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Formerly Utilized Sites Remedial Action Program (FUSRAP)

ADMINISTRATIVE RECORD

for Maywood, New Jersey

U.S. Department of Energy

0489-0613.1

102682 93-292

Department of Energy
Field Office, Oak Ridge
P.O. Box 2001
Oak Ridge, Tennessee 37831— 8723

April 7, 1993

Mr. Jeffrey Gratz, Project Manager
Federal Facilities Section
U. S. Environmental Protection Agency
Region II
Jacob K. Javits Federal Building
New York, New York 10278

Dear Mr. Gratz:

MAYWOOD SITE -- POST-REMEDIAL ACTION REPORT FOR THE TIME-CRITICAL REMOVAL ACTION AT 90 AVENUE C, LODI, NEW JERSEY - PUBLISH

Enclosed for your information is a copy of the subject document, which has been issued for publication. This report documents the time-critical removal action conducted by DOE at 90 Avenue C in Lodi, New Jersey in July 1991.

This is the final CERCLA report for this removal action.

If you have any questions, please call me at (615) 576-9634.

Sincerely,

Susan M. Cange

Susan M. Cange, Site Manager
Former Sites Restoration Division

Enclosure

DOE/OR/21949-353

Formerly Utilized Sites Remedial Action Program (FUSRAP)
Contract No. DE-AC05-910R21949

POST-REMEDIAL ACTION REPORT FOR THE TIME-CRITICAL REMOVAL ACTION AT 90 AVENUE C

Lodi, New Jersey

March 1993

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DOE/OR/21949-353

POST-REMEDIAL ACTION REPORT FOR THE TIME-CRITICAL REMOVAL ACTION CONDUCTED AT 90 AVENUE C LODI, NEW JERSEY

MARCH 1993

Prepared for

United States Department of Energy

Oak Ridge Field Office

Under Contract No. DE-AC05-91OR21949

By

Bechtel National, Inc.

Oak Ridge, Tennessee

Bechtel Job No. 14501

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FIGURES

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ACRONYMS

AEC	Atomic Energy Commission
BNI	Bechtel National, Inc.
CFR	Code of Federal Regulations
DOE	Department of Energy
FUSRAP	Formerly Utilized Sites Remedial Action Program
IVC	independent verification contractor
LSA	low-specific-activity
MCW	Maywood Chemical Works
MED	Manhattan Engineer District
MISS	Maywood Interim Storage Site
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
ORNL	Oak Ridge National Laboratory
PIC	pressurized ionization chamber
PMC	project management contractor
RI	remedial investigation

UNITS OF MEASURE

cm	centimeter
cpm	counts per minute
dpm	disintegrations per minute
ft	foot
g	gram
gal	gallon
h	hour
ha	hectare
in.	inch
km	kilometer
lb	pound
m	meter
mi	mile
µCi	microcurie
µR	microroentgen
ml	milliliter
mrad	millirad
mrem	millirem
pCi	picocurie
yd	yard
yr	year

1.0 INTRODUCTION

1.1 BACKGROUND

This report documents the time-critical removal action performed at the residential property located at 90 Avenue C in Lodi, New Jersey, and serves as the final report as required pursuant to the National Oil and Hazardous Substances Contingency Plan (NCP).

Work was performed under the Formerly Utilized Sites Remedial Action Program (FUSRAP), a U.S. Department of Energy (DOE) program instituted in 1974 to identify and clean up or otherwise control sites where residual radioactive contamination (exceeding current guidelines) remains primarily from activities carried out under contract to the Manhattan Engineer District (MED) and the Atomic Energy Commission (AEC) during the early years of the nation's atomic energy program. The goals of FUSRAP are to (1) control contamination at the sites, (2) keep the sites in compliance with applicable criteria for the protection of human health and the environment, and (3) to the extent possible, certify the sites for use without restrictions following decontamination. In addition to the former MED and AEC sites, Congress has authorized DOE--through FUSRAP--to undertake remedial actions at two sites in New Jersey where commercial operations had radioactively contaminated the environment. One of these is the Maywood site, which is located in Bergen County, New Jersey, approximately 20 km (12 mi) north-northwest of New York City and 21 km (13 mi) northeast of Newark, New Jersey (Figure 1-1).

Operations at the former Maywood Chemical Works (MCW) resulted in contamination of numerous properties in the boroughs of Maywood and Lodi and the township of Rochelle Park. These contaminated properties include the property previously owned by MCW (now owned by the Stepan Company); the adjoining DOE-owned property referred to as the Maywood Interim Storage Site (MISS); and numerous residential, commercial, and governmental vicinity properties. Together, all these properties are referred to as the Maywood site (Figure 1-2).

