CHEM-NUCLEAR SYSTEMS, INC.

The Leader In Nuclear Waste Management Services

SOIL CORING/MONITORING WELL INSTALLATION PROGRAM AND HYDROGEOLOGICAL/RADIOLOGICAL EVALUATION OF THE SAFETY LIGHT FACILITY BLOOMSBURG, PENNSYLVANIA

OCTOBER 11, 1990

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REVISIONS				
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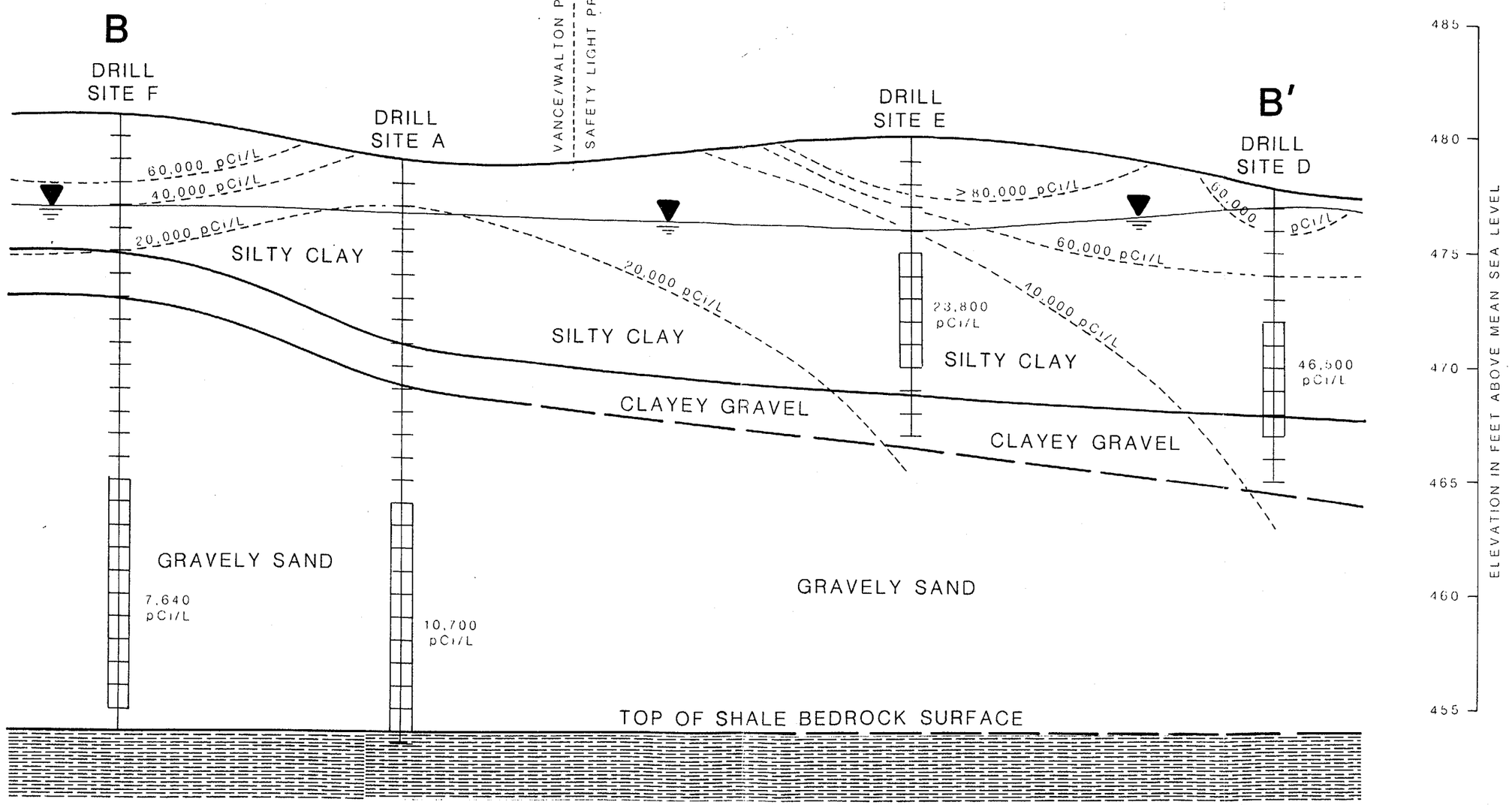

EXPLANATION

WATER TABLE SURFACE

40,000 pCi/L — H-3 CONTOUR
20,000 pCi/L CONTOUR INTERVALS

GEOLOGICAL CONTACT
DASHED WHERE INFERRED

0 20 40 60
SCALE IN FEET

VERTICAL SCALE: 1 INCH EQUALS 5 FEET

HORIZONTAL SCALE: 1 INCH EQUALS 20 FEET

VERTICAL EXAGGERATION: x4

ITEM	QTY	CODE ID	NOMENCLATURE OR DESCRIPTION

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TITLE
HYDROGEOLOGICAL PROFILE MAP B-B'

SIZE: B | DRAWING NUMBER: FIGURE 4 | REV

SCALE | WT | SHEET

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THIS PAGE IS AN OVERSIZED DRAWING OR FIGURE,

THAT CAN BE VIEWED AT THE RECORD TITLED:

FIGURE 3:
HYDROGEOLOGICAL PROFILE MAP
A-A'

WITHIN THIS PACKAGE...OR, BY SEARCHING USING THE DRAWING NUMBER:
FIGURE 3

NOTE: Because of this page's large file size, it may be more convenient to copy the file to a local drive and use the Imaging (Wang) viewer, which can be accessed from the Programs/Accessories menu.

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OCTOBER 11, 1990

CHEM-NUCLEAR SYSTEMS, INC.
ENVIRONMENTAL AND DOSIMETRY LABORATORY
BARNWELL, SOUTH CAROLINA

TABLE OF CONTENTS

TABLE OF CONTENTS

(CONTINUED)

SOIL CORING/MONITORING WELL INSTALLATION PROGRAM AND HYDROGEOLOGICAL/RADIOLOGICAL EVALUATION OF THE SAFETY LIGHT FACILITY BLOOMSBURG, PENNSYLVANIA

GENERAL

INTRODUCTION

During the period of 06-18-90 to 07-18-90, Chem-Nuclear Systems, Inc. (CNSI) conducted soil coring, monitoring well installation and groundwater sampling at the Safety Light Corporation (SLC) facility near Bloomsburg, Pennsylvania, for radiological and hydrogeological evaluations. Subsequent radiological analyses and hydrogeological data have been evaluated and are described in this report.

This study was initiated in response to a Partial Interim Settlement Agreement Between USR Industries and the NRC Staff for "... partial studies of the nature, scope, location, and movement of radioactive contamination at the Safety Light site located at 4150-A Old Berwick Road in Bloomsburg, Pennsylvania..." In addition, execution of the studies will generate part of the site characterization data required to be collected by the Nuclear Regulatory Commission (NRC) March Order (NRC, 1990). The technical resources to conduct this study were limited by available funding and, therefore, this study should not be considered comprehensive in scope.

SITE DESCRIPTION

The Safety Light facility currently manufactures tritium (H-3) light sources under an NRC license No. 37-00030-80 and is located approximately 5 km east of Bloomsburg, Pennsylvania. The facility is bounded on the north by Old Berwick Road and on the south by the Susquehanna River (Figure 1). The current

operations area is enclosed by a security fence. In addition, Safety Light owns the property southeast of the site adjacent to the Susquehanna River hereafter referred to as the Vance/Walton property.

Operations which took place in the late 1940's, 1950's and 1960's under previous owners involved the use of C-14, Fe-55, Co-60, Sr-90, Am-241, Cs-137, Ra-226, and other radionuclides (ORAU, 1982). Although some attempts at decontamination of selected parts of this facility were made in the 1970's, residual contamination, due to past practices, remain. Monitoring data shows that soils beneath the site are contaminated with Ra-226, Sr-90, and Cs-137 and shallow groundwaters are contaminated with H-3 and Sr-90 (NRC, 1988).

Soil and groundwater contamination appear to be caused by disposal of radioactive waste and effluents. Site operators have discarded both radioactive and chemical wastes on the site. The site operators have made numerous changes to its waste disposal and operation practices in response to directions from the regulators.

Attempts at mitigating site contamination were made by US Radium (a previous owner of the site), however, this program was not completed. Therefore, a considerable section of this site remains contaminated with both radioactive and nonradiological contaminants.

PREVIOUS STUDIES AND EVALUATIONS

Groundwater monitoring was initiated in 1978 by the installation of three monitoring wells by the Giles Drilling Corporation. Soil and groundwater samples from these three wells provided initial contamination levels and indicated the need for additional monitoring (RMC, 1979).

During 1979, Meiser & Earl conducted a hydrogeological investigation including the installation of thirteen monitoring wells with soil cores and excavation of backhoe test pits. The data was evaluated to characterize the hydrogeology of the site.

In conjunction with the Meiser & Earl investigation, the Radiation Management Corporation (RMC) conducted a radiological investigation, using soil and groundwater collected by Meiser & Earl. In addition, RMC collected and analyzed surface and near surface soil samples.

During 1981, Oak Ridge Associated Universities (ORAU) performed an extensive radiological survey at the Safety Light facility. Radiological analyses were performed, both on-site and off-site, on air, surface and subsurface soil, groundwater, vegetation, surface water, and aquatic organisms (ORAU, 1982).

In 1988, the US Nuclear Regulatory Commission performed an environmental evaluation of the Safety Light facility using available monitoring data to compile relevant information about the radioactive contamination of the site, assess hazards to nearby residents, and establish actions regarding the contamination.

PROJECT OBJECTIVES

The primary project objective of this study was to conduct field activities (soil coring, monitoring well installation and groundwater sampling) for radiological analyses and integrate the new data with existing information, to the extent possible, to assess the hydrogeologic flow regime and potential for off-site radiological migration from the site area.

Major components of the field work consisted of the following:

- Groundwater sampling at existing monitoring wells, using CNSI sampling methods, for H-3 analyses and water level measurements to provide baseline data.

- Surface gamma radiological survey for personnel protection and minimize sample cross contamination.

- Magnetic survey to assist in identifying buried metal objects that might be present as a result of backfilling in the abandoned canal.

- Soil coring for radiological analyses (H-3, Sr-90 and gamma isotopic) and hydrogeological characterization.

- Monitoring well installation for groundwater sampling and radiological analyses (H-3, Sr-90, gross alpha/beta, and gamma isotopic) and water level measurements.

- Rainwater sampling for H-3 analyses.

- Occupational and radiological protection including industrial safety for all aspects of field activities.

METHODOLOGY

INITIAL GROUNDWATER SAMPLING

During the period of 06-20-90 to 06-21-90, the CNSI personnel sampled the existing Safety Light Corporation (SLC) monitoring wells to provide baseline H-3 data. Although SLC has analyzed for H-3 from the existing monitoring wells, the wells are sampled on a staggered schedule and are not evacuated prior to sampling. Therefore, CNSI sampled the SLC monitoring wells prior to drilling activities, using CNSI sampling techniques which include monitoring well evacuation, to provide baseline H-3 data and to compare with preliminary radiological soil results to guide in

the selection of drilling sites.

Two sampling methods were selected based on the monitoring well diameters. All 6 inch diameter wells were evacuated and sampled with a submersible pump due to the large volume requirements. All 2 inch and 1.5 inch diameter wells were evacuated and sampled with 1.70 inch and 0.75 inch PVC bailers respectively.

Monitoring wells No. 2, 3, and 17 were not sampled due to inaccessibility (bent casing) or poor condition of casing. Monitoring well No. 11 was not sampled due to the presence of oil in the well.

All wells were evacuated by removing three well volumes or until the wells were pumped/bailed dry. Groundwater samples were collected into 4-ounce glass containers. Each container displayed the well number, date, and time collected. Field parameters (pH, conductivity, and temperature) were measured and recorded with other relevant field collection information (see Appendix A for the groundwater sampling collection forms).

Evacuated groundwater was placed into 55 gallon drums, sealed, clearly marked describing the contents, and removed by SLC for waste storage and disposal. All waste generated during this project became the property of Safety Light Corporation under their license.

Groundwater sampling equipment was decontaminated with control water (Bloomsburg city water) between monitoring wells. Due to the potential of surface contamination, plastic sheets were placed next to the wells for the sampling equipment and personnel protective clothing (gloves, anti-C's, and overboots) was used during sampling.

In addition to the SLC monitoring wells, the Vance/Walton well was evacuated and sampled. CNSI located the hand-dug well,

calculated the volume for evacuation (1600 gallons), measured the flow rate at the bath tub, and allowed the tap to flow until 1600 gallons were pumped out of the well. After 6.5 hours, a groundwater sample was collected. A chain-of-custody form was completed and 20 groundwater samples were delivered to the SLC laboratory for H-3 analyses.

MAGNETIC SURVEY

A magnetic survey was conducted using a Schonstedt Model GA-52B magnetic locator within the Vance/Walton property to assist in identifying buried metal objects that might be present as a result of backfilling in the abandoned canal and the placement of Drill Site A and B south and north of the canal respectively. Previous studies suggested the abandoned canal might influence groundwater movement and migration of radionuclides (NRC, 1988).

The magnetic locator detects the magnetic field of any ferrous object covered by soil, pavement, or shallow water. A grid pattern was established covering the suspected boundaries of the abandoned canal. The locations of buried ferrous objects were plotted in the field notebook using natural or manmade features for reference.

SURFACE GAMMA RADIOLOGICAL SURVEY

A surface gamma radiological survey was conducted at each proposed drill site using a portable micro-R meter. Existing monitoring data shows the presence of surface soil contamination, therefore, a radiological survey was conducted at each proposed drill site to allow the exact placement of the drill hole away from elevated levels of surface contamination.

Prior to placement of the drill rig, contaminated areas were marked with red paint by the Radiological Control Supervisor

(RCS). The RCS briefed the field crew concerning contamination levels prior to drilling activities.

SOIL CORINGS

Three different soil sampling techniques were used during drilling operations. All methods used 4.25 inch hollow stem augers to advance the hole and maintain borehole stability. Initially, a 5 foot split core barrel was used at Drill Site A. This method used a 5 foot split core barrel (2.75 inch ID) positioned at the lead 4.25 inch hollow stem auger with NW size drill rods. Continuous soil cores are obtained by advancing the augers and the core barrel at 5 foot intervals. However, this method proved to be inadequate, due to poor core recovery and the inability to penetrate through cobbles and boulders.

At 10 feet below land surface, the 5 foot split core barrel was replaced with a 2 inch diameter X 24 inch long split spoon sampler. The 2 inch split spoon sampler was advanced ahead of the 4.25 inch lead hollow stem auger using a 140 lb. hammer and cat head hoisting device. This method provided good quality soil samples (10-25.5 feet at Drill Site A), however, the quantity of each 2 foot sample was inadequate for the scheduled radiological soil analyses.

To increase the quantity of soil required for analyses, a 3 inch diameter X 24 inch long split spoon sampler was used at Drill Sites A-1, B, C, D, E, F, G, and I. Good quality and quantity samples were obtained with the 3 inch split spoon sampler. Due to the core loss from 0-10 feet at Drill Site A, a new corehole was drilled approximately 10 feet east and was resampled from 0-10 feet. These samples were designated "Drill Site A-1". The Drill Site A hole was abandoned with cement grout using standard grouting techniques.

All soil core handling included frisking the soil sampler with a beta-gamma pancake G-M detector to alert the field crew of potential gross contamination. The soil sampler was then opened to measure the core recovery and a visual lithologic description was performed by the field geologist. The soil sample was transferred to a plastic bag showing the drill site designation, depth in feet, date and time. A chain-of-custody form was completed and the samples were shipped by overnight mail to the CNSI Barnwell Laboratory. Upon removing the soil sample, the split spoon sampler was decontaminated and assembled for the next core run.

Soil cuttings from the flights of the augers were removed from the borehole area and placed into 55 gallon drums. All drums were identified (drill site designation, type of material, date and volume) and removed by SLC for waste storage and disposal.

The CNSI geologist documented soil coring activities by maintaining a field log book and completing daily drilling reports and lithologic descriptions. The daily drilling reports and lithologic descriptions are presented in Appendix B and C, respectively. The target depth for soil coring was at or near the top of shale bedrock. However, auger refusal prevented additional soil sampling, at a depth of 13 feet, for both Drill Site D and E. Flowing sands inside the augers presented sampling difficulties; however, these problems were solved by modifying drilling techniques.

Previous drilling projects (Meiser & Earl, 1979) described drilling difficulties in the area north of the abandoned canal due to large boulders in the uppermost sediments. CNSI also experienced difficulties at Drill Sites C and I. At Drill Site C, 10 feet of augers were sheared off due to subsurface conditions. At Drill Site I, two attempts of augering/soil coring were necessary to penetrate the bouldery material and in the process, damaged the flights of the augers.

In general, the method of hollow stem augering and split spoon sampling, although difficult in fluvial/glacial deposits, provided both good quality and quantity soil samples for radiological analyses.

MONITORING WELL INSTALLATION

A total of 9 monitoring wells were installed at Drill Sites A-I (see Appendix D for monitoring well construction diagrams). Immediately upon collecting the last core sample at each drill site, a monitoring well was installed through the augers. Well installation through the hollow stem augers was necessary due to unstable hole conditions.

Monitoring well materials consisted of 2 inch schedule 80 PVC casing and screen with flush jointed threaded ends. O-ring seals were used at each connection. A 10 foot slotted (0.01 inch) screen was installed at all drill sites except a 5 foot screen was installed at Drill Sites D and E due to the shallow depths and necessary annular seal requirements above the screen.

After the well materials were installed to the selected depth, AW drill rods were placed inside the PVC casing and screen for counter weight while the augers were hoisted out of the borehole. Upon removal of the augers, the sands and gravels collapsed within the borehole. In most cases, the collapse occurred completely around the screen and partially around the casing. After the collapse occurred, the upper portion of the borehole remained open for the placement of an annular seal (bentonite and cement grout). In some cases, the borehole collapse did not completely surround the screened interval. An artificial filter pack (FX50 filter sand) was placed around the remaining exposed screened interval. Due to the shallow depth for sand placement, the filter pack was gravity fed around and above the screen. A weighted tag bar was used to verify depths of placement.

The bentonite pellet seal was placed, in a similar manner, above the filter pack and allowed to hydrate prior to the placement of cement grout.

Cement grout was mixed at the drill sites to a minimum density of 13.0 lbs/gal. and gravity fed or tremied. A 4 inch x 4 inch x 60 inch carbon steel protective casing was installed around the exposed PVC casing and placed several feet into the cement grout. The cement grout was allowed to cure overnight prior to well development.

The deeper more productive wells were developed using air lift methods. The air lift device consisted of a 0.75 inch PVC pipe extending from the top of the casing to the bottom of the well. An air compressor, rated at 60 cfm, supplied the air down the 0.75 inch PVC pipe forcing the water out of the well casing and pumped directly into 55 gallon drums.

The shallow less productive wells were developed by hand bailing and the evacuated groundwater placed into 55 gallon drums. Development continued until the pH and conductivity stabilized. Well pads (6 inch x 4 foot X 4 foot) were poured around each well and dedicated PVC bailers were installed for future groundwater sampling.

RAINWATER SAMPLING

Preliminary H-3 soil data, evaluated in the field, indicated the suspected H-3 source might be related to atmospheric releases from past and present site operations and not related to buried sources. In addition, Safety Light Corporation internal monitoring data supported this observation.

On 07-10-90 and 07-11-90, 5 rainwater samples were collected. On 07-12-90, 32 rainwater samples were collected along the east and south fence line of the Safety Light facility. Aluminum pans were placed at 40 foot intervals along the fence line and one pan was placed on top of the Vance/Walton well.

During the time period of 10:00 am to 1:30 pm, rainwater samples were collected at the 32 locations. Continuous rain occurred during this period and the wind speed and direction was recorded at 30 minute intervals from the SLC on-site weather station.

All samples were poured into 4 ounce glass containers and sent to CNSI Barnwell Laboratory for H-3 analyses.

RADIOLOGICAL GROUNDWATER SAMPLING

Following all monitoring well installations and well development, the new 9 wells were evacuated and sampled for H-3, Sr-90, gamma isotopic, and gross alpha/beta analyses.

The wells were evacuated with dedicated 1.7 inch PVC bailers. A total of three well volumes were evacuated or until the well was bailed dry. Samples were collected in 4 ounce glass containers for H-3 analyses and in 1 gallon acidified plastic containers for Sr-90, gamma isotopic, and gross alpha/beta analyses. One duplicate sample was collected at Drill Site B and one field blank (Bloomsburg city water) was collected. At the request of the NRC, 1 quart nalgene containers were filled at the same sampling points used by CNSI and submitted to the NRC Region I.

Field parameters (pH, conductivity, and temperature) were measured and recorded with other relevant field collection information (see Appendix A for the groundwater sampling collection forms). Evacuated groundwater was placed into 55 gallon drums, sealed, clearly marked describing the contents, and removed by SLC for waste storage and disposal. A

chain-of-custody form was completed and the samples were hand delivered to the CNSI Barnwell Laboratory.

OCCUPATIONAL AND RADIATION PROTECTION

Occupational and radiation protection was performed to provide a means of conducting a safe working environment during the execution of soil coring, monitoring well installation, and groundwater sampling. All field personnel wore thermoluminescent dosimeters and provided bioassays prior to field work and immediately upon completion of field work. The CNSI Radiological Control Supervisor (RCS), conducted the following routine surveys;

- Daily whole body frisk of personnel performed when leaving work areas (i.e. drill sites and property south of Safety Light facility).
- Daily survey of drilling equipment when in use and prior to moving to new drill sites.
- Daily low volume air sampling downwind of drilling activities.
- Daily vehicle survey performed when used in work areas.
- Equipment removed from drill site checked for contamination.
- Composite soil sample of drill waste taken and checked for alpha contamination.
- Survey of soil and groundwater samples upon collection and prior to shipment.

In addition, the RCS conducted the following conditional surveys with a 2 inch x 2 inch NaI detector (low energy gamma) and a pancake G-M detector (beta-gamma);

- Initial area surveys (low energy gamma)
- Pre-drill surveys (low energy gamma and smears at hot spots).
- Post-drill surveys (low energy gamma).
- Site release survey (low energy gamma).

- Unconditional release of vehicles and drilling equipment (beta-gamma).

ANALYTICAL INSTRUMENTATION AND METHOD SUMMARY

Radiological counting instrumentation and methods used in support of the Safety Light project are briefly described. Analyses were performed by the CNSI Environmental and Dosimetry Laboratory in Barnwell, SC and Teledyne Isotopes of Westwood, NJ. The CNSI laboratory performed all analyses with the exception of Sr-90 which was performed by Teledyne.

Radiological analyses were performed in accordance with the site specific plan with one modification. An alternative sample preparation method was utilized for tritium in groundwater analyses. The alternative method consisted of distilling the groundwater samples prior to radioassay. Other changes to the site specific plan include the addition of gross alpha/beta screening analysis on groundwater samples and screening of soil samples for Ra-226 and Ra-228 by gamma spectroscopy. Finally, the collection of rainwater samples from locations around the perimeter of the facility for tritium analyses, which were not a part of the plan, were also added to the tasks.

Analytical methods for sample preparation and analyses are described for each analysis and are referenced to specific laboratory procedure numbers in Table 1. Minimum detectable amounts for each type of radiological analyses are presented in Table 2.

Calibration of counting systems were performed with reference standards traceable to the National Institute of Standards and Technology.

Gross Alpha/Beta in Groundwater

Gross alpha/beta screening analyses were performed on 9 groundwater samples collected from the monitoring wells. Samples were prepared for assay by filtering a 250 ml aliquot through a Whatman No. 44 filter paper and evaporating onto a stainless steel planchet. This procedure is based on method #00-01-1 described in the EPA Radiochemistry Procedures Manual, EPA 520/5-84-006, 1984.

A Tennelec Model LB-5100 gas flow proportional counter was used to perform gross alpha/beta radioassay. The system used a 2.25 inch detector having an 80 microgram/cm^2 detector window. The instrument has a background of 0.05 cpm in the alpha channel and 0.87 cpm in the beta channel. Detector efficiencies are 31% for Th-230 and 48% for Cs-137.

Tritium In Groundwater, Soil, And Rainwater

Tritium analyses were performed on 90 soil cores and 9 groundwater samples collected from the drill site locations. Tritium analyses were also performed on 37 rainwater samples collected from the boundary of the Safety Light facility.

Soil and groundwater samples were prepared for assay using an azeotropic distillation procedure. The procedure used 100 grams for soil core analyses and 25 ml for groundwater analyses. The sample was heated in an azeotrope still after mixing together with benzene. A 5 ml aliquot of the separated water was mixed with 15 ml of a scintillation solution in a plastic counting vial. Rainwater samples were prepared for assay by directly mixing a 5 ml aliquot of sample with 15 ml of a scintillation solution in a plastic counting vial. This procedure is based on method H-01 described in the EPA Radiochemistry Procedures Manual, EPA 520/5-84-006, 1984.

Tritium assay was performed using a Beckman Model LS-7500 Liquid Scintillation System. Automatic quench calibration was performed using an external standard method. Typical counting efficiency for tritium in quenched samples is 39%.

Gamma In Groundwater And Soil

Gamma spectroscopy analyses were performed on 68 soil cores and 9 groundwater samples collected from the drill site locations. Soil samples were prepared for assay by oven drying and passing the dried sample through as ASTM #35 mesh (500 μm) sieve. A 150 gram aliquot of the homogenous sample passing through the sieve was sealed in a 100 mm by 20 mm petri dish.

Soil cores were collected at approximately two foot intervals and contained various quantities of small pebbles and rock which would not pass through the sieve. One sample from Test Hole I consisted entirely of large rocks. Subsequently, some of the samples were composited to achieve the required aliquot for analysis. Sample compositing of up to six foot intervals was performed on three samples from Drill Site A and one sample from Drill Site F. Remaining composites were limited to four foot sampling intervals. Groundwater samples were prepared by filtering a 2 liter aliquot through a Whatman No. 44 filter paper and transferring into a sealed Marinelli beaker.

Gamma spectroscopy analysis instrumentation consisted of a Nuclear Data 9900 multi-channel analyzer to collect, store, and process spectral data from intrinsic germanium detectors. Two of the intrinsic germanium detectors were assigned to analyze soil and groundwater samples for this project. These two detectors have relative counting efficiencies of 18% and 22% for the 1333 keV photopeak of Co-60.

Calibration of gamma spectroscopy systems are based on Method 901.1 described in the EPA Prescribed Procedures for Measurement

of Radioactivity in Drinking Water, EPA-600/4-80-032, August, 1980. This calibration is applicable for samples that contain radionuclides emitting gamma photons with energies ranging from 88 to 1836 keV.

Analyses of Ra-226 and Ra-228 in soil are referenced to this calibration using a mixed gamma radionuclides standard with the specified energy range.

Since assay of the radium isotopes by gamma spectroscopy was not originally planned and included at the request of the US NRC, tracer tests using radium standards were not performed. Verification of Ra-226 progency ingrowth was performed by reanalyzing selected soil samples from each batch processed. Analysis of Ra-226 and Ra-228 in soil were based on the photopeaks of Bi-214 at 609 keV and Ac-228 at 911 keV respectively (Kahn, 1990). Gamma photopeak fractions for these energies are taken from NCRP Report No. 58.

Sr-90 In Groundwater And Soil

Analyses of Sr-90 were performed on 9 groundwater samples and 68 soil cores. Groundwater samples were prepared for assay by adding stable strontium carrier to 1 liter of sample and reducing the volume by evaporation. Strontium was separated by precipitating $Sr(NO_3)_2$ using nitric acid. A barium scavenge was performed to remove radium and other natural nuclides. Final purification of strontium was accomplished by precipitating $SrSO_4$.

An iron scavenge was performed, followed by addition of stable yttrium carrier and a minimum 5-day period of yttrium ingrowth. Yttrium was then precipitated as hydroxide, dissolved, and re-precipitated as oxalate. The yttrium oxalate was mounted on a nylon planchet and counted in a low level beta counter to infer Sr-90 activity.

Soil samples were prepared by drying under heat lamps and then removing a 10 gram aliquot of the dried sample. Stable strontium and calcium carriers were added and the sample was leached in hydrochloric acid and filtered. Calcium and strontium were precipitated as phosphates, collected by vacuum filtration, then dissolved in nitric acid. Strontium was separated by precipitating $(SrNO_3)_2$ using nitric acid. A barium scavenge was performed to remove radium and other natural nuclides. Final purification of strontium was accomplished by precipitating $SrSO_4$.

An iron scavenge was performed, followed by addition of stable yttrium carrier and a minimum 5-day period for Y-90 ingrowth. Yttrium was then precipitated as hydroxide, dissolved and re-precipitated as oxalate. The yttrium oxalate was mounted on a nylon planchet and counted in a low level beta counter to infer Sr-90 activity.

RESULTS

INITIAL GROUNDWATER SAMPLING RESULTS

Prior to drilling operations, CNSI sampled 20 existing monitoring wells and SLC performed the H-3 analyses for baseline data. The 1990 results are presented in Table 3 with 1981 data performed by Oak Ridge Associated Universities for comparisons.

The 1981 H-3 data indicated elevated levels in the southern portion of the site. H-3 concentrations exceeding 10,000 pCi/L occurred primarily within the southeast quadrant of the site. Monitoring wells in the northwest quadrant had the lowest concentrations of H-3 (~1,000 pCi/L).

The 1990 data shows a general increase in H-3 concentrations throughout the site and a pronounced increase within the

southeast quadrant of the site (see Figure 2). This baseline H-3 sampling results supported the need to concentrate radiological evaluations within this portion of the site.

During the sampling of the SLC monitoring wells, CNSI observed that many of the existing wells were poorly constructed and/or in the need of repair. The ability of these monitoring wells to provide representative groundwater samples for radiological analyses was a concern noted during this study.

Table 4 summarizes the observations made at the SLC monitoring wells. In general, the southern wells (1.5 and 2.0 inch diameter) near the river appear to be poorly constructed and damaged (due to river flooding). The northern wells (6 inch diameter) appear to be in good condition. Visible oil was observed in three of the 6 inch diameter wells (No. 11, 12, and 13).

MAGNETIC SURVEY RESULTS

Numerous small to large buried magnetic (ferrous) objects were detected within the Vance/Walton property. The purpose of the survey was to aid in the definition of the abandoned canal which appears to be located south of the Vance/Walton house and parallel to the river. Three large hardwood trees appear to be situated in the center of the abandoned canal.

A concentration of metal objects was observed within suspected boundaries of the canal and primarily near the SLC eastern fence line. These observations coincide with subtle visual features (ie., remnants of south bank, old fence line, and etc.).

The approximate location of the abandoned canal was confirmed by Mr. Rubenstein, a local resident. Mr. Rubenstein witnessed the abandonment of the canal in 1961. The southern bank of the canal was removed and placed into the 10 foot deep canal. Mr.

Rubenstein remembers that the resident of the Vance/Walton property (Mr. Walton) planted three river maples along this area after the canal was filled. Based on this information, Drill A, B, and F were selected and drilled south, north and in the abandoned canal respectively (see Figure 1).

HYDROGEOLOGY

Geologic Setting

The Safety Light facility lies within the Valley and Ridge Province of Pennsylvania. The site area is underlain by unconsolidated deposits laid down during the glacial age and underlain by Paleozoic bedrock formations which have experienced significant folding. The Berwick Anticline, striking northeast and southwest with the axis lying approximately 2.5 miles north of the site, controls the structure of the bedrock in this area (Pennsylvania Power & Light Co., 1978).

The southeast limb of the Berwick Anticline dips toward the Susquehanna River (Pennsylvania Power & Light Co., 1978) and confirmed by shale outcrop along US 11 and Interstate 80, observed by CNSI during a site visit in May, 1990.

The unconsolidated sediments underlying the Safety Light facility has been described by previous hydrogeologic investigations (Meiser & Earl, 1979). The outwash deposits were subdivided into two units.

- Upper unit: a very coarse sand and gravel with large sandstone boulders.

- Lower unit: sands and finer gravel above the bedrock.

Near the flood plain (from the upper limit of the abandoned canal to the river) the upper unit has been eroded and replaced with

silts, clayey silts, and coal silts by the Susquehanna River, (Meiser & Earl, 1979).

