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NORTH CAROLINA
DEPARTMENT OF ENVIRONMENT AND NATURAL RESOURCES
DIVISION OF WASTE MANAGEMENT

MICHAEL F. EASLEY, GOVERNOR
WILLIAM G. ROSS, JR., SECRETARY
DEXTER R. MATTHEWS, INTERIM DIRECTOR

NCDENR

September 28, 2001

Ms. Jennifer Wendel
NC Site Management Section Chief
EPA Region IV Waste Division
61 Forsyth Street, SW 11th Floor
Atlanta, Georgia 30303

RE: Site Re-Assessment Report
University of North Carolina at Chapel Hill Site
NCD 980 515 308
Chapel Hill, Orange County, North Carolina

Dear Ms. Wendel:

The University of North Carolina at Chapel Hill (UNC-CH) Mason Farm Road Low-Level Radioactive Waste Disposal Site served as a burial site for low-level radioactive material generated by the University from 1963 to 1970 (Reference 1). During those years, operations were performed according to the State of North Carolina's regulations in place at that time. Material reportedly disposed of at the site included laboratory disposables (rubber gloves, empty vials, paper, hypodermic needles, glass bottles, etc.), animal carcasses, and glass and plastic scintillation vials containing toluene and xylene-based counting media. The material was reportedly placed in boxes and/or plastic bags before being placed in the pits/trenches. The burials were performed in a series of pits/trenches dug by backhoe to a depth of typically 5 to 8 feet. Because of the shallow groundwater at the site, the waste was occasionally placed into the pits/trenches below the water table. The pits/trenches were at least 6 feet apart and were covered with a minimum of 4 feet of compacted earth. The exact number of pits/trenches at the site is unknown, but approximately 52 burials are thought to have occurred at the site (Reference 1).

The site is in a low-lying flat area of the University's Mason Farm Road property near Morgan Creek (Figure 1). A small drainage ditch flows immediately adjacent to the north side of the waste disposal area within the flood plain of Morgan Creek (Reference 1). Morgan Creek subsequently flows into Jordan Lake, the drinking water supply for the cities of Cary, Apex,

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Holly Springs, and Chatham County. Jordan Lake is approximately 14,000 surface acres and lies 0.5 to 0.75 miles downgradient from the site. Jordan Lake is also a State Park with recreational activities and fishing. Jurisdictional wetlands have been identified at the site, as well as numerous miles of wetland frontage that line Jordan Lake (Reference 1).

The North Carolina Department of Environment and Natural Resources, Division of Water Quality, Groundwater Section is the lead agency for the site and is actively working on the UNC-CH site along with the Division of Radiation Protection. The Superfund Section feels as though these sections, as well as UNC-CH, are acting in an expedient and thorough manner to clean-up the site. The following is a brief summary of some of the major activities at the site that have been performed under the supervision of the Groundwater Section: January 1996 the site was reported to the Groundwater Section by UNC-CH, A Comprehensive Site Assessment Report was completed in November 1996, A Source Remediation Corrective Action Plan was submitted in February 1997 and subsequently approved by the Groundwater Section in February 1998, A Soil/Groundwater Characterization Sampling and Analysis/Quality Assurance Plan was submitted in May 1998, A Work Plan for Investigation of Geophysical Anomaly was submitted in July 1999, A Work Plan to Install and Test Groundwater Recovery Well Network was submitted in April 2000, A Work Plan to Conduct Excavation and Waste Segregation Activities was submitted in July 2000, A Notice of Violation was submitted to UNC-CH for Failure to Implement Approved Corrective Action Plan in February 2001, A Status report for the Excavation and Waste Segregation Activities was submitted in February 2001, February 2001 UNC-CH was notified by South Carolina, Southeast Soil Recovery, Inc. regarding the denial to transport and treat the on-site soil at the South Carolina facility, and December 2000 Groundwater/Surface Water Sampling Report was submitted to the Groundwater Section in April 2001.

Based on the data received by the Groundwater Section from the Comprehensive Site Assessment Report dated November 1996, soils at the site have been contaminated by the pits/trenches (Reference 1). These samples were collected by Geoprobe from the zone immediately below the reported bottom of the disposal pits/trenches. Diethyl phthalate and bis(2-ethylhexyl)phthalate were detected at levels below the North Carolina Inactive Hazardous Sites Program Guidelines. Samples were also analyzed for the radionuclide isotopes tritium and carbon-14. Tritium was detected at levels below the Division of Radiation Protection and Environmental Protection Agency standards and carbon-14 was non-detect in all soil samples collected (Reference 1).

More recent groundwater and surface water sampling has been performed at the site. From data collected and reported in the December 2000 Groundwater/Surface Water Sampling Report, groundwater at the site has been impacted by toluene (highest concentrations, 270,000 ug/l), 1,4-dioxane (22,000 J ug/l), bis (2-ethylhexyl)phthalate (18 ug/l), tritium (18,200 +/- 1,150

pCi/l), and carbon-14 (570 +/- -48.2 pCi/l) (Reference 2). Surface water samples indicate an impact of methylene chloride (0.86 J ug/l), chloroform (2.6 ug/l), bromodichloromethane (0.89 J ug/l), bis(2-ethylhexyl)phthalate (5.1 J ug/l), and tritium (466 +/- 246 pCi/l). Although, methylene chloride, chloroform, bromodichloromethane and bis (2-ethylhexyl)phthalate appears to be from upgradient sources along Morgan Creek and may not be related to site activities (Reference 2).

According to the December 2000 Groundwater/Surface Water Sampling Report, the extent of impacted water, ground and surface, appear to remain within close proximity to the site. According to the same report, the overall constituents within the samples have decreased since sampling in 1998; however, the concentrations of 1,4-dioxane have increased. Neither tritium nor carbon-14 have been detected in concentrations that exceed the North Carolina standard (Reference 2).

As stated previously, the North Carolina Department of Environment and Natural Resources, Division of Water Quality, Groundwater Section is the lead agency for the site and is actively working on the UNC-CH site along with the Division of Radiation Protection. The Superfund Section feels as though these sections, as well as UNC-CH, are acting in an expedient and thorough manner to clean-up the site. If the Groundwater Section at any time is unwilling or unable to continue activities at the UNC-CH site, the NC Superfund Section will reactivate the investigation under CERCLA. If you have any questions regarding this recommendation or site activities, please contact me at (919) 733-2801 ext. 315.

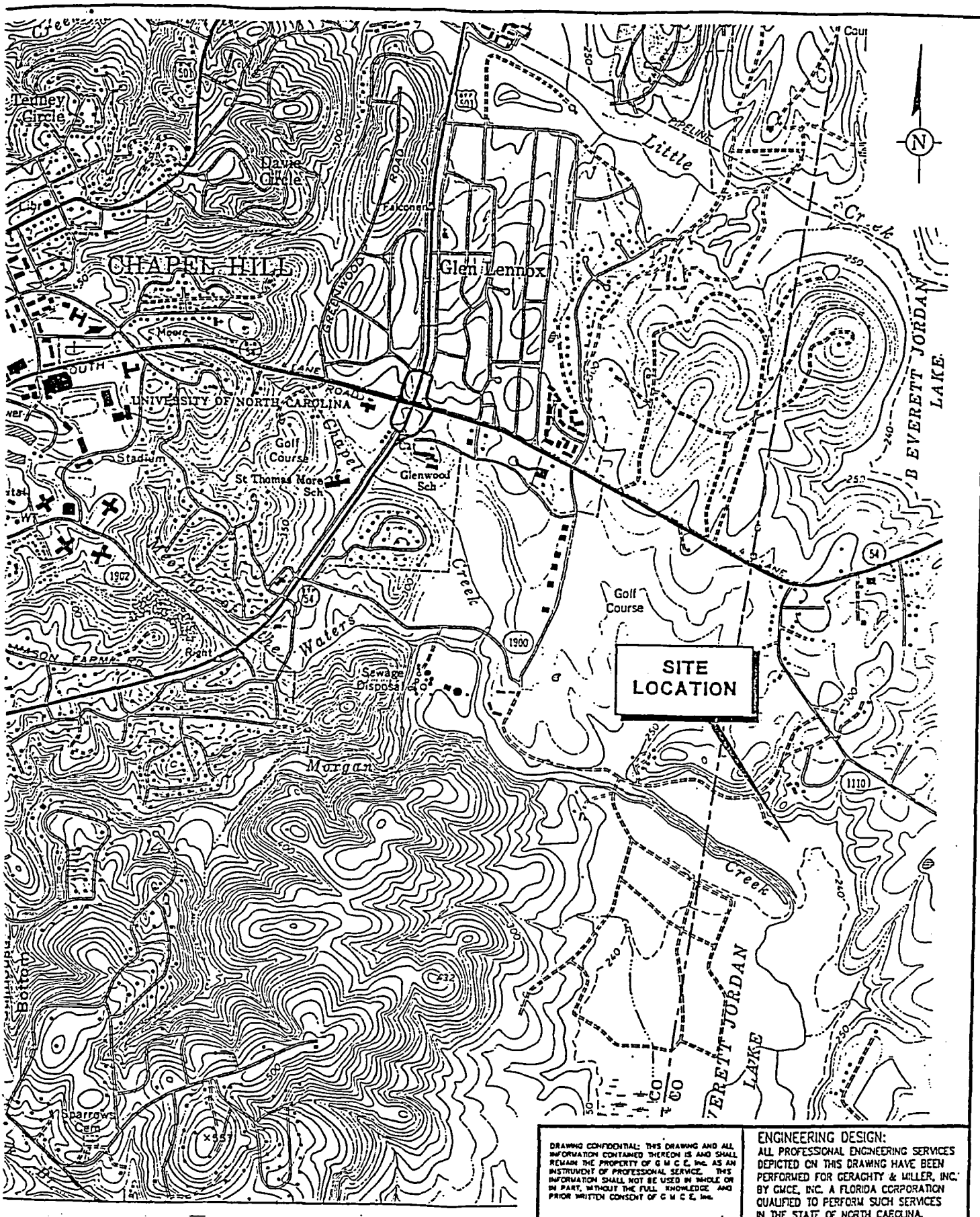
Sincerely,

Stephanie K. Grubbs

Stephanie K. Grubbs
Hydrogeologist
NC Superfund Section

Dan LaMontagne, Head
Site Evaluation and Removal Branch
NC Superfund Section

enclosure



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THE UNIVERSITY OF NORTH CAROLINA AT CHAPEL HILL MASON FARM LOW-LEVEL RADIOACTIVE WASTE DISPOSAL SITE	DRAWN B. HERRMAN	DATE 10/21/98	PROJECT MANAGER L. MORETZ	PROJECT OFFICER S. KEITH
	SITE LOCATION AND TOPOGRAPHY		LEAD DESIGN PROF. N. SHETTY	CHECKED D. MALONE
			PROJECT NUMBER NC000372.0004	FIGURE NUMBER 1

Reference 1

Ref. 1

COMPREHENSIVE SITE ASSESSMENT REPORT
UNIVERSITY OF NORTH CAROLINA
AT CHAPEL HILL
MASON FARM LOW-LEVEL RADIOACTIVE
WASTE DISPOSAL SITE
CHAPEL HILL, NORTH CAROLINA

Volume I

November 1996

Prepared for:

The University of North Carolina at Chapel Hill
212 Finley Golf Course Road
Chapel Hill, North Carolina

Prepared by:

GERAGHTY & MILLER, INC.
Environment and Infrastructure
CrossPointe II
2840 Plaza Place, Suite 350
Raleigh, North Carolina 27612
(919) 571-1662

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CONTENTS

Page

1.0 INTRODUCTION 1-1

2.0 SITE DESCRIPTION, OPERATIONS AND HISTORY 2-1

3.0 SETTING 3-1
- 3.1 ADJACENT PROPERTY USES 3-1
- 3.2 TOPOGRAPHY AND SURFACE-WATER DRAINAGE 3-1
- 3.3 POTENTIAL RECEPTORS 3-2

4.0 SITE ASSESSMENT METHODOLOGY 4-1
- 4.1 WETLANDS DELINEATION 4-1
- 4.2 SOIL BORINGS 4-2
- 4.3 MONITOR-WELL INSTALLATION AND DEVELOPMENT 4-2
- 4.4 GROUNDWATER AND SURFACE-WATER SAMPLING 4-4
- 4.5 AQUIFER TESTS 4-4
- 4.6 GEOTECHNICAL SAMPLING AND ANALYSIS 4-5
- 4.7 SURVEYING 4-5
- 4.8 WATER-LEVEL MEASUREMENTS 4-5

5.0 HYDROGEOLOGY 5-1
- 5.1 GEOLOGY 5-1
  - 5.1.1 Regional Geology 5-1
  - 5.1.2 Site-Specific Geology 5-1
- 5.2 GROUNDWATER AND SURFACE-WATER FLOW SYSTEM 5-2
  - 5.2.1 Groundwater and Surface-Water Flow Directions 5-2
  - 5.2.2 Hydraulic Conductivities 5-3

6.0 ANALYTICAL RESULTS 6-1
- 6.1 SOIL QUALITY RESULTS 6-1
  - 6.1.1 Volatile Organic and Semi-Volatile Organic Constituents 6-1
  - 6.1.2 Radionuclide Isotopes - Tritium and Carbon 14 6-2
- 6.2 GROUNDWATER AND SURFACE-WATER QUALITY RESULTS 6-3
  - 6.2.1 Volatile Organic and Semi-Volatile Organic Constituents 6-3
  - 6.2.2 Radionuclide Isotopes - Tritium and Carbon 14 6-4
- 6.3 GEOTECHNICAL ANALYTICAL RESULTS 6-5

7.0 PRINCIPAL FINDINGS AND CONCLUSIONS 7-1

8.0 REFERENCES 8-1

TABLES

4-1. Monitor-Well Construction Details.
5-1. Groundwater and Surface-Water Elevations.
5-2. Summary of Hydraulic Conductivity Data.
6-1. Summary of Radioisotope Analytical Data for Geoprobe Soil Samples.

