U.S. Army Corps
of Engineers

FINAL PHASE II REMEDIAL INVESTIGATION REPORT

for the

FORMER CHARLOTTE ARMY MISSILE PLANT
MECKLENBURG COUNTY, CHARLOTTE, NORTH CAROLINA
DERP-FUDS PROJECT NO. I04NC048501

Performed under:

Contract No. DACA01-96-D-0020
Delivery Order No. CV04

OCTOBER 2000

Submitted to:

U.S. Army Corps of Engineers
Savannah District
Savannah, Georgia

Prepared by:

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The following Final Phase II Remedial Investigation Report is predecisional. A Revised-Final Phase II RI Remedial Investigation Report will be generated. Therefore, this Report is not subject to release under the Freedom of Information Act (FOIA). Requests for the document must be referred to Commander, U.S. Army Corps of Engineers, Savannah District, CESAS-PM-H (John E. Keiser), 100 W. Oglethorpe Avenue, Savannah, GA 31402-3640.

This Final Phase II Remedial Investigation Report was prepared in accordance with the Statement of Work (SOW) prepared by the United States Army Corps of Engineers for the Phase II Remedial Investigation, located in Charlotte, North Carolina. This document was prepared under the supervision of David Wilderman, P.G., Project Manager.

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FORMER CHARLOTTE ARMY MISSILE PLANT

MECKLENBURG COUNTY, CHARLOTTE, NORTH CAROLINA

DERP-FUDS PROJECT NO. I04NC048501

DRAFT PHASE II REMEDIAL INVESTIGATION REPORT

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LIST OF ACRONYMS

ARAR	Applicable or Relevant and Appropriate Requirements
ASTM	American Society of Testing and Materials
AWQC	Ambient Water Quality Criteria
bls	Below land surface
BRA	Baseline Risk Assessment
BTEX	Benzene, Toluene, Ethylbenzene and Xylene
BZ	Bedrock Zone
CAMP	Charlotte Army Missile Plant
CBC	Criterion Background Concentration
CDI	Chronic Daily Intake
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
COC	Contaminant of Concern
COPC	Chemical of Potential Concern
CW	Chemical Concentration in Water
DCE	Dichloroethene
DERP	Defense Environmental Restoration Program
DIOF	Deionized organic-free
DNAPL	Dense Non-Aqueous Phase Liquid
DO	Delivery Order
DOD	Department of Defense
DQSR	Data Quality Summary Report
ED	Exposure Duration
EF	Exposure Frequency
F	Fahrenheit
FUDS	Formerly Utilized Defense Site
GC	Gas chromatograph
gpm	gallons per minute
GPR	Ground Penetrating Radar
HEAST	Health Effects Assessment Summary Table
HI	Hazard Index
HPF	Heat Pulse flowmeter
HQ	Hazard Quotient
HSA	Hollow Stem Auger
IDW	Investigation-Derived Waste
IR	Ingestion Rate
IRIS	Integrated Risk Information Systems
LT	Lifetime
LQL	Laboratory Quantitation Limit
MCL	Maximum Contaminant Level
M&E	Metcalf & Eddy, Inc.
mg/L	Milligrams per liter
MS/MSD	Matrix spike/matrix spike duplicate
MTBE	Methyl Tert-Butyl Ether

LIST OF ACRONYMS (continued)

MW	Monitoring Well
NC	North Carolina
NCAC	North Carolina Administrative Code
NCEA	Natural Center for Environmental Assessment
NCDENR	North Carolina Department of Environment and Natural Resources
PAR	Pathway Analysis Report
PCE	Tetrachloroethylene (Perchloroethylene)
ppb	Parts per billion
QA	Quality Assurance
QC	Quality Control
QRA	Quantitative Risk Assessment
RA	Risk Assessment
RAGS	Risk Assessment Guidance for Superfund
RBC	Risk Based Concentration
RCRA	Resource Conservation and Recovery Act
RfD	Reference dose
RI	Remedial Investigation
RME	Reasonable Maximum Exposure
RPD	Relative Percent Difference
SAV	Savannah District
SAP	Sampling and Analysis Plan
SF	Slope factor
SOW	Scope of Work
SVOC	Semi-volatile organic compound
SZ	Shallow Zone
TAL	Target Analyte List
TCE	Trichloroethene
TPH	Total Petroleum Hydrocarbons
TZ	Transition Zone
USEPA	United States Environmental Protection Agency
UST	Underground storage tank
USACE	United States Army Corps of Engineers
USCS	Unified Soil Classification System
VOC	Volatile organic compound

LIST OF REFERENCES

Army Pamphlet 40-578: Health Risk Assessment Guidance for Installation Restoration Program and Formerly Used Defense Sites

Army Regulation 200-1: Environmental Protection and Enhancement

Army Regulation 200-2: Environmental Effects of Army Action

J. R. Butler, 1983 Geologic History of the Charlotte Belt At the Old Pineville Quarry, Northeastern York County, South Carolina, in The Geology of the Carolinas, Carolina Geological Society Fiftieth Anniversary Volume, University of Tennessee Press, Knoxville, 1991.

J. R. Butler, 1971, Structure of the Charlotte Belt and Adjacent Belts in York County, South Carolina, in The Geology of the Carolinas, Carolina Geological Society Fiftieth Anniversary Volume, University of Tennessee Press, Knoxville, 1991.

Comprehensive Quality Assurance Plan, Savannah Laboratories and Environmental Services, Inc., Revision 1, May 1994.

Federal Acquisition Regulation, FAR Clause 52.236-13: Accident Prevention.

C.W. Fetter, Applied Hydrogeology; Third Edition, MacMillan College Publishing Company, 1994.

J. W. Horton, Jr., V.A. Zullo, The Geology of the Carolinas; Carolina Geological Society Fiftieth Anniversary Volume, University of Tennessee Press, Knoxville, 1991.

P. B. King; 1955, A Geologic Section Across the Southern Appalachians: An outline of the Geology in the Segment in Tennessee, North Carolina, and South Carolina, in The Geology of the Carolinas, Carolina Geological Society Fiftieth Anniversary Volume, University of Tennessee Press, Knoxville, 1991.

H.E. Legrand, M.J. Mondorff, 1952, Geology and Groundwater of the Charlotte Area, North Carolina; Bulletin Number 63, United States Dept. of the Interior, U.S. Geological Survey, North Carolina Dept. of Conservation and Development, Division of Mineral Resources, 1952.

C. M. McCachren, 1980, Soil Survey of Mecklenburg County, North Carolina, United States Department of Agriculture, Soil Conservation Service.

A.Y. McSween, Jr., 1981, Petrology of the Ogden Gabbroic Intrusion, York County, South Carolina, in The Geology of the Carolinas, Carolina Geological Society Fiftieth Anniversary Volume, University of Tennessee Press, Knoxville, 1991.

Metcalf & Eddy, Inc., Prefinal Report for Phase I Remedial Investigation at Former Charlotte Army Missile Plant, Charlotte, North Carolina, March 1998.

National Water Well Association, Sept. 1986, RCRA Groundwater Monitoring Technical Enforcement Guidance Document (TEGD), Dublin, Ohio.

NIOSH/OSHA/USCG/EPA, "Occupational Safety and Health Guidance Manual for Hazardous Waste Site Activities," October 1985.

Petroleum Testing Services, Inc., Phase I Site Assessment, Eckerd Drug Company, September 3, 1991.

Shield Environmental Associates, Inc., Comprehensive Site Assessment Eckerd Drug Company Facility, September 22, 1993.

SPATCO Environmental, Report of Site Assessment for Underground Storage Tank Closure, Eckerd Drug Company, August 1990.

J.L. Stucky; and S.G. Conrad; Explanatory Text for Geologic Map of North Carolina, Bulletin November 71, North Carolina Department of Conservation and Development, Division of Mineral Resources, Raleigh, North Carolina, 1958.

U.S. AEHA TG No 185: Commander's Guide to the Health Risk Assessment Process

U.S. Army Corps of Engineers, Chemical Data Quality Management for Hazardous Waste Remedial Activities, Department of the Army, ER 1110-1-263, October 1990.

U.S. Army Corps of Engineers, Geotechnical Investigations, Engineer Manual EM 1110-1-1804, 29 Feb 84.

U.S. Army Corps of Engineers, Monitor Well Design, Installation, and Documentation at Hazardous and/or Toxic Waste Sites, Engineer Manual EM 1110-1-4000, 31 August 1994.

U.S. Army Corps of Engineers, Requirements for the Preparation of Sampling and Analysis Plans, EM-200-1-3, 1 September 1994

U.S. Army Corps of Engineers, Safety and Health Requirements Manual, EM 385-1-1, September, 1996.

U.S. Army Corps of Engineers, Safety and Occupational Health Document Requirements for Hazardous, Toxic, and Radioactive Waste (HTRW) and Ordnance and Explosive Waste (OEW) Activities, ER 385-1-92, March 1994.

U.S. Army Corps of Engineers, Soil Sampling, Engineer Manual EM 1110-2-1907, 31 Mar 72.

U.S. EPA, Data Quality Objectives for Remedial Response Activities, Vol. 1, EPA 540/G-87/003a, OSWER Directive 9335.0-7B

U.S. EPA, Drinking Water Standards and Health Advisories, Office of Water, U.S. EPA., May 1995.

U.S. EPA, July, 1989. Exposure Factors Handbook, USEPA 600/8-89-043,

U.S. EPA, Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA, Office of Emergency and Remedial Response, Washington, DC., USEPA 540/G-89/004, 1988.

U.S. EPA, Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analyses, Hazardous Site Evaluation Division, February 1996.

U.S. EPA, Management of Investigation-Derived Wastes During Site Inspections (Advance Copy), Office of Emergency and Remedial Response, May 1991.

U.S. EPA, Methods for Chemical Analysis of Water and Wastes, USEPA 600/4-79-020.

U.S. EPA, National Functional Guidelines for Organic Data Review, USEPA Contract Lab Program, Draft, February 1996.

U.S. EPA, Procedures Manual for Groundwater at Solid Waste Disposal Facilities, Publication EPA 530-SW611.

U.S. EPA, RCRA Facility Investigation Guidance, Waste Management Division, Office of Solid Waste, OSWER Directive 9502.00-6D, EPA 530/SW-89-031, May 1898.

U.S. EPA, Risk Assessment Guidance for Superfund, Volume I Human Health & Volume II Environmental Evaluation Manual, 540/1-89-002.

U.S. EPA, November, 1995. Supplemental Guidance to RAGS: Region 4 Bulletins,

U.S. EPA, Superfund Exposure Assessment Manual.

U.S. EPA, Test Methods for Evaluating Solid Waste, SW-846, Third Edition, 1987 and revisions.

U.S. EPA OSWER, December 1994. Soil Screening Guidance, EPA/540/R-94/101

U.S. EPA Region 3, 4/13/2000. Risk Based Concentrations

U.S. EPA Region 4, November 1997. Draft Suggested Practices for Evaluation of a Site for Natural Attenuation.

U.S. EPA, September 1998. Technical Protocol for Evaluating Natural Attenuation of Chlorinated Solvents in Ground Water, Office of Research and Development, EPA/600/R-98/128.

U.S. EPA, April 1999. Use of Monitored Natural Attenuation at Superfund, RCRA Corrective Action, and Underground Storage Tank Sites, OSWER Directive 9200.4-17.

U S. EPA OSWER, Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities, EPA/540/F-94/043, August, 1994.

U.S. Government, Code of Federal Regulations, Chapter 40, Protection of the Environment, Parts 268 and 261.

U.S. Government, Code of Federal Regulations, Chapter 29, Occupational Safety and Health Administration, Labor, Part 1910.

F. A. Wilson; 1981, Geologic Interpretation of Geophysical Data from the "Mecklenburg-Weddington" Gabbro Complex, Southern Mecklenburg County, North Carolina, in The Geology of the Carolinas, Carolina Geological Society Fiftieth Anniversary Volume, University of Tennessee Press, Knoxville, 1991.

T.H. Wiedemeier, J.T. Wilson, D.H. Kampbell, R.N. Miller, and J.E. Hansen, 1995, Technical Protocol for Implementing Intrinsic Remediation With Long-Term Monitoring for Natural Attenuation of Fuel Contamination Dissolved in Groundwater v.1. Air Force Center for Environmental Excellence, Technology Transfer Division, Brooks Air Force Base, San Antonio, Texas.

EXECUTIVE SUMMARY

Metcalf & Eddy, Inc. (M&E) was retained by the United States Army Corps of Engineers (USACE), Savannah District (SAV), to perform a Phase II Remedial Investigation (RI) at the former Charlotte Army Missile Plant (CAMP) in Charlotte, Mecklenburg County, North Carolina. This effort was performed under the Contract No. DACA01-96-D-0020, Delivery Order (DO) No. CV04. The USACE SAV was assigned responsibility for the environmental assessment of this former army missile plant under the Department of Defense (DOD) Defense Environmental Restoration Program--Formerly Utilized Defense Sites (DERP-FUDS) Program. M&E previously completed the Phase I RI investigation at this site for the USACE under Contract No. DACA21-93-D-0049, Delivery Order No. 13.

The former CAMP is located on Statesville Avenue in Charlotte, Mecklenburg County, North Carolina. Current owners of the site are Eckerd Drug Company, 1860 Statesville, Bancroft Realty, Jerry L. and Joyce Dellinger, and Grief Brothers Corporation. The site is currently used as an industrial park for several companies although it is primarily a trucking distribution center for Eckerd Drug Company.

The Phase I RI performed by M&E indicated metals in subsurface soils (aluminum, lead, iron, manganese, and vanadium) at concentrations which both exceeded regulatory limits and two times the average background concentrations for subsurface soil samples. Volatile organic contamination (trichloroethene- TCE, chloroform, and carbon tetrachloride) was consistently detected in groundwater samples. The data suggested that two distinct plumes might exist in the groundwater indicating that at least two distinct sources of these contaminants may have been present at the site. TCE detected in deeper groundwater samples suggests that this contaminant may be migrating vertically through the aquifer and is present in lower portions of the water-bearing zone.

The objectives of this Phase II RI were to: establish the geologic and hydrogeologic framework of the shallow and bedrock aquifers, delineate the vertical and horizontal extent of groundwater contamination identified in the Phase I RI, determine the contaminant characteristics of the soil and groundwater, recommend further action; if necessary, and conduct a quantitative risk assessment (QRA). The QRA characterizes current or potential threats to human health and the environment, and.

Eighteen groundwater monitoring wells were installed per the SOW. The monitoring wells were constructed with well screens placed in three basic geologic zones; the shallow zone (SZ), transition zone (TZ), and the bedrock zone (BZ). The SZ is characterized by residuum; the complete weathering of parent bedrock. The upper portion of the TZ is comprised mainly of saprolite with lower reaches of the TZ characterized by partially weathered rock (PWR). The BZ consists of fractured, competent metamorphic bedrock. Eight SZ wells, ranging in termination depth from 15 to 27 feet below land surface (bls), and seven TZ wells terminating at depths from approximately 44 to 73 feet bls were installed. The three remaining wells were completed in

competent bedrock; the BZ. Boreholes into the BZ were advanced from depths of approximately 115 feet bls to nearly 128 feet bls. Wells in the BZ were constructed with screen sections intersecting prominent fracture zones which varied in depth from 68 feet bls to 117.5 feet bls. The TZ wells (above bedrock) were installed to delineate the horizontal extent of the contaminant plume. The three BZ wells were installed to characterize the hydrogeologic framework of the site, and to aid in the vertical delineation of possible contaminant plumes. Data from the geophysical logging conducted on the three BZ wells and a geostatistical evaluation were used to determine the optimum placement of plume delineation wells. Aquifer testing data and groundwater elevation measured in monitoring wells indicates groundwater flows to the northwest under an average hydraulic gradient of 0.02 ft/ft.

Phase II activities included collection of 37 groundwater samples, 19 from new wells (including two samples from COEMW29) and 18 from existing wells. This sample set included wells previously sampled in the Phase I RI. The volatile organic compounds (VOCs) detected in groundwater include bromodichloromethane, carbon tetrachloride, chloroform, 1,1-dichloroethene (1,1-DCE), naphthalene, and TCE. Groundwater metals that exceeded MCL or NCAC 2L standards included aluminum, chromium, iron, lead, and manganese. Both surface soil and subsurface soil samples were collected during the Phase II RI. Although trace concentrations of organic and inorganic Contaminants of Potential Concern (COPCs) were identified in surface soil, only arsenic consistently exceeded screening criteria. One surface water sample was also collected and no COPCs were identified in concentrations exceeding NCAC 2B screening criteria. The extent of subsurface contamination at the former CAMP has been largely defined. COPCs were identified in surface soil, subsurface soil, surface water, and groundwater.

The horizontal extent of contamination in the shallow aquifer has been adequately defined in most directions, most importantly, down-gradient of potential source areas. The vertical extent has not been completely defined however, borehole geophysical logging suggests that fracture density and groundwater flow decreases with depth; effectively limiting the vertical distribution of contaminants to relatively shallow bedrock zones.

The Pathways Analysis Report (PAR), performed as part of the Phase II RI, indicated that no present or potential future use exposure pathway was complete at the former CAMP. However, for conservative purposes, each potentially contaminated medium was evaluated during a screening level risk assessment. COPCs were present in surface soil, subsurface soil, and surface water samples; some in concentrations above screening criteria. COPCs consistently exceeding screening criteria (arsenic) are likely associated with natural conditions. Isolated trace concentrations of COPCs (i.e., the single aroclor 1260 detection at COEMW30 below the reporting limit) are not considered to be statistically significant. As a result, the surface soil, subsurface soil, and surface water media were excluded from the QRA based on the screening level risk assessment. COPCs were present in groundwater above screening criteria. Although no private or public potable wells were observed in proximity of the former CAMP and potable water is supplied to the area by municipal systems, future groundwater ingestion was quantitatively evaluated for an industrial worker exposure scenario. This conservative evaluation of groundwater ingestion was performed although the exposure assessment indicated the

groundwater exposure pathway was not complete.

The cumulative risk for ingestion of groundwater was calculated to be 3.5E-05. Although this exceeds a target of 1E-06, it is within the range for remediation of Superfund sites (1E-06 to 1E-04). The sum of the Hazard Quotient (HQ) values, or Hazard Index (HI), was calculated to be 0.84 and is below the generally accepted target of 1. Considering the conservative set of assumptions used, the potential risk/hazards calculated are not anticipated to result in adverse human health risks. Since groundwater consumption presently does not occur and is not anticipated for the future given the industrial nature of the site, the estimated risk levels do not support the need to develop remedial goals.

Groundwater geochemical data suggests if natural attenuation of chlorinated VOCs occurs at the former CAMP, it will proceed at a slow pace. Elevated concentrations of dissolved oxygen in groundwater reduces the likelihood that reductive dechlorination will occur. TCE concentrations in groundwater should, however, decline over time through diffusion and dilution. Considerable time may be required to significantly reduce the TCE mass relying solely on natural processes. Plume migration appears to occur primarily in the SZ and TZ of the shallow aquifer and may have stabilized at its current distribution. TCE will likely persist in the environment for several decades without a change in groundwater geochemistry or initiation of active remediation.

Groundwater at the former CAMP contains COPCs at concentrations above North Carolina Administrative Code (NCAC) criteria. The PAR identified no complete present or potential future use exposure pathway at the former CAMP and risk can not be quantified without a completed exposure pathway. In addition, the QRA performed as part of this Phase II RI suggests that risks associated with COPCs fall within acceptable limits based on a hypothetical industrial exposure scenario for groundwater ingestion. The potential for developing shallow groundwater resources for potable purposes in this area is very remote thus making the exposure scenario very conservative. Therefore, no remedial levels are proposed based on the data evaluated in this Phase II RI Report.

A program of annual groundwater sampling should be initiated to monitor the extent and movement of COPCs. Additional groundwater monitoring wells are also proposed to more accurately define plume boundaries. One SZ, three TZ, and two BZ wells are proposed. Groundwater samples should be collected for VOC analysis from wells strategically located both within and beyond the groundwater plume to gather data on COPC migration and distribution over the monitoring period. The annual monitoring plan includes collecting samples from seven SZ, five TZ, and four BZ wells. The long term monitoring program will continue for a period of five years. Annual monitoring summary reports will be submitted to North Carolina Department of Environment and Natural Resources (NCDENR) for review and comment. A five-year groundwater monitoring summary report will be prepared following the completion of the monitoring period that will evaluate trends in plume migration and suggest further action as required to protect human health and the environment.

1.0 INTRODUCTION

Metcalf & Eddy, Inc. (M&E) has been contracted by the United States Army Corps of Engineers (USACE), SAV to perform a Phase II Remedial Investigation (RI) at the former Charlotte Army Missile Plant (CAMP) in Charlotte, Mecklenburg County, North Carolina. A site location map is shown in **Figure 1.1**, and a site map is shown in **Figure 1.2**. This effort will be performed under the Contract No. DACA01-96-D-0020, Delivery Order (DO) No. CV04. The USACE SAV has been assigned responsibility for the environmental assessment of this former army missile plant under the Department of Defense (DOD) Defense Environmental Restoration Program--Formerly Utilized Defense Sites (DERP-FUDS) Program. M&E previously completed the Phase I RI investigation at this site for the USACE under Contract No. DACA21-93-D-0049, Delivery Order No. 13.

This document has been prepared in accordance with the USACE scope of work (SOW), dated September 3, 1998, for conducting a Phase II RI at the former CAMP. This report addresses all project requirements for the field investigation, chemical data acquisition, historical site use review, subsurface investigation, personnel health and safety, and data management. Although this site is not included on the National Priorities List, the investigation will follow Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) guidance.

1.1 Purpose of Report

The objectives of the Phase II RI are as follows:

- Conduct a record search of maps and diagrams in possession of Eckerd to identify any other previously existing sources of contamination.
- Establish the geologic and hydrogeologic framework of shallow and bedrock aquifers.
- Delineate the vertical and horizontal extent of groundwater contamination identified in the Phase I RI.
- Determine the contaminant characteristics of the soil and groundwater.
- Conduct a QRA to characterize current or potential threats to human health and the environment.
- Evaluate contaminant concentrations with respect to Applicable or Relevant and Appropriate Requirements (ARARs) of state or federal remediation standards.
- Recommend further action; if corrective action is recommended, obtain all information required, such that the project is ready to move into corrective action phase upon completion of the Phase II RI.

A site description, brief history, and SOW designed to achieve these objectives is presented below. The rationale used to select sampling locations and the analytical parameters for each sample is provided in subsequent sections.

1.2 Site Description

The former CAMP is located on Statesville Avenue in Charlotte, Mecklenburg County, North Carolina. The site coordinates are approximately 35° 14' 47" N latitude and 80° 50' 00" W longitude. The site is currently used as an industrial park for several companies.

Five former tank sites and two other areas of operation comprise the former CAMP investigation area. A brief description of each site is presented below. However, all of these sites have been combined into a single investigation area for the presentation of Phase II RI data in the report. The individual site boundaries and their relationship to other sites are shown in **Figure 1.3**. The area known as Site 2 was deleted from the SOW for the Phase I RI and was handled as a separate underground storage tank (UST) site. The numbering scheme used in the Phase I RI remains in use for this report.

1.2.1 Site 1

A map of Site 1 is provided in **Figure 1.4**. Site 1 consisted of the following tanks: an 8,000-gallon transmission oil tank; an 8,000-gallon motor oil tank; a 10,000-gallon diesel tank; and a 10,000-gallon antifreeze tank. An historical record search did reveal information regarding the locations of these tanks; however, the search did not provide information regarding whether the tanks were situated underground or aboveground. A visual inspection of the building interior revealed indications (anchor bolts in the floor and round markings) that the two 8,000-gallon tanks may have been aboveground. During the Phase I RI, a ground-penetrating radar (GPR) survey was used to investigate the presence of any USTs. There were no electromagnetic anomalies in this area that are consistent with the presence of USTs. A number of anomalies were noted that are consistent with shallow buried utilities. Some anomalies were noted that could not be tied to any apparent utility. Some of these could represent buried 1-inch copper grounding wires that were reported by site personnel to be present in the area.

1.2.2 Site 3

A map of Site 3 provided in **Figure 1.5** shows the former location of several storage tanks. These tanks included a 10,000-gallon sulfuric acid tank, a chrome holding tank, a cyanide tank, a neutralization tank, and a sulfur dioxide storage area. Historical records indicate that this site contained a settling tank, an open retention tank, another open tank, an IE Tank (definition of "IE" not provided in historical documents), and a 10,000-gallon sulfuric acid tank. The "open" tanks and the IE tank were located in former Building No. 56 and were probably aboveground. Historical documents do not indicate whether the sulfuric acid tank and the settling tank were located aboveground or underground. Sulfur dioxide is a gas, which is typically stored in pressurized gas cylinder.

Historical documents indicate that a canopy existed off the side of a building within Site 3. This canopy is a likely former storage area for the sulfur dioxide cylinders.

1.2.3 Site 4

A map of Site 4, which is provided in **Figure 1.6,** shows the former location of a 10,000-gallon UST. This tank was divided into two compartments. One compartment had a capacity of approximately 4,410-gallons of toluene and the other compartment had a capacity of approximately 5,420-gallons of xylene. The tank may also have been used to store petroleum products. Two 1 ½ -inch lines ran from these tanks to Site 8 (Building No. 50 - the solvent dispensing area shown in **Figure 1.10**). These lines were located approximately 3 feet below grade. Previous sampling in this area detected the following: xylenes, toluene, ethylbenzene, and methyl tert-butyl ether (MTBE). During the Phase I RI, a GPR survey was conducted at points along the suspected path of this pipeline. The survey recorded two linear electromagnetic anomalies that are in locations consistent with the suspected buried solvent pipelines.

1.2.4 Site 5

Figure 1.7 is a map of Site 5, the former location of a 5,000 to 6,000-gallon UST, which stored gasoline. Eckerd, the current property owners, used this tank for gasoline storage. In 1990 Eckerd removed and replaced the tank. Previous sampling has detected groundwater contamination in this area consisting of chloroform, trichloroethene (TCE), tetrachloroethylene (PCE), benzene, toluene, ethylbenzene, MTBE, xylenes, isopropyl ether, and ethylene dibromide. The Phase I RI was concerned with non-petroleum fuel related contamination from former DOD sources under DERP-FUDS directives. The site owner has the beneficial occupant of the property and has used the UST to store gasoline, and therefore, is responsible for any petroleum contamination from this source.

1.2.5 Site 6

Figure 1.8 is a map of Site 6, which shows the location of a former 3,000-gallon tank that stored process chemicals. This tank was an aboveground storage tank capable of holding sulfuric, chromic, and hydrochloric acids. The tank dimensions were approximately 7 feet in diameter and 12 feet long. A valve was located at the western end of the tank; a small (1-foot deep by 20-inch wide) drain pit was located beneath the valve.

1.2.6 Site 7

Figure 1.9 is a map of Site 7, which shows a former automotive machine shop area at which routine vehicle maintenance occurred. During the Phase I RI, six 6,000-gallon USTs located in Site 7 were discovered. As-built drawings from 1956 indicate that these tanks stored heating oil used at a boiler facility located west of the tanks. No additional information regarding these tanks was obtained. The automotive machine shop is currently abandoned and used only occasionally by the existing owners for storage. Previous sampling in this area has detected TCE, benzene, chloroform, PCE, toluene, and xylenes.

1.2.7 Site 8

Figure 1.10 is a map of Site 8, which shows a former solvent dispensing area. A 6,000-gallon aboveground TCE storage tank was located in this area. A 1½-inch line ran from the TCE tank to Building No. 50 - the solvent dispensing area. This line ran both above and below ground. Toluene and xylene were also dispensed from this area. Two 1½-inch lines ran to the dispensing pumps from Site 4.

1.3 Site History

Between 1941 and 1948, the United States acquired 80.05 acres in fee and by lease and easement for the site of the Charlotte Quartermaster Depot. In 1954, the installation was redesignated the Charlotte Army Missile Plant and converted to produce Nike guided missiles and repair parts. During the 1960s, the CAMP was predominantly used under facilities contracts to produce the Nike Ajax and Nike Hercules missiles and repair parts, with Douglas Aircraft Corporation being the prime contractor. The plant included six major buildings for manufacturing and administration, along with associated facilities. In 1945, the title of 0.44 acres of leased land was revested to the former owner. By quitclaim deed dated 1 September 1967, the United States of America conveyed 79.61 acres of land (77.65 acres fee and 1.96 acres easement) to Eighteen Twenty, Inc. (also known as Pat Hall Enterprises). Current owners of the site are Eckerd Drug Company, 1860 Statesville, Bancroft Realty, Jerry L. and Joyce Dellinger, and Grief Brothers Corporation. **Figure 1.2** shows the approximate boundaries for each property owner.

1.4 Previous Investigations

1.4.1 December 1965 Tank Survey

In December 1965, Charlotte Engineers, Inc. prepared a storage tank survey. The survey indicates the presence of numerous tanks on the property. A 3,000-gallon mixed chemical aboveground storage tank (Site 6) and a 6,000-gallon solvent aboveground storage tank (Site 8) were removed from the property sometime between 1965 and 1977.

1.4.2 1990 Site Assessment

In 1990, Eckerd Drug Company (Eckerd) had the following tanks removed:

- 5,000 to 6,000-gallon UST (Site 5); two soil samples contained low levels of benzene, toluene, ethylbenzene, xylenes (BTEX), Total Petroleum Hydrocarbons (TPH) - gasoline but non-detect for TPH-diesel
- 10,000-gallon UST (Site 4); three soil samples contained no BTEX or TPH-gasoline. TPH-diesel testing not performed
- 10,000-gallon UST (not included in the RI investigations because the tanks were utilized by Eckerd and they assume all responsibility for them under DERP-FUDS directives); and
- 4,000-gallon UST (not included in the RI investigations because Eckerd utilized the tanks and they assume all responsibility for them under DERP-FUDS directives).

1.4.3 1991 Phase I Site Assessment

Petroleum Testing Services, Inc. performed a Phase I Site Assessment for Eckerd. A monitoring well (MW01) was installed beneath the former 5,000 to 6,000-gallon gasoline tank (Site 5). A groundwater sample was collected and analyzed for purgeable halocarbons and purgeable aromatics including MTBE and xylenes. Benzene was detected at 330 parts µg/L and 1,1,2-trichloroethylene was detected at 1,500 µg/L in the groundwater sample collected from MW01. These concentrations exceeded the North Carolina Department of Environment, Health, and Natural Resources (NCDEHNR) Maximum Contaminant Levels (MCLs). Xylene was also detected at 240 µg/L, which was below the NCDEHNR MCLs. TPH-gasoline was detected at 9.8 mg/L in the soil samples collected from MW01.

Soil boring SB-1 was installed near the former location of the 10,000-gallon diesel and 4,000-gallon gasoline tanks. TPH-gasoline (17.4 mg/L) and TPH-diesel (41 mg/L) were detected in the samples collected from SB-1. The September 1990 North Carolina Division of Environmental Management TPH action level used in the report was 10 mg/L.

The report recommended additional investigation to define the extent of contamination in the soil and groundwater.

1.4.4 1993 Comprehensive Site Assessment

Between October 1991 and 1993, Shield Environmental Associates, Inc., on behalf of Eckerd, proceeded with further site investigations.

Between October 1991 and 1993, a total of four soil borings (SB-1, SB-2, SB-3, and SB-4) and seven SZ monitor well borings (MW-1 to MW-7) were advanced near Building 50 around the area where the 10,000-gallon diesel oil and the 4,000 gasoline tanks had been located. The soil borings SB-1 to SB-4 were analyzed for purgeable halocarbons and non-petroleum VOCs. No non-petroleum VOCs were detected in the soil samples collected from SB-1 through SB-4. Soil samples were collected for TPH analysis at each of the new monitoring well borings: MW02, MW03, and MW04. No soil samples were collected from MW05 since this boring was advanced through 11-feet of backfill material which was placed after the tank removal. Groundwater samples from these wells were collected and analyzed for BTEX and MTBE. BTEX contamination was detected in the monitor wells: MW-1, MW-2, MW-4 and MW-5.

This subsequently led to the Hydropunch investigation conducted in July 1992. Twelve (HP-1 through HP-12) Hydropunch borings were installed. Groundwater samples were collected from the Hydropunch borings and analyzed for purgeable aromatics and halocarbons. The purpose of the Hydropunch investigation was to determine the horizontal extent of groundwater contamination. Samples HP-2 and HP-6 had detections of purgeable aromatics and halocarbons.

The five existing monitoring wells (MW01 through MW05 were sampled in March of 1993 and analyzed for BTEX and MTBE. BTEX and MTBE were detected in MW-1 and MW-5.

Four additional Hydropunch borings were installed (HP-13 through HP-16) in May 1993 and groundwater was analyzed for methyl tert-butyl ether, Isopropyl ether, ethylene dibromide, BTEX, chlorobenzene, 1,2-dichlorobenzene, 1,3-dichlorobenzene, and 1,4-dichlorobenzene. None of these parameters was detected in these four groundwater samples.

Based on the results of the above sampling investigations, two additional monitoring wells (MW06 and MW07) were installed on the up-gradient side of the plume in June 1993. Samples from these wells were analyzed for BTEX, MTBE, and o-, m-, and p-dichlorobenzene.

Finally, in July 1993, a deeper well (MW1A) was installed to determine the vertical extent of contamination. Samples from this well were analyzed for purgeable halocarbons and aromatics. Trichloroethene was detected at 8,400 µg/L in MW-1A groundwater.

The following contaminants were detected at levels, which exceed the North Carolina groundwater standards in at least one sample: PCE, TCE, BTEX, and chloroform. Additionally, MTBE was detected at two locations (MW01 and MW06). Since MTBE was not added to fuels until the late 1970's, this would indicate that a potentially responsible party other than the DOD had stored fuel in the USTs in that vicinity.

The September 1993 report recommended the following:

- No further action pertaining to the assessment or remediation of the in situ soils since petroleum impacted soils were below the March 1993 action levels of 180 mg/L for low boiling point fuels - (i.e. gasoline) and 720 mg/L for high boiling fuels (i.e. diesel).
- Passive remediation for petroleum hydrocarbons in the groundwater since constituents were not moving significantly, will naturally degrade over time, and no groundwater receptors are within 1,500 feet of the site.
- Semi-annual sampling of all monitoring wells until benzene levels reduce to below 0.001 mg/L in MW01.
- Non-petroleum related Volatile Organic Compounds (VOC) constituents identified in the groundwater should be addressed by the U.S. Army Corps of Engineers.

1.4.5 Phase I Remedial Investigation 1997

From December 1996 to August 1997, M&E performed a Phase I RI at five former tank sites and two other areas of operation at the former CAMP. The descriptions of the sites are presented in Section 1.2. The objectives of the Phase I RI were:

- To determine the nature and extent of contamination from former DOD operations in areas where contamination had previously been identified by others;
- To determine the presence or absence of contamination from former DOD operations at potential sources where there existed little or no previous information (due to the close proximity of sites, information from these sites will aid determination of the extent of contamination from other sites);
- To assess the overall soil, geologic, hydrogeologic setting of the site;

- To collect data which will support a baseline risk assessment which characterizes the current or potential threats to human health and the environment;
- To identify ARARs; and
- To confirm, by visual inspection, that all transformers, blasting caps, primer cord, and aboveground storage tanks that were used during DOD ownership have been removed.

During this investigation, M&E conducted the following tasks:

1. A GPR survey at Site 1 and along a pipeline, which runs through Sites 8, 6, and 4.
2. The collection of fifty-eight subsurface soil samples from twenty-nine boring locations.
3. The collection of two soil samples from one hand auger boring location.
4. The collection of twenty-seven water samples from either Hydropunch or temporary well screens at twenty-seven boring locations.
5. The installations of twelve groundwater monitoring wells, including nine shallow (SZ) wells and three "deep" wells (proximal to the TZ).
6. The collection of groundwater samples from eleven of the twelve newly installed groundwater monitoring wells (one well contained visible evidence of an oily free product and was not sampled). Collection of groundwater samples from seven of the eight existing wells previously installed by Eckerd (one of the existing wells could not be found and therefore was not sampled).
7. A survey of sampled locations.

The GPR survey provided no evidence of USTs in Site 1. However, electromagnetic anomalies recorded in Sites 4, 6, and 8 were consistent with the presence of buried metallic piping, presumed to be the 1½-inch diameter solvent lines.

The results of the chemical analyses were compared to North Carolina Target Concentrations ARARs for both soils and groundwater. This comparison produced the following conclusions:

Aluminum, lead, iron, manganese, and vanadium were detected at concentrations that exceeded both the ARARs and two times the average background concentrations for subsurface soil samples. Historical research provided no information regarding the use of these metals at the site. A more comprehensive statistical determination of metals concentrations in background soils was needed to determine if on-site metals concentrations actually exceed background values.

Definitive data collection from the permanent groundwater wells indicates that the metals concentrations detected on-site were less than two times the average background concentrations in all samples except one for manganese.

Volatile organic contamination (TCE, chloroform, and carbon tetrachloride) were consistently detected in groundwater samples. The data suggests that two distinct plumes may exist in the groundwater indicating that at least two distinct sources of these contaminants may have been present at the site. Concentrations of TCE detected in deeper groundwater samples suggest that this contaminant is migrating vertically through the aquifer and is present in lower portions of

the water-bearing zone.

Results of the qualitative risk assessment indicate that additional investigation into the areal extent of organic chemicals and metals in groundwater was required. The occurrence of chemicals in groundwater could not be linked to contaminated shallow soils. Therefore, the source areas for groundwater contamination have not been identified. The source areas may have been removed during the tank removal tasks at the former CAMP and may no longer exist.

The following recommendations for further actions were presented based on the results of the Phase I RI. The purpose of this additional work was to address area where data gaps exist and information is needed to appropriately characterize the nature and extent of the contamination at the former CAMP:

1. Collect at least one year of quarterly sampling for VOCs to monitor groundwater contaminant concentrations over time.
2. Install seven additional "deep" (proximal to the TZ) wells to assess the extent of contamination existing in the lower portion of the aquifer.
3. Request from Eckerd a complete copy of all property maps and diagrams which they have for the former CAMP in order to identify any other sources of contamination.
4. Collect additional information regarding the tank(s) located near COEMW04. Sample contents of this tank(s) if necessary, remove tank and determine extent of contamination.
5. Install two additional SZ groundwater monitoring wells to assess the nature and extent of volatile organic contamination existing beneath and adjacent to Building 2.
6. Install one additional SZ groundwater monitoring well to assess the possible southerly migration of contaminants east of Building 1.
7. Install one additional SZ groundwater monitoring well to assess the nature and extent of volatile organic contamination existing northeast of Building 50.
8. Collect at least five background soil samples in order to establish a better statistical determination of the metals concentrations in background soils.

2.0 SITE CHARACTERISTICS

2.1 Surface Features

A fence surrounds the former CAMP properties that will be included in this Phase II RI (i.e. 1830 Statesville and Eckerd Property). Access to the former CAMP is either through a guard post, which is manned 24 hours per day or through a locked gate.

Relief at the site is approximately 30 feet with maximum elevations along the east portion of the property. The lowest areas are the loading docks between Buildings 2 and 3.

2.2 Surface Water Hydrology

More than 85 percent of the former CAMP surface is covered with asphalt, concrete, and buildings. Most of the soil has been cut, filled, and graded, and former surface characteristics have therefore been altered. The lack of infiltration results in a high volume of surface runoff. Topographic maps indicate that the only area of surface water within 0.5 miles of the former CAMP is an ephemeral stream located just off the property to the northwest.

2.3 Geology

2.3.1 Soil

Former CAMP soils, where undisturbed by anthropogenic activities, are comprised of three primary soil types: Cecil sandy clay loam (CeB2) with 2-8 percent slopes; Cecil Sandy Clay loam (CeD2) with 8-15% slopes, and eroded surfaces; and Cecil-urban land complex (CuB) with 2-8 percent slopes (Soil Conservation Service, 1980). The CeB2 and CeD2 soil types consists of a yellowish red sandy clay loam surface layer about 6 inches thick underlain by approximately 47 inches of subsoil. The upper part is red clay, and the lower part is red clay loam. Below this, to a depth of approximately 65 inches, is red and yellow loam. Organic matter content is low in the surface layer, with moderate permeability. The subsoil is strongly acidic. CeB2 has high potential for most urban uses due to broad, smooth ridges. The CuB soil type consists of Cecil soils and areas of urban land along with areas of altered or covered soil. The undisturbed Cecil soil is well drained. Typically, the surface layer is yellowish red sandy clay loam 6 inches thick, while the sub soil is red clay and red clay loam turning into a red and yellow loam.

2.3.2 Local Geology

Soil sampling was conducted at the former CAMP during the Phase II RI for lithologic description, geotechnical testing, or chemical analysis at 18 locations. Boring depths ranged from 15 to 127.7 feet below land surface (bls). Top of rock was encountered from 32 feet at COEMW14 to 77.5 feet bls at COEMW28. A soil sample for geotechnical testing was collected from within the screened interval during the installation of ten monitoring wells (COEMW13 through COEMW21 and COEMW26). The soil samples were analyzed for sieve analysis, Atterberg Limits, and moisture content. The geotechnical results are presented in **Table 2-1** and

Appendix A. The results agree with the Phase I geotechnical results where the majority of the samples are sandy silts, silty sands, and sandy or silty clays.

Based upon field observations and the geotechnical testing results, the former CAMP is underlain by unconsolidated soils consisting of residuum and saprolite material, followed by PWR. Geologic logs from the monitoring well drilling are presented in **Appendix B**.

Approximately 35 feet of residuum consisting of micaceous sandy silts (ML), silty sands (SM), silty clay (MH), and clayey sands (SC) underlie the site. The ML, SM, and MH designations are Unified Soil Classification System (USCS) soil classifications. The residuum is characterized by complete weathering of the parent bedrock, with relative soil densities generally ranging from loose to very firm for granular residuum and firm to stiff for cohesive residuum. Below the residuum is a fine to medium-grained saprolite composed of weathered biotite, quartz, feldspar, and hornblende. The saprolite is characterized by a soil-like texture, but is less weathered than the residuum and shows relict structure of the parent rock. The saprolite ranges from 15 to 30 feet thick at the site. The PWR is characterized by increased drilling difficulty and decreased split spoon recovery. Samples that were recovered consisted of fragments of metagranite, gneiss, and hydrothermally altered mafic or vein rock (the USACE performed a petrographic thin section description of a rock sample collected at the site which showed it to be a pyroxenite).

A geologic cross section location map showing the locations of two transects across the former CAMP site is provided in **Figure 2.1**. Geologic cross section A - A' is presented on **Figure 2.2**. Geologic cross section B - B' is presented on **Figure 2.3**.

2.3.3 Regional Geology

The former CAMP is located within the central Piedmont of North Carolina which extends from the northwestern edge of the Kings Mountain and Loundsville belts eastward and southward to the Raleigh and Kiokee metamorphic belts (Horton, et. al., 1991). Regional geologic features occurring in this region include the Carolina Slate, Charlotte, Kings Mountain, and Milton belts. The western boundary of this region is formed by the Kings Mountain and Loundsville shear zones. The eastern edge of the region is defined by a sequence of faults (Jonesboro and Nutbush Creek) and linear features which include the Raleigh and Eastern Slate belts. The study area is located within the Charlotte belt.

The Charlotte belt occurs near the northern reaches of the central Piedmont. The belt is typically characterized as "dominantly plutonic" with mineralogical compositions ranging from granite to gabbro (King, 1955). Four main peaks of plutonic activity occurred between the late Proterozoic and Carboniferous-Permian periods (McSween et. al., 1981). Most of the intrusive rocks in the Charlotte belt of Mecklenburg County are associated with the third major plutonic period which took place in the Silurian-Devonian Period (Butler, 1983). The southern boundary of the Charlotte belt is often associated with the Gold Hill Fault. Some authors suggest that only a metamorphic gradient separates the eastern edge of the Charlotte and Carolina belts; citing correlations between lithologic units. The remainder of this regional geology section will concentrate on members of the Charlotte belt.

The oldest rocks of the Charlotte Belt include mafic gneisses, amphibolites, metagabbros, and metavolcanic rocks. Less common in the area are biotite and granitic gneisses, mica schists, quartzite and ultramafic rocks. Metagabbros of Cambrian age and Gabbros of the Concord Plutonic Suite (Silurian) apparently surround the former CAMP. McSween and others suggest that rocks of the Concord Plutonic Suite are approximately 400 million years old. The site itself lies on metagranitoid rocks of Cambrian age (Horton et. Al., 1991).

