Formerly Utilized Sites Remedial
Action Program (FUSRAP)

Maywood Chemical Company Superfund Site

ADMINISTRATIVE RECORD

Document Number

MISS- 009.

US Army Corps
of Engineers®

063982

Bechtel National, Inc.
Systems Engineers — Constructors

Jackson Plaza Tower
800 Oak Ridge Turnpike
Oak Ridge, Tennessee 37830

Mail Address: P.O. Box 350, Oak Ridge, TN 37831-0350
Telex: 3785873

SEP 29 1989

U.S. Department of Energy
Oak Ridge Operations
Post Office Box 2001
Oak Ridge, Tennessee 37831-8723

Attention: Robert G. Atkin
Technical Services Division

Subject: Bechtel Job No. 14501, FUSRAP Project
DOE Contract No. DE-AC05-81OR20722
Publication of Radiological Characterization Report for seventeen residential properties, four municipa properties, and seven commercial properties in Lodi and Maywood, New Jersey
Code: 7315/WBS: 138

Dear Mr. Atkin:

Enclosed is one copy each of the 28 subject published reports for the properties listed in Attachment 1. These reports incorporate all comments received in this review cycle (CCNs 063165, 063327, 062285, and 061568) and are being published wit approval of Steve Oldham, as reported in CCN 063868.

Also enclosed (as Attachment 2) is a proposed distribution list for these reports. Please send us any changes to the proposed distribution list at your earliest convenience so we may distribute the reports.

BNI would like to express our thanks to Mr. Oldham for his cooperation and efforts to review these drafts in an accelerate manner. His efforts have allowed us to publish these reports o schedule. If you have any questions about these documents, please call me at 576-4718.

Very truly yours,

R C Robertson

R. C. Robertson
Project Manager - FUSRAP

RCR:wfs:1756x
Enclosure: As stated

cc: J. D. Berger, ORAU (w/e)
N. J. Beskid, ANL (w/e)

CONCURRENCE

095	r.u.			

DOE/OR/20722-156

RADIOLOGICAL CHARACTERIZATION REPORT
FOR THE GULF STATION PROPERTY
MAYWOOD, NEW JERSEY

SEPTEMBER 1989

Prepared for

UNITED STATES DEPARTMENT OF ENERGY

OAK RIDGE OPERATIONS OFFICE

Under Contract No. DE-AC05-81OR20722

By

N. C. Ring, D. J. Whiting, and W. F. Stanley

Bechtel National, Inc.

Oak Ridge, Tennessee

Bechtel Job No. 14501

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ABBREVIATIONS

cm	centimeter
cm^2	square centimeter
cpm	counts per minute
dpm	disintegrations per minute
ft	foot
h	hour
in.	inch
km^2	square kilometer
L	liter
L/min	liters per minute
m	meter
m^2	square meter
MeV	million electron volts
μR/h	microroentgens per hour
mi	mile
mi^2	square mile
min	minute
mrad/h	millirad per hour
mrem	millirem
mrem/yr	millirem per year
pCi/g	picocuries per gram
pCi/L	picocuries per liter
WL	working level
yd	yard
yd^3	cubic yard

1.0 INTRODUCTION AND SUMMARY

This section provides a brief description of the history and background of the Maywood site and its vicinity properties. Data obtained from the radiological characterization of this vicinity property are also presented.

1.1 INTRODUCTION

The 1984 Energy and Water Appropriations Act authorized the U.S. Department of Energy (DOE) to conduct a decontamination research and development project at four sites, including the site of the former Maywood Chemical Works (now owned by the Stepan Company) and its vicinity properties. The work is being administered under the Formerly Utilized Sites Remedial Action Program (FUSRAP) under the direction of the DOE Division of Facility and Site Decommissioning Projects. Several residential, commercial, and municipal properties in Maywood, New Jersey, are included in FUSRAP as vicinity properties. Figure 1-1 shows the location of the Maywood vicinity properties in relation to the former Maywood Chemical Works.

The U.S. Government initiated FUSRAP in 1974 to identify, clean up, or otherwise control sites where low-activity radioactive contamination (exceeding current guidelines) remains from the early years of the nation's atomic energy program or from commercial operations that resulted in conditions Congress has mandated that DOE remedy (Ref. 1).

FUSRAP is currently being managed by DOE Oak Ridge Operations. As the Project Management Contractor for FUSRAP, Bechtel National, Inc. (BNI) is responsible to DOE for planning, managing, and implementing FUSRAP.

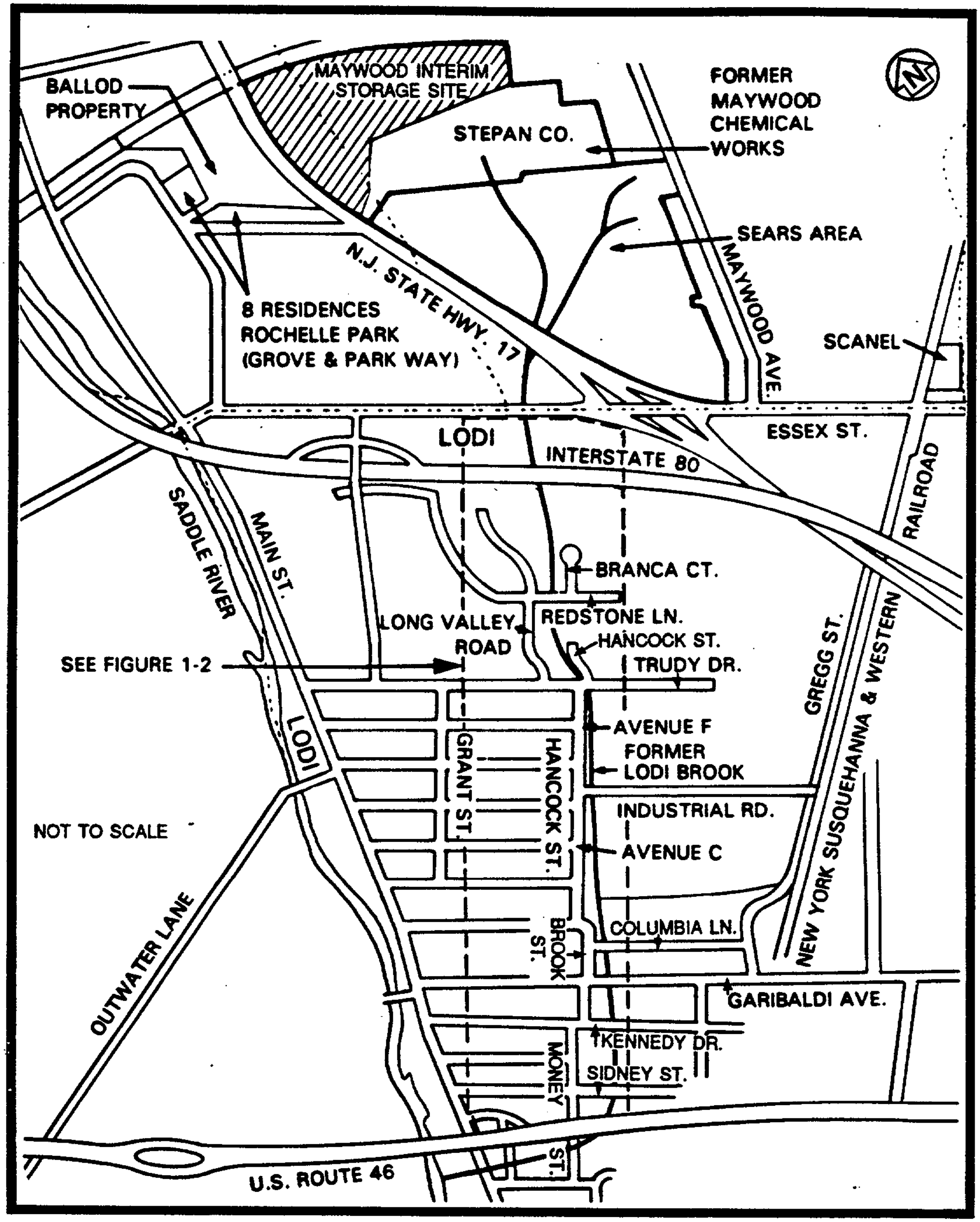

FIGURE 1-1 LOCATION OF LODI VICINITY PROPERTIES

1.2 PURPOSE

The purpose of the 1986 survey performed by BNI was to locate the horizontal and vertical boundaries of radionuclide concentrations exceeding remedial action guidelines.

