

**REMEDIAL INVESTIGATION REPORT  
THE UNIVERSITY OF NORTH CAROLINA  
AT CHAPEL HILL  
AIRPORT ROAD WASTE DISPOSAL AREA  
CHAPEL HILL, NORTH CAROLINA**

Volume I

November 20, 1996

Prepared for:

The University of North Carolina at Chapel Hill  
Chapel Hill, North Carolina

Prepared by:

GERAGHTY & MILLER, INC.  
*Environment and Infrastructure Services*  
2840 Plaza Place, Suite 350  
Raleigh, North Carolina 27612  
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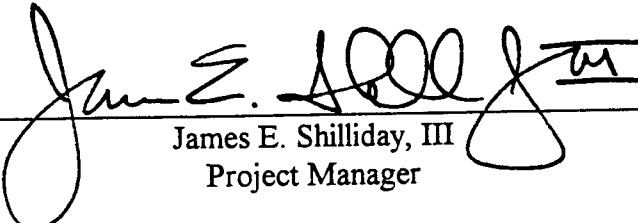
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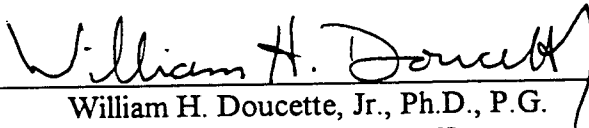


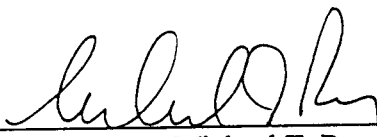
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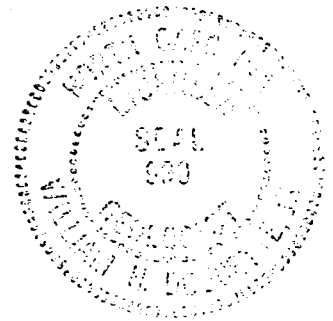
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**1.0 INTRODUCTION**

Geraghty & Miller, Inc., (Geraghty & Miller) was retained by the University of North Carolina at Chapel Hill (the University or UNC) to investigate groundwater conditions at the UNC Airport Road Waste Disposal Area (site). The Remedial Investigation (RI) is being performed voluntarily by the University, and this RI Report describes the scope of the investigation and the findings at the site. This report was developed to comply with the North Carolina Department of Environment, Health, and Natural Resources (NCDEHNR), Division of Solid Waste Management, Superfund Section requirements for responsible party voluntary site remedial action (NCDEHNR, 1996).

Background information on the site is provided in this section. Field methodology, scope of work and project objectives are presented in Section 2.0. Section 3.0 discusses the site environmental setting and potential receptors. Section 4.0 presents the nature and extent of environmental impacts at the site. Section 5.0 summarizes the principal findings of the RI.

**1.1 SITE LOCATION AND SURROUNDING LAND USE**

The site is located near Highway 86 (Airport Road) in Chapel Hill, Orange County, North Carolina (Figure 1-1). The site latitude is 35°56' 18.0" N, and the longitude is 79° 03' 22.0" W (NCDEHNR, 1993). The site consists of an 0.489-acre wooded parcel of University property that includes part of the entrance road to the former Airport Road UNC Old Sanitary Landfill. Approximately 0.2 acre of this tract was used from 1973 through 1978, with the approval of the State of North Carolina, to dispose of chemical waste from the University's facilities in 16 separate burials (see Section 1.2, Summary of Waste Activities). An adjacent 0.289-acre expansion was proposed and approved by the State of North Carolina for use when the original area was full. However, only two burials were made in 1979 in this expanded area. All references to "site" include the original 0.2-acre area (16 burials) and that portion of the expanded





area used for the two 1979 burials. Access to the site is restricted by an 8-foot-high locked fence erected by the University in early 1994 and several warning signs.

The tract containing the site encompasses 30.07 acres and was deeded to the University in 1940 to be used as a buffer zone for Horace Williams Airport. A deed description is included as Appendix A. This parcel is 1 of 14 properties owned by the University in this area, referred to collectively as the Horace Williams Properties. A composite map of the Horace Williams properties, which shows the site location, is included as Appendix B:

Town of Chapel Hill municipal facilities are located on a parcel leased from the University since 1979. This parcel is located east and southeast of the site. The municipal facility includes paved roadways, parking lots, a street and bus maintenance facility, and an animal shelter. The Horace Williams Airport is south and southwest of the site, and the former UNC Old Inactive Sanitary Landfill, which was used by the Town of Chapel Hill, is to the west. Wooded land extending to Crow Branch Creek, which serves as one of the property boundaries for the University tract, is north of the site. A small residential area, accessible from Airport Road, is located one-quarter to one-half mile north of the site. The majority of the east side of Airport Road is also developed for residential use (NCDEHNR, 1993).

The site is generally flat, sloping gently in the general direction of Crow Branch Creek to the north and towards the UNC Old Inactive Sanitary Landfill entrance road to the northwest. The site is covered by a thicket of 20-foot tall evergreen trees with an apparently undisturbed ground surface.

## 1.2 SUMMARY OF WASTE ACTIVITIES

The site was used from 1973 to 1979 by the University to dispose of wastes from the University's teaching, research, and hospital laboratories. A total of 18 burials in trenches were made at the site between 1973 and 1979 (NCDEHNR, 1993). A sketch showing the locations of the burials is included in Appendix C. A list of laboratory chemicals potentially disposed of at the



site (North Carolina Department of Human Resources [DHR], 1984) also is included in Appendix C.

### 1.3 SUMMARY OF PREVIOUS INVESTIGATIONS AT THE SITE

The University installed five monitor wells in the vicinity of the site after waste disposal activities ceased in 1979. The NCDEHNR Superfund Section completed a Preliminary Assessment (PA) on March 19, 1984, and a Site Inspection (SI) on June 19, 1984. The SI revealed that volatile organic compounds (VOCs), including benzene, chloroform, and methylene chloride, were detected in groundwater samples collected from Monitor Wells MW-1 and MW-2. There were several sampling events conducted prior to Geraghty & Miller's involvement in this project. Table 1-1 summarizes the groundwater sampling results from previous studies.

In August 1984, the Water Resources Research Institute (WRI) sampled monitor wells MW-1, MW-2, and MW-3 using neutron activation analysis. The WRI reported elevated concentrations of the anions chloride and bromide and the cations manganese and sodium. The University sampled Monitor Wells MW-1, MW-2, and MW-3 on three occasions from June 1985 to September 1992 for organic compound analysis. The following were the maximum VOC concentrations detected, shown in micrograms per liter ( $\mu\text{g/L}$ ) or parts per billion (ppb): benzene (49,000  $\mu\text{g/L}$ ); chloroform (96,000  $\mu\text{g/L}$ ); methylene chloride (320,000  $\mu\text{g/L}$ ); 1,2-dichloroethane (1,300  $\mu\text{g/L}$ ); trichlorofluoromethane (1,100  $\mu\text{g/L}$ ); and diethyl ether (350,000  $\mu\text{g/L}$ ). Constituents were not detected in upgradient well MW-3 except during one sampling event in September 1992. NCDEHNR suggested that the low concentrations of VOCs detected in this well during the September 1992 sampling event may be the result of a sampling error (cross-contamination) (NCDEHNR, 1993).