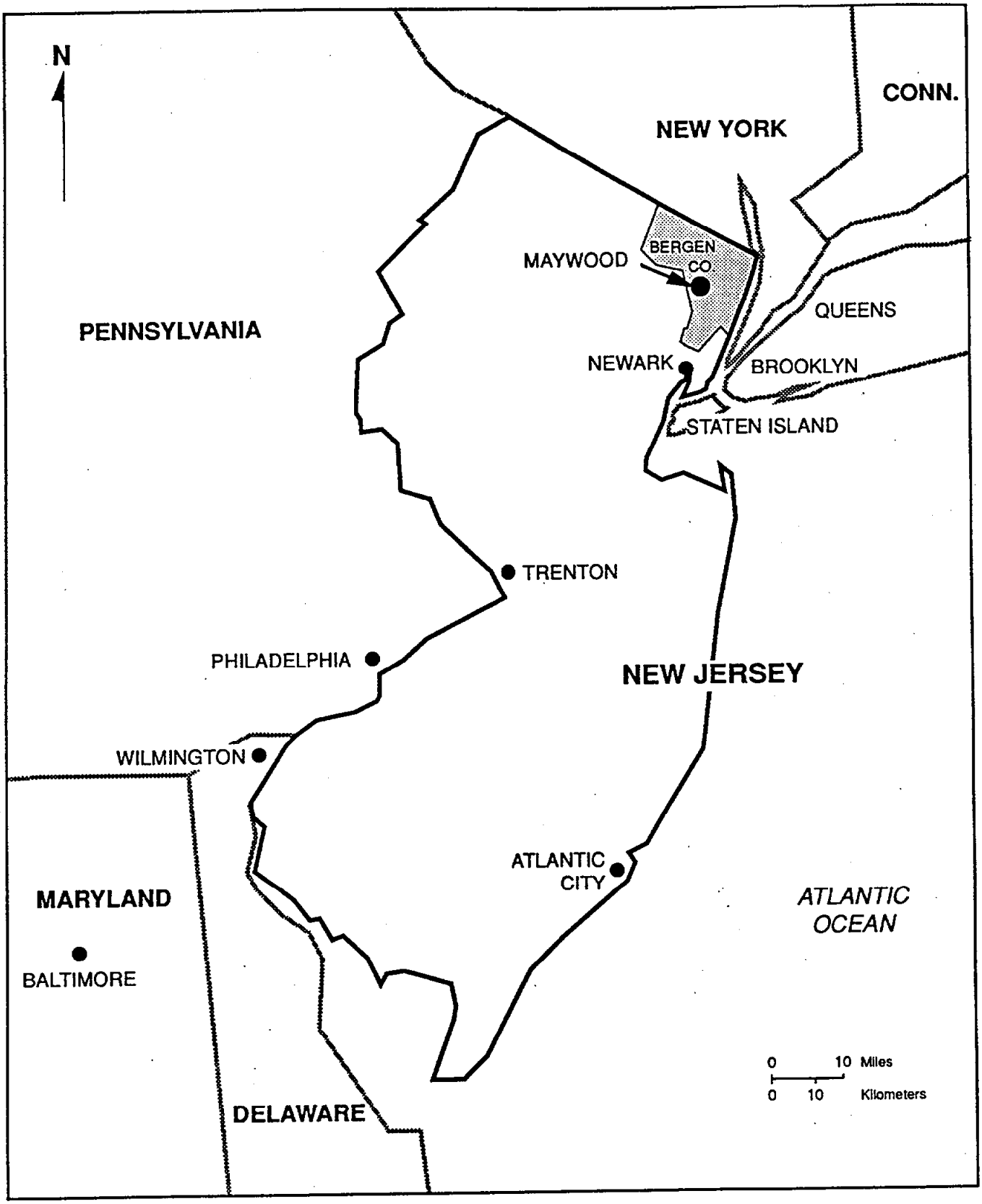

Figure 1-1
Location of Maywood, Bergen County, New Jersey

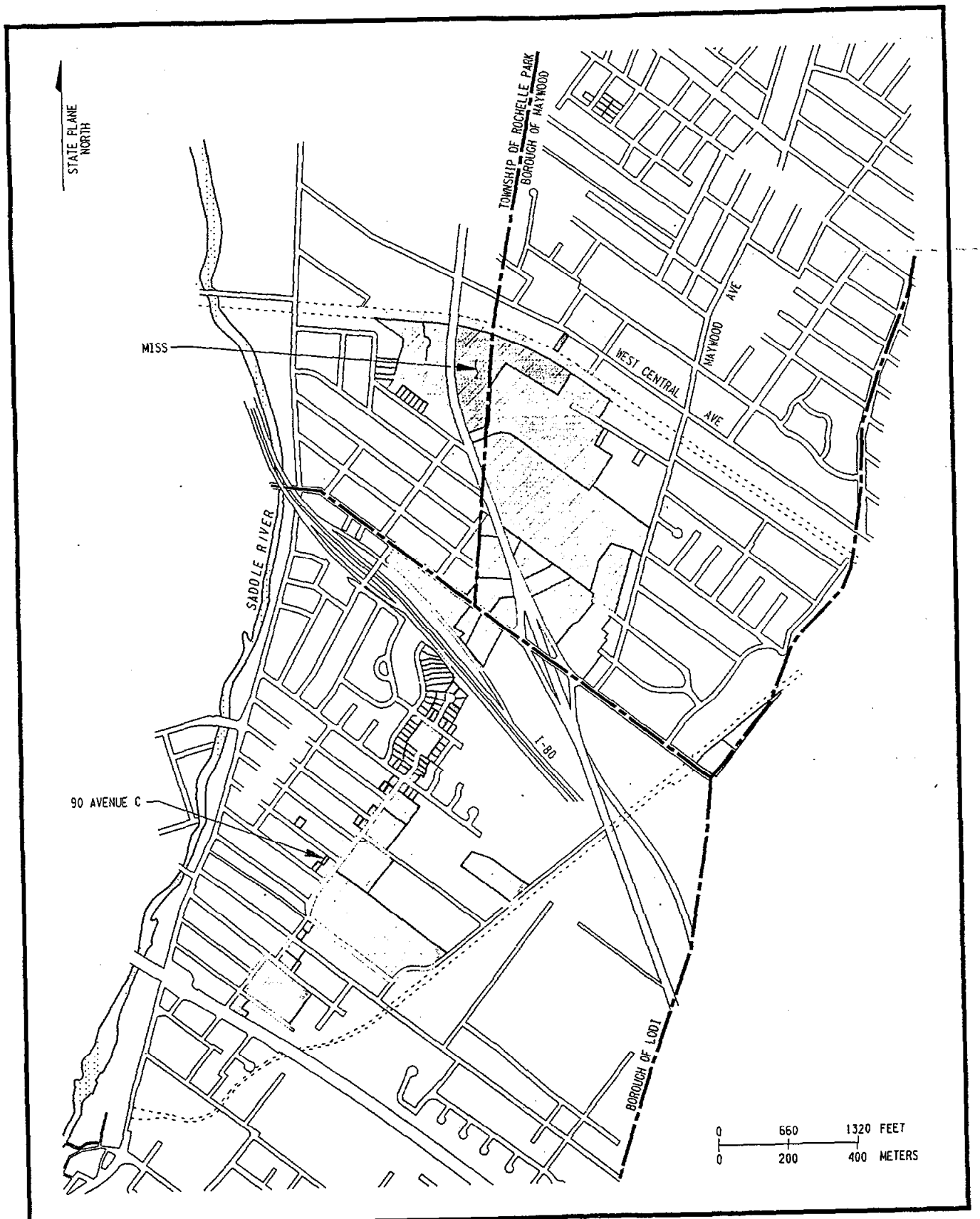

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Figure 1-2
Locations of the Properties that Compose the Maywood Site

The time-critical removal action taken at 90 Avenue C in Lodi was conducted in July 1991. This report documents the methods used to determine the extent of contamination, the type of remedial action performed, guidelines used, final excavation limits and depths, and data on the current radiological status of the property. Bechtel National, Inc. (BNI), the project management contractor (PMC), represented DOE in the planning, management, and implementation of the removal action. Oak Ridge National Laboratory (ORNL) was the independent verification contractor (IVC).

1.2 HISTORY

MCW was constructed in 1895. In 1916, the plant began extracting thorium and rare earths from monazite sand for use in manufacturing industrial products such as mantles for gas lanterns. The manufacturing process involved the production of mantle-grade compounds such as lithium hydroxide and lithium chloride (NRC 1981), rare earths, detergents, alkaloids, and essential oils. MCW stopped extracting thorium in 1956 but continued processing stockpiled material until 1959. The MCW property was sold to the Stepan Company in 1959. Stepan Company does not and has never processed radioactive materials.

The slurry that contained waste from the thorium processing operations was pumped to two earthen diked areas west of the plant (Cole et al. 1981). In 1932, the disposal areas were separated from the plant and partially covered by the construction of New Jersey State Highway 17 (Route 17).

Some process wastes, along with tea and coca leaves from other MCW process operations, were removed for use as mulch and fill on nearby properties, thereby contaminating those properties with radioactive thorium (Mata 1984). Additional waste apparently migrated off the MCW property via natural drainage associated with the former Lodi Brook. Historical photographs and maps indicate that the former course of the brook, which originated on the MCW property, generally coincides with the distribution of

contamination on properties in Lodi. Most of the open stream channel in Lodi has been replaced by a subsurface storm drain system.

Numerous radiological surveys have been performed at the Maywood site. In January 1981, EG&G Energy Measurements Group conducted an aerial radiological survey of the Stepan property and surrounding properties (EG&G 1981). The survey, which covered a 10-km^2 (3.9-mi^2) area, indicated contamination not only on the Stepan property but also in areas north and south of the property.

DOE was authorized to undertake a decontamination research and development project at the Maywood site by the Energy and Water Development Appropriations Act of 1984, and the site was accordingly assigned to FUSRAP. In June 1984, ORNL conducted a "drive-by" survey of Lodi using a mobile van; the results indicated contamination in addition to that identified during previous surveys (ORNL 1984). This survey was followed by ground surveys in the area (ORNL 1989), and BNI conducted additional characterization of the nature and extent of contamination in 1990 and 1991 (BNI 1992).

During 1984, 26,300 m^3 (34,400 yd^3) of contaminated soil and building materials was removed from eight residential properties and one commercial property (the Ballod property, which was partially cleaned up) in Rochelle Park and nine residential properties in Maywood. In 1985, to prevent further migration of contamination and to expedite cleanup of the vicinity properties, DOE negotiated access to a 4.7-ha (11.7-acre) portion of the Stepan property for use as an interim storage facility for contaminated materials; this area was designated as MISS. In September 1985, ownership of MISS was transferred to DOE. During 1985, approximately 380 m^3 (500 yd^3) of contaminated materials was removed from eight vicinity properties located on Avenue C, Avenue F, Hancock Street, and Trudy Drive in Lodi. These materials were placed in the storage pile at MISS. Between 1985 and the time-critical removal action at 90 Avenue C in July 1991, no further cleanup actions were conducted at the Maywood site.

1.3 JUSTIFICATION FOR ACTION

Radioactive contamination at 90 Avenue C was identified during a radiological survey performed by ORNL (ORNL 1989) and resulted in designation of the property for inclusion in FUSRAP.

The original owner of the residence was an employee of MCW, and interviews with family members revealed that discarded building and fill materials (mulch-like material from process wastes) were brought to the property from MCW and used in the construction of the kitchen/basement addition and the ceiling and wall in an upstairs bedroom. The fill materials were mixed with concrete to pour the basement walls. Radioactive contamination in these areas probably resulted from using the building and fill materials from MCW. Soil around the unattached garage was also contaminated; however, samples collected from beneath the garage did not indicate contamination.

As part of the remedial investigation (RI) of the Maywood site conducted by BNI in 1990 and 1991, a complete radiological and limited chemical characterization of the property was performed (BNI 1992). Figures 1-3 and 1-4 show the areas of surface and subsurface radioactive contamination detected on this property, as well as interior gamma radiation exposure measurements, based on evaluation of data collected during the RI. These data confirmed the ORNL findings that radioactive contamination was present in the kitchen/basement addition to the structure.

Based on analytical results received in February 1991, it was determined that the kitchen/basement addition, a small area in the ceiling of an upstairs bedroom, two isolated spots in the garage walls, and soil at two exterior areas were radioactively contaminated. Analytical results from the limited chemical sampling performed did not indicate the presence of chemical contamination in excess of any regulatory guidelines or the presence of hazardous waste as defined by the Resource Conservation and Recovery Act. Results of the radiological and chemical sampling performed during the RI are reported in the Remedial Investigation Report for the Maywood Site (BNI 1992).