1.3 SUMMARY

This report details the procedures and results of the radiological characterization of the Gulf Station property (Figure 1-2) in Maywood, New Jersey, which was conducted in August and September 1986. Additional data were obtained in February 1987.

Ultimately, the data generated during the radiological characterization will be used to define the complete scope of remedial action necessary to release the site.

The Gulf Station property is a commercial property located on New Jersey Route 17 and consists of a small concrete block building and asphalt-paved service area. It is operational 24 hours daily; this schedule and the presence of buried gasoline tanks and lines severely limited accessibility for radiological characterization of the property.

This characterization confirmed that thorium-232 is the primary radioactive contaminant at this property. No surface soil samples could be obtained because the majority of the property is covered by asphalt or concrete.

Subsurface soil samples obtained from one borehole location prior to collapse of the borehole indicated concentrations ranging from 3.2 to less than 8.9 pCi/g for thorium-232 and from 1.8 to less than 4.8 pCi/g for radium-226. The average background level in this area for both radium-226 and

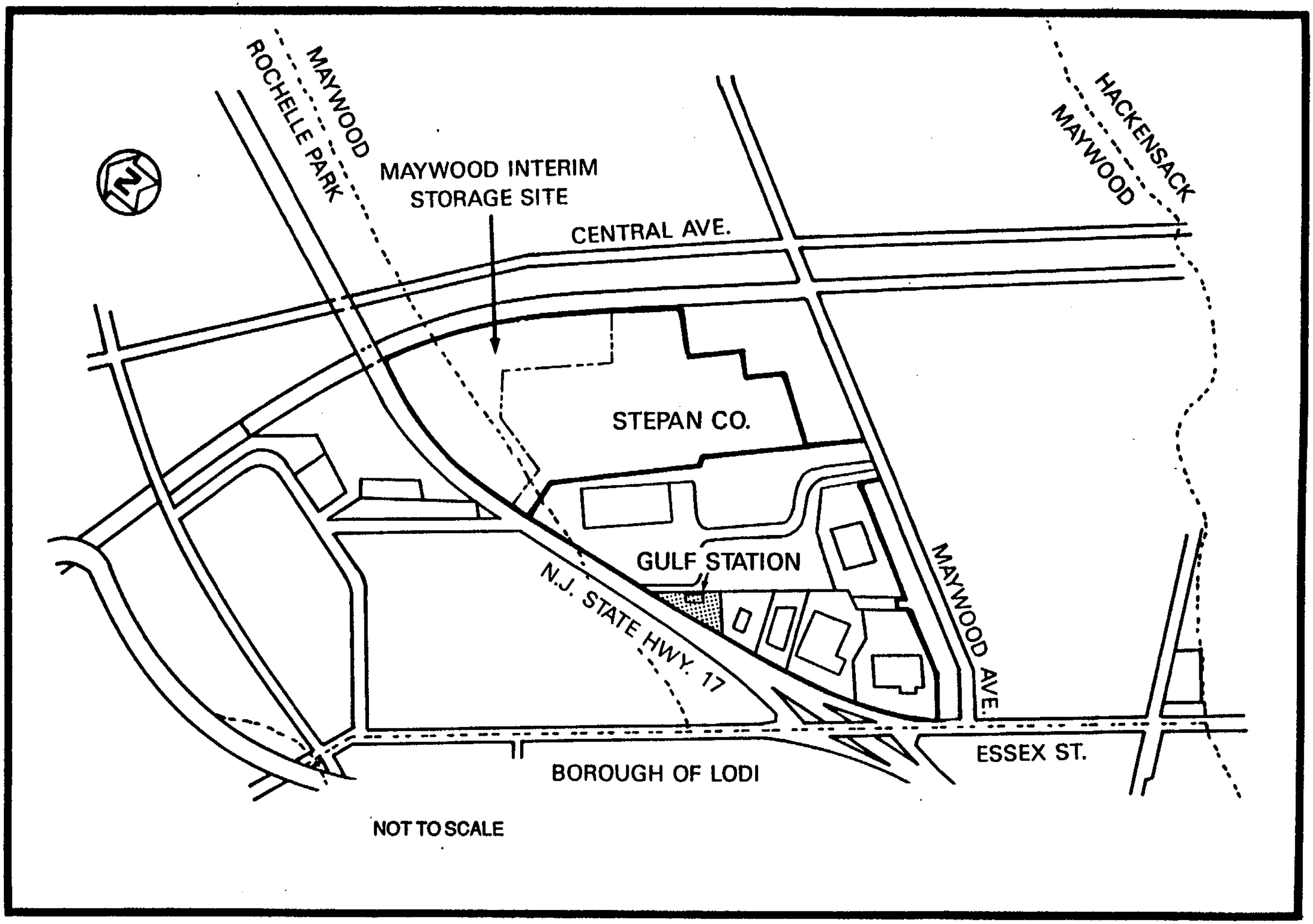

FIGURE 1-2 LOCATION OF THE GULF STATION PROPERTY

thorium-232 is 1.0 pCi/g. The concentrations of uranium-238 in this subsurface soil sample ranged from 9.2 to less than 51.0 pCi/g. Because the major contaminants at the vicinity properties are thorium and radium, the decontamination guidelines provide the appropriate guidance for the cleanup activities. DOE believes that these guidelines are conservative for considering potential adverse health effects that might occur in the future from any residual contamination. The dose contributions from uranium and any other radionuclides not numerically specified in these guidelines are not expected to be significant following decontamination. In addition, the vicinity properties will be decontaminated in a manner so as to reduce future doses to levels that are as low as reasonably achievable (ALARA) (Ref. 2).

Soil analysis data for this property did not indicate surface contamination. Subsurface investigation by gamma logging indicated contamination to a depth of 2.13 m (7.0 ft).

No exterior measurements were obtained because of severely limited access to the property and scheduling conflicts with the 24-hour operations of the service station.

All data tables for this property appear at the end of this report.

1.4 CONCLUSIONS

Evaluation of data collected, analyses performed, and historical documentation reviewed indicates the presence of radiological contamination on the Gulf Station property.

This contamination is primarily subsurface contamination ranging from a depth of 15.2 cm (6.0 in.) to 2.13 m (7.0 ft). In addition, the contamination appears to extend beneath the building, and there is a high probability that the contamination extends beneath New Jersey Route 17 in front of the property. The total affected area is estimated to be approximately 95 percent of the property. These conclusions are supported by documentation that establishes the presence of the former channel of Lodi Brook in this area. This channel is the suspected transport mechanism for the radiological contamination.

2.0 SITE HISTORY

The Maywood Chemical Works was founded in 1895. The company began processing thorium from monazite sand in 1916 (during World War I) for use in manufacturing gas mantles for various lighting devices. Process wastes from manufacturing operations were pumped to two areas surrounded by earthen dikes on property west of the plant. Subsequently, some of the contaminated wastes migrated onto adjacent and vicinity properties.

In 1928 and again between 1944 and 1946, some of the residues from the processing operations were moved from the company's property and used as mulch and fill in nearby low-lying areas. The fill material consisted of tea and coca leaves mixed with other material resulting from operations at the plant. Some fill material apparently contained thorium process wastes (Ref. 3).

