.3.3 indicated which monitoring and background wells are represented by the data reviewed. Onsite and offsite well sample data for the period between December 1991 and April 1992 were used for the above comparison of site groundwater quality to NYS drinking water levels, and for the subsequent development of target cleanup levels presented in Table 1-12.

1.7.3 PROPOSED SOILS CLEANUP LEVELS

Per NYSDEC's request, a groundwater-soil partitioning analysis was conducted to evaluate the potential impact of site soils contamination on groundwater in the onsite and offsite areas. The data evaluation methods are described below.

The partitioning analyses was based on the following assumptions and reference values:

- Total organic carbon (TOC) value of 0.5 percent

- A multiplier of 100 to account for expected soil contamination reduction, due to dilution and attenuation of contaminants along the entire potential length of their transport pathway from soils to groundwater

- Values for organic carbon partitioning constants (or K^{oc}) and Henry's law constants contained in the October 1986 OSWER Directive 9285, Superfund Public Health Evaluation Manual

For each chemical compound detected in the soils, a water-soils partitioning constant (Kd) was calculated from values for organic carbon partitioning constants (K_{oc}) provided by an EPA guidance document for each compound, and from the fraction of organic carbon (f_{oc}) of 0.5 percent. Next, the concentration of the compound in the soil phase (C_s) in ug/kg, and the concentration in the groundwater phase (C_w) in ug/L, were calculated from the following input values: the partitioning constant (K_d) and NYS groundwater quality standards. The calculated values for C_s, were then multiplied by 100 (the NYSDEC requested multiplier, used to account for expected soil contamination reduction due to dilution and attenuation), and converted to units of mg/kg to provide the target soil cleanup level for a given chemical compound.

As a result, the proposed target cleanup levels (in mg/kg) for detected site contaminants (which appear in the second column of Table 1-13) were calculated by the partitioning analyses.

1.8 VOLUMES OR AREAS TO REMEDIATE

Consistent with Section 1.3, Nature and Extent of Contamination, contamination requiring remediation at the Blauvelt Site consists of the two defined groundwater contamination plumes and the two defined contaminated soil areas. Additional monitoring will be conducted to further characterize the ambient air quality at the site. Based on the results of this monitoring, the extent of ambient air remediation will be determined. Real-time air monitoring would be performed using instruments such as a photoionization detector and a dust monitor, to measure any offsite migration of airborne site contaminants. If air contamination is detected along the site boundaries, site operations would be reduced or engineering controls would be implemented to effectively control air emissions. Based on the Draft Fish and Wildlife Impact Assessment (FWIA), no surface water or sediments in the nearby stream (a tributary of the Hackensack River) require remediation.

The following subsections provide estimates for the volume and area of groundwater and soils requiring remediation. These volumes and areas were assumed for purposes of the remediation feasibility evaluations in Sections 2.0 through 5.0.

1.8.1 Soils Contamination

Soil contamination at the Blauvelt Site is present in a smaller area under the Xerox plant building, and in a larger area where the former underground storage tanks (USTS) were located (see Figure 1-5, Extent of Soil Contamination). For each of these two soil contamination areas, the vertical extent of contamination is from the top of ground to approximately 18 feet below ground (or to the top of bedrock). The total in-place volume of soil contamination is approximately 8,640 cy. This volume includes approximately 7,800 cy of the contaminated soil around the former USTs, and approximately 840 cy of contaminated soil under the plant building.

1.8.2 Groundwater Contamination

Groundwater contamination is present in two distinct plumes, as shown on Figures 1-6 and 1-7. One smaller plume, of approximately 2,500-sy area based upon July 1992 groundwater quality data, is located within the overburden and shallow bedrock under the plant building. The thickness of this smaller plume is a minimum of about 42 feet as assessed by the existing monitoring wells. As the full vertical extent has not been defined, the actual thickness will be greater. The depth to the top of the plume (i.e., to the water table) is about 4 feet.

In this smaller plume, the total volume of groundwater requiring remediation in the onsite overburden zone is estimated at about 450,000 gallons. This estimate assumes, (1) a primary porosity of about 15 percent in the overburden zone, (2) an average overburden saturated thickness of 18 feet and, (3) an approximate 2,500 sy areal extent. The total volume of groundwater requiring remediation in the onsite shallow bedrock zone of this same plume is estimated at about 470,000 gallons. This estimate assumes: (1) a secondary porosity of about 10 percent in the shallow bedrock, (2) an average shallow bedrock saturated thickness of about 28 feet, and (3) an approximate 2500 sy areal extent.

A second, larger groundwater contamination plume is located within all three water-bearing zones at the site (i.e., overburden, shallow bedrock, and deep bedrock), as shown in Figures 1-6 through 1-8. This larger plume originates under the former underground USTs on site, and extends to the offsite area. The second plume covers a total area of approximately 72,000 sy, in the overburden and shallow rock based upon July 1992 groundwater quality data. The deep rock plume covers approximately 20,000 sy. The depth to the top of the water table is about 6 feet.

In this larger plume, the total volume of groundwater requiring remediation in the overburden zone is estimated at about 13 million gallons. This estimate assumes: (1) a primary porosity of about 15 percent in the overburden zone, (2) an average overburden saturated thickness of 18 feet, and (3) an approximate 72,000 sy areal extent. The total volume of groundwater requiring remediation in the shallow bedrock zone of this same plume is estimated at about 12 million gallons. This estimate assumes: (1) a secondary porosity of about 10 percent in the shallow bedrock, (2) an average shallow bedrock saturated thickness of about 25 feet, and (3) an approximate 11,250 sy areal extent.

The total volume of groundwater requiring remediation in the deep bedrock zone of this same plume is estimated at about 4 million gallons. This estimate assumes: (1) a secondary porosity of about 10 percent in the deep bedrock (2) an average deep bedrock saturated thickness of about

30 feet, and (3) an approximate 1,200 sy areal extent.

1.8.3 Surface Water/Sediments

Surface water and sediments in the nearby stream (a tributary of the Hackensack River) will benefit from onsite and offsite remediation.

1.9 SUMMARY OF IRM-TREATABILITY STUDIES

During the site characterization process, a number of IRM-Treatability studies were performed which resulted in the implementation of recovery and treatment processes proposed for consideration as a part of the site wide remedy on a pilot basis. The processes were evaluated to assess their applicability and effectiveness under a technology screening process. The results of the IRM-Treatability studies are contained in the following sections.

1.9.1 Groundwater: Interception and Treatment

1.9.1.1 Groundwater Interception

During 1986, Xerox installed ten recovery wells at the Blauvelt site, to recover contaminated groundwater within the overburden and top of rock water bearing zones at this end of the site. (Section 1.3 described the NAPL in more detail.) These ten wells were installed in a line extending along the northern edge of the site, roughly paralleling Bradley Hill Road and ending near the edge of the railroad bed at the northwest comer of the site, as shown on Figure 1-13. The ten recovery wells were installed to depths of 12.5 feet to 22 feet below ground surface, with a typical cross-section well design as shown on Figure 1-14. Appendix B provides the boring logs and typical construction logs for the ten recovery wells.

After these wells were installed, they were developed by Rochester Drilling. Well development continued until groundwater pumped from these wells were visually clear of silt. During 1988, silting problems within RW-2 resulted in this well being taken out of service. RW-2 was not used since that time and remained out of service until July 1992. The other nine developed wells were each fitted with a bottom-loading, submersible pump designed to recover groundwater from below the NAPL layer floating on the water table. Figure 1-15 presents a cross-section design of the type of submersible pump installed in the recovery wells. As shown by this figure, the pumps are pneumatically operated using compressed air supplied by the Blauvelt plant compressed air system.

Since the overburden materials have low permeability, the nine recovery wells were found to yield an average of approximately 3 to 4 gpm of groundwater without pumping the wells dry. Therefore, the total average yield of all nine wells combined was approximately 27 to 36 gpm. Consequently, the groundwater treatment system installed on site was designed for an average flow of 50 gpm, with a capability to treat up to 100 gpm.Start-up for the nine recovery wells occurred in November 1987, and these wells operated largely continuously until early 1992. During this operation, the flow rate from individual wells varied, and the combined total flow monthly into the groundwater treatment system from the nine wells varied between 58,000 and 1,080,000 gallons, as shown in Table 1-14. Nonaqueous-phase liquids (or NAPL) have not been observed in the groundwater flow from these recovery wells.

Also during the period of well operation, water levels were measured in nearby onsite monitoring wells; these water levels have varied between one to three feet. These measurements indicate that operation of the nine recovery wells was lowering the water table an average of about 1.8 feet, within an area at about a 50-foot radius from the recovery wells. It also means that the gradient of the groundwater within the wells' influence was locally reversed and, therefore, the wells were containing some portion of the contaminated groundwater to the vicinity of the recovery wells. This demonstrates that it would be feasible to contain contaminated groundwater via conventional-type pumping recovery well technology, within the zone of influence of such wells. These water table measurements also indicate that additional pumping wells would need to be installed in the offsite area in order to contain the offsite portion of the groundwater plume.

Slug tests were performed at twelve overburden wells in the offsite area during July 1992. Results of these slug tests provide local estimates for the hydraulic conductivity and transmissivity in the overburden groundwater zone. Additional, longer-term pumping tests are being conducted in the overburden and bedrock zones and will provide data on aquifer characteristics sufficient for preliminary design of a recovery well system to minimize further contaminant migration.

Operational records indicate one recovery well shutdown had occurred in February 1992, when the plant compressed air system failed. The recovery well operation was restarted in June 1992. For this restart, all ten recovery wells were redeveloped, the nine existing well pumps cleaned and refurbished, and a tenth pump installed in the tenth well (RW-2) that was not formerly operating. All ten recovery wells were started up again by the reconnection of the plant compressed air system to the pump air lines and the installation of a backup compressed air system dedicated to operation of the recovery wells. Upon well restart, the existing groundwater treatment system was placed back in service; this treatment system has been operating continuously again since June 1992 (see Section 1.9.1.2 for more details on the groundwater treatment system operation).

1.9.1.2 Groundwater Treatment

In 1987, Xerox completed installation of a groundwater treatment system within the Blauvelt site plant building. This initial system consisted of several individual treatment units (in order): a particulate filter, a free product/water separator, a flow equalization tank, and one air-stripping tower. In 1987, a State Pollution Discharge and Elimination System (SPDES) permit also was issued by New York State for the treatment system. Gaseous emissions from the stripping towers were sampled and analyzed at regularly scheduled intervals, and each analysis demonstrated that the emissions were within the limits of a Construction Permit issued by New York State for the treatment system.

The ultraviolet (UV) light/hydrogen peroxide system (manufactured by Peroxidation Systems, Inc.) was originally installed as a polishing unit to be used after the air stripper. Initial tests using the air stripper and PSI system did not provide adequate treatment to meet the SPDES limits. The PSI system was effective for destruction of most contaminants with the exception of 1,1,1-Trichloroethane which exhibited poor destruction efficiency. Consequently, Xerox installed liquid-phase activated carbon absorbers as an overall polishing step for the removal of residual contaminants such as 1,1,1,trichloroethane which were not effectively removed by the air stripper or the PSI system. Two liquid-phase activated carbon absorbers were later installed as a polishing step in October 1989.

In October 1989, the treatment system was restarted with the treatment units in the following order: particulate filter, oil/water separation, air stripper, PSI system, and liquid-phase activated carbon, with treated water being discharged to the local fresh water stream. In April 1990, Xerox changed the order of treatment units such that the PSI system would be placed before the air stripper, with the order of other treatment units remaining the same. The intention was to use the PSI system to destroy the majority of organics, thereby reducing air emissions associated with the air stripper. At this time, the cartridges in the particulate filter were changed to 5--micron size to reduce particulate buildup on the ultraviolet lamps within the UV/Peroxidation system. The treatment system has operated in this manner up to the present time.

The initial groundwater treatment system was operated for an extended period of time; subsequently, the treatment system was revised to the following treatment scheme (in order): a particulate filter, a free product/water separator, a flow equation tank, an ultraviolet light (UV)/ Peroxidation unit, one air-stripping tower, and two liquid-phase granular activated carbon (GAC) beds (operated in series) for final polishing. This revised treatment scheme is shown in Figure 1-16. The reason for this revision was that initial operating data indicated that the GAC beds were not capable of removing a few of the lighter-weight, more soluble contaminants to within the limits required by the SPDES permit for the system. Continued regular analyses of the gaseous emissions from the stripping towers has demonstrated that the emissions continue to comply with the Construction Permit. Carbon in the GAC beds did not require replacement with fresh carbon until July 1992.

During its entire period of operation, this,treatment system has been in continuous compliance with the SPDES permit. The revised treatment system has generally operated reliably.

The above facts demonstrate the short-term and long-term reliability of the individual unit technologies of which the system is composed, as well as the reliability of the treatment scheme as a whole. Since the types of groundwater contaminants detected throughout the groundwater plumes are the same as those detected in water recovered from the existing recovery wells, these technologies and the existing treatment scheme can be expected to be effective for full-scale groundwater remediation for the Blauvelt site. In summary, the individual groundwater treatment technologies and the present treatment system scheme used at the Blauvelt site have demonstrated to be appropriate for treatment of groundwater expected to be recovered during full-scale cleanup of the Blauvelt site.

1.9.2 SOIL/GROUNDWATER HIGH VACUUM E2-PHASE EXTRACTION AND TREATMENT

Xerox installed a 2-phase extraction system at the Blauvelt site to recover groundwater from selected monitoring wells in the onsite area shown on Figure 1-13. Startup for the three 2-phase extraction wells occurred in 1990, and these wells operated intermittently until 1992. This operation is considered to be an Interim Remediation Measure, or IRM, by the NYSDEC. The system consisted of a 30-HP vacuum pump, an air/water separation tank, a separation tank water removal pump, and accessory equipment.

Three existing monitoring wells were converted into 2-phase extraction wells by connecting them to the system. Construction logs for these three monitoring wells are provided in Appendix B. Connection to the system was achieved by lowering a vacuum pipe to or below the water table in each of the wells, and allowing the vacuum to extract groundwater from the wells (similar to the action of a straw). In the process of operating these wells, the high vacuum also extracted vapors from a nonaqueous-phase liquid (or NAPL) floating on the water in these wells.

The collected NAPL vapors are treated in an onsite treatment system, which discharges treated vapors into the atmosphere (i.e., system exhaust). Appendix E provides a copy of NYSDEC's March 20, 1992 letter to Xerox, in which the NYSDEC authorizes Xerox to modify its procedures for operating the 2-phase extraction system. This NYSDEC letter includes modifications for controlling the temperature and relative humidity of the collected vapors, for analyzing vapor samples on site, for contingency sampling and analyses, and for procedures to follow in the event of an emissions exceedance. The letter also indicates the maximum exhaust concentrations the agency will allow for tetrachloroethane, trichloroethane, 1,1-dichloroethane, vinyl chloride, and benzene. The three wells were each fitted with an airtight cap, so that the pressure applied by the vacuum pump could be maintained in the pipe "straw" used to recover the groundwater. Figure 1-17 presents a process flow schematic of existing 2-phase extraction and vapor-phase carbon treatment systems for groundwater recovery and NAPL vapor treatment.

2.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES

Section 2.0 provides the results of identifying and screening the remediation technologies the determined to be potentially applicable for the Blauvelt Site.

2.1 GENERAL RESPONSE ACTIONS

This section summarizes and screens the general response actions determined to be potentially necessary for the site remediation. These seven general response action are:

- No Action/Institutional Controls
- Contaminant
- Removal of Contaminated Media
- Groundwater Treatment
- Soils Treatment
- Residual Waste Treatment
- Transport and Disposal of Contaminated Media

Definitions for each of the above response actions are as follows. No Action/Institutional Controls is implementing no actual remediation of a site, but imposing institutional (or governmental) restrictions at the site to reduce adverse impacts on human health and the environment. Such restrictions could include installing security fences and posting non-trespassing signs. Containment is minimizing the further migration of contaminants from contaminated media into clean media or areas. Containment can consist of providing physical or hydraulic barriers to migration. Removal of contaminated media can be either partially or completely removing the media from to a location onsite that is more protective of human health or the environment, or removing the media form the site altogether.

Groundwater treatment is the chemical, physical and/or thermal processing of groundwater, such that contaminant concentrations are reduced to lower or nondetectable levels. Similarly, soils treatment is the reduction of concentrations to lower or nondetectable levels, using other types of chemical, physical and/or thermal processes. Residual waste treatment is the reduction of contaminant concentrations through one or more process. Finally, transport and disposal of contaminated media is the shipment of removed media off site to an appropriate and approved disposal facility.

The No Action/Institutional Controls response action was retained throughout this FS, to allow comparison to active remediation methods. All the other response actions listed above were retained for the technology evaluations in Section 2.2, since at least one technology for each of these response actions could be reasonable for a portion of the site remediation.

2.2 REMEDIATION TECHNOLOGIES

A range of remediation "technologies" that are potentially appropriate for the onsite and/or offsite areas of the Blauvelt Site were identified. Per NYSDEC's April 21, 1992 letter to Xerox and subsequent conversations with NYSDEC, "technologies" are considered relatively general remediation methods (such as "groundwater recovery wells," for example), while "process options" are considered more specific methods (such as "conventional pumping wells," for purposes of groundwater recovery). NYSDEC further requested that technologies be evaluated and screened first, followed by process options. This section summarizes the results of technology screening, whereas Section 2.3 describes process options and Section 2.4 presents the results of process option screening.

2.2.1 Onsite Soils

Potential technologies for remediation of onsite soils are as follows:

- In-situ extraction and recovery of soil contaminants, which is the removal of contaminants from the soil by a chemical and/or physical process that does not require excavating or moving the soils. An example of a physical extraction process is using vapor-phase extraction vacuum wells (conventional technology) or two-phase extraction vacuum wells (Xerox' 2-Phase Vacuum Extraction Process technology) installed in place(i.e., in the contaminated subsurface) for extraction and recovery of soil vapors and/or groundwater.

- In-situ treatment of soil contaminants, which is the reduction of contaminants in soils by a chemical and/or physical process that does not require excavating or moving the soils

- Onsite recovery of soil contamination, which is a chemical, physical, or thermal process for removing or reducing contaminants that requires excavation of the soils prior to processing

- Soil excavation and offsite disposal, which is the removal of the soils using earthmoving equipment, followed by the transport of the soils to an appropriate and approved offsite disposal facility (such as a hazardous waste landfill)

- Soil capping, which is the installation of one or more layers of impermeable or low permeable materials over the surface of the contaminated soil area

Each of the technologies listed above were retained for the remediation process option evaluations in Section 2.3, since at least one process option under each of these technologies is potentially appropriate for a portion of the site remediation.

2.2.2 Air Treatment (Treatment of Recovered Soil Vapors)

Contaminated vapors that are extracted from the soils can be considered residual wastes from soil treatment. Such vapors need to be collected and treated prior to release to the atmosphere, to minimize or prevent any adverse effects to human health or the environment. Therefore, contaminant vapor collection and treatment is a technology that will be retained for the remediation process options evaluations.

2.2.3 Groundwater Plume/NAPL Containment and Recovery

Potential technologies for containment and recovery of groundwater plumes and/or

NAPL are as follows:

- Active Recovery and Containment, which is the installation and operation of a system to mechanically induce groundwater and/or NAPL to flow toward a collection point (and thereby restricting the movement of these liquids into clean areas), followed by mechanically withdrawing these liquids from the subsurface. Potentially feasible process options for active recovery/containment are always achieved with some type of pumping system. Alteratively, the pumping system could induce the transfer of volatile organics from the dissolved or NAPL phase into a vapor phase, followed by collection of these extracted vapors.

- Passive Recovery and Containment, which is the installation and operation of a system that relies on gravity flow of groundwater and/or NAPL toward a collection point (and thereby restricting the movement of these liquids into clean areas), followed by mechanically withdrawing these liquids from the subsurface. Potentially feasible process options for passive recovery/contaminant include some type of interceptor trench or subsurface drains.

Each of the technologies listed above were retained for the remediation process option evaluations in Section 2.3, since at least one process option under each of these technologies is potentially appropriate for a portion of the site remediation.

2.2.4 Groundwater Treatment

Potential technologies for treatment of groundwater are as follows:

- Solids Filtration, which is the physical removal of suspended solids by passing the water through an inert media, in which the solids are trapped in voids of the media. For purposes of this FS, a cartridge filter containing porous media is the process option assumed.

- Free Product Removal, which is the physical separation of floating NAPL (or free product-phase contamination) from recovered groundwater; separated NAPL is then placed in containers for shipment to an offsite disposal facility. For purposes of this FS, typical oil/water separation is the process option assumed.

- Flow Equalization, which is the use of a sufficiently sized storage tank to allow mixing of the influent groundwater so that variations in water chemistry are minimized prior to the water reaching subsequent treatment units.

- Oxidation of groundwater contaminants, which is the chemical degradation of organic contaminants to smaller (usually less toxic) compounds.

- Stripping of contaminants, which is the physical removal of contaminants from the dissolved phase in groundwater to a vapor phase, by contacting the groundwater with an air stream to induce the phase transfer. The air stream acquires the contaminants and, thus becomes a residual waste that must be collected and treated.

- Adsorptive Removal, which is the physical/chemical removal of contaminants by passing groundwater through a porous media that attracts (or binds) the contaminants to its surface.

- Biological Degradation, which is the reduction of groundwater contamination by passing the water through a tank, containing microbiological organisms capable of metabolizing the contaminants for energy.

Each of the technologies listed above were retained for the remediation process option evaluations in Section 2.3, since at least one process option under each of these technologies is potentially appropriate for some or all of the groundwater contaminants. The solids filtration, free product removal, and flow equalization technologies are themselves process options that would be desirable or necessary for treatment of groundwater recovered during the Blauvelt Site remediation, no matter which physical/chemical treatment methods were used for removal of dissolved-phase contaminants. Therefore, these three technologies/ process options were retained throughout the rest of the FS evaluations, and are hereafter referred to as the "Common Components" of any groundwater treatment schemes considered.

2.2.5 Surface Water/Sediments

Per Section 1.3, Nature and Extent of Contamination, and Section 1.6, Fish and Wildlife Impact Assessment, no remediation of surface water or stream sediments in the onsite or offsite areas is required.

2.3 PROCESS OPTIONS

In this section, process options are identified and described that are specific remediation methods under each of the technologies selected in Section 2.2. Potentially feasible process options are discussed for both soils and contaminant vapors that might be recovered during soil treatment. In some cases, the technology has only one variation (i.e, one process option).

2.3.1 Onsite Soils/Air (Or Soil Vapor) Remediation

Potential process options under the soil remediation technologies are as follows:

1. In-situ extraction/recovery technology:
   - Conventional-Type Vapor Extraction Wells
   - Xerox' 2-Phase Vacuum Extraction Process, Two-Phase Extraction Wells
   - Soil Flushing

2. In-situ treatment technology:
   - In-situ Bioremediation
   - In-situ Chemical Solidification

3. Onsite recovery/treatment technology:

- Excavation and Onsite Soil Washing
- Excavation and Onsite Aeration
- Excavation and Thermal Stripping

4. Excavation/offsite disposal technology:

   - Excavation/Offsite Disposal

5. Soil capping technology:
   - Concrete Pavement
   - Bituminous Concrete Cap

Each of the above process options are described below. These process options are being considered for the approximately 1300 sy soil area around the former location of the USTS, as well as the approximately 140 sy soil area under the former CRC areas of the Xerox plant building. The combined areas are estimated to contain about 8,640 cy in place, or about 9,500 cy if removed (assuming a 10 percent volume expansion may occur during excavation).

2.3.1.1 Conventional Vapor Extraction Wells

Conventional vapor extraction wells represent a remediation process option that has been used for remediation of soils contaminated with volatile organics. A typical conventional vapor extraction system (or VES) consists of a network of air withdrawal (or vacuum) wells installed in the unsaturated zone, a vacuum pump and a manifold system of PVC pipes for applying a vacuum over the top of the air wells, and an in-line carbon adsorption system for VOC capture (or a fume incineration system for VOC destruction). VES wells could be installed vertically to the full depth of the contaminated soil zone.

In conventional vacuum extraction, a piping manifold would connect all wells to vacuum pumps. Vacuum pumps used in conventional systems typically exert vacuum pressures between 5 to 10 inches of mercury at the well head. Sometimes, the stripping rate for VOCs has been enhanced by also using wells to introduce atmospheric air into the subsurface. The process option has been applied in both pilot test and full-scale remediation programs for stripping volatile organics (VOCS) from soils left in place (i.e., an in-situ treatment).

The basic manner in which the vacuum pump develops pressure in the subsurface, and the overall approach for system pilot testing and well layout are summarized below. After an initial startup period for a VES system, a vacuum becomes established in the soil column and VOCs are drawn out of the soil, and through the air wells. In all VES operations, the daily VOC removal rates eventually decrease as volatiles are recovered by the soil. This occurs since the volatiles extraction process causes desorption of organics from soils, thus decreasing the VOC concentration in the soil, which eventually reduces the diffusion rate of volatiles from the soil.

The application of VES to unsaturated zone remediation is a multistep process. Specifically, full-scale VES systems are designed with the aid of pilot and/or field-scale tests. Results of such tests are then used to construct a full-scale system designed to operate at optimum efficiency for the particular site conditions.

Pilot tests involve the installation of a preselected number of extraction wells, and the testing of each well individually and/or in combination. Pilot wells are typically installed to the top of unfractured bedrock or to a depth into fractured bedrock. A primary vapor phase carbon (VPC) system could be used to recover stripped volatile organics from the contaminant vapors extracted from each VES well. Prior to VES well installation, additional soil borings are typically advanced to better characterize the soil and geologic strata in the contaminated area, and to obtain soil samples for analysis.

The following determinations are typically made during short-term pilot testing:

- The radius of influence of each VES well
- Initial rates of extraction for total VOCs and specific volatile compounds
- Efficiency of a carbon adsorption system for recovering VOCs from VES exhaust
- Vacuum pressures required for significant volatilization of organic contaminants from the soils and from the top of the water table.

In a pilot test of longer duration, data could be collected for predicting the activated carbon usage or fume incineration requirements, VES capital and operation and maintenance costs, and the required time for cleanup of the required treatment zone.

2.3.1.2 2-Phase Vacuum Extraction Process Recovery Wells

2-Phase Vacuum Extraction is another in-situ treatment process option that, like conventional vapor extraction systems (see Section 2.3.1.1 above) consists of a network of vacuum extraction wells, a vacuum pump, and a vapor-phase carbon adsorption unit to remove extracted VOCS. However, the 2-Phase Vacuum Extraction system applies the vacuum at the end of a vacuum pipe installed with its suction end at a preselected depth in the well, rather than applying the vacuum at the top of the extraction wells, as for conventional vapor extraction wells. In addition, vacuum pressures applied with, the 2-Phase Vacuum Extraction (i.e., 15 to 25 inches of mercury) are substantially higher than used in conventional vapor extraction. If the selected depth is below the static water table, use of the 2-Phase Vacuum Extraction also achieves drawdown of the water table and extraction of groundwater. The 2-Phase Vacuum Extraction Process has been patented by Xerox.

The basic manner in which the 2-Phase Vacuum Extraction develops vacuum pressures in the subsurface and volatilizes and extracts soil contaminants is similar to that described in Section 2.3.1.1 for the conventional vapor extraction systems. In addition, the overall approach for pilot testing and designing the 2-Phase Vacuum Extraction wells and well layout are similar to that described earlier for conventional extraction. However, there are still significant differences between the designs of a 2-Phase Vacuum Extraction Process and a conventional extraction system as well as their effectiveness in various types of subsurface materials. For instance, the higher vacuum of 2-Phase Vacuum Extraction is more cost-effective when applied for relatively lower permeability soils, while conventional vapor extraction is more cost effective for higher permeability soils.

2.3.1.3 Soil Flushing

Soil flushing is a process option in which contaminant extraction and recovery is conducted without excavating or moving soils (i.e., in-situ). Soil flushing involves the application of large volumes of fluid to the area of contaminated soil and the subsequent collection and processing of the spent flushing solution. Water has commonly been used as the flushing solution, although aqueous surfactant solutions and organic solvents can also be used. The applied fluid would dissolve and carry away organic contaminants as the fluid percolated down through the soil column. The basic principle behind soil flushing is that, upon contact of the soil with the flushing fluid, the chemical bonding between the compounds and the soil particles can be broken. The nature of the extraction fluid required depends on the chemical nature of contaminant to be removed and the mineralogy of the soil. The more water-soluble the contaminant, the more efficiently it could be removed by flushing. However, the lower the permeability of soils, the less efficiently any contaminants can be removed via flushing; flushing is not considered efficient for soils with moderate to low permeability.

Subsurface drains installed below the depth of soil contamination or wellpoints would be used for collecting spent fluids. If drains were used, they would need to be spaced closely together so that the contaminated fluid was collected for treatment or for recycle as makeup fluid. To maintain controlled treatment, application of this method would require the use of groundwater monitoring wells to detect the escape of fluids beyond the treatment area. These wells would be installed along the perimeter of the treatment area, and to the depth of the treatment zone. When the last volume of recovered fluid contained concentrations of contaminants below the NYSDEC Guidance Levels, it could be assumed that maximum contaminant recoveries had occurred. The soil would then be flushed with additional water to remove residual surfactants or solvents. This water would then be collected for treatment.

Confirmatory sampling of the soils would be performed for the area on an approximate 50 foot grid. Soil samples would be taken from three depths (surface, intermediate, top of bedrock) and would be analyzed for the volatile organic constituents found in previous sampling events as part of performance monitoring. In the event that NYSDEC Guidance Levels were not reached, additional flushing or an alternate method of treatment would be necessary.

The permitting process for soil flushing would include submission of a work plan for mobilization and operation onsite and compliance with regularly scheduled collection and reporting of operations data. The design work plan would include detailed design information for the soil flushing method and a description of environmental monitoring procedures, and handling procedures for contaminated water. Soil flushing and water treatment/disposal may require compliance with New York's hazardous waste rules 6 NYCRR Part 372.2.

2.3.1.4 In-situ Bioremediation

In-situ biological treatment (or bioremediation) is a process option for treating contaminated soil zones or aquifers via microbial degradation. This process option involves altering environmental conditions to enhance microbial catabolism or cometabolism of organic contaminants, resulting in their breakdown and detoxification. Microbial activity can degrade organic constituents through aerobic, anaerobic, or fermentative respiration. The bioremediation method that has been most actively developed, and widely applied, for in-situ treatment relies on aerobic microbial processes. Anaerobic bioremediation has been demonstrated to be a potentially viable process in recent laboratory investigations, but has not been fully demonstrated in field applications.
In-situ bioremediation is not appropriate for every combination of hydrogeologic condition and chemical contamination, but it has been proven successful in remediating sites that were contaminated with petroleum products and aromatic and aliphatic hydrocarbons, especially in shallow areas with adequate soil permeability. The efficiency of biodegrading volatile organics varies, depending on the compound.

Bioremediation may be accomplished by one of two overall approaches: enhanced bioremediation and cultured bioremediation. In enhanced bioremediation, the population of naturally occurring microorganisms is significantly increased by the introduction and control of oxygen or (if necessary) major nutrients (such as nitrogen and phosphorus). Enhanced bioremediation is employed primarily for restoring a groundwater aquifer. In cultured bioremediation, the natural microbial culture, which has been previously exposed to the contaminants, is seeded with the naturally occurring enzyme system of the microbes that facilitate decomposition of the organic contaminants. In time, the induced microbe culture can multiply because of its enzymatic degradation capability for the contaminant thereby increasing the biodegradation rate.

The feasibility of in-situ bioremediation is dictated by soil, contaminants and site characteristics. Factors which determine the applicability of this approach are listed below; each of these is discussed in the following paragraphs:

- Site hydrogeology and site characteristics
- Biodegradability of the organic compounds
- Environmental factors, which affect the degradation ability of the microbial population

A complete hydrogeologic and soil assessment is necessary to design an in-situ biodegradation system, since the conditions that may influence the in-situ biological activity must be defined. The most critical hydrogeologic factors are those that affect the ability to provide proper distribution of oxygen or (if necessary) nutrients through the contaminated area. This includes fluctuations in depth to groundwater, hydraulic conductivity, hydraulic gradient, soil porosity and concentration of contaminants. The contaminated zone must be defined both horizontally and vertically, and a pumping or vacuum extraction system must be designed to allow for the controlled movement of groundwater through the area.

A series of chemical and microbiological issues must be addressed to identify biodegradable materials within the site, and to identify (if necessary) the type of nutrient formulation best suited to stimulate the bacteria and yet be compatible with the site chemistry. In general organic compounds which are similar to those found in nature are biodegradable. These include aliphatic (straight chain) hydrocarbons, aromatic compounds (up to 3 rings), simple amities, alcohols, esters, ketones, and ethers. Also, certain chlorinated hydrocarbons have been shown to be biodegradable. The mineral spirits that are contaminants of the onsite area soils, at the Blauvelt Site, are straight-chain aliphatic hydrocarbons. The main organic contaminants of these Blauvelt Site soils are aromatics (such as toluene) and chlorinated hydrocarbons (such as tetrachloroethane and 1,2-dichloroethane). More complex and highly chlorinated materials, including many polymers and pesticides, are typically not readily biodegradable. The feasibility and efficiency of biodegrading larger aromatic compounds is generally in between that of the aliphatic hydrocarbons and highly chlorinated compounds. If soils contain a mix of organics, the microorganisms would tend to degrade the simpler, lower molecular weight and, thus, more easily degraded chemicals first. Presence of more easily degraded chemicals may allow a buildup in the population of microorganisms, sufficient for later degradation of larger, more complex chemical molecules.

The environment in which a contaminant is found also affects whether or not the contaminant is biodegradable. For example, certain organic and inorganic compounds can inhibit the growth of bacteria and, thus, interfere with the degradation of other compounds otherwise considered biodegradable. Also, soils of moderate to low permeability are typically less aerated naturally, and are difficult to aerate sufficiently (by chemical or physical methods) to enhance biodegradation.

The availability of the contaminant compounds to microbial organisms will also influence biodegradability. Compounds with greater aqueous solubilities are generally more susceptible to the degradative enzymes of the microbes. Therefore, the use of surfactants or other additives sometimes can be used to increase the solubility and degradability of some compounds. Specific environmental factors may affect microbial activity and population size, and may influence the rate and extent of biodegradation. Some of these factors are pH, temperature, the presence of toxins and growth inhibitors, levels of organic and inorganic nutrients, trace elements, and the redox (reduction-oxidation) potential of the subsurface.

2.3.1.5 In-situ Chemical Solidification

In-situ chemical solidification is a process option in which aqueous or dry chemicals are introduced as the soils are broken up and mixed by the augers inserted into the soil column. By this process, the chemicals are mixed with the soils, which causes a heat-generating (or exothermic) reaction in the soils and the soil/chemical mixture solidifies. Chemicals typically used include materials containing lime (such as cement mixtures), fine silicates, or materials (such as fly ash) that contain silicates and lime. In-situ chemical solidification has been tested and used in the field for a few full-scale soil treatment; excavating the soils and mixing the soils with the chemicals on a concrete staging pad has been found to be a more effective method. Effectiveness of the solidification is usually determined by measuring the compressive strength of the solidified soil and/or by subjecting the solidified soil to a Toxicity Characteristic Leachate Procedure (TCLP) test. Chemical solidification must be monitored, since any volatile organics present in the soils could be released to the air due to the exothermic reaction.

2.3.1.6 Excavation and Onsite Soil Washing

Soil washing is a process option that consists of vigorous, water-based scrubbing of excavated soils. The objective of the process is to reduce the volume of soil that requires treatment by concentrating the contaminants in a smaller volume of material while producing a washed soil product which meets appropriate cleanup criteria. The treatment process is based on the premise that contaminants are primarily associated with the finer size fractions of the soil matrix (i.e., associated with the silts, clays, and organic matter). By mixing soil with water and subjecting the slurry to intense scrubbing, aggregates are broken up, freeing the contaminated fine particles from the coarser sand and gravel. In addition, the surfaces of the coarse particles are cleaned by abrasive action.

For cases where the contaminants are principally associated with the fine size fractions, the amount of soil passing 74 microns should not normally exceed about 35 percent in order to achieve an economical volume reduction. However, the fraction of silt and clay in the soil may not be a factor when dissolving of contaminants is the primary mechanism for contaminant removal.

The soil washing process is characterized by three mechanisms: dispersion and separation of contaminated fine particles scouring of coarse particle surfaces, and dissolving of contaminants. Soil is mixed with water and subjected to various unit operations which may include mixing trommels, pug mills, vibrating screens, froth flotation cells, attrition scrubbing machines, hydrocyclones, screw classifiers, and various dewatering operations. Water has typically been used as the washing fluid, although removal efficiency may be improved by using aqueous surfactant solutions, chelating agents, pH adjustment, or heat. In many test cases, however, water alone was sufficient to achieve the desired level of contaminant removal.

Intensive scrubbing is the technology at the core of the soil washing process. For the gravel fraction, scrubbing is accomplished with a mixing trommel, pug mill, or ball mill. For the sand fraction, a multi-stage, counter-current attrition scrubbing circuit with inter-stage classification could be used. This scrubbing action disintegrates soil aggregates, freeing contaminated fine particles from the sand and gravel fraction. In addition, surficial contamination is removed from the coarse fraction by the abrasive scouring action of the particles themselves. Contaminants may also be dissolved as dictated by their solubility characteristics or partition coefficients.

Contaminated residual products would need to be treated by other methods. Process water could be recycled after appropriate treatment. Physical, chemical, biological or thermal processes could be used for treatment of the residual products, such as the fine soil fraction. Another option for the contaminated fines could include offsite disposal.

Excavation and handling of contaminated soil would be required as part of soil washing. Excavation and removal of contaminated materials would typically be performed using standard earthwork equipment and techniques. Due to the volatile nature of the Blauvelt Site soil contaminants, vapor control would be required during excavation practices. If necessary to control volatile organic emissions from the exposed soils, vapor suppressing foam could be used and other measures would be implemented as needed to protect workers, plant personnel, and the community.

Excavation of saturated soil in contaminated areas would typically require dewatering, and water collection and treatment. During excavation, temporary localized sumps could be used with construction pumps to remove water from the excavations. An excavated soil staging area would consist of a sacrificial asphalt surface, to be disposed of after excavation activities are completed, that would be bermed around the perimeter to contain runoff from precipitation. From the staging area, the soils would be transported to the soil washing unit.

As indicated in Section 1.8, the total volume of soils from the onsite area around the former location of the USTs is about 6,500 cy (assuming a 10 percent volume expansion occurs during excavation). This volume could increase as excavation proceeded, if additional areas were found to be contaminated to unacceptable levels. The final volume requiring treatment would be determined by soil sample analyses conducted as part of remediation performance monitoring. Soil samples taken during excavation would consist of random sampling from each foot of soil excavated (frequency of approximately one sample per 500 cubic yards), and confirmatory sampling of the excavation sideslopes and bottom if the excavation is not taken to bedrock. These soil samples would be analyzed for the volatile organics found in previous sampling events.

Samples taken during excavation would be used to evaluate the limit of soil excavation, and samples taken from the sideslopes and bottom will be used to confirm that the remaining soils meet the target soil cleanup levels proposed for the site. Soils found to be acceptable could be stockpiled during excavation in order to provide backfill material and to stabilize slopes in the excavation area. Backfill material and washed soil which meet the target cleanup levels would be used to fill the excavated area to its former elevation or to predetermined elevations.

The permitting process for soil excavation and onsite washing would include submission of a work plan for mobilization and operation onsite and compliance with regularly scheduled collection and reporting of operations data. The design work plan would include detailed design information for the excavation and soil washing methods and a description of environmental monitoring procedures and handling procedures for contaminated materials (i.e, residual products, soils, and water). Disposal and/or treatment of contaminated residual products and waste water may require compliance with New York's hazardous waste rules 6 NYCRR Part 372.2. Permitting requirements would also include submitting a permit application to the NYSDEC for air quality emissions its during excavation.

2.3.1.7 <u>Excavation and On Site Soil Aeration</u>

Excavation and Soil Aeration is a process option consisting of removing organic compounds via soil via beds, aggressive application of an air stream across the surface of soil particles, or the passage of excavated soils through a dirt screen commonly used in highway construction projects (soil screening). Safe handling of contaminated soil would be required as part of soil aeration. Excavation and removal of contaminated materials would typically be performed using standard earthwork equipment and techniques. Due to the volatile nature of the soil contaminants, vapor control would be required during excavation practices. To control volatile organic emissions from the exposed soils, vapor suppressing foam could be used for minimizing emissions from soils staged for processing, and other measures would be implemented as needed to protect workers, plant personnel, and the community. Excavation of saturated soil in contaminated areas would typically require dewatering, and water collection and treatment. During excavation, temporary localized sumps could be used with construction pumps to remove water from the excavations. An excavated soil staging area would consist of a sacrificial asphalt surface, to be disposed of after excavation activities are completed, that would be bermed around the perimeter to contain runoff from soil drainage and precipitation. From the staging area, the soils would be transported to the soil aeration area.

Initially, soils known to be contaminated would be excavated for treatment. The total volume to be excavated could increase as excavation proceeded, if additional areas were found to be contaminated to unacceptable levels, as determined by soil sample analyses conducted during the removal process as part of performance monitoring. Soil samples taken during excavation would consist of random sampling from each foot of soil excavated (frequency of approximately one sample per 500 cubic yards), and confirmatory sampling of the excavation sideslopes and bottom, if the excavation is not taken to bedrock. These soil samples would be analyzed for the volatile organics found in previous sampling events.

Samples taken from the excavated material would be used to evaluate the limit of soil excavation, and samples taken from the sideslopes and bottom would be used to confirm that the remaining soils meet the proposed target soil cleanup levels. Soils found to be acceptable could be stockpiled during excavation in order to provide backfill material and to stabilize slopes in the excavation area. Backfill material and aerated soil which meet the target cleanup levels would be used to fill the excavated area to its former elevation or to predetermined elevations.
The simplest process variation for removing volatile organics from soils consists of spreading excavated soils in 3- to 6-inch-deep drying beds and cultivating the soil at intervals to expose the

volatiles to natural evaporation processes. As drying occurs, soil desegregates and the surface area for evaporation increases, thus increasing the overall volatiles removal rate. However, the soil drying does not usually proceed at a constant rate.

A second variation for enhancing volatile evaporation rates involves forcing ambient or heated air up through shallow piles of excavated soils. This is accomplished by blowing air through perforated piping installed at the base of the soil piles. If necessary, excavated soils can be allowed to drain free water prior to aeration.

A third variation for enhancing volatile evaporation rates involves the passage of excavated soils through a dirt screen. In this process, the evaporation rate is increased due to both soil disaggregation and the draft produced as soil falls from the feed belt to the screen. Initial drainage of contaminated soils may be necessary to avoid excessive clogging of the dirt screen. Each variation of soil aeration would require extensive controls on the volatile organic emissions from the aeration process. Vapor would be controlled using liners over the piles or the dirt screen. A system to collect and treat the vapor phase would be necessary. Vapor treatment such as granular activated carbon could be used, and treated vapor could be released to the atmosphere (or forced back into the soil, in the case of shallow-pile soil aeration). Performance monitoring for soil aeration would consist of evaluating "drying" time to meet the target soil cleanup levels and treated vapor quality.

The permitting process for soil excavation and onsite aeration would include submission of a work plan for mobilization and operation onsite and compliance with regularly scheduled collection and reporting of operations data. The design work plan would include detailed design information for the excavation and soil aeration methods and a description of environmental monitoring procedures and handling procedures for contaminated materials (i.e, vapor, soils, and water). Disposal and/or treatment of contaminated vapor and waste water may require compliance with New York's hazardous waste rules 6 NYCRR Part 372.2. Permitting requirements would also include submitting a permit application to the NYSDEC for air quality emissions limits during excavation and soil aeration.

2.3.1.8 Excavation and Thermal Stripping

Excavation and Thermal Stripping is a process option consisting of removing organic compounds by passing excavated soils through a unit that heats the soils to a temperature sufficient to drive the organics adsorbed on the surface of soil particles into a vapor phase. Vapor phase organics are then collected and the vapor can be treated by passing it through a vapor-phase carbon unit. Thermal stripping has been proven capable of extracting volatile organics, and some semi-volatile organics. Excavation, soil staging, soil handling, and soil sampling and analyses would be similar to that for Excavation and Onsite Soil Aeration (see Section 2.3.1.7). The thermal unit for stripping the organics would require an operating permit from NYSDEC, and would need to meet anticipated strict air emission control requirements.

2.3.1.9 Excavation and Offsite Disposal

The objective of soil excavation is to remove the contaminated soils and transport them to an appropriate landfill for disposal. Excavation and handling of contaminated soil may be required as part of the selected remedial measures. Excavation and removal of contaminated materials would typically be performed using standard earthwork equipment and techniques.
Due to the volatile nature of the soil contaminants, vapor control would be required during excavation practices. To control volatile organic emissions from the exposed soils, vapor suppressing foam would be used and other measures would be implemented as needed to protect workers, plant personnel, and the community.

Excavation of saturated soil in contaminated areas would typically require dewatering, and water collection and treatment. During excavation, temporary localized sumps could be used with construction pumps to remove water from the excavations. Upon excavation of the soil, additional water may be removed by gravity drainage of the materials in a staging area. The staging area would consist of a sacrificial asphalt surface, to be disposed of after excavation activities are completed, that would be bermed around the perimeter to contain runoff from soil drainage and precipitation. Filter presses could be used, if necessary, to further dewater if gravity drainage proved insufficient.

Initially, soils known to be contaminated would be excavated for disposal. Subsurface soils samples in two areas on the Blauvelt Site indicated constituent levels above the NYSDEC Guidance Levels, as discussed in Section 2.3.1.2. Offsite subsurface soil samples have not exceeded the NYSDEC Guidance Levels, therefore, excavation of offsite soils is not considered further. The larger area of onsite soil contamination, at the Blauvelt Site (see Figure 1-8, was assumed to extend to an average depth of 18 feet to the top of bedrock. The in-place volume of these soils was estimated to be 7,800 cubic yards. The smaller area of onsite soil contamination was assumed to extend to an average depth of 18 feet to the top of bedrock with an estimated in-place volume of 840 cubic yards.

The total volume to be excavated could increase as excavation proceeded if additional areas were found to be contaminated to unacceptable levels, as determined by soil borings and soil analysis conducted during the removal process as part of performance monitoring. Soil samples taken during excavation would consist of random sampling from each foot of soil excavated (frequency of approximately one sample per 500 cubic yards) and confirmatory sampling of the excavation sideslopes and bottom if the excavation is not taken to bedrock. These soil samples will be analyzed for the volatile organic constituents found in previous sampling events. Samples taken during excavation will be used to evaluate the limit of soil excavation and samples taken from the sideslopes and bottom will be used to confirm that the remaining soils meet the NYSDEC Guidance Levels. Soils found to be acceptable could be stockpiled during excavation in order to provide backfill material and to stabilize slopes in the excavation area. Backfill material, in addition to soils found to be acceptable, would be used to fill the excavated area to its former elevation or to predetermined elevations.

Contaminated soil excavated during remedial activities could be disposed of offsite at a commercial landfill, assuming the material is not a land-ban waste at the time of disposal. TCLP analyses of the excavated soil would be necessary to quantify the characteristic nature of the contaminants and to evaluate the type (i.e. hazardous or nonhazardous) of landfill that could accept the excavated material. Offsite disposal would also be contingent on acceptance of the waste materials at the disposal facility, based on data supplied on waste characterization applications. Offsite transport would be performed by licensed hazardous waste haulers, with all shipments tracked and documented with manifests. The procedures outlined by NYSDEC TAGM 3018 would be followed for all offsite disposal remedial actions.

The permitting process for soil excavation and offsite disposal would include submission of a work plan for mobilization and operation onsite, and compliance with regularly scheduled collection and reporting of operations data. The design work plan would include detailed design information for the excavation methods and a description of environmental monitoring procedures, and handling procedures for contaminated materials (i.e, soils and water). Excavation and offsite disposal of the contaminated soils may require compliance with New York's hazardous waste rules 6 NYCRR Part 372.2 and RCRA land disposal requirements. Permitting requirements would also include submitting a permit application to the NYSDEC for air quality emissions limits during excavation.

2.3.1.10 Concrete Pavement

Concrete pavement is a process option sometimes used to seal the surface of an area so that contaminated materials are isolated from surface water and noncontaminated areas. Concrete pavement can be installed to minimize the infiltration of surface water into the underlying soils, to accommodate settling, to provide efficient site drainage, and to minimize cover maintenance. An appropriate conceptual concrete pavement system (from bottom to top) could consist of proof-rolled subgrade material (compacted to a depth of 6 to 12 inches), 6 inches of aggregate subbase, a spray sealant, a concrete layer, and a concrete sealer coat. The pavement design would be evaluated based on the expected use (or non-use) of the areas to be capped.

Performance monitoring would consist of daily inspection of cap placement procedures to ensure the quality of the cap installation. The anticipated permitting requirement for capping would include submission of a work plan and design documents for installation of the cap.

2.3.1.11 Bituminous Concrete Cap

A bituminous concrete cap is a somewhat different cap process option used for sealing the surface of a contaminated area, so that contaminants are isolated from surface water and noncontaminated areas. A cap system can be designed to minimize the infiltration of surface water into the underlying soils, to accommodate settling, to provide efficient site drainage, and to minimize cover maintenance.

An appropriate conceptual bituminous concrete cap system design (from bottom to top) is shown on Figure 2-3 could consist of proof-rolled subgrade material (compacted to a depth of 6 to 12 inches), 6 inches of aggregate subbase, a spray sealant, a bituminous concrete (or asphalt) layer, a 2-inch asphalt base coat, and a 2-inch asphalt top coat. The cap design would be evaluated based on the expected use (or non-use) of the areas to be capped. The key component of the cap system is relatively lower permeability, as compared to a plain concrete cap, provided by the bituminous concrete layer.

Performance monitoring would consist of daily inspection of cap placement procedures to ensure the quality of the cap installation. The anticipated permitting requirement for capping would include submission of a work plan and design documents for installation of the cap.

2.3.2 Air Treatment (Treatment of Recovered Soil Vapors)

Potential process options under the contaminant vapor collection and treatment technology are vapor-phase carbon (VPC) adsorption and fume incineration. These process options are described below.

2.3.2.1 Vapor-Phase Carbon (VPC) Adsorption

Vapor-Phase Carbon (or VPC) Adsorption is an appropriate process option for treating the gaseous phase (or vapor) discharges from a conventional vacuum extraction well, from 2-Phase Vacuum Extraction wells or from an air stripper. VPC systems consist of one or more columns (or beds) of granular activated carbon (GAC), with a carbon density typically 30 lb/ft'. Compared to liquid-phase GAC systems for treating groundwater, VPC systems have relatively large GAC particles with large and highly permeable void spaces. Contaminated vapors flow through the column (or carbon beds) and adsorb to the carbon. The treated vapors leave the GAC bed with reduced concentrations of contaminants. Treatment of a continuous vapor stream can occur, with the same carbon supply in the treatment unit for a period of time until the carbon begins to lose its capacity to adsorb the contaminants. At that stage, the carbon is considered spent and is replaced with fresh carbon, or the carbon contaminants are removed by thermal or steam-stripping, referred to as "carbon regeneration".

Individual VPC systems will normally be designed for influent vapor (or air) velocities between 80 and 100 fpm through the adsorption bed. The contaminant removal efficiencies normally decrease at velocities in excess of 100 fpm. Removal efficiencies across a VPC system are usually well in excess of 90 percent. The larger the surface area of the VPC bed, the larger the VPC unit itself and, thus the higher the capital cost of the unit; however, the larger the unit, the higher the volume of vapor that can be treated in a given time period.

There are typically three types of bed designs: a fixed, deep bed that can be regenerated; a thin bed that can be regenerated; and a nonregenerable bed absorber. A fixed deep bed (i.e., a 4-foot-deep carbon bed) is typically used for applications in which volatile organic compound (VOC) concentrations vary between 500 and 5,000 ppm. Applications falling in the concentration range of up to 500 ppm VOCs are usually well suited to thin-bed design. Thin beds generally consist of a deep carbon bed partitioned into several horizontal sections within the same adsorption vessel.

At concentrations up to approximately 500 ppm VOCS, regenerable VPC units are more cost effective. At low concentrations (between 1 and 2 ppm VOCS), nonregenerable VPC systems are more cost effective. Normally, a nonregenerable system will consist simply of a blower and some type of carbon chamber designed for easy replacement and withdrawal of the spent carbon. At the end of the useful life of the carbon (i.e., when it becomes spent), it is withdrawn and replaced. The spent carbon is then disposed or returned to the supplier for reactivation. Generally, VPC systems consist of two or more columns (or beds) for continuous, automatic processing of the influent air stream. Once spent the absorbers are regenerated, which produces a concentrated waste that is typically incinerated. Multiple bed systems are available which are operated so that the influent vapor stream continuously passes through at least one absorber while a second absorber undergoes regeneration.

2.3.2.2 Fume Incineration

Fume incineration also can be used to treat the gaseous-phase discharge from a 2-Phase Vacuum Extraction well or an air stripper. There are a variety of thermal incineration technologies applicable to treatment of contaminated vapors. Some of the more common forms are fluidized bed and multiple hearth. Fume incineration uses high temperature oxidation under controlled conditions to degrade contaminants into products that generally include $C0_2$, H_20 vapor, HCl, $S0_2$, and NO, gases, and ash. The operating temperatures for these forms vary between approximately 1200° and 1800°F. Generally, the higher the volatility of the organic contaminant, the more easily it is incinerated. However, the lower the organic concentration in the vapor being treated, the lower the energy efficiency and cost-effectiveness of the thermal treatment, since the vapors would still need to be heated to high temperatures.

Organic materials can ordinarily be burned if they are mixed with air to provide an oxygen content in the 10 to 15 percent range, have a hydrocarbon concentration above a lower combustion limit, and are heated above a spontaneous ignition temperature. The resulting combustion can produce essentially complete oxidation of the combustion mixture. The lower combustion limit is the concentration of any organic material that produces temperatures high enough to sustain flame reactions. These reactions result in the formation of free radicals that are highly reactive. Oxidation of organic materials can also take place at concentrations well below the lower combustible limit if the temperature is high enough and allowable reaction time is long enough.

2.3.3 Onsite and Offsite Groundwater/NAPL Plume Containment, Recovery and Groundwater Treatment

Potential process options for groundwater and NAPL containment/recovery technologies are as follows:

Active Recovery and Containment

- Conventional Pumping Wells
- 2-Phase Vacuum Extraction Process Recovery Wells

Passive Recovery and Containment

- Blasted Trench for Groundwater/NAPL Containment and Recovery

Potential process options for groundwater treatment technologies are as follows:

- Common Components (i.e., solids filtration, oil/water separation, and flow equilibration) for the groundwater treatment. These three process options were selected as part of the groundwater treatment scheme for each of the remediation alternatives developed in Section 3.0. The options were described in Section 2.2-4.

- Ultraviolet (UV) Light/Peroxidation

- Air Stripping

- Steam Stripping

- Liquid-Phase Carbon Adsorption

- In-situ Bioremediation

Each of the above three process options for groundwater containment/recovery and the last five options for groundwater treatment are described below.

2.3.3.1 Conventional Pumping Wells

Conventional pumping wells are a process option that consists of a network of standard pumping wells screened in the subsurface zone containing dissolved-phase contamination and/or NAPL equipped with pumps for recovering water and/or NAPL. One purpose of conventional pumping wells could be to capture contaminated groundwater and NAPL (if any is present) and, thus, contain the contaminant plumes so that further migration of contaminants is minimized. This containment is a form of source control for contaminants.

Conventional pumping recovery wells employ pumps for removing groundwater flowing into a well. Various types of submersible pumps could be used, depending on the depth and water yielding characteristics. Both bottom-loading and top-loading ejector pumps are available. Either type of ejector pump can be installed to remove only water phase, even when the aquifer contains a reasonably thick layer of floating, light nonaqueous-phase liquid (NAPL) or a sinking, dense NAPL Alteratively, such pumps can be installed for removing both water and NAPL (dual-phase recovery) or just a NAPL layer. If a floating NAPL layer is too thin, conventional skimming pumps are available to remove essentially only the NAPL. Typically, a well having a minimum 4-inch diameter is requircd for pump installation.

To contain further migration of a groundwater plume or NAPL, conventional pumping wells would need to be installed close enough that their radii of influence overlap sufficiently to capture liquids flowing through the well field. A well's radius of influence is the area that contributes water to that well.

Well fields can be designed in an infinite number of ways, each with a different well spacing, number of wells, and well pattern. The unique hydrogeologic characteristics of the aquifer containing the contamination are what dictate the required well spacing for either full or partial plume and NAPL containment. Specifically, the well spacing depends on the average water yield that can be sustained by a well of a given diameter and pump capacity, as well as the hydraulic conductivity and thickness of the aquifer. Generally, the higher the sustainable water yield, the larger the well spacing that can be allowed to achieve the desired plume containment and groundwater recovery (i.e., the fewer the number of wells needed).

Generally, the most effective well layout for containment is to install wells in lines perpendicular to the direction of contaminant migration and pump them at rates sufficient to cause a localized reversal of flow, thereby impeding further contaminant migration.

Conventional pumping wells are likely to be efficient and cost-effective in onsite and offsite zones where the permeability is relatively higher (i.e., sandy or gravely soils, or highly fractured or weathered rock). Fractured/weathered zones are expected in the shallow bedrock and deep bedrock in both the onsite and offsite areas of the Blauvelt Site, where sustainable water yields are estimated to range between 3 and 10 gpm.

Conventional wells equipped with submersible pumps may prove to be more energy efficient than 2-Phase Vacuum Extraction wells for removing water from bedrock zones. However, the overburden zone of both areas is estimated to have an order of magnitude less permeability than the bedrock zones and, therefore, conventional pumping wells might prove to have low efficiency and low cost-effectiveness. In lower permeability zones like the overburden, the achievable zone of influence around a conventional well would be small and, thus, a large number of wells would be needed for effective containment and groundwater recovery. A relatively long time to complete groundwater recovery would be expected with conventional pumping wells in the overburden.

2.3.3.2 2-Phase Vacuum Extraction Process Recovery Wells

At sites other than the Blauvelt Site, 2-Phase Vacuum Extraction wells have been demonstrated to be more efficient and cost-effective in low permeability zones than have conventional pumping wells (see Sections 2.3.2 and 2.3.2 for a description of 2-Phase Vacuum Extraction). At these sites, high-vacuum wells have removed groundwater, NAPL and vapors from a greater radii of influence than conventional wells. Thus, 2-Phase Vacuum Extraction wells would have an advantage over conventional wells in the low-permeable overburden zones of the onsite and offsite areas. 2-Phase Vacuum Extraction wells may prove to be less energy-efficient than deep conventional wells for deep bedrock groundwater recovery. During the design phase of the site remediation, aquifer testing and analyses would occur to confirm the necessary spacing for 2-Phase Vacuum Extraction wells.

2.3.3.3 Blasted Trench

A blasted trench is a process option that is one type of interceptor trench specifically designed for use in lower permeability bedrock where yields of conventional pumping wells are low. A blasted trench would consist of a zone of increased permeability bedrock by carefully detonating explosives placed into the subsurface at the desired depths for trench installation. Once installed the blasted trench could serve as a conduit that intercepts groundwater and/or NAPL and transports these fluids to a pump well(s) installed in the trench.

A blasted interceptor trench could be installed to lower the water table such that the highest water level will not reach the maximum depth of contaminated material (i.e., to achieve water table control). The main purpose of applying this process option is to capture contaminated groundwater and/or NAPL (if any NAPL present) in subsurface zones having relatively low permeability. Capture of groundwater and NAPL via a blasted trench could potentially contain the contaminant plumes so that further migration of contaminants is minimized. This containment is a form of source control for contaminants.

The permitting process for installation of a blasted trench and for groundwater collection and treatment would include submission of a work plan for mobilization and operation on site and compliance with regularly scheduled collection and reporting of operations data. The design work plan would include detailed design information for the blasting operation and groundwater collection and treatment methods, as well as descriptions of environmental monitoring and contaminated materials (i.e, soils and water) handling procedures. Treatment of contaminated groundwater and disposal and/or treatment of excavated soils may require compliance with New York's hazardous waste rules contained in 6 NYCRR Part 372.2. Permitting requirements may also include submitting a permit application to the NYSDEC for air quality emissions limits during excavation.

A blasted trench would provide a complete hydraulic barrier, over the area defined by the trench length and depth, and would collect all groundwater and NAPL that passed through that area. Disadvantages of blasted trenches are as follows:

- Trench installation would be more difficult in offsite areas not owned by Xerox.

- Trenches would be less cost-effective than recovery wells in relatively permeable bedrock zones where containment can be achieved with wells placed at relatively large spacings.

2.3.4 Groundwater Treatment

2.3.4.1 Common Components

The following common process options were selected to be the necessary and common components of any treatment scheme for recovered groundwater: solids filtration, removal of NAPL (via an oil/water separator), and flow equalization. At this time, this common components would be applied in the order given above during treatment of recovered groundwater. These common components have been selected for all the remediation alternatives developed in Section 3 and evaluated in Section 4.

2.3.4.2 Ultraviolet (UV) Light/Peroxidation

Ultraviolet (UV) light/Peroxidation is a treatment process option which consists of adding hydrogen peroxide to groundwater (i.e., chemical oxidation) being irradiated with ultraviolet light (i.e., UV light oxidation). The UV light breaks the peroxide into two OH-radicals and also increases the rate of contaminant reduction that might otherwise occur via chemical oxidation alone. With UV/Peroxidation, the required rate of hydrogen peroxide addition to achieve effective treatment is dependent on the specific contaminants in the groundwater. For instance, UV/Peroxidation is cost-effective for destruction of unsaturated chlorinated solvents, since these compounds require low chemical feed requirements and short treatment times relative to other compounds. However, the rate of destruction of saturated organic compounds like 1,1,1-trichloroethane is slower. Compared to other potential process options, UV/Peroxidation systems are relatively more costly to install, and require more operator attention.

2.3.4.3 Air Stripping

Air stripping is a process option that removes organics from groundwater by passing air through contaminated water to facilitate transfer of volatile organics from the liquid phase to the gas (air) phase. The degree to which stripping is successful at removing volatiles from a liquid stream depends on the volatility of the compounds present, the mass ratio of air to water flow, the surface area of the air/liquid interface and the temperature at which stripping is conducted. The volatility of a compound is reflected by its Henry's Constant, which is the ratio of the compound's equilibrium concentration in air to that in water. In general, the larger the Henry's Constant, the more readily the compound can be removed from a liquid by stripping.

The volumetric air to water ratio is related to the configuration of a particular stripping system, and may vary over an order of magnitude from one stripper installation to the next. The temperature at which stripping occurs has a significant impact on the degree of volatiles removal possible at a given air the water ratio. As the air temperature is increased, volatile compounds are more readily stripped.

Three methods of air stripping are most prevalent: diffused aeration, mechanical aerator and packed or spray tower stripping. Counter-current packed tower air stripping has been most frequently employed for groundwater cleanup operations. It is generally the most efficient stripping process.

VOC air emissions from the stripper off gas may require further treatment to maintain acceptable ambient air quality. Two potential process options for emissions treatment, vapor-phase carbon and time incineration, were discussed in an earlier section of this FS.

2.3.4.4 Steam Stripping

Steam stripping is a process option consisting of passing steam in a counter-current direction downward through a packed tower. As for air stripping, the purpose of steam stripping is to strip organics into the vapor phase. This vapor phase exits from the stripper column and is routed to a condenser to cool the vapors and convert them to a liquid phase (or "condensate"). From the condenser, the condensate flows to a decanter where the organic layer is drawn off and the bottoms are routed back into the stripper tower influent. Effluent from the stripping tower is further treated by routing it to liquid-phase carbon or another type of treatment prior to discharge.

For some steam stripping processes, such as the Aqua Detox process, variations can be made in the magnitude of vacuum applied to the steam flow in the stripping unit. By maintaining the stripping column at a negative pressure, more efficient stripping of organics at lower temperatures can be achieved, thereby reducing the energy required to heat the influent groundwater to the desired operating temperature. Steam stripping has been shown to be effective at removing a wide variety of organic substances, but is most cost-effective when the influent groundwater contains lower volatile organics that do not strip efficiently by air stripping alone.

2.3.4.5 Liquid-Phase Carbon Treatment

Liquid-phase carbon (LPC) treatment is a process option commonly used for the removal of organic contaminants from groundwater. LPC treatment employs granular activated carbon (GAC), which is highly porous and contains a high surface area, to chemically and physically trap contaminants. This adsorption of contaminants typically occurs in fixed beds (or columns) containing GAC. Nonchlorinated contaminants are more efficiently adsorbed via LPC than chlorinated contaminants. Therefore, to achieve adequate treatment of chlorinated contaminants, the GAC in the treatment bed would need to be frequently replaced. LPC units can either be obtained as premanufactured and assembled, skidmounted units or can be custom manufactured for unique requirements.

As for VPC treatment (see Section 2.2.2), the carbon in the LPC unit must be regenerated when it becomes saturated with adsorbed contaminants (i.e., spent); saturation is predicted by observing an upward trend in residual contaminant concentrations measured in the treated effluent. Spent carbon can be regenerated via dry thermal or steam treatment either at an offsite facility or onsite.