The structure of the Charlotte belt is difficult to determine because of the abundance of post-deformational plutons. In the region southwest of Charlotte, compositional layering and schistosity are generally steep to vertical and strike northeast; the few folds that have been observed are mostly isoclinal, with nearly vertical axial surfaces and hinges that plunge gently northeast or southwest (Butler, 1971). Sillimanite occurs at several localities near Charlotte and indicates rocks in this portion of the belt are regionally metamorphosed in the upper range of the amphibolite facies.

2.4 Hydrogeology

The lithologies described previously comprise the aquifer at the site. Water levels in wells installed within the SZ (residuum), the TZ (saprolite and PWR), and the BZ of the aquifer at the site were measured on February 28, 2000, except COEMW19, -27, and -30 which were measured the next day. The water levels and survey data were used to calculate groundwater elevations, from which potentiometric surface maps of the SZ, TZ, and BZ portions of the aquifer were generated (**Figures 2.4, 2.5,** and **2.6**, respectively). Within the SZ portion of the aquifer, data contours indicate that groundwater flows to the northwest. The calculated average hydraulic gradient to the north-northwest (as measured from the potentiometric surface map) is 0.02 ft/ft. Within the TZ portion of the aquifer, data contours indicate that the groundwater flow direction is similar to flow in the SZ portion (north-northwest). The hydraulic gradient within the TZ portion of the aquifer is approximately 0.01 ft/ft. Within the BZ portion of the aquifer, data contours indicate that the groundwater flow direction is generally similar to flow in the SZ and TZ (north-northwest). The hydraulic gradient within the BZ portion of the aquifer is approximately 0.01 ft/ft. Groundwater within the aquifer is generally unconfined; however, groundwater within the TZ and BZ may be locally confined. A summary of groundwater elevations is presented in **Table 2-2**.

In general, there appears to be a downward vertical gradient at the site as exhibited in the higher groundwater elevations recorded in the SZ wells at well nests. Locations where a downward vertical gradient was not observed is at well nest COEMW21 and COEMW14, where water levels were about equal, and at COEMW26 and COEMW02, where an upward gradient was observed.

2.5 Demographics

The closest city to the former CAMP area is Charlotte, Mecklenburg County, North Carolina. There are approximately 18,620 businesses located in Mecklenburg County. One Thousand

ninety-eight of these businesses are manufacturing facilities. There are 17 institutes of higher learning located in the Charlotte, Gastonia, and Rock Hill, N.C. Hill - S.C. Metropolitan Statistical Area (MSA) which includes Mecklenburg County.

According to the 1990 census the population of Mecklenburg County was 511,433 and in 1995 population was estimated to be 581,466. This represents approximately 215,000 households.

2.6 Climate

Mecklenburg County has a warm, humid climate with a mean annual rainfall of 43 inches (McCachren, et al, 1980). The county occupies a moderate plateau ranging in elevation from 520 to more than 830 feet. Rainfall is fairly uniformly distributed from December through July. Heaviest rainfall normally occurs in February, March, and July, with March being the wettest month (4.58 inches on the average). The driest months are October and November, with October having a monthly average of 2.51 inches of precipitation. Average daily maximum temperatures in January and July are 52° Fahrenheit (F) and 89° F, respectively. The average annual daily maximum temperature is 71° F with an average minimum temperature of 50° F.

2.7 Ecology

Wildlife is almost absent at the site due to the industrial setting. Stray cats and rodents have been observed on site as well as rabbit droppings. Other animals include birds, hawks, and frogs.

Two endangered species are listed by the U.S. Fish and Wildlife Service as existing within Mecklenburg County, North Carolina. They are the Carolina Heelsplitter Clam and Schweinitz's Sunflower. Neither species is expected to exist within the study area of the former CAMP due to the expanse of pavement.

2.8 Historical Records/ Database Search

As part of the Phase II RI process at the former CAMP, a geologic literature search was performed. The purpose of the geologic literature search was to identify additional or more recent sources of information concerning the former CAMP not identified during the Phase I RI. Places searched for information includes:
North Carolina Geologic Survey - Raleigh
United States Geologic Survey, Open-File Reports, Miscellaneous Maps, and Professional Papers
University of North Carolina - Charlotte, Library and Geology Department
University of North Carolina - Chapel Hill, Library and Geology Department
GEOREF - A geologic reference database, includes Dissertations, Theses, and trade journals

Presented below is a summary of the geological literature obtained:

1. A Study of Lineaments in the Knoxville, Johnson City, Winston-Salem, and Charlotte Quadrangles, Alison E. Alcott, UNC-Chapel Hill, B.S. Geology Honors Paper, 1997.

2. Listing of Concentrations of Variables of Stream Sediment, Stream Water and Groundwater for Charlotte 30'x60' Quadrangle - NURE Database, Robert Carpenter and Jeffrey C. Reid, North Carolina Geologic Survey, Raleigh, Open-File Report 93-14, July 1993.

3. Geology and Groundwater in the Charlotte Area, North Carolina, H.E. LeGrand and M.J. Mundorff, North Carolina Geologic Survey, Raleigh, Bulletin 63, 1952.

4. Simple Bouguer Gravity Map of the Charlotte 1°x2° Quadrangle, North Carolina and South Carolina, F.A. Wilson and D.L. Daniels, Scale 1:250,000, U.S.G.S. Map I-1251-A, 1980.

5. A Hydrogeochemical Atlas of North Carolina, North Carolina Geologic Survey, Raleigh, Bulletin 94, July 1993.

6. Mineral Resources of the Charlotte 1°x2° Quadrangle, North Carolina and South Carolina, J.E. Gair, U.S.G.S. Professional Paper 1462, 1989.

7. Geophysical and Geologic Studies in Southern Mecklenburg County and Vicinity, North Carolina and South Carolina, Fred Wilson (Ph.D. Dissertation 1981), U.S.G.S. Open-File Report 83-93, 1983.

SUMMARY OF PERTINENT INFORMATION

A review of the literature revealed that the papers/studies encompass a large area or are of regional extent and do not detail the former CAMP site, as it is relatively small. However, the following information concerning the region was obtained:

- Lineaments in the region predominantly trend NE-SW and correspond to faults and geologic contacts. Fewer NW-SE lineaments were observed.
- Stream water values of conductivity/pH and metals content in the county for comparison to site values against.
- Groundwater production is from different rock types in the county.
- Based on the Bouguer gravity map contours, the inferred geologic structure in the CAMP area is relatively flat, i.e. no gravity highs or lows or steep gradients are associated with the former CAMP site.

2.9 Potential Receptor Survey

A Potential Receptor Survey was conducted on May 24, 1999 which entailed a windshield survey of the area within a one mile radius to identify water bodies, potable wells, topography, evidence of city supplied water, etc. The only water bodies found were drainage ditches along the sides of roads, the closest being the ditch on the west side of Statesville Avenue at Woodward Avenue, at the northwest corner of the site. The sole use of these ditches is to control rainwater runoff. These ditches contain water only for a short time after rainfall events. The

ditch at the northwest corner of the site may be partially fed by a spring. The ditch drains to the northwest and intersects Interstate I-77, about 0.49 mile west of the site. No potable wells were observed in the site area during the M&E windshield survey. But, a search of the DENR groundwater well registration files indicates seven wells within a 1-mile radius. All of the wells are in an up-gradient or side-gradient location and are unlikely to be impacted by CAMP activities. And, no information is available to indicate if the wells are still active. An illustration of the search radius and the location potable wells is superimposed on a USGS 7.5-Minute Quadrangle map area is provided in **Figure 2.7**. Additional information on potable wells in proximity to CAMP is provided in Section 4.2.

3.0 SITE INVESTIGATION PROCEDURES

Eighteen monitor wells were installed per the SOW. The wells were drilled at depths into the upper aquifer down to the top of bedrock. There were eight SZ wells, seven TZ wells, and three BZ wells at total depths of 114.6, 117.8, and 127.7 feet bls. The TZ wells (above bedrock) were installed to delineate the plume. The three BZ wells were installed to characterize the hydrogeologic framework of the site, and to aid in the vertical delineation of possible contaminant plumes.

3.1 Equipment Decontamination

All drilling and sampling equipment was decontaminated prior to arrival on site, before the start of each hole, and before leaving the site. Decontamination of the drill rig, large tools, and downhole equipment consisted of steam cleaning. Decontamination of split spoons and sampling tools consisted of an Alconox wash and a potable water rinse. Decontamination of surface soil sampling equipment consisted of an Alconox wash, a potable water rinse, a pesticide-grade isopropanol rinse, and a deionized, organic-free (DIOF) water rinse.

All water used for decontamination and well construction was from a potable source (hydrant) located in the study area. The bulk of decontamination operations occurred on a plastic lined "decontamination pad" constructed on the asphalt next to the former onsite gas station. The decontamination fluids were pumped into drums and stored onsite. The only decontamination not conducted at the decontamination pad was decontamination of sampling tools used during sampling activities. These items were decontaminated between each sample in clean 5-gallon buckets at the drilling location. This water was also containerized in drums. All decontamination fluids were stored onsite next to Building 1 until proper disposal was arranged.

3.2 Investigation-Derived Waste Management

Investigation-Derived Waste (IDW) generated from the Phase II RI was classified as one of the following: drill cuttings, decontamination fluids and solids, development water, purge water, personal protective equipment waste, and general trash. All of the drill cuttings and water brought to the surface during soil boring, well installation, and development activities were containerized in drums. Decontamination fluids, well purge water, and well development fluids were also stored in drums. Soils were drummed separately for each well or drill site. A "waste material" label was placed on each drum or tank until the waste was properly classified. Each drum was labeled with the boring/well number, a unique drum number, M&E's name and phone number, the USACE point of contact and phone number, generation date, and contents using a permanent pen.

All of the drums were composite sampled for disposal purposes on March 14 and 15, 2000. Twelve composite soil samples and three composite water samples were collected. The samples were analyzed for toxicity characteristic leaching procedure volatiles, semivolatiles, metals, PCBs, pesticides, and herbicides. The analytical results indicated the all of the IDW was not regulated waste. Consequently, the IDW was disposed of by Innovative Waste Services at the

Hydro-Vac Services facility in Chattanooga, Tennessee. Disposal manifests documenting the proper disposal of all IDW is provided in **Appendix C**. All general trash was disposed of in onsite dumpsters with the permission of Eckerd.

3.3 Sample Identification

Each sample collect during the Phase II RI at the former CAMP was assigned a unique code identifying the project, matrix type, location, and sample number. The sample numbering system contains elements that also identify project sample duplicates, Quality Assurance (QA) split samples, and various Quality Control (QC) samples (i.e., trip blanks, equipment rinsate, and matrix spike samples). To protect the usability of laboratory analytical results, sample collection was documented in the field logbook, the sample containers were labeled, chain-of-custody completed, and the samples were shipped to the subcontractor laboratory in accordance with the procedures in the Sampling and Analysis Plan (SAP).

3.3.1 Sample Designation

Each sample identification code contained the location name, including two letters identifying the sample matrix/source type: SS for surface soil, SW for surface water, and MW for groundwater monitoring well. Each sample was then identified with two digits identifying the sample number collected at that location.
Typical sample numbers appear as follows:

COESS0201	Surface Soil, Location 2, Sample Number 01.
COEMW0302	Groundwater, Monitoring Well Number 3, Sample Number 02.
COESW05	Surface water, Location 5

3.3.2 Quality Assurance/Quality Control Samples

QA and QC samples were collected with the field samples, using the same procedures, equipment, and personnel. Field duplicate QC samples and QA field split samples were collected at a frequency of 10 percent of all field samples collected. Field personnel labeled the QC duplicate sample so that it was not distinguishable by laboratory personnel. The QA split sample was identified with the same designation as the original sample with the suffix "QA" and sent directly to the designated QA laboratory. QC duplicate samples were numbered as regular samples beginning with the number "50" for MW samples and the duplicated sample was noted in the field logbook. Typical QA and QC sample numbers appear as follows:

COEMW5001	Groundwater, Monitoring Well duplicate sample, Sample Number 01. Corresponding sample number noted in field logbook.
COEMW0302/QA	Groundwater, Monitoring Well Number 3, Sample Number 02, Split sample to USACE designated QA lab.

Other field and laboratory QC samples such as trip blanks (TB) and equipment blanks (EB) were labeled consecutively as they were collected. One trip blank was included in each cooler shipped to the laboratory that contained water samples for volatile analysis. A total of three equipment

blanks were collected during the monitoring well sampling event as specified by the USACE. Matrix spike/matrix spike duplicate (MS/MSD) samples were designated on the chain of custody and 2 times the volume of the field sample was collected at a frequency of one MS/MSD sample per twenty field samples.

3.4 Drilling Methods and Soil Sampling

3.4.1 Hollow Stem Auger Drilling

A hollow stem auger (HSA) column simultaneously rotates and axially advances using a mechanically or hydraulically powered drill rig. The hollow stem of the auger allows the use of various methods for continuous or intermittent sampling of soil material. Augers with an inside diameter of 6.25-inch were used to allow sufficient borehole annulus for well material placement. Casing and screens for monitoring wells were set through the augers when the desired depth (or refusal) was reached. The sand filter pack, bentonite, and grout were generally placed in the borehole after removal of the augers or either placed as the augers were gradually withdrawn from the hole. Drilling was performed in accordance with the methods described in the Phase II RI Work Plan, **Appendix D**, Section 8. HSA drilling was used to install all SZ wells.

3.4.2 Mud Rotary Drilling

Mud rotary drilling consisted of pumping drilling fluid down hollow rotating drill rods and through an 6-inch (nominal) outside diameter bit attached at the lower end of the drill rods set inside the 6-inch outer casing. Mud rotary drilling was attempted with potable water first and if cuttings circulation was poor, then bentonite powder was added to the drill fluid to increase the mud density, circulate cuttings out of the borehole, and stabilize the borehole walls. The drilling fluid was circulated back to the surface by moving up the annular space between the drill rods and the borehole wall and was then discharged at the surface through a pipe into a sedimentation tank. Cuttings were retained at the front of the tank by a series of baffles. Cuttings were periodically removed from the tank and transferred to 55-gallon drums for subsequent analysis. Mud rotary drilling was used to drill the TZ wells (COEMW20 through COEMW27) and to set the casings at the rock wells (COEMW28, -29, and -30).

3.4.3 Air Hammer Drilling

The rig setup for air rotary is similar to direct mud rotary except the circulation medium is air instead of water or drilling mud. Compressed air is circulated down through the drill rods to cool the bit, and carries cuttings up the open hole to the surface. A cyclone separator slows the air velocity and allows the cuttings to fall into a container. A 6-inch or 10-inch diameter down-the-hole hammer, which operates with a pounding action as it rotates, was used due to the very hard geologic formations. Drilling was performed in accordance with the methods described in the Phase II RI Work Plan, **Appendix D**, Section 8. Air hammer drilling was used on the three rock wells (COEMW28, -29, and -30).

3.4.4 Soil Sampling at Monitoring Well Locations

Split spoon sampling was conducted in accordance with American Society of Testing and Materials (ASTM) ASTM D1586, "Method for Penetration Test, and Split Barrel Sampling of Soils." Soil samples were collected for lithologic description but not for chemical analysis and only from one well of a well cluster. Soil was examined and described on geologic logs by a registered geologist. Descriptions included comments on grain size percentages, color, plasticity, consistency, density, moisture content, texture, structure, angularity, etc., as described in USACE EM 1110-1-4000. This information was logged on USACE Engineering Form 1836. Geologic Logs are included in **Appendix B**.

Ten soil samples were collected following ASTM D1586 methods and sampled for the physical analysis of grain size distribution (ASTM D422), Atterburg limits (ASTM D4318), moisture content (ASTM D2216). The soil samples were used to estimate characteristics of soil properties that may affect the fate and transport of contaminants in the subsurface.

3.5 Monitoring Well Installation

3.5.1 Installation Procedures

The well materials for the SZ wells were either installed through the augers or once the augers were pulled. Well materials were placed in TZ and BZ wells immediately after removing the drill stem and bit. A gauged, weighted line was used to monitor to filter pack placement. The filter pack extended at least 2 feet above the top of the screen. At least a 2-foot thick bentonite pellet seal was placed above the top of the filter pack. The pellets were allowed to fall into the annulus between the auger/borehole and the well casing. If the seal was installed above the water table, approximately 5 gallons of water was used to hydrate the pellets. A minimum of 1 hour of bentonite hydration was allowed before grouting.

Grout was placed by pouring from the surface for depths of five feet or less. For greater depths, grout was installed via tremie pipe. Grout was placed from the top of the bentonite seal to the surface. Following curing and settling, additional grout was added as needed. All wells were completed flush to ground with an 8-inch-diameter traffic-bearing manhole with a bolt-down cover to prevent tampering. Each well was completed with a 4-inch thick, 2-foot square concrete pad, sloped away from the well surrounding the steel manhole assembly. The concrete and manhole assembly was completed flush to existing grade.

3.5.2 Well Development

Development of new wells began at least 48 hours after grouting was complete. Well development consisted of mechanical pumping and surging. Water levels, specific conductance, temperature, pH, and turbidity was measured and recorded before and during development. Each well was developed until the column of water in the well was free of visible sediment, and the pH, temperature, specific conductance, and turbidity had stabilized, or was below 10 nephelometric turbidity units. A clear glass jar was filled with groundwater from the well, labeled, and photographed with 35-mm color print film to be part of the well log. All developed

water was drummed pending analysis. At least five well volumes of water, including the saturated borehole volume (assuming 30 percent porosity) was removed during development. In addition, five times the volume of any water added to the well during filter pack placement was removed. Monitoring well development sheets and photographs documenting well development activities are provided in **Appendix D**.

3.5.3 Well Abandonment

Boreholes that were not completed with monitoring wells, along with any boring deemed unacceptable for monitoring well installation, were abandoned by pumping bentonite/grout slurry to the bottom of the hole via tremie pipe. Grout was pumped until it flowed at the ground surface and topped off the next day to fill any settling that may have occurred. All well abandonment was conducted in accordance with applicable State and Federal Regulations.

3.6 Sample Collection

3.6.1 Surface Soil

Five surface soil samples were collected as part of the QRA. These soil samples were analyzed for VOCs by United States Environmental Protection Agency (USEPA) method 8260B/5035, Semi-volatile organic compound (SVOC) by USEPA method 8270C/3550, sulfate by USEPA method 9036, PCBs by USEPA method 8082/3550, and target analyte list (TAL) metals by USEPA method 6010/3050A/7000. **Figure 3.1** shows the location of all surface soil samples collected during the Phase II RI. All samples were collected following procedures outlined in the Work Plan and SAP prepared for the Phase II RI. All samples were collected from 6 to 12-inches bls.

3.6.2 Surface Water

One surface water sample was collected as part of the QRA to determine human health risks at the former CAMP. **Figure 3.1** shows the location of the surface water sample collected during the Phase II RI. The sample was collected following procedures outlined in the Work Plan and SAP prepared for the Phase II RI. The sample was analyzed for VOCs (USEPA method 8260B/5035), methane by GC, nitrate/nitrite (USEPA method 353.2), sulfate (USEPA method 9036), chloride (USEPA method 9251), alkalinity (USEPA method 301.1), cyanide (USEPA method 9010B), and TAL metals (USEPA method 6010/3050A//7000) as described in the SAP.

3.6.3 Monitoring Wells

A total of 37 groundwater samples were collected during this Phase II RI (well COEMW29 has two screens zones and COEMW04 contains free product and was not sampled). **Figure 3.1** shows the location of all groundwater monitoring wells sampled in February/March 2000 and source areas that were studied as part of the Phase II RI. Each well was sampled in a manner consistent with that used during the Phase I RI investigation. All samples were collected following procedures outlined in the Work Plan and SAP prepared for the Phase II RI. Eighteen

new and eighteen existing wells (including 6 Eckerd wells) were sampled during the Phase II RI project. The groundwater samples were analyzed for VOCs (USEPA method 8260B/5035), methane by GC, nitrate/nitrite (USEPA method 353.2), sulfate (USEPA method 9036), chloride (USEPA method 9251), alkalinity (USEPA method 301.1), and TAL metals (USEPA method 6010/3050A/7000) as described in the SAP. Wells COEMW02, -05, -17, and -26 were also analyzed for cyanide (USEPA method 9010B). The potable water source (fire hydrant) was also sampled for all the analytes listed above. A site map showing areas of concern is presented in **Figure 3.2**. This figure shows the possible source areas that are studied under the Phase II RI.

4.0 SITE INVESTIGATION ACTIVITIES

4.1 Field Activity Overview

M&E and technical subcontractors performed a number of field activities at the former CAMP during the Phase II RI as discussed in the sections below. These activities were designed to define the extent of surface and subsurface contamination and to characterize the geologic framework of water bearing zones beneath the site.

The Phase II RI field investigation was divided into three stages: Stage I- Geologic Mapping/Subsurface Study/Risk Assessment, Stage II- Groundwater Contaminant Plume Delineation, and Stage III- Aquifer Testing. The first stage of the investigation was conducted to collect additional information on the hydrogeologic framework of the shallow and bedrock aquifers. A number of direct (installation of three BZ wells and borehole geophysical surveys) and indirect (lineament studies and review of existing information, studies, and research papers) methods were utilized during this first stage of the investigation. A geostatistical evaluation of the lineament and subsurface data was conducted. A QRA was conducted concurrently with the geologic investigations in Stage I. Details of the risk assessment are provided in Section 7.

Hydrogeologic aquifer testing was conducted in Stage III using newly-installed and existing monitoring wells to collect hydraulic data from both the shallow and deeper portions of the shallow aquifer. Data collected from the stage I of this investigation was necessary to select the best locations for the proposed wells to define the vertical and horizontal extent of contamination (Stage II). Sampling sheets documenting sample collection procedures, sample locations, conditions at the sampling location, and other pertinent information are provided in **Appendix D**. Field equipment calibration sheets are provided in **Appendix E**.

4.1.1 Potable Well Survey

No potable wells were observed in the area, but a search of the NCDENR groundwater well registration files indicate seven wells within a 1-mile radius. An illustration of the potable well search radius superimposed on a topographic map of the investigation area is provided on **Figure 2.7**. All of these wells are in an up-gradient or side-gradient location and are unlikely to be impacted by former CAMP activities. The Charlotte Municipal Utilities Department supplies potable water to the former CAMP area and no information is available to indicate wells within the search radius are still active. The construction details of the aforementioned seven wells are unknown, as that portion of the NCDENR form was largely incomplete. A list of registered water supply systems that use groundwater, posted on the NCDENR webpage, did not give addresses of the wells; only addresses of the owners. The majority of the systems listed are operated by churches and restaurants, i.e. transient populations or limited use. The USGS reported that no registered wells were within a 1-mile radius of CAMP. The Census Bureau also has records of wells in the Charlotte area but these records do not show exact well locations and will not be available to the public until 2062.

The North Carolina Department of Environment and Natural Resources (NCDENR) Groundwater Section was contacted to search for wells within a one mile radius of former CAMP in records of drinking water wells. Some records exist, but since well registration is not required, data are incomplete. The Census Bureau has confidential records, which include private well data. The 1990 Census reported 97 drilled wells and 21 hand installed wells in the Block 3 Group, some of which are within a one-mile radius of the site. However, no maps have been developed and information identifying well owners (names and addresses) will not become available until 2062.

4.2 Risk Assessment Sampling

4.2.1 Soil

M&E personnel collected five surface soil samples at the site (**Figure 3.1**) on February 28, 2000. These samples were initially considered to be representative of background conditions and were collected from the southwestern area of the site in areas thought to be unaffected by CAMP activities. The samples were, however, collected from landscaped areas near existing structures and most likely are not representative of true undisturbed background soil quality. Nevertheless, the soil sample results are discussed in Section 5 of this report and are provided primarily for comparison purposes in this report. Risk assessment data review is provided in Section 7.

4.2.2 Surface Water

M&E personnel collected one surface water sample (**Figure 3.1**) on February 28, 2000 at the outfall of a man made drainage culvert located at the northwestern corner of the site across Statesville Avenue. Surface water sample results are discussed in Section 5 of this report. Risk assessment data review is provided in Section 7.

4.3 Lineament Study

A lineament study utilizing USGS 7.5-Minute Quadrangle maps of the site and surrounding area was performed. On the topographic maps, linear geomorphic features were identified by the alignment of topography or topographic features, which are laterally continuous. The results of the lineament study indicate nine lineaments within a one-mile radius of the site. These lineaments are overlain on a USGS 7.5-minute quadrangle map and presented in **Figure 4.1.** Some of the lineaments may be man-made features. None of the lineaments within the one-mile radius intersect the site property, however, one lineament is adjacent to the site (stream located just off the property to the northwest). The trend of the lineaments range from N15W to N85W (seven lineaments) and N50E (two lineaments). The closest lineament to the site has a trend of N55W. It would appear that the most down-gradient proposed wells would be in a position to intersect this suspected lineation. The lineament study was also utilized in the geostatistical study to determine optimal well locations.

4.4 Borehole Geophysical Logging

Geophysical logging of the three boreholes of the rock wells was conducted on September 29 and 30, 1999. Geophysical logging of the three boreholes of rock wells (COEMW-28, -29 and -30) was conducted while boreholes were open hole (with the exception of surface casings). The 4-inch diameter open hole extended into rock between 40 and 50 feet in order to have a sufficient logging distance to identify potential water-bearing fractures. Fluid temperature, caliper, natural gamma, acoustic televiewer/spectrum and heat pulse flowmeter (HPF) logs were completed for each well. The additional parameters of single point resistance (SPR), spontaneous potential (SP), and fluid resistivity were run in addition to the SOW since these parameters were already set up and incurred no additional cost. The purpose of the logging was to evaluate the geology and groundwater flow characteristics at each of the three rock wells. The geophysical logging can reveal the orientation, distribution and hydraulic properties of fractures, which exert influence upon the migration of chemical constituents in groundwater. Reports of the geophysical logging, including copies of the logs, are presented in **Appendix F** (fluid temperature, caliper, natural gamma ray, acoustic televiewer, and HPF). The three rock boreholes were completed as permanent monitor wells after the completion of geophysical logging. Well construction schematics are provided in **Appendix G**. Each well was set in a 2-foot by 2-foot concrete pad and capped with a bolt-equipped steel manhole.

4.4.1 Borehole Geophysical Logging Methodology

A description of the methodology and purpose of each geophysical logging parameter follows.

Fluid temperature / resistivity log

The fluid temperature and resistivity logs provide a vertical temperature profile of the water in the well bore. Groundwater entering or leaving the well at various levels can cause slight changes in the fluid temperature, which can be an indication of water-producing zones. The fluid temperature log was completed first, and was recorded from the top of the well down, to minimize the effects of logging instruments on the temperature profile of the well. A second fluid temperature / fluid resistivity log was made coming up the borehole under pumping conditions. The fluid temperature log has a resolution of 0.1 degrees and a range of –20 to +80 degrees. The fluid resistivity has a resolution of 0.05% and a range of 0 ohm-m to 100 ohm-m.

Natural Gamma / Caliper / SPR / SP Log

A multi-sensor probe was used to acquire the caliper, natural gamma, SP, and SPR logs. The logs are acquired coming up the borehole at a speed of 15 feet / minute. The natural gamma log measures the variation in gamma radiation produced naturally by geologic materials and, therefore, indirectly provides an indication of lithology. Accessory minerals in crystalline rocks commonly emit higher natural gamma radiation and a gamma log can indicate the distribution of these minerals and, indirectly, foliation in crystalline rocks. In the weathered zone, minerals emitting higher levels of gamma radiation tend to occur in clays and zones of accumulation. Unconsolidated sand and silt generally has very low levels of natural gamma radiation. The caliper log measures the diameter of the borehole. Fractures may be indicated by changes in borehole diameter depending on fracture size and orientation. The caliper log measuring range is 1.7 to 24 inches with a resolution of 0.2 inches.

Full-Waveform Sonics
Full-Waveform Sonics Logs are run coming up the borehole at approximately 8 feet / minute. These logs are plotted as variable density logs. The variable density logs represent the full-waveform sonic log as a series of discrete times at which the waveform crosses the amplitude threshold.

Acoustic televiewer logs
The acoustic logs measure the amplitude and pulse travel time of transmitted acoustic pulses returning from the borehole wall. The acoustic televiewer is a borehole acoustic reflectance device that utilizes the amplitude and travel time of an ultrasonic beam reflected from the borehole wall to detect the presence of possible features exposed on that wall. These features are typically those that produce a change in the acoustic impedance and thus the reflectance coefficient of the material. The resulting log provides an oriented image of the borehole wall. From these logs, the depth, orientation, and dip of fractures intersecting the borehole can be determined. The acoustic televiewer probe can resolve features as small as 2 mm and detect fractures as small as 0.1 mm.

Heat Pulse Flowmeter Logging
The wells were logged using a HPF under both ambient (non-pumping) and pumping conditions. The ambient log provided information on groundwater movement through the open borehole as a result of naturally occurring vertical gradient differences. For the pumping log, various intervals of the borehole were isolated using a packer (thereby varying the interval measured by the flowmeter) to determine relative production and hydraulic conductivity characteristics. The resulting log is a profile of the vertical distribution of flow production in the well. Production from each zone was corrected for ambient flow. The HPF instrument accurately measures flow from 0.1 to 1.5 gallons per minute (gpm).

The HPF is set up with the pump withdrawing water from above the flowmeter. The flowmeter relies on a set of diverters between the upper and lower thermistors to direct borehole flow through the center of the tool. Refer to **Appendix F** for details on the design of the flowmeter logging equipment.

4.4.2 Borehole Geophysical Logging Results

The results of the geophysical logging of COEMW28, -29, and -30 are summarized below. Copies of the logging reports are included in **Appendix F**.

COEMW28

- The interval logged was 78.5 feet bls (bottom of casing) to 127.7 feet bls (total depth). Fluid temperature indicates no outstanding producing zones.
- The caliper log indicates no washout or cavity features. The uniformity of borehole diameter likely indicates unweathered bedrock (see **Appendix F**).
- The natural gamma log indicates a few areas of higher radiation, possibly due to higher feldspar or mica content (gamma sources) in the rock, but these areas do not correlate with

the presence of fractures these areas.

- The acoustic televiewer log indicated 14 fractures in the borehole with a cluster centered between 90 and 95 feet bls. Many of the fractures between 90 to 95 feet bls dip to the northeast at angles between 4° and 34°, other fractures present in the borehole appear randomly oriented.
- Ambient water flow in COEMW28 was very minor. Three fractures, each producing less than 0.05 gpm, were indicated in the 90 to 95 foot range. One other water producing fracture was detected at 81 feet bls.

COEMW29

- The interval logged was 75.2 feet bls (bottom of casing) to 117.8 feet bls (total depth). Fluid temperature indicates no significant water producing zones.
- The caliper log indicates no washout or cavity features. The uniformity of borehole diameter likely indicates unweathered bedrock (see **Appendix F**).
- The natural gamma log indicates a significant increase in gamma radiation at 60 (in overburden) and 100 (in rock) feet bls, probably indicating a zone of weathering or accumulation of gamma source material.
- The acoustic televiewer log indicates 36 fractures in the borehole. Numerous clusters of fractures are found within the 90 to 110 feet bls interval. The fractures within this interval range in dip from 4° to 72°. Another fracture cluster is noted at 114.8 to 115.9 feet bls. Many fractures in the 114 to 115 interval dip to the southeast at 36° to 42°. Northeast dipping fractures tend to occur between 75 to 89 feet bls.
- Ambient flow in well COEMW29 was up to 1 gpm (see **Appendix F**). Seven water-bearing fractures were identified and all produce 0.5 to 1 gpm. Fracture in depths bls were 83, 89, 95, 97, 99, 107, and 114.

COEMW30

- The interval logged was 64.1 feet bls (bottom of casing) to 114.6 feet bls (total depth). The fluid temperature log indicates a producing zone at 69 to 71 feet bls.
- The acoustic televiewer log indicates a large washout zone or cavity from 69 to 71 feet bls. The uniformity of hole diameter below 71 feet bls probably indicates unweathered bedrock (see Appendix F).
- The natural gamma log indicates a small decrease in gamma radiation between 69 and 71 feet bls, indicating a zone of weathering.
- The acoustic televiewer log indicates 6 fractures in the borehole besides the cavity at 69 to71 feet. The major fracture trend dips to the southeast between 24 to 36 degrees.
- Ambient flow in COEMW30 was minor except from the cavity and a fracture at 67 feet bls. Flow at the fracture at 67 feet bls was 1 gpm but the flow from the cavity at 69 to 71 feet bls could not be determined because the cavity was too large and the flow tool could not isolate the cavity.

4.4.3 Borehole Geophysical Logging Summary

Geophysical logging of COEMW28, -29, and -30 indicates that the bedrock is fractured but not all fractures are water bearing. The water-producing fractures were determined form the Heat

Pulse flowmeter logs. The heat pulse flowmeter logs indicated which fractures produced water when stressed. Screen intervals for the permanent monitor wells were selected based on the interpretation of all information collected from the suite of geophysical logging at each borehole location. The screen interval for COEMW28 was determined to be 90 to 95 feet bls. Two screen intervals for COEMW29 were chosen based upon heat pulse flowmeter readings. The screen intervals chosen were 92.5 to 97.5 feet bls and 112.5 to 117.5 feet bls. The screen interval for COEMW30 was selected at 68 to 73 feet bls.

4.5 Geostatistical Study

A geostatistical study was performed using data from previous studies at CAMP and data from the initial stages of the Phase II RI performed by M&E. These data were input into a geostatistical model to determine the statistical significance of the acquired data. Statistically significant data were identified for use in optimizing selection of proposed well locations at former CAMP for plume delineation. The data utilized in the geostatistical study included groundwater analyses from the 29 temporary wells (COEHP01-29), nine existing SZ monitoring wells (COEMW01, -8, and -12), three existing TZ monitoring wells (COEMW9-11), three new BZ wells (COEMW28-30), and seven existing SZ and one existing TZ (MW1A) monitoring wells installed by Eckerd.

This model evaluates how critical sampling points are (both existing and proposed) in relation to the estimated TCE distribution. The geostatistical study performed by Hydrovision is presented in **Appendix H**.

Interpretation of the data was conducted following the procedures outlined below:

- An exploratory statistical analysis was performed by investigating the range and frequency distribution, data outliers, and spatial coverage of data (using statistics, histograms, probability plots, etc). Geostatistical software GS+ was used to perform the statistics.
- An underlying variogram model is used to determine directional and spatial correlation of the data.
- A kriging estimation was performed on the data based on selected variogram models.
- Repeat analysis involving subsurface and surface data using co-kriging to examine cross-correlation was performed.
- The best possible placement of sampling locations (wells) based on the hydrogeochemical factors was identified. Less confident (i.e., higher error) data in the estimation indicted a higher probability that additional sampling was needed.

The conclusions reached by the geostatistical study confirmed the location of the majority of the proposed well locations with the recommendation of moving two wells to more optimized locations (COEMW20 and COEMW23). In accordance with the geostatistical model, the wells were placed in the optimum locations for groundwater monitoring of dissolved contaminant plumes.

4.6 Aquifer Testing and Groundwater Characteristics

Aquifer testing (slug tests) were conducted in ten newly installed and existing wells at the former CAMP. The aquifer testing consisted of rising head or "slug-out" aquifer tests. The objectives of these tests were to estimate the hydrogeologic properties of the aquifer in the SZ zone (water table), TZ zone (weathered rock), and the BZ zone (rock) underlying the site.

4.6.1 Slug Testing Methodology

The following test procedures was followed for conducting slug tests using a solid slug or a bailer to displace water in a well:

- Measure the static water level in the well and note the position of the water level in relation to the top of the screen.
- Place a pressure transducer that is connected to an electronic data logger near the bottom of the well.
- Place a solid slug or a bailer into the well so that the entire slug is submersed in groundwater. Let the water level recover to static conditions.
- Program the data logger to record data on a logarithmic cycle and so the transducer is set to the desired reference level (e.g., zero).
- To begin a test, withdraw the slug while simultaneously pressing the start key on the data logger to begin recording data. Continue recording data until the water level has recovered to within 10 percent of the static water level based on the maximum displacement caused by the slug or until enough data has been collected to produce a useable time-recovery curve.
- At the conclusion of the test, downloaded the data to a computer.
- Aquifer test data reduced and interpreted using Bouwer & Rice methodology.

4.6.2 Aquifer Testing Results

Falling head "slug" tests were performed on ten wells: four SZ wells, five TZ wells, and one BZ well. The SZ wells were MW04, COEMW05, COEMW08, and COEMW14. The TZ wells were MW1A, COEMW09, COEMW10, COEMW11, and COEMW25. The BZ well was COEMW28. Results obtained from these tests are presented in **Table 4-1** and in **Appendix I.**

Analysis of data was performed using Aqtesolve Professional v.2.5 (1999) groundwater modeling software utilizing the Bouwer and Rice methodology for hydraulic conductivity estimation. The unconfined method was used for the SZ wells and the confined method was used for the TZ and BZ wells because these wells exhibited pressure when opened in the field, indicating some degree of confining by the overburden. The SZ hydraulic conductivity values obtained ranged from 0.027 ft/min at COEMW08 to 0.019 ft/min at COEMW05 with an average value (geometric mean) of 0.011 ft/min. The TZ hydraulic conductivity values obtained ranged from 0.0094 ft/min at COEMW09 to 0.000029 ft/min at COEMW11 with an average value (geometric mean) of 0.0048 ft/min. The BZ hydraulic conductivity value was 0.00014 ft/min at COEMW28.

4.7 Well Survey

The locations of all monitoring wells and sample locations were surveyed by a licensed professional surveyor. The survey provided coordinates of all sampling locations referenced to the State Plane Coordinate System and elevations were referenced to the National Geodetic Vertical Datum of 1929.

Elevation of natural ground surface was surveyed at every sampling location to the closest 0.1 foot. In addition, the top of casing elevation was determined to the closest 0.01 foot for each well. Horizontal accuracy was to the nearest foot. Survey data is provided in **Appendix J**. A summary of groundwater monitoring well survey data is provided in **Table 2-2**.

4.8 Groundwater sampling

Well locations were selected to define the vertical and horizontal extent of the TCE groundwater contamination plumes previously identified in Phase I of the RI. A total of 37 groundwater samples were collected during the Phase II RI from February 29 to March 5, 2000. The groundwater samples were collected from permanently installed SZ, TZ, and BZ groundwater monitoring wells. Each well was purged with either a peristaltic or Grundfos pump in accordance with procedures outlined in the Phase II RI SAP prior to collecting a sample. Well COEMW29 was sampled with a Well-Wizard bladder pump and packer system powered by inert nitrogen gas (99.99% pure). The lower screen was purged with only the top packer in place and sampled through the teflon-lined tube. The pump/packer assembly was then removed from the well and the lower packer attached and lowered into the well to bracket the upper screen. The upper screen was then purged and sampled through the teflon-lined tubing. Groundwater sampling sheets are provided in **Appendix D**. Each sample was analyzed for VOC, methane, sulfate, cyanide, alkalinity, chloride, nitrate, and TAL metals. Wells COEMW02, COEMW05, COEMW17, and COEMW26 were also sampled for cyanide. Also, pH, conductivity, temperature, dissolved oxygen, and oxidation-reduction potential measurements were collected in the field.

Analytical results of groundwater samples confirm the presence of organic VOC contamination. A discussion of groundwater analytical results is provided in Section 5 of this report.

5.0 DATA EVALUATION AND EXTENT OF CONTAMINATION

5.1 Applicable or Relevant and Appropriate Requirements (ARAR)

5.1.1 Background Criteria

Background soil and groundwater sampling locations were identified in the Phase II RI Work Plan. There is no background surface water location identified since no up-gradient surface water exists. Background locations were selected within the site where impacts from past operations were not expected. Chemical analysis of background soil samples included VOCs, SVOCs, sulfate, PCBs, and TAL metals. Groundwater samples were analyzed for VOCs, methane, sulfate, cyanide (4 wells), alkalinity, chloride, nitrate, and TAL metals. All background soil and groundwater sample locations are illustrated **Figure 3.1**. All sampling locations were located in close proximity to former CAMP buildings and more recent improvements associated with commercial/ industrial operations at the site. Naturally occurring levels of inorganic analytes were established based on background sample analyses. Background concentrations of organic parameters in these media are assumed to be the method detection limit. Background soil and groundwater quality is summarized in Section 5.3 of this report.

5.1.2 Groundwater and Surface Water Criteria

MCLs have been federally promulgated under the Safe Drinking Water Act. The MCL is an enforceable standard, which was established for drinking water purposes, and they are applied to contaminants in groundwater as well as surface water.

The State of North Carolina Department of Environmental Health and Natural Resources has promulgated groundwater standards (Title 15A, Subchapter 2L, Sections .0100, .0200, and .0300), which for most contaminants are more stringent than MCLs. The state groundwater standards are health-based criteria used to determine if contamination exists and may be applied as remediation goals. For sites with more than one groundwater contaminant, site-specific risk-based cleanup goals are typically derived to account for cumulative effects. The North Carolina Guidelines for Responsible Party Voluntary Site Remedial Action (March 1996) lists health-based remediation goals as the lower of either State Subchapter 2L Standards or Federal MCLs. Where neither of the standards exist, the health-based remediation goal calculated using the current State and USEPA risk assessment guidance are applied. These criteria will be compared to background concentrations prior to being considered as a remediation goal.

North Carolina has also promulgated surface water standards (Title 15A Subchapter 2B, Sections .0100 and .0200). These state standards have been established to maintain the water quality of surface waters of the State. They are developed upon ecological and human health-based data and can be used to both determine if contamination exists and as remediation goals [2L .0208(a)(1)&(2)]. These criteria will be compared to background concentrations prior to being applied as a remediation goal

The parameters analyzed in groundwater and surface water included VOCs (EPA method

8260B/5035), TAL metals (EPA Methods 6010/3050A/7000), methane (EPA Method 8015DAI), sulfate (EPA Method 9036), cyanide (EPA Method 9010B), alkalinity (EPA Method 310.1), and chloride (EPA Method 9251). The corresponding MCLs and State 2L standards, where they exist, and criterion background concentrations (CBC) for inorganic COPCs are listed in **Table 5-1** for constituents identified in the groundwater. The CBC is equal to two times the average background concentration. Available State 2B surface water standards are listed in **Table 5-4** for constituents identified in the surface water sample.

5.1.3 Soil Criteria

Soil samples were evaluated using the USEPA Region 3 Risk Based Concentrations (RBC Table 4/13/200) and CBCs for the protection of human health. RBCs are based on ingestion of soil under both the residential and industrial use scenarios. Section 5.3 discusses the analytical results of the soil samples collected during this Phase II RI. The risk assessment (Section 7) discusses the data with respect to the health-based USEPA risk assessment guidance and background concentrations. Surface soil samples were evaluated using the residential RBCs. For metals, surface soil contaminants were also compared to the CBC. Subsurface soil containing organic compounds was compared to the listed RBC for an industrial exposure scenario. Soil containing metals were compared to industrial RBCs and the site-specific CBC, which is two times the average background concentration. Screening criteria are provided in **Table 5-2** for the constituents detected in soil.

5.2 Data Validation

Analytical data was reviewed and validated by M&E staff chemists using the QA/QC requirements provided in the SW846 analytical methods and the guidance provided in the USEPA National Functional Guidelines for Organic Data Review. Data validation summaries were written and compliance to the prescribed criteria was verified and listed in the summary. A data quality summary report (DQSR), contained in **Appendix K**, describes the evaluation of the required QC results provided by the subcontractor laboratory, for each method of analysis.

Laboratory data was evaluated to assess holding times, laboratory blanks, laboratory control samples, surrogate recoveries, and (MS/MSD) recoveries and the relative percent difference (RPD) between duplicate analyses. This criterion was used to evaluate the accuracy and precision of the data generated by the laboratory. The quality of the laboratory data is assessed through evaluation of the following:

- Adherence to prescribed sample preparation and analysis methods
- Recovery and RPD of MS/MSD from field samples
- Method blank contamination
- Analysis within holding time criteria
- Recovery of surrogate spikes
- Recovery of laboratory control samples
- Field duplicate precision
- Proper sample preservation

During the independent validation process by M&E, all laboratory QC data were reviewed, evaluated and compared to the defined criteria, then assigned a data qualifier. These qualifiers are detailed in the DQSR contained in **Appendix K**. Data qualifiers were not assigned to data that were in compliance with the quality control requirements and review criteria.

