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Contract No. DE-AC05-81OR20722

RADIOLOGICAL CHARACTERIZATION REPORT FOR FUSRAP PROPERTIES IN THE ST. LOUIS, MISSOURI, AREA

August 1990

Bechtel National, Inc.

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Department of Energy
Oak Ridge Operations
P.O. Box 2001
Oak Ridge, Tennessee 37831—

October 12, 1990

Distribution

RADIOLOGICAL CHARACTERIZATION REPORT FOR FUSRAP PROPERTIES IN THE ST. LOUIS, MISSOURI, AREA

Enclosed for your information is a copy of the subject report which was prepared as part of DOE's Formerly Utilized Sites Remedial Action Program (FUSRAP).

If you have any questions on the content of this report or desire additional information, please contact me at (615) 576-9634.

Sincerely,

David G. Adler, Site Manager
Technical Services Division

Enclosure

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RADIOLOGICAL CHARACTERIZATION REPORT FOR FUSRAP PROPERTIES IN THE ST. LOUIS, MISSOURI, AREA

VOLUME I

AUGUST 1990

Prepared for
United States Department of Energy
Oak Ridge Operations Office
Under Contract No. DE-AC05-81OR20722

By

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Bechtel Job No. 14501

EXECUTIVE SUMMARY

Radiological characterization surveys were conducted on properties located in Hazelwood, Berkeley, and St. Louis, Missouri. Areas surveyed include the Norfolk and Western Railroad Properties; portions of Latty Avenue, McDonnell Boulevard, Hazelwood Avenue, and Pershall Road (the haul roads) and associated properties; Latty Avenue vicinity properties; portions of Coldwater Creek and its vicinity properties; and the St. Louis Airport Site (SLAPS) vicinity properties.

The surveys were performed as part of the Formerly Utilized Sites Remedial Action Program (FUSRAP), a U.S. Department of Energy (DOE) program to identify and clean up or otherwise control sites where residual radioactive contamination (exceeding current guidelines) remains from the early years of the nation's atomic energy program or from commercial operations causing conditions that Congress has mandated DOE to remedy.

These St. Louis sites have been included on the National Priorities List, a list of sites identified for remedial action under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980, also known as Superfund. Plans are currently under way to initiate a remedial investigation/feasibility study (RI/FS) for the St. Louis sites. The data collected from the radiological surveys discussed in this report will be incorporated into the RI and FS processes for these sites.

Radiological surveys were conducted on Missouri FUSRAP properties for DOE from 1986 through 1989 by Bechtel National, Inc., the FUSRAP project management contractor, and its radiological subcontractor, Thermo Analytical/Eberline. The results are presented in this report. The goal of the surveys was to identify radionuclides present on the properties at above-guideline concentrations and to determine depths and areal limits of such radioactive

REFERENCE FOR SECTION 2.0

2-1 U.S. Department of Energy. U.S. Department of Energy Guidelines for Residual Radioactivity at Formerly Utilized Sites Remedial Action Program and Remote Surplus Facilities Management Program Sites, Rev. 2, Washington, D.C., March 1987.

3.0 CHARACTERIZATION RESULTS FOR THE LATTY AVENUE VICINITY PROPERTIES

This section reports characterization results for six Latty Avenue vicinity properties, whose locations are shown in Figure 1-3. Detailed results for each property are provided in Subsections 3.1 through 3.6. It should be noted that the term "elevated concentrations" of radionuclides refers to concentrations above DOE guidelines.

Characterization of the properties adjacent to Latty Avenue was necessary to determine the horizontal and vertical boundaries of radioactive contamination that exceed DOE remedial action guidelines. Soil sampling locations were determined based on walkover gamma radiation scans conducted on each property and soil sample analytical results from the shoulders of Latty Avenue.

3.1 PROPERTY 1

Near-surface gamma radiation measurements at Property 1 ranged from background to approximately 58,000 cpm. Downhole gamma logging was performed to indicate the general depth of gamma-emitting radionuclides. Gamma logging was only performed in the drilled boreholes at the Latty Avenue vicinity properties, not in the hand-augered holes. These data were used as an aid in the selection and analysis of soil samples. No significant variations in count rates were observed as gamma logging progressed in the boreholes on Property 1, indicating that the distribution of gamma-emitting radionuclides is relatively constant with depth. Detailed gamma logging results are reported in Table 3-1. (Note: All data tables for Section 3.0 are contained in Volume II of this report.)

Soil sampling locations on Property 1 are shown in Figures 3-1 and 3-2. Analytical results for soil (Table 3-2) revealed areas with elevated concentrations of radium-226 and thorium-230 in surface and subsurface samples. Thorium-230 was identified as the major contaminant. All uranium concentrations were below 30 pCi/g. Radium-226 concentrations ranged from 0.5 to 11 pCi/g. Thorium-232 concentrations ranged from 0.7 to 5 pCi/g. The concentrations of thorium-230 ranged from 0.7 to 810 pCi/g in the selected samples analyzed for thorium-230.

Areas and depths of contamination on Property 1 are shown in Figure 3-3. Before remedial action begins, additional soil samples will be collected and analyzed from areas at which contamination boundaries need to be defined more accurately. The areas and depths of contamination shown in Figure 3-3 depict a conservative or over-estimate of contamination boundaries.

3.2 PROPERTY 2

Near-surface gamma radiation measurements at Property 2 ranged from approximately 2,000 to approximately 22,000 cpm. Downhole gamma logging was performed in the boreholes on this property, and detailed gamma logging results are reported in Table 3-3.

Soil sampling locations on Property 2 are shown in Figures 3-4 and 3-5. Analytical results for soil revealed areas with elevated concentrations of radium-226 and thorium-230 in surface and subsurface samples. Uranium-238 concentrations ranged from less than 3 to 100 pCi/g. Radium-226 concentrations ranged from 0.6 to 89 pCi/g. Thorium-232 concentrations ranged from 0.7 to 5 pCi/g. Concentrations of thorium-230 ranged from 0.4 to 5,700 pCi/g in the selected samples analyzed for thorium-230.

Analytical results for soil are provided in Table 3-4. Areas and depths of contamination on Property 2 are shown in Figure 3-6.

3.3 PROPERTY 3

Near-surface gamma radiation measurements at Property 3 ranged from approximately 2,000 to approximately 8,000 cpm. Detailed gamma logging results are reported in Table 3-5. No significant variations in count rates were observed as gamma logging progressed in the boreholes on this property.

Soil sampling locations on the Property 3 are shown in Figures 3-7 and 3-8. Analytical results for soil revealed areas with elevated concentrations of thorium-230 in surface and subsurface samples. All uranium-238 concentrations were less than 39 pCi/g. Radium-226 concentrations ranged from 0.6 to 4 pCi/g. Concentrations of thorium-232 ranged from less than 1 to 5 pCi/g. Thorium-230 concentrations ranged from 0.2 to 31 pCi/g.

Analytical results for soil are provided in Table 3-6. Areas and depths of contamination on Property 3 are shown in Figure 3-9.

3.4 PROPERTY 4

Near-surface gamma radiation measurements at Property 4 ranged from approximately 4,000 to approximately 7,000 cpm. No significant variations in count rates were observed as gamma logging progressed in the boreholes on this property. Detailed gamma logging results are reported in Table 3-7.

Soil sampling locations on Property 4 are shown in Figures 3-10 and 3-11. Analytical results for soil (Table 3-8) revealed areas with elevated concentrations of radium-226 and thorium-230 in surface and subsurface samples. All uranium-238 concentrations were less than 20 pCi/g. Radium-226 concentrations ranged from 0.5 to 10 pCi/g. Thorium-232 concentrations ranged from 0.5 to 4 pCi/g, and thorium-230 concentrations ranged from 0.7 to 460 pCi/g.

The areas and depths of radioactive contamination on Property 4 are shown in Figure 3-12.

3.5 PROPERTY 5

No near-surface gamma radiation measurements were made on Property 5 because the walkover survey showed no areas in which readings exceeded twice background radiation levels. No significant variations in count rates were observed as gamma logging progressed in the boreholes on this property. Detailed gamma logging results are reported in Table 3-9.

Soil sampling locations on Property 5 are shown in Figures 3-13 and 3-14. Analytical results for soil (Table 3-10) revealed areas with elevated concentrations of thorium-230 in surface samples. All uranium-238 concentrations were less than 30 pCi/g. Radium-226 concentrations ranged from 0.7 to 4 pCi/g. Concentrations of thorium-232 ranged from 0.8 to 7 pCi/g. Thorium-230 concentrations ranged from 0.6 to 12 pCi/g. Areas and depths of contamination on Property 5 are shown in Figure 3-15.

3.6 PROPERTY 6

Near-surface gamma radiation measurements at Property 6 ranged from approximately 6,000 to approximately 7,000 cpm.

Downhole gamma logging was performed on this property to indicate the general depth of gamma-emitting radionuclides. No significant variations in count rates were observed as gamma logging progressed in the boreholes on Property 6. Detailed gamma logging results are reported in Table 3-11.

Surface soil sampling locations on this property are shown in Figure 3-16, and subsurface soil sampling locations are shown in Figure 3-17. Analytical results for soil (Table 3-12) revealed areas with elevated concentrations of thorium-230 in surface samples. All uranium-238 concentrations were below 14 pCi/g. Radium-226 concentrations ranged from 0.4 to 3 pCi/g. Concentrations of thorium-232 and thorium-230 ranged from 0.8 to 4 pCi/g and less than 0.7 to 21 pCi/g, respectively. Further soil sampling is required at Property 6 before the boundaries of radioactive contamination can be determined. This sampling will occur prior to remedial action.

Radioactive contamination is present on all six Latty Avenue vicinity properties. Thorium-230 was identified as the major contaminant. Depths of contamination range from surface to 4.3 m (14 ft) at one location on Property 1. Typically, contamination is confined to the top 1 m (3 ft) of soil. In general, the areas of contamination are smaller and fewer with distance away from Latty Avenue.

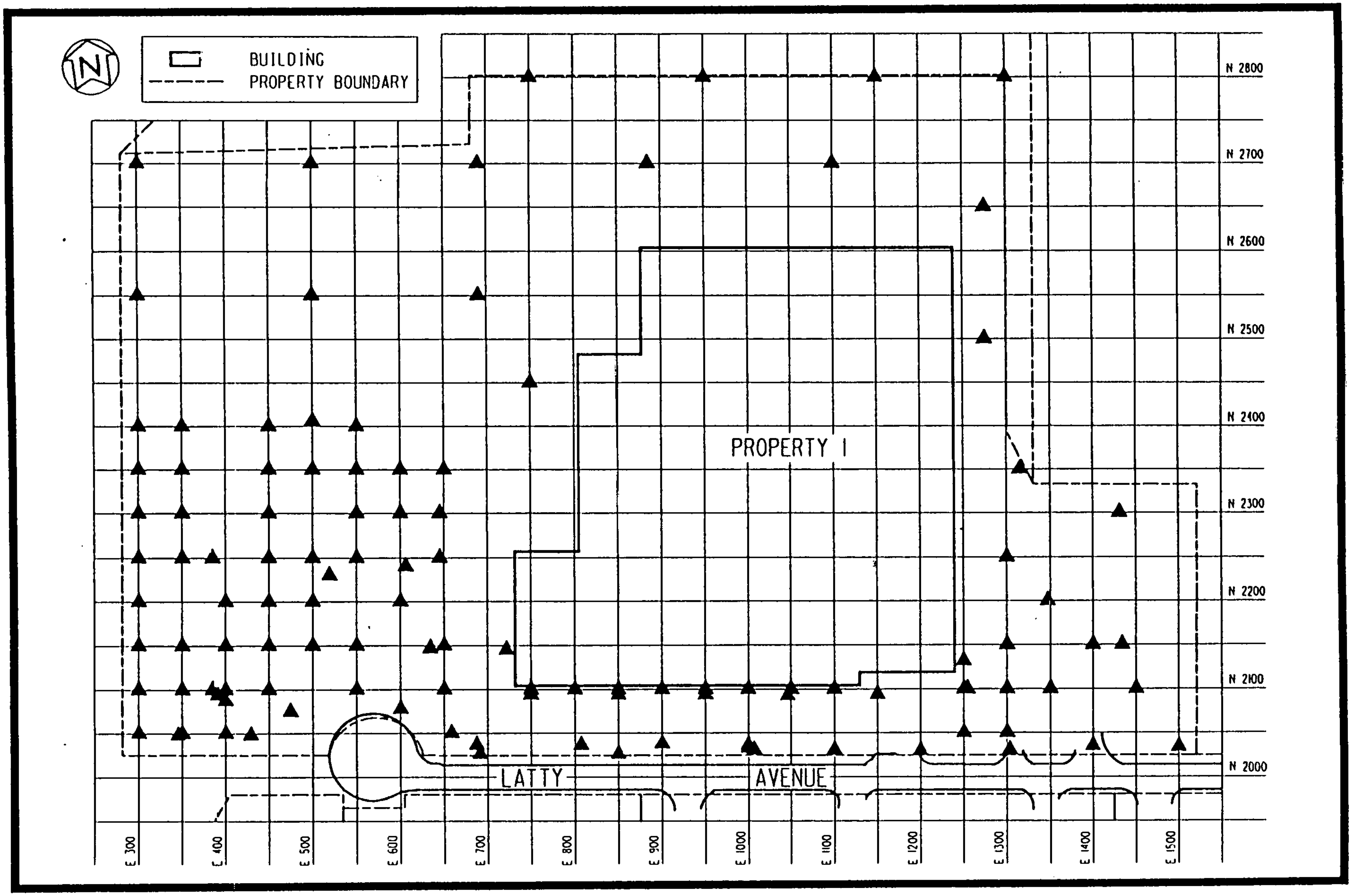

FIGURE 3-1 SURFACE SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF PROPERTY 1 ON LATTY AVENUE

S34WMS18.DGN FIG2

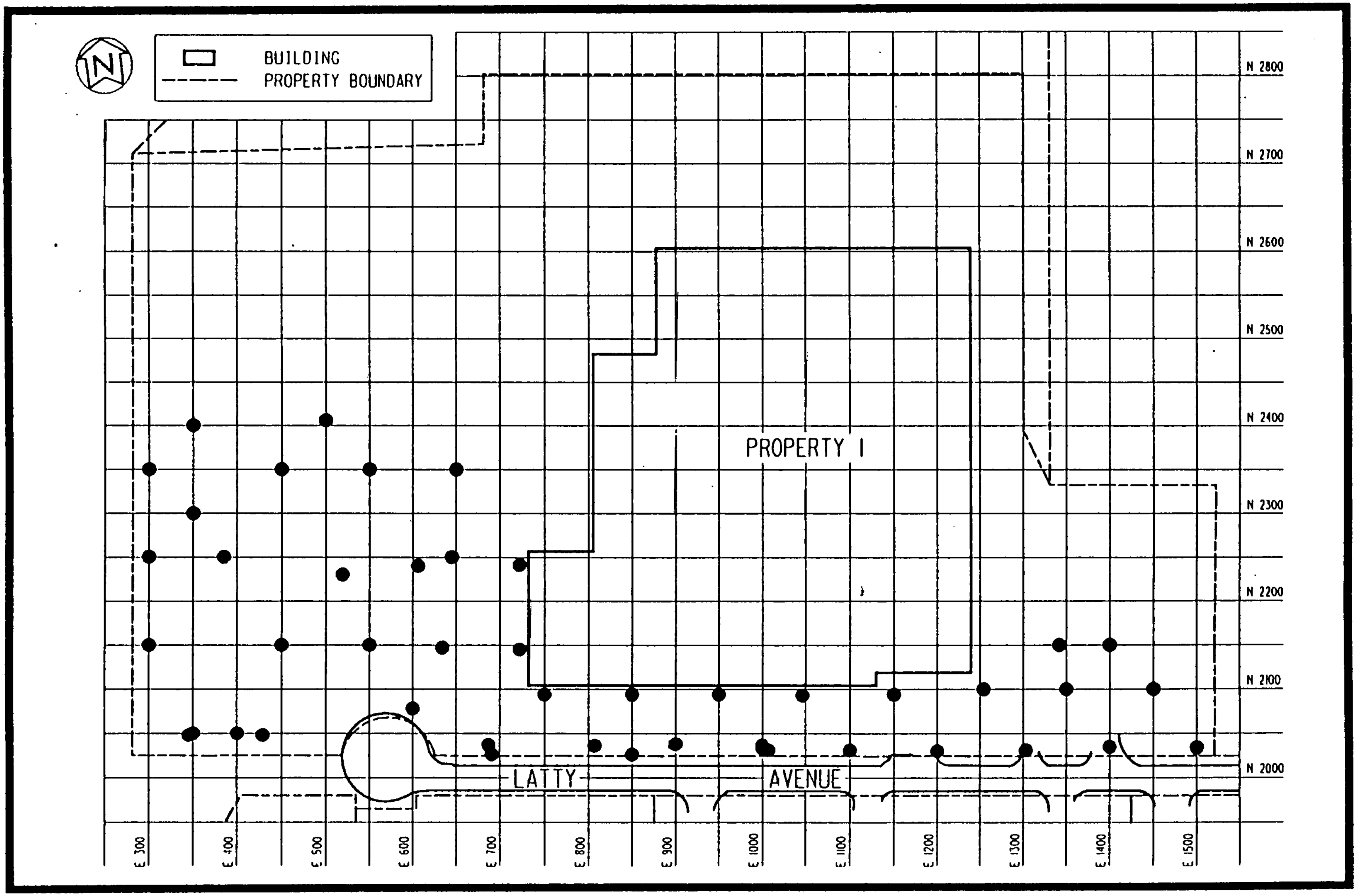

FIGURE 3-2 SUBSURFACE SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF PROPERTY 1 ON LATTY AVENUE

S34WMS18.DGN FIG4

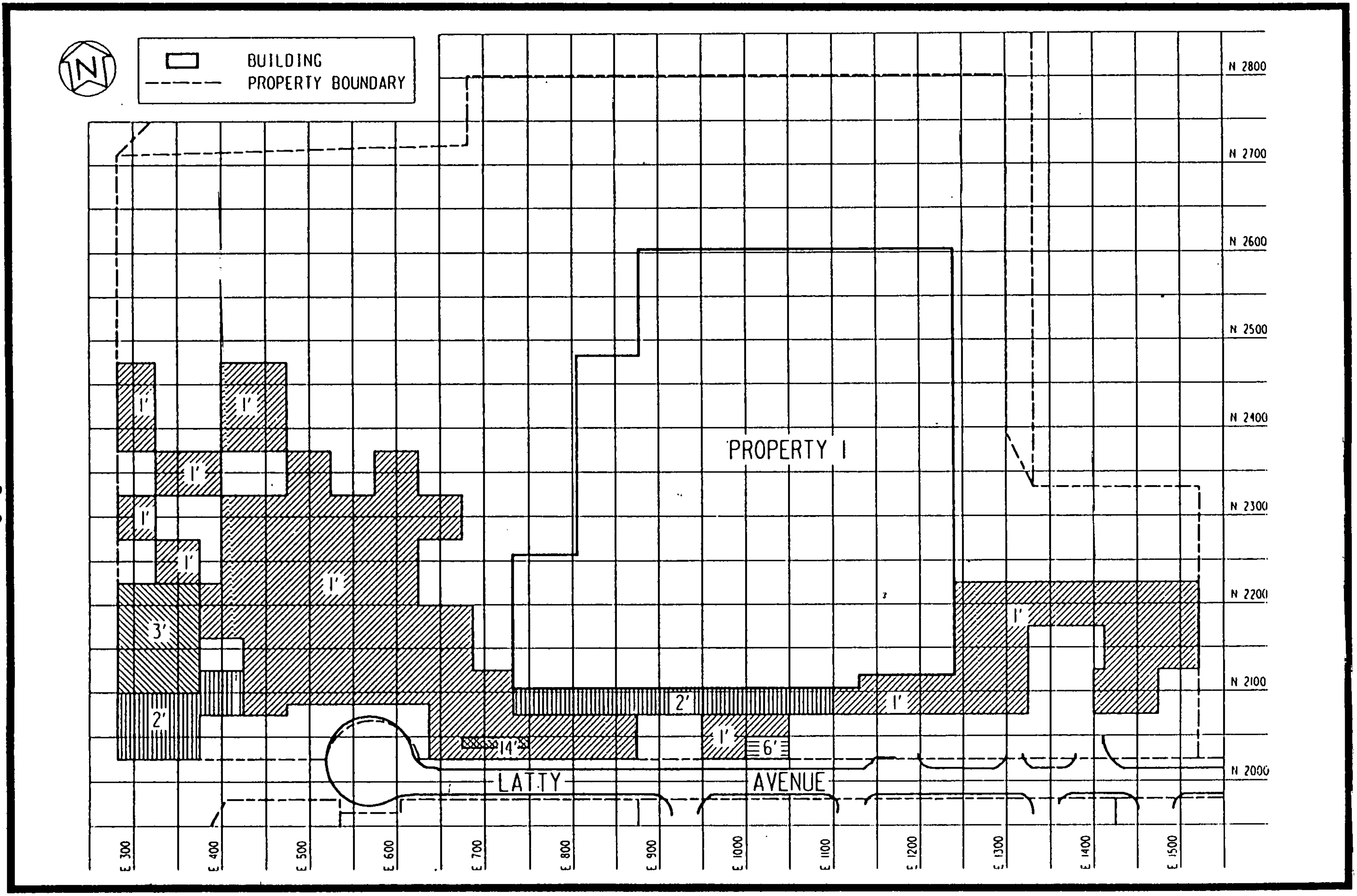

FIGURE 3-3 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT PROPERTY 1 ON LATTY AVENUE

534WM-18.DGN FIG7

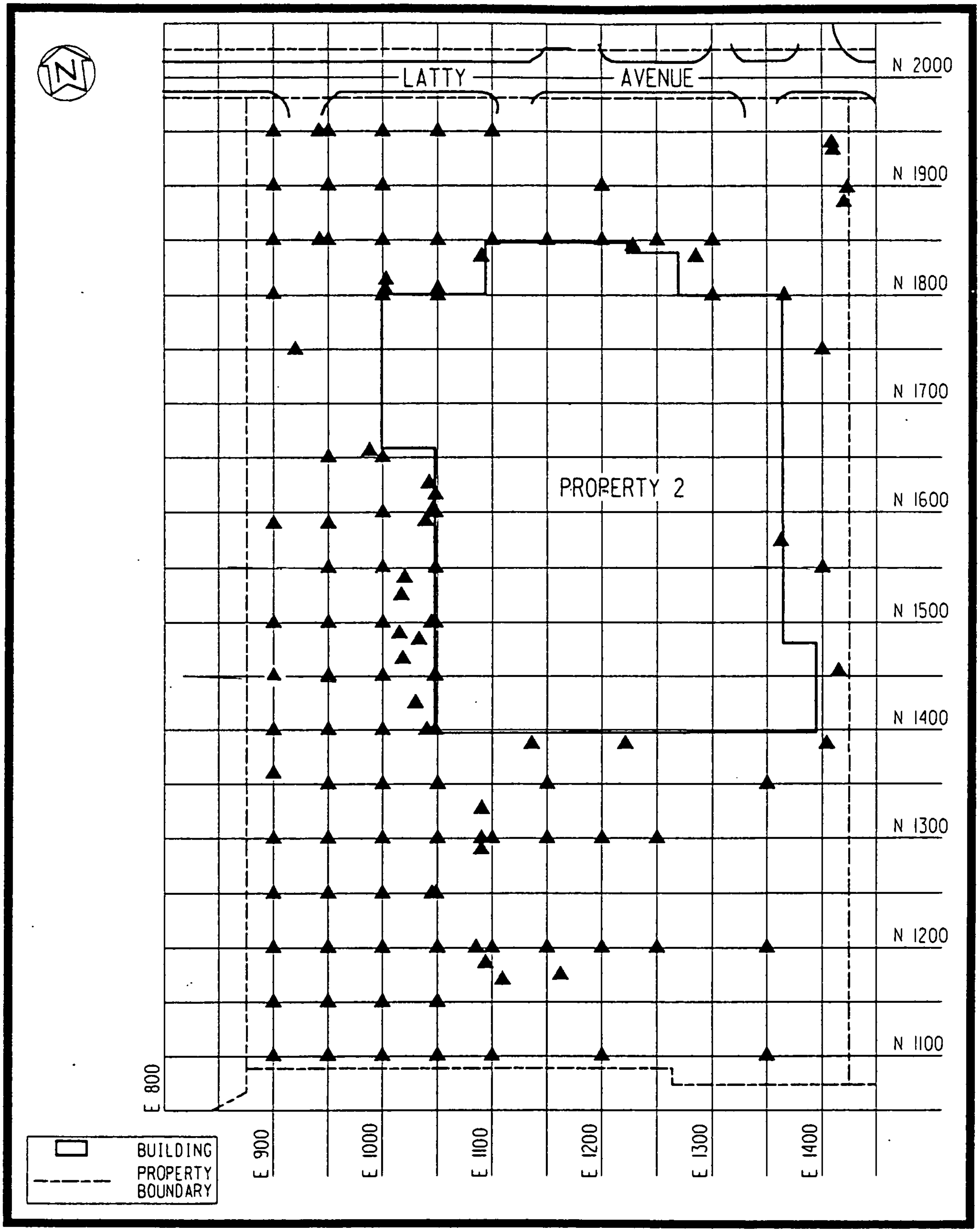

FIGURE 3-4 SURFACE SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF PROPERTY 2 ON LATTY AVENUE

S34WMS16.DGN FIG2

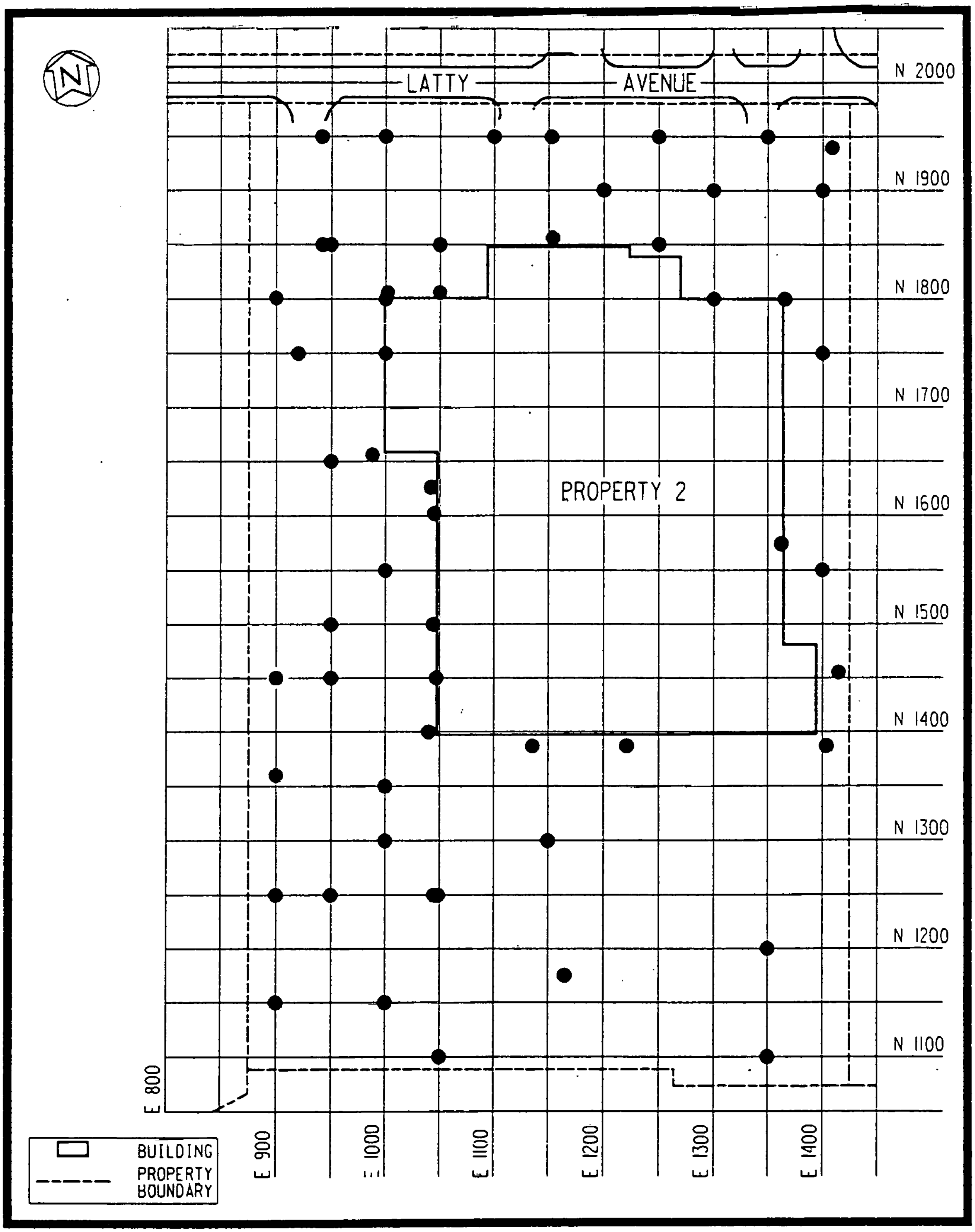

FIGURE 3-5 SUBSURFACE SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF PROPERTY 2 ON LATTY AVENUE

S34WMS16.DGN FIG4

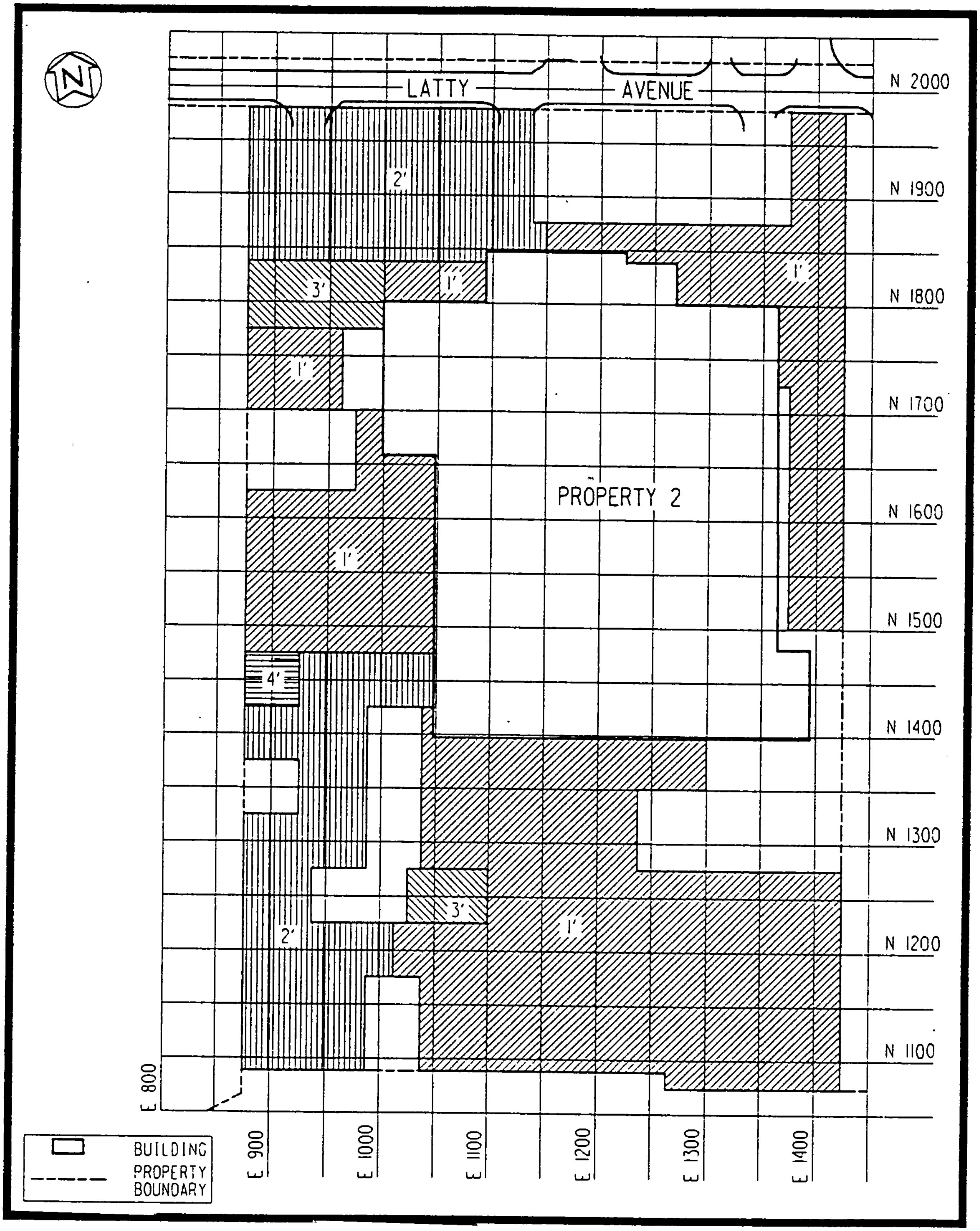

FIGURE 3-6 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT PROPERTY 2 ON LATTY AVENUE

134WMS16.DGN FIG7

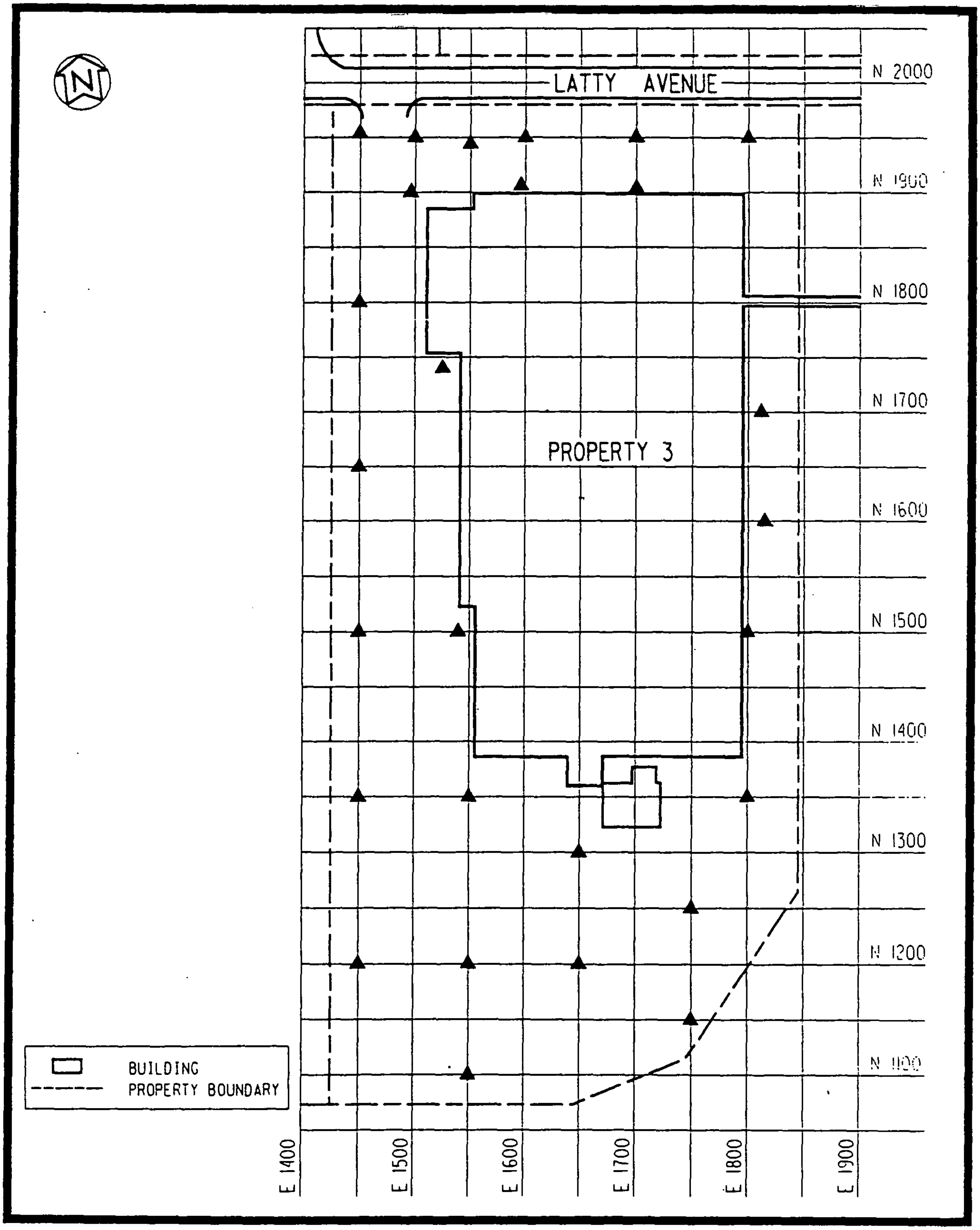

FIGURE 3-7 SURFACE SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF PROPERTY 3 ON LATTY AVENUE

S34WMS15.DGN FIG2

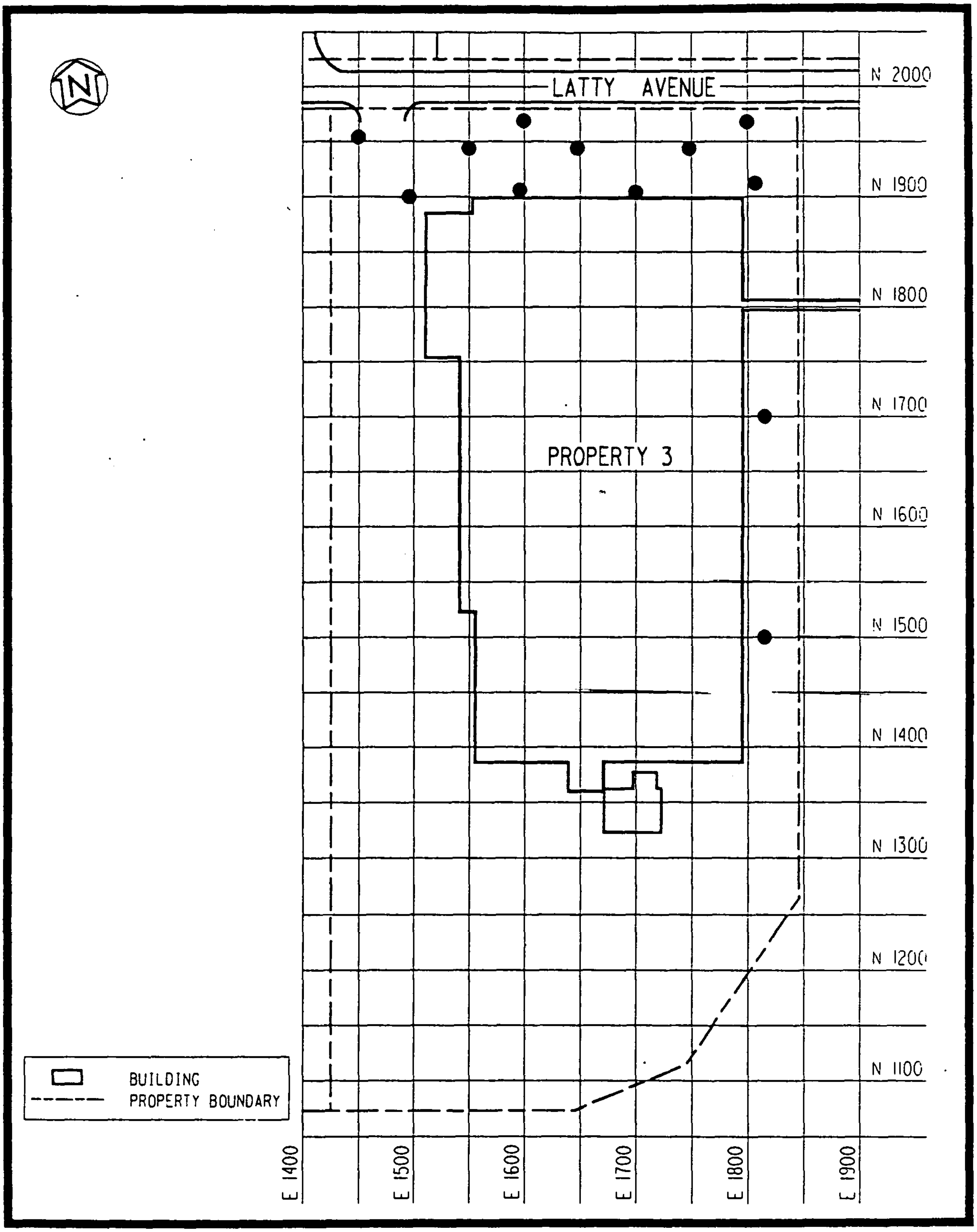

FIGURE 3-8 SUBSURFACE SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF PROPERTY 3 ON LATTY AVENUE

S34WMS15.DGN FIG4

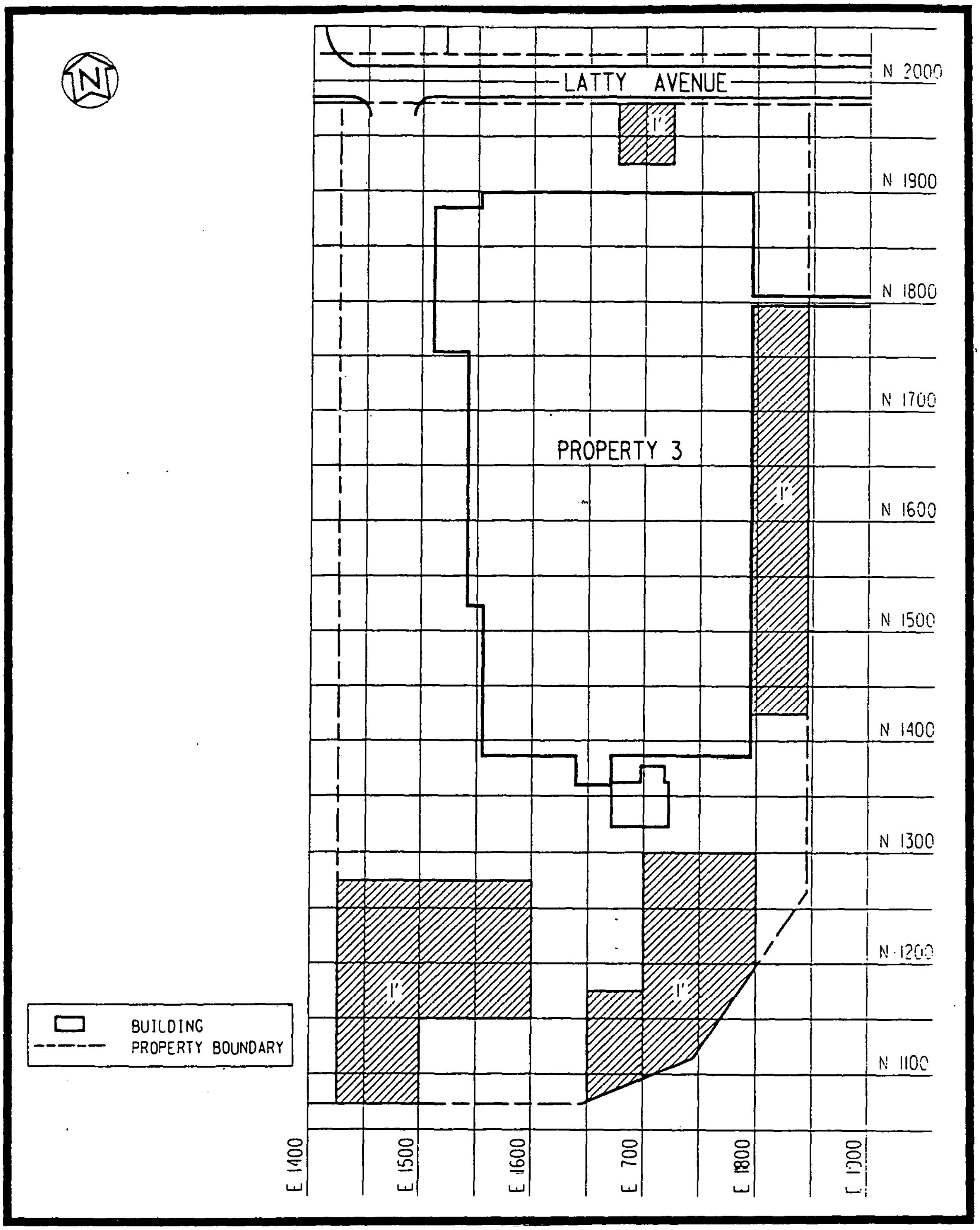

FIGURE 3-9 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT PROPERTY 3 ON LATTY AVENUE

S34WMS15.DGN FIG7

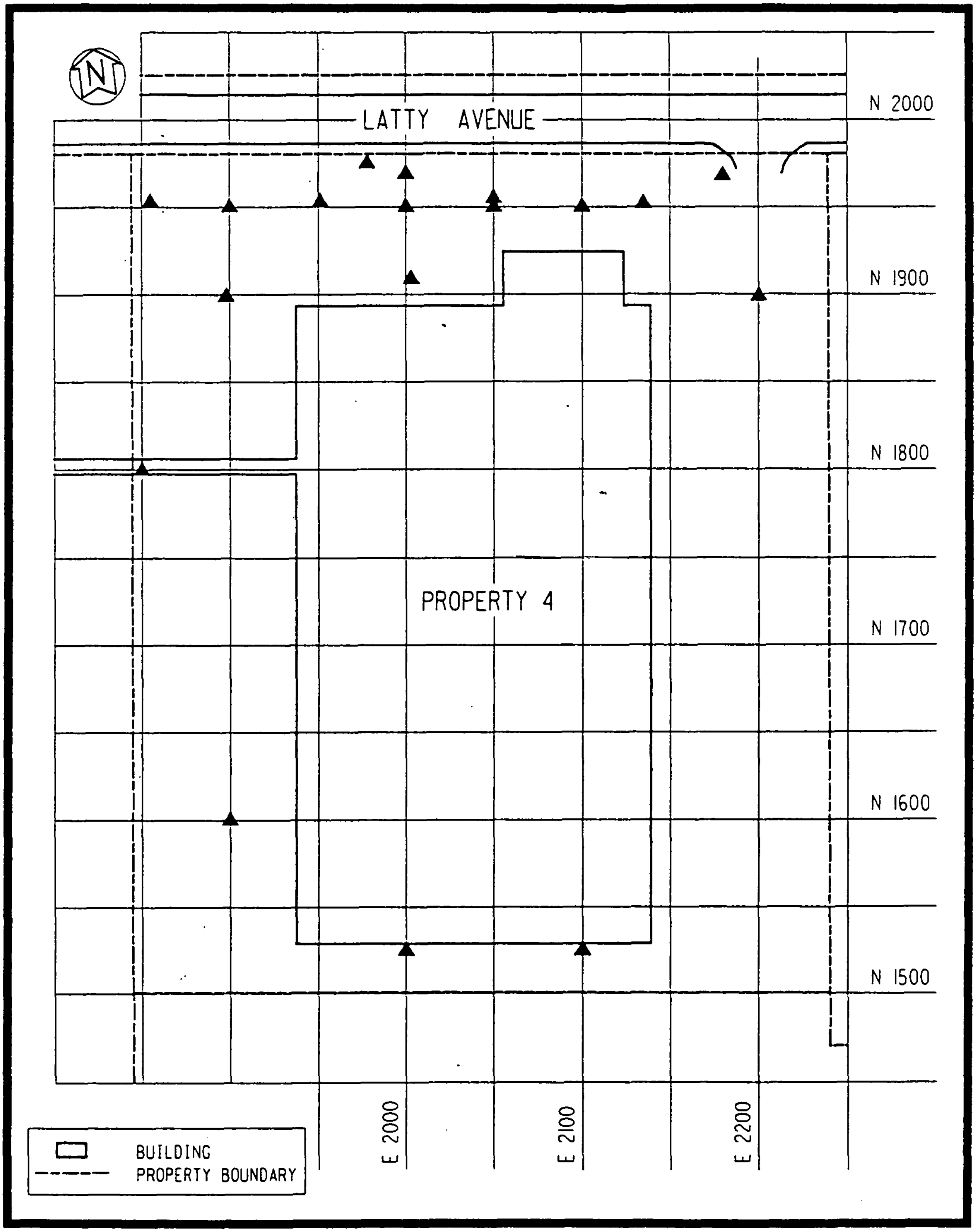

FIGURE 3-10 SURFACE SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF THE PROPERTY 4 ON LATTY AVENUE

S34WMS14.DGN FIG2

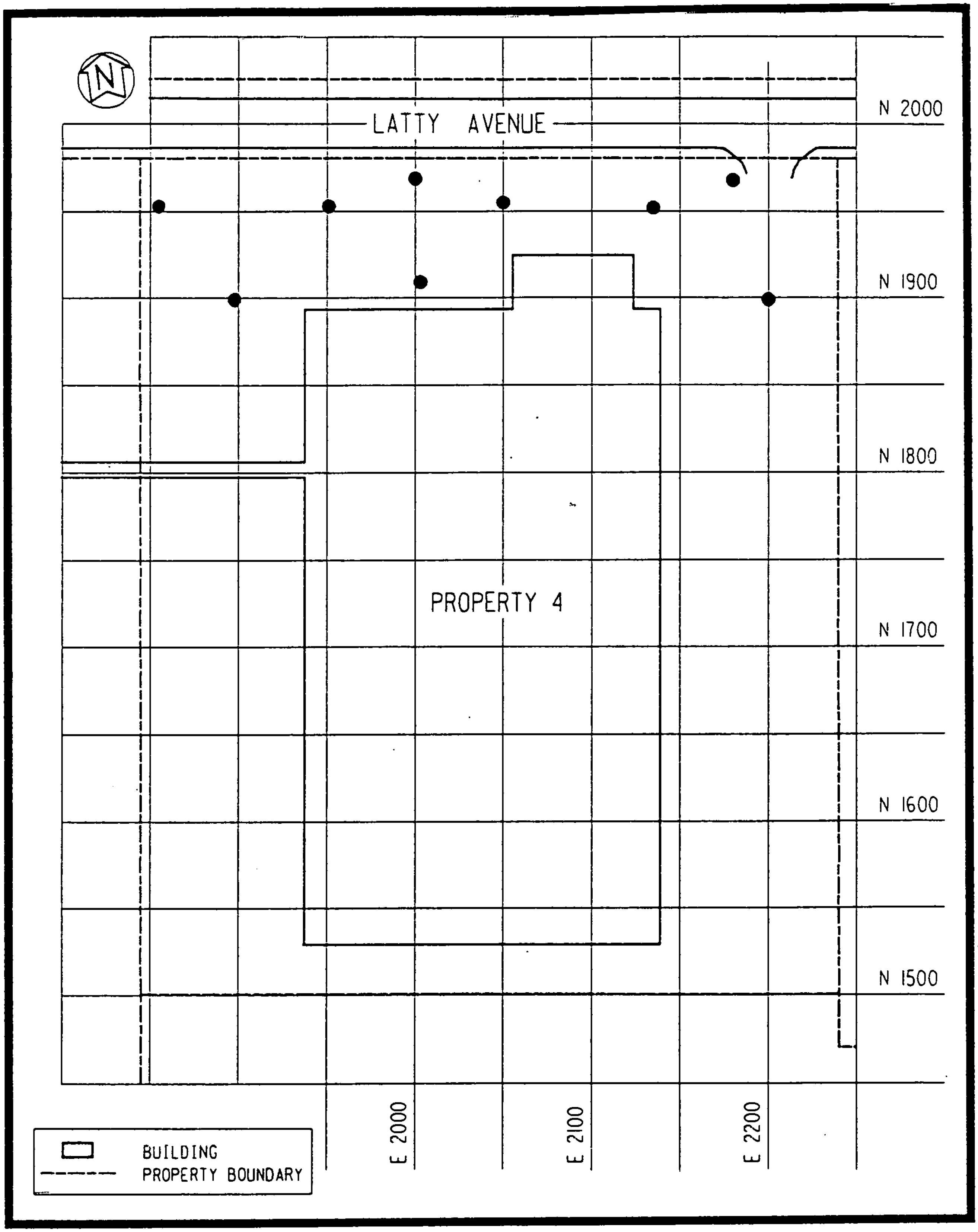

FIGURE 3-11 SUBSURFACE SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF PROPERTY 4 ON LATTY AVENUE

S34WMS14.DGN FIG4

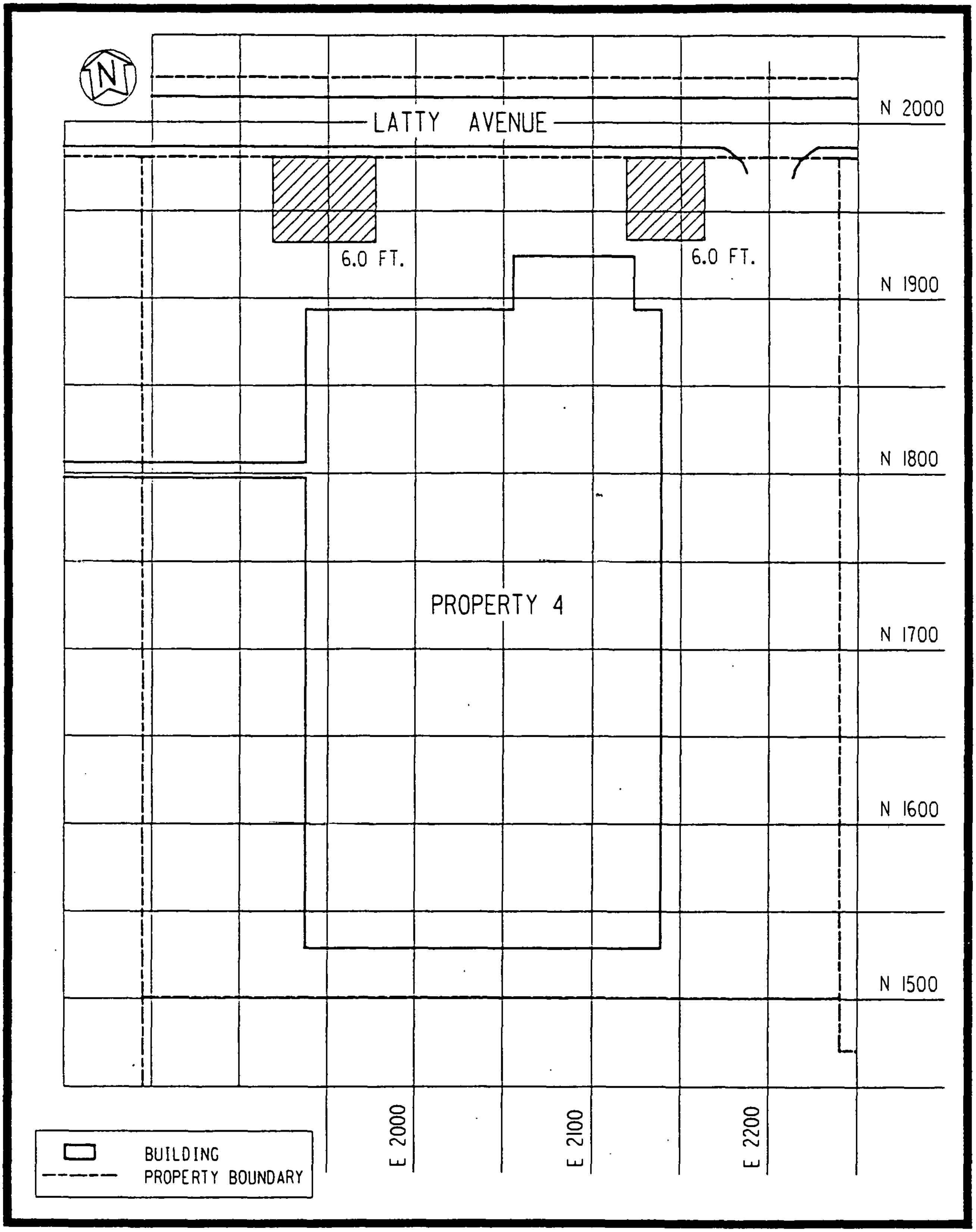

FIGURE 3-12 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT PROPERTY 4 ON LATTY AVENUE

S34WMS14.DGN FIG7

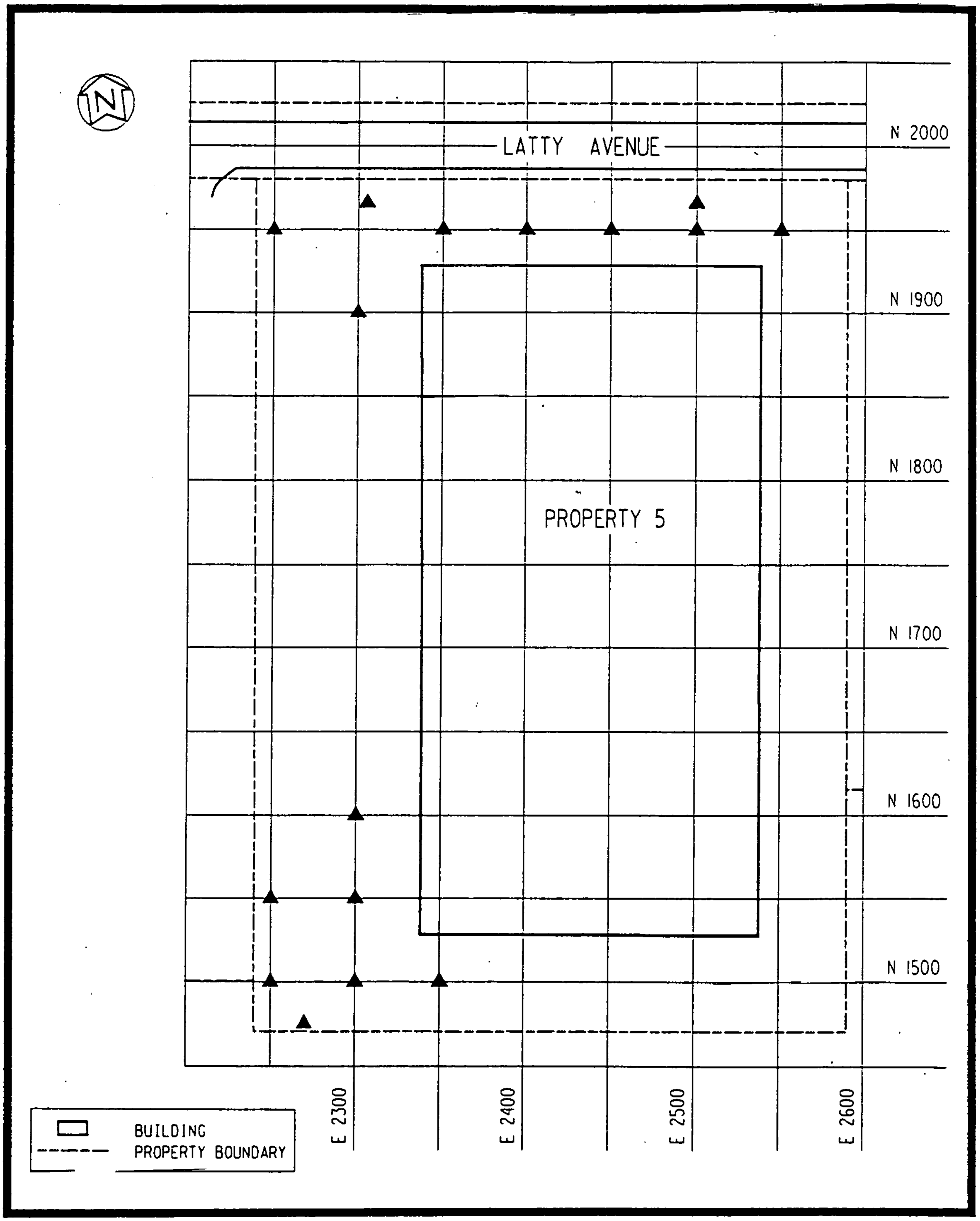

FIGURE 3-13 SURFACE SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF PROPERTY 5 ON LATTY AVENUE

S34WMS13.DGN FIG2

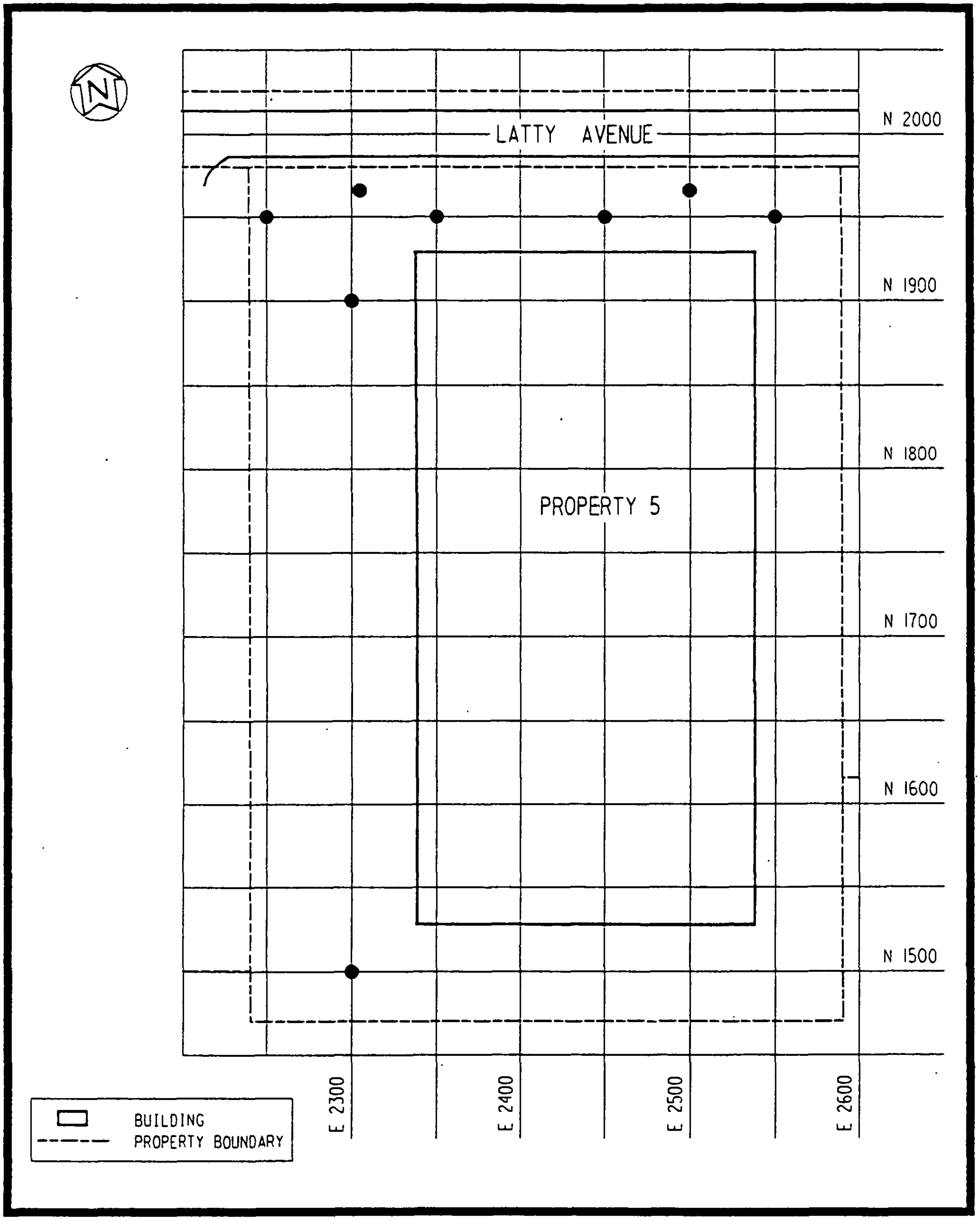

FIGURE 3-14 SUBSURFACE SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF PROPERTY 5 ON LATTY AVENUE

S34WMS13.DGN FIG4

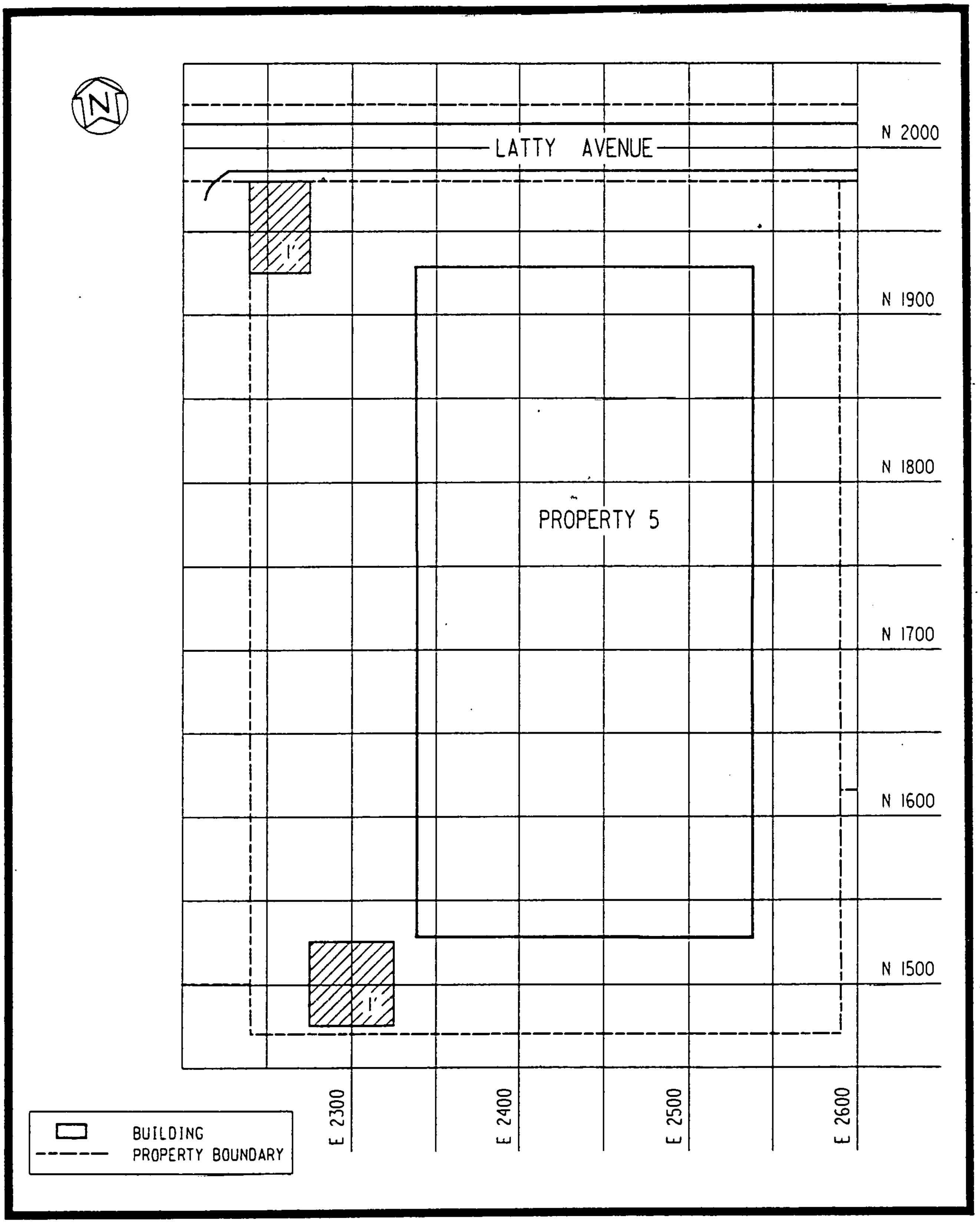

FIGURE 3-15 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT PROPERTY 5 ON LATTY AVENUE

S34WMS13.DGN FIG7

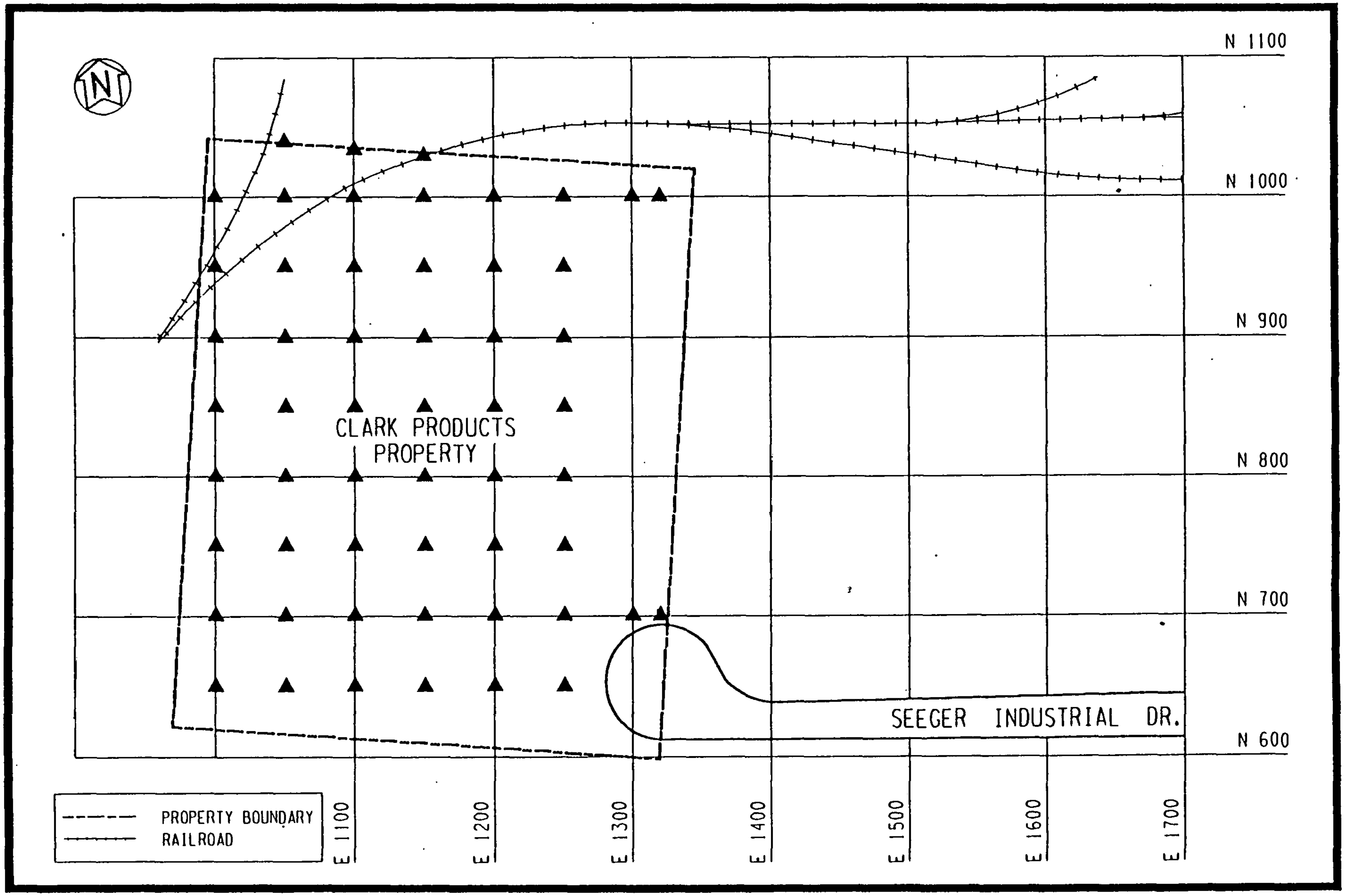

FIGURE 3-16 SURFACE SOIL SAMPLING LOCATIONS FOR PROPERTY 6 ON SEEGER INDUSTRIAL DRIVE

S34WMS45.DGN

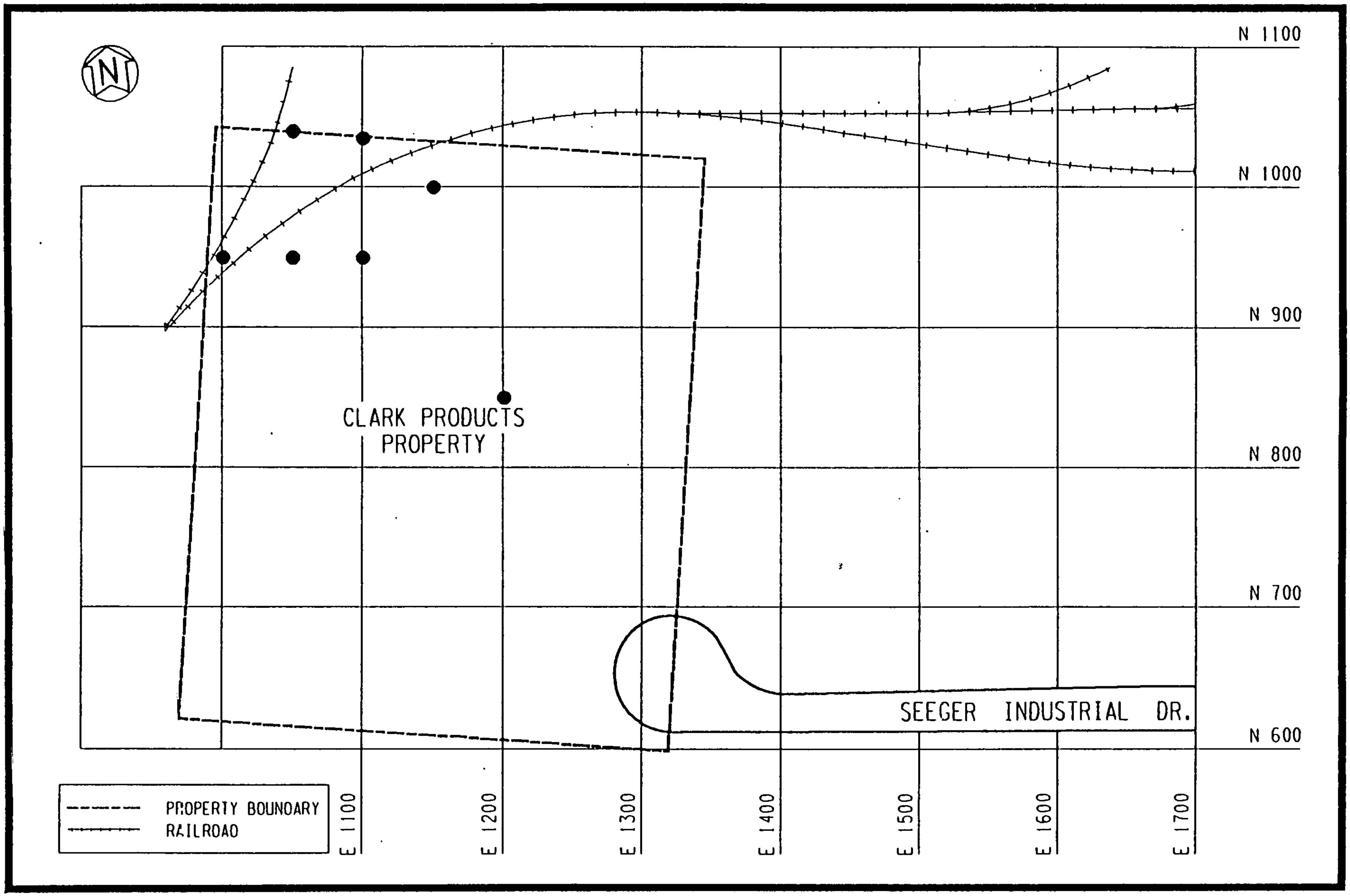

FIGURE 3-17 SUBSURFACE SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF PROPERTY 6 ON SEEGER INDUSTRIAL DRIVE

S34WMS45.DGN

4.0 CHARACTERIZATION RESULTS FOR THE NORFOLK AND WESTERN RAILROAD PROPERTIES

Characterization results for seven Norfolk and Western Railroad properties are reported in this section. When the term "elevated concentrations" is used, it refers to concentrations that exceed DOE guidelines. Characterization of the railroad properties was necessary to determine the boundaries and magnitude of radioactive contamination. The approach utilized in collecting soil samples from these properties was based on systematic sampling.

Near-surface gamma radiation measurements at the Norfolk and Western Railroad properties adjacent to 9200 Latty Avenue and south of SLAPS ranged from approximately 2,000 to approximately 554,000 cpm. No near-surface gamma radiation measurements were made on the Norfolk and Western Railroad properties adjacent to Hazelwood Avenue, Eva Avenue, Coldwater Creek, or Hanley Road because thorium-230 had already been identified as the primary contaminant before these surveys were initiated. Because thorium-230 cannot be detected in situ, the usefulness of gamma radiation scans and measurements is minimized.

Detailed results for each property are provided in the following subsections.

4.1 NORFOLK AND WESTERN RAILROAD PROPERTY ADJACENT TO 9200 LATTY AVENUE

Gamma radiation exposure rates measured on the railroad property adjacent to 9200 Latty Avenue ranged from 9 to 27 μR/h with an average of 12 μR/h. Background has not been subtracted from these measurements. Some of these measurements were actually made on Property 2 adjacent to HISS. They are reported in this section so that all the gamma radiation exposure rates at properties adjacent to 9200 Latty Avenue may be viewed together. Gamma radiation exposure rates at the railroad property are presented in Table 4-1.

contamination. This goal was achieved; however, there are some properties identified in this report for which the precise boundaries of radioactive contamination have not yet been determined. A limited number of additional soil samples will be required to define the extent of contamination identified for these properties. Data collected from areas adjacent to these properties have been extrapolated, both horizontally and vertically, to provide a conservative overestimate of the volume of contaminated soil present. Additional soil samples will be collected and analyzed from these limited areas before remedial action begins. The data from these additional soil samples will be provided in an addendum to this characterization report.

Survey results indicate that radioactive contamination is present on some of the properties in concentrations exceeding current DOE guidelines. In general, the contamination is shallow (i.e., confined to the top two feet of soil) and occurs in relatively low concentrations. The principal radioactive contaminant is thorium-230, although analyses also identified elevated levels of uranium-238 and radium-226.

Although thorium-230 was identified in concentrations exceeding DOE guidelines, there are no immediate health risks to people in the vicinity, given the current use of the properties. Thorium-230 emits alpha radiation, which cannot penetrate the dead layer of skin on a person's body; therefore, there is no external exposure hazard. Thorium-230 poses a radiological hazard only if it is ingested or inhaled. The guidelines were derived to protect a member of the general public even if an individual built a house over the contamination, lived there for 50 years, grew all his own food, ate meat from cattle grazing in the area, drank milk from cows grazing in the area, and drank water from the contaminated area. Because none of these pathways of exposure applies at the St. Louis FUSRAP properties, and given the nature of thorium-230, the contamination poses virtually no hazard.

Throughout the RI/FS process, public comments will be solicited to provide an opportunity for the public to participate in the design and implementation of the RI/FS process and, ultimately, to allow for public involvement in the selection of cleanup options. At this point, most of the field investigations necessary for the St. Louis area FUSRAP sites have been completed. Data from these investigations will be documented in an RI report. The FS will utilize information from the RI to develop and evaluate cleanup alternatives and will ultimately lead to a record of decision by the U.S. Environmental Protection Agency (EPA) and DOE for implementation of the selected alternative. It is important to realize, however, that selection of a final cleanup alternative will be done as part of the RI/FS process described above. This process will evaluate a full range of reasonable alternatives including on-site disposal (i.e., at SLAPS) and off-site disposal. The public will have a continuing role in the process through review of reports and attendance at public meetings. Oversight of the entire RI/FS process will be provided by EPA and the Missouri Department of Natural Resources.

TABLE OF CONTENTS

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LIST OF TABLES

NOTE: TABLES 3-1 THROUGH 5-7 ARE CONTAINED IN VOLUME II OF THIS REPORT. TABLES 5-8 THROUGH 7-8 ARE CONTAINED IN VOLUME III.

ACRONYMS

AEC	Atomic Energy Commission
BNI	Bechtel National, Inc.
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
DOE	U.S. Department of Energy
FUSRAP	Formerly Utilized Sites Remedial Action Program
HISS	Hazelwood Interim Storage Site
MED	Manhattan Engineer District
NRC	Nuclear Regulatory Commission
NEPA	National Environmental Policy Act
ORAU	Oak Ridge Associated Universities
ORNL	Oak Ridge National Laboratory
PIC	pressurized ionization chamber
PMC	project management contractor
SLAPS	St. Louis Airport Site
SLDS	St. Louis Downtown Site
TMA/E	Thermo Analytical/Eberline
TMC	Technical Measurements Center
TSCL	temporary slope and construction line

ABBREVIATIONS

cm	centimeter
cm^2	square centimeter
cpm	counts per minute
ft	foot
h	hour
ha	hectares
in.	inch
km	kilometer
m	meter
m^2	square meter
m^3	cubic meter
mi	mile
mrem	millirem
mrem/yr	millirem per year
mR/h	milliroentgens per hour
μR/h	microroentgens per hour
pCi/g	picocuries per gram
yd^3	cubic yard
yr	year

1.0 INTRODUCTION

The characterization activities reported in this document were conducted as part of the Formerly Utilized Sites Remedial Action Program (FUSRAP), a U.S. Department of Energy (DOE) effort to identify and clean up or otherwise control sites where residual radioactive contamination (exceeding current guidelines) remains from the early years of the nation's atomic energy program or from commercial operations causing conditions that Congress has mandated DOE to remedy. Bechtel National, Inc. (BNI) acts as the project management contractor (PMC), responsible to DOE for planning, managing, and implementing FUSRAP. Surveys were conducted from 1986 through 1989 at DOE's direction by BNI and its radiological subcontractor, Thermo Analytical/Eberline (TMA/E).

1.1 PURPOSE AND OBJECTIVES

This report describes the procedures used to conduct the 1986 through 1989 radiological characterization of FUSRAP properties in the St. Louis, Missouri, area (see Figure 1-1). These properties include

- Latty Avenue vicinity properties
- Portions of Coldwater Creek and its vicinity properties
- Norfolk and Western Railroad properties
- St. Louis Airport Site (SLAPS) vicinity properties
- Portions of Latty Avenue, McDonnell Boulevard, Hazelwood Avenue, and Pershall Road (the haul roads) and associated vicinity properties

The St. Louis sites have been placed on the National Priorities List, which is a list of sites identified for remediation under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980, also referred to as Superfund.

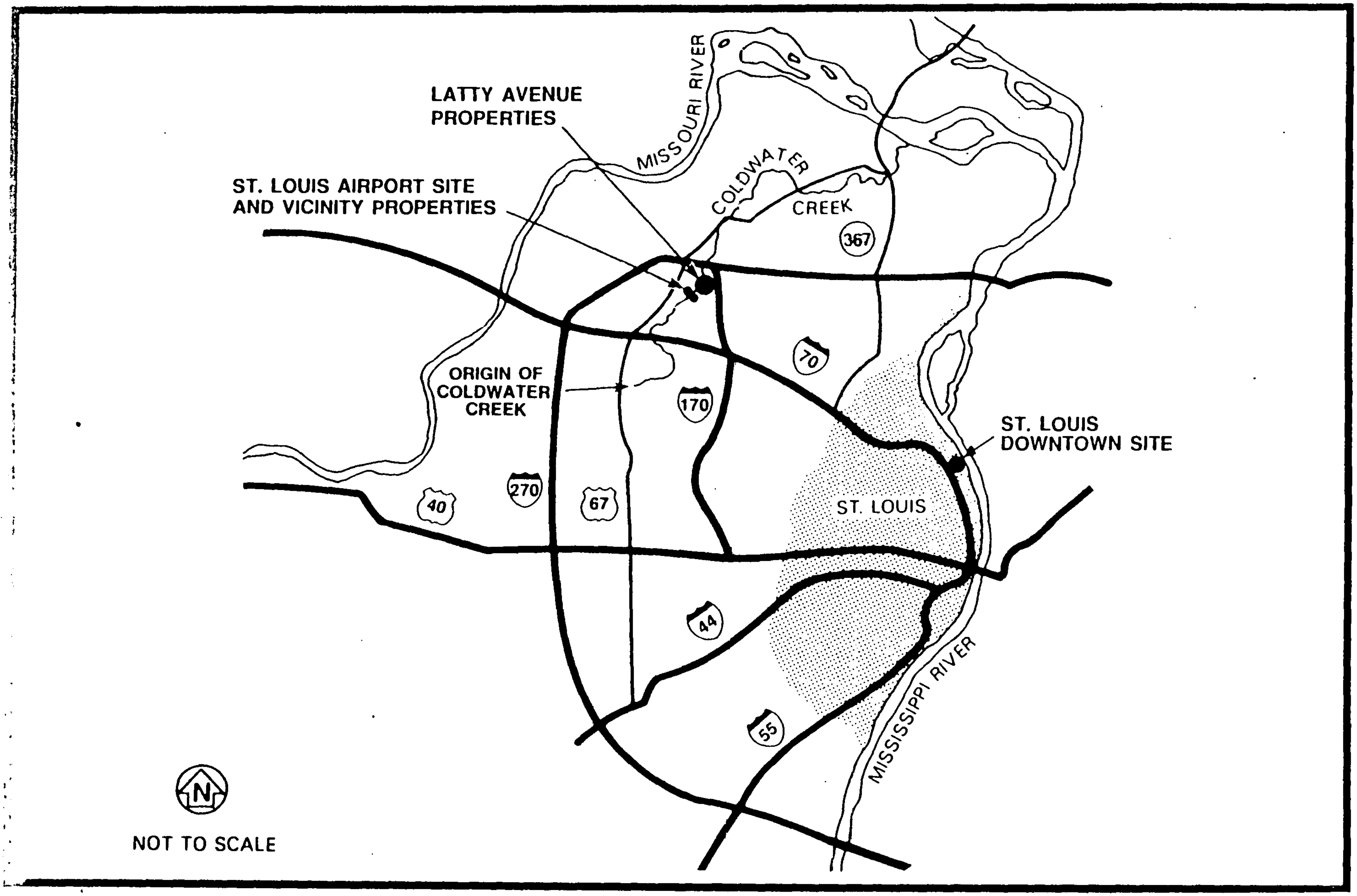

FIGURE 1-1 LOCATIONS OF FUSRAP PROPERTIES IN THE ST. LOUIS, MISSOURI, AREA

The objective of these characterization activities is to define the horizontal and vertical boundaries of radioactive contamination exceeding DOE guidelines. The data collected from the radiological surveys discussed in this report will be incorporated into the remedial investigation and feasibility study reports for the St. Louis sites.

1.2 LOCATION AND DESCRIPTION

SLAPS is an 8.8-ha (21.7-acre) tract located in St. Louis County, Missouri, approximately 24 km (15 mi) from downtown St. Louis and immediately north of the Lambert-St. Louis International Airport. SLAPS is bounded by the Norfolk and Western Railroad and Banshee Road on the south, Coldwater Creek on the west, and McDonnell Boulevard and adjacent recreational fields on the north and east. Figure 1-2 shows the location of SLAPS and the Latty Avenue properties. The Latty Avenue properties [Hazelwood Interim Storage Site (HISS) on the eastern half and the Futura Coatings property on the western half] are located at 9200 Latty Avenue. These properties cover a 4.5-ha (11-acre) tract located in the city limits of Hazelwood and are approximately 3.2 km (2 mi) northeast of the control tower of the Lambert-St. Louis International Airport.

Each Latty Avenue vicinity property characterized as part of the radiological survey was assigned a numerical identifier that corresponds to a St. Louis County tax map locator number. Table 1-1 references the assigned identifier to its respective tax map locator number. The Latty Avenue vicinity properties lie within the cities of Hazelwood and Berkeley and are shown in Figure 1-3.

The haul roads, believed to have been used during waste transfer among the St. Louis properties, include Latty Avenue, McDonnell Boulevard, Hazelwood Avenue, Pershall Road, Eva Avenue, and Frost Avenue. Characterization results from the right-of-way of these roads are reported with those of the appropriate associated vicinity properties. These routes traverse Hazelwood, Berkeley, and St. Louis and are located near HISS and SLAPS as shown in Figure 1-4.

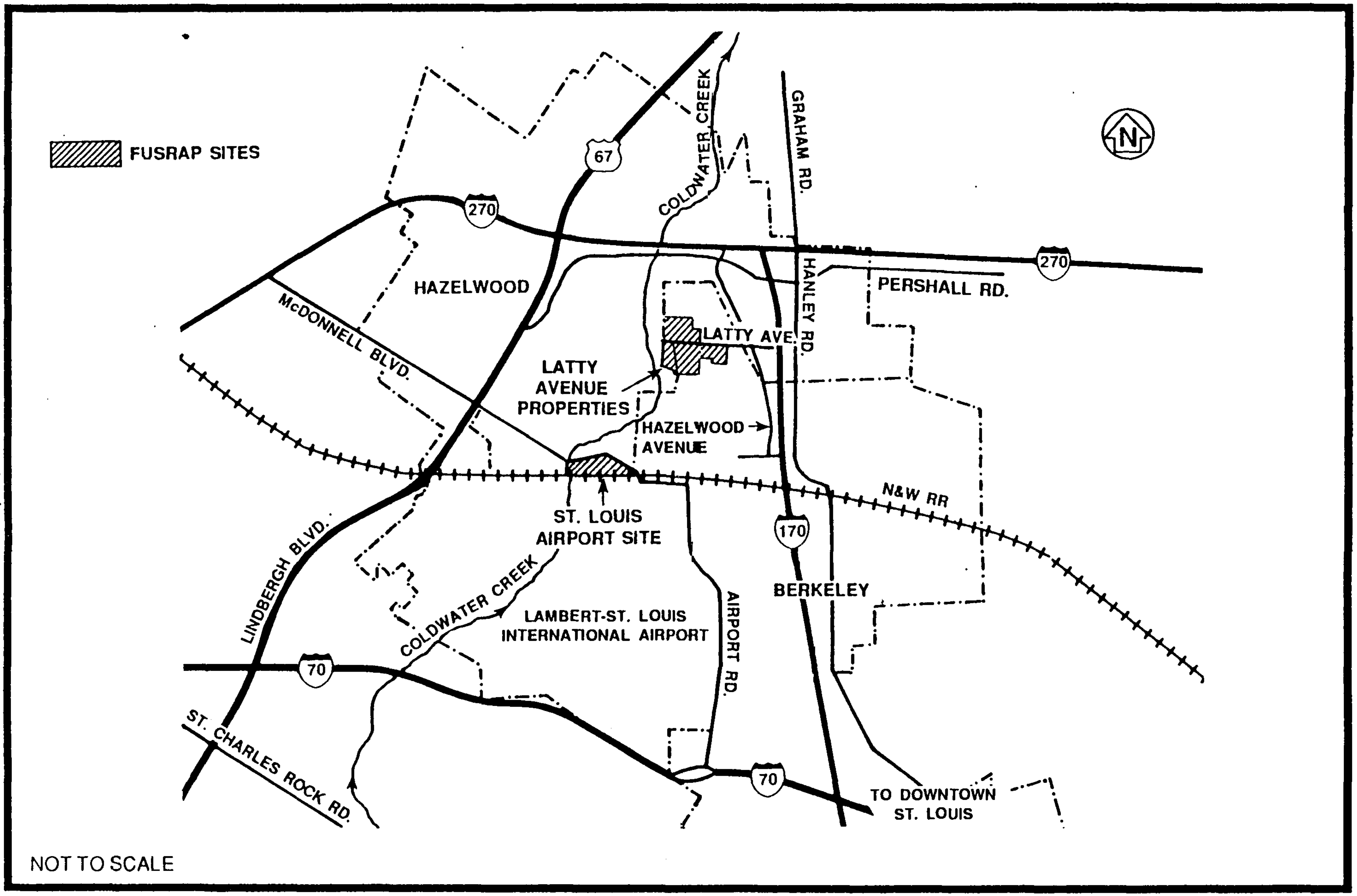

FIGURE 1-2 LOCATIONS OF THE LATTY AVENUE PROPERTIES AND SLAPS

TABLE 1-1

TAX MAP REFERENCE LIST FOR

LATTY AVENUE VICINITY PROPERTIES

Reference Number	Tax Map Locator Number
Property 1	10K530098
Property 2	10K510012
Property 3	10K520022
Property 4	10K520044
Property 5	10K520033
Property 6	10K510067

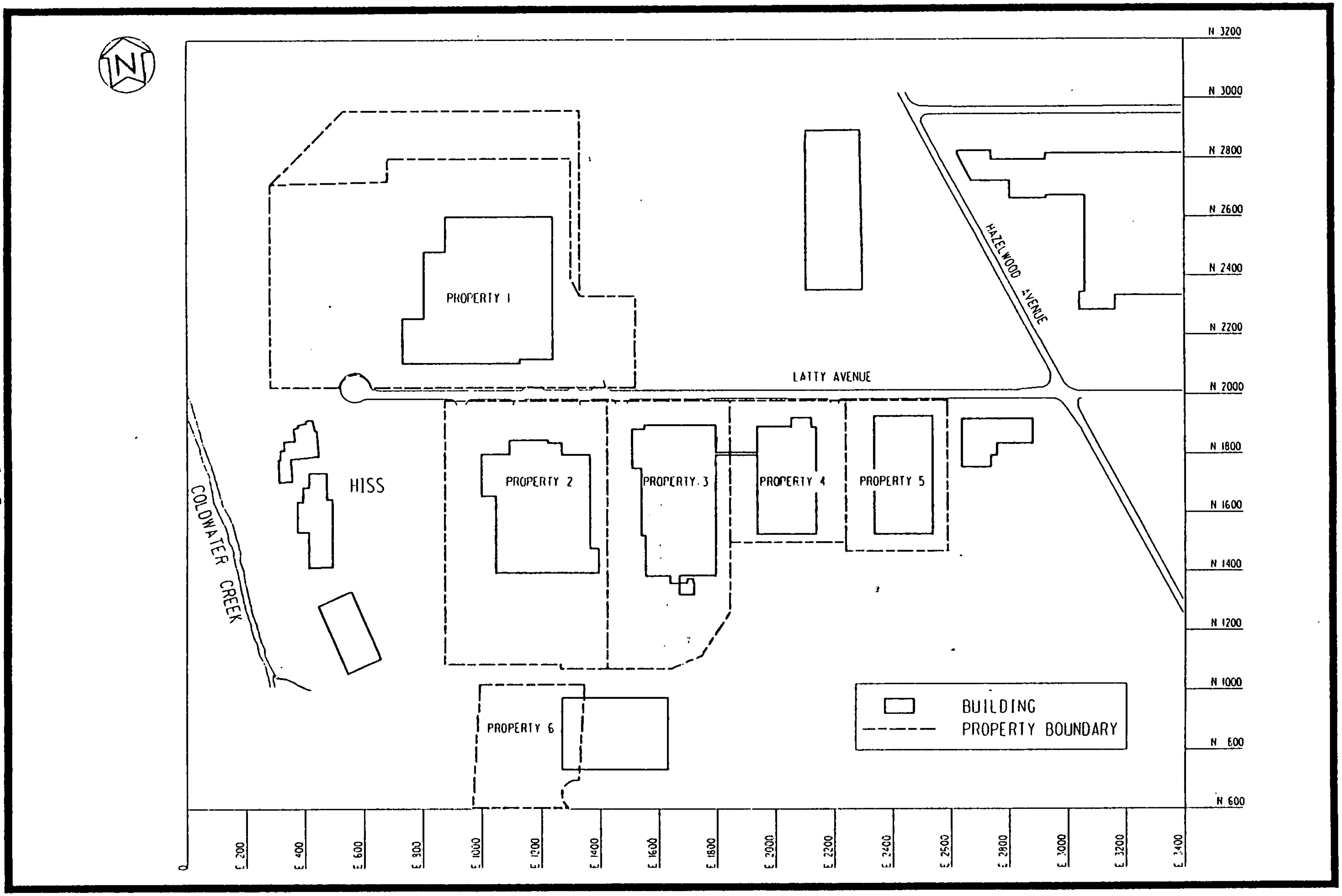

FIGURE 1-3 LOCATIONS OF THE LATTY AVENUE VICINITY PROPERTIES

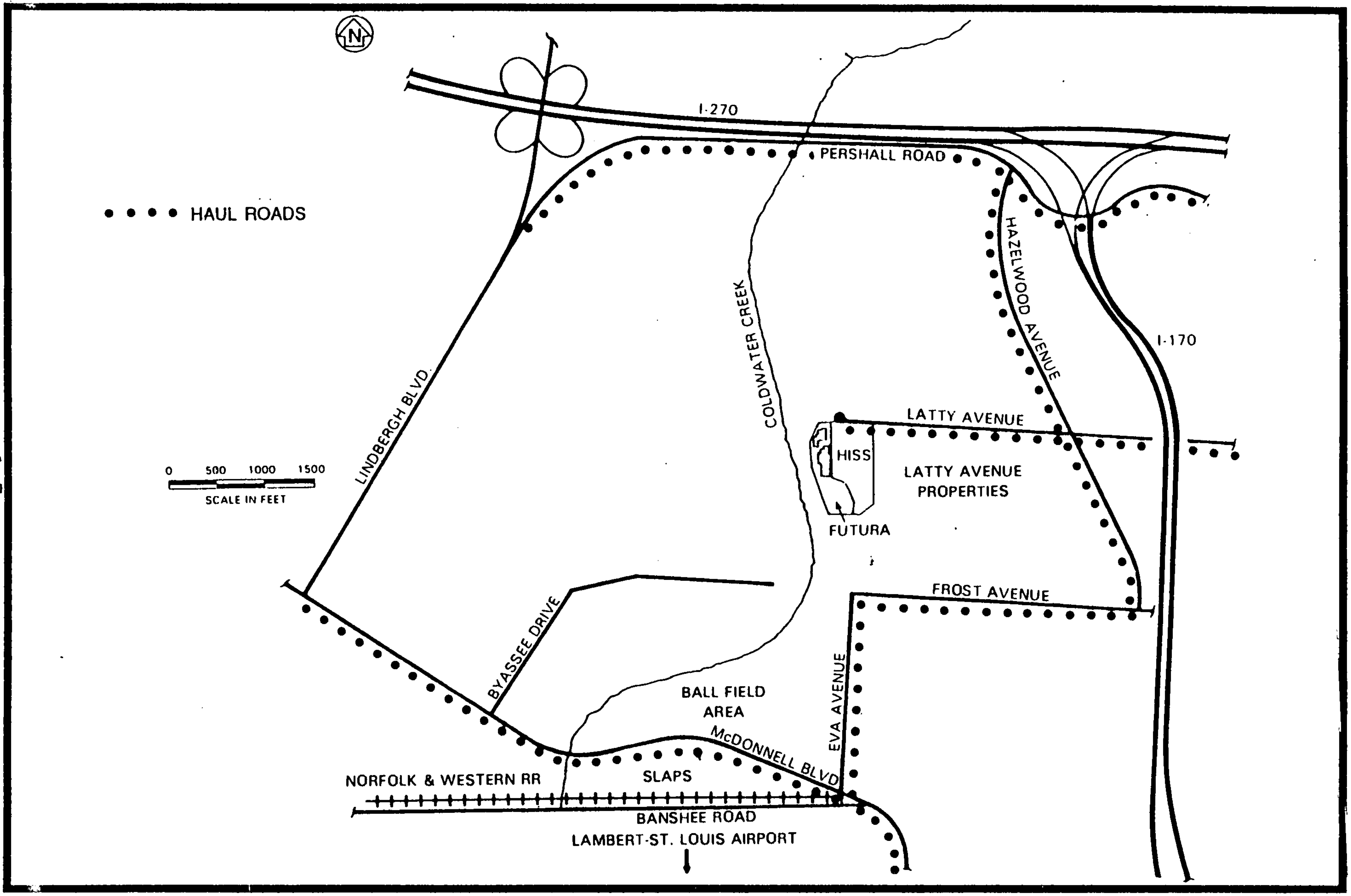

FIGURE 1-4 LOCATIONS OF THE HAUL ROADS SURVEYED BY BNI FOR DOE

In addition to these haul roads, several adjacent properties were included as part of the radiological characterization (see Figure 1-5). Each haul road vicinity property characterized as part of the radiological survey was assigned a numerical identifier that corresponds to a St. Louis County tax map locator number. Table 1-2 references the assigned identifier to its respective tax map locator number.

SLAPS was acquired by the Atomic Energy Commission (AEC) in 1947. From that time until approximately 1966, the site was used to store waste materials from the uranium feed materials plant at the St. Louis Downtown Site (SLDS). Radioactive contamination of the SLAPS vicinity properties may be the result of movement of contaminated soils from SLAPS via surface runoff or transfer by vehicles. In 1973, ownership of SLAPS was transferred by quitclaim deed from AEC to the City of St. Louis. The 1985 Energy and Water Development Appropriations Act (Public Law 98-360) authorized DOE to reacquire the property from the city for use as a permanent disposal site. Actionc to transfer ownership of the property to DOE have been initiated.

The SLAPS vicinity properties include Banshee Road, the area south of Banshee Road owned by the St. Louis Airport Authority, the recreational areas to the north of SLAPS known as the ball field area, and the ditches to the north and south of SLAPS. Figure 1-6 shows the locations of the SLAPS vicinity properties.

Coldwater Creek, a tributary of the Missouri River, has an overall length of 30.6 km (19 mi). The creek, which originates about 5.8 km (3.6 mi) south of SLAPS at a small spring-fed lake, flows for a distance of 152 m (500 ft) along the west side of SLAPS and discharges into the Missouri River about 22.5 km (14 mi) northeast of the site. Beneath the airport, Coldwater Creek flows in an underground drainage passage. The location of Coldwater Creek is shown in Figure 1-1.

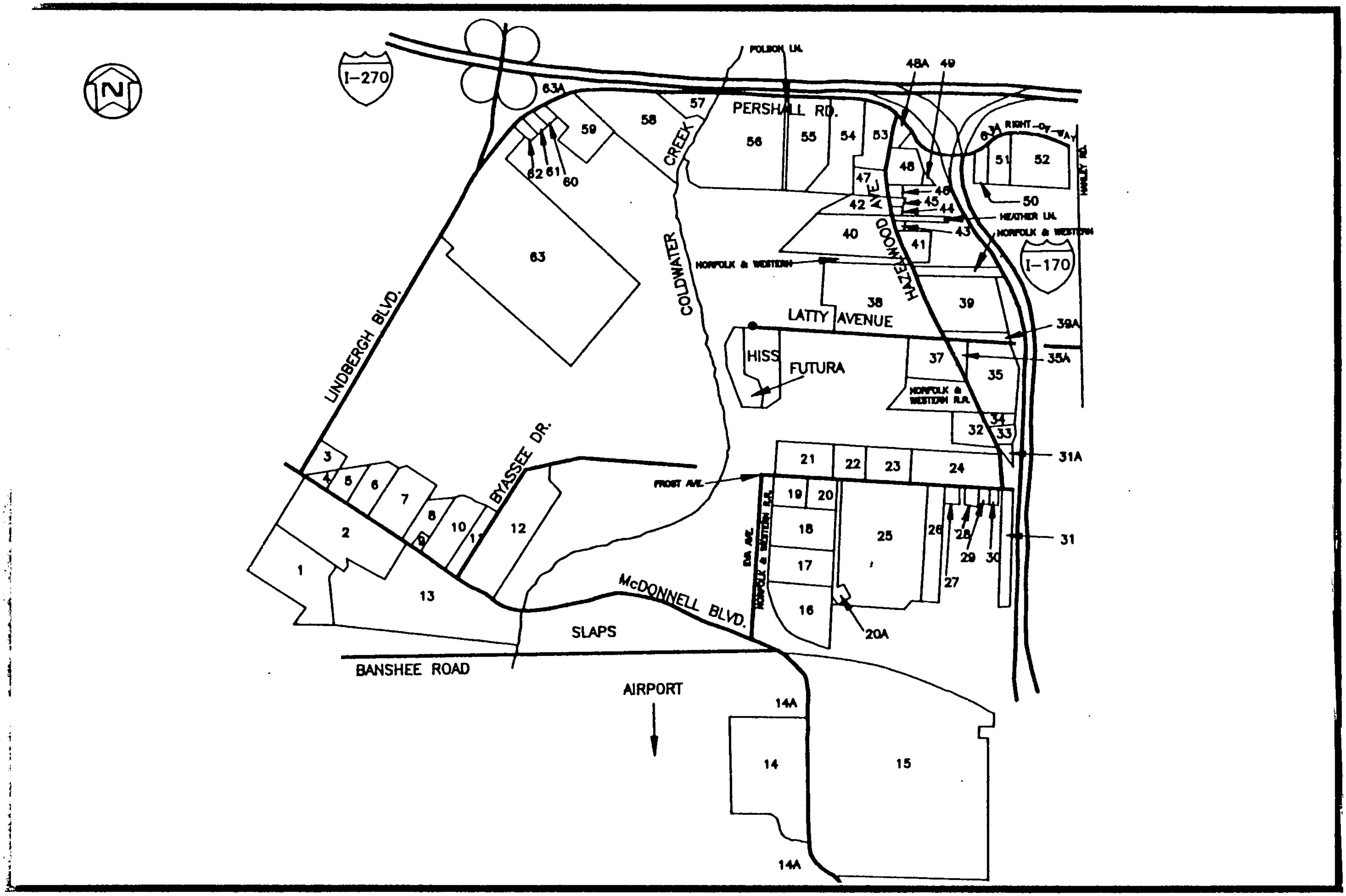

FIGURE 1-5 LOCATIONS OF THE HAUL ROADS VICINITY PROPERTIES

TABLE 1-2

TAX MAP REFERENCE LIST FOR
HAUL ROADS VICINITY PROPERTIES

Reference Number	Tax Map Locator Number
Property 1	10L220893
Property 2	10L240093
Property 3	10L520098
Property 4	10L240082
Property 5	10L330095
Property 6	10L330040
Property 7	10L330031
Property 8	10L330022
Property 9	10L330073
Property 10	10L340023
Property 11	10L340014
Property 12	10L340032
Property 13	10L310011
Property 14	11K510035
Property 14A	State of Missouri McDonnell Boulevard Right-of-Way
Property 15	11K520050
Property 16	10K210064
Property 17	10K210053
Property 18	10K230051
Property 19	10K230031
Property 20	10K230040
Property 20A	10K210031
Property 21	10K230073
Property 22	10K240106
Property 23	10K240094
Property 24	10K330140
Property 25	10K220151
Property 26	10K220140
Property 27	10K330030
Property 28	10K330063
Property 29	10K330074
Property 30	10K330085
Property 31	10K310111
Property 31A	10K330131
Property 32	10K330173
Property 33	10K330113
Property 34	10K330122
Property 35	10K610080

TABLE 1-2

(continued)

Reference Number	Tax Map Locator Number
Property 37	10K520066
Property 38	10K540097
Property 39	10K630303
Property 40	09K220140
Property 41	10K540031
Property 42	09K220041
Property 43	10K540075
Property 44	09K220030
Property 45	09K220052
Property 46	09K220074
Property 47	09K220085
Property 48	09K220184
Property 48A	09K220173
Property 49	09K310153
Property 50	09K310164
Property 51	09K310175
Property 52	09K322187
Property 53	09K220162
Property 54	09K220106
Property 55	09K210053
Property 56	09K210064
Property 57	09K140026
Property 58	09K140015
Property 59	09K110304
Property 60	09K130027
Property 61	09K130016
Property 62	09K130038
Property 63	10K430020
Property 63A	State of Missouri Pershall Road Right-of-Way

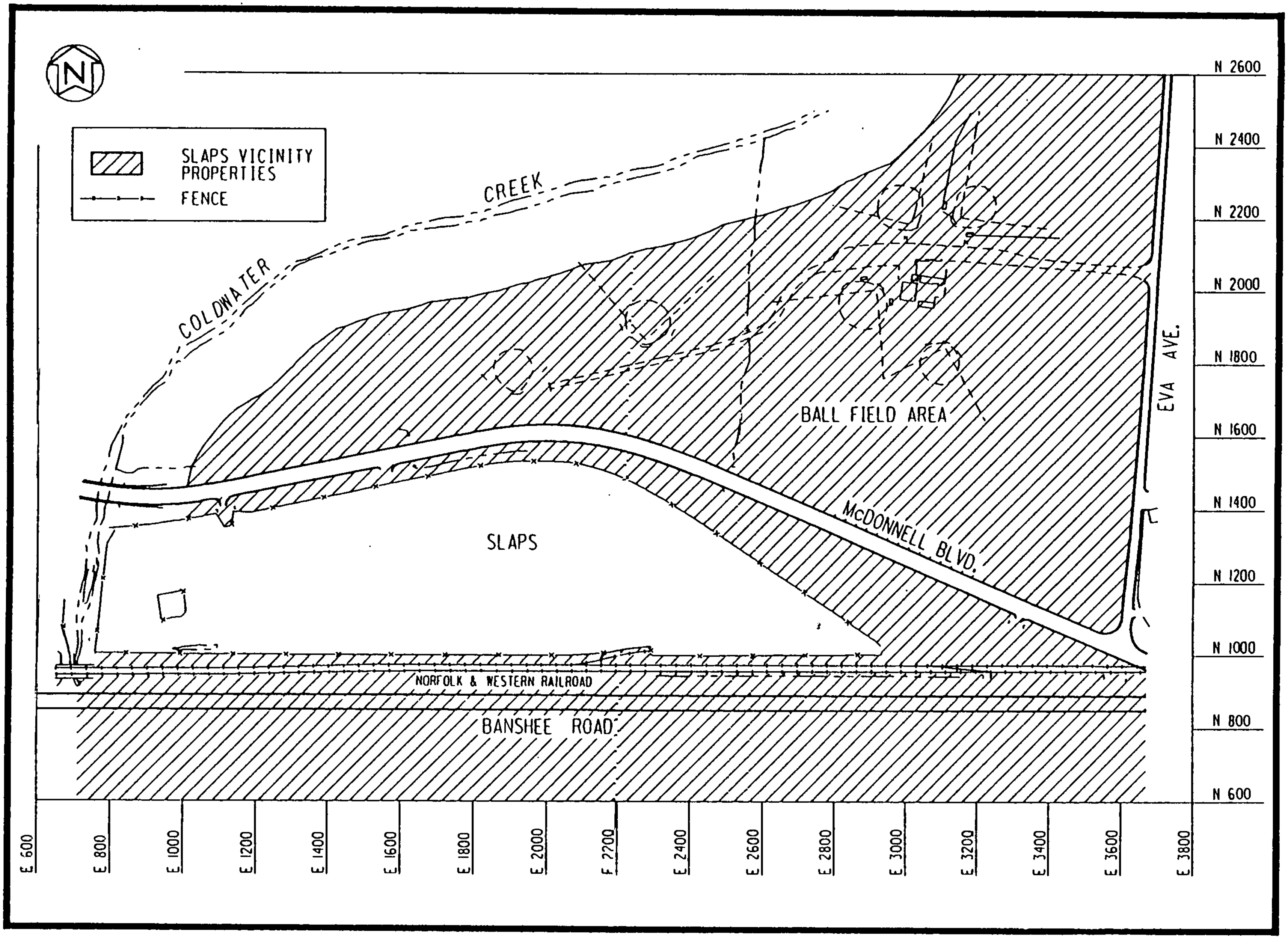

FIGURE 1-6 LOCATIONS OF THE SLAPS VICINITY PROPERTIES

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TABLE 1-3

TAX MAP REFERENCE LIST FOR

COLDWATER CREEK VICINITY PROPERTIES

Reference Number	Tax Map Locator Number
Property 1	09K120095
Property 2	09K120149
Property 3	09K120040
Property 4	09K120127
Property 5	09K120116
Property 6	10K440030
Property 7	10K440096
Property 8	10K440074
Property 9	10K420010
Property 10	10K140024

Each vicinity property associated with Coldwater Creek was assigned a numerical identifier that corresponds to a St. Louis County tax map locator number. Table 1-3 references the assigned identifier to its respective tax map locator number. Figure 1-7 shows the vicinity properties associated with Coldwater Creek.

1.3 HISTORY AND PREVIOUS RADIOLOGICAL SURVEYS

In 1966, ore residues and uranium- and radium-bearing process wastes stored at SLAPS were purchased by the Continental Mining and Milling Company of Chicago, Illinois, and placed in storage at 9200 Latty Avenue. These wastes were generated by a St. Louis plant (currently owned by Mallinckrodt, Inc.) between 1942 and the late 1950s under contracts with AEC and its predecessor, the Manhattan Engineer District (MED). Some of the residues were dried in two buildings on site before being shipped to a Colorado mill. The rest were removed from 9200 Latty Avenue (currently HISS) in 1973, to terminate a Nuclear Regulatory Commission (NRC) license for storage, and the property was later sold to the current owner. At this time, barium sulfate residues were reportedly diluted with site soil and transported to West Lake Landfill in St. Louis County.

The residues stored at 9200 Latty Avenue were deposited directly on the ground. When the last residues were removed from the ground surface, a reported 30- to 46-cm (12- to 18-in.) layer of topsoil also was removed before the property was sold. It appears that parts of the property are contaminated in excess of current guidelines as a result of mechanical earth-moving activities and water percolation (Refs. 1-1 and 1-2). The primary contaminant is thorium-230. Much of the uranium and radium in the ore had been removed during earlier processing. It is possible that McDonnell Boulevard was the haul road used for the transport of barium sulfate residues. Pershall Road and Hazelwood Avenue also were possible haul roads during the transport of residues among the St. Louis sites. The soils along the shoulders of Latty Avenue also were surveyed and found to be contaminated, possibly as a result of residues spilling from the transport trucks.

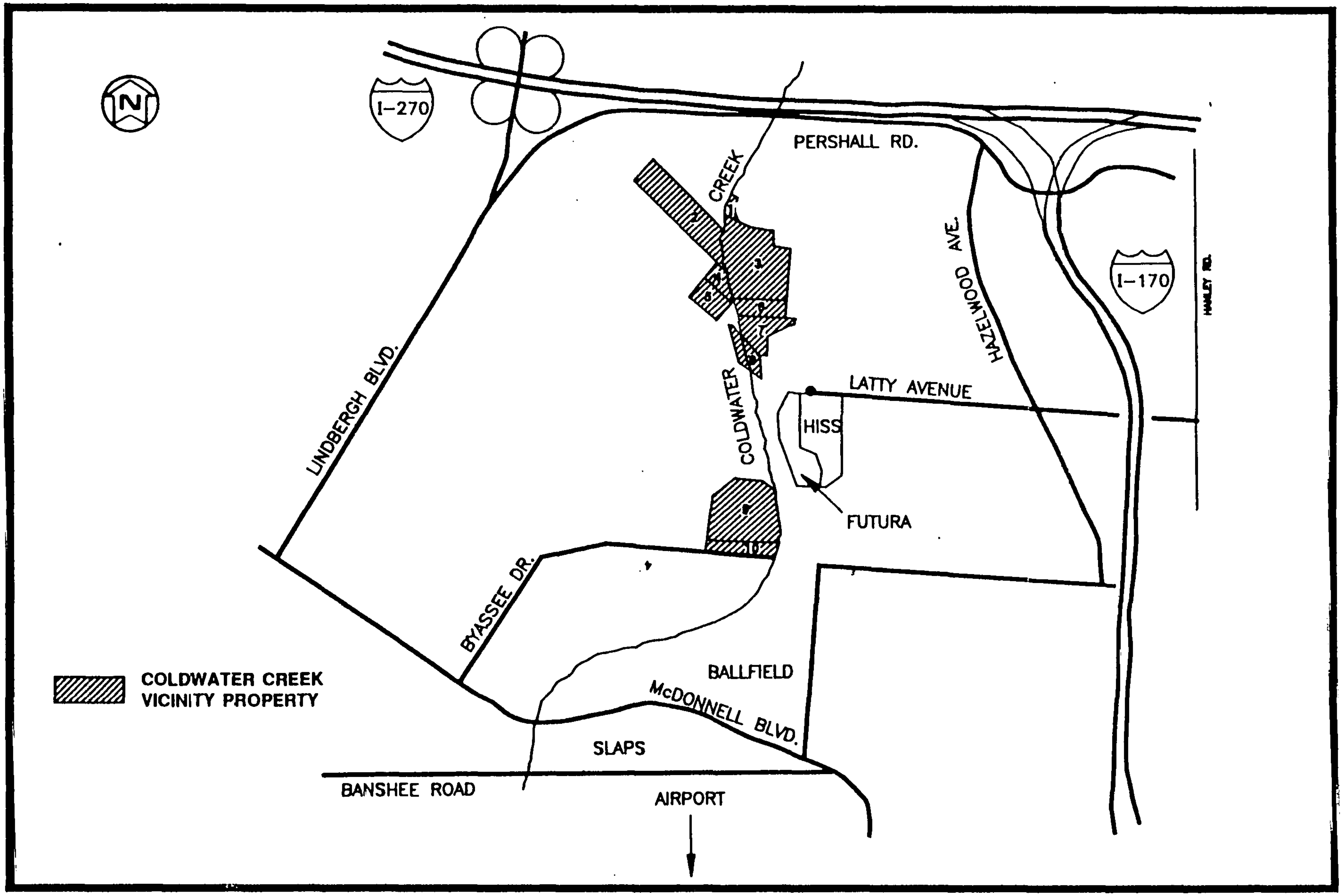

FIGURE 1-7 LOCATIONS OF THE COLDWATER CREEK VICINITY PROPERTIES

1.3.1 Latty Avenue Vicinity Properties

In 1981, Oak Ridge Associated Universities (ORAU) performed a radiological survey of the northern and eastern boundaries of HISS for NRC (Refs. 1-3 and 1-4). Levels of contamination, principally thorium-230, similar to those levels on the site were found in both areas.

In September 1983, DOE directed Oak Ridge National Laboratory (ORNL) to perform a preliminary survey of properties adjacent to and in the vicinity of HISS at 9200 Latty Avenue to determine if radioactive contamination in excess of guidelines was present. The potentially contaminated areas identified during that preliminary evaluation were then more thoroughly surveyed by ORNL during January and February 1984. Results of the survey established that radioactive contamination was present over most of the HISS vicinity properties, extending north and south in some areas onto adjacent private properties along Latty Avenue (Refs. 1-5 and 1-6). ORNL discovered that redistribution of the contamination had occurred, probably as a result of flooding, surface runoff, and road and utility line activities. The major contaminant found was thorium-230; radium-226 and uranium-238 were present in lesser amounts.

Based on the ORNL characterization, DOE directed BNI to perform remedial action in 1984 on the contaminated areas within the temporary slope and construction line (TSCL) along Latty Avenue (Ref. 1-7). The TSCL included all areas that could have been disturbed during a drainage improvement project being carried out by the cities of Hazelwood and Berkeley. During the remedial action, contamination exceeding guidelines was found to extend beyond the TSCL.