CONTENTS (continued)

TABLES

6-2. Summary of Volatile Organic and Semi-Volatile Organic Constituents Detected in Groundwater Samples.
6-3. Summary of Volatile Organic and Semi-Volatile Organic Constituents Detected in Surface-Water Samples.
6-4. Summary of Tritium Radioisotope Analytical Data for Groundwater and Surface-Water Samples.
6-5. Summary of C-14 Radioisotope Analytical Data for Groundwater and Surface-Water Samples.

FIGURES

1-1. Site Location Map.
2-1. Site Layout.
2-2. Estimated Number and Position of Mason Farm Burial Pits.
4-1. Geoprobe™ Locations.
4-2. Groundwater and Surface-Water Sampling Locations.
5-1. Cross-Section Location Map.
5-2. Geologic Cross-Section A - A'.
5-3. Groundwater Potentiometric Surface, August 7, 1996.
5-4. Groundwater Potentiometric Surface, August 27, 1996.
6-1. Groundwater and Surface-Water Constituent Concentrations.
6-2. 1,4 Dioxane Isoconcentration Contours.

APPENDICES

A. Wetland Delineation Report Regulatory Correspondence and Nationwide Permit #14.
B. Geoprobe™ Boring Logs.
C. Well Construction Diagrams and Lithologic Logs.
D. Sampling and Slug Testing Protocols.
E. Slug Test Plots.
F. Chemical Analytical Results.
G. Geotechnical Testing Results

COMPREHENSIVE SITE ASSESSMENT REPORT
UNIVERSITY OF NORTH CAROLINA
AT CHAPEL HILL
MASON FARM LOW-LEVEL RADIOACTIVE
WASTE DISPOSAL SITE
CHAPEL HILL, NORTH CAROLINA

EXECUTIVE SUMMARY

The University of North Carolina at Chapel Hill (the University) Mason Farm Low-Level Radioactive Waste Disposal Site served as a burial site for low-level radioactive material generated by the University from 1963 to 1970. During its active life, operations were performed according to regulations in place at that time. The site was developed and used prior to the creation of Jordan Lake. At the time of it's use the water table was lower than at the present time. Since the lake was created in the early 1980s, the water table has risen at the site as a result of the lake's impoundment such that the burial pits are now below the water table. In 1989 the Division of Radiation Protection (DRP) conducted limited sampling at the site. Since 1991, the site has been monitored for radioactivity under a plan approved by the DRP. No radioactivity significantly above natural background levels has been detected in groundwater outside the waste disposal area during any current or past sampling.

In early 1996, the University began exploring the possibility of removing the waste material and as part of its research sampled the groundwater at the site for chemical constituents. The sample from the monitoring well inside one of the burial pits (MW-3) contained toluene at a concentration greater than 100,000 parts per billion (ppb) in the groundwater. Because the site is adjacent to a ditch which flows into Morgan Creek, a tributary to Jordan Lake, the University immediately sampled the surface water. Both upstream and downstream samples contained no analyzed constituents above the Practical Quantitation Limit (PQL).

The University contacted the DRP and the Division of Environmental Management (DEM) and reported the above-cited findings. Additionally, the University met with the DRP, the DEM and the Division of Solid Waste Management (DSWM) to discuss further investigation of

the site. An agreement was made that the site would be investigated under the DEM guidelines for a Comprehensive Site Assessment (CSA). This report presents the results of this CSA.

Initially, soil samples were collected from eight locations immediately adjacent to the site at a depth just below the reported bottom of the burial pits. No samples were collected inside the fenced site. The purpose of these samples was to determine whether the material in the pits had leached into soils immediately adjacent to the burial pits. The samples were analyzed for volatile and semi-volatile organic compounds (SVOC), tritium and carbon-14. The soils adjacent to the fenced area have not been impacted above either State or Federal standards or State or Federal comparable remediation guidelines for chemicals in the soil. Only very low levels of tritium, below the State DRP standard and the USEPA Interim Drinking Water Maximum Contaminant Limit (MCL), were detected in interstitial waters of the soil samples. No C-14 was detected in the soil samples and the only VOC or SVOC detected was diethyl phthalate. The phthalate was only detected in one sample at a concentration well below the State remediation guideline.

The second phase of investigation involved the installation of five monitor wells to determine the nature and extent of any releases from the site. These wells and two previously existing wells were sampled and analyzed for volatile and semi-volatile organic compounds, tritium and carbon-14. The results indicate that the groundwater has been impacted by site activities, but the extent of chemical constituents is limited to the upper portion of the water-table aquifer within and near the fenced disposal area. Toluene was detected in only one well, MW-3, which monitors burial pit water within the fenced disposal area. An earlier detect of toluene in this well prompted this CSA. A SVOC, 1,4-dioxane (diethylene ether), was detected in six of the eight wells sampled with the highest concentration (21,000 ppb) in well MW-3. The lateral extent of 1,4-dioxane is generally restricted to the disposal pits area with significantly reduced concentrations in wells outside the waste disposal area.

Surface water has not been significantly impacted by activities at the site. Toluene was detected at a concentration of 1.9 ppb in sample SW-3 which was collected in a drainage ditch immediately downgradient of the disposal area. Other constituents detected in Morgan Creek may be attributed to other upstream sources.

Groundwater and surface water samples were analyzed for tritium and C-14 isotopes which are indicative of the low-level radioactive waste placed in the burial pits. Neither tritium nor C-14 were detected at concentrations exceeding the DRP for discharge to surface water. Tritium was detected above the Federal MCL of 20,000 pCi/L in well MW-3, inside the waste disposal area, but was not detected above the MCL in any other wells.

COMPREHENSIVE SITE ASSESSMENT REPORT
UNIVERSITY OF NORTH CAROLINA
AT CHAPEL HILL
MASON FARM LOW-LEVEL RADIOACTIVE
WASTE DISPOSAL SITE
CHAPEL HILL, NORTH CAROLINA

1.0 INTRODUCTION

The University of North Carolina at Chapel Hill (the University) retained Geraghty & Miller, Inc., (Geraghty & Miller) to conduct an environmental investigation at the Mason Farm Low-Level Radioactive Waste Disposal Site on the University's Mason Farm property in Chapel Hill, North Carolina (Figure 1-1). The site was used between November 1963 and sometime in 1970 as a burial site for low-level radioactive waste generated at the University. During its active life, operations were performed according to regulations in place at that time. The site was developed and used prior to the creation of Jordan Lake. At the time of it's use the water table was lower than at present. Since the lake was created in the early 1980s, the water table has risen at the site as a result of the lake's impoundment such that the burial pits are now below the water table. In 1989 the Division of Radiation Protection (DRP) conducted limited sampling at the site. Since 1991, the site has been monitored for radioactivity under a plan approved by the DRP. No radioactivity significantly above natural background levels has been detected in groundwater outside the waste disposal area during any current or past sampling.

In early 1996, the University began exploring the possibility of removing the waste material and, as part of their research, sampled the groundwater at the site for chemical constituents. The University's Health and Safety Office sampled three shallow monitoring wells on January 19, 1996, and analyzed them for methylene chloride, benzene, toluene, ethylbenzene, and total xylenes. Results of analyses of samples from two wells (MW-1 and MW-2) located on the perimeter of the site were Below Quantitation Limits (BQL). The sample from the monitoring well inside one of the burial pits (MW-3) contained toluene at a concentration greater than 100,000 parts per billion (ppb) in the groundwater. Because the site is adjacent to a ditch which flows into Morgan Creek, a tributary to Jordan Lake, the University immediately sampled the

surface water. Both upstream and downstream samples contained no analyzed constituents above the Practical Quantitation Limit (PQL).

The University contacted the DRP and reported the above-cited findings. Further, the University met with the DRP, the Division of Environmental Management (DEM) and the Division of Solid Waste Management (DSWM) to discuss further investigation of the site. An agreement was made that the site would be investigated under the DEM guidelines for a Comprehensive Site Assessment (CSA). This report presents the results of this CSA.

Geraghty & Miller prepared this CSA for the University, consistent with DEM guidance (NCDEHNR, 1993). This report presents the results of soil sampling, monitor-well installation and sampling, and surface-water sampling. The field work was conducted between June and August 1996. Descriptions of the field procedures, the laboratory reports, and other information also are provided.

2.0 SITE DESCRIPTION, OPERATIONS AND HISTORY

The site is in a low-lying area of the University's Mason Farm property near Morgan Creek as shown on Figure 1-1. A small drainage ditch flows immediately adjacent to the north side of the waste disposal area. Jordan Lake lies approximately three-quarters of a mile downgradient of the site. A wetlands delineation survey, which was performed as part of this investigation, indicates that part of the site lies within a jurisdictional wetlands (Appendix A). The waste disposal area, which encompasses an area approximately 100 feet by 150 feet, was fenced prior to initial operation and remains fenced. The site layout is depicted on Figure 2-1.

The site was formerly used as a low-level radioactive waste disposal site for the University between November 1963 and sometime in 1970. Material reportedly disposed of at the site consisted of laboratory disposables (rubber gloves, empty vials, paper, hypodermic needles, glass bottles, etc.), animal carcasses, and glass and plastic scintillation vials (containing toluene and xylene-based counting media). The material was reportedly placed in boxes and/or plastic bags before being placed in the trenches.

Disposal protocols followed standards set by the State of North Carolina at that time. At the time of the burials, Jordan Lake had not been impounded and therefore the water table was lower than at present. The burials were performed in a series of pits/trenches dug by a backhoe to a depth of typically between 5 and 8 feet. Because of the shallow groundwater table at the site, the waste was at times placed into trenches below the water table. The pits were at least 6 feet apart and were covered with at least 4 feet of compacted earth. The exact number of disposal pits at the site is unknown, but approximately 52 burials are thought to have occurred in a pattern depicted in Figure 2-2.

Previous site investigations are basically limited to routine semi-annual monitoring of the site which has occurred since 1991. However, the DRP sampled the site in the late 1980's and some sampling was conducted during a master's thesis by Charles E. Maples in 1990. Results of the semi-annual sampling indicate that no radioactivity significantly above natural background levels has been detected in groundwater outside the waste disposal area. Reports from the

University's semi-annual sampling have been submitted to the DRP. Additional sampling for organic constituents was performed by University in early 1996. Analysis from this sampling event indicated that toluene was present in the groundwater above 100,000 ppb. The results of this sampling were submitted to the DRP and the DEM and prompted this CSA.

3.0 SETTING

3.1 ADJACENT PROPERTY USES

The waste disposal area is a small (100' x 150') area located in a large parcel (>100 acres) of undeveloped land owned by the University. University property surrounds the site for a distance of at least 1,500 feet in all directions. The waste disposal area is located near a biological preserve and there is no commercial or residential development within 1,500 feet of the site. One residence, owned by the University, lies approximately 1,500 feet northeast of the site in an upgradient direction. The area is provided water by the Orange Water and Sewer Authority Water (OWASA) Distribution System. No residences are downgradient of the site because the disposal area is located in the floodplain of Jordan Lake. Access to the floodplain area where the waste disposal area is located is restricted through a locked gate owned by the University. Additionally, the waste disposal area is surrounded by a locked chain-link fence.

3.2 TOPOGRAPHY AND SURFACE-WATER DRAINAGE

The site is depicted on a United States Geological Survey (USGS) 7.5-minute series Chapel Hill topographic quadrangle (Figure 1-1). Topography in the immediate Chapel Hill area consists of occasional hills and valleys. The site is situated on a low-lying, flat area on the floodplain of Morgan Creek upgradient of Jordan Lake. Jurisdictional wetlands have been identified at the site. Approximate elevation of the site is 243 feet above mean sea level (ft msl). The flood stage of Jordan Lake is approximately 241 ft msl, with normal pool being approximately 220 ft msl.

