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SAMPLING AND ANALYSIS PLAN FOR ZONE F SITE 22 BUILDING 242 SITE IDENTIFICATION NUMBER 10645 CNC CHARLESTON SC

8/1/2000

CH2M HILL

SAMPLING AND ANALYSIS PLAN
FOR
ZONE F/ SITE 22- BUILDING 242

SITE IDENTIFICATION # 10645

Charleston Naval Complex
Charleston, South Carolina

SOUTHERN DIVISION
NAVAL FACILITIES ENGINEERING COMMAND

Contract Number N62467-99-C-0960

August 2000

SAMPLING AND ANALYSIS PLAN
FOR
ZONE F/ SITE 22-BUILDING 242

SITE IDENTIFICATION # 10645

Charleston Naval Complex
Charleston, South Carolina

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

Submitted by:
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Contract Number: N62467-99-C-0960

August 2000

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ACRONYMS

AST	Aboveground Storage Tank
bls	below land surface
BTEX	Benzene, Toluene, Ethylbenzene, and Xylene Isomers
CAP	Corrective Action Plan
CNC	Charleston Naval Complex
COC	Chemical of Concern
EISOPQAM	Environmental Investigations Standard Operating Procedures and Quality Assurance Manual
EPA	Environmental Protection Agency
ft	foot
mg/kg	microgram per kilogram
mg/L	microgram per liter
OVA	Organic Vapor Analyzer
QA	Quality Assurance
QC	Quality Control
RBSL	Risk-Based Screening Level
RDA	Redevelopment Authority
SAP	Sampling and Analysis Plan
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

1.0 INTRODUCTION

This Sampling and Analysis Plan (SAP) has been prepared by CH2M-JONES, LLC. The plan is designed for Zone F/ Site 22-Building 242; Underground Storage Tank (UST) 242 located at the Charleston Naval Complex (CNC), Charleston, South Carolina.

The South Carolina Department of Health and Environmental Control (SCDHEC) has designated this site as Identification Number: 10645. This SAP provides methods to further evaluate the applicability of intrinsic remediation and monitoring well abandonment as a corrective action for UST 242 in accordance with SCDHEC Corrective Action Guidance, June 1997.

1.1 General Site Description

The CNC is in the city of North Charleston, on the west bank of the Cooper River in Charleston County, South Carolina as shown in 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 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.

Building 242 is a garage constructed in 1989 and was last occupied in March 1996. UST 242 was a 5,000 gallon waste oil tank on the east side of the building. The UST was installed in 1989 and was equipped with a leak detection monitor with an alarm in the garage supervisors office. The UST was an Owens-Corning double wall fiberglass tank (Tetra Tech NUS, Inc. [TTNUS] Rapid Assessment [RA], 2000).

1.2 Objective

This RA presents the groundwater monitoring plan to assess the down gradient plume migration and intrinsic bioremediation/natural attenuation of petroleum hydrocarbons contamination in order to validate the assumptions and calculations used in the in the RA completed by TTNUS 2000. Details for the abandonment of monitoring wells at this site are also included in this plan.

2.0 RECEPTOR SURVEY

A receptor survey of the site vicinity was conducted by TTNUS to identify potential receptors for petroleum hydrocarbon contamination. Figure 2 depicts the public utilities located within 250 feet of the former UST 242 study area. Specific information concerning the depth of utilities below land surface (bls) is currently unavailable, however, utilities at this site generally are between 2 to 6 feet (ft) bls. The following utility receptors were located:

Sanitary sewer, water utility: A sanitary sewer line originates to the northeast of Building 242. This line runs in a southeasterly direction toward 11th street, and then continues parallel to 11th street. A sewer line running parallel to Ramsey Street connects to this line at the streets intersection. This line runs underneath the west side of building 242. A sewer line also runs off this and connects to Building 1175, which is located to the east of Building 242. There are no water mains located within 250 feet of building 242.

Electrical utility, gas utility: A subsurface electrical line runs approximately 50 feet to the east of Building 242 and continues along the north side of Building to terminate on Avenue A south. A gas utility line runs approximately 50 feet south of Building 242, and connects to a gas utility line associated with Building 1175.

Storm drain utility: there are two storm drains located 80 feet east of Building 242.

Compressed air utility: A compressed air utility line runs parallel to Avenue A south on the west side of Building 242, and enters the north end of the Building.

According to the SLA report completed by TTNUS, 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 drinking water wells, which utilize the shallow aquifer, are located within a 4- mile radius of CNC. Irrigation wells are not identified within 1,000 feet of the site. Numerous monitoring wells are located within 1,000 feet of the site.

There are no city, county or state-zoning ordinances, the property (CNC) is currently owned by the federal government. Information concerning zoning ordinances was obtained from the SOUTHDIV Remedial Project Manager located at 2155 Eagle Drive, North Charleston, South Carolina 29406 (TTNUS, 1999).

2.1 Fate and Transport Modeling

The Dominico was the Fate and Transport model used to determine groundwater SSTLs in the risk analysis. The impacted groundwater source area was modeled as 50 feet wide and 6.56 feet deep according to the RA report.

2.2 Soil Leaching SSTL

Soil leaching SSTLs were calculated for benzene and naphthalene concentrations leaching from subsurface soil to groundwater using SCDHEC Soil Leachability Model and Selected Minimum RBSLs. The soil leaching SSTLs calculated in the RA for benzene and naphthalene are provided in the table below:

Chemical of Concern	Concentration in CNC-B05/ 22SLB050304	Soil Leaching SSTL (mg/kg)
Benzene	0.005	0.602
Naphthalene	0.572	126.72

3.0 PROPOSED REMEDIATION TECHNOLOGY

Based on the results of the RA modeling, an Intrinsic Remediation with a monitoring period of 12 months will be performed for the site. The monitoring program will consist of sampling initially a total of five surrounding wells adjacent to the source point, and only sampling selected wells thereafter. The proposed monitoring program is described in detail in Sections 4.0 and 5.0 of this plan.

4.0 MONITORING WELL INSTALLATION AND ABANDONMENT

4.1 Monitoring Well Installation

Because of the large amount of monitoring wells located in and around this site, no monitoring wells will be installed as part of this plan.

4.2 Monitoring Well Abandonment

Seven monitoring wells will be abandoned at Building 242 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. - CHECK WITH IR. TO SEE IF IR NEEDS WELLS

4.3 Surveying

Because no monitoring wells will be installed at this site, a new survey will not be conducted.

4.4 Equipment Decontamination

All drilling equipment, augers, well casing and screens, and soil and groundwater sampling equipment involved in field sampling activities will be decontaminated according to the Environmental Protection Agencies (EPA) " Environmental Investigations Standard Operating Procedures and Quality Assurance Manual (EISOPQAM).

5.0 PROPOSED GROUNDWATER MONITORING PROGRAM

5.1 Monitoring Frequency and Reporting

The groundwater monitoring program proposed at building 242 will be performed in accordance with SCDHEC Corrective Action Guidance, June 1997, and consist of the following:

TABLE 4

Sampling date	Monitoring Wells Sampled	Field Measures	Laboratory Analytical
Second half [1] 2000	CNC22- MW-01, MW-02, MW-03, MW-04, MW-05, MW-06, MW-07	T°, pH, DO, Conductivity, Depth to water, Total depth, Turbidity	MTBE 8260 Naphthalene 8260 BTEX 8260 Sulfate, nitrate, total dissolved iron, alkalinity, methane
First half [2] 2001	CNC22- MW-03, MW-04, MW-06	T°, pH, DO, Conductivity, Depth to water, Total depth, Turbidity	MTBE 8260 Naphthalene 8260 BTEX 8260 Sulfate, nitrate, total dissolved iron, alkalinity, methane

1. Second half is defined by the second half of the year (July through December).
2. First half is defined by the first half of the year (January through June).

- **Frequency:** Initially all monitoring wells at this site will be sampled. Thereafter, groundwater samples will be collected from wells MW-03 as a source well, MW-06 as the up gradient well and MW-04 as the down gradient well.

- **Reporting:** Semi-annual groundwater monitoring reports will be submitted to SCDHEC.

Included in the semi-annual reports will be field and analytical information from the certified laboratory indicating well numbers, analytical methods used, date sampled, date analyzed, and method detection limits.

At the end of the 12-month period, (or as necessary) a performance evaluation will be submitted to SCDHEC providing the effectiveness of the intrinsic biodegradation/natural attenuation occurring and any recommendations for the site.

- **Groundwater Sampling**

Prior to any groundwater sampling, each well will be measured for water levels and total depth and each well will be purged in accordance the EPA EISOPQAM.

5.2 Analytical Parameters

The following constituents will be analyzed for each groundwater sample:

- Naphthalene using method 8260.
- BTEX using method 8260
- MTBE using method 8260

The following parameters will be analyzed in order to evaluate the effectiveness of intrinsic remediation:

- Nitrate (NO^{-3})
- Sulfate (SO^{-4})
- Total dissolved iron
- Methane (CH_4)
- Alkalinity

5.3 Field Measurements

The following parameters will be sampled in the field:

- Temperature
- pH
- Dissolved Oxygen
- Depth to water table
- Depth of well
- Turbidity
- Specific Conductance

Field measurements will be recorded in the field book and in field forms.

5.4 Groundwater Level Measurements

Groundwater measurements will be taken from all monitoring wells at the site during each sampling event. All water level measurements will be taken on the same day as anticipated sampling.

Measurements will be taken with an electrical water level meter or interface probe if floating product is present using the highest part of the top of the casing as a reference point for determining depths to water and total depths. Water level measurements will be recorded to the nearest 0.01-foot in the field book.

5.5 Sample Handling

Sample Handling will be conducted with the following references:

EPA EISOPQAM (EPA May, 1996)
Charleston Naval Shipyard Sampling and Analysis Plan, June 1999

5.6 Sample Packing and Shipping

The following forms will be completed to complete the packing/shipping process:

- Sample labels
- Chain-of-custody labels
- Appropriate labels applied to shipping coolers
- Chain-of-custody forms
- Federal express air bills

5.7 Quality Check

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 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.

5.8 Field QA/QC

More information on field QC can be found in section 5.6

5.9 Control Limits

TABLE 5

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.

5.10 Record keeping

In addition to records kept in logbooks, forms will be kept on log sheets for soil and groundwater. See Appendix B.

5.11 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-~~7307~~
   5525

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

REFERENCES

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

Tetra Tech NUS, Inc.; 1999 Rapid Assessment for Site 22 (Building 242), Charleston, South Carolina.

United States Environmental Protection Agency. 1990. Code of Federal Regulations 136.

United States Environmental Protection Agency. 1988. EPA Users Guide to Contract Laboratory Program.

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

APPENDIX A

IN-SITU SOIL RISK EVALUATION

SOUTH CAROLINA
Department of Health and Environmental Control (DHEC)

Site Data

SITE ID #		COUNTY	Columbia
FACILITY NAME	Site 22, Building 242		
STREET ADDRESS	Charleston Naval Complex, North Charleston, SC		

Soil Risk Evaluation Data

					Figure
TPH		381	mg/kg		
Soil % SAND (Estimated)		64	%		
Soil % CLAY (Estimated)		25	%		
Worst Case	Benzene	0.005	mg/kg	Cs	
Soil Analyses	Toluene		mg/kg	Cs	
	Ethylbenzene		mg/kg	Cs	
	Xylenes		mg/kg	Cs	
	Naphthalene	0.572	mg/kg	Cs	
	MTBE		mg/kg	Cs	
Natural Organic Carbon Content		4470	mg/kg	foc	
Average Annual Recharge		25	cm	Hw	
Distance from highest Soil Impact to water table		60.960	cm	L	
Bulk Density of Soil		1.64	g/cc	Bd	1
Wetting Front Suction		15	cm	Hf	2
Soil Hydraulic Conductivity		1.13E-04	cm/sec	Kf	3
Porosity		0.45	decimal %	Φ	4
Residual Water Content		0.09	decimal %	Wr	5

List possible human exposure pathways from surface soil.
Soil leaching to groundwater - off-site ingestion or irrigational use of shallow groundwater.

IN-SITU SOIL RISK EVALUATION

SOIL LEACHABILITY MODEL FOR BENZENE

RISK-BASED CORRECTIVE ACTION FOR PETROLEUM RELEASES

SITE INFORMATION:

Site: [redacted]

Location: [redacted]

REFERENCES:

(1) SCDHEC, RBCA For Petroleum Releases, June 1995, Appendix B, Figure 1.
(2) SCDHEC, RBCA For Petroleum Releases, June 1995, Appendix B, Table 2.
(3) SCDHEC, RBCA For Petroleum Releases, June 1995, Appendix B, Input Parameters.
(4) SCDHEC, RBCA For Petroleum Releases, June 1995, Appendix B, Table 1.
(5) SCDHEC, RBCA For Petroleum Releases, June 1995, Appendix B, Figure 2.
(6) SCDHEC, RBCA For Petroleum Releases, June 1995, Appendix B, Figure 3.
(7) SCDHEC, RBCA For Petroleum Releases, June 1995, Appendix B, Figure 4.
(8) SCDHEC, RBCA For Petroleum Releases, June 1995, Appendix B, Figure 5.

INPUT:

COC	Chemical of Concern		BENZENE
Bd	Soil Bulk Density (1)	g/cm3	1.64
Crabl	Risk Based Screening Level	mg/L	0.15
Cs	Concentration of COC in soil	mg/kg	0.005
DAF	Dilution/Attenuation Factor (2)	unitless	8
foc	Organic Carbon Content in Soil (3)	mg/kg	4470
H'	Henry's Law Constant (4)	unitless	0.23
Hf	Wetting front suction head (always negative) (5)	cm	-15
Hw	Average Annual Recharge (3)	cm	25.00
Kf	Soil Hydraulic Conductivity (6)	cm/s	1.13E-04
Koc	Soil/Water Partioning Coefficient (2)	ml/g	81
L	Depth between soil sample with greatest COC concentration to groundwater.	cm	61
Φ	Porosity (7)	unitless	0.45
t1/2	Biodegradation "half life" (2)	days	16
TPH	Total Petroleum Hydrocarbons, EPA Method 3550	mg/kg	381
Wr	Residual Water Content (8)	volume fraction	0.09

CALCULATIONS:

Equation Set I - Determine soil pore water concentration resulting from physical partioning (Cw).

Step 1 - Calculate the total organic carbon content (fcs) of the soil.

fcs = (foc +TPH/1.724)*1E-6 = 0.0047 decimal %

Step 2 - Calculate the concentration of COC in soil pore water (Cw) directly in contact with the contaminate soil.