Sediments cored and described during the execution of this project are characterized in a similar manner as the Meiser & Earl report conducted during 1979. Lithologic descriptions are presented in Appendix C.

The shale bedrock surface was encountered at Drill Sites A, G, and F (refer to Figure 3, Hydrogeological Profile Map A-A' and Figure 4, Hydrogeological Profile Map B-B'). The contact between the shale and overlying gravely sands is sharp and distinct. The shale is characterized as black, fissile, dense, and dipping at a 45° angle. The bedrock surface, underlying the site, has been eroded to a flat surface (455 feet above mean sea level).

Overlying the shale bedrock surface are gravely sands. The gravely sands are characterized as variable amounts of fine gravel and coarse grain sand with good visible porosity. These outwash deposits range from 10-20 feet thick.

Overlying the gravely sands are clayey gravels. These sediments are characterized as clayey gravels with variable amounts of cobbles and boulders which predominate north of the abandoned canal (Drill Site B) and penetration with hollow stem augers was extremely difficult.

South of the abandoned canal, the clayey gravels have been eroded by the Susquehanna River and replaced with fluvial silty clay or silt (see Figures 3 and 4). Occasional cobbles occur in this unit to the east, while the western edge of the site (Drill Site G) is devoid of pebbles or cobbles. Poor visible porosity is characteristic throughout this unit.

Water Table Conditions

The water table is nearly flat from the northern portion of the site (Old Berwick Road) to the northern extent of the abandoned canal then falls rapidly toward the Susquehanna River (see Figure 5). The steep groundwater gradients along this portion of the site correspond with the topographic expression of the land surface. No anomalous features were observed in the water table surface. The water table contours on Figure 5 appear typical for this hydrogeologic setting. Groundwater flow appears to flow southward toward the Susquehanna River.

RADIOLOGICAL SOIL RESULTS

Soil samples were collected at 2 foot intervals at the drill sites for radiological analyses including H-3, Sr-90 and gamma isotopic analysis. Some consolidation of soil samples were necessary for Sr-90 and gamma isotopic analyses due to insufficient quantities after removing large sized material.

Due to the close proximity of Drill Site B and H, soil cores were only collected at Drill Site B. Detailed radiological soil results are presented in Appendix E and are summarized in the following sections.

H-3 In Soil

H-3 soil data is summarized in Table 5 and presented in more detail in Appendix E. In addition, H-3 soil profiles are illustrated in Figures 6 through 13.

Common to all soil profiles are high concentrations of H-3 in the surface sediments (0-4 feet) and decreasing concentrations with depth. Decreasing concentrations of H-3 with depth is fairly uniform, however, H-3 concentrations appear to increase slightly

below the water table surface, then continue to decrease with depth.

In addition to the observation that the near surface sediments contain the highest concentrations of H-3, these sediments are generally unsaturated. Therefore, H-3 contamination appears to be migrating vertically from the surface down through the unsaturated sediments and into the water bearing sediments. The distribution of H-3 in the soil columns suggests that groundwater containing H-3 from the Safety Light facility does not appear to be migrating eastward toward the Vance/Walton property.

Sr-90 And Gamma Isotopic In Soil

Results from Sr-90 and gamma isotopic analyses in soil indicate the presence of Sr-90, Cs-137, Ra-226, and Ra-228 at low concentrations (<3 pCi/gm) and are shown in Table 6. Generally, these radionuclides are at baseline levels up to approximately twice baseline levels (based on ORAU 1982 baseline data).

It should be noted that all CNSI drilling sites were biased away from observed elevated contaminated areas due to the project scope of work and health and safety considerations. Assessment of surficial contamination was not a part of this study, however, widespread surficial contamination was observed along the southern fence line to the river edge (see section "Radiological Survey Results" for additional details). This observation is consistent with internal SLC data and previous investigations (ORAU, 1982).

Sr-90 was at baseline levels in soil at Drill Sites B, C, F, and I with the following exception. Drill Site F (6-10 feet) showed Sr-90 concentrations of 2.2 pCi/gm. Drill Site F is in the abandoned canal and the depth of the elevated levels correspond to the original base of the canal. A possible interpretation is

that Sr-90 contamination may have migrated from the SLC property when the canal was open.

Drill Sites A, D, E, and G, located in the southern portion of the study area and south of the abandoned canal, show above baseline Sr-90 levels in the soil. These elevated soil samples correspond to elevated levels of Sr-90 in groundwater. The distribution of Sr-90 in the soil profiles show the highest levels within the saturated zone and midway in the soil columns.

Cs-137 was detected above baseline values at several drill site locations in the surficial deposits only. Below the surficial deposits, the concentrations were at baseline values. Ra-226 and Ra-228 soil results appear consistent with natural baseline values.

H-3 IN RAINWATER

Rainy conditions occurred at the work site during the period of 07-09-90 through 07-13-90. Although rainwater sampling was not in the scope-of-work for this project, CNSI included this work element to the project after evaluating preliminary H-3 analyses in soil.

Elevated H-3 concentrations in soil profiles indicated the possible source of H-3 contamination might be related to an atmospheric source from site operations. To support this theory, rainwater samples were collected and analyzed for H-3 at the CNSI Barnwell Laboratory.

On 07-10-90, rainwater samples were collected near Drill Sites B, C, E, and F. These samples contained H-3 concentration ranging from 130,000 pCi/L to 51,700 pCi/L. On 07-11-90, a rainwater sample was collected near Well No. 14. This sample contained 24,900 pCi/L of H-3.

On 07-12-90, 32 rainwater samples were collected along the southern and eastern fence lines. Figure 14 illustrates the location of the sampling points, concentration of H-3, and wind direction. In addition, the rainwater results are tabulated in Table 7.

Figure 14 shows that H-3 in rainwater is being distributed and controlled by wind direction away from the site facilities. Known atmospheric release points include the H-3 Main Process Building, the Solid Waste Building, and the Liquid Waste Hold-Up Building.

Assuming the predominant wind direction is toward the southeast (ORAU, 1982), elevated H-3 in soil and groundwater appears to be related to atmospheric sources from past and present SLC site activities.

RADIOLOGICAL GROUNDWATER SAMPLING RESULTS

Groundwater samples were collected at the new 9 monitoring wells. Radiological analyses were performed including Sr-90, gamma isotopic, gross alpha/beta, and H-3. The results are summarized in Table 8 and presented in more detail in Appendix E. In addition, the quality control data for radiological analyses are shown in Appendix F. Gross beta, Sr-90 and H-3 activity was detected and is discussed in the following sections.

H-3 in Groundwater

Monitoring wells located in and around the southeastern quadrant of the site showed the highest concentrations of H-3 in groundwater. H-3 values for the new wells are consistent with the existing monitoring wells (see Figure 2). In addition, groundwater results (opposite the screened interval) is consistent with the corresponding soil results except for Drill Site H. Drill Site H showed a lower value than the corresponding

soil results. Subsequent sampling by SLC provided a value of 23,600 pCi/L which compares favorably with the H-3 soil data.

The first round of groundwater sampling supports the soil sampling H-3 results illustrating higher H-3 concentrations in the surficial sediments which decrease with depth, therefore, shallow monitoring wells constructed immediately below the water table will yield higher concentrations of H-3 than wells constructed at greater depths.

Figure 3, Hydrogeological Profile A-A', and Figure 4, Hydrogeologic Profile B-B', illustrates the distribution of H-3 through the unsaturated zone and the saturated zone.

Gross Beta Activity in Groundwater

Gross Beta activity for the new wells (CNSI data) and gross beta activity for the existing wells (SLC data) were combined to construct Figure 15. This map shows the highest activity in the south-central part of the site. The source appears to be the two underground buried silos. Monitoring wells upgradient of the silos have low beta activity, while wells located downgradient of the silos have the greatest beta activity.

Sr-90 In Groundwater

During the period of October 1978 to January 1980, the Radiation Management Corporation analyzed environmental samples collected by U.S. Radium. On 03-10-79, 8 groundwater samples and 1 surface water sample were collected and analyzed for Sr-90 and shown on Figure 16. Sr-90 was detected, at relatively high concentrations, at monitoring wells No. 1, 2, and 3, at concentrations of 33,300 pCi/L, 5,600 pCi/L, and 2,340 pCi/L respectively. These monitoring wells are directly downgradient of the two buried silos (see Figure 5, Water Table Contour Map) and have been suspected as a radiological source for groundwater

contamination (RMC, 1979). In addition, monitoring wells No. 4, 5, 6, and 19, located southeast and southwest of the buried silos, showed concentrations of Sr-90 ranging from 222-770 pCi/L. Lateral movement of contaminated groundwater due to transient groundwater effects appear unlikely to account for the occurrence of Sr-90 in these wells.

Backhoe pits excavated in and around the abandoned canal (RMC, 1979), suggest "... waste may have been used as fill material in the old canal." Therefore, the source of Sr-90 in monitor wells No. 4, 5, 6, and 19 may be from the abandoned canal.

CNSI sampled and analyzed for Sr-90 in groundwater at monitoring wells A-I and results are illustrated in Figure 16 and presented in Table 8. Sr-90 was detected in groundwater in all wells in or south (downgradient) of the abandoned canal ranging from 1.9-44 pCi/L. Wells located north of the canal were less than detection limits (<0.9 - <2 pCi/L).

Concentrations of Sr-90 in groundwater have a trend of decreasing concentration away from boundaries of the Safety Light property, as contoured in Figure 16. It was noted that fill in the abandoned canal, within the Vance/Walton property (Drill Site F), consisted of silty clay without any trash or debris. Characteristics of the abandoned canal within the Safety Light boundaries consisted of radioactive debris and trash (RMC, 1979). This may account for the observed trending of Sr-90 concentrations in groundwater.

The new Sr-90 groundwater data supports previous investigation (RMC, 1979) suggesting the abandoned canal may be a source of Sr-90 contamination along the southeastern and southwestern portions of the study area. Sr-90 groundwater contamination, within the south-central portion of the study area, appears to be migrating from the buried silos.

RADIOLOGICAL SURVEY RESULTS

The CNSI Radiation Control Supervisor (RCS) performed radiological surveys during all field work. Results of these surveys are summarized as follows:

- Initial area surveys indicated no surface abnormalities within the Vance/Walton property with the exception of the areas along the SLC property line. Pre-drill surveys indicated areas up to 1.5 times background.

- Minor contamination was detected on personnel protective clothing, drilling equipment, and sampling equipment. All items were decontaminated, resurveyed, and returned to use.

- No airborne activity above background (typically E-11μCi/ml) was detected. All samples indicated short-lived beta-gamma and alpha activities which is indicative of radon and its daughters.

- Post-drill and site release surveys indicated no change in radiation/contamination levels.

The following radioactive materials were transferred by CNSI during field activities.

Safety Light Corporation	(41) 55 gal drums of drilling waste	0.305144 mCi
CNSI Environmental Lab	(6) packages of soil samples *	0.02609 mCi
	Total	0.331234 mCi

* Soil samples to be returned to Safety Light Corporation for disposal after analyses by CNSI and Teledyne are completed.

In addition to routine and conditional radiological surveys, precautionary radiological surveys were conducted for personnel safety in and around existing monitoring wells and at the CNSI drill sites. Assessment of surficial contamination was not included in the scope of work; however, limited precautionary radiological surveys were conducted immediately around work areas for personnel protection and contamination control. Readings were taken with a 2 inch x 2 inch NaI low energy gamma detector and are described as follows using SLC monitoring wells for reference:

- Monitor well #2 - marsh area SW, approximately 30 feet wide and 50 feet long, 6 to 10 times background.

- Monitor well #5 - localized "hot spot" covered with herculite sheet, plywood, and clean fill (allowed vehicles passage to work area on west side). Yellow/white powder (phosphorous) uncovered at site (sample given to NRC Region I). Discussed with Safety Light personnel and believed to be buried radium rope - 100 times background.

- Monitor well #6 - general area leading to "hot spot" at #5, approximately 5 feet wide and 20 feet long, 20 times background.

- Monitor well #12 - general area near on-site burial location south of monitor well along fence, 10-15 times background.

- Monitor well #14 - at old concrete pad (old garage) approximately 200 feet south of well, 10-15 times background.

- Monitor well #18 - along south fence line various isolated "hot spots" in area 10 feet wide and 50 feet long, 10-25 times background.

- Monitor well #19 - area of tank discharge line has increasing radiation levels with depth and some isolated "hot spots" on surface, 3-10 times background.

- Monitor well #23 - depression around well, 10-15 times background and open disposal pit 10 feet west of well, 20-50 times background.

- Drainage ditch near monitor well #5 - Discharge from Safety Light property to Susquehanna River, contains numerous underwater "hot spots" which vary 50-100 times background.

CONCLUSIONS

Previous investigations suggested the normal southerly flow of groundwater may be diverted laterally (east/west) by the abandoned canal. Radiological and hydrogeological data collected and evaluated during this study indicates groundwater flow is in a southerly direction toward the Susquehanna River. There is no strong evidence to support lateral flow along the abandoned canal.

In addition, it has been suggested that H-3 might be associated with the abandoned canal and buried sources; however, this investigation indicates the source and distribution of H-3 within the study area is associated with present and past atmospheric releases due to site operations.

Other conclusions related to this study are as follows;

1. The hydrogeological characteristics of the study area, including the stratigraphic units and groundwater flow patterns, appear to be typical for this region. No detrimental features were observed that might influence groundwater flow patterns.

2. Groundwater flow appears to move from the northern portion of the study area southward toward the Susquehanna River. Groundwater flow is primarily controlled by topographic expression of the land surface and appears typical for this area.

3. Elevated H-3 was detected in soil, groundwater, and rainwater. The highest concentrations of H-3 were detected in soil and groundwater in the southeastern quadrant of the study area and appears to be related to atmospheric sources (present site operations).

4. Sr-90 was detected in both soil and groundwater. This study and previous investigations indicate the major source of the groundwater contamination is from the buried silos located within the south-central portion of the Safety Light facility. Low concentrations of Sr-90 were detected at drill sites located along the southeastern and southwestern portions of the study area and may be attributed to residual Sr-90 contamination along the canal when it was open or the placement of contaminated fill when the canal was abandoned. Sr-90 migration, via groundwater movement along the east/west abandoned canal, is not suspected.

5. Cs-137, Ra-226, and Ra-228 was detected in soil at low concentrations. Drill sites were biased away from known or observed elevated levels of surficial radiological contamination. In addition, previous investigations and

current observations indicate widespread and elevated levels of surficial radiological contamination primarily within the southern portion of the study area.

6. The abandoned canal, located in the southern portion of the study area, does not appear to be a potential pathway for the eastward migration of contaminated groundwater away from the Safety Light facility. The characteristics of the abandoned canal within the boundaries of the Safety Light facility, were not addressed during this study, however, previous investigations indicate the abandoned canal may be a source of radioactive contamination.

7. Radioactive contaminated soil and groundwater was detected in areas outside the boundaries of the Safety Light facility. Due to the limited nature of this project, additional environmental monitoring and site characterization will be necessary to fully address the issue raised during this investigation. These additional studies could be performed as part of remedial action efforts or independently.

REFERENCES

ASTM, 1986, Annual Book of ASTM Standards "Soil and Rock; Building Stones", Volume 04.08, Section 4.

CNSI Procedure, FS-AD-005, "Field Project Administration and Control."

CNSI Procedure, CN-AD-020, "Chem-Nuclear Health Physics Policy Manual."

CNSI Procedure, CN-SF-020, "Minimum Industrial Safety Standards for CNSI."

CNSI Procedure, FS-RP-001, "Radiological Controls Procedure for Field Projects."

CNSI Procedure, FS-RP-002, "Portable Instrumentation/Survey Record Procedure for Field Projects."

CNSI Procedure, FS-RP-012, "Radiation Work Permits Application and Use."

CNSI Procedure, FS-RP-015, "Release of Vehicles and Equipment/Materials for Unrestricted Use."

CNSI Procedure, RA-AD-001, "Required Notifications and Reports Following an Emergency."

CNSI Procedure, RA-OP-001, "Operating Procedure for Brokering of Radioactive Materials at Commercial Facilities."

CNSI Procedure, S20-AD-013, "General Laboratory Procedures."

CNSI Procedure, QA-AD-001, "Quality Assurance Program."

Code of Federal Regulations, 29CFR1910.120, "Hazardous Waste Operations and Emergency Response."

Environmental Protection Agency, 1977, Handbook for Analytical Quality Control in Radioanalytical Laboratories, EPA-600, 17-77-088.

Environmental Protection Agency, 1980, Prescribed Procedures for Measurement of Radioactivity in Drinking Water, EPA-600/4-80-032.

Environmental Protection Agency, 1984, EPA Radiochemistry Procedures Manual, EPA-520/5-84-006.

Kahn, B., 1990, Analysis of 228Ra and 226Ra in Public Water Supplies by a Gamma-Ray Spectrometer, Health Physics Volume 59, No. 1, pp. 125-131.

REFERENCES: (continued)

Meiser & Earl, 1979, "Hydrogeologic Investigation of Alluvial Ground-Water System", U.S. Radium Corporation, Bloomsburg, Pa.

National Council on Radiation Protection and Measurements Report, 1976, "Environmental Radiation Measurements", No. 50.

National Council on Radiation Protection and Measurements Reports, 1985 Second Edition, "A Handbook of Radioactivity Measurements Procedures", No. 58.

NRC, 1990, "Partial Interim Settlement Agreement Between USR Industries and The NRC Staff."

Oak Ridge Associated Universities, 1982, Final Report, "Environmental Survey of the Safety Light Corporation, Bloomsburg, Pennsylvania".

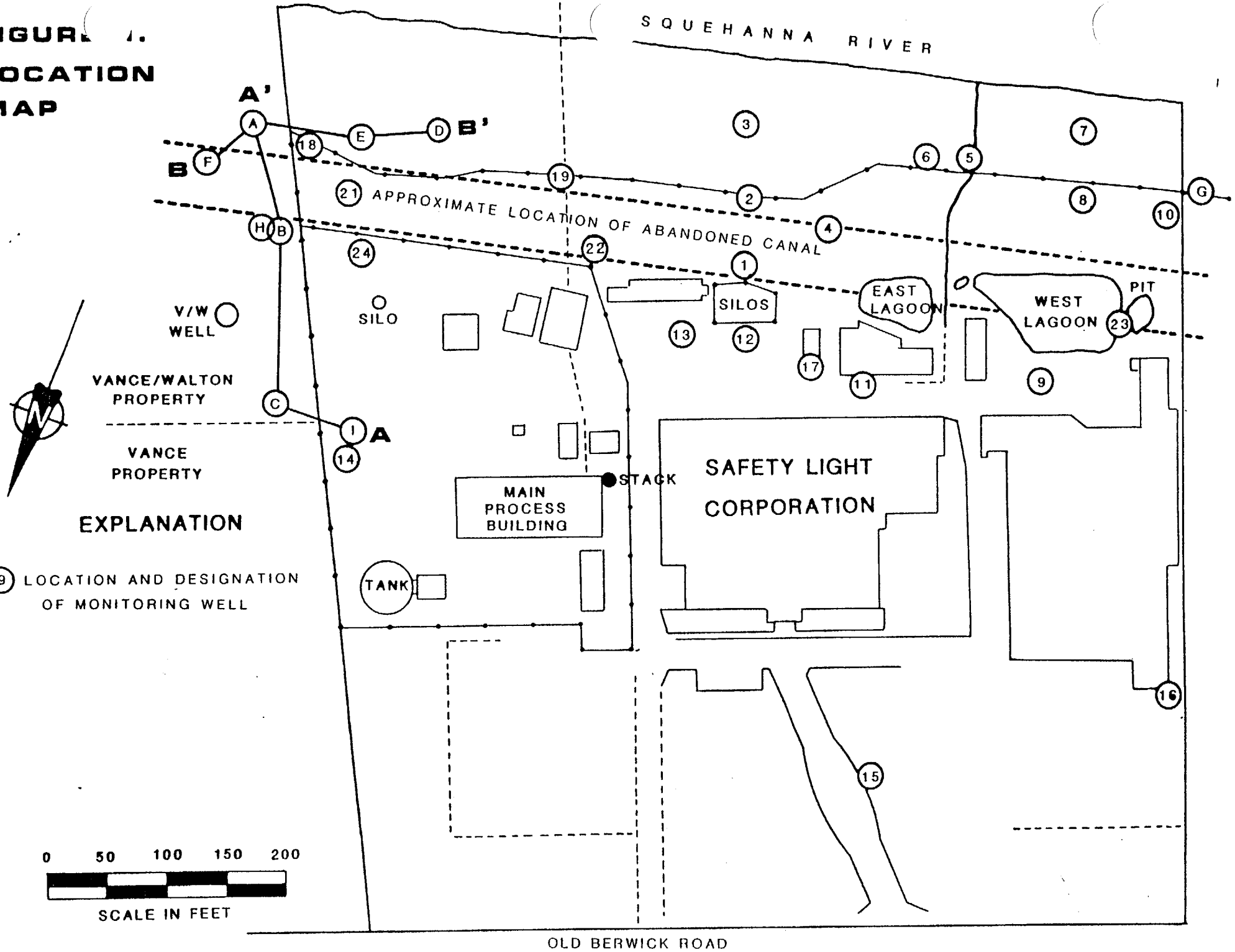
Radiation Management Corporation, 1979, "Radiological Investigation of the Grounds and Ground Water", U.S. Radium Corporation, Bloomsburg, Pennsylvania.

Pennsylvania Power & Light Company, 1978, "Susquehanna Steam Electric Station, Environmental Report Operating License Stage", Volume 2.

US Atomic Energy Commission,, 1974, Regulatory Guide 1.86, "Termination of Operating Licenses for Nuclear Reactors."

US Nuclear Regulatory Commission, 1988, "Environmental Evaluation of the Safety Light Corporation Site, Bloomsburg, Pennsylvania."

FIGURE 1.
LOCATION MAP



FIGU 2.
H-3 I
GROUNDWATER
JUNE/JULY
1990

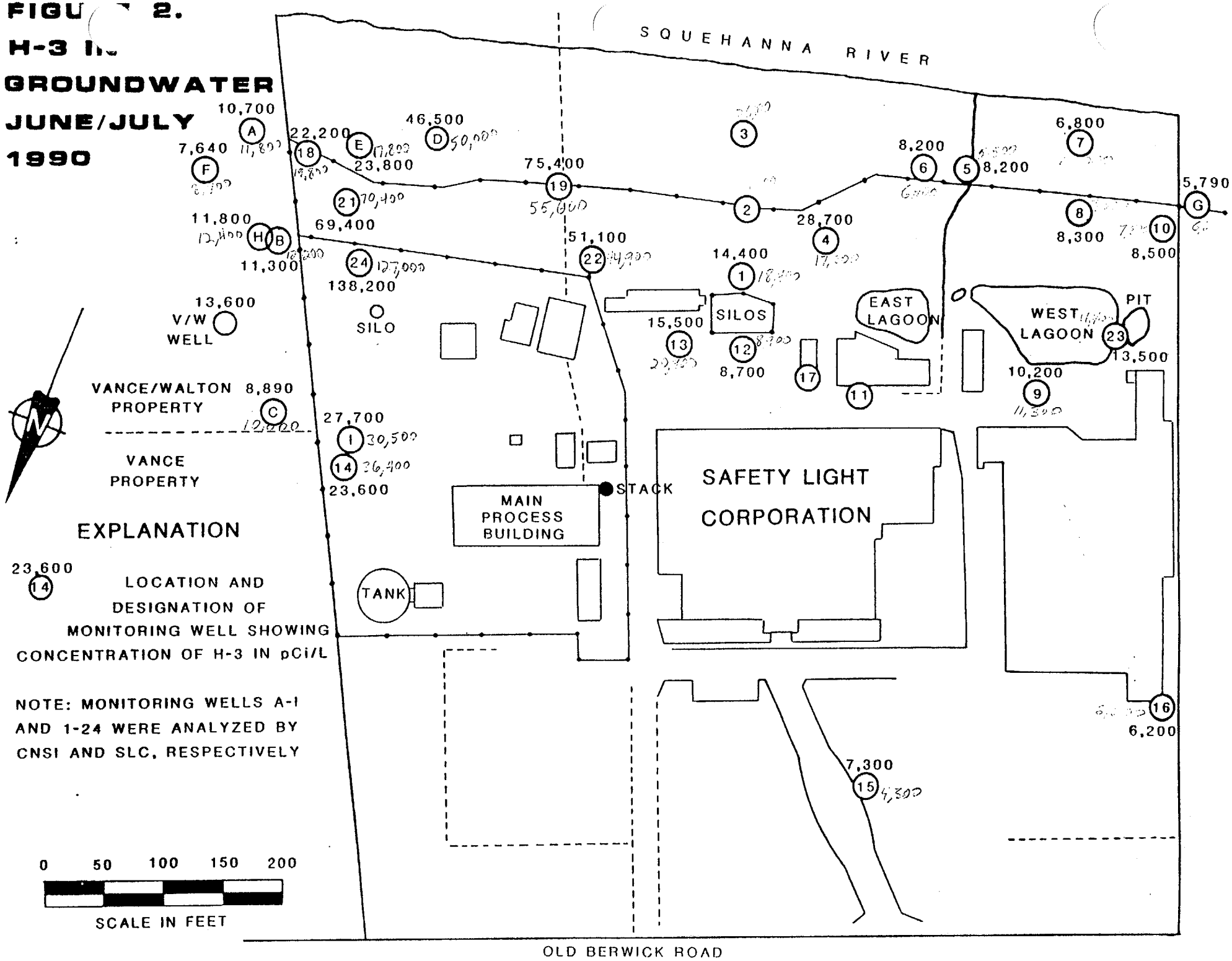
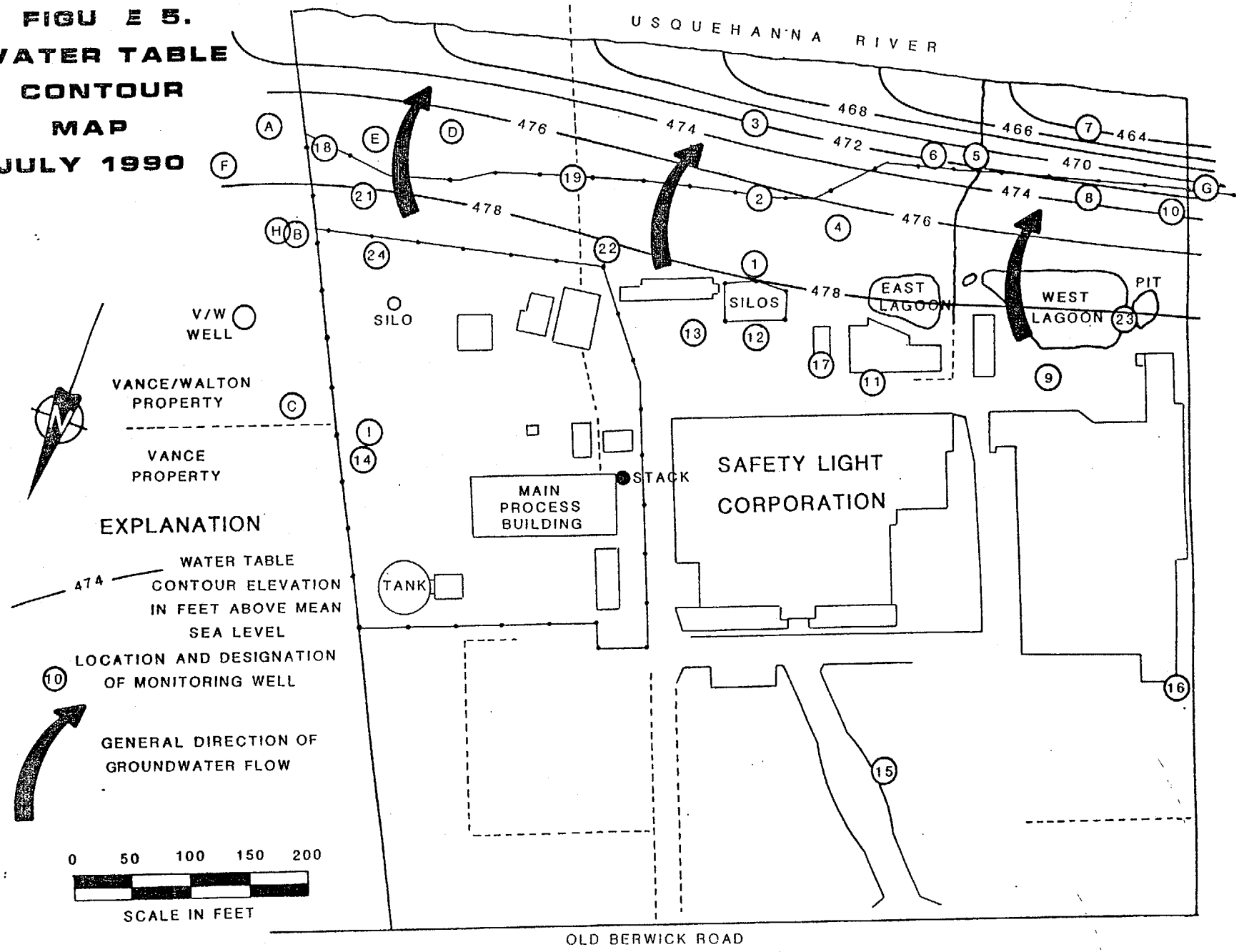