Normal surface-water drainage is southeast toward Jordan Lake. A drainage ditch is present immediately adjacent to the northern side of the waste disposal area. Water from the waste disposal area likely drains into this ditch, which discharges into Jordan Lake, approximately 1/2 mile from the site.

3.3 POTENTIAL RECEPTORS

Residents of Chapel Hill and portions of southern Orange County and southern Durham County are provided with water via the OWASA. OWASA obtains water from a surface-water intake on University Lake, approximately 3 miles southwest of the subject site. Rural areas of Orange County are supplied with water via individual water-supply wells. There are no known water-supply wells within 0.5 mile of the site, and there are no known subsurface utilities at or near the waste disposal area.

The primary receptor would be surface water flowing in a small ditch immediately adjacent to the former disposal site. Water from this ditch eventually flows into Jordan Lake, which serves as a water supply to the Towns of Cary and Apex. However, Jordan Lake encompasses over 14,000 surface acres, and any potential constituents released from the site would have little or no impact on the water quality of the reservoir. The intake for Cary and Apex water supply is on the east side of Jordan Lake at Highway 64, over 10 miles from the waste disposal area.

4.0 SITE ASSESSMENT METHODOLOGY

Geraghty & Miller conducted an environmental investigation at the site in three phases. The initial phase involved the delineation of wetlands at the site in April 1996. The initial intrusive field investigation, conducted in June 1996, involved the collection of soil samples using a Geoprobe. Based upon the results of the soil sampling phase, a third phase of work involving the installation and sampling of groundwater monitoring wells, surface-water sampling, and slug testing was performed in July 1996. The objectives of the site assessment program were to:

- perform a wetlands delineation and identify any wetlands permitting issues with the performance of the CSA and potential future remedial activities;
- gather site-specific hydrogeologic information;
- delineate the extent of any radiological isotopes, volatile and semi-volatile organic compounds in the groundwater;
- determine if surface water has been impacted by the site;
- Identify criteria for dewatering, slope stability, and other geotechnical properties required for future possible site excavation.

This section describes the field activities performed to achieve the aforementioned objectives.

4.1 WETLANDS DELINEATION

A delineation of jurisdictional wetlands boundaries at the site and immediate surrounding area was performed on April 16, 1996. The wetlands boundaries were flagged with surveyor's tape in preparation for the potential survey and/or verification by the U.S. Army Corps of

Engineers (COE). Wetlands were identified at the site with approximately one-half of the fenced site itself lying within the wetlands. The wetlands boundary is illustrated on Figure 2-1. Because the site is in a wetlands and access by drilling equipment was impossible without the construction of a temporary gravel road, the COE was notified. Nationwide Permit #14 was obtained to allow construction of a temporary road for assessment and potential remedial activity purposes. Details regarding the wetlands delineation and permit approval documentation are included in Appendix A of this report.

4.2 SOIL BORINGS

Geraghty & Miller completed eight soil borings around the perimeter of the site (Figure 4-1) on June 6, 1996, using Geoprobe™ technology. These borings were completed to obtain soil samples for C-14, tritium, volatile organic compounds (VOC), and semi-volatile organic compounds (SVOC) analysis to assess any releases to the soils around the site and to better locate the monitoring wells. Soil samples were collected continuously for lithologic description and were screened using an organic vapor analyzer (OVA). Soil samples were collected from each boring at a depth immediately below the reported depth of the disposal trenches (8 feet) and submitted for laboratory analysis. Boring logs are provided in Appendix B.

4.3 MONITOR-WELL INSTALLATION AND DEVELOPMENT

Following receipt and evaluation of the soils analytical results collected via Geoprobe, Geraghty & Miller installed four shallow monitor wells (designated GM-4, GM-5, GM-6, and GM-8) and one deep Type III monitor well (designated GM-7) on July 18 and 19, 1996. The locations of these monitor wells are shown on Figure 4-2. The drilling was performed using hollow-stem augers for the shallow wells and for installing the surface casing of the Type III well. An air hammer rig was used for drilling the final segment of the Type III well.

All of the monitor wells were installed in unconsolidated sediments. The shallow wells were constructed with 5-foot-long screens to monitor the upper portion of the water table,

including the sand layer present between approximately 8 to 10 feet below grade. The disposal pits were reportedly a maximum depth of approximately 8 feet, which would put the bottom of the pits immediately above or intersecting this sand layer. The rationale was to monitor this sandy zone which, if a major release had occurred, would be contaminated.

The Type III well, GM-7, was installed to delineate the vertical extent of any released constituents, provide vertical hydraulic gradient data, and deeper lithologic information. A 6-1/2-inch-diameter polyvinyl chloride (PVC) surface casing was grouted into place in a tight clay at a depth of 21 feet below land surface (ft bls) to seal off any potential contamination from migrating downward during drilling. After allowing the surface casing grout to set 24 hours, the borehole was advanced to 44 ft bls using an air hammer bit. The 2-inch well was then set to monitor the zone from 34 to 44 ft bls.

Well GM-6 was installed to monitor the shallow zone near Morgan Creek to determine if any released constituents were migrating toward the creek and to provide water-level data between the creek and the site.

Monitor-well construction details are listed in Table 4-1. Well construction diagrams and lithologic logs are provided in Appendix C. Monitor-well locations are depicted on Figure 4-2. The monitor wells were constructed with 2-inch-diameter, schedule 40 PVC well casing. The shallow wells were constructed with 5 feet of No. 10 slot PVC screen, while deep well GM-7 was constructed with a 10-foot screen. Monitor wells MW-1 through MW-3 were installed in 1989 or 1990 to monitor groundwater at the waste disposal area. MW-3 was reportedly installed to monitor the groundwater in a disposal pit. Well MW-4 was installed in January 1996 by hand-auger and monitors the upper few feet of the water table near the waste disposal area. No well construction logs are available for the previously existing wells. Note that well MW-1 was accidentally destroyed when it was run over by a vehicle.

Following installation, all newly-installed monitor wells were developed to remove residual clay, silt, and fine sands from the well to allow collection of representative groundwater

quality samples. Development was performed on July 24, 1996, by purging the wells using a disposable polyethylene bailer until the water was relatively clear to the unaided eye and field parameters such as pH, conductivity, and temperature had stabilized.

All drill cuttings, well development, and decontamination water/solids were placed in labeled, 55-gallon drums and placed inside the locked fence. After characterization for disposal, these investigation derived wastes were properly disposed of offsite.

4.4 GROUNDWATER AND SURFACE-WATER SAMPLING

Groundwater and surface-water samples were collected on July 25 and 26, 1996. Groundwater samples were collected from the five newly-installed monitor wells and the three previously-existing wells. Surface-water samples were collected upgradient and downgradient from the site in both Morgan Creek and the adjacent drainage ditch. Sampling locations are shown on Figure 4-2. All samples were submitted for the following analyses: C-14 (Method RICHRC5022), tritium (Method RICHRC5007), VOCs (USEPA Method 8260), and SVOCs (USEPA Method 8270). Additionally, field parameters including pH, conductivity, and temperature were collected at each sample location. Details regarding the sampling protocols are included in Appendix D.

4.5 AQUIFER TESTS

In-situ aquifer tests (slug tests) were conducted on all onsite monitor wells to allow calculation of an average hydraulic conductivity for the lithologic material underlying the site. Additionally, two temporary piezometers (TW-1 and TW-2) were installed to allow determination of the upper silty clay zone present to a depth of approximately 8 ft bls. Both slug-in and slug-out tests were conducted on the monitor wells. Only recovery tests were conducted on the two temporary piezometers. This was achieved by bailing the piezometers down and hand measuring the recovery rate. Details regarding the aquifer testing protocols and subsequent data analyses are included in Appendix D. The results of the slug testing are discussed in Section 5.2.2.

4.6 GEOTECHNICAL SAMPLING AND ANALYSIS

Geotechnical sampling and analysis were performed to determine geotechnical properties which may be useful during a possible remedial phase. Continuous split-spoon sampling was conducted in all borings drilled for well installation. Additionally, two Shelby tube samples were collected from the upper silty clay unit in borings and were analyzed for: vertical permeability, unconfined compressive strength, moisture content, grain size, Atterberg limits, and moisture-density relationship. A side slope stability analysis was also performed to assess the possibility of failure during any future excavation activity at the site. Results of the geotechnical analysis are discussed in Section 6.3.

4.7 SURVEYING

A water-level measuring point (top of casing) was established at each monitor well and at two staff gauges installed in Morgan Creek. The elevation of each measuring point was determined to within +/- 0.01 ft msl by a registered surveyor, Combined Surveying Resources of Raleigh, North Carolina. Additionally, the surface of the water in the drainage ditch at surface-water sampling locations (SW-3 and SW-4) were surveyed on August 7, which allowed incorporation of these measurements into a water-level contour map for that date. The boundary of the site's fence, the temporary gravel road, and the dirt access road were also surveyed to provide an accurate site base map.

4.8 WATER-LEVEL MEASUREMENTS

Depth-to-water measurements from the top of casing were collected from each monitor well and the two staff gauges in Morgan Creek on August 7 and August 27, 1996. The water-level measurements were converted to water-level elevations using the well survey data. Groundwater flow direction and hydraulic gradients are discussed in Section 5.2.1.

5.0 HYDROGEOLOGY

5.1 GEOLOGY

Information on the regional and site-specific geology is provided in the following paragraphs.

5.1.1 Regional Geology

Chapel Hill lies within the Eastern Piedmont Physiographic Province. The site, located in southwestern Durham County which 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 Triassic Basins. 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. The site is located close to the Triassic Basin/Carolina Slate Belt boundary. 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.

5.1.2 Site-Specific Geology

Three primary lithologic units were encountered at the site and are depicted in a cross-section. The location of the cross-section is shown in Figure 5-1, and the cross section is presented in Figure 5-2. Cross-section A to A' extends across the site from north to south and includes lithologic information from monitor wells GM-4, GM-7, and GM-6.

The upper few inches is comprised of an organic-rich topsoil, indicative of a low-lying wetlands area. A saturated, silty to sandy clay layer occurs to a depth of approximately 8 to 12 ft

bls. This upper silty to sandy clay layer typically coarsens downward, with sand concentrations increasing from approximately 10 percent land surface to nearly 90 percent at a depth of approximately 10 ft bls. The sandy unit also contains minor amounts of gravel and cobbles, which may be indicative of a stream channel deposit. A silty to sandy clay lies beneath this relatively thin sand deposit to a depth of at least 44 ft bls, the maximum depth drilled during this investigation.

5.2 GROUNDWATER AND SURFACE-WATER FLOW SYSTEM

The hydrogeologic parameters of the groundwater and surface-water flow systems are discussed in this subsection.

5.2.1 Groundwater and Surface-Water Flow Directions

The waste disposal area lies on the floodplain of Morgan Creek near the floodplain of Jordan Lake; therefore, depth to groundwater at the site is very shallow. Also, Morgan Creek has been channelized and bermed; therefore, the elevation of the water in the creek at times is higher than the site. During the investigation, groundwater occurred within a foot of land surface. At times, the entire site is flooded with several inches to a few feet of water. Because the topography is nearly flat and groundwater is shallow, the groundwater hydraulic gradients are very low. Based upon groundwater elevation data collected on August 7 and August 27, 1996, the average horizontal hydraulic gradient is approximately 0.009 feet/foot (unitless).

Water-level data measurements are presented in Table 5-1. The water-level elevation data compiled from August 7, 1996, and August 27, 1996, were used to construct water-table contour maps (Figures 5-3 and 5-4). As shown on the maps, the groundwater table surface is relatively flat. The water elevation data from August 7 include water levels in the drainage ditch adjacent to the site. When these data are used, it becomes apparent that groundwater from at least the northeastern portion of the site, which lies in the wetlands, discharges to this ditch. Based upon topography, the general groundwater flow direction for the area should be eastward, toward Jordan Lake; however, as shown on Figures 5-3 and 5-4, a slight mound of groundwater is

present in association with the higher ground in the area which may cause a radial groundwater flow pattern locally around the site.

Note that the surface-water elevations in Morgan Creek and the drainage ditch are slightly higher in downstream locations SW-1 and SW-3, respectively. One explanation is that the high surface-water levels in what should be downstream locations may be the result of wind pushing water back up into the creek and ditch from Jordan Lake. Another explanation is the water flowing into the lake is slowing down and backing up somewhat before entering the lake.

A downward vertical hydraulic gradient exists at the site, as evidenced by the difference between the water-level elevation in shallow monitor well GM-8 and the water level in the adjacent deep monitor well GM-7. The centers of the screened intervals for shallow monitor well GM-8 and deep monitor well GM-7 are separated by approximately 31 feet. A vertical gradient can therefore be calculated for the shallow/deep well pair by dividing the difference in water-level elevations for the two wells by the distance between the center points of the two screened intervals. Water-level elevation data from well pair GM-7/GM-8 indicate a downward vertical hydraulic gradient of 0.070 ft/ft (August 7, 1996) and 0.099 ft/ft (August 27, 1996).