5.2.1 Qualified Results

In general, the qualifiers that were applied to the data as determined by the detailed validation process included estimated results indicated by a "J" due to various QC criteria falling outside prescribed limits, such as surrogate recoveries and spike recoveries. The majority of the estimated results are due to laboratory flags for compounds detected below the Laboratory Quantitation Limit (LQL): sample dilutions are required to analyze samples having high concentrations of one or more organic compounds.

5.2.2 Overall Data Quality

RPD were not calculated for non-detected results where one or both field duplicate sample concentrations were reported less than the LQL. Results associated with an RPD greater than 50% were due to very low concentrations detected in the samples and were not qualified. As stated above, the majority of estimated (J) results are due to the laboratory flags where compounds are detected below the laboratory LQL. The amount of useable data collected during the RFI is enough to meet the completeness objective of greater than 95% for all matrices. Additional discussion of data usability is provided in Section 7.

5.3 Summary of Analytical Results

5.3.1 Background Locations

Suitable background surface soil sampling locations do not exist at the former CAMP as mentioned in the PAR (**Appendix L**) and specific background surface soil sample locations were not selected for the Phase II RI. The site has undergone intensive grading and industrial activity for decades and undisturbed soil is not present. Five surface soil samples were collected from the southern area of the site in areas thought to be unaffected by former CAMP activities (**Figure 3.1**). The samples were collected within landscaped areas adjacent to Buildings 4 and 5. The results of constituents detected in all surface soil samples collected during the Phase II RI are listed in **Table 5-3**. Soil quality in these samples may be consistent with overall surface soil quality at the former CAMP and the presence of trace concentrations of organics and metals in surface soil suggest that anthropogenic activities have impacted soil quality. Therefore, these surface soil samples are provided solely for comparison purposes in this report and should not be construed to represent true undisturbed background soil quality.

Subsurface soil samples were compared to soil samples collected from background monitoring well borings during both Phase I and Phase II. During Phase I, only two samples in one soil boring (HP29) were used for calculation of soil subsurface background concentrations. During

Phase II an additional soil sample was collected from the BZ background well COEMW28. See **Figure 3.1** for background soil sample locations. The Phase II RI sample was analyzed for VOCs, SVOCs, sulfate, PCBs, and TAL metals. Inorganic analytical results from this sample and the two background subsurface soil samples collected during the Phase I RI were combined to develop the arithmetic average background concentration and CBC (the arithmetic average concentration multiplied by two).

Background groundwater conditions were assessed calculating the average of the concentrations of compounds detected in monitoring wells COEMW08, COEMW09, and COEMW28. These wells represent a combination of up-gradient conditions: in SZ, TZ and BZ monitoring wells, respectively. Organic constituents that are not naturally occurring were not detected in background wells with the exception of acetone. Acetone is a common laboratory contaminant and is also a breakdown product of isopropyl alcohol; used in sampling equipment decontamination procedures. These wells are therefore considered to be representative of background conditions.

5.3.2 Surface Soil Quality

Acetone and Polynuclear Aromatic Hydrocarbons (PAHs) were detected in surface soil samples at concentrations below the respective RBCs. Trace concentrations of acetone identified in surface soil samples may be a result of incidental laboratory or field contamination (i.e., associated with the incomplete removal of isopropyl alcohol used in field equipment decontamination). Fuel components (PAHs) that were identified in two of five surface soil samples are likely associated with vehicular discharges common in parking areas surrounding Buildings 4 and 5. While several metals were detected in surface soil samples, only arsenic concentrations exceeded the RBC criterion. The results of constituents detected in all surface soil samples collected during the Phase II RI are listed in **Table 5-3**. Soil quality in these five samples may be consistent with overall surface soil quality at the former CAMP (i.e., marginally affected by commercial/ industrial activities in the area).

5.3.3 Subsurface Soil Quality

Subsurface soil samples were collected from above the water table at the 18 new monitoring well locations. Samples were analyzed for VOCs, SVOCs, sulfate, PCBs, and TAL metals. The analytical results show that acetone was detected in nine samples but concentrations were well below the RBC. Positive detections of acetone in soil samples are commonly a result of incidental laboratory or field contamination. TCE was detected at two of locations (COEMW26 and COEMW30) at concentrations well below the RBC. Sulfate was not detected at any well location. Aroclor 1260 was detected in one down-gradient location (COEMW30) at 0.026 J mg/kg; well below all screening criteria. No SVOCs were detected in the soil samples.

Several metals were detected in subsurface soil samples but none exceeded their respective Industrial RBC. The subsurface soil sample results are summarized in **Table 5-5** and complete analytical results are provided in **Appendix K**.

The CBC generated during the Phase II RI was used to reevaluate soil analytical results obtained during the Phase I RI. Arsenic in Phase I RI subsurface soil samples exceeded the industrial RBC of 3.8 mg/kg in several locations at concentrations ranging from 1.3 mg/kg to 7.4 mg/kg. The lead concentration at COEHP07 (490 J mg/kg) marginally exceeded the provisional screening criteria of 400 mg/kg at one Phase I RI location. The Phase I subsurface soil data is presented in **Table 5-6**. Reevaluation of the Phase I RI soil analyses with respect to the Phase II CBC indicates that only arsenic is consistently present above both the industrial RBC and the CBC. However, arsenic concentrations are relatively low overall, are present near the detection limits, and are all less than or equal to two times the industrial RBC. One exception to this occurs at COEHP23 where arsenic (8.4 mg/kg) is slightly greater than twice the industrial RBC of 3.8 mg/kg. The presence of arsenic in subsurface soil may be attributable to naturally occurring conditions. Additional data on the concentrations of naturally occurring elements in soil are available in *Elemental Concentrations in Soils and Other Surficial Materials of the Coterminous United States*, USGS Geological Survey Professional Paper 1270 (H.T. Shacklette, and J.G. Boerngen, 1984). According to the Paper, the arsenic concentration range in Eastern United States (US) soils ranges from 0.1 to 73 mg/kg. The arithmetic mean given for arsenic reported in by Shacklette, & Boerngen is 7.4 mg/kg. The concentration range of arsenic in subsurface soils of former CAMP is below the mean Eastern US arsenic concentration presented in the Professional Paper; with the single exception noted above. Thus, the occurrence of arsenic in subsurface soil is most likely derived from natural materials and is not considered to be significant in magnitude or frequency.

5.3.4 Surface Water

One surface water sample, designated COESW01, was collected from the outfall of a man made stream drainage feature during the Phase II RI. This sample was analyzed for the same parameters as the groundwater: VOCs, TAL metals, cyanide, methane alkalinity, chloride, and nitrite/nitrate. The surface water sample location is down-gradient of the site and it is the only surface water identified in the area. According to maps of NCDENR, Division of Water Quality Planning Branch, Water Supply Watershed Protection, surface water at the site is not classified as class I, II, III, or IV.

The organic compounds detected in surface water were carbon tetrachloride, chloroform, 1,1-dichloroethene, TCE and naphthalene. These compounds were identified at concentrations ranging from 0.15 µg/L to 45 µg/L. TCE was detected at a concentration of 45 µg/L, which exceeds the federal MCL of 5.0 but is below the NCAC 2B standard of 92.4 µg/L. **Table 5-4** lists the constituents detected in all surface water samples as compared to the NCAC 2B Groundwater Standards. No surface water parameter exceeded NCAC 2B standards.

5.3.5 Groundwater Quality

All groundwater samples were analyzed for VOCs (USEPA method 8260B/5035), TAL metals (USEPA 6010/3050A 7470/7471), and water quality parameters. Four wells also were analyzed

for cyanide (USEPA method 9010B). These wells are COEMW02, COEMW05, COEMW17, and COEMW26 and are located in the area on the east-end of Building No. 2. No cyanide was detected in any of the wells. Groundwater sample results are summarized in **Table 5-7** and complete analytical results for all groundwater samples are provided in **Appendix K**.

VOCs
Several organic compounds were found in the groundwater that exceeded federal MCL as well as North Carolina 2L Standards. Constituents exceeding the standards include chlorinated VOCs; most prevalent among these are chloroform, TCE and 1,1-dichloroethene. Several other chlorinated VOC compounds and naphthalene are present at concentrations above the MCL and 2L standards, however, TCE is the most widespread constituent, and it occurs at the highest concentrations.

Illustrations of TCE concentrations in the SZ, TZ, and BZ portions of the shallow aquifer are provided in **Figures 5.1, 5.2,** and **5.3**, respectively. Other chlorinated VOC detected may be degradation products of TCE. Potential groundwater exposure and human health risk associated with impacted groundwater is addressed in Section 7.

TAL Metals
The inorganic analytes detected in the groundwater appear to be associated with naturally occurring sources. Aluminum, chromium, iron, lead, and manganese concentrations in several groundwater wells exceed the MCL and NCAC 2L standards. A summary of constituents detected in groundwater, water quality parameters, and groundwater screening criteria is presented in **Table 5-7**. Analytical results for all groundwater samples are provided in **Appendix K**.

Water Quality Parameters
Additional water quality analyses were performed on groundwater samples which include alkalinity, chloride, nitrate/nitrite, sulfate, methane, and field measured parameters: pH, temperature, specific conductance, dissolved oxygen and oxidation/reduction potential (redox). Geochemical analytical results are discussed in Section 6 of this report and are summarized on **Table 5-7**. Complete laboratory reports for all geochemical parameters are also provided in **Appendix K**.

6.0 CONTAMINANT FATE AND TRANSPORT

6.1 Geochemical Environment

Thirty-seven groundwater samples were collected from selected former CAMP monitoring wells for field and laboratory analysis of geochemical parameters. The geochemical data were collected to determine if conditions in groundwater were favorable for the natural biologic decay of chlorinated hydrocarbons identified in the shallow aquifer. A summary of water quality parameters analyzed in groundwater is provided in **Table 5-7** and in **Table 6-1**.

The dominant contaminant identified at the former CAMP is TCE. The most favorable condition for the anaerobic biological decay of TCE is a reducing environment with low dissolved oxygen, abundant soluble iron, and moderate pH. Geochemical analyses of selected wells within and outside the TCE plume yield data to evaluate if these reducing conditions exist. The USEPA Directive 9200.4-17 (Interim Final has been approved for use as guidance) addresses the use of monitored natural attenuation at CERCLA and Resource Conservation and Recovery Act (RCRA) sites. This guidance was used to evaluate the efficacy of natural processes in reducing concentrations of VOC in groundwater at the former CAMP.

In addition to geochemical indicators of natural biologic decay, the breakdown of TCE typically generates chemical daughter products through the removal of chloride ions (by reductive dechlorination, methanogenesis, etc.). Common daughter products of the reductive dechlorination process include: cis-1,2-DCE, trans-1,2-DCE, 1,1-DCE, vinyl chloride, ethene, and carbon dioxide. Also, certain nutrients/minerals and physical parameters (temperature, pH, etc.) are essential in the breakdown process and can be indicators of favorable/ unfavorable conditions for reductive dechlorination. The absence of certain catalysts in the aquifer, such as having insufficient carbon in the form of available total organic carbon, can limit the biodegradation process. Interpretation of conditions favorable to natural attenuation was also considered during the geochemical evaluation.

Ranges of geochemical, chemical, and physical parameters monitored during preliminary screening for anaerobic biodegradation processes suggest conditions are not favorable for reductive dechlorination to occur at optimal rates. Detection limits for potential reductive dechlorination daughter products from the shallow well screen sample at COEMW29 were elevated because of the elevated TCE concentration. Some of these compounds might be present in groundwater but they cannot be accurately quantified. The sample from the deeper screen did show some evidence of daughter product generation (namely 1,1-DCE and elevated chloride with respect to other BZ wells). However, the dissolved oxygen concentration in groundwater (above the commonly accepted tolerance level of <5 mg/l) and elevated oxidation reduction (redox) potential do not support reductive dechlorination.

Available groundwater data suggests that the former CAMP exhibits "Type 3" behavior with respect to chlorinated compound biodegradation. Type 3 behavior dominates in areas that are characterized by inadequate concentrations of native and/or anthropogenic carbon, and concentrations of dissolved oxygen that are greater than 1.0 milligrams per liter (mg/L) (USEPA,

1998). Reductive dechlorination will not occur under these aerobic conditions. Information on the types of biological degradation is provided in the Draft USEPA Region 4 Suggested Practices for Evaluation of a Site for Natural Attenuation (USEPA, November 1997). The lack of byproducts of TCE degradation in groundwater (except COEMW29) also supports the lack of reductive dechlorination. The absence of elevated concentrations of chloride ions and carbon dioxide, the high redox potential, and the elevated sulfate ion concentration in groundwater suggest that active reductive dechlorination is unlikely to have a significant impact on reducing TCE concentrations in the groundwater.

6.2 Potential Migration Routes

Hydraulic gradient and anisotropy both serve to influence plume migration within the CAMP Area. The plume appears to have migrated northwestward from the suspected source following the potentiometric surface. Bedrock topography may also influence the northwesterly migration of the TCE plume. Analytical results of groundwater samples indicated that TCE, with only minor concentrations of daughter products commonly associated with biologic metabolism, are present at the site within source areas. Detection of TCE greater than the MCL were found in 70 percent of the groundwater samples analyzed. The TCE detection in COEMW29 is stratified within the water column (e.g., shallow BZ 4100 and deeper BZ 1700 µg/L). These analytical results are consistent with the findings of the Phase I RI that indicates that TCE may be migrating vertically within the fractured bedrock.

No confirmed sources of TCE were identified in the historical record. During the initial phases of a typical release, TCE would diffuse downward through the porous matrix of the unsaturated zone of the shallow aquifer. During this phase, migration of the TCE is a function of gravity, the permeability of the porous matrix, the viscosity of TCE, and the interactions of TCE with the porous matrix.

The downward migration of TCE (as a product-phase or "Dense Non Aqueous Phase (DNAPL)") would continue until it encounters the shallow water table. At this point (if mass-loading rates are sufficient) the DNAPL will continue to move downward through the aquifer by displacing groundwater from the porous matrix as it advances. A small percentage of DNAPL TCE will dissolve into the groundwater with which it interacts, forming a diffusion halo around the plume. As the DNAPL plume advances through the matrix, dissolved-phase TCE will be left in its wake, gradually increasing in size but decreasing in concentration (the dilution factor) as more groundwater interacts with the advancing plume. Product-phase TCE will continue diffusing downward through the porous matrix until either loading rates diminish to a point where the remnant DNAPL TCE plume is completely dissolved in groundwater or an impermeable barrier is encountered. At the CAMP site, both conditions appear to have been met at least to some degree.

Once an impermeable barrier is encountered, product-phase TCE may pool at this interface (dependent on loading rates and bedrock topographic controls) or plume migration may continue into another permeable matrix through bedrock fractures and fissures. Product-phase TCE will then diffuse into the fracture system displacing groundwater as it moves and increasing the size

of the diffusion halo as it interacts with groundwater in the bedrock. Plume migration of product-phase TCE will continue until the loading rates or barrier conditions (impermeability) are encountered.

As stated, a small percentage of product-phase TCE is converted to dissolved-phase as it interacts with groundwater encountered in the aquifer. Through time, as more groundwater interacts with the advancing plume, the diffusion halo increases greatly in size and volume. As the diffusion halo increases in size, additional hydrogeological forces serve to influence its diffusion through the permeable matrix of the aquifer. As with the product-phase plume, gravity is also a chief factor influencing the downward migration TCE-impacted groundwater. However, groundwater flows through the permeable matrix as a function of hydraulic gradient, permeability, viscosity, and anisotropy (preferential permeability and transmissivity); therefore, these same functions will also serve to influence migration of the diffusion halo (dissolved-phase TCE). As observed within the CAMP site, the groundwater flow direction in the SZ and TZ is generally toward the northwest. The dissolved-phase TCE migration pattern, when compared with the potentiometric surface (shallow and transition zones), and general top-of-bedrock topography appears influenced by these parameters. From its source, the migration of TCE seems to be influenced by the hydraulic gradient and top-of-bedrock topography, moving northwesterly following the hydraulic gradient. This is most clearly illustrated in **Figures 2.2** and **2.3**. These figures graphically illustrate that the concentrations of TCE decrease in a down-gradient direction (to the north in Geologic Cross-section A-A'). The TCE concentration in the subsurface appears to be primarily influenced by dilution and dispersion.

TCE migration into the BZ appears to be confined to channelized (fracture) flow within the virtually impermeable bedrock matrix. HPF results indicate that groundwater contribution into bedrock wells COEMW28 and COEMW30 is almost exclusively limited to the uppermost fractures; effectively limiting TCE migration to the uppermost fracture zones. Groundwater contribution from fractures in COEMW29 is more evenly distributed throughout BZ. The concentrations of TCE measured in the BZ are indicative of impact by dissolved-phase TCE as opposed to product-phase TCE. No product-phase TCE was observed during the Phase II RI.

Contaminant Distribution

The distribution of TCE within the former CAMP is the result of TCE migration via the hydrogeologic controls of porosity/permeability, gravity, top-of-bedrock topography, groundwater flow gradient, anisotropy (transmissivity), aqueous geochemistry, and time. The slug test results indicate that the highest hydraulic conductivity (k) is within the SZ followed by the TZ and BZ. The average k values for the SZ, TZ, and BZ were 16.25 ft/day, 6.88 ft/day, and 0.20 ft/day, respectively. The SZ and TZ hydraulic conductivity was in the range of silts and sandy silts (Fetter 1994). The geotechnical testing results presented in **Table 2-1** indicate clayey silt and silty in the SZ and silty sand in the TZ well tested. The expected effective porosity (N_e) for silt is 0.1-0.3 (Wiedemeier, 1995). The seepage velocity for groundwater flow in the SZ, TZ, and BZ was approximated using the following equation:

$$V = k/N_e\ (dH/dL)$$

where;

V= seepage velocity (ft/year)
k= hydraulic conductivity (ft/day)
N_e= effective porosity
(dH/dL)= hydraulic gradient (feet/feet) for each zone

The calculated seepage velocities for the SZ, TZ, and BZ are 593.0, 125.5 and 7.3 feet/year respectively. These estimates were calculated using the k values, an estimated N_e of 0.2 for the SZ and TZ and 0.1 for BZ, and the hydraulic gradient from the potentiometric maps (**Figures 5.1, 5.2,** and **5.3**).

The flow velocity indicates the fastest geological media is the SZ, followed by the TZ and BZ. The geophysical logging of the BZ wells suggest that fracture density decreases with depth and that not all fractures were water bearing. Therefore, the SZ and TZ are the most critical zones for potential future monitoring or mitigation efforts in terms of TCE mass storage and potential future migration.

6.3 Contaminant Persistence and Migration

Groundwater geochemical data suggests that the former CAMP exhibits "Type 3" behavior with respect to chlorinated VOC biodegradation. **Table 6-1** presents the field parameters measured during monitor well purging. Elevated concentrations of dissolved oxygen (ranging from 0.32 to 10.58 mg/L) reduces the likelihood that reductive dechlorination will occur. TCE concentrations in groundwater should decline over time through diffusion and dilution. However, considerable time would be required to significantly reduce the TCE mass relying solely on natural processes. Plume migration appears to occur primarily in the upper portion of the bedrock aquifer and may have stabilized at its current distribution. The presence of unaltered TCE in numerous groundwater wells nearly 35 years after ceasing operations at the former CAMP attests to the persistence of chlorinated VOCs in the environment. TCE will likely persist in the environment for several decades without a change in groundwater geochemistry or initiation of active remediation.

6.4 Potential Receptors

A Potential Receptor Survey was conducted on May 24, 1999 which entailed a windshield survey of the area within a one mile radius to identify water bodies, potable wells, topography, evidence of city supplied water, etc. Details of the survey are presented in Section 4.1.1 of this report. In addition, a detailed assessment of potential human health risks associated with contamination identified at former CAMP site is provided in Section 7 of this report.

7.0 QUANTITATIVE RISK ASSESSMENT

7.1 Introduction

7.1.1 Overview

The QRA performed for this investigation consists of two parts; a Pathway Analysis Report (PAR) and a quantitative risk characterization. The PAR identifies risk assessment assumptions, exposure pathways, and data that will be used in the QRA. Risk is evaluated for exposure to chemicals identified in a medium having a completed pathway based on information presented in the PAR. Pathways that contain COPCs but are not complete may also be included in the QRA for ultimate conservative purposes or to evaluate potential future exposure scenarios. The PAR prepared for the Phase II RI at the former CAMP is provided in **Appendix L**. This QRA was prepared in accordance with the SOW for the Phase II RI at the former CAMP.

Exposure pathways for surface soil, subsurface soil, groundwater, and surface water are evaluated in the PAR. Reasons for eliminating an incomplete pathway are provided in the PAR. No exposure pathway is complete as a result of the PAR evaluation. However, the groundwater pathway is evaluated under a potential future use scenario for ultimate conservative purposes because COPCs are present in groundwater samples above screening criteria. Screening criteria include: RBCs developed by USEPA Region 3 for tap water, drinking water MCLs, and NCAC 2L standards for groundwater. Background data are also reviewed to compare data results to naturally occurring levels of inorganic analytes. If an exposure pathway is potentially complete, specific assumptions, inputs, and the corresponding references are given. Reasonable maximum exposure (RME) for potential receptors is considered. Default values are used where applicable and the analytical methods for risk calculation are outlined.

7.1.2 Site Use

Residential areas are located beyond a 0.5-mile radius of the study area and separated from the former CAMP by a road. Future site use is expected to remain industrial given the history and surrounding industrial site use. The former CAMP is zoned for commercial/industrial use. Either locked gates or a guard station controls access to the site property. Unauthorized personnel are not allowed to enter the former CAMP area.

7.1.3 Well Survey

To identify possible private and/or public water supply wells within a one-mile radius, applicable state, county and local agencies were contacted, and a visual "windshield" survey was performed. Information on the potable well search is provided in Section 2.9 and Section 4.1 of this report. Previous investigation into the use of potable wells in close proximity to the former CAMP was summarized in the Phase I RI. No potable wells were observed during field reconnaissance surveys. Additionally, Mecklenburg County Water Authority records indicate the former CAMP and adjacent properties within a one mile radius are serviced by municipal water supply.

7.2 Risk Assessment Data Review

Standardized tables 1 through 10 as outlined in the EPA Risk Assessment Guidance for Superfund (RAGS), Part D (EPA 540-R-97-003, 1998) are provided in **Appendix M.** A Data Usability table is also provided in **Appendix M.** As is presented in the Data Usability table, data collected for use in the QRA meets acceptable criteria. Media sampled, analytical results, and selection of COPCs are discussed below.

7.2.1 Surface Soil Results

No screening criteria were exceeded in surface soil samples and pathway exposure is not quantified in the absence of contamination. Surface soil is not considered to be a contaminated media as set forth in the PAR, **Appendix L.** Surface soil sample results are summarized in **Table 5-3.**

7.2.2 Subsurface Soil Results

No screening criteria were exceeded in subsurface soil samples and pathway exposure is not quantified in the absence of contamination. Subsurface soil is not considered to be a contaminated media as set forth in the PAR, **Appendix L.** Subsurface soil sample results are summarized in **Table 5-5.**

7.2.3 Surface Water Results

One surface water sample was collected from the outfall of a man-made drainage culvert at the site. No COPCs were detected in the surface water sample above the NCAC 2B standards. The federal MCL was used to evaluate surface water results where no NCAC 2B standard was available. Only aluminum, at a concentration of 78 µg/L, was detected in the surface water above the federal MCL for drinking water of 50 µg/L. No human health risk associated with this marginal exceedence of the tap water standard is anticipated. Surface water is therefore not considered to be a contaminated medium as set forth in the PAR, **Appendix L,** and pathway exposure is not quantified in the absence of contamination. Surface water sample results are summarized in **Table 5-4.**

7.2.4 Groundwater Results

Background groundwater conditions were assessed by evaluating the analytical data for wells COEMW08, COEMW09 and COEMW28. These locations combine up-gradient and down-gradient conditions as well as SZ, TZ and BZ wells, respectively, installed at former CAMP. Organic constituents that are not naturally occurring were detected in the designated background monitoring wells. The compounds chloroform, 1,1-dichloroethene, naphthalene, and TCE were all identified at concentrations below the LQL or 1 µg/L and were flagged estimated (J).

All groundwater sample results are summarized in **Table 5-7**. A summary of the occurrence, distribution, and selection of COPCs in the groundwater medium is presented **Appendix M, Table 2.1**.

TCE is the most widespread organic compound identified, and it occurs at the highest concentrations in MW1A. Results of the multilevel sampling reveal that TCE is stratified within the water column at COEMW29. Some of the other chlorinated VOCs detected may be degradation products of TCE including cis-1,2-dichloroethene and 1,1-dichloroethene.

7.3 Potential Exposure Pathways

7.3.1 Potential Surface Soil, Subsurface Soil, and Surface Water Pathways

COPCs were not identified in surface soil, subsurface soil or surface water at concentration above screening criteria. Therefore, these media were excluded from further consideration in the QRA.

7.3.2 Potential Groundwater Pathways

As discussed in Section 7.1.3, no private or public water supply wells were identified within one mile of the site. City supplied water exists throughout the area. Consequently, current groundwater ingestion is not considered to be a complete pathway. Given public water supply in the area, future groundwater ingestion is similarly not anticipated. However, to be ultimately conservative, future groundwater ingestion is quantified for an industrial worker, although it is considered to be extremely unlikely.

7.4 Risk Characterization

To characterize potential human health risk; (1) exposure is identified to estimate potential human contact, (2) chemical specific-toxicity values are input to correlate exposure with possible adverse health effects, (3) risk is calculated following published guidance, and (4) the calculated risk is compared to acceptable levels. Conservative assumptions are used to provide upper bound estimates and represent RME.

7.4.1 Exposure Assessment

For human exposure to occur, a pathway must be complete. That is, all of the following must be present: a source, a transport medium (e.g., groundwater), an exposure point (location), and an exposure route (e.g., ingestion). Although considered to be extremely unlikely, risk associated with future groundwater ingestion by an industrial worker is quantified. As noted, this scenario is unlikely due to public water supply in the area, and therefore it represents a very conservative evaluation of groundwater and the associated contamination identified. No other pathways are considered to be potentially complete.

7.4.2 Toxicity Assessment

In quantifying risk, compounds are classified as carcinogenic or non-carcinogenic. For carcinogens, exposure can result in some probability of tumor formation, which is referred to as a no-threshold response. Non-carcinogens, on the other hand, exhibit a threshold below which no adverse effects are expected.

Carcinogens have a weight-of-evidence, which is a measure of the likelihood that a compound is a human carcinogen. Classifications are A, B1, B2, C, D, and E where A denotes a known human carcinogen and E is non-carcinogenic. The carcinogenic evaluation also considers a slope factor (SF) which represents the chemical dose-response relationship. Weight-of-evidence classifications and oral slope factors for chemicals identified in groundwater are summarized in **Appendix M, Table 6**.

Health criteria for non-carcinogens are based on reference doses (RfDs) which represent the daily exposure level that is unlikely to result in deleterious human health effects during a lifetime. Chronic RfDs have been developed to be protective for long-term exposures. Oral RfDs for chemicals identified in groundwater are also summarized in **Appendix M, Table 5**.

Toxicity values were obtained from the USEPA Integrated Risk Information System (IRIS). If unavailable on IRIS, then the USEPA Health Effects Assessment Summary Tables (HEAST) were consulted. If still unavailable, the USEPA National Center for Environmental Assessment (NCEA) regional support provisional values obtained from the Region III RBC table was used.

7.4.3 Risk Calculation

Risk from potential future groundwater ingestion is calculated following the USEPA Risk Assessment Guidance for Superfund Volume 1 Human Health Evaluation Manual, EPA/540/1-89/002, December 1989. Both carcinogenic and non-carcinogenic properties of COPCs are considered.

To quantify exposure, intake is considered. The chronic daily intake (CDI) represents exposure normalized for body weight and time. For carcinogens, lifetime cancer risk equals the CDI times the slope factor (Risk = CDI x SF). USEPA has established an acceptable risk range of 1E-06 to 1E-04 for remediation of Superfund sites. A 1E-06 risk level corresponds to a one in one million probability that an individual contracts cancer due to a particular chemical exposure, and this level is the most common reference for comparative purposes.

Risk associated with non-carcinogens is expressed as the hazard quotient (HQ) which is the ratio of the CDI and Reference Dose (RfD) (HQ = CDI / RfD). The sum of all hazard quotients for chemicals of concern is called the hazard index (HI). USEPA notes that a hazard index of less than 1 is typically not associated with adverse health effects. A hazard index of 10 has also been used as a reference point for site remediation.

In quantifying carcinogenic risk and the non-carcinogenic hazard index, risk for an individual compound is first considered.

The equation used to calculate the CDI, exposure assumptions, and references are outlined below. Where chronic daily intake (CDI) is measured in (mg/kg-day).

$$CDI = (CW \times IR \times EF \times ED)/(365 \times BW \times LT)$$

where:

CW	=	Chemical concentration in water (mg/L)
IR	=	Ingestion rate (1 L/day)
EF	=	Exposure frequency (250 days/year)
ED	=	Exposure duration (25 years)
BW	=	Body weight (70 kg)
LT	=	Lifetime (70 years)

Following the USEPA Supplemental Guidance to RAGS: Region 4 Bulletins, November 1995, intake assumptions for possible future exposures are represented by default values in attempt to reflect the RME. Bulletin No. 3 includes default values for an industrial exposure assessment, which are the values for IR, EF, and ED given above. Groundwater exposure point concentrations, summarized on **Table 3.1** of **Appendix M**, are based on the arithmetic average of wells in the highly concentrated area of the plume (those exceeding MCLs). The most recent groundwater data available (June 1999) are used to calculate averages. A body weight value of 70 kg and lifetime of 70 years are used in accordance with Risk Assessment Guidance Document (RAGS) and the USEPA Exposure Factors Handbook, USEPA 600/8-89-043, July, 1989. Default values used in risk characterization are summarized in **Appendix M, Table 4**.

In calculating CW, if no concentrations exceeded the MCL or if no MCL exists, then the maximum concentration detected was used. The CW, CDI, and corresponding risk and HQ are summarized in **Appendix M, Table 9**.

7.5 Discussion of Risk Results and Conclusions

As can be seen by reviewing **Appendix M, Table 9**, the major contributors to carcinogenic risk was TCE and chloroform. The major contributors to the non-carcinogenic HI were TCE, iron, and manganese. TCE contributes to risk and the HI as the most widespread constituent at the highest concentrations. 1,1-DCE and carbon tetrachloride contribute to carcinogenic risk as more highly toxic compounds.

The cumulative risk for ingestion of groundwater was calculated to be 3.5E-05. Although this exceeds a target of 1E-06, it is within the range for remediation of Superfund sites (1E-06 to 1E-04). The sum of the HQ values, or HI, was calculated to be 0.84 and is below the generally accepted target of 1. Considering the conservative set of assumptions used, the potential risk/hazards calculated are not anticipated to result in adverse human health risks. Since groundwater consumption presently does not occur and is not anticipated for the future given the industrial nature of the site, the estimated risk levels are not intended for use in developing remedial goals.

7.5.1 Uncertainties

Several sources of uncertainty are inherent in the risk assessment process. The amount of chemical exposure is one such uncertainty. Since the CW, IR, EF, and ED are all unknowns for a hypothetical future scenario, very conservative assumptions (default values) were applied in the risk assessment. These assumptions include drinking one liter per day of groundwater from the most contaminated portion of the plume, 250 days per year for 25 years. These conservative values tend to overestimate risk. Furthermore, derived CAMP risk/hazards due to groundwater exposure are not expected at all since future groundwater ingestion is not anticipated.

A second source of uncertainty is in the toxicity assessment. Health effects data are estimated from animal studies, and these results are then used to approximate human responses. Since test animals are of much lower body weight than even a child, adverse health effects based on animal data may be exaggerated when compared to a human receptor. In addition, animal test results are based on high doses, while human exposure is more typically lower dose. Uncertainty may also enter the risk calculation when dose-response toxicity testing data are approximated by a linear relationship (which is usually a better estimate for low doses). Toxicity data are based on exposure to one chemical at a time, and possible interaction effects cannot be accurately predicted. All these data extrapolation procedures add uncertainty to the risk estimate.

Given uncertainties, the conservative assumptions used in the exposure and toxicity assessments are intended to represent a reasonable maximum exposure and be protective of human health.

8.0 CONCLUSIONS AND RECOMMENDATIONS

8.1 Nature and Extent of Contamination

M&E performed a geostatistical evaluation of historical groundwater chemical analyses to select the optimal placement of SZ, TZ, and BZ monitoring wells for plume delineation in the Phase II RI. Well locations were selected to define the vertical and horizontal extent of VOCs, SVOCs, and metals contamination in groundwater. The groundwater monitoring wells were generally located around the perimeter of TCE groundwater plumes identified during the Phase I RI with the rationale of creating closure (i.e. no contamination detected) or determining separation of identified plumes. A number of structures and anthropogenic features (railroads, power lines, etc.) also affected well site selection. The wells were designed to evaluate groundwater quality in the SZ, TZ and Bedrock Zone (BZ) of the upper aquifer. SZ wells extend to approximately from 15 to 28 feet bls and are screened in saprolite; the uppermost water bearing zone. TZ wells extend into more competent rock and range in depth from approximately 44 to 75 feet while BZ wells were finished to a depth ranging from 73 to 118 feet bls. Each well was installed, developed, and sampled in a manner consistent with that used during the Phase I RI investigation.

Each groundwater sample was analyzed for VOCs, SVOCs, and metals. A total of 37 groundwater samples were collected during the Phase II RI. The groundwater samples were collected from permanently installed SZ, TZ, and BZ groundwater monitoring wells. Analytical results of groundwater samples confirm the presence of VOC contamination. TCE is the most prominent contaminant identified in groundwater. Illustrations of TCE identified in groundwater samples collected from monitor wells are provided in **Figures 5.1**, **5.2**, and **5.3**, respectively. These figures illustrate the distribution of TCE in groundwater of the SZ, TZ, and BZ.

The horizontal extent of contamination in the shallow aquifer has been adequately defined in most directions, most importantly, down-gradient of potential source areas. The vertical extent of the TCE plume has not been completely defined. Contamination extends vertically beyond 118 feet bls in the most impacted portion of the facility. However, borehole geophysical logging suggests that fracture density and groundwater flow decreases with depth; effectively limiting the vertical distribution of contaminants to relatively shallow bedrock zones. TCE was not detected hydraulically down-gradient of the plume center (COEMW29), at monitor wells COEMW01, -19, and –30.

8.2 Contaminant Fate and Transport

Hydraulic gradient and anisotropy both serve to influence plume migration within the CAMP Area. The plume appears to have migrated toward the northwest from suspected source areas (near MW01A and COEMW02) following the potentiometric surface. Bedrock topography also appears to influence the northwesterly migration of the plume.

Groundwater flows through shallow aquifer at the former CAMP as a function of hydraulic gradient, permeability, viscosity, and anisotropy (preferential permeability and transmissivity);

therefore, these same functions will also serve to influence migration dissolved-phase TCE. As observed within the CAMP site, the groundwater flow direction in the SZ and TZ is generally toward the northwest. The dissolved-phase TCE migration pattern is influenced by the potentiometric surface (shallow and transition zones) and top-of-bedrock topography. TCE migration into the BZ is most likely confined to channelized (fracture) flow within the virtually impermeable bedrock matrix. HPF results indicate that groundwater contribution into the bedrock wells is almost exclusively limited to small clusters of fractures. The degree of interconnectivity between these fracture sets is unknown. The concentrations of TCE measured in the bedrock well COEMW29 possibly indicates that the BZ has been impacted by dissolved-phase TCE. No evidence of product-phase pooling was observed within the former CAMP site with exception of floating hydrocarbons in COEMW04 (not related to the larger TCE plume).

No TCE release is suspected to have occurred since the late 1960s. Contaminants have not migrated significant distances from the suspected source areas considering the probably release took place more than 30 years ago. Additionally, no contaminants were identified in surface soil, surface water, or sediment, which exceed acceptable levels of risk. This suggests that a shallow continuing source of TCE does not exist and that aquifer hydraulic and geochemical properties may have stabilized the areal distribution of contaminants.

8.3 Quantitative Risk Assessment

A QRA was performed to evaluate potential exposure to contaminants in surface soil, subsurface soil, surface water, and groundwater. Data were reviewed to identify COPCs. COPCs were not identified in surface soil, subsurface soil, or surface water at concentrations above screening criteria. Therefore, these media were excluded from further consideration in the QRA. COPCs were present in groundwater above screening criteria. Several VOCs were present at levels above federal drinking water MCLs or North Carolina groundwater standards. The PAR indicated that no present or potential future use pathway was complete at the former CAMP. Although no private or public potable wells were observed in proximity of the former CAMP and potable water is supplied to the area by municipal systems, future groundwater ingestion was quantitatively evaluated for an industrial worker exposure scenario.

The cumulative risk for ingestion of groundwater was calculated to be 3.5E-05. Although this exceeds a target of 1E-06, it is within the range for remediation of Superfund sites (1E-06 to 1E-04). The sum of the Hazard Quotient (HQ) values, or Hazard Index (HI), was calculated to be 0.84 and is below the generally accepted target of 1. Considering the conservative set of assumptions used, the potential risk/hazards calculated are not anticipated to result in adverse human health risks. Since groundwater consumption presently does not occur and is not anticipated for the future given the industrial nature of the site, the estimated risk levels do not support the need to develop remedial goals.

8.4 Summary

The former CAMP site is located in the Charlotte Belt of the Central Section of the Piedmont Physiographic Province (central Piedmont). Topography is characterized by gently rolling

slopes cut or bounded by valleys of steeper slope. Soils within the former CAMP area are generally described as sandy silts, silty sands, and sandy or silty clays, however much of this horizon has been removed due to construction activities. The residuum is divided into two lithostratigraphic zones; the SZ, comprised of the soil horizon and saprolite and the TZ, comprised of partially weathered rock. Both zones were derived from the weathering of the underlying metagranite, gneiss, and hydrothermally altered mafic or vein rock (described in petrographic thin section as a pyroxenite). The metagranite and gneiss bedrock forms the BZ, the third and lowermost lithostratigraphic zone on site. The average depth to bedrock is approximately 70 feet bls. The bedrock contains numerous fractures that influence groundwater flow and plume migration within the bedrock.

Hydrogeology at the former CAMP represents a complex system of interconnected aquifers corresponding to the above lithostratigraphic zones. Groundwater elevation measurements indicate that the zones are largely interconnected. However, differing hydraulic and lithologic properties allow for separating the zones. Groundwater flow is northwesterly in all zones. Plume migration within the former CAMP occurs as a function of the hydraulic gradient, bedrock topography, and aquifer anisotropy.

Contaminants have not migrated significant distances from the suspected source considering any release from former CAMP occurred more than 30 years ago. Additionally, no contaminants were identified in surface soil, subsurface soil, or surface water that exceed acceptable levels of risk. The horizontal and vertical extent of groundwater contamination has been relatively well defined. Additional groundwater monitoring wells are required to fully define the horizontal extent of TCE in groundwater.

8.5 Recommendations

8.5.1 Additional Well Installation and Geophysical Testing

Additional groundwater monitoring wells will be required to fully delineate the horizontal extent of TCE in groundwater. A review of existing groundwater sample results, groundwater flow directions, lineament patterns, and hydrogeological data was performed to evaluate the quantity and placement of plume delineation wells.

One SZ, three TZ, and two (BZ) wells groundwater monitoring wells are proposed to more accurately define plume boundaries. The locations of the proposed wells are provided on **Figure 8.1**. The proposed groundwater monitoring wells will be located beyond the estimated perimeter of TCE groundwater plumes identified during the Phase II RI with the rationale of creating plume closure (i.e. a well that defines the TCE extent with no contamination detected).

Each well will be designed to evaluate groundwater quality in the SZ, TZ, or BZ of the shallow aquifer. All wells will be installed consistent with the Phase II RI methodology. SZ wells will extend to approximately 30 feet bls and penetrate to the top of competent rock (as indicated by drill rig resistance). TZ wells will extend into competent rock approximately 15 to 25 feet (total depth ranging from 40 to 70 feet bls) while BZ wells will be finished to a depth ranging from 70

to 115 feet bls).

A suite of geophysical logs will be performed on the BZ well prior to well construction. At a minimum, borehole flow meter tests (static and induced flow) and acoustic televiewer logs will be performed in the open borehole. The geophysical logs will be used to determine optimal well screen placement in the BZ.

Each groundwater monitoring well will be constructed of 2-inch diameter polyvinyl chloride riser casing equipped with a 10-foot section of 0.010-inch, machine slotted well screen. The screen will be placed at the designated screen interval for the borehole. The screened interval may be adjusted to intersect a productive fracture based on the geologists' recommendation. Each well will be constructed in accordance with procedures outlined in the Phase II RI Work Plan, **Appendix B,** Monitoring Well Installation Plan. Silica sand filter media of compatible size with the well screen (30/45 grade or equivalent) will be installed in the borehole annulus. A weighted measuring tape will be used to monitor to filter pack placement. The filter pack will extend approximately 2 feet above the top of the screen. A bentonite pellet seal at least 2-feet thick will be placed above the top of the filter pack. The pellets were allowed to fall into the annulus between the borehole and the well casing. The bentonite pellets will be allowed to hydrate for a minimum of 1 hour before grouting. Grout will be placed by pouring from the surface for depths of five feet or less. For greater depths, grout will be installed via tremie pipe. Grout will be used to seal the borehole from the top of the bentonite seal to the surface. Following curing and settling, additional grout will be added as needed. All wells will be completed flush to ground with an 8-inch-diameter traffic-bearing manhole with a bolt-down cover to prevent tampering. Each well will be completed in a 4-inch thick, 2-foot square concrete pad, sloped away from the well, surrounding the steel manhole assembly. The concrete and manhole assembly will be completed flush to existing grade.

Following installation, each well will be developed and sampled in a manner consistent with that used during the Phase II RI investigation. Similarly, all IDW generated during the installation, development, and sampling of the wells will be containerized, characterized, and disposed in accordance with procedures used in the Phase II RI.

Groundwater samples from these wells will be analyzed for VOC (USEPA method 8260B/5035). Analytical results will be used to define the extent of TCE in groundwater at the former CAMP. The results of groundwater samples and geophysical logs will be summarized in a Phase II RI Addendum Report. Appropriate figures and tables will be provided in the report to support the data collected during the additional investigation.

8.5.2 Treatment Option Evaluation

A number of remedial technologies are available for treating groundwater contaminated with chlorinated VOCs. However, the calculated level of risk associated with the industrial exposure scenario did not exceed the commonly accepted risk range of 1.0E-04 to 1.0E-06. Similarly, the HI was below the guidance criteria of 1. Human health risk from exposure to contaminated groundwater does not exist without a completed pathway. Therefore, a long-term monitoring

program should be initiated to monitor the movement of VOCs in groundwater and assess their future impact on potential receptors. Monitoring of this kind coupled with restrictive covenants on the use of groundwater at the former CAMP should be adequate to protect potential human receptors from adverse health risks.

Groundwater samples should be collected for VOC analysis from wells strategically located both within and beyond the groundwater plume to gather data on COPC migration and distribution over the monitoring period. The annual monitoring plan includes collecting samples from seven SZ wells (COEMW01, COEMW02, COEMW04, COEMW08, COEMW12, COEMW18, and the proposed SZ well), five TZ wells (MW1A, COEMW11, COEMW26, and the two proposed TZ wells), and four BZ wells (COEMW29, COEMW30, and the two new BZ wells). The long term monitoring program will continue for a period of five years. Annual monitoring summary reports will be submitted to North Carolina Department of Environment and Natural Resources (NCDENR) for review and comment. A five-year groundwater monitoring summary report will be prepared following the completion of the monitoring period that will evaluate trends in plume migration and suggest further action / no action as required to protect human health and the environment.

Alternatively, an appropriate groundwater remedial technology may be considered to meet more aggressive project remedial objectives or regulatory requirements. These technologies are typically characterized by in-situ or ex-situ technologies. Several technologies that may be considered for potential remedial applications are highlighted below. A combination of remedial technologies is often the most effective approach to meeting remedial goals.

Groundwater extraction and above ground treatment is the most widely utilized and documented method available for the restoration of chlorinated VOC-contaminated groundwater. A submersible water table depression pump, located in a recovery well, extracts the groundwater from the contaminated zone and delivers it to an above ground treatment system (i.e., air stripping unit, carbon absorption system, biological reactor, etc.). Treated groundwater is then returned to the aquifer through a recharge gallery or injection well located up-gradient of the recovery well or it may be discharged to a sanitary sewer.

