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CORRECTIVE ACTION PLAN (CAP) DATED 29 AUGUST 2000 FOR ZONE C SITE 29 BUILDING NH-46 WITH SOUTH CAROLINA DEPARTMENT OF HEALTH AND ENVIRONMENTAL CONTROL REVIEW LETTER CNC CHARLESTON SC

10/06/2000

CH2M JONES LLC

D H E C
PROMOTE PROTECT PROSPER
2600 Bull Street
Columbia, SC 29201-1708

6 October 2000

Department of the Navy
Southern Division NFEC
P.O. Box 190010
North Charleston, SC 29419-9010
Attention: Mr. Gabriel Magwood

Re: Corrective Action Plan dated 29 August 2000
Zone C/Site 29-Building NH 46 (Site Identification # 17755)
Charleston Naval Complex/Charleston Naval Base
Charleston, SC
Charleston County

Dear Mr. Magwood:

The author has completed technical review of the referenced document. As submitted, the plan provides a short term monitoring program to establish natural intrinsic biodegradation/attenuation as the remedial process for groundwater contamination at the subject site. The proposed monitoring program appears reasonable for the known contaminants and the facility may proceed, as appropriate.

Should you have any questions please contact me at (803) 898-3559 or bristopl@columb32.dhec.state.sc.us.

Sincerely,

Paul L. Bristol, Hydrogeologist
Groundwater Quality Section
Bureau of Water

cc: Trident District EQC

CORRECTIVE ACTION PLAN
FOR
SITE 29, BUILDING NH 46, ZONE C

Site Identification # 17755

Charleston Naval Complex
Charleston, South Carolina

Submitted to:
Southern Division
Naval Facilities Engineering Command
2155 Eagle Drive
Charleston, South Carolina 29406

Submitted by:
CH2M-JONES, LLC.
115 Perimeter Center Place NE
Suite 700
Atlanta, Georgia 30346-1278

CH2MHILL

Contract Number: N62467-99-C-0960

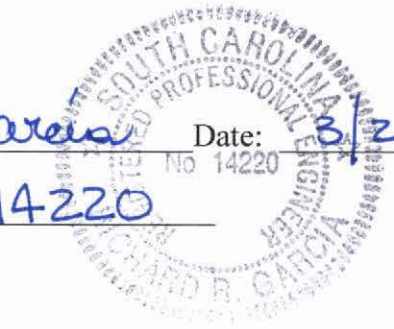
March 2001

CERTIFICATION

I certify that the information contained in this report is true, and complete to the best of my knowledge, information, and belief.

Approved By: R. Garcia Date: 3/28/01

South Carolina Registration No. 14220



ACRONYMS

AFVR	Aggressive Fluid - Vapor Recovery
bls	below land surface
BTEX	benzene, toluene, ethylbenzene and xylenes
BRAC	Defense Base Realignment and Closure Act
CAP	Corrective Action Plan
CNC	Charleston Naval Complex
CoC	Chemical of Concern
CSAP	Comprehensive Sampling and Analysis Plan
DOT	Department of Transportation
EISOPQAM	Environmental Investigations Standard Operating Procedures and Quality Assurance Manual
EPA	Environmental Protection Agency
ft bls	feet below land surface
µg/kg	microgram per kilogram
µg/L	microgram per liter
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
OVA	Organic Vapor Analyzer
PVC	polyvinyl chloride
QA	Quality Assurance
QC	Quality Control
RA	Rapid Assessment
RAR	Rapid Assessment Report
RBSL	Risk-Based Screening Level
SCDHEC	South Carolina Department of Health and Environmental Control
SOUTHDIV	Southern Division Naval Facilities Engineering Command
SSTL	Site-Specific Target Level
TTNUS	Tetra Tech NUS
UST	Underground Storage Tank

TABLE OF CONTENTS

1.0 INTRODUCTION

This Corrective Action Plan (CAP) has been prepared by CH2M-JONES, LLC. The plan is designed for Site 29, Building NH 46, Zone C; located at the Charleston Naval Complex (CNC), Charleston, South Carolina. Site 29 contains the location of a former petroleum Underground Storage Tank (UST) system used to supply fuel oil to the building. The South Carolina Department of Health and Environmental Control (SCDHEC) has designated this site as Identification Number: 17755.

This CAP provides a method for active remediation of the site by manually removing free product from the groundwater in the vicinity of the former UST basin using 2" bailers; conducting groundwater sampling to evaluate the active remediation of the site; and implementing intrinsic remediation and monitoring well abandonment as a corrective action in accordance with SCDHEC Corrective Action Guidance, June 1997. If manual removal of free product is not achievable within six months, additional remediation activities will be implemented, to include removal of source area soils and free petroleum product through excavation activities. The CAP was developed using the information provided in the Rapid Assessment Report (RAR) for Site 29 prepared by Tetra Tech NUS, Inc. (TTNUS), dated January 2000. The applicable tables and figures from the RAR have been incorporated into this CAP.

1.1 General Site Description

The CNC is located in the city of North Charleston, on the west bank of the Cooper River in Charleston County, South Carolina (Figure 1). This installation consists of two major areas: an undeveloped dredge materials area on the east bank of the Cooper River on Daniel Island in Berkley County, and a developed area on the west bank of the Cooper River. The developed portion of the base is on the peninsula bounded on the west by the Ashley River and on the east by the Cooper River. The site is located within the developed portion of the base (Figure 2).

The area surrounding CNC is "mature urban", having long been developed with commercial, industrial, and residential land use. Commercial areas are primarily west of CNC; industrial areas are primarily to the north of the base along Shipyard Creek. A site vicinity map, which exhibits adjacent properties and structures, vicinity roads, current utilities, and vicinity surface drainage, is included as Figure 2.

1.2 Site Background

The CNC began operations in 1901, when the Navy acquired the property. In 1993, the CNC was added to the list of bases scheduled for closure under the Defense Base Realignment and Closure Act (BRAC). BRAC regulates the closure of the base and transition of the property back to the community. With the scheduled closure of the base, environmental cleanup has proceeded to make the property available for redevelopment after closure.

Building NH 46 was part of the former Naval Hospital complex. One 1,500-gallon steel UST, UST NH46-5, was installed in 1941 and was used to supply fuel oil to the building's boilers and emergency generators. The UST was located on the western side of the building (Figure 3).

From August 1998 through September 1998, UST NH46-5 was removed, cleaned, and recycled as scrap metal. At the time UST NH46-5 was removed, no pitting or holes were found in the tank or fuel distribution piping. Rust was observed on the outer tank wall but had not penetrated the tank's sheet metal. Rust was also observed throughout the entire fuel distribution piping run. A loose piping joint was identified approximately midway between the fill pipe inlet and UST NH46-5. The fuel supply and return line for UST NH46-5 consisted of ½-inch-diameter copper tubing, which traveled below ground for a distance of approximately 26 feet into the southwest side of Building NH 46 (SPORTENDETCHASN, 1998).

During the removal of UST NH46-5 the tank was accidentally punctured at 6 feet below land surface (ft bls) releasing approximately 50 gallons of fuel oil onto the soil. The soil impacted by the spill was excavated and placed in 55-gallon steel drums for disposal. No groundwater was encountered during the removal of the UST NH 46-5 system (SPORTENDETCHASN, 1998).

During the removal of UST NH46-5, grab soil samples were obtained from the UST and piping excavations. Analytical results of the samples indicated reportable concentrations of benzene, toluene, ethylbenzene, and xylene (BTEX) and polynuclear aromatic hydrocarbon (PAH) compounds. However, the detection limits for the samples were elevated due to matrix interference (SPORTENDETCHASN, 1998).

From May 1999 through September 1999, TTNUS completed a Rapid Assessment (RA) for Site 29. The information from the Rapid Assessment Report (RAR), prepared by TTNUS, dated January 2000, is summarized in Section 2.0 of this report. The RAR was approved by SCDHEC on February 28, 2000.

2.0 RAPID ASSESSMENT SUMMARY

TTNUS completed a Rapid Assessment Report (RAR), dated January 2000, for Site 29, Building NH 46, Zone C. The assessment information was used to develop this CAP. The information from the RAR is summarized in this section.

2.1 Receptor Survey

TTNUS personnel conducted a receptor survey of the site vicinity to identify potential receptors for petroleum hydrocarbon contamination. Figure 2 depicts the public utilities located within 250 feet of the former UST study area. The receptor utilities located on or near the site include sanitary sewer, potable water, natural gas, storm sewer, and electrical. Specific information concerning the depth of utilities below land surface is currently unavailable, however, utilities at this site are generally between 2 and 6 ft bls.

A survey of groundwater users within a 7-mile radius of CNC was conducted by the South Carolina Water Resources Commission to ascertain the extent of any shallow groundwater usage. Results of the water use investigation revealed that no shallow potable water wells or irrigation wells were identified within 1,000 feet of the site. Numerous monitoring wells are located within 1,000 feet of the site. The nearest surface water body to UST NH 46-5 is Noisette Creek located approximately 1,500 feet to the north.

There are no city, county or state-zoning ordinances since the federal government currently owns the CNC property. Information concerning zoning ordinances was obtained from the SOUTHDIV Remedial Project Manager located at 2155 Eagle Drive, North Charleston, South Carolina 29406.

2.2 Assessment Information

From May 1999 through September 1999, TTNUS conducted field activities for the RA, which included the installation and sampling of thirteen (13) soil borings, six (6) shallow monitoring wells, one (1) deep monitoring well, and three (3) temporary piezometers. Sample locations are shown on Figure 3. The soil and groundwater field and laboratory sampling data from the RA is summarized in Tables 1 through 8.

As reported in the RAR, the site geology consists of sandy silt from ground surface to approximately 3 to 13 ft bls, underlain by silty sand and sand deposits to approximately 20 to 28 ft bls. Clays with interbedded sands and silty sands were encountered from 20 ft bls to 38 ft bls. Two geologic cross sections of the site are depicted in Figures 4 and 5. Groundwater levels ranged from 8 to 11.5 ft bls (Table 1). Based upon groundwater level measurements collected on September 10, 1999, surficial groundwater flow is to the east-northeast; a groundwater potentiometric map for this date is presented in Figure 6.

During the RA, soil contaminant concentrations exceeded Risk-Based Screening Levels (RBSLs) established by SCDHEC (Risk-Based Corrective Action For Petroleum Release,

January 5, 1998). Table 7 summarizes the CoCs detected in the soil samples. The RBSLs in sandy soil for benzene and naphthalene of 5 µg/kg and 210 µg/kg, respectively, were exceeded in boring CNC29-B05. Benzene was found in CNC29-B05 at 9 µg/kg, and naphthalene was found at 50,300 µg/kg (Table 7). The duplicate sample contained ethylbenzene at 3,500 µg/kg, which exceeded the ethylbenzene RBSL of 1,260 µg/kg. The duplicate sample also contained benzene and naphthalene above their RBSLs at 46 µg/kg and 22,400 µg/kg, respectively. The RBSL for sandy soil was used based on the boring log descriptions and a grain size analysis completed on sample 29SLB060809 collected from boring CNC29-B06. Total organic carbon was also detected at 6,780 mg/kg in soil sample 29SLB060809. The estimated areal distributions of benzene, toluene, ethylbenzene, total xylenes, and naphthalenes from the June 1999 soil sampling event are presented in Figures 8 through 12.

During two groundwater measurement events on July 26 - 27, 1999 and August 7, 1999, free product was detected in one well location (CNC29-MW01) with measurements ranging from 0.81 to 1.12 feet thickness (Table 1). The estimated areal extent of free product is depicted on Figure 7. For concentrations of CoCs in the well containing free product, the maximum solubility in equilibrium with fuel oil was calculated using Raoult's Law. Calculated concentrations for benzene, toluene and naphthalene in equilibrium with free product exceeded their respective RBSLs (Appendix G, TTNUS, January 2000). Based upon groundwater sampling conducted during the RA, groundwater CoCs were not identified in any of the other wells.

2.3 Fate and Transport Modeling

The aquifer characterization calculated by TTNUS and the fate and transport parameters determined by TTNUS during the RA are summarized in Table 9. As illustrated in Figures 13 and 14, the Domenico model was used to predict the distance at which the tip of the contaminant plume is attenuated to SCDHEC RBSLs in 10 and 20 years, respectively.

2.4 Comparison of Analytical Results with RBSLs

Soil CoCs were identified by comparing soil analytical results with RBSLs. Concentrations of benzene, ethylbenzene, and naphthalene each exceeded their respective RBSLs in sample CNC29-B05. In addition, the detection limit for benzene in sample CNC29-B06 (<600 µg/kg) was above the RBSL for benzene. Benzene was therefore identified as a CoC for CNC29-B06.

Groundwater CoCs were identified by comparing groundwater analytical results with RBSLs. Free product was identified in CNC29-MW01. The maximum concentrations of CoCs in CNC29-MW01 were calculated using Raoult's Law and an assumed free product composition similar to kerosene, which generally contains approximately 44% naphthalene (TTNUS, January 2000, Appendix F). Based on these calculations, CoCs that exceeded RBSLs in CNC29-MW01 included benzene, toluene, and naphthalene. Table 10 provides a comparison of RBSLs and maximum observed concentrations in soil and groundwater.

2.5 Exposure Pathway Analysis

In the RA, TTNUS evaluated the receptor characterizations of the potentially exposed populations in the vicinity of the site and identified the potentially complete exposure pathways for those receptors. Exposure pathway analysis for current land use and future land is summarized in Tables 11 and 12.

2.6 Site-Specific Target Levels (SSTLs)

SSTLs were calculated for soils for the identified CoCs. In the RA, TTNUS considered only one scenario for the calculations of SSTLs: on-site construction worker exposure to subsurface soil and groundwater. No other exposure routes or pathways were considered likely threats (Tables 11 and 12). The minimum SSTLs for this scenario were selected at this site for each CoC. The SSTLs calculated for soil are as follows: benzene, 1.2635 mg/kg; ethylbenzene, 108 mg/kg; and, naphthalene, 245 mg/kg. The observed concentrations of benzene, ethylbenzene, and naphthalene at the site of 0.6 mg/kg, 3.5 mg/kg, and 50.3 mg/kg, respectively, were below their respective SSTLs.

The maximum observed contaminant concentrations of benzene, ethylbenzene, and naphthalene in soil did not exceed the minimum calculated SSTLs protective of a construction worker in a utility trench. The concentrations of benzene, ethylbenzene, and naphthalene in the groundwater resulting from leaching from the soil to the groundwater will not exceed the RBSLs for a construction worker in a utility trench (0.15 mg/L, 6.05 mg/L, or 1.63 mg/L, respectively). Therefore, the petroleum contamination detected at Site 29 is not considered a threat to construction workers in nearby utilities.

3.0 PROPOSED CORRECTIVE ACTION

This CAP provides a method for active remediation of the site. Active remediation will be accomplished by weekly manual removal of free product from CNC29-MW01. Weekly free product abatement will continue until smaller amounts of free product are recorded at which time the weekly schedule may be changed to bi-weekly in order to optimize the manual recovery efforts. If supported by monitoring data, intrinsic remediation and monitoring well abandonment will be implemented as a corrective action in accordance with SCDHEC Corrective Action Guidance, (June 1997), until contaminant concentrations decrease below RBSLs or action levels approved by SCHDEC. If manual abatement is not achievable within **six months**, source area soils will be excavated and free product will be pumped from the water table within the source area excavation. Following the excavation, groundwater sampling and residual free product measurements will be conducted to evaluate the active remediation of the site. The proposed active remediation plan is described in Section 4.0, and the proposed intrinsic remediation plan is described in Section 5.0.