2.3.4.6 In-Situ Bioremediation

In-situ biological treatment (or bioremediation) is a process option for treating contaminated groundwater aquifers via microbial degradation. This process option was described in Section 2.2.1 for remediation of soils; application of in-situ bioremediation to groundwater remediation has many similarities. Bioremediation of groundwater involves altering environmental conditions to enhance microbial degradation of organic contaminants, resulting in their breakdown and detoxification. Microbial activity can degrade organic constituents through aerobic, anaerobic, or fermentative respiration, but the aerobic variation is the most effective one for most contaminants and the developed variation.

The efficiency of biodegrading volatile organics varies, depending on the contaminant. In-situ bioremediation is not appropriate for every combination of hydrogeologic condition and chemical contamination, but it has been proven successful in remediating sites that were contaminated with petroleum products and aromatic and aliphatic hydrocarbons, especially in shallow areas with adequate soil permeability.

Bioremediation may be accomplished by one of two overall approaches: enhanced bioremediation and cultured bioremediation (see Section 2.2.2 for a description of these two approaches). Both approaches may, and often do, need control of oxygen or (if necessary) major nutrients (such as nitrogen and phosphorus).

The feasibility of in-situ bioremediation for groundwater remediation is partly dictated by groundwater characteristics. The feasibility is also dictated by soils, contaminant, and site characteristics and the following factors:

- Site hydrogeology and site characteristics

- Biodegradability of the organic compounds

- Environmental factors, which affect the degradation ability of the microbial population

A complete hydrogeologic and groundwater quality assessment is necessary to design an in-situ biodegradation system since the conditions that may influence the in-situ biological activity must be defined. The most critical hydrogeologic factors are those that affect the ability to provide proper distribution of oxygen or (if necessary) nutrients through the contaminated area. This includes fluctuations in depth to groundwater, hydraulic conductivity, hydraulic gradient, soil porosity and concentration of contaminants.

2.4 RESULTS OF PROCESS OPTION SCREENING

Process options selected as a result of the above options screening are identified, and a rationale for their selection summarized, in the following paragraphs. All other process options have been screened out and will not be considered further.

GROUNDWATER AND NAPL CONTAINMENT AND RECOVERY

Process options for groundwater containment that have been selected for further consideration are conventional pumping recovery wells and 2-Phase Vacuum Extraction wells. These two process options are more effective and implementable than any in-situ treatment method for cleanup of the low-permeable overburden zone of the onsite and offsite areas. If one or more of these options are used for overburden zone remediation, then they can be extended relatively easily to remediation of the bedrock zones. Also, since these options can hydraulically control the groundwater contamination plumes, as well as safely recover the water for treatment, the options are more appropriate than any cleanup method that involves excavation of subsurface materials (which would pose risks to human health and the environment); the recovery well processes are also more cost-effective than methods involving excavation.

Further, one or more of the above two groundwater/NAPL containment options are probably the best methods for containing the groundwater and NAPL plumes to their existing locations. This determination is based on site hydrogeological information known to date, and may be revised as a result of aquifer testing tasks expected during the design phase of the site remediation. Known site hydrogeological information and estimates are provided in Section 1.2.1 of this FS. Section 1.2.3 provides details on a preliminary groundwater pumping well analysis that generated an estimated layout for either conventional type or 2-Phase Vacuum Extraction wells. This layout is estimated to be sufficient for containment of the offsite groundwater plume in the overburden, shallow bedrock, and deep bedrock zone. A plan view of the layout is shown in Figure 1-3.

The rationale for selecting the above two process options for subsequent alternatives development is that each have some advantages for different portions of the site, as indicated below:

- Conventional pumping wells are likely to be more efficient and cost-effective in onsite and offsite zones where the permeability is relatively higher. Such zones are expected to include the shallow bedrock and deep bedrock in both the onsite and offsite areas, where sustainable water yields are estimated to average 5 to 10 gpm, based on the short-term pump tests performed at the site by Dames and Moore. Additional aquifer tests will be conducted during the design phase of the project to confirm aquifer characteristics and aquifer response. Conventional wells, equipped with submersible pumps, may prove to be more energy-efficient than 2-Phase Vacuum Extraction wells for removing water from deep bedrock zones. However, the overburden zone of both areas is estimated to have an order of magnitude less permeability than the bedrock zones and, therefore, conventional pumping wells might have low efficiency and low cost-effectiveness in the overburden. Bedrock trench construction by blasting may be considered as an enhancement to conventional pumping wells if pumping tests indicate low well yields and small areas of influence are likely in the shallow and deep bedrock.

- At sites other than the Blauvelt Site, 2-Phase Vacuum Extraction wells have been demonstrated to be efficient and cost-effective for groundwater recovery from relatively shallow depths in subsurface zones that have low permeability (see Sections 2.3.2 and 2.3.2 for a description of 2-Phase Vacuum Extraction). At these sites, high-vacuum wells have removed groundwater, NAPL and vapors from a greater radii of influence than conventional wells. Thus, 2-Phase Vacuum Extraction wells would have an advantage over conventional wells in the low-permeable overburden zones of the onsite and offsite areas. A potential disadvantage of 2-phase extraction wells is that they may need to be very closely spaced to function adequately as water/NAPL containment for part or all of the overburden zone materials. During the design phase of the site remediation, aquifer testing and analyses would occur to allow determination of the tradeoff between 2-Phase Vacuum Extraction well spacing and installing a recovery trench.

In light of the above, conventional pumping wells and 2-phase extraction wells were considered in the development of remediation alternatives in Section 3.0. Due to the low permeability of the overburden zone in the onsite area, the existing line of ten, relatively closely spaced, conventional type recovery wells, located in roughly an east-west orientation along the downgradient end of the Blauvelt Site would be the most appropriate method for containing contaminated groundwater and NAPL on site; therefore, this containment well line is included in all alternatives developed (except a No Action alternative). Recovery wells are included in all remediation alternatives developed, sometimes as a combination of 2-Phase Vacuum Extraction Process wells for overburden and shallow bedrock recovery and conventional wells for bedrock zone recovery, and sometimes as conventional wells for recovery from all three zones.

GROUNDWATER TREATMENT SCHEME

The following process options were selected during the options screening, and have together been selected as the groundwater treatment scheme for each of the remediation alternatives developed in Section 3.0: solids filtration, removal of NAPL (via an oil/water separator), flow equation, UV/Peroxidation, air stripping, and Liquid-phase carbon (LPC) treatment. This treatment scheme has already been used on site for the treatment of groundwater recovered during IRM operations and has proven highly successful in treating the water to meet discharge requirements of the treatment system's SPDES permit. During the design phase of site remediation, additional aquifer characterization and groundwater quality updating would occur; these analyses would be expected to revise the basis provided in this FS for the average and range of groundwater flow rates and contaminant concentrations as influent to the treatment system.

Based on groundwater sample analyses available to date, groundwater that would be collected from the offsite area would be expected to contain volatile organics only. Consequently, offsite groundwater would be expected to be easily treated via air stripping alone; therefore, the existing onsite groundwater treatment system may be modified so that offsite groundwater is treated by routing it from a separate flow equation/ solids filtration unit directly to the existing air stripping unit before SPDES discharge.

SOIL REMEDIATION

Remediation process options that have been selected for further consideration for onsite soils include (1) 2-Phase Vacuum Extraction for removal of soil contamination by wells installed through the depth of the overburden zone, (2) installation of a cap over the contaminated soil area, and (3) excavation and offsite disposal of soils that are considered to contain "hot spot" concentrations of contaminants. The 2-Phase Vacuum Extraction and the capping options are expected to be more effective, environmentally safe, and cost-effective than any other potential process options for cleanup of site soils. The "hot spot" soil excavation and offsite disposal option has also been considered further, since soil disposal has been a common remediation method in the past, and since it can be compared to the 2-Phase Vacuum Extraction and capping options.

2-Phase Vacuum Extraction wells have been installed on site as a successful IRM for removal of contaminated groundwater in the onsite area as described in Section 1.9. 2-Phase Vacuum Extraction has not yet been tested at the Blauvelt Site for soil vapor extraction, although NAPL vapors have been extracted with the groundwater during operation of the 2-Phase Vacuum Extraction in the onsite area. Soil vapor extraction via 2-Phase Vacuum Extraction Process has been successfully demonstrated at many other sites for full remediation of soils containing volatile organics, such as at the Blauvelt Site.

Removal of soil vapors via 2-Phase Vacuum Extraction would be more protective of human health and the environment, more easily implemented and controlled, and more cost-effective than other process options such as excavation and onsite treatment (such as aeration or washing), in-situ bioremediaticn, or soil flushing. 2-Phase Vacuum Extraction would be more effective than in-situ bioremediation, sincc bioremediation is more suitcd for subsurfaccs more permeable than the site's overburden zone and the rate of contaminant reduction would be much lower via bioremediation.

Soil capping has often been used in site cleanup projects to isolate contaminated soils from potential human and environmental receptors above ground. It is also effective at reducing infiltration of rainfall and surface runoff that could drive soil contamination further into the subsurface and into groundwater. In addition, soil capping has bcen used to create an impermeable cover in an area where soil vapor extraction wells have been installed. Used in this way, soil capping would force wells to draw in air from throughout the contamination zone (rather than clean air from the atmosphere), thus maximizing the extraction well efficiency. Soil capping is a readily implemented and cost-effective. Therefore, soil capping was also selected for further consideration in the development of remediation alternatives.

For treatment of soil vapors, the vapor-phase carbon (VPC) and the fume incineration process options have been selected for further consideration. VPC has been successfully demonstrated as part of an IRM (see Section 1.9) at the Blauvelt Site for treatment of vapors collected during the 2-Phase Vacuum Extraction Process recovery of NAPL floating on the water table. Fume incineration would be expected to have effectiveness similar to that of VPC; therefore, the actual process option to be used for vapor treatment during the full-scale remediation of the site will be selected during the design and field implementation phases of the site cleanup. Additional sampling will be conducted to monitor ambient air quality during operation of the groundwater treatment system and two-phase extraction system.

3.0 DEVELOPMENT OF ALTERNATIVES

This section builds on the remediation process options described in Section 2.3 by combining the appropriate individual process options into six remediation alternatives. These remediation alternatives are listed below:

- Alternative 1: CONTINUED ENVIRONMENTAL MONITORING (NO ACTION)
- Alternative 2: SOURCE CONTROL AND ACTIVE REMEDIATION BY 2-PHASE VACUUM EXTRACTION AND CONVENTIONAL RECOVERY WELLS
- Alternative 3: SOURCE CONTROL AND ACTIVE REMEDIATION BY 2-PHASE VACUUM EXTRACTION AND CONVENTIONAL WELLS AND ENHANCED ONSITE BIOREMEDIATION
- Alternative 4: SOURCE CONTROL AND ACTIVE REMEDIATION BY CONVENTIONAL RECOVERY WELLS
- Alternative 5: SOURCE CONTROL (BY 2-PHASE VACUUM EXTRACTION AND CONVENTIONAL WELLS AND GROUNDWATER PLUME CONTAINMENT BY CONVENTIONAL RECOVERY WELLS
- Alternative 6: SOURCE CONTROL AND EXCAVATION AND DISPOSAL OF ONSITE HOT-SPOT SOIL CONTAMINATION AREAS

Table 3-1 indicates the process options included in each of the above remediation alternatives.

A detailed evaluation of the alternatives using the NYSDEC guidance (NYSDEC, 1990), follows as Section 4.0.

3.1 ALTERNATIVE 1: CONTINUED ENVIRONMENTAL MONITORING

3.1.1 Conceptual Design

Alternative 1 includes continued environmental monitoring. The monitoring will include periodic sampling of air (and/or emission points), surface water, groundwater, sediments, and soil.

Institutional controls such as deed restrictions on land and groundwater use would also be required as part of Alternative 1.

3.1.2 Method of Implementation

Implementation of Alternative 1 would consist of no action other than continued monitoring.

The element involved in implementing the no action alternative are as follows:

- Continuation of quarterly groundwater monitoring.

3.2 ALTERNATIVE 2: SOURCE CONTROL AND ACTIVE REMEDIATION BY 2-PHASE VACUUM EXTRACTION AND CONVENTIONAL RECOVERY WELLS

3.2.1 Conceptual Design

The purposes of Alternative 2 are: to achieve control of the sources of site contamination (by NAPL recovery and groundwater plume containment to actively remediate the soil contamination at the site; and to actively remediate the groundwater via groundwater recovery and onsite treatment. Alternative 2 prescribes recovery of contaminated groundwater from all three water-bearing zones in the onsite and offsite areas: (1) the overburden zone, (2) the shallow bedrock zone, and (3) the deep bedrock zone. In general, source control under this alternative is achieved via removal of NAPL and contaminated soil vapors from the subsurface in the onsite area of the Blauvelt Site, plus containing the groundwater contamination plumes to their present onsite and offsite area locations.

Active groundwater remediation is achieved via use of conventional wells to recover the deep bedrock groundwater plume, and 2-Phase Vacuum Extraction wells to recover the overburden and shallow bedrock plumes. Any recovered groundwater would be treated onsite and discharged to a local surface water (as described in detail in Section 2.3.4, Groundwater Treatment and Discharge). Active soil remediation is achieved by soil vapor recovery induced by application of the 2-Phase Vacuum Extraction process.

Detailed descriptions were presented in Section 2.3 for the process options (i.e., specific technologies) required for the Alternative 2 components. Components of Alternative 2 are as follows:

- Onsite Source Control: by NAPL and Soil Vapor Recovery (using onsite 2-Phase Vacuum Extraction wells); and by Groundwater Containment (using existing onsite conventional recovery wells).

- Active Onsite Remediation: by NAPL and soil vapor source control treatment of recovered soil vapors and NAPL vapors; groundwater plume recovery from the overburden and shallow bedrock zones using 2-Phase Vacuum Extraction wells and from the deep bedrock zones using conventional type pumping wells; recovered groundwater treatment in an onsite treatment system; offsite disposal of recovered NAPL at an approved facility; permissible discharge of treated vapors to the atmosphere; and SPDES-Permitted Discharge of treated water.

- Offsite Containment: groundwater plume containment by a line of 2-Phase Vacuum Extraction wells could recover groundwater from the overburden zone. This groundwater recovery would dewater the overburden zone and the operation of all the 2-Phase Vacuum Extraction wells would continue to achieve recovery of contaminated soil vapors. Organic contaminants already in the soil vapor phase would be recovered first. As these vapors are recovered, organics adsorbed to the surface of soil particles would transfer into the vapor phase and, thus, would also be available for recovery. The source area portion of the plume will be under consideration for capping as a means of enhancing remedial effectiveness and/or mitigating potential for airborne contaminant exposure, as required.

- Offsite Disposal of Recovered NAPL

  Any NAPL recovered by the 2-Phase Vacuum Extraction wells would be sampled and analyzed for its constituents, and then shipped off site to a New York-approved hazardous waste (or recycling) facility for proper disposal (or recycling).

- Treatment of Recovered Soil Vapors and NAPL Vapors

  Soil vapors recovered from the overburden zone by the onsite 2-Phase Vacuum Extraction wells, as well as vapors extracted simultaneously with NAPL recovery, would be routed to a vapor-phase carbon (VPC) adsorption system (or an alternative type of treatment system, such as a fume incinerator, that would provide equivalent treatment) to be located in the onsite area. The vapor treatment system would remove organic contaminants from the vapors, and then discharge treated vapors as described below.

- Permissible Discharge of Treated Vapors

  Treated vapors exiting the VPC system would be discharged to the atmosphere. Such discharges occurring during the ongoing IRM program at the site have not required a Permit to Construct (PC) or a Certificate to Operate (CO) issued by NYSDEC (per New York State's Air Guide, 1991).

- Onsite Groundwater Containment (using existing, onsite wells)

  The ten existing, onsite conventional recovery wells (Well Nos. RW-1 through RW-10) would continue to be used for containing the shallow bedrock portion of the larger plume to its present location. These ten recovery wells are screened within approximately the top ten feet of the shallow bedrock. Since the operation of the 2-Phase Vacuum Extraction wells would tend to dewater the overburden zone, this would control the portion of the plume in the overburden. These ten wells are located (see Figure 1-12) in roughly an east-west line along the northern end of the onsite area. All these wells are screened over both the overburden and shallow bedrock zones. In addition, existing Well RI-10 is screened in the deep bedrock zone and, therefore, would be pumped to contain the deep bedrock portion of the onsite plume. Groundwater recovered by these wells would be routed to the proposed onsite groundwater treatment system (see below).

- Onsite Groundwater Plume Recovery

Once substantial soil vapor recovery has occurred, the straws in these 2-Phase Vacuum Extraction wells would be lowered sufficiently to provide active recovery of groundwater from the shallow bedrock plume. At this time, an existing onsite monitoring well (Well No. RI-10) would be placed on line as a conventional pumping well, to recover groundwater from the small onsite portion of the deep bedrock plume. Groundwater recovery would continue until the site's groundwater remediation goals were met.

- Offsite Groundwater Plume Containment

About eight 2-Phase Vacuum Extraction wells would be installed in the offsite area, as shown on Figure 1-3, to contain the plume, in the overburden and shallow bedrock zones, to its present location. These wells would be screened over the overburden and shallow bedrock zones. All groundwater recovered by these wells would be routed to the proposed onsite groundwater treatment system (see below).

- Offsite Groundwater Plume Recovery

In addition to the eight 2-Phase Vacuum Extraction mentioned above for plume containment, about eleven additional 2-Phase Vacuum Extraction wells would be installed in the offsite area (see Figure 1-4) to provide active recovery of ground water from the overburden and shallow bedrock zones. Additional overburden and shallow bedrock groundwater recovery also would be provided by the eight 2-Phase Vacuum Extraction wells to be installed for offsite plume containment (see above). About six conventional pumping wells would be installed in the offsite area (see Figure 1-4) to provide active recovery of ground water from the deep bedrock zones. Of these 6 conventional wells, two existing offsite monitoring wells (Well Nos. MW-OS-5D and MW-OS- 1 1D) would be placed on line as pumping wells, to recover ground water from the offsite portion of the deep bedrock plume. Groundwater recovery would continue until the site's groundwater remediation goals were met.

- Groundwater Treatment and Discharge

Treatment of groundwater recovered from both 2-Phase Vacuum Extraction and conventional wells would be accomplished by routing the water to an onsite treatment system and subsequently discharging the treated water to the nearby stream under an SPDES permit. This onsite treatment system would consist of the existing onsite system whieh would be upgraded (to accommodate a significantly larger anticipated influent flow. The existing treatment system may also be modified to allow ground water collected from the offsite area (which primarily contains volatile organics) to be segregated from other collected ground water and be treated by air stripping. It is anticipated that ground water collected from the onsite area (which contains volatile organics and organics less efficiently removed via air stripping) would still require treatment via the existing onsite treatment scheme. Groundwater treatment would meet the performance goals discussed in Section 1.7. Details of this concept design were described earlier in Section 2.3.4.

- Groundwater Monitoring Program

The existing set of groundwater monitoring wells in the onsite and offsite areas would continue to be used to monitor groundwater quality. During the first year of remediation, the monitoring wells would be sampled quarterly to determine the effectiveness of plume containment and recovery. Beginning in the second year of remediation, the monitoring wells would be prioritized for sampling semiannually or annually for continued water quality characterization and remediation performance monitoring.

Figure 1-3 and 1-4 present conceptual site layouts showing preliminary proposed locations for onsite and offsite groundwater plume containment wells and recovery wells, respectively. Installation of containment and recovery wells would proceed in stages and the impact of these wells would be assessed, so that plans for additional well installations can be modified (where necessary) prior to installation. Also, hydrogeological analyses and modeling during the design phase of implementing remediation and field measurements taken during remediation startup would indicate the need for any modifications to this well layout.

Remediation components common to Alternatives 2 through 5 include: the continued use of the ten (10) existing conventional recovery wells (No.s RW-1 through RW-10) to contain contaminated groundwater in the onsite area, use of the existing onsite groundwater treatment system, and continued use of the existing groundwater monitoring program for the site. Remediation components common to only Alternatives 2, 3, and 5 include 2-Phase Vacuum Extraction of soil vapors from the onsite area, treatment of recovered vapors, and discharge of treated vapors to the atmosphere.

3.2.2 Method of Implementation

Implementation of Alternative 2 would consist of the design and construction of the recovery well system and treatment systems, system start-up, system operation, and addressing any regulatory issues such as obtaining discharge permits.

The major elements involved in implementing Alternative 2 are as follows:

- Hydrogeologic analyses and modeling to confirm aquifer characteristics for the groundwater pumping program, using existing data on hydrogeological and groundwater chemistry. Updating the characterization of the onsite and offsite groundwater quality per treatment system and drinking water parameters. Unless the contaminant chemistry in the groundwater changes significantly prior to full-scale remediation, bench-scale and pilot-scale testing would not be needed to determine design and operation parameters for the proposed parallel treatment system.

- Detailed design of the source control, groundwater recovery and treatment systems.

- Preparation of a Work Plan for implementing remediation.

- Completion, agency submittal, and approval of permit applications necessary for constructing and operating the remediation system (i.e., an air permit from NYSDEC for excavation of contaminated soils during installation of trenches for process pipes); an upgrade of the current IRM vapor-phase treatment system to allow full-scale operation; and well installation permits for onsite and offsite areas. Prior to modifying the existing groundwater treatment facility, the current SPDES permit would require an amendment to reflect the increased load on the treatment system.

- Preparation and implementation of health and safety monitoring programs for all remediation steps.

- Mobilization of treatment equipment may require a long lead time and, therefore, equipment would be ordered prior to the mobilization of construction-related activities. Equipment procurement would include obtaining appropriate spare parts, including spare vacuum pumps and submersible well pumps.

- Installation of additional 2-Phase Vacuum Extraction wells (or one or more recovery trench) for NAPL and soil vapor recovery in the onsite area, and installation of additional conventional and 2-Phase Vacuum Extraction wells for groundwater recovery in the onsite and offsite areas.

- Installation of piping systems to route NAPL, contaminant vapors, and ground water recovered from 2-Phase Vacuum Extraction wells (and/or recovery trenches) to the appropriate collection and treatment systems. Pipe installation for well servicing would involve excavation for installation of underground piping in certain locations of both the onsite and offsite areas, where aboveground piping would interfere with traffic patterns or other facility operations. In the Onsite area, every truckload (or approximately every 20 cubic yards) of excavated soils from well installations would require sampling and analysis per the Toxicity Characteristic Leachate Test (TCLP), prior to offsite disposal. In the offsite area where no soils were determined to be above the proposed target cleanup levels, it is assumed that no sampling or analyses would be required, prior to offsite disposal, for soils removed during well installations. For FS costing purposes, onsite soils were assumed to require hazardous transport and disposal and offsite soils were assumed to require non-hazardous transport and disposal.

- Installation, start up and operation of the NAPL and soil vapor recovery systems, including potential upgrading of the existing treatment of recovered vapors; and offsite disposal of recovered NAPL. Startup would occur only after a final inspection of equipment has been made to confirm the proper installation and function of the system equipment.

- Modification of the existing groundwater treatment system as necessary to handle the anticipated increase groundwater withdrawal rate during full-scale operation. System operation would include offsite disposal of spent carbon from the liquid-phase carbon adsorption (LPC) polishing units in this system, and continuation of SPDES permit monitoring.

- Start up and operation of the groundwater recovery well system.

- Modification (if necessary) of the discharge piping system from the groundwater treatment system to the discharge outfall to the nearby stream-

- Implementation of a monitoring program for the 2-Phase Vacuum Extraction system to include soil gas sampling, soil vacuum measurements, and water level measurements.

- Continuation of quarterly an/or annual groundwater quality monitoring to confirm progress of the groundwater plume containment and remediation.

3.3 ALTERNATIVE 3: SOURCE CONTROL AND ACTIVE REMEDIATION BY 2-PHASE VACUUM EXTRACTION AND CONVENTIONAL RECOVERY WELLS AND

ENHANCED ONSITE BIOREMEDIATION

3.3.1 Conceptual Design

As for Alternative 2, the purposes of Alternative 3 are to achieve control of the sources of site contamination (i.e., source control) and to actively remediate the soil and groundwater contamination (i.e., groundwater plumes) at the site. Alternative 3 prescribes recovery of contaminated groundwater from all three water-bearing zones in the onsite and offsite areas: (1) the overburden zone, (2) the shallow bedrock zone, and (3) the deep bedrock zone. In general, source control under this alternative is achieved by removal of NAPL and contaminated soil vapors from the subsurface in the onsite area of the Blauvelt Site, plus containing the groundwater contamination plumes to their present onsite and offsite area locations. In contrast to Alternative 2, Alternative 3 achieves source control by also providing 2-Phase extraction enhanced in-situ bioremediation of soil contaminants, particularly the mineral spirits, which are expected to be less efficiently removed by the 2-Phase Vacuum Extraction process alone.

Active groundwater remediation is achieved by use of conventional wells to recover the deep bedrock groundwater plume, and 2-Phase extraction wells to recover the overburden and shallow bedrock plumes. Any recovered groundwater would be treated onsite and discharged to a local surface water (as described in detail in Section 2.3.4, Groundwater Treatment and Discharge). Active soil remediation is achieved by soil vapor recovery and enhanced bioremediation.

Detailed descriptions were presented in Section 2.3 for the process options (i.e., specific technologies) required for the Alternative 3 components. Components of Alternative 3 are exactly the same as for Alternative 2, plus a 2-Phase Vacuum Extraction enhanced bioremediation component unique to Alternative 3:

Unlike Alternative 4 (see Section 3.4.1), there would be no cap installed over the defined contaminated soil area around the location of the former USTs.

A conceptual design for the components common to Alternatives 2 and 3 was presented earlier in Section 3.2.1. These components were as follows:

- NAPL and soil vapor recovery (using onsite 2-Phase extraction wells)
- Offsite disposal of recovered NAPL
- Vapor-phase carbon treatment of recovered soil vapors and NAPL vapors
- Permissible discharge of treated vapors
- Onsite groundwater containment (using existing, onsite wells)
- Onsite groundwater plume recovery
- Offsite groundwater plume containment
- Offsite groundwater plume recovery
- Groundwater treatment and discharge
- Groundwater monitoring program

A conceptual design for the Alternative 3, 2-Phase extraction enhanced bioremediation component is presented below:

<u>2-Phase Vacuum Extraction Enhanced Bioremediation</u>

In-situ biodegradation (or bioremediation) would be induced for contaminants in the soil contamination area around the former location of the USTs (see Figure 1-5, Extent of Soil Contamination). These contaminants include the volatile organics and the mineral spirits listed in Table 1-2. Bioremediation of these contaminants would be enhanced by two processes:

- 2-Phase Vacuum Extraction well operation: The approximately fifteen 2-Phase Vacuum Extraction wells, proposed for soil vapor recovery in this larger soil contamination area, would also cause atmospheric air to enter the subsurface soils and, thus, provide the soils with oxygen necessary for biodegradation of the organic contaminants. This air flow into the subsurface would be induced by withdrawing vapors from the soil, which would create a vacuum pressure gradient across the soil mass. In this way, the natural rate of contaminant biodegradation in the subsurface soils would increase, since the available oxygen supply would increase.

- Supplemental Nutrient Addition (as necessary): If necessary to promote sufficient in situ biodegradation, aqueous solutions of nutrients can be added to the subsurface, by pumping controlled amounts of the solution into 2-Phase Vacuum Extraction wells (temporarily taken off line for this purpose) that are located upgradient to the contaminated soil area. In this way, the nutrients would percolate through the zone of contamination. After the nutrient addition has reached the subsurface soils, all 2-Phase Vacuum Extraction wells can be placed back on line for soil vapor recovery and inducement of air flow into the subsurface. Thereafter, nutrient additions could be made on an as-needed basis. In this way, the natural rate of contaminant biodegradation in the subsurface soils would be increased even further, since the available supply of nutrients would increase.

Figures 1-3 and 1-4 present conceptual site layouts showing preliminary proposed locations for onsite and offsite groundwater plume containment wells and recovery wells, respectively. In summary, a total of about fifteen 2-Phase Vacuum Extraction wells would be installed in the onsite area for recovery from the overburden and shallow bedrock zones. Of these fifteen wells, nine would be new wells, and six would be existing monitoring wells modified for use with 2-Phase Vacuum Extraction. About eight 2-Phase Vacuum Extraction wells would be installed in the offsite area, as shown on Figure 1-3. to contain the plume to its present location in the overburden and shallow bedrock zones. These wells would be screened in the overburden and shallow bedrock zones.

In addition, about eleven additional 2-Phase Extraction wells would be installed in the offsite area (see Figure 1-4) to provide active recovery of groundwater from the overburden and shallow bedrock zones. Additional overburden and shallow bedrock groundwater recovery also would be provided by the eight 2-Phase extraction wells to be installed for offsite plume containment (see above). About six conventional pumping wells would be installed in the offsite area (see Figure 1-4) to provide active recovery of groundwater from the deep bedrock zones. Of these six conventional wells, two existing offsite monitoring wells (Well Nos. MW-OS-5D and MW-OS-11D) would be placed on line as pumping wells, to recover ground water from the offsite portion of the deep bedrock plume. The actual number of conventional and 2-Phase extraction wells to be used would be finalized during initial site remediation implementation and field testing. All groundwater recovered by these wells would be routed to the proposed existing onsite groundwater treatment system, which would be modified as described for Alternative 2.

3.3.2 Method of Implementation

Implementation of Alternative 3 would proceed similarly to that described in Section 3.2.2 for Alternative 2, since most of the components for these alternatives would be the same. However, Alternative 3 is unique in that it also includes 2-Phase extraction enhanced bioremediation.

Implementation of the enhanced bioremediation component would occur as follows. Bioremediation of onsite soils would be started simultaneously with the recovery of soil vapors. As described in Section 3.3.1, the 2-Phase Extraction Process system for recovery of soil vapors would be optimized to draw atmospheric air (and thus oxygen) into the subsurface. If necessary to promote sufficient biodegradation of organic contaminants (such as the mineral spirits), aqueous solutions of nutrients could be introduced to the subsurface by occasionally taking the 2-Phase Extraction wells off line, and using these wells for controlled pumping of nutrients solutions into the subsurface.

3.4 ALTERNATIVE 4: SOURCE CONTROL AND ACTIVE REMEDIATION VIA CONVENTIONAL RECOVERY WELLS

3.4.1 Conceptual Design

The purposes of Alternative 4 are to achieve partial control of the sources of site contamination and to actively remediate the groundwater contamination at the site. Alternative 4 prescribes recovery of contaminated groundwater from all three water-bearing zones in the onsite and offsite areas: (1) the overburden zone, (2) the shallow bedrock zone, and (3) the deep bedrock zone. In general, partial source control under this alternative is achieved by removal of NAPL from the subsurface in the onsite area of the Blauvelt Site, installing a bituminous concrete cap over the soil contamination area around the former UST location, and containing the groundwater contamination plumes to their present onsite and offsite area locations.

Active groundwater remediation is achieved through use of conventional wells to recover the groundwater contamination plume from all three water-bearing zones. Any recovered groundwater would be treated on site and discharged to local surface water course (as described in detail in Section 2.3.4, Groundwater Treatment and Discharge). Alternative 4 does not include any active soil remediation.

Detailed descriptions were presented in Section 2.3 for the process options (i.e., specific technologies) required for the Alternative 2 components. Components of Alternative 4 are as follows:

- Onsite Source Control: NAPL Recovery (using onsite conventional wells); installing a bituminous concrete cap over soils in the former UST area (i.e., partial control of potential soil contaminant migration); and onsite groundwater plume containment (using existing onsite conventional recovery wells). However, unlike Alternatives 2 and 3, Alternative 4 does not include recovery of contaminated soil vapors, so it provides no control over the lateral migration of soil contaminants into onsite and offsite ground water.

- Active Onsite Remediation: NAPL source control (mentioned above); groundwater plume recovery from all three water-bearing zones (using conventional type pumping wells); recovered groundwater treatment in an onsite treatment system; offsite disposal of recovered NAPL (at an approved facility); and SPDES-permitted discharge of treated water.

- <u>Offsite Containment</u>: Groundwater plume containment from a line of conventional type pumping wells.

- <u>Active Offsite Remediation</u>: groundwater plume recovery from all three water-bearing zones (using conventional type pumping wells); recovered groundwater treatment in an onsite treatment system (same system as for onsite remediation); and SPDES-permitted discharge of treated water (same as for onsite remediation).

A conceptual design for each of Alternative 4's components is presented below:

- <u>NAPL Recovery (using onsite conventional wells)</u>

  About fifteen conventional wells would be installed in the onsite area for recovery from the overburden and shallow bedrock zones. Where possible, existing onsite monitoring wells would be converted to conventional pumping wells to accomplish recovery. Of these fifteen conventional wells, nine would be new wells, and six would be existing monitoring wells modified for groundwater recovery. In those conventional wells to be installed within the defined areal extent of soil contamination (the two soil areas shown on Figure 1-5), either toploading submersible pumps or free product-skimming pumps would be initially set to extract NAPL floating on the water table. Any water inadvertently removed during the NAPL recovery would be removed by an oil/water separator, and then routed to the proposed onsite groundwater treatment system (see below).

  The actual number of conventional wells to be used would be finalized during initial site remediation implementation and field testing. All groundwater recovered by these wells would be routed to the proposed existing onsite groundwater treatment system, which would be modified as described for Alternative 2.

- <u>Offsite Disposal of Recovered NAPL</u>

  Any NAPL recovered via the conventional wells would be sampled and analyzed for its constituents, and then shipped off site to a NY-approved hazardous waste (or recycling) facility for proper disposal (or recycling).

Onsite Groundwater Containment (using existing, onsite wells)

The 10 existing, onsite conventional recovery wells (Well Nos. RW-1 through RW-10) would continue to be used for containing the overburden and shallow bedrock portions of the larger plume to its present location (i e., containment wells). These ten wells are located (see Figure 1-12) in roughly an east-west line along the northern end of the onsite area. These wells are screened over both the overburden and shallow bedrock zones. Groundwater recovered by these wells would be routed to the proposed onsite groundwater treatment system (see below).

- Onsite Groundwater Plume Recovery

After NAPL recovery, the NAPL-recovery pumps would be replaced by submersible pumps in all the conventional wells, so that the conventional pumping well system could actively recover groundwater from the overburden and shallow bedrock zones. At this time, an existing onsite monitoring well (Well No. RI-10) would be placed on line as a conventional pumping well, to recover groundwater from the small onsite portion of the deep bedrock plume. Groundwater recovery would continue until the site's groundwater remediation goals were met.

- Bituminous Concrete Cap over Former UST-Area Soil Contamination

Alternative 4 also includes installation of a bituminous concrete cap over the area of soils contamination defined at the location of the former USTs in the onsite area. This cap would cover an area of approximately 1,400 square yards (to include some overlap) and would minimize infiltration of rainfall into the contaminated soil area and reduce the rate of further migration of soil contaminants into site groundwater. This would constitute a partial containment of the soil contamination.

- Offsite Groundwater Plume Containment

  About eight conventional wells would be installed in the offsite area, as shown on Figure 1-3, to contain the plume, in the overburden and shallow bedrock zones, to its present location. These wells would be screened over the overburden and shallow bedrock zones. All groundwater recovered by these wells would be routed to the proposed onsite groundwater treatment system (see below).

- Offsite Groundwater Plume Containment

  About eleven additional conventional wells would be installed in the offsite area (see Figure 14) to provide active recovery of ground water from the overburden and shallow bedrock zones. Additional overburden and shallow bedrock groundwater recovery also would be provided by the eight conventional wells to be installed for offsite plume containment. About six conventional pumping wells would be installed in the offsite area (see Figure 1-4) to provide active recovery of ground water from the deep bedrock zones. Of these 6 conventional wells, two existing offsite monitoring wells (Well Nos. MW-OS-5D and MW-OS-11D) would be placed on line as pumping wells, to recover ground water from the offsite portion of the deep bedrock plume. The actual number of conventional type wells to be used would be finalized during initial site remediation implementation and field testing. Groundwater recovery would continue until the site's groundwater remediation goals were met. All groundwater recovered by these wells would be routed to the proposed existing onsite groundwater treatment system, which would be modified as described for Alternative 2.

- Groundwater Treatment and Discharge

  Treatment of groundwater recovered from conventional wells would be accomplished by routing the water to an onsite treatment system and, subsequently, discharging the treated water to the nearby stream, under a SPDES permit. The treatment and discharge processes would occur the same as described earlier for Alternatives 2 and 3. Details of this concept design were described earlier in Section 2.3.4.

- Groundwater Monitoring Program

  The groundwater monitoring program for Alternative 4 would be the same as described earlier for Alternatives 2 and 3.

  Figures 1-3 and 1-4 present conceptual site layouts showing preliminary proposed locations for onsite and offsite groundwater plume containment wells and recovery wells, respectively.

3.4.2 Method of Implementation

Some of the implementation steps described in Section 3.2.2 for Alternative 2, for NAPL recovery and groundwater containment/recovery, would also apply for Alternative 4. However, unlike Alternative 2, Alternative 4 would employ conventional recovery wells for NAPL recovery, and only conventional pumping wells for groundwater plume containment and recovery. Alternative 4 also includes installing a cap over contaminated soils in the onsite area.
The major elements involved in implementing Alternative 4 are as follows:

- Hydrogeologic analyses and modeling to confirm aquifer characteristics for the groundwater pumping program, and updating the characterization of the onsite and offsite groundwater quality treatment system and drinking water parameters. Unless the contaminant chemistry in the groundwater changes significantly prior to full-scale remediation, bench-scale and pilot scale testing would not be needed to determine design and operation parameters for the proposed parallel treatment system.

- Detailed design of the source control, groundwater recovery and treatment systems.

- Preparation of a Work Plan for implementing remediation.

- Completion, agency submittal, and approval of permit applications necessary for constructing and operating the remediation system (i.e., potentially, an air permit from NYSDEC for excavation of contaminated soils; and well installation permits for onsite and offsite areas. Prior to modifying the existing groundwater treatment facility, the current SPDES permit would require an amendment to reflect the increased load on the treatment system and the inclusion of additional components to the system (if necessary).

- Preparation and implementation of health and safety monitoring programs for all remediation steps.

- Mobilization of treatment equipment may require a long lead time and, therefore, equipment would be ordered prior to the mobilization of construction-related activities.

- Installation of additional conventional wells for NAPL recovery in the onsite area, and installation of additional conventional wells for groundwater recovery in the onsite and offsite areas.

- Installation of piping systems to route recovered NAPL contaminant vapors, and groundwater to the appropriate collection and treatment systems. This would involve excavation for installation of underground piping in certain locations of both the onsite and offsite areas, where aboveground piping would interfere with traffic patterns or other facility operations. In the onsite area, every truckload (or approximately every 20 cubic yards) of excavated soils from well installations would require sampling and analysis per the Toxicity Characteristic Leachate Test (TCLP), prior to offsite disposal.

- In the offsite area where no soils were determined to be above the proposed target cleanup levels, it is assumed that no sampling or analyses would be required, prior to offsite disposal, for soils removed during well installations. For FS costing purposes, onsite soils were assumed to require hazardous transport and disposal and offsite soils were assumed to require nonhazardous transport and disposal.

- Installation, start up and operation of the NAPL recovery systems, and offsite disposal of recovered NAPL. Startup would occur only after a final inspection of equipment has been made to confirm the proper installation and function of the system equipment.

- Modification of the existing onsite groundwater treatment system, as would be necessary to handle the anticipated increase groundwater withdrawal rate during full-scale operation. System operation would include offsite disposal of spent carbon from the liquid-phase carbon adsorption (LPC) polishing units in this system, and continuation of SPDES permit monitoring.

- Start up and operation of the groundwater recovery system.

- Modification (if necessary) of the discharge piping system from the groundwater treatment system to the discharge outfall to the nearby stream

- Installation of a bituminous concrete cap after installation of recovery wells is completed, since some wells will be installed within the area requiring capping.

- Continuation of quarterly groundwater quality monitoring to confirm progress of the groundwater plume containment and remediation.

Construction of the conventional pumping wells would require excavation for installation of underground piping in certain locations of both the onsite and offsite areas, where aboveground piping would interfere with traffic patterns or other facility operations. As for Alternative 2 and 3, every truckload of soils excavated from the onsite area during well installation would require TCLP analysis, prior to offsite disposal. Also as for Alternatives 2 and 3, it is assumed that no sampling or analyses would be required for offsite drilling soils (believed to be clean), prior to offsite disposal. For FS costing purposes, onsite soils were assumed to require hazardous transport and disposal and offsite soils were assumed to require nonhazardous transport and disposal.

3.5 ALTERNATIVE 5: SOURCE CONTROL BY 2-PHASE VACUUM EXTRACTION AND CONVENTIONAL WELLS AND GROUNDWATER PLUME CONTAINMENT (BY CONVENTIONAL RECOVERY WELLS

3.5.1 Conceptual Design

The purposes of Alternative 5 are to achieve control of the sources of site contamination and to control the groundwater plumes at the site. Alternative 5 prescribes containment of contaminated groundwater in all three water-bearing zones in the onsite and offsite areas: (1) the overburden zone, (2) the shallow bedrock zone, and (3) the deep bedrock zone. In general, partial source control under this alternative is achieved via removal of NAPL from the subsurface in the onsite area of the Blauvelt Site, and containing the groundwater contamination plumes to their present onsite and offsite area locations.

Unlike Alternative 4, Alternative 5 would not include installation of a bituminous concrete cap over the area of soils contamination defined at the location of the former USTs in the onsite area. No active groundwater remediation is included in Alternative 5, other than recovery of NAPL from the water table in the onsite area.

Detailed descriptions were presented in Section 2.3 for the process options (i.e., specific technologies) required for the Alternative 5-components. Components of Alternative 5 are as follows:

- Onsite Source Control: NAPL recovery (using onsite conventional wells) and soil vapor recovery (using conventional wells modified to use 2-Phase Extraction as described for Alternative 2); and groundwater containment using existing onsite conventional recovery wells.

- Active Onsite Remediation: NAPL and soil vapor source control (as mentioned above); treatment (in the existing onsite groundwater treatment system) of groundwater removed during groundwater plume containment; offsite disposal of recovered NAPL at an approved facility; and SPDES-permitted discharge of treated water.

- Offsite Containment: groundwater plume containment through a line of conventional pumping wells.

A conceptual design for each of Alternative 5's components is presented below:

- NAPL and Soil Vapor Recovery (using onsite 2-Phase Vacuum Extraction Process Wells)

  About fifteen conventional wells would be installed in the onsite area of the Blauvelt Site, as shown in Figure 1-4. Where possible, existing onsite monitoring wells would be converted to conventional wells to accomplish recovery of the NAPL floating on the water table. Of these fifteen conventional wells, nine would be new wells, and six would be existing monitoring wells modified for recovery. The actual number of wells to be used would be finalized during initial site remediation implementation and field testing. All the wells would be screened over the overburden and shallow bedrock zones.

  After NAPL recovery, all the conventional wells would then be modified to allow soil vapor recovery from the overburden zone within the defined areal extent of soil contamination (the two soil areas shown on Figure 1-5). Well modification would be accomplished by inserting the end of a 2-Phase Extraction system recovery pipe (or "straw") below the water table. Any vapors removed by the 2-Phase Extraction straws would be removed in the 2-Phase Extraction system's air/water separator, and then routed to vapor treatment (see below). 2-Phase Vacuum Extraction well operation would dewater the overburden zone. Any water removed by the straws would be removed via an oil/water separator, and then routed to the proposed onsite groundwater treatment system (see below). Operation of all the wells would continue until sufficient vapor recovery was achieved. Organic contaminants already in the soil vapor phase would be recovered first. As these vapors are recovered, organics adsorbed to the surface of soil particles would transfer into the vapor phase and, thus, would also be available for recovery.

- Offsite Disposal of Recovered NAPL

  Any NAPL recovered from the conventional wells would be sampled and analyzed for its constituents, and then shipped off site to a New York-approved hazardous waste (or recycling) facility for proper disposal (or recycling).

- Onsite Groundwater Containment (using existing, onsite wells)

The ten existing, onsite conventional recovery wells (Well Nos. RW-1 through RW-10) would continue to be used for containing the overburden and shallow bedrock portions of the larger plume to its present location (i.e., containment wells). These ten wells are located (see Figure 1-12) in roughly an east-west line along the northern end of the onsite area. All these wells are screened over both the overburden and shallow bedrock zones. In addition, existing Well RI-10 is screened from the overburden zone into the deep bedrock zone and, therefore, would be pumped to contain the deep bedrock portion of the onsite plume. Groundwater recovered by these wells would be routed to the proposed onsite groundwater treatment system (see below).

- <u>Offsite Groundwater Plume Containment</u>

About eight conventional wells would be installed in the offsite area, as shown on Figure 1-3, to contain the plume, in the overburden and shallow bedrock zones, to its present location. These wells would be screened through the overburden and shallow bedrock zones. All groundwater recovered by these wells would be routed to the proposed onsite groundwater treatment system (see below).

- <u>Groundwater Treatment and Discharge</u>

Treatment of groundwater recovered from conventional wells would be accomplished by routing the water to an onsite treatment system and, subsequently, discharging the treated water to the nearby stream under an SPDES permit. The treatment and discharge processes would occur the same as described earlier for Alternatives 2 and 3, except that the treatment capacity of the existing, onsite groundwater treatment system may be nearly sufficient for treatment of any water recovered during plume containment. For purposes of providing detailed costing for Alternative 5, it was assumed that the UV/Peroxidation unit in the existing onsite treatment system would be upgraded to a larger capacity, to ensure sufficient overall groundwater treatment capacity in the system. Treatment system requirements would be confirmed during the design phase of implementing the site remediation. Details of the existing treatment system were described earlier in Section 1.9.

- <u>Groundwater Monitoring Program</u>

  The groundwater monitoring program for Alternative 5 would be the same as described earlier for Alternatives 2, 3 and 4.

  Figures 1-3 presents a conceptual site layout showing preliminary proposed locations for onsite and offsite groundwater plume containment wells. In summary, the ten existing recovery wells would be used as containment wells for containment of the plume in the overburden and shallow bedrock zones in the onsite area. In the offsite area, a total of about eight conventional wells would be operated in the overburden and shallow bedrock to contain the plume in these zones. As shown in Figure 1-3, two of these wells would be provided by converting existing monitoring wells to recovery wells. Also in the offsite area, two additional conventional wells would be installed in the deep bedrock portion of the groundwater plume, to contain it to its present location.

3.5.2 Method of Implementation

Some of the implementation steps described in Section 3.2.2 for Alternative 2, for NAPL and soil vapor recovery and for groundwater plume containment, would apply for Alternative 5. However, unlike Alternative 2, Alternative 5 would employ only conventional recovery wells for groundwater plume containment and NAPL recovery. Unlike Alternative 4, Alternative 5 does not include installing a cap over contaminated soils in the onsite area. Therefore, the major elements involved in implementing Alternative 5 are as follows:

- Hydrogeologic analyses and modeling to confirm aquifer characteristics for the groundwater pumping program, and updating the characterization of the onsite and offsite groundwater quality per treatment system and drinking water parameters.

- Detailed design of the source control, groundwater containment and recovered groundwater treatment system.

- Preparation of a Work Plan for implementing remediation.

- Completion, agency submittal, and approval of permit applications necessary for constructing and operating the remediation system (i.e., an air permit from NYSDEC for any excavation of contaminated soils required during piping installations in the onsite area); modification of the permit for the existing groundwater treatment system to allow a capacity upgrade (if necessary); and well installation permits for offsite areas. Prior to modifying the existing groundwater treatment facility, the current SPDES permit would require an amendment to reflect the increased load on the treatment system.

Preparation and implementation of health and safety monitoring programs for all remediation steps.

- Mobilization of treatment equipment may require a long lead time and, therefore, equipment would be ordered prior to the mobilization of construction-related activities.

- Installation wells for NAPL and soil vapor recovery in the onsite area, and installation of additional wells for groundwater containment in the offsite areas.

- Installation of piping systems to route recovered NAPL, contaminant vapors, and groundwater to the appropriate collection and treatment systems. This would involve excavation for installation of underground piping in certain locations of both the onsite and offsite areas, where aboveground piping would interfere with traffic patterns or other facility operations. In the onsite area, every truckload (or approximately every 20 cubic yards) of excavated soils from well installations would require sampling and analysis per the Toxicity Characteristic Leachate Test (TCLP), prior to offsite disposal. In the offsite area where no soils were determined to be above the proposed target cleanup levels, it is assumed that no sampling or analyses would be required, prior to offsite disposal, for soils removed during well installations. For FS costing purposes, onsite soils were assumed to require hazardous transport and disposal and offsite soils were assumed to require nonhazardous transport and disposal.

- Installation, start up and operation of the NAPL and soil vapor recovery systems, including upgrading the system for treatment of recovered vapors; and offsite disposal of recovered NAPL Startup would occur only after a final inspection of equipment has been made to confirm the proper installation and function of the system equipment.

- Upgrading of the UV/Peroxidation treatment unit to a larger capacity, and restart of the groundwater treatment system. System operation would include offsite disposal of spent carbon from the liquid-phase carbon adsorption (LPC) polishing units in this system, and continuation of SPDES permit monitoring.

- Start up and operation of the groundwater containment well system.

- Modification (if necessary) of the discharge piping system from the groundwater treatment system to the discharge outfall to the nearby stream.

- Implementation of a monitoring program for the 2-Phase Extraction system for the soil vapor recovery, to include soil gas sampling, soil vacuum measurements, and water level measurements.

- Continuation of quarterly groundwater quality monitoring to confirm progress of the groundwater plume containment.

3.6 ALTERNATIVE 6: SOURCE CONTROL AND EXCAVATION AND ONSITE TREATMENT OF HOT-SPOT SOIL CONTAMINATION AREAS

3.6.1 Conceptual Design

Similar to Alternative 5, the purposes of Alternative 6 are to achieve control of the sources of site contamination and to contain the groundwater contamination at the site. Like Alternative 5, Alternative 6 prescribes containment of contaminated groundwater in all three water-bearing zones in the onsite and offsite areas: (1) the overburden zone, (2) the shallow bedrock zone, and (3) the deep bedrock zone. In general, partial source control under this alternative is achieved by, 1) removal of NAPL from the subsurface in the onsite area of the Blauvelt Site, by 2) excavating and treating, in an onsite volatiles stripping system, contaminated soil areas that are considered to contain "hot spot" levels of contaminants, and by 3) containing the groundwater contamination plumes to their present onsite and offsite area locations. Unlike Alternative 4, Alternative 6 does not include installing a bituminous concrete cap over any soil contamination areas. No active groundwater remediation is included in Alternative 6, other than recovery of NAPL from the water table in the onsite area.

Detailed descriptions were presented in Section 2.3 for the process options (i.e., specific technologies) required for the Alternative 6 components. Components of Alternative 6 are as follows:

- Onsite Source Control: NAPL recovery (using onsite conventional wells); excavating "hot-spot" contaminated soils in the former UST area and treating these excavated soils on site, using soil aeration technology to strip volatile organics (i.e., partial removal of soil contamination); and groundwater containment (using existing onsite conventional recovery wells).

- Active Onsite Remediation: NAPL and soil vapor source control (as mentioned above); excavating "hot-spot" contaminated soils in the former UST area and treating these excavated soils with onsite aeration (i.e., partial removal of soil contamination); treatment (in the existing onsite groundwater treatment system) of groundwater removed during groundwater plume containment; offsite disposal of recovered NAPL (at an approved facility); and SPDES-permitted discharge of treated water.

- Offsite Containment: groundwater plume containment through a line of conventional type pumping wells.

  Unlike Alternative 4, Alternative 6 does not include installation of a bituminous concrete cap over the area of soils contamination defined at the location of the former USTs in the onsite area.

A conceptual design for each of Alternative 6's components is presented below:

- Excavation and Onsite Aeration of "Hot Spot Soil"

About one-half of the contaminated soils from around the former underground storage tank (UST) location might contain "hot-spot" levels of contaminants. These "hot spot" soil areas may contain approximately 2,900 cy of soil in place, or about 3,300 cy of soil once excavated (assuming 15% expansion of soils during excavation). Under Alternative 6, these former UST area soils would be excavated and treated on site by aeration. Aeration would remove organic compounds so that these soils could be considered clean and replaced on site. Aeration could be accomplished via use of passive soil drying beds, forced aeration piles, or the passage of excavated soils through a dirt screen commonly used in highway construction projects (soil screening). Forced aeration involves pushing ambient or heated air up through shallow piles of excavated soils. This is accomplished by using air blowers to move air through perforated piping installed at the base of the soil piles. If necessary, excavated soils can be allowed to drain free water prior to aeration. Selection of the actual aeration method for this alternative would occur during the design phase of site remediation; Section 2.3.1.7 provides details of these alternative soil aeration technologies. Each variation of soil aeration would require extensive controls on the volatile organic emissions from the aeration process.

Removal of "hot spot" soils would typically be performed using standard earthwork equipment and techniques. Due to the volatile nature of the soil contaminants, vapor control would be required during "excavation practices. Excavation of saturated soil in contaminated areas would typically require dewatering, and water collection and treatment. During excavation, temporary localized sumps could be used with construction pumps to remove water from the excavations. An excavated soil staging area would consist of a sacrificial asphalt surface, to be disposed of after excavation activities are completed, that would be bermed around the perimeter to contain runoff from soil drainage and precipitation. From the staging area, the soils would be transported to the soil aeration area.

Soil samples taken during excavation would consist of random sampling from each foot of soil excavated (frequency of approximately one sample per 500 cubic yards), and confirmatory sampling of the excavation sideslopes and bottom, if the excavation is not taken to bedrock. These soil samples would be analyzed for the volatile organics found in previous sampling events.

Samples taken from the excavated material would be used to evaluate the limit of soil excavation, and samples taken from the sideslopes and bottom would be used to confirm that the remaining soils did not contain "hot-spot" levels of contaminants. Soils found to be acceptable could be stockpiled during excavation in order to provide backfill material and to stabilize slopes in the excavation area. Backfill material and aerated soil which met the target cleanup levels would be used to fill the excavated area to its former elevation or to predetermined elevations.

- NAPL and Soil Vapor Recovery (using onsite 2-Phase Extraction Wells)

About fifteen conventional wells would be installed in the onsite area of the Blauvelt Site, as shown in Figure 1-4. Where possible, existing onsite monitoring wells would be converted to conventional wells to accomplish recovery of the NAPL floating on the water table. Of these conventional wells, nine would be new wells, and six would be existing monitoring wells modified for the recovery. The actual number of wells to be used would be finalized during initial site remediation implementation and field testing. A preliminary layout for the wells during active NAPL and soil vapor recovery, is shown on Figure 1-4. All the wells would be screened over both the overburden and shallow bedrock zones.

After NAPL recovery, all the conventional wells would then be modified to allow soil vapor recovery from the overburden zone within the defined areal extent of soil contamination (the two soil areas shown on Figure 1-5). Well modification would be accomplished by inserting the end of an 2-Phase extraction recovery pipe (or "straw") below the water table. Any vapors removed by the 2-Phase Extraction straws would be removed in the 2-Phase Extraction system's air/water separator, and then routed to vapor treatment (see below). 2-Phase Extraction well operation would dewater the overburden zone, which would leave all the contaminated soils within an unsaturated zone. Any water removed by the straws would be removed with an oil/water separator, and then routed to the proposed onsite groundwater treatment system (see below). Operation of all the 2-Phase Vacuum Extraction wells would continue until sufficient vapor recovery was achieved. Organic contaminants already in the soil vapor phase would be recovered first. As these vapors are recovered, organics adsorbed to the surface of soil particles would transfer into the vapor phase and, thus, would also be available for recovery.

- <u>Offsite Disposal of Recovered NAPL</u>

  Any NAPL recovered would be sampled and analyzed for its constituents, and then shipped off site to a New York-approved hazardous waste (or recycling) facility for proper disposal (or recycling).

- <u>Onsite Groundwater Containment (using existing, onsite wells)</u>

  The ten existing, onsite conventional recovery wells (Well Nos. RW-1 through RW-10) would continue to be used for containing the overburden and shallow bedrock portions of the larger plume to its present location (i.e., containment wells). These wells are located (see Figure 1-12) in roughly an east-west line along the northern end of the onsite area. All these wells are screened over both the overburden and shallow bedrock zones. In addition, existing Well RI-10 is screened from the overburden zone into the deep bedrock zone and, therefore, would be pumped to contain the deep bedrock portion of the onsite plume. All groundwater recovered by these wells would be routed to the proposed onsite groundwater treatment system (see below).

- <u>Offsite Groundwater Plume Containment</u>

  About eight conventional wells would be installed in the offsite area, as shown on Figure 1-3, to contain the plume, in the overburden and shallow bedrock zones, to its present location. These wells would be screened through the overburden and shallow bedrock zones. All groundwater recovered by these wells would be routed to the proposed onsite groundwater treatment system (see below).

- Groundwater Treatment and Discharge

Treatment of groundwater recovered from conventional wells would be accomplished by routing the water to an onsite treatment system and, subsequently, discharging the treated water to the nearby stream, under an SPDES permit. The treatment and discharge processes would occur the same as described earlier for Alternatives 2 and 3, except that the treatment capacity of the existing, onsite groundwater treatment system may be nearly sufficient for treatment of any water recovered during plume containment. For purposes of providing detailed costing for Alternative 5, it was assumed that the UV/Peroxidation unit in the existing onsite treatment system would be upgraded to a larger capacity, to ensure sufficient overall groundwater treatment capacity in the system. Treatment system requirements would be confirmed during the design phase of implementing the site remediation. Details of the existing treatment system were described earlier in Section 1.9.

- Groundwater Monitoring Program

The groundwater monitoring program for Alternative 5 would be the same as described earlier for Alternatives 2, 3 and 4.

Figures 1-3 presents a conceptual site layout showing preliminary proposed locations for onsite and offsite groundwater plume containment wells. In summary, the ten existing recovery wells would be used as containment wells for containment of the plume in the overburden and shallow bedrock zones in the onsite area. In the offsite area, about eight conventional wells would be operated in the overburden-and shallow bedrock to contain the plume in these zones. As shown in Figure 1-3, two of these wells would be provided by converting existing monitoring wells to recovery wells. Also in the offsite area, two additional conventional wells would be installed in the deep bedrock portion of the groundwater plume, to contain it to its present location.

3.6.2 Method of Implementation

Some of the implementation steps described in Section 3.2.2 for Alternative 2, for NAPL and soil vapor recovery and for groundwater plume containment, would apply for Alternative 6. However, unlike Alternative 2, Alternative 6 would employ only conventional pumping recovery wells for groundwater plume containment and NAPL recovery. Unlike Alternative 4, Alternative 6 does not include installing a cap over contaminated soils in the onsite area. Therefore, the major elements involved in implementing Alternative 6 are as follows:

- Hydrogeologic analyses and modeling to confirm aquifer characteristics for the groundwater pumping program and updating the characterization of the onsite and offsite groundwater quality per treatment system and drinking water parameters.

- Detailed design of the source control, groundwater containment and recovered groundwater treatment system.

- Preparation of a Work Plan for implementing remediation.

- Completion, agency submittal, and approval of permit applications necessary for constructing and operating the remediation system (i.e., an air permit from NYSDEC for any excavation and onsite treatment of contaminated soils during "hot spot" soil remediation and piping installation in the onsite area); modification of the permit for the existing groundwater treatment system, to allow a capacity upgrade (if necessary); and well installation permits for offsite areas. Prior to modifying the existing groundwater treatment facility, the current SPDES permit would require an. amendment to reflect the increased load on the treatment system.

- Preparation and implementation of health and safety monitoring programs for all remediation steps.

- Mobilization of treatment equipment may require a long lead time and, therefore, equipment would be ordered prior to the mobilization of construction-related activities.

- Excavation and onsite treatment of soil areas containing contaminant concentrations considered to be at "hot-spot" levels. Performance monitoring for soil aeration would consist of evaluating "drying" time to meet the target soil cleanup levels and treated vapor quality.

- Installation wells for NAPL and soil vapor recovery in the onsite area, and installation of additional wells for groundwater containment in the offsite areas.

- Installation of piping systems to route recovered NAPL, contaminant vapors, and groundwater to the appropriate collection and treatment systems. This measurements, and water level measurements would involve excavation for installation of underground piping in certain locations of both the onsite and offsite areas, where aboveground piping would interfere with traffic patterns or other facility operations. In the onsite area, every truckload (or approximately every 20 cubic yards) of excavated soils from well installations would require sampling and analysis per the Toxicity Characteristic Leachate Test (TCLP), prior to offsite disposal. In the offsite area where no soils were determined to be above the proposed target cleanup levels, it is assumed that no sampling or analyses would be required, prior to offsite disposal, for soils removed during well installations. For FS consistency purposes, onsite soils were assumed to require hazardous transport and disposal and offsite soils were assumed to require nonhazardous transport and disposal.

- Installation, start up and operation of the NAPL and soil vapor recovery systems, including upgrading the system for treatment of recovered vapors; and offsite disposal of recovered NAPL. Startup would occur only after a final inspection of equipment has been made to confirm the proper installation and function of the system equipment.

- Upgrading of the UV/Peroxidation treatment unit to a larger capacity, and restart of the groundwater treatment system. System operation would include offsite disposal of spent carbon from the liquid-phase carbon adsorption (LPC) polishing units in this system, and continuation of SPDES permit monitoring.

- Start up and operation of the groundwater containment well system.

- Modification (ff necessary) of the discharge piping system from the groundwater treatment system to the discharge outfall to the nearby stream.

- Implementation of a monitoring program for the 2-Phase Vacuum Extraction Proccss system for the soil vapor recovery, to include soil gas sampling, soil vacuum measurements, and water level measurements.

- Continuation of quarterly groundwater quality monitoring to confirm progress of the groundwater plume containment.

4.0 DETAILED ANALYSIS OF ALTERNATIVES

This section presents the detailed analysis of the five alternatives and the no action alternative were devised from various process options which had passed the earlier screening evaluations for remediation of contaminated soils and groundwater. A total of four process options, plus a complete groundwater treatment scheme, were retained as a result of the process option screening conducted in Subsection 2.4. Relevant information for each of the alternatives is presented to enable the selection of a preferred alternative.

The alternatives to be analyzed were assembled from the technologies retained in Subsection 2.4. These alternatives were assessed using criteria developed by the NYSDEC in HWR-90-4030 (NYSDEC, 1990). The criteria used to evaluate and compare the alternatives are discussed in the following sections.

Six alternatives were formed as a result of combining the selected process options and the selected groundwater treatment scheme, as shown on Table 4-1. Common elements in each alternative include groundwater treatment and groundwater monitoring. Each alternative that implements the 2-Phase Extraction System also includes soil vapor recovery and collection, and treatment of collected vapors, as common elements.

The six alternatives were analyzed with respect to the seven evaluation criteria presented in HWR-90-4030 (NYSDEC, 1990):

- Compliance with New York State SCGs
- Protection of human health and the environment
- Short-term impacts and effectiveness
- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, and volume
- Implementability
- Detailed Present-Worth Cost

These criteria are the basis of the detailed analysis presented in Subsection 4.1.

4.1 ANALYSIS OF INDIVIDUAL ALTERNATIVES

This subsection presents the detailed analysis of each of the remediation alternatives formed from the combination of the process options retained after the process options screening conducted in Subsection 2.4.

4.1.1 Alternative 1- NO ACTION

Alternative 1 consists of no additional action other than long term monitoring. A more detailed description of Alternative 1 components is provided in Subsection 3.1.

4.1.1.1 Compliance with SCGS

The no action alternative would not comply with all location- and chemical-specific SCGS. Location-specific SCGs that Alternative 1 would not comply with include, 1) the need to control the onsite soil contamination, since it is a continuing source of contamination to groundwater, and 2) the need to minimize the further migration of (i.e., to contain) the offsite portion of the groundwater contamination plume.

Chemical-specific SCGs that Alternative 1 would not comply with include, 1) the need to reduce onsite soil contaminants to the proposed target soil cleanup levels, and 2) the need to reduce onsite and offsite groundwater contaminants to the proposed target groundwater cleanup levels.

4.1.1.2 Overall Protection of Human Health and the Environment

The Human Health Assessment (HHA) for the Xerox Blauvelt site indicated that the site does not cause unacceptable exposure of contaminants to Xerox workers, offsite workers, or offsite residents.

The HHA did indicate that the site may potentially cause exposure to trespassers who walk in the local stream in the offsite area. Also, future onsite construction workers would potentially be exposed to contamination as indicated in the HHA- Potential exposure pathways include dermal contact and ingestion of stream water and sediments for trespassers and dermal contact and ingestion of subsurface soil and the inhalation of soil vapors for construction workers. However, risk associated with exposure to trespassers and workers are low.

The present use of offsite groundwater from residential drinking water wells has not been confirmed. However, some wells may exist and may be affected by the offsite groundwater contamination. In addition, the potential for future groundwater use, as a result of residential development, may be affected by offsite groundwater contamination. Currently, municipal potable water supplies in New York's Rockland County, are supplied by the Spring Valley Company, which obtains drinking water from numerous groundwater withdrawal wellfields (located throughout Rockland County) and from two surface water intakes.

Available soils data indicates that onsite soils containing the chemicals of concern at the site are subsurface soils and, thus, are not generally available for dermal contact or inhalation by offsite residents, Xerox workers, offsite workers, or trespassers.