Cw = Cs*((Wr *1g/cc+Bd)/((Bd*Koc*fcs)+Wr+((ø-Wr)*H'))) = 0.0109 mg/l

Equation Set II - Determine the velocity of the soil pore water (Vw)

Step 1 - Calculate the air filled porosity (f) in decimal percent.

f = ø - Wr = 0.36 decimal %

Step 2 - Determine the time for water to percolate through the vadose zone soil (from depth of worst case soil sample to the water table at site).

t = (f/Kf)*(L-((Hw-Hf)*(ln((Hw+L-Hf)/(Hw-Hf))))) = 76,225 seconds

Step 3 - Determine the velocity of the water (Vw) in feet per year.

Vw = (L/30.48cm/ft)/(t/31,500,000sec/year) = 826 ft/year

Equation Set III - Determine the organic retardation effect (Vc) of the contaminant.

Step 1 - Calculate the soil/water distribution coefficient (Kd) (ml/g) for uncontaminated soil.

Kd = Koc*foc*1E-6 = 0.36207 ml/g

Step 2 - Calculate the retardation effect of natural soil organic matter on COC migration.

Vc = Vw/(1+((Bd*Kd)/ø)) = 356 ft/year

Equation Set IV - Determine biodegradation rates and provide final COC concentration (Cf) at depth of concern.

Step 1 - Calculate the time (Tc) in days required for the COC to reach groundwater.

Tc = 365 day/yr*((L/30.48cm/ft)/Vc) = 2.05 days

Step 2 - Calculate estimated concentration of COC in the soil pore water (Cp) necessary to protect groundwater.

Cp = 10^(log (Crsbl)+((Tc/2.3)*(0.693/t1/2))) = 0.1639 mg/l

COC concentration in soil pore water (Cw) is less than concentration necessary to protect groundwater (Cp). Not necessary to calculate SSTL

Equation Set V - Calculate the Site Specific Target Level (SSTL) for the COC in soil.

Csstl for BENZENE in soil = Cp*DAF*(((Bd*Koc*fcs)+Wr+(F*'H'''))/(Wr*1g/cc+Bd)) = **0.602236** mg/kg

PREPARED BY:_____

Date

CHECKED BY:_____

Date

IN-SITU SOIL RISK EVALUATION

SOUTH CAROLINA
Department of Health and Environmental Control (DHEC)

Site Data

SITE ID # 0
FACILITY NAME Site 22, Building 242

Instructions

Provide results, separately, for each constituent in the worst case soil analysis.

Data

List Constituent: BENZENE
(BTEX, Napth.)

				Table
Bioremediation "half-life"	16	days	t 1/2	1
Soil/water partitioning coefficient	81	ml/g	K oc	1

Results

				Equation Set	Step
Total Organic Carbon Content	0.0045	decimal %	f cs	I	1
Leachate Concentration	0.011	mg/l	C w	I	2
Air Filled Porosity	0.36	decimal %	f	II	1
Infiltration Rate Time	76,225	seconds	t	II	2
Velocity of Water	826	ft/year	V w	II	3
Soil/Water Distribution Coefficient	0.3621	ml/g	K d	III	1
Contaminant Percolation Rate	356	ft/year	V c	III	2
Time to Reach Groundwater	2.05	days	T c	IV	1
Concentration reaching Groundwater	0.1639	mg/l	C p	IV	2
Site Specific Target Level	**0.60**	mg/kg	C sstl	V	

Conclusions

Does concentration of chemical of concern in soil exceed SSTL? NO

Risk of Human Exposure due to contaminated soil.

_____ YES X NO

IN-SITU SOIL RISK EVALUATION

SOIL LEACHABILITY MODEL FOR NAPHTHALENE

RISK-BASED CORRECTIVE ACTION FOR PETROLEUM RELEASES

SITE INFORMATION:

Site: Site 22, Building 242

Location: Charleston Naval Complex, North Charleston, SC

REFERENCES:

(1) SCDHEC, RBCA For Petroleum Releases, June 1995, Appendix B, Figure 1.
(2) SCDHEC, RBCA For Petroleum Releases, June 1995, Appendix B, Table 2.
(3) SCDHEC, RBCA For Petroleum Releases, June 1995, Appendix B, Input Parameters.
(4) SCDHEC, RBCA For Petroleum Releases, June 1995, Appendix B, Table 1.
(5) SCDHEC, RBCA For Petroleum Releases, June 1995, Appendix B, Figure 2.
(6) SCDHEC, RBCA For Petroleum Releases, June 1995, Appendix B, Figure 3.
(7) SCDHEC, RBCA For Petroleum Releases, June 1995, Appendix B, Figure 4.
(8) SCDHEC, RBCA For Petroleum Releases, June 1995, Appendix B, Figure 5.

INPUT:

			NAPHTHALENE
COC	Chemical of Concern		
Bd	Soil Bulk Density (1)	g/cm3	1.64
Crsbl	Risk Based Screening Level	mg/L	1.63
Cs	Concentration of COC in soil	mg/kg	0.572
DAF	Dilution/Attenuation Factor (2)	unitless	8
foc	Organic Carbon Content in Soil (3)	mg/kg	4470
H'	Henry's Law Constant (4)	unitless	0.23
Hf	Wetting front suction head (always negative) (5)	cm	-15
Hw	Average Annual Recharge (3)	cm	25
Kf	Soil Hydraulic Conductivity (6)	cm/s	0.0001
Koc	Soil/Water Partioning Coefficient (2)	ml/g	1543
L	Depth between soil sample with greatest COC concentration to groundwater.	cm	61
ø	Porosity (7)	unitless	0.45
t1/2	Biodegradation "half life" (2)	days	48
TPH	Total Petroleum Hydrocarbons, EPA Method 3550	mg/kg	381
Wr	Residual Water Content (8)	volume fraction	0.09

CALCULATIONS:

Equation Set I - Determine soil pore water concentration resulting from physical partioning (Cw).

Step 1 - Calculate the total organic carbon content (fcs) of the soil.

fcs = (foc + TPH/1.724)*1E-6 = 0.0047 decimal %

Step 2 - Calculate the concentration of COC in soil pore water (Cw) directly in contact with the contaminate soil.

Cw = Cs*((Wr *1g/cc + Bd)/((Bd*Koc*fcs) + Wr + ((ø-Wr)*H'))) = 0.01 mg/l

Equation Set II - Determine the velocity of the soil pore water (Vw)

Step 1 - Calculate the air filled porosity (f) in decimal percent.

f = ø - Wr = 0.36 decimal %

Step 2 - Determine the time for water to percolate through the vadose zone soil (from depth of worst case soil sample to the water table at site).

t = (f/Kf)*(L-(Hw-Hf))*(ln(Hw + ((L-Hf)/(Hw-Hf)))) = 76,225 seconds

Step 3 - Determine the velocity of the water (Vw) in feet per year.

Vw = (L/30.48cm/ft)/(t/31,500,000sec/year) = 826 ft/year

Equation Set III - Determine the organic retardation effect (Vc) of the contaminant.

Step 1 - Calculate the soil/water distribution coefficient (Kd) (ml/g) for uncontaminated soil.

Kd = Koc*foc*1E-6 = 6.89721 ml/g

Step 2 - Calculate the retardation effect of natural soil organic matter on COC migration.

Vc = Vw*(1 + ((Bd*Kd)/ø)) = 32 ft/year

Equation Set IV - Determine biodegradation rates and provide final COC concentration (Cf) at depth of concern.

Step 1 - Calculate the time (Tc) in days required for the COC to reach groundwater.

Tc = 365 day/yr*((L/30.48cm/ft)/Vc) = **23.08** days

Step 2 - Calculate estimated concentration of COC in the soil pore water (Cp) necessary to protect groundwater.

Cp = 10^(log (Crsbl)+((Tc/2.3)*(0.693/t1/2))) = **2.28** mg/l

COC concentration in soil pore water (Cp) is greater than Crsbl, therefore the SSTL must be calculated.

Equation Set V - Calculate the Site Specific Target Level (SSTL) for the COC in soil.

Csstl for APHTHALENE in soil = Cp*DAF*(((Bd*Koc*fcs)+Wr+(F*'H''))/(Wr*1g/cc+Bd)) = **126.718125** mg/kg

PREPARED BY:_____

Date

CHECKED BY:_____

Date

IN-SITU SOIL RISK EVALUATION

SOUTH CAROLINA
Department of Health and Environmental Control (DHEC)

Site Data

SITE ID # 0
FACILITY NAME Site 22, Building 242

Instructions

Provid results, separately, for each constituent in the worst case soil analysis.

Data

List Constituent: NAPHTHALENE
(BTEX, Napth.)

				Table
Bioremediation "half-life"	48	days	t 1/2	1
Soil/water partitioning coefficient	1543	ml/g	K oc	1

Results

				Equation Set	Step
Total Organic Carbon Content	0.0045	decimal %	f cs	I	1
Leachate Concentration	0.007	mg/l	C w	I	2
Air Filled Porosity	0.36	decimal %	f	II	1
Infiltration Rate Time	76,225	seconds	t	II	2
Velocity of Water	826	ft/year	V w	II	3
Soil/Water Distribution Coefficient	6.90	ml/g	K d	III	1
Contaminant Percolation Rate	32	ft/year	V c	III	2
Time to Reach Groundwater	23	days	T c	IV	1
Concentration reaching Groundwater	2.28	mg/l	C p	IV	2
Site Specific Target Level	**126.72**	mg/kg	C sstl	V	

Conclusions

Does concentration of chemical of concern in soil exceed SSTL? NO

Risk of Human Exposure due to contaminated soil.

_____ **YES** X **NO**

IN-SITU SOIL RISK EVALUATION

APPENDIX B

APPENDIX C

SITE 22
ZONE F, CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA
SCDHEC UST ID No. 10646

DOMENICO'S DILUTION/ATTENUATION EQUATION FOR GROUNDWATER TRANSPORT

Site-Specific Target Level Calculations for Groundwater: Potential Future Migration to the Cooper River

Parameter Descriptions:	Units
POE = Point of Exposure	
SSTL = Site-Specific Target Level	mg/L
$SSTL_{SOURCE}$ = Hydrocarbon Concentration in Plume Source Area protective of RBSLs at POE	mg/L
$SSTL_{COMP}$ = Hydrocarbon Concentration at Compliance Point protective of RBSLs at POE	mg/L
X_{POE} = x = Distance from Plume Source to POE (along Centerline)	m
X_{COMP} = x = Distance from POE to Compliance Point (along Centerline)	m
Y = Source Width (Perpendicular to Flow Direction)	m
Z = Source Depth (Perpendicular to Flow Direction in Vertical Plane)	m
K_s = Saturated Hydraulic Conductivity	m/sec
I = Groundwater Gradient	cm/cm
θ = Porosity in Saturated Zone	cm^3/cm^3

Parameter Descriptions:	Units
ρ_s = Soil Bulk Density	g/cm^3
f_{oc} = Fraction Organic Carbon in Soil	g-C/g-soil
α_X = Longitudinal Dispersivity = 0.2x	m
α_Y = Transverse Dispersivity = $\alpha_X/300$	m
α_Z = Vertical Dispersivity = 1×10^{-40}	m
k_{oc} = Organic Carbon Partition Coefficient	cm^3-H_2O/g-C
k_o = Soil-Water Sorption Coefficient	cm^3-H_2O/g-soil
V = Pore Water Velocity	m/sec
R_c = Constituent Retardation Factor	
V/R_c = Maximum Transport Rate of Dissolved Constituent = $(K_sI/\theta R_c)$	m/sec
RBSL = Risk-Based Screening Level in Water Provided by SCDHEC (1998)	mg/L

Dilution & Attenuation without Biological Decay

Constituent	X_{POE} ft	X_{POE} m	Y m	Z m	t sec	K_s m/sec	I m/m	θ cm^3/cm^3	ρ_s g/cm^3	α_X m	α_Y m	α_Z m	f_{oc} g-C/g-soil	k_{oc} cm^3-H_2O/g-C	k_o cm^3-H_2O/g-s	V m/sec	R_c	C_{POE}/C_{SOURCE}
Benzene	720	219.459	15	2	1.00E+13	1.13E-06	0.0027	0.45	1.64	21.96	7.32	1.10	4.47E-03	83	0.37101	6.78E-09	2.352	7.646E-03
MTBE	720	219.459	15	2	1.00E+13	1.13E-06	0.0027	0.45	1.64	21.96	7.32	1.10	4.47E-03	11.5	0.051405	6.78E-09	1.187	7.646E-03

Constituent	X_{COMP} ft	X_{COMP} m	Y m	Z m	t sec	K_s m/sec	I m/m	θ cm^3/cm^3	ρ_s g/cm^3	α_X m	α_Y m	α_Z m	f_{oc} g-C/g-soil	k_{oc} cm^3-H_2O/g-C	k_o cm^3-H_2O/g-s	V m/sec	R_c	C_{POE}/C_{COMP}
Benzene	686	209.791	15	2	1.00E+12	1.13E-06	0.0027	0.45	1.64	20.88	6.96	1.04	4.47E-03	83	0.37101	6.78E-09	2.352	8.444E-03
MTBE	686	209.791	15	2	1.00E+13	1.13E-06	0.0027	0.45	1.64	20.88	6.96	1.04	4.47E-03	11.5	0.051405	6.78E-09	1.187	8.444E-03

Source: South Carolina Department of Health and Environmental Control (SCDHEC) 1998. *Risk-Based Corrective Action for Petroleum Releases*, Bureau of Underground Storage Tank Management.