FIGURE 5. WATER TABLE CONTOUR MAP JULY 1990



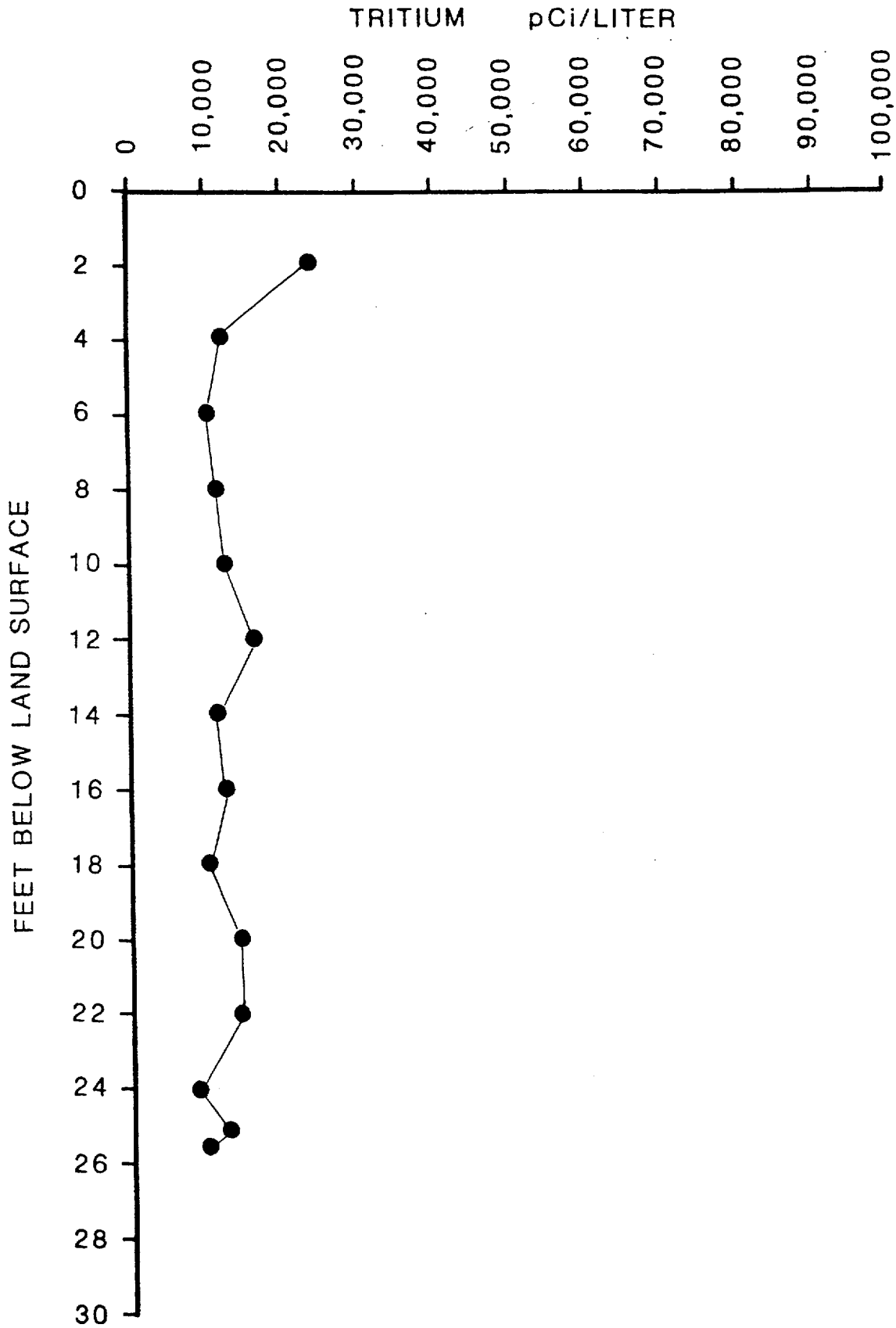


FIGURE 6. DRILL SITE A: H-3 IN SOIL

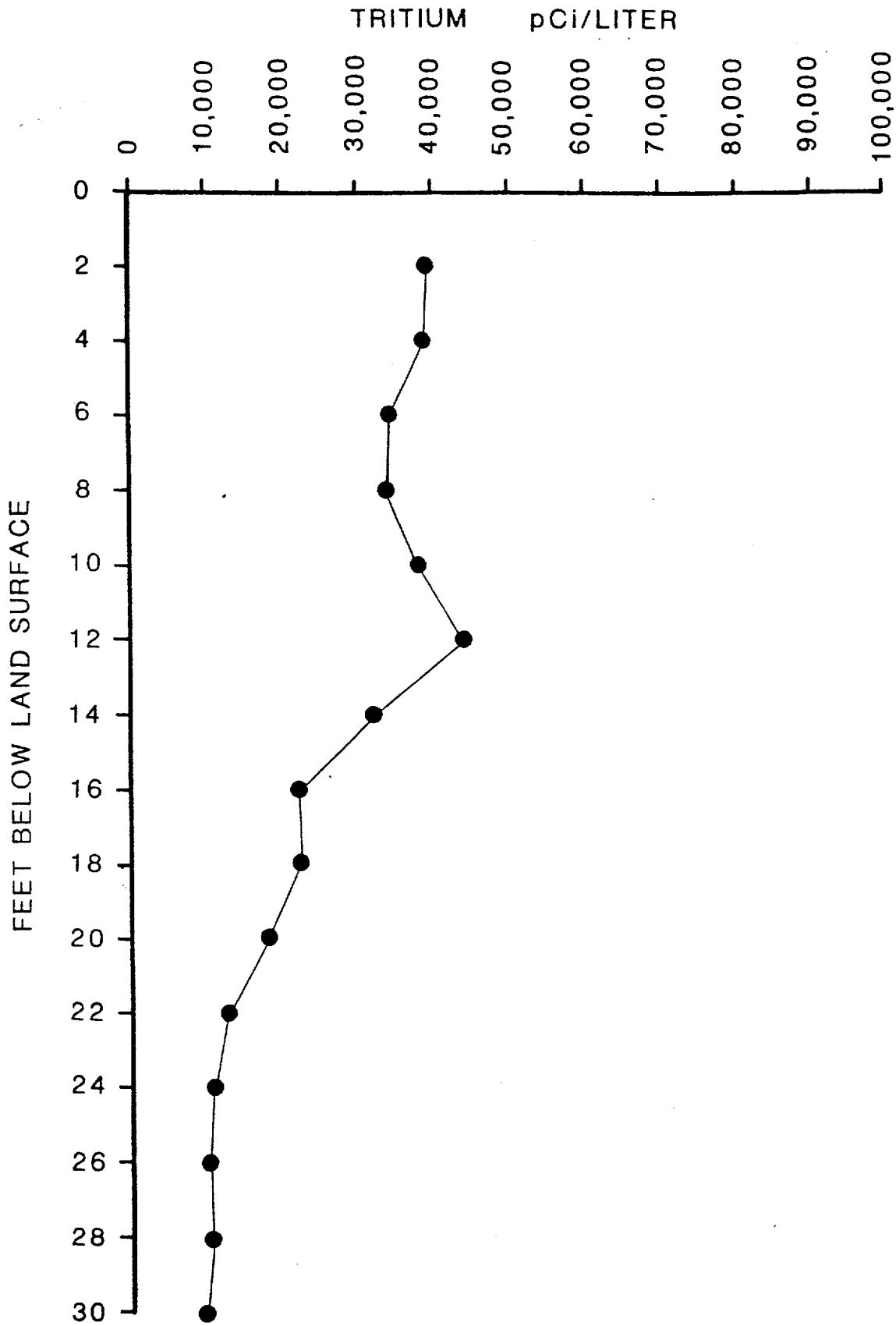


FIGURE 7. DRILL SITE B: H-3 IN SOIL

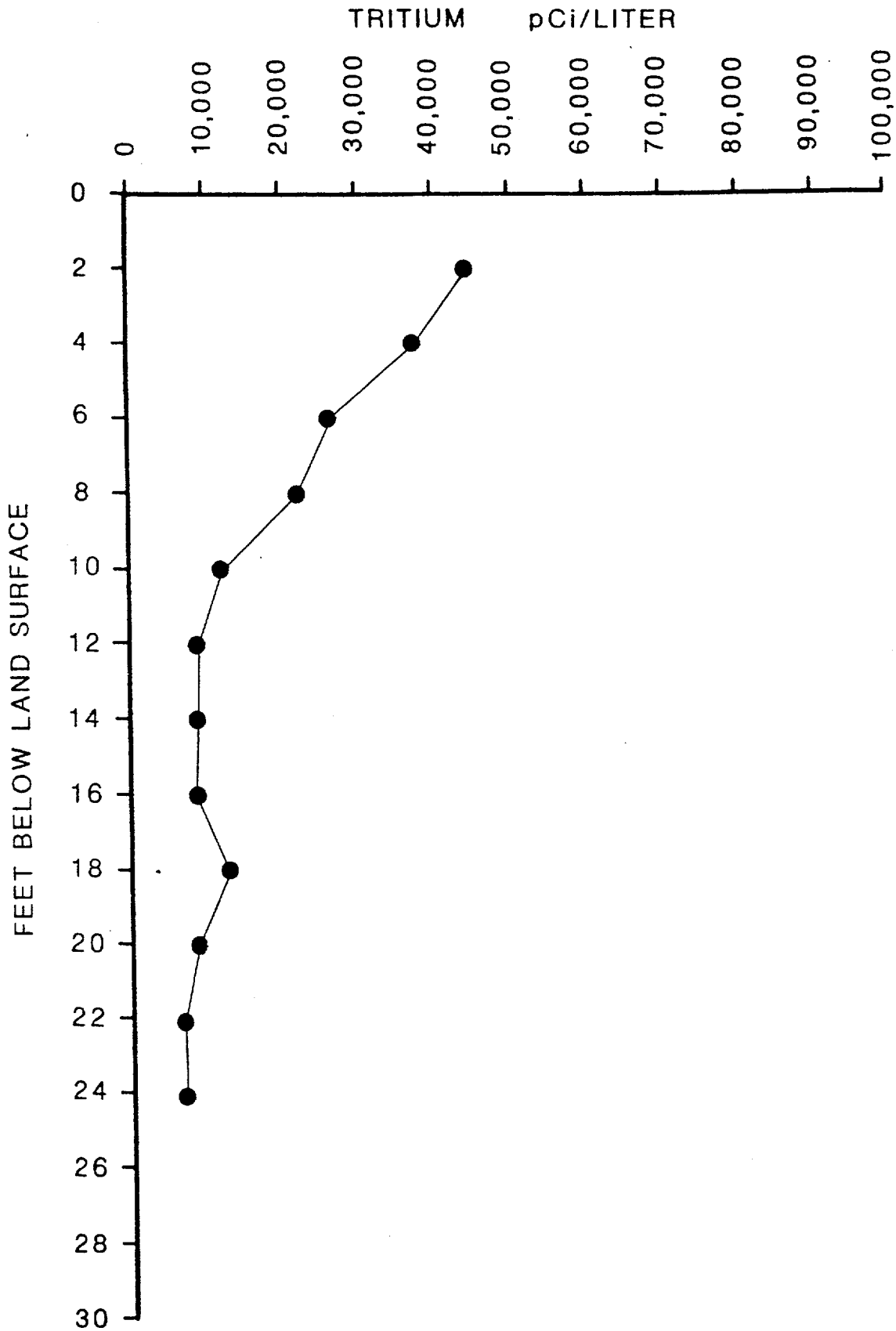


FIGURE 8. DRILL SITE C: H-3 IN SOIL

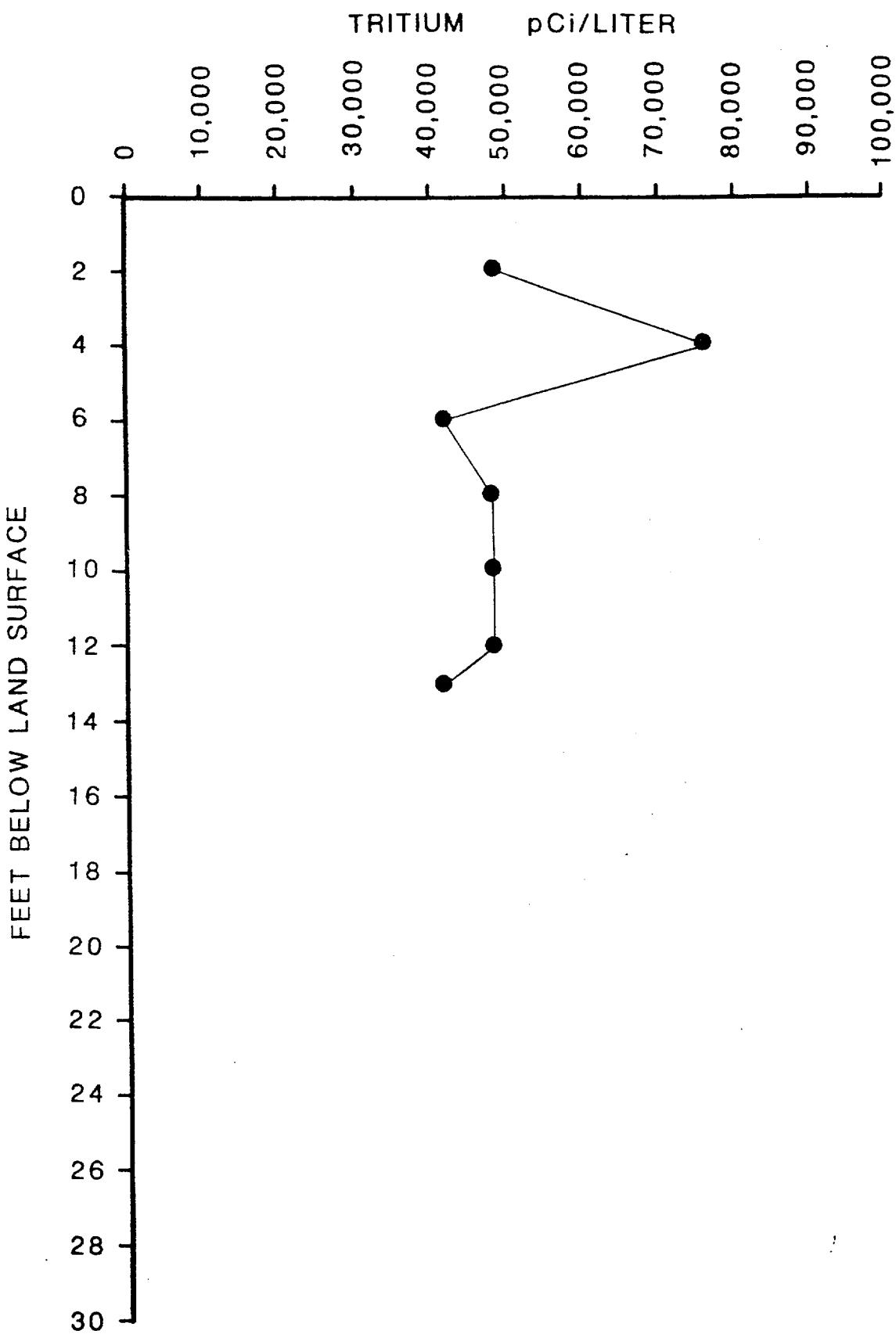


FIGURE 9. DRILL SITE D: H-3 IN SOIL

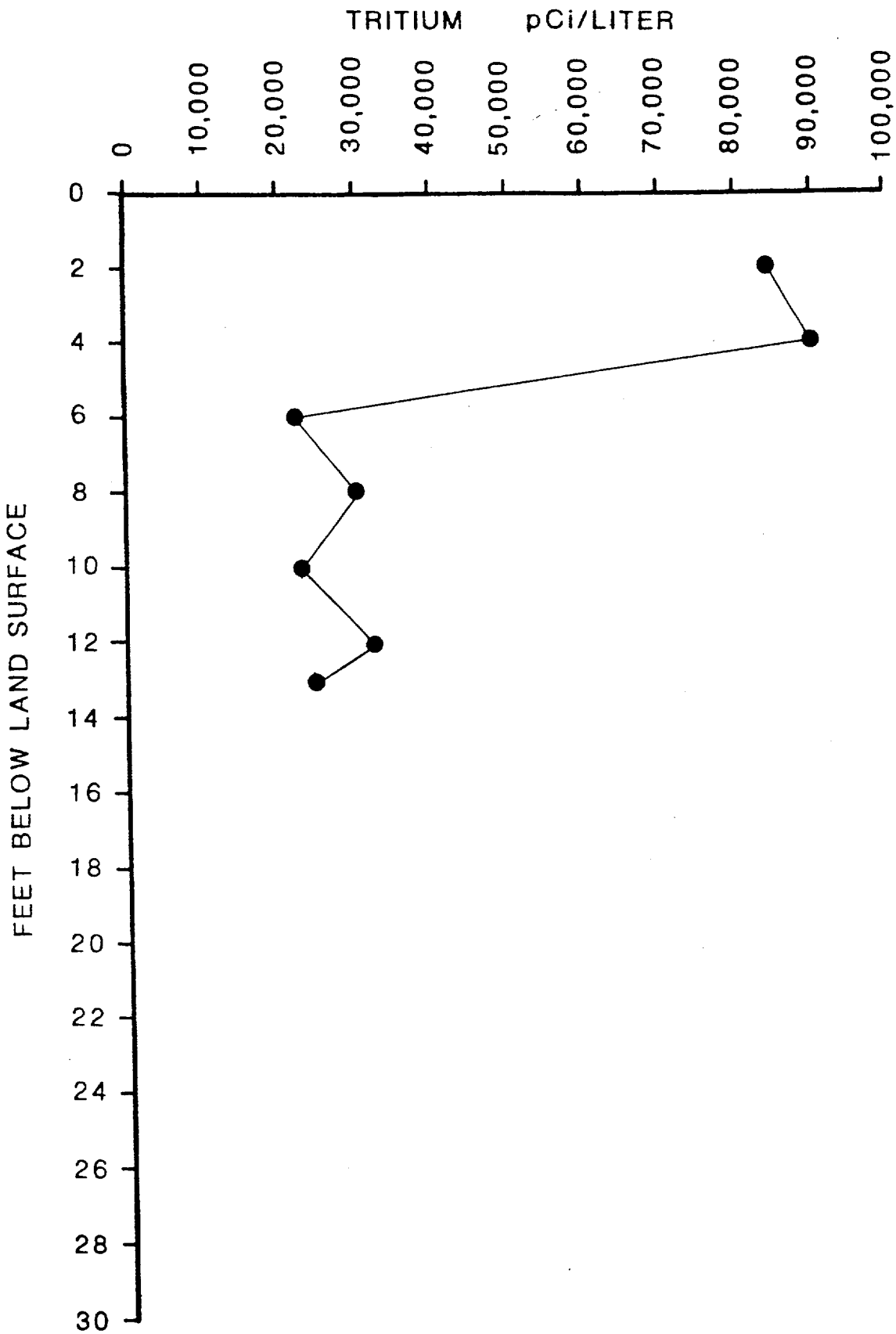


FIGURE 10. DRILL SITE E: H-3 IN SOIL

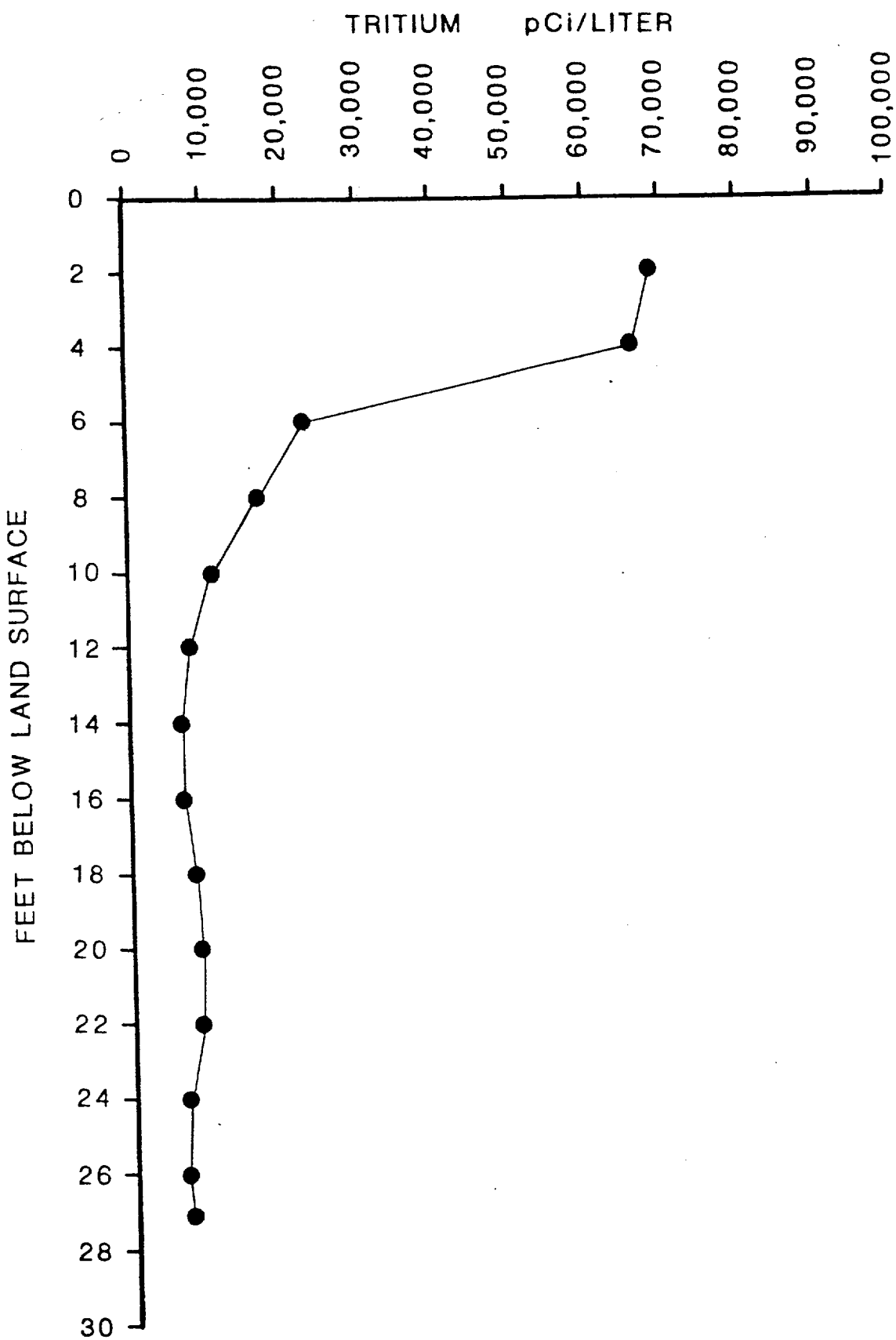


FIGURE 11. DRILL SITE F: H-3 IN SOIL

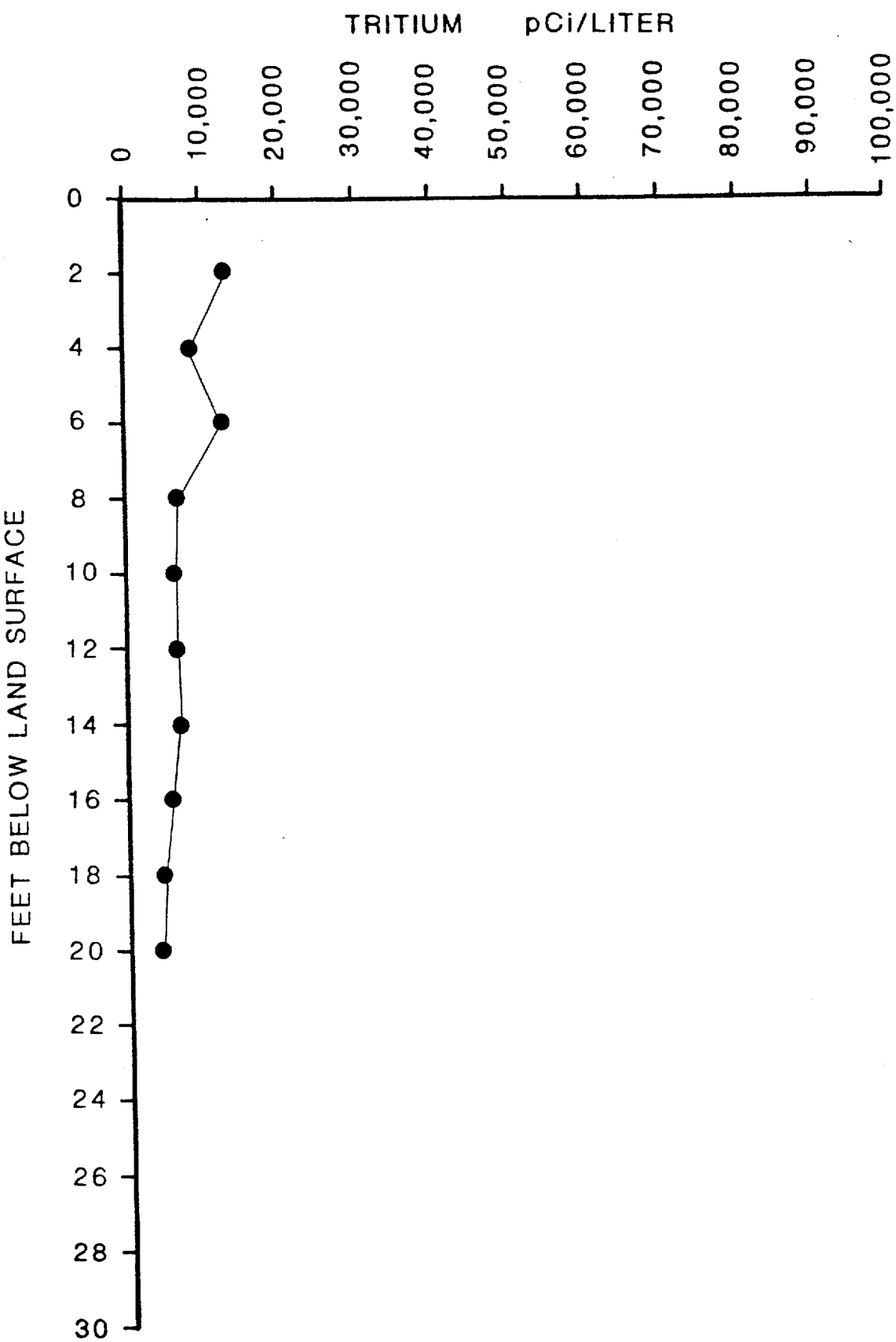


FIGURE 12. DRILL SITE G: H-3 IN SOIL

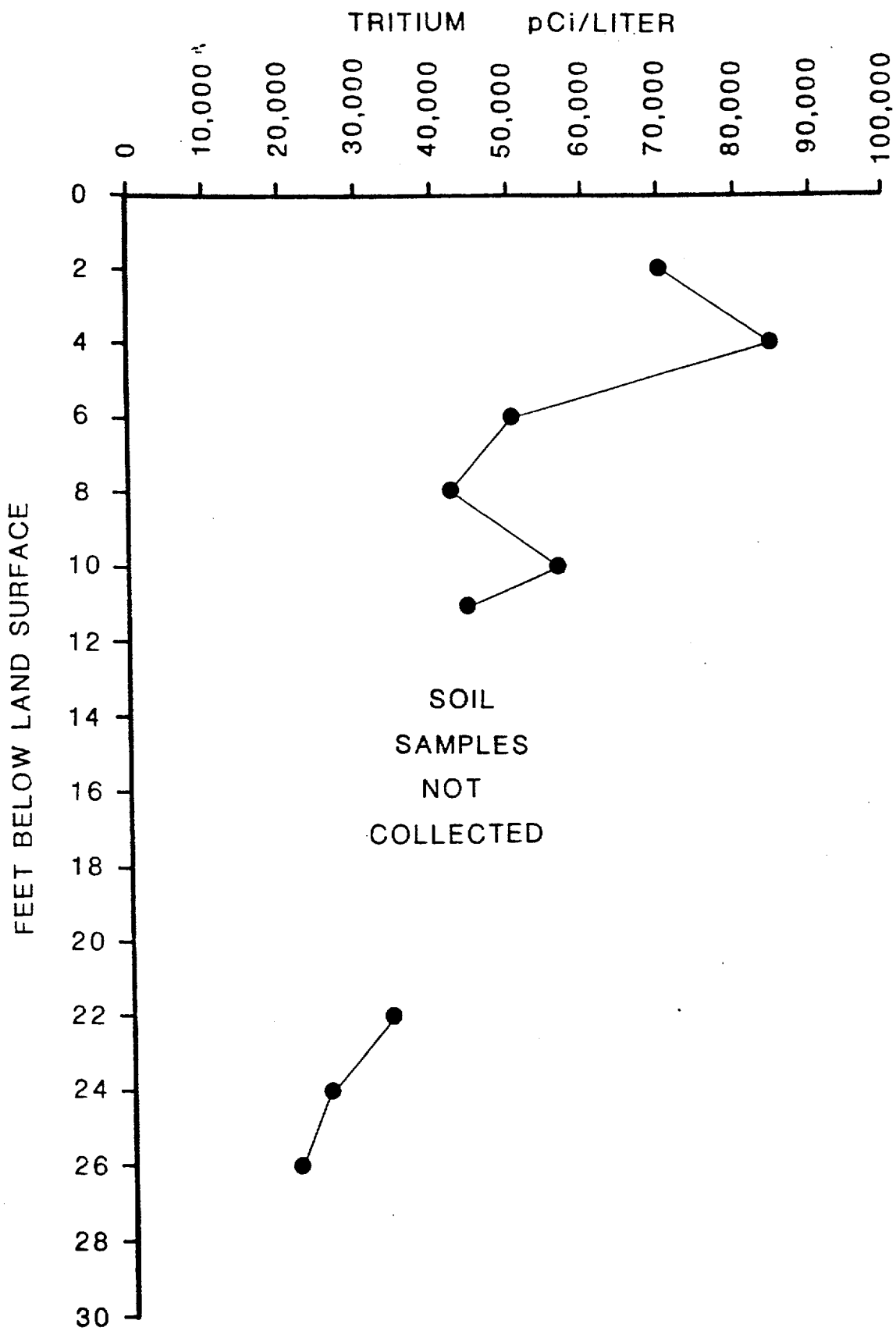


FIGURE 13. DRILL SITE I: H-3 IN SOIL

FIGURE 14.
H-3 IN RAINWATER
7-12-90

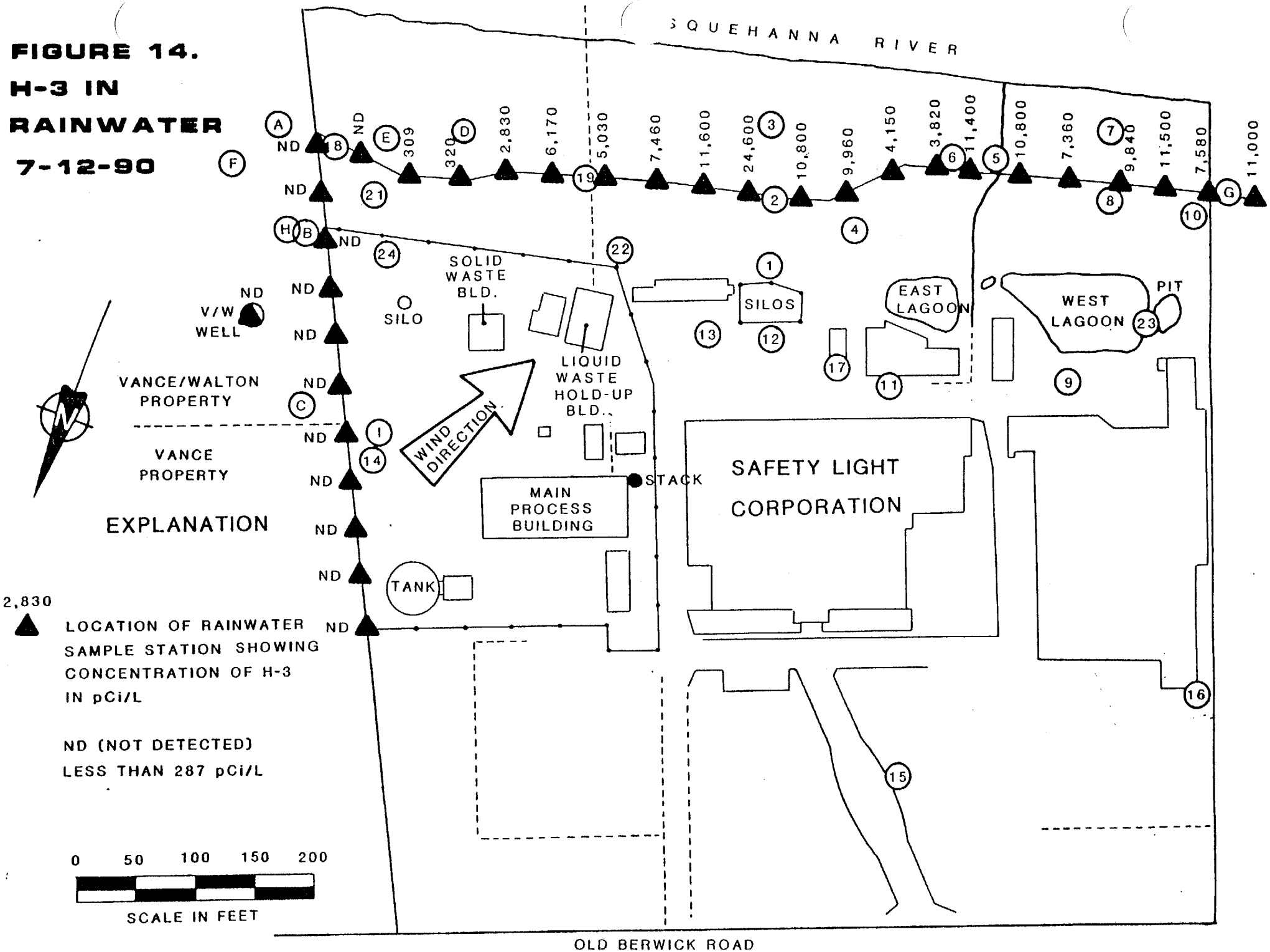
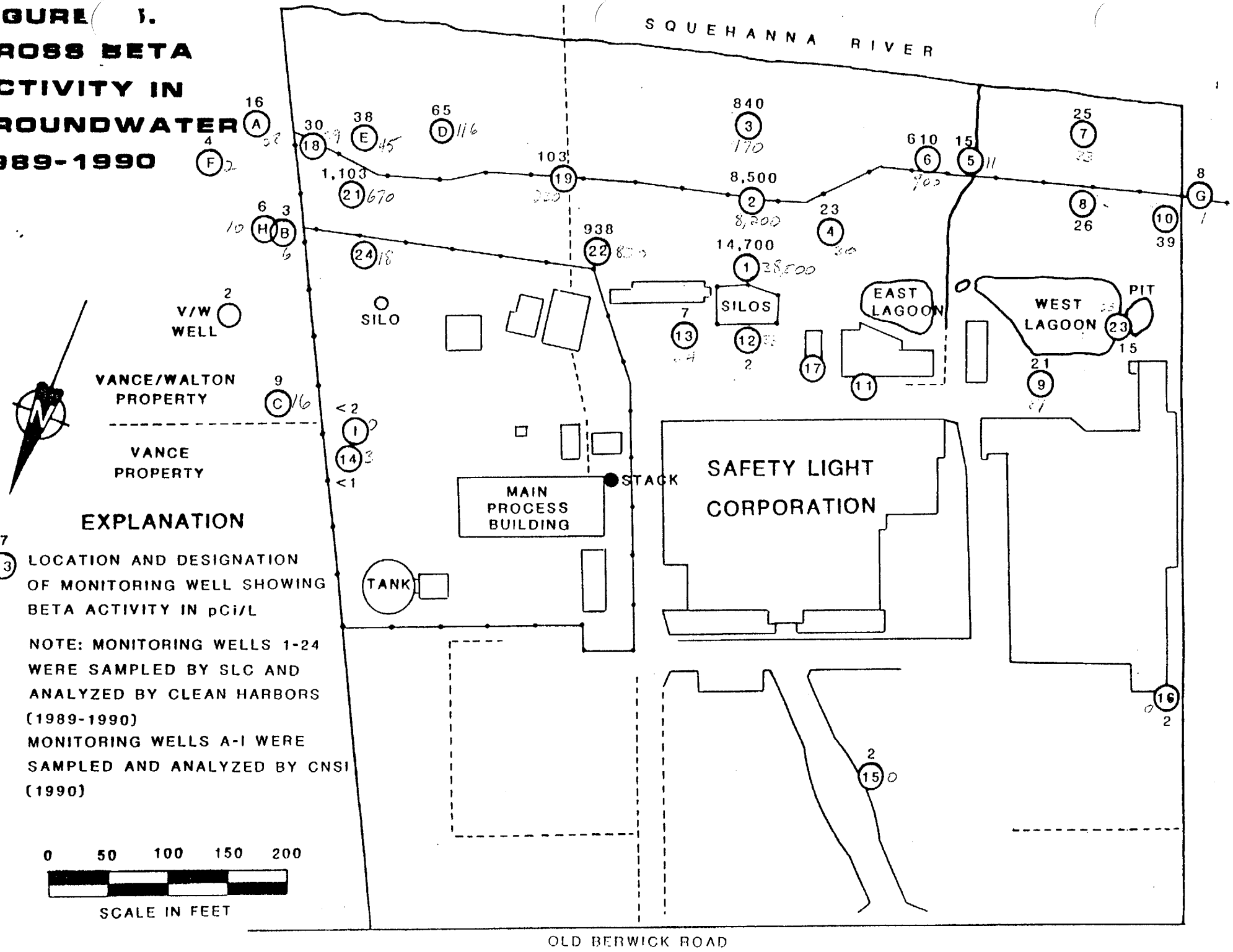