The human health risks potentially associated with the site appear to be acceptable (see Section 5, HHA), residual environmental risks, primarily from groundwater contamination, will be significant if the no action alternative (Alternative 1) is implemented. However, no significant environmental impacts are associated with the existing onsite groundwater treatment system, since the current SPDES permit requirements are satisfied and are anticipated to continue to be met. As explained in Section 1.6 of this FS, present ecological risks that potentially could be associated with site-related contaminants, are either nonexistent or not significant (in both the onsite and offsite areas).

4.1.1.3 Short-Term Effectiveness

Alternative 1 would not be effective in remediation of onsite soils, since it does not include any soil removal, treatment, or containment. In addition, Alternative 1 does not include any contaminant, recovery or treatment of contaminated groundwater in the offsite area and, therefore, would not be effective in the short term for reducing contaminant levels in offsite groundwater.

The significant short-term environmental risk associated with this alternative is the continued gradual migration of contaminated soil vapors and the continued migration of the offsite groundwater plume into presently clean areas.

4.1.1.4 Long-Term Effectiveness

Alternative 1 would not achieve a reduction in the mobility, volume and toxicity of contamination. The Alternative does not effect the mobility of soil bound contamination to the groundwater phase. Offsite groundwater contamination would not be recovered or contained, since there are no offsite containment or recovery wells proposed under this alternative. A relatively large quantity of untreated groundwater and soils would remain at the site. Extensive long-term monitoring of plume migration and operation and maintenance of the IRM systems would be required for Alternative 1.

Alternative 1 would not meet the drinking water standards specified by NYSDEC as the performance goal for groundwater remediation for the Blauvelt Site, nor the target soil cleanup levels proposed for the site. Therefore, significant future remedial action may be anticipated with this alternative.

4.1.1.5 Reduction of Toxicity, Mobility, or Volume

No reduction in toxicity, mobility, or volume of these contaminants would not be provided by Alternative 1.

4.1.1.6 Implementability

Alternative 1 is technically feasible at the Blauvelt Site, since it involves no new process options, construction, nor monitoring programs.

4.1.1.7 Detailed Cost

The total present worth cost associated with Alternative 1, No Action is $315,100.

4.1.2 SOURCE CONTROL AND ACTIVE REMEDIATION VIA 2-PHASE VACUUM EXTRACTION AND CONVENTIONAL RECOVERY WELLS

A detailed description of Alternative 2 components is provided in Subsection 3.2.

4.1.2.1 Compliance with SCGs

Location, chemical, and action-specific SCGs would be met with the implementation of Alternative 2. Alternative 2 would comply with the location-specific SCGs such as, 1) controlling the onsite soils contamination by 2-Phase Vacuum Extraction of soil vapors, and 2) containing the offsite portion of the groundwater contamination plume, with conventional and 2-Phase Vacuum Extraction wells. Alternative 2 would comply with the chemical-specific SCGs, such as, 1) reducing soil contaminants to the proposed target soil cleanup levels, 2) reducing contaminants in extracted vapors, and 3) reducing onsite and offsite groundwater contaminants to the proposed target groundwater cleanup levels. The groundwater treatment system would be regulated under a modification to the SPDES permit for the current onsite system.

In addition, Alternative 2 complies with action-specific SCGs, due to its inclusion of vapor phase treatment of recovered vapors, its inclusion of the installation of additional conventional and 2-Phase Extraction wells, its inclusion of a proposed modified groundwater treatment system, and its inclusion of groundwater and ambient air monitoring programs.

4.1.2.2 Overall Protection of Human Health and the Environment

Alternative 2 would be protective of human health and the environment, since it actively removes and treats the contamination in soils and groundwater. If Alternative 2 were implemented, anticipated human exposure to soil or groundwater contaminants would not increase over their current levels and will significantly decrease during completion of the groundwater remediation. During remediation, it is anticipated that deed restrictions may remain for groundwater use in the onsite and offsite areas of the Blauvelt Site.

As explained in Section 1.6 of this FS, present ecological (i.e., environmental) risks that potentially could be associated with site-related contaminants, and potential ecological risks associated with Alternative 2, are either nonexistent or not significant in both the onsite and offsite areas.

4.1.2.3 Short-Term Effectiveness

In the short term, Alternative 2 would be effective in recovering the NAPL floating on the water table and the contaminated vapors in onsite soils, and would be expected to be effective in containing the contaminated groundwater in the onsite and offsite portions of the larger groundwater plume. The existing treatment scheme for recovered groundwater is effective in treating groundwater, as evidenced by the treatment system's SPDES compliance record (see Section 1.9). This treatment scheme would also be used for Alternative 2, although the treatment capacity would be increased. In the short term, Alternative 2 would be expected to reduce the migration of soil contaminants into groundwater, as well as minimize the further migration of the onsite and offsite portions of the groundwater plumes. Also, Alternative 2 includes recovery and treatment of contaminated groundwater in both the onsite and offsite areas and, therefore, would be effective in the short term for reducing contaminant levels in offsite groundwater to the proposed target cleanup levels.

Based on the Human Health Assessment (HHA) performed for the Blauvelt Site (see Section 1.5), present adverse risks to human health due to site-related contamination are either nonexistent or within acceptable limits in both the onsite and offsite areas. The remediation proposed under Alternative 2 would only improve on this situation.

During excavation for installing pipelines to service proposed new wells in the onsite area, some volatilization of organic contaminants in the onsite soils may occur. Protective measures for the community and workers would be required. Proper safety methods to be implemented during well installation would prevent any potential, short-term risk due to the spillage of drilling fluids and drill cuttings. Similarly, proper safety methods to be implemented during well development would prevent any potential, short-term risk due to spillage of well water.

4.1.2.4 Long-Term Effectiveness

Alternative 2 would be a permanent remedy, since a significant reduction in the mobility and volume of soil and groundwater contamination would be provided. After remediation, the quantity of untreated hazardous waste left at the site would be significantly reduced. Comprehensive, long-term monitoring of groundwater plume response, as well as operation and maintenance of the wells and treatment systems would be required for Alternative 2.

Alternative 2 would be expected to be reliable in meeting the drinking water standards specified by NYSDEC as the performance goal for groundwater remediation for the Blauvelt Site. Since this alternative would be expected to significantly reduce volatile organic soil contamination in the onsite area, no additional future remedial actions are anticipated.

4.1.2.5 Reduction of Toxicity, Mobility or Volume

Alternative 2 would reduce the mobility and volume of contaminants in onsite soils and in onsite and offsite groundwater. Mobility of onsite soil contaminants would be reduced by the 2-Phase Extraction and onsite treatment of soil vapors; this type of remediation would also reduce the total volume of volatile organic contaminants in the soils. Both the mobility and volume of groundwater contaminants would be reduced by the 2-Phase Extraction of NAPL from the water table, and by the active recovery and onsite treatment of dissolved-phase contaminants in the groundwater with both conventional and 2-Phase Extractions wells. The recovery and treatment of the groundwater plumes would reduce the overall toxicity of the groundwater itself; similarly, the 2-Phase Extraction of the soil vapors would reduce the overall toxicity of the onsite soils.

The containment wells proposed for Alternative 2 would reduce the potential for the groundwater plumes to migrate further into areas of currently clean groundwater. Certain dissolved-phase organic contaminants would be destroyed (and thus their toxicity reduced) in the

UV/Peroxidation unit of the groundwater treatment system. Sludge and filtered solids from the groundwater treatment plant, spent carbon from the vapor-phase carbon unit (for soil vapor treatment), and spent carbon from the liquid-phase carbon treatment unit (in the groundwater treatment system) will constitute the residual wastes that will require shipment to a permitted, offsite facility for treatment and disposal.

4.1.2.6 Implementability

Alternative 2 is technically feasible at the Blauvelt Site, since the necessary technologies, process options, equipment and manpower are commercially available. Standard earthmoving equipment would be used for construction of any access ways necessary to allow well installation in the offsite area. The required SPDES permit amendment, and remediation system construction and operating permits would be obtainable for the site cleanup. Sufficient area would should be available in both the onsite and offsite areas to implement Alternative 2 components, and approval for access to the onsite and offsite areas to be involved in the remediation is assumed for the purpose of this FS.

4.1.2.7 Detailed Cost

The total present worth cost associated with Alternative 2 is $3,238,400. The cost estimate for Alternative 2 is presented in Appendix H as Tables H-4 and H-5, and assumes a 30-year cleanup period at a 5 percent discount rate. The actual cleanup period is expected to be less than 30 years.

4.1.3 Alternative 3- SOURCE CONTROL AND ACTIVE REMEDIATION WITH 2-PHASE EXTRACTION AND CONVENTIONAL RECOVERY WELLS AND 2-PHASE EXTRACTION ENHANCED ONSITE BIOREMEDIATION

A detailed description of Alternative 3 components are provided in Subsection 3.3.
As the components of Alternative 3 are those of Alternative 2 with the addition of 2-phase extraction enhanced bioremediation, the Alternative 3 analysis differs slightly from the analysis presented in Subsection 4.1.2 for Alternative 2. The enhanced bioremediation is intended to

increase the efficiency of the onsite shallow 2-Phase Extraction System used to recover soil vapors. Therefore, under the NYSDEC evaluation criteria for the Overall Protection of Human Health and the Environment, the magnitude of residual environmental risks after remediation would be low and similar to that for Alternative 2. The remaining evaluation criteria are the same as for Alternative 2.

4.1.3.1 Compliance with SCGs

Location, chemical, and action-specific SCGs would be met with the implementation of Alternative 3. Alternative 3 would comply with the location-specific SCGs such as, 1) controlling the onsite source contamination, and 2) containing the offsite portion of the groundwater contamination plume. Alternative 3 would comply with the chemical-specific SCGS, including:

1) reducing soil contaminants to the proposed target soil cleanup levels.

2) reducing contaminants in extracted vapors.

3) reducing onsite and offsite groundwater contaminants to the proposed target groundwater cleanup levels.

In addition, Alternative 3 complies with action-specific SCGS, due to its inclusion of vapor phase carbon treatment of recovered vapors, permitting for a modified vapor-phase carbon treatment system, permitting for the installation of additional conventional and 2-Phase Vacuum Extraction Process wells, permitting of a proposed modified groundwater treatment system, and its inclusion of groundwater and ambient air monitoring programs.

4.1.3.2 Overall Protection of Human Health and the Environment

Alternative 3 would be protective of human health and the environment, since it actively removes and treats the contamination in soils and groundwater. If Alternative 3 were implemented, anticipated human exposure to soil or groundwater contaminants would be low and within acceptable limits following completion of the groundwater remediation. During remediation, it is anticipated that deed restrictions may remain for groundwater use in the onsite and offsite areas of the Blauvelt Site.

As explained in Section 1.6 of this FS, present ecological risks that potentially could be associated with site-related contaminants, and potential ecological risks associated with Alternative 3, are either nonexistent or not significant (in both the onsite and offsite areas).

4.1.3.3 Short-Term Effectiveness

Like Alternative 2, Alternative 3 would be effective in the short term at recovering the NAPL floating on the water table and the contaminated vapors in onsite soils and would be expected to be effective in containing the contaminated groundwater in the onsite portion of the larger groundwater plume. Since the existing treatment scheme for recovered groundwater is effective in treating groundwater, this treatment scheme would also be used for Alternative 3 although the treatment capacity would be increased. As for Alternative 2, Alternative 3 would be expected to reduce the migration of contaminated soil vapors into groundwater, and minimize the further migration of the onsite and offsite portions of the groundwater plumes. Like Alternative 2, Alternative 3 would be effective in the short term for reducing contaminant levels in offsite groundwater, by recovering and treating contaminated groundwater in both the onsite and offsite areas.

Based on the HHA performed for the site (see Section 1.5), present adverse risks to human health due to site-related contamination are either nonexistent or within acceptable limits in both the onsite and offsite areas. The remediation proposed under Alternative 3 would only improve on this situation.

As for Alternative 2, excavation of onsite area soils might be required for installing pipelines to service proposed new wells; therefore, some volatilization of organic contaminants in the onsite soils may occur. Alternative 3 would implement the same protective measures as Alternative 2 for the remediation workers and the community, and the same safety methods for well installation and development to prevent any potential, short-term risks.

4.1.3.4 Long-Term Effectiveness

Alternative 3 would be a permanent remedy, since a significant reduction in the mobility and volume soil and groundwater contamination would be provided. After remediation, the quantity of untreated hazardous waste left at the site would be significantly reduced. Comprehensive, long-term monitoring of groundwater plume response, as well as operation and maintenance of the wells and treatment systems would be required for Alternative 3.

Alternative 3 would be expected to be reliable in meeting drinking water standards specified by NYSDEC as the performance goal for groundwater remediation for the Blauvelt Site. Since this alternative would be expected to significantly reduce volatile organic soil contamination in the onsite area, no additional future remedial actions are anticipated.

4.1.3.5 Reduction in Toxicity, Mobility and Volume

Alternative 3 would reduce the mobility and volume of soils and groundwater contaminants similarly to Alternative 2. In addition, Alternative 3 might reduce the toxicity of some soil contaminants in the onsite area through the in-situ biodegradation component of this alternative. Like Alternative 2, Alternative 3 would reduce the toxicity of some of the dissolved-phase organic contaminants in the groundwater, by treatment in the UV/Peroxidation unit of the onsite groundwater treatment system; however, the other units in this treatment system would remove groundwater contaminants only. As with Alternative 2, Alternative 3 would reduce the potential for further migration of the groundwater contamination plumes.

4.1.3.6 Implementability

As for Alternative 2, Alternative 3 is technically feasible at the Blauvelt Site, since the necessary technologies, process options, equipment and manpower are commercially available. This includes the process, equipment and manpower necessary to implement the 2-Phase Extraction Enhanced Bioremediation component of Alternative 3. Standard earthmoving equipment would be used for construction of any access ways necessary to allow well installation in the offsite area. The required SPDES permit amendment, and remediation system construction and operating permits would be obtainable for the site cleanup. Sufficient area would should be available in both the onsite and offsite areas to implement Alternative 3 components, and approval for access to the onsite and offsite areas to be involved in the remediation is assumed for the purpose of this FS.

4.1.3.7 Detailed Cost

The total present worth cost associated with Alternative 3 is $3,541,700.The cost estimate for Alternative 3 is presented in Appendix H as Tables H-6 and H-7, and assumes a 30-year clean-up period at a 5 percent discount rate. The estimated time of operation is less than 30 years.

4.1.4 Alternative 4- SOURCE CONTROL AND ACTIVE REMEDIATION VIA CONVENTIONAL RECOVERY WELLS

A detailed description of Alternative 4 components is provided in Subsection 3.4.

4.1.4.1 Compliance with SCGs

Location, chemical, and action-specific SCGs would be met with the implementation of Alternative 4. Alternative 4 would not comply with location-specific SCGs as much as Alternatives 2 and 3. For instance, Alternative 4 would not fully control the volatile organic soil contamination in the onsite area; the alternative would only provide partial control of this soil contamination by installing a bituminous concrete cap over the soils. However, Alternative 4 would contain the offsite portion of the groundwater contamination plume, via conventional containment wells.

Alternative 4 would not comply with the chemical-specific SCGs for soils (i.e., the proposed target cleanup levels for soils), since this alternative would only cap the soils and not provide any active soil remediation. However, similarly to Alternatives 2 and 3, Alternative 4 would comply with chemical-specific SCGs for groundwater (i.e., with the proposed target groundwater cleanup levels), by providing active remediation of groundwater. Alternative 4 would reduce onsite and offsite groundwater contaminants to the proposed target cleanup levels, via groundwater plume recovery (using conventional wells) and via groundwater treatment (using an onsite treatment system). This groundwater treatment system would be regulated under a modification to the SPDES permit for the current onsite system.

In addition, Alternative 4 complies with action-specific SCGS, due to its permitting of a proposed modified groundwater treatment system, and its inclusion of groundwater and ambient air monitoring programs.

4.1.4.2 Overall Protection of Human Health and the Environment

Alternative 4 would not be as protective of human health and the environment as either Alternatives 2 or 3, since Alternative 4 does not actively remove or treat the contaminated soil vapors in the onsite area. However, Alternative 4 does actively remove and treat the contamination in groundwater and, therefore, would be protective of human health and the environment in terms of potential exposures to groundwater. If Alternative 4 were implemented, anticipated human exposure to groundwater contaminants would be low and within acceptable limits following completion of the groundwater remediation. Also, while human exposure to soil contaminants potentially would be higher than with either Alternative 2 or 3, this exposure would still be expected to be within acceptable limits. During remediation, it is anticipated that deed restrictions may remain for groundwater use in the onsite and offsite areas of the Blauvelt Site.

As explained in Section 1.6 of this FS, present ecological risks that potentially could be associated with site-related contaminants, and potential ecological risks associated with Alternative 4, are either nonexistent or not significant.

4.1.4.3 Short-Term Effectiveness

Like Alternatives 2 and 3, Alternative 4 would be effective in the short term in recovering the NAPL floating on the water table and would be expected to be effective in containing the contaminated groundwater in the onsite portion of the larger groundwater plume. Since the existing treatment scheme for recovered groundwater is effective in treating groundwater, this treatment scheme would also be used for Alternative 4 although the treatment capacity would be increased.

Alternative 4 would be expected to reduce the migration of contaminated soil vapors into groundwater, and minimize the further migration of the onsite and offsite portions of the groundwater plumes. Like Alternatives 2 and 3, Alternative 4 would be effective in the short term for reducing contaminant levels in offsite groundwater to the proposed target cleanup levels, by recovering and treating contaminated groundwater in both the onsite and offsite areas. However, Alternative 4 would not be effective in remediation of onsite soils, since it does not include any soil removal, treatment or containment.

Based on the HHA performed for the site (see Section 1.5), present adverse risks to human health due to site-related contamination are either nonexistent or within acceptable limits in both the onsite and offsite areas. The remediation proposed under Alternative 4 would only improve on this situation.

Similar to Alternatives 2 and 3, excavation of onsite area soils might be required for installing pipelines to service proposed new wells; therefore, some volatilization of organic contaminants in the onsite soils may occur. Alternative 4 would implement the same protective measures as Alternatives 2 and 3 for the remediation workers and the community, and the same safety methods for well installation and development to prevent any potential, short-term risks.

4.1.4.4 Long-Term Effectiveness

Alternative 4 would not be a completely permanent remedy, since this alternative includes no active remediation of soils and, therefore, a significant reduction in the mobility and volume of soil contamination would not be provided. However, a significant reduction in the mobility and volume of groundwater contamination would be provided via recovery and treatment of onsite and offsite groundwater. After remediation, the quantity of groundwater contamination left at the site would be significantly reduced. Comprehensive, long-term monitoring of groundwater plume recovery, as well as operation and maintenance of the wells and treatment systems would be required for Alternative 4.

Alternative 4 would be expected to be reliable in meeting drinking water standards specified by NYSDEC as the performance goal for groundwater remediation for the Blauvelt Site, and the target soil cleanup levels proposed for the site. Therefore, no additional future remedial actions are anticipated.

4.1.4.5 Reduction of Toxicity, Mobility, or Volume

Unlike Alternatives 2 and 3, Alternative 4 would not reduce the mobility and volume of contaminants in onsite soils. However, Alternative 4 would reduce the mobility and volume of contaminants in onsite and offsite groundwater. Both the mobility and volume of groundwater contaminants would be reduced by the recovery of NAPL from the water table using conventional wells, and by the active recovery and onsite treatment of dissolved-phase contaminants in the groundwater. The above recovery and treatment of the groundwater plumes would reduce the overall toxicity of the groundwater itself.

The containment wells proposed for Alternative 4 would reduce the potential for the groundwater plumes to migrate further into areas of currently clean groundwater. Certain dissolved-phase organic contaminants would be destroyed in the UV/Peroxidation unit of the groundwater treatment system; however, no actual reduction in the toxicity of other groundwater or soil contaminants would occur via the process options included in Alternative 4. Sludge and filtered solids from the groundwater treatment plant, spent carbon from the vapor-phase carbon unit (for soil vapor treatment), and spent carbon from the liquid-phase carbon treatment unit (in the groundwater treatment system) will constitute the residual wastes that will require shipment to a permitted, offsite facility for treatment and disposal.

4.1.4.6 Implementability

Alternative 4 is technically feasible at the Blauvelt Site, since the necessary technologies, process options, equipment and manpower are commercially available. Standard earthmoving equipment would be used for the construction of any access ways necessary to allow well installation in the offsite area. The required SPDES permit amendment, and remediation system construction and operating permits would be obtainable for the site cleanup. Sufficient area would should be available in both the onsite and offsite areas to implement Alternative 4 components, and approval for access to the onsite and offsite areas to be involved in the remediation is assumed for the purpose of this FS.

4.1.4.7 Detailed Cost

The total present worth cost associated with Alternative 4 is $2,035,800. The cost estimate for Alternative 4 is presented Appendix H as Tables H-6 and H-7, and assumes a 30-year period at a 5 percent discount rate.

4.1.5 Alternative 5 SOURCE CONTROL AND GROUNDWATER PLUME CONTAINMENT WITH CONVENTIONAL RECOVERY WELLS

A detailed description of Alternative 5 components are provided in Subsection 3.5.

4.1.5.1 Compliance with SCGs

Alternative 5 would not comply with all location and chemical-specific SCGs. Alternative 5 would comply with the location-specific SCGs such as, controlling the onsite soils contamination (which is a source of groundwater contamination), by 2-Phase Extraction of soil vapors. However Alternative 5 would not comply with the need to minimize the further migration of the offsite portion of the groundwater contamination plume.

Alternative 5 does include active remediation of the onsite soils contamination by 2-Phase Extraction of contaminated soil vapors, and onsite carbon treatment of extracted soil vapors. Alternative 5 does not include any active groundwater remediation and, therefore would not comply with the chemical-specific SCGs to reduce onsite and offsite groundwater contaminants to the proposed target groundwater cleanup levels. Alternative 5 would comply with the requirement to treat recovered groundwater from the extraction process per the Xerox plant's SPDES permit limits. Alternative 5 would comply with all known action-specific SCGs associated with the NAPL and soil vapor recovery, as well as SCGs for groundwater treatment.

4.1.5.2 Overall Protection of Human Health and the Environment

Human exposure to the types and amounts of contaminants currently present in the onsite soil contamination area were determined to be within acceptable risk limits (see Section 1.5). In addition, residual soil contaminants remaining after the 2-Phase Extraction soil vapor recovery component of Alternative 5 are also anticipated to be within acceptable risk limits.

While current human health risks appear to be acceptable (see Section 1.5) and would not increase if Alternative 5 were implemented, residual environmental risks (primarily from groundwater contamination) would be significant if Alternative 5 is implemented, since it does not include any active groundwater remediation. The present use of offsite groundwater from residential drinking water wells has not been confirmed, however, some wells may exist and may be affected by the offsite groundwater contamination. In addition, the potential for future groundwater use, as a result of residential development may be affected by offsite groundwater contamination. Currently, municipal potable water supplies in New York's Rockland County, are supplied by the Spring Valley Company, which obtains drinking water from numerous groundwater withdrawal wellfields (located throughout Rockland County) and from two surface water intakes. During and after remediation, deed restrictions would be required for groundwater use in the onsite and offsite areas of the Blauvelt Site. No significant environmental impacts would be associated directly with the existing onsite groundwater treatment system, since the current SPDES permit requirements are satisfied and are anticipated to continue to be met.

As explained in Section 1.6 of this FS, present ecological risks that potentially could be associated with site-related contaminants, and potential ecological risks associated with Alternative 5, are either nonexistent or not significant in both the onsite and offsite areas.

4.1.5.3 Short-Term Effectiveness

In the short term Alternative 5 would be effective in recovering the NAPL floating on the water table and the contaminated soil vapors and would be expected to be effective in containing the contaminated groundwater in the onsite portion of the larger groundwater plume. The existing treatment scheme for recovered groundwater is effective in treating groundwater, as evidenced by the treatment system's SPDES compliance record (see Section 1.9). This treatment scheme would also be used for Alternative 5.

In the short term, Alternative 5 would be expected to reduce the migration of contaminated soil vapors into groundwater, as well as minimize the further migration of the onsite and offsite portions of the groundwater plumes. Alternative 5 does not include significant, active recovery and treatment of contaminated groundwater in either the onsite or offsite areas and, therefore, would not be effective in the short term for reducing contaminant levels in offsite groundwater to the proposed target cleanup levels.

Based on the Human Health Assessment (HHA) performed for the Blauvelt Site (see Section 1.5), present adverse risks to human health due to site-related contamination are either nonexistent or within acceptable limits in both the onsite and offsite areas. The remediation proposed under Alternative 5 would provide plume containments as would Alternatives 2 through 4.

Similar to Alternatives 2 through 4, excavation of onsite area soils might be required for installing pipelines to service proposed new wells; therefore, some volatilization of organic contaminants in the onsite soils may occur. Alternative 5 would implement the same protective measures as Alternatives 2 through 4 for the remediation workers and the community, and the same safety methods for well installation and development to prevent any potential, short-term risks.

The significant short-term environmental risk associated with implementation of Alternative 5, would be that contaminants in the onsite and offsite portions of the groundwater plumes would not be significantly reduced without active groundwater recovery and treatment.

4.1.5.4 Long-Term Effectiveness

Alternative 5 would not provide a permanent remedy for all of the site contamination, since a significant reduction in the volume of the groundwater contamination would not be achieved. With Alternative 5, there would be limited recovery and treatment of groundwater contamination, and a relatively large quantity of untreated groundwater would remain at the site. Extensive long-term monitoring of the plume migration, of the effectiveness of plume containment as well as long-term operation and maintenance of the containment well system would be required for Alternative 5.

Alternative 5 would not meet drinking water standards specified by NYSDEC as the performance goal for groundwater remediation for the Blauvelt Site. Therefore, some significant future remedial action may be anticipated if Alternative 5 were implemented. However, this alternative would be expected to significantly reduce volatile organic soil contamination in the onsite area.

4.1.5.5 Reduction of Toxicity, Mobility or Volume

As with Alternatives 2, 3 and 4, Alternative 5 would reduce the potential for further migration of the groundwater contamination plumes, by using wells for containment of these plumes to their present locations. Alternative 5 includes 2-Phase Extraction of NAPL; therefore, this alternative does reduce the mobility and volume of the NAPL contaminant. Alternative 5 also includes 2-Phase Extraction of contaminated soil vapors; therefore, this alternative does reduce the mobility and volume of the volatile organic contaminants in the onsite soils. However, since Alternative 5 does not provide a significant amount of active remediation of dissolved-phase contaminants in groundwater, this alternative does not reduce the toxicity, mobility, or volume of these contaminants.

4.1.5.6 Implementability

Alternative 5 is technically feasible at the Blauvelt Site, since the necessary technologies, process options, equipment and manpower are commercially available. Standard earthmoving equipment would be used for the construction of any access ways necessary to allow well installation in the offsite area. The required SPDES permit amendment and remediation system construction and operating permits would be obtainable for the site cleanup. Sufficient area would should be available in both the onsite and offsite areas to implement Alternative 5 components, and approval for access to the onsite and offsite areas to be involved in the remediation is assumed for the purpose of this FS.

4.1.5.7 Detailed Cost

The total present worth cost associated with Alternative 5 is $2,242,400. The cost estimate for Alternative 5 is presented in Appendix H as Tables H-8 and H-9, and assumes a 30-year period at a 5 percent discount rate.

4.1.6 Alternative 6- SOURCE CONTROL AND EXCAVATION AND DISPOSAL OF ONSITE HOT-SPOT SOIL CONTAMINATION AREAS

A detailed description of Alternative 6 components are provided in Subsection 3.5.

4.1.6.1 Compliance with SCGs

Alternative 6 would not comply with all location- and chemical-specific SCGS. Alternative 6 would not comply with the location-specific SCGs such as, controlling the onsite soils contamination (which is a source of groundwater contamination), since it requires the remediation (via excavation and offsite disposal) of only part of the onsite soil contamination (i.e., the "hot spots"). However Alternative 6 would comply with the need to minimize the further migration of the offsite portion of the groundwater contamination plume.

Alternative 6 does include active remediation of some of the onsite soils contamination by excavation and offsite disposal of the soil areas with "hot spot" levels of contaminants, around the former location of the USTS. However, approximately one-half of the contaminated soils and the NAPL plume may be left on site under this Alternative. In addition, Alternative 6 does not include any active groundwater remediation and, therefore, this alternative would not comply with the chemical-specific SCGs to reduce onsite and offsite groundwater contaminants to the proposed target groundwater cleanup levels. Alternative 6 would comply with the requirement to treat recovered groundwater per the Xerox plant's SPDES permit limits. Alternative 6 would comply with all known action specific SCGs associated with the groundwater recovery.

4.1.6.2 Overall Protection of Human Health and the Environment

Human exposure to the types and amounts of contaminants currently present in the onsite soil contamination area were determined to be within acceptable risk limits (see Section 1.5 and Appendix D). In addition, residual soil contaminants remaining after the "hot spot" soil areas are excavated are also anticipated to be within acceptable risk limits.

While current human health risks appear to be acceptable (see Section 1.5) and would not increase if Alternative 6 were implemented, residual environmental risks (primarily from remaining soils and groundwater contamination) would be significant if Alternative 6 is implemented, since it does not include any active groundwater remediation and only partial soils remediation. The present use of offsite groundwater from residential drinking water wells has not been confirmed. However, some wells may exist and may be affected by the offsite groundwater contamination. In addition, the potential for future groundwater use, as a result of residential development, may be affected by offsite groundwater contamination.

Currently, municipal potable water supplies in New York's Rockland County, are supplied by the Spring Valley Company, which obtains drinking water from numerous groundwater withdrawal wellfields (located throughout Rockland County) and from two surface water intakes. During and after remediation, deed restrictions would be required for groundwater use in the onsite and offsite areas of the Blauvelt Site. No significant environmental impacts would be associated directly with the existing onsite groundwater treatment system, since the current SPDES permit requirements are satisfied and are anticipated to continue to be met.

As explained in Section 1.6 of this FS, present ecological risks that potentially could be associated with site-related contaminants, and potential ecological risks associated with Alternative 6, are either nonexistent or not significant in both the onsite and offsite areas.

4.1.6.3 Short-Term Effectiveness

In the short term, Alternative 6 would be effective in containing the contaminated ground water in the onsite portion of the larger groundwater plume by operation of the 10 existing containment wells (Well Nos. RW-1 through RW-10). The existing treatment scheme for recovered groundwater is effective at treating groundwater, as evidenced by the treatment system's SPDES compliance record (see Section 1.9). This treatment scheme would also be used for Alternative 6.

In the short term, Alternative 6 would be expected to reduce the migration of soil contaminants from the "hot spot" areas into groundwater, as well as minimize the further migration of the onsite and offsite portions of the groundwater plumes. However, Alternative 6 does not include significant, active recovery and treatment of contaminated ground water in either the onsite or offsite areas and, therefore, would not be effective in the short term for reducing contaminant levels in offsite groundwater to the proposed target cleanup levels.

Based on the Human Health Assessment (HHA) performed for the Blauvelt Site (see Section 1.5), present adverse risks to human health due to site-related contamination are either nonexistent or within acceptable limits in both the onsite and offsite areas. The remediation proposed under Alternative 6 would improve this situation but not as much as would Alternatives 2 through 4.

Alternative 6 would implement the same protective measures as Alternatives 2 through 4 for the remediation workers and the community, and the same safety methods for well installation and development to prevent any potential, short-term risks.

The significant short-term environmental risk associated with implementation of Alternative 6, would be that contaminants in the onsite and offsite portions of the groundwater plumes would not be significantly reduced via operation of containment wells and without active groundwater recovery and treatment.

4.1.6.4 Long-Term Effectiveness

Alternative 6 would not provide a permanent remedy for all of the site contamination, since a significant reduction in the volume of the groundwater contamination would not be achieved. The volume of contaminated soils would be reduced. With Alternative 6, there would be limited recovery and treatment of groundwater contamination, and a relatively large quantity of untreated groundwater would remain at the site. Extensive long term monitoring of the plume migration, of the effectiveness of plume containment, as well as long-term operation and maintenance of the containment well system would be required for Alternative 6.

Alternative 6 would not meet drinking water standards specified by NYSDEC as the performance goal for groundwater remediation for the Blauvelt Site. Therefore, some significant future remedial action may be anticipated if Alternative 6 were implemented. However, this alternative would be expected to reduce volatile organic soil contamination in the onsite area.

4.1.6.5 Reduction of Toxicity, Mobility, or Volume

As with Alternatives 2, 3, 4 and 5, Alternative 6 would reduce the potential for further migration of the groundwater contamination plumes, by using wells for containment of these plumes to their present locations. Alternative 6 does not include 2-Phase Extraction of NAPL; therefore, this alternative does not reduce the mobility and volume of the NAPL contaminant in groundwater. Alternative 6 also does not include 2-Phase Extraction of contaminated soil vapors; therefore, this alternative does not reduce the mobility and volume of the volatile organic contaminants in the onsite soils as much as other alternatives. However, since Alternative 6 does not provide a significant amount of active remediation of dissolved-phase contaminants in groundwater, this alternative does not reduce the toxicity, mobility, or volume of these contaminants.

4.1.6.6 Implementability

Alternative 6 is technically feasible at the Blauvelt Site, since the necessary technologies, process options, equipment and manpower are commercially available. Standard earthmoving equipment would be used for the construction of any access ways necessary to allow well installation in the offsite area. The required SPDES permit amendment, and remediation system construction and operating permits would be obtainable for the site cleanup. Sufficient area would should be available in both the onsite and offsite areas to implement Alternative 6 components, and approval for access to the onsite and offsite areas to be involved in the remediation is assumed for the purpose of this FS.

4.1.6.7 Detailed Cost

The total present worth cost associated with Alternative 6 is $2,163,100. The cost estimate for Alternative 6 is presented in Appendix H as Tables H-12 and H-13, and assumes a 30-year period at a 5 percent discount rate.

4.2 COMPARATIVE ANALYSIS OF ALTERNATIVES

The seven evaluation criteria used in the detailed analysis of remediation alternatives are:

- Compliance with Applicable New York State Standards, Criteria, and Guidance (SCGS)
- Overall Protection of Human Health and the Environment
- Short-Term Effectiveness
- Long-Term Effectiveness
- Reduction of Toxicity, Mobility, and Volume
- Implementability
- Cost

4.2.1 Compliance with New York SCGs

Each of the six alternatives was evaluated with respect to compliance with applicable or relevant and appropriate New York State Standards, Criteria and Guidance (SCGs). For contaminants without promulgated SCGs, negotiation with NYSDEC to develop such criteria is recommended. This review also included federal standards that are more stringent than the State standards. In accordance with HWM-90-4030 (NYSDEC, 1990), three categories of SCGs were reviewed: chemical, location, and action-specific, as previously presented in Section 1.4.

Alternative 1 is not anticipated to comply with the three categories of SCGS, since the "no action" alternative would not be satisfactory in containing or recovering a majority of the site contamination. Alternatives 2 and 3 are anticipated to comply with the three categories of SCGS. Alternative 4 is not anticipated to comply with the chemical-specific SCGs for soil remediation or location-specific SCGS. Chemical-specific SCGs are anticipated to be met for Alternatives 2 and 3. Alternative 4, which includes groundwater recovery and capping of contaminated soils, would not satisfy the New York Hazardous Waste Rules as discussed in Subsection 4.2.4.1. Alternative 5 would meet chemical-specific SCGs for soil remediation, but not for groundwater remediation, since this alternative does not actively remediate groundwater. Alternative 6 would not meet chemical-specific SCGs for soil remediation or for groundwater remediation, since this alternative includes active remediation for only the "hot spot" areas of soil contamination, and no active remediation for ground water. All the alternatives would be expected to comply with action-specific SCGs.

4.2.2 Overall Protection of Human Health and the Environment

The second criterion evaluated for the six alternatives was overall protection of human health and the environment. For each of the six alternatives, future use of onsite area and of the offsite area (within the defined areal extent of groundwater contamination) was assumed to be commercial or light industry, consistent with known plans for the Blauvelt Site and immediate offsite area. Since Alternatives 2 and 3 would actively remediate the soils and groundwater contamination, these alternatives would be fully protective. Alternative 4 would be protective due to active groundwater remediation, but not protective in terms of soil contamination, since this alternative does not include active soils remediation.

Three additional factors were analyzed:

1. Human health and the environment exposure after the remediation
2. Magnitude of residual public health risks after the remediation
3. Magnitude of residual environmental risks after the remediation

Exposure to contaminants by offsite receptors via an air pathway needs to be further defined by additional air monitoring. The initial site ambient air sampling detected an exceedance of the TCE, AGC. All remedial alternatives, with the exception of Alternative 1, include some form of vapor emission controls in their design. Operation of remedial alternatives 2 through 6 will lower the human health risks associated with the site.

Concerns about possible ambient air exceedances during remedial installation will be considered in the work plan. Engineering controls will be used to maintain the lowest possible air concentration and the protection of human health of site workers and off-site receptors. Groundwater and soil routes of exposure were deemed acceptable for the six alternatives.

Protection of human health and the environment was estimated to be least for Alternative 1 and the greatest for Alternatives 2 and 3. Alternative 4 was also estimated to be less protective (than the Alternatives 2 and 3) of human health and the environment, since soil contamination would remain after remediation.

4.2.3 Short-Term Effectiveness

The third criterion evaluated was short-term effectiveness. This criterion is used to assess the effects of each alternative during construction and implementation. Three analysis factors are evaluated:

1. Protection of the community during the remedial action

2. The environmental impacts that may result from implementation of the remedial action

3. The time necessary to implement the remedy and achieve remedial response objectives

A fourth analysis factor that applies to short-term effectiveness is protection of workers during remedial action. Appropriate considerations to this factor are included within the development and cost estimates of each of the five alternatives.

The definition of remedial action as used in this evaluation includes recovery and treatment of contaminated groundwater and soil vapors.

For each alternative, there would be short-term risks to the community that need to be addressed. Risks could be associated with potential airborne releases or spills of contaminants during well installation and development which could easily be controlled with the use of appropriate drilling methods and spill prevention measures. The short-term risk associated with the no action alternative (Alternative 1) is continued migration of the contaminated groundwater plume. This risk would potentially require restrictions on community use of groundwater as a source of drinking water.

Significant environmental impacts would also need to be addressed for each alternative. Risks associated with well development (under Alternatives 2 through 5) would require mitigative measures to minimize potential impacts. Plume movement would not be contained with the implementation of Alternative 1 and, therefore, efforts to minimize environmental impact would not be reliable.

The proposed length to complete the site remedy under each alternative was estimated to potentially require at least 30 years. However, the required control period for short-term risks, was assumed to be less than ten years for Alternatives 2 and 3. As Alternatives 1, 4 and 5 would not be significantly effective in reducing short-term risk, efforts to control short term risk would require greater than ten years.

4.2.4 Long-Term Effectiveness

The fourth evaluation criterion is long-term effectiveness. For this criterion, there are five analysis factors:

1. The type of Remedial Action (i.e. on- or offsite treatment)
2. Permanence of Remedial Action
3. Lifetime of Remedial Action
4. Quantity and nature of waste or residual left onsite

5. Adequacy and reliability of controls.

Alternatives 2 through 6 all provide effective onsite treatment of recovered groundwater, but only Alternatives 2, 3 and 5 provide effective onsite treatment of soil contamination. Residual wastes (such as sludge, filtered solids, or spent carbon) from onsite groundwater treatment, would require additional offsite treatment. Alternatives were analyzed for the onsite treatment category because residual waste treatment was considered to be a result of the primary treatment. Alternative 6 does not provide effective remediation of all of the onsite soil contamination.

Each alternative was reviewed to assess whether it included: a process that would irreversibly destroy or detoxify all or most hazardous wastes; a process option that would separate, treat or concentrate hazardous waste, and would permanently or significantly reduce the volume; or a solidification/chemical fixation process that may not reduce toxicity or volume, but would significantly and permanently reduce the mobility. Alternatives 2 and 3, were considered permanent remedies because the alternatives involve recovery and treatment processes that would significantly reduce the volume of groundwater and soils contamination in both the onsite and offsite areas of the site. Alternative 4 would provide a permanent remedy for groundwater contamination, but not a permanent remedy for soils contamination. Even though Alternatives 5 and 6 involve treatment processes that would permanently remove contamination from the groundwater, a significant reduction in contaminated groundwater volume would not be attained.

For the Alternatives 1, 4 and 5, that were not considered fully permanent remedies, the lifetime of the remedial action was estimated. Alternative 1 was considered to be have no long-term effectiveness. Alternative 4 was expected to have a duration of 25 to 30 years for groundwater remediation, but no lifetime for soil remediation.

Alternatives that were considered to be permanent remedies (Alternatives 2 and 3) were estimated to leave insignificant quantities of untreated hazardous waste onsite. Because Alternatives 1, 4 and 6 would leave all or some of the contaminated soils in place, significant quantities of onsite hazardous waste would remain onsite.

Each alternative would require monitoring for a period after the remediation. Environmental controls such as monitoring the water treatment effluent and leak inspections for process piping would be required during remediation. Extensive long-term monitoring would be required for Alternatives 1 through 6 to monitor the effectiveness of the groundwater plume containment.

4.2.5 Reduction of Toxicity, Mobility or Volume

The fifth evaluation criterion is reduction of toxicity, mobility or volume. For this criterion there are three analysis factors:

1. Volume of hazardous waste destroyed or treated
2. Reduction in mobility of hazardous waste
3. Irreversibility of the treatment

Alternatives 2 through 6 would not reduce the actual toxicity of contaminants (although removal of contaminants into a residual treatment waste would occur). Alternatives 2,3 and 4 would reduce the mobility and volume of contaminated onsite and offsite groundwater to similar degrees. Alternative 2 and 3, but not Alternative 4, would reduce the mobility and volume of contaminated onsite soils to a similar degree; Alternative 4 does not actively remediate soil contamination.

Alternatives 2, 3, 4, 5 and 6 would minimize the further migration of the onsite and offsite groundwater contamination plume.

As a result of each remedial alternative, untreated or concentrated hazardous waste would be produced (i.e. sludge, filtered solids, and spent carbon from the groundwater treatment system; and spent carbon for any vapor-phase carbon treatment units). Offsite destruction or treatment of the residuals would be necessary. Alternatives 1, 5 or 6 would not significantly reduce the mobility or volume of contaminated groundwater.

The irreversibility of waste treatment is contingent on the subsequent treatment or destruction of primary treatment by-products for each alternative, treatment was considered to be irreversible for most of the hazardous waste constituents.

4.2.6 Implementability

The sixth evaluation criterion is implementability. For this criterion, three factors were evaluated:

1. Technical Feasibility
2. Administrative Feasibility
3. Technology Availability

Constructability of each alternative was considered to be high with no uncertainties as to construction. Alternatives 2 and 3 were considered to be somewhat reliable in meeting all the specified performance goals. Alternatives 1, 5 and 6 were considered not reliable in meeting the performance goals.

Longer startup times would be anticipated for the alternatives requiring 2-Phase Extraction well installation and startup (Alternatives 2, 3, and 5), since a 2-Phase Extraction system requires more accessory equipment. Implementation of either Alternatives 1 or 4 is not likely to include technical delays, since Alternative 1 has no action and since Alternative 4 requires installation of conventional wells which have been used at many other sites for groundwater recovery. Implementation of Alternative 6 would be likely to include technical delays, due to the requirement under this alternative to obtain approval for disposal of excavated soils off site and significant engineering controls needed to reduce potential exposure during implementation.

No future remedial action is expected for the alternatives that are considered fully reliable in meeting performance goals (Alternatives 2, and 3), and which would contain and/or recover a majority of groundwater and soils contamination. For Alternatives 4, 5 and 6, some future remedial actions might be necessary even after implementing the alternative. Alternative 1 would destroy the least quantity of waste; therefore; significant future remedial actions would be necessary.

Alternatives 2, 3 and 4 would require the normal degree of coordination with other agencies. Extensive coordination may be required to implement Alternatives 1, 5 and 6, since they only contain (rather than recover and treat) groundwater contamination.

The remediation process options included in all the alternatives are commercially available. Additional equipment and specialists are expected to be available without undue delay in the event that technical problems arise.

4.2.7 Detailed Cost

The final evaluation criterion for the six remediation alternatives was detailed present worth cost. The costs for each alternative were calculated from the cost tables contained in Appendix H.

4.3 COST SENSITIVITY ANALYSES

A cost sensitivity analysis was performed for each of the six alternatives evaluated in the detailed analysis, Section 4.0. The purpose of the sensitivity analysis is to assess the effect that variations in specific assumptions associated with the design, implementation, operation, discount rate, and required time to achieve remediation objectives have on the present worth cost of the alternative. All cost data for evaluation of alternatives use a 30 year project life, 5% discount rate and 100% quantity estimate. Other costs presented in the tables are for informational purposes only and were not used for remedy selection.

4.3.1 Volume of Material to Treat

As the quantity of hazardous waste, in the form of ground water and soil vapors cannot be defined exactly, some uncertainty exists as to the volume of hazardous waste that would require remediation. Therefore, a cost sensitivity analysis for variable volume was performed based on three potential volume estimates: 1) the current estimated soil area and groundwater plume areas, 2) 50 percent of the current estimate, and 3) 200 percent of the current estimate.

Estimated Total Remediation Cost tables are provided in Appendix H for each alternative.

Values for estimated line items (i.e., "current quantities") are provided with corresponding unit costs. For each line item, a "100% of Quantity Cost" is provided that assumes that the entire "current quantity" listed for that line item would be needed for implementing the remediation alternative. In addition, a "50% of Quantity Cost" was provided (for each line item) that represents the cost if only 50% of the estimated soils and ground water volumes actually need to be remediated. The "50% of Quantity Cost" represents one half the expected cost for a line item. The cost of a line could be reduced by one half if the actual volume of soil and groundwater requiring remediation is determined to be one half the estimated volume. The "200% of Quantity Cost" represents twice the expected cost for a line item. The cost of a line item could double if the actual volume of soil and groundwater requiring remediation is determined to be double the estimated volume.

Overall, a 50 percent decrease in volume would result in a 30 to 40 percent decrease in the total remediation cost. A 200 percent increase in volume would result in a 170 to 180 percent increase in the total remediation cost.

Thus, each line item cost, with the exception of treatment equipment and the groundwater treatment system was adjusted linearly to reflect quantity variations. Costs for treatment equipment items (such as instrument and process controls, electrical equipment, sheds, and the vapor-phase carbon system) were not adjusted to reflect quantity variations because downsizing or upgrading was not considered to significantly affect costs. Groundwater treatment unit costs were not adjusted because the quantity of water to be treated would have no impact on flow rates, and, therefore, no impact on the equipment needed. A two-fold increase in the quantity would increase groundwater treatment costs by approximately one-third.

5.0 RECOMMENDED ALTERNATIVE

This FS provides a comprehensive review and evaluation of potential alternatives for remediation of both the onsite and offsite areas of the Blauvelt Site. The remediation alternatives consider a range of cleanup approaches, from no action to traditional source containment measures to active remediation measures. The alternatives also represent a range of cleanup approaches in terms of environmental effectiveness, human and environmental risk, remediation technologies and process options, and implementation costs. To ensure objectivity, the alternatives evaluations were performed using appropriate environmental and engineering feasibility analyses, as well as NYSDEC-specified criteria and methods.

As a result of this evaluation, Alternative 2 Source Control and Active Remediation with 2-Phase Extraction and Conventional Recovery Wells, is recommended for implementation at the Blauvelt Site. This alternative is intended to satisfy the remediation goals discussed in Section 1.7 of this FS. The following sections provide details of the elements comprising the Alternative 2 preferred remedy, details of the conceptual design for Alternative 2, and a preliminary implementation schedule.

5.1 PREFERRED REMEDY

Aspects of the recommended alternative may change, or be modified, based on the results of additional data anticipated for site and contaminant characteristics, or based on NYSDEC input. In summary, Alternative 2 consists of the following key components:

- Onsite Source Control: NAPL and soil vapor recovery (using onsite 2-Phase extraction wells); and groundwater containment (using existing onsite conventional recovery wells)

- Active Onsite Remediation: NAPL and soil vapor source control (mentioned above); vapor-phase carbon treatment (or an equivalent treatment method) for recovered soil vapors and NAPL vapors; Groundwater Plume Recovery from the overburden and shallow bedrock zones (using 2-Phase Vacuum Extraction wells) and from the deep bedrock zones (using conventional type pumping wells); recovered groundwater treatment in the existing onsite treatment system; offsite disposal of recovered NAPL (at an approved facility); permitted discharge of treated vapors to the atmosphere; and SPDES-permitted Discharge of treated water.

- Offsite Containment: groundwater plume containment from lines of 2-phase vacuum extraction process type pumping wells

- Active Offsite Remediation: groundwater plume recovery from the overburden and shallow bedrock zones (using 2-Phase Extraction wells), and from the deep bedrock zones (using conventional pumping wells); recovered groundwater treatment in the existing onsite treatment system (same system as for onsite remediation); and SPDES-permitted discharge of treated water (same as for onsite remediation).

Detailed descriptions were presented in Section 2.3 for the process options (i.e., specific technologies) required for the Alternative 2 components.

Alternative 2 is the most appropriate alternative for the remediation of the onsite and offsite areas, since it is the most protective of human health and the environment. The alternative embodies three major protective features, which are summarized below:

1) Unlike Alternatives 1, 4, and 5, Alternative 2 actively remediates both the contaminated groundwater and the contaminated soils at the site. Alternative 2 includes active recovery of NAPL and contaminant soil vapors, and active recovery and treatment of groundwater in both plumes, through all three water-bearing zones at the site. While Alternative 4 includes active recovery of NAPL and active recovery and treatment of groundwater in both plumes, Alternative 4 includes capping of the contaminated soils rather than active recovery of contaminant soil vapors.

   Alternative 1 (No Action) does not address contamination in the offsite area, provides no onsite control of contaminated groundwater and NAPL and no control or remediation of volatile organics in the soils. Alternative 4 (source control and active remediation with conventional recovery wells) only provides a cap for partial control of the soil volatile organics, but does provide active recovery of NAPL and contaminated ground water, as well as treatment of ground water. Alternative 5 does include NAPL and soil vapor recovery, but would recover onsite and offsite ground water only for the purposes of containing the plumes to their present location.

2) Alternative 2 would protect human health and the environment by containing the groundwater plumes to their present locations, plus actively recovering and treating the ground water. Although use of the groundwater aquifer for drinking water supplies has not been well documented by past surveys, there may be some future potential for use of the aquifer as a drinking water source. While available data indicate that site-related contaminants are not currently posing adverse impacts to the local ecology (see Section 1.6), containment and recover of the groundwater plumes under Alternative 2 would provide additional assurances that the site will not have adverse ecological impacts in the future.

In addition, the Fish and Wildlife Impact Analyses (see Section 1.6) concluded that available data for the onsite and offsite areas do not indicate that active groundwater recovery would result in drying up the local stream, although this stream flow does have a small groundwater recharge component. Alternative 2 also protects human health and the environment by containing and recovering the most concentrated source of the site contaminants (i.e., the NAPL), as well as recovering the vapor phase organic contaminants in the overburden zone soils. Both recovered groundwater and soil vapors would be carefully controlled during recovery and, subsequently, treated on site as proposed under Alternative 2. The air emission limits required by NYSDEC for operation of the existing 2-Phase Extraction system (see NYSDEC letter in Appendix E) would also be met during full-scale remediation.

3) Alternative 2 is much more cost-effective than any other potential alternative that might include excavation and disposal of onsite overburden soils (as in Alternative 6) or merely capping of soils. Also, based on currently available information on the volatile organics and mineral spirits contamination in the soils, Alternative 3 (which is the same as Alternative 2, except includes the additional 2-Phase Extraction enhanced onsite

bioremediation) is not likely to be as cost-effective as Alternative 2, since available data from the Remedial Investigation indicates that most of the soil contamination consists of the volatile organics, which are more efficiently (and thus more cost-effectively) removed by 2-Phase Extraction.

The purpose for the mineral spirits component of the Xerox solvent blend is to reduce the volatility of the solvent mixture and, thus, reduce the loss (and potential health and safety risks) of the other solvents. The extent to which the mineral spirits fraction of the soil contamination may hinder 2-Phase Extraction recovery of the volatiles is not known at this time. Additional physical and chemical information that may be obtained in the future for these onsite soils may justify re-evaluation of Alternative 3, with the 2-Phase Extraction enhanced bioremediation.

In selecting Alternative 2, several key concerns were considered:

- In contrast to the No Action (Alternative 1) and Alternative 5 containment alternatives, Alternative 2 would utilize methods to permanently remove more of the contaminants in the ground water.

- The anticipated design objectives for installation and operation of 2-Phase Extraction wells for NAPL and soil vapor recovery would allow the 2-Phase Extraction system to be flexible in responding to variable contaminant concentrations, moisture levels, water table elevations and permeabilities in the overburden soils. This flexibility would increase the effectiveness of the 2-Phase Extraction wells for contaminant recovery.

- Alternative 2 is protective of human health and the environment. For instance, the air emission limits required by NYSDEC for operation of the existing 2-Phase Extraction system (see Appendix E) would be met during full-2-Phase Extraction wells would be installed in the offsite area for recovery from the overburden and shallow bedrock zones. Some of these wells would be installed and screened over both the overburden and shallow bedrock zones, and some would be installed for recovery in only the shallow bedrock zone. About four conventional pumping wells would be installed for groundwater recovery in the onsite and offsite areas of the deep bedrock zone. The conceptual design for each of Alternative 2's components is provided below:

NAPL and Soil Vapor Recovery (using onsite 2-Phase Extraction)

About nine 2-Phase Extraction wells would be installed in the onsite area of the Blauvelt Site, as shown on Figure 14. These wells would be screened over both the overburden and shallow bedrock zones. In those 2-Phase Extraction wells to be installed within the defined areal extent of soil contamination (the two soil areas shown on Figure 1-5), the end of the 2-Phase Extraction recovery pipe (or "straw") would be initially set at the water table to extract NAPL floating on the water table. To minimize efforts required to separate recovered NAPL from a water phase, this NAPL recovery would be done prior to active groundwater recovery. Active recovery would occur later when the straws in the wells are lowered to the bottom of the overburden zone. Any vapors removed by the 2-Phase Extraction straws would be removed in the system's air/water separator, and then routed to vapor treatment (see below). Any water inadvertently removed by the straws would be removed via an oil/water separator, and then routed to the proposed onsite groundwater treatment system (see below).

After NAPL recovery, all the 2-Phase Extraction wells would be placed on line, with their extraction straws set to within a few feet from the top of bedrock, so that the system could recover groundwater from the overburden zone. This groundwater recovery would dewater the overburden zone, which would leave all the contaminated soils within an unsaturated zone.

Operation of all the 2-Phase Extraction wells would continue to achieve recovery of contaminated soil vapors. Organic contaminants already in the soil vapor phase would be recovered first. As these vapors are recovered, organics adsorbed to the surface of soil particles would transfer into the vapor phase and, thus, would also be available for recovery. Any NAPL recovered with the 2-Phase Extraction wells would be sampled and analyzed for its constituents, and then shipped offsite to a NY-approved hazardous waste (or recycling) facility for proper disposal (or recycling).

Treatment of Recovered Soil and NAPL Vapors

Soil vapors recovered from the overburden zone by the onsite 2-Phase Extraction wells, as well as vapors extracted simultaneously with NAPL recovery, would be routed from the system's air/water separator to a vapor treatment system to be located in the onsite area. This vapor treatment system may be a vapor-phase carbon (VPC) adsorption system, or an equivalent treatment system; the selection of the vapor treatment system for full-scale site remediation will be made during the design phase of the remediation. A VPC system would remove organic contaminants from the vapors, and then discharge treated vapors as described below. Treated vapors exiting the VPC system would be discharged to the atmosphere, under a Permit to Construct (PC) and a Certificate to Operate (CO) issued by NYSDEC (per New York State's Air Guide, 1991). The PC/CO would conform to New York State's Division of Air Resources guidelines and New York State Ambient Air Quality Standards (summarized in Section 1.4). Xerox's existing PC/CO for their current VPC system (see Section 1.9, Summary of IRM/Treatability Studies) could be amended for purposes of the full-site remediation. Air monitoring required by this permit, as well as the Air Monitoring Program (described below) would be conducted.

Onsite and Offsite Groundwater Containment

The ten existing, onsite conventional recovery wells (Well Nos. RW-1 through RW-10) would continue to be used for containing the overburden and shallow bedrock portions of the larger plume to its present location (i.e., containment wells). The system will be modified as necessary by changing pumps and discharge rates so that an effective migration control system is established. Additional recovery wells will be added, if necessary, to achieve effective migration control. These ten wells are located (see Figure 1-12) in roughly an east-west line along the northern end of the onsite area. All these wells are screened over both the overburden and shallow bedrock zones. All groundwater recovered by these wells would be routed to the proposed onsite groundwater treatment system (see below). About four 2-Phase Extraction wells would be installed in the offsite area, as shown on Figure 1-3, to contain the plume in the shallow bedrock zone to its present location. These wells would be screened over the shallow bedrock zone only.

These 4 wells are located in roughly a north-south containment line at the northern end of the plume, and would be screened only through the only zone (shallow bedrock) occupied by this furthest end of the offsite plume. All groundwater recovered by these wells would be routed to the proposed onsite groundwater treatment system (see below).

Onsite and Offsite Groundwater Plume Recovery

Once substantial soil vapor recovery has occurred from the onsite 2-Phase Extraction wells, the straws in these wells would be lowered sufficiently to provide active recovery of groundwater from the shallow bedrock plume. At this time, an existing onsite monitoring well (Well No. RI-10) would be placed on line as a conventional pumping well, to recover groundwater from the small onsite portion of the deep bedrock plume. Groundwater recovery would continue until the site's groundwater remediation goals were met.

2-Phase Extraction wells would be installed in the offsite area (see Figure 1-4) to provide active recovery of groundwater from the overburden and shallow bedrock zones. Additional shallow bedrock groundwater recovery would be provided by the four 2-Phase Extraction wells to be installed for offsite plume containment (see above). At this time, two existing offsite monitoring wells (Well Nos. MW-OS-5D and MW-OS-7D) would be placed on line as a conventional pumping wells, to recover groundwater from the offsite portion of the deep bedrock plume. Additional wells would be installed based on the observed influence of the initial groundwater pumping. Groundwater recovery would continue until the site's groundwater remediation goals were met.

Groundwater Treatment and Discharge

Treatment of ground water recovered from both 2-Phase Extraction and conventional wells would be accomplished by routing the water to an onsite treatment system and, subsequently, discharging the treated water to the nearby stream, under an SPDES permit. This onsite treatment system would consist of the existing onsite system, which may be modified to accommodate a larger influent design flow, and to allow ground water collected from the offsite area (which primarily contains volatile organics) to be segregated from other collected ground water and be treated via air stripping. It is anticipated that ground water collected from the onsite area (which contains volatile organics and organics less efficiently removed via air stripping) would still require the treatment via the existing onsite groundwater treatment scheme. Groundwater treatment would meet the performance goals discussed in Section 1.7. In this way, Alternative 2 provides the flexibility to modify the system for treating ground water, in response to variations in the chemical quality of ground water collected during remediation. Details of this concept design were described earlier in Section 2.3.4.

Groundwater Monitoring Program

Groundwater monitoring would consist of the installation of ten new offsite and five new onsite monitoring wells. During the first year of remediation, the monitoring wells would be sampled quarterly to determine the effectiveness of plume containment and recovery; beginning in the second year of remediation, the monitoring wells would be sampled annually for these same purposes.

Air Monitoring Program

The site remediation program would be designed to maintain air emissions (if any) to below selected action levels for potential contaminants. Air monitoring would be conducted during those remediation activities in which the potential exists for air emissions (i.e., during excavation and well installation, during startup of 2-Phase Extraction wells for NAPL and soil vapor recovery, and during startup of the groundwater treatment system). Air monitoring would consist of periodic measurements at locations along the site boundaries, using air monitoring instruments such as an OVA for volatile organics and a dust monitor for lead. This monitoring would be in addition to monitoring for compliance with health and safety requirements.

An action level of one-half the health based TLV would be established for contaminants of concern. If this level is exceeded, appropriate engineering controls would be applied to control the transfer of volatile compounds to the ambient air. If an air action level were exceeded, then daily air samples would be shipped to an offsite laboratory for volatile organics and/or lead, depending on what action levels were exceeded. All air samples would be collected using appropriate EPA-approved procedures.

The engineered solution offered by Alternative 2 provides the following benefits to the remediation design and implementation:

- Includes soil vapor recovery system controls, such as air-tight seals on all vapor recovery piping, vacuum pumps, and 2-Phase Extraction wells, and vacuum pressure controls.

- Includes NAPL recovery system controls, such as leak-resistant piping and adjustable pump intake level settings.

- Includes the ability to modify the groundwater containment and recovery well system, and to modify the soil vapor recovery system, as necessary, to improve the progress of remediation. Potential modifications would include adding new wells if the original set was not sufficient, and taking wells off line as the cleanup progresses. Full-scale remediation of the site would be implemented as a staged operation, so that remediation systems could be modified in the field (if necessary) to optimize remediation system performance.

- Includes liquid level, flow rate, chemical feed rate, and emergency shutoff controls for the proposed full-scale groundwater treatment system, similar to those controls used for the current onsite treatment system.

- A post-remediation monitoring plan will be developed during the remedial design process. Two consecutive groundwater monitoring well sampling and analysis events will be used to demonstrate that groundwater has been remediated to meet current NYSDEC-mandated target cleanup levels for the groundwater. Both existing monitoring wells and selected new monitoring wells would be part of the program.

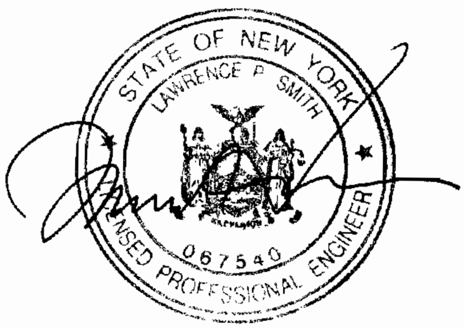
5.2 IMPLEMENTATION SCHEDULE

Implementation of Alternative 2 would be coordinated with NYSDEC, as well as appropriate local environmental and governmental agencies and the various offsite area property owners where appropriate. The objectives of such efforts would be to avoid disruptions in business activities in both the onsite and offsite areas.

Implementation of the remedy will occur in an expedited fashion and follow a number of parallel paths developed as sub projects. Current planning is focused on attacking the contaminant plume from each end (source area at the south, leading edge at the north) with initial efforts to contain followed by additional installations to remediate. Source areas will be addressed simultaneously and independently of the extended plume. The final remedy is intended to be 50% operational by the end of calendar year 1993. Full operation of the on and off-site portions of the remedy are expected by mid year 1994. A proposed schedule for implementation will be prepared at the initiation of the design process.

CERTIFICATION

This Feasibility Study was finalized by H&A of New York based on incorporation of H&A of New York responses to DEC comments on the Draft Feasibility Study prepared by Woodward Clyde Consultants, and based on additional data gathered at the site by H&A since completion of the Draft FS. H&A of New York hereby states to the best of its knowledge this Final Feasibility Study has been performed in accordance with the DEC approved work plan and subsequent DEC comments on the Draft FS.



Lawrence P. Smith, P.E.
Partner

TABLE 1-1

ASSUMED AQUIFER CHARACTERISTICS FOR REMEDIATION ALTERNATIVES DEVELOPMENT

Aquifer transmissivity (T)	-	between 1,000 and 8,900 gpd/ft in bedrock
	-	between 600 and 2,900 gpd/ft in overburden
Apparent specific yield	-	0.0089 (for T = 1,000 gpd/ft to 0.001 (for T = 8,900 gpd/ft) for bedrock
	-	0.04 (for T = 600 gpd/ft to 0.056 (for T = 2,900 gpd/ft) for overburden
Average pumping rate	-	2 to 5 gpm
Radius of Influence of a Single Well	-	approximately 280 feet in bedrock
	-	approximately 125 feet in overburden

TABLE 1-2

SUMMARY OF ON-SITE SOIL QUALITY
RANGE OF ANALYTICAL CONCENTRATIONS
XEROX, BLAUVELT, NEW YORK

				Well Designation		
Parameter (ug/kg)	**Minimum**	**Location**	**Date**	**Maximum**	**Location**	**Date**
Methylene chloride	ND	--	--	276,000*	RI-5/VES-1	10/90
Vinyl chloride	ND	--	--	515	RIB-4	10/90
Chloroethane	ND	--	--	271	RIB-4	10/90
1,1-Dichloroethene	ND	--	--	12.3	RI-6	10/90
1,1-Dichloroethane	ND	--	--	269	RIB-4	10/90
1,2-Dichloroethane	ND	--	--	16.2	RIB-4	10/90
1,2-Dichloroethene (cis+trans)	ND	--	--	19,200	RIB-3	10/90
1,1,1-Trichloroethane	ND	--	--	1,520,000	RI-5/VES-1	10/90
Trichloroethene	ND	--	--	156,000	RI-5/VES-1	10/90
Tetrachloroethene	ND	--	--	9,590,000	RIB-3	10/90
Toluene	ND	--	--	104	RIB-4	10/90
Ethylbenzene	ND	--	--	28.4	RIB-4	10/90
Total Xylenes (o,m,p)	ND	--	--	91,800	RI-10	10/90
Total Volatiles	ND	--	--	10,902,000	RI-5/VES-1	10/90
Mineral Spirits	ND	--	--	71,700,000	RI-5/VES-1	10/90
Lead (ppm)	ND	--	--	4,520	RIB-2	10/90

ND = None Detected
*Analyte found in lab or method blank.