DOMENICO DILUTION/ATTENUATION MODEL WITHOUT BIOLOGICAL DECAY

$$\frac{C_X}{C_{SOURCE}} = \frac{1}{2} erfc \left[\frac{\left(x - \frac{vt}{R_c} \right)}{2\sqrt{\alpha_X \frac{vt}{R_c}}} \right] \times erf \left[\frac{Y}{4\sqrt{\alpha_Y x}} \right] \times erf \left[\frac{Z}{2\sqrt{\alpha_Z x}} \right]$$

Constituent	POE RBSL mg/L	$SSTL_{SOURCE}$ mg/L	$SSTL_{COMP}$ mg/L
Benzene	0.005	0.654	0.592
MTBE	0.040	5.231	4.737

SITE 22
ZONE F, CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA

DOMENICO'S DILUTION/ATTENUATION EQUATION FOR GROUNDWATER TRANSPORT

Predicted 10-year Migration of Constituents in Groundwater

Parameter Descriptions:	Units
POE = Point of Exposure	
SSTL = Site-Specific Target Level	mg/L
$SSTL_{SOURCE}$ = Hydrocarbon Concentration in Plume Source Area protective of RBSLs at POE	mg/L
$SSTL_{COMP}$ = Hydrocarbon Concentration at Compliance Point protective of RBSLs at POE	mg/L
X_{POE} = x = Distance from Plume Source to POE (along Centerline)	m
X_{COMP} = x = Distance from POE to Compliance Point (along Centerline)	m
Y = Source Width (Perpendicular to Flow Direction)	m
Z = Source Depth (Perpendicular to Flow Direction in Vertical Plane)	m
K_s = Saturated Hydraulic Conductivity	m/sec
I = Groundwater Gradient	cm/cm
θ = Porosity in Saturated Zone	cm^3/cm^3

Parameter Descriptions:	Units
ρ_s = Soil Bulk Density	g/cm^3
f_{oc} = Fraction Organic Carbon in Soil	g-C/g-soil
α_x = Longitudinal Dispersivity = x/10	m
α_y = Transverse Dispersivity = $\alpha_x/3$	m
α_z = Vertical Dispersivity = $\alpha_x/20$	m
k_{oc} = Organic Carbon Partition Coefficient	cm^3-H_2O/g-C
k_o = Soil-Water Sorption Coefficient	cm^3-H_2O/g-soil
V = Pore Water Velocity	m/sec
R_c = Constituent Retardation Factor	
V/R_c = Maximum Transport Rate of Dissolved Constituent = $(K_sI)/(\theta R_c)$	m/sec
RBSL = Risk-Based Screening Level in Water Provided by SCDHEC (1998)	mg/L

Dilution & Attenuation without Biological Decay

Constituent	X_{POE} ft	X_{POE} m	Y m	Z m	t sec	K_s m/sec	I m/m	θ m^3/cm^3	ρ_s g/cm^3	α_x m	α_y m	α_z m	f_{oc} g-C/g-soil	k_{oc} cm^3-H_2O/g-C	k_o cm^3-H_2O/g-soil	V m/sec	R_c	C_{POE}/C_{SOURCE}
Benzene	5.5	1.67642	15	2	3.15E+08	1.13E-06	0.0027	0.45	1.84	0.17	0.06	0.01	4.47E-03	83	0.37101	6.78E-09	2.352	8.228E-02
MTBE	2.7	0.82297	15	2	3.15E+08	1.13E-06	0.0027	0.45	1.84	0.08	0.03	0.00	4.47E-03	11.5	0.051405	6.78E-09	1.187	9.838E-01

Source: South Carolina Department of Health and Environmental Control (SCDHEC) 1998. *Risk-Based Corrective Action for Petroleum Releases*, Bureau of Underground Storage Tank Management.

DOMENICO DILUTION/ATTENUATION MODEL WITHOUT BIOLOGICAL DECAY

$$\frac{C_X}{C_{SOURCE}} = \frac{1}{2} erfc\left[\frac{\left(x - \frac{vt}{R_c}\right)}{2\sqrt{\alpha_X \frac{vt}{R_c}}}\right] \times erf\left[\frac{Y}{4\sqrt{\alpha_Y x}}\right] \times erf\left[\frac{Z}{2\sqrt{\alpha_Z x}}\right]$$

Constituent	C_{SOURCE} mg/L	C_X mg/L
Benzene	0.056	0.005
MTBE	0.042	0.040

Prepared By: [signature]

Reviewed By: [signature]

SITE 22
ZONE F, CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA

DOMENICO'S DILUTION/ATTENUATION EQUATION FOR GROUNDWATER TRANSPORT

Predicted 20-year Migration of Constituents in Groundwater

Parameter Descriptions:	Units
POE = Point of Exposure	
SSTL = Site-Specific Target Level	mg/L
$SSTL_{SOURCE}$ = Hydrocarbon Concentration in Plume Source Area protective of RBSLs at POE	mg/L
$SSTL_{COMP}$ = Hydrocarbon Concentration at Compliance Point protective of RBSLs at POE	mg/L
X_{POE} = x = Distance from Plume Source to POE (along Centerline)	m
X_{COMP} = x = Distance from POE to Compliance Point (along Centerline)	m
Y = Source Width (Perpendicular to Flow Direction)	m
Z = Source Depth (Perpendicular to Flow Direction in Vertical Plane)	m
K_s = Saturated Hydraulic Conductivity	m/sec
I = Groundwater Gradient	cm/cm
θ = Porosity in Saturated Zone	cm^3/cm^3

Parameter Descriptions:	Units
ρ_s = Soil Bulk Density	g/cm^3
f_{oc} = Fraction Organic Carbon in Soil	g-C/g-soil
α_x = Longitudinal Dispersivity = x/10	m
α_y = Transverse Dispersivity = $\alpha_x/3$	m
α_z = Vertical Dispersivity = $\alpha_x/20$	m
k_{oc} = Organic Carbon Partition Coefficient	cm^3-H_2O/g-C
k_D = Soil-Water Sorption Coefficient	cm^3-H_2O/g-soil
V = Pore Water Velocity	m/sec
R_c = Constituent Retardation Factor	
V/R_c = Maximum Transport Rate of Dissolved Constituent = $(K_s I)/(\theta R_c)$	m/sec
RBSL = Risk-Based Screening Level in Water Provided by SCDHEC (1998)	mg/L

Dilution & Attenuation without Biological Decay

Constituent	X_{POE} ft	X_{POE} m	Y m	Z m	t sec	K_s m/sec	I m/m	θ m^3/cm^3	ρ_s g/cm^3	α_x m	α_y m	α_z m	f_{oc} g-C/g-soil	k_{oc} cm^3-H_2O/g-C	k_D cm^3-H_2O/g-soil	V m/sec	R_c	C_{POE}/C_{SOURCE}
Benzene	11	3.35284	15	2	6.31E+08	1.13E-06	0.0027	0.45	1.64	0.34	0.11	0.02	4.47E-03	83	0.37101	6.78E-09	2.352	8.228E-02
MTBE	5	1.52402	15	2	6.31E+08	1.13E-06	0.0027	0.45	1.64	0.15	0.05	0.01	4.47E-03	11.5	0.051405	6.78E-09	1.187	9.763E-01

Source: South Carolina Department of Health and Environmental Control (SCDHEC) 1998. *Risk-Based Corrective Action for Petroleum Releases*, Bureau of Underground Storage Tank Management.

DOMENICO DILUTION/ATTENUATION MODEL WITHOUT BIOLOGICAL DECAY

$$\frac{C_X}{C_{SOURCE}} = \frac{1}{2} erfc\left[\frac{\left(x - \frac{vt}{R_c}\right)}{2\sqrt{\alpha_X \frac{vt}{R_c}}}\right] \times erf\left[\frac{Y}{4\sqrt{\alpha_Y x}}\right] \times erf\left[\frac{Z}{2\sqrt{\alpha_Z x}}\right]$$

Constituent	C_{SOURCE} mg/L	C_X mg/L
Benzene	0.056	0.005
MTBE	0.042	0.041

Prepared By: [signature]

Reviewed By: [signature]

TABLE 1

GROUNDWATER ELEVATIONS
SITE 22, BUILDING 242
ZONE F, CHARLESTON NAVAL BASE COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA

Well #	Total Depth of Well (ft)	Top of Casing Elevation, ft (MSL)	Date Measured	Depth to Water, ft (BTOC)	Depth to Product, ft (BTOC)	Product Thickness (ft)	Groundwater Elevation (MSL)
CNC22-M01	12.18	9.27	9/10/99	5.64	ND	ND	3.63
CNC22-M02	14.35	9.41	9/10/99	5.94	ND	ND	3.47
CNC22-M03	13.75	9.42	9/10/99	6.11	ND	ND	3.31
CNC22-M04	14.05	9.39	9/10/99	6.12	ND	ND	3.27
CNC22-M05	14.02	9.41	9/10/99	5.92	ND	ND	3.49
CNC22-M06	14.21	9.34	9/10/99	5.90	ND	ND	3.44
CNC22-M07D	28.33	9.64	9/10/99	5.80	ND	ND	3.84

Notes:
MSL - Mean Sea Level
LRS - Local Relative Survey
BTOC - Below Top of Casing
NM - Not Measured
ND- Not Detected
ft - Feet
* Permanent Piezometer Well
**Corrected Depth to Water Measurements Based on Free Product Thickness

TABLE 2

GROUNDWATER FIELD MEASUREMENTS
SITE 22, BUILDING 242
ZONE F, CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA

Well I.D.	Date Sampled	Purge method	Volume (gallons)	Temp. (° C)	pH	Specific Conductivity (uMHOS/cm)	Turbidity (NTU)	Dissolved Oxygen (mg/L)
CNC22-M01	9/10/99	PP	5.25	30.4	6.34	1.42	0	1.48
CNC22-M02	9/10/99	PP	4.05	27.2	6.04	2.260	0	0.65
CNC22-M03	9/10/99	PP	3.75	29.1	5.56	2.33	1	1.28
CNC22-M04	9/10/99	PP	4.00	28.0	4.47	3.250	0	1.05
CNC22-M05	9/10/99	PP	6.50	27.5	5.94	6.4	0	1.85
CNC22-M06	9/10/99	PP	4.14	26.3	5.72	6.06	0	1.5
CNC22-M07D	9/10/99	PP	4.00	25.9	8.45	1.25	>999	3.42

Notes:
(° C) - Degrees Celsius
PP - Peristaltic pump, low flow technique
uMHOS/cm - Micro MHOS per centimer
NTU - Nephelometric turbidity units
mg/L - milligrams per liter

TABLE 3

GROUNDWATER NATURAL ATTENUATION FIELD MEASUREMENTS
SITE 22, BUILDING 242
ZONE F, 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)	Ferrous Iron (mg/L)	Nitrite (mg/L)	Manganese (mg/L)	Nitrogen/ Nitrate (mg/L)*	Sulfate (mg/L)*
CNC22-M03	9/21/99	0.80	79.2	384	0.02	3.30	0.117	0.1	NA	NA
CNC22-M04	9/21/99	0.30	19.7	500	0.00	3.30	0.004	0.0	NA	NA
CNC22-M06	9/21/99	1.00	116.0	588	0.00	3.30	0.021	14.4	NA	NA

Notes:
mg/L - Milligrams per liter
ug/L - Micrograms per liter
NA - Not Analyzed
E- Estimated Concentration
* Fixed base laboratory analysis

TABLE 4

SUMMARY OF OVA SOIL SCREENING RESULTS
SITE 22, BUILDING 242
ZONE F, FORMER CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA

Sample Location	Sample Identification	Sample Depth (feet)	Organic Vapor Headspace Concentration (ppm)
CNC22-B01	22SSB0104	0-4	3
	22SSB0108	4-8	0
	22SSB0112	8-12	2
CNC22-B02	22SSB0204	0-4	0
	22SSB0208	4-8	0
	22SSB0212	8-12	0
	22SSB0215	12-15	0
CNC22-B03	22SSB0304	0-4	0
	22SSB0308	4-8	0
	22SSB0312	8-12	0
	22SSB0315	12-15	0
CNC22-B04	22SSB0404	0-4	0
	22SSB0408	4-8	25
CNC22-B05	22SSB0504	0-4	160
CNC22-B06	22SSB0604	0-4	0
	22SSB0608	4-8	0
	22SSB0611	8-11	0
CNC22-B07	22SSB0708	4-8	0
CNC22-B08	22SSB0804	0-4	0
	22SSB0808	4-8	0
	22SSB0812	8-12	0
	22SSB0815	12-15	0
CNC22-B09	22SSB0904	0-4	28
	22SSB0908	4-8	150
CNC22-B10	22SSB1003	3	0
	22SSB1006	6	0
	22SSB1009	9	230
CNC22-B11	22SSB1104	4	0
	22SSB1108	8	0
	22SSB1110	10	0
CNC22-B12	22SSB1203	3	37
	22SSB1206	6	77
CNC22-B13	22SSB1301	1	No Recording
	22SSB1302	2	No Recording
	22SSB1303	3	No Recording
	22SSB1304	4	No Recording
	22SSB1305	5	No Recording
	22SSB1306	6	No Recording
	22SSB1307	7	No Recording
	22SSB1308	8	No Recording
	22SSB1309	9	No Recording
	22SSB1310	10	No Recording
	22SSB1311	11	No Recording
	22SSB1312	12	No Recording

TABLE 4-CONTINUED

SUMMARY OF OVA SOIL SCREENING RESULTS
SITE 22, BUILDING 242
Zone F, Former Charleston Naval Complex
North Charleston, South Carolina

Sample Location	Sample Identification	Sample Depth (feet)	Organic Vapor Headspace Concentration
CNC22-B14	22SSB1407	7	0
	22SSB1409	9	14
CNC22-B15	22SSB1506	6	110
	22SSB1510	10	50
CNC22-B16	22SSB1601	1	No Recording
	22SSB1602	2	No Recording
	22SSB1603	3	No Recording
	22SSB1604	4	No Recording
	22SSB1605	5	No Recording
	22SSB1606	6	No Recording
	22SSB1607	7	No Recording
	22SSB1608	8	No Recording
	22SSB1609	9	No Recording
	22SSB1610	10	No Recording
	22SSB1611	11	No Recording
	22SSB1612	12	No Recording
CNC22-B17	22SSB1707	7	260
	22SSB1710	10	90
CNC22-B18	22SSB1807	7	220
CNC22-B19	22SSB1903	3	5
	22SSB1907	7	13
	22SSB1909	9	14
CNC22-B20	22SSB2003	3	20
	22SSB2005	5	100
	22SSB2007	7	20
CNC22-B21	22SSB2104	4	60
	22SSB2106	6	20
	22SSB2109	9	0
CNC22-B22	22SSB2202	2	20
	22SSB2206	6	90
CNC22-B23	22SSB2305	5	70

Notes:
OVA - organic vapor analyzer equipped with a flame ionization detector and charcoal filter where necessary
ND- not detected

TABLE 5

SUMMARY OF MOBILE LABORATORY SCREENING RESULTS FOR SOIL
SITE 22, BUILDING 242
ZONE F, FORMER CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA

Sample Location	Sample Identification	Sample Depth (feet)	Laboratory Screening Data[1]					
			Benzene (µg/Kg)	Toluene (µg/Kg)	Ethylbenzene (µg/Kg)	Total Xylenes (µg/Kg)	Naphthalene (µg/Kg)	Di sel Range Organics (mg/Kg)
CNC22-B01	22SFB011112	11-12*	ND	ND	ND	ND	ND	ND
CNC22-B02	22SFB021112	11-12*	ND	ND	ND	ND	ND	ND
CNC22-B03	22SFB031112	11-12*	ND	ND	ND	ND	ND	ND
CNC22-B04	22SFB040006	0-6	ND	ND	ND	ND	ND	ND
CNC22-B05	22SFB050508	5-8	ND	ND	ND	ND	ND	ND
CNC22-B06	22SFB060405	4-5	ND	ND	ND	ND	ND	ND
CNC22-B07	22SFB071112	11-12*	ND	ND	ND	ND	ND	ND
CNC22-B08	22SFB080304	3-4	ND	ND	ND	ND	ND	ND
CNC22-B09	22SFB090405	4-5	ND	ND	ND	ND	ND	ND
CNC22-B10	22SFB100506	5-6	ND	ND	ND	ND	ND	ND
CNC22-B11	22SFB110708	7-8	ND	ND	ND	ND	51.8J	66
CNC22-B12	22SFB120607	6-7	ND	ND	ND	ND	ND	ND
CNC22-B13	22SFB130607	6-7	ND	ND	ND	ND	ND	ND
CNC22-B14	22SFB140708	7-8	ND	ND	ND	ND	ND	ND
CNC22-B15	22SFB150607	6-7	ND	ND	ND	ND	ND	ND
CNC22-B16	22SFB160708	7-8	ND	ND	ND	ND	ND	ND
CNC22-B17	22SFB170708	7-8	ND	ND	ND	ND	ND	ND
CNC22-B18	22SFB180708	7-8	ND	ND	ND	ND	ND	47
CNC22-B19	22SFB190910	9-10*	ND	ND	ND	ND	ND	ND
CNC22-B20	22SFB200506	5-6	ND	ND	ND	ND	ND	ND
CNC22-B21	22SFB210506	5-6	ND	ND	ND	ND	ND	1300
CNC22-B22	22SFB220506	5-6	ND	ND	ND	ND	ND	ND
CNC22-B23	22SFB230506	5-6	ND	ND	ND	ND	ND	ND

NOTES:
[1] Laboratory screening data were analyzed using USEPA Method 8020/8015M. Compounds not detected are reported as less than the instrument detection limit.
µg/kg = micrograms per kilogram
mg/kg = milligrams per kilogram
J = Estimated value detection was above the instrument minimum detection level, but below the practical quantification limit.
E = Estimated value detection exceeded the upper calibration range of the instrument.
* Soil samples collected above water table at time of boring installation.