Air sparging is a widely documented method for removing chlorinated VOCs from groundwater. A compressor and diffusers are used to deliver air to the contaminated zone. The high pressure, high volume air, encourages volatilization of the VOCs into the air stream and allows the contaminant to travel to the vadose zone for removal using soil vapor extraction technology. Extracted vapors are either treated or discharged directly to the ambient air in accordance with permit requirements.

Recirculating wells are an innovative technology for in-situ remediation. High pressure, high volume air is delivered to a diffuser below the upper-screened section of the recirculating well. Groundwater is then air-lifted from the lower intake screen to the upper discharge screen. Volatilization of the VOC occurs during the vertical transport in the well. The volatilized VOCs are then exhausted above ground. The water stripped of VOC, returns to the ground through the upper-screened portion of the well. This treated groundwater then travels in a tortuous path back

to the lower screened section eventually completing the recirculating loop. Vertical gradients created in the loop promote physical removal of contaminants from beyond the circulation cell through dispersion. Due to its unique design, recirculating wells can be used for "hot-spot" treatment or plume containment.

In-situ chemical oxidation is a technology that chemically converts VOCs to stable by-products. The process uses an oxidizing agent (typically hydrogen peroxide, ozone, and potassium permanganate) and a catalyst (usually iron) to eventually convert contaminants to non-toxic byproducts. Chemical oxidation can be used for hot-spot remediation or as a permeable reactive barrier wall. The oxidizing agent is typically injected into the ground using injection wells or direct push points at strategic locations. Contaminants are destroyed in-situ and therefore require no secondary treatment.

Enhanced biodegradation is a treatment technology that is gaining acceptance in the remediation field. The biodegradation process breaks down contaminants using microbes to metabolize VOCs. Through a biological process called reductive dechlorination, anaerobic microorganisms indigenous to the aquifer can use hydrogen to remove the chlorine atoms from chlorinated VOCs resulting in the production of comparatively non-toxic end products such as ethene. This process is often enhanced by the addition of nutrients, minerals, or catalysts. One commercially available hydrogen release compound, for example, is polylactate ester specially formulated for the slow release of lactic acid upon hydration. Indigenous microbes metabolize the lactic acid released from this additive that produces the hydrogen necessary for reductive dechlorination to occur. Parameters that effect chlorinated VOC consuming bacteria include physical and chemical properties of the contaminated medium (i.e., temperature, pH, redox potential, etc.), contaminant concentrations, enzymatic activity; and the types of microbial populations present, their spatial distribution, and their population density.

Natural attenuation is a passive method of VOC plume remediation. In productive environments, aerobic or anaerobic degradation of dissolved VOCs can be the most efficient and cost effective remedial method. Natural attenuation requires direct sampling to verify that the contaminant mass is being reduced and historical tracking of periodic sampling efforts to record the rate and magnitude of remediation.

Remedial alternatives for treating contaminated groundwater at the former CAMP will be evaluated following the installation of the proposed plume delineation wells and after the completion of the first year of groundwater monitoring. Remedial alternatives will be reevaluated each year in the monitoring summary report throughout the long term monitoring program. A particular technology may be employed with the approval of the NCDENR to decrease contaminant mass in the shallow aquifer and speed the rate of natural attenuation. Restrictive covenants may also be placed on aquifer use if required as part of the monitoring program and final remedial implementation.

TABLES

TABLE 2-1
GEOTECHNICAL RESULTS

Location	Sample Depth (ft)	Unified Soil Classification	Natural Moisture Content (%)	Atterberg Limits (%)			% Passing #200 Sieve	% Sand
				Liquid Limit	Plastic Limit	Plastic Index		
COEMW-13	13 - 15	ML	36.9	45	41	4	61	39
COEMW-14	23 - 25	SM	13.7	25	NP	NP	23	77
COEMW-15	18 - 20	SM	24.1	26	NP	NP	40	60
COEMW-16	23 - 25	ML	19.1	31	29	2	56	44
COEMW-17	13 - 15	SM	27.9	36	NP	NP	31	69
COEMW-18	13 - 15	SM	25.7	34	29	5	31	69
COEMW-19	13 - 15	CH	20.4	52	24	28	56	44
COEMW-20	24 - 26	SM	17.8	30	NP	NP	44	56
COEMW-21	43	SM	13.5	24	NP	NP	22	78
COEMW-26	58 - 60	SM	14.2	23	NP	NP	21	79

ML - clayey silt
SM - silty sand
CH - fat clay

(campgeotech.xls)

TABLE 2-2
CAMP II - MONITORING WELL DATA SUMMARY

Location	Monitored Zone	Screen Depth, ft.	Well Diam, in.	Surface Casing Depth, bls	Water Level ft, TOC (1)	Elevation, TOC (MSL)	Water Level Elevation (MSL)
Eckerd wells							
MW1A	Intermediate	57.0 - 62.0	2		12.75	737.78	725.03
MW01	Shallow	5.0 - 20.0	2		12.67	737.59	724.92
MW02	Shallow	5.0 - 20.0	2		12.58	738.76	726.18
MW03	Shallow	4.0 - 19.0	2		12.35	737.35	725.00
MW04	Shallow	4.0 - 19.0	2		14.22	738.68	724.46
MW06	Shallow	5.0 - 20.0	2		12.95	739.34	726.39
MW07	Shallow	10.0 - 25.0	2		17.94	745.09	727.15
Phase I wells							
COEMW01	Shallow	7.5 - 17.5	2		7.22	725.85	718.63
COEMW02	Shallow	5.5 - 15.5	2		6.68	728.85	722.17
COEMW03	Shallow	15.5 - 25.5	2		21.23	748.38	727.15
COEMW04	Shallow	10.0 - 20.0	2		NA	739.98	NA*
COEMW05	Shallow	4.75 - 14.75	2		7.43	729.10	721.67
COEMW06	Shallow	5.75 - 15.75	2		4.91	725.63	720.72
COEMW07	Shallow	18.3 -28.3	2		18.30	743.33	725.03
COEMW08	Shallow	15.3 - 25.3	2		17.69	743.85	726.16
COEMW09	Intermediate	65.0 - 75.0	2	39.1	18.31	743.47	725.16
COEMW10	Intermediate	49.1 - 59.1	2	39.5	18.46	744.20	725.74
COEMW11	Intermediate	54.0 - 64.0	2	39.2	18.74	737.66	718.92
COEMW12	Shallow	5.0 - 15.0	2		8.07	725.35	717.28
Phase II wells							
COEMW13	Shallow	10.0 - 20.0	2		13.56	740.24	726.68
COEMW14	Shallow	11.0 - 21.0	2		11.77	738.29	726.52
COEMW15	Shallow	13.0 - 23.0	2		14.85	737.87	723.02
COEMW16	Shallow	17.0 - 27.0	2		21.95	747.30	725.35
COEMW17	Shallow	5.0 - 15.0	2		4.10	725.23	721.13
COEMW18	Shallow	8.0 - 18.0	2		8.41	725.21	716.80
COEMW19	Shallow	8.0 - 18.0	2		13.45	724.80	711.35
COEMW20	Shallow	17.5 - 27.5	2		16.47	735.11	718.64
COEMW21	Intermediate	38.9 - 43.9	2	38.5	12.08	738.59	726.51
COEMW22	Intermediate	41.8 - 46.8	2	38.9	22.43	748.63	726.20
COEMW23	Intermediate	62.5 - 72.5	2	38.7	19.05	742.29	723.24
COEMW24	Intermediate	42.2 - 47.2	2	38.3	18.06	739.69	721.63
COEMW25	Intermediate	61.4 - 71.4	2	38.5	4.80	726.29	721.49
COEMW26	Intermediate	62.0 - 72.0	2	38.2	5.71	728.90	723.19
COEMW27	Intermediate	57.1 - 67.1	2	38.7	8.30	725.25	716.95
COEMW28	Rock	90.0 - 95.0	2	78.5	18.16	743.32	725.16
COEMW29	Rock	92.5 - 97.5 112.5 - 117.5	2	75.2	16.63	737.88	721.25
COEMW30	Rock	68.0 - 73.0	2	64.1	8.60	725.43	716.83

(campwellsumm.xls)

(1) TOC - top of casing
water levels measured 2/28/00, except COEMWs -19,-27, and -30 measured 2/29/00
NA* - not measured due to history of free product
MSL - mean sea level

TABLE 4-1
SUMMARY OF SLUG TEST RESULTS
CHARLOTTE ARMY MISSLE PLANT
CHARLOTTE, NC

		Hydraulic Conductivity		
Well ID	**Zone**	**ft/min**	**ft/day**	**cm/sec**
MW1A	Intermediate	8.49E-03	12.23	4.31E-03
MW04	Shallow	8.82E-03	12.70	4.48E-03
COWME05	Shallow	1.10E-03	1.58	5.57E-04
COEMW08	Shallow	2.76E-02	39.77	1.40E-02
COEMW09	Intermediate	9.38E-03	13.51	4.77E-03
COEMW10	Intermediate	3.96E-04	0.57	2.01E-04
COEMW11	Intermediate	2.99E-05	0.04	1.52E-05
COEMW14	Shallow	7.60E-03	10.95	3.86E-03
COEMW25	Intermediate	8.00E-04	1.15	4.07E-04
COEMW28	Rock	1.40E-04	0.20	7.11E-05
Average				
Shallow		1.13E-02	16.25	5.73E-03
Intermediate		4.78E-03	6.88	2.43E-03
Rock		1.40E-04	0.20	7.11E-05

TABLE 5-1
APPLICABLE, RELEVANT AND APPROPRIATE REQUIRMENTS FOR GROUNDWATER
Chemical Parameters Identified in Groundwater Phase II RI

	EPA Maximum Contaminant Levels [1]	North Carolina Groundwater Standards [2]	USEPA R3 RBC Tap Water [3]	Critierion Background Concentrations [4]
TCL Volatile Organics (ug/L)				
Acetone	-	700	3700 n	25
Bromodichloromethane	100	-	0.17 c	1.0
Carbon tetrachloride	5	0.3	0.16 c	1.0
Chloroform	100	0.19	0.15 c	1.0
1,1-Dichloroethene	7	7	0.044 c	1.0
cis-1,2-Dichloroethene	70	70	61 n	1.0
Naphthalene	-	21	6.5 n	1.0
1,1,1-Trichloroethane	200	200	3200 n	1.0
Trichloroethene	5	2.8	1.6 c	1.0
TAL Metals (ug/L)				
Aluminum	50	-	37,000	66
Barium	2000	2000	2,600	91.3
Calcium	-	-	-	52,667
Chromium	100	50	110	14.6
Cobalt	-	-	2,200	20
Iron	300	300	11,000	140
Lead	15	15	-	10
Magnesium	-	-	-	18,133
Manganese	50	50	730	8
Mercury	2	1.1	11	0.4
Nickel	100	100	730	80
Potassium	-	-		6,267
Sodium	-	-		24,667
Vanadium	-	-	260	10
Zinc	500	2100	11,000	40
Water Quality Parameters (mg/L)				
Alkalinity (to pH 4.5) as CaCO3	-	-	NA	213
Chloride	-	250	NA	14.5
Methane (ug/L)	-	-	NA	0.272
Nitrate	10	10	NA	1.7
Nitrite-N	1	1	NA	0.071
Sulfate	250	250	NA	42.8

1 - Maximum Contaminant Level (MCL), USEPA Drinking Water Regulations and Health Advisories-Primary Standards
Secondary Standards - Aluminum, Iron, Manganese, Zinc, Nitrate & Sulfate
a - MCL for total trihalomethanes includes chloroform+bromoform+bromodichloromethane+dibromochloromethane
2 - State of North Carolina Chapter 2L Standards for Groundwater (NCDENR Title 15A Section .0200)
3 - USEPA Region 3 Risk Based Concentrations for Tap Water, April 13, 2000
c - based on human health carcinogenic effects; n- non-carcinogenic
4 - Criterion Background Concentration based on the detection limit for organics and two times the average background concentration of inorganics in samples from COEMW08, COEMW09 & COEMW28.

TABLE 5-2
APPLICABLE SOIL SCREENING CRITERIA
FOR CHEMICAL PARAMETERS IDENTIFIED IN PHASE II RI

CONSTITUENT	USEPA Region 3 RBC (1) Industrial mg/kg	USEPA Region 3 RBC (1) Residential mg/kg	Criterion Background Concentration Subsurface Soil (2)	Average Surface Soil Concentration (3)
INORGANICS (mg/kg)				
Aluminum	200,000	7,800	46,667	36,800
Arsenic*	3.8	0.43	3.33*	13.52
Barium	140,000	5,500	77	95.6
Beryllium*	4,100	160	2*	1.02
Cadmium*	1,000	39	2.5*	NA
Calcium	-	-	6,453	15016
Chromium	-	-	217	110.4
Cobalt	120,000	4,700	224	25.2
Copper	82,000	3,100	137	123.2
Iron	610,000	23,000	79,333	110,400
Lead	400**	-	56	121.2
Magnesium	-	-	12,813	2656
Manganese	4,100	1,600	1,267	784
Mercury*	-	-	0.03*	0.12
Nickel	41,000	1,600	32	24.28
Potassium	-	-	4,700	1464
Selenium	1,000	390	5*	NA
Sodium*	-	-	250*	NA
Vanadium*	14,000	550	279	328
Zinc	610,000	23,000	92	217.2

(NA) not analyzed

(1) USEPA Region 3 Risk-Based Concentrations (4/13/2000) in soil for Industrial and Residential use scenarios c- carcinogenic risk; all others non-cancer risk

(2) Criterion Background Concentration is based on 2 times the average concentration in soils collected from background soil borings HP29 (Phase I) and MW28 (Phase II).

(3) Average concentration based on twice (2X) the mean concentration in Phase II surface soils.

* An asterisks indicates that the parameter was not detected at background locations and the CBC was calculated based on 1/2 the detection limit multiplied by a factor of two.

** Lead criteria is a provisional value from U S. EPA OSWER, Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities, EPA/540/F-94/043, August, 1994.

TABLE 5-3
SUMMARY OF CONSTITUENTS DETECTED IN SURFACE SOIL SAMPLES
FORMER CHARLOTTE ARMY MISSILE PLANT

SITE SAMPLE ID DATE DEPTH (ft) RESULT TYPE UNITS CONSTITUENT:	INDUSTRIAL RBC (1) mg/kg	RESIDENTIAL RBC (1) mg/kg	COESS-1 COESS-1 02/28/2000 1.00 Primary mg/kg	COESS-2 COESS-2 02/28/2000 1.00 Primary mg/kg	COESS-3 COESS-3 02/28/2000 1.00 Primary mg/kg	COESS-4 COESS-4 02/28/2000 1.00 Primary mg/kg	COESS-5 COESS-5 02/28/2000 1.00 Primary mg/kg
ORGANICS							
Acetone	200,000	7,800	< 0.062	< 0.07	0.12	< 0.066	< 0.055
Benzo(a)anthracene	7.8	0.87	0.66	< 0.46	< 0.45	< 0.46	< 0.41
Benzo(a)pyrene	0.78	0.09	0.63	< 0.46	< 0.45	< 0.46	0.55
Benzo(g,h,i)perylene	-	-	< 0.43	< 0.46	< 0.45	< 0.46	0.41
Benzo(k)fluoranthene	78	8.7	0.6	< 0.46	< 0.45	< 0.46	0.57
Benzo(b)fluoranthene	7.8	0.87	0.72	< 0.46	< 0.45	< 0.46	0.75
Chrysene	780	87	0.8	< 0.46	< 0.45	< 0.46	0.77
Fluoranthene	82,000	3,100	1.8	< 0.46	< 0.45	< 0.46	1.6
Indeno(1,2,3-cd)pyrene	7.80	0.87	0.48	< 0.46	< 0.45	< 0.46	0.48
Phenanthrene	-	-	1.4	< 0.46	< 0.45	< 0.46	0.95
Pyrene	61,000	2,300	1.3	< 0.46	< 0.45	< 0.46	1.5
TAL METALS							
Aluminum	2,000,000	7,800	14,000	20,000	22,000	21,000	15,000
Antimony	820	31	1	0.81	< 0.5	1.8	< 0.5
Arsenic	3.80	0.43	**7.6**	**5.3**	**5.7**	< 5	**13**
Barium	140,000	5,500	43	41	60	51	44
Beryllium	4,100	160	0.65	< 0.56	< 0.54	1.1	< 0.49
Calcium	-	-	2,300	1,800	32,000	440	1,000
Chromium (2)	6,100	230	90	56	58	26	46
Cobalt	120,000	4,700	11	11	13	18	10
Copper	82,000	3,100	58	91	56	60	43
Iron	610,000	23,000	45,000	61,000	40,000	87,000	43,000
Lead	400*	400*	69	55	66	19	94
Magnesium	-	-	1,400	1,100	2,300	840	1,000
Manganese	41,000	1,600	420	370	440	420	310
Mercury	-	-	0.063	0.051	0.073	0.038	0.076
Nickel	41,000	1,600	11	13	16	9.7	11
Potassium	-	-	770	650	1300	370	570
Vanadium	14,000	550	160	190	130	240	100
Zinc	610,000	23,000	130	66	110	57	180

Values in bold font exceed the Industrial RBC.
(1) USEPA Region 3 RBC Table 4/13/2000
(2) Chromium is analyzed as total chromium and is compared to the RBC for chromium VI.
* Lead criteria is a provisional value from U S. EPA OSWER, Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities, EPA/540/F-94/043, August, 1994.

TABLE 5-4
SUMMARY OF CONSTITUENTS DETECTED IN SURFACE WATER SAMPLES
FORMER CHARLOTTE ARMY MISSILE PLANT

SITE ID SAMPLE ID DATE CONSTITUENT	EPA Maximum Contaminant Levels [1]	North Carolina Surface water Standards [2]	Detection Limit [3]	COESWE01 COESW0101 02/28/2000
TCL Volatile Organics				
Units in ug/L				
Carbon tetrachloride	5	4.42	1.0	(0.15)
Chloroform	80	-	1.0	(0.39)
1,1-Dichloroethene	7	-	1.0	(0.42)
cis-1,2-Dichloroethene	70	-	1.0	6.8
Naphthalene	-	-	1.0	(0.36)
Trichloroethene	5	92.4	1.0	45
TAL Metals				
Units in ug/L				
Aluminum	50	-	0.2	(78)
Barium	2000	-	0.01	330
Calcium	-	-	0.5	16,000
Iron	300	1000	0.05	190
Lead	15	25	0.005	(2.4)
Magnesium	-	-	0.5	5100
Manganese	50	-	0.01	27
Potassium	-	-	1.0	2100
Sodium	-	-	0.5	7500
Vanadium	-	-	0.01	(3.3)
Zinc	500	50	0.02	37
Water Quality Parameters				
Units in mg/L				
Alkalinity (to pH 4.5) as CaCO3	-	-	1.0	50
Chloride	-	230,000	1.0	9.0
Methane	-	-	0.19	0.0013
Nitrate	10	-	0.05	1.7
Nitrite-N	1	-	0.05	0.050J
Sulfate	250	-	5.0	12

J - Result is estimated

( ) concentration is reported below Laboratory Quantitation Limit; Bold=exceeds MCL.

1 - Maximum Contaminant Level (MCL), USEPA Drinking Water Regulations and Health Advisories-Primary Standards

Secondary Standards provided for Aluminum, Iron, Manganese, Zinc, Nitrate & Sulfate

a - MCL for total trihalomethanes includes chloroform+bromoform+bromodichloromethane+dibromochloromethane

2 - State of North Carolina Chapter ISA NCAC 2B .2000 Standards for Class C Surface Water (NCAC Title 15A Section .0200)

3 - Criteria for background concentrations is the detection limit for VOCs

A dash '-' indicates that parameter does not have a groundwater standard currently promulgated.

TABLE 5-5
SUMMARY OF CONSTITUENTS DETECTED IN SUBSURFACE SOIL SAMPLES
FORMER CHARLOTTE ARMY MISSILE PLANT PHASE II RI

SITE	USEPA Region 3 RBC (1)		CRITERION	AVERAGE	COEMW13	COEMW14	COEMW15	COEMW16	COEMW17
SAMPLE ID	Industrial	Residential	BACKGROUND	SURFACE SOIL	COEMW1301	COEMW1401	COEMW1501	COEMW1601	COEMW1701
DATE	mg/kg	mg/kg	CONC. (2)	CONCENTRATION	01/31/2000	01/05/2000	02/03/2000	02/04/2000	02/01/2000
DEPTH (ft)				mg/kg	10	10	15	15	5
RESULT TYPE					Primary	Primary	Primary	Primary	Primary
CONSTITUENT									
ORGANICS (mg/kg)									
Acetone	200,000	7,800	N/A	N/A	0.076	0.073	0.12	<0.064	<0.065
Trichloroethylene	5200 c	580 c	N/A	N/A	<0.0073	<0.0068	<0.0061	<0.0061	<0.0063
Aroclor 1260	2.9 c	0.32 c	N/A	N/A	<0.049	<0.045	<0.044	<0.042	<0.043
INORGANICS (mg/kg)									
Aluminum	200,000	7,800	46,667	18,400	17,000	2,900	16,000	36,000	21,000
Barium	140,000	5,500	77	48	43	430	240	250	69
Beryllium*	4,100	160	2*	0.7	<0.597	<2	<0.541	1.3	0.61
Cadmium*	1,000	39	2.5*	ND	<0.746	<2.5	<0.676	2	<0.649
Calcium	-	-	6,453	7,508	790	1100	3500	6400	1500
Chromium	-	-	217	55	15	13	7.8	50	31
Cobalt	120,000	4,700	224	13	17	28	23	52	9.9
Copper	82,000	3,100	137	62	44	94	44	140	41
Iron	610,000	23,000	79,333	55,200	45,000	47,000	23,000	57,000	14,000
Lead	400**	-	56	61	8.4	9.9	3.2	4.9	9.8
Magnesium	-	-	12,813	1,328	1,400	7,200	11,000	17,000	840
Manganese	4,100	1,600	1,267	392	420	1600	530	1,300	110
Mercury*	-	-	0.03*	0.06	<0.03	<0.02	<0.027	1.6	<0.026
Nickel	41,000	1,600	32	12	6.4	13	9.2	58	10
Potassium	-	-	4,700	732	1,000	4,500	4,500	2,900	390
Selenium	1,000	390	5*	ND	<1.493	<5	<1.351	<1	1.3
Sodium*	-	-	250*	ND	<74.627	<250	<67.568	<50	130U
Vanadium*	14,000	550	279	164	130	210	72	220	120
Zinc	610,000	23,000	92	108	17	65	49	110	25

BOLD cells indicate values that exceed CBC only.
BOLD and bracketed [ ] cells indicate values exceed both CBC and RBC.
(1) USEPA Region 3 Risk-Based Concentrations (4/13/2000) in soil for Industrial and Residential use scenarios; c - carcinogenic risk
(2) Criterion Background Concentration is based on 2 times the average concentration of soils collected from background soil borings; HP29 (Phase I) and MW28 (Phase II).
* An asterisks indicates that the parameter was not detected at background locations and the CBC was calculated based on 1/2 the detection limit multiplied by a factor of two.
** Lead criteria is a provisional value from U S. EPA OSWER, EPA/540/F-94/043, August, 1994.
N/A = Not Applicable
J = RESULT IS ESTIMATED.

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TABLE 5-5
SUMMARY OF CONSTITUENTS DETECTED IN SUBSURFACE SOIL SAMPLES
FORMER CHARLOTTE ARMY MISSILE PLANT PHASE II RI

SITE	USEPA Region 3 RBC (1)		CRITERION	AVERAGE	COEMW18	COEMW18	COEMW19	COEMW20	COEMW21
SAMPLE ID	Industrial	Residential	BACKGROUND	SURFACE SOIL	COEMW1801	COEMW1801	COEMW1901	COEMW2001	COEMW2101
DATE	mg/kg	mg/kg	CONC. (2)	CONCENTRATION	02/02/2000	02/02/2000	02/02/2000	02/01/2000	01/06/2000
DEPTH (ft)				mg/kg	7	7	7	15	10
RESULT TYPE					Primary	Duplicate 1	Primary	Primary	Primary
CONSTITUENT									
ORGANICS (mg/kg)									
Acetone	200,000	7,800	N/A	N/A	0.23	0.35	<0.059	<0.061	<0.074
Trichloroethylene	5200 c	580 c	N/A	N/A	<0.0047	<0.0045	<0.0052	<0.0055	<0.0075
Aroclor 1260	2.9 c	0.32 c	N/A	N/A	<0.037	<0.039	<0.039	<0.041	<0.049
INORGANICS (mg/kg)									
Aluminum	200,000	7,800	46,667	18,400	12,000	4,200	11,000	11,000	25,000
Barium	140,000	5,500	77	48	21	27	16	69	400
Beryllium*	4,100	160	2*	0.7	<0.444	<0.471	<0.476	<0.494	<2
Cadmium*	1,000	39	2.5*	ND	<0.556	<0.5	<0.595	<0.617	<2.5
Calcium	-	-	6,453	7,508	630	360	430	5100	150
Chromium	-	-	217	55	43	25	25	14	9.7
Cobalt	120,000	4,700	224	13	3.5	9.3	2.4	22	54
Copper	82,000	3,100	137	62	20	6	10	59	59
Iron	610,000	23,000	79,333	55,200	40,000	9,500	14,000	28,000	41,000
Lead	400**	-	56	61	8.5	5.5	5	4.1	8.1
Magnesium	-	-	12,813	1,328	660	140	480	7,800	4,600
Manganese	4,100	1,600	1,267	392	72	580	20	770	2,500
Mercury*	-	-	0.03*	0.06	<0.02	<0.024	<0.024	<0.02	<0.02
Nickel	41,000	1,600	32	12	5.8	<4.7	5.3	19	14
Potassium	-	-	4,700	732	300	<118	140	200	3300
Selenium	1,000	390	5*	ND	1.6	<1	<1	<1.235	<5
Sodium*	-	-	250*	ND	89U	99U	130U	100U	<250
Vanadium*	14,000	550	279	164	86	33	72	97	92
Zinc	610,000	23,000	92	108	8.9	4.5	74	38	48

BOLD cells indicate values that exceed CBC only.
BOLD and bracketed [ ] cells indicate values exceed both CBC and RBC.
(1) USEPA Region 3 Risk-Based Concentrations (4/13/2000) in soil for Industrial and Residential use scenarios; c - carcinogeni
(2) Criterion Background Concentration is based on 2 times the average concentration of soils collected from background soil borings; HP29 (Phase I) and MW28 (Phase II).
* An asterisks indicates that the parameter was not detected at background locations and the CBC was calculated based on 1/2 the detection limit multiplied by a factor of two.
** Lead criteria is a provisional value from U S. EPA OSWER, EPA/540/F-94/043, August, 1994.
N/A = Not Applicable
J = RESULT IS ESTIMATED.

P:\hazwaste\camp2\phase II RI\final report\tabl5-5 SUBSOIL CBC half DL V2.XLS

TABLE 5-5
SUMMARY OF CONSTITUENTS DETECTED IN SUBSURFACE SOIL SAMPLES
FORMER CHARLOTTE ARMY MISSILE PLANT PHASE II RI

SITE	USEPA Region 3 RBC (1)		CRITERION	AVERAGE	COEMW22	COEMW23	COEMW24	COEMW25	COEMW26
SAMPLE ID	Industrial	Residential	BACKGROUND	SURFACE SOIL	COEMW2201	COEMW2301	COEMW2401	COEMW2501	COEMW2601
DATE	mg/kg	mg/kg	CONC. (2)	CONCENTRATION	01/17/2000	01/10/2000	01/18/2000	01/11/2000	01/11/2000
DEPTH (ft)				mg/kg	15	15	10	6	7
RESULT TYPE					Primary	Primary	Primary	Primary	Primary
CONSTITUENT									
ORGANICS (mg/kg)									
Acetone	200,000	7,800	N/A	N/A	<0.062	0.087	0.075	<0.066	<0.062
Trichloroethylene	5200 c	580 c	N/A	N/A	<0.0062	<0.0072	<0.0066	<0.0062	0.012J
Aroclor 1260	2.9 c	0.32 c	N/A	N/A	<0.038	<0.048	<0.040	<0.044	<0.044
INORGANICS (mg/kg)									
Aluminum	200,000	7,800	46,667	18,400	22,000	21,000	18,000	30,000	16,000
Barium	140,000	5,500	77	48	66	94	75	180	120
Beryllium*	4,100	160	2*	0.7	<2	<2	<2	<2	<2
Cadmium*	1,000	39	2.5*	ND	<2.5	<2.5	<2.5	<2.5	<2.5
Calcium	-	-	6,453	7,508	520	3400	740	500	2000
Chromium	-	-	217	55	37	15	19	14	18
Cobalt	120,000	4,700	224	13	21	23	22	31	17
Copper	82,000	3,100	137	62	50	50	63	73	47
Iron	610,000	23,000	79,333	55,200	52,000	46,000	46,000	45,000	31,000
Lead	400**	-	56	61	17	18	11	9.7	5.6
Magnesium	-	-	12,813	1,328	810	4,600	1,600	4,000	7,600
Manganese	4,100	1,600	1,267	392	810	510	510	820	240
Mercury*	-	-	0.03*	0.06	<0.024	0.08	0.028	<0.027	<0.027
Nickel	41,000	1,600	32	12	8.6	6.7	<5.634	8.8	10
Potassium	-	-	4,700	732	<122	3,300	1,500	3,800	5,000
Selenium	1,000	390	5*	ND	<5	<5	<5	<5	<5
Sodium*	-	-	250*	ND	<250	<250	<250	<250	<250
Vanadium*	14,000	550	279	164	190	160	180	160	110
Zinc	610,000	23,000	92	108	21	45	27	36	48

BOLD cells indicate values that exceed CBC only.
BOLD and bracketed [ ] cells indicate values exceed both CBC and RBC.
(1) USEPA Region 3 Risk-Based Concentrations (4/13/2000) in soil for Industrial and Residential use scenarios; c - carcinogeni
(2) Criterion Background Concentration is based on 2 times the average concentration of soils collected from background soil borings; HP29 (Phase I) and MW28 (Phase II).
* An asterisks indicates that the parameter was not detected at background locations and the CBC was calculated based on 1/2 the detection limit multiplied by a factor of two.
** Lead criteria is a provisional value from U S. EPA OSWER, EPA/540/F-94/043, August, 1994.
N/A = Not Applicable
J = RESULT IS ESTIMATED.

P:\hazwaste\camp2\phase II RI\final report\tabl5-5 SUBSOIL CBC half DL V2.XLS

TABLE 5-5
SUMMARY OF CONSTITUENTS DETECTED IN SUBSURFACE SOIL SAMPLES
FORMER CHARLOTTE ARMY MISSILE PLANT PHASE II RI

SITE	USEPA Region 3 RBC (1)		CRITERION	AVERAGE	COEMW27	COEMW29	COEMW30
SAMPLE ID	Industrial	Residential	BACKGROUND	SURFACE SOIL	COEMW2701	COEMW29	COEMW30
DATE	mg/kg	mg/kg	CONC. (2)	CONCENTRATION	01/07/2000	06/25/1999	06/23/1999
DEPTH (ft)				mg/kg	7	92	68
RESULT TYPE					Primary	Primary	Primary
CONSTITUENT							
ORGANICS (mg/kg)							
Acetone	200,000	7,800	N/A	N/A	<0.058	0.05	0/021
Trichloroethylene	5200 c	580 c	N/A	N/A	0.0057	<0.0053	0.0016
Aroclor 1260	2.9 c	0.32 c	N/A	N/A	<0.038	<0.038	0.026J
INORGANICS (mg/kg)							
Aluminum	200,000	7,800	46,667	18,400	25,000	19,000	20,000
Barium	140,000	5,500	77	48	170	43	220
Beryllium*	4,100	160	2*	0.7	<2	<0.4	<2
Cadmium*	1,000	39	2.5*	ND	<2.5	<0.5	<2.5
Calcium	-	-	6,453	7,508	5000	1100	4400
Chromium	-	-	217	55	12	33	16
Cobalt	120,000	4,700	224	13	15	4.4	24
Copper	82,000	3,100	137	62	44	23	52
Iron	610,000	23,000	79,333	55,200	39,000	16,000	31,000
Lead	400**	-	56	61	7.7	7.6	18
Magnesium	-	-	12,813	1,328	6,300	1,000	8,300
Manganese	4,100	1,600	1,267	392	280	100	690
Mercury*	-	-	0.03*	0.06	<0.023	0.034	<0.02
Nickel	41,000	1,600	32	12	9.8	9.4	13
Potassium	-	-	4,700	732	760	650	4,800
Selenium	1,000	390	5*	ND	<5	<1	<5
Sodium*	-	-	250*	ND	<250	73	<250
Vanadium*	14,000	550	279	164	130	100	110
Zinc	610,000	23,000	92	108	38	22	76

BOLD cells indicate values that exceed CBC only.
BOLD and bracketed [ ] cells indicate values exceed both CBC and RBC.
(1) USEPA Region 3 Risk-Based Concentrations (4/13/2000) in soil for Industrial and Residential use scenarios; c - carcinogeni
(2) Criterion Background Concentration is based on 2 times the average concentration of soils collected from background soil borings; HP29 (Phase I) and MW28 (Phase II).
* An asterisks indicates that the parameter was not detected at background locations and the CBC was calculated based on 1/2 the detection limit multiplied by a factor of two.
** Lead criteria is a provisional value from U S. EPA OSWER, EPA/540/F-94/043, August, 1994.
N/A = Not Applicable
J = RESULT IS ESTIMATED.

P:\hazwaste\camp2\phase II RI\final report\tabl5-5 SUBSOIL CBC half DL V2.XLS

TABLE 5-6
SUMMARY OF CONSTITUENTS DETECTED IN PHASE I RI SUBSURFACE SOIL SAMPLES

SITE			COEHA01	COEHA01	COEHA05	COEHP01	COEHP01	COEHP01
SAMPLE ID	USEPA	Criterion (1)	COEHA0101	COEHA0102	COEHA0501	SB0101	SB0102	SB5001
DATE	Region III	Background	06/08/1997	06/08/1997	06/08/1997	01/08/1997	01/08/1997	01/08/1997
DEPTH (ft)	RBC	Concentration	5.00	10.00	5.00	6.00	10.00	10.00
CONSTITUENT (mg/kg)			Primary	Primary	Primary	Primary	Primary	Duplicate 1
Acetone	200,000	N/A	<0.067	<0.06	<0.064	<0.063	<0.057	<0.064
Ethyl benzene	200,000	N/A	<0.0067	<0.006	<0.0064	<0.0063	<0.0057	<0.0064
Naphthalene	-	N/A	<0.0067	<0.006	<0.0064	<0.0063#	<0.0057#	<0.0064#
Toluene	410,000	N/A	0.0054	0.0037	0.015	<0.0063	<0.0057	<0.0064
Trichloroethene	520	N/A	<0.0067	<0.006	<0.0064	<0.0063	<0.0057	<0.0064
m-Xylene	410,000	N/A	<0.0067	<0.006	0.0032	<0.0063	<0.0057	<0.0064
o-Xylene	410,000	N/A	<0.0067	<0.006	<0.0064	<0.0063	<0.0057	<0.0064
Benzo(a)anthracene	-	N/A	<0.44	<0.4	<0.42	<0.41	<0.38	<0.42
Bis(2-ethylhexyl)phthalate	-	N/A	<0.44	<0.4	<0.42	<0.41	<0.38	<0.42
Benzo(b)fluoranthene	-	N/A	<0.44	<0.4	<0.42	<0.41	<0.38	<0.42
3,3'-Dichlorobenzidine	13	N/A	<0.88	<0.8	<0.85	<0.82	<0.75	<0.85
Diethyl phthalate	1,600,000	N/A	<0.44	0.89	0.9	<0.41	<0.38	<0.42
Fluoranthene	-	N/A	<0.44	<0.4	<0.42	<0.41	<0.38	<0.42
2-Methylnaphthalene	-	N/A	<0.44	<0.4	<0.42	<0.41	<0.38	<0.42
Phenanthrene	-	N/A	<0.44	<0.4	<0.42	<0.41	<0.38	<0.42
Pyrene	61,000	N/A	<0.44	<0.4	<0.42	<0.41	<0.38	<0.42
4,4'-DDE	17	N/A	<0.0044	<0.004J	<0.0042	0.0069J	<0.0038J	0.0052
4,4'-DDT	17	N/A	<0.0044	<0.004J	<0.0042	0.0075J	<0.0038J	0.0053
Aroclor 1260	2.9	N/A	<0.044	<0.04J	<0.042	0.089J	<0.038J	0.08
Aluminum	200,000	46,667	21000J	26000	30000	16000	27000	24000
Arsenic*	3.8	3.33	3.0	<1.0	2.9	<5.0	<5.0	<5.0
Barium	140,000	77	35	98	41	29	53	48
Beryllium*	4,100	2	<2.0	<0.80	<2.0	<2.0	<2.0	<2.0
Calcium	-	6,453	500	130	500	2100	13000	3000
Chromium	6,100	217	46	36	50	29	16	67
Cobalt	120,000	224	11	8.3	19	22	27	19
Copper	82,000	137	48	36	58	39	66	39
Iron	610,000	79,333	64000J	13000	68000	39000	46000	41000
Lead	400**	56	8.1	6.4	8.1	32	1.9	30
Magnesium	-	12,813	460J	1600	600	1200	12000	1300
Manganese	4,100	1,267	260	56	310	370	570	560
Mercury*	3.8	0.03	0.056	<0.030	0.044	0.039	<0.030	<0.030
Nickel	41,000	32	8.0	10	11	<20	72	<20
Potassium	-	4,700	240	1100	320	<500	<500	<500
Selenium	1,000	5	<5.0	<1.0	<5.0	<5.0	<5.0	<5.0
Sodium*	-	250	<100	<50	<100	370	<250	330
Vanadium*	14,000	279	190	88	200	150	130	150
Zinc	610,000	92	23	26	30	46	58	97
Sulfate	-	163	NT	NT	NT	NT	NT	NT

J = RESULT IS ESTIMATED.
R = RESULT IS REJECTED.
#=Constituent in more than one test method, highest result reported.
N/A = Not Applicable
NT= Not analyzed
BOLD cells indicate values that exceed CBC only.
BOLD and bracketed [ ] cells indicate values exceed both CBC and RBC.
(1) CBC based on an average of two Phase I (COEHP29) and one Phase II (COEMW28) samples.
* An asterisks indicates that the parameter was not detected at background locations and the CBC was calculated based on 1/2 the detection limit multiplied by a factor of two.
** Lead criteria is a provisional value from U S. EPA OSWER, Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities, EPA/540/F-94/043, August, 1994.