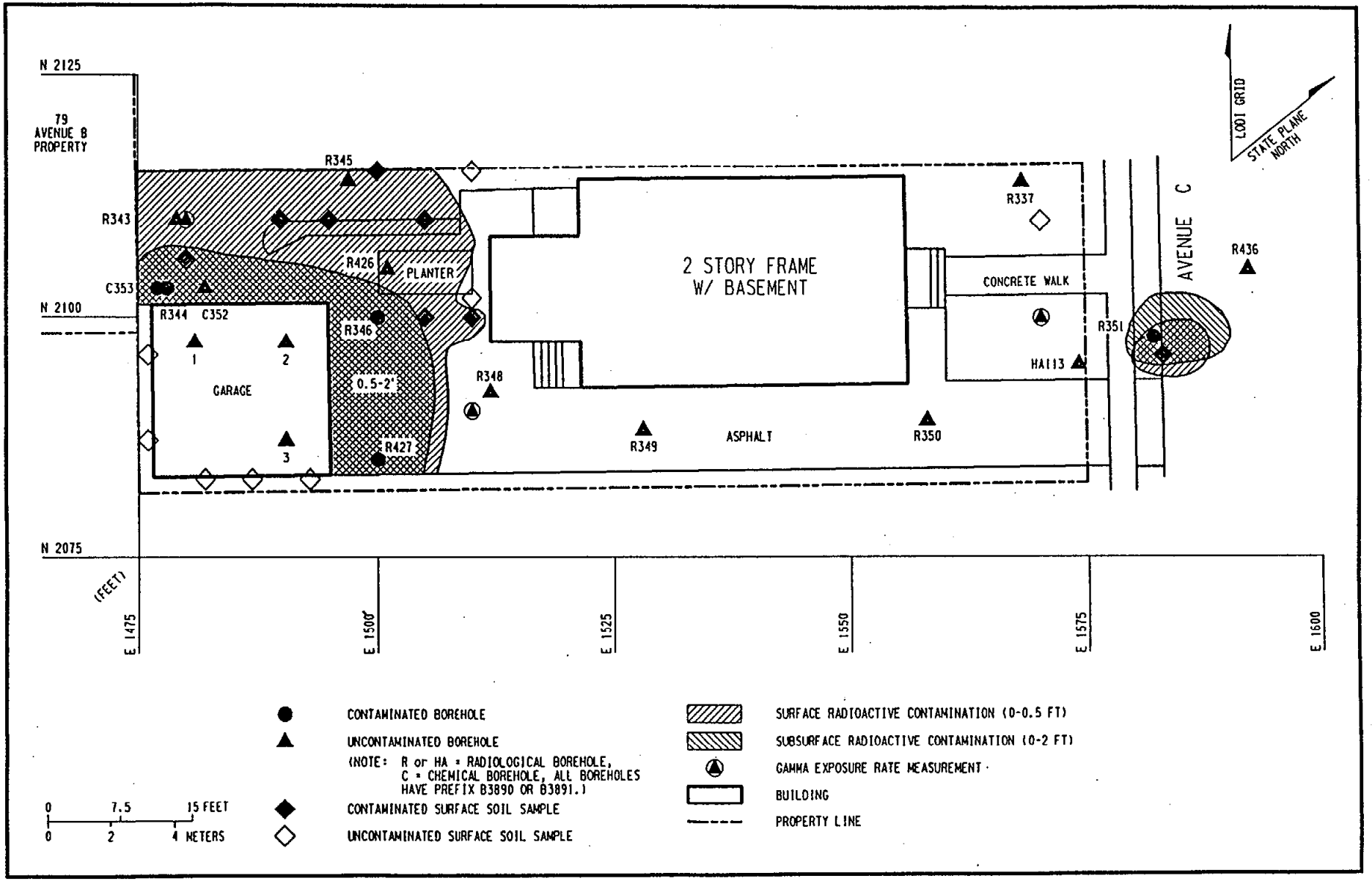

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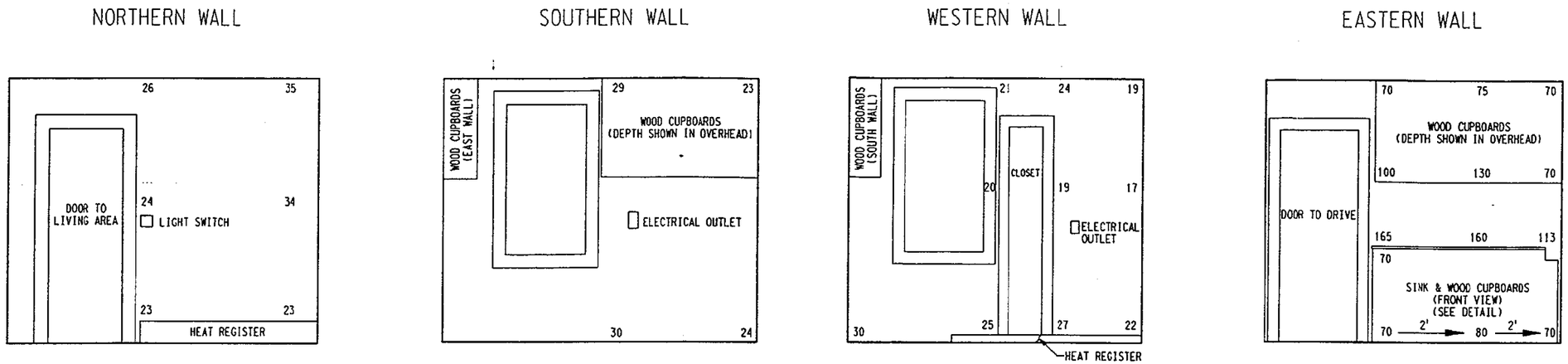
Figure 1-3
Sampling Locations and Areas of Radioactive Contamination
Before Remedial Action

42 = GAMMA MEASUREMENTS IN COUNTS PER MINUTE x 1000

(108) = BETA-GAMMA MEASUREMENTS IN COUNTS PER MINUTE

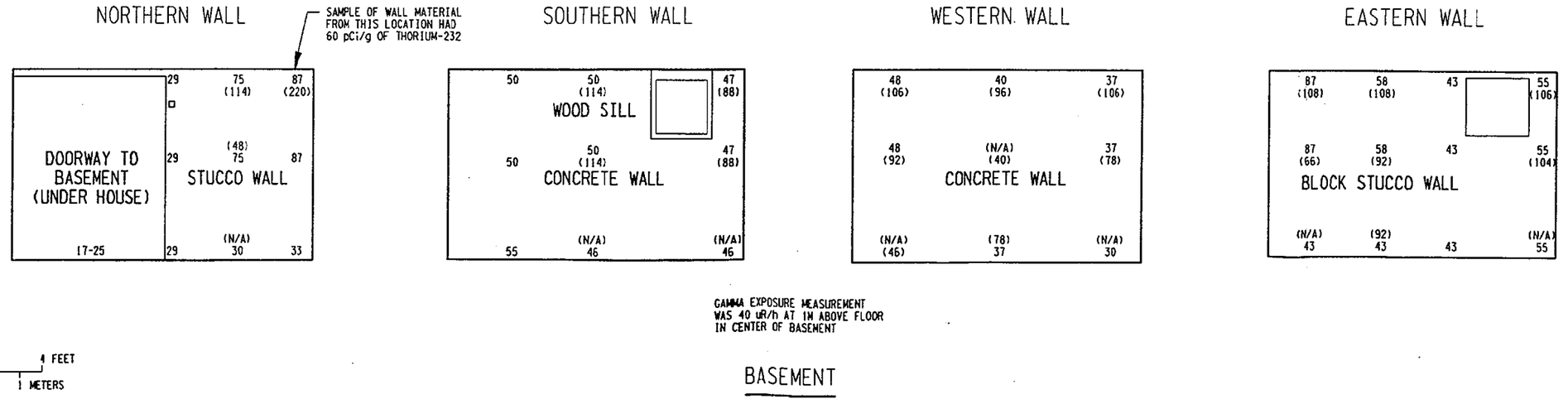
N/A = NO BETA-GAMMA MEASUREMENT WAS TAKEN

BACKGROUND = 7,500 cpm



GAMMA EXPOSURE MEASUREMENT WAS 42 uR/h AT 1M ABOVE FLOOR IN FRONT OF SINK

1ST FLOOR



GAMMA EXPOSURE MEASUREMENT WAS 40 uR/h AT 1M ABOVE FLOOR IN CENTER OF BASEMENT

BASEMENT

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Figure 1-4
Locations of Indoor Gamma and Beta-Gamma Measurements

Interior gamma radiation exposure rates were significantly elevated in comparison with naturally occurring radiation (Figure 1-4): 38-42 μR/h at 1 m (3 ft) above the floor in the kitchen addition and 36-40 μR/h at 1 m (3 ft) above the floor in the basement addition. The average, naturally occurring background gamma radiation exposure rate in the Maywood area (9 μR/h) is included in these measurements. These measurements also exceeded the DOE exposure guideline for buildings or habitable structures (20 μR/h minus average background for the area).

