TASK ORDER NO. 4
FINAL DRAFT VERIFICATION INVESTIGATION
RADFORD ARMY AMMUNITION PLANT, VIRGINIA
VOLUME II OF III
Contract No. DAAA15-90-D-0015

Prepared for:

Commander, U.S. Army Toxic and Hazardous Materials Agency
Aberdeen Proving Ground, Maryland 21010-5401

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VERIFICATION INVESTIGATION
VOLUME II
Appendix A through Appendix E.2

(Final Draft)

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APPENDIX A

APPENDIX A
METHODOLOGY FOR THE RISK ASSESSMENT

Appendix A presents the general baseline risk assessment methodology followed for the Verification Investigation (VI) sites at RAAP. This appendix includes a discussion of the identification of potential contaminants of concern; the exposure assessment; a summary of contaminant fate and transport properties; the toxicity assessment; the risk characterization; and a discussion on the methodology of the environmental evaluation.

A.1 IDENTIFICATION OF POTENTIAL CONTAMINANTS OF CONCERN

The identification of potential contaminants of concern is conducted in the contamination assessment portion of the VI. The goal of selecting potential contaminants of concern is to limit the risk assessment to those constituents that are likely to have adverse impacts. This approach avoids the necessity of evaluating relatively innocuous analytes or analytes detected at relatively low concentrations at RAAP and focuses instead on contaminants that have been detected at levels that may be of concern.

The first step in selecting potential contaminants of concern is to identify those that were detected at the facility. Analytical data were reviewed to identify all analytes detected at concentrations above their detection limits. Sampled media include soil, groundwater, surface water, and sediment. The selection process considers all analytes that were detected in soil, groundwater, surface water, and sediment; this includes metals and other inorganic constituents, explosives, volatile organics, semivolatile organics, and pesticides. Contaminants of concern were identified using the following general criteria:

- Concentration
- Toxicity
- Mobility and Persistence
- QA/QC

Potential contaminants of concern are those observed at each of the sites at concentrations that exceed both health based numbers (HBNs) and background concentrations. The HBNs are permit specified numbers; if HBNs for a particular detected analyte were not available in the permit, then HBNs were developed according to the procedures outlined in Appendix D. In general, those analytes detected at levels greater than their HBNs in at least one sample from an environmental medium were considered as potential contaminants of concern if the concentration detected also exceeded background levels. If a detected analyte was found at a concentration below its HBN or below background concentrations, it was generally not selected as a contaminant of concern. Exceptions to this are noted in the text for each site. By using exceedances of HBNs as guidelines for the selection of potential contaminants of concern, the influence of toxicity and concentration is considered in the selection process. Analytes detected at concentrations within the limits defined by the HBNs are considered to be present at levels that would not likely present a risk to public health.

Chemicals that are essential human nutrients, toxic at only very high doses (e.g., iron, magnesium, calcium, potassium, and sodium), and detected at low concentrations (i.e., only slightly elevated above what appears to be naturally occurring levels) were not selected for evaluation. Similarly, naturally occurring organic chemicals (e.g., benzoic acid, carbon disulfide) present at low levels or low frequency and inconsistent with the possible source were not selected for evaluation.

Mobility and persistence of chemicals were considered during the selection of potential contaminants of concern. If an analyte was detected slightly above its HBN or background, and is also known to be a relatively immobile constituent in the media of concern, it may not be selected as a contaminant of concern. Conversely, a highly mobile or very persistent chemical may be selected as a contaminant of concern even if it only slightly exceeds its HBN or background.

Analytes may have been excluded from consideration as potential contaminants of concern on a site- or medium- specific basis if they did not meet the QA/QC requirements. For example, detected analytes suspected to be laboratory blanks or sampling artifacts based on analysis of various blanks (method blanks, equipment blanks, trip blanks, etc.) were excluded from further consideration unless they are expected to be site related or were detected at significantly elevated concentrations. Examples of common laboratory artifacts include acetone, 2-butanone, chloroform, methylene chloride, toluene, and phthalate esters.

A.2 EXPOSURE ASSESSMENT

Under current EPA guidelines (USEPA, 1989) the assessment of human exposure at sites contaminated with potentially toxic constituents is carried out in three steps:

- Characterization of exposure setting (i.e., relevant physical characteristics of the site and potentially exposed populations)
- Identification and evaluation of pathways by which the previously identified populations may become exposed
- Quantification of the exposure (i.e., estimation of exposure point concentrations and human intake of contaminants).

Relevant physical characteristics of each site are discussed in Sections 2.0 through 31. The remaining items are discussed below.

A.2.1 IDENTIFICATION OF POTENTIAL RECEPTORS

The RCRA permit issued to RAAP requires that data be collected to identify human populations and environmental systems that are susceptible to exposure from contamination at the subject SWMUs. Demographics, groundwater and surface water use, and ecological characteristics data are necessary to identify potential receptors and pathways of contamination exposure. These issues are discussed in the following sections.

Future land use is considered to be similar to the current land use scenario--i.e., RAAP will continue to remain an active army installation and there are no plans for future residential development for RAAP. Therefore, potential future and current receptors are assumed to be similar.

A.2.1.1 Local Demographics. As described in Section 2.5, the area surrounding RAAP is mostly rural, with minimal development. The estimated 1988 populations of Montgomery and Pulaski Counties was 101,000 combined, with an approximate overall population density of 143 persons per square mile. The closest residential community is Fairlawn, approximately 3 miles to the southwest. Figure 2-6 and Table 2-6 identify the owners and locations of properties bordering RAAP.

In 1980, the median age of persons in Montgomery and Pulaski Counties was 23.7 and 31.3, respectively. Population characteristics of the two counties are shown in Table A-1.

The 36 SWMUs being investigated under this VI are located well within the installation boundaries. Due to the military nature of activities at RAAP, access to the installation is limited to official visitors. However, the general public does have access to the New River, which flows through RAAP and near several SWMUs, but a security fence separates the river from RAAP. Of concern in the VI are SWMUs 8, 10, 31, 35, 36, 43, 45, and 54, which are located adjacent to the New River (See Figure 2-3). Persons boating, fishing or swimming in the river could potentially be exposed to contaminants migrating from these SWMUs via shallow groundwater. However, due to the significant dilution capacity of this river, potential exposure from an individual SWMU is considered minimal. Of particular concern is SWMU 13, located on the banks of the New River; however, this SWMU is addressed in a separate RFI document.

Hunting is not permitted on RAAP property, and recreation by RAAP employees is limited to activities such as softball, jogging, etc.

A.2.1.2 Groundwater Receptors. There are two known supply wells at RAAP (Insert 1)--well No. 1 is not currently used, well No. 2 is used as a backup potable supply for a tenant activity, the U. S. Army Research, Development and Acquisition Information Systems Agency. Although potential contamination of groundwater is a concern at many of the SWMUs being investigated under this VI, neither of these two RAAP supply wells are located in the immediate vicinity of any of the SWMUs.

Groundwater is a source of water supply to some residents in the Town of Blacksburg, but the supply wells are located more than 5 miles east of RAAP. In addition, shallow groundwater for many of the SWMUs flows toward the New River and would not likely migrate toward any groundwater users in the vicinity of RAAP.

Groundwater usage in the vicinity of RAAP has not been directly characterized. An off-post well inventory to identify potential receptors is being conducted as an RFI activity. The survey involves a records search of well logs maintained by the Virginia State Water Control Board and/or the Pulaski and Montgomery County Health Departments. Pertinent data such as well locations, depths, production rates, and uses is being collected.

A.2.1.3 Surface Water Receptors. Most water used at RAAP is taken from the New River via two intakes--one located approximately 2 miles upstream of the mouth of Stroubles Creek and the other located approximately 6 miles downstream of the mouth of Stroubles Creek (Figure 2-5). Upstream of RAAP, the New River serves as a source of water supply for the cities of Blacksburg and Christiansburg.

The Commonwealth of Virginia has classified the stretch of the New River that passes through RAAP as water generally satisfactory for public or municipal water supplies, secondary contact recreation, and propagation of fish and aquatic life.

Stroubles Creek, which drains approximately one-third of the RAAP Main Manufacturing Area, enters the New River approximately 1 mile east of the New River Bridge (Figure 2-5). A large portion of the flow in Stroubles Creek is attributable to effluent from the Blacksburg municipal sewage treatment plant. There are no known domestic or recreational uses of this stream.

A.2.1.4 Air Quality. Much of the two-county area is susceptible to inversion layers in the fall, causing entrapment of particulate matter as well as gases from manufacturing processes and auto exhaust.

Air emissions from SWMUs at RAAP are of concern primarily at the two SWMUs where burning operations take place--SWMU 13 and SWMU 17. These burning area, permitted by the Virginia Air Pollution Control board, are a subject of the separate RFI.

A.2.1.5 Threatened and Endangered Species. Available date indicate that no threatened or endangered species are suspected of inhabiting RAAP, nor are there any known species with unusual aesthetic value. No species are know to occur exclusively at RAAP or to be absent from the rest of the two counties or the State. There are no species know for which the installation lies at the limit of their ranges. Indications are that the numbers of some species, including the ruffed grouse and upland plovers, have become depleted or have disappeared from RAAP (USATHAMA, 1976).

A.2.2 Identification of Exposure Pathways

The exposure pathways assessment for RAAP is based on environmental conditions, an evaluation of contaminants of concern, and an evaluation of potential receptors. Table A-2 is a preliminary evaluation of potential exposure pathways at RAAP. An exposure pathway is composed of a contaminant source, a release mechanism or transport medium by which the contaminant is transported to the location of exposure, an exposure route by which the contaminant enters the receptors body, and a potential receptor. The site-specific analysis of whether these pathways are operable or complete (or the rationale for why they are incomplete) under current land use is discussed in each site-specific section of the VI report.

Future land use is considered to be similar to the current land use scenario--i.e., RAAP will continue to remain an active army installation and there are no plans for future residential development for RAAP. Therefore, potential future and current exposure pathways are assumed to be similar.

A.2.3 Quantification of Exposure

Due to the limited data available for most VI sites and the nature of a VI, the risk assessments presented in this document are necessarily qualitative; therefore, quantification of the exposure is not conducted. Instead, an estimate of whether the exposure is expected to be negligible, minimal, low, moderate, or high is provided.

A.3 ENVIRONMENTAL FATE AND TRANSPORT OF CONTAMINANTS

Potential human and environmental exposure to each of the contaminants of concern is influenced by the environmental fate and transport properties of each contaminant. Environmental fate and transport information is summarized in Tables A-3 and A-4 for potential inorganic and organic contaminants of concern, respectively.

A.4 TOXICITY ASSESSMENT

The purpose of the toxicity assessment is twofold:

- To weigh available evidence regarding the potential for particular contaminants to cause adverse effects in exposed individuals.
- To estimate, where possible, the relationship between the extent of exposure to a contaminant and the increased likelihood or severity of adverse effects.

A slope factor and the accompanying weight-of-evidence determination are the toxicity data most commonly used to evaluate potential human carcinogenic risks. The slope factor is a plausible upper-bound estimate of the probability of a response per unit intake of a chemical over a lifetime. The slope factor is used to estimate an upper-bound probability of an individual developing cancer as a result of a lifetime of exposure to a particular level of a potential carcinogen.

A reference dose (RfD) is the toxicity value used most often in evaluating noncarcinogenic effects. RfDs for noncarcinogenic effects are estimates of daily exposure levels for the human population, including sensitive subpopulations, that are likely without an appreciable risk of deleterious effects during a lifetime. Chronic RfDs are specifically developed to be protective for long-term exposure to a compound (7 years or longer).

Table A-5 presents available oral and inhalation slope factors and RfDs, as applicable, for the contaminants of concern. Also shown are the weight-of-evidence classification and type of cancer(s) for chemicals with slope factors, and the uncertainty factor, confidence level, and critical effects for chemicals with RfDs.

RfDs are not presented for lead, because--after careful consideration of toxicity date on lead--EPA has decided that the derivation of RfDs is inappropriate (USEPA, 1992). Rather, EPA has developed an uptake/biokinetic (UBK) model that estimates the total lead uptake (ug Pb/day) in children from diet, inhalation, and ingestion of soil, dust, and pain, and predicts a blood lead level (ug Pb/dL) based on total lead uptake. Blood lead is considered the best indicator of recent lead exposure and has been reliably correlated with neurotoxicity measures in developing children. Therefore, the UBK model for lead is used to assess potential exposure to lead at RAAP sites. This model is discussed in more detail in Appendix D.

A.5 RISK CHARACTERIZATION

In the risk characterization section, estimated intakes of contaminants of concern, determined by the analysis of exposure pathways, are combined with health effects criteria to calculate potential carcinogenic risks and noncarcinogenic health hazards. However, because this risk assessment is qualitative in nature, the current or potential future human health risks are only qualitatively evaluated.

A.6 ENVIRONMENTAL EVALUATION

The environmental evaluation was conducted using the same general steps identified above for the human health risk assessment.

- Identification of potential contaminants of concern
- Characterization of exposure setting (i.e., relevant physical characteristics of the site and potentially exposed populations)
- Identification and evaluation of pathways by which the previously identified populations may become exposed
- Qualitative evaluation of exposure and potential environmental threat

Relevant physical characteristics of the facility are discussed in Section 2.0. A description of the environmental setting and flora and fauna at RAAP are included in Sections 2.4 and 2.6, respectively.

Potential contaminants of concern were identified using the procedures discussed in Section A.1. Potential environmental effects were qualitatively evaluated by consideration of potential access of wildlife to the individual SWMUs, potential for contact of wildlife with contamination detected at the SWMUs, and a qualitative evaluation of potential exposure to ecological receptors. For evaluation of potential exposure to surface water contaminants, detected concentrations were compared to Ambient Water Quality Criteria (AWQC).

TABLE A-1

Population Characterics (1989)
Montgomery and Pulaski Counties

	Male	Female	White	Nonwhite	19 and Under	20-64 Yr	Over 65 Yr
Montgomery County	52.4%	47.6%	96.3%	3.7%	26.0%	66.7%	7.3%
Pulaski County	48.5%	51.5%	94.3%	5.7%	26.9%	60.0%	13.1%

SOURCE: NRVDPC, 1989.

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TABLE A–2

Preliminary Evaluation of Potential Exposure Pathways for RAAP, Virginia

	Exposure Pathway	Source	Release Mechanism or Transport Medium	Exposure Route	Potential Receptors
1	Direct dermal contact with contaminated soil and subsequent absorption of contaminants by skin.	Contaminated soil	Direct, wind erosion	Direct dermal contact	RAAP employees; recreators
2	Inadvertent ingestion of contaminated soil.		Direct, wind erosion	Ingestion	RAAP employees; recreators
3	Inhalation of contaminated soil as dust.		Wind erosion	Inhalation of dust	RAAP employees; recreators; downwind residents
4	Inhalation of vapors volatilized from soil.		Volatilization, wind	Inhalation of vapors	RAAP employees; recreators; downwind residents
5	Ingestion of contaminated drinking water.	Contaminated groundwater	Leaching, advection, dispersion, well	Ingestion	RAAP employees; downgradient residents
6	Inhalation of volatile contaminants emitted from groundwater during showering and other indoor activities using household water.		Leaching, advection, dispersion, well	Inhalation of volatiles during showering, etc.	Downgradient residents

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TABLE A–2 (cont'd)

Exposure Pathway	Source	Release Mechanism or Transport Medium	Exposure Route	Potential Receptors
7 Absorption of contaminants subsequent to dermal contact with groundwater during showering and other indoor activities using household water.	Contaminated groundwater	Leaching, advection, dispersion, well	Direct dermal contact	Downgradient residents
8 Ingestion of contaminated surface water used as a drinking water source.	Contaminated surface water	Surface runoff, leaching, downstream transport	Ingestion	RAAP employees; downstream residents
9 Absorption of contaminants subsequent to dermal contact with surface water during swimming.		Surface runoff, leaching, downstream transport	Direct dermal contact	Recreators in New River
10 Inadvertent ingestion of contaminated surface water during swimming.		Surface runoff, leaching, downstream transport	Ingestion	Recreators in New River
11 Inhalation of volatile contaminants emitted from surface water during swimming.		Surface runoff, leaching, downstream transport	Inhalation	Recreators in New River
12 Absorption of contaminants subsequent to dermal contact with sediment during swimming.	Contaminated sediment	Surface runoff, downstream transport	Direct dermal contact	Recreators in New River

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TABLE A-2 (cont'd)

Exposure Pathway	Source	Release Mechanism or Transport Medium	Exposure Route	Potential Receptors
13 Inadvertent ingestion of contaminated sediment during swimming.	Contaminated sediment	Surface runoff, downstream transport	Ingestion	Recreators in New River
14 Inhalation of volatile contaminants emitted from sediment during swimming.		Surface runoff, downstream transport	Inhalation	Recreators in New River
15 Consumption of game that feed on vegetation growing in contaminated soil or that have ingested contaminated surface water.	Indirect pathways	Biouptake, animals, hunting	Ingestion of game	Hunters and their families
16 Consumption of fish that have ingested contaminated surface water, food, or sediment.		Biouptake, fish, fishing	Ingestion of fish	Fishermen and their families

TABLE A-3

Summary of Environmental Fate and Transport of Metals Selected as Potential Contaminants of Concern (a)

Chemical	Chemical Speciation	Volatilization	Sorption	Bioaccumulation/ Biotransformation	Aquatic Bioconcentration Factor (BCF)	Principal Environmental Fate
Antimony	Present in any of four valence states (−3, 0, +3 or +5). Stibnite (Sb_2S3) is the most common naturally occurring form.	May be volatilized when in the form of SbH_3 or its methyl derivatives.	Sorption to clays and minerals occur, but extent is not known.	Although it is thought that biomethylation could occur in the environment, this has not been demonstrated. Bioaccumulation is minor.	1	Sorption to clays and minerals is normally the most important mechanism resulting in the removal of Sb from solution.
Arsenic	Formation of elemental As and arsine are unlikely in soils, groundwater or surface water. Arsenic (V) oxide can become reduced to the arsenic (III) oxide; the corresponding anions are very soluble and mobile.	The biotransformation products, dimethylarsine and trimethylarsine are very volatile.	Monovalent arsenate and arsenite ions are the most strongly sorbed soluble species. Other soluble species appear to be mobile.	Microbial methylation in soils is considered to be very slow. Methylarsines can be produced by many yeasts, bacteria, and fungi. Bioaccumulation of arsenic from soils is slight.	44	Environmental transport of arsenic is cyclical but landfilled material can act as a long-term source. Leaching of the mobile forms of arsenic probably occurs.
Barium	Present as the +2 cation in natural environments.	Not considered relevant.	Precipitates from solution as the carbonate or sulfate. Strongly sorbed by clay.	Not considered relevant.		Sorption is the dominant fate in landfills but it can be mobilized by hard water.
Cadmium	Present as the +2 cation in natural environments.	Not considered relevant	Cadmium is strongly sorbed by clays, organic matter, and metal oxides.	Potentially accumulated by plants and animals.	6.4	Landfilled cadmium is strongly sorbed.
Cobalt	Present on the 0 or +2 oxidation states in the natural environment.	Not considered significant.	Adsorp to clay minerals and hydrous oxides of iron, manganese or aluminum.	The element cobalt is considered nonbiodegradable in the environment. Traces of cobalt are accumulated by microorganisms, higher plants, and animals.	40−4000	Sorption is the dominant fate in aquatic and terrestrial systems.
Chromium	Speciation may determine mobility since chromium (III) hydroxide is insoluble but chromium (VI) complexes are usually soluble.	Not considered significant.	Chromium (III) hydroxide is insoluble but chromium (VI), if present as chromate, is reported to be mobile in landfills.	Chromium (VI) can be accumulated by plants and animals.	16	Leaching of chromium (VI) is possible, but chromium (III) is much less mobile.

TABLE A-3 (cont'd)

Chemical	Chemical Speciation	Volatilization	Sorption	Bioaccumulation/ Biotransformation	Bioconcentration Factor (BCF)	Environmental Fate
Copper	Present as the +2 cation in natural environments.	Not significant.	Strongly sorbed by clay minerals and organic matter.	Potentially accumulated by all organisms.	290	Sorption is the dominant fate in landfills.
Lead	The carbonate and sulfate control solubility in aerobic environments; under anaerobic conditions the sulfide will precipitate.	Not significant.	Strongly sorbed by components of soil.	Lead is accumulated from the atmosphere by both plants and animals.	49	Sorption is the dominant fate in landfills.
Manganese	Transformations occur between MN (II), MN (III), and MN (IV); MN (II) predominates.	Probably not important.	Hydrous manganese oxides have an affinity for clay minerals and trace metals.	Accumulated by aquatic organisms to a variable extent.		Manganese is ubiquitous in the soil environment and will, therefore, be present in groundwater.
Nickel	Stable state in natural systems is Ni (II), the compounds of which are soluble with the exception of the sulfide.	Probably not important.	Nickel is mobile in the terrestrial and aquatic environments.	Potentially accumulated by aquatic organisms.	47	Leaching appears to be the principal fate of nickel in landfills.
Nitrates	Inorganic nitrates are components of metals combined with the monovalent nitrate radical (NO_3); combination of NO_3 and hydrogen produces nitric acid.	Not considered relevant	Generally nitrate will move with water through soil pore spaces. Clay soil tends to retain nitrates more than sandy soil.	Inorganic and organic forms are available for plant or crop uptake. No info on biomagnification was identified.	Not found in literature	Fate is linked to the nitrogen cycle where various forms of nitrogen are altered by nitrogen fixation, assimilation and reduction of nitrate.
Sulfates	Can exist as sulfide, sulfites, sulfates or organic sulfur compounds.	Not considered relevant	Generally sulfates will move with water through soil pore spaces.	Inorganic and organic forms are available for plant and animal uptake. No information on biomagnification was identified.	Not found in literature	Fate is linked to the sulfur cycle where various forms of sulfur are altered by aerobic and aneurobic bacteria, sulfur bacteria, and oxidation.

TABLE A-3 (cont'd)

Chemical	Chemical Speciation	Volatilization	Sorption	Bioaccumulation/ Biotransformation	Bioconcentration Factor (BCF)	Environmental Fate
Thallium	The thallic ion (Tl+3) is hydrolyzed to form the colloidal oxide over the pH range of natural waters. Depending on the relative kinetics of reduction compared to hydrolysis, however, precipitation as $Tl(OH)_3$ may be an effective mechanism for removing thallium from solution via the following scenario: thallium (III) precipitates as the oxide or hydroxide and settles to the bed sediments; in the sediments, the reducing conditions cause reduction to Tl(I), which reacts with sulfide to form the insoluble compound Tl_2S.	Not considered significant.	Strongly absorbed by montmaorillonitic clays. Actively sorbed into the sediments in the aquatic environment.	No evidence was found to that thallium is biologically transformed in the aquatic environment (Callahan et al., 1979), and no other information was available. The thallium is considered non-degradable in the environment. Thallium is readily taken up by aquatic organisms.	100,000	Much of the thallium present in aquatic systems is likely to remain in solution and be transported to the oceans. Sorption to clay minerals is probably an important environmental fate process.
Zinc	Predominant species is the Zn+2 cation.	Not important.	Zinc is not strongly sorbed by soil constituents and is considered easily mobilized.	Zinc can be bioaccumulated by both plants and animals.	432	Leaching appears to be the principal fate of zinc in landfills.

(a) Based on information given in Callahan et al. (1979) and USEPA (1987 and 1988c).

TABLE A-4

Summary of Environmental Fate and Transport of Organic Chemicals Selected as Potential Contaminants of Concern (a)

Category/ Chemical	Photolysis/ Oxidation	Hydrolysis	Volatilization	Sorption	Biodegradation	Environmental Fate
BNA's:						
Phthalate esters	Not significant.	Very slow unless catalyzed by microbial enzymes.	Significance uncertain.	Dominant physical process in soils and groundwater.	Degraded by many different types of soil microorganisms.	The most probable fate in soils and groundwater is biodegradation. This chemical is retarded by solid aquifer materials.
Bis(2-chlorethyl)ether	Direct photolysis not expected to take place in the atmosphere or surface water. Photo-oxidation in the troposphere is likely to occur.	Slow hydrolytic clearage of the C-C1 bonds can occur and is probably the most important aquatic fate.	Some volatilization from aquatic and terrestrial systems probably occurs.	Sorption onto particulate matter does not appear to be significant.	Significant degradation may occur in aquatic environment after a period of acclimation.	Somewhat soluble in water and can migrate through the soil.
N-Nitrosodi-phenylamine	Photolysis is slow. No information found on oxidation.	Not easily hydrolyzed under normal environmental conditions. Rapid hydrolysis in conditions of high temperature and/or low pH.	Unlikely to volatilize; confirming data not found in literature.	High potential for significant sorption to soil.	Only important in condition with active microbial population.	Sorption to soil is the most important fate process.
Explosives:						
2,4-DNT	Important process in surface water (half-life = 5 days)	Not relevant.	Important process for surface water (half-life = 2 days)	Sorption by clay may be important at RAAP sites.	Microbial destruction in soil and groundwater is slow but may be significant for RAAP sites.	Sorption by clay and biodegradation are important in soil and groundwater; photolysis and volatilization are important in surface water.
2,6-DNT	Important process. (t 1/2 = 1 day)	Not relevant.	Important process from surface water (t 1/2 = 9 days)	Sorption to clay may be important at RAAP sites.	Microbial transformation in the groundwater is slow but may be significant for environmental destruction.	Sorption to clay and biodegradation are important in groundwater; photolysis and volatilization are dominant in surface water.

(a) Based on information presented in Callahan et al (1979) and USEPA (1987 and 1988c). Additional information on explosives is provided by Burrows et al (1989).

TABLE A-5

Summary of Toxicity Criteria for the Contaminants of Concern

Chemicals	RfDo (mg/kg/day)	UF	Confidence	Critical Effect	RfDI (mg/kg/day)(aa)	UF	Confidence	Critical Effect
TAL Inorganics								
Antimony	4.0E-04	1000	Low	Longevity; blood glucose levels; serum cholesterol	ND	--	--	--
Arsenic	3.0E-04	3	Medium	Hyperpigmentation, keratosis vascular complications	UR	--	--	--
Barium	7.0E-02	3	Medium	Hypertension tested	1.4E-04	1000	--	Fetotoxicity
Cadmium	5.0E-04(b) 1.0E-03(b)	10	High	Proteinurea	UR	--	--	--
Chromium III	1.0E+00	100(c)	Low	NOAEL; highest level tested	6.0E-07	1000	--	Nasal mucosal atrophy
Chromium VI	5.0E-03	500	Low	NOAEL; highest level tested	6.0E-07	1000	--	Nasal mucosal atrophy
Cobalt	1.0E-05	--	Low	Toxicity assessment in sensitive humans	2.86E-04	--	Low	--
Copper	3.7E-02	1	Low	MCL	1.0E-02	--	Low	--
Lead	IUBK Model (see text)			Neurotoxicity in children	ID	--	--	--
Manganese	1E-01	1	Medium	Dietary essential level	1.0E-04	300(d)	Medium	Respiratory signs; psychomotor disturbances
Nickel	2.0E-02(e)	300	Medium	Decreased body, liver and spleen weights blood and CNS disorders	UR	--	--	--
Thallium	6.0E-05(g)	3000	Low	NOAEL; highest level tested	ND	--	--	--
Vanadium	7.0E-03	100	Low	NOAEL; highest level tested	ND	--	--	--
Zinc	2.0E-01(h)	100	--	Anemia	ND	--	--	--

TABLE A-5 (cont'd)

Chemicals	RfDo (mg/kg/day)	UF	Confidence	Critical Effect	RfDi (mg/kg/day)(aa)	UF	Confidence	Critical Effect
Explosives								
2,4-DNT	2.0E-03	100	--	NOAEL; higher levels produced anemia, neurological effects, methemoglobinemia, bile duct hyperplasia	ND	--	--	--
2,6-DNT	1.0E-03	3000	--	Mild splenic hematopoeisis; lymphoid depletion	ND	--	--	--
Other Inorganics								
Nitrate	1.6E+00	1	High	NOAEL; higher doses associated with methemoglobinemia	ND	--	--	--
Nitrite	1E-01	10	High	NOAEL; higher doses associated with methemoglobinemia	ND	--	--	--
Sulfate	ID	--	--	--	ID	--	--	--
N-nitrosodiphenylamine	ND	--	--	--	ND	--	--	--

TABLE A–5 (cont'd)

Chemicals	SFo 1/(mg/kg/day)	Types of Cancer	SFI 1/(mg/kg/day)	Types of Cancer	Weight-of-Evidence Class	Sources(a)
TAL Inorganics						
Antimony	ND	--	ND	--	--	1,1,1,1
Arsenic	1.75E+00	Skin cancers	1.4E+01	Lung cancers	A	1,1,1,1
Barium	ND	--	ND	--	--	1,2,1,1
Cadmium	ND	--	6.3E+00	Lung, tracheal, and bronchial tumors	B1	1,1,1,1
Chromium III	ND	--	ND	--	--	1,2,1,1
Chromium VI	ND	--	4.2E+01	Lung tumors	A	1,2,1,1
Cobalt	ND	--	ND	--	--	3,3,1,1
Copper	ND	--	ND	--	D	3,3,1,1
Lead	ID	Renal tumors	ID	Digestive tract; respiratory system; peritoneum	B2	4,4,1,1
Manganese	ND	--	ND	--	D	1,1,1,1
Nickel	ND	--	8.4E-01 (f) 1.7E+00 (f)	Lung and nasal tumors	A	1,1,1,1
Thallium	ID	--	ND	--	D	1,1,1,1
Vanadium	ND	--	ND	--	--	2,1,1,1
Zinc	ND	--	ND	--	D	2,1,1,1

TABLE A-5 (cont'd)

Chemicals	SFo 1/(mg/kg/day)	Types of Cancer	SFI 1/(mg/kg/day)	Types of Cancer	Weight-of-Evidence Class	Sources(a)
Explosives						
2,4-DNT	6.8E-01	Hepatocellular carcinomas; mammary fibroadenomas	ND	--	B2	5,1,1,1
2,6-DNT	6.8E-01	Hepatocellular carcinomas; mammary fibroadenomas	ND	--	B2	5,1,1,1
Other Inorganics						
Nitrate	ND	--	ND	--	--	1,1,1,1
Nitrite	ND	--	ND	--	--	1,1,1,1
Sulfate	ID	--	ID	--	--	-, -, -, -
N-nitrosodiphenylamine	4.9E-03	Bladder tumors	ND	--	B2	1,1,1,1

TABLE A–5 (cont'd)

Footnotes:

(a) Source codes are listed below. The 4 values shown in this column are the sources for the oral RfD, the inhalation RfD, the oral slope factor, and the inhalation slope factor, respectively. Dashes indicate that no information was found in any of the cited regulatory documents or communications.

(1) USEPA, 1992
(2) USEPA, 1991a
(3) USEPA, 1991b
(4) USEPA, 1991c
(5) Brower, 1992

(b) *The oral slope factors are listed for cadmium in water and dietary cadmium, respectively.*
(c) A modifying factor of 10 was also used to reflect uncertainty in the data base and the variable absorption of chromium.
(d) A modifying factor of 3 was also used to account for the uncertainty in manganese exposure levels in the principal study.
(e) Listed value is for the soluble salts of nickel
(f) Listed values are for nickel refinery dust and nickel subsulfide, respectively.
(g) Value is for thallium as thallium sulfate
(h) Under RfD/RfC Work Group review.
"_" Not applicable

Acronyms:
RfDo = Oral Reference Dose
UF = Uncertainty Factor
RfDi = Inhalation Reference Dose
SFo = Oral Slope Factor
SFi = Inhalation Slope Factor
ND = No Data
UR = Under Review
NOEL = No observable effect level
NOAEL = No observable adverse effect level
MCL = Maximum Contaminant Level
CNS = Central nervous system
RfC = Reference concentration
CRAVE = Carcinogen Risk Assessment Verification Endeavor

APPENDIX B

APPENDIX B
SUMMARY OF GEOTECHNICAL AND SAMPLING PROCEDURES

B.1 GEOTECHNICAL PROCEDURES

B.1.1 Monitoring Well Installation

The following sections describe the borehole drilling and installation methods for the monitoring wells installed for the VI. The field program for the VI study areas included the following:

- Twenty-one monitoring well and piezometer borings and installations at eight SWMUs.
- Physical soil tests performed on 24 soil boring samples.
- Surveying of the new monitoring wells for elevation and state planar coordinates.

All locations for well installations were marked, then cleared by RAAP personnel for utilities prior to drilling.

B.1.1.1 Well Drilling Methodology. All necessary approvals for equipment, methods, and materials were obtained from USATHAMA prior to the start of drilling. All geotechnical methods were performed in accordance with the procedures outlined in the VI Work Plan (Dames & Moore, 1990a).

Overburden well borings were performed using hollow-stem auger, air rotary or mud rotary methods. The presence of dense layers of river jack (cobbles and boulders) in several borings required the use of air rotary or mud rotary drilling methods. Below are descriptions of three methods used to drill through unconsolidated sediments during the VI program.

For 4-inch monitoring wells installed with hollow stem augering the following method was used: a 6.25-inch inside diameter hollow stem auger was used to advance the boring while a 24-inch split spoon sampler was advanced at 5-foot intervals using the Standard

Penetration Test (ASTM D-1586). Detailed logs were developed for each boring. Hollow-stem augering, as described above, was performed through the overburden until bedrock was encountered or until either air or mud rotary drilling methods were necessary to penetrate layers of river jack (cobbles and boulders) at which auger refusal occurred.

For 4-inch monitoring wells installed with the mud rotary method of drilling necessary approval was obtained from USATHAMA prior to drilling. A sample of the bentonite clay powder to be used as a thickening agent for drilling was submitted to USATHAMA for approval prior to beginning the VI. The water used for drilling was obtained from the RAAP water treatment plant at a point prior to treatment. The mud rotary method of drilling used materials that were unlikely to alter the chemical character of the penetrated soils. A 6-inch roller cone bit was advanced during drilling and then a 10-inch reaming bit was used to enlarge the borehole to the required diameter for piezometer/well installation. After penetrating to the required depth, the mud was flushed from the borehole using water from the approved source. Volumes of mud and water lost into the formation were recorded at the time of drilling and flushing. Samples of cuttings from the borehole were collected and used to develop logs for each boring.

For 4-inch monitoring wells installed with the air rotary method of drilling, necessary approval was obtained from USATHAMA prior to drilling. The air rotary drilling in the overburden consisted of advancing a 6-inch tricone roller bit while a 24-inch split spoon sampler was advanced at 5-foot intervals using the Standard Penetration Test (ASTM D-1586). A 10-inch tricone roller bit was then used to ream the borehole to the required diameter. Detailed logs were developed for each boring including the recording of blows needed to drive the sampler at intervals of 6-inches of penetration.

For 4-inch monitoring wells that required bedrock penetration, either NX rock coring or air hammer methods were utilized. These two methods are described below.

Whenever possible, NX rock coring was used to penetrate bedrock to the required depth. Prior to coring, a temporary 10-inch polyvinyl chloride casing (PVC) was used to seal off the overburden material. NX rock coring was then performed in 5-foot runs to obtain intact samples of bedrock for subsurface logging. During coring detailed boring logs were maintained which indicated the time required to complete each run, water loss to the formation and other pertinent drilling data. The rock cores were placed in wooden core boxes and photographed with appropriate identification. NX rock coring was performed to a depth of approximately 15 feet below the encountered water table. After completion of the rock coring, a 8-inch roller bit or air hammer was used to ream out the hole to install the well. Water from the approved source was used for the coring or reaming. Waste drilling water was not containerized unless contamination was apparent at the time of drilling or existing data indicated that contamination was likely to be encountered.

If significant water loss was encountered or expected during drilling then percussive air hammer drilling was used to either penetrate bedrock or ream existing boreholes to the required depth. Before drilling with the percussive air hammer, USATHAMA approval was obtained. Prior to use of the air hammer a temporary 10-inch PVC casing was used to seal off the overburden material. A 6-inch percussive air hammer was used to advance the borehole to the required depth. The borehole was then reamed with a 8-inch air hammer bit. A detailed log was maintained during drilling including collection of cuttings from the borehole.

During drilling an experienced geologist supervised the drilling of each borehole and maintained continuous detailed subsurface logs by examining drill cuttings, recording samples, and noting first-encountered and static groundwater levels for each borehole. A daily log was maintained and included information pertaining to progress of drilling operations, problems encountered, and well installation procedures. All original boring logs, well diagrams, and field notes were regularly submitted to USATHAMA during the field program.

All drill rigs and all other sampling equipment were decontaminated prior to arrival at RAAP, prior to drilling the first borehole, and after the drilling of each borehole. A portable steam-cleaner with a steam temperature of 220° F and a pressure of 1,000 psi was utilized. A decontamination pad was constructed on a gravel area adjacent to SWMU 43 in area designated by RAAP and USATHAMA. A sample from the water source onsite used for drilling, rinsing, and steam-cleaning was analyzed and results submitted to USATHAMA for approval as an appropriate source before fieldwork initiation.

B.1.1.2 Well Construction Overburden monitoring wells were installed in the newly drilled boreholes using either a 6.25-inch I.D. dry hollow-stem auger, or an 8-inch mud rotary roller bit method whenever possible. Well installations and all geotechnical procedures were performed according to procedures in the VI Work Plan, USATHAMA's 1987 Geotechnical Requirements, and the requirements of the Commonwealth of Virginia. All well casing and screening materials were made of new Schedule 40 PVC. PVC is considered appropriate for the conditions encountered and the contaminants of concern. The screen for each well was approximately 10 feet long with a slot size of 10 (0.010 inch). This screen length will ensure that the screens remain opposite the producing groundwater zone even during drier periods, lessening the chances of a dry well during future groundwater sampling efforts. Only threaded couplings were used to join sections of PVC casing and screening materials. All well casings and screens were steam cleaned prior to insertion in the borehole.

Well installation procedures and well placement criteria were developed specific to the local conditions because of the complex geology and groundwater conditions at RAAP. The general rationale for the site specific installation criteria were presented in the VI work plan, but a summary of these criteria are presented herein. Well screens were to be placed across the water table that could have been at or only a few feet above bedrock. Water found immediately above and below the soil/rock contact was considered to be hydrologically similar, not as separate units, due to the fractured character of the rock. Where the water table was found in the rock at depth, the irregular fracture inflow and often slow infiltration rate made field determination of proper screen placement very uncertain. Screens no longer than 10 feet were considered appropriate to intercept both the inflow fractures and the static water table that could be (and was) at much higher elevations.

With the exception of well 32MW1, 4-inch diameter casings were installed in each borehole (A 2-inch diameter casing was installed in 32MW1 due to installation difficulties while attempting to install a four-inch well). The casing had an appropriate screen, was plugged at the bottom, and had a 2.5-foot stickup. Unless unusual conditions were encountered, the screen was located no more than 3 feet above the bottom of the borehole and opposite the producing groundwater zone. The top of the screen was positioned 1 to 2 feet above the stabilized water level encountered, where possible, for all shallow wells to intercept petroleum hydrocarbons or other contaminants that may be floating on the water table, as well as other types of constituents. The screened section was sand packed, to at least 5 feet above the screen, wherever circumstances permitted.

In order to allow room for a sufficient annulus seal and to prevent vertical infiltration of surface water, a minimum of a 5-foot thick bentonite seal was placed above the sand pack where conditions permitted, and the remaining annular space between the top of the seal and ground surface was grouted with a cement and bentonite mixture. The grout was pumped into the open annulus through a rigid tremie pipe, which was lowered into the hollow stem of the augers, outside the well casing, to the bottom of the annulus. Grout was pumped until undiluted grout rose to the surface. Augers were then removed, allowing the grout to fall into the evacuated hole, but the augers were maintained at a depth so that grout did not fall below the bottom of the deepest auger. Grout was then added to fill the remaining open annulus, as more augers were removed. Grout placement continued until all augers were removed and grout was present at the ground surface. Data concerning screen, filter sand, bentonite seal and grout thickness, and depths were recorded. An installation diagram was prepared for each well.

The bedrock wells installed during the RAAP VI were placed within the reamed bedrock and consisted of a 15-foot screen and sand pack similar to the overburden wells. The bottom of each screen was placed approximately 12 to 13 feet below the water table, with the sand pack extending up to 5 feet below the soil/bedrock contact. A 5-foot bentonite pellet seal was then placed above the sand pack and terminated at the soil/bedrock contact. Bentonite/cement grout was then placed from above the bentonite seal to the ground surface.

A 5-foot length of protective, clean steel casing--with a minimum diameter of at least 6 inches and a locking cap--was installed over the well casing immediately after grouting, to a depth of 2.5 feet below the ground surface. The steel protective casing was placed so that no more than 0.25-foot of height separated the top of well casing and the top of protective casing. An internal mortar collar was placed within the steel protective casing and outside the PVC well casing to a height of 0.5 foot above ground surface. An internal drainage hole was drilled through the steel casing just above the mortar collar. After the grout had thoroughly set, a 4-inch thick, 4-foot by 4-foot sloped concrete pad was poured around each well casing. A 6-inch external mortar collar was then placed around each protective steel casing. The protective steel casing was then brush painted with orange paint and identified by placing an inscribed metal plate on top of each locking cap. Additional protection was provided by four steel posts set within each corner of the concrete pad.

B.1.1.3 Well Development Proper well development will remove water, drilling muds, and other fluids or materials introduced into the aquifer as a result of borehole drilling operations. It also functions to reduce the amount of fine-grained sediment around the sand-packed portions of the annulus, which might otherwise clog the well screen, and to enhance porosity for free flow in the screened zone. Well development techniques that could potentially contaminate or alter the chemistry of the water-producing zones were avoided. Well development equipment was decontaminated prior to use and between wells. Prior to development, the static water level was measured and recorded. Field conductivity, temperature, and pH were also measured and recorded before, at least twice during, and at completion of development to ensure that the development process was complete.

Depending on the site conditions, well development was completed using either a 2 or 4-inch submersible pump, a suction lift centrifugal pump, a 3.25 inch PVC bailer or an air compressor. All pumps were thoroughly checked and cleaned prior to use. During well development, disposable equipment such as polypropalene tubing and rope was not used at other well locations in order to prevent cross-contamination between wells. In order to ensure complete well development, water was removed throughout the water column by periodically changing the position of the pump or bailer during development. In addition, the well cap and interior of the well casing were washed with water withdrawn from the well during development. A bottom discharging bailer was used to create a surging action to help loosen and remove fine grained sediment. In addition, wells were developed until water was clear to the unaided eye and sediment remaining in the well occupies less than one percent of the screen length. At a minimum, the standing water volume in the well and in the saturated annulus was removed at least five times. In cases where drilling fluids were introduced and lost into the well, and additional quantity equal to five times the measured volume of lost fluids were removed. In several cases, significant fluid loss and slow recharge required removal of less than five times the volume of fluids lost during drilling. Well development in all cases was continued until pH, conductivity, and temperature measurements had stabilized. For each well, a 1-pint sample of the last water removed during development was captured and retained. The water level in each well was allowed to fully recover prior to any purging and groundwater sampling.

During air development (well 32MW1 only), a polypropalene air hose was inserted through a hole in the well cap at the well head. Air was then forced to the bottom of the well by means of an air compressor, thereby air-lifting sediments and water to a discharge point at the well head. The air compressor was periodically shut off to allow the aerated water column to fill back into the screened area and surge the sediments loose within the screen.

B.1.1.4 Boring and Well Abandonment During the VI program several soil borings were abandoned for the following reasons: significant karst solution features made further drilling impractical, potential waste or hazardous landfill materials were encountered during drilling, drilling refusal was encountered on large boulders or obstructions, or groundwater was not encountered to the maximum planned drilling depth. USATHAMA was contacted for approval prior to any abandonment.

Any soil boring in which a well was not installed was sealed upon completion. The following procedure details abandonment procedures used. No wells were abandoned with PVC in place.

The boring was sealed by grouting from the bottom of the boring to ground surface, or in the case of large karst features by insertion of an inert (PVC) plug to a depth above solution features. Abandonment was accomplished by placing a grout pipe at the bottom of the boring (i.e., to the maximum depth drilled) and pumping grout through the pipe until undiluted grout flows from the boring at ground surface. After grout placement, any drill casing/augers were removed.

After 24 hours, the abandoned drilling site was checked for grout settlement. Any settlement depression was filled with grout and rechecked 24 hours later. This process was repeated until firm grout remained at ground surface.

Grout was composed by weight of 20 parts cement (Portland cement type II) to one part untreated bentonite powder, with a maximum of 8 gallons of USATHAMA-approved water per 94-pound bag of cement. Neither additives nor borehole cuttings were mixed with the grout. Bentonite was added after the required amount of cement was mixed with water. All grout materials were combined in an aboveground, rigid container and mechanically mixed onsite to produce a thick, lump-free mixture.

B.1.1.5 Field Measurement of Conductivity and pH Field measurements of conductivity, temperature, and pH were recorded during well development each time a water sample was collected, each time an individual well was purged, and again after it was sampled. Conductivity and temperature were measured using a Fisher-Porter or equivalent field electrical conductivity meter. Measurements were made in the field according to the instrument manufacturer's recommendations. Each instrument was checked and calibrated before sampling at each location and at the beginning and end of each day using standard potassium chloride (KCl) solutions with known conductivity.

Field meters to be used during sampling--specifically, the pH and specific conductance meters--were checked to ensure proper calibration and precision response before initiation of the field program. Thermometers were checked against a precision thermometer certified by the National Institute of Standards and Technology (NIST; formerly National Bureau of Standards). In addition, buffer solutions and standard KCl solutions used to field calibrate the pH and conductivity meters were laboratory tested to ensure accuracy. The preparation date of standard solutions was clearly marked on each of the containers to be taken into the field. A log that documents problems experienced with the instrument, corrective measures taken, battery replacement dates, dates of use, and user was maintained for each meter and thermometer. Appropriate new batteries were purchased and kept with the meters to facilitate replacement in the field.

All equipment to be used during the field sampling was examined to certify that it was in operating condition. This included checking the manufacturer's operating manuals and the instructions with each instrument to ensure that all maintenance items were being observed. Field notes from previous sampling trips were reviewed so that any prior equipment problems could be remedied. A spare electrode was sent with each pH meter that was used for field measurements. Two thermometers were sent to sampling locations where temperature measurements were required.

B.1.1.6 Physical Soil Testing As required by USATHAMA, physical testing of at least 10 to 20 percent of the soil samples obtained during the field investigation was conducted to characterize the encountered soil formations and their hydrogeologic properties. The samples selected for testing represented the range and frequency of soil types encountered within the study areas. At least one physical sample was tested from each completed boring. The laboratory tests included determination of particle-size distribution (ASTM D-422) and Atterberg limits (ASTM D-4318), and assignment of classification using the Unified Soil Classification System (USCS).

Particle-size analyses was performed to classify the coarser grained soils and to correlate with permeability and other properties. These tests included washed sieve analyses and percent fines determinations (percent of sample finer than a U.S. No. 200 sieve size). Atterberg limits of representative fine-grained soil samples were evaluated to aid in classification and correlation to permeability characteristics. Procedures for all tests were conducted in accordance with those described in the Annual Book of ASTM Standards, Volume 04.08 (formerly Part 19).

B.1.1.7 Surveying After completion of the last well, the newly installed wells were surveyed by licensed surveyors to determine location coordinates and vertical elevation. The Virginia State Planar Coordinate System was referenced, with locations surveyed to ±1 feet.

Elevations to the top of the wells were reported within ±0.01 foot, using the National Geodetic Vertical Datum of 1929.

B.1.1.8 Containerization, Storage, and Disposal of Field-Generated Wastes Completion of the proposed field program resulted in the generation of bore soil cuttings, core drilling fluids, well development purge water, and well sampling purge water. Purge water and soil cuttings generated from well installation and development of the new monitoring wells and from sampling new and existing wells were containerized at the time of removal if contamination was apparent at the time of removal or existing data proved that significant contamination is present. At the time of purging, the suspected contaminated water was placed in 55-gallon drums and then transferred by the drilling subcontractor and Dames & Moore to a designated on-post industrial sewer for disposal. RAAP personnel were responsible for disposal of soil suspected of contamination. Water from equipment decontamination was transferred to an industrial sewer when significant contamination was suspected.

B.2 SAMPLING PROCEDURES

The following sections describe the field sampling program and sampling procedures followed throughout the entire investigation.

B.2.1 Groundwater Sampling

A primary consideration in obtaining a representative groundwater sample was to guard against mixing the sample with standing, stagnant water in the well casing. In a nonpumping well, there will be little or no vertical mixing of the volume of water above the screened interval, and stratification may occur. Such stagnant water may contain foreign or degraded material, resulting in unrepresentative sample and misleading chemical data. Therefore, purging of wells was necessary prior to sample collection.

The following procedures were used when collecting groundwater samples from all monitoring wells:

- Sampling began no sooner than 14 days after well development had been completed. All equipment used to purge wells and collect samples was protected from ground surface contact and contamination by use of clean plastic sheeting. Sampling efforts minimized the possibility of windblown particles contaminating the sample or sample equipment.
- Groundwater elevations in each well were measured and recorded prior to purging and sampling.
- Where appropriate, monitoring wells were purged using either a 4-inch or 2-inch submersible pump, or suction lift surface pumps. The pumps were thoroughly checked to ensure that all seals were in good conditions, and were cleaned prior to use. Transfer tubing (polypipe) was not re-used at other well sites; this prevented contamination from other sample locations.
- Where recharge rate permitted, the well was purged by an appropriate pump or bailer to remove five times the volume of the standing water in the well and saturated annulus. Water levels were allowed to recover to a volume sufficient for sample collection prior to sample withdrawal.
- Where recharge rates did not permit the purging of five times the volume of the standing water in the well and saturated annulus, the following procedures were followed after USATHAMA approval to ensure adequate purging. The well was bailed dry. After one hour, the water level was checked and if the well did not recharge 90% or more, then an additional hour was allowed for recharge of the well. After 2 hours total elapsed time, the well was bailed dry for a second time. The well was allowed to recharge for an additional 2 hours, the well was bailed dry for a third time. Water levels were then allowed to recover to a volume sufficient for sample collection (approximately 2 hours), and the sample was taken.
- Alconox detergent was used as a cleaning agent on 3-inch PVC bailers which were used to purge 4-inch monitoring wells that had poor recovery. After

washing the PVC bailer with Alconox, the bailer was rinsed with water from the approved source and dried with a paper towel.

- Before, during, and after purging the well, a sample was collected for the field determination of pH, conductivity and temperature.
- When purging of the well was completed, all equipment used to purge the well was decontaminated except for disposable items such as plastic sheeting and polypipe, which were placed in trash bags.
- At each well, the sample was collected with a bailer dedicated to that well. All other sampling equipment was rinsed with approved water between wells to prevent cross contamination.
- Sample containers and caps were triple-rinsed with the water being sampled. The samples were collected so as to minimize aeration as water enters the bottle. Sample containers of appropriate volume and construction were prepared by the laboratory to ensure the collection of sufficient volumes for all specified analyses.
- Bailed and collected samples for volatile, total organic carbon, and total organic halogen analysis were placed in screw-cap, septum-top vials, filled so that there were no air bubbles present to allow volatilization. These samples were not filtered.
- Hydrochloric acid was added in the field as a preservative to yield a pH <2 for volatile organic compounds analysis.
- Sulfuric acid was added in the field as a preservative to yield a pH <2 for the total organic carbon analysis.
- 1 ml of sodium sulfite was added in the field as a preservative for the total organic halogen analysis.

- Bailed and collected samples for metals analysis were placed in screw-cap, plastic cubitainers. These samples were filtered in the field using a peristaltic pump and a 0.45 micron filter. Occasionally, both filtered and unfiltered samples were submitted for analysis.

- Nitric acid was added in the field as a preservative to yield a pH <2 for the metals analysis.

- Bailed and collected samples for total phenols, phosphates, nitrates, and nitrites were placed in screw-cap, plastic cubitainers and glass jars. These samples were not filtered.

- Sulfuric acid was added in the field as a preservative to yield a pH <2 for the total phenols, phosphates, nitrates and nitrites analyses.

- Bailed and collected samples for explosives, nitroglycerin, nitroguaradine, semi-volatiles, pH, chlorine, and sulfates were placed in screw-cap glass jars or in a screw-cap, plastic cubitainer. These samples were not filtered, nor was acid added as a preservative.

- Sample containers were labeled with appropriate identifying information (location, date, time, condition, etc.), and each sample logged in a field notebook at the time of collection. Labeling and logbook information requirements specified in the field sampling program were met.

- All sample containers were transferred to a temperature-controlled chest, maintained at a temperature of 4°C, and delivered to the laboratory in sufficient time so that specified holding times were not exceeded.

- Appropriate safety precautions were followed during sampling to guard against anticipated physical and environmental hazards of toxic materials. Details were specified in the Site-Specific Health and Safety Plan.

B.2.2 Surface Water Sampling

Surface water samples were collected during the VI field investigation from ponds, streams, and springs on RAAP. Samples were analyzed for one or more of the following: VOCs, explosives, semi-volatiles, metals, TOC, TOX, pH, Cl, SO_4, PO_4, NO_2, NG and NQ.

The following procedures were used when collecting surface water samples:

- Before sampling, equipment was rinsed downflow or away from the sampling point, with care taken not to disturb sediments at the sampling point. After sampling each location, the equipment was decontaminated using approved water.
- Samples for volatiles, TOC, and TOX were placed in septum-sealed vials, and filled so that there were no bubbles present to allow volatilization. These samples were not filtered.
- Samples for explosives, NG, NQ, and semi-volatiles were placed in one liter glass jars. These samples were not filtered.
- Samples for metals, pH, Cl, SO_4, PO_4, NO_2, and NO_3 were placed in one liter plastic cubitainers. These samples were not filtered.
- The sample bottles and caps were triple-rinsed with the water being sampled before filling the bottle with the sample to be analyzed.
- Hydrochloric acid was added in the field as a preservation to yield a pH <2 for the volatile analysis.
- Nitric acid was added in the field as a preservation to yield a pH <2 for the metals analysis.
- Sulfuric acid was added in the field as a preservation to yield a pH <2 for the TOC, PO_4, NO_2, and NO_3 analyses.

- All sample containers were transferred to a temperature-controlled chest (kept at a temperature of 4°C) and delivered to the laboratory in sufficient time so that specified holding times were not exceeded.

B.2.3 Soil and Sediment Sampling

The following procedures were used when collecting soil and sediment samples:

- Sediment samples were collected to a depth of approximately 12 inches beneath the sediment-water interface, whenever possible. Samples were collected with a shovel or other hand-operated sampler. In sampling, care was taken to collect and retain the "fines," which often contain the highest concentrations of chemical deposits.

- Near surface soil samples were collected from 0 to 1 foot below ground surface. Hand augers were used to collect samples to depths of 5 feet when drilling rigs were not utilized. Unless indicated otherwise, all soil samples were taken from discrete locations. Composite sampling was performed at some SWMUs to cover a larger geographic area in sampling and simultaneously reduce the analytical program. Similar sample volumes from composite locations were, upon collection, placed in an appropriately large container. The sample was then homogenized by mixing with a stainless-steel utensil and submitting for analysis. At soil sampling location where analysis for VOCs was necessary, samples were not composited. A discrete VOC sample was collected for each composite location.

- Soil sampling equipment (stainless steel hand augers, shovel, stainless steel bowls and spoons) were washed between samples with Alconox detergent, rinsed with approved water, and dried with paper towels to prevent cross-contamination.

- All equipment used to collect soil and sediment samples was protected from ground contact and contamination by use of clean plastic sheeting.

- Only stainless steel spoons and bowls were used for transfer of soil prior to placement in sample jars.

- Samples were marked with identifying information and logged in the field notebook. Identifying information on the labels of all sample bottles included source/sampling location, date and time sample was taken, identity of sampler, and parameter(s) to be analyzed.

- All sample containers were transferred to a temperature-controlled chest (kept at a temperature of 4°C) and delivered to the laboratory in sufficient time so that specified holding times were not exceeded.

- Appropriate precautions, as detailed in the Site-Specific Health and Safety Plan, were observed during sampling. Specified procedures were used to guard against anticipated physical and environmental hazards.

B.2.4 Sludge Sampling

The following procedures were used when collecting sludge samples.

- Sludge sampling equipment (stainless steel hand auger bucket with a disposable plastic bottom lining, stainless steel hand auger, and stainless steel bowls and spoons) were washed between samples with approved water and dried with a paper towel to prevent cross-contamination.

- All equipment used to collect sludge samples was protected from ground contact and contamination by use of clean plastic sheeting.

- Sludge samples from SWMUs 8, 9, and 39 were collected by dragging a stainless steel cup or hand auger bucket with a disposal plastic bottom along the bottom of the sampling area with nylon cord. All other sludge samples were collected by using a stainless steel hand auger or spoon. A stainless steel bowl was used for transfer of sludge prior to placement in sample jars.

- Samples were marked with identifying information and logged in the field notebook. Identifying information on the labels of all sample bottles included source/sampling location, date and time sample was taken, identity of sampler, and parameter(s) to be analyzed.

- All sample containers were transferred to a temperature controlled chest (kept at a temperature of 4°C) and delivered to a laboratory in sufficient time so that specified holding times were not exceeded.
- Appropriate precautions, as detailed in the Site-Specific Health and Safety Plan, were observed during sampling. Specified procedures were used to guard against anticipated physical and environmental hazards.

APPENDIX C

Test Name (Analyte) 8.24

ELEMENT IS USED IN THE FOLLOWING IR RECORDS AND DATA BASE TABLES:

Level 1 Record	Level 1 Column(s)	Level 2 Record	Level 2 Column(s)	Level 3 Table(s)	Level 3 DB Column
Analysis	2-7	SCC(all)	75-80	chem/cqc	test_nm

ELEMENT SIZE AND CHARACTERISTICS:

6 alphanumeric characters, left justified

ELEMENT DESCRIPTION:

Code to identify the analyte or parameter being measured.

ACCEPTABLE CRITERIA:

- Required on all chemical and radiological records
- Must match one of the acceptable codes listed below
- For unknowns, must be within the range of UNK001 through UNK999
- Lab must be certified for the specific Test Name except when one of the following conditions exists:

Method is "99", non-USATHAMA approved or semiquantitative screening
Method is "00", which is valid for the following Test Names:

ACIDIT	CORRTY	SALINE
ALK	CROCO	SALINI
ALKBIC	DO	SSOL
ALKCAR	DOC	TASTE
ALKHYD	EPTOX	TDS
ALKPHE	FIBGLS	TEMP
ALPHAG	FLASH	TOC
AMOS	FSTREP	TOTASH
ANPHO	HARD	TOX
ASBEST	IGNIT	TPHAVG
BETAG	MINWOL	TPHC
BOD	ODOR	TPHDSL
CHARD	OILGR	TPHGAS
CHRYS	ORGFIB	TREACT
COD	PARTIC	TSOLID
COLI	PH	TSS
COLOR	REACTY	TURBID
COND	RESIST	

NOTE: For unknown compounds, use the code "UNKXXX" where "XXX" represents the number assigned by the field lab to the unknowns from 001 thru 999. The numbers are full field, so "unknown one" would be expressed as "UNK001" with the zeros included. The description of what "UNK001" represents will be defined in the contractor's reports and other documentation and be consistent within the same installation. Therefore "UNK001" can only represent one unique unknown for each installation.

ACCEPTABLE ENTRIES:

Chemical and Radiological Data:

(Sorted alphabetically by Test-Name code)

01NHCL	0.1N Hydrochloric acid
10CUDM	10-Cyclopentylundecanoic acid, methyl ester
10MEOH	10% Methanol
10MUDM	10-Methylundecanoic acid, methyl ester
10OEME	10-Octadecenoic acid, methyl ester
111TCE	1,1,1-Trichloroethane
112TCE	1,1,2-Trichloroethane
113MCH	1,1,3-Trimethylcyclohexane
11C1PE	1,1-Dichloro-1-propene
11C1PN	1,1-Dichloropropane
11DCE	1,1-Dichloroethylene / 1,1-Dichloroethene
11DCLE	1,1-Dichloroethane
11DCPE	1,1-Dichloropropene
11DMEB	(1,1-Dimethylethyl) benzene
11DPH	1,1-Diphenylhydrazine
11MCPE	1,1-Dimethylcyclopentane
1234MB	1,2,3,4-Tetramethylbenzene
123CPR	1,2,3-Trichloropropane
123MCH	1,2,3-Trimethylcyclohexane
123PDA	1,2,3-Propanetriol diacetate
123TCB	1,2,3-Trichlorobenzene
123TMB	1,2,3-Trimethylbenzene
124MCH	1,2,4-Trimethylcyclohexane
124TCB	1,2,4-Trichlorobenzene
124TMB	1,2,4-Trimethylbenzene
12DB3C	1,2-Dibromo-3-chloropropane
12DBD4	1,2-Dichlorobenzene-D4
12DBRE	1,2-Dibromoethane / Ethyl dibromide
12DCD4	1,2-Dichloroethane-D4

ACCEPTABLE ENTRIES: (Cont.)

12DCE	1,2-Dichloroethenes / 1,2-Dichloroethylenes (cis and trans isomers)
12DCLB	1,2-Dichlorobenzene
12DCLE	1,2-Dichloroethane
12DCLP	1,2-Dichloropropane
12DCPE	1,2-Dichloropropene, total
12DMB	1,2-Dimethylbenzene / o-Xylene
12DNAP	1,2-Dimethylnaphthalene
12DPB	1,2-Diphenylbenzene
12DPH	1,2-Diphenylhydrazine
12EPCH	Cyclohexene oxide / 1,2-Epoxycyclohexene
12EPEB	1,2-Epoxyethylbenzene / Styrene oxide
12MCPE	1,2-Dimethylcyclopentane
12MTDM	12-Methyltetradecanoic acid, methyl ester
12TMCP	1,1,2,2-Tetramethylcyclopropane
135MCH	1,3,5-Trimethylcyclohexane
135TMB	1,3,5-Trimethylbenzene
135TNB	1,3,5-Trinitrobenzene
13BDE	1,3-Butadiene
13CPDO	1,3-Cyclopentadione
13DBD4	1,3-Dichlorobenzene-D4
13DCLB	1,3-Dichlorobenzene
13DCP	1,3-Dichloropropane
13DCPE	1,3-Dichloropropene
13DEB	1,3-Diethylbenzene
13DFB	1,3-Difluorobenzene
13DMB	1,3-Dimethylbenzene / m-Xylene
13DMBB	(1,3-Dimethylbutyl) benzene
13DMCH	1,3-Dimethylcyclohexane
13DNAP	1,3-Dimethylnaphthalene
13DNB	1,3-Dinitrobenzene
13DPPR	1,1'-(1,3-Propanediyl) bis[benzene] / 1,3-Diphenylpropane
13HIND	1,3-Dihydro-2H-indol-2-one
13MCPE	1,3-Dimethylcyclopentane
13TDAM	13-Tetradecynoic acid, methyl ester
14D2EB	1,4-Dimethyl-2-ethylbenzene
14DACB	1,4-Diacetylbenzene
14DBD4	1,4-Dichlorobenzene-D4
14DCBU	1,4-Dichlorobutane
14DCLB	1,4-Dichlorobenzene
14DFB	1,4-Difluorobenzene
14DIOX	1,4-Dioxane

ACCEPTABLE ENTRIES: (Cont.)

14DMB	1,4-Dimethylbenzene / p-Xylene
14DMCH	1,4-Dimethylcyclohexane
14DMNP	1,4-Dihydro-1,4-methanonaphthalene
14DMXA	1,4-Dimethoxyanthracene
14DNB	1,4-Dinitrobenzene
14HXDE	1,4-Hexadiene
14MPME	14-Methylpentadecanic acid, methyl ester
15DNAP	1,5-Dimethylnaphthalene
15MHME	15-Methylhexadecanoic acid, methyl ester
167TMN	1,6,7-Trimethylnaphthalene
16DMIN	1,6-Dimethylindan
16DNAP	1,6-Dimethylnaphthalene
16MHME	16-Methylheptadecanoic acid, methyl ester
17PTCE	17-Pentatriacontene
18DNAP	1,8-Dimethylnaphthalene
18O18D	1,2,3,4,4A,5,8,8A-Octahydro-1,4,5,8-dimethanol-naphthalen-2-ol
1A3MPZ	1-Acetyl-3-methyl-5-pyrazolone
1A4HMB	1-Acetyl-4-(1-hydroxy-1-methylethyl) benzene
1BY4HB	1-Benzyl-4-hydroxybenzimidazole
1C3L	1-Propanol
1C4L	1-Butanol
1CDMPZ	1-Carbamoyl-3,5-dimethyl-2-pyrazoline
1CH	1-Chlorohexane
1CL24H	1-Chloro-2,4-hexadiene
1CLODC	1-Chlorooctadecane
1CNAP	1-Chloronaphthalene
1DODCL	1-Dodecanol
1E24DB	1-Ethyl-2,4-dimethylbenzene
1E2MB	1-Ethyl-2-methylbenzene
1EHB	1-Ethylhexylbenzene
1EHIND	1-Ethylidene-1H-indene
1EPB	1-Ethylpropylbenzene
1FNAP	1-Fluoronaphthalene
1HPDOL	1-Heptadecanol
1HX3OL	1-Hexen-3-ol
1HXE	1-Hexene
1M2PEC	1-Methyl-2-(2-propenyl) cyclopentane
1M7MEN	1-Methyl-7-(1-methylethyl) naphthalene
1MBAAN	1-Methylbenz (A) anthracene
1MCPNE	1-Methylcyclopentene
1MDB	1-Methyldecylbenzene

ACCEPTABLE ENTRIES: *(Cont.)*

1MECHX	1-Methylethylcyclohexane
1MECPR	1-Methylethylcyclopropane
1MEIND	1-Methylindan
1MFLRE	1-Methyl-9H-fluorene
1MNAP	1-Methylnaphthalene
1MNB	1-Methylnonylbenzene
1MPRB	(1-Methylpropyl) benzene
1MPYR	1-Methylpyrene
1MX1PE	1-Methoxy-1-propene
1N2ONE	1-Nitro-2-octanone
1NAPA	1-Naphthylamine
1NHP	1-Nitroheptane
1NKCL	1.0N Potassium chloride solution
1NPN	1-Nitropropane
1OCTOL	1-Octanol
1PECHX	1-Propenylcyclohexane
1PNAP	1-Phenylnaphthalene
1TBCHA	1-t-Butylcyclohexanecarboxylic acid
210DMU	2,10-Dimethylundecane
225SCB	2,2',5,5'-Tetrachlorobiphenyl
225TCB	2,2',5-Trichlorobiphenyl
226TMO	2,2,6-Trimethyloctane
22DCP	2,2-Dichloropropane
22DMC4	2,2-Dimethylbutane
2345CB	2,3,4,5-Tetrachlorobiphenyl
2346CP	2,3,4,6-Tetrachlorophenol
2356CP	2,3,5,6-Tetrachlorophenol
235TCP	2,3,5-Trichlorophenol
235TMD	2,3,5-Trimethyldecane
236TMN	2,3,6-Trimethylnaphthalene
237TMO	2,3,7-Trimethyloctane
23C1PE	2,3-Dichloro-1-propene
23D2HL	2,3-Dimethyl-2-hexanol
23DCLP	2,3-Dichlorophenol
23DMC4	2,3-Dimethylbutane
23DMC5	2,3-Dimethylpentane
23DMP	2,3-Dimethylphenol
23DNAP	2,3-Dimenthylnaphthalene
23TMP	2,2,3,3-Tetramethylpentane
245PCB	2,2'4,5,5'-Pentachlorobiphenyl
245T	2,4,5-Trichlorophenoxyacetic acid

ACCEPTABLE ENTRIES: *(Cont.)*

245TCP	2,4,5-Trichlorophenol
245TP	2-(2,4,5-Trichlorophenoxy) Propionic Acid
246MPY	2,4,6-Trimethylpyridine
246TBP	2,4,6-Tribromophenol
246TCA	2,4,6-Trichloroaniline
246TCP	2,4,6-Trichlorophenol
246TMO	2,4,6-Trimethyloctane
246TNP	2,4,6-Trinitrophenol / Picric acid
246TNR	2,4,6-Trinitroresorcinol / Styphnic acid
246TNT	2,4,6-Trinitrotoluene / alpha-Trinitrotoluene
247HOI	2,2,4,4,7,7-Hexamethyloctahydro-1H-indene
247TMO	2,4,7-Trimethyloctane
24D	2,4-Dichlorophenoxyacetic acid / 2,4-D
24DB	4-(2,4-Dichlorophenoxy)butyric acid / 2,4-DB
24DCB	2,4'-Dichlorobiphenyl
24DCLP	2,4-Dichlorophenol
24DMC5	2,4-Dimethylpentane
24DMD	2,4-Dimethyldecane
24DMHX	2,4-Dimethylhexane
24DMPN	2,4-Dimethylphenol
24DNP	2,4-Dinitrophenol
24DNT	2,4-Dinitrotoluene
24M2PL	2,4-Dimethyl-2-pentanol
24NPD3	2,4-Dinitrophenol-D3
24T13P	2,2,4-Trimethyl-1,3-pentanediol
256TMD	2,5,6-Trimethyldecane
25C14D	2,5-Cyclohexadien-1,4-dione
25DCLP	2,5-Dichlorophenol
25DMP	2,5-Dimethylphenol
25DMPA	2,5-Dimethylphenanthrene
25DTHF	2,5-Dimethyltetrahydrofuran
25ETHF	2,5-Diethyltetrahydrofuran
25HPCB	2,2',3,4,5,5',6-Heptachlorobiphenyl
25HXCB	2,2',3,4,5,5'-Hexachlorobiphenyl
25OCCB	2,2',3,3',4,4',5,5'-Octachlorobiphenyl
2611MD	2,6,11-Trimethyldodecane
26DBMP	2,6-Di-tert-butyl-4-methylphenol / 2,6-Di-tert-butyl-4-cresol
26DCLP	2,6-Dichlorophenol
26DMO	2,6-Dimethyloctane
26DMP	2,6-Dimethylphenol
26DMST	2,6-Dimethylstyrene

ACCEPTABLE ENTRIES: (Cont.)

26DMUD	2,6-Dimethylundecane
26DNA	2,6-Dinitroaniline
26DNT	2,6-Dinitrotoluene
26HPCB	2,2',3,4,4',5,6-Heptachlorobiphenyl
27DMO	2,7-Dimethyloctane
27DNAP	2,7-Dimethylnaphthalene
29DMUD	2,9-Dimethylundecane
2A46DA	2-Amino-4,6-dinitroaniline
2A46DT	2-Amino-4,6-dinitrotoluene
2A4NT	2-Amino-4-nitrotoluene
2ACAMF	2-Acetylaminofluorene
2B1CP	2-Bromo-1-chloropropane
2B1OOL	2-Butyl-1-octanol
2B4MFU	2-(t-butyl)-4-methylfuran
2BEETO	2-(2-N-Butoxyethoxy) ethanol
2BEMDE	2,2-Bis(ethylmercapto) diethyl ether
2BMMPR	2,2-Bis(methylmercapto) propane
2BNMNM	2-Butyl-N-methylnorleucine, methyl ester
2BRHXA	2-Bromohexanoic acid
2BUTHF	2-Butyltetrahydrofuran
2BUXEL	2-Butoxyethanol
2C4E	2-Butene
2C6MPZ	2-Chloro-6-methoxy-10H-phenothiazine
2C7O	2-Heptanone / Methylpentyl ketone
2CBMN	o-Chlorobenzylidine malononitrile
2CECHO	2-(2-Cyanoethyl) cyclohexanone
2CH46D	2-Cyclohexyl-4,6-dinitrophenol
2CHAEE	2-Cyclopentene-1-hendecanoic acid, ethyl ester
2CHE1L	2-Cyclohexen-1-ol
2CHE1O	2-Cyclohexen-1-one
2CLBP	2-Chlorobiphenyl
2CLEVE	(2-Chloroethoxy) ethene / 2-Chloroethylvinyl ether
2CLP	2-Chlorophenol
2CLPD4	2-Chlorophenol-D4
2CLT	2-Chlorotoluene
2CMCHO	2-(Cyanomethyl) cyclohexanone
2CNAP	2-Chloronaphthalene
2DMPEN	2,2-Dimethylpentane
2E1HXL	2-Ethyl-1-hexanol
2E2HPD	2-Ethyl-2-hydroxymethyl-1, 3-propanediol
2E4MPL	2-Ethyl-4-methyl-1-pentanol

ACCEPTABLE ENTRIES: (Cont.)

2EC6A	2-Ethylhexanoic acid
2ECYBL	2-Ethylcyclobutanol
2EP	2-Ethylphenol
2FBP	2-Fluorobiphenyl
2FNAP	2-Fluoronaphthalene
2FP	2-Fluorophenol
2HBDDM	2-Hydroxybutanedioic acid, dimethyl ester
2HBNZL	2-Hydroxybenzaldehyde / Salicylaldehyde
2HNDOL	2-Hendecanol / 2-Undecanol
2HYBP	2-Hydroxybiphenyl
2M1DDL	2-Methyl-1-dodecanol
2M1PNE	2-Methyl-1-pentene
2M24P	2-Methyl-2,4-pentanediol
2M2BDA	2-Methyl-2-butenediamide
2M2C3L	2-Methyl-2-propanol / tert-Butanol
2M2H3B	2-Methyl-2-hydroxy-3-butyne
2M3HXE	2-Methyl-3-hexene
2M3PNO	2-Methyl-3-pentanone
2MBZA	2-Methylbenzyl alcohol
2MC3	2-Methylpropane / Isobutane
2MC4	2-Methylbutane / Isopentane
2MC6	2-Methylhexane / Isoheptane
2MC7	2-Methylheptane / Isooctane
2MCPNE	2-Methylcyclopentanone
2MCYPL	2-Methylcyclopentanol
2MDEC	2-Methyldecane
2MDOD	2-Methyldodecane
2MENAP	2-(1-Methylethyl) naphthalene
2MEODE	2-Methyloctadecanoic acid
2MEPEN	2-Methylpentane
2MMECO	2-Methyl-5-(1-methylethyl)-2-cyclohexen-1-one
2MNAP	2-Methylnaphthalene
2MP	2-Methylphenol / 2-Cresol / o-Cresol
2MPA1E	2-Isobutyric acid
2MPAHT	2-Methylpropanoic acid, 3-hydroxy-2,4,4-trimethyl-1,3-propanediyl ester
2MPAME	2-Methylpropanoic acid, methyl ester
2MPEAE	2-Methyl-2-propenoic acid, 1,2-ethanediyl ester
2MPYR	2-Methylpyrene
2MTETD	2-Methyltetradecane
2MTHF	2-Methyltetrahydrofuran
2MTHPM	2-Methylthio-4-hydroxypyrimidine

ACCEPTABLE ENTRIES: (Cont.)

2MX1PE	2-Methoxy-1-propene
2MXEXL	2-(2-Methoxyethoxy) ethanol / Diethylenegylcol monomethyl ether
2MXMC3	2-Methoxy-2-methylpropane / tert-Butylmethyl ether
2MXTMB	2-Methoxy-2,3,3-trimethylbutane
2N3C	3-Methyl-2-nitrophenol / 2-Nitro-m-cresol
2NANIL	2-Nitroaniline
2NAPA	2-Naphthylamine
2NBZLZ	2-Nitrobenzalazine
2NKCL	2.0N Potassium chloride solution
2NNDPA	2-Nitro-N-nitrosodiphenylamine
2NODCO	2-Nonadecanone
2NP	2-Nitrophenol
2NPN	2-Nitropropane
2NT	2-Nitrotoluene
2OXBEL	2,2-Oxybis[ethanol] (obsolete - use DEGLYC)
2PETOH	2-Phenylethanol
2PHXEL	2-Phenoxyethanol
2PICO	2-Picoline
2PNAP	2-Phenylnaphthalene
2PROL	2-Propanol
2PXEXL	2-(2-Phenoxyethoxy) ethanol
2PY1OL	2-Propyn-1-ol
2SB46D	2-sec-Butyl-4,6-dinitrophenol
2TCLEA	1,1,1,2-Tetrachloroethane
2TMHPD	2,6,10,14-Tetramethylheptadecane
2TMPD	2,6,10,14-Tetramethylpentadecane
33DCBD	3,3'-Dichlorobenzidine
33DMBP	3,3'-Dimethoxybiphenyl / 3,3'-Dimethoxybenzidine
33DMEB	3,3'-Dimethylbiphenyl / 3,3'-Dimethylbenzidine
33DMHX	3,3-Dimethylhexane
33DMPN	3,3-Dimethylpentane
344TPE	3,4,4-Trimethyl-2-pentene
345T1H	3,4,5-Trimethyl-1-hexene
34BZFA	3,4-Benzofluoranthene
34CBD6	3,3',4,4'-Tetrachlorobiphenyl-D6
34D1DE	3,4-Dimethyl-1-decene
34DCLP	3,4-Dichlorophenol
34DMP	3,4-Dimethylphenol
34DNT	3,4-Dinitrotoluene
35DMP	3,5-Dimethylphenol
35DNA	3,5-Dinitroaniline

ACCEPTABLE ENTRIES: (Cont.)

35DNP	3,5-Dinitrophenol
35DNT	3,5-Dinitrotoluene
35M3HL	3,5-Dimethyl-3-hexanol
36DF9O	3,6-Dichlorofluoren-9-one
36DMO	3,6-Dimethyloctane
36TMPA	3,4,5,6-Tetramethylphenanthrene
37DMNN	3,7-Dimethylnonane
38DMUD	3,8-Dimethylundecane
3BPETH	3-Butenylpentyl ether
3C1C3E	3-Chloro-1-propene / Allyl chloride
3CHXD	3-Cyclohexyldecane
3CLP	3-Chlorophenol
3CLPRN	3-Chloropropionitrile
3CLT	3-Chlorotoluene
3CMCH	3-(Chloromethyl) cyclohexene
3DCHEO	3,5-Dimethyl-2-cyclohexen-1-one
3E22MP	3-Ethyl-2,2-dimethylpentane / 3-(t-Butyl)-pentane
3E25DH	3-Ethyl-2,5-dimethyl-3-hexene
3EE2BO	3,4-Epoxy-3-ethyl-2-butanone
3EEBOD	3-Ethyl-5-(2-ethylbutyl) octadecane
3EHXDE	3-Ethyl-1,4-hexadiene
3EP	3-Ethylphenol
3HDMPL	3-(Hydroxymethyl)-4,4-dimethylpentanal
3HDMPT	3-Hydroxy-2,7-dimethyl-4-[3H]-pteridinone
3HXE2O	3-Hexen-2-one
3HYBA	3-Hydroxybenzaldehyde
3M1PL	3-Methyl-1-pentanol
3M2C1O	3-Methoxy-2-cyclopenten-1-one
3M2C5E	3-Methyl-2-pentene
3M2CHO	3-Methyl-2-cyclohexen-1-one
3M2HXL	3-Methyl-2-hexanol
3M5PNN	3-Methyl-5-propylnonane
3MBP	3-Methylbiphenyl
3MC6	3-Methylhexane
3MCA	3-Methylcholanthrene
3MCHRY	3-Methylchrysene
3MDEC	3-Methyldecane
3MEPEN	3-Methylpentane
3MP	3-Methylphenol / 3-Cresol / m-Cresol
3MPANR	3-Methylphenanthrene
3MUND	3-Methylundecane

ACCEPTABLE ENTRIES: (Cont.)

3MXIMZ	3-Methoxyimidazole
3MXT	3-Methoxytoluene
3NANIL	3-Nitroaniline
3NT	3-Nitrotoluene
3OCTOL	3-Octanol
3OPPAE	3-Oxo-3-phenylpropanoic acid, ethyl ester
3PC3AC	3-Phenylpropanoyl chloride/Hydrocinnamyl chloride
3PT	3-Propyltoluene
3S5E3L	(3beta)-Stigmast-5-en-3-ol
3TBUP	3-(t-Butyl) phenol
3TCHEO	3,5,5-Trimethyl-2-cyclohexen-1-one
41MEHP	4-(1-Methylethyl) heptane
44DCBZ	4,4'-Dichlorobenzophenone
44DFBZ	4,4-Difluorobenzophenone
44DMPE	4,4-Dimethyl-2-pentene
44DMUD	4,4-Dimethylundecane
468T1N	4,6,8-Trimethyl-1-nonene
46DN2C	2-Methyl-4,6-dinitrophenol / 4,6-Dinitro-2-cresol
47DMUD	4,7-Dimethylundecane
48DMHD	4,8-Dimethylhendecane
4A2NT	4-Amino-2-nitrotoluene
4A35DT	4-Amino-3,5-dinitrotoluene
4ABP	4-Aminobiphenyl
4AMORP	4-Acetylmorpholine
4B3P2O	4-Butoxy-3-penten-2-one
4BFB	4-Bromofluorobenzene
4BRPPE	4-Bromophenylphenyl ether
4C3MBE	4-Chloro-3-methyl-1-butene
4CANIL	4-Chloroaniline
4CCHXL	4-Chlorocyclohexanol
4CL2C	2-Methyl-4-chlorophenol / 4-Chloro-2-cresol
4CL3C	3-Methyl-4-chlorophenol / 4-Chloro-m-cresol / 4-Chloro-3-cresol / 4-Chloro-3-methylphenol
4CLPPE	4-Chlorophenylphenyl ether
4CLT	4-Chlorotoluene
4DM2PL	4,4-Dimethyl-2-pentanol
4E2MHX	4-Ethyl-2-methylhexane
4E2OCE	4-Ethyl-2-octene
4ETMHP	4-Ethyl-2,2,6,6-tetramethylheptane
4FANIL	4-Fluoroaniline
4FT	4-Fluorotoluene

ACCEPTABLE ENTRIES: (Cont.)

4H35BA	4-Hydroxy-3,5-dimethoxybenzaldehyde
4H3MBA	4-Hydroxy-3-methoxybenzaldehyde / Vanillin
4HAZOB	4-Hydroxyazobenzene
4HYBA	4-Hydroxybenzaldehyde
4IOMQU	4-Iodomethylquinuclidine
4M2PNO	4-Methyl-2-pentanone
4M2PPL	4-Methyl-2-propyl-1-pentanol
4MBP	4-Methylbiphenyl
4MBSA	4-Methylbenzene sulfonamide
4MC7	4-Methylheptane
4MDBFU	4-Methyldibenzofuran
4MENPA	4-(1-Methylethyl)-N-phenylaniline
4MFLRE	4-Methyl-9H-fluorene
4MMBHE	4-Methyl-1-(1-methylethyl)-bicyclo[3.1.0]hex-2-ene
4MP	4-Methylphenol / 4-Cresol / p-Cresol
4MPANR	4-Methylphenanthrene
4MPYR	4-Methylpyrene
4MXCHL	4-Methoxycyclohexanol
4MXP	4-Methoxyphenol
4NANIL	4-Nitroaniline
4NP	4-Nitrophenol
4NT	4-Nitrotoluene
4TBU2C	2-Methyl-4-(t-butyl) phenol / 4-t-Butyl-2-cresol
4TOP	4-t-Octylphenol
50H50A	50% Hexane - 50% acetone
50M50A	50% Methylene chloride - 50% acetone
50WMAN	50% Water - 25% Methanol - 25% acetonitrile
5CL2C	5-Chloro-o-cresol / 2-Methyl-5-chlorophenol
5E2MHP	5-Ethyl-2-methylheptane
5E5MD	5-Ethyl-5-methyldecane
5M2HXO	5-Methyl-2-hexanone
5M5HAL	5-Methyl-5-hydroxyhexanoic acid lactone
5N2OL	5-Norboren-2-ol
5NOTOL	5-Nitro-o-toluidine
5PTRID	5-Propyltridecane
6CL3C	3-Methyl-6-chlorophenol / 6-Chloro-3-cresol
6E6MFV	6-Ethyl-6-methylfulvene
6M3HPL	6-Methyl-3-heptanol
6MDOD	6-Methyldodecane
6MEPUR	6-Methylpurine
6MTRID	6-Methyltridecane

ACCEPTABLE ENTRIES: (Cont.)

6TBU2C	2-Methyl-6-(t-butyl) phenol / 6-t-Butyl-2-cresol
712DMA	7,12-Dimethylbenz[A]anthracene
7MTRID	7-Methyltridecane
8MNNDL	8-Methyl-1,8-nonanediol
9FLENO	9-Fluorenone
9HFLRE	9H-Fluoren-9-one
9MBAAN	9-Methylbenz[A]anthracene
9MXANT	9-Methoxyanthracene
AACHXE	Acetic acid, cyclohexyl ester
AADMP	alpha ,alpha-Dimethylphenethylamine
ABHC	alpha-Benzenehexachloride / alpha-Hexachlorocyclohexane
AC	Hydrogen cyanide / Hydrocyanic acid
AC228	Actinium 228
ACDHMW	Acids (high molecular weight)
ACET	Acetone
ACHE	Anticholinesterase
ACIDIT	Acidity
ACLDAN	alpha-Chlordane
ACHLOR	alpha-Chlordane (obsolete-use ACLDAN)
ACND10	Acenaphthene-D10
ACPHN	Acetophenone
ACROLN	Acrolein
ACRYLO	Acrylonitrile
ADHP	Ammonium dihydrogen phosphate
AENSLF	alpha-Endosulfan / Endosulfan I
AG	Silver
AG110M	Silver 110 (metastable)
AL	Aluminum
ALACL	Alachlor
ALAL	Aliphatic alcohols
ALDEHY	Aldehydes
ALDI	Aldicarb / 2-Methyl-2-(methylthio)propanal O-[(methylamino)carbonyl] oxime
ALDRN	Aldrin
ALHC	Aliphatic hydrocarbons
ALHMW	Alcohols (high molecular weight)
ALK	Alkalinity
ALKBIC	Alkalinity - bicarbonate
ALKCAR	Alkalinity - carbonate
ALKHYD	Alkalinity - hydroxide
ALKN	Alkanes

ACEPTABLE ENTRIES: (Cont.)