In 1986, DOE directed BNI to provide radiological support to the cities during their road improvement project. During this coverage, radium-226 and thorium-230 contamination in excess of DOE remedial action guidelines was found at depths ranging from 0.6 to 2.4 m (2 to 8 ft) along and under Latty Avenue. Based on gamma count rates, materials contaminated in excess of remedial action guidelines were removed and placed in storage at HISS. Approximately 4,206 m^3 (4,600 yd^3) of material was placed in a storage pile developed specifically to accommodate these materials and covered with a low-permeability membrane. In addition to gamma scanning the soil that was not placed in storage at HISS, gross alpha counting was used as a screening technique. Using gross alpha counting, soil samples were scanned for alpha-emitting radionuclides, such as thorium-230, in excess of DOE remedial action guidelines. Soils that did not exhibit contamination in excess of DOE remedial action guidelines were used as fill material on the railroad property located between the Futura Coatings site and Coldwater Creek and along the entire length of Latty Avenue.

Radiological characterization of the Latty Avenue vicinity properties was necessary to define the locations and boundaries of the contamination identified in the ORNL survey and to evaluate disposal alternatives.

1.3.2 Coldwater Creek and Vicinity Properties

In 1982, DOE directed BNI to perform a radiological characterization of the ditches to the north of SLAPS and portions of Coldwater Creek (Ref. 1-8). Results of this survey indicated that gamma-emitting contamination exceeding remedial action guidelines was present. This survey did not include measuring thorium-230 concentrations in soils. Subsequent analysis of additional radionuclides showed the presence of thorium-230 in above-guideline concentrations; therefore, all later field work conducted in the St. Louis area involved analyzing for thorium-230. Characterization efforts continued in 1986 at the SLAPS ditches and involved analyzing archived soil samples from the 1982 survey for thorium-230. The results of these analyses indicated the need to collect soil samples beyond the area surveyed in 1982 (on the ball field) to adequately determine the extent of contamination. Results for the ball field characterization are reported in Section 7.0 of this report.

Additionally, sediment samples were collected in 1986 from the sides and center of Coldwater Creek beginning at SLAPS and continuing downstream to HISS. The data from these samples indicated spotty contamination along the entire distance.

1.3.3 Norfolk and Western Railroad Properties and SLAPS Vicinity Properties

A radiological and limited chemical characterization was conducted at SLAPS in 1986 by BNI. Results of this survey showed contamination present on SLAPS extending to depths as great as 5.5 m (18 ft) (Ref 1-9). The Norfolk and Western Railroad property forms the southern boundary of SLAPS. The radiological characterization of the SLAPS vicinity properties, Banshee Road, and the railroad property was necessary to define the magnitude and boundaries of the contamination and evaluate disposal alternatives. No formal radiological characterization had been performed on these properties until that of 1986-1989.

1.3.4 Haul Roads

In 1985, DOE directed ORNL to perform a radiological survey of the roads thought to have been used to transport contaminated material to and from SLAPS and HISS (Ref. 1-10). Results of the ORNL gamma radiation walkover scan of the roadsides showed areas where gamma exposure rates are in excess of background radiation levels. Gamma exposure rates up to 90 $\mu R/h$ were found on the surface of McDonnell Boulevard. Soil sample analysis results from the 1985 survey showed thorium-230 to be the major contaminant. As a result of this survey, parts of Hazelwood Avenue, Pershall Road, and McDonnell Boulevard were designated for remedial action in 1986.

REFERENCES FOR SECTION 1.0

1-1 Bechtel National, Inc. Characterization Report for the Hazelwood Interim Storage Site, Hazelwood, Missouri, DOE/OR/20722-141, Oak Ridge, Tenn., June 1987.

1-2 Bechtel National, Inc. Radiological Characterization Report for the Futura Coatings Site, Hazelwood, Missouri, DOE/OR/20722-158, Oak Ridge, Tenn., July 1987.

1-3 Oak Ridge Associated Universities. Preliminary Radiological Survey of Proposed Street Right-of-Way at Futura Coatings, Inc., 9200 Latty Avenue, Hazelwood, Missouri, Oak Ridge, Tenn., December 1981.

1-4 Oak Ridge Associated Universities. Concentrations of Radionuclides in Soil Samples from Property at 9150 Latty Avenue, Hazelwood, Missouri, Oak Ridge, Tenn., April 28, 1982.

1-5 Oak Ridge National Laboratory. Radiological Survey of Latty Avenue in the Vicinity of the Former Cotter Site, Hazelwood/Berkeley, Missouri (LM001), ORNL/TM-10006, Oak Ridge, Tenn., May 1987.

1-6 Oak Ridge National Laboratory. Radiological Survey of Properties in the Vicinity of the Former Cotter Site, Hazelwood/Berkeley, Missouri (LM003), ORNL/TM-10008, Oak Ridge, Tenn., May 1987.

1-7 Bechtel National, Inc. Post-Remedial Action Report for the Hazelwood Site - 1984, DOE/OR/20722-76, Oak Ridge, Tenn., September 1985.

1-8 Bechtel National, Inc. Radiological Survey of the Ditches at the St. Louis Airport Site (SLAPS), Oak Ridge, Tenn., August 1983.

1-9 Bechtel National, Inc. Radiological and Limited Chemical Characterization Report for the St. Louis Airport Site, St. Louis, Missouri, DOE/OR/20722-163, Oak Ridge, Tenn., August 1987.

1-10 Oak Ridge National Laboratory. Results of the Radiation Measurements Taken at Transportation Routes (LM004) in Hazelwood, Missouri, ORNL/RASA-86/31, Oak Ridge, Tenn., December 1986.

2.0 STUDY AREA INVESTIGATION

The radiological characterization surveys conducted at the FUSRAP properties in St. Louis consisted of the following steps: establishing a reproducible grid system, clearing the area to be surveyed as appropriate, performing gamma radiation walkover scans and near-surface gamma radiation measurements where applicable, and collecting and analyzing surface and subsurface soil samples. The types of radiological measurements taken and the methods used are described in Subsections 2.2 and 2.3.

2.1 GRID SYSTEM

A civil surveyor established a 15-m (50-ft) grid on the vicinity properties adjacent to Latty Avenue by marking the intersections of a series of perpendicular lines, as shown in Figure 2-1. [Figure 2-1 is marked at 61-m (200-ft) intervals because of the size of the drawing.] The grid origin used during the remedial action conducted in 1984 along the Latty Avenue right-of-way was reestablished.

A 15-m (50-ft) grid was also established over the haul roads and adjacent properties, extending approximately 46-m (150 ft) from the roadways (see Figure 2-2). [Figure 2-2 is marked at 305-m (1,000-ft) intervals because of the size of the drawing.] A 15-m (50-ft) grid was established over the SLAPS vicinity properties as shown in Figure 2-3. [Figure 2-3 is marked at 61-m (200-ft) intervals because of the size of the drawing.] The grid origin was the southwest corner of SLAPS. These grids were tied to the SLAPS grid system and to the Missouri state grid system with sufficient detail to allow for reestablishment at a later date. When characterization work was initially performed at 9200 Latty Avenue and SLAPS, each site was treated independently and a grid was established at each. At that time, it was not suspected that contamination would be as extensive as it is in the area and that the two sites would be essentially continuous. This accounts for having different grid systems for the two sites.

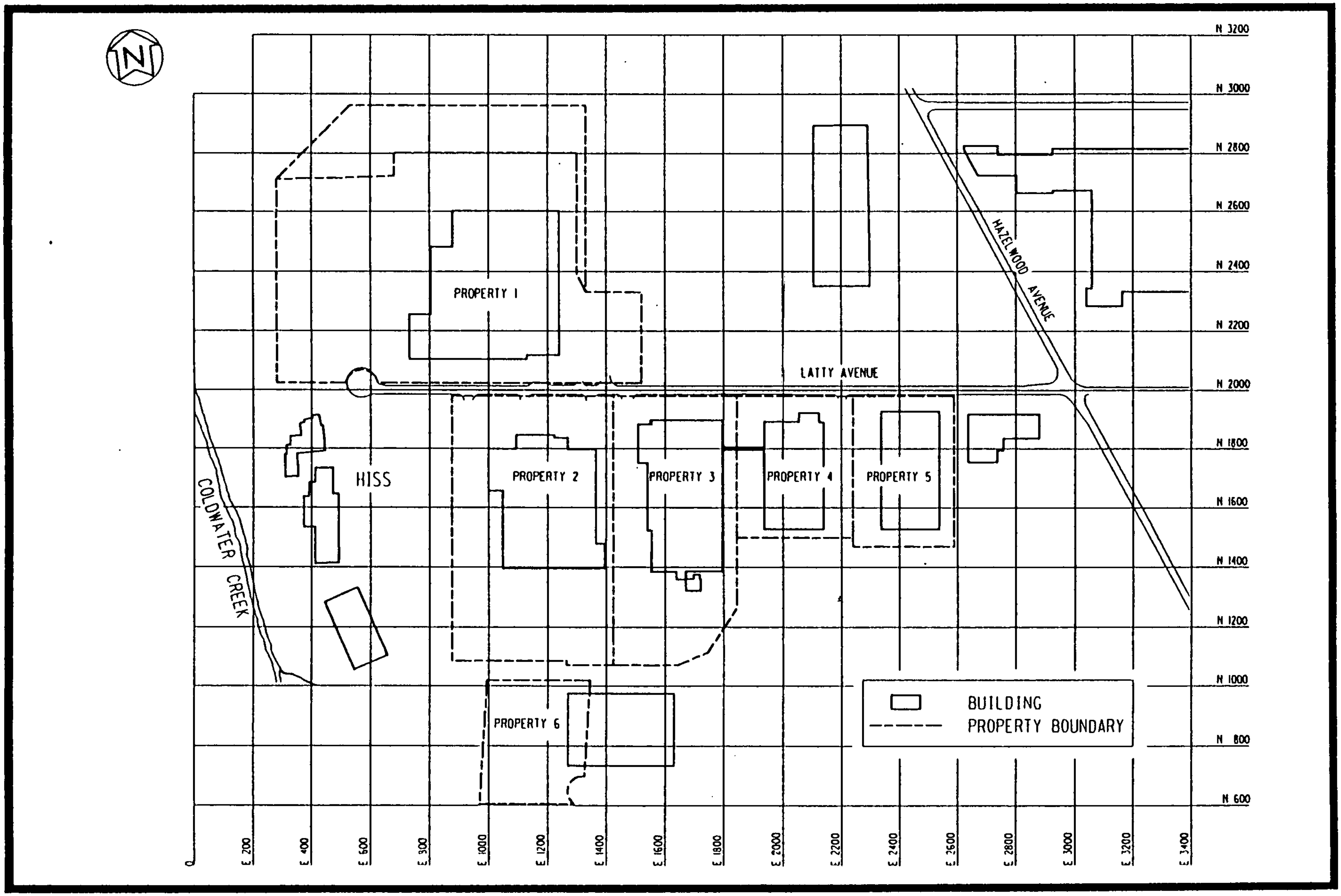

FIGURE 2-1 SURVEY GRID FOR THE VICINITY PROPERTIES ADJACENT TO LATTY AVENUE

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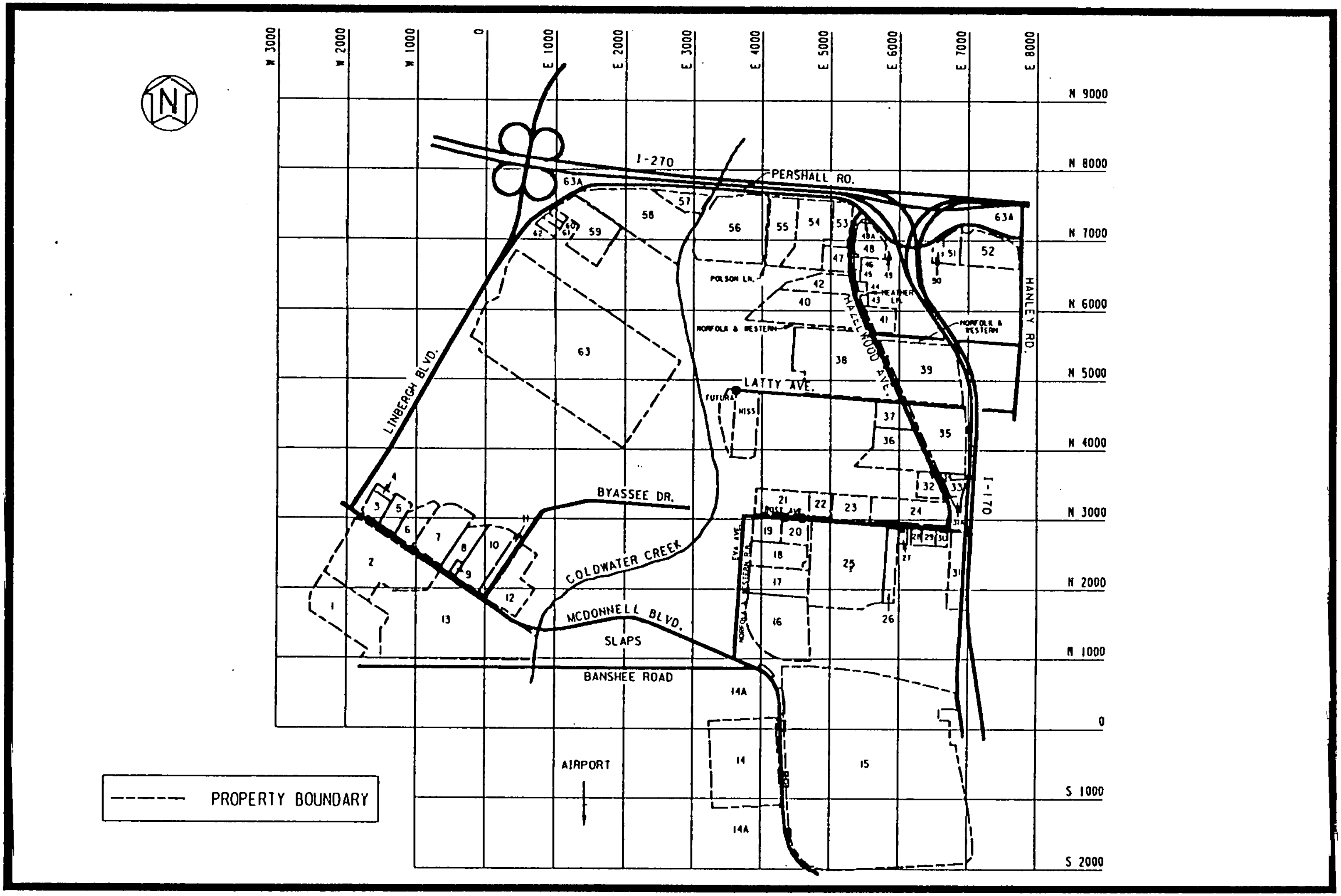

FIGURE 2-2 SURVEY GRID FOR THE HAUL ROADS AND ASSOCIATED VICINITY PROPERTIES

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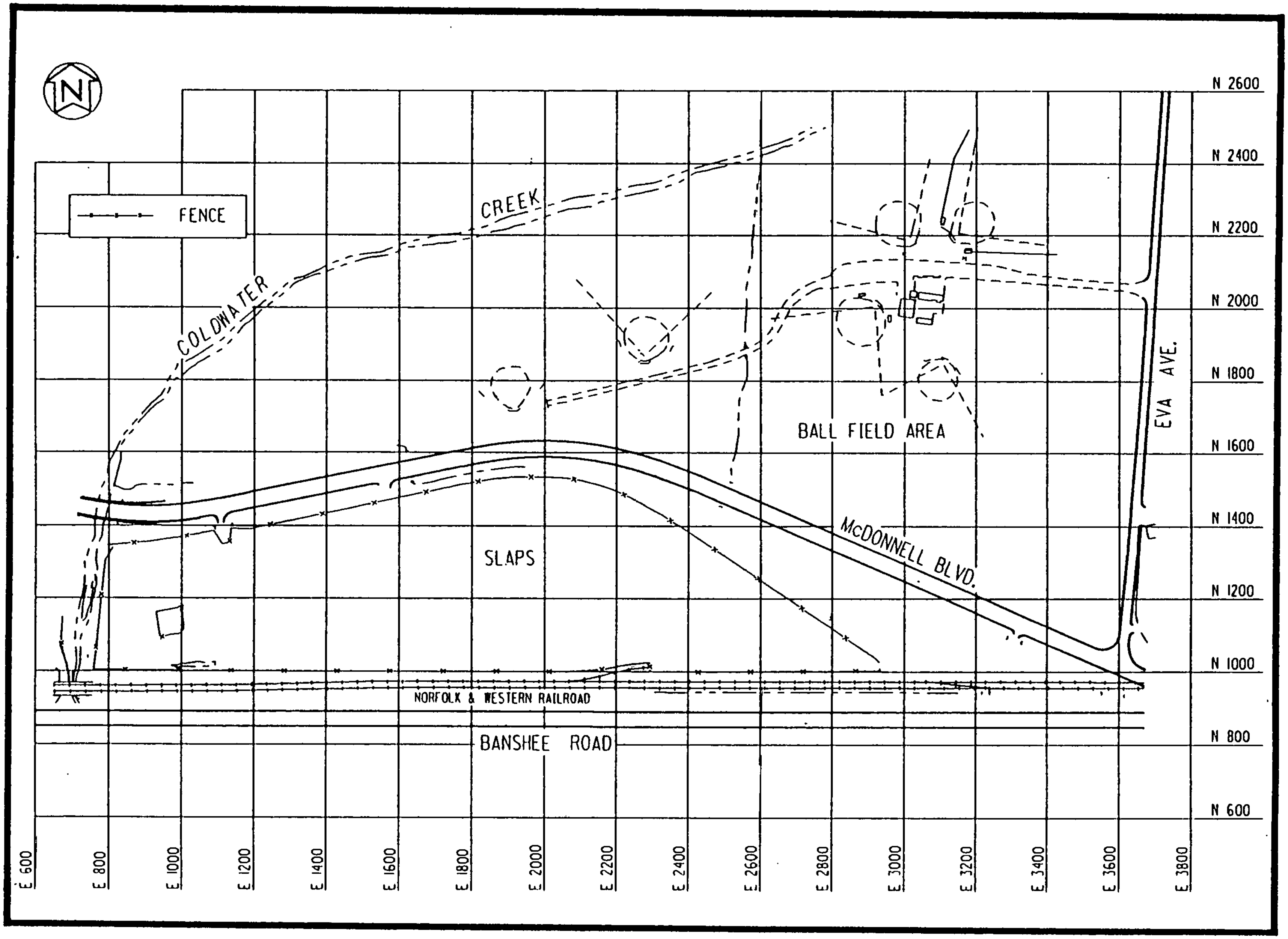

FIGURE 2-3 SURVEY GRID FOR THE SLAPS VICINITY PROPERTIES

S53W9817.DGN

Minimal clearing was done along Coldwater Creek so that a traverse line could be established with right angle offsets at 152-m (500-ft) intervals (Figure 2-4). The traverse line was referenced back to the SLAPS grid. Sampling locations were determined by measuring along the offset lines. All characterization data correspond to coordinates on the grids. All grids shown in the figures in this document are displayed in measurement units of feet.

2.2 RADIOLOGICAL SURVEYS

The characterization survey consisted of two major components: surface surveys and subsurface investigations. Surface surveys were performed first to provide information about the patterns of contamination and to assist in the identification of areas in which subsurface contamination could be present. The subsurface investigations were performed subsequently to establish the depths of contamination in areas that the surface surveys identified as being contaminated. An additional purpose of the subsurface investigations was to locate any subsurface contamination that lacked surface manifestation.

2.2.1 Methods

Two types of surface survey methods were used: walkover surveys and near-surface gamma radiation surveys. Initial gamma radiation walkover scans were performed within grid blocks on the vicinity properties adjacent to Latty Avenue and SLAPS using an unshielded gamma scintillation detector. A gamma radiation walkover scan was done on accessible areas of Coldwater Creek's banks and any associated properties. Areas in which readings exceeded twice the gamma radiation background level were marked on a site drawing. This type of survey covers virtually all the ground surface and has the advantage that it can be conducted quickly; however, the boundaries of the areas identified as being contaminated may not be precisely correct because of the effect of nearby contamination on detector readings.

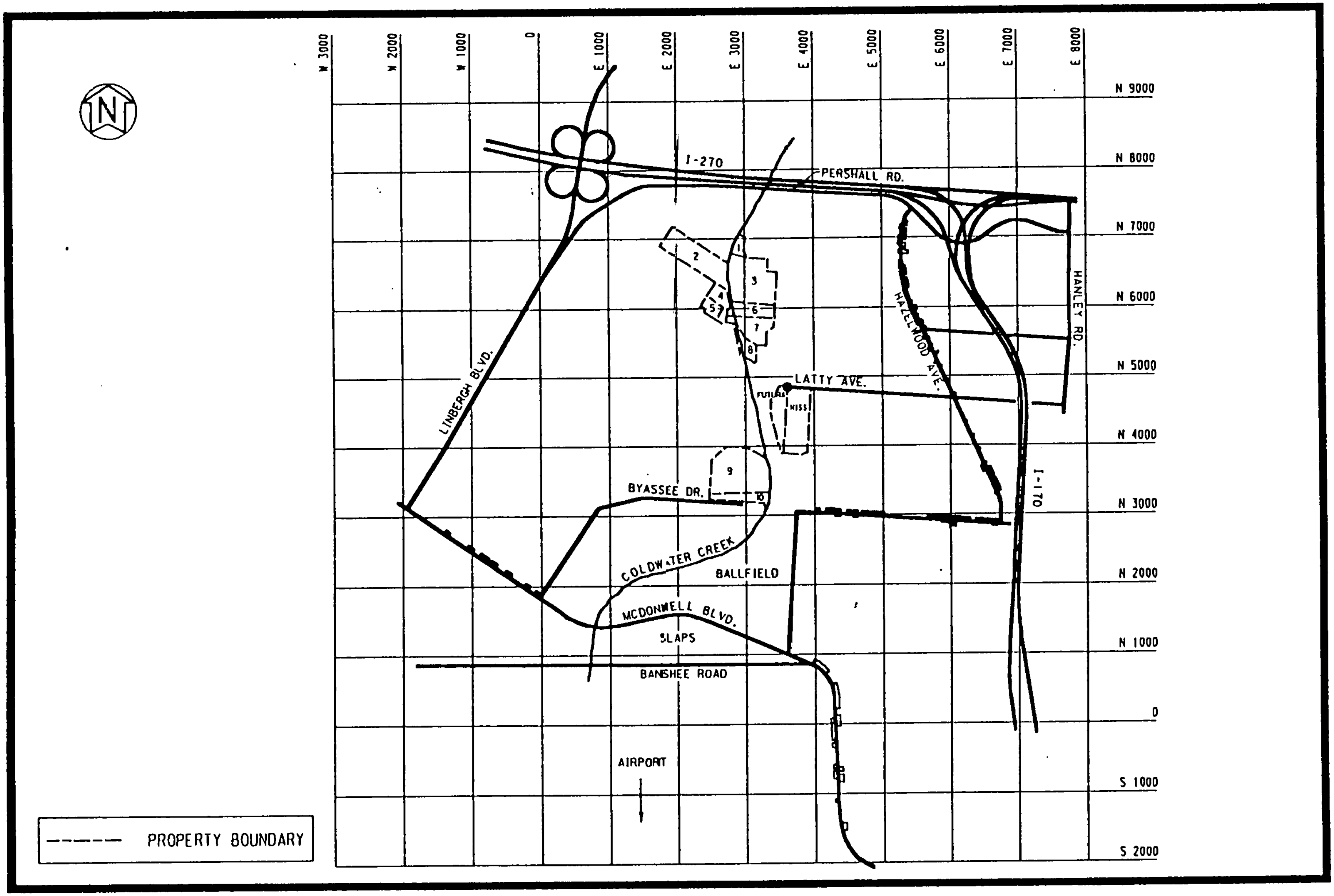

FIGURE 2-4 SURVEY GRID FOR COLDWATER CREEK

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Near-surface gamma radiation measurements were made 30 cm (12 in.) above the ground surface at 3.8-m (12.5-ft) intervals in the areas identified as contaminated on the basis of the gamma radiation walkover scan. This survey was performed to define more clearly the boundaries of contamination identified by the earlier walkover survey. The same kind of detector that was used during the walkover survey, a 5-cm by 5-cm (2-in. by 2-in.) sodium-iodide, thallium-activated [NaI(Tl)] detector, was used during this survey. The detector was mounted in a probe assembly surrounded with a conical lead shield to reduce the gamma intensity through the sides, thus producing a downward directional response. The detector was calibrated at the Technical Measurements Center (TMC) in Grand Junction, Colorado.

It should be pointed out that neither the walkover nor the near-surface gamma radiation survey is effective for detecting the presence of thorium-230. Thorium-230 is an alpha-emitting radionuclide that cannot be detected in situ.

Gamma exposure rates at 1 m (3 ft) above the ground were measured on the Norfolk and Western Railroad property adjacent to HISS and on the SLAPS vicinity properties to the north and south of SLAPS using a pressurized ionization chamber (PIC). The PIC has a response to gamma radiation that is proportional to exposure in roentgens. Readings were made at 37 selected grid points on the Norfolk and Western Railroad property adjacent to HISS (see Figure 2-5) and at 69 locations at SLAPS and vicinity properties (see Figure 2-6). This exposure rate information will be valuable for use in remedial action planning, environmental monitoring, and the preparation of documentation required by CERCLA/National Environmental Policy Act (NEPA) activities.

Subsurface investigations were conducted by drilling and/or hand-augering holes at most 30.5-m (100-ft) grid intersections. The depth to which each borehole was drilled was based on guidance from

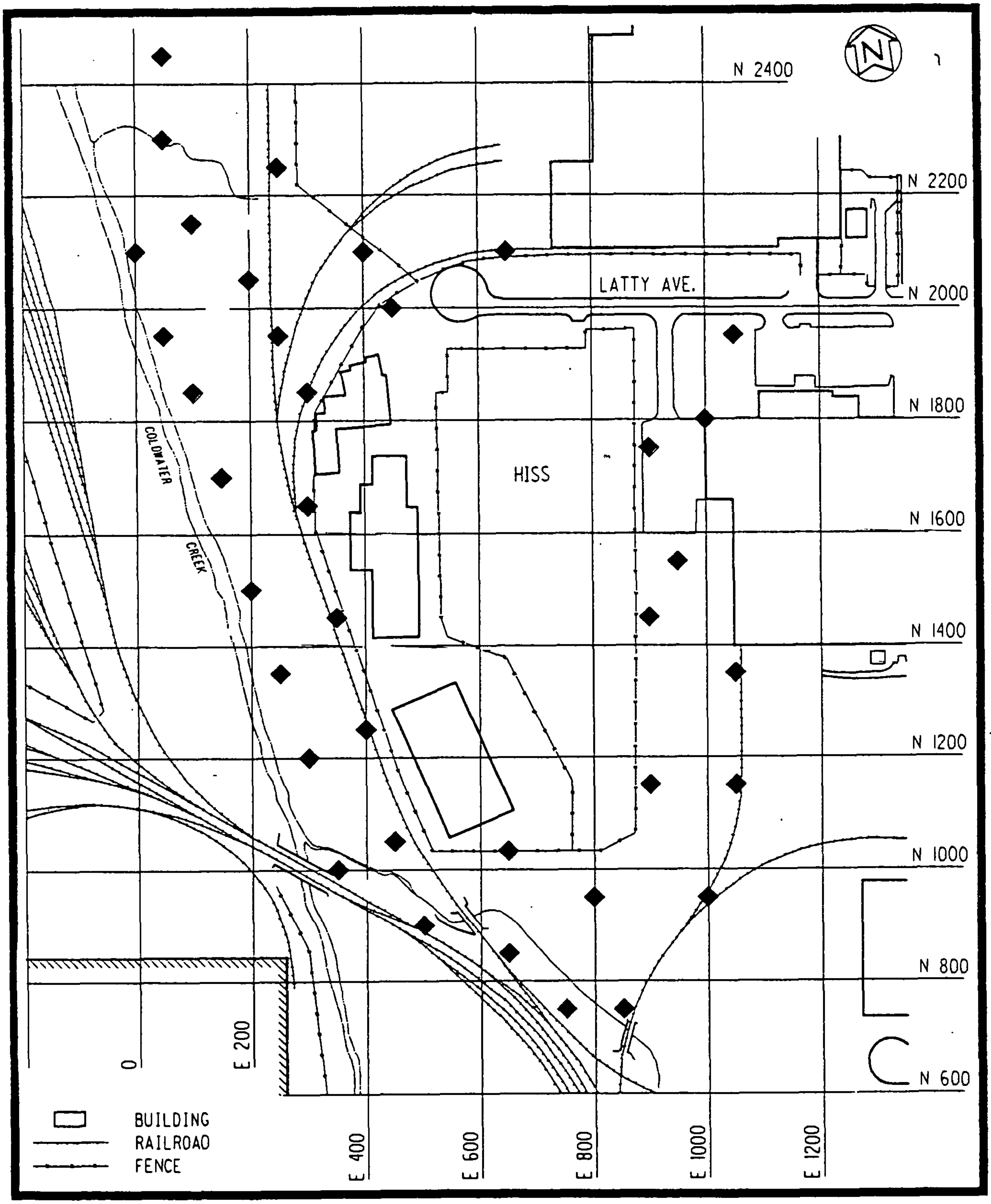

FIGURE 2-5 GAMMA EXPOSURE RATE MEASUREMENT LOCATIONS AT THE NORFOLK AND WESTERN RAILROAD PROPERTY ADJACENT TO HISS

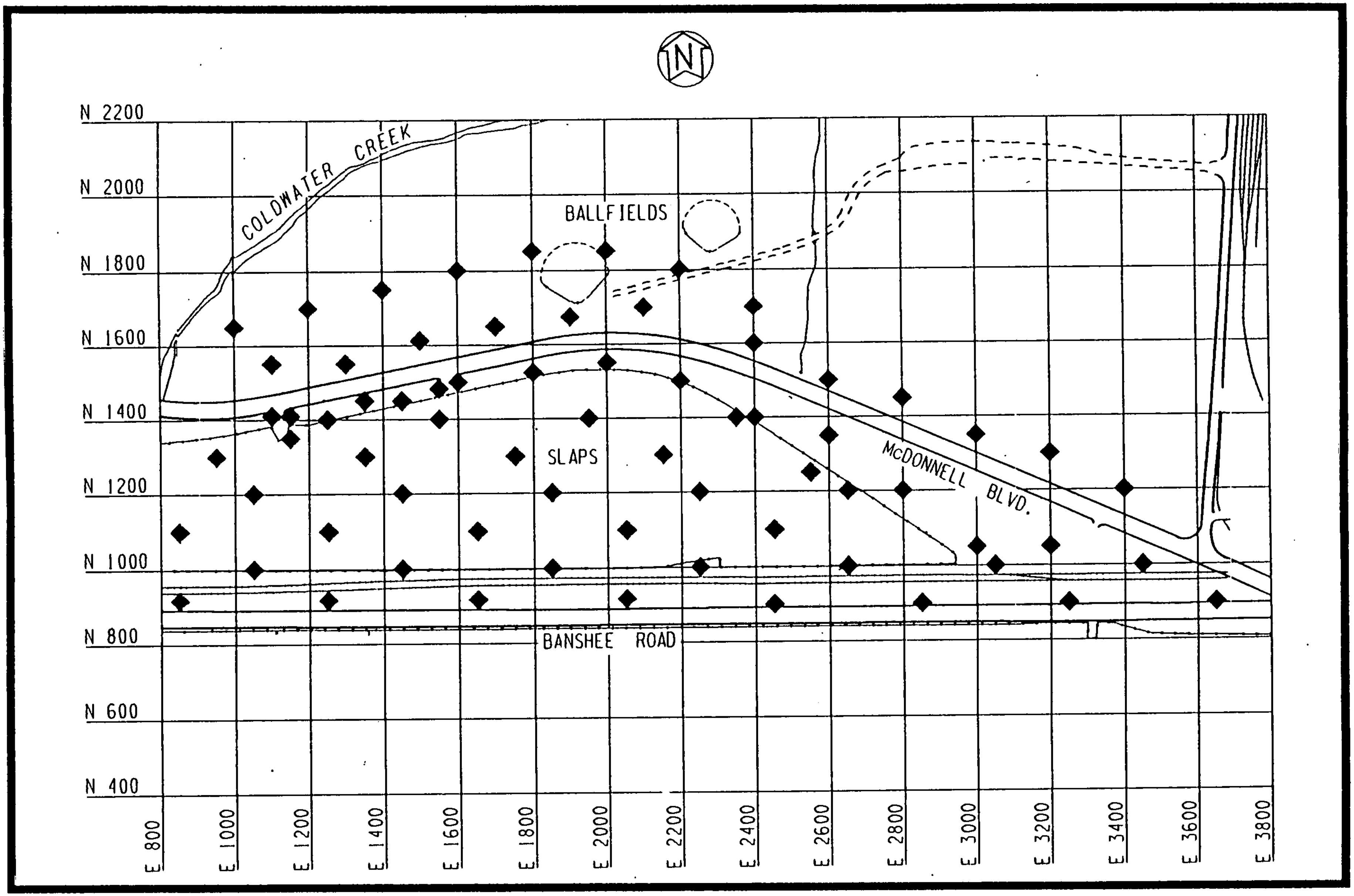

FIGURE 2-6 GAMMA EXPOSURE RATE MEASUREMENT LOCATIONS AT SLAPS AND VICINITY PROPERTIES

the geologist on site and the radiological support representative. The hand-augered holes were typically 1 to 1.3 m (3 to 4 ft) deep. Although gamma logging is typically used to determine the depth of subsurface contamination, thorium-230 (the principal contaminant) cannot be detected in situ; therefore, continuous soil samples were collected from the surface to the bottom of the hole by driving a split spoon sampler in advance of the auger. Deviations from this methodology required by field conditions are described in each section of this report.

Downhole gamma logging was performed in each characterization hole to indicate the general depth of contamination from gamma-emitting radionuclides. Gamma logging was accomplished by lowering an unshielded NaI(Tl) detector into the hole and recording the count rate as a function of depth. Downhole gamma logging data were used for the selection and analysis of soil samples to determine the concentrations of uranium, radium, and thorium.

2.2.2 Sample Collection and Analysis

Biased surface soil samples [0 to 15 cm (0 to 6 in.)] were collected based on results from the gamma radiation walkover scans. Each sample was counted for 10 minutes using an intrinsic germanium detector housed in a lead counting cave lined with cadmium and copper. The pulse height distribution was sorted using a computer-based multichannel analyzer. Radionuclide concentrations were determined by comparing the gamma spectrum of each sample with the spectrum of a certified counting standard for the radionuclide of interest.

Subsurface soil samples were collected from the borehole and hand augered hole locations. Wherever possible, continuous sampling was performed from the surface to in-situ (not previously disturbed) soil, as identified by the field geologist.

Following sample collection, the downhole gamma logs were reviewed, and samples were selected for analysis of uranium-238, radium-226, and thorium-232 concentrations. Samples were typically chosen for analysis at 0.3-m (1-ft) intervals. These analyses were performed using the gamma spectroscopy system described previously.

At the same time that samples were selected for the analysis program described above, samples were also identified for thorium-230 analysis. The primary goal of the thorium-230 analysis program was to determine whether above-guideline concentrations of thorium-230 exist in areas where neither uranium-238, radium-226, nor thorium-232 is present in concentrations exceeding guidelines.

Experience in the St. Louis area has shown that when the radium-226 concentration is elevated above background levels, it is reasonable to assume that the concentration of thorium-230 exceeds the DOE guideline of 15 pCi/g. Based on this rationale, as well as on the downhole gamma logs and available gamma spectroscopy results, samples were selected for thorium-230 analysis. Typically, this meant that samples were selected from regions of each borehole where gamma logging results showed a decrease in the count rate, indicating a drop in the radium-226 concentration.

To expedite the sampling and analysis process, multiple-depth samples were selected from each borehole for initial analysis. Selection of these samples was based on an evaluation of gamma logs. By using this selection method, the boundaries of contamination could be established in a single phase of analysis. As analytical data became available, other samples also were selected to resolve inconsistencies or to provide additional information on specific regions. It should be noted that the sampling locations depicted in figures in this document represent locations from which soil samples were analyzed. In some instances, soil samples may have been collected from a property but analysis was not necessary.

2.3 CHARACTERIZATION RESULTS

The results of the characterization effort for each group of FUSRAP properties in the St. Louis area are described in the following sections. To permit comparison of the results with current DOE guidelines for radionuclides in soil, these guidelines are presented in Table 2-1 (see Ref. 2-1). Actual cleanup limits will be determined in the remedial investigation/feasibility study-environmental impact study process. A guideline for uranium in soil at these properties is currently being established.

All direct field measurements and laboratory results in this report represent gross readings; background measurements and concentrations have not been subtracted. All downhole gamma logging measurements reported in this document have been rounded to the nearest thousand cpm.

Analysis results for soil are provided in Sections 3.0 through 7.0. The "less than" (<) notation in reporting results indicates that the radionuclide was not present in concentrations that are quantifiable with the instruments and techniques used. The "less than" value represents the lower limit of the quantitative capacity of the instrument and technique used. Therefore, the actual concentration of the radionuclide is less than the value preceded by the "less than" symbol. Determination of a "less than" value is based on various factors, including the volume, size, and weight of the sample; the type of detector used; the counting time; and the background count rate.

In addition, because radioactive decay is a random process, a correlation between the rate of disintegration and a given radionuclide concentration cannot be precisely established. For this reason, the exact concentration of the radionuclide cannot be determined. As such, each value that can be quantitatively determined has an associated uncertainty term ($\pm$2 sigma), which represents the amount by which the actual concentration can be expected to differ from the value given in the table. The uncertainty term has an associated confidence level of 95 percent.

TABLE 2-1

SUMMARY OF RESIDUAL CONTAMINATION GUIDELINES
FOR FUSRAP PROPERTIES IN THE ST. LOUIS, MISSOURI, AREA

BASIC DOSE LIMITS

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

SOIL (LAND) GUIDELINE

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.

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[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 or the sum of the ratios of the soil concentrations of each radionuclide to the allowable limit for that radionuclide will not exceed 1 (unity).

[b]These guidelines represent residual concentrations above background averaged across 15-cm-thick layers as described above and over any contiguous 100-cm^2 surface area.

[c]Localized concentrations in excess of these limits are allowable provided that the average concentration over a 100-m^2 area does not exceed these limits. However, concentrations must be as low as reasonably achievable (ALARA).

2.4 BACKGROUND MEASUREMENTS

Background data are compared with site data to establish whether site radiological measurements are elevated. Background data are also important because guidelines governing remedial action are typically presented in terms of acceptable levels above background.

The locations from which background samples and measurements were taken are shown in Figure 2-7. Location 1 is open, grassy land with no trees. The area is owned by the City of St. Louis and is expected to become part of the St. Louis Airport during a planned expansion project. There are no structures within about 0.2 km (0.1 mi) of the area. Location 2 is also open, grassy land with no trees. There are no structures within 0.5 km (0.3 mi) of the area. Location 3 is an open area near a school with some grass and trees. A park surrounds the school; a gasoline station is located several hundred feet from the area.

Near-surface gamma radiation levels, gamma exposure rates, and gamma radiation levels at 1 m (3 ft) above the ground surface were measured at three background locations in the St. Louis area to establish naturally occurring radiation levels. These measurements were made because the DOE basic dose limit of 100 mrem/yr effective dose equivalent does not include background radiation doses. The average near-surface gamma radiation level from these locations was approximately 10,000 cpm, and gamma radiation levels 1 m (3 ft) above the ground surface averaged approximately 10,000 cpm. The average background gamma exposure rate was 10 μR/h. Individual background measurements are listed in Table 2-2.

Average background concentrations of uranium-234, uranium-235, and uranium-238 measured in surface soils at the three background locations were 1.1, 0.1, and 1.1 pCi/g, respectively. The average background concentration of radium-226 was 0.9 pCi/g. The average background concentrations of thorium-232 and thorium-230 were 1.0 and 1.3 pCi/g, respectively.

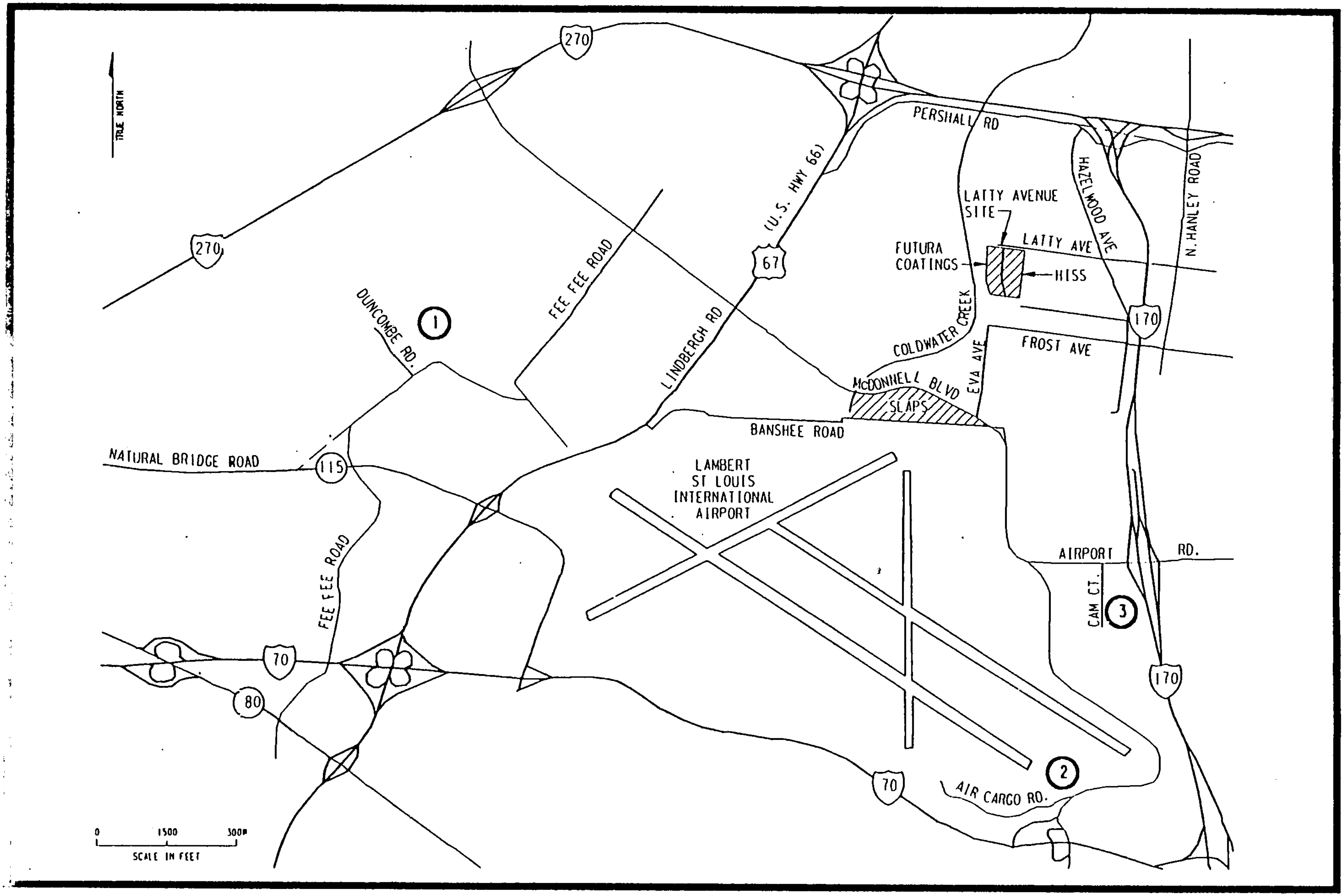

FIGURE 2-7 BACKGROUND SAMPLE AND MEASUREMENT LOCATIONS IN THE ST. LOUIS AREA

F127.DGN

TABLE 2-2

BACKGROUND RADIONUCLIDE CONCENTRATIONS IN SOIL

AND RADIATION LEVELS IN THE ST. LOUIS AREA

Measurement Location	Gamma Exposure Rate at 3 ft (μR/h)	Gamma Radiation at 3 ft (cpm)	Near-Surface Gamma Radiation (cpm)	Radionuclide Concentration (pCi/g) +/- 2 sigma)					
				Uranium-234	Uranium-235	Uranium-238	Radium-226	Thorium-232	Thorium-230
1	10	10,000	10,000	1.2 ± 0.3	< 0.1	1.2 ± 0.3	0.9 ± 0.4	1.0 ± 0.6	1.2 ± 0.3
2	10	9,000	9,000	1.0 ± 0.2	< 0.1	1.0 ± 0.2	0.9 ± 0.4	1.0 ± 0.5	1.3 ± 0.3
3	10	10,000	10,000	1.2 ± 0.2	0.1 ± 0.1	1.0 ± 0.2	0.9 ± 0.4	1.1 ± 0.3	1.5 ± 0.5
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Average	10	10,000	10,000	1.1 ± 0.2	0.1 ± 0.1	1.1 ± 0.2	0.9 ± 0.4	1.0 ± 0.5	1.3 ± 0.4

(Note: All data tables for properties in this section are presented in Volume II of this report.) Measurement locations are shown in Figure 2-5. For comparison, the DOE basic dose limit of 100 mrem/yr above background is equivalent to an exposure rate of approximately 11 μR/h above background, assuming exposure for a full year (8,760 h).

Downhole gamma logging was performed in the boreholes on the Norfolk and Western Railroad property adjacent to 9200 Latty Avenue to indicate the general depth of gamma-emitting radionuclides. The data were used as an aid in the selection and analysis of soil samples. Significant variations in count rates were observed as gamma logging progressed at three borehole locations, indicating possible contamination from gamma-emitting radionuclides. Detailed gamma logging results are reported in Table 4-2.

Soil sampling locations on the railroad property adjacent to 9200 Latty Avenue are shown in Figures 4-1 and 4-2. Analytical results for soil (Table 4-3) revealed areas with elevated concentrations of radium-226 in surface samples and thorium-230 in surface and subsurface samples.

Uranium-238 concentrations ranged from less than 4 to 390 pCi/g. Concentrations of radium-226 ranged from 0.6 to 1,100 pCi/g. Thorium-232 concentrations ranged from 0.6 to 7 pCi/g. Thorium-230 concentrations ranged from 0.7 to 26,000 pCi/g. Contamination areas and depths on the Norfolk and Western Railroad property adjacent to 9200 Latty Avenue are shown in Figure 4-3.

4.2 NORFOLK AND WESTERN RAILROAD PROPERTY ADJACENT TO HANLEY ROAD

No significant variations in count rates were observed as gamma logging progressed in the boreholes on the Norfolk and Western Railroad property adjacent to Hanley Road. Detailed gamma logging results are reported in Table 4-4.

Soil sampling locations on this property are shown in Figures 4-4 and 4-5. Analytical results for soil (Table 4-5) revealed no areas exhibiting elevated radionuclide concentrations above guidelines. Uranium-238 concentrations were less than 7 pCi/g. Radium-226 concentrations were 1.6 and 2.2 pCi/g in the two samples analyzed, and concentrations of thorium-232 were 2.0 and 2.5 pCi/g in these same two samples. Thorium-230 concentrations ranged from 0.8 to 6 pCi/g.

4.3 NORFOLK AND WESTERN RAILROAD PROPERTY SOUTH OF SLAPS

No significant variations in count rates were observed as gamma logging progressed in the boreholes on the Norfolk and Western Railroad property south of SLAPS. Detailed gamma logging results are reported in Table 4-6.

Soil sampling locations on this property are shown in Figures 4-6 and 4-7. Analytical results for soil (Table 4-7) revealed elevated concentrations of radium-226 in surface samples and thorium-230 in surface and subsurface samples.

Uranium-238 concentrations ranged from less than 3 to 27 pCi/g. Radium-226 concentrations ranged from 0.6 to 8 pCi/g. Concentrations of thorium-232 and thorium-230 ranged from 0.6 to 5 pCi/g and 1.5 to 170 pCi/g, respectively. Areas and depths of contamination on the Norfolk and Western Railroad property south of SLAPS are shown in Figure 4-8.

4.4 NORFOLK AND WESTERN RAILROAD PROPERTY ADJACENT TO COLDWATER CREEK

No significant variations in count rates were observed as gamma logging progressed in the boreholes on the Norfolk and Western Railroad property adjacent to Coldwater Creek. Detailed gamma logging results are reported in Table 4-8.

Surface soil sampling locations on this property are shown in Figure 4-9. Subsurface sampling locations are shown in Figure 4-10. Analytical results for soil revealed areas with elevated concentrations of radium-226 and thorium-230 in surface samples.

All uranium-238 concentrations were below 23 pCi/g. Concentrations of radium-226 ranged from 0.7 to 15 pCi/g. Thorium-232 concentrations ranged from less than 0.1 to 4 pCi/g, and thorium-230 concentrations ranged from less than 0.3 to 1,300 pCi/g. Analytical results for soil are provided in Table 4-9.

Additional soil sampling is required on this property before the boundaries of radioactive contamination can be determined. This sampling will occur prior to remedial action.

4.5 NORFOLK AND WESTERN RAILROAD PROPERTY ADJACENT TO HAZELWOOD AVENUE AND SOUTH OF LATTY AVENUE

Downhole gamma logging was not performed at the sampling locations on the Norfolk and Western Railroad property adjacent to Hazelwood Avenue located south of Latty Avenue because thorium-230 had previously been identified as the major contaminant, and it cannot be detected in situ.

In an attempt to determine if thorium-230 contamination existed on the railroad properties adjacent to Hazelwood and Eva Avenues, three parallel rows of hand-augered holes, 1 m (3 ft) deep, at 50-ft intervals, were placed on each property. The first row was at the road's edge, running the length of the property adjacent to Hazelwood Avenue. The second row was on the property, 15 m (50 ft) from the first row. The third row was 30 m (100 ft) from the second row. Locations on this railroad property from which soil samples were collected and analyzed are shown in Figure 4-11. The first row of samples 0 to 30 cm (0 to 1 ft) in depth were analyzed for thorium-230, the primary contaminant, before a determination was made concerning analysis of second and third row samples. If no contamination at levels exceeding guidelines was observed, samples from subsequent rows were not analyzed. Samples were collected at intervals of 0 to 30, 30 to 60, and 60 to 90 cm (0 to 1, 1 to 2, and 2 to 3 ft) in depth. All samples that were not analyzed for thorium-230 were archived for later retrieval and analysis if required. Analytical results for soil revealed 15 areas with elevated concentrations of thorium-230. Thorium-230 concentrations ranged from 1.2 to 210 pCi/g; analytical results are provided in Table 4-10.

Additional soil sampling is required at the railroad property adjacent to Hazelwood Avenue and south of Latty Avenue before all boundaries of radioactive contamination can be established. This sampling will occur prior to remedial action. Figure 4-12 depicts the areas and depths of contamination known to date.

4.6 NORFOLK AND WESTERN RAILROAD PROPERTY ADJACENT TO HAZELWOOD AVENUE AND NORTH OF LATTY AVENUE

Downhole gamma logging was not performed at the sampling locations on the Norfolk and Western Railroad property adjacent to Hazelwood Avenue and north of Latty Avenue because thorium-230 had previously been identified as the major contaminant, and it cannot be detected in situ.

Six surface soil samples were collected and analyzed for thorium-230 from this property. Soil sampling locations are shown in Figure 4-13. Analytical results for soil (Table 4-11) revealed no areas exhibiting elevated concentrations of thorium-230. Concentrations of thorium-230 ranged from 1.9 to 3.8 pCi/g. Additional soil samples collected and analyzed in this vicinity are shown in Figures 5-79, 5-83 through 5-85, 5-87, and 5-89.

4.7 NORFOLK AND WESTERN RAILROAD PROPERTY ADJACENT TO EVA AVENUE

Downhole gamma logging was not performed at the sampling locations on the Norfolk and Western Railroad property adjacent to Eva Avenue because thorium-230 had previously been identified as the major contaminant, and it cannot be detected in situ.

Seventy-two soil samples were collected from the locations shown in Figure 4-14 and analyzed for thorium-230. Additional soil sampling in this vicinity was conducted on adjacent properties, and the locations are shown in Figures 5-38, 5-40, and 5-41. Analytical results for soil (Table 4-12) revealed 23 locations exhibiting elevated concentrations of thorium-230. Concentrations of thorium-230 ranged from less than 0.8 to 85 pCi/g. Figure 4-15 shows areas and depths of contamination at the railroad property adjacent to Eva Avenue.

In summary, characterization results from the railroad properties indicate that radioactive contamination is present on all of the properties except for the right-of-way north of Latty Avenue and the property adjacent to Hanley Road. Thorium-230 was identified as the primary contaminant. In general, the contamination is shallow [0.6 m (2 ft)]; a few smaller areas extend to greater depths.

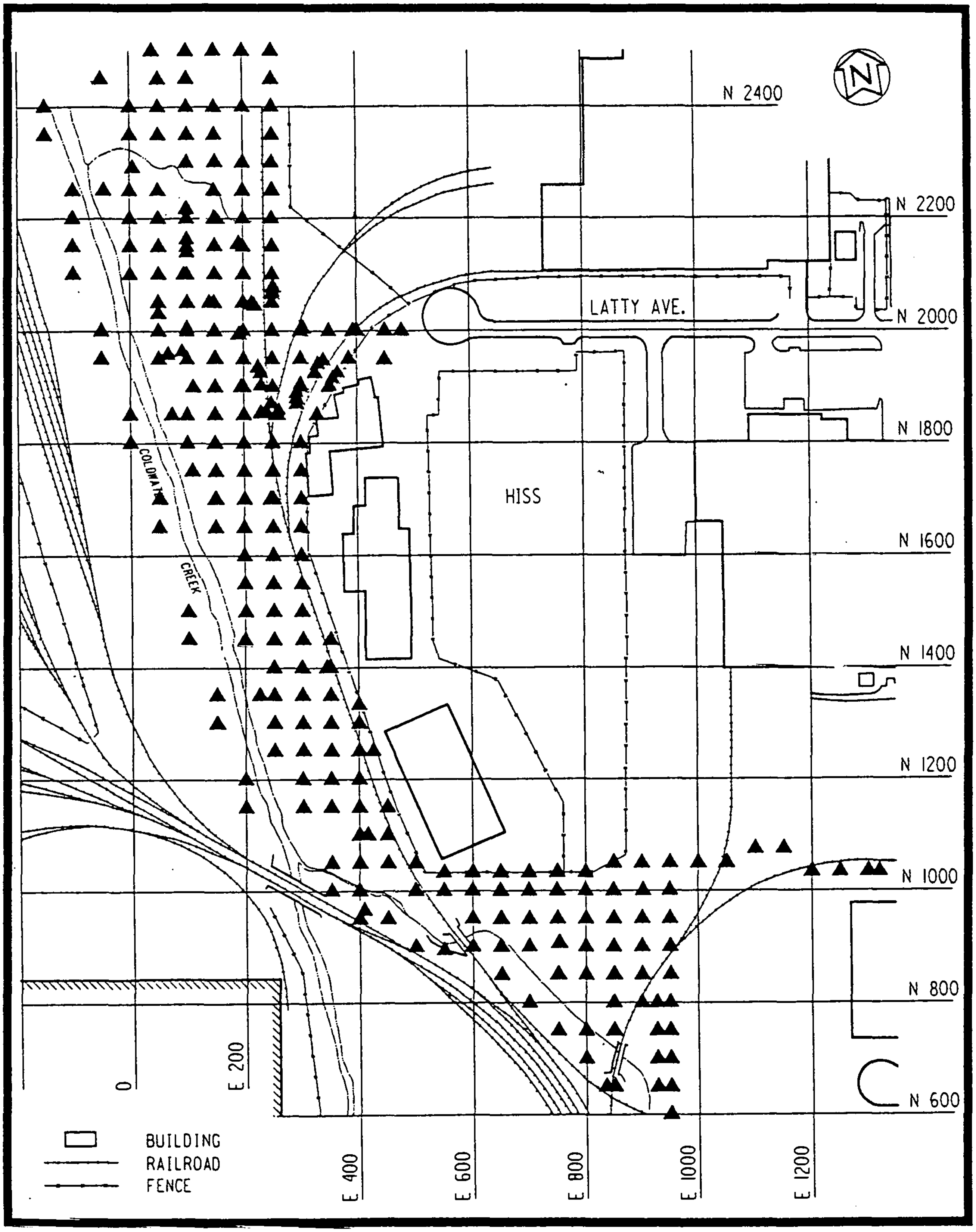


FIGURE 4-1 SURFACE SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF THE NORFOLK AND WESTERN RAILROAD PROPERTY ADJACENT TO 9200 LATTY AVENUE

S34WMS20.DGN

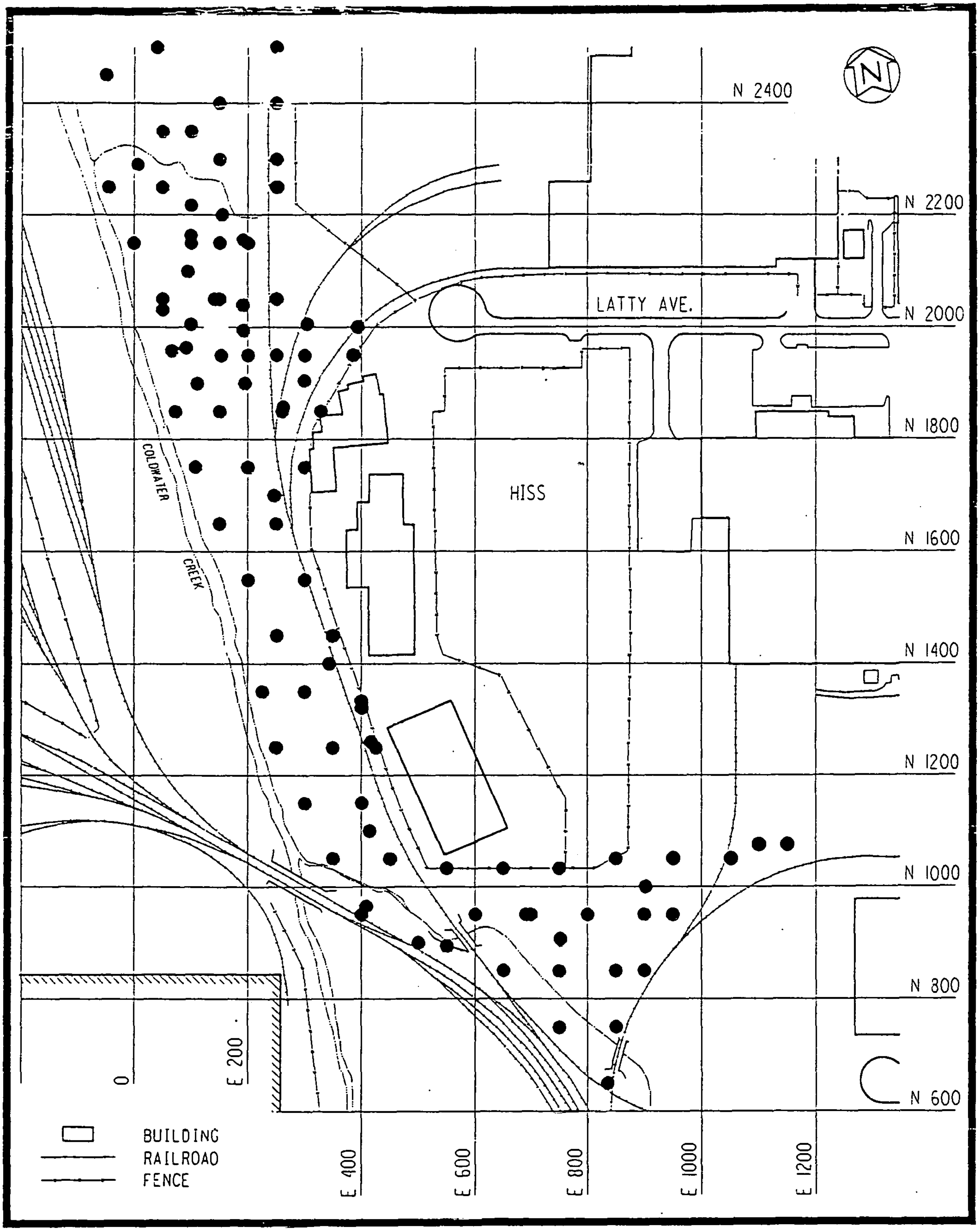


FIGURE 4-2 SUBSURFACE SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF THE NORFOLK AND WESTERN RAILROAD PROPERTY ADJACENT TO 9200 LATTY AVENUE

S34WMS20.DGN

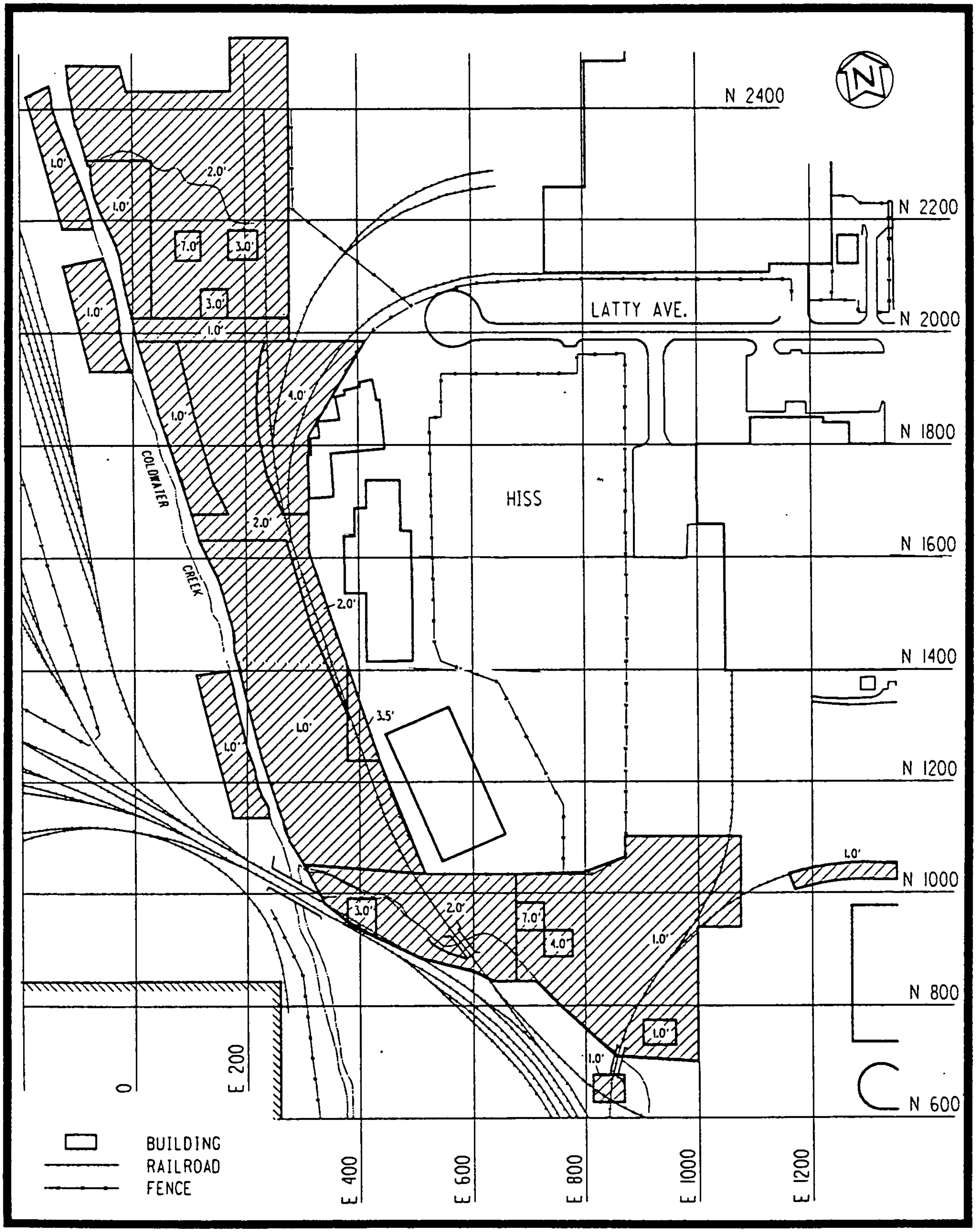


FIGURE 4-3 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT THE NORFOLK AND WESTERN RAILROAD PROPERTY ADJACENT TO 9200 LATTY AVENUE

S34WMS20.DGN

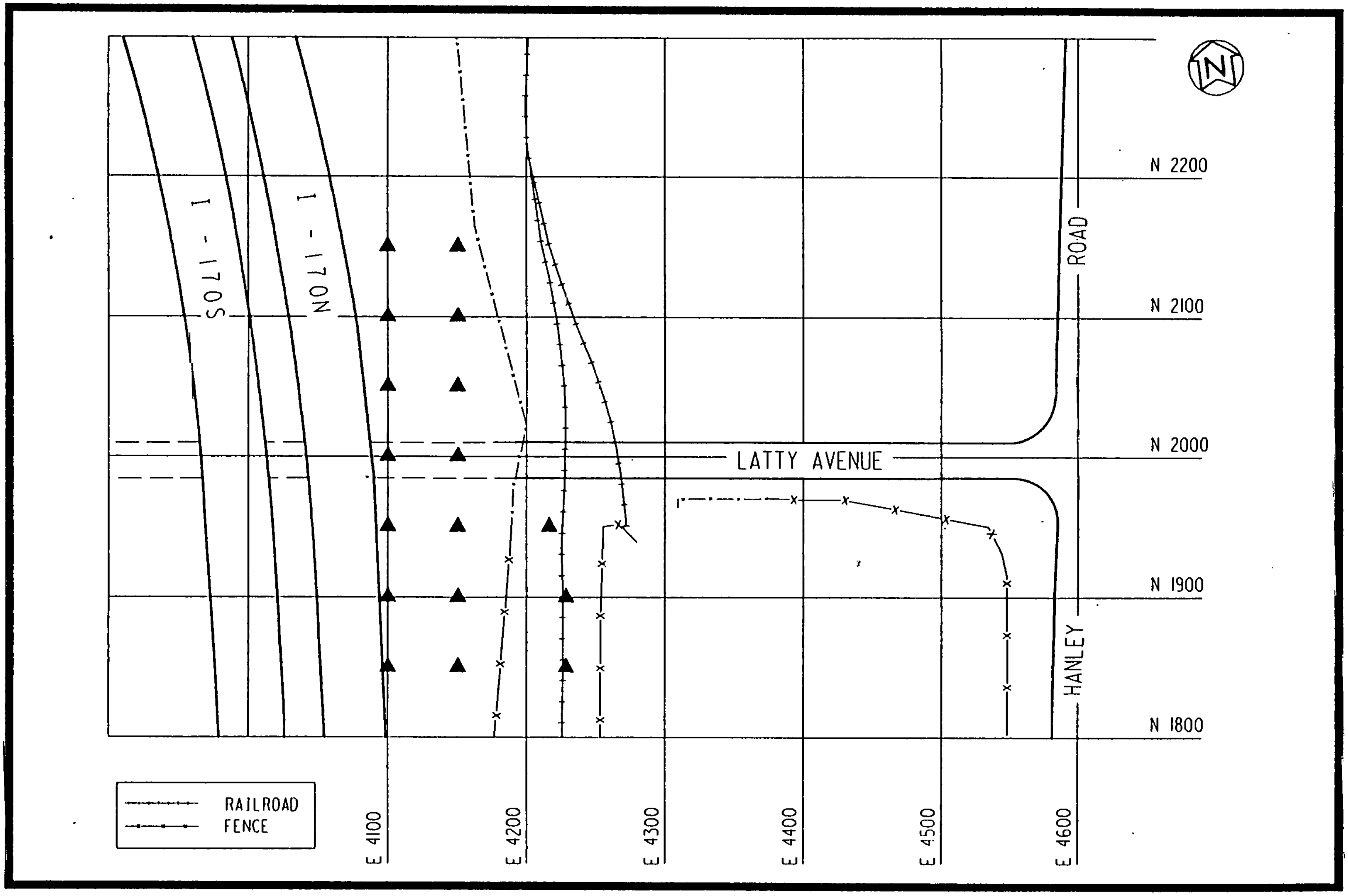


FIGURE 4-4 SURFACE SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF THE NORFOLK AND WESTERN RAILROAD PROPERTY ADJACENT TO HANLEY ROAD

S34WMS21.DGN

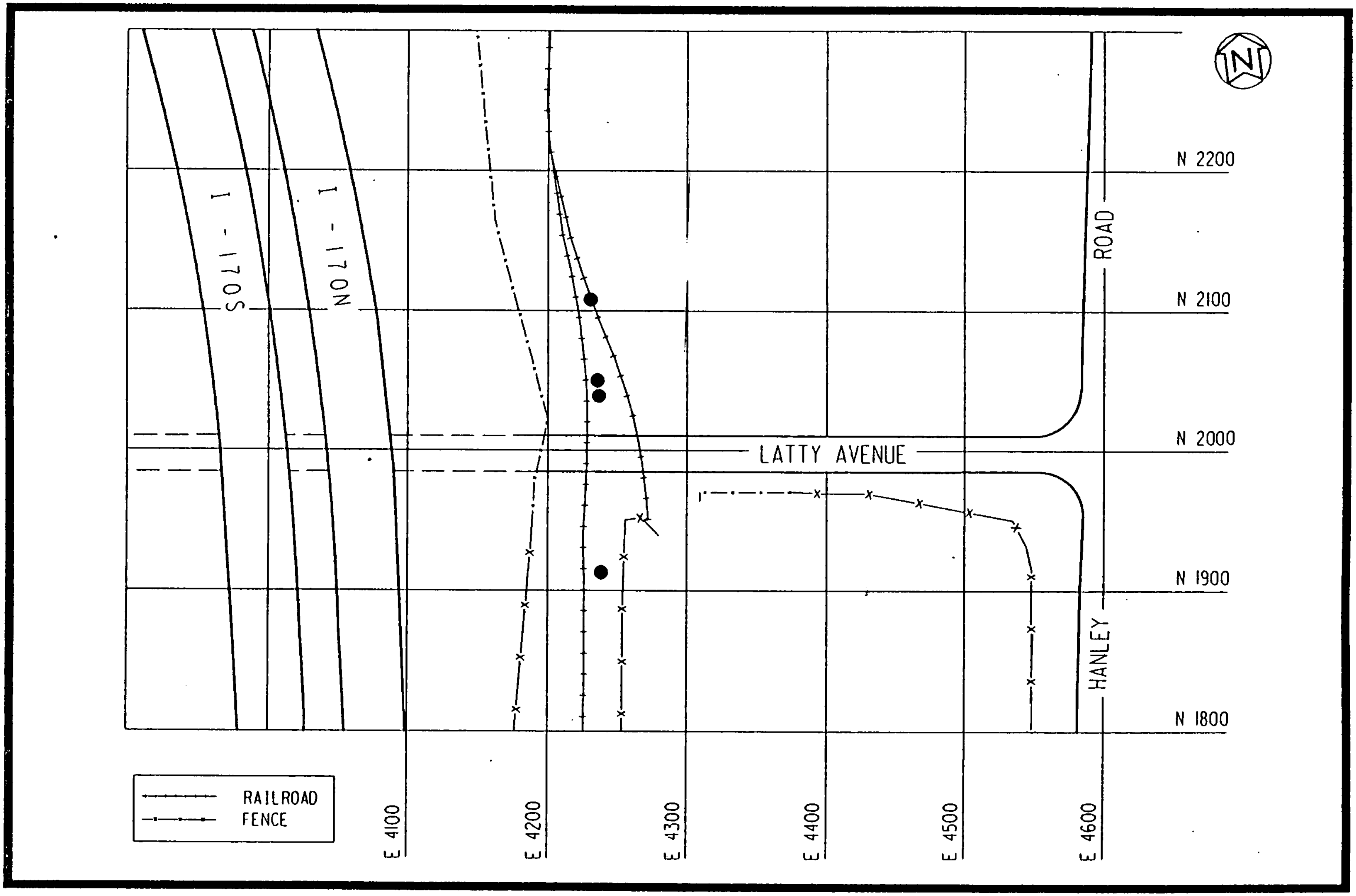


FIGURE 4-5 SUBSURFACE SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF THE NORFOLK AND WESTERN RAILROAD PROPERTY ADJACENT TO HANLEY ROAD

S34WMS21.DGN

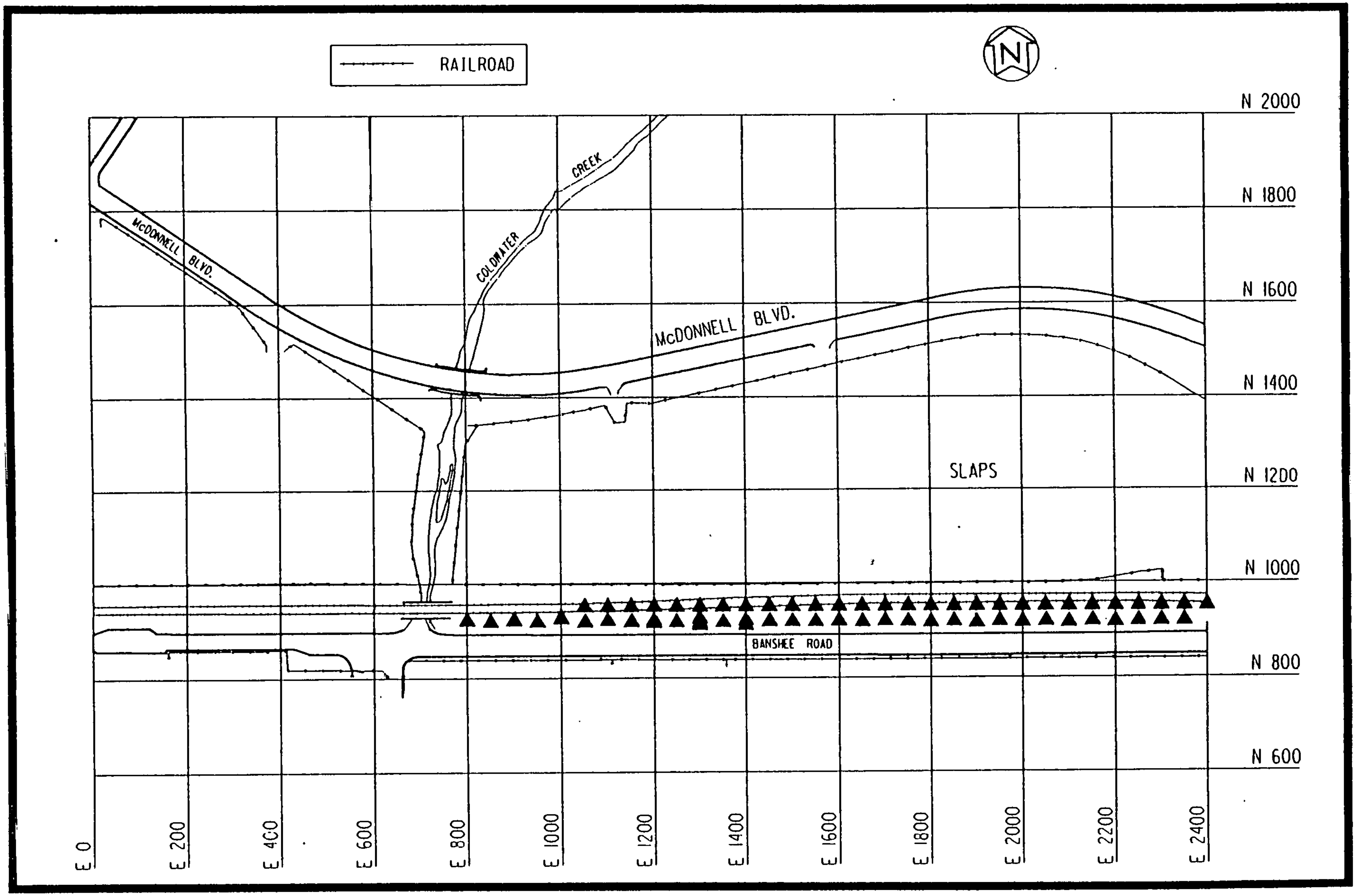


FIGURE 4-6 SURFACE SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF THE NORFOLK AND WESTERN RAILROAD PROPERTY SOUTH OF SLAPS

S34WMS58.DGN

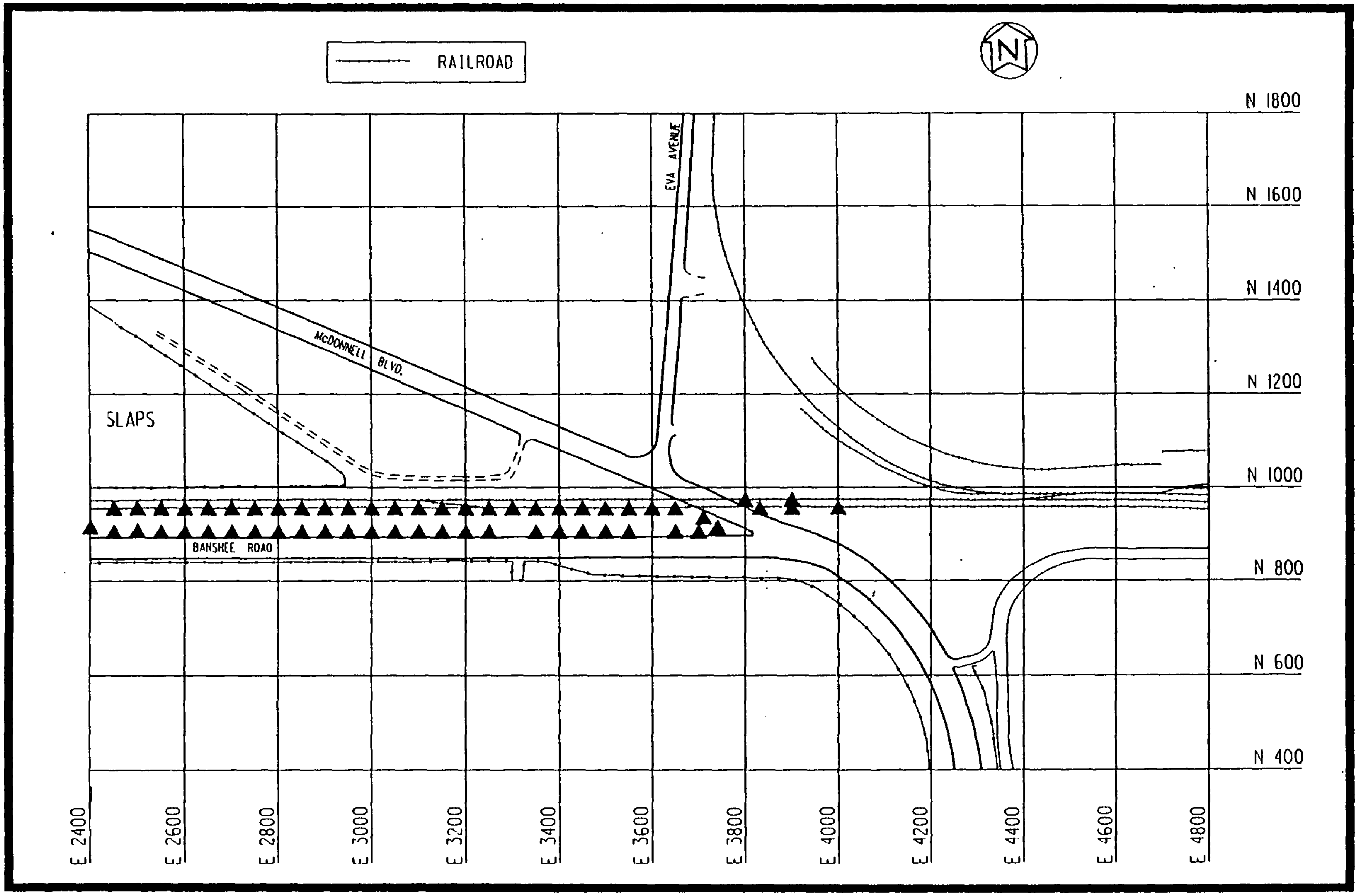


FIGURE 4-6 SURFACE SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF THE NORFOLK AND WESTERN RAILROAD PROPERTY SOUTH OF SLAPS (CONT.)

S34WMS59.DGN

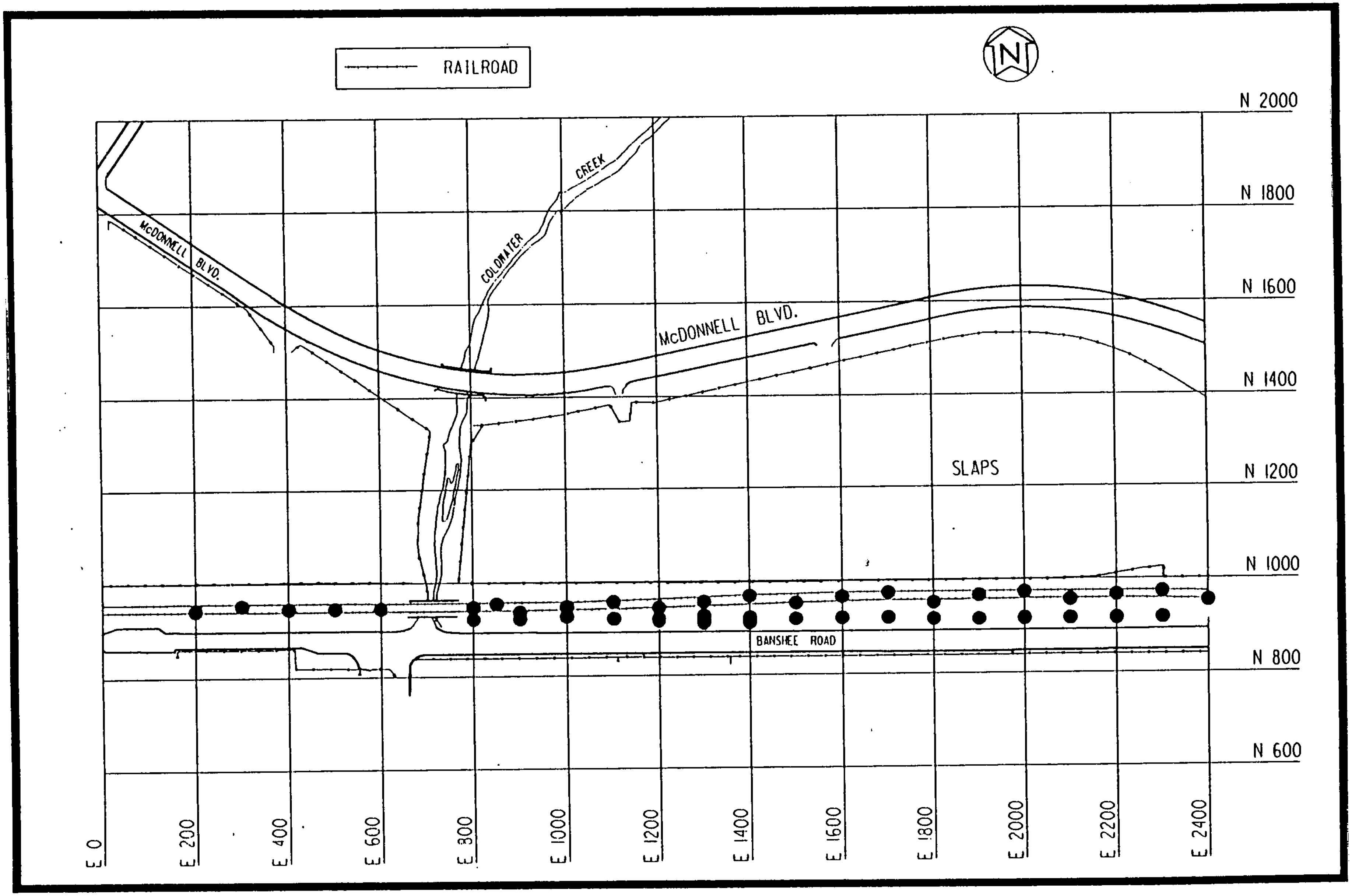


FIGURE 4-7 SUBSURFACE SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF THE NORFOLK AND WESTERN RAILROAD PROPERTY SOUTH OF SLAPS

S34WMS58.DGN

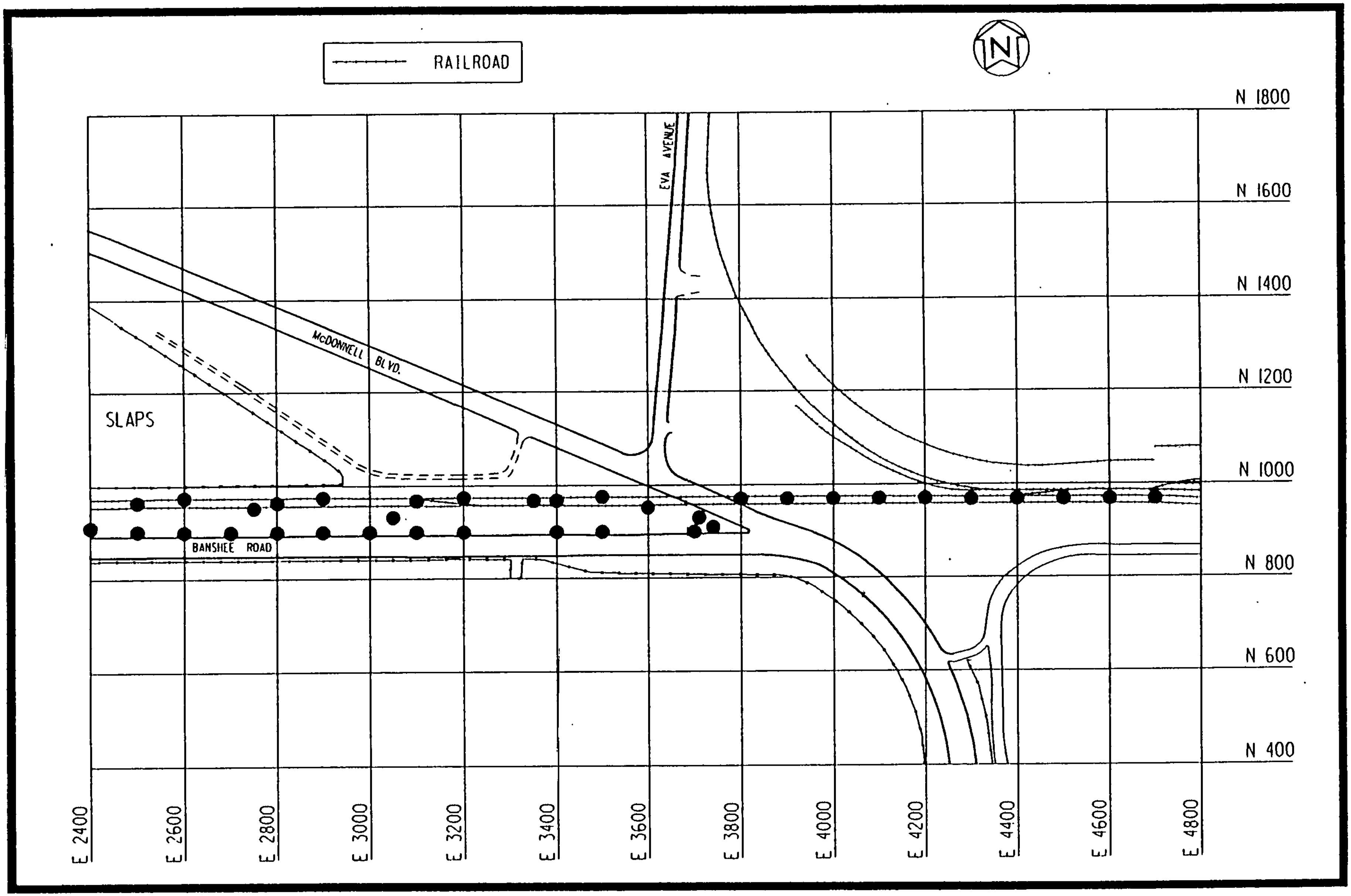


FIGURE 4-7 SUBSURFACE SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF THE NORFOLK AND WESTERN RAILROAD PROPERTY SOUTH OF SLAPS (CONT.)

S34WMS59.DGN

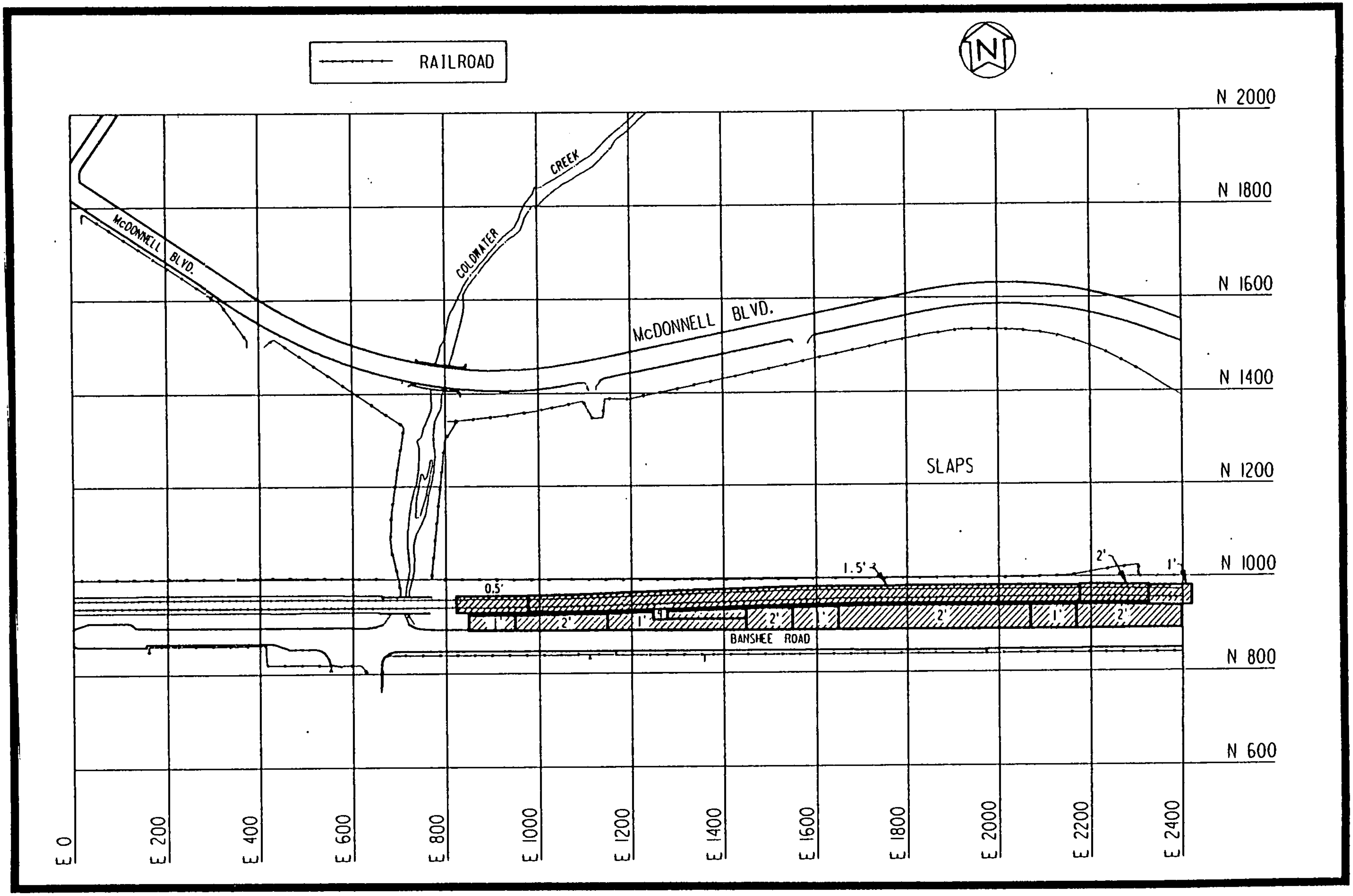


FIGURE 4-8 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT THE NORFOLK AND WESTERN RAILROAD PROPERTY SOUTH OF SLAPS

S34WMS5B.DGN

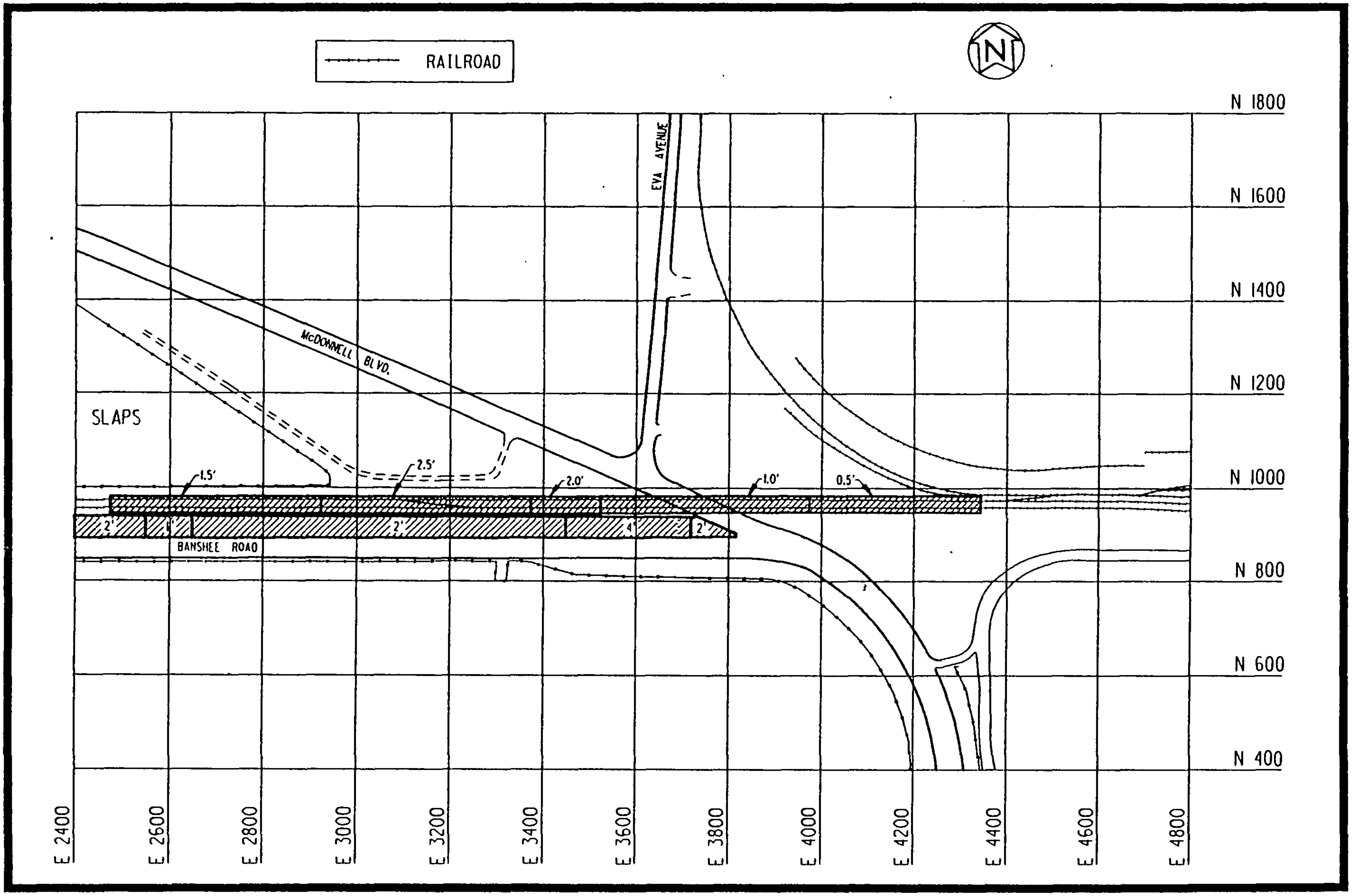


FIGURE 4-8 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT THE NORFOLK AND WESTERN RAILROAD PROPERTY SOUTH OF SLAPS (CONT.)

S34WMS59.DGN

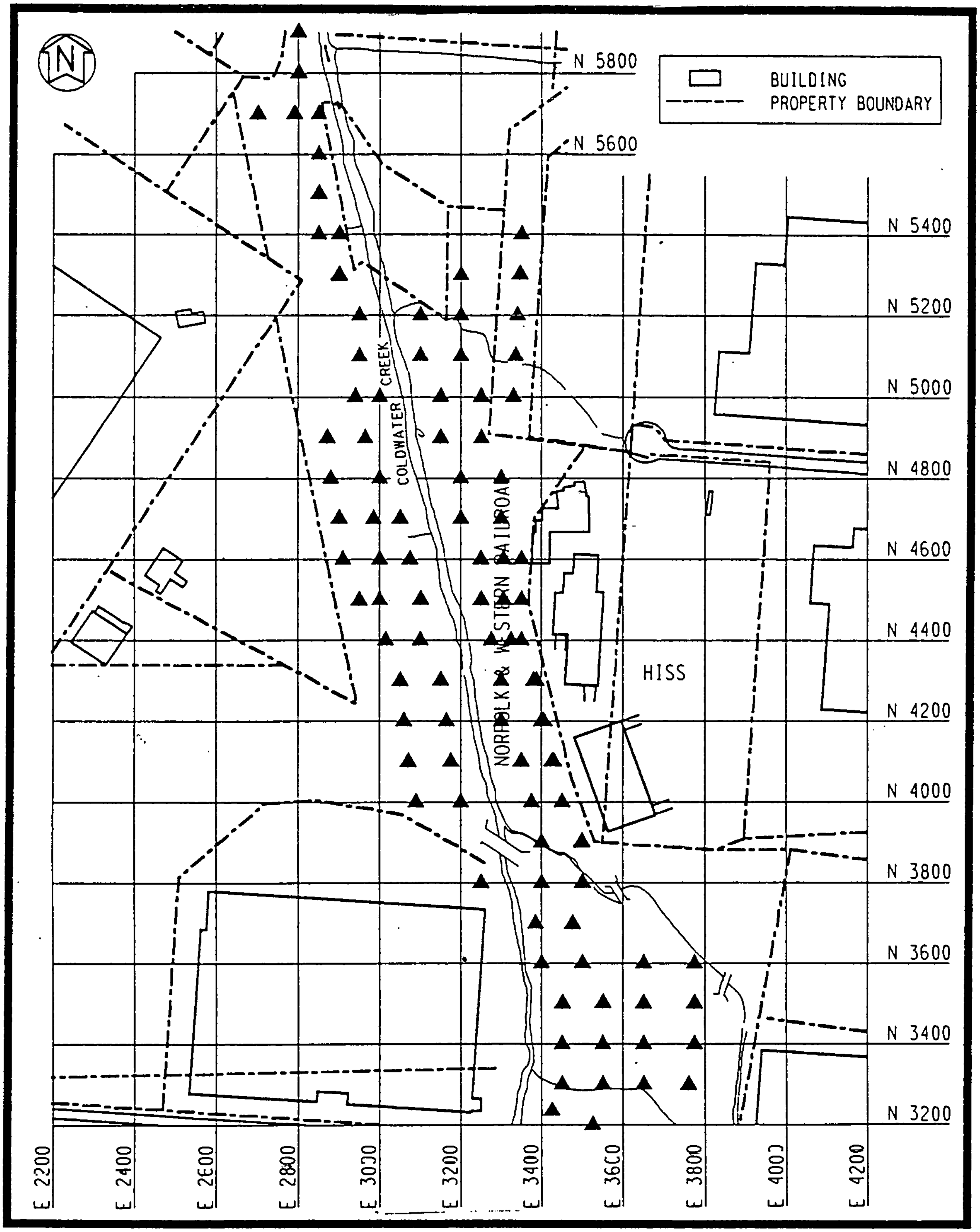


FIGURE 4-9 SURFACE SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF THE NORFOLK AND WESTERN RAILROAD PROPERTY ADJACENT TO COLDWATER CREEK

S34WMS57.DGN

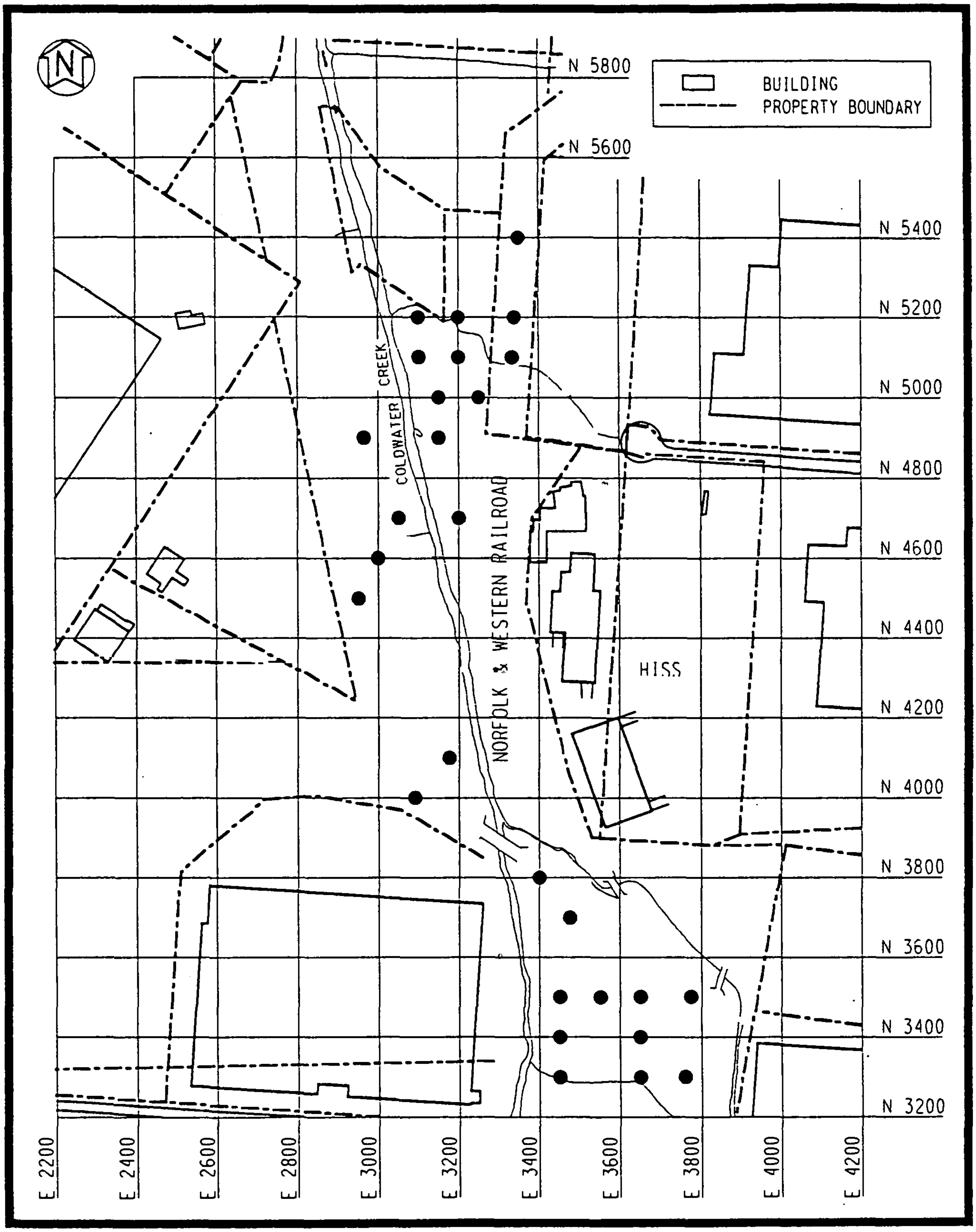


FIGURE 4-10 SUBSURFACE SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF THE NORFOLK AND WESTERN RAILROAD PROPERTY ADJACENT TO COLDWATER CREEK

S34WMS57.DGN

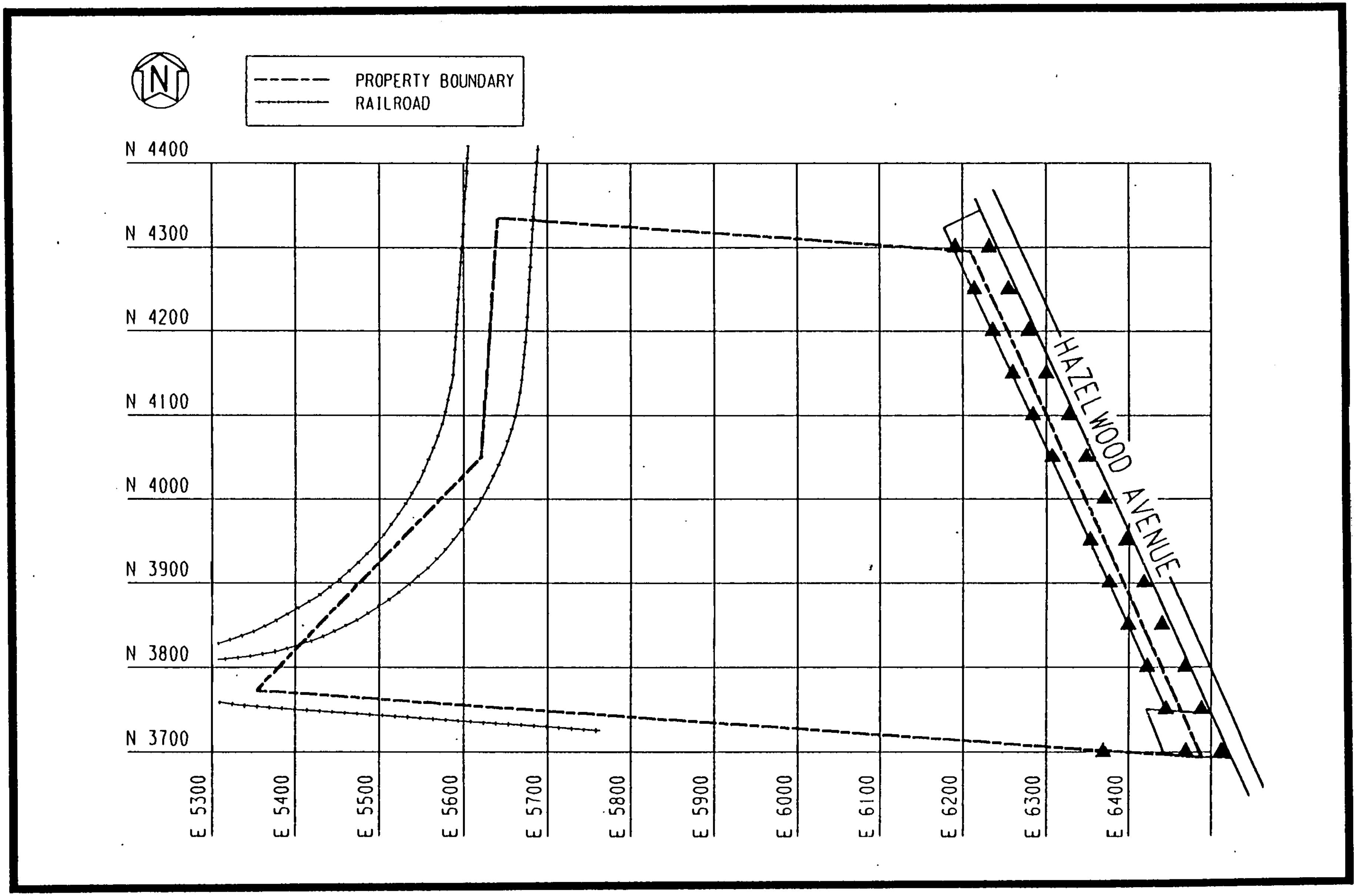


FIGURE 4-11 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF THE NORFOLK AND WESTERN RAILROAD PROPERTY ADJACENT TO HAZELWOOD AVENUE AND SOUTH OF LATTY AVENUE

134F061.DGN

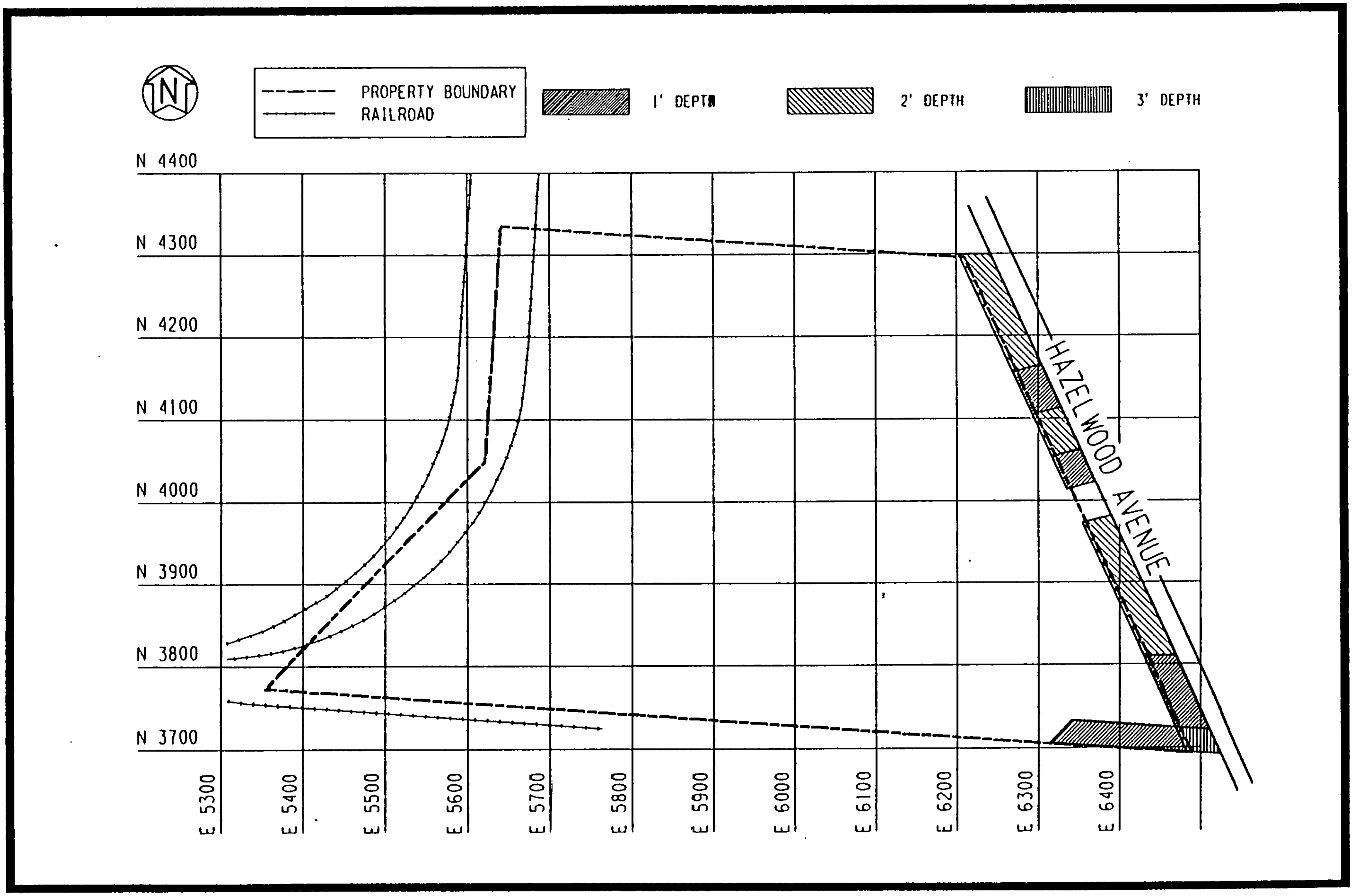


FIGURE 4-12 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT THE NORFOLK AND WESTERN RAILROAD PROPERTY ADJACENT TO HAZELWOOD AVENUE AND SOUTH OF LATTY AVENUE

134F061.DGN

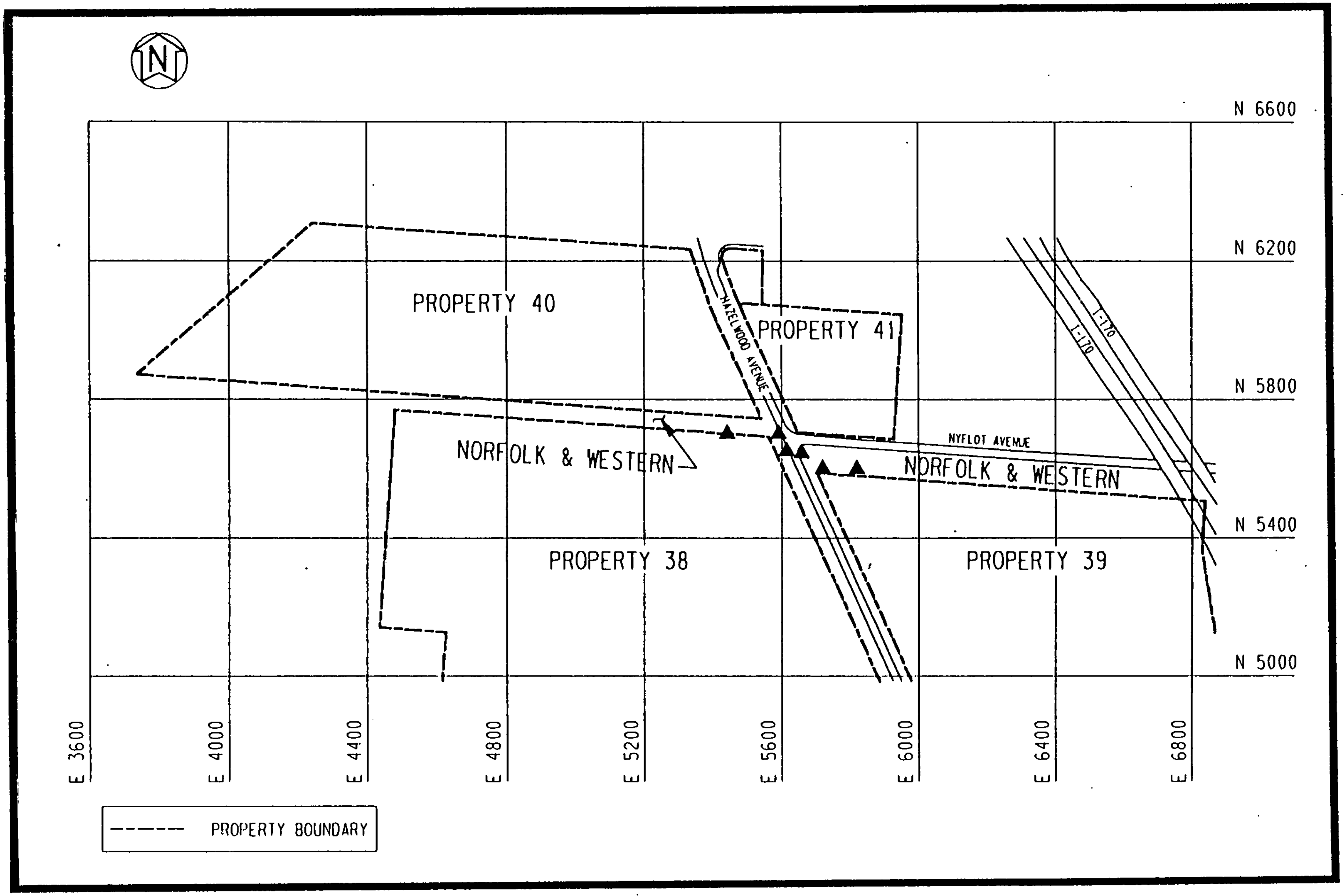


FIGURE 4-13 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF THE NORFOLK AND WESTERN RAILROAD PROPERTY ADJACENT TO HAZELWOOD AVENUE AND NORTH OF LATTY AVENUE

134F103.DGN

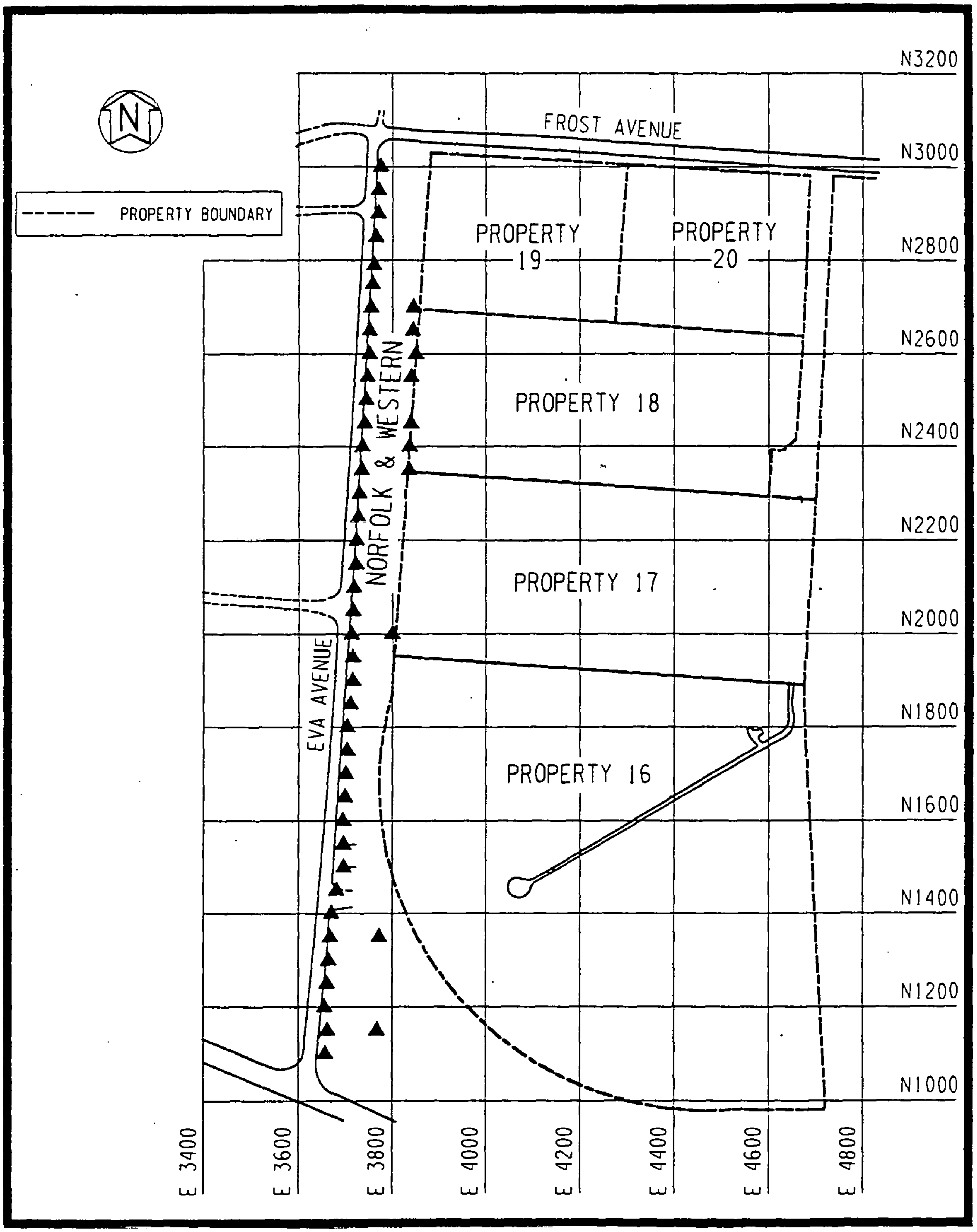


FIGURE 4-14 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF THE NORFOLK AND WESTERN RAILROAD PROPERTY ADJACENT TO EVA AVENUE

134F091.DGN

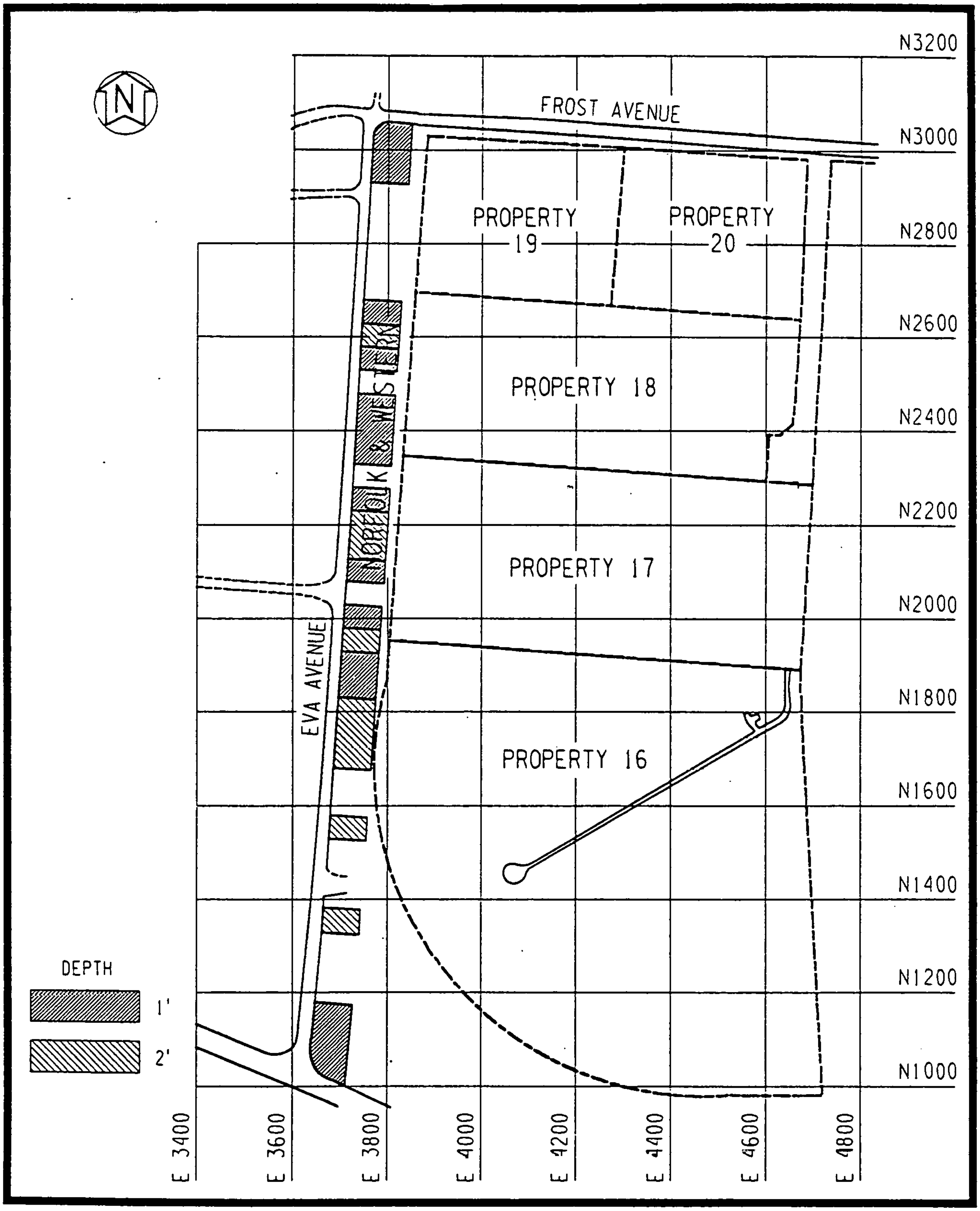


FIGURE 4-15 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT THE NORFOLK AND WESTERN RAILROAD PROPERTY ADJACENT TO EVA AVENUE

134F091.DGN DEPTH

5.0 CHARACTERIZATION RESULTS FOR THE HAUL ROADS AND ASSOCIATED PROPERTIES

Sixty-six properties adjacent to McDonnell Boulevard, Eva Avenue, Frost Avenue, Hazelwood Avenue, and Pershall Road (Figure 1-5) were surveyed as part of the haul roads vicinity properties radiological characterization.