FIGURE 1. GROSS BETA ACTIVITY IN GROUNDWATER 1989-1990



FIGU 16.
SR-90 IN
GROUNDWATER
CONTOUR
MAP
JULY 1990

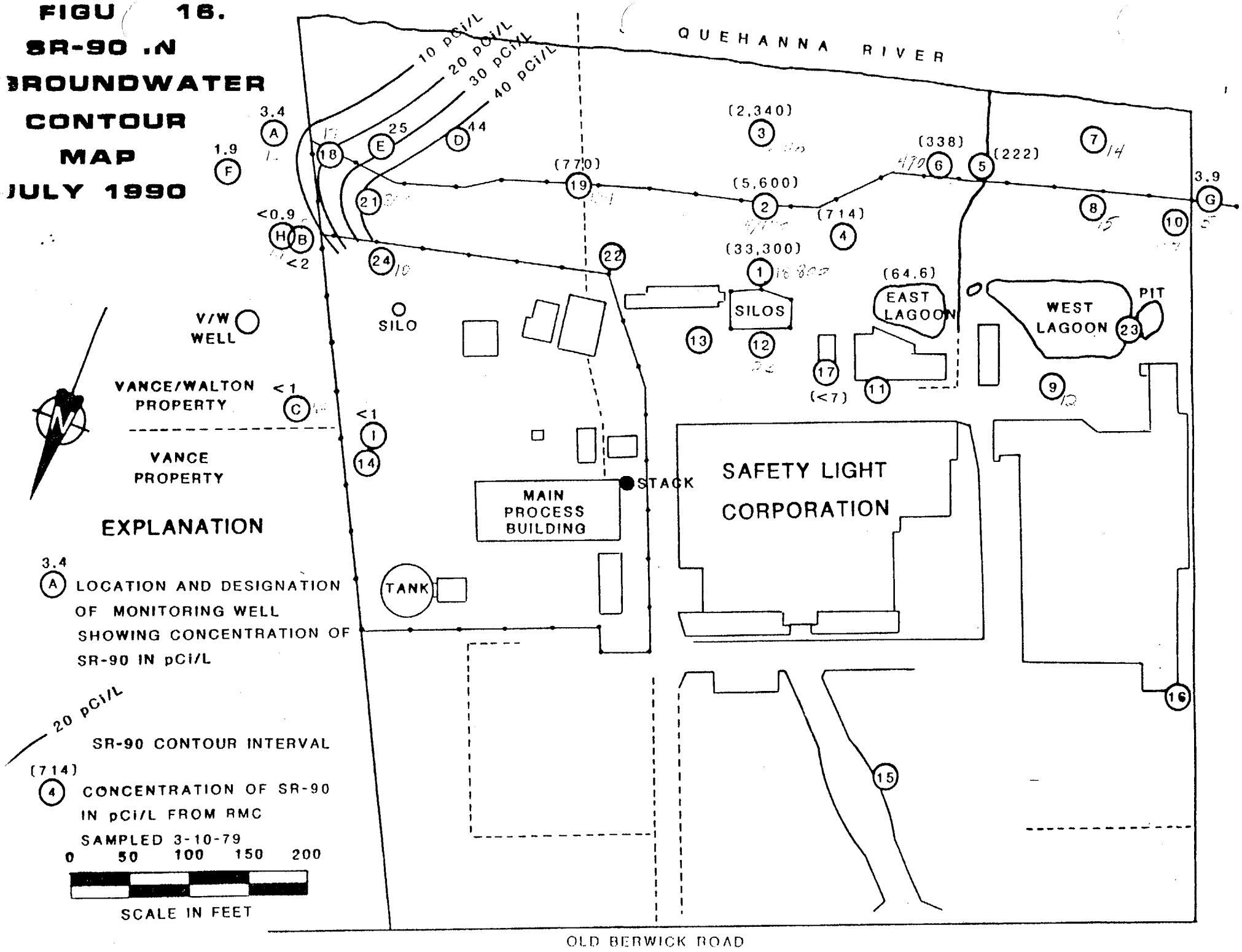


TABLE 1

Analytical Methods

Media and Analysis	Analytical Method	Instrumentation
H-3 in groundwater	CNSI H-01	Liquid Scintillation Counter
H-3 in soil and groundwater	CNSI H-02	Liquid Scintillation Counter
Sr-90 in water	TI PR-032-16	Low Background Alpha/Beta Counter
Sr-90 in soil	TI PR-032-25	Low Background Alpha/Beta Counter
Gamma Spectroscopy (Cs-137) in water	CNSI GI-08	HPGe Spectroscopy
Gamma Spectroscopy (Cs-137) in soil	CNSI GI-05	HPGe Spectroscopy
Gross alpha/beta in groundwater	CNSI GA-05	Gas-Flow Proportional Counter

TABLE 2

Sample Media/MDA's

Media and Analysis	Required Sample Size	Minimum Detectable Amount (MDA)	Analytical Laboratory
H-3 in groundwater	.05 liter	300 pCi/liter	CNSI
Sr-90 in groundwater	1.00 liter	5 pCi/liter	Teledyne Isotopes
H-3 in soil	100 grams	300 pCi/liter*	CNSI
Sr-90 in soil	200 grams	0.1 pCi/gm-dry	Teledyne Isotopes
Gamma Spectroscopy (Cs-137) in groundwater	2.00 liters	5 pCi/liter	CNSI
Gamma Spectroscopy in soil	150 grams		CNSI
Cs-137		0.2 pCi/gm-dry	
Ra-226		0.4 pCi/gm-dry	
Ra-228		1.0 pCi/gm-dry	
Gross alpha in groundwater	0.250 liters	1 pCi/liter	CNSI
Gross beta in groundwater	0.250 liters	2 pCi/liter	CNSI

* Water extracted from soil

TABLE 3

H-3 CONCENTRATIONS IN GROUNDWATER

MONITORING WELL NO.	(A) CNSI/SLC 1990 H-3 (pCi/L.)	(B) ORAU 1981 H-3 (pCi/L.)	(A-B) CHANGE (pCi/L.)
1	*14,400	7,140	+7,260
4	28,700	13,500	+15,200
5	*8,200	4,690	+3,510
6	8,200	4,490	+3,710
7	6,800	5,920	+880
8	8,300	3,470	+4,830
9	10,200	11,000	-800
10	8,500	6,120	+2,380
12	8,700	3,670	+5,030
13	15,500	6,530	+8,970
14	23,600	5,920	+17,680
15	7,300	820	+6,480
16	6,200	1020	+5,180
18	22,200	3,670	+18,530
19	75,400	8,980	+66,420
21	69,400	72,200	-2,800
22	*51,100	20,600	+30,500
23	13,500	9,180	+4,320
24	138,200	6,120	+132,080
VANCE WALTON	13,600	NA	———

* Liquid Scintillation results (counts/minute on channel 3) indicate other radioisotopes other than H-3 may be present.

TABLE

OBSERVATION MADE AT THE SLC MONITORING WELLS

Well Designation	Well Cap Missing	Protective Casing Missing	Damaged Casing	Surface Depression Around Well	Visible Oil in Water	Well Screen at Surface
1						
2			X			
3	X	X	X			
4			X			
5	X		X			
6	X	X				
7	X	X				
8	X	X	X	X		X
9						
10			X			X
11					X	
12					X	
13					X	
14						
15						
16						
17						
18						
19						
20	ABANDONED (DESTROYED)					
21	X	X		X		
22	X	X				
23		X		X		
24	X	X				

TABLE 5

SAFETY LIGHT PROJECT SAMPLE RESULTS SUMMARY
H-3 IN SOIL

TEST HOLE/ DESCRIPTION	SAMPLE DEPTH	ANALYTICAL RESULTS (pCi/L)
A - SOIL	0 - 2'	24300
A1 - SOIL	2 - 4'	12800
A1 - SOIL	4 - 6'	11100
A1 - SOIL	6 - 8'	12100
A1 - SOIL	8 - 10'	13200
A - SOIL	10 - 12'	17700
A - SOIL	12 - 14'	12000
A - SOIL	14 - 16'	12700
A - SOIL	16 - 18'	10800
A - SOIL	18 - 20'	14500
A - SOIL	20 - 22'	15200
A - SOIL	22 - 24'	9640
A - SOIL	24 - 25'	13500
A - SOIL	25 - 25.5'	10800
B - SOIL	0 - 2'	39900
B - SOIL	2 - 4'	39400
B - SOIL	4 - 6'	34800
B - SOIL	6 - 8'	34300
B - SOIL	8 - 10'	38400
B - SOIL	10 - 12'	44300
B - SOIL	12 - 14'	32300
B - SOIL	14 - 16'	22400
B - SOIL	16 - 18'	23200
B - SOIL	18 - 20'	18400
B - SOIL	20 - 22'	13300
B - SOIL	22 - 24'	11400
B - SOIL	24 - 26'	10400
B - SOIL	26 - 28'	10800
B - SOIL	28 - 30'	10200
C - SOIL	0 - 2'	45100
C - SOIL	2 - 4'	38100
C - SOIL	4 - 6'	26800
C - SOIL	6 - 8'	22600
C - SOIL	8 - 10'	12300
C - SOIL	10 - 12'	9590
C - SOIL	12 - 14'	9620
C - SOIL	14 - 16'	9470
C - SOIL	16 - 18'	13400
C - SOIL	18 - 20'	9960
C - SOIL	20 - 22'	7540
C - SOIL	22 - 24'	7670

TABLE 5

SAFETY LIGHT PROJECT SAMPLE RESULTS SUMMARY
H-3 IN SOIL

TEST HOLE/ DESCRIPTION	SAMPLE DEPTH	ANALYTICAL RESULTS (pCi/L)
D - SOIL	0 - 2'	49600
D - SOIL	2 - 4'	76700
D - SOIL	4 - 6'	42300
D - SOIL	6 - 8'	49100
D - SOIL	8 - 10'	49400
D - SOIL	10 - 12'	49500
D - SOIL	12 - 13'	42400
E - SOIL	0 - 2'	84200
E - SOIL	2 - 4'	90100
E - SOIL	4 - 6'	22500
E - SOIL	6 - 8'	30100
E - SOIL	8 - 10'	23300
E - SOIL	10 - 12'	32900
E - SOIL	12 - 13'	24700
F - SOIL	0 - 2'	69600
F - SOIL	2 - 4'	66300
F - SOIL	4 - 6'	23700
F - SOIL	6 - 8'	17600
F - SOIL	8 - 10'	11300
F - SOIL	10 - 12'	7960
F - SOIL	12 - 14'	7130
F - SOIL	14 - 16'	7530
F - SOIL	16 - 18'	8150
F - SOIL	18 - 20'	9380
F - SOIL	20 - 22'	9010
F - SOIL	22 - 24'	7640
F - SOIL	24 - 26'	7620
F - SOIL	26 - 27'	7800
F - SOIL	26.8-27.0'	7940
G - SOIL	0 - 2'	13800
G - SOIL	2 - 4'	8700
G - SOIL	4 - 6'	11300
G - SOIL	6 - 8'	7560
G - SOIL	8 - 10'	6720
G - SOIL	10 - 12'	7100
G - SOIL	12 - 14'	7810
G - SOIL	14 - 16'	6180
G - SOIL	16 - 18'	5330
G - SOIL	18 - 20'	4600
G - SOIL	19.8-20.0'	4640

TABLE 5

SAFETY LIGHT PROJECT SAMPLE RESULTS SUMMARY
H-3 IN SOIL

TEST HOLE/ DESCRIPTION	SAMPLE DEPTH	ANALYTICAL RESULTS (pCi/L)
I - SOIL	0 - 2'	70500
I - SOIL	2 - 4'	85700
I - SOIL	4 - 6'	51200
I - SOIL	6 - 8'	42700
I - SOIL	8 - 10'	57200
I - SOIL	10 - 11'	45000
I - SOIL	12 - 14'	* RESULTS NOT AVAILABLE
I - SOIL	20 - 22'	34700
I - SOIL	22 - 24'	26400
I - SOIL	24 - 26'	22500

* INSUFFICIENT SOIL FOR ANALYSIS; SAMPLE CONSISTED OF ROCKS.

TABLE 6

SAFETY LIGHT PROJECT SAMPLE RESULTS SUMMARY
CS-137,SR-90,RA-226, AND RA-228 IN SOIL

TEST HOLE / SAMPLE DEPTH	---- ANALYTICAL RESULTS (pCi/gm - dry wt) ---- SR-90	CS-137	RA-226	RA-228
A 0 - 2'	0.70	2.57	1.11	1.44
A1 2 - 4'	0.45	<0.09	0.97	1.31
A1 4 - 6'	0.89	<0.06	0.83	0.96
A1 6 - 10'	0.78	<0.09	0.70	1.19
A 10 - 16'	0.78	0.07	0.53	1.07
A 16 - 22'	1.3	0.08	0.54	0.85
A 22 - 25.5'	0.22	0.09	0.59	0.70
B 0 - 2'	<0.03	<0.10	0.98	1.07
B 2 - 4'	<0.03	<0.11	0.66	0.82
B 4 - 6'	<0.05	<0.06	0.69	0.96
B 6 - 8'	<0.04	<0.07	0.79	1.04
B 8 - 12'	<0.04	<0.08	0.70	1.11
B 12 - 16'	0.17	<0.09	0.57	0.98
B 16 - 20'	<0.50	<0.09	0.54	0.86
B 20 - 22'	<0.20	<0.11	0.46	0.95
B 22 - 24'	0.17	<0.08	0.55	0.94
B 24 - 26'	0.34	<0.09	0.57	0.96
B 26 - 30'	<0.2	<0.05	0.65	0.80
C 0 - 2'	<0.1	0.87	0.83	0.53
C 2 - 6'	<0.05	0.32	0.83	0.80
C 6 - 8'	0.14	<0.11	0.67	0.63
C 8 - 10'	<0.04	<0.08	0.72	0.64
C 10 - 12'	<0.06	<0.08	0.71	0.95
C 12 - 14'	<0.07	<0.06	0.55	0.86
C 14 - 18'	<0.08	<0.09	0.70	0.51
C 18 - 20'	<0.09	<0.09	0.61	0.69
C 20 - 22'	<0.07	<0.07	0.54	0.68
C 22 - 24'	<0.1	<0.07	0.53	0.72
D 0 - 2'	0.51	<0.09	0.75	0.91
D 2 - 4'	0.74	0.46	0.96	0.96
D 4 - 6'	0.33	<0.06	0.99	1.43
D 6 - 8'	0.37	0.10	0.82	1.02
D 8 - 10'	1.0	0.08	0.72	1.35
D 10 - 12'	1.3	<0.06	0.58	0.67
D 12 - 13'	1.7	<0.06	0.67	1.35
E 0 - 4'	0.45	1.32	0.83	1.00
E 4 - 6'	0.85	0.05	0.84	1.14
E 6 - 8'	1.2	0.39	0.74	1.32
E 8 - 10'	1.4	0.15	0.89	1.34
E 10 - 13'	0.94	0.09	0.79	1.24

TABLE 6

SAFETY LIGHT PROJECT SAMPLE RESULTS SUMMARY
CS-137,SR-90,RA-226, AND RA-228 IN SOIL

TEST HOLE / SAMPLE DEPTH	---- ANALYTICAL RESULTS (pCi/gm - dry wt) ---- SR-90	CS-137	RA-226	RA-228
F 0 - 6'	0.68	1.45	0.87	1.17
F 6 - 10'	2.2	0.46	0.55	0.56
F 10 - 12'	0.19	<0.08	0.39	0.81
F 12 - 14'	<0.07	<0.08	0.38	0.60
F 14 - 16'	0.12	<0.06	0.48	0.60
F 16 - 18'	0.11	<0.07	0.48	0.91
F 18 - 20'	0.22	<0.07	0.53	0.77
F 20 - 22'	0.14	<0.07	0.38	0.57
F 22 - 24'	0.06	<0.08	0.38	0.58
F 24 - 26'	0.06	<0.04	0.46	0.48
F 26 - 27'	0.07	<0.05	0.41	0.73
G 0 - 2'	0.17	0.47	0.98	1.09
G 2 - 4'	0.34	0.24	1.04	1.42
G 4 - 6'	0.52	0.31	1.74	0.95
G 6 - 8'	0.37	0.16	1.20	0.74
G 8 - 10'	1.9	<0.11	0.76	0.87
G 10 - 12'	0.82	<0.08	1.03	1.20
G 12 - 14'	0.13	<0.07	0.51	0.89
G 14 - 18'	<0.10	<0.07	0.54	0.84
G 18 - 20'	<0.09	<0.07	0.61	0.78
I 0 - 2'	<0.08	0.58	0.86	0.65
I 2 - 4'	0.24	0.25	0.80	0.77
I 4 - 6'	<0.03	<0.06	0.58	1.07
I 6 - 8'	<0.03	<0.05	0.60	0.89
I 8 - 10'	<0.02	<0.07	0.34	1.25
I 10 - 11'	<0.04	<0.08	0.61	1.01
I 20 - 24'	<0.07	0.17	0.49	0.94
I 24 - 26'	<0.02	<0.08	0.70	0.76

TABLE 7

SAFETY LIGHT PROJECT SAMPLE RESULTS SUMMARY
H-3 IN RAINWATER

SAMPLE DESCRIPTION	ANALYTICAL RESULTS (pCi/L)
Test Hole B - RAINWATER	88000
Test Hole C - RAINWATER	51700
Test Hole E - RAINWATER	130000
Test Hole F - RAINWATER	78100
FENCELINE NEAR WELL 14 - RAINWATER	24900

SAMPLE DESCRIPTION *		ANALYTICAL RESULTS (pCi/L)
LOCATION 1	eastern fence line	<287
LOCATION 2	eastern fence line	<287
LOCATION 3	eastern fence line	<287
LOCATION 4	eastern fence line	<287
LOCATION 5	eastern fence line	<287
LOCATION 6	eastern fence line	<287
LOCATION 7	eastern fence line	<287
LOCATION 8	eastern fence line	<287
LOCATION 9	eastern fence line	<287
LOCATION 10	eastern fence line	<287
LOCATION 11	eastern fence line	<287
LOCATION 12	southern fence line	<287
LOCATION 13	southern fence line	309
LOCATION 14	southern fence line	320
LOCATION 15	southern fence line	2830
LOCATION 16	southern fence line	6170
LOCATION 17	southern fence line	5030
LOCATION 18	southern fence line	7460
LOCATION 19	southern fence line	11600
LOCATION 20	southern fence line	24600
LOCATION 21	southern fence line	10800
LOCATION 22	southern fence line	9960
LOCATION 23	southern fence line	4150
LOCATION 24	southern fence line	3820
LOCATION 25	southern fence line	11400
LOCATION 26	southern fence line	10800
LOCATION 27	southern fence line	7360
LOCATION 28	southern fence line	9840
LOCATION 29	southern fence line	11500
LOCATION 30	southern fence line	7580
LOCATION 31	southern fence line	11000
LOCATION 32	Vance/Walton well	<287

* See Figure 14, H-3 in Rainwater, for Sample Locations.

TABLE 8

SAFETY LIGHT PROJECT
GROUNDWATER SAMPLE RESULTS SUMMARY

TEST HOLE	ANALYTICAL RESULTS (pCi/L.)				
	SR-90	CS-137	Gross Alpha	Gross Beta	Tritium
A	3.4	<5.00	<1.14	15.80	10700
B	<2.0	<4.34	<1.39	3.25	11300
C	<1.0	<3.99	<1.94	8.58	8890
D	44.0	<4.63	<1.25	64.70	46500
E	25.0	<4.80	<1.39	38.30	23800
F	1.9	<4.39	<1.56	3.76	7640
G	3.9	<2.52	<1.39	7.62	5790
H	<0.9	<5.21	<1.81	5.59	11800
I	<1.0	<3.34	<0.91	<1.73	27700

APPENDIX A

GROUNDWATER SAMPLING COLLECTION FORMS

CLIENT: SAFETY LIGHT CORPORATION

CONTACT: NORMAN FRITZ

LOCATION: BLOOMSBURG, PA

TYPE OF SAMPLING: GROUNDWATER

METHOD: BAILER/PUMP

WEATHER: WARM WITH SHOWERS

	3.3 GAL	9.0 GAL	5.1 GAL	6.9 GAL	5.1 GAL
Well #:	1	2	3	4	5
Diameter of Well:	1½"	2"	1½"	2"	2"
Height of Well Casing:	—	—	—	—	—
Total Depth of Well:	23.9	22.6	22.7	19.5	15.1
Depth to Water:	10.2	5.1	2.0	5.8	5.4
Net Depth to Water (less casing):	13.7	17.5	20.7	13.7	9.7
Volume of Water (Total Depth less Depth to Water):	1.1 GAL	3.0 GAL	1.7 GAL	2.3 GAL	1.7 GAL
Date/Time Well Purged:	10:25 06-21-90	—	—	12:09 06-21-90	1:54 06-21-90
Total Volume Purged:	3.3 GAL	INACCESSIBLE DUE TO BENT CASING	INACCESSIBLE DUE TO CASING	(DRY) 5.0 GAL	DIFFICULT TO BAIL 3.0 GAL
Appearance of Water:	LT. BROWN	"	"	DRK. BROWN	DRK. BROWN
Conductivity:	210	"	"	110	1,100
pH:	6.6	"	"	5.5	6.5
Temp.:	18°C	"	"	18°C	18°C
# Sample Bottles:	1	"	"	1	1
Date/Time Sampled:	10:30 06-21-90	"	"	12:10 06-21-90	1:55 06-21-90

NOTES:

Metal Samples filtered on site through 0.45 micron filter paper? ___ Yes _X_ No

Chain-of-Custody record attached? _X_ Yes ___ No

Method of Shipment: Hand delivered

Sampled by: Greg Powers

Signature: _____

Samples to be analyzed for: H-3

Volume of well = $\pi r^2 \times h$

CLIENT: SAFETY LIGHT CORPORATION

CONTACT: NORMAN FRITZ

LOCATION: BLOOMSBURG, PA

TYPE OF SAMPLING: GROUNDWATER

METHOD: BAILER/PUMP

WEATHER: WARM WITH SHOWERS

	5.4 GAL	3.3 GAL	5.7 GAL	7.2 GAL	8.4 GAL
Well #:	6	7	8	9	10
Diameter of Well:	2"	2"	2"	6"	2"
Height of Well Casing:	—	—	—	—	—
Total Depth of Well:	15.6	20.9	19.3	31.6	16.9
Depth to Water:	5.3	14.7	8.3	15.6	0.7
Net Depth to Water (less casing):	10.3	6.2	11.0	16.0	16.2
Volume of Water (Total Depth less Depth to Water):	1.8 GAL	1.1 GAL	1.9 GAL	24.0 GAL	2.8 GAL
Date/Time Well Purged:	2:09 06-21-90	1:39 06-21-90	11:49 06-21-90	2:40 06-20-90	10:50 06-21-90
Total Volume Purged:	3.0 GAL	3.3 GAL	5.7 GAL	72 GAL	(DRY) 7.5 GAL
Appearance of Water:	DRK. BROWN	DRK. GRAY	DRK. BROWN	RUSTY BROWN	DARK BROWN
Conductivity:	120	210	160	160	200
pH:	6.2	6.2	6.2	6.2	6.8
Temp.:	20°C	19°C	20°C	19°C	19°C
# Sample Bottles:	1	1	1	1	1
Date/Time Sampled:	2:10 06-21-90	1:40 06-21-90	11:50 06-21-90	2:45 06-20-90	10:55 06-21-90
	OBSTRUCTION IN WELL				

NOTES:

Metal Samples filtered on site through 0.45 micron filter paper? ___ Yes _X_ No

Chain-of-Custody record attached? _X_ Yes ___ No

Method of Shipment: Hand delivered

Sampled by: Greg Powers

Signature: _____

Samples to be analyzed for: H-3

Volume of well = $\pi r^2 \times h$

CLIENT: SAFETY LIGHT CORPORATION

CONTACT: NORMAN FRITZ

LOCATION: BLOOMSBURG, PA

TYPE OF SAMPLING: GROUNDWATER

METHOD: BAILER/PUMP

WEATHER: WARM WITH SHOWERS

		110 GAL	81 GAL	64 GAL	55 GAL
Well #:	11	12	13	14	15
Diameter of Well:	6"	6"	6"	6"	6"
Height of Well Casing:	---	---	---	---	---
Total Depth of Well:	30.1	39.4	30.8	30.5	36.9
Depth to Water:	15.6	15.0	12.9	16.3	24.7
Net Depth to Water (less casing):	14.5	24.4	17.9	14.2	12.2
Volume of Water (Total Depth less Depth to Water):	21.8 GAL	36.6 GAL	26.9 GAL	21.3 GAL	18.3 GAL
Date/Time Well Purged:	OIL IN WELL DID NOT SAMPLE	2:05 06-20-90	1:30 06-20-90	12:50 06-20-90	11:30 06-20-90
Total Volume Purged:	"	110 GAL	81 GAL	64 GAL	55 GAL
Appearance of Water:	"	OILY BLACK	OILY BLACK	DARK BROWN	CLEAR
Conductivity:	"	160	190	60	150
pH:	"	6.2	6.2	5.8	6.2
Temp.:	"	19°C	19°C	18°C	18°C
# Sample Bottles:	"	1	1	1	1
Date/Time Sampled:	"	2:10 06-20-90	1:35 06-20-90	12:55 06-20-90	11:35 06-20-90

NOTES:

Metal Samples filtered on site through 0.45 micron filter paper? ___ Yes _X_ No

Chain-of-Custody record attached? _X_ Yes ___ No

Method of Shipment: Hand delivered

Sampled by: Greg Powers

Signature: _____

Samples to be analyzed for: H-3

Volume of well = $\pi r^2 \times h$

CLIENT: SAFETY LIGHT CORPORATION

CONTACT: NORMAN FRITZ

LOCATION: BLOOMSBURG, PENNSYLVANIA

TYPE OF SAMPLING: GROUNDWATER

METHOD: BAILER/PUMP

WEATHER: WARM WITH SHOWERS

	57 GAL		6.9 GAL	6.9 GAL	0.9 GAL
Well #:	16	17	18	19	21
Diameter of Well:	6"	4"	2"	2"	1½"
Height of Well Casing:	---	---	---	---	---
Total Depth of Well:	36.8	80.1	16.9	17.4	11.0
Depth to Water:	24.1	14.0	3.4	4.0	7.0
Net Depth to Water (less casing):	12.7	66.1	13.5	13.4	4.0
Volume of Water (Total Depth less Depth to Water):	19.1 GAL	WILL NOT SAMPLE DUE TO POOR	2.3 GAL	2.3 GAL	0.3 GAL
Date/Time Well Purged:	10:45 06-20-90	CONDITION OF CASING	2:49 06-21-90	3:25 06-21-90	2:59 06-21-90
Total Volume Purged:	55 GAL	"	6.9 GAL	DRY 4.5 GAL	0.9 GAL
Appearance of Water:	DARK BROWN	"	BROWN	BROWN	BROWN
Conductivity:	150	"	200	115	380
pH:	6.0	"	6.2	6.0	6.0
Temp.:	18°C	"	19°C	19°C	19°C
# Sample Bottles:	1	"	1	1	1
Date/Time Sampled:	10:50 06-20-90	"	2:50 06-21-90	3:30 06-21-90	3:00 06-21-90

NOTES:

Metal Samples filtered on site through 0.45 micron filter paper? ___ Yes _X_ No

Chain-of-Custody record attached? _X_ Yes ___ No

Method of Shipment: Hand delivered

Sampled by: Greg Powers

Signature: _____

Samples to be analyzed for: H-3

Volume of well = $\pi r^2 \times h$

CLIENT: SAFETY LIGHT CORPORATION

CONTACT: NORMAN FRITZ

LOCATION: BLOOMSBURG, PENNSYLVANIA

TYPE OF SAMPLING: GROUNDWATER

METHOD: BAILER/PUMP

WEATHER: WARM WITH SHOWERS

	0.9 GAL	0.9 GAL	1.2 GAL		
Well #:	22	23	24	VANCE WALTON WELL	
Diameter of Well:	1½"	1½"	2"	3 FEET	
Height of Well Casing:	---	---	---	---	
Total Depth of Well:	11.6	15.9	13.3	21.0	
Depth to Water:	7.4	12.1	10.8	11.0	
Net Depth to Water (less casing):	4.2	3.8	2.5	10.0	
Volume of Water (Total Depth less Depth to Water):	0.3 GAL	0.3 GAL	0.4 GAL	528 GAL	
Date/Time Well Purged:	3:49 06-21-90	8:30 06-21-90	1:40 06-21-90	3:30 06-20-90	
Total Volume Purged:	-NONE- JUST ENOUGH TO SAMPLE	1.0 GAL	1.2 GAL	1600 GAL	
Appearance of Water:	BROWN	CLEAR	DARK BROWN	CLEAR	
Conductivity:	160	---	120	140	
pH:	6.5	---	6.2	6.6	
Temp.:	19°C	---	19°C	20°C	
# Sample Bottles:	1	1	1	1	
Date/Time Sampled:	3:50 06-21-90	8:33 06-21-90	1:40 06-21-90	3:30 06-20-90	

NOTES:

Metal Samples filtered on site through 0.45 micron filter paper? ___ Yes _X_ No

Chain-of-Custody record attached? _X_ Yes ___ No

Method of Shipment: Hand delivered

Sampled by: Greg Powers

Signature: _____

Samples to be analyzed for: H-3

Volume of well = $\pi r^2 \times h$

CLIENT: SAFETY LIGHT CORPORATION

CONTACT: NORMAN FRITZ

LOCATION: BLOOMSBURG, PA

TYPE OF SAMPLING: GROUNDWATER

METHOD: BAILING

WEATHER: CLEAR AND WARM

	11.2 GAL	9.7 GAL	3.4 GAL	5.4 GAL	3.8 GAL
Well #:	A	B	C	D	E
Diameter of Well:	2	2	2	2	2
Height of Well Casing:	1.6	1.4	1.5	2.5	1.4
Total Depth of Well:	26.3	31.5	23.0	14.3	13.3
Depth to Water:	4.3	12.4	16.4	3.7	6.0
Net Water Column	22.0	19.1	6.6	10.6	7.3
Volume of Water (Total Depth less Depth to Water):	3.7 gal	3.2 gal	1.1 gal	1.8 gal	1.2 gal
Date/Time Well Purged:	11:10 07-18-90	10:30 07-18-90	7:20 07-18-90	7:35 07-18-90	7:30 07-18-90
Total Volume Purged:	12.0 gal	10.0 gal	(Dry) 2.4 gal	(Dry) 4.5 gal	(Dry) 1.8 gal
Appearance of Water:	Brown	Grayish	Lt. Brown	Brown	Brown
Conductivity:	190	200	880	210	200
pH:	4.2	4.8	5.5	5.0	5.2
Temp.:	18°C	18°C	18°C	19°C	18°C
# Sample Bottles:	3	3	3	3	3
Date/Time Sampled:	11:18 07-18-90	10:40 07-18-90	11:00 07-18-90	10:30 07-18-90	7:00 07-19-90

NOTES:

Metal Samples filtered on site through 0.45 micron filter paper? ___ Yes X No

Chain-of-Custody record attached? X Yes ___ No

Method of Shipment: Hand delivery

Sampled by: Greg Powers

Signature: _____

Samples to be analyzed for: H-3, Gamma, Sr-90, Gross Alpha/Beta

Volume of well = $\pi r^2 \times h$

CLIENT: SAFETY LIGHT CORPORATION

CONTACT: NORMAN FRITZ

LOCATION: BLOOMSBURG, PA

TYPE OF SAMPLING: GROUNDWATER

METHOD: BAILING

WEATHER: CLEAR AND WARM

	10.8 GAL	6.2 GAL	5.0 GAL	5.0 GAL	
Well #:	F	G	H	I	COLLECTED
Diameter of Well:	2	2	2	2	DUP AT
Height of Well Casing:	1.9	1.0	1.8	1.9	WELL B
Total Depth of Well:	27.8	19.6	21.6	26.6	AND
Depth to Water:	6.6	7.5	11.8	16.7	BLANK
Net Water Column	21.2	12.1	9.8	9.9	FROM
Volume of Water (Total Depth less Depth to Water):	3.6 GAL	2.1 GAL	1.7 GAL	1.7 GAL	CITY
Date/Time Well Purged:	10:55 07-18-90	11:45 07-18-90	10:45 07-18-90	1:00 07-18-90	WATER
Total Volume Purged:	11.0 GAL	(DRY) 5.5 GAL	5.0 GAL	5.0 GAL	———
Appearance of Water:	BROWN	BROWN	DRK. BROWN	BROWN	———
Conductivity:	190	160	210	160	———
pH:	4.8	5.0	5.5	5.8	———
Temp.:	18°C	18°C	17.5°C	18°C	———
# Sample Bottles:	3	3	3	3	———
Date/Time Sampled:	11:00 07-18-90	12:00 07-18-90	10:52 07-18-90	1:05 07-18-90	07-18-90

NOTES:

Metal Samples filtered on site through 0.45 micron filter paper? ___ Yes _X_ No

Chain-of-Custody record attached? _X_ Yes ___ No

Method of Shipment: Hand delivery

Sampled by: Greg Powers

Signature: _____

Samples to be analyzed for: H-3, Gamma, Sr-90, Gross Alpha/Beta

Volume of well = $\pi r^2 \times h$

APPENDIX B

DAILY DRILLING REPORTS

CNSI DAILY DRILLING REPORT

Date: 06-22-90

Well: A

Drilling Contractor: Chem-Nuclear Systems, Inc.