TABLE 1-2 (Continued)

SUMMARY OF OFF-SITE SOIL QUALITY
RANGE OF ANALYTICAL CONCENTRATIONS
XEROX, BLAUVELT, NEW YORK

Well Designation

Parameter (ug/kg)	Minimum	Location	Date	Maximum	Location	Date
Methylene chloride	ND	--	--	12.4*	MW-OS-6R	9/91
Vinyl chloride	ND	--	--	ND	--	--
Chloroethane	ND	--	--	ND	--	--
1,1-Dichloroethene	ND	--	--	ND	--	--
1,1-Dichloroethane	ND	--	--	ND	--	--
1,2-Dichloroethane	ND	--	--	ND	--	--
1,2-Dichloroethene (cis+trans)	ND	--	--	cis 10.7	MW-OS-2R	10/91
1,1,1-Trichloroethane	ND	--	--	ND	--	--
Trichloroethene	ND	--	--	6.66	MW-OS-2R	10/91
Tetrachloroethene	ND	--	--	28.3	MW-OS-2R	10/91
Toluene	ND	--	--	ND	--	--
Ethylbenzene	ND	--	--	ND	--	--
Total Xylenes (o,m,p)	ND	--	--	ND	--	--
Total Volatiles	ND	--	--	44.3	MW-OS-2R	10/91
Mineral Spirits	ND	--	--	ND	--	--
Lead (ppm)	NA	--	--	NA	--	--

ND = None Detected
NA = Not Analyzed
*Total volatile concentration at MW-OS-6R.

TABLE 1-3

SUMMARY OF ON-SITE GROUNDWATER QUALITY
RANGE OF ANALYTICAL CONCENTRATIONS
OVERBURDEN MONITORING WELLS
XEROX, BLAUVELT, NEW YORK

	Well Designation					
Parameter (ppb)	Minimum	Location	Date	Maximum	Location	Date
Methylene chloride	ND	--	--	6,690	W-1	12/90
Vinyl chloride	ND	--	--	3.62	W-8	12/90
Chloroethane	ND	--	--	ND	--	--
1,1-Dichloroethene	ND	--	--	2,000	MW-16	1/92
1,1-Dichloroethane	ND	--	--	5,400	MW-13*	12/90
1,2-Dichloroethane	ND	--	--	4,380	W-1	5/91
1,2-Dichloroethene (cis+trans)	ND	--	--	311,000	MW-13*	12/90
Chloroform	ND	--	--	33,300	MW-13*	12/90
Bromoform	ND	--	--	ND	--	--
Dibromochloromethane	ND	--	--	ND	--	--
Bromodichloromethane	ND	--	--	7.12	W-8	5/91
1,1,1-Trichloroethane	ND	--	--	57,000	MW-17	1/92
1,1,2-Trichloroethane	ND	--	--	ND	--	--
Trichloroethene	ND	--	--	39,100	MW-17	11/91
Tetrachloroethene	1.4	U-6	9/91	72,400	MW-17	11/91
Toluene	ND	--	--	821	MW-16	2/91
Total Volatiles (ppb)	1.44	W-3	9/91	429,230	MW-13*	2/91
Lead (ppm)	ND	--	--	0.199	W-1	12/90
Mineral Spirits	ND	--	--	220,000	MW-17	1/92

ND = None Detected
*NAPL Present

92C2193.T14/TDG/XB-D22

TABLE 1-3 (Continued)

SUMMARY OF ON-SITE GROUNDWATER QUALITY
RANGE OF ANALYTICAL CONCENTRATIONS
DEEP BEDROCK MONITORING WELLS
XEROX, BLAUVELT, NEW YORK

Well Designation

Parameter (ppb)	Minimum	Location	Date	Maximum	Location	Date
Methylene chloride	ND	--	--	ND	--	--
Vinyl chloride	ND	--	--	ND	--	--
Chloroethane	ND	--	--	ND	--	--
1,1-Dichloroethene	ND	--	--	ND	--	--
1,1-Dichloroethane	ND	--	--	ND	--	--
1,2-Dichloroethane	ND	--	--	ND	--	--
1,2-Dichloroethene (cis+trans)	ND	--	--	2.1	RI-10	1/92
Chloroform	ND	--	--	2.84	RI-10	12/90
Bromoform	ND	--	--	ND	--	--
Dibromochloromethane	ND	--	--	ND	--	--
Bromodichloromethane	ND	--	--	ND	--	--
1,1,1-Trichloroethane	ND	--	--	4.5	RI-10	1/92
1,1,2-Trichloroethane	ND	--	--	ND	--	--
Trichloroethene	ND	--	--	ND	--	--
Tetrachloroethene	7.41	RI-10	11/91	20	RI-10	12/90
Toluene	ND	--	--	ND	--	--
Total Volatiles (ppb)	7.41	RI-10	11/91	31.6	RI-10	1/92
Lead (ppm)	ND	--	--	ND	--	--
Mineral Spirits	ND	--	--	ND	--	--

ND = None Detected

TABLE 1-4

SUMMARY OF OFF-SITE GROUNDWATER QUALITY
RANGE OF ANALYTICAL CONCENTRATIONS
OVERBURDEN MONITORING WELLS
XEROX, BLAUVELT, NEW YORK

Well Designation

Parameter (ppb)	Minimum	Location	Date	Maximum	Location	Date
Methylene chloride	ND	--	--	ND	--	--
Vinyl chloride	ND	--	--	ND	--	--
Chloroethane	ND	--	--	ND	--	--
1,1-Dichloroethene	ND	--	--	98.4	MW-OS-2	1/92
1,1-Dichloroethane	ND	--	--	33	MW-OS-2	4/92
1,2-Dichloroethane	ND	--	--	ND	--	--
1,2-Dichloroethene (cis+trans)	ND	--	--	3,380	MW-OS-2	1/92
Chloroform	ND	--	--	8	MW-OS-4	1/92
Bromoform	ND	--	--	ND	--	--
Dibromochloromethane	ND	--	--	ND	--	--
Bromodichloromethane	ND	--	--	ND	--	--
1,1,1-Trichloroethane	ND	--	--	640	MW-OS-2	4/92
1,1,2-Trichloroethane	ND	--	--	ND	--	--
Trichloroethene	ND	--	--	1,500	MW-OS-2	1/92
Tetrachloroethene	ND	--	--	5,880	MW-OS-2	1/92
Toluene	ND	--	--	ND	--	--
Total Volatiles (ppb)	ND	--	--	11,648.4	MW-OS-2	1/92
Lead (ppm)	ND	--	--	0.152	MW-OS-2	1/92
Mineral Spirits	ND	--	--	ND	--	--

ND = None Detected

TABLE 1-4 (Continued)

SUMMARY OF OFF-SITE GROUNDWATER QUALITY
RANGE OF ANALYTICAL CONCENTRATIONS
SHALLOW BEDROCK MONITORING WELLS
XEROX, BLAUVELT, NEW YORK

Well Designation

Parameter (ppb)	Minimum	Location	Date	Maximum	Location	Date
Methylene chloride	ND	--	--	ND	--	--
Vinyl chloride	ND	--	--	ND	--	--
Chloroethane	ND	--	--	ND	--	--
1,1-Dichloroethene	ND	--	--	139	MW-OS-11R	1/92
1,1-Dichloroethane	ND	--	--	23.4	MW-OS-11R	1/92
1,2-Dichloroethane	ND	--	--	ND	--	--
1,2-Dichloroethene (cis+trans)	ND	--	--	547	MW-OS-11R	1/92
Chloroform	ND	--	--	9.11	MW-OS-9R	1/92
Bromoform	ND	--	--	ND	--	--
Dibromochloromethane	ND	--	--	ND	--	--
Bromodichloromethane	ND	--	--	ND	--	--
1,1,1-Trichloroethane	ND	--	--	560	MW-OS-11R	1/92
1,1,2-Trichloroethane	ND	--	--	ND	--	--
Trichloroethene	ND	--	--	912	MW-OS-11R	1/92
Tetrachloroethene	ND	--	--	1,220	MW-OS-11R	1/92
Toluene	ND	--	--	ND	--	--
Total Volatiles (ppb)	2.8	MW-OS-11R	1/92	3,401.4	MW-OS-11R	1/92
Lead (ppm)	ND	--	--	0.0406	MW-OS-12R	4/92
Mineral Spirits	ND	--	--	ND	--	--

ND = None Detected

TABLE 1-4 (Continued)

SUMMARY OF OFF-SITE GROUNDWATER QUALITY
RANGE OF ANALYTICAL CONCENTRATIONS
DEEP BEDROCK MONITORING WELLS
XEROX, BLAUVELT, NEW YORK

Well Designation

Parameter (ppb)	Minimum	Location	Date	Maximum	Location	Date
Methylene Chloride	ND	--	--	ND	--	--
Vinyl Chloride	ND	--	--	ND	--	--
Chloroethane	ND	--	--	ND	--	--
1,1-Dichloroethene	ND	--	--	19	MW-OD-11D	7/92
1,1-Dichhloroethane	ND	--	--	3.0	MW-OS-5D	7/92
1,2-Dichloroethane	ND	--	--	ND	--	--
1,2-Dichloroethene (cis+trans)	ND	--	--	185	MW-OS-5D	7/92
Chloroform	ND	--	--	6.58	MW-OS-5D	1/92
Bromoform	ND	--	--	ND	--	--
Dibromochloromethane	ND	--	--	ND	--	--
Bromodichloromethane	ND	--	--	ND	--	--
1,1,1-Trichloroethane	ND	--	--	90	MW-OS-5D	7/92
1,1,2-Trichloroethane	ND	--	--	ND	--	--
Trichloroethene	ND	--	--	100	MW-OS-11D	7/92
Tetrachloroethene	6.1	MW-OS-7D	4/92	170	MW-OS-11D	7/92
Toleune	ND	--	--	ND	--	--
Total Volatiles (ppb)	6.1	MW-OS-7D	4/92	528	MW-0S-5D	7/92
Lead (ppm)	ND	--	--	ND	--	--
Mineral Spirits	ND	--	--	ND	--	--

ND = None Detected

TABLE 1-5
THE CONCENTRATIONS ($\mu g/L$) OF VOCs IN SURFACE WATERSAMPLES FROM THE BLAUVELTSITE

	SAMPLING STATIONS									
COMPOUND	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**Detection Limit**
1,1-Dichloroethane	ND[1]	ND	ND	1.97	2.55	2.53	*	ND	ND	1
1,2-Dichloroethene (total)	8.24	ND	1.40	4.52	7.61	7.45	*	ND	ND	1
1,1,1-Trichloroethane	3.70	ND	2.13	7.65	16.6	17.3	*	ND	ND	1
Trichloroethene	4.99	ND	3.59	12.1	25.1	26.1	*	ND	ND	1
Tetrachloroethene	12.5	2.21	6.66	21.2	46.3	53.9	*	ND	ND	1
Total VOCs	29.43	2.21	13.78	47.44	98.16	107.28	*	ND	ND	

*No Data - Dry at time of sampling
[1]ND = Not Detectable

TABLE 1-6
THE CONCENTRATIONS ($\mu g/Kg$) OF VOCs IN STREAM SEDIMENT SAMPLES FROM THE BLAUVELTSITE

	SAMPLING STATIONS									
COMPOUND	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**Detection Limit**
1,1-Dichloroethane	ND[1]	ND	ND	ND	6.82	9.81	ND	ND	ND	5
1,2-Dichloroethene (total)	ND	8.58	ND	ND	27.0	ND	20.7	ND	ND	5
1,1,1-Trichloroethane	16.6	ND	ND	ND	ND	ND	ND	ND	ND	5
Trichloroethene	ND	10.7	7.10	ND	ND	ND	19.9	ND	ND	5
Tetrachloroethene	ND	25.1	ND	12.8	ND	ND	42.1	ND	ND	5
Methylene chloride	12.8	7.09	7.03	9.13	8.79	ND	5.43	9.74	ND	5
Total VOCs	29.4	51.47	14.13	21.93	42.61	9.81	88.13	9.74	ND	

*No Data - Dry at time of sampling
[1]ND = Not Detectable

TABLE 1-7

LISTING OF ARAR CITATIONS

CHEMICAL-SPECIFIC

- 6 NYCRR Part 703, NYSDEC Surface Water and Groundwater Quality Standards.
- NYSDEC Division of Water Technical and Operational Guidance Series (1.1.1) Ambient Water Quality Standards and Guidance Values.
- 6 NYCRR Part 257, Air Quality Standards
- New York State Air Guide 1, Guidelines for the Control of Toxic Ambient Air Contaminants.

ACTION-SPECIFIC

•	6 NYCRR Part 360	-	Solid Waste Management Facilities
	Part 361	-	Siting of Industrial Hazardous Waste Facilities
•	Article 27, Title 11 of the ECL	-	Industrial Siting Hazardous Waste Facilities
•	6 NYCRR Part 264	-	Waste Transporter Permits
•	Amendments to 6 NYCRR Part 370 and 373		
•	6 NYCRR Part 370	-	Hazardous Waste Management System: General
	Part 371	-	Identification and Listing of Hazardous Wastes
	Part 372	-	Hazardous Waste Manifest System and Related Standards for Generators, Transporters and Facilities
•	6 NYCRR Subpart 373-1	-	Hazardous Waste Treatment, Storage and Disposal Facility Permitting Requirements
	Subpart 373-2	-	Final Status Standards for Owners and Operators of Hazardous Waste TSD Facilities
•	6 NYCRR Part 374	-	Standards for the Management of Specific Hazardous Wastes and Specific Types of Hazardous Waste Management Facilities
	Part 375	-	Inactive Hazardous Waste Disposal Sites
•	6 NYCRR Part 750-757	-	Implementation of NPDES Program in NYS

TABLE 1-8

SUMMARY OF CHEMICAL-SPECIFIC CRITERIA WITHIN NEW YORK STATE SCGs

			Air[2] ($\mu g/m^3$)	
Contaminant	Surface Water[1] (μg/l)	Groundwater[1] (μg/l)	SGC[3]	AGC[4]
Vinyl chloride	2	2	1,300	0.02
Chloroform	7[6]	7[6]	980	23.0
1,2-Dichloroethane	0.8[6]	5[6]	950	0.039
Benzene	0.7[6]	0.7[6]	30	0.12
Chlorobenzene	5[7]	5[6]	11,000	20.0
1,2-Dichlorobenzene	NA	4.7[6]	30,000	200
1,3-Dichlorobenzene	20[6]	5	30,000	200
1,4-Dichlorobenzene	30[6]	4.7[6]	NA	NA
Carbon Tetrachloride	NA	5[6]	1,300	0.07
1,1,2-Trichloroethane	0.6[6]	5	13,000	0.06
1,1-Dichloroethane	NA	5[6]	190,000	500
1,2-Dichloroethene	5[6]*	5[6]	190,000	1,900
Ethylbenzene	5[6]*	5[6]	100,000	1,000
Methylene Chloride	5[6]*	5[6]	41,000	27
1,1,1-Trichloroethane	5[6]*	5[6]	450,000	1,000
Tetrachloroethane	NA	NA	81,000	0.075
Toluene	5[6]*	5[6]	89,000	2,000
Trichloroethene	3[6]*	5[6]	33,000	.045
Xylenes (M, P, and O)	5[6]*	5[6]	100,000	300
Lead	50[6]	25[6]	1.5[9]	NA

Notes:
(1) NYSDEC Division of Water Technical and Operational Guidance Series (1.1.1) Ambient Water Quality Standards and Guidance Values.
(2) New York State Air Guide-1, NYSDEC, 1991 Edition.
(3) SGC - Short-term guideline concentration.
(4) AGC - Annual guideline concentration.
(5) NA - No applicable criteria available.
(6) Criteria based on protection of human health (water source).
(7) Criteria based on protection of aquatic life.
(8) Federal Standard - Averaging period is 3 consecutive months.
* Guidance Value.

TABLE 1-9
PLANT SPECIES IDENTIFIED
AT XEROX - BLAUVELT SITE

PLANT SPECIES

Species Name	Common Name	Area A	Area B	Area C	Area D	Area E	Area F	Area G	Area H
Acer negundo	ash-leaf maple					X	X	X	
Acer platanoides	Norway maple (crimson king)								X
Acer rubrum	red maple	X	X	X	X		X	X	
Acer saccharinum	silver maple		X	X			X		
Agrimonia parviflora	small flower agrimony		X					X	
Ajuga reptans	ground mint	X							
Allaria petiolata	garlic mustard						X		
Alnus serrulata	smooth alder							X	
Ambrosia artemisiifolia	ragweed	X							
Ambrosia trifida	ragweed	X				X			
Apocynum sp.	dogbane	X							
Arisaema triphyllum	jack-in-the-pulpit			X					
Betula papyrifera	white birch								X
Betula populifolia	grey birch			X					
Carex sp.	sedge	X						X	
Carpinus caroliniana	muscle wood			X					
Carya ovata	shagbark hickory	X	X	X					
Catalpa catalpa	catalpa				X		X		
Celastrus orbiculata	bittersweet			X			X		
Chysopsis intybus	chickory	X							
Cornus amomum	silky dogwood				X	X		X	
Cornus florida	flowering dogwood			X					
Cornus stolinifera	red-osier dogwood	X	X					X	
Cuscuta gronovii	dodder					X	X	X	

TABLE 1-9 (continued)
PLANT SPECIES IDENTIFIED
AT XEROX - BLAUVELT SITE

PLANT SPECIES

Species Name	Common Name	Area A	Area B	Area C	Area D	Area E	Area F	Area G	Area H
Daucus carota	Queen Ann's lace	X							
Epilobium lactiflorum	willow herb						X	X	
Equisetum sp.	horsetail	X			X				
Eupatorium fistalosum	joe-pye-weed	X						X	
Eupatorium perfoliatum	boneset					X		X	
Euthamia graminifolia	grass-leaf-goldenrod				X			X	
Fraxinus americana	white ash			X			X		
Fraxinus pennsylvanica	green ash	X			X			X	
Gleditsia triacanthos	honey locust								
Impatiens capensis	jewelweed	X	X			X	X	X	
Juncus effusus	soft rush	X							
Juniperus spp.	juniper								X
Lindera benzoin	spice bush	X	X	X					
Liriodendron tulipifera	tulip poplar			X			X		
Lonicera japonica	Japanese honeysuckle	X	X				X		
Lythrum salicaria	purple loosestrife	X					X	X	
Medicago sativa	alfalfa	X							
Oenothera elata	evening primrose						X	X	
Oneoclea sensibilis	sensitive fern							X	
Parthenocissus quinquefolia	Virginia creeper			X		X			
Phragites australis	common reed	X					X	X	
Phytolacca americana	poke weed			X					
Picea omorika	black spruce								X
Picea pungens	blue spruce								X
Pieris japonica	andromeda								X

TABLE 1-9 (continued)
PLANT SPECIES IDENTIFIED
AT XEROX - BLAUVELT SITE

PLANT SPECIES

Species Name	Common Name	Area A	Area B	Area C	Area D	Area E	Area F	Area G	Area H
Pilea fontana	clear weed					X			
Pinus strobus	white pine								X
Pinus thunbergiana	black pine								X
Plantanus occidentalis	sycamore							X	
Polygonum pennsylavnicum	Pennsylavnia smartweed	X				X	X	X	
Polygonum sagittatum	tearthumb	X							
Populus deltoides	big toothed aspen							X	
Prunis serotina	black cherry		X	X					
Pyrus ioensis	crab apple			X					
Quercus alba	white oak			X					
Quercus palustris	pin oak		X						
Quercus rubra	red oak	X	X	X					
Rhododendron catawbiense	rhododendron								X
Rhododendron spp.	Azalea								X
Rhus typhina	stag-horn sumac				X	X	X	X	
Robinia pseudoacacia	black locust							X	
Rosa multiflora	wild rose	X	X				X	X	
Rubus sp.	raspberry						X		
Salix babylonica	weeping willow					X	X		X
Salix bebbiana	willow	X					X	X	
Salix nigra	black willow	X				X		X	
Sambucus canadensis	elderberry							X	
Sassafras albidium	sassafras				X				
Sicyos angulatas	bur-cucumber					X	X	X	
Solidago spp.	goldenrod					X			

TABLE 1-9 (continued)
PLANT SPECIES IDENTIFIED
AT XEROX - BLAUVELT SITE

PLANT SPECIES

Species Name	Common Name	Area A	Area B	Area C	Area D	Area E	Area F	Area G	Area H
Spirea latifolia	meadowsweet	X							
Taxus baccata	yew								X
Toxicodendron radicans	pioson ivy		X	X					
Trifolium repens	clover	X							
Tsuga canadensis	hemlock								X
Typha angustifolia	narrow leaf cattail							X	
Typha latifolia	common cattail						X	X	
Ulmus americana	Ameriacn elm		X						
Ulmus rubra	slippery elm	X	X	X					
Viburnum acerfolium	maple-leaf viburnum			X					
Viburnum prunifolia	black haw		X	X					
Vinca minor	periwinkle								X

TABLE 1-10
SUMMARY OF MACROINVERTEBRATES
COLLECTED AT THE XEROX BLAUVELT SITE
BLAUVELT, NEW YORK
JUNE 1991

	Tolerance Value	Station 5			Station 2			Station 8			Station 9		
		Reps			Reps			Reps			Reps		
		1	2	3	1	2	3	1	2	3	1	2	3
TURBELLARIA													
Planariidae													
Cura foremanii	(4)								1				
Phagocata gracilis	(4)	12	16	18									
NEMATODA		4	5	22									
NEMATOMORPHA					2	6	18	25	34	33			
ANNELIDA													
Oligochaeta													
Naididae	(8)*								1	1			
Tubificidae	(8)*	29	15	48		22	9	2	1	1	55	14	12
Lumbriculidae	(8)*	127	17	26	2	8	6	7	1	2			
Hirudinea													
Glossiphonidae													
Helobdella triserialis	(10)*											2	

TABLE 1-10
SUMMARY OF MACROINVERTEBRATES
COLLECTED AT THE XEROX BLAUVELT SITE
BLAUVELT, NEW YORK
JUNE 1991

	Tolerance Value	Station 5			Station 2			Station 8			Station 9		
		Reps			Reps			Reps			Reps		
		1	2	3	1	2	3	1	2	3	1	2	3
Erpobdellidae													
Erpobdella punctata							1						
Mooreobdella sp.											4	16	7
ISOPODA													
Asellidae													
Caecidotea communis	(8)	10	3	3	15	16	30	35	94	93	221	384	155
Lirceus sp.	(8)	1	1										
AMPHIPODA													
Gammaridae													
Gammarus sp.	(4)			1		6	2						
Talitridae													
Hyalella azteca	(8)										58	117	57
DECAPODA													
Cambridae													
Oronectes sp.			3	3			1						
HYDRACARINA		1											

TABLE 1-10
SUMMARY OF MACROINVERTEBRATES
COLLECTED AT THE XEROX BLAUVELT SITE
BLAUVELT, NEW YORK
JUNE 1991

	Tolerance Value	Station 5			Station 2			Station 8			Station 9		
		Reps			Reps			Reps			Reps		
		1	2	3	1	2	3	1	2	3	1	2	3
INSECTA													
Plecoptera													
Chloroperlidae	(1)												2
Ephemeroptera													
Baetidae													
Baetis sp.	(4)			1	4	26		46				113	
Siphlonuridae													
Ameletus sp.	(7)						19		43	78	37		49
Heptageniidae													
Stenonema sp.	(4)		2		2		4		2	1	3	5	7
Ephemarellidae													
Attenella sp.	(1)										3		1
ODONATA													
Gomphidae													
Gomphus sp.	(1)							1				2	

TABLE 1-10
SUMMARY OF MACROINVERTEBRATES
COLLECTED AT THE XEROX BLAUVELT SITE
BLAUVELT, NEW YORK
JUNE 1991

	Tolerance Value	Station 5			Station 2			Station 8			Station 9		
		Reps			Reps			Reps			Reps		
		1	2	3	1	2	3	1	2	3	1	2	3
HEMIPTERA													
Gerridae													
Gerris sp.						1	1						
TRICHOPTERA													
Glossosomatidae													
Glossosoma sp.	(0)				21	35	29	15	15	38	4	10	12
Hydroptilidae		1											
Stactobiella sp.	(4)							2		2		19	24
Limnephilidae													
Hesperophylax sp.	(4)			2									
Hydropsychidae				57									
Cheumatopsyche sp.	(4)	20		139	11	26	85	42		63	53	117	176
Hydropsyche sp.	(4)	8	123	28	4	9	36	16	14	17	8	23	47
Diplectrona modesta	(4)		13										
Psychomyiidae													
Lype diversa	(2)		11	15									

TABLE 1-10
SUMMARY OF MACROINVERTEBRATES
COLLECTED AT THE XEROX BLAUVELT SITE
BLAUVELT, NEW YORK
JUNE 1991

	Tolerance Value	Station 5			Station 2			Station 8			Station 9		
		Reps			Reps			Reps			Reps		
		1	2	3	1	2	3	1	2	3	1	2	3
Polycentropodidae													
Polycentropus sp.	(6)	10	3					4	16	12			
COLEOPTERA													
Haliplidae													
Peltodytes sp.											7	13	7
Haliplus sp.											2		
Dytiscidae													
Oreodytes sp.								1					
Bidessini										1			2
Agabus sp.		1	4	2						2			
Hydaticus sp.						1	1	4			9	15	5
Hydrophilidae													
Hydrobius sp.			1										
Psephenidae													
Ectopria sp.	(4)			2				1		1			

TABLE 1-10
SUMMARY OF MACROINVERTEBRATES
COLLECTED AT THE XEROX BLAUVELT SITE
BLAUVELT, NEW YORK
JUNE 1991

	Tolerance Value	Station 5			Station 2			Station 8			Station 9		
		Reps			Reps			Reps			Reps		
		1	2	3	1	2	3	1	2	3	1	2	3
Elimidae													
Oulimnius sp.	(4)	2	2		4	4	7	1					
Heterelmis sp.	(4)				4	4	3	6	2		6		
Dubiraphia sp.	(4)										1		18
Ordobrevia sp.	(4)											9	
DIPTERA													
Tipulidae			2	2									
Tipula sp.	(3)							1					23
Tipula abdominalis	(3)			1									
Antocha sp.	(3)	11	2	5	14	7	10	67	26	35	2	2	1
Unidentified Tabanidae	(6)		1										
Ceratopogonidae	(6)	1											
Simuliidae													
Simulium sp.	(6)	134	270	363	53	197	232	17	124	91	24	101	93
Chironomidae	(6)	795	1053	568	48	148	286	228	402	351	101	159	180

TABLE 1-10
SUMMARY OF MACROINVERTEBRATES
COLLECTED AT THE XEROX BLAUVELT SITE
BLAUVELT, NEW YORK
JUNE 1991

	Tolerance Value	Station 5			Station 2			Station 8			Station 9		
		Reps			Reps			Reps			Reps		
		1	2	3	1	2	3	1	2	3	1	2	3
GASTROPODA													
Lymnaeidae	(6)*										66	228	108
Physidae	(8)	76	130	163		2		6	5	2	168	463	216
PELECYPODA													
Sphaeriidae	(8)	82	629	1337							2	3	
TOTAL TAXA		19	22	22	13	17	19	21	16	19	21	21	22
INDIV./FT^2		1325	2306	2806	184	518	780	527	781	824	831	1815	1202

Note: Tolerance Values based on USEPA Rapid Bioassessment Protocol. Asterisk indicates estimated value.

TABLE 1-11
COMPARISON OF THE MAXIMUM CONCENTRATION OF VOCs IN SURFACE WATER VERSUS THE USEPA LOWEST OBSERVED EFFECT LEVEL FOR THE SAME OR CLOSELY RELATED SUBSTANCES AT THE BLAUVELT SITE

Site Compound	Blauvelt Site Maximum (ug/l)	EPA Regulated Compound	EPA LOEL (μg/l)	
			Acute	Chronic
1.1 Dichloroethane	2.55	1,2 Dichloroethane	118,000	20,000
1,2-Dichloroethene (total)	8.24	Dichloroethene	11,600	--
1,1,1-Trichloroethane	17.30	Trichlorinated ethanes	18,000	9,400
Trichloroethene	/26.10	Trichloroethene	45,000	21,900
Tetrachloroethene	53.90	Tetrachloroethanes	9,320	2,400
Total VOCs	107.28	Halo methanes (generic)	11,000	--

TABLE 1-12

PROPOSED TARGET CLEANUP LEVELS FOR GROUNDWATER CONTAMINANTS OF CONCERN

Parameter	Proposed Cleanup Level (ug/l)	Detected Concentration Range (ug/l)
Bromodichloromethane	5[2]	ND-7.12
Bromoform	50[1]	ND-14.9
Chloroethane	5[2]	ND-2.48
Chloroform	7[1]	ND-33,300
Dibromochloromethane	5[2]	ND-39.1
1,1-Dichloroethane	5[2]	ND-5,400
1,2-Dichloroethane	5[2]	ND-4,380
1,1-Dichloroethene	5[2]	ND-2,000
1,2-Dichloroethene, total	5[2]	ND-327,000
Methylene chloride	5[2]	ND-6,690
Tetrachloroethene	5[2]	ND-72,400
1,1,1-Trichloroethane	5[2]	ND-57,000
Trichloroethene	5[2]	ND-43,700
Toluene	5[2]	ND-821
Vinyl chloride	2[1]	ND-987

Notes:

(1) New York State Drinking Water Standards, 6 NYCRR, Part 703, September 1991; and 10 NYCRR, Part 5.

(2) The New York State Department of Environmental Conservation's (NYSDEC's) Guidance Cleanup Level, per the October 1991 Guidance for Site Cleanup.

(3) Table modified from 1992 Draft Feasibility Study by Woodward-Clyde Consultants.

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TABLE 1-13

PROPOSED TARGET CLEANUP LEVELS FOR SOILS CONTAMINANTS OF CONCERN

Parameter	Proposed Cleanup Level (mg/kg)	Detected Concentration Range (ug/l)
Chloroethane	0.358	ND-0.271
1,1-Dichloroethane	0.075	ND-0.269
1,2-Dichloroethane	0.035	ND-0.016
1,1-Dichloroethene	0.163	ND-0.012
1,2-Dichloroethene (cis and trans)	0.250	ND-19.20
Ethylbenzene	2.75	ND-0.028
Methylene chloride	0.022	ND-276
1,1,1-Trichloroethane	0.380	ND-1,520
Trichlorethene	0.315	ND-156
Toluene	0.750	ND-104
Vinyl chloride	0.057	ND-0.515
Xylenes, total	0.600	ND-91.8

Note:

(1) Table modified from 1992 Draft Feasibility Study by Woodward-Clyde Consultants.

DJV:gmc
70302-50\tables.wp

TABLE 1-14

COMBINED TOTAL MONTHLY FLOW INTO THE ONSITE GROUNDWATER TREATMENT SYSTEM

Month	Flow (gallons)
1-92	464,840
12-91	709,990
11-91	771,140
10-91	580,340
09-91	564,920
08-91	862,050
07-91	656,730
06-91	767,890
05-91	661,670
04-91	642,620
03-91	650,590
02-91	578,800
01-91	627,580
12-90	718,930
11-90	806,860
10-90	790,630
09-90	751,440
08-90	862,650
07-90	NA
06-90	1,079,980
05-90	649,020
04-90	424,000
03-90	517,570
02-90	167,220
01-90	58,803

TABLE 1-15

REPRESENTATIVE DATA FOR THE MASS OF CONTAMINANTS REMOVED BY THE REVISED GROUNDWATER TREATMENT SYSTEM

Date (week of)	Mass of Contaminants Removed (lbs)
09-30-90	10.2
10-07-90	6.5
10-14-90	8.5
10-21-90	1.0
10-28-90	8.7
11-05-90	10.8
11-12-90	10.5
11-19-90	15.5
11-26-90	14.7
12-03-90	13.3
12-10-90	15.2
12-17-90	9.5
12-24-90	13.0
12-31-90	8.6
01-07-91	10.2
01-14-91	12.4
01-21-91	10.9
01-28-91	10.7

TABLE 3-1

PROCESS OPTIONS INCLUDED IN REMEDIATION ALTERNATIVES XEROX CORPORATION

Process Options Within Components	ALTERNATIVES					
	1	2	3	4	5	6
Onsite Source Control						
Conventional Wells for NAPL Recovery				X	X	X
2-Phase Extraction Wells for NAPL Recovery		X	X			
Offsite NAPL Disposal		X	X	X	X	X
2-Phase Extraction Wells for Soil Vapor Recovery		X	X		X	
Soil Capping (Bituminous Concrete)				X		
Existing Conventional Groundwater Containment Well Line (Well Nos. RW-1 through RW-10)		X	X	X	X	X
Active Onsite Remediation						
2-Phase Extraction Wells for Soil Vapor Recovery		X	X		X	
Extracted Soil Vapor Treatment		X	X		X	
Extracted NAPL Vapor Treatment		X	X		X	
Conventional Wells for Groundwater Recovery		X	X	X		
2-Phase Extraction Wells for Groundwater Recovery		X	X			
Onsite Groundwater Treatment		X	X	X	X	X
System-Enhanced Bioremediation			X			
Excavate "Hot Spot" Contaminated Soils						X
Offsite Containment						
Conventional Wells		X	X	X	X	X
2-Phase Extraction Wells		X	X			
Active Offsite Remediation						
Conventional Wells		X	X	X		
2-Phase Extraction Wells		X	X			
Onsite Groundwater Treatment		X	X	X		

Note: Table modified from 1992 Draft Feasibility Study by Woodward-Clyde Consultants.

DJV:gmc
70302-50\tables.wp

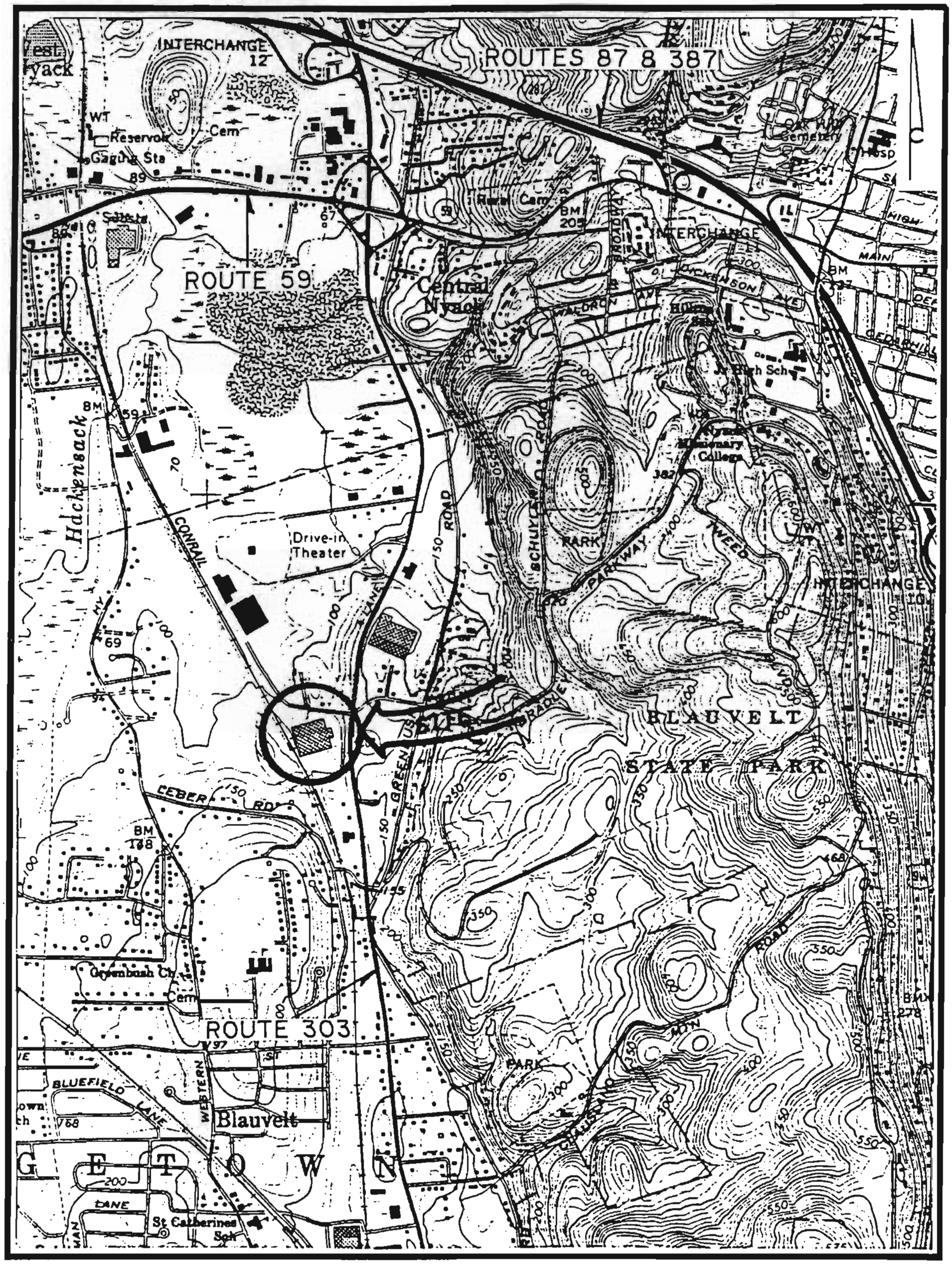
TABLE 4-1

PROCESS OPTIONS INCLUDED IN REMEDIATION ALTERNATIVES XEROX CORPORATION

Process Options Within Components	ALTERNATIVES 1	2	3	4	5	6
Onsite Source Control						
Conventional Wells for NAPL Recovery				X	X	X
2-Phase Extraction Wells for NAPL Recovery		X	X			
Offsite NAPL Disposal		X	X	X	X	X
2-Phase Extraction Wells for Soil Vapor Recovery		X	X		X	
Soil Capping (Bituminous Concrete)				X		
Existing Conventional Groundwater Containment Well Line (Well Nos. RW-1 through RW-10)		X	X	X	X	X
Active Onsite Remediation						
2-Phase Extraction Wells for Soil Vapor Recovery		X	X		X	
Extracted Soil Vapor Treatment		X	X		X	
Extracted NAPL Vapor Treatment		X	X		X	
Conventional Wells for Groundwater Recovery		X	X	X		
2-Phase Extraction Wells for Groundwater Recovery		X	X			
Onsite Groundwater Treatment		X	X	X	X	X
System-Enhanced Bioremediation			X			
Excavate "Hot Spot" Contaminated Soils						X
Offsite Containment						
Conventional Wells		X	X	X	X	X
2-Phase Extraction Wells		X	X			
Active Offsite Remediation						
Conventional Wells		X	X	X		
2-Phase Extraction Wells		X	X			
Onsite Groundwater Treatment		X	X	X		

Note: Table Modified from 1992 Draft Feasibility Study by Woodward-Clyde Consultants.

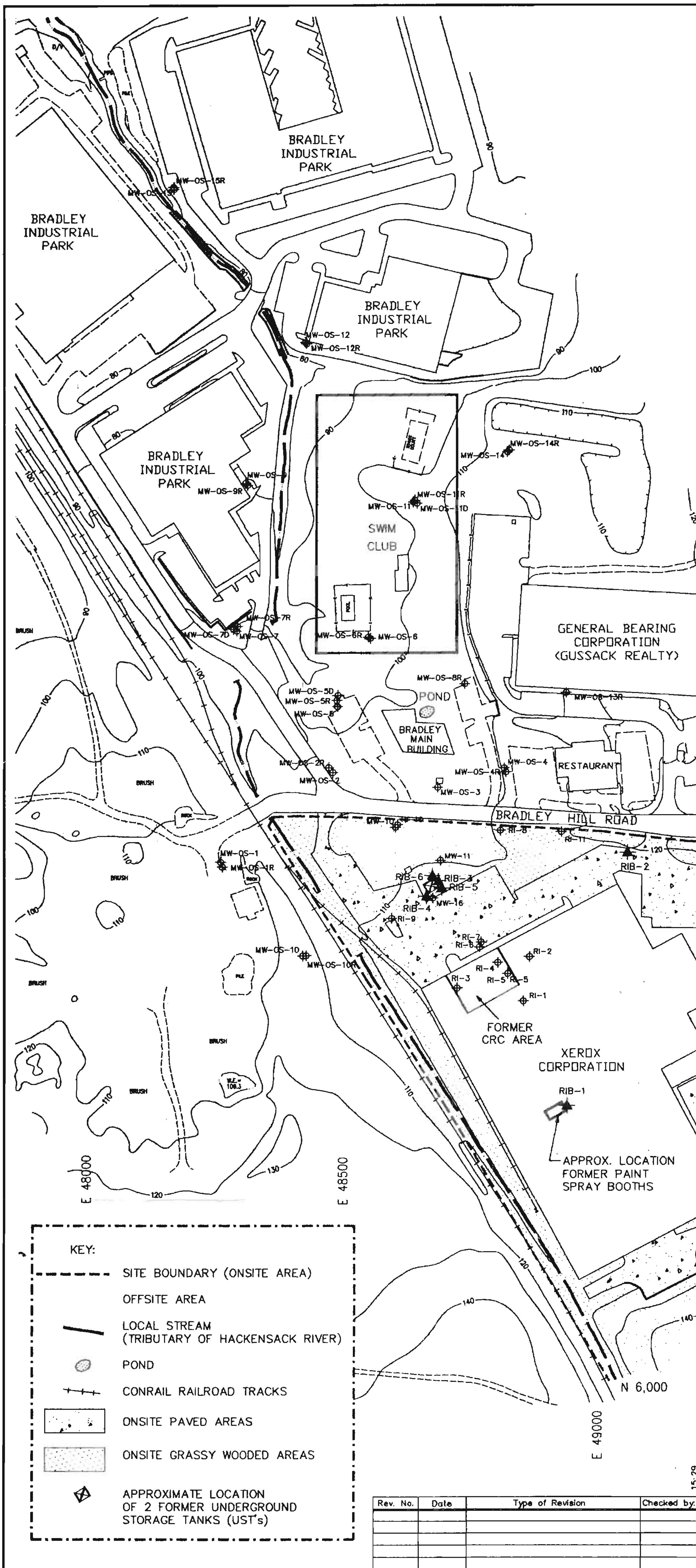
DJV:gmc
70302-40\tables.wp



1000 0 1000 2000 3000 4000 5000 6000 7000 FEET
1 0.5 0 1 KILOMETER

REGIONAL LOCATION PLAN

FIGURE 1-1



Rev. No.	Date	Type of Revision	Checked by:

15:29

SITE PLAN
XEROX CORPORATION
BLAUVELT, NEW YORK

Woodward-Clyde Consultants
Consulting Engineers, Geologists and Environmental Scientists

Job No.: 92C2193	Drawing No. 21930320	Date: 10/06/1992
Drawn by: DEG	Checked by: MEK	FIGURE 1-2
Scale: 0 — 200 Feet		

N

LEGEND:

- ● PROPOSED OVERBURDEN/SHALLOW BEDROCK CONTAINMENT WELLS (UTILIZING EXISTING MONITORING WELL RI-5)
- ▲ PROPOSED DEEP BEDROCK CONTAINMENT WELLS (UTILIZING EXISTING MONITORING WELLS MW-OS-5D, MW-OS-11D, AND RI-10)
- ⌖ EXISTING ONSITE RECOVERY WELLS
- ESTIMATED PERIMETER OF ONSITE AND OFFSITE AREAS OF OVERBURDEN AND SHALLOW BEDROCK GROUNDWATER IMPACT
- ESTIMATED PERIMETER OF ONSITE AND OFFSITE AREAS OF DEEP BEDROCK GROUNDWATER IMPACT
- XEROX PROPERTY BOUNDARY

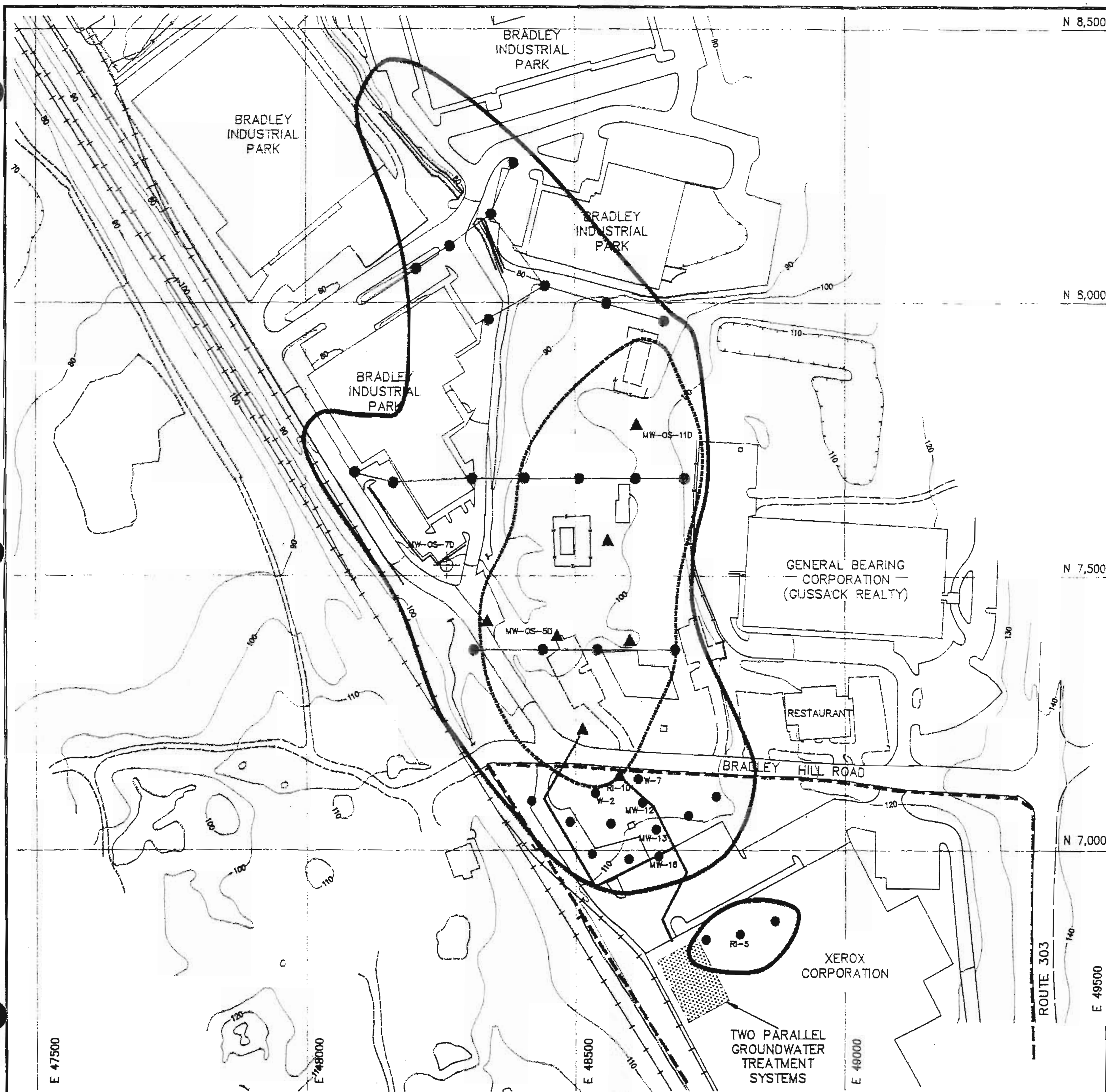
ESTIMATED LAYOUT FOR
GROUNDWATER CONTAINMENT WELLS
IN ONSITE AND OFFSITE AREAS
XEROX CORPORATION
BLAUVELT, NEW YORK

Woodward-Clyde Consultants
Consulting Engineers, Geologists and Environmental Scientists

Rev. No.	Date	Type of Revision	Checked by:

Job No.: 92C2193	Drawing No. 21932062	Date: 10/08/92
Drawn by: TP	Checked by: MK	FIGURE 1-3
Scale: 0 — 200 Feet		

11:36



NOTES:

1. FIGURE MODIFIED FROM 1992 DRAFT FEASIBILITY STUDY BY WOODWARD-CLYDE CONSULTANTS.
2. THE WELL CONFIGURATION SHOWN REPRESENTS A PRELIMINARY CONCEPTUAL DESIGN. THE IMPLEMENTATION OF THE FINAL REMEDY WILL USE A PHASED APPROACH, USING DATA FROM INITIAL INSTALLATIONS TO GUIDE SUBSEQUENT WELL PLACEMENT.

LEGEND:

- PROPOSED OVERBURDEN/SHALLOW BEDROCK GROUNDWATER RECOVERY WELLS FOR OFFSITE AREA
- PROPOSED SHALLOW BEDROCK RECOVERY WELLS
- PROPOSED DEEP BEDROCK RECOVERY WELLS (UTILIZING EXISTING MONITORING WELLS MW-OS-5D, MW-OS-11D, AND RI-10)
- PROPOSED LOCATIONS FOR GROUNDWATER RECOVERY WELLS FOR ALL ZONES IN ONSITE AREA (EXISTING WELLS USED WHERE POSSIBLE)
- ESTIMATED PERIMETER OF ONSITE AND OFFSITE AREAS OF SHALLOW BEDROCK GROUNDWATER IMPACT
- ESTIMATED PERIMETER OF ONSITE AND OFFSITE AREAS OF DEEP BEDROCK GROUNDWATER IMPACT
- XEROX PROPERTY BOUNDARY

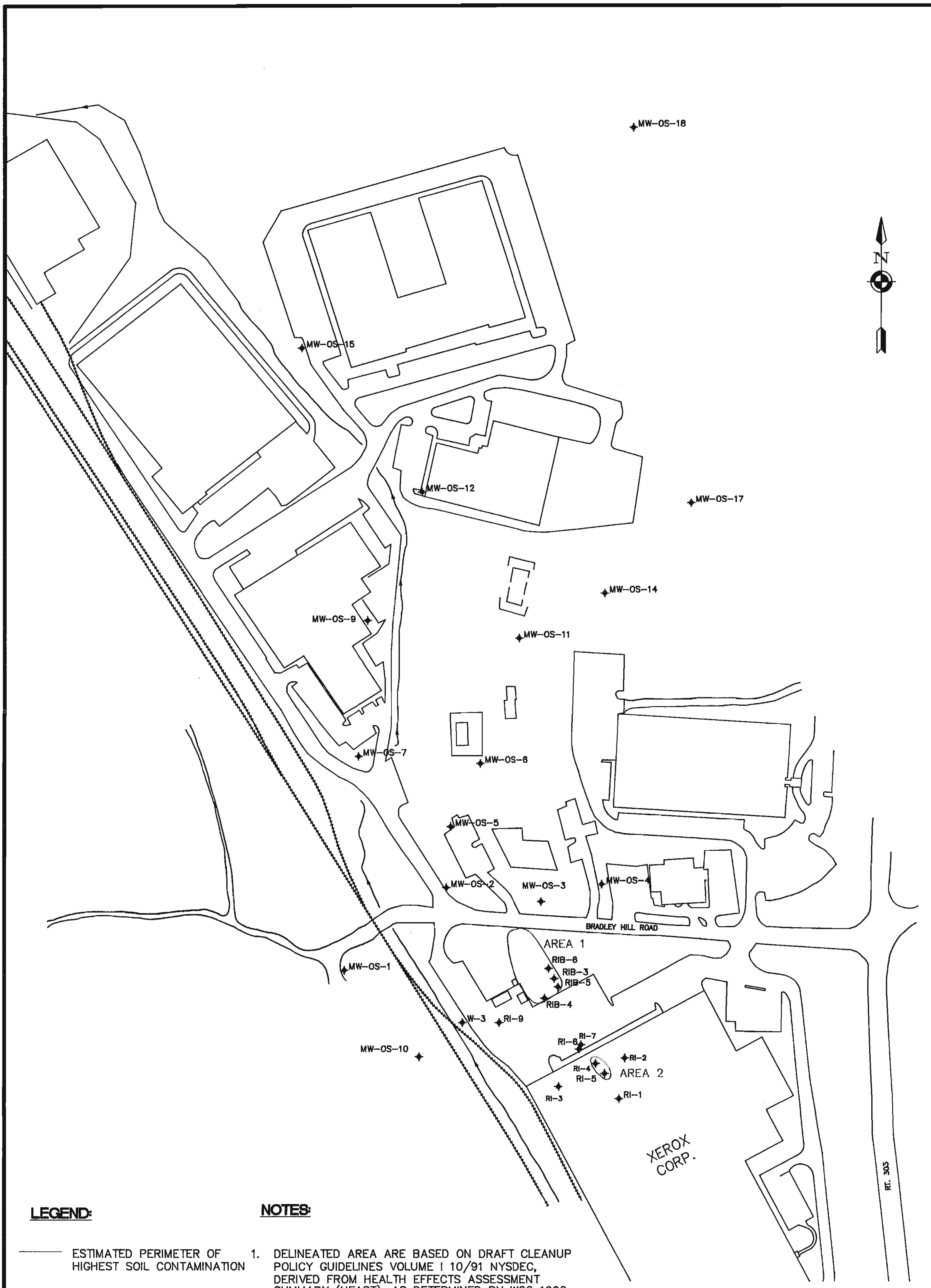
Rev. No.	Date	Type of Revision	Checked by:

11:17

ESTIMATED LAYOUT FOR ACTIVE GROUNDWATER RECOVERY WELLS
XEROX CORPORATION
BLAUVELT, NEW YORK

Woodward-Clyde Consultants
Consulting Engineers, Geologists and Environmental Scientists

Job No.: 92C2183	Drawing No. 21932061	Date: 10/06/92
Drawn by: TP	Checked by: MK	
Scale: 0 — 200 Feet		FIGURE 1-4



LEGEND:

——— ESTIMATED PERIMETER OF HIGHEST SOIL CONTAMINATION

NOTES:

1. DELINEATED AREA ARE BASED ON DRAFT CLEANUP POLICY GUIDELINES VOLUME I 10/91 NYSDEC, DERIVED FROM HEALTH EFFECTS ASSESSMENT SUMMARY (HEAST), AS DETERMINED BY WCC 1992.

2. MODIFIED FROM 1992 DRAFT FEASIBILITY STUDY BY WOODWARD CLYDE CONSULTANTS.

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XEROX CORPORATION
BLAUVELT, NEW YORK

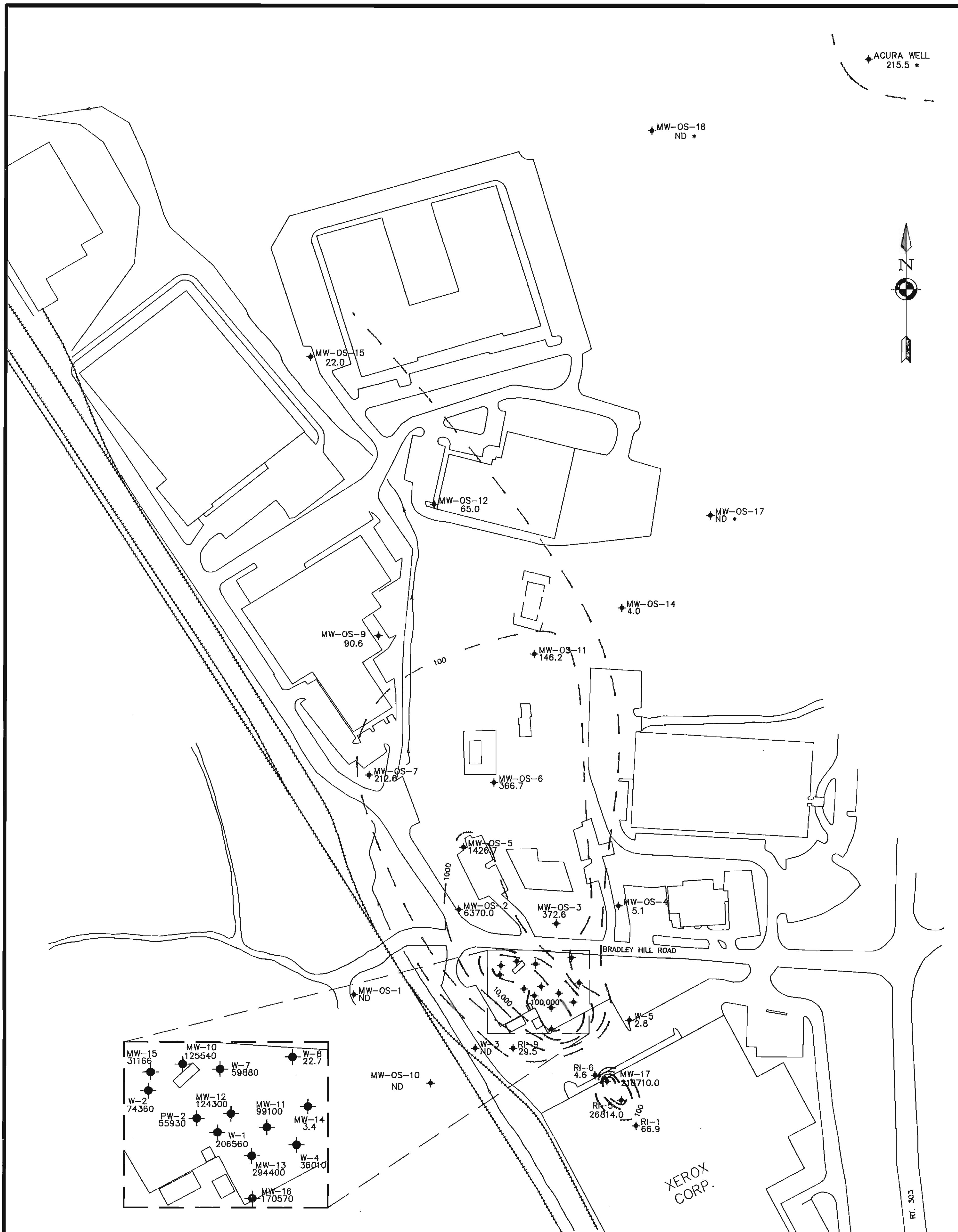
AREAL EXTENT OF HIGHEST SOIL CONTAMINATION

SCALE: 1 IN. = 200 FT. MARCH 1993

FILE NO. 70302-50

Y:\ ACAD\ 70302 50\ SOIL DWG

FIGURE 1-5



LEGEND:

- MONITORING WELL LOCATION
- PW-2 — MONITORING WELL NAME
- 55930 — TOTAL VOLATILES CONCENTRATION IN PPB.

NOTES:

1. ANALYTICAL DATA PRESENTED IN PART PER BILLION (PPB) EQUIVALENT TO MICROGRAMS PER LITER.
2. * INDICATES RESULT FROM OCTOBER 1992.
3. DASHED "CONTOUR LINES" REPRESENT SCHEMATIC ILLUSTRATION OF CONCENTRATIONS BETWEEN WELLS; ACTUAL LEVELS WILL VARY BETWEEN WELLS.
4. "CONTOUR" INTERVAL CORRESPONDS TO ORDER OF MAGNITUDE CHANGES IN CONCENTRATION.

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XEROX CORPORATION
BLAUVELT, NEW YORK

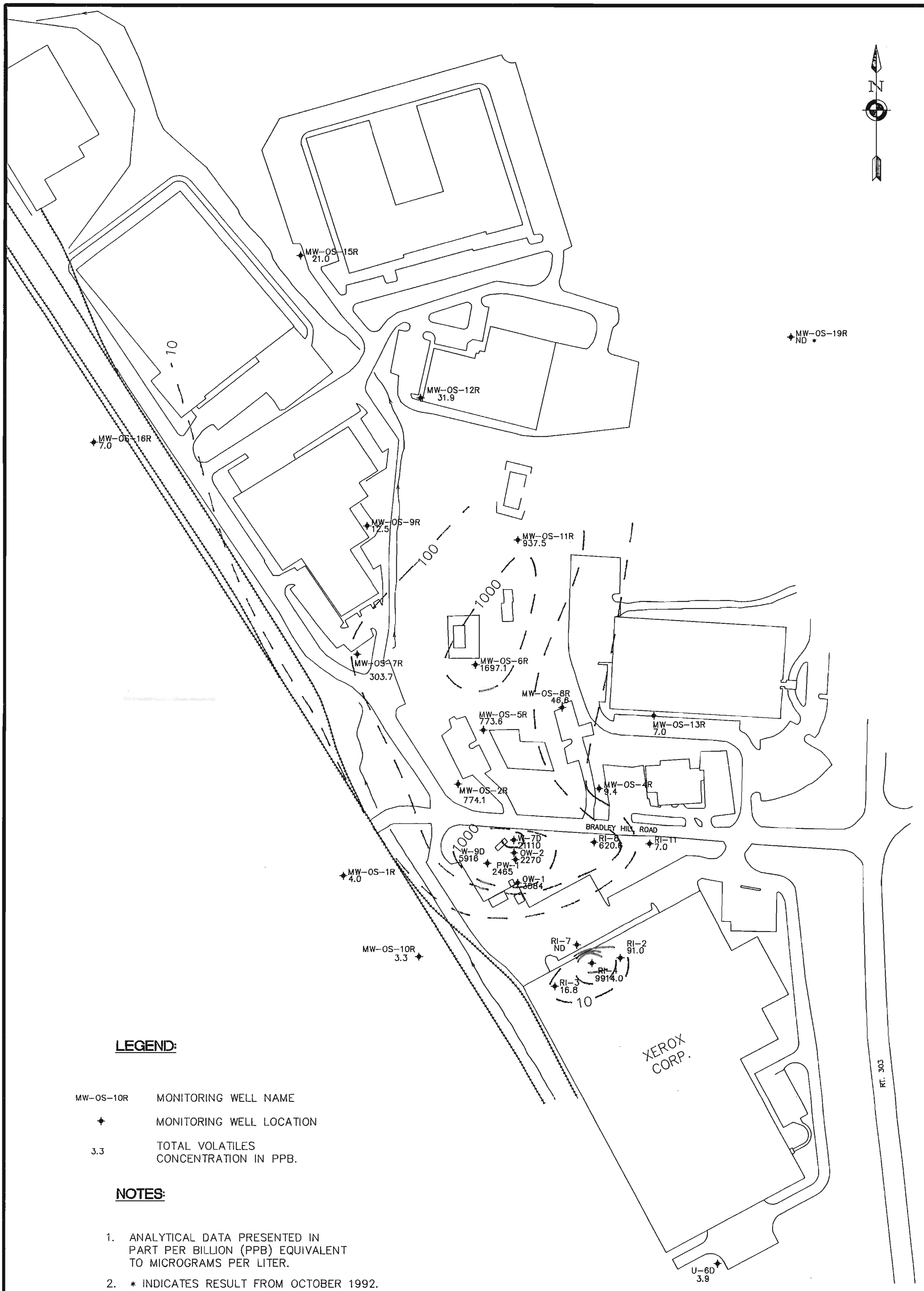
OVERBURDEN GROUNDWATER QUALITY
TOTAL VOLATILES (ug/L)
JULY 1992

SCALE: 1 IN. = 200 FT. MARCH 1993

FILE NO. 70302-50

X:\ACAD\70302-50\SQJUL92.DWG

FIGURE 1-6



LEGEND:

MW-OS-10R	MONITORING WELL NAME
✦	MONITORING WELL LOCATION
3.3	TOTAL VOLATILES CONCENTRATION IN PPB.

NOTES:

1. ANALYTICAL DATA PRESENTED IN PART PER BILLION (PPB) EQUIVALENT TO MICROGRAMS PER LITER.
2. * INDICATES RESULT FROM OCTOBER 1992.
3. DASHED "CONTOUR LINES" REPRESENT SCHEMATIC ILLUSTRATION OF CONCENTRATIONS BETWEEN WELLS; ACTUAL LEVELS WILL VARY BETWEEN WELLS.
4. "CONTOUR" INTERVAL CORRESPONDS TO ORDER OF MAGNITUDE CHANGES IN CONCENTRATION.