In June 1991, Greenhorne & O'Mara, Inc., completed a Phase II Screening Site Investigation (SSI) for the NCDEHNR Superfund Section at the UNC Old Inactive Sanitary Landfill; however, the SSI focused primarily on the Chemical Waste Disposal Area. Groundwater, surface soil, surface water and sediment samples were collected during the SSI. Groundwater samples collected from monitor wells MW-1, MW-2, and MW-3 contained benzene



and chloroform. Two additional VOCs (trimethylhydrazine and trichlorofluoromethane) were detected, but the results are subject to quantitative bias because matrix spike recoveries for these analytes were outside control limits. Relatively low (less than five times quantitation limits) concentrations of semi-volatile constituents were detected; only three of these (phenol, dimethylphthalate, and isophorone) were detected at or above quantitation limits. Several metals/inorganic compounds were detected in these groundwater samples. Barium, chromium, and lead were detected but at concentrations less than Maximum Contaminant Levels (MCLs) allowable in public drinking-water supplies. It is noted that arsenic was detected at an estimated concentration of 3.5 µg/L (estimated) in the groundwater sample from well MW-2, which is below the North Carolina groundwater standard of 50 µg/L. The Site Inspection Prioritization (NCDEHNR, 1993) incorrectly listed the arsenic result for the groundwater sample from well MW-2 as 3.5 milligrams per liter (mg/L) or parts per million (ppm), estimated. This report also indicated that arsenic detected was above the health-based benchmark concentration.

One surface soil composite sample collected from a down-slope location near the site during the SSI reportedly contained 75 micrograms per kilogram (µg/kg) or parts per billion (ppb) dry weight basis chloroform (see Table 1-2). No other VOCs, semi-volatile organic compounds (SVOCs), pesticides, or PCBs were detected in this sample. Concentrations of arsenic, copper, and chromium detected in this soil sample were greater than three times their respective background concentrations, but results for arsenic and chromium were qualified as estimated. No organic constituents or significant concentrations of inorganic constituents were detected in off-site surface-water, sediment, or drinking-water samples collected during the Phase II SSI.



## **2.0 FIELD METHODOLOGY**

The investigation design and field methodologies used during the remedial investigation are summarized in this section. Specific methods are discussed in the RI Work Plan (Geraghty & Miller, 1995) and are not reported herein. However, complete descriptions are provided in instances where the methods specified in the RI Work Plan were modified or other methods were used during the implementation of the field program.

### **2.1 OVERVIEW OF FIELD ACTIVITIES**

Field activities at the site have been divided into three phases. Phase I consisted of the installation and sampling of six monitor wells. Phase II consisted of bedrock coring, installation of 10 additional monitor wells and groundwater and surface-water sampling. Phase III consisted of installation of four monitor wells, soil borings and a soil gas study. Each of the phases of work is discussed separately in the following sections. The locations of monitor wells and surface-water samples are shown in Figure 2-1. Well construction information is provided in Table 2-1.

### **2.2 PHASE I - MONITOR WELL INSTALLATION AND SAMPLING**

Installation of top of bedrock and bedrock monitor wells were proposed in the Work Plan to expand the original existing monitor well network which had been installed by the University.

The initial drilling by Geraghty & Miller took place during April 1995, when five shallow to intermediate depth Type II monitor wells (MW-6, MW-9, MW-11, MW-12 and MW-13) and one deeper Type III monitor well (MW-7) were installed at the site. Monitor well locations are shown on Figure 2-1. The screened intervals for wells MW-6 and MW-12 were set in unconsolidated materials, and/or highly weathered bedrock. The screened intervals for wells MW-7, MW-9, MW-11, and MW-13 were set entirely in relatively competent bedrock. Monitor wells were installed using both hollow-stem auger and air rotary methods as outlined in the Work Plan, with the following variations. Monitor Well MW-12 was constructed with PVC due to its distance from the source. The installation of Monitor Well MW-8 was attempted, but abandoned



due to the presence of landfill material and garbage in the planned location. Monitor Well MW-10 was planned to be a deep bedrock monitor well installed approximately 15 feet west of Monitor Well MW-1. During the attempted installation of a 10-inch-diameter surface casing at this location, highly weathered, soft zones were encountered in the bedrock which would have prevented adequate seating and sealing of the surface casing. Because of the potential for vertical contaminant transport, and because high organic vapor readings (>10,000 ppm) were encountered during drilling, the decision was made not to complete well MW-10 to avoid potential carry-down cross contamination. No Shelby Tubes were collected during drilling, due to presence of weathered rock and saprolite in the investigation area. Appendix D presents the soil boring logs, and Appendix E presents monitor well construction diagrams.

Screening level analyses were performed on samples from Monitor Wells MW-11, MW-12 and MW-13 to assist in selecting locations for future wells.

Upon completion of the drilling program, all newly installed monitor wells were sampled in early May 1995, including monitor wells MW-11, MW-12 and MW-13. Existing monitor wells MW-1, MW-2 and MW-3 were also sampled. A 2-inch Grundfos Redi-Flo™ stainless steel submersible pump was used for purging and sampling. Groundwater removed during sampling and development was containerized for later disposal. The samples were submitted to IEA Laboratories (IEA) in Cary, North Carolina for analysis by USEPA Methods 8240 (Target Compound List [TCL] VOCs), 8270 (TCL semi-volatile organics), 6010/7470 (Target Analyte List [TAL] metals/mercury), 301.1 (alkalinity), and 160.1 (Total Dissolved Solids [TDS]). The ten most abundant tentatively-identified compounds (TICs) for USEPA Methods 8240 and 8270 were reported by the laboratory as specified by the guidelines in effect at the time of preparation of the Work Plan. Groundwater sampling results are discussed in Section 4.2.

### **2.3 PHASE II - MONITOR-WELL INSTALLATION AND SAMPLING**

Analytical results of groundwater samples collected during Phase I of the investigation indicated that subsurface groundwater contamination was present in both the surficial and bedrock aquifers. An expanded investigative plan was then developed, which included the



installation of three bedrock coreholes and ten additional monitor wells and surface-water sampling of Crow Branch Creek.