TABLE 6

SUMMARY OF MOBILE LABORATORY SCREENING RESULTS FOR GROUNDWATER
SITE 22, BUILDING 242
ZONE F, FORMER CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA

Sample Location	Sample Identification	Sample Depth (feet)	Laboratory Screening Data[1]					
			Benzene (µg/L)	Toluene (µg/L)	Ethylbenzene (µg/L)	Total Xylenes (µg/L)	Naphthalene (µg/L)	Di sel Range Organics (mg/L)
CNC22-B01	22GFB011013	10-13	ND	ND	ND	ND	ND	ND
CNC22-B02	22GFB021315	13-15	ND	ND	ND	ND	ND	ND
CNC22-B03	22GFB031315	13-15	ND	ND	ND	ND	ND	ND
CNC22-B04	22GFB041315	13-15	ND	ND	ND	ND	ND	ND
CNC22-B05	22GFB050811	8-11	ND	ND	ND	14.0	ND	ND
CNC22-B06	22GFB060811	8-11	ND	ND	ND	ND	ND	ND
CNC22-B07	22GFB071315	13-15	27.3	ND	ND	ND	ND	ND
CNC22-B08	22GFB081315	13-15	ND	ND	ND	ND	ND	ND
CNC22-B09	22GFB090811	8-11	ND	ND	ND	ND	ND	ND
CNC22-B10	22GFB100512	5-12	ND	ND	ND	ND	ND	ND
CNC22-B11	22GFB110612	6-12	ND	ND	ND	ND	ND	ND
CNC22-B12	22GFB120612	6-12	ND	ND	ND	ND	ND	ND
CNC22-B13	22GFB130612	6-12	ND	ND	ND	ND	ND	ND
CNC22-B14	22GFB140812	8-12	ND	ND	ND	ND	ND	ND
CNC22-B15	22GFB150812	8-12	ND	ND	ND	ND	25.9	ND
CNC22-B16	22GFB160812	8-12	16.3	ND	ND	ND	ND	ND
CNC22-B17	22GFB170712	7-12	ND	ND	ND	ND	ND	ND
CNC22-B18	22GFB180812	8-12	20.4	ND	ND	ND	ND	ND
CNC22-B19	22GFB191012	10-12	ND	ND	ND	ND	ND	ND
CNC22-B20	22GFB201012	10-12	ND	ND	ND	ND	ND	ND
CNC22-B21	22GFB210612	6-12	ND	ND	ND	ND	ND	4.98
CNC22-B22	22GFB220612	6-12	ND	ND	ND	ND	ND	ND
CNC22-B23	22GFB230912	9-12	ND	ND	ND	ND	ND	ND

NOTES:
[1] Laboratory screening data were analyzed using USEPA Method 8020/8015M. Compounds not detected are reported as less than the instrument detection limit.
µg/L = micrograms per liter
mg/L = milligrams per liter
J = Estimated value detection was above the instrument minimum detection level, but below the practical quantification limit.
E = Estimated value detection exceeded the upper calibration range of the instrument.

TABLE 7

SUMMARY OF FIXED-BASE LABORATORY ANALYTICAL RESULTS FOR CHEMICALS OF CONCERN IN SOIL
SITE 22, BUILDING 242
ZONE F, 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	478	364	11119	17687	7042	55930	3146	21265	52
CNC22-B02 / 22SLB020708	8/18/99	< 5	2[J]	< 5	< 5	< 400	< 400	< 400	< 400	< 400	< 5
CNC22-B05 / 22SLB050304	8/18/99	5[J]	2[J]	37	75	< 360	< 360	< 360	< 360	< 360	572
CNC22-B07 / 22SLB070910	8/18/99	< 6	< 6	< 6	< 6	< 400	< 400	< 400	< 400	< 400	< 6
CNC22-B11 / 22SLB110708	8/18/99	< 5	4[J]	< 5	< 5	< 400	< 400	< 400	< 400	< 400	< 5
CNC22-B11 / 22SLB110708D	8/18/99	< 5	< 5	< 5	< 5	< 400	< 400	< 400	< 400	< 400	< 5
CNC22-B15 / 22SLB150506	8/18/99	< 6	< 6	< 6	< 6	< 430	< 430	< 430	< 430	< 430	< 6
CNC22-B018 / 22SLB180708	8/18/99	< 4	4[J]	< 4	< 4	< 400	< 400	< 400	< 400	< 400	< 4
CNC22-B21 / 22SLB210506	8/18/99	< 4	3[J]	< 4	< 4	< 400	< 400	< 400	< 400	< 400	< 4

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

NA - Not analyzed

[1] South Carolina Department of Health and Environmental Control Risk Based Screening Levels for clay-rich 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 22, BUILDING 242
ZONE F, 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)	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)	MTBE (ug/L)
RBSL[1]		5	700	1000	10000	10 [2]	10 [2]	10 [2]	10 [2]	10 [2]	10 [2]	40
CNC22M-01 / 22GLM0101	10-Sep-99	< 5	< 5	< 5	< 5	< 5	< 10	< 10	< 10	< 10	< 10	< 5
CNC22M-02 / 22GLM0201	10-Sep-99	29	< 5	< 5	< 5	< 5	< 10	< 10	< 10	< 10	< 10	6
CNC22M-03 / 22GLM0301	21-Sep-99	56	< 5	< 5	< 5	< 5	< 12	< 12	< 12	< 12	< 12	39
CNC22M-03 / 22GLM0301D[3]	14-Sep-99	NA	NA	NA	NA	NA	< 10	< 10	< 10	< 10	< 10	NA
CNC22M-03 / 22GLM0301D[3]	21-Sep-99	56	< 5	4 (J)	< 5	< 5	< 11	< 11	< 11	< 11	< 11	42
CNC22M-04 / 22GLM0401	21-Sep-99	3 [J]	< 5	< 5	< 5	< 5	< 11	< 11	< 11	< 11	< 11	< 5
CNC22M-05 / 22GLM0501	10-Sep-99	< 5	< 5	< 5	< 5	< 5	< 10	< 10	< 10	< 10	< 10	< 5
CNC22M-06 / 22GLM0601	21-Sep-99	7	< 5	< 5	< 5	< 5	< 11	< 11	< 11	< 11	< 11	< 5
CNC22M-07 / 22GLM0701	10-Sep-99	< 5	< 5	< 5	< 5	< 5	< 10	< 10	< 10	< 10	< 10	< 5

All concentrations are in ug/L.

NA - Not analyzed

[1] South Carolina Department of Health and Environmental Control Risk Based Screening Levels for groundwater.

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

[3] Duplicate sample

(J) Indicates presence of 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 22, BUILDING 242
ZONE F, CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA

Monitoring Well/ Sample No.	Sample Date	Lead (ug/L)	Arsenic (ug/L)	Barium (ug/L)	Cadmium (ug/L)	Total Chromium (ug/L)	Mercury (ug/L)	Selenium (ug/L)	Silver (ug/L)
RBSL[1]		15	50	2000	5	100	2	50	5
CNC22M-01 / 22GLM0101	10-Sep-99	< 1.1	< 4.0	30.9	< 1.94	< 4.31	< 0.03	< 2.57	< 2.54
CNC22M-02 / 22GLM0201	10-Sep-99	< 1.09	22.4	17.5	< 1.94	< 4.31	< 0.06	< 2.57	< 2.54
CNC22M-03 / 22GLM0301	21-Sep-99	< 1.1	18.6	24.3	< 1.94	< 4.31	< 0.09	< 3.6	< 2.54
CNC22M-03 / 22GLM0301D	21-Sep-99	< 1.09	15.8	23.8	< 1.94	< 4.31	< 0.02	< 2.57	< 2.54
CNC22M-04 / 22GLM0401	21-Sep-99	< 1.3	8.2	28.4	< 2.6	< 4.31	< 0.05	< 2.57	< 2.54
CNC22M-05 / 22GLM0501	10-Sep-99	< 1.5	31	30.4	< 1.94	< 4.31	< 0.04	< 2.57	< 2.54
CNC22M-06 / 22GLM0601	21-Sep-99	< 1.3	< 6.1	65.4	< 1.94	< 4.31	< 0.05	< 2.57	< 2.54
CNC22M-07 / 22GLM0701	10-Sep-99	< 1.3	< 4.2	116	< 1.94	< 4.31	< 0.03	< 2.57	< 2.54

All concentrations are in ug/L.
NA - Not analyzed
(1) South Carolina Department of Health and Environmental Control Risk Based Screening Levels for groundwater.

TABLE 9

FATE AND TRANSPORT INPUT PARAMETERS
SITE 22, BUILDING 242
ZONE F, CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA

Parameter	Domenico Dilution/Attenuation Model (1)
Hydraulic Conductivity [m/sec]	1.13E-06
Hydraulic Gradient	0.0027
Porosity (a)	0.45
Estimated Plume Length [ft]	NA
Soil Bulk Density (a) [kg/L]	1.64
Partition Coefficient [L/kg]	- chemical specific
Fraction of Organic Carbon in soil [g/g]	4.47E-03
First Order Decay Rate [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)

Notes:

(1) - *South Carolina Risk-Based Corrective Action for Petroleum Releases,* South Carolina Department of Health and Environmental Control, 1998.

(a) - Determined from SCDHEC 1998 Tables C1 and C3

(b) - Default value

(c) - Assumption of the Domenico model

TABLE 10

COMPARISON OF MAXIMUM CONCENTRATIONS TO RBSLs
SITE 22, BUILDING 242
ZONE F, CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA

Chemical of Concern	Maximum Concentration Soil (mg/kg)	Tier 1 Soil Leaching RBSLs (mg/kg)[a]	Maximum Concentration GW (mg/L)	Tier 1 RBSLs GW (mg/L)[b]	RBSLs GW Protective of On-Site Construction Worker[c]
Benzene		0.005		0.005	0.15
Toluene	0.004	0.478	0.004(J)	1	5.38
Ethylbenzene	0.037	0.364	ND -	0.7	6.05
Xylenes	0.075	1.119	ND	10	102.33
Benzo(a)anthracene	ND	17.687	ND	0.010	-
Benzo(b)fluoranthene	ND	7.042	ND	0.010	-
Benzo(k)fluoranthene	ND	5.593	ND	0.010	-
Chyrsene	ND	3.146	ND	0.010	-
Dibenzo(a,h)anthracene	ND	21.265	ND	0.010	-
MTBE	NA	NA		0.040	25.9
Naphthalene		0.052	ND	0.010	1.63

(a) - From Risk-Based Corrective Action for Petroleum Releases, Table B4, Depth to GW - <5 ft, SCDHEC RBCA Guidelines, 1998.
(b) - From Risk-Based Corrective Action for Petroleum Releases, Table B1, SCDHEC RBCA Guidelines, 1998.
(c) - Calculated for dermal, incidental ingestion, and inhalation routes for the on-site construction worker (see Section 3.5.1 of the text and Appendix H).
(d) - Groundwater concentration in equilbrium with free product as calculated using Raoult's Law.
GW - Groundwater
RBSLs - Risk Based Screening Levels
ND - Not detected
NA - Not analyzed
Shaded cell indicates the concentration exceeded one of the RBSLs.
J - Estimated value detection was above instrument minimum detecton limit, but below practical quantification limit

TABLE 11

EXPOSURE PATHWAY ASSESSMENT - CURRENT USE
SITE 22, BUILDING 242
ZONE F, 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	No volatilization to enclosed space.	
	Explosion Hazard	No	No explosion hazard.	
Groundwater	Ingestion	No	No water supply well downgradient or residential basements.	
	Dermal contact	No		
	Inhalation	No		
Surface Water	Ingestion	No	Cooper River 720 feet downgradient	
	Dermal contact	No		
	Inhalation	No		
Surficial Soil	Ingestion	No	No impacted surface soil	
	Dermal contact	No		
	Inhalation	No		
Subsurface Soil	Ingestion	Yes	Leachibility model performed for benzene and naphthalene	No additional data required
	Dermal contact	Yes		
	Inhalation	yes		
	Leaching to Groundwater			

TABLE 12

EXPOSURE PATHWAY ASSESSMENT - FUTURE USE
SITE22, BUILDING 242
ZONE F, 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	No volatilization to enclosed space.	
	Explosion Hazard	No	No explosion hazard.	
Groundwater	Ingestion	Yes	Future use of property expected to be industrial or commercial. Sewer line and storm drain within 80 feet of site; therefore, construction worker exposure possible.	No additional data required
	Dermal contact	Yes		
	Inhalation	Yes		
Surface Water	Ingestion	Yes	Cooper River 720 feet downgradient via regional groundwater flow	No additional data required
	Dermal contact	No		
	Inhalation	No		
Surficial Soil	Ingestion	No	No impacted surface soil	
	Dermal contact	No		
	Inhalation	No		
Subsurface Soil	Ingestion	Yes	Leachability model performed for benzene and naphthalene for construction worker exposure	No additional data required
	Dermal contact	Yes		
	Inhalation	Yes		
	Leaching to Groundwater	Yes		