ALKPHE	Alkalinity - phenolphthalein
ALPGF	Alpha gross-field
ALPGL	Alpha gross-lab
ALPGLA	Alpha gross-soluble acid fraction
ALPGLW	Alpha gross-soluble water fraction
ALPHAG	Alpha gross
ALPHPN	alpha-Pinene
ALYLOL	Allyl alcohol
AM241	Americium 241
AMCARB	Aminocarb
AMGD	Aminoguanidine
AMINCR	4-(Dimethylamino)-3-methylphenolmethyl-carbamate / Mexacarbate
AMOS	Amosite asbestos
ANAPNE	Acenaphthene
ANAPYL	Acenaphthylene
ANELNT	Anion elutent
ANIL	Aniline
ANPHO	Anthophyllite asbestos
ANTRC	Anthracene
ANTRCN	9-Anthracenecarbonitrile
ANTRQU	9,10-Anthracenedione / Athraquinone
ARAMT	Aramite
AS	Arsenic
ASBEST	Asbestos
ASEXT	Arsenic extractable
ASTOT	Arsenic total
ATNBA	2,4,6-Trinitrobenzaldehyde
ATNT	alpha-Trinitrotoluene (obsolete - use 246TNT)
ATZ	Atrazine
AU	Gold
AYLETH	Allyl ether
AZACN	Azacylononane
AZM	Azinphos methyl
B	Boron
B2CEXM	Bis (2-chloroethoxy) methane
B2CIPE	Bis (2-chloroisopropyl) ether
B2CLEE	Bis (2-chloroethyl) ether
B2EHP	Bis (2-ethylhexyl) phthalate
BA	Barium
BA140	Barium-140
BAANTR	Benzo[A]anthracene

ACCEPTABLE ENTRIES: (Cont.)

BAC	Benzal chloride
BAHXE	Butanoic acid, 1-hexyl ester
BAPYR	Benzo[A]pyrene
BARBAN	4-Chloro-2-butyl m-chlorocarbanilate / Barban
BBFANT	Benzo[B]fluoranthene
BBFLRE	Benzo[B]fluorene
BBHC	beta-Benzenehexachloride / beta-Hexachlorocyclohexane
BBNFN	Benzo[B]naphtho(2,3-D]furan
BBNTHP	Benzo[B]naphtho[1,2-D]thiophene
BBZP	Butylbenzyl phthalate
BCHPD	Bicyclo[2,2,1]hepta-2,5-diene
BCLDAN	beta-Chlordane
BCLME	Bis (chloromethyl) ether
BCMSO	Bis (carboxymethyl) sulfoxide
BCMSO2	Bis (carboxymethyl) sulfone
BCPHCE	2,2-Bis(chlorophenyl)chloroethylene (DDT related)
BCY3HX	Bicyclo[3,1,0]hexane
BDADME	Butanedioic acid, dimethyl ester
BDEANT	7H-Benz[DE]anthracen-7-one
BE	Beryllium
BE7	Beryllium 7
BEETO	1-(2-Butoxyethoxy) ethanol
BEGAG	Beta gamma gross
BENSLF	beta-Endosulfan / Endosulfan II
BENZA	Benzanthrone
BENZAL	Benzaldehyde
BENZID	Benzidine
BENZOA	Benzoic acid
BEP	2-Butoxyethanol phosphate
BEPYR	Benzo(E)pyrine
BETAG	Beta gross
BETGF	Beta gross-field
BETGL	Beta gross-lab
BETGLA	Beta gross-soluble acid fraction
BETGLW	Beta gross-soluble water fraction
BF2ANT	Benzobifluoroanthene
BGHIFA	Benzo[G,H,I]fluroanthene
BGHIPY	Benzo[G,H,I]perylene
BHC	BHC - nonspecific
BI	Bismuth
BI212	Bismuth 212

ACCEPTABLE ENTRIES: (Cont.)

BI214	Bismuth 214
BICYHX	Bicyclohexyl
BIDBI	1,5-Bis (1,1-dimethylethyl)-3,3-dimethylbicyclo[3.1.0]hexane-2-one
BINAP	Binaphthyl
BJFANT	Benzo[J]fluoranthene
BKFANT	Benzo[K]fluoranthene
BLDX	Bladex
BMP	Butylmethyl phthalate
BOD	Biological oxygen demand
BOLS	Bolstar
BPBG	Butylphthalyl butylglycolate
BR	Bromide
BRC6H5	Bromobenzene
BRCLM	Bromochloromethane
BRDCLM	Bromodichloromethane
BRMCIL	Bromacil
BTAZON	3-(1-Methylethyl)-1H-2,1,3-benzothiadiazin-4(3H)-one-2,2-dioxide / Bentazon
BTC	Benzotrichloride
BTHIOL	Benzenethiol
BTMSOA	Bis (trimethylsilyl) oxalic acid
BTZ	Benzothiazole
BUC6H5	Butylbenzene
BUEETH	Butylethyl ether
BZ	3-Quinuclidinyl benzilate
BZAL2M	alpha, alpha-Dimethylbenzenemethanol
BZALC	Benzyl alcohol
BZAPAN	Benzo(A)phenanthrene
BZCPAN	Benzo[C]phenanthrene
BZFANT	Benzfluoranthene
BZHQUN	Benzo[H]quinoline
BZOAME	Benzoic acid, methyl ester / Methyl benzoate
BZONH4	Benzoic acid, ammonium salt
BZOTHP	Benzo[B]thiophene
BZOTRP	Benzo[B]triphenylene
BZOTRZ	1H-Benzotriazole / 1,2,3-Benzotriazole
BZPA	Benzenephosphonic acid
BZYLBR	Benzyl bromide / alpha-Bromotoluene
BZYLCL	Benzyl chloride
C10	Decane
C11	Hendecane

ACCEPTABLE ENTRIES: (Cont.)

C12	Dodecane
C12AMM	8-Methyldecanoic acid, methyl ester
C12DCE	cis-1,2-Dichloroethylene / cis-1,2-Dichloroethene
C13	Tridecane
C13DCP	cis-1,3-Dichloropropylene / cis-1,3-Dichloropropene
C14	Tetradecane
C14A	Tetradecanoic acid / Myristic acid
C14AME	Tetradecanoic acid, methyl ester
C15	Pentadecane
C15A	Pentadecanoic acid
C16	Hexadecane
C16A	Hexadecanoic acid / Palmitic acid
C16ABE	Hexadecanoic acid, butyl ester
C16ADM	Hexadecanoic acid, dimethyl ester
C16AEH	Hexadecanoic acid, bis (2-ethylhexyl) ester
C16AME	Hexadecanoic acid, methyl ester
C16SAT	Saturated hydrocabons (C16)
C17	Heptadecane
C17A	C17 alkane
C17AM	Heptadecanoic acid, methyl ester
C18	Octadecane
C185FP	Bis (pentafluorophenyl) phenyl phosphine
C18A	C18 alkane
C18ABE	Octadecanoic acid, butyl ester
C18AE	Octadecanoic acid, ethyl ester
C18AME	Octadecanoic acid, methyl ester
C18AOD	Octadecanoic acid, octadecyl ester
C18UNS	C18H30O Unknown
C19	Nonadecane
C19A	Nonadecanoic acid
C1ADME	Carbonic acid, dimethyl ester
C20	Eicosane
C21	Heneicosane
C22UNS	C22H40O Unknown
C25	Pentacosane
C2AEE	Acetic acid, ethyl ester / Ethyl acetate
C2AVE	Acetic acid, vinyl ester / Vinyl acetate
C2H3CL	Chloroethene / Vinyl chloride
C2H5CL	Chloroethane
C30AME	Triacontanoic acid, methyl ester
C35	Pentatriacontane

ACCEPTABLE ENTRIES: (Cont.)

C36	Hexatriacontane
C3A2MB	Propanoic acid, 2-methylbutyl ester
C3AME	Propanoic acid, methyl ester
C4	Butane
C4HX1L	cis-4-Hexen-1-ol
C5A	Pentanoic acid / Valeric acid
C6D6	Benzene-D6
C6H6	Benzene
C6HOH	Cyclohexanol
C7	Heptane
C7A	Heptanoic acid
C7NB1	Heptachloronorbornene
C8	Octane
C8A	C8 alkane
C8AME	Octanoic acid, methyl ester
C9	Nonane
CA	Calcium
CAAH	Chloroacetaldehyde
CACO3S	Calcium carbonate solution
CALLMW	Hydrocarbons (all molecular weights)
CAMBEN	3-Amino-2,5-dichlorobenzoic acid / Chloramben
CAME	Carbamic acid, methyl ester
CAMP	Camphor
CAPLCT	Caprolactam / 6-Aminohexanoic acid lactam
CAPTAN	Captan
CARB14	Carbon 14
CARBAZ	9H-Carbazole / Carbazole
CARBOF	2,3-Dihydro-2,2-dimethyl-7-benzofuranyl methylcarbamate
CATOL	Catechol
CBA	o-Chlorobenzaldehyde
CBCCH	cis-1-Bromo-2-chlorocyclohexane
CBOA	o-Chlorobenzoic acid
CC3	XXCC3
CCL2F2	Dichlorodifluoromethane
CCL3F	Trichlorofluoromethane
CCL4	Carbon tetrachloride
CCLDAN	cis-Chlordane
CCLF	Chlorofluoromethane
CCLF2	Chlorodifluoromethane
CCLF3	Trifluorochloromethane
CD	Cadmium

ACCEPTABLE ENTRIES: (Cont.)

CD2CL2	Methylene chloride-D2
CDACH	cis-1,2-Diacetoxycyclohexane
CDCBU	cis-1,4-Dichloro-2-butene
CDCL3	Chloroform-D
CDNBIS	Chlorodinitrobenzene isomer
CE	Cerium
CE141	Cerium 141
CE144	Cerium 144
CEC	Cation exchange capacity
CF252	Californium 252
CG	Phosgene / Carbonyl chloride
CH2BR2	Methylene bromide
CH2CL2	Methylene chloride
CH3BR	Bromomethane
CH3CL	Chloromethane
CH3CN	Acetonitrile
CH3I	Iodomethane
CH4	Methane
CHARD	Calculated Hardness
CHBR3	Bromoform
CHCL2I	Dichloroiodomethane
CHCL3	Chloroform
CHNO	Ethanolamine
CHNO2	Diethanolamine
CHO	1,2-Cyclohexane oxide
CHOLA	Cholestane
CHONE	Cyclohexanone
CHRY	Chrysene
CHRYS	Chrysotile asbestos
CK	Cyanogen chloride
CL	Chloride
CL10BP	Decachlorobiphenyl
CL2	Chlorine
CL2ACN	Dichloroacetonitrile
CL2BP	Dichlorobiphenyls
CL2BZ	Dichlorobenzenes
CL2CH2	Dichloromethane
CL2ETH	Ethylene chlorohydrin
CL2NAP	Dichloronaphthalenes
CL3BP	Trichlorobiphenyls
CL3C3E	Trichloropropenes

ACCEPTABLE ENTRIES: (Cont.)

CL3NAP	Trichloronaphthalenes
CL3P	Trichlorophenols
CL4BP	Tetrachlorobiphenyls
CL4NAP	Tetrachloronaphthalenes
CL4XYL	2,4,5,6-Tetrachlorometaxylene / Tetrachlorometaxylene
CL5B	Pentachlorobenzene
CL5BP	Pentachlorobiphenyls
CL5ET	Pentachloroethane
CL6BP	Hexachlorobiphenyls
CL6BZ	Hexachlorobenzene
CL6CP	Hexachlorocyclopentadiene
CL6ET	Hexachloroethane
CL7BP	Heptachlorobiphenyls
CL7NB	Heptachloronorbornadienes
CLBZL	Chlorobenzilate
CLC2A	Chloroacetic acid
CLC6D5	Chlorobenzene-D5
CLC6H5	Chlorobenzene / Monochlorobenzene
CLCYHX	Chlorocyclohexane
CLD	Chlorine demand
CLDAN	Chlordane
CLDEN	Chlordene
CLNAP	Chloronaphthalenes
CLO3	Chlorate
CLP	Chlorophenols
CLPRPM	Isopropyl m-chlorocarbanilate / Chlorpropham
CLTHL	Chlorothalonil
CLVRA	2-Chlorovinyl arsonic acid
CLXB	Chlorinated benzenes
CLXNAP	Chlorinated naphthalenes
CMME	Chloromethyl methyl ether
CMONOX	Carbon monoxide
CN	Chloroacetophenone
CO	Cobalt
CO2	Carbon dioxide
CO3	Carbonate
CO57	Cobalt 57
CO58	Cobalt 58
CO60	Cobalt 60
COD	Chemical oxygen demand
COLI	Fecal coliform

ACCEPTABLE ENTRIES: (Cont.)

COLOR	Color
COND	Specific conductivity
COND-F	Specific conductivity as tested in the field
CORRTY	Corrositivity (tendency to corrode)
COUMA	Coumaphos
COUMRN	2,3-Dihydrobenzofuran / Coumaran
CPCXAL	Cyclopentanecarboxaldehyde
CPMS	p-Chlorophenylmethyl sulfide
CPMSO	p-Chlorophenylmethyl sulfoxide
CPMSO2	p-Chlorophenylmethyl sulfone
CPO	Cyclopentanone
CPYR	Chloropyrifos
CR	Chromium
CR3	Chromium, III
CR51	Chromium 51
CRBRL	Carbaryl
CRFRN	Carbofuran
CRHEX	Hexavalent chromium
CRO4	Chromate
CROCO	Crocidolite asbestos
CRTALD	Crotonaldehyde / trans-2-Butenal
CRYOF	Cryoflex
CS	Cesium
CS134	Cesium 134
CS137	Cesium 137
CS2	Carbon disulfide
CSOL	Cresols
CT	Chlorotoluene
CU	Copper
CUEXT	Copper extractable
CUTOT	Copper total
CX	Phosgene oxime / Dichloroformoxime
CYDODC	Cyclododecane
CYHX	Cyclohexane
CYHXA	Cyclohexylamine
CYHXB	Cyclohexylbenzene / Phenylcyclohexane
CYHXE	Cyclohexene
CYN	Cyanide
CYNAM	Amenable cyanide
CYNF	Cyanide, free form
CYOCTE	Cyclooctatetraene

ACCEPTABLE ENTRIES: (Cont.)

CYPD	Cyclopentadiene
CYPNE	Cyclopentene
CYSD12	Chrysene-D12
DALA	2,2-Dichloropropionic acid / Dalapon
DBABA	Dibenz[A,B]anthracene
DBAEPY	Dibenzo[A,E]pyrene
DBAHA	Dibenz[A,H]anthracene
DBAHPY	Dibenzo[A,H]pyrene
DBAIPY	Dibenzo[A,I]pyrene
DBAJA	Dibenz[A,J]acridine
DBATTS	2,4-Dihydroxybenzoic acid, tris-trimethysilyl
DBCP	Dibromochloropropane
DBHC	delta-Benzenehexachloride / delta-Hexachlorocyclohexane
DBRCLM	Dibromochloromethane
DBRDCM	Dibromodichloromethane
DBTSPY	4,5-Dimethyl-2,6-bis (trimethylsiloxy) pyrimidine
DBUCLE	Dibutylchlorendate
DBZFUR	Dibenzofuran
DBZTHP	Dibenzothiophene
DCAA	2,4-Dichlorophenyl acetic acid / DCAA
DCAMBA	Dicamba / 2-Methoxy-3,6-dichlorobenzoic acid
DCBPH	Dichlorobenzophenone
DCBUT	Dichlorobutane
DCHP	Dicyclohexyl phthalate
DCLB	Dichlorobenzene - nonspecific
DCLRN	Dichloran / Dichlorobenzalkonium chloride
DCMBF	5,7-Dichloro-2-methylbenzofuran
DCMPSX	Decamethylcyclopentasiloxane
DCPA	2,3,5,6-Tetrachloro-1,4-benzenedicarboxylic acid dimethyl ester / Dacthal
DCPD	Dicyclopentadiene
DCPL	Dichlorophenlactic
DDVP	Vapona / Dichlorvos / Dichlorophos
DEA	Diethylamine
DECYLB	Decylbenzene
DEDMP	Diethyldimethyl diphosphonate
DEETH	Diethyl ether
DEGLYC	2,2-Oxybis[ethanol] / Diethylene glycol
DEMBZA	N,N-Diethyl-3-methylbenzamide
DEMO	Demeton-O
DEMP	Diethyl methylphosphonite / TR
DEMS	Demeton-S

ACCEPTABLE ENTRIES: (Cont.)

DEP	Diethyl phthalate
DEPD4	Diethyl phthalate-D4
DHBZPY	3,4-Dihydro-2H-1-benzopyran
DHDMAC	9,10-Dihydro-9,9-dimethylacridine
DIACAL	Diacetone alcohol / 4-Hydroxy-4-methyl-2-pentanone
DIADS	Bis (diisopropylaminoethyl) disulfide
DIAEL	Bis (diisopropylamino) ethanol
DIAEP	S-Diisopropylaminoethyl methylphosphonothioate
DIAET	Bis (diisopropylamino) ethanethiol
DIALAT	Diallate / Diisopropylthiocarbamic acid
DIAS	Bis (diisopropylamino) ethylsulfide
DIASO2	Bis (diisopropylamino) erhylsulfonate
DIAZ	Diazinon
DIBP	Diisobutyl phthalate
DICLP	Dichlorophenols
DICOF	Dicofol
DICP	2-(2,4-Dichlorophenoxy)propionic acid / Dichloroprop
DIDDP	Diisopropyldimethyl diphosphonate
DIESEL	Diesel fuel / Fuel oil no. 2
DIH2O	Deionized warer
DIMP	Diisopropyl methylphosphonare
DINO	2,4-Dinitro-6-sec-butylphenol / DINOSEB
DIOP	Diisooctyl phthalate
DIOXOL	Dioxolane
DIPETH	Diisopropyl ether
DIPK	Diisopropyl ketone / Dimethyl-2-propanone
DIPUR	Diisopropyl urea
DISBCB	Diisobutyl carbinol
DISP	Phosphorus, dissolved (as P)
DITH	Dithiane
DIURON	3-(3,4-Dichlorophenyl)-1,1-dimethylurea / Diuron
DL2HPG	dl-2-(3-Hydroxyphenyl) glycine
DLDRN	Dieldrin
DM	Adamsite
DM1ACH	2,2-Dimethyl-1-acetylcyclohexane
DMA	Dimethylaniline (obsolete - use NNDMA)
DMCAR	Dimethyl dithiocarbonate
DMCP	Dimethylcyclopentane - nonspecific
DMCPDE	1,2-Dimethylcyclopentadiene
DMDS	Dimethyl disulfide
DMEBZO	4-(1,1-Dimethylethyl)benzoic acid

ACCEPTABLE ENTRIES: (Cont.)

DMETDA	N,N-Dimethyl-1,2-ethanediamine
DMETH	Dimethyl ether
DMIP	Dimethyl isophthalate
DMMP	Dimethyl methylphosphate
DMOATE	Dimethoate
DMP	Dimethyl phthalate
DMPCHE	3-(2,2-Dimethylpropoxy) cyclohexene
DMPHEN	Dimethyl phenol / Dimethylhydroxy benzene
DMPTHF	2,2-Dimethyl-5-(1-methylpropyl) tetrahydrofuran
DMXDMS	Dimethoxydimethylsilane
DNBEE	1,1-Di-n-butylethylene / 1,1-Di-n-butylethene
DNBP	Di-N-butyl phthalate
DNOP	Di-N-octyl phthalate
DNOPD4	Di-N-octyl phthalate-D4
DNPP	Di-N-pentyl phthalate
DNTISO	Dinitrotoluene isomer
DO	Dissolved oxygen
DOAD	Dioctyl adipate / Hexanedioic acid, dioctyl ester
DOAZ	Dioctyl azelate
DOC	Dissolved organic carbon
DODECB	Dodecylbenzene
DOETH	Dioctyl ether
DOPAM	4-(2-Aminoethyl) pyrocatechol / Dopamine
DPA	Diphenylamine
DPETH	Diphenyl ether
DPETYN	1,1-(1,2-Ethynediyl) bis[benzene]
DPH	Diphenylhydrazines - nonspecific
DPHNY	Diphenyl
DPNTLL	D-(-)-Pantolyl lactone
DPSO	Diphenyl sulfoxide
DPSULF	1,1-Thiobis[benzene] / Diphenyl sulfide
DRBM	Dibromomethane
DSEDIN	Diseleno diindole
DSTON	Disulfoton
DTB4C	2,6-Di-tert-butyl-4-cresol (obsolete - use 26DBMP)
DTCHBO	1.alpha.(E),4.alpha.-1-(1,4-Dihydroxy-2,6,6-trimethyl-2-cyclohexen-1-yl)-2-buten-1-one
DURS	Dursban
DXYA12	DXYA12
DYSCAN	GC-MS dye scan
EA2192	S-2-Diisopropylaminoethyl methylphosphonic acid

ACCEPTABLE ENTRIES: (Cont.)

EBCPGL	Ethyl-2,2-bis (4-chlorophenyl) glycolate
ED	Dichloroethyl arsine
EDBDAS	3-Phenylpropanol
EGMEE	Ethylene glycol, monoethyl ether / 1,1-Oxybis(2-ethoxy) ethane
EICOSL	1-Eicosanol
EMFUR	3-Ethyl-4-methyloctane
EMPA	Ethyl methylphosphonic acid / Ethyl methylphosphonate
EMS	Ethyl methanesulfonate
ENDRN	Endrin
ENDRNA	Endrin aldehyde
ENDRNK	Endrin ketone
ENHETH	Ethyl-N-hexyl ether
EPCLHD	Epichlorohydrin / Chloromethyloxirane
EPHEN	Ethyl phenol / Ethylhydroxy benzene
EPTOX	Extraction procedure toxic organics
ESFSO4	Endosulfan sulfate
ET3MBZ	1-Ethyl-3-methylbenzene
ET4MBZ	1-Ethyl-4-methylbenzene
ETBD10	Ethylbenzene-D10
ETC6H5	Ethylbenzene
ETCYHX	Ethylcyclohexane
ETHACD	Acetic acid / Ethanoic acid
ETHBR	Bromoethane / Ethyl bromide
ETHER	Ether - nonspecific
ETHION	Ethion
ETHOPR	Ethoprop
ETHPO4	Ethyl phosphate / Phosphoric acid, triethyl ester
ETMACR	Ethyl methacrylate
ETMEBZ	Ethylmethyl benzene
ETOH	Ethanol
ETOX	Ethylene oxide / Oxirane / Anprolene
EU	Europium
F	Fluoride
F10BP	Decafluorobiphenyl
FABPEE	Formic acid, beta-phenylethyl ester
FACHXE	Formic acid, cyclohexyl ester
FAMPHR	Famphur
FANT	Fluoranthene
FARN	Farnesol
FATAL	Fatty alcohols
FC2A	Fluoroacetic acid

ACCEPTABLE ENTRIES: (Cont.)

FE	Iron
FE59	Iron 59
FENRN	3-Phenyl-1,1-dimethylurea / Fenuron
FENRNT	1,1-Dimethyl-3-phenylurea trichloroacetate
FIBGLS	Fibrous glass / Fiberglass
FLASH	Flash point
FLMTRN	1,1-Dimethyl-3-(A,A,A-trifluoro-m-tolyl)urea
FLRENE	Fluorene
FLUMET	Fluometuron
FNT	Fenthion
FOIL1	Fuel oil no. 1
FOIL6	Fuel oil no. 6
FORM	Formaldehyde / Methyl aldehyde
FREON	Freon / Dichlorofluoromethane
FRN112	Freon 112 / Tetrachlorodifluoroethane
FST	Fensulfothion
FSTREP	Fecal streptococci
FURAL	Furfuryl alcohol / 2-Furanmethanol
FURANS	Dibenzofurans - nonspecific
GA	Tabun / Ethyl-N,N-dimethyl phosphoramidocyanidate
GALM	Gallium
GAMAG	Gamma gross
GAMMAS	Gamma scan / Gamma screen
GAS	Gasoline / Gasoline, regular
GB	Sarin / Isopropyl methylphosphonofluoridate
GBHC	gamma-Hexachlorocyclohexane (obsolete - use LIN)
GCHLOR	gamma-Chlordane (obsolete-use GCLDAN)
GCLDAN	gamma-Chlordane
GD	Soman / Pinacolyl methylphosphonofluoridate
GE	Germanium
GLPHST	Glyphosate
GRNDY	Green dye
GUNIT	Guanidine nitrate
H	Levinstein mustard
H2O	Water
H2S	Hydrogen sulfide
H3PO4	Phosphoric acid
HARD	Total hardness
HCBD	Hexachlorobutadiene / Hexachloro-1,3-butadiene
HCNB	Hexachloronorbornadiene
HCO3	Bicarbonate

ACCEPTABLE ENTRIES: (Cont.)

HD	Distilled mustard / Bis (2-chloroethyl) sulfide
HEDODA	N,N-Bis(2-hydroxyethyl)dodecanamide
HEXAC	Hexanoic acid / Caproic acid
HEXANE	Hexane
HG	Mercury
HGEXT	Mercury extractable
HGTOT	Mercury total
HMTCHE	2,6,10,15,19,23-Hexamethyl-2,6,10,14,18,22-tetracosahexane
HMX	Cyclotetramethylenetetranitramine
HN	Nitrogen mustard
HO	Holmium
HPCDD	Heptachlorodibenzodioxin - nonspecific
HPCDF	Heptachlorodibenzofuran - nonspecific
HPCL	Heptachlor
HPCLE	Heptachlor epoxide
HPLH2O	HPLC-grade water
HPO4	Hydrolyzable phosphate
HTH	Hypochlorite
HWX013	Halowax 1013
HWX099	Halowax 1099
HXAB2E	Hexanedioic acid, bis (2-ethylhexyl) ester
HXADBE	Hexanedioic acid, dibutyl esrer / Dibutyl adipate
HXADME	Hexanedioic acid, dimethyl ester / Dimethyl adipate
HXADOE	Hexanedioic acid, dioctyl ester (obsolete - use DOAD)
HXCDD	Hexachlorodibenzodioxin - nonspecific
HXCDF	Hexachlorodibenzofuran - nonspecific
HXCOS	Hexacosane
HXCPEN	Perchloropropene / Hexachloropropene
HXHMAZ	4,5,6,7,8,8A-Hexahydro-8A-methyl-2-[1H]-azuleone
HXMETA	1,3,5,7-Tetraazatricyclo[3.3.13.7]decane / Hexamethylene tetramine
HXMTSX	Hexamethylcyclotrisiloxane
HYDARO	Hydroxylated aromatics / Aromatics, hydroxylated
HYDRND	1H-Indene, octahydro- / Hydrindane
HYDRZ	Hydrazine
HYNB	7-Hydroxynorbornadiene
I	Iodine (as I)
I131	Iodine 131
ICDPYR	Indeno[1,2,3-C,D]pyrene
IGNIT	Ignitability
IMPA	Isopropyl methylphosphonic acid / Isopropyl methylphosphonate
IN	Indium

ACCEPTABLE ENTRIES: (Cont.)

INDAN	1-Hydroxy-2,3-methylene indan [M.W.146]
INDENE	Indene
INDOLE	Indole / 2,3-Benzopyrrole
IOCDF	Octachlorodibenzofuran, C13 isomeric
IPA	Isopropylamine
ISODR	Isodrin
ISOPBZ	Isopropylbenzene / Cumene
ISOPHR	Isophorone
ISOPT	Isopropyltoluene
ISOQUN	Isoquinoline
ISOVAL	3-Methylbutanoic acid / Isovaleric acid
ISOSAF	Isosafrole
ITCDD	2,3,7,8-Tetrachlorodibenzodioxin, C13 isomeric
ITCDF	2,3,7,8-Tetrachlorodibenzofuran, C13 isomeric
K	Potassium
K40	Potassium 40
KB	2-Diisopropylaminoethanol
KEP	Kepone / Chlordecone
KEND	Ketoendrin
L	Lewisite
LA	Lanthanum
LA140	Lanthanum 140
LACYBB	Lactic acid, cyclic butaneboronate
LAURIC	Lauric acid
LI	Lithium
LIGNIN	Lignin
LIN	Lindane / gamma-Benzenehexachloride / gamma-Hexachlorocyclohexane
LINRN	3-(3,4-Dichlorophenyl)-1-methoxy-1-methylurea / Linuron
LIPID	Lipids, percentage
LO	Lewisite oxide
LT	Bis (2-diisopropylaminoethyl) methylphosphonite
LT-A	Bis (2-diisopropylaminoethyl) methylphosphonate
MALO	Malononitrile
MBADOE	3-Methylbutanoic acid, 3,7-dimethyl-2,4,6-octatrienyl ester
MBAS	Foaming agents / Methylyne blue active substance
MBOH	alpha-Methylbenzyl alcohol
MBZ	Metribuzin
MBZA	alpha-Methylbenzyl acetoacetate
MBZCAC	5-Methylbenzo[C]acridine
MBZCL	alpha-Methylbenzyl-2-chloroacetoacetate
MCPA	4-Chloro-o-tolyloxyacetic acid / MCPA

ACCEPTABLE ENTRIES: (Cont.)

MCPP	2-(4-Chloro-2-methylphenoxy)propionic acid / MCPP
MDCL	2-Methylundecanal / 2-Methylhendecanal
ME2AEA	Dimethyl arsenic acid
ME2C11	Dimethylundecanes
ME2HG	Dimethyl mercury
ME2HPL	Methyl-2-heptanols
ME2HPO	Methyl-2-heptanones
ME2NAP	Dimethylnaphthalenes
ME3C10	Trimethyldecanes
ME3C11	Trimethylundecanes
ME3C6	Trimethyl hexanes
ME3NAP	Trimethylnaphthalenes
MEAOA	Methyl arsonic acid
MEBPIP	1,1'-Methylenebis[piperidine]
MEC6D8	Toluene-D8
MEC6H5	Toluene
MECC6	Methylcyclohexane
MECYBU	Methylcyclobutane
MECYDC	Methylcyclodecane
MECYPE	Methylcyclopentane
MEHG	Methyl mercury
MEHGCL	Methyl mercury chloride
MEK	Methyl ethyl ketone / 2-Butanone
MELAM	Melamine / 1,3,5-Triazine-2,4,6-triamine
MEOH	Methanol
MEPHEN	Methylethyl phenol / Methylethylhydroxy benzene
MEPOH	2-Methylpentanol
MERP	Merphos
MES	Methyl sulfide / Thiobismethane
MESTOX	Mesityl oxide / 4-Methyl-3-penten-2-one
METARB	Methioarb
METHCB	3,5-Dimethyl-4-(methylthio) phenyl methylcarbamate
METLAP	Methylnaphthalenes
METMYL	Methomyl
MEVIN	Mevinphos
MEXCLR	Methoxychlor
MG	Magnesium
MHYDRZ	Methylhydrazine
MIBCOH	Methyl isobutyl carbinol (4-methyl-2-pentanol)
MIBK	Methylisobutyl ketone
MINWOL	Mineral wool

ACCEPTABLE ENTRIES: (Cont.)

MIPK	Methylisopropyl ketone
MIREX	Mirex
MLNAT	Molinate
MLTHN	Malathion
MMS	Methyl methanesulfonate
MN	Manganese
MN54	Manganese 54
MNBK	Methyl-N-butyl ketone / 2-Hexanone
MNCRPH	Dimethyl-(E)-1-methyl-2-methylcarbamoylvinyl phosphate
MNRNTC	3-(p-Chlorophenyl)-1-1-dimethylurea trichloroacetate
MO	Molybdenum
MO99	Molybdenum 99
MONRN	3-(p-Chlorophenyl)-1,1-dimethylurea / Monuron
MP	Methylphenols
MPA	Methylphosphonic acid
MPDDD	2-(m-Chlorophenyl)-2-(p-chlorophenyl)-1,1- dichloroethane
MPK	Methylpropyl ketone / 2-Pentanone
MPRTHN	Parathion methyl
MQFH2O	Milli-Q-filtered water
MSSCAN	GC-MS organic scan
MTHCRN	Methylacrylonitrile / 2-Methyl-2-propenenitrile / Methacrylonitrile
MTHMYL	S-Methyl-N-((methylcarbamoyl)-oxy)-thioactimidate
MTRITN	Methyl trithion
MTRZL	Metrazol / Cardiazole
MXCRBT	4-Dimethylamino-3,5-xylyl N-methylcarbamate
N2KJEL	Nitrogen by Kjeldahl Method
NA	Sodium
NA22	Sodium 22
NACL	Sodium chloride
NACLO	Sodium hypochlorite
NALED	Naled
NAOHME	50% 1M NaOH - 50% Methanol
NAP	Naphthalene
NAPD8	Naphthalene-D8
NB	Nitrobenzene
NB94	Niobium 94 / Columbium
NB95	Niobium 95 / Columbium
NBACET	n-Butylacetate
NBD5	Nitrobenzene-D5
NBMBSA	N-Butyl-4-methylbenzenesulfonamide
NBUETH	1,1'-Oxybis[butane] / n-Butyl ether

ACCEPTABLE ENTRIES: (Cont.)

NC	Nitrocellulose
NC1	Nitrocellulose 12%N
NC2	Nitrocellulose 13.4%N
NCLN	Nortricyclanol
NCPPPA	N-(4-Chlorophenyl)-3-phenyl-2-propenamide
ND	Neodymium
NDHXA	N-Nitrodihexylamine
NDIOX	Nitrogen dioxide
NDMBSA	N,4-Dimethylbenzenesulfonamide
NDNPA	Nitrosodi-N-propylamine
NE2PEA	N-Ethyl-2-propenamide
NEBRN	1-n-Butyl-3-(3,4-dichlorophenyl)-1-methylurea / Neburon
NECHXA	N-Ethylcyclohexylamine
NG	Nitroglycerine
NH3	Ammonia
NH3N2	Ammonia nitrogen
NH4	Ammonium
NH4NIT	Ammonium nitrate
NH4PIC	Ammonium picrate / 2,4,6-Trinitrophenol ammonium salt
NHEDCA	N-(2-Hydroxyethyl)-decanamide
NI	Nickel
NI63	Nickel 63
NIOB	Niobium
NIT	Nitrite, nitrate - nonspecific
NITARO	Nitroaromatics
NMANIL	N-Methylaniline
NMCANE	N-Methylcarbamic acid, 1-naphthyl ester
NMNSOA	N-Methyl-N-nitrosoaniline
NN4HPL	N-Nitroso-4-hydroxyproline
NNADME	Nonanedioic acid, dimethyl ester
NNDEA	N-Nitrosodiethylamine
NNDMA	N,N-Dimethylaniline
NNDMEA	N-Nitrosodimethylamine
NNDNB	N-Nitroso-di-N-butylamine
NNDNPA	N-Nitrosodi-N-propylamine
NNDPA	N-Nitrosodiphenylamine
NNMEA	N-Nitrosomethylethylamine
NNMORP	N-Nitrosomorpholine
NNPIP	N-Nitrosopiperidine
NNPIPA	N-Nitrosopentylisopentylamine
NNPYRL	N-Nitrosopyrrolidine

ACCEPTABLE ENTRIES: (Cont.)

NO2	Nitrite
NO3	Nitrate
NONPHE	Nonyl phenol (any isomer)
NPOX	Nonpurgeable organic halides
NPQ	Naphthoquinone
NQ	Nitroguanidine
NTMBSA	N,N,4-Trimethylbenzenesulfonamide
O2	Oxygen
OCADME	Octanedioic acid, dimethyl ester
OCDD	Octachlorodibenzodioxin - nonspecific
OCDF	Octachlorodibenzofuran - nonspecific
ODAPDM	Octadecanoic acid, (2-phenyl-1,3-dioxolan-4-yl) methyl ester
ODECA	Octadecanoic acid / Stearic acid
ODMNSX	Octadecamethylcyclononasiloxane
ODOR	Odor
OEMP	O-Ethyl methylphosphonate
OILGR	Oil & grease
OMCTSX	Octamethylcyclotetrasiloxane
OPDDD	2-(o-Chlorophenyl)-2-(p-chlorophenyl)-1,1- dichloroethane
OPDDE	2-(o-Chlorophenyl)-2-(p-chlorophenyl)-1,1-dichloroethene
OPDDT	2-(o-Chlorophenyl)-2-(p-chlorophenyl)1,1,1-trichloroethane
OPO4	Organophosphates
ORGFIB	Organic fibers
OS	Osmium
OXAL	Oxalic Acid
OXAMYL	Methyl N',N'-dimethyl-N-((methylcarbamoyl)oxy)-1-amylacetate / Oxamyl
OXAT	1,4-Oxathiane
OXCN	Oxacyclononane
OZONE	Ozone
P4	Phosphorus
PA234	Protactinium 234
PA2HDE	Propanoic acid, 2-hydroxydecyl ester
PA2MBE	Pentanoic acid, 2-methylbutyl ester
PAD4NE	Phosphoric acid, diethyl-4-nitrophenyl ester
PAH	Polynuclear aromatic hydrocarbons
PAODPE	Phosphoric acid, octyldiphenyl ester
PARTIC	Particulate matter / Particulates measured by filter
PATBUE	Propanoic acid, t-butyl ester
PATPE	Phosphoric acid, triphenyl ester
PB	Lead
PB211	Lead 211

ACCEPTABLE ENTRIES: (Cont.)

PB212	Lead 212
PB214	Lead 214
PBSTY	Lead styphnate
PBTE	Lead, tetraethyl / Tetraethyllead
PCB016	PCB 1016
PCB221	PCB 1221
PCB232	PCB 1232
PCB242	PCB 1242
PCB248	PCB 1248
PCB254	PCB 1254
PCB260	PCB 1260
PCB262	PCB 1262
PCDD	Pentachlorodibenzodioxin - nonspecific
PCDF	Pentachlorodibenzofuran - nonspecific
PCH	Pentachlorohexane
PCLORM	Dimethyl-2,3,5,6-trichloropicolinic acid / Picloram
PCNB	Pentachloronitrobenzene
PCP	Pentachlorophenol
PCYMEN	4-(1-Methylethyl) toluene / p-Cymene
PD	Dichlorophenyl arsine
PDHYD	Phosphorus, dissolved hydrolyzable (as P)
PDMAB	p-Dimethylaminoazobenzene
PDMSLX	Polydimethyl siloxane / Dimethylpoly siloxane
PDORG	Phosphorus, dissolved organic (as P)
PEGE	Polyethyleneglycol ethers
PENAMD	N-Pentamide
PENTAN	Pentane
PERTHN	Perthane
PETDIL	Petroleum distillates
PETN	Pentaerythritol tetranitrate
PFP	Pentafluorophenol
PH	pH
PH-F	pH as tested in the field
PHAD10	Phenanthrene-D10
PHANTR	Phenanthrene
PHENA	Phenacetin
PHENAA	Phenylacetic acid
PHEND5	Phenol-D5
PHEND6	Phenol-D6
PHENLC	Phenolics - nonspecific
PHENOL	Phenol

ACCEPTABLE ENTRIES: (Cont.)

PHOR	Phorate
PHTHA	1,2-Benzenedicarboxylic acid / Phthalic acid
PHTHL	Phthalates
PHXAA	Phenoxyacetic acid
PHYCP	1,2,3,4,5-Pentahydroxycyclopentane
PHYDR	Phosphorus, total hydrolyzable (as P)
PHYETH	1,1'-(1,3-Phenylene)ethanone
PIC3	3-Picoline
PIPER	Piperidine
PLEXI	Methyl methacrylate / Plexiglass
PMPA	Propyl methylphosphonic acid
PO4	Phosphate
PO4ORT	Orthophosphate
PORG	Phosphorus, total organic (as P)
POX	Purgeable organic halogen
PPDDD	2,2-Bis (p-chlorophenyl)-1,1-dichloroethane
PPDDE	2,2-Bis (p-chlorophenyl)-1,1-dichloroethene
PPDDT	2,2-Bis (p-chlorophenyl)-1,1,1-trichloroethane
PPTDE	2,2-Bis (p-chlorophenyl)-2-phenyl-1,1- dichloroethene
PQUIN	1,4-Benzoquinone / p-Benzoquinone
PRC6H5	Propylbenzene / n-Propylbenzene
PROACD	Propionic acid
PROMET	Prometon / Primatol / 2,4-Bis(isopropylamino)-6-methoxy-1,3,5-triazine
PRONA	Pronamide
PROPHM	Isopropyl carbanilate / IPC / Propham
PROPOX	Propylene oxide / Methyl oxirane
PROPXR	2-(1-Methyloxy)phenol methylcarbamate / Propoxur
PRTHN	Parathion
PT	Platinum
PTHZ	Phthalazinone
PU238	Plutonium 238 isotope
PU239	Plutonium 239 isotope
PU240	Plutonium 240 isotope
PYLD12	Perylene-D12
PYR	Pyrene
PYRD10	Pyrene-D10
PYRDIN	Pyridine
QA	2-Diisopropylaminoethyl methylphosphinate
QALT	Co-eluting compounds QA and LT (q.v.)
QB	2-Diisopropylaminoethyl ethyl methylphosphonate
QL	QL / Ethyl 2-diisopropylaminoethyl methylphosphonite

ACCEPTABLE ENTRIES: (Cont.)

QUINO	Quinoline / Benzo[B]pyridine
RA	Radium
RA223	Radium 223
RA224	Radium 224
RA226	Radium 226
RA228	Radium 228
RB	Rubidium
RDX	Cyclonite / Hexahydro-1,3,5-trinitro-1,3,4-triazine
RE	Rhenium
REACTY	Reactivity
REDDY	Red dye
RESACI	Resin acids
RESIST	Resistivity
RESO	Resorcinol / 1,3-Benzenediol
RN	Radon
RN226	Radon 226
RO	Rhodium
RO106	Rhodium 106
RON	Ronnel
ROTEN	Rotenone
RU	Ruthenium
RU103	Ruthenium 103
RU106	Ruthenium 106
S	Sulfur
S2CL2	Sulfur monochloride
SAFROL	Safrole / 5-(2-Propenyl)-1,3-benzodioxole
SALINE	Saline
SALINI	Salinity
SB	Antimony
SB124	Antimony-124
SB125	Antimony-125
SBBEN	sec-Butylbenzene / 2-Phenylbutane
SC	Scandium
SCN	Thiocyanate
SE	Selenium
SEVIN	Sevin / 1-Naphthalenol methylcarbamate
SFOTEP	Sulfotepp / Thiodiphosphoric acid, tetraethyl ester
SI	Silica
SIDRN	1-(2-Methylcyclohexyl)-3-phenylurea / Siduron
SIL	Silicone
SILCON	Silicon

ACCEPTABLE ENTRIES: (Cont.)

SILVEX	Silvex
SIMAZ	Simazine / 6-Chloro-N,N'-diethyl-1,3,5-triazine-2,4-diamine
SN	Tin
SO2	Sulfur Dioxide
SO3	Sulfite
SO4	Sulfate
SPIRO	(1',5 trans)-7-Chloro-6-hydroxy-2',4- dimethoxy-6'-methyl spiro [benzofuran-2-(3H)-1'-(2)-cyclohexene]-3, 4'-dione
SQUAL	Squalene
SR	Strontium
SR90	Strontium 90
SSOL	Settleable solids
STB	Super tropical bleach
STERO	Steroids
STIGMA	Stigmastenal
STIR	Stirophos / Tetrachlorvinphos
STROBN	Strobane / Terpine polychlorinates
STYPH	Styphnate ion
STYPHA	Styphnic acid (obsolete - use 246TNR)
STYR	Styrene
SUADME	Sulfuric acid, dimethyl ester
SULFID	Sulfide
SUPONA	Supona / 2-Chloro-1-(2,4-dichlorophenyl) vinyldiethyl phosphate
SWEP	Methyl-N-(3,4-di-chlorophenyl)carbamate / Swep
T12DCE	trans-1,2-Dichloroethene / trans-1,2-Dichloroethylene
T13DCP	trans-1,3-Dichloropropene
T1B2BC	trans-1-Bromo-2-butylcyclopropane
T2DEC	trans-2-Decene
TA	Tantalum
TANNIN	Tannin
TASTE	Taste
TBA	Tributylamine
TBASDE	Thiobutyric acid, S-decyl ester
TBBEN	tert-Butylbenzene / 2-Methyl-2-phenylpropane
TBCARB	2,2-Dimethyl-1-propanol / tert-Butylcarbinol / Neopentyl alcohol
TBP	Tributyl phosphate
TCB	Tetrachlorobenzenes
TCB1	1,2,4,5-Tetrachlorobenzene
TCB2	1,2,3,4-Tetrachlorobenzene
TCB3	1,2,3,5-Tetrachlorobenzene
TCDD	2,3,7,8-Tetrachlorodibenzo-p-dioxin / Dioxin

ACCEPTABLE ENTRIES: (Cont.)

TCDF	2,3,7,8-Tetrachlorodibenzofuran
TCHDCS	trans-1,2-Cyclohexandiol, cyclic sulfite
TCLDAN	trans-Chlordane
TCLEA	1,1,2,2-Tetrachloroethane
TCLEE	Tetrachloroethylene / Tetrachloroethene
TCLTFE	1,1,2-Trichloro-1,2,2-trifluoroethane
TCN	Trichloronate
TCOS	Tetracosane
TCP	Trichloropropane
TCSAME	15-Tetracosenoic acid, methyl ester
TCST	Trichlorostyrenes
TCYN	Total cyanide
TDCBU	trans-1,4-Dichloro-2-butene
TDEMET	Demeton total
TDGCL	Thiodiglycol
TDGCLA	Thiodiglycolic acid
TDMHSX	Tetradecamethyl hexasiloxane
TDODTL	tert-Dodecanethiol
TDS	Total dissolved solids
TE	Tellurium
TEGLME	Triethylene glycol, methyl ether
TEGLYC	2,2'-[1,2-Ethanediylbis(oxy)] bis[ethanol] / Triethylene glycol
TEMP	Temperature
TEMP-F	Temperature as tested in the field
TEPO4	Triethyl phosphate
TETPT	Tetrachlorocyclopentene
TETR	Tetrazene
TETRYL	Nitramine / N-Methyl-N,2,4,6-tetranitroaniline / Tetryl
TFAAPE	Trifluoroacetic acid, 1,5-pentanediyl ester
TFDCLE	1,1,2-Trifluoro-1,2-dichloroethane
TFTCLE	1,1,1-Trichloro-2,2,2-trifluoroethane
TGLYME	Tetraglyme
TH	Thorium
TH227	Thorium 227
TH228	Thorium 228
TH230	Thorium 230
TH232	Thorium 232
TH234	Thorium 234
THBNC	Thiobencarb
THCDD	Total hexachlorodibenzo-p-dioxins
THCDF	Total hexachlorodibenzofurans

ACCEPTABLE ENTRIES: (Cont.)

THF	Tetrahydrofuran
THMNAP	1,2,3,4-Tetrahydro-1H-methylnaphthalene
THNAP	1,2,3,4-Tetrahydronaphthalene / Tetralin
THNCRB	Thinocarb
THP2ML	Tetrahydropyranyl-2-methanol
THPCDD	Total heptachlorodibenzo-p-dioxins
THPCDF	Total heptachlorodibenzofurans
TI	Titanium
TINNIN	Tannin and lignin combined
TL	Thallium
TL208	Thallium 208
TM3PL	2,3,4-Trimethyl-3-pentanol
TMBPET	2-(2-(4-(1,1,3,3-Tetramethyl)butyl)phenoxy)ethanol
TMHPDO	3,3,6-Trimethyl-1,5-heptadien-4-one
TMHXL	3,5,5-Trimethyl-1-hexanol
TMNT	Total mononitrotoluenes
TMODEO	2,2,7,7-Tetramethyl-4,5-octadien-3-one
TMP	Trimethyl phosphate
TMPHAN	Tetramethylphenanthrene
TMPO	Trimethylphosphonate
TMPO3	Trimethyl phosphite
TMPO4	Trimethyl phosphate (obsolete - use TMP)
TMTCON	3,5,24-Trimethyltetracontane
TMUR	Tetramethylurea
TNBISO	Trinitrobenzene isomer
TNTISO	Trinitrotoluene isomer
TOC	Total organic carbon
TOCDD	Total octochlorodibenzo-p-dioxins
TOCDF	Total octachlorodibenzofurans
TOKU	Tokuthion / Prothiophos
TORC	Total organic content, 444C (ASTM)
TOTASH	Total ash / Ash, total
TOTCOL	Total coliform
TOTDDT	Total value of all DDT, DDE, DDD isomers
TOTGAF	Total gravimetric, acid fraction
TOTHG2	Total mercury
TOTPCB	Total PCBs
TOX	Total organic halogens
TPCDD	Total pentachlorodibenzo-p-dioxins
TPCDF	Total pentachlorodibenzofurans
TPH	Thiophene

ACCEPTABLE ENTRIES: (Cont.)

TPHAVG	Total petroleum hydrocarbons, aviation gasoline fraction
TPHC	Total petroleum hydrocarbons
TPHDSL	Total petroleum hydrocarbons, diesel fraction
TPHGAS	Total petroleum hydrocarbons, gas fraction
TPO4	Total phosphates
TPP	Triphenylphosphate
TRCLE	Trichloroethylene / Trichloroethene
TREACT	Tramolite-actinolite asbestos
TREFLN	Trifluralin / Treflan
TRIBZ	Trichlorobenzenes
TRIMBZ	Trimethylbenzenes
TRIPT	Trichlorocyclopentene
TRITIU	Tritium
TRITN	Trithion
TRMTDE	2,3,4-Trimethyl-4-tetradecene
TRO	Diethyl methylphosphonate
TRPD14	Terphenyl-D14
TRPHEN	Triphenylene
TRXMET	Trihalomethanes
TS	Total sulfur
TSAHPE	p-Toluenesulfonic acid, heptyl ester
TSOLID	Total solids
TSS	Total suspended solids
TTCDD	Total tetrachlorodibenzo-p-dioxins
TTCDF	Total tetrachlorodibenzofurans
TTCP	Tetrachlorophenol
TTCTFE	Trichlorotrifluoroethane
TTO	Total toxic organics
TU	Total uranium
TURBID	Turbidity
TVS	Total volatile solids
TXPHEN	Toxaphene
TXYLEN	Xylenes, total combined
U	Uranium
U234	Uranium 234
U235	Uranium 235
U238	Uranium 238
UDMH	Unsymmetrical dimethyl hydrazine
UNKXXX	Unknown compound, XXX = 001 thru 999.
UREA	Urea / Carbamide / Carbonyl diamide
V	Vanadium

ACCEPTABLE ENTRIES: (Cont.)

VARHY	Various hydrocarbons with increasing M.W.
VFA	Vinyl formate
VM	O-Ethyl-S-(2-diethylaminoethyl) methylphosphonothiolate
VX	O-Ethyl-S-(2-diisopropylaminoethyl) methylphosphonothiolate
W	Tungsten
WP	White phosphorus
XPLOSV	Explosive spray
XYLEN	Xylenes
Y	Yttrium
YB	Ytterbium
YELDY	Yellow dye
YL	Ethyl methylphosphinate
YLQLTR	Co-eluting compounds YL, QL and DEMP (q.v.)
ZINPHS	Zinophos / Thionazin
ZN	Zinc
ZN65	Zinc 65
ZR	Zirconium
ZR95	Zirconium 95

Chemical and Radiological Data:

(Sorted alphabetically by Test Name)

(1-Methylpropyl) benzene	1MPRB
(1',5 trans)-7-Chloro-6-hydroxy-2', 4-dimethoxy-6'-methyl spiro[benzofuran-2-(3H)-1'-(2)-cyclohexene]-3, 4'-dione	SPIRO
(1,1-Dimethylethyl) benzene	11DMEB
(1,3-Dimethylbutyl) benzene	13DMBB
(2-Chloroethoxy) ethene	2CLEVE
(3beta)-Stigmast-5-en-3-ol	3SSE3L
0.1N Hydrochloric acid	01NHCL
1-(2-Butoxyethoxy) ethanol	BEETO
1-(2-Methylcyclohexyl)-3-phenylurea	SIDRN
1-Acetyl-3-methyl-5-pyrazolone	1A3MPZ
1-Acetyl-4-(1-hydroxy-1-methylethyl) benzene	1A4HMB
1-Benzyl-4-hydroxybenzimidazole	1BY4HB
1-Butanol	1C4L
1-Carbamoyl-3,5-dimethyl-2-pyrazoline	1CDMPZ
1-Chloro-2,4-hexadiene	1CL24H
1-Chlorohexane	1CH
1-Chloronaphthalene	1CNAP

APPENDIX D

APPENDIX D
HEALTH BASED NUMBERS AND OTHER COMPARISON CRITERIA

A set of health based numbers (HBNs) and other comparison criteria were developed for this report. Included in the set were analytes detected at Radford Army Ammunition Plant (RAAP) that did not have HBNs specified in the Resource Conservation and Recovery Act (RCRA) permit for RAAP. The methodology for development of these HBNs and other comparison criteria is described below. Table D-1 presents the HBNs and other comparison criteria developed for analytes detected at RAAP during the VI that do not have permit-specified HBNs. It is important to note that several detected analytes exhibit both carcinogenic and noncarcinogenic toxic effects. The HBN for a given analyte is the lesser of the carcinogenic and noncarcinogenic values.

D.1 GROUNDWATER AND SURFACE WATER HBNs AND OTHER COMPARISON CRITERIA

If HBNs were not specified in the RAAP permit, maximum contaminant levels (MCLs) are used as the groundwater and surface water comparison criteria, if available. Groundwater and surface water criteria are assumed to be identical because there is a municipal drinking water intake downstream of RAAP on the New River; therefore, drinking water criteria are generally applicable to both surface water and groundwater at RAAP. In the absence of MCLs, HBNs were developed according to the methodology provided in RCRA Part 264 Subpart S regulations (40 CFR Part 264; July 27, 1990), as described below.

In the absence of an MCL, an HBN for noncarcinogenic effects is calculated according to the following equation (Eq. D-1):

$$HBN = (RfD \times BW)/(Iw)$$

where:

HBN = Health based number (mg/l)

RfD = Reference dose (mg/kg/day)

BW = Body weight (kg)

Iw = Intake of water (l/day)

For noncarcinogenic effects a water intake (Iw) of 2 l/day is assumed for a 70 kg adult (BW) (40 CFR 264; July 27, 1990). The reference dose (RfD) is the toxicity value used most often in evaluating noncarcinogenic effects. RfDs for noncarcinogenic effects are estimates of daily exposure levels for the human population, including sensitive subpopulations, that are likely without an appreciable risk of deleterious effects during a lifetime. The RfD is used in risk assessments to estimate the potential for noncarcinogenic health effects, which is measured by the hazard quotient (HQ). In summary, the HQ is the intake divided by the RfD. EPA guidance suggests that there may be concern for potential noncarcinogenic health effects if a HQ exceeds one (USEPA, 1989). In general, the greater the value of the HQ above unity, the greater the level of concern for noncarcinogenic effects. In developing HBNs, the RfD is used to estimate the contaminant concentration that provides a daily intake that results in a HQ of 1.

In the absence if an MCL, an HBN for carcinogenic effects is calculated according to the following equation (Eq. D-2):

HBN = (R x BW x LT)/(SF x Iw x ED)

where:

R = Assumed risk level (unitless)

LT = Assumed lifetime (years)

SF = Carcinogenic Slope Factor (1/(mg/kg/day))

ED = Exposure duration (years)

For carcinogenic effects, a water intake (Iw) of 2 l/day is assumed for a 70 kg adult (BW); exposure is assumed to be 70 years (ED) of a 70 year lifetime (LT) (40 CFR 264; July 27, 1990). The slope factor (SF) and the accompanying weight-of-evidence determination are the toxicity data most commonly used to evaluate potential human carcinogenic risks. The slope factor is a plausible upper-bound estimate of the probability of a response per unit intake of a chemical over a lifetime. The slope factor is used in risk assessments to estimate an upper-bound probability of an individual developing cancer as a result of a lifetime exposure to a particular level of a potential carcinogen. In developing

HBNs, the slope factor is used to estimate the contaminant concentration that, given lifetime exposure, would result in the specified probability of an individual developing cancer. As specified in RCRA Part 264, for potential carcinogens, a risk level of 1E-06 is assumed for Class A and B carcinogens and a risk level of 1E-05 is assumed for Class C carcinogens.

In the absence of an MCL and relevant health effects values (RfD or SF), other comparison criteria were considered. These include the drinking water equivalent level (DWEL), secondary maximum contaminant level (SMCL), maximum contaminant level goal (MCLG), and other criteria, as available. Table D-1 indicates whether these comparison criteria were used as the HBN.

D.2 SOIL HBNs AND OTHER COMPARISON CRITERIA

If HBNs were not specified in the RAAP permit, HBNs were developed according to the methodology provided in RCRA Part 264 Subpart S regulations (40 CFR Part 264; July 27, 1990), as described below.

HBNs for noncarcinogenic effects are calculated according to the following equation (Eq. D-3):

HBN = (RfD x BW)/(Is x CF)

where:

HBN = Health based number (mg/kg)

RfD = Reference dose (mg/kg/day)

BW = Body weight (kg)

Is = Intake of soil (g/day)

CF = Conversion factor (1E-03 kg/g)

HBNs for carcinogenic effects are calculated according to the following equation (Eq. D-4):

HBN = (R x BW x LT)/(SF x Is x ED x CF)

where:

R = Assumed risk level (unitless)

LT = Assumed lifetime (years)

SF = Carcinogenic Slope Factor (1/(mg/kg/day))

ED = Exposure duration (years)

In deriving HBNs for hazardous constituents in soil, other than those which are known or suspected to be carcinogens, a soil intake (Is) of 0.2 g/day for a 16 kg child (BW) over a five year exposure period (age 1-6) is assumed (40 CFR Part 264; July 27, 1990). A conversion factor of 1E-03 kg/g is required for unit adjustment. For hazardous constituents which are known or suspected to be carcinogens, a soil intake of 0.1 g/day (Is) for a 70 kg adult (BW) over a 70 year lifetime exposure period (ED and LT) is assumed (40 CFR Part 264; July 27, 1990). The RfD and SF are discussed in Section D.1.

An RfD is not available for lead, because--after careful consideration of toxicity data on lead--EPA has decided that the derivation of an RfD is inappropriate (USEPA, 1992a). Rather, EPA has developed an uptake/biokinetic (UBK) model that estimates total lead uptake (ug Pb/day) in children from diet, inhalation, and ingestion of soil, dust, and paint, and predicts a blood lead level in micrograms of lead per deciliter (ug Pb/dL) based on total lead uptake. Blood lead is considered the best indicator of recent lead exposure and has been reliably correlated with neurotoxicity measures in developing children. Therefore, the UBK model for lead is used to develop soil HBNs for lead. This model and the development of HBNs for lead are discussed in detail in Section D.3.

D.3 DEVELOPMENT OF HBNs FOR LEAD IN SOIL

A description of the UBK model is presented below in Section D.3.1; this information was obtained form Users' Guide for Lead: A PC Software Application of the Uptake Biokinetic Model, Version 0.50 (USEPA, 1991c). Application of the UBK model for development of HBNs for lead at RAAP is discussed in Section D.3.2.

D.3.1 Uptake/Biokinetic Model for Lead

The purpose of the lead UBK model is to estimate the total lead uptake (ug Pb/day) in humans that results from diet, and inhalation and ingestion of soil, dust, and paint, and to predict a blood lead level (ug Pb/dL) based on total lead uptake. The current version of the model estimates lead uptake and blood lead levels in children from 0 to 6 years old. Therefore, this model applies only to the residential land use scenario. The UBK model contains two separate sections: (1) the uptake section, which estimates the monthly uptake of lead from diet, air, soil/dust, water, and paint; and (2) the biokinetic section, which uses the monthly lead uptake to estimate blood levels. Final results are reported on an annual basis. These sections of the model are described briefly below. A more detailed description of the UBK model is presented in the reference cited above (USEPA, 1991c).

D.3.1.1 Uptake Section of the Model. The uptake section of the model uses the user-entered values or default values to estimate a daily intake of lead from air, diet, water, soil/dust, and paint. It is important to understand that "intake" of lead is different from "uptake" of lead. Intake is the amount of lead brought into the body by the various exposure routes. Uptake is the amount of lead absorbed into the body's blood-plasma system. Uptake is calculated from intake by the following general formula:

UPTAKE = *INTAKE X ABSORPTION* factor

For each of the exposure routes, the following formulas are used:

UPAIR = *INAIR X ABSAIR*

UPDIET = *INDIET X ABSDIET*

UPDUST = *INDUST X ABSDUST*

UPSOIL = *INSOIL X ABSOIL*

UPWATER = *INWATER X ABSWATER*

UPPAINT = *INPAINT X ABSPAINT*

The absorption factors are determined by either the linear absorption method or the nonlinear active passive method. The linear method uses a constant absorption percentage (for each age and exposure route) that is multiplied by the lead intakes to calculate the lead uptakes. In the nonlinear method, the absorption percentage varies with lead concentration, volume of the gut, and other factors. The nonlinear method is the program default. The intakes entered by the user are on a daily basis. Multiplying the daily intakes by 30 yields the estimated monthly intakes. The total monthly uptake, is therefore:

UPTAKE	=	*UPAIR + UPDIET + UPDUST + UPSOIL + UPWATER + UPPAINT*

The monthly uptakes are then passed to the biokinetic section of the model for estimation of blood lead levels.

Information pertaining to the intake values for various exposure routes are discussed below.

D.3.1.1.1 Air Intake. The daily intake of lead resulting from air exposure is calculated using a time-weighted average (TWA) method, as follows (the asterisk symbolizes multiplication):

Intake (ug Pb/day) = ((TO*CO + TI*CI)/24) * Vent Rate (m^3 air/day)
where:
TO and TI are the time outdoors and indoors (in hours), and
CO and CI are the concentrations outdoors and indoors (ug PB/m^3).

D.3.1.1.2 Water Intake. The daily drinking water intake of lead is calculated by multiplying the water concentration (ug Pb/L) by the daily consumption rate (in liters). Alternate factors (which include "first-draw" and fountain" water) are included in the formula if the user specified their use. If specified, the formula for drinking water intake becomes:

INWATER	=	water consumption x ((flushed concentration x flushed fraction) + (first draw concentration x first draw fraction) + (fountain concentration x fountain fraction))

D.3.1.1.3 Soil and Dust Intake. The lead concentrations of soil are directly entered by the user. For each age group, the soil intake is calculated by multiplying the soil concentration by the amount of soil and dust ingested. This value is then multiplied by the fraction of the soil and dust amount that is soil. The program uses defaults of 45 percent soil to 55 percent dust.

If the user selects a constant dust concentration or variable dust concentrations, the dust intake is calculated exactly the same as for soil. Dust differs from soil in that it has the added option of using multiple source analysis to determine dust intake. Multiple source analysis sums the dust intake from three primary sources: (1) contribution to house dust from soil dust, (2) contribution to house dust from airborne fallout, and (3) contribution from alternate dust sources. The alternate dust sources include lead in house dust from paint sources and lead exposures at occupational settings, second homes, daycare facilities, and schools. If the user does not use alternate dust sources, the dust intake is calculated only from contributions (1) and (2) above, which is the program default.

D.3.1.2 Biokinetic Section of the Model. The biokinetic section of the model uses the total lead uptake for each month to calculate the amount of lead that occurs in a number of body compartments. The body compartments include the plasma and extra cellular fluid (ECF) pool, the red blood cell (RBC) pool, the kidney, the liver, trabecular bone, cortical bone, and other soft tissue pools.

The first consideration is the amount of lead occurring in these compartments at time zero (birth). This is determined by the maternal contribution. The user selects either the infant method or the fetal method to estimate the maternal contribution. The fetal method is the program default. The infant method uses default values to determine the compartment lead levels for a newborn. For example, the blood lead level of a newborn is estimated to be 85 percent of the maternal blood level (current default for maternal level; is 7.50 ug Pb/dL). The newborn organ lead levels are then estimated from the blood lead level. The fetal method is a self-contained model that iteratively determines lead levels in a fetus during pregnancy.

Although complicated mathematically, the biokinetic model is relatively simple in concept. In general, lead enters the body through uptake, lead leaves the body through urine and feces, and lead is exchanged among body compartments. (The uptake section of the model is discussed in Section D.3.1.1.) The important factor of the biokinetic model is the transition of lead among body compartments (which includes its removal by urine and feces via transition to kidney and liver). The transition times (residence times) are the rate-determining factors that give the rate at which lead enters, leaves, and remains in each compartment during each monthly iteration. The formulas used to estimate the transition times are provided in Appendix B of the referenced EPA document (USEPA 1991c). The transition times are calculated on a monthly basis and depend on body weight and weight of the organs at that monthly age.

Blood lead levels increase with increases of lead uptake. If the lead uptake is increased to excessively high levels (several hundred ug Pb/day or more), the lead concentration in the red blood cells begins to equal or exceed the saturation concentration of the red blood cells. When the program recognizes this condition, the biokinetic model iterations are terminated and a warning is displayed. It is still possible, however, to get very close to the saturation concentration without a warning being issued. In some of these situations, unrealistically high blood levels are being generated.

D.3.1.3 Values of Default Parameters. The values of various default parameters that can be changed by the user are listed below. Default values for gastrointestinal tract absorption and biokinetic residence times are provided in Appendices A and B (USEPA, 1991c), respectively.

Air Data:

Air Concentration: 0.20 ug Pb/m^3
Lung Absorption: 32 percent
Vary Air Conc by Year: NO
Ventilation Rate:

Age 0-1:	2.0 m^3/day
Age 1-2:	3.0 m^3/day
Age 2-3:	5.0 m^3/day
Age 3-4:	5.0 m^3/day
Age 4-5:	5.0 m^3/day
Age 5-6:	7.0 m^3/day
Age 6-7:	7.0 m^3/day

Water Data:

Water Concentration: 4.00 ug/L
Use Alternate Values: NO
Water Consumption:

Age 0-1:	0.20 L/day
Age 1-2:	0.50 L/day
Age 2-3:	0.52 L/day

Age 3-4: 0.53 L/day
Age 4-5: 0.55 L/day
Age 5-6: 0.58 L/day
Age 6-7: 0.59 L/day

Diet Data:

Use Alternate Values: NO
Diet Intake:
Age 0-1: 5.88 ug Pb/day
Age 1-2: 5.92 ug Pb/day
Age 2-3: 6.79 ug Pb/day
Age 3-4: 6.57 ug Pb/day
Age 4-5: 6.36 ug Pb/day
Age 5-6: 6.75 ug Pb/day
Age 6-7: 7.48 ug Pb/day

Soil and Dust Data:

Constant Soil Conc: 200 ug Pb/g
Constant Dust Conc: 200 ug Pb/g
Percent of Soil and Dust That is Soil: 45
Amount Ingested Daily: 0.10 g Pb (all ages)

Multiple Source Analysis:

Soil Contribution to House
Lead Dust (conversion factor): 0.28
Air Contribution to House
Lead Dust (conversion factor): 100
Use Alternate Dust Sources: NO

Paint Data:

Amount Ingested Daily: 0.0 ug Pb (all ages)

Maternal Data:

Infant Model:
Mother's Blood Lead Conc at Birth: 7.50 ug Pb/L

Fetal Model:

Air:

Conc Outdoors:	0.200 ug Pb/m^3
Conc Indoors:	0.060 ug Pb/m^3
Conc at Work:	0.060 ug Pb/m^3
Vent Rate Outdoors:	1.0 m^3/hr
Vent Rate Indoors:	1.0 m^3/hr
Vent Rate at Work:	1.0 m^3/hr
Vent Rate Sleeping:	1.0 m^3/hr

Water:

Conc at Home:	9.00 ug Pb/L
Conc at Work:	9.00 ug Pb/L
Consumption at Home:	2.0 L/day
Consumption at Work:	2.0 L/day

Diet:

Consumption:	1,000 g food/day
Conc:	0.10 ug Pb/g food

Dust:

House Consumption:	0.020 g dust/day
House Conc:	200.0 ug Pb/g dust
2nd Occupation Exposure:	0.00 ug Pb/day
Other Dust Intake:	0.00 ug Pb/day

Absorption:

Air:	50.0% (in lungs)
Diet:	10.0% (in gastrointestinal tract)
Water:	10.0% (in gastrointestinal tract)
Dust:	10.0% (in gastrointestinal tract)

Graph Values:

GSD:	1.42
Cutoff:	10 ug Pb/dL

D.3.2 Application of the UBK Model to Development of Soil HBNs

EPA (1991d) has identified blood lead concentrations of 10 to 15 ug/dL as levels of concern for adverse effects. Therefore, these levels are used as the basis for developing soil HBNs for lead. The UBK model was run using the default values presented and discussed in Section D.3.1, a lead groundwater concentration of 15 ug/l, and a varying soil concentration. A concentration of 15 ug/l in groundwater is used because this is the MCL for lead and, therefore, the HBN for lead in groundwater.

Based upon application of the UBK model, two potential HBNs for lead in RAAP soil are identified--200 and 500 mg/kg total lead. The HBN for lead depends, in part, upon what percentage of the population you want to protect and the blood lead cutoff selected. Figure D-1 presents a graph of the bell-shaped probability density function at a soil concentration of 200 mg/kg Pb; at this soil concentration, the model estimated a high degree of protectiveness of >99.6 percent of children in a residential setting (i.e., at 200 mg/kg, >99.6 percent of an exposed sensitive population (young children) would be expected to have blood lead levels of less than or equal to 10 ug/dL).

Figures D-2 and D-3 present graphs of the bell-shaped probability density function at a soil concentration of 500 mg/kg Pb and using cutoffs of 10 and 15 ug/dL blood lead levels, respectively. At a soil concentration of 500 mg/kg, the model predicts that >89.6 percent of the children would have blood lead levels of less than or equal to 10 ug/dL. As indicated in Figure D-3, at 500 mg/kg, >99.2 percent of the children would have blood lead levels of less than or equal to 15 ug/dL.

TABLE D–1

HBNs and Other Comparison Criteria Developed for Detected Analytes Without Permit Specified HBNs

Contaminant	Oral RfD (mg/kg/day)	Oral SF (1/(mg/kg/day))	Noncarcinogenic GW HBN (m) (mg/l)	Carcinogenic GW HBN (n) (mg/l)	Noncarcinogenic Soil HBN (o) (mg/kg)	Carcinogenic Soil HBN (p) (mg/kg)
Metals:						
Aluminum	2.9E+00 (c)	NA	1.0E+02	NC	2.3E+05	NC
Calcium	NA	NA	NC	NC	NC	NC
Cobalt	1.0E–05 (c)	NA	3.5E–04	NC	8.0E–01	NC
Copper	3.7E–02 (c)	NA	1.3E+00	NC	3.0E+03	NC
Iron	NA	NA	3.0E–01 (k)	NC	NC	NC
Lead	IUBK (see text)	NA	1.5E–02 (l)	NC	200 – 500 (l)	NC
Magnesium	NA	NA	NC	NC	NC	NC
Manganese	1.0E–01 (a)	NA	3.5E+00	NC	8.0E+03	NC
Potassium	NA	NA	NC	NC	NC	NC
Sodium	NA	NA	2.0E+01 (j)	NC	NC	NC
Vanadium	7.0E–03 (a)	NA	2.5E–01	NC	5.6E+02	NC
Zinc	2.0E–01 (b)	NA	7.0E+00	NC	1.6E+04	NC
Other Inorganics:						
Chloride	NA	NA	2.5E+02 (k)	NC	NC	NC
Nitrogen	NA	NA	NC	NC	NC	NC
Nitrate/nitrite	1.6E+00 (a)	NA	1.0E+01 (l)	NC	1.3E+05	NC
Phosphate	NA	NA	NC	NC	NC	NC
Sulfate	NA	NA	400/500 (l)	NC	NC	NC
Semi–VOAs:						
Acenapthene	6.0E–02 (a)	NA	2.1E+00	NC	4.8E+03	NC
Acenaphthylene	NA	NA	NC	NC	NC	NC
Carbon Disulfide	1.0E–01 (a)	NA	3.5E+00	NC	8.0E+03	NC
Dibenzofuran	NA	NA	1.2E–01 (l)	NC	NC	NC
Fluorene	4.0E–02 (a)	NA	1.4E+00	NC	3.2E+03	NC
2–Methylnaphthalene	NA	NA	NC	NC	NC	NC
Phenolics	6.0E–01 (a)(e)	NA	2.1E+01	NC	4.8E+04	NC
TPH	NA	NA	NC	NC	NC	NC
Explosives:						
135TNB	5.0E–05 (a)	NA	1.8E–03	NC	4.0E+00	NC
13DNB	1.0E–04 (a)	NA	3.5E–03	NC	8.0E+00	NC
246TNT	5.0E–04 (a)	3.0E–02 (a)	1.8E–02	1.2E–02 (h)	4.0E+01	2.3E+02 (h)
26DNT	1.0E–03 (d)	6.8E–01 (a)	3.5E–02	5.1E–05 (g)	8.0E+01	1.0E+00 (g)
24DNT	2.0E–03 (d)	6.8E–01 (a)	7.0E–02	5.1E–05 (g)	1.6E+02	1.0E+00 (g)
HMX	5.0E–02 (a)	NA	1.8E+00	NC	4.0E+03	NC
RDX	3.0E–03 (a)	1.1E–01 (a)	1.1E–01	3.2E–03 (h)	2.4E+02	6.4E+01 (h)
Tetryl	1.0E–02	NA	3.5E–01	NC	8.0E+02	NC
2–Nitroaniline	NA	NA	NC	NC	NC	NC

TABLE D-1 (cont'd)

Sources: (a) – USEPA, 1992a
(b) USEPA, 1991a
(c) USEPA, 1991b
(d) Brower, 1992.

(e) – – Based on RfD for phenol.
(f) – Based on the organoleptic water criterion (USEPA, 1987).
(g) – Class A or B carcinogen; therefore, a risk level of 1E–06 used.
(h) – Class C carcinogen; therefore, a risk level of 1E–05 used.
(i) – Maximum contaminant level (MCL).
(j) – Drinking water equivalent level (DWEL).
(k) – Secondary maximum contaminant level (SMCL) (not health based).
(l) – Based on uptake biokinetic (UBK) model for lead.
(m) – Unless otherwise noted, calculated according to Equation D–1.
(n) – Unless otherwise noted, calculated according to Equation D–2.
(o) – Unless otherwise noted, calculated according to Equation D–3.
(p) – Unless otherwise noted, calculated according to Equation D–4.
NA – Not available.
NC – Not calculated because health effects criteria not available.

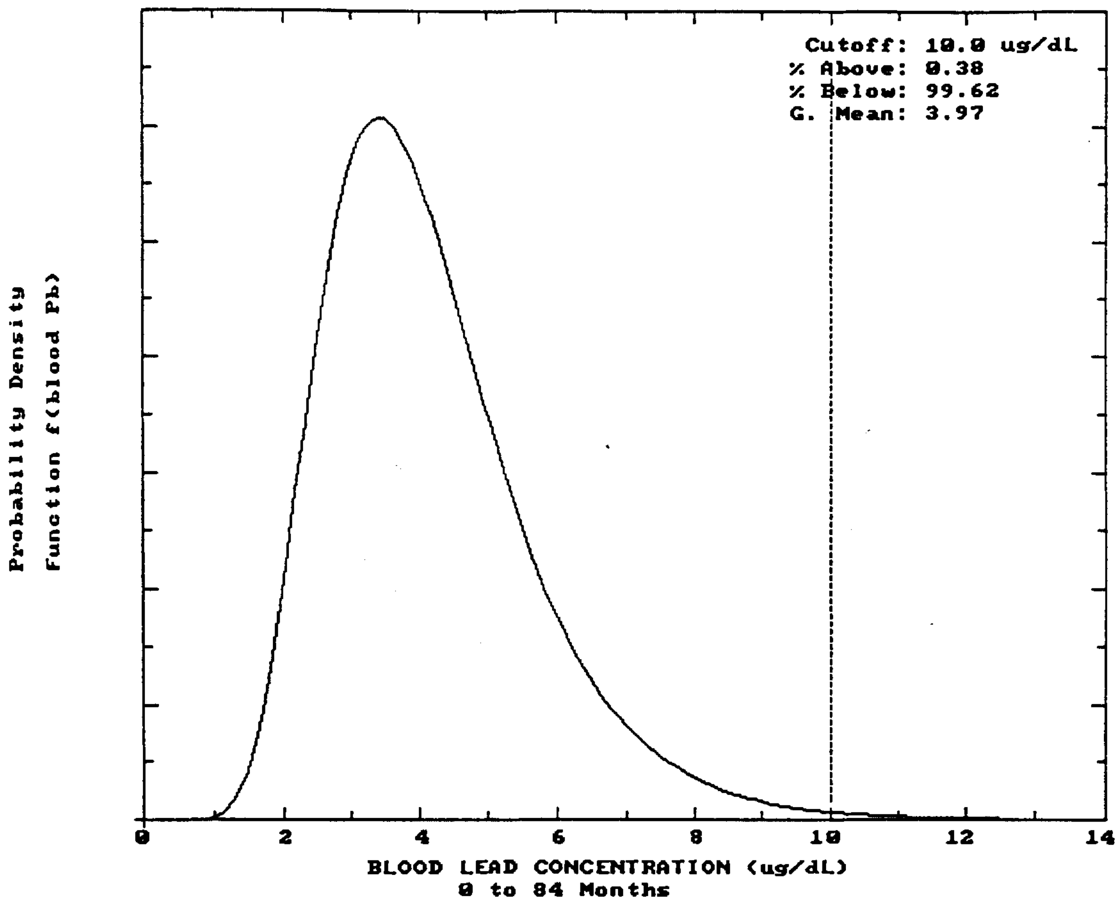

FIGURE D-1

Bell-Shaped Probability Density Function
at a Soil Concentration of 200 mg/kg Pb

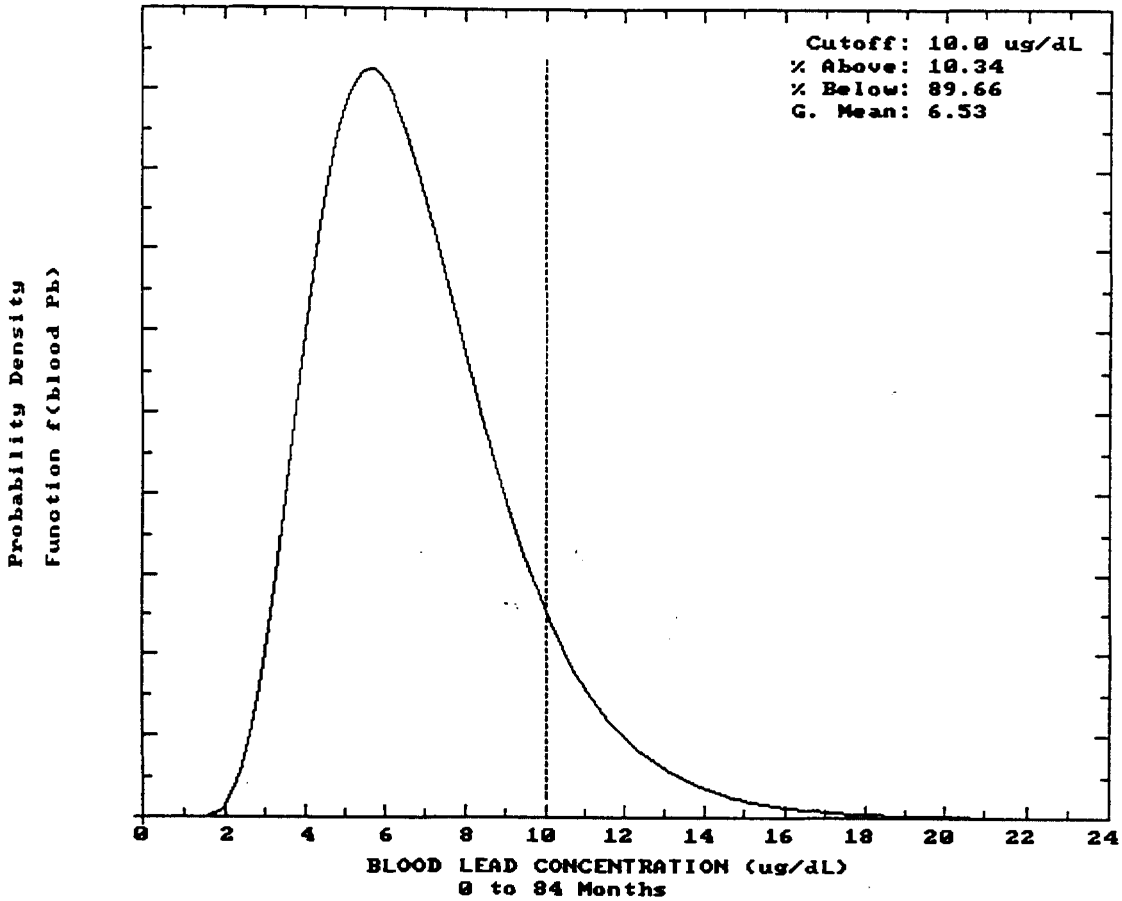

FIGURE D-2

Bell-Shaped Probability Density Function at a Soil Concentration of 500 mg/kg Pb Using a Cutoff of 10 ug/dL Blood Lead

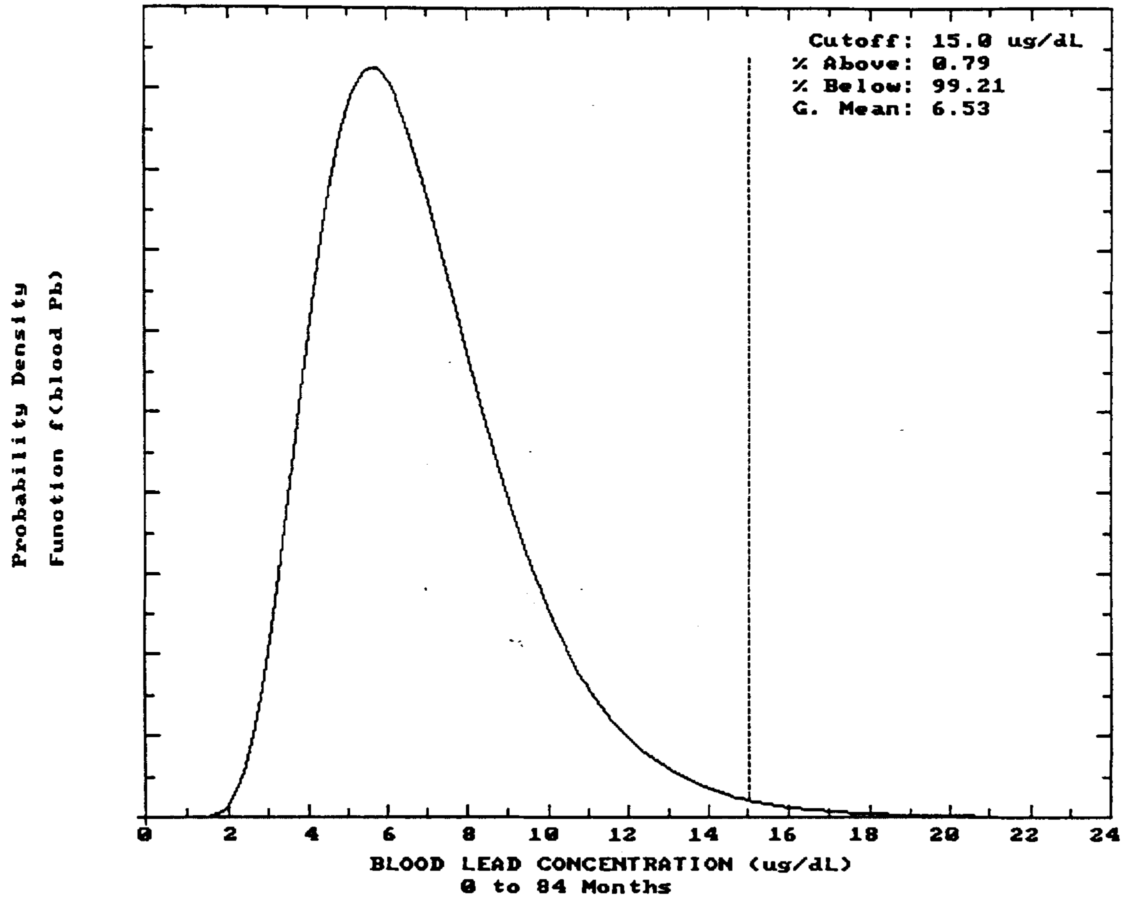

FIGURE D-3

Bell-Shaped Probability Density Function
at a Soil Concentration of 500 mg/kg Pb
Using a Cutoff of 15 ug/dL Blood Lead

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APPENDIX E

APPENDIX E.1

Boring Logs, Well Construction Diagrams and Survey Data

BORING 10MW1

Surface Elevation: **1701.3** Feet, MSL
Location: Radford AAP, Virginia
Start: 07:32 on 8-16-91
Finish: 12:00 on 8-16-91

Depth (Feet)	Sampling Method	Sample No.	Blows/Foot	Core Run No.	% Recovery	RQD %
0	SPT	1	28			
5	SPT	2	10			
10	SPT	3	9			
15	SPT	4	6			
20	NX			1	70	0

Symbols	Description
ML	DARK BROWN (7.5YR 3/2) FILL (SANDY SILT WITH COAL CHIPS)
ML	DARK BROWN (7.5YR 3/4) CLAYEY SILT WITH FINE SAND. MICACEOUS, MOIST GRADES MORE CLAY AND LESS SAND WITH MOTTLING
SM	DARK GRAY (10YR 4/1) FINE SAND, MICACEOUS, TRACE SILT
LS	LIGHT GRAY LIMESTONE, WEATHERED AND FRACTURED, WITH OXIDIZED SEAMS, WITH CALCITE CRYSTALS AND VEINS, ABUNDANT CLAY PARTINGS, ZONES WITH PITS AND VUGS NO OXIDIZED SEAMS BELOW 20.6 FEET GRADES GRAYISH BROWN TRACE PYRITE BELOW 23.0 FEET AIR ROTARY DRILL WITHOUT CORING BELOW 25.0 FEET

BOREHOLE TERMINATED AT A DEPTH OF 31.0 FEET

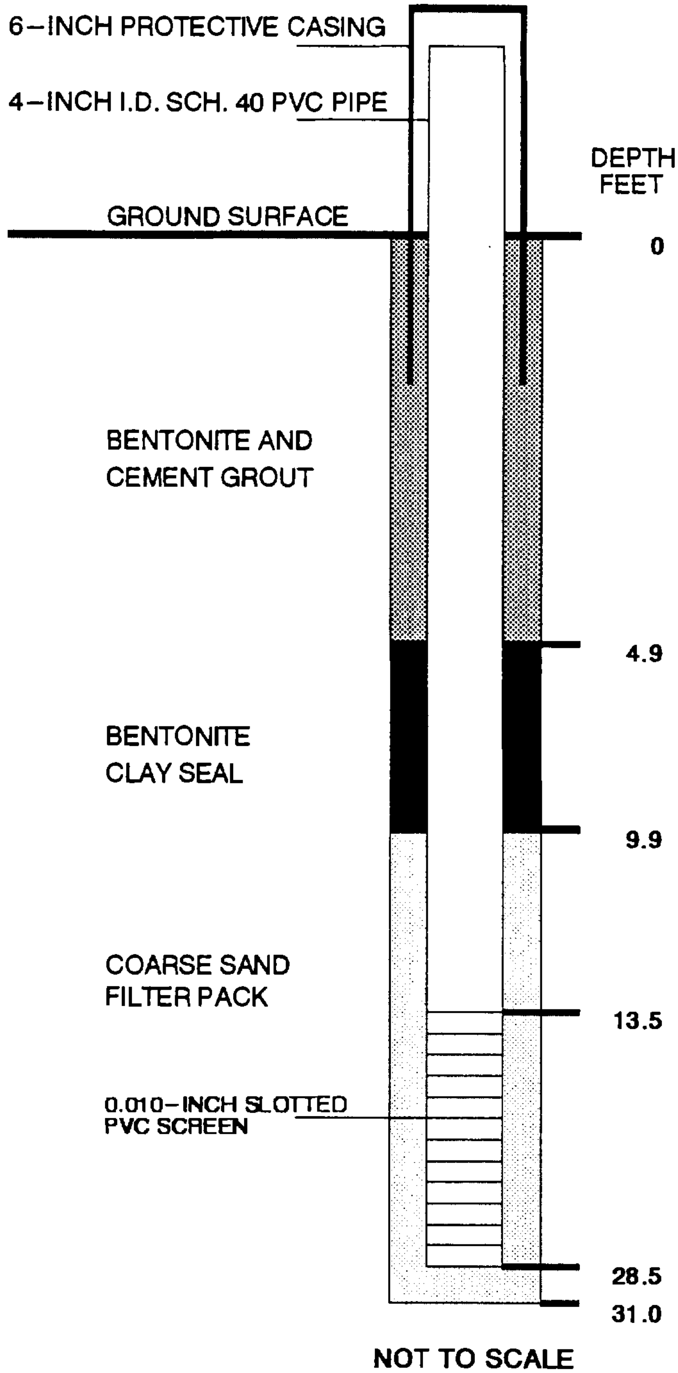
Depth scale: 0–12 Meters; 0–40 Feet.