Driller: L. Still

Driller's Helper(s): W. Inabinett/A. Bohacheff

CNSI Geologist: G. Powers

Time	Activities
7:00 am	
8:00 am	
9:00 am	
10:00 am	Started to rig up at drill site A, set hose and barracade rope.
11:00 am	Alex set up controlled area around borehole.
12:00 noon	Continued to rig up.
1:00 pm	Started drilling, 0-5′ poor sample recovery (rocks), hit big rock at 6′.
2:00 pm	Pulled augers and attempted to break up rock, continued augering, rock at 8′.
3:00 pm	Pulled augers and barrel, ran in rods with wing bit, augered to 9′.
4:00 pm	Pulled rod and barrel, poor recovery (only ½" pebbles and broken cobbles), cleaned equipment.

Remarks: Extremely difficult augering penetration due to cobbles. Pulled augers several times to break up rocks with NW rod, drag bit and 140 lb. hammer. Poor sample recovery due to bit plugging off with rocks. Soil auger flight return poor due to high water table.

CNSI DAILY DRILLING REPORT

Date: 06-23-90

Well: A

Drilling Contractor: Chem-Nuclear Systems, Inc.

Driller: L. Still

Driller's Helper(s): W. Inabinett/A. Bohacheff

CNSI Geologist: G. Powers

Time	Activities
7:00 am	Rained out. Worked on equipment.
8:00 am	Continued to rain.
9:00 am	Continued to rain.
10:00 am	Continued to rain.
11:00 am	Continued to rain.
12:00 noon	Returned to drill site at 12:30. Changed auger heads, using basket.
1:00 pm	1st split spoon at 1:45 (good recovery).
2:00 pm	2nd split spoon (12-14'), 50% recovery.
3:00 pm	3rd split spoon (14-16') 50% recovery, total depth for the day, cleaned equipment.

Remarks: Note: Split spoon sampling proved to be slower but provided good quality soil samples. Will continue using procedures with split spoon.

CNSI DAILY DRILLING REPORT

Date: 06-25-90

Well: A

Drilling Contractor: Chem-Nuclear Systems, Inc.

Driller: L. Still

Driller's Helper(s): W. Inabinett/A. Bohacheff

CNSI Geologist: G. Powers

Time	Activities
7:00 am	Unloaded environmental truck and took to repair shop.
8:00 am	(8:30)-augered to 16′, sample 16-18′ (~ 60% recovery).
9:00 am	(9:30)-sampled 18-20′ (~ 60% recovery), (9:45)-sampled 20-22′.
10:00 am	(10:30)-augered to 22′, sampled 22-24′, augered, sampled 24-26′.
11:00 am	Reached total depth at 25.5′. Augered to 25.0′. Sand heave to 20′.
12:00 noon	Pulled augers, hole fell in to 10′, cleaned augers.
1:00 pm	Ran augers in hole, exchanged catcher, sand heave to 21.
2:00 pm	Ran in with 3½" tricone and NW to wash out, washed out.
3:00 pm	Fell back, jetted ouside casing and fell back, advanced augers into shale and jetted, then fell back.
4:00 pm	Same as above.
5:00 pm	Cleaned equipment and departed at 5:00.

Remarks: Problem with heaving sand. Did not have problem when we reached total depth. However, during the period when the casing was assembled, (~ ½ hour) sand heave occured. Will move to new drill site and attempt to set well immediately after total depth.

CNSI DAILY DRILLING REPORT

Date: 06-26-90

Well: B

Drilling Contractor: Chem-Nuclear Systems, Inc.

Driller: L. Still

Driller's Helper(s): W. Inabinett/A. Bohacheff

CNSI Geologist: G. Powers

Time	Activities
7:00 am	Rigged down at drill site A.
8:00 am	Rig stuck in mud for ~ 1½ hours.
9:00 am	Rigged up at drill site B, cleaned equipment.
10:00 am	Started drilling at 10:30. Cleaned (0-2′) cobbles out by hand.
11:00 am	Continued to remove cobbles, moved North 10′.
12:00 noon	Started over at 12:30.
1:00 pm	At 4′.
2:00 pm	At 8′, slow but steady drilling, water table at 10′.
3:00 pm	3:20 at 16′, continued drilling, 3:40 at 20′.
4:00 pm	At 22′ (100% recovery), 4:45 at 23′, 5:00 reached total depth at 30′.
5:00 pm	Set well to 30′.
6:00 pm	Prepared to cement hole, mixed 5 bags of 13.3 lbs/gal.
7:00 pm	Cleaned equipment.

Remarks: Ran in bottom of screen to 30′. Top of screen 20′, No. 10 slot. Hole collapsed to 11′. Bentonite pellets (1 bucket) 5′.

CNSI DAILY DRILLING REPORT

Date: 06-27-90

Well: C

Drilling Contractor: Chem-Nuclear Systems, Inc.

Driller: L. Still

Driller's Helper(s): W. Inabinett/A Bohacheff

CNSI Geologist: G. Powers

Time	Activities
7:00 am	Started to rig down at drill site B.
8:00 am	Repaired hydraulic hose on rig, continued to rig down.
9:00 am	Decontaminated rig and drilling tools.
10:00 am	Continued to rig down and cleaned equipment.
11:00 am	Started developong at B, starting pH 7 and conductivity 130.
12:00 noon	Continued development, ½ full barrel, pH 7.6 and conductivity 130.
1:00 pm	Started to rig up at drill site C.
2:00 pm	Started drilling.
3:00 pm	At 8'. Alex returns with cement.
4:00 pm	Reached total depth for the day at 10'.

Remarks: Note: Penetrated numberous sandstone boulders, hard and slow drilling.

CNSI DAILY DRILLING REPORT

Date: 06-28-90

Well: C

Drilling Contractor: Chem-Nuclear Systems, Inc.

Driller: L. Still

Driller's Helper(s): W. Inabinett/A. Bohacheff

CNSI Geologist: G. Powers

Time	Activities
7:00 am	Started sampling at 10'.
8:00 am	At 18'. Abundant cobbles (hard augering), water table at 16'.
9:00 am	Continued sampling to 24'. Would not cut with augers.
10:00 am	Set well to 21' (10') screen, pulled augers, left 10' in hole (22-12') broke off.
11:00 am	Hole collapsed to 9½', bentonite pellets to 6'.
12:00 noon	Cleaned drilling tools, completed development at Well B.
1:00 pm	Cement casing from 6' to LS with 4 bags at 6½ gal/bag, 13.5 lbs/gal.
2:00 pm	Set pad at Well B.
3:00 pm	

Remarks: Sand starting to flow at 20'. Mixed 55 gal bentonite to pump in hole to hold back sands. Well specs Sch 80 PVC casing (threaded) slotted screen (10'), No. 10 slot, Sch 80 PVC casing, screend from 11-21'.

CNSI DAILY DRILLING REPORT

Date: 06-30-90

Well: A-1

Drilling Contractor: Chem-Nuclear Systems, Inc.

Driller: L. Still

Driller's Helper(s): W. Inabinett/A. Bohacheff

CNSI Geologist: G. Powers

Time	Activities
7:00 am	(7:30)-started sampling (0-2'), water in hole at 4' and rising.
8:00 am	At 6'. 8:15 at 10' (last sample).
9:00 am	(9:15)-started augering, sand heave, spooned out heave to 25'.
10:00 am	Set screen to 25', filled to 7'.
11:00 am	Placed bentonite pellets to 3½'.
12:00 noon	Grout casing 0-3½', set protective casing.
1:00 pm	(1:30)-completed work at A-1 location, added 1 gallon chlorox to Well C.
2:00 pm	Added 5 gallons water to break down mud (bentonite), painted posts.
3:00 pm	

Remarks: Note: Sampled with augers to 10' to replace loss of recovery from previous drilling. Well specs, 10' Sch 80 PVC threaded screen (No 10), 15' Sch 80 PVC casing, 3/8" bentonite pellets.

CNSI DAILY DRILLING REPORT

Date: 07-04-90

Well: D

Drilling Contractor: Chem-Nuclear Systems, Inc.

Driller: L. Still

Driller's Helper(s): W. Inabinett/A. Bohacheff

CNSI Geologist: G. Powers

Time	Activities
7:00 am	Started sampling at D site, walked fence line with N. Fritz.
8:00 am	At 8', (8:20)-12', augered to 10.5' and hit rock, broke gear box.
9:00 am	Shear keys broken, started to locate store open with key stock.
10:00 am	Difficulty finding stores open (4th of July).
11:00 am	Called owner of store to open up.
12:00 noon	Found key stock.
1:00 pm	Repaired gear box, 1:40-started drilling.
2:00 pm	Sampled to 13', auger refusal at 11', started to set well to 11'.
3:00 pm	Fill to 8', started adding sand pack, top of sand at 2', added 1' bentonite pellets.
4:00 pm	Allowed pellets to hydrate overnight, cleaned equipment and rig.

Remarks: 4-6' sample 20-40 counts above background. Stopped drilling at 10.5' when broke box. Well specs: Sch 80 (No. 10 slot) 5' PVC screen, bottom of screen at 11, top of screen at 6', fill to 8', FX 50 gravel pack.

CNSI DAILY DRILLING REPORT

Date: 07-05-90

Well: E

Drilling Contractor: Chem-Nuclear Systems, Inc.

Driller: L. Still

Driller's Helper(s): W. Inabinett/A. Bohacheff

CNSI Geologist: G. Powers

Time	Activities
7:00 am	Grouted well D (0-1') and set protective casing.
8:00 am	Went to store to re-stock project supplies, waited on permission from NRC to drill E site.
9:00 am	Discussed future well sites with Lynn Deering.
10:00 am	Continued discussion with NRC.
11:00 am	Started drilling at Well site E, 11:35 at 4'.
12:00 noon	12:10 at 8', stopped due to lightning and rain. Rain stopped at 1:00.
1:00 pm	Continued drilling. Auger refusal at 10', sampled to 12'.
2:00 pm	Sampled again to 13' (spoon refusal), started to set well.
3:00 pm	Set bottom of screen at 10', top of screen at 5', fill to 8', tremmied sand to 4'.
4:00 pm	Started bailing to lower water level, placed bentonite to 2½'.
5:00 pm	Cleaned equipment.

Remarks: Well specs: 5' Sch 80 PVC slotted screen (No. 10 slot), 10' Sch 80 PVC casing.

CNSI DAILY DRILLING REPORT

Date: 07-07-90

Well: F

Drilling Contractor: Chem-Nuclear Systems, Inc.

Driller: L. Still

Driller's Helper(s): W. Inabinett/A. Bohacheff

CNSI Geologist: G. Powers

Time	Activities
7:00 am	
8:00 am	
9:00 am	
10:00 am	Prepared to drill at site F. Started drilling at 10:45.
11:00 am	11:05 at 2', 11:45 at 8' and counted smear.
12:00 noon	At 10'.
1:00 pm	At 18' (good drilling results), 1:55 at 22'.
2:00 pm	2:30 at 26', reached total depth with augers 26', sampled 26-27' total depth (refusal).
3:00 pm	Started to set well, set to 26', cleaned equipment.
4:00 pm	Fill to 6', tremmied 5 gallons prehydrated bentonite to 5', mixed grout.
5:00 pm	Cement grout 0-5' bls. Set protective casing, cleaned equipment.

Remarks: Smear results: alpha beta <MDA, gamma 5 dpm-okay.
Well Specs: bottom of screen 26', top of screen 16', fill to 13½'.

CNSI DAILY DRILLING REPORT

Date: 07-10-90

Well: G

Drilling Contractor: Chem-Nuclear Systems, Inc.

Driller: L. Still

Driller's Helper(s): W. Inabinett/A. Bohacheff

CNSI Geologist: G. Powers

Time	Activities
7:00 am	
8:00 am	
9:00 am	Started to rig up. 9:30, rig stuck in mud.
10:00 am	Waited on dozer.
11:00 am	Set up rig at drill site G. Started drilling at 11:30.
12:00 noon	12:05 at 12'.
1:00 pm	1:30 at 20' (start of sand heave), sampled to 20'augers to 18'.
2:00 pm	Set well to 18', 2:30 placed sand to 6', placed bentonite pellets to 4'.
3:00 pm	Rigged down, moved equipment to wash pad.
4:00 pm	Finished rigging down at well site G.

Remarks: Bottom of screen 18', top of screen at 8', fill to 15', add sand FX-50 to 6', bentonite to 4'. Well specs: 10'PVC Sch 80 slotted (No. 10) screen, Sch 80 PVC threaded casing, FX 50 sand, bentonite pellets.

CNSI DAILY DRILLING REPORT

Date: 07-13-90

Well: H

Drilling Contractor: Chem-Nuclear Systems, Inc.

Driller: L. Still

Driller's Helper(s): W. Inabinett/A. Bohacheff

CNSI Geologist: G. Powers

Time	Activities
7:00 am	
8:00 am	8:30 set up at drill site H (next to B). Waited for NRC permission to drill.
9:00 am	9:15 started drilling.
10:00 am	10:00 at 15′, 10:30 reached total depth (20′). Set well to 20′.
11:00 am	Prepared to cement hole. Wayne strained back.
12:00 noon	Work ceased.
1:00 pm	
2:00 pm	
3:00 pm	3:30 back at site to cement Well H.
4:00 pm	Completed grouting, 13.3 lbs/gal, mixed 2 bags, set protective casing.
5:00 pm	Cleaned equipment.

Remarks: Well Specs: Bottom of screen at 20′, top of screen at 10′, fill at 10′, sand pack to 8′, bentonite pellets to 4½′.

CNSI DAILY DRILLING REPORT

Date: 07-16-90

Well: I

Drilling Contractor: Chem-Nuclear Systems, Inc.

Driller: L. Still

Driller's Helper(s): W. Inabinett/A. Bohacheff

CNSI Geologist: G. Powers

Time	Activities
7:00 am	Loaded equipment.
8:00 am	Performed magnetic survey.
9:00 am	Started rigging up at drill Site H.
10:00 am	Continued to rig up. 10:45 started drilling.
11:00 am	11:30 at 8'.
12:00 noon	12:10-extremely hard drilling. Stopped to let cat-head cool down.
1:00 pm	1:00 spoon refusal at 11', rotary drilled to 12', stopped.
2:00 pm	
3:00 pm	3:15 moved North, 3:30 started augering, no samples.
4:00 pm	4:00 sampled 12-13' (only rock), straight augering to 13'.
5:00 pm	5:10 at 24', 5:25 at 26'. 5:30 set well to 25'.

Remarks: Note: Add water and drill (rotary) 11'. Well Specs: botton of screen at 25', top of screen at 15', fill to 14.5', sand to 11', bentonite to 9', 10' Sch 80 PVC slotted screen, No. 10, 15 PVC Sch 80 casing, FX 50 sand, bentonite pellets.

APPENDIX C

LITHOLOGIC DESCRIPTIONS

CNSI LOW-LEVEL RADIOACTIVE WASTE MANAGEMENT FACILITY
ENVIRONMENTAL AND DOSIMETRY LABORATORY
BARNWELL, SOUTH CAROLINA

HOLE NO: A	LOCATION: BLOOMSBURG, PA	TOTAL DEPTH: 25.5 FEET
DRILLER: L. STILL GEOLOGIST: G. POWERS	DRILL RIG: D-50 SAMPLING PROCEDURE: HOLLOW STEM AUGERING	DATE STARTED: 06-22-90 DATE COMPLETED: 06-25-90

DEPTH	ELEV AMSL	STRIP CHART	RECOVERY	STRATA CHANGE	LITHOLOGIC DESCRIPTION: ROCK NAME, COLOR, COLOR PATTERN, GRAIN SIZE, PERCENT SAND, ROUNDNESS, MINERALOGY, CALCAREOUS, STRUCTURE, FOSSILS, STRENGTH, ACCESSORIES	REMARKS
0						
2			0-5' (0.5')		SILTY CLAY, PALE BROWN, ~ 80% CLAY, ORGANIC, W/GRASS ROOTS, WET AND SATURATED @ 5', OCCASIONAL COBBLES NEAR SURFACE	POOR SAMPLE RECOVERY DUE TO ROCK PLUGGING OFF CORE SHOE
4					NO RECOVERY	
6			5-6' (0')		NO RECOVERY	WATER IN AUGER 06-22-90
8			6-8' (0')		NO RECOVERY	PEBBLES AND COBBLES AND CLAY
10			8-9' (0')		END OF DAY USING SPLIT SPOONS @10'	06-22-90 06-23-90
			9-10 AUGERED 10.0'			
12			10-12' (0.7')	12.0'	SILTY SAND, MODERATE YELLOWISH BROWN, MEDIUM GRAIN, <10% FINES, OCCASIONAL PEBBLES, ORGANICS, GOOD VISABLE POROSITY, LOOSE, SATURATED	
14			12-14' (1.0')	14.0'	CLAYEY GRAVEL, MODERATE YELLOWISH BROWN, ~ 20% CLAY, PEBBLES (~ 1"), WELL ROUNDED, VERY POORLY SORTED, SATURATED, LOOSE	
16			14-16' (0.9')		SAND, DARK YELLOWISH BROWN, MEDIUM GRAIN, <10% FINES, WELL SORTED, GOOD VISABLE POROSITY, BLACK CARBONACEOUS MATERIAL (ORG) @16', MODERATE REDDISH SILTSTONE CLAST (~1/8") THROUGHOUT, LOOSE, SATURATED	06-23-90 06-25-90
18			16-18' (1.2')		SILTY SAND, BLACK W/MODERATE YELLOWISH BROWN BANDING, FINE GRAIN TO MEDIUM GRAIN, ~ 20% FINES (ORGANIC SILTS), MODERATE GOOD VISABLE POROSITY, 1/8" SILTSTONE RIP UP CLASTS, LOOSE, VERY SOFT	
20			18-20' (1.27')	19.5'	AS ABOVE W/SANDSTONE (HARD) FRAGMENTS NEAR BASE AND ABUNDANT PEBBLES (~ 1-2")	
22			20-22' (1.6')		GRAVELY SAND, PALE BROWN, SPECKLED, ~ 80% SAND, ~20% GRAVEL AND PEBBLES (~ 1") POORLY SORTED, SILTSTONE RIP UP CLASTS (1/8") LOOSE, LESS DENSE, FAIR VISABLE POROSITY, SATURATED	HARD DRIVING W/HAMMER
24			22-24' (1.6')		AS ABOVE W/ORGANIC SILT (~ 5%)	

CNSI LOW-LEVEL RADIOACTIVE WASTE MANAGEMENT FACILITY
ENVIRONMENTAL AND DOSIMETRY LABORATORY
BARNWELL, SOUTH CAROLINA

HOLE NO: A

DEPTH	ELEV AMSL	STRIP CHART	RECOVERY	STRATA CHANGE	LITHOLOGIC DESCRIPTION: ROCK NAME, COLOR, COLOR PATTERN, GRAIN SIZE, PERCENT SAND, ROUNDNESS, MINERALOGY, CALCAREOUS, STRUCTURE, FOSSILS, STRENGTH, ACCESSORIES	REMARKS
24						
			24-25.5' (1.5')	25.0	SAND W/OCCASIONAL PEBBLES, PALE YELLOWISH BROWN, MEDIUM GRAIN, ~ 95% SAND AND ~ 5% PEBBLES (~ ½"), GOOD VISABLE POROSITY, <5% FINES, LOOSE, SATURATED	
26					25.0-25.5' SHALE, BLACK, FISSILE, DENSE BEDROCK	SPLIT SPOON REFUSAL @25.5'
28					TOTAL DEPTH @25.5'	

CNSI LOW-LEVEL RADIOACTIVE WASTE MANAGEMENT FACILITY
ENVIRONMENTAL AND DOSIMETRY LABORATORY
BARNWELL, SOUTH CAROLINA

HOLE NO: A-1	LOCATION: BLOOMSBURG, PA	TOTAL DEPTH: 25 FEET
DRILLER: L. STILL GEOLOGIST: G. POWERS	DRILL RIG: D-50 SAMPLING PROCEDURE: HOLLOW STEM AUGER W/3" SPLIT SPOON	DATE STARTED: 06-30-90 DATE COMPLETED: 06-30-90

DEPTH	ELEV AMSL	STRIP CHART	RECOVERY	STRATA CHANGE	LITHOLOGIC DESCRIPTION: ROCK NAME, COLOR, COLOR PATTERN, GRAIN SIZE, PERCENT SAND, ROUNDNESS, MINERALOGY, CALCAREOUS, STRUCTURE, FOSSILS, STRENGTH, ACCESSORIES	REMARKS
0						
2			0-2' (1.7')		SILTY CLAY, PALE BROWN, ~ 85% FINES, STICKY, OCCASIONAL PEBBLES, POOR VISABLE POROSITY, WELL ROUNDED QUARTZ PEBBLES (~ 1-2"), MOIST	
4			2-4' (0.8')		AS ABOVE W/LESS PEBBLES AND SATURATED	WATER IN HOLE AND RISING
6			4-6' (1.2')		AS ABOVE W/MODERATE RED SANDSTONE COBBLE	
8			6-8' (1.2')	8.0'	SILTY SANDY CLAY, MODERATE YELLOWISH BROWN, ~ 75% FINES, OCCASIONAL COBBLES OR PEBBLES, SOFT, SATURATED, POOR VISABLE POROSITY.	
10			8-10' (1.3')		SANDY CLAYEY GRAVEL, MODERATE YELLOWISH BROWN, ~ 60% GRAVEL, ~ 25% COARSE SAND, ~ 15% CLAY, OCCASIONAL COBBLES, POOR VISABLE POROSITY.	
12					STRAIGHT AUGERING W/OUT SPLIT SPOONS	
14					10-25 FEET - NO SAMPLES	
16					AUGERED TO 25'	
18						
20						
22						
24						

CNSI LOW-LEVEL RADIOACTIVE WASTE MANAGEMENT FACILITY
ENVIRONMENTAL AND DOSIMETRY LABORATORY
BARNWELL, SOUTH CAROLINA

HOLE NO: B	LOCATION: BLOOMSBURG, PA	TOTAL DEPTH: 30 FEET
DRILLER: L. STILL GEOLOGIST: G. POWERS	DRILL RIG: D-50 SAMPLING PROCEDURE: HOLLOW STEM AUGERS W/3" SPLIT SPOONS	DATE STARTED: 06-26-90 DATE COMPLETED: 06-26-90

DEPTH	ELEV AMSL	STRIP CHART	RECOVERY	STRATA CHANGE	LITHOLOGIC DESCRIPTION: ROCK NAME, COLOR, COLOR PATTERN, GRAIN SIZE, PERCENT SAND, ROUNDNESS, MINERALOGY, CALCAREOUS, STRUCTURE, FOSSILS, STRENGTH, ACCESSORIES	REMARKS
0						
2			0-2' (1.4')		SILTY CLAY, MODERATE YELLOWISH BROWN, ~ 90-95% FINES, OCCASIONAL PEBBLES AND COBBLES, MOIST, TRACE BLACK CARBONEOUS MATERIAL (COAL?), COBBLES UP TO 6"	DIFFICULTY AUGERING
4			2-4' (1.5')		AS ABOVE	
6			4-6' (1.5')		AS ABOVE BECOMING SANDY W/DEPTH	
8			6-8' (1.6')		SANDY CLAYEY GRAVEL, DARK YELLOWISH BROWN, ~ 30% CLAY, ~ 30% SAND, ~ 40% GRAVEL, MOIST, DENSE, POOR VISABLE POROSITY, OCCASIONAL WELL ROUNDED COBBLES	AUGERING CONTINUED DIFFICULT DUE TO ROCKS
10			8-10' (1.4')		AS ABOVE SATURATED AT BASE	STATIC WATER LEVEL 06-26-90
12			10-12' (1.0')		SANDY CLAYEY GRAVEL, MODERATE BROWN, ~ 20% CLAY, ~ 20% SAND, ~ 60% GRAVEL, OCCASIONAL COBBLES, SATURATED, TRACE BLACK CARBONEOUS MATERIAL	
14			12-14' (0.8')	14.0'	GRAVELY CLAYEY SAND, MODERATE BROWN, ~ 20% GRAVEL, ~ 20% CLAY, ~ 60% SAND, OCCASIONAL COBBLES, SATURATED, FAIR VISABLE POROSITY	COBBLES FROM AUGERS (4-6")
16			14-16' (0.9')	15.0'	SAND, MODERATE BROWN, MEDIUM GRAIN, <10% FINES, GOOD VISABLE POROSITY GRAVELY SANDY CLAY, MODERATE BROWN, POORLY SORTED, POOR VISABLE POROSITY, SATURATED	
18			16-18' (0.5')		GRAVELY SANDY CLAY (AS ABOVE)	
20			18-20' (1.0')	19.5'	AS ABOVE ORGANIC SILT, BLACK, SOFT @19.5'	
22			20-22' (2.0')		SAND, COARSE GRAIN, WELL SORTED, DARK YELLOWISH BROWN, VERY GOOD VISABLE POROSITY	
24			22-24' (1.5')		AS ABOVE	

CNSI LOW-LEVEL RADIOACTIVE WASTE MANAGEMENT FACILITY
ENVIRONMENTAL AND DOSIMETRY LABORATORY
BARNWELL, SOUTH CAROLINA

HOLE NO: B

DEPTH	ELEV AMSL	STRIP CHART	RECOVERY	STRATA CHANGE	LITHOLOGIC DESCRIPTION: ROCK NAME, COLOR, COLOR PATTERN, GRAIN SIZE, PERCENT SAND, ROUNDNESS, MINERALOGY, CALCAREOUS, STRUCTURE, FOSSILS, STRENGTH, ACCESSORIES	REMARKS
24						
26			24-26' (1.8')	26.0'	SAND, GRAYISH BROWN, COARSE GRAIN SAND, <10% FINES, VERY GOOD VISABLE POROSITY, LOOSE, DENSE, THIN LAYERS, BLACK ORGANIC SILT	
28			26-28' (1.0')		SANDY GRAVEL, GRAYISH BROWN, <10% FINES, 50% GRAVEL AND 50% SAND, GOOD VISABLE POROSITY, SATURATED	
30			28-30' (1.0')		AS ABOVE TOTAL DEPTH @30'	

CNSI LOW-LEVEL RADIOACTIVE WASTE MANAGEMENT FACILITY
ENVIRONMENTAL AND DOSIMETRY LABORATORY
BARNWELL, SOUTH CAROLINA

HOLE NO: C	LOCATION: BLOOMSBURG, PA	TOTAL DEPTH: 24 FEET
DRILLER: L. STILL GEOLOGIST: G. POWERS	DRILL RIG: D-50 SAMPLING PROCEDURE: HOLLOW STEM AUGERS W/3" SPLIT SPOONS	DATE STARTED: 06-27-90 DATE COMPLETED: 06-28-90

DEPTH	ELEV AMSL	STRIP CHART	RECOVERY	STRATA CHANGE	LITHOLOGIC DESCRIPTION: ROCK NAME, COLOR, COLOR PATTERN, GRAIN SIZE, PERCENT SAND, ROUNDNESS, MINERALOGY, CALCAREOUS, STRUCTURE, FOSSILS, STRENGTH, ACCESSORIES	REMARKS
0						
2			0-2' (0.8')	1.0' 2.0'	ROAD BED MATERIAL (CRUSHED ROCK), OLIVE BLACK GRAVELY SANDY CLAY, MODERATE YELLOWISH BROWN, OCCASIONAL COBBLES, MOIST, POOR VISABLE POROSITY.	
4			2-4' (0.8')	3.0'	ROAD BED MATERIAL (AS ABOVE) GRAVELY SANDY CLAY (AS ABOVE)	
6			4-6' (1.5')		SANDY CLAYEY GRAVEL, MODERATE YELLOWISH BROWN, GRAYISH BROWN, OCCASIONAL COBLES, MOIST, ~ 30-50% FINES, POOR VISABLE POROSITY, COBBLES (~ 4-6").	
8			6-8' (1.3')		AS ABOVE SANDSTONE BOULDER, GRAYISH PINK, INDURATED (½') SANDY CLAYEY GRAVEL, MODERATE YELLOWISH BROWN	VERY HARD DRIVING @9'
10			8-10' (1.5')		SANDY CLAYEY GRAVEL, DARK YELLOWISH BROWN SANDSTONE BOULDER, DARK YELLOWISH ORANGE, INDURATED (½'). SANDY CLAYEY GRAVEL, MODERATE YELLOWISH BROWN.	06-27-90 06-28-90
12			10-12' (1.2')		AS ABOVE SANDSTONE BOULDER, PALE REDDISH, INDURATED	
14			12-14' (0.8')		GRAVELY CLAY, GRAYISH BROWN, ~ 80% CLAY, POOR VISABLE POROSITY. SANDSTONE BOULDER, PALE YELLOWISH BROWN, INDURATED.	ABNT COBBLES FROM AUGERS (2-4")
16			14-16' (1.5')	16.0'	AS ABOVE VERY MOIST @ BASE WATER TABLE	ABNT COBBLES FROM AUGERS (2-4")
18			16-18' (1.0')	18.0'	SANDY GRAVEL, GRAYISH BROWN, ~ 15% FINES, OCCASIONAL COBBLES, SATURATED	
20			18-20' (1.5')		SAND, GRAYISH BROWN, MEDIUM COARSE GRAIN, <10% FINES, VERY GOOD VISABLE POROSITY, LOOSE, SATURATED.	
22			20-22' (1.5')		AS ABOVE ADD MUD @22'	5" FILL IN AUGERS
24			22-24' (1.2')		AS ABOVE TOTAL DEPTH 24'	24" FILL SPOON OUT AND RESAMPLE