TABLE 13

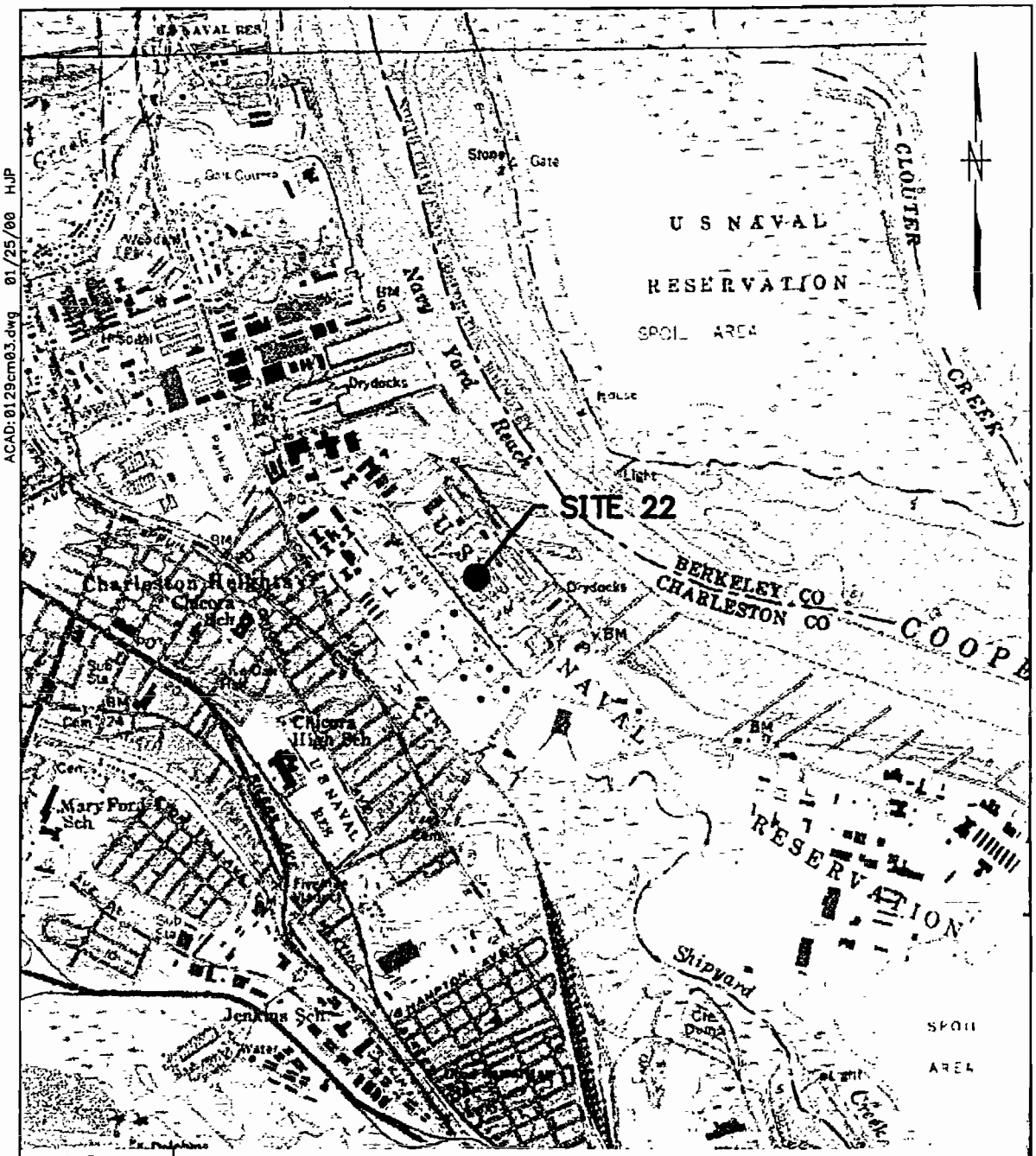
COMPARISON OF MAXIMUM GROUNDWATER CONCENTRATIONS TO SSTLs
SITE 22, BUILDING 242
ZONE F, CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA

Chemical of Concern	Source Area Concentration (mg/L)	SSTLs Protective of Surface Water (Cooper River)		SSTLs Protective of Construction Workers	Minimum On-Site SSTLs [a]
		$SSTL_{SOURCE}$ (mg/L)	$SSTL_{COMP}$ (mg/L)	$SSTL_{SOURCE}$ (mg/L)	(mg/L)
Benzene	0.056	0.654	0.592	0.15	0.15
MTBE	0.042	5.231	4.737	25.90	5.23

mg/L - milligrams per liter
Shaded cell indicates the concentration exceeded the SSTL.

(a) The minimum on-site SSTLs are chosen as those SSTLs protective of both surface water (the Cooper River) and the on-site construction worker.

ACAD:0129cm03.dwg 01/25/00 HJP



SOURCE: QUADRANGLE MAP SOUTH CAROLINA, REVISED 1979
QUADRANGLE MAP NORTH CHARLESTON REVISED, 1979

DRAWN BY HJP DATE 8/20/99		SITE LOCATION MAP SITE 22, BUILDING 242, ZONE F CHARLESTON NAVAL COMPLEX NORTH CHARLESTON, SC	CONTRACT NO. N0129
CHECKED BY DATE			APPROVED BY DATE
COST/SCHED-AREA			APPROVED BY DATE
SCALE AS NOTED			DRAWING NO. FIGURE 1 / REV. 0

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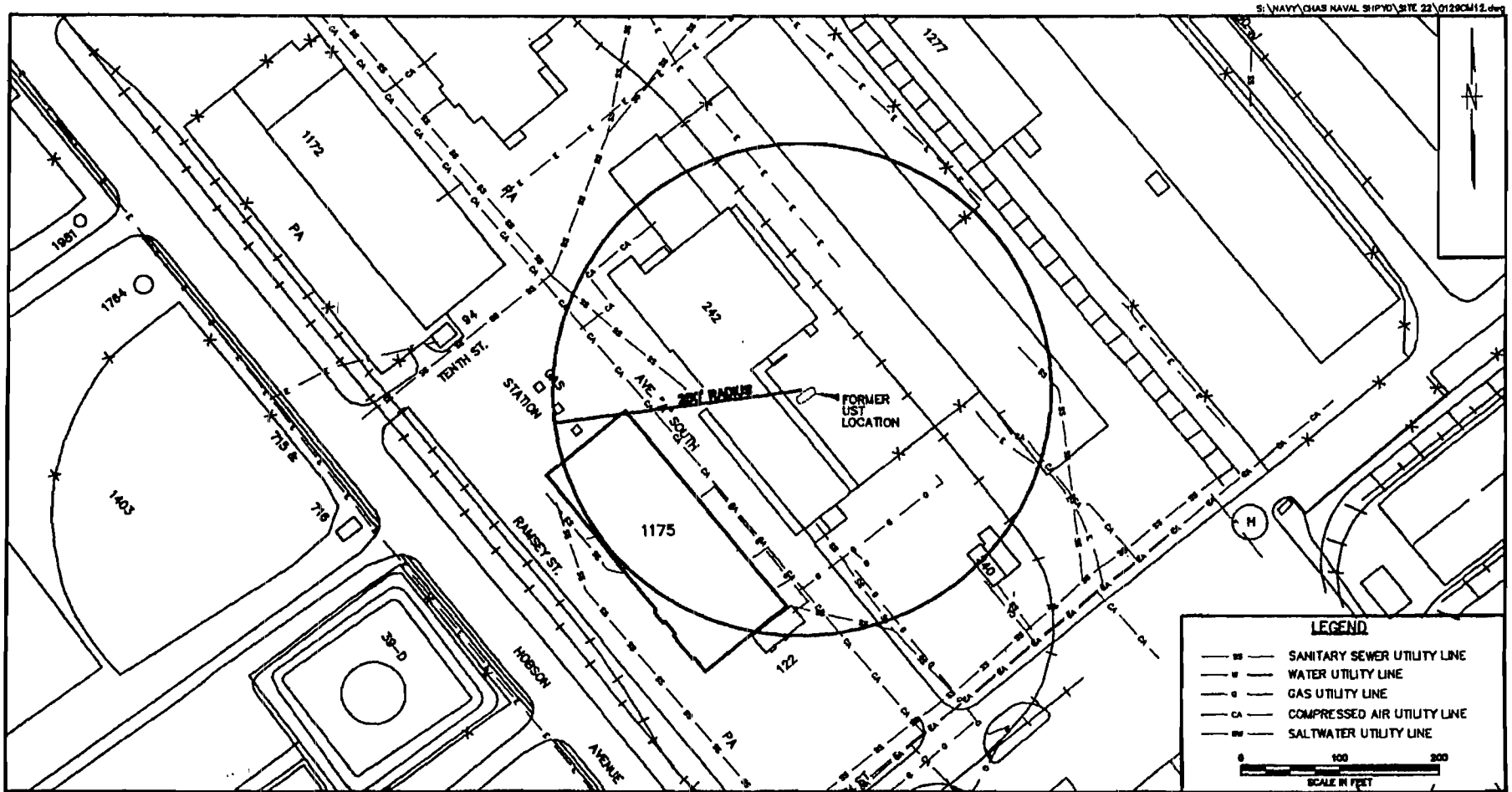

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY LLK DATE 11/2/99
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

SITE VICINITY MAP
SITE 22, BUILDING 242
ZONE F, CHARLESTON NAVAL COMPLEX
NORTH CHARLESTON, SOUTH CAROLINA

CONTRACT NO. 0219
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 2
REV. 0

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

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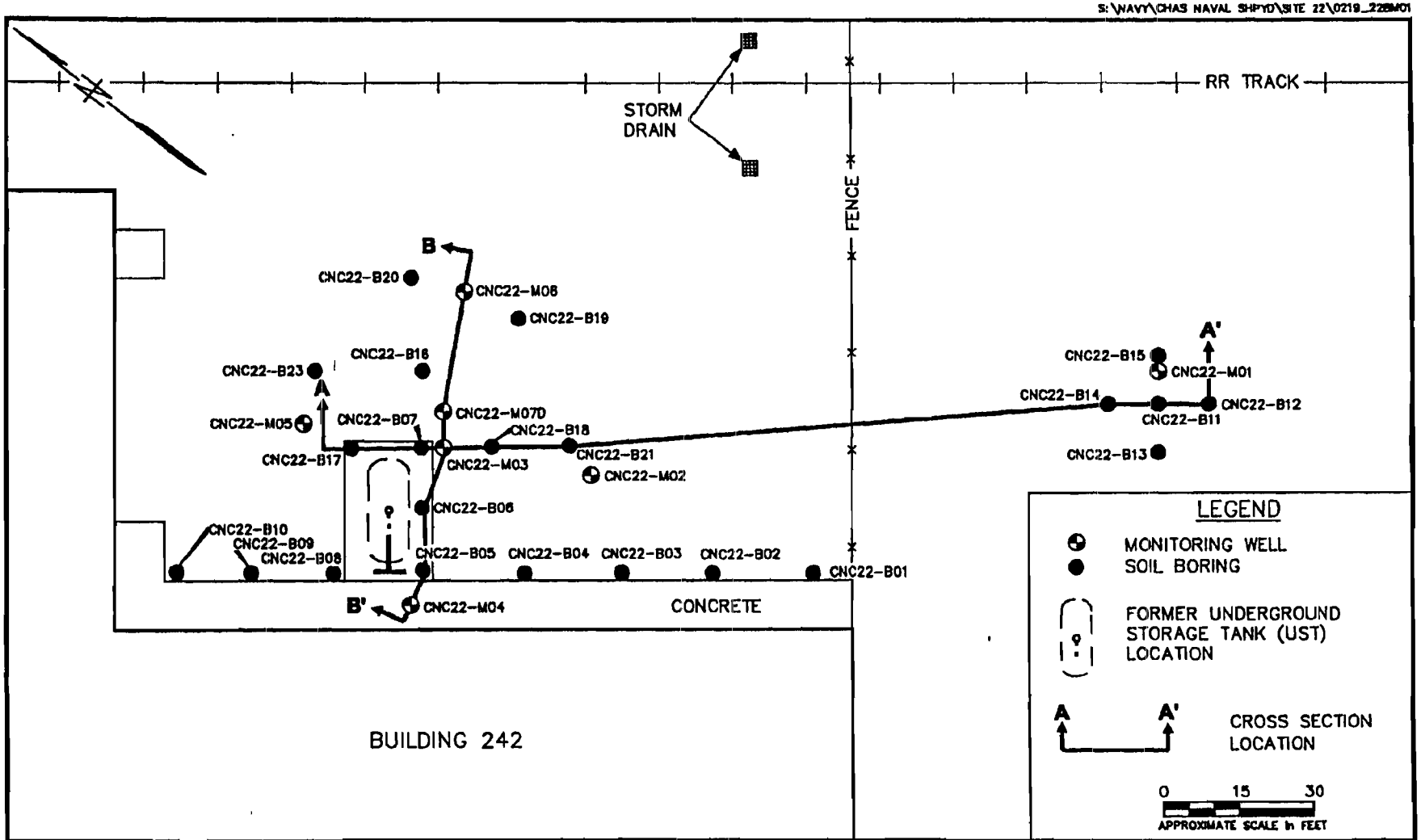
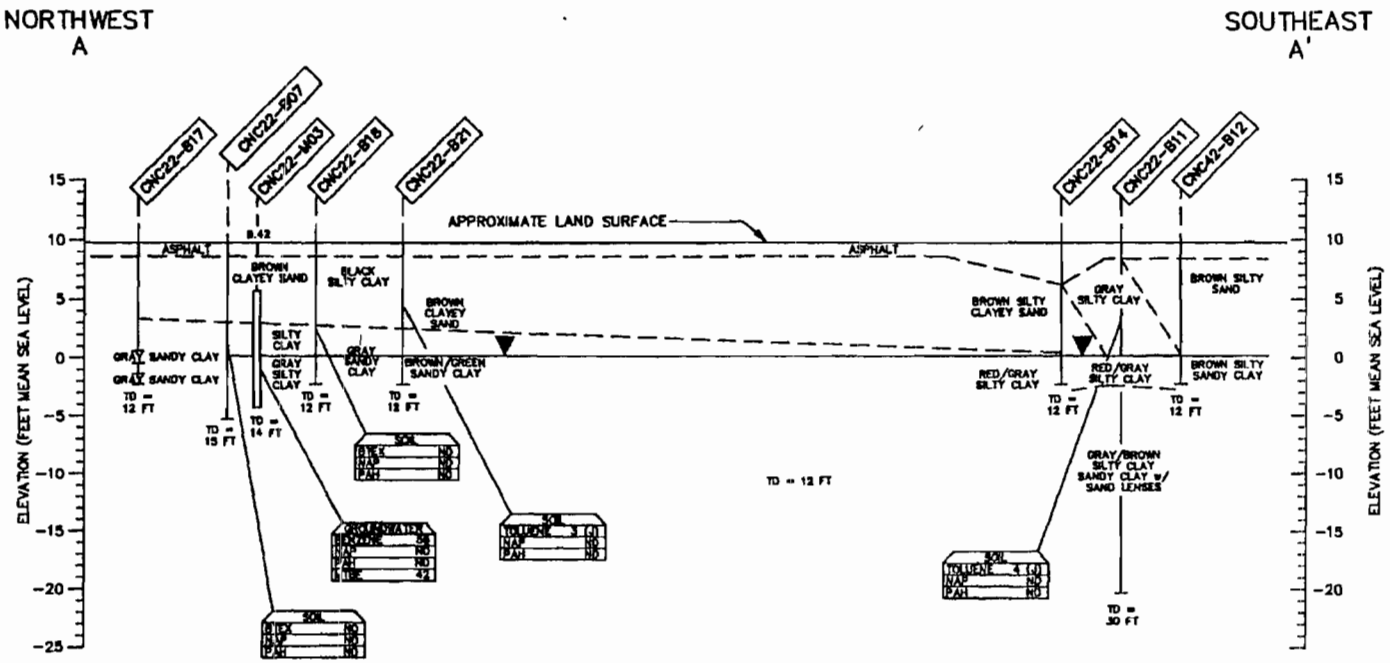