Neither walkover gamma scans nor near-surface gamma radiation measurements were performed at these vicinity properties because thorium-230 had already been identified as the major contaminant. Thorium-230 cannot be detected in the field, so the usefulness of gamma radiation scans and measurements is minimized. With minor exceptions, the radiological investigation was conducted on the vicinity properties by collecting soil samples in 0.3-m (1-ft) increments to a depth of 1 m (3 ft). Soil samples were collected at 15.2-m (50-ft) grid intersections 15.2 m (50 ft) onto the property from the road's edge, and at 30.5-m (100-ft) grid intersections 45.7 m (150 ft) onto the property from the road's edge. The 0- to 0.3-m (0- to 1-ft) soil samples collected from the road's edge were analyzed for thorium-230. Based on results from these analyses, a determination was made whether or not to analyze successively deeper samples and/or samples collected further back from the road's edge. Downhole gamma logging was not performed at the haul roads vicinity properties.

For ease of reporting, all vicinity properties have been assigned a numerical identifier. All soil samples collected from the rights-of-way are reported with the property immediately adjacent to them even though the actual property boundary does not extend to the road's edge. When the term "elevated levels" of radionuclides is used, it refers to levels exceeding DOE guidelines.

5.1 LATTY AVENUE, McDONNELL BOULEVARD, HAZELWOOD AVENUE, AND PERSHALL ROAD

In December 1984, ORNL conducted a mobile gamma scanning survey of potential transportation routes to and from the Latty Avenue properties and the West Lake Landfill (Ref. 5-1). Anomalies were detected on McDonnell Boulevard, Hazelwood Avenue, and Pershall Road. Based on the results of the ORNL gamma scan, additional sampling along these roads was initiated to detect the presence of thorium-230 in excess of DOE guidelines.

The radiological characterization included collecting soil samples from the shoulders of the haul roads in addition to sampling underneath the pavement. Composite sampling was performed in the rights-of-way on McDonnell Boulevard, Hazelwood Avenue, and Pershall Road to reduce the large number of samples that would have been collected if discrete (i.e., non-composited) samples were taken. Surface samples were obtained at 15.2-m (50-ft) intervals and then composited. Typically, four samples from a 45.7-m (150-ft) segment were composited. Because the compositing scheme that was administered could dilute the soil sample concentrations from a contaminated area by mixing with soil from an uncontaminated area, an adjusted criterion of 2 pCi/g was followed. The composite samples were considered to be contaminated if the radionuclide activity was greater than 2 pCi/g.

Near-surface gamma radiation measurements at Latty Avenue ranged from approximately 2,200 to approximately 6,100 cpm. Near-surface gamma radiation levels were not measured at McDonnell Boulevard, Hazelwood Avenue, or Pershall Road because thorium-230 had already been identified as the major contaminant. Since thorium-230 cannot be detected in the field, the usefulness of gamma radiation scans and measurements is minimal.

Downhole gamma logging was performed in several of the boreholes at Latty Avenue to indicate the general depth of contamination from gamma-emitting radionuclides. These data were used as an aid in the selection and analysis of soil samples. No significant variations in count rates were observed as gamma logging progressed in the boreholes. Many of the boreholes in Latty Avenue were drilled to sample areas around the storm sewer lines that were installed by the city of Berkeley. These borehole locations have north grid coordinates of 1988.0, 2000.0, and 2012.0. Downhole gamma logging was not performed in these boreholes because every soil sample collected was analyzed for uranium-238, radium-226, thorium-232, and thorium-230. Detailed gamma logging results for Latty Avenue are reported in Table 5-1. (Note: Data tables 5-1 through 5-7 are contained in Volume II of this report. Data tables 5-8 through 7-8 are contained in Volume III.)

Soil sampling locations at Latty Avenue are shown in Figures 5-1 and 5-2. Analytical results for soil collected at Latty Avenue (Table 5-2) revealed areas with elevated concentrations of radium-226 and thorium-230 in surface and subsurface samples. Uranium-238 concentrations ranged from less than 3 to 48.2 pCi/g. Radium-226 concentrations ranged from 0.6 to 39.9 pCi/g. Concentrations of thorium-232 ranged from 0.4 to 9.5 pCi/g. Thorium-230 concentrations ranged from less than 0.2 to 1,413 pCi/g. Areas and depths of contamination are shown in Figure 5-3. In most instances, contamination is confined to the surface soil [i.e., 0 to 0.3 m (0 to 1 ft)]. A small area of contamination on the south side of Latty Avenue near Property 37, on the haul roads, extended to a depth of 2.1 m (7 ft).

Downhole gamma logging was performed in the boreholes at McDonnell Boulevard. Variations in count rates were observed as gamma logging progressed. Detailed gamma logging results for McDonnell Boulevard are reported in Table 5-3.

Soil sampling locations at McDonnell Boulevard are shown in Figures 5-4, 5-5, and 5-6. Analytical results for soil collected at McDonnell Boulevard (Table 5-4) revealed areas with elevated concentrations of radium-226, thorium-232, and thorium-230 in the composite samples. Elevated concentrations of thorium-230 also were detected in subsurface samples. Uranium-238 concentrations ranged from less than 2 to 59 pCi/g. Radium-226 concentrations ranged from 0.7 to 64 pCi/g. Concentrations of thorium-232 ranged from less than 0.7 to 9 pCi/g. Thorium-230 concentrations ranged from 0.7 to 2,900 pCi/g. Areas and depths of contamination are depicted in Figure 5-7. Contamination ranges from the surface to a depth of 4.5 m (15 ft) at one location and extends approximately 275 m (900 ft) east of Coldwater Creek and 122 m (400 ft) west of the creek. One isolated area of contamination, extending to a depth of 1.5 m (5 ft), exists near the intersection of McDonnell Boulevard and Eva Avenue.

No significant variations in count rates were observed as gamma logging progressed in the boreholes drilled at Hazelwood Avenue. Gamma logging results for Hazelwood Avenue are reported in Table 5-5.

Soil sampling locations at Hazelwood Avenue are shown in Figures 5-8, 5-9, and 5-10. Analytical results for soil collected at Hazelwood Avenue (Table 5-6) showed areas with elevated concentrations of radium-226, thorium-232, and thorium-230 in the composite samples. Uranium-238 concentrations ranged from less than 4 to 72 pCi/g. Radium-226 concentrations ranged from 0.6 to 42 pCi/g. Concentrations of thorium-232 ranged from 0.8 to 9 pCi/g. Thorium-230 concentrations ranged from 0.9 to 4,810 pCi/g. Figure 5-11 shows the areas and depths of radioactive contamination at Hazelwood Avenue. Contamination exists along both sides of Hazelwood Avenue to an average depth of 0.3 m (1 ft) from Hazelwood Avenue's intersection with Frost Avenue to Pershall Road.

No significant variations in count rates were observed as gamma logging progressed in the boreholes drilled at Pershall Road. Gamma logging results for Pershall Road are reported in Table 5-7.

Soil sampling locations at Pershall Road are shown in Figures 5-12, 5-13, and 5-14. Analytical results for soil collected at Pershall

Road (Table 5-8) revealed areas with elevated concentrations of radium-226, thorium-232, and thorium-230 in surface samples. Elevated concentrations of thorium-230 also were detected in subsurface samples. Uranium-238 concentrations ranged from less than 3 to 73 pCi/g. Concentrations of radium-226 ranged from 0.4 to 92 pCi/g. Thorium-232 concentrations ranged from 0.7 to less than 9 pCi/g, and thorium-230 concentrations ranged from 0.6 to 4,900 pCi/g. Areas and depths of contamination are shown in Figure 5-15. The average depth of contamination at Pershall Road is 1 m (3 ft); a few isolated areas of contamination extend to a depth of 4 m (13 ft).

In general, radioactive contamination is present in some areas underneath Latty Avenue, McDonnell Boulevard, and Pershall Road, and contamination exists along both sides of Hazelwood Avenue and Pershall Road. Thorium-230 was identified as the primary contaminant. The SLAPS ditches are on either side of McDonnell Boulevard, and results from the characterization of these ditches are reported in Section 7.0. Vicinity properties adjacent to Latty Avenue were characterized, and results are reported in Section 3.0. Vicinity properties adjacent to McDonnell Boulevard, Hazelwood Avenue, and Pershall Road were characterized; results for each property are reported in the following subsections.

5.2 PROPERTY 1

Property 1 is bordered by Lindbergh Boulevard on the west. Twenty-eight soil sampling locations were hand-augered in the Lindbergh Boulevard right-of-way bordering Property 1. The samples collected from these locations are archived for future analysis if necessary; however, soil sample analysis results from properties on McDonnell Boulevard near Lindbergh Boulevard do not indicate the need for analyzing Property 1 samples. There is no evidence to suggest that Lindbergh Boulevard was used as a haul route during the waste transport activities between the St. Louis sites.

5.3 PROPERTY 2

Property 2 is bordered by McDonnell Boulevard on the north and Lindbergh Boulevard on the west. Locations from which soil samples were collected and analyzed are shown in Figure 5-16. Analytical results for soil collected from this property (Table 5-9) revealed no areas exhibiting elevated concentrations of thorium-230. Thorium-230 concentrations ranged from less than 0.6 to 3.5 pCi/g.

5.4 PROPERTY 3

Property 3 is bordered by Lindbergh Boulevard on the west. Locations from which soil samples were collected and analyzed are shown in Figure 5-17. Analytical results for soil collected from this property (Table 5-10) revealed no areas exhibiting elevated concentrations of thorium-230, which ranged from less than 0.6 to 2.4 pCi/g.

5.5 PROPERTY 4

Property 4 is located on McDonnell Boulevard. Locations from which soil samples were collected and analyzed from the McDonnell Boulevard right-of-way bordering Property 4 are shown in Figure 5-18. Analytical results for soil (Table 5-11) revealed no areas exhibiting elevated concentrations of thorium-230. Thorium-230 concentrations ranged from 1.4 to 3.9 pCi/g.

5.6 PROPERTY 5

Property 5 is located on McDonnell Boulevard. Locations from which soil samples were collected and analyzed are shown in Figure 5-19. Analytical results for soil collected from this property (Table 5-12) revealed one area exhibiting an elevated concentration of thorium-230. Thorium-230 concentrations ranged from 1.1 to 14 pCi/g. Areas and depths of thorium-230 contamination on Property 5 are shown in Figure 5-20.

5.7 PROPERTY 6

Property 6 is located on McDonnell Boulevard. Locations from which soil samples were collected and analyzed are shown in Figure 5-21. Analytical results for soil (Table 5-13) revealed no areas exhibiting elevated concentrations of thorium-230, which ranged from 1.1 to 1.3 pCi/g.

5.8 PROPERTY 7

Property 7 is located on McDonnell Boulevard. Locations from which soil samples were collected and analyzed are shown in Figure 5-22. Analytical results for soil (Table 5-14) revealed six areas with elevated concentrations of thorium-230, which ranged from less than 0.6 to 32 pCi/g. Areas and depths of thorium-230 contamination at Property 7 are shown in Figure 5-23.

5.9 PROPERTY 8

Property 8 is located on McDonnell Boulevard. Soil sampling locations at this property are shown in Figure 5-24. Analytical results for soil (Table 5-15) revealed no areas exhibiting elevated thorium-230 concentrations. Thorium-230 concentrations ranged from 1.2 to 2.2 pCi/g.

5.10 PROPERTY 9

Property 9 is located on McDonnell Boulevard. Soil sampling locations augered at Property 9 are shown in Figure 5-25.

Analytical results for soil, provided in Table 5-16, revealed elevated concentrations of thorium-230 at two locations. Areas and depths of thorium-230 contamination are shown in Figure 5-26. Before remedial action begins, additional soil samples will be collected and analyzed from this property to more accurately define contamination boundaries. Figure 5-26 depicts a conservative estimate of contamination boundaries.

5.11 PROPERTY 10

Property 10 is located on McDonnell Boulevard. Locations from which soil samples were collected and analyzed are shown in Figure 5-27. Analytical results for soil (Table 5-17) revealed one area with an elevated concentration of thorium-230. Thorium-230 concentrations ranged from 1.2 to 7.2 pCi/g. Areas and depths of thorium-230 contamination at Property 10 are shown in Figure 5-28.

5.12 PROPERTY 11

Property 11 is bordered by McDonnell Boulevard on the south and Byassee Drive on the east. Locations from which soil samples were collected and analyzed are shown in Figure 5-29. Analytical results for soil (Table 5-18) revealed two areas with elevated concentrations of thorium-230, which ranged from less than 0.8 to 18 pCi/g. Areas and depths of thorium-230 contamination at Property 11 are shown in Figure 5-30.

5.13 PROPERTY 12

Property 12 is bordered by McDonnell Boulevard on the south and Byassee Drive on the west. In January 1988, a radiological survey was performed on the southern portion of this property that included a walkover gamma scan and collection and analysis of 54 soil samples for uranium-238, radium-226, thorium-232, and thorium-230. Soil sampling locations on Property 12 are shown in Figure 5-31. Analytical results for (Table 5-19) soil revealed elevated concentrations of radium-226 and thorium-230 in surface and subsurface samples. All uranium-238 concentrations were less than 19 pCi/g. Radium-226 concentrations ranged from 0.6 to 13 pCi/g. Concentrations of thorium-232 and thorium-230 ranged from 0.7 to 5 pCi/g and from less than 1 to 570 pCi/g, respectively. Soil samples collected during the 1989 characterization effort at the haul roads were analyzed for thorium-230 only; therefore, there are no results reported for uranium-238, radium-226, or thorium-232 in Table 5-19. Further soil sampling is required before boundaries of radioactive contamination can be established at Property 12. This sampling will occur before remedial action begins.

5.14 PROPERTY 13

Property 13 is located on McDonnell Boulevard. Locations from which soil samples were collected and analyzed are shown in Figure 5-32. Analytical results for soil (Table 5-20) revealed 14 areas with elevated concentrations of thorium-230, which ranged from less than 0.7 to 370 pCi/g. Additional soil sampling is required before boundaries of radiological contamination can be determined at Property 13. This sampling will take place before remedial action begins.

5.15 PROPERTY 14

Property 14 is located on McDonnell Boulevard, east of SLAPS. Locations from which soil samples were collected and analyzed are shown in Figure 5-33. Analytical results for soil (Table 5-21) revealed 10 areas exhibiting elevated concentrations of thorium-230, which ranged from less than 0.9 to 33 pCi/g. Areas and depths of radioactive contamination at Property 14 are shown in Figure 5-34.

5.16 PROPERTY 14A

Soil samples were collected along the right-of-way of McDonnell Boulevard southeast of SLAPS, identified as Property 14A, and analyzed for thorium-230.

Soil sampling locations at Property 14A are shown in Figure 5-35. Analytical results for soil (Table 5-22) revealed elevated thorium-230 concentrations at nine locations. Concentrations of thorium-230 ranged from less than 0.4 to 36 pCi/g. Further soil sampling is required to establish the boundaries of radioactive contamination on Property 14A; this sampling will take place before remedial action begins.

5.17 PROPERTY 15

Property 15 is located on McDonnell Boulevard, southeast of SLAPS. Locations from which samples were collected and analyzed are shown in Figure 5-36. Analytical results for soil (Table 5-23) revealed 19 areas with elevated concentrations of thorium-230, which ranged from less than 0.6 to 460 pCi/g. Areas and depths of radiological contamination at Property 15 are shown in Figure 5-37.

Properties 1 through 15 all border McDonnell Boulevard. Contamination on these properties is generally confined to locations immediately adjacent to the boulevard and is generally shallow [less than 0.6 m (2 ft)]. Spotty radioactive contamination exists along McDonnell Boulevard from approximately the west 1400 line to the east 4400 line; boundaries of contamination have been established.

5.18 PROPERTY 16

Property 16 is located east of Eva Avenue. Nine of the soil samples collected from this property were analyzed for thorium-230. Samples collected from the Norfolk and Western Railroad property adjacent to Eva Avenue, bordering this property, were analyzed and are reported in Section 4.0. Locations from which soil samples were collected and analyzed from Property 16 are shown in Figure 5-38. Analytical results for soil (Table 5-24) revealed one sampling location exhibiting an elevated concentration of thorium-230; thorium-230 concentrations ranged from 1.5 to 6.6 pCi/g. Areas and depths of radioactive contamination at Property 16 are depicted in Figure 5-39.

5.19 PROPERTY 17

Property 17 is located east of Eva Avenue. Four soil samples collected from this property were analyzed for thorium-230. Samples collected from the Norfolk and Western Railroad property adjacent to Eva Avenue, bordering this property, were analyzed and are reported in Section 4.0. Locations from which soil samples were collected and analyzed are shown in Figure 5-40. Analytical results for soil (Table 5-25) revealed that none of the sampling locations exhibited elevated levels of thorium-230. Thorium-230 concentrations ranged from less than 0.9 to 1.4 pCi/g.

5.20 PROPERTY 18

Property 18 is located east of Eva Avenue. Soil samples collected from this property have been archived. Samples collected from the Eva Avenue right-of-way, bordering this property, were analyzed and are reported in Section 4.0. After analysis of the archived samples from the Norfolk and Western Railroad property adjacent to Eva Avenue is complete, samples from Property 18 will be analyzed if necessary.

5.21 PROPERTY 19

Property 19 is located east of Eva Avenue on Frost Avenue. Locations from which soil samples were collected and analyzed are shown in Figure 5-41. Analytical results for soil (Table 5-26) revealed one area with an elevated concentration of thorium-230. Concentrations of thorium-230 ranged from less than 0.7 to 11 pCi/g. The area and depth of thorium-230 contamination at Property 19 are shown in Figure 5-42.

Properties 16 through 19 are near Eva Avenue. (The property immediately adjacent to Eva Avenue is the Norfolk and Western Railroad property; analytical results for soil collected from this property are reported in Section 4.0.) Because of results from the Norfolk and Western characterization, a small number of samples were collected from Properties 16, 17, 18, and 19 to better define the boundaries of contamination. Only one sampling location on Property 16 exhibited a concentration of thorium-230 exceeding DOE guidelines. One small area of radioactive contamination exists on Property 19, on the Eva Avenue side adjacent to Frost Avenue.

5.22 PROPERTY 20

Property 20 is located on Frost Avenue. Locations from which soil samples were collected and analyzed are shown in Figure 5-43. Analytical results for soil (Table 5-27) revealed two areas with elevated concentrations of thorium-230, which ranged from 0.7 to 8.4 pCi/g. Areas and depths of radioactive contamination at Property 20 are shown in Figure 5-44.

5.23 PROPERTY 20A

Property 20A is located on Frost Avenue. Soil sampling locations are shown in Figure 5-45. Analytical results for soil (Table 5-28) revealed no areas exhibiting elevated concentrations of thorium-230. Thorium-230 concentrations ranged from less than 0.6 to 2.6 pCi/g.

5.24 PROPERTY 21

Property 21 is located on the north side of Frost Avenue. Locations from which soil samples were collected and analyzed are shown in Figure 5-46. Analytical results for soil (Table 5-29) revealed seven areas with elevated concentrations of thorium-230. Thorium-230 concentrations ranged from less than 0.5 to 230 pCi/g. The boundaries of radioactive contamination at Property 21 are depicted in Figure 5-47.

5.25 PROPERTY 22

Property 22 is located on Frost Avenue. Locations from which soil samples were collected and analyzed are shown in Figure 5-48. Analytical results for soil (Table 5-30) revealed six sampling locations with elevated concentrations of thorium-230. Concentrations of thorium-230 ranged from less than 0.6 to 110 pCi/g. Areas and depths of radioactive contamination at Property 22 are shown in Figure 5-49.

5.26 PROPERTY 23

Property 23 is located on Frost Avenue. Locations from which soil samples were collected and analyzed are shown in Figure 5-50. Analytical results for soil (Table 5-31) revealed seven sampling locations with elevated concentrations of thorium-230, which ranged from less than 0.8 to 710 pCi/g. Areas and depths of radioactive contamination at Property 23 are shown in Figure 5-51.

5.27 PROPERTY 24

Property 24 is located on the corner at the intersection of Hazelwood and Frost Avenues. Locations from which soil samples were collected and analyzed are shown in Figure 5-52. Analytical results for soil (Table 5-32) revealed 15 locations with elevated concentrations of thorium-230. Thorium-230 concentrations ranged from less than 0.4 to 710 pCi/g. The areal and vertical extents of radioactive contamination at Property 24 are shown in Figure 5-53.

5.28 PROPERTY 25

Property 25 is located on the south side of Frost Avenue. Locations from which samples were collected and analyzed from the Frost Avenue right-of-way bordering Property 25 are shown in Figure 5-54. Analytical results for soil (Table 5-33) revealed no areas exhibiting elevated levels of thorium-230. Thorium-230 concentrations ranged from 1 to 4.8 pCi/g.

5.29 PROPERTY 26

Property 26 is located on Frost Avenue. Locations from which soil samples were collected and analyzed are shown in Figure 5-55. Analytical results for soil (Table 5-34) revealed two sampling locations with elevated concentrations of thorium-230, which ranged from 1.4 to 6.9 pCi/g. Areas and depths of radioactive contamination at Property 26 are shown in Figure 5-56.

5.30 PROPERTY 27

Property 27 is located on the west corner at the intersection of Frost Avenue and Romiss Court. Locations from which soil samples were collected and analyzed are shown in Figure 5-57. Analytical results for soil (Table 5-35) revealed two areas with elevated concentrations of thorium-230, which ranged from 1.4 to 8.1 pCi/g. Areas and depths of radioactive contamination at Property 27 are shown in Figure 5-58. The area of contamination shown in Figure 5-58 is a conservative estimate of contamination boundaries. Before remedial action begins, additional soil samples will be collected and analyzed from this property to more accurately define contamination boundaries.

5.31 PROPERTY 28

Property 28 is located on the east corner at the intersection of Frost Avenue and Romiss Court. Locations from which soil samples were collected and analyzed are shown in Figure 5-59. Analytical results for soil (Table 5-36) revealed no areas exhibiting elevated levels of thorium-230. Thorium-230 concentrations ranged from 1.5 to 4.6 pCi/g.

5.32 PROPERTY 29

Property 29 is located on Frost Avenue. Locations from which soil samples were collected and analyzed are shown in Figure 5-60. None of the soil samples analyzed exhibited elevated thorium-230 concentrations, which ranged from 0.7 to 3.2 pCi/g. Analytical results for soil are provided in Table 5-37.

5.33 PROPERTY 30

Property 30 is located on the corner at the intersection of Frost Avenue and Jonas Place. Soil sampling locations at this property are shown in Figure 5-61. Analytical results for soil (Table 5-38) revealed one sampling location with an elevated concentration of thorium-230. Thorium-230 concentrations ranged from 1 to 8.8 pCi/g. Areas and depths of radioactive contamination at Property 30 are shown in Figure 5-62.

5.34 PROPERTY 31

Property 31 is located on Frost Avenue east of Jonas Place. Locations from which soil samples were collected and analyzed from the road's edge adjacent to Property 31 are shown in Figure 5-63. None of the samples exhibited elevated levels of thorium-230. Thorium-230 concentrations ranged from 1.2 to 2.1 pCi/g. Analytical results for soil are provided in Table 5-39.

Characterization results from the properties on Frost Avenue show that contaminated areas and levels of radioactivity appear to be greater on the properties located on the north side of Frost Avenue. In general, areas of contamination are shallow [0.6 m (2 ft)] and spotty along the length of Frost Avenue.

5.35 PROPERTY 31A

Property 31A is located on Hazelwood Avenue. Locations from which soil samples were collected and analyzed adjacent to this property are shown in Figure 5-64. Analytical results for soil (Table 5-40) revealed three sampling locations with elevated concentrations of thorium-230, which ranged from less than 1 to 41 pCi/g. Before remedial action begins, additional soil samples will be collected from the property to better define the boundaries of radioactive contamination.

5.36 PROPERTY 32

Property 32 is located on the corner at the intersection of Hazelwood Avenue and Seeger Industrial Drive. Locations from which soil samples were collected and analyzed are shown in Figure 5-65. Analytical results for soil (Table 5-41) revealed six sampling locations with elevated concentrations of thorium-230, which ranged from less than 0.3 to 540 pCi/g. Areas and depths of radioactive contamination at Property 32 are shown in Figure 5-66. Before remedial action begins, additional soil samples will be collected and analyzed to better define the boundaries of contamination. The areas of contamination shown in Figure 5-66 depict a conservative estimate of contamination boundaries.

5.37 PROPERTY 33

Property 33 is located on Hazelwood Avenue. Soil sampling locations are shown in Figure 5-67. Analytical results for soil (Table 5-42) revealed elevated concentrations of thorium-230 at four locations.

Thorium-230 concentrations ranged from 1.1 to 170 pCi/g. Areas and depths of radioactive contamination at Property 33 are shown in Figure 5-68.

5.38 PROPERTY 34

Property 34 is located on Hazelwood Avenue. Soil sampling locations are shown in Figure 5-69. Analytical results for soil collected from this property (Table 5-43) revealed three areas with elevated concentrations of thorium-230, which ranged from 1.3 to 140 pCi/g. Areas and depths of contamination at Property 34 are shown in Figure 5-70.

5.39 PROPERTY 35

Property 35 is bordered by Hazelwood Avenue on the west and Latty Avenue on the north. In January 1988, a radiological survey was performed on this property as part of the Latty Avenue vicinity properties characterization effort. The 1988 survey included a walkover gamma scan, collection of downhole gamma logging data, and collection and analysis of 246 soil samples for uranium-238, radium-226, thorium-232, and thorium-230.

Near-surface gamma radiation measurements at Property 35 ranged from approximately 4,000 to approximately 9,000 cpm. Downhole gamma logging was performed to indicate the general depth of gamma-emitting radionuclides. These data were used as an aid in the selection and analysis of soil samples. No significant variations in count rates were observed as gamma logging progressed in the boreholes on Property 35. Detailed gamma logging results are reported in Table 5-44.

Surface soil sampling locations from the 1988 survey conducted on Property 35 are shown in Figure 5-71. Subsurface locations are shown in Figure 5-72. (Note that these samples were collected using the Latty Avenue grid system.) In an effort to better define the boundaries of radioactive contamination on this property, additional sampling was performed during the haul roads vicinity property surveys in 1989. Soil sampling locations on Property 35 from the 1989 radiological survey are shown in Figure 5-73. (Note that these samples were collected using the SLAPS grid system.)

Analytical results for soil revealed elevated concentrations of radium-226 in surface soils and thorium-230 in surface and subsurface soils. All uranium-238 concentrations were less than 19 pCi/g. Radium-226 concentrations ranged from 0.7 to 11 pCi/g. Concentrations of thorium-232 and thorium-230 ranged from 0.8 to 5 pCi/g and from 0.8 to 1,014 pCi/g, respectively. Analytical results for soil collected and analyzed from the 1988 survey are provided in Table 5-45. Soil samples collected during the 1989 characterization effort at the haul roads were analyzed for thorium-230 only and are reported in Table 5-46. The boundaries of radioactive contamination at Property 35 are depicted in Figure 5-74.

Property 36, surveyed during the haul roads characterization effort, is reported in Subsection 4.5 as the Norfolk and Western Railroad property adjacent to Hazelwood Avenue and south of Latty Avenue.

5.40 PROPERTY 37

Property 37 is bordered by Latty Avenue on the north and Hazelwood Avenue on the east. In 1987, a radiological survey was performed on this property as part of the Latty Avenue vicinity properties characterization effort. The 1987 survey included a walkover gamma scan and collection and analysis of 41 soil samples for uranium-238, radium-226, thorium-232, and thorium-230.

Near-surface gamma radiation measurements at Property 37 ranged from approximately 2,000 to approximately 12,000 cpm. Downhole gamma logging was performed to indicate the general depth of gamma-emitting radionuclides. These data were used as an aid in the selection and analysis of soil samples. No significant variations in count rates were observed as gamma logging progressed in the boreholes. Detailed gamma logging results are reported in Table 5-47.

Surface soil sampling locations from the 1987 survey conducted on Property 37 are shown in Figure 5-75. Subsurface locations are shown in Figure 5-76. (Note that these samples were collected using the Latty Avenue grid system.) In an effort to better define the boundaries of radioactive contamination on this property, additional sampling was performed during the haul roads vicinity property surveys in 1989. Soil sampling locations on Property 37 from the 1989 radiological survey are shown in Figure 5-77. (Note that these samples were collected using the SLAPS grid system.)

Analytical results for soil revealed elevated concentrations of radium-226 and thorium-230 in surface samples. All uranium-238 concentrations were less than 37 pCi/g. Radium-226 concentrations ranged from 0.6 to 7 pCi/g. Thorium-232 and thorium-230 concentrations ranged from 0.8 to 7 pCi/g and from less than 0.8 to 600 pCi/g, respectively. Analytical results for soil collected and analyzed from the 1987 survey are provided in Table 5-48. Soil samples collected during the 1989 characterization effort at the haul roads were analyzed for thorium-230 only and are reported in Table 5-49. The boundaries of radioactive contamination at Property 37 are shown in Figure 5-78. Contamination is shown at Latty Avenue, adjacent to Property 37. These areas of contamination are also shown in Figure 5-3 and were determined from the soil sample results collected during the radiological characterization of Latty Avenue.

5.41 PROPERTY 38

Property 38 is bordered by Latty Avenue on the south and Hazelwood Avenue on the east. In 1987, a radiological survey was performed on this property as part of the Latty Avenue vicinity properties characterization effort. The 1987 survey included downhole gamma logging of the boreholes and collection and analysis of 268 soil samples for uranium-238, radium-226, thorium-232, and thorium-230.

Downhole gamma logging was performed to indicate the general depth of gamma-emitting radionuclides. These data were used as an aid in the selection and analysis of soil samples. No significant variations in count rates were observed as gamma logging progressed in the boreholes. Detailed gamma logging results are reported in Table 5-50.

Surface soil sampling locations from the 1987 survey conducted on Property 38 are shown in Figure 5-79. Subsurface locations are shown in Figure 5-80. (Note that these samples were collected using the Latty Avenue grid system.) In an effort to better define the boundaries of radioactive contamination on this property, additional sampling was performed during the haul roads vicinity property surveys in 1989. Soil sampling locations on Property 38 from the 1989 radiological survey are shown in Figure 5-81. (Note that these samples were collected using the SLAPS grid system.)

Analytical results for soil revealed areas with elevated concentrations of thorium-230. All uranium-238 concentrations were less than 25 pCi/g. Radium-226 concentrations ranged from 0.6 to 6 pCi/g. Concentrations of thorium-232 and thorium-230 ranged from 0.6 to 5 pCi/g and from 0.5 to 1,200 pCi/g, respectively. Analytical results for soil collected and analyzed from the 1987 survey are provided in Table 5-51. Soil samples collected during the 1989 characterization effort at the haul roads were analyzed for thorium-230 only and are reported in Table 5-52. The boundaries of radioactive contamination at Property 38 are shown in Figure 5-82. Contamination is shown at Latty Avenue, adjacent to Property 38. These areas of contamination are also shown in Figure 5-3 and were determined from the soil sample results collected during the radiological characterization of Latty Avenue.

5.42 PROPERTY 39

Property 39 is located on the east side of Hazelwood Avenue. In 1987, a radiological survey was performed on this property as part of the Latty Avenue vicinity properties characterization effort. The 1987 survey included downhole gamma logging of the boreholes and collection and analysis of 46 soil samples for uranium-238, radium-226, thorium-232, and thorium-230.

Downhole gamma logging was performed to indicate the general depth of gamma-emitting radionuclides. These data were used as an aid in the selection and analysis of soil samples. No significant variations in count rates were observed as gamma logging progressed in the boreholes. Detailed gamma logging results are reported in Table 5-53.

Surface soil sampling locations from the 1987 survey conducted on Property 39 are shown in Figure 5-83. Subsurface locations are shown in Figure 5-84. (Note that these samples were collected using the Latty Avenue grid system.) In an effort to better define the boundaries of radioactive contamination on this property, additional sampling was performed during the haul roads vicinity property surveys in 1989. Soil sampling locations on Property 39 from the 1989 radiological survey are shown in Figure 5-85. (Note that these samples were collected using the SLAPS grid system.)

Analytical results for soil revealed areas exhibiting elevated concentrations of thorium-230 in surface and subsurface soils. All uranium-238 concentrations were less than 14 pCi/g. Radium-226 concentrations ranged from 0.7 to 3.2 pCi/g. Concentrations of thorium-232 and thorium-230 ranged from 0.6 to 3 pCi/g and from less than 0.8 to 200 pCi/g, respectively. Analytical results for soil collected and analyzed from the 1987 survey are provided in Table 5-54. Soil samples collected during the 1989 characterization effort at the haul roads are reported in Table 5-55. The boundaries of radioactive contamination at Property 39 are shown in Figure 5-86.

Contamination is shown at Latty Avenue, adjacent to Property 39. These areas of contamination are also shown in Figure 5-3 and were determined from the soil sample results collected during the radiological characterization of Latty Avenue.

5.43 PROPERTY 40

Property 40 is located on Hazelwood Avenue. Soil sampling locations from which samples were collected and analyzed from Property 40 are shown in Figure 5-87. Analytical results for soil (Table 5-56) revealed nine sampling locations with elevated levels of thorium-230. Thorium-230 concentrations ranged from less than 0.5 to 110 pCi/g. Areas and depths of radioactive contamination at Property 40 are shown in Figure 5-88.

5.44 PROPERTY 41

Property 41 is bordered by Nyflot Avenue on the south and Hazelwood Avenue on the west. Soil sampling locations at this property are shown in Figure 5-89. Analytical results for soil (Table 5-57) revealed three locations exhibiting elevated concentrations of thorium-230, which ranged from 0.8 to 53 pCi/g. Areas and depths of radioactive contamination at Property 41 are shown in Figure 5-90.

5.45 PROPERTY 42

Property 42 is located on Hazelwood Avenue. Locations from which soil samples were collected and analyzed are shown in Figure 5-91. Analytical results for soil (Table 5-58) revealed six sampling locations with elevated concentrations of thorium-230, which ranged from 1.4 to 63 pCi/g. Areas and depths of radioactive contamination at Property 42 are shown in Figure 5-92.

5.46 PROPERTY 43

Property 43 is bordered by Heather Lane on the north and Hazelwood Avenue on the west. Locations from which soil samples were collected and analyzed are shown in Figure 5-93. Analytical results for soil (Table 5-59) revealed two sampling locations with elevated concentrations of thorium-230, which ranged from less than 0.8 to 22 pCi/g. Areas and depths of radioactive contamination at Property 43 are shown in Figure 5-94.

5.47 PROPERTY 44

Property 44 is bordered by Heather Lane on the south and Hazelwood Avenue on the west. Soil sampling locations on Property 44 are shown in Figure 5-95. Analytical results for soil (Table 5-60) revealed three areas with elevated concentrations of thorium-230, which ranged from 1.1 to 91 pCi/g. Areas and depths of radioactive contamination at Property 44 are shown in Figure 5-96.

5.48 PROPERTY 45

Property 45 is located on Hazelwood Avenue. Locations from which soil samples were collected and analyzed are shown in Figure 5-97. Analytical results for soil (Table 5-61) revealed three sampling locations exhibiting elevated levels of thorium-230, which ranged from 1 to 21 pCi/g. Areas and depths of radioactive contamination at Property 45 are shown in Figure 5-98.

5.49 PROPERTY 46

Property 46 is located on Hazelwood Avenue. Locations from which soil samples were collected and analyzed are shown in Figure 5-99. Analytical results for soil (Table 5-62) revealed one area with an elevated concentration of thorium-230. Thorium-230 concentrations ranged from less than 0.8 to 7 pCi/g. Additional soil sampling is required to better define the boundaries of radioactive contamination; this sampling will occur before remedial action begins.

5.50 PROPERTY 47

Property 47 is located on Hazelwood Avenue. Locations from which soil samples were collected and analyzed are shown in Figure 5-100. Analytical results for soil (Table 5-63) revealed three areas with elevated concentrations of thorium-230, which ranged from 0.9 to 110 pCi/g. Areas and depths of radioactive contamination at Property 47 are shown in Figure 5-101.

5.51 PROPERTY 48

Property 48 is bordered by Hazelwood Avenue on the west and Pershall Road on the east. Locations from which soil samples were collected and analyzed are shown in Figure 5-102. Analytical results for soil (Table 5-64) revealed eight sampling locations exhibiting elevated concentrations of thorium-230, which ranged from 0.7 to 34 pCi/g. Areas and depths of radioactive contamination at Property 48 are shown in Figure 5-103.

5.52 PROPERTY 48A

Property 48A is located on the east corner at the intersection of Hazelwood Avenue and Pershall Road. Locations from which soil samples were collected and analyzed from the rights-of-way adjacent to this property are shown in Figure 5-104. Analytical results for soil (Table 5-65) revealed that none of the sampling locations exhibited elevated levels of thorium-230. Thorium-230 concentrations ranged from 1.4 to 1.9 pCi/g.

Properties 31A through 48A and Property 53 border Hazelwood Avenue. Characterization results from these properties show that contamination is generally confined to locations immediately adjacent to the road and is shallow [0.6 m (2 ft)]. Radioactive contamination is spotty along Hazelwood Avenue from its intersection with Frost Avenue to Pershall Road.

5.53 PROPERTY 49

Property 49 is located on Pershall Road. Locations from which soil samples were collected and analyzed from the right-of-way adjacent to this property are shown in Figure 5-105. None of the soil sample analytical results (Table 5-66) exhibited elevated levels of thorium-230. Concentrations of thorium-230 ranged from 0.8 to 1.5 pCi/g.

5.54 PROPERTY 50

Property 50 is located on the south side of Pershall Road. Locations from which soil samples were collected and analyzed from the Pershall Road right-of-way adjacent to Property 50 are shown in Figure 5-106. None of the soil sample analytical results (Table 5-67) exhibited elevated concentrations of thorium-230. Thorium-230 concentrations ranged from 1 to 1.4 pCi/g.

5.55 PROPERTY 51

Property 51 is located on the south side of Pershall Road. Locations from which soil samples were collected and analyzed from the Pershall Road right-of-way bordering this property are shown in Figure 5-107. None of the soil sample analytical results (Table 5-68) exhibited elevated levels of thorium-230. Thorium-230 concentrations ranged from 1 to 1.7 pCi/g.

5.56 PROPERTY 52

Property 52 is bordered by Pershall Road on the north and Hanley Road on the east. Locations from which soil samples were collected and analyzed from the Pershall Road right-of-way adjacent to Property 52 are shown in Figure 5-108. None of the soil sample analytical results (Table 5-69) revealed elevated levels of thorium-230. Thorium-230 concentrations ranged from 1 to 4.3 pCi/g.

5.57 PROPERTY 53

Property 53 is located on the west corner at the Pershall Road and Hazelwood Avenue intersection. Locations from which soil samples were collected and analyzed from the rights-of-way bordering this property are shown in Figure 5-109. Analytical results for soil (Table 5-70) revealed four locations with elevated concentrations of thorium-230, which ranged from 0.8 to 21 pCi/g. Areas and depths of radioactive contamination at Property 53 are shown in Figure 5-110.

5.58 PROPERTY 54

Property 54 is located on the south side of Pershall Road. Locations from which samples were collected and analyzed from the Pershall Road right-of-way adjacent to Property 54 are shown in Figure 5-111. Analytical results for soil (Table 5-71) revealed that none of the locations exhibited elevated concentrations of thorium-230. Thorium-230 concentrations ranged from 0.7 to 1.7 pCi/g.

5.59 PROPERTY 55

Property 55 is bordered by Pershall Road on the north and Polson Lane on the west. Locations from which soil samples were collected and analyzed from the Pershall Road right-of-way bordering this property are shown in Figure 5-112. None of the analytical results (Table 5-72) indicated elevated thorium-230 concentrations, which ranged from 1.3 to 2.3 pCi/g.

5.60 PROPERTY 56

Property 56 is bordered by Pershall Road on the north and Coldwater Creek on the west. Locations from which soil samples were collected and analyzed are shown in Figure 5-113. Analytical results for soil (Table 5-73) revealed two areas with elevated levels of thorium-230. Thorium-230 concentrations ranged from less than 0.7 to 1,100 pCi/g. Additional soil sampling is required before the boundaries of radioactive contamination can be established at Property 56. This sampling will occur prior to remedial action.

5.61 PROPERTY 57

Property 57 is bordered by Pershall Road on the north and Coldwater Creek on the east. Locations from which soil samples were collected and analyzed are shown in Figure 5-114. In 1987, a portion of this property was sampled during the Coldwater Creek sampling effort, and surface soil samples were collected and analyzed. Analytical results for soil (Table 5-74) revealed elevated concentrations of thorium-230 at two locations. All uranium-238 concentrations were less than 15 pCi/g. Radium-226 concentrations ranged from 0.7 to 2.1 pCi/g. Concentrations of thorium-232 ranged from 0.7 to 3 pCi/g. Thorium-230 concentrations ranged from 1.3 to 19 pCi/g. Additional soil sampling is required before the boundaries of radioactive contamination can be determined at Property 57. This sampling will occur prior to remedial action.

5.62 PROPERTY 58

Property 58, located on Pershall Road, is bordered by Coldwater Creek on the southwest. Locations from which soil samples were collected and analyzed are shown in Figure 5-115. In 1987, a portion of this property was sampled during the Coldwater Creek sampling effort, and surface soil samples were collected and analyzed. Analytical results for soil (Table 5-75) revealed three sampling locations exhibiting elevated levels of thorium-230. All uranium-238 concentrations were less than 15 pCi/g. Radium-226 concentrations ranged from 0.6 to 2.8 pCi/g. Concentrations of thorium-232 ranged from 0.7 to 3 pCi/g. Thorium-230 concentrations ranged from less than 0.9 to 8.5 pCi/g. The boundaries of radioactive contamination at Property 58 are shown in Figure 5-116.

5.63 PROPERTY 59

Property 59 is located on the south side of Pershall Road. Locations from which soil samples were collected and analyzed from the Pershall Road right-of-way adjacent to Property 59 are shown in Figure 5-117. None of the analytical results (Table 5-76) revealed elevated concentrations of thorium-230, which ranged from 1.3 to 2.2 pCi/g.

5.64 PROPERTY 60

Property 60 is located on Pershall Road. Locations from which soil samples were collected and analyzed are shown in Figure 5-118. None of the analytical results (Table 5-77) revealed elevated levels of thorium-230. Thorium-230 concentrations ranged from less than 0.9 to 1.5 pCi/g.

5.65 PROPERTY 61

Property 61 is located on Pershall Road. Locations from which soil samples were collected and analyzed are shown in Figure 5-119. None of the analytical results (Table 5-78) revealed elevated levels of thorium-230, which ranged from 0.8 to 1.7 pCi/g.

5.66 PROPERTY 62

Property 62 is located on Pershall Road. Locations from which soil samples were collected and analyzed are shown in Figure 5-120. None of the analytical results (Table 5-79) revealed elevated concentrations of thorium-230, which ranged from 1 to 3.4 pCi/g.

5.67 PROPERTY 63

Property 63 is located on Pershall Road. Locations from which soil samples were collected and analyzed from the Pershall Road right-of-way adjacent to Property 63 are shown in Figure 5-121.

Analytical results for soil (Table 5-80) revealed one sampling location exhibiting an elevated concentration of thorium-230. Thorium-230 concentrations ranged from 1 to 10 pCi/g. Before remedial action on the haul roads vicinity properties begins, additional soil samples will be collected from this one area and analyzed to define the depth of contamination.

5.68 PROPERTY 63A

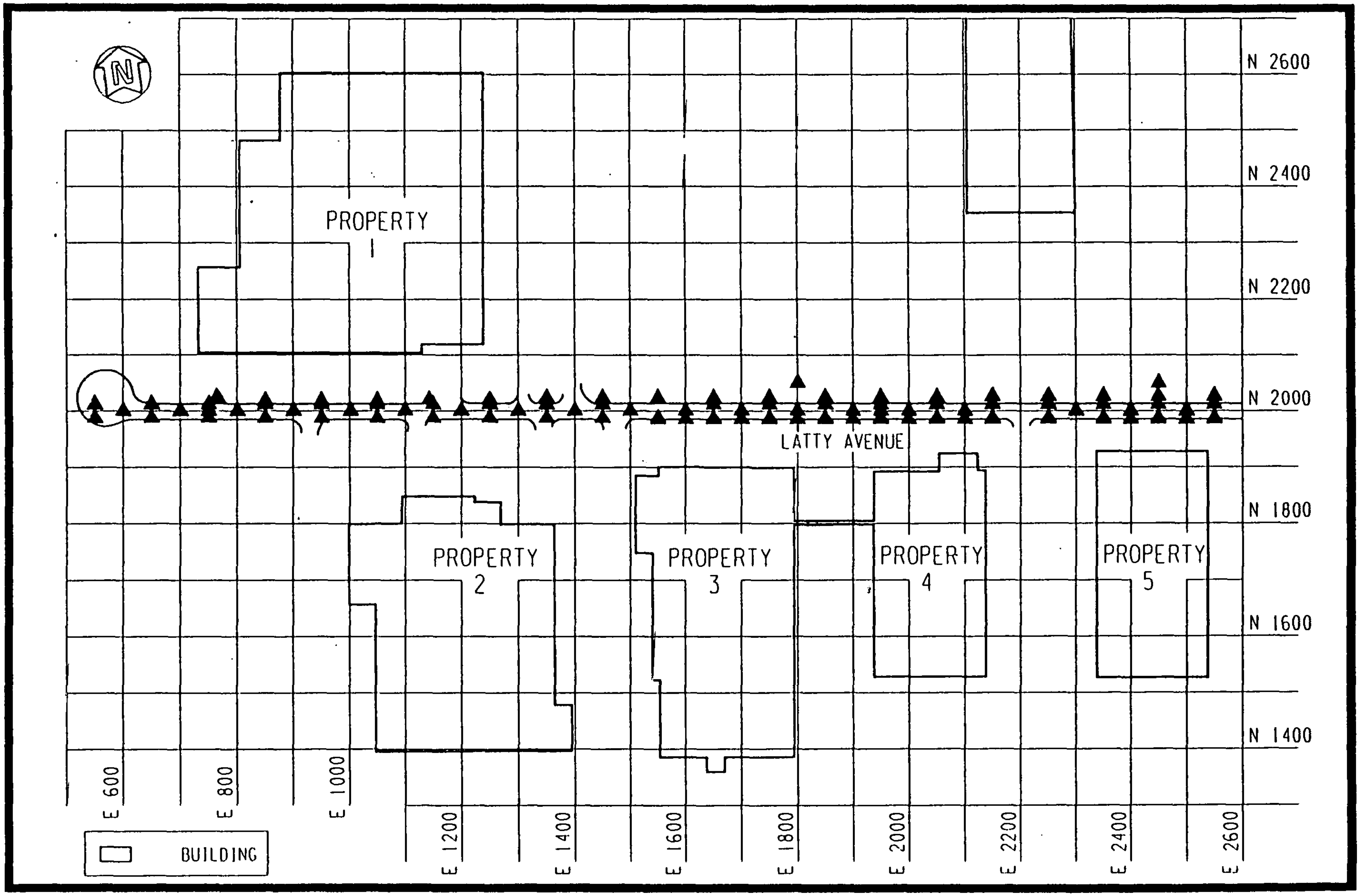
Soil samples were collected and analyzed for thorium-230 along the right-of-way of Pershall Road on the north side, adjacent to Interstate 270. All data obtained from this sampling effort are reported as Property 63A.

Soil sampling locations are shown in Figure 5-122. Analytical results for soil (Table 5-81) revealed elevated concentrations of thorium-230 at eight locations. Concentrations of thorium-230 ranged from 0.6 to 200 pCi/g. To define boundaries of radioactive contamination, additional soil samples will be collected and analyzed before remedial action begins.

Properties 49 through 63A border Pershall Road. Characterization results show that contamination is generally confined to areas immediately adjacent to the road and is shallow [0.6 m (2 ft)]. The boundaries of contamination have been established at Pershall Road; levels of thorium-230 exceeding DOE guidelines were not detected in any of the soil samples from the area east of the Hazelwood Avenue intersection with Pershall Road. Only one sampling location on Property 63 exhibited an elevated (above-guidelines) level of thorium-230, and 30 soil samples from south of this location revealed no areas exhibiting elevated levels. Radioactive contamination on the properties adjacent to Pershall Road is extremely spotty from Property 53 to the one location on Property 63 that showed an elevated level of thorium-230.

REFERENCE FOR SECTION 5.0

5-1. Oak Ridge National Laboratory. Results of the Mobile Gamma Scanning Activities in Berkeley, Bridgeton, and Hazelwood, Missouri, ORNL/RASA-85/7, Oak Ridge, Tenn., June 1985.



S34WMS28.DGN FIG2

FIGURE 5-1 SURFACE SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF LATTY AVENUE

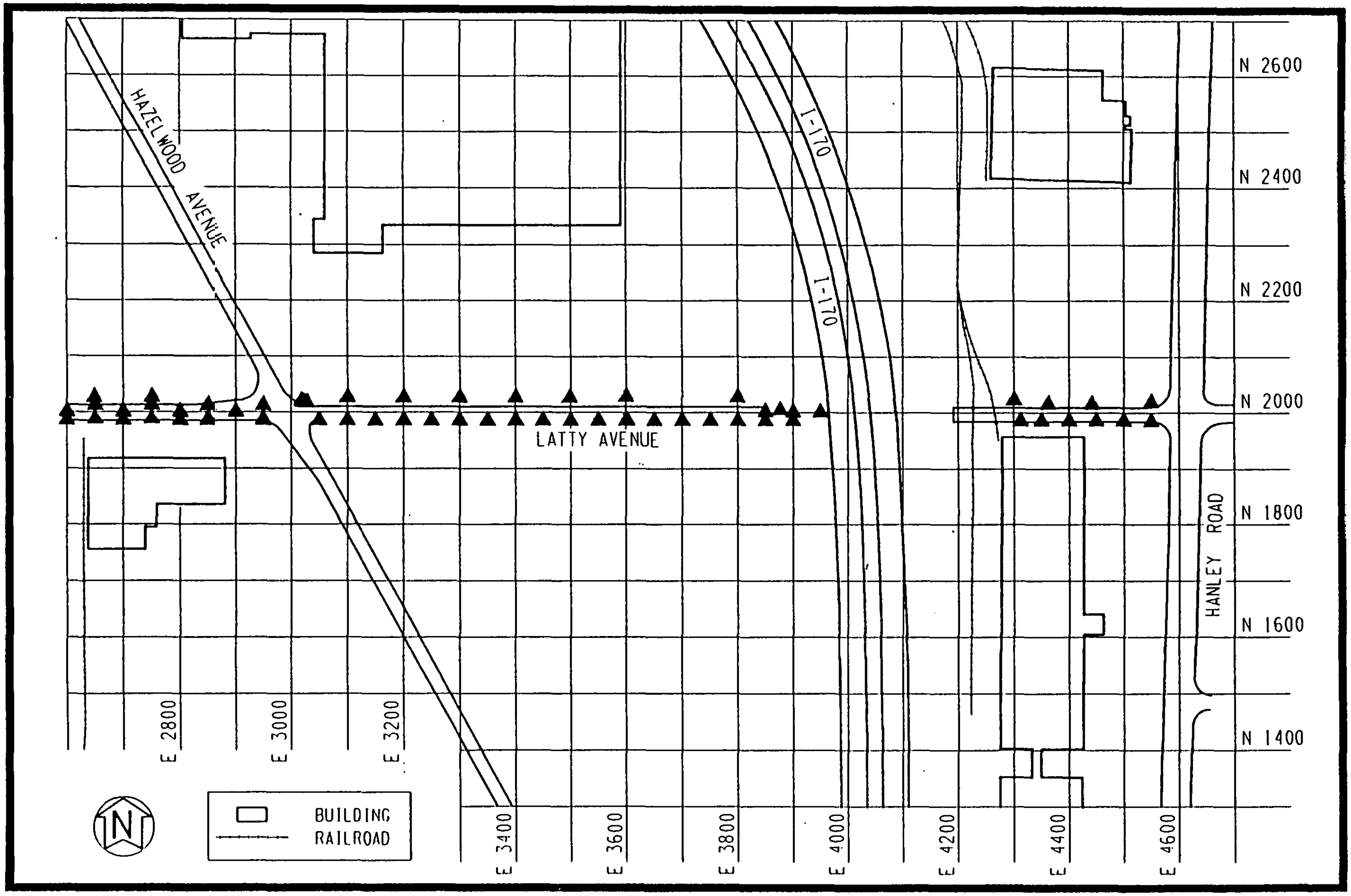


FIGURE 5-1 SURFACE SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF LATTY AVENUE (CONT.)

S34WMS29.DGN FIG2

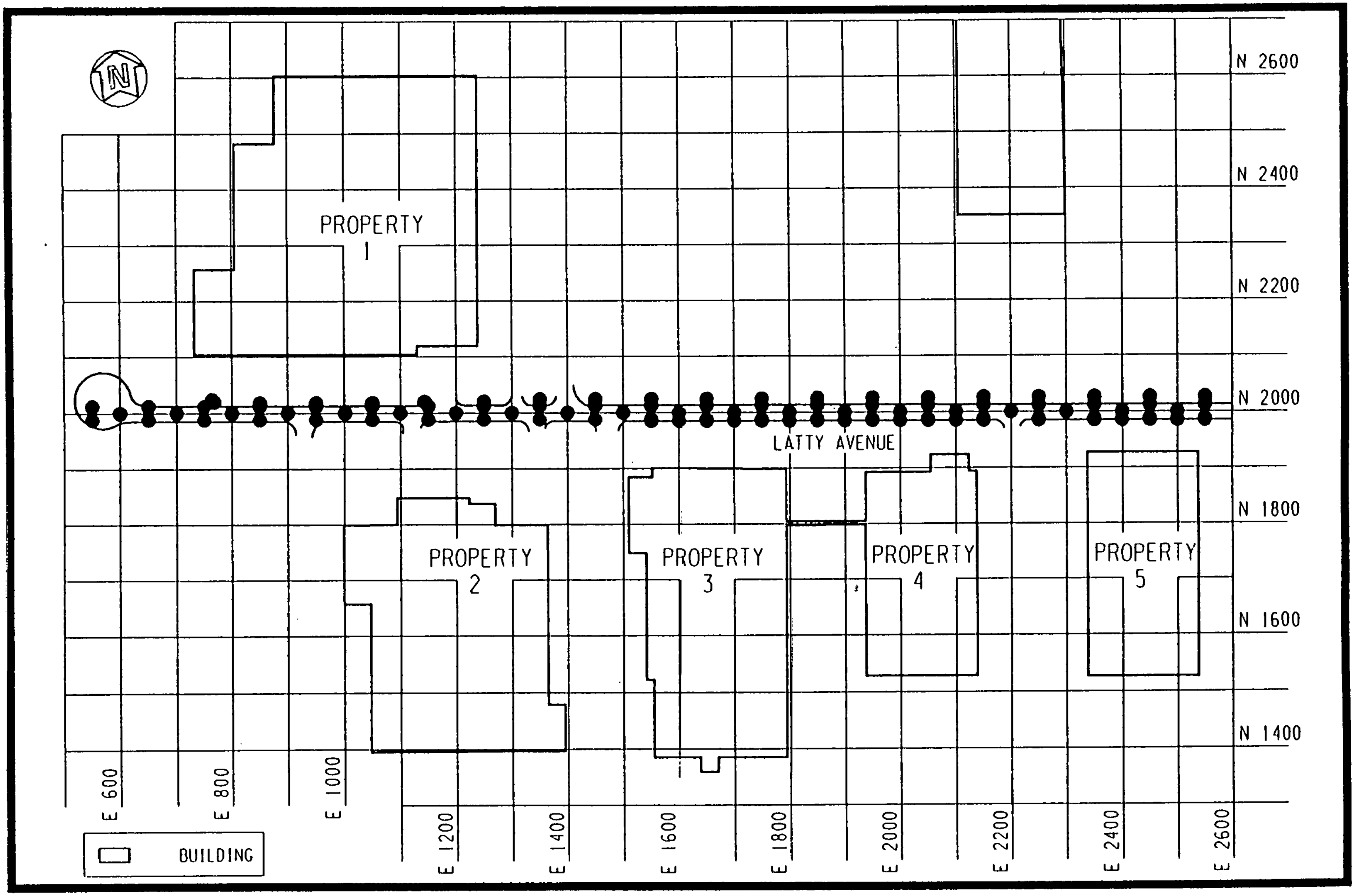


FIGURE 5-2 SUBSURFACE SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF LATTY AVENUE

S34WMS26.DGN FIG4

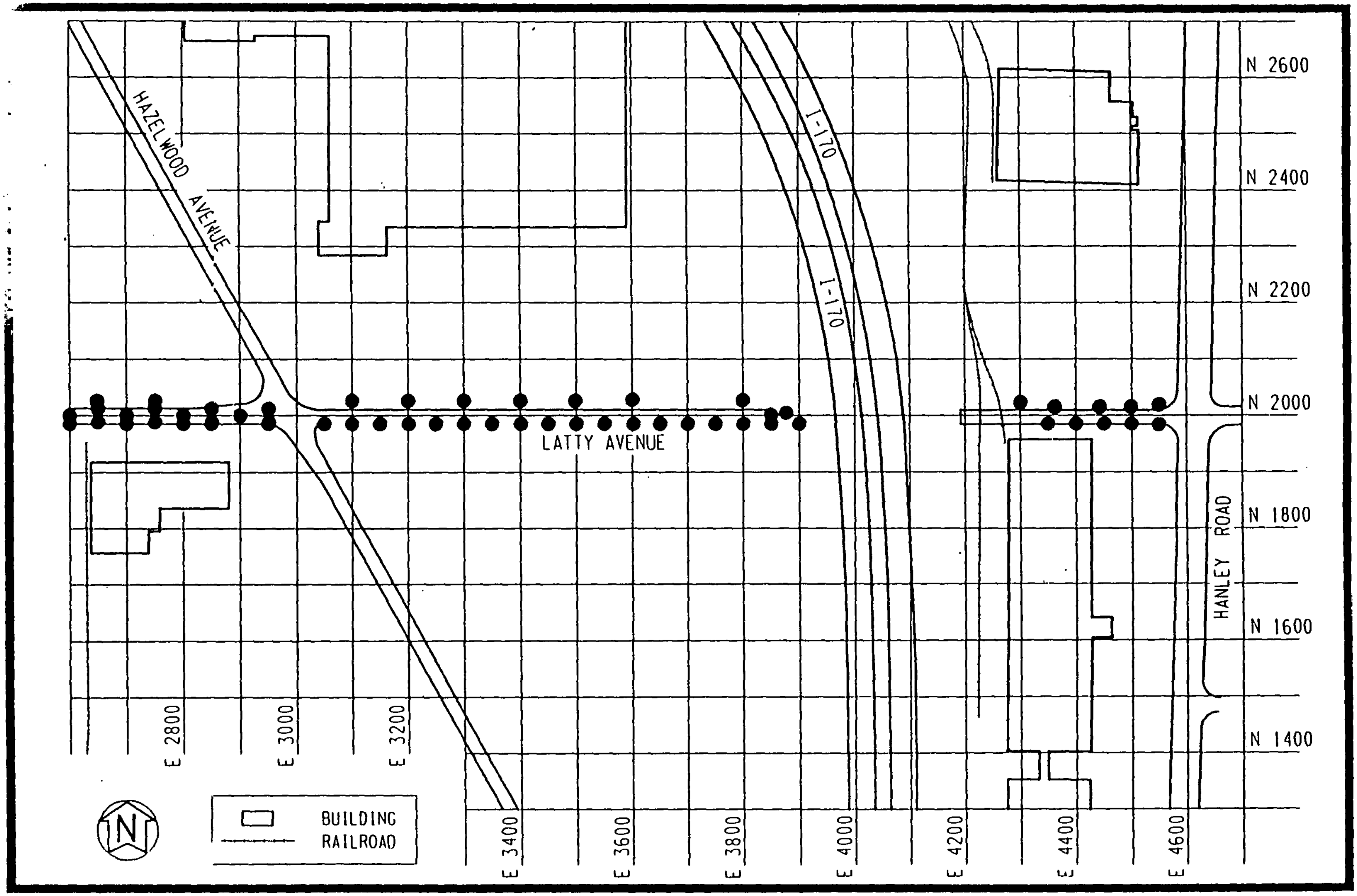


FIGURE 5-2 SUBSURFACE SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF LATTY AVENUE (CONT.)

534WMS29.DGN FIG4

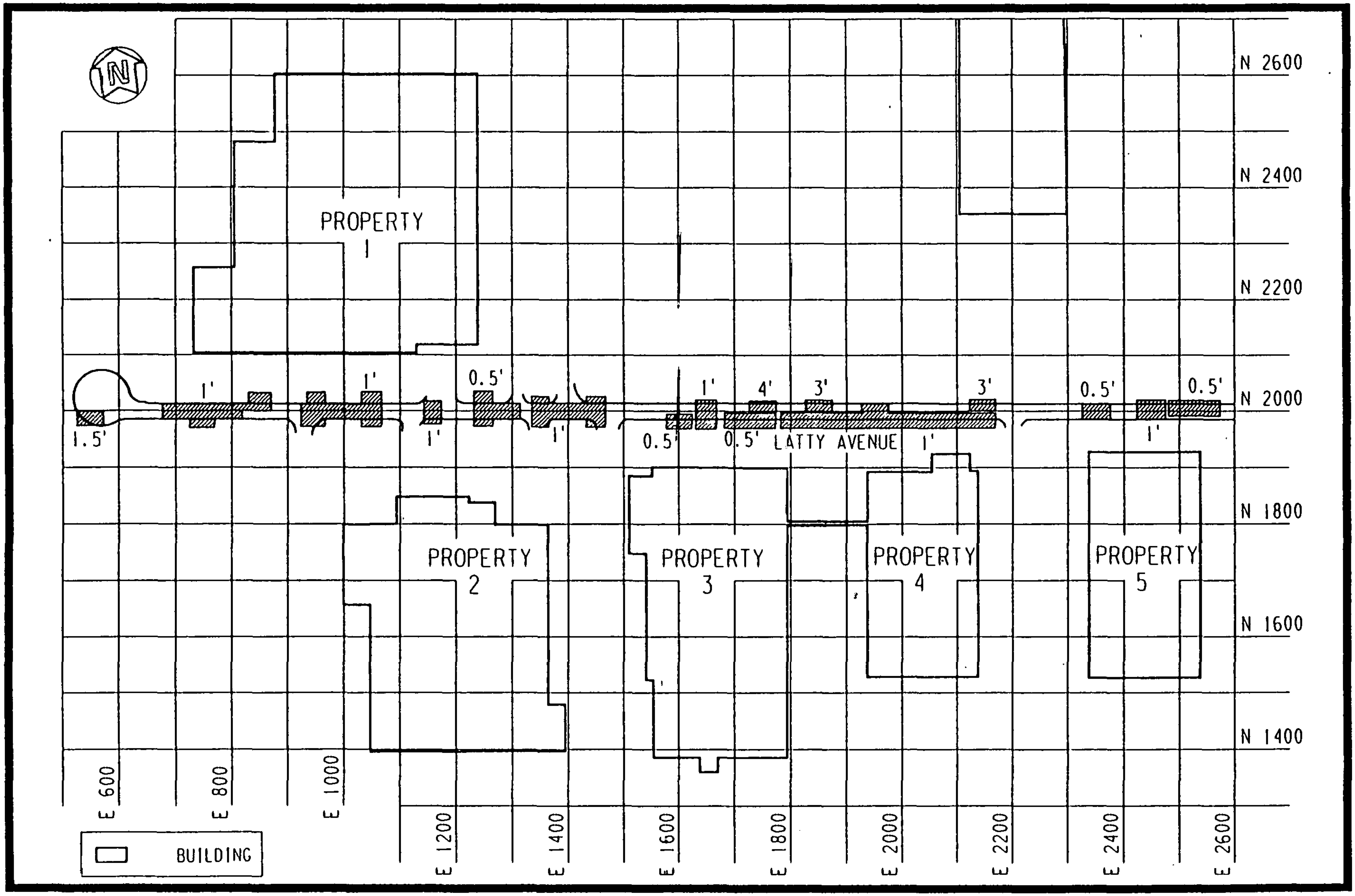


FIGURE 5-3 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT LATTY AVENUE

S34WMS28.DGN FIG7

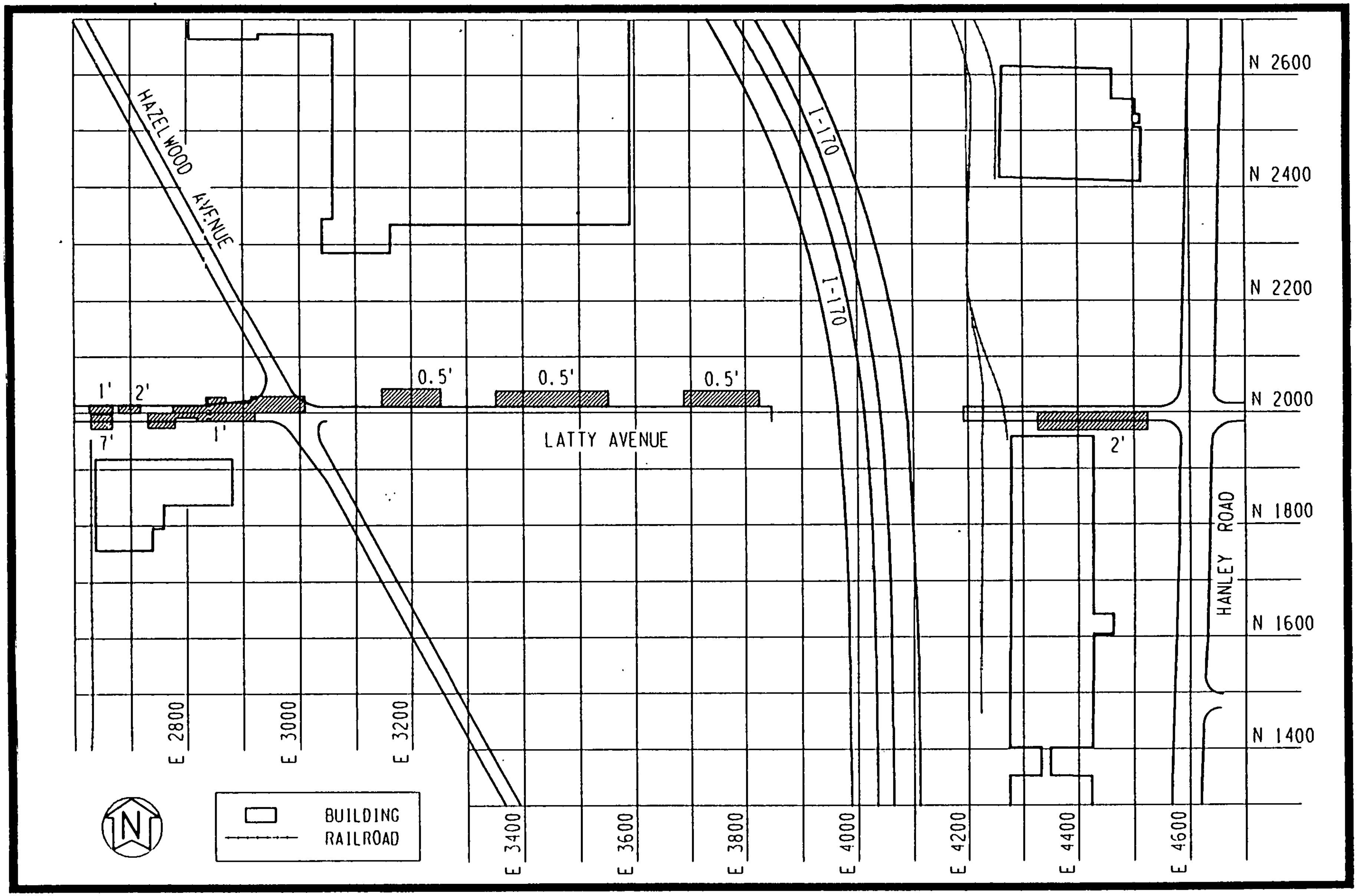


FIGURE 5-3 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT LATTY AVENUE (CONT.)

S34WMS29.DGN FIG7

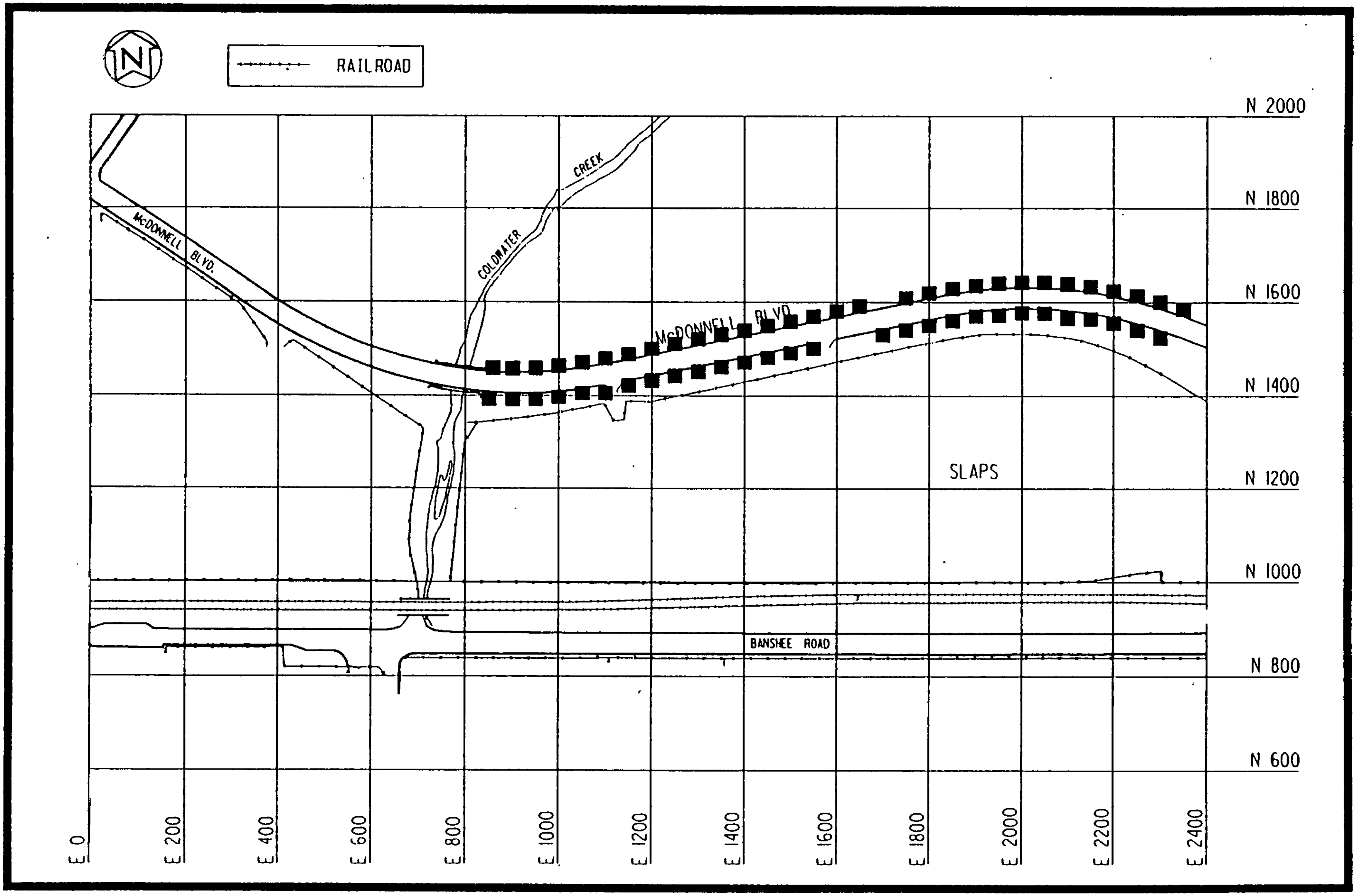


FIGURE 5-4 COMPOSITE SURFACE SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF MCDONNELL BOULEVARD

S34WMS24.DGN

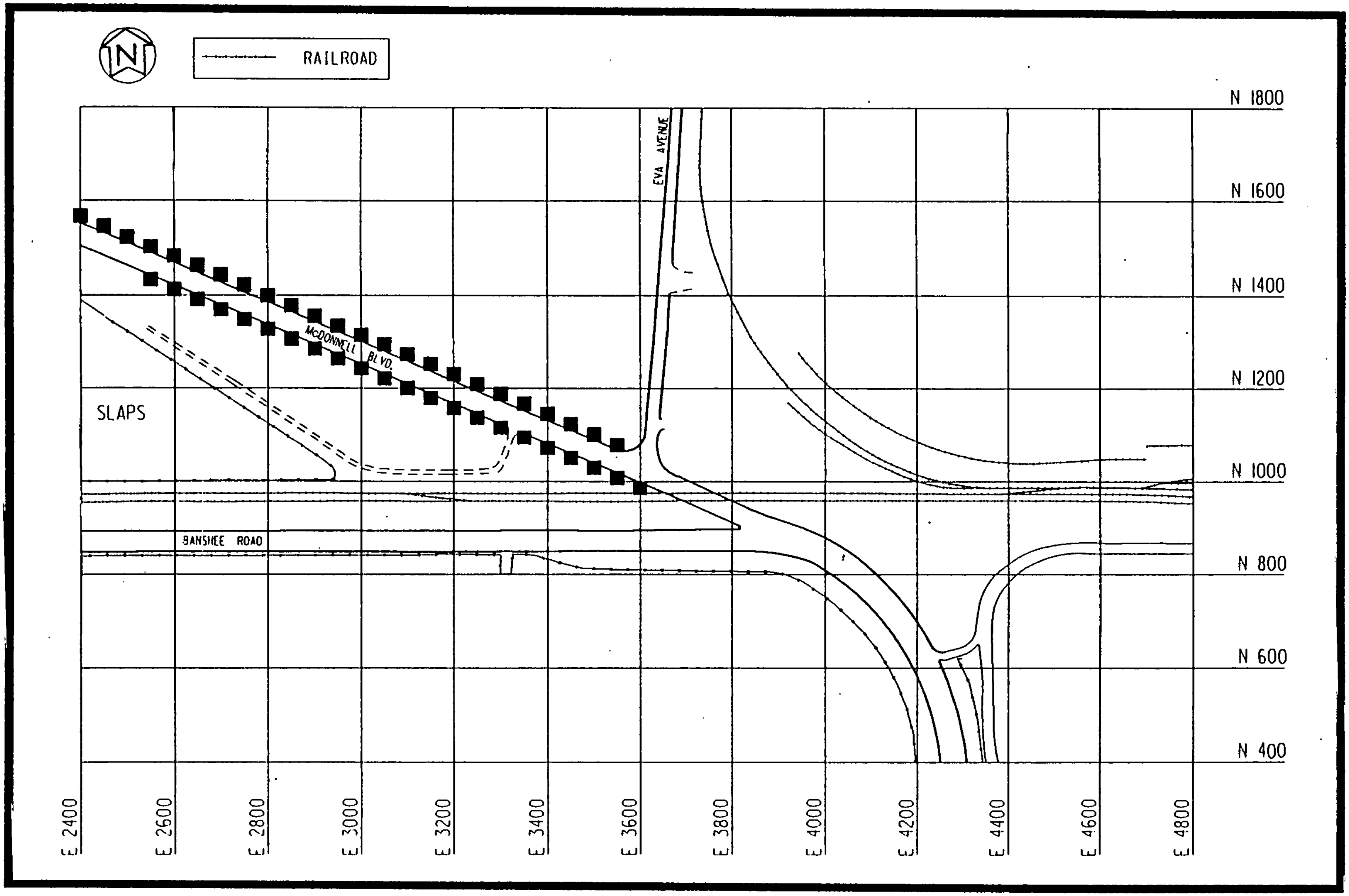


FIGURE 5-4 COMPOSITE SURFACE SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF MCDONNELL BOULEVARD (CONT.)

S34WMS25.DGN

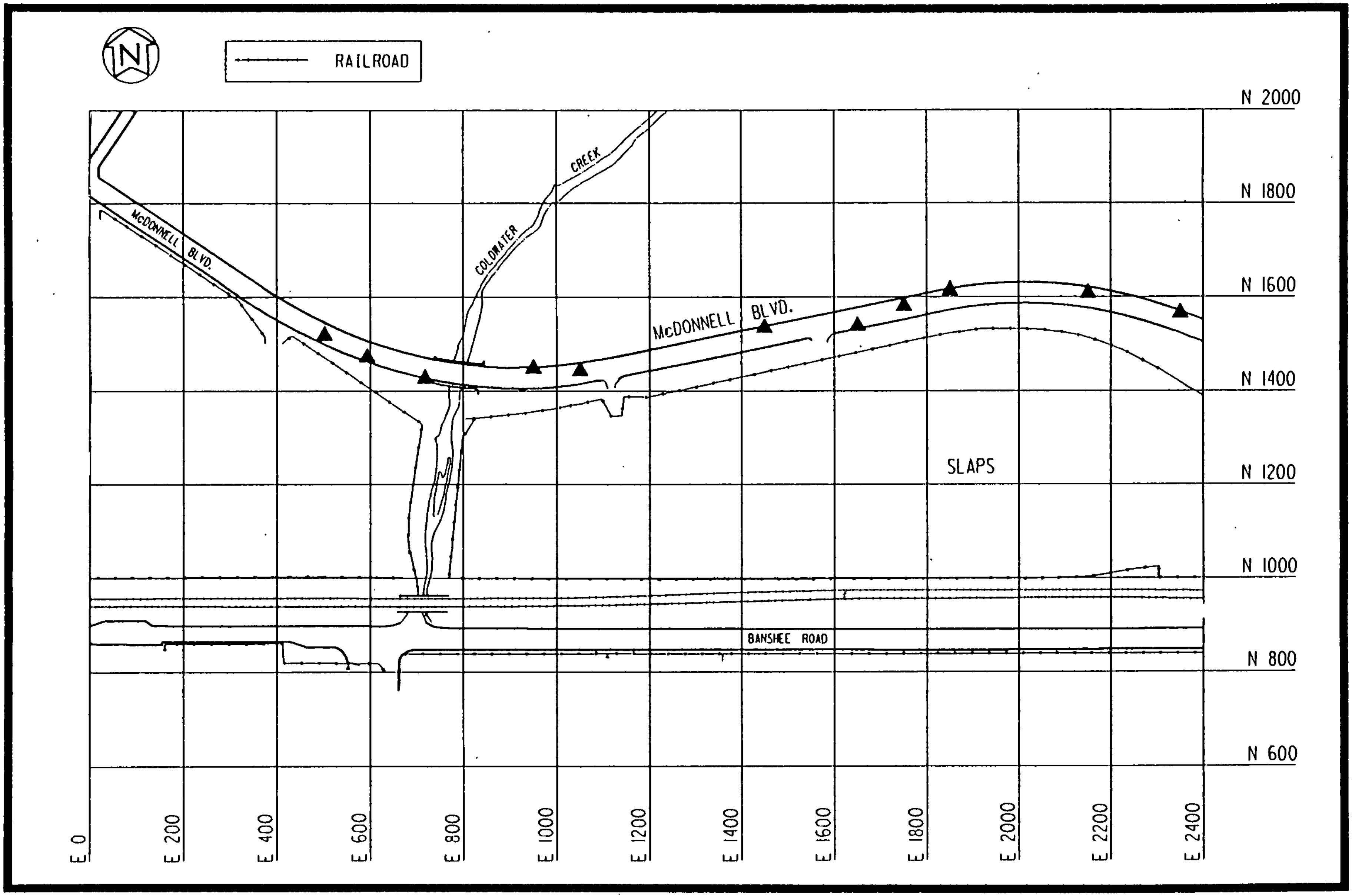


FIGURE 5-5 SURFACE SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF MCDONNELL BOULEVARD

S34WMS24.DGN

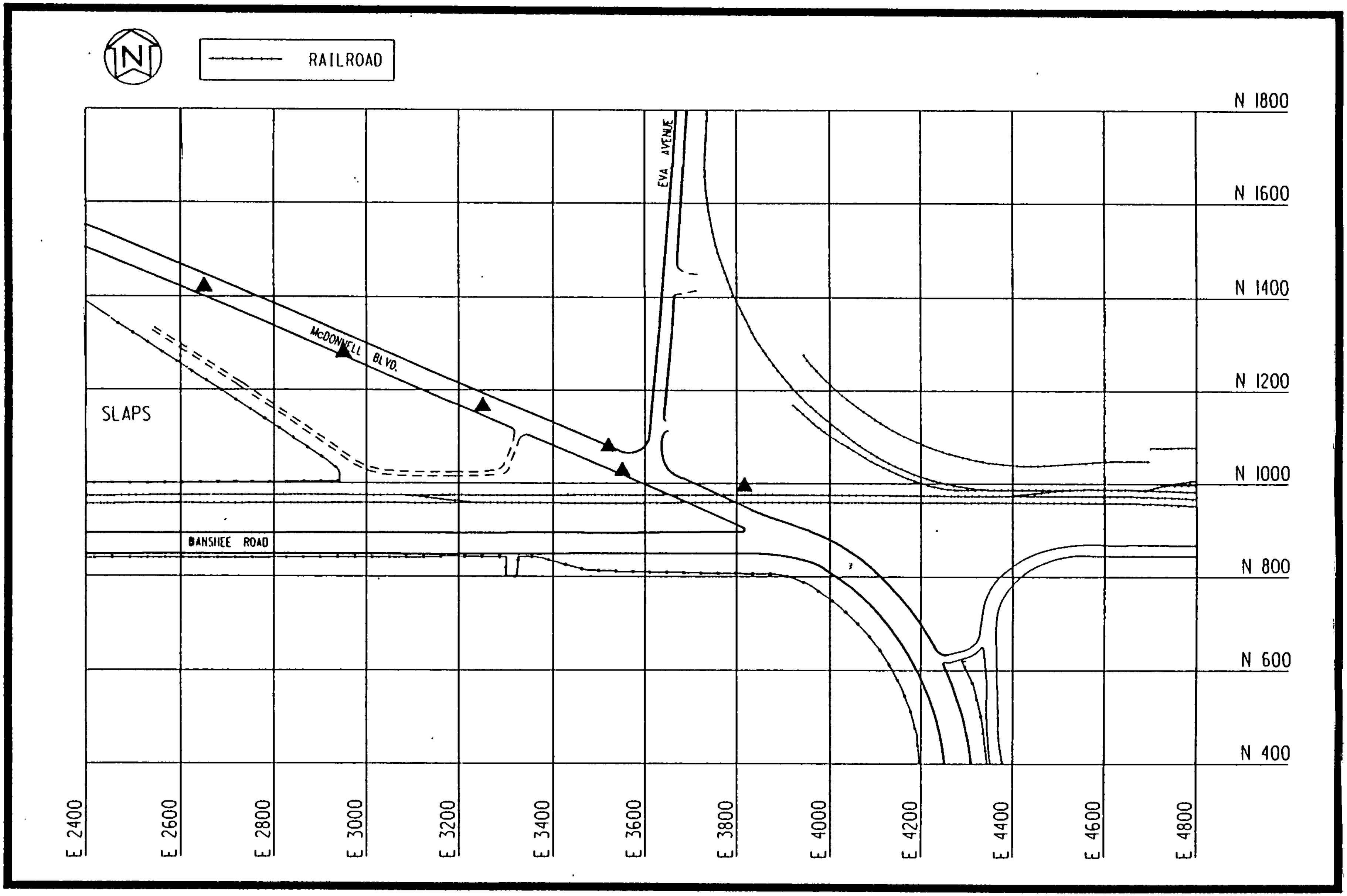


FIGURE 5-5 SURFACE SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF MCDONNELL BOULEVARD (CONT.)

S34WMS25.DGN

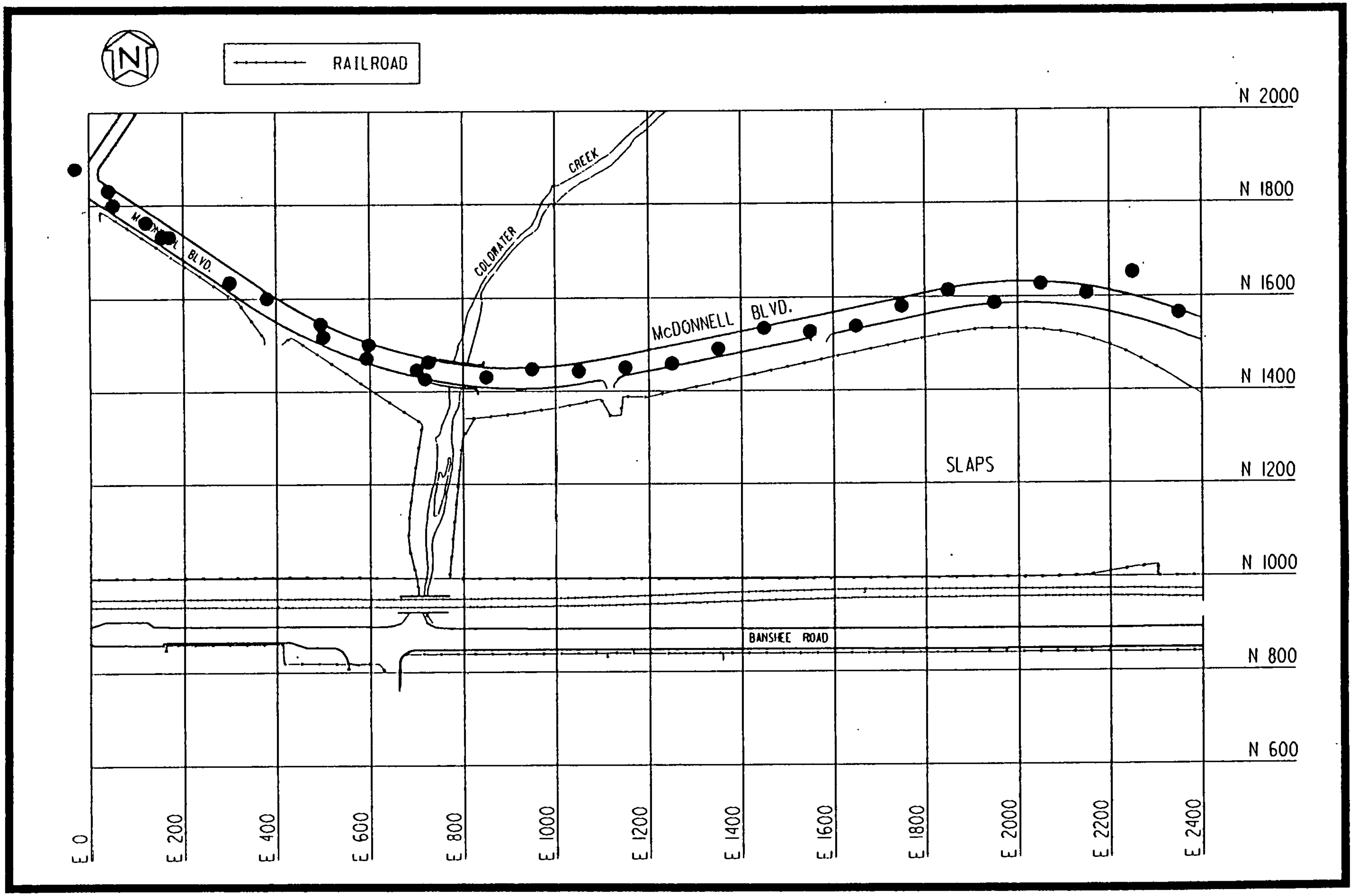


FIGURE 5-6 SUBSURFACE SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF MCDONNELL BOULEVARD

S34WMS24.DGN

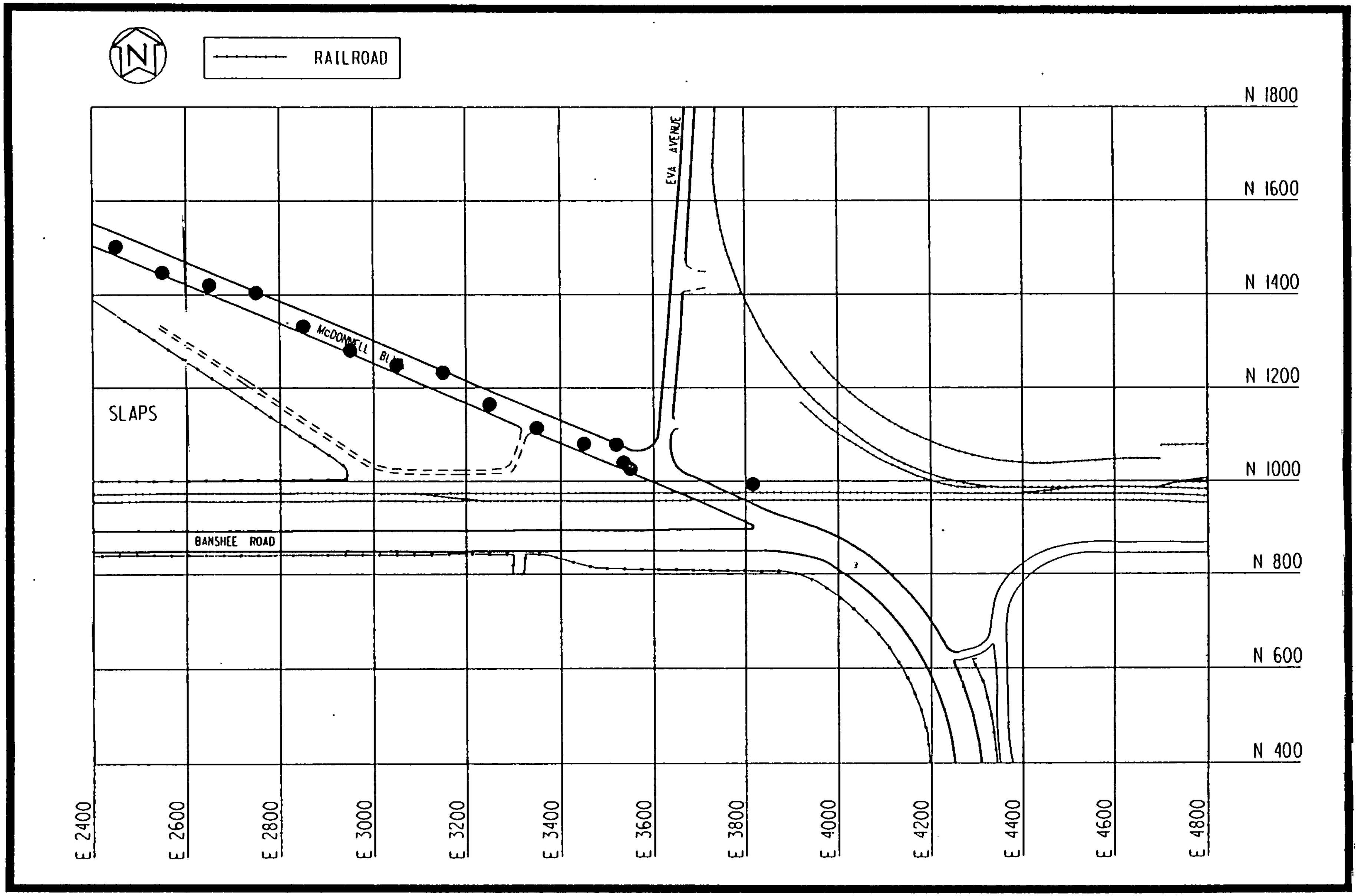


FIGURE 5-6 SUBSURFACE SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF MCDONNELL BOULEVARD (CONT.)

S34WMS25.DGN

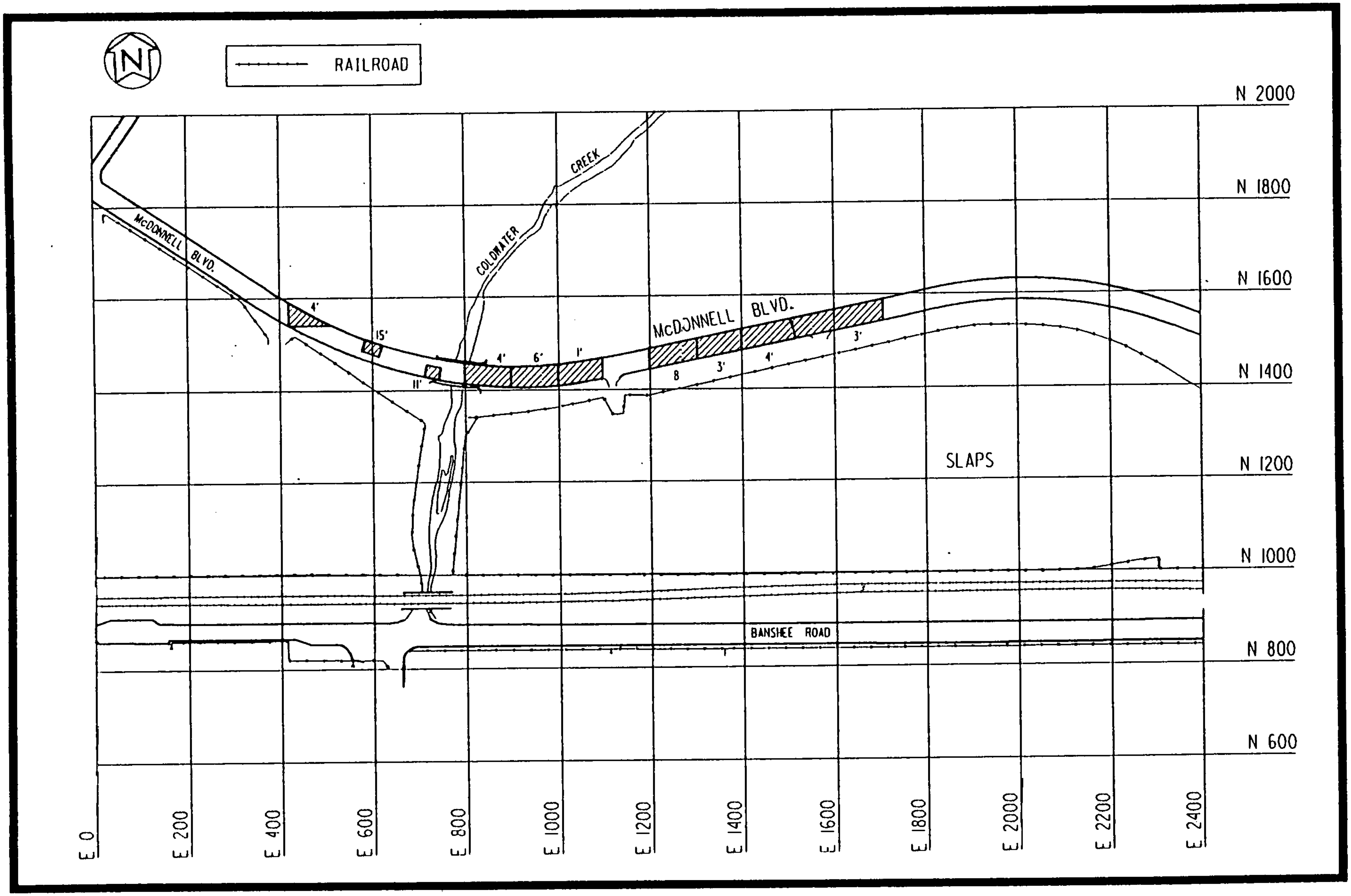


FIGURE 5-7 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT MCDONNELL BOULEVARD

S34WMS24.DGN

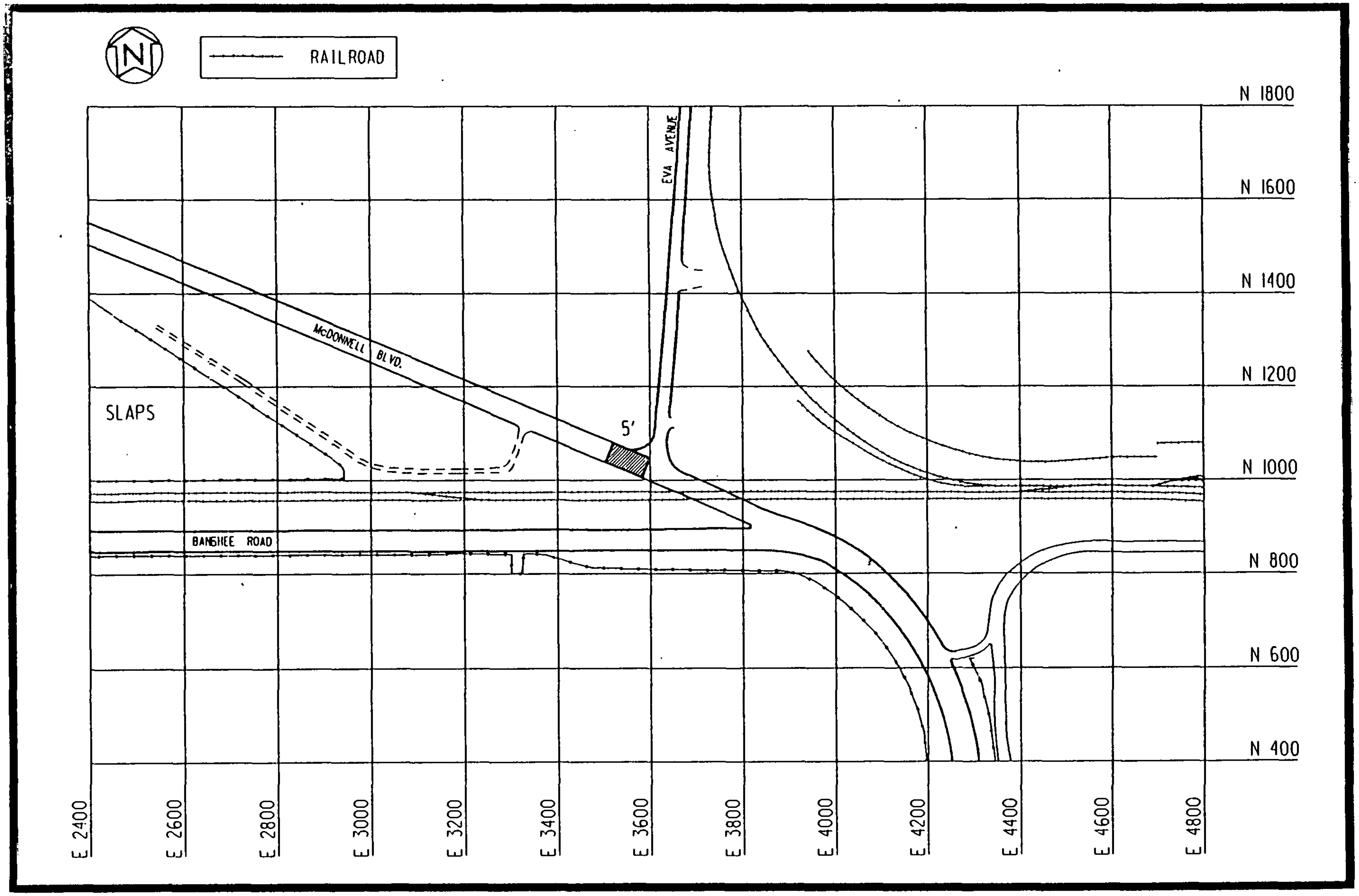


FIGURE 5-7 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT MCDONNELL BOULEVARD (CONT.)

S34WMS25.DGN

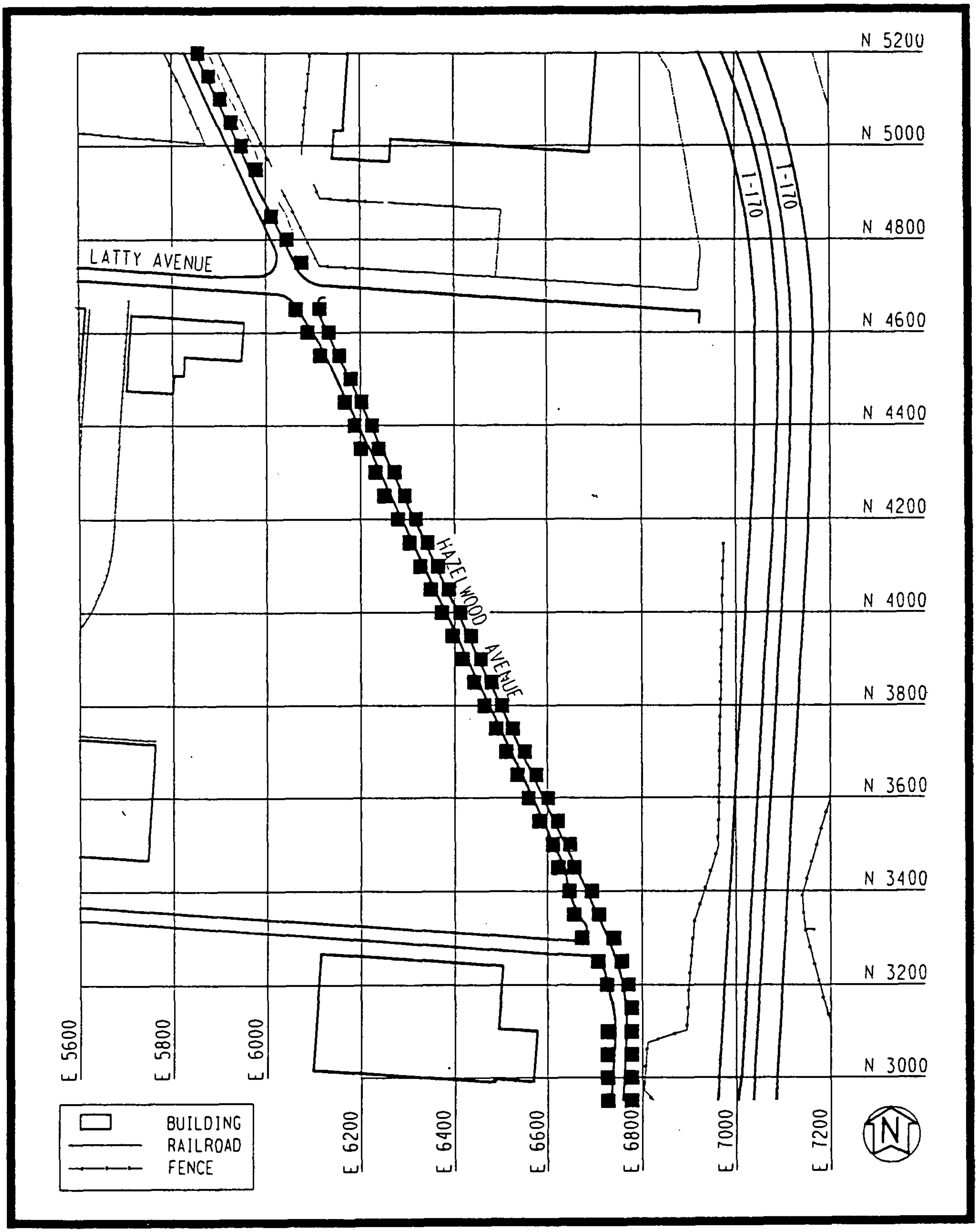


FIGURE 5-8 COMPOSITE SURFACE SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAZELWOOD AVENUE

S34WMS31.DGN

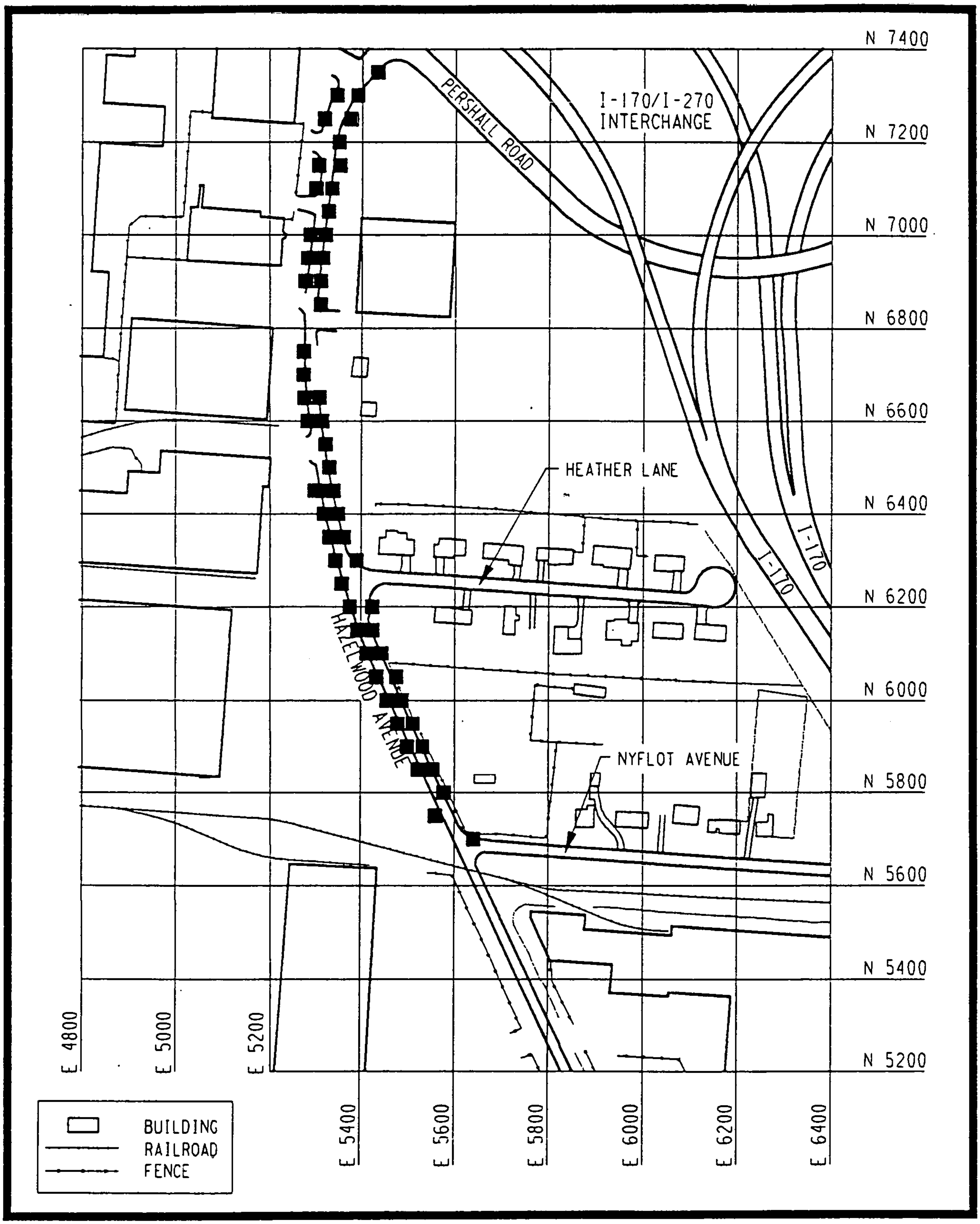


FIGURE 5-8 COMPOSITE SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAZELWOOD AVENUE (CONT.)

S34WMS30.DGN

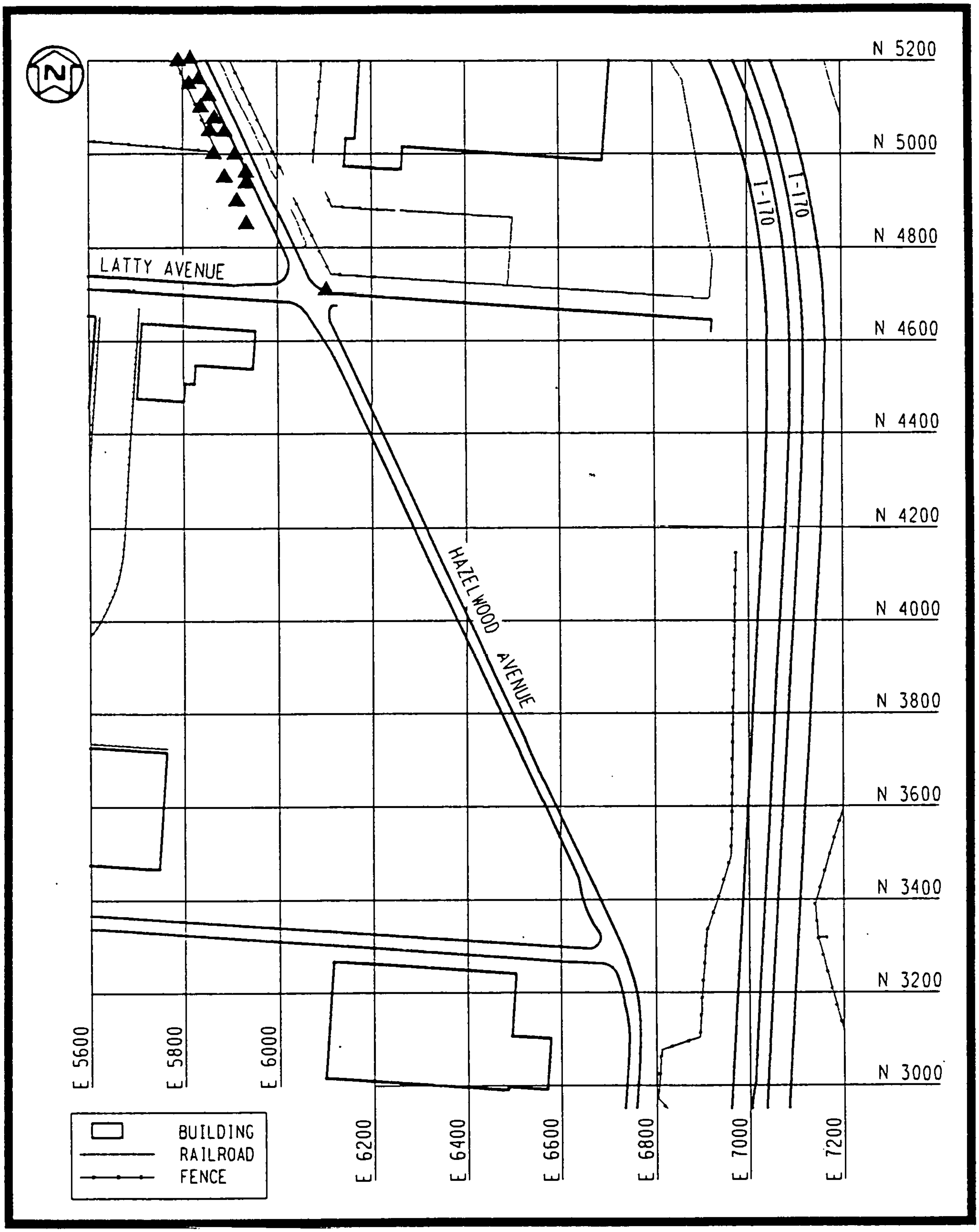


FIGURE 5-9 SURFACE SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAZELWOOD AVENUE

S34WMS31.DGN

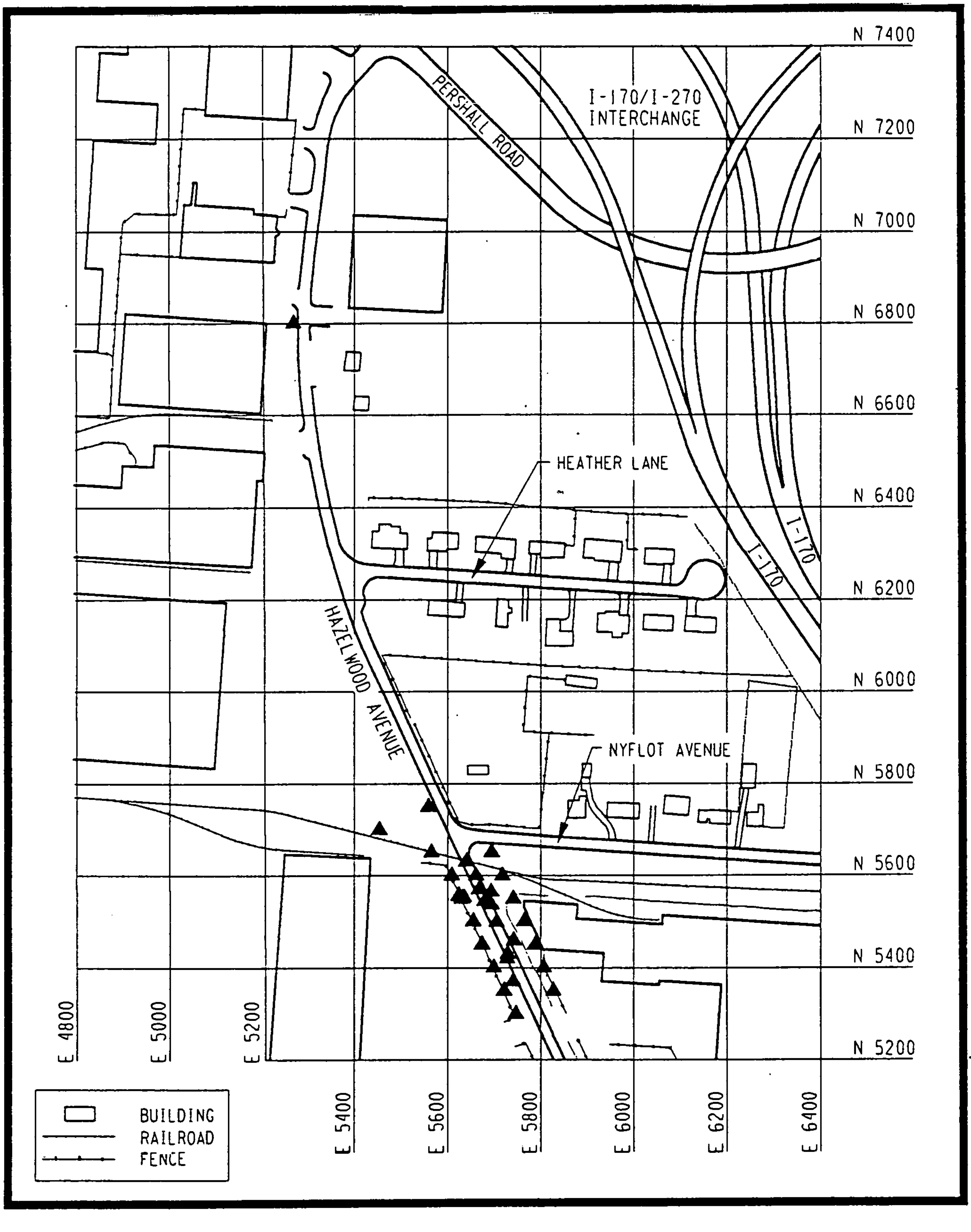


FIGURE 5-9 SURFACE SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAZELWOOD AVENUE (CONT.)