### **2.3.1 Bedrock Coring**

Installation of the three bedrock coreholes began in July 1995 to characterize the nature of the fractured bedrock in a location hydraulically downgradient of the source area and to obtain a vertical profile of VOC concentrations in the bedrock aquifer. Prior to coring, an 8-inch pilot hole was drilled through the unconsolidated soils/saprolite to competent bedrock using hollow-stem auger and air rotary methods. A 6-inch-diameter steel surface casing was then set in place. Beginning at the top of bedrock, 20-foot-long coring runs were then attempted. Upon completion of a coring run, the corehole was enlarged with an air hammer. A pneumatic packer was then installed in the hole at the top of the 20-foot zone to isolate the interval from the remainder of the borehole. A groundwater sample was then collected from the isolated zone and submitted for 24-hour turn-around analysis for VOCs. Upon sampling completion, the fractures within the 20-foot zone were sealed by pressure grouting. The 20-foot zone then was redrilled with the air hammer prior to beginning the next coring run.

Corehole locations are included on Figure 2-1 and core logs are included in Appendix F. Corehole CH-1 was advanced to a total depth of 174 feet; corehole CH-2 was advanced to a total depth of 60 feet; and corehole CH-3 was advanced to a total depth of 88 feet. Coreholes CH-1 and CH-3 were converted to monitor wells.

### **2.3.2 Monitor-Well Installation**

To define the downgradient extent of the contaminant plume, a total of 10 additional monitor wells were installed in July and August 1995. Five Type II monitor wells (MW-18, MW-19, MW-20, MW-21 and MW-22) and five Type III monitor wells (MW-14, MW-15, MW-16, MW-17 and MW-23) were installed. Monitor Wells MW-14 and MW-23 were installed in coreholes CH-1 and CH-3, respectively. The screened intervals for wells MW-18, MW-19, MW-20, and MW-22 were installed in unconsolidated materials and/or highly weathered bedrock. The



screened intervals for wells MW-14, MW-15, MW-16, MW-17, MW-21, and MW-23 were installed entirely in relatively competent bedrock. The monitor wells were installed using hollow-stem augers and air rotary methods.

Upon completion of Phase II drilling in late July 1995, all monitor wells, with the exception of MW-14 and MW-23, were sampled. Monitor Wells MW-14 and MW-23 were not sampled since they were not completed at the time of sampling other wells. Samples were collected with a Grundfos Redi-Flo™ 2 stainless steel submersible pump and disposable Teflon™ bailers and submitted to IEA for VOC analysis by USEPA Method 8240. Samples from wells MW-17, MW-18, and MW-19, were also analyzed for SVOCs and for inorganic parameters, and samples from wells MW-20, MW-21, and MW-22 also were analyzed for inorganics. Groundwater sampling results are discussed in Section 4.2.

### **2.3.3 Surface-Water Sampling**

Surface-water samples were collected on June 15, 1995, from six locations along Crow Branch Creek both up and down stream of the site. Surface-water sampling locations are shown on Figure 2-1. Surface-water sampling was not included in the original Work Plan because impacts via this pathway had not been indicated during previous surface-water sampling events (NCDEHNR, 1993). Surface-water samples collected in June 1995 were analyzed for VOCs by USEPA Method 8240 plus the 10 most abundant TICs, selected metals (calcium, iron, magnesium, manganese, potassium, and sodium) by USEPA Method 200.7, alkalinity by USEPA Method 310.1, ammonia by USEPA Method 350.3, chloride by USEPA Method 325.2, nitrate by USEPA Method 353.2, sulfate by USEPA Method 375.4, and TDS by USEPA Method 160.1. Surface-water samples were collected by direct immersion of sample bottles, taking care not to lose sample preservatives. Field measurements of pH, specific conductance, and oxidation-reduction potential (ORP) were also recorded at each surface-water sampling location. Field measurements were conducted by immersion of the direct-reading instrument probes into the creek. The purpose of the field measurement and anion-cation data collection was to characterize the quality of the surface water at different points along Crow Branch Creek.



Surface-water samples from these six locations were collected on a quarterly basis starting in June 1995, with additional sampling events conducted on October 25, 1995, January 26, 1996, May 9, 1996, and August 7, 1996. The analytical parametric coverage for each of these quarterly events was the same as for the initial sampling event, except for the addition of TAL metals by USEPA Method 200.7 for sample location SW-3 during the January 1996 and May 1996 sampling events. Surface-water sampling results are discussed in Section 4.3.

## **2.4 PHASE III-SUPPLEMENTAL INVESTIGATION**

Phase III of the site investigation consisted of the installation of two Type II monitor wells (MW-25 and MW-28) and two Type III monitor wells (MW-24 and MW-26), groundwater sampling, four shallow geotechnical soil borings, five Geoprobe™ borings and surface emission flux sampling. The screened interval for well MW-25 was set in unconsolidated materials and the screened intervals for wells MW-24, MW-26, and MW-28 were set entirely in relatively competent bedrock. Locations of the emission flux sampling points are illustrated in Figure 2-3.

### **2.4.1 Monitor-Well Installation and Sampling**

A total of four additional monitor wells (MW-24, MW-25, MW-26 and MW-28) were installed at the site in late January and early February 1996 for confirmation that the limits of the contaminant plume have been delineated. An attempt was made to install an additional bedrock monitor well (MW- 27); however, the boring was abandoned as it lacked sufficient fractures to yield useable quantities of water. The monitor wells were installed using the hollow-stem auger and air rotary methods. Locations of these wells are depicted on Figure 2-1.

Monitor Well MW-24 was installed to evaluate the vertical extent of site-related constituents in the deeper bedrock saturated zone. A surface casing was installed to a depth of 105 feet below land surface (ft bls), and the borehole was advanced into rock using an air hammer to a total depth of 200 ft bls. No obvious water-bearing fractures were encountered in the interval from 105 to 200 ft bls. However, water was observed in the borehole after it was left undisturbed for several hours. To determine the depth interval yielding water, inflatable packers





were set at depths of 125 and 168 ft bls, and samples of water were collected below the packers and analyzed for VOCs by USEPA Method 8260. Based on the results of the packer tests, Monitor Well MW-24 was set at a total depth of 195 feet, with 20 feet of slotted screen at the well terminus.

Groundwater samples were collected from these four new monitor wells in January and February 1996. The following Phase I and Phase II monitor wells were also sampled: MW-4, MW-5, MW-20, MW-21, and MW-23. These existing monitor wells were resampled and analyzed for VOCs by USEPA Method 8260 using a 25-milliliter (ml) sample purge, which achieves lower Practical Quantitation Limits (PQLs). Resampling of these existing wells and sample analysis using a more sensitive analytical technique were conducted because these wells, along with the new wells, represent the downgradient periphery of the groundwater VOC plume. Results of these analyses are presented in Section 4-2.