5.2.2 Hydraulic Conductivities

In-situ aquifer tests (slug tests) were performed on the five newly-installed wells (GM-4, GM-5, GM-6, GM-7, and GM-8) and two newly-installed shallow, temporary piezometers (TW-1 and TW-2) to obtain estimates of the hydraulic conductivity (K) for the site. The K value from GM-7 provides insight into hydraulic conductivity for the lower silty clay; the K values from GM-4, GM-5, GM-6, and GM-8 yield information on the sandy layer combined with portions of the upper and lower silt clay zones; and the K values from TW-1 and TW-2 provide data only on the upper silty clay unit where the waste was buried.

Analysis of the slug test data using the AQTESOLV™ software program provided the K values for the various units as shown on Table 5-2. The shallow silty clay zone, where the waste

was buried, has a K on the order of 3×10^{-5} centimeters per second (cm/sec). The thin silty sand layer beneath the upper silty clay has an average K on the order of 2.5×10^{-3} cm/sec. The lower silty clay zone has the lowest measured K, on the order of 4.7×10^{-7} cm/sec. The K values from all of the slug tests performed ranged from 4.59×10^{-3} in the silty sand to 4.68×10^{-7} in the lower silty clay zone. Graphical plots of water-level displacement in centimeters versus time in seconds were generated for each of the slug tests, and these are included in Appendix E.

In addition to determination of K values using slug testing, three soil samples were collected using Shelby tube samplers. Two samples were collected from the upper silty clay zone where the waste is buried and one was collected from the lower silty clay zone. These three samples were submitted for geotechnical analysis including vertical permeability testing. All three of the samples had a vertical permeability on the order of 10^{-7} cm/sec indicating a very low vertical permeability for these lithologic units.

5.2.3 Groundwater Flow Velocity

Groundwater flow in the surficial aquifer at the site, as determined from the two sets of water-level elevation data, is northeasterly toward the drainage ditch. An estimated average horizontal hydraulic gradient was calculated to be approximately 0.009 ft/ft across the area of investigation. The average interstitial groundwater flow 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

Ne = effective porosity

Three lithologic units were encountered at the site, an upper silty clay unit, a middle silty sand unit and a lower silty clay unit. An average groundwater flow velocity has been calculated for each of these units using data determined by Geraghty & Miller.

Upper silty clay unit:

K = (0.085) ft/day

$\frac{dh}{dl}$ = 0.009 ft/ft

Ne = 0.05 (An effective porosity of 5 percent was assumed for the upper silty clay zone based upon the grain-size analyses performed on Shelby tube samples collected from the lithologic unit.)

then $V = \frac{0.085 \text{ ft/day } (0.009 \text{ ft/ft})}{0.05}$

V = 0.015 ft/day = 5.48 ft/year

This value is an average horizontal groundwater flow velocity for the upper silty clay unit where the burial pits were dug. Inhomogeneities in this zone could lead to higher or lower localized rates of flow.

Middle Silty Sand Unit:

K = (7.08) ft/day

$\frac{dh}{dl}$ = 0.009 ft/ft

Ne = 0.20 (assumed to be 20 percent based upon the field lithologic description of a silty sand and the corresponding effective porosity from Fetter, 1980)

6.0 ANALYTICAL RESULTS

Soil and groundwater samples were analyzed using USEPA-accepted analytical methods consistent with the NCDEHNR guidelines (NCDEHNR, 1993). Laboratory certificates and data validation notes are provided in Appendix F.

6.1 SOIL QUALITY RESULTS

Soil samples were collected in June 1996 using a Geoprobe and analyzed for VOCs, SVOCs, tritium, and C-14 to determine if soils in the immediate vicinity of the disposal area had been impacted by activities at the site. Samples typically were collected from the zone immediately below the reported bottom of the disposal pits (8 to 10 ft bls); however, one deeper sample was collected from GP-3 at 13.5 to 14.5 ft bls.

6.1.1 Volatile Organic and Semi-Volatile Organic Constituents

Only one semi-volatile compound, diethyl phthalate, detected at 0.50 ppm in the deep sample from GP-3 was detected in any of soil samples. Another SVOC (bis [2-ethylhexyl] phthalate) was detected at 0.017 ppm in the field blank associated with the soil sampling. These two phthalates are commonly found in plastics. Their presence may be related to the plastic bags in which some of the waste material was placed prior to burial. However, because the concentrations are low it is also possible their presence is related to the field sampling procedures where plastic sleeves and latex gloves were used for sample collection or their presence may be related to laboratory contamination. The soil remediation goals for diethyl phthalate and bis [2-ethylhexyl] phthalate, as outlined in the October 1996 North Carolina Inactive Hazardous Sites Program Guidelines, are 12,600 ppm and 46 ppm, respectively. Because there are no other soil remediation guidelines available through the DEM for these compounds, the Hazardous Sites Program Guidelines have been used for comparison purposes.

then $V = \frac{7.08 \text{ ft/day } (0.009 \text{ ft/ft})}{.20}$

$V = 0.319$ ft/day = 116.4 ft/year

This value is an average groundwater flow velocity for the middle silty sand unit. Inhomogeneities in this zone could lead to higher or lower localized rates of flow.

Lower silty clay unit:

$K = (0.0013)$ ft/day

$\frac{dh}{dl} = 0.009$ ft/ft

Ne = 0.05 (An effective porosity of 5 percent was assumed for the upper silty clay zone based upon the grain-size analyses performed on Shelby tube samples collected from the lithologic unit.)

then $V = \frac{0.0013 \text{ ft/day } (0.009 \text{ ft/ft})}{0.05}$

$V = 0.000234$ ft/day = 0.0854 ft/year

This value is an average horizontal groundwater flow velocity for the lower silty clay unit. Inhomogeneities in this zone could lead to higher or lower localized rates of flow.

6.1.2 Radionuclide Isotopes - Tritium and Carbon 14

All of the soil samples collected with the Geoprobe were analyzed for tritium and C-14. Because analysis of tritium in soils cannot be performed directly, the tritium analyses were performed on interstitial water found in the soil samples using soil sampling methodology. All of the soil samples were collected from below the water table. Tritium was detected above the minimum detectable activity (MDA) in six samples. The MDA is the smallest amount of sample activity that yields a net count of the isotope being sampled within the accuracy of the analytical method. The presence of tritium may be expected anytime shallow groundwater is analyzed for tritium because tritium occurs in groundwater naturally. Beginning in 1953, the occurrence of tritium has increased with the advent of large-scale atmospheric testing of nuclear weapons and the dispersion of particles released from the testing. Groundwater researchers use tritium to identify water that has entered the groundwater flow system since 1953, when weapons testing in the atmosphere was initiated (Freeze and Cherry, 1979). The tritium levels detected in the Geoprobe samples at the waste disposal area are well below the North Carolina DRP and EPA standard as shown on Table 6-1. This table presents the tritium analytical data both in picocuries/liter (pCi/L) and in microcuries/milliliter (µCi/ml) because pCi/L is used for the MDA while µCi/ml is used by the DRP as a standard (15A NCAC 11 .0117 [a][1], Appendix B, Table 2) for discharge to surface water. The EPA Interim Drinking Water Maximum Contaminant Limit (MCL) for tritium is 20,000 pCi/L and the North Carolina Standard is 0.001 µCi/ml.

None of the soil samples analyzed contained detectable levels of C-14. See Table 6-1.

6.2 GROUNDWATER AND SURFACE-WATER QUALITY RESULTS

6.2.1 Volatile Organic and Semi-Volatile Organic Constituents

Samples from the two previously-existing wells and the five newly-installed wells, as well as four surface-water samples were collected on July 25 and 26, 1996, to characterize site water quality. All of the samples were analyzed for VOCs, SVOCs, tritium and C-14. The groundwater and surface-water quality analytical results for VOCs and SVOCs are summarized in Tables 6-2 and 6-3, respectively. The analytical results for tritium and C-14 are summarized in Tables 6-4 and 6-5, respectively. Figure 6-1 illustrates on the site map the distribution of detected constituents.

Two VOCs, toluene and carbon disulfide, were detected in the groundwater at the site. Toluene was detected at a concentration of 390,000 ppb in monitor well MW-3, the previously existing well that is reportedly screened in a burial pit. (As discussed in Section 4.3, well MW-3 was installed in 1989 or 1990 and no construction details are available). The State of North Carolina 2L Groundwater Standard (2L standard) for toluene is 1000 ppb. Toluene was not detected in any of the other groundwater samples; however, it was detected at 1.9 ppb in surface-water sample SW-3 collected from the ditch immediately downgradient of the disposal area. Carbon disulfide was detected at concentrations well below the interim allowable concentration in wells GM-4 and GM-8. Based upon the data, toluene is the only Method 8260 VOC present at the site, and it has not migrated in the groundwater beyond the disposal pits area.

Two SVOCs, 1,4-dioxane (diethylene ether) and naphthalene, were detected in groundwater at concentrations exceeding the 2L standard. The 2L standards for 1,4-dioxane and napthalene are 7 ppb and 21 ppb, respectively. 1,4-Dioxane was detected in six of the eight wells sampled with concentrations ranging from an estimated concentration of 13 ppb in well GM-5 to 21,000 ppb in well MW-3. As shown on Figure 6-2, the lateral extent of 1,4-Dioxane is generally restricted to the disposal pits area with significantly reduced concentrations in wells outside the fenced waste disposal area. 1-4-Dioxane was not detected in deep monitor well GM-7 or in the

surface-water samples, suggesting the constituent is limited to the upper groundwater zone in the immediate vicinity of the disposal area. Naphthalene was detected at a concentration of 1,500 ppb in well MW-3 but was not detected in any other samples indicating that this constituent is limited to the waste disposal area and has not migrated outside the fenced area.

The surface-water samples collected from Morgan Creek, SW-1, and SW-2 contained bromodichloromethane, chloroform, and dibromochloromethane at relatively low concentrations (Table 6-3). There are no current North Carolina surface water standards. Concentrations of these constituents were greater in the upstream sample (SW-2) and therefore not considered indicative of site activities but is likely related to an upstream source.

6.2.2 Radionuclide Isotopes - Tritium and Carbon 14

Groundwater and surface-water samples were analyzed for tritium and C-14 isotopes, which are indicative of the low-level radioactive waste placed in the burial pits. Summaries of the results of the tritium and C-14 analyses are presented on Tables 6-4 and 6-5, respectively. The tables present the data both in picocuries/liter (pCi/L) and in microcuries/milliliter (µCi/ml) because pCi/L is used for the Federal MCL while µCi/ml is used by the DRP as a standard for discharge to surface water.

As shown on Tables 6-4 and 6-5, neither tritium nor C-14 was detected at concentrations exceeding the DRP standard for the respective isotope. Typically, the concentrations detected were a small percentage of the DRP standard. Tritium was detected in well MW-3 at a concentration above the MCL of 20,000 pCi/L in well MW-3; however, this was the only detect above that standard. The radionuclide analytical results indicate that these constituents are locally present within the waste disposal area groundwater at low concentrations but they have not migrated outside the fenced area.

6.3 GEOTECHNICAL ANALYTICAL RESULTS

As indicated in Section 4.6, soil samples were collected for geotechnical evaluation. These samples were analyzed for geotechnical parameters such as particle size distribution, Atterberg limits, permeability, moisture content, and shear strength. The test results were primarily used to evaluate the stability of the side slopes of a potential excavation pit. The analyses indicate that an excavation slope of 1 horizontal to 1 vertical will be feasible with a factor of safety of 1.2. Appendix G presents the geotechnical testing and the slope stability analysis results.

In addition, hydraulic conductivity values from the slug testing and laboratory vertical permeability testing were used to evaluate the potential inflow of water into the excavation (see Appendix G). The inflow of water is assumed to be highest along the Morgan Creek side face of the excavation. The majority of water is expected to inflow via the middle sand layer which lies approximately 8 to 10 feet below land surface. Based upon assumptions and calculations in Appendix G, approximately 3,500 gallons per day (gpd) of water is estimated to inflow from the creek-side face of the excavation. Additionally, water will seep into the excavation from other sides, but will be comparatively less. This water can be pumped into storage tanks from suitably located sumps along the southern side of the excavation area. Detailed estimation of dewatering needs will be discussed in the corrective action design phase.

7.0 PRINCIPAL FINDINGS AND CONCLUSIONS

The Mason Farm Low-Level Radioactive Waste Disposal Site served as a disposal site from 1963 to 1970. During its active life, operations were performed according to regulations in place at that time. The site was developed and used prior to the creation of Jordan Lake. At the time of it's use the water table was lower than at present. Since the lake was created in the early 1980s, the water table has risen at the site as a result of the lake's impoundment such that the burial pits are now below the water table. The site is fenced and has been monitored for radionuclides (tritium and C-14) since 1991. The results have been submitted to the DRP. Expanded analytical work performed by the University in early 1996 showed an elevated concentration of toluene in one well (MW-3) that is screened in a burial pit. The presence of this VOC prompted the initiation of this CSA to determine if a release has occurred from the site.