DRAWN BY LLK	DATE 11/1/99	SITE MAP SITE 22, BUILDING 242 ZONE F, CHARLESTON NAVAL SHIPYARD CHARLESTON, SOUTH CAROLINA	CONTRACT NO. 0219
CHECKED BY	DATE		APPROVED BY DATE
COST/SCHED-AREA			APPROVED BY DATE
SCALE AS NOTED			DRAWING NO. FIGURE 3 REV. 0

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



NOTE: SEE FIGURE 3 FOR CROSS-SECTION LOCATION

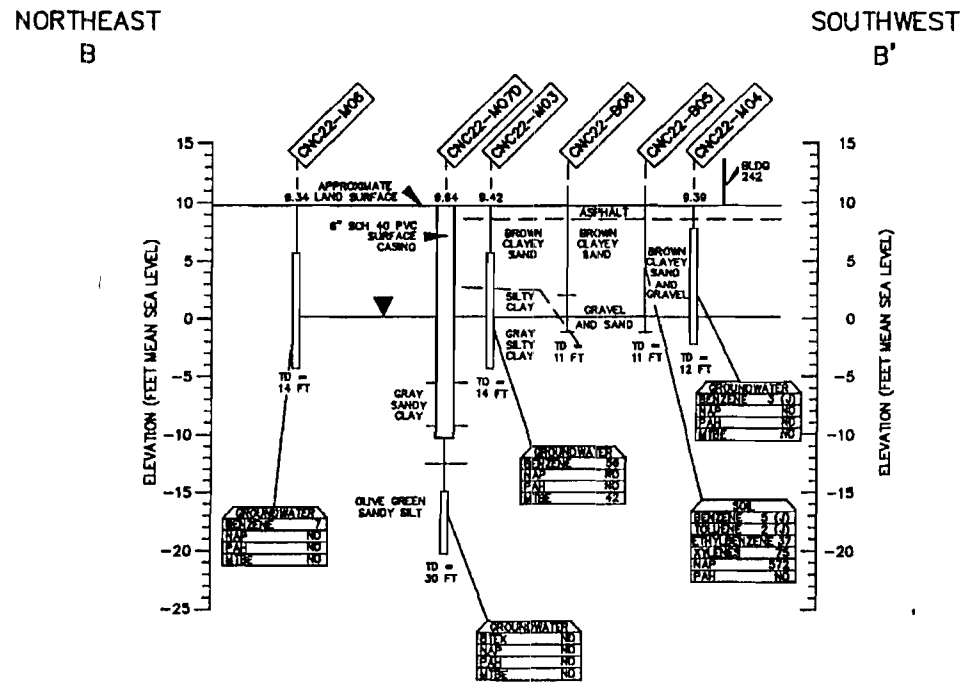
NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY LLK DATE 11/04/99
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

GEOLOGIC CROSS-SECTION A-A'
SITE 22, BUILDING 242
ZONE F, CHARLESTON NAVAL SHIPYARD
CHARLESTON, SOUTH CAROLINA

CONTRACT NO. 0219
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 4
REV. 0

FORM CADD NO. RDV_SHLDWR - REV 0 - 1/20/99



LEGEND

CNC22-MW08 — MONITORING WELL OR BORING NUMBER

9.34 — TOP-OF-CASING ELEVATION (FT ABOVE MEAN SEA LEVEL)

TOP OF MONITORED INTERVAL

APPROXIMATE POTENTIOMETRIC SURFACE

BOTTOM OF MONITORED INTERVAL

TD = 14 FT

SOIL
BTEX ND
NAP ND
PAH ND

REPORTED CONCENTRATIONS IN SAMPLES
SOIL–MICROGRAMS PER KILOGRAM (µg/kg)
GW–MICROGRAMS PER LITER (µg/L)

BTEX = SUM OF BENZENE, TOLUENE, ETHYLBENZENE, AND TOTAL XYLENES

NAP = NAPHTHALENE

PAH = POLYNUCLEAR AROMATIC HYDROCARBONS

ND = NONE DETECTED

(J) = ESTIMATED VALUE

0 10 20
APPROXIMATE SCALE in FEET (HORIZONTAL)

0 5 10
APPROXIMATE SCALE in FEET (VERTICAL)

NOTE: SEE FIGURE 3 FOR CROSS-SECTION LOCATION

NO.	DATE	REVISIONS	BY	CHKD	APPD	REFERENCES

DRAWN BY LLK DATE 11/05/99
CHECKED BY DATE
COST/SCHED-AREA
SCALE AS NOTED

GEOLOGIC CROSS-SECTION B–B'
SITE 22, BUILDING 242
ZONE F, CHARLESTON NAVAL SHIPYARD
CHARLESTON, SOUTH CAROLINA

CONTRACT NO. 0219
APPROVED BY DATE
APPROVED BY DATE
DRAWING NO. FIGURE 5
REV. 0

FORM CADD NO. SDIY_BLDWG – REV 0 – 1/26/96

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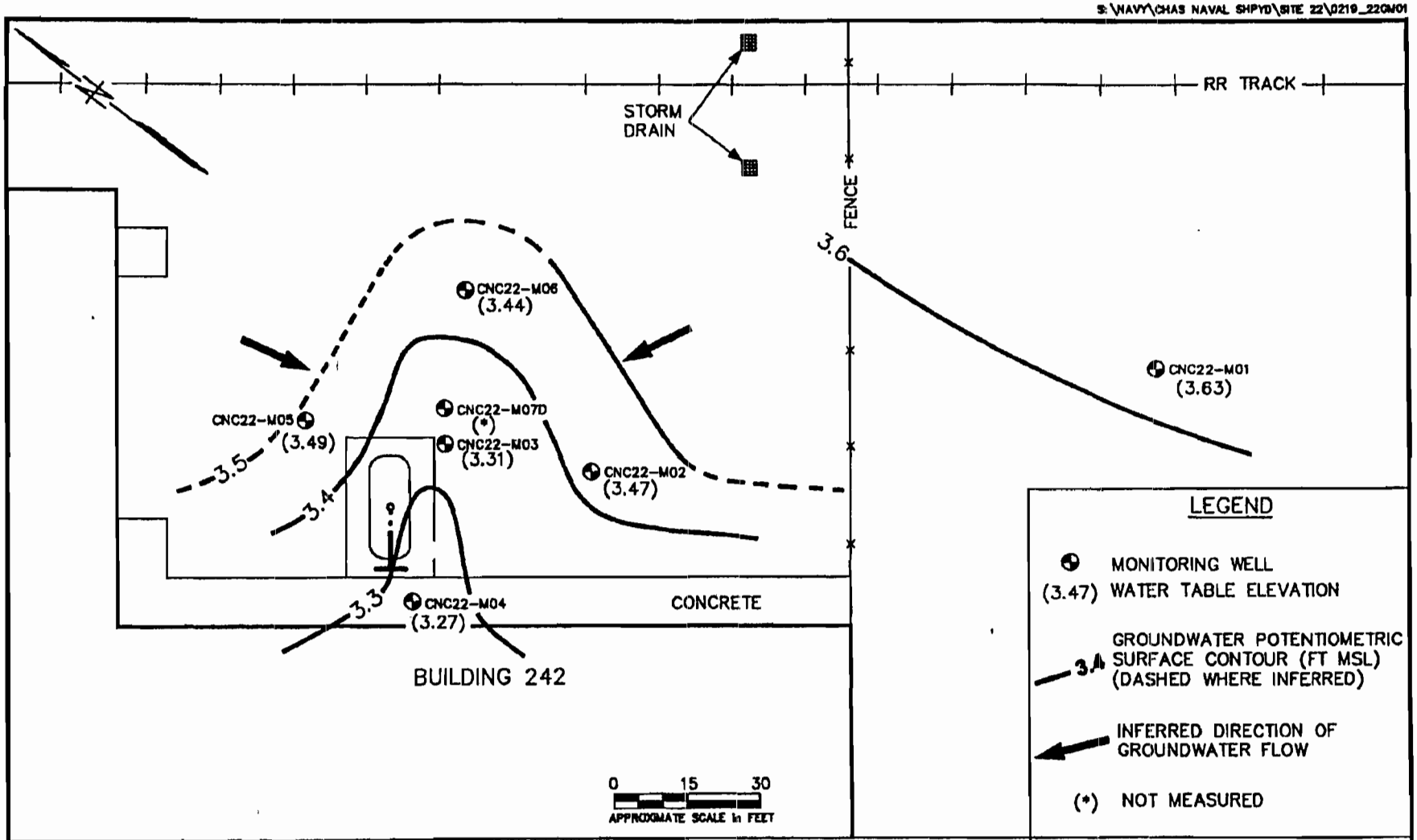

DRAWN BY LLK	DATE 11/1/99	GROUNDWATER POTENTIOMETRIC MAP SITE 22, BUILDING 242 SEPTEMBER 10, 1999 ZONE F, CHARLESTON NAVAL SHIPYARD CHARLESTON, SOUTH CAROLINA
CHECKED BY	DATE	
COST/SCHED-AREA		
SCALE AS NOTED		

CONTRACT NO.	0219
APPROVED BY	DATE
APPROVED BY	DATE
DRAWING NO. FIGURE 6	REV. 0

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

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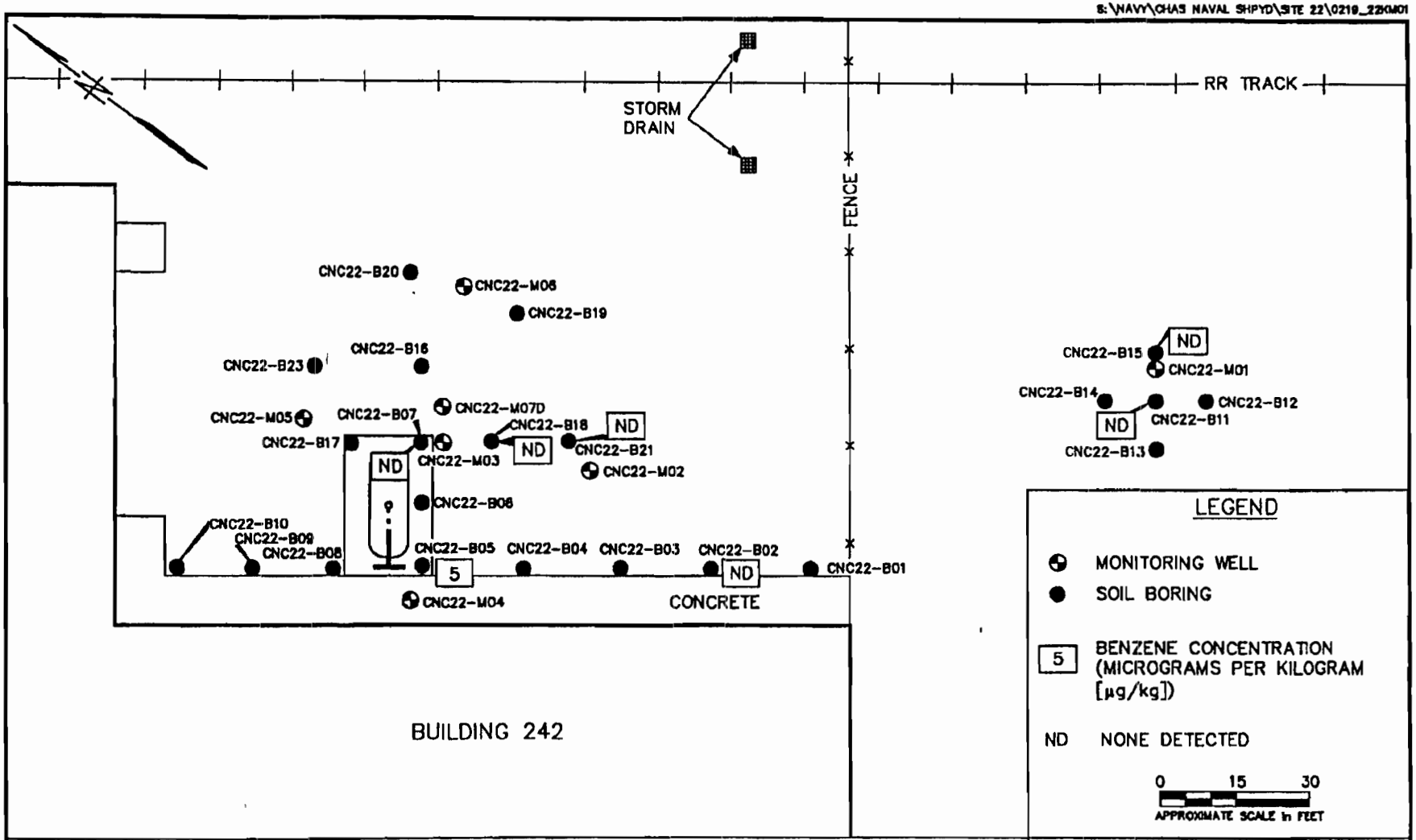

DRAWN BY LLK	DATE 11/1/99	SOIL BENZENE CONCENTRATION MAP AUGUST 18, 1999 SITE 22, BUILDING 242 ZONE F, CHARLESTON NAVAL SHIPYARD CHARLESTON, SOUTH CAROLINA	CONTRACT NO. 0219
CHECKED BY	DATE		APPROVED BY DATE
COST/SCHED-AREA			APPROVED BY DATE
SCALE AS NOTED			DRAWING NO. FIGURE 7 REV. 0