Due to a laboratory oversight, the following groundwater monitor wells were resampled in April 1996 and analyzed for VOCs including diethyl ether by USEPA Method 8260 with a 25-ml purge: MW-4, MW-5, MW-20, MW-21, and MW-23.

#### **2.4.2 Geotechnical Assessment**

A geotechnical investigation was performed adjacent to the former waste disposal area to aid in the definition of viable remedial options. A total of four soil borings (Figure 2-2) were installed during late January 1996. Initially, it was planned that a Shelby tube sample be collected from each boring; however, subsurface rock collapsed two of the Shelby tubes and bent the two others beyond use. Thus, only one Shelby tube sample was collected. Based on the difficult drilling conditions, no additional Shelby tubes were attempted. Soil samples were analyzed for geotechnical parameters such as Atterberg's Limits, moisture content, specific gravity, density, and particle-size distribution.



### **2.4.3 Soil Contamination Assessment**

Five Geoprobe™ holes (GP-1 through GP-5) were installed during late January 1996 to address the potential for contaminated soil adjacent to the waste disposal area (Figure 2-2). Soil samples were collected from the borings for laboratory analysis using USEPA Method 8260. The results of the soil sample analyses are presented in Section 4.1.

### **2.4.4 Soil Gas Survey**

An air quality study was performed with passive, non-invasive gas detectors to address the potential for vapor seeping through the land surface. The detectors were deployed in the disposal area and were allowed to remain undisturbed for several days. The Emflux™ air sampling system, manufactured by Quadrel Services, Inc. (Quadrel) of Clarksburg, Maryland, was selected to conduct the survey.

The Emflux™ system consists of wire mesh sample collection devices, approximately 2 inches long. The base of the sample collection device was suspended approximately 1 to 2 inches above the ground surface by a stainless steel wire stake. The detector was protected from disturbance by a stainless steel protective cover, extending approximately 0.5 inch below the ground surface. A cloth camouflage cover was used to conceal the protective cover.

Field deployment and retrieval of Emflux™ sample collectors were accomplished by a two-person team. One of the team members was considered “clean” and handled only the sample collector, while the second team member was a support person. Upon arrival at a sample location, the support person cleared and prepared the ground surface, removing any existing vegetation or debris. Next, the support person removed a protective cover from the kit and marked the exact location on the ground for the detector. The support person then opened the glass vial containing the sample detector, poured the detector into the gloved hand of the clean person and re-sealed the glass vial. The clean person obtained a stainless steel cartridge stake, attached the sample collector and inserted the stake into the ground in the center of the previously



marked location. The protective cover and camouflage cloth cover were then placed over the detector by the support person.

Following deployment of a detector, the support person entered the time, location, and field conditions on a field deployment form. During retrieval, the deployment activities are reversed and a chain of custody record was completed.

Quality Assurance/Quality Control (QA/QC) samples consisted of a trip blank and three field blanks. The trip blank arrived in a sealed collector vial, which was not opened. The three field blanks were collected at pre-determined sample point locations and provided information regarding ambient air conditions. Field blanks were collected by placing the field blank detector into the kit provided aspirator bulb and pumping approximately 20 times.

A total of 42 Emflux™ detectors were deployed at the site (Figure 2-3) on May 2, 1996, and retrieved on May 6, 1996. The detectors, trip blank and field blanks were then shipped to Quadrel for laboratory analysis by USEPA Method 8240 (modified) for benzene, carbon tetrachloride, chloroform, tetrachloroethene, and methylene chloride. These constituents were selected based on the following factors:

- toxicity - all are known or suspected human carcinogens;
- mobility - all have relatively high vapor pressures and Henry's Law Constants; and
- occurrence in other site media - all have been detected in site groundwater and/or subsoils.

The results of the soil gas survey are presented in Section 4.4.



### **3.0 ENVIRONMENTAL SETTING**

#### **3.1 SURFACE FEATURES**

The site is within the Piedmont Physiographic Province, an intermediate area between the Coastal Plain and Appalachian Mountains. The land within the Piedmont Province generally consists of rounded hills and longer ridges trending northeast/southwest with some prominent mountains.

The land surface in the area of the site generally slopes north-northwest to Crow Branch Creek, a perennial stream which flows towards the northeast. A gravel access road borders the site to the north. To the south and east is a paved road. West of the site is vacant land with scrub vegetation and a few young pine trees.

Soil at the site is mapped as a member of the Enon series, a soil consisting of surface loam underlain by layers of clay loam and clay (NCDEHNR, 1993). Beneath a depth of approximately 30 inches, the Enon soil consists of loam saprolite, a zone of highly weathered, disintegrated bedrock (NCDEHNR, 1993). Within the Piedmont, the saprolite generally ranges in thickness from 1 to 2 feet near bedrock outcrops to more than 100 feet elsewhere.

#### **3.2 GROUNDWATER USE AND POTENTIAL RECEPTORS**

The primary source of drinking water for most residents of Chapel Hill, North Carolina, is the Orange Water and Sewer Authority (OWASA), which draws its supply from two surface-water intakes (NCDEHNR, 1993). Most of the area within a 4-mile radius of the site is served by the OWASA distribution system (NCDEHNR, 1993).

No municipal wells are located within a 4-mile radius of the site (NCDEHNR, 1993). Individual residences and subdivisions north and west of the site and outside of the OWASA distribution system use groundwater as their drinking-water supply. The closest drinking-water well is over one-half mile away. The nearest community water-supply well operates 1.9 miles north of the site at the Northwood subdivision (NCDEHNR, 1993).



Based on census data for Orange County and a house count using United States Geological Survey (USGS) topographic maps, it has been estimated that the total number of groundwater users within 4 miles of the site is 3,941 persons. The distribution of these 3,941 persons within each discrete distance category is provided below.

<u>Distance (miles)</u>	<u>Total Population</u>	<u>Groundwater Population</u>
0 to ¼	336	0
¼ to ½	876	0
½ to 1	3,408	16
1 to 2	19,547	758
2 to 3	25,022	1,193
3 to 4	7,764	1,974

Private drinking-water well sampling conducted by the State at a domestic well approximately 0.9 mile northwest of the site did not show any detectable concentrations of any hazardous constituents (NCDEHNR, 1993). One well approximately 0.45 mile north of the site was identified by the NCDEHNR Superfund Section in 1993 during off-site reconnaissance for the Site Inspection Prioritization (NCDEHNR, 1993). However, this well had been out of use for 20 years. It was concluded by the State that there was no documented contamination of any potable drinking-water wells within a 4-mile radius of the site (NCDEHNR, 1993).