3.1 Soil Remediation

Soil contamination was identified in the vicinity of the former UST NH46-5 basin. Ethylbenzene, benzene, and naphthalene were found above their RBSLs in CNC29-B05 at the 8 to 9 ft bls interval. CNC29-B05 was located at the northern end of the former tank location, and CNC29-MW01 (containing free product) is downgradient from CNC29-B05. The area around CNC29-B05 is the probable source area of the free product observed in CNC29-MW01. If the manual abatement of free product is not effective, a series of hand auger borings will be advanced to further delineate the soil contamination around CNC29-B05. Proposed boring locations are identified in Figure 15. Soil samples will be collected from each boring at the 5-7 and 7-9 foot intervals, based on the identified zone of contamination in CNC29-05 of 8 to 9 ft bls. Samples will be analyzed for BTEX and naphthalene. After the source area has been delineated, the area will be excavated to the appropriate depth (assumed to be at least ten feet, or one foot below the observed concentrations of CoCs). The excavation will extend horizontally to borings for which CoC concentrations have been determined to be less than RBSLs.

3.2 Groundwater Remediation

Free product was identified in the vicinity of the former UST NH46-5 basin. Groundwater measurements collected by (CH2M-JONES, LLC) in CNC29-MW01, CNC29-MW03, CNC29-MW04, and CNC29-MW07 on February 21, 2001, confirmed the presence of 0.8 feet of free product in CNC29-MW01. The other measured wells did not contain free product. Therefore, the active groundwater remediation of the site will include the removal of free product identified in the vicinity of CNC29-MW01 and groundwater sampling to evaluate the active remediation of the site.

The following document was used as a source for remedial design: *How to Effectively Recover Free Product at Leaking Underground Storage Tank Sites* [United States Environmental Protection Agency (EPA), 1996]. Five approaches were considered for free product recovery:

manual removal of free product via periodic bailing; excavation to the water table, with pumping of free product from the water table; passive removal/skimmer system; bioremediation (injection); and dual-phase vapor and groundwater recovery.

The volume of free product at this site is estimated at 200 cubic feet or 1,487 gallons using the following data obtained from the RAR: area of free product is approximately 520.5 square feet (Figure 7; calculated using the area of an ellipse), average thickness of free product over the affected area is 0.97 feet (Table 1), and porosity (n) = 0.47 (Table 9). Due to the limited area of free product estimated for this site, the remedial strategy designed for Site 29 includes manual removal of free product through weekly bailing. Weekly bailing will continue until reduced volumes indicate that a bi-weekly schedule is more effective for the manual recovery efforts. If manual abatement is not achievable within six months of being implemented, the remedial strategy will include abandonment of CNC29-MW01; excavation of the area around CNC29-MW01 to the water table; and, pumping of free product from the water table as it enters the excavation. A vacuum truck will remove free product that flows into the excavation. Free product removal will continue until only a sheen is apparent on the water surface, or until such time as it is determined that a sufficient volume of free product is still present to warrant additional remedial approaches. CNC29-MW01 will be readvanced as a 4-inch-diameter monitoring well following the completion of excavation activities to facilitate the use of this well for additional free product collection, if warranted.

If the remedial action proceeds to the excavation phase, observations gathered during the excavation phase, combined with subsequent data from the readvanced CNC29-MW01, will be used to make further decisions regarding remedial alternatives for the site. If free product persists, one or more of the following active approaches will be considered:

- A passive removal/skimmer system may be implemented at the site to remove free product. A passive, floating skimmer with a product recovery filter canister is designed to remove free product down to a sheen or thickness of 0.01 feet thickness. Typically, the skimmer is lowered into the well until the midpoint of the skimmer is located at the fluid level in the well. Floating hydrocarbons (free product) enters the skimmer through the floating intake outer debris screen and then through an inner oileophilic hydrophobic screen, and down into a clear canister for storage. To empty the skimmer, the device is brought to the surface, and the canister is drained using the discharge valve at the skimmer base. A dedicated, free product bailer will be utilized to remove free product from the top of the wells in the target area if free product thickness is near or less than 0.01 feet.

- An 8-hour Aggressive Fluid – Vapor Recovery (AFVR) event or multiple events may be conducted to remove free product from the source area. The AFVR will consist of a vacuum truck utilized to extract fluid and vapor from the target well point (CNC29-MW01). The AFVR assembly will connect the vacuum hose to the top of the wellhead with the design such that liquid and vapor will be extracted from the top of the water column in the target well point. .

- Enhanced bioremediation may be used to target specific locations to enhance the natural degradation of contaminants at the site. Bioremediation consists of the injection of naturally occurring microbes with an affinity towards digesting specific contaminants and the injection of nutrients to support the microbes. Typically, the bioremediation mixture of microbes and nutrients is injected through well points that are installed into the contaminated zone using direct push technology.

4.0 PROPOSED ACTIVE REMEDIATION

Active remediation of the site will include manual removal of free product from the water table through weekly bailing of free product from monitoring well CNC29-MW01. Note that weekly bailing will continue until reduced volumes indicate that a bi-weekly schedule is more effective for the manual recovery efforts. If manual abatement is not achievable, additional active remediation activities will be performed, including removing source area soils, removing free product, and conducting groundwater sampling to evaluate the active remediation of the site. Excavation of the source area soils will be conducted. Free product will be pumped from the excavation around CNC29-MW01. Based on the information obtained during the excavation and the results of the subsequent groundwater monitoring, the following actions may be considered if free product continues to persist at the site and/or groundwater contaminant concentrations do not decrease: installation of a passive removal/skimmer system; performance of an 8-hour Aggressive Fluid – Vapor Recovery (AFVR) event or multiple events; and/or the use of bioremediation to target specific locations and enhance the natural degradation of site contaminants.

4.1 Source Area Soil Removal

If manual free product abatement is not achievable, soil excavation activities will be conducted based on supplemental source area delineation. If the samples from the supplemental borings are less than RBSLs, the excavation will extend to those borings. A backhoe will be used to excavate source area soils. Soil will be loaded into trucks for appropriate disposal. Any free product that enters the excavation will be removed with a vacuum truck, and will be appropriately disposed (sent to a fuel recycler, etc.). Field personnel will not enter the excavation. Confirmation samples will be collected from the bucket of the excavating equipment to verify that the source area has been effectively removed. Proposed confirmation samples are to be analyzed and collected for quick-turn or mobile-lab analyses so that remedial activities can progress on a timely schedule. Based on the areal extent of benzene, ethylbenzene, and naphthalene identified in the RAR, in addition to an estimated excavation depth of 10 feet, the anticipated volume of soil to be excavated is estimated at 6,900 cubic feet (Figure 16). (If an expansion factor of 25% is used, the volume of soil sent off site will be approximately 8,600 cubic feet). This volume estimate may be refined based on the results of the supplemental soil boring analyses. The excavation will be backfilled, compacted, and the area repaved (returned to its original condition). The excavation will be backfilled to one foot above the water table with coarse Number 2 stone. Bank-run sand and gravel will be used to fill the remainder of the excavation.

Prior to excavating, the utilities will be cleared by local utility markers. Hand digging will be performed prior to backhoe excavation to determine the exact locations of utility pipes. Sewer and storm drain pipe runs are expected to be encountered at approximately 5 to 6 ft bls in the area around CNC29-B05.

4.2 Free Product Recovery

Free product will be removed by bailing free product from monitoring well CNC29-MW01 beginning with a weekly recovery schedule. If manual abatement is not achievable, remaining free product will be removed by excavating the area around CNC29-MW01 to the water table and pumping the free product from the excavation into a vacuum truck. After the free product has been reduced to sheen thickness, or after it has been determined that additional remedial techniques may be required, the excavation will be backfilled, compacted, and the area repaved. CNC29-MW01 will be readvanced, to continue monitoring for free product. The proposed well diameter is four inches, to allow for future installation of pumps, skimmers, or other remedial equipment.

If free product persists at the site after the excavation, additional recovery methods will be evaluated. The type of remedial action required will depend upon the observed residual product thickness. Options to be evaluated may include a passive removal/skimmer system, aggressive fluid vapor recovery, or enhanced bioremediation.

If a skimmer is selected for additional removal of free product, a passive, floating skimmer with a product recovery filter canister will be used. A Product Recovery Canister (Model PRC-94) or an equivalent device for a 2-inch diameter well and/or a 4-inch diameter well with a capacity of 0.25 liter or greater should be adequate for the conditions at the site assuming that product levels are greater than 0.01 feet in recovery wells. A minimum thickness of 0.01 feet is required for the Model PRC-94 and most passive skimmer devices. A dedicated, free product bailer will be utilized to remove free product from the top of the wells if free product thickness is near or less than 0.01 feet.

Monitoring well CNC29-01 may be used as the target well point if AFVR is warranted for this site. Any free product and contaminated groundwater from the AFVR event will be containerized in a tanker vehicle and disposed at an appropriate facility based upon fluid contents.

The former UST basin and the associated contaminant plume will be the target area if bioremediation is warranted at the site. An SCDHEC-approved bioremediation product will be utilized at the site. The bioremediation product will be delivered into the contaminated zone through injection points typically installed using direct push technology in a grid pattern over the target area.

SCDHEC will be contacted prior to the implementation of the different remedial approaches at the site, if AFVR and bioremediation is warranted at the site.

4.3 Monitoring Well Installation

If manual abatement is not achievable within the specified duration of six months and excavation activities proceed, one monitoring well (CNC29-MW01 readvanced) will be installed at the site. The location of the proposed well is shown on Figure 7. The well will

consist of 4-inch diameter polyvinyl chloride (PVC) well casing installed to a depth of 15.5 ft bls with a 0.01-inch slotted screened interval from 5 to 15 ft bls.

If any wells are unusable or new wells are warranted for any other reason, the wells will be installed to the same specification as existing monitoring wells unless site conditions change and warrant otherwise. The wells will be installed in accordance with South Carolina Well Standards and Regulations R.61-71. A utility locate will be completed prior to any well installation activities. Any necessary permits will be acquired prior to well installation activities.

4.4 Surveying

Surveying of any new well locations will be conducted as a part of this CAP.

4.5 Soil Boring Schedule

If manual abatement is not achievable within the specified duration of six months and excavation activities proceed, hand auger borings will be advanced to further delineate source area soils around CNC29-B05. Proposed hand auger boring locations are identified on Figure 15. Hand auger borings will be completed subsequent to approval of the plan by SCDHEC.

4.6 Sampling and Analysis Plan

Free product removal will be conducted by initiating weekly bailing of free product from CNC29-MW01. If no free product is observed in CNC29-MW01 for a period of four weeks, groundwater samples will be collected from CNC29-MW01. Groundwater sampling will then be conducted quarterly, assuming that free product does not reappear.

If manual abatement is not achievable within the specified duration of six months and excavation activities proceed, then CNC29-MW01 will be tested for the presence of free product using an interface probe one week after excavation activities have been completed and CNC29-MW01 has been re-advanced. If free product is not present, groundwater samples will be collected and submitted to a laboratory for BTEX and naphthalene analyses. Following the initial sampling event, groundwater samples will be collected from CNC29-MW01 every month for three months. Quarterly monitoring will begin after three months. For example, if the excavation has been completed and CNC29-MW01 reinstalled by April 16, 2001, the first set of samples would be collected from CNC29-MW-01 on April 23, 2001. Subsequent sampling events would be conducted on May 23, 2001, June 23, 2001, and July 23, 2001. Based on the sample data gathered, the need for additional active removal approaches may be determined. If free product has not returned to the well, quarterly sampling and intrinsic remediation (if necessary) would begin at this time.

Once free product has been removed from the site, groundwater samples will be collected from all monitoring wells. The groundwater samples will be submitted to a certified laboratory for

analysis of benzene, toluene, ethylbenzene and xylenes (BTEX) and naphthalene by EPA Method 8260.

Groundwater level measurements will be collected from all monitoring wells prior to all groundwater sampling events. Measurements will be taken with an electrical water level indicator or interface probe if floating product is present. No groundwater samples will be collected if free product is measurable.

From three to six well volumes will be purged from each well prior to groundwater sampling. Field measurements of pH, groundwater temperature, specific conductance, dissolved oxygen, and turbidity will be taken during groundwater sampling events.

All sampling procedures will be conducted in accordance with EPA Environmental Investigations Standard Operating Procedures and Quality Assurance Manual (EISOPQAM), 1996. Any contaminated groundwater collected during the well sampling events will be containerized in DOT-approved (Specification 7H) 55-gallon drums and disposed of at a later date pending fluid contents analysis.

4.7 Reporting

Semi-annual monitoring reports will be submitted to SCDHEC. The reports will summarize and include copies of field and laboratory analytical data. Upon completion of active remediation, a Performance Evaluation Report will also be submitted to SCDHEC to summarizes the remediation activities, evaluate the soil and water quality data, and provide recommendations for the site.

4.8 Equipment Decontamination

All drilling and excavating equipment, augers, well casing and screens, and soil and groundwater sampling equipment involved in field sampling activities will be decontaminated according to the EPA EISOPQAM.

4.9 Sample Handling

Sample handling will be conducted in accordance to the following references: EPA EISOPQAM, Code of Federal Regulations 136, 1990, and EPA Users Guide to Contract Laboratory Program, 1988. The following forms will be completed for packing/shipping process: sample labels, chain-of-custody labels, appropriate labels applied to shipping coolers, and chain-of-custody forms.

4.10 Quality Control (QC)

In addition to periodic calibration of field equipment and the completions of the appropriate documentation, quality control (QC) samples will be collected during sampling events. QC

samples may include field blanks, field duplicates, and trip blanks. Definitions of each can be found below as described by the EPA EISOPQAM:

- **Field Blank:** A sample collected using organic-free water, which has been run over/through sample collection equipment. These samples are used to determine if contaminants have been introduced by contact of the sample medium with sampling equipment. Equipment field blanks are often associated with collecting rinse blanks of equipment that has been field cleaned.

- **Field Duplicates:** Two or more samples collected from a common source. The purpose of a duplicate sample is to estimate the variability of a given characteristic or contamination associated with a population.

- **Trip Blank:** A sample, which is prepared prior to the sampling event in the actual container and is stored with the investigative samples throughout the sampling event. They are often packaged for shipment with the other samples and submitted for analysis. At no time after their preparation are trip blanks to be opened before they reach the laboratory. Trip blanks are used to determine if samples were contaminated during storage and/or transportation back to the laboratory (a measure of sample handling variability resulting in positive bias in contaminant concentration). If samples are to be shipped, trip blanks are to be provided with each shipment but not for each cooler.

4.11 Field Quality Assurance / Quality Control (QA/QC)

All sampling procedures will be conducted in accordance with EPA EISOPQAM. More information on field QC can be found in Sections 4.8 through 4.10.

QA/QC specifications for selected field measurements are summarized below.

Analysis	Control Parameter	Control Limit	Corrective Action
Air Monitoring	Check Calibration of OVA daily	Calibrate to manufactures specifications	Recalibrate. If unable to calibrate, replace.
pH of water	Continuing calibration check of pH 7.0 buffer	pH = 7.0	Recalibrate. If unable to calibrate, replace electrode.
Specific Conductance of water	Continuing calibration check of standard solution	> 1% of standard	Recalibrate.

4.12 Record keeping

In addition to required sampling documentation (see Section 4.9), standardized forms, log sheets and logbooks will be completed during all field activities.

5.0 PROPOSED INTRINSIC REMEDIATION

Upon completion of active remediation, if warranted, intrinsic remediation will be implemented until contaminant concentrations decrease below RBSLs or other action levels approved by SCHDEC. This CAP provides a method for implementing intrinsic remediation and monitoring well abandonment as a corrective action in accordance with SCDHEC Corrective Action Guidance, June 1997. The intrinsic remediation method may be modified based upon the results of active remediation.

5.1 Monitoring Well Installation

If manual abatement is not achievable within the specified duration of six months and excavation activities proceed, CNC29-MW01 will be readvanced after source area excavation activities have been completed. No additional new wells are proposed. Assuming the wells from the active remediation method are in good condition, no monitoring wells will be installed for the intrinsic remediation. If any wells are unusable or new wells are warranted for any other reason, the wells will be installed to the same specification as existing monitoring wells unless site conditions change and warrant otherwise.

5.2 Surveying

After CNC29-MW01 has been readvanced, the well will be resurveyed. Additional monitoring wells are not scheduled to be installed as a part of the intrinsic CAP. Surveying of any new well locations will be conducted if warranted.