TABLE 5-6
SUMMARY OF CONSTITUENTS DETECTED IN PHASE I RI SUBSURFACE SOIL SAMPLES

SITE			COEHP02	COEHP02	COEHP03	COEHP03	COEHP04	COEHP04
SAMPLE ID	USEPA	Criterion (1)	SB0201	SB0202	SB0301	SB0302	SB0401	SB0402
DATE	Region III	Background	01/07/1997	01/07/1997	01/07/1997	01/07/1997	12/05/1996	12/05/1996
DEPTH (ft)	RBC	Concentration	6.00	10.00	6.00	10.00	6.00	8.00
CONSTITUENT (mg/kg)			Primary	Primary	Primary	Primary	Primary	Primary
Acetone	200,000	N/A	<0.059	<0.061	<0.064	<0.06	<0.067J	<0.07
Ethyl benzene	200,000	N/A	<0.0059	<0.0061	<0.0064	<0.006	<0.0067J	<0.007
Naphthalene	-	N/A	<0.0059#	<0.0061#	<0.0064#	<0.006#	<0.0067#J	<0.007#
Toluene	410,000	N/A	<0.0059	<0.0061	<0.0064	<0.006	<0.0067J	<0.007
Trichloroethene	520	N/A	<0.0059	<0.0061	<0.0064	<0.006	<0.0066J	<0.007
m-Xylene	410,000	N/A	<0.0059	<0.0061	<0.0064	<0.006	<0.013J	<0.014
o-Xylene	410,000	N/A	<0.0059	<0.0061	<0.0064	<0.006	<0.0067J	<0.007
Benzo(a)anthracene	-	N/A	<0.39	<0.4	<0.42	<0.4	<0.44	<0.46
Bis(2-ethylhexyl)phthalate	-	N/A	<0.39	<0.4	<0.42	<0.4	<0.44	<0.46
Benzo(b)fluoranthene	-	N/A	<0.39	<0.4	<0.42	<0.4	<0.44	<0.46
3,3'-Dichlorobenzidine	13	N/A	<0.79	<0.8	<0.84	<0.8	<0.89	<0.93
Diethyl phthalate	1,600,000	N/A	<0.39	<0.4	<0.42	<0.4	<0.44	<0.46
Fluoranthene	-	N/A	<0.39	<0.4	<0.42	<0.4	<0.44	<0.46
2-Methylnaphthalene	-	N/A	<0.39	<0.4	<0.42	<0.4	<0.44	<0.46
Phenanthrene	-	N/A	<0.39	<0.4	<0.42	<0.4	<0.44	<0.46
Pyrene	61,000	N/A	<0.39	<0.4	<0.42	<0.4	<0.44	<0.46
4,4'-DDE	17	N/A	<0.0039	<0.004	<0.0042	<0.004	<0.0044	<0.0046
4,4'-DDT	17	N/A	<0.0039	<0.004	<0.0042	<0.004	<0.0044	<0.0046
Aroclor 1260	2.9	N/A	<0.039	<0.04	<0.042	<0.04	<0.044	<0.046
Aluminum	200,000	46,667	33000	37000	31000	32000J	26000J	26000J
Arsenic*	3.8	3.33	<5.0	<500	<5.0	<5.0	3.0	3.6
Barium	140,000	77	<500	<500	210	<500	220	220
Beryllium*	4,100	2	<2.0	<2.0	<2.0	<2.0	0.99	1.1
Calcium	-	6,453	<25000	<24000	7400	<24000J	5200J	2900J
Chromium	6,100	217	<500	<500	14	<500	94	46
Cobalt	120,000	224	<500	<500	22	<500	40	25
Copper	82,000	137	<1200	<1200	65	<1200	93	72
Iron	610,000	79,333	82000	77000	36000	38000J	47000J	53000J
Lead	400**	56	0.96	4.0	2.4	2.2J	<0.50	4.2
Magnesium	-	12,813	<25000	<24000	12000	<24000J	32000J	15000J
Manganese	4,100	1,267	800	1000	720	830J	1300J	410J
Mercury*	3.8	0.03	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Nickel	41,000	32	<2000	<2000	<20	<20	47	25
Potassium	-	4,700	<50000	<50000	8200	<50000J	3500J	12000J
Selenium	1,000	5	<5.0	<5.0	<5.0	<5.0	1.8	2.4
Sodium*	-	250	<250	<24000	<250	<24000J	<50	<100
Vanadium*	14,000	279	<500	<500	100	<500	100	150
Zinc	610,000	92	<1000	<1000	65	<1000	97	120
Sulfate	-	163	NT	NT	NT	NT	<100	<100

J = RESULT IS ESTIMATED.
R = RESULT IS REJECTED.
#=Constituent in more than one test method, highest result reported.
N/A = Not Applicable
NT= Not analyzed
BOLD cells indicate values that exceed CBC only.
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(1) CBC based on an average of two Phase I (COEHP29) and one Phase II (COEMW28) samples.
* An asterisks indicates that the parameter was not detected at background locations and the CBC was calculated based on 1/2 the detection limit multiplied by a factor of two.
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TABLE 5-6
SUMMARY OF CONSTITUENTS DETECTED IN PHASE I RI SUBSURFACE SOIL SAMPLES

SITE			COEHP05	COEHP05	COEHP06	COEHP06	COEHP07	COEHP07
SAMPLE ID	USEPA	Criterion (1)	SB0501	SB0502	SB0601	SB0602	SB0701	SB0702
DATE	Region III	Background	12/06/1996	12/06/1996	12/07/1996	12/07/1996	01/11/1997	01/11/1997
DEPTH (ft)	RBC	Concentration	12.00	14.00	6.00	8.00	10.00	18.00
CONSTITUENT (mg/kg)			Primary	Primary	Primary	Primary	Primary	Primary
Acetone	200,000	N/A	0.13	0.11	<0.07	<0.072	<0.068	<0.072
Ethyl benzene	200,000	N/A	<0.0058	<0.0064	<0.007	<0.0072	<0.0068	<0.0072
Naphthalene	-	N/A	<0.0058#	<0.0064#	<0.007#	<0.0072#	<0.0068	<0.0072
Toluene	410,000	N/A	<0.0058	<0.0064	<0.007	<0.0072	<0.0068	<0.0072
Trichloroethene	520	N/A	<0.0058	<0.0064	0.097J	0.075	<0.0068	<0.0072
m-Xylene	410,000	N/A	<0.012	<0.013	<0.014	<0.014	<0.0068	<0.0072
o-Xylene	410,000	N/A	<0.0058	<0.0064	<0.007	<0.0072	<0.0068	<0.0072
Benzo(a)anthracene	-	N/A	<0.42	<0.43	<0.47	<0.48	<0.45	<0.48
Bis(2-ethylhexyl)phthalate	-	N/A	<0.42	<0.43	<0.47	<0.48	<0.45	<0.48
Benzo(b)fluoranthene	-	N/A	<0.42	<0.43	<0.46	<0.48	<0.45J	<0.48
3,3'-Dichlorobenzidine	13	N/A	<0.83	<0.87	<0.94	<0.95	<0.9	<0.96
Diethyl phthalate	1,600,000	N/A	<0.42	<0.43	<0.47	<0.48	<0.45	<0.48
Fluoranthene	-	N/A	<0.42	<0.43	<0.46	<0.48	<0.45	<0.48
2-Methylnaphthalene	-	N/A	<0.42	<0.43	<0.47	<0.48	<0.45	<0.48
Phenanthrene	-	N/A	<0.42	<0.43	<0.46	<0.48	<0.45J	<0.48
Pyrene	61,000	N/A	<0.42	<0.43	<0.46	<0.48	<0.45	<0.48
4,4'-DDE	17	N/A	<0.0041	<0.0043	<0.0046	<0.0047	<0.0045J	<0.0048
4,4'-DDT	17	N/A	<0.0041	<0.0043	<0.0046	<0.0047	<0.0045J	<0.0048
Aroclor 1260	2.9	N/A	<0.041	<0.043	<0.046	<0.047	<0.045J	<0.048
Aluminum	200,000	46,667	20000J	15000J	31000J	22000J	28000J	35000J
Arsenic*	3.8	3.33	<2.0	<2.0	2.3	3.2	**[8.8]**	<5.0
Barium	140,000	77	**100**	**110**	**250**	**250**	**130**	**310**
Beryllium*	4,100	2	0.59	0.76	0.92	1.0	<2.0	**2.4**
Calcium	-	6,453	4600J	3700J	1500J	1300J	1100J	590J
Chromium	6,100	217	21	16	26	16	38	12
Cobalt	120,000	224	20	34	20	19	28	40
Copper	82,000	137	58	59	89	72	90	98
Iron	610,000	79,333	35000J	35000J	48000J	45000J	**81000J**	64000J
Lead	400**	56	6.0	6.7	5.7	6.2	**[490J]**	22J
Magnesium	-	12,813	9500J	10000J	95000J	9300J	1900J	8700J
Manganese	4,100	1,267	230J	290J	330J	420J	720J	950J
Mercury*	3.8	0.03	<0.030	<0.030	<0.030	<0.030	**0.096**	<0.030
Nickel	41,000	32	12	14	12	11	<20	<20
Potassium	-	4,700	6200J	6400J	10000J	9900J	930J	7700J
Selenium	1,000	5	<2.0	<2.0	<2.0	<2.0	<5.0	<5.0
Sodium*	-	250	<100	<100	<100	<100	<250R	<250R
Vanadium*	14,000	279	96	96	160	140	250	240
Zinc	610,000	92	62	78	71	66	**140**	76
Sulfate	-	163	<100	<100	210	<100	NT	NT

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NT= Not analyzed
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TABLE 5-6
SUMMARY OF CONSTITUENTS DETECTED IN PHASE I RI SUBSURFACE SOIL SAMPLES

SITE			COEHP08	COEHP08	COEHP09	COEHP09	COEHP10	COEHP10
SAMPLE ID	USEPA	Criterion (1)	SB0801	SB0802	SB0901	SB0901	SB1001	SB1002
DATE	Region III	Background	01/13/1997	01/13/1997	01/11/1997	01/11/1997	12/12/1996	12/12/1996
DEPTH (ft)	RBC	Concentration	8.00	18.00	10.00	18.00	10.00	18.00
CONSTITUENT (mg/kg)			Primary	Primary	Primary	Primary	Primary	Primary
Acetone	200,000	N/A	<0.07	<0.07	<0.071	<0.067	<0.066	<0.071
Ethyl benzene	200,000	N/A	<0.0068	<0.007	<0.0071	<0.0067	<0.0066	<0.0071
Naphthalene	-	N/A	<0.0068	<0.007	<0.0071	<0.0067	<0.0066#	<0.0071#
Toluene	410,000	N/A	<0.0068	<0.007	<0.0071	<0.0067	<0.0066	<0.0071
Trichloroethene	520	N/A	<0.0068	<0.007	<0.0071	<0.0067	<0.0066	<0.0071
m-Xylene	410,000	N/A	<0.0068	<0.007	<0.0071	<0.0067	<0.013	<0.014
o-Xylene	410,000	N/A	<0.0068	<0.007	<0.0071	<0.0067	<0.0066	<0.0071
Benzo(a)anthracene	-	N/A	<0.45	<0.46	<0.45	<0.45	<0.44	<0.47
Bis(2-ethylhexyl)phthalate	-	N/A	<0.45	<0.46	<0.45	<0.45	<0.44	<0.47
Benzo(b)fluoranthene	-	N/A	<0.45	<0.46	<0.46J	<0.45	<0.44	<0.47
3,3'-Dichlorobenzidine	13	N/A	<0.9	<0.93	<0.89	<0.89	<0.88	<0.94
Diethyl phthalate	1,600,000	N/A	<0.45	<0.46	<0.45	<0.45	<0.44	<0.47
Fluoranthene	-	N/A	<0.45	<0.46	<0.46J	<0.45	<0.44	<0.47
2-Methylnaphthalene	-	N/A	<0.45	<0.46	<0.45	<0.45	<0.44	<0.47
Phenanthrene	-	N/A	<0.45	<0.46	<0.46J	<0.45	<0.44	<0.47
Pyrene	61,000	N/A	<0.45	<0.46	<0.46J	<0.45	<0.44	<0.47
4,4'-DDE	17	N/A	<0.0045	<0.0046	<0.0046J	<0.0045J	<0.0044	<0.0047
4,4'-DDT	17	N/A	<0.0045	<0.0046	<0.0046J	<0.0045J	<0.0044	<0.0047
Aroclor 1260	2.9	N/A	<0.045	<0.046	<0.046J	<0.045J	<0.044	<0.047
Aluminum	200,000	46,667	37000	37000	50000J	42000J	31000J	25000J
Arsenic*	3.8	3.33	<5.0	<5.0	[7.4]	<5.0	[5.6#]	[4.6#]
Barium	140,000	77	270	310	240	440	260	[330]
Beryllium*	4,100	2	<2.0	<2.0	2.3	<2.0	1.2	1.1
Calcium	-	6,453	830	350	1800J	4700J	540J	320J
Chromium	6,100	217	20	17	31	18	11	8.1
Cobalt	120,000	224	56	23	44	23	63	31
Copper	82,000	137	95	130	140	88	92	81
Iron	610,000	79,333	56000	51000	66000J	39000J	63000J	48000J
Lead	400**	56	16	8.2	12J	5.9J	9.7	7.9
Magnesium	-	12,813	4900	8500	6300J	12000J	5300J	8500J
Manganese	4,100	1,267	1200	930	720J	580J	960J	1000J
Mercury*	3.8	0.03	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Nickel	41,000	32	<20	<20	27	<20	12	12
Potassium	-	4,700	4400	7500	4200J	8900J	5800J	9000J
Selenium	1,000	5	<5.0	<5.0	<5.0	<5.0	2.7#	2.8#
Sodium*	-	250	<250	<250	<250R	<250R	<100	120
Vanadium*	14,000	279	180	150	220	140	200	150
Zinc	610,000	92	47	70	77	73	52	69
Sulfate	-	163	NT	NT	NT	NT	NT	NT

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TABLE 5-6
SUMMARY OF CONSTITUENTS DETECTED IN PHASE I RI SUBSURFACE SOIL SAMPLES

SITE			COEHP11	COEHP11	COEHP12	COEHP12	COEHP12	COEHP13
SAMPLE ID	USEPA	Criterion (1)	SB1102	SB1101	SB1201	SB5301	SB1202	SB1301
DATE	Region III	Background	12/08/1996	12/08/1996	12/11/1996	12/11/1996	12/11/1996	12/11/1996
DEPTH (ft)	RBC	Concentration	50.50	20.00	6.00	6.00	12.00	12.00
CONSTITUENT (mg/kg)			Primary	Primary	Primary	Duplicate 1	Primary	Primary
Acetone	200,000	N/A	<0.061	0.063	<0.066	0.17	<0.068	1.8
Ethyl benzene	200,000	N/A	<0.0061	<0.0063	<0.0066	<0.0069	<0.0068	0.077
Naphthalene	-	N/A	<0.0061#	<0.0063#	<0.0066#	<0.0069#	<0.0068#	0.29#
Toluene	410,000	N/A	<0.0061	<0.0063	<0.0066	<0.0069	<0.0068	<0.034
Trichloroethene	520	N/A	<0.0061	<0.0063	<0.0066	<0.0069	<0.0068	<0.034
m-Xylene	410,000	N/A	<0.012	<0.013	<0.013	<0.014	<0.014	0.29
o-Xylene	410,000	N/A	<0.0061	<0.0063	<0.0066	<0.0069	<0.0068	<0.034
Benzo(a)anthracene	-	N/A	<0.4	<0.42	<0.43	<0.45	<0.45	0.46
Bis(2-ethylhexyl)phthalate	-	N/A	<0.4	<0.42	<0.43	<0.45	<0.45	<0.45
Benzo(b)fluoranthene	-	N/A	<0.4	<0.42	<0.43	<0.45	<0.45	0.47
3,3'-Dichlorobenzidine	13	N/A	<0.8	<0.84	<0.87	<0.9	<0.9	<0.9
Diethyl phthalate	1,600,000	N/A	<0.4	<0.42	<0.43	<0.45	<0.45	<0.45
Fluoranthene	-	N/A	<0.4	<0.42	<0.43	<0.45	<0.45	1.6
2-Methylnaphthalene	-	N/A	<0.4	<0.42	<0.43	<0.45	<0.45	<0.45
Phenanthrene	-	N/A	<0.4	<0.42	<0.43	<0.45	<0.45	1.3
Pyrene	61,000	N/A	<0.4	<0.42	<0.43	<0.45	<0.45	1.1
4,4'-DDE	17	N/A	<0.004	<0.0042	<0.0043	<0.0045	<0.0045	<0.023
4,4'-DDT	17	N/A	<0.004	<0.0042	<0.0043	<0.0045	<0.0045	<0.023
Aroclor 1260	2.9	N/A	<0.04	<0.042	<0.043	<0.045	<0.045	<0.23
Aluminum	200,000	46,667	22000J	3200J	33000J	45000	38000J	28000J
Arsenic*	3.8	3.33	2.1#	2.6#	[5.1#]	[5.0]	[5.1#]	[4.6#]
Barium	140,000	77	210	260	280	430	430	360
Beryllium*	4,100	2	<0.40	0.80	1.2	1.4	1.4	1.4
Calcium	-	6,453	4300J	5200J	430J	800	760J	3000J
Chromium	6,100	217	9.9	13	9.1	11	15	16
Cobalt	120,000	224	14	20	39	31	39	25
Copper	82,000	137	57	72	70	100	86	64
Iron	610,000	79,333	27000J	38000J	51000J	60000	56000J	50000J
Lead	400**	56	3.6	4.2	7.4	7.3	9.0	4.8
Magnesium	-	12,813	8000J	12000J	6100J	8400	8100J	10000J
Manganese	4,100	1,267	370J	750J	830J	1200	1300J	860J
Mercury*	3.8	0.03	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Nickel	41,000	32	8.0	19	9.3	16	16	11
Potassium	-	4,700	7900J	87000J	7300J	9400	8100J	5400J
Selenium	1,000	5	<2.0#	1.5#	3.3#	3.6	4.1#	<2.0#
Sodium*	-	250	<50	<50	<100	<100	<100	<100
Vanadium*	14,000	279	93	96	140	180	160	140
Zinc	610,000	92	40	82	64	80	84	91
Sulfate	-	163	NT	NT	NT	NT	NT	NT

J = RESULT IS ESTIMATED.
R = RESULT IS REJECTED.
#=Constituent in more than one test method, highest result reported.
N/A = Not Applicable
NT= Not analyzed
BOLD cells indicate values that exceed CBC only.
BOLD and bracketed [ ] cells indicate values exceed both CBC and RBC.
(1) CBC based on an average of two Phase I (COEHP29) and one Phase II (COEMW28) samples.
* An asterisks indicates that the parameter was not detected at background locations and the CBC was calculated based on 1/2 the detection limit multiplied by a factor of two.
** Lead criteria is a provisional value from U S. EPA OSWER, Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities, EPA/540/F-94/043, August, 1994.

TABLE 5-6
SUMMARY OF CONSTITUENTS DETECTED IN PHASE I RI SUBSURFACE SOIL SAMPLES

SITE			COEHP13	COEHP14	COEHP14	COEHP15	COEHP15	COEHP16
SAMPLE ID	USEPA	Criterion (1)	SB1302	COEHP14	SB1402	SB1501	SB1502	SB1601
DATE	Region III	Background	12/11/1996	12/07/1996	12/07/1996	12/08/1996	12/08/1996	01/13/1997
DEPTH (ft)	RBC	Concentration	14.00	6.00	12.00	8.00	14.00	4.00
CONSTITUENT (mg/kg)			Primary	Primary	Primary	Primary	Primary	Primary
Acetone	200,000	N/A	<0.32	<0.073	<0.066	<0.071	<0.072	<0.067
Ethyl benzene	200,000	N/A	<0.032	<0.007	<0.0066	<0.0071	<0.0072	<0.0067
Naphthalene	-	N/A	<0.032?#	<0.007#	<0.0066#	<0.00717#	<0.00727#	<0.0067
Toluene	410,000	N/A	<0.032	<0.007	<0.0066	<0.0071	<0.0072	<0.0067
Trichloroethene	520	N/A	0.041	<0.007	<0.0066	<0.0071	<0.0072	<0.0067
m-Xylene	410,000	N/A	<0.064	<0.014	<0.013	<0.014	<0.014	<0.0067
o-Xylene	410,000	N/A	<0.032	<0.007	<0.0066	0.0071	<0.0072	<0.0067
Benzo(a)anthracene	-	N/A	<0.44	<0.49	<0.44	<0.46	<0.48	<0.44
Bis(2-ethylhexyl)phthalate	-	N/A	<0.44	<0.49	<0.44	<0.46	<0.48	<0.45
Benzo(b)fluoranthene	-	N/A	<0.44	<0.49	<0.44	<0.46	<0.48	<0.44
3,3'-Dichlorobenzidine	13	N/A	<0.88	<0.98	<0.88	<0.93	<0.96	<0.89
Diethyl phthalate	1,600,000	N/A	<0.44	<0.49	<0.44	<0.46	<0.48	<0.45
Fluoranthene	-	N/A	1.1	<0.48	<0.44	<0.46	<0.48	<0.44
2-Methylnaphthalene	-	N/A	0.59	<0.49	<0.44	<0.46	<0.48	<0.45
Phenanthrene	-	N/A	0.98	<0.49	<0.44	<0.46	<0.48	<0.44
Pyrene	61,000	N/A	0.8	<0.48	<0.44	<0.46	<0.48	<0.44
4,4'-DDE	17	N/A	<0.0044	<0.0049	<0.0043	<0.0046	<0.0048	0.0058
4,4'-DDT	17	N/A	<0.0044	<0.0049	<0.0043	<0.0046	<0.0048	0.017
Aroclor 1260	2.9	N/A	<0.044	<0.046	<0.043	<0.046	<0.048	<0.045
Aluminum	200,000	46,667	34000J	<20	42000J	29000J	29000J	25000
Arsenic*	3.8	3.33	3.1#	<1#	<2.0	[5.0#]	3.7#	[5.4]
Barium	140,000	77	450	<1	470	180	150	92
Beryllium*	4,100	2	0.90	<0.4	1.1	0.90	1.9	<2.0
Calcium	-	6,453	3000J	<50	3400J	<50J	<50J	1000
Chromium	6,100	217	15	<1	12	13	10	27
Cobalt	120,000	224	22	<1	21	57	22	39
Copper	82,000	137	70	<2.6	69	110	39	79
Iron	610,000	79,333	45000J	<5	36000J	61000J	52000J	63000
Lead	400**	56	4.0	<0.5	5.3	10	5.7	16
Magnesium	-	12,813	11000J	<5	12000J	5400J	3600J	2800
Manganese	4,100	1,267	870J	<1	580J	1300J	1000J	660
Mercury*	3.8	0.03	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Nickel	41,000	32	14	<4	8.1	12	11	<20
Potassium	-	4,700	9900J	<100	8800J	4300J	1700J	1700
Selenium	1,000	5	<2.0#	<2.0#	<2.0	2.9#	2.4#	<5.0
Sodium*	-	250	<100	<100	<100	<100	<100	<250
Vanadium*	14,000	279	130	<1	110	190	170	200
Zinc	610,000	92	67	<2	81	54	57	50
Sulfate	-	163	NT	NT	NT	NT	NT	NT

J = RESULT IS ESTIMATED.
R = RESULT IS REJECTED.
#=Constituent in more than one test method, highest result reported.
N/A = Not Applicable
NT= Not analyzed
BOLD cells indicate values that exceed CBC only.
BOLD and bracketed [ ] cells indicate values exceed both CBC and RBC.
(1) CBC based on an average of two Phase I (COEHP29) and one Phase II (COEMW28) samples.
* An asterisks indicates that the parameter was not detected at background locations and the CBC was calculated based on 1/2 the detection limit multiplied by a factor of two.
** Lead criteria is a provisional value from U S. EPA OSWER, Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities, EPA/540/F-94/043, August, 1994.

TABLE 5-6
SUMMARY OF CONSTITUENTS DETECTED IN PHASE I RI SUBSURFACE SOIL SAMPLES

SITE			COEHP16	COEHP17	COEHP17	COEHP17	COEHP18	COEHP18
SAMPLE ID	USEPA	Criterion (1)	SB1602	SB1701	SB5401	SB1702	SB1801	SB1802
DATE	Region III	Background	01/13/1997	01/11/1997	01/11/1997	01/11/1997	01/12/1997	01/12/1997
DEPTH (ft)	RBC	Concentration	18.00	10.00	10.00	20.00	10.00	18.00
CONSTITUENT (mg/kg)			Primary	Primary	Duplicate 1	Primary	Primary	Primary
Acetone	200,000	N/A	<0.074	<0.068	<0.069	<0.074	<0.066	<0.071
Ethyl benzene	200,000	N/A	<0.0074	<0.0068	<0.0069	<0.0074	<0.0066	<0.0071
Naphthalene	-	N/A	<0.0074	<0.0068	<0.0069	<0.0074	<0.0066	<0.0071
Toluene	410,000	N/A	<0.0074	<0.0068	<0.0069	<0.0074	<0.0066	<0.0071
Trichloroethene	520	N/A	<0.0074	<0.0068	<0.0069	<0.0074	<0.0066	<0.0071
m-Xylene	410,000	N/A	<0.0074	<0.0068	<0.0069	<0.0074	<0.0066	<0.0071
o-Xylene	410,000	N/A	<0.0074	<0.0068	<0.0069	<0.0074	<0.0066	<0.0071
Benzo(a)anthracene	-	N/A	<0.49	<0.45	<0.46	<0.49	<0.43	<0.47
Bis(2-ethylhexyl)phthalate	-	N/A	<0.49	<0.45	<0.46	<0.49	<0.43	<0.47
Benzo(b)fluoranthene	-	N/A	<0.49	<0.45	<0.46	<0.49	<0.43	<0.47
3,3'-Dichlorobenzidine	13	N/A	<0.97	<0.9	<0.92	0.97	<0.87	<0.94
Diethyl phthalate	1,600,000	N/A	<0.49	<0.45	<0.46	<0.49	<0.43	<0.47
Fluoranthene	-	N/A	<0.49	<0.45	<0.46	<0.49	<0.43	<0.47
2-Methylnaphthalene	-	N/A	<0.49	<0.45	<0.46	<0.49	<0.43	<0.47
Phenanthrene	-	N/A	<0.49	<0.45	<0.46	<0.49	<0.43	<0.47
Pyrene	61,000	N/A	<0.49	<0.45	<0.46	<0.49	<0.43	<0.47
4,4'-DDE	17	N/A	<0.0049	<0.0045J	<0.0046	<0.0049	<0.0043	<0.0047
4,4'-DDT	17	N/A	<0.0049	<0.0045J	<0.0046	<0.0049	<0.0043	<0.0047
Aroclor 1260	2.9	N/A	<0.049	<0.045J	<0.046	<0.049	<0.043	<0.047
Aluminum	200,000	46,667	31000	20000J	19000	20000J	16000J	24000J
Arsenic*	3.8	3.33	[5.1]	[6.2]	[5.7]	[5.3]	<5.0	<5.0
Barium	140,000	77	**140**	56	53	**160**	**160**	**190**
Beryllium*	4,100	2	2.0	<2.0	<2.0	2.3	<2.0	<2.0
Calcium	-	6,453	470	<250J	<250	340J	940J	640J
Chromium	6,100	217	18	26	21	18	22	12
Cobalt	120,000	224	36	78	65	75	57	19
Copper	82,000	137	100	78	63	97	64	75
Iron	610,000	79,333	59000	56000J	51000	45000J	34000J	45000J
Lead	400**	56	5.2	8.9J	7.2	2.4J	2.4J	5.2J
Magnesium	-	12,813	6300	890J	910	1500J	2500J	8600J
Manganese	4,100	1,267	540	1300J	930	1500J	930J	402J
Mercury*	3.8	0.03	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Nickel	41,000	32	<20	<20	<20	<20	<20	<20
Potassium	-	4,700	5300	<500J	<500	<500J	2200J	7800J
Selenium	1,000	5	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Sodium*	-	250	<250	<250R	<250	<250R	<250R	<250R
Vanadium*	14,000	279	190	200	180	150	110	140
Zinc	610,000	92	73	58	47	56	26	58
Sulfate	-	163	NT	NT	NT	NT	NT	NT

J = RESULT IS ESTIMATED.
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#=Constituent in more than one test method, highest result reported.
N/A = Not Applicable
NT= Not analyzed
BOLD cells indicate values that exceed CBC only.
BOLD and bracketed [ ] cells indicate values exceed both CBC and RBC.
(1) CBC based on an average of two Phase I (COEHP29) and one Phase II (COEMW28) samples.
* An asterisks indicates that the parameter was not detected at background locations and the CBC was calculated based on 1/2 the detection limit multiplied by a factor of two.
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TABLE 5-6
SUMMARY OF CONSTITUENTS DETECTED IN PHASE I RI SUBSURFACE SOIL SAMPLES

SITE			COEHP19	COEHP19	COEHP20	COEHP20	COEHP21	COEHP21
SAMPLE ID	USEPA	Criterion (1)	SB1901	SB1902	SB2001	SB2002	SB2101	SB2102
DATE	Region III	Background	12/04/1996	12/04/1996	01/07/1997	01/07/1997	01/12/1997	01/12/1997
DEPTH (ft)	RBC	Concentration	6.00	8.00	10.00	12.00	8.00	14.00
CONSTITUENT (mg/kg)			Primary	Primary	Primary	Primary	Primary	Primary
Acetone	200,000	N/A	<0.072	<0.073	0.135	<0.07	<0.062	<0.064
Ethyl benzene	200,000	N/A	<0.0072	<0.0073	<0.0076	<0.007	<0.0062	<0.0064
Naphthalene	-	N/A	<0.0072#	<0.0073#	<0.0076#	<0.007#	<0.0062	<0.0064
Toluene	410,000	N/A	<0.0072	<0.0073	<0.0076	<0.007	<0.0062	<0.0064
Trichloroethene	520	N/A	0.018	0.068	0.025	0.03	<0.0062	<0.0064
m-Xylene	410,000	N/A	<0.014	<0.015	<0.0076	<0.007	<0.0062	<0.0064
o-Xylene	410,000	N/A	<0.0072	<0.0073	<0.0076	<0.007	<0.0062	<0.0064
Benzo(a)anthracene	-	N/A	<0.48	<0.49	<0.5	<0.46	<0.41	<0.42
Bis(2-ethylhexyl)phthalate	-	N/A	<0.48	<0.49	<0.5	<0.46	<0.41	<0.42
Benzo(b)fluoranthene	-	N/A	<0.48	<0.49	<0.5	<0.46	<0.41	<0.42
3,3'-Dichlorobenzidine	13	N/A	<0.97	<0.98	<1	<0.93	<0.82	<0.84
Diethyl phthalate	1,600,000	N/A	<0.48	<0.49	<0.5	<0.46	<0.41	<0.42
Fluoranthene	-	N/A	<0.48	<0.48	<0.5	<0.46	<0.41	<0.42
2-Methylnaphthalene	-	N/A	<0.48	<0.49	<0.5	<0.46	<0.41	<0.42
Phenanthrene	-	N/A	<0.48	<0.49	<0.5	<0.46	<0.41	<0.42
Pyrene	61,000	N/A	<0.48	<0.48	<0.5	<0.46	<0.41	<0.42
4,4'-DDE	17	N/A	<0.0048	<0.0049	<0.005	<0.0046	<0.0041	<0.0042
4,4'-DDT	17	N/A	<0.0048	<0.0049	<0.005	<0.0046	<0.0041	<0.0042
Aroclor 1260	2.9	N/A	<0.048	<0.049	<0.05	<0.046	<0.041	<0.042
Aluminum	200,000	46,667	34000J	36000J	43000	31000	41000R	45000J
Arsenic*	3.8	3.33	2.5	3.1	<500	<5.0	[6.7]	[6.6]
Barium	140,000	77	270	270	<500	<460	210	210
Beryllium*	4,100	2	0.93	1.0	<200	<2.0	<2.0	<2.0
Calcium	-	6,453	220J	310J	<24000J	<23000J	14000J	16000J
Chromium	6,100	217	15	19	<500	<460	89	85
Cobalt	120,000	224	33	30	<500	<460	63	52
Copper	82,000	137	81	75	<1200	<1200	200	160
Iron	610,000	79,333	51000J	55000J	93000J	36000J	98000J	90000J
Lead	400**	56	7.8	11	7.1	5.8	1.9J	2.1J
Magnesium	-	12,813	7000J	7200J	<24000J	<23000J	19000J	19000J
Manganese	4,100	1,267	940J	770J	1800J	720J	1300J	1400J
Mercury*	3.8	0.03	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Nickel	41,000	32	13	14	<2000	<20	65	60
Potassium	-	4,700	7600J	7600J	<50000J	<46000J	<250J	2900J
Selenium	1,000	5	<2.0	<2.0	<5.0	<5.0	<5.0	<5.0
Sodium*	-	250	<100	<100	<250R	<23000J	<250R	<250R
Vanadium*	14,000	279	150	160	<500	<460	320	280
Zinc	610,000	92	61	66	<1000	<920	94	98
Sulfate	-	163	NT	NT	NT	NT	NT	NT

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N/A = Not Applicable
NT= Not analyzed
BOLD cells indicate values that exceed CBC only.
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(1) CBC based on an average of two Phase I (COEHP29) and one Phase II (COEMW28) samples.
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TABLE 5-6
SUMMARY OF CONSTITUENTS DETECTED IN PHASE I RI SUBSURFACE SOIL SAMPLES

SITE			COEHP22	COEHP22	COEHP23	COEHP23	COEHP23	COEHP24
SAMPLE ID	USEPA	Criterion (1)	SB2201	SB2202	SB2301	SB5201	SB2302	SB2401
DATE	Region III	Background	01/12/1997	01/12/1997	12/11/1996	12/11/1996	12/11/1996	01/10/1997
DEPTH (ft)	RBC	Concentration	30.00	52.00	4.00	4.00	10.00	10.00
CONSTITUENT (mg/kg)			Primary	Primary	Primary	Duplicate 1	Primary	Primary
Acetone	200,000	N/A	<0.06	<0.058	0.6	0.62	0.12	<0.068
Ethyl benzene	200,000	N/A	<0.006	<0.0058	<0.0064	<0.0065	<0.0071	<0.0068
Naphthalene	-	N/A	<0.006	<0.0058	<0.0063#	<0.0065#	<0.0071#	<0.0068#
Toluene	410,000	N/A	<0.006	<0.0058	<0.0063	<0.0065	<0.0071	<0.0068
Trichloroethene	520	N/A	<0.006	<0.0058	<0.0064	<0.0065	<0.0071	<0.0068
m-Xylene	410,000	N/A	<0.006	<0.0058	<0.012	<0.013	<0.014	<0.0068
o-Xylene	410,000	N/A	<0.006	<0.0058	<0.0064	<0.0065	<0.0071	<0.0068
Benzo(a)anthracene	-	N/A	<0.4	<0.39	<0.42	<0.43	<0.47	<0.46
Bis(2-ethylhexyl)phthalate	-	N/A	<0.4	<0.39	<0.42	<0.43	<0.47	<0.45
Benzo(b)fluoranthene	-	N/A	<0.4	<0.39	<0.42	<0.42	<0.47	<0.46
3,3'-Dichlorobenzidine	13	N/A	<0.8	<0.78	<0.84	<0.86	<0.94	<0.92
Diethyl phthalate	1,600,000	N/A	<0.4	<0.39	<0.42	<0.43	<0.47	<0.46
Fluoranthene	-	N/A	<0.4	<0.39	0.8	<0.42	<0.47	<0.46
2-Methylnaphthalene	-	N/A	<0.4	<0.39	<0.42	<0.43	<0.47	<0.46
Phenanthrene	-	N/A	<0.4	<0.39	0.65	<0.42	<0.47	<0.46
Pyrene	61,000	N/A	<0.4	<0.39	0.72	<0.42	<0.47	<0.46
4,4'-DDE	17	N/A	<0.004	<0.0039	<0.042	0.0045	<0.0047	<0.0046
4,4'-DDT	17	N/A	<0.004	<0.0039	<0.042	<0.0043	<0.0047	<0.0046
Aroclor 1260	2.9	N/A	<0.04	<0.039	<0.42	<0.043	<0.047	<0.046
Aluminum	200,000	46,667	34000J	31000J	35000J	30000	37000J	22000J
Arsenic*	3.8	3.33	<5.0	<5.0	[6.9#]	[8.4]	<2.0#	<5.0
Barium	140,000	77	190	180	71	92	83	350
Beryllium*	4,100	2	<2.0	<2.0	0.69	1.1	0.58	<2.0
Calcium	-	6,453	9400J	9300J	1100J	1400	490J	<250
Chromium	6,100	217	30	16	42	190	18	12
Cobalt	120,000	224	24	23	15	30	10	120
Copper	82,000	137	74	81	59	75	57	82
Iron	610,000	79,333	39000J	35000J	61000J	87000	16000J	56000J
Lead	400**	56	3.1J	2.8J	14	8.0	5.8	5.5
Magnesium	-	12,813	13000J	12000J	5100J	2200	3200J	1500J
Manganese	4,100	1,267	680J	780J	410J	680	96J	2500J
Mercury*	3.8	0.03	<0.030	<0.030	<0.030	0.052	<0.030	<0.030
Nickel	41,000	32	<20	<20	13	24	13	<20J
Potassium	-	4,700	8200J	7300J	670J	390	1700J	1200
Selenium	1,000	5	<5.0	<5.0	3.6#	5.0	<2.0#	<5.0
Sodium*	-	250	<250R	<250R	<100	<200	<100	<250R
Vanadium*	14,000	279	120	100	170	270	93	180
Zinc	610,000	92	74	65	37	35	46	38
Sulfate	-	163	NT	NT	NT	NT	NT	NT

J = RESULT IS ESTIMATED.
R = RESULT IS REJECTED.
#=Constituent in more than one test method, highest result reported.
N/A = Not Applicable
NT= Not analyzed
BOLD cells indicate values that exceed CBC only.
BOLD and bracketed [ ] cells indicate values exceed both CBC and RBC.
(1) CBC based on an average of two Phase I (COEHP29) and one Phase II (COEMW28) samples.
* An asterisks indicates that the parameter was not detected at background locations and the CBC was calculated based on 1/2 the detection limit multiplied by a factor of two.
** Lead criteria is a provisional value from U S. EPA OSWER, Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities, EPA/540/F-94/043, August, 1994.

TABLE 5-6
SUMMARY OF CONSTITUENTS DETECTED IN PHASE I RI SUBSURFACE SOIL SAMPLES

SITE			COEHP24	COEHP25	COEHP25	COEHP25	COEHP26	COEHP26
SAMPLE ID	USEPA	Criterion (1)	SB2402	SB2501	SB2502	SB5501	SB2601	SB2602
DATE	Region III	Background	01/10/1997	01/08/1997	01/08/1997	01/08/1997	01/09/1997	01/09/1997
DEPTH (ft)	RBC	Concentration	22.00	10.00	17.00	17.00	6.00	12.00
CONSTITUENT (mg/kg)			Primary	Primary	Primary	Duplicate 1	Primary	Primary
Acetone	200,000	N/A	<0.069	<0.059	<0.072	<0.072	<0.068	<0.067
Ethyl benzene	200,000	N/A	<0.0069	<0.0059	<0.0072	<0.0072	<0.0068	<0.0067
Naphthalene	-	N/A	<0.0069#	<0.0059#	<0.0072#	<0.0072#	<0.0068#	<0.0067#
Toluene	410,000	N/A	<0.0069	<0.0059	<0.0072	<0.0072	<0.0068	<0.0067
Trichloroethene	520	N/A	<0.0069	<0.0059	<0.0072	<0.0072	<0.0068	<0.0067
m-Xylene	410,000	N/A	<0.0069	<0.0059	<0.0072	<0.0072	<0.0068	<0.0067
o-Xylene	410,000	N/A	<0.0069	<0.0059	<0.0072	<0.0072	<0.0068	<0.0067
Benzo(a)anthracene	-	N/A	<0.47	<0.39	<0.48	<0.48	<0.45	<0.45
Bis(2-ethylhexyl)phthalate	-	N/A	<0.47	<0.39	<0.48	<0.48	<0.45	<0.45
Benzo(b)fluoranthene	-	N/A	<0.47	<0.39	<0.48	<0.48	<0.45	<0.45
3,3'-Dichlorobenzidine	13	N/A	<0.94	<0.79	<0.96	<0.96	<0.9	<0.89
Diethyl phthalate	1,600,000	N/A	<0.47	<0.39	<0.48	<0.48	<0.45	<0.45
Fluoranthene	-	N/A	<0.47	<0.39	<0.48	<0.48	<0.45	<0.45
2-Methylnaphthalene	-	N/A	<0.47	<0.39	<0.48	<0.48	<0.45	<0.45
Phenanthrene	-	N/A	<0.47	<0.39	<0.48	<0.48	<0.45	<0.45
Pyrene	61,000	N/A	<0.47	<0.39	<0.48	<0.48	<0.45	<0.45
4,4'-DDE	17	N/A	<0.0047	<0.0039	<0.0048	<0.0048	<0.0045	<0.0045
4,4'-DDT	17	N/A	<0.0047	<0.0039	<0.0048	<0.0048	<0.0045	<0.0045
Aroclor 1260	2.9	N/A	<0.047	<0.039	<0.048	<0.048	<0.045	<0.045
Aluminum	200,000	46,667	35000J	23000	40000	34000	38000J	42000J
Arsenic*	3.8	3.33	<5.0	<5.0	<5.0	<5.0	[7.4]	<5.0
Barium	140,000	77	290	88	350	350	120	310
Beryllium*	4,100	2	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Calcium	-	6,453	560	<250	410	440	530	4500
Chromium	6,100	217	10	110	12	11	31	21
Cobalt	120,000	224	37	16	72	83	38	25
Copper	82,000	137	59	150	98	92	91	110
Iron	610,000	79,333	49000J	7400	53000	47000	75000J	50000J
Lead	400**	56	4.0	5.6	11	11	7.2	3.1
Magnesium	-	12,813	10000J	630	9200	9600	2600J	14000J
Manganese	4,100	1,267	780J	30	1300	1600	880J	920J
Mercury*	3.8	0.03	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Nickel	41,000	32	<20J	<20	<20	<20	<20J	<20J
Potassium	-	4,700	10000	<500	8900	9200	1500	5800
Selenium	1,000	5	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Sodium*	-	250	<250R	<250	<250	<250	<250R	<250R
Vanadium*	14,000	279	160	98	180	164	230	160
Zinc	610,000	92	83	16	76	73	46	90
Sulfate	-	163	NT	NT	NT	NT	NT	NT

J = RESULT IS ESTIMATED.
R = RESULT IS REJECTED.
#=Constituent in more than one test method, highest result reported.
N/A = Not Applicable
NT= Not analyzed
BOLD cells indicate values that exceed CBC only.
BOLD and bracketed [ ] cells indicate values exceed both CBC and RBC.
(1) CBC based on an average of two Phase I (COEHP29) and one Phase II (COEMW28) samples.
* An asterisks indicates that the parameter was not detected at background locations and the CBC was calculated based on 1/2 the detection limit multiplied by a factor of two.
** Lead criteria is a provisional value from U S. EPA OSWER, Revised Interim Soil Lead Guidance for CERCLA Sites and RCRA Corrective Action Facilities, EPA/540/F-94/043, August, 1994.

TABLE 5-6
SUMMARY OF CONSTITUENTS DETECTED IN PHASE I RI SUBSURFACE SOIL SAMPLES

SITE			COEHP27	COEHP27	COEHP28	COEHP28	COEHP29	COEHP29
SAMPLE ID	USEPA	Criterion (1)	SB2701	SB2702	SB2801	SB2802	SB2901	SB2902
DATE	Region III	Background	01/10/1997	01/10/1997	01/10/1997	01/10/1997	01/08/1997	01/08/1997
DEPTH (ft)	RBC	Concentration	10.00	17.00	8.00	17.00	10.00	18.00
CONSTITUENT (mg/kg)			Primary	Primary	Primary	Primary	Primary	Primary
Acetone	200,000	N/A	<0.072	<0.073	<0.068	<0.068	<0.059	<0.057
Ethyl benzene	200,000	N/A	<0.0072	<0.0073	<0.0068	<0.0068	<0.0059	<0.0057
Naphthalene	-	N/A	<0.0072#	<0.0073#	<0.0068#	<0.0068#	<0.0059#	<0.0057#
Toluene	410,000	N/A	<0.0072	<0.0073	<0.0068	<0.0068	<0.0059	<0.0057
Trichloroethene	520	N/A	<0.0072	<0.0072	<0.0068	<0.0068	<0.0059	<0.0057
m-Xylene	410,000	N/A	<0.0072	<0.0073	<0.0068	<0.0068	<0.0059	<0.0057
o-Xylene	410,000	N/A	<0.0072	<0.0073	<0.0068	<0.0068	<0.0059	<0.0057
Benzo(a)anthracene	-	N/A	<0.47	<0.49	<0.45	<0.46	<0.39	<0.37
Bis(2-ethylhexyl)phthalate	-	N/A	<0.47	<0.49	<0.45	<0.45	<0.39	0.39
Benzo(b)fluoranthene	-	N/A	<0.47	<0.49	<0.45	<0.46	<0.39	<0.37
3,3'-Dichlorobenzidine	13	N/A	<0.94	<0.97	<0.9	<0.93	<0.79	<0.74
Diethyl phthalate	1,600,000	N/A	<0.47	<0.49	<0.45	<0.46	<0.39	<0.37
Fluoranthene	-	N/A	<0.47	<0.49	<0.45	<0.46	<0.39	<0.37
2-Methylnaphthalene	-	N/A	<0.47	<0.49	<0.45	<0.46	<0.39	<0.37
Phenanthrene	-	N/A	<0.47	<0.49	<0.45	<0.46	<0.39	<0.37
Pyrene	61,000	N/A	<0.47	<0.49	<0.45	<0.46	<0.39	<0.37
4,4'-DDE	17	N/A	<0.0047J	<0.0049	<0.0046	<0.0046	<0.0039	<0.0037
4,4'-DDT	17	N/A	<0.0047J	<0.0049	<0.0046	<0.0046	<0.0039	<0.0037
Aroclor 1260	2.9	N/A	<0.047J	<0.049	<0.046	<0.046	<0.039	<0.037
Aluminum	200,000	46,667	30000J	36000J	26000J	23000J	20000	14000
Barium	140,000	77	200	380	120	220	37	76
Beryllium*	4,100	2	2.2	<2.0	<2.0	<2.0	<2.0	<2.0
Calcium	-	6,453	780	260	360	330	380	4900
Chromium	6,100	217	23	16	18	19	35	30
Cobalt	120,000	224	81	61	41	140	17	39
Copper	82,000	137	77	24	68	100	27	29
Iron	610,000	79,333	50000J	53000J	55000J	55000J	43000	31000
Lead	400**	56	6.5	4.8	4.3	6.6	7.7	4.1
Magnesium	-	12,813	5900J	7700J	4300J	6900J	520	6700
Manganese	4,100	1,267	1600J	1600J	590J	2700J	560	450
Mercury*	3.8	0.03	<0.030	<0.030	<0.030	<0.030	<0.030	<0.030
Nickel	41,000	32	<20J	<20J	<20J	26J	<20	<20
Potassium	-	4,700	5800	5300	5100	6000	<500	2000
Selenium	1,000	5	<5.0	<5.0	<5.0	<5.0	<5.0	<5.0
Sodium*	-	250	<250R	<250R	<250R	<250R	<250	<250
Zinc	610,000	92	93	85	85	130	20	49

R = RESULT IS REJECTED.
N/A = Not Applicable
NT= Not analyzed
BOLD cells indicate values that exceed CBC only.
BOLD and bracketed [ ] cells indicate values exceed both CBC and RBC.
(1) CBC based on an average of two Phase I (COEHP29) and one Phase II (COEMW28) samples.
* An asterisks indicates that the parameter was not detected at background locations and the CBC was calculated based on 1/2 the detection limit multiplied by a factor of two.
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TABLE 5-7
SUMMARY OF CONSTITUENTS DETECTED IN PHASE II RI GROUNDWATER SAMPLES
FORMER CHARLOTTE ARMY MISSILE PLANT

SITE				COEMW01	COEMW02	COEMW03	COEMW05	COEMW05	COEMW06	COEMW07
SAMPLE ID	EPA MCLs [1]	N C	Critierion	COEMW0102	COEMW0202	COEMW0302	COEMW0502	COEMW5102	COEMW0602	COEMW0702
DATE		Groundwater	Background	02/29/2000	03/03/2000	03/01/2000	02/29/2000	02/29/2000	03/03/2000	03/05/2000
RESULT TYPE		Standards [2]	Concentrations [3]	Primary	Primary	Primary	Primary	Duplicate 1	Primary	Primary
TCL Volatile Organics (µg/L)										
Acetone	-	700	25	<25	<1200	<25	<62	<62	<250	<120
Bromodichloromethane	80a	-	1.0	(0.42)	<50	<1.0	<2.5	<2.5	<10	<5
Carbon tetrachloride	5	0.3	1.0	<1.0	<50	<1.0	<2.5	<2.5	<10	<5
Chloroform	80a	0.19	1.0	4.3	(7.1)	<1.0	(2.0)	(2.2)	(2.2)	(1.3)
1,1-Dichloroethene	7	7	1.0	<1.0	(11)	(0.56)	<2.5	<2.5	(2.3)	<5
cis-1,2-Dichloroethene	70	70	1.0	<1.0	<50	<1.0	<2.5	<2.5	<10	<5
Methylene chloride	5	5	4.1	<5.0	<100	<2.0	<12	<12	(3.5)	<10
Naphthalene	-	21	1.0	<1.0	(22)	1.4	<2.5	<2.5	(2.4)	6.1
1,1,1-Trichloroethane	200	200	1.0	<1.0	<50	<1.0	<2.5	<2.5	(3.0)	<5
1,1,2-Trichloroethane	5	-	0.19	<1.0	<50	<1.0	(0.63)	(0.60)	<10	<5
Trichloroethene	5	2.8	1.0	<1.0	[1600]	2.1	[68]	[69]	[660]	[140]
TAL Metals (µg/L)										
Aluminum	50	-	66	(34)	(35)	[480]	<200	(28)	<200	[(170)]
Arsenic	50	50	0.008	<0.010	<0.0010	<0.010	0.0041J	<0.010	<0.010	0.0037JB
Barium	2000	2000	91.3	33	31	13	37	37	110	130
Calcium	-	-	52,667	19,000	14,000J	3800	11000	11000	34000J	2800J
Chromium	100	50	14.6	23	<10	(3.3)	<10	<10	(3.3)	<10
Cobalt	-	-	20	<10	<10	<10	<10	<10	94	(3.9)
Iron	300	300	140	(33)	<50	250	<50	<50	[2300]	<50
Lead	15	15	10	<5	<5	<5	<5	<5	<5	<5
Magnesium	-	-	18,133	6300	5300	1500	3600	3700	10000	4000
Manganese	50	50	8	<10	30	(3.8)	<10	<10	[8800]	[59]
Mercury	2	1.1	0.4	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Nickel	100	100	80	<40	<40	<40	<40	<40	<40	<40
Potassium	-	-	6,267	(340)	(680)	(780)	(710)	(730)	3600	(990)
Sodium	-	-	24,667	13000	23000	3800	7300	7400	26000	9200
Vanadium	-	-	10	(5.3)	(2.5)	(3.3)	(2.6)	(2.9)	<10	<10
Zinc	500	2100	40	<20	<20	<20	<20	<20	<20	(16)
Water Quality Parameters (mg/L)										
Alkalinity (to pH 4.5) as CaCO3	-	-	213	69	56	12	35	NT	170	4.2
Chloride	250	250	14.5	8.3	6.8	9.0	12	NT	28	9.8
Dissolved Oxygen	-	-	1.51	5.73	1.53	9.61	6.66	-	4.8	1.22
Methane	-	-	0.272	<0.00019	0.00045	(0.00013)	(0.00013)	NT	0.041	(0.00013)
Nitrate	10	10	1.7	<0.050	0.33	0.075	1.09	NT	1.0	3.5
Nitrite-N	1	1	0.071	(0.0040)	0.050J	<0.050	<0.050	NT	0.0090J	0.05J
Sulfate	250	250	42.8	17	150J	<5.0	6.4	NT	7.7J	5.7J

1 - Maximum Contaminant Level (MCL), USEPA Drinking Water Regulations and Health Advisories-Primary Standards
Secondary Standards provided for Aluminum, Chloride, Iron, Manganese, Zinc & Sulfate
a - MCL for total trihalomethanes includes chloroform+bromoform+bromodichloromethane+dibromochloromethane
2 - State of North Carolina Chapter 2L Standards for Groundwater (NCDENR Title 15A Section .0200)
3 - Criterion Background Concentration based on two times the average background
concentration for metals and water quality parameters. Background for VOCs is the laboratory detection limit.
4- Cyanide was analyzed in COEMW02, -05, -17, -26, and was not detected (<0.010).
( ) Concentration is reported below Lower Quantitation Limit.
[ ] Concentration exceeds all screening criteria.
(-) No standard
J = estimated value. B = compound detected in method blank.J = estimated value. B = compound detected in method blank.