C34WH332.DGN

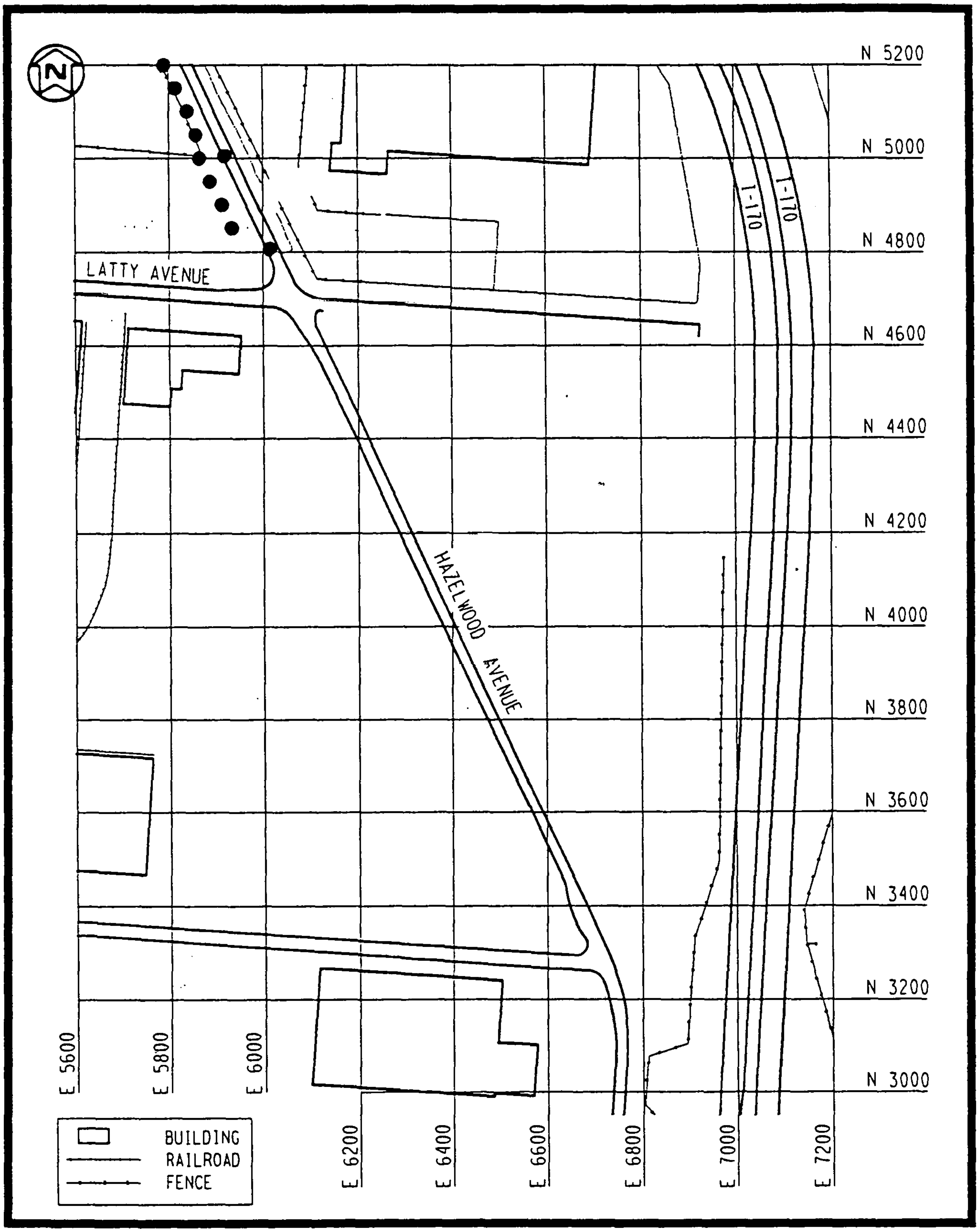


FIGURE 5-10 SUBSURFACE SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAZELWOOD AVENUE

S34WMS31.DGN

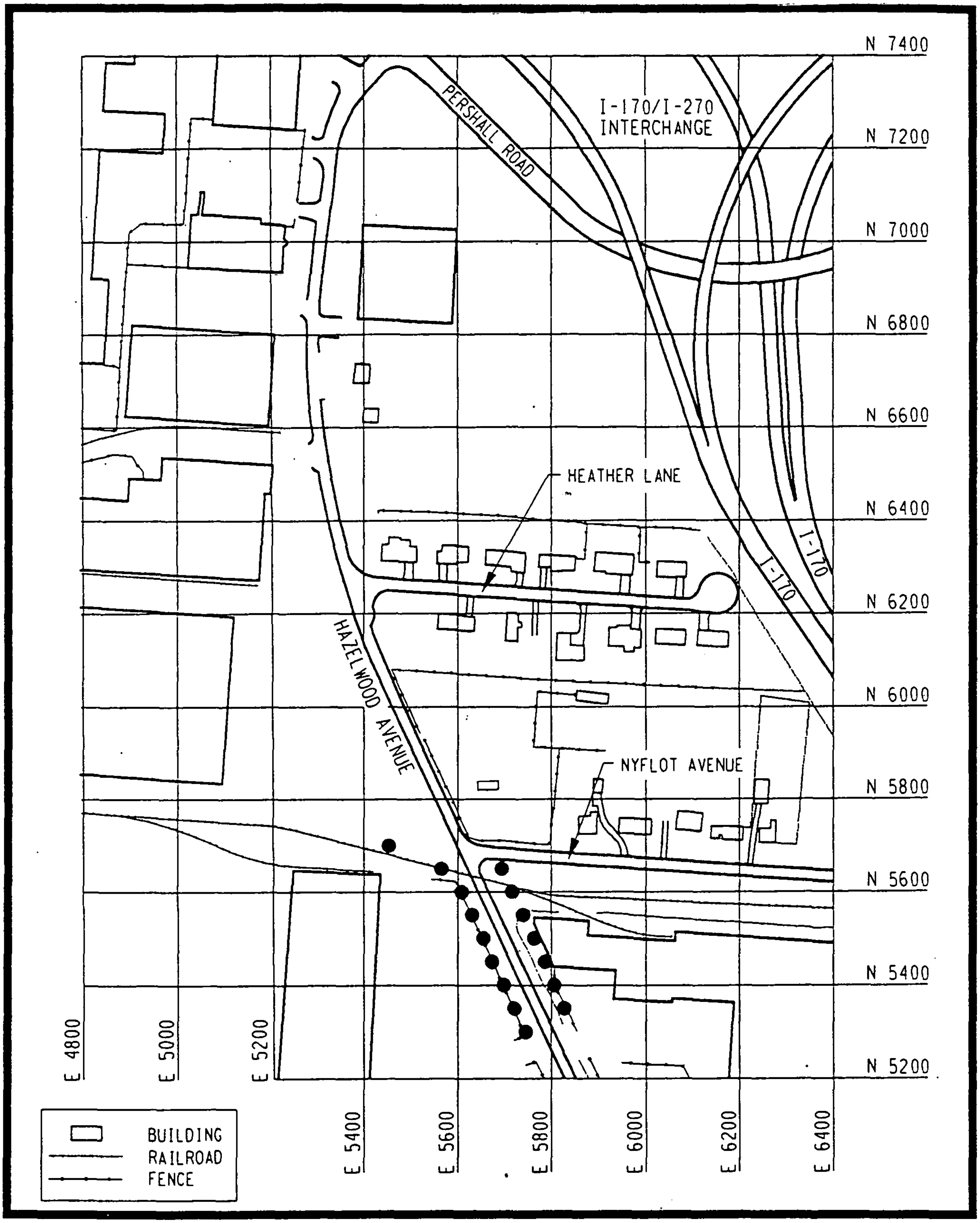


FIGURE 5-10 SUBSURFACE SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAZELWOOD AVENUE (CONT.)

S34WMS30.DGN

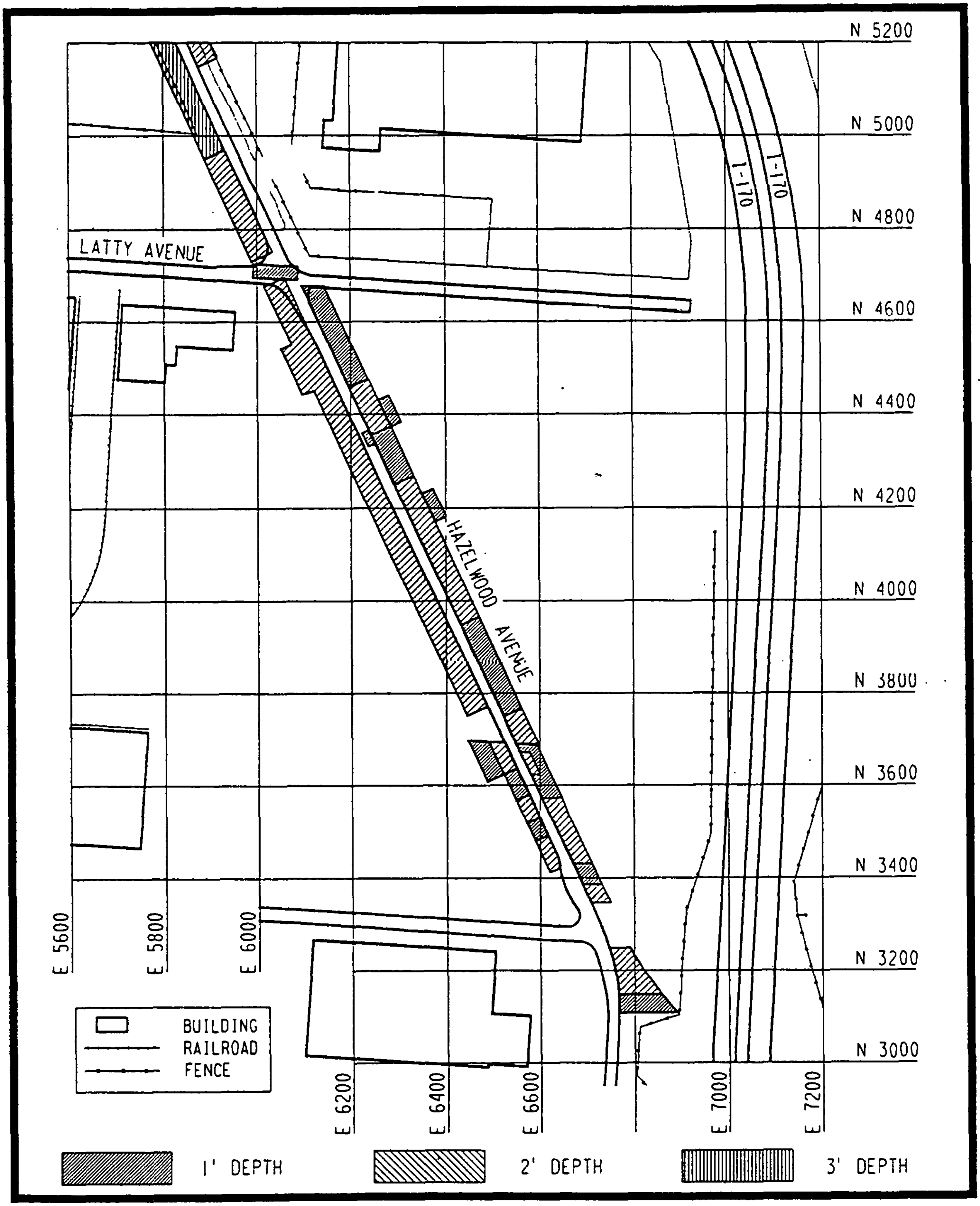


FIGURE 5-11 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT HAZELWOOD AVENUE

S34WMS31.DGN

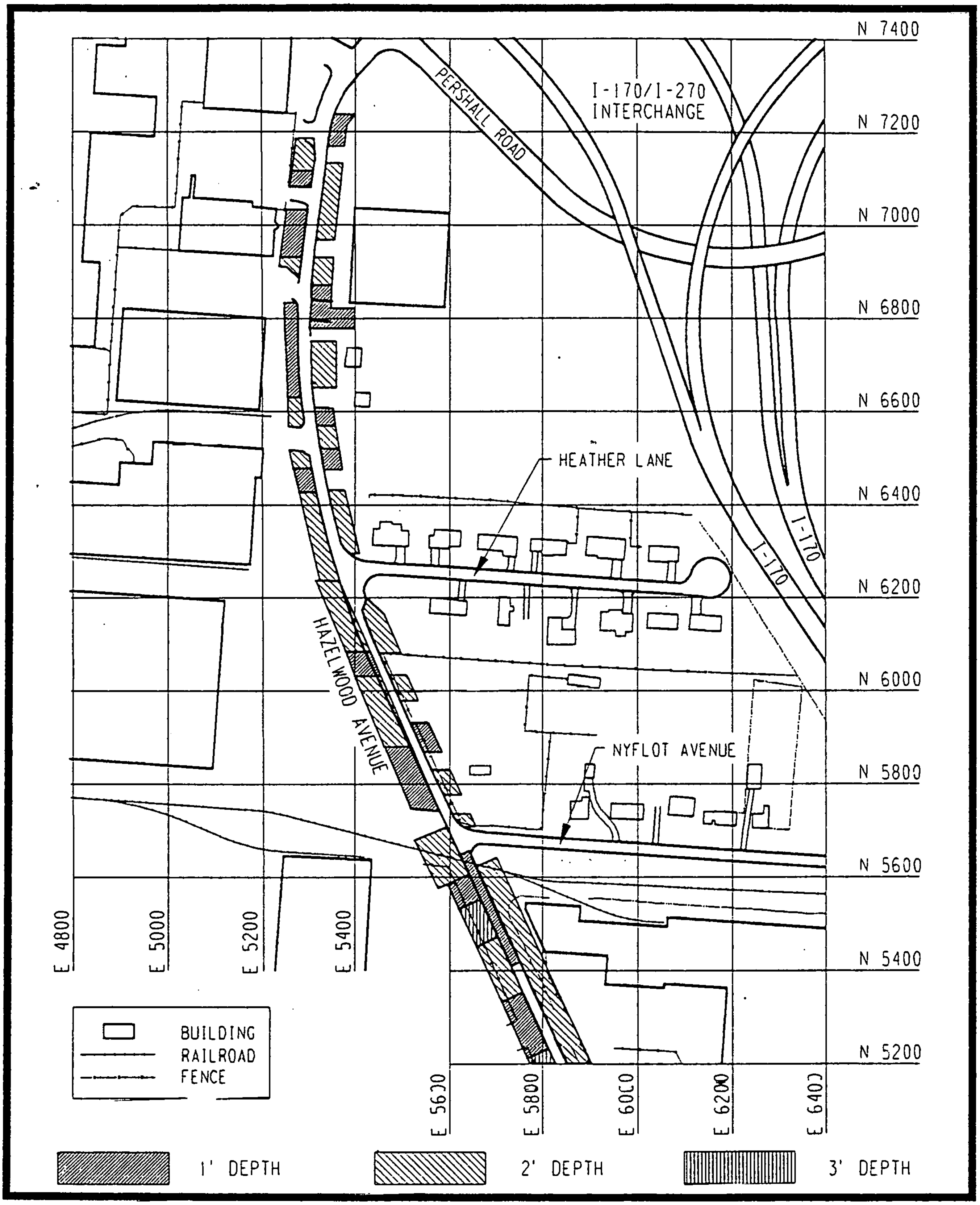


FIGURE 5-11 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT HAZELWOOD AVENUE (CONT.)

34WMS30.DGN

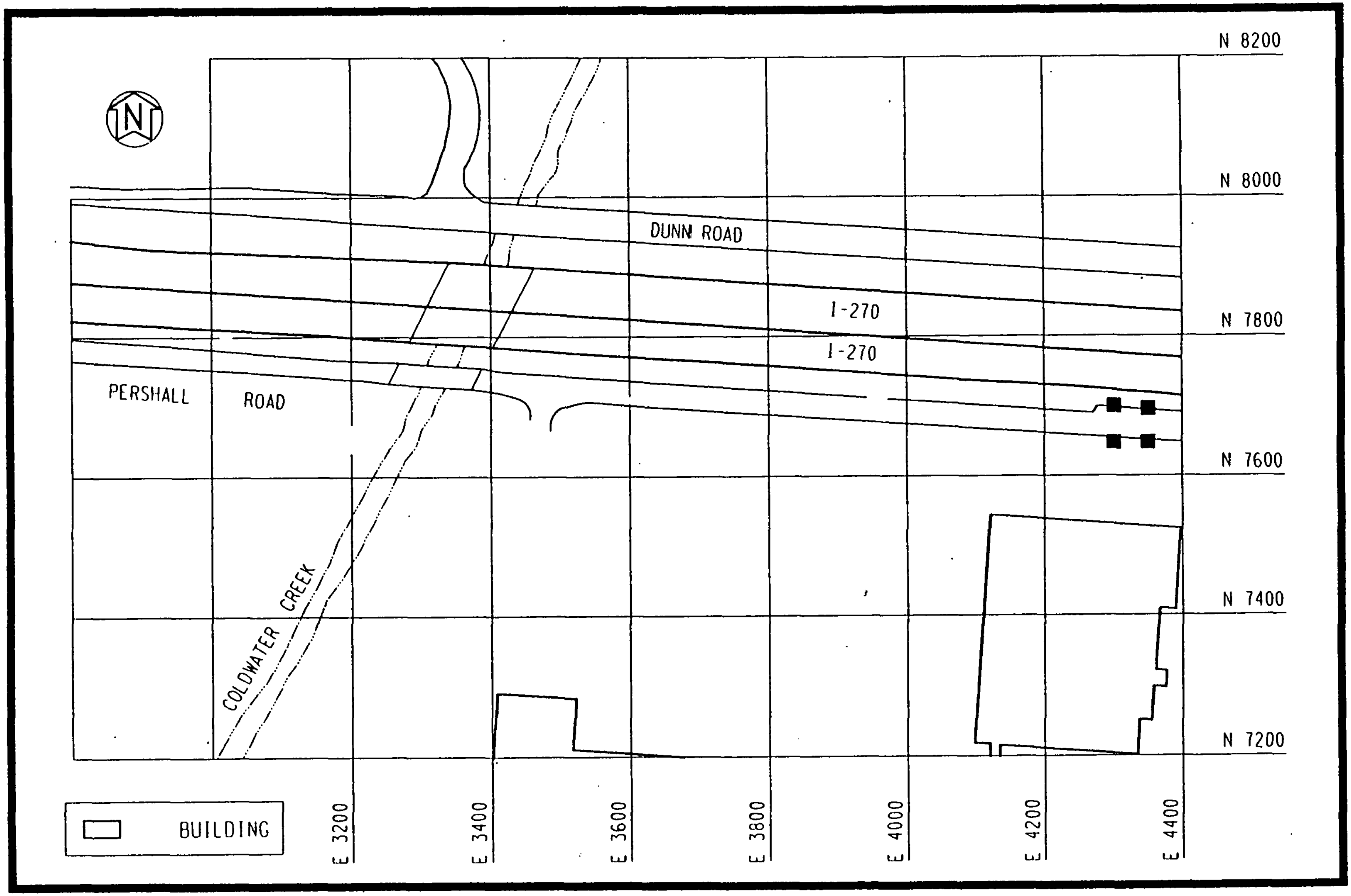


FIGURE 5-12 COMPOSITE SURFACE SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF PERSHALL ROAD

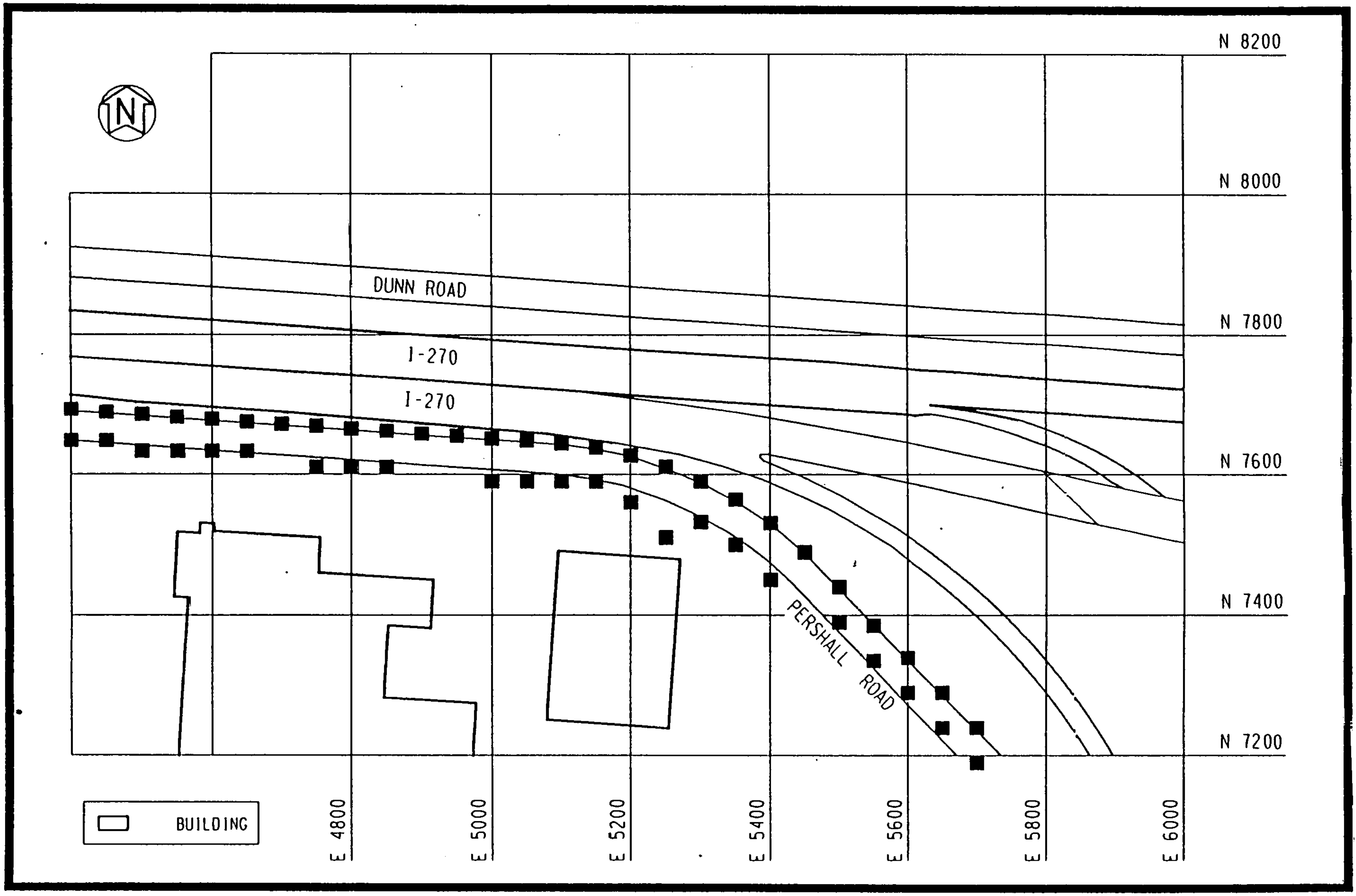


FIGURE 5-12 COMPOSITE SURFACE SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF PERSHALL ROAD (CONT.)

S34WMS32.DGN

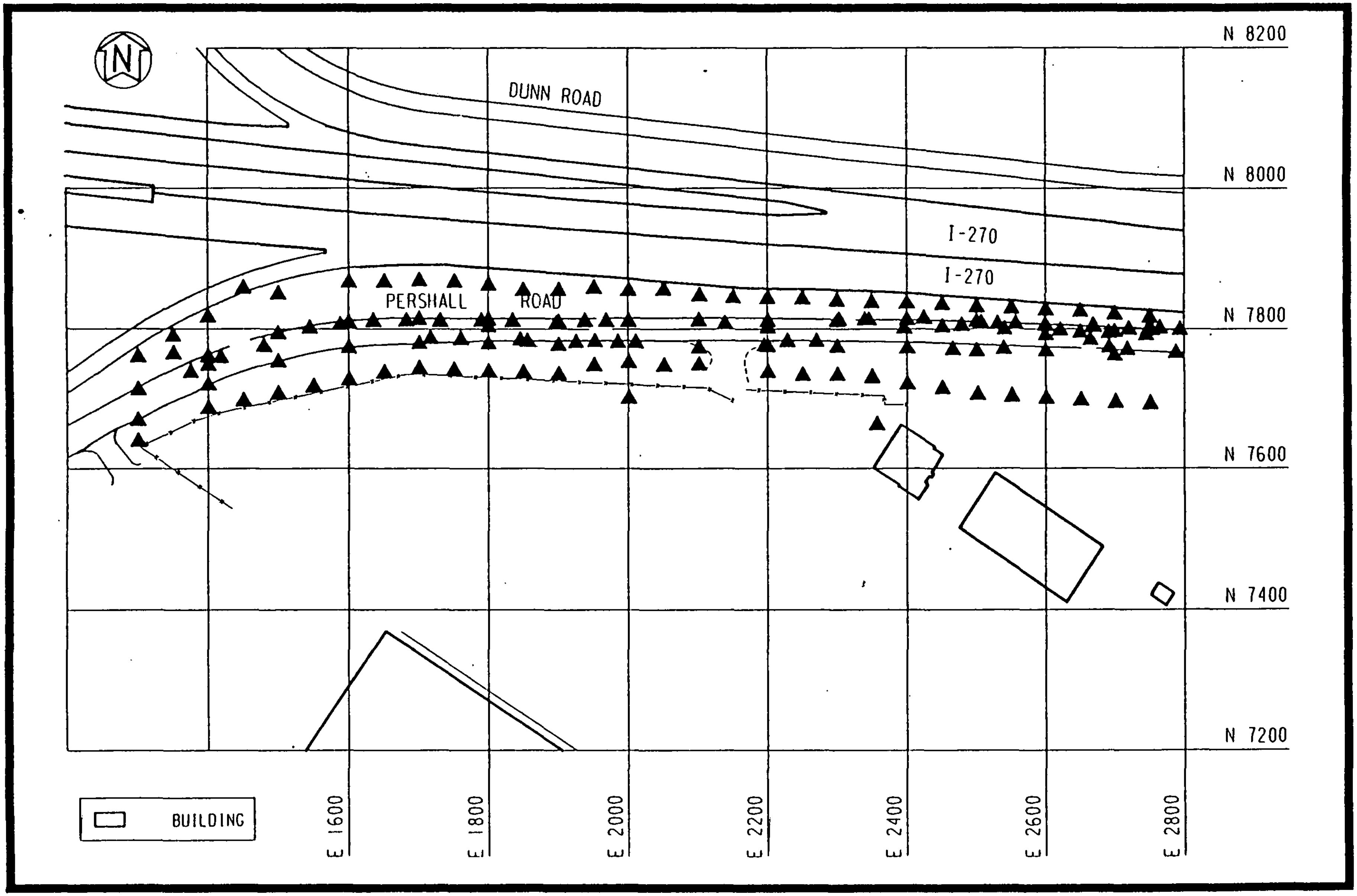


FIGURE 5-13 SURFACE SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF PERSHALL ROAD

S34WMS32.DGN

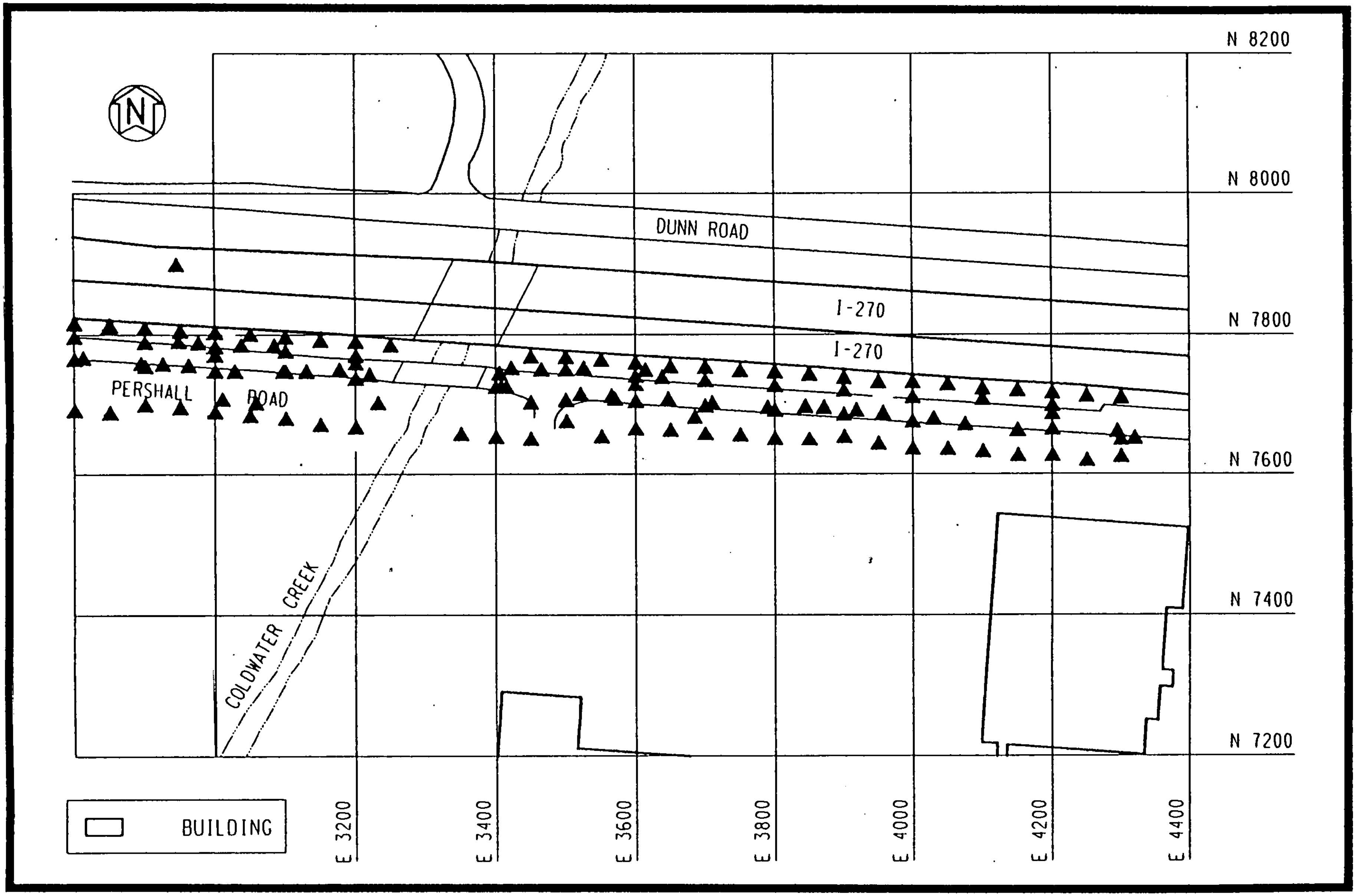


FIGURE 5-13 SURFACE SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF PERSHALL ROAD (CONT.)

S34WMS33.DGN FIG2

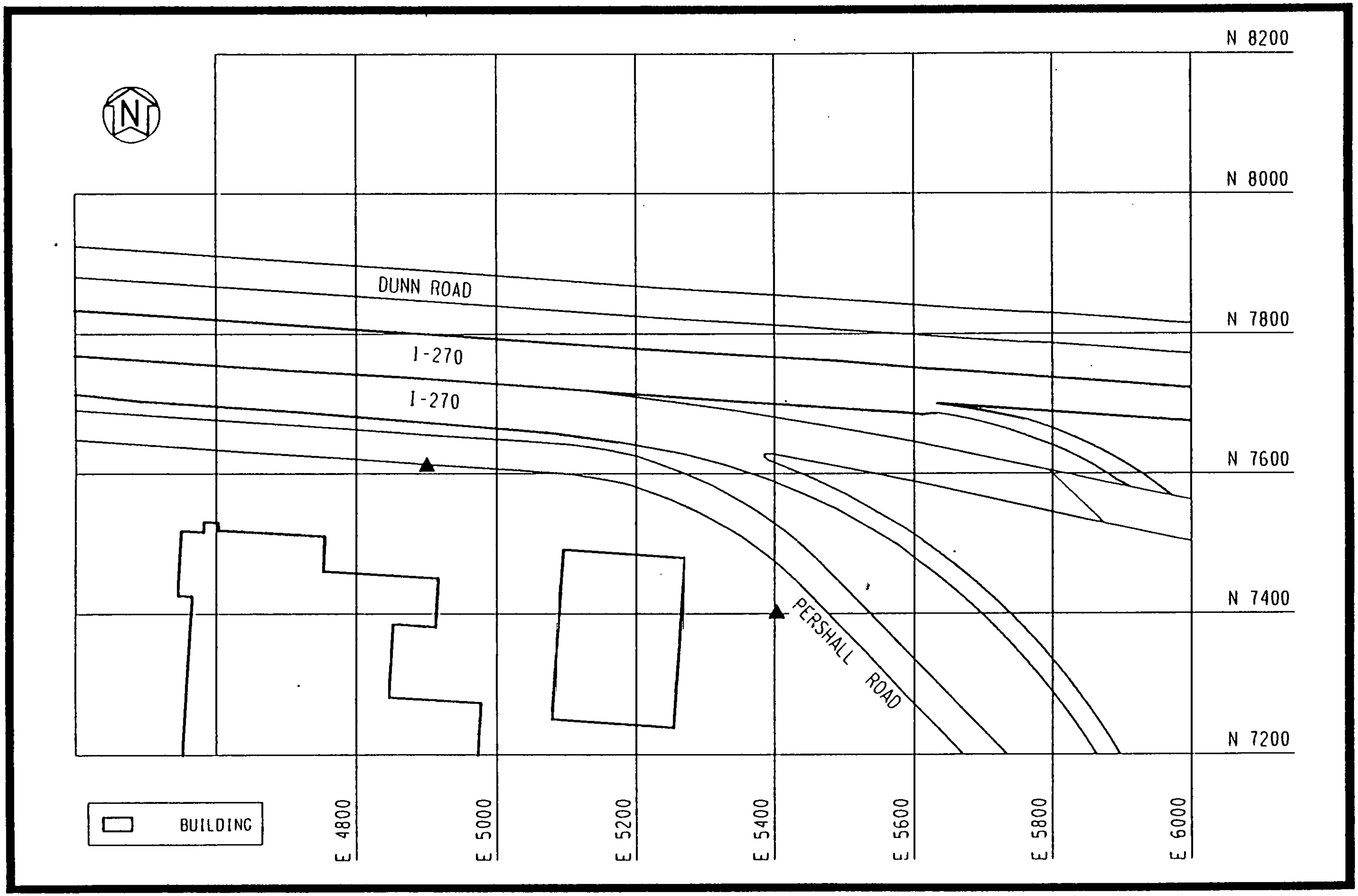


FIGURE 5-13 SURFACE SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF PERSHALL ROAD (CONT.)

534WMS32.DGN

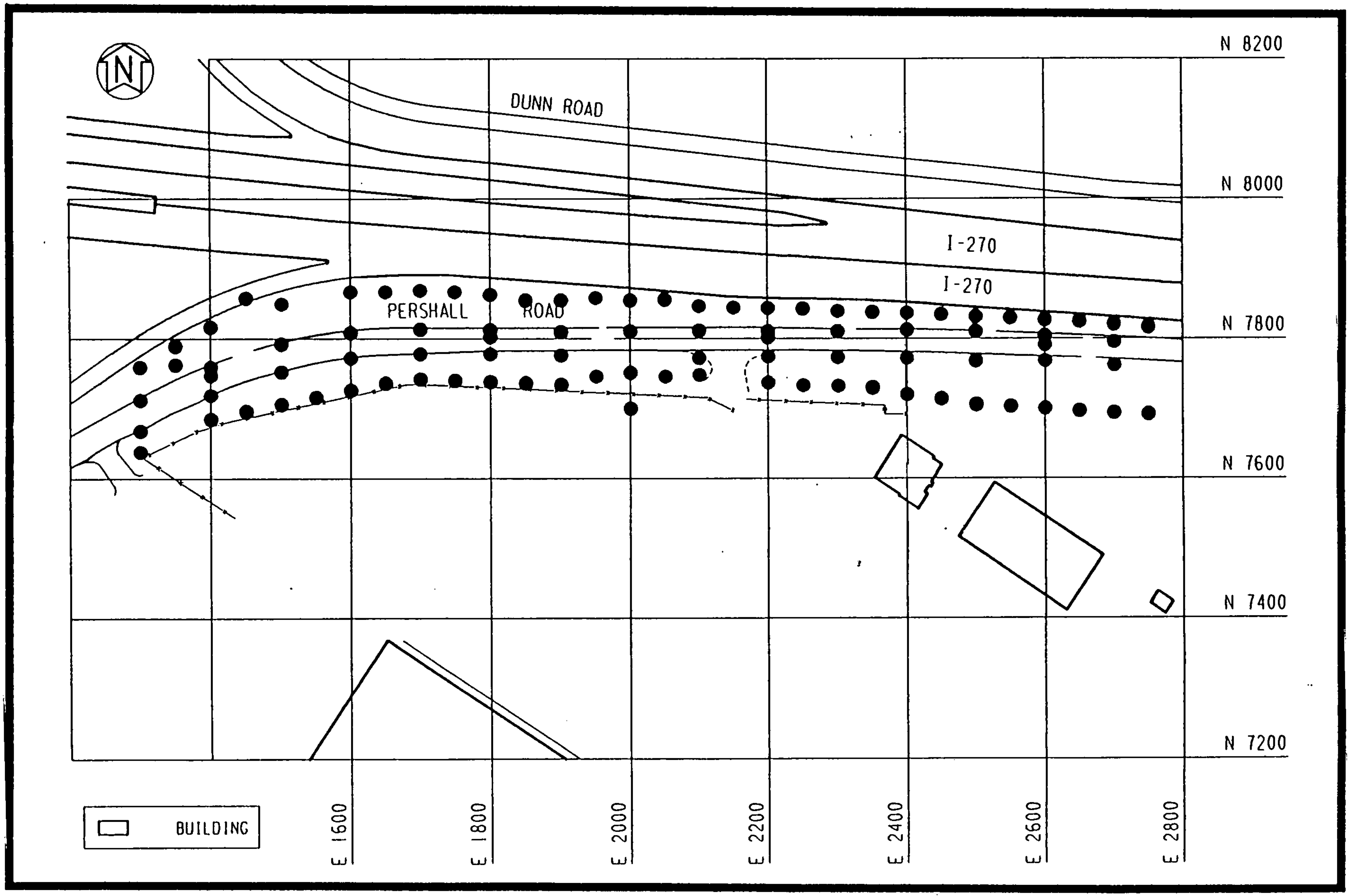


FIGURE 5-14 SUBSURFACE SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF PERSHALL ROAD

S34WMS32.DGN

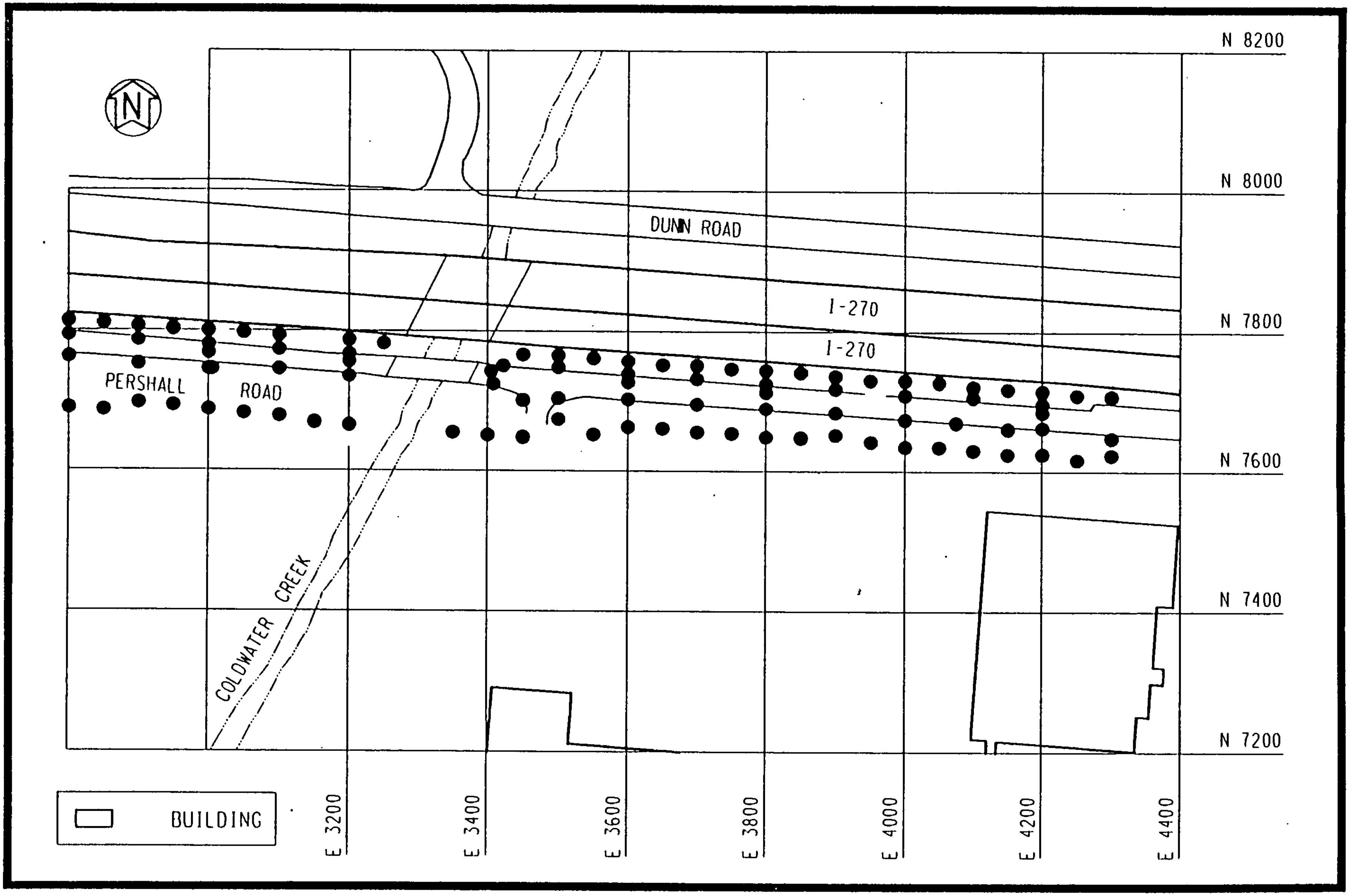


FIGURE 5-14 SUBSURFACE SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF PERSHALL ROAD (CONT.)

S34WMS33.DGN FIG4

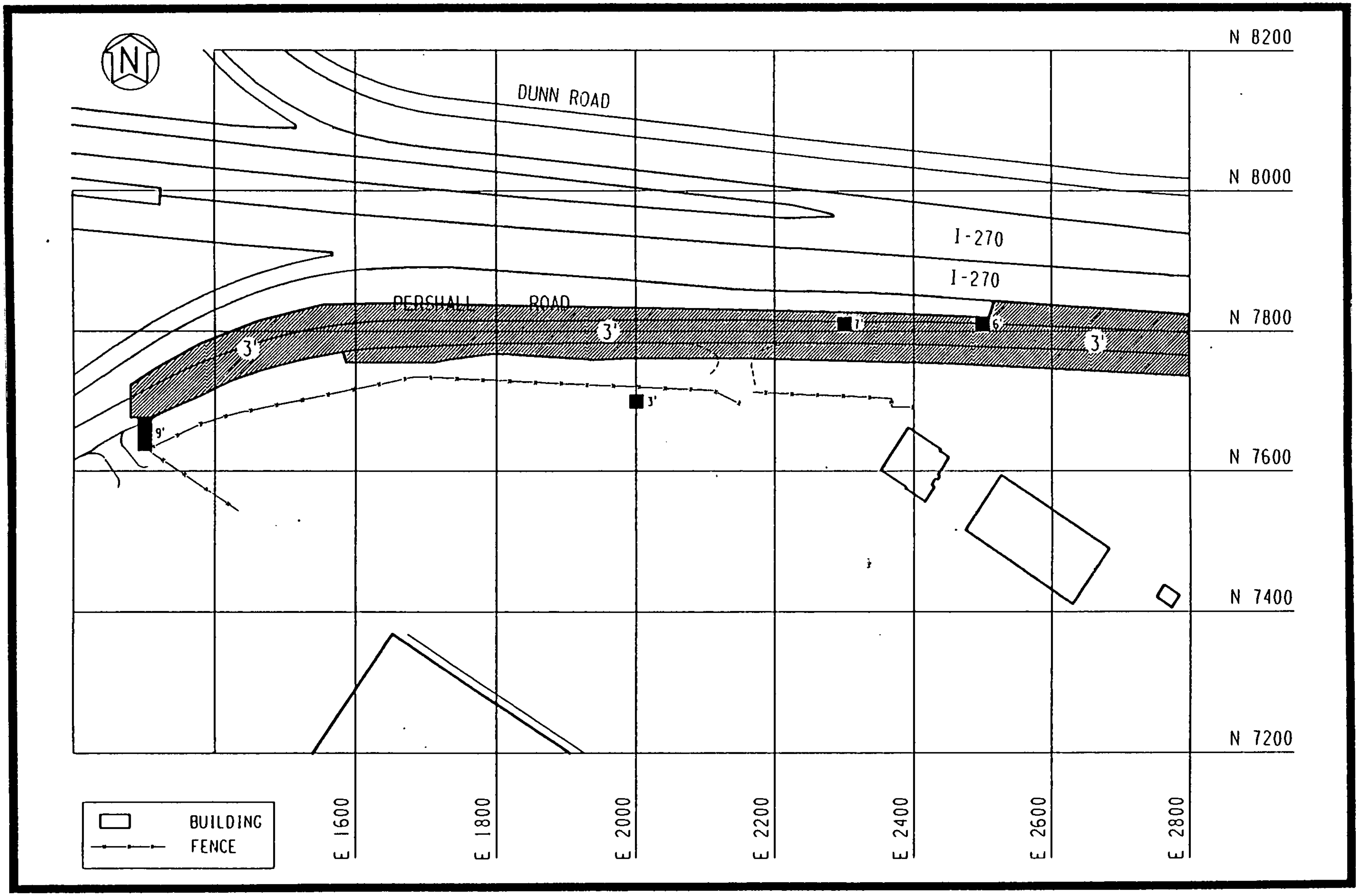
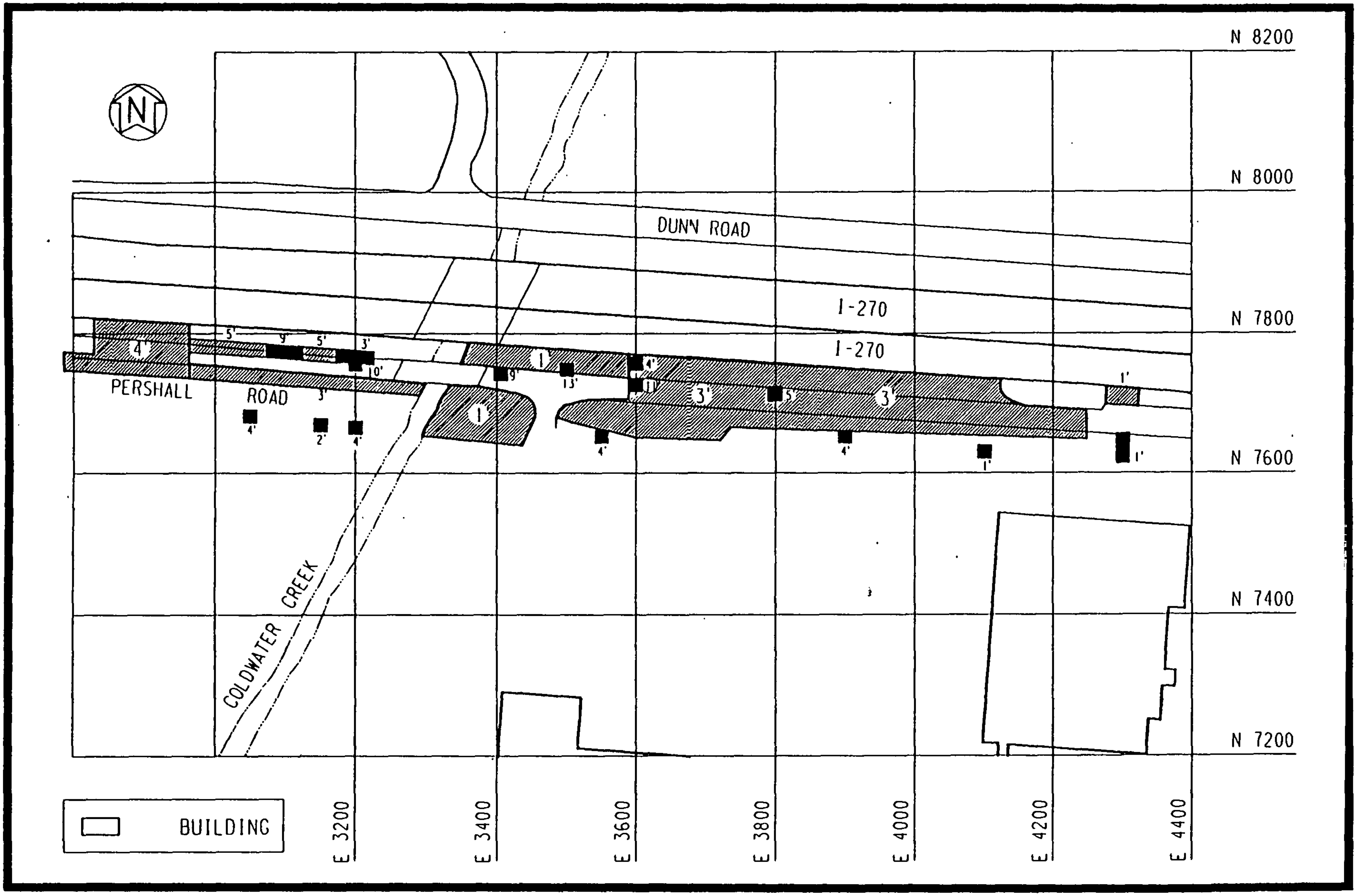


FIGURE 5-15 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT PERSHALL ROAD

S34WMS32.DGN



534WMS33.DGN AREA

FIGURE 5-15 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT PERSHALL ROAD (CONT.)

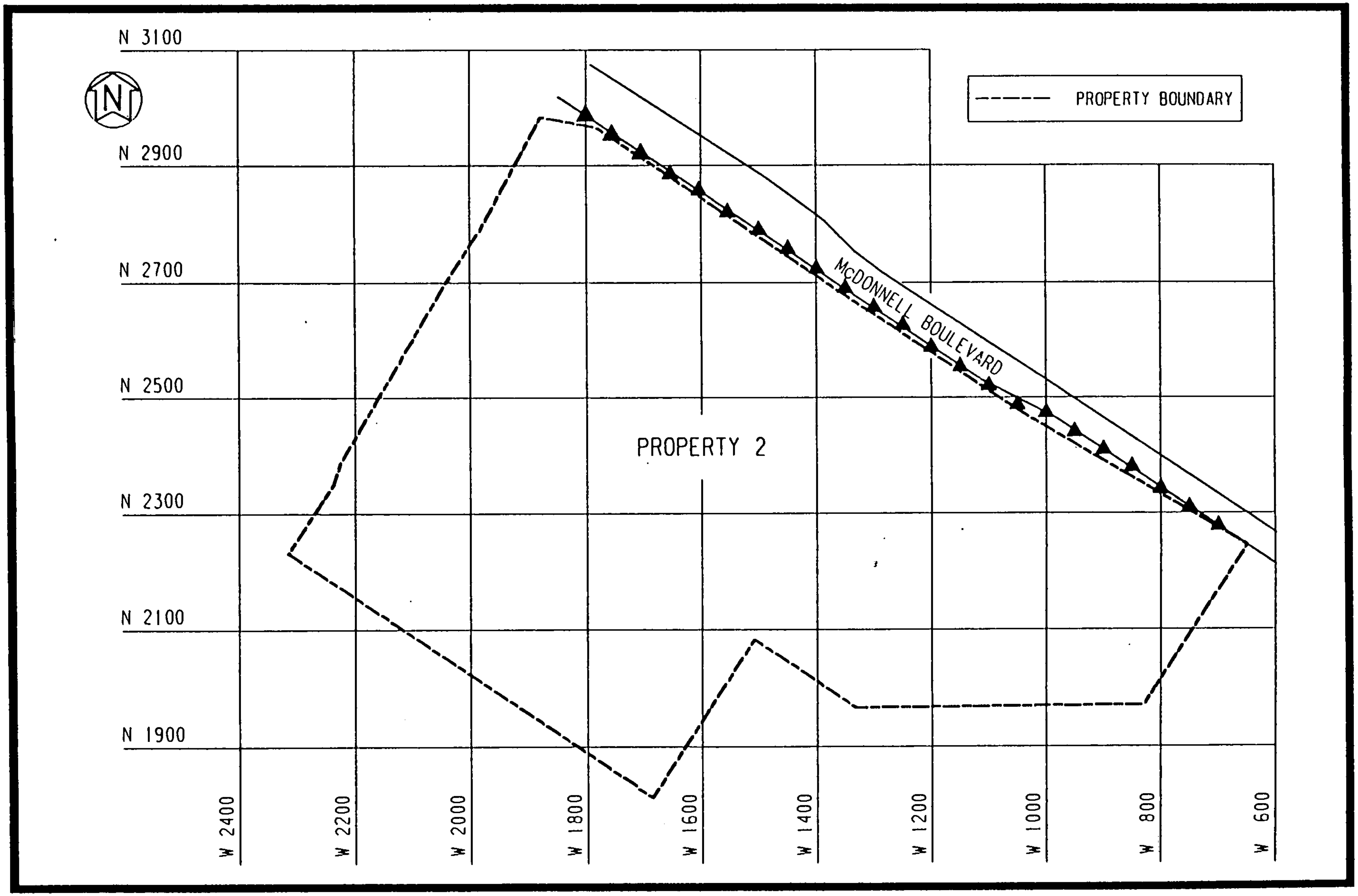


FIGURE 5-16 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 2

134F047.DGN

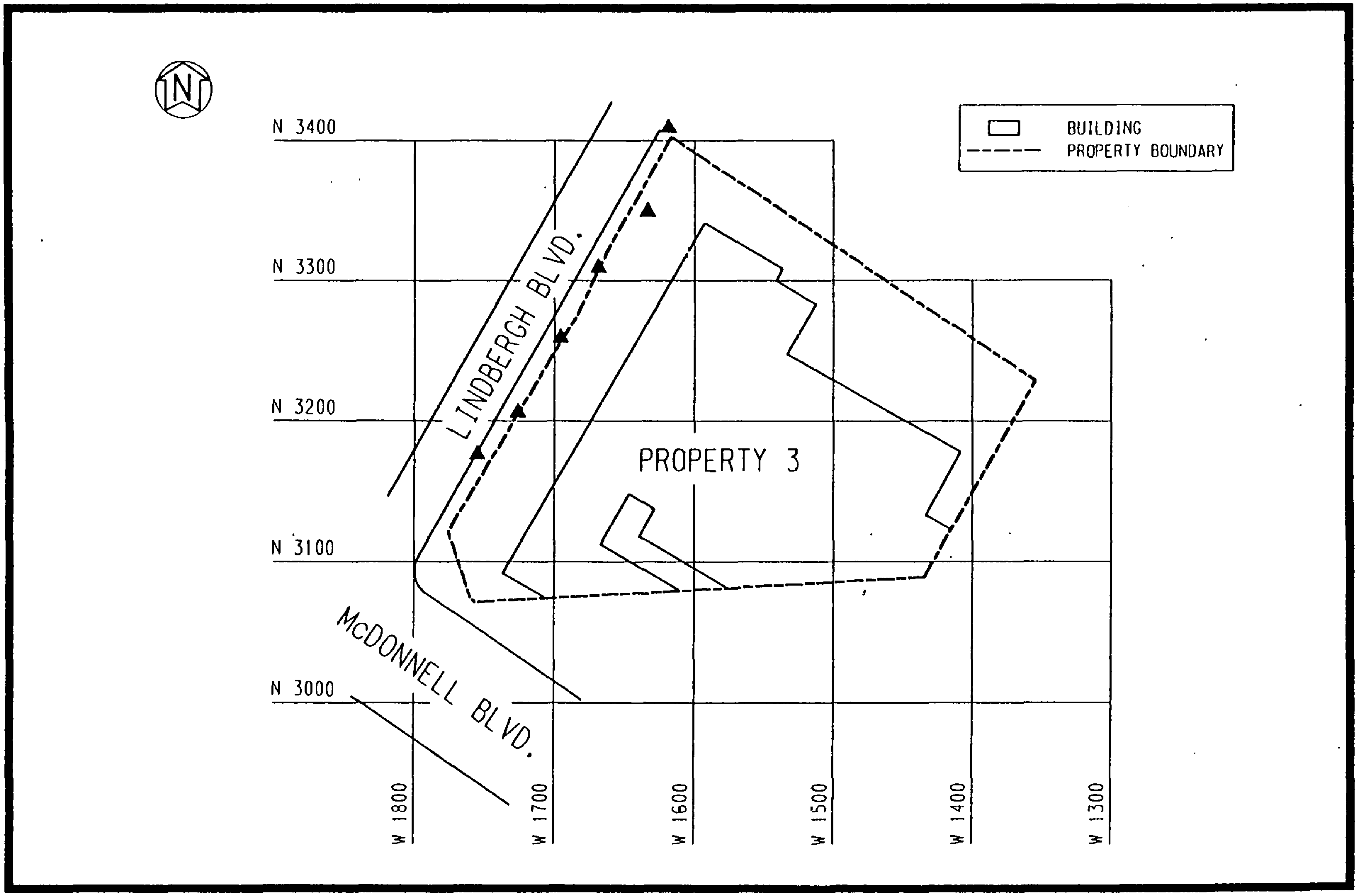


FIGURE 5-17 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 3

134F068.DGN

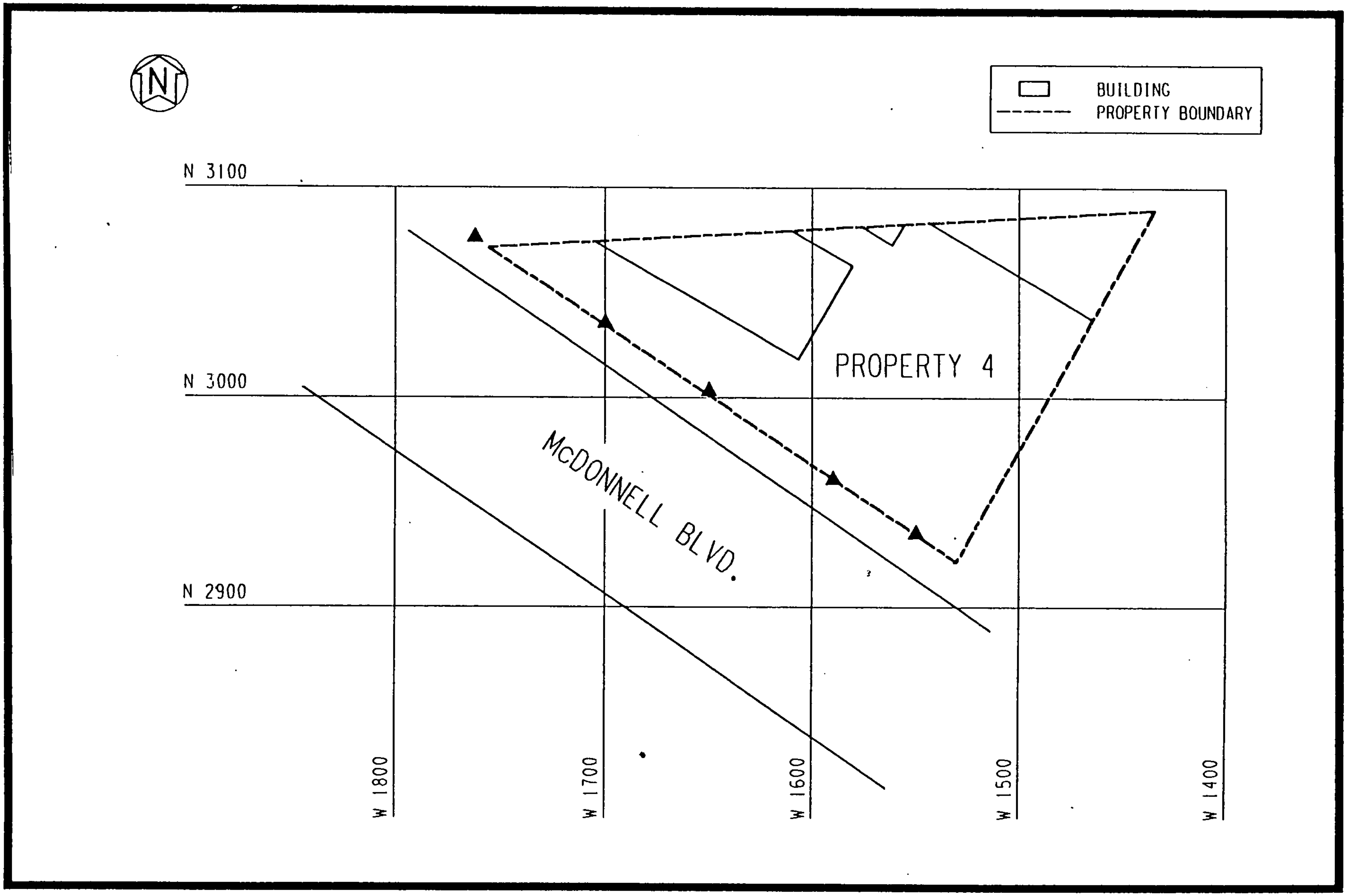


FIGURE 5-18 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 4

134F067.DGN

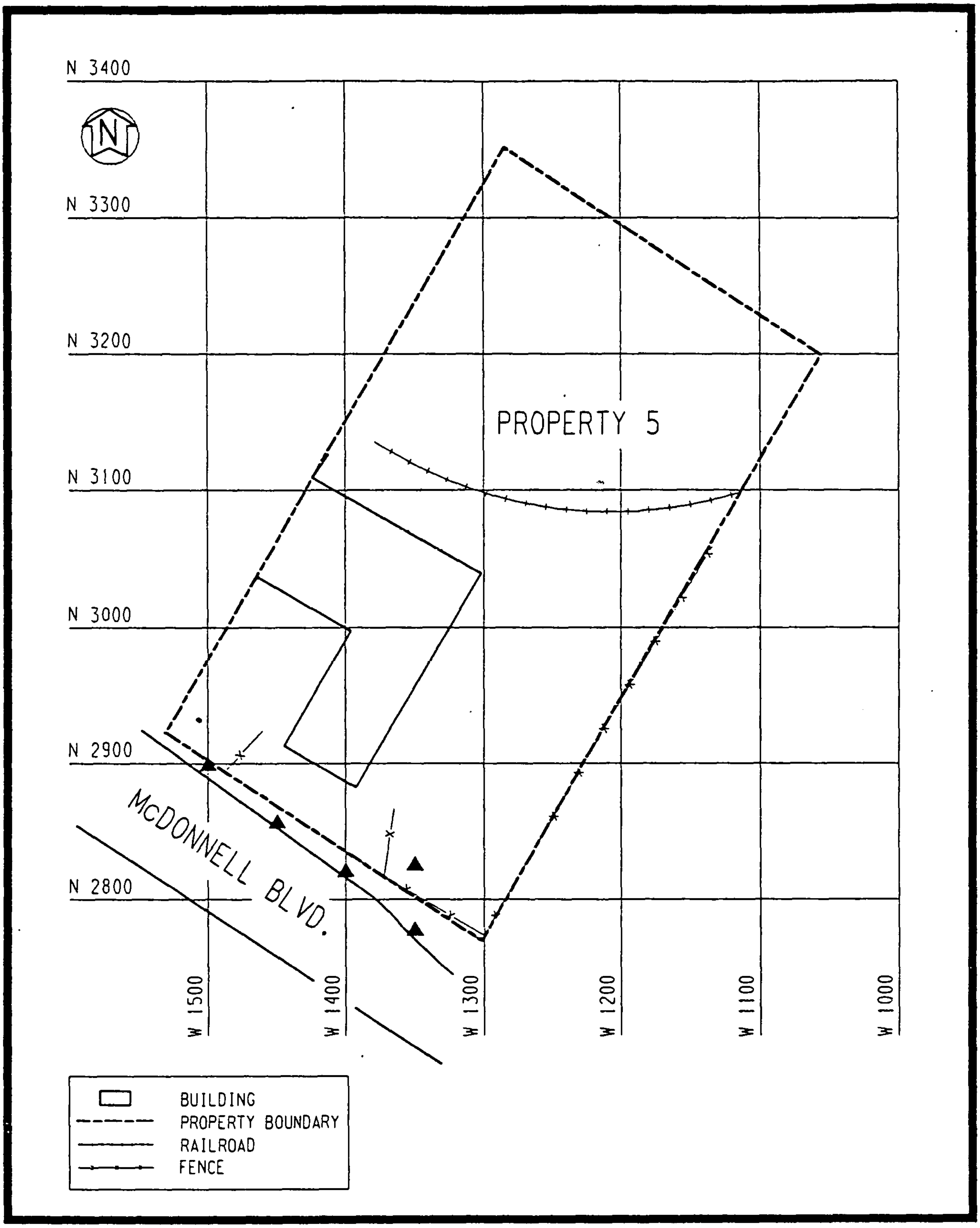


FIGURE 5-19 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 5

134F066.DGN SAMPLE

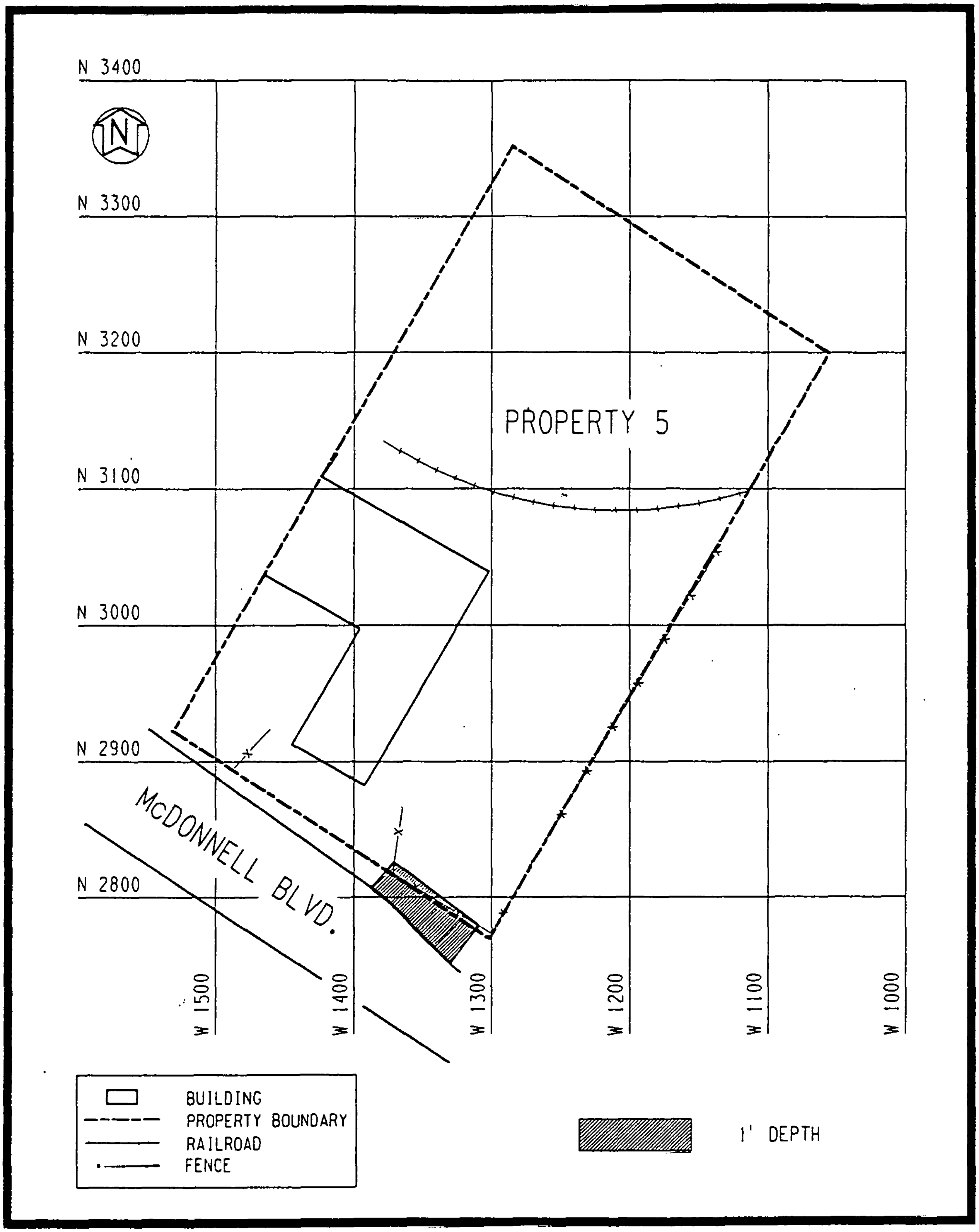


FIGURE 5-20 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT HAUL ROADS VICINITY PROPERTY 5

34F066.DGN DEPTHS

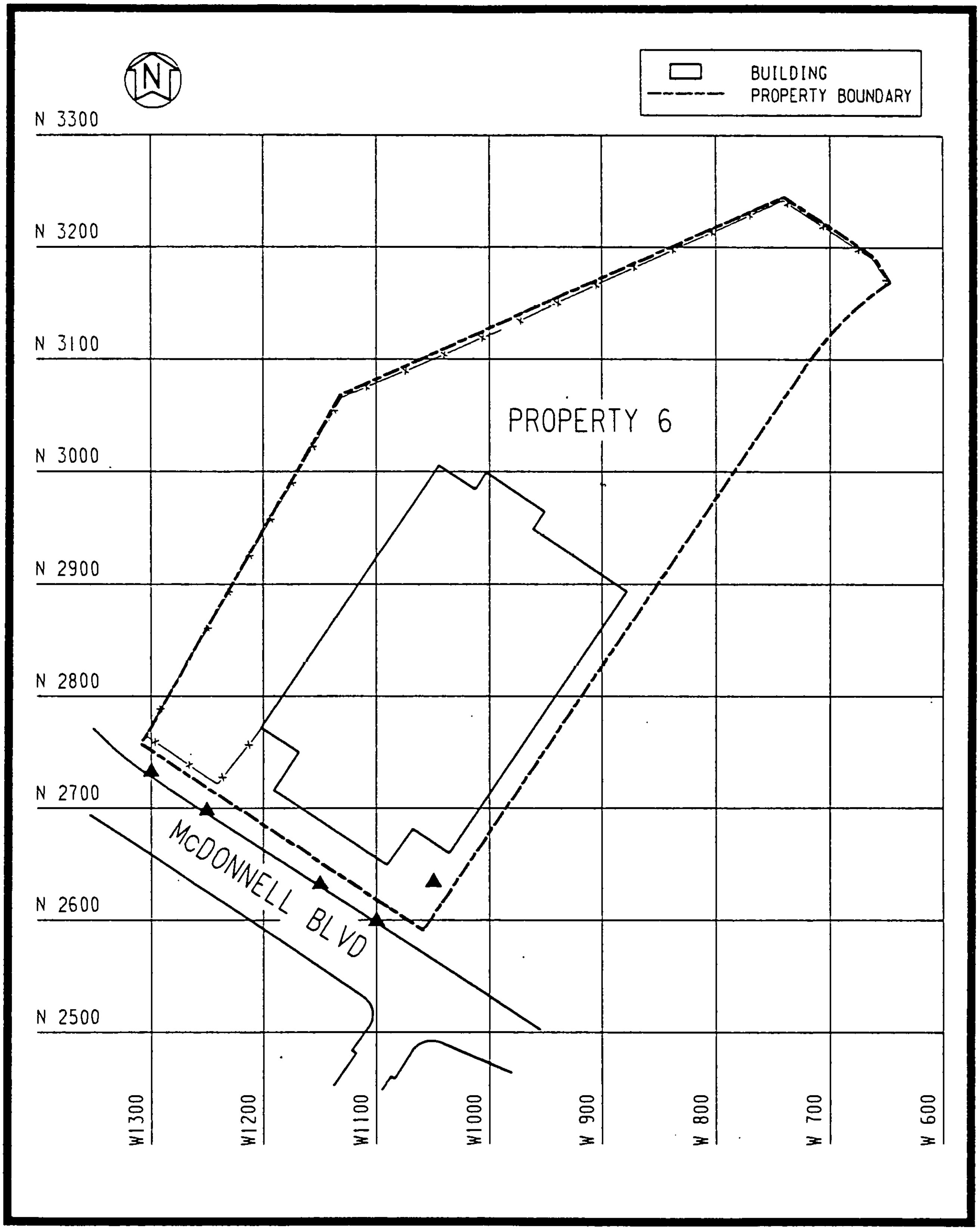


FIGURE 5-21 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 6

134F056.DGN

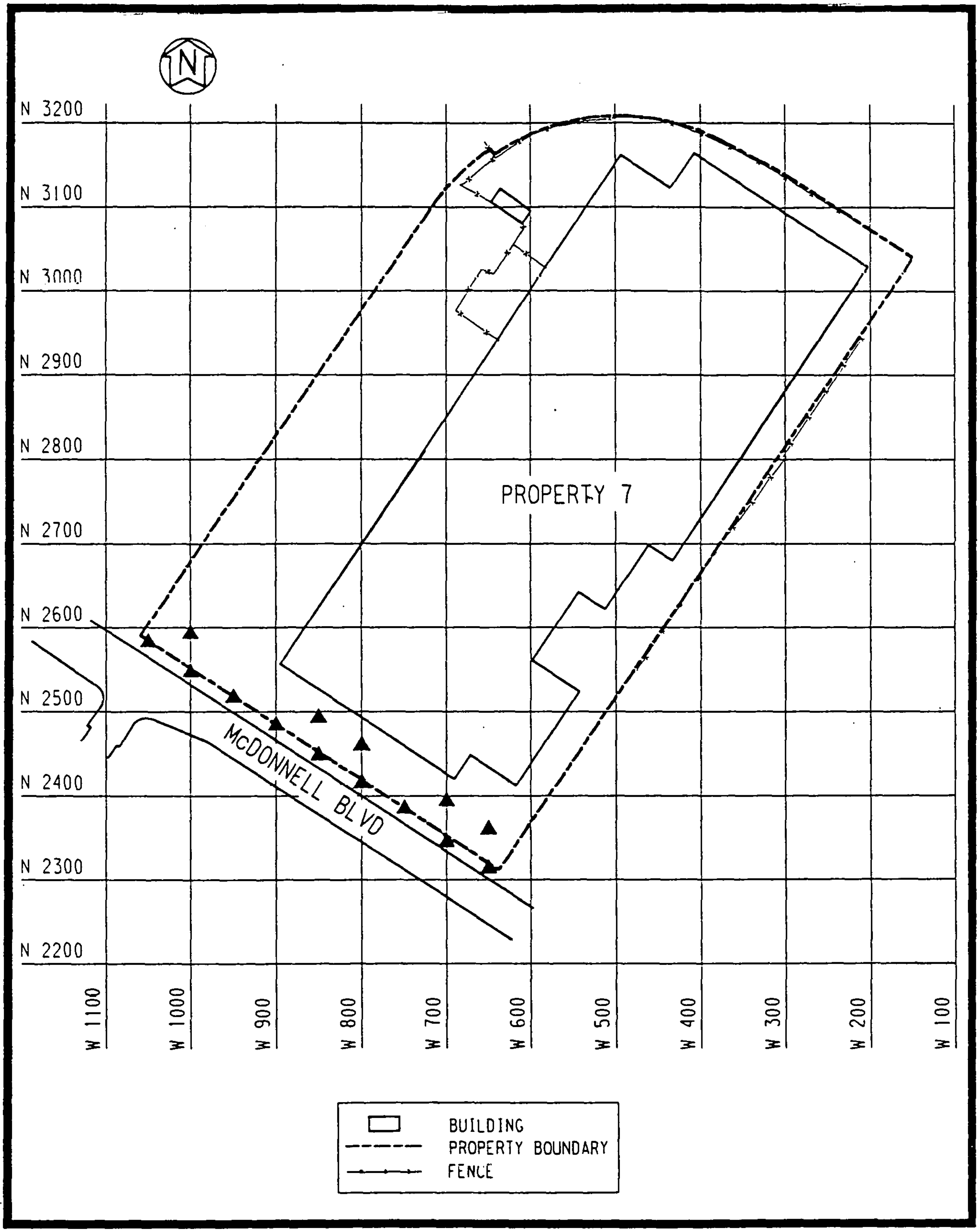


FIGURE 5-22 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 7

134F054.DGN SAMPLE

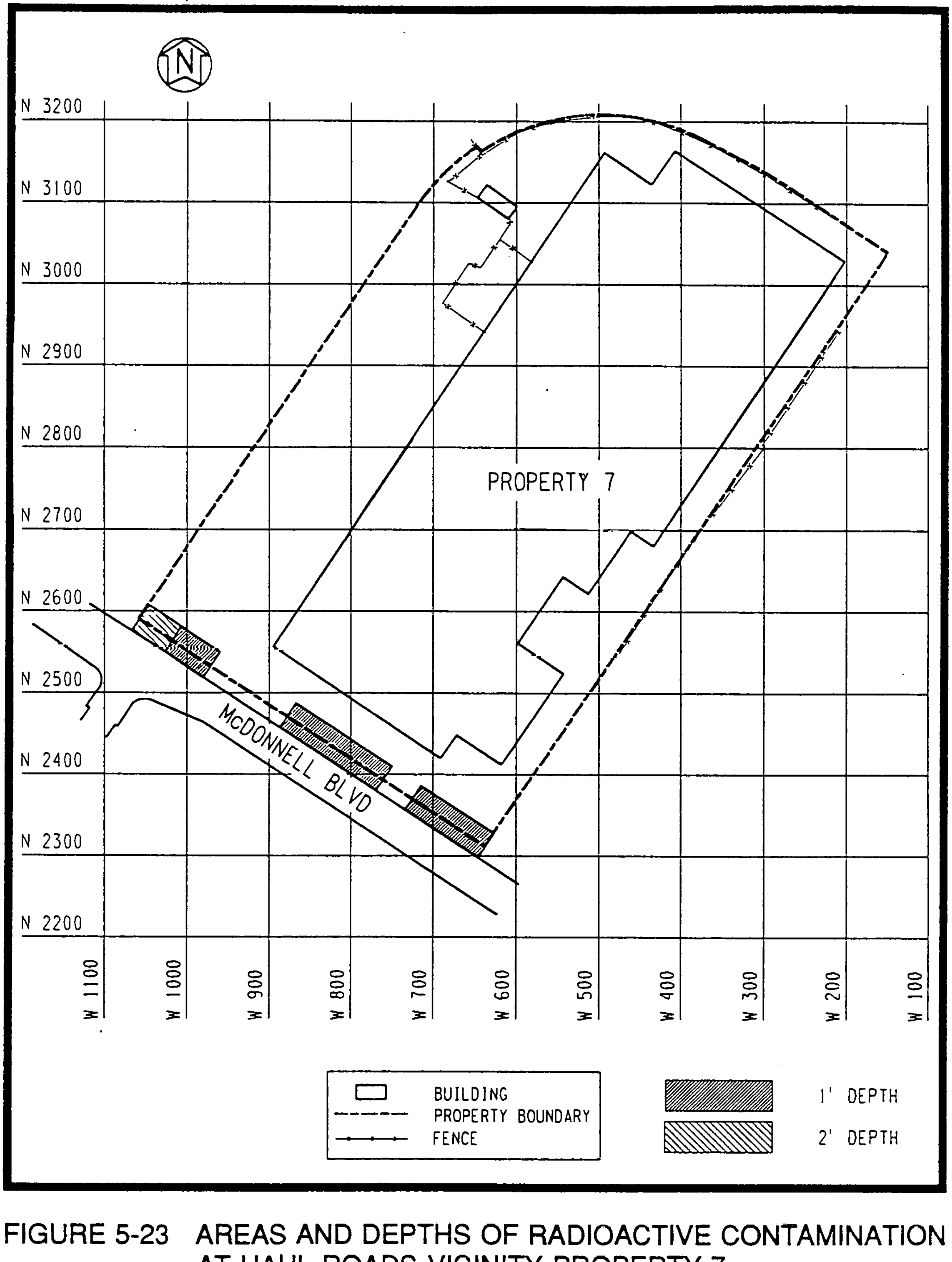


FIGURE 5-23 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT HAUL ROADS VICINITY PROPERTY 7

134F054.DGN DEPTH

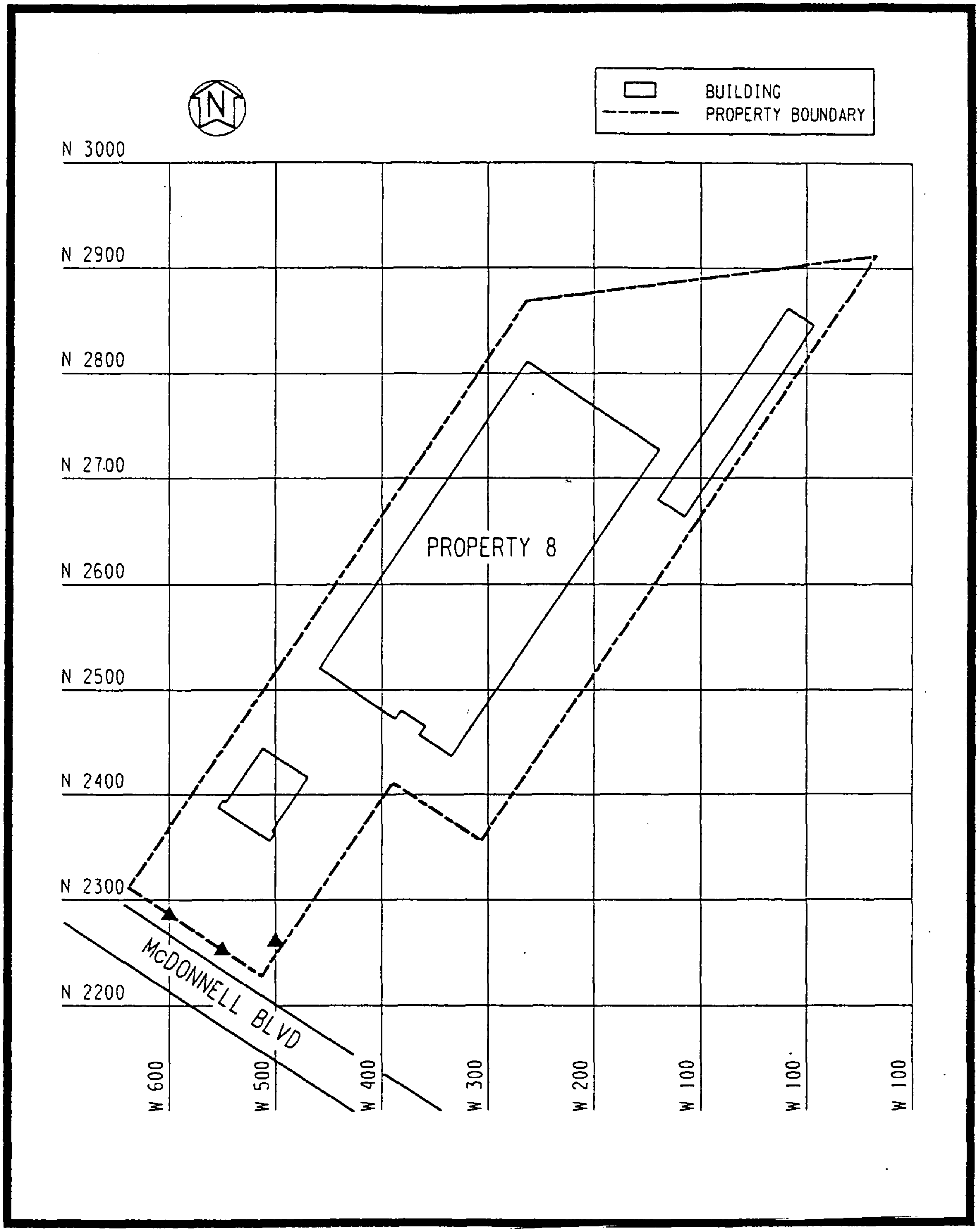


FIGURE 5-24 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 8

34F053.DGN

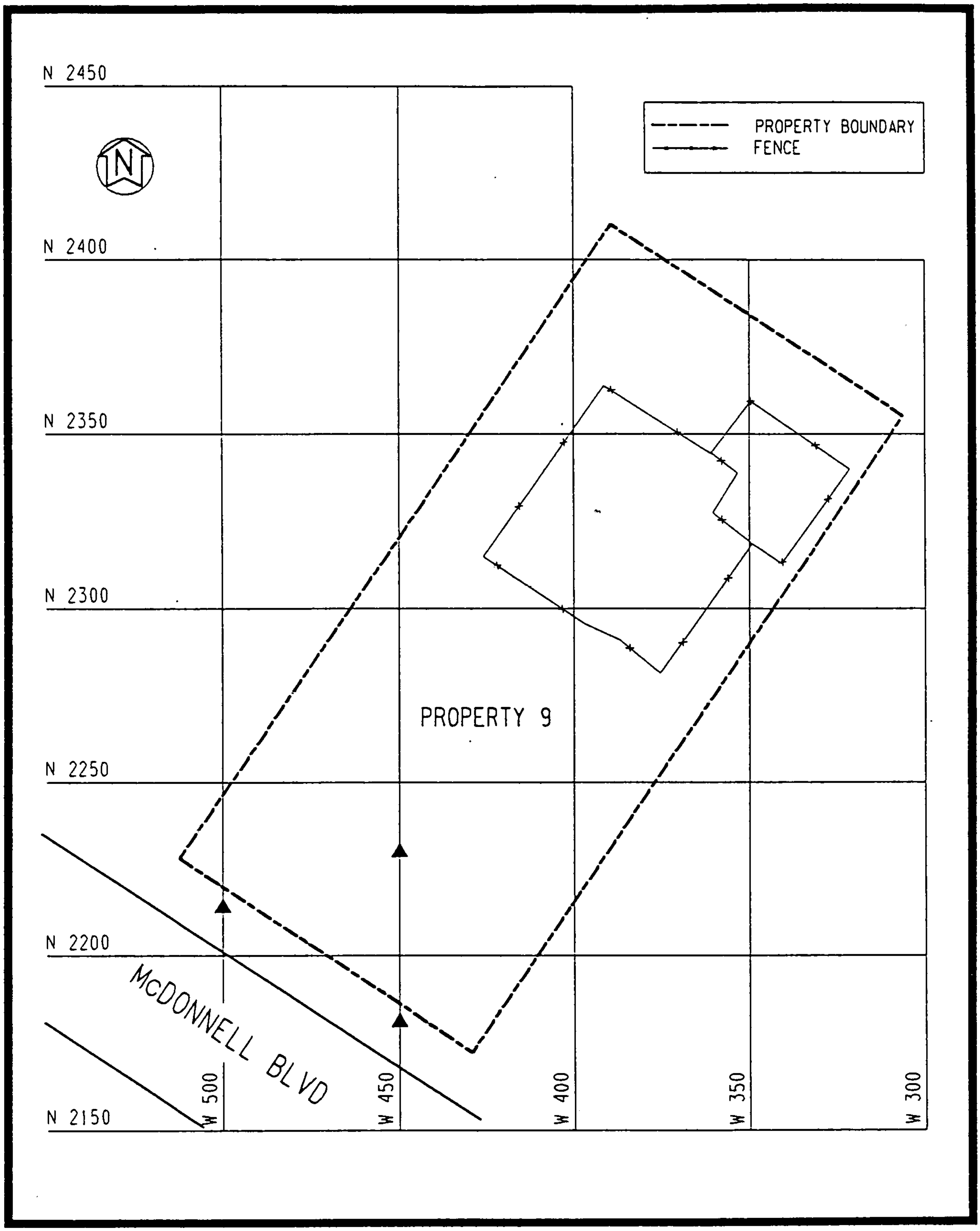


FIGURE 5-25 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 9

134F052.DGN SAMPLE

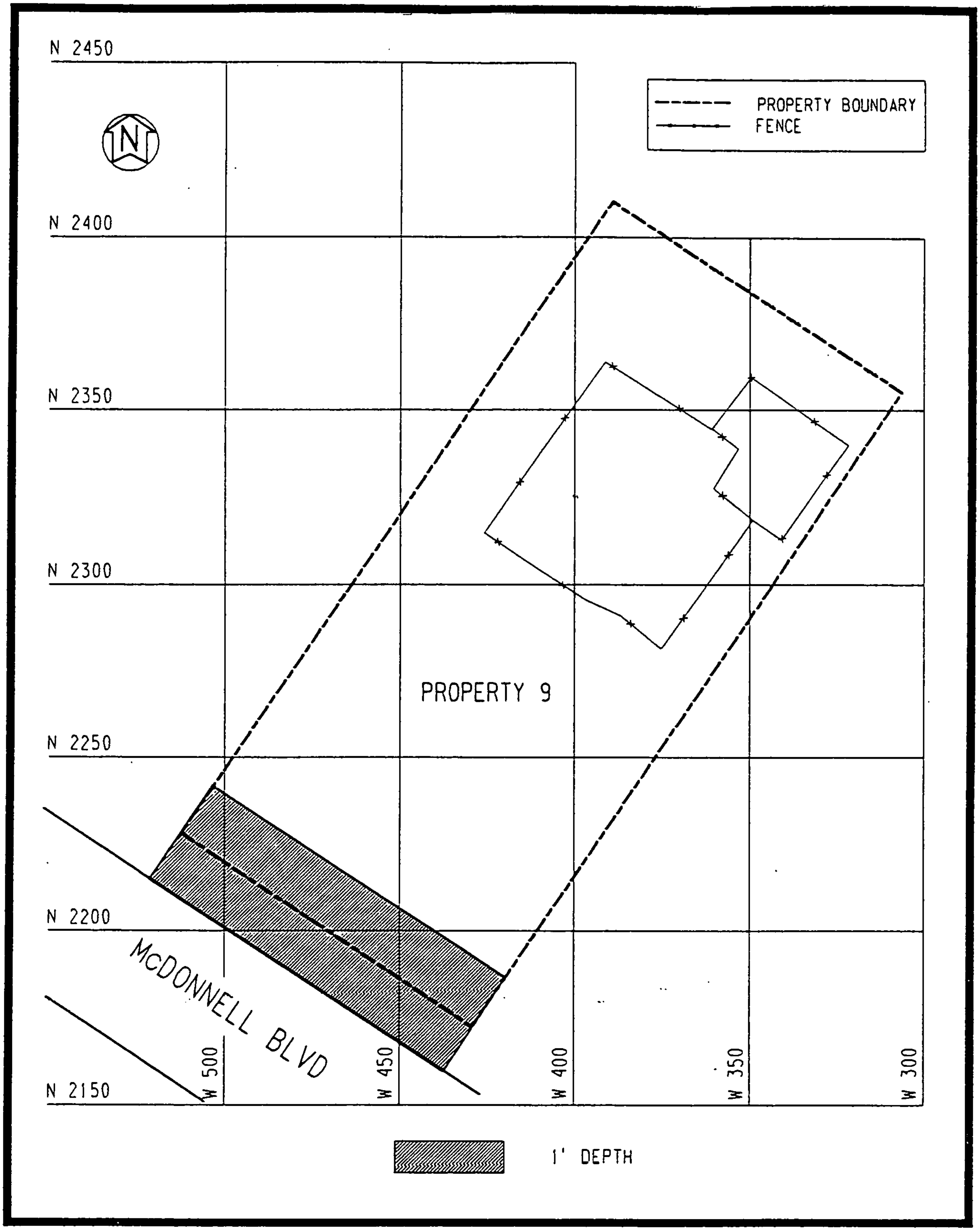


FIGURE 5-26 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT HAUL ROADS VICINITY PROPERTY 9

134F052.DGN DEPTH

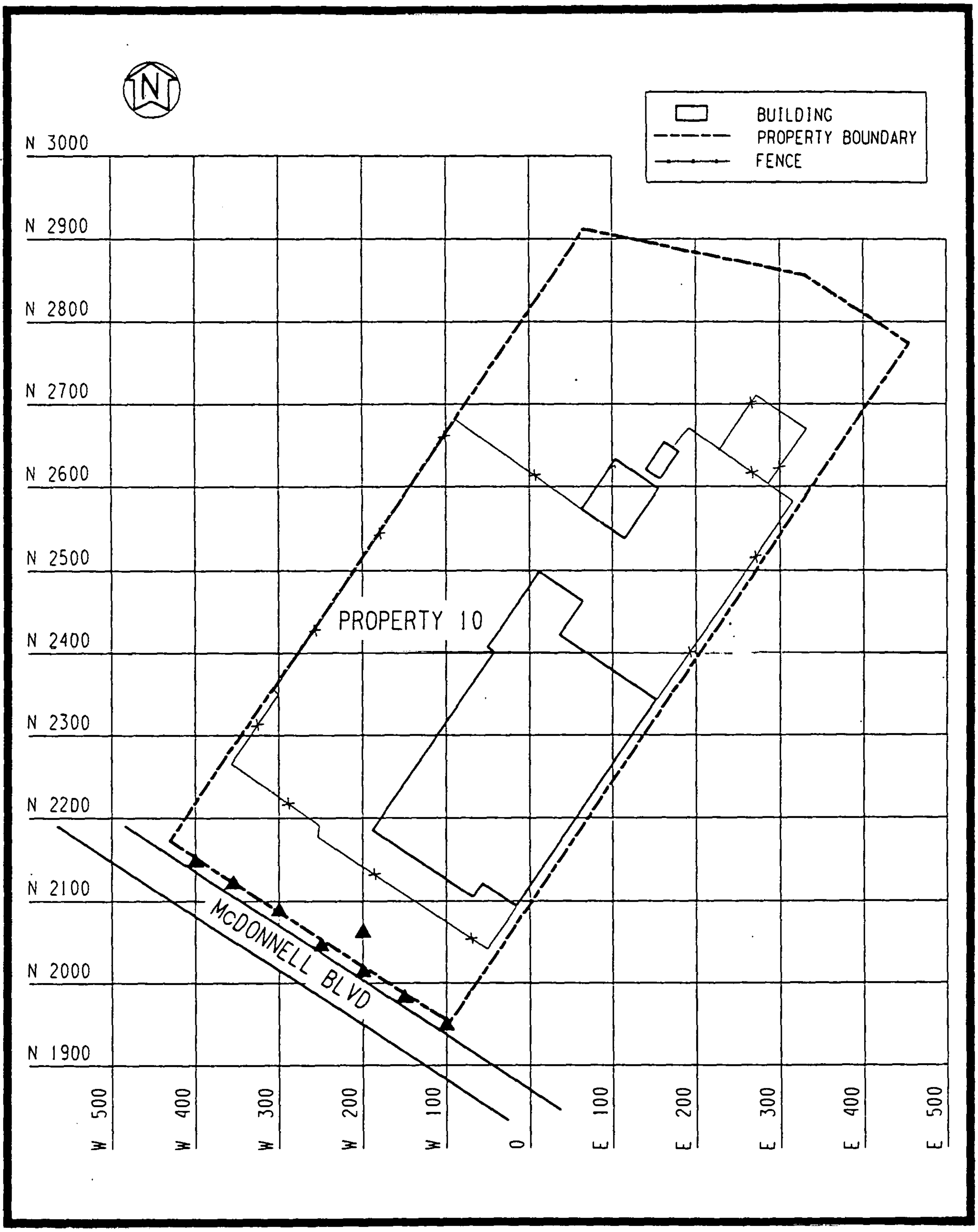


FIGURE 5-27 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 10

134F051.DGN SAMPLE

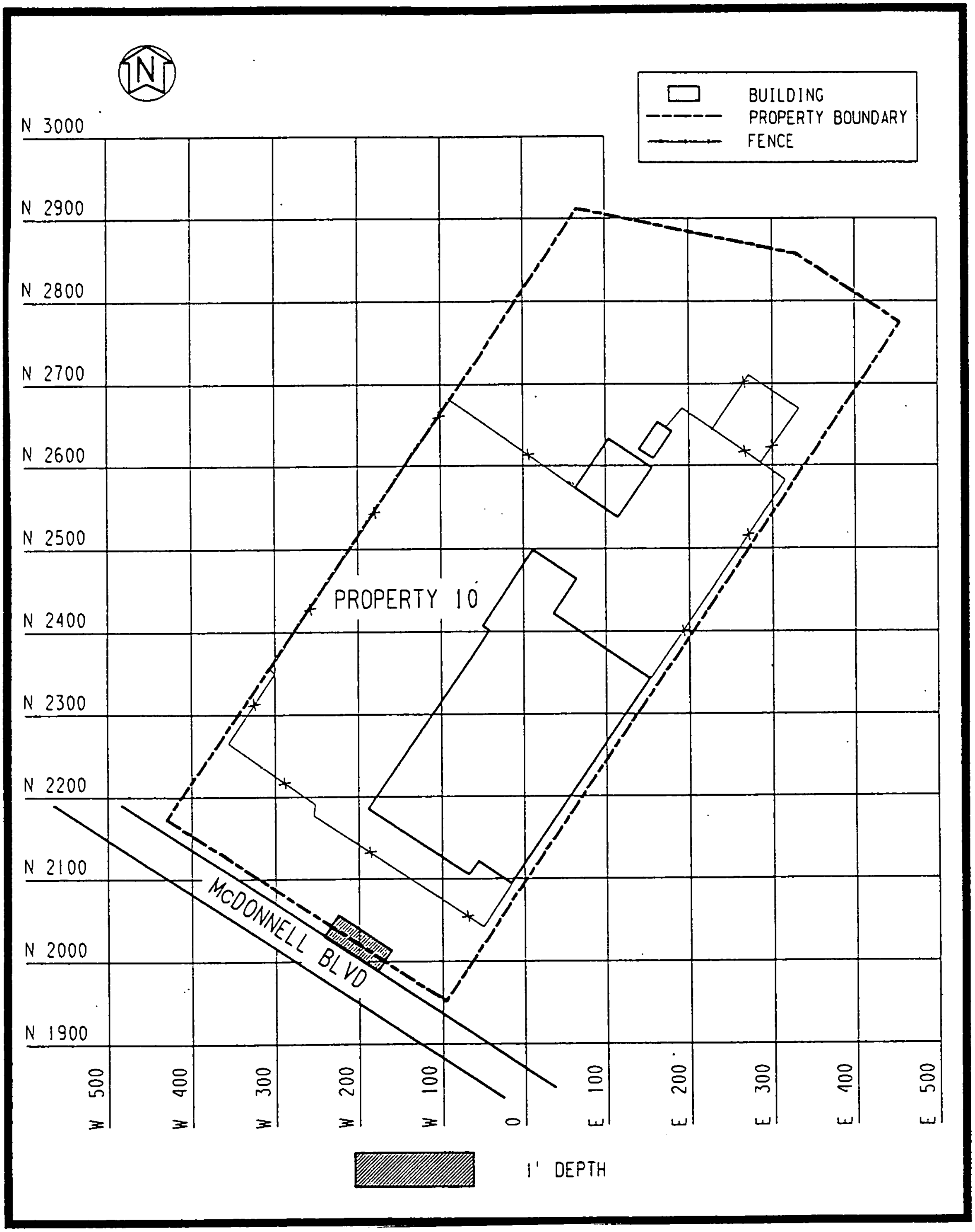


FIGURE 5-28 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT HAUL ROADS VICINITY PROPERTY 10

134F051.DGN DEPTH

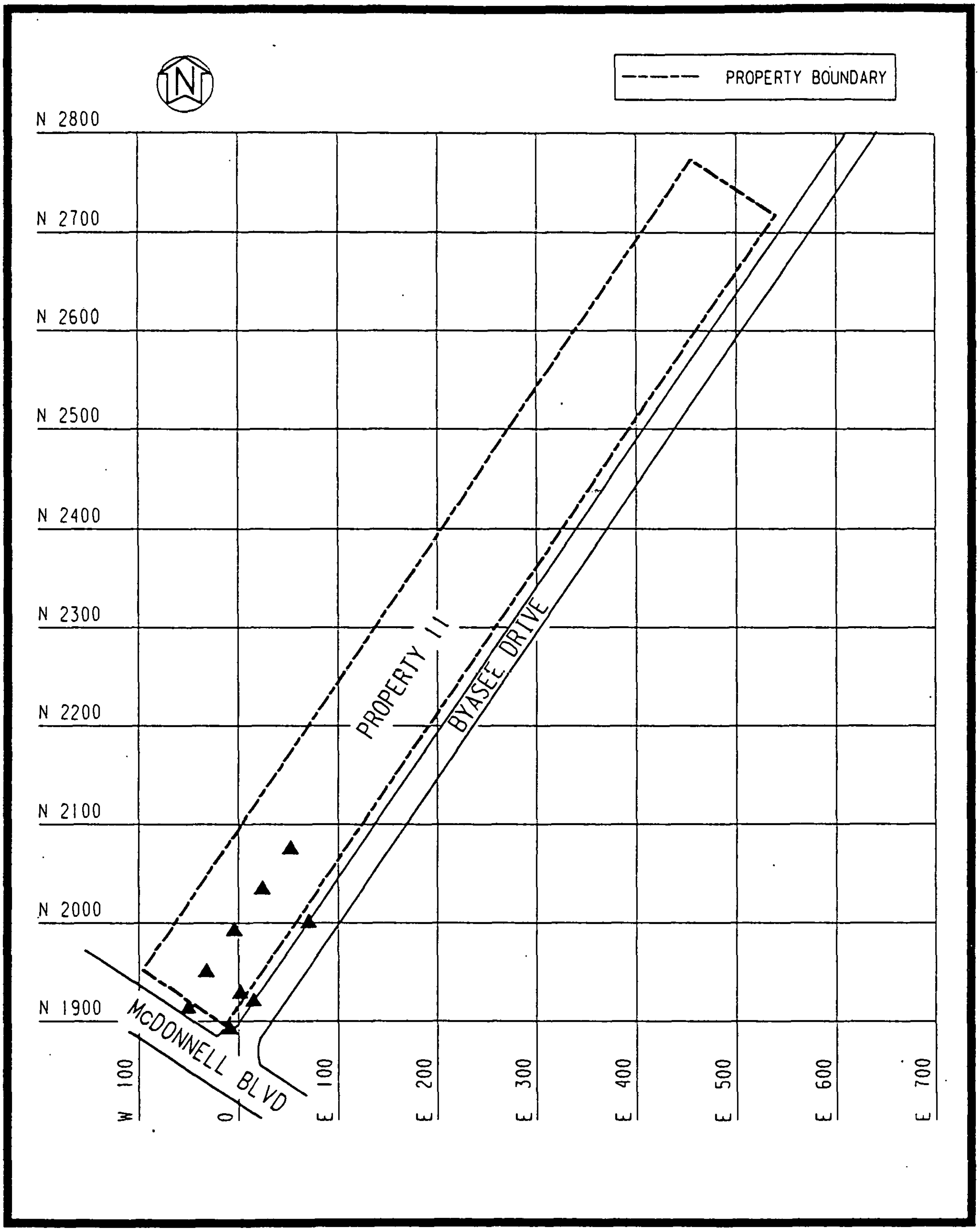


FIGURE 5-29 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 11

134F050.DGN SAMPLE

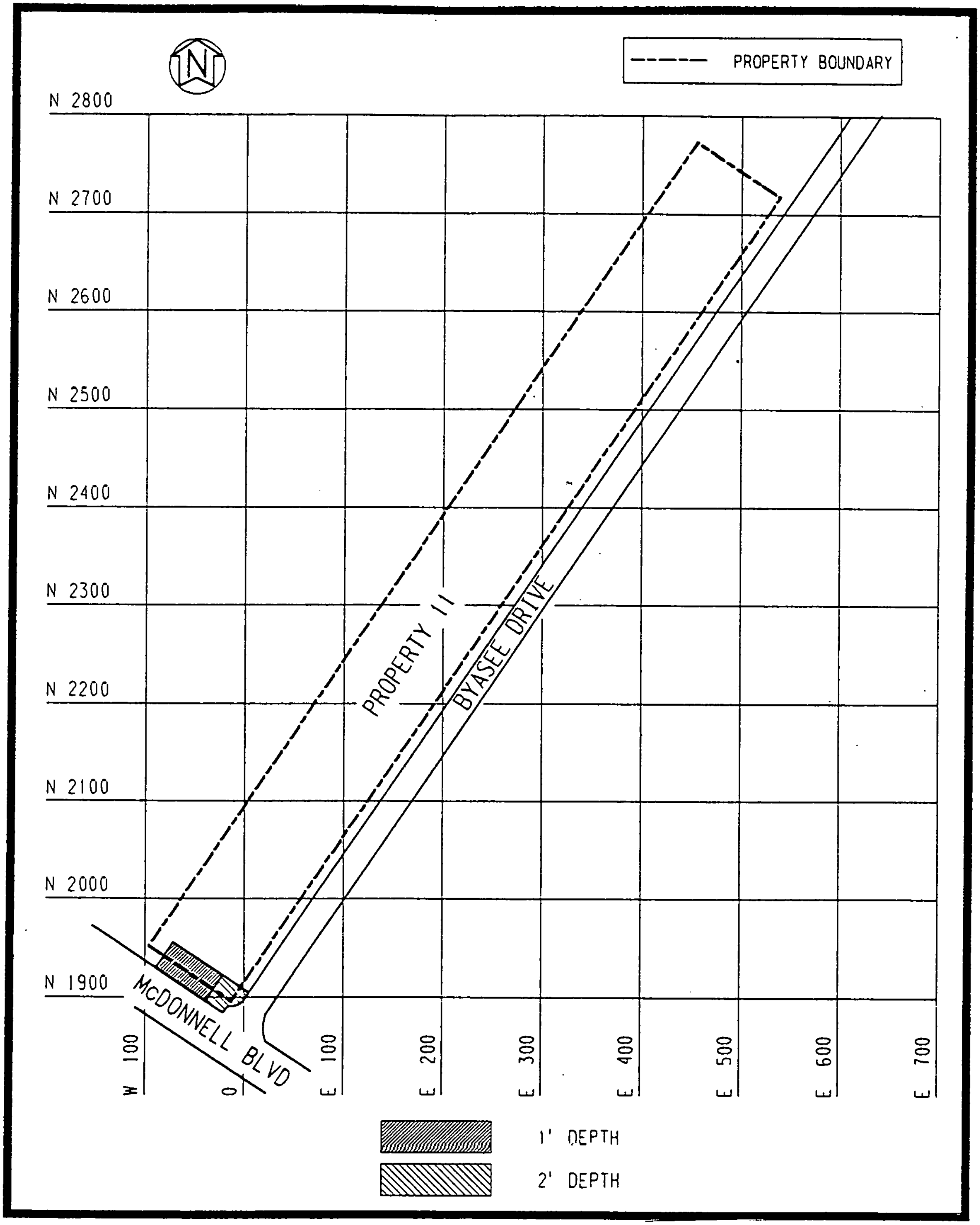


FIGURE 5-30 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT HAUL ROADS VICINITY PROPERTY 11

134F050.DGN DEPTH

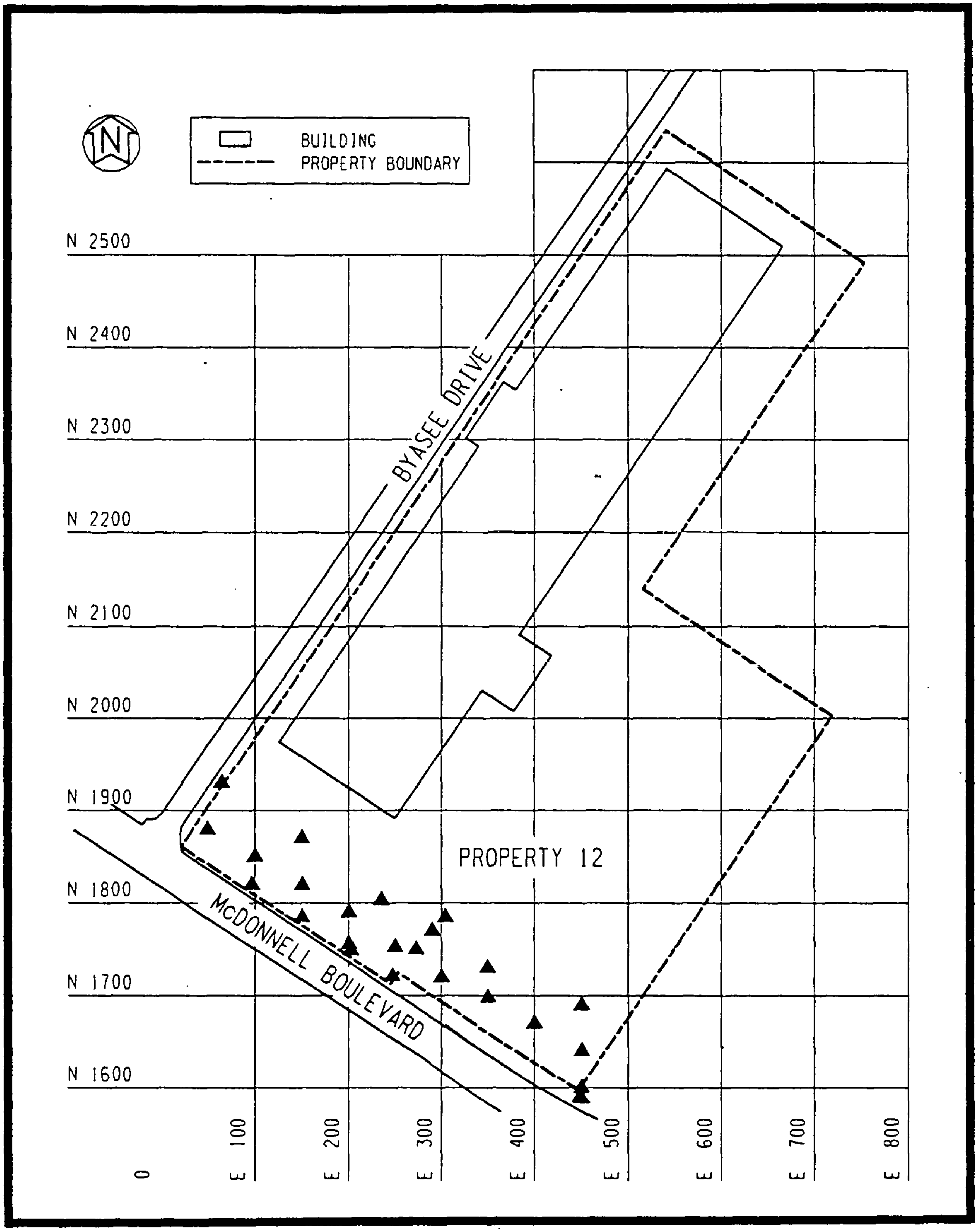


FIGURE 5-31 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 12

134F049.DGN SDIL

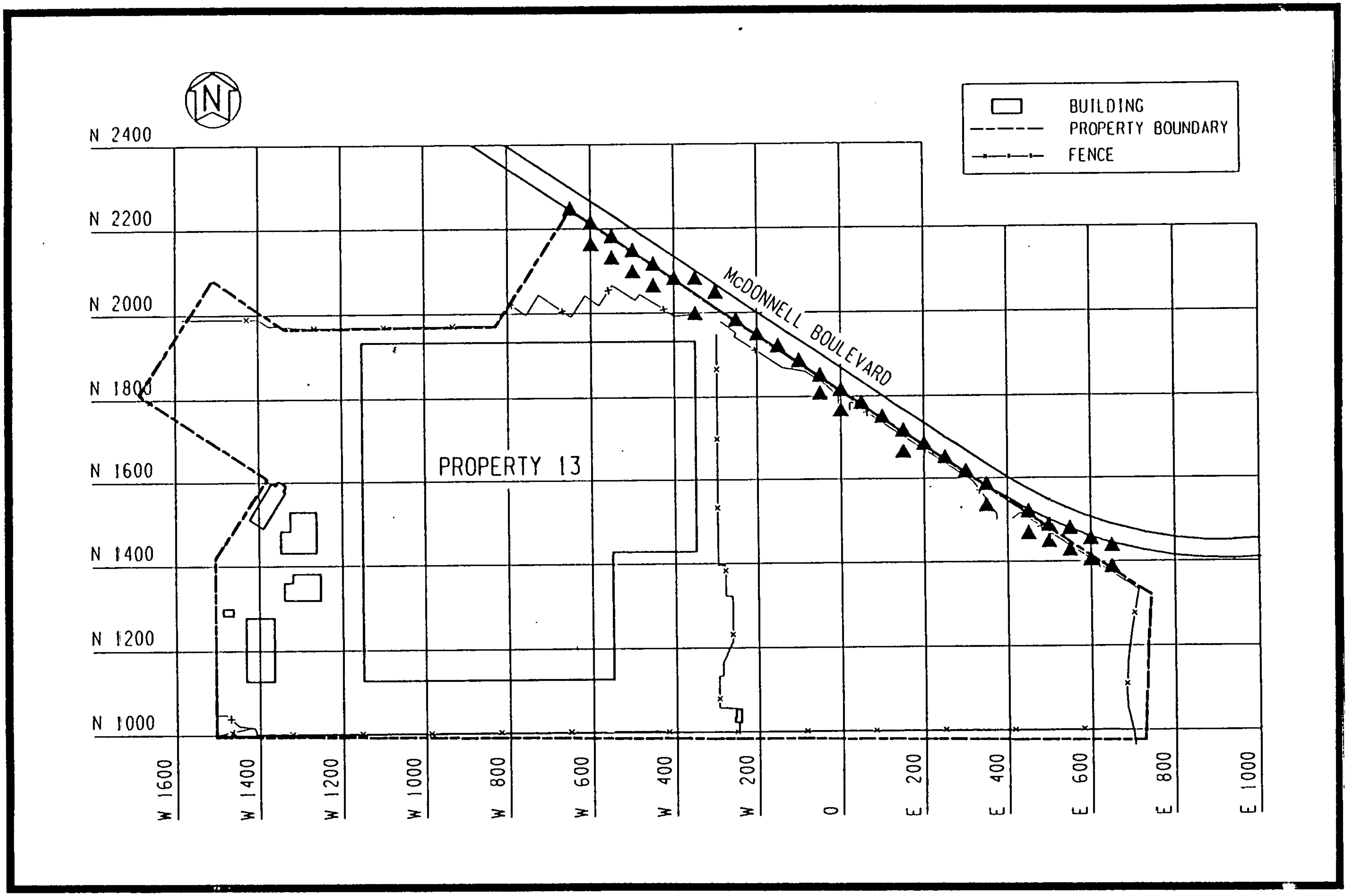


FIGURE 5-32 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 13

134F046.DGN SOIL

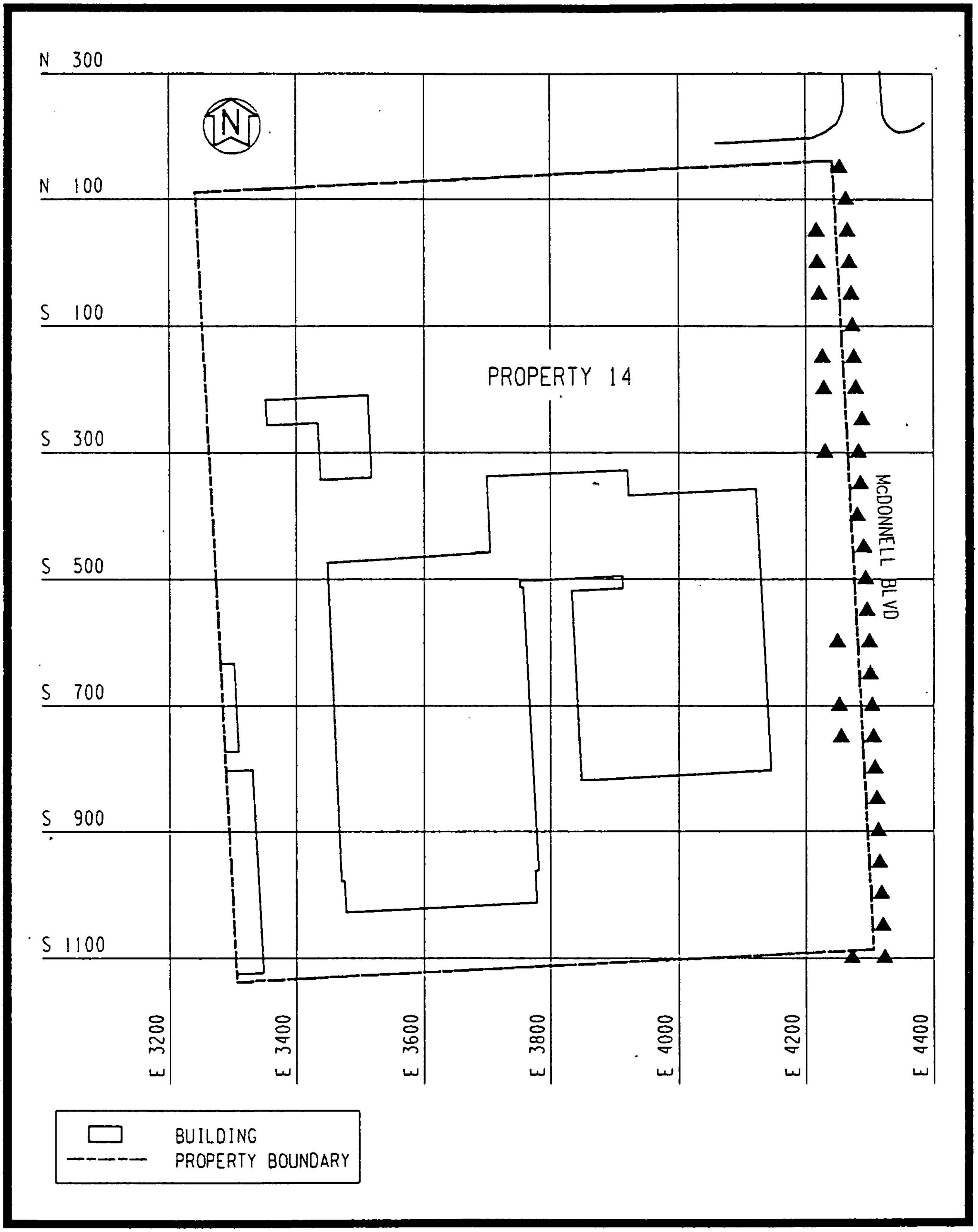


FIGURE 5-33 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 14

134F040.DGN SAMPLE

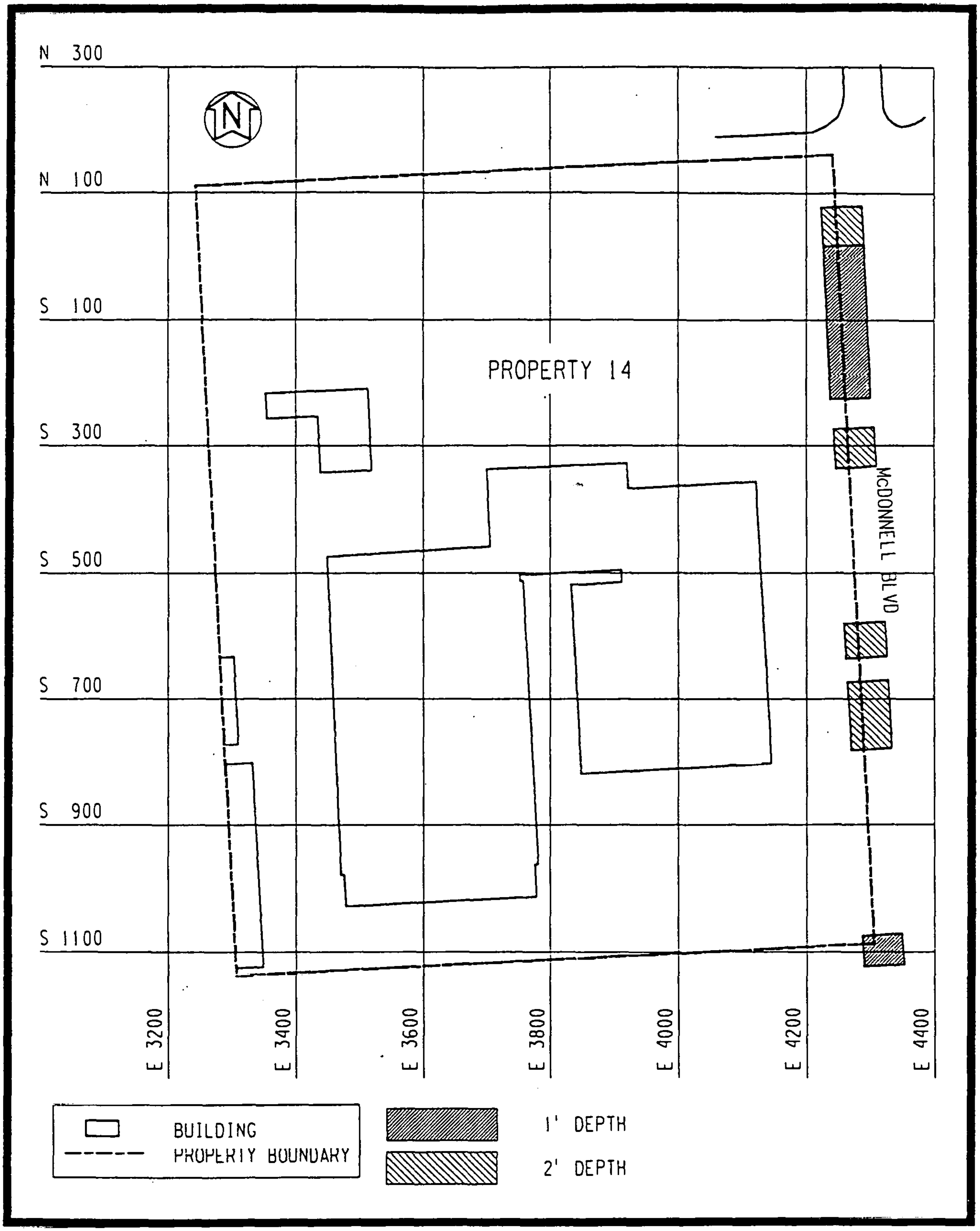


FIGURE 5-34 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT HAUL ROADS VICINITY PROPERTY 14

134F040.DGN DEPTH

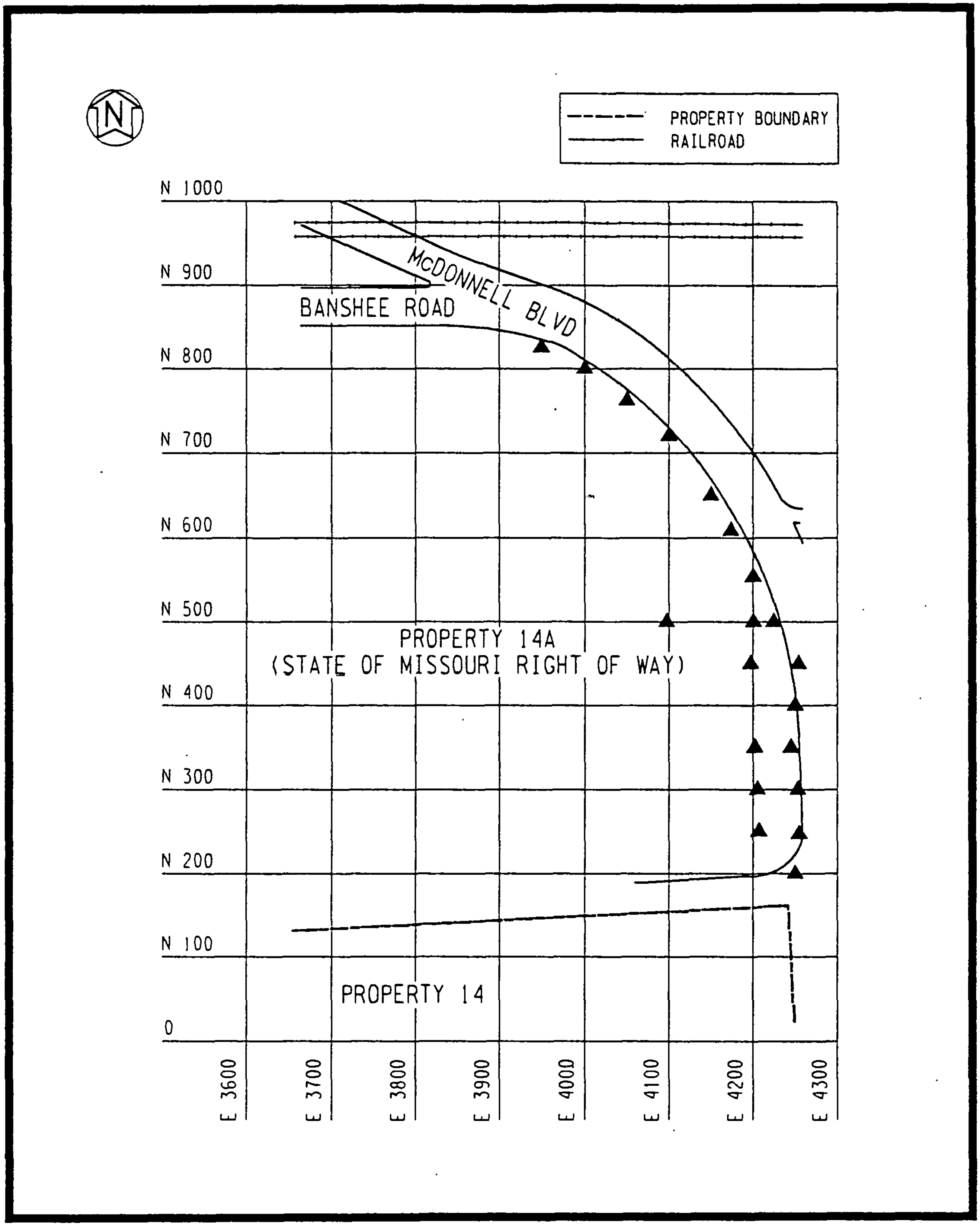


FIGURE 5-35 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 14A

134F087.DGN

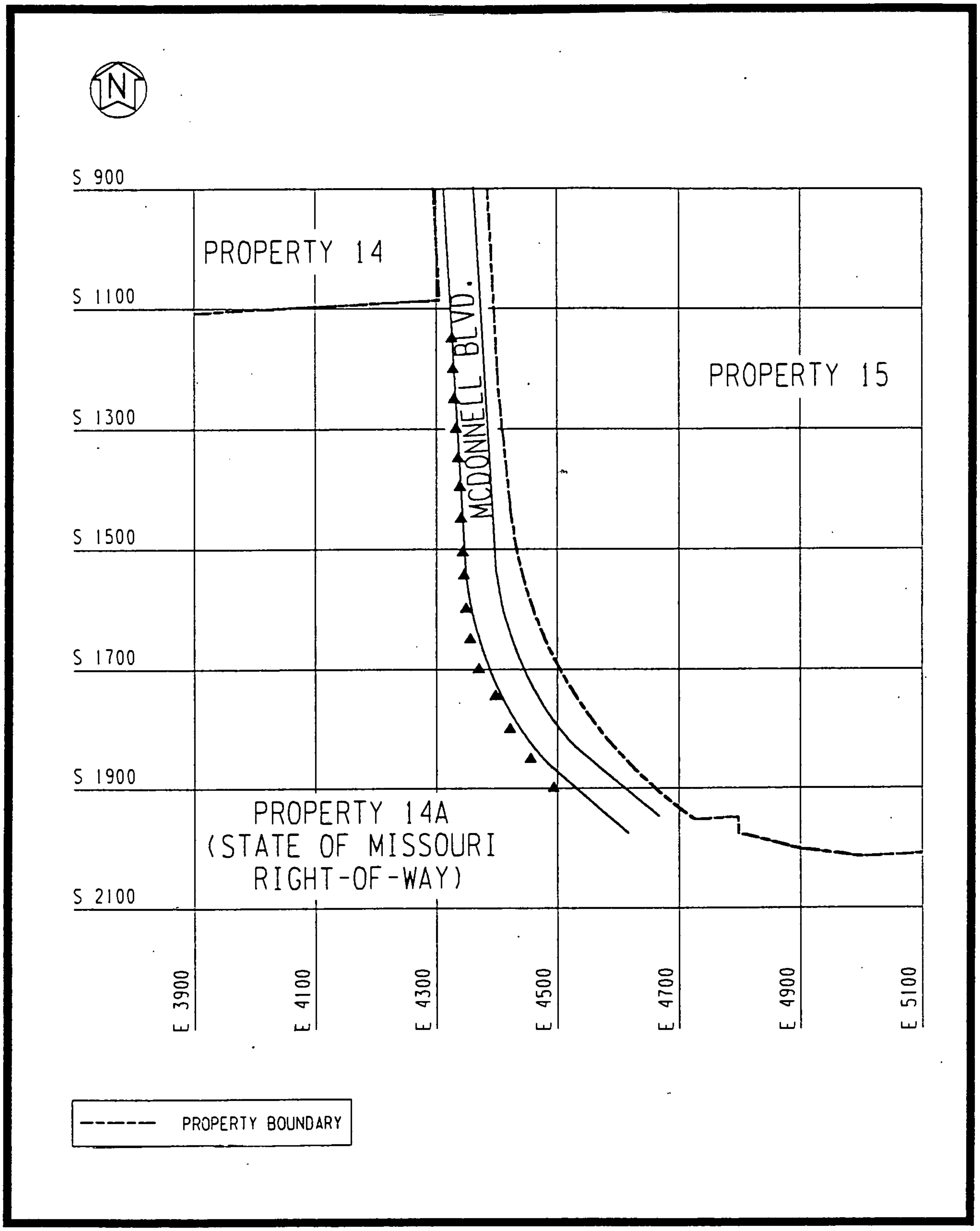


FIGURE 5-35 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 14A (CONT.)