5.3 Soil Boring Schedule

No other soils borings are scheduled for the CAP unless site conditions change and warrant otherwise.

5.4 Monitoring Well Abandonment

All monitoring wells will be abandoned upon receiving approval by SCDHEC. The wells will be abandoned following the South Carolina Well Standards and Regulations R.61-71. The well abandonment will include grouting wells, removing stick-ups and removing all guard posts. Any well casing and screen removed will be decontaminated and disposed of as general refuse.

5.5 Sampling and Analysis Plan

Groundwater samples will be collected semi-annually for a period of 18 months from monitoring well CNC29-MW01. The groundwater samples will be submitted to a certified laboratory for analysis of BTEX and naphthalene by EPA Method 8260. The following parameters will also be considered for analysis in order to evaluate the effectiveness of intrinsic remediation: nitrate (NO^{-3}), sulfate (SO^{-4}), total dissolved iron, methane (CH_4), and alkalinity.

Groundwater level measurements will be collected from all monitoring wells prior to all groundwater sampling events. Measurements will be taken with an electrical water level indicator or interface probe if floating product is present. No groundwater samples will be collected if free product is measurable.

From three to six well volumes will be purged from each well prior to groundwater sampling. Field measurements of pH, groundwater temperature, specific conductance, dissolved oxygen, and turbidity will be taken during groundwater sampling events.

All sampling procedures will be conducted in accordance with EPA EISOPQAM. Any contaminated groundwater collected during the well sampling events will be containerized in DOT-approved (Specification 7H) 55-gallon drums and disposed of at a later date pending fluid contents analysis.

5.6 Reporting

Semi-annual monitoring reports will be submitted to SCDHEC. The reports will summarize and include copies of field and laboratory analytical data. Upon completion of 18 months of sampling, a Performance Evaluation Report will also be submitted to SCDHEC to summarize the sampling activities, evaluate the soil and water quality data, and provide recommendations for the site.

6.0 SITE MANAGEMENT AND BASE SUPPORT

Throughout the investigation activities, work on the CNC will be coordinated through SOUTHDIV and SCDHEC.

The primary contacts for each are as follows:

1. SOUTHDIV point of contact
   Gabe Magwood
   Southern Division Engineering Command
   2155 Eagle Drive
   North Charleston, SC 29406
   (843) 820-7307

2. SOUTHDIV point of contact
   Tony Hunt
   Southern Division Engineering Command
   2155 Eagle Drive
   North Charleston, SC 29406
   (843) 820-5525

3. SCDHEC point of contact
   Michael Bishop
   South Carolina Department of Health and Environmental Control
   2600 Bull Street
   Columbia, SC 29201
   (843) 898-3559

7.0 REFERENCES

Comprehensive Sampling and Analysis Plan (Ensafe/ Allen & Hoshall. July 1996).

South Carolina Department of Health and Environmental Control. 1997. Corrective Action Guidance.

SPORTENDETCHASN, (Supervisor of Ship Building, Conversion and Repair, United States Navy, Portsmouth Virginia, Environmental Detachment Charleston), 1998. Underground Storage Tank (UST) Assessment Report, Charleston Naval Base Complex, North Charleston, South Carolina, September 22, 1998.

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United States Environmental Protection Agency. 1996. EPA Environmental Investigations Standard Operating Procedures for Quality Assurance Manual.

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8.0 TABLES

TABLE 1

GROUNDWATER ELEVATIONS
SITE 29, BUILDING NH 46
ZONE C, CHARLESTON NAVAL BASE COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA

Well No.	Total Depth of Well (ft)	Top of Casing Elevation, ft (MSL)	Date Measured	Depth to Free Product (BTOC)	Product Thickness, ft	Depth to Water, ft (BTOC)	Groundwater Elevation, ft (MSL)
CNC29-MW01	16.5	20.88	7/27/99	NR	0.81	NR	NA
			8/3/99	10.11	1.12	11.23	9.65
			9/10/99	ND	ND	11.59	9.29
CNC29-MW02	16.5	21.59	7/26/99	ND	ND	10.66	10.93
			9/10/99	ND	ND	11.09	10.50
CNC29-MW03	16.5	20.81	7/27/99	ND	ND	9.47	11.34
			9/10/99	ND	ND	9.93	10.88
CNC29-MW04	16.5	20.70	7/26/99	ND	ND	9.95	10.75
			9/10/99	ND	ND	10.45	10.25
CNC29-MW05	16.5	20.32	7/26/99	ND	ND	9.67	10.65
			9/10/99	ND	ND	10.23	10.09
CNC29-MW06	16.5	20.10	8/7/99	ND	ND	9.67	10.43
			9/10/99	ND	ND	10.20	9.90
CNC29-MW07	41.0	20.57	7/27/99	ND	ND	8.03	12.54
			9/10/99	ND	ND	8.62	11.95

'es:
.L - Mean Sea Level
BTOC - Below Top of Casing
ft - feet
ND - Not Detected
NR - Not Recorded
NA - Not Available

TABLE 2

GROUNDWATER FIELD MEASUREMENTS
SITE 29, BUILDING NH 46
ZONE C, CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA

Well I.D.	Date Sampled	Purge method	Volume (gallons)	Temp. (° C)	pH	Conductivity (mS/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/l)
CNC29-MW02	07/26/99	PP	2.0	26.8	5.06	0.064	0	2.92
CNC29-MW03	07/27/99	PP	3.4	26.6	5.80	0.061	0	2.61
CNC29-MW04	07/26/99	PP	2.1	27.4	5.65	0.068	0	2.91
CNC29-MW05	07/26/99	PP	2.2	27.7	5.67	0.080	0	1.72
CNC29-MW06	08/07/99	PP	3.3	27.5	5.95	0.09	6	1.87
CNC29-MW07	07/27/99	PP	18.3	26.8	8.15	0.23	40	1.84

Notes:
(° C) - Degrees Celsius
PP - Peristaltic pump, low flow technique
uMHOS/cm - Micro HOS per centimeter
NTU - Nephelometric turbidity units
mg/l - Milligrams per liter

TABLE 3

GROUNDWATER NATURAL ATTENUATION FIELD MEASUREMENTS
SITE 29, BUILDING NH 46
ZONE C, CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA

Well I.D.	Date Sampled	Dissolved Oxygen (mg/L)	Alkalinity (mg/L)	Carbon Dioxide (mg/L)	Sulfide (mg/L)	Hydrogen Sulfide (mg/L)	Ferrous Iron (mg/L)	Nitrite (mg/L)	Manganese (mg/L)	Nitrogen/ Nitrate (mg/L)*	Sulfate (mg/L)*	Methane (ug/L)*
CNC29-MW03	7/27/99	2.0	16	41	0.03	Not analyzed	0.01	0.025	Not analyzed	0.066	8.60	<5.2
CNC30-MW01	8/22/99	0.4	45	88	0.80	5.0	0.21	0.003	0.2	< 0.05	1.20	9,200
CNC30-MW05	8/22/99	0.4	11	34	0.01	0.0	0.81	0.010	0.0	0.790	33.00	7

Notes:
mg/L - Milligrams per liter
ug/L - Micrograms per liter
E- Estimated Concentration
* Fixed base laboratory analysis

TABLE 4

SUMMARY OF OVA SOIL SCREENING RESULTS
SITE 29, BUILDING NH 46
ZONE C, FORMER CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA

Sample Location	Sample Depth (feet)	Total Organic Vapor Headspace Concentration
CNC29-B01	1-2	2
	2-3	2
	3-4	2
	4-5	2
	8-9	2
CNC29-B02	4-5	4
	7-8	4
	8-9	4
CNC29-B03	7-8	7
CNC29-B04	2-3	4
	3-4	4
	5-6	4
	7-8	4
CNC29-B05	2-3	3.5
	3-4	3.5
	5-6	4
	8-9	100
	9-10	10
CNC29-B06	2-3	4
	3-4	4
	4-5	4
	5-6	4
	6-7	4
	7-8	4
	8-9	7
CNC29-B07	3-4	2
	6-7	2
	7-8	7
CNC29-B08	2-3	4
	3-4	4
	5-6	4
	6-7	4
	7-8	4
	8-9	4
	9-10	4
CNC29-B09	1-2	4
	2-3	4
	3-4	4
	4-5	4
	5-6	4
	6-7	4
	7-8	4
	8-9	4
	9-10	4

TABLE 4 (Continued)

SUMMARY OF OVA SOIL SCREENING RESULTS
SITE 29, BUILDING NH 46
ZONE C, FORMER CHARLESOTN NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA

Sample Location	Sample Depth (feet)	Total Organic Vapor Headspace Concentration
CNC29-B10	3-4	4
	5-6	4
	6-7	4
	8-9	4
	9-10	4
	11-12	4
CNC29-B11	2-3	4
	3-4	4
	5-6	4
	6-7	4
	7-8	4
	8-9	4
CNC29-B12	9-10	4
	2-3	4
	3-4	4
	5-6	4
	6-7	4
	7-8	4
	8-9	4
	9-10	4
CNC29-B13	2-3	3
	3-4	3
	4-5	3
	5-6	3
	6-7	3
	7-8	3
	8-9	3

Note:
OVA - organic vapor analyzer equipped with a flame ionization detector

TABLE 5

SUMMARY OF MOBILE LABORATORY SCREENING RESULTS FOR SOIL
SITE 29, BUILDING NH 46
ZONE C, CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA

Sample Location	Sample Identification	Sample Depth (feet)	Mobile Laboratory Screening Data [1]					
			Benzene (ug/kg)	Toluene (ug/kg)	Ethylbenzene (ug/kg)	Total Xylenes (ug/kg)	Naph-thalene (ug/kg)	Diesel Range Organics (mg/kg)
CNC29-B01	29SFB01-0708	7-8	<5.0	<5.0	<5.0	<5.0	<5.0	14
CNC29-B02	29SFB02-0708	7-8	<5.0	<5.0	<5.0	<5.0	<5.0	15
CNC29-B03	29SFB03-0708	7-8	<5.0	<5.0	<5.0	<5.0	<5.0	26
CNC29-B04	29SFB04-0708	7-8	<5.0	<5.0	<5.0	<5.0	<5.0	19
CNC29-B05	29SFB05-0809	8-9	<5.0	<5.0	16	70	5000	3400
CNC29-B06	29SFB06-0809	8-9	<5.0	<5.0	<5.0	<5.0	<5.0	21
CNC29-B07	29SFB07-0708	7-8	<5.0	<5.0	<5.0	<5.0	<5.0	19
CNC29-B08	29SFB08-0708	7-8	<5.0	<5.0	<5.0	<5.0	<5.0	<10
CNC29-B09	29SFB09-0708	7-8	<5.0	<5.0	<5.0	<5.0	<5.0	<10
CNC29-B10	29SFB10-1112	11-12	<5.0	<5.0	<5.0	<5.0	<5.0	<10
CNC29-B11	29SFB11-0708	7-8	<5.0	<5.0	<5.0	<5.0	<5.0	<10
CNC29-B12	29SFB12-0708	7-8	<5.0	<5.0	<5.0	<5.0	<5.0	<10
CNC29-B13	29SFB13-0708	7-8	<5.0	<5.0	<5.0	<5.0	<5.0	<10
CNC29-B13	29SFB13-0708[2]	7-8	NA	NA	NA	NA	NA	<10

NOTES:
[1] Mobile laboratory screening data were analyzed using USEPA Method 8021/8015M. Compounds not detected are reported as less than the instrument detection limit.
[2] Laboratory duplicate

NA Not analyzed
ug/kg Micrograms per kilogram
mg/kg Milligrams per kilogram

TABLE 6

SUMMARY OF MOBILE LABORATORY SCREENING RESULTS FOR GROUNDWATER
SITE 29, BUILDING NH 46
ZONE C, FORMER CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA

Sample Location	Sample Identification	Laboratory Screening Data[1]					
		Benzene (ug/L)	Toluene (ug/L)	Ethylbenzene (ug/L)	Total Xylenes (ug/L)	Naph-thalene (ug/L)	Diesel Range Organics (mg/L)
CNC29-B01	29GFB01-12	<1.0	<1.0	<1.0	<1.0	33	<0.1
CNC29-B02	29GFB02-12	<1.0	<1.0	<1.0	<1.0	<1.0	0.2
CNC29-B03	29GFB03-12	<1.0	<1.0	<1.0	<1.0	<1.0	0.1
CNC29-B04	29GFB04-12	<1.0	<1.0	<1.0	<1.0	<1.0	<0.1
CNC29-B05	29GFB05-12	86	32	130	280	600	2.3
CNC29-B06	29GFB06-12	61	8.1	91	140	600	0.8
CNC29-B06	29GFDB06-12[2]	75	8.3	140	201	700	NA
CNC29-B07	29GFB07-12	<1.0	<1.0	<1.0	<1.0	<1.0	0.2
CNC29-B08	29GFB08-12	<1.0	<1.0	<1.0	<1.0	<1.0	<0.1
CNC29-B09	29GFB09-12	<1.0	<1.0	<1.0	<1.0	<1.0	<0.1
CNC29-B10	29GFB10-16	<1.0	<1.0	<1.0	<1.0	<1.0	0.1
CNC29-B11	29GFB11-12	<1.0	<1.0	<1.0	<1.0	<1.0	0.1
CNC29-B12	29GFB12-14	53	<1.0	72	351	4000	4.0
CNC29-B13	29GFB13-12	<1.0	<1.0	<1.0	<1.0	<1.0	<0.1

NOTES:
[1] Laboratory screening data were analyzed using USEPA Method 8020/8015M. Compounds not detected are reported as less than the instrument detection limit.
[2] Laboratory duplicate

NA Not analyzed
ug/L Micrograms per liter
mg/L Milligrams per liter

TABLE 7

SUMMARY OF FIXED-BASE LABORATORY ANALYTICAL RESULTS FOR CHEMICALS OF CONCERN IN SOIL
SITE 29, BUILDING NH 46
ZONE C, CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA

Soil Boring / Sample No.	Sample Date	Benzene (ug/kg)	Toluene (ug/kg)	Ethyl-benzene (ug/kg)	Xylenes (total) (ug/kg)	Benzo(a) anthracene (ug/kg)	Benzo(b) fluoranthene (ug/kg)	Benzo(k) fluoranthene (ug/kg)	Chrysene (ug/kg)	Dibenzo(a,h) anthracene (ug/kg)	Naphthalene (ug/kg)
RBSL [1]		5	1622	1260	42471	73084	29097	231109	12998	87866	210
CNC29-B04 / 29SLB040708	1-Jun-99	< 6	< 6	< 6	< 6	< 360	< 360	< 360	< 360	< 360	< 6
CNC29-B05 / 29SLB050809	1-Jun-99	9	120	1200	3400	< 6900	< 6900	< 6900	< 6900	< 6900	50300
CNC29-B05 / 29SLB050809D	1-Jun-99	46	260	3500	9000	< 360	< 360	< 360	< 360	< 360	22400
CNC29-B06 / 29SLB060809	1-Jun-99	< 600	< 600	< 600	< 600	< 360	< 360	< 360	< 360	< 360	< 600
CNC29-B07 / 29SLB070708	1-Jun-99	< 6	< 6	< 6	< 6	< 360	< 360	< 360	< 360	< 360	< 6
CNC29-B11 / 29SLB110708	1-Jun-99	< 7	< 7	< 7	< 7	< 330	< 330	< 330	< 330	< 330	4 [J]
CNC29-B12 / 29SLB120708	1-Jun-99	< 6	< 6	< 6	< 6	< 360	< 360	< 360	< 360	< 360	< 6
CNC29-TL / 29TL00301 [2]	1-Jun-99	< 5	< 5	< 5	< 5	NA	NA	NA	NA	NA	< 5

All concentrations are in micrograms per kilograms (ug/kg).

NA - Not Analyzed

[1] South Carolina Department of Health and Environmental Control Risk Based Screening Levels for sandy soils; depth to groundwater less than 5 feet.

[2] Trip blank

[J] Indicates the presence of an analyte at a concentration less than the reporting limit and greater than the detection limit.