LOG OF BORING

Dames & Moore

WELL INSTALLATION DIAGRAM
FOR VERIFICATION INVESTIGATION
RADFORD AAP, VIRGINIA

Location: 10MW1
Installation Date: 8/16/91
Surface Elevation: 1701.3 Feet
Top of PVC Elevation: 1703.62 Feet



Water at 15.34 feet on 1/14/92

Top of bedrock at 22.9 feet

BORING 32MW1

Surface Elevation: 1736.4 Feet
Location: Radford AAP, Virginia
Start: 2:11 on 10-30-91
Finish: 1:20 on 11-1-91

Depth (Feet)	Sampling Method	Sample No.	Blows/Foot	Core Run No.	% Recovery	RQD %	Symbols	Description
0	SPT	1	24		65		SM	YELLOWISH RED (5YR 5/8) SILTY FINE SAND, MICACEOUS, TRACE BLACK COALY STAINING
5	SPT	2	15		50			
							GM	YELLOWISH RED (5YR 5/8) SANDY GRAVEL, SLIGHTLY MOIST
								GRADES TO DARK YELLOWISH BROWN (10YR 4/4), WITH SOME SILT
10	SPT	3	52		65			
								COBBLE SEAM 13.5 TO 16.0 FEET
15								
							SM	STRONG BROWN SILTY SAND (7.5YR 5/6), VERY MOIST
								LIGHT OLIVE (2.5Y 5/4) CLAYEY SILTY SAND SEAM OVERLYING BEDROCK
20							LS/Shale	HIGHLY WEATHERED BRECCIATED LIMESTONE, SOFT, WITH PIECES OF RED AND GREEN SHALE AND OCCASIONAL SILTSTONE AND SHALE SEAMS
	NX			1	60	0		
25								BECOMES 5Y 5/1 GRAY LIMESTONE BRECCIA WITH DUSKY RED (2.5YR 3/2) SHALE SEAMS, HIGHLY PITTED, SOFT
								BECOMES BRECCIATED, WITH ABUNDANT CALCITE INFILLING OF CRACKS AND PITS
	NX			2	30	30		
30								
35	AH	4						GREENISH GRAY, 5G 6/1 LIMESTONE, WITH OCCASIONAL SILTSTONE AND SHALE SEAMS
40	AH	5						BECOMING HARDER MORE COMPETENT LIMESTONE

PLATE
LOG OF BORING

Dames & Moore

FILE

BORING 32MW1 (Cont'd)

Depth (Feet)	Sampling Method	Sample No.	Blows/Foot	Core Run No.	% Recovery	RQD %	Sample Interval	Symbols	Description
40	AH	6					■	LS Shale	DRY LIMESTONE 5G61 GRAY, OCCASIONAL SOFT ZONES SILTSTONE AND SHALE
									GRADING SOFTER VERY SLIGHTLY MOIST, INCREASED SHALE
45	AH	7					■		
50	AH	8					■		
									CONTINUED SOFT LIMESTONE, BECOMING DARK GRAY 10YR 4/1
55									
									GREENISH GRAY (5G 6/1) SILTY LIMESTONE, CONTINUED BEDS OF LIMESTONE, SHALE, AND SILTSTONE
	AH	9					■		
60	AH	10					■		VERY DARK GRAY (10YR 5/1) LIMESTONE AND LIGHT GRAY (5G 6/1) SILTSTONE, ABUNDANT CALCITE PIECES
									DARK GRAY (2.5Y N/4) LIMESTONE BECOMING HARDER, SOME CLAY PARTINGS
65	AH	11					■		
70	AH	12					■		CUTTINGS ARE VERY SOFT DARK GRAY (2.5Y N/3) INTERBEDDED LIMESTONE AND SHALE
									BECOMING VERY MOIST, SILTY AND SANDY INTERBEDDED LIMESTONE AND SHALE
75	AH	13					■		
	AH	14					■		WET AND MUDDY
80									

PLATE
LOG OF BORING

Dames & Moore

BORING 32MW1 (Cont'd)

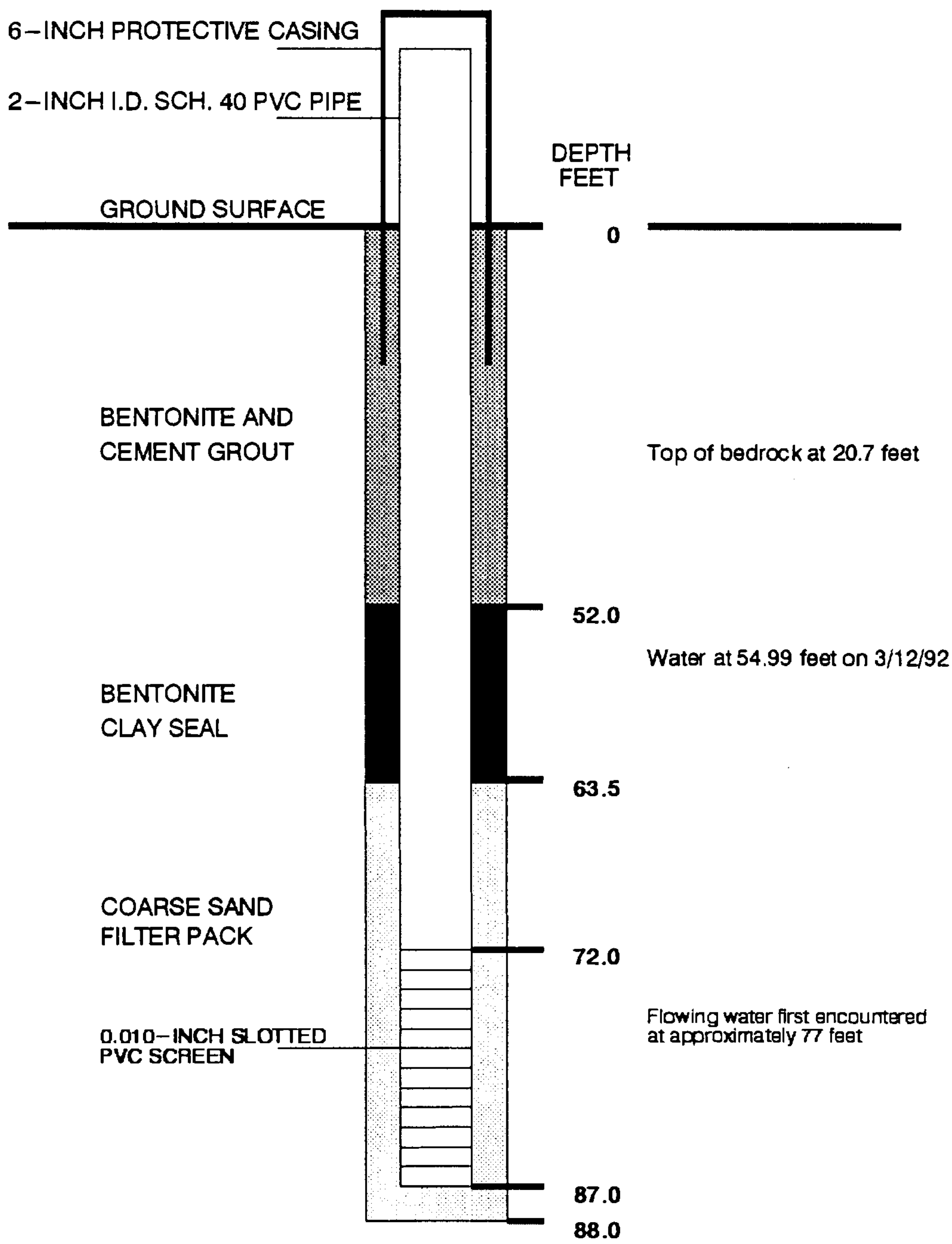
Depth (Feet)	Sampling Method	Sample No.	Blows/Foot	Core Run No.	% Recovery	RQD %	Sample Interval	Symbols	Description
80	AH	12						LS / Shale	CONTINUED WET
85									
90									TERMINATE BOREHOLE AT A DEPTH OF 88.0 FEET

PLATE
LOG OF BORING

Dames & Moore

WELL INSTALLATION DIAGRAM
FOR VERIFICATION INVESTIGATION
RADFORD AAP, VIRGINIA

Location: 32MW1
Installation Date: 9/27/91
Surface Elevation:1736.4 Feet
Top of PVC Elevation: 1738.31 Feet



NOT TO SCALE

BORING 40MW2

Surface Elevation: 1881.1 Feet
Location: Radford AAP, Virginia
Start: 13:42 on 10-29-91
Finish: 11:00 on 10-30-91

Depth (Feet)	Sampling Method	Sample No.	Blows/Foot	Core Run No.	% Recovery	RQD %	Symbols	Description
0	SPT	1	42		90		ML	REDDISH YELLOW (7.5YR 5/8) SILTY CLAY, TRACE SAND, STIFF, DRY
								GRADED CONTACT
							ML	YELLOWISH RED (5YR 5/8) CLAYEY SILT SLIGHTLY PLASTIC, SLIGHTLY MOIST
5	SPT	2	11		100			WITH OCCASIONAL VERY FINE SANDY LENSES
10	SPT	3	9		100			VERY MOIST, BECOMING SANDY
15	SPT	4	13		90			THIN SILT SEAM, LIGHT YELLOWISH BROWN (2.5Y 6/4), STIFF, DRY, BRITTLE, FROM 16.5-17.0 FEET, OVERLYING BEDROCK
	AH	5					LS/DS Shale	LIGHT BROWNISH GRAY (10YR 6/2) HIGHLY WEATHERED DOLOSTONE (SILTSTONE) DID NOT ATTEMPT NX ROCK CORING AT THIS LOCATION DUE TO THE POOR ROCK QUALITY AND EXCESSIVE WATER LOSSES AT BORINGS 40MW1A, 40MW3A, AND 40MW4. THIS BORING WAS LOGGED BY VISUAL OBSERVATION OF CUTTINGS SAMPLES COLLECTED WITH THE AIR HAMMER SOFT, FAST DRILLING
20								
	AH	6						GRAY (10YR 6/1) DOLOSTONE, HIGHLY WEATHERED, SOFT, WITH INTERBEDDED SEAMS OF WEATHERED SILTSTONE (PALE BROWN) AND LIMESTONE
25								WITH SOME DARKER GRAY AND BLUISH GRAY DOLOMITE SEAMS
	AH	7						
30								
35								
	AH	8						BECOMING HARDER DOLOSTONE, WITH MORE OF THE BLUISH GRAY DOLOSTONE, AND SOME SOFT LIMESTONE SEAMS
40								

PLATE
LOG OF BORING

Dames & Moore

BORING 40MW2 (Cont'd)

Depth (Feet)	Sampling Method	Sample No.	Blows/Foot	Core Run No.	% Recovery	RQD %	Sample Interval	Symbols	Description
40									
	AH	9					■		SAME WITH SOME OLIVE AND LIGHT BROWN DOLOSTONE SEAMS
45									
	AH	10					■	LS/DS Shale	HIGHLY WEATHERED SEAM AT 49.0 FEET
50	AH	11					■		
									VERY SOFT, VERY WEATHERED TO SILT AND CLAY SILT AND CLAY PREVENTED CUTTINGS RETURN
55									
60	AH	12					■		
									BOREHOLE TERMINATED AT A DEPTH OF 60.0 FEET

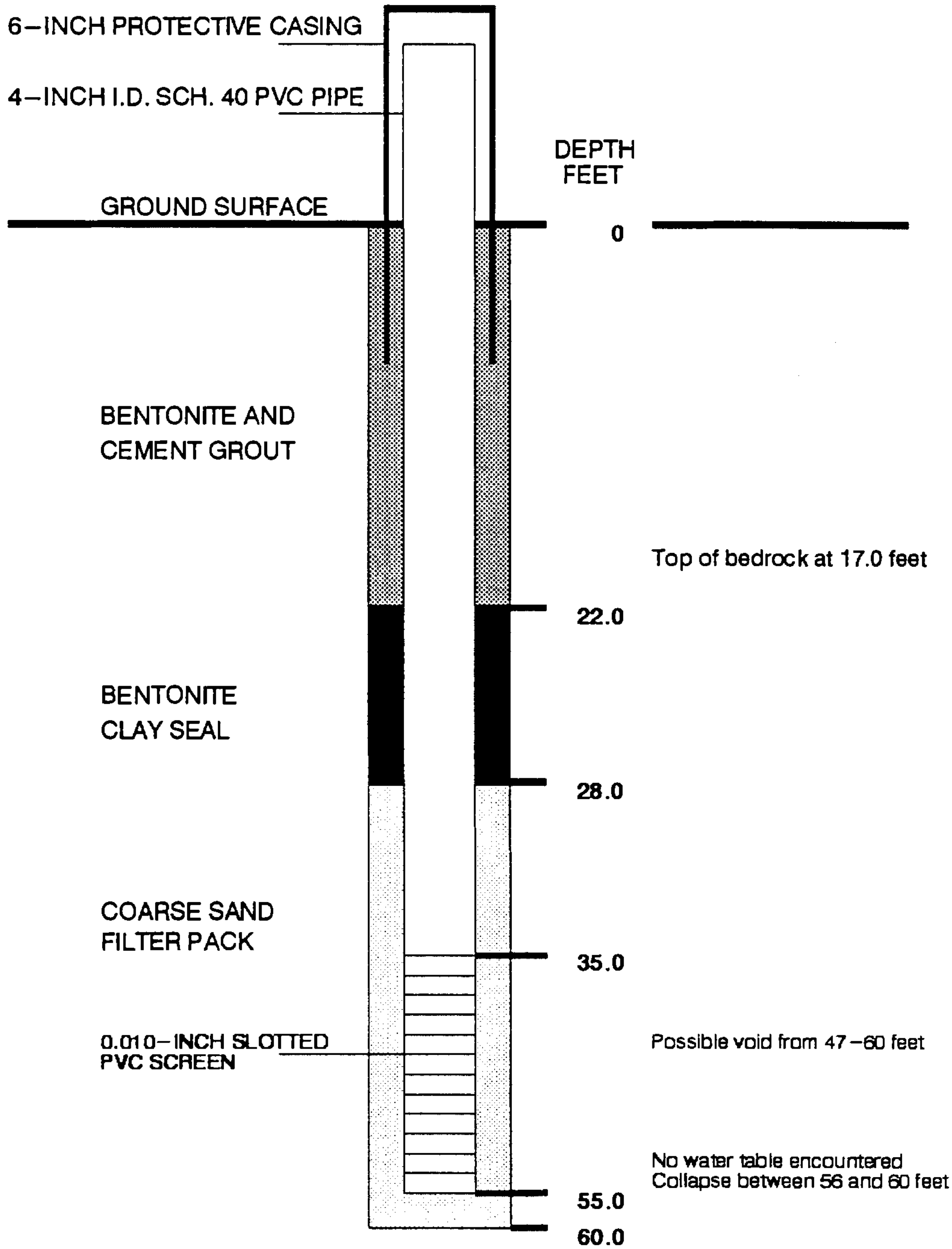
PLATE
LOG OF BORING

Dames & Moore

FILE

WELL INSTALLATION DIAGRAM
FOR VERIFICATION INVESTIGATION
RADFORD AAP, VIRGINIA

Location: 40MW2
Installation Date: 10/30/91
Surface Elevation: 1881.1 Feet
Top of PVC Elevation: 1882.51 Feet



NOT TO SCALE

Dames & Moore

BORING 40MW4

Surface Elevation: 1906.1 Feet, MSL
Location: Radford AAP, Virginia
Start: 08:45 on 10-28-91
Finish: 08:59 on 10-29-91

Depth (Feet)	Sampling Method	Sample No.	Blows/Foot	Core Run No.	% Recovery	RQD %	Symbols	Description
0	SPT	1	16		40		ML	YELLOWISH BROWN (10YR 5/4) FINE SANDY SILT, OVERLAIN BY YELLOWISH BROWN CLAY WITH GRAY MOTTLING
								SLIGHTLY MOIST, WITH SOME FINE TO MEDIUM SAND, COHESIVE, SOFT
5	SPT	2	5		100			
								GRADING MORE MOIST
10	SPT	3	8		100			STRONG BROWN (10YR 5/6)
15							LS / DS / Shale	WHITE (10YR 8/1) CLAY SEAM, VERY MOIST, OVERLYING ROCK AT 14.0 FEET ROCK IS HIGHLY WEATHERED ATTEMPT AT NX CORING AT THIS DEPTH WOULD PROBABLY RESULT IN EXCESSIVE WATER LOSS. BOREHOLE WAS THEREFORE REAMED WITH AN 8-INCH AIR HAMMER TO A DEPTH OF 35.0 FEET WHERE ROCK CORING WAS ATTEMPTED
20								INTERBEDDED GRAY DOLOSTONE AND LIGHT BROWN (7.5YR 6/3) SILTSTONE AND LIMESTONE SEAMS
25	AH	1						CUTTINGS REPRESENT HIGHLY WEATHERED INTERBEDDED DOLOSTONE AND SILTSTONE LAYERS, ABUNDANT SILT
30	AH	2						
	AH	3						GRAY (N/6) DOLOSTONE, GETTING HARDER
35							LS / DS	BEGIN CORING AT 35.0 FEET DOLOSTONE, PALE OLIVE (5Y 6/3) WITH THIN LIMESTONE SEAMS, WHICH ARE SLIGHTLY PITTED. BEDDING DIPS SLIGHTLY. SOME BLACK MINERAL STAINING AT FRACTURES, BLUISH GRAY FROM 36.1-36.7 FEET
	NX			1	100	50		37.5-39.0 FEET ARE LIGHT RED (10YR 6/6) SEAMS OF DOLOSTONE 39.0 FEET GRAY N/6 DOLOSTONE
40								

PLATE
LOG OF BORING

Dames & Moore

BORING 40MW4 (Cont'd)

Depth (Feet)	Sampling Method	Sample No.	Blows/Foot	Core Run No.	% Recovery	RQD %	Symbols	Description
40	NX			2	100	100	LS/DS	40.0–LARGE SOLUTION CAVITY 41.0–SOLUTION CAVITY STOP CORING DUE TO EXCESSIVE WATER LOSS
45								CUTTINGS NOT RETURNING TO SURFACE
50								
	AH	7						BLUISH GRAY (N/5) DOLOSTONE CHIPS AND BROWN (7.5YR 5/2) LIMESTONE
55	AH	8						
60	AH	9						BECOMING SOFTER INTERBEDDED DOLOSTONE AND LIMESTONE
	AH	10						WITH BROWN (7.5YR 5/3) SANDSTONE AND SILTSTONE
65	AH	11						
							Silt & Clay Filled Cavity	66.0–74.0 FEET WEATHERED TO SILT–STRONG BROWN (7.5YR 5/6) WITH SOME SANDSTONE AND SILTSTONE
70								NO CUTTINGS RETURN PROBABLY SILT AND CLAY FILLED CAVITY
							LS/DS/Shale	MORE ROCK, LESS SILT, NOT COMPETENT ROCK
75								LOST AIR CIRCULATION BELOW 64.0 FEET
80								

PLATE
LOG OF BORING

Dames & Moore

BORING 40MW4 (Cont'd)

Depth (Feet)	Sampling Method	Sample No.	Blows/Foot	Core Run No.	% Recovery	RQD %	Sample Interval	Symbols	Description
80	AH	12						LS / DS / SLTST	BECOMING HARDER AT 80.5 FEET, CUTTINGS ARE LIGHT OLIVE BROWN (2.5Y 5/4) WITH DOLOSTONECHIPS
	AH	13							
85									
									AT 88.0 FEET BECOMING SOFTER
90									

BOREHOLE TERMINATED AT A DEPTH OF 90.0 FEET. CAVE-IN TO 69.0 FEET

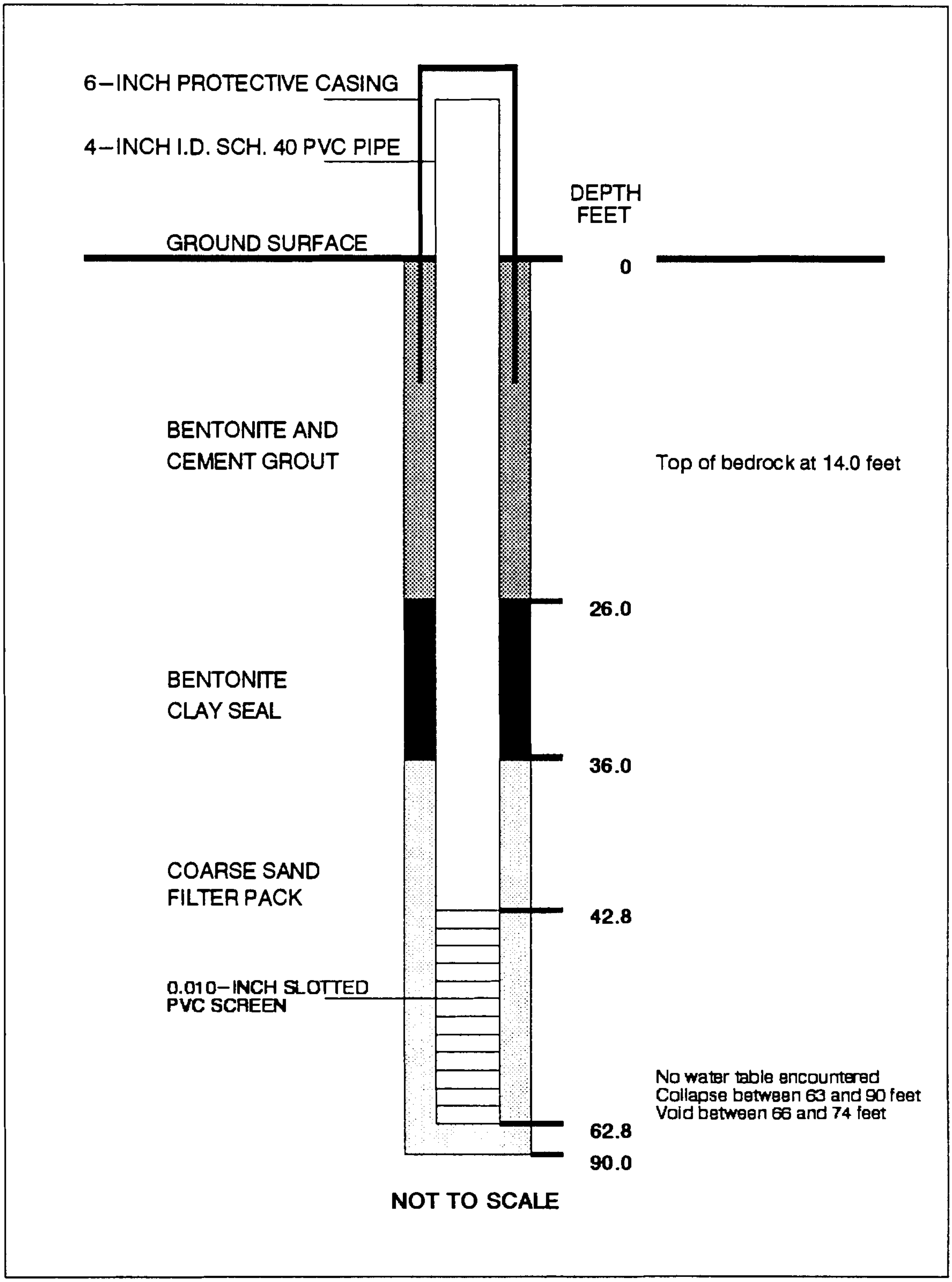
PLATE
LOG OF BORING

Dames & Moore

FILE

WELL INSTALLATION DIAGRAM
FOR VERIFICATION INVESTIGATION
RADFORD AAP, VIRGINIA

Location: 40MW4
Installation Date: 10/29/91
Surface Elevation: 1906.1 Feet
Top of PVC Elevation: 1908.11 Feet



BORING 41MW1

Surface Elevation: **1,802.9** Feet, MSL
Location: Radford AAP, Virginia
Start: 08:15 on 10-8-91
Finish: 10:45 on 10-10-91

Depth (Feet)	Sampling Method	Sample No.	Blows/Foot	Core Run No.	% Recovery	RQD %
0	SPT	1	19		10	
5	SPT	2	10		5	
10	SPT	3	63		79	
20	NX			1	100	85
25	NX			2	98	100
30	NX			3	100	27
35	NX			4	100	50
40	NX			5	82	96

Sample Interval

Symbols	Description
CL	REDDISH BROWN (5YR 4/4) SILTY CLAY, STIFF, LITTLE YELLOW AND OLIVE MOTTLING, DRY GRADING DARK BROWN (7.5YR 3/3) BECOMING SLIGHTLY PLASTIC, TRACE MEDIUM SAND, SLIGHTLY MOIST SLIGHTLY GRAVELLY GRADING SOFTER GRAVEL SEAM 11.0-12.0 FEET BLACK SILT, SOFT, AND LIGHT BROWN SILT WITH REDDISH YELLOW MOTTLING OVERLAYING BEDROCK AT 13.0 FEET
LS/DLST	LIMESTONE/DOLOSTONE, LIGHT GRAY TO BLUISH BLACK, HARD, WELL CEMENTED, MODERATELY TO HIGHLY FRACTURED, WITH CALCITE INFILLING RUST COLORED STAINING FOUND AT MOST FRACTURES GRADES TO LIGHT GRAY (N/7), HARD ZONE OF MORE FRACTURES, THICKER CALCITE VEINS, SOME SAND AND CLAY FILLED PARTINGS BECOMES DARK GRAY TO BLUISH BLACK, WITH ABUNDANT CALCITE FILLED CRACKS. RUST COLORED STAINING, LESS FREQUENT TRACE PYRITE AT 24.0 FEET LESS FRACTURED, CALCITE VEINS BECOME PITTED AND VUGGY GRAYISH BROWN (2.5Y 5/2) HIGHLY WEATHERED AND FRACTURED ZONE FROM 32.0 TO 35.0 FEET SOME FRACTURES STAINED STRONG BROWN (7.5YR 5/6) GRAY (N/5) CONTINUED GRAY, HARD, WITH HEALED CRACKS AND FRACTURES

PLATE
LOG OF BORING

Dames & Moore

BORING 41MW1 (Cont'd)

Depth (Feet): 40 – 80

Sampling Method	Sample No.	Blows/Foot	Core Run No.	% Recovery	RQD %
NX			6	80	90
NX			7	90	93
NX			8	100	57
NX			9	100	98
NX			10	100	83
NX			11	100	88
NX			12	96	100
NX			13	100	90

Symbols: LS/DLST

Description

GRADES TO 10YR 4/3 DARK BROWN WITH VARYING SHADES OF GRAY, WITH ABUNDANT CALCITE CRYSTALS, SLIGHT PITTING

BECOMING LESS FRACTURED, WITH FRACTURES OCCURRING ALONG CALCITE VEINS, WHERE MINERAL STAINING IS EVIDENT (YELLOWISH BROWN AND BLACK)

SAME LIMESTONE/DOLOSTONE WITH FEW FRACTURES AND YELLOWISH RED STAINING AT FRACTURES

SOME LIGHT OLIVE SHADING

BECOMES PITTED, CALCITE MORE OBUNDANT, THIN SEAMS OF MORE WEATHERED LIMESTONE INTERBEDDED WITH THE HARDER DOLOSTONE/ LIMESTONE

PITTING ENDS 62.9 FEET WHERE BECOMES HARDER

BECOMING DARKER, FEW FRACTURES

GRADING DARKER TO DARK BLUISH GRAY (5B 4/1), WITH FEW FRACTURES AND CALCITE-HOLED CRACKS HEALED CRACKS SHOW SLIGHT SIGNS OF WEATHERING

PLATE
LOG OF BORING

Dames & Moore

BORING 41MW1 (Cont'd)

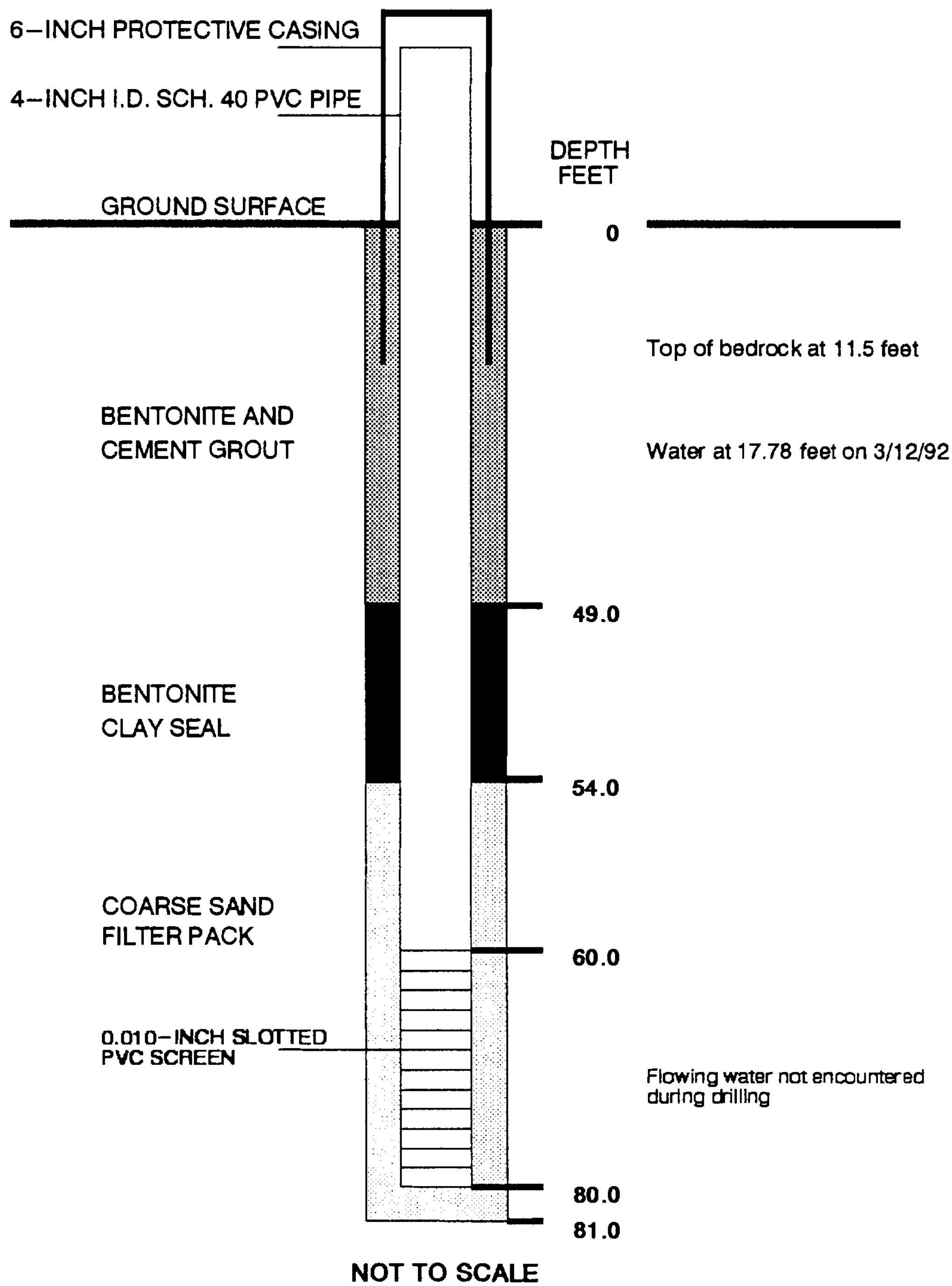
Depth (Feet)	Sampling Method	Sample No.	Blows/Foot	Core Run No.	% Recovery	RQD %	Sample Interval	Symbols	Description
80									WITH SLIGHT ORANGE-YELLOW STAINING
									BORING TERMINATED AT A DEPTH OF 81.5 FEET
85									

PLATE
LOG OF BORING

Dames & Moore

WELL INSTALLATION DIAGRAM
FOR VERIFICATION INVESTIGATION
RADFORD AAP, VIRGINIA

Location: 41MW1
Installation Date: 10/10/91
Surface Elevation: 1802.9 Feet
Top of PVC Elevation: 1805.15 Feet



Dames & Moore

BORING 41MW2

Surface Elevation: **1,795.4** Feet, MSL
Location: Radford AAP, Virginia
Start: 10:25 on 9-4-91
Finish: 15:30 on 9-6-91

Depth (Feet)	Sampling Method	Sample No.	Blows/Foot	Core Run No.	% Recovery	RQD %	Symbols	Description
0	SPT	1	13		60		CL	BROWN (7.5YR 5/4) SILTY SANDY CLAY WITH PEA GRAVEL, SLIGHTLY PLASTIC, SLIGHTLY MOIST, MEDIUM STIFF
5	SPT	2	17		30			PLASTICITY INCREASING, SAND CONTENT DECREASING
								OCCASIONAL GRAVEL ZONES CLAY BECOMING MOIST
10	SPT	3	11		45			
15	SPT	4	11		65			OCCASIONAL SILTY ZONES GRAVEL DECREASING
							CL	STRONG BROWN (7.5YR 4/6) HIGHLY PLASTIC CLAY, SMALL BLACK SPECKS, TRACE SAND, NO GRAVELS, VERY STIFF OCCASIONAL GRAVELS OR COBBLES
20	SPT	5	49		90			
25	SPT	6	42		0			
	SPT	7			35			
30							LS/DLST	YELLOWISH BROWN (5YR 4/4) SILTY CLAY, WITH SOME REDDISH BROWN MOTTLING, OVERLYING BEDROCK BLUE-GRAY LIMESTONE/DOLOSTONE, DRY, HARD
35								
40								

PLATE
LOG OF BORING

Dames & Moore

BORING 41MW2 (Cont'd)

Depth (Feet)	Sampling Method	Sample No.	Blows/Foot	Core Run No.	% Recovery	RQD %	Sample Interval	Symbols	Description
40								LS/DLST	
	AH	1					■		BLUE GRAY LIMESTONE/DOLOSTONE, HARD
45									
50									
55	AH	2					■		BLUE-GRAY LIMESTONE/DOLOSTONE, HARD
60									
	AH	3					■		BLUE-GRAY LIMESTONE/DOLOSTONE, HARD, DRY
65									
70									
	AH	4					■		BLUE-GRAY LIMESTONE/DOLOSTONE, HARD, DRY
75									
80									

PLATE
LOG OF BORING

BORING 41MW2 (Cont'd)

Depth (Feet)	Sampling Method	Sample No.	Blows/Foot	Core Run No.	% Recovery	RQD %	Sample Interval	Symbols	Description
80								LS/DLST	
85	AH	5							BLUE-GRAY LIMESTONE/DOLOSTONE, HARD, DRY
90									
95	AH	6							BECOMING SOFTER GRAY, CLAYEY LIMESTONE/DOLOSTONE
100	AH	7							GRAY, CLAYEY, SOFT LIMESTONE/DOLOSTONE
105									
110									
115	AH	8							ROCK GETTING SOFTER, CUTTINGS SLIGHTLY MOIST
120									

PLATE
LOG OF BORING

Dames & Moore

FILE

BORING 41MW2 (Cont'd)

Depth (Feet)	Sampling Method	Sample No.	Blows/Foot	Core Run No.	% Recovery	RQD %	Sample Interval	Symbols	Description
120	AH	9						LS/DLST	CUTTINGS MOIST, SOFT, LIGHT GRAY CLAYEY LIMESTONE/DOLOSTONE
125									

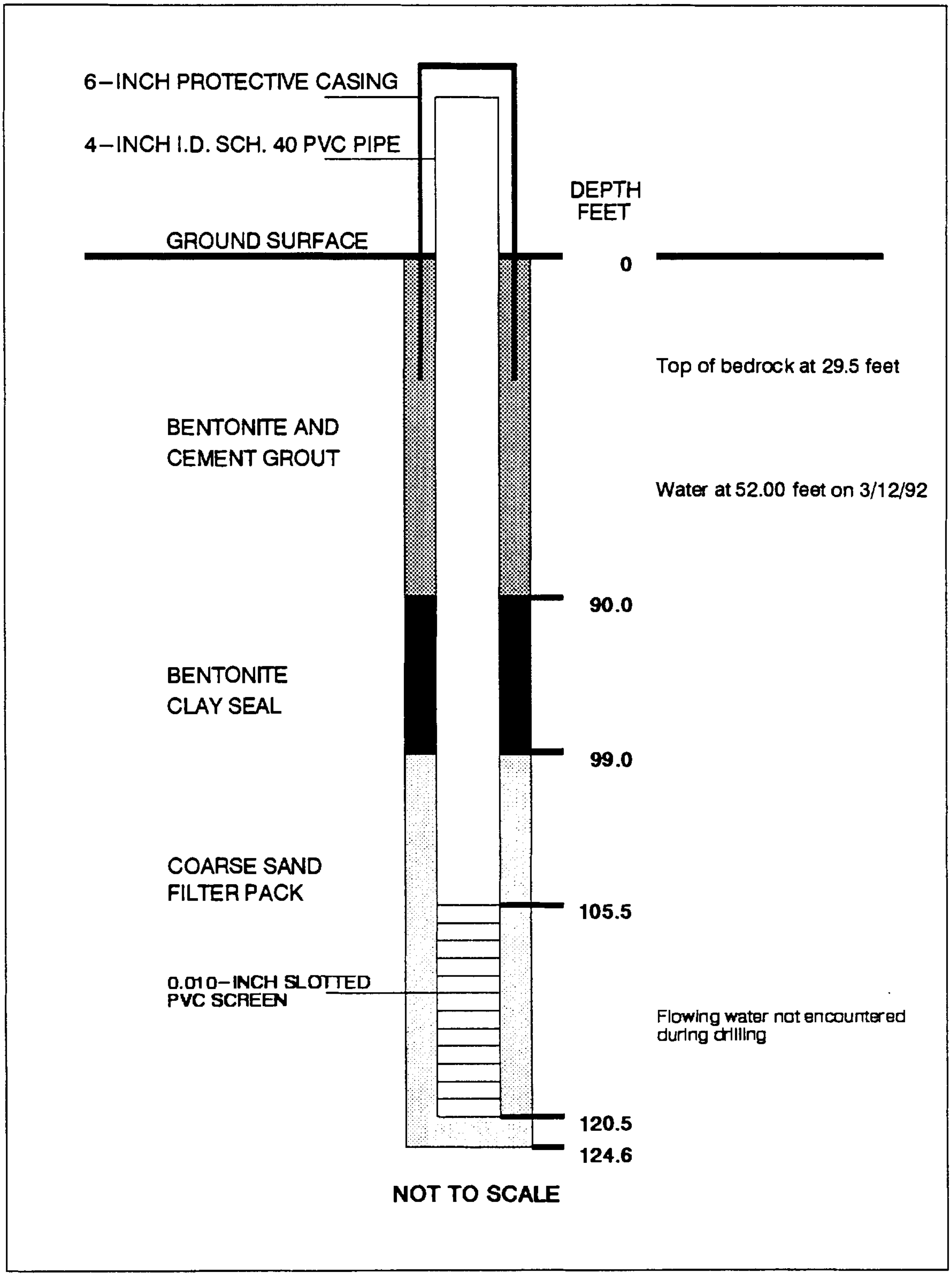
BORING TERMINATED AT A DEPTH OF 125.0 FEET

PLATE
LOG OF BORING

Dames & Moore

WELL INSTALLATION DIAGRAM
FOR VERIFICATION INVESTIGATION
RADFORD AAP, VIRGINIA

Location: 41MW2
Installation Date: 9/6/91
Surface Elevation: 1795.4 Feet
Top of PVC Elevation: 1797.45 Feet



BORING 41MW3

Surface Elevation: **1,757.3** Feet, MSL
Location: Radford AAP, Virginia
Start: 07:30 on 10-17-91
Finish: 14:00 on 10-17-91

Depth (Feet)	Sampling Method	Sample No.	Blows/Foot	Core Run No.	% Recovery	RQD %
0	SPT	1	35		65	
5	SPT	2	22		65	
10	SPT	3	18		95	
15	SPT	4	103		45	
20	SPT	5	82		80	
25	SPT	6	35		80	
30	SPT	7	50/0		100	
35	NX			1	95	66
40						

Symbols	Description
ML	STRONG BROWN (7.5YR 4/6) CLAYEY SILT WITH SOME GRAVELS, WITH REDDISH BROWN AND VERY PALE BROWN MOTTLING
CL	DARK YELLOWISH BROWN (10YR 4/4) SANDY CLAY, HIGHLY PLASTIC WITH OCCASIONAL GRAVELLY ZONES BECOMES STRONG BROWN (7.5YR 5/6) MORE GRAVELS VERY GRAVELLY 14–19 FEET, WITH CLAY
ML	PALE OLIVE (5YR 6/3) AND OLIVE YELLOW (2.5Y 6/6) SILT, HARD, DRY, FRIABLE, SLIGHTLY GRAVELLY, WITH SOME BLACK STAINING OCCASIONAL THIN SILTSTONE SEAMS (OLIVE GRAY) GRADES TO LIGHT YELLOWISH BROWN (2.5Y 6/4) WITH OLIVE AND GRAY MOTTLING
CL	STRONG BROWN (7.5YR 5/6) CLAY, SOFT, MOIST, STICKY, HIGHLY PLASTIC
SH	DARK GREENISH GRAY (5BG 4/1) SHALE, WITH ABUNDANT CALCITE VEINS, NO APPARENT BEDDING, YELLOW STAINING AT FRACTURES BECOMES HIGHLY WEATHERED YELLOWISH BROWN WITH INCREASED CLAY OCCASIONAL LAYERS OF SILTSTONE AND PITTED LIMESTONE

PLATE
LOG OF BORING

Dames & Moore

BORING 41MW3 (Cont'd)

Depth (Feet)	Sampling Method	Sample No.	Blows/Foot	Core Run No.	% Recovery	RQD %	Symbols	Description
40							SH	LESS WEATHERED DARK GREENISH GRAY SHALE WITH CALCITE VEINS
	NX			2	88	45		WITH HIGHLY WEATHERED AND CLAYEY ZONES
							DLST	BECOMES PITTED AND SLIGHTLY VUGGY CLAYEY DOLOSTONE, GRAY (N/5) WITH THIN LIMESTONE SEAMS, HIGHLY WEATHERED, SANDY
45								
	NX			3	100	78		BLUISH GRAY, HIGHLY CRACKED AND RECEMENTED WITH SOME REDDISH BROWN STAINING
50								CONTINUED HIGHLY WEATHERED
								WET
								BROWN (10YR 5/3) DOLOSTONE, WET, MUDDY
55								
								SOFT, MUDDY
60								
								BOREHOLE TERMINATED AT A DEPTH OF 62.0 FEET
65								

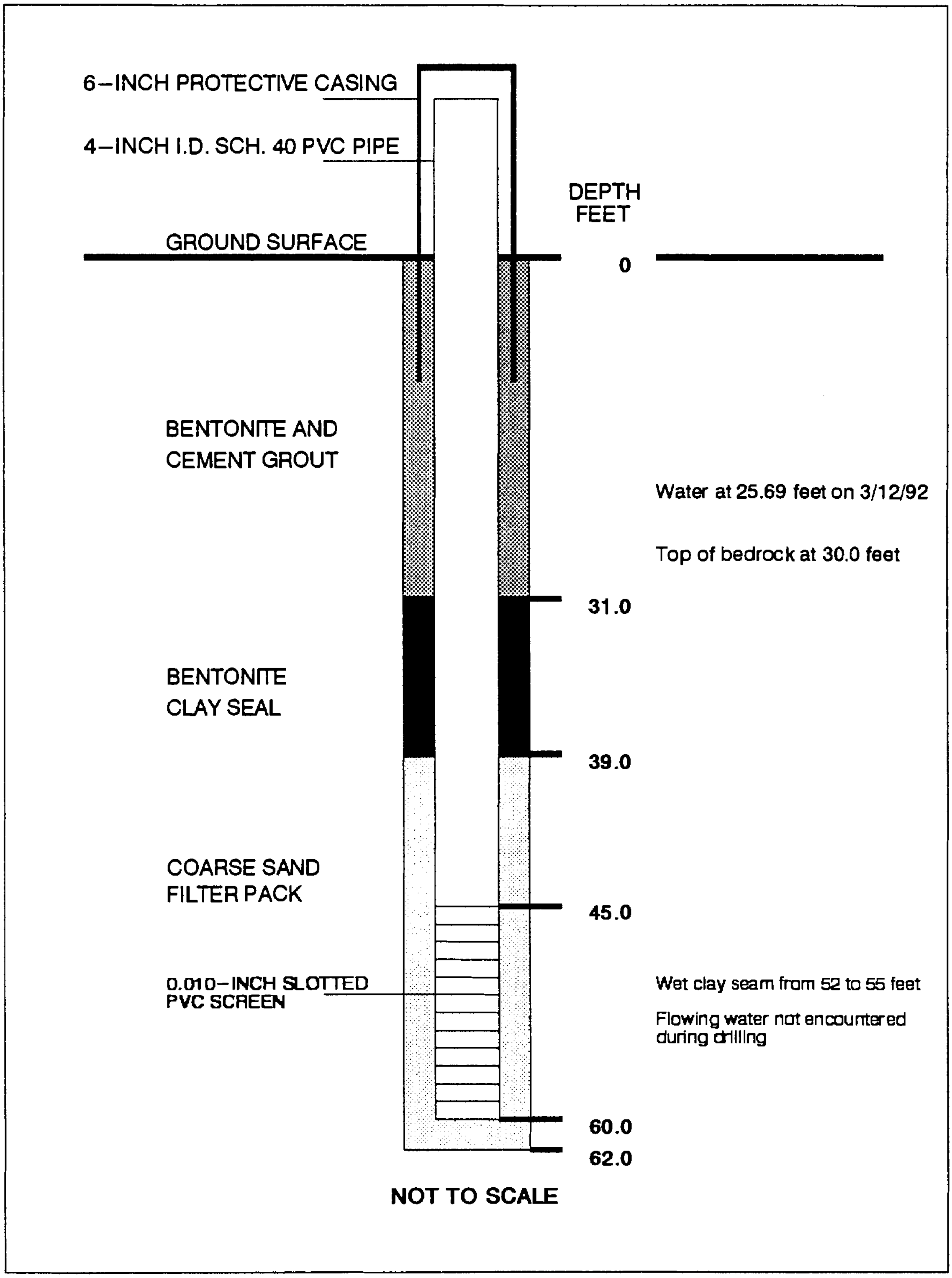
PLATE
LOG OF BORING

Dames & Moore

FILE

WELL INSTALLATION DIAGRAM
FOR VERIFICATION INVESTIGATION
RADFORD AAP, VIRGINIA

Location: 41MW3
Installation Date: 10/17/91
Surface Elevation: 1757.3 Feet
Top of PVC Elevation: 1759.35 Feet



BORING 43MW1

Surface Elevation: **1,703.9** Feet, MSL
Location: Radford AAP, Virginia
Start: 07:30 on 8-13-91
Finish: 08:50 on 8-13-91

Depth (Feet)	Sampling Method	Sample No.	Blows/Foot	Core Run No.	% Recovery	RQD %	Symbols	Description
0	SPT	1	11		83		ML	YELLOWISH BROWN (10YR 5/4) SANDY SILT, TRACE ORANGE MOTTLING, STIFF, DRY
								GRADING MOIST
5	SPT	2	28		100			
10	SPT	3	12		100			
							SM	YELLOWISH BROWN (10YR 5/6) SILTY SAND, VERY MOIST, LOOSE, MICACEOUS, TRACE GRAY MOTTLING
15	SPT	4	10		60			
								WATER AT 18.0 FEET
							CL	LIGHT GRAY (2.5Y N/7) CLAY WITH LIMESTONE GRAVEL WITH HIGHLY FRACTURED HIGHLY WEATHERED LIMESTONE PIECES
20	SPT	5	50/1		75			
							LS	N/7 LIGHT GRAY LIMESTONE, HARD, NOT HIGHLY WEATHERED
25								HIGHLY WEATHERED ZONE
								BOREHOLE TERMINATED AT A DEPTH OF 28.0 FEET
30								

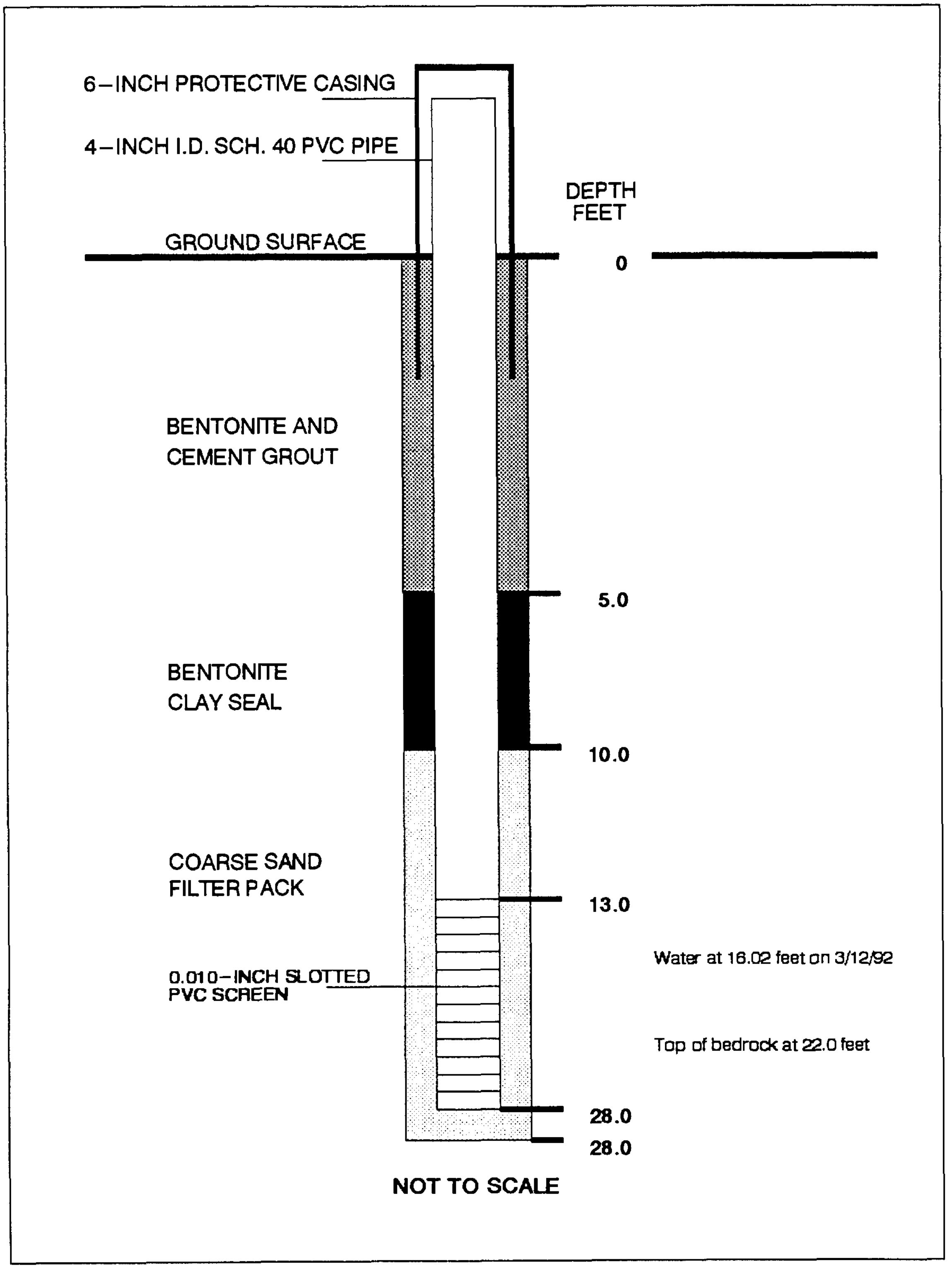
PLATE
LOG OF BORING

Dames & Moore

FILE

WELL INSTALLATION DIAGRAM
FOR VERIFICATION INVESTIGATION
RADFORD AAP, VIRGINIA

Location: 43MW1
Installation Date: 8/13/91
Surface Elevation: 1703.9 Feet
Top of PVC Elevation: 1705.87 Feet



BORING 43MW2

Surface Elevation: **1,705.0** Feet, MSL
Location: Radford AAP, Virginia
Start: 07:28 on 8-13-91
Finish: 14:40 on 8-13-91

Depth (Feet)	Sampling Method	Sample No.	Blows/Foot	Core Run No.	% Recovery	RQD %
0	SPT	1	14		80	
5	SPT	2	20		80	
10	SPT	3	16		80	
15	SPT	4	14		75	
20	SPT	5	4		5	
	SPT	6	0		0	
25	SPT	7	100/5		100	
30	SPT	8	100/0		0	
35						

Symbols	Description
ML	REDDISH BROWN (5YR 4/3) SILTM SLIGHTLY MOIST, TRACE FINE SAND
ML	DARK BROWN (7.5YR 4/4) SLIGHTLY CLAYEY SILT, MICACEOUS, COHESIVE WITH OCCASIONAL THIN GRAVELLY AREAS
SM	DARK BROWN (7.5YR 4/4) SILTY FINE SAND, TRACE CLAY, MICACEOUS, MOIST WITH GRAVELS MOISTURE INCREASING VERY GRAVELLY
GM	GRAYISH BROWN (10YR 5/2) SILTY CLAYEY GRAVELS, WITH LARGE COBBLES
LS	GRAY 2.5Y N/5 WEATHERED LIMESTONE INTERBEDDED WITH SILTSTONE OR SHALE

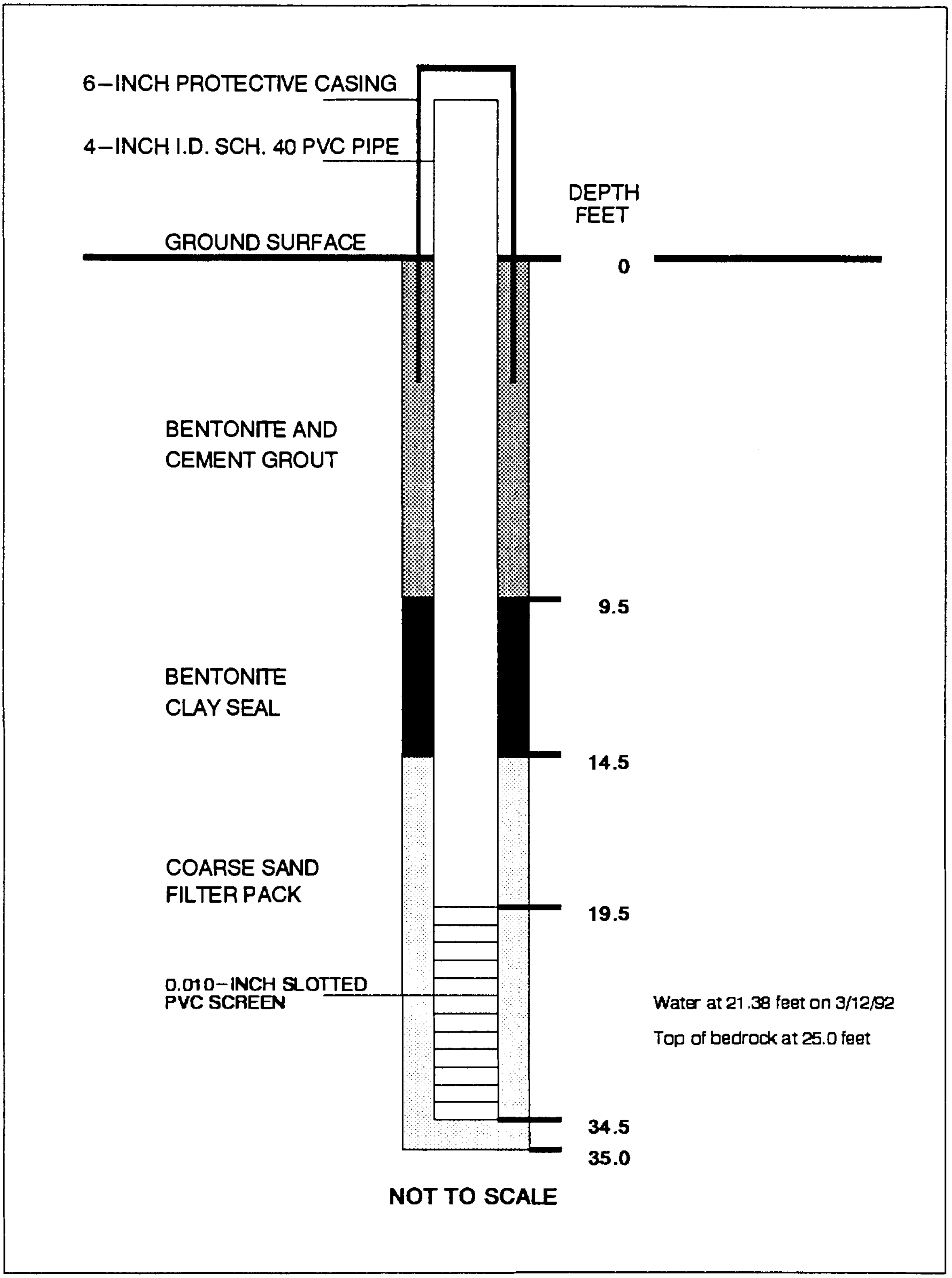
BOREHOLE TERMINATED AT A DEPTH OF 35.0 FEET

PLATE
LOG OF BORING

Dames & Moore

WELL INSTALLATION DIAGRAM
FOR VERIFICATION INVESTIGATION
RADFORD AAP, VIRGINIA

Location: 43MW2
Installation Date: 8/14/91
Surface Elevation: 1705.0 Feet
Top of PVC Elevation: 1707.62 Feet



Dames & Moore

BORING 43MW3

Surface Elevation: **1,701.2** Feet, MSL
Location: Radford AAP, Virginia
Start: 08:00 on 8-19-91
Finish: 11:30 on 8-19-91

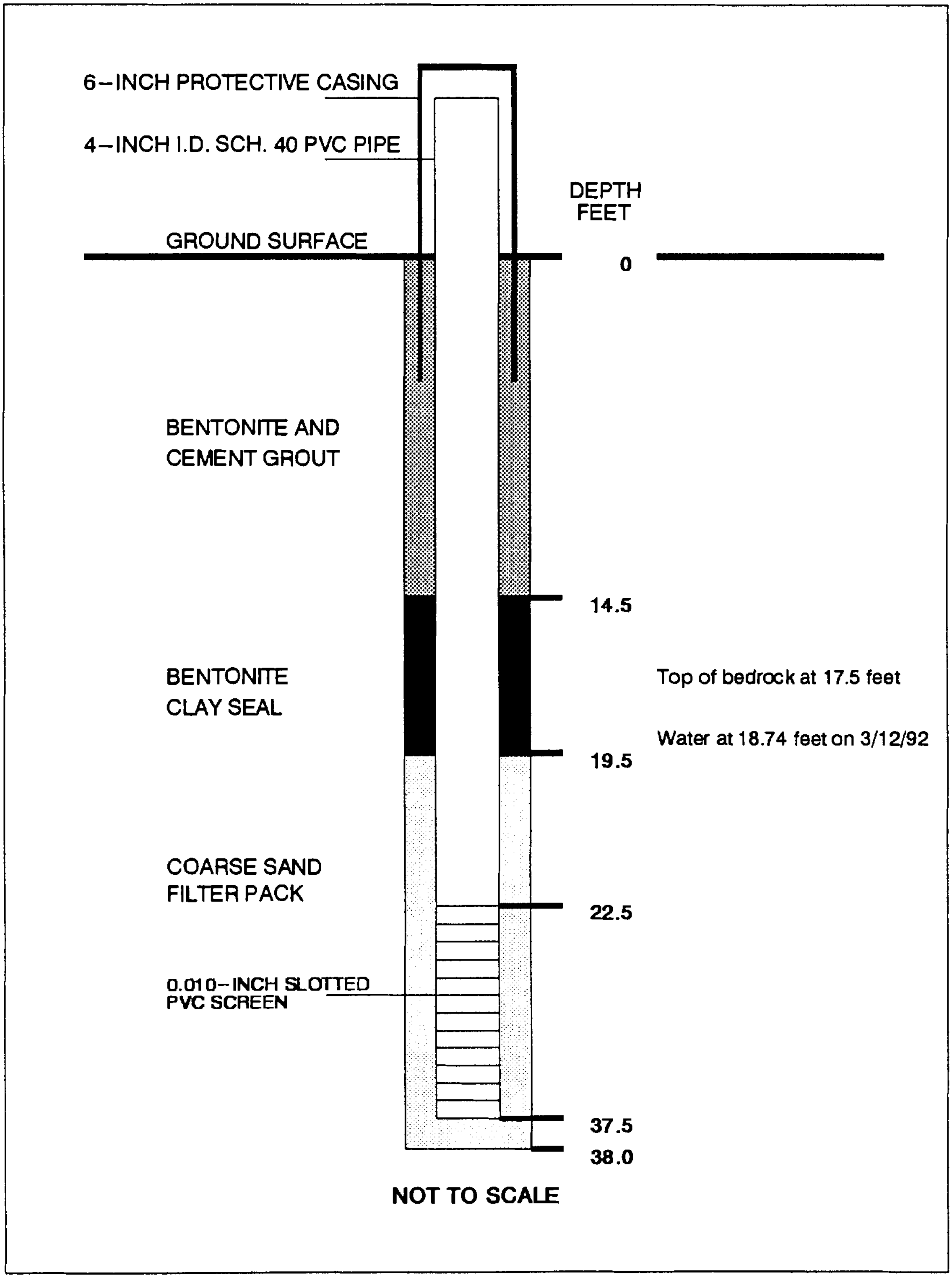
Depth (Feet)	Sampling Method	Sample No.	Blows/Foot	Core Run No.	% Recovery	RQD %	Symbols	Description
0	SPT	1	32		92		ML	DARK BROWN (10YR 3/3) SILTY FINE SAND, MICACEOUS, DRY, THIN BLACK ASH LAYER AT 0.5 FEET
5	SPT	2	16		79		ML	DARK YELLOWISH BROWN (10YR 4/4) FINE SANDY SILT, MICACEOUS, TRACE DUSKY RED MOTTLING, SLIGHTLY MOIST; CLAY SEAM
10	SPT	3	13		92		SP	OLIVE GRAY (5Y 4/2) FINE SAND, TRACE SILT, MICACEOUS, LOOSE, SLIGHTLY COHESIVE; WITH OCCASIONAL CLAYEY ZONES
15	SPT	4	18		96		SP	CLAY SEAM 15.5 TO 16.5 FEET; GRAY (5Y 5/1) SAND SEAM, 16.5-17.0 FEET
							LS	GRAY (2.5Y N/5) LIMESTONE, HIGHLY WEATHERED, WITH PALE YELLOW (2.5Y 8/2) SAND AND SILT
	SPT	5	100/5		0		LS	
20	NX			1	90	42	LS	GRAY (2.5Y N/5) WEATHERED LIMESTONE, HIGHLY FRACTURED, WITH ABUNDANT THIN DEFORMED LAYERS, DIPPING TO 45 DEGREES, SEAMS STAINED BROWNISH YELLOW
25	NX			2	70	36	LS	GRADING TO LIMESTONE BRECCIA
30	NX			3	74	48	LS	BROWNISH GRAY LIMESTONE, DEFORMED; BECOMES GRAY, SOFT, LIMESTONE BRECCIA
35	NX			4	50	8	LS	WITH GREEN TINT, HIGH SHALE AND CLAY CONENT, CONTINUED HIGHLY FRACTURED
40								BOREHOLE TERMINATED AT A DEPTH OF 40.0 FEET

PLATE
LOG OF BORING

Dames & Moore

WELL INSTALLATION DIAGRAM
FOR VERIFICATION INVESTIGATION
RADFORD AAP, VIRGINIA

Location: 43MW3
Installation Date: 8/19/91
Surface Elevation: 1701.2 Feet
Top of PVC Elevation: 1703.35 Feet



Dames & Moore

BORING 43MW4

Surface Elevation: 0
Location: Radford AAP, Virginia
Start: 07:46 ON 8-15-91
Finish: 11:07 ON 8-15-91

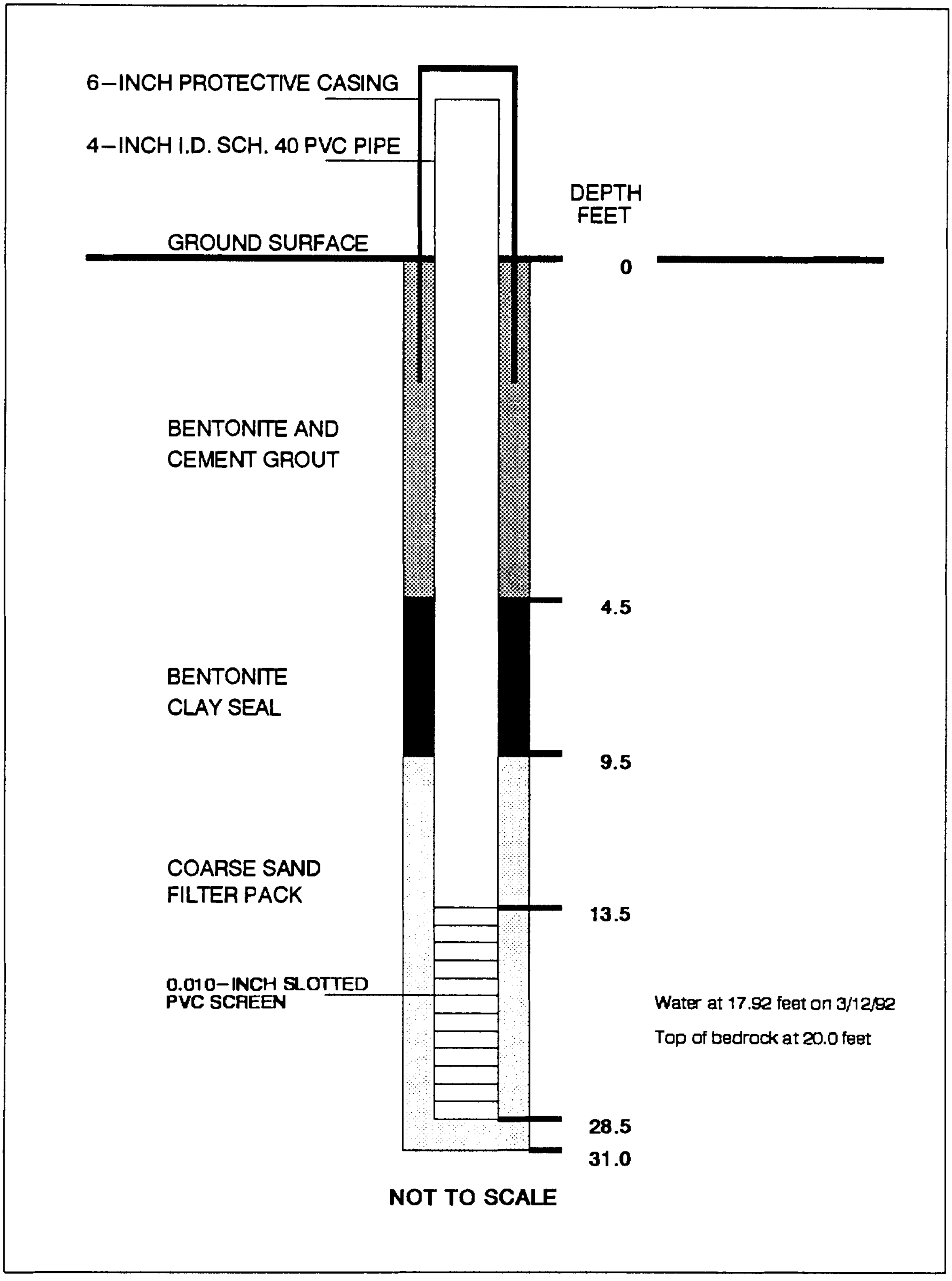
Depth (Feet)	Sampling Method	Sample No.	Blows/Foot	Core Run No.	% Recovery	RQD %	Symbols	Description
0							ML	DARK BROWN (7.5YR 4/3) CLAYEY SANDY SILT, MEDIUM STIFF, DRY
5	SPT	1	16		100		ML	GRADING STIFF, MICACEOUS
							SM	BROWN (7.5YR 5/4) SILTY FINE SAND, MICACEOUS, SLIGHTLY STIFF
10	SPT	2	15		90		SM	WITH OCCASIONAL CLAYEY ZONES
							SM	GRADING DARK GRAYISH BROWN (2.5YR 4/2), MEDIUM SAND
15	SPT	3	23		80		SM	
							SM	WATER AT 18.5 FEET THIN 2.5YR 4/5 OLIVE BROWN FINE SANDY SILTY SEAM ABOVE WEATHERED BEDROCK
20	SPT	4	41		20		LS	GRAY (2.5Y N/5) WEATHERED LIMESTONE, SLIGHTLY PITTED, REDDISH YELLOW CLAY INFILLING AT WEATHERED FRACTURES
							LS	HIGHLY PITTED AND VUGGY, GRADING TO OLIVE BROWN AND WEATHERED
25	NX			1	96		LS	BECOMES VERY DARK GRAY, LESS WEATHERED, WITH CALCITE VEINS
30								BOREHOLE TERMINATED AT A DEPTH OF 27.5 FEET

PLATE
LOG OF BORING

Dames & Moore

WELL INSTALLATION DIAGRAM
FOR VERIFICATION INVESTIGATION
RADFORD AAP, VIRGINIA

Location: 43MW4
Installation Date: 8/19/91
Surface Elevation: 1700.9 Feet
Top of PVC Elevation: 1702.78 Feet



Dames & Moore

BORING 43MW5

Surface Elevation: **1,700.4** Feet, MSL
Location: Radford AAP, Virginia
Start: 07:46 ON 8/15/91
Finish: 11:07 ON 8/15/91

Depth (Feet)	Sampling Method	Sample No.	Blows/Foot	Core Run No.	% Recovery	RQD %	Sample Interval
0–5	NO SAMPLES COLLECTED BECAUSE DRILLED THROUGH LANDFILL						
~19	SPT	1			0	0	
~23	NX			1	0	0	
~27	NX			2	40		
~32	NX			3	70		
~37	NX			4	76	0	

Symbols	Description
ML	BROWN(7.5YR 5/4)CLAY AND SILT, CLAY
ML	BOWNISH YELLOW(10YR 5/6) CLAY AND SILT, WITH LANDFILL MATERIAL INCLUDING PAPER, CARDBOARD, BANDAIDS METAL, RAGS
SM	DARK OLIVE GRAY(5YR 3/2) CLAYEY FINE SAND STILL IN LANDFILL THIN SEAM OF DARK GRAY (2.5YR 10/4) CLAYEY, GRAVELLY SILT OVERLYING WEATHERED BEDROCK
LS	DARK GRAY TO GRAY HIGHLY WEATHERED LIMESTONE CONGLOMERATE NO NX CORE RECOVERY DUE TO SOFT, HIGHLY WEATHERED ROCK. GRAY (2.5YR N/5)LIMESTONE CONGLOMERATE, MEDIUM GRAINED,5 OF 4, POORLY CEMENTED, MUCH CLAY DUE TO IN FILLING AND WEATHERING, BLACK CLAYEY MEDIUM GRAVEL LIMESTONE CONGLOMERATE, SLIGHTLY HARDER BUT HIGHLY WEATHERED AND FRACTURED , WITH BLACK CLAY IN FILLING OF CRACKS BECOMING HIGHLY CRACKED AND RE-CEMENTED WITH CALCITE; HIGHLY WEATHERED TO CLAYSTONE AT 34FEET. CONTINUED SOFT, HIGHLY WEATHERED LIMESTONE WITH HIGH CLAY CONTENT AND ABUNDANT CALCITE.