### 3.3 SURFACE-WATER AND ECOLOGICAL FEATURES

Overland surface drainage and groundwater at the site are expected to flow to the north, and may discharge into Crow Branch Creek, approximately 500 feet north of the site. Crow Branch Creek meanders approximately 0.7 miles to the northeast where it converges with Booker Creek. Booker Creek meanders over a distance approximately 1.0 miles to the east and discharges into Eastwood Lake. From the dam on Eastwood Lake, Booker Creek flows 2 miles south to Little Creek, which continues southeast and empties into B. Everette Jordan Lake (Jordan Lake) after another 3.7 miles (NCDEHNR, 1993). The end of a 15-mile surface-water



pathway is located close to Farrington Point at a narrow point on the lake (NCDEHNR, 1993). The average annual flows of the surface water bodies within the 15-mile pathway are: Crow Branch Creek, 2.54 cubic feet per second (cfs); Eastwood Lake, 4.31 cfs; Booker Creek, 6.14 cfs; Little Creek, 17.88 cfs; and Jordan Lake, 1,679 cfs (NCDEHNR, 1993). There are no surface drinking-water intakes located within the 15-mile surface-water pathway.

Crow Branch Creek and Booker Creek are not reported to be fisheries (NCDEHNR, 1993). The nearest fishery is reportedly Eastwood Lake, which is 1.9 miles downstream of the site (NCDEHNR, 1993). Little Creek is also used for fishing. Jordan Lake is a major recreational fishery in the Chapel Hill area which reportedly yields at least 25 pounds of fish per acre annually over its 14,000-acre area (NCDEHNR, 1993).

The North Carolina Natural Heritage Program has identified one rare animal and two rare plant species in the 15-mile surface-water pathway. Bald eagles, a federally-designated endangered species, inhabit two locations on Jordan Lake, 12 and 13.5 miles downstream of the site (NCDEHNR, 1993). Sweet Pinesap, federally-proposed endangered species, is a plant species found on Little Creek, 6 miles downstream of the site (NCDEHNR, 1993). Thin-pod white indigo, a rare plant species in the State of North Carolina, is a plant species found 15 miles downstream (NCDEHNR, 1993).

The nearest wetland downstream of the site consists of an 0.2-mile frontage that straddles Crow Branch Creek at the upper end of Eastwood Lake located 1.8 to 1.9 miles downstream (NCDEHNR, 1993). An additional 16.6 miles of wetland frontage is located within the 15-mile surface-water pathway around Little Creek and the upper end of Jordan Lake beginning about 4 miles downstream of the site (NCDEHNR, 1993).



### 3.4 GEOLOGY

#### 3.4.1 Regional Geology

Chapel Hill and Orange County lie within the eastern Piedmont physiographic province. Chapel Hill, located in the southeastern corner of Orange County, lies within the easternmost portion of the Carolina Slate Belt. This northeast/southwest trending geologic belt consists primarily of metamorphosed granitic rocks and volcanic rocks. Immediately east of Chapel Hill is the boundary between the Carolina Slate Belt and the northeast/southwest-trending Durham Triassic Basin. The rocks in the vicinity of Chapel Hill consists primarily of intrusive igneous rocks having a variable composition ranging from granites, quartz monzonites, granodiorites, quartz diorites, diorites, and gabbros (Allen and Wilson, 1968). Allen and Wilson (1968) also reported that north/south trending Triassic basaltic and diabase dikes are present approximately 2 miles west and 1 mile east of Chapel Hill. Structurally, several small faults and shear zones are found throughout the county, with the majority trending strongly northeast/southwest. Measured foliations also exhibit strong northeast/southwest orientations.

Bedrock underlying the saprolite at the site is mapped as intrusive igneous rocks of middle to upper Paleozoic age. The igneous complex intrudes surrounding metamorphosed igneous rock and reportedly varies in mineral composition, grading in lithology from granite to diorite to gabbro (NCDEHNR, 1993).

#### 3.4.2 Site-Specific Geology

Investigative activities (bedrock core boring and soil borings) revealed a relatively thin layer of residual soils and weathered rock (saprolite) overlying competent bedrock. The surficial saprolite unit varies in lithology from sandy clay to clayey sand, with a variable thickness ranging from approximately 5 to 20 feet. Competent bedrock consisting of granodiorite underlies the saprolite. The equigranular granodiorite contains abundant high angle fractures commonly filled with pyrite, calcium carbonate and chlorite. Occasional brecciated zones were noted at various



depths during coring (core logs are provided in Appendix F). No evidence of diabase dikes were observed during site exploration.

A geologic cross-section location map is shown in Figure 3-1. A north-south geologic cross-section showing these features is presented in Figure 3-2. An east-west geologic cross-section is shown in Figure 3-3.

### 3.4.3 Topographic Lineament Analysis

To better determine the potential groundwater controls (fractures, joints, and faults) that may affect groundwater flow at the facility, a topographic lineament analysis was conducted. The site lies within an igneous intrusive and metamorphosed rock complex (Mann et al., 1965) in the eastern Piedmont physiographic province. This analysis was performed utilizing the United States Geological Survey (USGS, 1978, photorevised 1981) Chapel Hill 7½ minute Topographic Quadrangle and aerial photos from the Agricultural Stabilization and Conservation Service (ASCS).

Using the topographic map and aerial photographs, the study area was searched for linear topographic elements through an area with a 2-mile radius centered on the site. The linear topographic features were scribed upon the topographic map (Figure 3-4), and orientation and length measurements were then collected and tabulated (Table 3-1). These data were compiled and sorted according to orientation (spatial frequency) and cumulative length. The data were then used to construct rose diagrams for the spatial frequency (Figure 3-5) and cumulative length of the lineaments within a specific angular orientation (Figure 3-6). The length of the blades of the rose depict a relative relationship of the spatial parameters (orientation and length) of the lineaments within the study area. Based upon spatial frequency, the predominate orientation lineament trend lies between N 21° and 30°W. Secondary orientation lineaments are apparent on the spatial frequency rose diagram in the range of N11° and 40°W, N81° and 90°W, and N51° and 60°E (Figure 3-5). The lineaments sorted by cumulative length show a general orientation between N51° and 60°E with a slightly lesser, but broader spatial distribution of secondary orientations in the northwest and southeast directions (Figure 3-6). Overall, there is no dominant





orientation of lineaments when sorted by cumulative length. While some orientations stand out slightly, there are lineaments in virtually every direction. There is some correlation between the spatial frequency and the cumulative lengths. This is especially true in the ranges of N21° and 40°W, N81° and 90°W, and N51° and 60°E.