The principal findings and conclusions of the CSA are as follows:

- There are no municipal water-supply wells or residential wells within 1,500 feet of the site, and there are no surface-water intakes for public water supplies within 0.5 mile of the site. The closest known surface water supply intake is at University Lake, approximately 4 miles upgradient from the site. The waste disposal area is in the upper floodplain of Jordan Lake and both surface water and groundwater at the site flow toward the lake. Jordan Lake is the water supply for the Towns of Cary and Apex, however, the water supply intake for these towns is over 10 miles away and the disposal area would not affect this water supply.

- The site lies on a topographically flat floodplain and is underlain by a clayey-sandy silt to a depth of approximately 8 to 12 ft bls. This upper clayey-sandy silt typically coarsens downward to a depth of approximately 10 ft bls, where a relatively thin sand unit is present. This sand unit, which contains minor amounts of gravel and cobbles, is approximately 3 feet thick. Beneath the sand to a depth of at least 44 ft bls is a sandy, silty clay. Bedrock was not encountered at the site. The depth to water is typically less than 2 feet, and at times the site is flooded during periods of heavy rainfall.

- In-situ aquifer tests performed on the newly-installed wells indicated that the surficial clayey sandy silt unit (where the burial pits were dug) has an average K value of 3 x 10^{-5} cm/sec. The sandy unit that lies immediately below the base of the burial pits has an average K value of 2.5 x 10^{-3} cm/sec, and the lower silty clay zone has a K on the order of 4.7 x 10^{-7} cm/sec.

- Water-level elevation measurements indicate that groundwater in the surficial aquifer flows radially outward from the disposal area with a relatively low horizontal hydraulic gradient of 0.009 ft/ft. Overall groundwater and surface-water flow, however, is south eastward toward Jordan Lake. Using the calculated hydraulic conductivity of the sand unit and the measured hydraulic gradient, a horizontal flow velocity of approximately 116 ft/yr was calculated for the sand unit. Using K values for the upper silty clay unit and the lower silty clay unit average flow velocities of approximately 5 ft/yr and less than 1 ft/yr, respectively, were calculated.

- The soils adjacent to the fenced area have not been impacted above either State or Federal standards or State or Federal comparable remediation guidelines for chemicals in the soil. Only very low levels of tritium, below the State DRP standard and the Federal MCL, were detected in interstitial waters of the soil samples. No C-14 was detected in the soil samples and the only VOC or SVOC detected was diethyl phthalate. The phthalate was only detected in one sample at a concentration well below the State remediation guideline.

- Groundwater at the site has been impacted by waste disposal activities, but the extent of chemical constituents in the groundwater is limited to the upper portion of the water-table aquifer within and near the fenced disposal area. Toluene was detected in only one well, MW-3, which monitors burial pit water within the fenced disposal area. An earlier detect of toluene in this well prompted the CSA. A SVOC, 1,4-dioxane (diethylene ether), was detected in six of the eight wells sampled, with the highest concentration (21,000 ppb) in well MW-3. The lateral extent of 1,4-dioxane is

generally restricted to the disposal pits area with significantly reduced concentrations in wells outside the waste disposal area.

- Surface water has not been significantly impacted by activities at the site. Toluene was detected at a concentration of 1.9 ppb in sample SW-3, which was collected in a drainage ditch immediately downgradient of the disposal area. Other constituents detected in Morgan Creek may be attributed to an upstream source.

- Groundwater and surface-water samples were analyzed for tritium and C-14 radionuclides, which are indicative of the low-level radioactive waste placed in the burial pits. Neither tritium or C-14 was detected at concentrations exceeding the DRP standard for discharge to surface water. Tritium was detected above the 20,000 pCi/L EPA Interim Drinking Water Maximum Contaminant Limit in well MW-3, inside the waste disposal area but was not detected above the MCL in any other wells.

- Based upon the findings of this investigation it is recommended that an additional shallow well be installed west of existing well GM-4 plus an additional round of water quality samples and water level data will be collected. The additional well should better define the plume to the west of the waste disposal area. Results of the additional well installation and sampling will be included in the corrective action plan (CAP).

8.0 REFERENCES

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Table 6-2. Summary of Volatile Organic and Semi-Volatile Organic Constituents Detected in Groundwater Samples Collected at the UNC Mason Farm Low Level Radioactive Waste Disposal Site in Chapel Hill, North Carolina.

Constituents	NCAC 2L Groundwater Standard	Sample ID: Date Sampled:	MW-2 7/26/96	MW-3 7/25/96	GM-4 7/26/96	DUP-2* 7/26/96	GM-5 7/26/96	GM-6 7/26/96	GM-7 7/26/96	GM-8 7/26/96
Volatile Organics (USEPA Method 8260) ppb										
Carbon disulfide	700**		<1.0	<5,000	14J	4.0J	<1.0	<1.0	<1.0	3.7
Toluene	1,000		<1.0	390,000	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Semi-Volatile Organics (USEPA Method 8270A) ppb										
1,4-Dioxane (diethylene ether)	7		26	21,000	3,200	3,700	13J	<10	<10	37
Naphthalene	21		<10	1,500	<250	<250	<10	<10	<10	<10

ppb Micrograms per liter.
< Constituent was not detected above the reporting limit.
J Constituent concentration is qualified as estimated because the sample duplicate criteria were not met.
* Field replicate sample of groundwater sample GM-4.
NCAC 2L North Carolina Administrative Code, Title 15A, Chapter 2L, Groundwater Quality Standards, February 8, 1994.
[ ] Constituent concentration exceeds the 15A NCAC 2L Standard.
** Interim maximum allowable concentration effective May 16, 1995.
NOTE: Only detected constituents are reported on this table. Other VOC and SVOC constituents not detected are not listed.

Table 6-3. Summary of Volatile Organic and Semi-Volatile Organic Constituents Detected in Surface-Water Samples Collected at the UNC Mason Farm Low Level Radioactive Waste Disposal Site in Chapel Hill, North Carolina.

Constituents	Sample ID: Date Sampled:	SW-1 7/25/96	SW-2 7/25/96	SW-3 7/25/96	SW-4 7/25/96	DUP-1* 7/25/96
Volatile Organics (USEPA Method 8260) ppb						
Bromodichloromethane		1.9	2.1	<1.0	<1.0	<1.0
Chloroform		4.2	4.6	<1.0	<1.0	<1.0
Dibromochloromethane		<1.0	1.0	<1.0	<1.0	<1.0
Toluene		<1.0	<1.0	1.9	<1.0	<1.0

ppb Micrograms per liter.
< Constituent was not detected above the reporting limit.
* Field replicate sample of surface-water sample SW-4.
NOTE: No State of North Carolina surface water quality standards exist for the detected constituents.

Table 6-4. Summary of Tritium Radioisotope Analytical Data for Groundwater and Surface-Water Samples Collected from the UNC-CH Mason Farm Low Level Radioactive Waste Disposal Site on July 25, 1996.

Sample ID	MDA (pCi/L)	Result (pCi/L)	NC STD (µCi/ml)	Result (µCi/ml)
MW-2	2.88E+02	1.97E+02	1.0E-03	1.97E-07
MW-3	2.88E+02	2.62E+04	1.0E-03	2.62E-05
GM-4	2.88E+02	2.45E+03	1.0E-03	2.45E-06
DUP-2	2.88E+02	2.33E+03	1.0E-03	2.33E-06
GM-5	2.88E+02	1.31E+02	1.0E-03	1.31E-07
GM-6	2.88E+02	1.64E+01	1.0E-03	1.64E-08
GM-7	2.88E+02	-5.02E+01	1.0E-03	-5.02E-08
GM-8	2.88E+02	1.77E+02	1.0E-03	1.77E-07
SW-1	2.88E+02	1.46E+02	1.0E-03	1.46E-07
SW-2	2.88E+02	4.89E+02	1.0E-03	4.89E-07
SW-3	2.88E+02	1.25E+02	1.0E-03	1.25E-07
SW-4	2.88E+02	1.57E+02	1.0E-03	1.57E-07
DUP-1	2.88E+02	7.94E+01	1.0E-03	7.94E-08

pCi/L Picocuries per liter.
µCi/ml Microcuries per milliliter.
MDA Minimum detectable activity; the smallest amount of sample activity that yields a net count of the isotope being sampled within the accuracy of the analytical method.
NC STD North Carolina Division of Radiation Protection (DRP), 15A NCAC 11 .0117 (a)(1) Appendix B, Table 2.
Constituent concentration greater than the EPA Interim Drinking Water maximum contaminant level (>MCL) of 20,000 pCi/L.
All data were validated as quantitative.
NOTE: Results are presented in pCi/L and µCi/ml for ease of comparison because the Federal MCL is in pCi/L and the North Carolina Standard is in µCi/ml. The conversion of pCi/L to µCi/ml is: pCi/L (E -09) = µCi/ml.

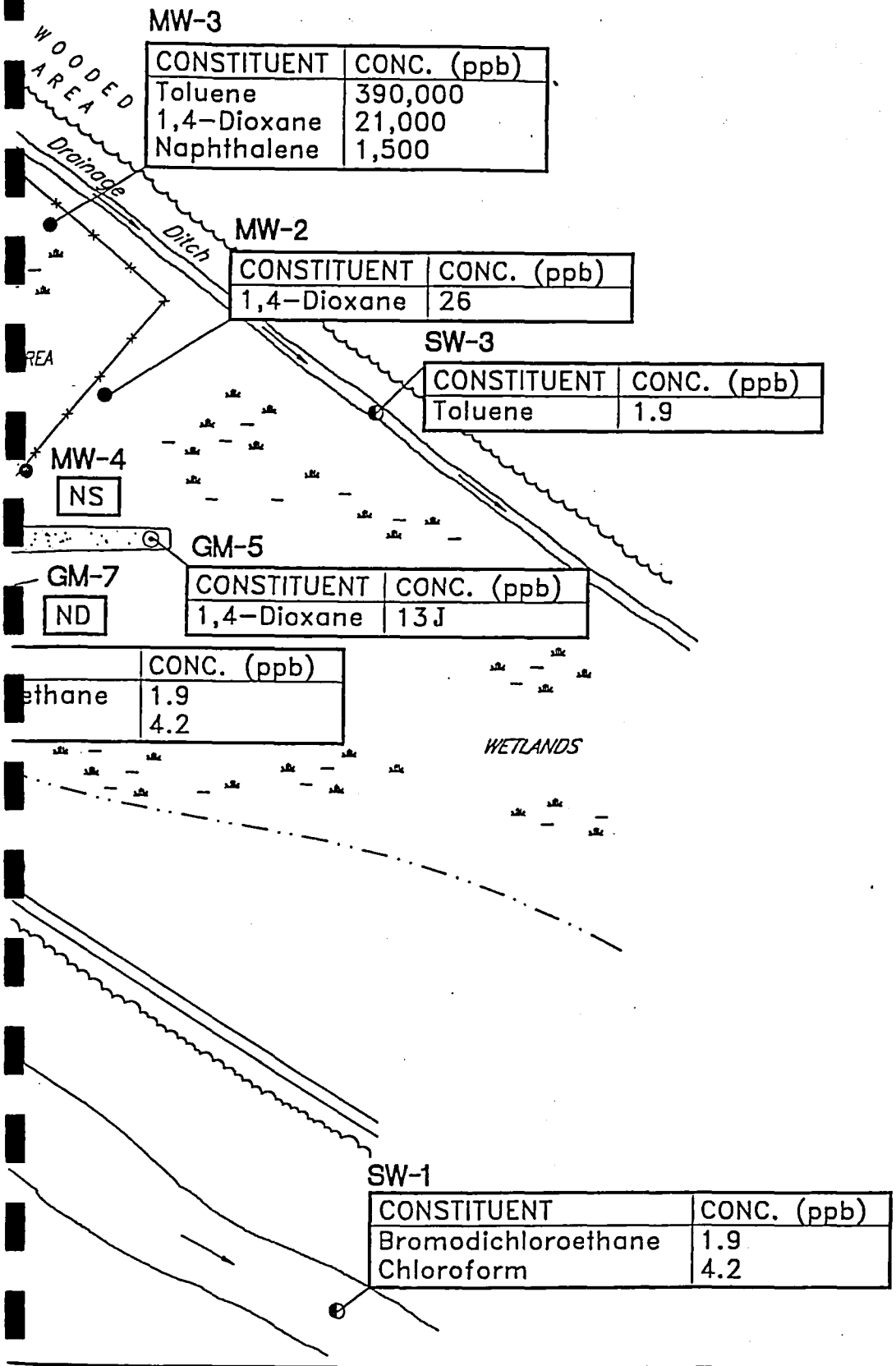
Table 6-5. Summary of C-14 Radioisotope Analytical Data for Groundwater and Surface-Water Samples Collected from the UNC-CH Mason Farm Low Level Radioactive Waste Disposal Site on July 25, 1996.