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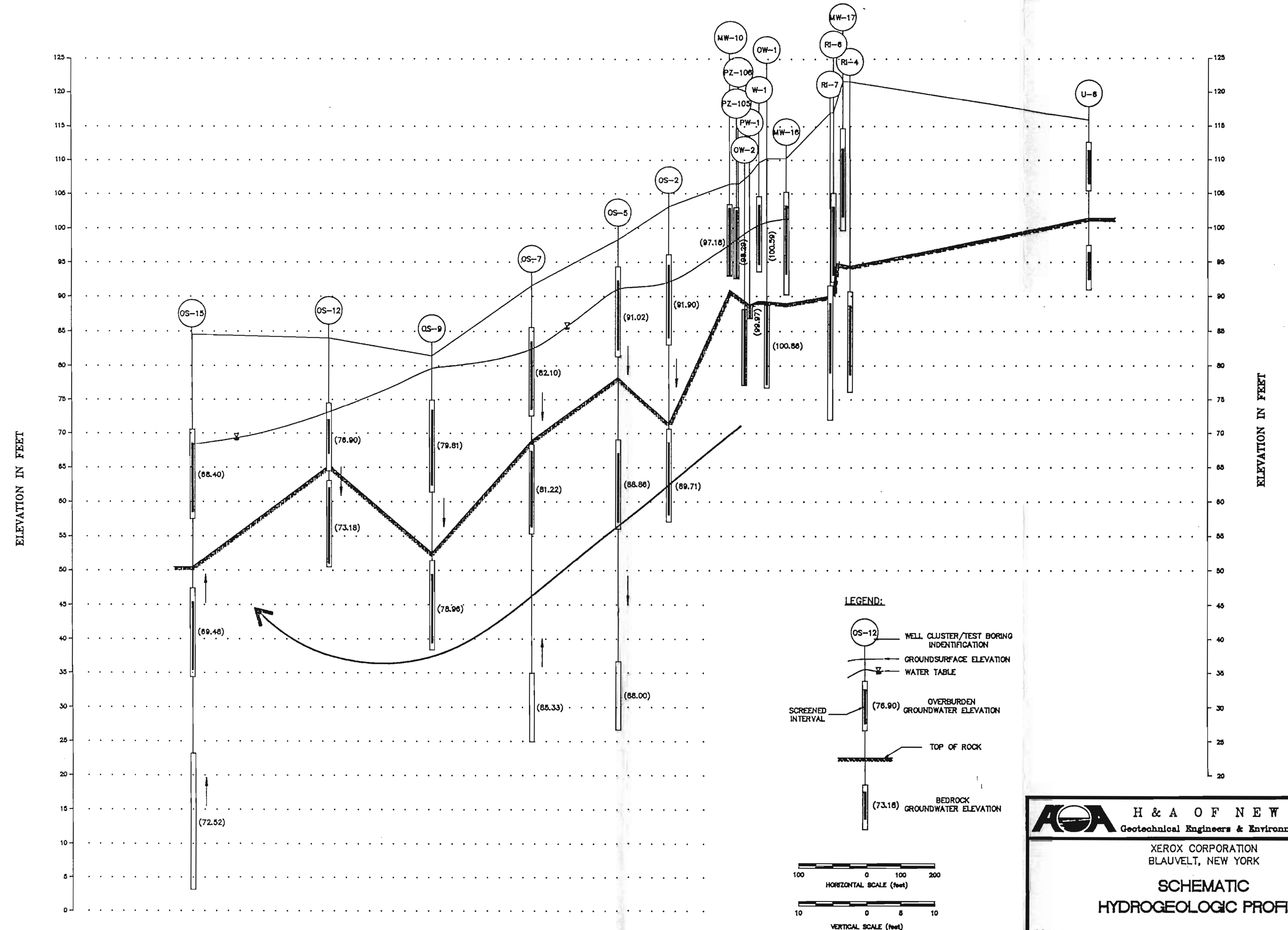
BLAUVELT, NEW YORK

SHALLOW ROCK GROUNDWATER QUALITY
TOTAL VOLATILES (ug/L)
JULY 1992

SCALE 1 IN. = 200 FT. MARCH 1993

FIGURE 1-7

FILE NO. 70302-50



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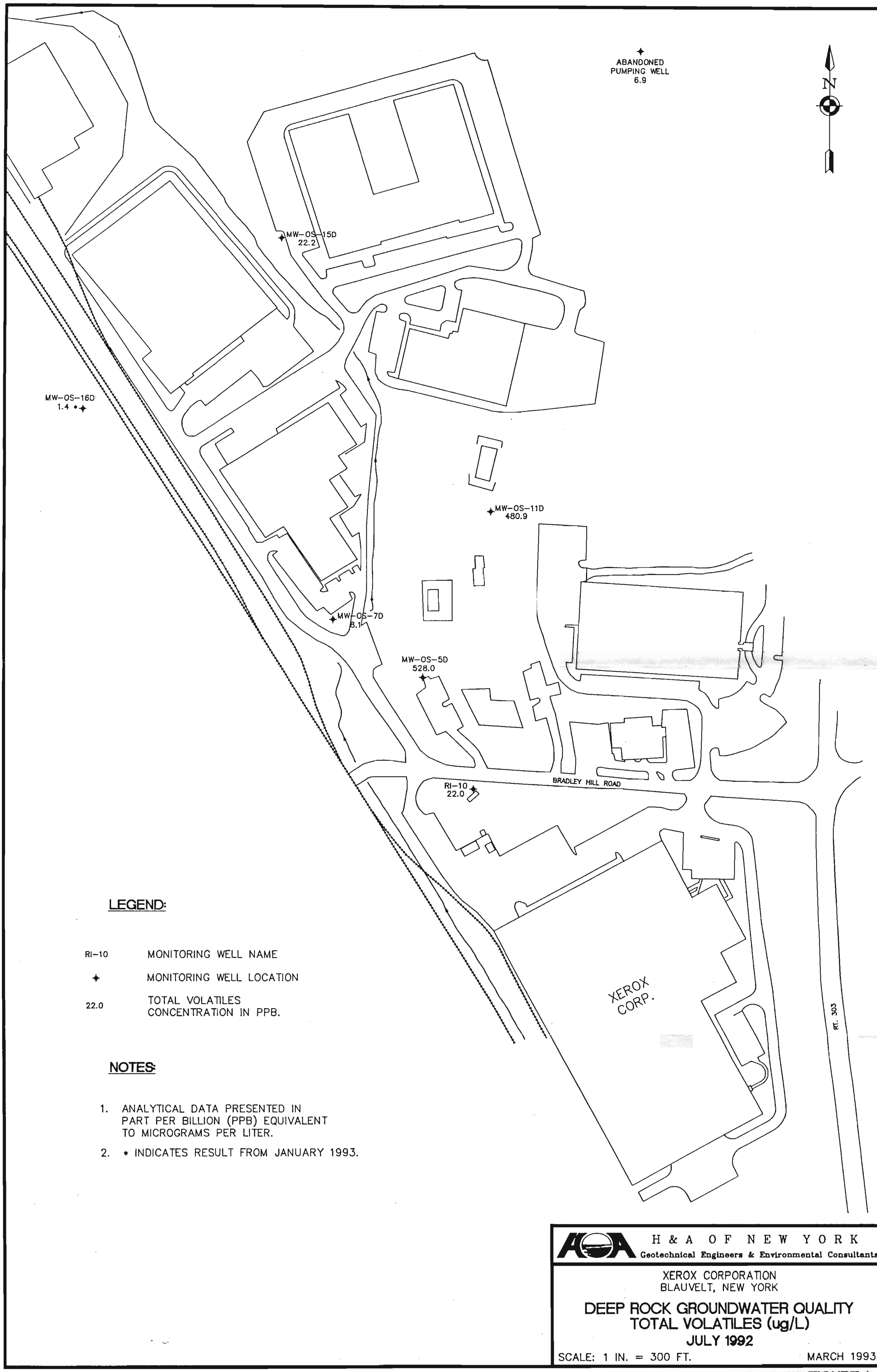
XEROX CORPORATION
BLAUVELT, NEW YORK

SCHEMATIC
HYDROGEOLOGIC PROFILE

SCALE AS SHOWN | MARCH 1993

FIGURE 1-9

FILE NO. 70302-50



LEGEND:

RI-10	MONITORING WELL NAME
✦	MONITORING WELL LOCATION
22.0	TOTAL VOLATILES CONCENTRATION IN PPB.

NOTES:

1. ANALYTICAL DATA PRESENTED IN PART PER BILLION (PPB) EQUIVALENT TO MICROGRAMS PER LITER.
2. * INDICATES RESULT FROM JANUARY 1993.

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XEROX CORPORATION
BLAUVELT, NEW YORK

DEEP ROCK GROUNDWATER QUALITY
TOTAL VOLATILES (ug/L)
JULY 1992

SCALE: 1 IN. = 300 FT. MARCH 1993

FILE NO. 70302-50

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FIGURE 1-8

Rev. No.	Date	Type of Revision	Checked by:

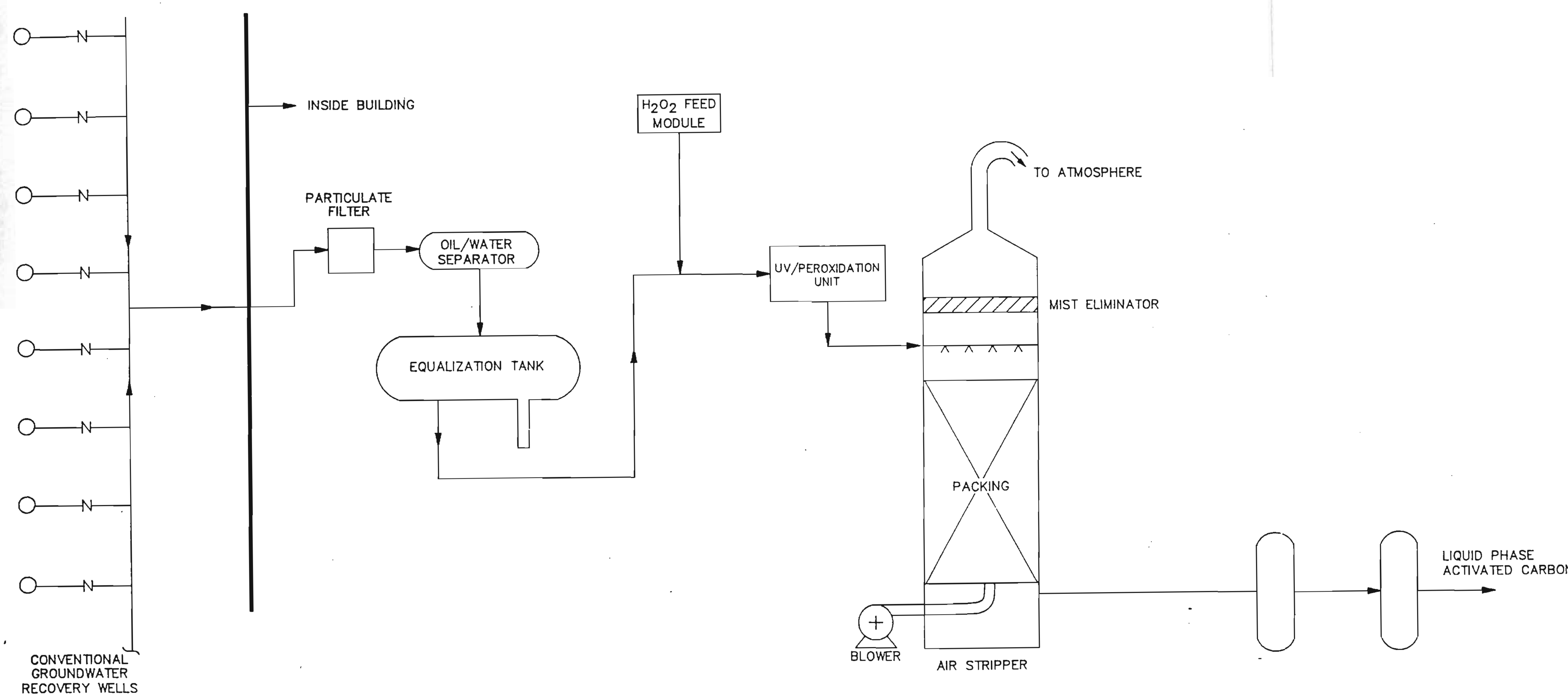
SURFACEWATER & SEDIMENT SAMPLING LOCATION
XEROX CORPORATION
BLAUVELT, NEW YORK

Woodward-Clyde Consultants
Consulting Engineers, Geologists and Environmental Scientists

Job No.: 92C2183	Drawing No. 21932130	Date: 10/08/1982
Drawn by: DEG	Checked by:	FIGURE 1-10
Scale: 0 — 300 Feet		

11:90


N
Municipal Park
Blauvelt State Park
N!A-4
NA-5
Hackensack River
1/2 Mile Radius
Drive-In Theater
Stream
TENNIS COURT
PAVILION
POOL
Bradley Hill Road
XEROX BLDG.
DEBRIS PILES
BLAUVELT
LEGEND:
BUILDINGS
FOREST
MAN-MADE FEATURES
WETLAND
LANDFILL
COVERTYPE LOCATION MAP
XEROX CORPORATION
BLAUVELT, NEW YORK
Woodward-Clyde Consultants
Consulting Engineers, Geologists and Environmental Scientists
Job No.: 92C2193
Drawing No. 21932030
Date: 10/30/1992
Drawn by: TP
Checked by:
Scale:
0
500 FEET
FIGURE 1-11
Rev. No.
Date
Type of Revision
Checked by:
10:42



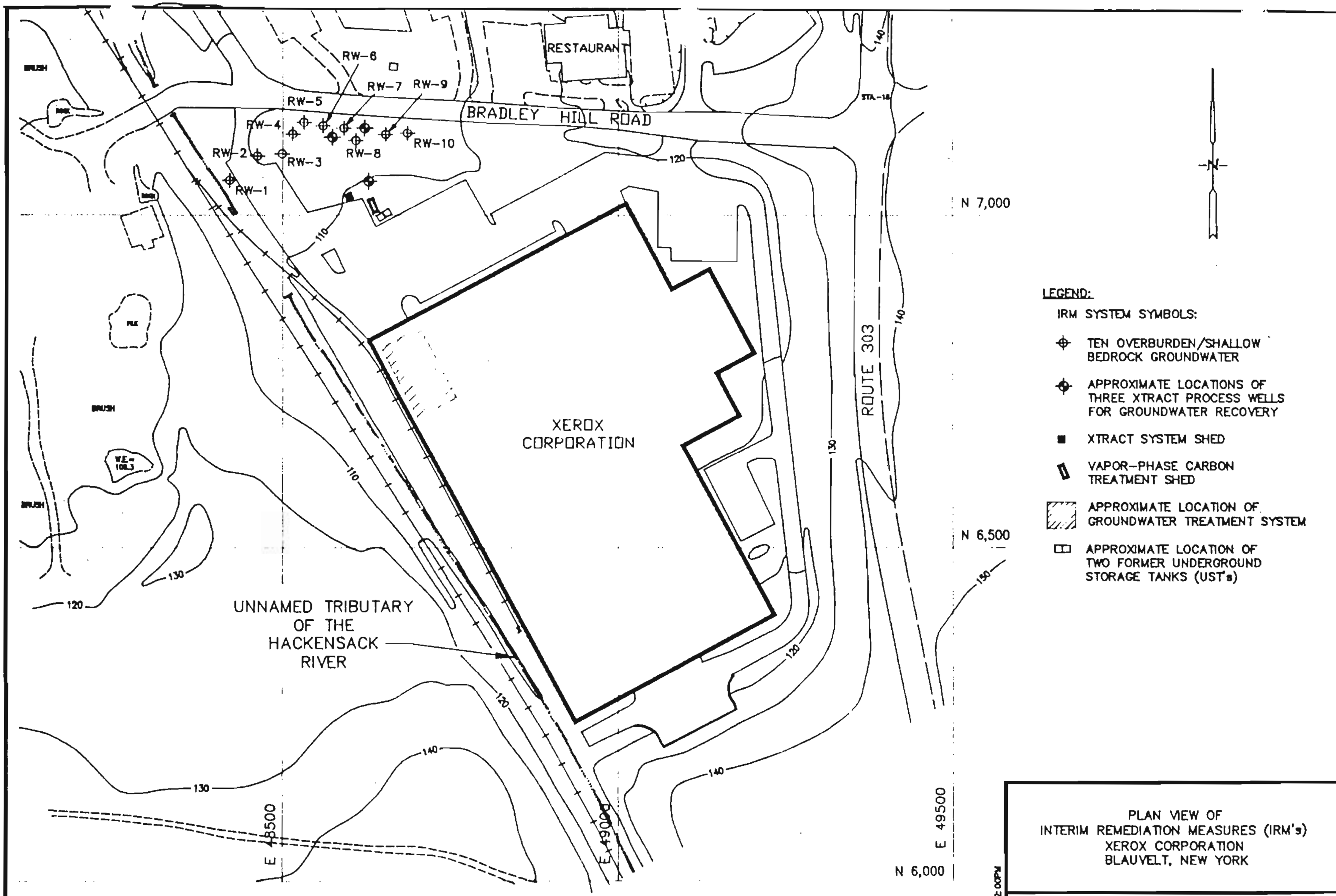
15:37

Rev. No.	Date	Type of Revision	Checked by:

SCHEMATIC OF EXISTING GROUNDWATER
TREATMENT SYSTEM
XEROX CORPORATION
BLAUVELT, NEW YORK

Woodward-Clyde Consultants
Consulting Engineers, Geologists and Environmental Scientists

Job No.: 92C2193	Drawing No. TMP	Date: 09/29/1992
Drawn by: DEG	Checked by:	FIGURE 1-16
Scale: NOT TO SCALE		

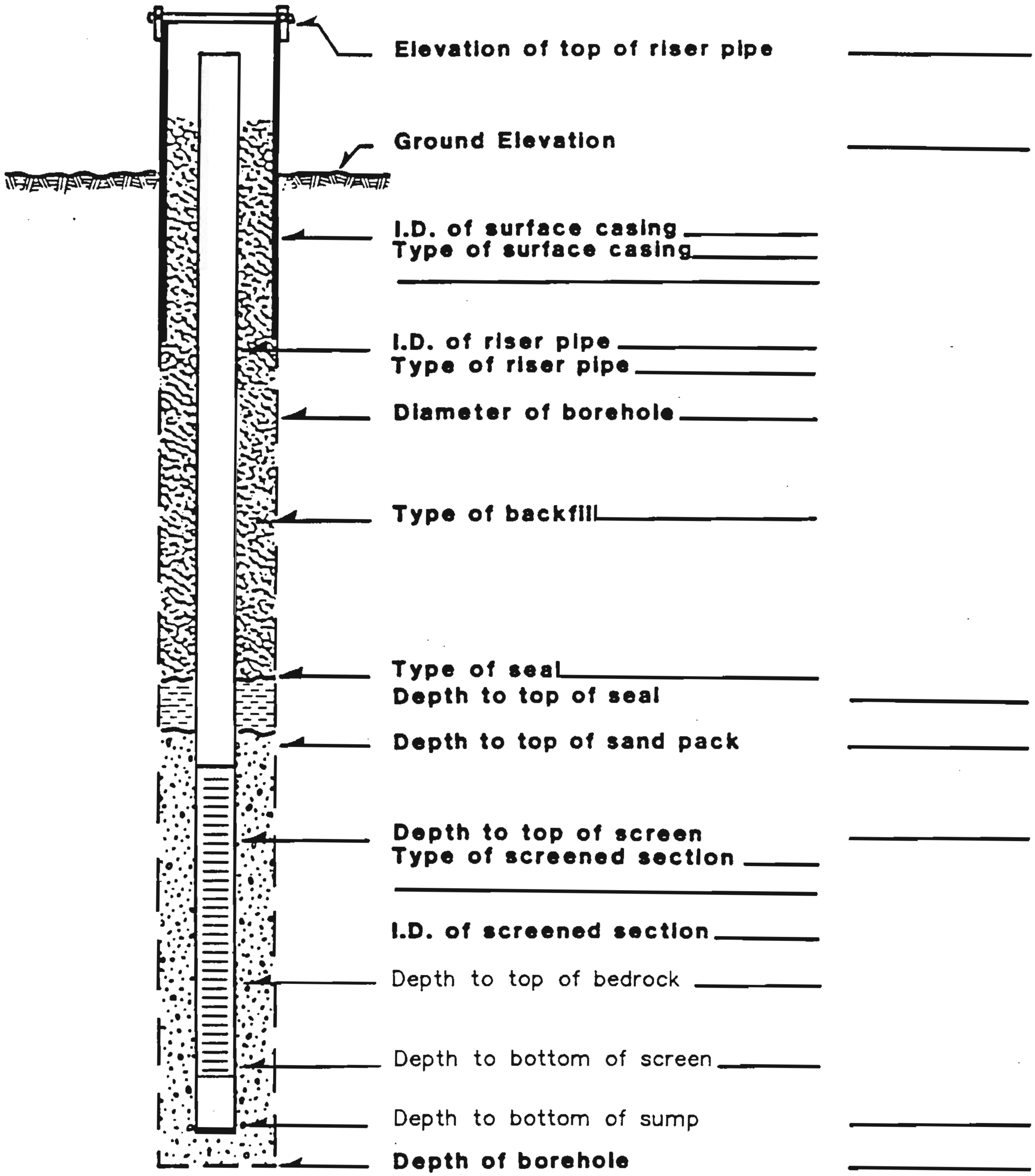


Rev. No.	Date	Type of Revision	Checked by:

PLAN VIEW OF
INTERIM REMEDIATION MEASURES (IRM's)
XEROX CORPORATION
BLAUVELT, NEW YORK

Woodward-Clyde Consultants
Consulting Engineers, Geologists and Environmental Scientists

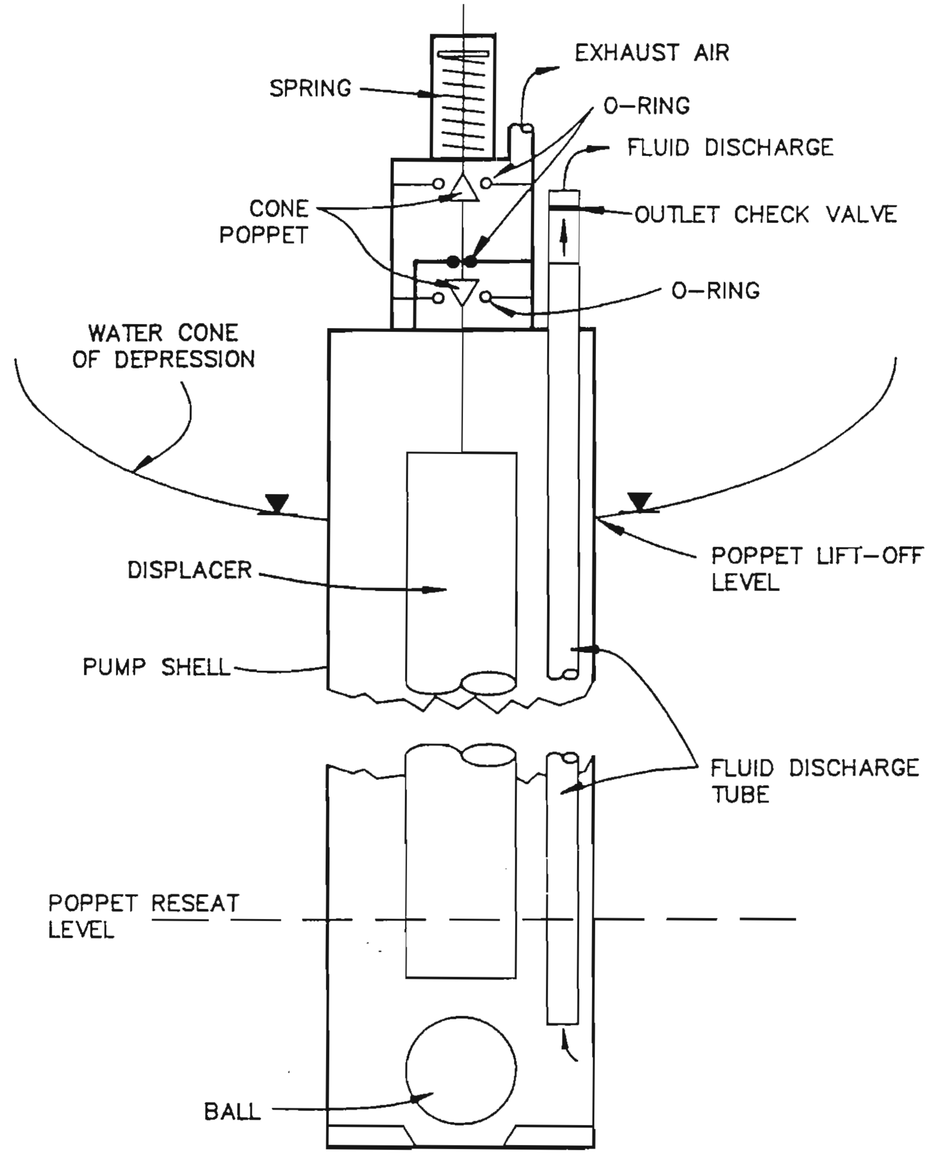
Job No.: 92C2183	Drawing No. 21932180	Date: 10/08/92
Drawn by: DEG	Checked by: DMH	
Scale: 0 — 200 FT.		FIGURE 1-13



TYPICAL CROSS-SECTION FOR EXISTING
GROUNDWATER RECOVERY WELLS

DRAWN BY:	CHECKED BY:	PROJECT NO: 92C2193	DATE: 8-21-92	FIGURE 1-14

Woodward-Clyde Consultants



OPERATION

1. WATER ENTERS LOWER BALL CHECK VALVE AS AIR EXHAUST FROM PUMP
2. WATER RISES INSIDE PUMP UNWEIGHTING DISPLACER
3. WHEN WATER FILLS PUMP TO POPPET LIFT-OFF LEVEL, THE SPRING CAN OVERCOME RESIDUAL WEIGHT OF DISPLACER CAUSING CONE POPPETS TO REDIRECT AIR.
4. PRESSURIZED AIR ENTERS PUMP WHILE AIR EXHAUST IS CLOSED. WATER IS PUSHED UP THE FLUID DISCHARGE TUBE, THROUGH THE OUTLET CHECK VALVE AND OUT THE WELL.
5. WHEN ENOUGH WATER IS PUSHED TO LOWER THE WATER LEVEL INSIDE THE PUMP TO THE POPPET RESEAT LEVEL, THE DISPLACER WEIGHT OVERCOMES THE SPRING FORCE AND CAUSES THE CONE POPPETS TO SHUT OFF THE PRESSURIZED AIR, OPEN THE EXHAUSTS, AND ALLOW THE PUMP TO FILL.

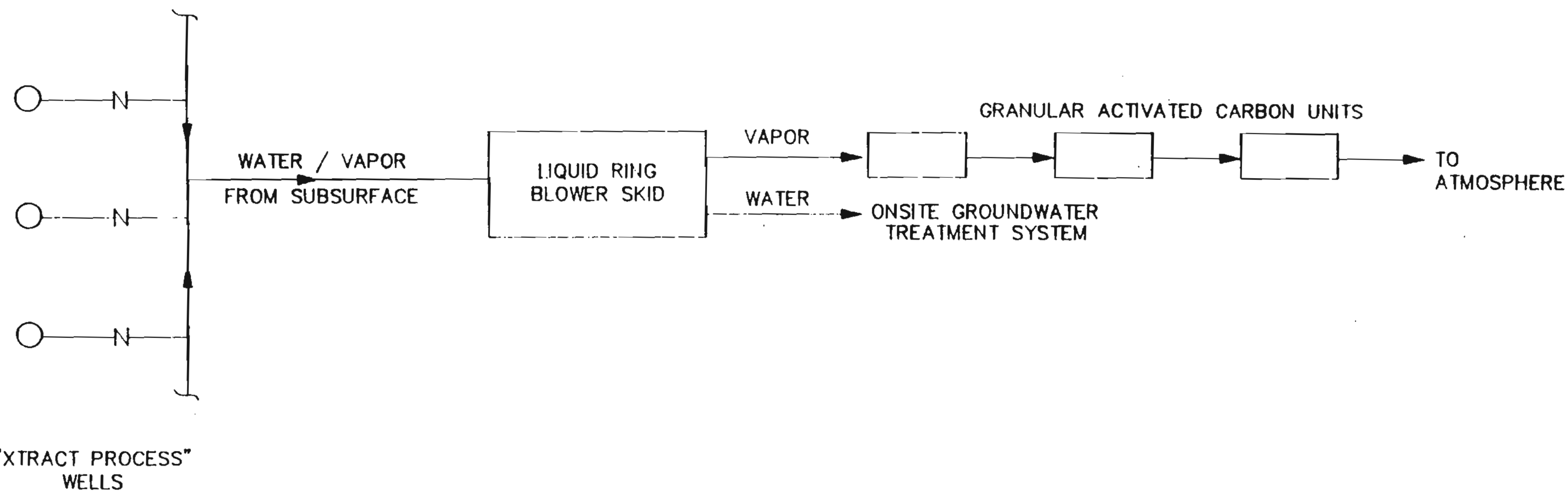
15:41

TYPICAL BOTTOM-LOADING RECOVERY WELL PUMP
SCHEMATIC & DESCRIPTION
XEROX CORPORATION
BLAUVELT, NEW YORK

Rev. No.	Date	Type of Revision	Checked by:

Woodward-Clyde Consultants
Consulting Engineers, Geologists and Environmental Sc...

Job No.: 92C2193	Drawing No. 2193027A	Date: 09/29/1992
Drawn by: TP	Checked by:	
Scale: Not to Scale		FIGURE 1-15



PROCESS FLOW SCHEMATIC OF EXISTING
"XTRACT PROCESS" AND VAPOR-PHASE CARBON SYSTEMS FOR
WATER RECOVERY AND WATER/VAPOR TREATMENT
XEROX CORPORATION
BLAUVELT, NEW YORK

Rev. No.	Date	Type of Revision	Checked by:

15:12

Woodward-Clyde Consultants
Consulting Engineers, Geologists and Environmental Scientists

Job No.: 92C2193	Drawing No. 21930290	Date: 08/21/1992
Drawn by: TP	Checked by: DMH	FIGURE 1-17
Scale:		

New York State Department of Environmental Conservation
50 Wolf Road, Albany, New York 12233 7010

APR 2 1 1992

Thomas C. Jorling
Commissioner

RECEIVED
APR 27 1992
ENVIRONMENTAL ENGINEERING

Mr. Eliott N. Duffney
Tecnnical Specialist, Environmental Engineering
Xerox Corporation
800 Phillips Road
Building 304-13S
Webster, New York 14580

Dear Mr. Duffney:

Re: Xerox-Blauvelt Site (#344021)
FS Work Plan

I have reviewed the proposed Feasibility Study (FS) work plan for the subject site enclosed with your April 10, 1992 letter to me. I have prepared and enclosed an outline of the issues the FS Report for the site will need to address. This outline can serve as the basis for discussions to be held in a meeting tentatively scheduled for the week of May 4, 1992.

Essentially, I concur that elements of the FS can be "focused," but the report must thoroughly document the basis for a recommended remedial alternative. In large part, this will amount to documenting the studies, treatability results, and conclusions of the efforts behind the IRMs at the site. Additionally, the "focus" of the FS will depend upon the Department's evaluation of the effectiveness of the existing IRMs.

Considering the amount of information already available, a September 1992 submittal of the final RI/FS report is achievable. I will speak with you shortly to finalize the date and location of our next meeting.

Sincerely,

Susan S. McCormick for

Andrew J. English, P.E.
Environmental Engineer
Div. of Haz. Waste Remediation

Enclosure

c: w/enc. R. Ehlenberger, WCC
W. Lowden, NYSDOH

FEASIBILITY STUDY OUTLINE
DISCUSSION DOCUMENT
XEROX-BLAUVELT SITE #344021

Executive Summary

1. Introduction

- 1.1 Purpose and Organization of Report
- 1.2 Background Information (Summarizing from RI Report)
  - 1.2.1 Site Description
  - 1.2.2 Site History
- 1.3 Nature and Extent of Contamination
  - 1.3.1 On-site Soils
  - 1.3.2 On-site Groundwater
  - 1.3.3 Off-site Soils
  - 1.3.4 Off-site Groundwater
  - 1.3.5 Surface Water
  - 1.3.6 Surface Water Sediments
  - 1.3.7 Air
- 1.4 ARARs and TBC Criteria
  - 1.4.1 Chemical Specific
  - 1.4.2 Action Specific
  - 1.4.3 Location Specific

(Note: These must be very specific and comprehensive. For example, it is not adequate to state that Part 373-2 applies; specific citations and requirements must be listed. This must include all ARARs/TBCs such as State/federal laws, regulations, guidance, etc.)

- 1.5 Health Risk Assessment
  - 1.5.1 Exposure Pathways and Routes (properly distinguished)
  - 1.5.2 Exposure Concentrations and Chemical Intakes

(Note: Unless other values are acceptably supported, intake level calculations should use the standard default exposure factors in OSWER Directive 9285.6-03, dated March 25, 1991. Overall, the risk assessment must be consistent with "Risk Assessment Guidance for Superfund: Volume 1," EPA/540/1-89/002, dated December 1989.)

  - 1.5.3 Toxicological Information

(Note: This section should provide the values and sources of the RfDs and slope factors for the chemicals that present the bulk of the risk as well as provide enough descriptive information so that a lay person will have a basic understanding of the toxicities. Estimates of the relative risks of the alternatives in comparison to no action should be presented.)

  - 1.5.4 Carcinogenic Risk (by media; chemical specific & cumulative)
    - 1.5.4.1 Baseline
    - 1.5.4.2 Remedy
  - 1.5.5 Non-carcinogenic Risk (by media; hazard indices)
    - 1.5.5.1 Baseline

1.5.5.2 Remedy

1.5.6 Uncertainties

1.6 Habitat-Based Assessment

(Note: This shall be completed in accordance with DEC guidance.) The goals of the assessment are to; 1) characterize the ecological values at and around the site; 2) identify the habitats and potential fish and wildlife receptors; 3) identify possible food chain contamination pathways; and 4) identify additional sampling needs, if needed.)

1.6.1 Site Description

1.6.1.1 Vegetative Covertype Map (0.5 mile radius)

1.6.1.2 Identification of Special Resources (2 mile radius)

1.6.1.3 Habitat Description

1.6.2 Fish and Wildlife Populations

1.6.3 Fish and Wildlife ARARs/TBCs

1.6.4 Conclusions

1.7 Remedial Goals (by media)

1.8 Volumes or Areas to Remediate (by media with figures)

1.9 Summary of IRM-Treatability Studies

1.9.1 Groundwater: Interception and Treatment

1.9.2 Soil/Groundwater High Vacuum Extraction and Treatment

2. Identification and Screening of Technologies - Phase I FS

2.1 Identify General Response Actions (e.g., no action, institutional controls, containment removal/treatment; for each media)

2.2 Identify Remedial Technologies (by media)

2.3 Identify Process Options

2.4 Screen Process Options

2.4.1 Effectiveness

2.4.2 Impermeability

2.4.3 Cost

(Note: A significant portion of the work normally accomplished in this step has essentially been completed during the process of selecting process options for use in the IRMs. The steps, options, and conclusions from that process should be summarized here. Although much of the evaluation process has already been completed, the FS report must thoroughly document the process. Therefore, the intention is not to waste time and resources evaluating unrealistic options but to document all of the work that has already been completed and provide a check that better alternatives have not been overlooked.)

3. Development and Screening of Alternatives

3.1 Development of Alternatives

(Note: Process options from Step 2 should be combined into a range of alternatives that are protective of human health and the environment and attain/comply with ARARs. In accordance with the NCP, the no-action alternative must be carried through the FS to show the need for remediation.)

3.2 Screening of Alternatives

(Note: Depending upon how well the report is documented up to this point, this step may be omitted and the report would go directly to the detailed analysis. If the list of potential alternatives is extensive (e.g., greater than six or seven), screening may be needed to narrow the list.)

3.2.1 Effectiveness
3.2.2 Implementability
3.2.3 Cost

4. Detailed Analysis of Alternatives

4.1 Introduction
4.2 Individual Analyses

(Note: Each alternative must be evaluated in terms of the following criteria: 1) protection of human health and the environment; 2) comply/attain ARARs; 3) short-term impacts and effectiveness; 4) long-term effectiveness and permanence; 5) reduction of toxicity, mobility, or volume; 6) implementability; and 7) cost. The RI/FS guidance manual contains lists of issues to be addressed for each criterion. Since the selection of the remedy relies heavily on this portion of the FS, the detailed analysis must be thorough, well reasoned, and consistent between alternatives.)

4.3 Comparative Analysis

(Note: A summary analysis is presented that compares the alternatives to each other for each criterion.

4.3.1 Protection of Human Health and the Environment
4.3.2 Compliance with ARARs
... etc.
4.3.7 Cost (back-up sheets able to show accuracy of -30 to +50 percent)

4.4 Sensitivity Analysis

(Note: A cost sensitivity analysis shall be performed for factors that could significantly change the capital and/or O&M costs for the remedy. At a minimum, these factors shall include discount rate (assume 5% in the detailed analysis and evaluate at 3% and 10% for the sensitivity analysis), time to achieve remedial objectives, volume of material to treat/dispose, and O&M costs.)

5. Recommended Alternative

5.1 Preferred Remedy
5.2 Conceptual Design
5.3 Implementation Schedule

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

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

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

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

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

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

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

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						

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

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

LOG of BORING No. SP-7

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

DEPTH, ft.	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

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	Brown to dark brown clayey SILT with trace silt and sand					11
		8	-red brown clayey silt and brown loose sand					280
5		7						220
		4	Red brown clayey SAND, moist to wet					260
		5	-red brown clayey sand, observed dark brown free product					240
10		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

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

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

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

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
20		29						<1
		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

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

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					
			- dark red brown silty sand, little clay trace gravel, odor, moist					700
								>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

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
15		19	-red brown coarse to medium sand with some gravel andsome fine sand and silt					12
		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

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					
		21	-reddish brown fine sand and silt, black non-aqueous phase liquid present					200
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

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 clav					8
15		14	-red brown to dark brown coarse to medium sand with little gravel					2
		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

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
10		7	-red brown silty sand with some clay					< 1
		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
20		26						16
		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

Woodward-Clyde Consultants

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

Woodward-Clyde Consultants

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
			SILTSTONE					
25								

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

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

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 ateel

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:

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'

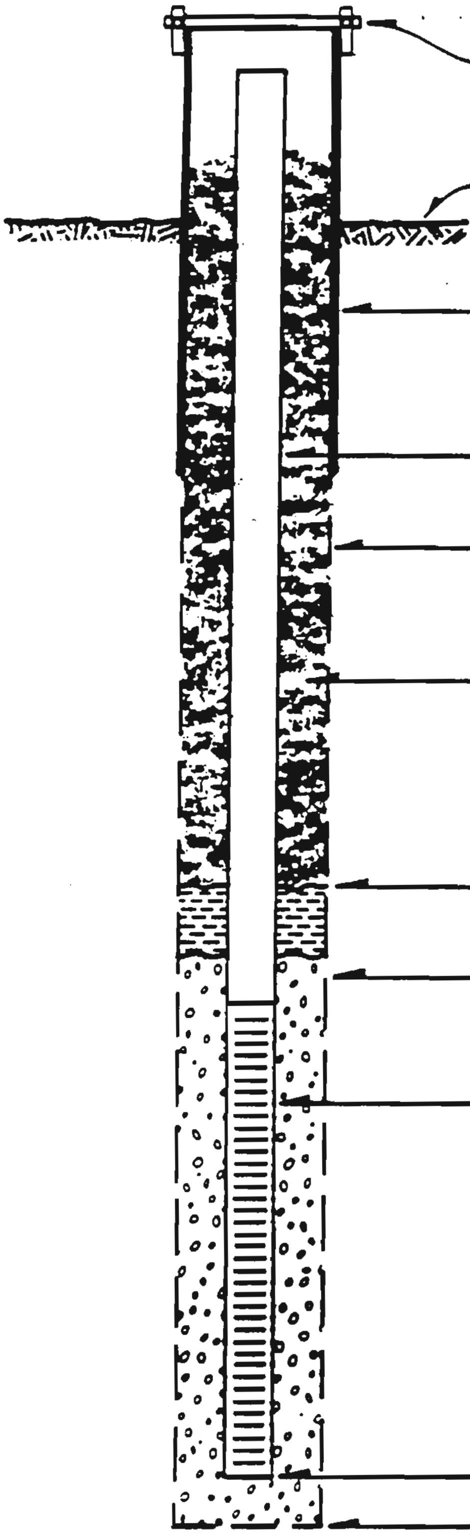
Depth to top of screen 4'
Type of screened section
Johnson stainless steel #10 slot

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

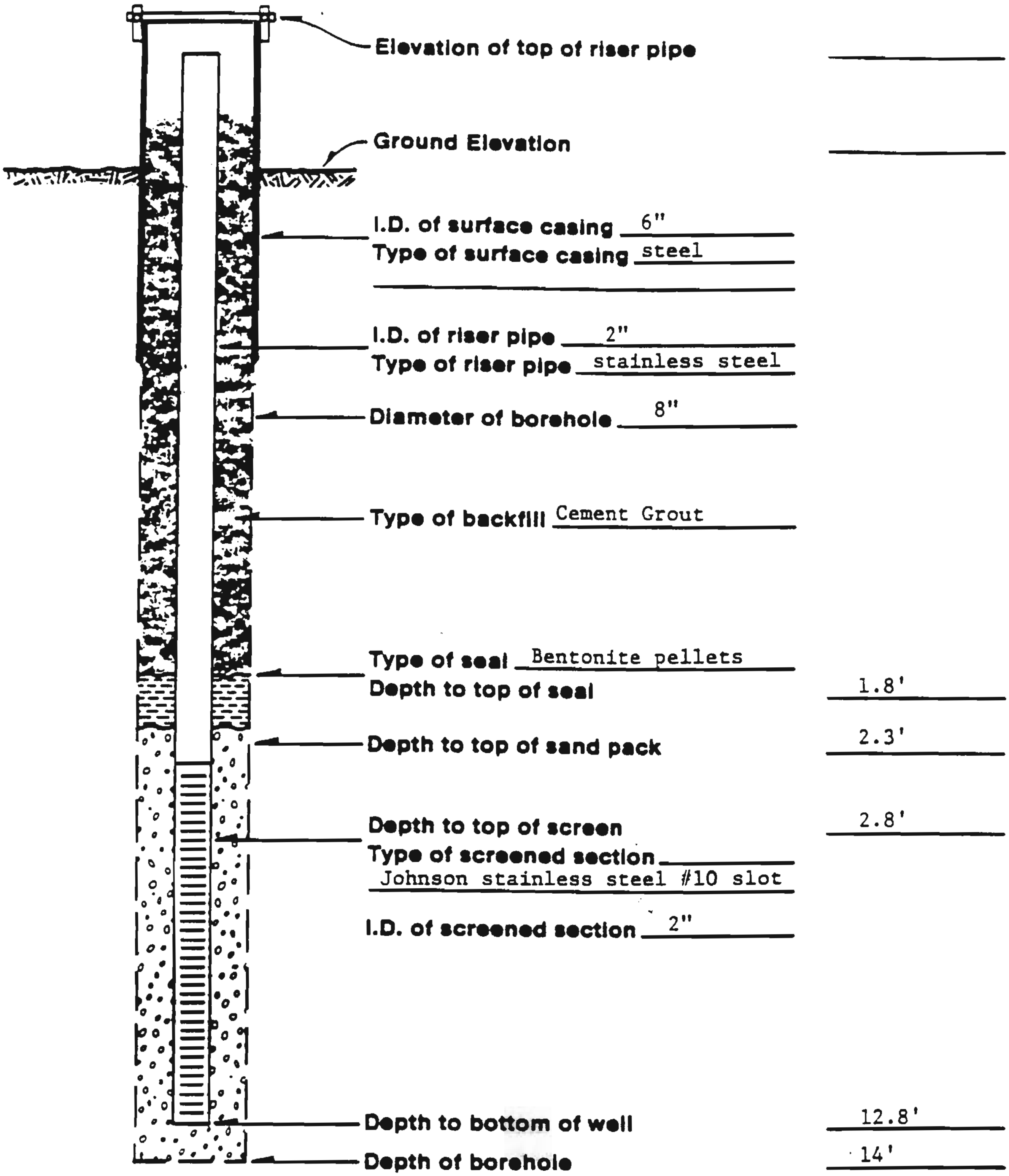
I.D. of screened section 2"

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:



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 C-1

DRAFT AMBIENT AIR TOXIC MONITORING PROGRAM REPORT

AMBIENT AIR TOXIC MONITORING PROGRAM
XEROX CORPORATION
BLAUVELT, NEW YORK

1.0 INTRODUCTION

A baseline ambient air monitoring program was conducted at the Xerox remediation site in Blauvelt, New York to comply with conditions of the approved Remedial Investigation/Feasibility Study (FI/FS) work plan. The purpose of the study was to obtain baseline measurements to be utilized in evaluating potential airborne emissions from the site subsurface contamination.

2.0 OVERVIEW OF THE AMBIENT AIR MONITORING PROGRAM

A description of the monitoring procedures and equipment are outlined in the following sections of this report.

2.1 SAMPLING LOCATIONS AND SCHEDULE

The ambient air monitoring was conducted over an 8-hour period between 10 A.M. and 6 P.M. on May 28, 1992. Air monitors were set up at four locations within the vicinity of the spill area, one upwind, one downwind and two locations within the immediate spill area (see Figure B-1). The upwind monitor (No. 4) was located west of the spill area between the parking lot and the railroad tracks. The downwind monitor (No. 1) was located to the southeast of the spill area, between the parking lot and dense treerow. The two monitors within the spill area were located adjacent to wells MW-13 and PW-2. An additional co-located monitor was set up at Location 2 to provide an assessment of the data precision.

During the monitoring program, the following meteorological conditions were recorded: wind speed, wind direction, air temperature, relative humidity and sky conditions. These data were taken periodically during the monitoring program to document changes in the weather conditions. During the monitoring program, a front passed through the area, resulting in a significant change in the wind direction and sky cover towards the end of the monitoring event.

Throughout the monitoring program, winds were generally light and variable, ranging in speed from 3 to 7 mph, with calm periods. The wind direction was predominantly from the north to northwest during the majority to the monitoring program. The air temperature was fairly consistent, ranging from 61°F to 66°F, while the relative humidity dropped off sharply from 61 to 63 percent in the morning to 42 to 46 percent in the afternoon. The sky cover was approximately 10 percent in the morning, increasing to almost 100 percent with a light shower in the late afternoon.

2.2 MONITORING EQUIPMENT

The ambient air monitoring was conducted utilizing a Gilian Air Monitoring System, with the air inlets mounted at a height of approximately 3 to 4 feet above the ground surface. The Gilian Air Monitoring System consists of a small portable air pump which draws a continuous air sample through a collection manifold, where the sampling medium are located. An activated Carbotrap-300 sorbent tube was utilized as the sampling medium. The Carbotrap-300 tube provides a combined sampling medium consisting of Tenax and Carbon Molecular Sieve adsorbents.

The test method utilized for the monitoring program was a modified Environmental Protection Agency (EPA) method TO-1 (Determination of Volatile Organic Compounds in Ambient Air Using Tenax Adsorption and Gas Chromatograph) and EPA TO-2 (Determination of Volatile Organic Compounds in Ambient Air Using Carbon Molecular Sieve Adsorption and Gas Chromatography/Mass Spectrometry). The TO-1 and TO-2 test methods were selected because of the low anticipated ambient air concentrations. These methods provide the lowest level of detection available in comparison to other approved air monitoring methods.

Each Gilian Air Monitoring System was set up to run for an 8-hour period in order to obtain a representative measurement of average daytime ambient air concentrations. At each monitoring location, the sampling manifold was equipped with two Carbotrap-300 tubes combined in series to prevent compound breakthrough.

The sample flow rates for each of the Gilian Air Monitoring Systems were set at approximately 150 ml/min prior to set up in the field. This flow rate was selected to maintain the total sample volume below 100 liters (the cutoff for potential breakthrough). The flow rates were tested and adjusted to the present values, where necessary, at the beginning of the monitoring program. Flow rates were periodically checked throughout the monitoring event, approximately every 90 minutes, and at the conclusion of the monitoring event. Equipment checks were also performed periodically to confirm that the Gilian Air Monitoring Systems were operating properly.

2.3 SAMPLE HANDLING

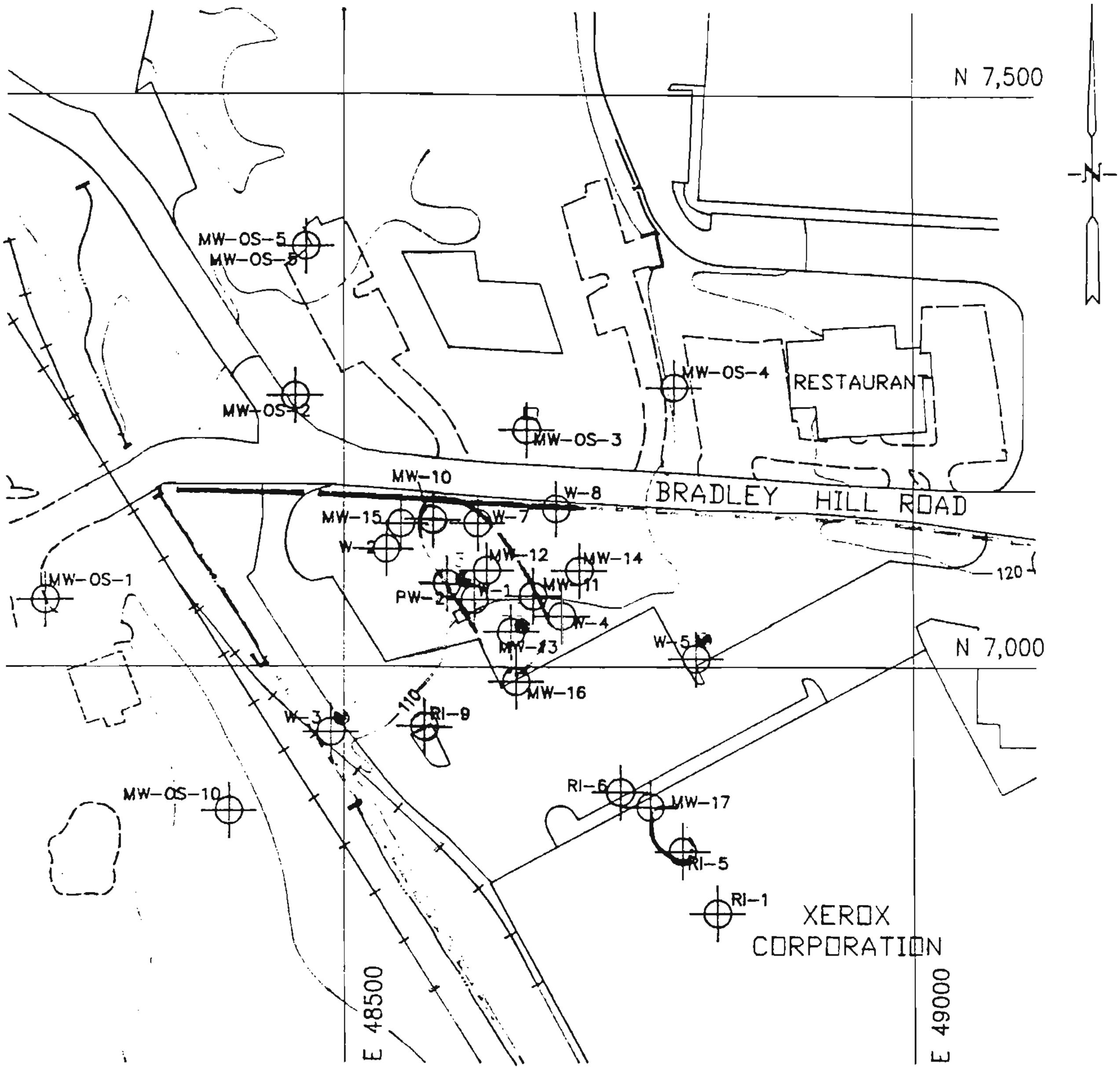
At the beginning of the monitoring program, the caps were removed from the Carbotrap-300 tubes and the tubes were placed in the sample manifolds. At the conclusion of the monitoring program, the Carbotrap-300 tubes were removed from the sample manifolds, recapped, labeled, and placed into an ice-filled travel cooler. Chain-of-custody forms were filled out and placed with samples for shipment to the analytical laboratory.

3.0 ANALYTICAL METHODS, QA/QC, AND SELECTED LABORATORY

3.1 ANALYTICAL METHODS

Analyses were conducted utilizing gas chromatograph/mass spectrometry (GC/MS) methods in accordance with EPA toxic organic test methods. The ambient air samples were analyzed using a modified EPA TO-1/TO-2 method. These methods were modified to include the following specific analytes:

- 1,1-Dichloroethene
- 1,1-Dichloroethane
- trans-1,2-Dichloroethene
- Ethylbenzene
- Benzene
- Methylene Chloride
- 1,1,1-Trichloroethane
- Tetrachloroethene
- Toluene



LEGEND:

AMBIENT AIR MONITORING LOCATIONS

SPILL AREA

3:42PM

Rev. No.	Date	Type of Revision	Checked by

AMBIENT AIR MONITORING LOCATIONS
XEROX CORPORATION
BLAUVELT, NEW YORK

Woodward-Clyde Consultants
Consulting Engineers, Geologists and Environmental Scientists

Job No.: 92C2192	Drawing No. 21920020	Date: 08/18/92
Drawn by: JWC	Checked by:	FIGURE B-1
Scale: 0 — 150'		

HUMAN HEALTH ASSESSMENT
XEROX FACILITY
BLAUVELT, NEW YORK

Prepared For:
Xerox Corporation
800 Phillips Road
Webster, New York

Prepared By:
Woodward-Clyde Consultants
122 South Michigan Avenue
Chicago, Illinois

Reprinted with modifications by
H&A of New York
189 North Water Street
Rochester, New York 14604

March 1993
Project No. 92C2193

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EXECUTIVE SUMMARY

A human health assessment (assessment) has been developed by Woodward-Clyde Consultants (WCC) for the Xerox Facility (site) in Blauvelt, New York. The objective of the assessment is to ascertain whether unacceptable health risks are posed to humans by current site conditions. The assessment examines potential health impacts that could be incurred by humans currently in or near the site as a result of exposure to site-related chemicals under current and plausible future site use. The human health assessment follows guidance developed by the U.S. Environmental Protection Agency (EPA) for performing baseline risk assessment under the Superfund Program.

The Xerox facility is located in the unincorporated town of Blauvelt, Rockland County, New York. From 1970 to 1979, the site was used as a refurbishing facility for leased equipment. Two underground storage tanks (USTs) were located north of the building and were used for the storage of virgin and waste solvents. Two documented spills from the waste solvent tank resulted in the introduction of organic contaminants into the sub-surface. In addition, an area inside the building where spraying operations took place is also associated with the release of solvents. The refurbishing operations ceased in 1979 and the facility is currently used for warehousing and office space.

The available chemical data for groundwater, surface water, soils and sediments were examined for applicability in the risk assessment and selection of chemicals of concern. Validation of the data was not within WCC's scope of work, so all data were assumed to be adequate for use in a human health assessment. Some criteria were applied to select chemicals of concern, such as frequency of detection; others could not be applied due to lack of information (comparability with background, presence in blanks). Few detected chemicals were removed from consideration as a chemical of concern by the selection process.

Four groups of receptors were examined for potential exposure: on-site workers, off-site workers, off-site residents and trespassers. Of these receptor groups, only trespassers were identified as having complete exposure pathways. Potential exposure of adult and youth trespassers to chemicals contained in surface water and sediments of a creek which crosses the site property was assessed for reasonable maximum exposures (RME) and more typical exposures. Dermal and incidental exposure were considered. The resultant upper bound cancer risk estimates were all at or below the acceptable risk range identified by the U.S. Environmental Protection Agency (EPA of 1×10^{-4} to 1×10^{-6}. The resultant non-carcinogenic Hazard Indices were all below the comparison threshold value of 1.0. This suggests that unacceptable health risks are not posed by exposure to chemicals at the site.

The conclusions, however, is limited by several assumptions made in the assessment. These assumptions, including the following:

- Site-related chemicals in groundwater have not migrated past Bradley Industrial Park into residential areas north of the site, and no or limited private wells exist in these northern residential areas. Available well information does not completely identify location, operation and depth of wells in the vicinity of the site. Available information does suggest, however, that limited, if any, wells are in operation immediately down-gradient of the site. In addition, no available information suggests any significant or complete pathways for human exposure to contaminants from other uses of groundwater, including the case of the occasional use (by Mr. McGee) of water from the groundwater-fed pond (offsite area) for lawn irrigation. For these reasons, exposure to groundwater was not assessed. However, the assessment did examine the concentrations of chemicals found in groundwater on or downgradient of the site and identified the presence of multiple chemicals at concentrations which exceeded (often greatly) the chemical's Safe Drinking Water Act Maximum Contaminant Levels (MCLs).

- The considered receptor groups wold not be exposed to sub-surface soils under normal circumstances, so all exposure pathways were identified as incomplete. It was recognized that future construction workers may excavate or otherwise disturb sub-surface soils, but it was assumed any sub-surface disturbance would performed under the requirements of an appropriate Health and Safety Plan (HSP), which would adequately protect all workers from exposures.

- Exposure to sub-surface soil chemicals that have migrated to the overlying atmosphere was not assessed because the pathway was anticipated to be minimal for all receptors groups. Some limited available ambient air data were available with which to examine this assumption, and generally confirmed that exposure via ambient air would not pose unacceptable health risks. Additional air monitoring is recommended to further quantify the TCE AGC exceedance.

- Exposure to surface soils was not assessed because there was virtually no surface soil data and the site history suggests that chemical releases occurred solely to the sub-surface or within the building and were largely solvents. Analysis of one surface soil sample north of the building detected a lead concentration of 4,520 mg/kg which is above the EPA's recommended soil lead level. The results of this sampling have not been confirmed by resampling of the surface soils. A second sample was determined to have 41.7 mg/kg total lead.

1.0 INTRODUCTION AND OBJECTIVES

A human health assessment has been developed by Woodward-Clyde Consultants for the Xerox Facility in Blauvelt, New York. The objective of the assessment is to ascertain whether unacceptable health risks are posed to humans by current site conditions. The assessment examines potential health impacts that could be incurred by humans currently on or near the site as a result of exposure to site-related chemicals (as currently determined) under current and plausible future site use.

The assessment follows guidance developed by the U.S. Environmental Protection Agency (EPA) for performing baseline risk assessment under the Superfund Program. This guidance includes "Risk Assessment Guidance for Superfund - Volume I: Human Health Evaluation Manual (Part A)" (EPA, 1989a), "Human Health Evaluation Manual, Supplemental Guidance: 'Standard Default Exposure Factors'" (EPA, 1991b), and other supplemental assessment guidance.

2.0 SITE BACKGROUND

The Xerox site is briefly described in this section. A more complete description of the site is provided elsewhere in this report and in previous site reports (Dames and Moore, 1985). In addition, the site setting is more completely described in Section 4.0 of this assessment.

The Xerox facility (site) is located in the unincorporated town of Blauvelt, Rockland County, New York. From 1970 to 1979, the site was used as a refurbishing facility for leased equipment. Two underground storage tanks (USTs) were located north of the building and were used for the storage of virgin and waste solvents. Two documented spills from the waste solvent tank resulted in the introduction of organic contaminants into the sub-surface. In addition, an are inside the building where spraying operations took place also is associated with the release of solvents. The refurbishing operations ceased in 1979 and the facility is currently being used for warehousing and office space.

3.0 SUMMARY OF ANALYTICAL DATA

Chemical analytical data obtained through sampling of groundwater, soil, sediment and surface water at the site are presented in this section. The objective of this data summary is to be able discussion of potential human exposure pathways at the site.

3.1 GENERAL DISCUSSIONS

A focused evaluation of site media was conducted during the investigative phase at the site. Specifically, media were analyzed for individual volatile organic compounds (VOCs) and (in some samples) lead; a full analytical scan was not performed. All results as supplied by the analytical laboratory (General Testing Corporation) are assumed to be adequate for use in a quantitative risk assessment. This assumption is anticipated to result in a conservative estimate of potential health risks.

A summary of the results of groundwater, soil, surface water and sediment sampling is presented in the following sub-sections. Figure 3-1 indicates the location of samples collected on and off of the site property.

3.2 GROUNDWATER ANALYTICAL DATA

Table 3-1 presents the results of groundwater chemical analysis of overburden (approximately 0-25 feet below ground surface [bgs]), shallow bedrock (approximately 25-40 feet bgs) and deeper bedrock (approximately 60-70 feet bgs) groundwater wells. The frequency of detection of each chemical in each unit is calculated, as are the mean and 95% upper confidence limit (UCL) concentration.[1] In general, highest chemical concentrations were detected in overburden wells, with decreasing chemical concentrations in deeper strata; however, there have been elevated levels contaminants in offsite bedrock wells on occasion. Also, wells that are located on the site property have higher chemical concentrations than off-site wells (those denoted by "OS"). Off-

---

1 The 95% upper confidence limit concentration is derived by applying the student's "t" distribution and the sample standard deviation of the untransformed data, assuming that chemicals not detected at certain locations are present at one-half of the practical quantitation limit (PQL).

site wells also have a lower frequency of detection of chemicals.

3.3 SOIL ANALYTICAL DATA

Table 3-2 present the results of chemical analysis of soils collected from the surface (0-2 feet in depth), subsurface (2-10 feet in depth) and deeper intervals (greater than 10 feet in depth). The division of soils into intervals of "surface", "sub-surface" and "deeper" soils is performed to examine the chemical present and concentrations at different depths. This allows an examination of the potential for exposure to soil-bound chemicals during different types of activities (e.g., non-intrusive versus intrusive activities).

Surface soil samples (0-2 feet) were collected primarily from the area underneath the former spray booth within the building, with a few samples collected from the grassy area near former underground storage tanks (USTs) south of Bradley Hill Road. The presence of volatile organic compounds (VOCs) in surface soils is limited to methylene chloride, tetrachloroethane (PCE), 1,1,1-trichloroethane (1,1,1-TCA) and trichloroethane (TCE), in soils collected from underneath the building. Lead was analyzed in only one surface soil sample (RIB-2, in the grassy area adjacent to Bradley Hill Road), and was detected at a concentration of 4,520 mg/kg. This location was resampled in December 1992 and the analysis showed a total lead concentration of 41.7 mg/kg.

Sub-surface soil samples (2-10 feet) were collected from the area of the former USTs north of the building, with some off-site soil samples collected north of the site within Bradley Industrial Park. VOCs were detected in most on-site soil samples, and included methylene chloride, PCE< 1,1,1-TCA, TCE, chlorothen, 1,1-dichloroethane (1,1-DCA), 1,2-dichloroethane (1,1-DCE), ethylbenzene, toluene, vinyl chloride and xylenes. VOCs were not detected in off-site soil samples, with the exception of one detection of methylene chloride at MW-OS-6R (6-8 feet) on the swim club property at a concentration of 12.4 ug/kg. Analysis of lead was not performed in any sub-surface soil sample.

Deeper soil samples (greater than 10 feet in depth) were collected from beneath the building near the former spray booth, north of the building near the former USTs and in off-site areas within Bradley Industrial Park. The presence of VOCs in deeper soil samples was less frequent than in either surface or sub-surface soils. VOCs were detected primarily in the former spray booth and UST locations. VOCs detected included 1,1-DCA, 1,1-DCE, 1,2-DCE (total), methylene chloride, PCE, 1,1,1-TCA and TCE. Lead was analyzed and detected in soils from both inside and outside of the Xerox building, at concentration ranging from 7.7-17.1 mg/kg.

Off-site deeper soil samples, with a few exceptions, did not contain VOCs. Three VOC's were detected at one off-site location, MW-OS-2R (at depths of 10-12 feet and 20-22 feet), just north of Bradley Hill Road, about 200 feet northwest of RI-10 (total 1,2-DCE at 10.7 and 7.9 ug/kg, PCE at 28.3 and 15.8 ug/kg and TCE at 5.3 and 6.7 ug/kg for the two depths, respectively). Only one VOC (methylene chloride) was detected at two other off-site locations. Location MW-OS-6R, depth interval 22-24 feet, contained methylene chloride at a concentration of 8.3 ug/kg. Location MW-OS-9R contained methylene chloride at two depth intervals: 10-12 feet at a concentration of 6.7 ug/kg and 28-30 feet at a concentration of 5.5 ug/kg. MW-OS-6R is on the swim club property and MW-OS-9R is adjacent to another property within Bradley Industrial Park, west of the swim club. Sub-surface and deeper soil sampling locations between these two locations and the on-site soil locations were not found to contain VOCs, suggesting an independent source or presence as a result of inadvertent introduction during sampling or analysis.

3.4 SURFACE WATER ANALYTICAL DATA

Table 3-3 presents the results of chemical analysis of surface water collected from a small creek which flows through the site. Samples were collected from the nine locations; sample location 9 is located in an upstream (background) location.

Five VOCs were detected in six surface water samples: 1,1-DCA, 1,2-DCE (total), PCE< 1,1,1-TCA and TCE in samples 1, 2, 3, 4, 5 and 6. No VOCs were detected in the upstream surface water sample (9) or in sample locations 7 and 8. Concentrations of most VOCs were low: under 10 ug/L for 1,1-DCA and 1,2-DCE (total); under 20 ug/L for 1,1,1-TCA; under 30 ug/L for TCE and under 60 ug/L for PCE.

3.5 SEDIMENT ANALYTICAL DATA

Table 3-4 presents the results of chemical analysis of sediments collected from the stream at the same general location in which surface water samples were collected. Six VOCs were detected at all sediment sampling locations except the up-gradient location. In addition to the five VOCs detected in surface water samples, methylene chloride was also detected in sediments in all but two samples (sample numbers 6 and 9), at concentrations ranging from about 5-15 ug/kg.

4.0 INTRODUCTION OF CHEMICALS OF CONCERN

4.1 INTRODUCTION

The chemical data are examined in this section to select chemical of concern to be addressed in the human health assessment. The objective of the chemical selection process is to evaluate the chemical data against a number of criteria to select those chemicals that may pose a potential health risk if humans are exposed.

The chemical selection process typically involves examining the following factors:

- Review of data quality;
- Comparison with background concentrations;
- Review of frequency of detection; and
- Comparison with health-based benchmarks.

These criteria are discussed in the following sections.