134F090.DGN

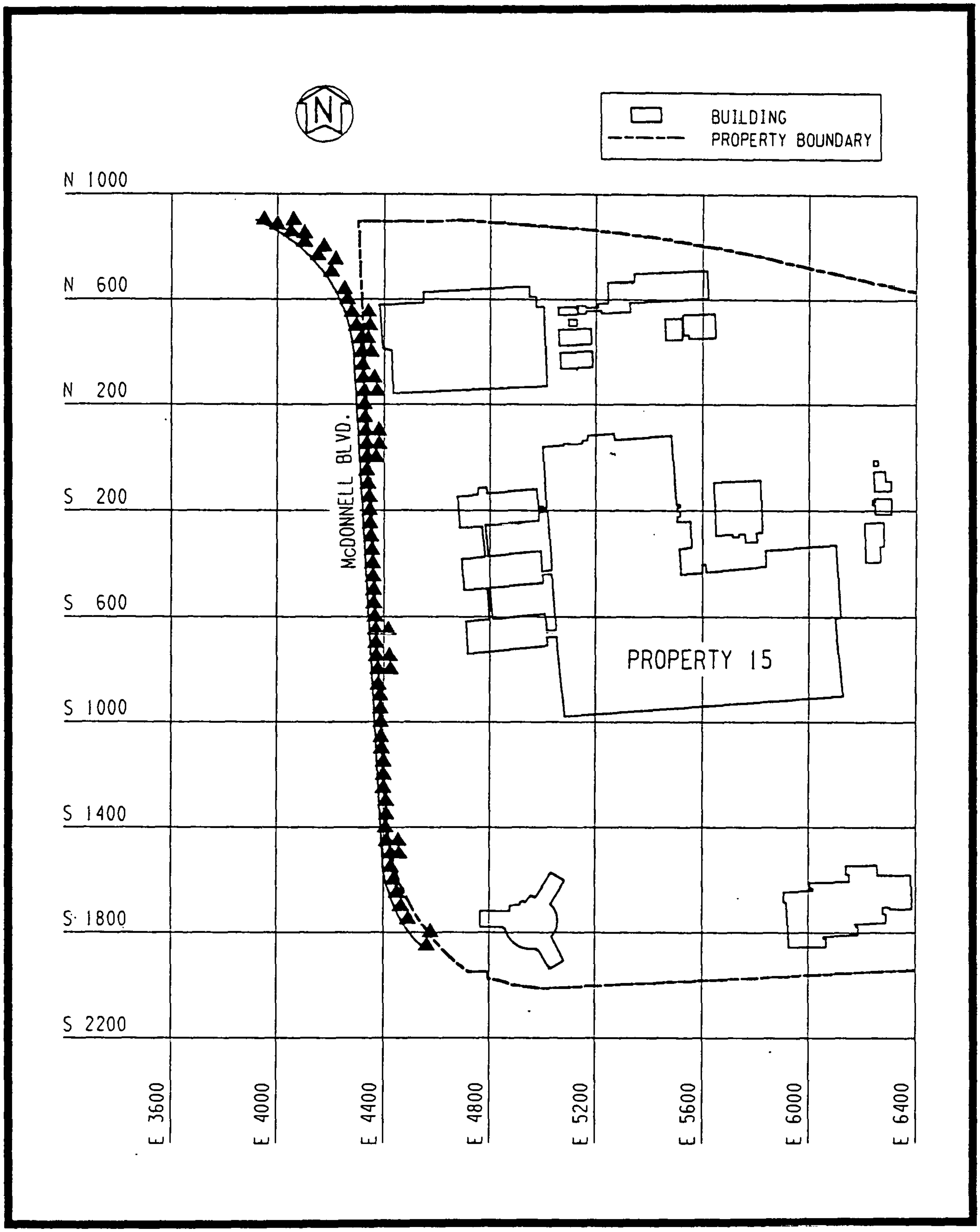


FIGURE 5-36 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS' VICINITY PROPERTY 15

4F070.DGN SAMPLE

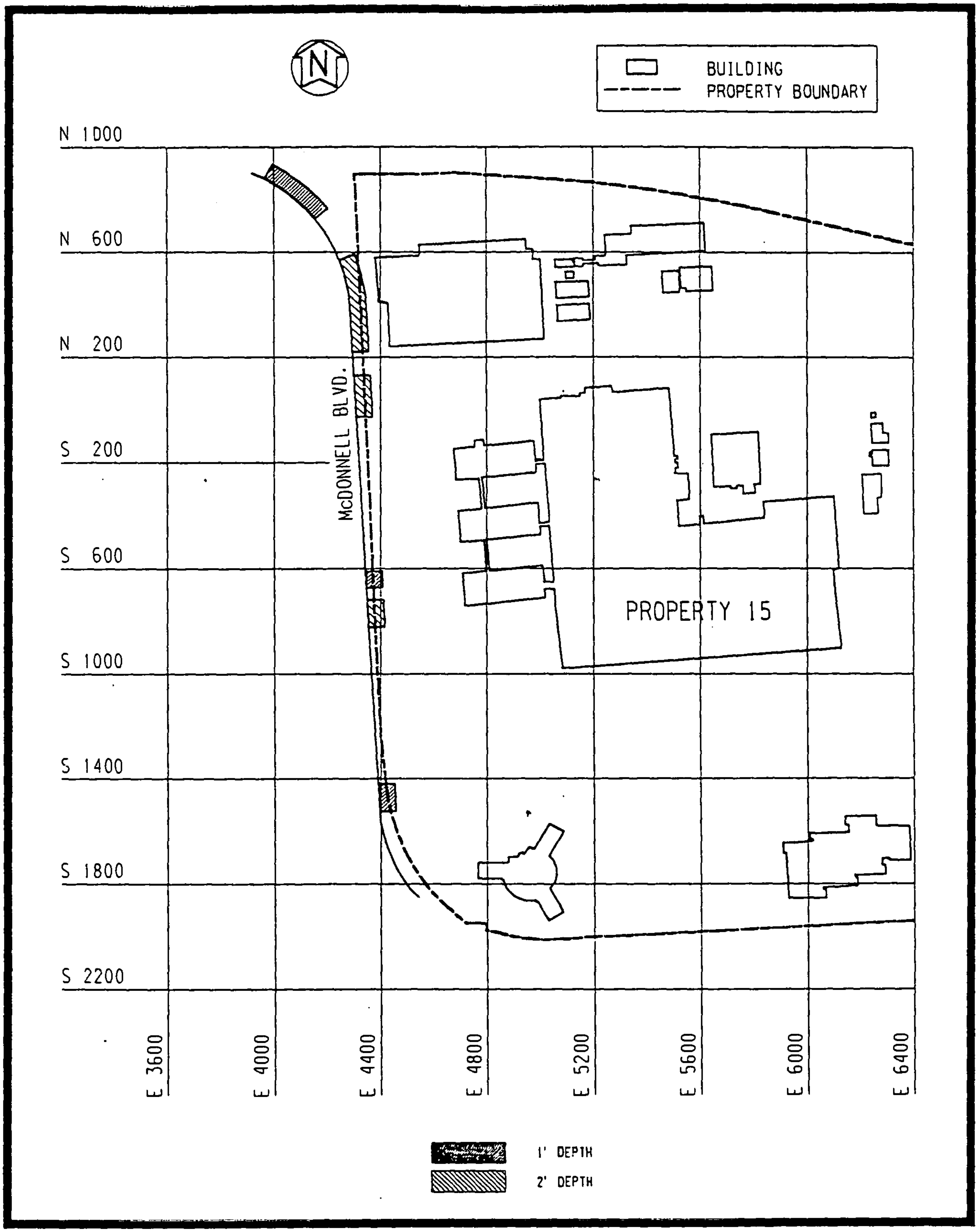


FIGURE 5-37 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT HAUL ROADS VICINITY PROPERTY 15

134F070.DGN DEPTH

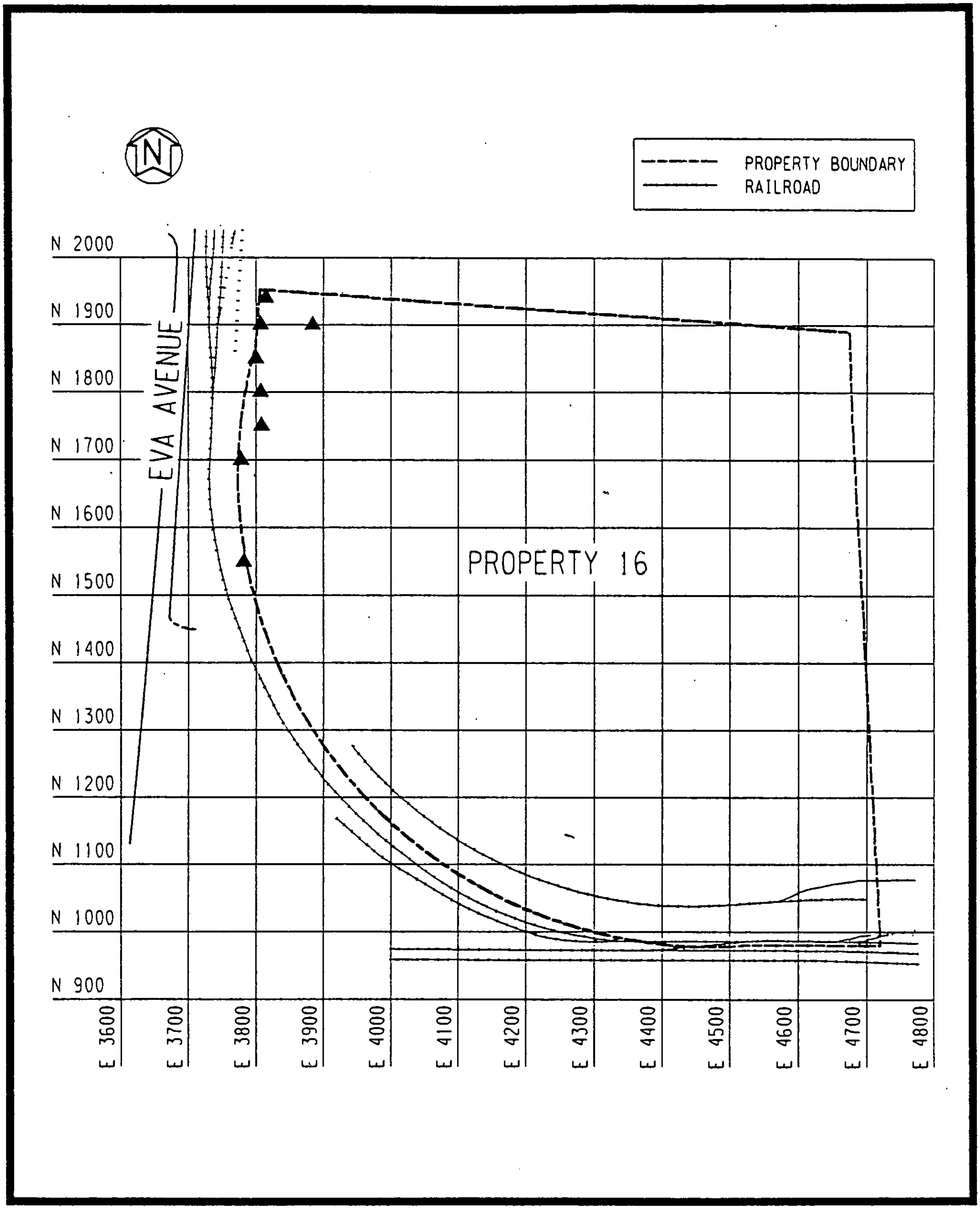


FIGURE 5-38 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 16

134F055.DGN

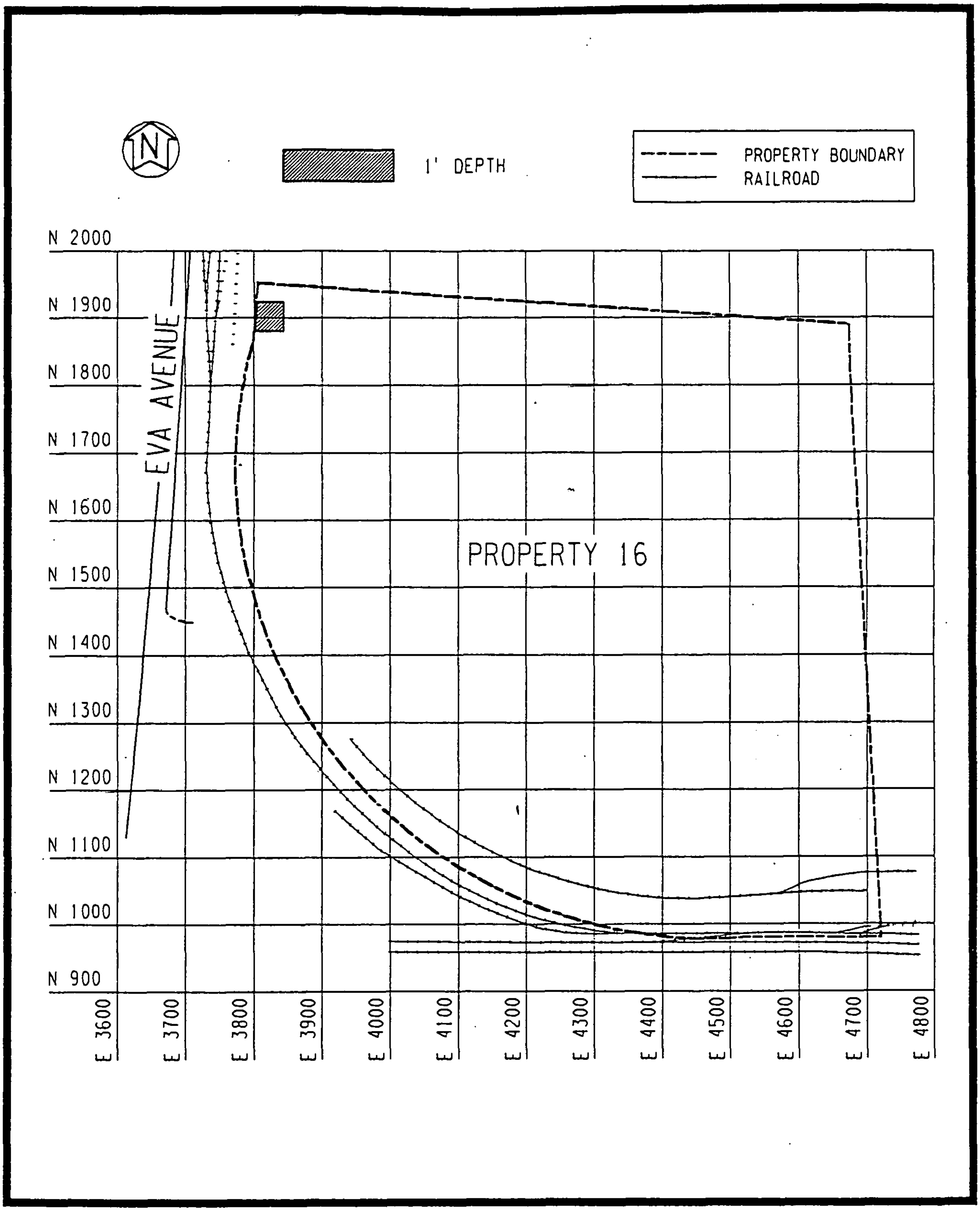


FIGURE 5-39 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT HAUL ROADS VICINITY PROPERTY 16

134F055.DGN

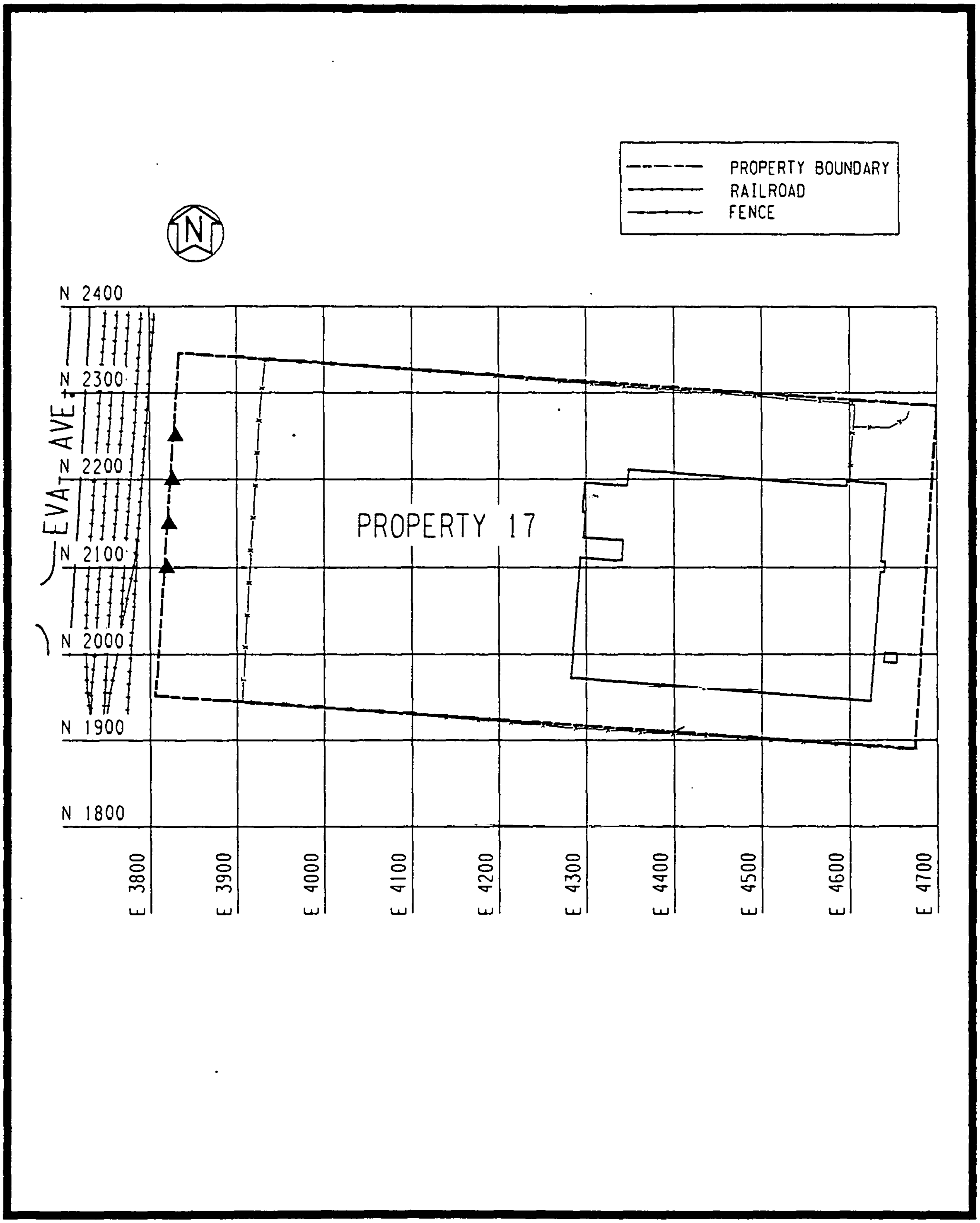


FIGURE 5-40 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 17

134F057.DGN

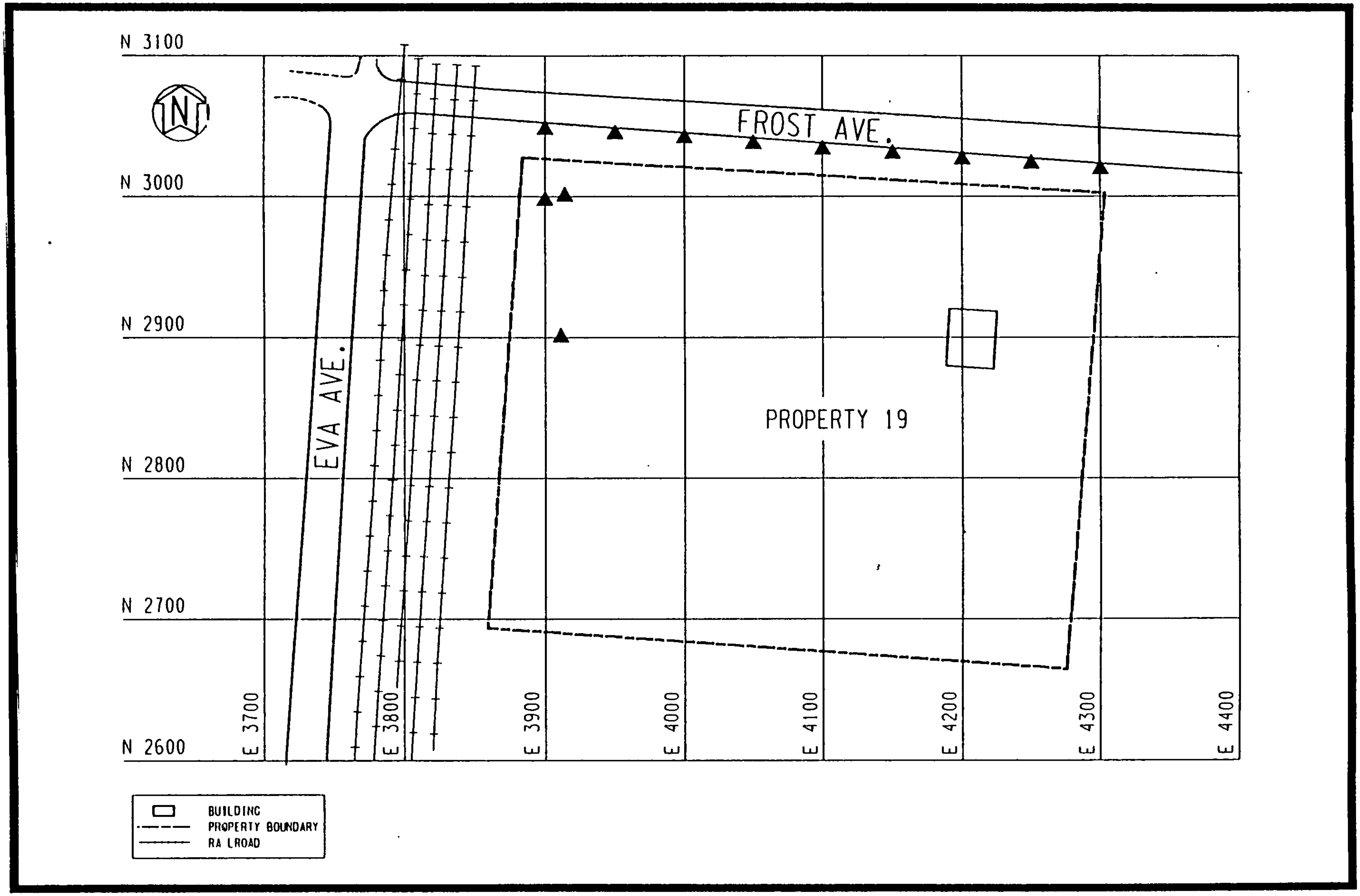


FIGURE 5-41 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 19

134F059.DGN SAMPLE

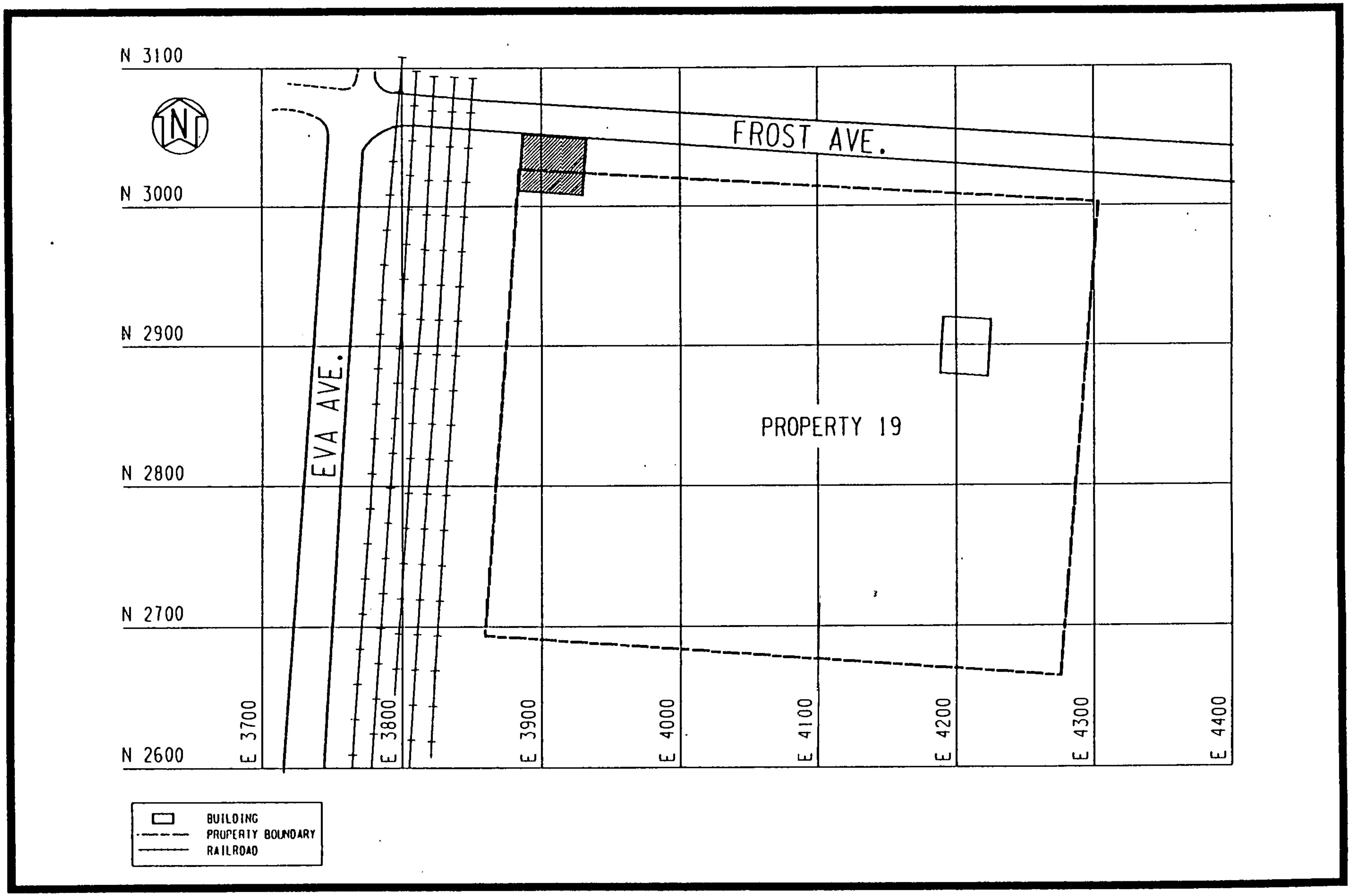


FIGURE 5-42 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT HAUL ROADS VICINITY PROPERTY 19

134F059.DGN DEPTH

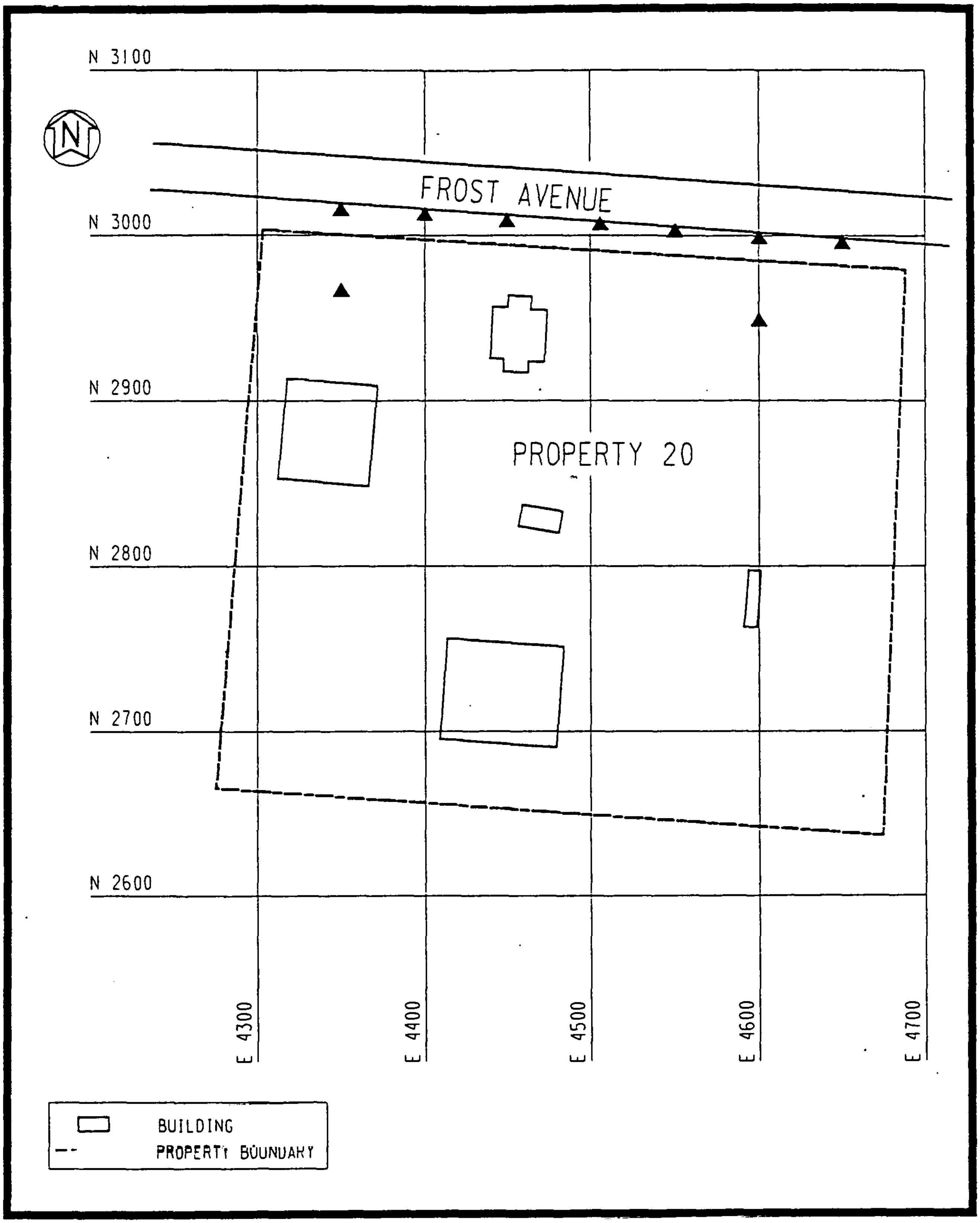


FIGURE 5-43 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 20

134F060.DGN SAMPLE

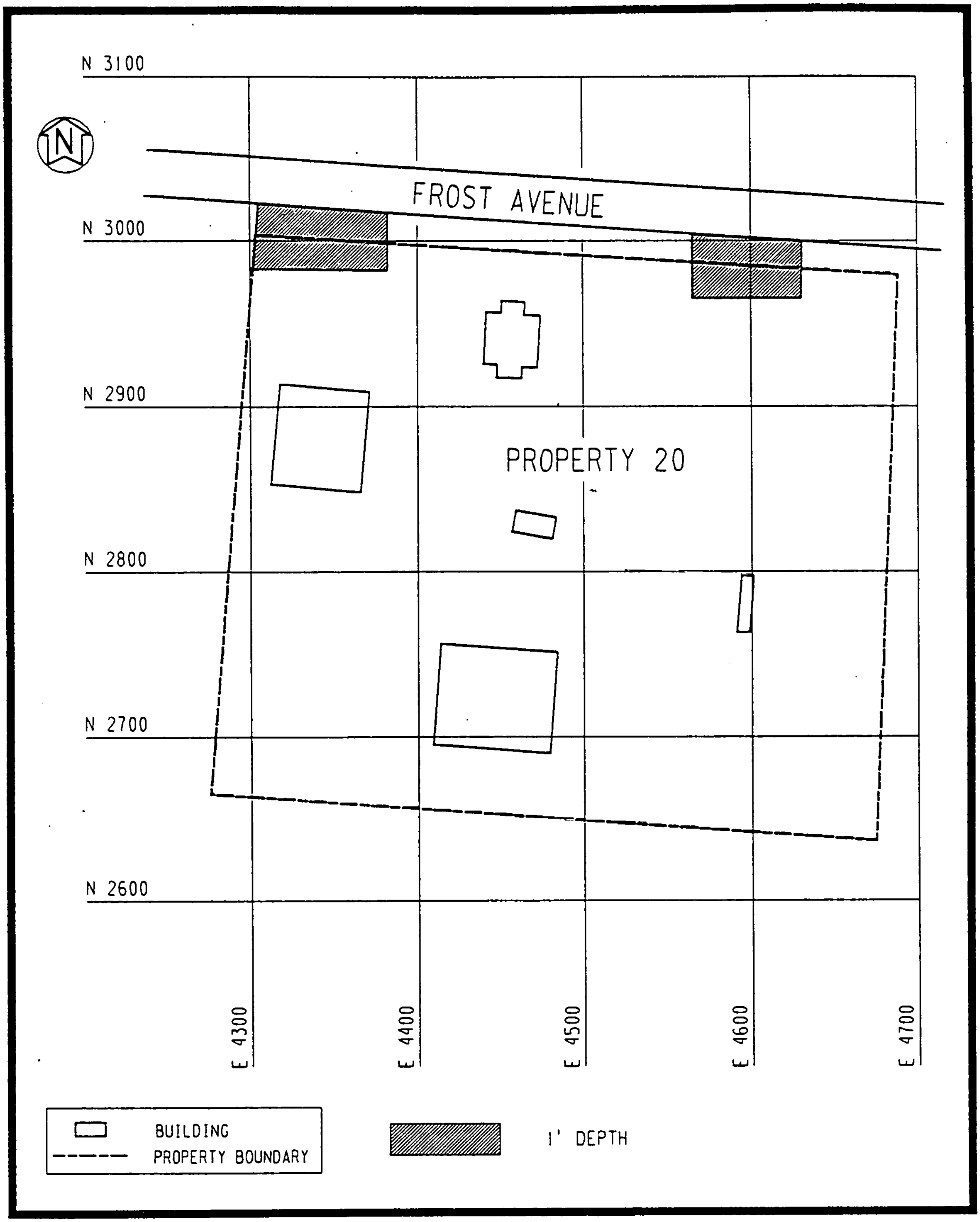


FIGURE 5-44 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT HAUL ROADS VICINITY PROPERTY 20

134F060.DGN DEPTH

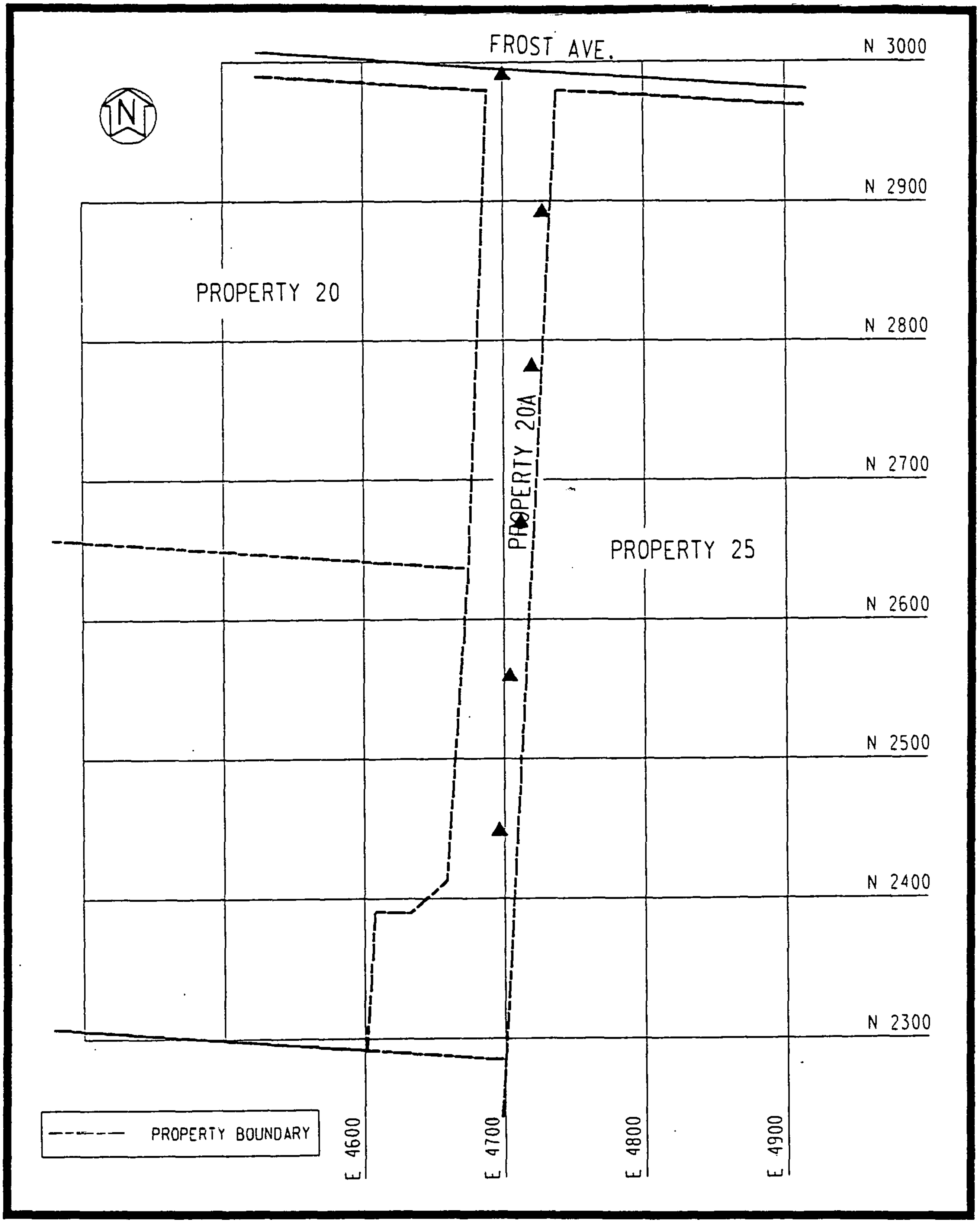


FIGURE 5-45 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 20A

134F093.DGN

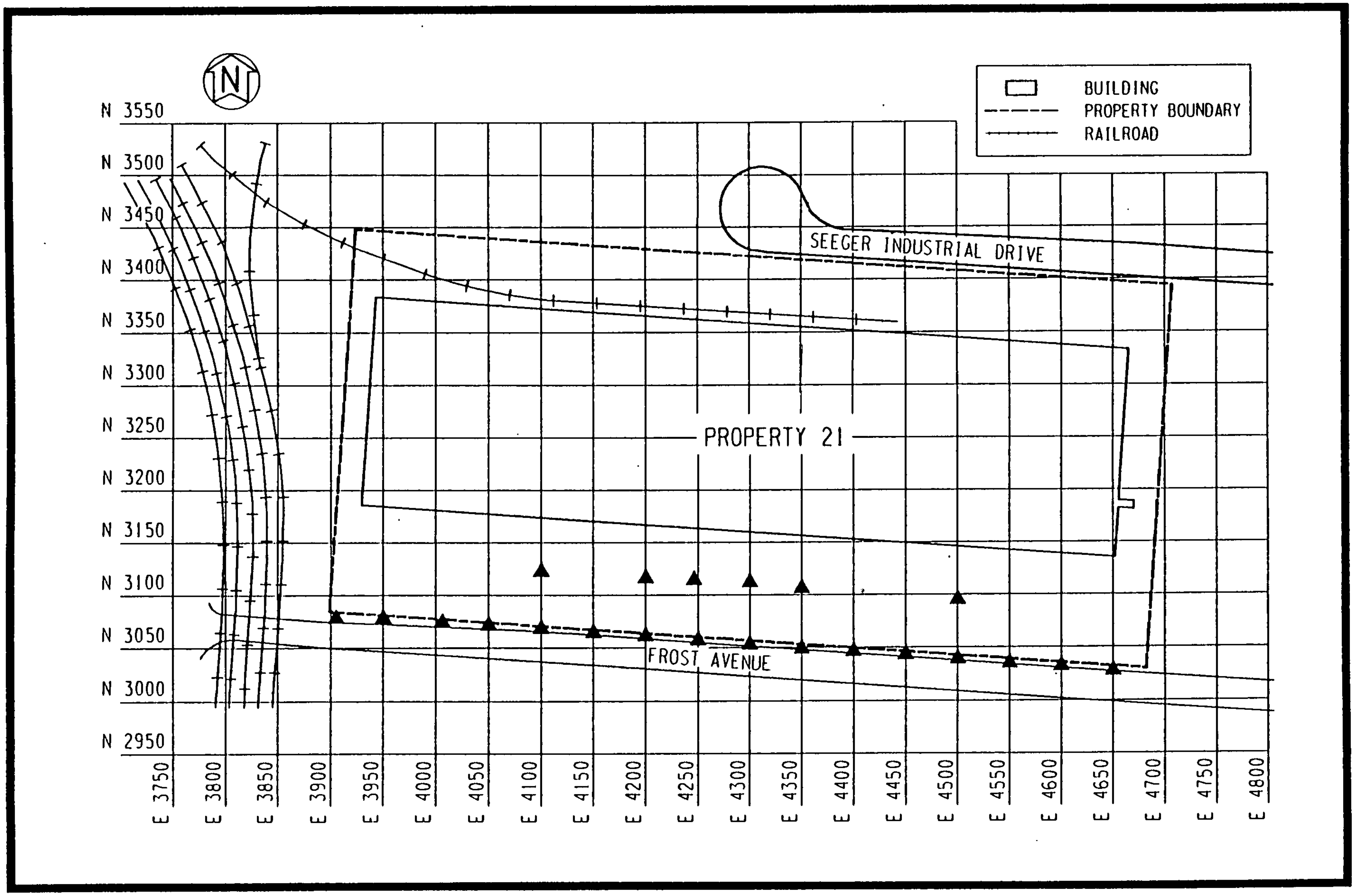


FIGURE 5-46 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 21

134F010.DGN SAMPLE

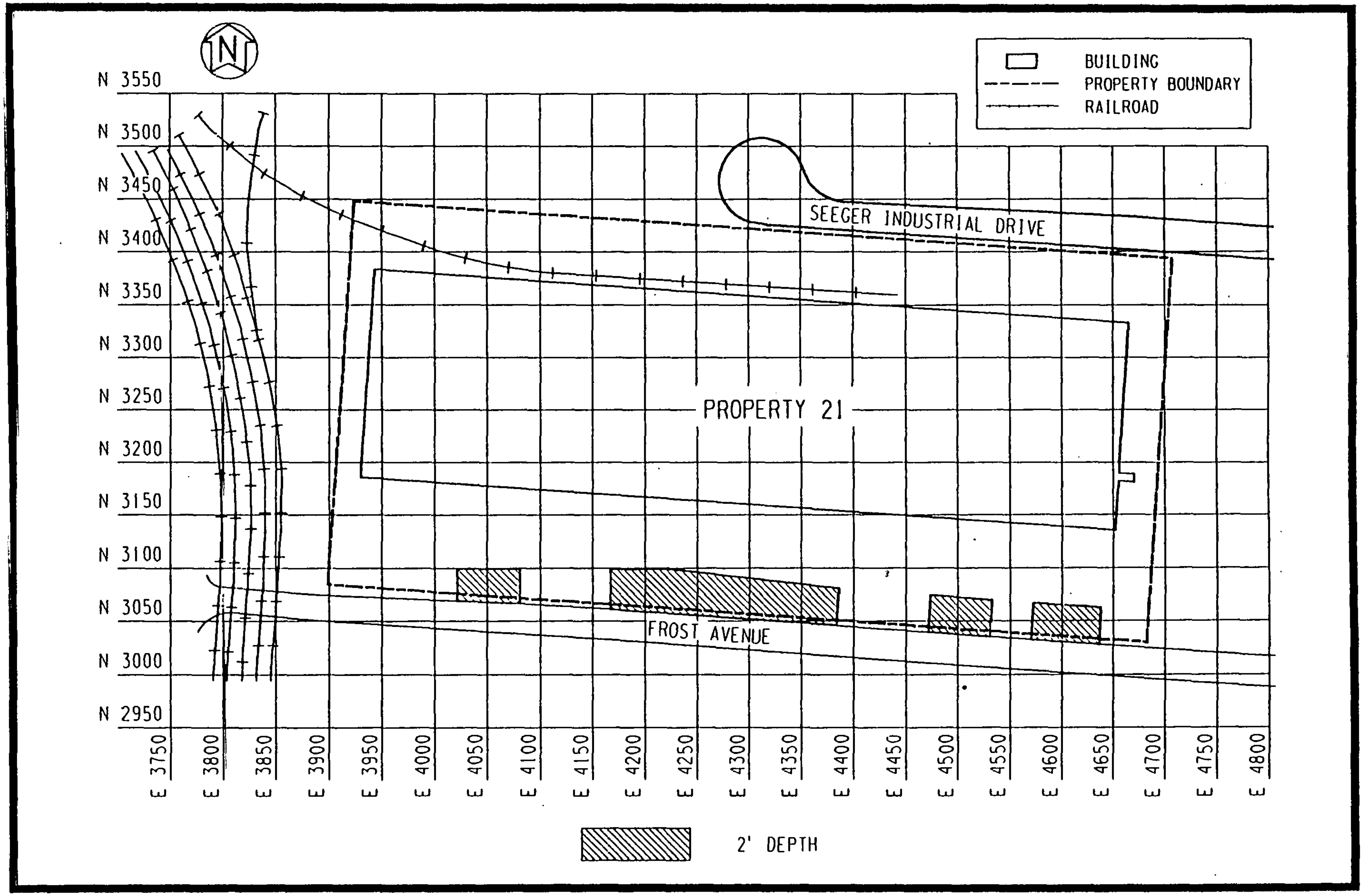


FIGURE 5-47 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT HAUL ROADS VICINITY PROPERTY 21

134F010.DGN DEPTH

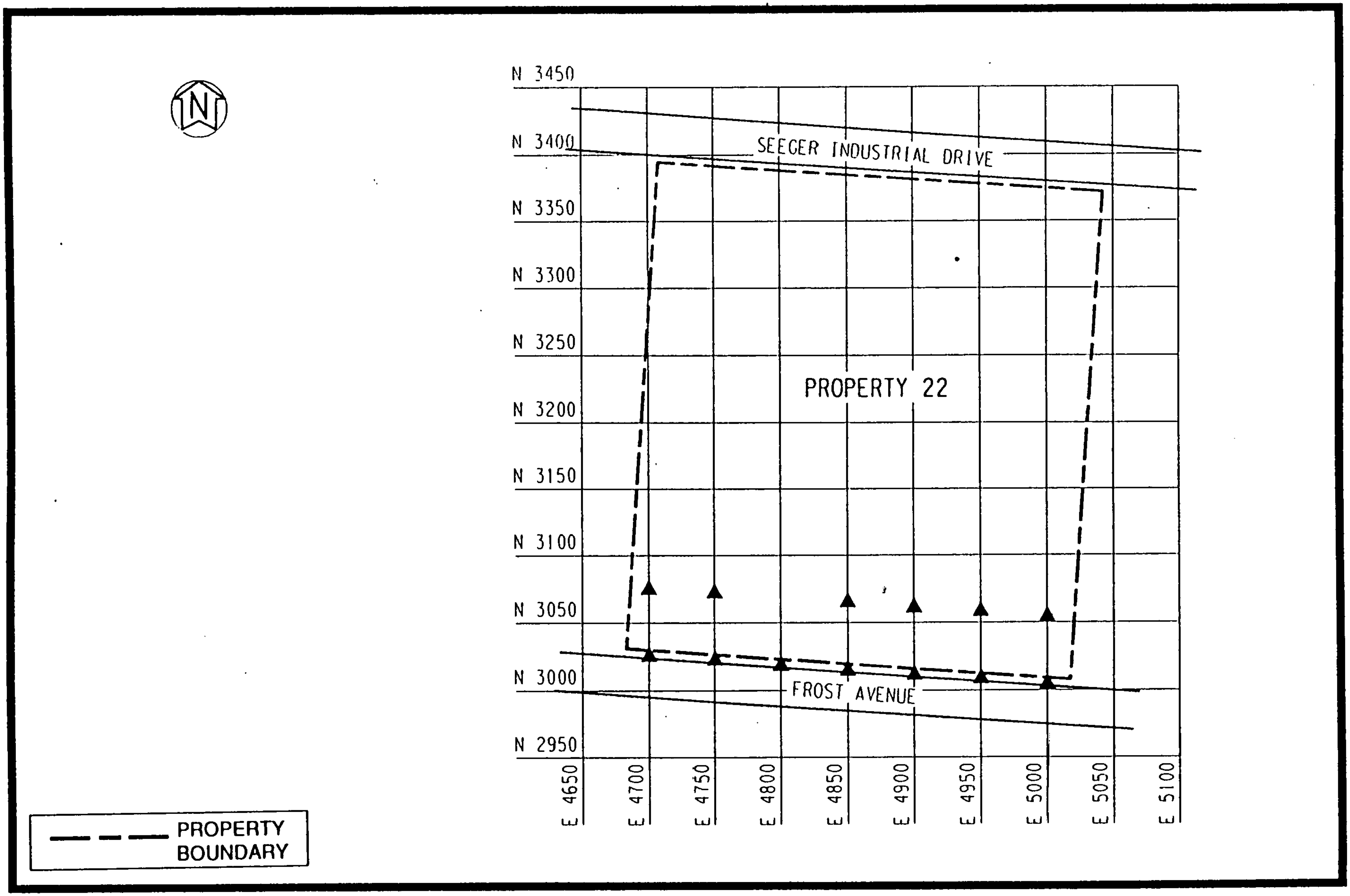


FIGURE 5-48 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 22

134F012.DGN

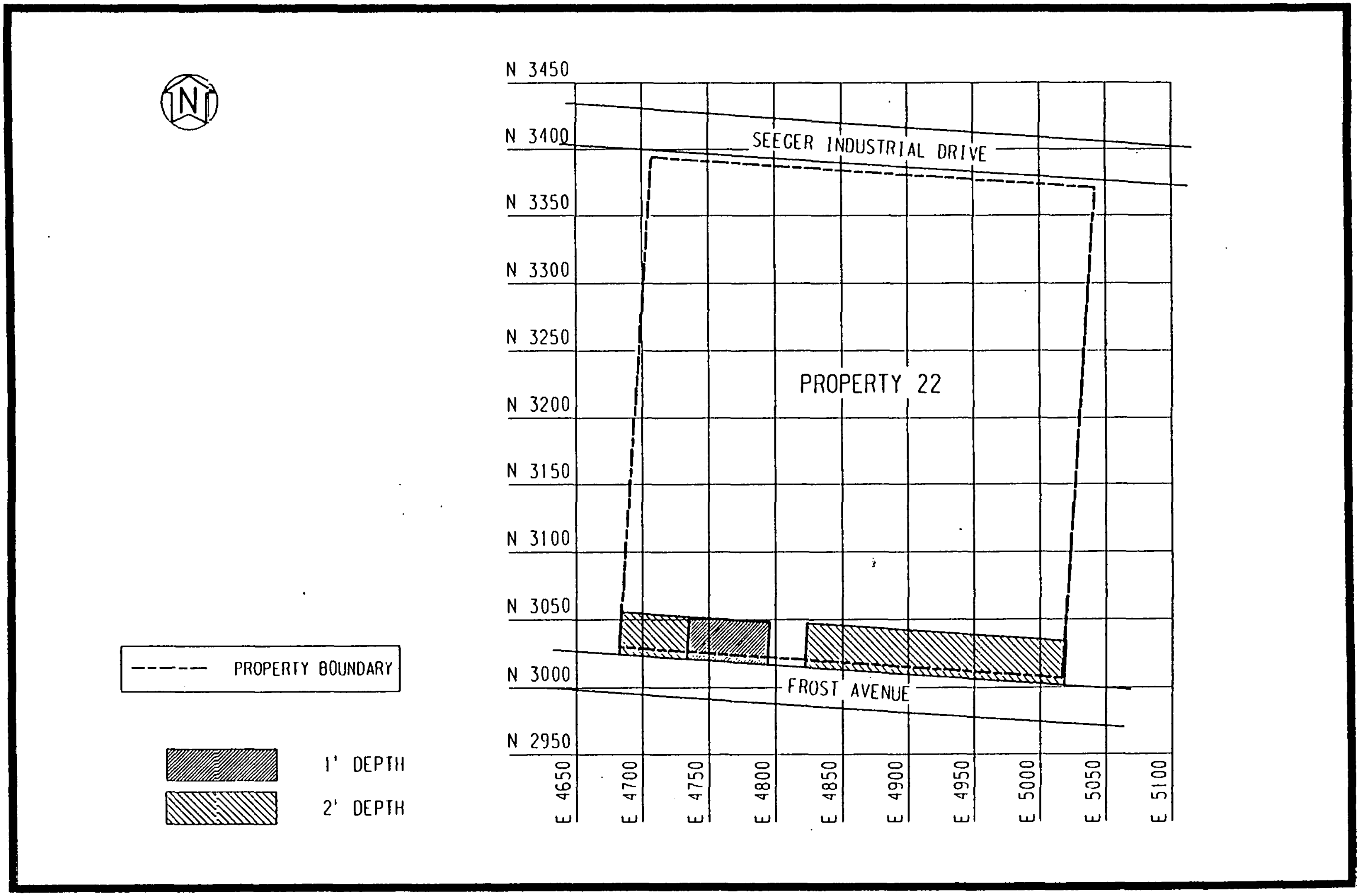


FIGURE 5-49 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT HAUL ROADS VICINITY PROPERTY 22

134F011.DGN DEPTH

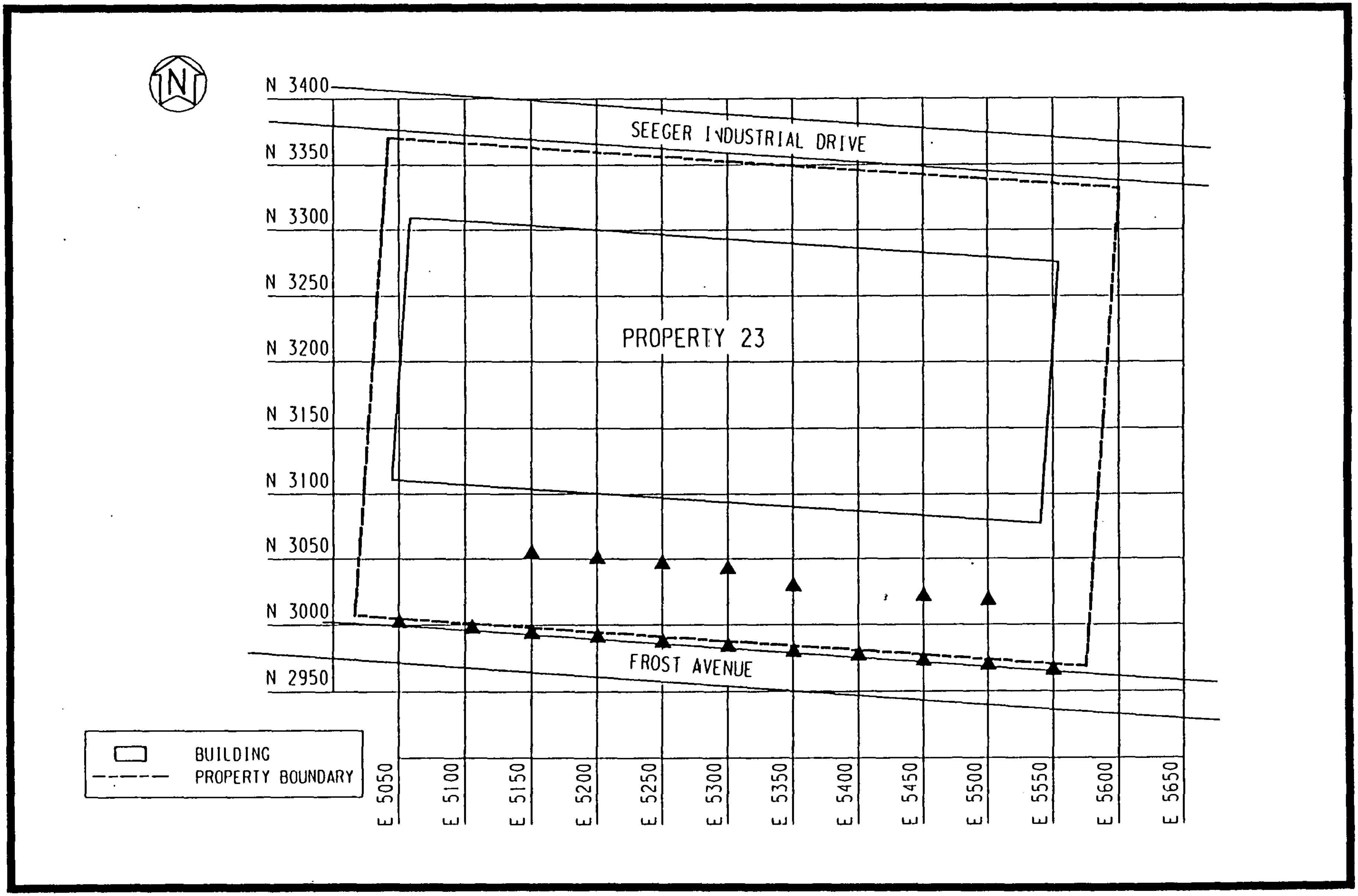


FIGURE 5-50 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 23

14F012.DGN

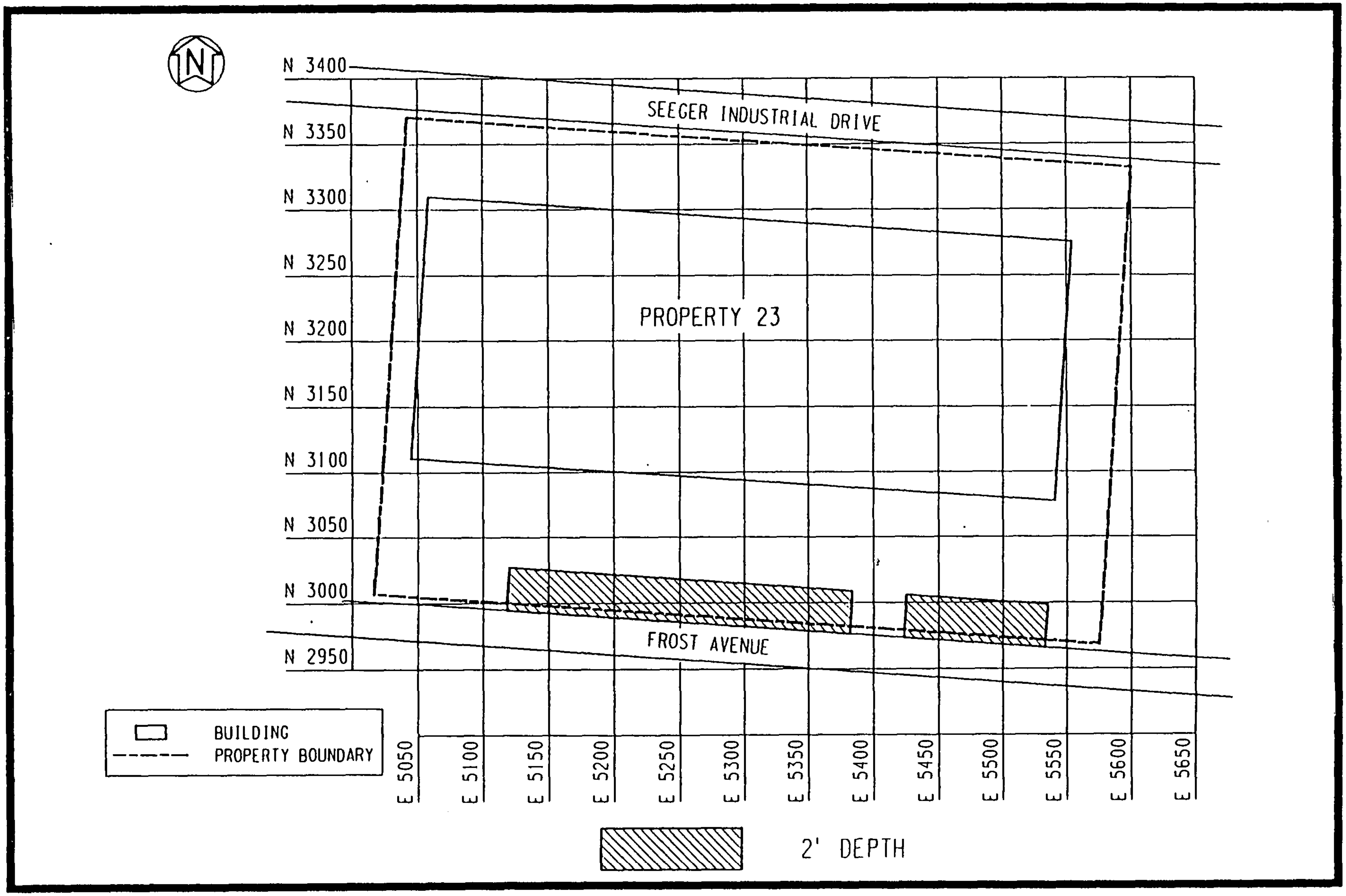


FIGURE 5-51 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT HAUL ROADS VICINITY PROPERTY 23

134F012.DGN FIG7

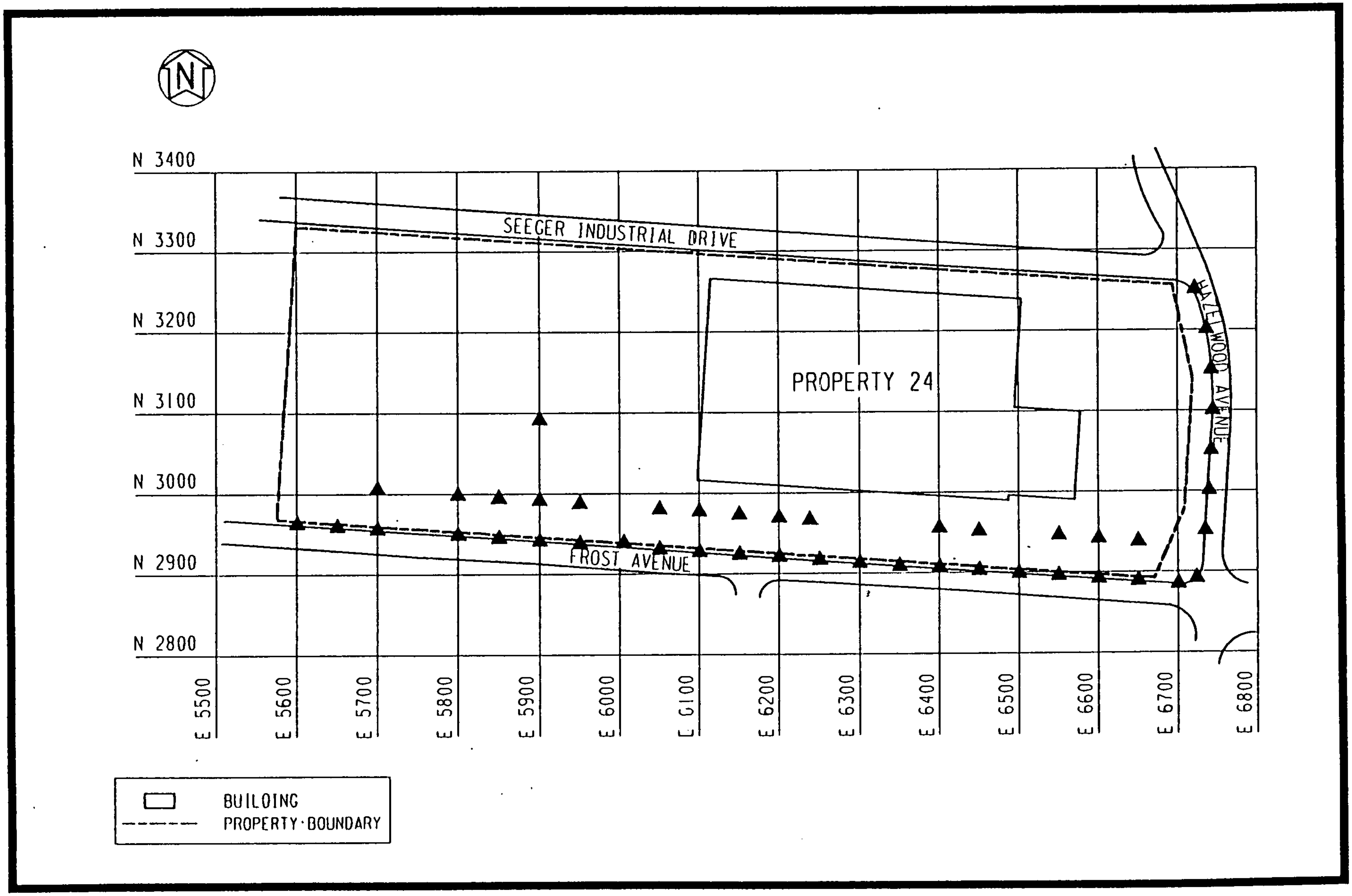


FIGURE 5-52 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 24

134F013.DGN SAMPLE

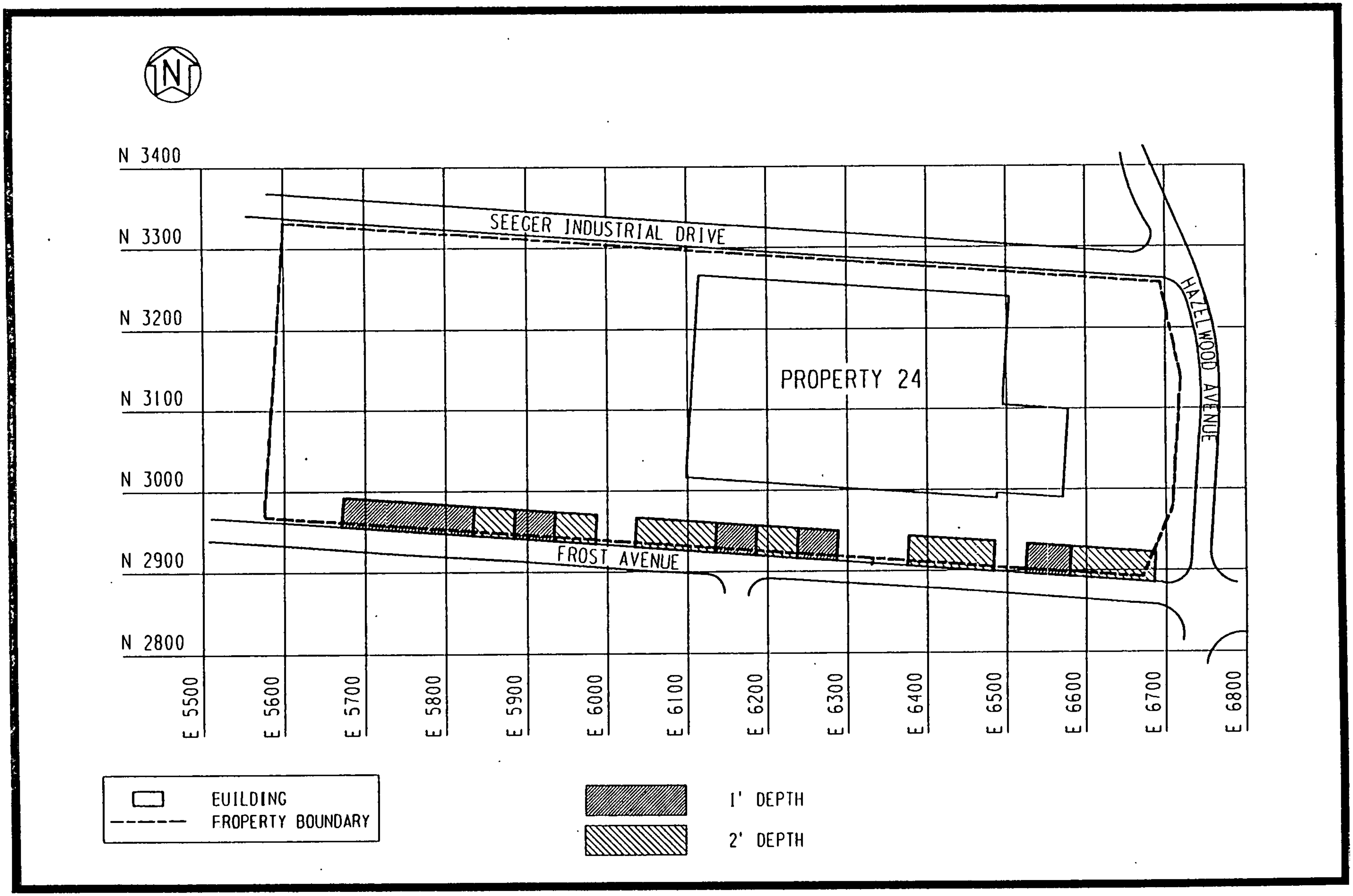


FIGURE 5-53 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT HAUL ROADS VICINITY PROPERTY 24

134F013.DGN

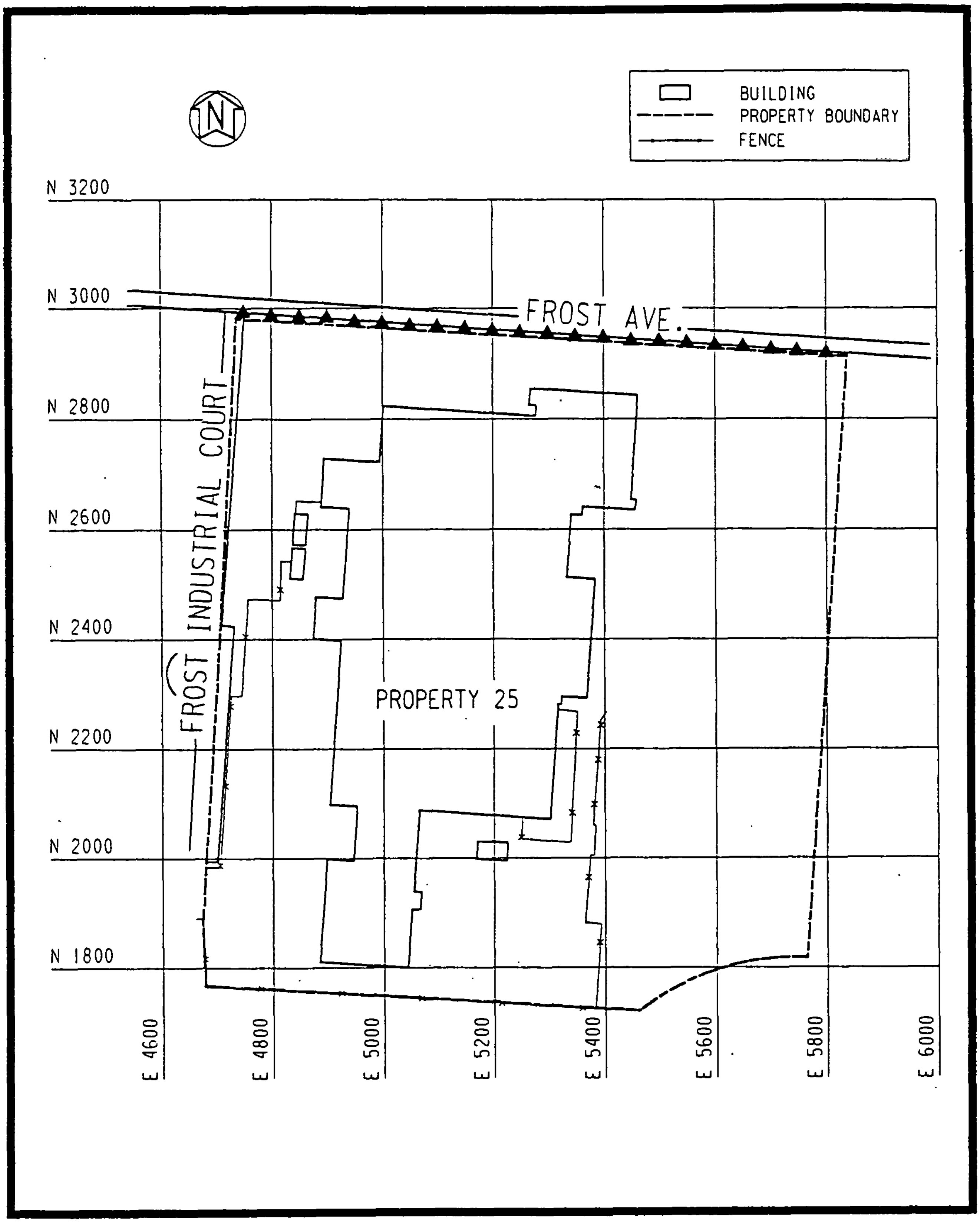


FIGURE 5-54 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 25

134F062.DGN

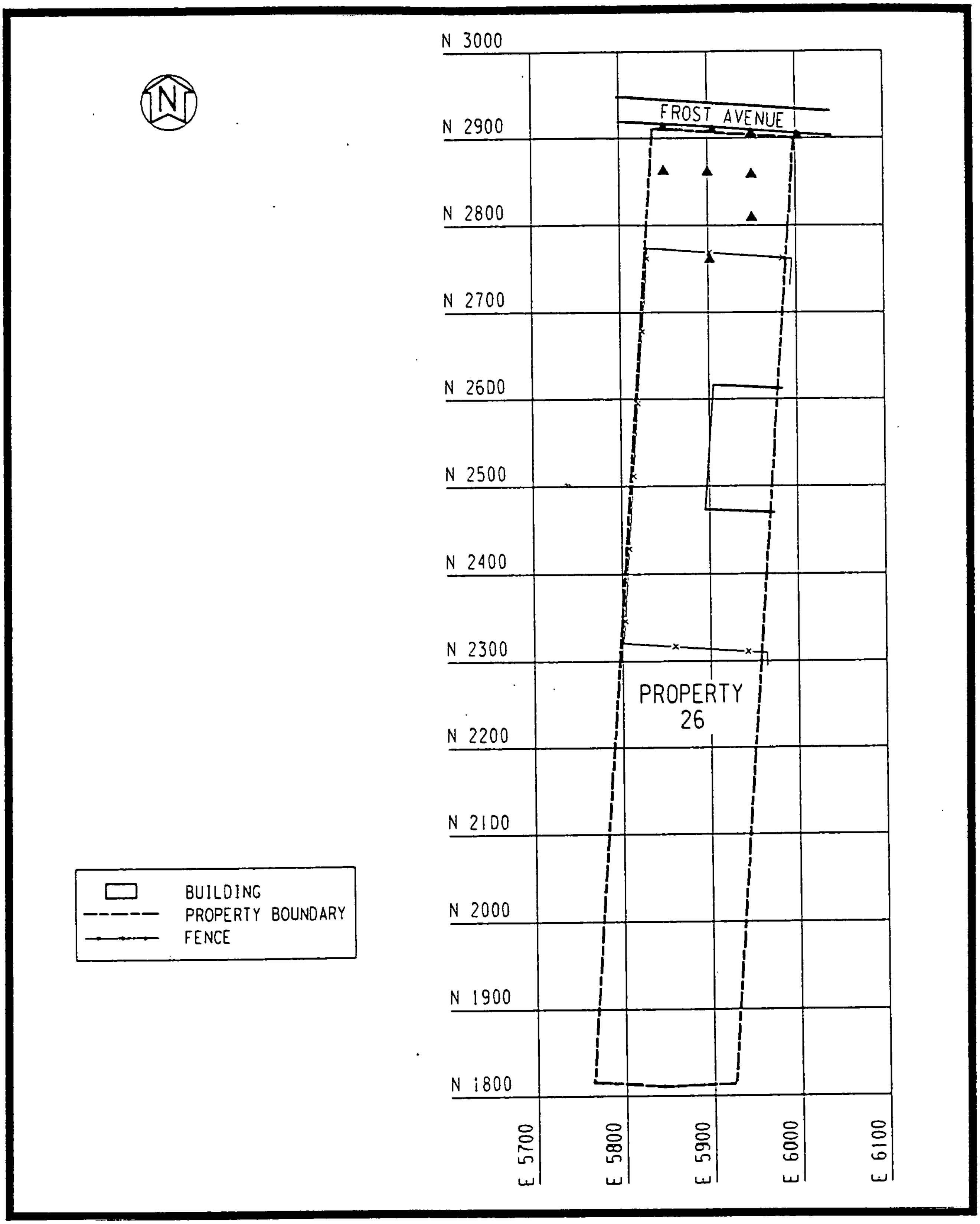


FIGURE 5-55 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 26

134F018.DGN SAMPLE

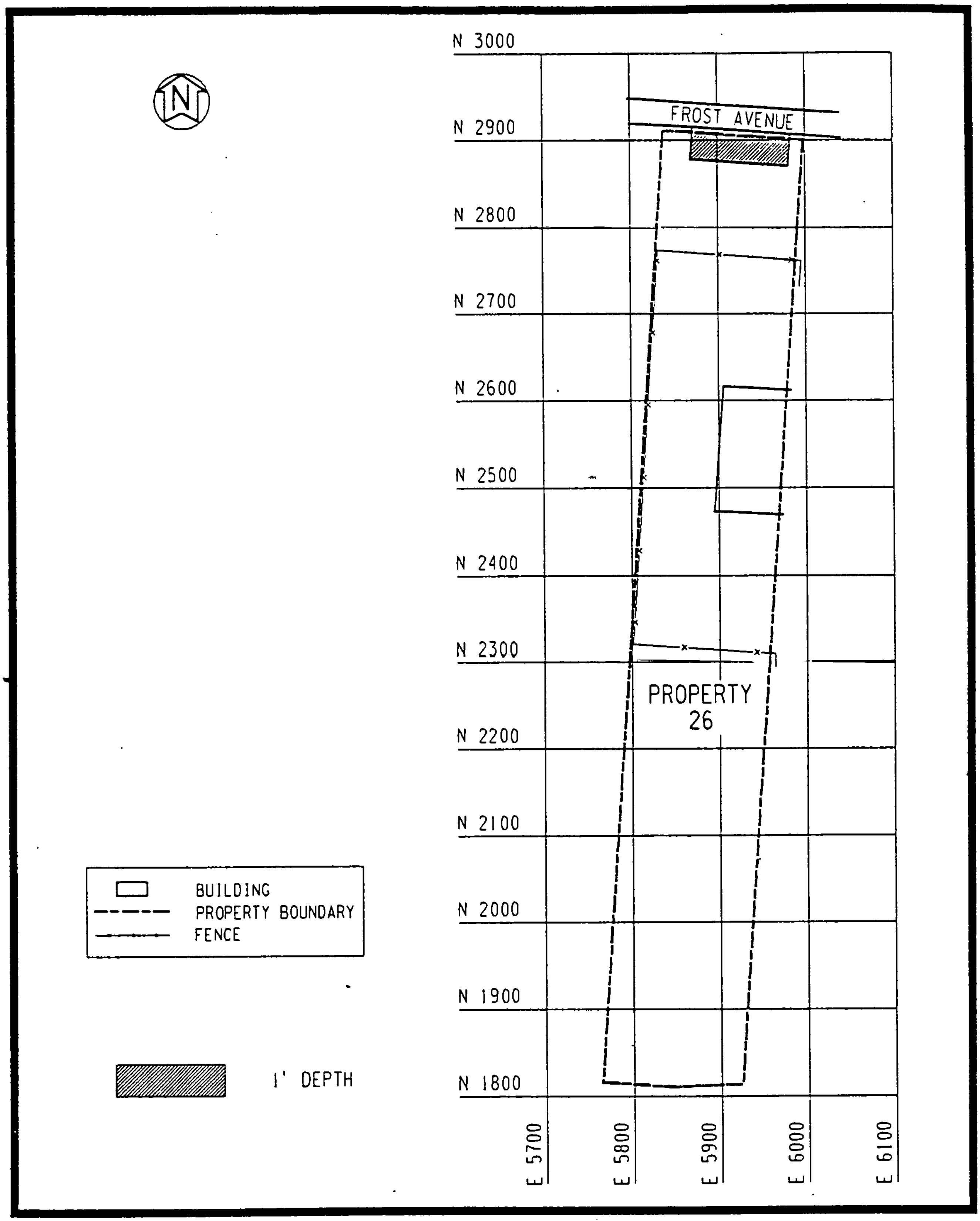


FIGURE 5-56 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT HAUL ROADS VICINITY PROPERTY 26

134F018.DGN DEPTH

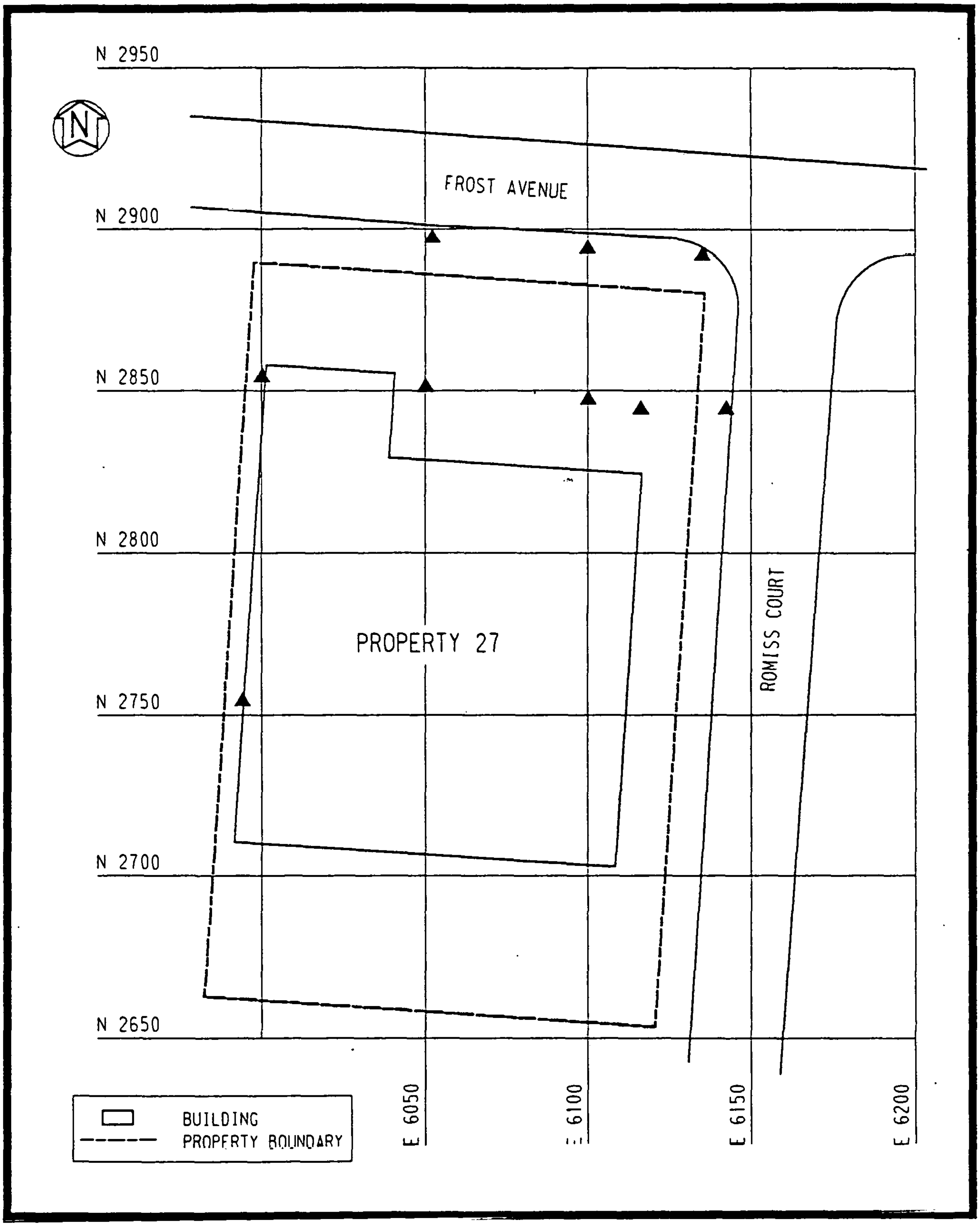


FIGURE 5-57 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 27

134F019.DGN SAMPLE

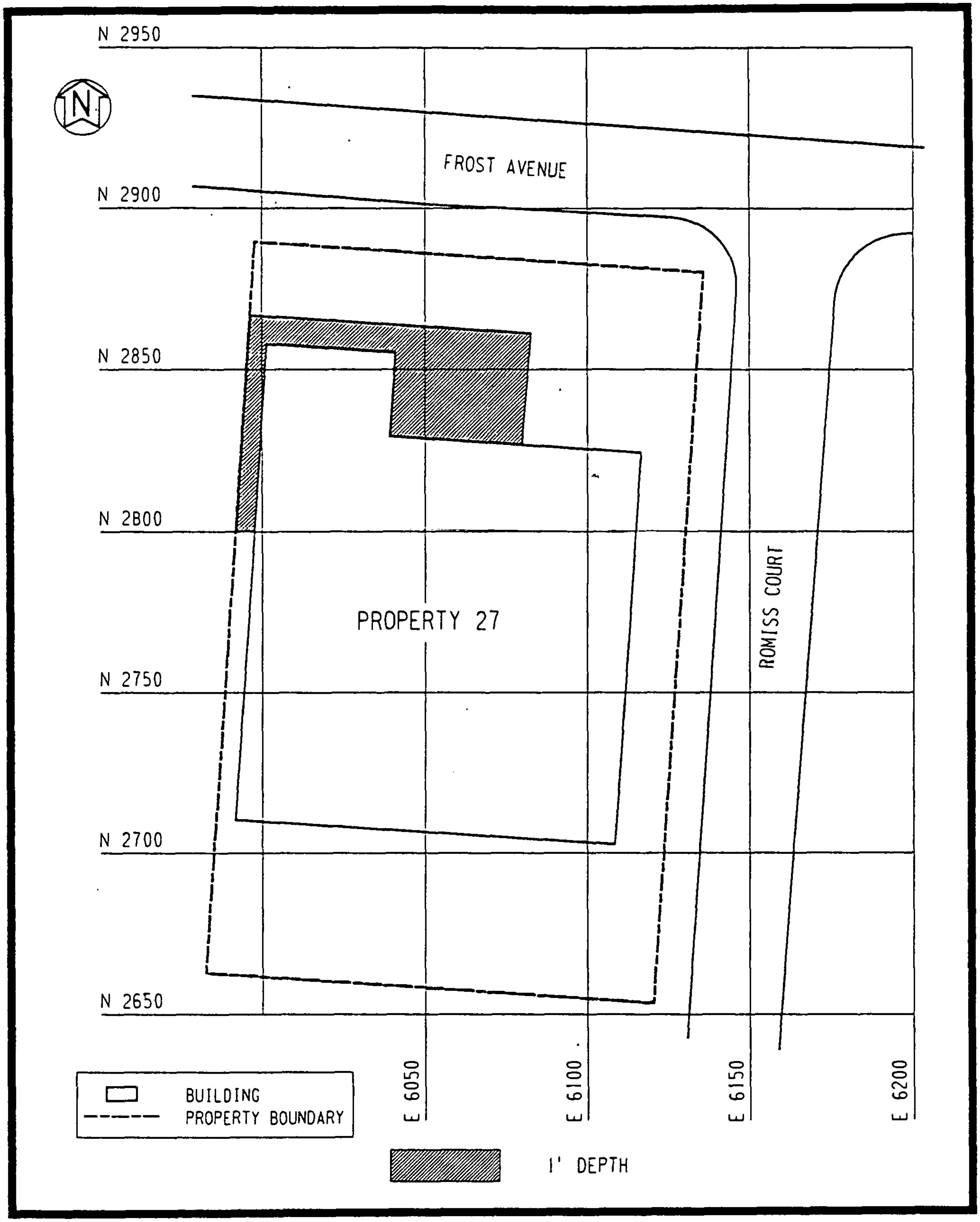


FIGURE 5-58 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT HAUL ROADS VICINITY PROPERTY 27

134F019.DGN DEPTH

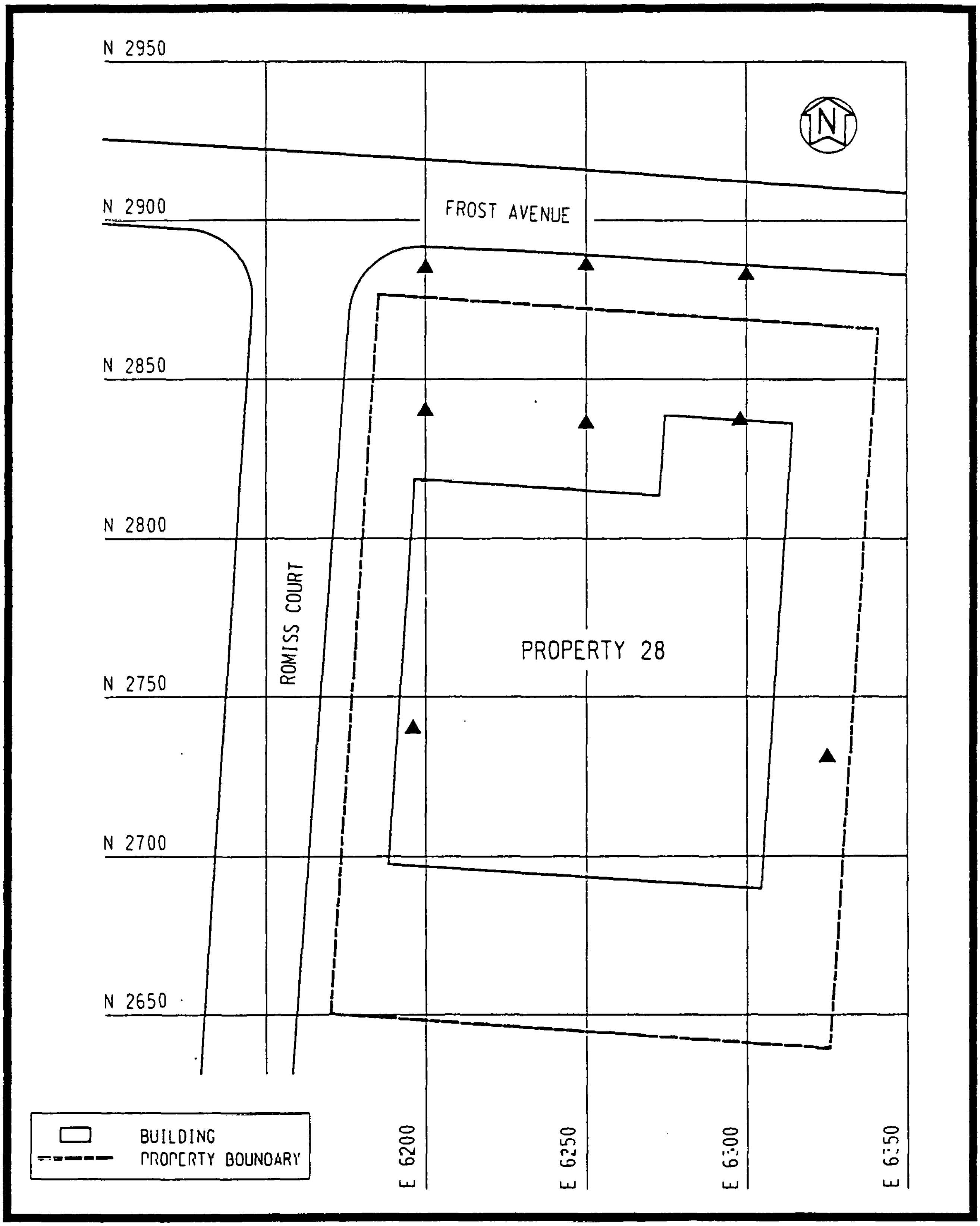


FIGURE 5-59 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 28

134F044.DGN

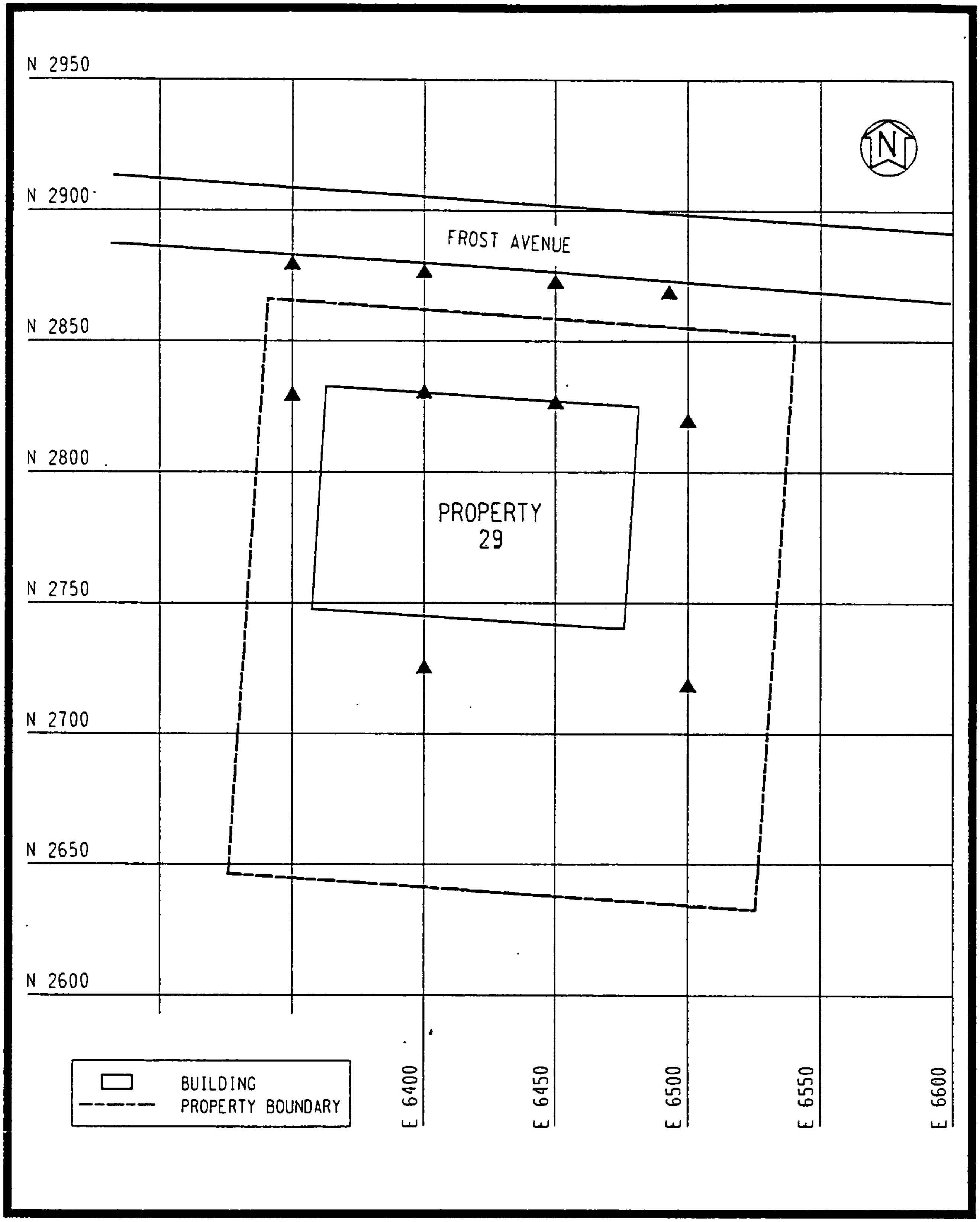


FIGURE 5-60 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 29

134F045.DGN

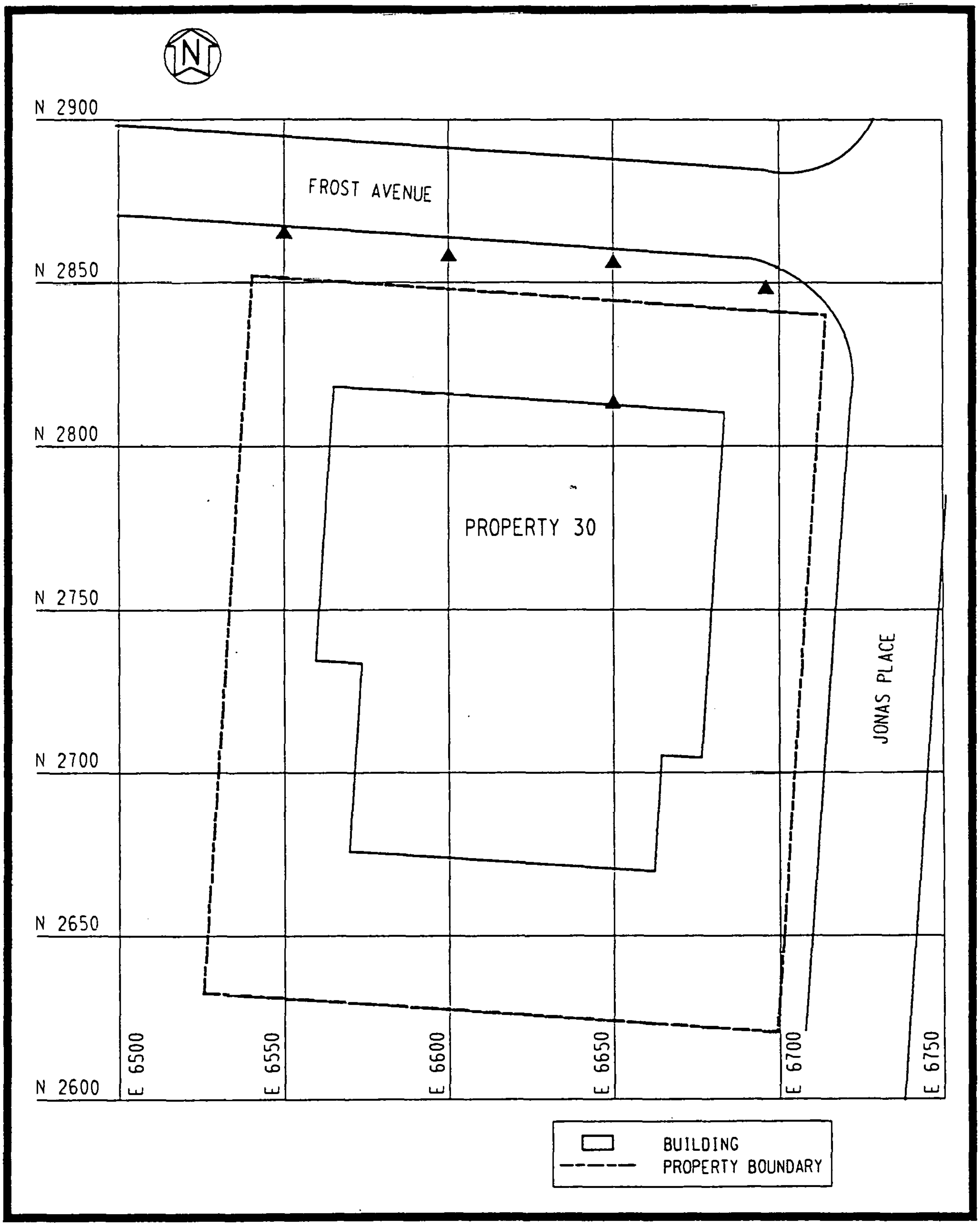


FIGURE 5-61 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 30

134F039.DGN SAMPLE

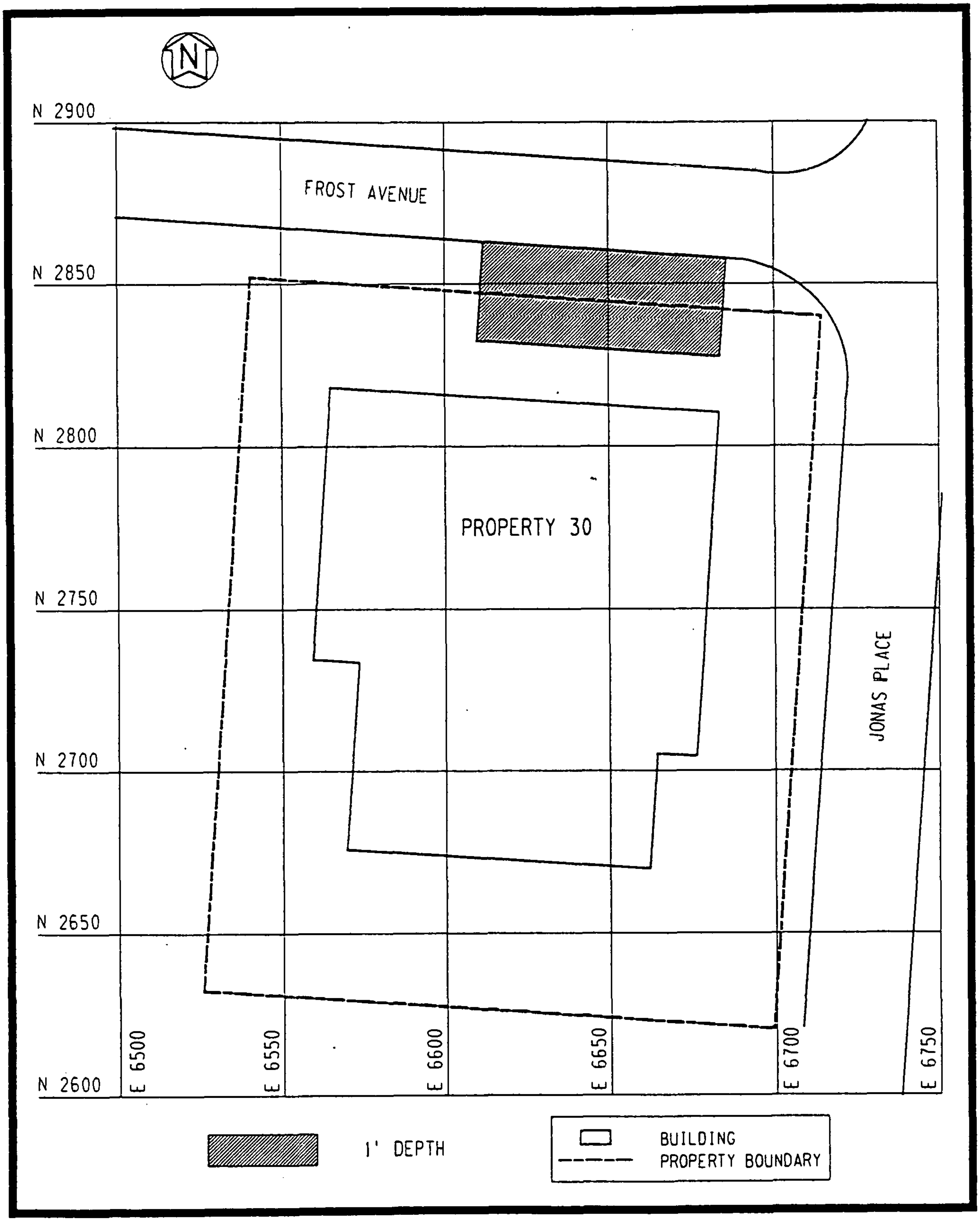


FIGURE 5-62 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT HAUL ROADS VICINITY PROPERTY 30

134F039.DGN DEPTH

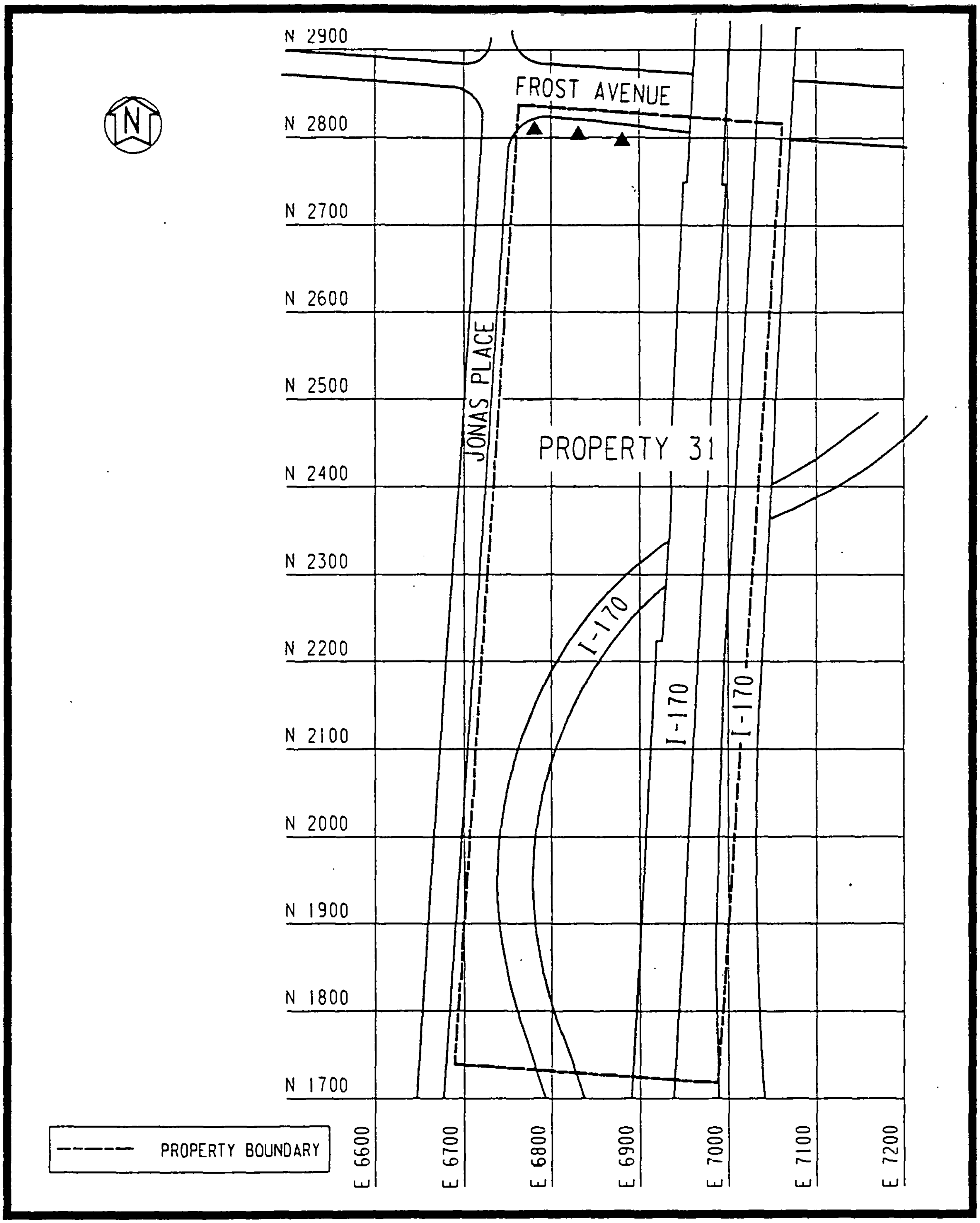


FIGURE 5-63 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 31

134F064.DGN

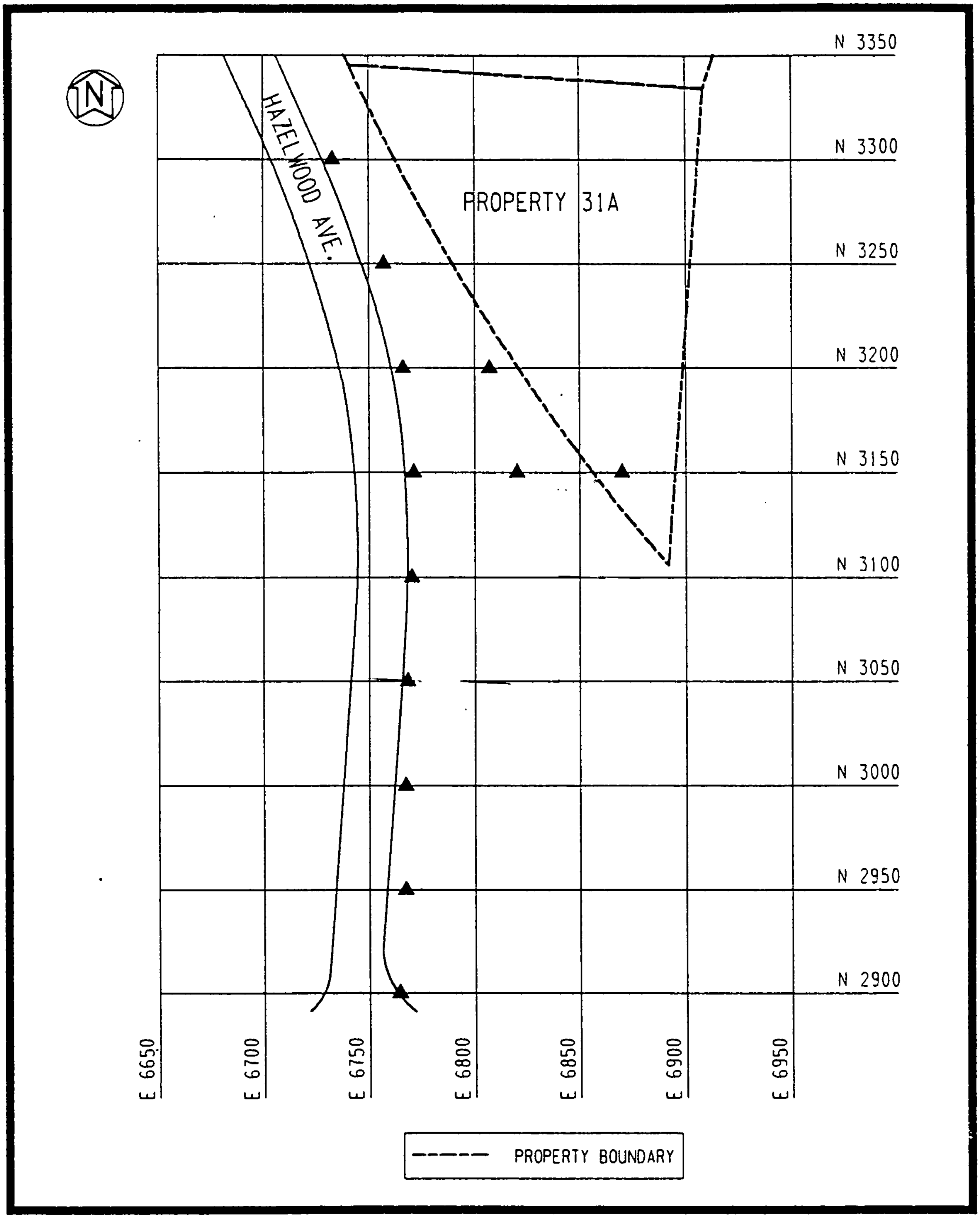


FIGURE 5-64 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 31A

134F092.DGN

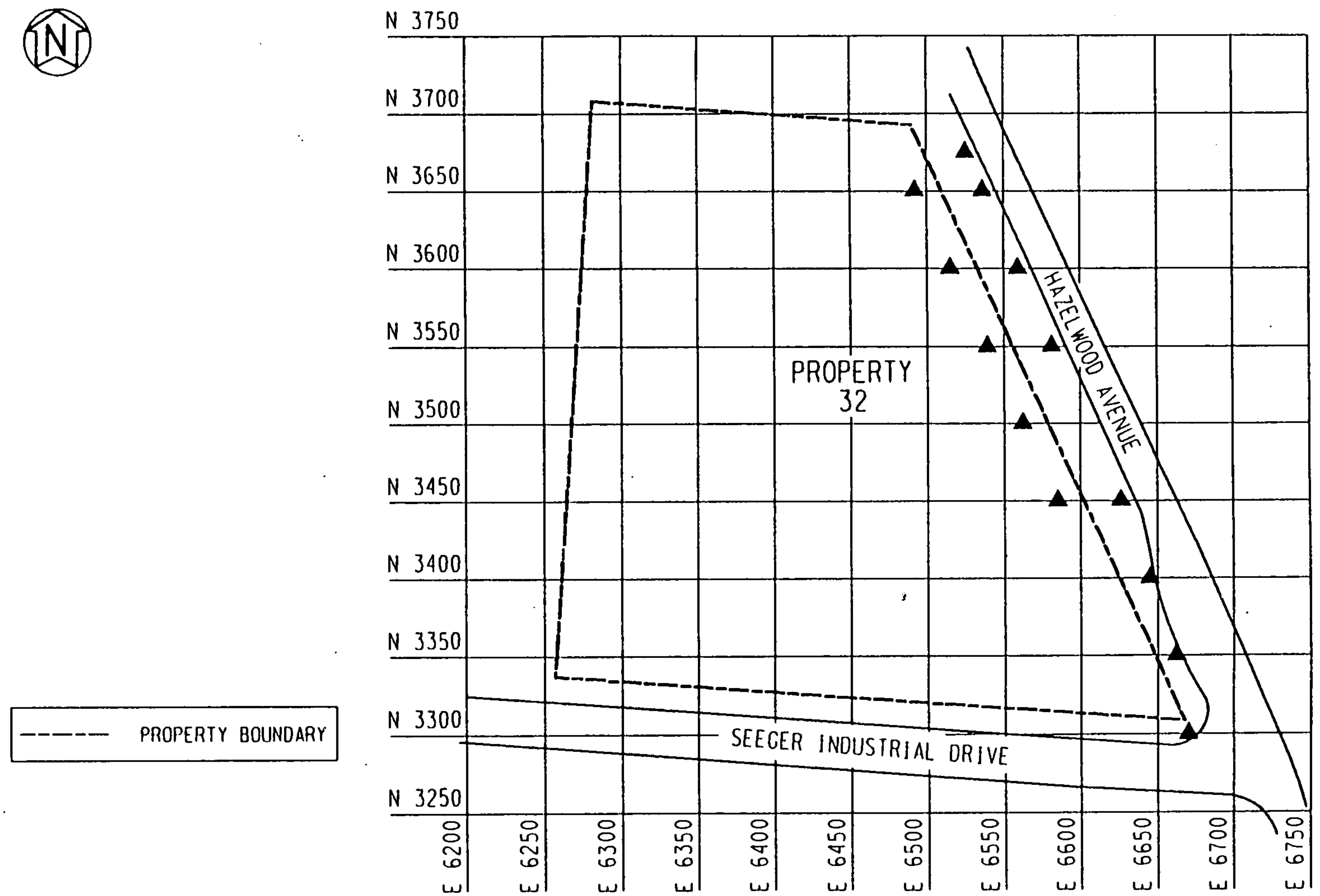


FIGURE 5-65 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 32

134F01-.DGN SAMPLE

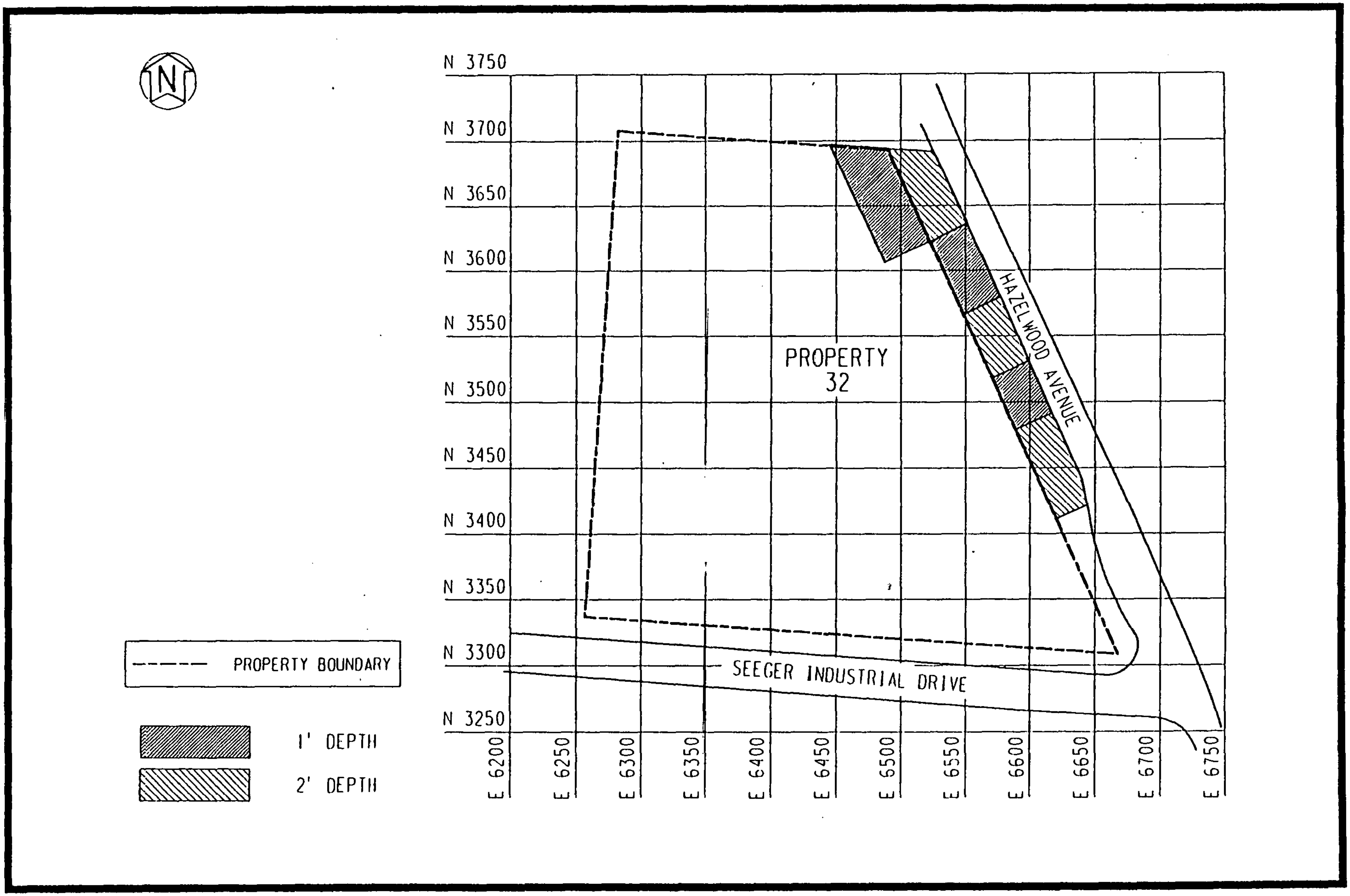


FIGURE 5-66 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT HAUL ROADS VICINITY PROPERTY 32

134F014.DGN DEPTH

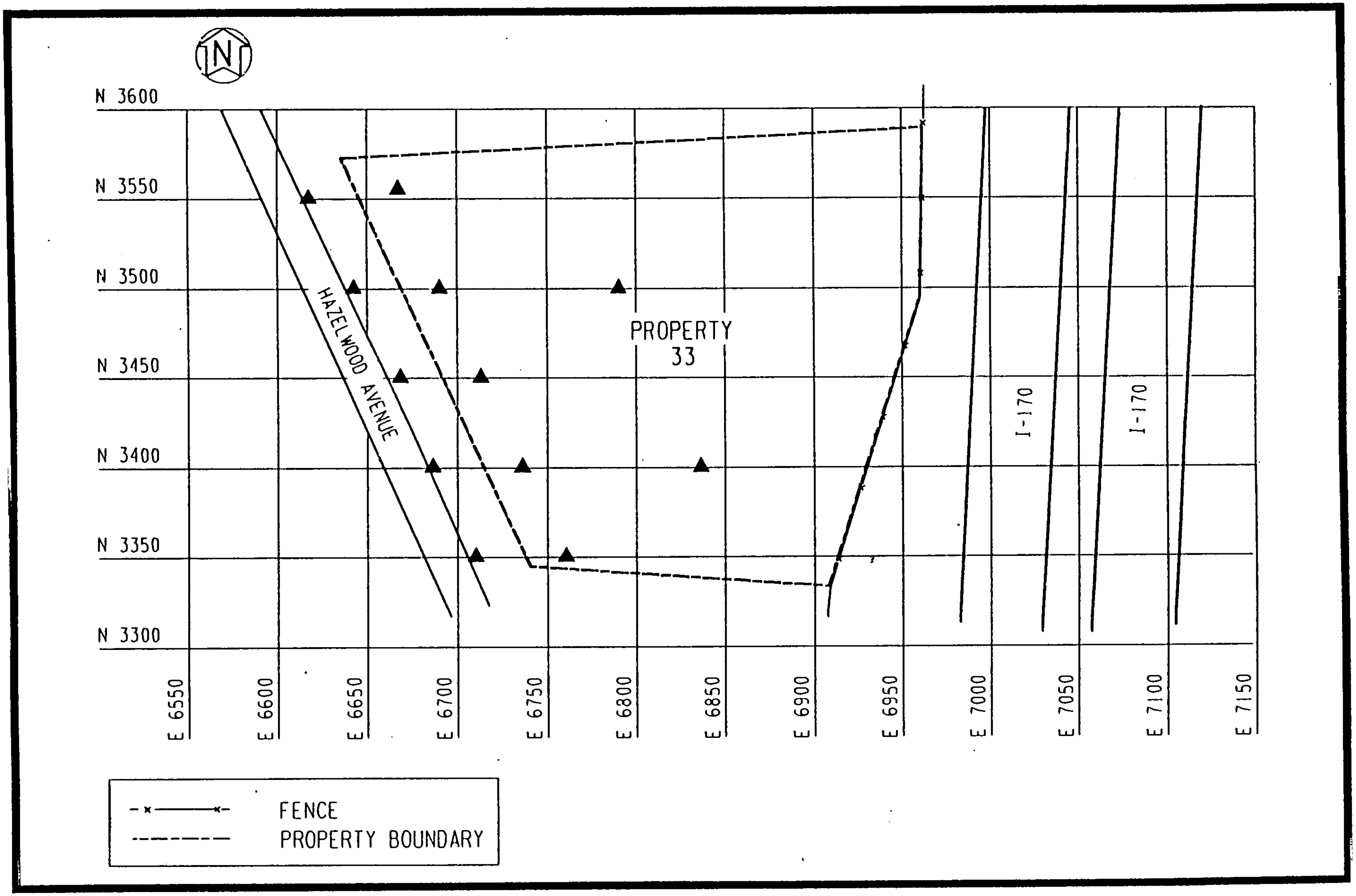


FIGURE 5-67 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 33

134F015.DGN SAMPLE

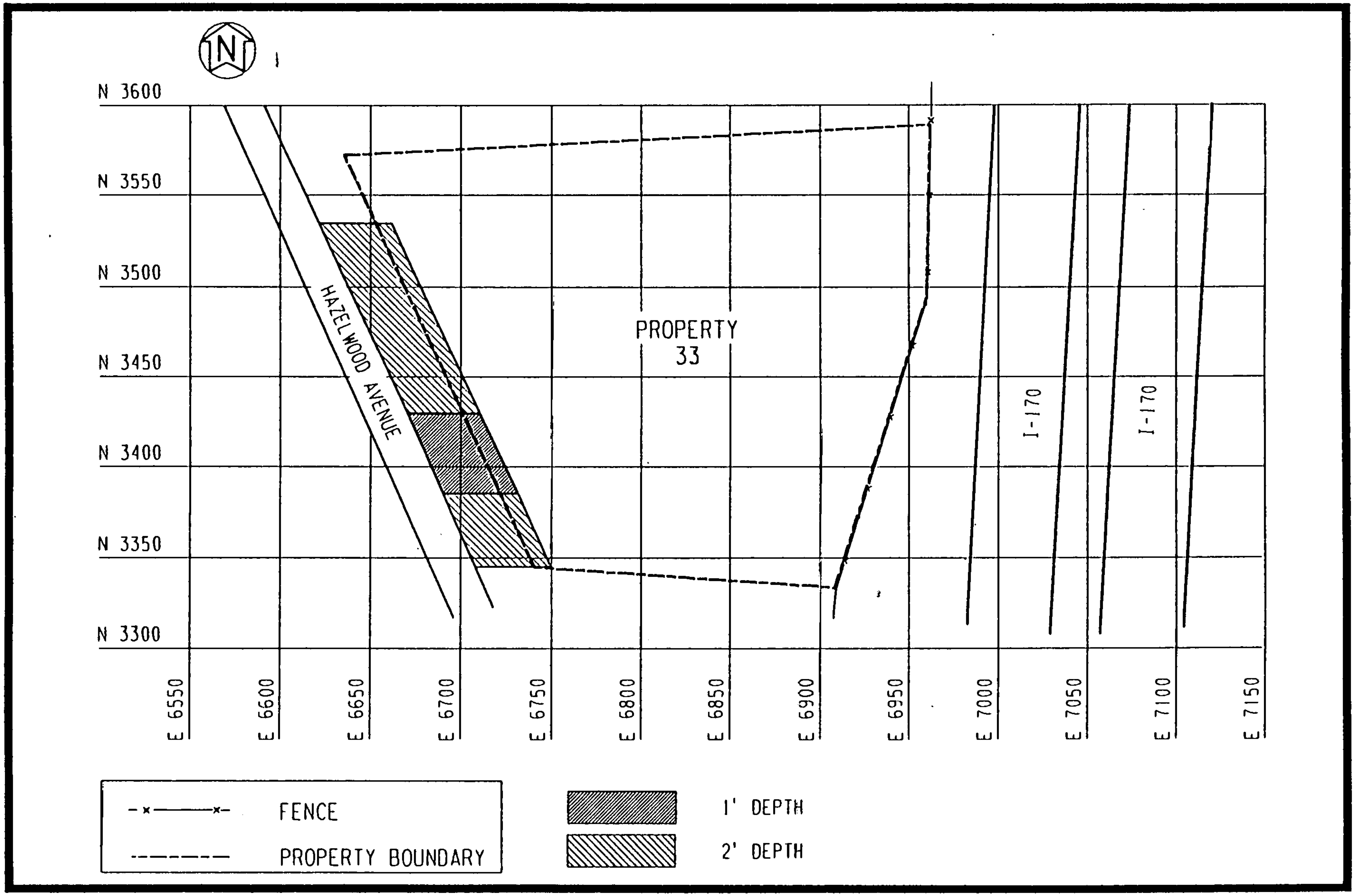


FIGURE 5-68 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT HAUL ROADS VICINITY PROPERTY 33

134F015.DGN DEPTH

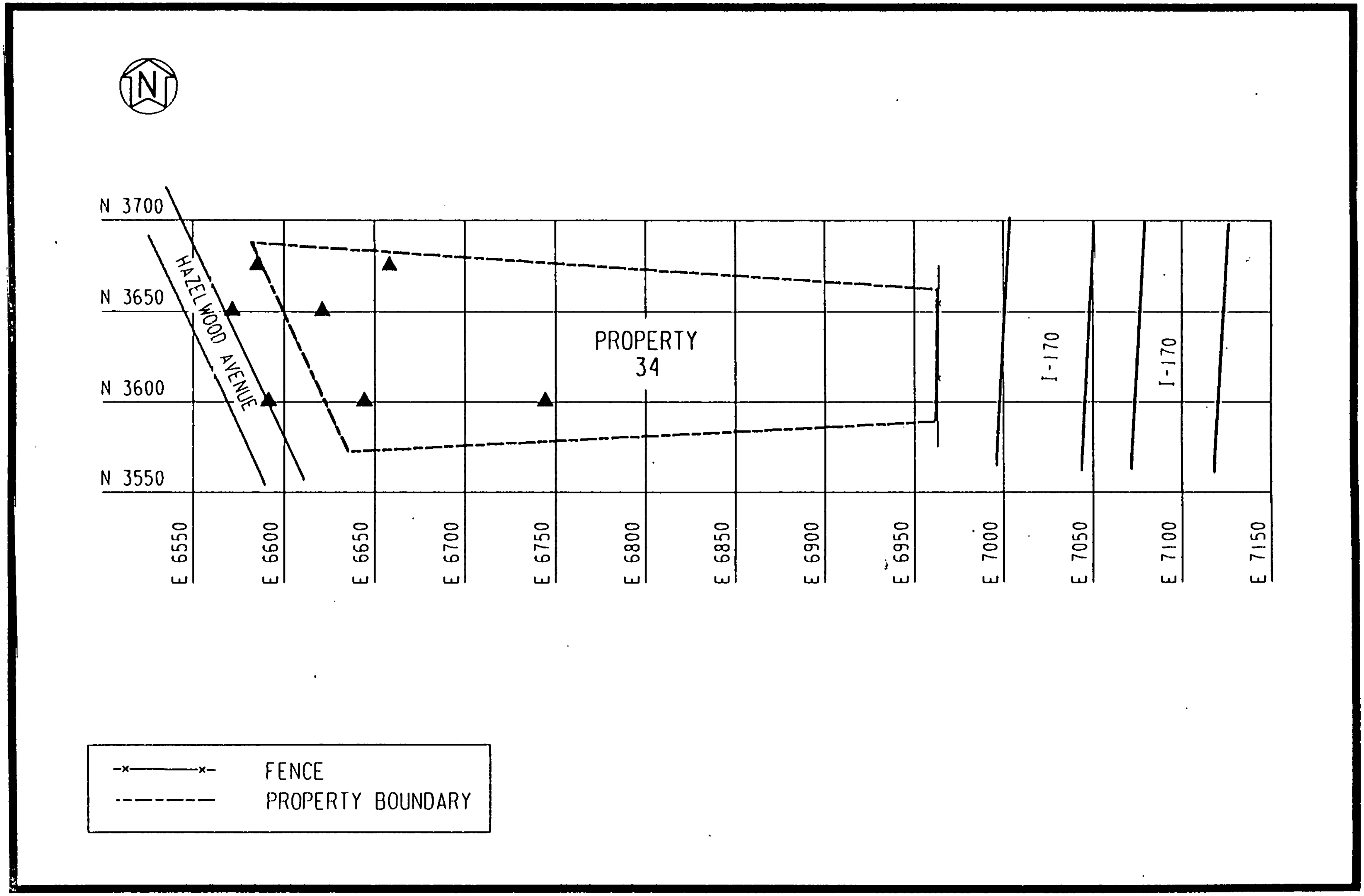


FIGURE 5-69 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 34

134F017.DGN SAMPLE

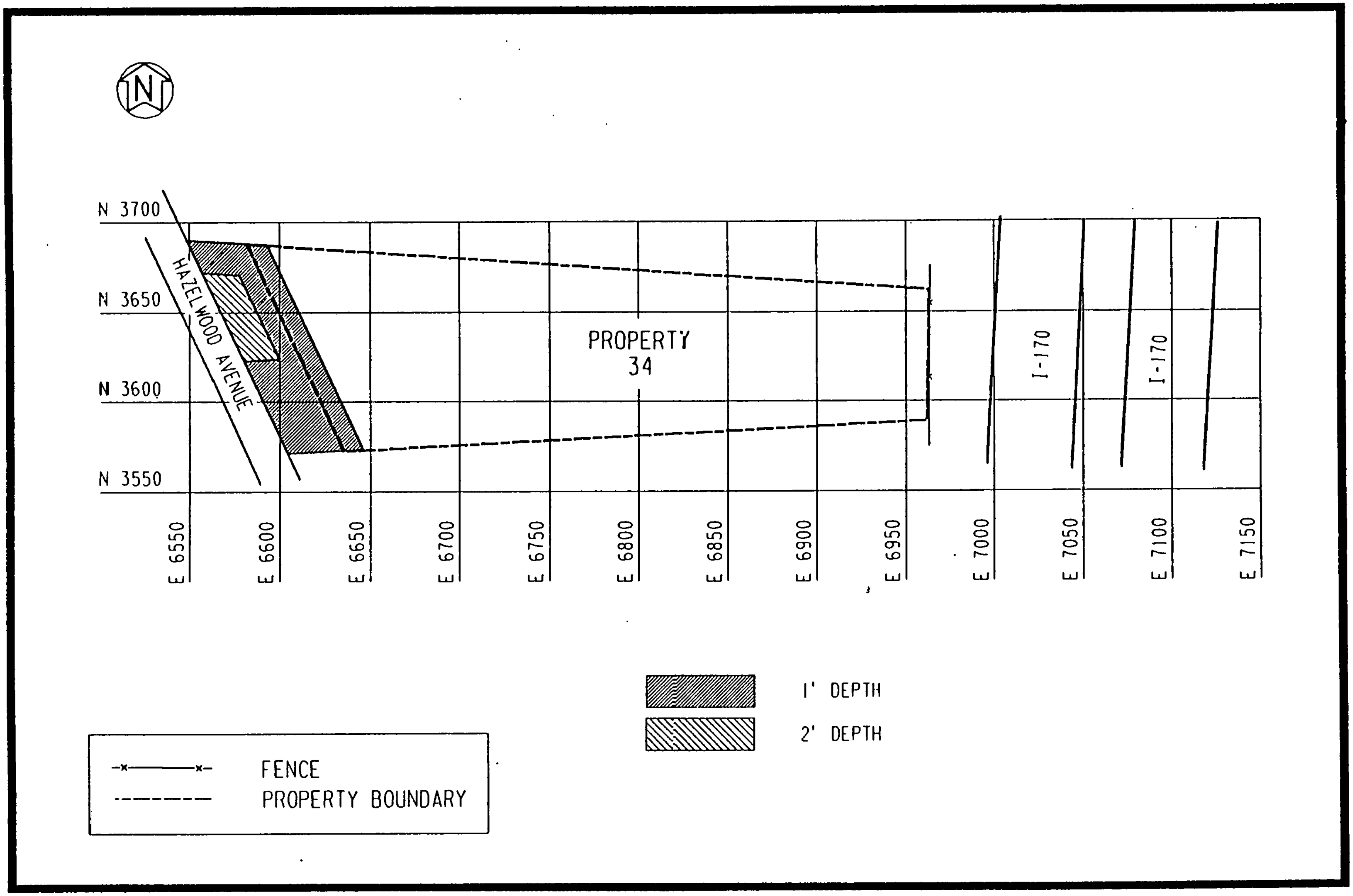


FIGURE 5-70 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT HAUL ROADS VICINITY PROPERTY 34

134F017.DGN DEPTH

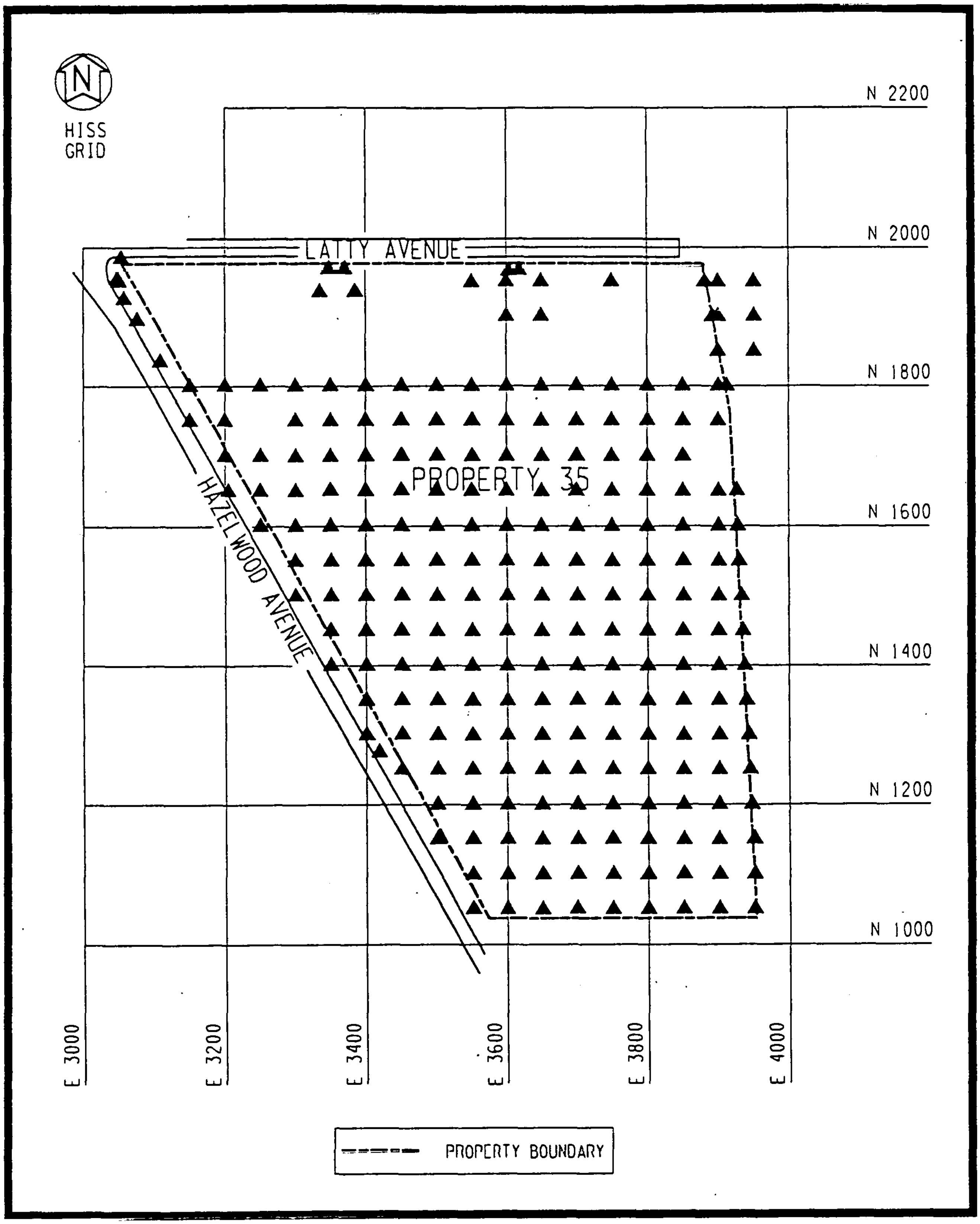


FIGURE 5-71 SURFACE SOIL SAMPLING LOCATIONS FOR 1988 RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 35

134F104.DGN SAMPLE

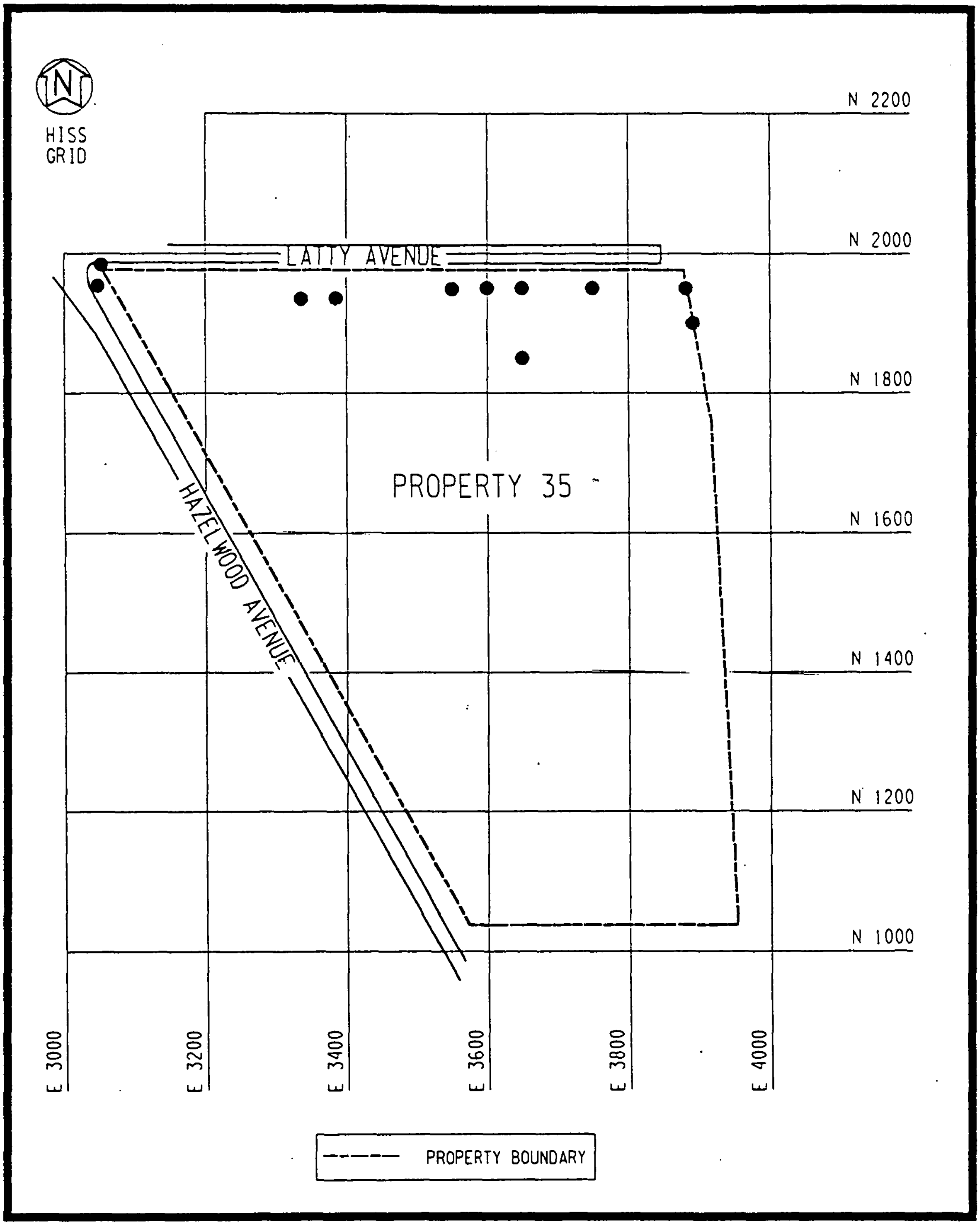


FIGURE 5-72 SUBSURFACE SOIL SAMPLING LOCATIONS FOR 1988 RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 35

134F104.DGN SUB

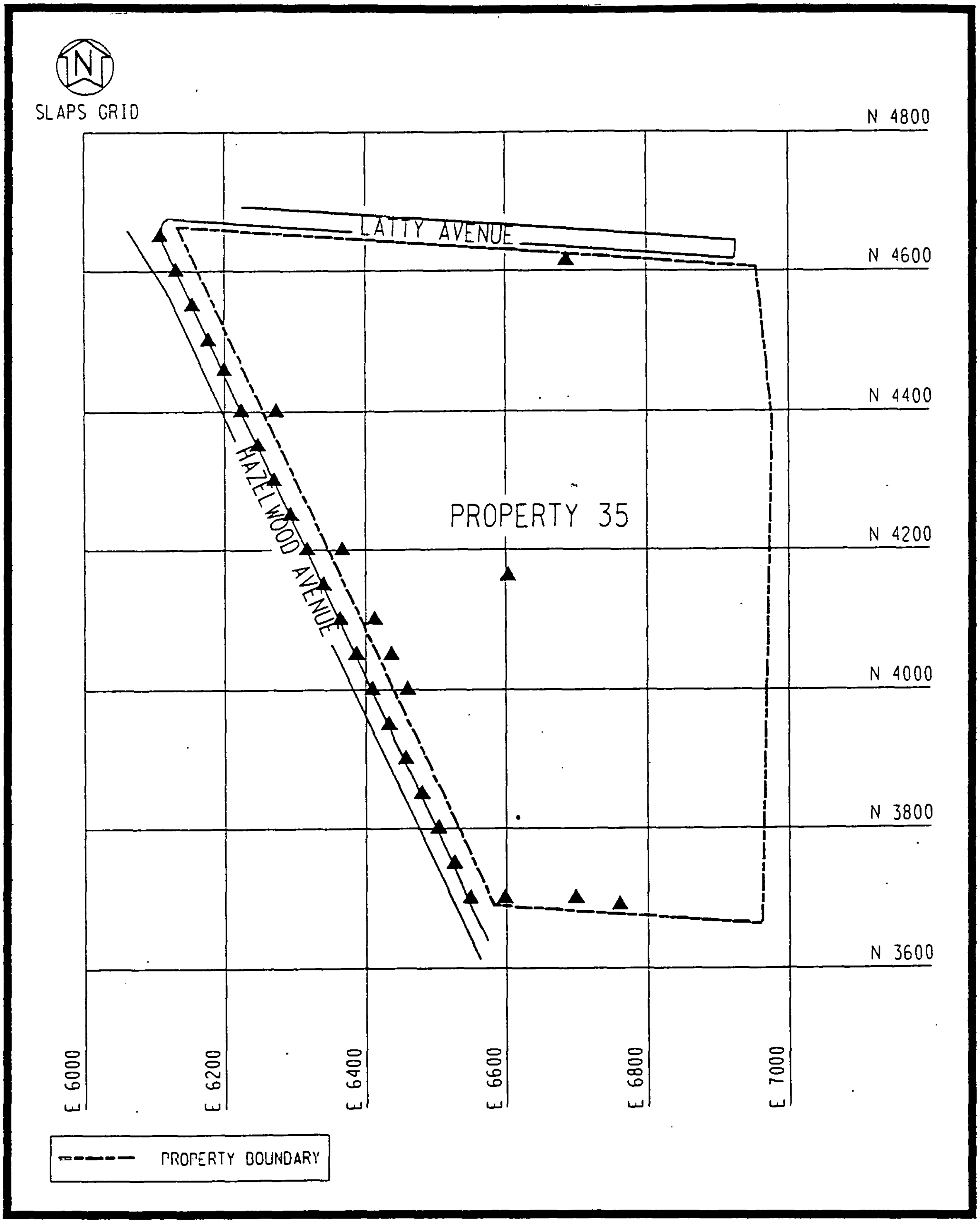


FIGURE 5-73 SOIL SAMPLING LOCATIONS FOR 1989 RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 35

134F099.DGN

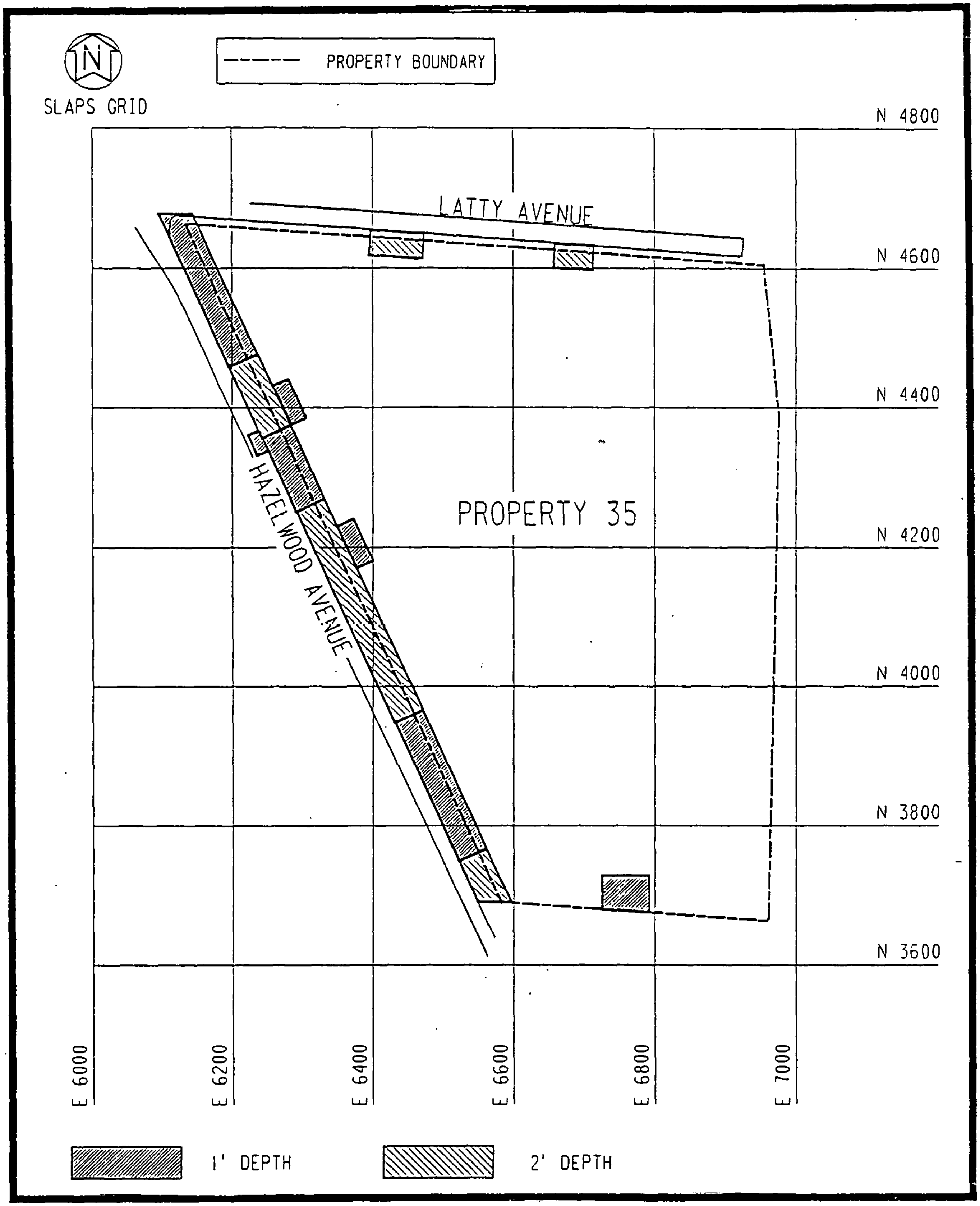


FIGURE 5-74 AREAS AND DEPTHS OF CONTAMINATION AT HAUL ROADS VICINITY PROPERTY 35

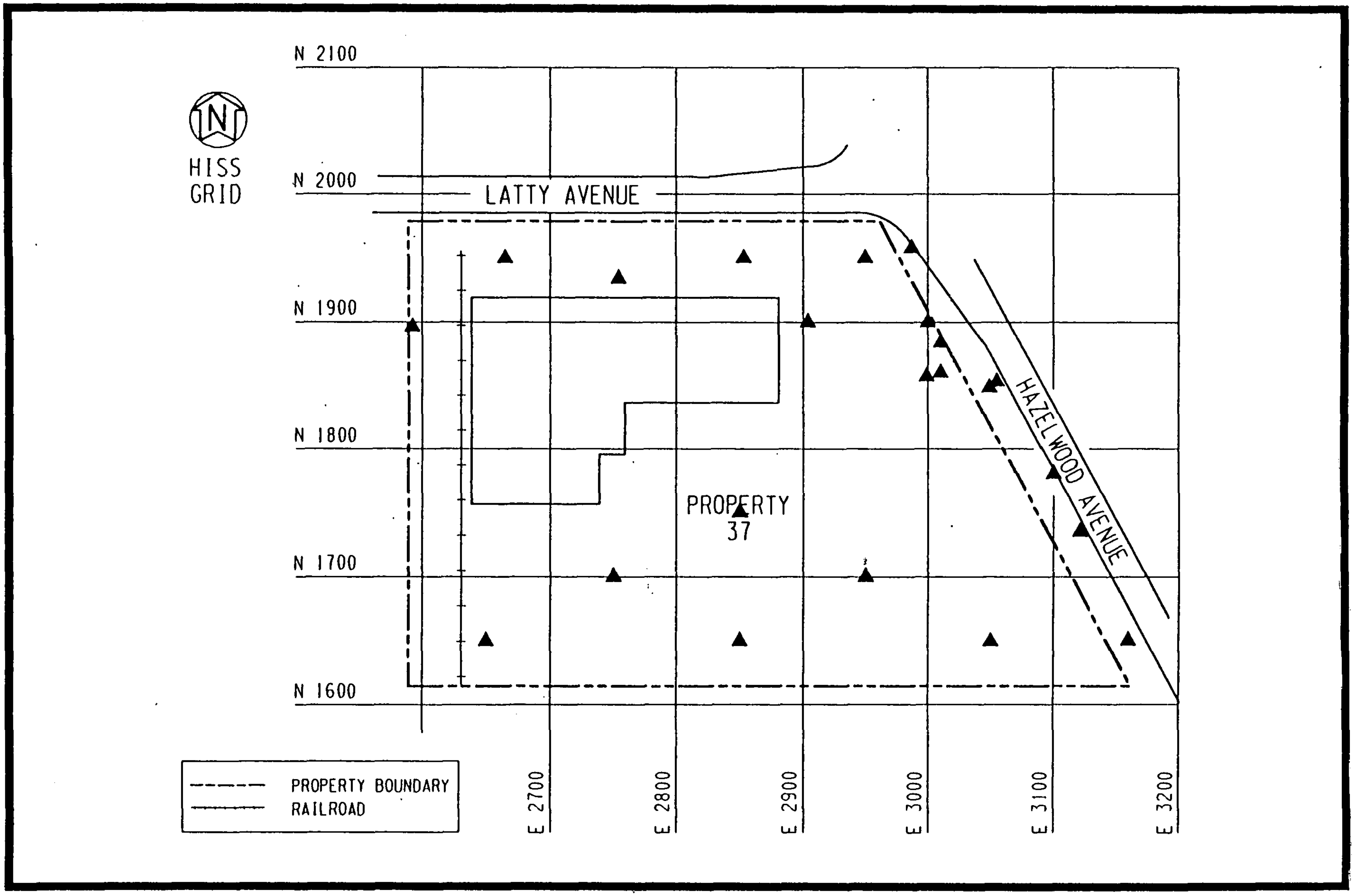


FIGURE 5-75 SURFACE SOIL SAMPLING LOCATIONS FOR 1987 RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 37

134F077.DGN SAMPLE

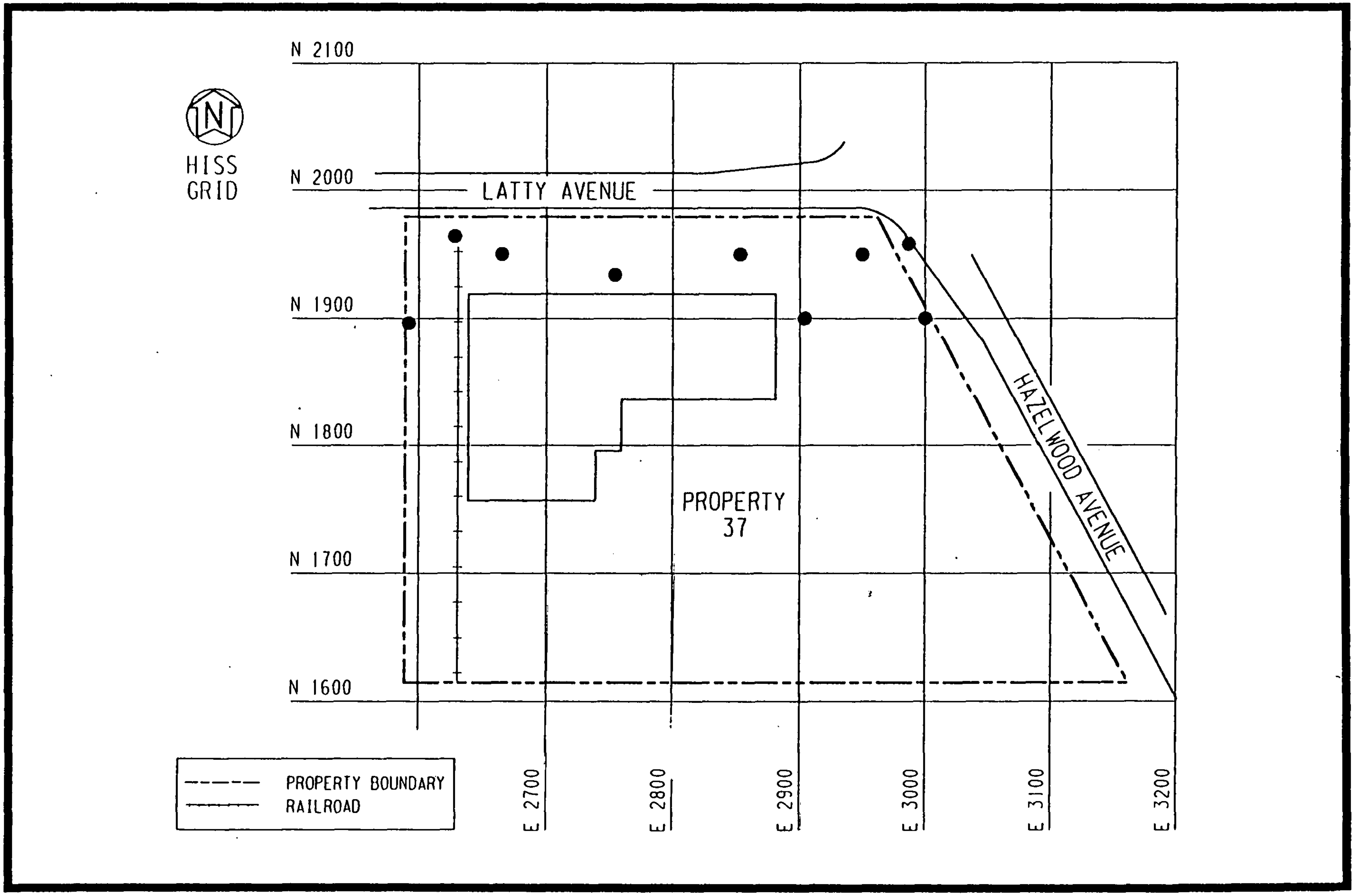


FIGURE 5-76 SUBSURFACE SOIL SAMPLING LOCATIONS FOR 1987 RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 37

134F077.DGN SUB

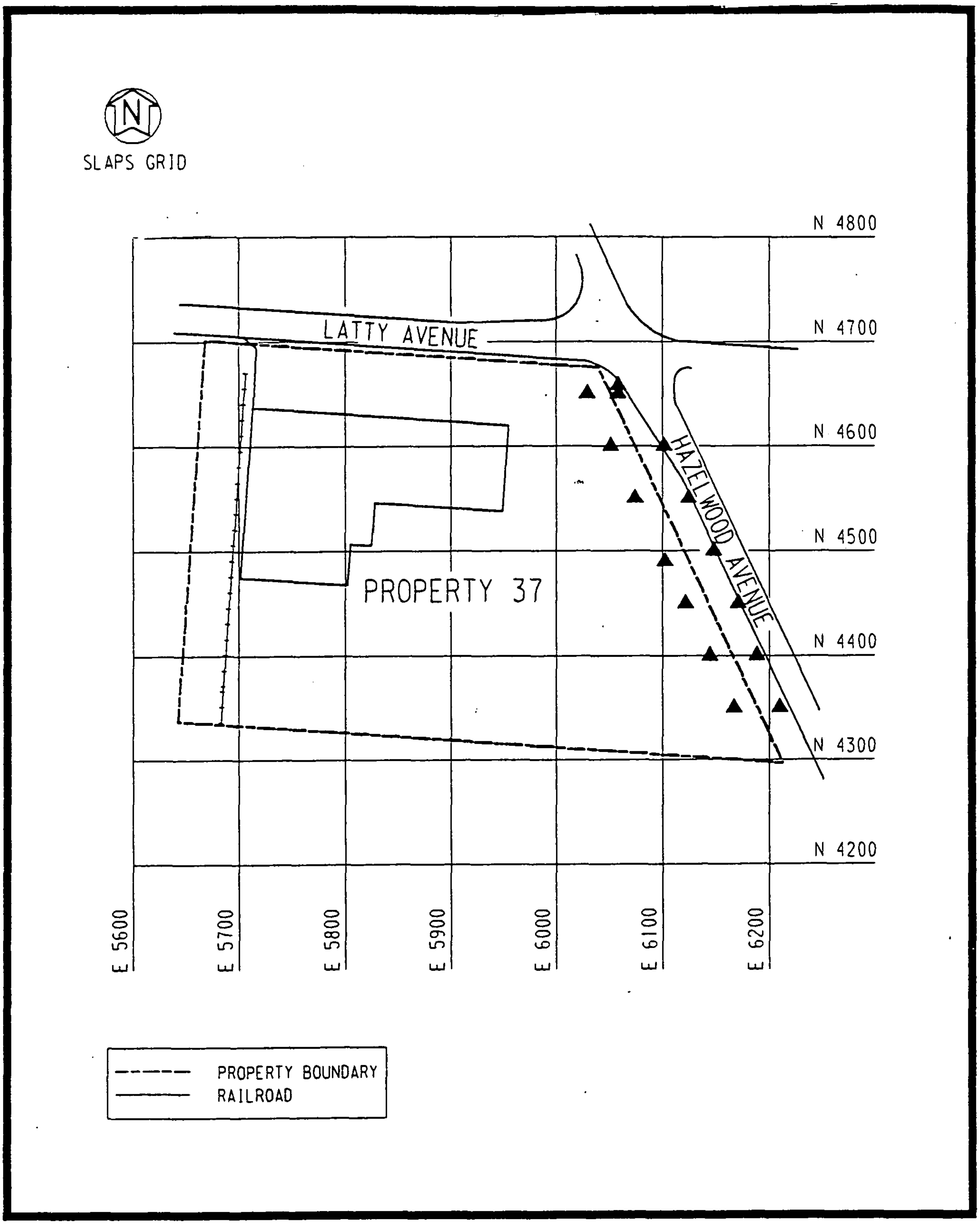


FIGURE 5-77 SOIL SAMPLING LOCATIONS FOR 1989 RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 37

134F100.DGN

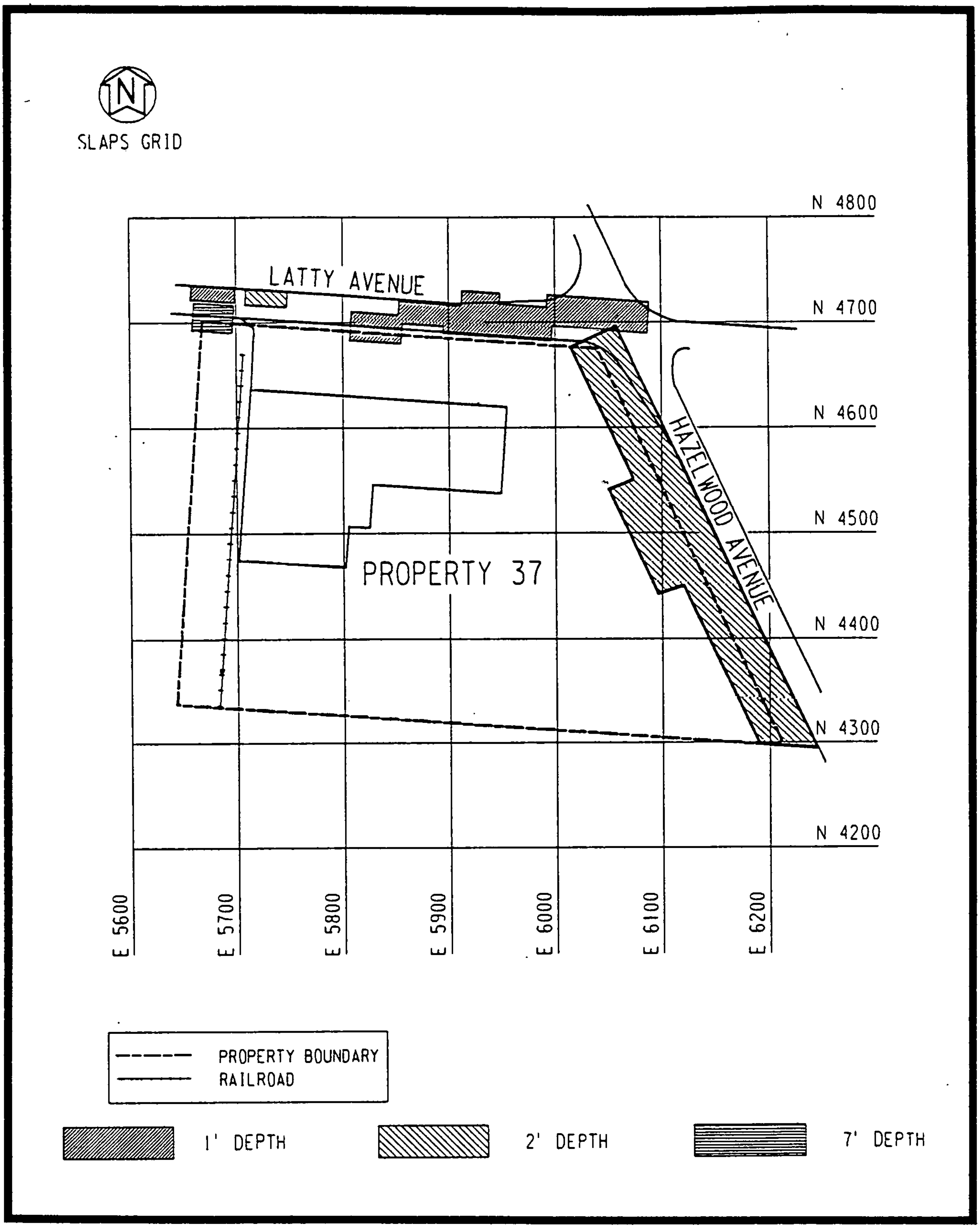


FIGURE 5-78 AREAS AND DEPTHS OF CONTAMINATION AT HAUL ROADS VICINITY PROPERTY 37

134F100.DGN

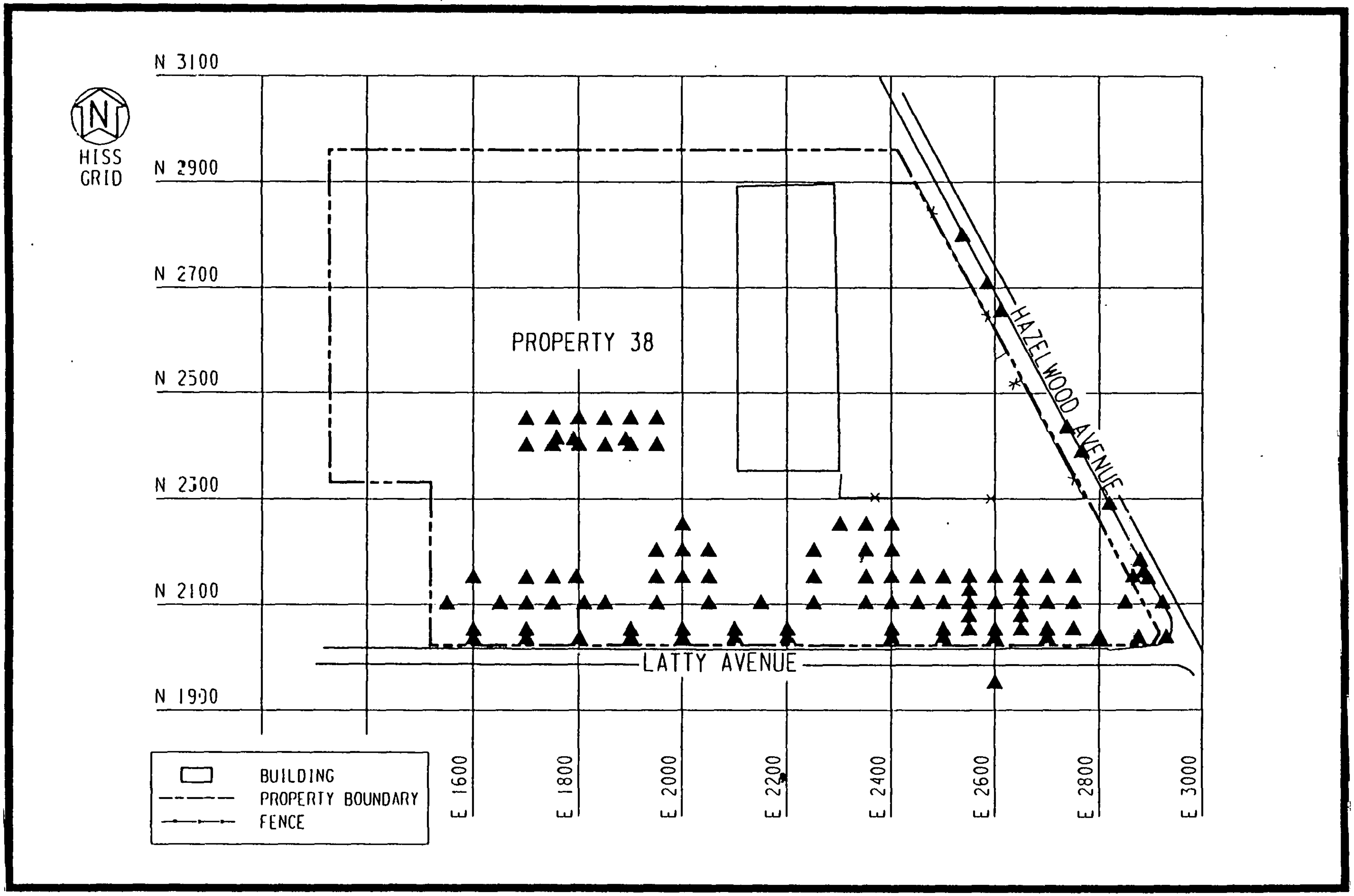


FIGURE 5-79 SURFACE SOIL SAMPLING LOCATIONS FOR 1987 RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 38

134F076.DGN

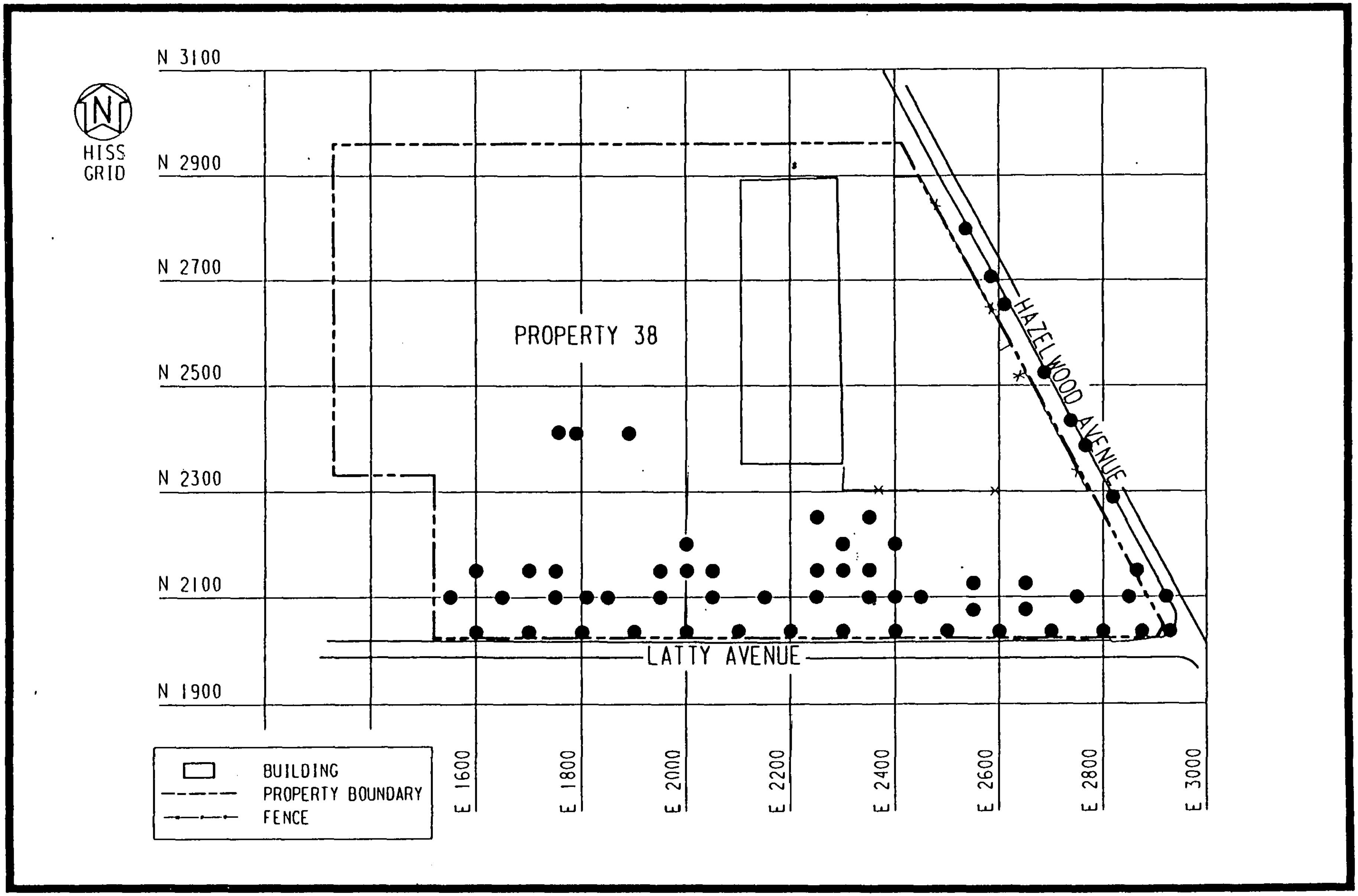


FIGURE 5-80 SUBSURFACE SOIL SAMPLING LOCATIONS FOR 1987 RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 38

134F076.DGN

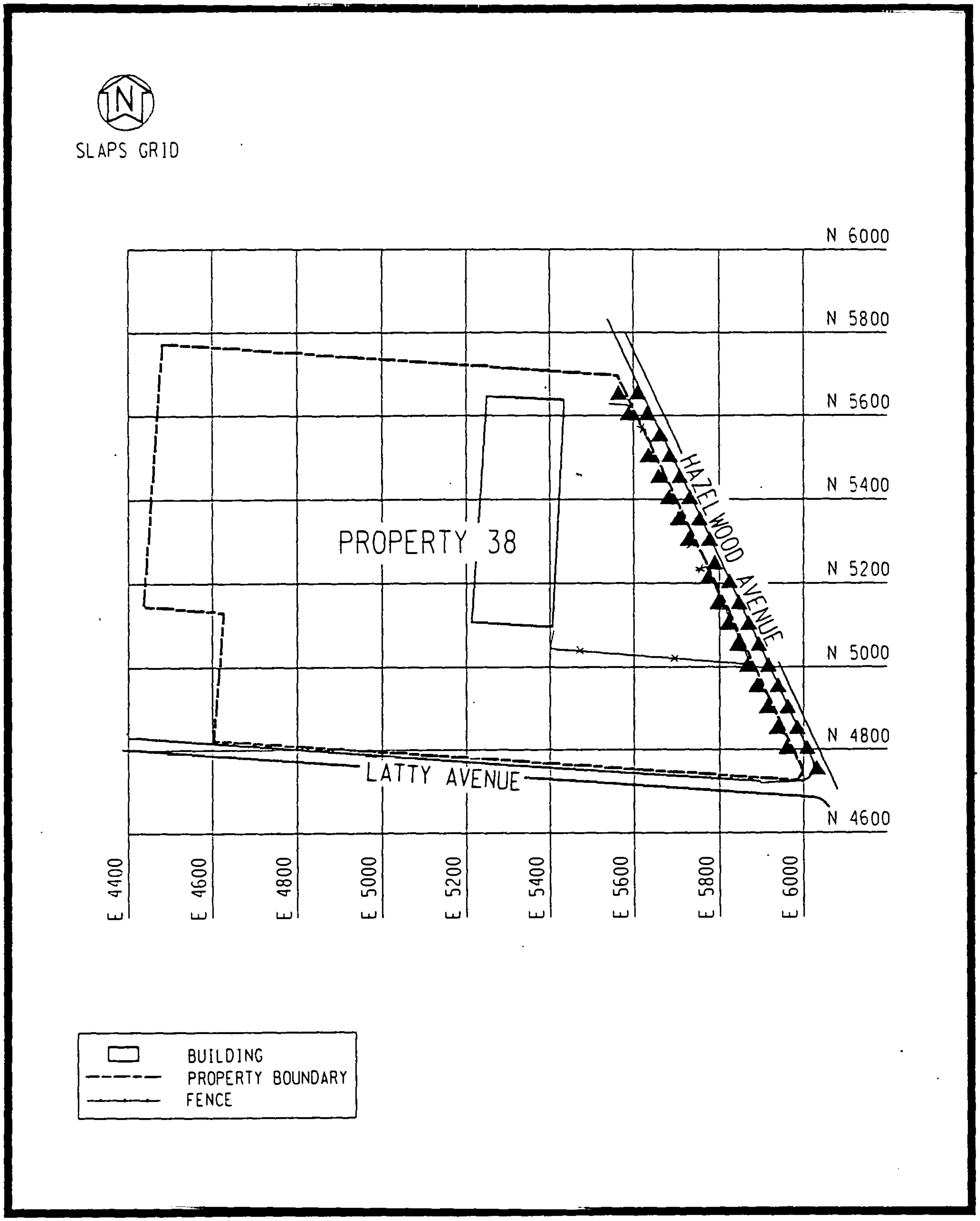


FIGURE 5-81 SOIL SAMPLING LOCATIONS FOR 1989 RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 38

134F101.DGN

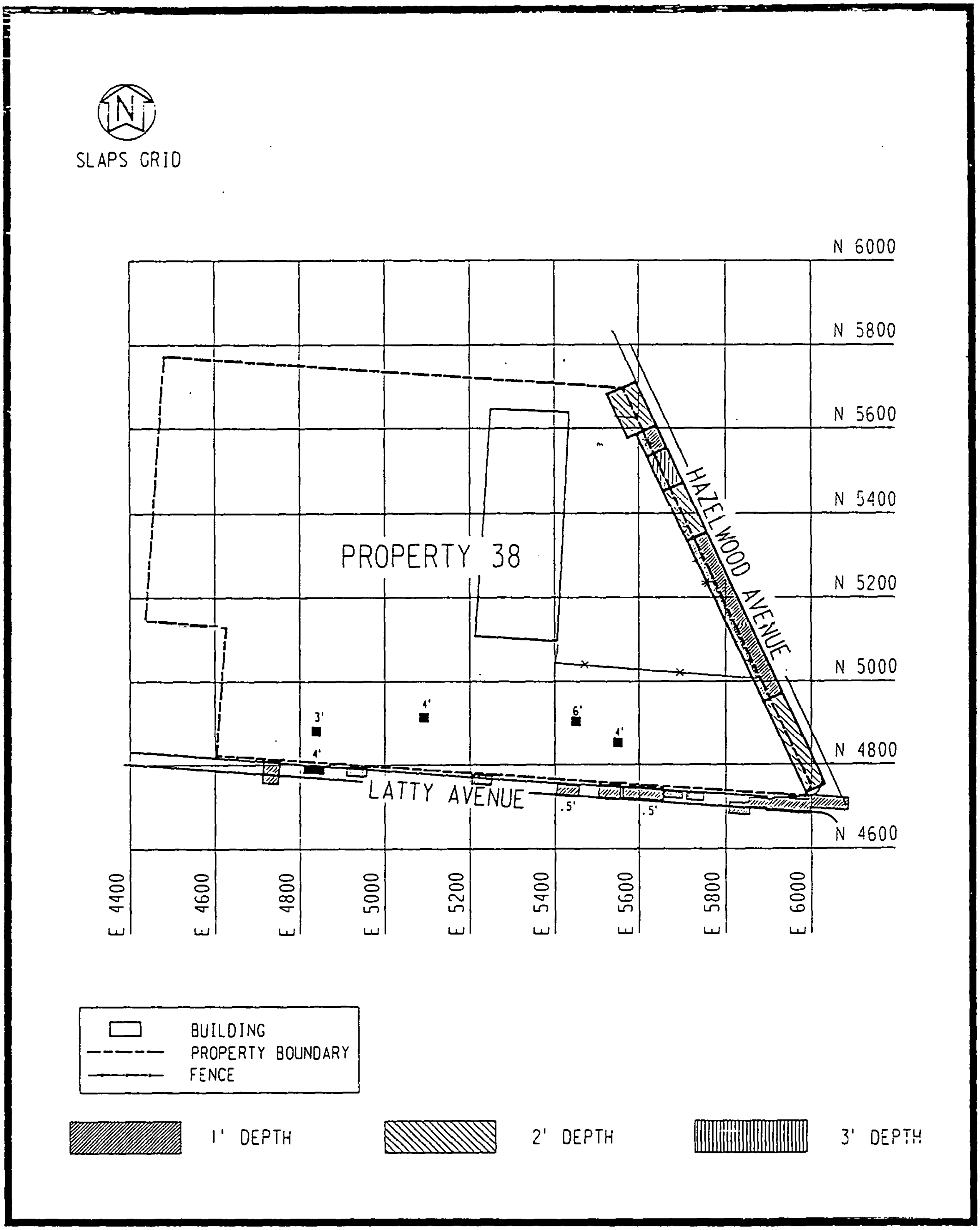


FIGURE 5-82 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION HAUL ROADS VICINITY PROPERTY 38

134F101.DGN

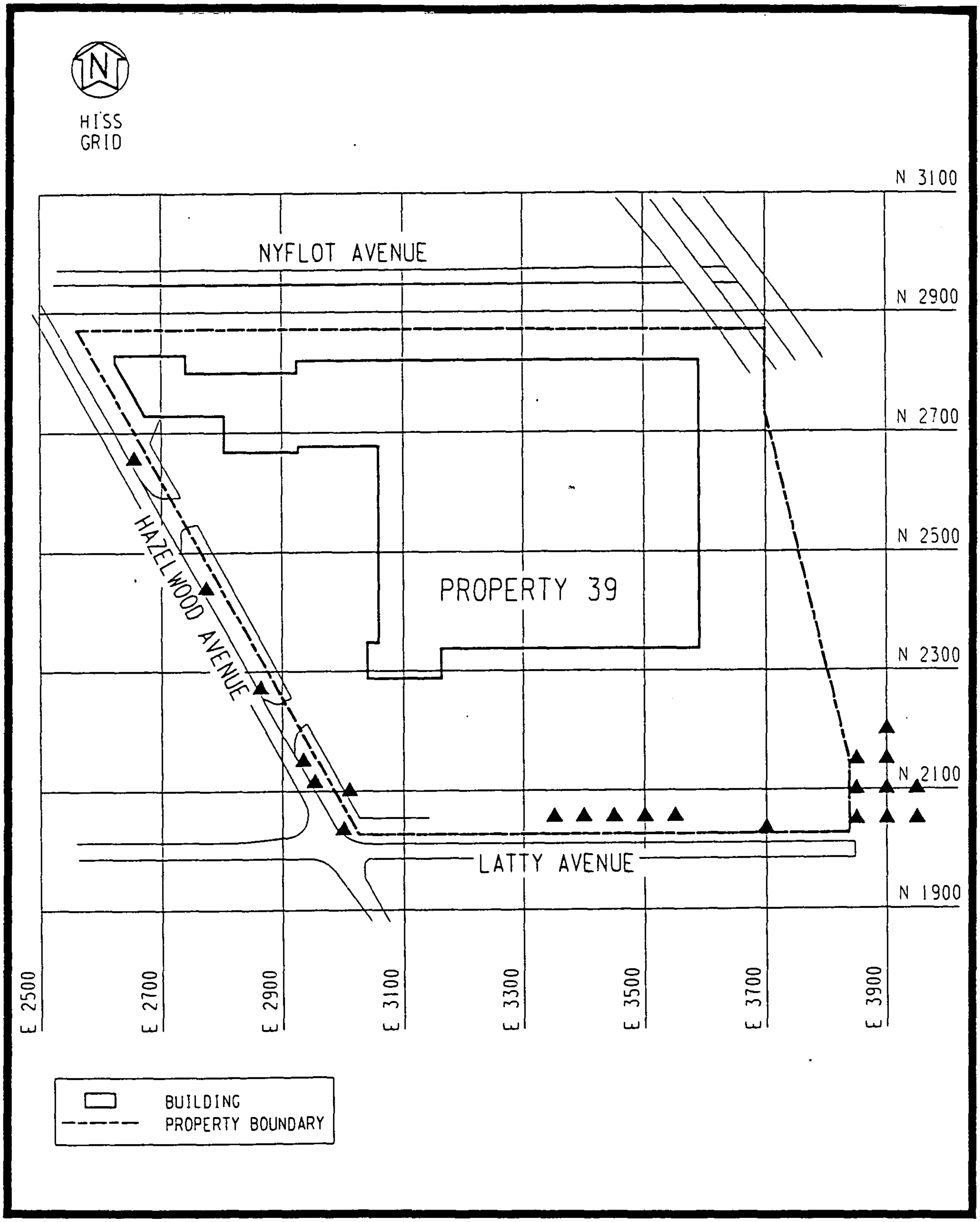


FIGURE 5-83 SURFACE SOIL SAMPLING LOCATIONS FOR 1987 RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 39

134F105.DGN SAMPLE

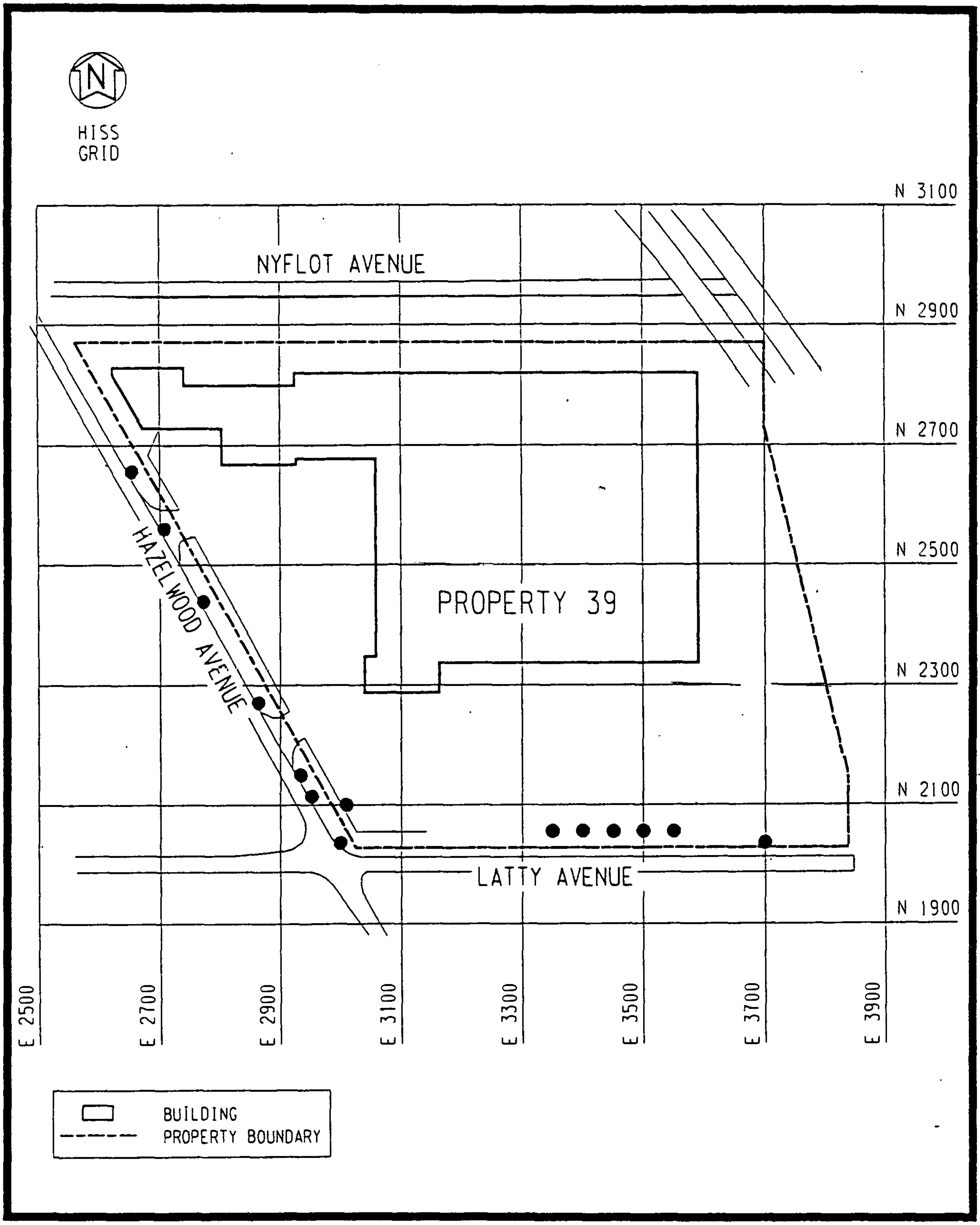


FIGURE 5-84 SUBSURFACE SOIL SAMPLING LOCATIONS FOR 1987 RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 39

134F105.DGN SUB

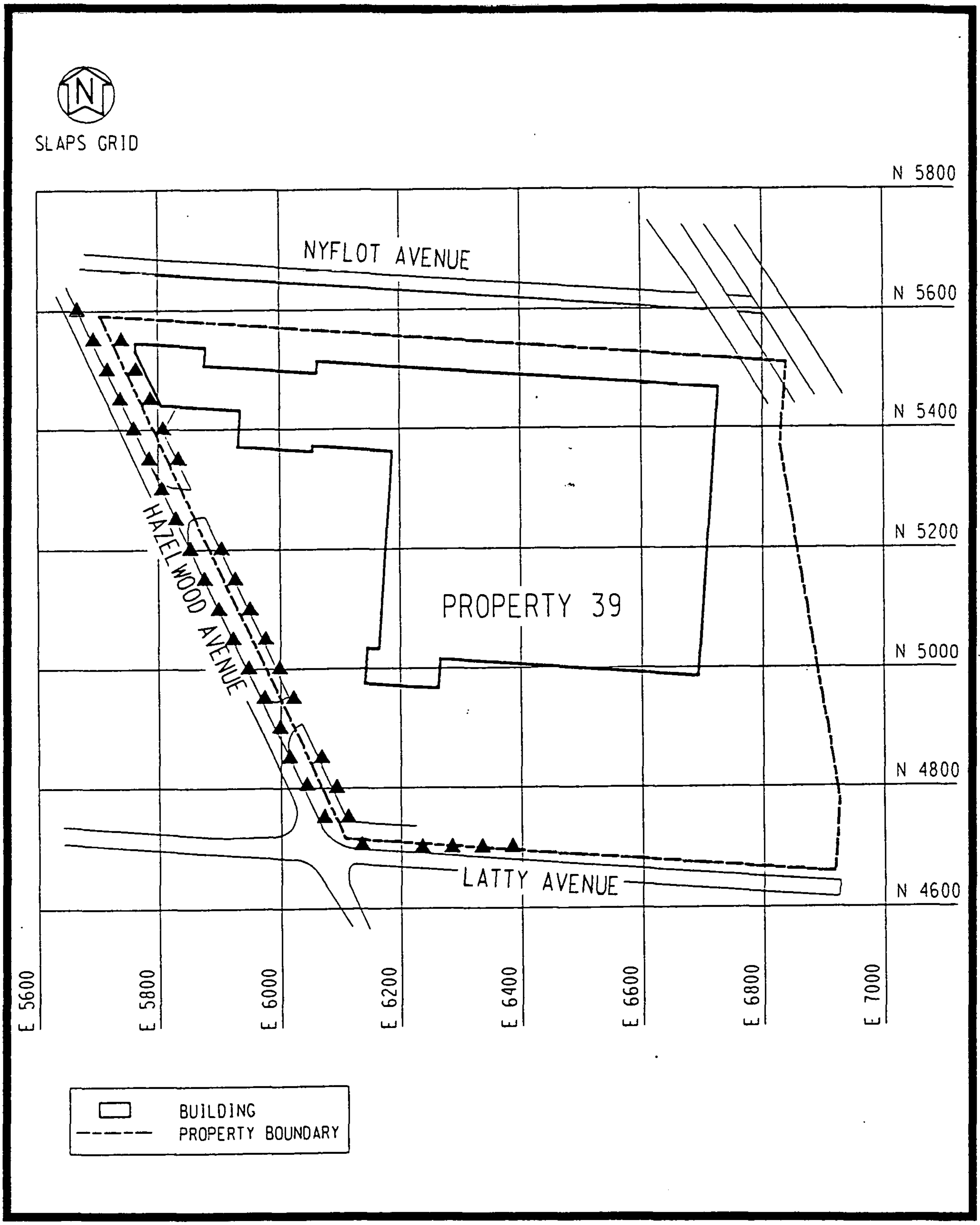


FIGURE 5-85 SOIL SAMPLING LOCATIONS FOR 1989 RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 39

134F102.DGN

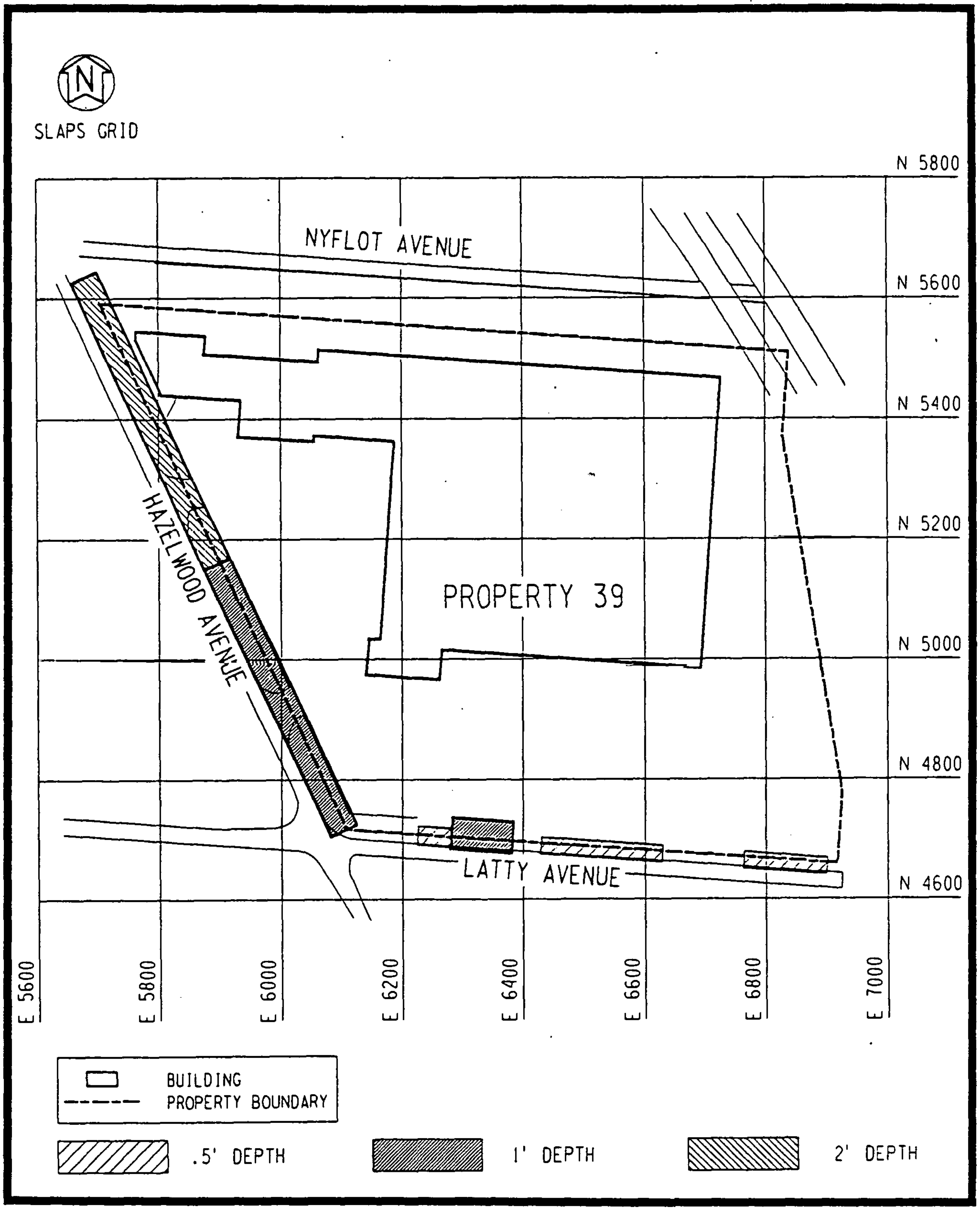


FIGURE 5-86 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT HAUL ROADS VICINITY PROPERTY 39

134F102.DGN

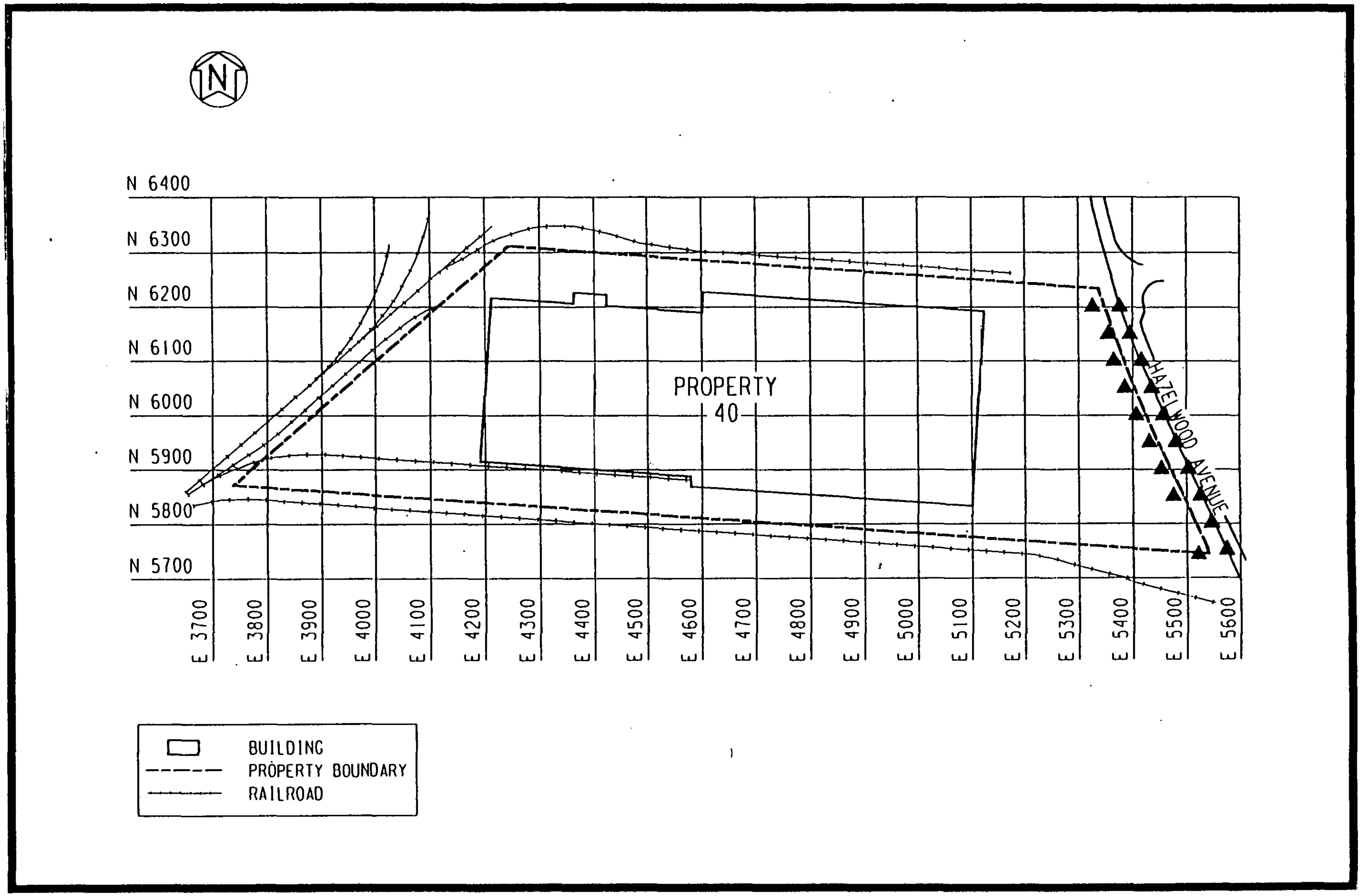


FIGURE 5-87 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 40

.34F020 DGN SAMPLE

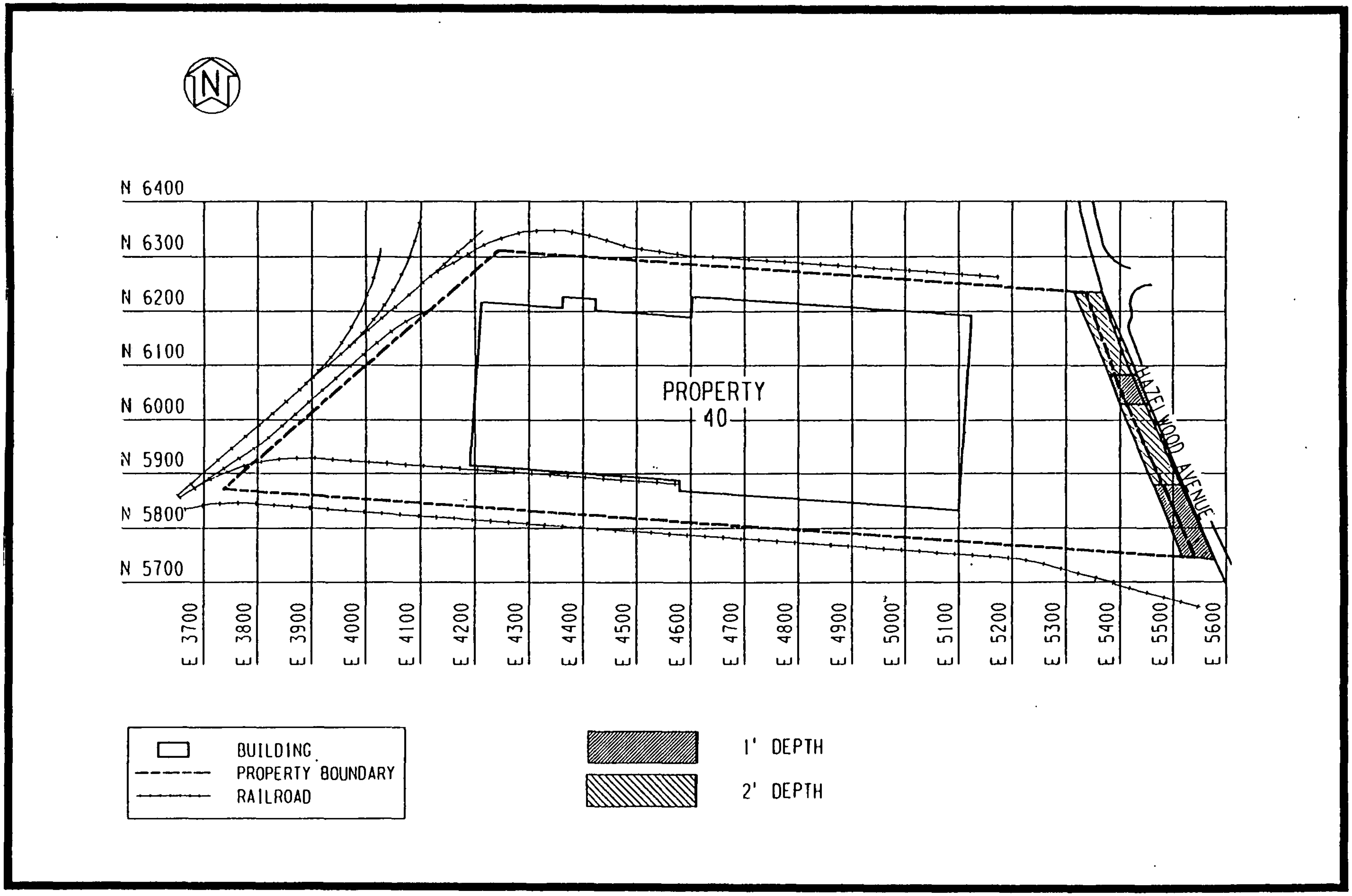


FIGURE 5-88 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT HAUL ROADS VICINITY PROPERTY 40

134F020.DGN DEPTH

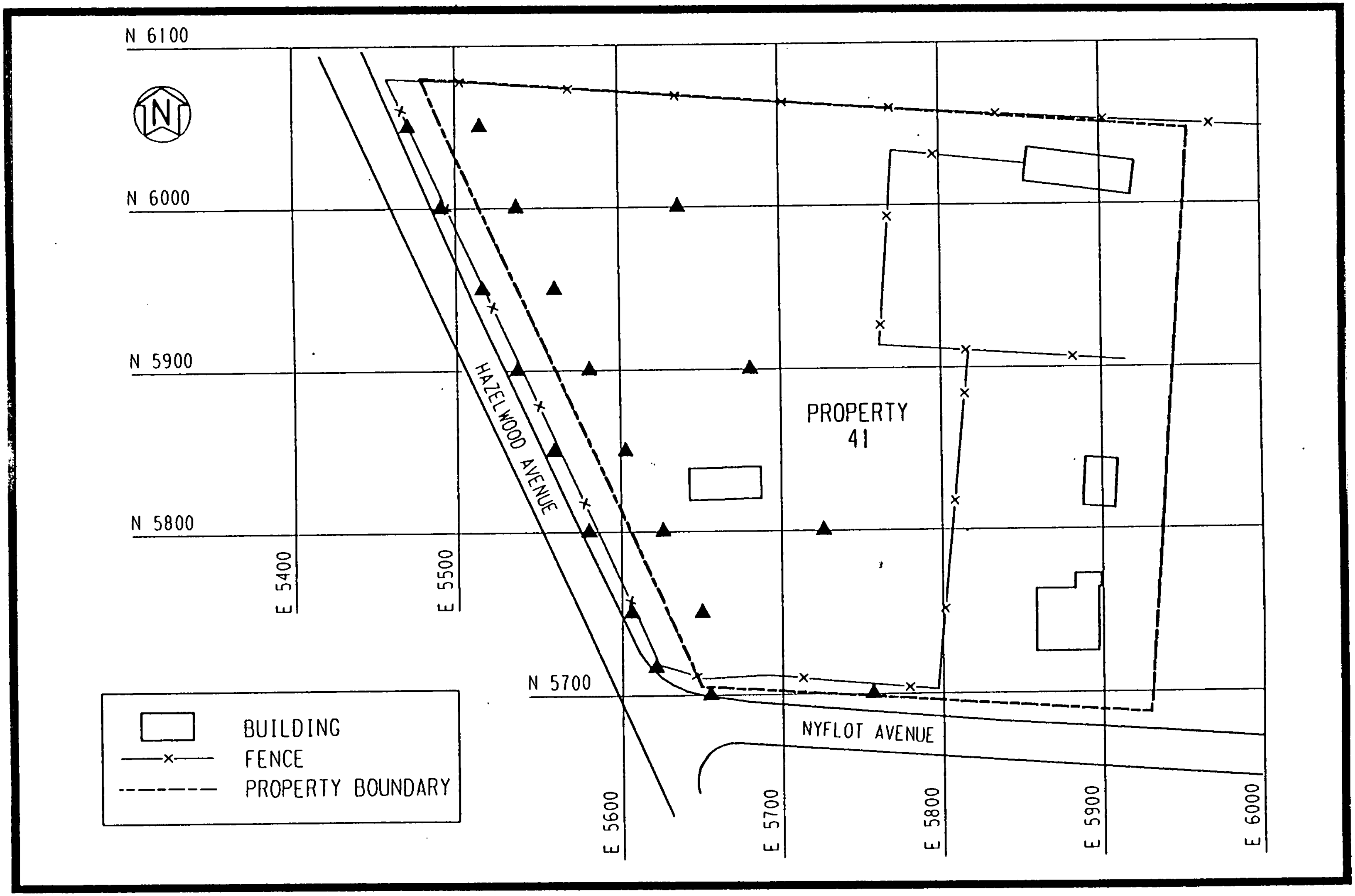


FIGURE 5-89 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 41

14F041.DGN SAMPLE

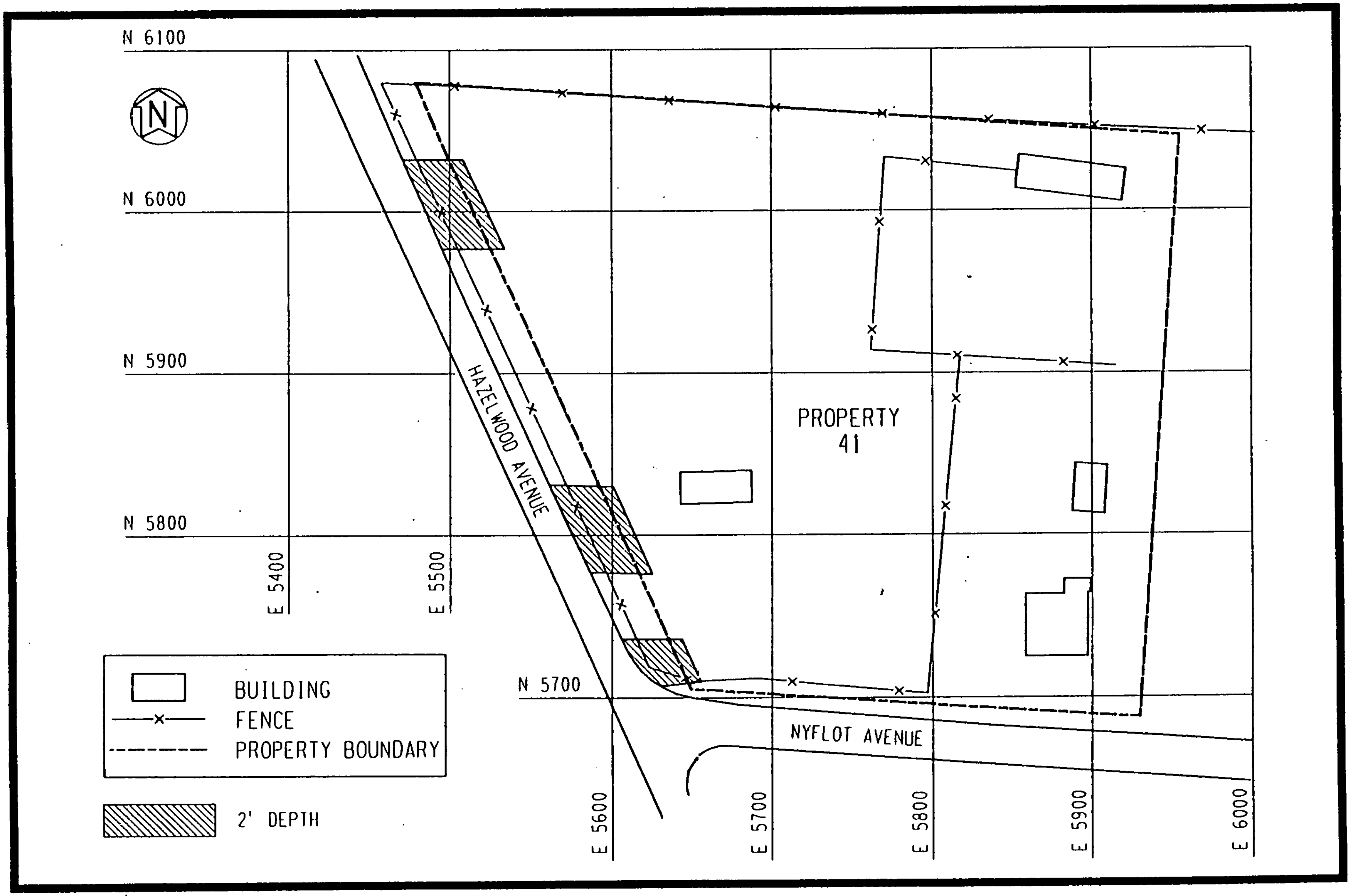


FIGURE 5-90 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT HAUL ROADS VICINITY PROPERTY 41

134F041.DGN DEPTH

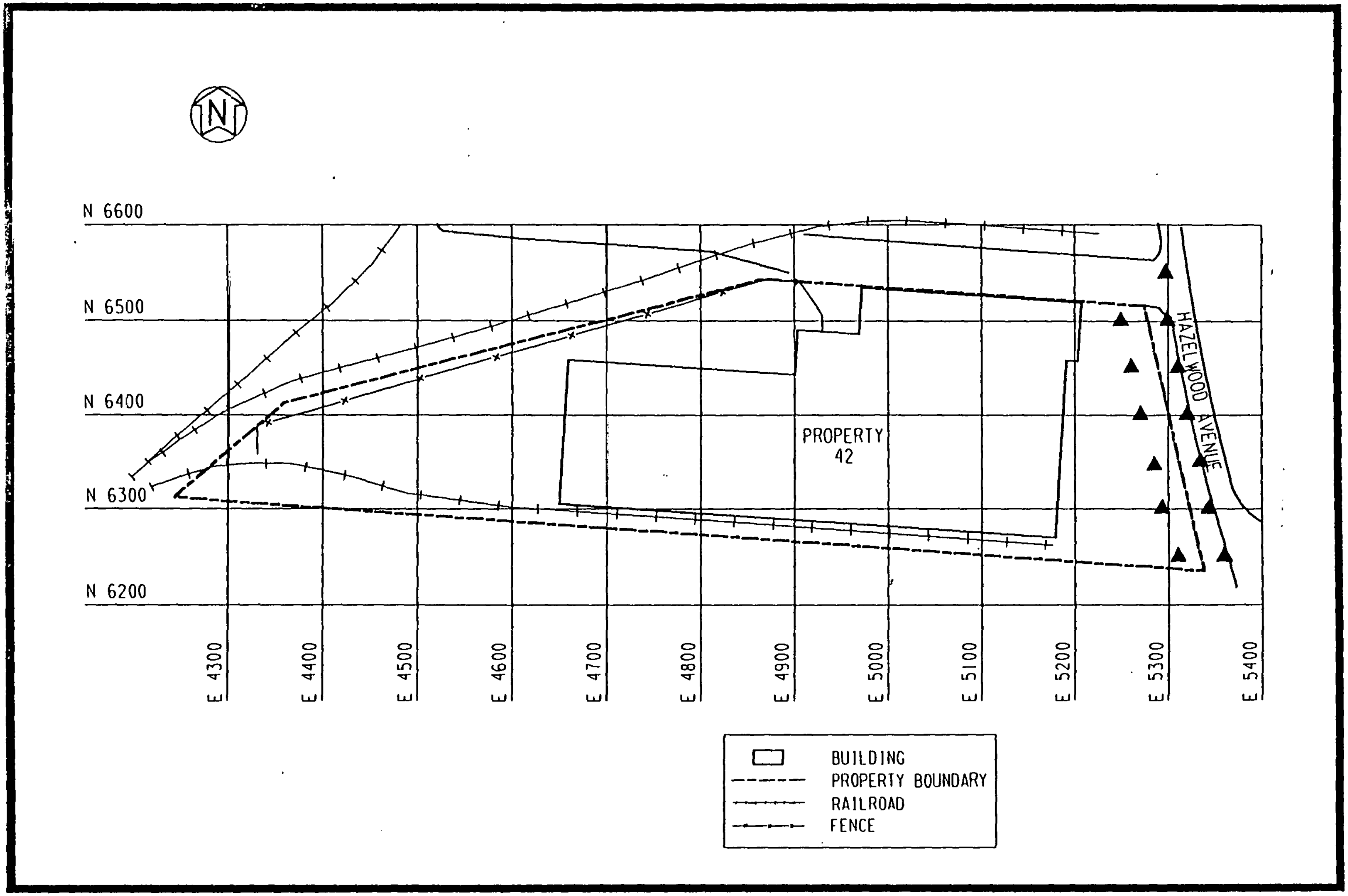


FIGURE 5-91 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 42

21.DGN SAMPLE

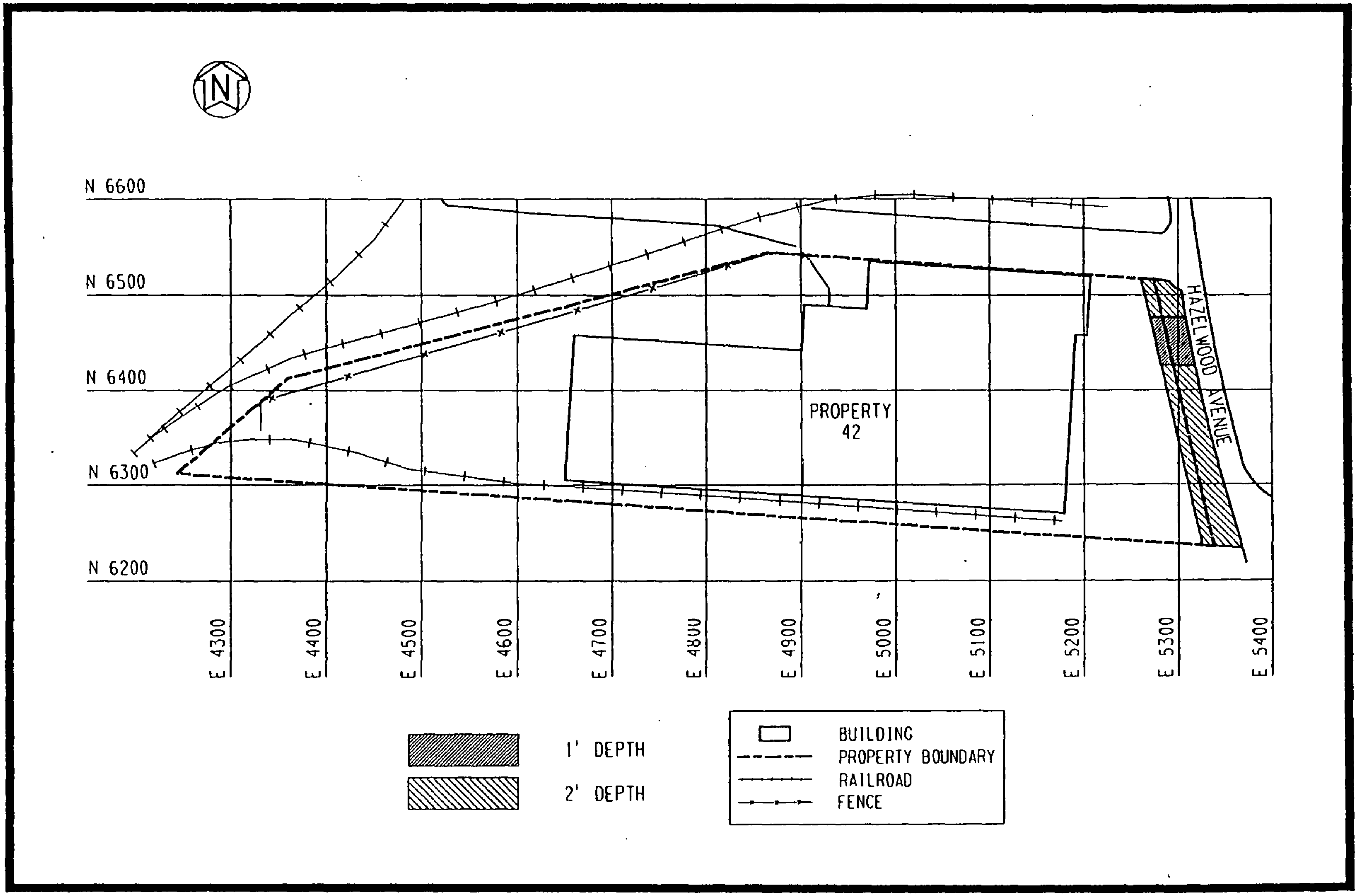


FIGURE 5-92 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT HAUL ROADS VICINITY PROPERTY 42

134F021.DGN DEPTH

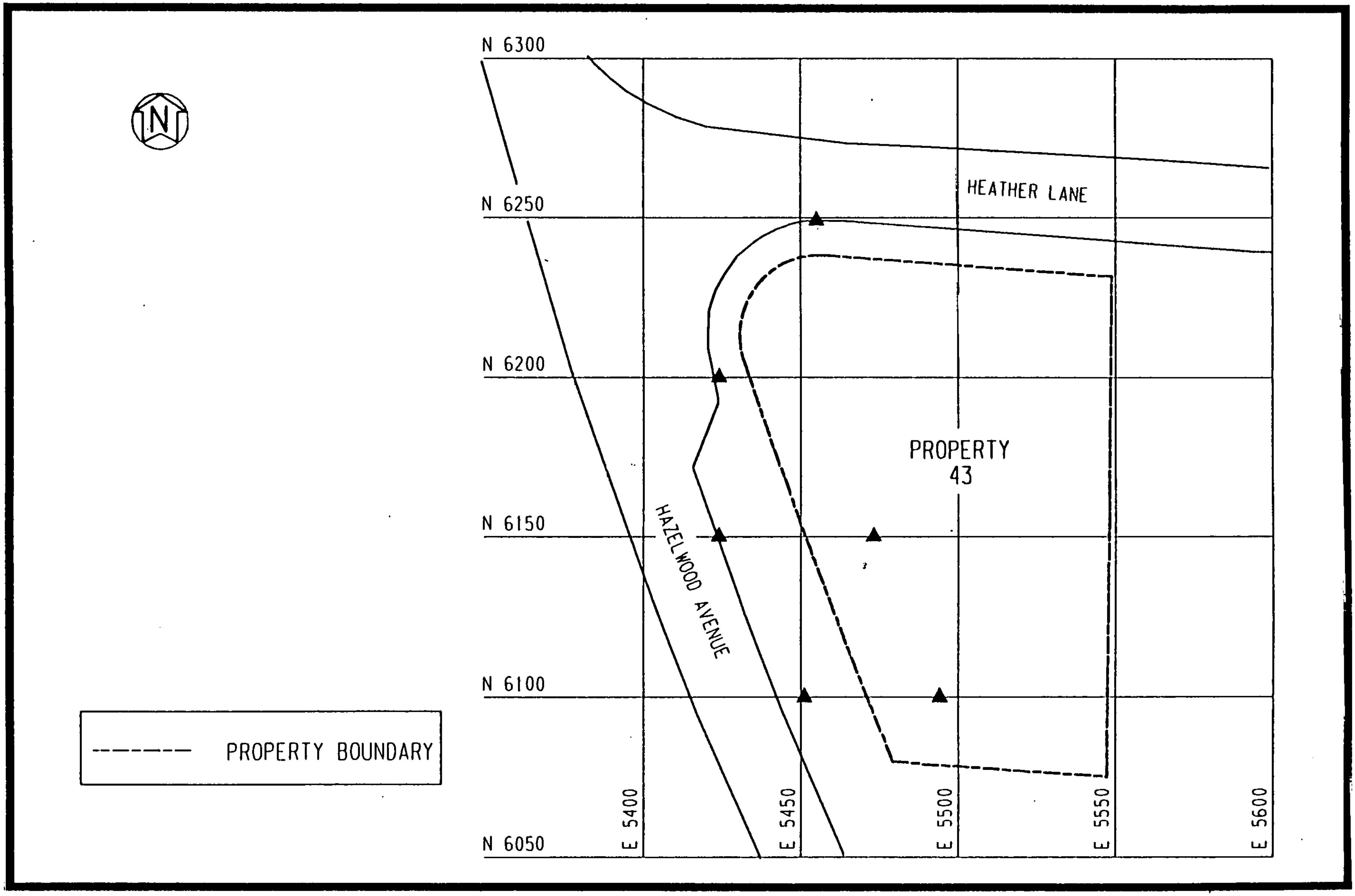


FIGURE 5-93 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 43

134F042.DGN

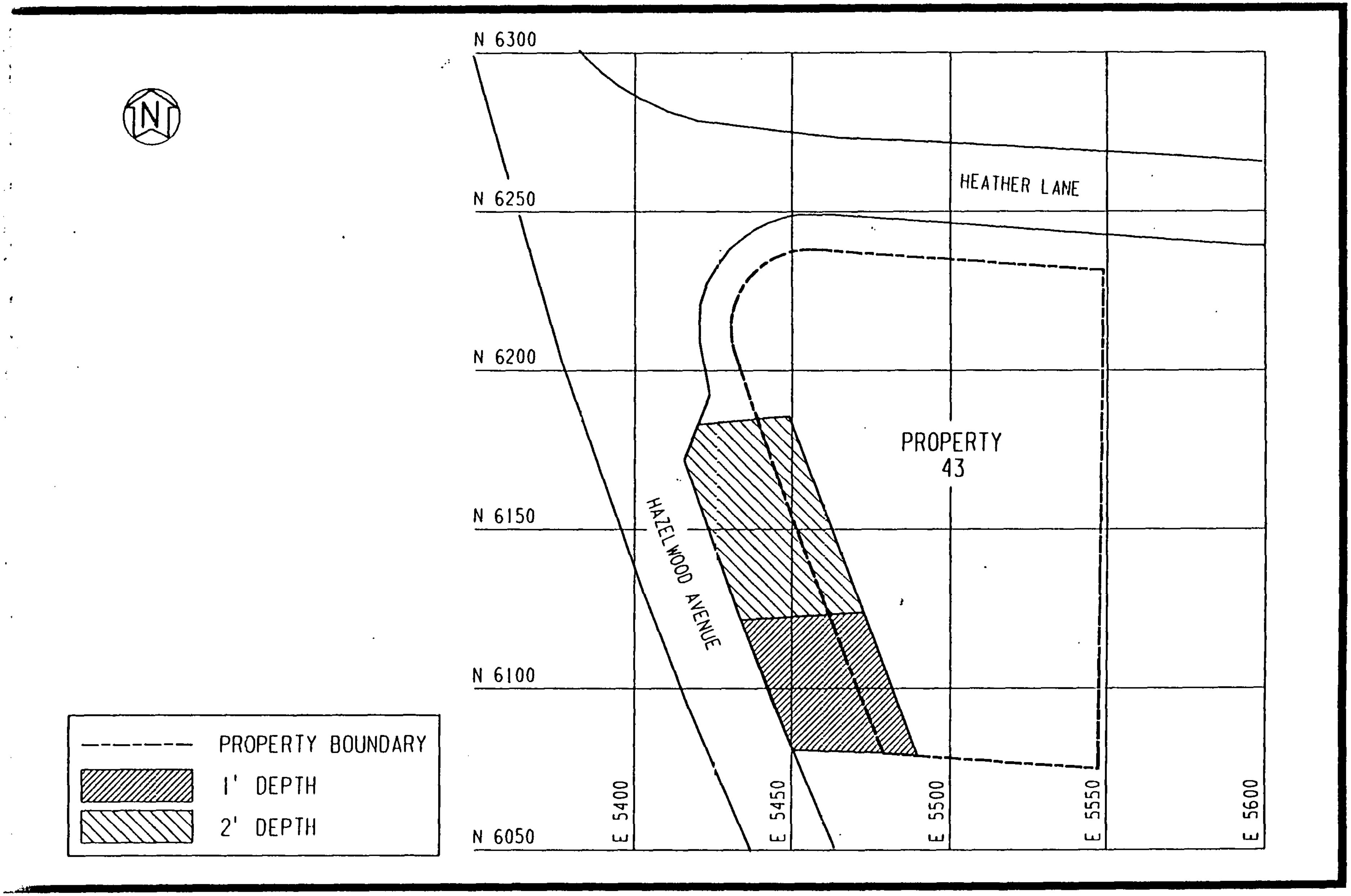


FIGURE 5-94 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT HAUL ROADS VICINITY PROPERTY 43