TABLE 8

SUMMARY OF FIXED-BASE LABORATORY ANALYTICAL RESULTS FOR CHEMICALS OF CONCERN IN GROUNDWATER
SITE 29, BUILDING NH 46
ZONE C, CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA

Monitoring Well/ Sample No.	Sample Date	Benzene (ug/L)	Ethyl-benzene (ug/L)	Toluene (ug/L)	Xylenes (total) (ug/L)	MTBE (ug/L)	Naphthalene (ug/L)	Benzo(a) anthracene (ug/L)	Benzo(b) fluoranthene (ug/L)	Benzo(k) fluoranthene (ug/L)	Chrysene (ug/L)	Dibenzo(a,h) anthracene (ug/L)
RBSL[1]		5	700	1000	10000	40	10 [2]	10 [2]	10 [2]	10 [2]	10 [2]	10 [2]
CNC29-MW01	26-Jul-99	310[3]	100[3]	4650[3]	790[3]	-	23350[3]	-	-	-	-	-
CNC29-MW02 / 29GLM0201	26-Jul-99	< 5	< 5	< 5	< 5	< 5	< 5	<10	<10	<10	<10	<10
CNC29-MW03 / 29GLM0301	27-Jul-99	< 5	< 5	< 5	< 5	< 5	< 5	<10	<10	<10	<10	<10
CNC29-MW04 / 29GLM0401	26-Jul-99	< 5	< 5	< 5	< 5	< 5	< 5	<10	<10	<10	<10	<10
CNC29-MW04 / 29GLM0401D	26-Jul-99	< 5	< 5	< 5	< 5	< 5	< 5	<10	<10	<10	<10	<10
CNC29-MW05 / 29GLM0501	26-Jul-99	< 5	< 5	< 5	< 5	< 5	< 5	<10	<10	<10	<10	<10
CNC29-MW06 / 29GLM0601	7-Aug-99	< 5	< 5	< 5	< 5	< 5	< 5	<10	<10	<10	<10	<10
CNC29-MW07 / 29GLM0701	27-Jul-99	< 5	< 5	< 5	< 5	< 5	< 5	<10	<10	<10	<10	<10
CNC29TL[4] / 29TL00901	27-Jul-99	< 5	< 5	< 5	< 5	< 5	< 5	NA	NA	NA	NA	NA

All concentrations are in ug/L.

ND - Not detected.

NA - Not analyzed

(1) South Carolina Department of Health and Environmental Control Risk Based Screening Levels for ground water.

(2) The Risk based screening level for individual PAH CoC is 10 ug/L or 25 ug/L for total PAHs.

(3) Concentrations in equilibrium with free product as calculated by Raoult's Law (See Appendix G)

(4) Trip blank

(J) Indicates presence of analyte at a concentration less than the reporting limit and greater than the detection limit.

TABLE 9

FATE AND TRANSPORT INPUT PARAMETERS
SITE 29, BUILDING NH 46
ZONE C, CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA

Parameter	Domenico Dilution/Attenuation Model[1]
Hydraulic Conductivity [m/sec]	1.43E-05
Hydraulic Gradient	0.0055
Porosity[a]	0.47
Estimated Plume Length [ft]	NA
Soil Bulk Density[a] [kg/L]	1.45
Fractional Organic Carbon	6.78E-03
First Order Decay Rate[a] [sec^{-1}]	0
Modeled Plume Length [ft]	NA
Modeled Plume Width [ft]	NA
Source Width[b] [m]	15
Source Thickness[b] [m]	2
Soluble Mass [kg]	Infinite[c]

(1) - *South Carolina Risk-Based Corrective Action for Petroleum Releases,* South Carolina Department of Health and Environmental Control, 1998.
(a) - Stated values are default values for sandy soil.
(b) - Values determined from American Society for Testing and Materials (ASTM) Standard Guide for RISK Based Corrective Action Applied at Petroleum Sites, 1997
(c) - Assumption of the Domenico Model

TABLE 10

COMPARISON OF MAXIMUM CONCENTRATIONS TO RBSLs
SITE 29, BUILDING NH46
ZONE C, CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA

Chemical of Concern	Maximum Concentration (Soil) (mg/kg)	RBSLs Soil (mg/kg)[a]	Maximum Concentration GW (mg/L)	RBSLs GW (mg/L)[b]
Benzene	< 0.600	0.005	0.31	0.005
Toluene	< 0.600	1.622	4.65	1
Ethylbenzene	3.5	1.26	0.1	0.7
Xylenes	9	42.471	0.79	10
MTBE	NA	NA	NA	0.04
Naphthalene	50.3	0.21	23.35	0.010

(a) - From Risk-Based Corrective Action for Petroleum Releases, Table 4, Depth to GW - <5 ft, SCDHEC RBCA Guidelines, 1998.
(b) - From Risk-Based Corrective Action for Petroleum Releases, Table B1, SCDHEC RBCA Guidelines, 1998.
GW - Groundwater
RBSLs - Risk Based Screening Levels
Shaded cell indicates the concentration exceeded the RBSL.

TABLE 11

EXPOSURE PATHWAY ASSESSMENT - CURRENT LAND USE
SITE 29, BUILDING NH 46
ZONE C, CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA

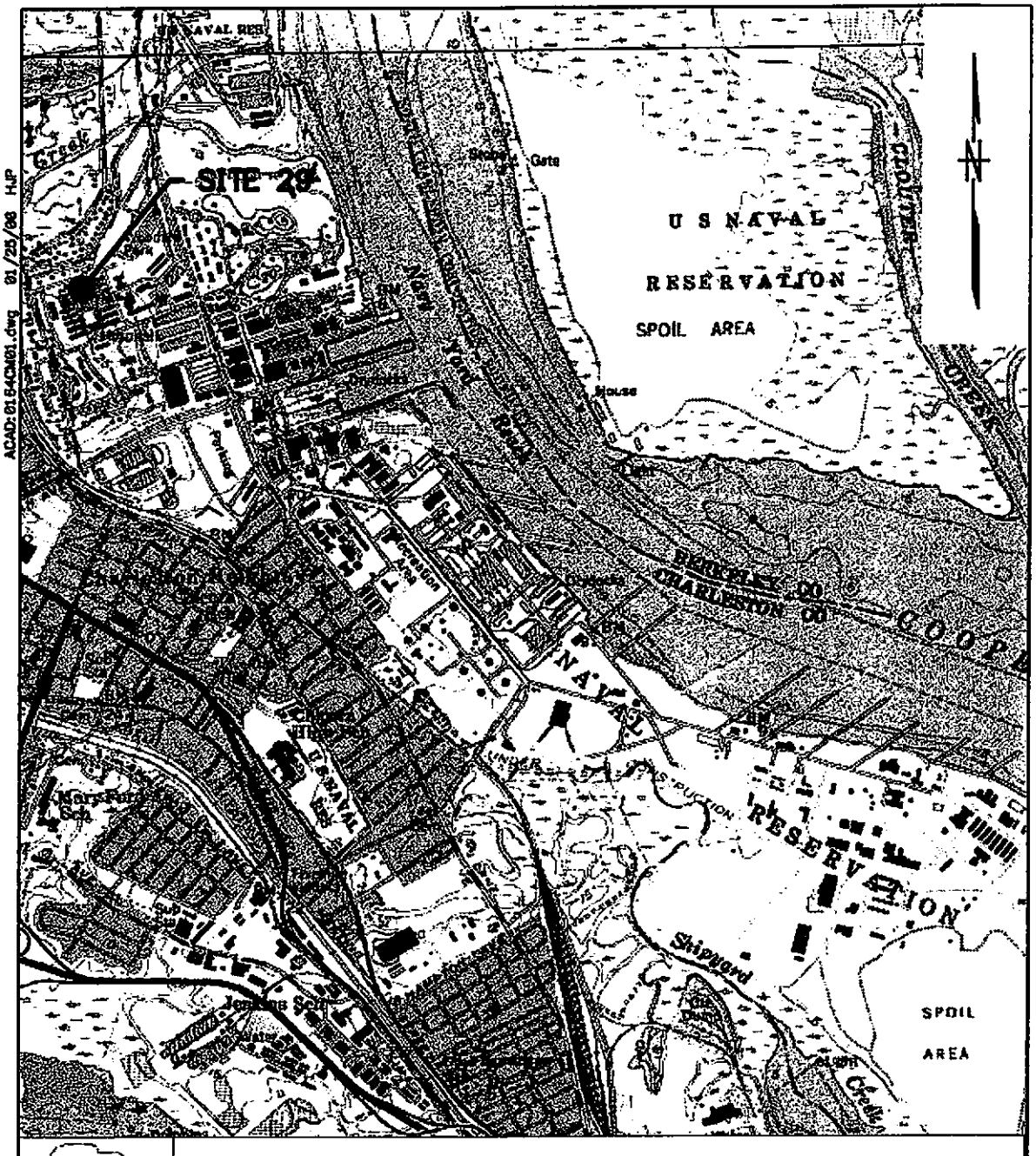
Media	Exposure Route	Pathway Selected for Evaluation? (Yes or No)	Exposure point or Reason for Non-Selection	Data Requirements (if pathway selected)
Air	Inhalation	No	Area of Building NH 46 below grade is above water table and not expected to act as a basement. Foundation of building assumed as a vapor barrior.No explosion hazard.	
	Explosion Hazard	No		
Groundwater	Ingestion	No	No current groundwater pathways completed. Drinking water provided by city.	
	Dermal contact	No		
	Inhalation	No		
Surface Water	Ingestion	No	No surface water bodies within 1,000 feet	
	Dermal contact	No		
	Inhalation	No		
Surficial Soil	Ingestion	No	No surficial soil impact.	
	Dermal contact	No		
	Inhalation	No		
Subsurface Soil	Ingestion	No	No current complete pathways.	
	Dermal contact	No		
	Inhalation	No		

TABLE 12

EXPOSURE PATHWAY ASSESSMENT – FUTURE LAND USE
SITE 29, BUILDING NH 46
ZONE C, CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA

Media	Exposure Route	Pathway Selected for Evaluation? (Yes or No)	Exposure point or Reason for Non-Selection	Data Requirements (if pathway selected)
Air	Inhalation Explosion Hazard	No No	Area of Building NH 46 below grade is above water table and not expected to act as a basement. Foundation of building assumed as a vapor barrior. No explosion hazard.	
Groundwater	Ingestion Dermal contact Inhalation	Yes Yes Yes	Groundwater exposure by potential construction worker (most likely in utility corridor). Both direct exposure and exposure by soil leaching to groundwater evaluated. Potential for volatilization and inhalation.	No additional data needed.
Surface Water	Ingestion Dermal contact Inhalation	No No No	No surface water bodies within 1,000 feet	
Surficial Soil	Ingestion Dermal contact Inhalation	No No No	Soil exposure by potential construction worker (most likely in utility corridor). Although there is no surficial soil impact, subsurface soil evaluated as surface soil for construction worker as direct contact likely in utility trench.	No additional data needed.
Subsurface Soil	Ingestion Dermal contact Inhalation	YES YES YEs	Soil exposure by potential construction worker (most likely in utility corridor). Soil leaching to groundwater provides exposure pathway.	

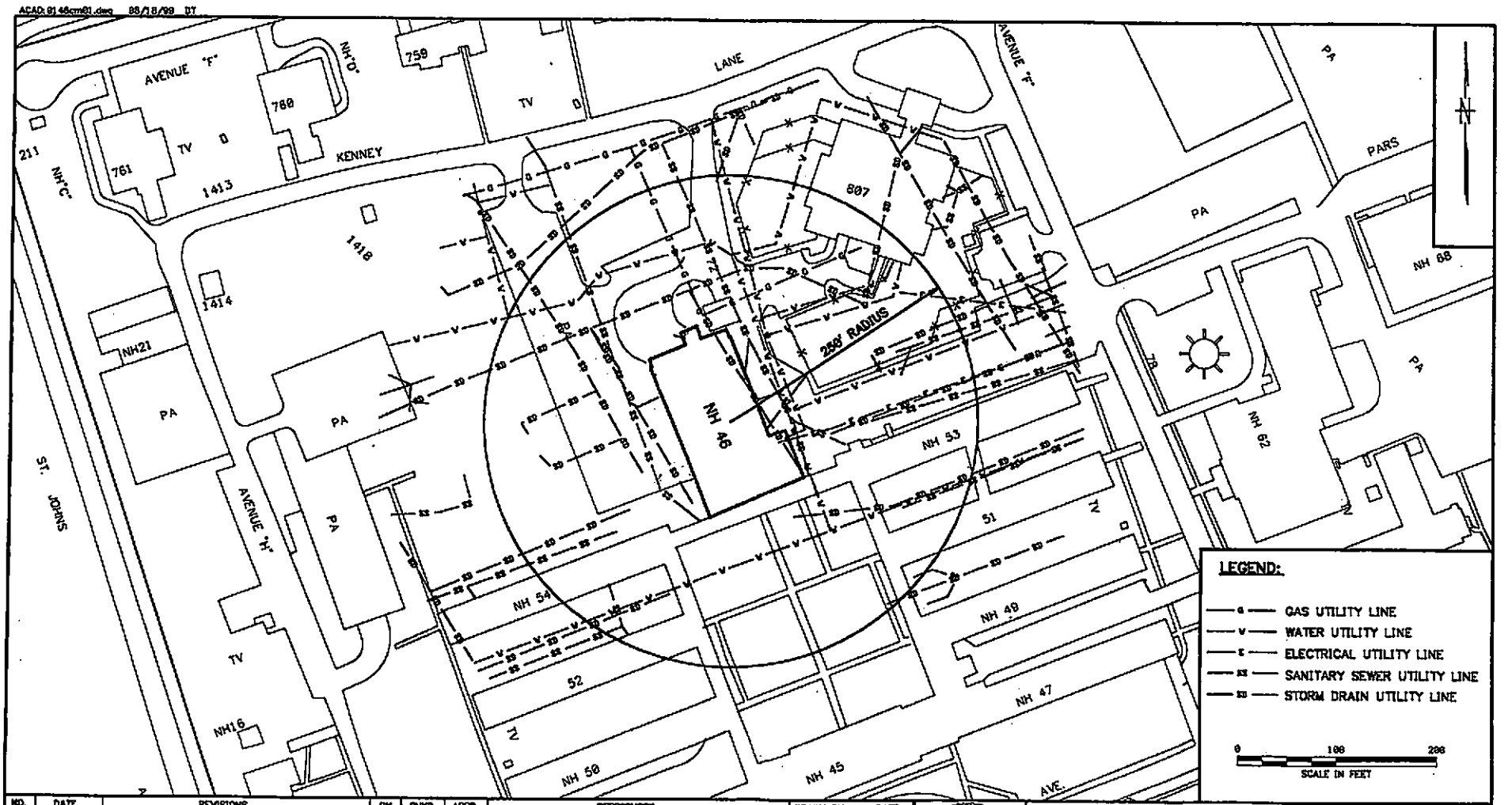
9.0 FIGURES



ACAD:01.84CM01.dwg 01/25/00 HJP

DRAWN BY DATE: HJP 8/20/99		SITE LOCATION MAP SITE 29, BUILDING NH46-5, ZONE C CHARLESTON NAVAL COMPLEX NORTH CHARLESTON, SC	CONTRACT NO. N0164
CHECKED BY DATE			APPROVED BY DATE
COST/SCHED--AREA			APPROVED BY DATE
SCALE: AS NOTED			DRAWING NO. FIGURE 1 / REV. 0