FORM CADD NO. SDIV_AH.DWG – REV 0 – 1/20/98

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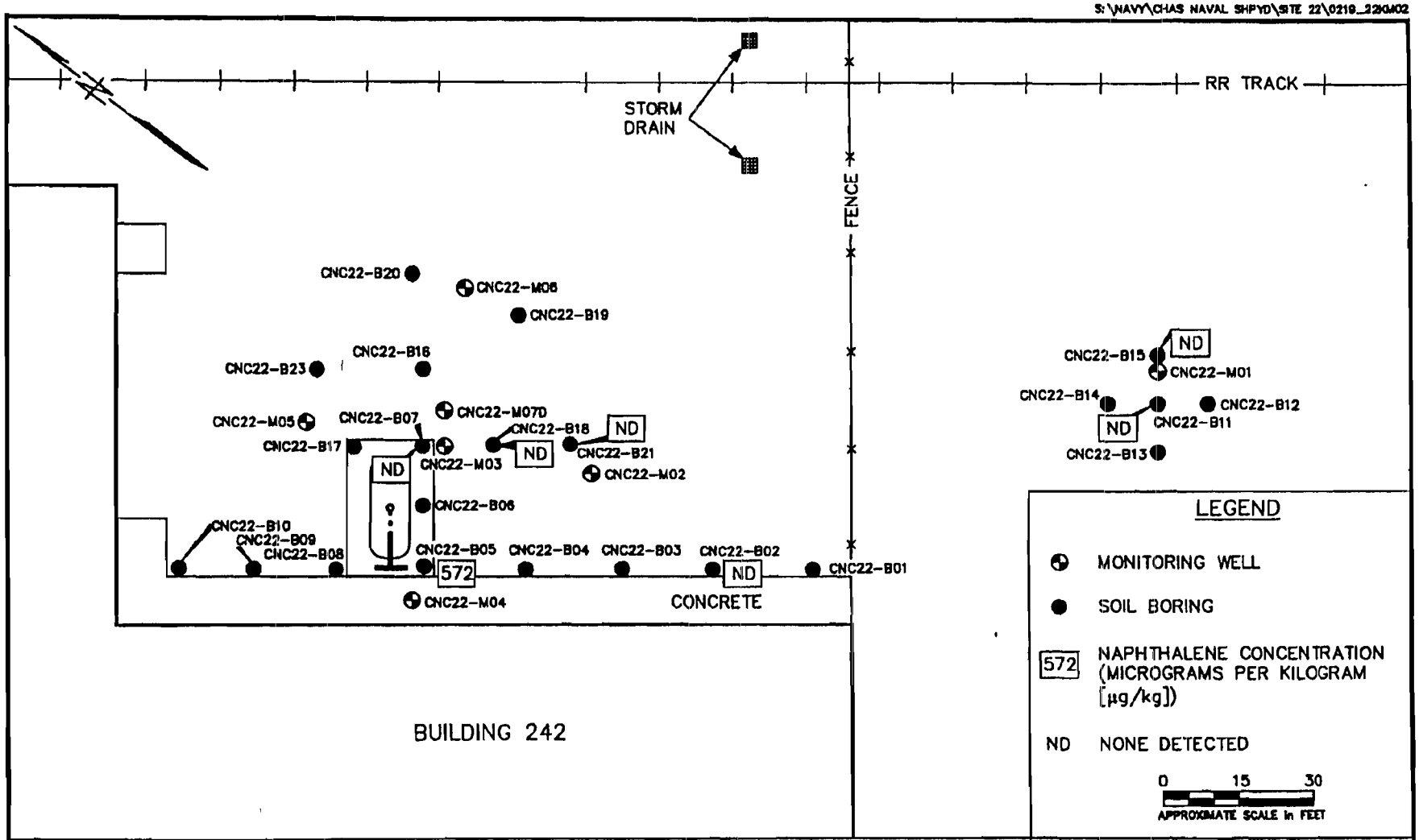

LEGEND

- MONITORING WELL
- SOIL BORING
- 572 NAPHTHALENE CONCENTRATION (MICROGRAMS PER KILOGRAM [µg/kg])
- ND NONE DETECTED

0 15 30
APPROXIMATE SCALE in FEET

DRAWN BY LLK	DATE 11/1/99	SOIL NAPHTHALENE CONCENTRATION MAP AUGUST 18,1999 SITE 22, BUILDING 242 ZONE F, CHARLESTON NAVAL SHIPYARD CHARLESTON, SOUTH CAROLINA	CONTRACT NO. 0219
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_AH.DWG - REV 0 - 1/20/98

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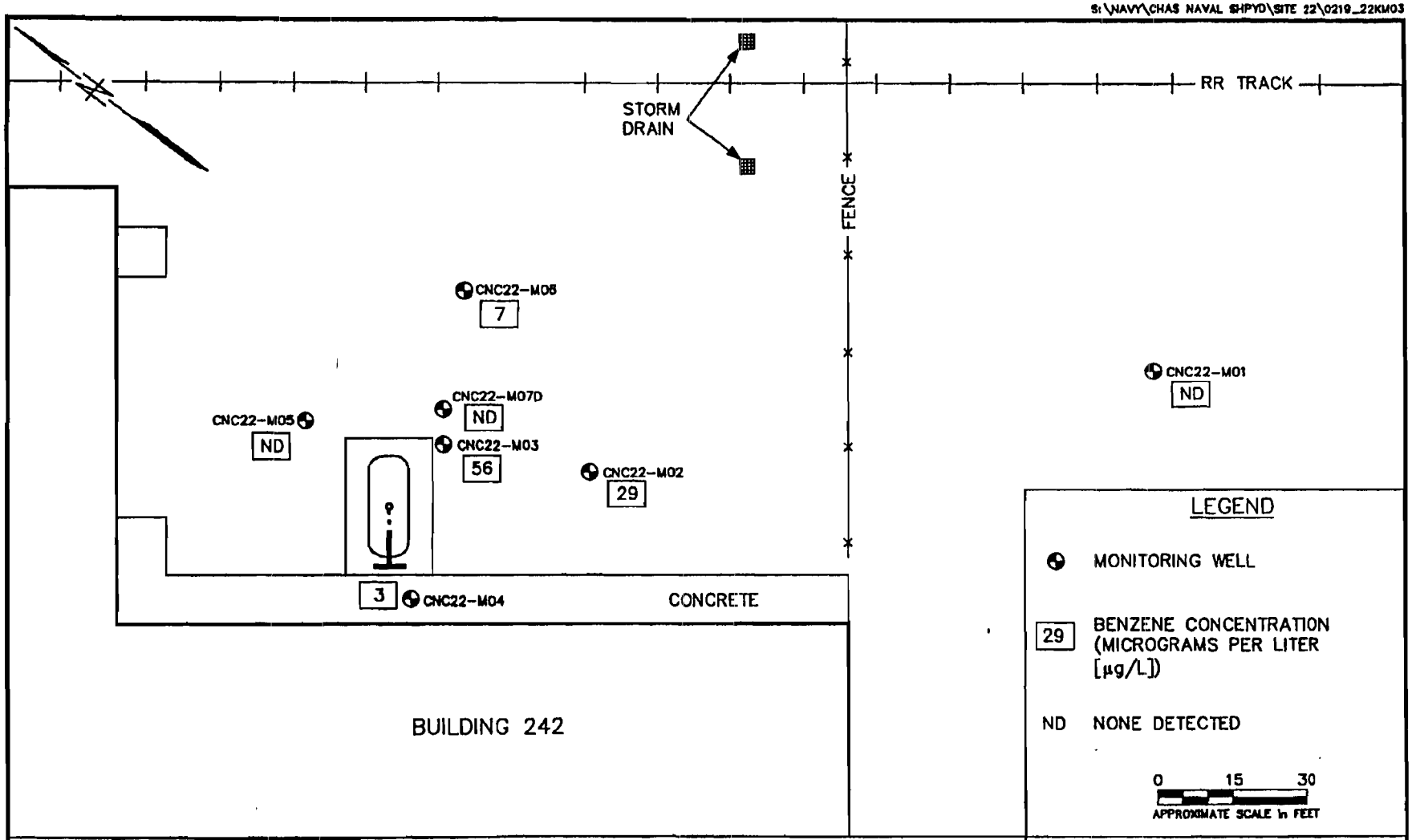

DRAWN BY LLK	DATE 11/1/99	GROUNDWATER BENZENE CONCENTRATION MAP SEPTEMBER 10 AND 21, 1999 SITE 22, BUILDING 242 ZONE F, CHARLESTON NAVAL SHIPYARD CHARLESTON, SOUTH CAROLINA	CONTRACT NO. 0219
CHECKED BY	DATE		APPROVED BY DATE
COST/SCHED-AREA			APPROVED BY DATE
SCALE AS NOTED			DRAWING NO. FIGURE 9 REV. 0

FORM CADD NO. SDIV_AH.DWG – REV 0 – 1/20/98

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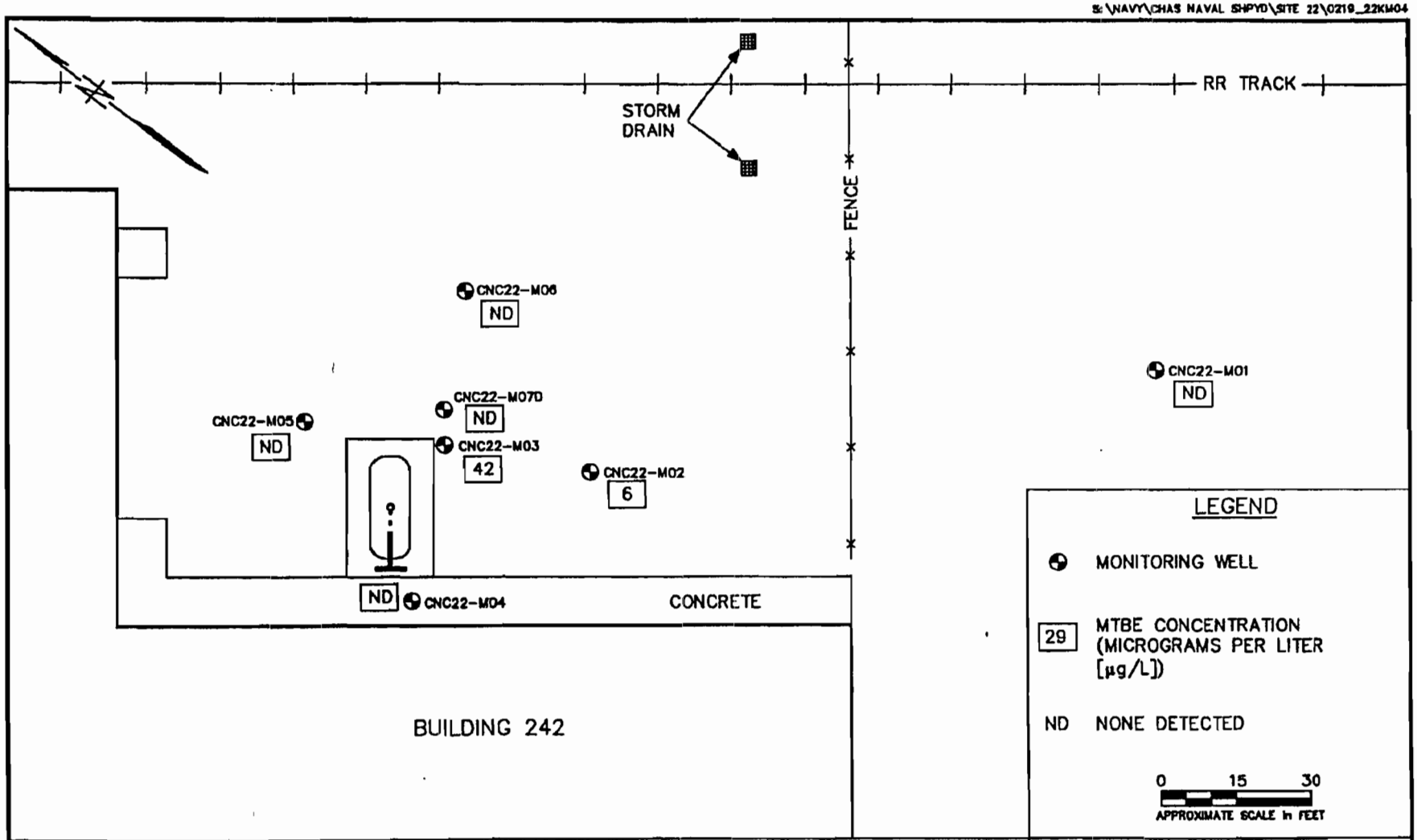

DRAWN BY LLK	DATE 11/1/99	GROUNDWATER MTBE CONCENTRATION MAP SEPTEMBER 10 AND 21, 1999 SITE 22, BUILDING 242 ZONE F, CHARLESTON NAVAL SHIPYARD CHARLESTON, SOUTH CAROLINA	CONTRACT NO. 0219
CHECKED BY	DATE		APPROVED BY DATE
COST/SCHED-AREA			APPROVED BY DATE
SCALE AS NOTED			DRAWING NO. FIGURE 10 REV. 0

FORM CADD NO. SDIV_AH.DWG – REV 0 – 1/20/98

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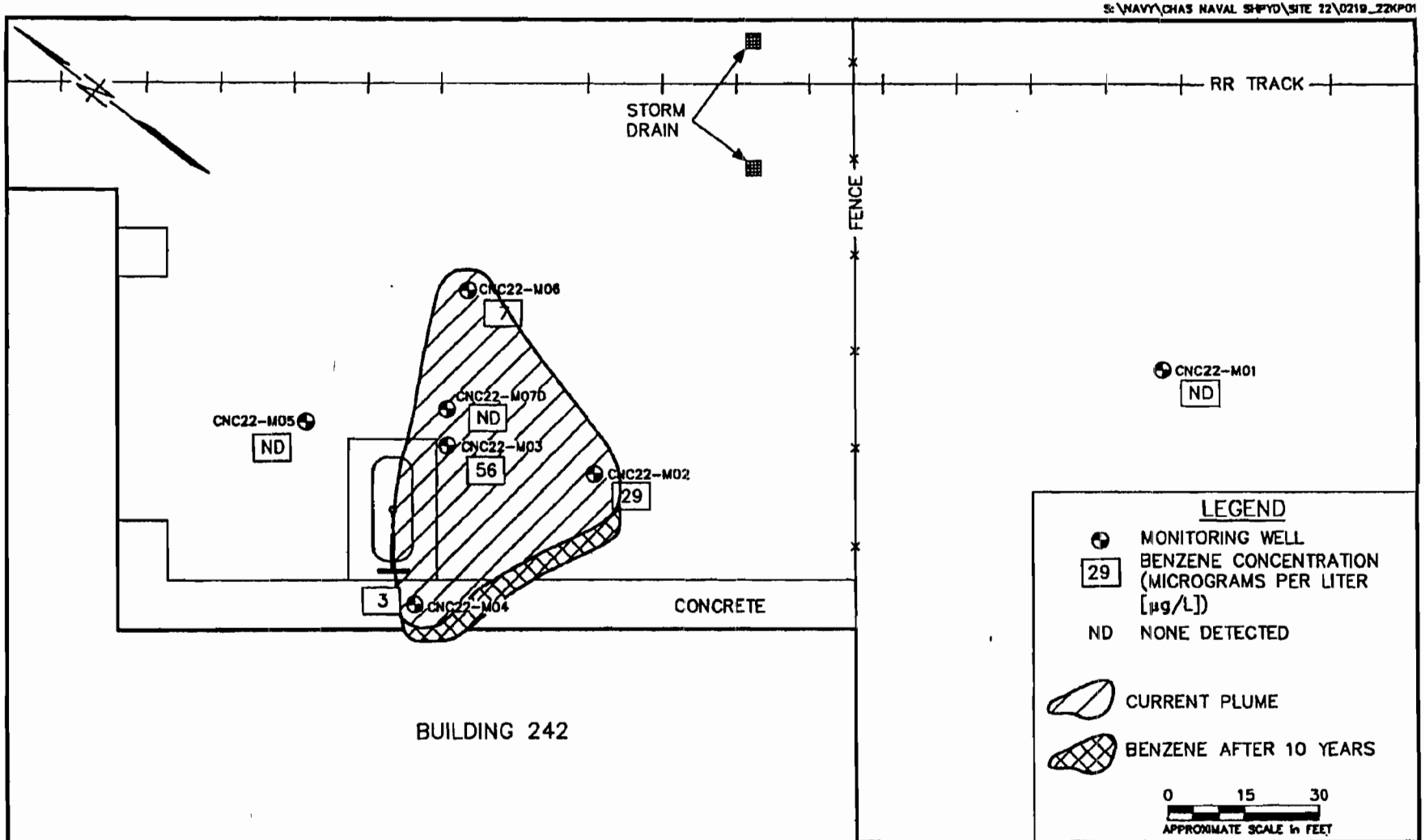