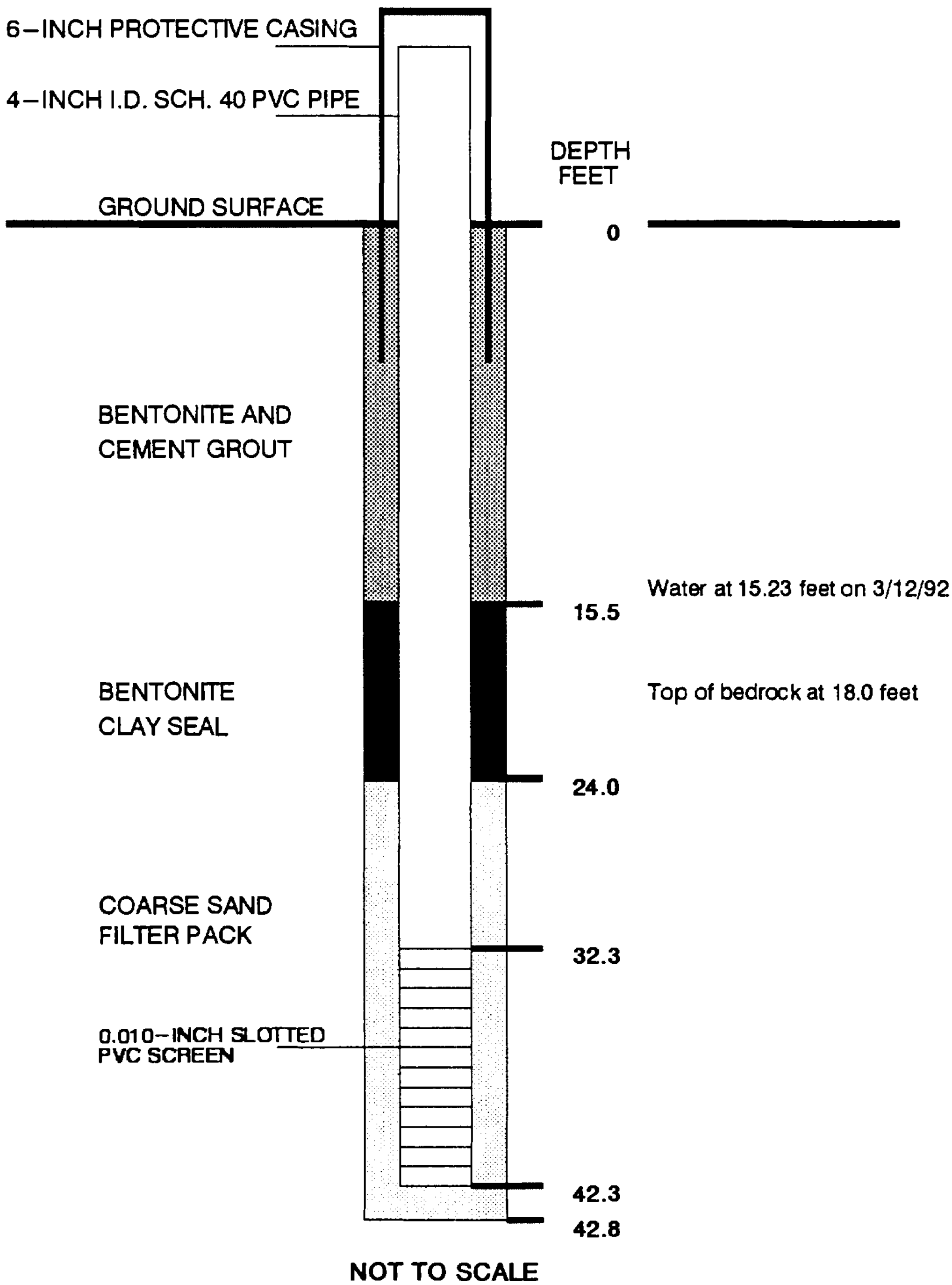
BORING TERMINATED AT A DEPTH OF 42.8 FEET

PLATE
LOG OF BORING

Dames & Moore

WELL INSTALLATION DIAGRAM
FOR VERIFICATION INVESTIGATION
RADFORD AAP, VIRGINIA

Location: 43MW5
Installation Date: 8/15/91
Surface Elevation: 1700.4 Feet
Top of PVC Elevation: 1702.94 Feet



Dames & Moore

BORING 43MW6

Surface Elevation: **1,701.2** Feet, MSL
Location: Radford AAP, Virginia
Start: 11:58 on 8-13-91
Finish: 14:00 on 8-14-91

Depth (Feet)	Sampling Method	Sample No.	Blows/Foot	Core Run No.	% Recovery	RQD %
0	SPT	1	10		83	
5	SPT	2	9		54	
10	SPT	3	35		19	
15	SPT	4	37		67	
20	SPT	5	50/1		100	
25	NX			1	80	0
30	NX			2	60	40
35	NX			3	10	0
40						

Symbols	Description
ML	BROWN (7.5YR 5/4) SANDY SILT, WITH BLACK MINERAL STAINS
ML	ENCOUNTERED LANDFILL MATERIAL AT 1.5 FEET, SOIL MATRIX IS BLACK (2.5YR 2.5/0) SILTY SAND (FILL MATERIAL), VERY MOIST, MODERATE ODOR, LANDFILL MATERIAL INCLUDES PLASTIC, RUBBER, PAPER AND TRASH
SM	DARK GRAY SILTY SAND, FINE TO MEDIUM, VERY MOIST, SOME SMALL PEBBLES WITH THIN BROWNISH YELLOW (10YR 6/6) CLAY SEAM ABOVE WEATHERED LIMESTONE
LS	BROWNISH YELLOW (10YR 6/6) LIMESTONE, WEATHERED TO SMALL PEBBLES DARK GRAY (10YR N/4) LIMESTONE, HIGHLY FRACTURED, HARD, WITH SOME SAND AND ORANGE STAINING AT FRACTURES SOME FRACTURES ARE POORLY RECEMENTED PITTED AND VUGGY, WITH SOME PYRITE INFILLING THIN LAMINATIONS WITH CLAY PARTINGS, HIGH CLAY CONTENT, SHALY HIGHLY WEATHERED AND SOFT HIGHLY FRACTURED, LITTLE RECOVERY BLACK, HIGHLY WEATHERED LIMESTONE, HIGHLY FRACTURED

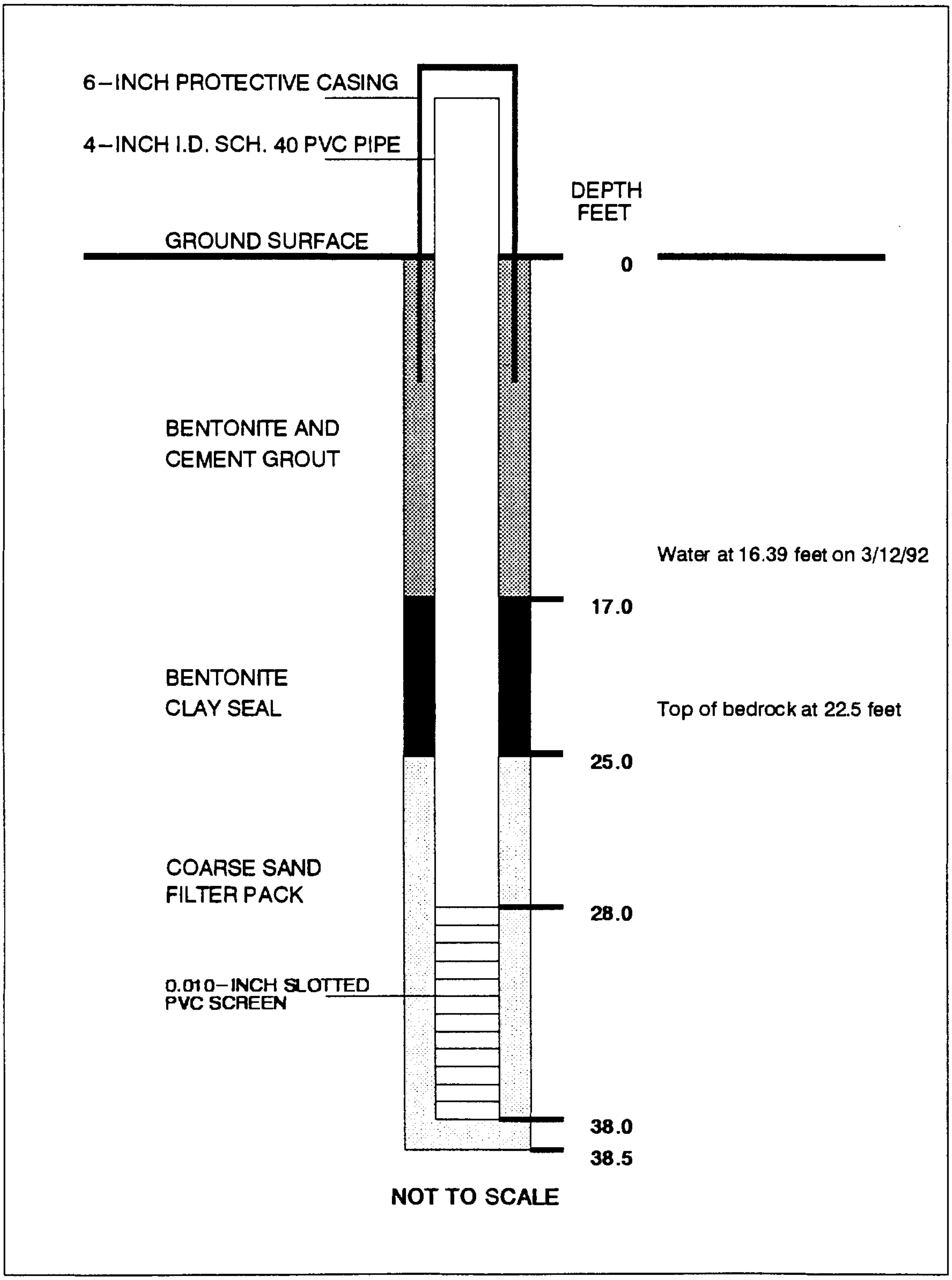
BORING TERMINATED AT A DEPTH OF 38.0 FEET

PLATE
LOG OF BORING

Dames & Moore

WELL INSTALLATION DIAGRAM
FOR VERIFICATION INVESTIGATION
RADFORD AAP, VIRGINIA

Location: 43MW6
Installation Date: 8/14/91
Surface Elevation: 1701.2 Feet
Top of PVC Elevation: 1703.88 Feet



BORING 45MW1

Surface Elevation: **1,707.5** Feet, MSL
Location: Radford AAP, Virginia
Start: 07:22 on 9-28-91
Finish: 12:20 on 9-28-91

Depth (Feet)	Sampling Method	Sample No.	Blows/Foot	Core Run No.	% Recovery	RQD %	Sample Interval
0	SPT	1	22		80		
5	SPT	2	16		95		
10	SPT	3	16		70		
	SPT	4	100/3		0		
15	SPT	5	103		45		
	SPT	6	21		30		
20							
25	SPT	7	0		5		
	SPT	8	12		50		
30							

Symbols	Description
SM	DARK YELLOWISH BROWN (10YR 4/6) SILTY FINE SAND, WITH CLAY, MICACEOUS, MOIST, MEDIUM DENSE, OVERLAIN BY ONE FOOT OF DARK BROWN (10YR 3/3) FINE SILTY SAND, WITH ROOT MATERIAL CLAY GRADES OUT WITH TRACE PEA GRAVELS SAND GRADES TO MEDIUM GRAVELS INCREASING
GM	DARK YELLOWISH BROWN (10YR 4/6) SILTY SANDY GRAVEL WITH COBBLES, VERY MOIST
ML	DARK YELLOWISH BROWN (10YR 3/6) VERY SOFT SILT, VERY MOIST TO SATURATED ENCOUNTERED WATER AT 22.0 FEET GRADING TO DARK GRAYISH BROWN (10YR 4/2)), WITH SAND BACOMING CLAYEY

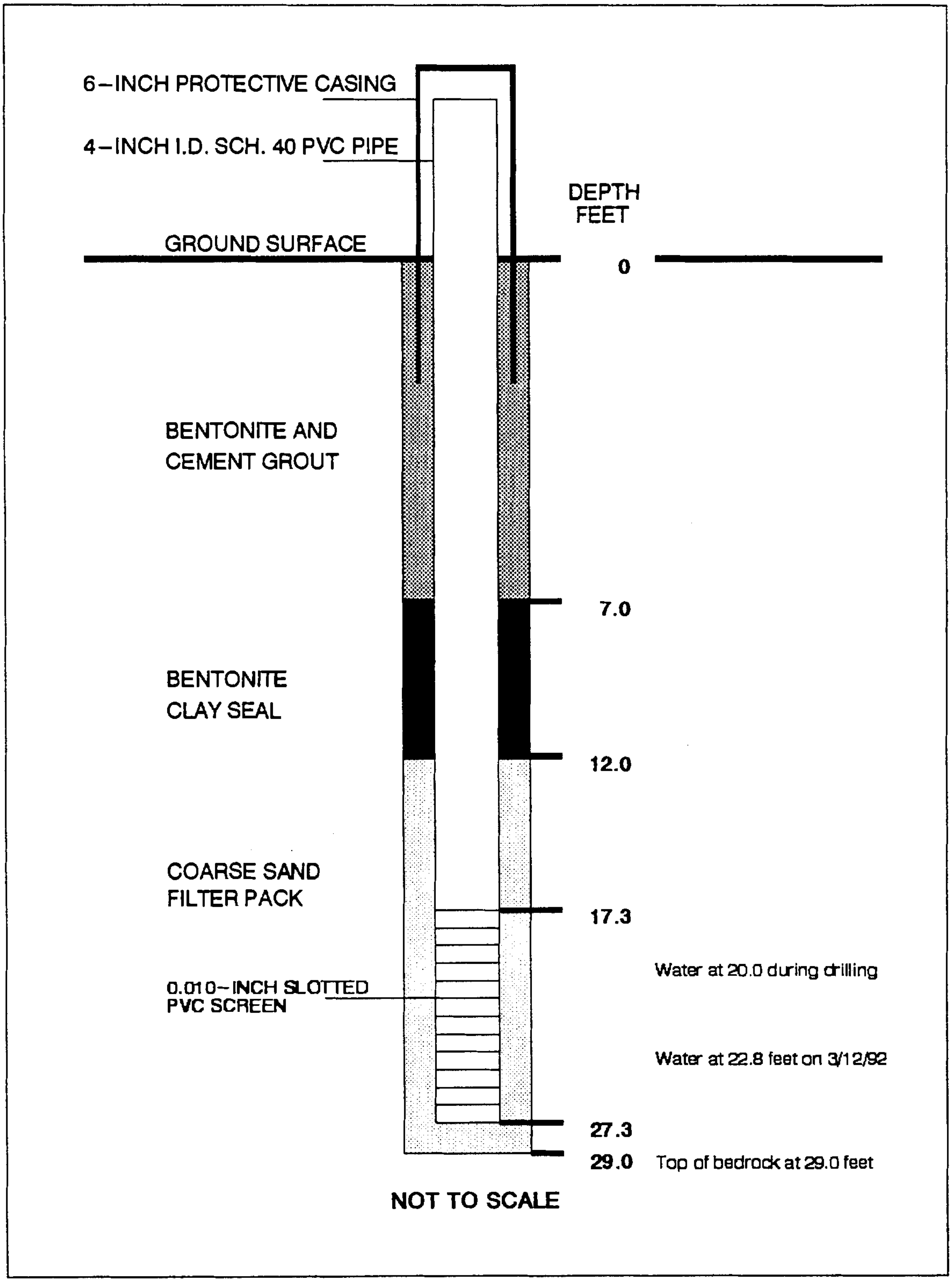
BOREHOLE TERMINATED AT A DEPTH OF 29.0 FEET

PLATE
LOG OF BORING

Dames & Moore

WELL INSTALLATION DIAGRAM
FOR VERIFICATION INVESTIGATION
RADFORD AAP, VIRGINIA

Location: 45MW1
Installation Date: 9/28/91
Surface Elevation: 1707.5 Feet
Top of PVC Elevation: 1709.70 Feet



BORING 45MW2

Surface Elevation: **1,703.7** Feet, MSL
Location: Radford AAP, Virginia
Start: 07:22 on 9-29-91
Finish: 08:30 on 9-29-91

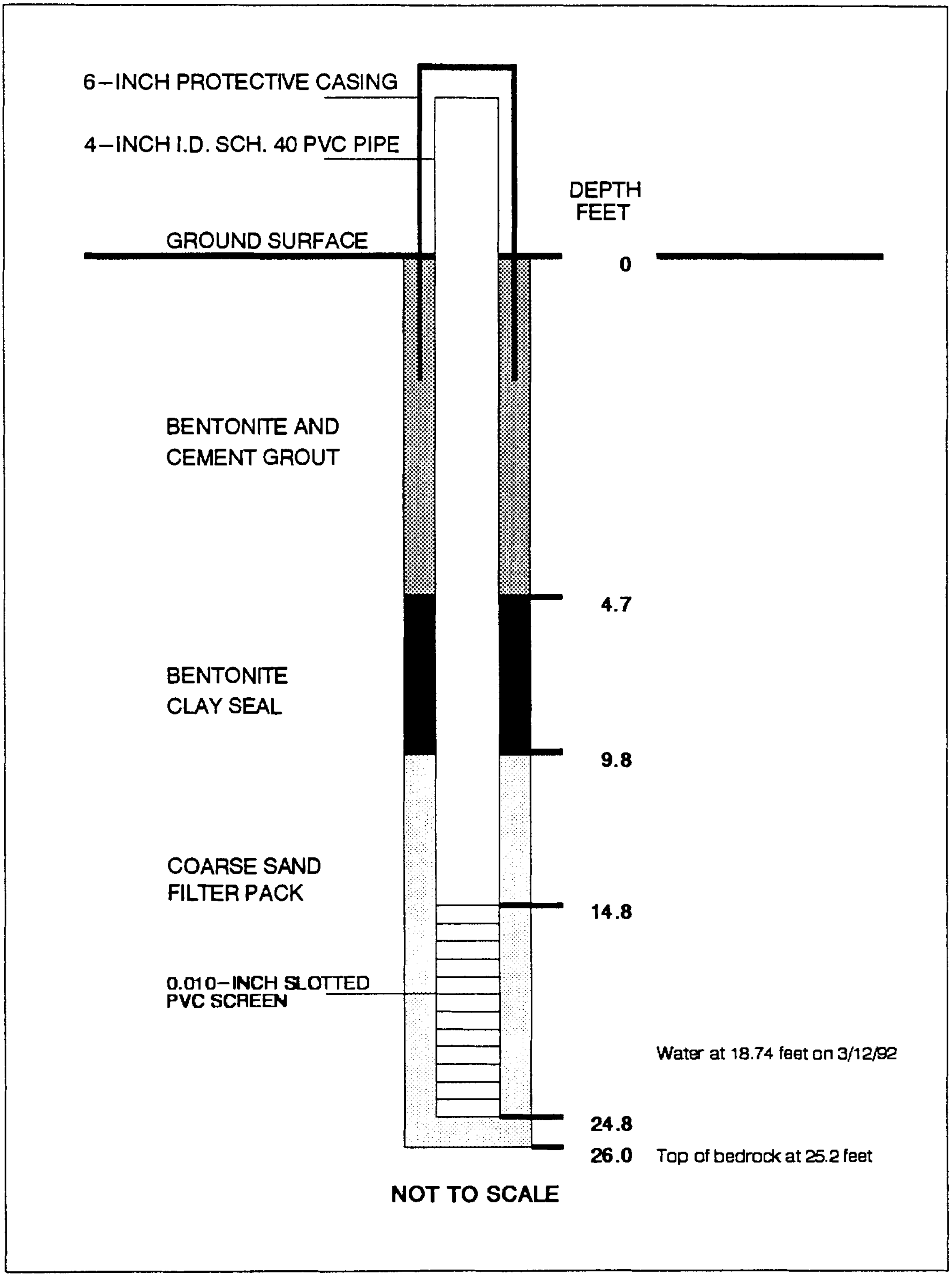
Depth (Feet)	Sampling Method	Sample No.	Blows/Foot	Core Run No.	% Recovery	RQD %	Symbols	Description
0	SPT	1	21		91.6		ML	LIGHT BROWN (7.5YR 6/4) SAND WITH SILT, MICACEOUS, SLIGHTLY MOIST, STIFF, ROOTS TO 0.2 FEET
							SM	PALE BROWN (10YR 6/3) SILTY FINE SAND, MEDIUM DENSE, SLIGHTLY MOIST, MICACEOUS
5	SPT	2	14		58.3			
								GRADING BROWN (10YR 5/3) WITH MEDIUM SAND
10	SPT	3	11		91.7			WITH SOME MAGNETITE STAINS
								INCREASING MOISTURE WITH DEPTH
15	SPT	4	15		95.8			
								ENCOUNTERED WATER
								VERY LOOSESILTY SAND 20.0-20.5 FEET
20	SPT	5	0		33		GM	BROWN (10YR 5/3) SILTY GRAVEL, ROUNDED GRAVEL IS WEATHERED DOLOSTONE
25	SPT	6	75/1		25			
								BOREHOLE TERMINATED AT A DEPTH OF 26.0 FEET

PLATE
LOG OF BORING

Dames & Moore

WELL INSTALLATION DIAGRAM
FOR VERIFICATION INVESTIGATION
RADFORD AAP, VIRGINIA

Location: 45MW2
Installation Date: 9/30/91
Surface Elevation: 1703.7 Feet
Top of PVC Elevation: 1706.17 Feet



Dames & Moore

BORING 45MW3

Surface Elevation: **1,704.1** Feet, MSL
Location: Radford AAP, Virginia
Start: 10:41 on 9-29-91
Finish: 11:49 on 9-29-91

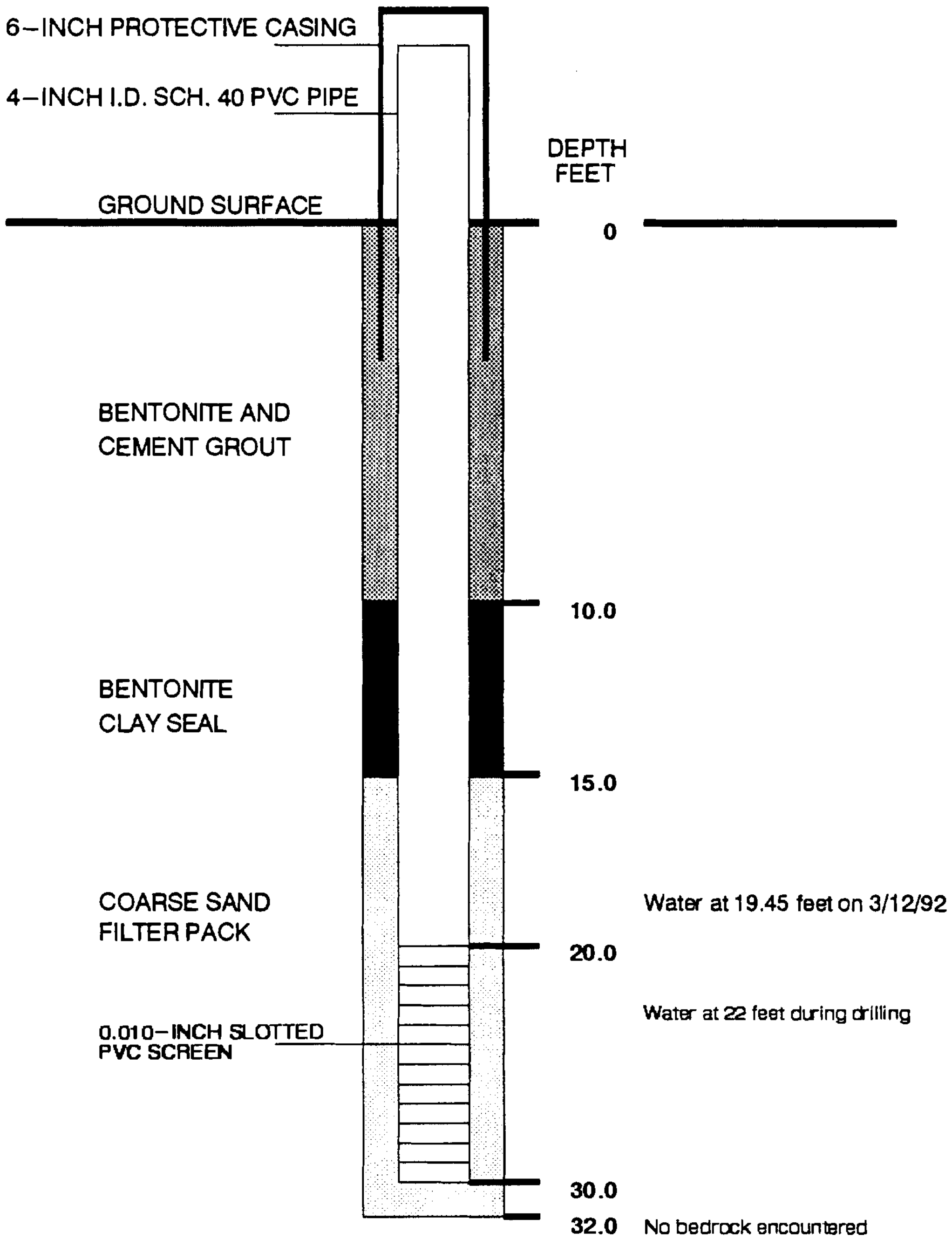
Depth (Feet)	Sampling Method	Sample No.	Blows/Foot	Core Run No.	% Recovery	RQD %	Symbols	Description
0	SPT	1	18		87.5		ML	BROWN (10YR 5/3) FINE SANDY SILT, DRY, VERY STIFF, TRACE ORGANICS, FILL PENETRATED LANDFILL AT 1.0 FEET, OCCASIONAL SMALL BLACK RUBBER AND PAPER GRADING MOIST, NO PAPER BELOW 3.0 FEET
5	SPT	2	11		95.8		SM	VERY PALE BROWN (10YR 7/4) FINE TO MEDIUM SAND, MOIST, NATURAL UNDISTURBED SOILS, MEDIUM DENSE, MICACEOUS WITH SOME THINLY LAMINATED LENSES OF FINE BROWN SILT
10	SPT	3	13		91.7			INCREASING MOISTURE WITH DEPTH, SOME MAGNETITE STAINS
15	SPT	4	15		62.5			GRADING BROWN (10YR 5/3)
20	SPT	5	31		91.7		GM	BROWN (10YR 5/3) SILTY GRAVEL, VERY MOIST ENCOUNTERED WATER AT 22.0 FEET
25	SPT	6	9		66.7		SC	REDDISH BROWN (5YR 4/3) SILTY CLAY, HIGHLY PLASTIC, STICKY, SOME FINE SAND, SOME GRAY MOTTLING
	SPT	7	0		33.3			GRADING BROWN (10YR 5/3) VERY STIFF
30								BOREHOLE TERMINATED AT A DEPTH OF 30.5 FEET
35								

PLATE
LOG OF BORING

Dames & Moore

WELL INSTALLATION DIAGRAM
FOR VERIFICATION INVESTIGATION
RADFORD AAP, VIRGINIA

Location: 45MW3
Installation Date: 9/30/91
Surface Elevation: 1704.1 Feet
Top of PVC Elevation: 1706.52 Feet



NOT TO SCALE

BORING 54MW1

Surface Elevation: **1,705.7** Feet, MSL
Location: Radford AAP, Virginia
Start: 08:25 on 11-5-91
Finish: 09:05 on 11-6-91

Depth (Feet)	Sampling Method	Sample No.	Blows/Foot	Core Run No.	% Recovery	RQD %	Symbols	Description
0	SPT	1	19		20		ML	DARK BROWN (7.5YR 3/4) FINE SANDY SILT, DRY, STIFF, WITH ROOT MATERIAL
							SM	DARK BROWN (7.5YR 4/4), SILTY FINE SAND, SLIGHTLY MOIST, SLIGHTLY CLAYEY, MICACEOUS, MEDIUM DENSE, TRACE RED MOTTLING
5	SPT	2	27		100			LESS CLAY, MORE MICACEOUS OCCASIONAL THIN SAND SEAMS
10	SPT	3	11		85			
15	SPT	4	18		85			SOME ONE-INCH POCKETS OB BLACK, COALY MOTTLING
								GRAVELLY AND COBBLY FROM 18.5 TO TOP OF WEATHERED SHALE
	AH	5					SH/SLTST	GREENISH GRAY (5GY 5/1) WEATHERED SILTSTONE AND SHALE
20	AH	6						GREENISH GRAY (5BG 5/1), SOFT SILTY SHALE
	AH	7						
25								
							SH/SLTST/LS	WITH INTERBEDDED LAYERS OF GRAY (N/4) DOLOSTONE/ LIMESTONE
	AH	8						
30								
	AH	9						GRAY (N/5) VERY SILTY SHALE AND DOLOSTONE/ LIMESTONE
35								
	AH	10						BECOMING VERY SLIGHTLY MOIST (CUTTINGS ARE COHESIVE)
40								

PLATE
LOG OF BORING

Dames & Moore

FILE

BORING 54MW1 (Cont'd)

Depth (Feet)	Sampling Method	Sample No.	Blows/Foot	Core Run No.	% Recovery	RQD %	Sample Interval	Symbols	Description
40								SH / SLTST / LS	CONTINUED SOFT SHALE AND DOLOSTONE/ LIMESTONE
45	AH	11					■		
50	AH	12					■		WITH MORE GRAY (N/4) HARD LIMESTONE/ DOLOSTONE CHIPS
55	AH	13					■		CUTTINGS MOIST ONLY
									VERY DARK GRAY DOLOSTONE AND SHALE, MOIST
60									BOREHOLE TERMINATED AT A DEPTH OF 60.0 FEET

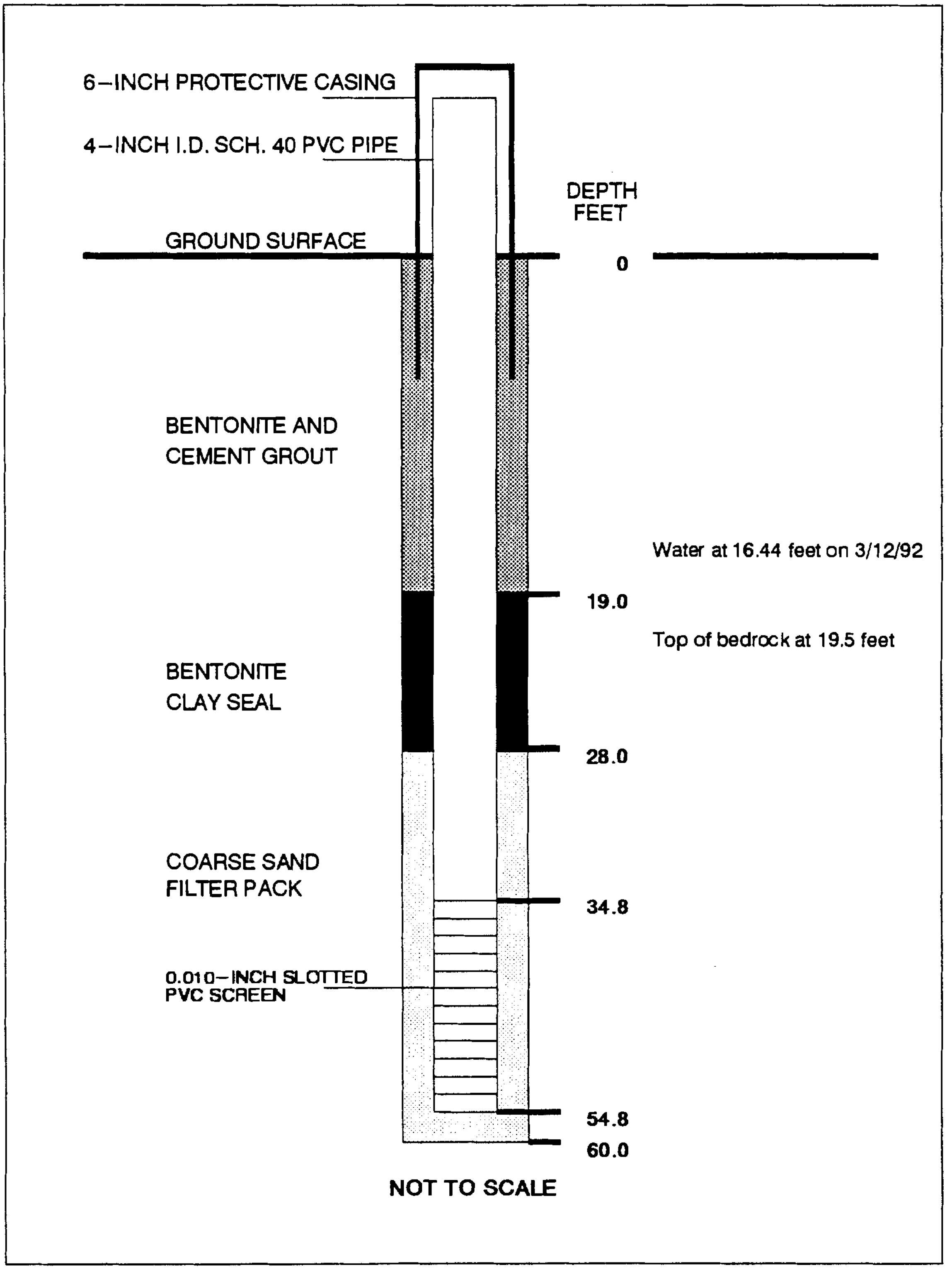
PLATE
LOG OF BORING

Dames & Moore

FILE

WELL INSTALLATION DIAGRAM
FOR VERIFICATION INVESTIGATION
RADFORD AAP, VIRGINIA

Location: 54MW1
Installation Date: 11/6/91
Surface Elevation: 1705.7 Feet
Top of PVC Elevation: 1707.78 Feet



BORING 54MW1A

Surface Elevation: **1,704.0** Feet, MSL
Location: Radford AAP, Virginia
Start: 08:25 on 9-16-91
Finish: 09:05 on 9-17-91

Depth (Feet)	Sampling Method	Sample No.	Blows/Foot	Core Run No.	% Recovery	RQD %	Sample Interval	Symbols	Description
0	SPT	1	16		90			ML	DARK BROWN (7.5YR 3/4) FINE SANDY SILT, SLIGHTLY MOIST, MICACEOUS
								SM	DARK BROWN (7.5YR 4/4) SILTY FINE SAND, SLIGHTLY MOIST, SLIGHTLY CLAYEY, MICACEOUS, MEDIUM DENSE
5	SPT	2	12		70				
									LESS CLAY, MORE MICACEOUS
									OCCASIONAL THIN SAND SEAM
10	SPT	3	16		100				
15	SPT	4	16		100				
									GRAVEL SEAM FROM 19.0 FEET TO TOP OF BEDROCK
20	SPT	5	100/5		100				
								SH / SLTST	LIGHT OLIVE BROWN (2.5Y 5/3) AND OLIVE YELLOW (2.5Y 6/6) SILTY CLAYEY TILL LENSE ON TOP OF BEDROCK
	NX			1	0	0			NO NX CORE RECOVERY. REAM CUTTINGS REVEAL GREENISH GRAY (5BG 5/1) SILTY SHALE
25									VERY POOR NX RECOVERY (4%) DARK BROWN (7.5YR 4/4) SANDSTONE GRAVEL. IN PORES OF SANDSTONE IS LIGHT GRAY (7.5YR N/7) CLAY, HIGHLY PLASTIC
	NX			2	4	0			
									REAM CUTTINGS REVEAL HIGHLY SILTY GREENISH GRAY (5BG 5/1) SHALE
30								SH / SLTST / LS	DARK GRAY HIGHLY SILTY SOFT SHALE, WITH DOLOSTONE/LIMESTONE
	AH	1							
									SOFT DARK GRAY
35	AH	2							
	AH	3							SAND SEAM AT 37.0 FEET
									LESS DUSTY AND SANDY
40									

PLATE
LOG OF BORING

Dames & Moore

FILE

BORING 54MW1A (Cont'd)

Depth (Feet)	Sampling Method	Sample No.	Blows/Foot	Core Run No.	% Recovery	RQD %	Sample Interval	Symbols	Description
40								SH / SLTST / LS	CUTTINGS SLIGHTLY MORE MOIST, COHESIVE, SILTY
	AH	4							
								LS / SLTST / LS	WITH SOME LIGHT GRAY DOLOSTONE CHIPS
45	AH	5							
									WITH ABUNDANT LIGHT GRAY LIMESTONE AND DOLOSTONE CHIPS
50	AH	6							
									GRAY SANDY SILT-PROBABLE FAULT GOUGE
									BORING TERMINATED AT A DEPTH OF 52.0 FEET
55									

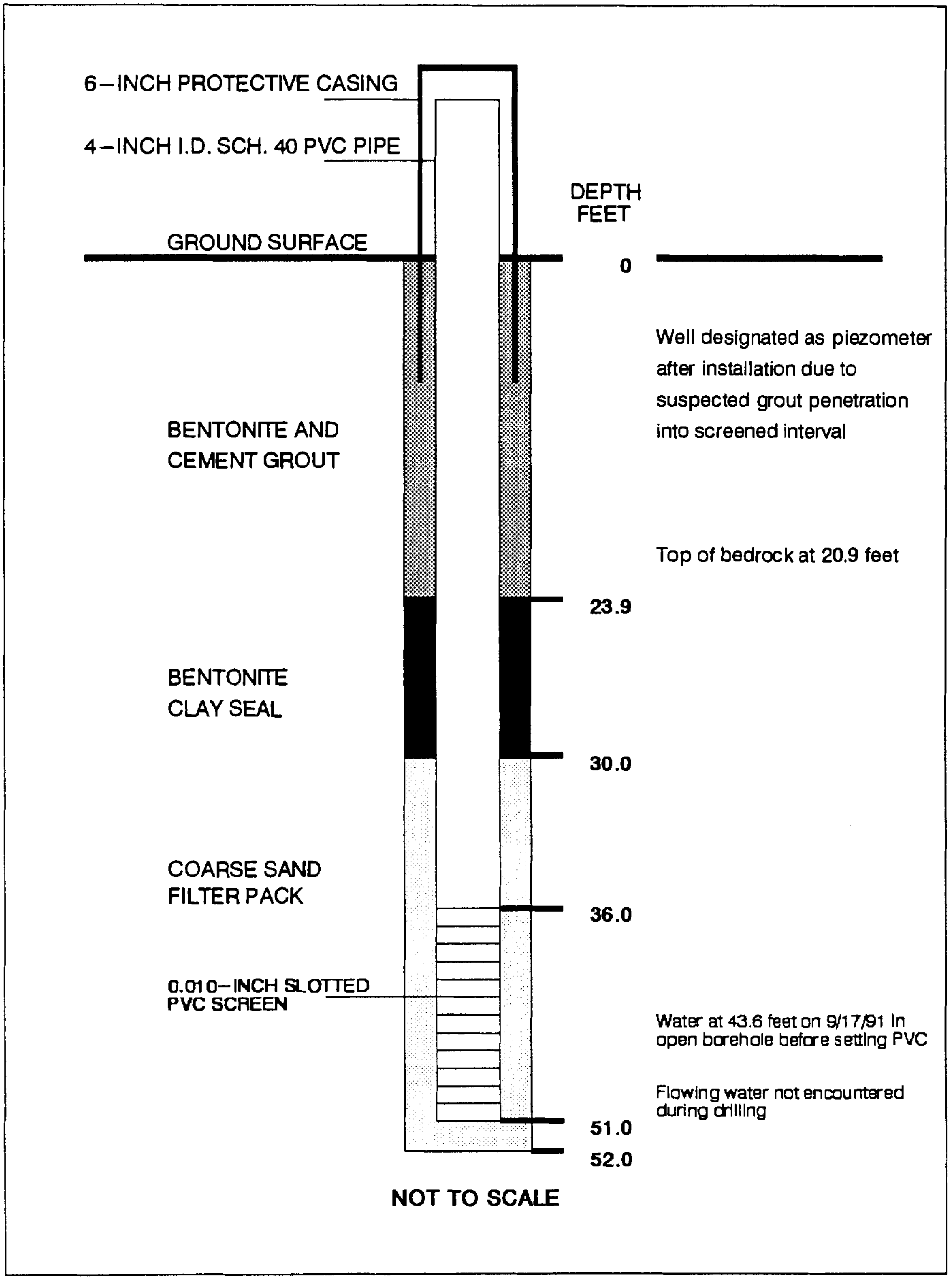
PLATE
LOG OF BORING

Dames & Moore

FILE

PIEZOMETER INSTALLATION DIAGRAM
FOR VERIFICATION INVESTIGATION
RADFORD AAP, VIRGINIA

Location: 54MW1A
Installation Date: 9/17/91
Surface Elevation: 1704 Feet*
Top of PVC Elevation: 1705 Feet*
*Estimated, not surveyed



BORING 54MW2

Surface Elevation: **1,698.9** Feet, MSL
Location: Radford AAP, Virginia
Start: 10:20 on 9-17-91
Finish: 14:45 on 9-17-91

Depth (Feet)	Sampling Method	Sample No.	Blows/Foot	Core Run No.	% Recovery	RQD %
0	SPT	1	11		90	
5	SPT	2	7		100	
10	SPT	3	9		100	
15	SPT	4	12		100	
	SPT	5	100/3		100	
20	SPT	6	50/1		100	
	NX			1	32	0
25						
30						

Symbols	Description
SM	DARK BROWN (7.5YR 3/3) SILTY FINE GRAINED SAND, SLIGHTLY MOIST, MICACEOUS, LOOSE
	BECOMING MORE MICACEOUS
	MOISTURE AND SILT INCREASING WITH DEPTH
	OCCASIONAL SILTY OR CLAYEY LENSES OR SEAMS
	15.5–16.0 FEET SILTY CLAY SEAMS
	MOIST
	THIN BROWN (10YR 5/3) SANDY GRAVELLY SEAM
SH/LS	DARK GRAY (7.5YR N/4) INTERBEDDED, HIGHLY WEATHERED SHALE AND LIMESTONE WITH DARK BROWN (10YR 4/3) STAINING, HIGHLY FRACTURED
	GREENISH GRAY (5G 6/1) HIGHLY WEATHERED, HIGHLY FRACTURED SHALE, WITH MANY THIN CALCITE VEINS, ROCK FRAGMENTS ARE HARD

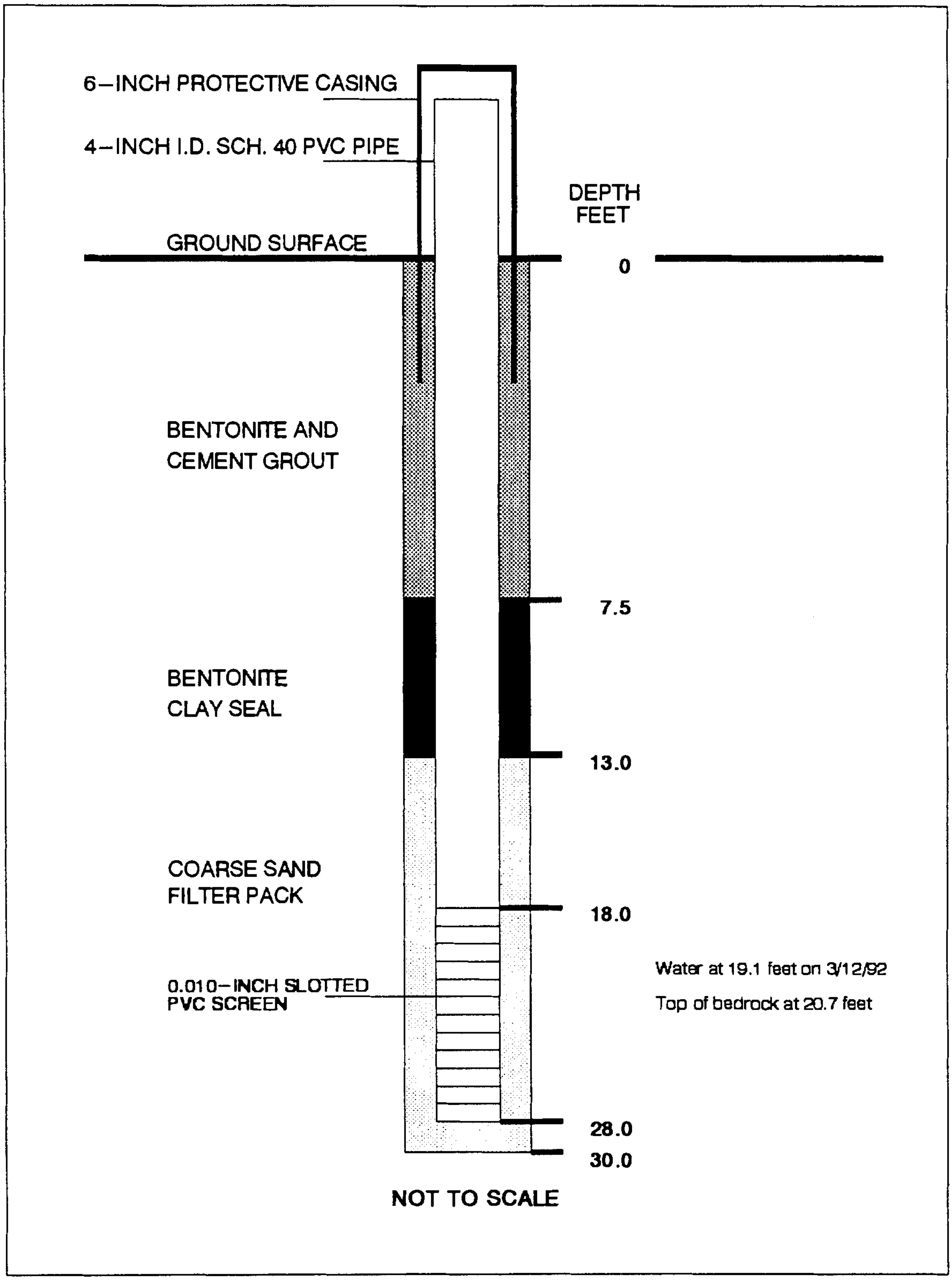
BOREHOLE TERMINATED AT A DEPTH OF 30.0 FEET

PLATE
LOG OF BORING

Dames & Moore

WELL INSTALLATION DIAGRAM
FOR VERIFICATION INVESTIGATION
RADFORD AAP, VIRGINIA

Location: 54MW2
Installation Date: 9/17/91
Surface Elevation: 1698.9 Feet
Top of PVC Elevation: 1701.41 Feet



Dames & Moore

BORING 54MW3

Surface Elevation: **1,700.6** Feet, MSL
Location: Radford AAP, Virginia
Start: 07:21 on 9-18-91
Finish: 11:42 on 9-18-91

Depth (Feet)	Sampling Method	Sample No.	Blows/Foot	Core Run No.	% Recovery	RQD %
0	SPT	1	6		80	
5	SPT	2	9		75	
10	SPT	3	8		100	
15	SPT	4	11		100	
20	SPT	5	11		70	
	SPT	6	100/5		100	
25	NX			1	34	0
30	NX			2	60	20
35						

Symbols	Description
SM	DARK BROWN (7.5YR 3/3) SILTY FINE SAND, SLIGHTLY MOIST, MICACEOUS, LOOSE BECOMING MORE MICACEOUS MOISTURE AND SILT INCREASING WITH DEPTH OCCASIONAL CLAYEY SAND LENSES OR SEAMS OCCASIONAL SAND (LITTLE FINES) LENSES OR SEAMS HIGH-CLAY OR HIGH-SILT LENSES FREQUENT
GM	THIN GRAYISH BROWN SAND SEAM 20.0-21.0 FEET GRAYISH BROWN (10YR 5/2) SILTY SANDY GRAVEL, VERY MOIST TO WET
SH/LS	GRAY (10YR 5/1) SILT SEAM TOP OF ROCK DARK GRAY SILTY SHALE, 10YR 4/1, WITH SOFT LIMESTONE INCLUSIONS, HIGHLY WEATHERED , HIGHLY FRACTURED, WITH OCCASIONAL GRAVEL SEAMS. POOR RECOVERY BECOMES SOFTER, DARKER, VERY THINLY BEDDED, CLAYEY COALY SILTSTONE
SH/LS	VERY DARK GRAY 10YR 3/1, HARD, CEMENTED, BRECCIATED LIMESTONE TO 32.3 FEET, BECOMING HIGHLY FRACTURED, CRACKED, SHARPLY ANGULAR LIMESTONE AND SHALE PIECES WITH VERY THIN CALCITE VEINS

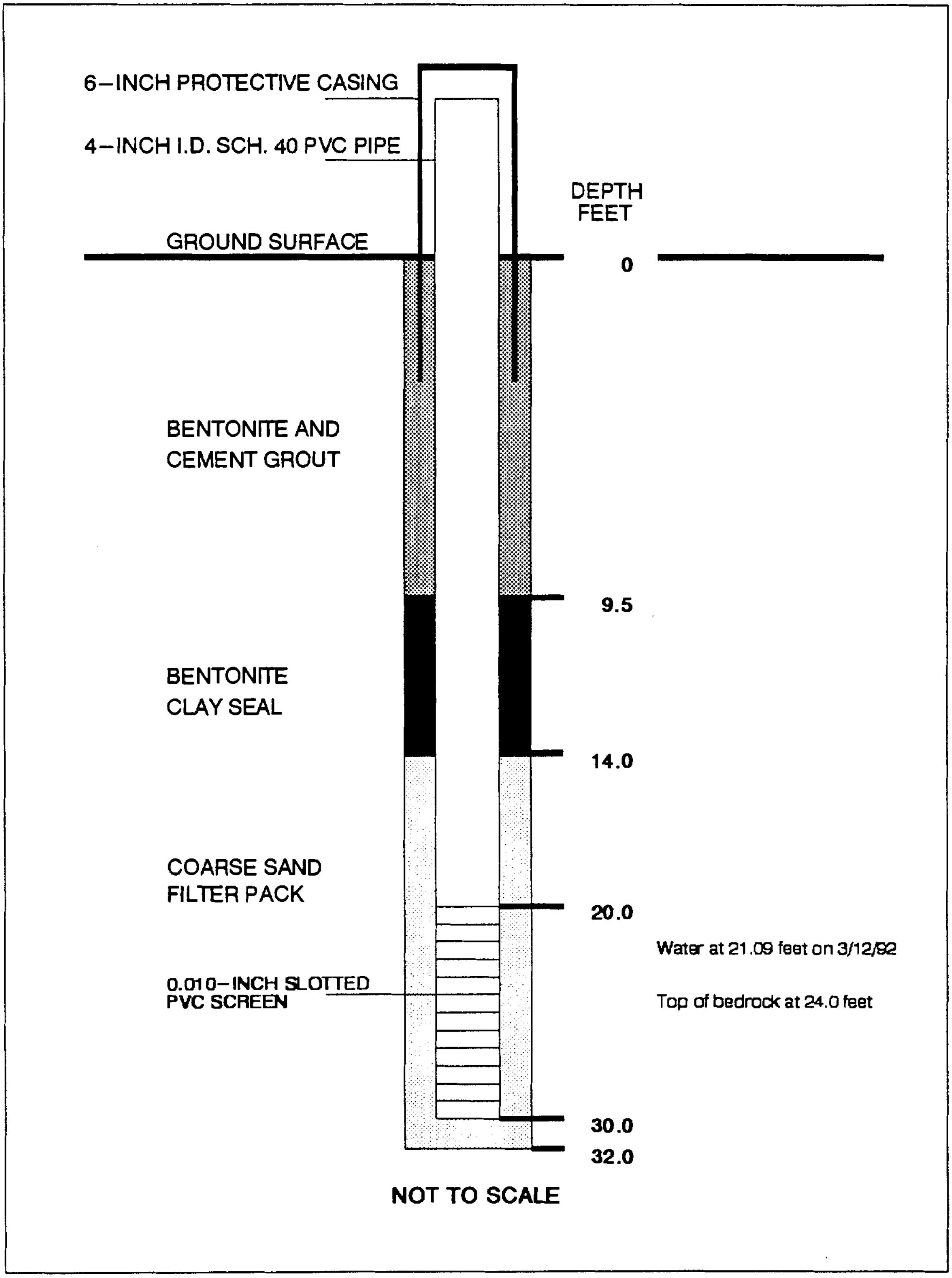
BOREHOLE TERMINATED AT A DEPTH OF 35.0 FEET

PLATE
LOG OF BORING

Dames & Moore

WELL INSTALLATION DIAGRAM
FOR VERIFICATION INVESTIGATION
RADFORD AAP, VIRGINIA

Location: 54MW3
Installation Date: 9/18/91
Surface Elevation: 1700.6 Feet
Top of PVC Elevation: 1702.15 Feet



Dames & Moore

BORING 74MW1

Surface Elevation: **1,732.6** Feet, MSL
Location: Radford AAP, Virginia
Start: 07:46 on 10-7-91
Finish: 12:55 on 10-7-91

Depth (Feet)	Sampling Method	Sample No.	Blows/Foot	Core Run No.	% Recovery	RQD %
0	SPT	1	44		71	
5	SPT	2	25		75	
10	SPT	3	15		79	
15	SPT	4	14		75	
20	SPT	5	11		79	
25	NX			1	65	33
30	NX			2	96	90
35						
40						

Symbols	Description
ML	BROWNISH YELLOW (10YR 6/8) SANDY SILT, DRY, HARD GRADING YELLOWISH BROWN WITH MORE SAND, SLIGHTLY MOIST, WITH MAGNETITE STAINING
SM	YELLOWISH BROWN SILTY MEDIUM GRAINED SAND, MOIST GRADING
SW	VERY PALE BROWN (10YR 7/4) MEDIUM GRAINED SAND, WELL GRADED, WITH MAGNETITE STAINING
GM	BROWNISH YELLOW (10YR 6/6) SILTY GRAVEL, MOIST WITH LOOSE SAND AT 22.0 FEET GRADED BROWN SANDY SILT, WET
LS/DS	DARK GRAY (N/4) LIMESTONE, DOLOSTONE, WITH CALCITE INFILLING AT FRACTURES AND VOIDS, HIGHLY WEATHERED AN FRACTURED STEEPLY DIPPING FROM 29.0–31.0 FEET CONTINUED DARK GRAY HIGHLY PITTED AT 33.0 FEET WATER ENCOUNTERED AT 37.5 FEET

PLATE
LOG OF BORING

Dames & Moore

BORING 74MW1 (Cont'd)

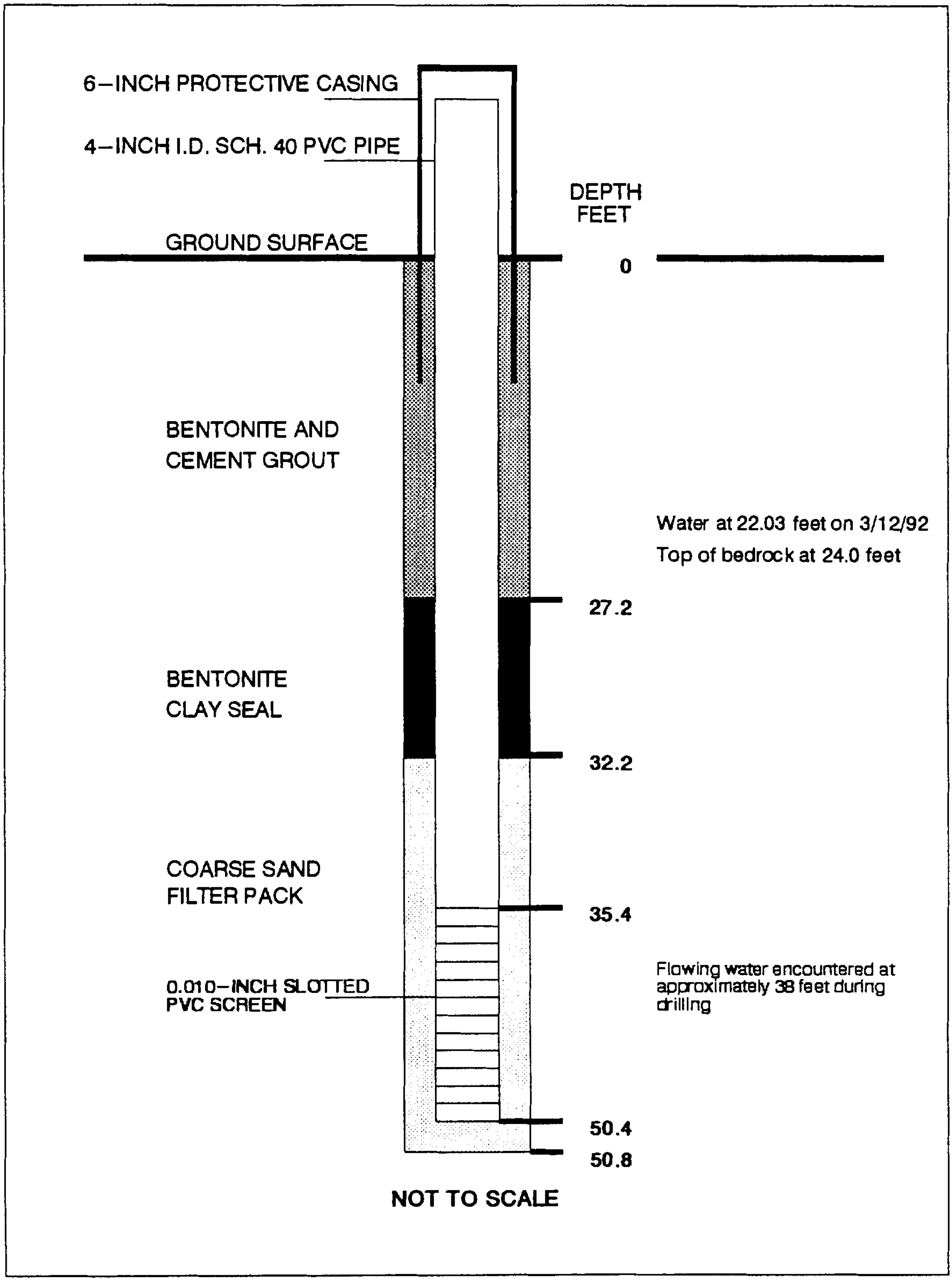
Depth (Feet)	Sampling Method	Sample No.	Blows/Foot	Core Run No.	% Recovery	RQD %	Sample Interval	Symbols	Description
40								LS/DS	DARK GRAY N/7 LIMESTONE/DOLOSTONE
45									
50									BORING TERMINATED AT A DEPTH OF 48.0 FEET

PLATE
LOG OF BORING

Dames & Moore

WELL INSTALLATION DIAGRAM
FOR VERIFICATION INVESTIGATION
RADFORD AAP, VIRGINIA

Location: 74MW1
Installation Date: 10/7/91
Surface Elevation: 1732.6 Feet
Top of PVC Elevation: 1734.85 Feet



BORING 6SB1

Surface Elevation: 1794.0 Feet
Location: Radford AAP, Virginia
Start: 09:14 on 11-5-91
Finish: 10:15 on 11-5-91

Depth (Feet)	Sampling Method	Sample No.	Blows/Foot	Core Run No.	% Recovery	RQD %	Sample Interval	Symbols	Description
0								CL	RED, (2.5YR 4/6) SANDY CLAY, MEDIUM PLASTICITY, TRACE BLACK MINERALS
	C	1			100				BECOMES DARK RED (2.5YR 3/6) LESS SAND
5									GRAVELLY WITH TRACE STRONG BROWN (7.5YR 5/8) MOTTLING, BECOMING SLIGHTLY MOIST, SOFTER
	C	2			50				
									MICACEOUS
10								CL	DARK YELLOWISH BROWN (10YR 4/4) SILTY SANDY CLAY, GRAVELLY
	C	3			100				LESS SAND
15								ML	DARK YELLOWISH BROWN (10YR 4/6) CLAYEY SILT, WITH OCCASIONAL SANDY ZONES AND TRACE YELLOWISH BROWN (10YR 5/6) MOTTLING
	C	4			50				CHEMICAL SAMPLE COLLECTED AT 18.0 FEET
									GRADING SLIGHTLY DARKER AND GRAVELLY
20	C	5			100				CHEMICAL SAMPLE COLLECTED AT 20.5 FEET
									BORING TERMINATED AT A DEPTH OF 21.0 FEET
25									

PLATE
LOG OF BORING

Dames & Moore

BORING 6SB2

Surface Elevation: 1794.0 Feet
Location: Radford AAP, Virginia
Start: 4:15 on 11/4/91
Finish: 10:15 on 11-5-91

Depth (Feet)	Sampling Method	Sample No.	Blows/Foot	Core Run No.	% Recovery	RQD %	Sample Interval	Symbols	Description
0								CL	RED (2.5YR 4/6) SANDY CLAY
	C	1			100				GRADING REDDER WITH BLACK SPECKS
5									STRONG BROWN (7.5YR 5/6) GRAVELLY SILTY SANDY SEAM FROM 4.5 TO 7.5 FEET, GRADING SLIGHTLY MOIST
	C	2			40				SOFTER, WITH INCREASED SILT AND CLAY
									8.5 TO 9.0 GRAVEL SEAM
10								CL	DARK YELLOWISH BROWN (7.5YR 5/8) SANDY SILTY CLAY, SOFT, VERY MOIST, WITH DARK YELLOWISH BROWN (10YR 4/4) CLAYEY SAND (POSSIBLY SLUDGE)
	C	3			100				CHEMICAL SAMPLE COLLECTED AT 14.0 FEET
15								ML	DARK YELLOWISH BROWN (10YR 4/4) CLAYEY SILT, TRACE SAND, SOME YELLOWISH BROWN (7.5YR 5/8) MOTTLING
	C	4			50				
20									BECOMES DARK GRAYISH BROWN (2.5Y 4/2)
	C	5			100				BECOMES DARK OLIVE GRAY (5Y 3/2) NO SLUDGEY APPEARANCE CHEMICAL SAMPLE COLLECTED AT 22.0 FEET BORING TERMINATED AT A DEPTH OF 22.0 FEET
25									

PLATE
LOG OF BORING

Dames & Moore

BORING 17SB1

Surface Elevation: 1891.0 Feet, MSL
Location: Radford AAP, Virginia
Start: 11:33 on 11-5-91
Finish: 11:50 on 11-5-91

Depth (Feet)	Sampling Method	Sample No.	Blows/Foot	Core Run No.	% Recovery	RQD %	Sample Interval	Symbols	Description
0								GM	YELLOWISH BROWN (10YR 6/6) SANDY SILTY CLAYEY GRAVELS
	C	1		1	6				
5									CHEMICAL SAMPLE COLLECTED AT 8.0 FEET
	C	2		2	75				GRADED CONTACT
								GC	STRONG BROWN (7.5YR 5/6) SILTY GRAVELLY CLAY, SOME BLACK STAINING, POSSIBLY CAVE IN FROM ABOVE CHEMICAL SAMPLE COLLECTED AT 9.0 FEET
10									BOREHOLE TERMINATED AT A DEPTH OF 9.0 FEET

PLATE
LOG OF BORING

Dames & Moore

BORING 17SB2

Surface Elevation: 1892.0 Feet, MSL
Location: Radford AAP, Virginia
Start: 12:05 on 11-5-91
Finish: 12:25 on 11-5-91

Depth (Feet)	Sampling Method	Sample No.	Blows/Foot	Core Run No.	% Recovery	RQD %	Samples	Symbols	Description
0								GM	YELLOWISH BROWN (10YR 6/6) SANDY SILTY CLAYEY GRAVELS
	C	1		1	8				
5									CHEMICAL SAMPLE COLLECTED AT 5.0 FEET BECOMES PRODUCT-STAINED, WITH ODOR, SLIGHTLY MOIST
	C	2		2	8			GC	STRONG BROWN (7.5YR 4/6) GRAVELLY CLAY, WITH SAND AND SILT, SLIGHTLY MOIST
10									CHEMICAL SAMPLE COLLECTED AT 10.0 FEET BOREHOLE TERMINATED AT A DEPTH OF 10.0 FEET

PLATE
LOG OF BORING

Dames & Moore

BORING 17SB3

Surface Elevation: 1875.0 Feet, MSL
Location: Radford AAP, Virginia
Start: 12:56 on 11-5-91
Finish: 1:15 on 11-5-91

Depth (Feet)	Sampling Method	Sample No.	Blows/Foot	Core Run No.	% Recovery	RQD %	Sample Interval	Symbols	Description
0								GM	STRONG BROWN (7.5YR 4/6) SANDY SILTY GRAVELS
	C	1		1	56				GRADED CONTACT
								CL	STRONG BROWN (7.5YR 4/6) SILTY CLAY, MEDIUM PLASTICITY, STIFF, NO ODOR CHEMICAL SAMPLE COLLECTED AT 2.5-5.0 FEET CHEMICAL SAMPLE COLLECTED AT 5.5-7.0 FEET
5	C	2		2	75			ML	REDDISH YELLOW (7.5YR 6/8) SILT, TRACE SAND, SOFT, VERY MOIST, NO ODOR
									BOREHOLE TERMINATED AT A DEPTH OF 7.0 FEET
10									

PLATE
LOG OF BORING

Dames & Moore

FILE

BORING 32MW2

Surface Elevation: 1780.0 Feet
Location: Radford AAP, Virginia
Start: 15:17 on 9-30-91
Finish: 13:15 on 10-1-91

Depth (Feet)	Sampling Method	Sample No.	Blows/Foot	Core Run No.	% Recovery	RQD %	Symbols	Description
0	SPT	1	35		83		ML	LIGHT YELLOWISH BROWN SANDY SILT, DRY, TRACE MAGNETITE
							CL	YELLOWISH RED (5YR 5/6) SILTY CLAY, HARD, WITH SOME BLACK MINERALS
5	SPT	2	42		79			SLIGHTLY MOIST WITH OCCASIONAL ROUNDED DOLOMITE PEBBLES
10	SPT	3	17		96		CL	BECOMES YELLOWISH BROWN (10YR 5/8) SANDY CLAY, VERY STIFF, MOIST, WITH BLACK MINERAL STAINING
							ML	YELLOWISH BROWN (10YR 5/8) CLAYEY SILT, SOME BLACK MINERAL STAINING, MOIST, MASSIVE
15	SPT	4	13		92			
20	SPT	5	10		92		ML	BECOMES REDDISH YELLOW (5YR 6/6) SILTY CLAY, MEDIUM PLASTICITY, VERY MOSIT OCCASIONAL THIN REDDISH BROWN AND BLACK LAMINATIONS
							LS	WEATHERED GRAY N/4 LIMESTONE
25	SPT	6	50/2		100			
30								LIMESTONE, DARK GRAY (N/4) HIGHLY WEATHERED AND FRACTURED, WEAKLY CEMENTED, SOME HEMATITE STAINING
	NX			1	68	40		PITTED WITH CALCITE INFILLING OF VOIDS AND FRACTURES
35								BECOMING LIGHT GRAY (N/4), LESS WEATHERED, HEMATITE STAINING AT FRACTURES AND PITS, CALCITE CRYSTALLIZATION IN VOIDS AND PITS ARE PRONOUNCED
	NX			2	98	80		SOFT SEAM AT 39.0-40.0 FEET
40								

PLATE
LOG OF BORING

Dames & Moore

BORING 32MW2 (Cont'd)

Depth (Feet)	Sampling Method	Sample No.	Blows/Foot	Core Run No.	% Recovery	RQD %	Sample Interval	Symbols	Description
40								LS	LIGHT GRAY (N/7) LIMESTONE
	NX			3	20	40			BECOMES SOFT, HIGHLY FRACTURED AND PITTED AT 42.0 TO 45.0 FEET
45								Void	VOID FROM 45.0 TO 55.0 FEET
50	NX			4	0	0			
55								LS	SOFT GREENISH GRAY (5Y 6/1) CLAYEY LIMESTONE WITH HEMATITE STAINING AND INCLUSIONS OF MAGNITITE
	NX			5	50	0		Void	
									TERMINATE BOREHOLE AT A DEPTH OF 57.0 FEET
60									

PLATE
LOG OF BORING

Dames & Moore

FILE

BORING 40MW1A

Surface Elevation: **1,895.0** Feet, MSL
Location: Radford AAP, Virginia
Start: 11:00 on 10-21-91
Finish: 10:53 on 10-22-91

Sampling Method	Sample No.	Blows/Foot	Core Run No.	% Recovery	RQD %
SPT	1	16		25	
NX			1	50	16
NX			2	82	20
NX	1		3	100	53
NX			4	27	0
AH	2				
AH	3				
AH	4				
AH	5				
AH	6				
AH	7				
AH	8				
AH	9				

Depth (Feet): 0, 5, 10, 15, 20, 25, 30, 35, 40

Symbols	Description
CL	DARK YELLOWISH BROWN (10YR 4/6) SILTY CLAY, SLIGHT PLASTICITY, DRY
LS / DS / Shale	HIGHLY WEATHERED INTERBEDDED BLUISH GRAY AND BROWNISH GRAY DOLOSTONE AND RED SHALES, WITH FREQUENT ZONES OF CALCITE VEINS AND WEATHERED LIMESTONE SEAMS, MANY SEAMS WEATHERED TO CLAY
	DIPPING UP TO 20 DEGREES
	HIGHLY CLAYEY WITH BLACK MINERAL STAINING, SOFT
	GETTING HARDER CONTINUED HIGHLY FRACTURED DOLOSTONE, LIMESTONE AND SHALE, WITH MOST FRACTURES OCCURRING ALONG CLAY PARTINGS
	RED SHALE AND YELLOWISH BROWN LIMESTONE CONTENT INCREASING; BEDDING NEARLY HORIZONTAL
	CALCITE AND LIMESTONE SEAMS BECOMING PITTED
	VOID 21.5-23.0 FEET
	STOPPED CORING AT 23.0 FEET, DUE TO EXCESSIVE WATER LOSS AND POOR ROCK QUIALITY. SUBSEQUENT LOG OF BORING IS FROM ROCK CUTTINGS AND DRILLING CONDITIONS
	BROWNISH GRAY AND BLUISH GRAY LIMESTONE, INTERBEDDED WITH SILTY SHALES
	SAME, WITH SOME SOFT SILTSTONE SEAMS. SOME THIN CALCITE LAMINATIONS NOTED IN SOFT SILTSTONE CUTTINGS
	HIGHLY SILTY, CONTINUED INTERBEDDED DOLOSTONE LIMESTONE AND SHALE (SILTSTONE)
	GRADING HARDER

PLATE
LOG OF BORING

Dames & Moore

FILE

BORING 40MW1A (Cont'd)

Depth (Feet)	Sample No.	Symbols	Description
40			
	AH 10		
45			ROCK CHIPS MAINLY LIGHT YELLOWISH BROWN, WITH SHADES OF BLUE GRAY AND BROWNISH GRAY, HARD, LESS SILTY
	AH 11		
			GRADING
50	AH 12		
	AH 13		HARD, MAINLY BLUISH GRAY DOLOSTONE WITH SOME PALE YELLOW INTERBEDDED SOFT LAYERS OF SILTSTONE
55	AH 14		
60	AH 15	LS / DS / Shale	
	AH 16		ROCK BECOMING HARDER, MORE DOLOSTONE LESS SILTSTONE, DUSTY
65			
	AH 17		
70	AH 18		CUTTINGS SLIGHTLY COHESIVE, VERY SLIGHT MOISTURE CONTENT, VERY SOFT, HIGHLY WEATHERED ZONE MAINLY PALE YELLOW TO LIGHT YELLOWISH BROWN (2.5Y 6/1) SILT CUTTINGS
	AH 19		
75			
			GRADING
	AH 20		
80			BLUISH GRAY DOLOSTONE AND VERY PALE BROWN (10YR 8/4) SILTSTONE, DRY

Column headings: Depth (Feet), Sampling Method, Sample No., Blows/Foot, Core Run No., % Recovery, RQD %, Sample Interval, Symbols, Description

PLATE
LOG OF BORING

Dames & Moore

BORING 40MW1A (Cont'd)

Depth (Feet)	Sampling Method	Sample No.	Blows/Foot	Core Run No.	% Recovery	RQD %	Sample Interval	Symbols	Description
80									ROCK IS DOLOSTONE, SHALE, AND LIMESTONE. SOFT, DRY AND SILTY
85	AH	21							BLUISH GRAY AND LIGHT BROWNISH GRAY DOLOSTONE, MUCH HARDER, DRY, DUSTY
90									
	AH	22							WITH SOME VERY PALE BROWN SOFT INTERBEDDED SILTSTONE SEAMS
	AH	23							BECOMING LIGHT GRAY (10YR 7/1) LIMESTONE
95									
	AH	24							
100	AH	25						LS / DS / Shale	
	AH	26							
105									
									STOP DRILLING 6:16 PM 10-21-91
									RESUME DRILLING 7:40 AM 10-22-91 NO WATER INFLUX
	AH	27							WITH MORE BROWN (10YR 5/3) SILTSTONE, SOFTER
110									
	AH	28							BLUISH GRAY LIMESTONE AND DOLOSTONE
115									
	AH	29							
									GETTING HARDER, DARKER GRAY
120									

PLATE
LOG OF BORING

Dames & Moore

FILE

BORING 40MW1A (Cont'd)

Depth (Feet)	Sampling Method	Sample No.	Blows/Foot	Core Run No.	% Recovery	RQD %	Sample Interval	Symbols	Description
120	AH	30					■	LS / DS / Shale	SAME, DRY, HARD
125	AH	31					■		BECOMING LESS DUSTY, SOFTER
130									
	AH	32					■		BLUISH GRAY WITH ABUNDANT CALCITE CRYSTALS AND PALE YELLOW (5Y 7/2) SILTSTONE LAYERS LINE 4
135	AH	33					■		SOFTER, SILTY, WITH TRACE FINE SAND, SLIGHTLY MOIST CUTTINGS ARE SMALL, ROUNDED
140	AH	34					■		SAME
145	AH	35					■		SAME
150									
	AH	36					■		SAME
155	AH	37					■		SAME
160									SAME
	AH	38					■		BORING TERMINATED AT A DEPTH OF 162.0 FEET

PLATE
LOG OF BORING

Dames & Moore

BORING 40MW3A

Surface Elevation: 1905.0 Feet, MSL
Location: Radford AAP, Virginia
Start: 10:31 on 10-18-91
Finish: 10:15 on 10-21-91

Depth (Feet)	Sampling Method	Sample No.	Blows/Foot	Core Run No.	% Recovery	RQD %
0–2	SPT	1	21		65	
10–13.5	NX			1	88	69
13.5–17	NX			2	100	21
17–22.5	NX			3	90	25
22.5–26.2	NX			4	100	69

Symbols	Description
CL	DARK YELLOWISH BROWN (10YR 5/4) CLAY, TRACE FINE SAND, WITH SOME BLACK STAINING AT 1.5 FEET, SOME CINDERS AND GRAVEL TO 1.5 FEET
DS/LS/Shale	LIGHT YELLOWISH BROWN (2.5Y 6/4) SILTSTONE WITH HIGHLY WEATHERED DOLOSTONE AND LIMESTONE SEAMS DUE TO POOR ROCK QUALITY DID NOT CORE UNTIL 10.0 FEET TO TRY TO AVOID EXCESSIVE WATER LOSS VERY PALE BROWN (10YR 7/3) DOLOSTONE WITH VERY THIN LIMESTONE SEAMS LIMESTONE SEAMS BECOMING THICKER, WITH SOME PITS, VUGS, AND CAVITIES WITH THIN LAYERS OF LIGHT GREENISH GRAY AND PALE BROWN DOLOSTONE, WITH MANY FRACTURES WHICH OCCUR ALONG BEDDING PLANES BECOMES THINLY BEDDED, MODERATELY WEATHERED, PALE BROWN DOLOSTONE HIGHLY FRACTURED FROM 20.0–21.0 FEET BECOMING BLUISH GRAY (N/4) DOLOSTONE AT 22.5 FEET, HARD, WITH SOME BROWNISH YELLOW STAINING AT FRACTURES STOP NX CORING AT 26.2 FEET DUE TO EXCESSIVE WATER LOSS VERY DUSTY, DRY BECOMES SOFTER AT 31.5–32.0 FEET SLIGHTLY MOIST AT 36.0 FEET
Void	ENCOUNTERED A VOID OR CAVITY AT 38.0 FEET

PLATE
LOG OF BORING

Dames & Moore

BORING 40MW3A (Cont'd)

Depth (Feet)	Sampling Method	Sample No.	Blows/Foot	Core Run No.	% Recovery	RQD %	Sample Interval	Symbols	Description
40								Void	
									MUD IN VOID
45									
	GA	2							CAVITY EXTENDS TO 49.0 FEET
50									BOREHOLE TERMINATED AT A DEPTH OF 49.0 FEET

PLATE
LOG OF BORING

Dames & Moore

BORING 41MW3A

Surface Elevation: **1,795.0** Feet, MSL
Location: Radford AAP, Virginia
Start: 07:30 on 10-15-91
Finish: 09:15 on 10-15-91

Depth (Feet)	Sampling Method	Sample No.	Blows/Foot	Core Run No.	% Recovery	RQD %	Symbols	Description
0	SPT	1	43		45		CL	STRONG BROWN (7.5YR 4/6) SILTY CLAY, SLIGHT PLASTICITY, SLIGHTLY MOIST, WITH YELLOW (10YR 4/6) MOTTLING
								PLASTICITY INCREASING
5	SPT	2	17		90			
								BECOMES GRAVELLY AND SANDY AT 6.5 FEET, MOIST, MEDIUM STIFF, WITH SOME LIGHT OLIVE BROWN MOTTLING
							CL	OLIVE BROWN (2.5Y 4/3) SANDY CLAY, MOIST, PLASTIC, WITH GRAVEL
10	SPT	3	13		25			
15	SPT	4	10		65			
20	SPT	5	100/4		30			ENCOUNTER WOOD PIECES AT 20.5 FEET
25	SPT	6	100/5		100			SLIGHT BLACK MOTTLING
								BOREHOLE TERMINATED AT A DEPTH OF 27.0 FEET
30								

PLATE
LOG OF BORING

Dames & Moore

FILE

BORING 41SB1

Surface Elevation: 1730.0 Feet, MSL
Location: Radford AAP, Virginia
Start: 15:09 on 10-25-91
Finish: 15:45 on 10-25-91

Depth (Feet)	Sampling Method	Sample No.	Blows/Foot	Core Run No.	% Recovery	RQD %	Sample Interval	Symbols	Description
0	C	1			10			ML	BROWN (7.5YR 5/4) SANDY SILT, MOIST, FILL MATERIAL
5	C	2			60			CL/ML	BLACK (10YR 2/1) CLAY AND SILT, VERY MOIST, PROBABLY RED WATER ASH WASTE CHEMICAL SAMPLE COLLECTED 8.0-10.0 FEET
10	C	3			60				BECOMES INTERBEDDED WITH YELLOWISH RED (5YR 5/6) SILTY CLAY FROM 12.0 TO 13.0 FEET, VERY MOIST
								GC	BLUISH GRAY (5B 5/1) LIMESTONE AND DOLOMITE GRAVEL FROM 13.0-13.4 FEET
15								CL	REDDISH YELLOW SILTY CLAY WITH BLACK MINERAL INCLUSIONS CHEMICAL SAMPLE COLLECTED 14.0-15.0 FEET BELOW 15.0 FEET IS CLEAN SOIL

BOREHOLE TERMINATED AT A DEPTH OF 15.0 FEET

PLATE
LOG OF BORING

Dames & Moore

BORING 41MW3B

Surface Elevation: **1,760.0** Feet, MSL
Location: Radford AAP, Virginia
Start: 12:07 on 10-15-91
Finish: 12:40 on 10-16-91

Depth (Feet)	Sampling Method	Sample No.	Blows/Foot	Core Run No.	% Recovery	RQD %
0	SPT	1	35		65	
5	SPT	2	22		65	
10	SPT	3	18		95	
15	SPT	4	103		45	
20	SPT	5	82		80	
25	SPT	6	35		80	
30	SPT	7	50/0		100	
35	NX			1	95	66
40						

Symbols	Description
ML	STRONG BROWN (7.5YR 4/6) CLAYEY SILT WITH SOME GRAVELS, WITH REDDISH BROWN AND VERY PALE BROWN MOTTLING
CL	DARK YELLOWISH BROWN (10YR 4/4) SANDY CLAY, HIGHLY PLASTIC WITH OCCASIONAL GRAVELLY ZONES BECOMES STRONG BROWN (7.5YR 5/6) MORE GRAVELS VERY GRAVELLY 14-19 FEET, WITH CLAY
ML	PALE OLIVE (5YR 6/3) AND OLIVE YELLOW (2.5Y 6/6) SILT, HARD, DRY, FRIABLE, SLIGHTLY GRAVELLY, WITH SOME BLACK STAINING OCCASIONAL THIN SILTSTONE SEAMS (OLIVE GRAY) GRADES TO LIGHT YELLOWISH BROWN (2.5Y 6/4) WITH OLIVE AND GRAY MOTTLING
CL	STRONG BROWN (7.5YR 5/6) CLAY, SOFT, MOIST, STICKY, HIGHLY PLASTIC
SH	DARK GREENISH GRAY (5BG 4/1) SHALE, WITH ABUNDANT CALCITE VEINS, NO APPARENT BEDDING, YELLOW STAINING AT FRACTURES BECOMES HIGHLY WEATHERED YELLOWISH BROWN WITH INCREASED CLAY OCCASIONAL LAYERS OF SILTSTONE AND PITTED LIMESTONE

PLATE
LOG OF BORING

Dames & Moore

BORING 41MW3B (Cont'd)

Depth (Feet)	Sampling Method	Sample No.	Blows/Foot	Core Run No.	% Recovery	RQD %	Symbols
40							SH
	NX			2	88	45	
45							
	NX			3	100	78	DLST
50							
55							

Description

LESS WEATHERED DARK GREENISH GRAY SHALE WITH CALCITE VEINS

WITH HIGHLY WEATHERED AND CLAYEY ZONES

BECOMES PITTED AND SLIGHTLY VUGGY CLAYEY DOLOSTONE, GRAY (N/5) WITH THIN LIMESTONE SEAMS, HIGHLY WEATHERED, SANDY

BLUISH GRAY, HIGHLY CRACKED AND RECEMENTED WITH SOME REDDISH BROWN STAINING

CONTINUED HIGHLY WEATHERED

BOREHOLE TERMINATED AT A DEPTH OF 55.0 FEET

PLATE
LOG OF BORING

Dames & Moore

BORING 48SB1

Surface Elevation: **1,826.0** Feet, MSL
Location: Radford AAP, Virginia
Start: 08:06 on 8-19-91
Finish: 10:08 on 8-19-91

Depth (Feet)	Sampling Method	Sample No.	Blows/Foot	Core Run No.	% Recovery	RQD %	Sample Interval	Symbols	Description
0–5	C	1			40			ML	LIGHT BROWN (7.5YR 6/3) SANDY SILT, SLIGHTLY MOIST, FILL
5–9	C	2			50			GC	LIGHT BROWN (7.5YR 6/3) CLAYEY SILTY GRAVELS WITH COBBLES, PROBABLE LANDFILL BLACK STAINING – APPARENT OIL LANDFILL, WET CHEMICAL SAMPLE COLLECTED 8.0 FEET
9–12.5	C	3			50			CL	BROWN (7.5YR 5/4) SILTY CLAY, TRACE FINE SAND, WET SOME PLASTICITY, PROBABLY OUT OF LANDFILL AT 9.0 FEET BECOMING GRAVELLY AT 10.0 FEET
12.5–15								SM	STRONG BROWN (7.5YR 5/8) SILTY SAND, SOME GRAVEL, WET CHEMICAL SAMPLE COLLECTED 13.0 FEET GRAVEL SEAM AT 14.5–15.0 FEET BOREHOLE TERMINATED AT A DEPTH OF 15.0 FEET

PLATE
LOG OF BORING

Dames & Moore

BORING 48SB2

Surface Elevation: **1,827.0** Feet, MSL
Location: Radford AAP, Virginia
Start: 14:15 on 8-16-91
Finish: 15:50 on 8-16-91

Depth (Feet)	Sampling Method	Sample No.	Blows/Foot	Core Run No.	% Recovery	RQD %	Symbols	Description
0	SPT	1	10		16		ML	YELLOWISH RED (5YR 5/6) SILT, STIFF, SLIGHTLY MOIST
5	SPT	2	4		16		ML	GRADING TO BROWN (7.5YR 5/2) WITH TRACE FINE SAND, SOFT
								PROBABLE LANDFILL AT 9.5 FEET
10	SPT	3	2		67		CL ML	BLACK (10YR 2/1) STAINED CLAY AND SILT, NO ODOR CHEMICAL SAMPLE COLLECTED 11.0-12.0 FEET PROBABLY OUT OF LANDFILL AT 12.0 FEET
	SPT	4	3		8		CL	LIGHT BROWN (7.5YR 6/3) SILTY CLAY, WET, SOFT
15	SPT	5	50		8		CL	GRADING TO BROWN (10YR 5/3) SILTY CLAY WITH GRAVEL, VERY MOIST
	SPT	6	100/5		0		CL	
	SPT	7	100/5		0		CL	
20	SPT	8	10		92		CL	GRADING TO YELLOWISH BROWN (10YR 5/4), STIFF, GRAVELS GRADE OUT CHEMICAL SAMPLE COLLECTED 20.0-22.0 FEET
25								BOREHOLE TERMINATED AT A DEPTH OF 22.0 FEET

PLATE
LOG OF BORING

Dames & Moore

BORING 48SB3

Surface Elevation: **1,821.0** Feet, MSL
Location: Radford AAP, Virginia
Start: 11:25 on 8-19-91
Finish: 14:28 on 8-18-91

Depth (Feet)	Sampling Method	Sample No.	Blows/Foot	Core Run No.	% Recovery	RQD %	Sample Interval	Symbols	Description
0								ML	STRONG BROWN (7.5YR 5/8) FINE SANDY SILT, SLIGHTLY MOIST, TRACE GRAVELS
	C	1			50				
5								SM/SC	STRONG BROWN (7.5YR 5/8) SILTY CLAYEY SAND, SOME GRAVELS, SLIGHTLY MOIST
	C	2			4				
10								GC	PROBABLE LANDFILL AT 9.0 FEET STRONG BROWN (7.5YR 5/6) SILTY GRAVEL WITH FINE TO MEDIUM SAND, SLIGHT PETROLEUM ODOR
	C	3			40				GRADED CONTACT
15								ML	YELLOWISH BROWN (10YR 5/6) SANDY SILT, MOIST, STRONG ODOR
	C	4			50				CHEMICAL SAMPLE COLLECTED 18.0-20.0 FEET
20									BORING TERMINATED AT A DEPTH OF 20.0 FEET

PLATE
LOG OF BORING

Dames & Moore

Army Pollution Abatement Program Study, Installation of Monitoring Wells, Radford Army Ammunition Plant, Radford, VA, 3-9 April 1981, (USAEHA Control No. 81-26-8251-81)

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT RAAP 81-26-8251-81 DATE 4 Apr 81

LOCATION Site 6, East of lagoon between 2nd road & Steam line (see map) DRILLERS Smithson, Hoddinott Craig, Gates (logger)

DRILL RIG Acker II w/ 4 in continuous flight auger BORE HOLE MW 13

TD= 45 feet

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS (water level initial 49 ft. 24 hr. 43' 10 ")	
		fill material for road		31.5 ft. schedule 40 2 in ID PVC casing
			29 ft of concrete grout	
5 ft				
		same material		
10 ft		Reddish brown silty clay, very plastic, damp.		
	MB 10-15			
15 ft				

HSE-ES Form 78, 1 Jun 80

Replaces USAEHA Form 95, 12 Aug 74, which will be used.

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT RAAP 81-26-8251-81 DATE 4 April 81

LOCATION Site 6, east of lagoon between 2nd road & steam line (see map) DRILLERS Smithson, Hoddinott Craig, Gates (logger)

DRILL RIG Acker II, w/ 4 in continuous flight auger BORE HOLE MW 13

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS	
		Easy drilling		
		same material	Concrete grout	PVC casing
20 ft				
25 ft		getting tighter	4 ft of Bentonite	
		same material, easy drilling clay is wetter-very plastic	28 ft of sand pack	
30 ft				

HSE-ES Form 78, 1 Jun 80

Replaces USAEHA Form 95, 12 Aug 74, which will be used.

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT RAAP 81-26-8251-81 DATE 4 April 81

LOCATION Site 6, east of lagoon between 2nd road and steam line (see map) DRILLERS Smithson, Hoddinott Craig, Gates (logger)

DRILL RIG Acker II, w/ 4 in continuous flight auger BORE HOLE MW 13

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS	
		gravel sound-- turnings from auger wet & sticky- near water table		
35 ft		same material	sand pack	12.5 ft of slotted schedule 40, 2 in ID PVC screen (0.008-0.010")
40 ft		Change in engine pitch- grinding thumping noise-may be Elbrook FM. Pulled Auger to investigate.		
	▼	Elbrook Dolomite (last 5 ft of Auger very wet).		
45 ft		TD 45 feet	Depth of well 45 feet	

NOTE: Well development loss of +400 gallons of water in 2 min. after pumpimg at 150 psi. Water level fluctuated very little.

Army Pollution Abatement Program Study, Installation of Monitoring Wells, Radford Army Ammunition Plant, Radford, VA, 3-9 April 1981, (USAEHA Control No. 81-26-8251-81)

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT RAAP 81-26-8251-81 DATE 4 April 81

LOCATION Site 6, west of apex of lagoon DRILLERS Smithson, Hoddinott Craig, Gates (logger)

DRILL RIG Acker II w/ 4 in continuous flight Auger BORE HOLE MW 14

TD= 45 ft

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS (water level-dry 48 hr.-dry , loss of fluid)	
		Red silty clay, very plastic, damp Drilling easy	12 ft of concrete grout	18 ft of schedule 40, 2 in ID PVC casing
		Small pea gravel in red silty clay		
5 ft				
		same material (very Plastic)		
	MB 5-10			
10 ft				
		clay very soft-easy drilling	2 ft of Bentonite	
15 ft			sand	

HSE-ES Form 78, 1 Jun 80

Replaces USAEHA Form 95, 12 Aug 74, which will be used.

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT RAAP 81-26-8251-81 DATE 4 April 81

LOCATION Site 6, west of apex of Lagoon DRILLERS Smithson, Hoddinott Craig, Gates (logger)

DRILL RIG Acker II, w/ 4 in continuous flight auger BORE HOLE MW 14

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS	
15				PVC casing
		same material		
			31 ft of sand pack	15 ft of slotted 2 in ID, schedule 40, PVC screen
20 ft				
		same material- getting wetter		
25 ft		Silty clay with gravel (¼-½ in)		
		water table close		
		very easy drilling		
30 ft				

HSE-ES Form 78, 1 Jun 80

Replaces USAEHA Form 95, 12 Aug 74, which will be used.

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT RAAP 81-26-8251-81 DATE 4 April 81

LOCATION Site 6, west of apex of lagoon DRILLERS Smithson, Hoddinott Craig, Gates (logger)

DRILL RIG Acker II, w/ 4 in continuous flight auger BORE HOLE MW 14

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS	
		same material		slotted PVC screen
		wet clay has sealed water lenses		add 2 ft of sed trap
~~35 ft~~			sand pack	bottom of well 35 ft.
		no returns		
40 ft			sand pack	
		No Elbrook FM encountered, may be a sink hole.	During well development lost 200 gallons of fluid in less than 2 minutes. /there is a void at depth	
45 ft		TD 45 ft		

NOTE: fluid loss of 100 gallons water at 100 psi in 2 minutes.

HSE-ES Form 78, 1 Jun 80
Replaces USAEHA Form 95, 12 Aug 74, which will be used.

Army Pollution Abatement Program Study, Installation of Monitoring Wells, Radford Army Ammunition Plant, Radford, VA, 3-9 April 1981, (USAEHA Control No. 81-26-8251-81)

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT RAAP 81-26-8251-81 DATE 4 April 81

LOCATION Site 6, next to southwest corner of bldg. 3019 (boiling tub house) DRILLERS Smithson, Hoddinott Craig, Gates (logger)

DRILL RIG Acker II w/ 4 in continuous flight Auger BORE HOLE MW 15

TD=30 ft

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS (water level initial=dry; 24 hr= dry, loss of fluid)	
		Fill material	4'8" of concrete frout	9 ft of schedule 40, 2 in ID PVC casing
		red silty clay, saturated (sticky)		
5 ft			1'8" of Bentonite	
	MB 5-10		22.7 ft of sand pack	
				18.5 ft of slotted 2 in ID PVC screen (0.008-0.010")
10 ft		same material		
15 ft				

HSE-ES Form 78, 1 Jun 80

Replaces USAEHA Form 95, 12 Aug 74, which will be used.

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT RAAP 81-26-8251-81

DATE 4 April 81

LOCATION Site 6, next to southwest corner of bldg. 3019 (boiling tub house)

DRILLERS Smithson, Hoddinott Craig, Gates (logger)

DRILL RIG AckerII w/ 4 in continuous flight Auger

BORE HOLE MW 15

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS	
		same material		
20 ft			sand pack	
		same material-very sticky water table difficult to locate due to clay plastering the sides of the bore hole		
25 ft		It seems that we have been passing through small perched lenses of water		
		weathered Elbrook FM		2.5 ft of sed. trap
		drilling getting difficult (4700 psi) Refusal - Elbrook FM		
30 ft			Fall back	

30 ft TD

NOTE: during well development lost 400 gallons of fluid in 2 min. under 250 psi. There is a void at depth.

Army Pollution Abatement Program Study, Installation of Monitoring Wells, Radford Army Ammunition Plant, Radford, VA, 3-9 April 1981, (USAEHA Control No. 81-26-8251-81)

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT RAAP 81-26-8251-81

DATE 4 April 81

LOCATION Site 6, south of lagoon & rail tracks or a hill next to Blg. 3003 (spent acid storage)

DRILLERS Smithson, Hoddinott, Craig, GAtes (logger)

DRILL RIG ~~Acker II w/ 4 in~~ continuous flight auger

BORE HOLE ~~MW 16~~

TD= 21 ft

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS (water level initial= wet, no yield; 24 hr.= dry, loss of fluid)	
0		Red, silty micaceous clay, dry	1 ft of concrete grout	11 ft of schedule 40, 2 in ID PVC casing
			7 ft of Bentonite grout	
5 ft		Reddish brown micaceous sandy silt with ¼-1" gravel		
			13 ft of sand pack	
10 ft	MB 10-15	same material		
		Getting more coarse		10 ft of screen
		getting wetter		
15 ft				

HSE-ES Form 78, 1 Jun 80

Replaces USAEHA Form 95, 12 Aug 74, which will be used.