FORM CADD NO. SUIV_AV.DWG - REV 0 - 1/20/98



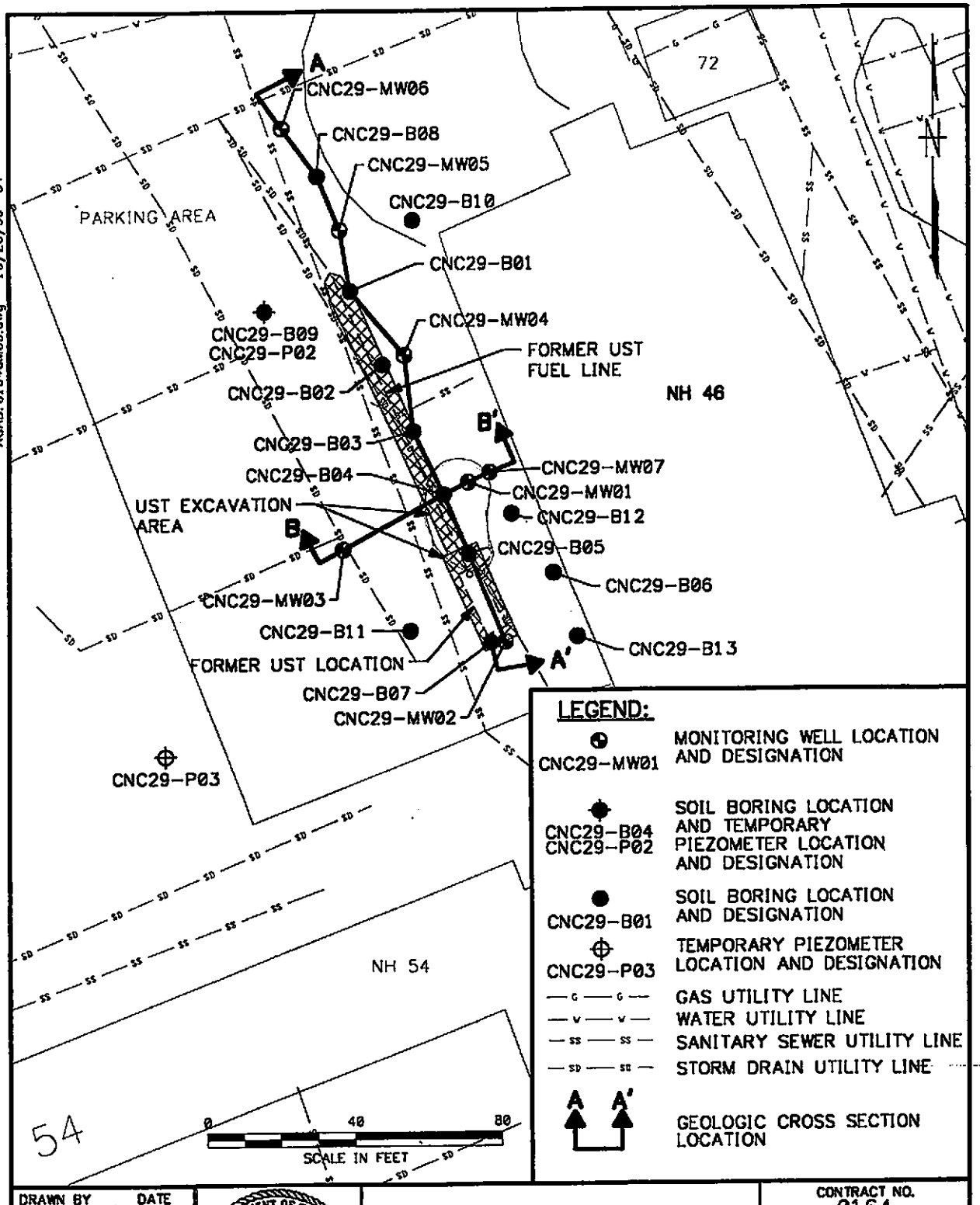
NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY DATE: DLT 8/18/99
CHECKED BY DATE:
COST/SCHED-AREA:
SCALE: AS NOTED

SITE VICINITY MAP
SITE 29, BUILDING NH 46
ZONE C, CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA

CONTRACT NO. 0146
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 2
REV. 0

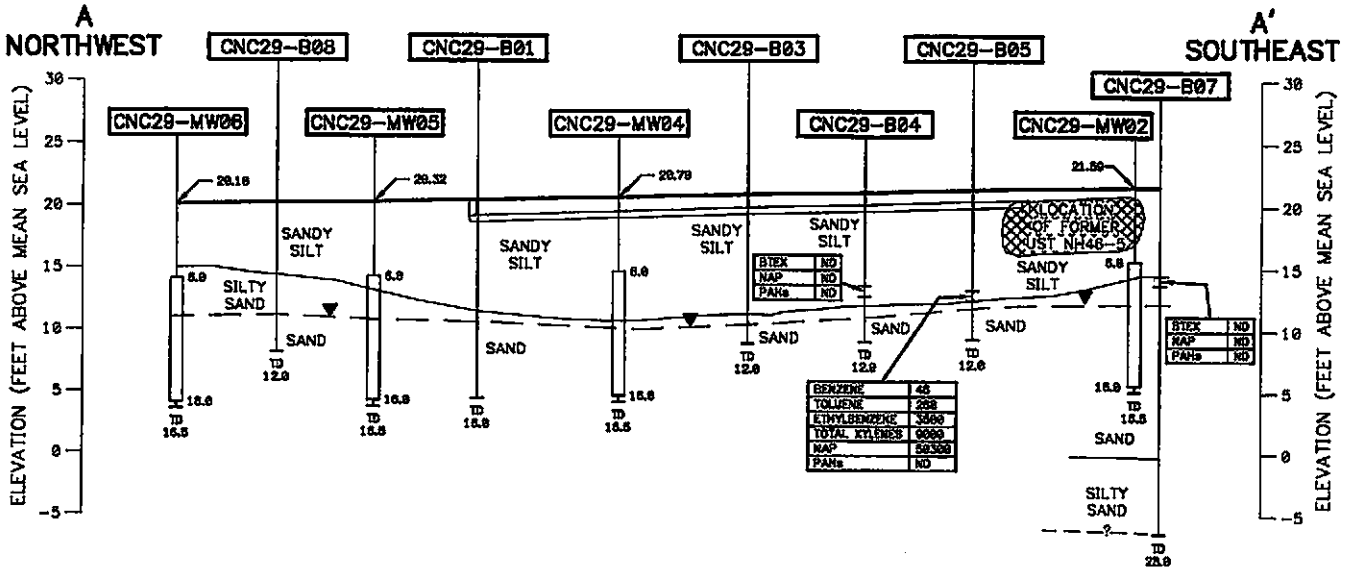
FORM CADD NO. XXIV_BLDG - REV 0 - 1/20/98

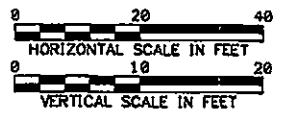


DRAWN BY DLT DATE 10/20/99		SITE MAP AND SAMPLING LOCATIONS SITE 29, BUILDING NH 46 ZONE C, CHARLESTON NAVAL COMPLEX NORTH CHARLESTON, SOUTH CAROLINA	CONTRACT NO. 0164
CHECKED BY DATE			APPROVED BY DATE
COST/SCHED-AREA			APPROVED BY DATE
SCALE AS NOTED			DRAWING NO. FIGURE 3 REV. 0

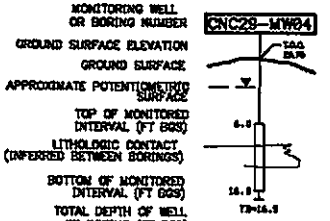
FORM CADD NO. SDIV_AV.DWG - REV 0 - 1/20/98

ACAD:0154GN03.dwg 10/25/99 DT





LEGEND:



BTEX = BENZENE, TOLUENE, ETHYLBENZENE AND TOTAL XYLENES
NAP = NAPHTHALENES
PAHs = POLYNUCLEAR AROMATIC HYDROCARBONS
ND = NOT DETECTED (BELOW LABORATORY DETECTION LIMITS)

NOTE:

GROUNDWATER BTEX, NAPHTHALENE AND PAH PARAMETERS REPORTED BELOW LABORATORY DETECTION LIMITS IN MONITORING WELLS CNC29-MW02, CNC29-MW04, CNC29-MW05 AND CNC29-MW06.

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

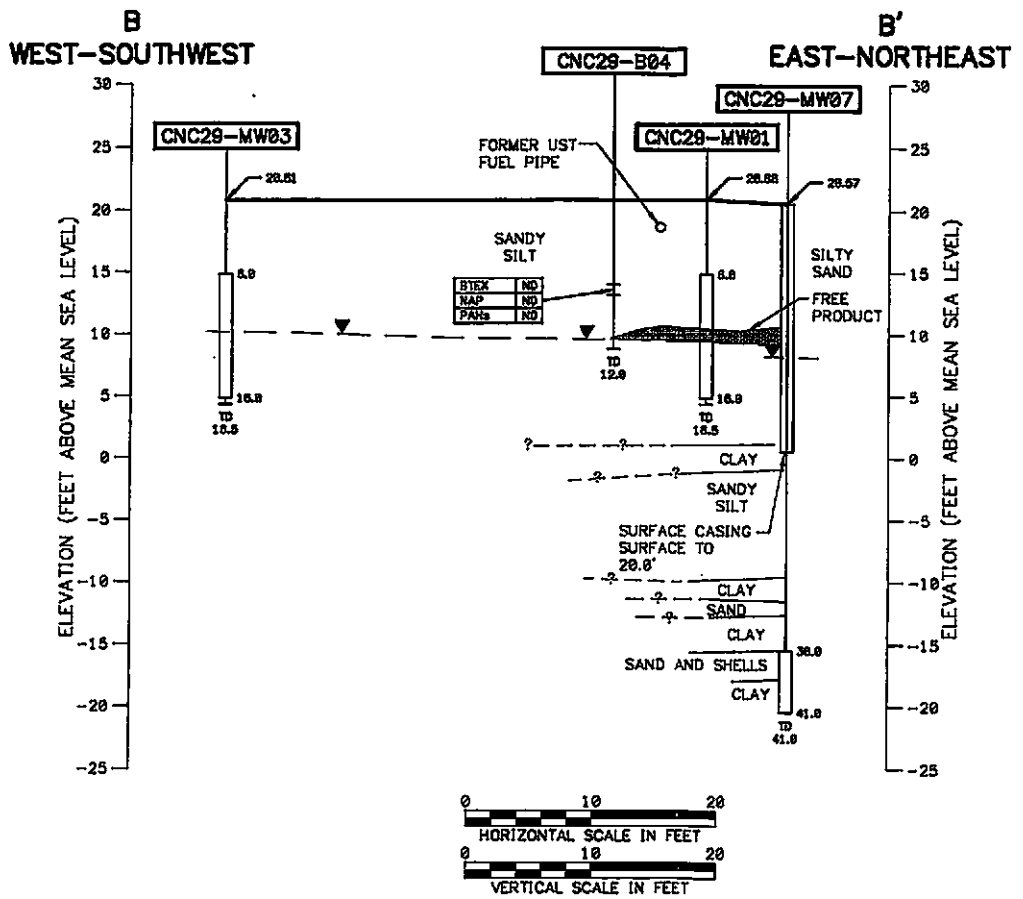
DRAWN BY DLT DATE 10/22/99
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

GEOLOGIC CROSS SECTION A-A'
SITE 29, BUILDING NH 46
ZONE C, CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA

CONTRACT NO. 0164
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 4
REV. 0

FORM CADD NO. SOUTH-BASIN - REV 0 - 9/9/98

ACAD:81640X04.dwg 10/25/99 DT



LEGEND:

MONITORING WELL OR BORING NUMBER — CNC29–MW01

GROUND SURFACE ELEVATION — 100.00 MSL

GROUND SURFACE

APPROXIMATE POTENTIOMETRIC SURFACE

TOP OF MONITORED INTERVAL (FT BGS) — 6.0

LITHOLOGIC CONTACT (INFERRED BETWEEN BORINGS)

BOTTOM OF MONITORED INTERVAL (FT BGS) — 16.0

TOTAL DEPTH OF WELL OR BORING (FT BGS) — TD=16.0

DETECTED SOIL PARAMENTER CONCENTRATIONS (ug/kg) AT SAMPLE DEPTH

BTEX	ND
NAP	ND
PAHs	ND

BTEX = BENZENE, TOLUENE, ETHYLBENZENE AND TOTAL XYLENES

NAP = NAPHTHALENES

PAHs = POLYNUCLEAR AROMATIC HYDROCARBONS

ND = NOT DETECTED (BELOW LABORATORY DETECTION LIMITS)

NOTE:

GROUNDWATER BTEX, NAPHTHALENE AND PAH PARAMETERS REPORTED BELOW LABORATORY DETECTION LIMITS IN MONITORING WELLS CNC29–MW01, CNC29–MW02 AND CNC29–MW07.