4.2 REVIEW OF DATA QUALITY

The objective of performing a review of the quality of the data is to ensure that data applied to the assessment are of adequate quality to support the quantitative conclusions drawn from the data. Factors addressed in this review typically include:

- Review of the quantitation limits for adequacy;
- Review of the data qualifiers (e.g., estimated "J" values, undetected "U" values, rejected "R" data); and
- Review of chemical presence in laboratory or field blanks ("B").

Actual sample quantitation limits were not available for the site data, so practical quantitation limits (PQLs) were used. While undetected results were identified by the laboratory (designated by the qualifier "U"), no data were presented as estimated ("J") or otherwise qualified. All data are, therefore, assumed to be actual chemical concentrations in the sampled medium. Since estimated ("J") data re commonly used in risk assessments along with non-qualified data, this assumption has little impact upon the assessment. Rejection of data was usually quite limited, based on available data quality assurance and quality control information, suggesting a minimal impact upon the assessment.

No information on field or laboratory blanks was available, so all chemicals are assumed to be present in the sample as a result of presence in the environment, not due to inadvertent introduction during sampling or analysis. Some of the chemicals detected, such as methylene chloride, are common laboratory artifacts. Inclusion of chemicals in the assessment that are actually a result of sampling or laboratory artifacts may result in an over-estimate of potential exposures.

In summary, the assessment assumes that all data are of sufficient quality to support a quantitative assessment, and this assumption is anticipated to result in a conservative assessment of potential health risks.

4.3 COMPARISON WITH BACKGROUND CONCENTRATIONS

This chemical selection criterion is most appropriately applied to the evaluation of chemicals that have a natural or ubiquitous presence in the environment, such as metals or certain organic compounds (e.g., polycyclic aromatic hydrocarbons). The chemicals analyzed in site media were primarily limited to VOCs, none of which have notable natural or ubiquitous presence in the environment. Therefore, this criterion has limited utility at this site. The exception to this is lead, which exists normally in the environment.

Comparison of lead in site soils with background concentrations cannot be performed because no soil background samples were collected. One groundwater well (U6), located hydrologically up-gradient from other site wells and the suspected source areas, could be considered a background location for groundwater; however, since this well is located on the site and was found to contain chemicals also found in site wells, it was not used as representative of background. The background sample locations for surface water and sediments did not contain any detected chemicals. No chemicals were removed from consideration as a chemical of concern as a result of comparison with background concentrations.

4.4 FREQUENCY OF DETECTION

This chemical selection criterion is used to identify those chemicals which are present at high enough frequency in site media to pose a potential exposure hazard. Chemicals with limited detection are unlikely to be contacted regularly enough to pose a potential health hazard. In the data summary tables, the frequency of detection for each chemical is presented. Table 4-1 summarizes the detection frequency for all chemicals in all media. If a chemical was only detected once in a medium, has a total frequency of detection of 5% or less in all media combined or less than 10% in each individual medium, it was removed from consideration as a chemical of concern. Based on these criteria, the following chemicals were removed from further consideration as a chemical of concern:

- Chlorothen (detected once in soil)
- 1,2-Dichloroethane (detected once in soil)
- Ethylbenzene (detected once in soil)
- Toluene (detected once in soil)
- Vinyl chloride (detected once in soil and once in groundwater)
- Xylenes (detected twice in soil)

4.5 COMPARISON WITH HEALTH-BASED BENCHMARKS

This criterion compares site chemical concentrations with readily available health-based benchmarks to evaluate whether chemicals are present in concentrations that may pose a health impact. Of the media sampled, soils and sediments do not have readily available human health-based benchmarks with which to compare site chemical concentrations. Therefore, this criterion was not applied to these media. Both groundwater and surface water average concentrations are compared with two human health-based benchmarks: the Safe Drinking Water Act Maximum Contaminant Levels (MCLs) and State of New York groundwater quality standards.[2] This comparison is shown on Table 4-2. Based on this comparison chloroform was removed from further consideration as a chemical of concern. The highest average concentration of chloroform detected in groundwater (deep bedrock wells) was 2.5 ug/L; the MCL and NY standard for

---

[2] Evaluation of potential ecological impacts of site media are assessed in a separate section of the Feasibility Study.

chloroform in groundwater is 100 ug/L. The maximum detected concentration of chloroform in any well was 9.1 ug/L. Chloroform was not detected in surface water.

4.6 SUMMARY

Based on the chemical selection process applied above, the following chemicals were selected as chemical of concern for the site:

- 1,1-DCA
- 1,1-DCE
- 1,2-DCE (total)
- Methylene chloride
- PCE
- 1,1,1-TCA
- TCE
- Lead

5.0 EXPOSURE ASSESSMENT

5.1 INTRODUCTION

This section of the assessment describes the potential human exposure pathways at the site and discusses the likelihood that any exposure pathway is complete. An exposure pathway generally consists of four elements: 1) a source and mechanism of release, 2) a retention or transport medium or media, 3) a point of potential human contact with the contaminated medium (exposure point), and 4) an exposure route (EPA 1989a). If one of these elements is missing, the potential exposure pathway is incomplete, and human exposure to the chemical cannot or does not occur. A quantitative assessment was performed for complete exposure pathways, as identified by this evaluation.

5.2 SITE SETTING

The Xerox facility is located in an industrial area of Blauvelt, Rockland County, New York. The northern portion and the periphery of the site is paved or covered with vegetation (either grass or woods); the remainder of the site property is occupied by the facility building. Land north of the site is occupied by Bradley Industrial Park, which contains numerous small industrial/commercial facilities, an operating restaurant on Bradley Road, across from the site, and a private swim club around which the industrial park is located. The site is bordered to the east by Route 303, a commercial thoroughfare. West of the site are railroad tracks, followed by undeveloped, vegetated land. South of the site are commercial facilities and residences. There are not residential areas immediately adjacent to the site. Residential areas do not exist near the site, primarily to the south, west and east, and further to the north.

A small creek flows north through the site property. The creek is a small water body that does not have a sustainable fish population. This creek has been defined as intermittent, but has not been observed by Xerox to be noncontinuous. The creek borders the western boundary of the building, flowing north along the railroad tracks. North of the building, the creek passes under a number of sub-surface pipes, then flows into a dense woodland area once crossing Bradley Hill Road. At this point in Bradley Industrial Park, the creek becomes channelized and somewhat wider. After leaving the park, the creek becomes dendritic, widening outward to form a marshy area, which eventually re-channelizes and flows to the Hackensack River. The presence of site-related chemicals in the creek suggests a potential hydrologic connection between groundwater and the creek. A small, landscaped pond (about 25' x 30'), exists near the main building of Bradley Industrial Park, and is connected to the creek.

5.3 POTENTIALLY EXPOSED RECEPTORS

Examination of potentially exposed receptors at the site includes consideration of the following populations:

- Potential residential receptors
- Potential on-site workers
- Potential off-site workers
- Potential construction workers
- Potential trespassers
- Potential recreational receptors

These populations may become potentially exposed only if there is a complete exposure route resulting in contact with chemicals of concern. The presence of these populations are described first, then the potential exposure pathways for these populations are examined for completeness, in the following sections.

5.3.1 Potential Residential Receptors

The site is currently an operating facility, used primarily for offices, telemarketing and warehousing, with no residential receptors currently located on-site. Xerox Corporation has indicated that use of the facility for light industry and office space is planned for at least 16 years. Based on this, on-site residential receptors are not a potentially exposed population.

Residential areas are located primarily to the south, west and east of the site, and at further distances, to the north. In addition, the vacant land to the west of the railroad tracks may be developed for residential use in the future. Based on proximity to the site alone, off-site residential populations are a potentially exposed population.

5.3.2 Potential On-Site Worker Populations

The Xerox facility is currently in use as office, tele-marketing and warehousing space. Workers at the facility may be potentially exposed to site-related chemicals if exposure pathways are complete. Since workers are located on the site, worker populations are a potentially exposed population.

5.3.3 Potential Off-Site Worker Populations

In addition to Xerox workers, off-site workers in Bradley Industrial Park (including visiting property owners) or Conrail workers along the railroad track west of the site are potentially exposed populations if chemicals from the site migrate to off-site areas.

5.3.4 Potential Construction Worker Populations

Construction or excavation of soil at the Xerox facility is a plausible occurrence under future land use. Excavation may occur during expansion activities or during remediation of site media.

In light of the knowledge of site conditions, it is anticipated that any construction or excavation performed at the site would be conducted under an appropriate Health and Safety Plan (HSP), which would provide appropriate protection for workers. Therefore, uncontrolled exposure to site chemicals is not likely to occur. Based on this, hypothetical future construction workers are not a potentially exposed population and the evaluation of complete exposure pathways for future construction workers is not performed.

5.3.5 Potential Trespasser Populations

The site is located in an industrial park, which has minimal attractiveness to trespassers. However, some of the land is grassy and/or wooded, and may attract trespassers to the site. In addition, the small creek which flows past the site and into the Bradley Industrial Park may also act as attractant for trespassers, who may wade in the water. Users of the private swim club within Bradley Industrial Park may occasionally walk down to the creek. Adults and older children could feasibly trespass in the area. Trespassing of very young children (age six and under) is not likely, given the distance of the site from residential areas. Based on these factors, adults and youth trespassers are potentially exposed populations.

5.3.6 Potential Recreational Populations

There are not significant areas near the site that serve as public or private recreational areas, such as parks or large water bodies. Therefore, recreational populations are not potentially exposed. Populations that may trespass the site for limited recreational purposes (such as wading in the creek) are considered as trespassers.

5.3.7 Summary of Potentially Exposed Populations

Based on the discussion above, the following are considered potentially exposed populations:

- Off-site residents;
- On-site workers;
- Off-site workers; and
- Trespassers.

Whether exposure of these populations is complete (i.e., whether or not it occurs) is dependent on the presence of site-related chemicals at locations where receptors are located. The completeness of exposure pathways is discussed in the next section.

5.4 POTENTIAL EXPOSURE PATHWAYS

Potential exposure routes which are considered for completeness are those presented in EPA's "Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Part A)" (EPA 1989a). These potential exposure routes are:

- Ingestion of groundwater;
- Dermal contact with groundwater;
- Incidental ingestion of surface water;
- Dermal contact with surface water;

- Incidental ingestion of sediments;
- Dermal contact with sediments;
- Inhalation of vapor phase chemicals (indoors and outdoors);
- Inhalation of soil-bound chemicals (indoors and outdoors);
- Incidental ingestion of soil;
- Dermal contact with soil; and
- Ingestion of biota into which chemicals have bioaccumulated.

Each of these exposure pathways is discussed in the following sections. Figure 5-1 depicts a conceptual model for the site, and highlights the potential exposure pathways.

5.4.1 Ingestion of Groundwater

Groundwater investigations indicate that groundwater in all three hydrostratigraphic units flows to the northwest, into the industrial park and away from the closer current residential areas. The chemical data collected at the site indicates that chemicals are present in groundwater at the site, and the groundwater plume extends north of the site within Bradley Industrial Park. Chemicals are contained in the overburden, shallow bedrock and deeper bedrock zones.

Municipal potable water supplies in Blauvelt and Rockland County, New York, are supplied by the Spring Valley Water Company (SVWC), which obtains water supplies from numerous groundwater withdrawal well fields located throughout Rockland County and two surface water intakes. A report by the SVWC indicates that no well fields are located in the vicinity of the site (SVWC, 1985).

A well inventory was conducted in 198 on behalf of Xerox Corporation to ascertain the existence of private groundwater wells in the vicinity of the site (WCC, 1989). The survey was based upon discussions with the New York State Department of Environmental Conservation (NYSDEC), and the New York State Department of Health (NYSDOH), and drew upon information provided by the Rockland County Health Department (RCHD) and the SVWC. Twenty-three private wells were identified as located in the vicinity of the site. These wells are summarized in Table 5-1. Most of these wells (22 of 33) are located in areas up- or side-gradient of the site. Ten wells were identified as located north or northeast of the site. Three wells were identified within Bradley Industrial Park, two wells along Route 303 belonging to commercial/recreational facilities, six commercial or residential wells were identified at distances of or greater than one quarter of a mile north/northeast of the site. Unfortunately, well depths and use of the wells are not known, so it cannot be determined if these wells represent potential exposure points. The report on this survey indicated that efforts were underway in 1989 to connect many of these residences to the municipal water supply through expansion of the municipal water distribution system (WCC 1989); however, a discussion with the RCHD indicated that these connections are not yet complete (RCHD, 7/92).

Recently (during 1992), the RCHD delivered survey questionnaires to commercial and residential dwellings in the area to determine which groundwater wells were still in use. Bradley Industrial Park was not surveyed. Only two responses were received, one from a residence and another from a commercial facility, both located one-half mile north of the site. Both of these wells were sampled. No chemicals were detected in the well of the commercial facility; the residential well was found to contain 9 ug/L of PCE prior to the in-home filter (this concentration exceeds the maximum contaminant level for PCE of 5 ug/L). The depth of the well is not known, so the potential for this well being impacted by site groundwater cannot be ascertained. The health department is following through on this finding (RCHD, 1992). The potential impacts of residential exposure to PCE in this well is discussed further in Section 7.0

Three wells were previously identified within Bradley Industrial Park: one at the main office for the park, one at Tri Seal Corporation and one at the Oratamin Swim Club. The depths of these wells are not known. The manager of the industrial park was contacted regarding the status of these wells (personal communication with Mr. John McGee, Bradley Industrial Park, 7/92). Mr. McGee indicated that the well in the park office hadn't been used for some time, and that the potable water for the office was obtained from SVWC. When Tri Seal Corporation was contacted, the management was not sure where their water was supplied from and suggested Mr. McGee be contacted (personal communication, Tri Seal Corporation, 7/92). Mr. McGee indicated that Tri Seal Corporation's potable water supply was also supplied by SVWC, although he thought that the company may use groundwater as non-contact process water. Mr. McGee was not sure of the source of water for the Oratamin Swim Club, although indicated that all other facilities within the industrial park obtained their water through the SVWC. Ms. Glenna Mara of the swim club was contacted and indicated that, to her knowledge, their water supply was also from the SVWC (personal communication, Ms. Glenna Mara, 7/92).

Based on information from the RCHD and discussions with the above individuals, exposure to groundwater is unlikely to occur to any receptor group located at or near the site (on-site workers, off-site workers, off-site residents or trespassers). Therefore, exposure to groundwater is not quantitatively assessed. However, since groundwater at the site has been impacted, the chemical analytical results of the groundwater analysis are examined semi-quantitatively by comparison to groundwater standards and drinking water values in Section 7.0.

5.4.2 Dermal Contact with Groundwater

Dermal contact with groundwater is likely only if groundwater near the site is used for direct contact purposes typical of residential use, such as bathing. Based on the discussion presented in the previous section, routine or significant groundwater use at the site or in areas immediately north of the site does not occur for any receptor group (on-site workers, off-site workers, off-site residents or trespassers). Therefore, significant dermal contact with groundwater is unlikely to occur and is not quantitatively assessed.

Xerox has information that an offsite property owner (Mr. McGee) occasionally uses groundwater from the groundwater-fed pond (in the offsite area) to sometimes irrigate this lawn during drought periods. Any potential for exposure of Mr. McGee to groundwater contaminants during his occasional irrigation activity, via dermal contact with pond water, is believed to be essentially nil or nonexistent. Therefore, no complete human exposure pathway via this activity has been identified. Consequently, no quantitative or semi-quantitative evaluation of potential exposure is warranted.

5.4.3 Ingestion of Surface Water

The small creek flows adjacent to and through the Xerox property and through Bradley Industrial Park. A field survey indicated that the creek widens and discharges into a swampy area north of the industrial park. This swampy area also receives input from other creeks, and eventually empties into the Hackensack River.

While the creek flows through the site or Bradley Industrial Park, it may act as attractant for trespassers. While wading or playing in the water, small amounts of surface water may be inadvertently ingested. Therefore, this exposure pathway is complete for trespassers and is assessed.

Potential downstream exposure of off-site residents to chemicals contained in the creek could occur in areas where the creek flows through residential areas. Surface water sample data indicate that any contaminant concentrations are low. Any volatile contaminants that have entered the creek water in the past would likely decrease in concentration, due to volatilization, as the water flowed down the creek bed. Thus, hazards associated with creek water contaminants would be low. The extent of exposure is likely to be similar to that experienced by trespassers. Assessment of trespasser exposure adequately addresses potential exposure of off-site residents.

Neither on-site workers nor off-site workers are anticipated to contact the creek during part of their normal work activities, so worker-related exposure to creek surface water is incomplete. If workers did contact creek surface water outside the scope of their normal work, the extent would be expected to be similar to contact by trespassers. Therefore, the potential exposure of workers to surface water is adequately covered by assessment of trespassers.

5.4.4 Dermal Contact with Surface Water

Potential dermal exposure to surface water amy occur to the same receptors discussed in the previous section, i.e., trespassers may be exposed to creek surface water during trespassing activities. This potential exposure pathway for trespassers is assessed. Potential dermal contact with surface water by on-site or off-site workers or off-site residents is adequately described by the assessment of trespassers.

5.4.5 Incidental Ingestion of Sediments

Potential incidental ingestion of sediments in the creek may occur to the same receptors discussed for the surface water exposure pathways. Therefore, incidental ingestion exposure to trespassers is assessed. Exposure to other receptors is adequately described by assessment of trespassers.

5.4.6 Dermal Contact with Sediments

Potential dermal exposure to sediments is assessed for potential trespassers. Exposure to on- and off-site workers and off-site residents is adequately described by assessment of trespassers.

5.4.7 Inhalation of Vapor Phase Chemicals

Volatile chemicals contained in soils could theoretically volatilize to the overlying atmosphere and result in exposure to receptors. However, the majority of soils containing volatile chemicals are located several feet beneath the surface and/or underneath pavement or buildings. Therefore, it is not likely that volatile chemicals would migrate to the overlying atmosphere at a significant rate. In addition, any volatile emissions from the soil are likely to be diluted by mixing with atmospheric winds to low or negligible concentrations. This suggest that exposure of off-site residents, on- or off-site workers or trespassers, although potentially complete, is not a major exposure pathway.

Recently, an "Ambient Air Toxic Monitoring Program" was conducted at the site by WCC (5/92) and is discussed elsewhere in the FS. In this program, five 8-hour samples were collected in the area of the former USTs and analyzed for a variety of volatile organic compounds.[3] Several volatile organic compounds were detected, but at low concentrations (in the low ug/m^3 range or below).

Results were compared with New York State 1991 proposed short-term (1 hr.) and annual guideline concentrations (SGC/AGC). The results are presented in Table 5-2. All air concentrations detected were below (often substantially) the short-term guideline values. All chemical concentrations, except benzene and TCE, were also below annual guideline values. Detected benzene concentrations ranged from 0.43 ug/m^3 to 0.95 ug/m^3, concentrations that are higher than the annual guidance concentration of 0.12 ug/m^3. However, ambient air concentrations of benzene of 6-10 ug/m^3 are typical of urban and residential areas, resulting primarily from combustion of gasoline by motor vehicles (Wallace, 1989). The presence of the parking lot and Route 303 near the monitored area could account for the benzene detected in

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[3] Analtyes included 1,1-DCA, 1,1-DCE, trans-1,2-DCE, ethylbenzene, benzene, methylene chloride, 1,1,1-TCA, PCE, toluene, TCE and o- and m & p-xylenes.

air samples. Benzene was not detected in soils.

Only one measurement of TCE (6.79 ug/m^3) exceeded the NY Annual guideline concentration of 0.45 ug/m^3. While TCE in ambient air is also not uncommon as a result of various sources, the presence of TCE at the site may be a result of release from site soils. Limitations in the data (change in wind direction and precipitation during sampling, a single sampling event(preclude using these results to assess potential health risks to on-site workers, off-site workers, off-site residents or trespassers. The detection of TCE in ambient air is examined semi-quantitatively in Section 7.0.

Indoor inhalation exposure to volatile chemicals through migration of the chemical through the building is not complete for off-site residents or off-site workers, since impacted soils are largely contained within the boundaries of the site property. Indoor inhalation exposure to on-site workers is not anticipated to be significant, since floor structures should impede the migration of volatile chemicals into indoor air spaces. In addition, indoor air quality in the work place is within the purview of OSHA (the Occupational Safety and Health Administration), which maintains requirements for indoor air quality for work place exposure.

Xerox has information that an offsite property owner (Mr. McGee) occasionally uses groundwater from the groundwater-fed pond (in the offsite area) to sometimes irrigate this lawn during drought periods. Any potential for exposure to Mr. McGee to groundwater contaminants during his occasional irrigation activity, via or inhalation of volatilized pondwater contaminants, is believed to be essentially nil or nonexistent. Therefore, no complete human exposure pathway via this activity has been identified. Consequently, no quantitative or semi-quantitative evaluation of potential exposure is warranted.

5.4.8 Inhalation of Soil-bound Chemicals

Entrainment of soil-bound chemicals in air could theoretically occur if site-related chemicals were contained on surface soil particles and surface soil were available for entrainment. However, the release of chemicals from the former USTs and the indoor release of chemicals in the former spray booth area have results in the impact of sub-surface or sub-structure soils. In addition, only limited amounts of outdoor soils are available for entrainment, since much of the land on the site is either paved or covered with vegetation. Furthermore, volatile compounds contained on exposed soils would be expected to volatilize quickly, reducing soil-bound concentrations over time. Based on these factors, this exposure pathway is incomplete for off-site residents, on-site residents, on-site workers, off-site workers and trespassers, and is not assessed.

5.4.9 Incidental Ingestion of Soil

Similar to the pathway for potential inhalation of volatilized, soil-borne chemicals, soils impacted by chemicals of concern at the site are largely deeper soils, and are not available for contact by off-site residents, on-site workers, off-site workers or trespassers. Therefore, this exposure pathway is incomplete for these receptors and is not assessed.

5.4.10 Dermal Contact with Soil

As indicated in the previous section, exposure of off-site residents, on-site workers, off-site workers and trespassers to impacted soil at the site is incomplete, and is not assessed.

5.4.11 Ingestion of Biota that have Bioaccumulated Chemicals

Field surveys of the creek that flows through the site indicate that the creek does not have a sustainable fish population in the vicinity of the site. Therefore, significant populations of aquatic organisms that could be caught and consumed by humans do not exist. In addition, the volatile organic compounds detected at the site do not have a propensity to bioaccumulate into fish tissue. This exposure pathway is incomplete and is not assessed.

5.4.12 Summary of Exposure Scenarios Assessed

The potential exposure pathways that are quantitatively assessed are summarized below:

- <u>Potential Off-site Residents</u>
  Exposure described by trespasser scenarios

- <u>On-site Workers</u>
  Exposure described by trespasser scenarios

- <u>Off-site Workers</u>
  Exposure described by trespasser scenarios

- <u>Potential Trespassers</u>
  Dermal contact with surface water
  Incidental ingestion of surface water
  Dermal contact with sediments
  Incidental ingestion of sediments

In addition, although not known to be a complete exposure pathway at the site, the groundwater quality at and north of the site is examined semi-quantitatively in Section 7.0, with respect to exceedences of drinking water quality standards. Furthermore, the available air monitoring data that exceed New York State AGC levels are also examined.

5.5 CALCULATION OF EXPOSURE POINT CONCENTRATIONS

To estimate the chemical concentrations to which the above receptors may be exposed, exposure point concentrations are derived according to guidelines developed by the EPA for the Superfund program (EPA 1989a). Exposure point concentrations are derived for four media: surface water, sediments, soil and air, discussed in the following sub-sections.

5.5.1 Surface Water Exposure Point Concentrations

The chemicals detected in surface water samples from the creek were presented in Table 3-3. The following detected chemicals were identified as chemicals of concern: 1,1-DCA, 1,2-DCE (total), PCE, 1,1,1-TCA and TCE (all chemicals detected were selected as chemicals of concern). Based on the sample results, concentrations relating to the 95% upper confidence limit (UCL) of the arithmetic mean were calculated, using the sample standard deviation and the student's "t" distribution. Chemicals that were not detected at some locations were assumed to be present at one-half of the detection limit (estimated by the practical quantitation limit). Results from sampling location 9 (background) were not included. The concentration used to estimate exposure the chemicals is the lower of either the 95% UCL or the maximum detected concentration.[4]

5.5.2 Sediment Exposure Point Concentrations

Chemicals detected in sediment samples from the creek were presented in Table 3-4. Chemicals of concern detected in sediments were: 1,1-DCA, 1-2, DCE (total), methylene chloride, PCE, 1,1,1-TCA and TCE (all chemicals detected were selected as chemicals of concern). The lower of either the 95% UCL or the maximum detected concentration is applied as the exposure point concentration for sediments.

5.5.3 Soil Exposure Point Concentrations

All exposure pathways to soils containing chemicals of concern were identified as incomplete or minor.

5.5.4 Groundwater Exposure Point Concentrations

All exposure pathways to groundwater containing chemicals of concern were identified as incomplete or minor.

5.6 CALCULATION OF CHEMICAL INTAKES

The complete exposure pathways identified in the exposure assessment are limited to those associated with trespassing:

- Dermal contact with surface water
- Incidental ingestion of surface water

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[4] In some instances, the 95% UCL concentration can exceed the maximum detected value if the detection limits are high relative to detected concentrations, or if the variance of the data is large. In these cases, the maximum detected concentration is applied as the exposure point concentration.

- Dermal contact with sediments; and
- Incidental ingestion of sediments.

Assessment of trespassers was identified as adequately describing potential exposure of on-site workers, off-site workers and off-site residents, as well.

Trespassers of adult and youth age (of age 9 to 18) were identified as potentially exposed receptors. Two different exposure scenarios are considered: a reasonable maximum exposure (RME) scenario and a more typical exposure. The RME exposure scenario generally applies default or more conservative assumptions regarding chemicals exposure point concentrations and exposures, whereas the more typical exposure scenario applies values descriptive of average exposures.

The exposure and intake parameters that are applied to predict chemical intakes in trespassers are presents in Table 5-3. The values adopted are either recommended by EPA guidance or are derived from the primary literature. The rationale for selection of these values and references are also provided.

Calculation of chemical intakes is performed by applying these values to standard intake equations, as presented in RAGS (EPA, 1989a). These equations vary for the different exposure pathways, but are of the general form:

$$I = C \left(\frac{CR*EDF}{BW}\right) \left(\frac{1}{AT}\right.$$

where:

I = Intake of the chemical (mg/kg-dy);

C = Concentration of the chemical in the contacted medium, (e.g., mg/L);

CR = Contact rate, or the amount of media contacted per unit time or event (e.g., L/hr);

EFD = Exposure frequency and duration, describing how long and how often exposure occurs, usually expressed in two or more terms (ET, exposure time; EF, exposure frequency, and ED, exposure duration (e.g., hr/day x days/year x years);

BW = Body weight (kg);

AT = Averaging time, the time over which exposure is averaged, which differs from carcinogens and non-carcinogens (days).

The intakes calculated by this approach are combined with toxicity values for the chemicals of concern to derive estimates of the potential health risks associated with the exposure. Toxicity values for the chemicals of concern are discussed and presented in Section 6.0.

6.0 TOXICITY ASSESSMENT

6.1 INTRODUCTION

This section of the assessment describes the types of toxicity values available for the chemicals assessed in this assessment. The toxicity values presented in this section are later combined with the chemical intakes calculated in the previous section to estimate the potential excess lifetime cancer risks and potential non-carcinogenic health hazards posed by exposure to the chemicals.

In general, two broad types of potential human toxicity are considered in this assessment: carcinogenicity and systemic toxicity (toxicity other than carcinogenicity, such as organ damage or impairment of physiological functions). Chemicals which can elicit a carcinogenic response are referred to as non-carcinogens, although a chemical can exhibit both carcinogenic and non-carcinogenic effects. The toxicity values applicable to carcinogens and non-carcinogens and the methods for applying these values are described in this section. Toxicity values for chemicals assessed are also presented in Table 6-1.

6.2 TOXICITY ASSESSMENT FOR NON-CARCINOGENIC CHEMICALS

The toxicity value for chemicals that can elicit non-carcinogenic effects is referred to as a reference dose (RfD). A chronic Rfd is an estimate of a daily exposure level for the human population, including sensitive sub-populations, that is likely to be without an appreciable risk of deleterious effects during a lifetime (EPA, 1989a). An RfD is described as the intake or dose of a chemical per unit of body weight per day (mg/kg-day). Chronic RfDs are appropriate for assessing exposures of 7 years duration or greater. For exposures of less than 7 years duration, sub-chronic RfDs have also been derived (often they are the same as chronic RfDs).

For inhalation exposure, reference air concentrations (RfC) have been derived, which are expressed as milligrams of chemical per cubic meter of air per day (mg/m^3-day). These values can be converted to a corresponding RfD, assuming an adult body weight of 70 kg and a respiration rate of 20 m^3/day.

RfDs and RfCs are generally derived for animal studies, in which the "no observed adverse effect level" (NOAEL) or "lowest observed adverse effect level")LOAEL) is reduced (divided) by the number of uncertainty factors, which generally range from 10 to 1000. These uncertainty factors account for extrapolation of animal data to humans (factor of 10), sensitivity among humans (factor of 10), use of an LOAEL instead of an NOAEL (factor of 10) and use of a sub-chronic, rather than chronic, study (factor of 10).

Use of RfDs and RfCs assumes the existence of a toxicological threshold for non-carcinogens, i.e., a level of intake below which no adverse effect is expected to occur. At intakes below this threshold, it is postulated that normal or protective mechanisms of the body can metabolize or excrete the chemical, or that a certain"critical" level of the chemical must be reached before a toxic effect can be manifested.

Exposure of receptors to non-carcinogens is assessed by comparing the estimated chemical intake to the RfD to derive a hazard quotient, in the following manner:

$$\frac{\text{Intake (mg/kg-dy)}}{\text{Rfd (mg/kg-dy)}} = \text{Hazard Quotient (unitless)}$$

A hazard quotient of less than unity (1) indicates that the estimated chemical intake is less than the chemical's RfD. Hazard quotients for exposure to multiple chemicals is a given exposure pathway, and also from multiple exposure pathways, are added to derive an overall Hazard Index:

$$HQ_1 + HQ_2 + HQ_3 + \ldots HQ_n = \text{Hazard Index (HI)}$$

The acceptability of the overall HI is assessed by comparing the HI with the threshold comparison value of 1.0. If an overall HI is less than one, then is it unlikely that unacceptable non-carcinogenic health effects would occur as a result of exposure to multiple chemicals over multiple exposure pathways. Application of this approach assumes toxicological additivity; that all chemicals affect the same organ system, and that multiple exposure will result in an additive effect. This is a conservative assumption that is unlikely to underestimate actual non-carcinogenic health effects. As a screening level approach, additivity is assumed. If, however, an

HI of greater than 1.0 is derived, it is appropriate to examine the chemicals contributing to the exceedence of 1.0, and determine whether it is appropriate to assume they act in an additive fashion. If not, separate HIs for each appropriate toxicity endpoint can be derived.

6.3 TOXICITY VALUES FOR CARCINOGENIC CHEMICALS

The toxicity value for chemicals that can elicit a carcinogenic effect is referred to as a cancer Slope Factor (SF). An SF is an upper-bound estimate of the incremental probability of an individual developing cancer over a lifetime as a result of exposure to a potential carcinogen. An SF is expressed as risk per unit intake, or $(mg/kg\text{-}dy)^{-1}$. In addition to the numerical SF, each carcinogenic chemical is assigned a "weight of evidence" category which describes the likelihood that the chemical is a human carcinogen. These categories are "A" (known human carcinogen), "B1" (probable human carcinogen, but with less evidence that B1), "C" (possible human carcinogen), "D" (inadequate evidence with regard to potential human carcinogenicity), and "E" (positive evidence for non-carcinogenicity). Chemicals that are assigned a weight of evidence category of A, B1 and B2 are always assessed as carcinogens; chemicals with a "C" classification are assessed as carcinogens on a case-by-case basis.

Slope factors are derived primarily from animal studies, although epidemiological data are used, if available, In general, the dose-response relationship seen in the study is extrapolated to lower doses by application of one of several models, in order to predict the dose-response relationship at levels typical of environmental exposures. The 95% upper confidence limit of the slope of the dose-response relationship at lower doses is calculated, and this upper bound slope is adopted as the SF. It may further be modified to account for species differences (differences in body weight or intake rates). SFs are, therefore, upper bound, conservative values.

EPA guidance assumes that carcinogenicity is a non-threshold response, and that any exposure level is associated with a finite probability of producing a carcinogenic response. Therefore, there is theoretically no level of exposure that does not pose a small, though finite, probability of producing a carcinogenic response.

Exposure to carcinogens is assessed by combining the estimated intake with the chemical's SF to derive a unitless estimate of cancer risk:

$$\text{Intake (mg/kd-dy)} \times \text{SF (mg/kg-dy)}^{-1} = \text{Upper Bound Risk (unitless)}$$

Upper bound risks are combined (summed) for all chemicals to which a receptor is exposed in an exposure pathway, and also for all exposure pathways that may co-occur, to derive an overall upper bound cancer risk estimate.

The acceptability of a cancer risk estimate is evaluated by comparing the estimate to the acceptable risk range adopted by EPA. EPA has stated, in the National Contingency Plan (EPA, 1990b), that risks between the range of 1×10^{-4} and 1×10^{-6} are considered acceptable (clearly, risk below 1×10^{-6} are also "acceptable"). EPA has also indicated that action (e.g., remediation) is generally not warranted where the cumulative carcinogenic site risk, based on a reasonable maximum exposure for both current and future land use, is less than 1×10^{-4} (EPA 1991a).

6.4 TOXICITY OF CHEMICALS OF CONCERN

Summaries of the potential toxicity of the chemicals of concern are not included in this assessment. For information on the potential toxicity of the chemicals of concern, it is recommended that appropriate sources be consulted, such as Toxicological Profiles developed by the Agency for Toxic Substances and Disease Registry (ATSDR).

7.0 RISK CHARACTERIZATIONS

7.1 INTRODUCTION

This section of the human health assessment describes the potential cancer risk and non-carcinogenic Hazard Indices associated with exposure to site-related chemicals from the Xerox/Blauvelt site. These risk and hazard estimates are compared with acceptable levels or ranges as identified by the EPA (EPA 1990b). In the following sections, potential carcinogenic risks are first discussed, followed by a discussion of potential non-carcinogenic health hazards. Following these quantitative assessment, semi-quantitative assessments of measured groundwater and ambient air concentration and concentrations of lead in surface soils are presented.

7.2 QUANTITATIVE ASSESSMENT OF POTENTIAL CANCER RISKS

Potential cancer risks were assessed for trespasser exposure to site chemicals through four exposure pathways:

- Dermal contact with sediments;
- Incidental ingestion of sediments;
- Dermal contact with surface water; and
- Incidental ingestion of surface water.

Table 7-1 presents the upper bound cancer risk estimates for the RME scenario and Table 7-2 presents the upper bound cancer risk estimates for more typical exposures.

The overall upper bound cancer risk estimate for adults under the RME scenario through all four exposure pathways is 1×10^{-6}. This upper bound risk estimate is on the lower end of the acceptable risk range of 1×10^{-4} to 1×10^{-6}. This indicates that reasonable maximum exposure of adult trespassers to site-related chemicals contained in surface water and sediments of the creek does not result in unacceptable carcinogenic health risks. The exposure pathway contributing the greatest amount to the overall upper bound cancer risk estimate is dermal contact with surface water. The chemical contributing most greatly is PCE.

For more typical exposures, the overall upper bound cancer risk estimate is 3×10^{-8}. This value is well below the acceptable risk range of 1×10^{-4} to 1×10^{-6}. This indicates that typical exposure of adult trespassers to site-related chemicals contained in surface water and sediments of the creek does not result in unacceptable carcinogenic health risks. Similar to the RME scenario, dermal contact with surface water is the predominant exposure pathway and PCE is the predominant chemical.

Youth trespassers were also assessed for the same pathways as adults. In the RME scenario, the overall upper bound cancer risk for all four exposure pathways is 5×10^{-7}. This value is below the lower end of the acceptable risk range of $1 \times 10\text{-}^{4}$ to 1×10^{-6}. This indicates that reasonable maximum exposure of youth trespassers to chemicals contained in the surface water and sediments of the creek does not result in unacceptable carcinogenic health risks. Dermal exposure to surface water is the predominant pathway; PCE is the predominant chemical.

For more typical exposure of youth trespassers, the overall upper bound cancer risk estimate is 1×10^{-8}. This value is well below the lower end of the acceptable risk range of 1×10^{-4} to 1×10^{-6}. This indicates that typical exposure of youth trespassers to chemicals contained in the surface water and sediments of the creek does not result in unacceptable carcinogenic health risks. Similar to the RME scenario, dermal exposure to surface water is the predominant pathway and PCE is the predominant chemical.

In summary, the assessment indicates that exposure to site-related chemicals in surface water and sediments of the creek does not pose an unacceptable carcinogenic health risk to either adult or youth trespassers under reasonable maximum or more typical exposures. This assessment is also applicable to similar exposures potentially experienced by on- and off-site workers and off-site residents.

7.3 QUANTITATIVE ASSESSMENT OF POTENTIAL NON-CARCINOGENIC HEALTH HAZARDS

Potential non-carcinogenic health hazards were assessed for the same four exposure pathways for potential adult and youth trespassers of the site. Pathway-specific and overall Hazard Indices associated with the exposures are presented on Tables 7-1 and 7-2.

Reasonable maximum exposure of adult trespassers to site chemicals in surface water and sediments of the creek is associated with an overall Hazard Index of 0.006. This Hazard Index is well below the threshold comparison of 1.0, indicating the unacceptable non-carcinogenic health hazards are not posed by exposure to site-related chemicals in the creek. The exposure pathway most greatly contributing to the Hazard Index is dermal contact with surface water; the greatest chemical contributor is PCE.

For more typical exposure of adult trespassers is essentially the same. The RME scenario is associated with an overall Hazard Index of 0.008, the more typical exposure, 0.0004. Both of these values are well below the threshold comparison value of 1.0, indicating that no unacceptable non-carcinogenic health hazards are posed by exposure. Dermal contact with PCE in surface water are the predominant factors.

In summary, the assessment indicates that exposure to site-related chemicals in surface water and sediments of the creek does not pose an unacceptable non-carcinogenic health hazardous to either adult or youth trespassers under reasonable maximum or more typical exposures. This assessment is also applicable to similar exposures potentially experienced by on-and off-site workers or off-site residents.

7.4 SEMI-QUANTITITATIVE ASSESSMENT OF POTENTIAL EXPOSURE TO GROUNDWATER

The available information suggests that there are no or very limited users of groundwater in the immediate vicinity of or down-gradient (northwest) from the site. Historically, wells did exist in some areas north of the site, but recent surveys suggest that use of these wells has been replaced by the municipal system. No information was available on whether these wells were in locations or at depths that could potentially be impacted by groundwater from the site.

Although routine potable use of the groundwater has not been identified for any receptor, it cannot be unequivocally stated that there are no users, or that there may not be users of the groundwater at a future time. Xerox has information that an offsite property owner (Mr. McGee) occasionally uses ground water from the groundwater-fed pond (in the offsite area) to sometimes irrigate his lawn during drought periods. Any potential for exposure of Mr. McGee to groundwater contaminants during his occasional irrigation activity, via either dermal contact with pond water or inhalation of volatilized water contaminants, is believed to be essentially nil or nonexistent. Therefore, no complete human exposure pathway via this activity has been identified. Consequently, no quantitative or semi-quantitative evaluation of potential exposure is warranted.

However, to assess the potential health risks of a potential user of ground water for drinking water, information on the location and depth of the well would be needed to derive an appropriate exposure point concentration. Since this information is not available, a reasonable quantitative assessment of the potential health risks could not be derived.

As a surrogate for developing quantitative risk estimates, the existing chemical concentrations in groundwater are examined in light of enforceable drinking water values available for the chemical. Table 7-3 presents a comparison of the maximum chemical concentration detected in overburden, shallow bedrock and deeper bedrock monitoring wells (segregated into off-site and on-site wells) with the chemical's Maximum Contaminant Level (MCL). All chemical detected in groundwater were considered, not just those selected as chemicals of concern for the quantitative assessment. This table shows that all three units, on- and off-site, contain chemicals in concentrations that exceed MCLs.

The wells furthest down-gradient from the site for which data are available, in a northeastern to northwestern direction, are MW-OS-11 and MW-OS-12 and MW-OS-9 (located within Bradley Industrial Park) and MW-OS-6 (located in the park, near the private swim club). (Other wells located further down-gradient have been installed, but chemical data were not available for this assessment). The maximum chemical concentrations detected in these "perimeter" wells are listed on the following:

(Values marked with an asterisk indicate that the chemical's MCL value, or, in the case of lead, its action level, has been exceeded, and ND indicates not detected):

Chemical	Overburden Well	Shallow Bedrock Well
	(ug/l)	(ug/l)
Chloroform	1.3	9.1
1,1-DCA	2.3	23.4
1,1-DCE	4.9	139*
1,2-DCE(total)	38	547*
Methylene chloride	ND	ND
PCE	63.1*	1,220*
1,1,1-TCA	32.2	560*
TCE	50.4*	912*
Vinyl chloride	ND	ND
Lead	21.4*	40.6*

MCLs are health-based concentrations applicable to drinking water sources that are derived by considering the potential health risks associated with consumption of this water. In addition to health effects, MCLs also consider other factors (such as best available treatment technologies, analytical limitations and cost). Despite these other considerations, MCLs are generally considered to be protective of public health.

The presence of several chemicals in groundwater beneath the site and in down-gradient areas indicates the groundwater, if consumed, could impact public health. The magnitude of potential health impacts would depend on the actual chemical concentrations at the point of groundwater withdrawal and how the water were used. However, given that exceedences of MCLs by over three orders of magnitude is sometimes encountered, consumption of groundwater at or closely down-gradient of the site has the potential to result in adverse health impacts.

RCHD has recently (in 1992) distributed questionnaires to residences in the vicinity of the site to identify existing wells. Two wells were identified: one residential well and one well in a commercial facility, both located about one-half mile north of the site, on Birchwood Drive (see attached figure). Other than that the wells exist, no other information could be obtained on the exact location of the well, the depth of the well, or the existence of other potential nearby sources of chemicals to the groundwater. Both wells were sampled and analyzed for chemicals. The commercial well was not found to contain any detected chemicals. The residential well was sampled at a point before an in-home filter, and was found to contain 9 ug/L, of PCE (RCHD, 7/92). The source of PCE at this residential well has not been determined.

The concentration detected, 9 ug/L, exceeds the MCL for PCE of 5 ug/L. Applying the conservative assumptions of water ingestion at a rate of 2 liters per day for a 70 kg adult over a 70 year time period, and the cancer slope factor for PCE of 0.052 $(mg/kg\text{-}dy)^{-1}$, the upper bound cancer risk associated with this consumption is:

Intake = [(9 ug/L) (2 L/dy)(365 dy/yr) (70 yr) (10^{-3} mg/ug)]/[(365 dy/yr)(70 yr) (70 kg)]

Intake = 0.00026 mg/kg-dy x 0.052 $(mg/kg\text{-}dy)^{-1}$ = 1×10^{-5}

This risk value, 1×10^{-5} , is within EPA's acceptable risk range of 1×10^{-4} to 1×10^{-6}, suggesting that consumption of this water at this concentration does not pose an unacceptable health risk, assuming that other exposure pathways are negligible and PCE concentrations do not increase.

7.5 SEMI-QUANTITATIVE ASSESSMENT OF POTENTIAL EXPOSURE TO AMBIENT AIR

A limited ambient air investigation was performed at the site on May 28, 1992. The area sampled was the grassy area north of the building at the location of the former USTs. This investigation included the collection of five 8-hour samples (one sampling event, five stations) and analysis of those samples for various volatile organic compounds. The results of the analysis were compared to New York State draft 1991 short term (1 hour) guidance concentrations (SGC) and annual guidance concentrations (AGC). All measures air concentrations were below SGC values, two chemicals had measurements which exceeded the AGC: benzene (all measurements) and TCE (one measurement).

The detected concentrations of benzene ranged from 0.43 ug/m^3 to 0.95 ug/m^3; the AGC is 0.12 ug/m^3. Benzene was not detected in soils, so it is not known whether the presence of benzene in ambient air could be attributed to benzene in soils. However, benzene is a common component of air in urban/suburban areas, primarily as a result of combustion of gasoline by motor vehicles. In an EPA study and review of other studies, typical concentrations of benzene in ambient air ranged from about 6-10 ug/m^3 (Wallace, 1989). This suggests that measured benzene air concentrations at the site may represent background levels in the area. The sampling locations near a parking lot and Route 303 suggest that auto emissions may be a significant contributor.

One reported concentration of TCE (6.79 ug/m^3) exceeded the AGC of 0.45 ug/m^3. TCE was detected at two other concentrations of 0.43 and 0.24 ug/m^3, and was not detected at the remaining two locations. TCE was detected in sub-surface soils in this area at concentrations ranging from 0.7 mg/kg to 110 mg/kg, suggesting a possible source (no sampling of surface soils for TCE was performed). A quantitative assessment of the potential air exposure pathway, using these data, was not performed for the following reasons:

- One 8-hour sampling period is insufficient to extrapolate to long term exposure periods.

- Fluctuations of atmospheric conditions during ambient air sampling complicate interpretation of the results and background conditions (wind direction shifts from N/NW to S/E, the humidity dropped from about 60% to 45% and light showers occurred during the sampling period).

- The potential presence of other sources of TCE complicated interpretation of the results (e.g., other industries in Bradley Industrial Park, the ConRail tracks).

Despite these limitations, the available TCE air data are examined in order to derive a conservative estimate of potential health risks to on-site workers that may be exposed to TCE in air.

The upper bound cancer risk associated with the maximum TCE air concentrations detected can be calculated, assuming an inhalation rate of 20 m^3 /day, exposure over 70 years, an adult body weight of 70 kg, and TCE's inhalation slope factor of 0.002 (mg/kg-day)$^{-1}$:

$$[(6.79\ ug/m^3)\ (20\ m^3/day)\ (365\ dy/yr)\ (70\ yr)\ (10^{-3}\ mg/ug)]\ /\ [(365\ dy/yr)(70\ yr)\ (70\ kg)]$$

$$= 0.00194\ mg/kg\text{-}dy$$

$(0.00194 \text{ mg/kg-dy}) (0.002 [\text{mg/kg-dy}^{-1}]) = 4 \times 10^{-6}$

This upper bound risk level of 4×10^{-6} falls within EPA's acceptable risk range. In reality, exposure of on-site workers to site air for 24 hours per day, 365 days per year for 70 years is not a reasonable expectation; actual exposure (if any) is expected to be much less, suggesting lower risk levels.

Extrapolation of these air concentrations or risk levels to off-site workers, off-site residents or trespassers cannot be reasonably made without additional information on climatological conditions of the area and more extensive data or modeling. Nonetheless, air concentrations would be expected to decline with distance, suggesting that exposures and risks would be less than levels conservatively implied by the maximum detected concentration. Therefore, exposure is not significant based on available data.

7.6 SEMI-QUANTITATIVE ASSESSMENT OF LEAD IN SOILS

Lead was not analyzed in the majority of soil samples; only one location in surface soils and two locations in deeper soils had analytical results for lead:

Location	Depth	Location	Result
RIB-2	0-2 ft.	East of former UST location	4520 mg/kg
RIB-1	14-16 ft.	Under building	9.68 mg/kg
RIB-2	14-16 ft.	East of former UST location	17.1 mg/kg
RIB-2	33-35 ft.	East of former UST location	7.68 mg/kg

Although no background soil samples were collected, concentrations of lead in the deeper soil intervals are comparable to typical lead soil concentrations in the B horizon of the eastern U.S. (mean = 14 mg/kg, U.S.G.S., 1975). The concentration detected in the one surface soil sample is not.

EPA has developed an advisory level for lead in soil of 250 mg/kg based on the possible oral ingestion route. The single concentration detected in RIB-2, 0-2 feet exceeds this range. Another surface soil sample was collected and analyzed during December 1992. The sample was collected in the vicinity of RI11 at o to 6 inches depth. The total lead in the sample was 41.7 mg/kg. This level is consistent with the analysis of deeper soil samples.

Lead was detected in groundwater from the overburden and shallow bedrock wells. Detected concentrations ranged from less than detectable concentrations to 152 ug/L in overburden wells; the highest concentration was detected in an off-site wells. In the overburden unit, the average concentration was approximately 15 ug/l in the January 1992 sampling round and 12 ug/L in the April 1992 sampling round. These concentrations are at or below the drinking water "action level" of 15 ug/L for lead.

In the shallow bedrock wells, lead was detected at concentrations ranging from less than detectable to 264 ug/L. The average concentration during the January 1992 sampling round was about 27 ug/L; during the April 1992 sampling round, 26 ug/L. These concentrations are above the 15 ug/L "action level" for lead. However, in site background wells U6 and U6D, the average background level for lead (i.e., about 81 ug/L between May 1991 and April 1992) was higher than this "action level."

8.0 ASSESSMENT OF UNCERTAINTIES

8.1 INTRODUCTION

The assessment of potential health impacts to humans on or near the site applied the best available information obtainable within the scope of the assessment. The methodology applied to assess potential health risks was adopted from guidance for EPA's Superfund program, and represents generally recognized risk assessment methodology. The approaches applied in the assessment were generally conservative in nature and were likely to result in an overestimate of potential chemical exposure and risks.

Uncertainties can result from different factors in the assessment, including sampling and analysis, estimation of exposure, and use of EPA toxicity values. Some of the more important uncertainties in these categories are discussed below.

8.2 UNCERTAINTIES IN SAMPLING AND ANALYSIS

- Inclusion of chemicals that may be related to sampling and laboratory introduction.

  Consistent with WCC's scope of work for site sample data evaluation, the WCC's comments on the data are as follows. Potentially, some of the chemicals or some detections of some chemicals may have been associated with sampling or laboratory introduction. This may be particularly relevant for methylene chloride, which is a common laboratory contaminant. Inclusion of chemicals present in samples as a result of sampling or laboratory introduction could result in overestimation of potential health risks.

- Purposive and/or limited sampling.

  Most sampling occurred in areas where chemical presence was expected (this is particularly true for soils). Therefore, the highest chemical concentrations were probably detected. This has probably skewed some of the exposure point concentrations towards the high end, resulting in conservative estimates of potential exposures. With regard to the pathways quantitatively assessed, however (exposure to sediments and surface water), this factor has probably had minimal impact. For surface soils, sampling was limited in number and location. Therefore, potential exposure to surface soils may not have been identified as an important exposure pathway. However, the history of contaminant releases at the site (i.e., subsurface releases during operation of the former underground storage tanks) suggests that surface soils would not be impacted, so this factor probably has minimal impact upon the assessment.

- Based on onsite TCL results, the analysis of specific analytes only.

  Analysis of groundwater, surface water, soil and sediment was limited to several volatile organic compounds, and in a few samples, lead. Based upon the known and suspected sources of contamination, volatile organic compounds are the only suspected chemicals of concern for the site.

- Incomplete characterization of the groundwater plume.

  Data from the most distant (down-gradient) wells from the site contain site-related chemicals, often at concentrations exceeding the chemical's MCL.

8.3 UNCERTAINTIES IN ESTIMATION OF EXPOSURE

- Use of EPA default or conservative exposure factors.

  In general, conservative default exposure factors were applied to estimate chemical intake. By design, these factors are conservative, and may have overestimated potential chemical intake. In particular, assumptions regarding the frequency of trespassing were probably conservative, resulting in conservative estimates of potential chemical intake.

- Exclusion of the ground water pathways on the basis of being incomplete.

  Exposure of receptors to ground water was identified as incomplete, because available information suggests that there are no nearby users of groundwater for potable purposes.

This identification was based upon information obtained from previous well surveys, discussions with the Rockland County Health Department and nearby industries. Although this information was sufficient to eliminate this exposure pathway as one of concern, it is possible that isolated, unidentified users of the groundwater exist. If there are local residents that rely on groundwater as a drinking water source, the associated health risks have not been assessed.

- Exclusion of the air exposure pathway on the basis of it being a minor exposure pathway.

  Exposure of subsurface soil chemicals that have migrated to the atmosphere was not quantified because of the limited data and anticipation that the pathway was minor. This pathway was assessed in a semi-quantitative manner for on-site workers, based on limited data from a single sampling event. This assessment indicated that health impacts would not be unacceptable. If available data are not an adequate measure of typical ambient air concentrations, potential health risks may have been over- or under-estimated.

- Assumption of exposure to subsurface soils only by construction workers having appropriate exposure protection.

  The assessment has assumed that subsurface soils could only be contacted by construction workers aware of the potential for exposure, and adhering to an adequate health and safety plan that would protect against uncontrolled exposures. Potential risks have not been evaluated for exposure to workers that were not applying adequate exposure protection.

- Use of maximum or 95% upper confidence limit concentrations.

  Following EPA guidance, these conservative values were used to estimate that potential chemical concentrations to which receptors may be exposed. This may have resulted in an overestimate of potential chemical intake.

8.4 UNCERTAINTIES IN ESTIMATION OF TOXICITY

- Use of EPA-derived toxicity values.

  In general, EPA toxicity values are conservative. Cancer Slope Factors (SFs) are upper bound estimates of potential risk per unit intake; non-carcinogenic Reference Doses (RfDs) incorporate a number of uncertainty and modifying factors. Use of these toxicity values are intended to prevent underestimation of potential health impacts; therefore, they may overestimate potential health impacts.

9.0 SUMMARY AND CONCLUSIONS

A human health assessment was performed for the Xerox Facility in Blauvelt, New York. The objective of the assessment was to examine the potential for unacceptable adverse health effects to occur as a result of human exposure to site related chemicals that are present or have migrated from the site.

Four different receptor groups were examined as potentially exposed populations: current on-site workers, off-site workers, off-site residents and trespassers. Of these, only trespassers were identified as having complete exposure pathways. Potential health effects associated with adult and youth trespasser exposure to site-related chemicals in surface water and sediments were assessed for both reasonable maximum and more typical exposures. These exposures also adequately addressed potential exposures that may be incurred by on-site workers, off-site workers and off-site residents. Exposure through the dermal and ingestion pathways were considered. Calculated upper bound risk estimates were at or below the acceptable cancer risk range of $1x10^{-4}$ to 1×10^{-6}, and non-carcinogenic Hazard Indices were below the threshold comparison value of 1.0. This indicates that exposure to site-related chemicals in surface water and sediments does not result in unacceptable cancer risks or non-carcinogenic health hazards.

Exposure to chemicals contained in groundwater was not quantitatively assessed because available information suggested that limited, if any, exposure points exist for groundwater at or near downgradient of the site. The extent of the groundwater plume has not been completely defined. However, concentrations of several chemicals contained in wells on the site and in the most distant well locations exceeded Safe Drinking Water Act Maximum Contaminant Levels (MCLs). This indicates that, if groundwater were to be used as a water supply within the area for which groundwater data are available, adverse health effects may be posed to consumers. Testing of the known groundwater supply wells downgradient of the site did not indicate unacceptable health risks.

Exposure to chemicals contained in subsurface soils was not quantitatively assessed, since receptors are not anticipated to have access to subsurface soils during normal activities. Future potential construction workers may have access to subsurface soils and, hence, chemicals contained in subsurface soils. However, this assessment assumed that any subsurface excavation or construction would be performed under an appropriate Health and Safety Plan (HSP), which would provide adequate protection of workers. Therefore, associated potential health risks were not assessed.

Exposure to chemicals contained in subsurface soils that have migrated to ambient air was not assessed because the exposure pathway was anticipated to be minimal. Limited air monitoring data was available to assess potential exposure to onsite workers. Examination of these data suggest that unacceptable health risks would not be posed to people having continuous contact with ambient air near the site. This conclusion is limited by the small data set and confounding factors that inhibit interpretation of the data set.

Exposure to chemicals contained in surface soils was not assessed because there are very limited data on chemical concentrations in surface soil, because the site history suggests that all chemical releases occurred in the subsurface soils or through the floor of the manufacturing building and into the underlying subsurface, and since the volatile organic compounds are the main chemicals of concern for the site. However, one measured concentration of lead in soil (4520 mg/kg) suggests that, at least in one location, high lead soil concentrations may be present on site. This lead concentration is above the recommended soil lead concentration developed by EPA that was derived to be protective of ingestion of soil. The result was not confirmed by additional testing. A second surface soil sample was analyzed and found to contain 41.7 mg/kg of total lead. No exposure of small children, the most sensitive population to lead exposure, is anticipated to occur on site.

Overall, the assessment suggests that adverse health effects are unlikely to be posed to current receptors on or near the site. However, this conclusions is dependent upon assumptions made regarding location and activities of receptors and the extent of chemical migration from the site. To confirm these conclusions, the following are recommended:

- Further sampling of groundwater may be needed to further define the extent of chemical migration.

- A follow-up on the 1989 well survey should be conducted to confirm the existence of private wells in the area. Owners of all previously identified wells should be contacted, and the use, location and depth of all wells determined. If wells are located within the area of potential chemical impact, they should be sampled for chemical content; and

- The exceedance of the TCE AGC found during the air monitoring program should be further analyzed through an expanded monitoring program. The sampling frequency location and method should be consistent with EPA guidance on Air Pathway analysis.

Information obtained from these activities should then be used to revise or confirm the conclusions reached in this assessment.

10.0 REFERENCES

Bradley Industrial Park (1992). Personal communication with Mr. John McGee, 7/92.

Dames and more (1985). Endangerment Assessment Report, Xerox Corporation, Blauvelt, New York.

Gale Research Company (1985). Climate of the States: Volume II, 3rd edition.

Oratamin Swim Club (1992). Personal communication with Ms. Glenna Mara, 7/92.

Rockland County Health Department, personal communication between Judy Korchak (RCHD) and Cynthia Fuller (Woodward-Clyde Consultants), July 16, 1992.

Spring Valley Water Company (1985). "Volatile Chemical Groundwater Contamination, Rockland County, New York", January 1985.

Tri Seal Corporation (1992). Personal Communication, 7/92.

U.S. Geological Survey (1975). "Background Geochemistry of Some Rocks, Soils, Plants and Vegetables in the Conterminous United States. U.S. Geological Survey Professional Paper 574-F.

U.S. EPA (1992). "Dermal Exposure Assessment: Principles and Application", EPA/600/8-91/011B, 2/92.

U.S. EPA (1991a) "Role of the Baseline Risk Assessment in Superfund Remedy Selection Decisions" OSWER Directive 9355.0-30, 4/91.

U.S.EPA (1991b). "Human Health Evaluation Manual, Supplemental Guidance: "Standard Default Exposure Factors", OSWER Directive 9285.6-03, 3/25/91.

U.S. EPA (1990a). "Air/Superfund National Technical Guidance Study Series: Volume II: Estimation of Baseline Air Emissions at Superfund Sites", EPA-450/1-89-002a, 8/90.

U.S. EPA (1990b). "National Oil and Hazardous Substance Pollution Contingency Plan" (NCP).3/90.

U.S. EPA (1989a). "Risk Assessment Guidance for Superfund: Volume I - Human Health Evaluation Manual (Pat A), EPA/540/1-89/002, 12/89.

U.S. EPA (1989b). "Interim Guidance on Establishing Soil Lead Cleanup Levels at Superfund Sites" OSWER Directive #9355.4-02, 9/7/89.

U.S. EPA (1989c). "Exposure Factors Handbook" EPA/600/8-89/043, 7/89.

U.S. EPA (1988). "Superfund Exposure Assessment Manual" EPA/540/1-88/001, 4/88.

U.S. EPA Region IV (1991). "Supplemental Region IV Risk Assessment Guidance" (as amended 2/11/92).

Wallace, LA (1989). "The Exposure of the General Population to Benzene." Cell Biology and Toxicology, Vol. 5, No. 3.

Woodward-Clyde Consultants (1989). "Private Well Inventory, Blauvelt, New York."
djv:70302-50.hha

New York State Department of Environmental Conservation
50 Wolf Road, Albany, New York 12233-7010

Thomas C. Jorling
Commissioner

RECEIVED
MAR 2 0 1992
ENVIRONMENTAL ENGINEERING

MAR : 3 1992

Mr. Ronald E. Hess
Xerox Corporation
800 Phillips Road
Bldg. 304-13S
Webster, NY 14580

Dear Mr. Hess:

Re: Xerox-Blauvelt Site (#344021)
VES Modifications

The New York State Department of Environmental Conservation (NYSDEC) has reviewed your February 28, 1992 request to modify the operation and emission limits for the soil vacuum extraction system (VES) at the subject site. As a result of this review, the May 23, 1991 authorization to operate the system is modified as follows:

1. Changes will be made to the seal water loop cooling system and the inlet heater to the carbon adsorption units to control the temperature and relative humidity of the vapor discharge. This should improve the collection efficiency of the carbon beds.

2. An on-site gas chromatograph will be installed for analyzing vapor samples from the system to determine system performance and compliance with the emission limits given below. Samples will be taken before and after the carbon units (three 2000 pound units in series) on a weekly basis during normal operations to determine compliance with the emission limits given in item 3 below.

3. If any changes are made to the VES that could result in increased emissions, sampling and analysis will occur within two operating hours to determine if emissions are within the following limits:

	Maximum Exhaust Concentration	
Contaminant	mg/m^3	ppb_v
Tetrachloroethene	10	1,450
Trichloroethene	60	11.000
1,1-Dichloroethene	3	750
Vinyl Chloride	3	1,150
Benzene	16	5,000

Note: Concentrations corrected to 20°C.

4. The VES may not be operated for more than eight hours from the first time that an analysis shows an exceedance of an emission limit. This time limit is cumulative and the "clock" does not restart after a system shutdown or a subsequent analysis. If the system cannot be adjusted within eight hours of operation so that emission limits are attained, the VES must be shut down and not restarted until authorized by the NYSDEC. If analyses show that emitted concentrations exceed the limits in item 3 by more than 100 times, the VES will be shut down immediately.

5. The gas chromatograph will be calibrated each day of use for the contaminants listed above and methylene chloride, 1,1-dichloroethane, 1,2-dichloroethene (total), 1,1,1-trichloroethane, and toluene. Calibration records will be made available upon request.

6. Modified piping and instrumentation drawings (as built) will be submitted to the NYSDEC after completion of the changes to the VES described in item 1 above.

7. A summary of the analytical results will be submitted to the NYSDEC on a monthly basis for review.

If you have any questions regarding the conditions of this authorization, please call me at 518-457-3395.

Sincerely,

Andrew J. English

Andrew J. English, P.E.
Environmental Engineer 2
Bureau of Eastern Remedial Action
Division of Hazardous Waste Remediation

cc: E. Duffney, Xerox

HazMat 90 West

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Enhanced Groundwater Extraction Utilizing Innovative Technology: "HIVAC"

by

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ENHANCED GROUNDWATER EXTRACTION UTILIZING INNOVATIVE TECHNOLOGY: "HIVAC"

by

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INTRODUCTION

In the past few years, activities at sites impacted by hazardous substances have been shifting from site investigation to site remediation. The most selected remedial programs for contaminated soil in the unsaturated zone are excavation followed by offsite disposal or in-situ vapor extraction systems. Groundwater cleanup efforts mainly consist of pump and treat.

Unsaturated zone remediation has been, in general, successful and effective in reducing concentrations of contaminants to levels accepted by regulatory agencies. However, groundwater remediation has been ineffective in reducing contaminant concentrations to acceptable levels in a reasonable time frame. As a result, pump and treat technology has been described by many as "cleanup in perpetuity."

This paper presents a case study where an enhanced groundwater extraction system has been developed to replace an existing conventional pumping well system. Included in the presentation is an overview of the site background, a brief description of the existing remedial program and its evaluation, and the steps in the development of the enhanced groundwater extraction system referred to in this paper as the "HIVAC".

BACKGROUND

The Xerox Corporation facility in Irvine, California, consists of two adjacent buildings (Figure 1) where previous operations involved refurbishing Xerox equipment and other related activities. The refurbishing process included organic solvents as cleaners and degreasers. Refurbishing operations were completely stopped in 1985 and the buildings are presently used as warehouse/distribution centers for newly manufactured equipment and components.

Soil and groundwater investigations were conducted at the Irvine site in 1985. As a result, chlorinated hydrocarbons (solvents) and petroleum-based hydrocarbons called minerals spirits were found to be the primary constituents of soil and groundwater contamination at the site. Most groundwater contamination occurs in a north-south band through the middle third of the site as shown on Figure 2. Soil contamination was found mainly beneath the two buildings in five separate areas located in the vicinity of former equipment cleaning booths and the previous hazardous materials storage yard (Figure 3). The lead agency monitoring soil and groundwater cleanup activities is the California Regional Water Quality Control Board, Santa Ana Region.

On-site hydrogeologic investigation has indicated the presence of four stratigraphic units, numbered from the surface downward, that underlie the subject site. Unit 1 generally comprises 10 to 15 feet of silty clay, covering the majority of the site. A sand channel underlying the parking lot bordering Teller Avenue is also found in Unit 1. Unit 2 is a less permeable clay and silty clay deposit that occurs in the depth interval of about 15 to 40 feet. Unit 3 is a fossiliferous sand, generally about 5 to 10 feet thick, that is encountered at depths of about 40 feet throughout the site; this sand is commonly referred to as the "40-foot sand." This sand is underlain by Unit 4, a sequence of clay, silty clay, sandy clay, sand, and gravel that extends to bedrock at a probable depth of about 300 feet. The stratigraphy at the Irvine site appears to correlate relatively well with reported sequences at other sites within an approximate one-mile radius.