Uncertainty exists as to how the properties in Lodi were contaminated. According to an area resident, fill from an unknown source was brought to Lodi and spread over large portions of the previously low-lying and swampy area. For several reasons, however, a more plausible explanation is that the contamination migrated along a drainage ditch originating on the Maywood Chemical Works property. First, it can be seen from photographs and tax maps of the area that the course of a previously existing stream known as Lodi Brook, which originated at the former Maywood Chemical Works, generally coincides with the path of contamination in Lodi. The brook was subsequently replaced by a storm drain system as the area was developed. Second, samples taken from Lodi properties indicate elevated concentrations of a series of elements known as rare earths. Rare earth elements are typically found in monazite sands, which also contain thorium. This type of sand was feedstock at the Maywood Chemical Works, and elevated levels are known to exist in the by-product of the extraction process. Third, the ratio of thorium to other radionuclides found on these Lodi properties is comparable to the ratio found in contaminated material on other properties in Lodi (Ref. 4). And finally, long-time residents of Lodi recalled chemical odors in and around the brook in Lodi and steam rising off the water. These observations suggest that discharges of contaminants occurred upstream.

The Stepan Chemical Company (now called the Stepan Company) purchased Maywood Chemical Works in 1959. The Stepan Company itself has never been involved in the manufacture or processing of any radioactive materials (Ref. 5).

Aerial photographs of the property show excavation activity sometime between April 1940 and March 1954 and development of the property by April 1961. On the basis of these photographs and geological information gained as a result of this characterization, it is believed that contamination to a depth of 2.13 m (7.0 ft) resulted from fill emplacement during property development. This belief is further substantiated by geological information, which indicated that the property is extremely flat [a consistent elevation of 14.2 m (46.5 ft)] and is underlain by brown, silty sand interbedded with a few thin, black organic silt lenses. This 1.52- to 2.13-m- (5- to 7-ft-) thick sequence overlies indigenous soil derived from the Brunswick sandstone in an oxidizing environment, and the black, organic silt lenses are characteristic of a cumulose soil found in a saturated, reducing environment (wetland). This wetland soil was naturally ubiquitous southeast of the Gulf Station property prior to its development. The silt was apparently moved onto the property to bring the land to its present grade; the combining of the silt with the sand resulted in the alternating brown sand/black silt sequences. Because these soils have been transported or disturbed, their exact origin is unknown; therefore, they must be considered fill material. The same black silt was used to bury the drainage conduit along the southern/southeastern boundary of the property. The location of this conduit is identifiable by a slight depression [0.30-m (1-ft) relief] in this area. The depression is the result of soil consolidation above the conduit. Runoff from the southern drainage system of the adjacent property to the north and east enters this buried conduit.

In 1984, excavation was performed on the property to install new gasoline tanks and to dig trenches [less than 0.91 m (3.0 ft) deep] to lay new gasoline lines. No evidence of radiological contamination was found in these trenches during the construction, and the subsurface soil sample taken during this characterization indicated no contamination present to a depth of 1.52 m (5.0 ft) in the area where a new gasoline tank was buried in 1984. However, from the historical evidence (aerial photographs) showing significant excavation of the property prior to its development and from most of the information gained during this characterization, it is suspected that contamination is present on this property at depths greater than 0.91 m (3.0 ft) in most areas and at depths greater than 1.52 m (5.0 ft) in areas of the collapsed borehole. The extent of contamination could not be defined more precisely because of the 24-hour operations at the service station and the gasoline tanks and lines buried on the property.

2.1 PREVIOUS RADIOLOGICAL SURVEYS

Numerous surveys of the Maywood site and its vicinity properties have been conducted. Among the past surveys, three that are pertinent to this vicinity property are detailed in this section.

January 1981--The Nuclear Regulatory Commission directed that a survey be conducted of the Stepan Company property and its vicinity properties in January 1981. Using the Stepan Company plant as the center, a 10.3-km^2 (4-mi^2) aerial survey was conducted by the EG&G Energy Measurements Group, which identified anomalous concentrations of thorium-232 to the north and south of the Stepan Company property. The Lodi vicinity properties were included in this survey (Ref. 6).

July 1983--NUS Corporation conducted a radiological survey of the Scanel and Sears properties from July 18 to August 9, 1983. This survey included several properties adjacent to the Sears property that are referred to as the Sears vicinity properties. The survey indicated areas requiring further investigation (Ref. 7).

2.2 REMEDIAL ACTION GUIDELINES

Table 2-1 summarizes the DOE guidelines for residual contamination. The thorium-232 and radium-226 limits listed in Table 2-1 will be used to determine the extent of remedial action required at the vicinity properties. DOE developed these guidelines to be consistent with the guidelines established by the U.S. Environmental Protection Agency (EPA) for the Uranium Mill Tailings Remedial Action Program.

TABLE 2-1
SUMMARY OF RESIDUAL CONTAMINATION GUIDELINES

BASIC DOSE LIMITS

The basic limit for the annual radiation dose received by an individual member of the general public is 100 mrem/yr.

SOIL GUIDELINES

Radionuclide	Soil Concentration (pCi/g) Above Background[a,b,c]
Radium-226 Radium-228 Thorium-230 Thorium-232	5 pCi/g when averaged over the first 15 cm of soil below the surface; 15 pCi/g when averaged over any 15-cm-thick soil layer below the surface layer.
Other Radionuclides	Soil guidelines will be calculated on a site-specific basis using the DOE manual developed for this use.

STRUCTURE GUIDELINES

Airborne Radon Decay Products

Generic guidelines for concentrations of airborne radon decay products shall apply to existing occupied or habitable structures on private property that has no radiological restrictions on its use; structures that will be demolished or buried are excluded. The applicable generic guideline (40 CFR 192) is: In any occupied or habitable building, the objective of remedial action shall be, and reasonable effort shall be made to achieve, an annual average (or equivalent) radon decay product concentration (including background) not to exceed 0.02 WL[d]. In any case, the radon decay product concentration (including background) shall not exceed 0.03 WL. Remedial actions are not required in order to comply with this guideline when there is reasonable assurance that residual radioactive materials are not the cause.

External Gamma Radiation

The average level of gamma radiation inside a building or habitable structure on a site that has no radiological restrictions on its use shall not exceed the background level by more than 20 μR/h.

Indoor/Outdoor Structure Surface Contamination

	Allowable Surface Residual Contamination[e] (dpm/100 cm²)		
Radionuclide[f]	Average[g,h]	Maximum[h,j]	Removable[h,j]
Transuranics, Ra-226, Ra-228, Th-230, Th-228 Pa-231, Ac-227, I-125, I-129	100	300	20
Th-Natural, Th-232, Sr-90, Ra-223, Ra-224 U-232, I-126, I-131, I-133	1,000	3,000	200
U-Natural, U-235, U-238, and associated decay products	5,000 α	15,000 α	1,000 α
Beta-gamma emitters (radionuclides with decay modes other than alpha emission or spontaneous fission) except Sr-90 and others noted above	5,000 β - γ	15,000 β - γ	1,000 β - γ

TABLE 2-1
(CONTINUED)

[a]These guidelines take into account ingrowth of radium-226 from thorium-230 and of radium-228 from thorium-232, and assume secular equilibrium. If either thorium-230 and radium-226 or thorium-232 and radium-228 are both present, not in secular equilibrium, the guidelines apply to the higher concentration. If other mixtures of radionuclides occur, the concentrations of individual radionuclides shall be reduced so that 1) the dose for the mixtures will not exceed the basic dose limit, or 2) the sum of ratios of the soil concentration of each radionuclide to the allowable limit for that radionuclide will not exceed 1 ("unity").

[b]These guidelines represent allowable residual concentrations above background averaged across any 15-cm-thick layer to any depth and over any contiguous 100-m² surface area.

[c]Localized concentrations in excess of these limits are allowable, provided that the average concentration over a 100-m² area does not exceed these limits. In addition, every reasonable effort shall be made to remove any source of radionuclide that exceeds 30 times the appropriate soil limit, regardless of the average concentration in the soil.