Sample ID	MDA (pCi/L)	Result (pCi/L)	NC STD (µCi/ml)	Result (µCi/ml)
MW-2	3.55E+00	2.39E+00	3.0E-05	2.39E-09
MW-3	3.55E+00	5.21E+02	3.0E-05	5.21E-07
GM-4	3.55E+00	7.12E+01	3.0E-05	7.12E-08
DUP-2	3.55E+00	7.17E+01	3.0E-05	7.17E-08
GM-5	3.55E+00	2.93E+00	3.0E-05	2.93E-09
GM-6	3.55E+00	6.76E-01	3.0E-05	6.76E-10
GM-7	3.55E+00	-2.48E-01	3.0E-05	-2.48E-10
GM-8	3.55E+00	1.78E+00	3.0E-05	1.78E-09
SW-1	3.55E+00	2.25E-01	3.0E-05	2.25E-10
SW-2	3.55E+00	1.71E+00	3.0E-05	1.71E-09
SW-3	3.55E+00	2.57E+00	3.0E-05	2.57E-09
SW-4	3.55E+00	1.73E+00	3.0E-05	1.73E-09
DUP-1	3.55E+00	1.46E+00	3.0E-05	1.46E-09

C-14 Carbon-14.
pCi/L *Picocuries per liter.*
µCi/ml Microcuries per milliliter.
MDA Minimum detectable activity; the smallest amount of sample activity that yields a net count of the isotope being sampled within the accuracy of the analytical method.
NC STD North Carolina Division of Radiation Protection (DRP), 15A NCAC 11 .0117 (a)(1) Appendix B, Table 2.
All data were validated as quantitative.
NOTE: Results are presented in pCi/L and µCi/ml for ease of comparison because the Federal MCL is in pCi/L and the North Carolina Standard is in µCi/ml. The conversion of pCi/L to µCi/ml is: pCi/L (E -09) = µCi/ml.

Excess Meals

No excess reimbursement will be allowed for meals unless such costs are included in



GERAGHTY & MILLER, INC.
Environmental Services

GROUNDWATER AND SURFACE WATER CONSTITUENT CONCENTRATIONS

THE UNIVERSITY OF NORTH CAROLINA AT CHAPEL HILL
MASON FARM LOW LEVEL RADIOACTIVE WASTE DISPOSAL SITE
CHAPEL HILL, NORTH CAROLINA

FIGURE
6-1

Transportation	P	10.36	0.00			

Daily total for subsistence not to exceed authorized amount for in-state or out-of-state travel.

Maximum Subsistence:

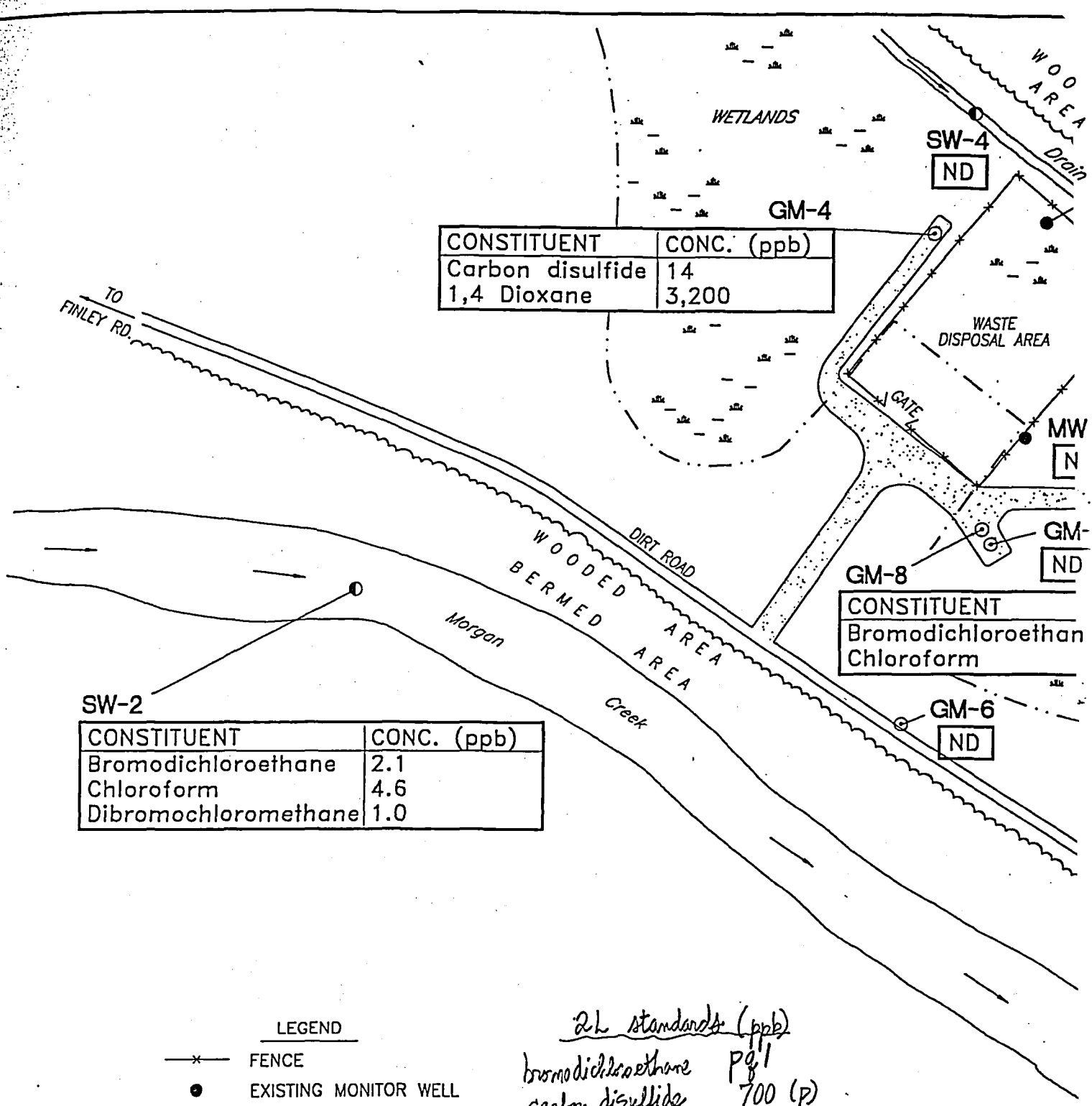
In-State	$81.00
Out-of-State	$93.00

LEGEND:

(1) Mode of Travel
R - Rental Car
A - Airfare
P - Private Car

(2) Type of Subsistence:
B - Breakfast L - Lunch
D - Dinner H - Hotel

(3) Other Travel Expenses:
ONLY Taxi, parking, baggage, telephone, or registration



LEGEND

—×—	FENCE
●	EXISTING MONITOR WELL
⊙	NEW MONITOR WELL
◐	SURFACE WATER SAMPLE
ppb	PARTS PER BILLION
ND	NOT DETECTED
J	ESTIMATED VALUE
NS	NOT SAMPLED (DRY)

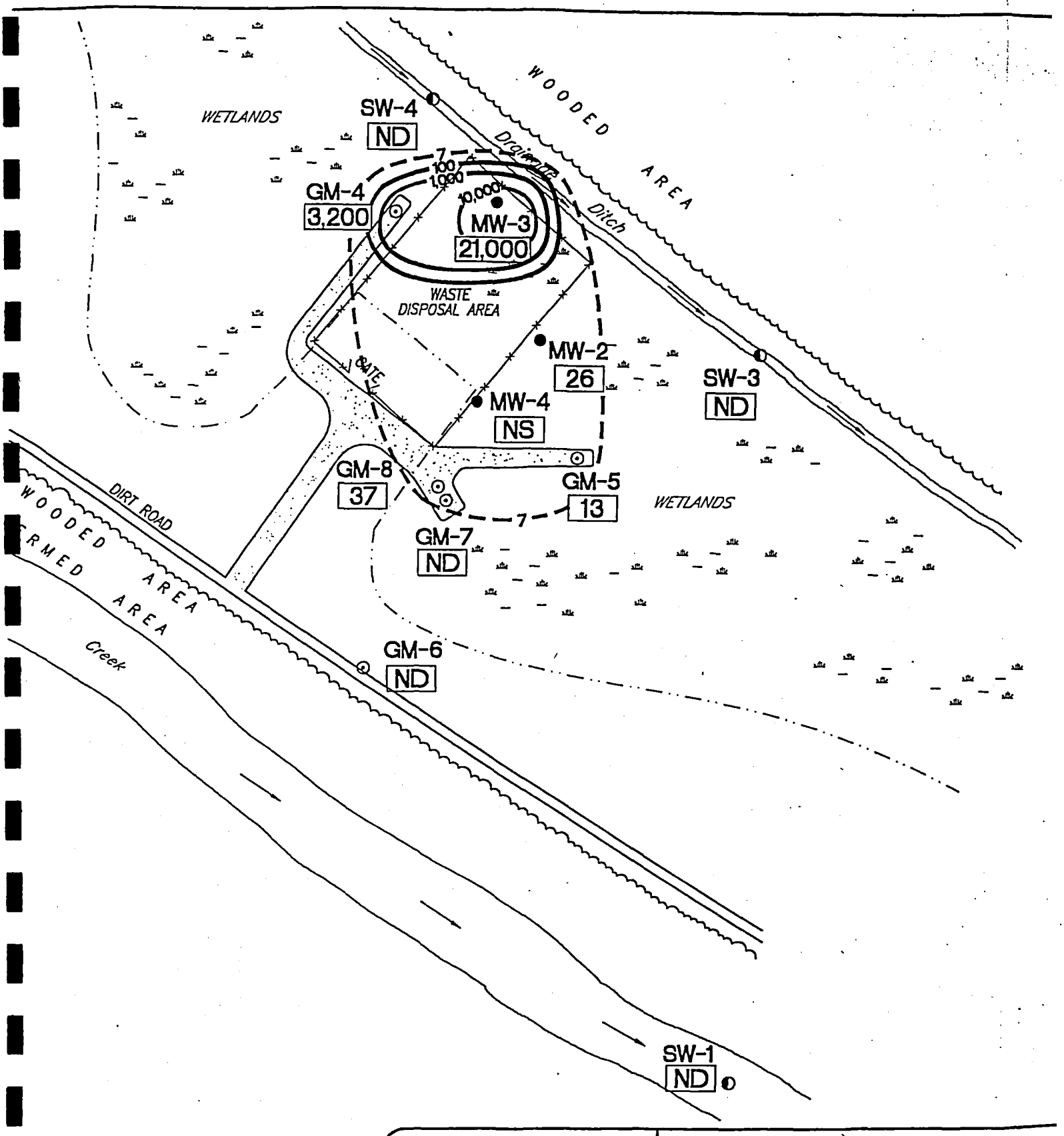
SCALE IN FEET
0 80 160

2L standards (ppb)

bromodichloroethane	pq/l
carbon disulfide	700 (p)
chloroform	0.19
dibromochloromethane	pq/l
1,4-dioxane (p-dioxane)	7.0
naphthalene	21
toluene	1,000

(p) = proposed 1/96

GERA
& MILL
Environmen



GERAGHTY & MILLER, INC.
Environmental Services

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THE UNIVERSITY OF NORTH CAROLI
MASON FARM LOW LEVEL RADIOACTIVE
CHAPEL HILL, NORTH C

Reference 2

Ref. 2

ARCADIS GERAGHTY & MILLER

ARCADIS Geraghty & Miller of
North Carolina, Inc.
2301 Rexwoods Drive
Suite 102
Raleigh
North Carolina 27607-3366
Tel 919 782 5511
Fax 919 782 5905

ENVIRONMENTAL

APR 04 2001

Mr. Larry Daw, L.G.
The University of North Carolina at Chapel Hill
Health and Safety Office
212 Finley Golf Course Road
Chapel Hill, NC 27514

RECEIVED
APR 6 2001
DENR RALEIGH REGIONAL OFFICE

Subject:
December 2000 Groundwater/Surface Water Sampling Report
Mason Farm Low-Level Radioactive Waste Disposal Site
Chapel Hill, North Carolina

Raleigh, NC,
3 April 2001

Contact:
Donald R. Malone, P.E.

Extension:
270

Dear Mr. Daw:

ARCADIS Geraghty & Miller is pleased to provide this letter report on the findings from the December 2000 groundwater and surface water sampling event at the University of North Carolina at Chapel Hill (UNC-CH), Mason Farm Low-Level Radioactive Waste (LLRW) Disposal Site (Figure 1). This sampling event was conducted to provide continued monitoring of the site while the phased corrective actions are being implemented. UNC-CH recently received a Notice of Violation (NOV) from the NCDENR, dated February 15, 2001 that required the university to prepare and implement a Corrective Action Plan (CAP) for impacted groundwater at the site. However, prior to CAP development, UNC-CH will need to install additional monitoring wells at the site to fully delineate the horizontal and vertical extent of groundwater constituents. The additional site assessment activities are planned for May 2001. The data contained herein from the December 2000 sampling event will be used to supplement the data collected in April 2001 so that the site constituents will be completely delineated.