The majority of Unit 1, the upper 10 to 15 feet, is unsaturated and comprises the vadose zone. The groundwater table generally is encountered at a depth of 10 to 15 feet, and Unit 2 is completely saturated. The "40-foot sand", Unit 3, is a confined aquifer where groundwater flows in a southeasterly direction. A generalized geologic cross-section of the site is shown in Figure 4.

Analytical results from groundwater samples have shown that the contaminants beneath the site are located primarily within the shallow (unit 1 and 2) zone. However, recent deep well installation and groundwater analyses have indicated that the "40-foot sand" in Unit 3 is contaminated in the vicinity of Jamboree Boulevard, at the southeast site boundary.

Analytical results of soil and groundwater exhibited concentrations up to 100 parts per million of chlorinated hydrocarbons and mineral spirits. Chlorinated hydrocarbon constituents mainly included trichloroethylene (TCE), tetrachloroethylene (PCE), and 1,1,1-trichloroethane. The total mass of contaminants was estimated to be about 300 pounds in the groundwater and 6,500 pounds in the unsaturated zone.

Findings of groundwater pumping tests at a number of wells at the site indicated that the saturated formation (Unit 2) has a very low recharge rate. Permeability values were estimated to be about 10^{-3} cm/sec for the clay and silty clay soil, with wells yielding 0.1 gallon per minute (gpm) at best, and 0.01 gpm typically. The sand channel in the parking lot (still in Unit 1) demonstrated a higher recharge rate of about 3 gpm. The "40-foot sand" allowed a pumping rate of about 1 gpm.

Based on the findings from the site investigation, a remedial program for the soil and groundwater was developed and implemented. The next section describes the remedial actions taken at the Irvine site.

REMEDIAL ACTION DEVELOPMENT, IMPLEMENTATION, AND EVALUATION

Remedial action at the Irvine site is divided between contaminated soil and groundwater cleanup activities. The soil and groundwater remediation program commenced in July 1987 with the start-up of both the vapor extraction system (VES) and the interim groundwater extraction and treatment system (GWTS). The interim GWTS was purposely designed and implemented to address the contamination source areas (hot spots) while the investigation continued to define the full extent of groundwater contamination. An expanded GWTS was designed, constructed, and started in October 1988 to cover the entire on-site shallow zone groundwater plume.

Xerox's overall objective is to clean up the site in a timely manner, which translates into designing an aggressive remedial program. As a result, the remedial program was developed to include a high density of groundwater extraction wells coupled with injection of clean water to enhance the flushing effect of the saturated zone.

As part of the overall remediation program, cleanup goals for soil and groundwater are also being developed in conjunction with the lead regulatory agency. Proposed cleanup level development methods include risk assessment and contaminant transport and fate (exposure assessment) approaches.

SOIL REMEDIATION

Soil remediation at the Irvine site consists of a VES that extracts volatilized contaminants from the unsaturated zone. The vapor extraction is performed through 13 VES wells installed in the five identified contaminated soil areas as shown on Figure 5. Extracted soil vapor is exhausted through two 400 pound granular activated carbon canisters as an air emission control measure.

The VES system design flow is 240 cubic feet per minute (cfm) resulting in a soil vapor flow of up to 20 cfm per well. The design vacuum is approximately 7 inches of mercury. The system can handle influent concentrations up to 500 ppm of total volatile organics.

GROUNDWATER REMEDIATION

The existing groundwater remediation program consists of 33 extraction wells and 11 injection wells located throughout the site (Figure 6). The function of most of the injection and extraction wells is designed to be alternated to accommodate the needs of the groundwater remediation program. Extracted contaminated groundwater is treated through an air stripper tower. Treated water is either injected back to the saturated zone or discharged to the storm drain, under an NPDES discharge permit. Contaminated air is treated using two 8,000 pound carbon canisters before being discharged to the atmosphere, under an Air Quality Management District permit.

The groundwater treatment system is designed to handle up to 50 gpm flow. However, the 33 shallow zone groundwater extraction wells generate only about 5 gpm. About 90% of the treated water is reinjected.

ENHANCED GROUNDWATER EXTRACTION SYSTEM (HIVAC)

The cleanup effectiveness evaluation indicated that there is a need to improve the groundwater remediation to satisfy the objective of site remediation in a timely manner. Therefore, to achieve this goal, groundwater extraction from the saturated tight clay must be accelerated. Consequently, a program to develop an enhanced groundwater extraction system was initiated.

Based on an ongoing remediation program at another Xerox facility, using a Xerox patent pending high vacuum extraction system, Xerox recommended testing its application at the Irvine site. As a result, Woodward-Clyde designed and constructed an enhanced groundwater extraction pilot unit, and developed a testing program. After developing certain improvements on the system, aimed at widening the applicability of the method to the varying well configurations and geologic conditions at the Irvine site, Woodward-Clyde conducted the HIVAC pilot testing. The findings were very encouraging with regard to increased extraction rates.

Based on the improved groundwater extraction rates exhibited by the HIVAC pilot test, an expanded HIVAC system was designed, constructed, and implemented. Similar to the pilot unit, the expanded system also resulted in improved extraction rates of groundwater and contaminants. Both the pilot and expanded HIVAC applications are presented in the following sections.

PILOT HIVAC TESTING

Pilot HIVAC tests were conducted on a number of wells at the Irvine site (Figure 9). The unit used in the pilot testing is capable of extracting up to 130 cfm of soil gas and vapors, or reaching a vacuum up to 25 inches of mercury (in. Hg). The testing consisted of applying high vacuum to extract groundwater from one well at a time for various periods of time. The groundwater extraction using the HIVAC unit resulted in extraction rates 5 to 10 times greater than conventional extraction using submersible pumps. For example, the daily groundwater extraction rate for Well W-27 was approximately 15 gallons using a submersible pump and 160 gallons using the HIVAC system. The results are summarized in Table 1. Furthermore, the HIVAC unit demonstrated high vapor extraction rates from the vadose zone in wells in or near source areas. Organic vapor analyzer (OVA) readings reached concentrations greater than 1,000 ppm. An estimated 3.5 pounds per day of volatile organics was removed through the air stream from Well W-27. Figure 10 shows the OVA organic vapor concentration results recorded for Well W-27.

In addition to recording groundwater extraction rates and OVA readings in the extracted air flow, contaminant concentrations in the groundwater were also monitored. Groundwater samples in the area (Figure 11) of the pilot test were collected and analyzed before and during the HIVAC application. As shown in Table 2, groundwater concentrations in the wells sampled from the W-27 area have shown a substantial decline. However, some variation in the groundwater concentrations over time is also noticeable. This variation may be attributed to plume movement toward the extraction well. These results were produced over a period of three months, therefore, a longer period of testing is required to establish long term effects of the system.

EXPANDED HIVAC TESTING

The expanded HIVAC testing plan was developed based on the pilot test results. The system capacity (cfm) was selected to be about 8 times greater than the pilot unit and was connected to 7 wells simultaneously. The selected area for the expanded HIVAC application is located in the southeast part of the property, between Jamboree and Teller buildings as shown on Figure 12. This area was selected because it exhibits the highest concentrations in groundwater and current groundwater extraction methods are not reducing contaminant levels quickly enough. Also, this area required less construction effort to connect the wells to the HIVAC unit.

The expanded HIVAC test consisted of applying high vacuum to extract groundwater from 7 wells simultaneously for a period of 3 months. Groundwater extraction from the 7 wells using the HIVAC unit resulted in an extraction rate approximately 5 times greater than the conventional pumping rate. However, the HIVAC extraction rate decreased from about 500 to 300 gallons per day after a few weeks of operation. This decline is due to the dewatering of the saturated zone at a rate greater than its recharge rate.

To evaluate the cleanup effectiveness of the HIVAC system on the contaminated groundwater, water samples from the evaluation area (shown in Figure 12) were collected and analyzed on a monthly basis. The results, summarized in Table 3, indicate a general decline in VOC concentration in the groundwater, confirming the results obtained from the pilot test. Again, some upward variation in groundwater concentration in individual wells is noticeable over the test period, which may be attributed to plume movement towards the extraction area.

An estimated VOC removal rate of 7 pounds per day was calculated based on daily OVA recordings. Daily OVA readings are shown in Figure 13. This graph resembles the graph generated from the OVA readings during the pilot test, where the vapor concentrations start at low values. After about two weeks the concentrations peak, followed by a rapid decline to a relatively constant low value.

The expanded and pilot HIVAC systems are currently continuing operation in their designated areas as part of the overall remediation plan. Additional HIVAC systems are planned to replace the existing conventional pumps in extraction wells at the site.

CONCLUSION

Based on the pilot and expanded HIVAC tests conducted at the Irvine site, the following conclusions about the HIVAC application may be stated:

- HIVAC application creates higher groundwater gradients toward the extraction well, resulting in greater extraction rates (at the Irvine site, 5 to 10 times greater than conventional submersible pumps).
- HIVAC application allows the extraction of groundwater and/or vapors (dual phase), resulting in the removal of contaminants in the solubilized, vapor, and/or residual phases.
- HIVAC application requires no electrical controls and/or electrical equipment at the well, thus reducing construction and maintenance efforts.
- HIVAC application is adaptable to variable well diameters and well screen intervals, therefore, additional well installations may not be required.
- HIVAC system operation is in general relatively quiet, making it possible to be installed indoors or close to residential/commercial areas without creating a disturbing noise.

Through the tests performed at the Irvine site, HIVAC application has significantly outperformed the existing conventional pumping system. We believe that this enhanced groundwater extraction method will substantially shorten the time required to clean up groundwater contamination and, therefore, reduce the operational, maintenance, and monitoring costs associated with typical groundwater remedial actions. It should be noted, however, that the benefits of the HIVAC are greater in tight (low yield) formations than in porous (high permeability) subsurface conditions.

The HIVAC application presented in this paper has been in operation for approximately one year (pilot unit), and about six months for the expanded unit. Despite the successful results obtained from the tests, long term application is needed to completely evaluate the system and its effectiveness in extracting groundwater and reducing contaminant levels.

In closing, Woodward-Clyde acknowledges Xerox Corporation for their proactive environmental attitude as demonstrated by their support of the research and development that led to the HIVAC system development and application.

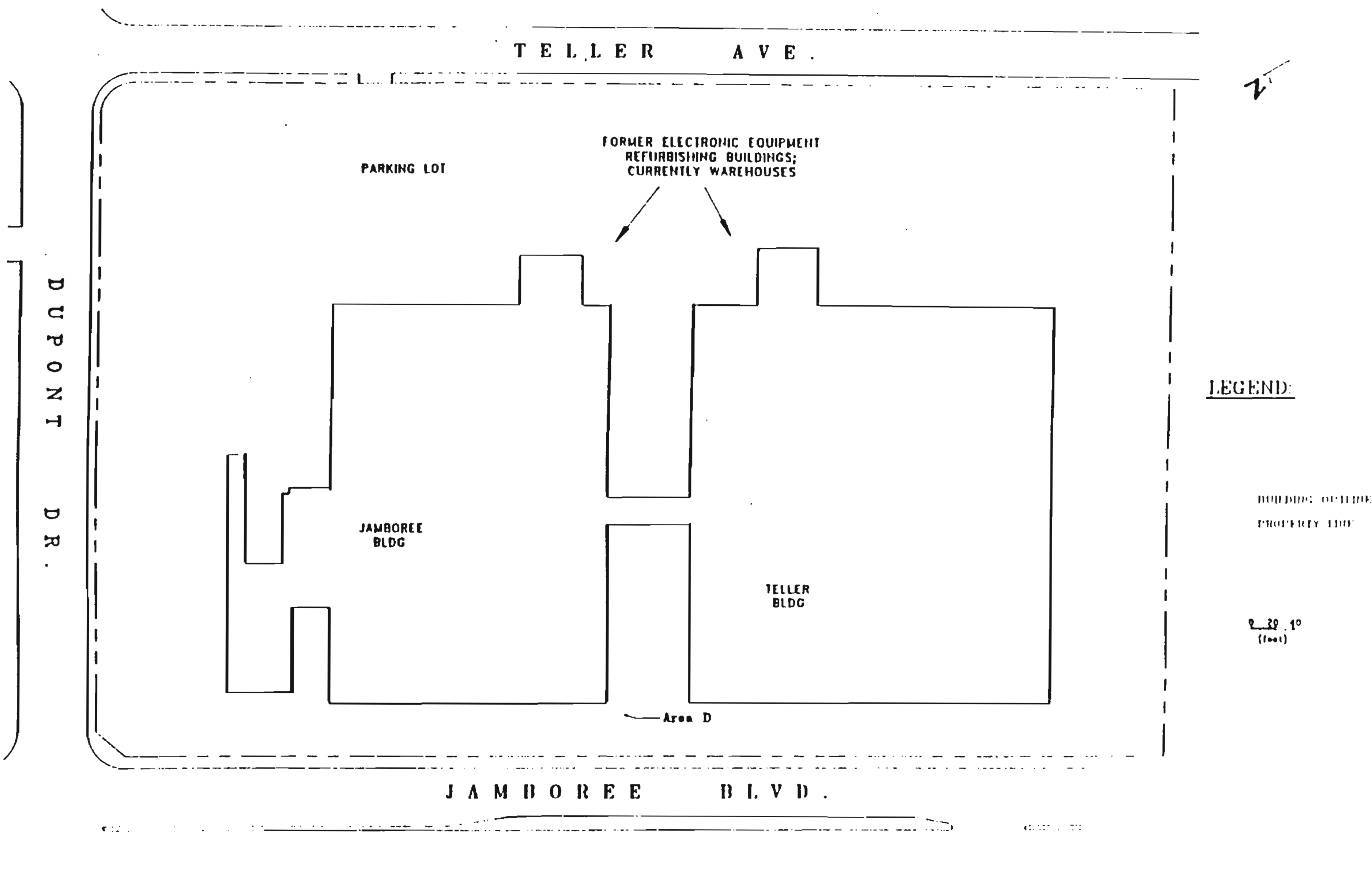


Figure 1. SITE MAP

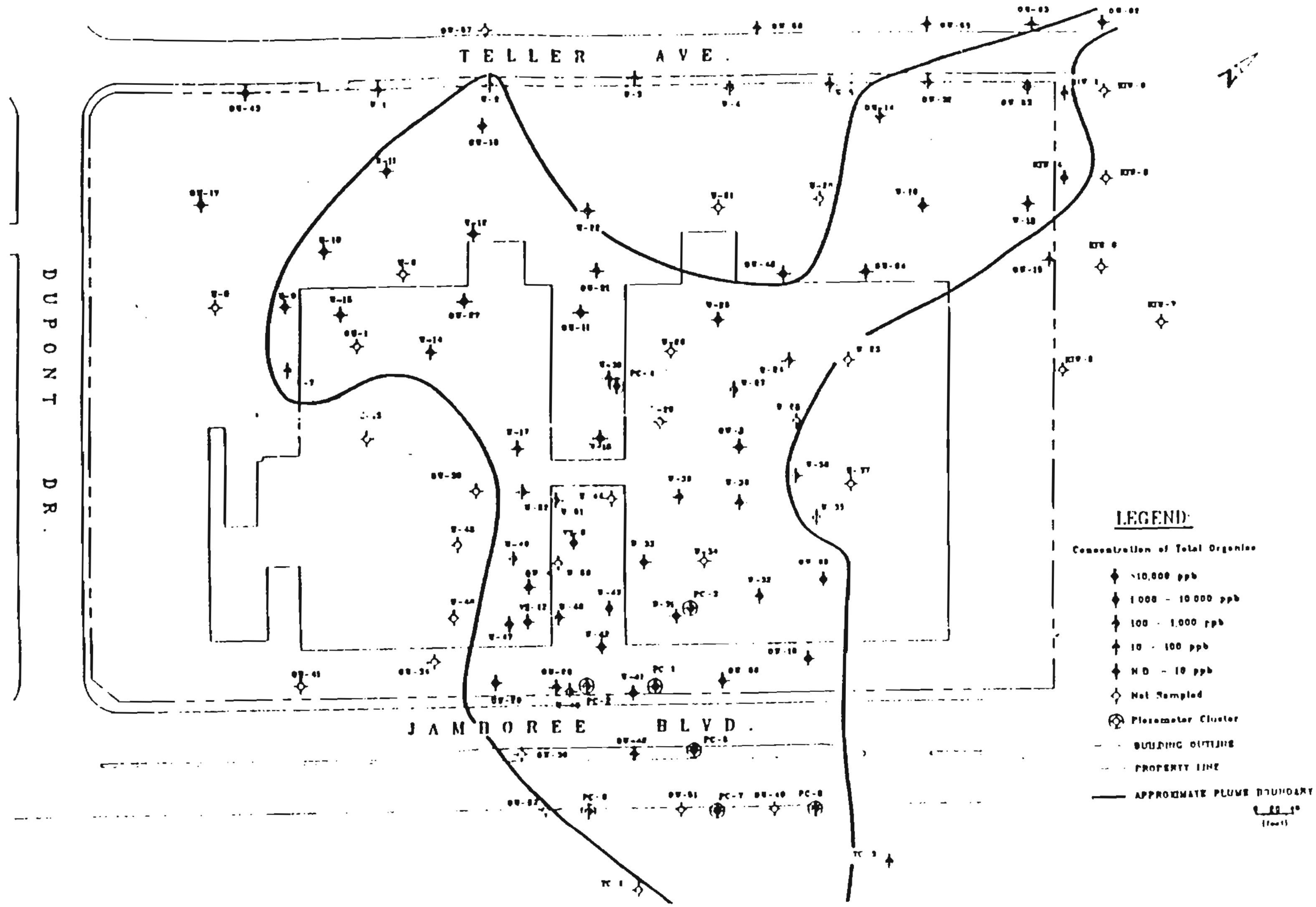


Figure 2. GROUNDWATER PLUME

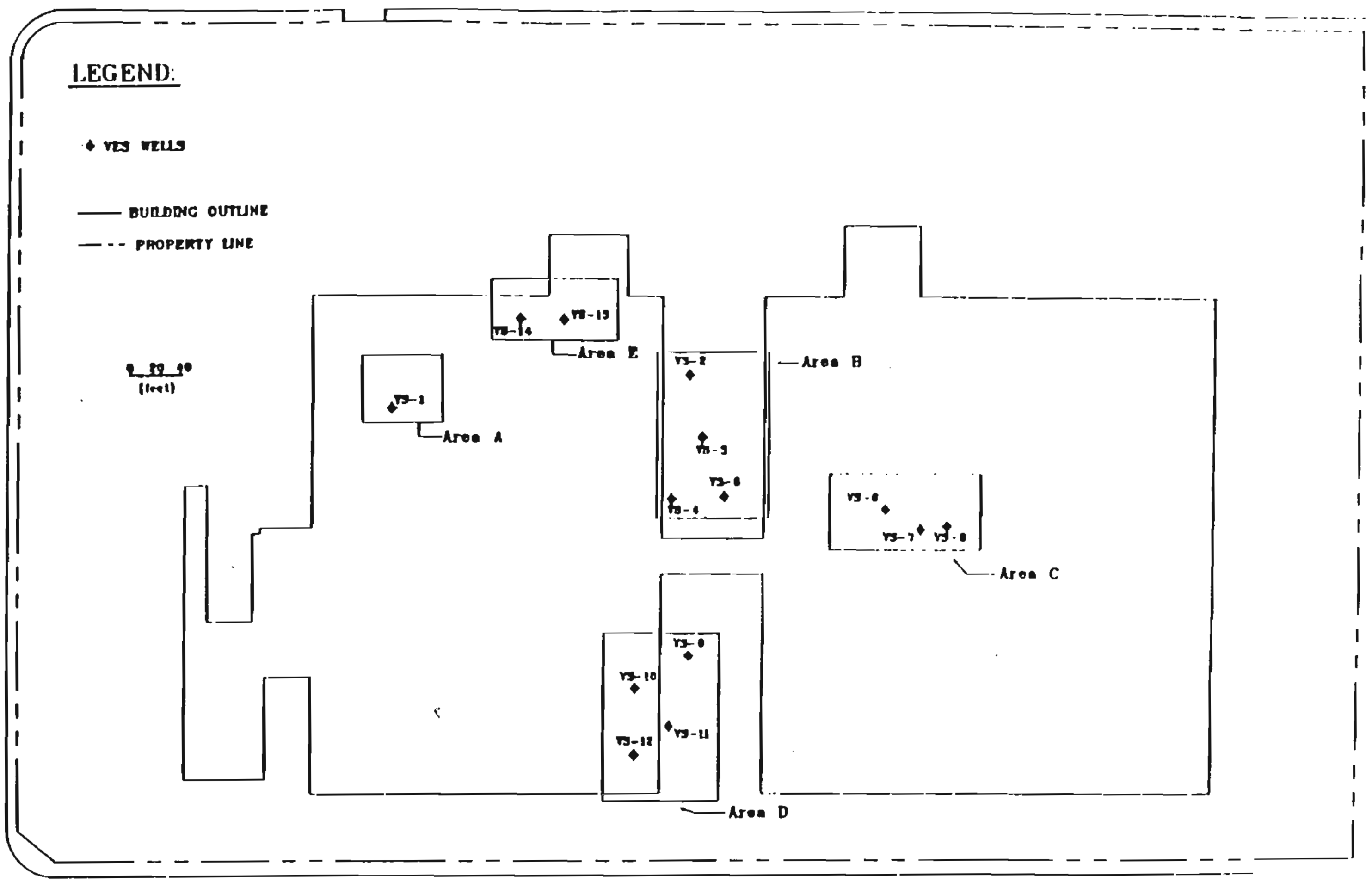


Figure 3. SOIL CONTAMINATED AREAS

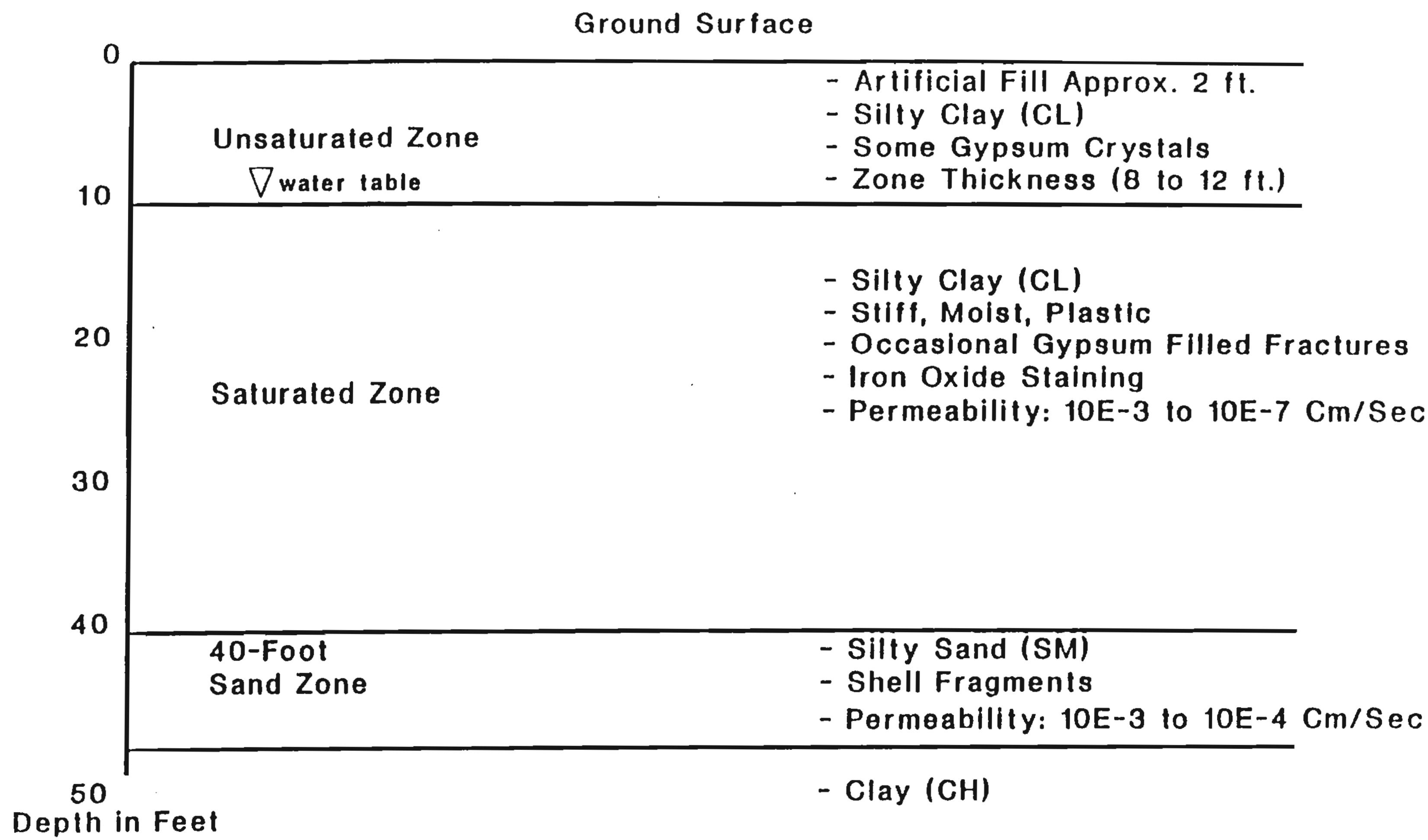


Figure 4. GENERALIZED GEOLOGIC CROSS-SECTION AT THE XEROX IRVINE SITE

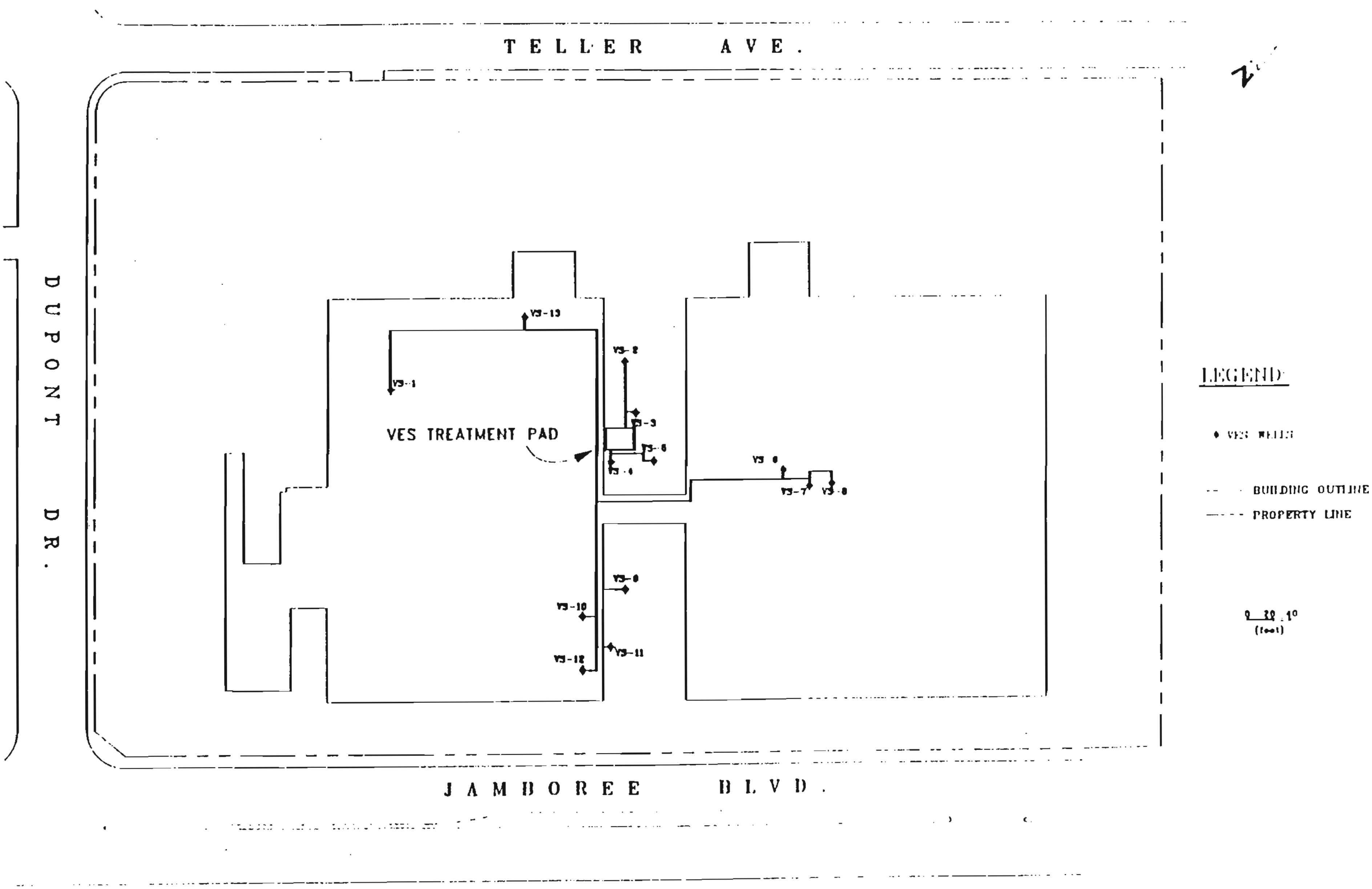


Figure 5. SOIL VAPOR EXTRACTION WELL FIELD

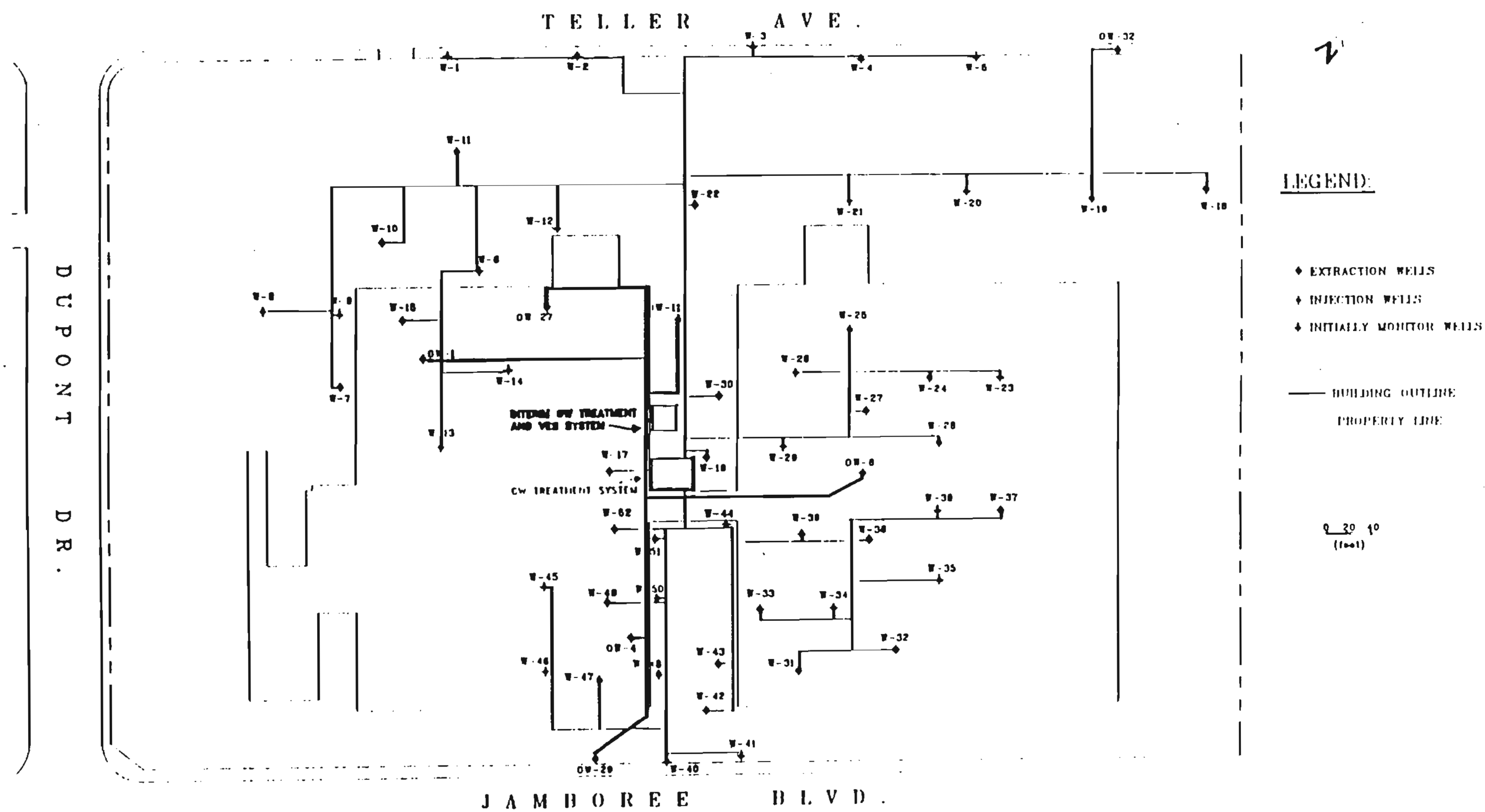


Figure 6. GROUNDWATER REMEDIATION WELL FIELD

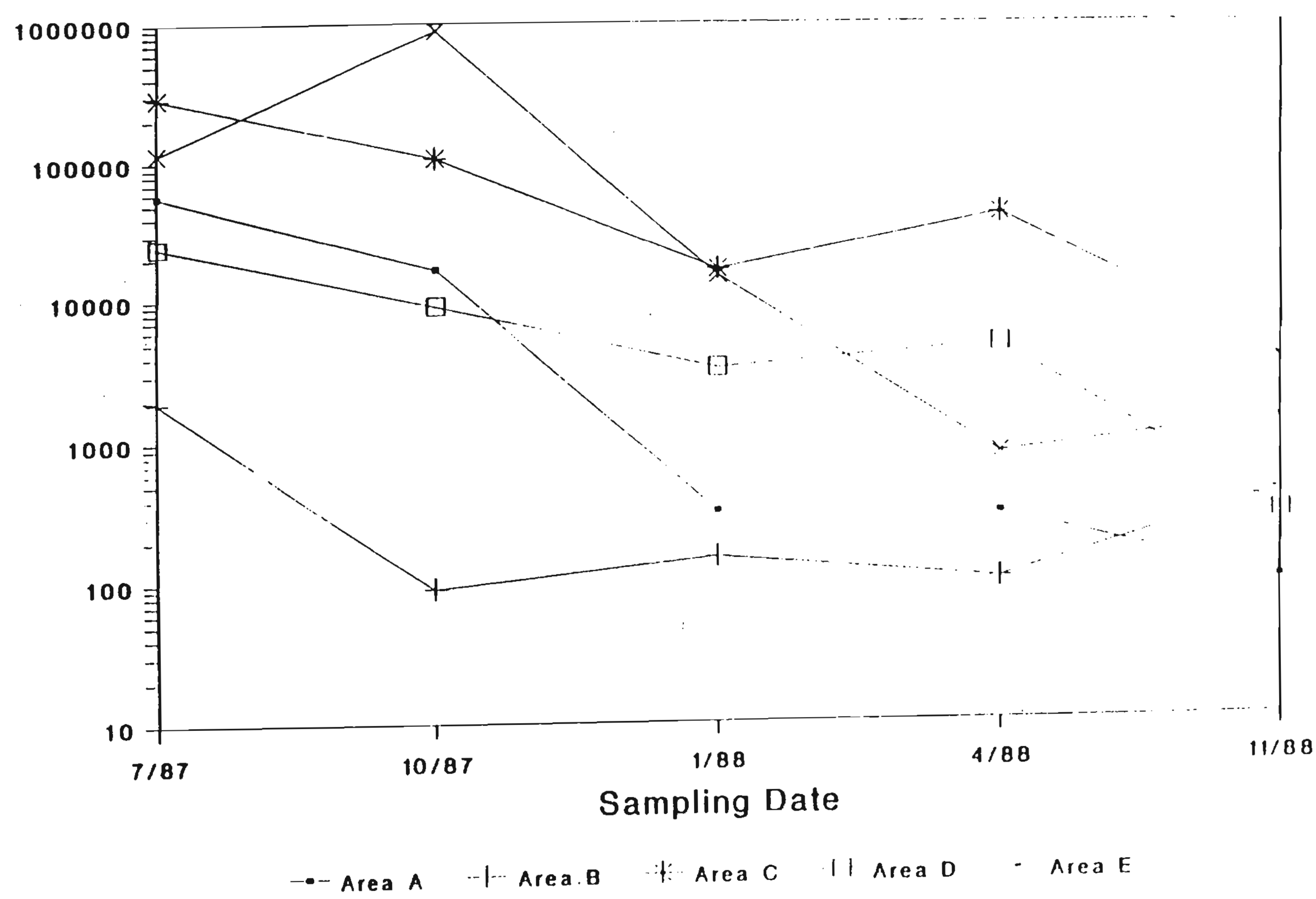


Figure 7. SOIL CLEANUP EVALUATION

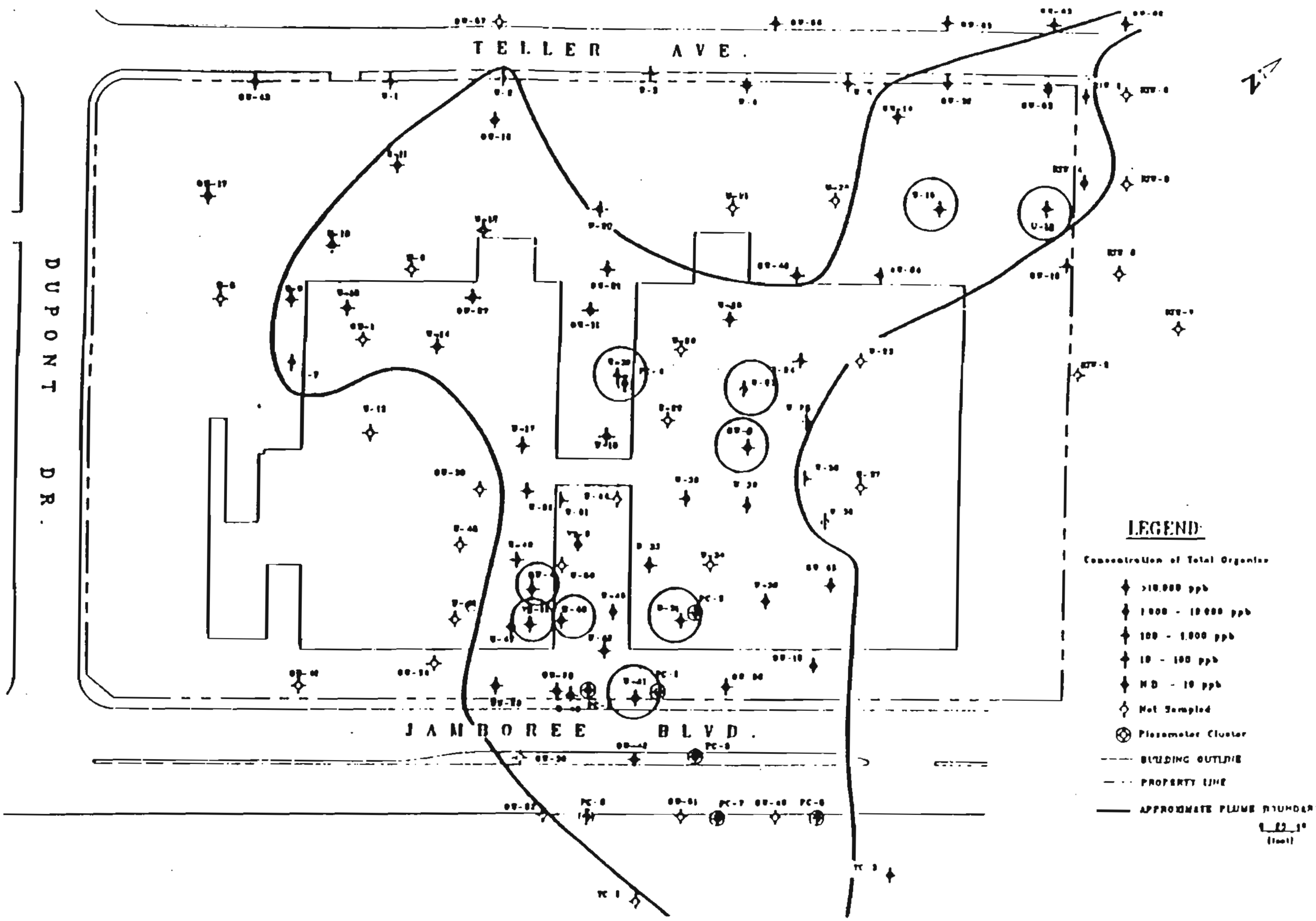


Figure 9. PILOT HIVAC TEST LOCATIONS

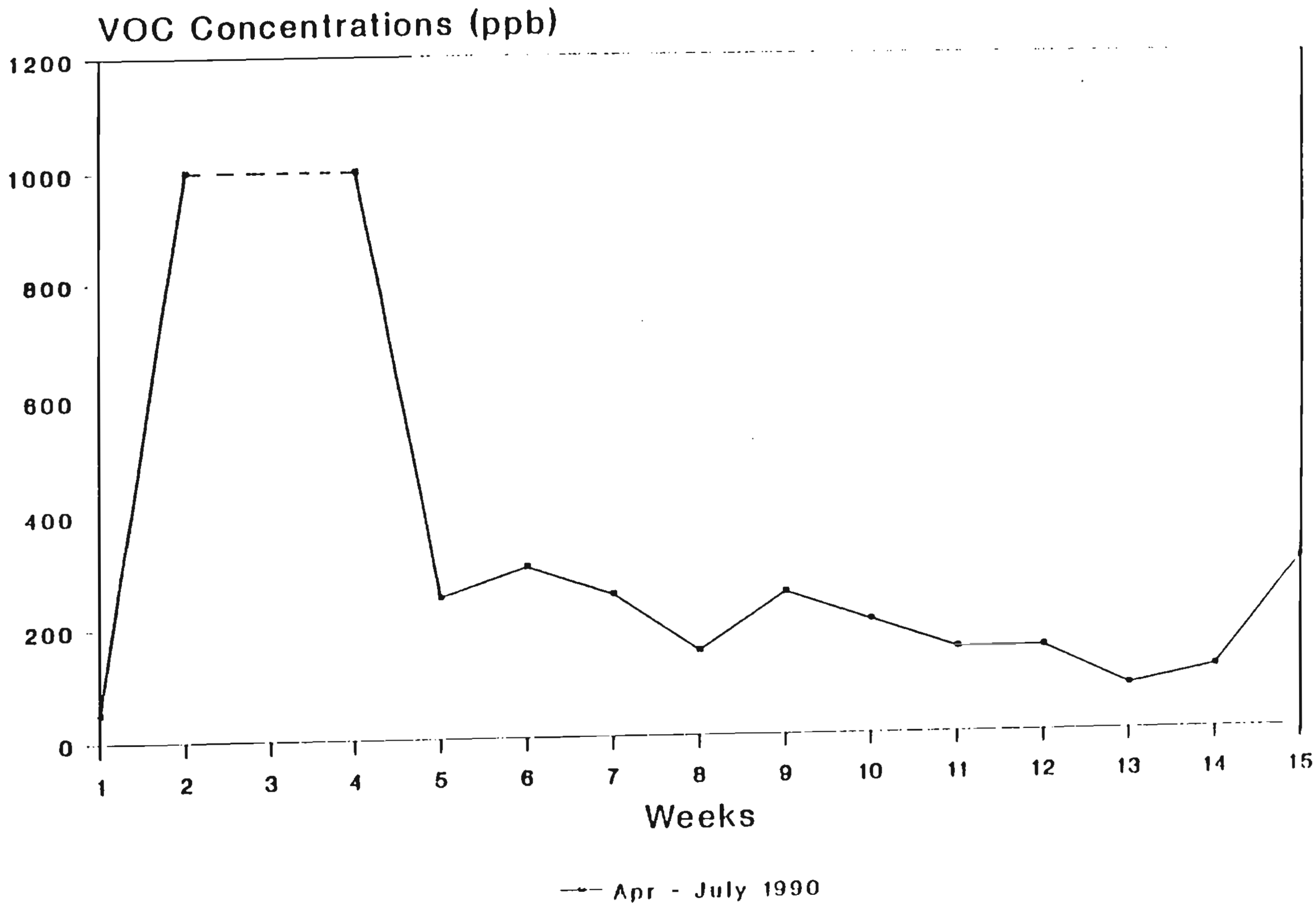


Figure 10. VAPOR ORGANIC CONCENTRATIONS READINGS (OVA) FOR THE PILOT HIVAC TESTING AT W-27

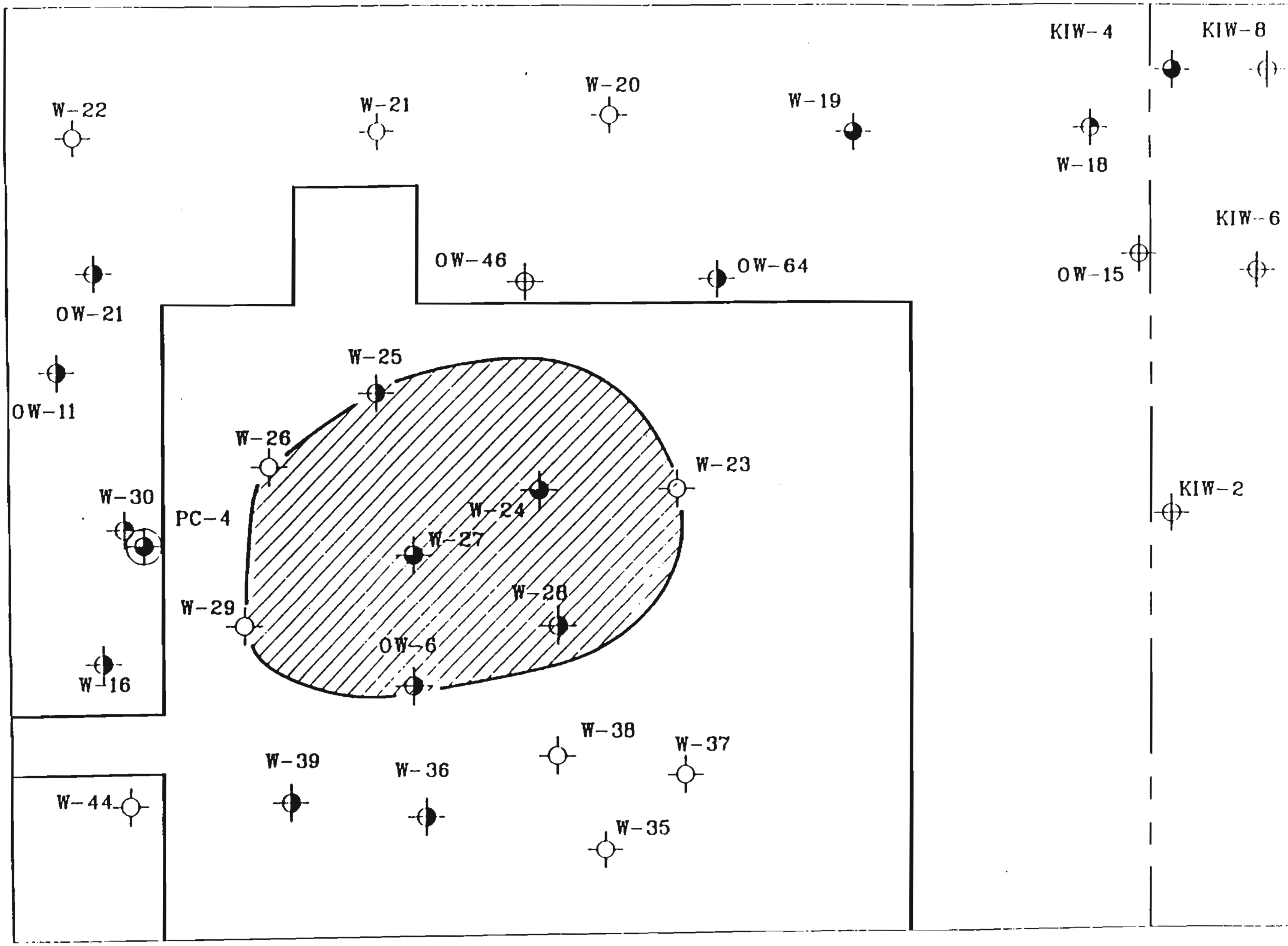


Figure 11. PILOT HIVAC TEST AREA AT W-27

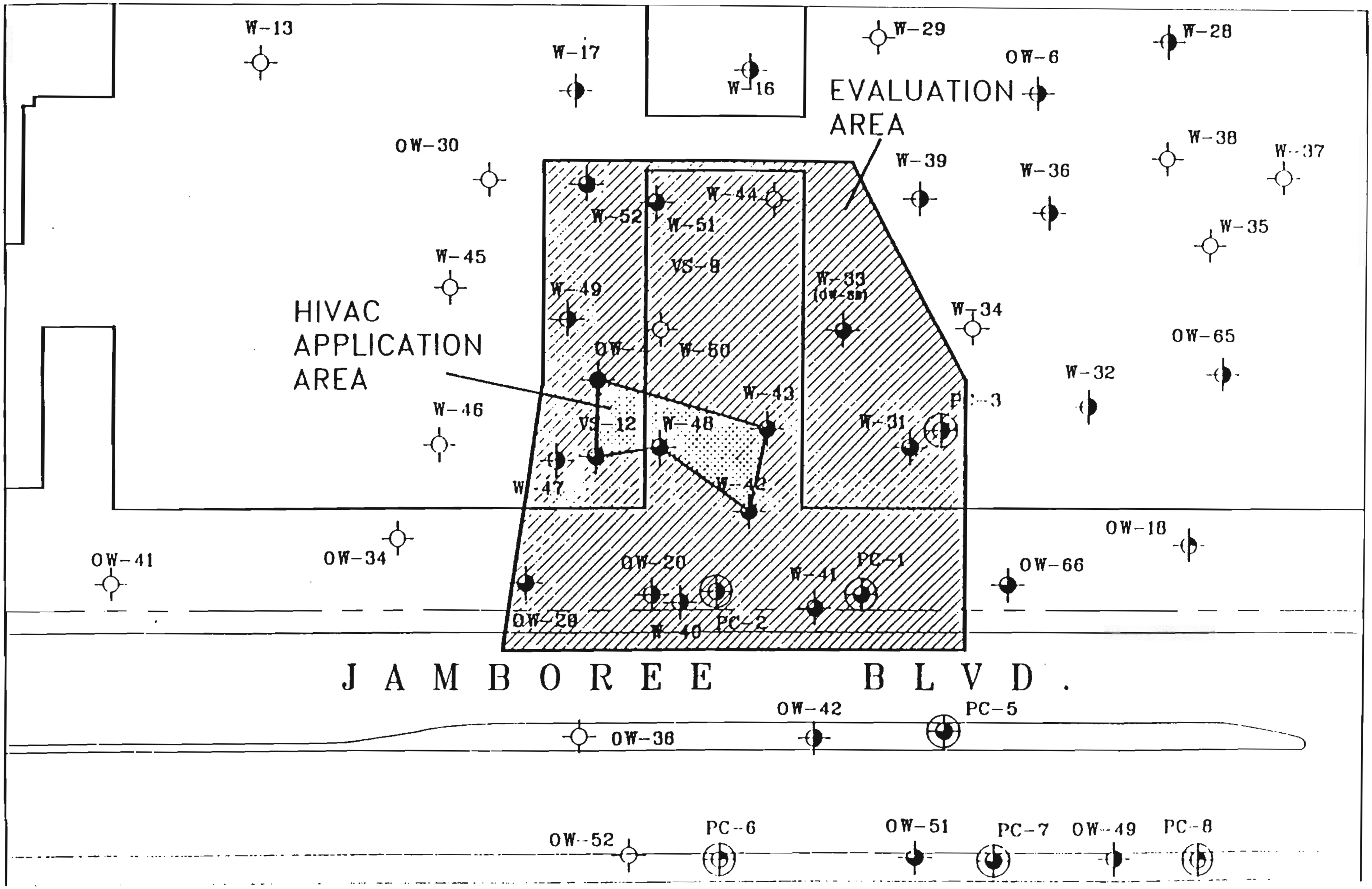


Figure 12. EXPANDED HIVAC TEST AREA

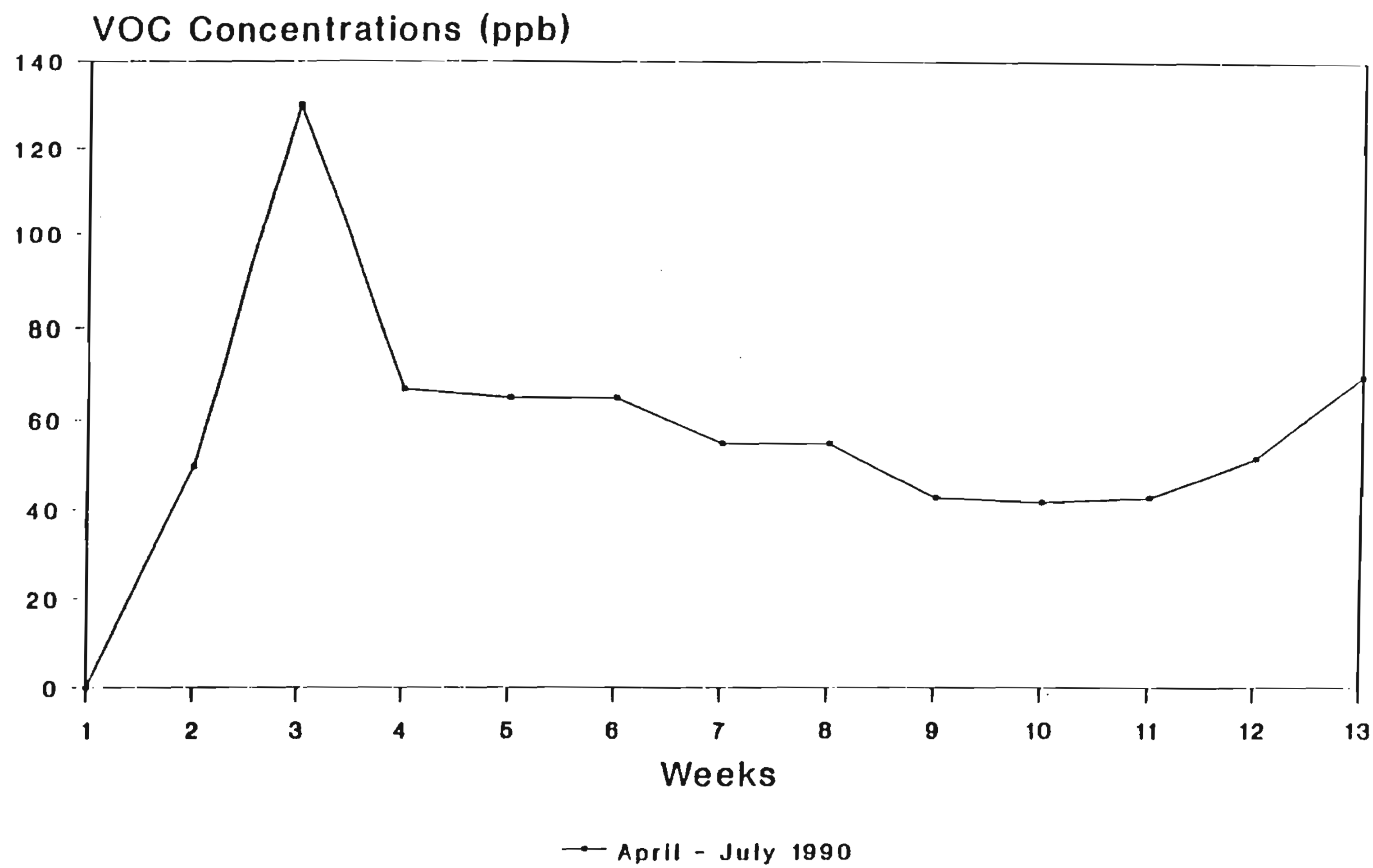


Figure 13. VAPOR ORGANIC CONCENTRATIONS READINGS (OVA) FOR THE EXPANDED HIVAC TESTING

Table 1. PILOT HIVAC GROUNDWATER EXTRACTION RATE RESULTS

Well ID#	Screened Interval (feet)	Approx. Depth to Groundwater (feet)	Conventional Pump Rate (gpm)	HIVAC Rate (gpm)
W-30	7 to 27	20	0.01	0.5
W-31	7 to 27	20	0.18	1.5
W-48	7 to 27	20	0.01	0.07
OW-▪4	5 to 15	12	0.01	0.09
VS-12	2 to 24	9	0.10	0.60
OW-6	7 to 27	9	‹ 0.1	~ 0.5
W-19	7 to 27	~15	« 0.1	0.27
W-18	7 to 27	~15	‹‹‹ 0.1	0.15
• W-27	7 to 27	~15	0.011	0.13
• W-41	7 to 33	~25	« 0.1	0.3 - 0.6

• Test Duration ~ 3 weeks, 8hrs/day

Table 2. GROUNDWATER CONCENTRATIONS OF VOC'S DURING THE PILOT HIVAC TEST AT W-27

Well ID#	Total VOC Concentrations (ppb)		
	Oct 1989** Before HIVAC Test	June 1990	July 1990
W-27	1814	537 •	1205
W-24	2190	187	1970
W-28	2833	437	No Water
OW-6	3299	87	806
W-25	401	268	267

• **Sampled on 2 May 1990**

** Samples collected before Pilot HIVAC application.

Table 3. GROUNDWATER CONCENTRATIONS OF VOC'S DURING THE EXPANDED HIVAC TEST

WELL ID#	TOTAL VOC CONCENTRATIONS (ppb)			
	April 1990 (Before HIVAC)	June 1990	July 1990	August 1990
OW-4	11360	4590	6020	7800
OW-29	11059	8960	6740	1500
VS-9	4575	9310	2550	161
VS-12	1316	318	155	1242
W-42	8712	759	146	9880
W-43	4381	2703	890	983
W-47 *	256	249	74	160
W-48	780	119	55	1520
W-49 *	258	874	772	204
OW-20 *	133	NS	83	2060
W-40 *	239	NS	47.	170
W-41 *	7118	NS	6250	610

* Monitoring Well Not Connected to the HIVAC

New York State Department of Environmental Conservation
50 Wolf Road, Albany, New York 12233-

Thomas C. Jorling
Commissioner

RECEIVED
MAR 7 1988

March 2, 1988

Mr. Derek Pimlett
Woodward - Clyde Consultants
5120 Butler Pike
Plymouth Meeting, PA 19462

Re: Xerox Corporation
SPDES Permit NY 021 5147

Dear Mr. Pimlett:

Per our telephone discussion attached is a copy of the draft SPDES permit for the Blauvelt Facility. This advance copy is for your information, with the formal draft to be forwarded to Xerox from the Region 3 Division of Regulatory Affairs.

Please note that detection limits using GC/MS supersede proposed water quality limitations for several parameters identified on the effluent limitation and action level pages.

If you have any questions on this, do not hesitate to contact either Ms. Carol Lamb or me at 518-457-6716.

Very truly yours,

Joseph F. Kelleher

Joseph F. Kelleher, P.E.
Chief
Chemical Systems Section

JFK/vc

Attachment

SPDES PERMIT FACT SHEET

Prepared by C. Lamb **Date** 02/19/88

Company Xerox Corporation **Permit No.** NY 021 5147

Location Blauvelt (T), Rockland County **Industrial Code No.** 4959

Industrial Segment Groundwater Remediation **Part No.** ______

Type of Processing & Production Rate: Groundwater is pumped from recovery wells, treated and discharged. Treatment system consists of filtration oil/water separation and air stripping.

Basis for Technology Effluent Limitations:

Parameter	Basis for Permit Conditions
Outfall No. 001 ; Treated Groundwater	**Discharge; Nominal Flow** 0.072 MGD
thylene Chloride	BAT/WO
,1-Dichloroethene	WQ
1,1-Dichloroethane	BAT
1,2-Dichloroethene	BAT
Chloroform	WQ/DL
1,1,1-Trichloroethane (TCA)	BAT
Trichloroethene (TCE)	WQ/DL
Tetrachloroethene (PCE)	WQ/DL
Benzene	WQ/DL
Toluene	BAT/WQ
Ethyl Benzene	WQ
Xylenes - Sum of all isomers	BAT/WQ
1,1,2-Trichloroethane	WQ/DL
Vinyl Chloride	WQ/DL
Chloroethane	AL
2-Chlorovinyl Ether	AL
Chlorobenzene	WQ/DL
1,3-Dichlorobenzene	WQ
1,4-Dichlorobenzene	AL

91-20-2 (2/86)—30a

NEW YORK STATE DEPARTMENT OF ENVIRONMENTAL CONSERVATION

State Pollutant Discharge Elimination System (SPDES) DISCHARGE PERMIT

Special Conditions (Part 1)

Industrial Code 4959

Discharge Class (CL) 0

Toxic Class (TX) T

Major D.B. 13

Sub D.B. 01

Water Index Number NJ-1-9-1

Facility ID Number: **NY**· 021 5147

UPA Tracking Number: 3-3924-00075/00003-0

Effective Date (EDP):

Expiration Date (ExDP):

Modification Date(s):

Attachment(s): *General Conditions (Part II, 2/85)*

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

Attn: Richard A. Van den Berg

Permittee Name: Xerox Corporation

Street: 800 Phillips Rd., Bldg. 304-135

City: Webster State: New York Zip Code: 14580

is authorized to discharge from the facility described below:

Facility Name: Xerox Corporation

Location (C,T,V): Blauvelt County: Rockland

Mailing Address (Street): 800 Phillips Rd., Bldg. 304-135

Mailing Address (City) Webster State: New York Zip Code 14580

from Outfall No. 001 at: Latitude 41:04:30 & Longitude 73:57:15

into receiving waters known as Tributary of Hackensack River Class A

and: (list other Outfalls, Receiving Waters & Water Classification)

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

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

PERMIT ADMINISTRATOR	DATE ISSUED	ADDRESS

Distribution:

SIGNATURE

EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

During the Period Beginning EDP

and lasting until EDP + 5 years

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

Outfall Number & Effluent Parameter	Discharge Limitations Daily Avg.	Discharge Limitations Daily Max.	Units	Minimum Monitoring Requirements Measurement Frequency	Minimum Monitoring Requirements Sample Type
Outfall 001; Treated Groundwater					
Flow	N/A	Monitor	MGD	Continuous	Recorder
Methylene Chloride	50		ug/l	Weekly	Grab
1,1-Dichloroethene	50		ug/l	Weekly	Grab
1,1-Dichloroethane		30	ug/l	Weekly	Grab
1,2-Dichloroethene		30	ug/l	Weekly	Grab
* Chloroform	0.001		lb/day	Weekly	Grab
1,1,1-Trichloroethane		20	ug/l	Weekly	Grab
* Trichloroethene	0.0025		lb/day	Weekly	Grab
* Tetrachloroethene	0.0025		lb/day	Weekly	Grab
* Benzene	0.0026		lb/day	Weekly	Grab
Toluene	50		ug/l	Weekly	Grab
Ethyl Benzene	50		ug/l	Weekly	Grab
Xylenes, Total	50		ug/l	Weekly	Grab
* Vinyl Chloride	0.011		lb/day	Weekly	Grab
* Chlorobenzene		0.004	lb/day	Weekly	Grab
1,3-Dichlorobenzene		5	ug/l	Weekly	Grab

* Detection limits for these parameters supersede the required water quality limitations

Parameter	Water Quality (ppb)	Detection Limit (ppb)
Chloroform	0.2	1.6
Trichloroethene	3.0	4.1
Tetrachloroethene	0.7	4.1
Benzene	1.0	4.4
Vinyl Chloride	0.3	18
Chlorobenzene	5.0	6.0

ACTION LEVEL REQUIREMENTS

The parameters listed below have been reported present in the discharge but at levels that currently do not require water-quality or technology-based limits. Action levels have been established which if exceeded will result in re-consideration of Water Quality and Technology based limits.

Routine action level monitoring results, if not provided for on the Discharge Monitoring Report (DMR) form, shall be appended to the DMR for the period during which the sampling was conducted. If submission of DMR's is not required by this permit, the results shall be maintained in accordance with instructions listed under MONITORING, RECORDING AND REPORTING.

If any of the action levels is exceeded, the permittee shall undertake a short-term, high-intensity monitoring program for this parameter. Samples identical to those required for routine monitoring purposes shall be taken on each of at least three operating days and analyzed. Results shall be expressed in terms of both concentration and mass, and shall be submitted no later than the end of the third month following the month when the action level was first exceeded. Results may be appended to a DMR or transmitted under separate cover to the addresses listed on the MONITORING, RECORDING AND REPORTING page of this permit. If levels higher than the action levels are confirmed, the result shall constitute a revised application and the permit shall be reopened for consideration of revised action levels or effluent limits.

The permittee is not authorized to discharge any of the listed parameters at levels which may cause or contribute to a violation of water quality standards.

Outfall Number and Effluent Parameter	Action Level	Units	Minimum Monitoring Requirements: Measurement Frequency	Minimum Monitoring Requirements: Sample Type
Outfall 001; Treated Groundwater				
* 1,1,2-Trichloroethane	0.003	lb/day	Monthly	Grab
Chloroethane	17	ug/l	Monthly	Grab
2-Chloro Vinyl Ether	50	ug/l	Monthly	Grab
1,4-Dichlorobenzene	4.7	ug/l	Monthly	Grab

* The detection limit of 5 ppb supersedes the proposed action level requirement of 0.5 ppb.