[d]A working level (WL) is any combination of short-lived radon decay products in 1 liter of air that will result in the ultimate emission of 1.3 x 105 MeV of potential alpha energy.

[e]As used in this table, dpm (disintegrations per minute) means the rate of emission by radioactive material as determined by correcting the counts per minute observed by an appropriate detector for background, efficiency, and geometric factors associated with the instrumentation.

[f]Where surface contamination by both alpha- and beta-gamma-emitting radionuclides exists, the limits established for alpha- and beta-gamma-emitting radionuclides should apply independently.

[g]Measurements of average contamination should not be averaged over more than 1 m². For objects of less surface area, the average shall be derived for each such object.

[h]The average and maximum radiation levels associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 mrad/h and 1.0 mrad/h, respectively, at 1 cm.

[i]The maximum contamination level applies to an area of not more than 100 cm².

[j]The amount of removable radioactive material per 100 cm² of surface area should be determined by wiping that area with dry filter or soft absorbent paper, applying moderate pressure, and measuring the amount of radioactive material on the wipe with an appropriate instrument of known efficiency. When removable contamination on objects of surface area less than 100 cm² is determined, the activity per unit area should be based on the actual area and the entire surface should be wiped. The numbers in this column are maximum amounts.

3.0 HEALTH AND SAFETY PLAN

BNI is responsible for protecting the health of personnel assigned to work at the site. As such, all subcontractors and their personnel were required to comply with the provisions of BNI health and safety requirements and as directed by the on-site BNI Health and Safety Officer.

3.1 SUBCONTRACTOR TRAINING

Before the start of work, all subcontractor personnel attended an orientation session presented by the BNI Health and Safety Officer to explain the nature of the material to be encountered in the work and the personnel monitoring and safety measures that are required.

3.2 SAFETY REQUIREMENTS

Subcontractor personnel complied with the following BNI requirements:

- Bioassay--Subcontractor personnel submitted bioassay samples before or at the beginning of on-site activity, upon completion of the activity, and periodically during site activities as requested by BNI.
- Protective Clothing/Equipment--Subcontractor personnel were required to wear the protective clothing/equipment specified in the subcontract or as directed by the BNI Health and Safety Officer.
- Dosimetry--Subcontractor personnel were required to wear and return daily the dosimeters and monitors issued by BNI.
- Controlled Area Access/Egress--Subcontractor personnel and equipment entering areas where access and egress were controlled for radiation and/or chemical safety purposes were surveyed by the BNI Health and Safety Officer (or personnel representing BNI) for contamination before leaving those areas.

- Medical Surveillance--Upon written direction from BNI, subcontractor personnel who work in areas where hazardous chemicals might exist were given a baseline and periodic health assessment defined in BNI's Medical Surveillance Program.

Radiation and/or chemical safety surveillance of all activities related to the scope of work was under the direct supervision of personnel representing BNI.

Health and safety-related requirements for all activities involving exposure to radiation, radioactive material, chemicals, and/or chemically contaminated materials and other associated industrial safety hazards are generated in compliance with applicable regulatory requirements and industry-wide standards. Copies of these requirements are located at the BNI project office for use by project personnel.

4.0 CHARACTERIZATION PROCEDURES

A master grid was established by the surveyor. BNI's radiological support subcontractor, Thermo Analytical/Eberline (TMA/E), established a grid on individual properties. The size of the grid blocks was adjusted to characterize each property adequately. The grid origin allows the grid to be reestablished during remedial action and is correlated with the New Jersey state grid system. All data correspond to coordinates on the characterization grid. The grid with the east and north coordinates is shown on all figures included in Sections 4.0 and 5.0 of this report.

4.1 FIELD RADIOLOGICAL CHARACTERIZATION

This section provides a description of the instrumentation and methodologies used to obtain exterior surface and subsurface measurements during radiological characterization of this property.

4.1.1 Measurements Taken and Methods Used

An initial walkover survey was performed using an unshielded gamma scintillation detector [5.0- by 5.0-cm (2- by 2-in.) thallium-activated sodium iodide probe] to identify areas of elevated radionuclide activity. Near-surface gamma measurements taken using a cone-shielded gamma scintillation detector were also used to determine areas of surface contamination. The shielded detector ensured that the majority of the radiation detected by the instrument originated from the ground directly beneath the unit. Shielding against lateral gamma flux, or shine, from nearby areas of contamination minimized potential sources of error in the measurements. The measurements were taken 30.4 cm (12 in.) above the ground at the intersections of

3.0-m (10-ft) grid lines. The shielded detector was calibrated at the Technical Measurements Center (TMC) in Grand Junction, Colorado, to provide a correlation of counts per minute (cpm) to picocuries per gram (pCi/g). This calibration demonstrated that approximately 11,000 cpm corresponds to the DOE guideline of 5 pCi/g plus local average background of 1 pCi/g for thorium-232 in surface soils (Ref. 8). The majority of the Gulf Station property is asphalt and concrete. The calibration correlation of 11,000 cpm for 5 pCi/g was developed for instruments taking readings above contaminated soil; therefore, the same correlation may not be applicable for readings taken above asphalt.

A subsurface investigation was conducted to determine the depth to which the previously identified surface contamination extended and to locate subsurface contamination where there was no surface manifestation. The subsurface characterization consisted of drilling five boreholes (Figure 4-1), using either a 7.6-cm- (3-in.-) or 15.2-cm- (6-in.-) diameter auger bit, and gamma logging them. The boreholes were drilled to depths determined in the field by the radiological and geological support representatives. Because of limited accessibility, only five boreholes were drilled during the subsurface investigation. Four of the boreholes were gamma logged to determine the depths and concentrations of radiological contamination; the remaining borehole collapsed (E10820, N8425). Subsurface soil samples were collected from the borehole, however, before it collapsed.

The downhole gamma logging technique was used because the procedure can be accomplished in less time than collecting soil samples, and the need for analyzing these samples in a laboratory is eliminated. A 5.0- by 5.0-cm (2- by 2-in.) sodium iodide gamma scintillation detector was used to