Field Activities and Sample Analysis

Groundwater samples were collected from the nine monitor wells at the site using disposable polyethylene bailers. In addition, surface water samples were collected from upgradient and downgradient locations in both Morgan Creek and the adjacent drainage ditch on the north side of the disposal area. Surface water samples were collected at the locations of existing staff gauges where samples had previously been collected. The water levels at all groundwater and surface water sample locations were measured prior to sample collection. The staff gauges located in Morgan Creek were missing or completely submerged at the time of sample collection, and therefore, water level at these locations could not be measured.

All samples were submitted to Severn Trent Laboratories for analysis by United States Environmental Protection Agency (USEPA) Method 8260 for volatile organic compounds (VOCs), including di-isopropyl ether; USEPA Method 8270 for semi-volatile organic compounds (SVOCs), including 1,4-dioxane; USEPA Method C01 (Carbon-14); and USEPA Method 906 (Tritium). Quality control samples included two blind duplicate samples, one field blank, one trip blank (USEPA Method 8260 only), and two equipment rinse blanks.

Purge water from previous sampling events was classified as non-hazardous, and therefore, the purge water generated during this sampling event also was considered to be non-hazardous. However, the purge water generated during the sampling activities were containerized within the fractionalization tank being used on site during the phased corrective actions ongoing during November and December 2000. At the time of use, the fractionization tank already contained groundwater from the dewatering activities. Upon completion of the phased corrective actions, the liquid contained in the fractionization tank was transferred to 55-gallon steel drums and temporarily stored on site. As of 22 March 2001, the drums still remain on site while UNC-CH obtains final approval from the Orange County Water and Sewer Authority (OWASA) for discharge to the sewer system.

Groundwater Flow Direction

Water level measurements collected on December 5, 2000 are tabulated with data from previous measurements to show historic trends (Table 1). The data from December 2000 was used to construct the potentiometric surface map shown on Figure 2. A comparison of the December 2000 data to previously obtained data indicates that the water table continues to be relatively flat. The primary flow direction for the surficial aquifer appears to be northeast toward the drainage ditch (Figure 2).

Analytical Results

Volatile and Semi-Volatile Organic Compounds

The groundwater and surface water quality analytical results for VOCs and SVOCs are summarized on Table 2 and Table 3. These tables display only detected constituents. ARCADIS Geraghty & Miller will provide copies of the laboratory analytical reports upon request. Table 2 compares the constituents detected in groundwater with the established North Carolina Administrative Code (NCAC) 2L groundwater quality standards. Historical data trends are shown in Table 4. Constituents detected in both groundwater and surface water samples are also summarized on a site map included as Figure 3.

In general, the analytical results from December 2000 are consistent with historical trends. The extent of impacted water appears to remain within close proximity to the

fenced area. Site constituents continue to remain undetected in upgradient well GM-9 and downgradient well GM-6 (Table 4). Overall, the number of constituents detected in the samples decreased from the March 1998 sampling event. Concentrations of 1,4-dioxane in monitor well MW-2 slightly increased from 23 µg/L in March 1998 to 37 µg/L in December 2000. Concentrations of 1,4-dioxane in GM-4 also increased from 1,500 µg/L to 3,800 µg/L between March 1998 and December 2000. The results of future monitoring events will be used to evaluate whether or not these changes represents a trend.

Chloroform, bromodichloromethane, and bis(2-Ethyhexyl)phthalate were detected in low concentrations in the samples obtained from surface water monitoring points SW-1 and SW-2, presumably from upgradient sources not related to the Mason Farm LLRW Disposal site. In addition, methylene chloride was detected in the sample from SW-2 (Table 3). Since Morgan Creek is upgradient of the site, it is unlikely that this contamination is related to the waste burial area.

Radionuclide Isotopes – Tritium and Carbon-14

The groundwater and surface water samples were analyzed for tritium and carbon-14 (C-14) isotopes, which are indicative of the low-level radioactive waste placed in burial pits at the site. Summaries of the tritium and C-14 analytical results are presented on Table 5 and Table 6, respectively. The tables present the data in picocuries per liter (pCi/L). The analytical data has been compared to the Federal Maximum Contaminant Levels (MCLs) and the North Carolina Division of Radiation Protection standards (NC STD) for discharges to surface water. The NC STD have been converted to pCi/L, normally it is expressed in microcuries per milliliter (µCi/mL).

None of the samples collected from the monitor wells contained tritium in excess of the MCL or NC STD (Table 5). A MCL does not exist for C-14, and therefore, the MCL was assumed to be the minimum detectable activity (MDA) for each sample run. As shown in Table 6, C-14 was only detected in one well (MW-3) above the MDA (i.e., surrogate MCL). However, none of the C-14 concentrations in any of the samples exceeded the NC STD. Based on the surface water samples and outlying groundwater wells, it does not appear that either tritium or C-14 is migrating outside the fenced border of the former waste disposal area.

Conclusions

The results of the December 2000 groundwater and surface water sampling event indicate that the environmental conditions at the Mason Farm site have remained relatively constant since the last full monitoring event conducted in March 1998. Groundwater elevations and flow direction are similar to previous measurements. The nature and extent of the impacted groundwater has not changed significantly

since the March 1998 monitoring event. The concentrations of most constituents detected in March 1998 decreased or remained about the same in December 2000 with the exception of 1,4-dioxane which increased in wells MW-2 and GM-4. Neither tritium nor C-14 was detected above NC STD standards. Tritium in well MW-3 has declined since the March 1998 event when it was detected above the MCL. However, C-14 has been detected in MW-3 at concentrations exceeding the MCL during this monitoring event. Low concentrations of three VOCs and one SVOC were detected in surface water samples collected at locations SW-1 and SW-2; however, their presence does not appear to be attributed to the Mason Farm site. The area of impacted groundwater appears to remain relatively small, with the highest concentrations remaining within the fenced area of the former disposal area.

In April 2001, ARCADIS Geraghty & Miller will conduct additional site assessment activities as requested by UNC-CH to fully delineate the horizontal and vertical extent of groundwater constituents at the site. The data contained herein from the December 2000 sampling event will be used to supplement the data to be collected in April 2001 so that the site constituents will be completely delineated.

ARCADIS Geraghty & Miller appreciates the opportunity to provide this letter report to UNC-CH. If you have any questions regarding this sampling event or this report, please contact either of the undersigned.

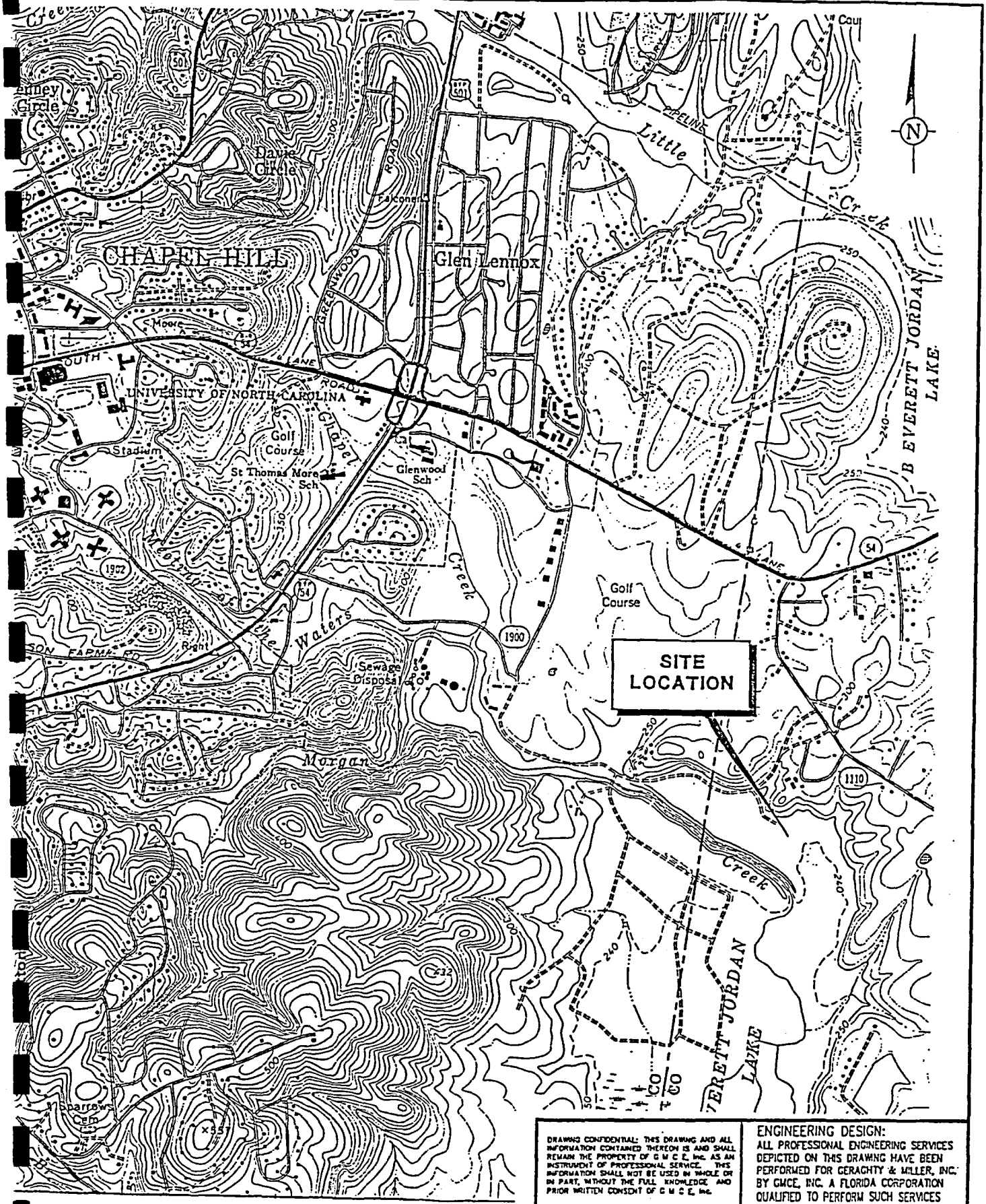
Sincerely,

ARCADIS Geraghty & Miller, Inc.

Jeff Hall, E.I.
Staff Engineer

Donald R. Malone, P.E.
Senior Engineer/Project Manager

NORTH CAROLINA PROFESSIONAL SEAL 20195 ENGINEER DONALD R. MALONE



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THE UNIVERSITY OF NORTH CAROLINA AT CHAPEL HILL

MASON FARM LOW-LEVEL RADIOACTIVE WASTE DISPOSAL SITE

SITE LOCATION AND TOPOGRAPHY

DRAWN	DATE	PROJECT MANAGER	PROJECT OFFICER
B. HERRMAN	10/21/98	L. MORETZ	S. KEITH
		LEAD DESIGN PROF. N. SHETTY	CHECKED D. MALONE
		PROJECT NUMBER NC000372.0004	FIGURE NUMBER 1

ARCADIS GERAGHTY&MILLER

Table 1. Historical Groundwater and Surface Water Elevations Measured at the Mason Farm Low-Level Radioactive Waste Disposal Site, The University of North Carolina at Chapel Hill, North Carolina.

Monitor Well ID	Measuring Point Elevation (ft msl)		August 27, 1996		December 3, 1996		March 3, 1998		December 5, 2000	
			Depth to Water (ft)	Water Level Elevation (ft msl)	Depth to Water (ft)	Water Level Elevation (ft msl)	Depth to Water (ft)	Water Level Elevation (ft msl)	Depth to Water (ft)	Water Level Elevation (ft msl)
MW-2	244.779		2.89	241.89	2.59	242.19	3.81	240.97	2.99	241.79
MW-3	246.832		4.41	242.42	4.38	242.45	4.42	242.41	4.74	242.09
MW-4	246.364		Dry	Dry	3.79	242.57	3.9	242.46	4.16	242.20
GM-4	244.628		2.64	241.99	2.08	242.55	2.19	242.44	2.59	242.04
GM-5	245.536		3.51	242.03	3.04	242.50	3.14	242.40	3.51	242.03
GM-6	246.153		3.97	242.18	3.28	242.87	3.59	242.56	3.93	242.22
GM-7	245.653		4.17	241.48	2.69	242.96	2.17	243.48	2.78	242.87
GM-8	245.394		3.28	242.11	2.75	242.64	2.85	242.54	3.17	242.22
GM-9	245.372	*	NM	NM	2.65	242.72	2.81	242.56	3.21	242.16
SW-1	244.682	**	1.80	242.18	XX	XX	XX	XX	XX	XX
SW-2	243.450		1.96	241.49	2.73	240.72	2.275	241.18	XX	XX
SW-3	244.123	*	NM	NM	NM	NM	XX	XX	1.42	242.70
SW-4	244.780	*	NM	NM	NM	NM	NM	NM	0.66	244.12

ft msl	Feet above mean sea level.
Dry	Not available - well was dry.
NM	Water level not measured.
XX	Staff gauge destroyed/missing.
*	Elevation established January 14, 1997.
**	Resurveyed on January 14, 1997 following staff gauge replacement. Original elevation = 243.982 ft msl.