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY DLT DATE 10/22/99

CHECKED BY DATE

COST/SCHED–AREA

SCALE AS NOTED

GEOLOGIC CROSS SECTION B–B'
SITE 29, BUILDING NH 46
ZONE C, CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA

CONTRACT NO. 0164

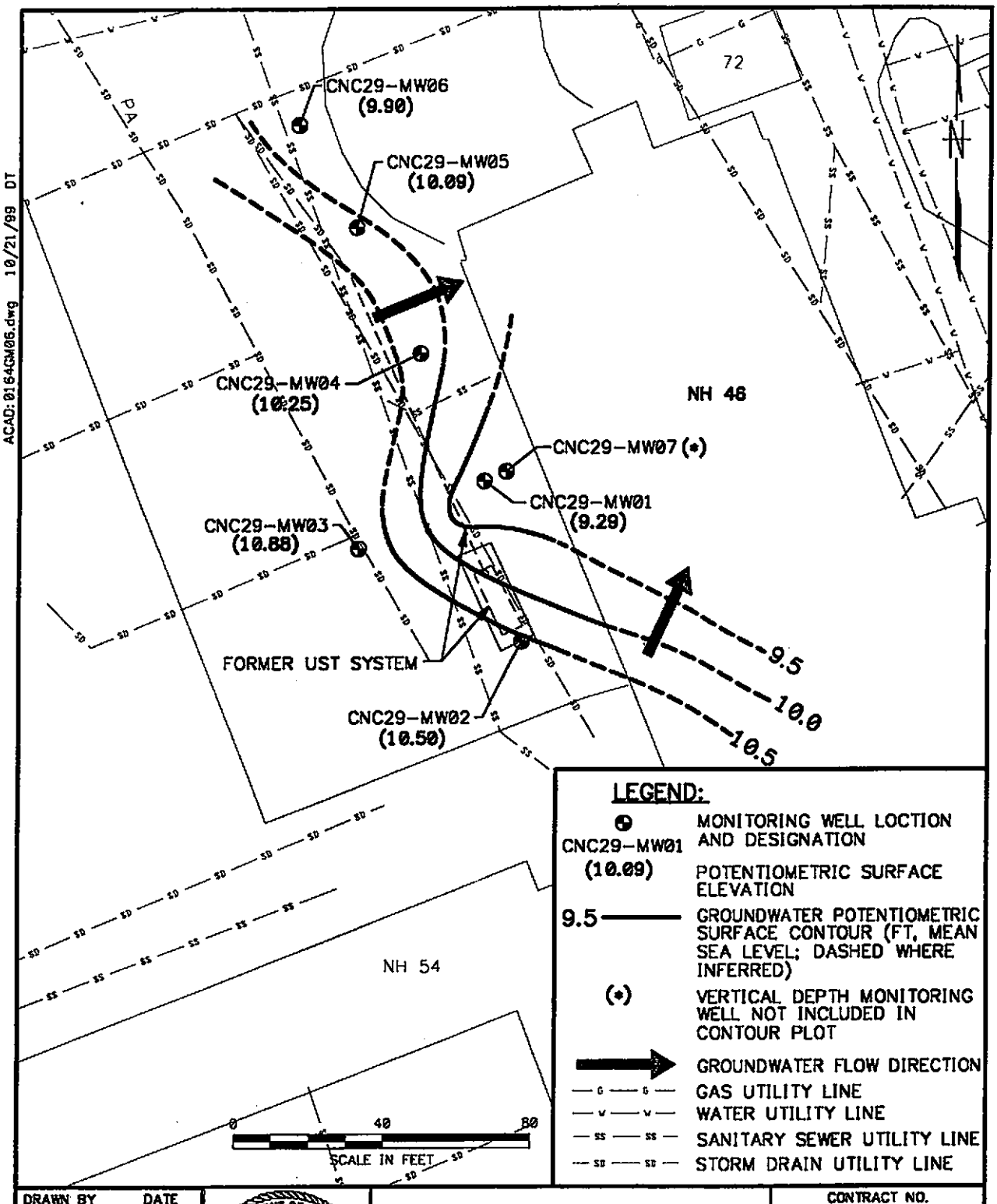
APPROVED BY DATE

APPROVED BY DATE

DRAWING NO. FIGURE 5

REV. 0

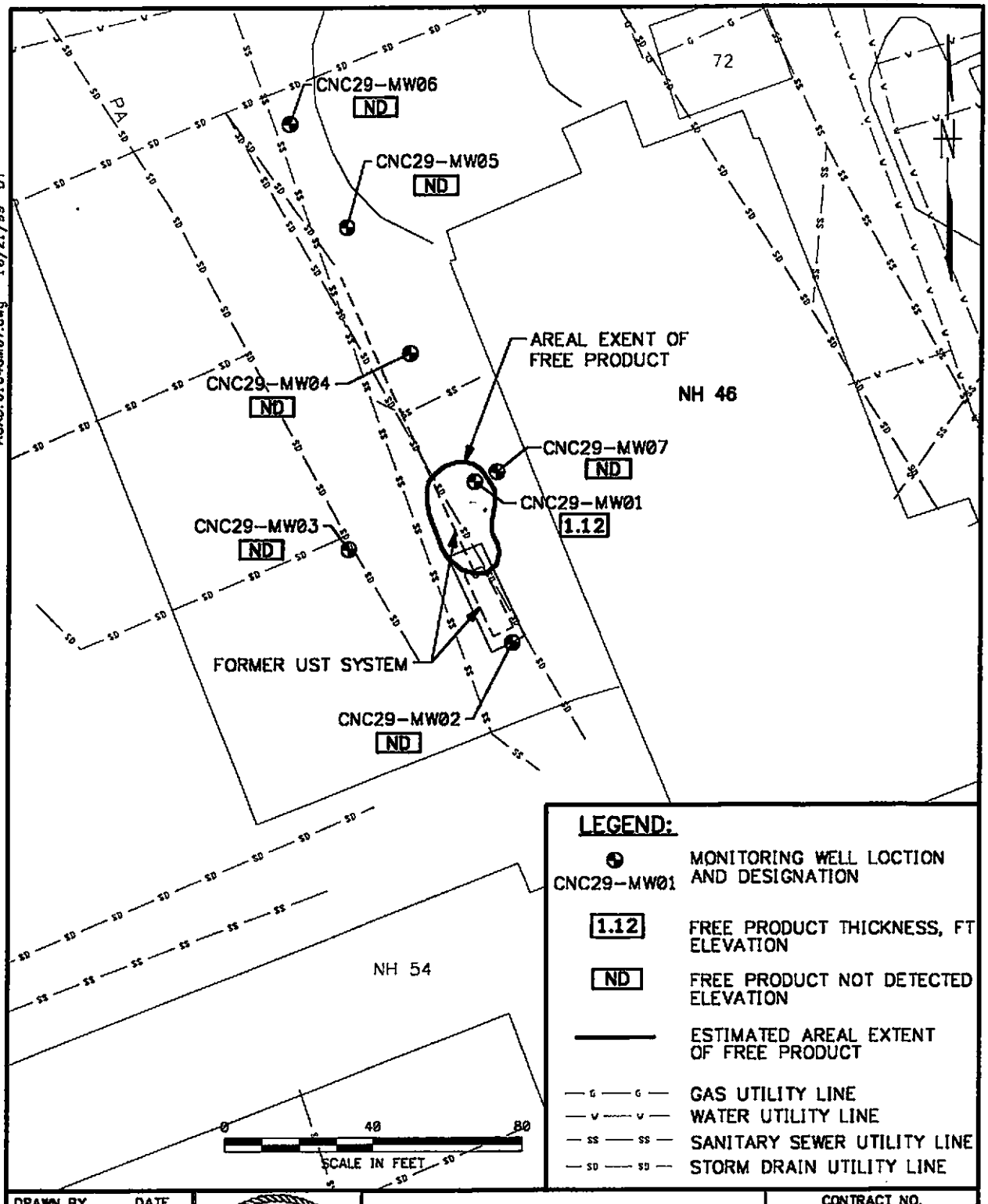
FORM CADD NO. SOUTH-BNDSK - REV 0 - 9/9/98



ACAD:0164GM06.dwg 10/21/99 DT

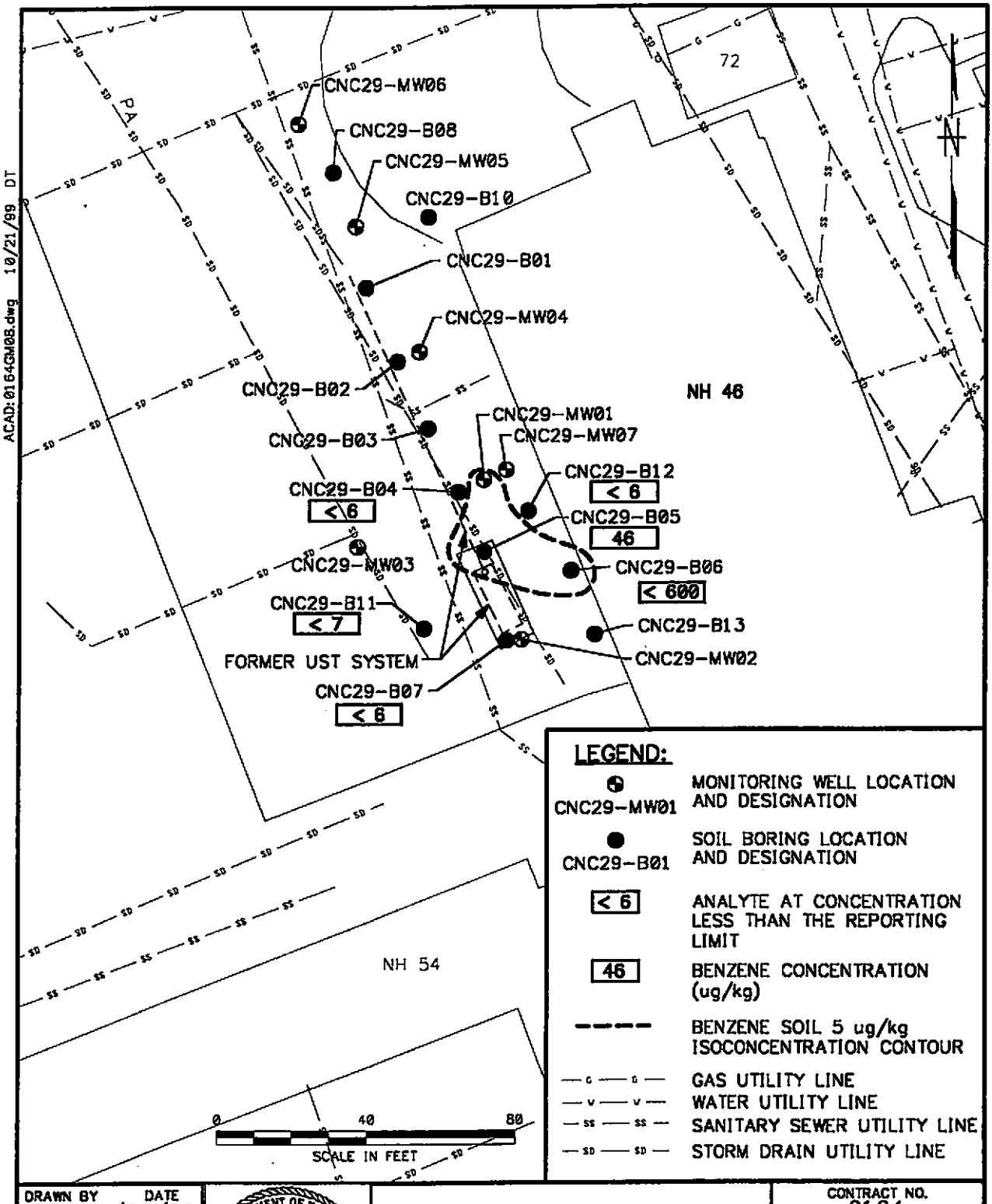
DRAWN BY DLT 10/21/99		GROUNDWATER POTENTIOMETRIC MAP (SEPTEMBER 10, 1999) SITE 29, BUILDIN NH 46 ZONE C, CHARLESTON NAVAL COMPLEX NORTH CHARLESTON, SOUTH CAROLINA	CONTRACT NO. 0164
CHECKED BY DATE			APPROVED BY DATE
COST/SCHED-AREA			APPROVED BY DATE
SCALE AS NOTED			DRAWING NO. FIGURE 6 / REV. 0

FORM CADD NO. SDIV_AV.DWG - REV 0 - 1/20/98



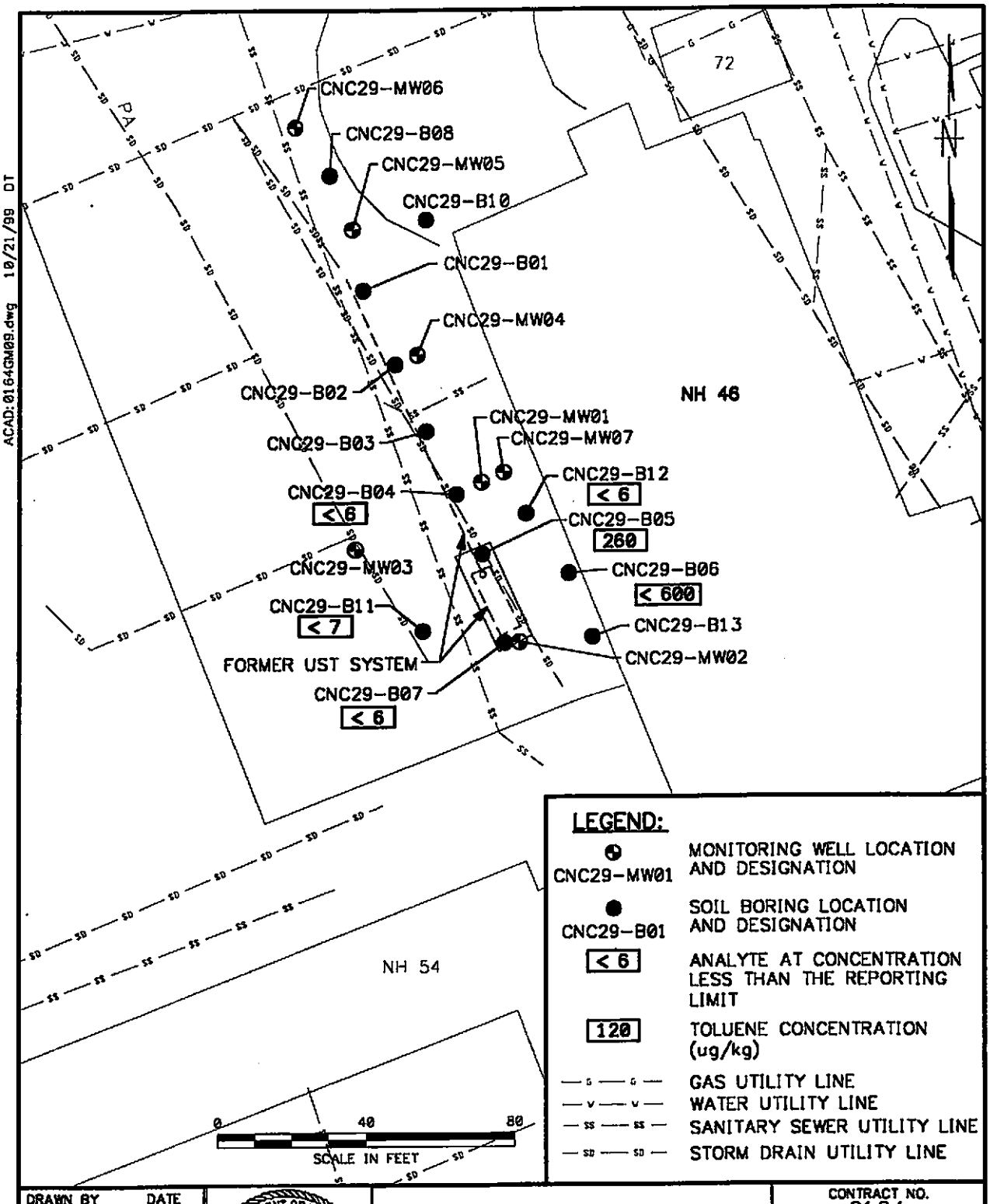
DRAWN BY DLT 10/21/99	AREAL EXTENT OF FREE PRODUCT (AUGUST 1999) SITE 29, BUILDING NH 46 ZONE C, CHARLESTON NAVAL COMPLEX NORTH CHARLESTON, SOUTH CAROLINA	CONTRACT NO. 0164	
CHECKED BY DATE		APPROVED BY DATE	
COST/SCHED-AREA		APPROVED BY DATE	
SCALE AS NOTED		DRAWING NO. FIGURE 7	REV. 0

FORM CADD NO. SDIV_AV.DWG - REV 0 - 1/20/98



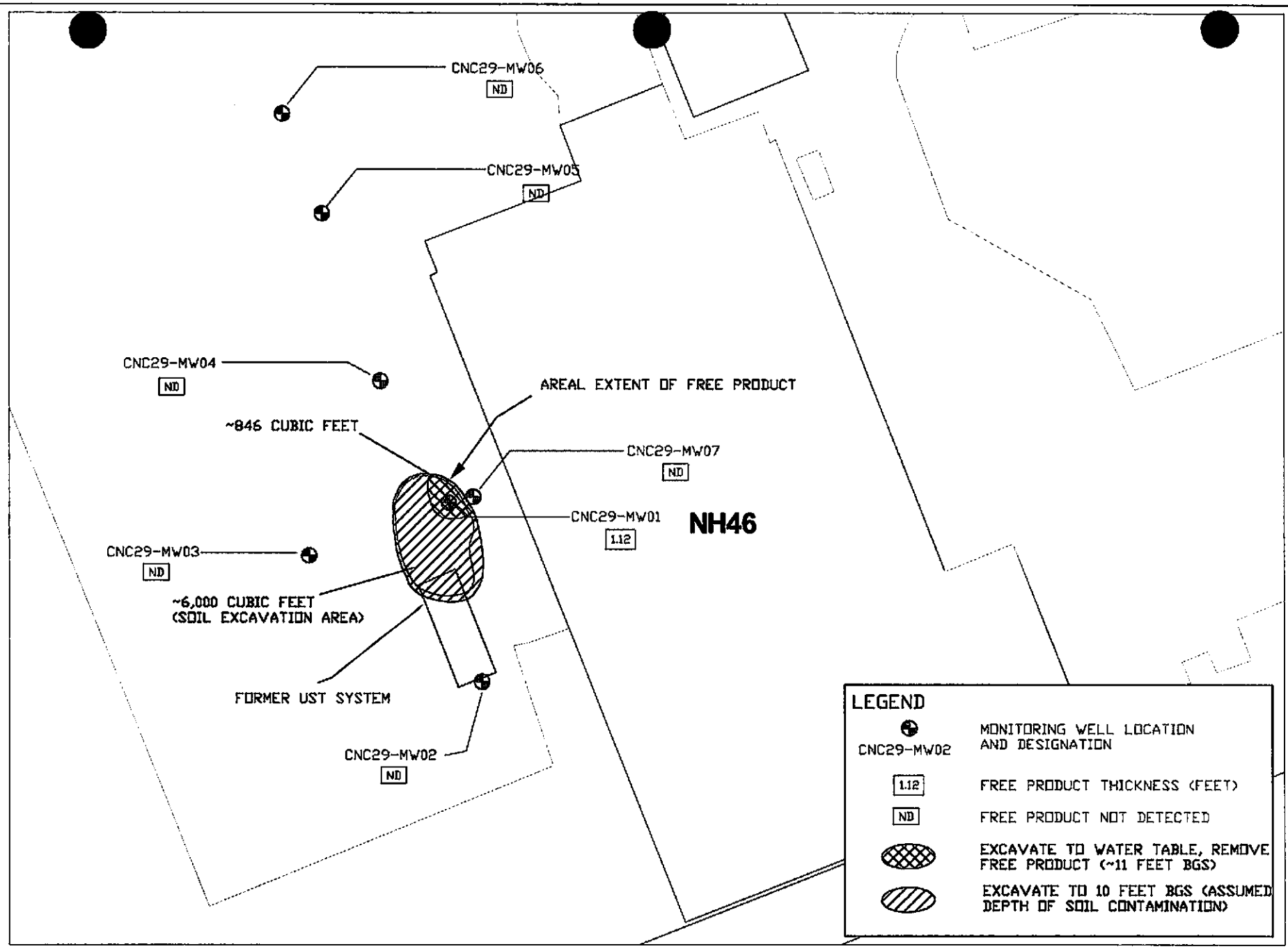
DRAWN BY DATE DLT 10/20/99		BENZENE SOIL CONCENTRATION MAP (JUNE 1999) SITE 29, BUILDING NH 46 ZONE C, CHARLESTON NAVAL COMPLEX NORTH CHARLESTON, SOUTH CAROLINA	CONTRACT NO. 0164
CHECKED BY DATE			APPROVED BY DATE
COST/SCHED--AREA			APPROVED BY DATE
SCALE AS NOTED			DRAWING NO. FIGURE 8 / REV. 0