Igneous rock complexes are relatively homogenous, and predominant joints and fracture systems may not exist. Fracture and joint systems typically form as a result of isostatic rebound due to erosional offloading. Since igneous rocks are relatively isotropic and homogenous with little textural fabric, fracture and joint development will typically mimic the general shape of the igneous pluton or be random. The amount of metamorphic rock underlying the site is limited and the area is predominantly of igneous rock type. This may explain the somewhat random orientation and length of the lineaments near the site. Topographic lineament analysis suggests that although random orientations were observed, a strong northwest-southeast orientation was observed. Groundwater flow direction in the bedrock aquifer at the site is to the north/northeast, which suggests a correlation between topographic linear features and groundwater flow. However, the groundwater flow in the shallow unconsolidated aquifer appears to flow in the north-northwest direction toward the Crow Branch Creek.

### **3.5 HYDROGEOLOGY**

#### **3.5.1 Conceptual Hydrogeologic Model of the Piedmont**

Figure 3-7 illustrates the fundamental units and features of the typical groundwater flow system of the Piedmont Province. According to Heath (1980) and LeGrand (1988), this hydrogeologic system possesses unique features in comparison to most other groundwater regions. These unique characteristics control the principal groundwater flow directions, flow volumes, and the location of system boundaries including recharge and discharge areas. The unique features of this Piedmont system are as follows:

- (1) The gneissic metamorphic rocks have been folded, faulted and interstratified with granite or diorite intrusions, resulting in little or no lateral or vertical continuity of hydraulic properties for the igneous rock units.
- (2) The active groundwater flow within these rocks is limited to fracture flow. The areal and vertical distribution and interconnection of these fractures is limited. For instance, fractures in crystalline rocks typically decrease both in width of opening and in frequency with depth. As a result, active groundwater circulation or flow within fractured igneous rocks is relatively shallow, primarily limited to the upper 250 feet of bedrock. In addition, the igneous rocks have very low storage capacity for groundwater.
- (3) Most of the water flowing in these fractures is derived from vertical leakage from the saprolitic soils and the "unfractured" matrix rock. The regolith or saprolite overlying the bedrock forms a shallow aquifer system which is the principal storage reservoir and provides a very local source for domestic drinking water. Figure 3-8 illustrates the important role of the regolith in providing water to a private domestic well. Groundwater movement within this shallow aquifer reservoir is predominantly vertical, intergranular flow.
- (4) The groundwater basins developed in this Piedmont system exhibit shallow flow paths and are not aerially extensive. These basins mimic surface water basins. That is, topographic high points such as ridges and hill tops form drainage basin boundaries and divides which groundwater does not flow across. The topographic highs, located on upland ridges, act as the principal area of groundwater recharge. Perennial stream beds represent another basin boundary, as they represent discharge areas where groundwater flows to the surface as diffuse seepage or springs. Shallow, local groundwater flow paths develop, efficiently moving recharge from hill tops to close-by permanent streams, marshes, and wetlands.

The interaction of these unique features within the Piedmont develops a series of shallow, aerially small, flow systems which are almost congruent with the surface-water drainage basins (LeGrand, 1988). Each groundwater basin, like the surface-water drainage basin, is separated

from adjacent basins. The water table develops in the saprolite in response to precipitation recharge and forms a subdued expression of the local topography. (LeGrand, 1988).

### 3.5.2 Site Hydrogeology

Groundwater at the site occurs in the unconsolidated zone (saprolite or residuum) at approximately 3 to 12 ft bls, depending on seasonal rainfall influences. The thickness of the unconsolidated zone decreases to the north of the disposal area, with the thinnest zones occurring in the vicinity of Crow Branch Creek. Water level elevations for all site wells were measured on August 3, 1995, April 16, 1996, and September 3, 1996. Water-level data for August 1995, April 1996, and September 1996 periods are provided in Tables 3-2, 3-3, and 3-4, respectively. Water level elevation maps for the shallow aquifer were prepared for these dates and are presented on Figures 3-9, 3-11, and 3-13, respectively. These maps show the groundwater flow direction in the unconsolidated zone to be generally to the north-northwest, toward Crow Branch Creek. As expected, water levels measured during the August 1995 and September 1996 periods were lower than those measured during the April 1996 period.

Apparent groundwater flow direction in the bedrock aquifer is generally similar to that of the surficial aquifer, with slightly more of a north-northeasterly component near Crow Branch Creek. Water-level elevations for bedrock wells are shown for August 3, 1995, April 16, 1996, and September 3, 1996, on Figures 3-10, 3-12, and 3-14, respectively. The direction of groundwater flow in the bedrock aquifer is also toward Crow Branch Creek. Since the water level in Monitor Well MW-24 had not completely recovered from the previous sampling event in April 1996 (see Table 3-3), the water-level data from this well was not used in preparing the groundwater flow map in Figure 3-12.

Upward vertical hydraulic gradients were measured at the site in three downgradient well clusters on September 3, 1996. The upward vertical hydraulic gradients measured on September 3, 1996 in these clusters were: MW-6/MW-7 (0.11 feet per foot [ft/ft]), MW-12/MW-15 (0.15 ft/ft), MW-25/MW-26 (0.02 ft/ft). Previous water level elevation measurement events indicated downward vertical hydraulic gradients in some of the downgradient well clusters; however, this is



thought to have been caused by well purging activities conducted prior to collection of the water level measurements. A downward vertical gradient of 0.03 ft/ft was measured at the waste disposal site at cluster MW-2/MW-14, which is consistent with a location close to a groundwater flow divide along a topographic high (ridge line). A three-dimensional block diagram representing groundwater flow patterns in the vicinity of the site is shown in Figure 3-15.

The *in-situ* hydraulic conductivity of the saturated sediments were calculated from slug test data obtained on select monitor wells. Slug tests were attempted on shallow aquifer monitor wells MW-2, MW-3, MW-6, MW-12, MW-19, and MW-20 and deeper (bedrock) monitor wells MW-11, MW-15, MW-17, MW-21 and MW-28. The slug tests typically were performed using a 5-foot cylindrical stainless steel dummy to displace the water in the wells while recording the water-level response with a pressure transducer and data logger. Hydraulic conductivities were calculated using Geraghty & Miller's software AQTESOLV which uses the methods presented by Bouwer and Rice (1976).

Wells that yielded usable slug test data include all monitor wells with the exception of monitor well MW-11. Only slug-out data for each well were used to calculate hydraulic conductivity (K) values for the surficial and bedrock aquifers. Calculated K values for the surficial aquifer range between  $4.52 \times 10^{-6}$  to  $2.31 \times 10^{-3}$  centimeters per second (cm/sec), with an average K of  $5.32 \times 10^{-4}$  cm/sec. Similarly, calculated K values for the bedrock aquifer range between  $3.44 \times 10^{-4}$  and  $1.45 \times 10^{-2}$  cm/sec, with an average K of  $4.26 \times 10^{-3}$  cm/sec. Aquifer test results are presented in Appendix G.