J 042.DGN FIG7

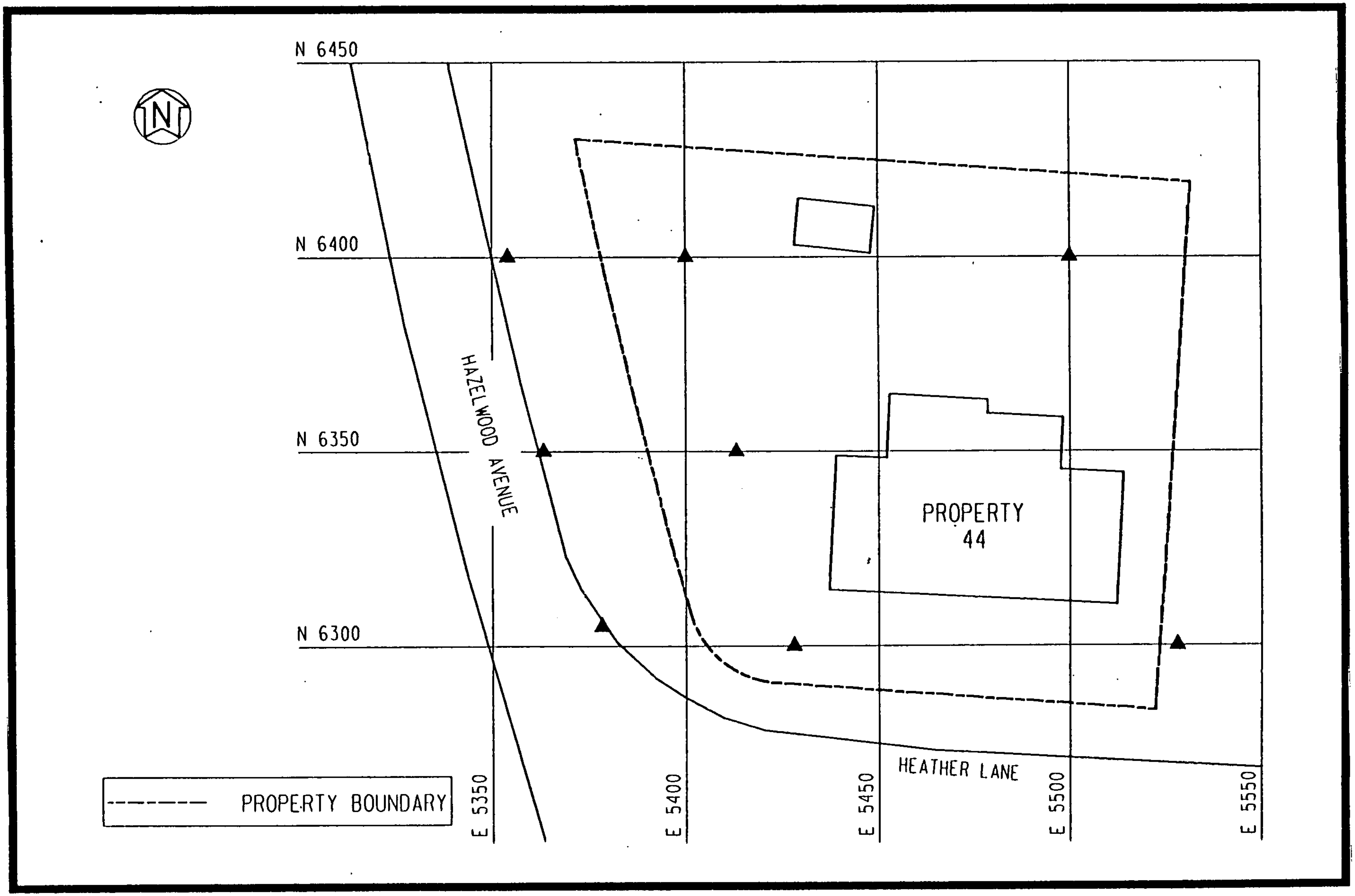


FIGURE 5-95 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 44

134FC43.DGN SAMPLE

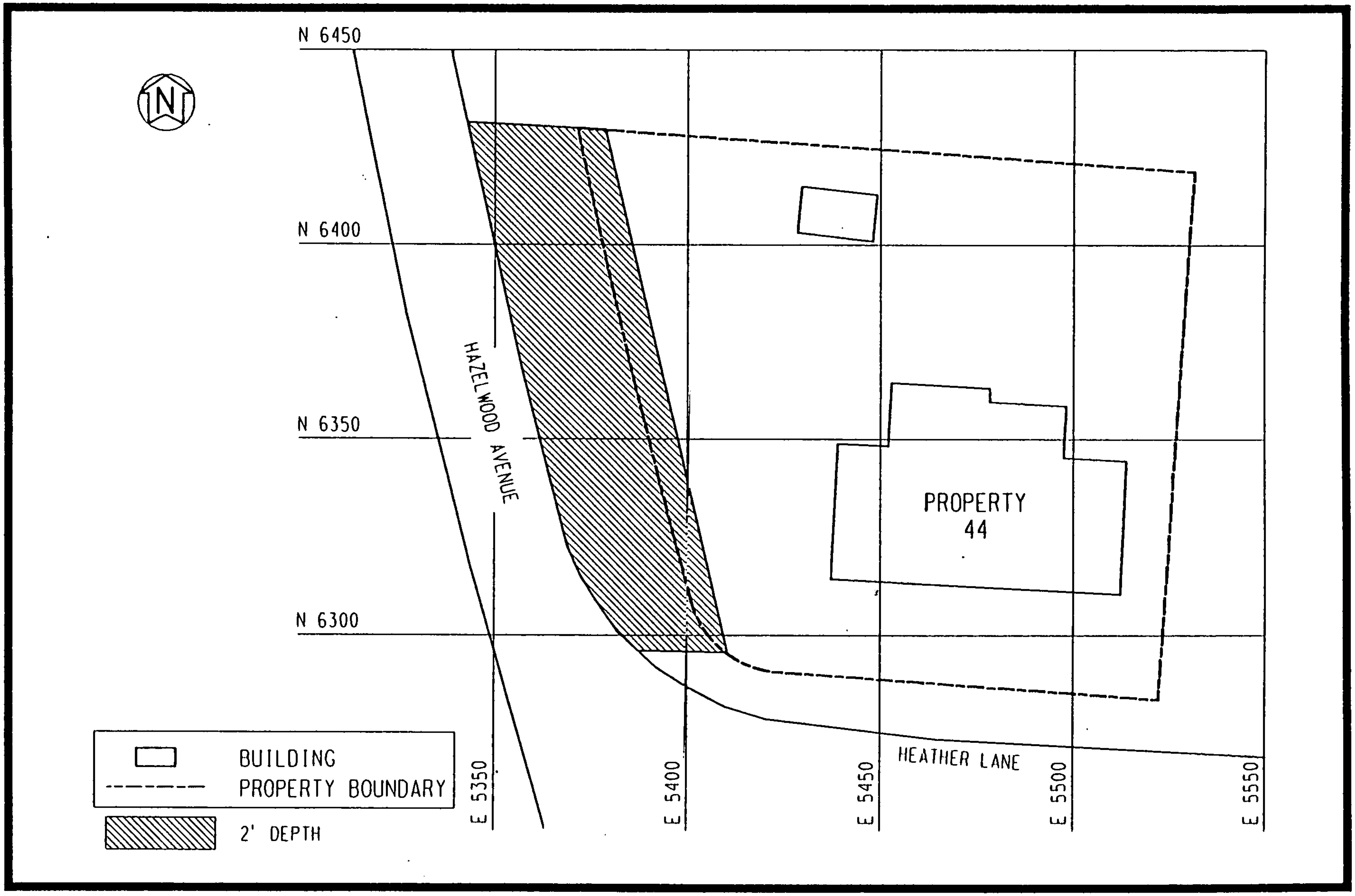


FIGURE 5-96 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT HAUL ROADS VICINITY PROPERTY 44

134F043.DGN DEPTH

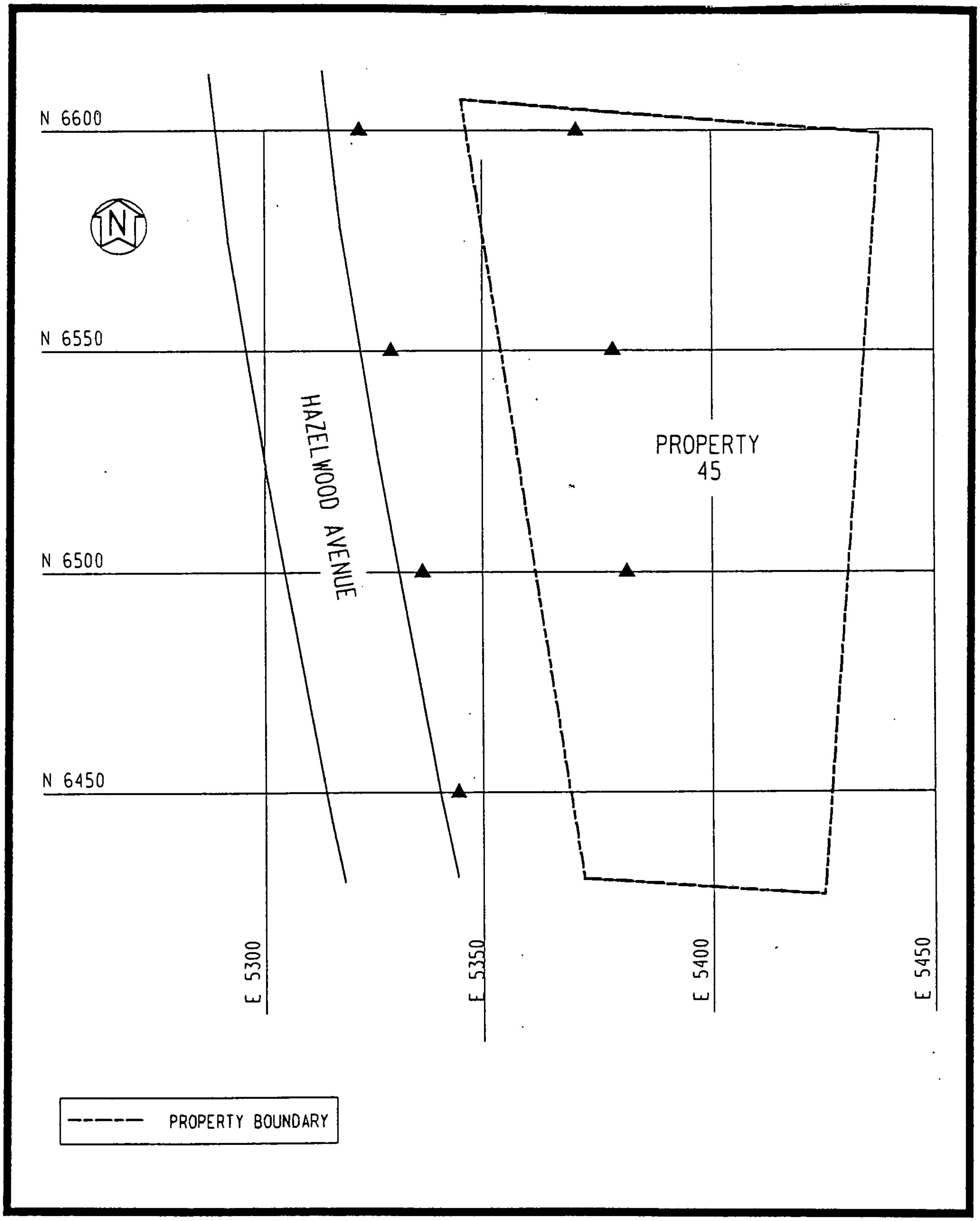


FIGURE 5-97 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 45

134F036.DGN SAMPLE

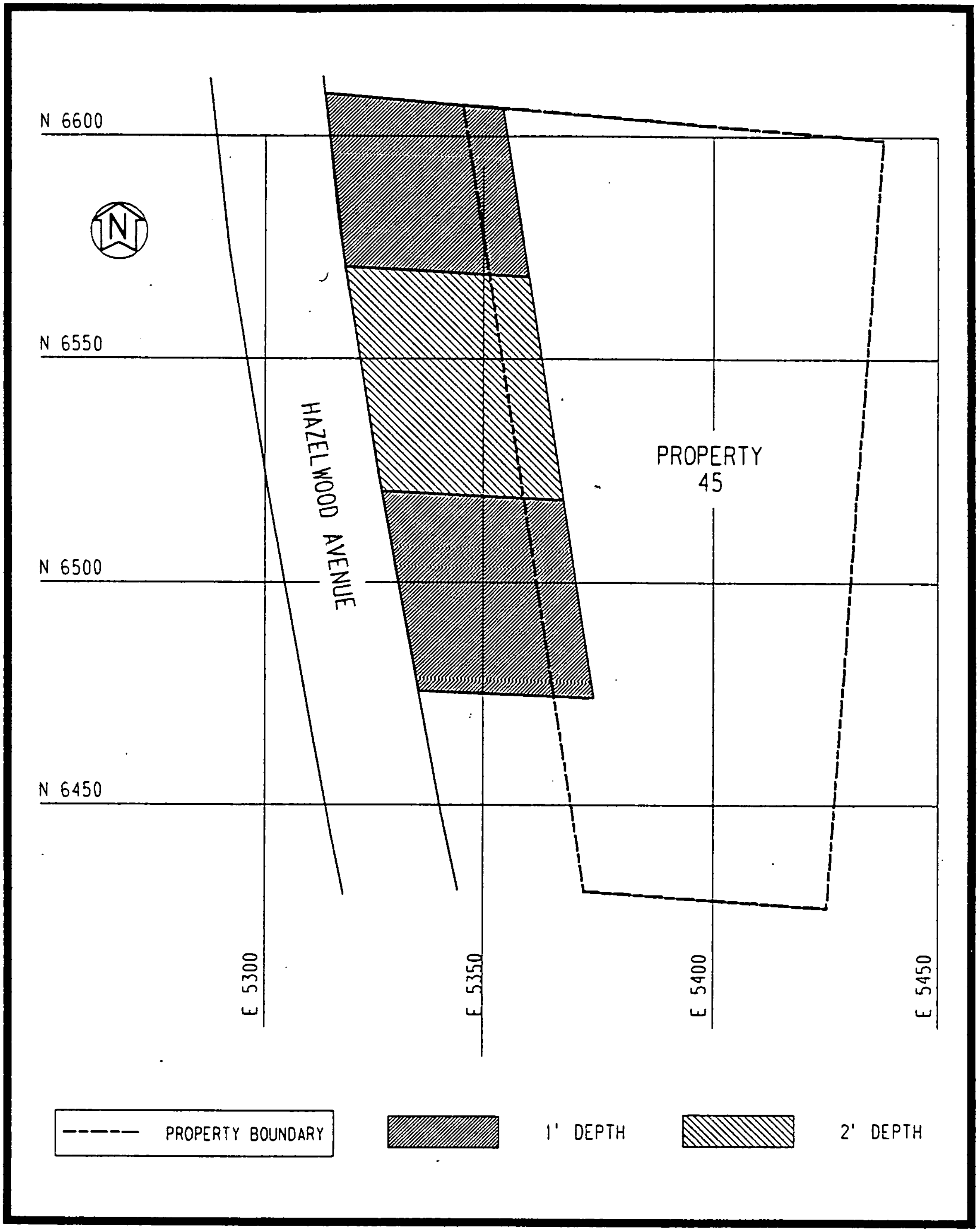


FIGURE 5-98 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT HAUL ROADS' VICINITY PROPERTY 45

134F036.DGN DEPTH

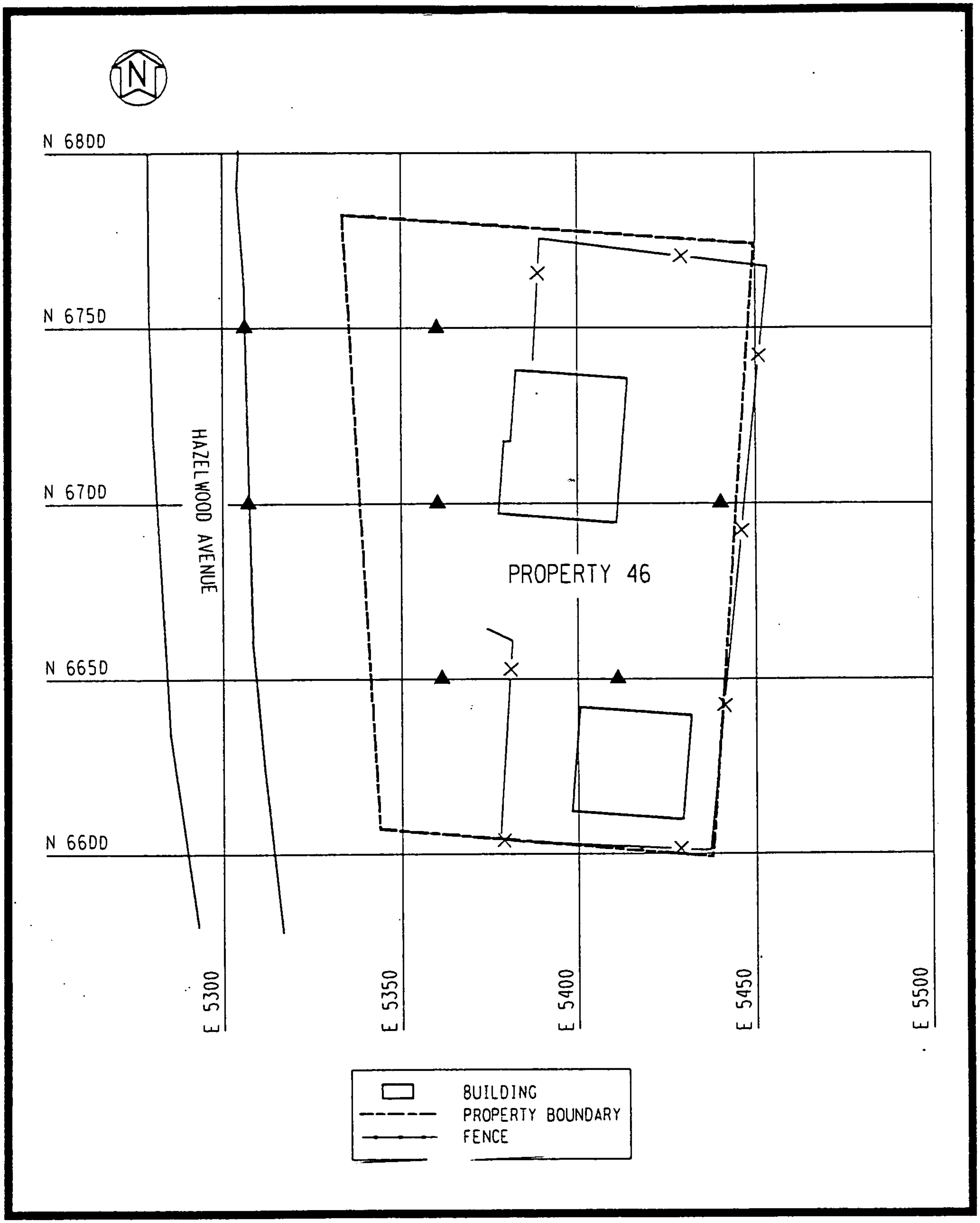


FIGURE 5-99 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 46

134F027.DGN SAMPLE

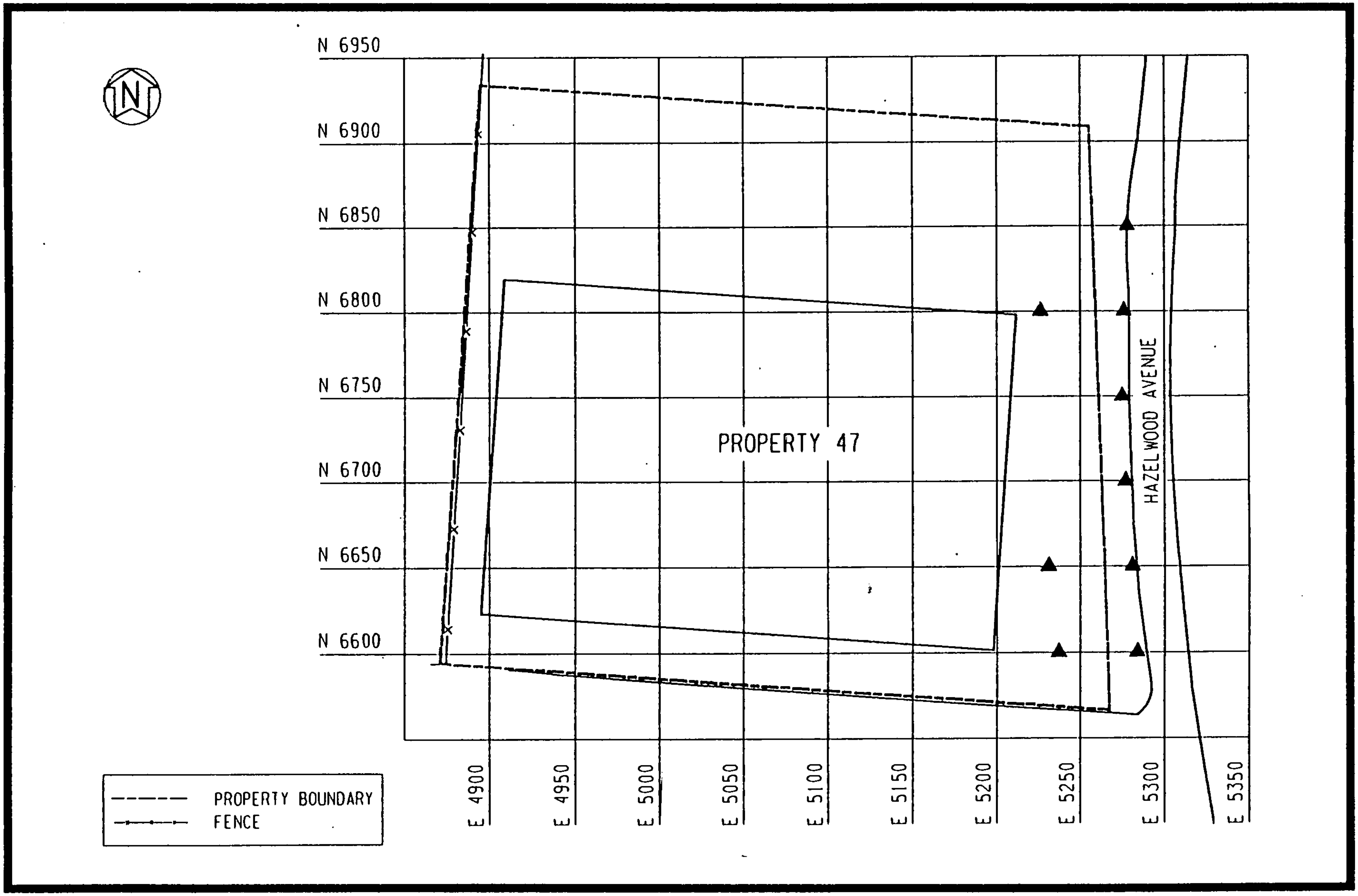


FIGURE 5-100 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 47

134F022.DGN SAMPLE

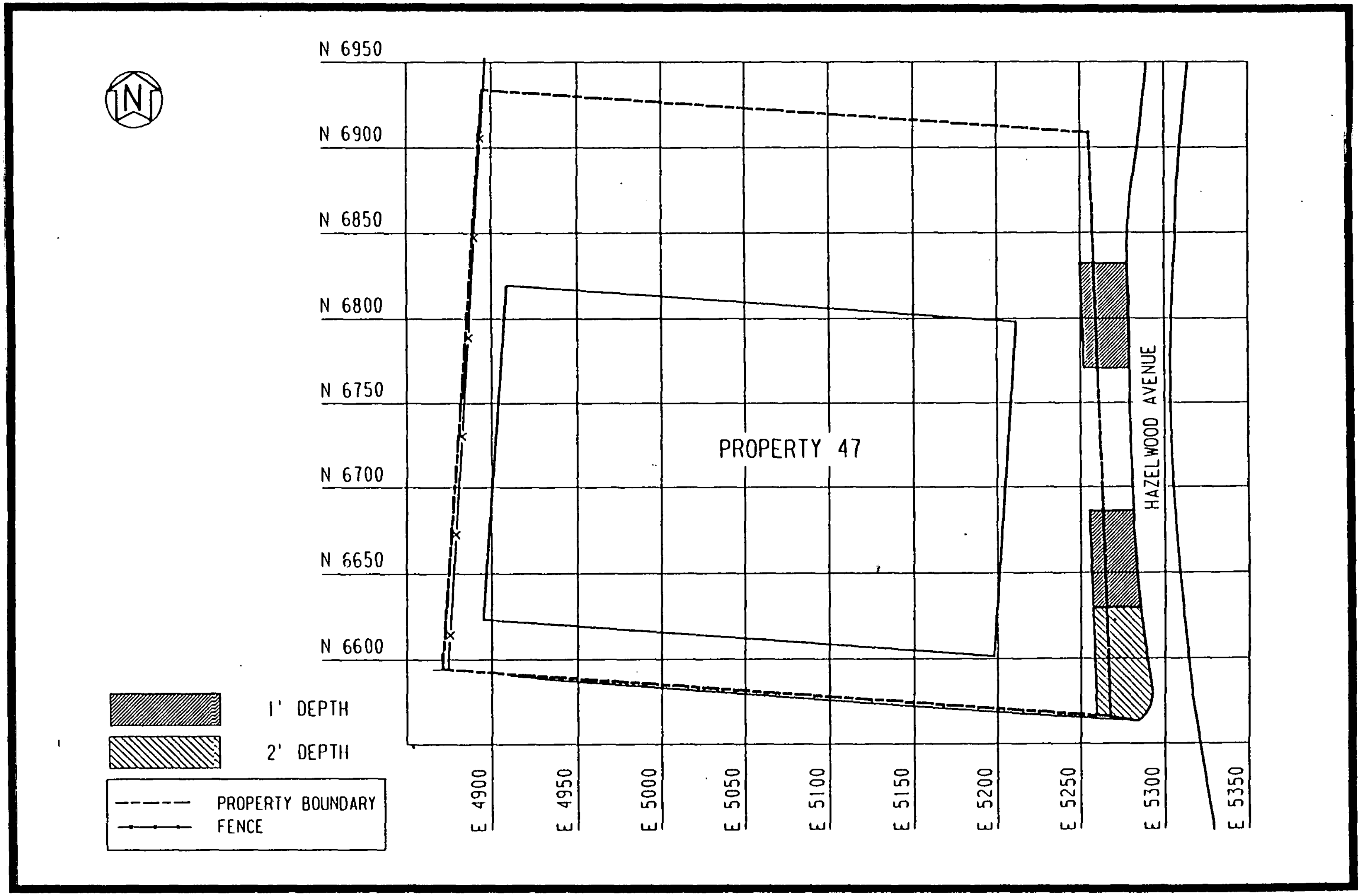


FIGURE 5-101 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT HAUL ROADS VICINITY PROPERTY 47

134F022.DGN DEPTH

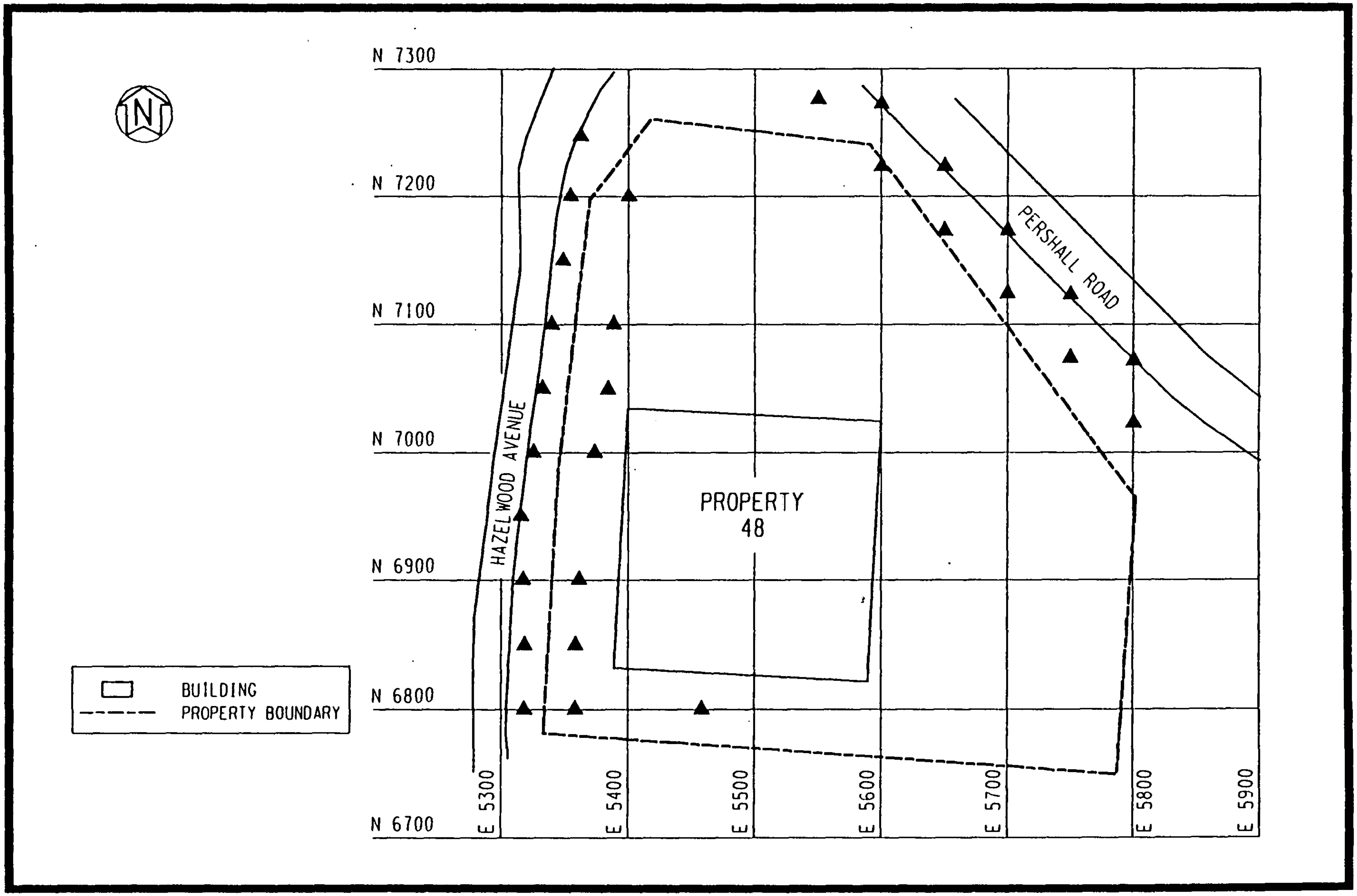


FIGURE 5-102 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 48

134F034.DGN SAMPLE

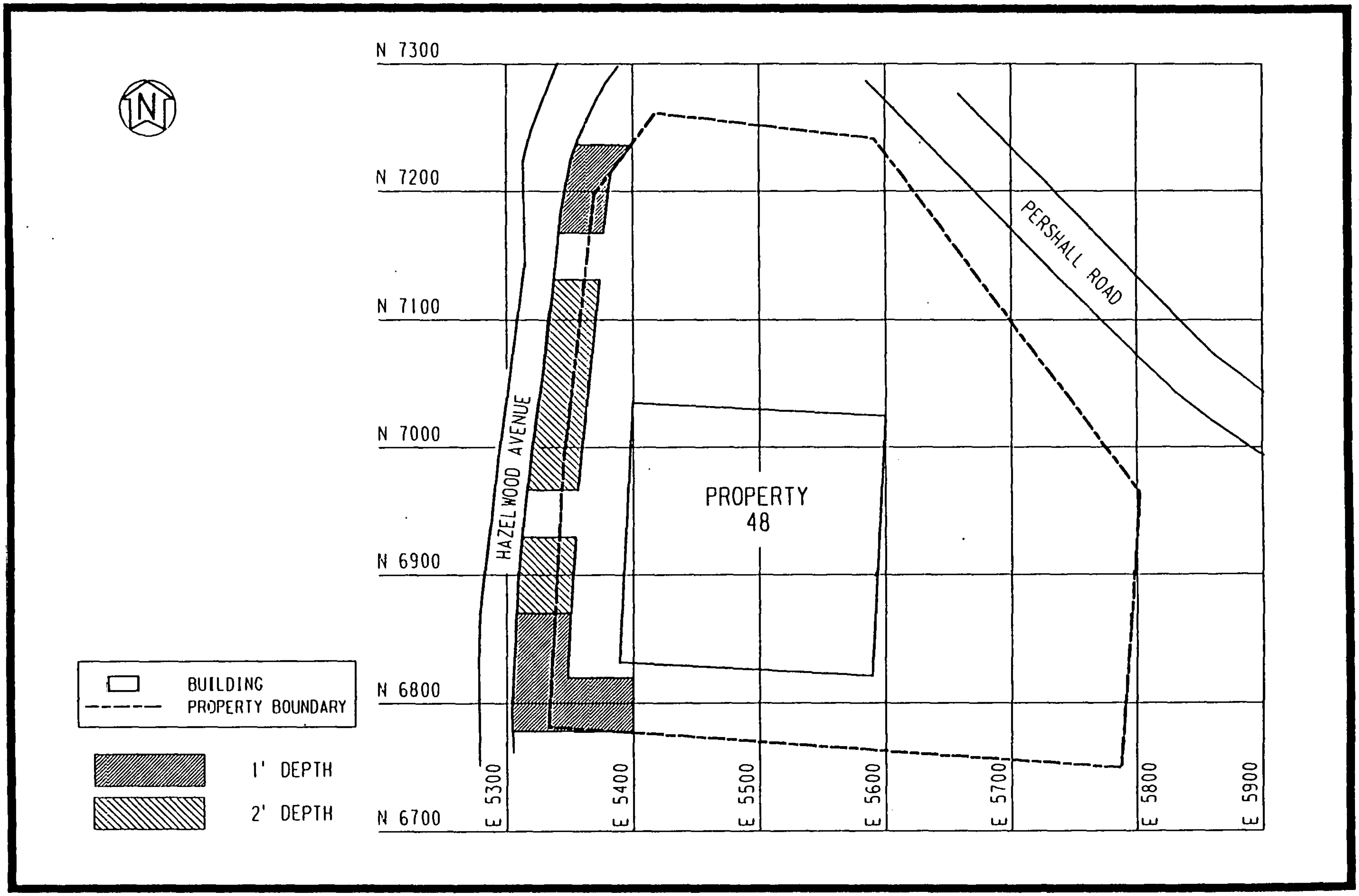


FIGURE 5-103 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT HAUL ROADS VICINITY PROPERTY 48

134F034.DGN DEPTH

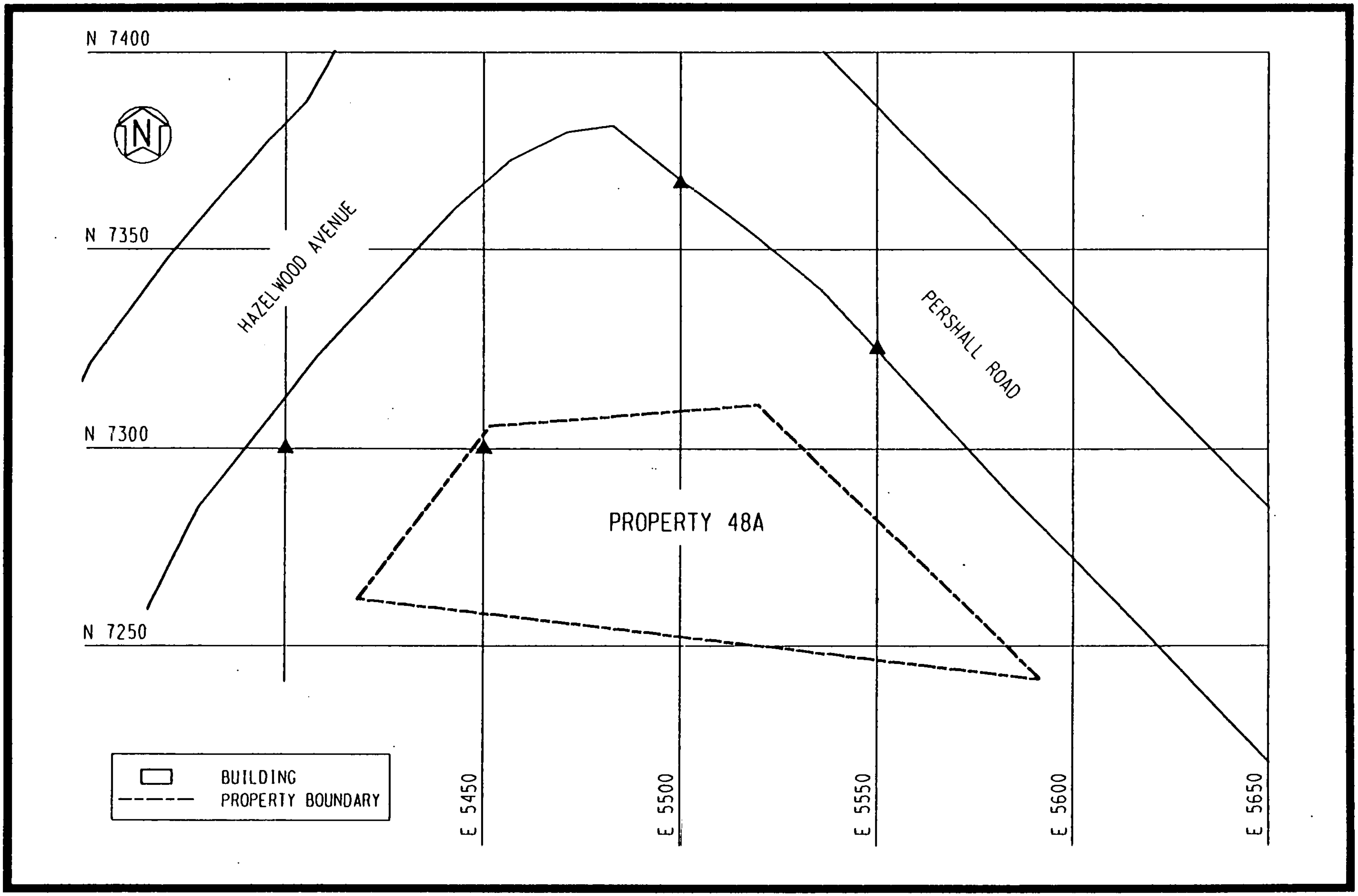


FIGURE 5-104 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 48A

134F033.DGN SAMPLE

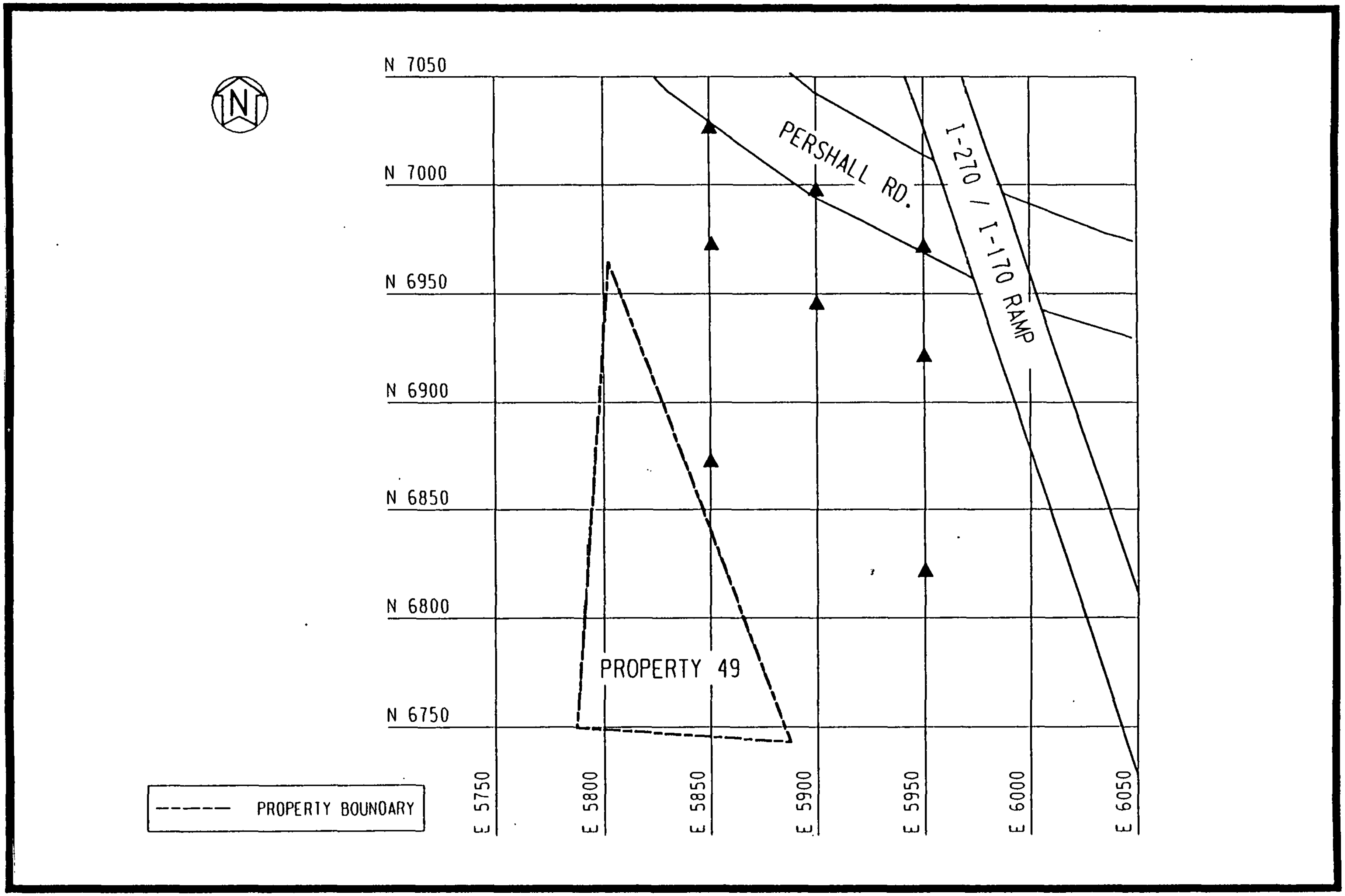


FIGURE 5-105 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 49

134F035.DGN SAMP..

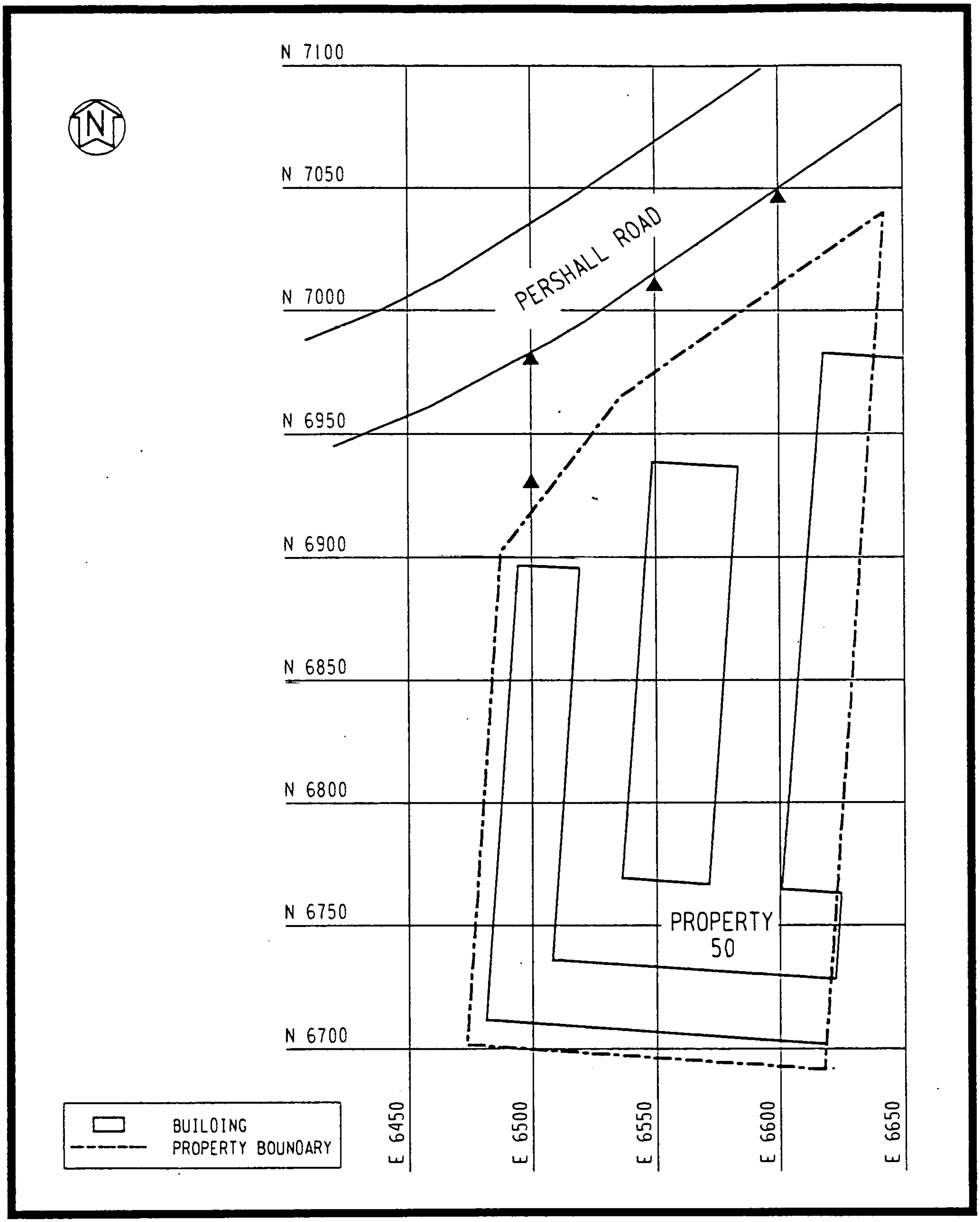


FIGURE 5-106 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 50

134F037.DGN SAMPLE

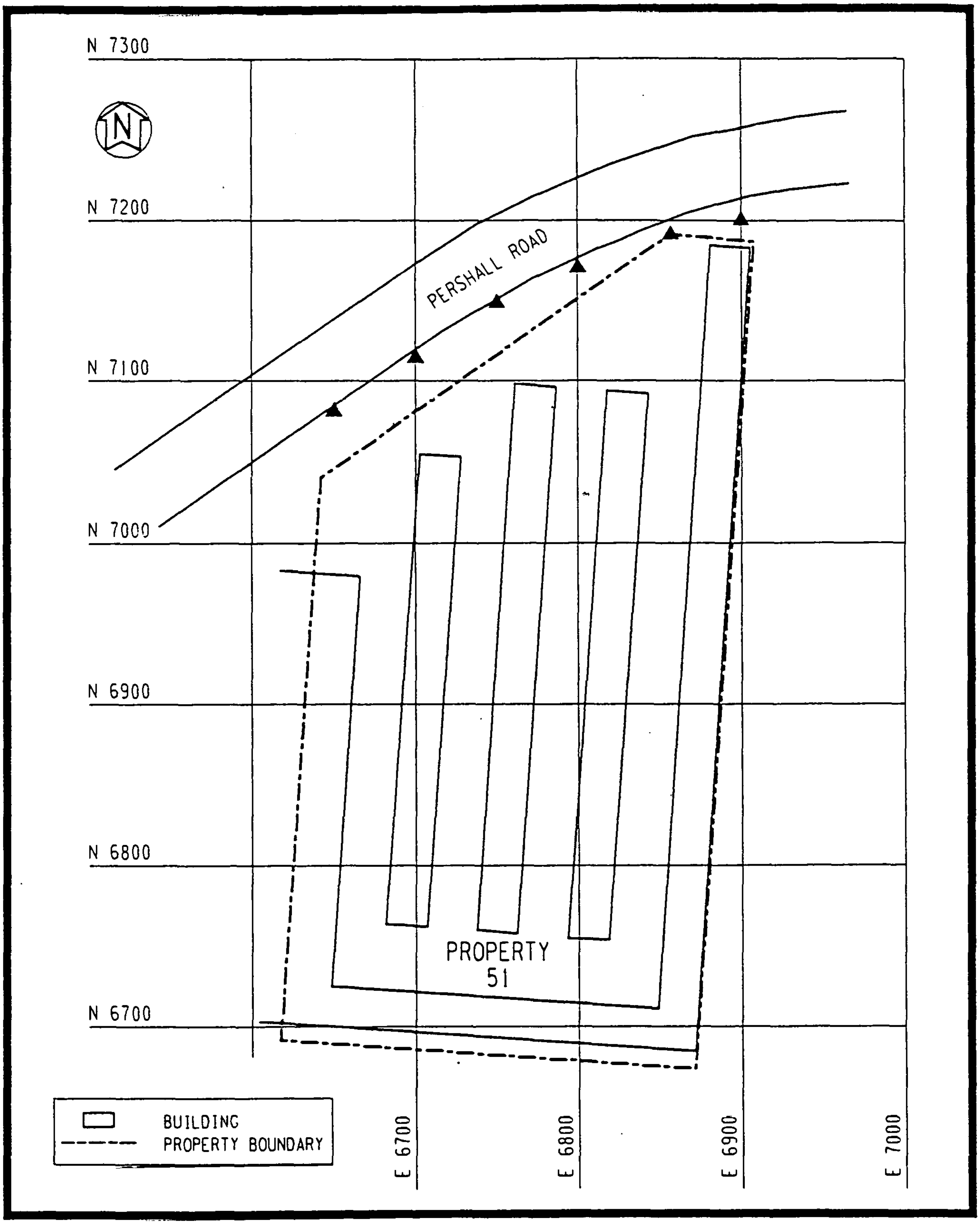


FIGURE 5-107 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 51

134F038.DGN SAMPLE

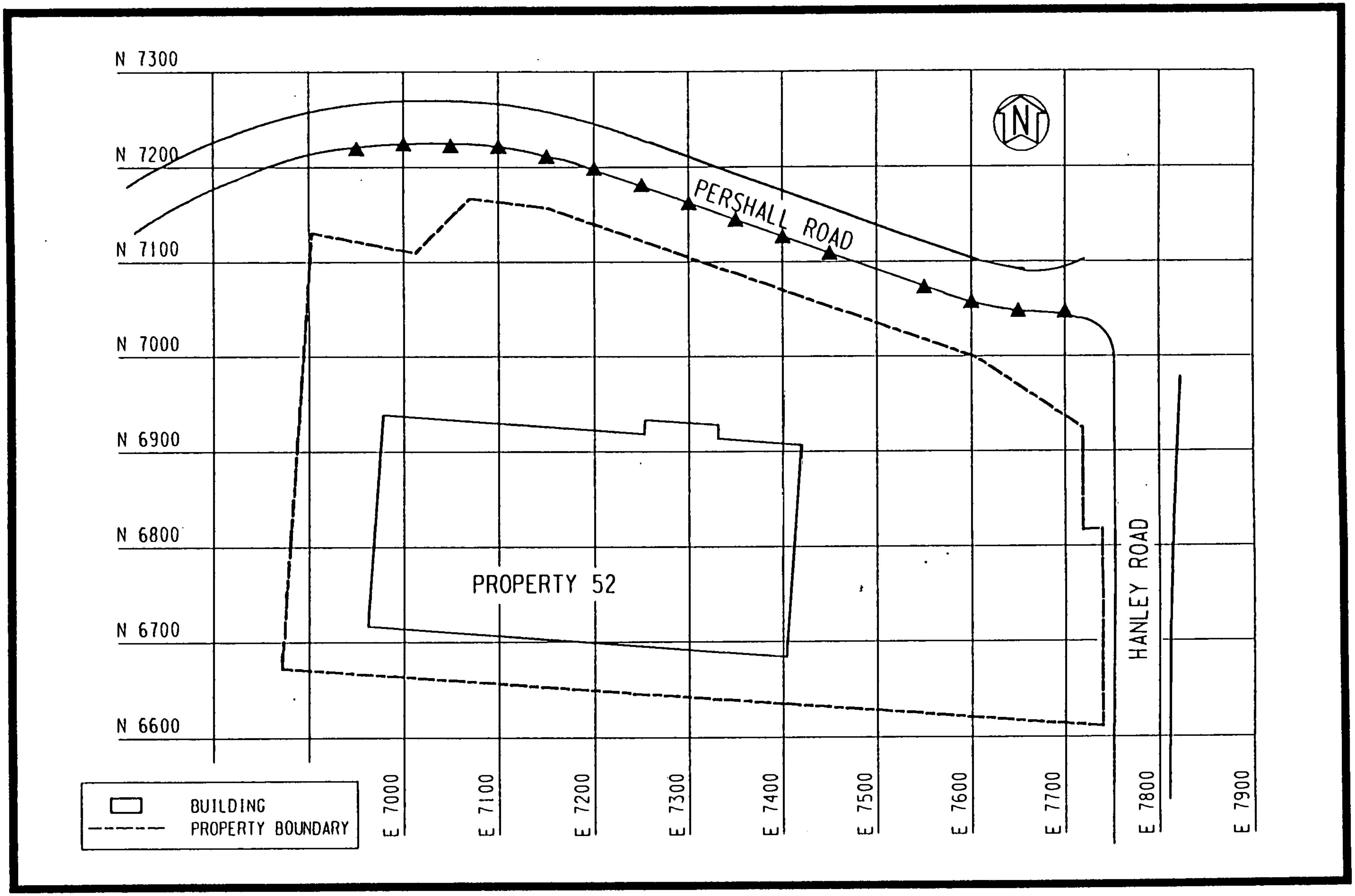


FIGURE 5-108 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 52

134F063.DGN SAMPLE

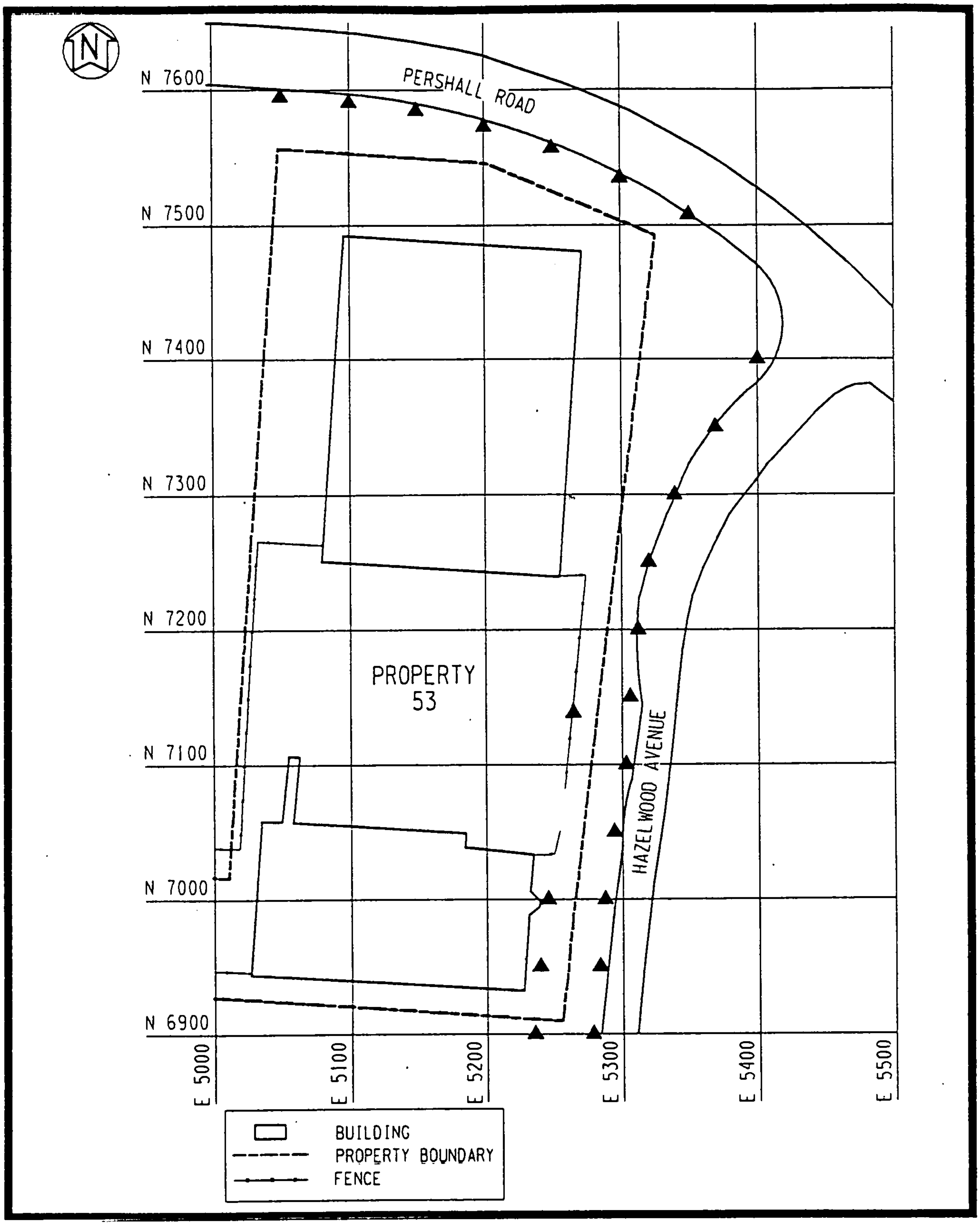


FIGURE 5-109 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 53

134F023.DGN SAMPLE

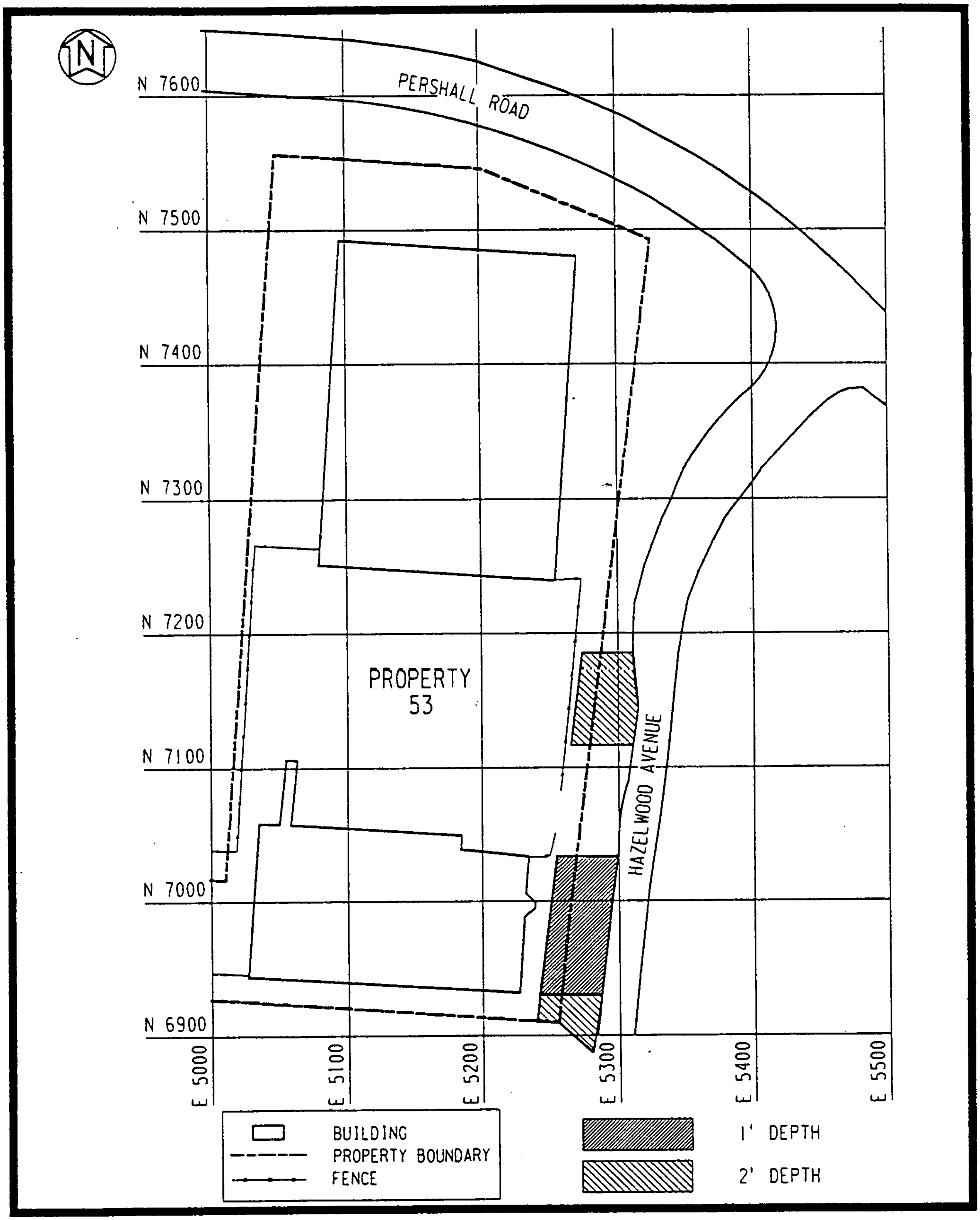


FIGURE 5-110 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT HAUL ROADS VICINITY PROPERTY 53

134F023.DGN DEPTH

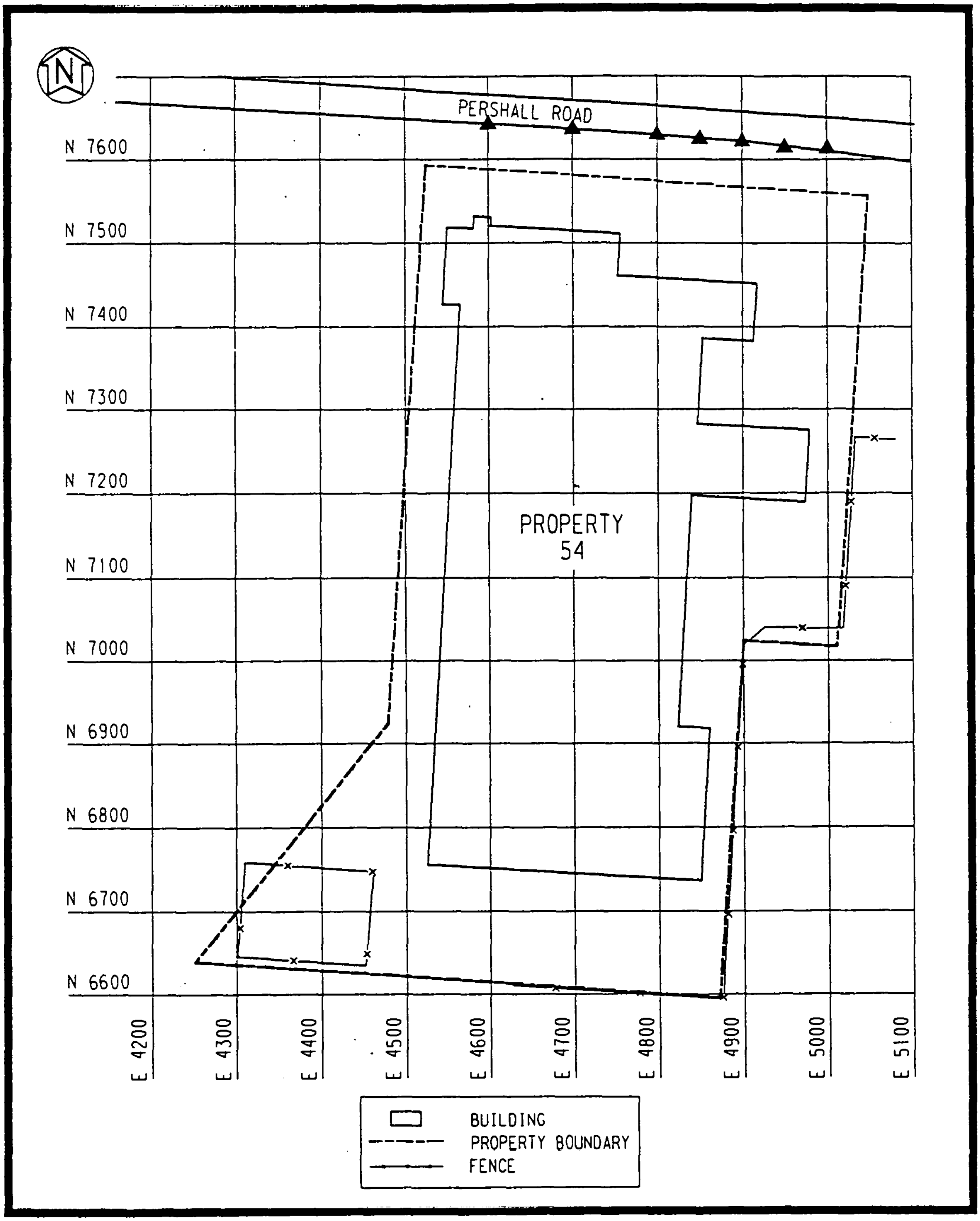


FIGURE 5-111 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 54

134F024.DGN SAMPLE

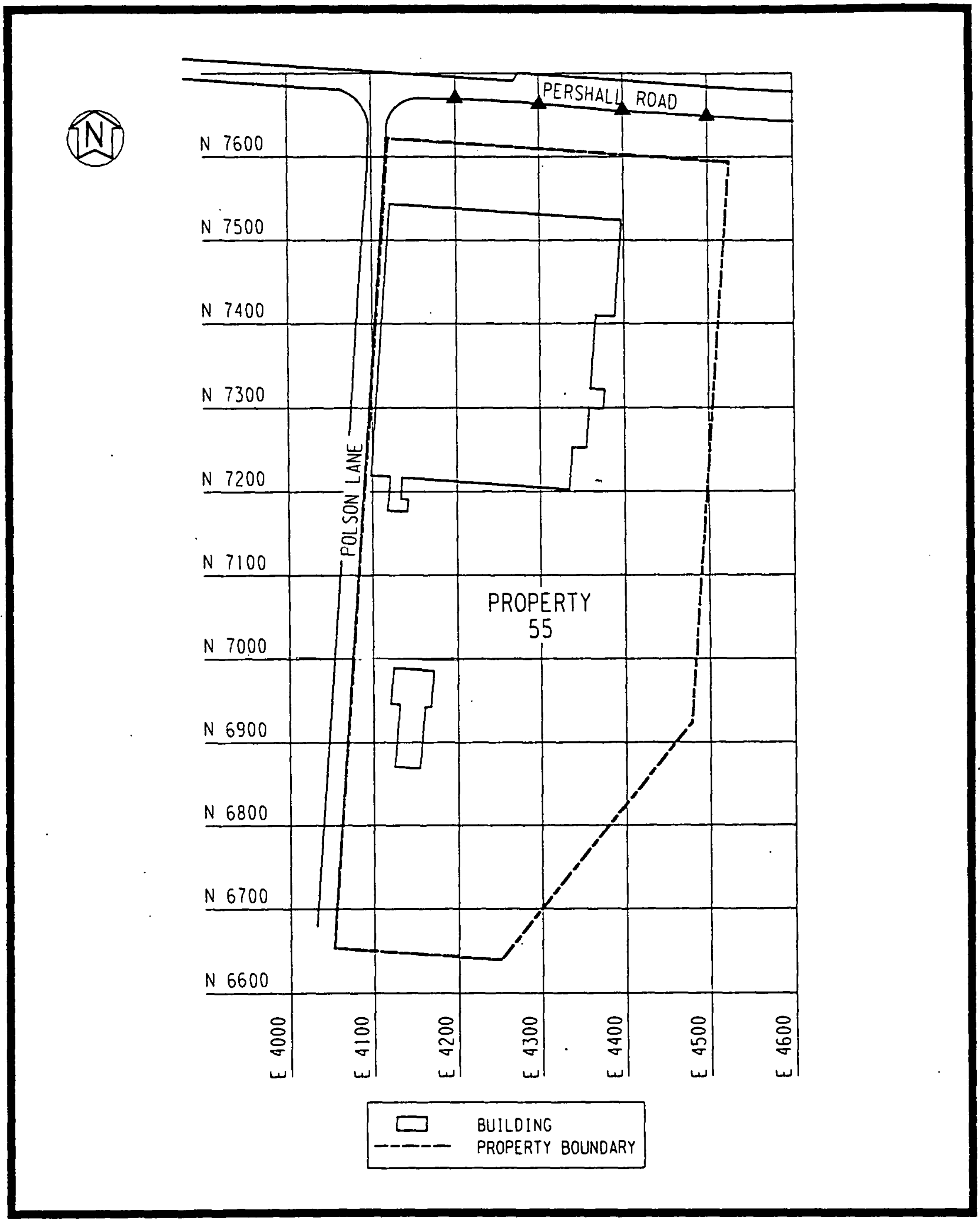


FIGURE 5-112 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 55

134F025.DGN SAMPLE

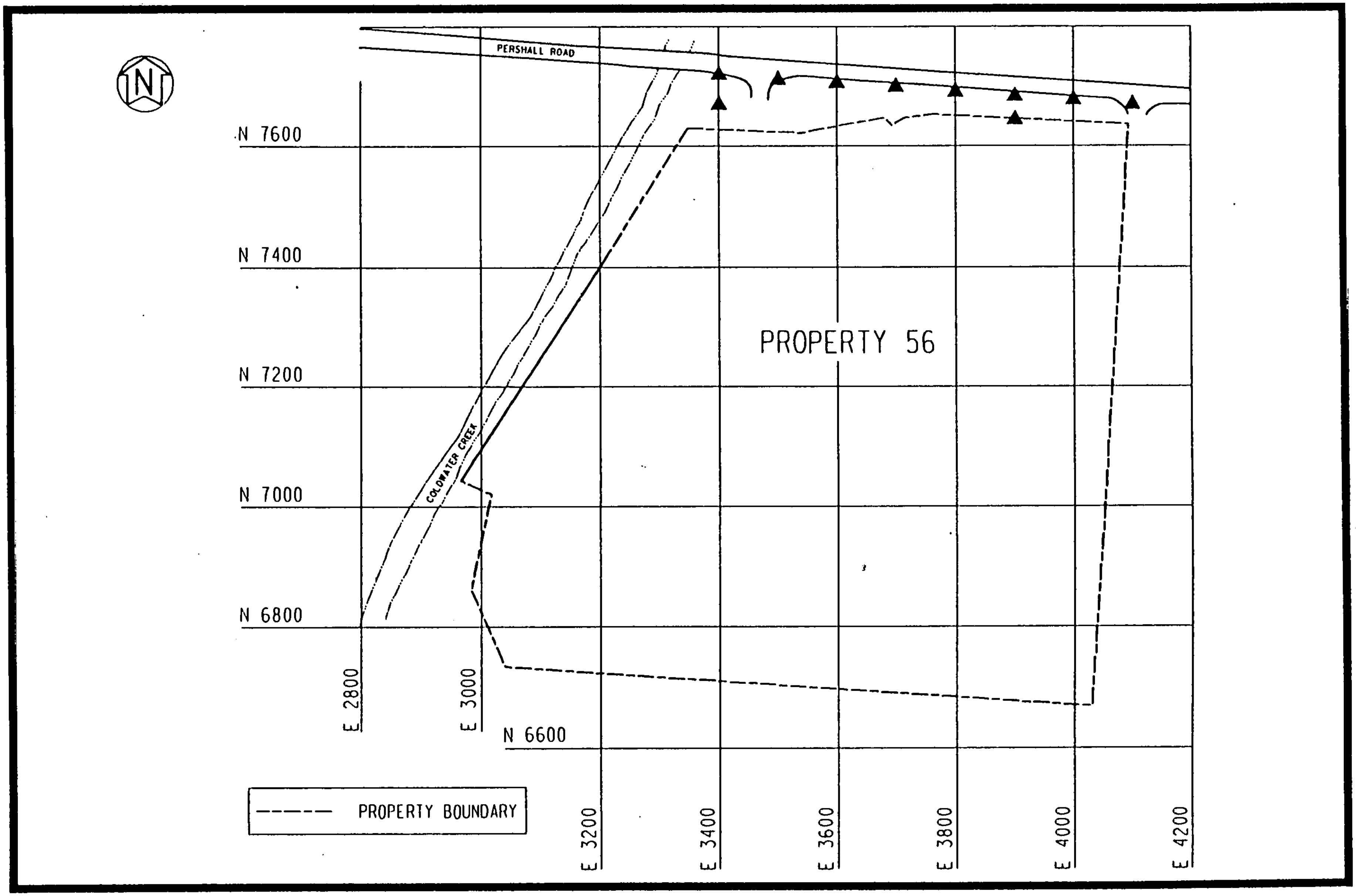


FIGURE 5-113 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 56

134F058 SAMPLE

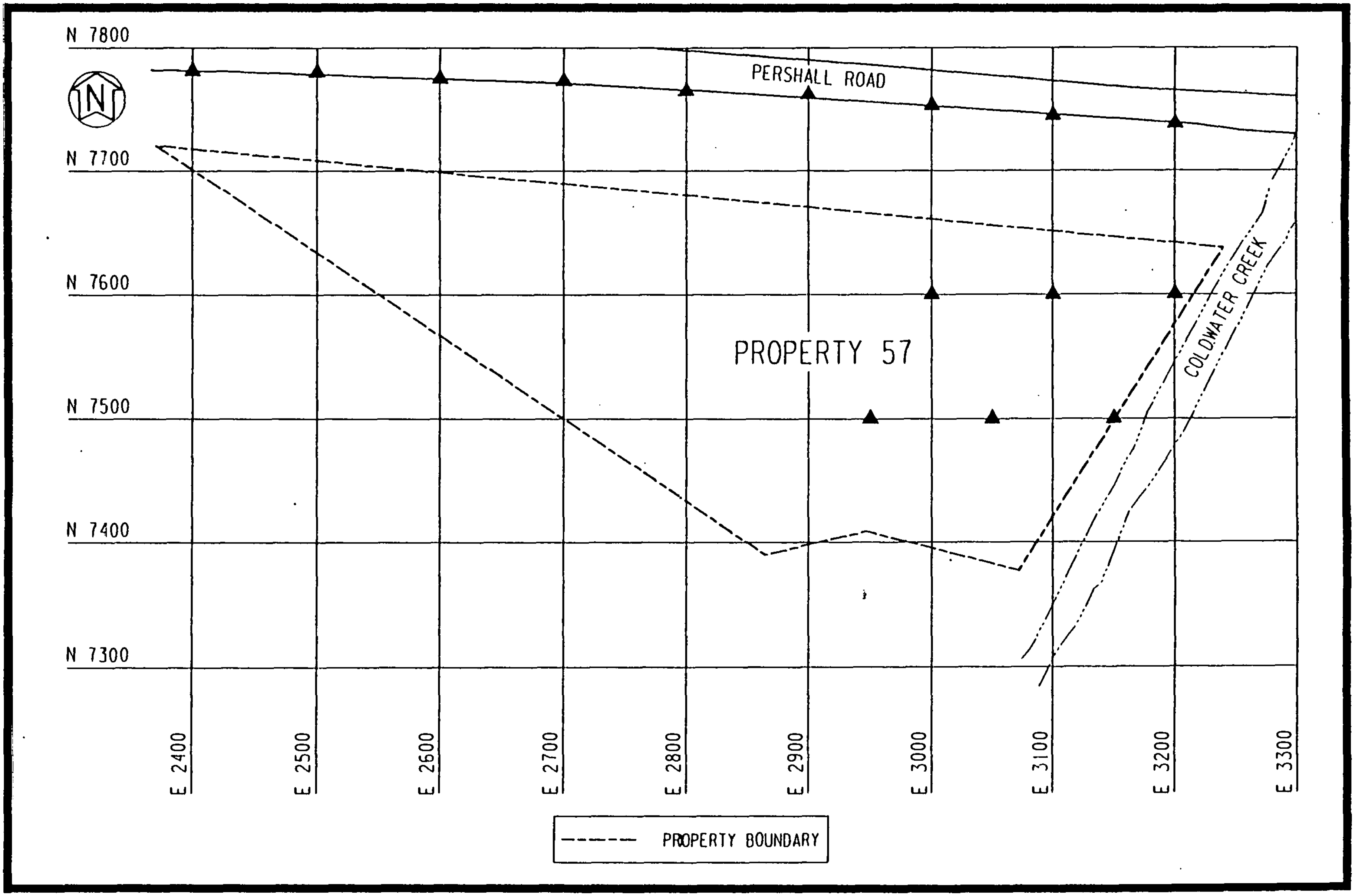


FIGURE 5-114 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 57

134F097 SAMPLE

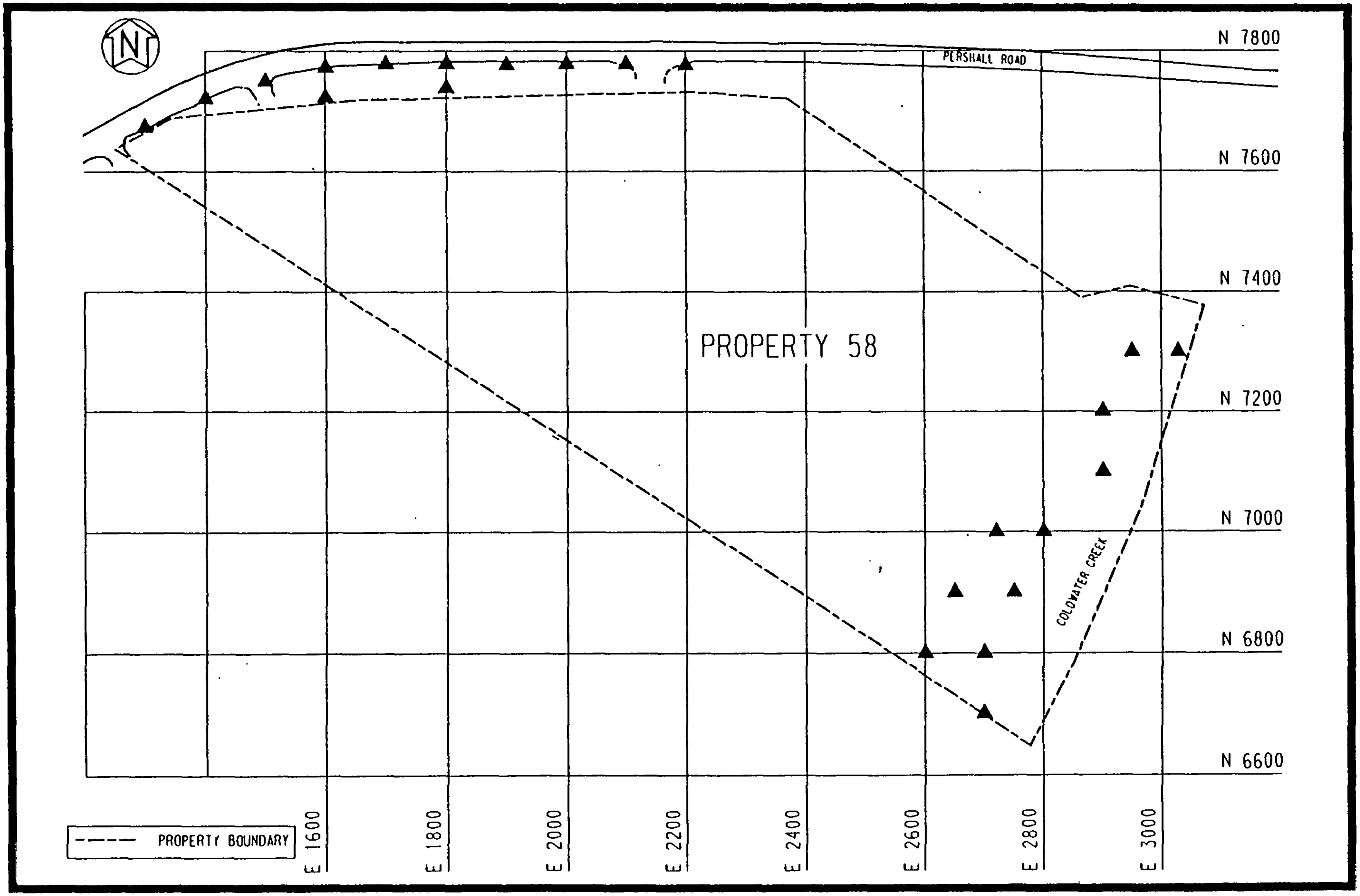


FIGURE 5-115 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 58

134F096 SAMPLE

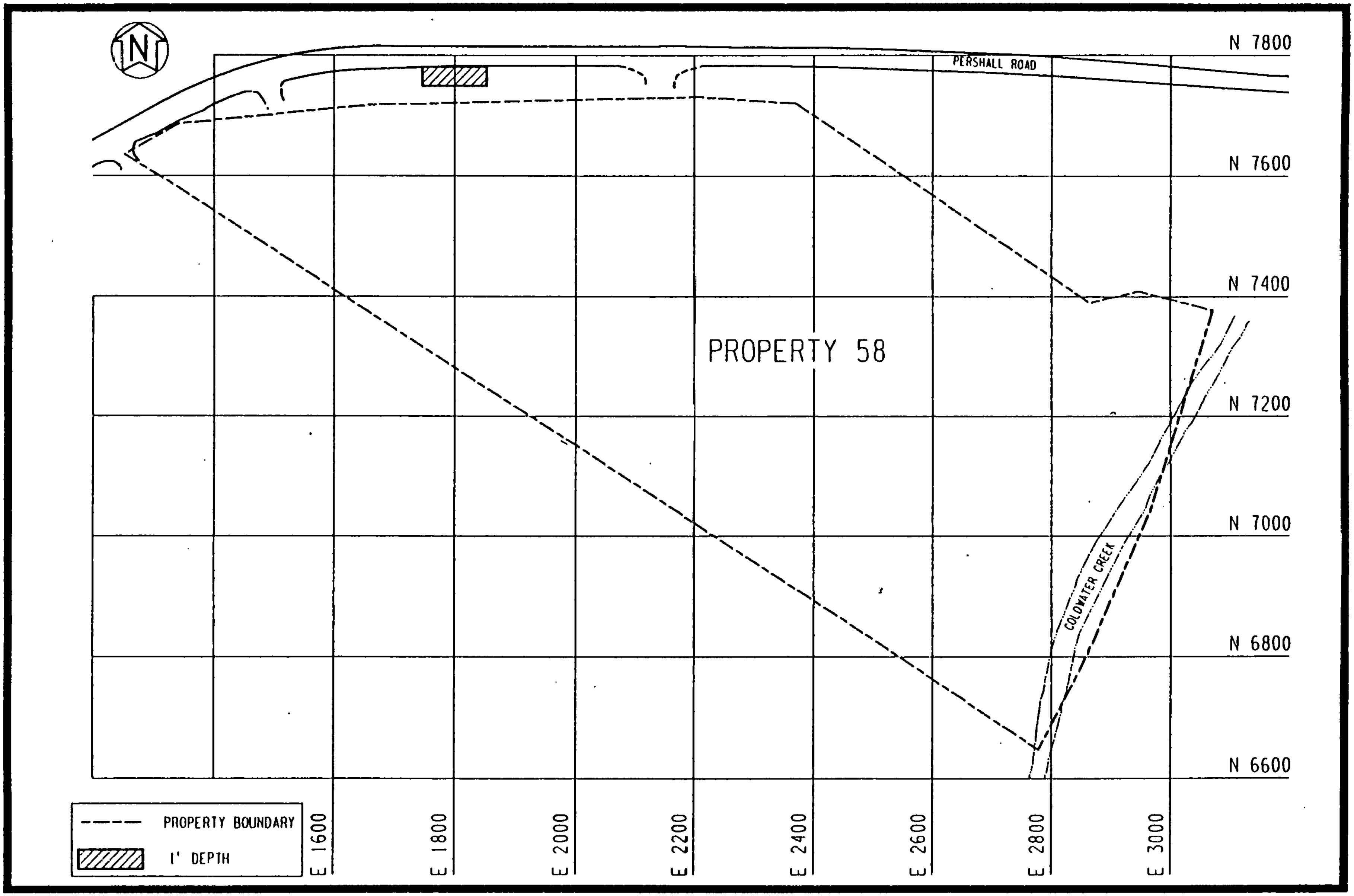


FIGURE 5-116 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT HAUL ROADS VICINITY PROPERTY 58

134F096 SOIL

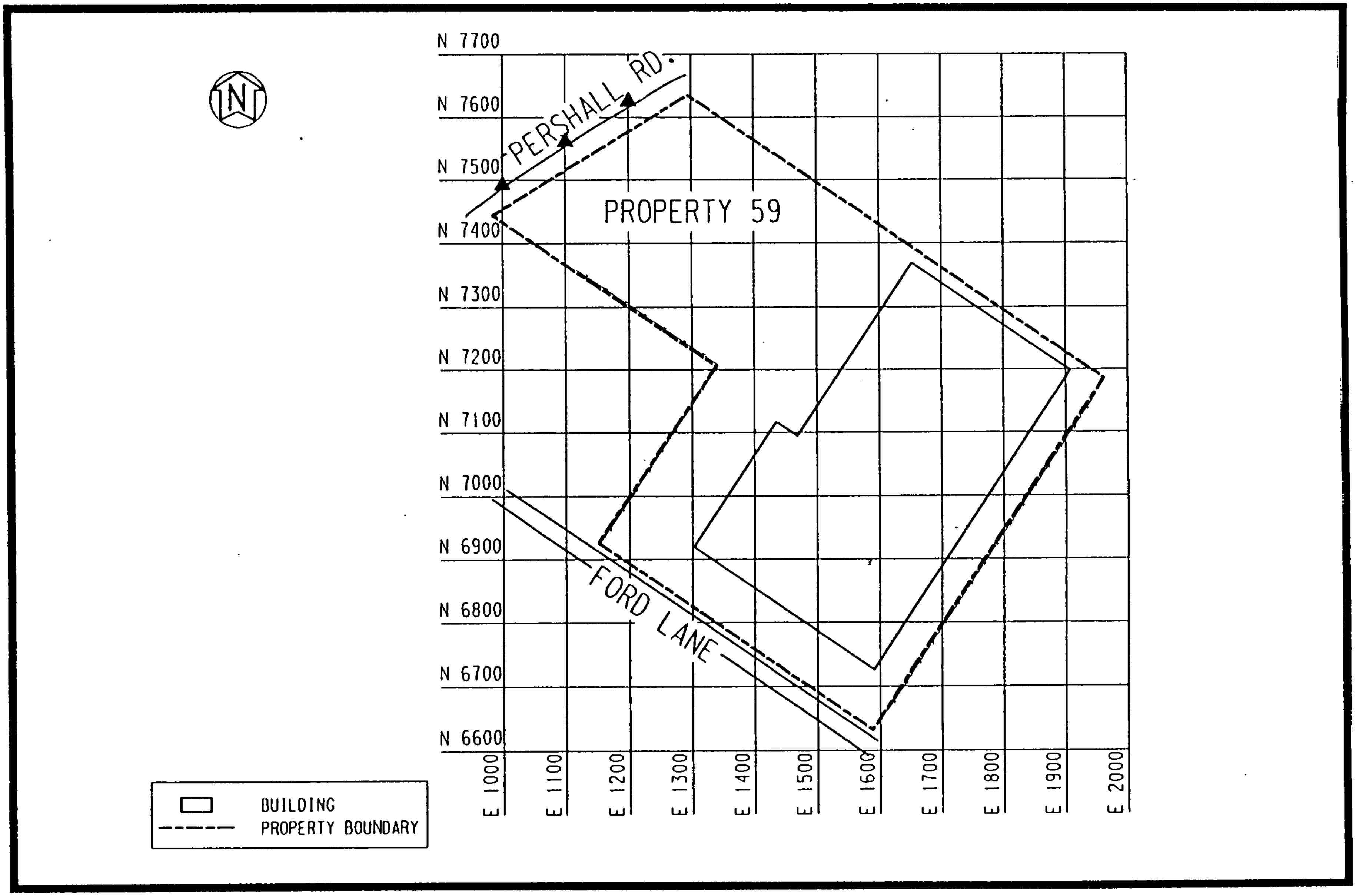


FIGURE 5-117 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 59

065.DGN SAMPLE

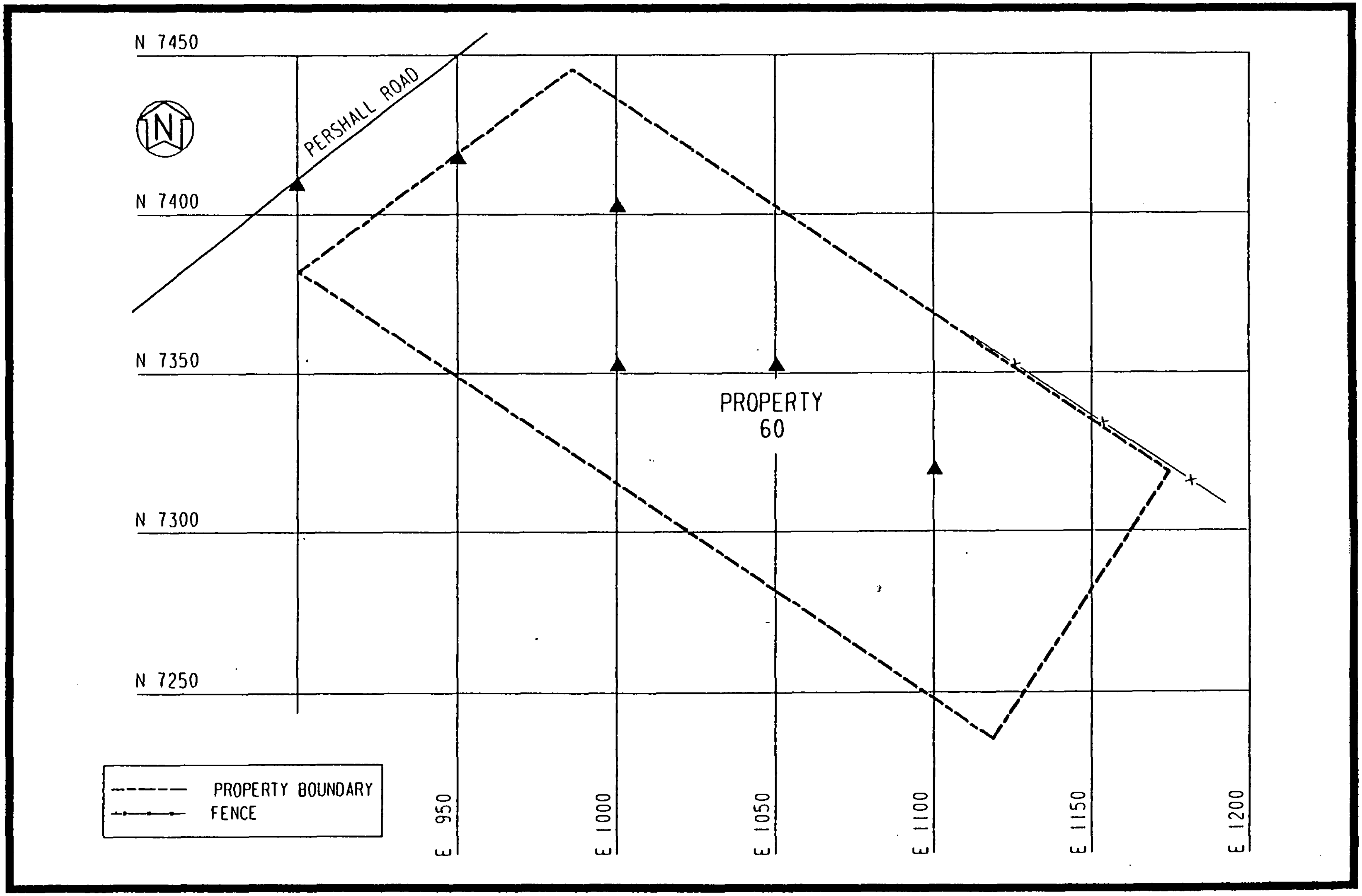


FIGURE 5-118 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 60

1 031.DGN SAMPLE

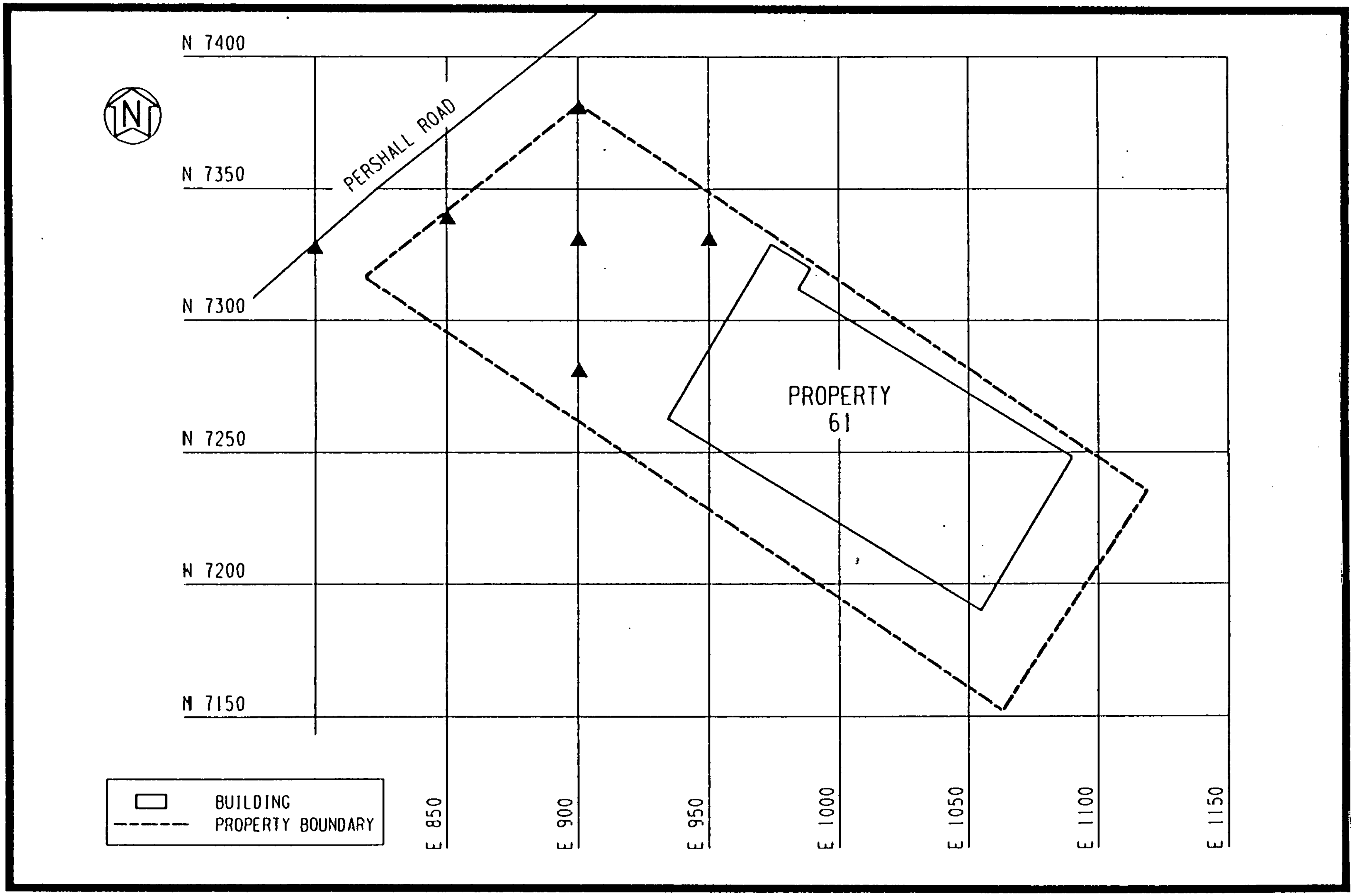


FIGURE 5-119 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 61

134F030.DGN SAMPLE

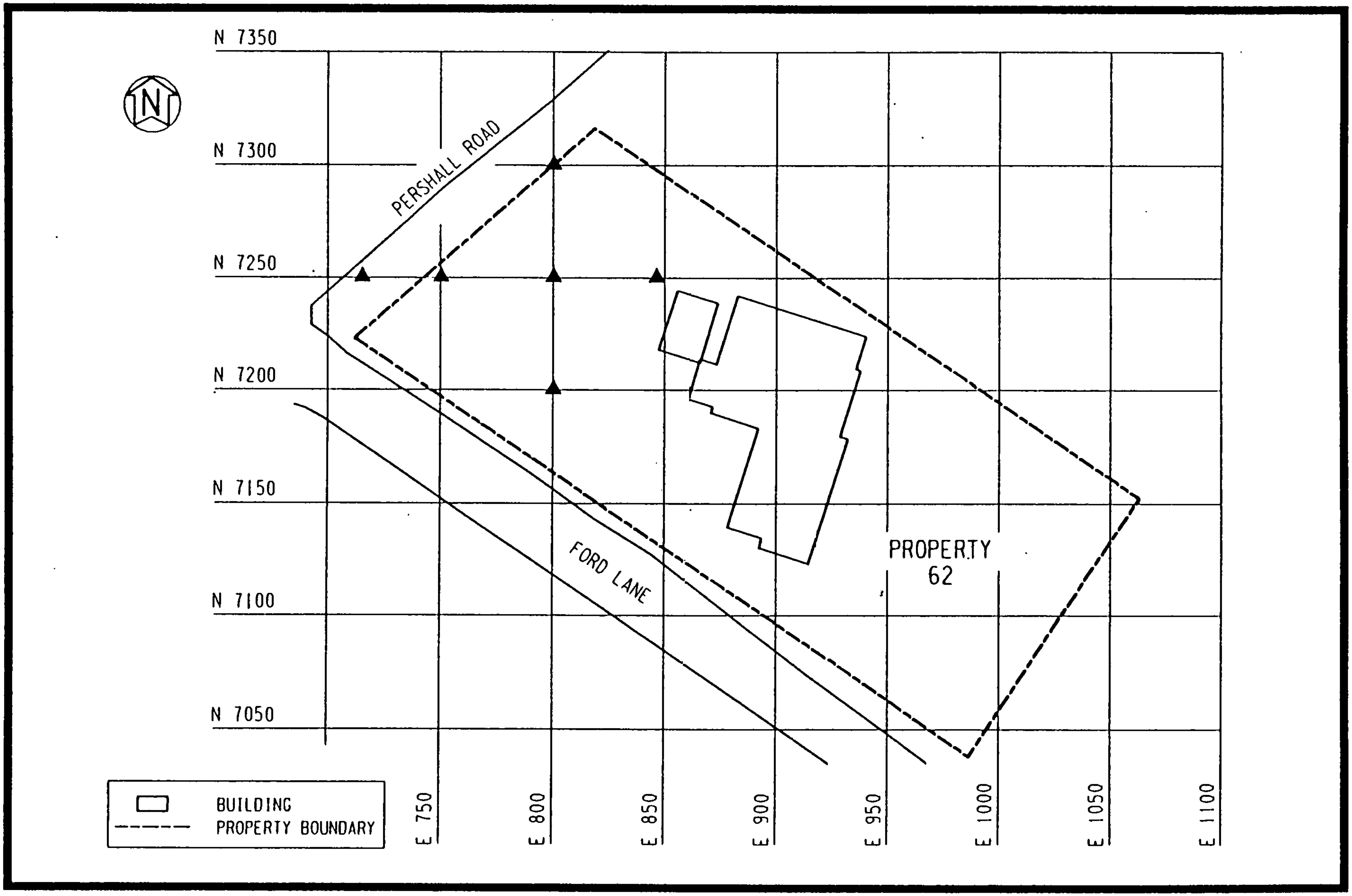


FIGURE 5-120 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 62

134F029.DGN SAMPLE

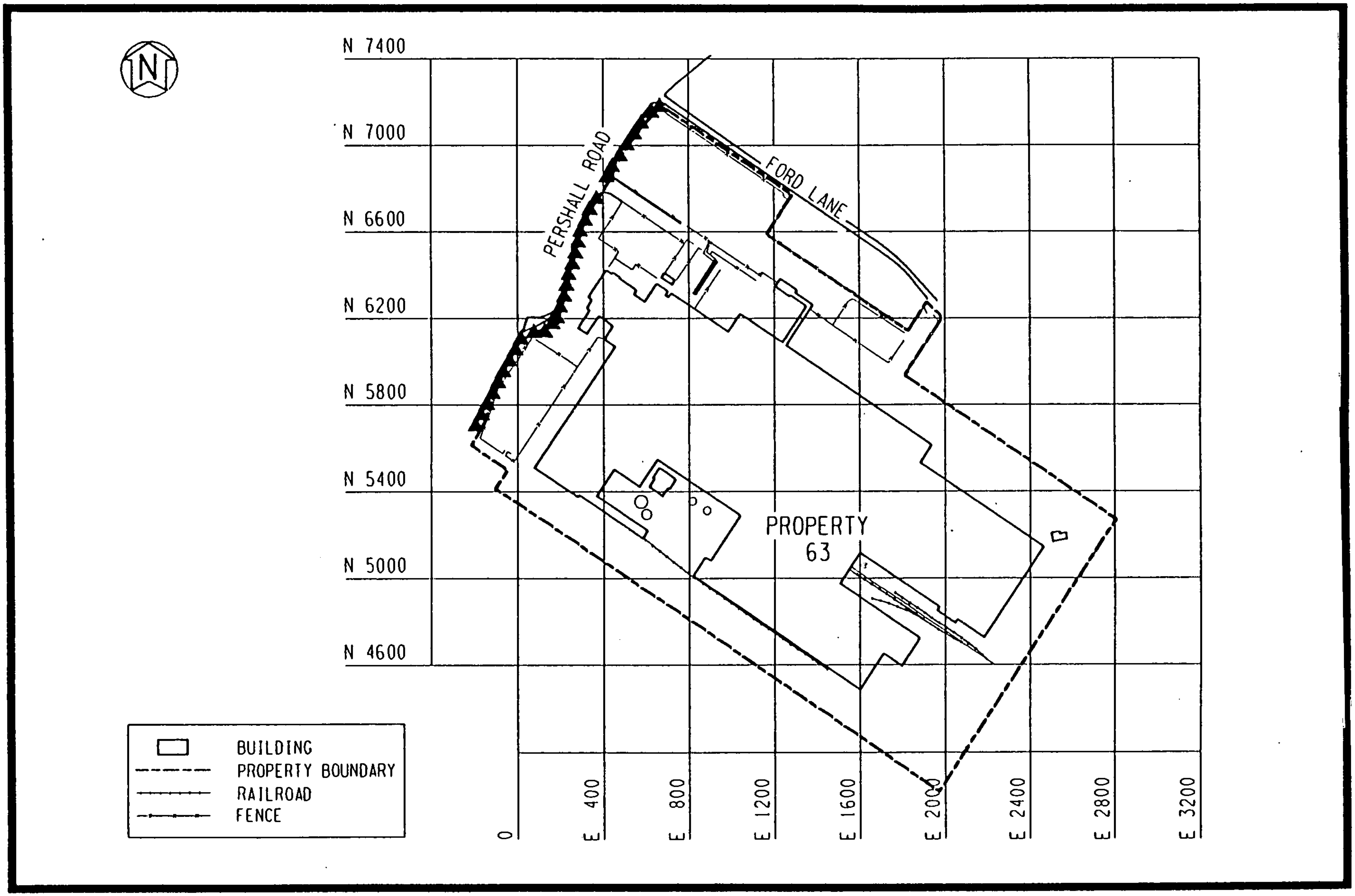
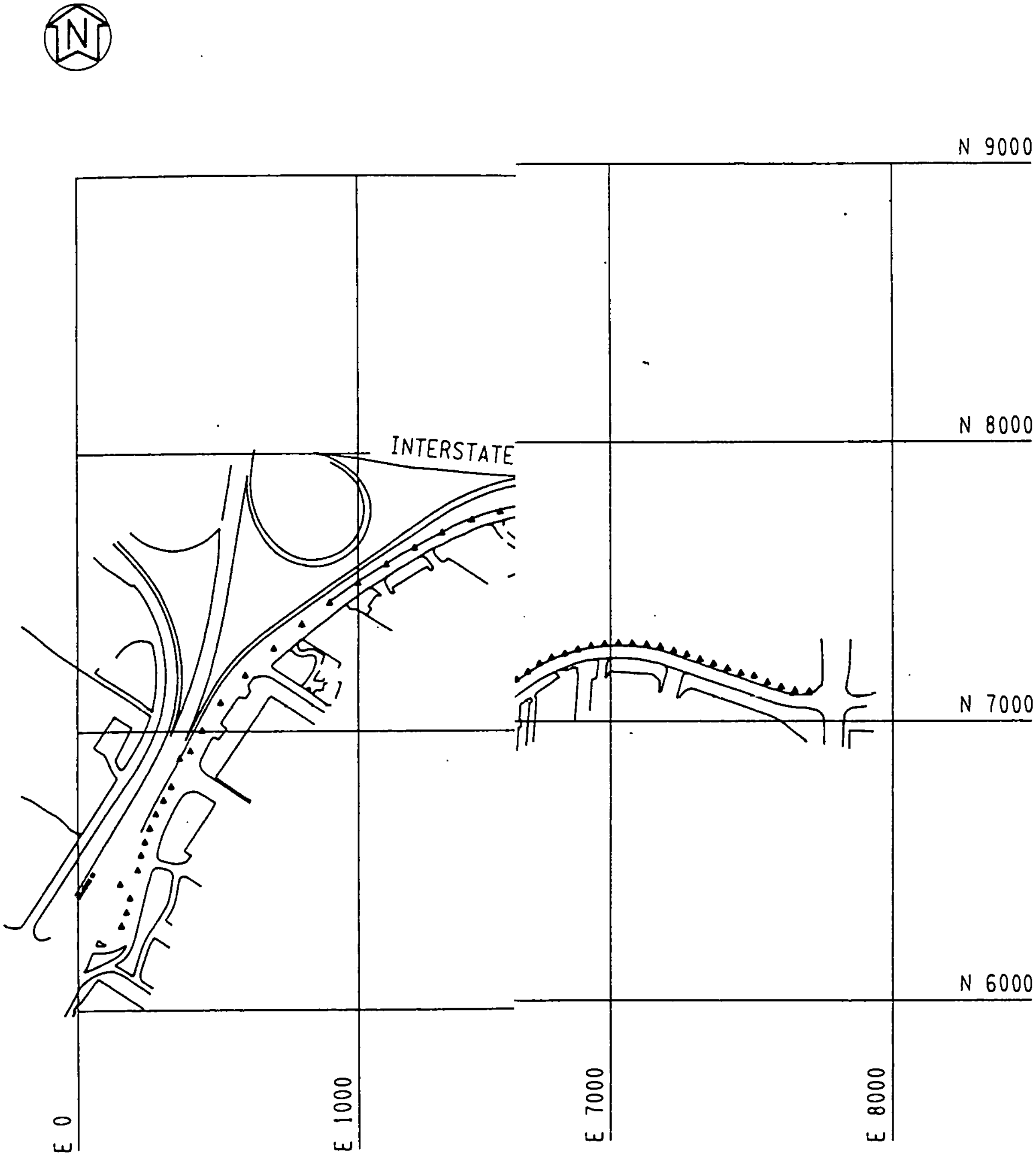


FIGURE 5-121 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF HAUL ROADS VICINITY PROPERTY 63

?6.DGN SAMPLE


N
N 9000
N 8000
N 7000
N 6000
INTERSTATE
E 0
E 1000
E 7000
E 8000

6.0 CHARACTERIZATION RESULTS FOR COLDWATER CREEK AND ASSOCIATED PROPERTIES

6.1 COLDWATER CREEK

A walkover gamma radiation survey was performed at all accessible areas of Coldwater Creek's banks and the associated vicinity properties. Near-surface gamma radiation measurements were not made at Coldwater Creek or its vicinity properties because results from the walkover survey indicated only a few isolated areas in which readings exceeded twice background radiation levels. Biased surface soil samples were collected from these areas. The Coldwater Creek vicinity properties are shown in Figure 1-7. It should be noted that the term "elevated concentrations" in this section refers to concentrations exceeding DOE guidelines.

Gamma logging was performed at most soil sampling locations even though the boreholes extended to a depth of only 0.3 m (1 ft). Detailed gamma logging results for Coldwater Creek are reported in Table 6-1. (Note: All data tables for this section are included in Volume III of this report.)

In 1986, surface sediment samples from the sides and center of Coldwater Creek, beginning at SLAPS and continuing downstream to HISS, were collected and analyzed. The data from these sample analyses indicated spotty contamination the entire distance; therefore, additional characterization activities were required. Sediment sampling locations from the 1986 characterization effort at the creek are shown in Figure 6-1.

Analytical results for sediment revealed areas with elevated concentrations of thorium-230. Uranium-238 concentrations ranged from 0.2 to 4.8 pCi/g. Concentrations of radium-226 ranged from 0.3 to 3.1 pCi/g. Concentrations of thorium-232 and thorium-230 ranged from less than 0.1 to 1.5 pCi/g and 0.5 to 110 pCi/g, respectively. Analytical results for sediment are provided in

Table 6-2. The sample identifier column indicates the number of feet downstream from SLAPS from which sediment samples were collected and whether the samples were taken from the right bank (R), left bank (L), or center (C) of the creek.

In 1987, the Coldwater Creek characterization included collecting and analyzing surface soil samples from the center of the creek (where accessible), 30.5 m (100 ft) to the east and west of this center line, and 61 m (200 ft) to the east and west of this center line. Soil samples were also collected from these same locations at the 15- to 30-cm (0.5- to 1-ft) depth and placed in archive. Samples were collected from the location of McDonnell Boulevard bridge over Coldwater Creek (approximately the north 1500 line) to Pershall Road (approximately the north 7750 line). Soil sampling locations are shown in Figure 6-2. Any sampling points located on an adjacent vicinity property are reported with their respective property in this section of the report.

Results from soil sample analyses indicate areas with elevated concentrations of radium-226 and thorium-230. Uranium-238 concentrations ranged from less than 2 to 78 pCi/g. Concentrations of radium-226 ranged from 0.6 to 71 pCi/g. Thorium-232 concentrations ranged from 0.7 to 5 pCi/g, and concentrations of thorium-230 ranged from 0.8 to 5,100 pCi/g. Analytical results for soil are provided in Table 6-3.

In 1989, the Coldwater Creek characterization included collecting and analyzing soil samples from the creek's banks at the water's edge for a distance of 2.4 km (1.5 mi) north of Pershall Road. Soil samples were collected from both sides of the creek at 30.5-m (100-ft) intervals for the first 0.8 km (0.5 mi) and at 61-m (200-ft) intervals for 1.6 km (1 mi) thereafter. Soil sampling locations are shown in Figure 6-3. Results from this sampling effort revealed 64 of the 175 samples exhibiting radionuclide concentrations exceeding the DOE remedial action guidelines. Further sample collection and analysis is required before boundaries of contamination at Coldwater Creek can be defined.

6.2 PROPERTY 1

Gamma logging was performed at the four sampling locations on Property 1. No significant variations in count rates were observed property. Gamma logging results are reported in Table 6-4.

Soil sampling locations on Property 1 are shown in Figure 6-4. Analytical results for soil (Table 6-5) revealed one location with an elevated concentration of thorium-230. All uranium-238 concentrations were below 14 pCi/g. Radium-226 concentrations ranged from 0.8 to 2.7 pCi/g. Concentrations of thorium-232 and thorium-230 ranged from less than 0.7 to 5 pCi/g and 1.4 to 38 pCi/g, respectively.

Further soil sampling is required to determine the areas and depths of contamination at Property 1. This sampling will occur prior to remedial action.

6.3 PROPERTY 2

Gamma logging was performed at seven of the eight sampling locations on Property 2. One location was a biased surface soil sample location. No significant variations in count rates were observed as gamma logging progressed at the sampling locations on this property. Gamma logging results are reported in Table 6-6.

Soil sampling locations on Property 2 are shown in Figure 6-5. Analytical results for soil (Table 6-7) revealed one location exhibiting an elevated concentration of thorium-230. All uranium-238 concentrations were below 20 pCi/g. Radium-226 concentrations ranged from 0.7 to 3 pCi/g. Concentrations of thorium-232 ranged from 0.9 to 4 pCi/g, and thorium-230 concentrations ranged from less than 1 to 7.7 pCi/g. Areas and depths of radioactive contamination at Property 2 are shown in Figure 6-6.

6.4 PROPERTY 3

Gamma logging was performed at 12 of the sampling locations on Property 3. The other soil samples collected from Property 3 were collected at a later date to assist in identifying the boundaries of radioactive contamination, and gamma logging was not performed in these boreholes. No significant variations in count rates were observed as gamma logging progressed at the sampling locations on this property. Gamma logging results are reported in Table 6-8.

Soil sampling locations on Property 3 are shown in Figure 6-7. Analytical results for soil (Table 6-9) revealed three areas with elevated concentrations of thorium-230. All uranium-238 concentrations were below 16 pCi/g. Radium-226 concentrations ranged from 0.3 to 4 pCi/g. Thorium-232 concentrations ranged from 0.8 to 4 pCi/g. Concentrations of thorium-230 ranged from less than 0.8 to 79 pCi/g.

Further soil sampling is required to establish boundaries of contamination at Property 3. This sampling will occur prior to remedial action.

6.5 PROPERTY 4

Gamma logging was performed at nine of the sampling locations on Property 4. No significant variations in count rates were observed as gamma logging progressed at the sampling locations on this property. One additional soil sample was collected from Property 4 at a later date. Gamma logging was not performed at this sampling location. Gamma logging results are reported in Table 6-10.

Soil sampling locations on Property 4 are shown in Figure 6-8. Analytical results for soil (Table 6-11) revealed no areas in which radionuclide concentrations exceeded the DOE guidelines for surface contamination. All uranium-238 concentrations were below 11 pCi/g. Radium-226 concentrations ranged from 0.6 to 1.8 pCi/g. Thorium-232 and thorium-230 concentrations ranged from 0.9 to 3 pCi/g and less than 0.6 to 5.1 pCi/g, respectively.

6.6 PROPERTY 5

Gamma logging was performed at one sampling location on Property 5. The other soil samples collected from Property 5 were collected at a later date to assist in identifying the boundaries of radioactive contamination, and gamma logging was not performed in these boreholes. No significant gamma-emitting contamination was detected at the one sampling location on this property. Gamma logging results are reported in Table 6-12.

The soil sampling locations on Property 5 are shown in Figure 6-9. Analytical results for soil revealed that thorium-230 was present in above-guideline concentrations. All uranium concentrations were below 16 pCi/g. Radium-226 concentrations ranged from 0.9 to 3 pCi/g. Thorium-232 concentrations ranged from 0.9 to 4 pCi/g, and concentrations of thorium-230 ranged from less than 0.7 to 61 pCi/g. Results for these radionuclides are reported in Table 6-13.

Further soil sampling is required to determine the boundaries of contamination at Property 5. This sampling will occur prior to remedial action.

6.7 PROPERTY 6

Gamma logging was performed at the three sampling locations on Property 6. No significant variations in count rates were observed as gamma logging progressed at the sampling locations on this property. Gamma logging results are reported in Table 6-14.

Soil sampling locations on Property 6 are shown in Figure 6-10. Analytical results for soil (Table 6-15) revealed no areas in which radionuclide concentrations exceeded the DOE guidelines for surface contamination. All uranium-238 concentrations were below 13 pCi/g.

Radium-226 concentrations ranged from 1.2 to 1.7 pCi/g. Concentrations of thorium-232 and thorium-230 ranged from less than 0.4 to 3 pCi/g and 1.1 to 5.2 pCi/g, respectively.

6.8 PROPERTY 7

Gamma logging was performed at the five sampling locations on Property 7. No significant variations in count rates were observed as gamma logging progressed at the sampling locations on this property. Gamma logging results are reported in Table 6-16.