FORM CADD NO. SDIV_AV.DWG - REV 0 - 1/20/98



DRAWN BY DLT 10/20/99		TOLUENE SOIL CONCENTRATION MAP (JUNE 1999) SITE 29, BUILDING NH 46 ZONE C, CHARLESTON NAVAL COMPLEX NORTH CHARLESTON, SOUTH CAROLINA	CONTRACT NO. 0164
CHECKED BY DATE			APPROVED BY DATE
COST/SCHED-AREA			APPROVED BY DATE
SCALE AS NOTED			DRAWING NO. FIGURE 9 / REV. 0

FORM CADD NO. SDIV_AV.DWG - REV 0 - 1/20/98



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CH2MHILL

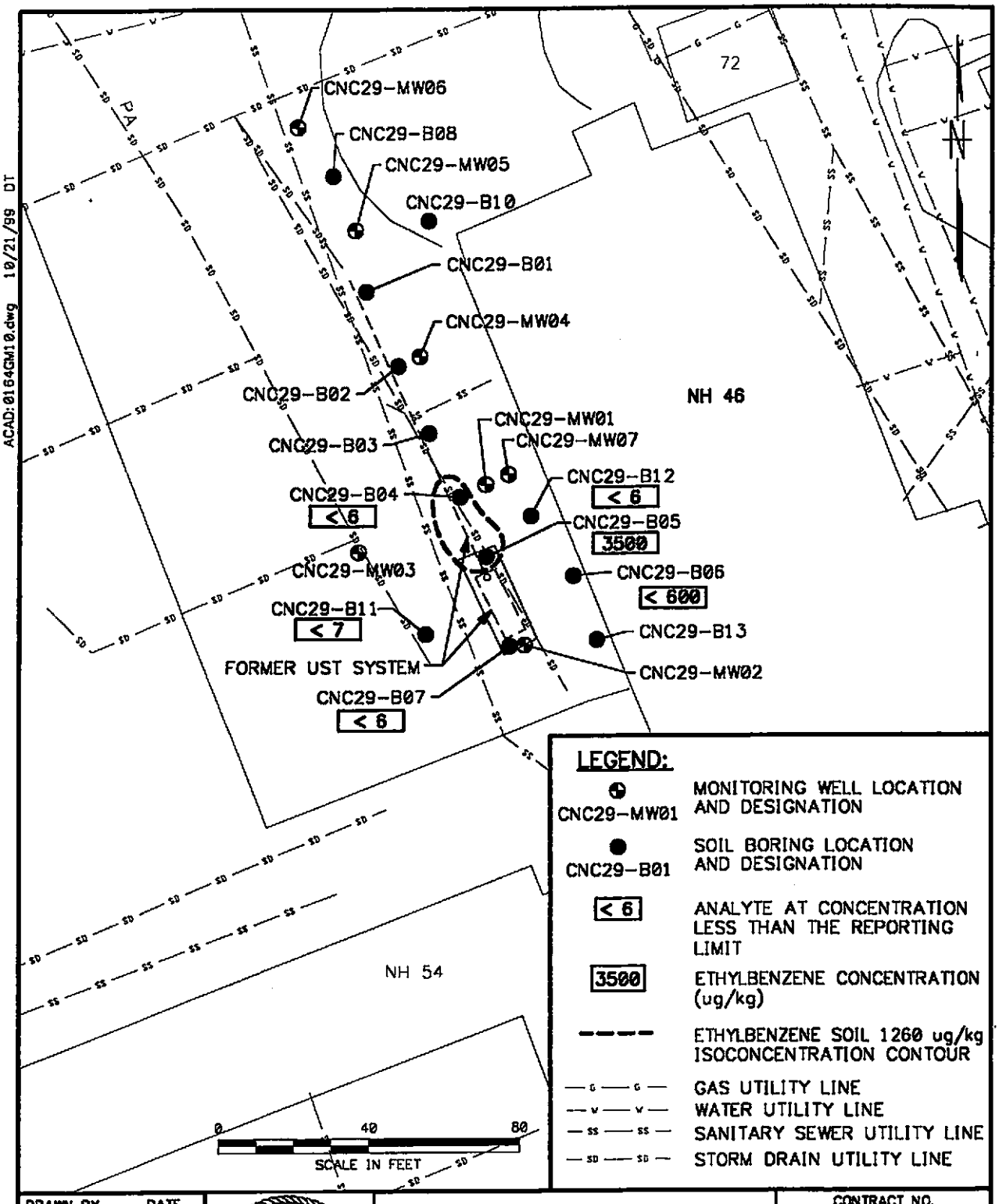
20 0 20 40 Feet

N

FIGURE 16
ESTIMATED EXTENT OF EXCAVATION

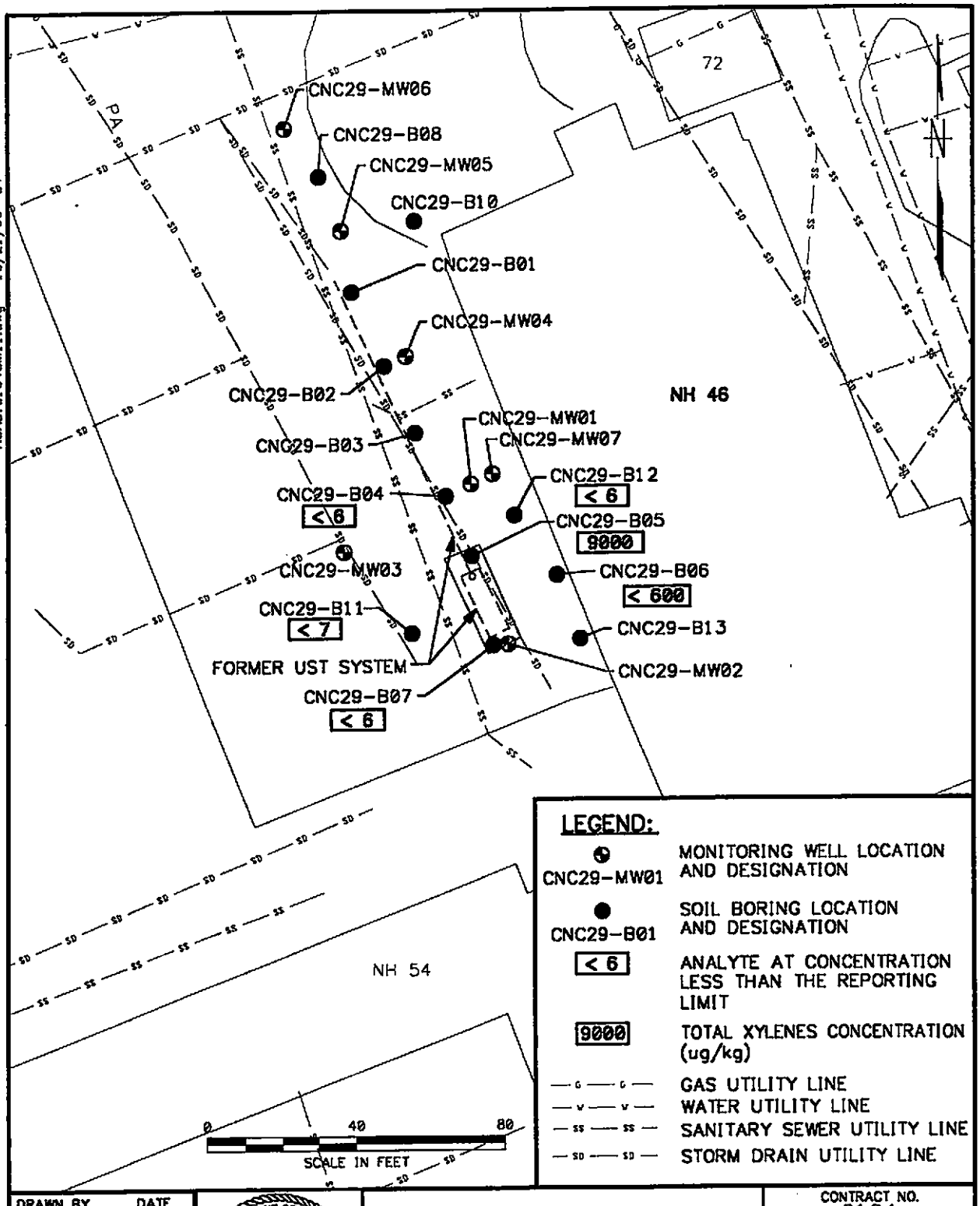
SITE 29, BUILDING NH46, ZONE C

CHARLESTON NAVEL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA



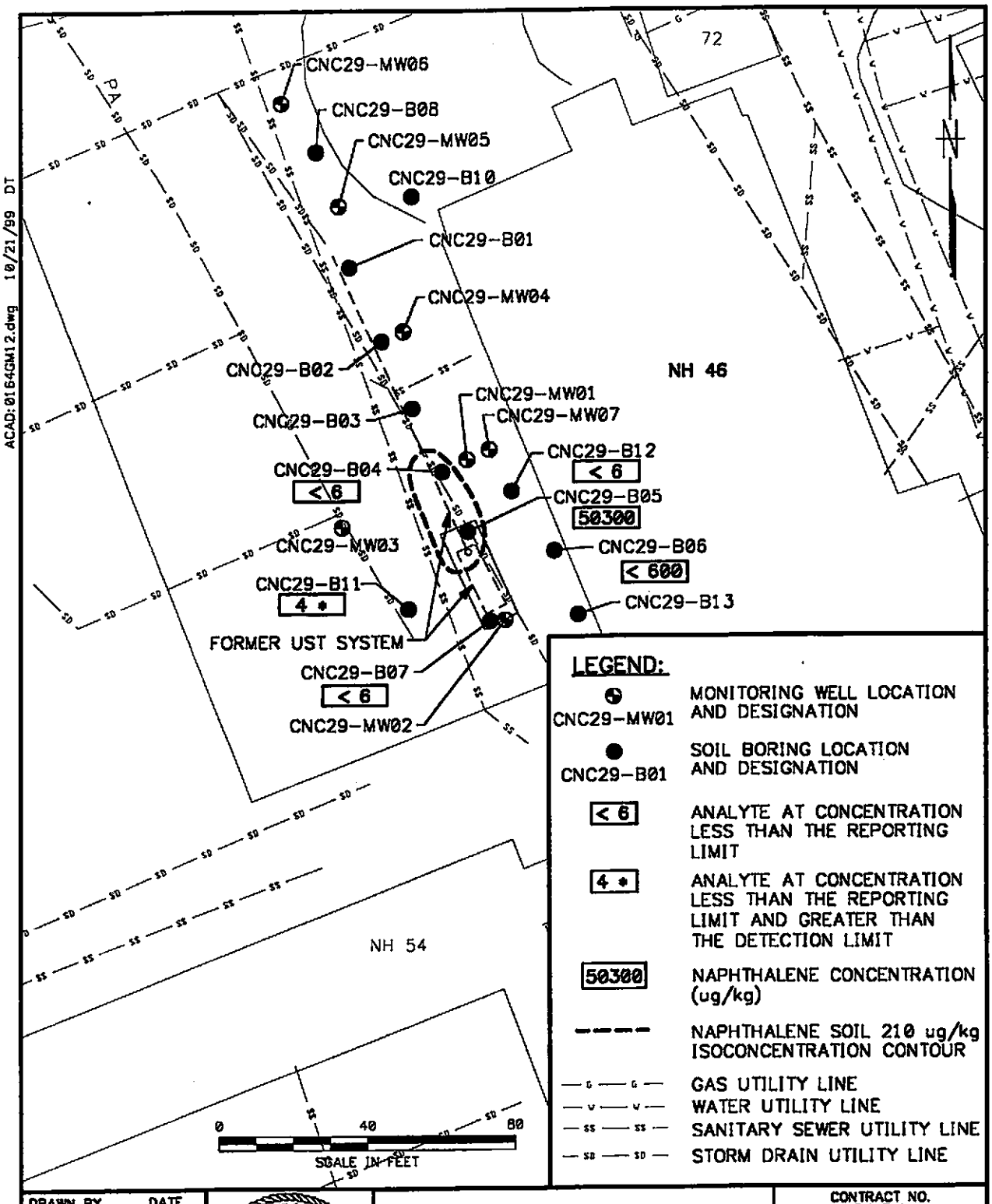
DRAWN BY DLT DATE 10/20/99		ETHYLBENZENE SOIL CONCENTRATION MAP (JUNE 1999) SITE 29, BUILDING NH 46 ZONE C, CHARLESTON NAVAL COMPLEX NORTH CHARLESTON, SOUTH CAROLINA	CONTRACT NO. 0164
CHECKED BY DATE			APPROVED BY DATE
COST/SCHED-AREA			APPROVED BY DATE
SCALE AS NOTED			DRAWING NO. FIGURE 10 REV. 0

FORM CADD NO. SDIV_AV.DWG - REV 0 - 1/20/98



DRAWN BY DATE: DLT 10/20/99		TOTAL XYLENES SOIL CONCENTRATION MAP (JUNE 1999) SITE 29, BUILDING NH 46 ZONE C, CHARLESTON NAVAL COMPLEX NORTH CHARLESTON, SOUTH CAROLINA	CONTRACT NO. 0164
CHECKED BY DATE			APPROVED BY DATE
COST/SCHED-AREA			APPROVED BY DATE
SCALE: AS NOTED			DRAWING NO. FIGURE 11 / REV. 0