Based on an appropriate-use scenario of the property at 90 Avenue C, potential exposure to the residents could have been as much as 1,500 mrem/yr, which exceeds the DOE basic dose limit to the general public of 100 mrem/yr above background (9 μR/h). This property-use scenario is based on exposures to radiation levels in the kitchen and the basement. As shown in Figure 1-4, exposure rates at contact on the wall over the sink were as high as 165 μR/h, with the gamma exposure rate being 42 μR/h at the edge of the sink [1 m (3 ft) from the wall]. The DOE limit of 100 mrem/yr above background would be exceeded if a person were exposed 1.7 hours a day at contact with the wall or 6.5 hours a day at the edge of the sink. In the basement (used as a bedroom), the maximum gamma exposure rate on the walls was 87 μR/h, with an exposure rate of 40 μR/h at a distance of 1 m (3 ft) from the wall. The DOE basic dose limit of 100 mrem/yr above background would be exceeded based on occupancy times of 3.2 hours a day at contact or 6.8 hours a day at 1 m (3 ft). Because the kitchen and the basement were rooms that were frequently occupied by the residents, it was necessary to reduce the potential levels of exposure.

The NCP defines removal actions, including time-critical removal actions, as the cleanup or removal of hazardous substances or contaminants that may present an imminent danger or those necessary to prevent, minimize, or mitigate damage to public health or the environment. Based on an evaluation of data collected from the 90 Avenue C property in Lodi, as well as the potential radiation exposures to the residents, DOE determined that a time-critical removal action was necessary to eliminate the source of the elevated exposure levels and protect residents of the home.

To reduce potential exposures, workers removed the kitchen/basement addition, a portion of the ceiling and north wall in an upstairs bedroom, contaminated material above the door leading to the dining room and the west rear corner of the house foundation/wood structure interface, and two isolated areas of contamination in the garage walls. Because the property owner planned to expand the living area, a portion of the contaminated soil in the back yard of the property was removed to allow the owner to restore the structure on uncontaminated soil. The remaining contaminated soil is at the rear of the property adjacent to the garage foundation, where it poses no immediate hazard to human health or the environment. Contaminated soil was removed from the front yard and placed in the contaminated area in the back yard adjacent to the garage foundation. This was done to reduce the volume of contaminated material placed in interim storage at MISS and to comply with the local building codes. The contamination that remains on the property will be cleaned up when the environmental review process for the Maywood site is completed and a cleanup remedy is selected in early 1994. This report documents cleanup activities and provides information on the current status of the property following the time-critical removal action in the areas described above.

2.0 REMEDIAL ACTION GUIDELINES

Radioactive contamination at 90 Avenue C consists primarily of thorium-232 but also includes lesser amounts of uranium-238 and radium-226, which are naturally occurring constituents of the ores processed by MCW. Table 2-1 lists the DOE residual contamination guidelines for release of formerly contaminated properties without use restrictions. These guidelines were adopted by DOE based on their compatibility with Environmental Protection Agency criteria for remedial action found in 40 CFR 192 (EPA 1980), "Uranium Mill Tailings Remedial Action Program" (DOE 1986), and DOE Order 5400.5, "Radiation Protection of the Public and the Environment" (DOE 1990). The guidelines are consistent with those that will be used for cleanup of the Maywood site.

For the time-critical removal action at 90 Avenue C, the DOE cleanup guidelines were 5 pCi/g averaged over the first 15 cm (6 in.) of soil below the surface and 15 pCi/g averaged over any 15-cm- (6-in.-) thick soil layer below the first layer (see Table 2-1). These guidelines applied to thorium-232 and radium-226 concentrations in soil after the background concentration of 1 pCi/g for the Maywood site was subtracted. This background concentration was determined by radiological analysis of soil samples collected from areas known to be uncontaminated (e.g., area parks) during several previous characterizations and the RI for the Maywood site. Thorium-232 occurs naturally at high concentrations in monazite sands (the raw feed material at MCW); however uranium-238 and radium-226 also occur naturally in monazite sand, but at lower concentrations than thorium-232. Therefore, uranium-238 and radium-226 (considered secondary contaminants) would generally not be present at elevated concentrations unless concentrations of thorium-232 greatly exceeded criteria. For the 90 Avenue C property, thorium-232 was the primary contaminant, and uranium-238 and radium-226 were not of significant concern. However, post-remedial action surveys included all three radionuclides in the verification analysis.

TABLE 2-1
SUMMARY OF RESIDUAL CONTAMINATION GUIDELINES

BASIC DOSE LIMITS

The basic limit for the annual radiation dose (excluding radon) received by an individual member of the general public is 100 mrem/yr. In implementing this limit, DOE applies as low as reasonable achievable principles to set site-specific guidelines.

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 and will comply with the basic dose limits when an appropriate-use scenario is considered.

Indoor/Outdoor Structure Surface Contamination

	Allowable Surface Residual Contamination[e] (dpm/100 cm²)		
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[k]	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[l]	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-m^2 surface area.

[c]If the average concentration in any surface or below-surface area less than or equal to 25 m^2 exceeds the authorized limit or guideline by a factor of $(100/A)^{1/2}$, where A is the area of the elevated region in square meters, limits for "hot spots" shall also be applicable. Procedures for calculating these hot spot limits, which depend on the extent of the elevated local concentrations, are given in the DOE Manual for Implementing Residual Radioactive Materials Guidelines, DOE/CH/890/. In addition, every reasonable effort shall be made to remove any source of radionuclide that exceeds 30 times the appropriate limit for soil, irrespective 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 1.3×10^5 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 measured 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 an area of more than 1 m^2. For objects of less surface area, the average should be derived for each such object.

[h]The average and maximum dose rates associated with surface contamination resulting from beta-gamma emitters should not exceed 0.2 mrad/h and 1.0 mrad/h, respectively, at a depth of 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 an area of that size 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. It is not necessary to use wiping tehniques to measure removable contamination levels if direct scan surveys indicate that total residual surface cotamination levels are within the limits for removable contamination.

[k]Guidelines for these radionuclides are not given in DOE Order 5400.5; however, these guidelines are considered applicable until guidance is provided.

[l] This category of radionuclides includes mixed fission products, including the Sr-90 which is present in them. It does not apply to Sr-90 which has been separated from the other fission products or mixtures where the Sr-90 has been enriched.

Source: DOE Order 5400.5 and 40 CFR 192

DOE cleanup guidelines for contamination on structural surfaces at 90 Avenue C, where thorium-232 was the primary contaminant, were an average of 1,000 dpm/100 cm^2 and a maximum of 3,000 dpm/100 cm^2 for fixed contamination and 200 dpm/100 cm^2 for removable contamination (see Table 2-1). Fixed contamination levels are based on direct measurements of the levels of radioactivity on structural surfaces; removable contamination levels are determined by swiping paper over a contaminated area and measuring the amount of radioactivity on the paper.

3.0 REMEDIAL ACTION

3.1 CLEANUP/DECONTAMINATION ACTIVITIES

Immediately before the time-critical removal action began, the property was radiologically surveyed to accurately define the boundaries of contamination and to supplement existing characterization information. As remediation was completed, exposure rate measurements were taken with a pressurized ionization chamber (PIC) to confirm that radiation levels were below the basic dose limit of 100 mrem/yr, and soil samples were collected and analyzed to determine that contaminated soil had been removed to levels below cleanup guidelines.

Techniques used in performing the removal action are summarized in Table 3-1. Following removal of contaminated materials, areas not included in the owner's planned restoration were restored to their original or similar conditions. The kitchen/basement addition was not restored because the property owner planned to increase the size of the remediated portion of the residence; however, a sufficient volume of contaminated soil was removed to allow construction of the expanded living space on uncontaminated soil. In addition, an uncontaminated area (as determined during the RI) of the front yard along the driveway was excavated to allow the owner to create a parking area to comply with local building codes for multiple family dwellings. Contaminated soil removed from the front yard was relocated to the known area of radioactive contamination in the back yard for future cleanup. Clean fill material was placed in the excavated area of the front yard.

Only the radioactively contaminated portions of the residence (i.e., contaminated kitchen/basement addition and areas of ceiling in an upstairs bedroom), contaminated soil in the front yard and back yard (where restoration by the home owner would occur), and a garage wall were remediated. The primary focus of the removal action was remediating the residence to eliminate contaminated areas where gamma radiation exposure rates were in excess of DOE

Table 3-1

Cleanup/Decontamination Techniques

Technique	Description
Hand wiping	Small areas or equipment that had loose dirt, dust, greasy film, etc., were wiped with a dry cloth or a cloth wetted with a detergent solution to remove the loose surface contamination.
Jackhammering	A conventional jackhammer was used to remove larger layers or chunks of concrete and asphalt.
Excavation	Contaminated concrete, asphalt, and soil were removed from exterior areas by using backhoes and shovels.
Sawing	Contaminated sheetrock and wood were removed by using electric saws.

guidelines for the general public. Radioactively contaminated soil remaining in the back yard adjacent to the garage will be removed later.

Radioactively contaminated soil, building debris, and personnel protective clothing generated during the removal action were packaged either in low-specific-activity (LSA) boxes or 55-gal drums and transported to MISS by railroad car for interim storage in Building 76. A total of 8 LSA boxes and 27 drums, containing approximately 25 m^3 (33 yd^3) of radioactively contaminated waste, were filled. A label identifying the contents was placed on each LSA box and drum, and the information was entered into the inventory maintained at MISS. Table 3-2 provides the individual drum and LSA box inventory and contents. In 1992 the contents of the 27 drums were consolidated into LSA boxes in Building 76.

3.1.1 Interior Areas

The first step in undertaking the removal action in the residence was to perform gamma radiation surveys to confirm and delineate the exact boundaries of contamination. Then, as work progressed, additional radiological surveys were continuously performed to determine which areas met cleanup guidelines and which ones required additional cleanup.

After uncontaminated siding from the kitchen addition and rear wall of the house were removed, workers removed radioactively contaminated wood used in the construction of the addition. Based on survey data collected during the RI, a 1.2- by 2.4-m (4- by 8-ft) area of the eastern wall of the kitchen was thought to contain contaminated material. However, after removal of that material, additional surveys of the three remaining walls indicated the presence of radioactive material above DOE cleanup guidelines. Elevated gamma radiation levels in these walls had been masked by the significantly higher gamma radiation levels detected in the eastern wall.

As the wooden building material was removed, each piece was scanned, and radioactively contaminated wood was segregated from uncontaminated wood. This included sawing or cutting off

Table 3-2

Drum and LSA Box Inventory

I.D. Number	Contents	Weight (lbs)	Volume of Waste in Container (percent)
Drums			
01-0001	Wood and wood building debris	141	90
01-0002	Wood and wood building debris	149	90
01-0003	Wood and wood building debris	136	90
01-0004	Wood and wood building debris	157	90
01-0005	Wood and wood building debris	127	90
01-0006	Wood and wood building debris	141	90
01-0007	Wood and wood building debris	139	90
01-0008	Wood and wood building debris	156	90
01-0009	Wood and wood building debris	148	90
01-0010	Wood and wood building debris	147	90
01-0011	Wood and wood building debris	144	90
01-0012	Wood and wood building debris	133	90
01-0013	Wood and wood building debris	138	90
01-0014	Wood and wood building debris	122	90
01-0015	Wood and wood building debris	129	90
01-0016	Wood and wood building debris	115	90
01-0017	Wood and wood building debris	125	90
01-0018	Wood and wood building debris	139	90
01-0019	Wood and wood building debris	137	90
01-0020	Wood and wood building debris	142	90
01-0021	Wood and wood building debris	132	90
01-0022	Wood and wood building debris	142	90
01-0023	Wood and wood building debris	127	90
01-0024	Wood and wood building debris	111	90
01-0025	Wood and wood building debris	145	90
01-0026	Wood and wood building debris	114	90
01-0035	Soil, rad. trash, concrete debris	176	95
LSA Boxes			
01-0027	Soil, rad. trash, concrete debris	7,136	99
01-0028	Soil, rad. trash, concrete debris	7,588	100
01-0029	Soil, rad. trash, concrete debris	7,598	99
01-0030	Soil, rad. trash, concrete debris	7,120	99
01-0031	Soil, rad. trash, concrete debris	7,305	99
01-0032	Soil	7,577	100
01-0033	Soil	7,598	100
01-0034	Soil	7,625	100

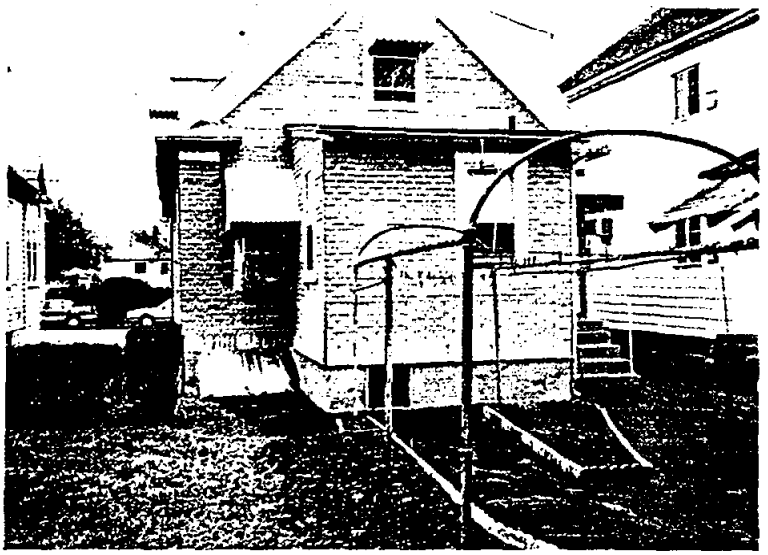
contaminated sections in an effort to minimize the volume of waste that would require interim storage.

Similar to the removal of contamination in the kitchen addition, removal of the small area of contamination in the ceiling in the upstairs bedroom led to the discovery of additional contaminated materials in the attic space above the ceiling and in the western wall of the bedroom beneath the windowsill.

After the kitchen addition was removed, work began on the contaminated basement addition of the structure. The concrete walls were broken up and scanned for radioactive contamination to segregate contaminated debris from uncontaminated debris to minimize the volume of waste that would require interim storage. Figure 3-1 shows the exterior of the kitchen/basement foundation addition before and during the removal action and following the expansion and restoration of the structure by the property owner.

3.1.2 Exterior Areas

After the kitchen/basement addition was removed, excavation of contaminated soil in the back yard began. An area measuring 6.7 m (22 ft) wide and extending 7 m (23 ft) from the rear wall of the remaining structure into the back yard was excavated to accommodate the expanded restoration planned by the property owner. The depths of contamination in the excavation ranged from 0.6 to 1.2 m (2 to 4 ft). Before the expansion and restoration of the structure, soil samples were collected from the perimeter walls of the excavated area (Figure 3-2). These samples were analyzed to confirm the radiological status of soil that was left in place for future cleanup. After sampling and before restoration, 10-mil plastic was placed and secured over the perimeter walls of the excavated area to segregate the contaminated soil that was not removed from the clean fill material used around the foundation of the new, expanded structure planned as part of the property owner's restoration. Sufficient contaminated soil was removed to ensure that the restored structure would not be placed in a contaminated area.



Exterior of kitchen/basement addition before removal action.

Same area during removal action.

Same area following expansion and restoration by property owner.

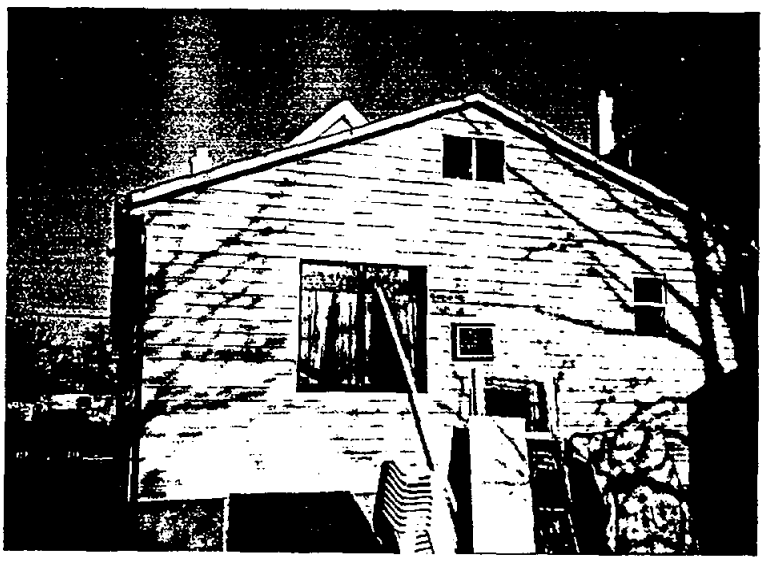


Figure 3-1
90 Avenue C Before and During Removal Action and Following Expansion and Restoration

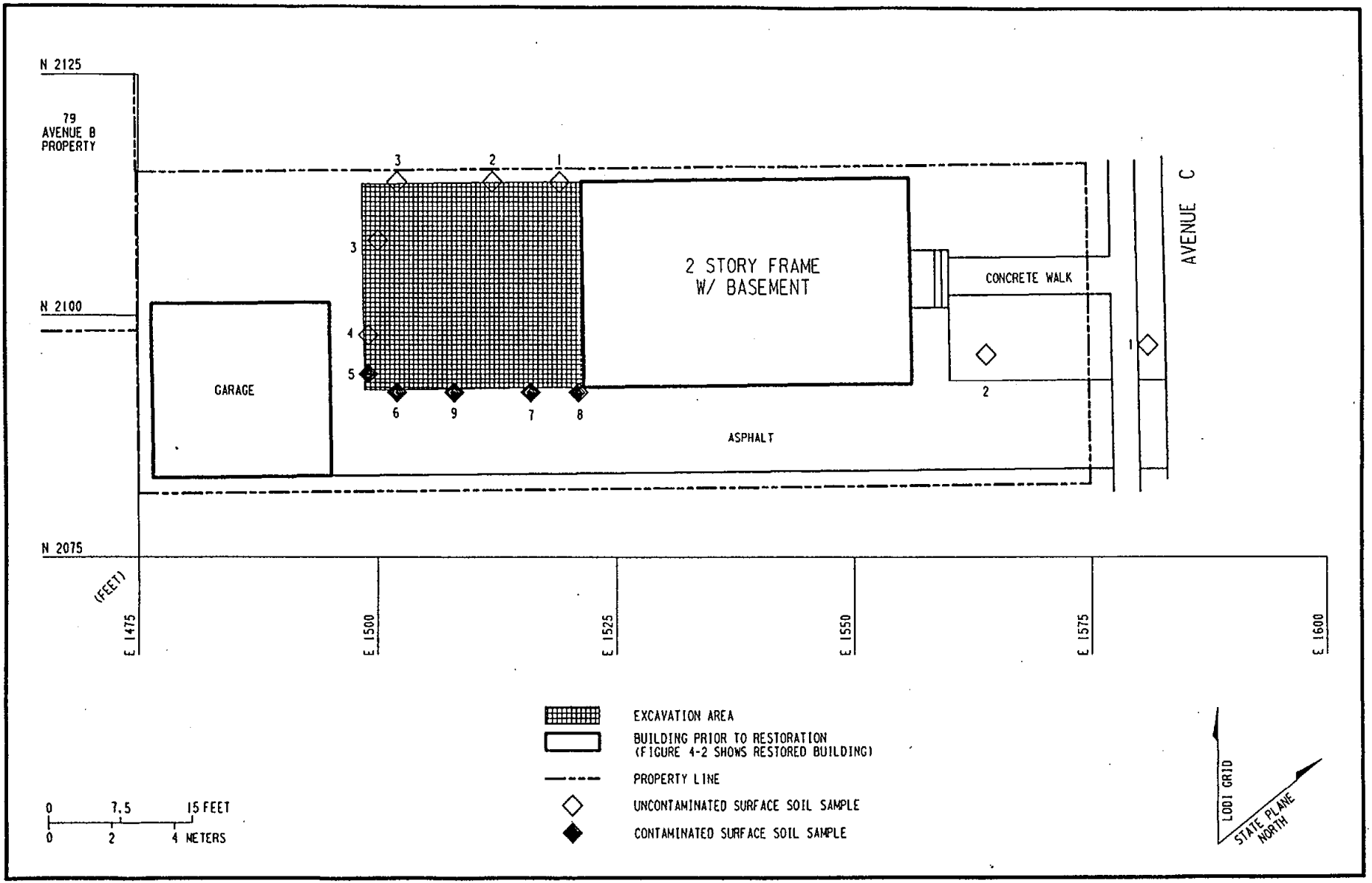


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Figure 3-2
Prerestoration Sampling Locations

A small volume, approximately 0.25 m^3 (9 ft^3), of radioactively contaminated soil in the front yard between the public sidewalk and the curb was removed and relocated to the back yard. The contaminated soil was placed in a known area of surface and subsurface contamination, and clean sod was placed over it to prevent contaminant migration via surface water runoff or air dispersion. The remaining radioactively contaminated soil on the property will be removed during cleanup of the Maywood site vicinity properties. Locations of post-remedial action sampling are presented in Subsection 4.1.

3.2 CONTAMINATION CONTROL DURING REMEDIAL ACTION

During the removal action, several methods of contamination control were implemented to protect workers and the public from exposure to radiation and to prevent the spread of radioactive contamination. The radiation dose rates at 90 Avenue C were very low, and the primary personnel exposure pathways were from personal and airborne contamination that could be inhaled or ingested.

All personnel working in contaminated areas were required to wear disposable coveralls, safety glasses, rubber boots, and gloves. If conditions warranted, additional protective clothing and equipment such as hoods and respirators were used.

Workers leaving radiologically restricted work areas were whole-body scanned (frisked) at the control point with a hand-held detector by a health physics technician to ensure that they were not contaminated and to prevent the spread of contamination to a clean area. If large portions of their disposable protective clothing were contaminated, the clothing was disposed of. If only small areas of the clothing were contaminated, those areas were cut out and disposed of to minimize the amount of radioactive waste.

Because spread of contaminated dust particles was a significant concern during the removal action work, measures were taken to control airborne contamination. In the upstairs bedroom where sections of the ceiling and wall beneath the window were being sawed open for removal, plastic sheeting tents were used to prevent the spread of airborne particulates from the immediate work area.

During remediation of exterior work areas, contamination control techniques included the use of containment tents and light wetting of soils to prevent the spread of dust. Sediment barriers (silt fences) were placed around excavated areas until post-remedial action surveys confirmed that contamination had been removed and samples of contaminated soils that were to remain could be collected. Where practical and necessary (i.e., near the basement excavation), a large plastic containment tent was built and used to control the spread of airborne contamination. Health physics technicians scanned building materials and cut off contaminated portions to minimize the amount of radioactive waste requiring interim storage.

For activities that had the potential for generating airborne contamination, particulate air monitoring devices were placed near the work area to provide continuous air monitoring and to ensure that radioactive contamination was not being spread outside the work area. All concentrations of airborne radioactivity measured outside of work areas were below the applicable DOE guidelines (3.0×10^{-12} μCi/ml).

4.0 POST-REMEDIAL ACTION MEASUREMENTS

The project management contractor (PMC) was responsible for implementing the time-critical removal action; the independent verification contractor (IVC) verified that the actions taken by the PMC removed radioactivity below the appropriate guidelines. As remedial actions were being completed, the PMC conducted preliminary radiological surveys. The IVC conducted radiological verification surveys to confirm that no radioactivity exceeding DOE guidelines remained in the remediated areas.

4.1 INTERIOR AREAS

Remediated areas in the upstairs bedroom were surveyed to determine whether DOE guidelines for residual surface contamination had been met. Direct contact beta-gamma measurements were taken with a Geiger-Müller counter, and direct contact alpha measurements were taken with an Eberline AC-3 alpha scintillation detector. Where physical features permitted, an average of five measurements were taken in the corners and center of 1- by 1-m (3- by 3-ft) squares. At a minimum, removable alpha contamination was measured in locations that exhibited direct alpha measurements above guidelines. Removable alpha activity was determined by wiping a 100-cm^2 (16-$in.^2$) area with an absorbent medium (filter paper) and measuring levels of radioactivity on the paper with an alpha scintillation counter. All post-remedial action direct contact alpha and beta-gamma radiation measurements and removable contamination measurements in the buildings were below the applicable guidelines presented in Table 2-1.

As part of the post-remedial action verification survey, PIC measurements were taken to confirm that the exposure rates are below the DOE radiation protection standard of 100 mrem/yr above background. PIC measurements taken in the center of the first-floor dining room, second-floor dining room, and upstairs bedroom revealed an exposure rate of 7 μR/h (dose rate of 61 mrem/yr) including background in each location. This exposure

rate is below the background rate of 9 μR/h and the DOE radiation protection standard of 100 mrem/yr above background.

Because the contaminated structure was removed rather than decontaminated, there are no radiation measurements for those portions of the structure. The PIC measurements were taken to ensure that exposure to radiation from the structure were alleviated.

4.2 EXTERIOR AREAS

Walkover gamma radiation scans were conducted to determine whether all soil that was radioactively contaminated in excess of DOE cleanup guidelines had been removed from the remediated areas. The technician held the radiation detector a few centimeters above the ground surface and slowly moved it over the ground while walking over the excavated areas. The advantage of the walkover survey was that the detector quickly scanned the areas as the excavation proceeded, thereby providing immediate results. If residual contamination appeared to exceed remedial action guidelines, additional excavation was performed; the area was then scanned again to verify that the contamination had been removed.

After gamma scanning indicated that all soil remaining in the excavated area was at or below the cleanup criteria, soil samples were collected for laboratory analysis. Soil sampling was the primary method used in exterior areas to confirm that all radioactive contamination exceeding DOE cleanup guidelines had been removed. Soil samples were collected in each excavated area and composited to provide samples representative of a 100-m^2 (1,076-ft^2) area. Analytical results for soil samples taken after remediation indicated that no radioactivity in excess of DOE cleanup guidelines remained in the excavated areas that the home owner was going to restore. However, radioactively contaminated soil does remain on the perimeter of the excavation for future removal. Table 4-1 provides the results of the samples taken in each excavation and from the perimeter walls of the back yard excavation. These results include the background level of 1.0 pCi/g for thorium-232 and radium-226. Figure 4-1 shows the

Table 4-1

Post-Remedial Action Soil Sampling Results

Location Number[a]	Coordinates East	Coordinates North	Concentration (pCi/g ± 2 sigma)[b] Uranium-238	Radium-226	Thorium-232
Verification Samples					
1	1581	2097	0.97 ± 1.1	0.61 ± 0.29	1.3 ± 0.21
2	1564	2096	< 1.8	0.66 ± 0.14	1.6 ± 0.18
3	1500	2108	< 1.7	0.59 ± 0.12	1.4 ± 0.27
Prerestoration Samples					
1	1519	2114	< 3.7	<0.84	3.2 ± 1.5
2	1512	2114	< 3.3	<0.89	<1.6
3	1502	2114	< 3.5	<0.72	3.7 ± 1.2
4	1499	2098	< 3.9	<0.87	4.4 ± 1.5
5	1499	2094	< 6.0	1.4 ± 0.35	12.8 ± 3.1[c]
6	1502	2092	<15.6	<2.5	76.8 ± 19.6[c]
7	1516	2092	<11.7	2.6 ± 0.91	42.3 ± 10.7[c]
8	1521	2092	< 4.5	<0.96	6.9 ± 0.71[c]
9	1508	2092	< 4.1	<0.77	7.5 ± 1.5[c]

[a]Figures 3-1 and 4-1 show sampling locations.

[b]Background concentration has not been subtracted.

[c]Thorium-232 concentrations in these samples are above the DOE guideline of 5 pCi/g for surface soils. These results were expected because the samples were from areas of contaminated soil that remain on the property. The contaminated soil that remains was separated from clean fill material with 10-mil plastic placed during restoration. The contaminated soil will be removed during cleanup of the Maywood site vicinity properties.

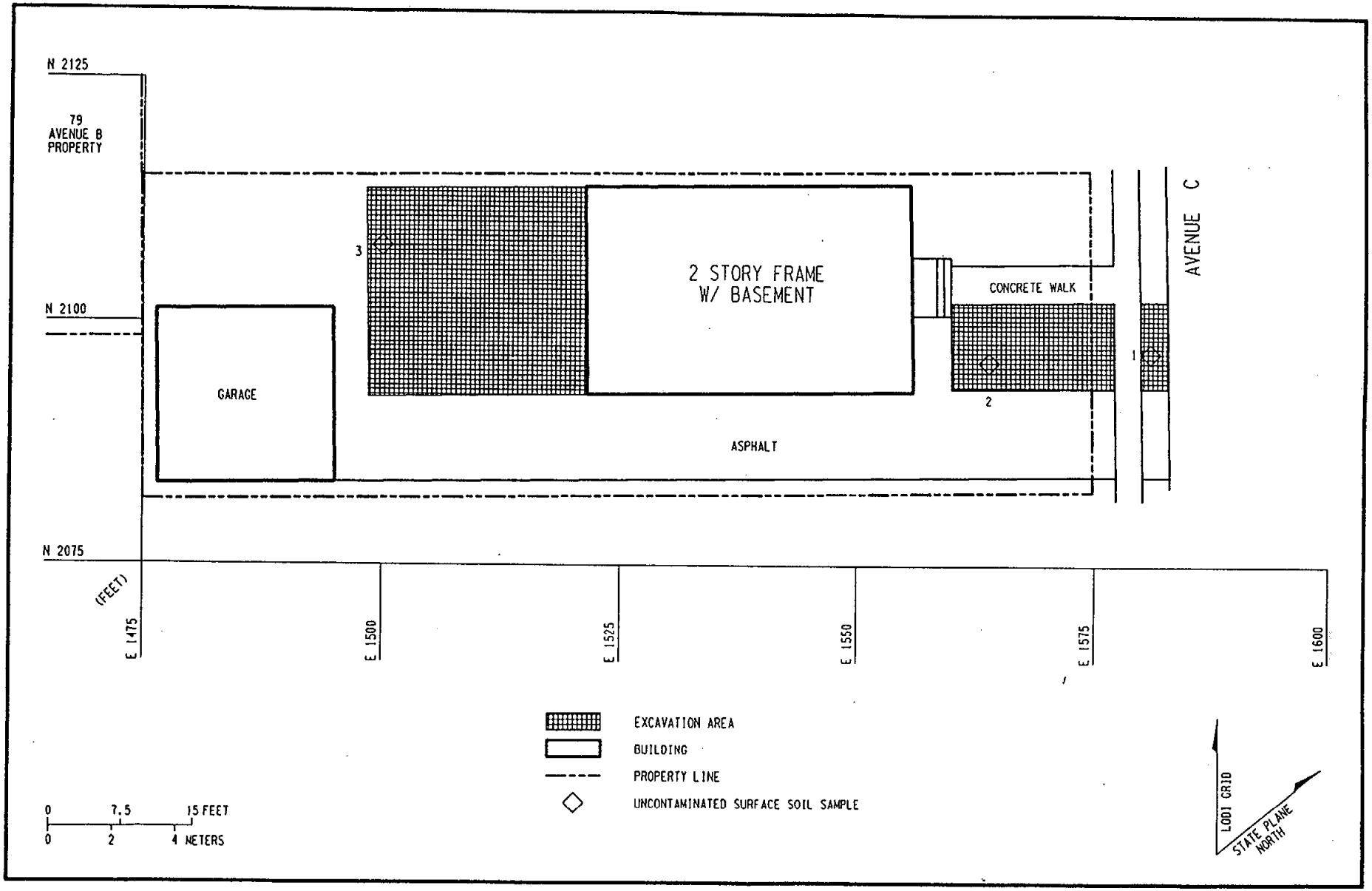

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Figure 4-1
Post-Remedial Action Survey Sampling Locations and Excavated Areas

excavated areas and locations of verification sampling, and Figure 4-2 shows the radiological status of the property after the time-critical removal action.

As part of the post-remedial action verification survey, PIC measurements were taken at 1 m (3 ft) above the ground surface in each remediated area. PIC measurements in the front yard (parking area by steps) and front yard excavation (by curb) revealed exposure rates of 7 and 6 μR/h (dose rates of 61 and 53 mrem/yr), respectively, including background. PIC measurements in the back yard excavation revealed exposure rates of 8 and 10 μR/h (dose rates of 70 and 88 mrem/yr) including background. All exposure rates are below or near the background rate of 9 μR/h and below the DOE radiation protection standard of 100 mrem/yr above the background level.