US ARMY ENVIRONMENTAL HYGIENE AGENCY

Army Pollution Abatement Program Study, Installation of Monitoring Wells, Radford Army Ammunition Plant, Radford, VA, 3-9 April 1981, (USAEHA Control No. 81-26-8251-81)

DRILLING LOG

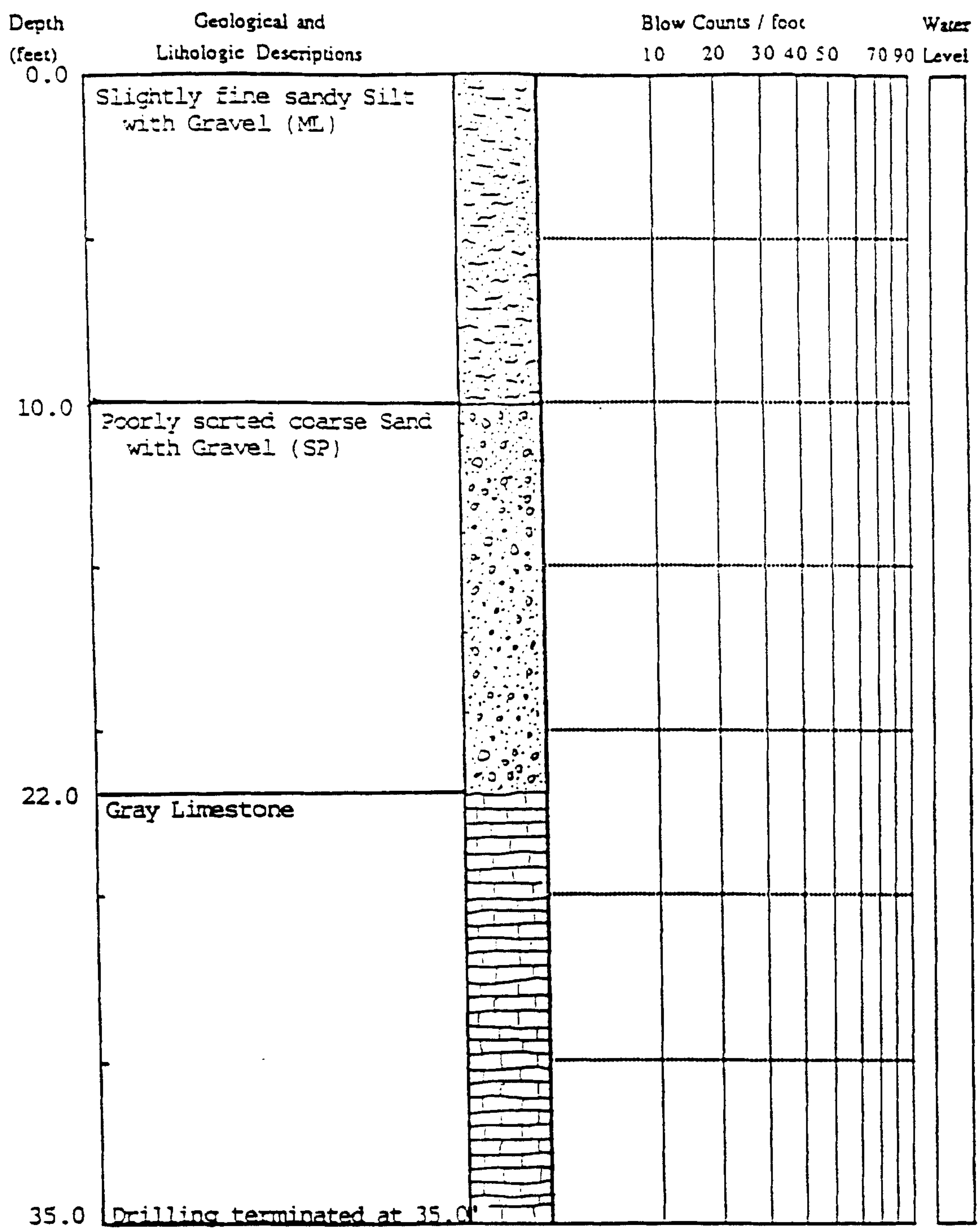
PROJECT RAAP 81-26-8251-81 DATE 4 April 81

LOCATION Site 6, south of lagoon & RR or by a hill next to bldg. 3003 DRILLERS Smithson, Hoddinott Craig, Gates (logger)

DRILL RIG Acker II BORE HOLE MW 16

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS	
		same material easy drilling	sand pack	Slotted 2 in ID schedule 40, PVC screen (0.008-0.010")
20 ft		Reddish brown/gold silty clay very wet, plastic, sticky		depth of well 21 ft
		Refusal—Elbrook Dolomite	TD 21 ft	
25 ft		NOTE: 300 lb of sand was placed in annular space, until it filled to 8 ft. A small cavern possibly exists at depth which was filled with sand pack.		
30 ft				

USAEHA Form 95, 12 Aug 74



Boring and sampling meets ASTM D-1586; Core drilling meets ASTM D-2113; Penetration is the number of blows of 140-pound hammer falling 30 inches required to drive a 1.4-inch ID sampler one foot.

Test Boring Records

Boring No. DG-1 Site Radford AAP

Job No. 194 Date 900827

Geophex

Source: Geophex, 1990

Well Number: DG-1 Drilling Method: Air Rotary

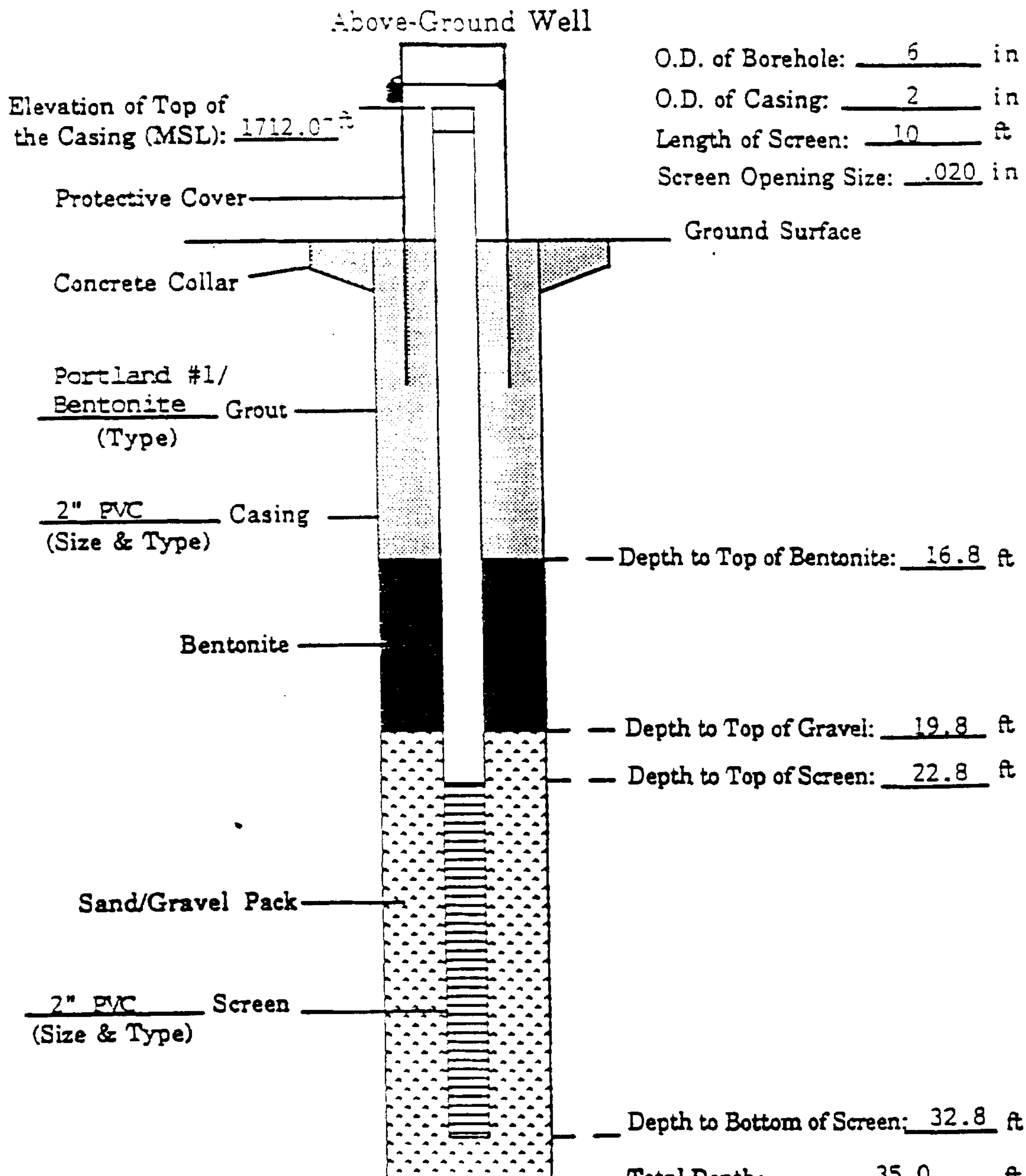
Date Started: 900827 Drilling Fluids: Air/Water

Date Finished: 900828 Static Water Level: 23.09 Date: 900903

Geologist/Engineer: Daw Observed By:

Remarks: Elevation to top of casing (TOC) is relative to D3 TOC. D3 TOC is assumed to be 1702.94 feet MSL.

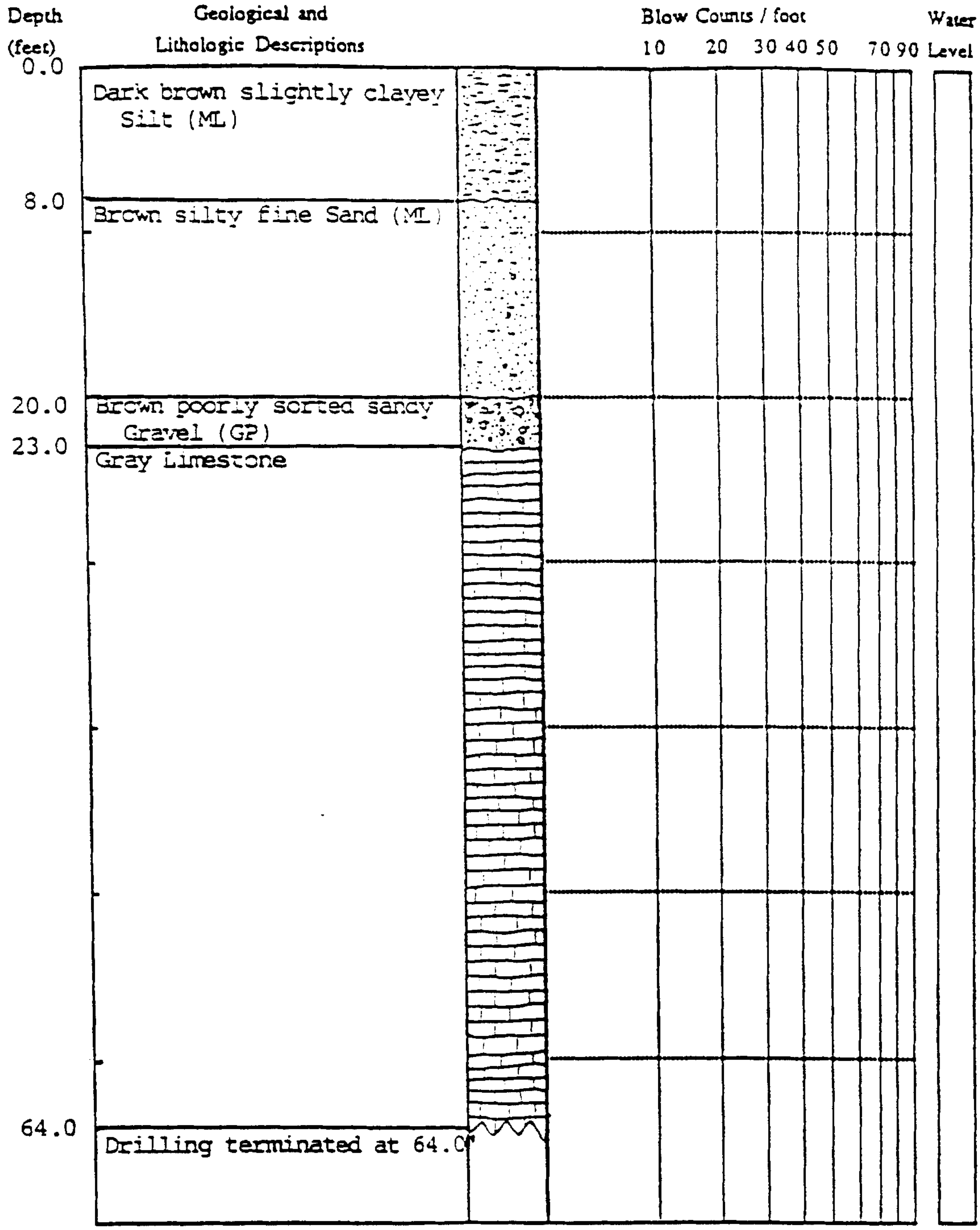
All depths referenced to ground surface



Not to Scale

Geophex	PROJECT: Radford AAP	Job No: 194 Figure No. Site:

Source: Geophex, 1990



Boring and sampling meets ASTM D-1586; Core drilling meets ASTM D-2113; Penetration is the number of blows of 140-pound hammer falling 30 inches required to drive a 1.4-inch ID sampler one foot.

Test Boring Records

Boring No. D3D Site Radford AAP

Job No. 194 Date 900828

Geophex

Source: Geophex, 1990

Well Number: D3D

Date Started: 900828

Date Finished: 900828

Geologist/Engineer: Daw

Drilling Method: Air Rotary

Drilling Fluids: Air/Water

Static Water Level: 18.02 Date: 900903

Observed By:

Remarks: Elevation to top of casing (TOC) is relative to D3 TOC. D3 TOC is assumed to be 1702.94 feet MSL.

All depths referenced to ground surface

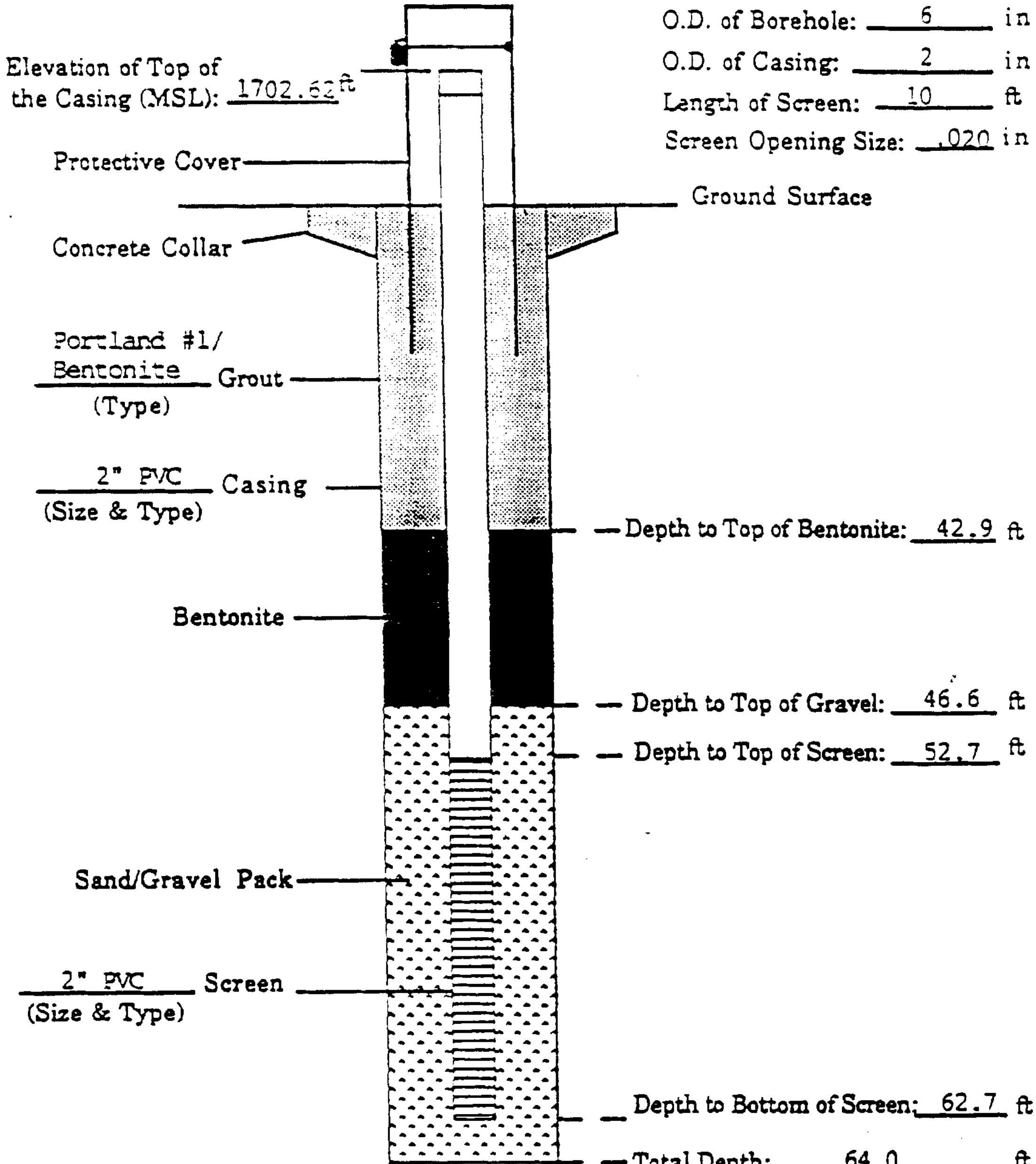
Above-Ground Well

O.D. of Borehole: 6 in

O.D. of Casing: 2 in

Length of Screen: 10 ft

Screen Opening Size: .020 in



Not to Scale

Geophex	PROJECT: Radford AAP	Job No: 194 Figure No. Site:

Source: Geophex, 1990

Geraghty & Miller, Inc.

WELL LOG

PROJECT: RADFORD
CLIENT: NUS
Date Prepared: 8/7/80 By: G.F.S.

DEPTH, IN FEET, BELOW LAND SURFACE	DESCRIPTION
0	Silt and sand, micaceous, brown
~3	Sand, fine to medium, well sorted, micaceous, brown
10	Same as above
~13	Water Table
15	Sand grades to coarse
~19	Same as above
20	Lost circulation (10-15 gpm)
~21	Changed from 5" fishtail bit to 3" NX core barrel
~24	Top of Rock
~24	Regained circulation
25	Limestone, badly weathered, lot of calcite, black
~34	Same as above
35	Bottom of Hole

Sample intervals (hatched): approx. 4–6 ft, 9–11 ft, 14–16 ft, 19–21 ft, 24–35 ft.

OWNER: Corps of Engineers
WELL No.: D-2
LOCATION: Lagoon D - Settling Ponds in use
TOPO SETTING:
GROUND ELEV.: 1713.12

DRILLING STARTED: 8/7/80
DRILLING COMPLETED: 8/8/80
DRILLER: M. J. Dean
TYPE OF RIG: CME-75

WELL DATA

HOLE DIAM.: 5" to 23 ft; 3" to 35 ft
TOTAL DEPTH: 35 ft
CASING DIAM.: 2 in Timco PVC
CASING LENGTH: 20 ft
SCREEN DIAM.: 2
SCREEN SETTING: 20-35 ft
SCREEN SLOT & TYPE: .010 PVC
WELL STATUS: Completed

GROUT

TYPE OF GROUT: Neat cement
GROUT DEPTH: 0-15 ft
VOLUME: .6 cu ft
TYPE OF PLUG: Bentonite
PLUG DEPTH: 14-15 ft
VOLUME: 1 lb

DEVELOPMENT

METHOD: Air
RATE: 0.1 gpm
LENGTH: 40 min.

TEST DATA

STATIC DEPTH TO WATER: 13.14
DATE MEASURED: 8/14/80
PUMPING DEPTH TO WATER:
DURATION OF TEST:
PUMPING RATE:
DATE OF TEST:
TYPE OF TEST:
PUMP SETTING:
SPECIFIC CAPACITY:

FINAL PUMP CAPACITY:
FINAL PUMP SETTING:
AVERAGE PUMPAGE:

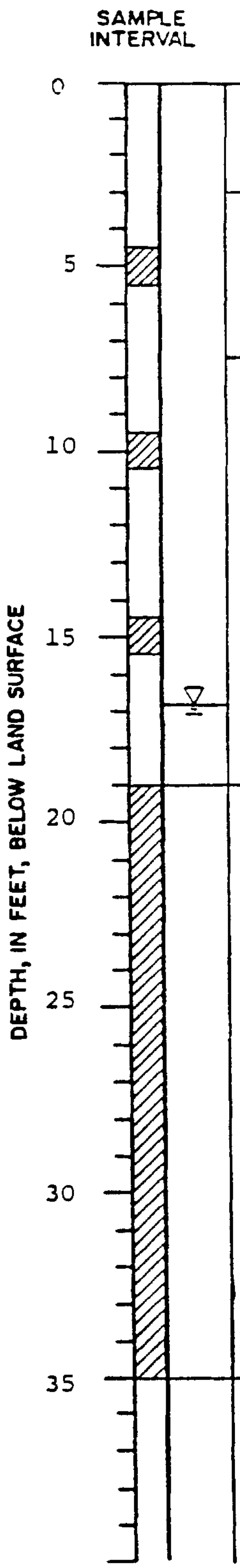
WATER QUALITY

Source: USACE, 1981

Geraghty & Miller, Inc.

WELL LOG

PROJECT: RADFORD
CLIENT: NUS
Date Prepared: 8/7/80 By: G.F.S.



DESCRIPTION

Depth (ft)	Description
0	Clay, silty, dark brown
~3	Silt, clayey, dark brown
~7.5	Sand, fine, silty, micaceous, brown
15	Sand grades to medium
~16.7	Water Table Change from 5" fishbit to 3" NX core barrel
~19	Top of Rock Lost Circulation Dolostone, calcite crystals and veins, gray
30	Same as above
35	Same as above Bottom of Hole

Source: USACE, 1981

OWNER: Corps of Engineers
WELL No.: D-3
LOCATION: Lagoon D - Settling Ponds
TOPO SETTING:
GROUND ELEV.: 1699.97

DRILLING STARTED: 8/7/80
DRILLING COMPLETED: 8/7/80
DRILLER: R. A. Monroe
TYPE OF RIG: C-40

WELL DATA

HOLE DIAM.: 5" to 19 ft; 3" to 35 ft
TOTAL DEPTH: 35 ft
CASING DIAM.: 2 in Timco PVC
CASING LENGTH: 20 ft
SCREEN DIAM.: 2 in
SCREEN SETTING: 20-35 ft
SCREEN SLOT & TYPE: .010 PVC
WELL STATUS: Completed

GROUT

TYPE OF GROUT: Neat cement
GROUT DEPTH: 0-15 ft
VOLUME: .6 cu ft
TYPE OF PLUG: Bentonite
PLUG DEPTH: 14-15 ft
VOLUME: 1 lb

DEVELOPMENT

METHOD: Air
RATE: 0.25 gpm
LENGTH: 25 min

TEST DATA

STATIC DEPTH TO WATER: 16.74
DATE MEASURED: 8/14/80
PUMPING DEPTH TO WATER:
DURATION OF TEST:
PUMPING RATE:
DATE OF TEST:
TYPE OF TEST:
PUMP SETTING:
SPECIFIC CAPACITY:

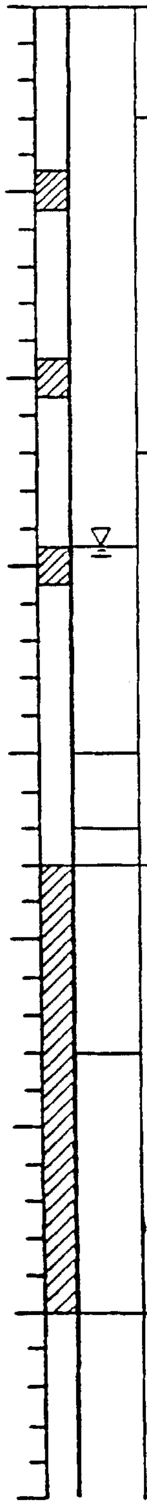
FINAL PUMP CAPACITY:
FINAL PUMP SETTING:
AVERAGE PUMPAGE:

WATER QUALITY

Geraghty & Miller, Inc.

WELL LOG

PROJECT: RADFORD
CLIENT: NUS
Date Prepared: 8/7/80 By: G.F.S.



SAMPLE INTERVAL (DEPTH, IN FEET, BELOW LAND SURFACE)	DESCRIPTION
0	Sand, fine, silty, some clay, micaceous, brown
	Clay, silty, brown
5	
	Clay balls, tarry, septic odor, dark gray
10	
	Sand, fine to medium, micaceous, well sorted, off-white to tan
	Water Table
15	
20	Lost Circulation (10-15 gpm)
	Regained Circulation (10-15 gpm)
	Top of Rock
	Limestone
25	No Recovery
	Lost Circulation (10-15 gpm)
30	
	No Recovery
35	Bottom of Hole

OWNER: Corps of Engineers
WELL No.: D-4
LOCATION: Lagoon D - Settling Ponds in use
TOPO SETTING:
GROUND ELEV.: 1713.44

DRILLING STARTED: 8/7/80
DRILLING COMPLETED: 8/7/80
DRILLER: M. J. Dean
TYPE OF RIG: CME-75

WELL DATA

HOLE DIAM.: 5" to 23 ft; 3" to 35 ft
TOTAL DEPTH: 35 ft
CASING DIAM.: 2 in Timco PVC
CASING LENGTH: 20 ft
SCREEN DIAM.: 2 in
SCREEN SETTING: 20-35 ft
SCREEN SLOT & TYPE: .010 PVC
WELL STATUS: Completed

GROUT

TYPE OF GROUT: Neat cement
GROUT DEPTH: 0-15 ft
VOLUME: .6 cu ft
TYPE OF PLUG: Bentonite
PLUG DEPTH: 14-15 ft
VOLUME: 1 lb

DEVELOPMENT

METHOD: Air
RATE: 0.1 gpm
LENGTH: 46 min

TEST DATA

STATIC DEPTH TO WATER: 14.43
DATE MEASURED: 8/14/80
PUMPING DEPTH TO WATER:
DURATION OF TEST:
PUMPING RATE:
DATE OF TEST:
TYPE OF TEST:
PUMP SETTING:
SPECIFIC CAPACITY:

FINAL PUMP CAPACITY:
FINAL PUMP SETTING:
AVERAGE PUMPAGE:

WATER QUALITY

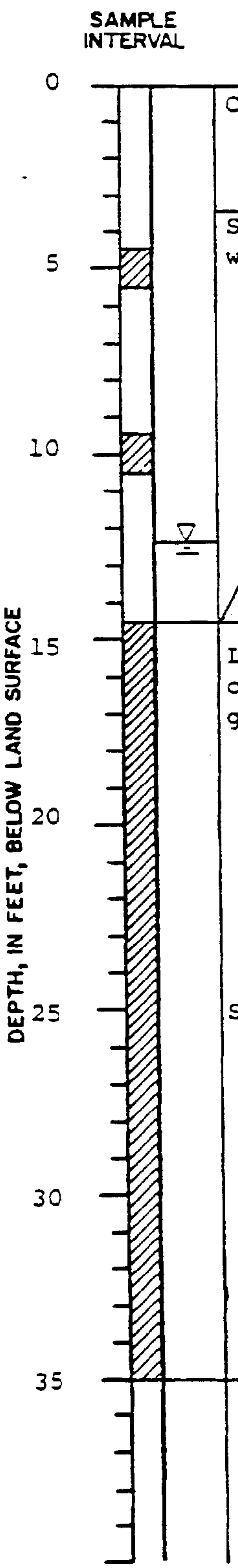
Source: USACE, 1981

Geraghty & Miller, Inc.

WELL LOG

PROJECT: RADFORD
CLIENT: NUS
Date Prepared: 8/7/80 By: G.F.S.

Depth (ft)	Description
0	Clay, silty, micaceous, brown
~3.5	Sand, fine, some silt, micaceous, well sorted, brown
~12	Water Table
~12.5	Changed from 5" fishtail bit to 3" NX core barrel
~14.5	Top of Rock
15	Limestone, soft, weathered, some calcite, some solution channels, gray
25	Same as above
35	Same as above
35	Bottom of Hole



OWNER: Corps of Engineers
WELL No.: D-5
LOCATION: Lagoon D - Settling Ponds in use
TOPO SETTING:
GROUND ELEV.: 1696.12

DRILLING STARTED: 8/7/80
DRILLING COMPLETED: 8/8/80
DRILLER: R. A. Monroe
TYPE OF RIG: C-40

WELL DATA

HOLE DIAM.: 5" to 14.5 ft; 3" to 35 ft
TOTAL DEPTH: 35 ft
CASING DIAM.: 2 in Timco PVC
CASING LENGTH: 20 ft
SCREEN DIAM.: 2 in
SCREEN SETTING: 20-35 ft
SCREEN SLOT & TYPE: .010 PVC
WELL STATUS: Completed

GROUT

TYPE OF GROUT: Neat cement
GROUT DEPTH: 0-15 ft
VOLUME: .6 cu ft
TYPE OF PLUG: Bentonite
PLUG DEPTH: 14-15 ft
VOLUME: 1 lb

DEVELOPMENT

METHOD: Air
RATE: 0.1 gpm
LENGTH: 47 min

TEST DATA

STATIC DEPTH TO WATER: 12.35
DATE MEASURED: 8/[illegible]/80
PUMPING DEPTH TO WATER:
DURATION OF TEST:
PUMPING RATE:
DATE OF TEST:
TYPE OF TEST:
PUMP SETTING:
SPECIFIC CAPACITY:

FINAL PUMP CAPACITY:
FINAL PUMP SETTING:
AVERAGE PUMPAGE:

WATER QUALITY

Source: USACE, 1981

Geraghty & Miller, Inc.

WELL LOG

PROJECT: RADFORD
CLIENT: NUS
Date Prepared: 8/8/80 By: G.F.S.

Depth (ft)	Description
0	Clay, silty, micaceous, brown
~8.5	Sand, fine, micaceous, well sorted, off-white
15	Sand grades into medium to coarse. Water Table
18	Top of Rock (Limestone). No recovery. Changed from 5" fishtail bit to 3" NX core barrel
25	Mudstone, pea sized, green
35	Same as above. Bottom of Hole

SAMPLE INTERVAL: 4–5 ft, 9–10 ft, 14–15 ft, 18–35 ft

DEPTH, IN FEET, BELOW LAND SURFACE

OWNER: Corps of Engineers
WELL No.: D-6
LOCATION: Lagoon D - Settling Ponds in use
TOPO SETTING:
GROUND ELEV.: 1699.64

DRILLING STARTED: 8/8/80
DRILLING COMPLETED: 8/11/80
DRILLER: R. A. Monroe
TYPE OF RIG: C-40

WELL DATA

HOLE DIAM.: 5" to 18 ft; 3" to 35 ft
TOTAL DEPTH: 35 ft
CASING DIAM.: 2 in Timco PVC
CASING LENGTH: 20 ft
SCREEN DIAM.: 2 in
SCREEN SETTING: 20-35 ft
SCREEN SLOT & TYPE: .010 PVC
WELL STATUS: Completed

GROUT

TYPE OF GROUT: Neat cement
GROUT DEPTH: 0-15 ft
VOLUME: .6 cu ft
TYPE OF PLUG: Bentonite
PLUG DEPTH: 14-15 ft
VOLUME: 1 lb

DEVELOPMENT

METHOD: Air
RATE: 3 gpm
LENGTH: 55 min

TEST DATA

STATIC DEPTH TO WATER: 15.40
DATE MEASURED: 8/13/80
PUMPING DEPTH TO WATER:
DURATION OF TEST:
PUMPING RATE:
DATE OF TEST:
TYPE OF TEST:
PUMP SETTING:
SPECIFIC CAPACITY:

FINAL PUMP CAPACITY:
FINAL PUMP SETTING:
AVERAGE PUMPAGE:

WATER QUALITY

Source: USACE, 1981

Hole No. DH-2

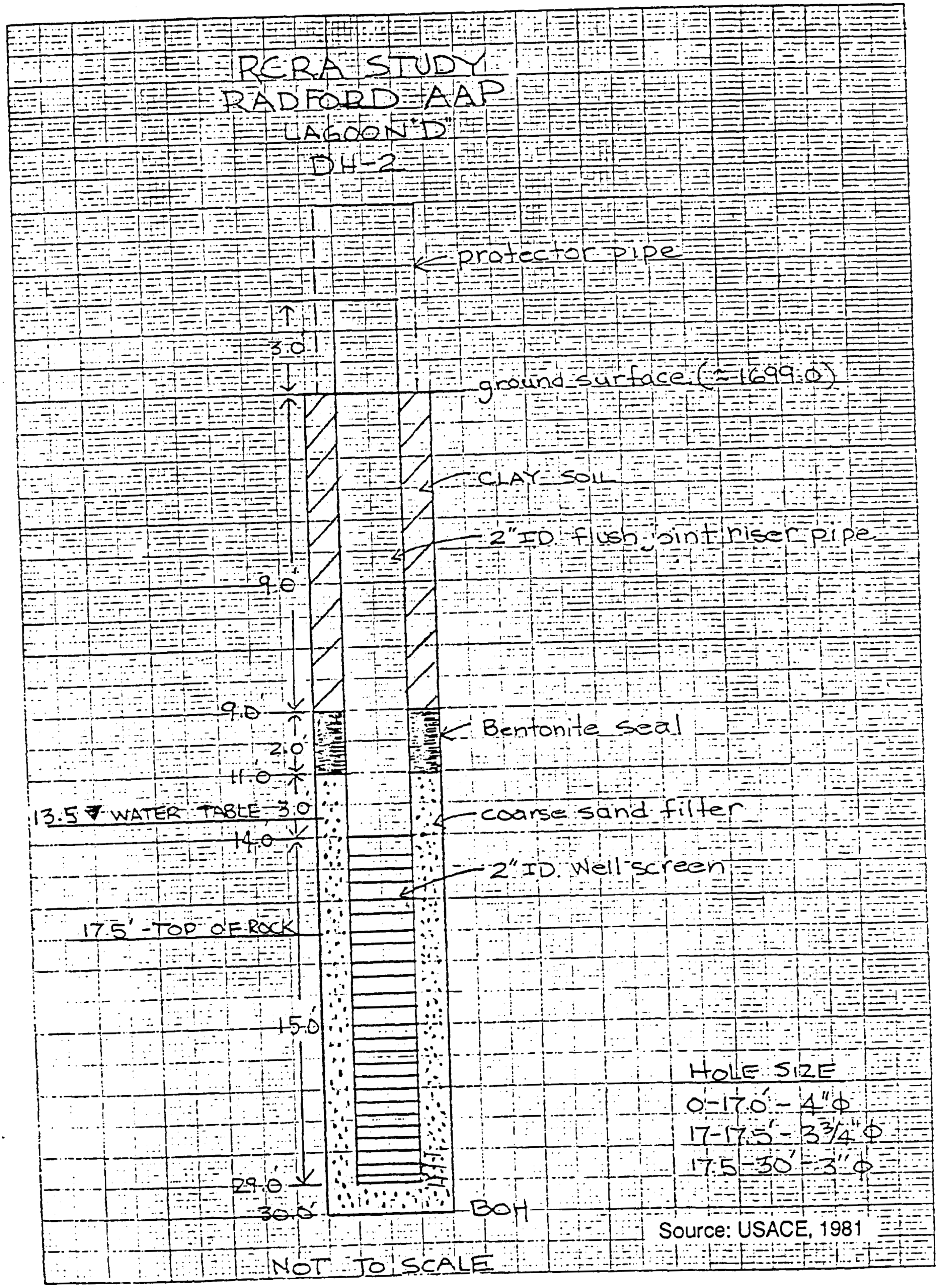
DRILLING LOG

Field	Entry
DIVISION	NAD
INSTALLATION	NAO
SHEET	1 OF 1 SHEETS
1. PROJECT	RCRA STUDY - LAGOON D
2. LOCATION (Coordinates or Station)	N 319,070 E1,407,780
3. DRILLING AGENCY	CUNNINGHAM CORE DRILLING
4. HOLE NO. (As shown on drawing title and file number)	DH-2
5. NAME OF DRILLER	BOB MONROE
6. DIRECTION OF HOLE	☒ VERTICAL ☐ INCLINED ______ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN	17.5
8. DEPTH DRILLED INTO ROCK	12.5
9. TOTAL DEPTH OF HOLE	30.0
10. SIZE AND TYPE OF BIT	2" O.D. SS; NX DIA
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)	MSL
12. MANUFACTURER'S DESIGNATION OF DRILL	SPRAGUE & HENWOOD 40C
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN	DISTURBED 4 ; UNDISTURBED 1
14. TOTAL NUMBER CORE BOXES	1
15. ELEVATION GROUND WATER	1684.9
16. DATE HOLE	STARTED 16 JULY 80 ; COMPLETED 16 JULY 80
17. ELEVATION TOP OF HOLE	1699.0
18. TOTAL CORE RECOVERY FOR BORING	5.9 34.6 %
19. SIGNATURE OF INSPECTOR	William J. Barker

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			3" topsoil	100	S-1	Split Spoon 2-2-4
			(ML) SILT, some v. fn sand, brn, slt. plast, moist tr. organics			advanced w/4" fishtail k(0-5) = 0
	4.5		(SM) SAND, v. fn-fn, little silt, brn, NP, v. moist	100	S-2	Split Spoon 1-2-3
						k(0-10) = .1 ft/day
			same (SM) in shelby tube v. moist	100	UD-1	Shelby tube-push
			less silt and little med. sand w/depth, saturated			k(0-15) = .49 ft/day k(0-17) = .81 ft/day
	16.0			100	S-3	Split Spoon 1-1-14
	17.0		(GP) GRAVEL, some fn-crs sand & cobbles, saturated	100	S-4	Split Spoon 17-30/.4
			Top of rock @ 17.5 LIMESTONE BRECCIA, blue gray angular fragments w/clayey silty matrix, badly weathered, soft to mod. hard more fragments than core pieces	35	Run 1 .9	Set casing to 18.0 NX Core: RQD = 0
				50%	Run 2 Box 1	k(17.5-30) = .49 ft/day NX Core RQD = 0
	30.0				5.0	
			BOH - 30.0 Water of completion: Water after 24 hrs:	13.5' 14.1'		Well installation took 2.0 hours

Right-margin depth scale: 0, 1.5, 5.0, 6.5, 10.0, 11.0, 15.0, 16.5, 17.5, 20.0, 30.0

Source: USACE, 1981



Source: USACE, 1981

Hole No. DH-4

DRILLING LOG	DIVISION: NAD	INSTALLATION: NAO	SHEET 1 OF 1 SHEETS

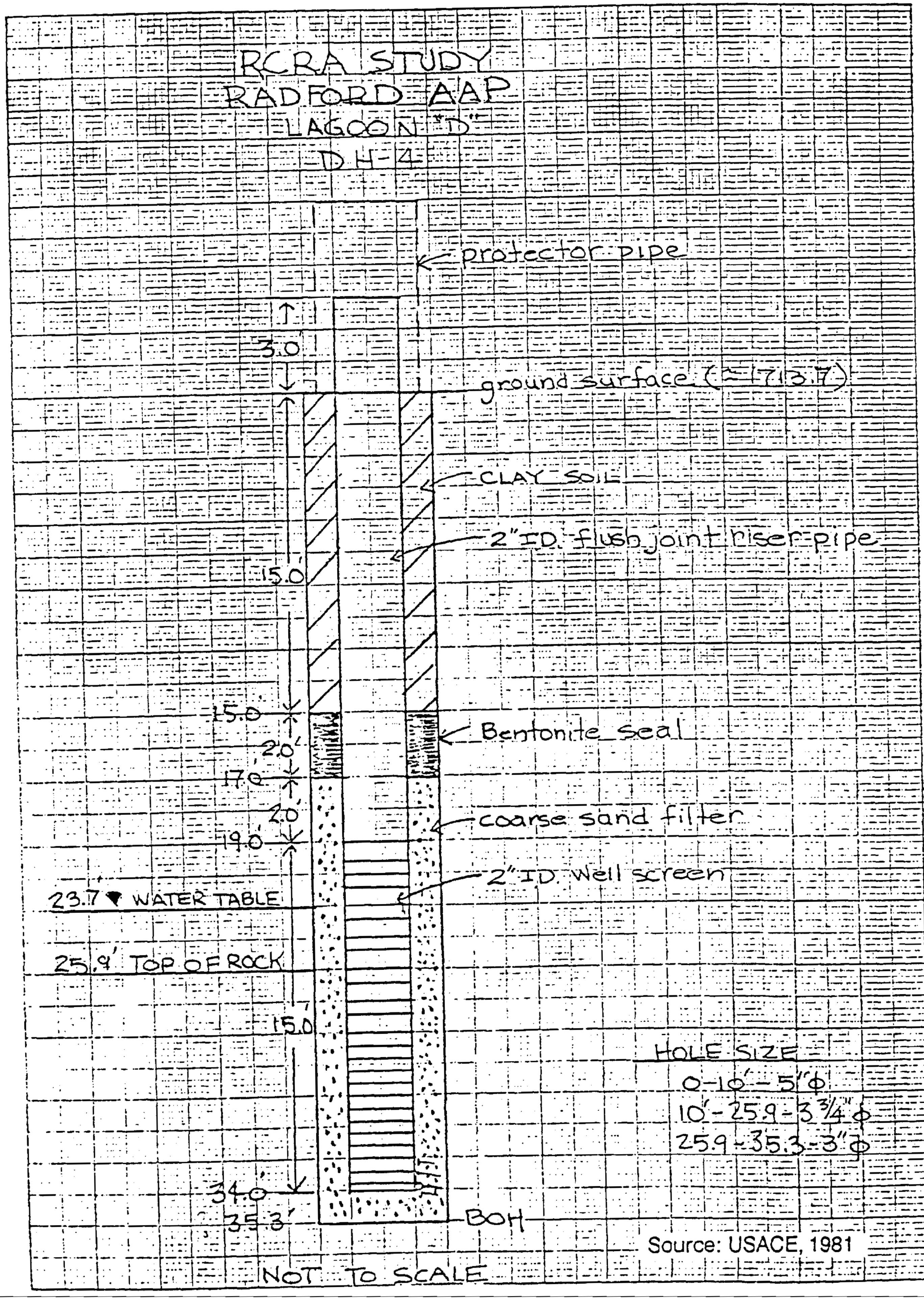
1. PROJECT: RCRA STUDY - LAGOON D	10. SIZE AND TYPE OF BIT: 2" O.D. SS: NX DIA
2. LOCATION (Coordinates or Station): N 318,740 E1,407,610	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
3. DRILLING AGENCY: CUNNINGHAM CORE DRILLING	12. MANUFACTURER'S DESIGNATION OF DRILL: SPRAGUE & HENWOOD 40C
4. HOLE NO. (As shown on drawing title and file number): DH-4	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 4; UNDISTURBED 0
5. NAME OF DRILLER: BOB MONROE	14. TOTAL NUMBER CORE BOXES: 1
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER: 1690.0
	16. DATE HOLE: STARTED 17 JULY 80; COMPLETED 18 JULY 80
7. THICKNESS OF OVERBURDEN: 25.9	17. ELEVATION TOP OF HOLE: 1713.7
8. DEPTH DRILLED INTO ROCK: 9.4	18. TOTAL CORE RECOVERY FOR BORING: 8.5 89 %
9. TOTAL DEPTH OF HOLE: 34.3	19. SIGNATURE OF INSPECTOR: William Barker

ELEVATION (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	BOX OR SAMPLE NO. (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)
			2" Topsoil (ML) SILT, little v. fn-fn sand, brn, slt plast. moist to dry	100	S-1	Split Spoon/6-6-5 K (0-5) = 0
1710.2	3.5		(SM) SAND, fn-fn some mica silt, tr. clay, slt plast moist, yel.brn	100	S-2	Split Spoon 4-6-8 K (5-10) = .87 ft/day set 4" casing to 10.0
1704.7	9.0		same (SM) w/some gravel and cobbles	100	S-3	Split Spoon 12-25-25 K (10-15) = 2.45 ft/day
1701.2	12.5		(GP) Gravels & Cobbles, some fn-crs sand, tr silt	0	S-4	Split Spoon 15-30/.4 no recovery on S-4 advanced casing to 20' K (15-20) = 6.16 ft/day
1693.7	20.0		(GC) Gravels and Sand fn-crs, some silt & clay, yel. brn, low plast saturated, very soft			hole caved below casing K (20-25.9) = 23.6 ft/day Split Spoon - WT of hammer from 20 - 25.9 set casing in rock to 26
1687.8	25.9		Cored river jack 25.9-26.1 Dolomitic limestone, blue gray, thin-med bedded, dipping 25-30° w/zones of irregular bedding dipping up to 70°, v. fn grained, mod hard, slt. weathered, many calcite healed fractures, some calcite filled vugs, largest core piece - 13", average = 5", smallest = 1"	89%	Run 1 Box 1 84	NX Core RQD = 40% K (25.9 - 35.3) = 13.7 ft/day No pressure
1679.4	34.3		BOH - 34.3			Water at completion -23.7 Water after 14hrs. hole size 0 - 10 -5" 10-25.9 -3 3/4" 25.9 - 35.3 -3" time of well installation was 2.75 hrs.

Source: USACE, 1981

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT: RCRA STUDY - LAGOON D | HOLE NO. DH-4


RCRA STUDY
RADFORD AAP
LAGOON "D"
DH-4
protector pipe
3.0
ground surface (≈1713.7)
CLAY SOIL
2" ID. flush joint riser pipe
15.0'
15.0
Bentonite seal
2.0'
17.0
2.0'
coarse sand filter
19.0
2" ID. Well screen
23.7 WATER TABLE
25.9' TOP OF ROCK
15.0'
HOLE SIZE
0-10'-5"φ
10'-25.9-3 3/4"φ
25.9-35.3-3"φ
34.0
35.3'
BOH
Source: USACE, 1981
NOT TO SCALE

Geraghty & Miller, Inc.

WELL LOG

PROJECT: RADFORD
CLIENT: NUS
Date Prepared: 8/4/80 By: G.F.S.

OWNER: Corps of Engineers
WELL No.: B-1
LOCATION: Site B - Flyash Disposal Site in Use
TOPO SETTING:
GROUND ELEV.: 1856.28

DRILLING STARTED: 8/4/80
DRILLING COMPLETED: 8/5/80
DRILLER: R. A. Monroe
TYPE OF RIG: C-40

WELL DATA

HOLE DIAM.: 5" to 11 ft; 3" to 90 ft
TOTAL DEPTH: 90 ft
CASING DIAM.: 2 in Timco PVC
CASING LENGTH: 75 ft
SCREEN DIAM.: 2 in
SCREEN SETTING: 75 to 90 ft
SCREEN SLOT & TYPE: .010 PVC
WELL STATUS: Dry Hole

GROUT

TYPE OF GROUT: Neat cement
GROUT DEPTH: 0-60 ft
VOLUME: 2 cu ft
TYPE OF PLUG: Bentonite
PLUG DEPTH: 59-60 ft
VOLUME: 1 lb

DEVELOPMENT

METHOD: None
RATE:
LENGTH:

TEST DATA

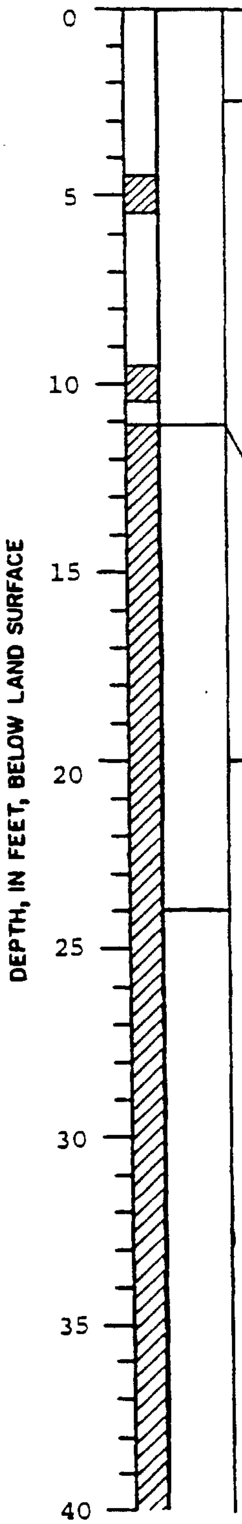
STATIC DEPTH TO WATER: Dry
DATE MEASURED: 8/11/80
PUMPING DEPTH TO WATER:
DURATION OF TEST:
PUMPING RATE:
DATE OF TEST:
TYPE OF TEST:
PUMP SETTING:
SPECIFIC CAPACITY:

FINAL PUMP CAPACITY:
FINAL PUMP SETTING:
AVERAGE PUMPAGE:

WATER QUALITY

SAMPLE INTERVAL

DESCRIPTION



Clay, silty, brown

Silt, sandy, reddish brown

Hit some River Jack

Change from 5" fishtail bit to 3" NX core barrel

Sand, med to coarse, brown

Lost Circulation (10-15 gpm)

No Recovery in core barrel

Geraghty & Miller, Inc.

WELL LOG

PROJECT: RADFORD
CLIENT: NUS
Date Prepared: 8/4/80 By: G. F. S.

OWNER: Corps of Engineers
WELL No.: B-1
LOCATION: Site B - Flyash Disposal Site in use
TOPO SETTING:
GROUND ELEV.: 1856.28

DRILLING STARTED: 8/4/80
DRILLING COMPLETED: 8/5/80
DRILLER: R. A. Monroe
TYPE OF RIG: C-40

REMARKS:

DEPTH, IN FEET, BELOW LAND SURFACE	SAMPLE INTERVAL	DESCRIPTION
40		Same as above
45		
50		Same as above
55		
60		Same as above
65		
70		Same as above
75		
80		Same as above

Geraghty & Miller, Inc.

WELL LOG

PROJECT RADFORD
CLIENT NUS
Date Prepared 8/4/80 By G.F.S.

OWNER Corps of Engineers
WELL No. B-1
LOCATION Site B - Flyash Disposal Site in use
TOPO SETTING
GROUND ELEV. 1856.28

DRILLING STARTED 8/4/80
DRILLING COMPLETED 8/5/80
DRILLER R. A. Monroe
TYPE OF RIG C-40

REMARKS

DEPTH, IN FEET, BELOW LAND SURFACE

SAMPLE INTERVAL	DESCRIPTION
80–90	Same as above
90	Bottom of Hole

Geraghty & Miller, Inc.

WELL LOG

PROJECT RADFORD
CLIENT NUS
Date Prepared 8/13/80 By W.E.T.

OWNER	Corps of Engineers
WELL No.	B-1R
LOCATION	Site B - Flyash Disposal Site in Use
TOPO SETTING	
GROUND ELEV.	1854.37
DRILLING STARTED	8/13/80
DRILLING COMPLETED	8/15/80
DRILLER	M. J. Dean
TYPE OF RIG	CME-75

WELL DATA

HOLE DIAM.	5" to 15 ft; 3" to 145 ft
TOTAL DEPTH	145 ft
CASING DIAM.	2 in Timco PVC
CASING LENGTH	130 ft
SCREEN DIAM.	2 in
SCREEN SETTING	130-145 ft
SCREEN SLOT & TYPE	.010 PVC
WELL STATUS	Completed

GROUT

TYPE OF GROUT	Neat cement
GROUT DEPTH	0-100 ft
VOLUME	6.0 cu ft
TYPE OF PLUG	Bentonite
PLUG DEPTH	109-110 ft
VOLUME	1 lb

DEVELOPMENT

METHOD	Air
RATE	0.1 gpm
LENGTH	120 min

TEST DATA

STATIC DEPTH TO WATER	128 ft
DATE MEASURED	8/15/80
PUMPING DEPTH TO WATER	
DURATION OF TEST	
PUMPING RATE	
DATE OF TEST	
TYPE OF TEST	
PUMP SETTING	
SPECIFIC CAPACITY	
FINAL PUMP CAPACITY	
FINAL PUMP SETTING	
AVERAGE PUMPAGE	

WATER QUALITY

DEPTH, IN FEET, BELOW LAND SURFACE

Depth	SAMPLE INTERVAL	DESCRIPTION
0		Sand, fine, silty, micaceous, reddish brown
5	4.5-5.5	
10	9.5-10.5	Same as above
		Change from 5" fishtail bit to 3" NX core barrel (at 15)
15	15-40	Same as above River Jack
20		Same as above River Jack
25		Same as above
30		Same as above River Jack
35		Same as above
40		Same as above

Geraghty & Miller, Inc.

WELL LOG

PROJECT: RADFORD
CLIENT: NUS
Date Prepared: 8/13/80 By: W.E.T.

OWNER: Corps of Engineers
WELL No.: B-1R
LOCATION: Site B - Flyash Disposal Site in use
TOPO SETTING:
GROUND ELEV.: 1854.87

DRILLING STARTED: 8/13/80
DRILLING COMPLETED: 8/15/80
DRILLER: M. J. Dean
TYPE OF RIG: CME-75

REMARKS:

DEPTH, IN FEET, BELOW LAND SURFACE	SAMPLE INTERVAL	DESCRIPTION
40		
45		River Jack
50		Same as above
55		
60		Same as above
65		
70		Same as above
75		
80		Same as above

Geraghty & Miller, Inc.

WELL LOG

PROJECT: RADFORD
CLIENT: NUS
Date Prepared: 8/13/80 By: W.E.T.

OWNER: Corps of Engineers
WELL No.: B-1R
LOCATION: Site B - Flyash Disposal Site in use
TOPO SETTING:
GROUND ELEV.: 1854.87

DRILLING STARTED: 8/13/80
DRILLING COMPLETED: 8/15/80
DRILLER: M. J. Dean
TYPE OF RIG: CME-75

REMARKS:

DEPTH, IN FEET, BELOW LAND SURFACE	DESCRIPTION
80	
85	Top of Rock
	Lost Circulation (10-15 gpm)
90	Limestone, brecciated, dolomitic, some vugs
95	Same as above
100	
105	Same as above
110	
115	Same as above
120	

SAMPLE INTERVAL

Geraghty & Miller, Inc.

WELL LOG

PROJECT RADFORD
CLIENT NUS
Date Prepared 8/13/80 By W.E.T.

OWNER Corps of Engineers
WELL No. B-1R
LOCATION Site B - Flyash Disposal Site in use
TOPO SETTING
GROUND ELEV. 1854.87

DRILLING STARTED 8/13/80
DRILLING COMPLETED 8/15/80
DRILLER M. J. Dean
TYPE OF RIG CME-75

REMARKS

DEPTH, IN FEET, BELOW LAND SURFACE	SAMPLE INTERVAL	DESCRIPTION
120		
125		Limestone, brecciated, some greenstone and sandstone inclusions
	▽	Water Table
130		
135		
140		Same as above
145		Bottom of Hole

Geraghty
& Miller, Inc.

WELL LOG

PROJECT: RADFORD
CLIENT: NUS
Date Prepared: 8/6/80 By: G.F.S.

OWNER: Corps of Engineers
WELL No.: B-2
LOCATION: Site B - Flyash Landfill in use
TOPO SETTING:
GROUND ELEV.: 1769.47

DRILLING STARTED: 8/6/80
DRILLING COMPLETED: 8/6/80
DRILLER: M. J. Dean
TYPE OF RIG: CME-75

WELL DATA

HOLE DIAM.: 5" to 30 ft; 3" to 90 ft
TOTAL DEPTH: 90 ft
CASING DIAM.: 2 in Timco PVC
CASING LENGTH: 75 ft
SCREEN DIAM.: 2 in
SCREEN SETTING: 75-90 ft
SCREEN SLOT & TYPE: .010 PVC
WELL STATUS: Completed

GROUT

TYPE OF GROUT: Neat cement
GROUT DEPTH: 0-50 ft
VOLUME: 2 cu ft
TYPE OF PLUG: Bentonite
PLUG DEPTH: 49-50 ft
VOLUME: 1 lb

DEVELOPMENT

METHOD: Air
RATE: 0.1 gpm
LENGTH: 27 min

TEST DATA

STATIC DEPTH TO WATER: 73.87 ft
DATE MEASURED: 8/12/80
PUMPING DEPTH TO WATER:
DURATION OF TEST:
PUMPING RATE:
DATE OF TEST:
TYPE OF TEST:
PUMP SETTING:
SPECIFIC CAPACITY:

FINAL PUMP CAPACITY:
FINAL PUMP SETTING:
AVERAGE PUMPAGE:

WATER QUALITY

DEPTH, IN FEET, BELOW LAND SURFACE	SAMPLE INTERVAL	DESCRIPTION
0		Sand, fine, silty, micaceous, brown
5	sample	
10	sample	Sand grading to medium with some pebbles
15	sample	Sand, fine, silty, micaceous, brown
20	sample	Sand grading into medium to coarse
25	sample	
28		Change from 5" fishtail bit to 3" NX core barrel
30	sample (30-40)	Top of Rock
		Lost circulation - put in 3" casing and regained circulation
35		Limestone, weathered, solution channels, slightly brecciated, gray
40		

Geraghty & Miller, Inc.

WELL LOG

PROJECT RADFORD
CLIENT NUS
Date Prepared 8/6/80 By G.F.S.

OWNER Corps of Engineers
WELL No. B-2
LOCATION Site B - Flyash Landfill in use
TOPO SETTING
GROUND ELEV. 1769.47

DRILLING STARTED 8/6/80
DRILLING COMPLETED 8/6/80
DRILLER M. J. Dean
TYPE OF RIG CME-75

REMARKS

DEPTH, IN FEET, BELOW LAND SURFACE	SAMPLE INTERVAL	DESCRIPTION
40		
45		Same as above
50		
55		Soft seam down to 66 ft
60		
65		Limestone, weathered, calcite veins, black
70		
75		Water Table
80		Same as above

Geraghty & Miller, Inc.

WELL LOG

PROJECT RADFORD
CLIENT NUS
Date Prepared 8/6/80 By G.F.S.

OWNER Corps of Engineers
WELL No. B-2
LOCATION Site B - Flyash Landfill in use
TOPO SETTING
GROUND ELEV. 1769.47

DRILLING STARTED 8/6/80
DRILLING COMPLETED 8/6/80
DRILLER M. J. Dean
TYPE OF RIG CME-75

REMARKS

DEPTH, IN FEET, BELOW LAND SURFACE	SAMPLE INTERVAL	DESCRIPTION
80–90	sampled (hatched)	Same as above
90		Bottom of Hole

Geraghty & Miller, Inc.

WELL LOG

PROJECT: RADFORD
CLIENT: NUS
Date Prepared: 8/4/80 By: G.F.S.

DEPTH, IN FEET, BELOW LAND SURFACE	DESCRIPTION
0	Clay, silty, some fine sand, brown
10	Same as above
	Some River Jack
15	Sand, fine to medium, some silt, micaceous, brown
20	Same as above
25	Same as above
30	Changed from 5" fishtail bit to 3" NX core barrel
	Top of Rock
	No recovery (Limestone)
35	Lost circulation (10-15 gpm)
40	

OWNER: Corps of Engineers
WELL No.: B-3
LOCATION: Site B - Flyash Landfill in use
TOPO SETTING:
GROUND ELEV.: 1765.09

DRILLING STARTED: 8/4/80
DRILLING COMPLETED: 8/5/80
DRILLER: M. J. Dean
TYPE OF RIG: CME-75

WELL DATA

HOLE DIAM.: 5" to 33 ft; 3" to 90 ft
TOTAL DEPTH: 90 ft
CASING DIAM.: 2 in Timco PVC
CASING LENGTH: 75 ft
SCREEN DIAM.: 2 in
SCREEN SETTING: 75-90 ft
SCREEN SLOT & TYPE: .010 PVC
WELL STATUS: Completed

GROUT

TYPE OF GROUT: Neat cement
GROUT DEPTH: 0-50 ft
VOLUME: 2 cu ft
TYPE OF PLUG: Bentonite
PLUG DEPTH: 49-50 ft
VOLUME: 1 lb

DEVELOPMENT

METHOD: Air
RATE: 0.25 gpm
LENGTH: 35 min

TEST DATA

STATIC DEPTH TO WATER: 77.72
DATE MEASURED: 8/12/80
PUMPING DEPTH TO WATER:
DURATION OF TEST:
PUMPING RATE:
DATE OF TEST:
TYPE OF TEST:
PUMP SETTING:
SPECIFIC CAPACITY:

FINAL PUMP CAPACITY:
FINAL PUMP SETTING:
AVERAGE PUMPAGE:

WATER QUALITY

Geraghty & Miller, Inc.

WELL LOG

PROJECT: RADFORD
CLIENT: NUS
Date Prepared: 8/4/80 By: G.F.S.

OWNER: Corps of Engineers
WELL No.: B-3
LOCATION: Site B - Flyash Landfill in use
TOPO SETTING:
GROUND ELEV.: 1765.09

DRILLING STARTED: 8/4/80
DRILLING COMPLETED: 8/5/80
DRILLER: M. J. Dean
TYPE OF RIG: CME-75

REMARKS:

DEPTH, IN FEET, BELOW LAND SURFACE	SAMPLE INTERVAL	DESCRIPTION
40–45		No recovery
50–55		No recovery
60–65		Limestone, weathered, some iron stains, some calcite veins, gray
70–75		Same as above
75–80		∇ Water Table

Geraghty
& Miller, Inc.

WELL LOG

PROJECT RADFORD
CLIENT NUS
Date Prepared 8/4/80 By G.F.S.

OWNER Corps of Engineers
WELL No. B-3
LOCATION Site B - Flyash Landfill in use
TOPO SETTING
GROUND ELEV. 1765.09

DRILLING STARTED 8/4/80
DRILLING COMPLETED 8/5/80
DRILLER M. J. Dean
TYPE OF RIG CME-75

REMARKS

DEPTH, IN FEET, BELOW LAND SURFACE

DEPTH	SAMPLE INTERVAL	DESCRIPTION
80	sampled 80–90	Same as above
85		
90		Same as above Bottom of Hole

Geraghty & Miller, Inc.

WELL LOG

PROJECT RADFORD
CLIENT NUS
Date Prepared 7/31/80 By G.F.S.

DEPTH, IN FEET, BELOW LAND SURFACE	SAMPLE INTERVAL	DESCRIPTION
0		Clay, silty, brown
~3		Sand, fine to medium, some silt, micaceous, brown
5	sample	
10	sample	Same as above
		Some pebbles
15	sample	Same as above
20	sample	Same as above
25	sample	Same as above
		Changed from 5" fishtail bit to 3" NX core barrel
		Top of Rock
30–40	sample (continuous core)	Lost Circulation (10-15 gpm)
		Limestone, weathered, some dolostone, iron stains, calcite veins, gray
35		
40		

OWNER Corps of Engineers
WELL No. B-4
LOCATION Site B - Flyash Landfill in use
TOPO SETTING
GROUND ELEV. 1764.64

DRILLING STARTED 7/31/80
DRILLING COMPLETED 8/4/80
DRILLER M. J. Dean
TYPE OF RIG CME-75

WELL DATA

HOLE DIAM. 5" to 29.5 ft; 3" to 90 ft
TOTAL DEPTH 90 ft
CASING DIAM. 2 in Timco PVC
CASING LENGTH 75 ft
SCREEN DIAM. 2 in
SCREEN SETTING 75-90 ft
SCREEN SLOT & TYPE .010 SCH 80
WELL STATUS

GROUT

TYPE OF GROUT Neat cement
GROUT DEPTH 0-55 ft
VOLUME 2 cu ft
TYPE OF PLUG Bentonite
PLUG DEPTH 54-55 ft
VOLUME 1 lb

DEVELOPMENT

METHOD Air
RATE 0.1 gpm
LENGTH 80 min

TEST DATA

STATIC DEPTH TO WATER 73.97
DATE MEASURED 8/12/80
PUMPING DEPTH TO WATER
DURATION OF TEST
PUMPING RATE
DATE OF TEST
TYPE OF TEST
PUMP SETTING
SPECIFIC CAPACITY

FINAL PUMP CAPACITY
FINAL PUMP SETTING
AVERAGE PUMPAGE

WATER QUALITY

Geraghty & Miller, Inc.

WELL LOG

PROJECT: RADFORD
CLIENT: NUS
Date Prepared: 7/31/80 By: G.F.S.

OWNER: Corps of Engineers
WELL No.: B-4
LOCATION: Site B - Flyash Landfill in use
TOPO SETTING:
GROUND ELEV.: 1764.64

DRILLING STARTED: 7/31/80
DRILLING COMPLETED: 8/4/80
DRILLER: M. J. Dean
TYPE OF RIG: CME-75

REMARKS:

DEPTH, IN FEET, BELOW LAND SURFACE	DESCRIPTION
40	Same as above
~46.5	Regained circulation - ran 3 in casing down to 31 ft
50	Same as above
~58	Lost circulation (10-15 gpm)
60	Same as above
~61	Regained circulation - ran 3 in casing down to 61 ft
70	Same as above
~71	Lost circulation (10-15 gpm)
~74	Water Table
80	

Depth scale: 40, 45, 50, 55, 60, 65, 70, 75, 80

Geraghty & Miller, Inc.

WELL LOG

PROJECT: RADFORD
CLIENT: NUS
Date Prepared: 7/31/80 By: G.F.S.

OWNER: Corps of Engineers
WELL No.: B-4
LOCATION: Site B - Flyash Landfill in use
TOPO SETTING: 1764.64
GROUND ELEV.:

DRILLING STARTED: 7/31/80
DRILLING COMPLETED: 8/4/80
DRILLER: M. J. Dean
TYPE OF RIG: CME-75

REMARKS:

DEPTH, IN FEET, BELOW LAND SURFACE

DEPTH	SAMPLE INTERVAL	DESCRIPTION
80–90	sampled (hatched)	Same as above
90		Same as above
90		Bottom of Hole

SITE "B"

Hole No. DH-1

DRILLING LOG	DIVISION NAD	INSTALLATION NAO	SHEET 1 OF 1 SHEETS

1. PROJECT LANDFILL "B"-RADFORD AAP	10. SIZE AND TYPE OF BIT 2" ODSS; NX DIA
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL
3. DRILLING AGENCY CUNNINGHAM CORE DRILLING	12. MANUFACTURER'S DESIGNATION OF DRILL CME - 75
4. HOLE NO. (As shown on drawing title and file number) DH-1	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 3; UNDISTURBED 0
5. NAME OF DRILLER BILL MONROE	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE [X] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER Not Encount.
	16. DATE HOLE: STARTED; COMPLETED
7. THICKNESS OF OVERBURDEN 34.6	17. ELEVATION TOP OF HOLE 1780
8. DEPTH DRILLED INTO ROCK	18. TOTAL CORE RECOVERY FOR BORING %
9. TOTAL DEPTH OF HOLE 34.6	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
1780			(CL) CLAY, some silt, little sand & gravel size rock fragments, red brn. & yel. brn., mottled, med. plastic, moist			Advanced hole w/6" hollow stem auger; sampled w/2" OD Split Spoon
	8.–10.				S-1	Split Spoon 7-6-7
						H. S. Auger
	18.–20.				S-2	Split Spoon 7-6-8
1755	25.0		same (CL) but more silt, less rock fragments, slt, micaceous and very moist			H. S. Auger
	28.–30.				S-3	Split Spoon 2-2-3
						H. S. Auger Auger refusal @ 34.6
1745.4	34.6		Top of Rock BOH			

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT) | PROJECT LANDFILL "B"-RADFORD AAP | HOLE NO. DH-1

SITE "B"

Hole No. DH-1A

DRILLING LOG	DIVISION NAO	INSTALLATION NAO	SHEET 1 OF 2 SHEETS

1. PROJECT Landfill "B" - Radford AAP	10. SIZE AND TYPE OF BIT 3" fishtail; NX DIA
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL
3. DRILLING AGENCY Cunningham Core Drilling	12. MANUFACTURER'S DESIGNATION OF DRILL CME-75
4. HOLE NO. (As shown on drawing title and file number) DH-1A	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED 0 — UNDISTURBED 0
5. NAME OF DRILLER Bill Monroe	14. TOTAL NUMBER CORE BOXES 3
6. DIRECTION OF HOLE [X] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER 74.5
	16. DATE HOLE — STARTED — COMPLETED
7. THICKNESS OF OVERBURDEN 33.0	17. ELEVATION TOP OF HOLE ≈ 1780
8. DEPTH DRILLED INTO ROCK 87.0	18. TOTAL CORE RECOVERY FOR BORING %
9. TOTAL DEPTH OF HOLE 120.0	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			Same Soil Profile as DH-1			Advanced w/fishtail and set NX casing to 33.0
1747	33.0		Top of rock limestone, gray, broken	50%	Run 1 1.0	NX core RQD = 0
1745	35.0		Soft mud seam			Mud seam no recovery
1737	43.0		Limestone, gray, no apparent bedding, fn, grained, mod hard to soft, mod. to badly weathered, very broken and fragmented	25%	Run 2 Box 1 1.0	NX core RQD = 0
				5%	Run 3 Box 1 .5	NX core RQD = 0
1723	57.0		Same limestone, not as broken but still mod. weathered w/ many calcite heated factures, fn. grained, mod. hard, sections of core indicate thin bedding dipping 30°-45° numerous calcite filled vugs some zones of irregular tight folding	100	Run 4	RQD = 66%
				91%	Run 5 Box 1 7.1	NX core RQD = 53%
				100	Run 6 Box 1&2 10.0	NX core RQD = 62%
1704	76.0		Some limestone, but more weathered, partially fragmented	100	Run 7 Box 2&3 10.0	NX core RQD = 0

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ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT LANDFILL "B"-RADFORD AAP — HOLE NO. DH-1A

SITE "B"

Hole No. DH-1A

DRILLING LOG	DIVISION 1	INSTALLATION NAO	SHEET 2 OF 2 SHEETS
1. PROJECT LANDFILL "B" - RADFORD AAP		10. SIZE AND TYPE OF BIT 3" fish tail;NX DIA	
2. LOCATION (Coordinates or Station)		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL	
3. DRILLING AGENCY CUNNINGHAM CORE DRILLING		12. MANUFACTURER'S DESIGNATION OF DRILL CME-75	
4. HOLE NO. (As shown on drawing title and file number) DH-1A		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 0; UNDISTURBED 0	
5. NAME OF DRILLER BILL MONROE		14. TOTAL NUMBER CORE BOXES 3	
6. DIRECTION OF HOLE [X] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER	
		16. DATE HOLE: STARTED; COMPLETED	
7. THICKNESS OF OVERBURDEN 33.0		17. ELEVATION TOP OF HOLE 1780	
8. DEPTH DRILLED INTO ROCK 87.0		18. TOTAL CORE RECOVERY FOR BORING %	
9. TOTAL DEPTH OF HOLE 120.0		19. SIGNATURE OF INSPECTOR	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
1697.5			Same, weathered and partially fragmented limestone	100	Run 7 Box 2 & 3 10.0	NX Core RQD = 0
			limestone becomes even more fragmented w/depth; broken along numerous calcite healed fractures (auto-brecciated)	66	Run 8 Box 3 6.6	NX Core RQD = 0
				47%	Run 9 Box 3 5.9	NX Core RQD = 0
				19%	Run 10 Box 3 1.4	NX Core RQD = 0
				25%	Run 11 Box 3 1.0	NX Core RQD = 0
1660	120		BOH			

Right margin depth marks: 82, 86, 96, 108, 11[illegible]

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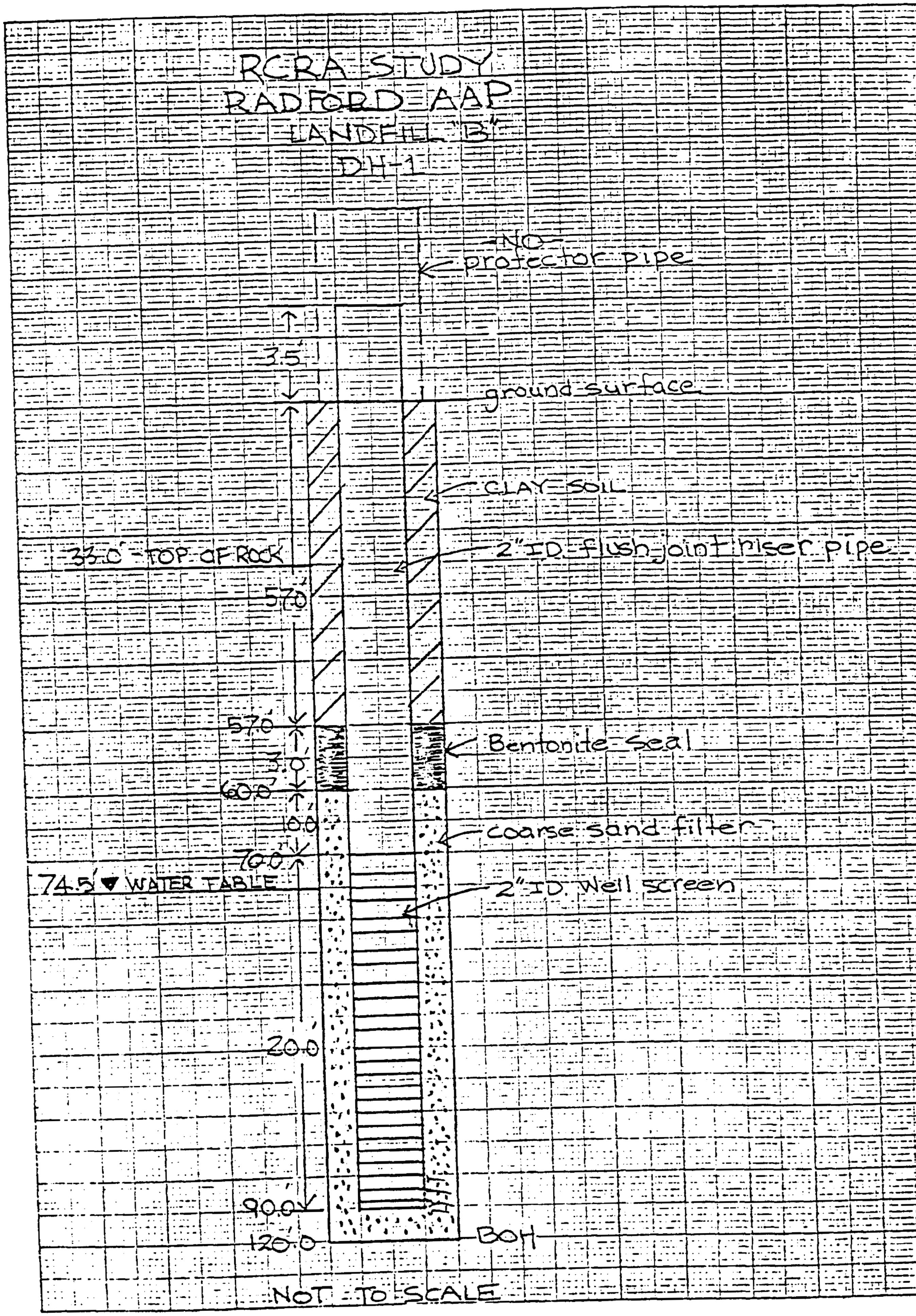
ENG FORM MAR 71 1836 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT) PROJECT LANDFILL "B"-RADFORD AAP HOLE NO. DH-1A


RCRA STUDY
RADFORD AAP
LANDFILL "B"
DH-1
-NO-
protector pipe
3.5'
ground surface
CLAY SOIL
33.0' - TOP OF ROCK
2" ID flush joint riser pipe
57.0'
57.0'
Bentonite Seal
3.0'
60.0'
10.0'
coarse sand filter
70.0'
74.5' WATER TABLE
2" ID Well screen
20.0'
90.0'
120.0
BOH
NOT TO SCALE

DRILLING LOG	DIVISION NAD	INSTALLATION NAO	SHEET 1 OF 3 SHEETS
1. PROJECT RCRA - LANDFILL B		10. SIZE AND TYPE OF BIT 2" OD. SS: NX DIA	
2. LOCATION (Coordinates or Station)		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL	
3. DRILLING AGENCY CUNNINGHAM DRILLING & GROUTING CORP.		12. MANUFACTURER'S DESIGNATION OF DRILL CME-75	
4. HOLE NO. (As shown on drawing title and file number) LF-B DH-2		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN	DISTURBED 9 / UNDISTURBED 2
5. NAME OF DRILLER MARVIN DEAN		14. TOTAL NUMBER CORE BOXES 3	
6. DIRECTION OF HOLE [X] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER (83.0)	
		16. DATE HOLE	STARTED 1 July 1980 / COMPLETED 8 July 1980
7. THICKNESS OF OVERBURDEN 54.7		17. ELEVATION TOP OF HOLE	
8. DEPTH DRILLED INTO ROCK 50.3		18. TOTAL CORE RECOVERY FOR BORING 40.3'	79%
9. TOTAL DEPTH OF HOLE 105.0'		19. SIGNATURE OF INSPECTOR	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
						Fishtail 0.0'-5.0' Perm. test 0.0-5.0 K=0
	5.0		(CL) CLAY, tr. of silt, tr. of fn. sand med. plast., moist, mottled yellow to orange.	100	S-1	Splitspoon 3-3-5
						Fishtail 6.5'-10.0' Perm. test 5.0'-10.0' K=0.018 ft./day
	10.0		(ML) SILT, some clay, no plast., dry, mottled lt. brown to dk. brown.	100	S-2	Splitspoon
						Fishtail 11.5'-15.0 Perm test 10.0-15.0 K=0.019 ft./day
	15.0		(ML) as above	100	S-3	Splitspoon 8-12-17
						Fishtail 16.5'-20.0 Perm. test 15.0-20.0 K=0.007 ft./day
	20.0		(CL) CLAY, some silt, tr. of org., lt. moisture, mottled lt. yellow to orange.	100	S-4	Splitspoon 7-11-13
				100	UD-1	SHELBY TUBE
						Fishtail 23.5-25.0'
	25.0		(CL) CLAY, as above, milaceous.	100	S-5	Splitspoon 7-10-12
						Fishtail 26.5'-30.0' Perm test 25.0-30.0 K=0.04 ft./day
	29.0					
	29.5		Cobbles, gravel & sand			
	30.0		(CL-SC) CLAY & SAND, fn. - crs., tr. of gravel. med. plast., v. moist, yel.-brown.	100	S-6	Splitspoon 7-12-15
	32.0					Fishtail 31.5'-35.0 Perm. Test 30.0-35.0 K=1.52 ft./day
	35.0		(SM) SAND fn., some mica silt, lt. crs. sand, gravel & cobbles, slt., plast., moist, orange-brn.	100	UD-2	SHELBY TUBE
						Fishtail 37.0-40.0' Perm test 35.0-40.0 K=30.8 ft./day
	40.0		(SM) as above	100	S-7	Splitspoon 2-2-3
						Fishtail 41.5-45.0' Perm. test 40.0-45.0' K=22.2 ft./day; cobbles encountered at 41.5'
	45.0			0	S-8	Splitspoon 2-2-3
						Fishtail 45.0-50.0 Perm. test 45.0-50.0 K=17.3 ft./day
	50.0					

Hole No. LF-B DH-2

DRILLING LOG

- DIVISION: NAD
- INSTALLATION: NAO
- SHEET 2 OF 3 SHEETS
- 1. PROJECT: RCRA - LANDFILL B
- 2. LOCATION (Coordinates or Station):
- 3. DRILLING AGENCY: CUNNINGHAM DRILLING & GROUTING CORP.
- 4. HOLE NO. (As shown on drawing title and file number): LF-B DH-2
- 5. NAME OF DRILLER: MARVIN DEAN
- 6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.
- 7. THICKNESS OF OVERBURDEN: 54.7
- 8. DEPTH DRILLED INTO ROCK: 50.3
- 9. TOTAL DEPTH OF HOLE: 105.0'
- 10. SIZE AND TYPE OF BIT: 2" OD. SS: NX DIA
- 11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
- 12. MANUFACTURER'S DESIGNATION OF DRILL: CME-75
- 13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 9; UNDISTURBED 2
- 14. TOTAL NUMBER CORE BOXES: 3
- 15. ELEVATION GROUND WATER: (83.0)
- 16. DATE HOLE: STARTED 1 July 1980; COMPLETED 8 July 1980
- 17. ELEVATION TOP OF HOLE:
- 18. TOTAL CORE RECOVERY FOR BORING: 40.3' 79 %
- 19. SIGNATURE OF INSPECTOR:

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	50.0					Weight of rod drop 50.0 54.0' Perm. test 50.0'-54.0' K=24.0 ft./day
			LIMESTONE in gravel size.			Splitspoon 18-50/.2
	55.0		Top of weathered rock	0	Run 1	Loss H_2OE 55.2' C. L.-5.0' Perm. test 54.7-59.7 K=18.8 ft./day
	59.7 60.0		Top of hard rock LIMESTONE frangemental, slightly calcareous, moderately hard, dense texture, slightly to unweathered, broken into gravel size fragments. Lt. gray to to dk. grey.	64	Run 2	C. L.-1.9' RQD-0% Perm. test 60.0'-65.0' K=0.28 ft./day
	65.0			100	Run 3	C. L.-0 RQD-0% Perm. test 65.0'-70.0' K=0.02 ft./day
	70.0			86	Run 4	C. L. 0.6' RQD-0% Perm. test 70.0' K=0.04 ft./day
	75.0		LIMESTONE, fragmental, calcareous, moderately hard dense texture, brecciated, badly weathered, highly vuggy, numerous calcite healed seams, gray-	92	Run 5	C. L. 0.5' RQD 50% Perm. test 75.0'-80.0' K=0.02 ft./day
	80.0			T2	Run 6	C. L. 1.2' RQD 63% islolated areas of thin bedding @ 50°. Perm. test 80.0'-85.0' K=0
	85.0		BRECCIA, calcareous, moderately hard, coarse, fragmented structure, badly weathered, v. vuggy dk. gray.	100	Run 7	C. L. 0 RQD 61%
	90.0			90	Run 8	C. L. 0.8' RQD-71% isolated areas of blue, green, yellow coloring Perm. test 85.0'-90.0' K=0 Perm. test 90.0'-95.0' K=0.02 ft./day Perm. test 93.8-98.8 K=0.06 ft./day
	100.0		BRECCIATED LIMESTONE, fragmental slightly calcareous, 1.0 od. hard, ~~coarse~~ textura, brecciated, scattered fractures, slightly to badly weathered. Vuggy, numerous calcite filled seams gray			

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT RCRA - LANDFILL B HOLE NO. LF-B DH-2

Hole No. LF-B DH-2

DRILLING LOG	DIVISION NAD	INSTALLATION NAO	SHEET 3 OF 3 SHEETS

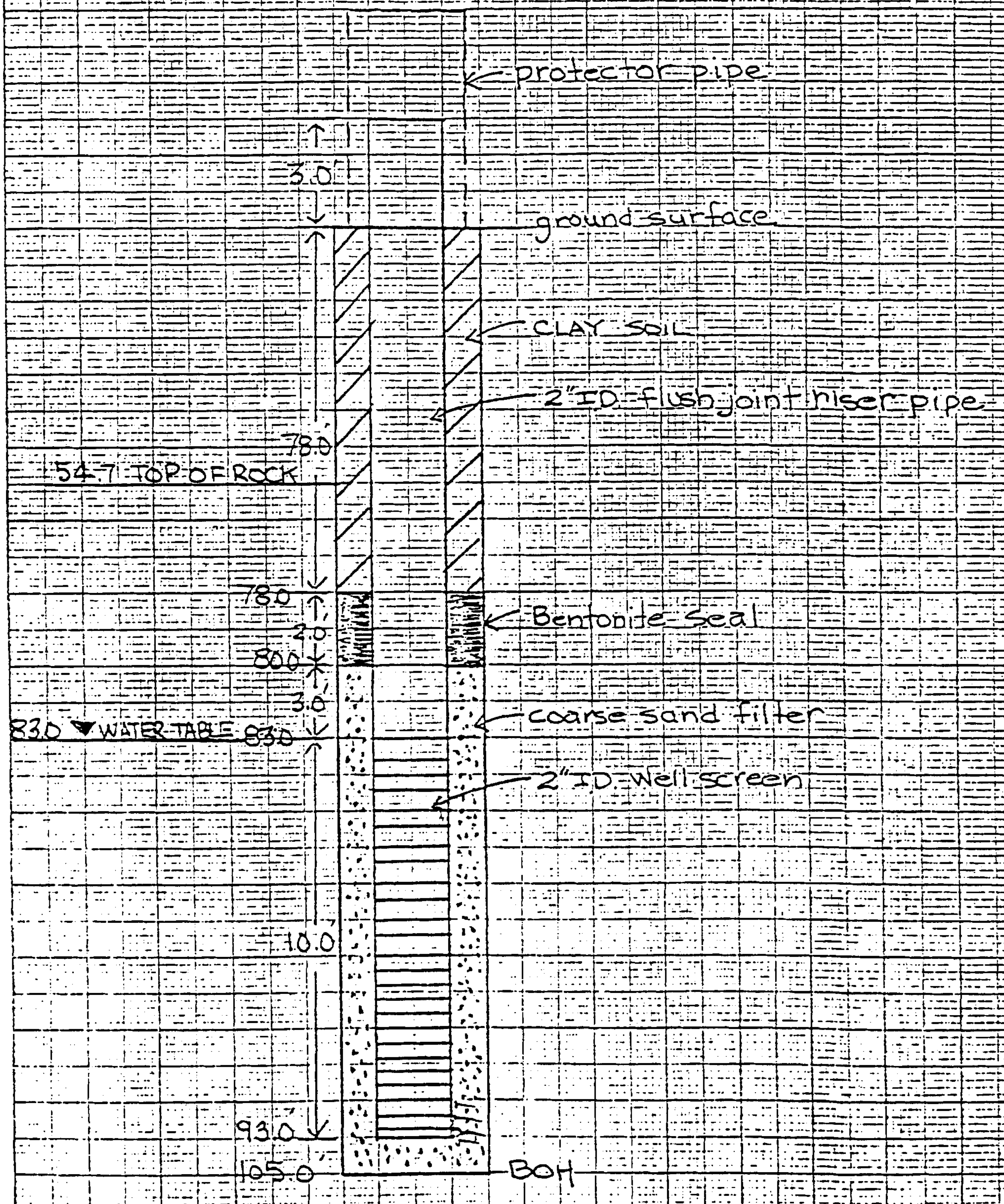
1. PROJECT: RCRA - LANDFILL B	10. SIZE AND TYPE OF BIT: 2" OD. SS: NX DIA
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
3. DRILLING AGENCY: CUNNINGHAM DRILLING & GROUTING CORP.	12. MANUFACTURER'S DESIGNATION OF DRILL: CME-75
4. HOLE NO. (As shown on drawing title and file number): LF-B DH-2	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 9; UNDISTURBED 2
5. NAME OF DRILLER: MARVIN SWEAN	14. TOTAL NUMBER CORE BOXES: 3
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED ___ DEG. FROM VERT.	15. ELEVATION GROUND WATER: (83.0)
	16. DATE HOLE: STARTED 1 July 1980; COMPLETED 8 July 1980
	17. ELEVATION TOP OF HOLE
7. THICKNESS OF OVERBURDEN: 54.7	18. TOTAL CORE RECOVERY FOR BORING: 40.3' 79 %
8. DEPTH DRILLED INTO ROCK: 50.3	19. SIGNATURE OF INSPECTOR
9. TOTAL DEPTH OF HOLE: 105.0'	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	100.0		BRECCIATED LIMESTONE			
	105.0					
			BOH 105.0			
			Water at competion=81.5'			
		✓	Water after 24 hrs. = 83.0'			

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT: RCRA - LANDFILL B | HOLE NO. LF-B DH-2

RCRA STUDY
RADFORD AAP
LANDFILL "B"
DH-2



NOT TO SCALE

Hole No. LF-B-DH-3

DRILLING LOG	DIVISION NAD	INSTALLATION NAO	SHEET 1 OF 3 SHEETS

1. PROJECT: RCRA Landfill B	10. SIZE AND TYPE OF BIT: 2" OD. SS: NX DIA
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
3. DRILLING AGENCY: CUNNINGHAM DRILLING & CORING CORP	12. MANUFACTURER'S DESIGNATION OF DRILL: SPRAGUE & HENWOOD 40C
4. HOLE NO. (As shown on drawing title and file number): LF-B DH-3	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 8; UNDISTURBED 1
5. NAME OF DRILLER: BOB MONROE	14. TOTAL NUMBER CORE BOXES: 4
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER: (80.0)
	16. DATE HOLE: STARTED 1 JULY 80; COMPLETED 12 JULY 80
	17. ELEVATION TOP OF HOLE
7. THICKNESS OF OVERBURDEN: 52.4	18. TOTAL CORE RECOVERY FOR BORING: 49.8 83%
8. DEPTH DRILLED INTO ROCK: 60.2	19. SIGNATURE OF INSPECTOR
9. TOTAL DEPTH OF HOLE: 112.6	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	1.0		Topsoil			Fishtail 0.0-4.7'
			(SP) SAND, fn-crs, little gravel, tr of silt, dry, yellow			
	4.7		Boulder			Core Rock 4.7'-5.0'
	5.0		(CL) CLAY, tr of sand, fn-crs, little gravel, med plast, moist, mottled yellow to orange	100	S-1	Split Spoon 10-20-32
						Fishtail 6.5-17.3 Boulders Encountered from 7.5-11.3
	10.0					
	11		(SP) SAND, fn-crs, yellow	0	S-2	Split Spoon 12-13-13
						Fishtail 12.8-15.0
	15.0			0	S-3	Split Spoon 5-6-12
						Fishtail 16.5'-20.0'
	17.3		(CL) CLAY, tr of weathered rock fragments, low plast, lt moist, yellow			
	20.0			100	S-4	Split Spoon 5-9-11
						Fishtail 21.5'-25.0' Perm Test 20.0'-25.0' K=1.0 ft/day
	25.0		(CL) AS ABOVE, with tr of fn sand	100	S-5	Split Spoon 1-1-2
						Fishtail 26.5'-30.0' Perm Test 25.0'-30.0' K=28 ft/day Perm Test 28.0-30.0 K=51 ft/day Loss drill water @ 28.7
	30.0		(CL) AS ABOVE, Med Plast	100	UD-1	Shelby Tube
						Fishtail 33.0'-35.0' Perm Test 30.0'-35.0' K>24 ft/day
	35.0		(CL) AS ABOVE	100	S-6	Split Spoon 1 = 1.5'
						Fishtail 36.5'-40.0' Perm Test 35.0'-40.0' K 20.9 ft/day
	40.0			0	S-7	Split Spoon 30/.2
						Fishtail 40.2'-45.0' Perm Test 40.0'-45.0' K>18.5 ft/day
	45.0		(CL) AS ABOVE	100	S-8	Split Spoon WOH = 1.5'
						Fishtail 46.5'-50.0'
	50.0					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT) | PROJECT: RCRA LANDFILL B | HOLE NO. LF-B-DH-3

DRILLING LOG	DIVISION NAD	INSTALLATION NAO	SHEET 2 OF 3 SHEETS
1. PROJECT RCRA- LANDFILL B		10. SIZE AND TYPE OF BIT 2" OD. SS: NX DIA	
2. LOCATION (Coordinates or Station)		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL	
3. DRILLING AGENCY CUNNINGHAM DRILLING & GROUTING CORP.		12. MANUFACTURER'S DESIGNATION OF DRILL SPRAGUE & HENWOOD 40C	
4. HOLE NO. (As shown on drawing title and file number) LFB-DH-3		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 8; UNDISTURBED 1	
5. NAME OF DRILLER BOB MONROE		14. TOTAL NUMBER CORE BOXES 4	
6. DIRECTION OF HOLE [X] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER (80.0)	
		16. DATE HOLE: STARTED 1 JULY 80; COMPLETED 12 JULY 80	
7. THICKNESS OF OVERBURDEN 52.4		17. ELEVATION TOP OF HOLE	
8. DEPTH DRILLED INTO ROCK 60.2		18. TOTAL CORE RECOVERY FOR BORING 49.8 83 %	
9. TOTAL DEPTH OF HOLE 112.6		19. SIGNATURE OF INSPECTOR	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	50.0		Top of Rock @ 52.4	0	UD-2	Shelby Tube
					S-9	Split Spoon 30/.3
	55.0		DOLOMITE, bedding absent, slightly calcaeous in isolated areas, moderately hard, dense texture, scattered fractures, some clay filled, some calcite healed, slightly weathered, vuggy, broken up into gravel size, lt gray	0	Run 1	CL-2.6' RQD-0 Perm Test 50.0'-55.0 K = .85 ft/day
				55	Run 2	CL = 1.0' RQD-0 Perm Test 56.0'-60.0' K = 4.1 ft/day
				100	Run 3	CL = 0 RQD-0
				85	Run 4	CL = 0.3' RQD-0
	60.0			100	Run 5	CL = 0 RQD-0
				100	Run 6	CL-0 RQD -0
			Some iron staining present in fractures	100	Run 7	CL = 0 RQD-0
				100	Run 8	CL = 0 RQD-0
	65.0			100	Run 9	CL = 0 RQD-0
				100	Run 10	CL = 0 RQD-0
				100	Run 11	CL=0 RQD-0
	70.0			100	Run 12	CL=0 RQD-0
				100	Run 13	CL=0 Jointed @ 45° RQD=0 Perm Test 68.0'-70.0' Roc[k] was broken up to seal pac[ker]
	75.0			100	Run 14	CL = 0 RQD-42% Perm Test 70.0'-75.0' K = 0.07 ft/year. Water level at 77.3' on 10 July Perm Test 75.0'-80.0' K=0.11 ft/day
	80.0			100	Run 15	CL = 0 RQD-0
	85.0			100	Run 16	CL = 0 RQD-0 Perm Test 80.0-85.0 K = 0.1 ft/day. Perm Test 83.0-88.0 K = 0.08 ft/day
	90.0		LIMESTONE, thin bedding, calcaeous, moderately hard, dense, scattered fractures, badly weathered, vuggy, dark gray	97	Run 17	CL = 0.2' RQD - 36% Perm Test 88.0-93.0 K = 0.10 ft/day
	95.0		SILTSTONE, thinly laminated, slightly calcareous, soft, fine texture, bedding gently dipping. Jointed along bedding planes, slightly to badly weath. lt grn to tan	66	Run 18	CL = 1.8' RQD-0 Perm Test 93.0-98.0 K=0
	100.0					

Hole No. LF-B-DH-3

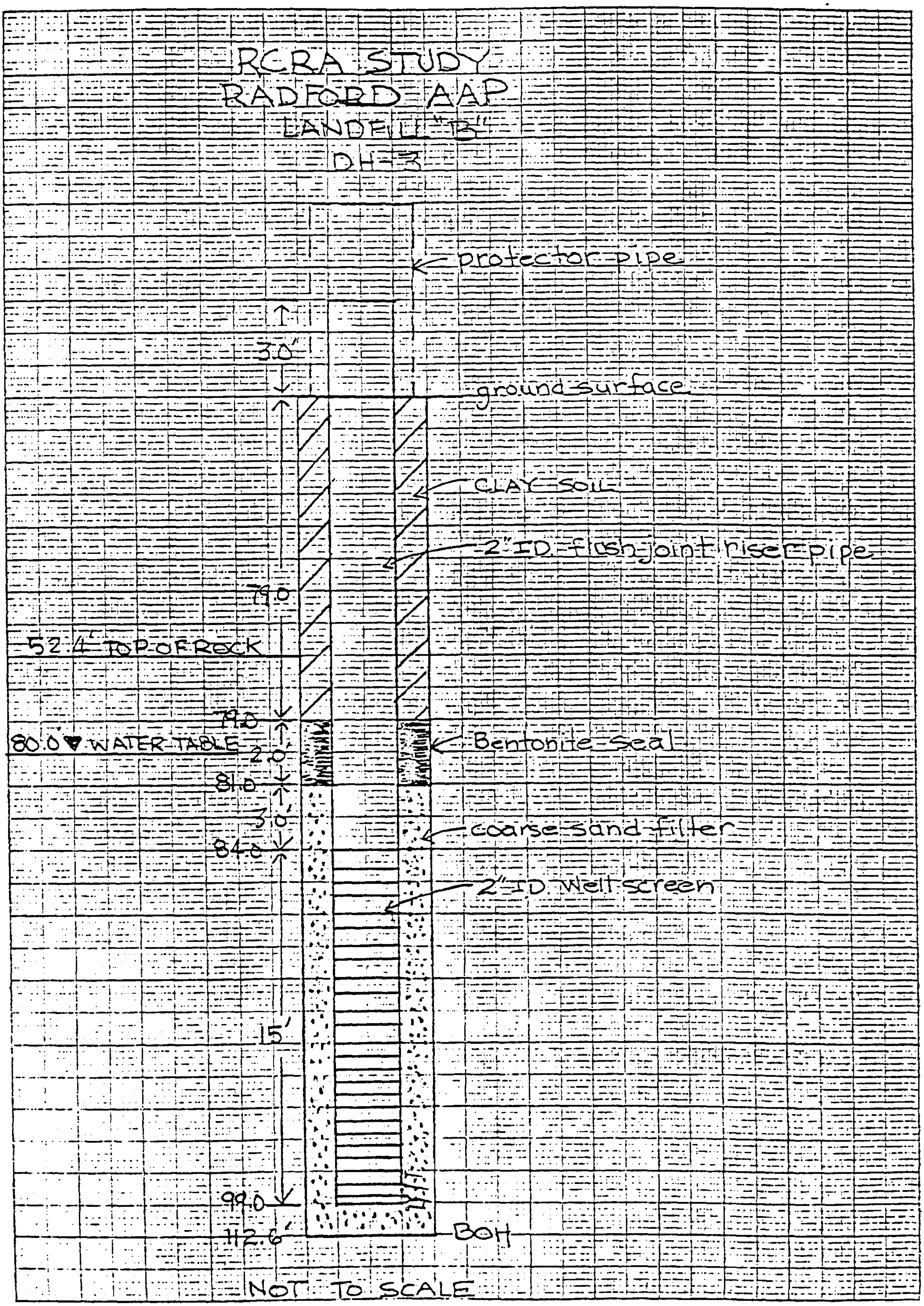
DRILLING LOG	DIVISION: NAD	INSTALLATION: NAO	SHEET 3 OF 3 SHEETS

1. PROJECT: RCRA LANDFILL B	10. SIZE AND TYPE OF BIT: 2" OD. SS: NX DIA
2. LOCATION (Coordinates or Station)	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
3. DRILLING AGENCY: CUNNINGHAM DRILLING & CORING CORP	12. MANUFACTURER'S DESIGNATION OF DRILL: SPRAGUE & HENWOOD 40C
4. HOLE NO. (As shown on drawing title and file number): LF-B DH-3	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 9; UNDISTURBED 1
5. NAME OF DRILLER: BOB MONROE	14. TOTAL NUMBER CORE BOXES: 4
6. DIRECTION OF HOLE: ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER: (80.0)
	16. DATE HOLE: STARTED 1 JULY 80; COMPLETED 12 JULY 80
7. THICKNESS OF OVERBURDEN: 52.4	17. ELEVATION TOP OF HOLE
8. DEPTH DRILLED INTO ROCK: 60.2	18. TOTAL CORE RECOVERY FOR BORING: 49.8 83 %
9. TOTAL DEPTH OF HOLE: 112.6	19. SIGNATURE OF INSPECTOR

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
	100.0		BRECCIA, massive bedding, calcareous, moderately hard, coarse texture, brecciated, badly weathered, matrix weathered to clay, blue and green	60	Run 19	CL = 2.0' RQD-0 Perm Test 98-105 K = 0.07 ft/day
	105.0			83	Run 20	CL = 0.5' RQD 21% Thin lense of siltstone in middle of run
	110.0			32	Run 21	CL = 3.3' RQD 9% Perm Test 105-112 K = 0
			BOH @ 112.6' water at completion = 80.0'			

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT: RCRA - LANDFILL -B | HOLE NO.: LF-B-DH-3


RCRA STUDY
RADFORD AAP
LANDFILL "B"
DH-3
protector pipe
3.0'
ground surface
CLAY SOIL
2" ID flush joint riser pipe
79.0
52.4' TOP OF ROCK
79.0
80.0' WATER TABLE
2.0'
Bentonite seal
81.0
3.0'
coarse sand filter
84.0
2" ID Well screen
15'
99.0
112.6'
BOH
NOT TO SCALE

Form No 500

BORING LOG

SINCE 1881

FROEHLING & ROBERTSON, INC.
FULL SERVICE LABORATORIES • ENGINEERING CHEMICAL
"ONE HUNDRED YEARS OF SERVICE"

Report No. R0L-62188 DATE November, 1984

Client: Hercules, Inc.			
Project: Radford Army Ammunition Plant; Monitoring Wells, Horseshoe Area Radford, VA			
Boring No.: FAL -1	Total Depth: 43.5'	Elevation:	Location: See plan
Type of Boring: Hollow-stem auger	Started: 11-5-84	Completed: 11-6-84	Driller: W. Simmons, Sr.