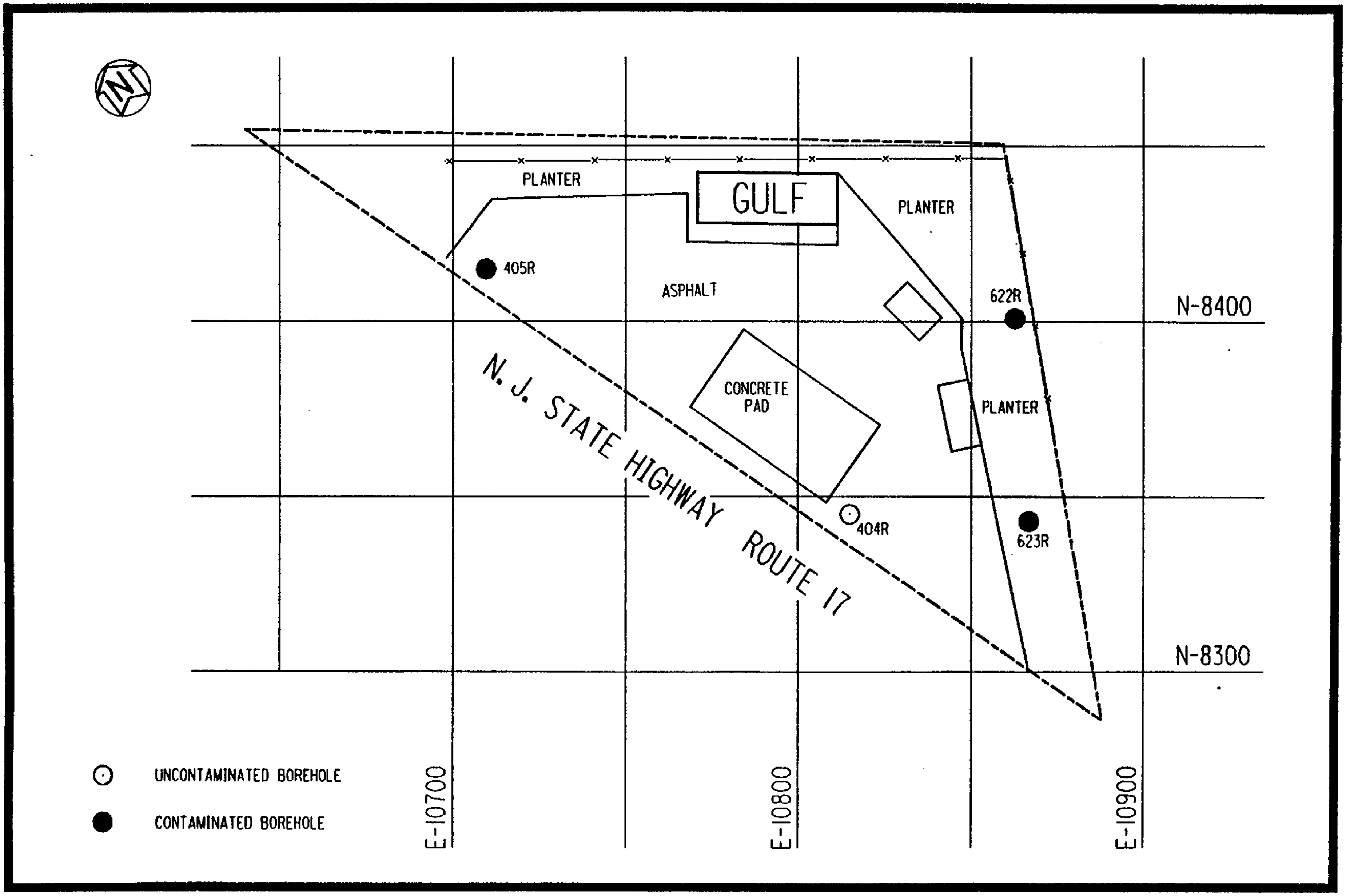

FIGURE 4-1 BOREHOLE LOCATIONS AT THE GULF STATION

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perform the downhole logging. The instrument was calibrated at TMC where it was determined that a count rate of approximately 40,000 cpm corresponds to the 15-pCi/g subsurface contamination guideline for thorium-232. This relationship has also been corroborated by results from previous characterizations where thorium-232 was found (Ref. 8).

Gamma radiation measurements were taken at 15.2-cm (6-in.) vertical intervals to determine the depth and concentration of the contamination. The gamma-logging data were reviewed to identify trends, whether or not concentrations exceeded the guidelines.

4.1.2 Sample Collection and Analysis

To identify surface areas where the level of contamination exceeded the DOE guideline of 5 pCi/g for thorium-232, areas with measurements of more than 11,000 cpm were plotted. Using these data as well as data from previous surveys (Refs. 5, 6, and 7), the locations of biased surface soil samples were selected to better define the limits of contamination. Subsurface soil samples were collected from one location (Figure 4-2) using the side-wall sampling method and was analyzed to compare laboratory soil sample results to downhole gamma radiation measurements. A cup or can attached to a steel pipe or wooden stake was inserted into the borehole and used to scrape samples off the side of the borehole at a specified depth. The sample was dried, pulverized, and counted for 10 min using an intrinsic germanium detector housed in a lead counting cave lined with cadmium and copper. The pulse height distribution was sorted using a computer-based, multichannel analyzer. Radionuclide concentrations were determined by comparing the gamma spectrum of each sample with the spectrum of a certified

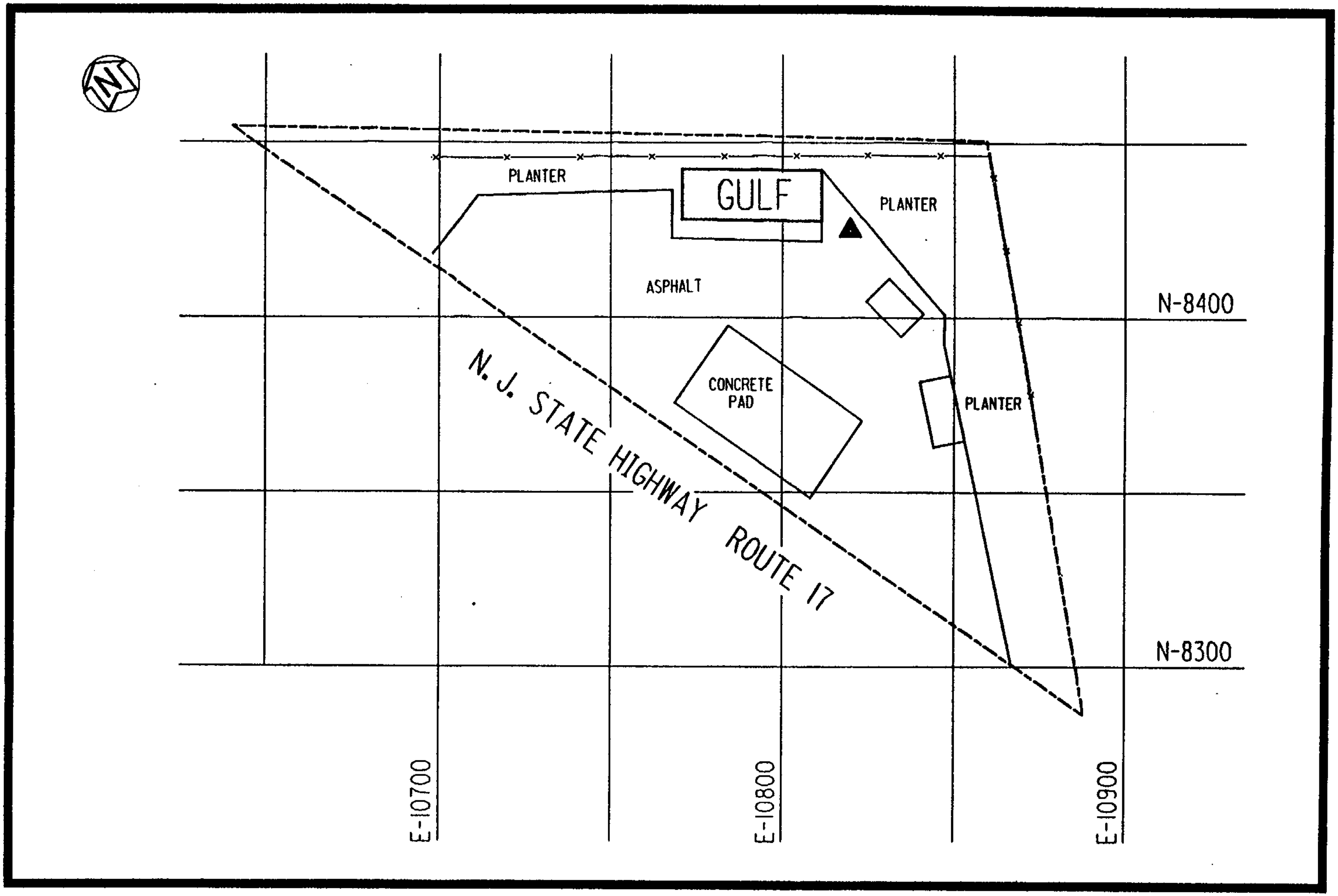

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FIGURE 4-2 SURFACE AND SUBSURFACE SOIL SAMPLING LOCATION AT THE GULF STATION counting standard for the radionuclide of interest. The subsurface soil samples were analyzed for radium-226, uranium-238, and thorium-232.

4.2 BUILDING RADIOLOGICAL CHARACTERIZATION

Because of the 24-hour operation of the service station, extremely limited accessibility to the property prohibited the collection of indoor data. Therefore, this element of radiological characterization activities was not conducted.

5.0 CHARACTERIZATION RESULTS

Radiological characterization results are presented in this section. The data included represent exterior surface and subsurface radiation measurements and interior radiation measurements.