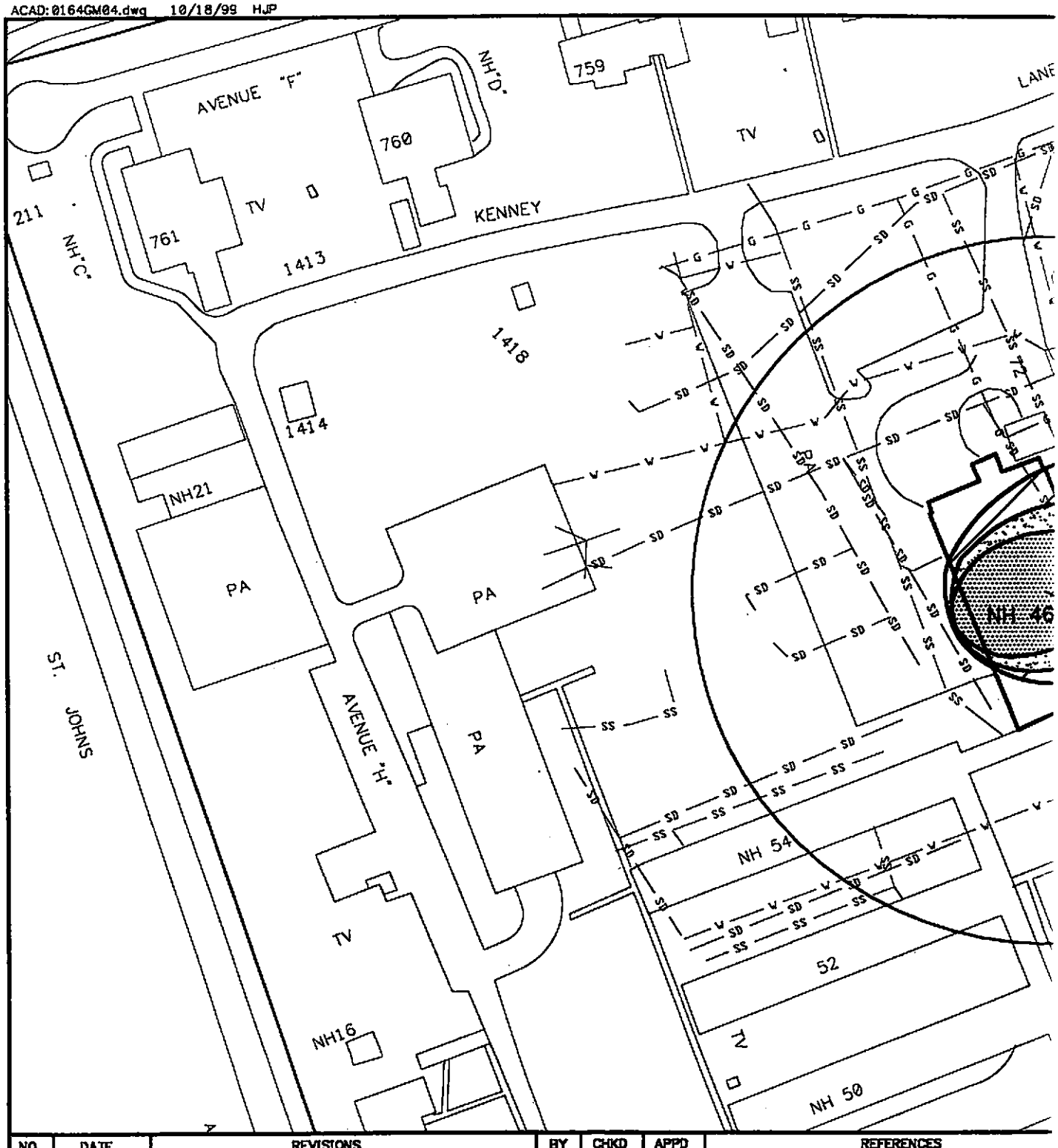
FORM CADD NO. SDIV_AV.DWG - REV 0 - 1/20/98



DRAWN BY DLT DATE 10/20/99		NAPHTHALENE SOIL CONCENTRATION MAP (JUNE 1999) SITE 29, BUILDING NH 46 ZONE C, CHARLESTON NAVAL COMPLEX NORTH CHARLESTON, SOUTH CAROLINA	CONTRACT NO. 0164
CHECKED BY DATE			APPROVED BY DATE
COST/SCHED-AREA			APPROVED BY DATE
SCALE AS NOTED			DRAWING NO. FIGURE 12 REV. 0

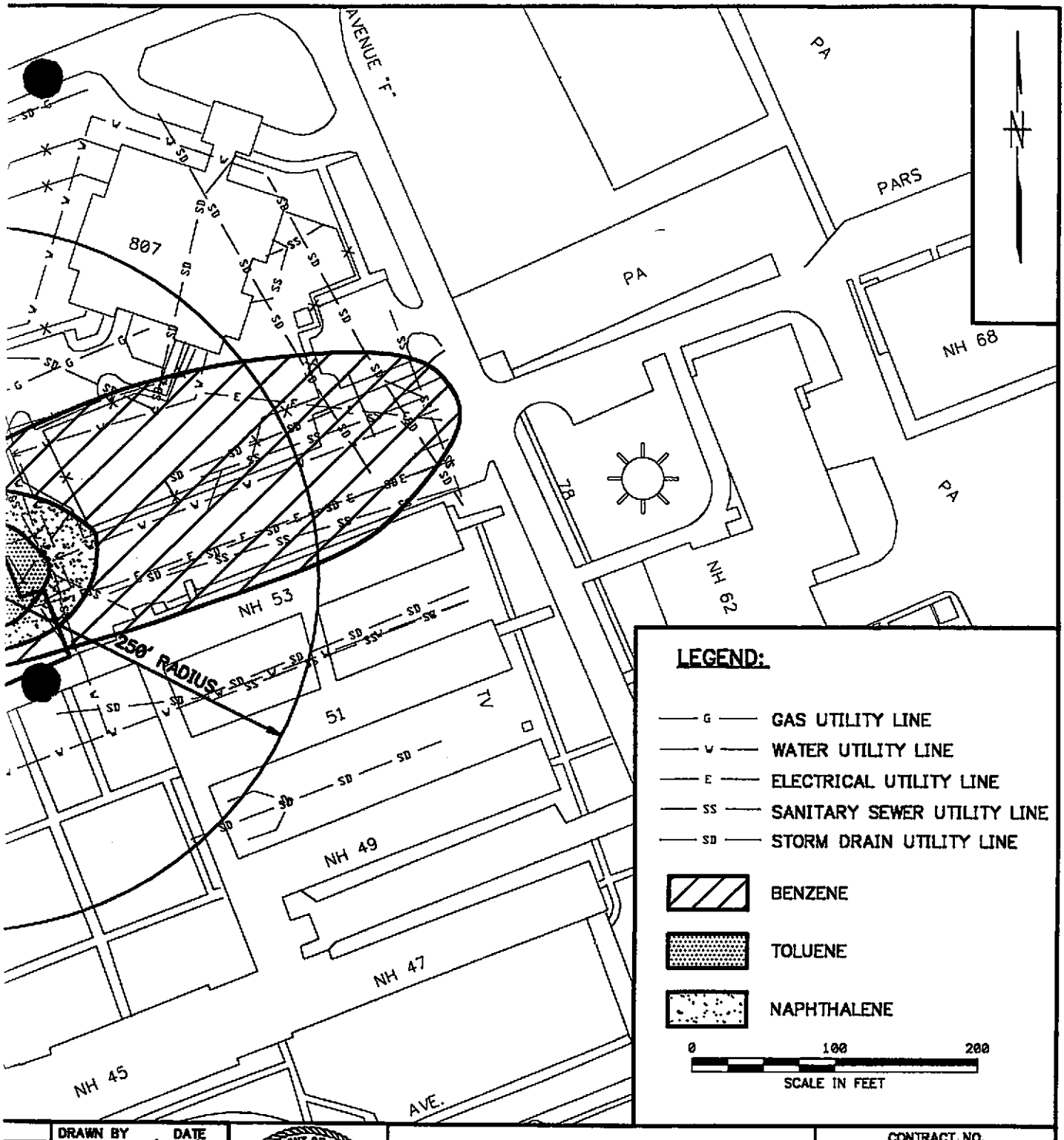
FORM CADD NO. SDIV_AV.DWG - REV 0 - 1/20/98

ACAD: 0164GM04.dwg 10/18/99 HJP

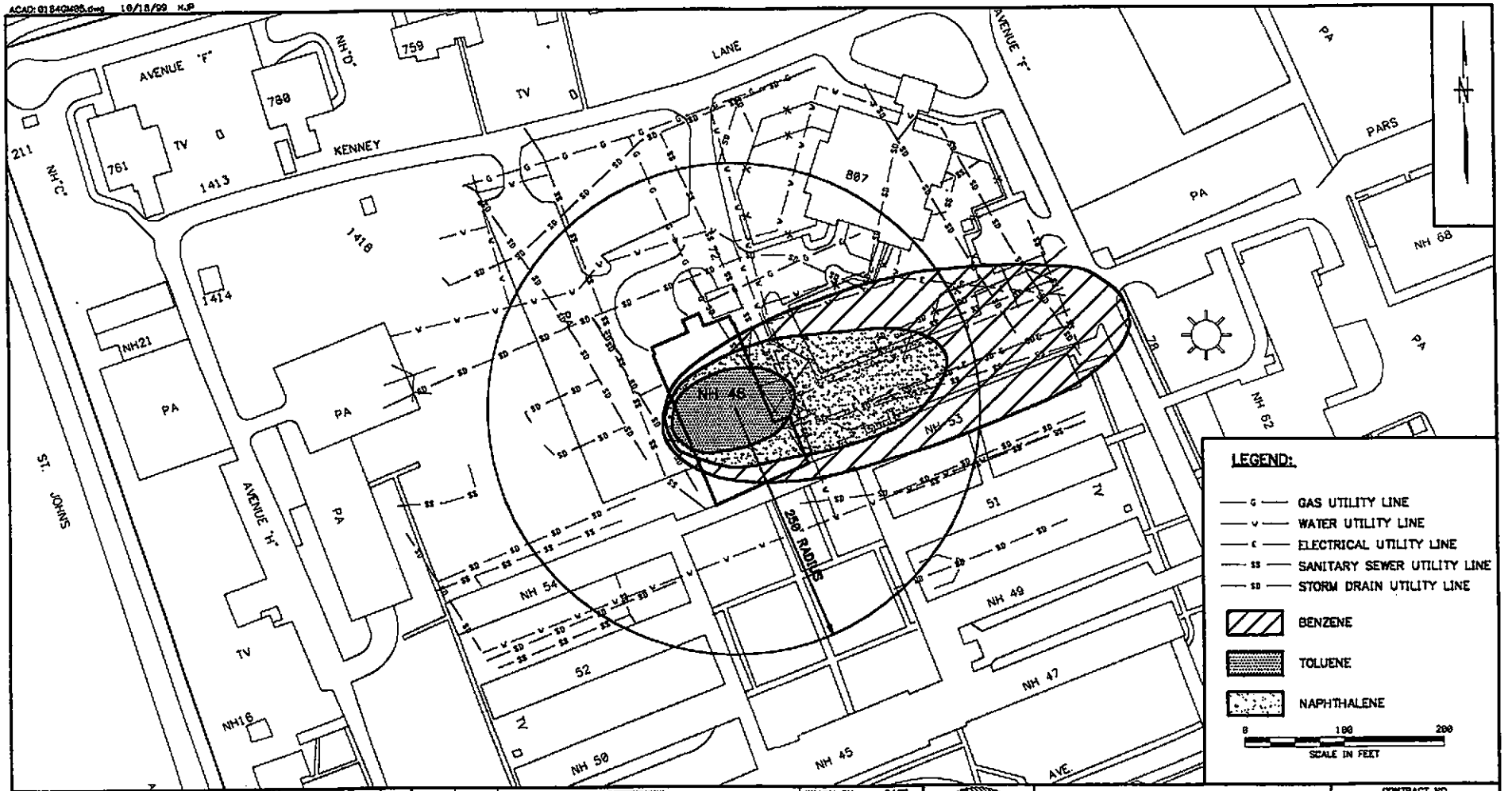


NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

FORM CADD NO. SDIV_BH.DWG - REV 0 - 1/20/98



DRAWN BY HJP DATE 10/18/99		PREDICTED 10-YEAR MIGRATION SITE 29, BUILDING NH 46 ZONE C, CHARLESTON NAVAL COMPLEX NORTH CHARLESTON, SOUTH CAROLINA	CONTRACT NO. 0164
CHECKED BY DATE			APPROVED BY DATE
COST/SCHED--AREA			APPROVED BY DATE
SCALE AS NOTED			DRAWING NO. FIGURE 13 REV. 0



NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY HJP DATE 10/18/99
CHECKED BY DATE
COST/SCHED--AREA
SCALE AS NOTED

PREDICTED 20-YEAR MIGRATION
SITE 29, BUILDING NH 46
ZONE C, CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA

CONTRACT NO. 0164
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 14
REV. 0

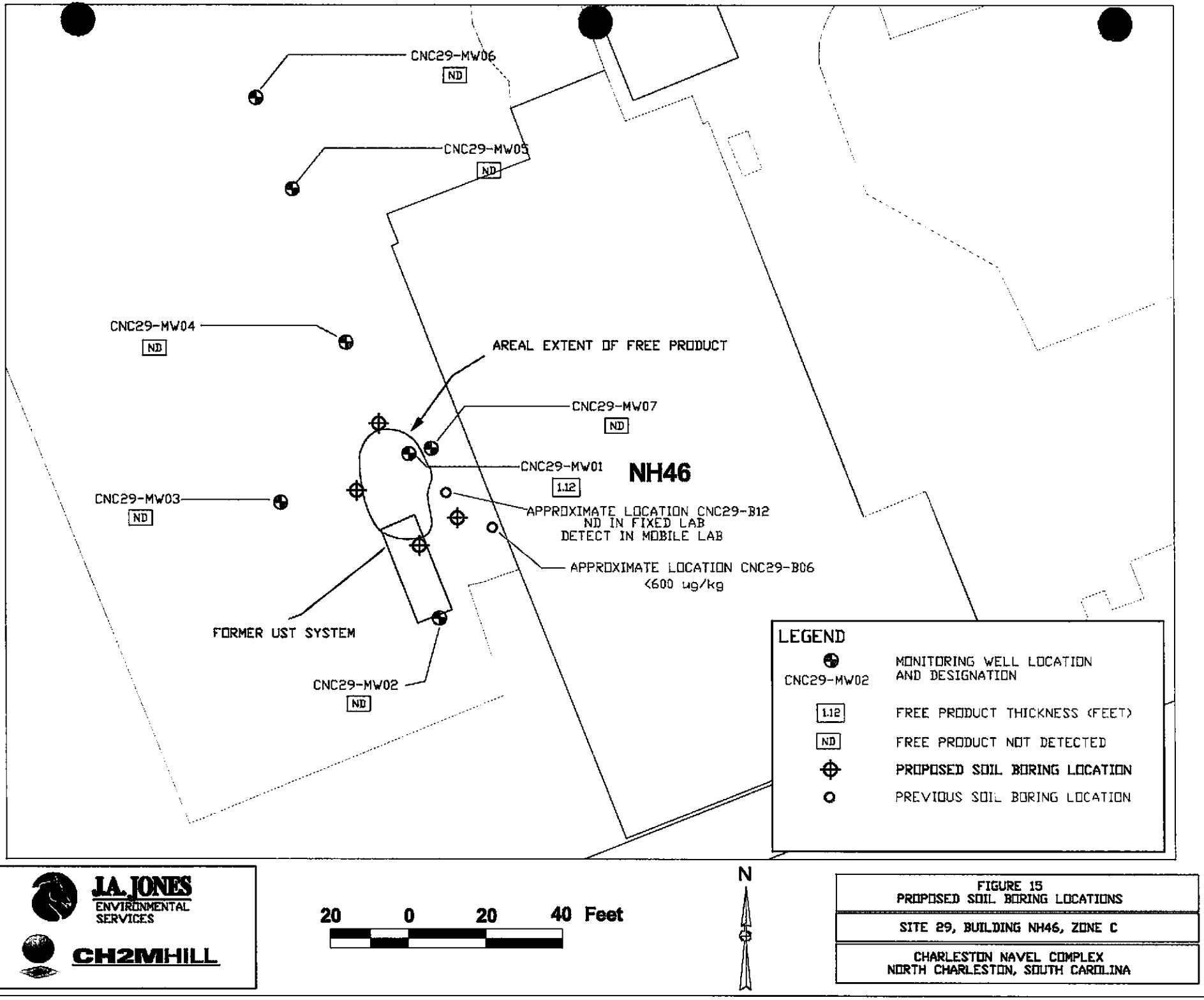


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FIGURE 15
PROPOSED SOIL BORING LOCATIONS

SITE 29, BUILDING NH46, ZONE C

CHARLESTON NAVEL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA