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Formerly Utilized Sites Remedial Action Program (FUSRAP)
Contract No. DE-AC05-81OR20722

POST-REMEDIAL ACTION REPORT FOR THE WAYNE SITE — 1985 AND 1987

Wayne, New Jersey

March 1989

Bechtel National, Inc.

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POST-REMEDIAL ACTION REPORT FOR THE WAYNE SITE - 1985 AND 1987 WAYNE, NEW JERSEY

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Prepared for

UNITED STATES DEPARTMENT OF ENERGY

OAK RIDGE OPERATIONS OFFICE

Under Contract No. DE-AC05-81OR20722

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ABBREVIATIONS

cm	centimeter*
cm^2	square centimeters
cpm	counts per minute
dpm	disintegrations per minute
ft	foot
ft^2	square feet
in.	inch
m	meter
m^2	square meter
MeV	million electron volts
µCi/ml	microcuries per milliliter
µR/hr	microroentgens per hour
mrad/hr	millirad per hour
mrem	millirem
mrem/yr	millirem per year
pCi/g	picocuries per gram
WL	working level

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*Words in boldface print are explained in the glossary.

1.0 INTRODUCTION

1.1 BACKGROUND

Under the Energy and Water Appropriations Act of FY 1984, Congress authorized the U.S. Department of Energy (DOE) to initiate a research and development decontamination project for the former W. R. Grace facility and vicinity properties in the Townships of Wayne and Pequannock, New Jersey. These properties were assigned by DOE to the Formerly Utilized Sites Remedial Action Program (FUSRAP), a program to identify, decontaminate, or otherwise control sites where residual radioactive contamination (exceeding current guidelines) remains from either the early days of the nation's atomic energy program or commercial operations causing conditions that Congress has mandated DOE to remedy. FUSRAP is currently being managed by the DOE Oak Ridge Operations office. Bechtel National, Inc. (BNI) is the project management contractor and acts as the DOE representative in planning, managing, and implementing FUSRAP.

As part of the work conducted during 1986 under FUSRAP, BNI removed radioactive contamination from three areas in Wayne, New Jersey. These areas were: a portion of Sheffield Brook; the front yard of the former W. R. Grace and Co. property [now the Wayne Interim Storage Site (WISS), owned by DOE]; and a small area on the right-of-way of Pompton Plains Crossroad adjacent to Lot 4A of Block 614. A post-remedial action report for 1986 was published in April 1987 (Ref. 1).

As part of the work conducted during 1985 and 1987 under FUSRAP, BNI removed radioactive contamination from six areas in Wayne, New Jersey. These areas were:

- Wayne Township Park
- Backyard of 112 Deerfield Road
- Side and front yards of 34 Farmingdale Road

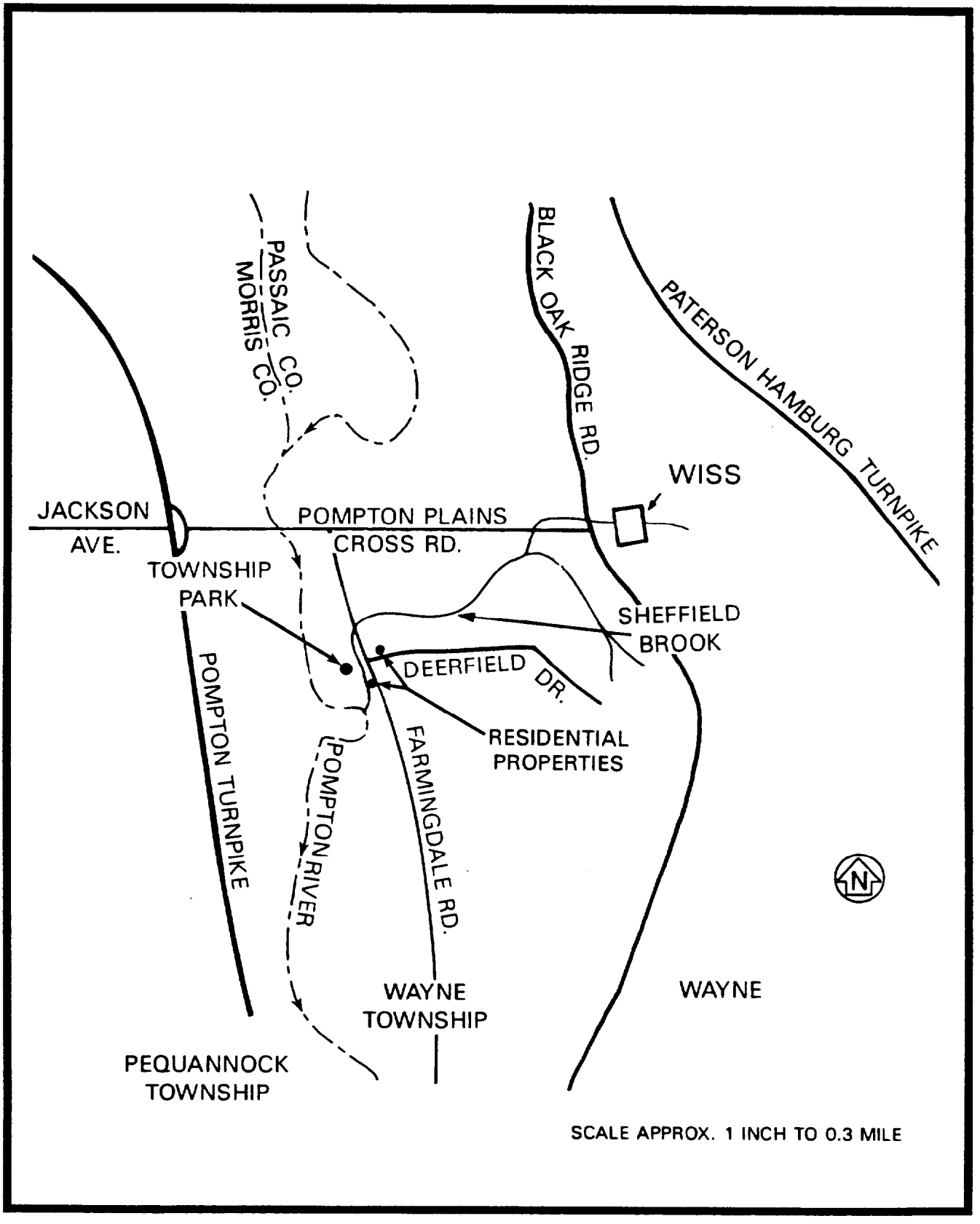

FIGURE 1-1 LOCATIONS OF SHEFFIELD BROOK, WAYNE TOWNSHIP PARK, AND THE RESIDENTIAL PROPERTIES IN THE VICINITY OF THE WAYNE SITE

- o Under Farmingdale Road
- o A portion of Sheffield Brook
- o The mouth of Sheffield Brook

The locations of these properties are shown in Figure 1-1.

The purpose of this report is to document post-remedial action sampling performed by BNI on the properties remediated during 1985 and 1987. This report briefly describes the origin of the radioactive contamination at the properties, the methods used to determine the extent of contamination, and the type of remedial action performed. The report also identifies the guidelines used in performing the remedial action, documents areas and depths of excavation, and provides data on the current radiological status of each property.

1.2 HISTORY

In 1948, Rare Earths, Inc., began processing monazite sand at their Wayne Township, New Jersey facility to extract thorium and rare earths. The Davidson Chemical Division of W. R. Grace and Co. acquired the facility in 1957. Processing continued at the W. R. Grace facility until July 1971, when the plant was closed. Applied Health Physics, Inc., decontaminated the buildings in 1974 (Ref. 2), and the property was released in January 1975 by the Nuclear Regulatory Commission (NRC).

In 1980, the New Jersey Department of Environmental Protection (NJDEP) requested that an aerial survey be conducted over the former W. R. Grace facility to determine the radiological conditions. This survey, conducted by EG&G in May 1981, identified elevated radiation levels on the W. R. Grace site and west of the site along Sheffield Brook (Ref. 3).

At the request of the NRC Division of Fuel Cycle and Material Safety, walkover surveys of the former W. R. Grace facility and the property immediately to the south of it were performed in May and July 1982 by the Radiological Site Assessment Program of Oak Ridge Associated Universities (ORAU) (Refs. 4 and 5). Similar surveys were conducted in 1982 by the NJDEP (Refs. 6 and 7). The NJDEP and ORAU surveys indicated surface radionuclide contamination concentrations greater than those acceptable under current DOE remedial action guidelines.

2.0 REMEDIAL ACTION GUIDELINES

The radioactive contamination at Sheffield Brook, Wayne Township Park, Farmingdale Road, and privately owned properties consisted primarily of thorium-232, with approximately equal levels of uranium-238 and typically much lower levels of radium-226. Table 2-1 lists the DOE residual contamination guidelines governing the release of formerly contaminated property for unrestricted release (Ref. 8). DOE implemented these guidelines on the basis of their compatibility with the criteria used for the same purpose by the Environmental Protection Agency (EPA) (Ref. 9). If the guidelines listed in Table 2-1 are exceeded, contaminated soil is removed from the property until concentrations are within guidelines. Once the guidelines have been met, the property can be released from the FUSRAP program.

The major radiological contaminant on the site was thorium-232. All uranium-238 soil concentrations measured at the Wayne site were well below typical uranium-238 guidelines used at DOE FUSRAP sites. Therefore, a site-specific guideline for uranium-238 was not calculated. However, if typical (as opposed to site-specific) values are used as the basis for calculating a guideline for uranium, this guideline would be approximately 75 pCi/g.

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 (LAND) GUIDELINES

Radionuclide	Soil Concentration (pCi/g) above background[a,b,c]
Radium-226 Radium-228 Thorium-230 Thorium-232	5 pCi/g, 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 it 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 cm^2)		
Radionuclide[f]	Average[g,h]	Maximum[h,i]	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

TABLE 2-1

(continued)

Indoor/Outdoor Structure Surface Contamination (continued)

Radionuclide[f]	Allowable Surface Residual Contamination[e] (dpm/100 cm^2) Average[g,h]	Maximum[h,i]	Removable[h,j]
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

[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 the dose for the mixtures will not exceed the basic dose limit.

[b]These guidelines represent allowable residual concentrations above background averaged across any 15-cm-thick layer to any depth and over any contiguous 100-m^2 surface area.

[c]Localized concentrations in excess of these limits are allowable provided that the average over a 100-m^2 area is not exceeded.

[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 1.3×10^5 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 m^2. 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 cm^2.

[j]The amount of removable radioactive material per 100 cm^2 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 cm^2 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 REMEDIAL ACTION

After the preliminary radiological surveys indicated that Sheffield Brook, the WISS, and a number of privately owned properties were contaminated, DOE designated the properties for remedial action. Property owners were notified and BNI began the engineering design and related activities. Just prior to excavation, BNI and the radiological support subcontractor, Thermo Analytical/Eberline (TMA/E), again surveyed the properties for radiation to define the boundaries of contamination more accurately.

3.1 CLEANUP/DECONTAMINATION ACTIVITIES

Figure 3-1 shows the areas excavated in 1985 and 1987. A total volume of approximately 14,900 yd^3 over an area of 161,600 ft^2 was excavated. The contaminated soil was placed in dump trucks and transported to the temporary storage pile at the WISS, where it will be stored with engineering safeguards until it can be moved to a permanent disposal site. All excavated areas were backfilled with clean fill and restored to original grade.

Wayne Township Park

The remedial action in Wayne Township Park involved excavation to a depth of 6 in. over an area of approximately 17,200 ft^2 located west of Deerfield Road. This was accomplished in two phases - 14,000 ft^2 in 1985 and 3,200 ft^2 in 1987. This includes a common area of 1,200 ft^2 where excavations were made in both phases to remove the remaining areas of contamination. These areas are shown in Figure 3-1.

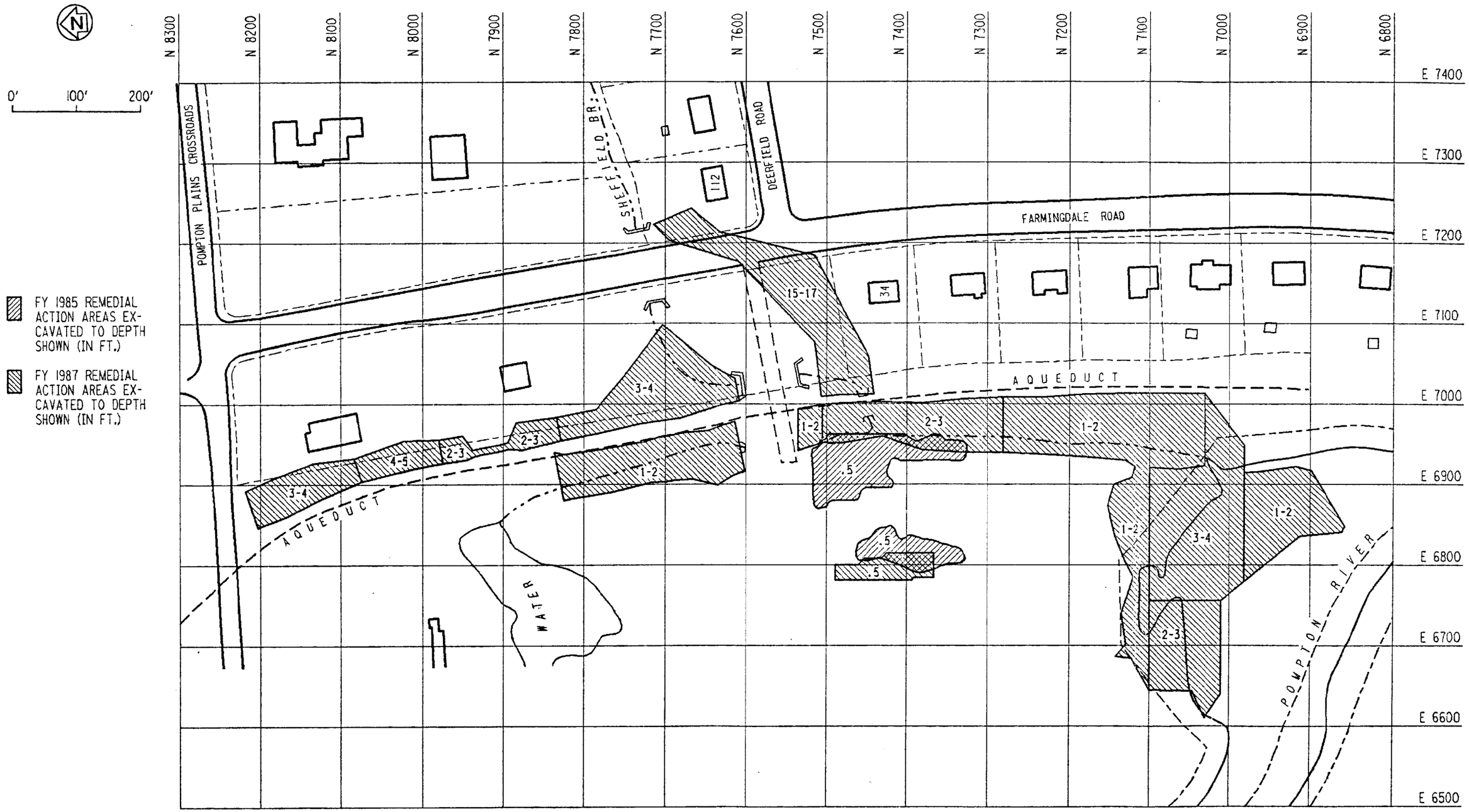

FIGURE 3-1 AREAS AND DEPTHS OF EXCAVATION AT THE WAYNE SITE

Backyard of 112 Deerfield Road

The remedial action in the backyard of 112 Deerfield Road consisted of excavation to a depth of 15 to 17 ft over an area of approximately 1,900 ft^2. This was the only property east of Farmingdale Road remediated in 1987.

Side and Front Yards of 34 Farmingdale Road

The characterization at 34 Farmingdale Road revealed no contamination on the property itself. However, overburden was removed to excavate contaminants west of the property along the original course of the brook (considered part of the Farmingdale Road excavation for the purpose of documentation).

Farmingdale Road

The remedial action under and along Farmingdale Road involved excavating to a depth of 15 to 17 ft over an area of 13,500 ft^2 following the original course of Sheffield Brook.

Remaining Portion of Sheffield Brook

The remedial action for the remaining portion of Sheffield Brook consisted of excavation to a depth of 0.5 to 2 ft over an area of approximately 83,300 ft^2. This involved an area west of Farmingdale Road extending toward the Pompton River and north to Pompton Plains Crossroad.

Mouth of Sheffield Brook

The remedial action at the mouth of Sheffield Brook involved excavation to a depth of 1 to 4 ft over an area of approximately 45,700 ft^2. A cofferdam was installed and the area was pumped dry prior to excavation.

3.2 CONTAMINATION CONTROL DURING THE CLEANUP

During the cleanup of the properties, several measures were implemented to eliminate the possibility of spreading the contaminated materials being removed. These measures were designed to protect workers and nearby residents from exposure to radiation and to keep exposures as low as reasonably achievable (ALARA). The primary pathway by which residents could have been exposed to radiation was through dust generated during the excavations. To keep exposures ALARA, work areas were kept free from dust by keeping the soil moistened.

To further control the spread of contaminants during the course of excavation work, haul trucks were draped with tarpaulins before they were loaded. This kept contaminated dirt from getting on the exteriors of trucks and later falling off the trucks onto clean property. If the truck was to be loaded in a clean area, it was parked on a tarpaulin that covered the ground beneath and around it. If contaminated soil was spilled during the loading process, the tarpaulin prevented the spread of contamination. Finally, before the radioactive soil was hauled away, the truck was covered to prevent soil from falling or blowing out of the truck onto clean ground.

As a precautionary measure, BNI also surveyed the haul route before and after the remedial action, and no differences from background conditions were noted. These combined measures resulted in effective control of the contamination.

During the cleanup, air samplers were placed near or in the vicinity of the excavation areas to continuously monitor the concentration of alpha-emitting radionuclides in the air (see Figure 3-2). The average concentration of the 98 air samples taken was 8×10^{-15} µCi/ml. All concentrations measured were below the DOE guideline for thorium-232 (1.0×10^{-12} µCi/ml) (Ref. 10).

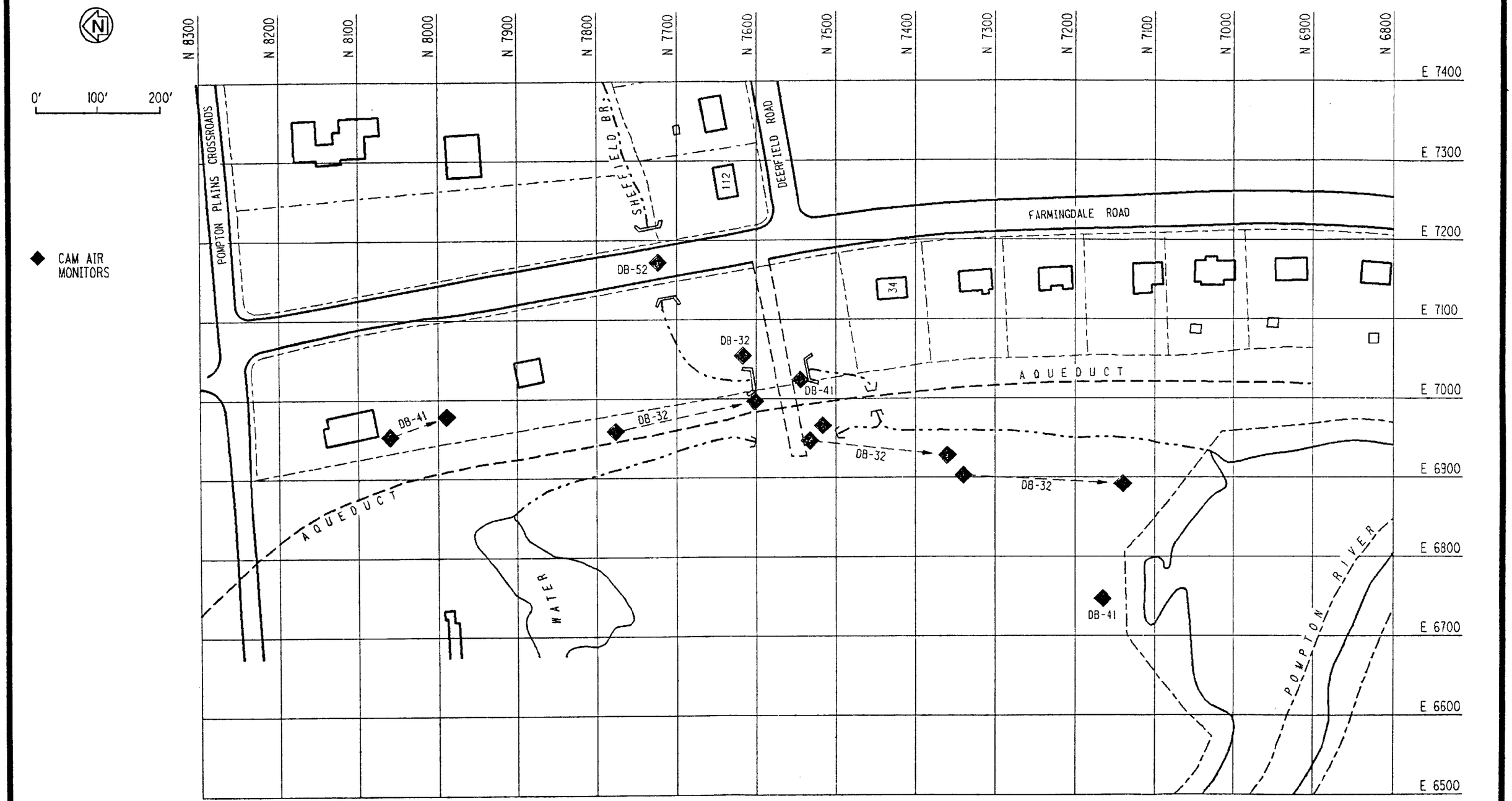

FIGURE 3-2 AIR MONITOR LOCATIONS AT THE WAYNE SITE

4.0 POST-REMEDIAL ACTION SAMPLING

After the excavations were performed, a radiological survey of the excavated areas was conducted to ensure that no radionuclide concentrations exceeding DOE guidelines remained. This survey included surface gamma radiation scans, soil sampling with a new post-remedial action protocol, and dose rate measurements.

4.1 SURFACE GAMMA RADIATION SCANS

Two types of gamma radiation scans were conducted to aid in determining whether all radioactively contaminated soil had been removed from an area. In the first, a walkover scan, the surveyor holds an unshielded gamma scintillation radiation detector a few centimeters above the ground surface and slowly moves it over the ground as he walks over the excavated area. This type of survey is performed to detect areas of residual contamination. If contamination appears to be in excess of remedial action guidelines, additional excavation is performed; the area is then scanned again to determine if the contamination has been removed. The advantage of the walkover survey is that the detector quickly scans the areas as the excavation proceeds.

The second type of gamma radiation scan is performed after all contamination detected by the walkover scan has been removed. This survey uses a cone-shielded gamma scintillation detector to ensure that the only radiation detected is that coming from the ground directly beneath the unit.

During both types of radiation scans of the properties, measurements were made in the excavated areas to ensure that each property had been cleaned of radioactively contaminated soils to below DOE guidelines. When either of these gamma radiation scans detected contamination that appeared to be in excess of the DOE guidelines, additional soil was removed, and the survey process was repeated until DOE guidelines were met.

4.2 SOIL SAMPLING

Soil sampling was the primary method used to ensure that the DOE remedial action guidelines were met. To confirm that the excavation had extended deeply enough to remove the contamination, soil samples were taken at intervals of 4.9 m at the bottom of the excavated area. The samples were analyzed in the laboratory to determine the concentrations of radium-226, thorium-232, and uranium-238. Soil sampling locations are shown in Figure 4-1.

4.3 NEW POST-REMEDIAL ACTION SAMPLING PROTOCOL

In FY 1986, a new post-remedial action sampling protocol was implemented by BNI to enhance the technical reliability of data collected during post-remedial action surveys. The new protocol did not affect the walkover scan, which was therefore performed the same way for both the FY 1985 and FY 1987 remedial actions. However, the procedure used during the scan with the cone-shielded detector was modified.

In FY 1985, nine readings were taken with the cone-shielded detector per 100 m^2 across the excavated areas. During FY 1987, readings were taken at 13 locations per 100-m^2 area.

The procedure for soil sampling also was modified to provide more representative sampling for each 100-m^2 area. During FY 1985 remedial action, four discrete samples were collected from each 100-m^2 area excavated. In FY 1987, 25 soil plugs, 15 cm deep and 2.5 cm in diameter, were taken at 2-m intervals across each 100-m^2 area of the excavation.

The plugs from each 100-m^2 area were combined into a 1.9-liter composite soil sample for that area. Since the new protocol was compatible with the previous one, no resampling of the areas excavated in FY 1985 was necessary.

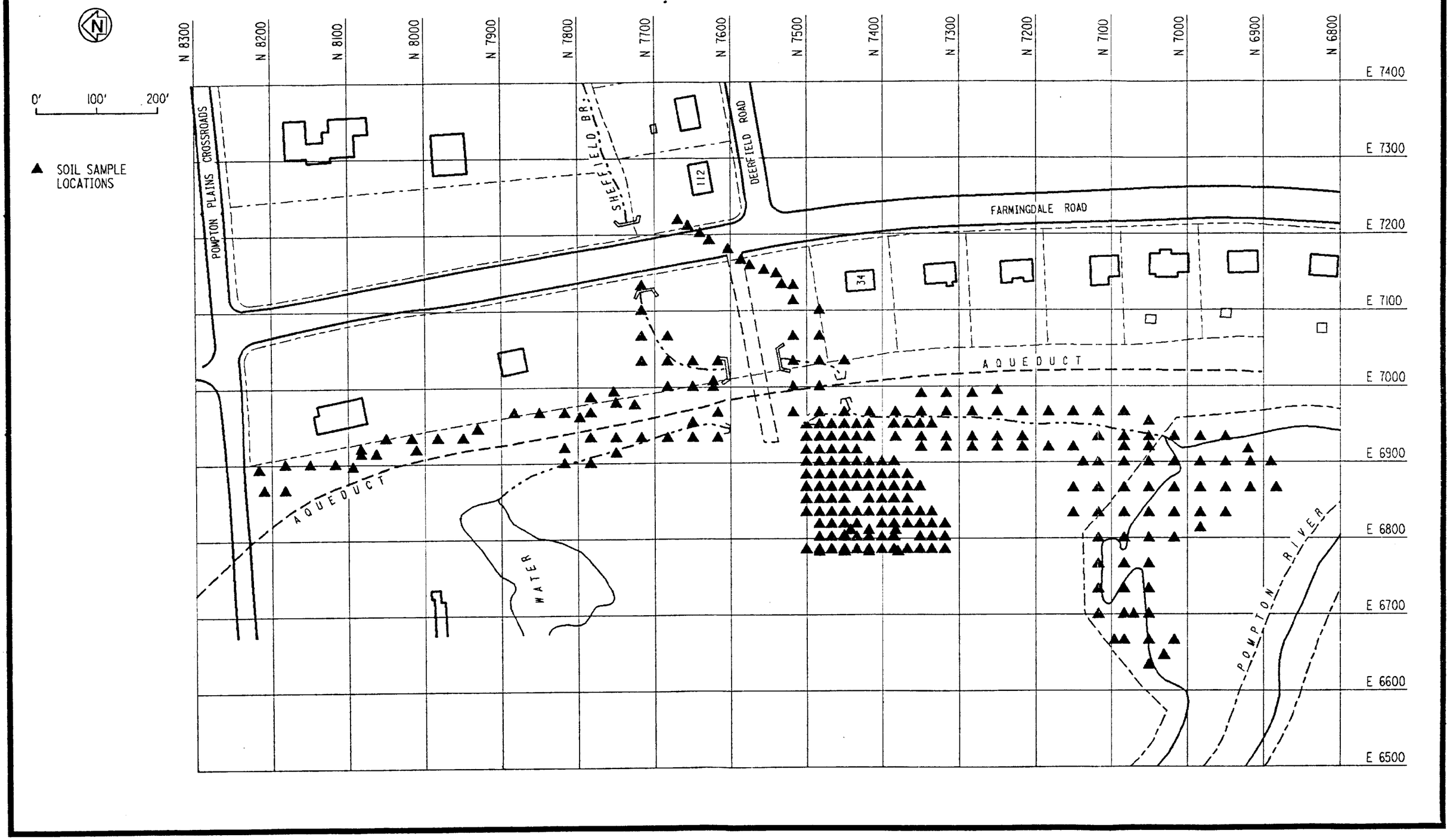

FIGURE 4-1 POST-REMEDIAL ACTION SOIL SAMPLING LOCATIONS AT THE WAYNE SITE 15

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4.4 DOSE RATE MEASUREMENTS

Dose rate measurements were taken at 1 m above the ground surface to measure the residual gamma radiation dose rate after removal of the contamination or after backfilling. Locations where dose rate measurements were taken are shown in Figure 4-2. Tables 4-1 and 4-2 report the calculated gamma radiation dose rates, assuming a conservative continuous exposure. For comparison, the DOE radiation protection standard is 100 mrem/yr above the background radiation level. Tables 4-1 and 4-2 reflect the values received after subtraction of a measured background of 108 mrem/yr (Ref. 11).

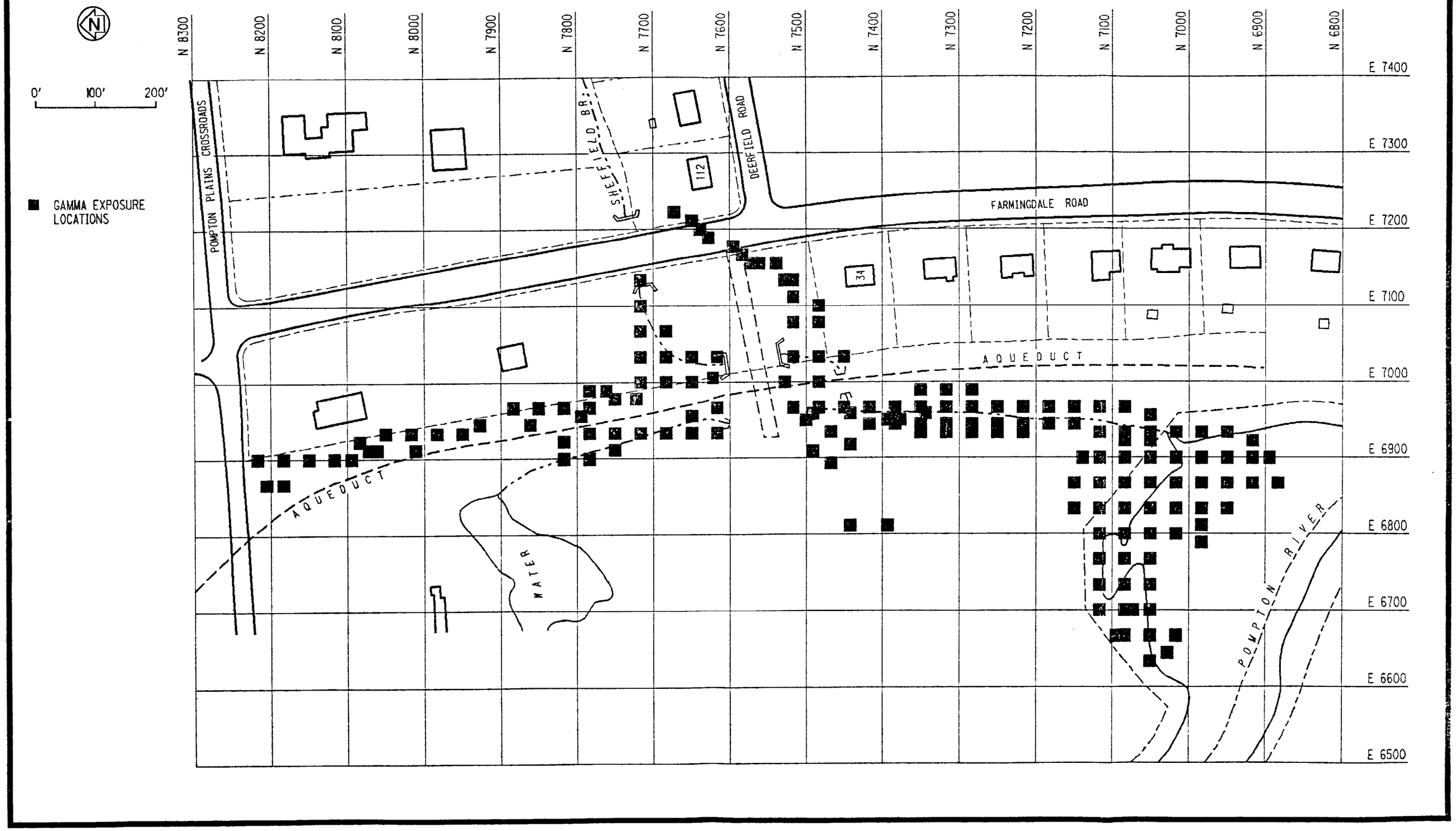

FIGURE 4-2 GAMMA RADIATION DOSE RATE MEASUREMENT LOCATIONS AT THE WAYNE SITE

TABLE 4-1

GAMMA RADIATION DOSE RATE MEASUREMENTS
AT WAYNE TOWNSHIP PARK - FY 1985

Coordinates		Dose Rate
North	East	(mrem/yr)[a]
7344	6958	5
7377	6950	40
7393	6811	5
7393	6950	23
7442	6811	27
7442	6917	31
7442	6958	31
7467	6893	14
7467	6934	49
7491	6909	31

[a]Converted from uR/h measurements by assuming continuous occupancy (365 days/yr) and subtracting a background contribution of 108 mrem/yr. The DOE standard permits exposures up to 100 mrem/yr above background (average over a lifetime -- see basic dose limits on Table 2-1).

TABLE 4-2

GAMMA RADIATION DOSE RATE MEASUREMENTS FOR SHEFFIELD BROOK - FY 1987

Coordinates East	Coordinates North	Dose Rate (mrem/yr)[a]
6633	7050	0
6644	7028	0
6667	7017	0
6667	7050	10
6667	7083	8
6667	7094	0
6700	7050	0
6700	7072	0
6700	7083	0
6700	7117	0
6733	7050	7
6733	7083	0
6733	7117	0
6767	7050	0
6767	7083	3
6767	7117	0
6789	6983	6
6800	7017	0
6800	7050	0
6800	7083	10
6800	7117	0
6811	6983	0
6833	6950	8
6833	6983	0
6833	7017	11
6833	7050	0
6833	7083	0
6833	7117	0
6833	7150	0
6867	6883	0
6867	6917	2
6867	6950	0
6867	6983	0
6867	7017	0
6867	7050	0
6867	7083	7
6867	7117	9
6867	7150	0
6867	8183	0
6867	8206	0
6900	6894	8
6900	6917	3
6900	6950	0

TABLE 4-2
(continued)

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Coordinates East	Coordinates North	Dose Rate (mrem/yr)[a]
6900	6983	22
6900	7017	20
6900	7050	5
6900	7083	14
6900	7117	0
6900	7139	2
6900	7783	0
6900	7817	2
6900	8094	0
6900	8117	0
6900	8150	0
6900	8183	0
6900	8217	0
6911	7750	0
6911	8011	0
6911	8061	0
6911	8072	0
6922	6917	3
6922	7050	0
6922	7083	4
6922	7817	0
6922	8083	0
6933	6950	6
6933	6983	3
6933	7017	30
6933	7050	0
6933	7083	0
6933	7117	0
6933	7217	0
6933	7250	0
6933	7283	0
6933	7317	0
6933	7350	0
6933	7617	0
6933	7650	0
6933	7683	0
6933	7717	0
6933	7750	0
6933	7783	0
6933	7950	0
6933	7983	0
6933	8017	0
6933	8050	0
6944	7150	0
6944	7183	0

TABLE 4-2
(continued)

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Coordinates East	Coordinates North	Dose Rate (mrem/yr)[a]
6944	7217	0
6944	7250	0
6944	7283	0
6944	7317	0
6944	7350	0
6944	7383	1
6944	7417	3
6944	7861	5
6944	7928	0
6956	7050	2
6956	7650	0
6956	7794	2
6967	7083	4
6967	7117	8
6967	7150	3
6967	7183	0
6967	7217	0
6967	7250	0
6967	7283	0
6967	7317	0
6967	7350	0
6967	7383	0
6967	7417	2
6967	7450	2
6967	7483	0
6967	7517	2
6967	7617	0
6967	7783	0
6967	7817	0
6967	7850	1
6967	7883	0
6978	7722	1
6978	7750	0
6989	7283	0
6989	7317	0
6989	7350	0
6989	7761	0
6989	7783	0
7000	7483	0
7000	7528	0
7000	7650	0
7000	7683	0
7000	7717	0
7006	7622	0

TABLE 4-2
(continued)

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Coordinates East	Coordinates North	Dose Rate (mrem/yr)[a]
7033	7450	0
7033	7483	0
7033	7517	2
7033	7617	0
7033	7650	0
7033	7683	0
7033	7717	0
7067	7683	0
7067	7717	0
7078	7483	0
7078	7517	0
7100	7483	1
7100	7717	0
7111	7517	8
7133	7517	0
7133	7528	4
7133	7717	0
7156	7539	0
7156	7561	10
7156	7572	2
7167	7583	4
7178	7594	8
7189	7628	2
7200	7639	0
7211	7650	0
7222	7672	0

[a]Converted from uR/h measurements by assuming continuous occupancy (365 days/yr) and subtracting a background contribution of 108 mrem/yr. The DOE standard permits exposures up to 100 mrem/yr above background (average over a lifetime -- see basic dose limits in Table 2-1).

5.0 POST-REMEDIAL ACTION STATUS

As shown in Tables 5-1 through 5-3, analytical results from soil samples taken after removing the radioactive materials show that no area of contamination remains in excess of DOE remedial action guidelines. Soil sample results include background, which for the northeastern United States typically includes about 1 pCi/g each of uranium, radium, and thorium (Ref. 12).

An independent assessment of the remedial action at the work areas will be conducted by the Oak Ridge National Laboratory (ORNL) Radiological Site Assessment Program on behalf of DOE. The purpose of the assessment will be to verify the BNI data supporting the adequacy of the remedial action and to confirm that radiological conditions at the properties comply with remedial action guidelines. In addition to the ORNL survey, remedial action activities, including archiving of soil samples, were monitored by the NJDEP.

Based on all data collected, the properties conform to all applicable DOE radiological guidelines governing unrestricted release of the properties.

TABLE 5-1

POST-REMEDIAL ACTION SAMPLING RESULTS
WAYNE TOWNSHIP PARK - FY 1985

Grid Location		Concentration (pCi/g ± 1 sigma)[a]		
East	North	Uranium-238	Radium-226	Thorium-232
6786	7319	2.3 ± 1.8	0.6 ± 0.2	1.5 ± 0.8
6786	7336	<1.4	0.8 ± 0.1	1.3 ± 0.6
6786	7352	<1.5	0.6 ± 0.1	1.8 ± 0.5
6786	7368	1.3 ± 0.1	0.8 ± 0.2	1.9 ± 0.6
6786	7385	2.0 ± 1.2	0.7 ± 0.2	2.0 ± 0.5
6786	7401	1.2 ± 1.6	0.7 ± 0.2	1.7 ± 0.7
6786	7418	<3.8	0.8 ± 0.4	2.7 ± 0.6
6786	7434	2.8 ± 1.3	0.6 ± 0.1	1.6 ± 0.5
6786	7450	<1.5	0.6 ± 0.2	1.4 ± 0.2
6786	7467	1.6 ± 1.2	0.7 ± 0.1	1.1 ± 0.4
6786	7483	2.9 ± 1.8	0.7 ± 0.3	2.3 ± 0.4
6786	7500	<2.1	0.7 ± 0.2	2.4 ± 0.7
6802	7319	<2.9	0.7 ± 0.1	1.0 ± 0.7
6802	7336	<1.7	0.5 ± 0.1	1.1 ± 0.3
6802	7352	<1.7	0.6 ± 0.2	0.9 ± 0.3
6802	7385	1.6 ± 1.5	0.7 ± 0.2	2.1 ± 1.2
6802	7386	2.0 ± 1.7	0.7 ± 0.2	2.1 ± 0.4
6802	7401	1.3 ± 1.9	0.8 ± 0.1	2.9 ± 0.7
6802	7418	3.6 ± 1.7	0.7 ± 0.1	3.7 ± 0.7
6802	7434	<2.6	0.9 ± 0.5	3.7 ± 1.4
6802	7450	<2.1	0.8 ± 0.1	2.2 ± 0.4
6802	7467	2.0 ± 1.3	0.5 ± 0.1	1.1 ± 0.5
6802	7483	<3.0	0.8 ± 0.2	2.3 ± 0.7
6811	7442	4.1 ± 2.0	1.1 ± 0.2	5.8 ± 0.9
6819	7319	1.3 ± 1.7	0.9 ± 0.2	3.6 ± 1.1
6819	7336	3.1 ± 1.9	0.9 ± 0.2	2.9 ± 0.5
6819	7352	3.7 ± 2.3	1.2 ± 0.1	5.6 ± 0.7
6819	7368	6.3 ± 1.7	1.1 ± 0.2	6.2 ± 0.9
6819	7385	4.6 ± 2.1	1.1 ± 0.2	7.1 ± 0.9
6819	7401	7.3 ± 2.9	1.2 ± 0.2	10.0 ± 1.5
6819	7434	3.3 ± 1.2	0.8 ± 0.1	2.9 ± 0.2
6819	7450	2.6 ± 1.8	0.9 ± 0.1	4.3 ± 0.9
6819	7467	1.1 ± 0.9	0.7 ± 0.2	0.9 ± 0.2
6819	7483	<1.6	0.5 ± 0.1	1.1 ± 0.7
6835	7336	<1.4	0.7 ± 0.1	1.7 ± 0.8
6835	7352	2.7 ± 1.9	0.8 ± 0.1	2.1 ± 0.3
6835	7368	<2.3	0.9 ± 0.5	3.4 ± 0.5
6835	7385	<1.6	0.8 ± 0.2	2.8 ± 1.0
6835	7401	2.0 ± 0.8	0.8 ± 0.2	2.7 ± 1.1
6835	7418	<2.3	0.9 ± 0.3	2.6 ± 0.8
6835	7434	<3.5	0.8 ± 0.1	1.8 ± 0.4
6835	7450	4.2 ± 2.3	1.0 ± 0.3	3.7 ± 1.3

TABLE 5-1
(continued)

Grid Location		Concentration (pCi/g ± 1 sigma)[a]		
East	North	Uranium-238	Radium-226	Thorium-232
6835	7467	1.5 ± 0.1	0.8 ± 0.1	2.6 ± 0.6
6835	7483	3.0 ± 1.6	0.9 ± 0.2	3.8 ± 0.8
6835	7500	3.5 ± 1.7	0.9 ± 0.3	3.8 ± 0.7
6852	7368	<2.1	0.6 ± 0.4	2.0 ± 0.5
6852	7385	<2.4	0.7 ± 0.2	3.0 ± 0.7
6852	7401	<3.1	0.6 ± 0.2	1.1 ± 0.6
6852	7418	3.9 ± 2.3	0.6 ± 0.1	4.3 ± 1.3
6852	7450	4.3 ± 1.9	1.0 ± 0.2	4.1 ± 0.9
6852	7467	4.4 ± 2.1	0.8 ± 0.1	3.8 ± 0.4
6852	7483	2.2 ± 1.8	0.8 ± 0.3	3.0 ± 0.8
6852	7500	2.4 ± 1.4	0.9 ± 0.1	3.3 ± 1.5
6868	7352	2.4 ± 1.3	0.7 ± 0.1	1.9 ± 0.3
6868	7368	2.1 ± 1.7	0.8 ± 0.1	2.5 ± 0.5
6868	7385	<2.6	0.7 ± 0.1	2.6 ± 0.3
6868	7401	3.7 ± 0.7	0.8 ± 0.2	2.8 ± 0.3
6868	7418	3.5 ± 0.3	0.8 ± 0.2	2.8 ± 0.5
6868	7434	<1.6	0.8 ± 0.1	3.0 ± 0.7
6868	7450	3.5 ± 0.1	0.8 ± 0.2	5.0 ± 0.8
6868	7467	4.3 ± 3.2	1.0 ± 0.1	5.8 ± 1.7
6868	7483	<3.7	0.8 ± 0.7	4.7 ± 1.6
6868	7500	3.8 ± 2.4	1.1 ± 0.2	4.7 ± 0.7
6884	7368	<3.6	0.9 ± 0.4	2.3 ± 0.9
6884	7385	2.7 ± 1.5	0.7 ± 0.1	1.5 ± 0.3
6884	7401	<2.4	0.8 ± 0.3	3.2 ± 1.0
6884	7418	<5.8	0.9 ± 0.4	3.7 ± 1.3
6884	7434	4.0 ± 1.9	0.9 ± 0.2	5.0 ± 1.2
6884	7450	3.5 ± 2.0	1.0 ± 0.3	5.6 ± 1.9
6884	7467	1.9 ± 1.4	0.9 ± 0.3	3.0 ± 0.5
6884	7483	3.1 ± 0.5	1.0 ± 0.4	5.2 ± 1.2
6884	7500	<3.8	1.1 ± 0.1	2.1 ± 0.6
6901	7385	0.9 ± 1.6	0.9 ± 0.1	2.8 ± 0.9
6901	7401	3.0 ± 1.8	0.8 ± 0.3	2.6 ± 1.1
6901	7418	1.0 ± 0.2	0.6 ± 0.1	1.2 ± 0.3
6901	7434	1.5 ± 0.2	0.8 ± 0.1	3.7 ± 1.0
6901	7450	3.3 ± 2.1	0.8 ± 0.2	3.2 ± 0.3
6901	7467	3.5 ± 0.4	0.8 ± 0.2	3.5 ± 0.5
6901	7483	3.2 ± 1.8	0.9 ± 0.1	5.5 ± 2.5
6901	7500	3.0 ± 1.7	0.9 ± 0.1	5.0 ± 1.5
6917	7434	3.3 ± 1.8	0.9 ± 0.2	5.7 ± 0.9
6917	7450	8.1 ± 2.4	1.0 ± 0.1	8.6 ± 2.2
6917	7467	3.3 ± 1.7	0.7 ± 0.1	4.8 ± 0.7
6917	7483	<4.4	0.9 ± 0.6	4.2 ± 0.5
6917	7500	1.5 ± 0.1	0.8 ± 0.1	2.0 ± 0.7
6934	7418	<3.2	0.9 ± 0.7	1.7 ± 0.7
6934	7434	<3.7	0.9 ± 0.1	1.4 ± 0.9

TABLE 5-1
(continued)

Grid Location		Concentration (pCi/g ± 1 sigma)[a]		
East	North	Uranium-238	Radium-226	Thorium-232
6934	7450	3.8 ± 3.1	1.0 ± 0.5	3.4 ± 2.0
6934	7467	<2.3	0.8 ± 0.2	1.3 ± 0.2
6934	7483	<2.0	0.8 ± 0.6	2.2 ± 0.4
6934	7500	<1.0	0.7 ± 0.2	1.5 ± 0.9
6950	7336	3.2 ± 1.8	0.8 ± 0.1	4.6 ± 0.8
6950	7352	<2.2	0.9 ± 0.2	4.5 ± 1.5
6950	7368	<3.8	1.0 ± 0.2	6.9 ± 2.0
6950	7385	<3.3	1.1 ± 0.4	4.4 ± 1.4
6950	7418	<3.8	1.0 ± 0.2	7.7 ± 1.1
6950	7434	3.9 ± 3.5	1.3 ± 0.2	4.9 ± 0.9
6950	7450	<4.6	0.7 ± 0.1	3.7 ± 1.1
6950	7467	4.9 ± 4.9	1.6 ± 0.6	7.3 ± 0.9
6950	7483	3.5 ± 2.2	1.0 ± 0.3	6.0 ± 3.0
6950	7500	2.8 ± 2.1	0.8 ± 0.2	3.6 ± 0.6

[a]Samples taken from bottom of excavation.

TABLE 5-2

POST-REMEDIAL ACTION SAMPLING RESULTS
WAYNE TOWNSHIP PARK - FY 1987

Grid Location		Concentration (pCi/g ± 1 sigma)[a]		
East	North	Uranium-238	Radium-226	Thorium-232
6783	7380	<2.1	0.6 ± 0.1	1.2 ± 0.3
6783	7418	<2.8	0.6 ± 0.2	1.5 ± 0.3
6783	7450	<2.8	0.5 ± 0.3	2.0 ± 0.7
6783	7483	<3.3	0.8 ± 0.3	2.1 ± 0.4
6804	7450	2.2 ± 1.4	0.8 ± 0.2	1.3 ± 0.4
6811	7383	<1.5	0.7 ± 0.3	2.7 ± 0.4
6811	7418	<3.2	0.9 ± 0.2	1.8 ± 1.7

[a]Samples taken from bottom of excavation.

TABLE 5-3

POST-REMEDIAL ACTION SOIL SAMPLING RESULTS FOR SHEFFIELD BROOK

Coordinates		Concentration (pCi/g ± 2 sigma)[a]		
East	North	Uranium-238	Radium-226	Thorium-232
6633	7050	1.4 ± 0.4	0.5 ± 0.1	1.0 ± 0.1
6646	7030	0.8 ± 0.3	0.5 ± 0.1	0.8 ± 0.1
6666	7017	1.7 ± 0.6	0.7 ± 0.1	2.7 ± 0.1
6666	7050	1.5 ± 0.5	0.6 ± 0.1	1.7 ± 0.1
6666	7083	< 0.7	0.4 ± 0.1	1.2 ± 0.2
6666	7096	2.7 ± 0.5	0.8 ± 0.1	2.5 ± 0.1
6700	7050	0.9 ± 0.3	0.6 ± 0.1	2.0 ± 0.2
6700	7070	1.2 ± 0.3	0.5 ± 0.1	1.7 ± 0.1
6700	7083	0.4 ± 0.3	0.6 ± 0.1	1.1 ± 0.1
6700	7117	1.6 ± 0.5	0.6 ± 0.1	1.0 ± 0.1
6733	7050	3.5 ± 0.6	0.6 ± 0.1	2.9 ± 0.1
6733	7083	1.0 ± 0.5	0.6 ± 0.1	1.9 ± 0.5
6733	7117	0.8 ± 0.3	1.2 ± 0.1	1.2 ± 0.1
6766	7050	1.1 ± 0.4	0.5 ± 0.1	1.4 ± 0.4
6766	7083	1.7 ± 0.5	0.7 ± 0.1	3.4 ± 1.2
6766	7117	1.0 ± 0.4	0.6 ± 0.1	1.1 ± 0.1
6800	7017	2.2 ± 0.7	0.7 ± 0.1	2.5 ± 0.1
6800	7050	1.9 ± 0.5	0.6 ± 0.1	2.5 ± 0.1
6800	7083	2.5 ± 0.4	0.8 ± 0.1	3.9 ± 0.1
6800	7117	2.3 ± 0.5	0.6 ± 0.1	1.0 ± 0.1
6813	6983	1.3 ± 0.5	0.6 ± 0.1	2.3 ± 0.2
6833	6950	1.8 ± 0.5	0.6 ± 0.1	2.0 ± 0.1
6833	6983	2.0 ± 0.5	0.6 ± 0.1	1.9 ± 0.1
6833	7017	3.0 ± 0.6	0.7 ± 0.1	4.3 ± 0.3
6833	7050	1.0 ± 0.3	0.5 ± 0.1	1.7 ± 0.2
6833	7083	0.7 ± 0.4	0.7 ± 0.1	2.0 ± 0.2
6833	7117	3.2 ± 0.4	0.7 ± 0.1	1.5 ± 0.1
6833	7150	1.3 ± 0.4	0.6 ± 0.1	1.2 ± 0.1
6866	6883	1.7 ± 0.4	0.4 ± 0.1	1.4 ± 0.1
6866	6917	2.5 ± 0.5	0.6 ± 0.1	3.1 ± 0.1
6866	6950	1.3 ± 0.4	0.7 ± 0.1	2.2 ± 0.2
6866	6983	2.5 ± 0.6	0.8 ± 0.1	2.2 ± 0.1
6866	7017	1.4 ± 0.5	0.6 ± 0.1	2.4 ± 0.1
6866	7050	2.3 ± 0.5	0.5 ± 0.1	2.0 ± 0.1
6866	7083	3.0 ± 0.4	0.6 ± 0.1	2.2 ± 0.1
6866	7117	1.2 ± 0.3	0.7 ± 0.1	1.5 ± 0.1
6866	7150	0.7 ± 0.4	0.6 ± 0.1	1.1 ± 0.1
6866	8183	< 1.5	0.7 ± 0.1	1.7 ± 0.2
6866	8210	< 1.0	0.6 ± 0.1	1.3 ± 0.2
6893	8217	0.6 ± 0.4	0.6 ± 0.1	0.9 ± 0.1
6896	8094	4.5 ± 0.9	0.5 ± 0.1	1.6 ± 0.2
6900	6890	3.5 ± 0.6	0.7 ± 0.1	3.0 ± 0.1
6900	6917	2.7 ± 0.4	0.7 ± 0.1	2.5 ± 0.1

TABLE 5-3
(continued)

Coordinates		Concentration (pCi/g ± 2 sigma)[a]		
East	North	Uranium-238	Radium-226	Thorium-232
6900	6950	1.3 ± 0.4	0.9 ± 0.1	2.8 ± 0.2
6900	6983	1.0 ± 0.5	0.9 ± 0.1	2.9 ± 0.1
6900	7017	1.1 ± 0.4	0.9 ± 0.1	1.5 ± 0.1
6900	7050	1.7 ± 0.5	0.6 ± 0.1	2.2 ± 0.1
6900	7083	3.0 ± 0.8	0.8 ± 0.1	5.1 ± 0.2
6900	7117	< 0.9	0.8 ± 0.1	2.9 ± 0.1
6900	7137	1.7 ± 0.4	0.6 ± 0.1	2.3 ± 0.1
6900	7783	0.9 ± 0.3	0.6 ± 0.1	1.0 ± 0.1
6900	7817	1.3 ± 0.4	0.7 ± 0.1	1.5 ± 0.1
6900	8117	0.9 ± 0.5	0.5 ± 0.1	1.0 ± 0.1
6900	8150	< 1.1	0.7 ± 0.1	1.4 ± 0.1
6900	8183	1.8 ± 0.7	0.7 ± 0.1	1.4 ± 0.1
6913	7750	0.7 ± 0.1	0.7 ± 0.1	1.0 ± 0.1
6913	8063	1.1 ± 0.5	0.5 ± 0.1	0.9 ± 0.3
6913	8083	< 0.9	0.4 ± 0.1	1.0 ± 0.1
6917	6920	1.5 ± 0.5	0.7 ± 0.1	2.3 ± 0.2
6918	8011	< 1.8	0.7 ± 0.1	1.9 ± 0.1
6920	7050	0.7 ± 0.3	0.5 ± 0.1	1.4 ± 0.1
6920	7083	1.1 ± 0.4	0.6 ± 0.1	2.4 ± 0.1
6920	7150	< 1.3	0.4 ± 0.1	0.8 ± 0.1
6920	7183	3.0 ± 1.0	0.7 ± 0.1	2.4 ± 0.1
6920	7217	3.9 ± 2.8	0.5 ± 0.1	2.1 ± 0.6
6920	7250	< 1.4	0.5 ± 0.1	1.4 ± 0.1
6920	7283	< 1.5	0.6 ± 0.1	1.3 ± 0.1
6920	7317	2.3 ± 0.8	0.8 ± 0.1	1.7 ± 0.2
6920	7350	< 1.8	0.5 ± 0.1	2.4 ± 0.2
6920	7817	1.1 ± 0.3	0.7 ± 0.1	1.5 ± 0.1
6920	8083	< 0.9	0.5 ± 0.1	0.9 ± 0.1
6933	6950	3.9 ± 0.5	0.9 ± 0.1	3.9 ± 0.5
6933	6983	1.5 ± 0.5	2.0 ± 0.1	2.1 ± 0.1
6933	7017	1.1 ± 0.4	0.6 ± 0.1	1.4 ± 0.1
6933	7050	1.4 ± 0.3	0.6 ± 0.1	1.2 ± 0.2
6933	7083	0.6 ± 0.3	0.4 ± 0.1	0.6 ± 0.1
6933	7117	< 0.7	0.5 ± 0.1	1.9 ± 0.1
6933	7217	4.5 ± 0.9	0.5 ± 0.1	1.6 ± 0.2
6933	7250	< 2.1	0.9 ± 0.1	3.3 ± 0.3
6933	7283	1.2 ± 0.6	0.6 ± 0.1	2.2 ± 0.2
6933	7317	1.6 ± 0.6	0.7 ± 0.1	1.6 ± 0.2
6933	7350	1.7 ± 0.7	0.9 ± 0.1	2.7 ± 0.2
6933	7383	< 2.0	1.3 ± 0.4	1.9 ± 0.6
6933	7417	< 1.0	0.9 ± 0.3	1.8 ± 0.5
6933	7617	0.8 ± 0.3	0.7 ± 0.1	1.5 ± 0.6
6933	7650	0.9 ± 0.2	0.7 ± 0.1	1.0 ± 0.1
6933	7683	2.1 ± 0.6	1.3 ± 0.1	2.1 ± 0.1
6933	7717	1.6 ± 0.3	0.6 ± 0.1	< 0.2

TABLE 5-3
(continued)

Coordinates		Concentration (pCi/g ± 2 sigma)[a]		
East	North	Uranium-238	Radium-226	Thorium-232
6933	7750	1.4 ± 0.4	0.7 ± 0.1	< 0.3
6933	7783	< 0.6	0.7 ± 0.1	1.0 ± 0.1
6933	7950	0.7 ± 0.5	0.6 ± 0.1	1.1 ± 0.1
6933	7983	< 1.1	0.6 ± 0.1	1.1 ± 0.1
6933	8017	< 0.8	0.4 ± 0.1	0.6 ± 0.1
6933	8050	< 0.8	0.3 ± 0.1	0.7 ± 0.3
6945	7931	< 1.4	0.6 ± 0.1	0.9 ± 0.1
6953	7050	1.5 ± 0.5	0.7 ± 0.1	1.5 ± 0.1
6953	7650	0.9 ± 0.3	0.7 ± 0.1	1.4 ± 0.1
6960	7797	2.2 ± 0.7	0.8 ± 0.1	1.8 ± 0.3
6966	7083	1.6 ± 0.5	0.8 ± 0.1	1.6 ± 0.5
6966	7117	2.4 ± 0.5	0.8 ± 0.1	2.8 ± 0.7
6966	7150	1.2 ± 0.4	0.6 ± 0.1	2.2 ± 0.1
6966	7183	1.0 ± 0.4	0.6 ± 0.1	2.0 ± 0.1
6966	7217	1.1 ± 0.4	0.5 ± 0.1	1.5 ± 0.1
6966	7250	1.8 ± 0.4	0.6 ± 0.1	2.1 ± 0.1
6966	7283	0.6 ± 0.3	0.4 ± 0.1	1.3 ± 0.1
6966	7317	1.4 ± 0.5	0.7 ± 0.1	2.1 ± 0.1
6966	7350	< 0.7	0.6 ± 0.1	1.3 ± 0.1
6966	7383	1.0 ± 0.4	0.6 ± 0.1	1.4 ± 0.1
6966	7417	1.8 ± 0.5	0.8 ± 0.1	3.1 ± 0.8
6966	7450	< 2.0	0.7 ± 0.2	1.3 ± 0.5
6966	7483	1.3 ± 0.3	0.8 ± 0.1	1.5 ± 0.1
6966	7517	< 1.8	0.8 ± 0.1	1.8 ± 0.2
6966	7617	2.1 ± 0.5	0.8 ± 0.1	1.8 ± 0.1
6966	7783	1.6 ± 0.5	0.5 ± 0.1	0.9 ± 0.1
6966	7817	1.9 ± 0.6	0.7 ± 0.1	1.0 ± 0.2
6966	7850	1.4 ± 0.5	0.7 ± 0.1	1.3 ± 0.3
6966	7883	2.1 ± 0.8	1.0 ± 0.1	3.2 ± 0.1
6976	7726	1.4 ± 0.4	0.8 ± 0.1	1.4 ± 0.1
6979	7750	< 1.8	0.7 ± 0.1	1.2 ± 0.4
6986	7783	< 0.8	0.6 ± 0.1	0.8 ± 0.1
6990	7283	1.6 ± 0.3	0.7 ± 0.1	1.1 ± 0.1
6990	7317	1.4 ± 0.5	0.7 ± 0.1	1.0 ± 0.1
6990	7350	1.8 ± 0.4	0.8 ± 0.1	1.1 ± 0.1
6993	7753	< 1.8	0.7 ± 0.1	1.0 ± 0.3
6994	7250	-b-	< 0.5[c]	6.5 ± 0.1[c]
7000	7483	0.5 ± 0.3	0.6 ± 0.1	0.8 ± 0.1
7000	7517	< 1.6	0.7 ± 0.1	1.0 ± 0.4
7000	7623	2.2 ± 0.8	1.3 ± 0.2	1.2 ± 0.2
7000	7650	< 1.7	0.7 ± 0.1	0.9 ± 0.3
7000	7683	< 1.9	0.9 ± 0.2	0.7 ± 0.1
7007	7623	1.1 ± 0.6	0.7 ± 0.1	0.9 ± 0.1
7033	7450	< 1.5	0.7 ± 0.1	0.8 ± 0.1
7033	7483	< 1.4	0.5 ± 0.1	0.8 ± 0.1