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TABLE 5-7
SUMMARY OF CONSTITUENTS DETECTED IN PHASE II RI GROUNDWATER SAMPLES
FORMER CHARLOTTE ARMY MISSILE PLANT

SITE				COEMW08	COEMW09	COEMW10	COEMW11	COEMW12	COEMW13	COEMW14
SAMPLE ID	EPA MCLs [1]	N C	Critierion	COEMW0802	COEMW0902	COEMW1002	COEMW1102	COEMW1202	COEMW1301	COEMW1401
DATE		Groundwater	Background	02/29/2000	02/29/2000	03/04/2000	03/02/2000	03/01/2000	03/05/2000	03/04/2000
RESULT TYPE		Standards [2]	Concentrations [3]	Primary	Primary	Primary	Primary	Primary	Primary	Primary
TCL Volatile Organics (µg/L)										
Acetone	-	700	25	<25	36	<250	34	<25	<250	<250
Bromodichloromethane	80a	-	1.0	<1.0	<1.0	<10	<1	<1.0	<10	<10
Carbon tetrachloride	5	0.3	1.0	<1.0	<1.0	<10	3.1	<1.0	<10	<10
Chloroform	80a	0.19	1.0	<1.0	(0.61)	20	2.3	(0.21)	19	<10
1,1-Dichloroethene	7	7	1.0	(0.26)	(0.20)	<10	<1	<1.0	<10	<10
cis-1,2-Dichloroethene	70	70	1.0	<1.0	<1.0	<10	<1	<1.0	<10	<10
Methylene chloride	5	5	4.1	<5.0	<5.0	<20	<5	<5.0	<20	<20
Naphthalene	-	21	1.0	(0.25)	(0.23)	(5.9)	(0.36)	<1.0	(4.4)	(2.2)
1,1,1-Trichloroethane	200	200	1.0	<1.0	<1.0	<10	<1	<1.0	<10	<10
1,1,2-Trichloroethane	5	-	0.19	<1.0	<1.0	<10	<1	<1.0	<10	<10
Trichloroethene	5	2.8	1.0	<1.0	<1.0	[390]	4.5	[18]	[390]	[360]
TAL Metals (µg/L)										
Aluminum	50	-	66	(37)	(34)	[570]	[14000]	(38)	(46)	(48)
Arsenic	50	50	0.008	<0.0010	<0.0010	<0.010	0.0046J	<0.010	0.0048JB	<0.010
Barium	2000	2000	91.3	41	45	16	34	54	55	31
Calcium	-	-	52,667	18000	24000	24000J	13000	21000	14000J	15000J
Chromium	100	50	14.6	<10	(1.9)	27	[200]	(1.9)	<10	<10
Cobalt	-	-	20	<10	<10	<10	14	<10	<10	<10
Iron	300	300	140	(23)	(27)	150	[18000]	<50	<50	(22)
Lead	15	15	10	<5	<5	<5	<5	<5	<5	<5
Magnesium	-	-	18,133	8700	12000	2400	18000	8300	4300	4900
Manganese	50	50	8	(2.8)	(3.5)	(3.1)	[270]	<10	[300]	[76]
Mercury	2	1.1	0.4	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Nickel	100	100	80	<40	<40	<40	84	<40	<40	<40
Potassium	-	-	6,267	1200	2100	1100	(940)	(700)	2700	1600
Sodium	-	-	24,667	17000	11000	6400	8200	32000	9400	7200
Vanadium	-	-	10	(2.7)	(6.7)	(9.1)	24	(3.7)	<10	<10
Zinc	500	2100	40	<20	<20	<20	45	<20	<20	<20
Water Quality Parameters (mg/L)										
Alkalinity (to pH 4.5) as CaCO3	-	-	213	60	130	62	48	68	29	21
Chloride	250	250	14.5	7.2	7.9	14	11	5.4	25	3.5
Dissolved Oxygen	-	-	1.51	1.54	2.97	8.75	6.99	7.68	7.03	8.99
Methane	-	-	0.272	<0.00019	(0.000098)	0.00021	<0.00019	(0.00013)	(0.00018)	(0.00014)
Nitrate	10	10	1.7	0.67	1.6	2.8	0.27	2.0	2.8	0.19
Nitrite-N	1	1	0.071	(0.0050)	(0.043)	0.05J	0.081	(0.0060)	0.05J	0.05J
Sulfate	250	250	42.8	48	9.5	<5	<5	67	16J	59J

1 - Maximum Contaminant Level (MCL), USEPA Drinking Water Regulations and Health Advisories-Primary Standards
Secondary Standards provided for Aluminum, Chloride, Iron, Manganese, Zinc & Sulfate
a - MCL for total trihalomethanes includes chloroform+bromoform+bromodichloromethane+dibromochloromethane
2 - State of North Carolina Chapter 2L Standards for Groundwater (NCDENR Title 15A Section .0200)
3 - Criterion Background Concentration based on two times the average background
concentration for metals and water quality parameters. Background for VOCs is the laboratory detection limit.
4- Cyanide was analyzed in COEMW02, -05, -17, -26, and was not detected (<0.010).

( ) Concentration is reported below Lower Quantitation Limit.
[ ] Concentration exceeds all screening criteria.
(-) No standard
J = estimated value. B = compound detected in method blank.J = estimated value. B = compound detected in method blank.

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TABLE 5-7
SUMMARY OF CONSTITUENTS DETECTED IN PHASE II RI GROUNDWATER SAMPLES
FORMER CHARLOTTE ARMY MISSILE PLANT

SITE				COEMW15	COEMW16	COEMW17	COEMW18	COEMW18	COEMW19	COEMW20
SAMPLE ID	EPA MCLs [1]	N C	Critierion	COEMW1501	COEMW1601	COEMW1701	COEMW1801	COEMW5201	COEMW1901	COEMW2001
DATE		Groundwater	Background	03/02/2000	02/29/2000	03/01/2000	03/01/2000	03/01/2000	03/01/2000	03/02/2000
RESULT TYPE		Standards [2]	Concentrations [3]	Primary	Primary	Primary	Primary	Duplicate 1	Primary	Primary
TCL Volatile Organics (µg/L)										
Acetone	-	700	25	<25	<25	(16)	<25	<25	<25	<25
Bromodichloromethane	80a	-	1.0	<1	<1.0	<1.0	<1.0	<1.0	<1.0	<1
Carbon tetrachloride	5	0.3	1.0	(0.72)	<1.0	<1.0	[6.2]	[6.3]	<1.0	<1
Chloroform	80a	0.19	1.0	(0.89)	1.2	2.3	4.5	4.4	(0.26)	(0.45)
1,1-Dichloroethene	7	7	1.0	(0.23)	<1.0	<1.0	<1.0	<1.0	<1.0	<1
cis-1,2-Dichloroethene	70	70	1.0	<1	(0.52)	<1.0	<1.0	<1.0	<1.0	<1
Methylene chloride	5	5	4.1	<2	<5.0	<2.0	<5.0	<5.0	<5.0	(0.46)
Naphthalene	-	21	1.0	(0.48)	<1.0	1.1	<1.0	<1.0	<1.0	1.4
1,1,1-Trichloroethane	200	200	1.0	<1	<1.0	<1.0	<1.0	<1.0	<1.0	<1
1,1,2-Trichloroethane	5	-	0.19	<1	<1.0	<1.0	<1.0	<1.0	<1.0	<1
Trichloroethene	5	2.8	1.0	[7.5]	(0.95)	[58]	(0.60)	(0.74)	<1.0	(0.98)
TAL Metals (µg/L)										
Aluminum	50	-	66	[660]	[290]	[(110)]	[(65)]	[(70)]	[(55)]	[(54)]
Arsenic	50	50	0.008	<0.010	0.0042J	<0.010	<0.010	<0.010	<0.010	<0.010
Barium	2000	2000	91.3	24	58	35	51	52	26	37
Calcium	-	-	52,667	12000	27000	16000	19000	20000	5800	21000
Chromium	100	50	14.6	<10	<10	<10	(4.7)	(4.6)	<10	<10
Cobalt	-	-	20	<10	(4.4)	<10	<10	<10	<10	<10
Iron	300	300	140	<50	<50	80	(47)	(47)	(28)	<50
Lead	15	15	10	<5	<5	<5	<5	<5	<5	<5
Magnesium	-	-	18,133	3600	13000	6500	9700	9800	2600	3600
Manganese	50	50	8	[74]	[350]	34	45	46	[74]	[74]
Mercury	2	1.1	0.4	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Nickel	100	100	80	(12)	[110]	<40	(5)	(5.4)	<40	(12)
Potassium	-	-	6,267	1200	2400	1900	(860)	(870)	(640)	1200
Sodium	-	-	24,667	6800	12000	9500	18000	18000	9200	6800
Vanadium	-	-	10	(4.5)	(3.3)	(4.9)	(5.9)	(5.8)	<10	(4.5)
Zinc	500	2100	40	(11)	<20	<20	<20	<20	<20	(11)
Water Quality Parameters (mg/L)										
Alkalinity (to pH 4.5) as CaCO3	-	-	213	29	48	69	52	NT	18	71
Chloride	250	250	14.5	3.4	24	8.4	8.0	NT	6.9	12
Dissolved Oxygen	-	-	1.51	8.2	4.22	3.35	3.5	-	3.9	5.31
Methane	-	-	0.272	(0.00011)	0.00039	0.00096	(0.00013)	NT	0.0002	(0.00015)
Nitrate	10	10	1.7	0.99	3.8	0.89	1.0	NT	2.6	0.99
Nitrite-N	1	1	0.071	<0.05	(0.0080)	(0.033)	(0.016)	NT	(0.0090)	(0.021)
Sulfate	250	250	42.8	24	49	7.5	63	NT	6.8	28

1 - Maximum Contaminant Level (MCL), USEPA Drinking Water Regulations and Health Advisories-Primary Standards
Secondary Standards provided for Aluminum, Chloride, Iron, Manganese, Zinc & Sulfate
a - MCL for total trihalomethanes includes chloroform+bromoform+bromodichloromethane+dibromochloromethane
2 - State of North Carolina Chapter 2L Standards for Groundwater (NCDENR Title 15A Section .0200)
3 - Criterion Background Concentration based on two times the average background
concentration for metals and water quality parameters. Background for VOCs is the laboratory detection limit.
4- Cyanide was analyzed in COEMW02, -05, -17, -28, and was not detected (<0.010).
( ) Concentration is reported below Lower Quantitation Limit.
[ ] Concentration exceeds all screening criteria.
(-) No standard
J = estimated value. B = compound detected in method blank.J = estimated value. B = compound detected in method blank.

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TABLE 5-7
SUMMARY OF CONSTITUENTS DETECTED IN PHASE II RI GROUNDWATER SAMPLES
FORMER CHARLOTTE ARMY MISSILE PLANT

SITE				COEMW21	COEMW22	COEMW23	COEMW24	COEMW25	COEMW26	COEMW27
SAMPLE ID	EPA MCLs[1]	N C	Critierion	COEMW2101	COEMW2201	COEMW2301	COEMW2401	COEMW2501	COEMW2601	COEMW2701
DATE		Groundwater	Background	03/05/2000	03/01/2000	03/03/2000	03/03/2000	03/03/2000	03/03/2000	03/01/2000
RESULT TYPE		Standards[2]	Concentrations[3]	Primary	Primary	Primary	Primary	Primary	Primary	Primary
TCL Volatile Organics (µg/L)										
Acetone	-	700	25	<620	88	<25	(33)	(63)	<25	(12)
Bromodichloromethane	80a	-	1.0	<25	<2.5	1.6	<2.5	<5.0	2.1	(0.52)
Carbon tetrachloride	5	0.3	1.0	<25	<2.5	<1	<2.5	<5.0	<1.0	(0.13)
Chloroform	80a	0.19	1.0	(12)	10	16	7.6	5.4	20	7.5
1,1-Dichloroethene	7	7	1.0	<25	<2.5	<1	<2.5	<5.0	<1.0	<1.0
cis-1,2-Dichloroethene	70	70	1.0	<25	<2.5	<1	<2.5	<5.0	<1.0	<1.0
Methylene chloride	5	5	4.1	<50	(0.98)	(1.4)	(2.9)	(2.5)	<2.0	<5.0
Naphthalene	-	21	1.0	<25	(0.75)	(0.63)	(0.99)	(1.8)	(0.29)	<1.0
1,1,1-Trichloroethane	200	200	1.0	<25	<2.5	<1	<2.5	<5.0	<1.0	<1.0
1,1,2-Trichloroethane	5	-	0.19	<25	(0.73)	(0.34)	<2.5	(1.5)	<1.0	(0.37)
Trichloroethene	5	2.8	1.0	[1600]	[170]	[30]	[120]	[300]	3.2	[60]
TAL Metals (µg/L)										
Aluminum	50	-	66	[350]	[230]	[180J]	[240]	(43)J	<200	[(74)]
Arsenic	50	50	0.008	0.0035JB	<0.010	0.0034J	0.0041J	<0.010	<0.010	<0.010
Barium	2000	2000	91.3	47	19	23	64	41	39	26
Calcium	-	-	52,667	45000J	19000	9800	52000	17000J	0J	13000
Chromium	100	50	14.6	(9.5)	[190]	<10	11	<10	<10	<10
Cobalt	-	-	20	<10	<10	<10	<10	<10	<10	<10
Iron	300	300	140	(25)	100	160	230	(27)	<50	70
Lead	15	15	10	<5	<5	<5	<5	<5	<5	<5
Magnesium	-	-	18,133	2800	2800	2800	12000	6800	10000	4700
Manganese	50	50	8	(1.8)	(6)	26	[190]	[220]	[170]	[180]
Mercury	2	1.1	0.4	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	0.2
Nickel	100	100	80	<40	<40	<40	<40	<40	<40	<40
Potassium	-	-	6,267	2200	1700	1700	2400	2900	3100	3300
Sodium	-	-	24,667	9300	9800	9900	14000	9200	10000	11000
Vanadium	-	-	10	15	12	4.8J	13	(3)	(4.3)	(5.7)
Zinc	500	2100	40	<20	<20	<20	<20	<20	<20	<20
Water Quality Parameters (mg/L)										
Alkalinity (to pH 4.5) as CaCO3	-	-	213	85	68	110	71	71	46	58
Chloride	250	250	14.5	15	19	8.7	8.3	9.8	7.8	8.3
Dissolved Oxygen	-	-	1.51	1.00	2.19	6.71	7.88	2.14	0.32	2.01
Methane	-	-	0.272	0.00038	0.00024	(0.00015)	0.00023	(0.00016)	(0.00014)	0.00021
Nitrate	10	10	1.7	0.83	1.2	0.28	0.43	1.1	0.18	0.34
Nitrite-N	1	1	0.071	0.27J	(0.040)	<0.050	(0.0040)	0.016J	0.050J	(0.022)
Sulfate	250	250	42.8	20J	6.5	6.7	47	15J	5.4J	11

1 - Maximum Contaminant Level (MCL), USEPA Drinking Water Regulations and Health Advisories-Primary Standards
Secondary Standards provided for Aluminum, Chloride, Iron, Manganese, Zinc & Sulfate
a - MCL for total trihalomethanes includes chloroform+bromoform+bromodichloromethane+dibromochloromethane
2 - State of North Carolina Chapter 2L Standards for Groundwater (NCDENR Title 15A Section .0200)
3 - Criterion Background Concentration based on two times the average background
concentration for metals and water quality parameters. Background for VOCs is the laboratory detection limit.
4- Cyanide was analyzed in COEMW02, -05, -17, -28, and was not detected (<0.010).
( ) Concentration is reported below Lower Quantitation Limit.
[ ] Concentration exceeds all screening criteria.
(-) No standard
J = estimated value. B = compound detected in method blank.J = estimated value. B = compound detected in method blank.

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TABLE 5-7
SUMMARY OF CONSTITUENTS DETECTED IN PHASE II RI GROUNDWATER SAMPLES
FORMER CHARLOTTE ARMY MISSILE PLANT

SITE				COEMW27	COEMW28	COEMW29	COEMW29	COEMW30	MW01	MW01A
SAMPLE ID	EPA MCLs [1]	N C	Critierion	COEMW5301	COEMW2801	COEMW2901	COEMW2902	COEMW3001	MW0102	MW01A02
DATE		Groundwater	Background	03/01/2000	02/29/2000	03/02/2000	03/02/2000	03/01/2000	03/02/2000	03/04/2000
RESULT TYPE		Standards [2]	Concentrations [3]	Duplicate 1	Primary	Primary	Primary	Primary	Primary	Primary
TCL Volatile Organics (µg/L)										
Acetone	-	700	25	(12)	97	<2500	<6200	(18)	<250	<6200
Bromodichloromethane	80a	-	1.0	(0.52)	<1.0	<100	<250	<1.0	<10	<250
Carbon tetrachloride	5	0.3	1.0	<1.0	<1.0	<100	<250	<1.0	(0.97)	<250
Chloroform	80a	0.19	1.0	7.6	<1.0	(16)	<250	<1.0	(4.6)	(39)
1,1-Dichloroethene	7	7	1.0	<1.0	<1.0	[280]	<250	<1.0	(3.4)	<250
cis-1,2-Dichloroethene	70	70	1.0	<1.0	<1.0	<100	<250	<1.0	<10	<250
Methylene chloride	5	5	4.1	<5.0	<1.0	<100	(89)	<5.0	(3.7)	(310)
Naphthalene	-	21	1.0	<1.0	(0.11)	(33)	(100)	(0.29)	10	<250
1,1,1-Trichloroethane	200	200	1.0	<1.0	<1.0	[250]	<250	<1.0	<10	<250
1,1,2-Trichloroethane	5	-	0.19	(0.38)	<1.0	<100	<250	<1.0	<10	<250
Trichloroethene	5	2.8	1.0	[58]	(0.22)	[1700]	[4100]	<1.0	[720]	[5800]
TAL Metals (µg/L)										
Aluminum	50	-	66	[(62)]	(28)	[380]	[23000]	[3800]	(42)	[(59)]
Arsenic	50	50	0.008	<0.010	<0.010	0.0036J	0.0087J	<0.010	<0.010	0.0040JB
Barium	2000	2000	91.3	26	51	12	120	80	46	41
Calcium	-	-	52,667	13000	37000	35000	44000	12000	34000	18000
Chromium	100	50	14.6	<10	<10	<10	(3.1)	(7)	(2.5)	<10
Cobalt	-	-	20	<10	<10	<10	<10	<10	<10	<10
Iron	300	300	140	(43)	160	190	[10000]	[1300]	(2.2)	(39)
Lead	15	15	10	<5	<5	<5	29	(3.7)	<5	<5
Magnesium	-	-	18,133	4700	6500	9500	15000	3600	4000	6900
Manganese	50	50	8	[180]	(5)	(5.7)	[170]	20	40	<10
Mercury	2	1.1	0.4	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Nickel	100	100	80	<40	<40	<40	(6.5)	(4.8)	<40	<40
Potassium	-	-	6,267	3300	6100	2700	<1000	4500	4600	1900
Sodium	-	-	24,667	11000	9000	9600	9600	14000	5800	7900
Vanadium	-	-	10	(5.4)	(6.3)	(6.6)	(6.6)	(4.2)	(2.9)	(2.7)
Zinc	500	2100	40	<20	<20	<20	<20	(14)	<6.5	<20
Water Quality Parameters (mg/L)										
Alkalinity (to pH 4.5) as CaCO3	-	-	213	NT	130	96	96	94	82	47
Chloride	250	250	14.5	NT	6.7	33	40	4.9	9.8	28
Dissolved Oxygen	-	-	1.51	-	0.34	5.59	5.25	4.21	4.33	5.41
Methane	-	-	0.272	NT	(0.00012)	(0.00011)	(0.0001)	(0.00015)	0.0002	0.00023
Nitrate	10	10	1.7	NT	0.29	1.1	1.2	1.6	0.39	2.2
Nitrite-N	1	1	0.071	NT	0.059	(0.005)	(0.027)	(0.013)	(0.007)	<0.05
Sulfate	250	250	42.8	NT	6.7	15	26	22	27	<5

1 - Maximum Contaminant Level (MCL), USEPA Drinking Water Regulations and Health Advisories-Primary Standards
Secondary Standards provided for Aluminum, Chloride, Iron, Manganese, Zinc & Sulfate
a - MCL for total trihalomethanes includes chloroform+bromoform+bromodichloromethane+dibromochloromethane
2 - State of North Carolina Chapter 2L Standards for Groundwater (NCDENR Title 15A Section .0200)
3 - Criterion Background Concentration based on two times the average background
concentration for metals and water quality parameters. Background for VOCs is the laboratory detection limit.
4- Cyanide was analyzed in COEMW02, -05, -17, -28, and was not detected (<0.010).
( ) Concentration is reported below Lower Quantitation Limit.
[ ] Concentration exceeds all screening criteria.
(-) No standard
J = estimated value. B = compound detected in method blank.J = estimated value. B = compound detected in method blank.

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TABLE 5-7
SUMMARY OF CONSTITUENTS DETECTED IN PHASE II RI GROUNDWATER SAMPLES
FORMER CHARLOTTE ARMY MISSILE PLANT

SITE				MW02	MW02	MW03	MW04	MW06	MW07
SAMPLE ID	EPA MCLs [1]	N C	Criterion	MW0202	MW5001	MW0302	MW0402	MW0602	MW0702
DATE		Groundwater	Background	03/03/2000	03/03/2000	03/01/2000	03/02/2000	03/04/2000	03/05/2000
RESULT TYPE		Standards [2]	Concentrations [3]	Primary	Duplicate 1	Primary	Primary	Primary	Primary
TCL Volatile Organics (µg/L)									
Acetone	-	700	25	<25	(13)	<25	<6200	<25	<25
Bromodichloromethane	80a	-	1.0	<1.0	<1	<1.0	<250	<1	<1
Carbon tetrachloride	5	0.3	1.0	<1.0	<1	<1.0	<250	<1	<1
Chloroform	80a	0.19	1.0	1.0	<1	<1.0	(35)	(0.36)	<1
1,1-Dichloroethene	7	7	1.0	<1.0	<1	<1.0	<250	<1	<1
cis-1,2-Dichloroethene	70	70	1.0	<1.0	<1	<1.0	<250	<1	<1
Methylene chloride	5	5	4.1	(1.1)	(1.1)	<2.0	<250	(1.1)	(0.38)
Naphthalene	-	21	1.0	(0.47)	1	(0.92)	<250	(0.91)	(0.16)
1,1,1-Trichloroethane	200	200	1.0	<1.0	<1	<1.0	<250	<1	<1
1,1,2-Trichloroethane	5	-	0.19	<1.0	<1	<1.0	(78)	<1	<1
Trichloroethene	5	2.8	1.0	<1.0	<1	[11]	[3500]	[11]	[15]
TAL Metals (µg/L)									
Aluminum	50	-	66	(30)	(33)	[(85)]	<200	(30)	<200
Arsenic	50	50	0.008	0.0037J	0.0041J	<0.010	<0.010	0.0037JB	<0.010
Barium	2000	2000	91.3	100	100	48	33	98	37
Calcium	-	-	52,667	25000	25000	41000	15000	84000J	11000J
Chromium	100	50	14.6	<10	<10	<10	15	12	<10
Cobalt	-	-	20	<10	<10	<10	<10	<10	<10
Iron	300	300	140	<50	<50	67	<50	<50	<50
Lead	15	15	10	<5	<5	<5	<5	<5	<5
Magnesium	-	-	18,133	6100	6300	13000	6100	32000	5300
Manganese	50	50	8	[710]	[840]	(2)	<10	<10	<10
Mercury	2	1.1	0.4	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Nickel	100	100	80	<40	<40	<40	<40	<40	<40
Potassium	-	-	6,267	4000	<1000	(850)	1200	1800	(680)
Sodium	-	-	24,667	1300	1400	18000	8700	13000	54000
Vanadium	-	-	10	<10	<10	(2.7)	(3)	<10	<10
Zinc	500	2100	40	<20	<20	<20	<20	<20	<20
Water Quality Parameters (mg/L)									
Alkalinity (to pH 4.5) as CaCO3	-	-	213	97	NT	120	35	310	81
Chloride	250	250	14.5	(0.85)	NT	10	25	2	7.3
Dissolved Oxygen	-	-	1.51	2.75	-	7.86	5.42	4.44	4.92
Methane	-	-	0.272	(0.0001)	NT	<0.00019	(0.00011)	<0.00019	(0.0001)
Nitrate	10	10	1.7	1.2	NT	6.9	0.19	0.99	[10]
Nitrite-N	1	1	0.071	<0.050	NT	(0.0050)	<0.05	0.05J	0.05J
Sulfate	250	250	42.8	5.2	NT	34	12	11	25J

1 - Maximum Contaminant Level (MCL), USEPA Drinking Water Regulations and Health Advisories-Primary Standards
Secondary Standards provided for Aluminum, Chloride, Iron, Manganese, Zinc & Sulfate
a - MCL for total trihalomethanes includes chloroform+bromoform+bromodichloromethane+dibromochloromethane
2 - State of North Carolina Chapter 2L Standards for Groundwater (NCDENR Title 15A Section .0200)
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(-) No standard
J = estimated value. B = compound detected in method blank.J = estimated value. B = compound detected in method blank.

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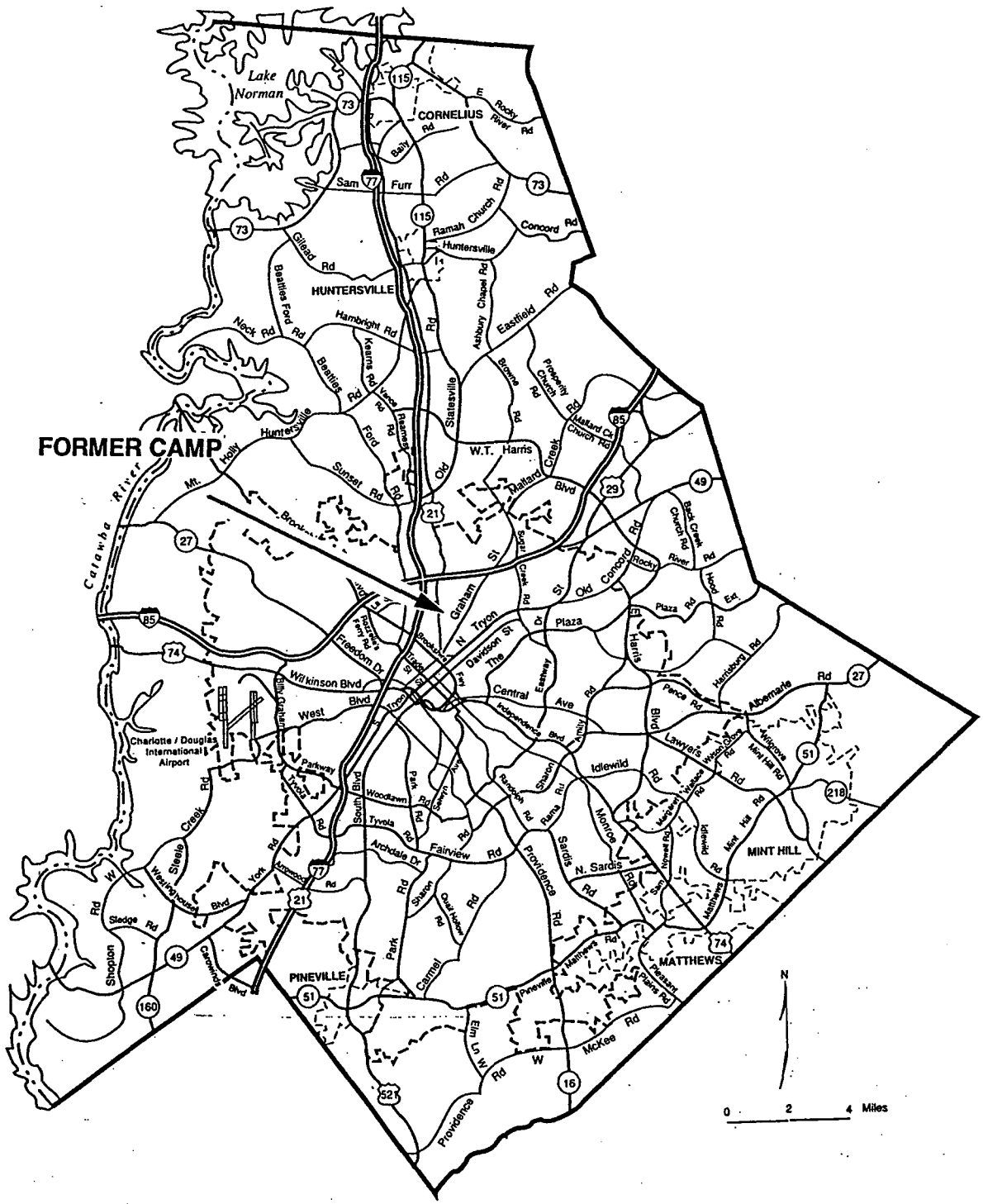
TABLE 6-1
SUMMARY OF GROUNDWATER FIELD MEASURED PARAMETERS
FORMER CHARLOTTE ARMY MISSILE PLANT

Well ID	Total Well Depth	Date Measured	Time Measured	Temperature	pH	Conductivity	Dissolved Oxygen	Oxidation Reduction Potential
	feet			(°C)	(S.U.)	(millisiemens)	percent saturation / (milligrams per liter)	(millivolts)
COEMW01	17.5	5/25/2000	1440	19.22	6.87	0.129	62.1% / 5.73	174.8
COEMW02	15.5	5/25/2000	1356	19.27	6.06	0.182	17.2% / 1.53	162.6
COEMW03	25.5	5/25/2000	1504	19.42	6.32	0.032	104.5% / 9.61	190.7
COEMW04	not sampled	-	-	-	-	-	-	-
COEMW05	14.75	5/25/2000	1401	17.74	6.18	0.096	70.3% / 6.66	172.6
COEMW06	15.75	5/25/2000	1432	18.84	6.56	0.174	51.7% / 4.80	193.2
COEMW07	28.3	5/25/2000	1447	20.87	5.20	0.101	14.1% / 1.22	238.7
COEMW08	25.3	5/25/2000	1418	18.80	6.33	0.172	16.6% / 1.54	165.4
COEMW09	75	5/25/2000	1415	18.12	7.04	0.214	31.5% / 2.97	120.9
COEMW10	59.1	5/25/2000	1517	18.70	10.72	0.209	94.0% / 8.75	110.9
COEMW11	64	5/25/2000	1710	19.37	7.24	0.112	76.0% / 6.99	190.6
COEMW12	15	5/25/2000	1331	18.26	6.47	0.271	83.3% / 7.68	207.3
COEMW13	20	5/25/2000	1554	19.27	6.77	0.144	77.1% / 7.03	204.3
COEMW14	21	5/25/2000	1546	19.55	7.99	0.14	98.3% / 8.99	11.78
COEMW15	23	5/25/2000	1715	18.59	6.48	0.093	87.7% / 8.20	215.2
COEMW16	27	5/25/2000	1659	19.66	6.31	0.227	46.2% / 4.22	212.8
COEMW17	15	5/25/2000	1345	17.65	6.48	0.146	35.9% / 3.35	196
COEMW18	18	5/25/2000	1320	19.54	6.32	0.191	38.3% / 3.50	199.7
COEMW19	18	5/25/2000	1256	21.10	5.69	0.081	44.2% / 3.90	191.9
COEMW20	27.5	5/25/2000	1600	18.7	6.63	0.175	57.4% /5.31	193.3
COEMW21	43.9	5/25/2000	1540	19.48	11.05	0.303	10.9% / 1.00	282.6
COEMW22	46.8	5/25/2000	1509	19.16	10.52	0.22	23.7% / 2.19	122
COEMW23	72.5	5/25/2000	1649	19.55	7.15	0.102	72.9% / 6.71	183.8
COEMW24	47.2	5/25/2000	1523	18.68	9.83	0.285	84.4% / 7.88	73.1
COEMW25	71.4	5/25/2000	14.26	18.29	6.62	0.175	23.1% / 2.14	184.3
COEMW26	72	5/25/2000	1352	18.18	6.56	0.203	3.8% / 0.32	138.2
COEMW27	67.1	5/25/2000	1336	18.77	6.82	0.128	21.7% / 2.01	139.9
COEMW28	95	5/25/2000	1408	17.91	7.23	0.247	3.6% / 0.31	23.5
COEMW29	97.5	5/25/2000	1620	18.56	7.71	0.227	59.9% / 5.59	165.8
COEMW29	117.5	5/25/2000	16.18	18.52	7.89	0.23	55.6% / 5.25	159.3
COEMW30	73	5/25/2000	1259	18.71	9.28	0.154	45.1% / 4.21	178
MW1A	62	5/25/2000	1135	19.13	7.21	0.169	58.8% / 5.41	158.3
MW01	20	5/25/2000	1631	18.92	7.45	0.217	46.6% / 4.33	171.3
MW02	20	5/25/2000	1528	18.54	7.52	0.165	30.1% / 2.75	181.1
MW03	19	5/25/2000	1606	17.81	6.57	0.275	82.8% / 7.86	181.4
MW04	19	5/25/2000	1612	20.32	6.28	0.002	60.1% / 5.42	181.5
MW06	20	5/25/2000	1534	19.68	6.63	0.56	52.5% / 4.44	203.4
MW07	25	5/25/2000	1454	20.98	5.94	0.003	55.3% / 4.92	272.8

FIGURES



U.S. ARMY
ENGINEER DISTRICT, SAVANNAH
CORPS OF ENGINEERS
SAVANNAH, GEORGIA

SITE LOCATION MAP

Figure 1.1.

METCALF & EDDY

SCALE:	DATE: MAY 1, 1996	APPROVED:

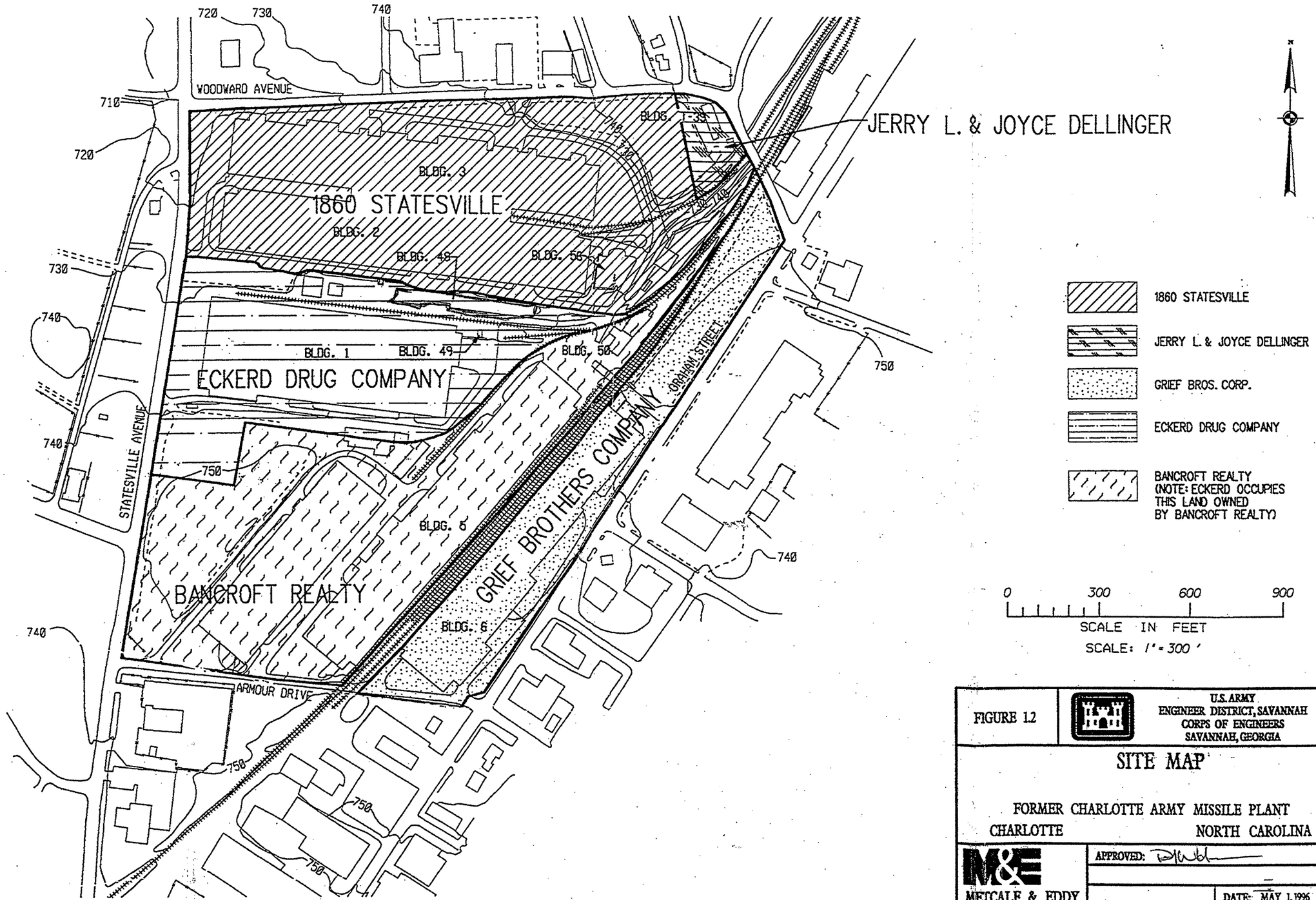


FIGURE 1.2

U.S. ARMY
ENGINEER DISTRICT, SAVANNAH
CORPS OF ENGINEERS
SAVANNAH, GEORGIA

SITE MAP

FORMER CHARLOTTE ARMY MISSILE PLANT
CHARLOTTE NORTH CAROLINA

M&E
METCALF & EDDY

APPROVED:

DATE: MAY 1, 1996

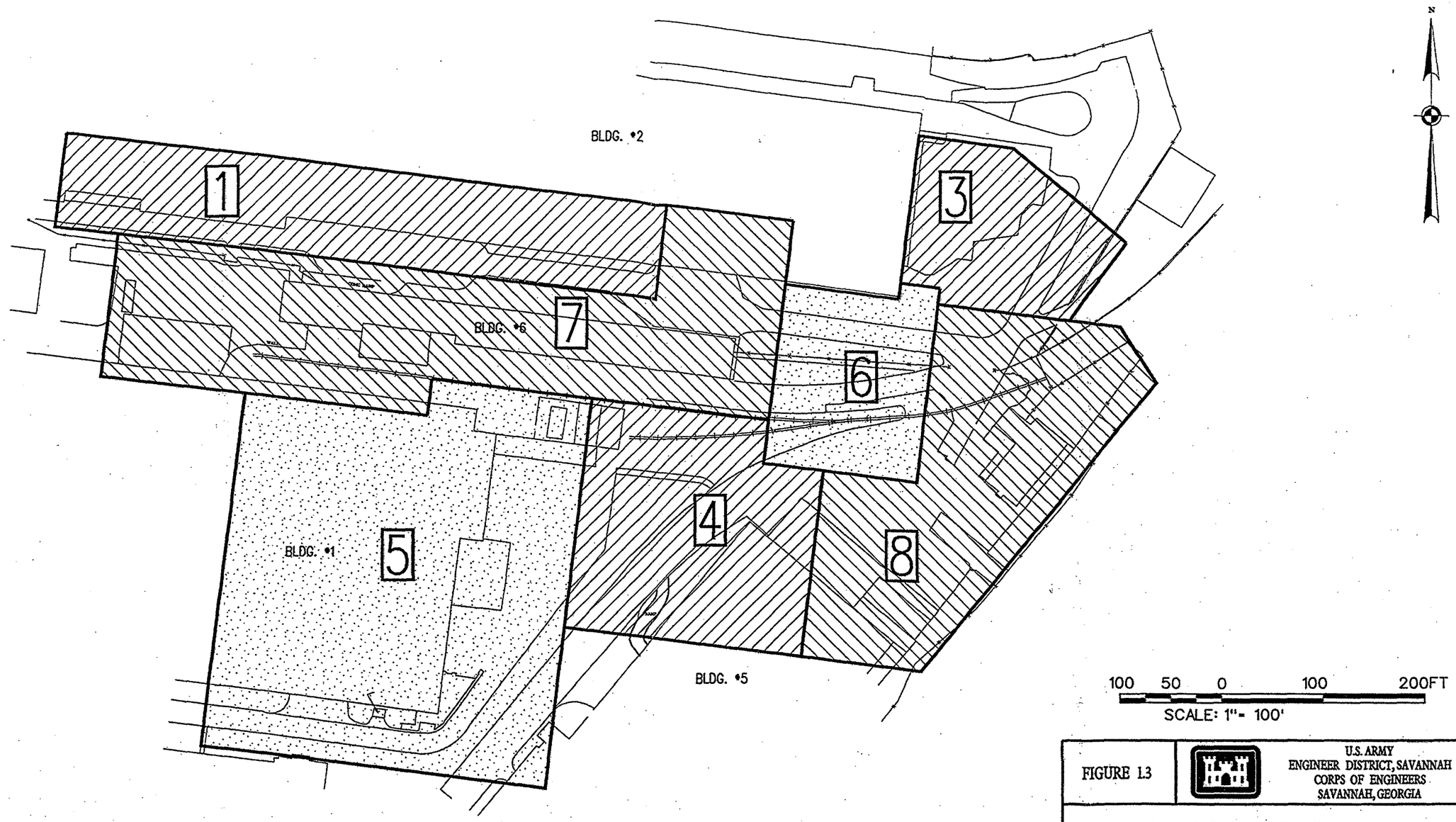


FIGURE 1.3

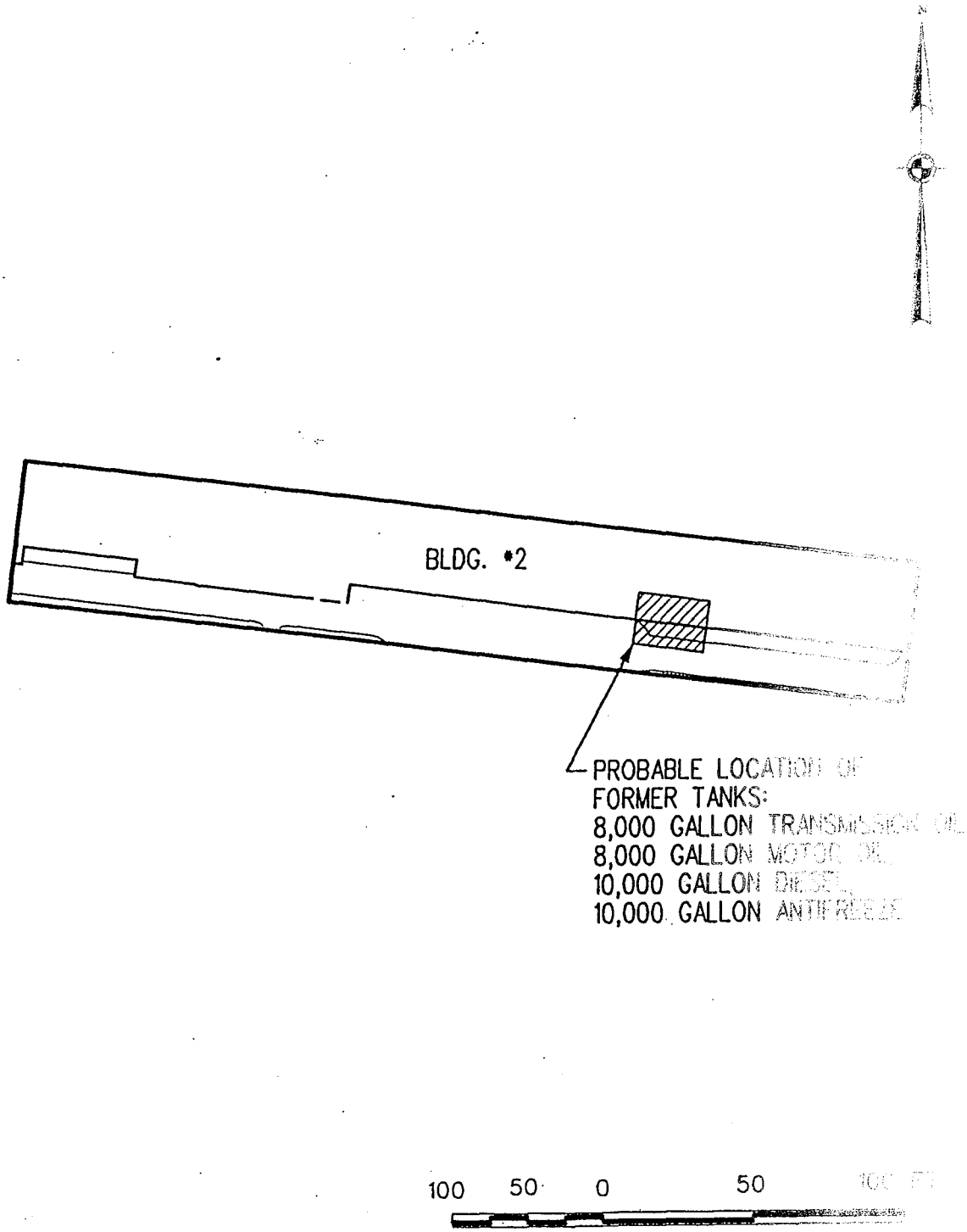
U.S. ARMY
ENGINEER DISTRICT, SAVANNAH
CORPS OF ENGINEERS
SAVANNAH, GEORGIA

INDIVIDUAL SITE BOUNDARIES

FORMER CHARLOTTE ARMY MISSILE PLANT
CHARLOTTE NORTH CAROLINA

M&E
Metcalf & Eddy

SCALE: 1"=80'



U.S. ARMY
ENGINEER DISTRICT, SAVANNAH
CORPS OF ENGINEERS
SAVANNAH, GEORGIA

MAP OF SITE 1

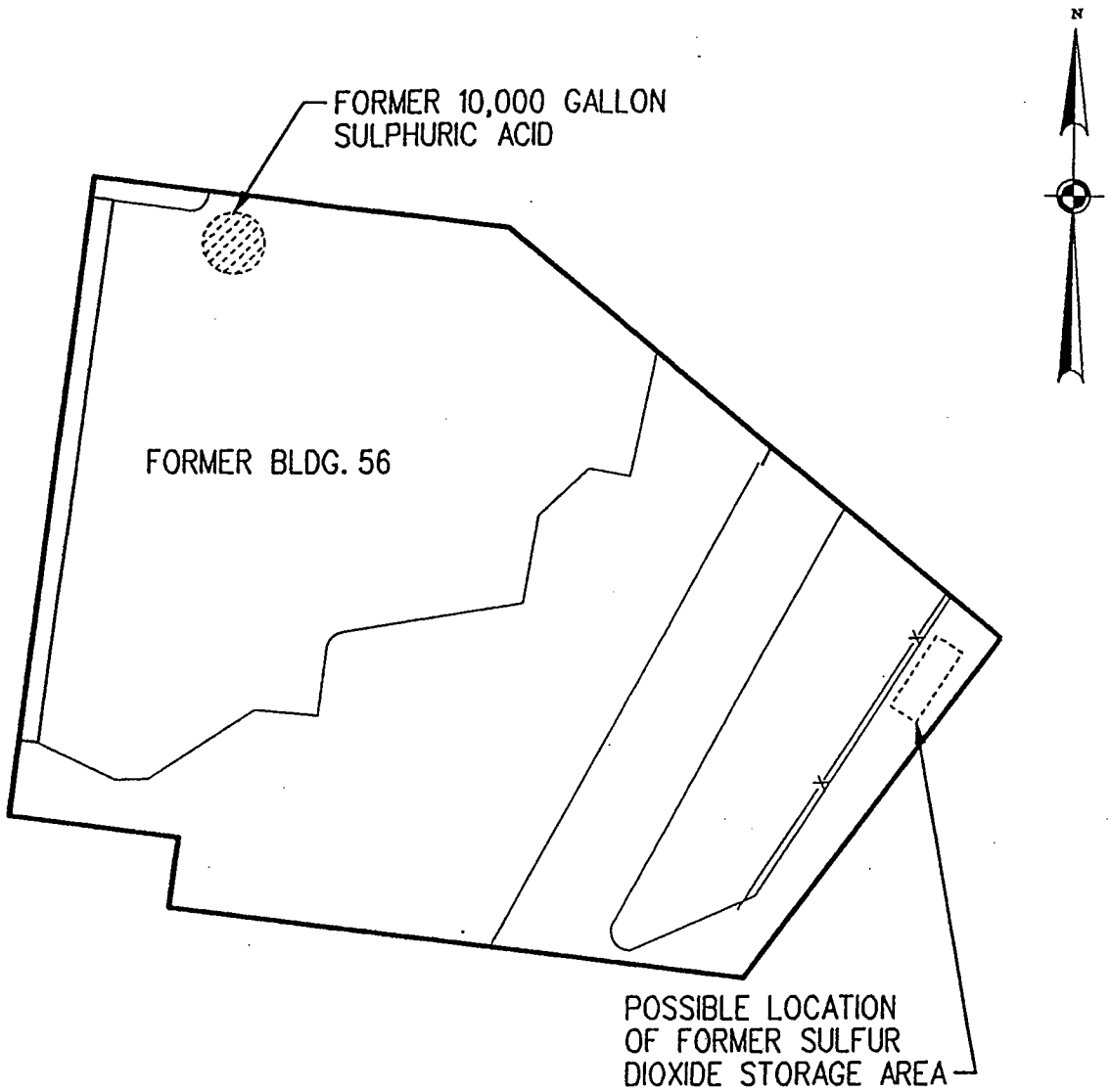
FORMER CHARLOTTE ARMY MISSILE PLANT

CHARLOTTE NORTH CAROLINA

FIGURE 1A

METCALF & EDDY

SCALE: 1" = 100'-0"



U.S. ARMY
ENGINEER DISTRICT, SAVANNAH
CORPS OF ENGINEERS
SAVANNAH, GEORGIA

MAP OF SITE 3

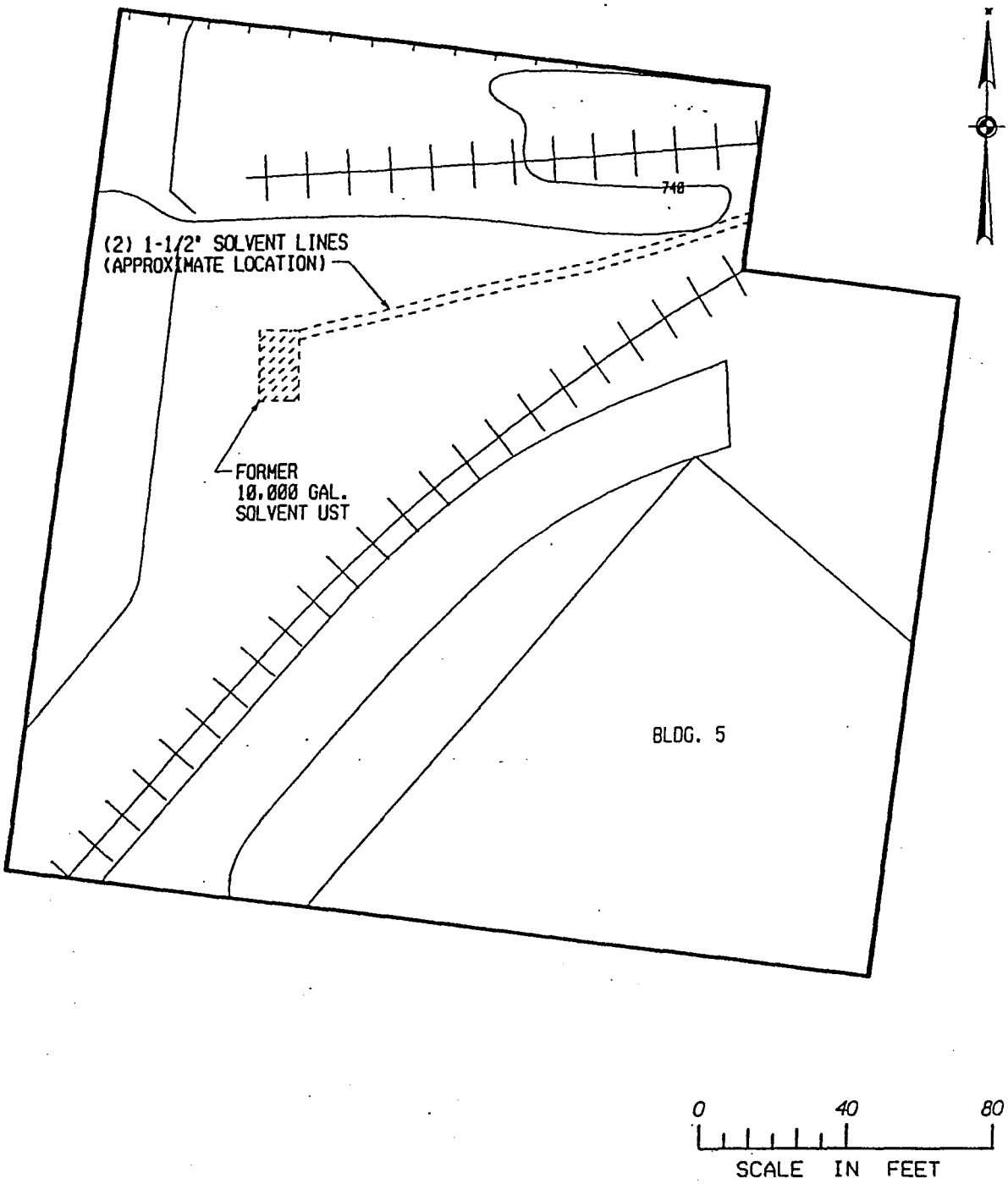
FORMER CHARLOTTE ARMY MISSILE PLANT

CHARLOTTE NORTH CAROLINA

FIGURE 1.5

METCALF & EDDY

SCALE: 1" = 40'-0"



U.S. ARMY
ENGINEER DISTRICT, SAVANNAH
CORPS OF ENGINEERS
SAVANNAH, GEORGIA

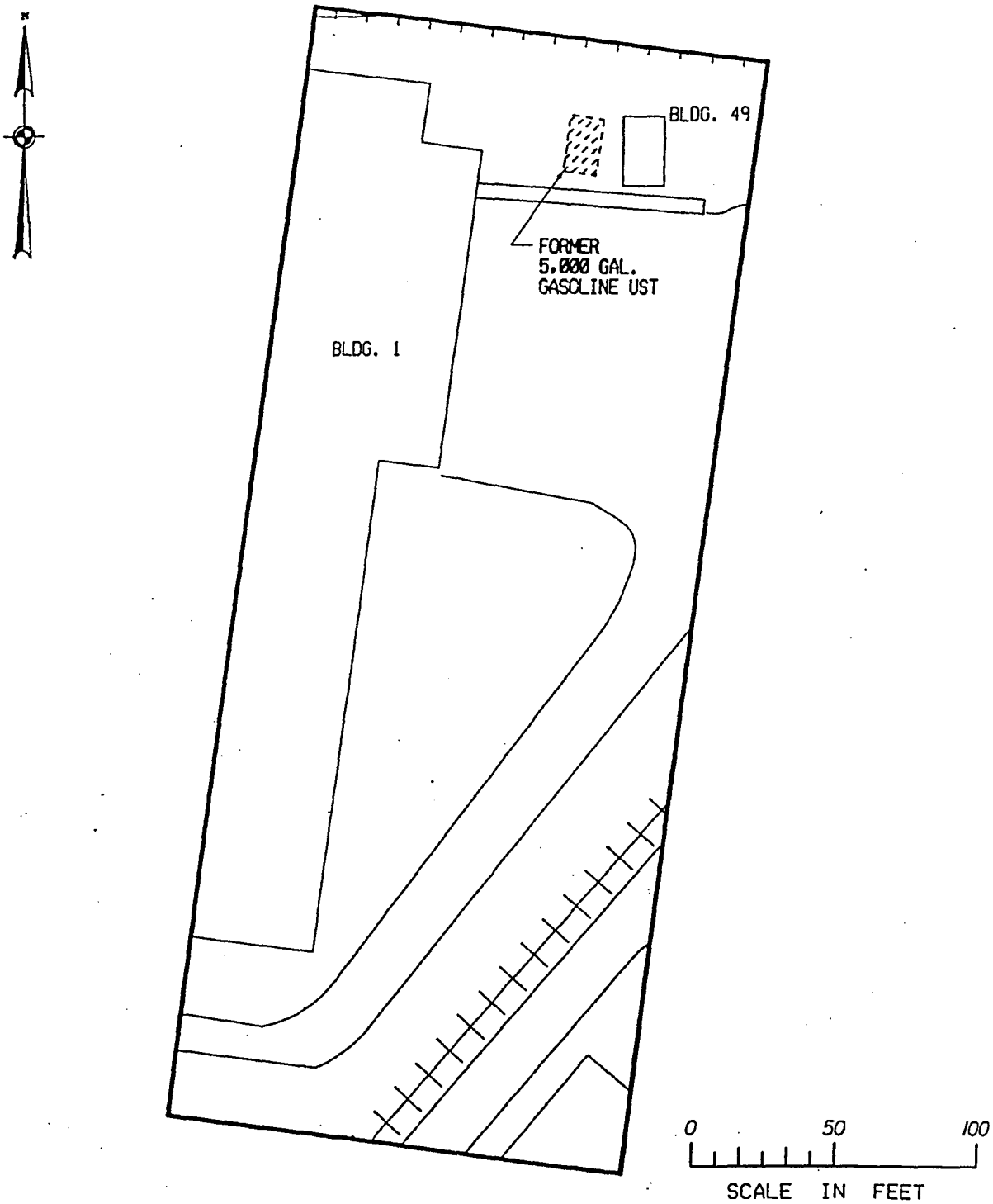
MAP OF SITE 4

FORMER CHARLOTTE ARMY MISSILE PLANT
CHARLOTTE NORTH CAROLINA

FIGURE 1.6

METCALF & EDDY

SCALE: 1" = 40'



U.S. ARMY
ENGINEER DISTRICT, SAVANNAH
CORPS OF ENGINEERS
SAVANNAH, GEORGIA

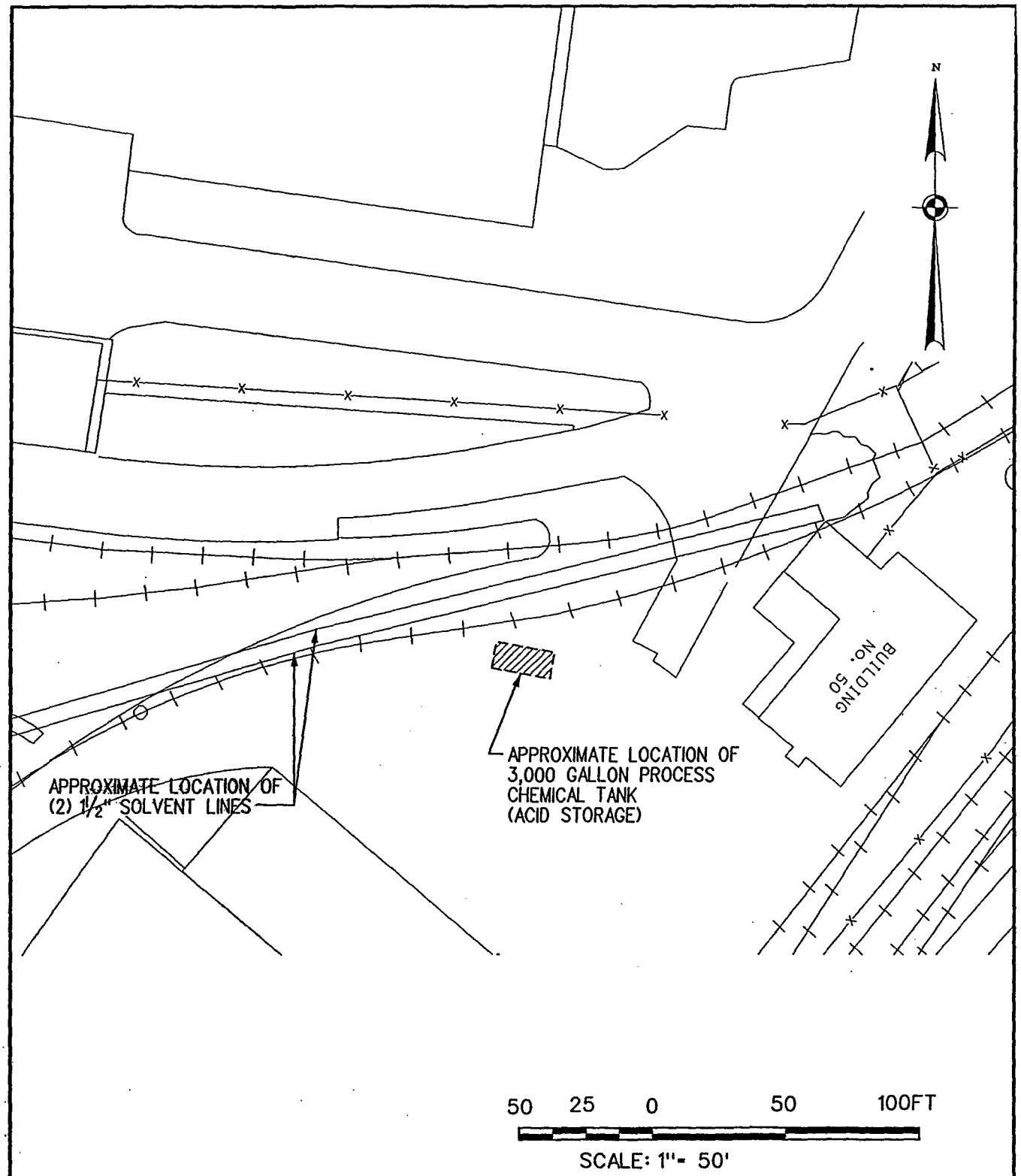
MAP OF SITE 5

FORMER CHARLOTTE ARMY MISSILE PLANT
CHARLOTTE NORTH CAROLINA

FIGURE 1.7

METCALF & EDDY

SCALE: 1" = 50'	DATE: MAY 1, 1996	APPROVED:	



U.S. ARMY
ENGINEER DISTRICT, SAVANNAH
CORPS OF ENGINEERS
SAVANNAH, GEORGIA

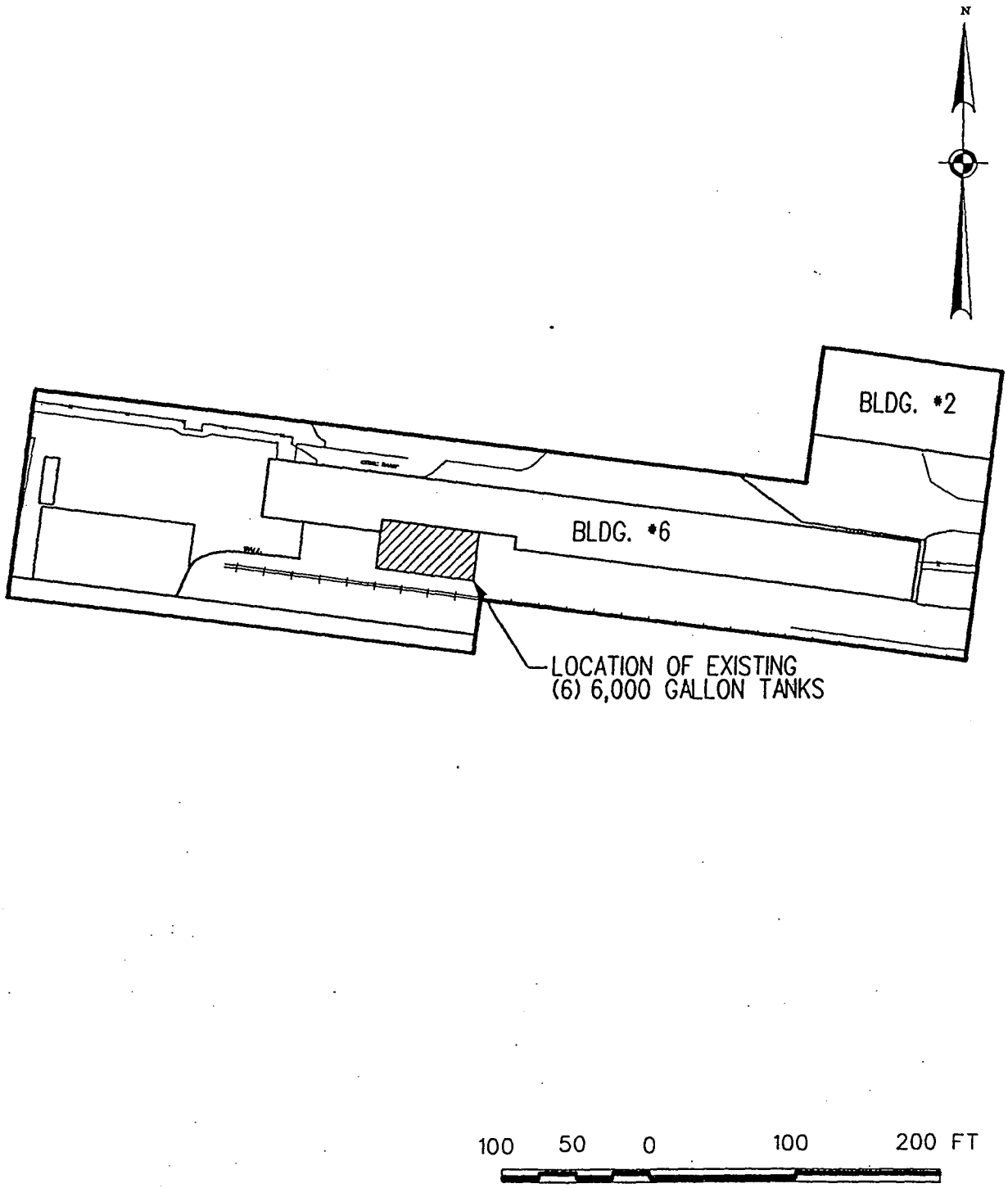
MAP OF SITE 6

FORMER CHARLOTTE ARMY MISSILE PLANT

CHARLOTTE NORTH CAROLINA

FIGURE 1.8

Metcalf & Eddy



U.S. ARMY
ENGINEER DISTRICT, SAVANNAH
CORPS OF ENGINEERS
SAVANNAH, GEORGIA

MAP OF SITE 7

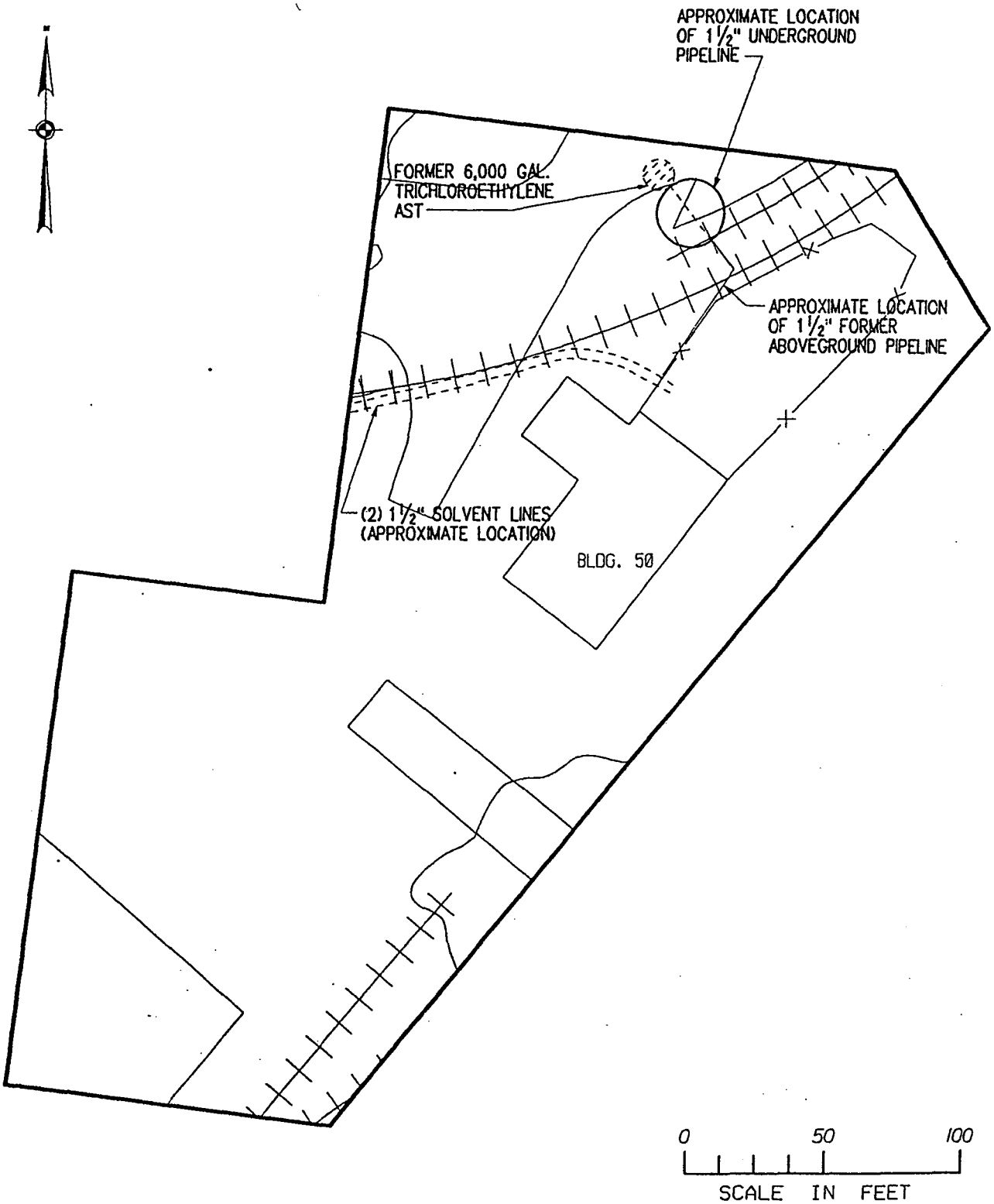
FORMER CHARLOTTE ARMY MISSILE PLANT

CHARLOTTE NORTH CAROLINA

SCALE: 1" = 100'-0"

FIGURE 1.9

METCALF & EDDY



U.S. ARMY
ENGINEER DISTRICT, SAVANNAH
CORPS OF ENGINEERS
SAVANNAH, GEORGIA

MAP OF SITE 8

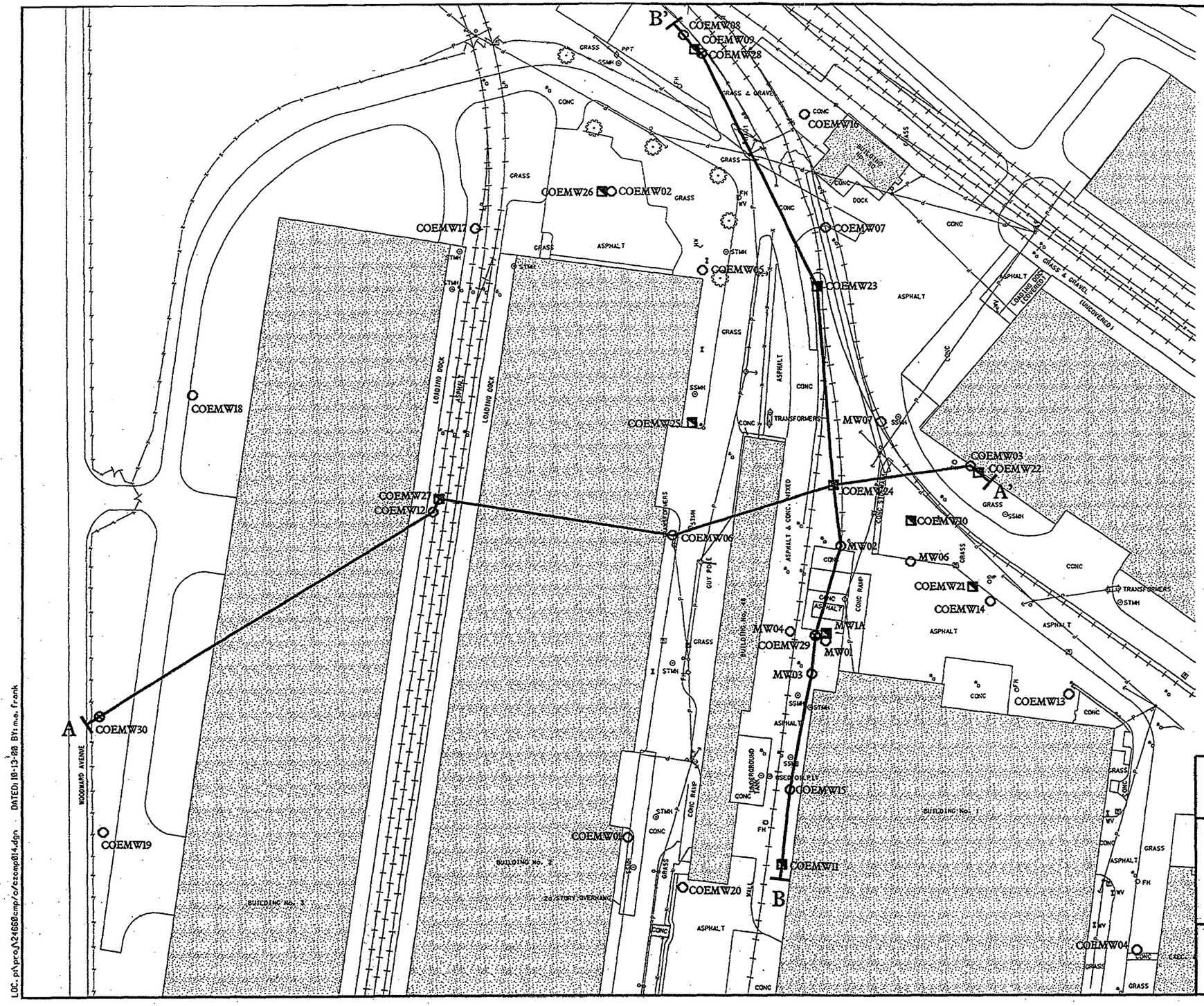
FORMER CHARLOTTE ARMY MISSILE PLANT

CHARLOTTE NORTH CAROLINA

FIGURE 1.10

METCALF & EDDY

SCALE: 1" = 50'



N

LEGEND:

MW01 OR COEMW01	SZ MONITORING WELL
COEMW21	TZ MONITORING WELL
COEMW28	BZ MONITORING WELL
-X-X-X-	CHAINLINK FENCE
*2	BUILDING
A–A'	CROSS SECTION LINE

100 50 0 100 200FT

SCALE: 1" = 100'

FIGURE 2.1

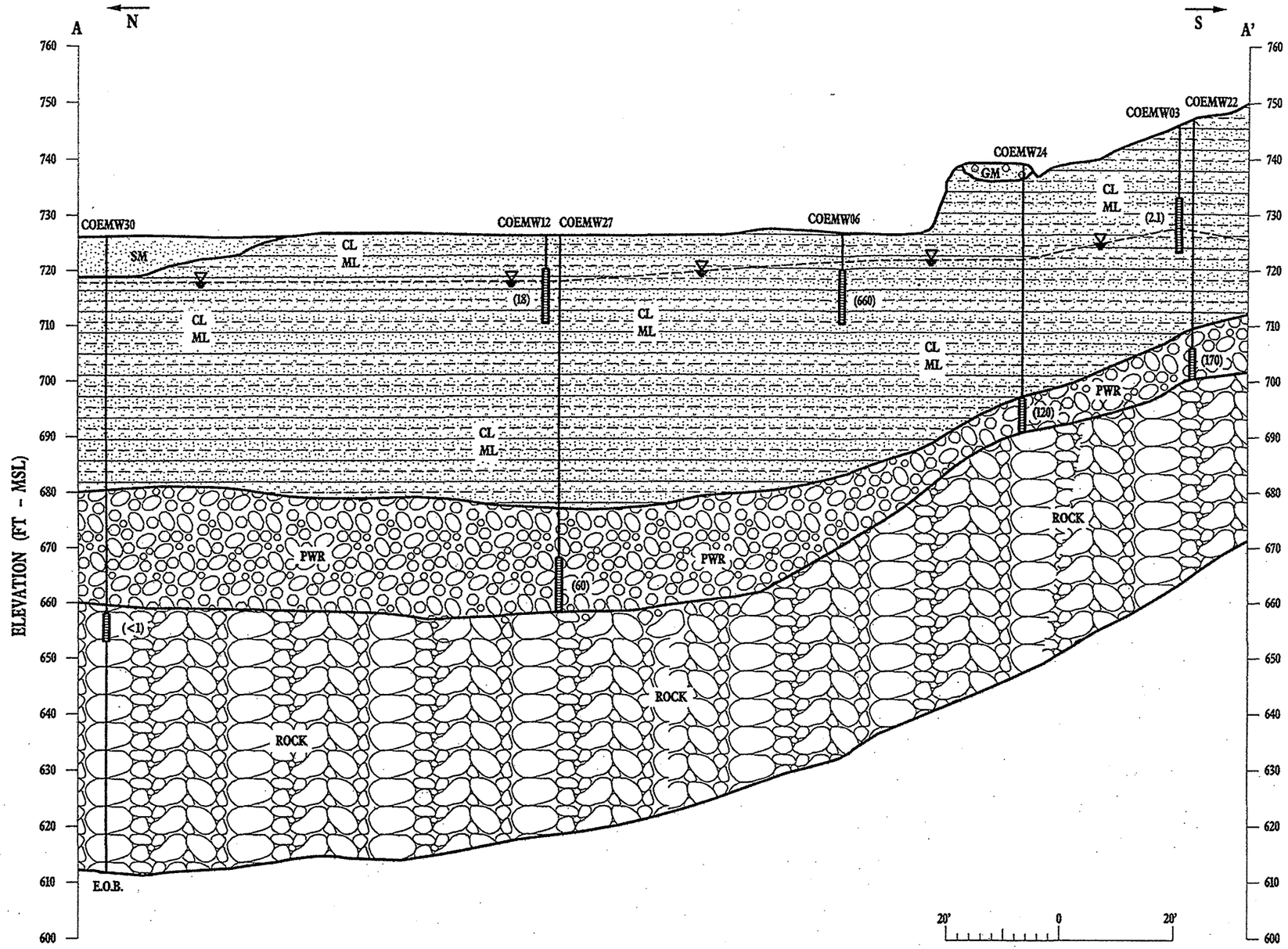
U.S. ARMY
ENGINEER DISTRICT, SAVANNAH
CORPS OF ENGINEERS
SAVANNAH, GEORGIA

CROSS SECTION LOCATION MAP
FORMER CHARLOTTE ARMY MISSILE PLANT

CHARLOTTE NORTH CAROLINA

M&E Metcalf & Eddy

LOC: p:\proj\24660cmp/c/czcmp814.dgn DATED: 10-13-98 BY: m.o. frank



LEGEND

SM	SILTY SAND
PWR	PARTIALLY WEATHERED ROCK
ROCK	METAMORPHIC / IGNEOUS ROCK DIORITIC, PYROXENITE
GM	SILTY GRAVEL
CL ML	SILTS, CLAYS SAPROLITE
▽	WATER LEVEL
▯	SCREEN INTERVAL
E.O.B.	END OF BORING
- - - - - -	POTENTIOMETRIC SURFACE WATER LEVELS MEASURED ON 2/28/00
(68)	TRICHLOROETHENE CONCENTRATION IN MICROGRAMS PER LITER. SAMPLES COLLECTED 2/29/00 TO 3/4/00.
(<1)	INDICATES CONCENTRATION IS BELOW LABORATORY DETECTION LIMITS.

20' 0 20'

SCALE: 1" = 20' (VERT.)

100' 0 100'

SCALE: 1" = 100' (HORIZ.)

V.E. = 5X

FIGURE 2.2

U.S. ARMY
ENGINEER DISTRICT, MOBILE
CORPS OF ENGINEERS
MOBILE, ALABAMA

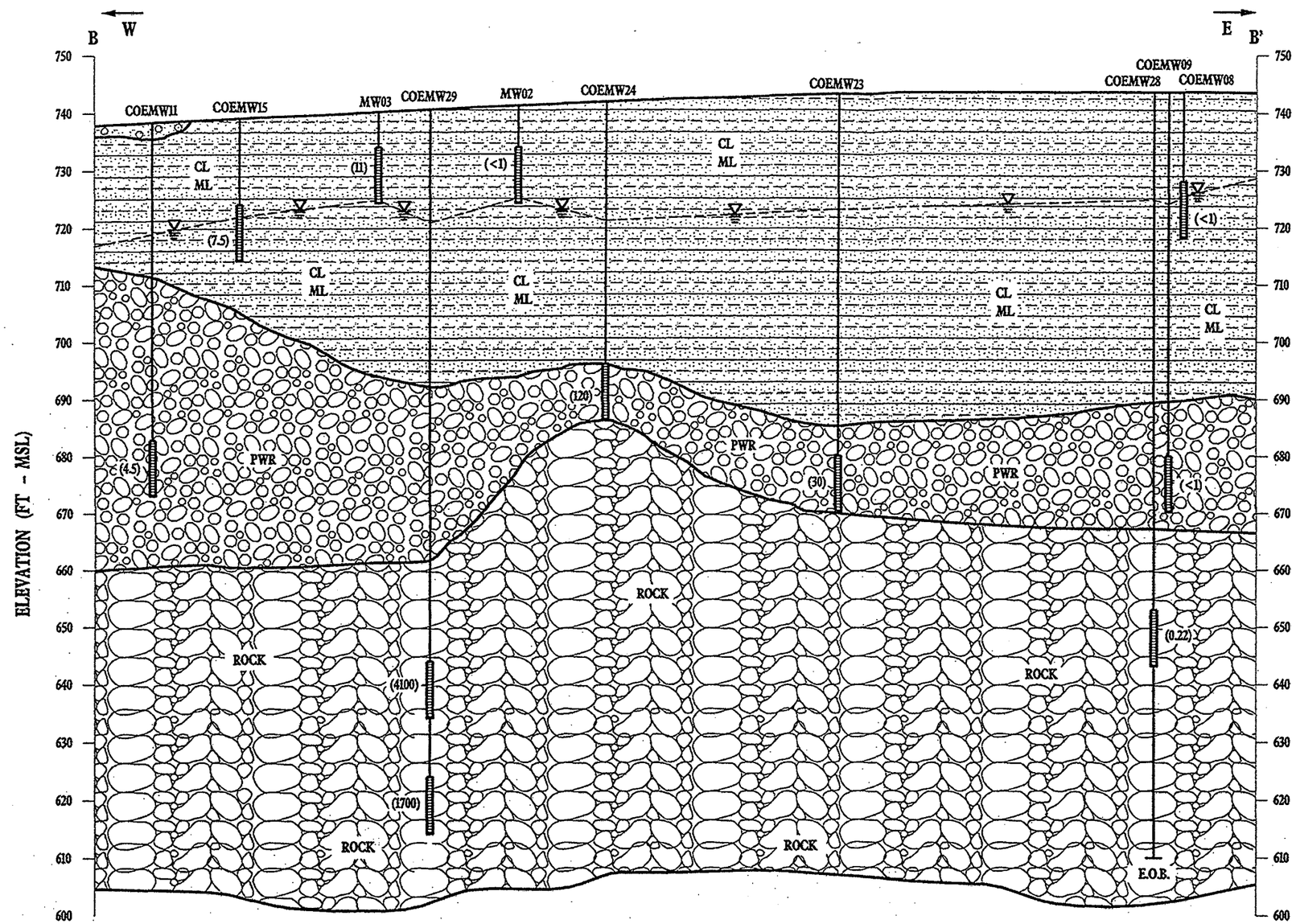
GEOLOGIC CROSS SECTION A–A'

FORMER CHARLOTTE ARMY MISSLE PLANT

CHARLOTTE, NORTH CAROLINA

M&E Metcalf & Eddy

LOC. pt\proj\24660cmp\C\CXcmp004.DGN DATED: 07-10-00 BY: M.A. FRANK



LEGEND

PWR	PARTIALLY WEATHERED ROCK
ROCK	METAMORPHIC / IGNEOUS ROCK DIORITIC, PYROXENITE
GC	CLAYEY GRAVEL
CL ML	SILTY CLAY, CLAYEY SILT
	WATER LEVEL
	SCREEN INTERVAL
E.O.B.	END OF BORING
- - - - - - -	POTENTIOMETRIC SURFACE WATER LEVELS MEASURED ON 2/28/00
(68)	TRICHLOROETHENE CONCENTRATION IN MICROGRAMS PER LITER SAMPLES COLLECTED 2/29/00 TO 3/4/00.
(<1)	INDICATES CONCENTRATION IS BELOW LABORATORY DETECTION LIMITS.

20' 0 20'

SCALE: 1" = 20' (VERT.)

100' 0 100'

SCALE: 1" = 100' (HORIZ.)