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	Sample Blows	Sample Depth (Feet)	% Core Recovery	REMARKS
	0.0	Red brown to brown clayey SILT (ML) roots *				* organics
						GROUNDWATER DATA
	1.0	Soft red-brown SILT, little fine sand, trace mica (ML) -ALLUVIUM-	3 2 4	4.5 – 6.0		
	6.5	Red and yellow mottled clayey SILT, trace fine sand, occasional relict structure (ML) -RESIDUUM-	4 5 6	9.5 – 11.0		
			4 4 3	14.5 – 16.0		
			1 2 1	19.5 – 20.0		
			2 3 4	24.5 – 26.0		
			*			* Sampler bouncing, not driven
		Auger refusal @ 28.5' Light gray to dove and blue thinly laminated argillaceous LIMESTONE with vugs and numerous calcite-healed fractures. Laminae display much contortion. Trace of algal structure at about 30.0'			28.5' – 33.5': 90%	33.5' Water level measured @ 33.5'

*No of blows req'd for a 140 lb hammer dropping 30 in. to drive 2 in O.D., 1.375 in I.D. sampler a total of 18 inches in three 6 in increments The sum of the last two increments of penetration is termed the standard penetration resistance. N

Scale 1"=5' unless otherwise noted

Form No. 500

BORING LOG

SINCE 1881

FROEHLING & ROBERTSON, INC.
FULL SERVICE LABORATORIES • ENGINEERING CHEMICAL
"ONE HUNDRED YEARS OF SERVICE"

Report No. ROL-62188 DATE November, 1984

Client: Hercules, Inc.			
Project: Radford Army Ammunition Plant; Monitoring Wells, Horseshoe Area Radford, VA			
Boring No.: FAL-1 cont.	Total Depth:	Elevation:	Location: See plan
Type of Boring: Hollow-stem auger	Started: 11-5-84	Completed: 11-6-84	Driller: W. Simmons, Sr.

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	Sample Blows*	Sample Depth (Feet)	% Core Recovery	REMARKS
	35.0	See description on previous page			95+ %	GROUNDWATER DATA
						38.5'
					> 95%	
	43.5					43.5'
		Boring terminated @ 43.5'				20' screen set from bottom

*No. of blows req'd for a 140 lb hammer dropping 30 in. to drive 2 in O.D., 1.375 in. I.D. sampler a total of 18 inches in three 6 in increments. The sum of the last two increments of penetration is termed the standard penetration resistance, N.

Scale 1"=5' unless otherwise noted

Form No. 500

BORING LOG

SINCE 1881

FROEHLING & ROBERTSON, INC.
FULL SERVICE LABORATORIES • ENGINEERING CHEMICAL
"ONE HUNDRED YEARS OF SERVICE"

Report No. ROL-62188 DATE November, 1984

Client: Hercules, Inc.

Project: Radford Army Ammunition Plant; Monitoring Wells, Horseshoe Area Radford, VA

Boring No.: FAL-2 | Total Depth: 44.1 | Elevation: | Location: See plan

Type of Boring: Hollow-stem auger | Started: 10-18-84 | Completed: 10-19-84 | Driller: W. Simmons, Sr.

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	Sample Blows	Sample Depth (Feet)	% Core Recovery	REMARKS
	0.0	Brown sandy SILT, roots, organics				GROUNDWATER DATA
	1.0	Yellow brown silty fine SAND trace fine gravel slightly micaceous -ALLUVIUM-	4 5 7	4.5 – 6.0		
		grades to	4 5 6	9.5 – 11.0		
		Yellow brown silty medium to fine sand, slightly micaceous (Driftwood)				
		grades to	6 10 8	14.5 – 16.0		
		Yellow tan coarse to fine sandy coarse to fine GRAVEL, slightly micaceous				
		grading back to	7 8 7	19.5 – 21.0		
		Brown coarse to fine sandy SILT, little clay, slightly micaceous	WOR	24.5 – 26.0		
	29.9	Gray brown shaley LIMESTONE, badly weathered to clayey SILT -RESIDUUM-	1 1 *	29.5 – 30.5		* 30/0.0' Water level measured @ 31.4' on 11-1-84
	34.5		*	34.5		* 40/0.0' Began coring @ 34.5'
	35.0	Auger & spoon refusal; begin coring				

*No. of blows req'd. for a 140 lb. hammer dropping 30 in. to drive 2 in O.D., 1.375 in. I.D. sampler a total of 18 inches in three 6 in. increments. The sum of the last two increments of penetration is termed the standard penetration resistance. N.

Scale 1"=5' unless otherwise noted

Form No. 500

BORING LOG

SINCE 1881

FROEHLING & ROBERTSON, INC.
FULL SERVICE LABORATORIES • ENGINEERING CHEMICAL
"ONE HUNDRED YEARS OF SERVICE"

Report No. ROL-62188 DATE November, 1984

Client: Hercules, Inc.			
Project: Radford Army Ammunition Plant; Monitoring Wells, Horseshoe Area Radford, VA			
Boring No.: FAL-2 cont.	Total Depth:	Elevation:	Location: See plan
Type of Boring: Hollow-stem auger	Started: 10-18-84	Completed: 10-19-84	Driller: W. Simmons, Sr.

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	*Sample Blows	Sample Depth (Feet)	% Core Recovery	REMARKS
	35.0	Dark to medium gray vuggy, saccharoidal thin bedded LIMESTONE with numerous calcite-healed fractures, several shale partings			30% / 20%	GROUNDWATER DATA Drill water lost @ 36.0'
	44.1	Boring terminated @ 44.1'				20' screen set from botton of hole

*No. of blows req'd for a 140 lb hammer dropping 30 in. to drive 2 in O.D., 1.375 in. I.D. sampler a total of 18 inches in three 6 in. increments. The sum of the last two increments of penetration is termed the standard penetration resistance, N.

Scale 1"=5' unless otherwise noted

Form No 500

BORING LOG

SINCE 1881

FROEHLING & ROBERTSON, INC.
FULL SERVICE LABORATORIES • ENGINEERING CHEMICAL
"ONE HUNDRED YEARS OF SERVICE"

Report No. ROL-62188 DATE November, 1984

Client: Hercules, Inc.			
Project: Radford Army Ammunition Plant; Monitoring Wells, Horseshoe Area Radford, VA			
Boring No.: FAL-3	Total Depth: 90.0'	Elevation:	Location: See plan
Type of Boring: Hollow-stem auger	Started: 10-19-84	Completed: 10-23-84	Driller: W. Simmons, Sr.

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	Sample Blows	Sample Depth (Feet)	% Core Recovery	REMARKS
	0.0	Black & red CINDER and red brown sandy SILT				GROUNDWATER DATA
	1.0	Brown silty fine SAND, trace clay slightly micaceous -ALLUVIUM- (SM)				
	3.0	Light tan fine sandy SILT trace to little clay (slightly micaceous) (ML)	4-4-6	4.5–6.0		
			8-8-10	9.5–11.0		
	13.5	Loose red tan fine sandy SILT, slightly micaceous (ML)	3-3-4	14.5–16.0		
			1-2-4	19.5–21.0		
			3-4-6	24.5–26.0		
			3-5-6	29.5–31.0		
	35.0	Dense red brown silty fine SAND occasional rounded quartz gravels (SM)	4	34.5		

*No. of blows req'd. for a 140 lb hammer dropping 30 in to drive 2 in O.D., 1.375 in. I.D. sampler a total of 18 inches in three 6 in increments. The sum of the last two increments of penetration is termed the standard penetration resistance, N.

Scale 1"=5' unless otherwise noted

Form No. 500

BORING LOG

SINCE 1881

FROEHLING & ROBERTSON, INC.
FULL SERVICE LABORATORIES • ENGINEERING CHEMICAL
"ONE HUNDRED YEARS OF SERVICE"

Report No. ROL-62188 DATE November, 1984

Client: Hercules, Inc.

Project: Radford Army Ammunition Plant; Monitoring Wells, Horseshoe Area Radford, VA

Boring No.: FAL-3 cont. | Total Depth: | Elevation: | Location: See plan

Type of Boring: Hollow-stem auger | Started: 10-19-84 | Completed: 10-23-84 | Driller: W. Simmons, Sr.

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	Sample Blows	Sample Depth (Feet)	% Core Recovery	REMARKS
	35.0		11 18			GROUNDWATER DATA
	36.0	Grading to Orange-tan and white coarse to fine sandy GRAVEL, some silt (GM)				
			6 11 5	39.5 – 41.0		
		Soft yellow-tan clayey SILT some fine sand, slightly micaceous (ML)	1 1 2	44.0 – 46.0		
		Stiff gray & brown clayey SILT some coarse to fine sand, slightly micaceous (ML)	15 14 9	49.5 – 51.0		
	53.0	Soft brown clayey SILT, trace fine sand, relict structure (ML) -RESIDUUM-	1 2 2	54.5 – 56.0		
			5 11 7	59.5 – 61.0		
			25 31 19	64.5 – 66.0		
			*	69.5		* Sample not driven
	70.0					

*No. of blows req'd. for a 140 lb hammer dropping 30 in. to drive 2 in O.D., 1.375 in. I.D. sampler a total of 18 inches in three 6 in. increments. The sum of the last two increments of penetration is termed the standard penetration resistance, N.

Scale 1"=5' unless otherwise noted

*No. of blows req'd. for a 140 lb hammer dropping 30 in. to drive 2 in O.D., 1.375 in. I.D. sampler a total of 18 inches in three 6 in. increments. The sum of the last two increments of penetration is termed the standard penetration resistance, N.

Scale 1"=5' unless otherwise noted

Form No 500

BORING LOG

SINCE 1881

FROEHLING & ROBERTSON, INC.
FULL SERVICE LABORATORIES • ENGINEERING CHEMICAL
"ONE HUNDRED YEARS OF SERVICE"

Report No. ROL-62188 DATE November, 1984

Client: Hercules, Inc.

Project: Radford Army Ammunition Plant; Monitoring Wells, Horseshoe Area Radford, VA

Boring No.: FAL-3 cont. | Total Depth: | Elevation: | Location: See plan

Type of Boring: Hollow-stem auger | Started: 10-19-84 | Completed: 10-23-84 | Driller: W. Simmons, Sr.

Elevation	Depth	DESCRIPTION OF MATERIALS (Classification)	Sample Blows	Sample Depth (Feet)	% Core Recovery	REMARKS
	70.0	Yellow tan clayey SILT, trace fine sand -RESIDUUM-				GROUNDWATER DATA Water level measured at 74.0'
	75.0		ND	74.5 – 76.0	∇	
	80.0		ND	79.5 – 81.0		Pump clean water into hole to clean out augers
	85.0		ND	84.5 – 86.0		
	90.0	Boring terminated at 90.0'				25' screen set from botton

*No of blows req'd for a 140 lb. hammer dropping 30 in. to drive 2 in O.D., 1.375 in. I.D. sampler a total of 18 inches in three 6 in. increments. The sum of the last two increments of penetration is termed the standard penetration resistance. N

Scale 1"=5' unless otherwise noted

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT 38-26-0128

DATE 2 Nov 80

LOCATION RAAP, Flyash No. 2 Landfill

DRILLERS Gates, Sandrin, Smithson, Warren

DRILL RIG Acker II, 4 inch Continuous Flight Auger

BORE HOLE BH1

Elevation of Hole 1,807 ft MSL

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
0–5 ft		Reddish-brown, silty clay w/cobbles (¼ - ½ inch gravel) micaceous	TD = 56 ft ▽ initial, dry, 2 Nov ▽ 24 hrs, dry, 3 Nov ▽ 48 hrs, dry, 4 Nov
5 ft			
	BS 6-11	Same material	
10 ft		Less gravel	Drilling easy
15 ft			

USAEHA Form 95, 12 Aug 74

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT 38-26-0128 | DATE 2 Nov 80

LOCATION RAAP, Flyash No. 2 Landfill | DRILLERS Gates, Sandrin; Smithson, Warren

DRILL RIG Acker II, 4 inch Continuous Flight Auger | BORE HOLE BH1

Elevation of Hole 1,807 ft MSL

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
		Some material (getting damper, m/plastic)	
20 ft			
		Same material (lots of micaceous clay)	Gravel sound
25 ft			
			Gravel sound Drilling easy
30 ft			

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US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT 38-26-0128 DATE 2 Nov 80

LOCATION RAAP, Flyash No. 2 Landfill DRILLERS Gates, Sandrin, Smithson, Warren

DRILL RIG Acker II, 4 inch Continuous Flight Auger BORE HOLE BH1

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN.	DESCRIPTION	REMARKS
		Same material v/plastic getting wetter	
35 ft			
	MB 36-41	Same material	
40 ft			
		Same material u/plastic Soil saturated	getting harder to drill, gravel noise tight
45 ft			WT close

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US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT 38-26-0128 DATE 2 Nov 80

LOCATION RAAP, Flyash No. 2 Landfill DRILLERS Gates, Sandrin, Smithson, Warren

DRILL RIG Acker II, 4 inch Continuous Flight Auger BORE HOLE BH1

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN.	DESCRIPTION	REMARKS
		Elbrook Dolomite	
50 ft			
			hard drilling 4241 PSI
55 ft			
		Refusal Powdered dolomite on Auger	
		TD 56 ft	
60 ft			

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US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT 38-26-0128

DATE 2 Nov 80

LOCATION RAAP, Flyash No. 2 Landfill

DRILLERS Gates, Sandrin, Smithson, Warren

DRILL RIG Acker II, 4 inch Continuous Flight Auger

BORE HOLE BH2

Elevation of Hole 1,789 ft MSL

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN.	DESCRIPTION	REMARKS
		Top soil, brown loam	TD - 25 ft ▽ initial, dry, 2 Nov ▽ 24 hrs, dry, 3 Nov ▽ 48 hrs, dry, 4 Nov
	MB 1-6	Reddish brown, sandy, silty clay, w/some gravel (¼ - ½ inch)	
5 ft			gravel sound
		Same material damp v/plastic	
10 ft			Easy drilling
	MB 11-16	Stiff, reddish-brown clay (¼ inch pea gravel) damp v/plastic	
15 ft			

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US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT 38-26-0128

DATE 2 Nov 80

LOCATION RAAP, Flyash No. 2 Landfill

DRILLERS Gates, Sandrin, Smithson, Warren

DRILL RIG Acker II, 4 inch Continuous Flight Auger

BORE HOLE BH2

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
		Same material getting more plastic sporadic gravel	
			hard drilling at 19 ft
20 ft			
	MB 21-25		
			hard drilling
25 ft		Refusal, Elbrook Dolomite	
		TD = 25 feet	
30 ft			

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US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT 38-26-0128 DATE 2 Nov 80

LOCATION RAAP, Flyash No. 2 Landfill DRILLERS Gates, Sandrin, Smithson, Warren

DRILL RIG Acker II, 4 inch Continuous Flight Auger BORE HOLE BH3

Elevation of Hole 1,781 ft MSL

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN.	DESCRIPTION	REMARKS
		Red, silty clay w/cobblers (4-8 inch Riverjack) damp, m/plastic micaceous	TD = 31 ft ▽ initial, dry, 2 Nov ▽ 24 hrs, dry, 3 Nov ▽ 48 hrs, dry, 4 Nov
		same material cobbles getting smaller	
5 ft			
	BS 7-12 moisture #5		
10 ft			
		Stiff clay w/some large sand grains	
15 ft			

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US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT 38-26-0128

DATE 2 Nov 80

LOCATION RAAP, Flyash No. 2 Landfill

DRILLERS Gates, Sandrin, Smithson, Warren

DRILL RIG Acker II, 4 inch Continuous Flight Auger

BORE HOLE BH3

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
		Gravel lense	Gravel sound
20 ft		Same material Reddish-brown clay w/small gravel and large sand	
25 ft	MB 22-27	getting damper more plastic	
		Same material	
30 ft			

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US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT 38-26-0128 DATE 2 Nov 80

LOCATION RAAP, Flyash No. 2 Landfill DRILLERS Gates, Sandrin, Smithson, Warren

DRILL RIG Acker II, 4 inch Continuous Flight Auger BORE HOLE BH3

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
		Refusal:Elbrook Dolomite	WT may be at 30 ft
		TD = 31 ft	
35 ft			

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US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT 38-26-0128 DATE 1 Nov 80

LOCATION RAAP, Flyash No. 2 Landfill DRILLERS Gates, Sandrin, Smithson, Warren

DRILL RIG Acker II, 4 inch Continuous Flight Auger BORE HOLE BH4

Elevation of Hole 1,775.7 ft MSL

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN.	DESCRIPTION	REMARKS
		Top soil, brown loam	TD = 45 ft
	MB 1-6	Reddish-brown, silty clay (moist, more plasticity)	∇ initial, 44 ft, 1 Nov ∇ 24 hrs, dry ∇ 48 hrs, 45 ft, 2 Nov ∇ 96 hrs, 45 ft, 4 Nov
5 ft			
	MB 6-10	Same material	getting damper
10 ft		Same material	getting stiffer
15 ft			

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US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT 38-26-0128 DATE 1 Nov 80

LOCATION RAAP, Flyash No. 2 Landfill DRILLERS Gates, Sandrin, Smithson, Warren

DRILL RIG Acker II, 4 inch Continuous Flight Auger BORE HOLE BH4

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
		Red, silty clay	Drilling easy
20 ft	ST/P 5,000 PSI 4,241 PSI		
		Red clay w/small ¼ inch pea gravel (damp, more plastic)	Gravel sound
25 ft	MB 25-30	Same material	sporadic gravels
30 ft			

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US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT 38-26-0128

DATE 1 Nov 80

LOCATION RAAP, Flyash No. 2 Landfill

DRILLERS Gates, Sandrin, Smithson, Warren

DRILL RIG Acker II, 4 inch Continuous Flight Auger

BORE HOLE BH4

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
		Same material (damper and more plastic) some gravel, some silt	Close to water table
35 ft			No sample return, clay probably plastered against side of hole
40 ft			
		Drilling getting hard 3,000 PSI getting wetter	Bit destroyed TD - 45 ft Elbrook Dolomite Formation
∇		slow drilling 5,300 PSI	
45 ft		Refusal	

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT 38-26-0128

DATE 3 Nov 80

LOCATION RAAP, Flyash No. 2 Landfill

DRILLERS Gates, Sandrin, Smithson, Warren

DRILL RIG Acker II, 4 inch Continuous Flight Auger

BORE HOLE BH5

Elevation of Hole 1,771 ft MSL

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
		Top soil, brown loam	TD = 31 ft ▽ initial, dry, 3 Nov
		Reddish-brown, silty micaceous clay damp, m/plastic	▽ 24 hrs, 22.5 ft, 4 Nov
5 ft			
	MB 7-12	Same material	
10 ft			
15 ft		Same material	

USAEHA Form 95, 12 Aug 74

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT 38-26-0128

DATE 3 Nov 80

LOCATION RAAP, Flyash No. 2 Landfill

DRILLERS Gates, Sandrin, Smithson, Warren

DRILL RIG Acker II, 4 inch Continuous Flight Auger

BORE HOLE BH5

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
		Same material	
20 ft		Getting wetter more plastic	
▼			Change in engine pitch ▽
25 ft		Saturated	
		Weathered Elbrook Dolomite	7,800 PSI
30 ft		TD = 31 ft	

USAEHA Form 95, 12 Aug 74

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT 38-26-0128 DATE 3 Nov 80

LOCATION RAAP, Flyash No. 2 Landfill DRILLERS Gates, Sandrin

Smithson, Warren

DRILL RIG Acker II, 4 inch Continuous Flight Auger BORE HOLE BH6

Elevation of Hole 1,767 ft MSL

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
		Disturbed fill	TD = 26 ft
		Reddish-brown, silty clay w/mica flakes damp, m/plastic	▽ Initial' dry, 3 Nov ▽ 24 hrs' 15 ft,10 inches 4 Nov
5 ft		Same material	
10 ft		Gravel sound (¼ - ½ inch gravel)	
		getting wetter, more plastic	possible Dolomite Lense
	BS 11-16		
15 ft			

USAEHA Form 95, 12 Aug 74

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT 38-26- 0128

DATE 3 Nov 80

LOCATION RAAP, Flyash No. 2 Landfill

DRILLERS Gates, Sandrin, Smithson, Warren

DRILL RIG Acker II, 4 inch Continuous Flight Auger

BORE HOLE BH6

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
▼	moisture BT	Clay saturated	▽
	MB 16-21		
20 ft		Blue L_s chips w/clay return (weathered Dolomite) Elbrook Dolomite	
25 ft		Weathered Elbrook Dolomite	
		TD = 26 ft	
30 ft			

USAEHA Form 95, 12 Aug 74

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT 38-26-0128 DATE 1 Nov 80

LOCATION RAAP, Flyash No. 2 Landfill DRILLERS Gates, Sandrin, Smithson, Warren

DRILL RIG Acker II, 4 inch Continuous Flight Auger BORE HOLE BH7

Elevation of Hole 1,772.1 ft MSL

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN.	DESCRIPTION	REMARKS
		Reddish-brown, silty clay	TD = 42 ft
	MB 0-6		▽ initial, 25 ft, 1 Nov
	moisture bottle #2 6-7 ft		▽ 24 hrs, 25 ft, 2 Nov
			▽ 72 hrs, 25 ft, 4 Nov
5 ft			
		Same material	
10 ft			
	ST/P	Red, clayey silt	Easy to push
15 ft			

USAEHA Form 95, 12 Aug 74

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT 38-26-0128

DATE 1 Nov 80

LOCATION RAAP, Flyash No. 2 Landfill

DRILLERS Gates, Sandrin
Smithson, Warren

DRILL RIG Acker II, 4 inch
Continuous Flight Auger

BORE HOLE BH7

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
		Gravel	Broke a drilling tooth gravel grinding sound
		1-½ inch gravel	
20 ft			
25 ft	▼		broke through gravel
		Brown, silty clay (very wet, plastic)	
30 ft			

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT 38-26-0128 DATE 1 Nov 80

LOCATION RAAP, Flyash No. 2 Landfill DRILLERS Gates, Sandrin, Smithson, Warren

DRILL RIG Acker II, 4 inch Continuous Flight Auger BORE HOLE BH7

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
		Same material	
35 ft		NOTE: Seem to have been drilling in weathered dolomite for the last 10 ft.	
40 ft			
42 ft		Lime mud to the surface	TD = 42 ft Elbrook Dolomite Formation
45 ft			

USAEHA Form 95, 12 Aug 74

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT 38-26-0128
DATE 1 Nov 80

LOCATION RAAP, Flyash No. 2 Landfill
DRILLERS Gates, Sandrin, Smithson, Warren

DRILL RIG Acker II, 4 inch Continuous Flight Auger
BORE HOLE BH8

Elevation of Hole 1,763.1 ft MSL

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
		Top soil, brown loam	TD = 36 ft
	MB 1-6	Reddish-brown, silty clay streaks of yellow (damp, more plastic)	▽ initial, 34 ft, 1 Nov ▽ 24 hrs, 34 ft, 2 Nov ▽ 48 hrs, 33 ft, 3 Nov ▽ 72 hrs, 34 ft, 4 Nov
5 ft			
		Same material (getting darker brown)	
10 ft		Same material	
	BS 11-16 moisture bottle #1	Getting more silty	
15 ft			

USAEHA Form 95, 12 Aug 74

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT 38-26-0128 DATE 1 Nov 80

LOCATION RAAP, Flyash No. 2 Landfill DRILLERS Gates, Sandrin, Smithson, Warren

DRILL RIG Acker II, 4 inch Continuous Flight Auger BORE HOLE BH8

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
	MB 16-21	¼ - ½ pea gravel in red clay getting damper	Gravel noise
20 ft			
		Gravels getting larger ½ - 1 inch gravels	
25 ft		Material getting finer	Sample not coming to surface
30 ft			

USAEHA Form 95, 12 Aug 74

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT 38-26-0128 DATE 1 Nov 80

LOCATION RAAP, Flyash No. 2 Landfill DRILLERS Gates, Sandrin, Smithson, Warren

DRILL RIG Acker II, 4 inch Continuous Flight Auger BORE HOLE BH8

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN.	DESCRIPTION	REMARKS
		Difficult drilling Broke through a hard lense	
	MB 32-36	Silty clay (saturated, more plastic)	
▽			TD - 36 ft Elbrook Dolomite Formation
35 ft		Refusal	
40 ft			

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT 38-26-0128 DATE 2 Nov 80

LOCATION RAAP, Flyash No. 2 Landfill DRILLERS Gates, Sandrin, Smithson, Warren

DRILL RIG Acker II, 4 inch Continuous Flight Auger BORE HOLE BH9

Elevation of Hole 1,765.3 ft MSL

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
		Brown loam	TD = 49 ft
		Orangish-brown, silty micaceous clay dry, more plastic	▽ initial, dry, 2 Nov ▽ 24 hrs, dry, 3 Nov
		Grey-blue, silty clay micaceous, dry, very stiff	▽ 48 hrs, dry, 4 Nov
5 ft	MB 3-11		
10 ft			
	ST/P 1,000 PSI moisture bt #3		
		same material getting damper	
15 ft			

USAEHA Form 95, 12 Aug 74

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT 38-26-0128 DATE 2 Nov 80

LOCATION RAAP, Flyash No. 2 Landfill DRILLERS Gates, Sandrin, Smithson, Warren

DRILL RIG Acker II, 4 inch Continuous Flight Auger BORE HOLE BH9

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN.	DESCRIPTION	REMARKS
		Same material (reddish-brown tint, weathered)	
20 ft			
	MB 21-26		
		Same material getting wetter	
25 ft			
30 ft		clay w/gravel (½ - 1½ inch)	gravel noise

USAEHA Form 95, 12 Aug 74

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT 38-26-0128 DATE 2 Nov 80

LOCATION RAAP, Flyash No. 2 Landfill DRILLERS Gates, Sandrin, Smithson, Warren

DRILL RIG Acker II, 4 inch Continuous Flight Auger BORE HOLE BH9

DEPTH	SAMPLE TYPE / BLOWS PER 6 IN.	DESCRIPTION	REMARKS
		Same material getting wetter, more plastic (some sand)	Drilling easy
35 ft			
		Same material	
40 ft			
		Same material	
45 ft			

USAEHA Form 95, 12 Aug 74

US ARMY ENVIRONMENTAL HYGIENE AGENCY

DRILLING LOG

PROJECT 38-26-0128

DATE 2 Nov 80

LOCATION RAAP, Flyash No. 2 Landfill

DRILLERS Gates, Sandrin, Smithson, Warren

DRILL RIG Acker II, 4 inch Continuous Flight Auger

BORE HOLE BH9

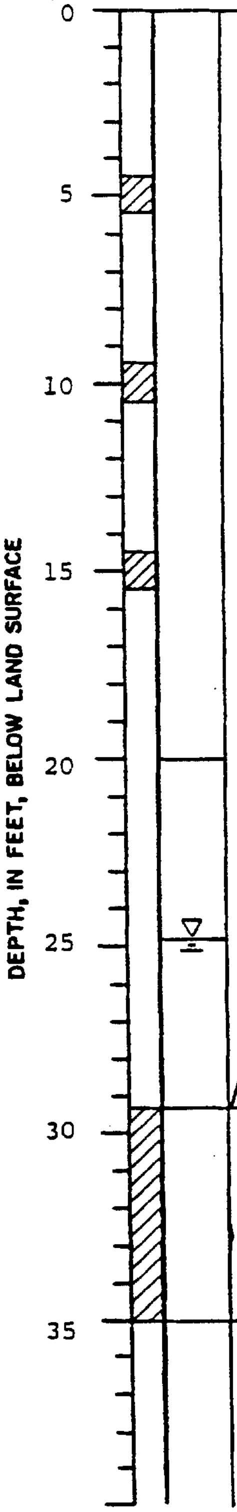
DEPTH	SAMPLE TYPE / BLOWS PER 6 IN	DESCRIPTION	REMARKS
		Refusal	difficult drilling
50 ft		Elbrook Dolomite Formation	

USAEHA Form 95, 12 Aug 74

Geraghty & Miller, Inc.

WELL LOG

PROJECT: RADFORD
CLIENT: NUS
Date Prepared: 8/8/80 By: G.F.S.



DESCRIPTION

- 0: Sand, fine, silty, micaceous, brown
- Sand grades to medium
- 15: Sand grades to coarse
- 20: Lost Circulation (10-15 gpm)
- No Recovery
- 25: Water Table
- Changed from 5" fishtail bit to 3" NX core barrel
- Top of Rock
- 30: Regained Circulation after putting in 30 ft of 3" casing
- Mudstone, some calcite veins, solid, massive, grayish green
- 35: Bottom of Hole

OWNER: Corps of Engineers
WELL No.: D-1
LOCATION: Lagoon D - Settling Ponds

TOPO SETTING:
GROUND ELEV.: 1714.68

DRILLING STARTED: 8/8/80
DRILLING COMPLETED: 8/11/80
DRILLER: M. J. Dean
TYPE OF RIG: CME-75

WELL DATA

HOLE DIAM.: 5" to 29.5 ft; 3" to 35 ft
TOTAL DEPTH: 35 ft
CASING DIAM.: 2 in Timco PVC
CASING LENGTH: 20 ft
SCREEN DIAM.: 2 in
SCREEN SETTING: 20-35 ft
SCREEN SLOT & TYPE: .010 PVC
WELL STATUS: Completed

GROUT

TYPE OF GROUT: Neat cement
GROUT DEPTH: 0-15 ft
VOLUME: .6 cu ft
TYPE OF PLUG: Bentonite
PLUG DEPTH: 14-15 ft
VOLUME: 1 lb

DEVELOPMENT

METHOD: Air
RATE: 0.5 gpm
LENGTH: 70 min

TEST DATA

STATIC DEPTH TO WATER: 24.96
DATE MEASURED: 8/14/80
PUMPING DEPTH TO WATER:
DURATION OF TEST:
PUMPING RATE:
DATE OF TEST:
TYPE OF TEST:
PUMP SETTING:
SPECIFIC CAPACITY:

FINAL PUMP CAPACITY:
FINAL PUMP SETTING:
AVERAGE PUMPAGE:

WATER QUALITY

Geraghty & Miller, Inc.

WELL LOG

PROJECT: RADFORD
CLIENT: NUS
Date Prepared: 8/7/80 By: G.F.S.

SAMPLE INTERVAL (Depth, in feet, below land surface)	DESCRIPTION
0	Silt and sand, micaceous, brown
3	Sand, fine to medium, well sorted, micaceous, brown
10	Same as above
13	Water Table
15	Sand grades to coarse
19	Same as above
20	Lost circulation (10-15 gpm)
21	Changed from 5" fishtail bit to 3" NX core barrel
23.5	Top of Rock
23.5	Regained circulation
24	Limestone, badly weathered, lot of calcite, black
34	Same as above
35	Bottom of Hole

OWNER: Corps of Engineers
WELL No.: D-2
LOCATION: Lagoon D - Settling Ponds in use
TOPO SETTING:
GROUND ELEV.: 1713.12

DRILLING STARTED: 8/7/80
DRILLING COMPLETED: 8/8/80
DRILLER: M. J. Dean
TYPE OF RIG: CME-75

WELL DATA

HOLE DIAM.: 5" to 23 ft; 3" to 35 ft
TOTAL DEPTH: 35 ft
CASING DIAM.: 2 in Timco PVC
CASING LENGTH: 20 ft
SCREEN DIAM.: 2
SCREEN SETTING: 20-35 ft
SCREEN SLOT & TYPE: .010 PVC
WELL STATUS: Completed

GROUT

TYPE OF GROUT: Neat cement
GROUT DEPTH: 0-15 ft
VOLUME: .6 cu ft
TYPE OF PLUG: Bentonite
PLUG DEPTH: 14-15 ft
VOLUME: 1 lb

DEVELOPMENT

METHOD: Air
RATE: 0.1 gpm
LENGTH: 40 min.

TEST DATA

STATIC DEPTH TO WATER: 13.14
DATE MEASURED: 8/14/80
PUMPING DEPTH TO WATER:
DURATION OF TEST:
PUMPING RATE:
DATE OF TEST:
TYPE OF TEST:
PUMP SETTING:
SPECIFIC CAPACITY:

FINAL PUMP CAPACITY:
FINAL PUMP SETTING:
AVERAGE PUMPAGE:

WATER QUALITY

Geraghty & Miller, Inc.

WELL LOG

PROJECT: RADFORD
CLIENT: NUS
Date Prepared: 8/7/80 By: G.F.S.

Depth (ft)	Description
0	Clay, silty, dark brown
	Silt, clayey, dark brown
5	
	Sand, fine, silty, micaceous, brown
10	
15	Sand grades to medium
	Water Table
	Change from 5" fishbit to 3" NX core barrel
	Top of Rock
	Lost Circulation
20	Dolostone, calcite crystals and veins, gray
25	
30	Same as above
35	Same as above
	Bottom of Hole

SAMPLE INTERVAL — DEPTH, IN FEET, BELOW LAND SURFACE

OWNER: Corps of Engineers
WELL No.: D-3
LOCATION: Lagoon D - Settling Pond
TOPO SETTING:
GROUND ELEV.: 1699.97

DRILLING STARTED: 8/7/80
DRILLING COMPLETED: 8/7/80
DRILLER: R. A. Monroe
TYPE OF RIG: C-40

WELL DATA

HOLE DIAM.: 5" to 19 ft; 3" to 35 ft
TOTAL DEPTH: 35 ft
CASING DIAM.: 2 in Timco PVC
CASING LENGTH: 20 ft
SCREEN DIAM.: 2 in
SCREEN SETTING: 20-35 ft
SCREEN SLOT & TYPE: .010 PVC
WELL STATUS: Completed

GROUT

TYPE OF GROUT: Neat cement
GROUT DEPTH: 0-15 ft
VOLUME: .6 cu ft
TYPE OF PLUG: Bentonite
PLUG DEPTH: 14-15 ft
VOLUME: 1 lb

DEVELOPMENT

METHOD: Air
RATE: 0.25 gpm
LENGTH: 25 min

TEST DATA

STATIC DEPTH TO WATER: 16.74
DATE MEASURED: 8/14/80
PUMPING DEPTH TO WATER:
DURATION OF TEST:
PUMPING RATE:
DATE OF TEST:
TYPE OF TEST:
PUMP SETTING:
SPECIFIC CAPACITY:

FINAL PUMP CAPACITY:
FINAL PUMP SETTING:
AVERAGE PUMPAGE:

WATER QUALITY

Geraghty & Miller, Inc.

WELL LOG

PROJECT RADFORD
CLIENT NUS
Date Prepared 8/7/80 By G.F.S.

SAMPLE INTERVAL (DEPTH, IN FEET, BELOW LAND SURFACE)	DESCRIPTION
0–3	Sand, fine, silty, some clay, micaceous, brown
3–12	Clay, silty, brown
	Clay balls, tarry, septic odor, dark gray
12–23	Sand, fine to medium, micaceous, well sorted, off-white to tan
~14.5	Water Table
20	Lost Circulation (10-15 gpm)
22	Regained Circulation (10-15 gpm)
23	Top of Rock
23–35	Limestone
	No Recovery
28	Lost Circulation (10-15 gpm)
	No Recovery
35	Bottom of Hole

OWNER Corps of Engineers
WELL No. D-4
LOCATION Lagoon D - Settling Ponds in use
TOPO SETTING
GROUND ELEV. 1713.44

DRILLING STARTED 8/7/80
DRILLING COMPLETED 8/7/80
DRILLER M. J. Dean
TYPE OF RIG CME-75

WELL DATA

HOLE DIAM. 5" to 23 ft; 3" to 35 ft
TOTAL DEPTH 35 ft
CASING DIAM. 2 in Timco PVC
CASING LENGTH 20 ft
SCREEN DIAM. 2 in
SCREEN SETTING 20-35 ft
SCREEN SLOT & TYPE .010 PVC
WELL STATUS Completed

GROUT

TYPE OF GROUT Neat cement
GROUT DEPTH 0-15 ft
VOLUME .6 cu ft
TYPE OF PLUG Bentonite
PLUG DEPTH 14-15 ft
VOLUME 1 lb

DEVELOPMENT

METHOD Air
RATE 0.1 gpm
LENGTH 46 min

TEST DATA

STATIC DEPTH TO WATER 14.43
DATE MEASURED 8/14/80
PUMPING DEPTH TO WATER
DURATION OF TEST
PUMPING RATE
DATE OF TEST
TYPE OF TEST
PUMP SETTING
SPECIFIC CAPACITY

FINAL PUMP CAPACITY
FINAL PUMP SETTING
AVERAGE PUMPAGE

WATER QUALITY

Geraghty & Miller, Inc.

WELL LOG

PROJECT: RADFORD
CLIENT: NUS
Date Prepared: 8/7/80 By: G.F.S.

DEPTH, IN FEET, BELOW LAND SURFACE	DESCRIPTION
0	Clay, silty, micaceous, brown
~3.5	Sand, fine, some silt, micaceous, well sorted, brown
~12 (▽)	Water Table
	Changed from 5" fishtail bit to 3" NX core barrel
14.5	Top of Rock
14.5	Limestone, soft, weathered, some calcite, some solution channels, gray
25	Same as above
35	Same as above
35	Bottom of Hole

Sample intervals: approx. 5–6 ft, 10–11 ft, 14.5–35 ft.

OWNER: Corps of Engineers
WELL No.: D-5
LOCATION: Lagoon D - Settling Ponds in use
TOPO SETTING:
GROUND ELEV.: 1696.12

DRILLING STARTED: 8/7/80
DRILLING COMPLETED: 8/8/80
DRILLER: R. A. Monroe
TYPE OF RIG: C-40

WELL DATA

HOLE DIAM.: 5" to 14.5 ft; 3" to 35 ft
TOTAL DEPTH: 35 ft
CASING DIAM.: 2 in Timco PVC
CASING LENGTH: 20 ft
SCREEN DIAM.: 2 in
SCREEN SETTING: 20-35 ft
SCREEN SLOT & TYPE: .010 PVC
WELL STATUS: Completed

GROUT

TYPE OF GROUT: Neat cement
GROUT DEPTH: 0-15 ft
VOLUME: .6 cu ft
TYPE OF PLUG: Bentonite
PLUG DEPTH: 14-15 ft
VOLUME: 1 lb

DEVELOPMENT

METHOD: Air
RATE: 0.1 gpm
LENGTH: 47 min

TEST DATA

STATIC DEPTH TO WATER: 12.35
DATE MEASURED: 8/13/80
PUMPING DEPTH TO WATER:
DURATION OF TEST:
PUMPING RATE:
DATE OF TEST:
TYPE OF TEST:
PUMP SETTING:
SPECIFIC CAPACITY:

FINAL PUMP CAPACITY:
FINAL PUMP SETTING:
AVERAGE PUMPAGE:

WATER QUALITY

Geraghty & Miller, Inc.

WELL LOG

PROJECT: RADFORD
CLIENT: NUS
Date Prepared: 8/8/80 By: G.F.S.

DEPTH, IN FEET, BELOW LAND SURFACE	SAMPLE INTERVAL	DESCRIPTION
0		Clay, silty, micaceous, brown
5	sample	
9		Sand, fine, micaceous, well sorted, off-white
10	sample	
15	sample; water table	Sand grades into medium to coarse. Water Table
18		Top of Rock (Limestone)
18–20	sample	No recovery. Changed from 5" fishtail bit to 3" NX core barrel
25	sample	Mudstone, pea sized, green
35		Same as above. Bottom of Hole

OWNER: Corps of Engineers
WELL No.: D-6
LOCATION: Lagoon D - Settling Ponds in use
TOPO SETTING:
GROUND ELEV.: 1699.64

DRILLING STARTED: 8/8/80
DRILLING COMPLETED: 8/11/80
DRILLER: R. A. Monroe
TYPE OF RIG: C-40

WELL DATA

HOLE DIAM.: 5" to 18 ft; 3" to 35 ft
TOTAL DEPTH: 35 ft
CASING DIAM.: 2 in Timco PVC
CASING LENGTH: 20 ft
SCREEN DIAM.: 2 in
SCREEN SETTING: 20-35 ft
SCREEN SLOT & TYPE: .010 PVC
WELL STATUS: Completed

GROUT

TYPE OF GROUT: Neat cement
GROUT DEPTH: 0-15 ft
VOLUME: .6 cu ft
TYPE OF PLUG: Bentonite
PLUG DEPTH: 14-15 ft
VOLUME: 1 lb

DEVELOPMENT

METHOD: Air
RATE: 3 gpm
LENGTH: 55 min

TEST DATA

STATIC DEPTH TO WATER: 15.40
DATE MEASURED: 8/13/80
PUMPING DEPTH TO WATER:
DURATION OF TEST:
PUMPING RATE:
DATE OF TEST:
TYPE OF TEST:
PUMP SETTING:
SPECIFIC CAPACITY:

FINAL PUMP CAPACITY:
FINAL PUMP SETTING:
AVERAGE PUMPAGE:

WATER QUALITY

Geraghty & Miller, Inc.

WELL LOG

PROJECT: RADFORD
CLIENT: NUS
Date Prepared: 8/12/80 By: G.F.S.

DEPTH, IN FEET, BELOW LAND SURFACE	DESCRIPTION
0	Sand, fine, silty, some clay, micaceous, brown
5	Lost circulation (10-15 gpm) River Jack
~8	Changed from 5" fishtail bit to 3" NX core barrel
10–15	No recovery
~19	Top of Rock
~19	Regained Circulation
20	Water Table
~21.5	Lost Circulation (10-15 gpm)
	Limestone, weathered, soft, some calcite, chalky, light gray
35	Same as Above
35	Bottom of Hole

OWNER: Corps of Engineers
WELL No.: D-7
LOCATION: Lagoon D - Settling Ponds
TOPO SETTING:
GROUND ELEV.: 1701.04

DRILLING STARTED: 8/12/80
DRILLING COMPLETED: 8/12/80
DRILLER: M. J. Dean
TYPE OF RIG: CME-75

WELL DATA

HOLE DIAM.: 5" to 8 ft; 3" to 35 ft
TOTAL DEPTH: 35 ft
CASING DIAM.: 2 in Timco PVC
CASING LENGTH: 20 ft
SCREEN DIAM.: 2 in
SCREEN SETTING: 20-35 ft
SCREEN SLOT & TYPE: .010 PVC
WELL STATUS: Completed

GROUT

TYPE OF GROUT: Neat cement
GROUT DEPTH: 0-15 ft
VOLUME: .4 cu ft
TYPE OF PLUG: Bentonite
PLUG DEPTH: 14-15 ft
VOLUME: 1 lb

DEVELOPMENT

METHOD: Air
RATE: 0.5 gpm
LENGTH: 120 min

TEST DATA

STATIC DEPTH TO WATER: 20.38
DATE MEASURED: 8/15/80
PUMPING DEPTH TO WATER:
DURATION OF TEST:
PUMPING RATE:
DATE OF TEST:
TYPE OF TEST:
PUMP SETTING:
SPECIFIC CAPACITY:

FINAL PUMP CAPACITY:
FINAL PUMP SETTING:
AVERAGE PUMPAGE:

WATER QUALITY

Geraghty & Miller, Inc.

WELL LOG

PROJECT RADFORD
CLIENT NUS
Date Prepared 8/11/80 By G.F.S.

DEPTH, IN FEET, BELOW LAND SURFACE	SAMPLE INTERVAL	DESCRIPTION
0		Sand, fine to medium, silty, micaceous, brown
5	sample	
10	sample	Same as above
15	sample	Sand grades to coarse
20	sample	Same as above
		Changed from 5" fishtail bit to 3" NX core barrel
24	∇	Top of Rock
24–35	sample	Limestone, calcite veins, some iron stains, some solution channels, gray
35		Same as above
35		Bottom of Hole

OWNER Corps of Engineers
WELL No. D-8
LOCATION Lagoon D - Settling Ponds
TOPO SETTING
GROUND ELEV. 1711.75

DRILLING STARTED 8/11/80
DRILLING COMPLETED 8/11/80
DRILLER M. J. Dean
TYPE OF RIG CME-75

WELL DATA

HOLE DIAM. 5" to 24 ft; 3" to 35 ft
TOTAL DEPTH 35 ft
CASING DIAM. 2 in Timco PVC
CASING LENGTH 20 ft
SCREEN DIAM. 2 in
SCREEN SETTING 20-35 ft
SCREEN SLOT & TYPE .010 PVC
WELL STATUS Completed

GROUT

TYPE OF GROUT Neat cement
GROUT DEPTH 0-15 ft
VOLUME .6 cu ft
TYPE OF PLUG Bentonite
PLUG DEPTH 14-15 ft
VOLUME 1 lb

DEVELOPMENT

METHOD Air
RATE .5 gpm
LENGTH 65 min

TEST DATA

STATIC DEPTH TO WATER 24.12
DATE MEASURED 8/13/80
PUMPING DEPTH TO WATER
DURATION OF TEST
PUMPING RATE
DATE OF TEST
TYPE OF TEST
PUMP SETTING
SPECIFIC CAPACITY

FINAL PUMP CAPACITY
FINAL PUMP SETTING
AVERAGE PUMPAGE

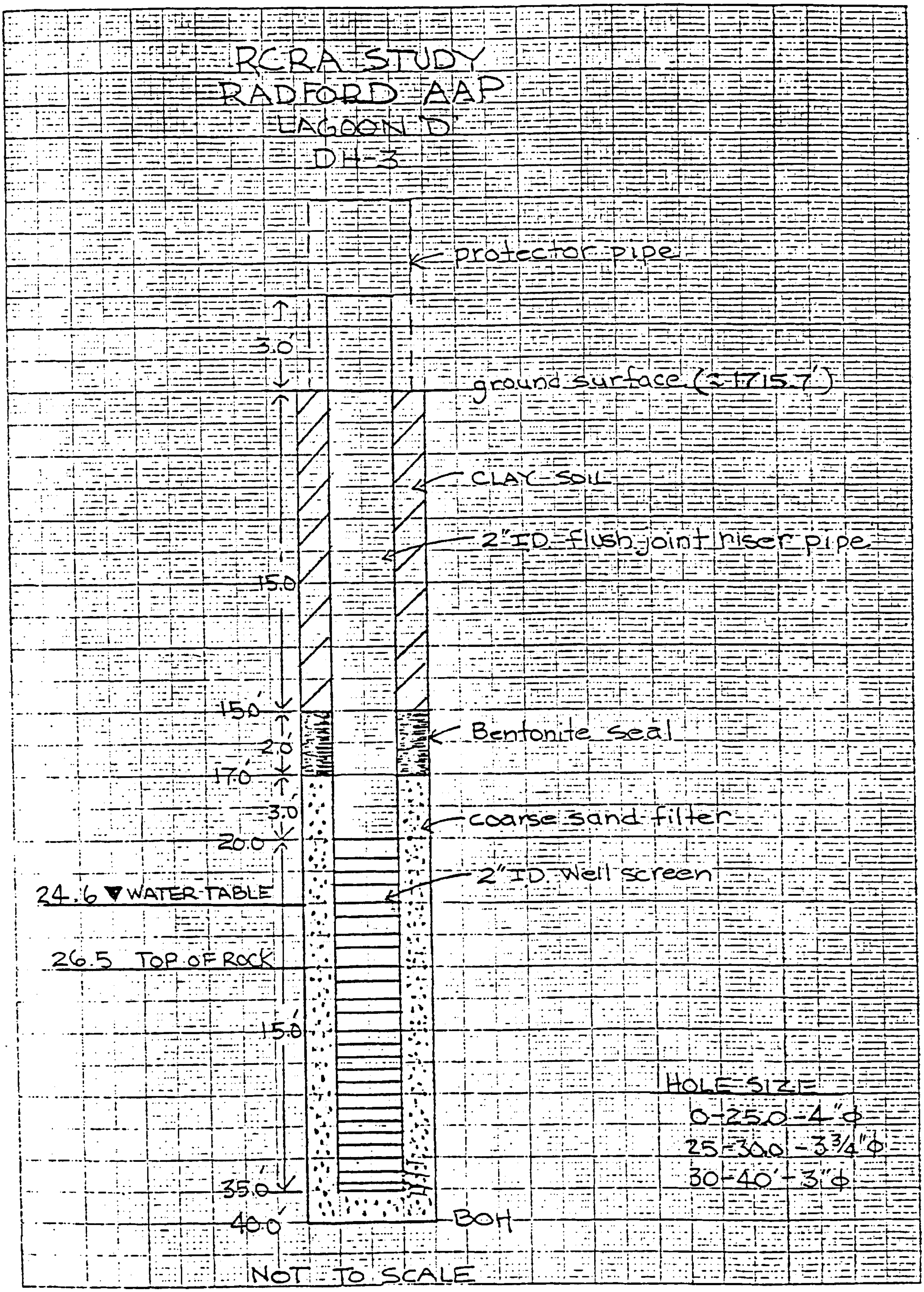
WATER QUALITY

Hole No. DH-3

DRILLING LOG	DIVISION NAD	INSTALLATION NAO	SHEET 1 OF 1 SHEETS

1. PROJECT: RCRA - LAGOON "D"	10. SIZE AND TYPE OF BIT: 2" O.D. SS; NX DIA
2. LOCATION (Coordinates or Station): N 318,400 E1. 408,317	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
3. DRILLING AGENCY: CUNNINGHAM CORE DRILLING	12. MANUFACTURER'S DESIGNATION OF DRILL: CME - 75
4. HOLE NO. (As shown on drawing title and file number): DH-3	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 6; UNDISTURBED 2
5. NAME OF DRILLER: MARVIN DEAN	14. TOTAL NUMBER CORE BOXES: 1
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER: 1692
	16. DATE HOLE: STARTED 16 JULY 80; COMPLETED 17 JULY 80
7. THICKNESS OF OVERBURDEN: 26.5	17. ELEVATION TOP OF HOLE: 1715.7
8. DEPTH DRILLED INTO ROCK: 13.5	18. TOTAL CORE RECOVERY FOR BORING: 5.2' 38 %
9. TOTAL DEPTH OF HOLE: 40.0	19. SIGNATURE OF INSPECTOR: William G Barker

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			3" Topsoil			
			(ML) SILT, little v. fn-fn sand, tr clay, low plast moist, yel. brn	100	S-1	Split Spoon 4-3-3
						advanced w/4" fishtail
						K = (0-5') = 0
1710.7	5.0		(ML-SM) SILT & SAND, v. fn to fn, micaceous, SH plast. moist, yel. brn	100	S-2	Split Spoon 5-7-11
						K = (0-10') = .32 ft/day
1706.7	9.0		(SM) SAND, v-fn-fn, little silt, NP, moist, lt brn	160	S-3	Split Spoon 2-3-3
1704.2	11.5		(SP SAND, v. fn-fn, little med sand, tr silt, lt brn moist, NP, becomes fn-med grained w/tr crs sand	75	UD-1	Shelby tube - push
						K = (0-15') = .14 ft/day
				50	S-4	Split Spoon 2-1-2
						K = (15-20') = .25 ft/day
			same fn-med SAND	50	UD-2	Shelby tube - push
1695.7	20		(SP-GP) SAND, fn-crs and gravel, tr silt, NP, v. moist to saturated	30	S-5	Split Spoon 9-6-4
						advanced w/casing K = (20-25) = 38.9 ft/day
1690.7	25.0		(SM-GM) SAND & GRAVEL	100	S-6	Split Spoon 5-4-5
1689.2	26.5		size LS fragments w/some silt, tr clay badly weathered rock	14	Run 1 Box 1 .5	advanced to 26.5 RQD = 0 K(25-30) = 40.8 ft/day
			Top of Rock LIMESTONE, blue gray to tan, irregular bedding dipping 10°-50° (tectonic activity apparent) v-fn grd, soft to med. hard, partially fragmented moderately to badly weath. mainly calcite healed fractures and vugs	23	Run 2 Box 1 1.5	advanced casing to 30.0' K(30-36.5) = 19.2 ft/day RQD = 0
				100	Run 3 2.0	RQD = 0
				80	Run 4 1.2	RQD = 0 K(30-40) = 12.7 ft/day
1675.7	40.0		BOH - 40.0'			water at completion = 23.7 water after 24 hrs. = 24.2 time for well installation was 2.5 hrs.


RCRA STUDY
RADFORD AAP
LAGOON 'D'
DH-3
protector pipe
3.0'
ground surface (≈1715.7')
CLAY SOIL
2" ID flush joint riser pipe
15.0'
15.0'
Bentonite seal
2.0'
17.0'
3.0'
coarse sand filter
20.0'
2" ID Well screen
24.6 WATER TABLE
26.5 TOP OF ROCK
15.0'
HOLE SIZE
0-25.0'-4"φ
25-30.0'-3 3/4"φ
30-40'-3"φ
35.0'
40.0'
BOH
NOT TO SCALE

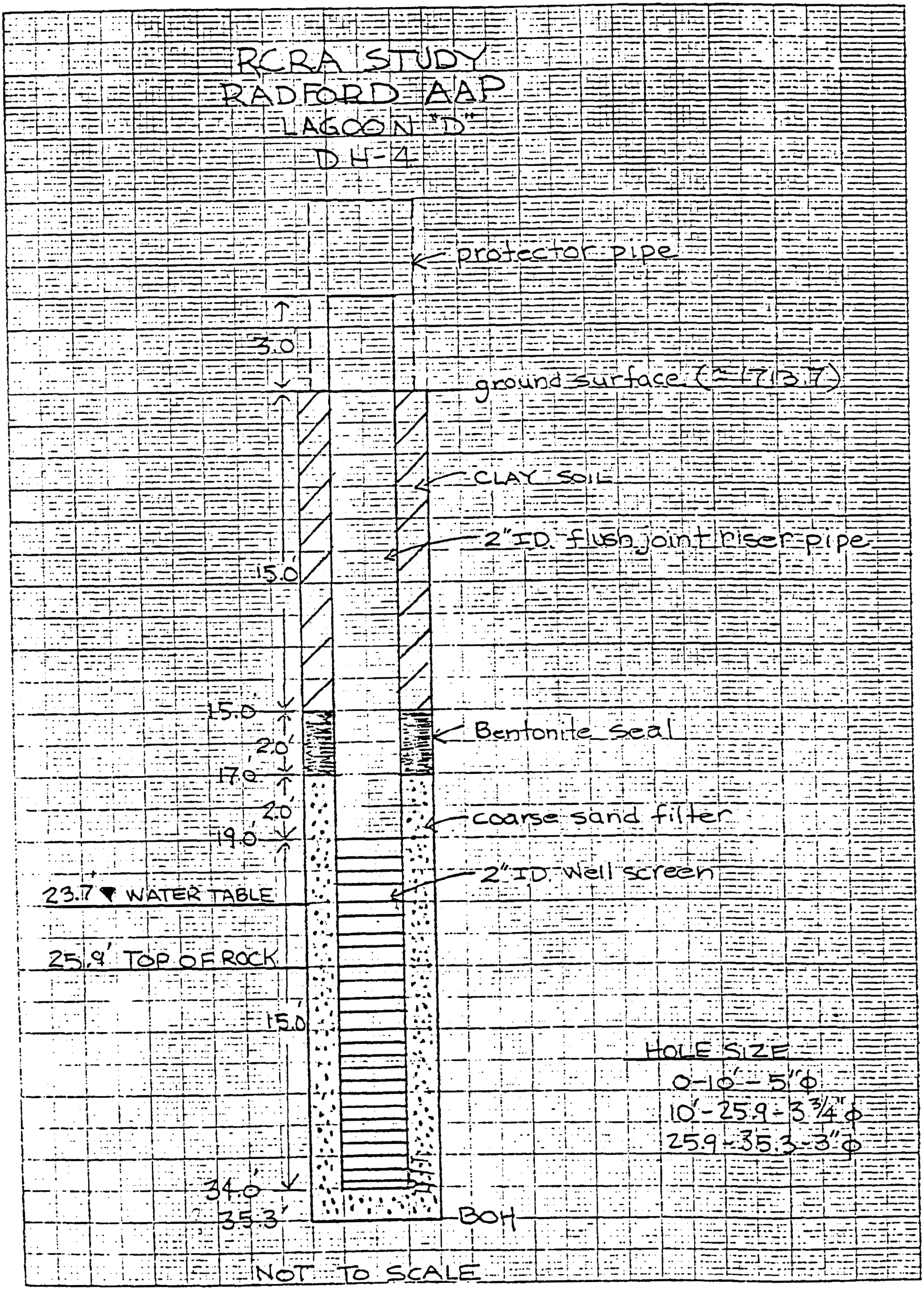
Hole No. DH-4

DRILLING LOG	DIVISION: NAD	INSTALLATION: NAO	SHEET 1 OF 1 SHEETS

1. PROJECT: RCRA STUDY - LAGOON D	10. SIZE AND TYPE OF BIT: 2" O.D. SS: NX DIA
2. LOCATION (Coordinates or Station): N 318,740 E1,407,610	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
3. DRILLING AGENCY: CUNNINGHAM CORE DRILLING	12. MANUFACTURER'S DESIGNATION OF DRILL: SPRAGUE & HENWOOD 40C
4. HOLE NO. (As shown on drawing title and file number): DH-4	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 4; UNDISTURBED 0
5. NAME OF DRILLER: BOB MONROE	14. TOTAL NUMBER CORE BOXES: 1
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER: 1690.0
	16. DATE HOLE: STARTED 17 JULY 80; COMPLETED 18 JULY 80
	17. ELEVATION TOP OF HOLE: 1713.7
7. THICKNESS OF OVERBURDEN: 25.9	18. TOTAL CORE RECOVERY FOR BORING: 8.5 89 %
8. DEPTH DRILLED INTO ROCK: 9.4	19. SIGNATURE OF INSPECTOR: William Barker
9. TOTAL DEPTH OF HOLE: 34.3	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
			2" Topsoil (ML) SILT, little v. fn-fn sand, brn, slt plast. moist to dry	100	S-1	Split Spoon/6-6-5 K (0-5) = 0
1710.2	3.5		(SM) SAND, fn-fn some mica silt, tr. clay, slt plast moist, yel.brn	100	S-2	Split Spoon 4-6-8 K (5-10) = .87 ft/day set 4" casing to 10.0
1704.7	9.0		same (SM) w/some gravel and cobbles	100	S-3	Split Spoon 12-25-25 K (10-15) = 2.45 ft/day
1701.2	12.5		(GP) Gravels & Cobbles, some fn-crs sand, tr silt	0	S-4	Split Spoon 15-30/.4 no recovery on S-4 advanced casing to 20' K (15-20) = 6.16 ft/day
1693.7	20.0		(GC) Gravels and Sand fn-crs, some silt & clay, yel. brn, low plast saturated, very soft			hole caved below casing K (20-25.9) = 23.6 ft/day Split Spoon - WT of hammer from 20 - 25.9 set casing in rock to 26
1687.8	25.9		Cored river jack 25.9-26.1 Dolomitic limestone, blue gray, thin-med bedded, dipping 25-30° w/zones of irregular bedding dipping up to 70°, v. fn grained, mod hard, Slt. weathered, many calcite healed fractures, some calcite filled vugs, largest core piece - 13", average = 5", smallest - 1"	89%	Run 1 Box 1 84	NX Core RQD = 40% K (25.9 - 35.3) = 13.7 ft/day No pressure
1679.4	34.3		BOH - 34.3			Water at completion -23.7 Water after 14hrs. hole size 0 - 10 -5" 10-25.9 -3 3/4" 25.9 - 35.3 -3" time of well installation was 2.75 hrs.

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT) | PROJECT: RCRA STUDY - LAGOON D | HOLE NO. DH-4


RCRA STUDY
RADFORD AAP
LAGOON "D"
D H-4
protector pipe
3.0'
ground surface (≈1713.7)
CLAY SOIL
2" I.D. flush joint riser pipe
15.0'
15.0'
2.0'
Bentonite seal
17.0'
2.0'
coarse sand filter
19.0'
2" I.D. Well screen
23.7 WATER TABLE
25.9' TOP OF ROCK
15.0'
HOLE SIZE
0-10'-5"φ
10'-25.9-3¾"φ
25.9-35.3-3"φ
34.0'
35.3'
BOH
NOT TO SCALE

Geraghty
& Miller, Inc.

WELL LOG

PROJECT RADFORD
CLIENT NUS
Date Prepared 7/23/80 By G.F.S.

OWNER Corps of Engineers
WELL No. H-1
LOCATION Lagoon H - Settling Ponds in use
TOPO SETTING
GROUND ELEV. 1712.48

DRILLING STARTED 7/23/80
DRILLING COMPLETED 7/24/80
DRILLER M. J. Dean
TYPE OF RIG CME-75

WELL DATA

HOLE DIAM. 5" to 15 ft; 3" to 40 ft
TOTAL DEPTH 40 ft
CASING DIAM. 2 in Timco PVC
CASING LENGTH 25 ft
SCREEN DIAM. 2 in
SCREEN SETTING 25-40 ft
SCREEN SLOT & TYPE .010 PVC
WELL STATUS Completed

GROUT

TYPE OF GROUT Neat cement
GROUT DEPTH 0-20 ft
VOLUME 1 cu ft
TYPE OF PLUG Bentonite
PLUG DEPTH 19-20 ft
VOLUME 1 lb

DEVELOPMENT

METHOD Air
RATE 0.1 gpm
LENGTH 101 min

TEST DATA

STATIC DEPTH TO WATER 31.90
DATE MEASURED 8/13/80
PUMPING DEPTH TO WATER
DURATION OF TEST
PUMPING RATE
DATE OF TEST
TYPE OF TEST
PUMP SETTING
SPECIFIC CAPACITY

FINAL PUMP CAPACITY
FINAL PUMP SETTING
AVERAGE PUMPAGE

WATER QUALITY

SAMPLE INTERVAL | DESCRIPTION

DEPTH, IN FEET, BELOW LAND SURFACE

Depth	Description
0	Silt and sand, fine, brown
10	Same as above
	River Jack
	Changed from 5" fishtail bit to 3" NX core barrel
15	Silt, sand, some gravel River Jack
	Sand, fine, silty, micaceous, brown
25	River Jack
	Lost Circulation (10-15 gpm)
	Top of Rock
	Limestone, calcite vugs, some quartz
30	Water Table
35	Same as above
40	Bottom of Hole

Geraghty & Miller, Inc.

WELL LOG

PROJECT: RADFORD
CLIENT: NUS
Date Prepared: 7/24/80 By: G.F.S.

DEPTH, IN FEET, BELOW LAND SURFACE	SAMPLE INTERVAL	DESCRIPTION
0		Clay and silt, brown
5	X	
8.5		Sand, fine, silty, some clay, micaceous, brown
10	X	
15	X	River Jack Sand grades to coarse
18		Change from 5" fishtail bit to 3" NX core barrel
20		Same as above
24		River Jack
27.39		Lost Circulation (10-15 gpm) Water Table No recovery
30		River Jack
40		No recovery Bottom of Hole

OWNER: Corps of Engineers
WELL No.: H-2
LOCATION: Lagoon H - Settling Ponds in use
TOPO SETTING:
GROUND ELEV.: 1709.90

DRILLING STARTED: 7/24/80
DRILLING COMPLETED: 7/24/80
DRILLER: R. A. Monroe
TYPE OF RIG: C-40

WELL DATA

HOLE DIAM.: 5" to 18 ft; 3" to 40 ft
TOTAL DEPTH: 40 ft
CASING DIAM.: 2 in Timco PVC
CASING LENGTH: 25 ft
SCREEN DIAM.: 2 in
SCREEN SETTING: 25-40
SCREEN SLOT & TYPE: .010 PVC
WELL STATUS: Completed

GROUT

TYPE OF GROUT: Neat cement
GROUT DEPTH: 0-20 ft
VOLUME: 1 cu ft
TYPE OF PLUG: Bentonite
PLUG DEPTH: 19-20 ft
VOLUME: 1 lb

DEVELOPMENT

METHOD: Air
RATE: 0.5 gpm
LENGTH: 45 min

TEST DATA

STATIC DEPTH TO WATER: 27.39
DATE MEASURED: 8/13/80
PUMPING DEPTH TO WATER:
DURATION OF TEST:
PUMPING RATE:
DATE OF TEST:
TYPE OF TEST:
PUMP SETTING:
SPECIFIC CAPACITY:

FINAL PUMP CAPACITY:
FINAL PUMP SETTING:
AVERAGE PUMPAGE:

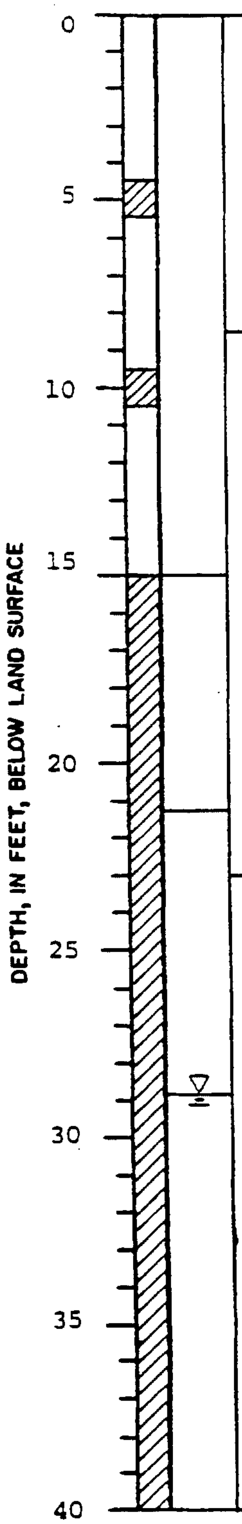
WATER QUALITY

Geraghty
& Miller, Inc.

WELL LOG

PROJECT: RADFORD
CLIENT: NUS
Date Prepared: 7/25/80 By: G.F.S.

SAMPLE INTERVAL	DESCRIPTION
0	Silt and sand, some clay, micaceous, brown
	Sand, fine to medium, silty, micaceous, brown
15	Changed from 5" fishtail bit to 7" NX core barrel
	River Jack
	River Jack
	Lost circulation (10-15 gpm)
	Top of Rock
	Limestone, solution channels, gray
	Water Table
	Same as above
40	Bottom of Hole



OWNER: Corps of Engineers
WELL No.: H-3
LOCATION: Lagoon H - Settling Ponds in use
TOPO SETTING:
GROUND ELEV.: 1709.66

DRILLING STARTED: 7/25/80
DRILLING COMPLETED: 7/25/80
DRILLER: R. A. Monroe
TYPE OF RIG: C-40

WELL DATA

HOLE DIAM.: 5" to 15 ft; 3 " to 40 ft
TOTAL DEPTH: 40 ft
CASING DIAM.: 2 in Timco PVC
CASING LENGTH: 25 ft
SCREEN DIAM.: 2 in
SCREEN SETTING: 25-40 ft
SCREEN SLOT & TYPE: .010 PVC
WELL STATUS: Completed

GROUT

TYPE OF GROUT: Neat cement
GROUT DEPTH: 0-20 ft
VOLUME: .8 cu ft
TYPE OF PLUG: Bentonite
PLUG DEPTH: 19-20 ft
VOLUME: 1 lb

DEVELOPMENT

METHOD:
RATE:
LENGTH:

TEST DATA

STATIC DEPTH TO WATER:
DATE MEASURED:
PUMPING DEPTH TO WATER:
DURATION OF TEST:
PUMPING RATE:
DATE OF TEST:
TYPE OF TEST:
PUMP SETTING:
SPECIFIC CAPACITY:

FINAL PUMP CAPACITY:
FINAL PUMP SETTING:
AVERAGE PUMPAGE:

WATER QUALITY

Geraghty & Miller, Inc.

WELL LOG

PROJECT RADFORD
CLIENT NUS
Date Prepared 7/25/80 By G.F.S.