TABLE 5-3
(continued)

Coordinates		Concentration (pCi/g ± 2 sigma)[a]		
East	North	Uranium-238	Radium-226	Thorium-232
7033	7517	3.1 ± 0.7	0.7 ± 0.1	0.7 ± 0.1
7033	7617	< 1.9	0.7 ± 0.1	1.5 ± 0.6
7033	7650	2.3 ± 0.8	0.8 ± 0.1	1.0 ± 0.2
7033	7683	< 0.8	0.7 ± 0.1	1.1 ± 0.5
7033	7717	< 1.7	0.8 ± 0.1	1.2 ± 0.3
7066	7483	2.6 ± 0.7	0.5 ± 0.1	1.0 ± 0.1
7066	7517	1.7 ± 0.8	0.7 ± 0.1	1.0 ± 0.1
7066	7683	1.3 ± 0.5	0.7 ± 0.1	1.3 ± 0.5
7066	7717	2.3 ± 0.7	0.7 ± 0.1	0.9 ± 0.2
7100	7483	1.7 ± 0.5	0.6 ± 0.1	1.1 ± 0.2
7100	7717	< 0.6	0.5 ± 0.1	0.9 ± 0.1
7100	7717	< 1.1	0.7 ± 0.1	1.1 ± 0.3
7113	7517	< 1.4	0.6 ± 0.1	0.9 ± 0.1
7133	7517	< 1.6	0.5 ± 0.1	1.2 ± 0.1
7133	7717	< 1.0	0.6 ± 0.1	1.0 ± 0.2
7134	7532	< 2.0	0.8 ± 0.3	1.4 ± 0.5
7148	7539	< 2.0	1.0 ± 0.3	1.3 ± 0.5
7153	7555	< 2.0	1.2 ± 0.4	0.9 ± 0.6
7159	7574	< 3.0	1.3 ± 0.6	1.9 ± 0.9
7166	7586	< 2.0	1.2 ± 0.3	0.9 ± 0.4
7180	7603	< 2.0	0.7 ± 0.3	2.0 ± 0.6
7192	7628	< 2.0	1.0 ± 0.3	2.2 ± 0.6
7202	7640	< 0.9	0.6 ± 0.1	0.8 ± 0.1
7211	7656	2.4 ± 0.7	0.7 ± 0.3	1.1 ± 0.1
7219	7669	3.1 ± 0.8	0.6 ± 0.1	0.8 ± 0.1

[a]Samples taken from bottom of excavation.

[b]Analysis not performed.

[c]Counted wet. A conversion factor was applied to compensate for emanation and moisture.

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Alpha-emitting - See radiation.

Background radiation - Background radiation refers to naturally occurring radiation emitted from either cosmic (e.g., from the sun) or terrestrial (e.g., from the earth) sources. Exposure to this type of radiation is unavoidable and its level varies greatly depending on geographic location; e.g., New Jersey typically receives 100 mrem/yr, Colorado receives about 300 mrem/yr, and some areas in South America receive up to 7,000 mrem/yr. Naturally occurring terrestrial radionuclides include uranium, radium, potassium, thorium, etc. These dose levels do not include the concentrations of naturally occurring radon inside buildings.

Beta-gamma-emitting - See radiation.

Centimeter - A centimeter is a metric unit of measurement for length; 1 inch is equal to 2.54 centimeters; 1 foot is equal to approximately 30 centimeters.

Contamination - Contamination is used generally to mean a concentration in the soil of radioactive materials exceeding naturally occurring levels. Contamination may or may not exceed the DOE cleanup guidelines.

Counts per minute - A count is the unit of measurement registered by a radiation detection instrument when radiation imparts its energy within the sensitive range of the detector probe. The number of counts registered per minute can be related to the number of disintegrations per minute occurring from a radioactive material.

Disintegrations per minute - Disintegrations per minute is the measurement indicating the amount of radiation being released from a substance per minute. See the definition of picocurie.

Dose - Dose as used in this report is actually dose equivalent and is used to relate absorbed dose (mrad) to an effect on the body. Dose is measured in mrem. Examples of dose are: a dose of 500,000 mrem to the whole body in a short time causes death in 50 percent of the people who receive it; a dose of 5,000,000 mrem may be delivered to a cancerous tumor during radiation treatment; normal background radiation results in an annual dose of about 100 mrem; DOE radiation protection standards limit the dose to members of the general public to 100 mrem/yr above background levels; living in a brick house results in a dose of about 75 mrem/yr above background.

Exposure rate - Exposure rate is the rate at which radiation imparts energy to the air. Exposure is typically measured in microroentgens (μR) and the exposure rate is typically given as μR/h. The dose to the whole body can be approximated by multiplying the exposure rate by the number of hours of exposure. For example, if an individual were exposed to gamma radiation at a rate of 20 μR/h for 168 hours per week (continuous exposure) for 52 weeks per year, the whole-body dose would be 170 mrem.

Gamma radiation - See radiation.

Gram - A gram is a metric unit for weight. It takes 454 grams to make 1 pound; 1 ounce equals 28 grams.

Meter - A meter is a metric unit of measurement for length; 1 meter is equal to approximately 39 inches.

Microcurie - A microcurie is 1,000,000 picocuries (see picocuries for additional explanation).

Microroentgen - A microroentgen is a unit used to measure radiation exposure. For further information, see the definition of exposure rate.

Milliliter - A milliliter is a unit of measure for volume. There are 3785 ml in 1 gallon.

Millirad - Millirad is a measure of the amount of energy imparted by radiation to a unit of mass. An absorbed dose rate is expressed in terms of mrad/h.

Millirem - Millirem is the unit used to measure radiation doses to man. The DOE limit is 100 mrem above background radiation levels for members of the general public in any one year. Naturally occurring radioactive substances in the ground result in a yearly exposure to everyone of about 100 mrem. To date, no difference can be detected in the health of population groups exposed to 100 mrem/yr above background and in the health of groups who are not exposed.

Monazite - Monazite is a mineral that contains unusually high concentrations of thorium and rare earth metals. Monazite is often found in sand and gravel deposits.

Picocurie - A picocurie is the unit of measure for radioactivity just as an ounce is a unit to measure weight. One picocurie means that one radioactive particle is released on the average of every 27 seconds.

Radium-226 - Radium-226 is a naturally occurring radioactive material that spontaneously emits alpha radiation.

Radiation - There are three primary types of radiation: alpha, beta, and gamma. Alpha radiation travels less than an inch in air before it stops. Alpha radiation cannot penetrate the outer layer of skin on the body. Beta radiation can penetrate the outer layers of skin but cannot reach the internal organs of the body. Gamma radiation is the most penetrating type and can usually reach the internal organs.

Radionuclide - A radionuclide is another word meaning a particular radioactive element. For example, uranium-235 is a radionuclide, uranium-238 is another, thorium-232 another, and so on.

Rare Earths - Rare earths refers to various types of metals present in the monazite sands. These were extracted from the monazite for their value. Rare earth metals include cerium, lanthanum, praseodymium, and neodymium.

Remedial action - Remedial action is a general term used to mean "cleanup of contamination that exceeds DOE guidelines." In practice, this may mean removing grass and soil, cutting trees, removing asphalt, etc. Remedial action also includes restoring remediated properties to their original conditions, to the extent that this is possible.

Thorium - Thorium is a naturally occurring element which is recovered from monazite for commercial purposes. Monazite contains from 3 to 9 percent thorium oxide. The principal use of thorium to date has been in the manufacture of gas lantern mantles because thorium oxide burns with a brilliant white light. Thorium oxide is also commonly found in high quality glasses and camera lenses because of its good optical characteristics.

Uranium - Uranium is a naturally occurring radioactive element. The principal use of uranium--when refined--is for the production of fuel for nuclear reactors. Uranium in its natural form is not suitable for use as a fuel source.

Working level - Working level is a unit to measure the energy expended in air by radon or its radioactive decay products. The term was derived to measure radon progeny concentrations to which uranium miners were exposed.