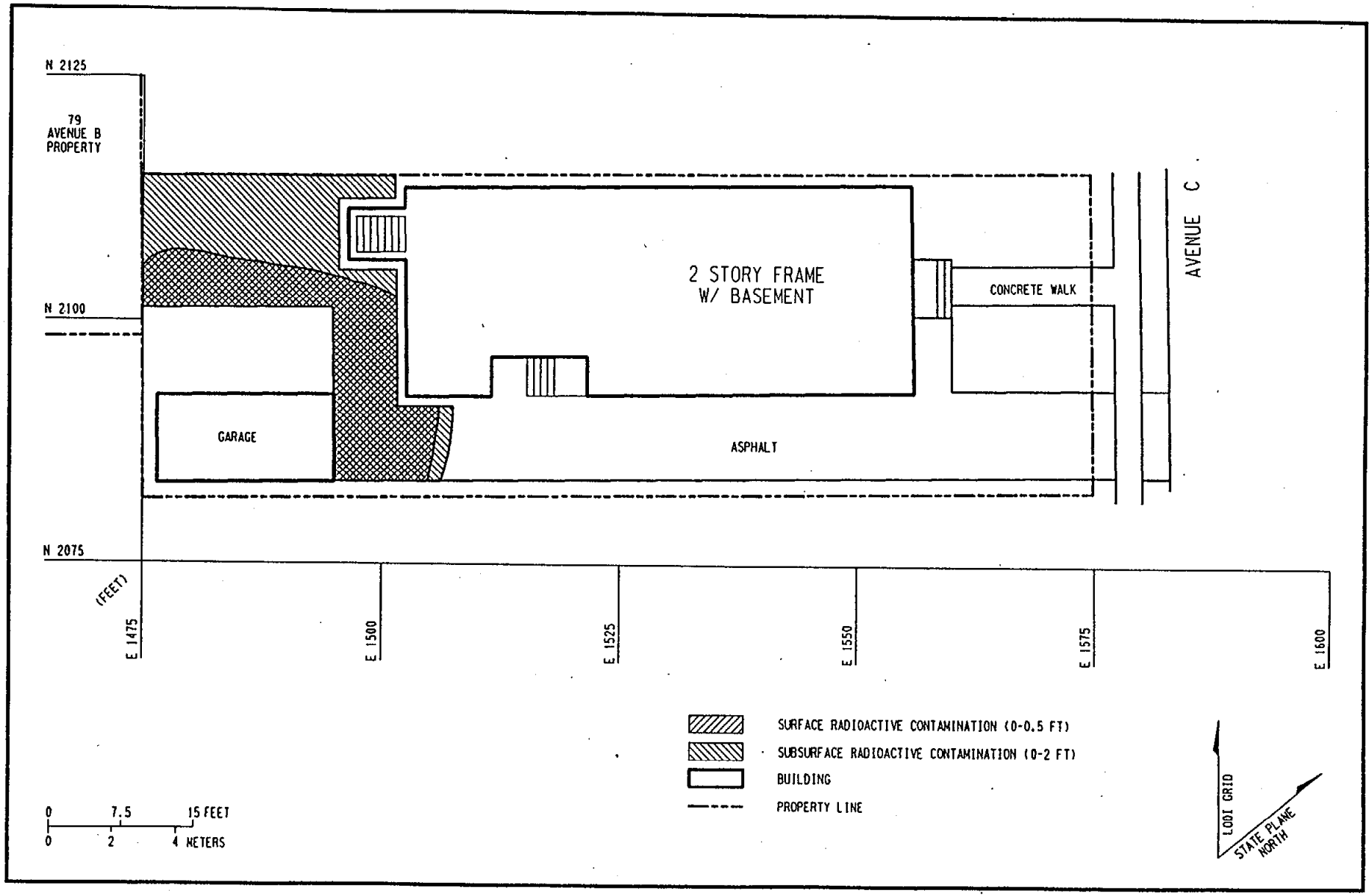

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Figure 4-2
Radiological Condition of Property After Removal Action

5.0 POST-REMEDIAL ACTION STATUS

Analytical results for post-remedial action surveys indicate that the levels of radioactivity in the remediated areas are in compliance with applicable DOE cleanup guidelines for radioactive contamination. The IVC reviewed the post-remedial action surveys and results, measurement procedures, and quality assurance data to determine whether the measurements obtained verify that these areas comply with the established DOE guidelines for the site.

The IVC is responsible for preparing a generic plan outlining the procedures used in conducting verification activities. There are two types of verification reviews (types A and B); the IVC conducted both types as specified in their verification plan.

Type A verification consisted of reviewing the post-remedial action survey results and included collecting and analyzing additional samples if necessary. In performing the type B verification review, the IVC conducted a survey of the site that included direct measurements, review of the post-remedial action survey methods and results, sampling, and laboratory analysis of soil samples.

After completing the verification study, the IVC reported its findings and recommendations to DOE-Headquarters and DOE Oak Ridge Field Office. DOE will review the data to certify that the remedial action was successful. The IVC's published verification report will become part of the administrative record file for the Maywood site.

Radioactively contaminated soil remains on the property in areas that were not remediated to accommodate restoration and expansion of the structure by the home owner. Contaminated soil is present beneath a portion of the driveway in front of the garage, adjacent to the garage foundation, and at the rear of the property (see Figure 4-2). This contaminated soil will be removed during cleanup of the Maywood site vicinity properties. No contaminated soil remains adjacent to the foundation of the restored living space; therefore, future remedial action will not be impacted by the new structure.

REFERENCES

Bechtel National, Inc. (BNI), 1992. Remedial Investigation Report for the Maywood Site, Maywood, New Jersey (Draft), DOE/OR/21949-337, Oak Ridge, Tenn. (June).

Cole, L. W., et al., 1981. Radiological Assessment of Ballod Associates Property (Stepan Chemical Company), Maywood, New Jersey, Oak Ridge Associated Universities, Oak Ridge, Tenn. (July).

Department of Energy (DOE), 1986. Formerly Utilized Sites Remedial Action Program, Summary Protocol, Identification - Characterization - Designation - Remedial Action - Certification, Washington, D.C. (January).

DOE, 1990. "Radiation Protection of the Public and the Environment," DOE Order 5400.5, Washington, D.C. (June).

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

Environmental Protection Agency (EPA), 1980. "Standards for Protection Against Uranium Mill Tailings" (April).

Mata, L., 1984. Site Analysis, Maywood Chemical Sites, Maywood and Rochelle Park, New Jersey, TS-PIC-84023, prepared by Bionetics Corporation, Warrenton, Va., for U.S. Environmental Protection Agency, Environmental Monitoring Systems Laboratory, Las Vegas, Nev. (May).

Nuclear Regulatory Commission (NRC), 1981. Stepan Company Inspection, Report No. 40-8610/80-01, Office of Inspection and Enforcement, Region I (February 18).

Oak Ridge National Laboratory (ORNL), 1984. Results of the Mobile Gamma Scanning Activities in Lodi, New Jersey, ORNL/RASA-83/3, Oak Ridge, Tenn. (October).

ORNL, 1989. Results of the Radiological Survey at 90 Avenue C (LJ079), Lodi, New Jersey, ORNL/RASA-88/67, Oak Ridge, Tenn. (June).

GLOSSARY

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. For example, due to naturally occurring radiation alone, New Jersey typically receives 100 millirem per year (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, and thorium (see **Radionuclide**). The dose levels do not include the concentrations of naturally occurring radon inside buildings.

Beta-gamma-emitting - See **Radiation.**

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

Contamination - Contamination is used generally to mean a concentration of one or more radioactive materials that exceeds naturally occurring levels. Contamination may or may not exceed the DOE cleanup guidelines.

Counts per minute - A count per minute (cpm) 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 as a radioactive material decays.

Disintegrations per minute - Disintegrations per minute (dpm) is the measurement indicating the amount of radiation being released from a substance per minute. See **Picocurie.**

Dose - As used in this report, dose is actually dose equivalent and is used to relate absorbed dose (mrad) to an effect on the body. Dose is measured in mrem. For comparison, a dose of 500,000 mrem to the whole body within 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 that may be received by members of the general public to 100 mrem/yr above background levels; living in a brick house typically results in a dose of about 75 mrem/yr above the background level.

Exposure rate - Exposure rate is the rate at which radiation imparts energy to the air. Exposure is typically measured in microroentgens (μR), and exposure rate is typically expressed 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 h/week (continuous exposure) for 52 weeks/yr, the whole-body dose on an annual basis would be 170 mrem.

Gamma radiation - See **Radiation.**

Gram - A gram (g) is a metric unit of weight. There are 454 g in 1 pound and 28 g in 1 ounce.

Meter - A meter (m) is a metric unit of length; 1 m is equal to approximately 39 inches.

Microroentgen - A microroentgen (μR) is a unit used to measure radiation exposure. For further information, see **Exposure rate.**

Millirem - The millirem (mrem) is the unit used to measure radiation dose to man. The DOE dose limit is 100 mrem above background radiation levels within any one-year period for members of the general public. Naturally occurring radioactive substances in the ground result in a yearly exposure of about 100 mrem to each member of the population. 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.

Picocurie - A picocurie (pCi) is a unit of measure for radioactivity, just as an ounce is a unit to measure weight. A measurement of 1 pCi equals 2.22 disintegrations per minute (dpm), which means that one radioactive particle is released on the average of every 27 seconds.

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

Radionuclide - Radioactive elements are also referred to as radionuclides. For example, uranium-235 is a radionuclide, uranium-238 is another, thorium-232 is another, and so on.

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

Remedial action - Remedial action is a general term used to mean "cleanup of contamination that exceeds DOE guidelines." It refers to any action required so that a property can be certified as being in compliance with guidelines and can therefore be released for future use. In practice, this may require removing grass and soil, cutting trees, and removing asphalt. Remedial action also includes

restoring remediated properties to their original conditions insofar as possible.

Secular equilibrium - This is radioactive equilibrium in which the parent and all the daughters in the decay chain have the same activity.

Thorium - Thorium is a naturally occurring element that is recovered from monazite for commercial purpose. 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.