DEPTH, IN FEET, BELOW LAND SURFACE	DESCRIPTION
0	Clay, silty, micaceous, brown
	Sand, fine to medium, silty, micaceous, brown
10	Same as above
15	Same as above
	Change from 5" fishtail bit to 3" NX core barrel
20	Same as above
	Lost circulation (10-15 gpm)
25	River Jack No recovery
	River Jack
	Water Table No recovery
	Top of Rock
	Limestone, hard, gray
	Same as above
40	Bottom of Hole

OWNER Corps of Engineers
WELL No. H-4
LOCATION Lagoon H - Settling Ponds in use
TOPO SETTING
GROUND ELEV. 1710.90

DRILLING STARTED 7/25/80
DRILLING COMPLETED 7/25/80
DRILLER M. J. Dean
TYPE OF RIG CME-75

WELL DATA

HOLE DIAM. 5" to 16 ft; 3" to 40 ft
TOTAL DEPTH 40 ft
CASING DIAM. 2 in Timco PVC
CASING LENGTH 25 ft
SCREEN DIAM. 2 in
SCREEN SETTING 25-40 ft
SCREEN SLOT & TYPE .010 PVC
WELL STATUS Completed

GROUT

TYPE OF GROUT Neat cement
GROUT DEPTH 0-20 ft
VOLUME .8 cu ft
TYPE OF PLUG Bentonite
PLUG DEPTH 19-20 ft
VOLUME 1 lb

DEVELOPMENT

METHOD Air
RATE 0.25 gpm
LENGTH 37 min

TEST DATA

STATIC DEPTH TO WATER
DATE MEASURED
PUMPING DEPTH TO WATER
DURATION OF TEST
PUMPING RATE
DATE OF TEST
TYPE OF TEST
PUMP SETTING
SPECIFIC CAPACITY

FINAL PUMP CAPACITY
FINAL PUMP SETTING
AVERAGE PUMPAGE

WATER QUALITY

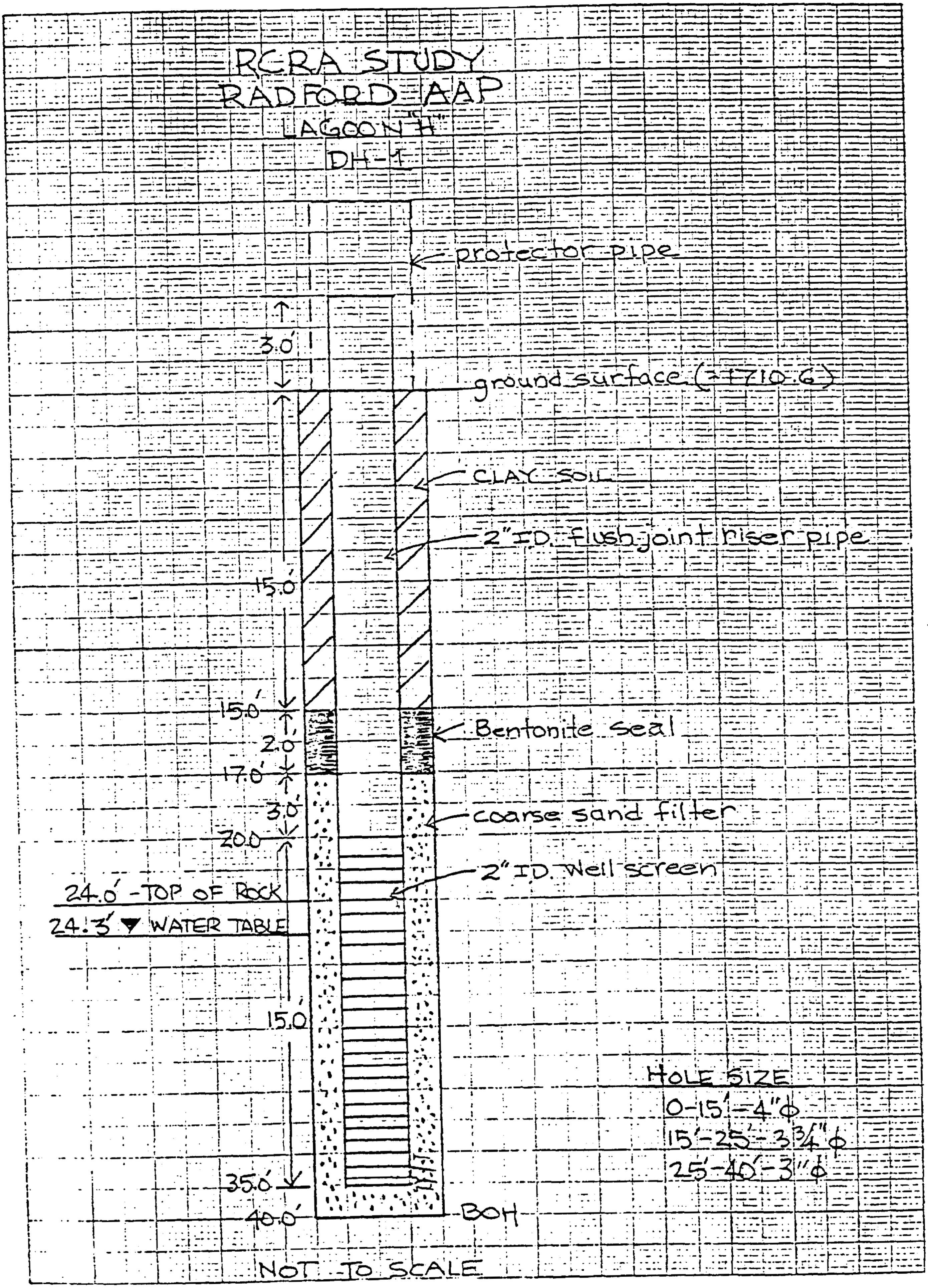
Hole No. DH-1

DRILLING LOG	DIVISION NAD	INSTALLATION NAO	SHEET 1 OF 1 SHEETS

1. PROJECT: LAGOON "H" - RCRA STUDY	10. SIZE AND TYPE OF BIT: 2" SS; NX DIA
2. LOCATION (Coordinates or Station): N 317,745 E 1,401,885	11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
3. DRILLING AGENCY: CUNNINGHAM CORE DRILLING	12. MANUFACTURER'S DESIGNATION OF DRILL: CME-75
4. HOLE NO. (As shown on drawing title and file number): DH-1	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED 5, UNDISTURBED 3
5. NAME OF DRILLER: MARVIN DEAN	14. TOTAL NUMBER CORE BOXES: 1
6. DIRECTION OF HOLE: [X] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER: 1686.1
	16. DATE HOLE: STARTED 14 July 1980; COMPLETED 15 July 1980
7. THICKNESS OF OVERBURDEN: 24.0	17. ELEVATION TOP OF HOLE: 1710.6
8. DEPTH DRILLED INTO ROCK: 16.0	18. TOTAL CORE RECOVERY FOR BORING: 9.0 56.2%
9. TOTAL DEPTH OF HOLE: 40.0	19. SIGNATURE OF INSPECTOR: William J Barker

ELEVATION (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	BOX OR SAMPLE NO. (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)
			6" Topsoil (SC) SAND, fn-med. little to some micaceous silt and clay, moist		S-1	Split Spoon 3-9-10 washed w/fishtail to 5.0 - then ran pez. test K = .39 ft/day
1705.6	5.0		(SM) SAND, v-fn-fn, some micaceous silt, tr med sand, NP, moist increase of silt and tr, clay w/depth	100	S-2	Split Spoon 5-8-8
1703.1	7.5			100	UD-1	Push 6.5-8.5 K(0-10) = .12 ft/day
			(ML) SILT, micaceous some v. fn. sand, tr. clay brn, slt plast, moist	100	S-3	Split Spoon 3-3-6
				100	UD-2	Push 11.5-13.5
1697.1	13.5		at bottom of tube - 13.5 becomes (SM) SAND, v. fn to fn, some silt, riverjack @ 15.5'			K(0-15) = .1 ft/day
				100	S-4	Split Spoon 5-8-12 K(15-20) = .13 ft/day
			(GP) Gravel & Cobbles some fn-fn sand, tr, silt brn, NP, saturated			
1690.6	20.0			100	S-5	Split Spoon 20-21-50/.4
1689.1	21.5		(GP) Limestone rock fragments			cored thru river jack from 20-24.0 K(20-25) = 22.1 ft/day
1686.6	24.0		TOP OF ROCK Limestone, med gray, v. fn grd, med bedded dipping 25° mod. hard to hard, mod spaced fractures (4" - 10") slt weathered	100	Run 1 1.0	RQD = 0
				96	Run 2 2.5	NX CORE RQD = 6.8
				46	Run 3 Box 1	NX CORE RQD = 39.0% K(25-36.4) = 22.8 ft/day drilled fast thru v. soft seam 31.4-35.9
1679.2	31.4		Soft Seam - lost water @ 31.4'		4.1	
1674.7	35.9		Some limestone as above but mod weathered Some calcite filled vugs	38	Run 4 Box 1 1.4	K(25-40) = 17.4 ft/day NX Core RQD = 14%
1670.6	40.0		BOH 40.0 Water level vanes with river elevation between 23.5 and 26.5			water at completion = 23.5' water after 24 hrs = 24.3' well installation = 3.0 hrs. hole size 0-15' - 4" 15-25 - 3 3/4" 25-40'-3"

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT) | PROJECT LAGOON "H" - RCRA STUDY | HOLE NO. DH-1

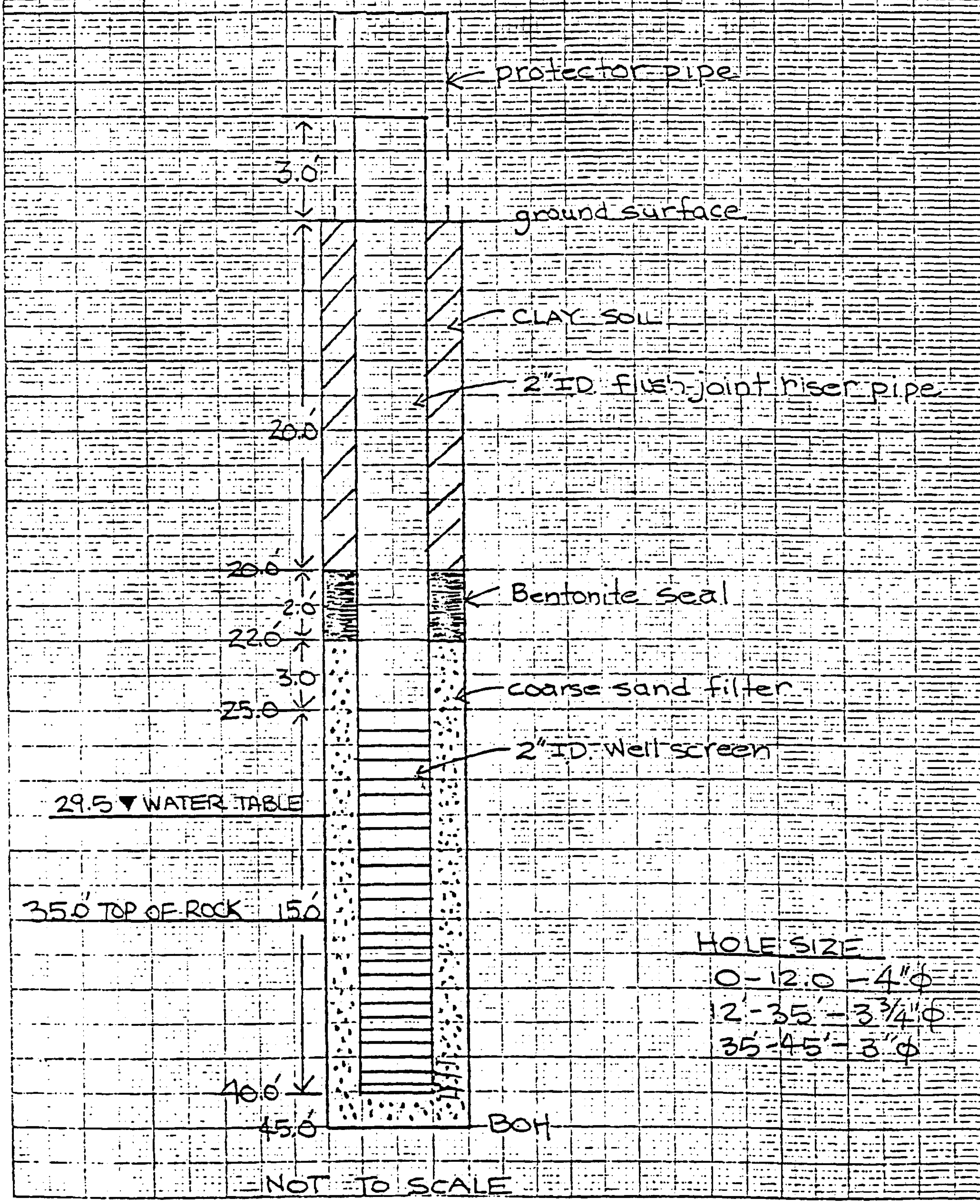

RCRA STUDY
RADFORD AAP
LAGOON "H"
DH-1
protector pipe
3.0'
ground surface (=1710.6)
CLAY SOIL
2" I.D. flush joint riser pipe
15.0'
15.0'
Bentonite seal
2.0'
17.0'
coarse sand filter
3.0'
20.0'
2" I.D. well screen
24.0' - TOP OF ROCK
24.3' ▼ WATER TABLE
15.0'
HOLE SIZE
0-15' - 4"φ
15'-25' - 3 3/4"φ
25'-40' - 3"φ
35.0'
40.0'
BOH
NOT TO SCALE

Hole No. LH-DH-2

DRILLING LOG	DIVISION NAD	INSTALLATION NAO	SHEET 1 OF 1 SHEETS
1. PROJECT RCRA LAGOON H		10. SIZE AND TYPE OF BIT	
2. LOCATION (Coordinates or Station) N 317590 E1402095		11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL	
3. DRILLING AGENCY CUNNINGHAM CRILLING & GROUTING		12. MANUFACTURER'S DESIGNATION OF DRILL CME - 75	
4. HOLE NO. (As shown on drawing title and file number) LH-DH-2		13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN	DISTURBED 7 / UNDISTURBED 0
5. NAME OF DRILLER MARVIN DEAN		14. TOTAL NUMBER CORE BOXES 1	
6. DIRECTION OF HOLE [X] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.		15. ELEVATION GROUND WATER 1683.7	
		16. DATE HOLE	STARTED 11 JULY 80 / COMPLETED 14 JULY 80
7. THICKNESS OF OVERBURDEN 35.0		17. ELEVATION TOP OF HOLE 1713.0	
8. DEPTH DRILLED INTO ROCK 10.0		18. TOTAL CORE RECOVERY FOR BORING 8.0'	80%
9. TOTAL DEPTH OF HOLE 45.0		19. SIGNATURE OF INSPECTOR	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
1713.0			(SM) SAND fn., some silt, tr of organics, tr of rock frag, micaeous moist, light brown	100	S-1	Split Spoon 2-2-8
						Perm Test 0-5.0 K = 0.22 ft/day
			(SM) AS ABOVE	100	S-2	Split Spoon 6-18-9
						Perm Test 5.0-10.0 K = 0.08 ft/day
			(SM) AS ABOVE	100	S-3	Split Spoon 4-3-6
1701.0	12.0		Riverjack consisting of boulders, cobbles, gravel, sand, silt, and clay			Perm Test 10.0-15.0 K = 0.09 ft/day
				100	S-4	Split Spoon 15-16-5
						Perm Test 15.0-20.0 K = 0.32 ft/day
				60	S-5	Split Spoon 41-52-50/.
						Perm Test 20.0-25.0 K = 0.05 ft/day
				10	S-6	Split Spoon 100/.2
1683.7	29.3					Perm Test 25.0'-30.0' K = 0.01 ft/day Water Level @ 24 hrs. 29.3' Water Level @ 48 hrs. 29.3'
				10	S-7	Split Spoon 15-9-8
			Top of Rock @ 35.0			Perm Test 30.0'-35.0' K = 5.25 ft/day
1678.0			Limestone Breccia, Lt. gray yel. brn. & blue gray fragmented w/av. core size of 2"; Mod. hard, fn. grd., Mod. to badly weathered	80		Made 3 runs 80% recovery RQD=0 no perm. testing
1668.0			BOH @ 45.0 Water at completion=29.3 Water after 24 hrs.=29.5			Water level vanes with river elevation betwee 29.3 and 30.0

RCRA STUDY
RADFORD AAP
LAGOON "H"
DH-2



RCRA
Facility Investigation
Radford Army Ammunition Plant
Radford, Virginia

Monitoring Well Locations & Elevations
for
Dames & Moore

Site	Well	Top Elev. Inner (pvc) Pipe	Top Elev. Outer Casing	Top Elev. Concrete Pad	Ground Elev. At Well (Average)	Coordinates (Northing Easting)
SWMU-10	10MW1	1703.62	1703.84	1701.74	1701.28	319,145 1,407,606
	D-3	1702.95	1702.61	NO PAD	1700.51	319,112 1,407,702
	D-4	1714.38	1716.20	NO PAD	1713.42	318,631 1,407,800
	DDH2	1702.53	1702.10	NO PAD	1700.78	319,070 1,407,776
	DDH4	1715.85	1715.38	NO PAD	1713.16	318,741 1,407,605
	DG-1	1712.08	1712.27	NO PAD	1709.96	318,836 1,407,437
	D3D	1702.64	1703.00	NO PAD	1700.70	319,122 1,407,687
SWMU-13	13MW1	1701.44	1701.61	1699.11	1698.66	319,276 1,410,626
	13MW2	1702.62	1702.84	1701.76	1701.21	319,195 1,409,898
	13MW3	1694.47	1695.02	1693.81	1693.41	318,977 1,409,732
	13MW4	1696.40	1696.60	1695.56	1695.18	319,015 1,410,103
	13MW5	1696.40	1696.60	1695.51	1695.26	319,026 1,410,475
	13MW6	1696.05	1696.27	1694.31	1693.~~81~~ 85	319,091 1,410,872
	13MW7	1695.21	1695.42	1694.11	1693.~~81~~ 77	319,115 1,411,091

correction made via phone call

REVISED 12/31/91 VA. STATE PLANE COORDINATES (1927) SHOWN.

SHEET NO. 1 OF 1

ANDERSON AND ASSOCIATES, Inc.
Engineers
Surveyors
Planners
Blacksburg, Virginia

CALC	CHECKED	DATE	DOCUMENT NO.
CBK	ROC	18 DEC 91	08485005

RCRA
Facility Investigation
Radford Army Ammunition Plant
Radford, Virginia

Monitoring Well Locations & Elevations
for
Dames & Moore

Site	Well	Top Elev. Inner (pvc) Pipe	Top Elev. Outer Casing	Top Elev. Concrete Pad	Ground Elev. At Well (Average)	Coordinates (Northing Easting)
SWMU-O	OMW1	1780.04	1780.24	1777.96	1777.6	315,632 1,407,586
	P-1	1779.69	1779.61	NO PAD	1777.1	315,520 1,407,326
	P-2	1758.64	1758.59	NO PAD	1756.8	315,842 1,407,547
	P-3	1754.59	1754.58	NO PAD	1753.2	315,938 1,407,607
	P-4	1773.17	1773.32	1771.38	1771.2	315,890 1,407,681
	WC1-1	1787.48	1787.52	1785.31	1785.1	315,977 1,407,782
	WC1-2	1786.58	1787.47	1785.20	1784.8	315,975 1,407,795
	S4W-1	1753.27	1753.35	1750.77	1750.7	316,049 1,407,939
	8B	1740.14	1740.48	1738.23	1738.2	316,103 1,408,219
SWMU 17	40MW4	1908.11	1908.33	1906.56	1906.1	313,361 1,403,439
	17PZ1	1907.02	1907.24	1904.97	1904.7	313,185 1,404,071
	40MW2	1882.51	1882.71	1881.25	1881.1	313,663 1,403,550

PLOT AT .666=1

ANDERSON AND ASSOCIATES, Inc.
Engineers
Surveyors
Planners
Blacksburg, VA
Greensboro, NC

DRAWN	SCALE	DATE	DOCUMENT NO.
KJD	–	20 JAN 92	08485018

INDEX NO. A-8485-

ACAD 08485018

RCRA
Facility Investigation
Radford Army Ammunition Plant
Radford, Virginia

Monitoring Well Locations & Elevations
for
Dames & Moore

Site	Well	Top Elev. Inner (pvc) Pipe	Top Elev. Outer Casing	Top Elev. Concrete Pad	Ground Elev. At Well (Average)	Coordinates (Northing Easting)
SWMU-32	32MW1	1738.31	1738.64	1736.69	1736.40	321,026 1,404,613
SWMU-40	40MW2	1882.51	1882.71	1881.25	1881.1	313,663 1,403,550
	40MW4	1908.11	1908.33	1906.56	1906.1	313,361 1,403,439
SWMU-43	43MW1	1705.87	1706.10	1704.25	1703.90	318,346 1,411,372
	43MW2	1707.62	1707.86	1705.40	1704.95	318,206 1,410,585
	43MW3	1703.35	1703.57	1701.58	1701.15	318,402 1,410,435
	43MW4	1702.78	1703.01	1701.30	1700.90	318,440 1,410,643
	43MW5	1702.94	1703.16	1700.99	1700.40	318,539 1,411,209
	43MW6	1703.88	1704.09	1701.69	1701.24	318,584 1,411,422

PLOT AT .666=1

ANDERSON AND ASSOCIATES, Inc.

Engineers
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Blacksburg, VA
Greensboro, NC

DRAWN	SCALE	DATE	DOCUMENT NO.
KJD	—	24 JAN 92	08485020

INDEX NO. A-8485-

ACAD 08485020

RCRA
Facility Investigation
Radford Army Ammunition Plant
Radford, Virginia

Monitoring Well Locations & Elevations
for
Dames & Moore

Site	Well	Top Elev. Inner (pvc) Pipe	Top Elev. Outer Casing	Top Elev. Concrete Pad	Ground Elev. At Well (Average)	Coordinates (Northing Easting)
SWMU-41	41MW1	1805.15	1805.36	1803.42	1802.87	315,060 1,408,956
	41MW2	1797.45	1797.67	1795.82	1795.44	315,147 1,409,009
	41MW3	1759.35	1759.58	1757.41	1757.26	315,366 1,409,025
SWMU-45	45MW1	1709.70	1709.92	1707.93	1707.53	318,527 1,402,816
	45MW2	1706.17	1706.39	1704.04	1703.74	318,716 1,402,652
	45MW3	1706.52	1706.74	1704.58	1704.14	318,766 1,402,760
SWMU-54	54MW1	1707.78	1707.98	1705.88	1705.68	321,308 1,412,356
	54MW2	1701.41	1701.63	1699.16	1698.86	321,227 1,412,712
	54MW3	1702.15	1702.36	1700.96	1700.56	321,321 1,412,765
SWMU-74	74MW1	1734.85	1735.03	1732.81	1732.59	321,259 1,411,356

PLOT AT .666=1

ANDERSON AND ASSOCIATES, Inc.

Engineers
Surveyors
Planners

Blacksburg, VA
Greensboro, NC

DRAWN	SCALE	DATE	DOCUMENT NO.
KJD	–	24 JAN 92	08485021

INDEX NO. A-8485-21

ACAD 08485021

RCRA
Facility Investigation
Radford Army Ammunition Plant
Radford, Virginia

Monitoring Well Locations & Elevations
for
Dames & Moore

Site	Well	Top Elev. Inner (pvc) Pipe	Top Elev. Outer Casing	Top Elev. Concrete Pad	Ground Elev. At Well (Average)	Coordinates (Northing Easting)
28/51/52	51MW1	1823.13	1823.35	1821.49	1821.24	320,089 1,409,683
	51MW2	1834.77	1834.99	1833.41	1833.29	320,040 1,409,893
	C-1	1840.14	1839.71	NO PAD	1836.94	320,441 1,409,886
	C-2	1808.18	1808.53	NO PAD	1806.99	320,561 1,410,410
	C-3	1822.10	1821.65	NO PAD	1819.09	320,285 1,410,383
	C-4	1824.57	1826.84	1824.96	1824.74	320,056 1,410,230
	16-1	1815.82	1816.15	1814.55	1814.54	320,826 1,410,333
	16-2	1810.99	1810.99	1809.32	1809.24	320,669 1,410,575
	16-3	1824.77	1825.14	1823.35	1823.37	320,256 1,410,509
	16-4	1836.76	1838.48	1836.10	1835.84	320,198 1,409,917
	WC-1A	1812.61	1812.70	1810.58	1810.54	320,490 1,410,423
	WC-2A	1818.05	1818.04	1816.45	1816.07	320,667 1,410,367
	WC-1B	1812.95	1812.97	NO PAD	1811.29	320,504 1,410,431
	WC-2B	1818.71	1818.65	1817.04	1816.97	320,671 1,410,379
	CDH-2	1826.28	1825.89	NO PAD	1823.79	320,144 1,410,286
	CDH-3	1810.19	1813.34	NO PAD	1810.71	320,381 1,410,511
	MW-8	1815.82	1815.80	1813.52	1813.42	320,634 1,410,412
	MW-9	1808.88	1809.05	NO PAD	1806.54	320,560 1,410,421
	28MW1	1827.18	1827.33	1825.96	1825.71	320,869 1,409,937
	28MW2	1821.56	1821.77	1819.97	1819.91	320,820 1,409,557

NOTE: WELL CDH-1 APPEARS TO HAVE BEEN DESTROYED. FORMER LOCATION WAS N 320,441 E 1,410,000 (FROM OLD MAPPING, A&A JN 6268 DATED 6/28/88.)

PLOT AT .666=1

ANDERSON AND ASSOCIATES, Inc.

Engineers
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Blacksburg, VA
Greensboro, NC

DRAWN	SCALE	DATE	DOCUMENT NO.
KJD	—	20 JAN 92	08485019

INDEX NO. A-8485-

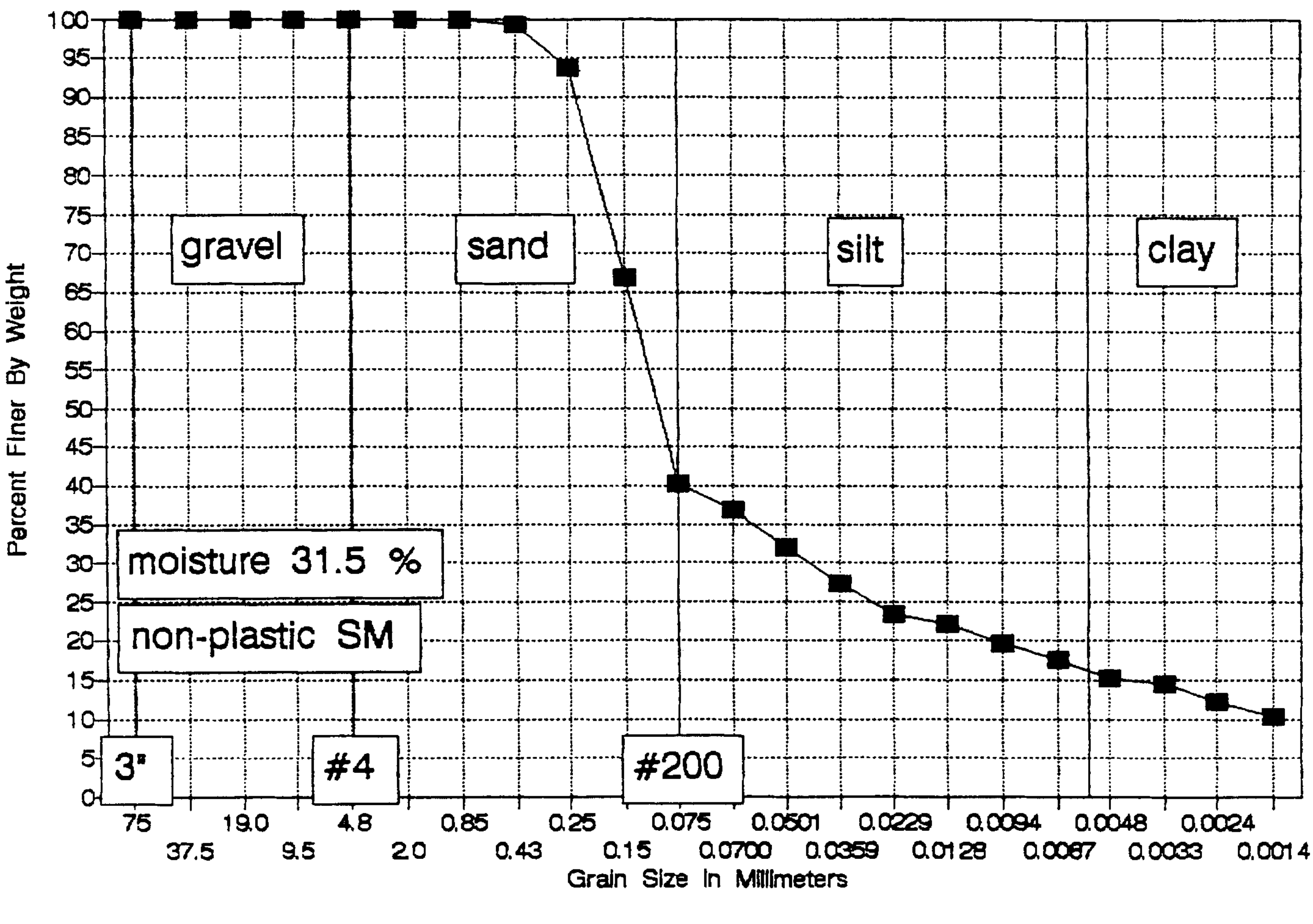
ACAD 08485019

APPENDIX E.2

Physical Soil Testing and Hydraulic Conductivity Data

GRADATION CURVE

Boring 10MW1 sample 4 at 15 to 17 feet



RAAP RFI
06702-077-155

Wt soil and dish	201.3
Dry soil & dish	178.9
Dish	107.7

Boring 10MW1 Sample 4 at 15-17 feet
Moisture Content = 31.5

SIEVE & HYDROMETER ANALYSIS

SIEVE PORTION

Dry weight of TOTAL sample= 71.2
sample split -#10 sieve = 40.68

Sieve #	Weight Retained	Total Percent Finer
1.5 inch		100.00%
3/4 inch	0	100.00%
3/8 inch	0	100.00%
# 4	0	100.00%
# 10	0	100.00%
# 20	0.04	99.90%
# 40	0.25	99.39%
# 60	2.54	93.76%
# 100	13.44	66.96%
# 200	24.34	40.17%

Constants this test
Gs= 2.65 20c=.01365 21c=.01348 22c=.01332
18c=.01399 19c=.01382
When 5 grams of Sodium
Hexametaphosphate used correction
= 6

HYDROMETER ANALYSIS

Elapsed time	Tc	R'	Zr	Particle Dia. mm	Percent Partial	Total Percent Finer
0.5	19	21	12.84	0.0700	36.87	36.87
1	19	19	13.17	0.0501	31.96	31.96
2	19	17.1	13.48	0.0359	27.29	27.29
5	19	15.5	13.74	0.0229	23.35	23.35
16	19	15	13.83	0.0128	22.12	22.12
30	19	14	13.99	0.0094	19.67	19.67
60	19	13.2	14.12	0.0067	17.70	17.70
120	19	12.2	14.29	0.0048	15.24	15.24
250	19	11.9	14.34	0.0033	14.50	14.50
500	19	11	14.49	0.0024	12.29	12.29
1456	18	10.2	14.62	0.0014	10.32	10.32

ATTERBERG LIMITS TEST DATA

FIELD CLASSIFICATION _ _ _ _ _ _ _ _ _ _ _ _ _ _ _

LABORATORY CLASSIFICATION _ _ _ _ _ _ _ _ _ _ _ _ _

JOB NO. 06702-077
CLIENT/OWNER RAAP RFI
LOCATION Virginia
BORING 10MW1 SAMPLE 4 DEPTH 15-1

FIELD DENSITY BY _ _ _ _ _/_ _/_ _

DETERMINATION	1	2
NUMBER OF RINGS		
WT OF RINGS + WET SOIL		
WT OF RINGS		
WT OF WET SOIL		
FIELD DENSITY		
DRY DENSITY		

THIS IS AN 1/8-INCH THREAD →

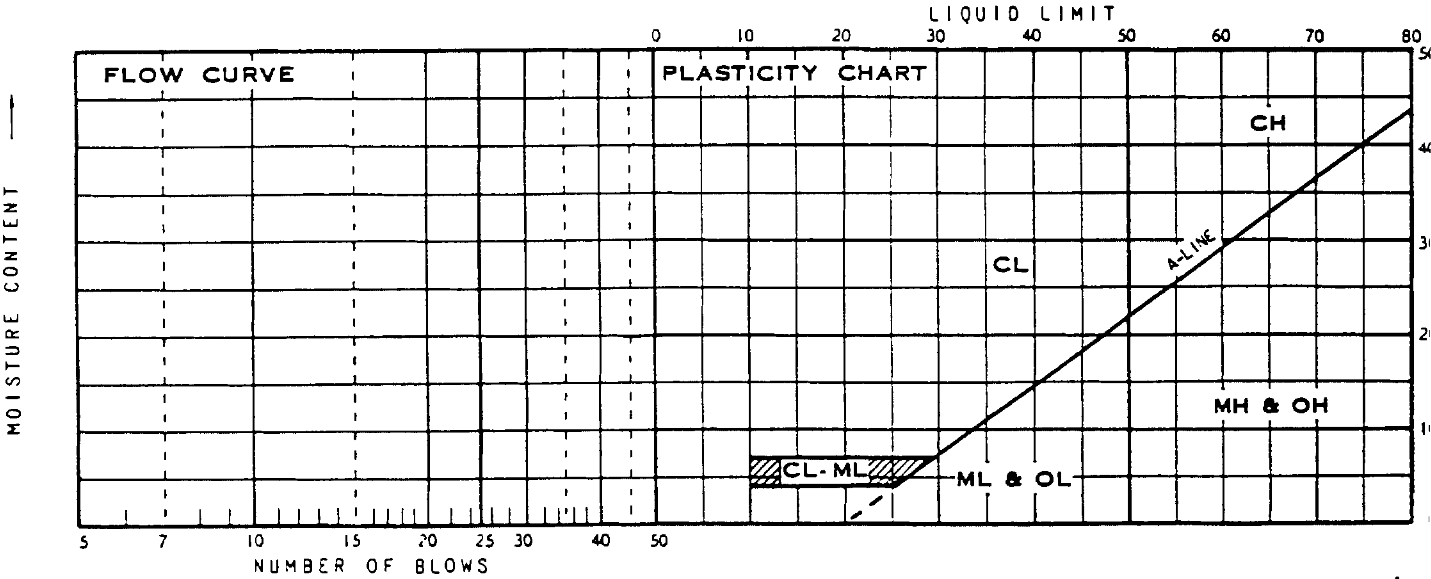
DETERMINATION	1	2
DISH		
WT OF DISH + WET SOIL		
WT OF DISH + DRY SOIL		
WT OF MOISTURE		
WT OF DISH		
WT OF DRY SOIL		
FIELD MOISTURE CONTENT		

PLASTIC LIMIT BY LF 1/1992

DETERMINATION	1	2	3	4	5	6
DISH	A-3	AL71				
WT OF DISH + WET SOIL	8.56	10.35		barely threads		
WT OF DISH + DRY SOIL	7.23	8.96				
WT OF MOISTURE						
WT OF DISH						
WT OF DRY SOIL						
MOISTURE CONTENT	24.53	25.00	AV=25			

LIQUID LIMIT

DETERMINATION	1	2	3	4	5	6
DISH		couldn't get adequate				
NUMBER OF BLOWS			blow count!			
WT OF DISH + WET SOIL						
WT OF DISH + DRY SOIL						
WT OF MOISTURE						
WT OF DISH						
WT OF DRY SOIL						
MOISTURE CONTENT						



SUMMARY

gal

DRY DENSITY	MOISTURE CONTENT	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	IDENTIFICATION	
					NP	

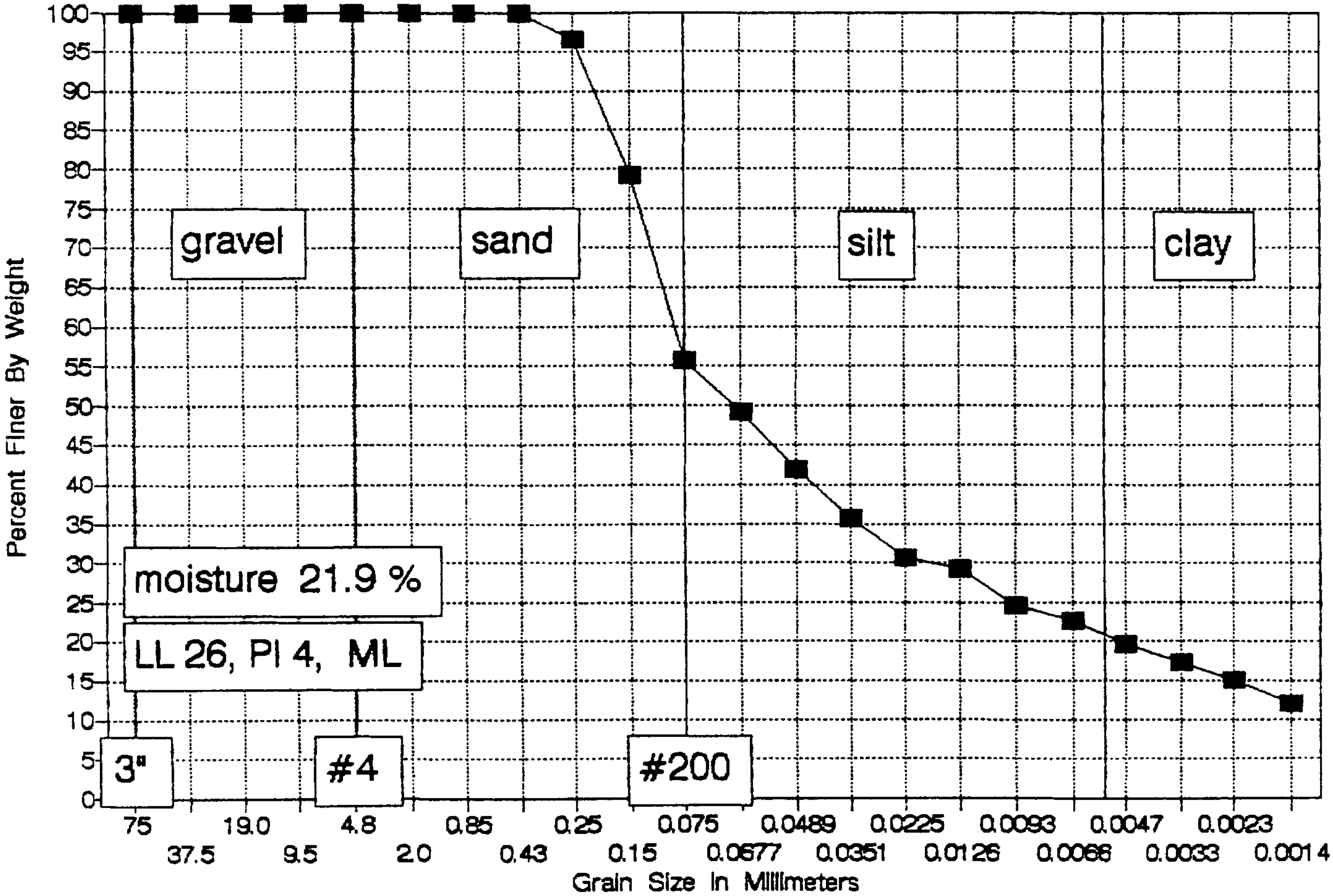
Dames & Moore

					NP	

Dames & Moore

GRADATION CURVE

Boring 10MW1 sample 2 at 5 to 7 feet



RAAP RFI
06702-077-155

Boring 10MW1 Sample 2 at 5-7 feet
Moisture Content = 21.9

Wt soil and dish	175.4
Dry soil & dish	162.7
Dish	104.7

SIEVE & HYDROMETER ANALYSIS

SIEVE PORTION

Dry weight of TOTAL sample= 58
sample split -#10 sieve = 40.67

Sieve #	Weight Retained	Total Percent Finer
1.5 inch		100.00%
3/4 inch	0	100.00%
3/8 inch	0	100.00%
# 4	0	100.00%
# 10	0	100.00%
# 20	0	100.00%
# 40	0.03	99.93%
# 60	1.39	96.58%
# 100	8.46	79.20%
# 200	17.99	55.77%

Constants this test
Gs= 2.65 20c=.01365 21c=.01348 22c=.01332
18c=.01399 19c=.01382
When 5 grams of Sodium
Hexametaphosphate used correction
= 6

HYDROMETER ANALYSIS

Elapsed time	Tc	R'	Zr	Particle Dia. mm	Percent Partial	Total Percent Finer
0.5	19	26	12.01	0.0677	49.18	49.18
1	19	23	12.51	0.0489	41.80	41.80
2	19	20.5	12.92	0.0351	35.65	35.65
5	19	18.5	13.25	0.0225	30.74	30.74
16	19	17.9	13.35	0.0126	29.26	29.26
30	19	16	13.66	0.0093	24.59	24.59
60	19	15.2	13.79	0.0066	22.62	22.62
120	19	14	13.99	0.0047	19.67	19.67
250	19	13	14.16	0.0033	17.21	17.21
500	19	12.1	14.30	0.0023	15.00	15.00
1464	18	10.9	14.50	0.0014	12.05	12.05

ATTERBERG LIMITS TEST DATA

JOB NO. 06702-077
CLIENT/OWNER RAAP RFI
LOCATION Virginia

FIELD CLASSIFICATION _______________

LABORATORY CLASSIFICATION _______________

BORING 10MW1 SAMPLE 2 DEPTH 5-7'

FIELD DENSITY BY ____/__/__

DETERMINATION	1	2
NUMBER OF RINGS		
WT OF RINGS + WET SOIL		
WT OF RINGS	——	——
WT OF WET SOIL		
FIELD DENSITY		
DRY DENSITY		

DETERMINATION	1	2
DISH		
WT OF DISH + WET SOIL		
WT OF DISH + DRY SOIL	——	——
WT OF MOISTURE		
WT OF DISH	——	——
WT OF DRY SOIL		
FIELD MOISTURE CONTENT		

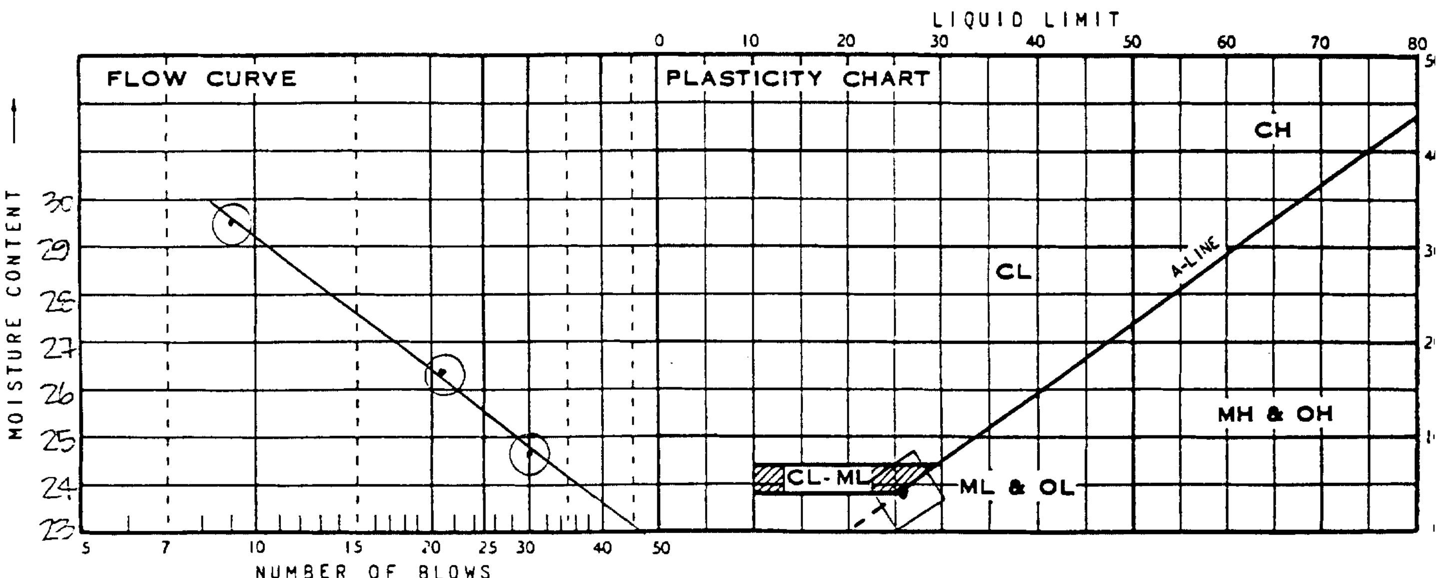
THIS IS AN 1/8-INCH THREAD →

PLASTIC LIMIT BY LF 1.12.82

DETERMINATION	1	2	3	4	5	6
DISH	AL129	AL92				
WT OF DISH + WET SOIL	10.45	11.82				
WT OF DISH + DRY SOIL	8.82	9.93	——	——	——	——
WT OF MOISTURE						
WT OF DISH	1.4	1.4	——	——	——	——
WT OF DRY SOIL						
MOISTURE CONTENT	21.97	22.16	AV=22			

LIQUID LIMIT

DETERMINATION	1	2	3	4	5	6
DISH	AL99	AL105	AL95			
NUMBER OF BLOWS	30	21	9			
WT OF DISH + WET SOIL	8.79	9.12	8.86			
WT OF DISH + DRY SOIL	7.32	7.51	7.16	——	——	——
WT OF MOISTURE						
WT OF DISH	1.4	1.4	1.4	——	——	——
WT OF DRY SOIL						
MOISTURE CONTENT	24.83	26.35	29.51			



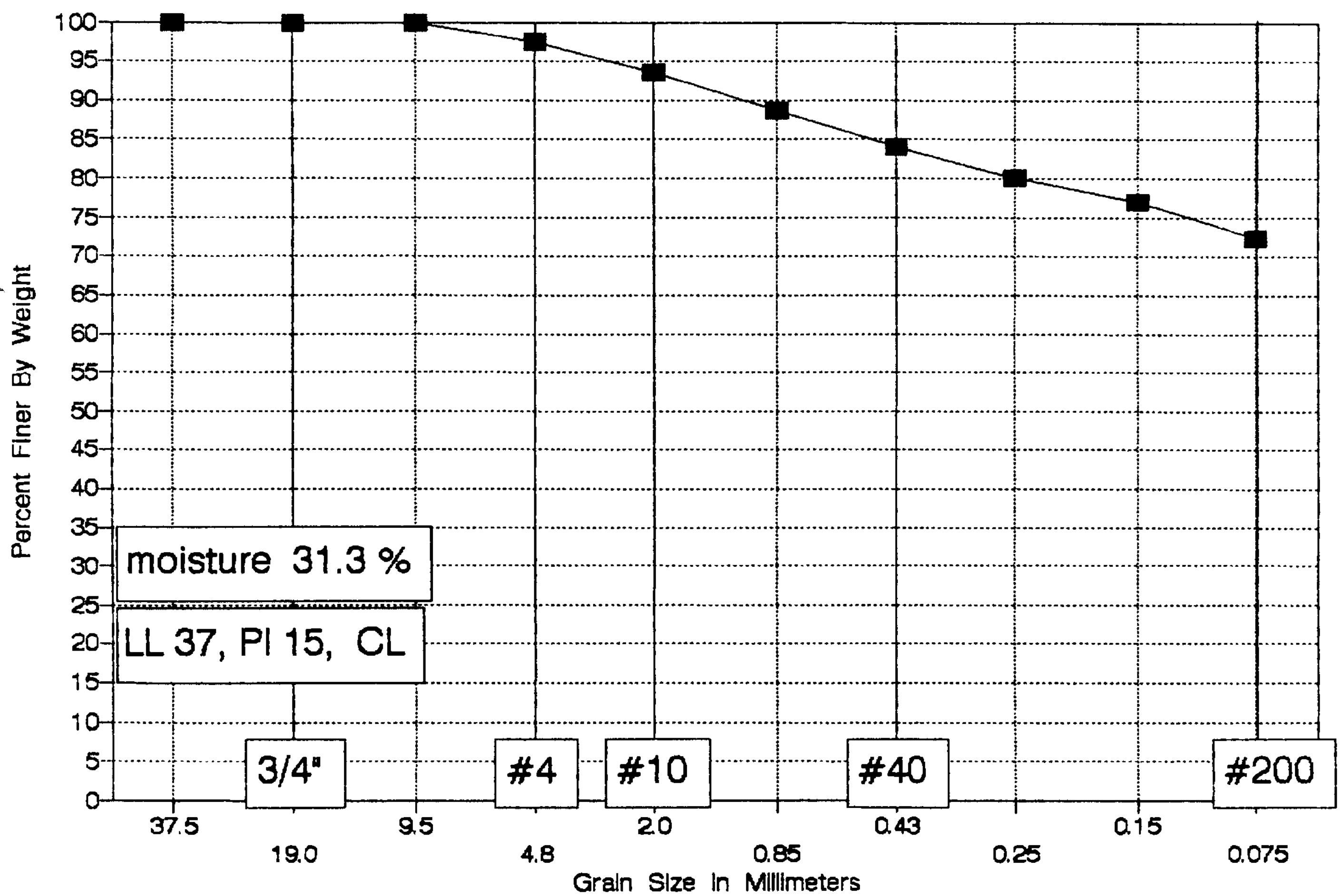
SUMMARY

DRY DENSITY	MOISTURE CONTENT	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	IDENTIFICATION	
		26	22	4	ML	

Dames & Moore

GRADATION CURVE

Boring 17 SB 1, sample at 10 feet



RAAP RFI
Usathama
Virginia

Boring 17 SB 1
Sample at 10 feet

Wt soil and dish	194.5
Dry soil & dish	173
Dish	104.3

Moisture Content = 31.3

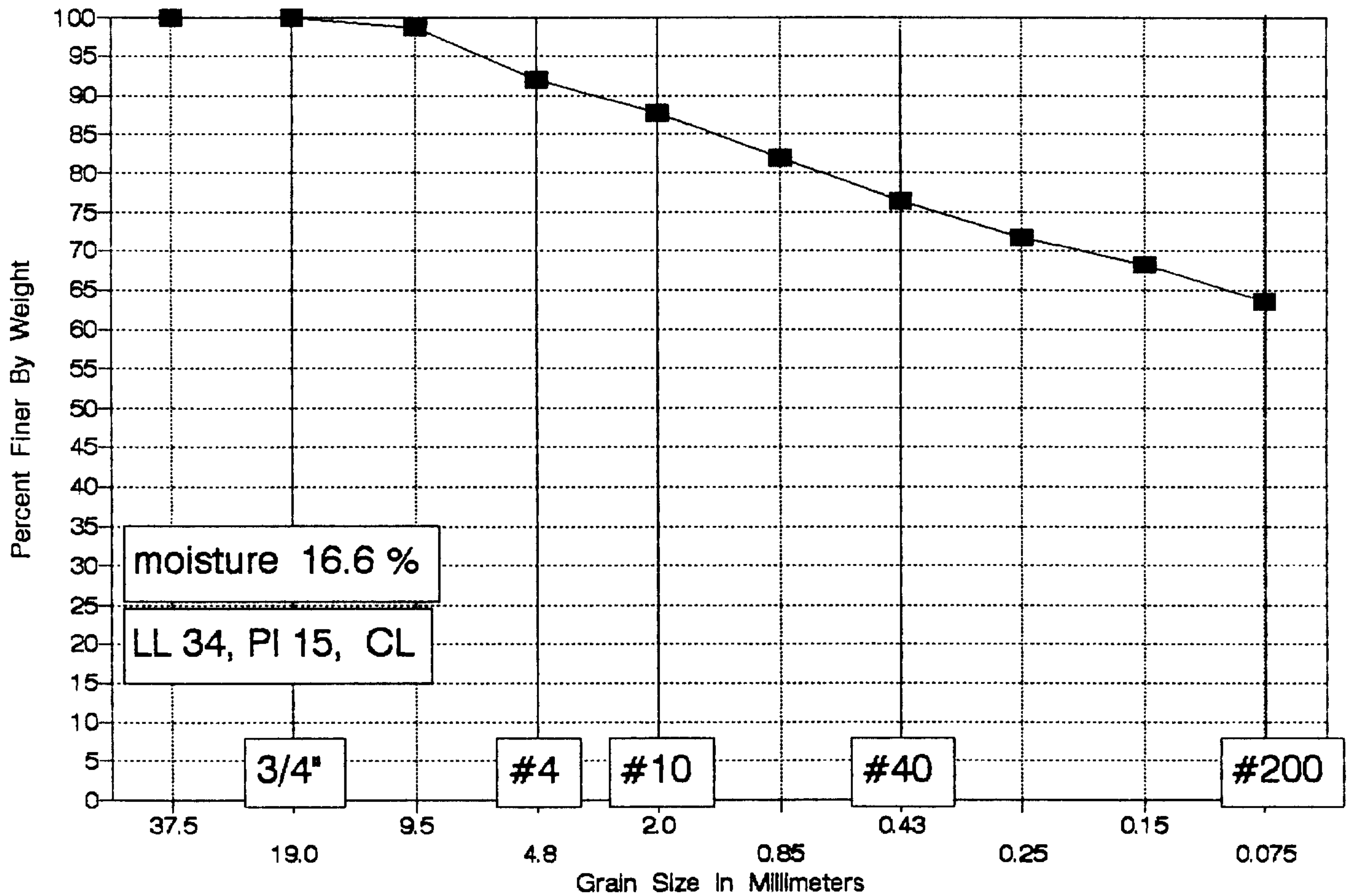
SIEVE ANALYSIS

Dry weight of total sample= 68.7

Sieve #	weight retained	% Finer		
1.5 inch	0	100.00%	100.0	37.5
3/4 inch	0	100.00%	100.0	19.0
3/8 inch	0	100.00%	100.0	9.5
# 4	1.7	97.53%	97.5	4.8
# 10	4.4	93.60%	93.6	2.0
# 20	7.7	88.79%	88.8	0.85
# 40	11	83.99%	84.0	0.43
# 60	13.6	80.20%	80.2	0.25
# 100	15.8	77.00%	77.0	0.15
# 200	19	72.34%	72.3	0.075

GRADATION CURVE

Boring 17 SB 2, sample at 10 feet



RAAP RFI
Usathama
Virginia

Wt soil and dish	199
Dry soil & dish	185.2
Dish	102.3

Boring 17 SB 2
Sample at 10 feet

Moisture Content = 16.6

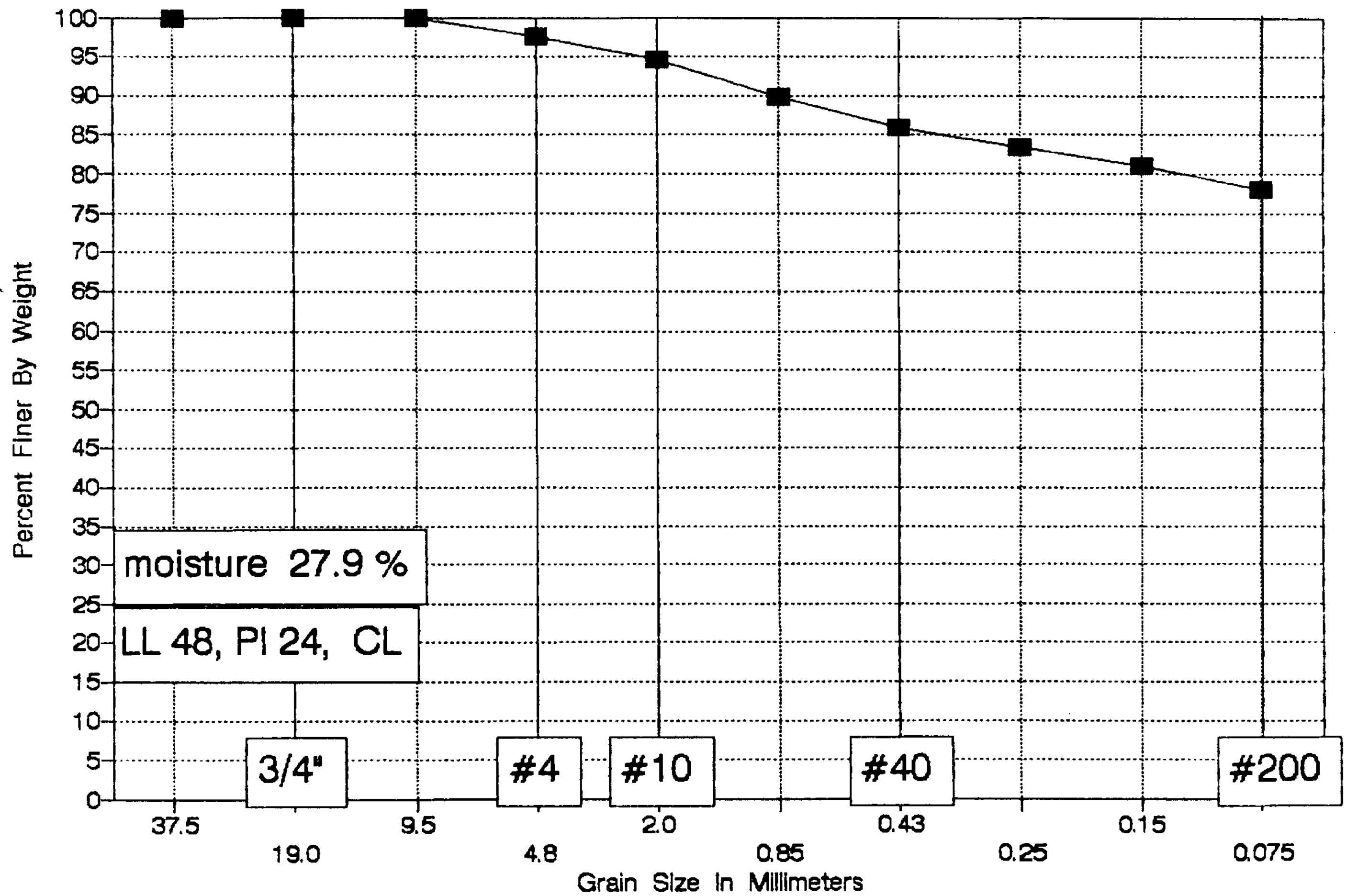
SIEVE ANALYSIS

Dry weight of total sample= 82.9

Sieve #	weight retained	% Finer		
1.5 inch	0	100.00%	100.0	37.5
3/4 inch	0	100.00%	100.0	19.0
3/8 inch	1.2	98.55%	98.6	9.5
# 4	6.5	92.16%	92.2	4.8
# 10	10.2	87.70%	87.7	2.0
# 20	15	81.91%	81.9	0.85
# 40	19.5	76.48%	76.5	0.43
# 60	23.4	71.77%	71.8	0.25
# 100	26.4	68.15%	68.2	0.15
# 200	30.2	63.57%	63.6	0.075

GRADATION CURVE

Boring 17 SB 3, sample at 3.0 feet



RAAP RFI
Usathama
Virginia

Wt soil and dish	197.1
Dry soil & dish	176.4
Dish	102.3

Boring 17 SB 3
Sample at 3.0 feet

Moisture Content = 27.9

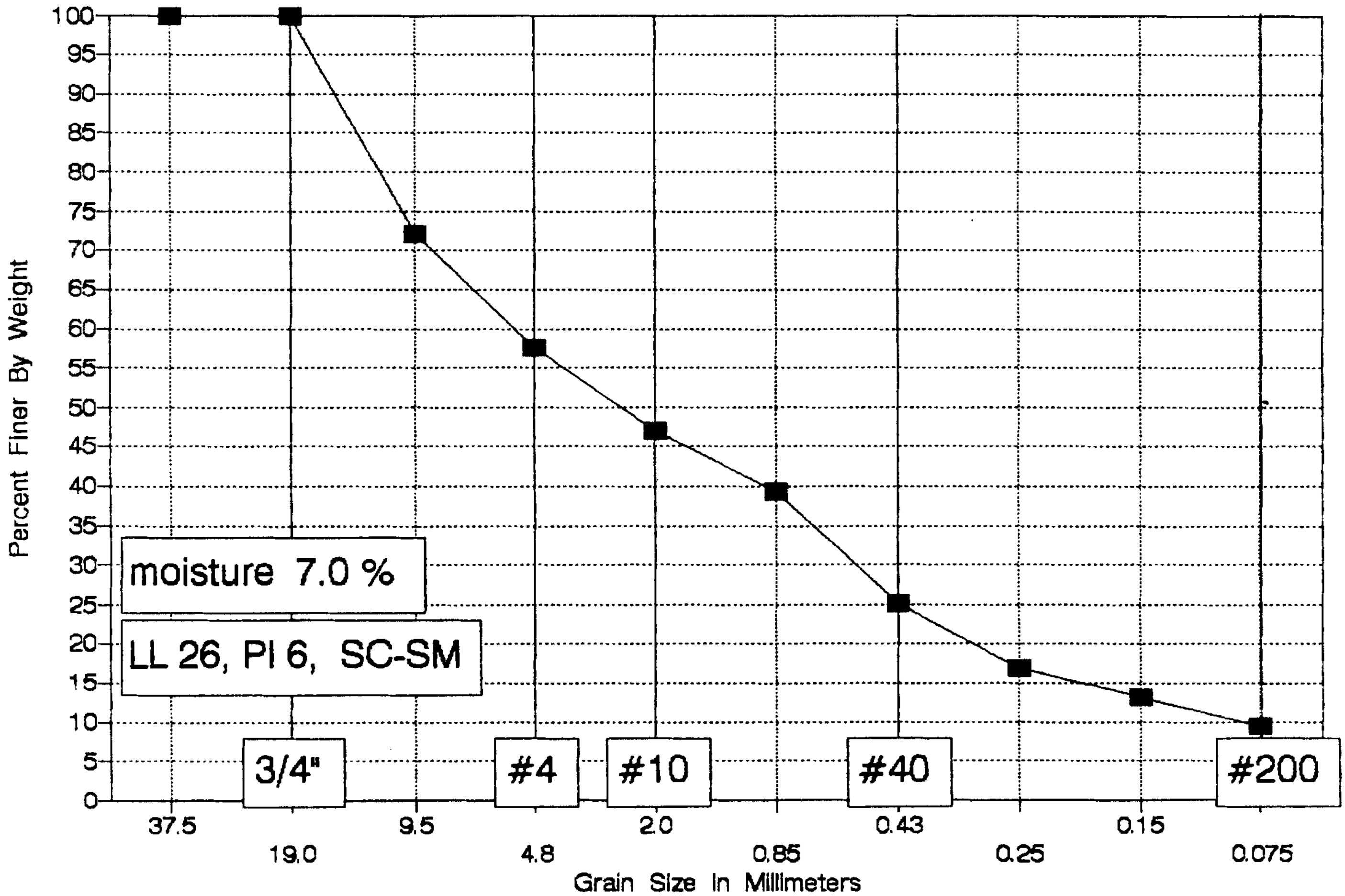
SIEVE ANALYSIS

Dry weight of total sample= 74.1

Sieve #	weight retained	% Finer		
1.5 inch	0	100.00%	100.0	37.5
3/4 inch	0	100.00%	100.0	19.0
3/8 inch	0	100.00%	100.0	9.5
# 4	1.7	97.71%	97.7	4.8
# 10	3.9	94.74%	94.7	2.0
# 20	7.5	89.88%	89.9	0.85
# 40	10.5	85.83%	85.8	0.43
# 60	12.4	83.27%	83.3	0.25
# 100	14.1	80.97%	81.0	0.15
# 200	16.2	78.14%	78.1	0.075

GRADATION CURVE

Boring 32 MW 1, sample at 10-12 feet



RAAP RFI
Usathama
Virginia

Boring 32 MW 1
Sample at 10-12 feet

Wt soil and dish	198.6
Dry soil & dish	192.8
Dish	110.4

Moisture Content = 7.0

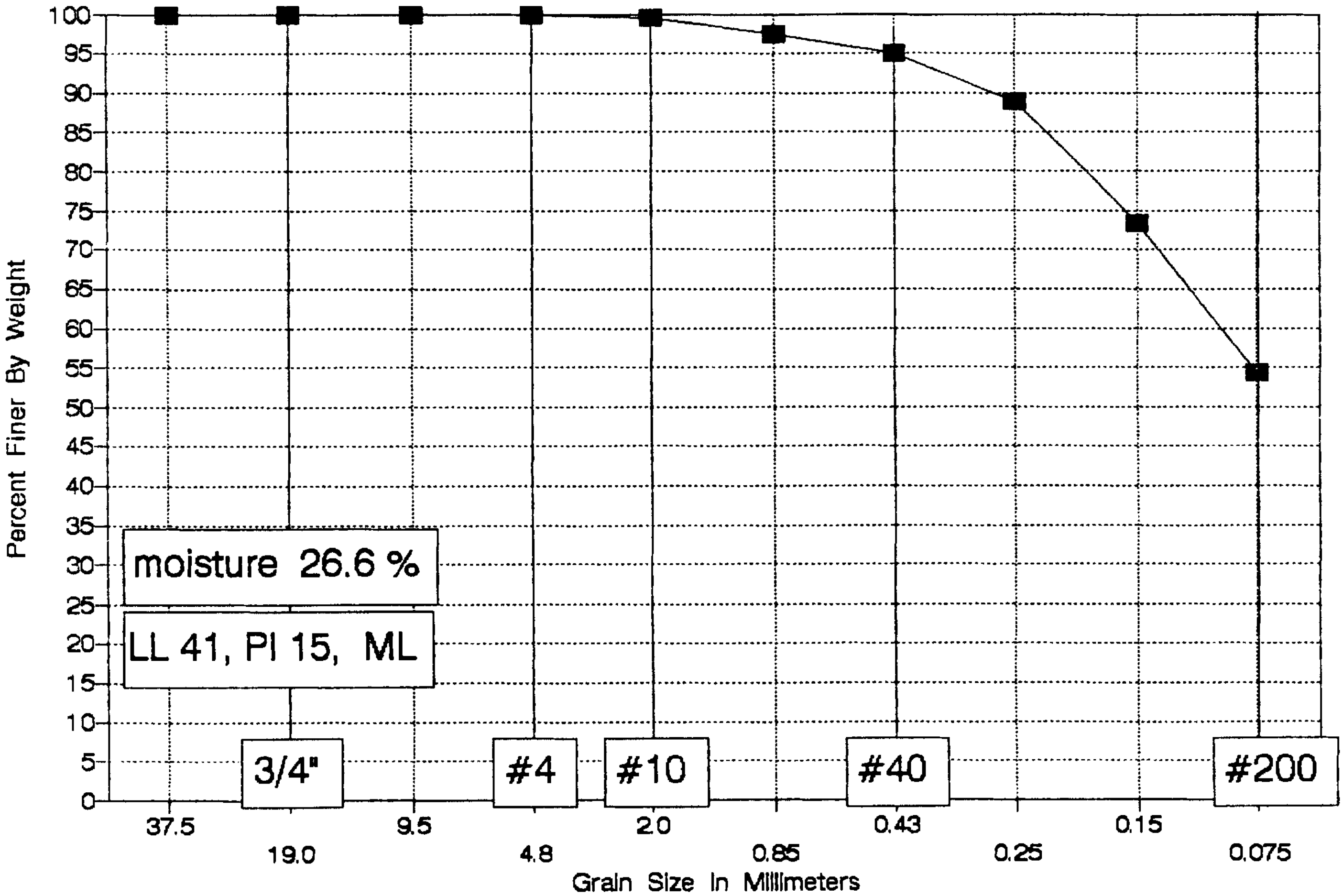
SIEVE ANALYSIS

Dry weight of total sample= 82.4

Sieve #	weight retained	% Finer		
1.5 inch	0	100.00%	100.0	37.5
3/4 inch	0	100.00%	100.0	19.0
3/8 inch	23	72.09%	72.1	9.5
# 4	35	57.52%	57.5	4.8
# 10	43.8	46.84%	46.8	2.0
# 20	50	39.32%	39.3	0.85
# 40	61.7	25.12%	25.1	0.43
# 60	68.5	16.87%	16.9	0.25
# 100	71.6	13.11%	13.1	0.15
# 200	74.6	9.47%	9.5	0.075

GRADATION CURVE

Boring 32 MW 2B, sample at 6.5-7 feet



RAAP RFI
Usathama
Virginia

Wt soil and dish	164.3
Dry soil & dish	152
Dish	105.8

Boring 32 MW 2B
Sample at 6.5-7 feet

Moisture Content = 26.6

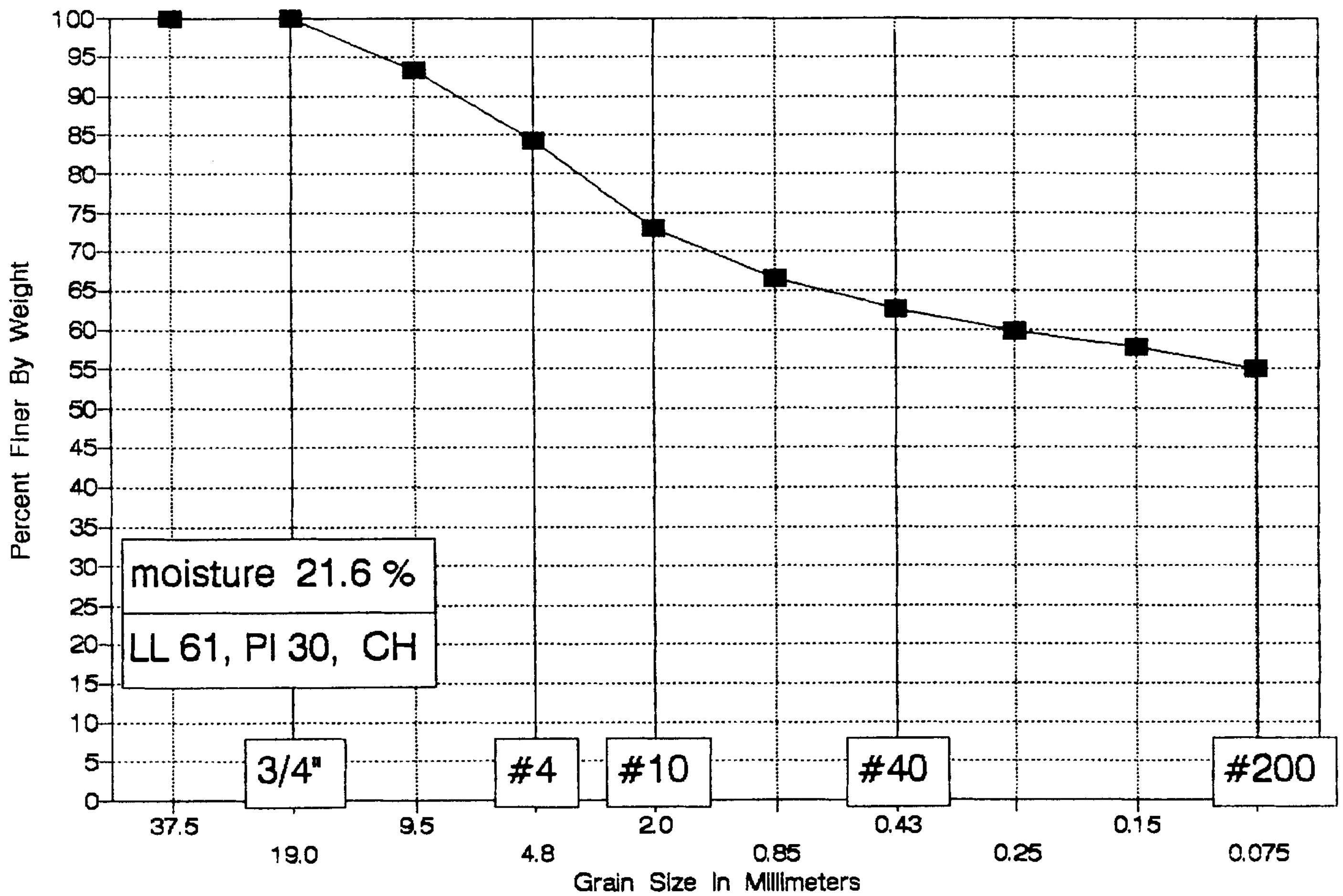
SIEVE ANALYSIS

Dry weight of total sample= 46.2

Sieve #	weight retained	% Finer		
1.5 inch	0	100.00%	100.0	37.5
3/4 inch	0	100.00%	100.0	19.0
3/8 inch	0	100.00%	100.0	9.5
# 4	0	100.00%	100.0	4.8
# 10	0.2	99.57%	99.6	2.0
# 20	1.2	97.40%	97.4	0.85
# 40	2.3	95.02%	95.0	0.43
# 60	5.1	88.96%	89.0	0.25
# 100	12.3	73.38%	73.4	0.15
# 200	21.1	54.33%	54.3	0.075

GRADATION CURVE

Boring 40 MW 1, sample at 0-2 feet



RAAP RFI
Usathama
Virginia

Boring 40 MW 1
Sample at 0-2 feet

Wt soil and dish	198.1
Dry soil & dish	182.3
Dish	109.2

Moisture Content = 21.6

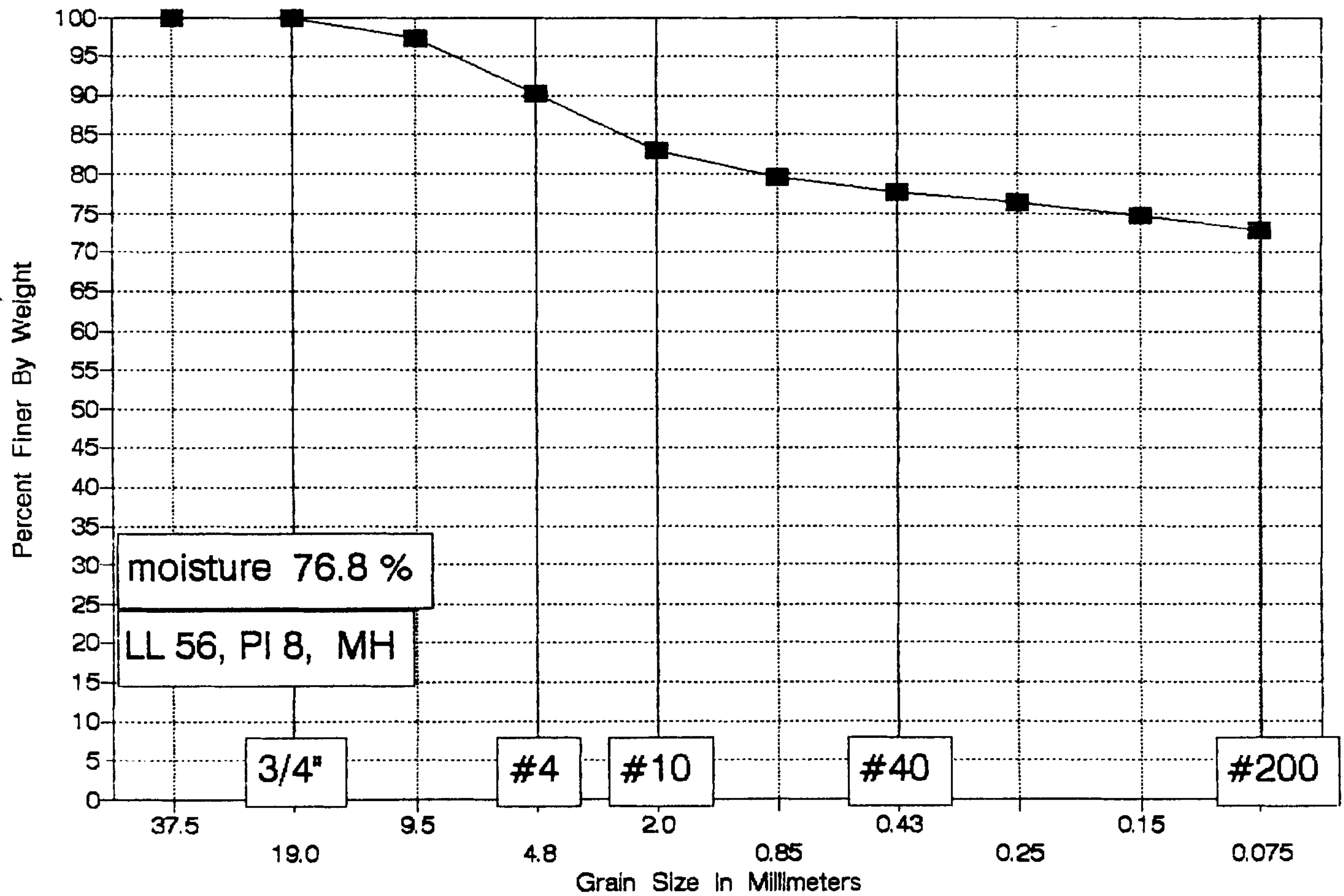
SIEVE ANALYSIS

Dry weight of total sample= 73.1

Sieve #	weight retained	% Finer		
1.5 inch	0	100.00%	100.0	37.5
3/4 inch	0	100.00%	100.0	19.0
3/8 inch	4.8	93.43%	93.4	9.5
# 4	11.5	84.27%	84.3	4.8
# 10	19.7	73.05%	73.1	2.0
# 20	24.5	66.48%	66.5	0.85
# 40	27.4	62.52%	62.5	0.43
# 60	29.4	59.78%	59.8	0.25
# 100	30.9	57.73%	57.7	0.15
# 200	33	54.86%	54.9	0.075

GRADATION CURVE

Boring 40 MW 2, sample at 10-12 feet



RAAP RFI
Usathama
Virginia

Wt soil and dish	215.9
Dry soil & dish	170.5
Dish	111.4

Boring 40 MW 2
Sample at 10-12 feet

Moisture Content = 76.8

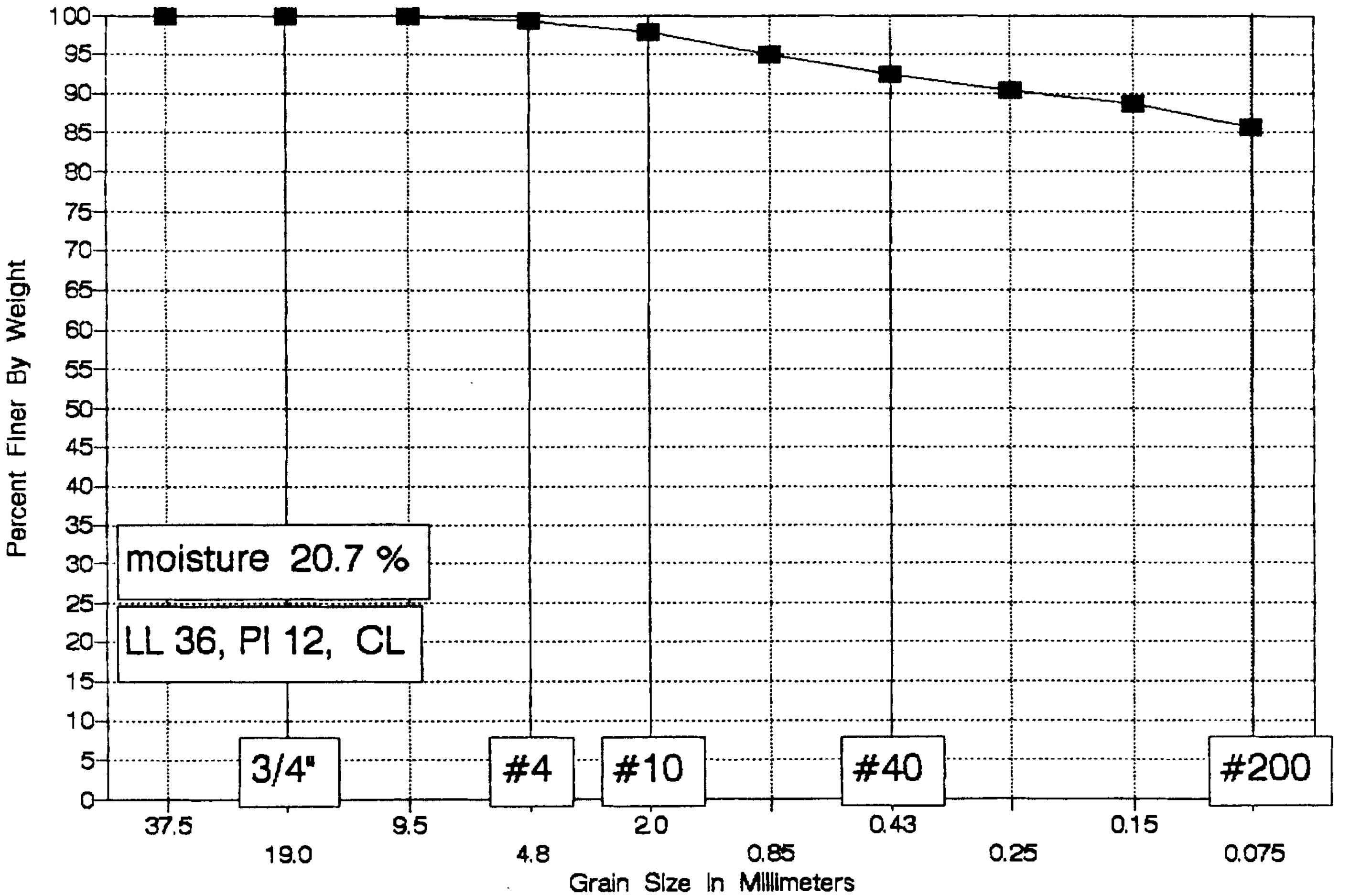
SIEVE ANALYSIS

Dry weight of total sample= 59.1

Sieve #	weight retained	% Finer		
1.5 inch	0	100.00%	100.0	37.5
3/4 inch	0	100.00%	100.0	19.0
3/8 inch	1.6	97.29%	97.3	9.5
# 4	5.8	90.19%	90.2	4.8
# 10	10.1	82.91%	82.9	2.0
# 20	12.1	79.53%	79.5	0.85
# 40	13.2	77.66%	77.7	0.43
# 60	14	76.31%	76.3	0.25
# 100	14.9	74.79%	74.8	0.15
# 200	16	72.93%	72.9	0.075

GRADATION CURVE

Boring 40 MW 3, sample at 0-2 feet



RAAP RFI
Usathama
Virginia

Wt soil and dish	240.5
Dry soil & dish	217.4
Dish	105.8

Boring 40 MW 3
Sample at 0-2 feet

Moisture Content = 20.7

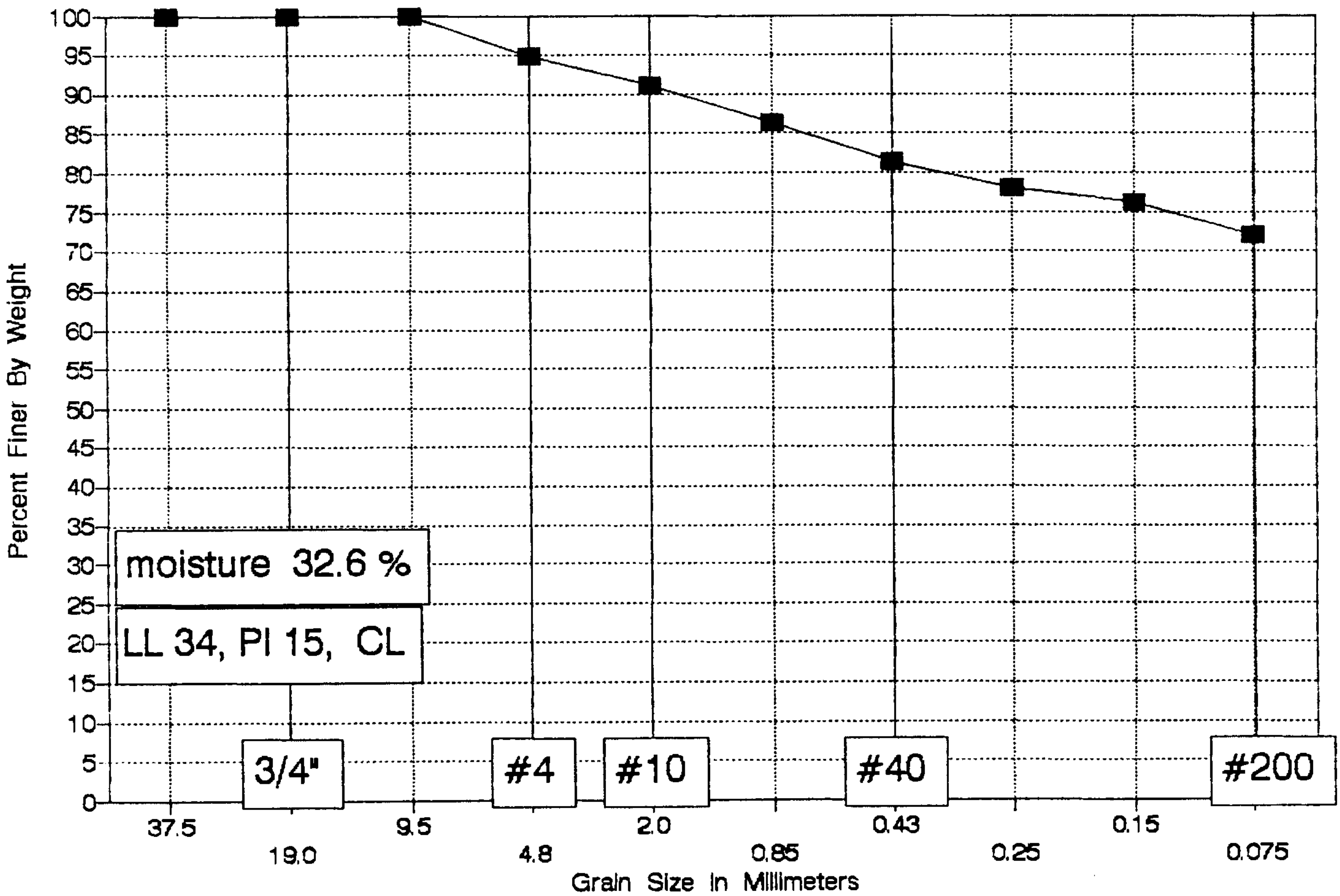
SIEVE ANALYSIS

Dry weight of total sample= 111.6

Sieve #	weight retained	% Finer		
1.5 inch	0	100.00%	100.0	37.5
3/4 inch	0	100.00%	100.0	19.0
3/8 inch	0	100.00%	100.0	9.5
# 4	0.7	99.37%	99.4	4.8
# 10	2.3	97.94%	97.9	2.0
# 20	5.6	94.98%	95.0	0.85
# 40	8.4	92.47%	92.5	0.43
# 60	10.8	90.32%	90.3	0.25
# 100	12.6	88.71%	88.7	0.15
# 200	15.9	85.75%	85.8	0.075

GRADATION CURVE

Boring 40 MW 3, sample at 38-49 feet



RAAP RFI
Usathama
Virginia

Boring 40 MW 3
Sample at 38-49 feet

Wt soil and dish	202.5
Dry soil & dish	180.1
Dish	111.4

Moisture Content = 32.6

SIEVE ANALYSIS

Dry weight of total sample= 68.7

Sieve #	weight retained	% Finer		
1.5 inch	0	100.00%	100.0	37.5
3/4 inch	0	100.00%	100.0	19.0
3/8 inch	0	100.00%	100.0	9.5
# 4	3.5	94.91%	94.9	4.8
# 10	6.1	91.12%	91.1	2.0
# 20	9.4	86.32%	86.3	0.85
# 40	12.7	81.51%	81.5	0.43
# 60	15	78.17%	78.2	0.25
# 100	16.4	76.13%	76.1	0.15
# 200	19.1	72.20%	72.2	0.075

RAAP RFI
Usathama
Virginia

Wt soil and dish	190.4
Dry soil & dish	161.4
Dish	108.3

Boring 40 MW 4
Sample at 5-7 feet

Moisture Content = 54.6

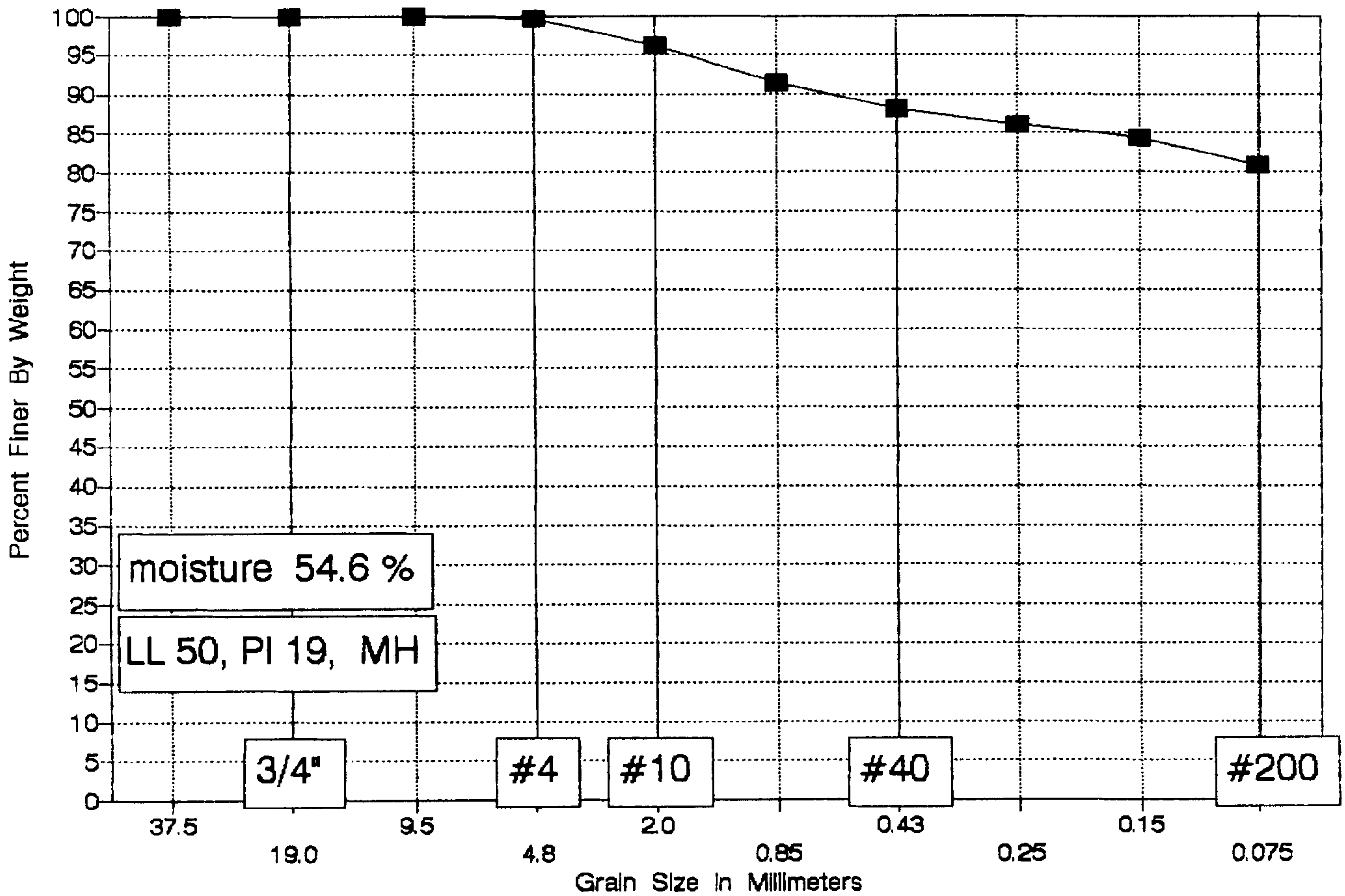
SIEVE ANALYSIS

Dry weight of total sample= 53.1

Sieve #	weight retained	% Finer		
1.5 inch	0	100.00%	100.0	37.5
3/4 inch	0	100.00%	100.0	19.0
3/8 inch	0	100.00%	100.0	9.5
# 4	0.1	99.81%	99.8	4.8
# 10	2	96.23%	96.2	2.0
# 20	4.6	91.34%	91.3	0.85
# 40	6.3	88.14%	88.1	0.43
# 60	7.4	86.06%	86.1	0.25
# 100	8.3	84.37%	84.4	0.15
# 200	10.2	80.79%	80.8	0.075