ARCADIS GERAGHTY&MILLER

Table 2. Summary of Analytical Results for Groundwater Samples, December 5 - 7, 2000, Mason Farm Low-Level Radioactive Waste Disposal Site, The University of North Carolina at Chapel Hill, North Carolina.

Constituents	NCAC 2L Groundwater Standard	Sample ID: Date Sampled:	MW-2 12/7/2000	MW-3 12/6/2000	MW-4 12/7/2000	GM-4 12/5/2000	GM-5 12/6/2000	GM-6 12/6/2000	GM-7 12/7/2000	GM-8 12/6/2000	GM-9 12/6/2000	DUP-2[5] 12/6/2000	EB-1 12/6/2000	FB-1 12/6/2000	Trip Blank 12/5/2000
Volatile Organics (USEPA Method 8260B) µg/L															
Toluene	1000		<1.0[1]	270,000	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Semi-Volatile Organics (USEPA Method 8270C) µg/L															
1,4-Dioxane	7		37	22,000 J[3]	93	3,800 J	17	<10	<10	6.4 J	<10	<10	<10	<10	NT[6]
bis(2-Ethylhexyl)phthalate	3		<10	<10,000 J	18	<1,000 J	<10	<10	6.1 J[4]	<10	<10	3.1 J	<10	<10	NT

NCAC 2L North Carolina Administrative Code Subchapter 2L Classifications and Water Quality Standards Applicable to Groundwaters in North Carolina

µg/L Micrograms per Liter

1 <1.0 - Constituent was not identified above the method detection limit.

2 [ ] Constituent concentration exceeds the 15A NCAC 2L Groundwater Standard.

3 Contituent concentration was quantified using a secondary dilution.

4 Constituent concentration is estimated.

5 Blind field duplicate of groundwater sample from GM-6.

6 NT - Not tested.

ARCADIS GERAGHTY&MILLER

Table 3. Summary of Analytical Results for Surface Water Samples, December 5, 2000, Mason Farm Low-Level Radioactive Waste Disposal Site,The University of North Carolina at Chapel Hill, North Carolina.

Sample ID:	SW-1	SW-2	SW-3	SW-4	DUP-1[3]	EB-2	FB-1	Trip Blank
Date Sampled:	12/5/2000	12/5/2000	12/5/2000	12/5/2000	12/5/2000	12/7/2000	12/6/2000	12/5/2000
Constituents								
Volatile Organics (USEPA Method 8260B) µg/L								
Methylene Chloride	<2.0[1]	0.86 J	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Chloroform	2.5	2.6	<1.0	<1.0	2.5	<1.0	<1.0	<1.0
Bromodichloromethane	0.88 J[2]	0.89 J	<1.0	<1.0	0.78 J	<1.0	<1.0	<1.0
Semi-Volatile Organics (USEPA Method 8270C) µg/L								
bis(2-Ethylhexyl)phthalate	4.0 J	5.1 J	<10	<10	4.3 J	<10	<10	NT[4]

µg/L Micrograms per Liter

1 Constituent was not detected.

2 Constituent concentration is estimated.

3 Blind field duplicate of surface water sample from SW-2.

4 Not tested.

ARCADIS GERAGHTY&MILLER

Table 4. Summary of Historical Analytical Results for Groundwater Samples, Mason Farm Low-Level Radioactive Waste Disposal Site, The University of North Carolina at Chapel Hill, North Carolina.

Constituents	Groundwater Standard[1]	Sample ID: Date Sampled (mm/dd/yr)	MW-2	MW-3	MW-4	GM-4	GM-5	GM-6	GM-7	GM-8	GM-9
Volatile Organics (USEPA Method 8260B) µg/L											
Toluene	1,000	July-96	<1.0	390,000	NS	<1.0	<1.0	<1.0	<1.0	<1.0	NS
	1,000	March-98	<1.0	330,000	<1.0	0.27 J	<1.0	<1.0	<1.0	<1.0	<1.0
	1,000	December-00	<1.0	270,000	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Benzene	1	July-96	<1.0	<20,000	NS	<1.0	<1.0	<1.0	<1.0	<1.0	NS
	1	March-98	<1.0	<20,000	<1.0	<1.0	<1.0	<1.0	1.9	<1.0	<1.0
	1	December-00	<1.0	<20,000	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Carbon Disulfide	700	July-96	<1.0	<5,000	NS	14 J	<1.0	<1.0	<1.0	3.7	NS
	700	March-98	<1.0	<20,000	<1.0	<1.0	<1.0	<1.0	4.3	<1.0	<1.0
	700	December-00	<1.0	<20,000	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
Semi-Volatile Organics (USEPA Method 8270C) µg/L											
1,4-Dioxane	7	July-96	26	21,000	NS	3,200	13 J	<10	<10	<10	NS
	7	March-98	23	37,000 DJ	80	1,500 J	26	<10	120	110	<10
	7	December-00	37	22,000 J	93	3,800 J	17	<10	<10	6.4 J	<10
bis(2-Ethylhexyl)phthalate	3	July-96	<10	<10	NS	<10	<10	<10	<10	<10	NS
	3	March-98	<10	22	<10	<500 J	<10	<10	<10	<10	<10
	3	December-00	<10	<10,000 J	18	<1,000 J	<10	<10	6.1 J[4]	<10	<10
Diethyl phthalate	5,000	July-96	<10	<10	NS	<10	<10	<10	<10	<10	NS
	5,000	March-98	<10	24	<10	<500 J	<10	<10	<10	<10	<10
	5,000	December-00	<10	<10	<10	<10	<10	<10	<10	<10	<10
Naphthalene	21	July-96	<10	1,500	NS	<250	<250	<10	<10	<10	NS
	21	March-98	<10	<10	<10	<10	<10	<10	<10	<10	<10
	21	December-00	<10	<10	<10	<10	<10	<10	<10	<10	<10
Radioisotopes (pCi/L)											
Tritium (H-3)	20,000	July-96	197	26,200	NS	2,450	131	16.4	-50.2	177	NS
	20,000	March-98	242 +/- 220	40,200 +/- 3,100	90 +/- 210	1,600 +/- 310	56.3 +/- 200	30.2 +/- 200	7.7 +/- 200	121 +/- 210	24.1 +/- 200
	20,000	December-00	28 +/- 207	18,200 +/- 1,150	49.6 +/- 209	1840 +/- 344	-130 +/- 193	75.4 +/- 209	399 +/- 241	326 +/- 232	-78.8 +/- 199
Carbon-14 (C-14)	No Standard	July-96	2.39	521	NS	71.2	2.93	0.676	-0.248	1.78	NS
	No Standard	March-98	-2.27 +/- 5.3	460 +/- 25	-3.02 +/- 5.3	69.8 +/- 8.0	-3.63 +/- 5.3	-6.37 +/- 5.2	-5.11 +/- 5.2	-1.19 +/- 5.4	-4.05 +/- 5.3
	No Standard	December-00	18.2 +/- 23.6	570 +/- 48.2	22 +/- 23.8	103 +/- 26.7	38.3 +/- 24.6	30 +/- 23	13.1 +/- 23.3	13.4 +/- 22.1	13 +/- 23.3

1 Groundwater Standard for Organic Constituents are the North Carolina Administrative Code (NCAC) Subchapter 2L
Groundwater Standard for Radioisotopes are the EPA Maximum Contaminant levels (MCL)

µg/L Micrograms per Liter

pCi/L Picocuries per Liter

Constituent concentration exceeds the 15A NCAC 2L Groundwater Standard.

Table 5. Summary of Tritium Analytical data from Groundwater and Surface Water Samples, December 5 - 7, 2000, Mason Farm Low-Level Radoactive Waste Disposal Site, The University of North Carolina at Chapel Hill, NC.

Sample ID	Result (pCi/L)	Total Error	MDA (pCi/L)	Validation Comments	MCL (pCi/L)	NC STD (pCi/L)
GM-4	1840	344	340		20,000	1.0E+07
GM-5	-130	193	339	ND	20,000	1.0E+07
GM-6	75.4	209	341	ND	20,000	1.0E+07
GM-7	399	241	338	J	20,000	1.0E+07
GM-8	326	232	339	ND[3]	20,000	1.0E+07
GM-9	-78.8	199	342	ND	20,000	1.0E+07
MW-2	28.0	207	337	ND	20,000	1.0E+07
MW-3	18,200	1,150	340		20,000	1.0E+07
MW-4	49.6	209	340	ND	20,000	1.0E+07
SW-1	466	246	347	J	20,000	1.0E+07
SW-2	-5.02	202	346	ND	20,000	1.0E+07
SW-3	-39.0	197	339	ND	20,000	1.0E+07
SW-4	98.6	212	344	ND	20,000	1.0E+07
DUP-1[2]	141	215	341	ND[3]	20,000	1.0E+07
DUP-2[1]	-110	195	339	ND	20,000	1.0E+07

pCi/L	Picocuries per liter.
Total error	The total propagated uncertainty of the sample result; includes the counting error, sample handling, preparation, and analysis. The sample result + or - the total error gives sample activity (range) with 95 percent confidence level.
MDA	Minimum detectable activity; the smallest amount of sample activity that yields a net count for which there is confidence at a predetermined level that activity is present.
1	Blind field duplicate of groundwater sample from GM-6.
2	Blind field duplicate of surface water sample from SW-2.
ND	Non detect. Result plus total uncertainty is less than the MDA.
ND[3]	Non detect. Result is qualified as not detected due to potential bias demonstrated by associated blank activity.
J	Estimated. Result is estimated due to as associated quality control parameter that is not within specified control limits.
MCL	USEPA Interim Drinking Water Maximum Contaminant Level.
NC STD	North Carolina Division of Radiation Protection, 59 NCAC 11.0114(a)(1) Appendix B, Table 2.
[ ]	Result exceeds the MCL or NC STD for tritium.

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Table 6. Summary of Carbon-14 Analytical data from Groundwater and Surface Water Samples, December 5 - 7, 2000, Mason Farm Low-Level Radoactive Waste Disposal Site, The University of North Carolina at Chapel Hill, NC.

Sample ID	Result (pCi/L)	Total Error	MDA (pCi/L)	Validation Comments	MCL (pCi/L)	NC STD (pCi/L)
GM-4	103	26.7	33.1	ND[3]	33.1	3.0E+05
GM-5	38.3	24.6	34.8	ND[3]	34.8	3.0E+05
GM-6	30	23	33.1	ND[3]	33.1	3.0E+05
GM-7	13.1	23.3	34.8	ND[3]	34.8	3.0E+05
GM-8	13.4	22.1	33.1	ND[3]	33.1	3.0E+05
GM-9	13	23.3	34.8	ND[3]	34.8	3.0E+05
MW-2	18.2	23.6	34.8	ND[3]	34.8	3.0E+05
MW-3	570	48	33.2	J	33.2	3.0E+05
MW-4	22	23.8	34.8	ND[3]	34.8	3.0E+05
SW-1	33.3	23.2	33.2	ND[3]	33.2	3.0E+05
SW-2	34.8	23.2	33.1	ND[3]	33.1	3.0E+05
SW-3	33.1	23.1	33.1	ND[3]	33.1	3.0E+05
SW-4	35.1	23.3	33.2	ND[3]	33.2	3.0E+05
DUP-1[2]	36.7	23.4	33.2	ND[3]	33.2	3.0E+05
DUP-2[1]	17.7	23.5	34.8	ND[3]	34.8	3.0E+05

pCi/L	Picocuries per liter.
Total error	The total propagated uncertainty of the sample result; includes the counting error, sample handling, preparation, and analysis. The sample result + or - the total error gives sample activity (range) with 95 percent confidence level.
MDA	Minimum detectable activity; the smallest amount of sample activity that yields a net count for which there is confidence at a predetermined level that activity is present.
1	Blind field duplicate of groundwater sample from GM-6.
2	Blind field duplicate of surface water sample from SW-2.
ND	Non detect. Result plus total uncertainty is less than the MDA.
ND[3]	Non detect. Result is qualified as not detected due to potential bias demonstrated by associated blank activity.
J	Estimated. Result is estimated due to as associated quality control parameter that is not within specified control limits.
MCL	USEPA Interim Drinking Water Maximum Contaminant Level. An MCL does not exist for C-14, so data was compared to the MDA.
NC STD	North Carolina Division of Radiation Protection, 59 NCAC 11.0114(a)(1) Appendix B, Table 2.
[box]	Result exceeds the MCL or NC STD for Carbon-14.