Using average hydraulic conductivity values and hydraulic gradients, the average groundwater flow velocity for surficial and bedrock aquifers in the vicinity of the former waste disposal area can be determined using a form of the Darcy equation as follows:

$$V = \frac{K}{Ne} \left( \frac{dh}{dl} \right)$$

where:

V = groundwater flow velocity



$K$  = hydraulic conductivity

$\frac{dh}{dl}$  = groundwater gradient

$dl$

$N_e$  = effective porosity (assumed to be 20 percent)

substituting values for the surficial aquifer determined by Geraghty & Miller:

Average  $K = 5.32 \times 10^{-4}$  cm/sec (1.50 ft/day)

$\frac{dh}{dl} = 0.04$  ft/ft

$dl$

$N_e$  = assumed to be 20 percent

then  $V = \frac{1.50 \text{ ft/day}}{0.20} \times (0.04 \text{ ft/ft})$

$V = 0.30 \text{ ft/day} = 109.5 \text{ ft/year}$  for the surficial aquifer

substituting values for the bedrock aquifer determined by Geraghty & Miller:

Average  $K = 4.26 \times 10^{-3}$  cm/sec (12.08 ft/day)

$\frac{dh}{dl} = 0.05$  ft/ft

$dl$

$N_e$  = assumed to be 10 percent

then  $V = \frac{12.08 \text{ ft/day}}{0.10} \times (0.05 \text{ ft/ft})$

$V = 6.04 \text{ ft/day} = 2,204.6 \text{ ft/year}$  for the bedrock aquifer

These values represent estimates of average flow velocities for groundwater at the site. Inhomogeneities in the aquifer could lead to higher or lower localized rates of flow.



## **4.0 NATURE AND EXTENT OF CONTAMINATION**

This section presents the results of the soil, groundwater, and surface-water investigations at the site. These findings are interpreted, together with local and regional geologic, hydrogeologic, and surface hydrologic information, to define the nature and extent of impacts to soil, groundwater, and surface water. Analytical reports of the soil and groundwater samples are attached as Appendix J (Volume II of this report).

### **4.1 SOIL SAMPLING RESULTS**

The analytical results of soil samples collected in close proximity to the disposal area are summarized in Table 4-1. The locations of soil samples are presented on Figure 2-2. Two of the five samples had detections of VOCs. Sample SB-1 contained 8 µg/kg chloroform. Sample SB-2 contained 20 µg/kg chloroform and 10 µg/kg methylene chloride. Inorganic constituents detected in the five soil samples, with a few minor exceptions, are below background levels of a soil sample obtained from east-central North Carolina (USGS, 1984).

### **4.2 GROUNDWATER SAMPLING RESULTS**

The results of groundwater sampling analysis for sampling events conducted in May 1995, July 1995, August 1995, January 1996, February 1996 and April 1996, are summarized in Table 4-2. Contaminated groundwater was identified extending from the vicinity of the chemical disposal area to the northwest terminating in the vicinity of Crow Branch Creek. The contaminants include both volatile and semi-volatile organic compounds. The primary volatile organic contaminants are benzene, chloroform, diethyl ether, and methylene chloride. Fifteen other volatile compounds were detected in groundwater. Semi-volatile compounds detected in groundwater included dichlorobenzene, phthalates, phenols, and benzoic acid. Iron and manganese were detected at concentrations above groundwater standards. Iron and manganese can be naturally occurring. Also high concentration of dissolved iron and manganese are found due to microbial reduction of organic compounds. Some metals were occasionally found in



groundwater samples slightly above groundwater standards. Occurrence of these metals were sporadic and could be due to presence of turbidity in the samples.

The contaminant plume is present in both the shallow saprolite zone and in the underlying bedrock to a depth of at least 174 feet. During the installation of Corehole No. 1 (CH-1) five rock intervals were sampled and the groundwater samples were analyzed for VOCs using Method 601 on a 24-hour turnaround time from the laboratory. During the installation of Corehole No. 3 (CH-3) two rock intervals were sampled and the groundwater samples were analyzed for VOCs using Method 8240. Table 4-3 summarizes the analytical results for the groundwater samples collected during the packer testing for coreholes CH-1 and CH-3 which were converted to Monitor Wells MW-14 and MW-23, respectively.

Laterally the contaminant plume appears to terminate in the vicinity of Crow Branch Creek. Contaminant isoconcentration contour maps for total VOCs, benzene, chloroform, diethyl ether, and methylene chloride are provided for the shallow unconsolidated zone (Figures 4-1, 4-2, 4-3, 4-4, and 4-5, respectively) and the bedrock zone (Figures 4-6, 4-7, 4-8, 4-9 and 4-10, respectively). The analytical data for bedrock aquifer monitor wells MW-14 and MW-24 were not included on the contaminant isoconcentration contour maps for bedrock monitor wells because the screened intervals for these wells are significantly deeper than the other bedrock wells and therefore the analytical data from these two wells is representative of contaminant concentrations in a deeper bedrock zone.

Site contaminants have not been detected during three consecutive sampling events in groundwater samples collected from shallow aquifer and/or bedrock aquifer wells to the north of the creek (MW-20, MW-21, and MW-23). While coring the borehole for Well MW-23 (corehole CH-3) two aquifer zones were sampled (19 to 52 ft bls and 52 to 88 ft bls). The groundwater samples collected from these two zones were analyzed for VOCs. Both acetone and chloroform were detected in the 19 to 52 ft bls groundwater sample at a concentration of 15 µg/L. The Groundwater Standards for acetone and chloroform are 700 µg/L and 0.19 µg/L, respectively. Other VOC constituents were detected at low concentrations in the groundwater samples from the two aquifer zones; however, these constituent concentrations were qualified as estimated



because the concentrations were below the practical quantitation limit but above the method detection limit.

There are two possible sources for the low concentrations of acetone and chloroform which were detected in the 19 to 52 ft bls groundwater sample from corehole CH-3. These constituents may have been introduced into the borehole during coring activities as water from a municipal water supply was pumped into the borehole to cool the core bit. This is supported by the fact that acetone was detected at a concentration of 1,400  $\mu\text{g/L}$  in a rinsate blank collected during the corehole/packer test sampling program. In addition, other VOCs may have been present in the rinsate blank but these constituents were not detected due to the elevated detection levels for the rinsate blank. It is also possible that these constituents have migrated north of the creek as a result of diffusion of the impacted groundwater plume which exists south of the creek. However, VOCs were not detected in groundwater samples collected from Well MW-23 during three subsequent groundwater sampling events following completion of the corehole/packer test program. Based on the results of the three subsequent rounds of groundwater data from Well MW-23 it does not appear that mass transport of VOCs is occurring across the creek. Therefore, the creek is functioning as a hydraulic barrier limiting the horizontal migration of the VOC plume.