CNSI LOW-LEVEL RADIOACTIVE WASTE MANAGEMENT FACILITY
ENVIRONMENTAL AND DOSIMETRY LABORATORY
BARNWELL, SOUTH CAROLINA

HOLE NO: D	LOCATION: BLOOMSBURG, PA	TOTAL DEPTH: 13 FEET
DRILLER: L. STILL GEOLOGIST: G. POWERS	DRILL RIG: D-50 SAMPLING PROCEDURE: HOLLOW STEM AUGERS W/3" SPLIT SPOONS	DATE STARTED: 07-04-90 DATE COMPLETED: 07-04-90

DEPTH	ELEV AMSL	STRIP CHART	RECOVERY	STRATA CHANGE	LITHOLOGIC DESCRIPTION: ROCK NAME, COLOR, COLOR PATTERN, GRAIN SIZE, PERCENT SAND, ROUNDNESS, MINERALOGY, CALCAREOUS, STRUCTURE, FOSSILS, STRENGTH, ACCESSORIES	REMARKS
0						
2			0-2' (1.4')		SILTY CLAY, DARK YELLOWISH BROWN, ~ 80% CLAY, OCCASIONAL PEBBLES, SOFT, MOIST, POOR VISABLE POROSITY.	WATER TABLE RISING DURING DRILLING
4			2-4' (0.8')		AS ABOVE W/INCREASING PEBBLE CONTENT W/DEPTH	
6			4-6' (2.0')		SILTY CLAY, MODERATE YELLOWISH BROWN, STICKY, SOFT, ~90% CLAY, MOIST, VERY POOR VISABLE POROSITY, OCCASIONAL PEBBLES.	20-40 COUNTS ABOVE BACK-GROUND
8			6-8' (1.5')		AS ABOVE W/SANDSTONE COBBLES @8' SATURATED @8' WATER	
10			8-10' (1.3')	10.0'	SILTY CLAY, MODERATE YELLOWISH BROWN, ~ 80% CLAY, SANDY AND GRAVELY IN PART, POOR VISABLE POROSITY, SATURATED SANDSTONE COBBLE (>4") @9'.	HARD AUGERING (COBBLES)
12			10-12' (2.0')		COARSE GRAIN SAND @10' GRADING TO CLAYEY SANDY GRAVEL W/DEPTH, MODERATE YELLOWISH BROWN, ABUNDANT COBBLES, SATURATED, FAIR VISABLE POROSITY.	BROKE GEAR BOX @10.5' (SHEAR KEY)
14			12-13' (0.8')		CLAYEY GRAVEL AND COBBLES, DARK YELLOWISH BROWN, EXTREMELY HARD GRANITE AND SANDSTONE COBBLES NOTE: AUGER REFUSAL @13'	TOTAL DEPTH @13'
16						
18						
20						
22						
24						

CNSI LOW-LEVEL RADIOACTIVE WASTE MANAGEMENT FACILITY
ENVIRONMENTAL AND DOSIMETRY LABORATORY
BARNWELL, SOUTH CAROLINA

HOLE NO: E	LOCATION: BLOOMSBURG, PENNSYLVANIA	TOTAL DEPTH: 13 FEET
DRILLER: LARRY STILL GEOLOGIST: GREG POWERS	DRILL RIG: D-50 SAMPLING PROCEDURE: HOLLOW STEM AUGERS	DATE STARTED: 07-05-90 DATE COMPLETED: 07-05-90

DEPTH	ELEV AMSL	STRIP CHART	RECOVERY	STRATA CHANGE	LITHOLOGIC DESCRIPTION: ROCK NAME, COLOR, COLOR PATTERN, GRAIN SIZE, PERCENT SAND, ROUNDNESS, MINERALOGY, CALCAREOUS, STRUCTURE, FOSSILS, STRENGTH, ACCESSORIES	REMARKS
0						
2			0-2' (0.5')		SILTY CLAY, MODERATE YELLOWISH BROWN, ~ 80% FINES, OCCASIONAL COBBLES, POOR VISABLE POROSITY, SATURATED @ 1'	STATIC WATER LEVEL
4			2-4' (0.8')		AS ABOVE	
6			4-6' (2.0')		SILTY CLAY, MODERATE YELLOWISH BROWN, ~ 95% FINES, STICKY, SOFT, NO ROCKS, VERY POOR VISABLE POROSITY, SATURATED	
8			6-8' (1.0')		AS ABOVE W/SANDSTONE COBBLES @ 8'	HARD AUGERING
10			8-10' (0.8')		SILTY CLAY, MODERATE YELLOWISH BROWN, ~ 80% FINES, OCCASIONAL LARGE HARD COBBLES OR BOULDERS, POOR VISABLE POROSITY, STICKY, SOFT CLAY, HARD ROCKS	VERY HARD AUGERING
12			10-12' (1.0')		SILTY CLAY, MODERATE YELLOWISH BROWN 11-12' VERY LARGE SANDSTONE BOULDER, DARK GRAY, INDURATED	AUGER REFUSAL @ 12'
14			12-13' (1.0')		SILTY CLAY W/ABUNDANT COBBLES AND BOULDERS TOTAL DEPTH @ 13'	SPOON REFUSAL @ 13'
16						
18						
20						
22						
24						

CNSI LOW-LEVEL RADIOACTIVE WASTE MANAGEMENT FACILITY
ENVIRONMENTAL AND DOSIMETRY LABORATORY
BARNWELL, SOUTH CAROLINA

HOLE NO: F	LOCATION: BLOOMSBURG, PENNSYLVANIA	TOTAL DEPTH: 27 FEET
DRILLER: LARRY STILL GEOLOGIST: GREG POWERS	DRILL RIG: D-50 SAMPLING PROCEDURE: HOLLOW STEM AUGERS W/3"SPLIT SPOON	DATE STARTED: 07-07-90 DATE COMPLETED: 07-07-90

DEPTH	ELEV AMSL	STRIP CHART	RECOVERY	STRATA CHANGE	LITHOLOGIC DESCRIPTION: ROCK NAME, COLOR, COLOR PATTERN, GRAIN SIZE, PERCENT SAND, ROUNDNESS, MINERALOGY, CALCAREOUS, STRUCTURE, FOSSILS, STRENGTH, ACCESSORIES	REMARKS
0						
2			0-2' (0.2')		SILTY CLAY W/COBBLES, DARK YELLOWISH BROWN, MOIST, POOR VISABLE POROSITY, ~ 80% FINES, ~ 20% COBBLES	POOR RECOVERY DUE TO COBBLES
4			2-4' (0.6')		AS ABOVE WITH ¼" LUMPS OF COAL	VERY SOFT SOILS (UNCOMPACTED)
6			4-6' (0.2')	6.0	SILTY CLAY W/COBBLES, DARK YELLOWISH BROWN, WOOD FRAGMENTS, SATURATED, POOR VISABLE POROSITY WATER TABLE	HARDER SAMPLING
8			6-8' (1.0')	8.0	SANDY CLAYEY GRAVEL, DARK YELLOWISH BROWN, ~ 20% FINES, FAIR VISABLE POROSITY, DENSE, SATURATED	
10			8-10' (1.7')		SAND, DARK YELLOWISH BROWN, MEDIUM-COARSE GRAIN, <10% FINES, VERY GOOD VISABLE POROSITY, SATURATED	
12			10-12' (2.0')		AS ABOVE	3" FILL SAND HEAVE
14			12-14' (2.0')		AS ABOVE W/COBBLES @ BASE	5" FILL SAND HEAVE
16			14-16' (2.0')		SAND, DARK YELLOWISH BROWN, MEDIUM-COARSE GRAIN, <10% FINES, VERY GOOD VISABLE POROSITY, SATURATED, COBBLES @16'	5" FILL SAND HEAVE
18			16-18' (2.0')		SAND, DARK YELLOWISH BROWN, MEDIUM GRAIN, <10% FINES, VERY GOOD VISABLE POROSITY, SATURATED, WELL SORTED	5" FILL SAND HEAVE
20			18-20' (2.0')	19.0	SAND, DARK YELLOWISH BROWN, FINE-MEDIUM GRAIN <10% FINES CLAYEY GRAVEL, DARK YELLOWISH BROWN, ~ 30% FINES, POOR VISABLE POROSITY, SATURATED	6" FILL SAND HEAVE
22			20-22' (1.2')		AS ABOVE	3" FILL SAND HEAVE
24			22-24' (1.8')		CLAYEY SANDY GRAVEL, DARK YELLOWISH BROWN, POORLY SORTED, DENSE, SATURATED, ~ 20% FINES, FAIR VISABLE POROSITY	3" FILL SAND HEAVE

CNSI LOW-LEVEL RADIOACTIVE WASTE MANAGEMENT FACILITY
ENVIRONMENTAL AND DOSIMETRY LABORATORY
BARNWELL, SOUTH CAROLINA

HOLE NO: F

DEPTH	ELEV AMSL	STRIP CHART	RECOVERY	STRATA CHANGE	LITHOLOGIC DESCRIPTION: ROCK NAME, COLOR, COLOR PATTERN, GRAIN SIZE, PERCENT SAND, ROUNDNESS, MINERALOGY, CALCAREOUS, STRUCTURE, FOSSILS, STRENGTH, ACCESSORIES	REMARKS
26			24-26' (1.4')		SANDY GRAVEL, DARK YELLOWISH BROWN, ~10% FINES, GOOD VISABLE POROSITY, WELL ROUNDED, DENSE	2" FILL SAND HEAVE
28			26-27' (0.4')		AS ABOVE SHALE, BLACK, FISSILE, DENSE TOTAL DEPTH 27.0'	

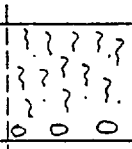
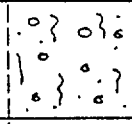
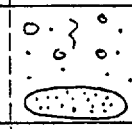
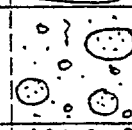
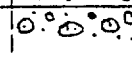
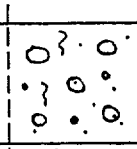
CNSI LOW-LEVEL RADIOACTIVE WASTE MANAGEMENT FACILITY
ENVIRONMENTAL AND DOSIMETRY LABORATORY
BARNWELL, SOUTH CAROLINA

HOLE NO: G	LOCATION: BLOOMSBURG, PENNSYLVANIA	TOTAL DEPTH: 20 FEET
DRILLER: LARRY STILL GEOLOGIST: GREG POWERS	DRILL RIG: D-50 SAMPLING PROCEDURE: HOLLOW STEM AUGERING W/3" SPLIT SPOON	DATE STARTED: 07-10-90 DATE COMPLETED: 07-10-90

DEPTH	ELEV AMSL	STRIP CHART	RECOVERY	STRATA CHANGE	LITHOLOGIC DESCRIPTION: ROCK NAME, COLOR, COLOR PATTERN, GRAIN SIZE, PERCENT SAND, ROUNDNESS, MINERALOGY, CALCAREOUS, STRUCTURE, FOSSILS, STRENGTH, ACCESSORIES	REMARKS
0						
2			0-2' (0.5')		SILT, DARK YELLOWISH BROWN, ~ 95% FINES, LOOSE, SOFT, FAIRLY DRY	
4			2-4' (1.8')		SILT, DARK YELLOWISH BROWN, DUSKY YELLOWISH BROWN (BLACK), COAL SILTS INTERLAYERED W/SILT, SOFT, MOIST, LOOSE	
6			4-6' (1.3')		SILT, GRAYISH BLACK, INCREASING COAL SILT CONTENT W/DEPTH	
8			6-8' (1.8')		SILTY CLAY, GRAYISH BLACK, STICKY, SOFT, POOR VISABLE POROSITY, ~ 95% FINES WATER LEVEL	▽
10			8-10' (2.0)	9.0	AS ABOVE CLAY, DARK YELLOWISH BROWN, STICKY, DENSE, ~ 95% FINES, VERY POOR VISABLE POROSITY, SATURATED	
12			10-12' (1.6')	12.0	SILTY CLAY, DUSKY YELLOWISH BROWN, SOFT, SATURATED CLAY, MODERATE YELLOWISH BROWN, STIFF, SATURATED	
14			12-14' (0.8')		CLAYEY GRAVEL, DARK YELLOWISH BROWN, POORLY SORTED, FAIR VISABLE POROSITY, ROUNDED AND ANGULAR GRAVEL, SATURATED	
16			14-16' (1.0')		AS ABOVE	
18			16-18' (1.2')	18.0	AS ABOVE BOTTOM OF AUGERS	
20			18-20' (2.0')		SANDY FINE GRAIN GRAVEL, DARK YELLOWISH BROWN, ~ 15% FINES, DENSE, GOOD VISABLE POROSITY SHALE 19.8 - 20', BLACK, FISSILE, 45° ANGLE, SHARP CONTACT	12" FILL SAND HEAVE TOTAL DEPTH 20.0'
22						
24						

CNSI LOW-LEVEL RADIOACTIVE WASTE MANAGEMENT FACILITY
ENVIRONMENTAL AND DOSIMETRY LABORATORY
BARNWELL, SOUTH CAROLINA

HOLE NO: I	LOCATION: BLOOMSBURG, PENNSYLVANIA	TOTAL DEPTH: 26 FEET
DRILLER: LARRY STILL GEOLOGIST: GREG POWERS	DRILL RIG: D-50 SAMPLING PROCEDURE: HOLLOW STEM AUGERS W/3" SPLIT SPOON BARREL	DATE STARTED: 07-16-90 DATE COMPLETED: 07-16-90

DEPTH 0	ELEV AMSL	STRIP CHART	RECOVERY	STRATA CHANGE	LITHOLOGIC DESCRIPTION: ROCK NAME, COLOR, COLOR PATTERN, GRAIN SIZE, PERCENT SAND, ROUNDNESS, MINERALOGY, CALCAREOUS, STRUCTURE, FOSSILS, STRENGTH, ACCESSORIES	REMARKS
2			0-2' (2.0')		SILTY CLAY, DARK YELLOWISH BROWN GRADING TO DARK YELLOWISH ORANGE, STICKY, STIFF, MOIST, ~ 90% FINES, POOR VISABLE POROSITY, COBBLES @ BASE	
4			2-4' (1.3')	4.0	CLAYEY GRAVEL, DARK YELLOWISH BROWN, ~ 20% FINES, 80% GRAVEL (1-2"), POOR VISABLE POROSITY	
6			4-6' (1.5')		SLIGHTLY CLAYEY GRAVEL W/SANDSTONE BOULDERS, FAIR VISABLE POROSITY, MOIST	
8			6-8' (1.4')		GRAVEL W/SANDSTONE BOULDERS, GRAYISH ORANGE, MODERATE RED SILTSTONE CHIPS (6-7'), FAIR VISABLE POROSITY, MOIST (SAMPLE CONTAINS PULVERIZED ROCK)	EXTREMELY HARD DRILLING ROCKS (SS)
10			8-10' (1.2')		AS ABOVE	EXTREMELY HARD DRILLING 565 BLOWS (2')
12			10-11' (0.5')		ROTARY DRILLED 11-12' START OF WELL I-1	EXTREMELY HARD DRILLING
14			12-13' (0.1')		SILTSTONE, MODERATE REDDISH BROWN, INDURATED AUGERED 13' - 20'	
16					AUGERED WATER TABLE	
18					AUGERED	
20					AUGERED	
22			20-22' (1.0')	24.0	CLAYEY GRAVEL W/SANDSTONE BOULDERS, MODERATE BROWN, SATURATED	
24			22-24' (1.2')		SAND, DUSKY YELLOWISH BROWN, MEDIUM-COARSE GRAIN, GOOD VISABLE POROSITY, SATURATED, GRAVEL @24'	

CNSI LOW-LEVEL RADIOACTIVE WASTE MANAGEMENT FACILITY
ENVIRONMENTAL AND DOSIMETRY LABORATORY
BARNWELL, SOUTH CAROLINA

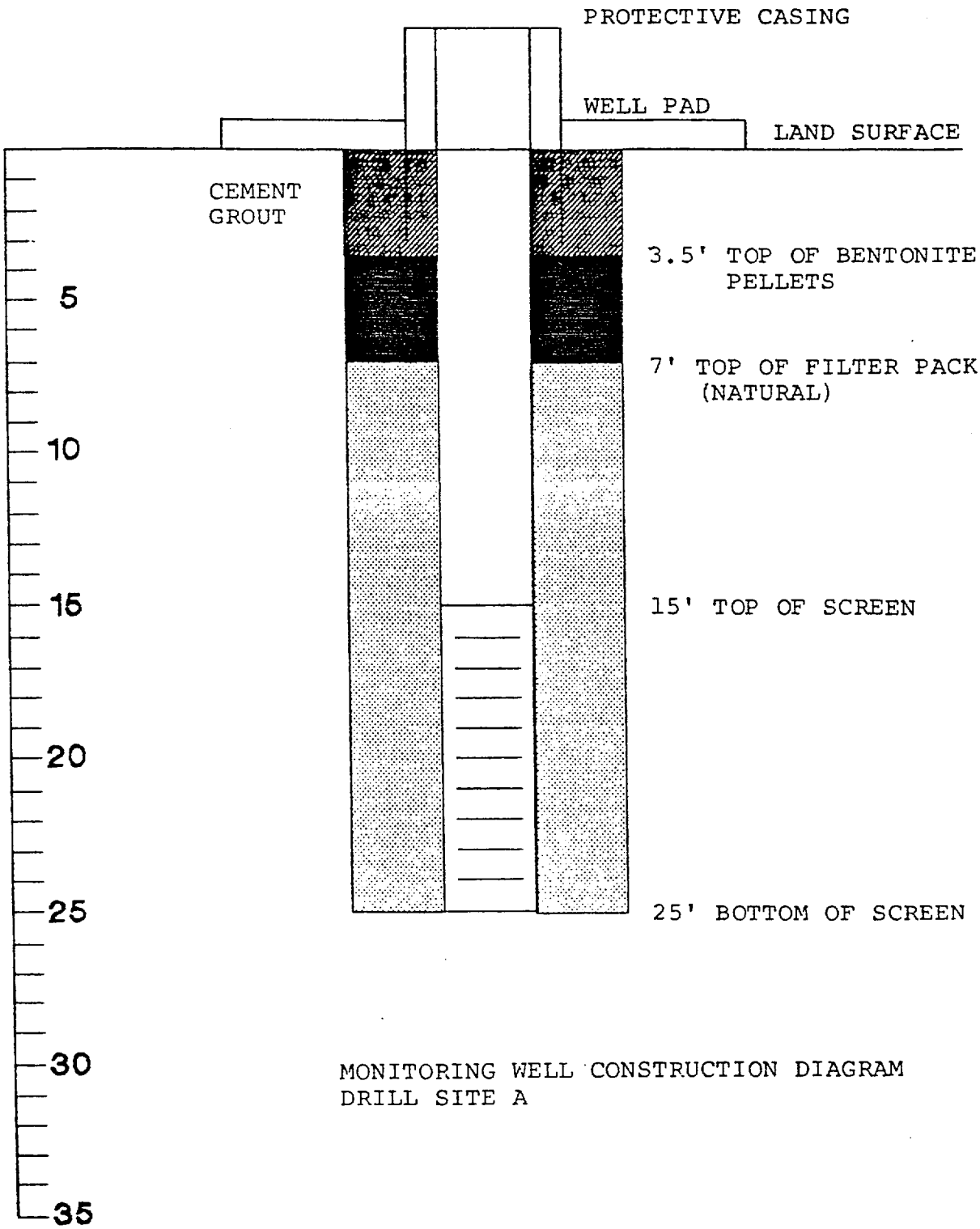
HOLE NO: I

PAGE: 2

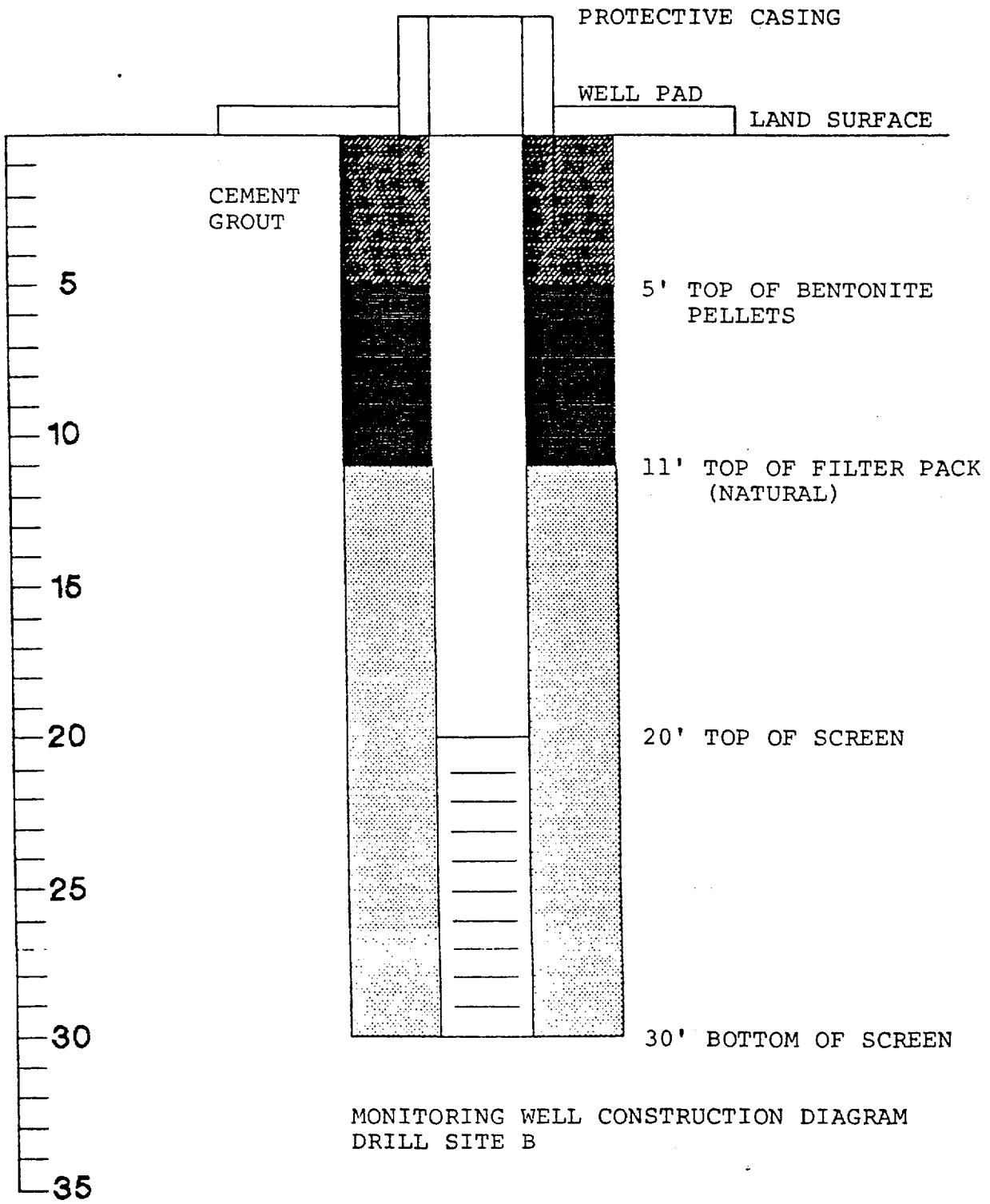
DEPTH	ELEV AMSL	STRIP CHART	RECOVERY	STRATA CHANGE	LITHOLOGIC DESCRIPTION: ROCK NAME, COLOR, COLOR PATTERN, GRAIN SIZE, PERCENT SAND, ROUNDNESS, MINERALOGY, CALCAREOUS, STRUCTURE, FOSSILS, STRENGTH, ACCESSORIES	REMARKS
26			24-26' (2.0')		SAND, DUSKY BROWN, MEDIUM TO COARSE GRAIN, <10% FINES, GOOD VISABLE POROSITY, GRAVEL @ 26', SATURATED, DENSE TOTAL DEPTH @ 26'	

APPENDIX D

MONITORING WELL CONSTRUCTION DIAGRAMS



MONITORING WELL CONSTRUCTION DIAGRAM
DRILL SITE A



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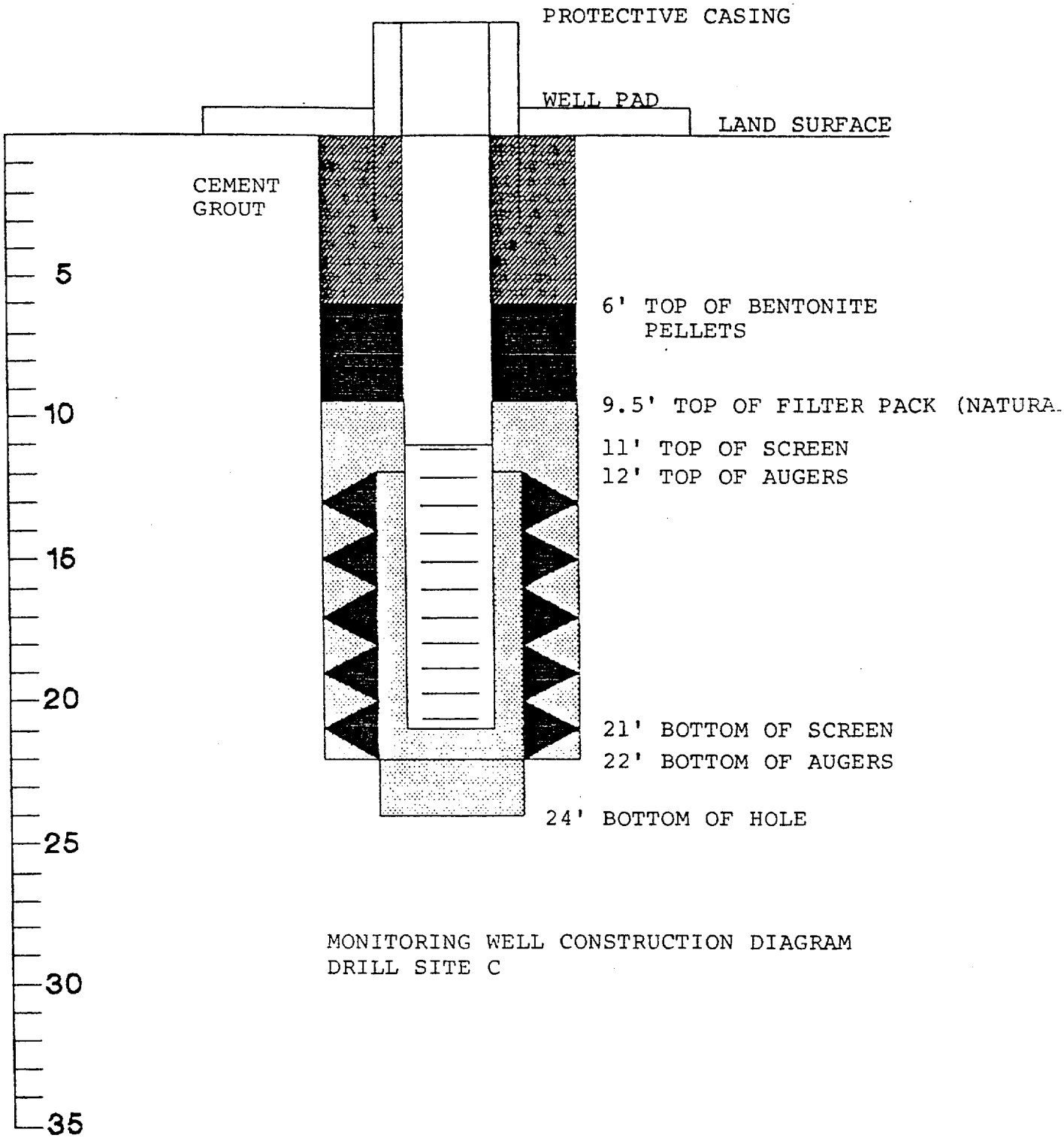
DRILL SITE B