DRAWN BY LLK	DATE 11/1/99	PREDICTED 10-YEAR MIGRATION OF BENZENE SITE 22, BUILDING 242 ZONE F, CHARLESTON NAVAL SHIPYARD CHARLESTON, SOUTH CAROLINA	CONTRACT NO. 0219
CHECKED BY	DATE		APPROVED BY DATE
COST/SCHED-AREA			APPROVED BY DATE
SCALE AS NOTED			DRAWING NO. FIGURE 11 REV. 0

FORM CADD NO. SDIV_AHLDWG – REV 0 – 1/20/98

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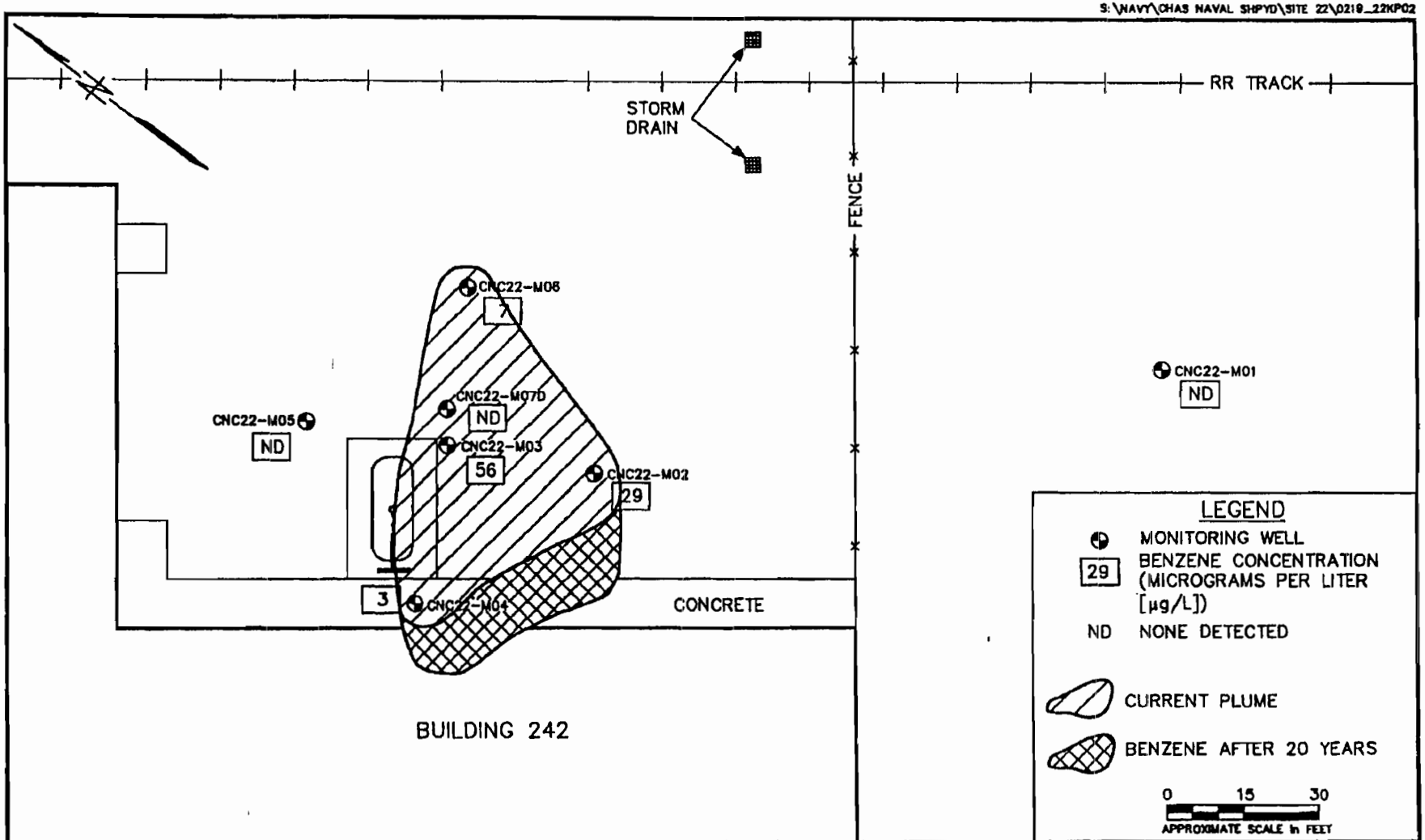

DRAWN BY LLK	DATE 11/1/99	PREDICTED 20-YEAR MIGRATION OF BENZENE SITE 22, BUILDING 242 ZONE F, CHARLESTON NAVAL SHIPYARD CHARLESTON, SOUTH CAROLINA	CONTRACT NO. 0219
CHECKED BY	DATE		APPROVED BY DATE
COST/SCHED-AREA			APPROVED BY DATE
SCALE AS NOTED			DRAWING NO. FIGURE 12 REV. 0

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

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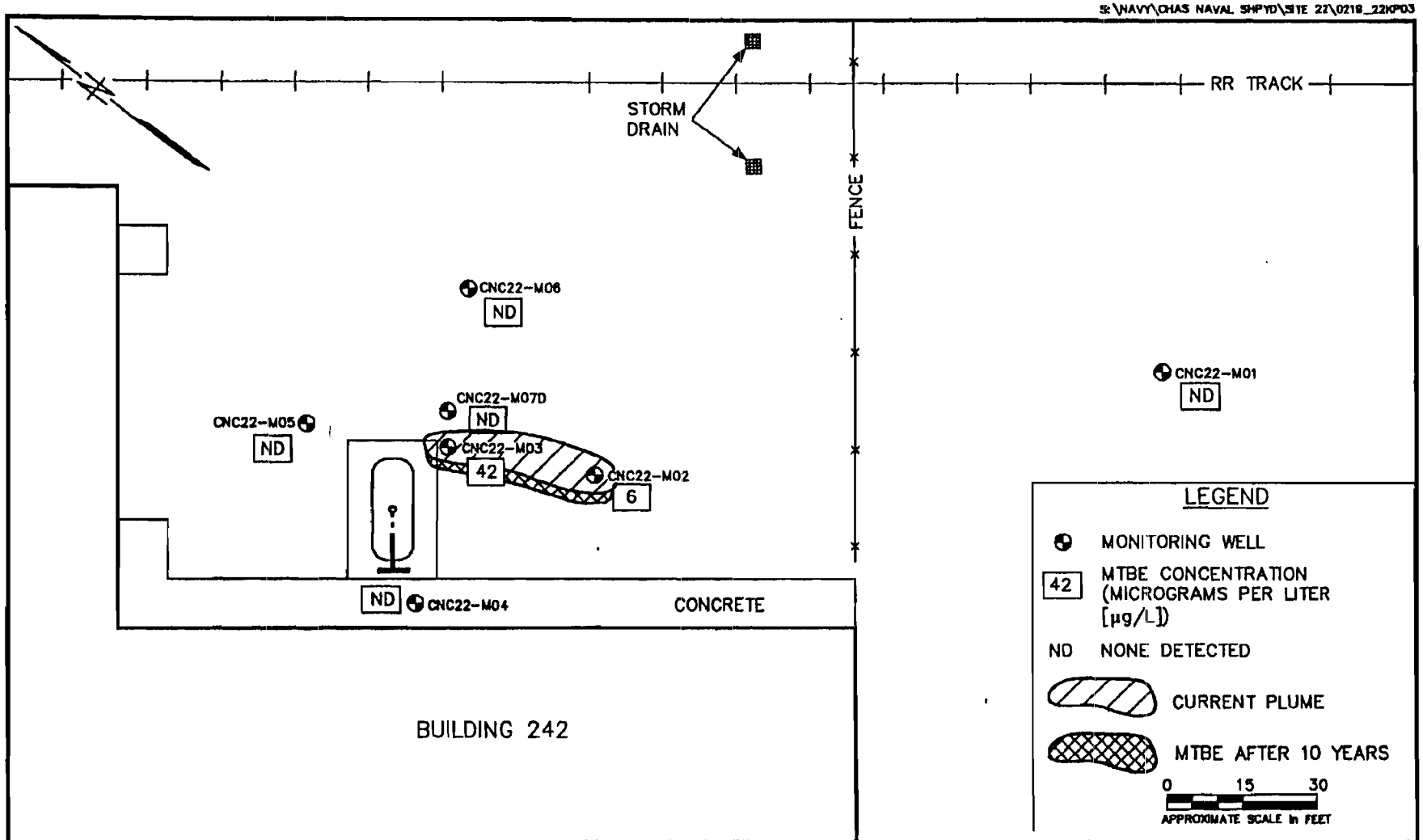

DRAWN BY LLK	DATE 11/1/99	PREDICTED 10-YEAR MIGRATION OF MTBE SITE 22, BUILDING 242 ZONE F, CHARLESTON NAVAL SHIPYARD CHARLESTON, SOUTH CAROLINA	CONTRACT NO. 0219
CHECKED BY	DATE		APPROVED BY DATE
COST/SCHED-AREA			APPROVED BY DATE
SCALE AS NOTED			DRAWING NO. FIGURE 13 REV. 0

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

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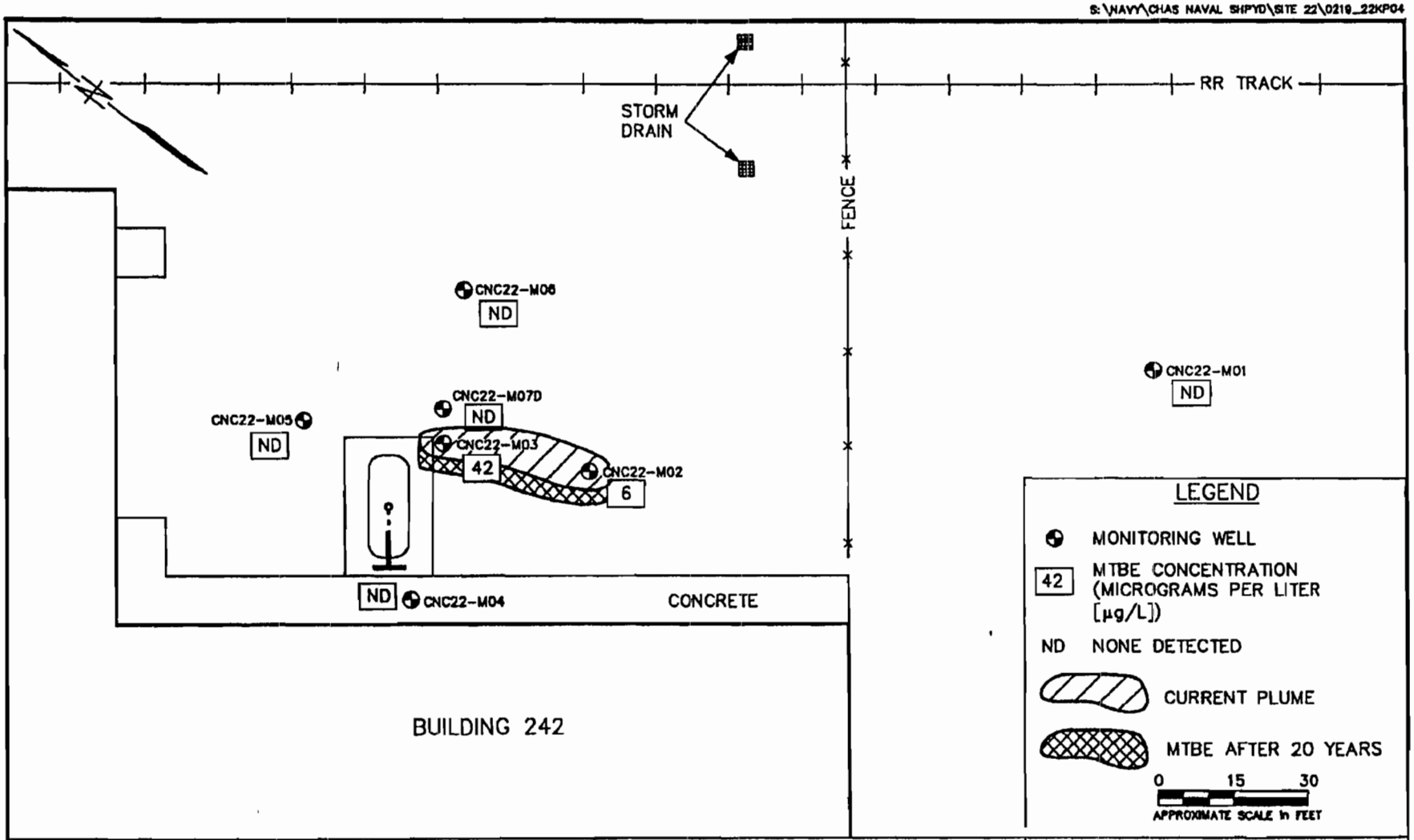

DRAWN BY LLK	DATE 11/1/99	PREDICTED 20-YEAR MIGRATION OF MTBE SITE 22, BUILDING 242 ZONE F, CHARLESTON NAVAL SHIPYARD CHARLESTON, SOUTH CAROLINA	CONTRACT NO. 0219
CHECKED BY	DATE		APPROVED BY DATE
COST/SCHED-AREA			APPROVED BY DATE
SCALE AS NOTED			DRAWING NO. FIGURE 14 REV. 0

FORM CADD NO. SDIV_AH.DWG – REV 0 – 1/20/98