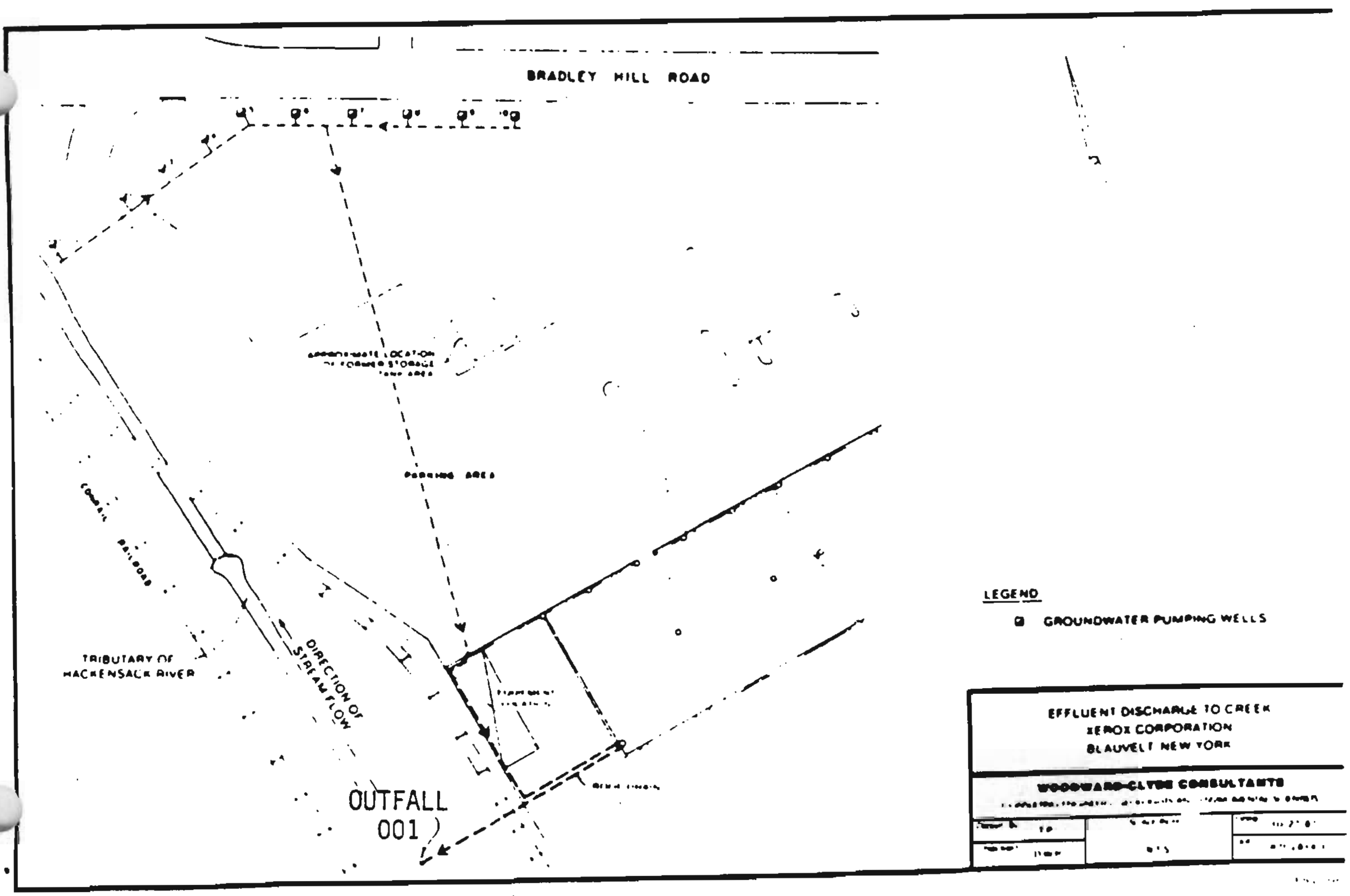
Definition of Daily Average and Daily Maximum

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

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

Monitoring Locations

Permittee shall take samples and measurements to meet the monitoring requirements at the location(s) indicated below (Show locations of outfalls with sketch or flow diagram as appropriate).



MONITORING, RECORDING AND REPORTING

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

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

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

■ Summarized and reported by submitting completed and signed Discharge Monitoring Report forms once every ________ month(s) to the locations specified below. Blank forms available at department offices listed below.

The first report will be due no later than ________

Thereafter, reports shall be submitted no later than the 28th of the following month(s): ________

Department of Environmental Conservation
Regional Water Engineer
202 Mamaroneck Ave.
White Plains, N.Y. 10601

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

☐ (Applicable only if checked)

________, Chief
Permit Administration Branch
Planning & Management Division
USEPA Region II, 26 Federal Plaza
New York, New York 10278

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

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

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

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

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

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

TABLE H-1
ALTERNATIVE COST SUMMARY
XEROX CORPORATION
BLAUVELT, NEW YORK

Alternative	Total Capital Cost 100 % of Qunatity	Total O&M Present Worth Cost 5% Discount Rate 30 Year Cleanup	Total Present Worth Cost
1	$0	$315,100	$315,100
2	$1,827,600	$1,410,800	$3,238,400
3	$2,015,900	$1,525,700	$3,541,600
4	$870,480	$1,164,800	$2,035,280
5	$931,200	$1,311,400	$2,242,600
6	$1,068,600	$1,094,100	$2,162,700

NOTE:

1. Table modified from 1992 Draft Feasibility Study by Woodward-Clyde Consultants.

TABLE H-2
ALTERNATIVE 1
ESTIMATED TOTAL REMEDIATION COST
XEROX CORPORATION
BLAUVELT, NEW YORK

Item Description	50% of Quantity Cost	100% of Quantity Cost	200% of Quantity Cost
Total Direct Cost (DC)	$0	$0	$0
Mobilization & Demobilization (10% of DC)	$0	$0	$0
Health and Safety (10% of DC)	$0	$0	$0
Engineering Costs (20% of DC)	$0	$0	$0
Subtotal	$0	$0	$0
Contingency (20%)	$0	$0	$0
Total Capital Cost	$0	$0	$0
Total O&M Present Worth Cost	$315,100	$315,100	$315,100
TOTAL PRESENT WORTH COST		$315,100	

NOTES:

1. Costs were generated based on 1992 dollars with a 30 year project life and a 5% rate of return.
2. Table modified from 1992 Draft Feasibility Study by Woodward-Clyde Consultants.

TABLE H-3
ALTERNATIVE 1
ESTIMATED OPERATION AND MAINTENANCE COST
XEROX CORPORATION
BLAUVELT, NEW YORK

Item Description	Annual	3% Rate of Return Cleanup Period (years)			5% Rate of Return Cleanup Period (years)			105% Rate of Return Cleanup Period (years)		
	Cost	5	15	30	5	15	30	5	15	30
Groundwater Monitoring System										
Well Maintenance	$500	$2,300	$6,000	$9,800	$2,200	$5,200	$7,700	$1,900	$3,800	$4,700
Sampling and Analysis	$20,000	$91,600	$238,800	$392,000	$86,600	$207,600	$307,400	$75,800	$152,100	$188,500
Totoal O&M Present Worth Cost	$20,500	$93,900	$244,800	$401,800	$88,800	$212,800	$315,100	$77,700	$155,900	$193,200

NOTES:
1. Costs were generated based on 1992 dollars with a 30 year project life and a 5% rate of return.
2. Table modified from 1992 Draft Feasibility Study by Woodward-Clyde Consultants.

TABLE H-4
ALTERNATIVE 2
ESTIMATED TOTAL REMEDIATION COST
XEROX CORPORATION
BLAUVELT, NEW YORK

Item Description	Current Quantity	Unit	Unit Cost	50% of Quantity Cost	100% of Quantity Cost	200% of Quantity Cost
XTRACT Recovery System (On Site)(2)						
Well Installation & Development	9	each	$8,000	$36,000	$72,000	$144,000
Filter Development Water	900	gal	$0.04	$18	$36	$72
Drill Cutting/Pipe Trench Soil Disposal	20	ton	$300	$3,000	$6,000	$12,000
Vacuum Pump Skid	3	each	$35,000	$52,500	$105,000	$210,000
Above Ground Piping & Insulation	350	L.F.	$14.75	$2,581	$5,163	$10,325
Below Ground Piping/Bedding/Trench	300	L.F.	$9.10	$1,365	$2,730	$5,460
Air/Water Separators	2	each	$750	$750	$1,500	$3,000
Instrument Control Package	2	each	$6,500	$13,000	$13,000	$13,000
Equipment Sheds	1	each	$20,000	$20,000	$20,000	$20,000
Accessory Pumps	4	each	$1,000	$2,000	$4,000	$2,000
Electrical Equipment	1	each	$6,500	$6,500	$6,500	$6,500
Piezometer Installation	10	each	$750	$7,500	$7,500	$7,500
TCLP Testing	2	each	$1,200	$1,200	$2,400	$4,800
Subtotal				$146,400	$245,800	$438,700
XTRACT Recovery System (Off Site)(2)						
Well Installation & Development	19	each	$8,000	$76,000	$152,000	$304,000
Filter Development Water	1,900	gal	$0.04	$38	$76	$152
Drill Cutting/Pipe Trench Soil Disposal	350	ton	$25	$4,375	$8,750	$17,500
Vacuum Pump Skids	3	each	$35,000	$52,500	$105,000	$210,000
Above Ground Piping & Insulation	250	L.F.	$14.75	$1,844	$3,688	$7,375
Below Ground Piping/Bedding/Trench	5600	L.F.	$9.10	$25,480	$50,960	$101,920
Air/Water Separators	5	each	$750	$1,875	$3,750	$7,500
Instrument Control Package	5	each	$6,500	$32,500	$32,500	$32,500
Equipment Sheds	1	each	$20,000	$20,000	$20,000	$20,000
Accessory Pumps	2	each	$1,000	$1,000	$2,000	$1,000
Electrical Equipment	1	each	$6,500	$6,500	$6,500	$6,500
TCLP Testing	2	each	$1,200	$1,200	$2,400	$4,800
Subtotal				$223,300	$387,600	$713,200
On Site Soil Vapor Collection & Treatment						
Above Ground Piping & Insulation	750	L.F.	$14.75	$5,531	$11,063	$22,125
Below Ground Piping/Bedding/Trench	200	L.F.	$9.10	$910	$1,820	$3,640
Vapor Treatment System						
Chiller Unit	1	each	$750	$750	$750	$750
Heater	1	each	$5,800	$5,800	$5,800	$5,800
Treatment Tanks	3	each	$15,000	$45,000	$45,000	$45,000
Piping	50	L.F.	$8.10	$203	$405	$203
Initial Treatment Reagent Supply	1	L.S.	$1,500	$1,500	$1,500	$1,500
Electrical Equipment	1	each	$4,000	$4,000	$4,000	$4,000

TABLE H-4 (Continued)
ALTERNATIVE 2
ESTIMATED TOTAL REMEDIATION COST
XEROX CORPORATION
BLAUVELT, NEW YORK

Item Description	Current Quantity	Unit	Unit Cost	50% of Quantity Cost	100% of Quantity Cost	200% of Quantity Cost
Instrument Control Package	1	each	$3,500	$3,500	$3,500	$3,500
Subtotal				$67,200	$73,800	$86,500
Conventional Pumping System (On Site and Off Site)						
Well Installation & Development	4	each	$3,500	$7,000	$14,000	$28,000
Filter Development Water	400	gal	$0.04	$8	$16	$32
Drill Cutting/Pipe Trench Soil Disposal	80	ton	$25	$1,000	$2,000	$4,000
Submersible Pump	8	each	$35,000	$140,000	$280,000	$560,000
Above Ground Piping & Insulation	100	L.F.	$14.75	$738	$1,475	$2,950
Below Ground Piping/Bedding/Trench	1200	L.F.	$9.10	$5,460	$10,920	$21,840
Instrument Control Package	2	each	$6,500	$6,500	$6,500	$6,500
Electrical Equipment	1	each	$6,500	$3,250	$3,250	$3,250
Equipment Sheds	1	each	$20,000	$10,000	$10,000	$10,000
TCLP Testing	2	each	$1,200	$1,200	$2,400	$4,800
Subtotal				$175,200	$330,600	$641,400
Groundwater Treatment						
Existing System Modifications	1	L.S.	$50,000	$25,000	$50,000	$66,500
Subtotal				$25,000	$50,000	$66,500

TABLE H-4 (Continued)
ALTERNATIVE 2
ESTIMATED TOTAL REMEDIATION COST
XEROX CORPORATION
BLAUVELT, NEW YORK

Item Description	50% of Quantity Cost	100% of Quantity Cost	200% of Quantity Cost
Total Direct Cost (DC)	$637,100	$1,087,800	$1,946,300
Mobilization & Demobilization (10% of DC)	$63,700	$108,800	$194,600
Health and Safety (10% of DC)	$63,700	$108,800	$194,600
Engineering Costs (20% of DC)	$127,400	$217,600	$389,300
Subtotal	$891,900	$1,523,000	$2,724,800
Contingency (20%)	$178,380	$304,600	$544,960
Total Capital Cost	$1,070,280	$1,827,600	$3,269,760
Total O&M Present Worth Cost	$1,410,800	$1,410,800	$1,410,800
TOTAL PRESENT WORTH COST		$3,238,400	

NOTES:
1. Costs were generated based on 1992 dollars with a 30 year project life and a 5% rate of return.
2. For both overburden and shallow rock groundwater recovery.
3. Table modified from 1992 Draft Feasibility Study by Woodward-Clyde Consultants.

TABLE H-5
ALTERNATIVE 2
ESTIMATED OPERATION AND MAINTENANCE COST
XEROX CORPORATION
BLAUVELT, NEW YORK

Item Description	Annual Cost	3% Rate of Return Cleanup Period (years)			5% Rate of Return Cleanup Period (years)			10% Rate of Return Cleanup Period (years)		
		5	15	30	5	15	30	5	15	30
XTRACT Recovery System (On Site)(2)										
Well Inspection & Maintenance	$3,500	$16,000	$41,800	$68,600	$15,200	$36,300	$53,800	$13,300	$26,600	$33,000
Pump Maintenance	$4,000	$18,300	$47,800	$78,400	$17,300	$41,500	$61,500	$15,200	$30,400	$37,700
Above Ground Piping	$600	$2,700	$7,200	$11,800	$2,600	$6,200	$9,200	$2,300	$4,600	$5,700
Below Ground Piping	$500	$2,300	$6,000	$9,800	$2,200	$5,200	$7,700	$1,900	$3,800	$4,700
Air/Water Separator	$50	$200	$600	$1,000	$200	$500	$800	$200	$400	$500
Instrument Controls	$200	$900	$2,400	$3,900	$900	$2,100	$3,100	$800	$1,500	$1,900
Accessory Pumps	$1,500	$6,900	$17,900	$29,400	$6,500	$15,600	$23,100	$5,700	$11,400	$14,100
Electrical Equipment	$200	$900	$2,400	$3,900	$900	$2,100	$3,100	$800	$1,500	$1,900
Subtotal	$10,550	$48,200	$126,100	$206,800	$45,800	$109,500	$162,300	$40,200	$80,200	$99,500
XTRACT Recovery System (Off Site)(2)										
Well Inspection & Maintenance	$1,000	$4,600	$11,900	$19,600	$4,300	$10,400	$15,400	$3,800	$7,600	$9,400
Pump Maintenance	$2,000	$9,200	$23,900	$39,200	$8,700	$20,800	$30,700	$7,600	$15,200	$18,900
Above Ground Piping	$100	$500	$1,200	$2,000	$400	$1,000	$1,500	$400	$800	$900
Below Ground Piping	$200	$900	$2,400	$3,900	$900	$2,100	$3,100	$800	$1,500	$1,900
Air/Water Separator	$100	$500	$1,200	$2,000	$400	$1,000	$1,500	$400	$800	$900
Instrument Controls	$100	$500	$1,200	$2,000	$400	$1,000	$1,500	$400	$800	$900
Accessory Pumps	$800	$3,700	$9,600	$15,700	$3,500	$8,300	$12,300	$3,000	$6,100	$7,500
Electrical Equipment	$50	$200	$600	$1,000	$200	$500	$800	$200	$400	$500
Subtotal	$4,350	$20,100	$52,000	$85,400	$18,800	$45,100	$66,800	$16,600	$33,200	$40,900
On Site Soil Vapor Collection & Treatment										
Above Ground Piping	$600	$2,700	$7,200	$11,800	$2,600	$6,200	$9,200	$2,300	$4,600	$5,700
Below Ground Piping	$500	$2,300	$6,000	$9,800	$2,200	$5,200	$7,700	$1,900	$3,800	$4,700
Vapor Treatment System										
Chiller Unit	$100	$500	$1,200	$2,000	$400	$1,000	$1,500	$400	$800	$900
Heater	$100	$500	$1,200	$2,000	$400	$1,000	$1,500	$400	$800	$900
Treatment Tanks	$2,000	$9,200	$23,900	$39,200	$8,700	$20,800	$30,700	$7,600	$15,200	$18,900
Piping	$150	$700	$1,800	$2,900	$600	$1,600	$2,300	$600	$1,100	$1,400

TABLE H-5 (Continued)
ALTERNATIVE 2
ESTIMATED OPERATION AND MAINTENANCE COST
XEROX CORPORATION
BLAUVELT, NEW YORK

Item Description	Annual Cost	3% Rate of Return Cleanup Period (years) 5	15	30	5% Rate of Return Cleanup Period (years) 5	15	30	10% Rate of Return Cleanup Period (years) 5	15	30
Reagent Supply	$5,000	$22,900	$59,700	$98,000	$21,600	$51,900	$76,900	$19,000	$38,000	$47,100
Electrical Equipment	$200	$900	$2,400	$3,900	$900	$2,100	$3,100	$800	$1,500	$1,900
Instrument Controls	$200	$900	$2,400	$3,900	$900	$2,100	$3,100	$800	$1,500	$1,900
Subtotal	$8,850	$40,600	$105,800	$173,500	$38,300	$91,900	$136,000	$33,800	$67,300	$83,400
Conventional Pumping System (On Site and Off Site)										
Well Inspection & Maintenance	$600	$2,700	$7,200	$11,800	$2,600	$6,200	$7,200	$2,300	$4,600	$5,700
Pump Maintenance	$750	$3,400	$9,000	$14,700	$3,200	$7,800	$11,500	$2,800	$5,700	$7,100
Above Ground Piping	$75	$300	$900	$1,500	$300	$800	$1,200	$300	$600	$700
Below Ground Piping	$300	$1,400	$3,600	$5,900	$1,300	$3,100	$4,600	$1,100	$2,300	$2,800
Instrument Control Package	$150	$700	$1,800	$2,900	$600	$1,600	$2,300	$600	$1,100	$1,400
Accessory Pumps	$200	$900	$2,400	$3,900	$900	$2,100	$3,100	$800	$1,500	$1,900
Electrical Equipment	$75	$300	$900	$1,500	$300	$800	$1,200	$300	$600	$700
Subtotal	$2,200	$9,700	$25,800	$42,200	$9,200	$22,400	$31,100	$8,200	$16,400	$20,300
Groundwater Treatment										
Free Product/Water Separator	$100	$500	$1,200	$2,000	$400	$1,000	$1,500	$400	$800	$900
Solids Filter	$100	$500	$1,200	$2,000	$400	$1,000	$1,500	$400	$800	$900
Flow Equilization Tank	$100	$500	$1,200	$2,000	$400	$1,000	$1,500	$400	$800	$900
UV/Peroxidation Unit	$500	$2,300	$6,000	$9,800	$2,200	$5,200	$7,700	$1,900	$3,800	$4,700
Air Stripper	$400	$1,800	$4,800	$7,800	$1,700	$4,200	$6,100	$1,500	$3,000	$3,800
Carbon Treatment Units	$500	$2,300	$6,000	$9,800	$2,200	$5,200	$7,700	$1,900	$3,800	$4,700
Process Instruments	$400	$1,800	$4,800	$7,800	$1,700	$4,200	$6,100	$1,500	$3,000	$3,800
Pumps	$500	$2,300	$6,000	$9,800	$2,200	$5,200	$7,700	$1,900	$3,800	$4,700
Piping	$100	$500	$1,200	$2,000	$400	$1,000	$1,500	$400	$800	$900
Carbon Supply	$15,000	$69,000	$179,000	$294,000	$65,000	$156,000	$231,000	$57,000	$114,000	$141,000
Air Compressors	$500	$2,300	$6,000	$9,800	$2,200	$5,200	$7,700	$1,900	$3,800	$4,700
Electrical Equipment	$300	$1,400	$3,600	$5,900	$1,300	$3,100	$4,600	$1,100	$2,300	$2,800
Subtotal	$18,500	$85,200	$221,000	$362,700	$80,100	$192,300	$284,600	$70,300	$140,700	$173,800

TABLE H-5 (Continued)
ALTERNATIVE 2
ESTIMATED OPERATION AND MAINTENANCE COST
XEROX CORPORATION
BLAUVELT, NEW YORK

Item Description	Annual Cost	3% Rate of Return Cleanup Period (years)			5% Rate of Return Cleanup Period (years)			10% Rate of Return Cleanup Period (years)		
		5	15	30	5	15	30	5	15	30
Groundwater Monitoring System										
Well Maintenance	$2,500	$11,000	$30,000	$49,000	$11,000	$26,000	$38,000	$9,000	$19,000	$24,000
Sampling and Analysis	$45,000	$206,000	$537,000	$882,000	$195,000	$467,000	$692,000	$171,000	$342,000	$424,000
Subtotal	$47,500	$217,000	$567,000	$931,000	$206,000	$493,000	$730,000	$180,000	$361,000	$448,000
Total O&M Present Worth Cost	**$92,000**	**$420,800**	**$1,097,700**	**$1,801,600**	**$398,200**	**$954,200**	**$1,410,800**	**$349,100**	**$698,800**	

Notes: 1. Costs were generated based on 1992 dollars
2. For overburden and shallow bedrock groundwater recovery

TABLE H-6
ALTERNATIVE 3
ESTIMATED TOTAL REMEDIATION COST
XEROX CORPORATION
BLAUVELT, NEW YORK

Item Description	Current Quantity	Unit	Unit Cost	50% of Quantity Cost	100% of Quantity Cost	200% of Quantity Cost
XTRACT Recovery System (On Site)(2)						
Well Installation & Development	9	each	$8,000	$36,000	$72,000	$144,000
Filter Development Water	900	gal	$0.04	$18	$36	$72
Drill Cutting/Pipe Trench Soil Disposal	20	ton	$300	$3,000	$6,000	$12,000
Vacuum Pump Skid	3	each	$35,000	$52,500	$105,000	$210,000
Above Ground Piping & Insulation	350	L.F.	$14.75	$2,581	$5,163	$10,325
Below Ground Piping/Bedding/Trench	300	L.F.	$9.10	$1,365	$2,730	$5,460
Air/Water Separators	2	each	$750	$750	$1,500	$3,000
Instrument Control Package	2	each	$6,500	$13,000	$13,000	$13,000
Equipment Sheds	1	each	$20,000	$20,000	$20,000	$20,000
Accessory Pumps	4	each	$1,000	$2,000	$4,000	$2,000
Electrical Equipment	1	each	$6,500	$6,500	$6,500	$6,500
Piezometer Installation	10	each	$750	$7,500	$7,500	$7,500
TCLP Testing	2	each	$1,200	$1,200	$2,400	$4,800
Subtotal				$146,400	$245,800	$438,700
XTRACT Recovery System (Off Site)(2)						
Well Installation & Development	19	each	$8,000	$76,000	$152,000	$304,000
Filter Development Water	1,900	gal	$0.04	$38	$76	$152
Drill Cutting/Pipe Trench Soil Disposal	350	ton	$25	$4,375	$8,750	$17,500
Vacuum Pump Skids	3	each	$35,000	$52,500	$105,000	$210,000
Above Ground Piping & Insulation	250	L.F.	$14.75	$1,844	$3,688	$7,375
Below Ground Piping/Bedding/Trench	5600	L.F.	$9.10	$25,480	$50,960	$101,920
Air/Water Separators	5	each	$750	$1,875	$3,750	$7,500
Instrument Control Package	5	each	$6,500	$32,500	$32,500	$32,500
Equipment Sheds	1	each	$20,000	$20,000	$20,000	$20,000
Accessory Pumps	2	each	$1,000	$1,000	$2,000	$1,000
Electrical Equipment	1	each	$6,500	$6,500	$6,500	$6,500
TCLP Testing	2	each	$1,200	$1,200	$2,400	$4,800
Subtotal				$223,300	$387,600	$713,200
On Site Soil Vapor Collection & Treatment						
Above Ground Piping & Insulation	750	L.F.	$14.75	$5,531	$11,063	$22,125
Below Ground Piping/Bedding/Trench	200	L.F.	$9.10	$910	$1,820	$3,640
Vapor Treatment System						
Chiller Unit	1	each	$750	$750	$750	$750
Heater	1	each	$5,800	$5,800	$5,800	$5,800
Treatment Tanks	3	each	$15,000	$45,000	$45,000	$45,000
Piping	50	L.F.	$8.10	$203	$405	$203
Initial Treatment Reagent Supply	1	L.S.	$1,500	$1,500	$1,500	$1,500
Electrical Equipment	1	each	$4,000	$4,000	$4,000	$4,000

TABLE H-6 (Continued)
ALTERNATIVE 3
ESTIMATED TOTAL REMEDIATION COST
XEROX CORPORATION
BLAUVELT, NEW YORK

Item Description	Current Quantity	Unit	Unit Cost	50% of Quantity Cost	100% of Quantity Cost	200% of Quantity Cost
Instrument Control Package	1	each	$3,500	$3,500	$3,500	$3,500
Subtotal				$67,200	$73,800	$86,500
Bioremediation System Support						
Initial Soil Oxygen/Nutrient Analysis	1	L.S.	$3,000	$1,500	$3,000	$6,000
Nutrient Addition for Startup	1	L.S.	$500	$250	$500	$1,000
Nutrient Solution Delivery System	1	L.S.	$26,500	$26,500	$26,500	$26,500
Nutrient Solution Tank	1	L.S.	$750	$750	$750	$750
Subtotal				$103,700	$112,100	$128,300
Conventional Pumping System (On Site and Off Site)						
Well Installation & Development	4	each	$3,500	$7,000	$14,000	$28,000
Filter Development Water	400	gal	$0.04	$8	$16	$32
Drill Cutting/Pipe Trench Soil Disposal	80	ton	$25	$1,000	$2,000	$4,000
Submersible Pump	8	each	$35,000	$140,000	$280,000	$560,000
Above Ground Piping & Insulation	100	L.F.	$14.75	$738	$1,475	$2,950
Below Ground Piping/Bedding/Trench	1200	L.F.	$9.10	$5,460	$10,920	$21,840
Instrument Control Package	2	each	$6,500	$6,500	$6,500	$6,500
Electrical Equipment	1	each	$6,500	$3,250	$3,250	$3,250
Equipment Sheds	1	each	$20,000	$10,000	$10,000	$10,000
TCLP Testing	2	each	$1,200	$1,200	$2,400	$4,800
Subtotal				$175,200	$330,600	$641,400
Groundwater Treatment						
Existing System Modifications	1	L.S.	$50,000	$50,000	$50,000	$66,500
Subtotal				$50,000	$50,000	$66,500

TABLE H-6 (Continued)
ALTERNATIVE 3
ESTIMATED TOTAL REMEDIATION COST
XEROX CORPORATION
BLAUVELT, NEW YORK

Item Description	50% of Quantity Cost	100% of Quantity Cost	200% of Quantity Cost
Total Direct Cost (DC)	$765,800	$1,199,900	$2,074,600
Mobilization & Demobilization (10% of DC)	$76,600	$120,000	$207,500
Health and Safety (10% of DC)	$76,600	$120,000	$207,500
Engineering Costs (20% of DC)	$153,200	$240,000	$414,900
Subtotal	$1,072,200	$1,679,900	$2,904,500
Contingency (20%)	$214,400	$336,000	$580,900
Total Capital Cost	$1,286,600	$2,015,900	$3,485,400
Total O&M Present Worth Cost	$1,525,700	$1,525,700	$1,525,700
TOTAL PRESENT WORTH COST		$3,541,600	

NOTES:

1. Costs were generated based on 1992 dollars with a 30 year project life and a 5% rate of return.
2. For both overburden and shallow rock groundwater recovery.
3. Table modified from 1992 Draft Feasibility Study by Woodward-Clyde Consultants.

TABLE H-7
ALTERNATIVE 3
ESTIMATED OPERATION AND MAINTENANCE COST
XEROX CORPORATION
BLAUVELT, NEW YORK

Item Description	Annual Cost	3% Rate of Return Cleanup Period (years)			5% Rate of Return Cleanup Period (years)			10% Rate of Return Cleanup Period (years)		
		5	15	30	5	15	30	5	15	30
XTRACT Recovery System (On Site)(2)										
Well Inspection & Maintenance	$3,500	$16,000	$41,800	$68,600	$15,200	$36,300	$53,800	$13,300	$26,600	$33,000
Pump Maintenance	$4,000	$18,300	$47,800	$78,400	$17,300	$41,500	$61,500	$15,200	$30,400	$37,700
Above Ground Piping	$600	$2,700	$7,200	$11,800	$2,600	$6,200	$9,200	$2,300	$4,600	$5,700
Below Ground Piping	$500	$2,300	$6,000	$9,800	$2,200	$5,200	$7,700	$1,900	$3,800	$4,700
Air/Water Separator	$50	$200	$600	$1,000	$200	$500	$800	$200	$400	$500
Instrument Controls	$200	$900	$2,400	$3,900	$900	$2,100	$3,100	$800	$1,500	$1,900
Accessory Pumps	$1,500	$6,900	$17,900	$29,400	$6,500	$15,600	$23,100	$5,700	$11,400	$14,100
Electrical Equipment	$200	$900	$2,400	$3,900	$900	$2,100	$3,100	$800	$1,500	$1,900
Subtotal	$10,550	$48,200	$126,100	$206,800	$45,800	$109,500	$162,300	$40,200	$80,200	$99,500
XTRACT Recovery System (Off Site)(2)										
Well Inspection & Maintenance	$1,000	$4,600	$11,900	$19,600	$4,300	$10,400	$15,400	$3,800	$7,600	$9,400
Pump Maintenance	$2,000	$9,200	$23,900	$39,200	$8,700	$20,800	$30,700	$7,600	$15,200	$18,900
Above Ground Piping	$100	$500	$1,200	$2,000	$400	$1,000	$1,500	$400	$800	$900
Below Ground Piping	$200	$900	$2,400	$3,900	$900	$2,100	$3,100	$800	$1,500	$1,900
Air/Water Separator	$100	$500	$1,200	$2,000	$400	$1,000	$1,500	$400	$800	$900
Instrument Controls	$100	$500	$1,200	$2,000	$400	$1,000	$1,500	$400	$800	$900
Accessory Pumps	$800	$3,700	$9,600	$15,700	$3,500	$8,300	$12,300	$3,000	$6,100	$7,500
Electrical Equipment	$50	$200	$600	$1,000	$200	$500	$800	$200	$400	$500
Subtotal	$4,350	$20,100	$52,000	$85,400	$18,800	$45,100	$66,800	$16,600	$33,200	$40,900
On Site Soil Vapor Collection & Treatment										
Above Ground Piping	$600	$2,700	$7,200	$11,800	$2,600	$6,200	$9,200	$2,300	$4,600	$5,700
Below Ground Piping	$500	$2,300	$6,000	$9,800	$2,200	$5,200	$7,700	$1,900	$3,800	$4,700
Vapor Treatment System										
Chiller Unit	$100	$500	$1,200	$2,000	$400	$1,000	$1,500	$400	$800	$900
Heater	$100	$500	$1,200	$2,000	$400	$1,000	$1,500	$400	$800	$900
Treatment Tanks	$2,000	$9,200	$23,900	$39,200	$8,700	$20,800	$30,700	$7,600	$15,200	$18,900
Piping	$150	$700	$1,800	$2,900	$600	$1,600	$2,300	$600	$1,100	$1,400

TABLE H-7 (Continued)
ALTERNATIVE 3
ESTIMATED OPERATION AND MAINTENANCE COST
XEROX CORPORATION
BLAUVELT, NEW YORK

Item Description	Annual Cost	3% Rate of Return Cleanup Period (years)			5% Rate of Return Cleanup Period (years)			10% Rate of Return Cleanup Period (years)		
		5	15	30	5	15	30	5	15	30
Reagent Supply	$5,000	$22,900	$59,700	$98,000	$21,600	$51,900	$76,900	$19,000	$38,000	$47,100
Electrical Equipment	$200	$900	$2,400	$3,900	$900	$2,100	$3,100	$800	$1,500	$1,900
Instrument Controls	$200	$900	$2,400	$3,900	$900	$2,100	$3,100	$800	$1,500	$1,900
Subtotal	$8,850	$40,600	$105,800	$173,500	$38,300	$91,900	$136,000	$33,800	$67,300	$83,400
Conventional Pumping System (On Site and Off Site)										
Well Inspection & Maintenance	$600	$2,700	$7,200	$11,800	$2,600	$6,200	$7,200	$2,300	$4,600	$5,700
Pump Maintenance	$750	$3,400	$9,000	$14,700	$3,200	$7,800	$11,500	$2,800	$5,700	$7,100
Above Ground Piping	$75	$300	$900	$1,500	$300	$800	$1,200	$300	$600	$700
Below Ground Piping	$300	$1,400	$3,600	$5,900	$1,300	$3,100	$4,600	$1,100	$2,300	$2,800
Instrument Control Package	$150	$700	$1,800	$2,900	$600	$1,600	$2,300	$600	$1,100	$1,400
Accessory Pumps	$200	$900	$2,400	$3,900	$900	$2,100	$3,100	$800	$1,500	$1,900
Electrical Equipment	$75	$300	$900	$1,500	$300	$800	$1,200	$300	$600	$700
Subtotal	$2,200	$9,700	$25,800	$42,200	$9,200	$22,400	$31,100	$8,200	$16,400	$20,300
Bioremediation System										
Support Nutrients	$2,500	$11,000	$30,000	$49,000	$11,000	$26,000	$38,000	$9,000	$19,000	$24,000
Subsurface Analyses	$5,000	$22,900	$59,700	$98,000	$21,600	$51,900	$76,900	$19,000	$38,000	$47,100
Subtotal	$7,500	$33,900	$89,700	$147,000	$32,600	$77,900	$114,900	$28,000	$57,000	$71,100
Groundwater Treatment										
Free Product/Water Separator	$100	$500	$1,200	$2,000	$400	$1,000	$1,500	$400	$800	$900
Solids Filter	$100	$500	$1,200	$2,000	$400	$1,000	$1,500	$400	$800	$900
Flow Equilization Tank	$100	$500	$1,200	$2,000	$400	$1,000	$1,500	$400	$800	$900
UV/Peroxidation Unit	$500	$2,300	$6,000	$9,800	$2,200	$5,200	$7,700	$1,900	$3,800	$4,700
Air Stripper	$400	$1,800	$4,800	$7,800	$1,700	$4,200	$6,100	$1,500	$3,000	$3,800
Carbon Treatment Units	$500	$2,300	$6,000	$9,800	$2,200	$5,200	$7,700	$1,900	$3,800	$4,700
Process Instruments	$400	$1,800	$4,800	$7,800	$1,700	$4,200	$6,100	$1,500	$3,000	$3,800
Pumps	$500	$2,300	$6,000	$9,800	$2,200	$5,200	$7,700	$1,900	$3,800	$4,700

TABLE H-7 (Continued)
ALTERNATIVE 3
ESTIMATED OPERATION AND MAINTENANCE COST
XEROX CORPORATION
BLAUVELT, NEW YORK

Item Description	Annual Cost	3% Rate of Return Cleanup Period (years)			5% Rate of Return Cleanup Period (years)			10% Rate of Return Cleanup Period (years)		
		5	15	30	5	15	30	5	15	30
Piping	$100	$500	$1,200	$2,000	$400	$1,000	$1,500	$400	$800	$900
Carbon Supply	$15,000	$69,000	$179,000	$294,000	$65,000	$156,000	$231,000	$57,000	$114,000	$141,000
Air Compressors	$500	$2,300	$6,000	$9,800	$2,200	$5,200	$7,700	$1,900	$3,800	$4,700
Electrical Equipment	$300	$1,400	$3,600	$5,900	$1,300	$3,100	$4,600	$1,100	$2,300	$2,800
Subtotal	$18,500	$85,200	$221,000	$362,700	$80,100	$192,300	$284,600	$70,300	$140,700	$173,800
Groundwater Monitoring System										
Well Maintenance	$2,500	$11,000	$30,000	$49,000	$11,000	$26,000	$38,000	$9,000	$19,000	$24,000
Sampling and Analysis	$45,000	$206,000	$537,000	$882,000	$195,000	$467,000	$692,000	$171,000	$342,000	$424,000
Subtotal	$47,500	$217,000	$567,000	$931,000	$206,000	$493,000	$730,000	$180,000	$361,000	$448,000
Total O&M Present Worth Cost	**$99,500**	**$454,700**	**$1,187,400**	**$1,948,600**	**$430,800**	**$1,032,100**	**$1,525,700**	**$377,100**	**$755,800**	**$937,000**

Notes: 1. Costs were generated based on 1992 dollars
2. For overburden and shallow bedrock groundwater recovery

TABLE H-8
ALTERNATIVE 4
ESTIMATED TOTAL REMEDIATION COST
XEROX CORPORATION
BLAUVELT, NEW YORK

Item Description	Current Quantity	Unit	Unit Cost	50% of Quantity Cost	100% of Quantity Cost	200% of Quantity Cost
Conventional Pumping System (On Site)						
Well Installation & Development	9	each	$3,500	$15,750	$31,500	$63,000
Filter Development Water	900	gal	$0.04	$18	$36	$72
Drill Cutting/Trench Soil Disposal	20	ton	$300	$3,000	$6,000	$12,000
Submersible Pumps	18	each	$2,500	$22,500	$45,000	$90,000
Above Ground Piping & Insulation	350	L.F.	$14.75	$2,581	$5,163	$10,325
Below Ground Piping/Bedding/Trench	300	L.F.	$9.10	$1,365	$2,730	$5,460
Instrument Control Package	2	each	$6,500	$13,000	$13,000	$13,000
Equipment Shed	1	each	$20,000	$20,000	$20,000	$20,000
Electrical Equipment	1	each	$6,500	$6,500	$6,500	$6,500
Piezometer Installation	10	each	$750	$7,500	$7,500	$7,500
TCLP Testing	2	each	$1,200	$1,200	$2,400	$4,800
Subtotal				$93,400	$139,800	$232,700
Conventional Pumping System (Off Site)						
Well Installation & Development	23	each	$3,500	$40,250	$80,500	$161,000
Filter Development Water	2,300	gal	$0.04	$46	$92	$184
Drill Cutting/Trench Soil Disposal	.370	ton	$25	$4,625	$9,250	$18,500
Submersible Pumps	35	each	$2,500	$43,750	$87,500	$175,000
Above Ground Piping & Insulation	240	L.F.	$14.75	$1,770	$3,540	$7,080
Below Ground Piping/Bedding/Trench	6000	L.F.	$9.10	$27,300	$54,600	$109,200
Instrument Control Package	5	each	$6,500	$32,500	$32,500	$32,500
Electrical Equipment	1	each	$6,500	$6,500	$6,500	$6,500
Equipment Sheds	1	each	$20,000	$20,000	$20,000	$20,000
TCLP Testing	2	each	$1,200	$1,200	$2,400	$4,800
Subtotal				$177,900	$296,900	$534,800
Onsite Soil Cap						
Site Clearing	0.3	acre	$710	$107	$213	$426
Proofroll Subgrade	1460	sy	$1.20	$876	$1,752	$3,504
Crushed Stone (6 inches)	1460	sy	$4.92	$3,592	$7,183	$14,366
Sealant	365	gal	$1.57	$287	$573	$1,146
Bituminous Concrete	1460	sy	$6.70	$4,891	$9,782	$19,564
Base Coat (2 inches)	1460	sy	$3.95	$2,884	$5,767	$11,534
Top Coat (2 inches)	1460	sy	$4.30	$3,139	$6,278	$12,556
Subtotal				$15,800	$31,500	$63,100
Groundwater Treatment						
Existing System Modifications	1	L.S.	$50,000	$50,000	$50,000	$66,500
Subtotal				$50,000	$50,000	$66,500

TABLE H-8 (Continued)
ALTERNATIVE 4
ESTIMATED TOTAL REMEDIATION COST
XEROX CORPORATION
BLAUVELT, NEW YORK

Item Description	50% of Quantity Cost	100% of Quantity Cost	200% of Quantity Cost
Total Direct Cost (DC)	$337,100	$518,200	$897,100
Mobilization & Demobilization (10% of DC)	$33,700	$51,800	$89,700
Health and Safety (10% of DC)	$33,700	$51,800	$89,700
Engineering Costs (20% of DC)	$67,400	$103,600	$179,400
Subtotal	$471,900	$725,400	$1,255,900
Contingency (20%)	$94,380	$145,080	$251,180
Total Capital Cost	$566,280	$870,480	$1,507,080
Total O&M Present Worth Cost	$1,164,800	$1,164,800	$1,164,800
TOTAL PRESENT WORTH COST		$2,035,280	

NOTES:

1. Costs were generated based on 1992 dollars with a 30 year project life and a 5% rate of return.
2. Table modified from 1992 Draft Feasibility Study by Woodward-Clyde Consultants.

TABLE H-9
ALTERNATIVE 4
ESTIMATED OPERATION AND MAINTENANCE COST
XEROX CORPORATION
BLAUVELT, NEW YORK

Item Description	Annual Cost	3% Rate of Return Cleanup Period (years) 5	15	30	5% Rate of Return Cleanup Period (years) 5	15	30	10% Rate of Return Cleanup Period (years) 5	15	30
Conventional Pumping System (On Site)										
Well Inspection & Maintenance	$2,500	$11,000	$30,000	$49,000	$11,000	$26,000	$38,000	$9,000	$19,000	$24,000
Pump Maintenance	$2,000	$9,200	$23,900	$39,200	$8,700	$20,800	$30,700	$7,600	$15,200	$18,900
Above Ground Piping	$500	$1,100	$3,000	$4,900	$1,100	$2,600	$3,800	$900	$1,900	$2,400
Below Ground Piping	$400	$1,800	$4,800	$7,800	$1,700	$4,200	$6,100	$1,500	$3,000	$3,800
Instrument Control Package	$100	$500	$1,200	$2,000	$400	$1,000	$1,500	$400	$800	$900
Electrical Equipment	$150	$700	$1,800	$2,900	$600	$1,600	$2,300	$600	$1,100	$1,400
Subtotal	$5,650	$24,300	$64,700	$105,800	$23,500	$56,200	$82,400	$20,000	$41,000	$51,400
Conventional Pumping System (Off Site)										
Well Inspection & Maintenance	$1,500	$7,000	$18,000	$29,000	$6,000	$16,000	$23,000	$6,000	$11,000	$14,000
Pump Maintenance	$2,000	$9,200	$23,900	$39,200	$8,700	$20,800	$30,700	$7,600	$15,200	$18,900
Above Ground Piping	$50	$200	$600	$1,000	$200	$500	$800	$200	$400	$500
Below Ground Piping	$250	$1,100	$3,000	$4,900	$1,100	$2,600	$3,800	$900	$1,900	$2,400
Instrument Control Package	$100	$500	$1,200	$2,000	$400	$1,000	$1,500	$400	$800	$900
Electrical Equipment	$50	$200	$600	$1,000	$200	$500	$800	$200	$400	$500
Subtotal	$3,950	$18,200	$47,300	$77,100	$16,600	$41,400	$60,600	$15,300	$29,700	$37,200
On Site Soil Cap										
Cap Inspection	$50	$200	$600	$1,000	$200	$500	$800	$200	$400	$500
Sealant	$200	$900	$2,400	$3,900	$900	$2,100	$3,100	$800	$1,500	$1,900
Resurface	$600	$2,700	$7,200	$11,800	$2,600	$6,200	$7,200	$2,300	$4,600	$5,700
Subtotal	$850	$3,800	$10,200	$16,700	$3,700	$8,800	$11,100	$3,300	$6,500	$8,100
Groundwater Treatment										
Free Product/Water Separator	$100	$500	$1,200	$2,000	$400	$1,000	$1,500	$400	$800	$900
Solids Filter	$100	$500	$1,200	$2,000	$400	$1,000	$1,500	$400	$800	$900
Flow Equalization Tank	$100	$500	$1,200	$2,000	$400	$1,000	$1,500	$400	$800	$900
UV/Peroxidation Unit	$500	$2,300	$6,000	$9,800	$2,200	$5,200	$7,700	$1,900	$3,800	$4,700

TABLE H-9 (Continued)
ALTERNATIVE 4
ESTIMATED OPERATION AND MAINTENANCE COST
XEROX CORPORATION
BLAUVELT, NEW YORK

Item Description	Annual Cost	3% Rate of Return Cleanup Period (years)			5% Rate of Return Cleanup Period (years)			10% Rate of Return Cleanup Period (years)		
		5	15	30	5	15	30	5	15	30
Air Stripping System	$400	$1,800	$4,800	$7,800	$1,700	$4,200	$6,100	$1,500	$3,000	$3,800
Carbon Treatment System	$500	$1,100	$3,000	$4,900	$1,100	$2,600	$3,800	$900	$1,900	$2,400
Process Instruments	$400	$1,800	$4,800	$7,800	$1,700	$4,200	$6,100	$1,500	$3,000	$3,800
Pumps	$500	$2,300	$6,000	$9,800	$2,200	$5,200	$7,700	$1,900	$3,800	$4,700
Piping	$100	$500	$1,200	$2,000	$400	$1,000	$1,500	$400	$800	$900
Carbon Supply	$15,000	$69,000	$179,000	$294,000	$65,000	$156,000	$231,000	$57,000	$114,000	$141,000
Air Compressors	$500	$2,300	$6,000	$9,800	$2,200	$5,200	$7,700	$1,900	$3,800	$4,700
Electrical Equipment	$300	$1,400	$3,600	$5,900	$1,300	$3,100	$4,600	$1,100	$2,300	$2,800
Subtotal	$18,500	$84,000	$218,000	$357,800	$79,000	$189,700	$280,700	$69,300	$138,800	$171,500
Groundwater Monitoring System										
Well Maintenance	$2,500	$11,000	$30,000	$49,000	$11,000	$26,000	$38,000	$9,000	$19,000	$24,000
Sampling and Analysis	$45,000	$206,000	$537,000	$882,000	$195,000	$467,000	$692,000	$171,000	$342,000	$424,000
Subtotal	$47,500	$217,000	$567,000	$931,000	$206,000	$493,000	$730,000	$180,000	$361,000	$448,000
Total O&M Present Worth Cost	**$76,500**	**$347,300**	**$907,200**	**$1,488,400**	**$328,800**	**$789,100**	**$1,164,800**	**$287,900**	**$577,000**	**$716,200**

Note: Costs were generated based on 1992 dollars

TABLE H-10
ALTERNATIVE 5
ESTIMATED TOTAL REMEDIATION COST
XEROX CORPORATION
BLAUVELT, NEW YORK

Item Description	Current Quantity	Unit	Unit Cost	50% of Quantity Cost	100% of Quantity Cost	200% of Quantity Cost
XTRACT Recovery System						
(Onsite Recovery)						
Well Installation & Development	9	each	$8,000	$36,000	$72,000	$144,000
Filter Development Water	900	gal	$0.04	$18	$36	$72
Drill Cutting/Pipe Trench Soil Disposal	20	ton	$300	$3,000	$6,000	$12,000
Vacuum Pump Skids	3	each	$35,000	$52,500	$105,000	$210,000
Above Ground Piping & Insulation	350	L.F.	$14.75	$2,581	$5,163	$10,325
Below Ground Piping/Bedding/Trench	300	L.F.	$9.10	$1,365	$2,730	$5,460
Air/Water Separators	2	each	$750	$750	$1,500	$3,000
Instrument Control Package	2	each	$6,500	$13,000	$13,000	$13,000
Equipment Sheds	1	each	$20,000	$20,000	$20,000	$20,000
Accessory Pumps	4	each	$1,000	$2,000	$4,000	$8,000
Electrical Equipment	1	each	$6,500	$6,500	$6,500	$6,500
Piezometer Installation	10	each	$750	$7,500	$7,500	$7,500
TCLP Testing	2	each	$1,200	$1,200	$2,400	$4,800
Subtotal				$146,400	$245,800	$444,700
Conventional Pumping System						
(Use Existing Wells On Site)				(No Addn.)	(No Addn.)	(No Addn.)
Well Installation & Development	10	each	$3,500	$17,500	$35,000	$70,000
(for Offsite Plume Containment)						
Filter Development Water	1,000	gal	$0.04	$20	$40	$80
Drill Cutting/Trench Soil Disposal	300	ton	$25	$3,750	$7,500	$15,000
Submersible Pumps	20	each	$2,500	$25,000	$50,000	$100,000
Above Ground Piping & Insulation	250	L.F.	$14.75	$1,844	$3,688	$7,375
Below Ground Piping/Bedding/Trench	5000	L.F.	$9.10	$22,750	$45,500	$91,000
Instrument Control Packages	3	each	$6,500	$19,500	$19,500	$19,500
Electrical Equipment	1	each	$6,500	$6,500	$6,500	$6,500
Equipment Sheds	1	each	$20,000	$20,000	$20,000	$20,000
TCLP Testing	2	each	$1,200	$1,200	$2,400	$4,800
Subtotal				$118,100	$190,100	$334,300
OnSite Soil Vapor Collection & Treatment						
Above Ground Piping & Insulation	750	L.F.	$14.75	$5,531	$11,063	$22,125
Below Ground Piping/Bedding/Trench	200	L.F.	$9.10	$910	$1,820	$3,640
Vapor Treatment System						$0
Chiller Unit	1	each	$750	$750	$750	$750
Heater	1	each	$500	$500	$500	$500
Treatment Tanks	3	each	$15,000	$45,000	$45,000	$45,000
Piping	50	L.F.	$8.10	$405	$405	$405
Initial Treatment Reagent Supply	1	L.S.	$1,500	$1,500	$1,500	$1,500
Electrical Equipment	1	each	$4,000	$4,000	$4,000	$4,000
Instrument Control Package	1	each	$3,500	$3,500	$3,500	$3,500
Subtotal				$62,100	$68,500	$81,400

TABLE H-10 (Continued)
ALTERNATIVE 5
ESTIMATED TOTAL REMEDIATION COST
XEROX CORPORATION
BLAUVELT, NEW YORK

Item Description	Current Quantity	Unit	Unit Cost	50% of Quantity Cost	100% of Quantity Cost	200% of Quantity Cost
Groundwater Treatment Upgrade Existing System Modifications	1	LS	$50,000	$25,000	$50,000	$66,500
Subtotal				$25,000	$50,000	$66,500
Total Direct Cost (DC)				$351,600	$554,400	$926,900
Mobilization & Demobilization (10% of DC)				$35,200	$55,400	$92,700
Health and Safety (10% of DC)				$35,200	$55,400	$92,700
Engineering Costs (20% of DC)				$70,400	$110,800	$185,400
Subtotal				$492,400	$776,000	$1,297,700
Contingency (20%)				$98,480	$155,200	$259,540
Total Capital Cost				$590,880	$931,200	$1,557,240
Total O&M Present Worth Cost				$1,311,400	$1,311,400	$1,311,400
TOTAL PRESENT WORTH COST					$2,242,600	

NOTES:

1. Costs were generated based on 1992 dollars with a 30 year project life and a 5% rate of return.
2. Table modified from 1992 Draft Feasibility Study by Woodward-Clyde Consultants.

TABLE H-11
ALTERNATIVE 5
ESTIMATED OPERATION AND MAINTENANCE COST
XEROX CORPORATION
BLAUVELT, NEW YORK

Item Description	Annual Cost	3% Rate of Return Cleanup Period (years) 5	15	30	5% Rate of Return Cleanup Period (years) 5	15	30	10% Rate of Return Cleanup Period (years) 5	15	30
XTRACT Recovery System (On Site)										
Well Inspection & Maintenance	$1,750	$8,000	$20,900	$34,300	$7,600	$18,200	$26,900	$6,600	$13,300	$16,500
Pump Maintenance	$2,000	$9,200	$23,900	$39,200	$8,700	$20,800	$30,700	$7,600	$15,200	$18,900
Above Ground Piping	$300	$1,400	$3,600	$5,900	$1,300	$3,100	$4,600	$1,100	$2,300	$2,800
Below Ground Piping	$250	$1,100	$3,000	$4,900	$1,100	$2,600	$3,800	$900	$1,900	$2,400
Air/Water Separators	$50	$200	$600	$1,000	$200	$500	$800	$200	$400	$500
Instrument Control Package	$100	$500	$1,200	$2,000	$400	$1,000	$1,500	$400	$800	$900
Accessory Pumps	$750	$3,400	$9,000	$14,700	$3,200	$7,800	$11,500	$2,800	$5,700	$7,100
Electrical Equipment	$100	$500	$1,200	$2,000	$400	$1,000	$1,500	$400	$800	$900
Subtotal	$5,300	$24,300	$63,400	$104,000	$22,900	$55,000	$81,300	$20,000	$40,400	$50,000
Conventional Pumping System (On Site and Off Site)										
Well Inspection & Maintenance	$1,600	$7,300	$19,100	$31,400	$6,900	$16,600	$24,600	$6,100	$12,200	$15,100
Pump Maintenance	$2,000	$9,200	$23,900	$39,200	$8,700	$20,800	$30,700	$7,600	$15,200	$18,900
Above Ground Piping	$100	$500	$1,200	$2,000	$400	$1,000	$1,500	$400	$800	$900
Below Ground Piping	$200	$900	$2,400	$3,900	$900	$2,100	$3,100	$800	$1,500	$1,900
Instrument Control Package	$200	$900	$2,400	$3,900	$900	$2,100	$3,100	$800	$1,500	$1,900
Electrical Equipment	$100	$500	$1,200	$2,000	$400	$1,000	$1,500	$400	$800	$900
Subtotal	$4,200	$19,300	$50,200	$82,400	$18,200	$43,600	$64,500	$16,100	$32,000	$39,600
On Site Soil Vapor Recovery & Collection										
Above Ground Piping	$600	$2,700	$7,200	$11,800	$2,600	$6,200	$9,200	$2,300	$4,600	$5,700
Below Ground Piping	$500	$2,300	$6,000	$9,800	$2,200	$5,200	$7,700	$1,900	$3,800	$4,700
Vapor Treatment System										
Chiller Unit	$100	$500	$1,200	$2,000	$400	$1,000	$1,500	$400	$800	$900
Heater	$100	$500	$1,200	$2,000	$400	$1,000	$1,500	$400	$800	$900
Treatment Tanks	$2,000	$9,200	$23,900	$39,200	$8,700	$20,800	$30,700	$7,600	$15,200	$18,900
Piping	$150	$700	$1,800	$2,900	$600	$1,600	$2,300	$600	$1,100	$1,400
Reagent Supply	$5,000	$22,900	$59,700	$98,000	$21,600	$51,900	$76,900	$19,000	$38,000	$47,100
Electrical Equipment	$200	$900	$2,400	$3,900	$900	$2,100	$3,100	$800	$1,500	$1,900

TABLE H -11 (Continued)
ALTERNATIVE 5
ESTIMATED OPERATION AND MAINTENANCE COST
XEROX CORPORATION
BLAUVELT, NEW YORK

Item Description	Annual Cost	3% Rate of Return Cleanup Period (years)			5% Rate of Return Cleanup Period (years)			10% Rate of Return Cleanup Period (years)		
		5	15	30	5	15	30	5	15	30
Instrument Control Package	$200	$900	$2,400	$3,900	$900	$2,100	$3,100	$800	$1,500	$1,900
Subtotal	$8,850	$40,600	$105,800	$173,500	$38,300	$91,900	$136,000	$33,800	$67,300	$83,400
Groundwater Treatment										
Free Product/Water Separator	$100	$500	$1,200	$2,000	$400	$1,000	$1,500	$400	$800	$900
Solids Filter	$100	$500	$1,200	$2,000	$400	$1,000	$1,500	$400	$800	$900
Flow Equalization Tank	$100	$500	$1,200	$2,000	$400	$1,000	$1,500	$400	$800	$900
UV/Peroxidation Unit	$500	$2,300	$6,000	$9,800	$2,200	$5,200	$7,700	$1,900	$3,800	$4,700
Air Stripping System	$400	$1,800	$4,800	$7,800	$1,700	$4,200	$6,100	$1,500	$3,000	$3,800
Carbon Treatment System	$500	$2,300	$6,000	$9,800	$2,200	$5,200	$7,700	$1,900	$3,800	$4,700
Process Instrument Package	$400	$1,800	$4,800	$7,800	$1,700	$4,200	$6,100	$1,500	$3,000	$3,800
Pumps	$500	$2,300	$6,000	$9,800	$2,200	$5,200	$7,700	$1,900	$3,800	$4,700
Piping	$100	$500	$1,200	$2,000	$400	$1,000	$1,500	$400	$800	$900
Carbon Supply	$10,000	$45,800	$119,400	$196,000	$43,300	$103,800	$153,700	$37,900	$76,100	$94,300
Hydrogen Peroxide Supply	$6,000	$27,500	$71,700	$117,600	$26,000	$62,300	$92,300	$1,900	$3,800	$4,700
Air Compressors	$500	$2,300	$6,000	$9,800	$2,200	$5,200	$7,700	$1,900	$3,800	$4,700
Electrical Equipment	$300	$1,400	$3,600	$5,900	$1,300	$3,100	$4,600	$1,100	$2,300	$2,800
Subtotal	$19,500	$89,500	$233,100	$382,300	$84,400	$202,400	$299,600	$53,100	$106,600	$131,800
Groundwater Monitoring System										
Well Maintenance	$2,500	$11,000	$30,000	$49,000	$11,000	$26,000	$38,000	$9,000	$19,000	$24,000
Sampling and Analysis	$45,000	$206,000	$537,000	$882,000	$195,000	$467,000	$692,000	$171,000	$342,000	$424,000
Subtotal	$47,500	$217,000	$567,000	$931,000	$206,000	$493,000	$730,000	$180,000	$361,000	$448,000
Total O&M Present Worth Cost	**$85,400**	**$390,700**	**$1,019,500**	**$1,673,200**	**$369,800**	**$885,900**	**$1,311,400**	**$303,000**	**$607,300**	**$752,800**

Note: Costs were generated based on 1992 dollars

TABLE H-12
ALTERNATIVE 6
ESTIMATED TOTAL REMEDIATION COST
XEROX CORPORATION
BLAUVELT, NEW YORK

Item Description	Current Quantity	Unit	Unit Cost	50% of Quantity Cost	100% of Quantity Cost	200% of Quantity Cost
"Hot Spot Soil Remediation						
"Hot Spot" Soil Excavation	2900	cy	$15	$21,750	$43,500	$87,000
"Hot Spot" Soil Treatment via Onsite Aeration	4700	ton	$75	$176,250	$352,500	$705,000
Subtotal				$198,000	$396,000	$792,000
Conventional Pumping System						
(Use Existing Wells On Site)				(No Addn.)	(No Addn.)	(No Addn.)
Well Installation & Development (for Offsite Plume Containment)	10	each	$3,500	$17,500	$35,000	$70,000
Filter Development Water	1,000	gal	$0.04	$20	$40	$80
Drill Cutting/Trench Soil Disposal	300	ton	$25	$3,750	$7,500	$15,000
Submersible Pumps	20	each	$2,500	$25,000	$50,000	$100,000
Above Ground Piping & Insulation	250	L.F.	$14.75	$1,844	$3,688	$7,375
Below Ground Piping/Bedding/Trench	5000	L.F.	$9.10	$22,750	$45,500	$91,000
Instrument Control Packages	3	each	$6,500	$19,500	$19,500	$19,500
Electrical Equipment	1	each	$6,500	$6,500	$6,500	$6,500
Equipment Sheds	1	each	$20,000	$20,000	$20,000	$20,000
TCLP Testing	2	each	$1,200	$1,200	$2,400	$4,800
Subtotal				$118,100	$190,100	$334,300

TABLE H-12 (Continued)
ALTERNATIVE 6
ESTIMATED TOTAL REMEDIATION COST
XEROX CORPORATION
BLAUVELT, NEW YORK

Item Description	Current Quantity	Unit	Unit Cost	50% of Quantity Cost	100% of Quantity Cost	200% of Quantity Cost
Groundwater Treatment Upgrade Existing System Modifications	1	LS	$50,000	$25,000	$50,000	$66,500
Subtotal				$25,000	$50,000	$66,500
Total Direct Cost (DC)				$341,100	$636,100	$1,192,800
Mobilization & Demobilization (10% of DC)				$34,100	$63,600	$119,300
Health and Safety (10% of DC)				$34,100	$63,600	$119,300
Engineering Costs (20% of DC)				$68,200	$127,200	$238,600
Subtotal				$477,500	$890,500	$1,670,000
Contingency (20%)				$95,500	$178,100	$334,000
Total Capital Cost				$573,000	$1,068,600	$2,004,000
Total O&M Present Worth Cost				$1,094,100	$1,094,100	$1,094,100
TOTAL PRESENT WORTH COST					$2,162,700	

NOTES:
1. Costs were generated based on 1992 dollars with a 30 year project life and a 5% rate of return.
2. Table modified from 1992 Draft Feasibility Study by Woodward-Clyde Consultants.

TABLE H-13
ALTERNATIVE 6
ESTIMATED OPERATION AND MAINTENANCE COST
XEROX CORPORATION
BLAUVELT, NEW YORK

Item Description	Annual Cost	3% Rate of Return Cleanup Period (years)			5% Rate of Return Cleanup Period (years)			10% Rate of Return Cleanup Period (years)		
		5	15	30	5	15	30	5	15	30
Conventional Pumping System (On Site and Off Site)										
Well Inspection & Maintenance	$1,600	$7,300	$19,100	$31,400	$6,900	$16,600	$24,600	$6,100	$12,200	$15,100
Pump Maintenance	$2,000	$9,200	$23,900	$39,200	$8,700	$20,800	$30,700	$7,600	$15,200	$18,900
Above Ground Piping	$100	$500	$1,200	$2,000	$400	$1,000	$1,500	$400	$800	$900
Below Ground Piping	$200	$900	$2,400	$3,900	$900	$2,100	$3,100	$800	$1,500	$1,900
Instrument Control Package	$200	$900	$2,400	$3,900	$900	$2,100	$3,100	$800	$1,500	$1,900
Electrical Equipment	$100	$500	$1,200	$2,000	$400	$1,000	$1,500	$400	$800	$900
Subtotal	$4,200	$19,300	$50,200	$82,400	$18,200	$43,600	$64,500	$16,100	$32,000	$39,600
Groundwater Treatment										
Free Product/Water Separator	$100	$500	$1,200	$2,000	$400	$1,000	$1,500	$400	$800	$900
Solids Filter	$100	$500	$1,200	$2,000	$400	$1,000	$1,500	$400	$800	$900
Flow Equalization Tank	$100	$500	$1,200	$2,000	$400	$1,000	$1,500	$400	$800	$900
UV/Peroxidation Unit	$500	$2,300	$6,000	$9,800	$2,200	$5,200	$7,700	$1,900	$3,800	$4,700
Air Stripping System	$400	$1,800	$4,800	$7,800	$1,700	$4,200	$6,100	$1,500	$3,000	$3,800
Carbon Adsorption System	$500	$2,300	$6,000	$9,800	$2,200	$5,200	$7,700	$1,900	$3,800	$4,700
Process Instrument Package	$400	$1,800	$4,800	$7,800	$1,700	$4,200	$6,100	$1,500	$3,000	$3,800
Pumps	$500	$2,300	$6,000	$9,800	$2,200	$5,200	$7,700	$1,900	$3,800	$4,700
Piping	$100	$500	$1,200	$2,000	$400	$1,000	$1,500	$400	$800	$900
Carbon Supply	$10,000	$45,800	$119,400	$196,000	$43,300	$103,800	$153,700	$37,900	$76,100	$94,300
Hydrogen Peroxide Supply	$6,000	$27,500	$71,700	$117,600	$26,000	$62,300	$92,300	$1,900	$3,800	$4,700
Air Compressors	$500	$2,300	$6,000	$9,800	$2,200	$5,200	$7,700	$1,900	$3,800	$4,700
Electrical Equipment	$300	$1,400	$3,600	$5,900	$1,300	$3,100	$4,600	$1,100	$2,300	$2,800
Subtotal	$19,500	$89,500	$233,100	$382,300	$84,400	$202,400	$299,600	$53,100	$106,600	$131,800
Groundwater Monitoring System										
Well Maintenance	$2,500	$11,000	$30,000	$49,000	$11,000	$26,000	$38,000	$9,000	$19,000	$24,000
Sampling and Analysis	$45,000	$206,000	$537,000	$882,000	$195,000	$467,000	$692,000	$171,000	$342,000	$424,000
Subtotal	$47,500	$217,000	$567,000	$931,000	$206,000	$493,000	$730,000	$180,000	$361,000	$448,000
Total O&M Present Worth Cost	$71,200	$325,800	$850,300	$1,395,700	$308,600	$739,000	$1,094,100	$249,200	$499,600	$619,400