MONITORING WELL CONSTRUCTION DIAGRAM
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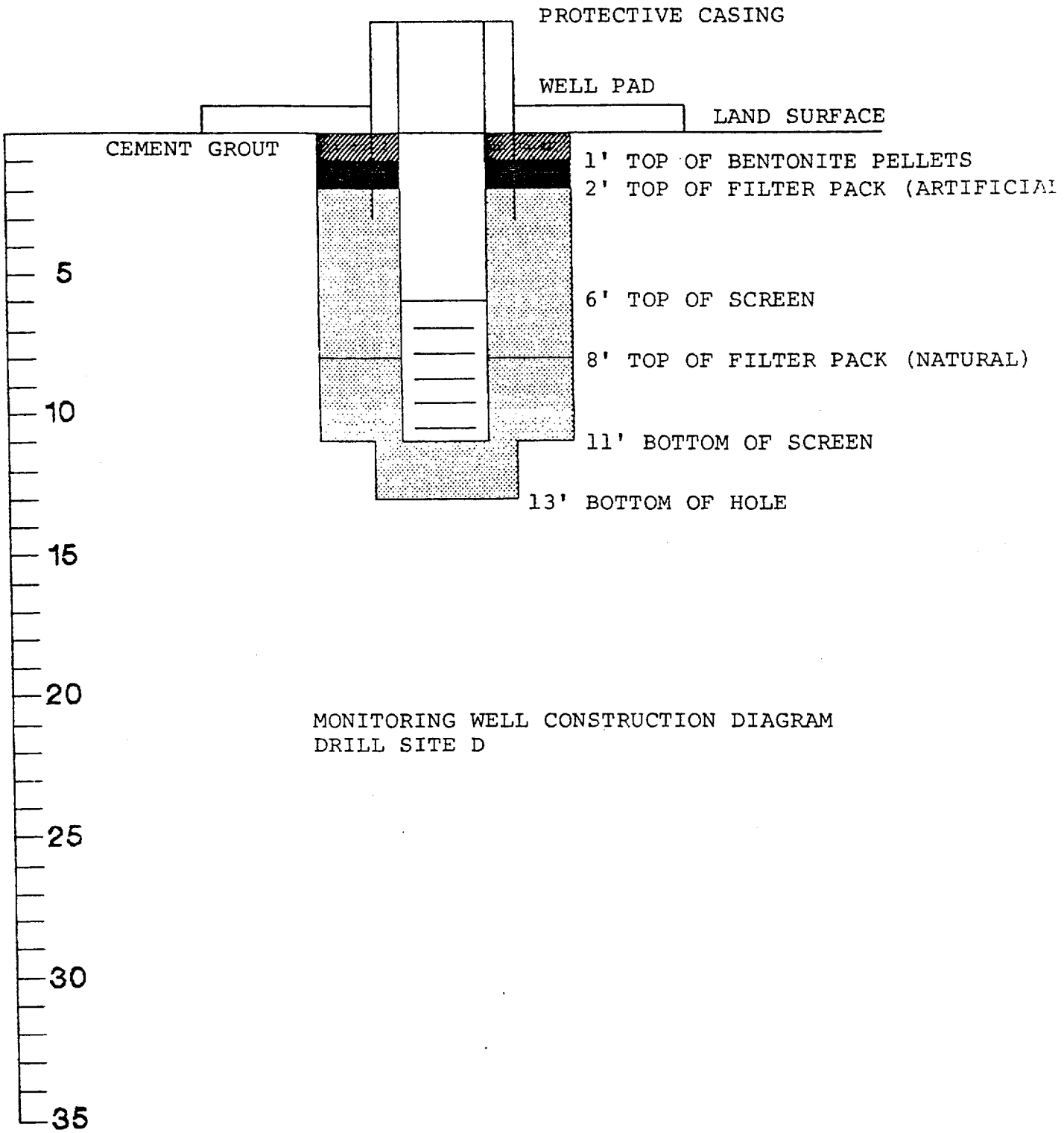
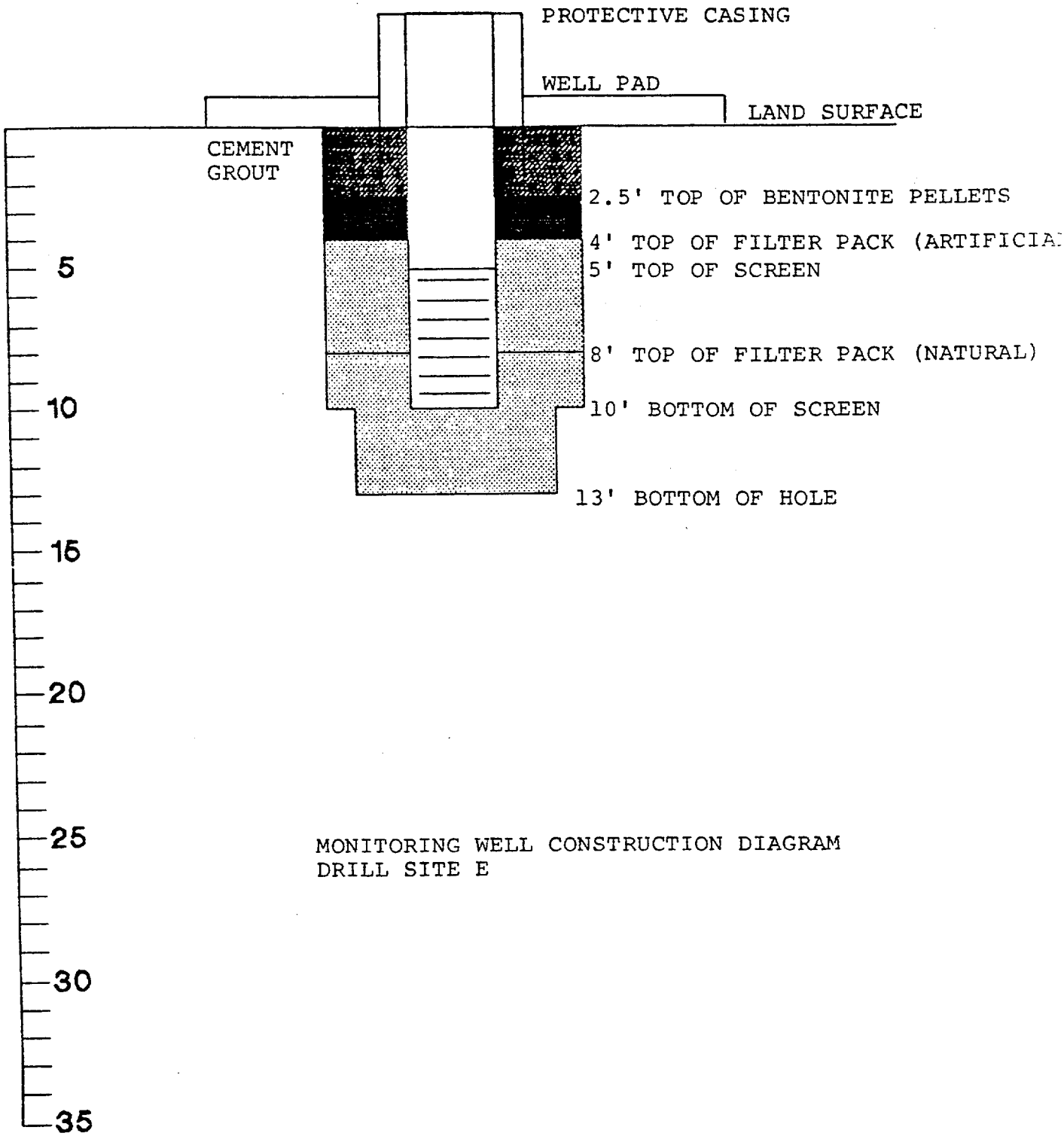
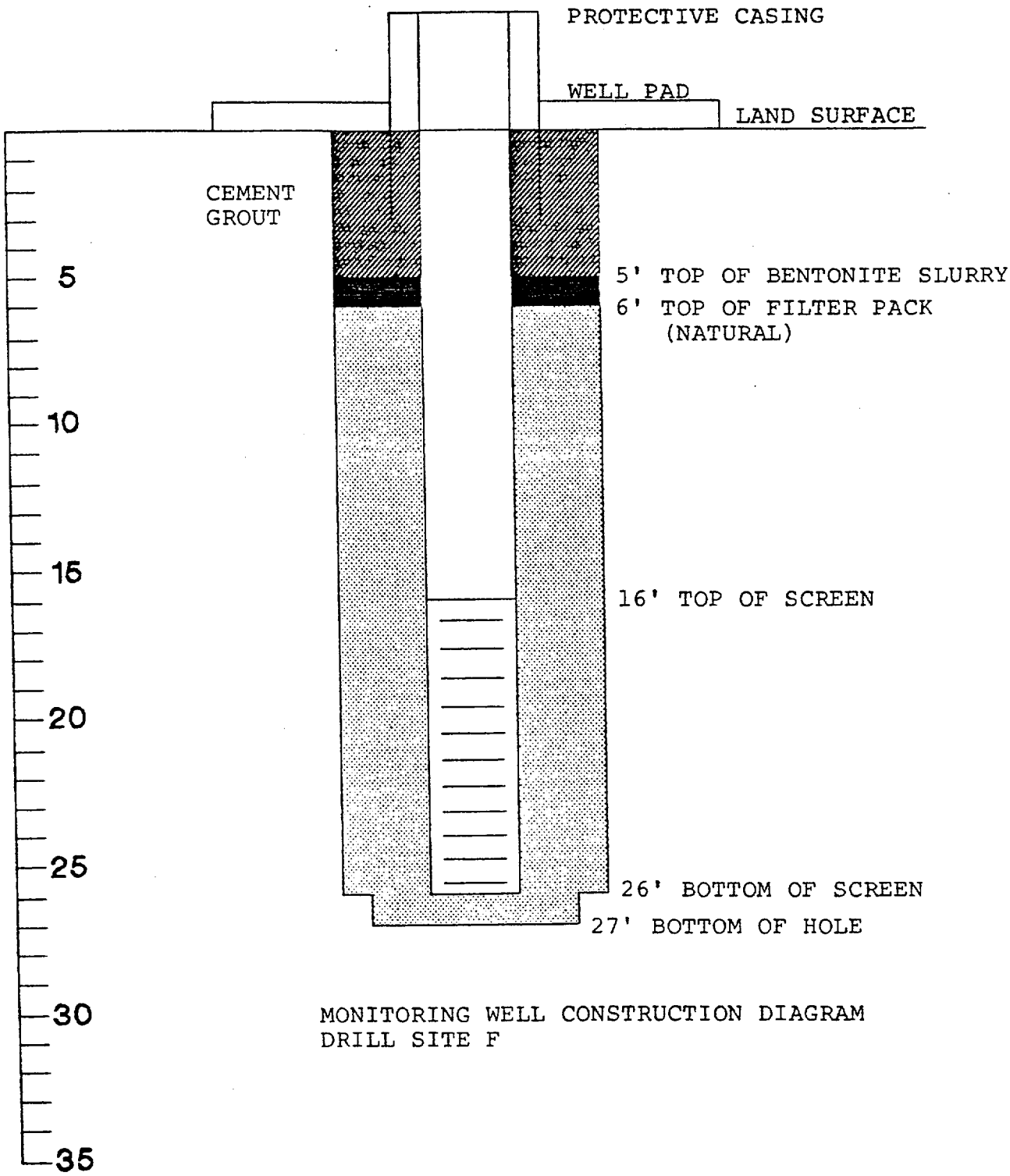


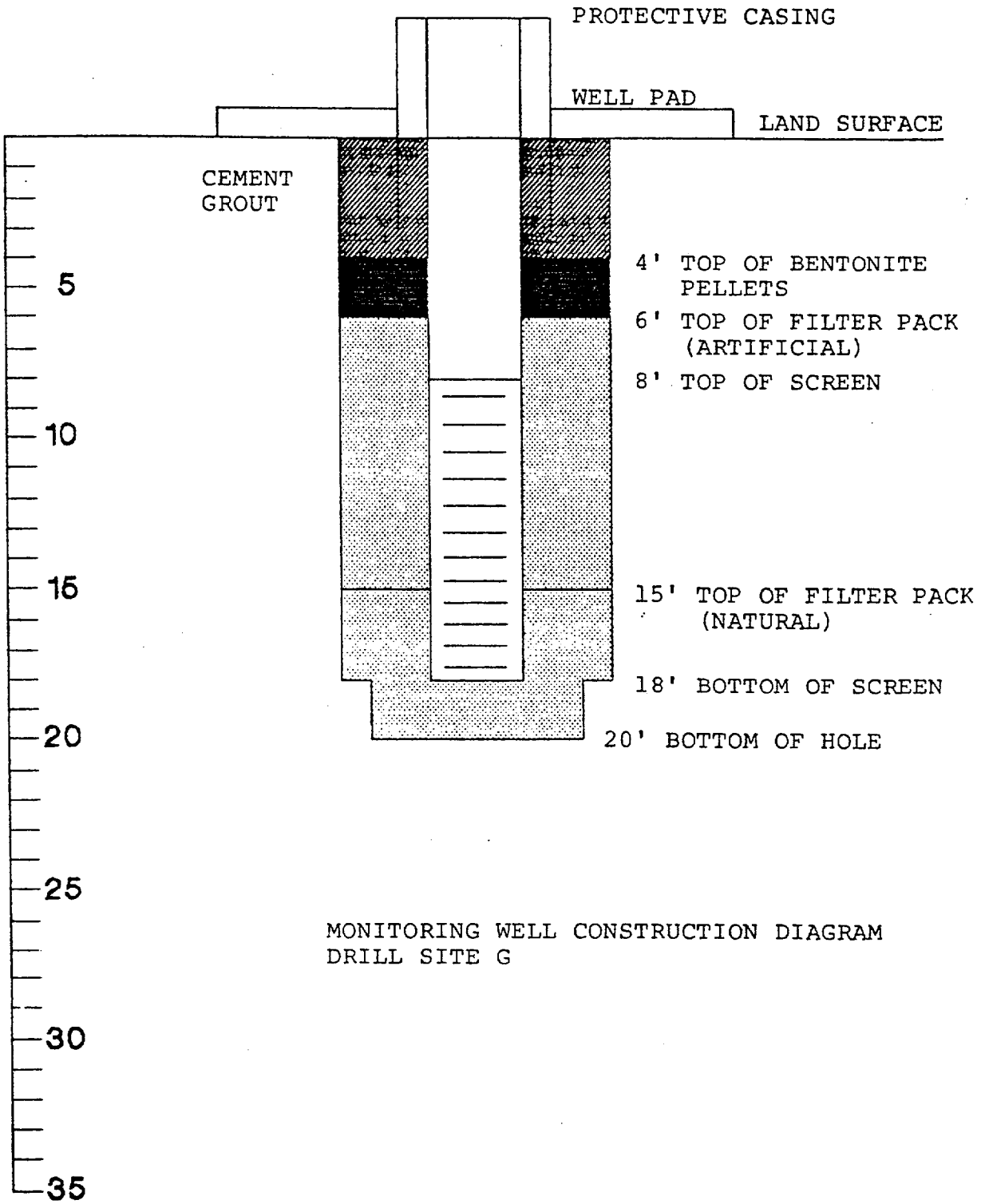
MONITORING WELL CONSTRUCTION DIAGRAM
DRILL SITE D



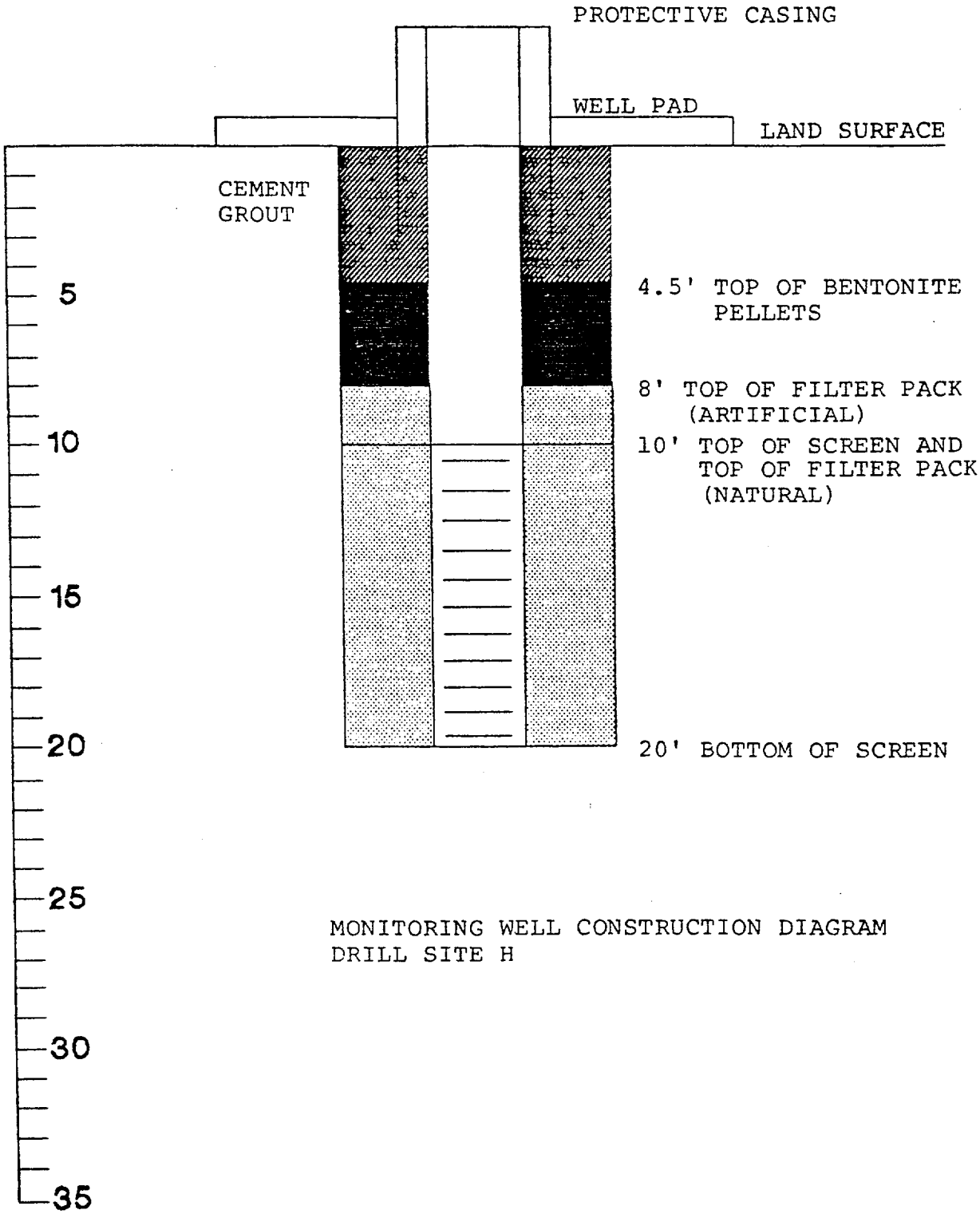
MONITORING WELL CONSTRUCTION DIAGRAM
DRILL SITE E



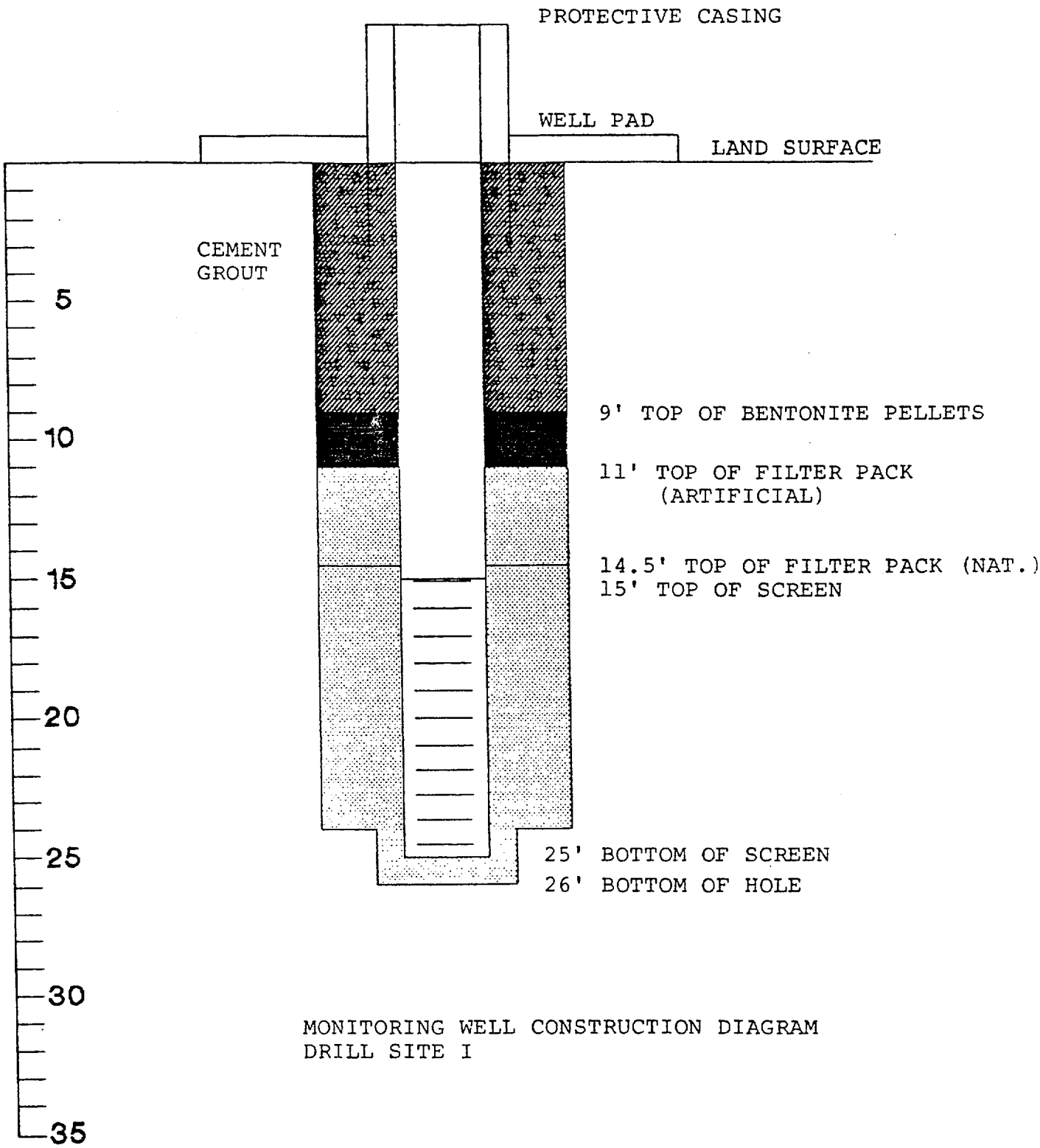
MONITORING WELL CONSTRUCTION DIAGRAM
DRILL SITE F



MONITORING WELL CONSTRUCTION DIAGRAM
DRILL SITE G



MONITORING WELL CONSTRUCTION DIAGRAM
DRILL SITE H



MONITORING WELL CONSTRUCTION DIAGRAM
DRILL SITE I

APPENDIX E

DETAILED RADIOLOGICAL RESULTS

CNSI ENVIRONMENTAL AND DOSIMETRY LABORATORY
SAFETY LIGHT PROJECT REPORT

Test Hole/Depth	Date Collected	Radionuclide Analysis	Analysis Results* (pCi/gm ± 2 Sigma)	Date Analyzed	Moisture Content
A/0-2'	06/23/90	SR-90	7.0E-01+-0.6E-01	07/26/90	24.8 %
		CS-137	2.57E+00+-2.36E-01	07/24/90	
		RA-226	1.11E+00+-2.58E-01	07/24/90	
		RA-228	1.44E+00+-4.42E-01	07/24/90	
A1/2-4'	06/30/90	SR-90	4.5E-01+-1.0E-01	08/04/90	24.3 %
		CS-137	< 9.35E-02	07/27/90	
		RA-226	9.65E-01+-2.90E-01	07/27/90	
		RA-228	1.31E+00+-4.94E-01	07/27/90	
A1/4-6'	06/30/90	SR-90	8.9E-01+-1.5E-01	08/04/90	18.1 %
		CS-137	< 6.50E-02	08/08/90	
		RA-226	8.25E-01+-1.90E-01	08/08/90	
		RA-228	9.64E-01+-3.31E-01	08/08/90	
A1/6-10'	06/30/90	SR-90	7.8E-01+-1.3E-01	08/04/90	9.8 %
		CS-137	< 9.28E-02	07/27/90	
		RA-226	7.00E-01+-2.34E-01	07/27/90	
		RA-228	1.19E+00+-4.80E-01	07/27/90	
A/10-16'	06/23/90	SR-90	7.8E-01+-0.7E-01	07/26/90	18.5 %
		CS-137	7.01E-02+-5.40E-02	08/08/90	
		RA-226	5.34E-01+-1.43E-01	08/08/90	
		RA-228	1.07E+00+-2.95E-01	08/08/90	
A/16-22'	06/25/90	SR-90	1.3E+00+-0.1E+00	07/26/90	12.4 %
		CS-137	7.80E-02+-5.30E-02	08/08/90	
		RA-226	5.41E-01+-1.42E-01	08/08/90	
		RA-228	8.45E-01+-2.89E-01	08/08/90	
A/22-25.5'	06/25/90	SR-90	2.2E-01+-0.4E-01	07/26/90	8.9 %
		CS-137	9.42E-02+-6.90E-02	08/08/90	
		RA-226	5.87E-01+-1.47E-01	08/08/90	
		RA-228	6.95E-01+-2.22E-01	08/08/90	

* pCi/gm - dry weight. Two sigma error represents counting statistics only.

CNSI ENVIRONMENTAL AND DOSIMETRY LABORATORY
SAFETY LIGHT PROJECT REPORT

Test Hole/Depth	Date Collected	Radionuclide Analysis	Analysis Results* (pCi/gm ± 2 Sigma)	Date Analyzed	Moisture Content
B/0-2'	06/26/90	SR-90	< 3.E-02	07/26/90	17.8 %
		CS-137	< 9.75E-02	07/25/90	
		RA-226	9.82E-01+-2.55E-01	07/25/90	
		RA-228	1.07E+00+-3.89E-01	07/25/90	
B/2-4'	06/26/90	SR-90	< 3.E-02	07/26/90	8.2 %
		CS-137	< 1.12E-01	07/25/90	
		RA-226	6.58E-01+-2.13E-01	07/25/90	
		RA-228	8.17E-01+-4.43E-01	07/25/90	
B/4-6'	06/26/90	SR-90	< 5.E-02	07/26/90	5.7 %
		CS-137	< 6.31E-02	07/25/90	
		RA-226	6.90E-01+-2.03E-01	07/25/90	
		RA-228	9.61E-01+-3.98E-01	07/25/90	
B/6-8'	06/26/90	SR-90	< 4.E-02	07/28/90	4.3 %
		CS-137	< 6.50E-02	07/25/90	
		RA-226	7.87E-01+-2.38E-01	07/25/90	
		RA-228	1.04E+00+-4.70E-01	07/25/90	
B/8-12'	06/26/90	SR-90	< 4.E-02	07/26/90	15.6 %
		CS-137	< 7.82E-02	07/26/90	
		RA-226	6.98E-01+-2.23E-01	07/26/90	
		RA-228	1.11E+00+-4.21E-01	07/26/90	
B/12-16'	06/26/90	SR-90	1.7E-01+-0.4E-01	07/26/90	7.5 %
		CS-137	< 9.38E-02	07/26/90	
		RA-226	5.74E-01+-2.15E-01	07/26/90	
		RA-228	9.77E-01+-4.30E-01	07/26/90	
B/16-20'	06/26/90	SR-90	< 5.E-01	08/10/90	8.1 %
		CS-137	< 8.64E-02	07/26/90	
		RA-226	5.41E-01+-1.98E-01	07/26/90	
		RA-228	8.56E-01+-3.13E-01	07/26/90	
B/20-22'	06/26/90	SR-90	< 2.E-01	08/04/90	12.0 %
		CS-137	< 1.06E-01	07/26/90	
		RA-226	4.64E-01+-2.39E-01	07/26/90	
		RA-228	9.47E-01+-4.13E-01	07/26/90	
B/22-24'	06/26/90	SR-90	1.7E-01+-0.7E-01	08/04/90	10.6 %
		CS-137	< 7.83E-02	07/26/90	
		RA-226	5.45E-01+-2.17E-01	07/26/90	
		RA-228	9.42E-01+-4.59E-01	07/26/90	

* pCi/gm - dry weight. Two sigma error represents counting statistics only.

CNSI ENVIRONMENTAL AND DOSIMETRY LABORATORY
SAFETY LIGHT PROJECT REPORT

Test Hole/Depth	Date Collected	Radionuclide Analysis	Analysis Results* (pCi/gm ± 2 Sigma)	Date Analyized	Moisture Content
B/24-26'	06/26/90	SR-90	3.4E-01+-0.4E-01	08/04/90	8.9 %
		CS-137	< 8.77E-02	07/26/90	
		RA-226	5.74E-01+-2.10E-01	07/26/90	
		RA-228	9.62E-01+-3.54E-01	07/26/90	
B/26-30'	06/26/90	SR-90	< 2.E-01	08/04/90	16.8 %
		CS-137	< 5.47E-02	07/26/90	
		RA-226	6.45E-01+-2.10E-01	07/26/90	
		RA-228	7.98E-01+-3.58E-01	07/26/90	

* pCi/gm - dry weight. Two sigma error represents counting statistics only.

CNSI ENVIRONMENTAL AND DOSIMETRY LABORATORY
SAFETY LIGHT PROJECT REPORT

Test Hole/Depth	Date Collected	Radionuclide Analysis	Analysis Results* (pCi/gm ± 2 Sigma)	Date Analyzed	Moisture Content
C/0-2'	06/27/90	SR-90	< 1.E-01	08/04/90	9.1 %
		CS-137	8.72E-01+-1.60E-01	07/27/90	
		RA-226	8.34E-01+-2.29E-01	07/27/90	
		RA-228	5.28E-01+-4.17E-01	07/27/90	
C/2-6'	06/27/90	SR-90	< 5.E-02	08/09/90	4.2 %
		CS-137	3.17E-01+-1.22E-01	07/27/90	
		RA-226	8.29E-01+-2.09E-01	07/27/90	
		RA-228	7.98E-01+-3.69E-01	07/27/90	
C/6-8'	06/27/90	SR-90	1.4E-01+-0.5E-01	08/07/90	1.5 %
		CS-137	< 1.06E-01	07/27/90	
		RA-226	6.71E-01+-2.06E-01	07/27/90	
		RA-228	6.26E-01+-3.16E-01	07/27/90	
C/8-10'	06/27/90	SR-90	< 4.E-02	08/07/90	4.2 %
		CS-137	< 8.00E-02	07/27/90	
		RA-226	7.17E-01+-1.96E-01	07/27/90	
		RA-228	6.44E-01+-3.37E-01	07/27/90	
C/10-12'	06/28/90	SR-90	< 6.E-02	08/07/90	3.5 %
		CS-137	< 7.60E-02	07/27/90	
		RA-226	7.10E-01+-1.94E-01	07/27/90	
		RA-228	9.52E-01+-4.10E-01	07/27/90	
C/12-14'	06/28/90	SR-90	< 7.E-02	08/07/90	3.8 %
		CS-137	< 5.82E-02	07/27/90	
		RA-226	5.50E-01+-2.37E-01	07/27/90	
		RA-228	8.62E-01+-4.18E-01	07/27/90	
C/14-18'	06/28/90	SR-90	< 8.E-02	08/07/90	6.5 %
		CS-137	< 8.87E-02	07/27/90	
		RA-226	6.98E-01+-1.94E-01	07/27/90	
		RA-228	5.10E-01+-3.73E-01	07/27/90	
C/18-20'	06/28/90	SR-90	< 9.E-02	08/07/90	11.5 %
		CS-137	< 8.53E-02	07/27/90	
		RA-226	6.10E-01+-1.95E-01	07/27/90	
		RA-228	6.88E-01+-3.20E-01	07/27/90	
C/20-22'	06/28/90	SR-90	< 7.E-02	08/07/90	15.2 %
		CS-137	< 6.88E-02	07/25/90	
		RA-226	5.39E-01+-2.18E-01	07/27/90	
		RA-228	6.77E-01+-3.77E-01	07/27/90	

* pCi/gm - dry weight. Two sigma error represents counting statistics only.

CNSI ENVIRONMENTAL AND DOSIMETRY LABORATORY
SAFETY LIGHT PROJECT REPORT

Test Hole/Depth	Date Collected	Radionuclide Analysis	Analysis Results* (pCi/gm ± 2 Sigma)	Date Analyzed	Moisture Content
C/22-24'	06/28/90	SR-90	< 1.E-01	08/07/90	13.7 %
		CS-137	< 7.28E-02	07/28/90	
		RA-226	5.28E-01+-1.92E-01	07/28/90	
		RA-228	7.21E-01+-4.38E-01	07/28/90	

* pCi/gm - dry weight. Two sigma error represents counting statistics only.

CNSI ENVIRONMENTAL AND DOSIMETRY LABORATORY
SAFETY LIGHT PROJECT REPORT

Test Hole/Depth	Date Collected	Radionuclide Analysis	Analysis Results* (pCi/gm ± 2 Sigma)	Date Analyzed	Moisture Content
D/0-2'	07/04/90	SR-90	5.1E-01+-0.9E-01	08/07/90	19.8 %
		CS-137	< 9.07E-02	07/28/90	
		RA-226	7.50E-01+-2.54E-01	07/28/90	
		RA-228	9.08E-01+-4.16E-01	07/28/90	
D/2-4'	07/04/90	SR-90	7.4E-01+-1.3E-01	08/09/90	15.7 %
		CS-137	4.64E-01+-1.33E-01	07/28/90	
		RA-226	9.57E-01+-2.41E-01	07/28/90	
		RA-228	9.62E-01+-3.62E-01	07/28/90	
D/4-6'	07/04/90	SR-90	3.3E-01+-1.0E-01	08/09/90	17.1 %
		CS-137	< 6.23E-02	08/08/90	
		RA-226	9.92E-01+-1.99E-01	08/08/90	
		RA-228	1.43E+00+-3.86E-01	08/08/90	
D/6-8'	07/04/90	SR-90	3.7E-01+-.09E-01	08/09/90	14.6 %
		CS-137	9.67E-02+-7.70E-02	07/28/90	
		RA-226	8.20E-01+-2.40E-01	07/28/90	
		RA-228	1.02E+00+-4.68E-01	07/28/90	
D/8-10'	07/04/90	SR-90	1.0E+00+-0.1E+00	08/09/90	12.2 %
		CS-137	8.33E-02+-6.70E-02	07/28/90	
		RA-226	7.23E-01+-2.45E-01	07/28/90	
		RA-228	1.35E+00+-4.78E-01	07/28/90	
D/10-12'	07/04/90	SR-90	1.3E+00+-0.2E+00	08/09/90	10.4 %
		CS-137	< 6.44E-02	08/08/90	
		RA-226	5.79E-01+-1.35E-01	08/09/90	
		RA-228	6.68E-01+-2.84E-01	08/09/90	
D/12-13'	07/04/90	SR-90	1.7E+00+-0.2E+00	08/09/90	8.7 %
		CS-137	< 5.50E-02	07/28/90	
		RA-226	6.67E-01+-2.15E-01	07/28/90	
		RA-228	1.35E+00+-4.63E-01	07/28/90	

* pCi/gm - dry weight. Two sigma error represents counting statistics only.