Monitor well MW-9 provides delineation of the eastern edge of the VOC plume, and was found to contain  $10 \pm \mu\text{g/L}$  of VOCs. Monitor well MW-17 on the western edge of the contaminant plume contained  $100 \pm \mu\text{g/L}$  of contaminants that may be more representative of another source (the former UNC Old Sanitary Landfill located west of the chemical disposal area).

Vertical definition of the plume has in practical terms been established near the downgradient edge of the plume at Well MW-24 which is in a well cluster with MW-12 and MW-15. Monitor well MW-24 is screened from 175 to 195 bls into bedrock. The detected contaminants were benzene (2  $\mu\text{g/L}$ ), chloroform (12  $\mu\text{g/L}$ ), methylene chloride (8  $\mu\text{g/L}$ ), acetone (60  $\mu\text{g/L}$ ), and phenol (470  $\mu\text{g/L}$ ). These concentrations are three orders of magnitude lower than the concentrations detected in MW-15, which is screened in a more fractured bedrock zone at 50 to 60 ft bls. However, near the source, contaminant concentrations increased with depth in





corehole CH-1 (MW-14). This may be due to the potential for dense non-aqueous phase liquids (DNAPLs) in the vicinity. However, no visible evidence of DNAPLs were found in the observation wells. Corehole CH-1(MW-14) was drilled to 175 ft. Because of the limited number of fractures, a well deeper than 200 ft bls would not likely provide a better definition of the plume's vertical depth.

### 4.3 SURFACE-WATER SAMPLING RESULTS

Results of the five rounds of surface-water samples from Crow Branch Creek are summarized in Table 4-4. VOCs were detected at two sampling locations SW-01 and SW-03 from the January 26, 1996, sampling event. Diethyl ether was detected in SW-03 from the August 7, 1996, sampling event. VOCs were not detected at any of the other sampling locations or other dates from SW-01 or SW-03. Location SW-01 is upstream from the likely zone of plume discharge to Crow Branch Creek and likely represents impact from another upstream source, probably the former UNC Old Sanitary Landfill. The detection of tetrachloroethene at SW-03 on January 26, 1996, was at the method detection limit and may represent discharge of the chemical waste area plume or another upstream source.

### 4.4 SURFACE EMISSION FLUX AND AIR DISPERSION MODELING RESULTS

Results of the Emflux™ soil gas survey are listed in Table 4-5. Figures 4-11, 4-12, 4-13, and 4-14 show the analytical soil gas results for benzene, chloroform, carbon tetrachloride, and tetrachloroethene. Detectable gas emission primarily occurred in the immediate vicinity of the waste disposal area with scattered lower level detection at points along the paved access road.

Air dispersion modeling was performed using data from the soil gas survey. The purpose of this modeling was to evaluate the potential for ambient air quality impact. SCREEN3 air quality dispersion model was used to predict the maximum ambient 1-hour average concentration. Appendix H provides the modeling results. The modeling results indicate that estimated mass emission rates of contaminants were less than North Carolina and USEPA Region IV Risk-Based Concentrations.



## 4.5 GEOTECHNICAL ASSESSMENT

As indicated in Section 2.4.2, soil samples were collected for geotechnical evaluation. These samples were analyzed for geotechnical parameters such as Atterberg limits, particle size distribution, specific gravity, density, and moisture-density relationship. Appendix I presents the results. The purpose of this evaluation was to obtain geotechnical information for future use in the remedial design process. Attempts were made to collect soil samples for permeability and unconfined shear strength. However, soil samples could not be obtained due to refusals encountered in most borings.

## 4.6 DOWN-THE-WELL MEASUREMENT

Screening tests were performed to evaluate the potential for existence of natural/intrinsic attenuation of contaminants at the site. Selected on-site wells for down-the-well measurements include monitoring wells MW-1 (shallow well near source -- contaminated), MW-3 (upgradient shallow well), MW-6 (downgradient shallow well -- contaminated), MW-7 (downgradient bedrock well), MW-12 (downgradient shallow well -- contaminated), and MW-15 (downgradient bedrock well -- contaminated). These wells were initially measured for dissolved oxygen, pH, temperature, specific conductance, and redox potential. Groundwater samples were not collected from these wells for analysis of inorganic and organic chemicals. Table 4-6 presents the down-the-well parameters measured in these monitoring wells. Based on the results, some monitoring wells indicate reducing (anaerobic) conditions, which are favorable for degradation of chlorinated organic compounds. However, a detailed evaluation of the intrinsic degradation involving collection of samples from the monitoring wells for analysis of organic and inorganic compounds along with the down-the-well measurements were not performed during this phase of investigation.



## **5.0 PRINCIPAL FINDINGS**

Based upon the results of the soil, groundwater, and surface-water investigations conducted at the site, the following findings summarize the current understanding of site conditions.

### **5.1 GENERAL FINDINGS**

- A release of volatile and semi-volatile organic compounds has resulted in the contamination of site groundwater and to a limited extent soils immediately adjacent to the waste disposal pits.
- Near the source area, contaminants increase with depth in the bedrock aquifer, suggesting the potential for DNAPLs in the vicinity.
- Currently, the study indicates that there are no known routes for exposure to people, and there are no groundwater users in the area. Contaminated soils are reportedly buried beneath approximately 4 to 6 feet of clean fill material and the area is fenced (NCDEHNR, 1993). Air emissions are below health-based levels.
- Impact on surface-water quality of Crow Branch Creek near the site is minimal.

### **5.2 SOIL CONDITIONS**

Soil samples outside the fenced disposal site showed limited impacts. Three of five samples had no VOC detects. The remaining two samples showed detection of two VOC compounds not greater than 20 µg/kg. There were no detects in any samples for semi-volatile organics or cyanide. With a few minor exceptions, metals and inorganics are below background levels.



### 5.3 GROUNDWATER CONDITIONS

- Groundwater flow in the vicinity of the site is north-northwest toward Crow Branch Creek.
- Groundwater occurs in the thin saprolite zone above bedrock and in the igneous bedrock.
- A plume of contaminated groundwater extends from the immediate vicinity of the disposal pits north-northwest toward Crow Branch Creek. Twenty-six volatile and semi-volatile constituents were detected in the plume. The primary contaminants are benzene, chloroform, diethyl ether, and methylene chloride.
- The vertical and horizontal extent of the contaminant plume has for all practical remedial purposes been defined. The plume does not extend beyond University property and does not pose an imminent threat of migrating to adjacent properties.

### 5.4 SURFACE-WATER CONDITIONS

Surface water in Crow Branch Creek downstream of the site was sampled on five occasions. One sample of five collected from a location near the point of potential plume discharge into Crow Branch Creek was found to contain low concentrations of two volatile constituents, tetrachloroethene (5 µg/L) and diethyl ether (5 to 10 µg/L). No detectable levels of semi-volatile substances were found in the creek.



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