V.E. = 5X

FIGURE 2.3

U.S. ARMY
ENGINEER DISTRICT, MOBILE
CORPS OF ENGINEERS
MOBILE, ALABAMA

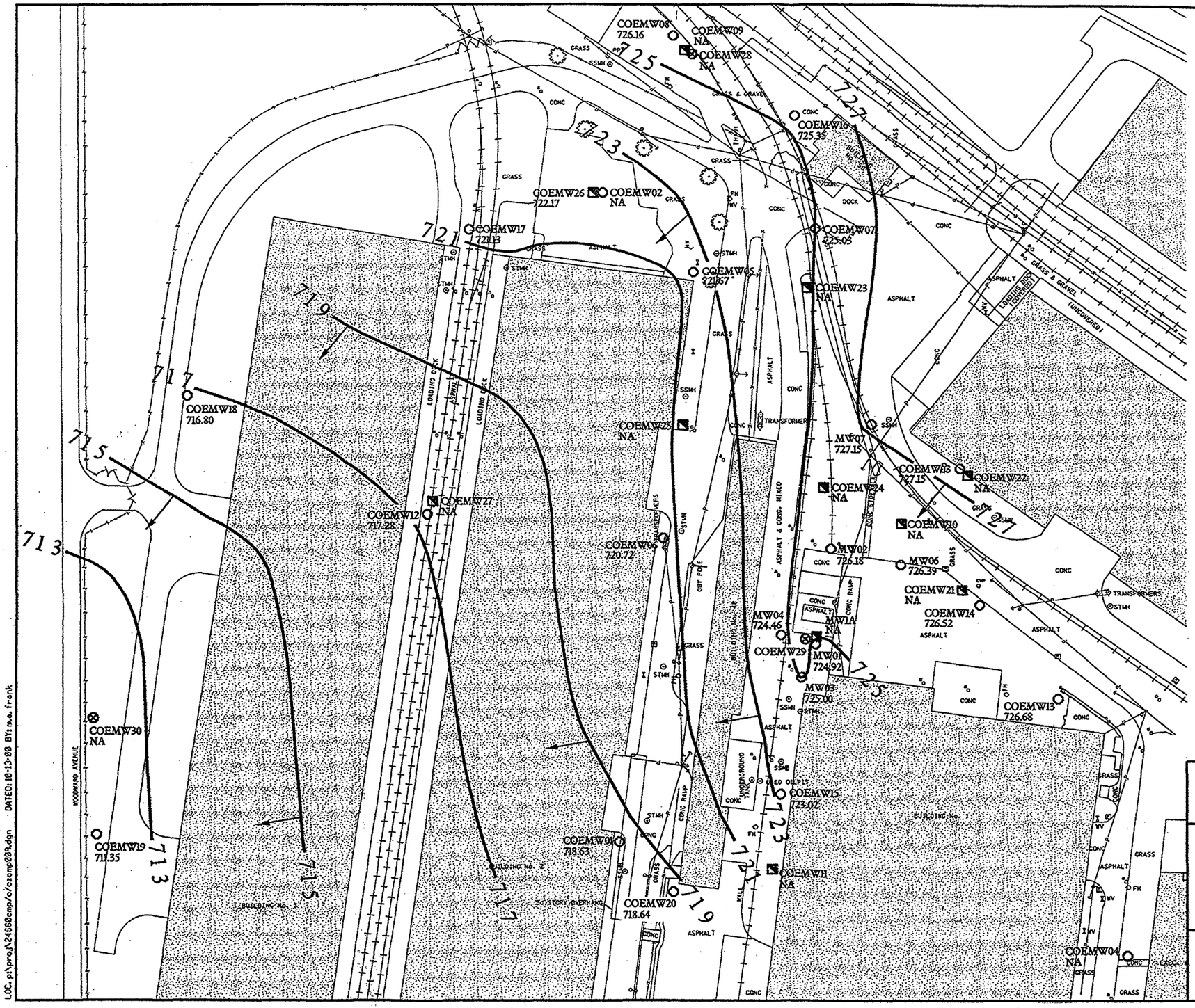
GEOLOGIC CROSS SECTION B–B'

FORMER CHARLOTTE ARMY MISSLE PLANT

CHARLOTTE, NORTH CAROLINA

M&E
Metcalf & Eddy

LOC. p:\proj\24660cmp\C\CXCMP003.DGN DATED: 07-11-00 BY: M.A. FRANK



N

LEGEND:

- MW01 OR COEMW01 — SZ MONITORING WELL
- COEMW21 — TZ MONITORING WELL
- COEMW28 — BZ MONITORING WELL
- CHAINLINK FENCE
- •2 — BUILDING
- 722.10 — GROUNDWATER ELEVATION (FEET ABOVE MEAN SEA LEVEL)
- 720 — LINE OF EQUAL GROUNDWATER ELEVATION IN FEET ABOVE MEAN SEA LEVEL
- GROUNDWATER FLOW DIRECTION
- NA — NOT APPLICABLE

NOTE:
GROUNDWATER MEASUREMENTS TAKEN ON FEBRUARY 28, 2000

POTENTIOMETRIC CONTOUR INTERVAL = 2'-0"

100 50 0 100 200FT

SCALE: 1" = 100'

FIGURE 2.4

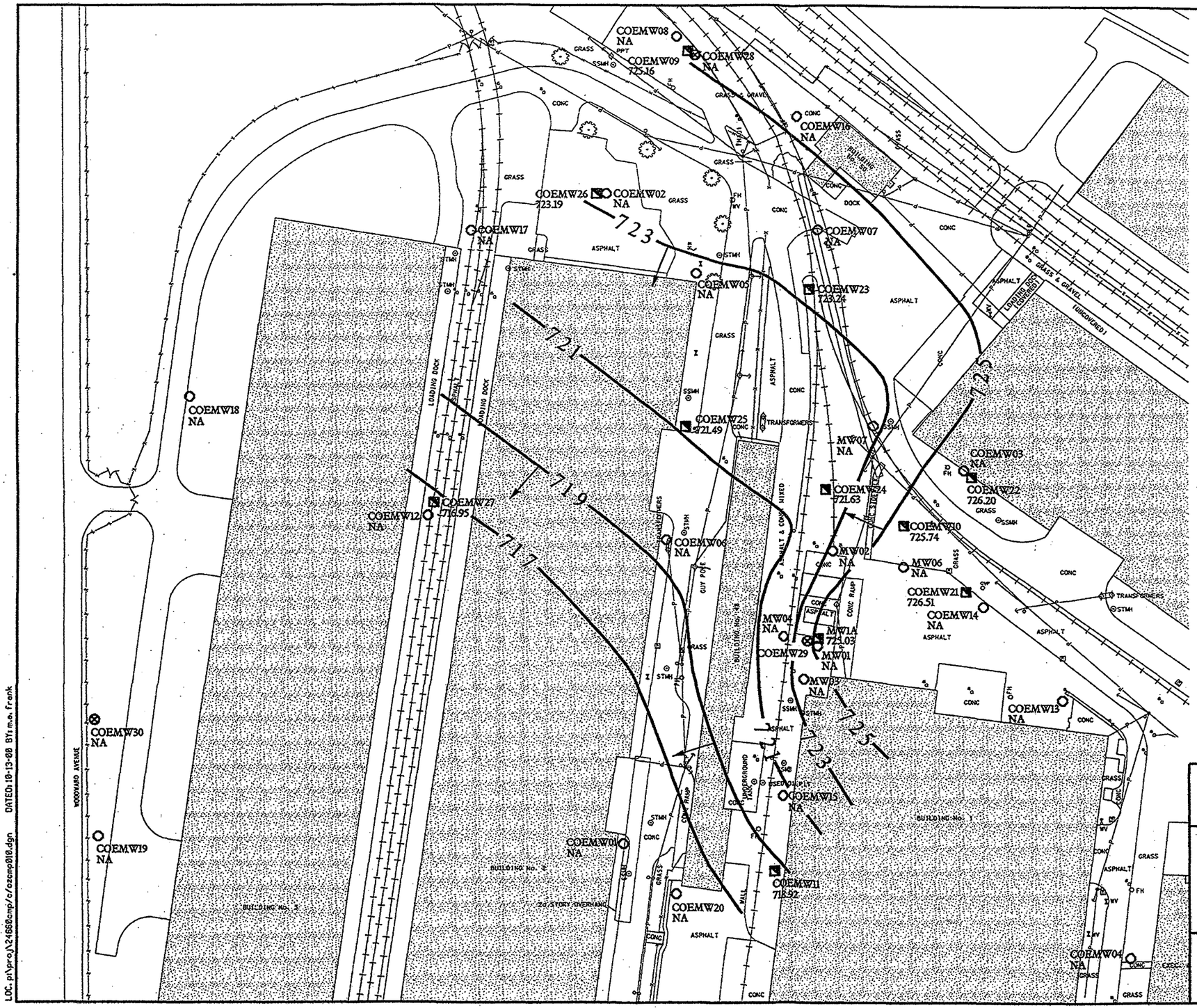
U.S. ARMY
ENGINEER DISTRICT, SAVANNAH
CORPS OF ENGINEERS
SAVANNAH, GEORGIA

POTENTIOMETRIC SURFACE MAP
SHALLOW ZONE
FORMER CHARLOTTE ARMY MISSILE PLANT

CHARLOTTE NORTH CAROLINA

M&E Metcalf & Eddy

LOC: p:\proj\24660emp/c/czmp003.dgn DATED: 10-13-00 BY: m.a. frank



N

LEGEND:

- MW01 OR COEMW01 — SZ MONITORING WELL
- COEMW21 — TZ MONITORING WELL
- COEMW28 — BZ MONITORING WELL
- CHAINLINK FENCE
- *2 — BUILDING
- 722.10 — GROUNDWATER ELEVATION (FEET ABOVE MEAN SEA LEVEL)
- 720 — LINE OF EQUAL GROUNDWATER ELEVATION IN FEET ABOVE MEAN SEA LEVEL
- GROUNDWATER FLOW DIRECTION
- NA — NOT APPLICABLE

NOTE:
GROUNDWATER MEASUREMENTS TAKEN ON FEBRUARY 28, 2000

POTENTIOMETRIC CONTOUR INTERVAL = 2'-0"

100 50 0 100 200FT

SCALE: 1" = 100'

FIGURE 2.5

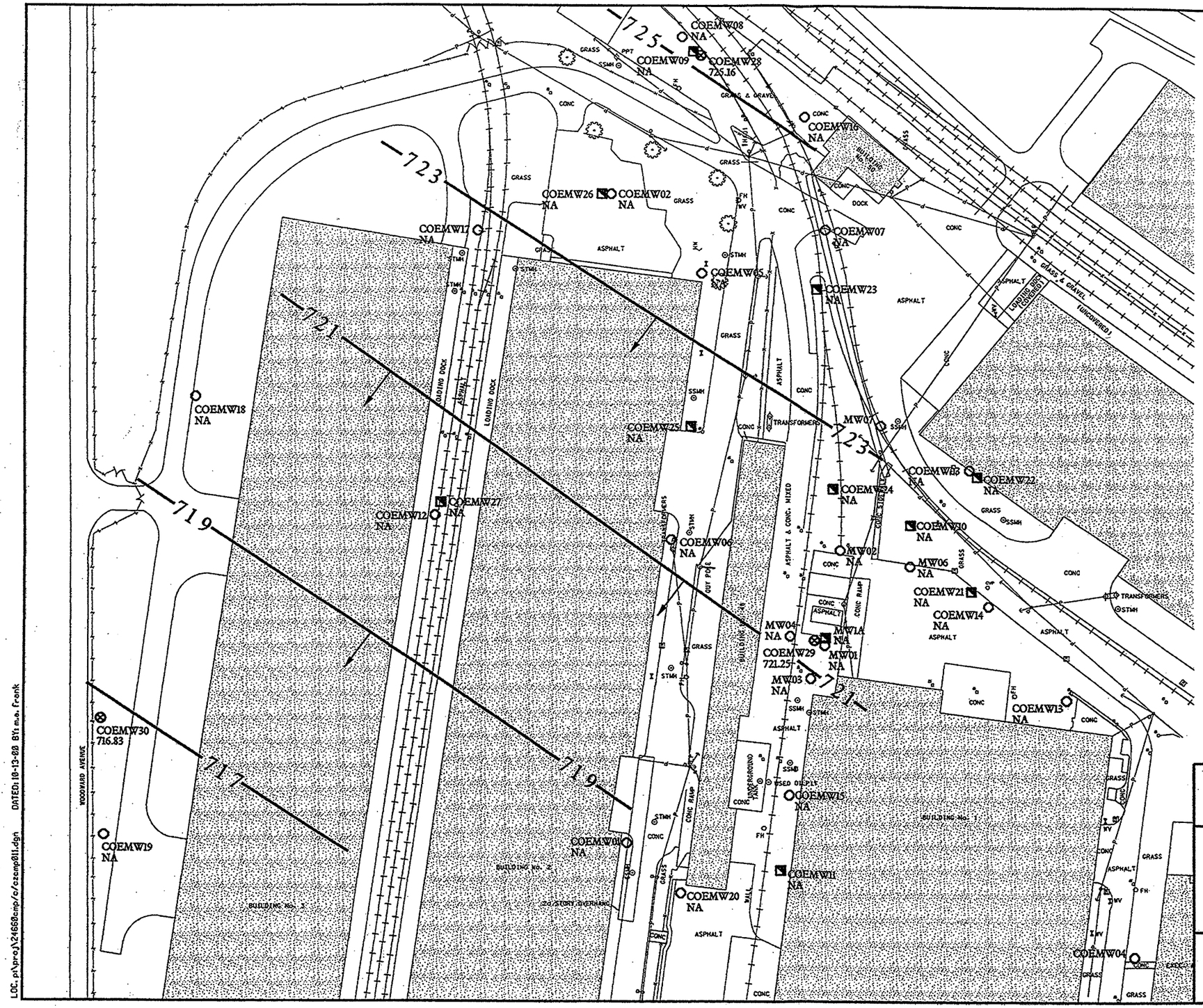
U.S. ARMY
ENGINEER DISTRICT, SAVANNAH
CORPS OF ENGINEERS
SAVANNAH, GEORGIA

POTENTIOMETRIC SURFACE MAP
TRANSITION ZONE
FORMER CHARLOTTE ARMY MISSILE PLANT

CHARLOTTE NORTH CAROLINA

Metcalf & Eddy

LOC: pt\proj\124680mp/c/czcmp010.dgn DATED: 10-13-00 BY: m.a. frank



LEGEND:

MW01 OR COEMW01	SZ MONITORING WELL
COEMW21	TZ MONITORING WELL
COEMW28	BZ MONITORING WELL
	CHAINLINK FENCE
*2	BUILDING
722.10	GROUNDWATER ELEVATION (FEET ABOVE MEAN SEA LEVEL)
720	LINE OF EQUAL GROUNDWATER ELEVATION IN FEET ABOVE MEAN SEA LEVEL
	GROUNDWATER FLOW DIRECTION
NA	NOT APPLICABLE

NOTE:
GROUNDWATER MEASUREMENTS TAKEN ON FEBRUARY 28-29, 2000

POTENTIOMETRIC CONTOUR INTERVAL = 2'-0"

100 50 0 100 200FT

SCALE: 1"= 100'

FIGURE 2.6

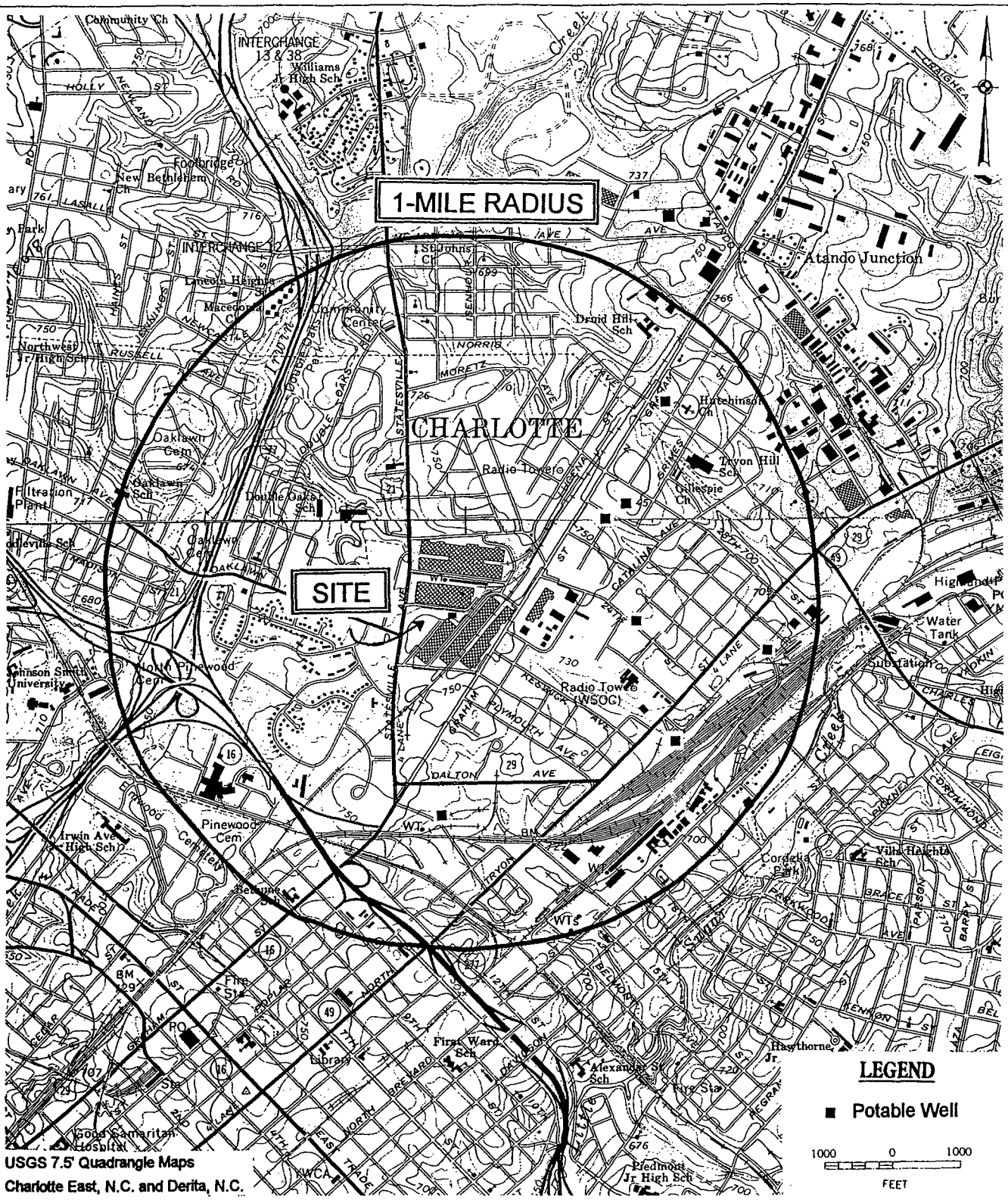
U.S. ARMY
ENGINEER DISTRICT, SAVANNAH
CORPS OF ENGINEERS
SAVANNAH, GEORGIA

POTENTIOMETRIC SURFACE MAP
BEDROCK ZONE
FORMER CHARLOTTE ARMY MISSILE PLANT

CHARLOTTE NORTH CAROLINA

Metcalf & Eddy

LOC: p:\proj\24668cmp/c/czcmp011.dgn DATED: 10-13-00 BY: m.s. frank



U.S. ARMY
ENGINEER DISTRICT, MOBILE
CORPS OF ENGINEERS
SAVANNAH, GEORGIA

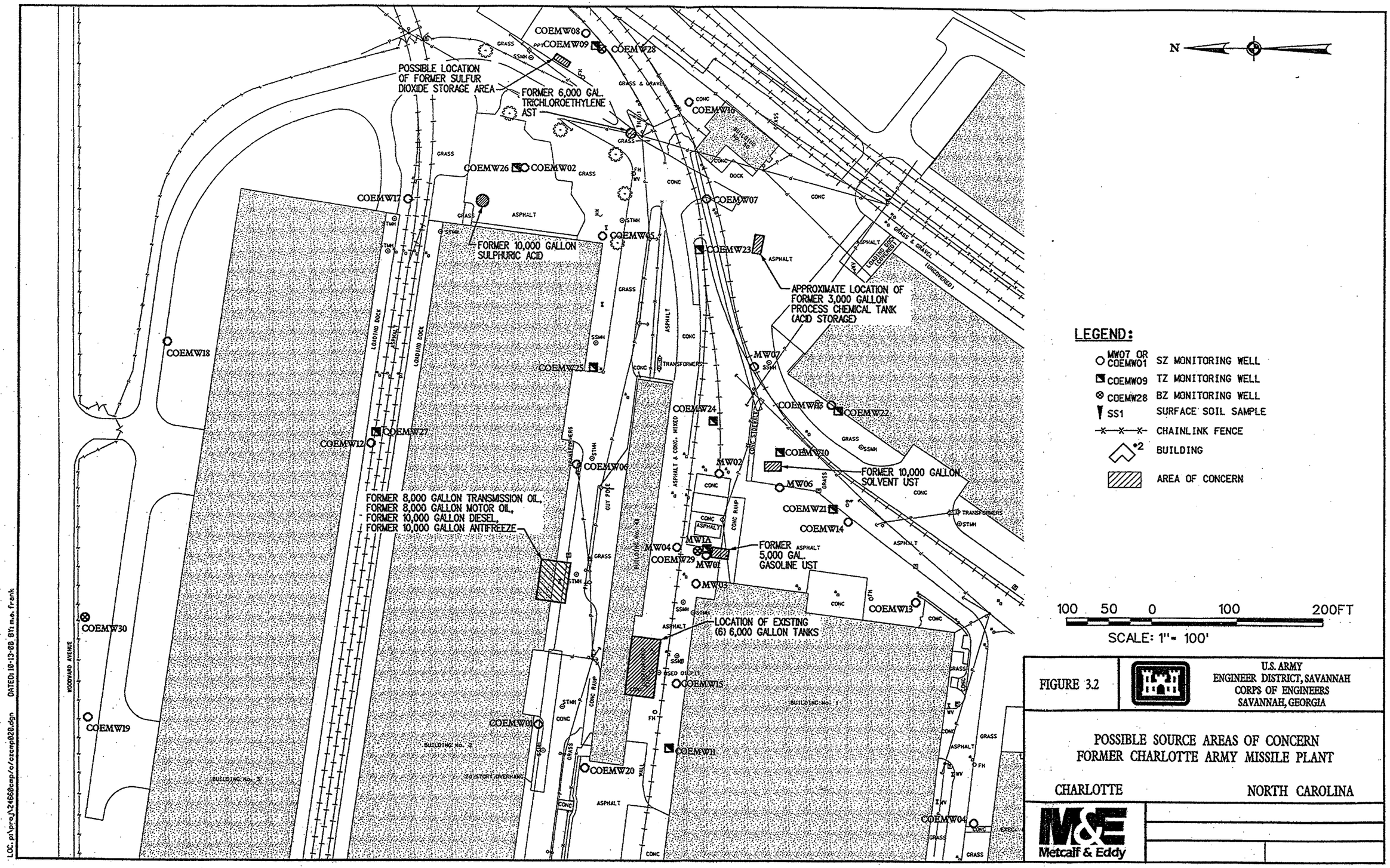
POTABLE WELLS WITHIN A 1-MILE RADIUS

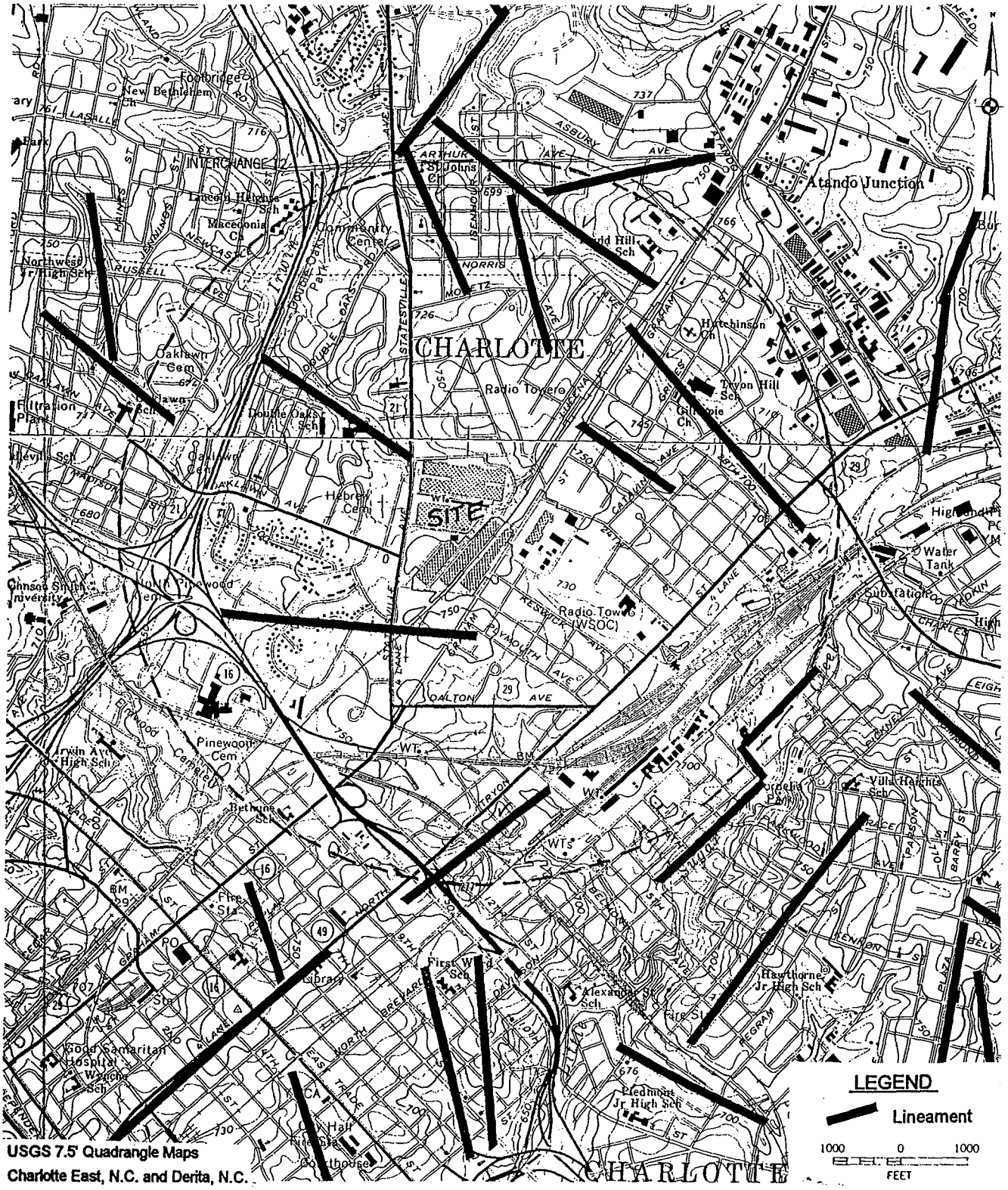
CHARLOTTE NORTH CAROLINA

FIGURE 2.7

Metcalf & Eddy

SCALE: 1:24,000	DATE:	APPROVED:	


N
POSSIBLE LOCATION OF FORMER SULFUR DIOXIDE STORAGE AREA
FORMER 6,000 GAL. TRICHLOROETHYLENE AST
FORMER 10,000 GALLON SULPHURIC ACID
APPROXIMATE LOCATION OF FORMER 3,000 GALLON PROCESS CHEMICAL TANK (ACID STORAGE)
FORMER 10,000 GALLON SOLVENT UST
FORMER 8,000 GALLON TRANSMISSION OIL,
FORMER 8,000 GALLON MOTOR OIL,
FORMER 10,000 GALLON DIESEL,
FORMER 10,000 GALLON ANTIFREEZE
FORMER 5,000 GAL. GASOLINE UST
LOCATION OF EXISTING (6) 6,000 GALLON TANKS
COEMW08
COEMW09
COEMW28
COEMW16
COEMW26
COEMW02
COEMW17
COEMW07
COEMW05
COEMW23
COEMW18
COEMW25
MW07
COEMW24
COEMW22
COEMW27
COEMW12
COEMW06
COEMW10
MW02
MW06
COEMW21
COEMW14
MW04
MW1A
COEMW29
MW01
MW03
COEMW13
COEMW30
COEMW15
COEMW19
COEMW01
COEMW11
COEMW20
COEMW04
WOODWARD AVENUE
LOADING DOCK
BUILDING NO. 1
BUILDING NO. 2
BUILDING NO. 3
BUILDING NO. 4
BUILDING NO. 5
BUILDING NO. 6
LOADING DOCK COVERED
GRASS & GRAVEL (UNCOVERED)
USED OIL PIT
CONC RAMP
TRANSFORMERS
ASPHALT
GRASS
CONC
LEGEND:
MW07 OR COEMW01 SZ MONITORING WELL
COEMW09 TZ MONITORING WELL
COEMW28 BZ MONITORING WELL
SS1 SURFACE SOIL SAMPLE
CHAINLINK FENCE
BUILDING
AREA OF CONCERN
100 50 0 100 200FT
SCALE: 1"= 100'
FIGURE 3.2
U.S. ARMY
ENGINEER DISTRICT, SAVANNAH
CORPS OF ENGINEERS
SAVANNAH, GEORGIA
POSSIBLE SOURCE AREAS OF CONCERN
FORMER CHARLOTTE ARMY MISSILE PLANT
CHARLOTTE
NORTH CAROLINA
M&E
Metcalf & Eddy
LOC: p:\proj\24660amp\c\czemp020.dgn DATED: 10-13-00 BY: m.a. frank



U.S. ARMY
ENGINEER DISTRICT, MOBILE
CORPS OF ENGINEERS
SAVANNAH, GEORGIA

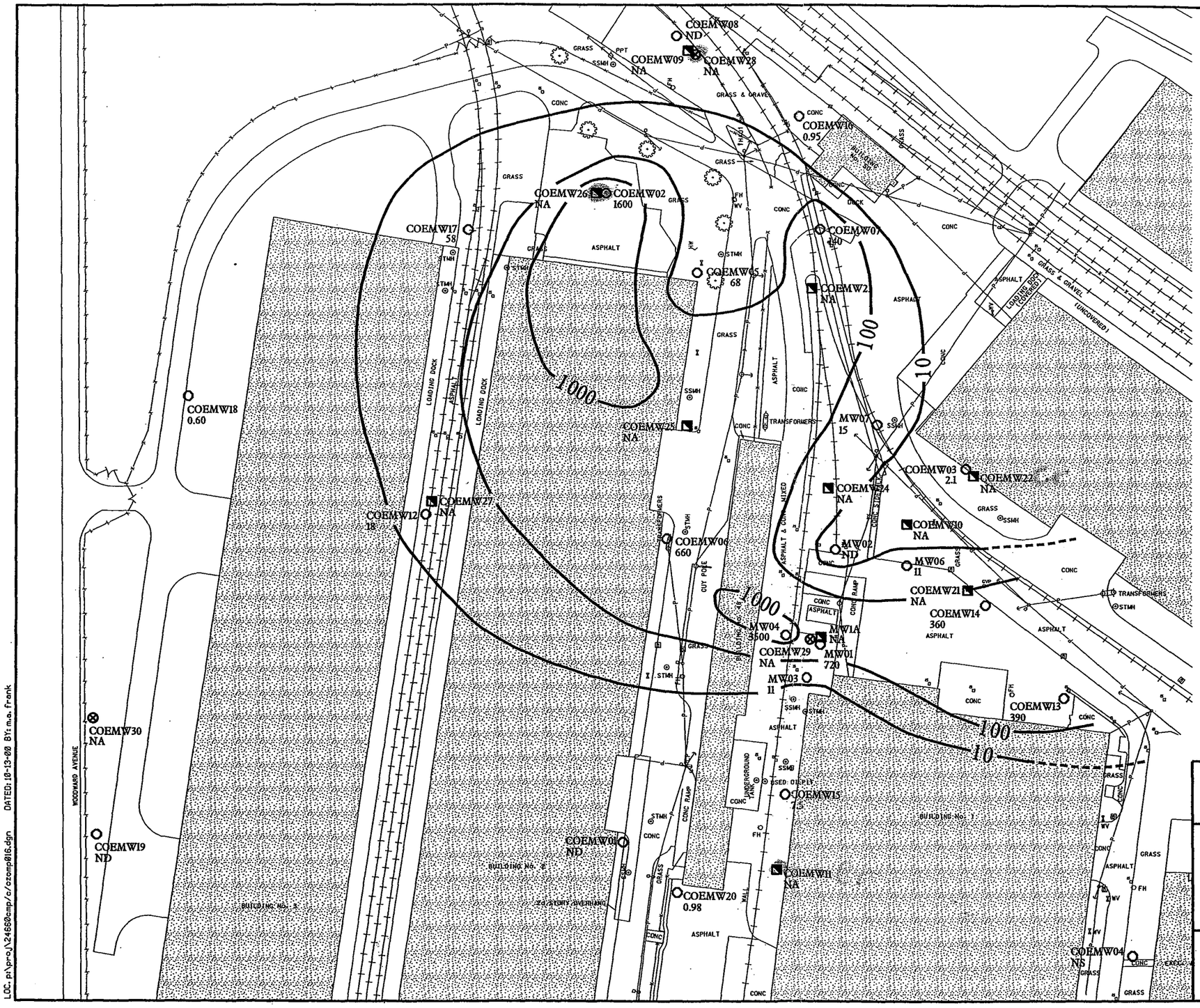
LINEAMENT TRACES WITHIN A 1-MILE RADIUS

CHARLOTTE NORTH CAROLINA

FIGURE 4.1

Metcalf & Eddy

SCALE: 1:24,000	DATE: 10·12·2000	APPROVED:



N

LEGEND:

MW01 OR COEMW01	SZ MONITORING WELL
COEMW21	TZ MONITORING WELL
COEMW28	BZ MONITORING WELL
	CHAINLINK FENCE
•2	BUILDING
NS	NOT SAMPLED- FREE PRODUCT IN WELL
ND	NOT DETECTED
NA	NOT APPLICABLE, NOT WITHIN SHALLOW ZONE
100	TCE ISOPLETH IN MICROGRAMS PER LITER (ug/L) (DASHED WHERE INFERRED)

GROUNDWATER SAMPLES COLLECTED FEBRUARY 29, 2000 TO MARCH 4, 2000

100 50 0 100 200FT

SCALE: 1"= 100'

FIGURE 5.1

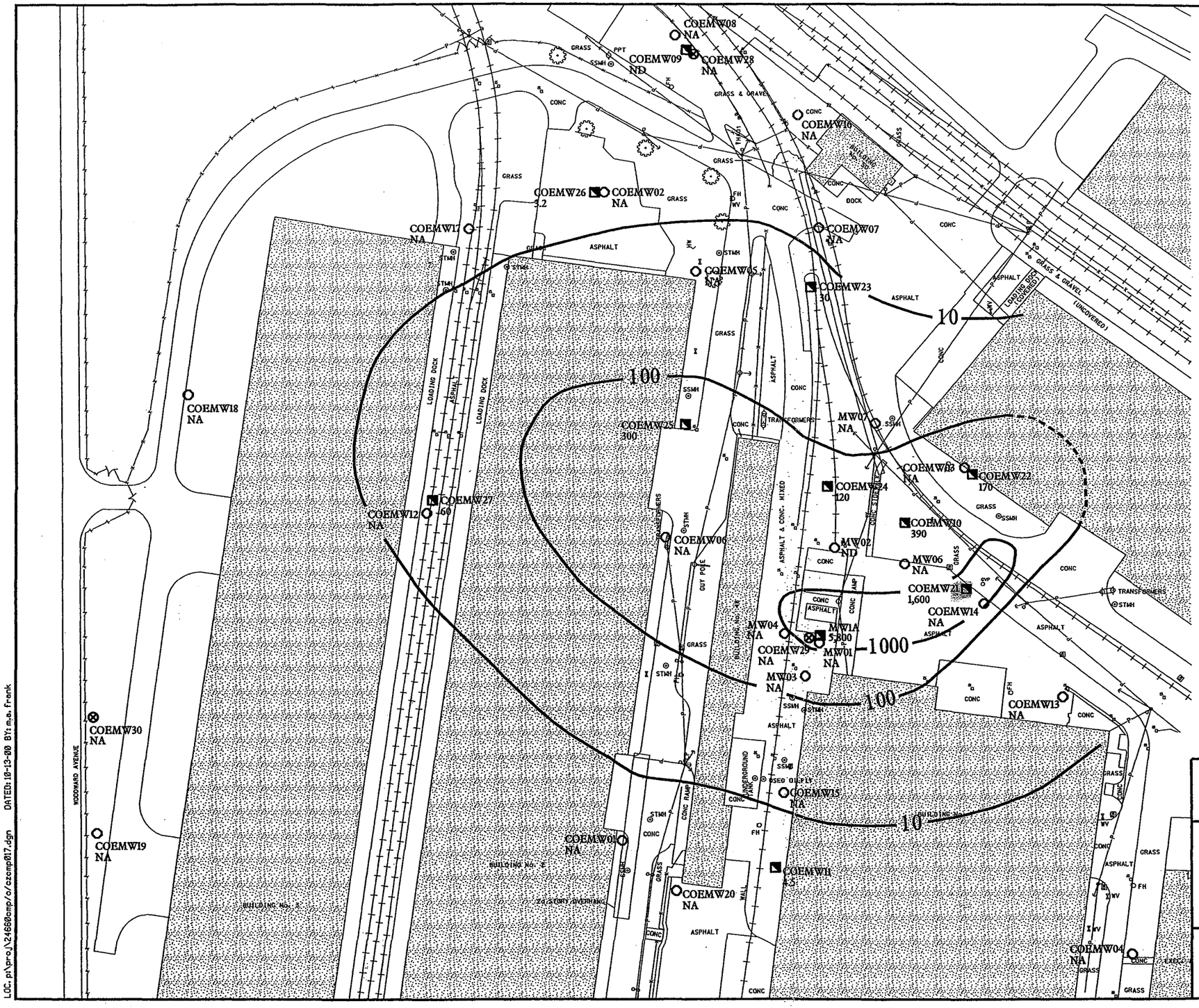
U.S. ARMY
ENGINEER DISTRICT, SAVANNAH
CORPS OF ENGINEERS
SAVANNAH, GEORGIA

TRICHLOROETHENE IN GROUNDWATER
SHALLOW ZONE
FORMER CHARLOTTE ARMY MISSILE PLANT

CHARLOTTE NORTH CAROLINA

Metcalf & Eddy

LOC: p:\proj\24650cmp/c/ozomp016.dgn DATED: 10-13-00 BY: m.a. frank



LEGEND:

- MW01 OR COEMW01 — SZ MONITORING WELL
- COEMW21 — TZ MONITORING WELL
- COEMW28 — BZ MONITORING WELL
- CHAINLINK FENCE
- •2 — BUILDING
- ND — NOT DETECTED
- NA — NOT APPLICABLE, NOT WITHIN TRANSITION ZONE
- 100 — TCE ISOPLETH IN MICROGRAMS PER LITER (ug/L) (DASHED WHERE INFERRED)

GROUNDWATER SAMPLES COLLECTED FEBRUARY 29, 2000 TO MARCH 4, 2000

100 50 0 100 200FT

SCALE: 1"= 100'

FIGURE 5.2

U.S. ARMY
ENGINEER DISTRICT, SAVANNAH
CORPS OF ENGINEERS
SAVANNAH, GEORGIA

TRICHLOROETHENE IN GROUNDWATER
TRANSITION ZONE
FORMER CHARLOTTE ARMY MISSILE PLANT

CHARLOTTE NORTH CAROLINA

M&E Metcalf & Eddy

LOC: p:\proj\24660emp/a/ezemp017.dgn DATED: 10-13-00 BY: m.a. Frank

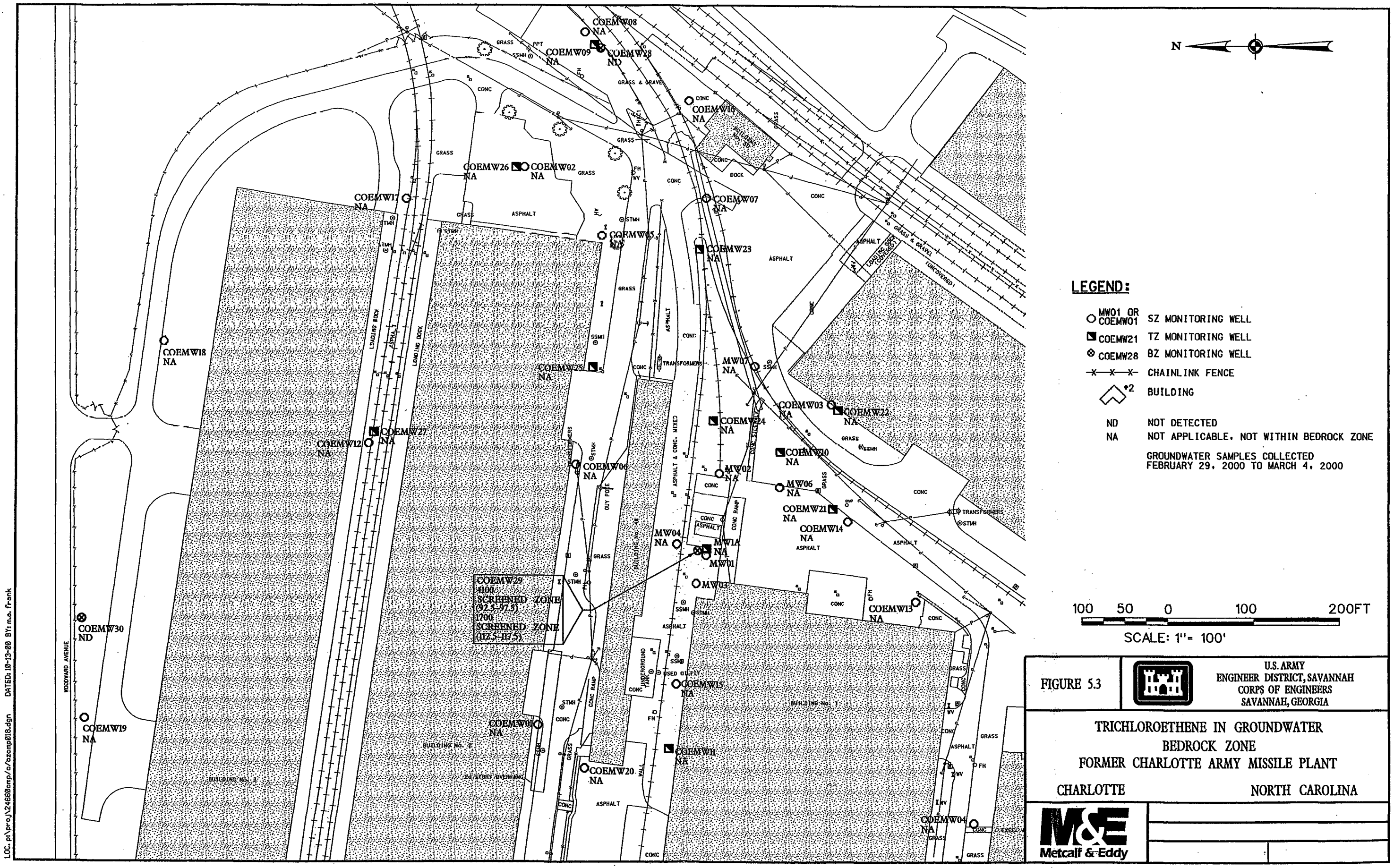


FIGURE 5.3

U.S. ARMY
ENGINEER DISTRICT, SAVANNAH
CORPS OF ENGINEERS
SAVANNAH, GEORGIA

TRICHLOROETHENE IN GROUNDWATER
BEDROCK ZONE
FORMER CHARLOTTE ARMY MISSILE PLANT

CHARLOTTE NORTH CAROLINA

M&E
Metcalf & Eddy

N

LEGEND:

- ● PROPOSED SZ MONITORING WELL
- ■ PROPOSED TZ MONITORING WELL
- ● PROPOSED BZ MONITORING WELL
- ○ MW01 OR COEMW01 EXISTING SZ MONITORING WELL
- ◪ COEMW21 EXISTING TZ MONITORING WELL
- ⊗ COEMW28 EXISTING BZ MONITORING WELL
- -x-x-x- CHAINLINK FENCE
- ◇2 BUILDING

100 50 0 100 200FT

SCALE: 1"= 100'

FIGURE 8.1

U.S. ARMY
ENGINEER DISTRICT, SAVANNAH
CORPS OF ENGINEERS
SAVANNAH, GEORGIA

PROPOSED WELL LOCATIONS
FORMER CHARLOTTE ARMY MISSILE PLANT

CHARLOTTE NORTH CAROLINA

Metcalf & Eddy

LOC. p:\proj\24660cmp/o/ozcmp019.dgn DATED: 10-13-00 BY: m.a. frank