5.1 FIELD RADIOLOGICAL CHARACTERIZATION

Near-surface gamma radiation measurements on the property ranged from 4,000 cpm to approximately 25,000 cpm. The average background level for this area is 5,000 cpm. A measurement of 11,000 cpm is approximately equal to the DOE guideline for thorium-232 of 5 pCi/g above background for surface soil contamination. Using this correlation, the near-surface gamma measurements were used to predict the extent of surface contamination. No areas of surface contamination were indicated by near-surface gamma measurements. In addition, near-surface gamma measurements indicate that contamination extends onto several properties contiguous with the Gulf Station property. These properties have also been radiologically characterized.

Furthermore, because 90 percent of the property is covered with asphalt and concrete, surface soil samples were not collected. Consequently, the surface manifestation is not totally known.

Analytical results for subsurface soil samples are given in Table 5-1, and gamma logging data are given in Table 5-2. The results in Table 5-2 showed a range from 7,000 cpm to 314,000 cpm. A measurement of 40,000 cpm is approximately equal to the DOE guideline for subsurface contamination of 15 pCi/g. Analyses of subsurface soil samples indicated uranium-238 concentrations ranging from 9.2 to less than

51.0 pCi/g, thorium-232 concentrations ranging from 3.2 to less than 8.9 pCi/g, and radium-226 concentrations ranging from 1.8 to less than 4.8 pCi/g. Use of the "less than" (<) notation in reporting results indicates that the radionuclide was not present in concentrations that are quantitative with the instruments and techniques used. The "less than" value represents the lower bound of the quantitative capacity of the instrument and technique used. The "less than" value is based on various factors, including the volume, size, and weight of the sample; the type of detector used; the counting time; and the background count rate. The actual concentration of the radionuclide is less than the value indicated. In addition, since radioactive decay is a random process, a correlation between the rate of disintegration and a given radionuclide concentration cannot be precisely established. For this reason, the exact concentration of the radionuclide cannot be determined. As such, each value that can be quantitatively determined has an associated uncertainty term ($\pm$), which represents the amount by which the actual concentration can be expected to differ from the value given in the table. The uncertainty term has an associated confidence level of 95 percent.

Thorium-232, the primary contaminant at the site, is the radionuclide most likely to exceed a specific DOE guideline in soil. Parameters for soil sample analysis were selected to ensure that the thorium-232 would be detected and measured at concentrations well below the lower guideline value of 5 pCi/g in excess of background level. Radionuclides of the uranium series, specifically uranium-238 and radium-226, are also potential contaminants but at lower concentrations than thorium-232. Therefore, these radionuclides (considered secondary contaminants) would not be present in concentrations in excess of guidelines unless thorium-232 was also present in concentrations in excess of its guideline level. Parameters selected for the thorium-232 analyses also provide detection sensitivities for uranium-238 and radium-226 that demonstrate that concentrations of these radionuclides are below guidelines. However, because of the relatively low gamma photon abundance of uranium-238, many of the uranium-238 concentrations were below the detection sensitivity of the analytical procedure; these concentrations are reported in the data tables as "less than" values. To obtain more sensitive readings for the uranium-238 radionuclide with these analytical methods, much longer instrument counting times would be required than were necessary for analysis of thorium-232, the primary contaminant.

On the basis of near-surface gamma radiation measurements, surface and subsurface soil sample analyses, and downhole gamma logging, contamination on this property is believed to consist primarily of subsurface contamination at depths ranging from 15.2 cm (6.0 in.) to 2.13 m (7.0 ft). The areas of subsurface contamination are shown in Figure 5-1. The subsurface contamination appears to extend beneath the building, and there is a high probability that it extends beneath New Jersey Route 17 that is adjacent to the property.

It is apparent from review of historical documentation (e.g., aerial photographs of the area, interviews with local residents, and previous radiological surveys) that the subsurface contamination on this property lies along the former channel of Lodi Brook and its associated floodplain. The contamination on this property is similar to contamination found on commercial properties in close proximity to this property. It has been established that the Lodi Brook channel through these neighboring properties once occupied locations connecting to those where stream sediments

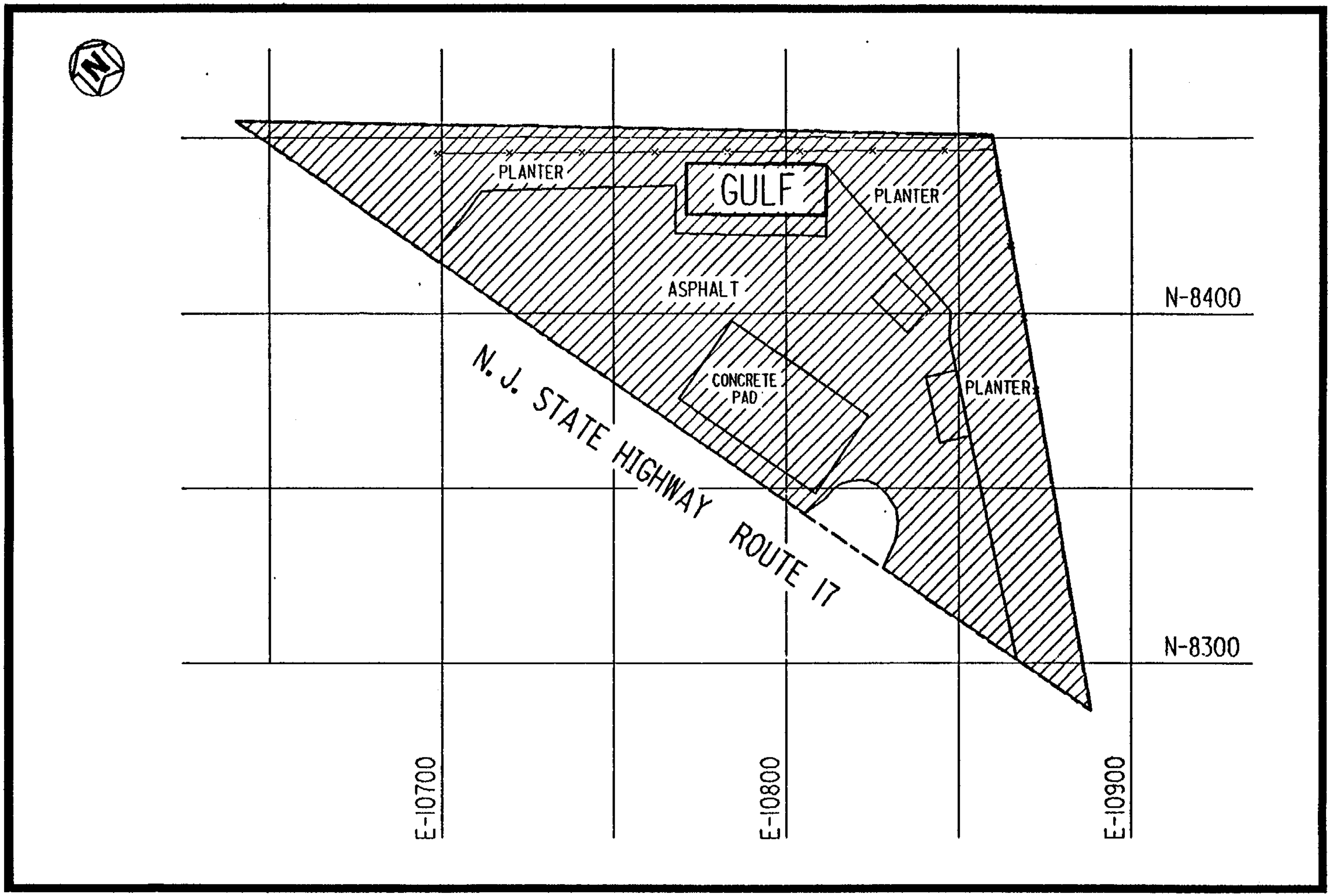

FIGURE 5-1 AREAS OF SUBSURFACE CONTAMINATION AT THE GULF STATION

were found at the Gulf Station property. Thus, the elevated gamma readings shown on gamma logs from boreholes drilled on this property serve as further indication of the suspected mechanism of transport for radiological contamination (i.e., stream deposition from Lodi Brook).