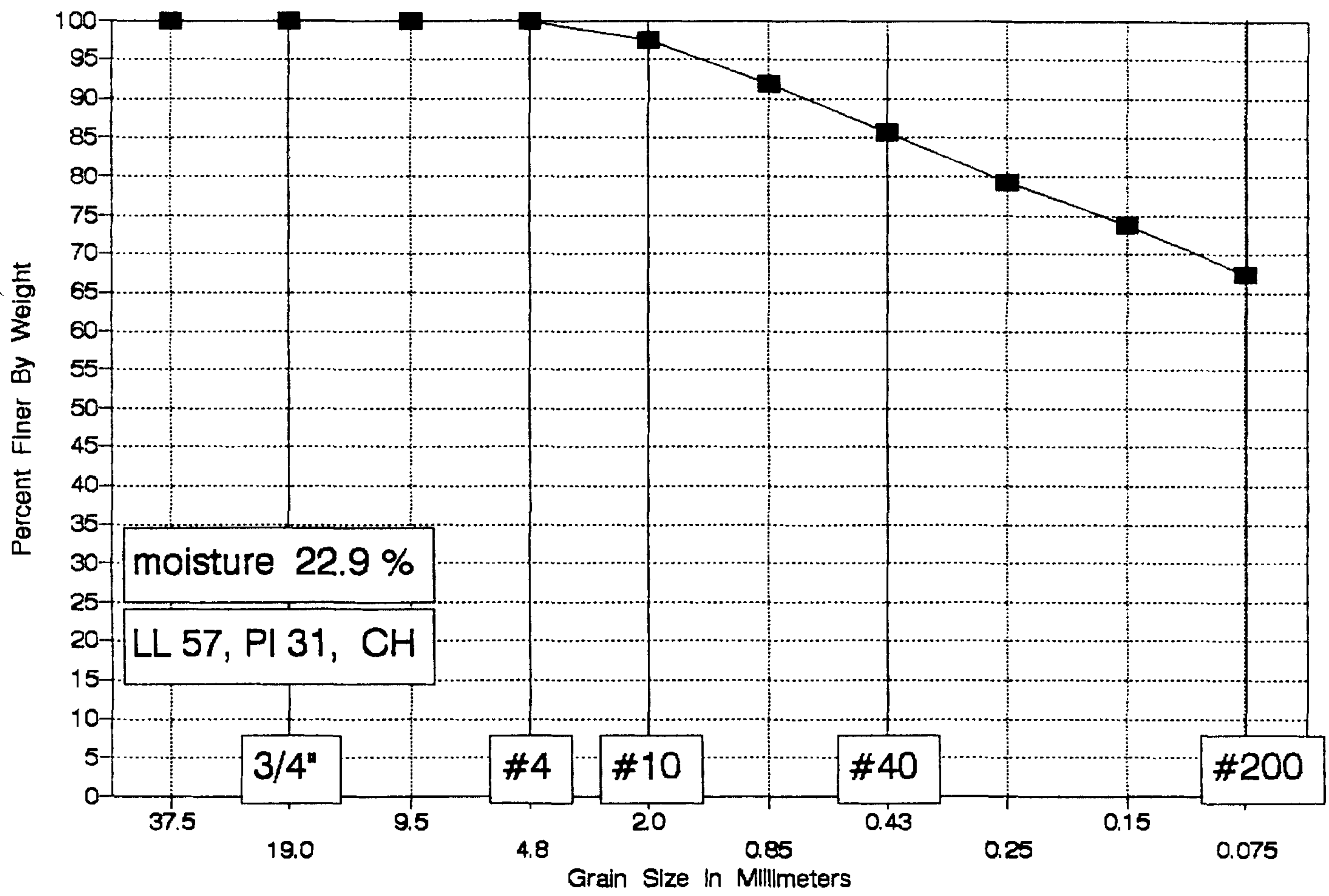
GRADATION CURVE

Boring 40 MW 4, sample at 5-7 feet



GRADATION CURVE

Boring 41 MW 1, sample at 0-2 feet



RAAP RFI
Usathama
Virginia

Wt soil and dish	198.7
Dry soil & dish	181.8
Dish	107.9

Boring 41 MW 1
Sample at 0-2 feet

Moisture Content = 22.9

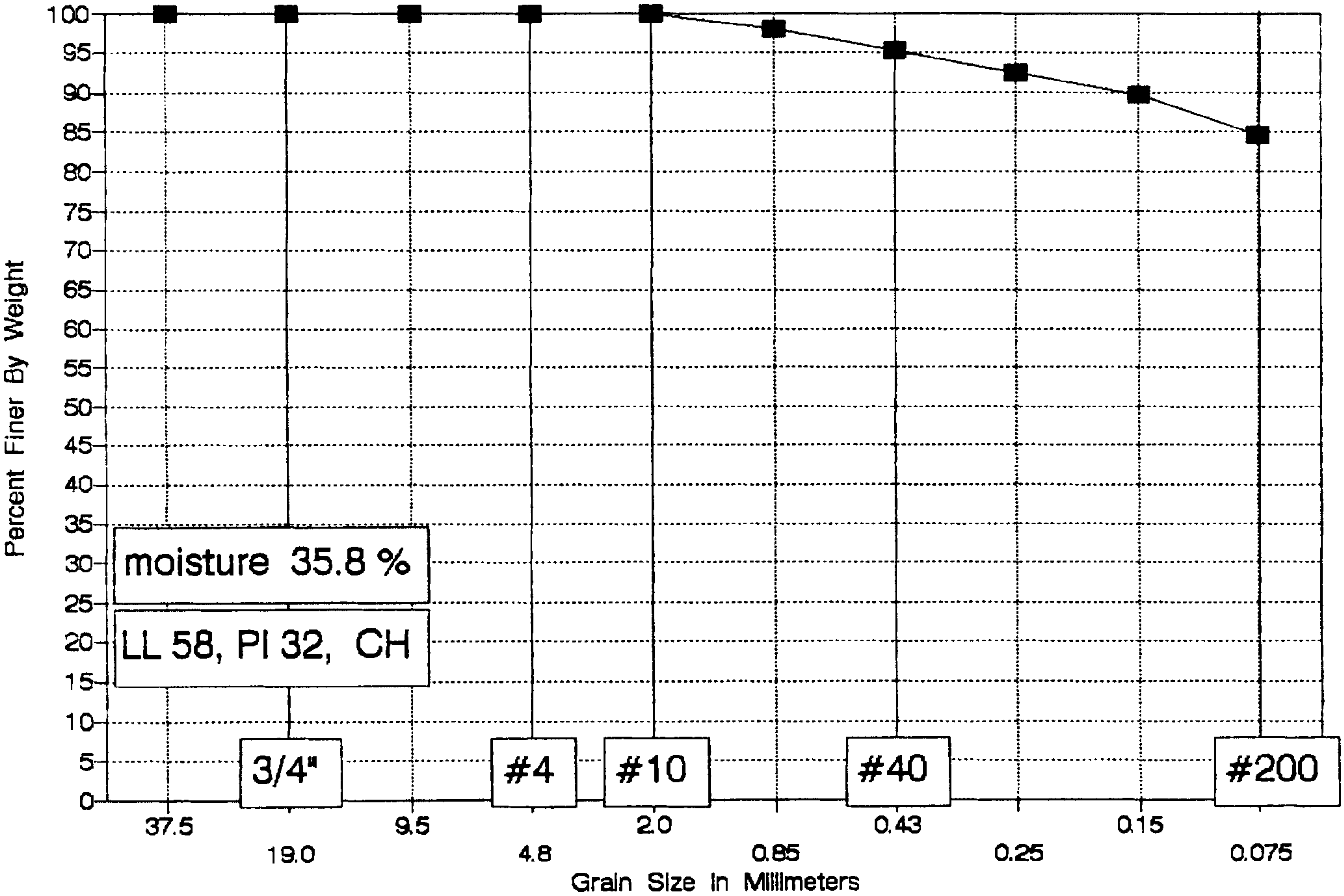
SIEVE ANALYSIS

Dry weight of total sample= 73.9

Sieve #	weight retained	% Finer		
1.5 inch	0	100.00%	100.0	37.5
3/4 inch	0	100.00%	100.0	19.0
3/8 inch	0	100.00%	100.0	9.5
# 4	0	100.00%	100.0	4.8
# 10	1.9	97.43%	97.4	2.0
# 20	6	91.88%	91.9	0.85
# 40	10.6	85.66%	85.7	0.43
# 60	15.3	79.30%	79.3	0.25
# 100	19.4	73.75%	73.7	0.15
# 200	24.1	67.39%	67.4	0.075

GRADATION CURVE

Boring 41 MW 2, sample at 20-22 feet



RAAP RFI
Usathama
Virginia

Wt soil and dish	210.2
Dry soil & dish	183.5
Dish	108.9

Boring 41 MW 2
Sample at 20-22 feet

Moisture Content = 35.8

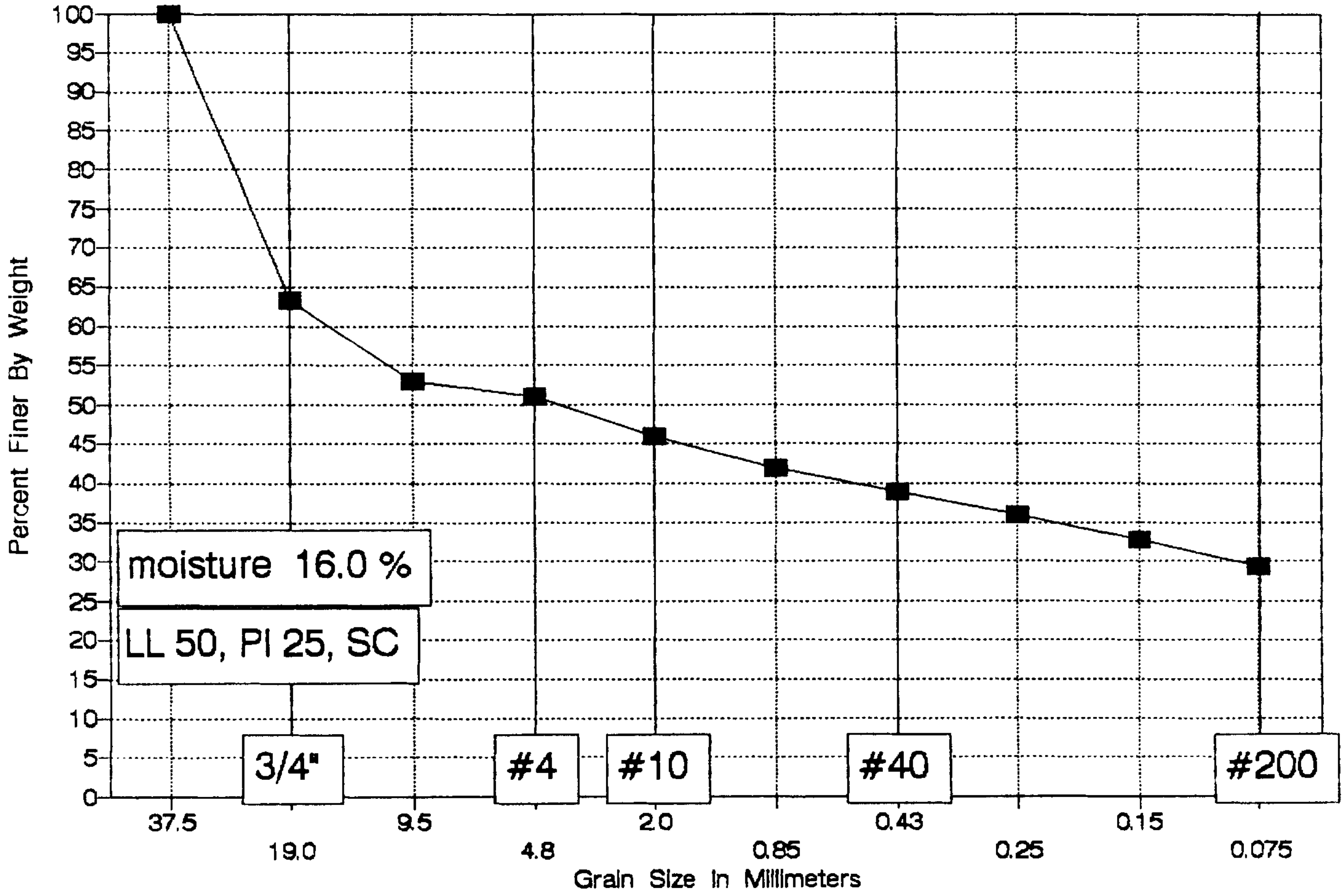
SIEVE ANALYSIS

Dry weight of total sample= 74.6

Sieve #	weight retained	% Finer		
1.5 inch	0	100.00%	100.0	37.5
3/4 inch	0	100.00%	100.0	19.0
3/8 inch	0	100.00%	100.0	9.5
# 4	0	100.00%	100.0	4.8
# 10	0.1	99.87%	99.9	2.0
# 20	1.4	98.12%	98.1	0.85
# 40	3.6	95.17%	95.2	0.43
# 60	5.7	92.36%	92.4	0.25
# 100	7.7	89.68%	89.7	0.15
# 200	11.5	84.58%	84.6	0.075

GRADATION CURVE

Boring 41 MW 3, sample at 15-17 feet



RAAP RFI
Usathama
Virginia

Wt soil and dish	227.3
Dry soil & dish	209.2
Dish	96.3

Boring 41 MW 3
Sample at 15-17 feet

Moisture Content = 16.0

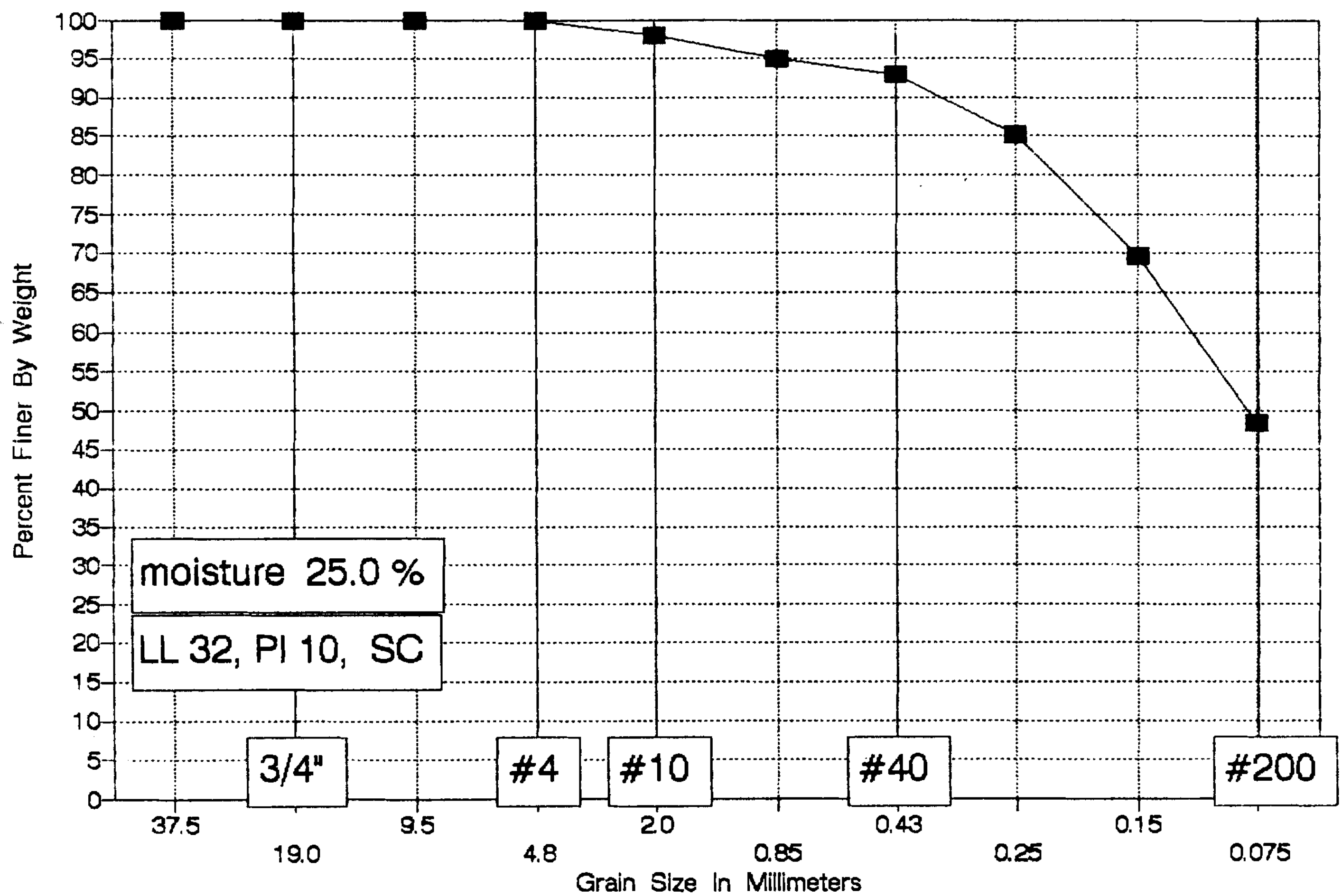
SIEVE ANALYSIS

Dry weight of total sample= 112.9

Sieve #	weight retained	% Finer		
1.5 inch	0	100.00%	100.0	37.5
3/4 inch	41.3	63.42%	63.4	19.0
3/8 inch	53.2	52.88%	52.9	9.5
# 4	55.3	51.02%	51.0	4.8
# 10	61	45.97%	46.0	2.0
# 20	65.6	41.90%	41.9	0.85
# 40	69	38.88%	38.9	0.43
# 60	72.3	35.96%	36.0	0.25
# 100	75.9	32.77%	32.8	0.15
# 200	79.8	29.32%	29.3	0.075

GRADATION CURVE

Boring 43 MW 1, sample at 11-11.5 feet



RAAP RFI
Usathama
Virginia

Wt soil and dish	184.2
Dry soil & dish	168.4
Dish	105.1

Boring 43 MW 1
Sample at 11-11.5 feet

Moisture Content = 25.0

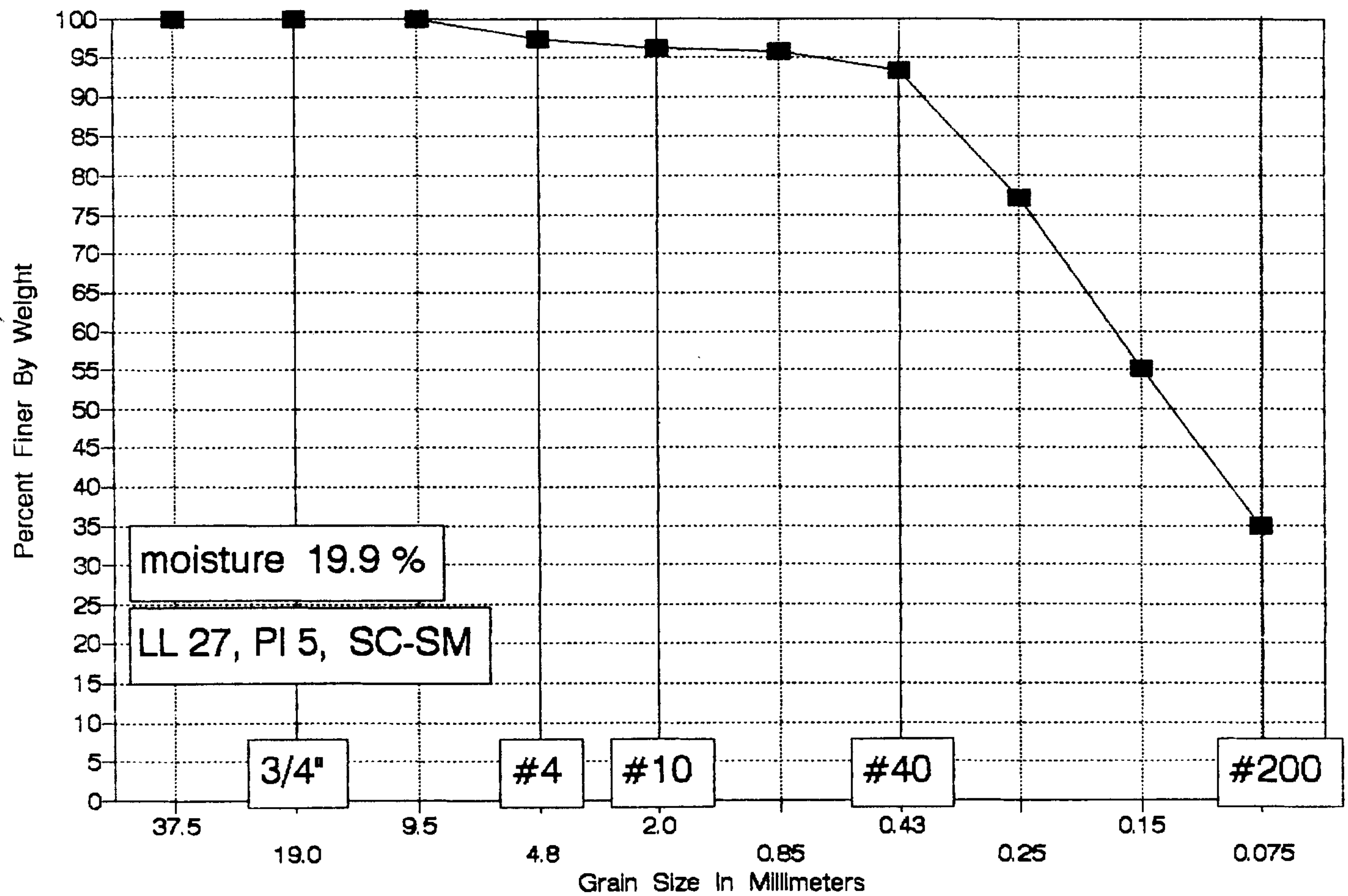
SIEVE ANALYSIS

Dry weight of total sample= 63.3

Sieve #	weight retained	% Finer		
1.5 inch	0	100.00%	100.0	37.5
3/4 inch	0	100.00%	100.0	19.0
3/8 inch	0	100.00%	100.0	9.5
# 4	0	100.00%	100.0	4.8
# 10	1.2	98.10%	98.1	2.0
# 20	3.1	95.10%	95.1	0.85
# 40	4.4	93.05%	93.0	0.43
# 60	9.4	85.15%	85.2	0.25
# 100	19.2	69.67%	69.7	0.15
# 200	32.7	48.34%	48.3	0.075

GRADATION CURVE

Boring 43 MW 2, sample at 5-7 feet



RAAP RFI
Usathama
Virginia

Wt soil and dish	204.7
Dry soil & dish	188.7
Dish	108.3

Boring 43 MW 2
Sample at 5-7 feet

Moisture Content = 19.9

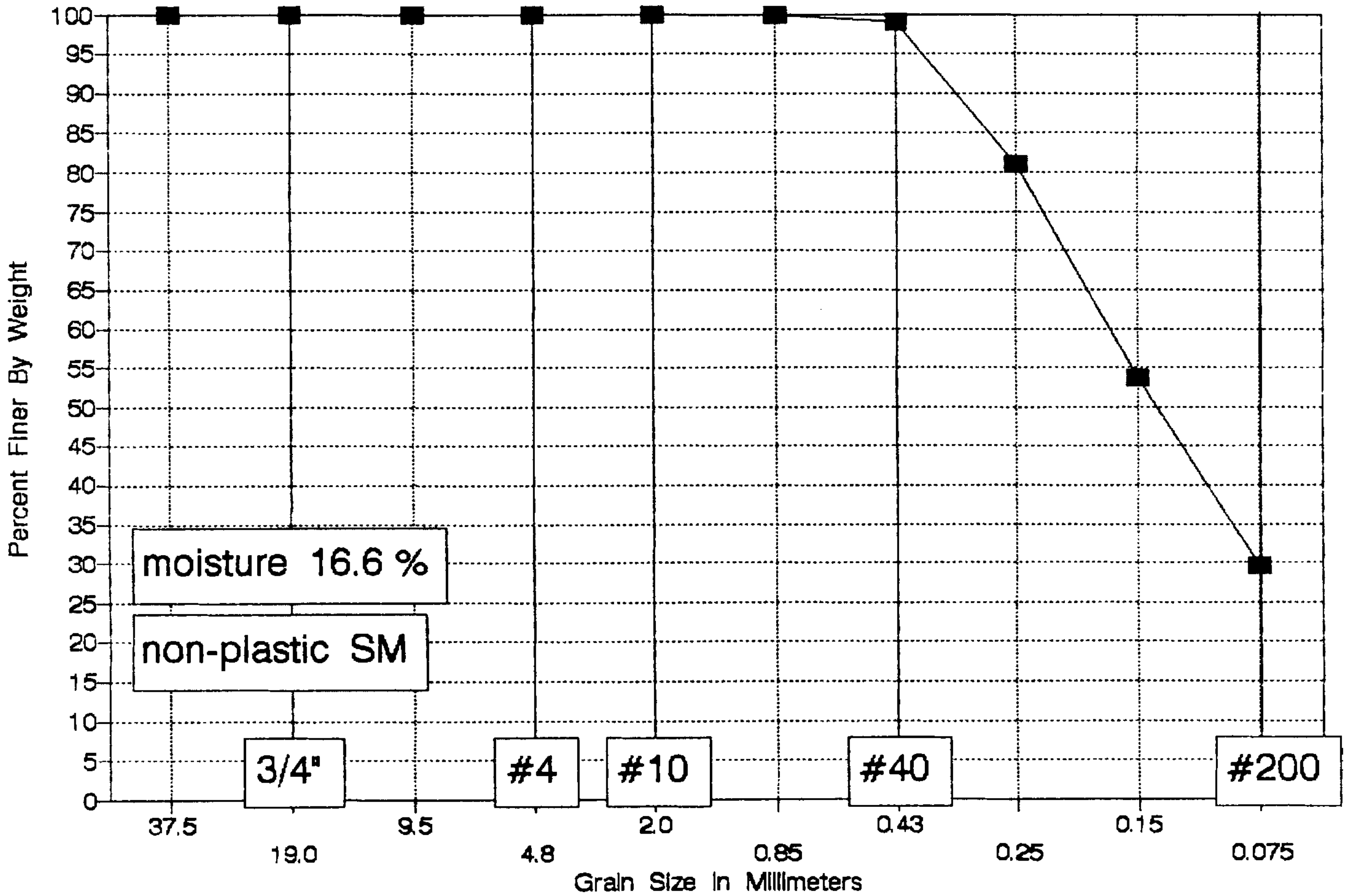
SIEVE ANALYSIS

Dry weight of total sample= 80.4

Sieve #	weight retained	% Finer		
1.5 inch	0	100.00%	100.0	37.5
3/4 inch	0	100.00%	100.0	19.0
3/8 inch	0	100.00%	100.0	9.5
# 4	2.2	97.26%	97.3	4.8
# 10	3.1	96.14%	96.1	2.0
# 20	3.4	95.77%	95.8	0.85
# 40	5.3	93.41%	93.4	0.43
# 60	18.3	77.24%	77.2	0.25
# 100	36.1	55.10%	55.1	0.15
# 200	52.3	34.95%	35.0	0.075

GRADATION CURVE

Boring 43 MW 3, sample at 10-12 feet



RAAP RFI
Usathama
Virginia

Wt soil and dish	244.2
Dry soil & dish	224.9
Dish	108.3

Boring 43 MW 3
Sample at 10-12 feet

Moisture Content = 16.6

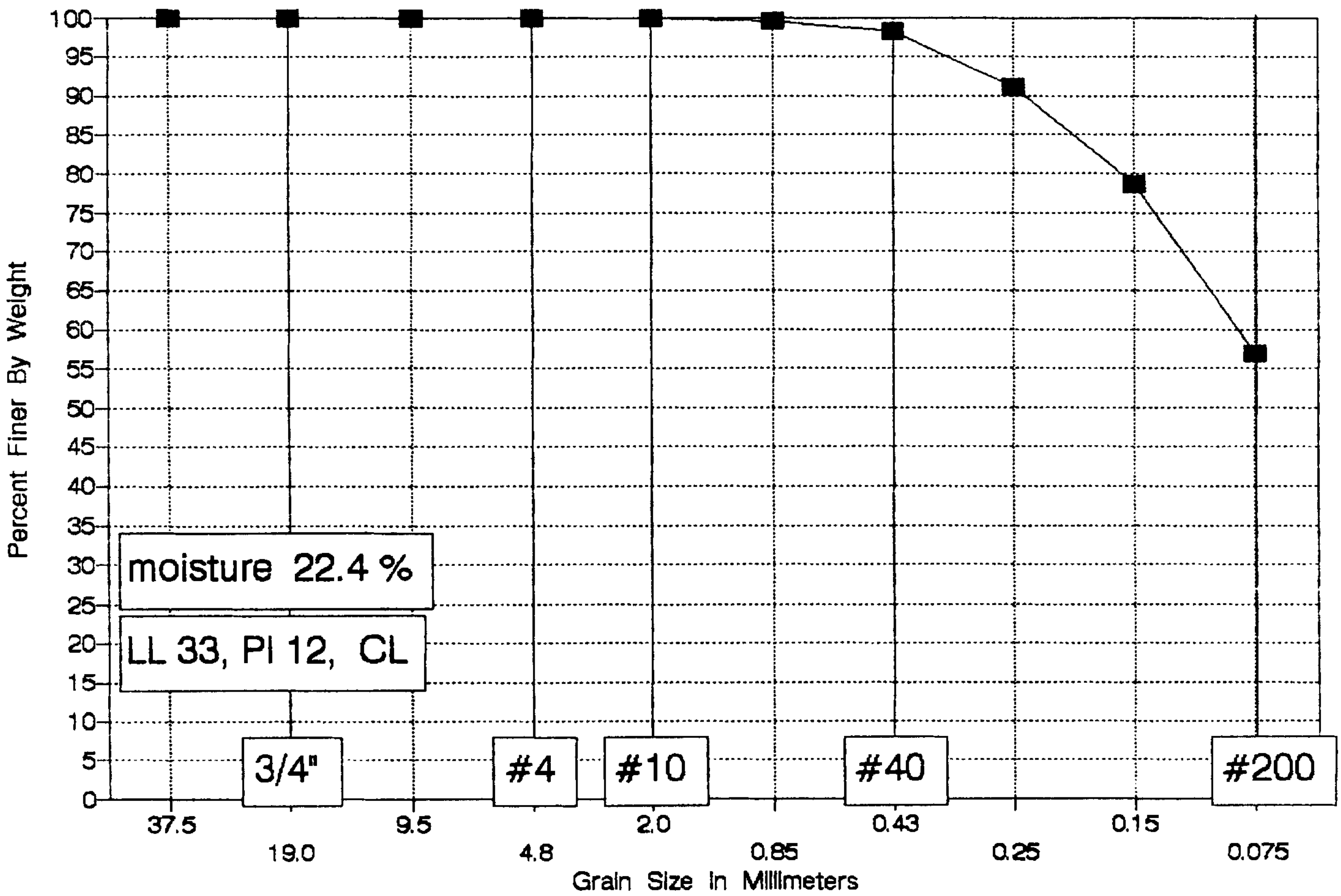
SIEVE ANALYSIS

Dry weight of total sample= 116.6

Sieve #	weight retained	% Finer		
1.5 inch	0	100.00%	100.0	37.5
3/4 inch	0	100.00%	100.0	19.0
3/8 inch	0	100.00%	100.0	9.5
# 4	0	100.00%	100.0	4.8
# 10	0	100.00%	100.0	2.0
# 20	0.1	99.91%	99.9	0.85
# 40	1.2	98.97%	99.0	0.43
# 60	22	81.13%	81.1	0.25
# 100	54.1	53.60%	53.6	0.15
# 200	82.2	29.50%	29.5	0.075

GRADATION CURVE

Boring 43 MW 4, sample at 5-7 feet



RAAP RFI
Usathama
Virginia

Wt soil and dish	214.3
Dry soil & dish	195
Dish	109

Boring 43 MW 4
Sample at 5-7 feet

Moisture Content = 22.4

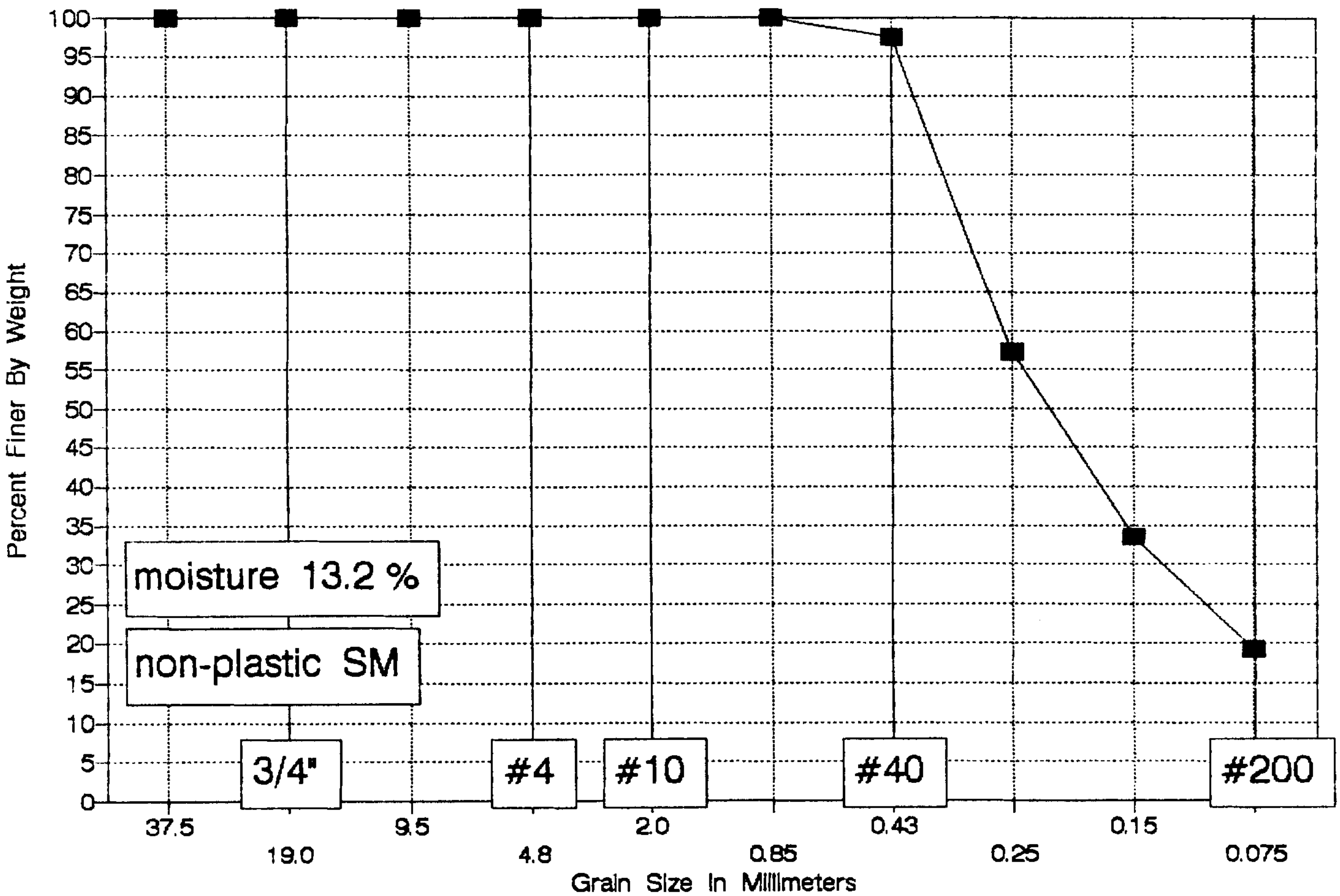
SIEVE ANALYSIS

Dry weight of total sample= 86

Sieve #	weight retained	% Finer		
1.5 inch	0	100.00%	100.0	37.5
3/4 inch	0	100.00%	100.0	19.0
3/8 inch	0	100.00%	100.0	9.5
# 4	0	100.00%	100.0	4.8
# 10	0	100.00%	100.0	2.0
# 20	0.4	99.53%	99.5	0.85
# 40	1.6	98.14%	98.1	0.43
# 60	7.6	91.16%	91.2	0.25
# 100	18.4	78.60%	78.6	0.15
# 200	37	56.98%	57.0	0.075

GRADATION CURVE

Boring 43 MW 4, sample at 15-17 feet



RAAP RFI
Usathama
Virginia

Wt soil and dish	194.6
Dry soil & dish	184.5
Dish	108.2

Boring 43 MW 4
Sample at 15-17 feet

Moisture Content = 13.2

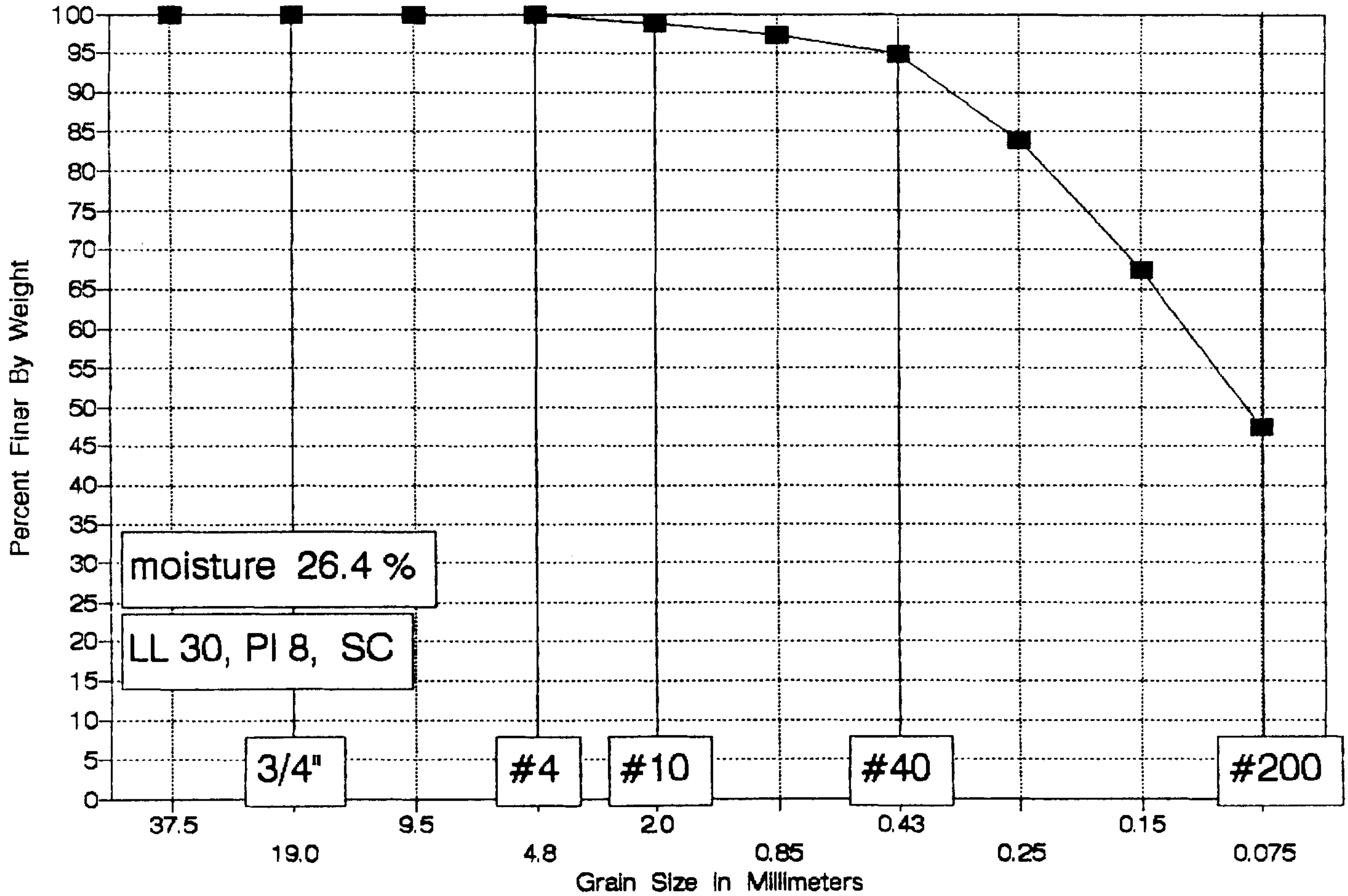
SIEVE ANALYSIS

Dry weight of total sample= 76.3

Sieve #	weight retained	% Finer		
1.5 inch	0	100.00%	100.0	37.5
3/4 inch	0	100.00%	100.0	19.0
3/8 inch	0	100.00%	100.0	9.5
# 4	0	100.00%	100.0	4.8
# 10	0	100.00%	100.0	2.0
# 20	0.1	99.87%	99.9	0.85
# 40	1.9	97.51%	97.5	0.43
# 60	32.6	57.27%	57.3	0.25
# 100	50.8	33.42%	33.4	0.15
# 200	61.6	19.27%	19.3	0.075

GRADATION CURVE

Boring 43 MW 6, sample at 0-2 feet



RAAP RFI
Usathama
Virginia

Wt soil and dish	165.5
Dry soil & dish	153.1
Dish	106.1

Boring 43 MW 6
Sample at 0-2 feet

Moisture Content = 26.4

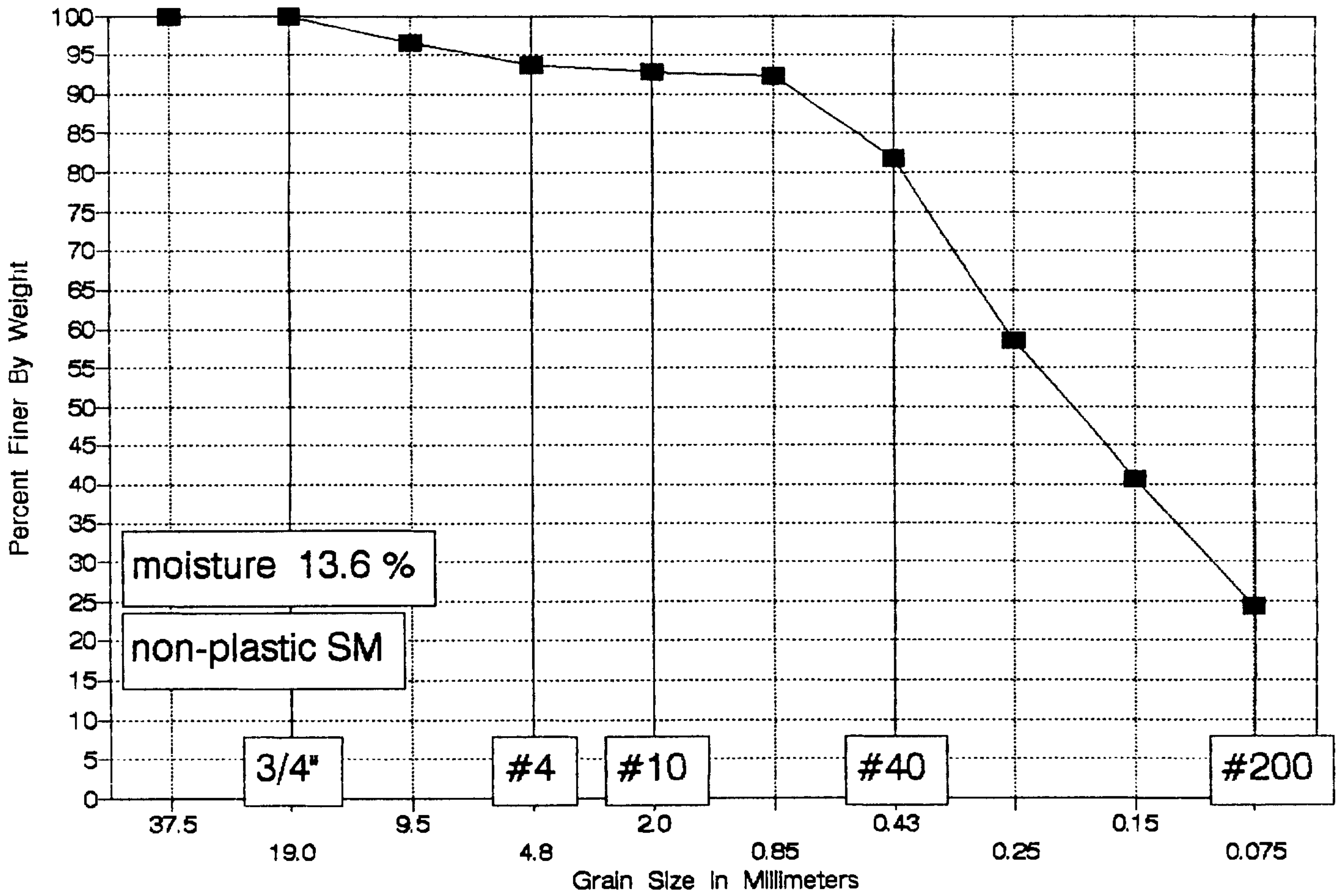
SIEVE ANALYSIS

Dry weight of total sample= 47

Sieve #	weight retained	% Finer		
1.5 inch	0	100.00%	100.0	37.5
3/4 inch	0	100.00%	100.0	19.0
3/8 inch	0	100.00%	100.0	9.5
# 4	0	100.00%	100.0	4.8
# 10	0.6	98.72%	98.7	2.0
# 20	1.3	97.23%	97.2	0.85
# 40	2.4	94.89%	94.9	0.43
# 60	7.6	83.83%	83.8	0.25
# 100	15.3	67.45%	67.4	0.15
# 200	24.7	47.45%	47.4	0.075

GRADATION CURVE

Boring 45 MW 1, sample at 10-12 feet



RAAP RFI
Usathama
Virginia

Wt soil and dish	240
Dry soil & dish	224.3
Dish	109.2

Boring 45 MW 1
Sample at 10-12 feet

Moisture Content = 13.6

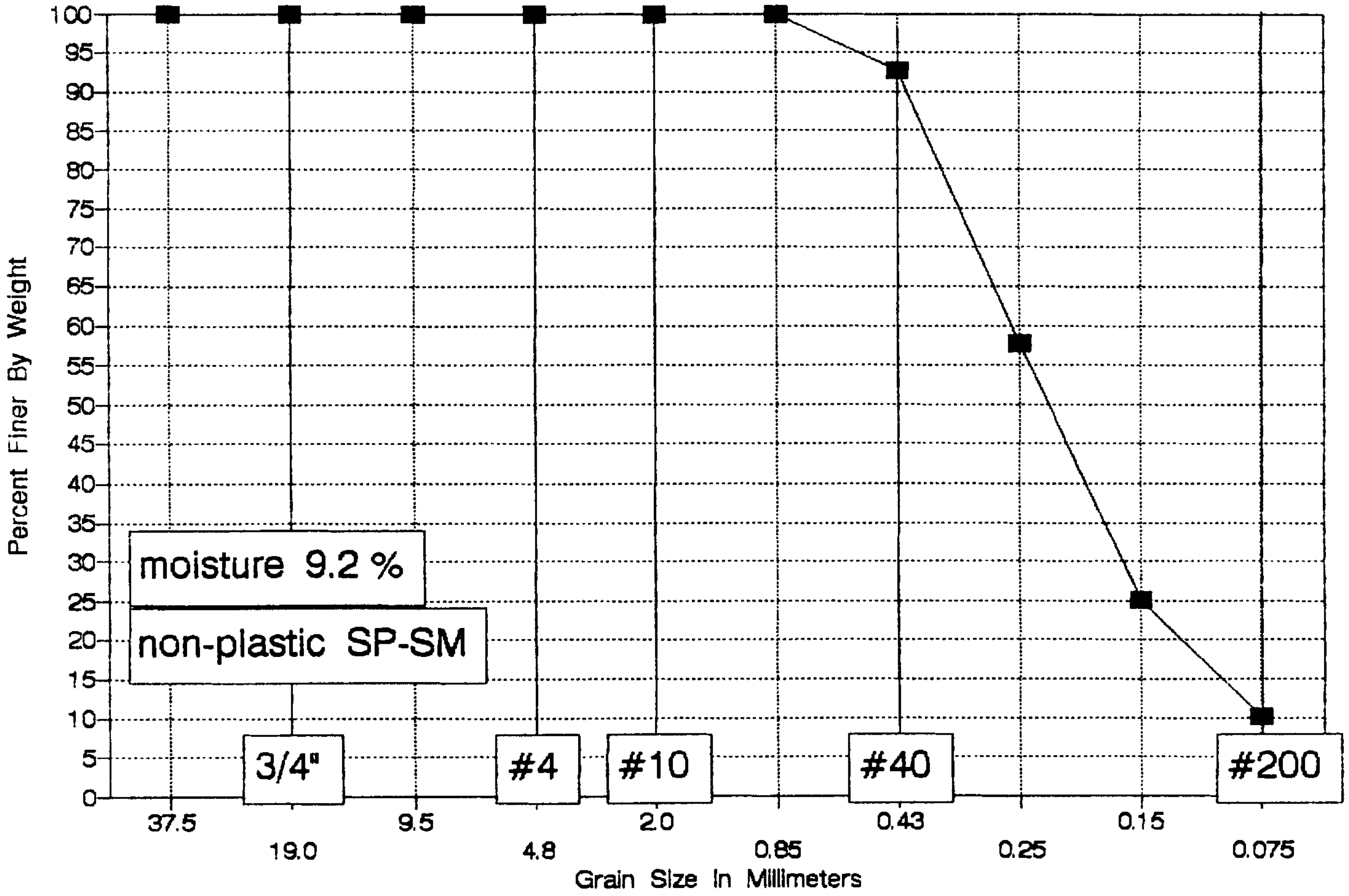
SIEVE ANALYSIS

Dry weight of total sample= 115.1

Sieve #	weight retained	% Finer		
1.5 inch	0	100.00%	100.0	37.5
3/4 inch	0	100.00%	100.0	19.0
3/8 inch	4	96.52%	96.5	9.5
# 4	7.1	93.83%	93.8	4.8
# 10	8.3	92.79%	92.8	2.0
# 20	9	92.18%	92.2	0.85
# 40	21	81.75%	81.8	0.43
# 60	47.8	58.47%	58.5	0.25
# 100	68.4	40.57%	40.6	0.15
# 200	87	24.41%	24.4	0.075

GRADATION CURVE

Boring 45 MW 2, sample at 5.5-6 feet



RAAP RFI
Usathama
Virginia

Boring 45 MW 2
Sample at 5.5-6 feet

Wt soil and dish	182.3
Dry soil & dish	175.9
Dish	106.7

Moisture Content = 9.2

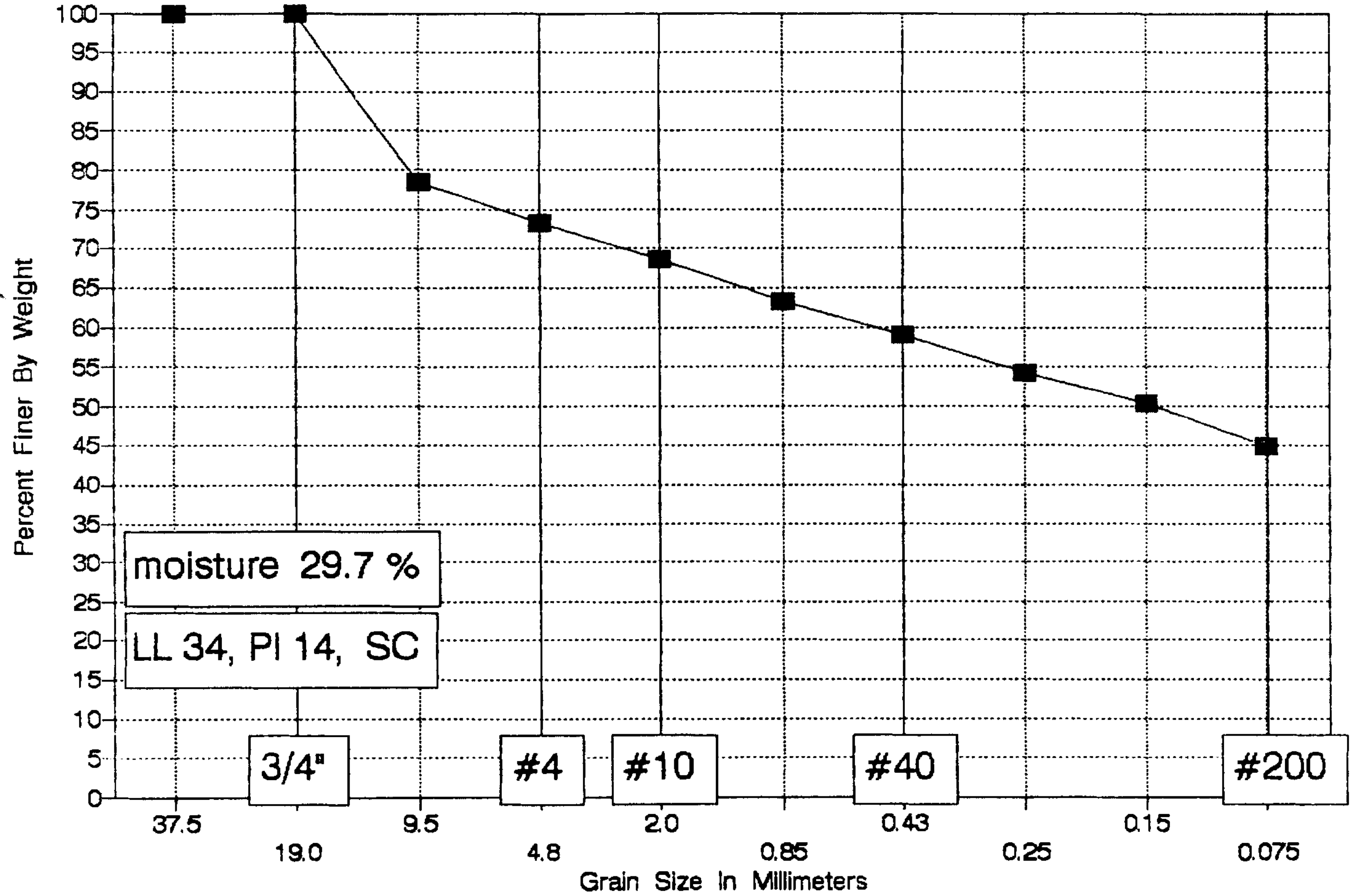
SIEVE ANALYSIS

Dry weight of total sample= 69.2

Sieve #	weight retained	% Finer		
1.5 inch	0	100.00%	100.0	37.5
3/4 inch	0	100.00%	100.0	19.0
3/8 inch	0	100.00%	100.0	9.5
# 4	0	100.00%	100.0	4.8
# 10	0	100.00%	100.0	2.0
# 20	0.1	99.86%	99.9	0.85
# 40	5.1	92.63%	92.6	0.43
# 60	29.2	57.80%	57.8	0.25
# 100	51.8	25.14%	25.1	0.15
# 200	62.1	10.26%	10.3	0.075

GRADATION CURVE

Boring 45 MW 3, sample at 26-27 feet



RAAP RFI
Usathama
Virginia

Boring 45 MW 3
Sample at 26-27 feet

Wt soil and dish	208.8
Dry soil & dish	185.4
Dish	106.7

Moisture Content = 29.7

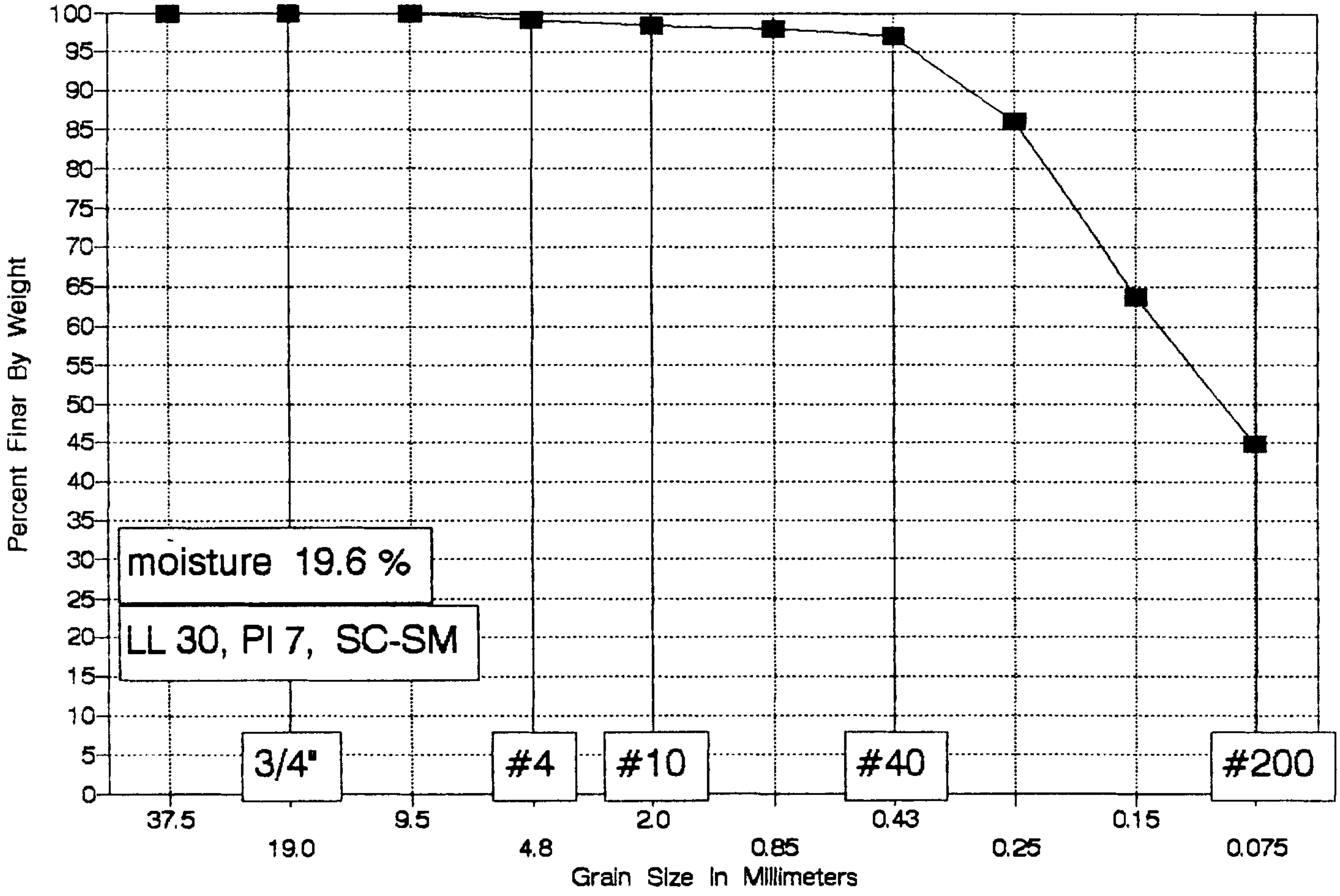
SIEVE ANALYSIS

Dry weight of total sample= 78.7

Sieve #	weight retained	% Finer		
1.5 inch	0	100.00%	100.0	37.5
3/4 inch	0	100.00%	100.0	19.0
3/8 inch	16.9	78.53%	78.5	9.5
# 4	21	73.32%	73.3	4.8
# 10	24.7	68.61%	68.6	2.0
# 20	28.8	63.41%	63.4	0.85
# 40	32.3	58.96%	59.0	0.43
# 60	36	54.26%	54.3	0.25
# 100	39.1	50.32%	50.3	0.15
# 200	43.4	44.85%	44.9	0.075

GRADATION CURVE

Boring 54 MW 1, sample at 5-7 feet



RAAP RFI
Usathama
Virginia

Wt soil and dish	246.6
Dry soil & dish	223.6
Dish	106.3

Boring 54 MW 1
Sample at 5-7 feet

Moisture Content = 19.6

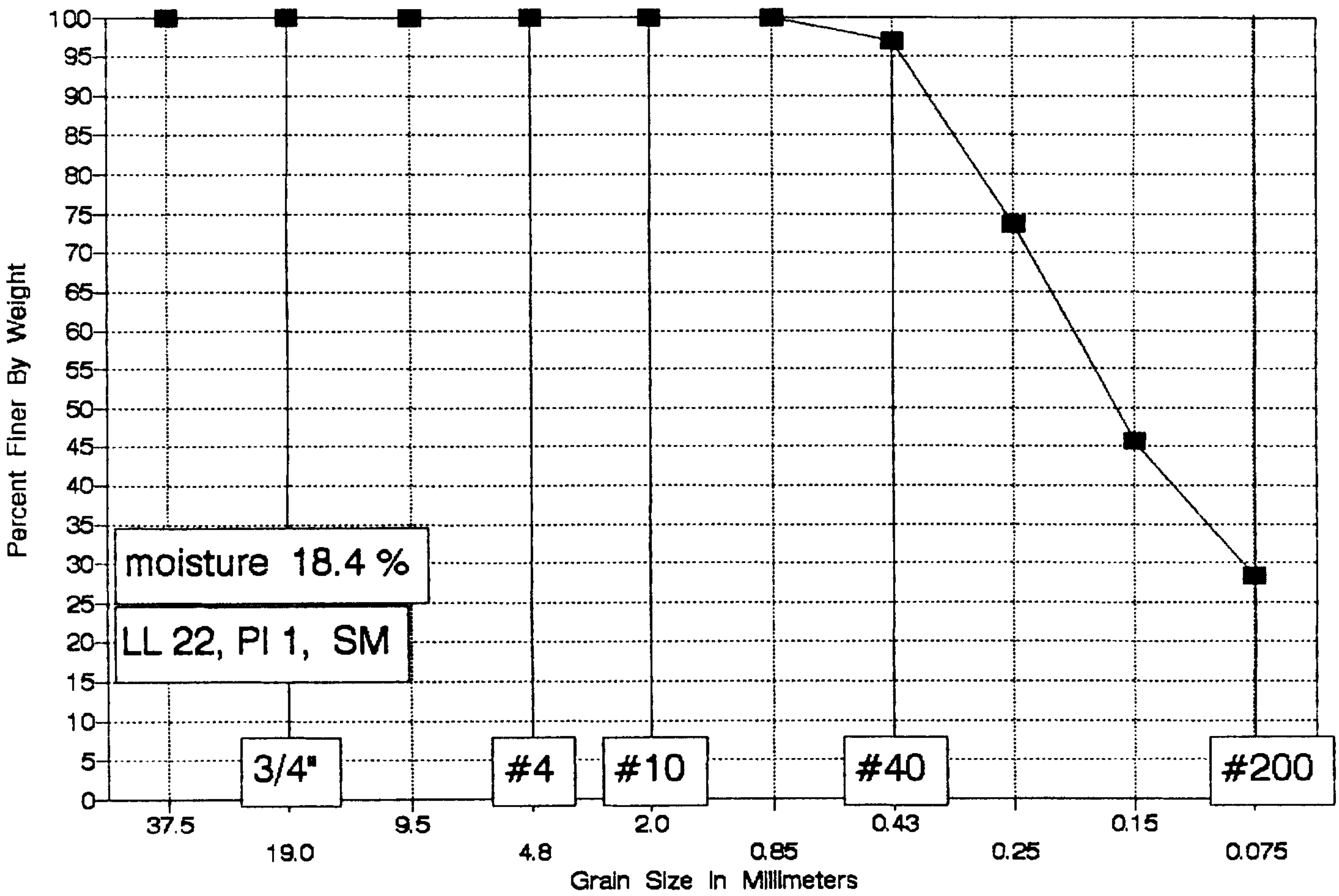
SIEVE ANALYSIS

Dry weight of total sample= 117.3

Sieve #	weight retained	% Finer		
1.5 inch	0	100.00%	100.0	37.5
3/4 inch	0	100.00%	100.0	19.0
3/8 inch	0	100.00%	100.0	9.5
# 4	0.9	99.23%	99.2	4.8
# 10	1.8	98.47%	98.5	2.0
# 20	2.2	98.12%	98.1	0.85
# 40	3.3	97.19%	97.2	0.43
# 60	16.3	86.10%	86.1	0.25
# 100	42.6	63.68%	63.7	0.15
# 200	64.6	44.93%	44.9	0.075

GRADATION CURVE

Boring 54 MW 2, sample at 5-7 feet



RAAP RFI
Usathama
Virginia

Wt soil and dish	266.4
Dry soil & dish	241.8
Dish	108.3

Boring 54 MW 2
Sample at 5-7 feet

Moisture Content = 18.4

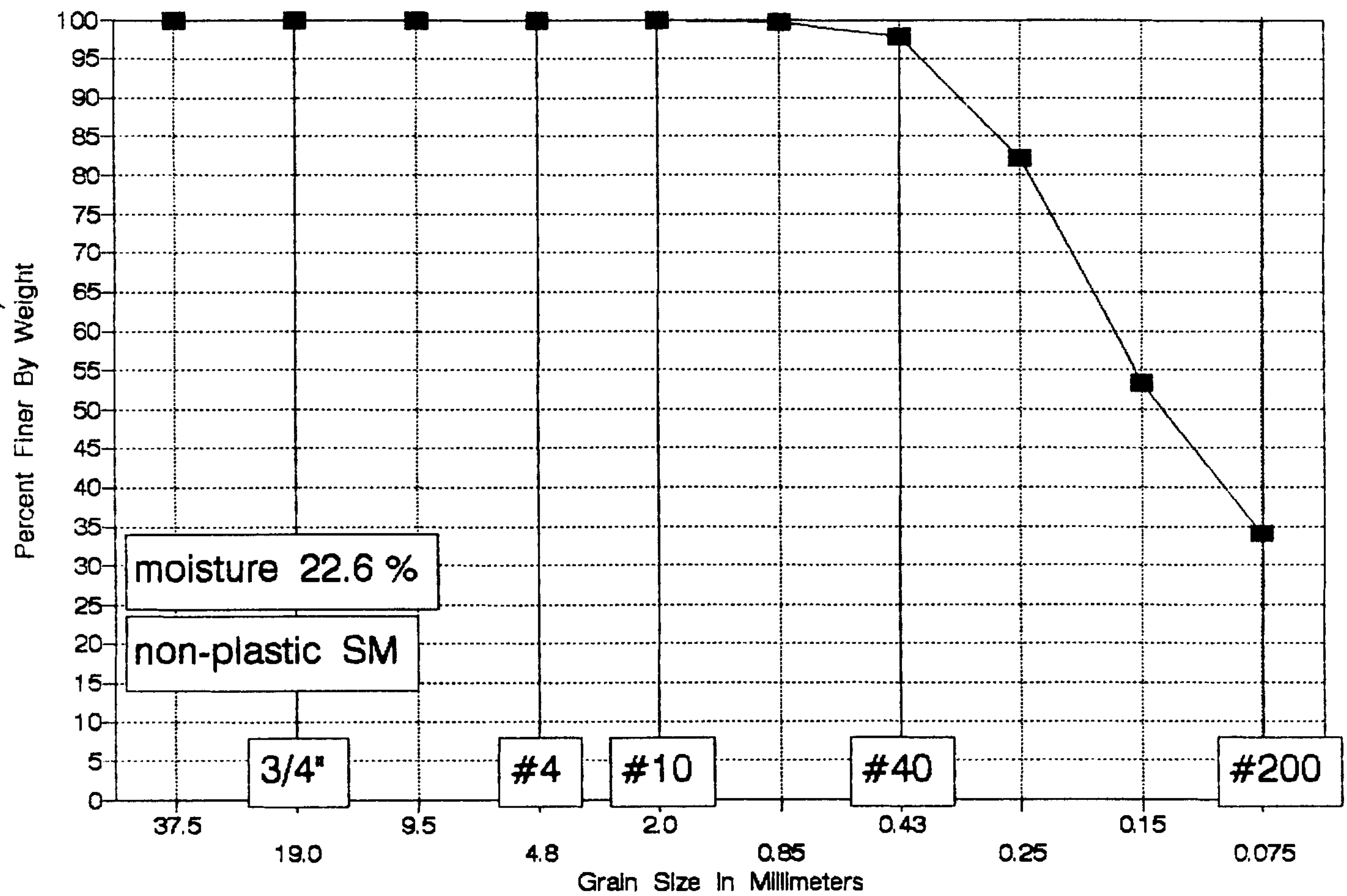
SIEVE ANALYSIS

Dry weight of total sample= 133.5

Sieve #	weight retained	% Finer		
1.5 inch	0	100.00%	100.0	37.5
3/4 inch	0	100.00%	100.0	19.0
3/8 inch	0	100.00%	100.0	9.5
# 4	0	100.00%	100.0	4.8
# 10	0	100.00%	100.0	2.0
# 20	0.1	99.93%	99.9	0.85
# 40	4	97.00%	97.0	0.43
# 60	35.3	73.56%	73.6	0.25
# 100	72.6	45.62%	45.6	0.15
# 200	95.8	28.24%	28.2	0.075

GRADATION CURVE

Boring 54 MW 3, sample at 15-17 feet



RAAP RFI
Usathama
Virginia

Wt soil and dish	208.1
Dry soil & dish	189.7
Dish	108.2

Boring 54 MW 3
Sample at 15-17 feet

Moisture Content = 22.6

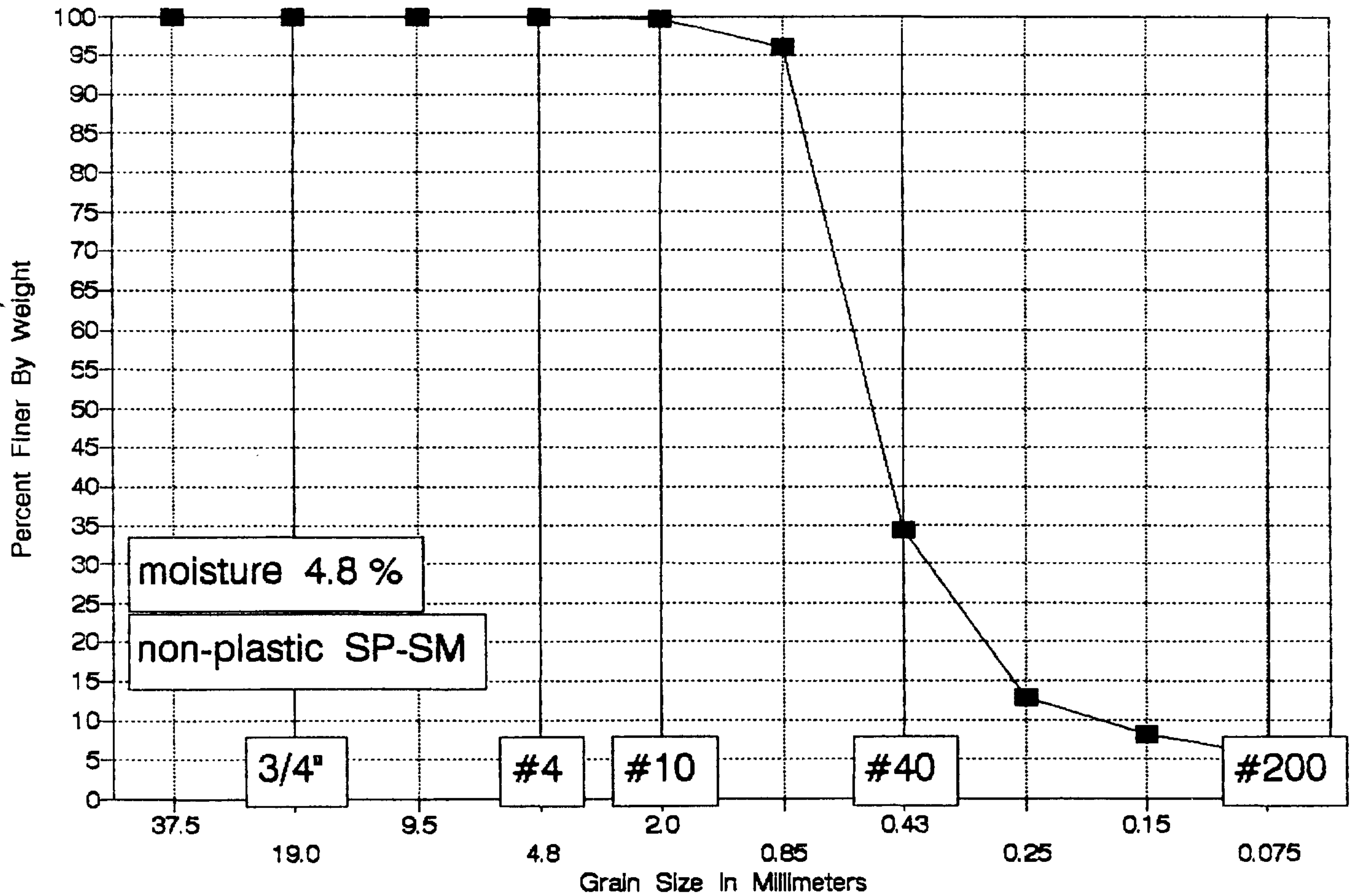
SIEVE ANALYSIS

Dry weight of total sample= 81.5

Sieve #	weight retained	% Finer		
1.5 inch	0	100.00%	100.0	37.5
3/4 inch	0	100.00%	100.0	19.0
3/8 inch	0	100.00%	100.0	9.5
# 4	0	100.00%	100.0	4.8
# 10	0.1	99.88%	99.9	2.0
# 20	0.2	99.75%	99.8	0.85
# 40	1.8	97.79%	97.8	0.43
# 60	14.5	82.21%	82.2	0.25
# 100	38.1	53.25%	53.3	0.15
# 200	53.8	33.99%	34.0	0.075

GRADATION CURVE

Boring 74 MW 1, sample at 16.5-17 feet



RAAP RFI
Usathama
Virginia

Wt soil and dish	193.8
Dry soil & dish	189.8
Dish	105.6

Boring 74 MW 1
Sample at 16.5-17 feet

Moisture Content = 4.8

SIEVE ANALYSIS

Dry weight of total sample= 84.2

Sieve #	weight retained	% Finer		
1.5 inch	0	100.00%	100.0	37.5
3/4 inch	0	100.00%	100.0	19.0
3/8 inch	0	100.00%	100.0	9.5
# 4	0	100.00%	100.0	4.8
# 10	0.3	99.64%	99.6	2.0
# 20	3.4	95.96%	96.0	0.85
# 40	55.3	34.32%	34.3	0.43
# 60	73.5	12.71%	12.7	0.25
# 100	77.3	8.19%	8.2	0.15
# 200	79.4	5.70%	5.7	0.075

Summary of Permeability Test Calculations
Radford Army Ammunition Plant, Radford, Viginia(1)

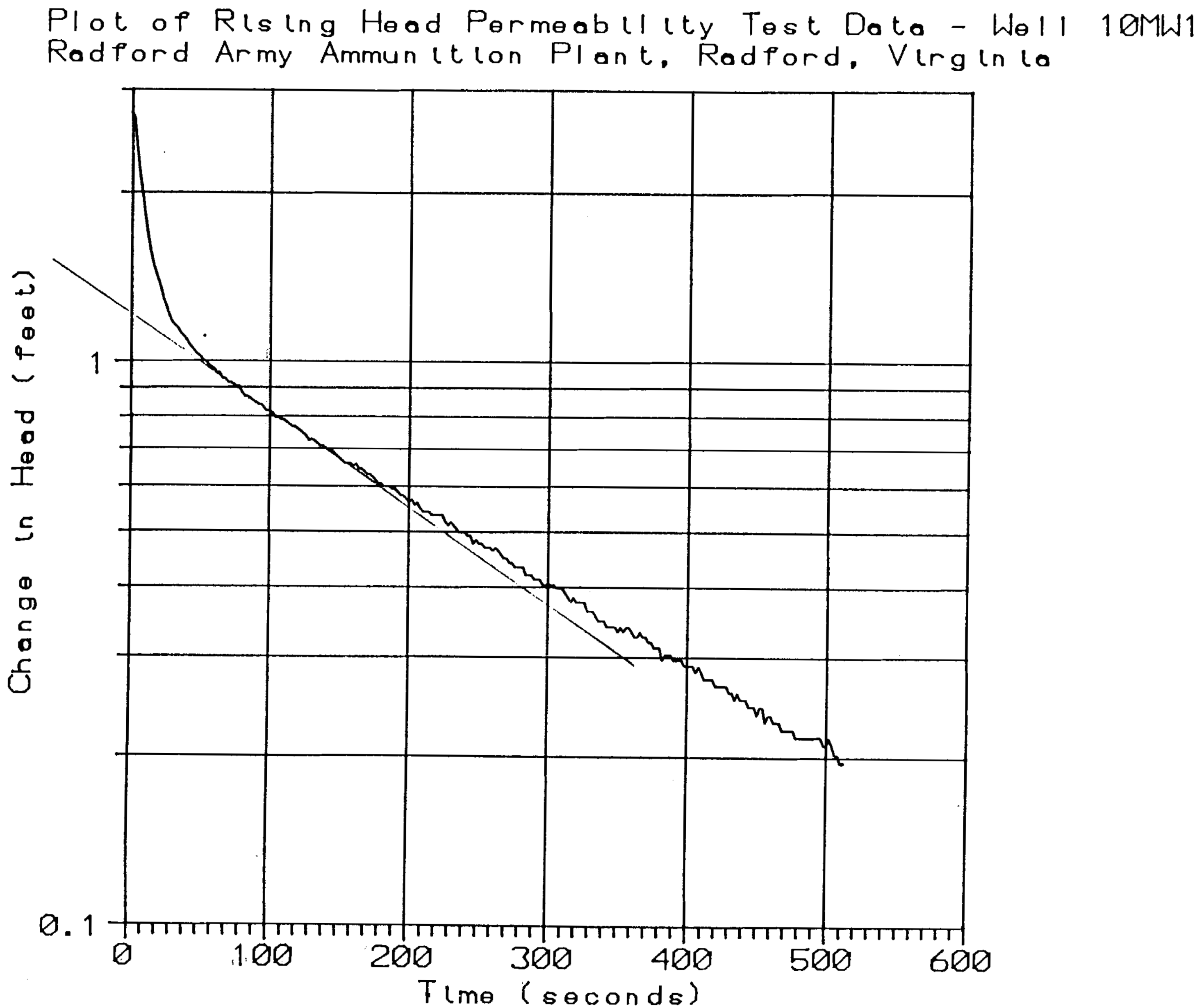
WELL NO.	K (cm/sec)	D (ft)	H (ft)	L (ft)	rw (ft)	rc (ft)	t (sec)	y0 (ft)	yt (ft)
10MW1FH	3.8E-04	10.91	8.91	8.91	0.42	0.17	200	0.95	0.45
10MW1RH	4.5E-04	10.91	8.91	8.91	0.42	0.17	150	1.3	0.67

$$K = \frac{r_c^2 \ln(R_e/r_w)}{2L_e} \frac{1}{t} \ln \frac{y_o}{y_t}$$

If $L_w < H$ then $\ln \frac{R_e}{r_w} = \left[\frac{1.1}{\ln(L_w/r_w)} + \frac{A + B \ln[(H - L_w)/r_w]}{L_e/r_w} \right]^{-1}$

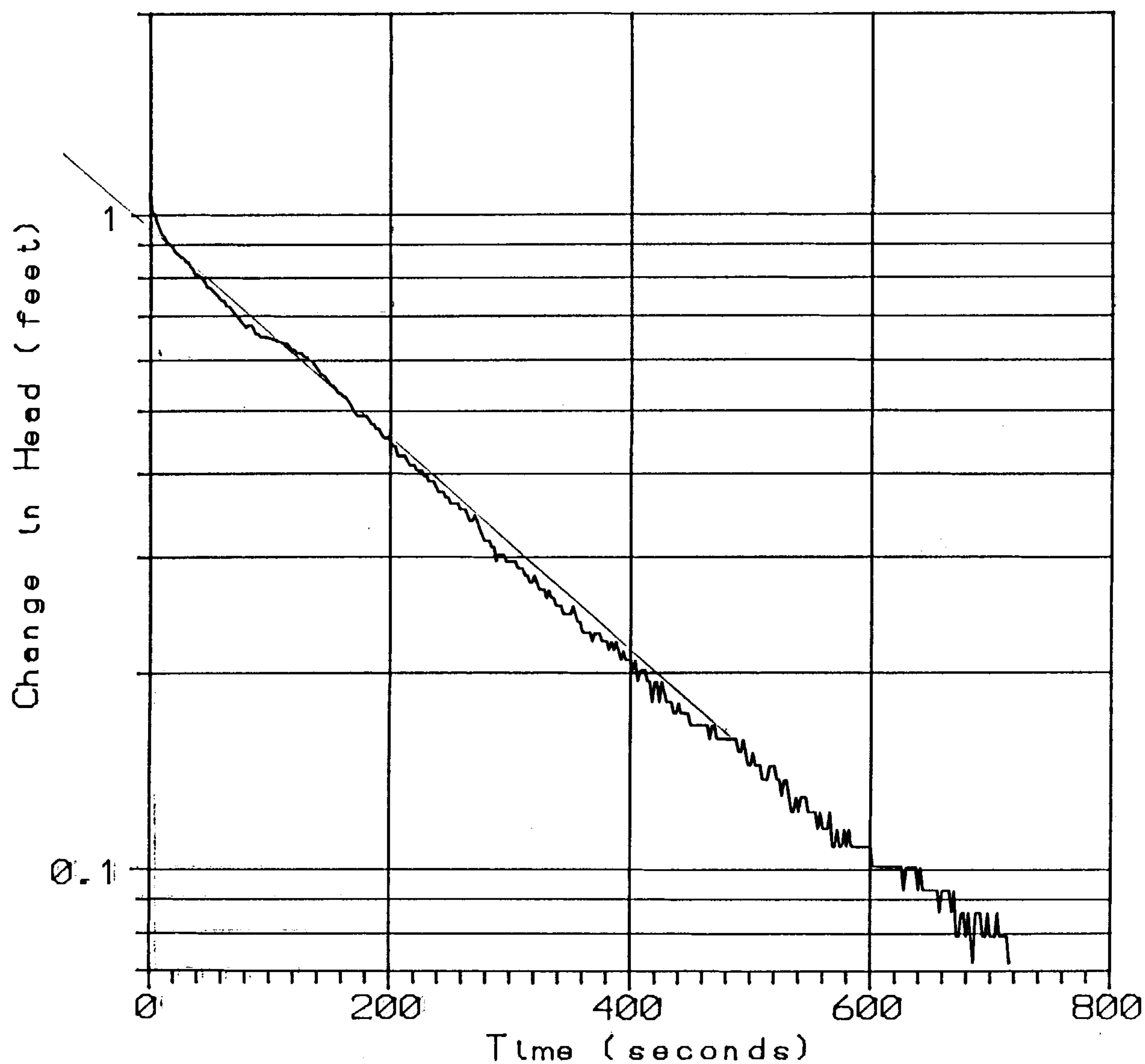
If $L_w = H$ then $\ln \frac{R_e}{r_w} = \left[\frac{1.1}{\ln(L_w/r_w)} + \frac{C}{L_e/r_w} \right]^{-1}$

(1) Bouwer and Rice, 1976



Plot of Rising Head Permeability Test Data - Well 10MW1
Radford Army Ammunition Plant, Radford, Virginia
Change in Head (feet)
1
0.1
0
100
200
300
400
500
600
Time (seconds)

Plot of Falling Head Permeability Test Data - Well 10MW1
Radford Army Ammunition Plant, Radford, Virginia



RESULTS OF PERMEABILITY TESTS MADE AT SITE D

Soil Boring	Depth (ft)	Lithologic Description	Permeability (cm/sec)
DH-1	0 - 5	silt	0+
	5 - 10	sand	0+
	10.0*	clay	4.4×10^{-6}
	10 - 15	sand	3.88×10^{-4}
	15 - 20	gravel	3.99×10^{-3}
	23 - 28	limestone	7.48×10^{-3}
	28 - 30.6	limestone	2.08×10^{-2}
DH-2	0 - 5	silt	0+
	0 - 10	silt and sand	3.53×10^{-5}
	10.0*	silt	1.2×10^{-3}
	0 - 15	silt and sand	1.73×10^{-4}
	0 - 17	silt and sand	2.86×10^{-4}
	17.5 - 30	limestone	1.73×10^{-4}
DH-3	0 - 5	silt	0+
	0 - 10	silt	1.13×10^{-4}
	11.5*	silt	3.2×10^{-5}
	0 - 15	silt and sand	4.94×10^{-5}
	15 - 20	sand	8.83×10^{-5}
	18.0*	silt	5.4×10^{-3}
	20 - 25	sand	1.37×10^{-2}
	25 - 30	gravel and limestone	1.44×10^{-2}
	30 - 36.5	limestone	6.78×10^{-3}
	30 - 40	limestone	4.48×10^{-3}
DH-4	0 - 5	silt and sand	0+
	5 - 10	sand	3.07×10^{-4}
	10 - 15	sand	8.65×10^{-4}
	15 - 20	gravel	2.17×10^{-3}
	20 - 25.9	gravel	8.33×10^{-3}
	25.9 - 35.3	limestone	4.8×10^{-3}

* Laboratory test; all others made in field.
+ Reported as 0, but probably less than 3.28×10^{-6} cm/sec. This is the minimum measurable with the equipment used.

Source: USACE, 1981