CNSI ENVIRONMENTAL AND DOSIMETRY LABORATORY
SAFETY LIGHT PROJECT REPORT

Test Hole/Depth	Date Collected	Radionuclide Analysis	Analysis Results* (pCi/gm ± 2 Sigma)	Date Analyzed	Moisture Content
E/0-4'	07/05/90	SR-90	4.5E-01+-1.0E-01	08/09/09	9.3 %
		CS-137	1.32E+00+-1.73E-01	07/28/90	
		RA-226	8.32E-01+-2.27E-01	07/28/90	
		RA-228	1.00E+00+-4.84E-01	07/28/90	
E/4-6'	07/05/90	SR-90	8.5E-01+-1.4E-01	08/09/90	19.2 %
		CS-137	4.60E-02+-4.70E-02	08/10/90	
		RA-226	8.35E-01+-1.75E-01	08/10/90	
		RA-228	1.14E+00+-3.36E-01	08/10/90	
E/6-8'	07/05/90	SR-90	1.2E+00+-0.2E+00	08/09/90	12.1 %
		CS-137	3.93E-01+-1.54E-01	07/31/90	
		RA-226	7.43E-01+-2.40E-01	07/31/90	
		RA-228	1.32E+00+-5.17E-01	07/31/90	
E/8-10'	07/05/90	SR-90	1.4E+00+-0.2E+00	08/10/90	12.7 %
		CS-137	1.50E-01+-1.06E-01	08/01/90	
		RA-226	8.93E-01+-2.28E-01	08/01/90	
		RA-228	1.34E+00+-3.71E-01	08/01/90	
E/10-13'	07/05/90	SR-90	9.4E-01+-2.3E-01	08/11/90	13.1 %
		CS-137	8.93E-02+-5.30E-02	08/09/90	
		RA-226	7.91E-01+-1.76E-01	08/09/90	
		RA-228	1.24E+00+-3.52E-01	08/09/90	

* pCi/gm - dry weight. Two sigma error represents counting statistics only.

CNSI ENVIRONMENTAL AND DOSIMETRY LABORATORY
SAFETY LIGHT PROJECT REPORT

Test Hole/Depth	Date Collected	Radionuclide Analysis	Analysis Results* (pCi/gm ± 2 Sigma)	Date Analyzed	Moisture Content
F/0-6'	07/07/90	SR-90	6.8E-01+-0.8E-01	08/30/90	7.6 %
		CS-137	1.45E+00+-2.16E-01	08/02/90	
		RA-226	8.65E-01+-2.90E-01	08/02/90	
		RA-228	1.17E+00+-5.23E-01	08/02/90	
F/6-10'	07/07/90	SR-90	2.2E+00+-0.1E+00	08/30/90	11.9 %
		CS-137	4.62E-01+-1.20E-01	08/02/90	
		RA-226	5.47E-01+-2.41E-01	08/02/90	
		RA-228	5.62E-01+-4.09E-01	08/02/90	
F/10-12'	07/07/90	SR-90	1.9E-01+-0.5E-01	08/30/90	14.6 %
		CS-137	< 8.27E-02	08/02/90	
		RA-226	3.90E-01+-2.00E-01	08/02/90	
		RA-228	8.06E-01+-3.98E-01	08/02/90	
F/12-14'	07/07/90	SR-90	< 7.E-02	09/01/90	13.5 %
		CS-137	< 8.05E-02	08/02/90	
		RA-226	3.81E-01+-1.76E-01	08/02/90	
		RA-228	5.99E-01+-3.44E-01	08/02/90	
F/14-16'	07/07/90	SR-90	1.2E-01+-0.5E-01	08/31/90	12.2 %
		CS-137	< 6.47E-02	08/10/90	
		RA-226	4.77E-01+-1.46E-01	08/10/90	
		RA-228	6.00E-01+-2.69E-01	08/10/90	
F/16-18'	07/07/90	SR-90	1.1E-01+-0.4E-01	08/30/90	12.1 %
		CS-137	< 7.27E-02	08/02/90	
		RA-226	4.76E-01+-1.50E-01	08/02/90	
		RA-228	9.08E-01+-3.80E-01	08/02/90	
F/18-20'	07/07/90	SR-90	2.2E-01+-0.5E-01	08/30/90	10.3 %
		CS-137	< 7.06E-02	08/02/90	
		RA-226	5.29E-01+-2.02E-01	08/02/90	
		RA-228	7.65E-01+-3.93E-01	08/02/90	
F/20-22'	07/07/90	SR-90	1.4E-01+-0.4E-01	08/30/90	9.5 %
		CS-137	< 7.39E-02	08/03/90	
		RA-226	3.84E-01+-1.44E-01	08/03/90	
		RA-228	5.65E-01+-3.63E-01	08/03/90	
F/22-24'	07/07/90	SR-90	5.8E-02+-3.6E-02	08/30/90	6.8 %
		CS-137	< 8.13E-02	08/03/90	
		RA-226	3.82E-01+-1.97E-01	08/03/90	
		RA-228	5.75E-01+-2.79E-01	08/03/90	

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CNSI ENVIRONMENTAL AND DOSIMETRY LABORATORY
SAFETY LIGHT PROJECT REPORT

Test Hole/Depth	Date Collected	Radionuclide Analysis	Analysis Results* (pCi/gm ± 2 Sigma)	Date Analyzed	Moisture Content
F/24-26'	07/07/90	SR-90	< 6.E-02	09/01/90	7.3 %
		CS-137	< 4.40E-02	08/03/90	
		RA-226	4.58E-01+-1.79E-01	08/03/90	
		RA-228	4.76E-01+-3.50E-01	08/03/90	
F/26-27'	07/07/90	SR-90	7.1E-02+-2.8E-02	09/01/90	15.8 %
		CS-137	< 4.92E-02	08/10/90	
		RA-226	4.12E-01+-1.32E-01	08/10/90	
		RA-228	7.26E-01+-2.46E-01	08/10/90	

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CNSI ENVIRONMENTAL AND DOSIMETRY LABORATORY
SAFETY LIGHT PROJECT REPORT

Test Hole/Depth	Date Collected	Radionuclide Analysis	Analysis Results* (pCi/gm ± 2 Sigma)	Date Analyzed	Moisture Content
G/0-2'	07/10/90	SR-90	1.7E-01+-1.1E-01	08/11/90	18.2 %
		CS-137	4.65E-01+-1.33E-01	08/01/90	
		RA-226	9.77E-01+-2.58E-01	08/01/90	
		RA-228	1.09E+00+-3.76E-01	08/01/90	
G/2-4'	07/10/90	SR-90	3.4E-01+-1.1E-01	08/11/90	19.0 %
		CS-137	2.39E-01+-1.16E-01	08/01/90	
		RA-226	1.04E+00+-2.90E-01	08/01/90	
		RA-228	1.42E+00+-5.03E-01	08/01/90	
G/4-6'	07/10/90	SR-90	5.2E-01+-1.1E-01	08/11/90	22.8 %
		CS-137	3.10E-01+-1.29E-01	08/01/90	
		RA-226	1.74E+00+-3.10E-01	08/01/90	
		RA-228	9.45E-01+-4.22E-01	08/01/90	
G/6-8'	07/10/90	SR-90	3.7E-01+-1.5E-01	08/11/90	27.2 %
		CS-137	1.56E-01+-1.08E-01	08/01/90	
		RA-226	1.20E+00+-2.87E-01	08/01/90	
		RA-228	7.37E-01+-4.32E-01	08/01/90	
G/8-10'	07/10/90	SR-90	1.9E+00+-0.2E+00	08/11/90	21.1 %
		CS-137	< 1.08E-01	08/01/90	
		RA-226	7.55E-01+-2.02E-01	08/01/90	
		RA-228	8.71E-01+-3.92E-01	08/01/90	
G/10-12'	07/10/90	SR-90	8.2E-01+-2.3E-01	08/14/90	18.7 %
		CS-137	< 7.81E-02	08/09/90	
		RA-226	1.03E+00+-1.77E-01	08/09/90	
		RA-228	1.20E+00+-3.07E-01	08/09/90	
G/12-14'	07/10/90	SR-90	1.3E-01+-0.8E-01	08/11/90	10.1 %
		CS-137	< 7.17E-02	08/02/90	
		RA-226	5.13E-01+-2.26E-01	08/02/90	
		RA-228	8.92E-01+-4.87E-01	08/02/90	
G/14-18'	07/10/90	SR-90	< 1.E-01	08/11/90	7.8 %
		CS-137	< 6.79E-02	08/02/90	
		RA-226	5.37E-01+-1.91E-01	08/02/90	
		RA-228	8.39E-01+-4.01E-01	08/02/90	
G/18-20'	07/10/90	SR-90	< 9.E-02	08/11/90	13.6 %
		CS-137	< 6.68E-02	08/02/90	
		RA-226	6.06E-01+-1.82E-01	08/02/90	
		RA-228	7.82E-01+-3.04E-01	08/02/90	

* pCi/gm - dry weight. Two sigma error represents counting statistics only.

CNSI ENVIRONMENTAL AND DOSIMETRY LABORATORY
SAFETY LIGHT PROJECT REPORT

Test Hole/Depth	Date Collected	Radionuclide Analysis	Analysis Results* (pCi/gm ± 2 Sigma)	Date Analyzed	Moisture Content
I/0-2'	07/16/90	SR-90	< 8.E-02	09/04/90	12.3 %
		CS-137	5.83E-01+-1.40E-01	08/03/90	
		RA-226	8.58E-01+-2.22E-01	08/03/90	
		RA-228	6.50E-01+-3.12E-01	08/03/90	
I/2-4'	07/16/90	SR-90	2.4E-01+-0.4E-01	09/01/90	8.2 %
		CS-137	2.53E-01+-1.13E-01	08/03/90	
		RA-226	7.96E-01+-2.18E-01	08/03/90	
		RA-228	7.71E-01+-4.12E-01	08/03/90	
I/4-6'	07/16/90	SR-90	< 3.E-02	09/01/90	2.7 %
		CS-137	< 5.79E-02	08/10/90	
		RA-226	5.77E-01+-1.45E-01	08/10/90	
		RA-228	1.07E+00+-4.70E-01	08/10/90	
I/6-8'	07/16/90	SR-90	< 3.E-02	09/01/90	2.6 %
		CS-137	< 5.33E-02	08/10/90	
		RA-226	5.97E-01+-1.36E-01	08/10/90	
		RA-228	8.85E-01+-3.34E-01	08/10/90	
I/8-10'	07/16/90	SR-90	< 2.E-02	09/01/90	2.3 %
		CS-137	< 6.70E-02	08/03/90	
		RA-226	3.37E-01+-1.89E-01	08/03/90	
		RA-228	1.25E+00+-3.66E-01	08/03/90	
I/10-11'	07/16/90	SR-90	< 4.E-02	09/01/90	2.1 %
		CS-137	< 8.19E-02	08/13/90	
		RA-226	6.06E-01+-2.39E-01	08/13/90	
		RA-228	1.01E+00+-4.73E-01	08/13/90	
I/20-24'	07/16/90	SR-90	< 7.E-02	09/01/90	14.9 %
		CS-137	1.73E-01+-6.30E-02	08/13/90	
		RA-226	4.85E-01+-1.40E-01	08/13/90	
		RA-228	9.43E-01+-2.94E-01	08/13/90	
I/24-26'	07/16/90	SR-90	< 2.E-02	09/01/90	10.1 %
		CS-137	< 7.81E-02	08/03/90	
		RA-226	7.04E-01+-2.03E-01	08/03/90	
		RA-228	7.61E-01+-3.84E-01	08/03/90	

* pCi/gm - dry weight. Two sigma error represents counting statistics only.

CNSI ENVIRONMENTAL AND DOSIMETRY LABORATORY
SAFETY LIGHT PROJECT REPORT

Test Hole/Depth	Date Collected	Radionuclide Analysis	Analysis Results* (pCi/L. ± 2 Sigma)	Date Analyized
A/0-2'	06/23/90	Tritium	2.43E+04+-4.90E+02	06/30/90
A1/2-4'	06/30/90	Tritium	1.28E+04+-3.76E+02	07/06/90
A1/4-6'	06/30/90	Tritium	1.11E+04+-3.57E+02	07/06/90
A1/6-8'	06/30/90	Tritium	1.21E+04+-3.68E+02	07/06/90
A1/8-10'	06/30/90	Tritium	1.32E+04+-3.81E+02	07/06/90
A/10-12'	06/23/90	Tritium	1.77E+04+-4.28E+02	06/30/90
A/12-14'	06/23/90	Tritium	1.20E+04+-3.67E+02	06/30/90
A/14-16'	06/23/90	Tritium	1.27E+04+-3.75E+02	06/30/90
A/16-18'	06/25/90	Tritium	1.08E+04+-3.53E+02	06/30/90
A/18-20'	06/25/90	Tritium	1.45E+04+-3.96E+02	06/30/90
A/20-22'	06/25/90	Tritium	1.52E+04+-4.00E+02	06/30/90
A/22-24'	06/25/90	Tritium	9.64E+03+-3.35E+02	06/30/90
A/24-25'	06/25/90	Tritium	1.35E+04+-3.81E+02	06/30/90
A/25-25.5'	06/25/90	Tritium	1.08E+04+-3.54E+02	06/30/90
B/0-2'	06/26/90	Tritium	3.99E+04+-6.17E+02	06/30/90
B/2-4'	06/26/90	Tritium	3.94E+04+-6.07E+02	06/30/90
B/4-6'	06/26/90	Tritium	3.48E+04+-5.75E+02	06/30/90
B/6-8'	06/26/90	Tritium	3.43E+04+-5.74E+02	06/30/90
B/8-10'	06/26/90	Tritium	3.84E+04+-6.02E+02	06/30/90
B/10-12'	06/26/90	Tritium	4.43E+04+-6.43E+02	06/30/90
B/12-14'	06/26/90	Tritium	3.23E+04+-5.58E+02	06/30/90
B/14-16'	06/26/90	Tritium	2.24E+04+-4.72E+02	06/30/90
B/16-18'	06/26/90	Tritium	2.32E+04+-4.80E+02	06/30/90

* Two sigma error represents counting statistics only.

CNSI ENVIRONMENTAL AND DOSIMETRY LABORATORY
SAFETY LIGHT PROJECT REPORT

Test Hole/Depth	Date Collected	Radionuclide Analysis	Analysis Results* (pCi/L. ± 2 Sigma)	Date Analyzed
B/18-20'	06/26/90	Tritium	1.84E+04+-4.35E+02	06/30/90
B/20-22'	06/26/90	Tritium	1.33E+04+-3.86E+02	06/30/90
B/22-24'	06/26/90	Tritium	1.14E+04+-3.57E+02	06/30/90
B/24-26'	06/26/90	Tritium	1.04E+04+-3.49E+02	06/30/90
B/26-28'	06/26/90	Tritium	1.08E+04+-3.53E+02	06/30/90
B/28-30'	06/26/90	Tritium	1.02E+04+-3.42E+02	06/30/90
C/0-2'	06/27/90	Tritium	4.51E+04+-6.53E+02	07/06/90
C/2-4'	06/27/90	Tritium	3.81E+04+-6.04E+02	07/06/90
C/4-6'	06/27/90	Tritium	2.68E+04+-5.13E+02	07/06/90
C/6-8'	06/27/90	Tritium	2.26E+04+-5.09E+02	07/06/90
C/8-10'	06/27/90	Tritium	1.23E+04+-3.73E+02	07/06/90
C/10-12'	06/28/90	Tritium	9.59E+03+-3.41E+02	07/06/90
C/12-14'	06/28/90	Tritium	9.62E+03+-3.39E+02	07/06/90
C/14-16'	06/28/90	Tritium	9.47E+03+-3.37E+02	07/06/90
C/16-18'	06/28/90	Tritium	1.34E+04+-3.85E+02	07/06/90
C/18-20'	06/28/90	Tritium	9.96E+03+-3.44E+02	07/06/90
C/20-22'	06/28/90	Tritium	7.54E+03+-3.10E+02	07/06/90
C/22-24'	06/28/90	Tritium	7.67E+03+-3.13E+02	07/06/90
D/0-2'	07/04/90	Tritium	4.96E+04+-6.85E+02	07/10/90
D/2-4'	07/04/90	Tritium	7.67E+04+-8.38E+02	07/10/90
D/4-6'	07/04/90	Tritium	4.23E+04+-6.34E+02	07/10/90
D/6-8'	07/04/90	Tritium	4.91E+04+-6.79E+02	07/10/90
D/8-10'	07/04/90	Tritium	4.94E+04+-6.84E+02	07/10/90

* Two sigma error represents counting statistics only.

CNSI ENVIRONMENTAL AND DOSIMETRY LABORATORY
SAFETY LIGHT PROJECT REPORT

Test Hole/Depth	Date Collected	Radionuclide Analysis	Analysis Results* (pCi/L. ± 2 Sigma)	Date Analyzed
D/10-12'	07/04/90	Tritium	4.95E+04+-6.82E+02	07/10/90
D/12-13'	07/04/90	Tritium	4.24E+04+-6.35E+02	07/10/90
E/0-2'	07/05/90	Tritium	8.42E+04+-8.87E+02	07/10/90
E/2-4'	07/05/90	Tritium	9.01E+04+-9.06E+02	07/10/90
E/4-6'	07/05/90	Tritium	2.25E+04+-4.77E+02	07/10/90
E/6-8'	07/05/90	Tritium	3.01E+04+-5.46E+02	07/10/90
E/8-10'	07/05/90	Tritium	2.33E+04+-4.85E+02	07/10/90
E/10-12'	07/05/90	Tritium	3.29E+04+-5.67E+02	07/10/90
E/12-13'	07/05/90	Tritium	2.47E+04+-4.97E+02	07/10/90
F/0-2'	07/07/90	Tritium	6.96E+04+-8.07E+02	07/16/90
F/2-4'	07/07/90	Tritium	6.63E+04+-7.88E+02	07/16/90
F/4-6'	07/07/90	Tritium	2.37E+04+-4.91E+02	07/16/90
F/6-8'	07/07/90	Tritium	1.76E+04+-4.38E+02	07/16/90
F/8-10'	07/07/90	Tritium	1.13E+04+-3.66E+02	07/16/90
F/10-12'	07/07/90	Tritium	7.96E+03+-3.22E+02	07/16/90
F/12-14'	07/07/90	Tritium	7.13E+03+-3.07E+02	07/16/90
F/14-16'	07/07/90	Tritium	7.53E+03+-3.11E+02	07/16/90
F/16-18'	07/07/90	Tritium	8.15E+03+-3.20E+02	07/16/90
F/18-20'	07/07/90	Tritium	9.38E+03+-3.38E+02	07/16/90
F/20-22'	07/07/90	Tritium	9.01E+03+-3.35E+02	07/16/90
F/22-24'	07/07/90	Tritium	7.64E+03+-3.14E+02	07/16/90
F/24-26'	07/07/90	Tritium	7.62E+03+-3.13E+02	07/16/90
F/26-27'	07/07/90	Tritium	7.80E+03+-3.17E+02	07/16/90

* Two sigma error represents counting statistics only.

CNSI ENVIRONMENTAL AND DOSIMETRY LABORATORY
SAFETY LIGHT PROJECT REPORT

Test Hole/Depth	Date Collected	Radionuclide Analysis	Analysis Results* (pCi/L. ± 2 Sigma)	Date Analyized
F/26.8-27'	07/07/90	Tritium	7.94E+03+-3.20E+02	07/16/90
G/0-2'	07/10/90	Tritium	1.38E+04+-3.95E+02	07/16/90
G/2-4'	07/10/90	Tritium	8.70E+03+-3.29E+02	07/16/90
G/4-6'	07/10/90	Tritium	1.13E+04+-3.62E+02	07/16/90
G/6-8'	07/10/90	Tritium	7.56E+03+-3.15E+02	07/16/90
G/8-10'	07/10/90	Tritium	6.72E+03+-3.00E+02	07/16/90
G/10-12'	07/10/90	Tritium	7.10E+03+-3.07E+02	07/16/90
G/12-14'	07/10/90	Tritium	7.81E+03+-3.17E+02	07/16/90
G/14-16'	07/10/90	Tritium	6.18E+03+-2.93E+02	07/16/90
G/16-18'	07/10/90	Tritium	5.33E+03+-2.77E+02	07/16/90
G/18-20'	07/10/90	Tritium	4.60E+03+-2.68E+02	07/16/90
G/19.8-20'	07/10/90	Tritium	4.64E+03+-2.70E+02	07/16/90
I/0-2'	07/16/90	Tritium	7.05E+04+-8.08E+02	07/19/90
I/2-4'	07/16/90	Tritium	8.57E+04+-8.88E+02	07/19/90
I/4-6'	07/16/90	Tritium	5.12E+04+-6.93E+02	07/19/90
I/6-8'	07/16/90	Tritium	4.27E+04+-6.31E+02	07/19/90
I/8-10'	07/16/90	Tritium	5.72E+04+-7.34E+02	07/19/90
I/10-11'	07/16/90	Tritium	4.50E+04+-6.69E+02	07/19/90
I/12-14'	07/16/90	Tritium	Results Not Available	**/**/**
I/20-22'	07/16/90	Tritium	3.47E+04+-5.79E+02	07/19/90
I/22-24'	07/16/90	Tritium	2.64E+04+-5.10E+02	07/19/90
I/24-26'	07/16/90	Tritium	2.25E+04+-4.80E+02	07/19/90

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CNSI ENVIRONMENTAL AND DOSIMETRY LABORATORY
SAFETY LIGHT PROJECT REPORT

Sample Description	Date Collected	Radionuclide Analysis	Analysis Results* (pCi/L. ± 2 Sigma)	Date Analyized
Location 1	07/12/90	Tritium	< 2.87E+02	07/28/90
Location 2	07/12/90	Tritium	< 2.87E+02	07/28/90
Location 3	07/12/90	Tritium	< 2.87E+02	07/28/90
Location 4	07/12/90	Tritium	< 2.87E+02	07/28/90
Location 5	07/12/90	Tritium	< 2.87E+02	07/28/90
Location 6	07/12/90	Tritium	< 2.87E+02	07/28/90
Location 7	07/12/90	Tritium	< 2.87E+02	07/28/90
Location 8	07/12/90	Tritium	< 2.87E+02	07/28/90
Location 9	07/12/90	Tritium	< 2.87E+02	07/28/90
Location 10	07/12/90	Tritium	< 2.87E+02	07/28/90
Location 11	07/12/90	Tritium	< 2.87E+02	07/28/90
Location 12	07/12/90	Tritium	< 2.87E+02	07/28/90
Location 13	07/12/90	Tritium	3.09E+02+-1.86E+02	07/28/90
Location 14	07/12/90	Tritium	3.20E+02+-1.86E+02	07/28/90
Location 15	07/12/90	Tritium	2.83E+03+-2.40E+02	07/28/90
Location 16	07/12/90	Tritium	6.17E+03+-2.94E+02	07/28/90
Location 17	07/12/90	Tritium	5.03E+03+-2.75E+02	07/28/90
Location 18	07/12/90	Tritium	7.46E+03+-3.15E+02	07/28/90
Location 19	07/12/90	Tritium	1.16E+04+-3.79E+02	07/28/90
Location 20	07/12/90	Tritium	2.46E+04+-5.03E+02	07/28/90
Location 21	07/12/90	Tritium	1.08E+04+-3.58E+02	07/28/90
Location 22	07/12/90	Tritium	9.96E+03+-3.50E+02	07/28/90

* Two sigma error represents counting statistics only.

CNSI ENVIRONMENTAL AND DOSIMETRY LABORATORY
SAFETY LIGHT PROJECT REPORT

Sample Description	Date Collected	Radionuclide Analysis	Analysis Results* (pCi/L. ± 2 Sigma)	Date Analyized
Location 23	07/12/90	Tritium	4.15E+03+-2.59E+02	07/28/90
Location 24	07/12/90	Tritium	3.82E+03+-2.54E+02	07/28/90
Location 25	07/12/90	Tritium	1.14E+04+-3.68E+02	07/28/90
Location 26	07/12/90	Tritium	1.08E+04+-3.58E+02	07/28/90
Location 27	07/12/90	Tritium	7.36E+03+-3.07E+02	07/28/90
Location 28	07/12/90	Tritium	9.84E+03+-3.41E+02	07/28/90
Location 29	07/12/90	Tritium	1.15E+04+-3.65E+02	07/28/90
Location 30	07/12/90	Tritium	7.58E+03+-3.10E+02	07/28/90
Location 31	07/12/90	Tritium	1.10E+04+-3.60E+02	07/28/90
Location 32	07/12/90	Tritium	< 2.87E+02	07/28/90
Test Hole B Rainwater	07/10/90	Tritium	8.80E+04+-9.67E+02	07/16/90
Test Hole C Rainwater	07/10/90	Tritium	5.17E+04+-7.10E+02	07/16/90
Test Hole E Rainwater	07/10/90	Tritium	1.30E+05+-1.16E+03	07/16/90
Test Hole F Rainwater	07/10/90	Tritium	7.81E+04+-8.99E+02	07/16/90
Fenceline Near Well 14-Rainwater	07/11/90	Tritium	2.49E+04+-5.01E+02	07/28/90

* Two sigma error represents counting statistics only.

CNSI ENVIRONMENTAL AND DOSIMETRY LABORATORY
SAFETY LIGHT PROJECT REPORT

Test Hole	Date Collected	Radionuclide Analysis	Analysis Results* (pCi/L. ± 2 Sigma)	Date Analyzed
A	07/18/90	SR-90	3.4E+00+-1.6E+00	09/08/90
		CS-137	< 5.00E+00	07/24/90
		Gross Alpha	< 1.14E+00	07/24/90
		Gross Beta	1.58E+01+-1.93E+00	07/24/90
		Tritium	1.07E+04+-2.55E+02	07/25/90
B	07/18/90	SR-90	< 2.E+00	09/08/90
		CS-137	< 4.34E+00	07/24/90
		Gross Alpha	< 1.39E+00	07/24/90
		Gross Beta	3.25E+00+-1.31E+00	07/24/90
		Tritium	1.13E+04+-2.62E+02	07/25/90
C	07/18/90	SR-90	< 1.E+00	09/06/90
		CS-137	< 3.99E+00	07/25/90
		Gross Alpha	< 1.94E+00	07/29/90
		Gross Beta	8.58E+00+-1.51E+00	07/29/90
		Tritium	8.89E+03+-2.38E+02	07/25/90
D	07/18/90	SR-90	4.4E+01+-0.4E+01	09/08/90
		CS-137	< 4.63E+00	07/25/90
		Gross Alpha	< 1.25E+00	07/24/90
		Gross Beta	6.47E+01+-3.43E+00	07/24/90
		Tritium	4.65E+04+-4.78E+02	07/25/90
E	07/18/90	SR-90	2.5E+01+-0.2E+01	09/06/90
		CS-137	< 4.80E+00	07/27/90
		Gross Alpha	< 1.39E+00	07/24/90
		Gross Beta	3.83E+01+-2.74E+00	07/24/90
		Tritium	2.38E+04+-3.53E+02	07/25/90
F	07/18/90	SR-90	1.9E+00+-0.9E+00	09/06/90
		CS-137	< 4.39E+00	07/25/90
		Gross Alpha	< 1.56E+00	07/24/90
		Gross Beta	3.76E+00+-1.36E+00	07/24/90
		Tritium	7.64E+03+-2.27E+02	07/25/90
G	07/18/90	SR-90	3.9E+00+-1.2E+00	09/06/90
		CS-137	< 2.52E+00	07/31/90
		Gross Alpha	< 1.39E+00	07/24/90
		Gross Beta	7.62E+00+-1.56E+00	07/24/90
		Tritium	5.79E+03+-2.07E+02	07/25/90

* Two sigma error represents counting statistics only.

CNSI ENVIRONMENTAL AND DOSIMETRY LABORATORY
SAFETY LIGHT PROJECT REPORT

Test Hole	Date Collected	Radionuclide Analysis	Analysis Results* (pCi/L. ± 2 Sigma)	Date Analyized
H	07/18/90	SR-90	< 9.E-01	09/06/90
		CS-137	< 5.21E+00	08/01/90
		Gross Alpha	< 1.81E+00	07/24/90
		Goss Beta	5.59E+00+-1.50E+00	07/24/90
		Tritium	1.18E+04+-2.64E+02	07/25/90
I	07/18/90	SR-90	< 1.E+00	09/06/90
		CS-137	< 3.34E+00	07/28/90
		Gross Alpha	< 9.07E-01	07/24/90
		Gross Beta	< 1.73E+00	07/24/90
		Tritium	2.77E+04+-3.79E+02	07/25/90

* Two sigma error represents counting statistics only.

APPENDIX F

ANALYTICAL QUALITY CONTROL

Quality Control of radiological analyses were performed in accordance with the CNSI Barnwell Environmental and Dosimetry Laboratory Quality Control Program (CNSI Procedure S20-AD-013, Appendix H). The quality control program is administered to ensure the accuracy and precision of data in order that results can be assembled in light of values known to be appropriate to the methodology and to continuously maintain the quality of analytical data.

Performance criteria of radiological analyses are are a function of each particular analysis under study and is established to demonstrate acceptable and attainable performance of precision and accuracy. The criteria established in CNSI Procedure S20-AD-013 is defined by the Environmental Protection Agency's Environmental Radioactivity Laboratory Intercomparison Studies Program (EPA, 1977). This criteria is applied to the external and internal components of the quality control program.

External quality control is maintained through participation in a collaborative testing program administered by the Quality Assurance Branch of the Environmental Protection Agency. A summary of the Chem-Nuclear Systems and Teledyne Isotopes participation in the EPA/QA Laboratory Intercomparison Program is enclosed. This data represents each laboratory's external quality assurance analyses for the project. Included in this summary are the type of analysis, the sample collection date, the EPA known value, and the laboratory's measured value. The error range for the EPA known value represents the expected accuracy and precision for triplicate analysis. The reported measured error value represents the counting error at 2 sigma for triplicate analysis for CNSI data and the standard error at 2

sigma for Teledyne data. Complete documentation of all analyses performed are recorded and filed.

Internal quality control includes the analysis of control samples along with routine samples. Control samples consist of duplicates, blanks, and spiked samples. A summary of quality control samples analyzed with samples from this project are shown below. These process quality control samples exclude measurements such as detector backgrounds, check source values, system calibrations, etc. Detailed records of each measurement are documented.

PROCESS CONTROL SUMMARY

	BLANKS	DUPLICATES	SPIKES
Gross alpha	2	1	1
Gross beta	2	1	1
Tritium	11	16	10
Gamma Emitters	8	8	7
Strontium	*	7	*

* Internal quality control data, for spikes and blanks, performed by Teledyne Isotopes, were not available for this report. Teledyne's QA procedures require blanks and spikes on 10% of samples processed.

CNSI EPA/QA INTERCOMPARISON PROGRAM RESULTS

		Collection Date	Analysis	PCI/LITER Known	PCI/LITER Measured
I.	GROSS ALPHA/BETA IN WATER:	01-26-90	Alpha	12 ± 8.7	10 ± 1.0
			Beta	12 ± 8.7	14 ± 1.0
		05-11-90	Alpha	22 ± 8.7	23 ± 1.7
			Beta	15 ± 8.7	19 ± 1.1
II.	TRITIUM IN WATER:	02-23-90	Tritium	4976 ± 863	4666 ± 113
		06-22-90	Tritium	2933 ± 620	2883 ± 94
III.	GAMMA IN WATER:	02-09-90	Ba-133	74 ± 12	74 ± 3.6
			Co-60	15 ± 8.7	17 ± 3
			Zn-65	139 ± 24	139 ± 9.8
			Ru-106	139 ± 24	119 ± 26
			Cs-134	18 ± 8.7	17 ± 2.0
			Cs-137	18 ± 8.7	20 ± 2.8
		06-06-90	Ba-133	99 ± 17	105 ± 3.6
			Co-60	24 ± 8.7	26 ± 2.3
			Zn-65	148 ± 26	152 ± 10
			Ru-106	210 ± 36	200 ± 25
			Cs-134	24 ± 8.7	23 ± 2.0
			Cs-137	25 ± 8.7	23 ± 2.7

TELEDYNE ISOTOPES EPA/QA INTERCOMPARISON PROGRAM RESULTS

		Collection Date	Analysis	PCI/LITER Known	PCI/LITER Measured
I.	STRONTIUM IN WATER:	10-31-89	Sr-90	7 ± 2.6	7 ± 0.0
		01-12-90	Sr-90	20 ± 2.6	19.7 ± 5.0