The vertical and horizontal limits of contamination as determined by this characterization effort are being evaluated to determine the volume of contaminated material that will require remedial action. To develop this estimate, BNI will consider the location of the contamination, construction techniques, and safety procedures.

5.2 BUILDING RADIOLOGICAL CHARACTERIZATION

No indoor measurements were obtained because of extremely limited accessibility to the property.

TABLE 5-1

SUBSURFACE RADIONUCLIDE CONCENTRATIONS IN SOIL

FOR THE GULF STATION PROPERTY

Coordinates[a]		Depth	Concentration (pCi/g ± 2 sigma)		
East	North	(ft)	Uranium-238	Radium-226	Thorium-232
10820	8425	0.0 - 1.0	<18.5	2.0 ± 1.1	5.3 ± 2.3
10820	8425	1.0 - 2.0	<51.0	1.8 ± 0.9	3.2 ± 0.1
10820	8425	3.0 - 4.0	<14.8	< 4.8	3.3 ± 0.5
10820	8425	4.0 - 5.0	9.2 ± 3.6	2.6 ± 0.9	< 8.9

[a]Sample locations are shown in Figure 4-2.

TABLE 5-2

DOWNHOLE GAMMA LOGGING RESULTS

FOR THE GULF STATION PROPERTY

Coordinates[a] East	Coordinates[a] North	Depth[b] (ft)	Count Rate[c] (cpm)
Borehole 405R[d]			
10710	8415	0.5	8000
10710	8415	1.0	10000
10710	8415	1.5	12000
10710	8415	2.0	14000
10710	8415	2.5	15000
10710	8415	3.0	15000
10710	8415	3.5	15000
10710	8415	4.0	20000
10710	8415	4.5	33000
10710	8415	5.0	79000
10710	8415	5.5	112000
10710	8415	6.0	51000
10710	8415	6.5	31000
10710	8415	7.0	25000
10710	8415	7.5	19000
10710	8415	8.0	14000
10710	8415	8.5	11000
Borehole 404R[d]			
10815	8345	0.5	7000
10815	8345	1.0	8000
10815	8345	1.5	9000
10815	8345	2.0	10000
10815	8345	2.5	11000
10815	8345	3.0	10000
10815	8345	3.5	11000
10815	8345	4.0	11000
10815	8345	4.5	10000
10815	8345	5.0	13000
10815	8345	5.5	16000
10815	8345	6.0	20000
10815	8345	6.5	21000

TABLE 5-2

(continued)

Coordinates[a] East	North	Depth[b] (ft)	Count Rate[c] (cpm)
Borehole 404R (continued)[d]			
10815	8345	7.0	19000
10815	8345	7.5	16000
10815	8345	8.0	12000
10815	8345	8.5	12000
10815	8345	9.0	11000
10815	8345	9.5	12000
Borehole 622R[d]			
10863	8401	0.5	34000
10863	8401	1.0	36000
10863	8401	1.5	38000
10863	8401	2.0	44000
10863	8401	2.5	73000
10863	8401	3.0	146000
10863	8401	3.5	274000
10863	8401	4.0	314000
10863	8401	4.5	212000
10863	8401	5.0	78000
10863	8401	5.5	31000
10863	8401	6.0	17000
10863	8401	6.5	14000
10863	8401	7.0	12000
10863	8401	7.5	12000
10863	8401	8.0	12000
10863	8401	8.5	12000
10863	8401	9.0	11000
10863	8401	9.5	11000
Borehole 623R[d]			
10867	8343	0.5	22000
10867	8343	1.0	24000
10867	8343	1.5	26000
10867	8343	2.0	30000

TABLE 5-2

(continued)

Coordinates[a] East	North	Depth[b] (ft)	Count Rate[c] (cpm)
Borehole 623R (continued)[d]			
10867	8343	2.5	48000
10867	8343	3.0	95000
10867	8343	3.5	129000
10867	8343	4.0	157000
10867	8343	4.5	262000
10867	8343	5.0	232000
10867	8343	5.5	107000
10867	8343	6.0	54000
10867	8343	6.5	50000
10867	8343	7.0	32000
10867	8343	7.5	17000
10867	8343	8.0	12000
10867	8343	8.5	11000

[a]Borehole locations are shown in Figure 4-1.

[b]The variations in depths of boreholes and corresponding results given in this table are based on the boreholes penetrating the contamination or the drill reaching refusal.

[c]Instrument used was 5.0- by 5.0-cm (2- by 2-in.) thallium-activated sodium iodide gamma scintillation detector.

[d]Bottom of borehole collapsed.

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3. Argonne National Laboratory. Action Description Memorandum, Proposed 1984 Remedial Actions at Maywood, New Jersey, Argonne, Ill., June 8, 1984.

4. Bechtel National, Inc. Post-Remedial Action Report for the Lodi Residential Properties, DOE/OR/20722-89, Oak Ridge, Tenn., August 1986.

5. NUS Corporation. Radiological Study of Maywood Chemical, Maywood, New Jersey, November 1983.

6. EG&G Energy Measurements Group. An Aerial Radiologic Survey of the Stepan Chemical Company and Surrounding Area, Maywood, New Jersey, NRC-8109, Oak Ridge, Tenn., September 1981.

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APPENDIX A
GEOLOGIC DRILL LOGS FOR GULF STATION

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP	14501-138	1 OF 1	MISS-404R

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
MAYWOOD INTERIM STORAGE SITE-GULF STATION	N8345,E10815	90°	N/A

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (FT.)	ROCK (FT.)	TOTAL DEPTH
8/8/86	8/8/86	MORETRENCH ENVIRONMENTAL SERVICES	MOBILE B-33	6"	10.0'	0.0	10.0'

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
N/A	N/A	N/A	N/A	46.5'	4.5'/42.0'	N/A

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
N/A	N/A	D McGRANE

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLE RECOVERY CORE RECOVERY	SAMPLE BLOWS "N" PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN G.P.M.	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION*	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							46.5	0				
6" AUGER THROUGHOUT.							46.2	0.3			0.0-0.3': ASPHALT.	
											0.3-10.0': SILTY SAND (SM-SC); COLOR STRATIFIED; FINE- TO COARSE-GRAINED SOFT; POORLY CONSOLIDATED (LOOSE) WITH A FEW DENSER CLAYEY ZONES (4.0-7.5 FT); MOIST TO SATURATED AT 4.5 FT. 0.3-7.5': DARK YELLOWISH BROWN (10YR4/2) WITH A FEW PALE GREEN (5G7/2) CLAYEY ZONES; CONTAINS NUMEROUS ROUNDED PEBBLES AND GRAVEL OF VARIOUS LITHOLOGIES. 7.5-10.0': DARK REDDISH BROWN (10R3/4); FINE-GRAINED; DECOMPOSED SANDSTONE.	▽ 8/8/86. SITE CHECKED FOR RADIOACTIVE CONTAMINATION AND HOLE GAMMA LOGGED BY EBERLINE ANALYTICAL CORPORATION.
								5				
							36.5	10				
											BOTTOM OF HOLE AT 10.0 FT. HOLE WAS IMMEDIATELY REFILLED WITH AUGER SPOILS AND RESEALED WITH ASPHALT.	* DESCRIPTION AND CLASSIFICATION BY VISUAL EXAMINATION OF CUTTINGS.

	SITE	HOLE NO.
SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENISON; P=PITCHER; O=OTHER	MAYWOOD INTERIM STORAGE SITE-GULF STATION	MISS-404R

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP	14501-138	1 OF 1	MISS-405R

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
MAYWOOD INTERIM STORAGE SITE - GULF STATION	N8415,E10710	90°	N/A

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (FT.)	ROCK (FT.)	TOTAL DEPTH
8/8/86	8/8/86	MORETRENCH ENV. SERV.	MOBILE B-33	6"	10.0'	0.0'	10.0'

CORE RECOVERY(FT./%)	CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
N/A	N/A	N/A	N/A	46.5'	4.5'/42.0'	N/A

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
N/A	N/A	D. McGRANE

SAMPLE TYPE AND DIAMETER	ELEVATION	DEPTH	DESCRIPTION AND CLASSIFICATION	NOTES ON: WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
6" AUGER THROUGHOUT.	46.5	0		
	46.2	0.3	0.0-0.3': ASPHALT.	
		5	0.3-10.0': SILTY SAND (SM-SC), COLOR STRATIFIED, FINE TO COARSE GRAINED, SOFT, POORLY CONSOLIDATED, (LOOSE) WITH A FEW DENSER CLAYEY ZONES (0.3-7.0'), MOIST TO SATURATED AT 4.5'. 0.3-7.0': DARK YELLOWISH BROWN (10YR4/2) WITH A FEW PALE GREEN (5G7/2), GRAY (N4), AND BLACK (ORGANIC RICH) CLAYEY ZONES, NUMEROUS ROUNDED PEBBLES AND GRAVEL OF VARIOUS LITHOLOGIES. 7.0-10.0': DARK REDDISH BROWN (10R3/4), FINE-GRAINED, DECOMPOSED SANDSTONE?	▽ 8/8/86 SITE CHECKED FOR RADIOACTIVE CONTAMINATION AND HOLE GAMMA LOGGED BY EBERLINE ANALYTICAL CORPORATION.
	36.5	10	BOTTOM OF HOLE AT 10.0'. HOLE WAS IMMEDIATELY FILLED WITH AUGER SPOILS AND RESEALED WITH ASPHALT.	

* DESCRIPTION AND CLASSIFICATION BY VISUAL EXAMINATION.

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENISON; P=PITCHER; O=OTHER

SITE	HOLE NO.
MAYWOOD INTERIM STORAGE SITE - GULF STATION	MISS-405R

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP	14501-138	1 OF 1	MISS-622R

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
MAYWOOD INTERIM STORAGE SITE - GULF STATION	N8401,E10063	90°	N/A

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (FT.)	ROCK (FT.)	TOTAL DEPTH
2/24/87	2/24/87	MORETRENCH ENV. SERV.	CME-55	6"	12.0'	0.0'	12.0'

CORE RECOVERY (FT./%)	CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
N/A	N/A	N/A	N/A	46.0'	10.0'/36.0'	N/A

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
N/A	N/A	D. McGRANE

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE, LENGTH CORE RUN	SAMPLE RECOVERY, CORE RECOVERY	SAMPLE BLOWS OF PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN GPM	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION*	NOTES ON WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							46.0	0				
6" AUGER THROUGHOUT.							34.0	5 10 12.0			0.0-12.0': SILTY SAND (SM) FILL AND INDIGENOUS MATERIAL (5.0-12.0'); COLORSTRATIFIED; FINE- TO MEDIUM-GRAINED WITH FEW TO NUMEROUS PIECES OF SUBANGULAR -ROUNDED GRAVEL OF VARIOUS LITHOLOGIES; SOFT; UNCONSOLIDATED; SOFT; UNCONSOLIDATED; SOMETIMES CLAYEY (SC-OH); MOIST - SATURATED AT 10.0'. 0.0-2.0': MODERATE BROWN (5YR3/4); NUMEROUS ORGANICS; FILL. 2.0-5.0': DARK YELLOWISH BROWN (10YR4/2); FEW ORGANICS; FILL. 5.0-7.0': BLACK; VERY SILTY; NUMEROUS ORGANICS; STREAM SEDIMENTS? 7.0-12.0': DARK YELLOWISH BROWN; DECOMPOSED SANDSTONE.	SITE CHECKED FOR RADIOACTIVE CONTAMINATION AND HOLE GAMMA LOGGED BY EBERLINE ANALYTICAL CORPORATION. ▽ 2/24/87
											BOTTOM OF HOLE AT 12.0 FT. HOLE WAS IMMEDIATELY BACKFILLED WITH A MIXTURE OF CONCRETE AND CLEAN AUGERSPOILS; 2/24/87.	* DESCRIPTION AND CLASSIFICATION BY VISUAL EXAMINATION OF CUTTINGS.

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENISON; P=PITCHER; O=OTHER	SITE	HOLE NO.
	MAYWOOD INTERIM STORAGE SITE - GULF STATION	MISS-622R

GEOLOGIC DRILL LOG

PROJECT	JOB NO.	SHEET NO.	HOLE NO.
FUSRAP	14501-138	1 OF 1	MISS-623R

SITE	COORDINATES	ANGLE FROM HORIZ.	BEARING
MAYWOOD INTERIM STORAGE SITE - GULF STATION	N8343,E10067	90°	N/A

BEGUN	COMPLETED	DRILLER	DRILL MAKE AND MODEL	HOLE SIZE	OVERBURDEN (FT.)	ROCK (FT.)	TOTAL DEPTH
2/24/87	2/24/87	MORETRENCH ENV. SERV.	CME-55	6"	10.0'	0.0'	10.0'

CORE RECOVERY(FT./%)	CORE BOXES	SAMPLES	EL. TOP OF CASING	GROUND EL.	DEPTH/EL. GROUND WATER	DEPTH/EL. TOP OF ROCK
N/A	N/A	N/A	N/A	46.5'	8.5'/38.0'	N/A

SAMPLE HAMMER WEIGHT/FALL	CASING LEFT IN HOLE: DIA./LENGTH	LOGGED BY:
N/A	N/A	D. McGRANE

SAMPLE TYPE AND DIAMETER	SAMPLER ADVANCE LENGTH CORE RUN	SAMPLE RECOVERY CORE RECOVERY	SAMPLE BLOWS "N" PERCENT CORE RECOVERY	WATER PRESSURE TESTS: LOSS IN GPM	PRESSURE P.S.I.	TIME IN MINUTES	ELEVATION	DEPTH	GRAPHIC LOG	SAMPLE	DESCRIPTION AND CLASSIFICATION	NOTES ON WATER LEVELS, WATER RETURN, CHARACTER OF DRILLING, ETC.
							46.5	0				
6" AUGER THROUGHOUT.								5			0.0-10.0': SILTY SAND (SM); FILL AND INDIGENOUS MATERIAL (4.0-10.0'); COLOR STRATIFIED; FINE- TO MEDIUM-GRAINED WITH FEW TO NUMEROUS PIECES OF SUBANGULAR TO ROUNDED GRAVEL OF VARIOUS LITHOLOGIES; SOFT; UNCONSOLIDATED; SOMETIMES CLAYEY (SC-OH); MOIST TO SATURATED AT 8.5'. 0.0-4.0': MODERATE BROWN (5YR3/4); NUMEROUS ORGANICS; FILL. 4.0-6.0': BLACK; VERY SILTY; NUMEROUS ORGANICS; STREAM SEDIMENTS 6.0-8.0': GRAY (N5). 8.0-10.0': DARK YELLOWISH BROWN (10YR4/2); DECOMPOSED SANDSTONE.	SITE CHECKED FOR RADIOACTIVE CONTAMINATION AND HOLE GAMMA LOGGED BY EBERLINE ANALYTICAL CORPORATION. 2/4/87
							36.5	10			BOTTOM OF HOLE AT 10.0 FT. HOLE WAS IMMEDIATELY BACKFILLED WITH A CEMENT AND CLEAN CUTTINGS GROUTMIXTURE, 2/24/87.	

SS=SPLIT SPOON; ST=SHELBY TUBE; D=DENISON; P=PITCHER; O=OTHER

SITE: MAYWOOD INTERIM STORAGE SITE - GULF STATION

HOLE NO.: MISS-623R