Soil sampling locations on Property 7 are shown in Figure 6-11. Analytical results for soil (Table 6-17) revealed no areas in which radionuclide concentrations exceeded the DOE guidelines for surface contamination. All uranium-238 concentrations were below 6 pCi/g. Concentrations of radium-226 ranged from 0.9 to 2.2 pCi/g. Thorium-232 concentrations ranged from less than 0.3 to 3 pCi/g, and thorium-230 concentrations ranged from 0.9 to 3.7 pCi/g.

6.9 PROPERTY 8

Gamma logging was performed at four sampling locations on Property 8. The other soil samples collected from Property 8 were collected at a later date to assist in identifying the boundaries of radioactive contamination, and gamma logging was not performed in these boreholes. No significant variations in count rates were observed as gamma logging progressed at the four sampling locations on this property. Gamma logging results are reported in Table 6-18.

Soil sampling locations on Property 8 are shown in Figure 6-12. Analytical results for soil (Table 6-19) revealed two areas with elevated concentrations of thorium-230. All uranium-238 concentrations were below 11 pCi/g. Radium-226 concentrations ranged from 0.4 to 2.8 pCi/g. Concentrations of thorium-232 and thorium-230 ranged from less than 1 to 4 pCi/g and 1.3 to 23 pCi/g, respectively.

Further soil sampling is required to determine the boundaries of radioactive contamination at Property 8. This sampling will occur prior to remedial action.

6.10 PROPERTY 9

Gamma logging was performed at one sampling location on Property 9. The other soil samples collected from Property 9 were collected at a later date to assist in identifying boundaries of radioactive contamination, and gamma logging was not performed in these boreholes. No significant gamma-emitting contamination was detected. Gamma logging results are reported in Table 6-20.

The soil sampling locations on Property 9 are shown in Figure 6-13. Analytical results for soil (Table 6-21) revealed an elevated concentration of thorium-230 in one area sampled. Uranium-238 concentrations were below 10 pCi/g. Radium-226 concentrations ranged from less than 0.5 to 2.3 pCi/g. Concentrations of thorium-232 and thorium-230 for Property 9 ranged from less than 1 to 3 and 1 to 6.5 pCi/g, respectively.

Further soil sampling is required to determine the boundaries of contamination at Property 9. This sampling will occur prior to remedial action.

6.11 PROPERTY 10

Gamma logging was performed at one sampling location on Property 10. The other soil samples collected from Property 10 were collected at a later date to assist in identifying the boundaries of radioactive contamination, and gamma logging was not performed in these boreholes. No significant gamma-emitting contamination was detected. Gamma logging results are reported in Table 6-22.

The soil sampling locations on Property 10 are shown in Figure 6-14. Analytical results for soil (Table 6-23) revealed no elevated levels of the radionuclides above DOE guidelines. Uranium-238 concentrations were less than 11 pCi/g. Radium-226 concentrations ranged from 1.6 to 1.8 pCi/g. Concentrations of thorium-232 and thorium-230 ranged from 1.7 to 3 and 1.5 to 5.7 pCi/g, respectively.

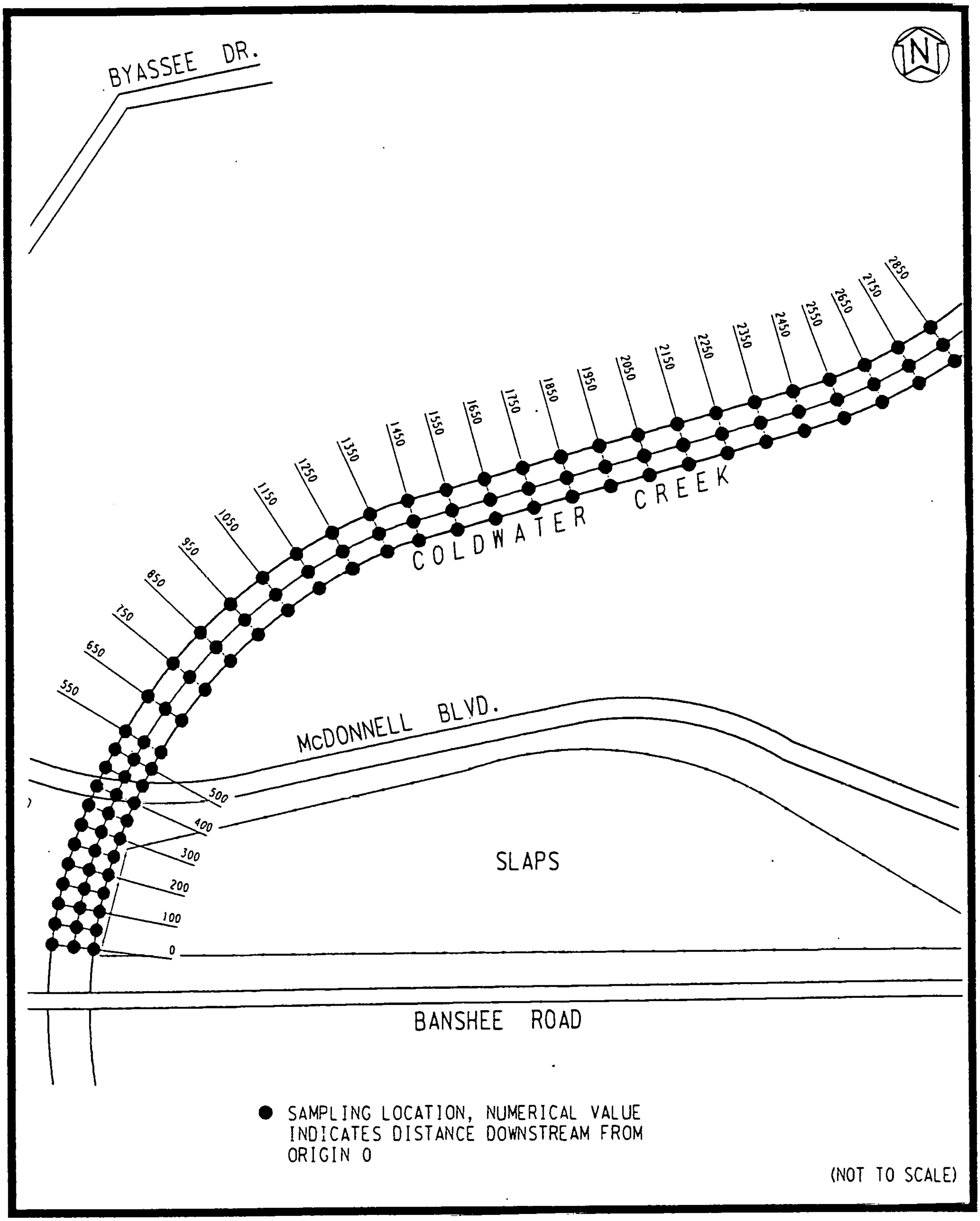


FIGURE 6-1 SURFACE SEDIMENT SAMPLING LOCATIONS FOR 1986 RADIOLOGICAL CHARACTERIZATION OF COLDWATER CREEK

S34WMS60.DGN FIG4

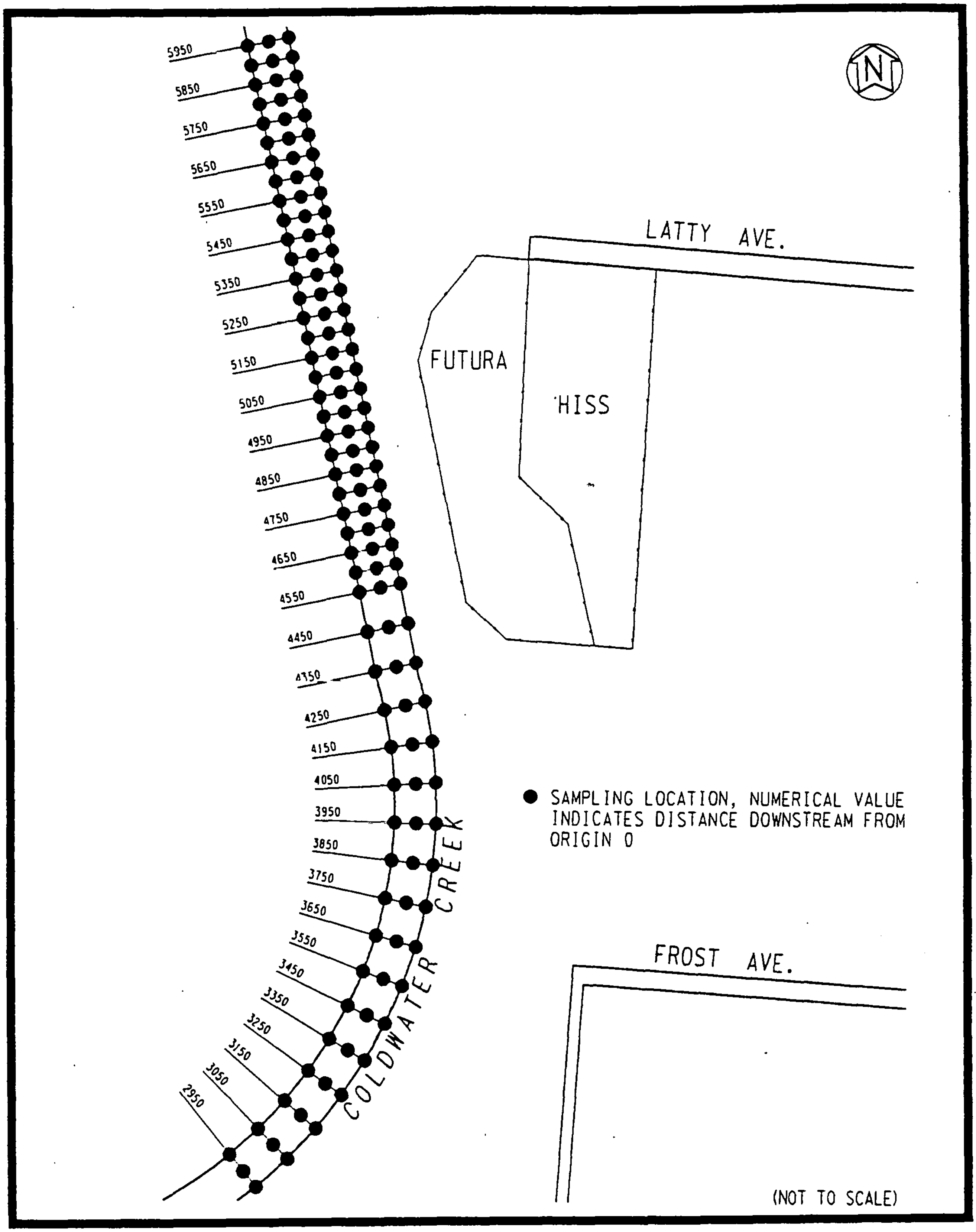


FIGURE 6-1 SURFACE SEDIMENT SAMPLING LOCATIONS FOR 1986 RADIOLOGICAL CHARACTERIZATION OF COLDWATER CREEK (CONT.)

S34WMS61.DGN

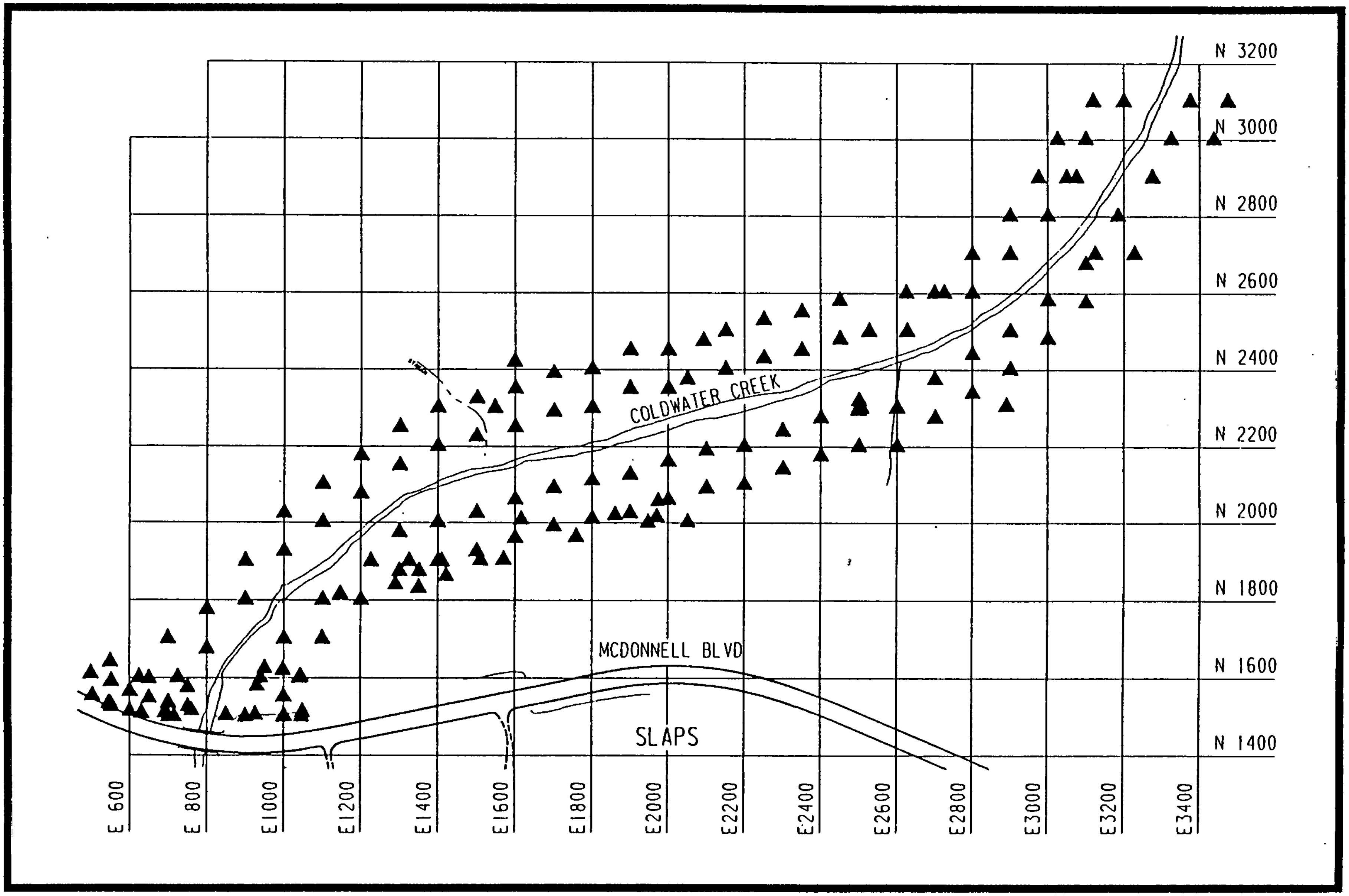


FIGURE 6-2 SOIL SAMPLING LOCATIONS FOR 1987 RADIOLOGICAL CHARACTERIZATION OF COLDWATER CREEK

S34WMS62.DGN

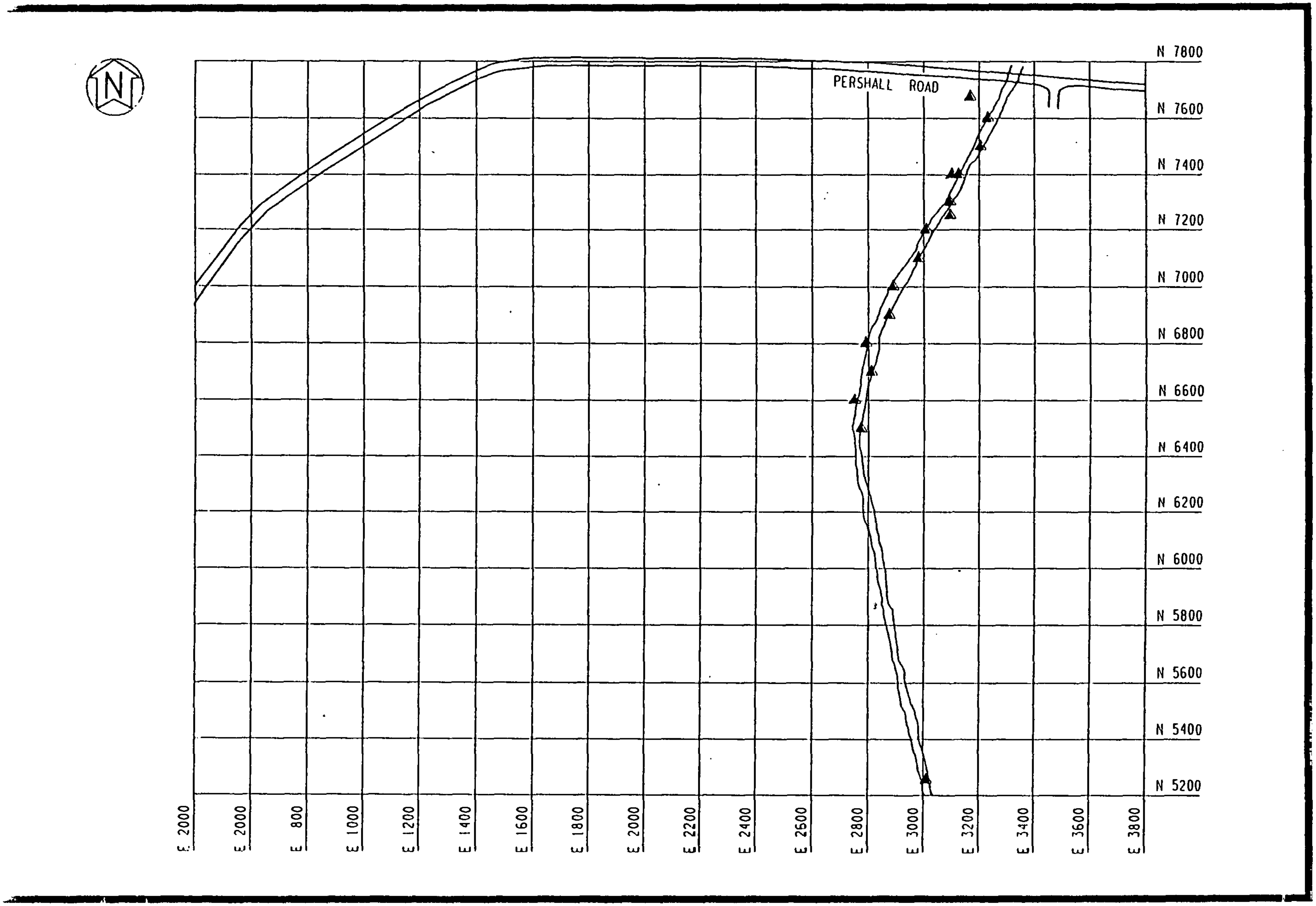


FIGURE 6-2 SOIL SAMPLING LOCATIONS FOR 1987 RADIOLOGICAL CHARACTERIZATION OF COLDWATER CREEK (CONT.)

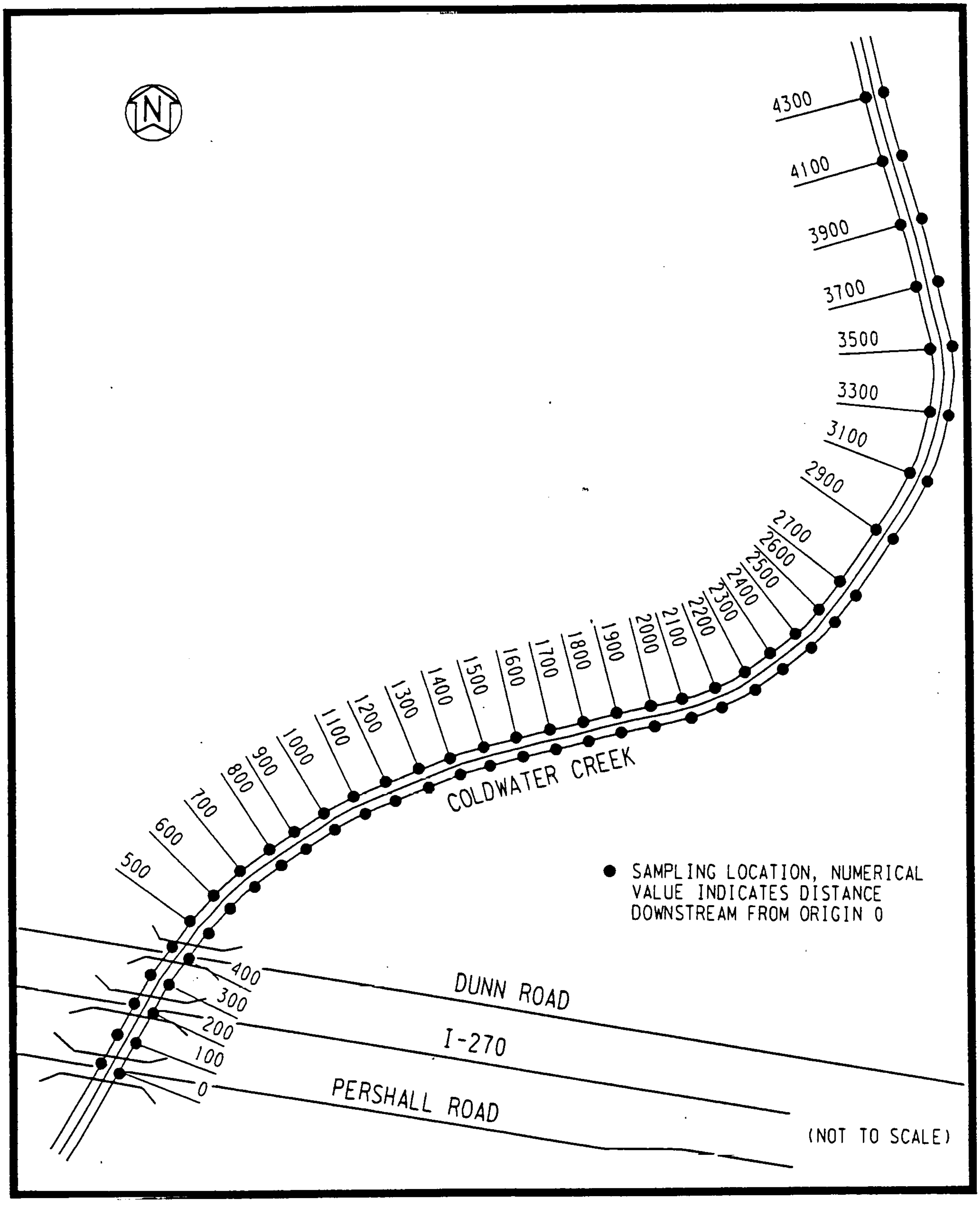


FIGURE 6-3 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF 1.5 MILES OF COLDWATER CREEK NORTH OF PERSHALL ROAD

F125.DGN

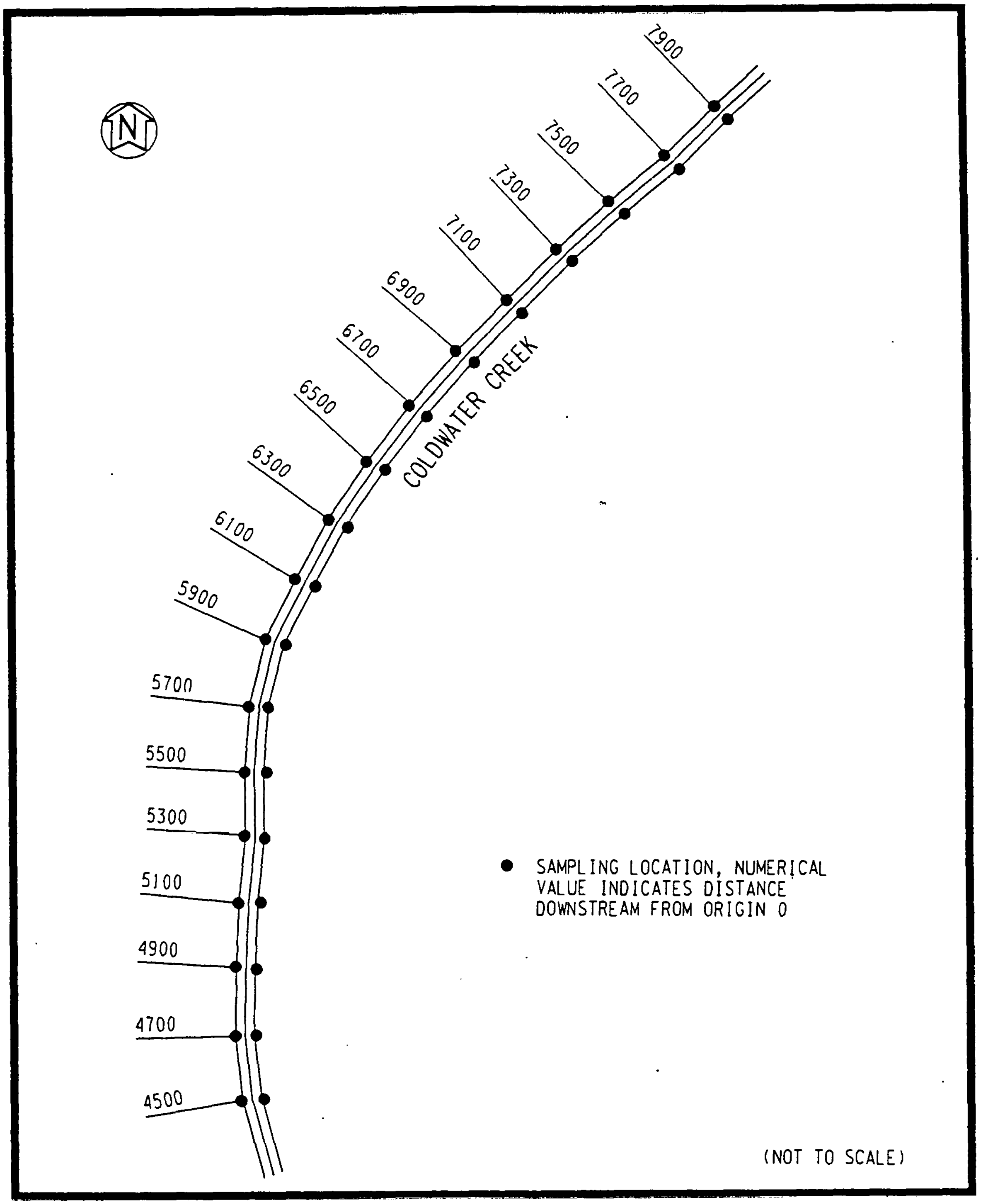


FIGURE 6-3 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF 1.5 MILES OF COLDWATER CREEK NORTH OF PERSHALL ROAD (CONT.)

134F126.DGN

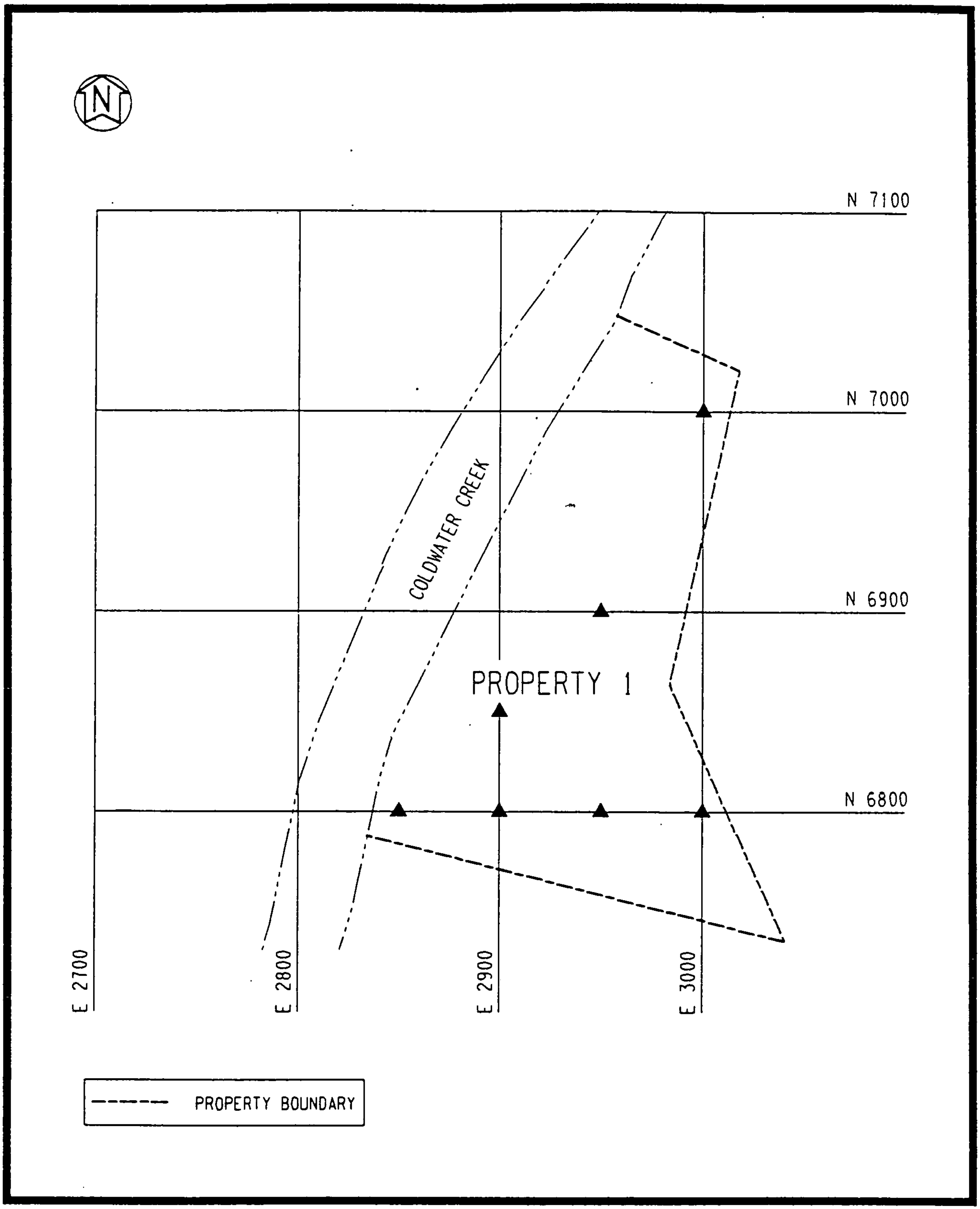


FIGURE 6-4 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF PROPERTY 1 ON COLDWATER CREEK

134F106.DGN

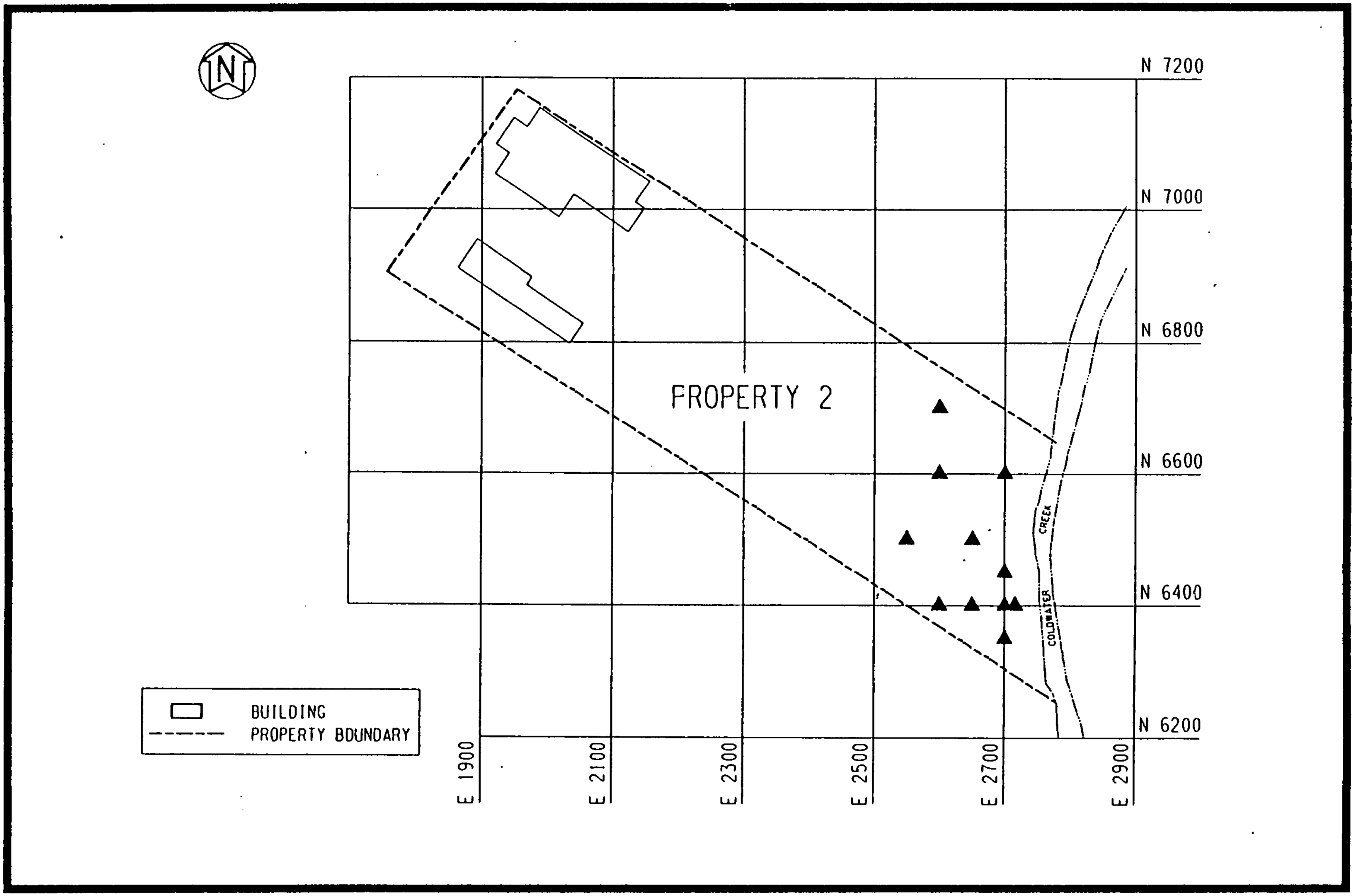


FIGURE 6-5 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF PROPERTY 2 ON COLDWATER CREEK

134F107.DGN

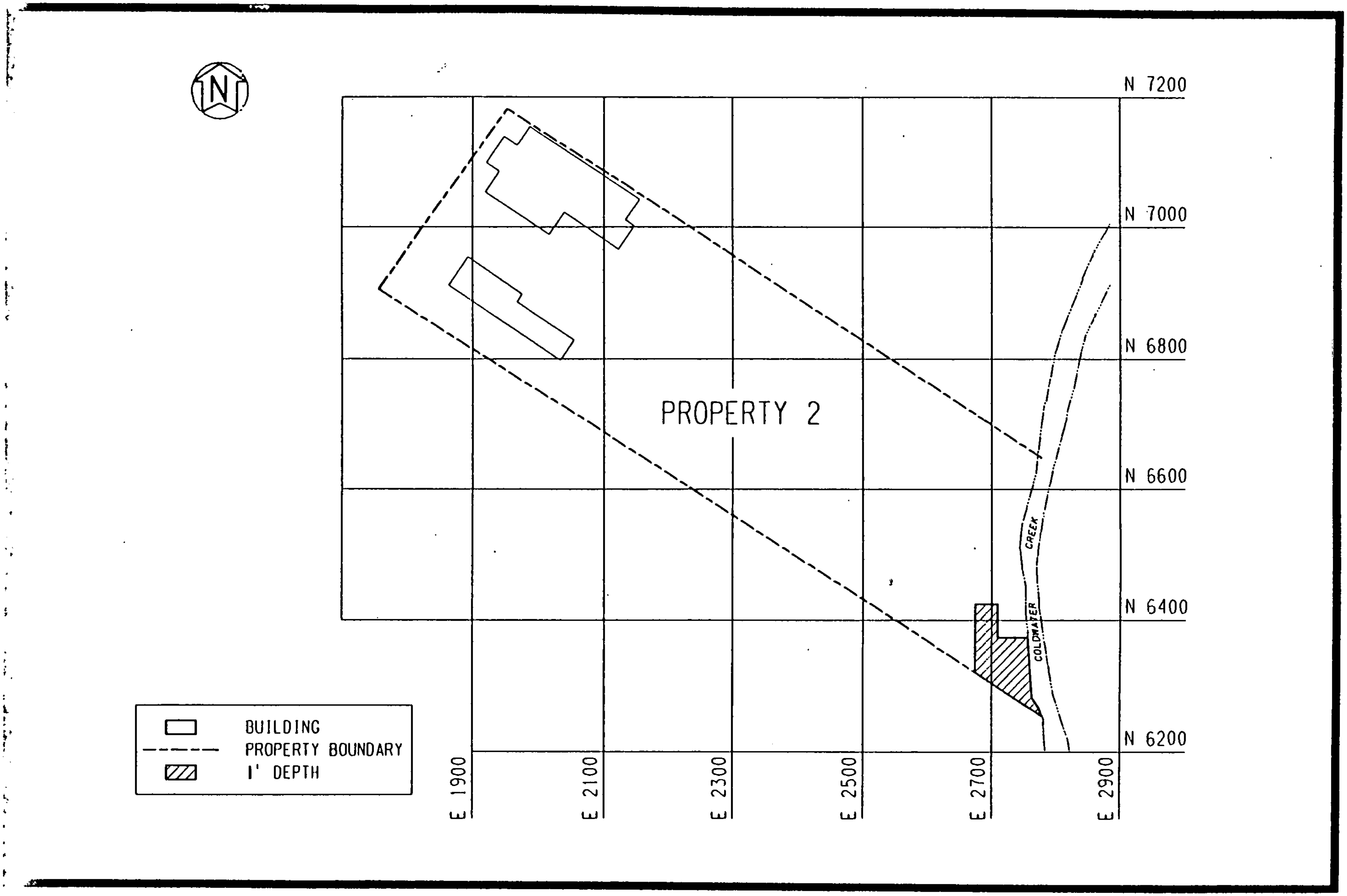


FIGURE 6-6 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT PROPERTY 2 ON COLDWATER CREEK

13 ..7.DGN

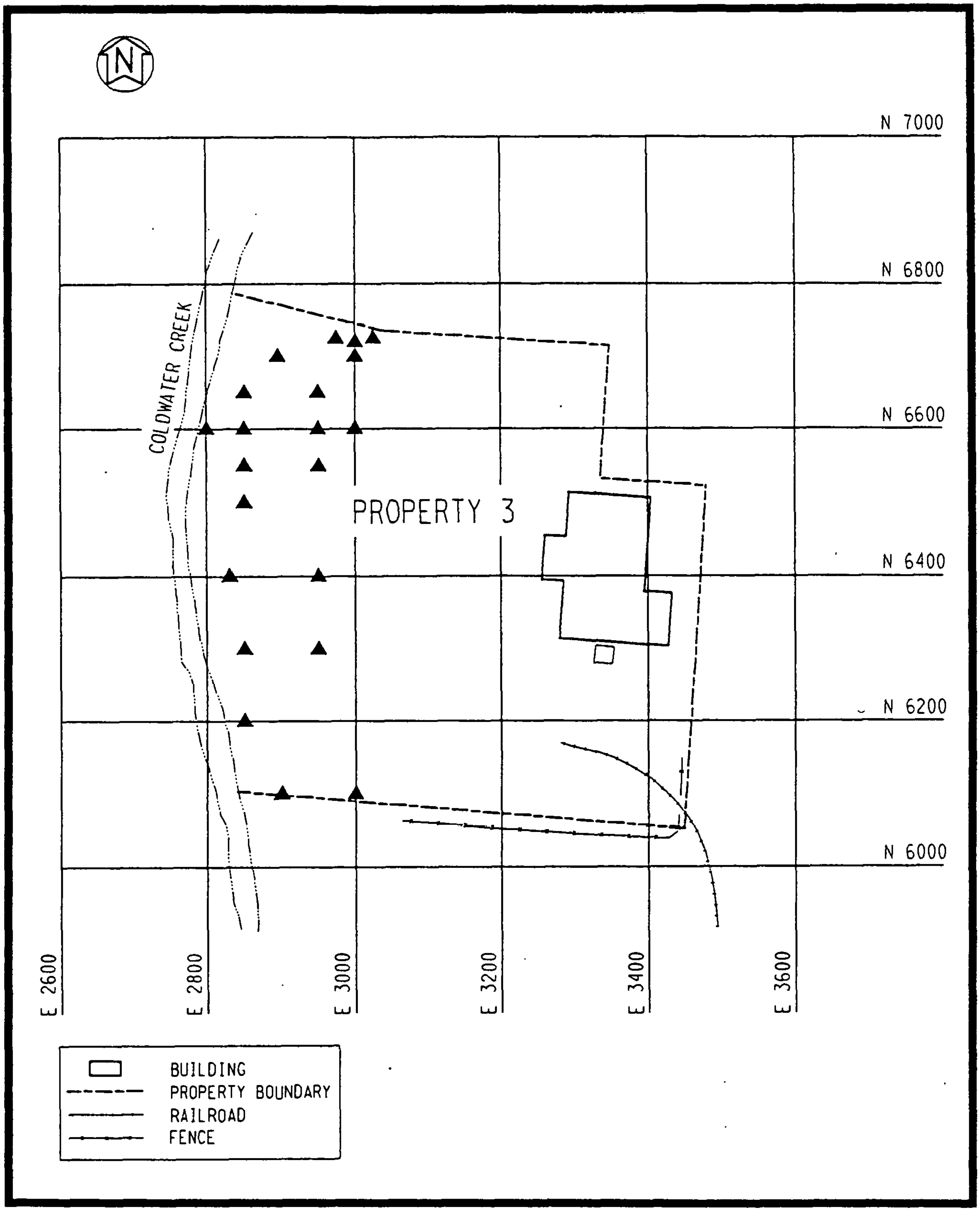


FIGURE 6-7 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF PROPERTY 3 ON COLDWATER CREEK

134F108.DGN

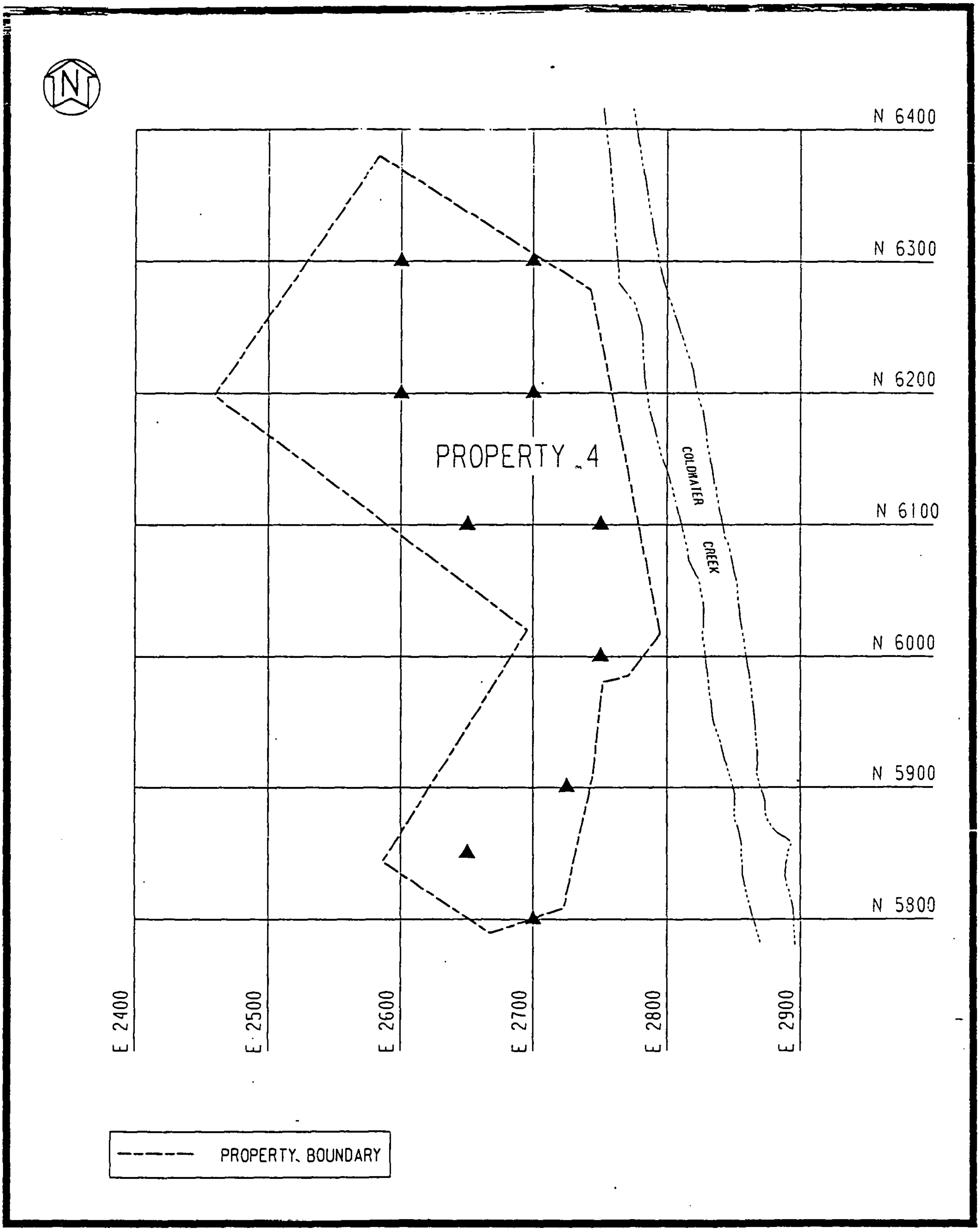


FIGURE 6-8 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF PROPERTY 4 ON COLDWATER CREEK

134F109.DGN

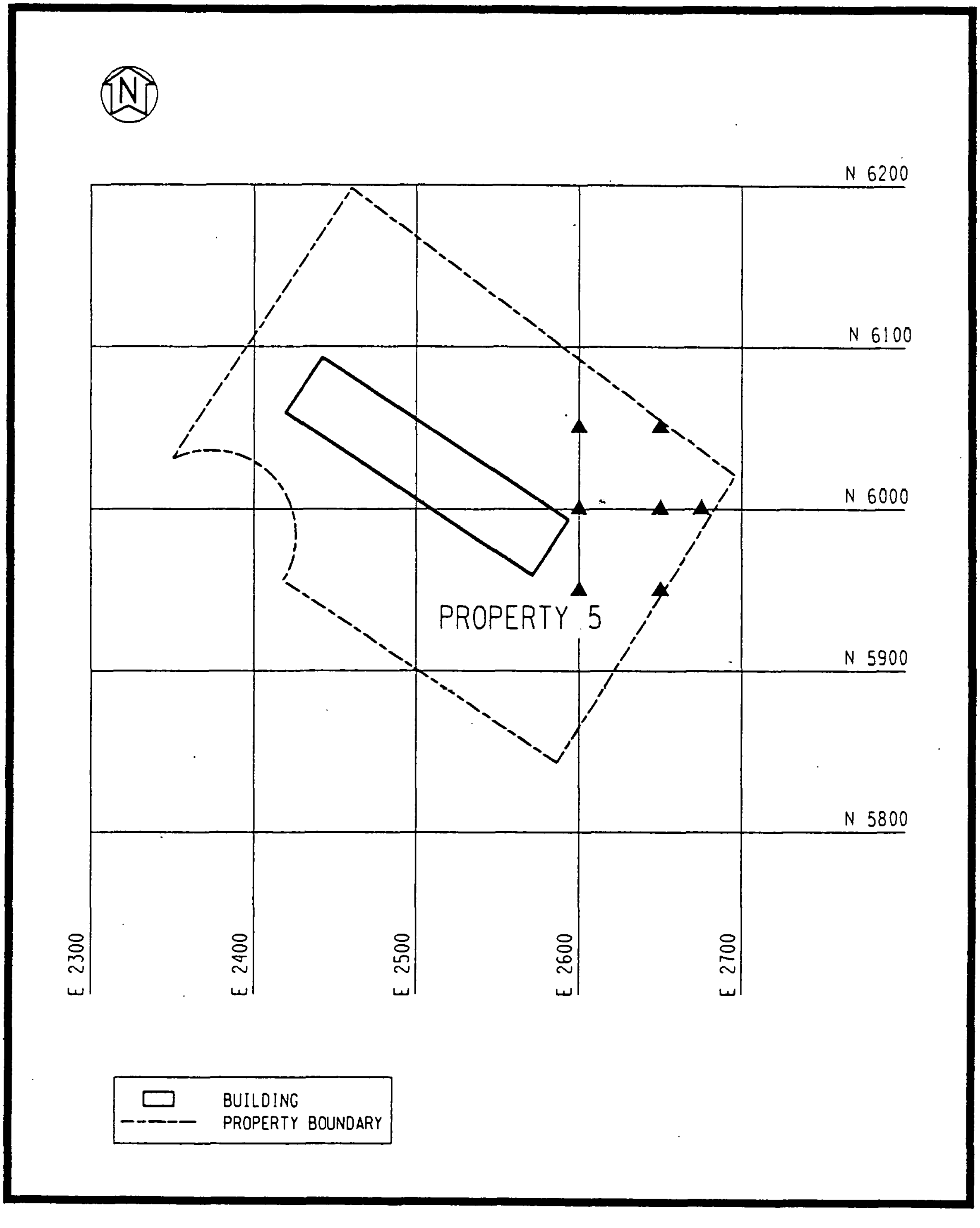


FIGURE 6-9 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF PROPERTY 5 ON COLDWATER CREEK

134F110.DGN

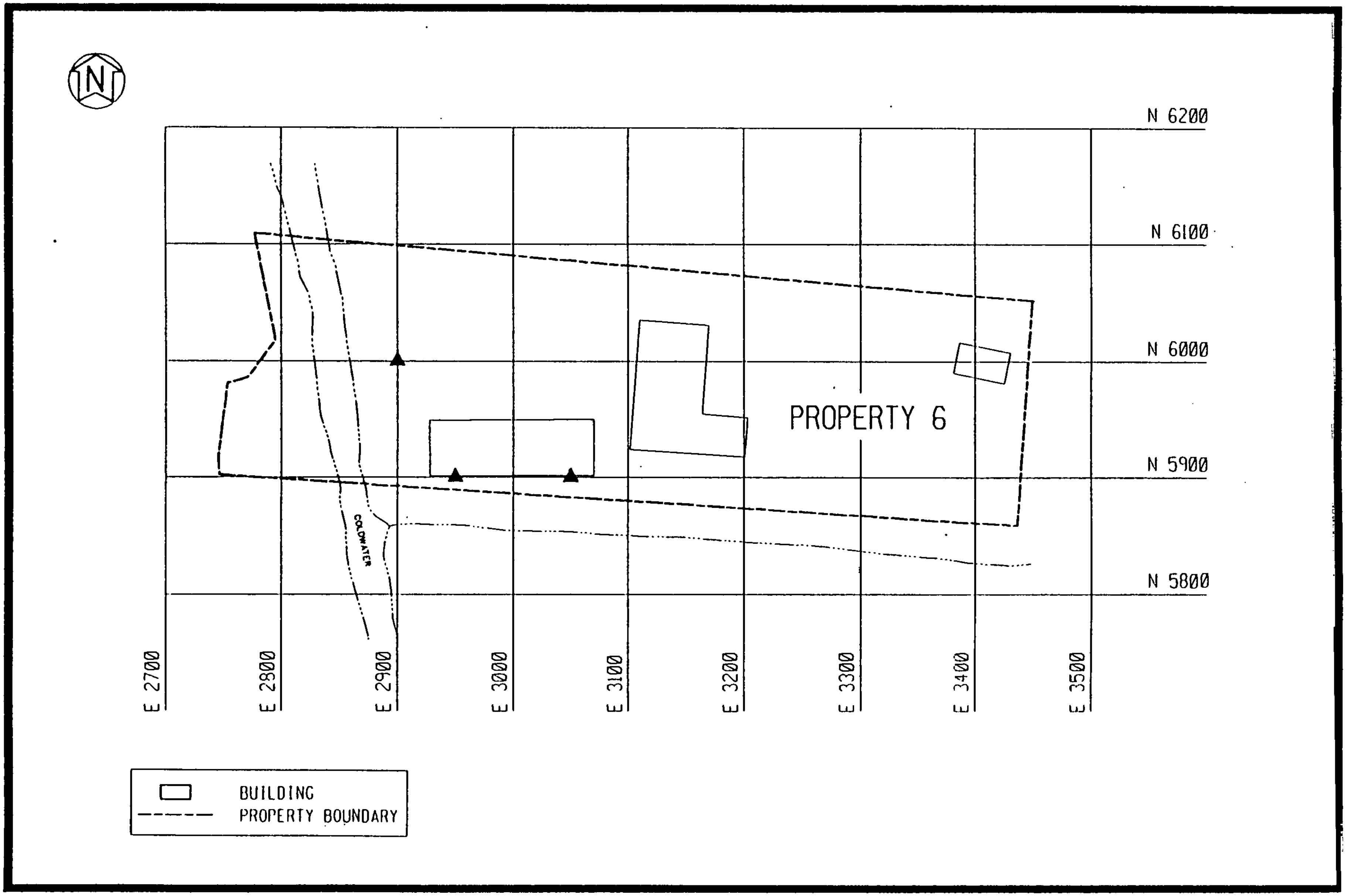


FIGURE 6-10 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF PROPERTY 6 ON COLDWATER CREEK

134F111.DGN

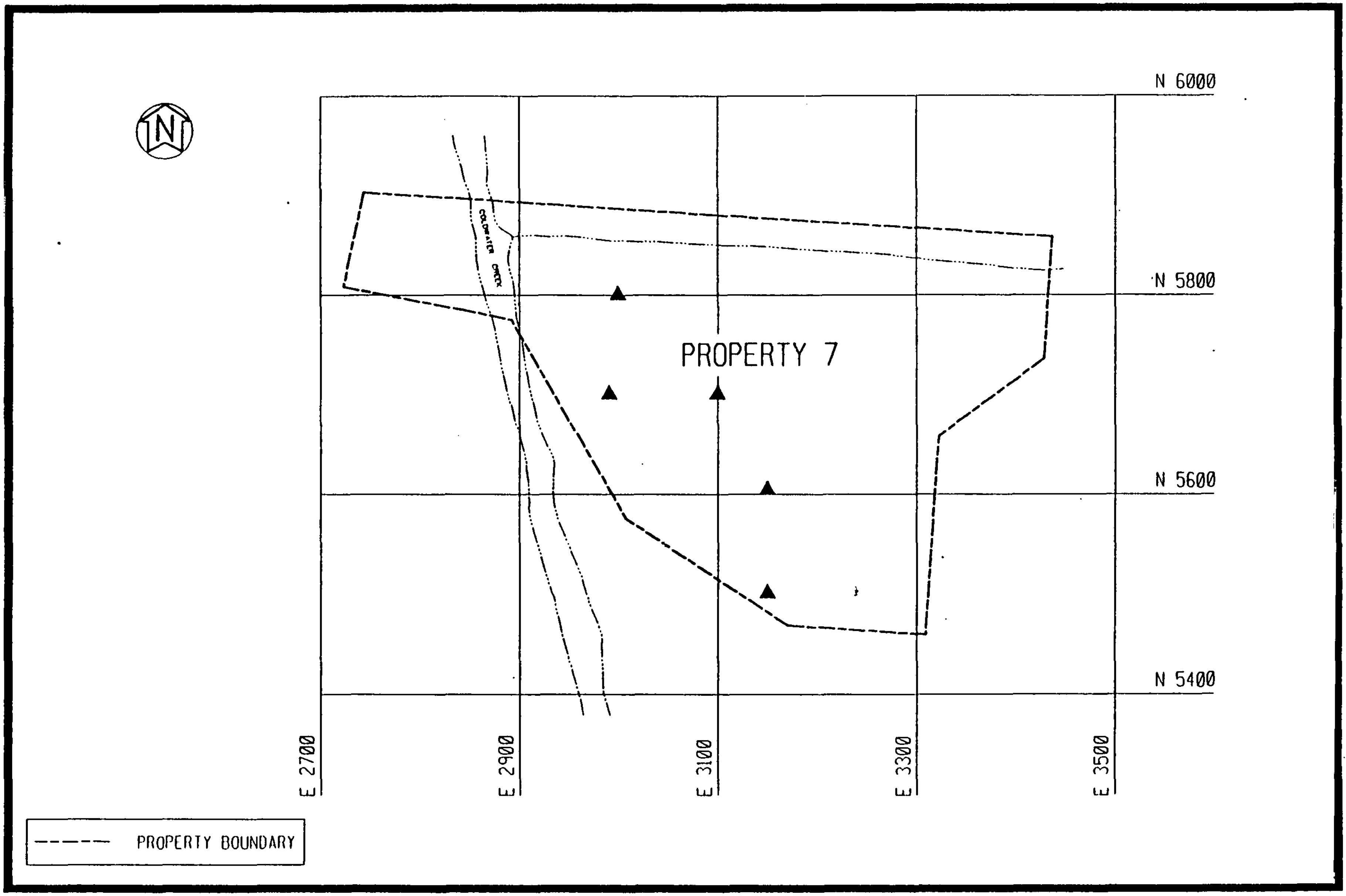


FIGURE 6-11 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF PROPERTY 7 ON COLDWATER CREEK

134F112.DGN

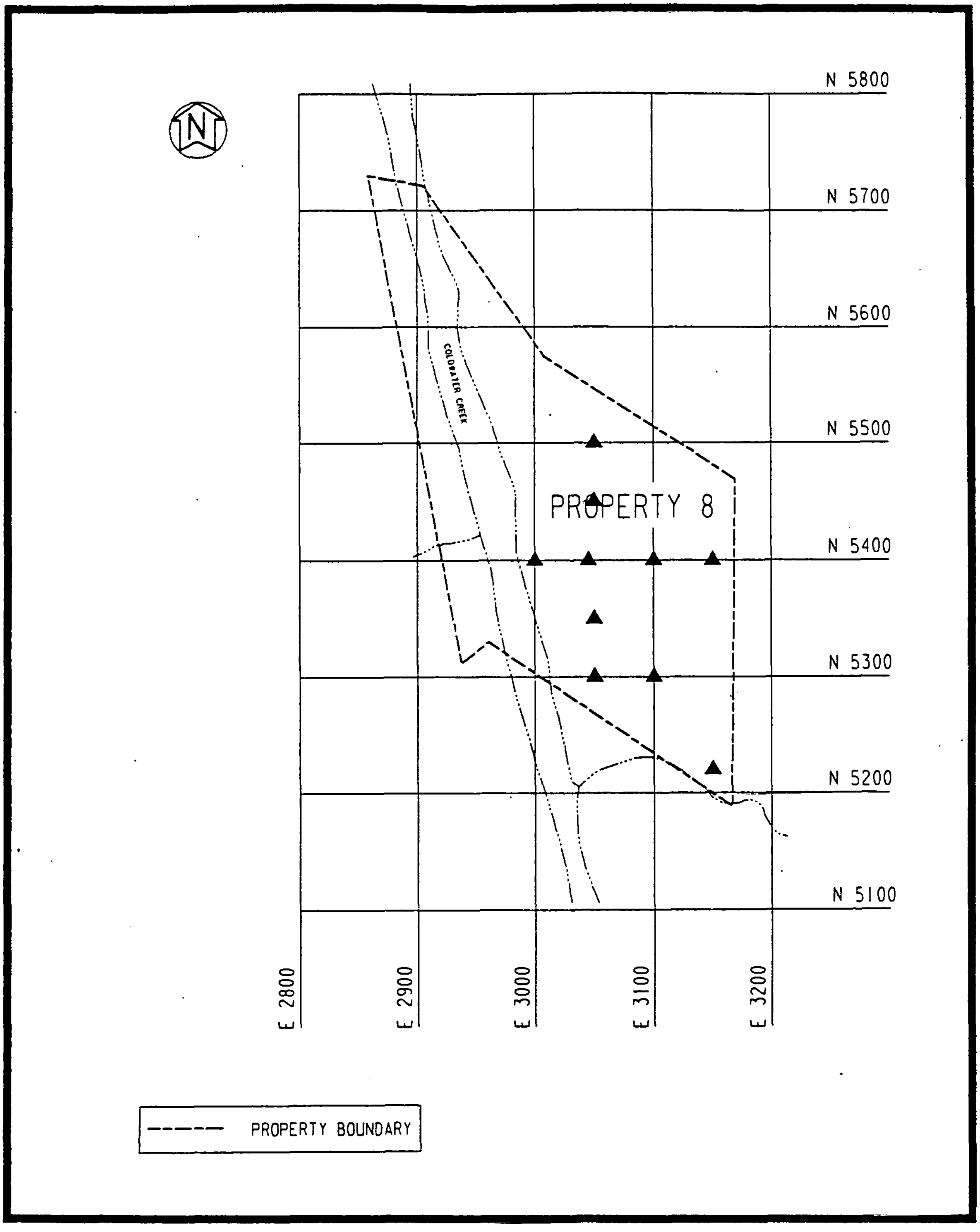


FIGURE 6-12 SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF PROPERTY 8 ON COLDWATER CREEK

134F113.DGN

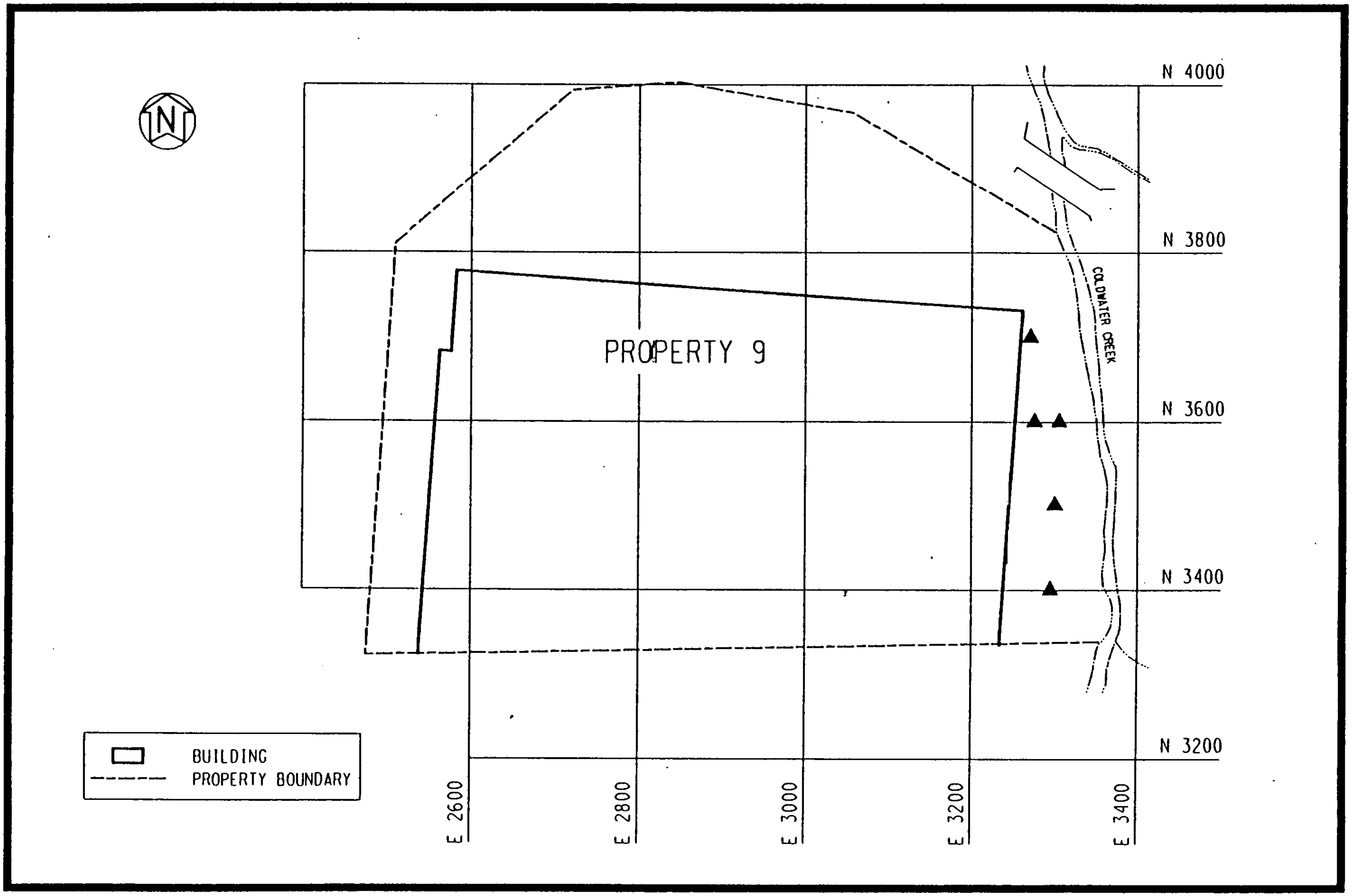


FIGURE 6-13 SOIL SAMPLING LOCATION FOR RADIOLOGICAL CHARACTERIZATION OF PROPERTY 9 ON COLDWATER CREEK

134F114.DGN

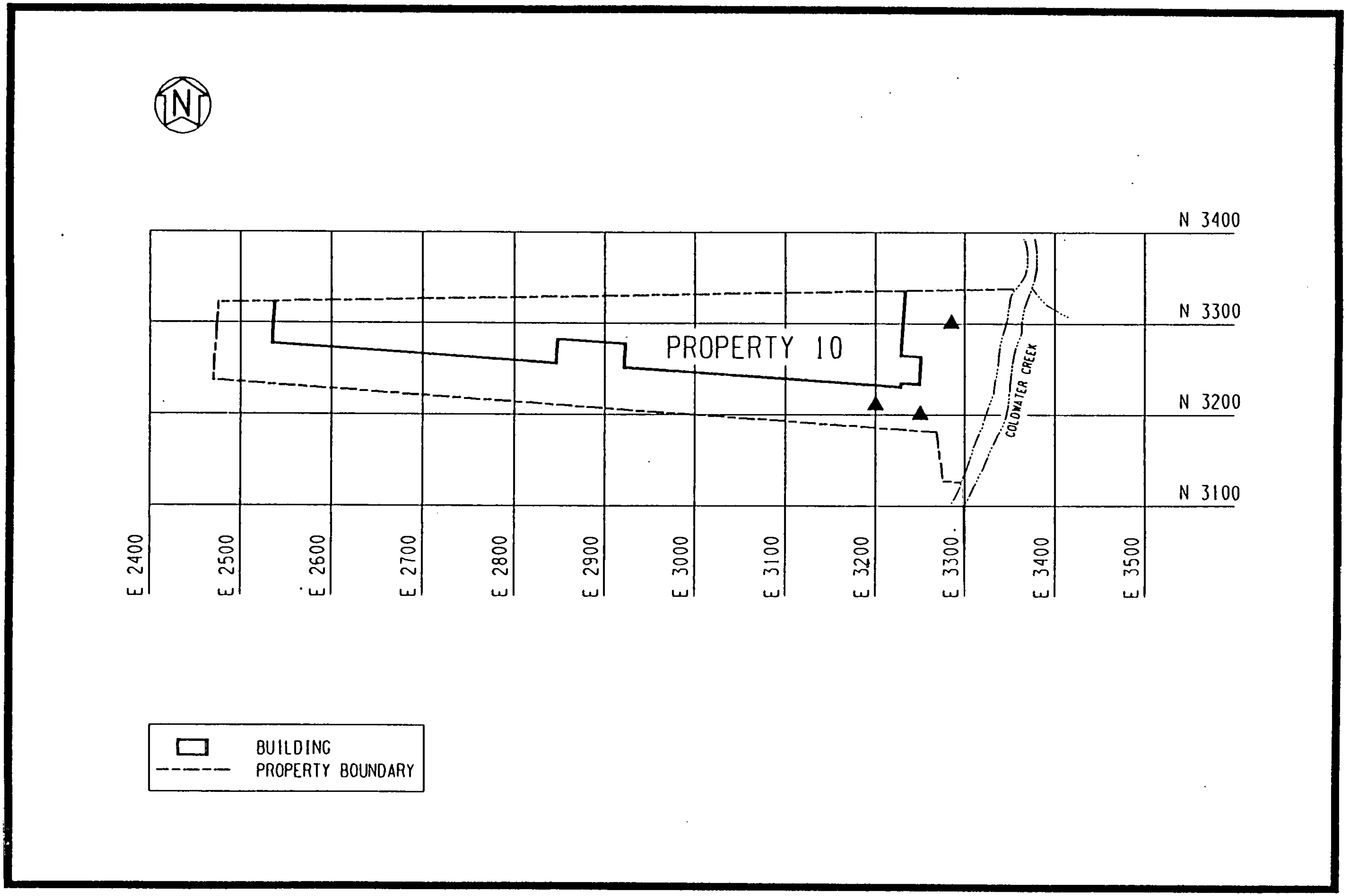


FIGURE 6-14 SOIL SAMPLING LOCATION FOR RADIOLOGICAL CHARACTERIZATION OF PROPERTY 10 ON COLDWATER CREEK

134F11_.DGN

7.0 CHARACTERIZATION RESULTS FOR THE VICINITY PROPERTIES ADJACENT TO SLAPS

The SLAPS vicinity properties include Banshee Road, ditches to the north and south of SLAPS, a portion of the property south of SLAPS owned by the St. Louis Airport Authority, and the City of St. Louis property to the north of SLAPS, known as the ball field area. These properties are shown in Figure 1-6. There are several boreholes on the SLAPS vicinity properties in which no downhole gamma logging was performed. These boreholes were drilled to support the geological investigation. They were placed in areas where contamination was not suspected; therefore, confirmatory soil samples were taken at random intervals. All soil sample results are reported in the tables in Volume III of this report. It should also be noted that when the term "elevated concentrations" of radionuclides is used, it refers to concentrations in excess of DOE guidelines.

7.1 BANSHEE ROAD

Forty-eight boreholes were drilled through Banshee Road during the radiological characterization survey. Downhole gamma logging was performed in 47 of these boreholes to determine the general depth of contamination from gamma-emitting radionuclides. No significant variations in count rates were observed as gamma logging progressed in the boreholes at Banshee Road. Detailed gamma logging results for Banshee Road are provided in Table 7-1.

Surface soil sampling locations at Banshee Road are shown in Figure 7-1. A surface soil sample was taken below the asphalt at each location. Subsurface soil sampling locations are shown in Figure 7-2. Analytical results for soil (Table 7-2) revealed two areas with elevated concentrations of thorium-230 in surface soils. Concentrations of uranium-238 at Banshee Road were less than 46 pCi/g. Radium-226 and thorium-232 concentrations were less than 7.1 pCi/g. Concentrations of thorium-230 ranged from less than 0.4

to 34 pCi/g. Areas and depths of radioactive contamination at Banshee Road are shown in Figure 7-3.

7.2 DITCHES TO THE NORTH AND SOUTH OF SLAPS

Near-surface gamma radiation measurements were made at the SLAPS ditches to identify areas with radioactivity exceeding DOE guidelines. These measurements ranged from approximately 4,000 to approximately 198,000 cpm.

Downhole gamma logging was performed in the augered holes and boreholes to indicate the general depth of gamma-emitting radionuclides. Significant variations in count rates were observed at 10 locations at the SLAPS ditches, indicating possible contamination from gamma-emitting radionuclides. Detailed gamma logging results for the ditches adjacent to SLAPS are provided in Table 7-3.

Surface soil sampling locations at the SLAPS ditches are shown in Figure 7-4. Subsurface sampling locations are shown in Figure 7-5. Analytical results for soil (Table 7-4) revealed areas with elevated concentrations of radium-226 and thorium-230 in surface and subsurface samples. Thorium-230 was identified as the major contaminant. Uranium-238 concentrations ranged from less than 1 to 94 pCi/g. Concentrations of radium-226 ranged from 0.7 to 130 pCi/g. Thorium-232 concentrations ranged from 0.7 to 6 pCi/g, and concentrations of thorium-230 ranged from 0.9 to 15,000 pCi/g. Areas and depths of radioactive contamination at the ditches adjacent to SLAPS are shown in Figure 7-6.

7.3 ST. LOUIS AIRPORT AUTHORITY PROPERTY

A portion of the property owned by the St. Louis Airport Authority was surveyed to determine the areal and vertical extent of radioactive contamination to the south of SLAPS. Near-surface gamma radiation measurements at this property ranged from approximately 2,000 to approximately 9,000 cpm.

Downhole gamma logging was performed in the boreholes. No significant variations in count rates were observed as gamma logging progressed in the boreholes on the St. Louis Airport Authority property. Detailed gamma logging results are reported in Table 7-5.

Surface soil sampling locations at the St. Louis Airport Authority property are shown in Figure 7-7. Subsurface soil sampling locations are shown in Figure 7-8. Analytical results for soil (Table 7-6) revealed areas with elevated concentrations of thorium-230 in surface samples. All uranium-238 concentrations were less than 11 pCi/g. Radium-226 concentrations ranged from 0.8 to 3.3 pCi/g. Concentrations of thorium-232 and thorium-230 ranged from 0.8 to 5 pCi/g and less than 0.7 to 39 pCi/g, respectively.

Areas and depths of radioactive contamination at the St. Louis Airport Authority property are shown in Figure 7-9.

7.4 BALL FIELD AREA

The ball field area, located north of SLAPS, is owned by the City of St. Louis and is leased to the City of Berkeley. Near-surface gamma radiation measurements at the ball field area ranged from approximately 7,000 to approximately 169,000 cpm.

Downhole gamma logging was performed in the augered holes. No significant variations in count rates were observed as gamma logging progressed in the augered holes at the ball field. Detailed gamma logging results are reported in Table 7-7.

Surface soil sampling locations at the ball field area are shown in Figure 7-10. Subsurface soil sampling locations are shown in Figure 7-11. Analytical results for soil (Table 7-8) revealed areas with elevated concentrations of radium-226 in surface samples and thorium-230 in surface and subsurface samples. Concentrations of uranium-238 ranged from less than 3 to 42 pCi/g. Radium-226 concentrations ranged from less than 0.5 to 190 pCi/g. Thorium-232 concentrations ranged from 0.6 to 5 pCi/g. Concentrations of thorium-230 ranged from less than 0.1 to 2,300 pCi/g.

Composite sampling was performed along the west side of Eva Avenue, following the same procedure used for the haul roads (Section 5.0). Based on the adjusted criteria (Subsection 5-1) for composite samples, soil collected for these composite samples showed elevated concentrations of radium-226, thorium-232, and thorium-230.

Based on soil sampling results for the ball field area, radiological contamination averaged 0.3 m (1 ft) in depth over the areas depicted in Figure 7-12. Contamination was not detected on the baseball infields.

Radioactive contamination (exceeding DOE guidelines) is present at two locations on Banshee Road, extending to a depth of 0.3 m (1 ft). Essentially all the ditch area north and south of SLAPS is contaminated ranging in depth from 0 to 4.3 m (0 to 14 ft). The 4.3-m (14-ft) depth of contamination occurred at one location. Radioactive contamination is present on the St. Louis Airport Authority property south of SLAPS, extending to a depth of 1.2 m (4 ft) at two locations. In general, the contamination is shallow [0.6 m (2 ft)] and extends the length of SLAPS between SLAPS and Banshee Road. There are several areas south of Banshee Road, on the airport property, that exhibited radioactive contamination in excess of DOE guidelines. These areas are shallow [0 to 0.6 m (0 to 2 ft)] and are confined to the area adjacent to Banshee Road. With the exception of the baseball infields, the ball field area does have radiological contamination to an average depth of 0.3 m (1 ft). Thorium-230 was identified as the primary contaminant on all these properties.

A conservative hazard analysis, utilizing data collected and analyzed from the area, was performed on the ball field area.

This analysis made conservative assumptions on conditions that are not normally present, such as continuous high dust levels containing radioactivity. The results of the hazard analysis show that a ball player will receive a maximum radiation dose per ball season that is below the dose the public receives from naturally occurring radiation in the earth, building materials, and the atmosphere. Based on this analysis, DOE has concluded that continued use of the ball field presents a level of risk well below the standards for the public; however, at present, the ball field area remains closed to the public at the city's request.

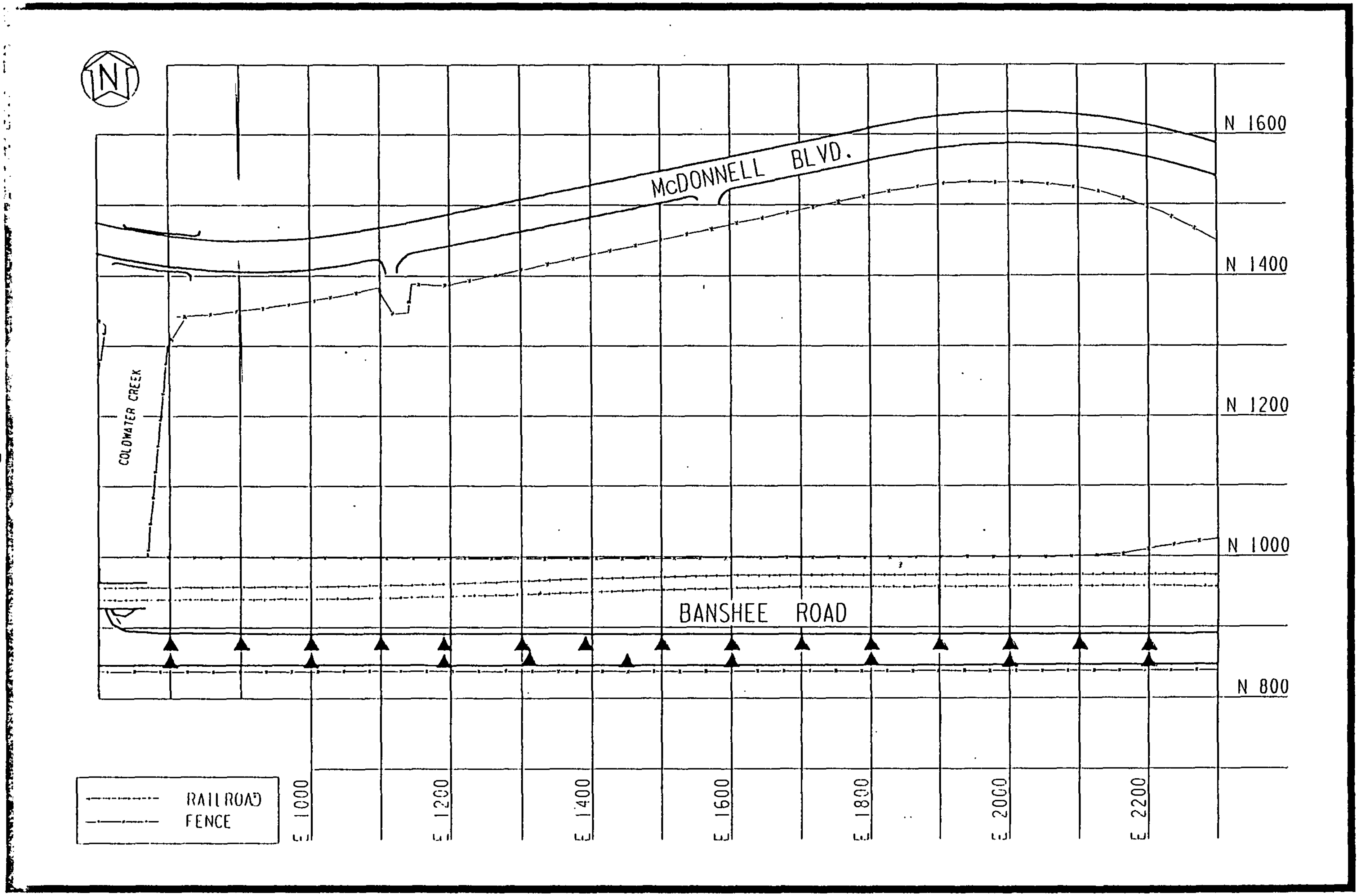


FIGURE 7-1 SURFACE SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF BANSHEE ROAD

S34WMS35.DGN

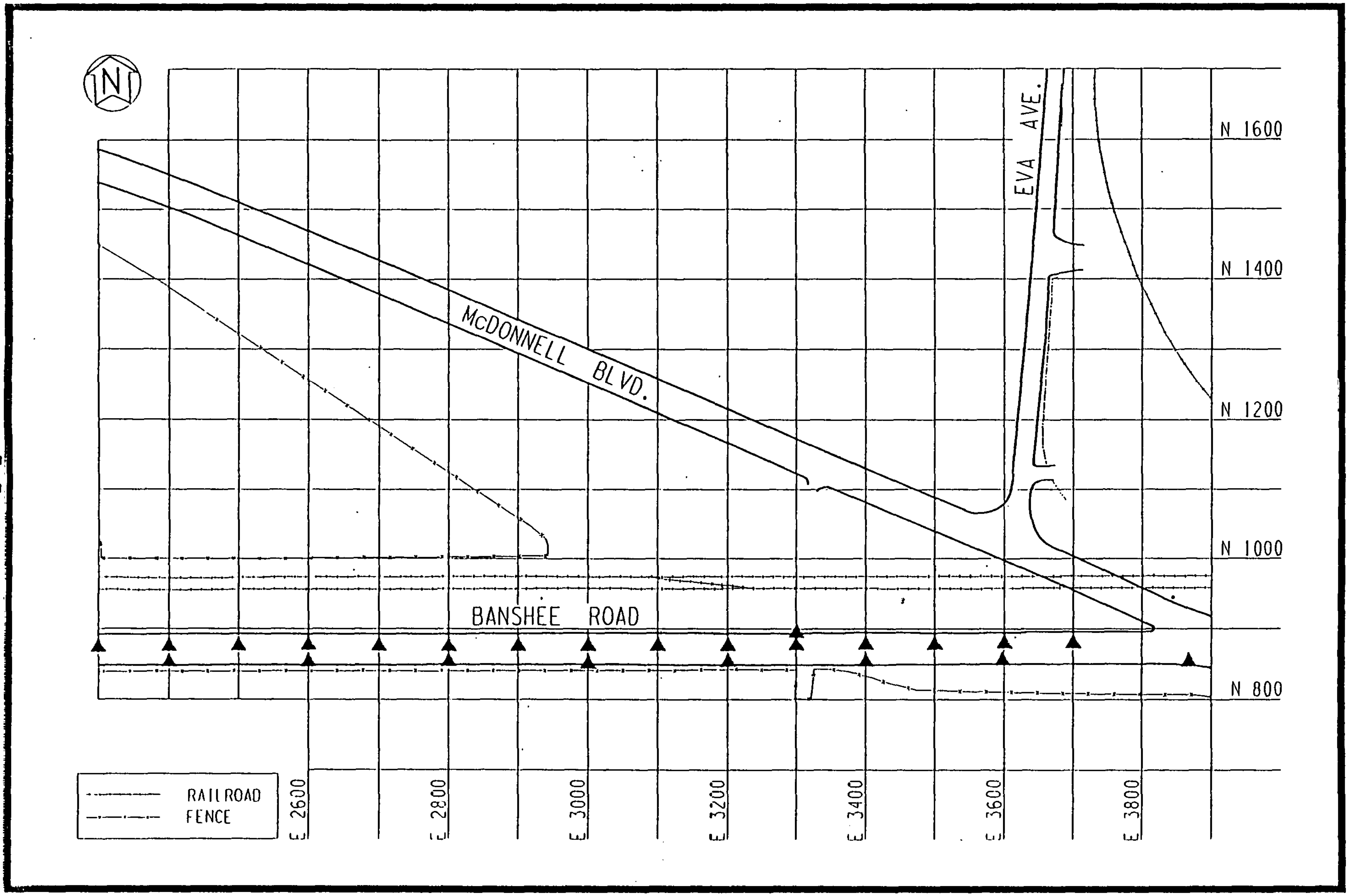


FIGURE 7-1 SURFACE SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF BANSHEE ROAD (CONT.)

S34WMS36.DGN

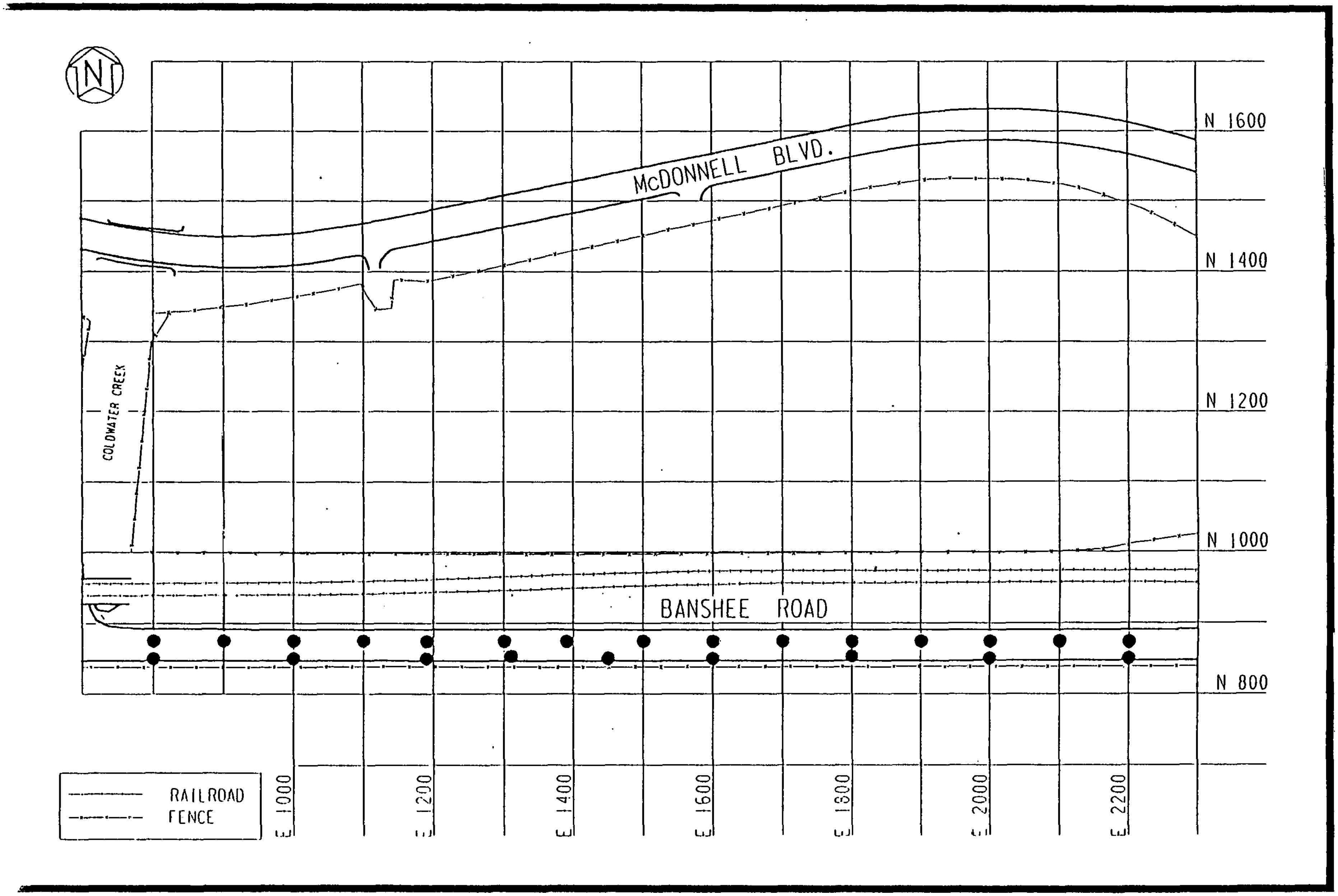


FIGURE 7-2 SUBSURFACE SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF BANSHEE ROAD

S34WMS35.DGN

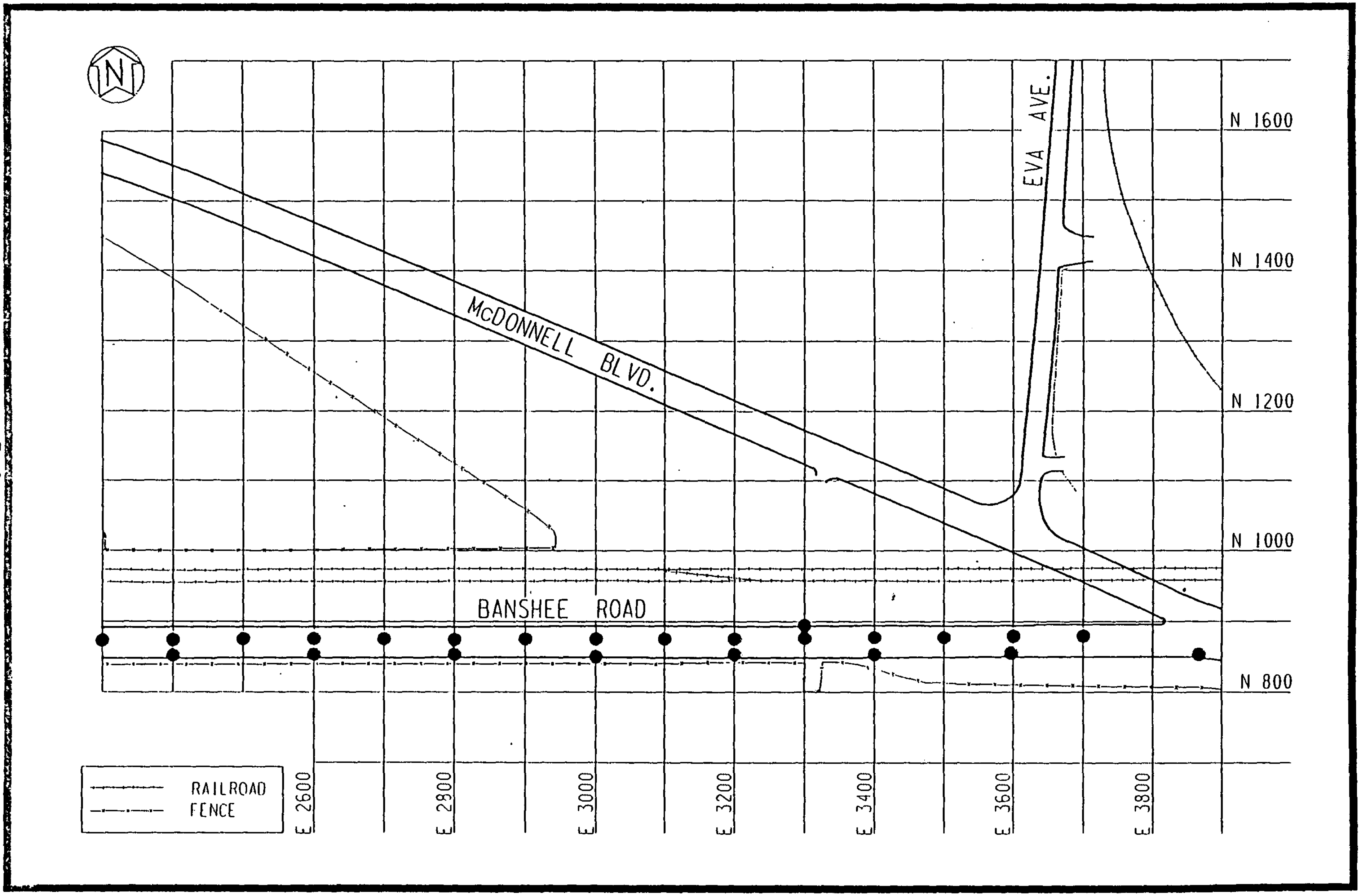


FIGURE 7-2 SUBSURFACE SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF BANSHEE ROAD (CONT.)

S34WH536.DGN

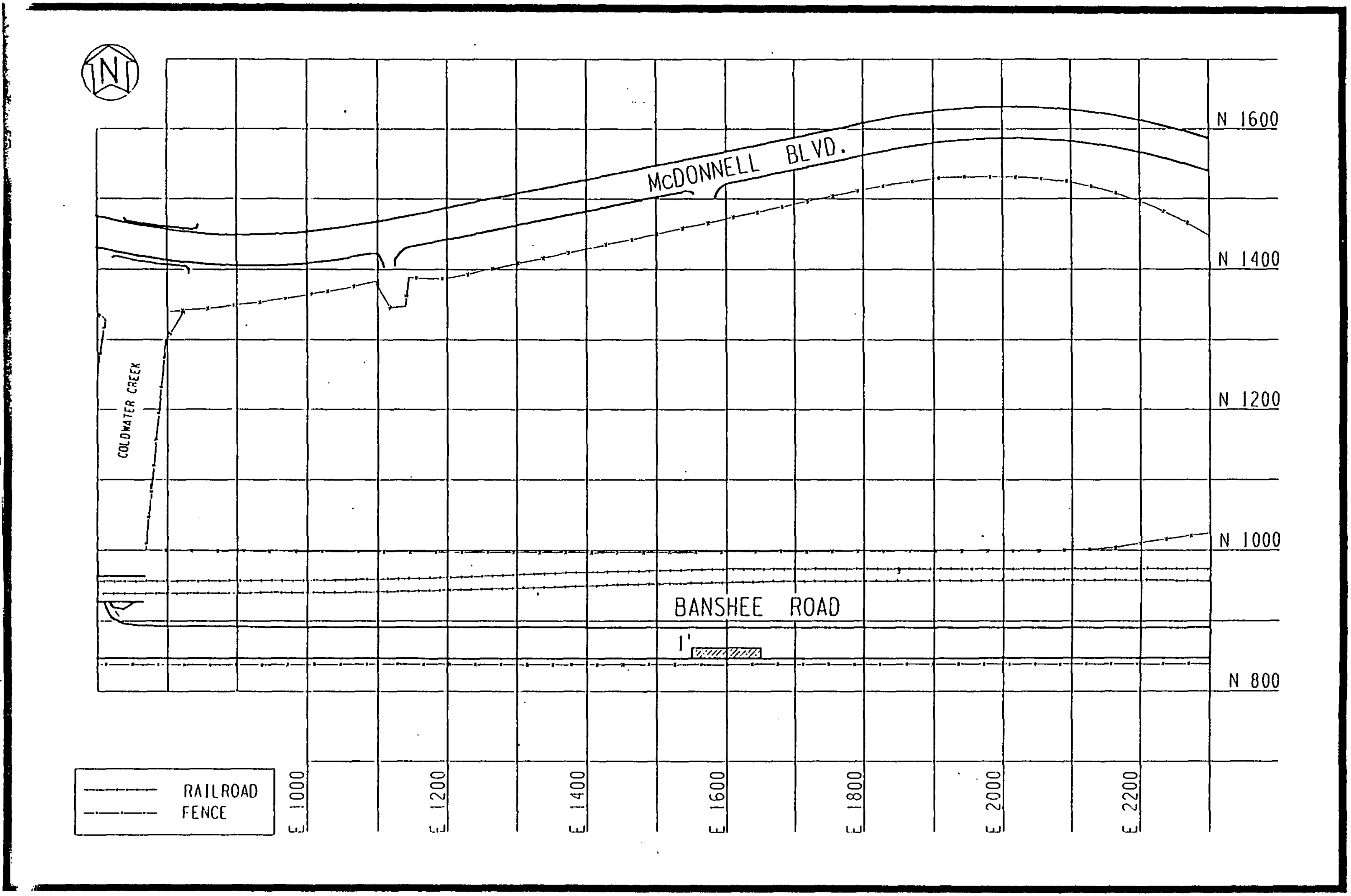


FIGURE 7-3 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT BANSHEE ROAD

S34WMS35.DGN

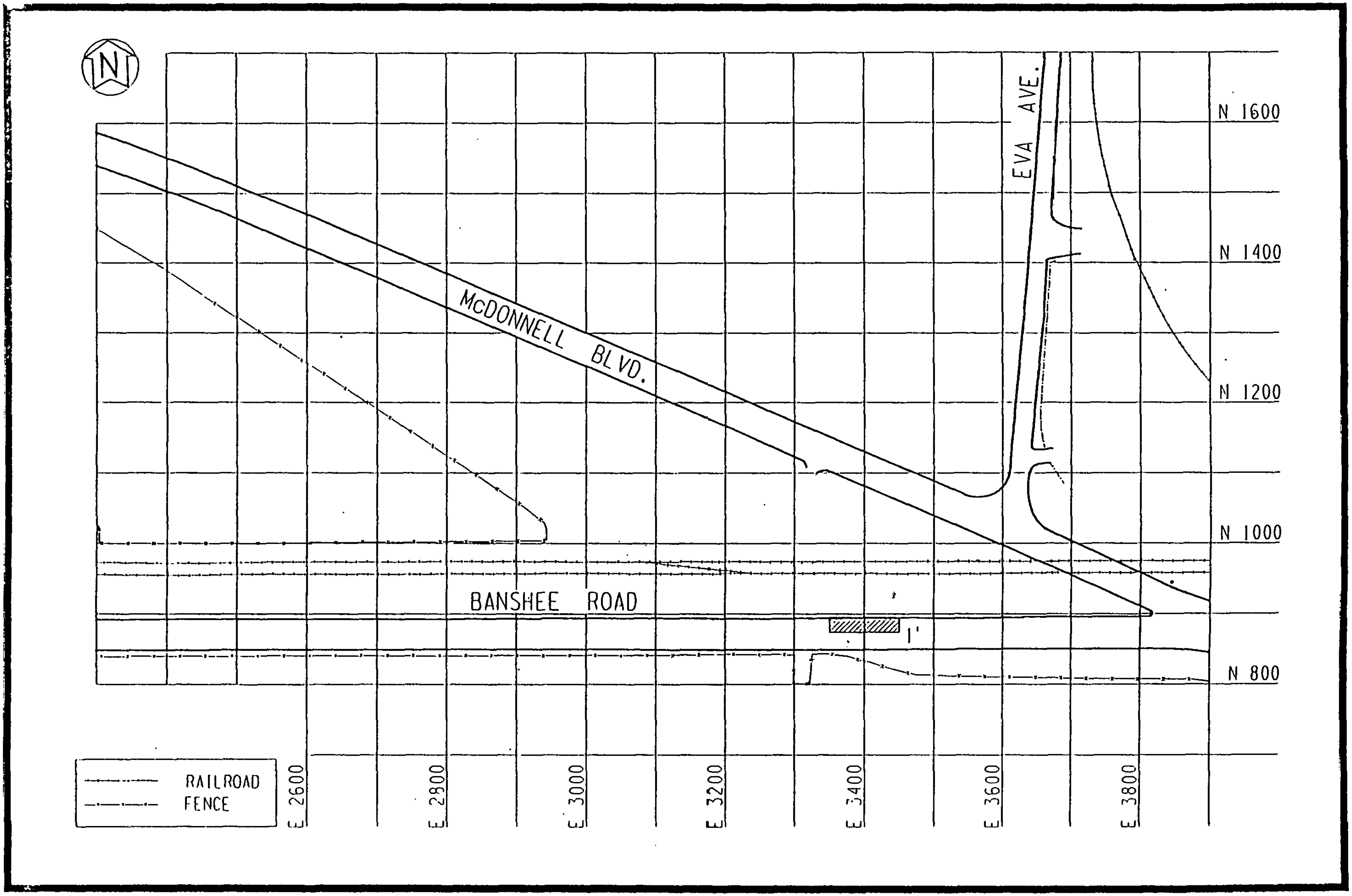


FIGURE 7-3 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT BANSHEE ROAD (CONT.)

S34WMS36.DGN

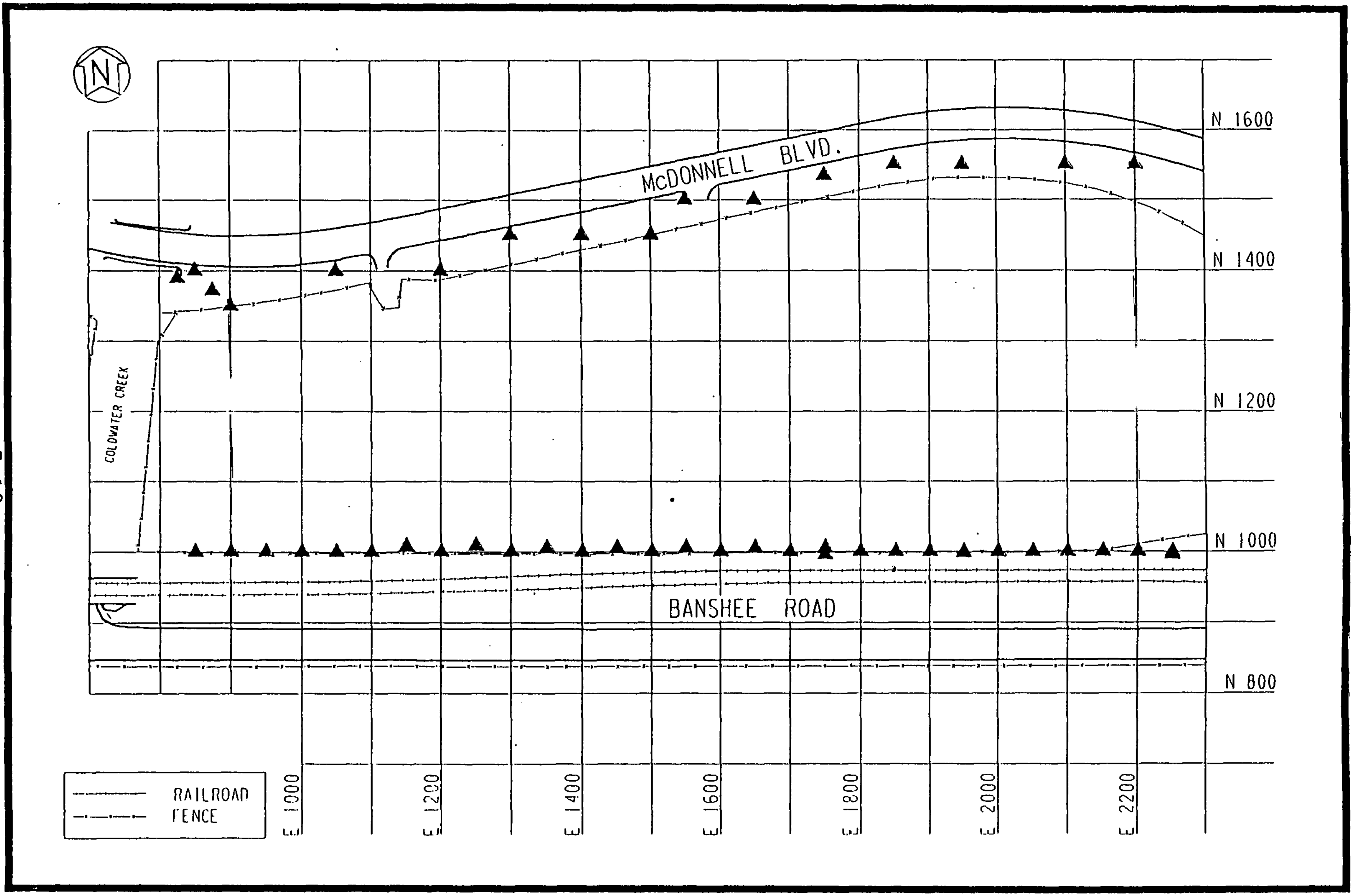


FIGURE 7-4 SURFACE SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF THE DITCHES TO THE NORTH AND SOUTH OF SLAPS

S34VM537.DGN

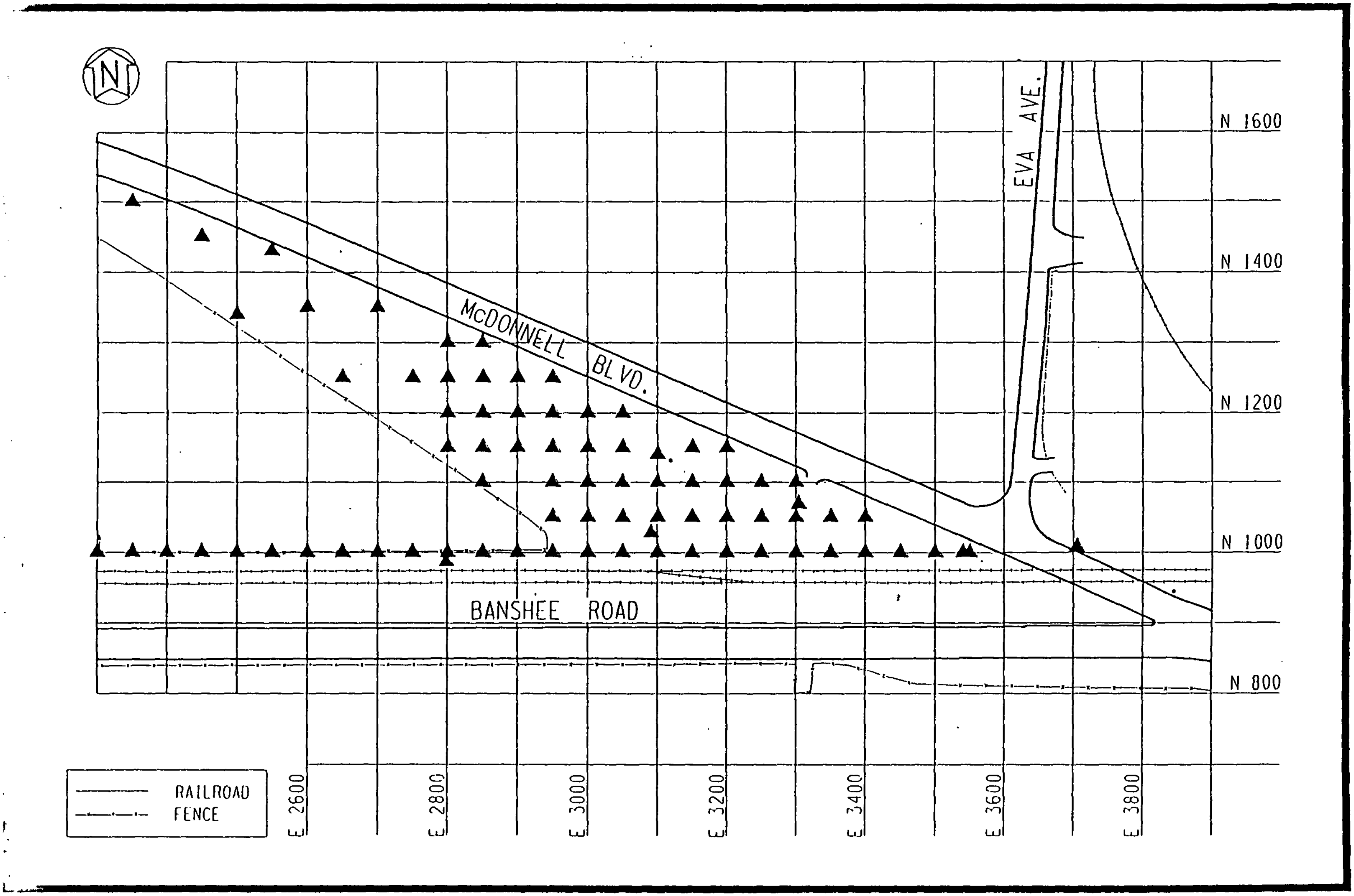


FIGURE 7-4 SURFACE SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF THE DITCHES TO THE NORTH AND SOUTH OF SLAPS (CONT.)

534WM538.DGN

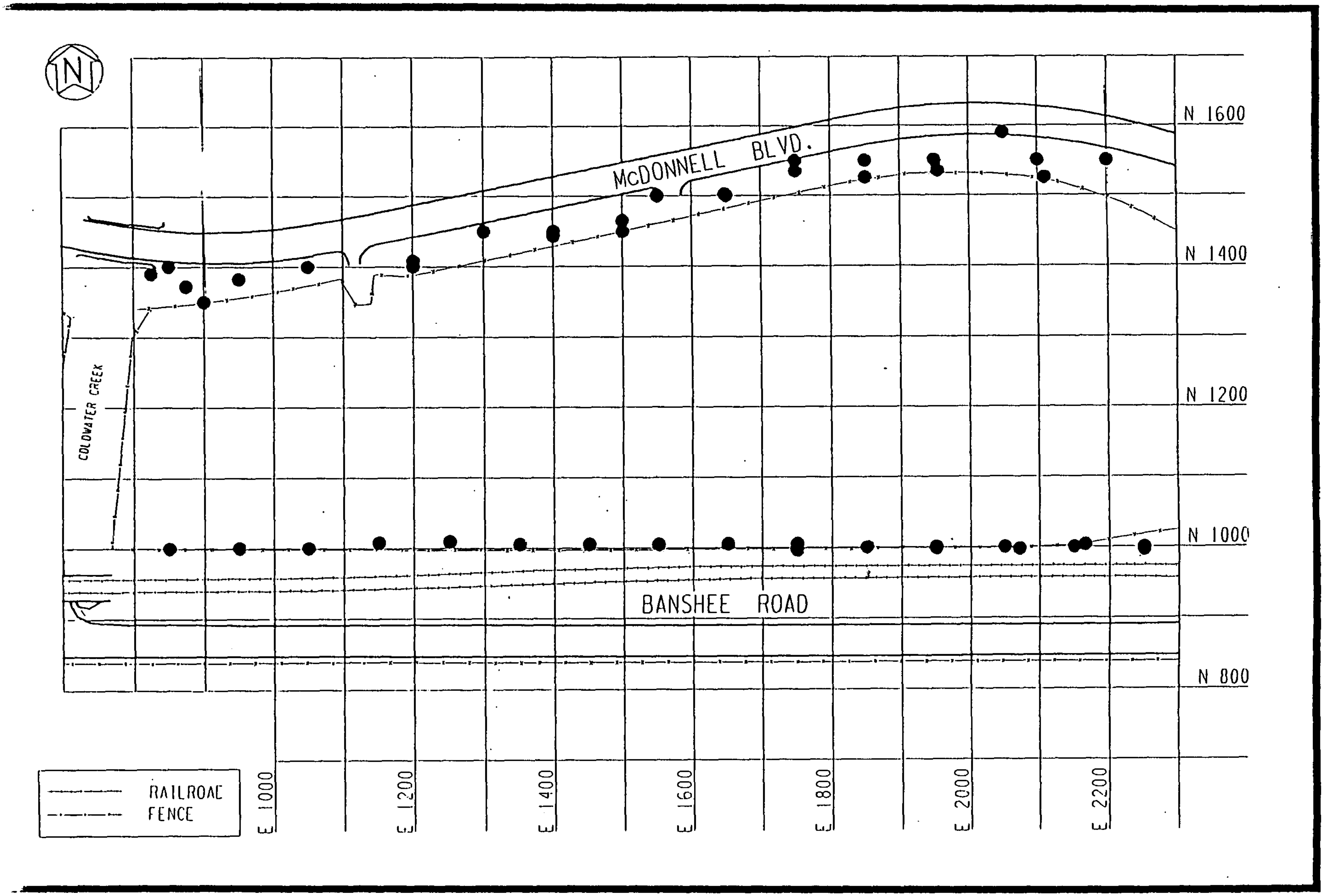


FIGURE 7-5 SUBSURFACE SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF THE DITCHES TO THE NORTH AND SOUTH OF SLAPS

4WMS37.DGN

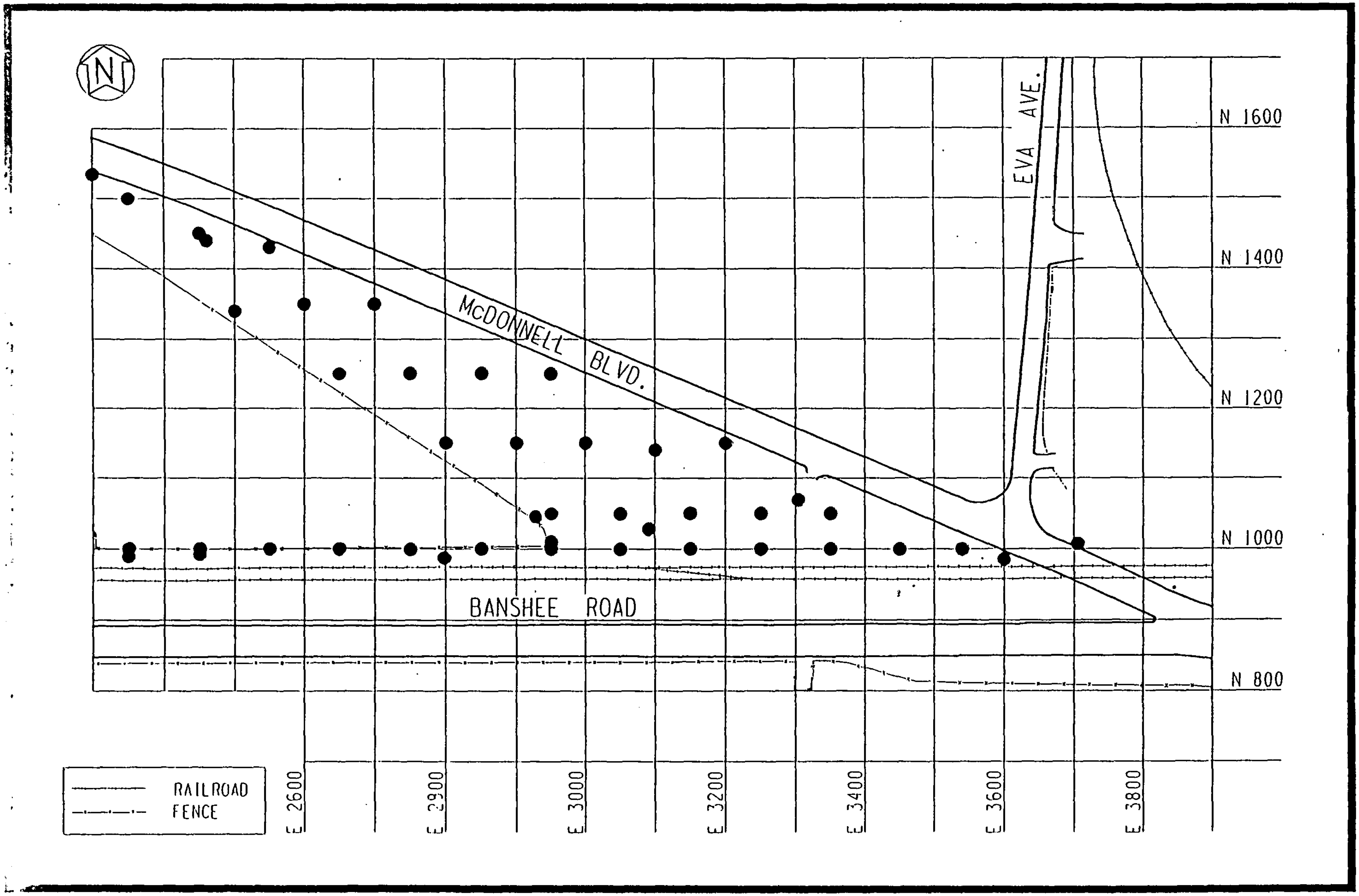


FIGURE 7-5 SUBSURFACE SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF THE DITCHES TO THE NORTH AND SOUTH OF SLAPS (CONT.)

S34W.DGN

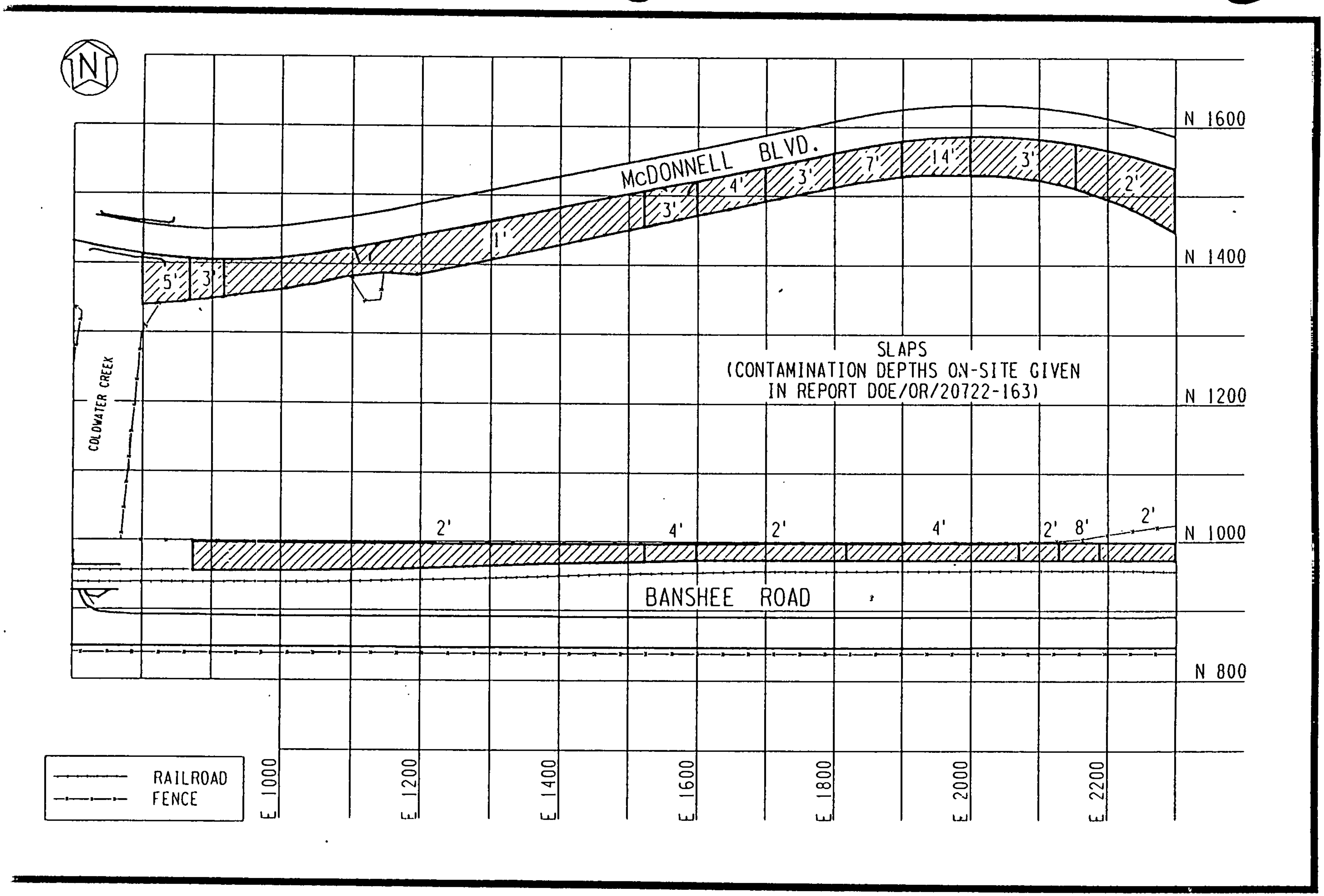


FIGURE 7-6 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT THE DITCHES TO THE NORTH AND SOUTH OF SLAPS

S34WHS37.DGN

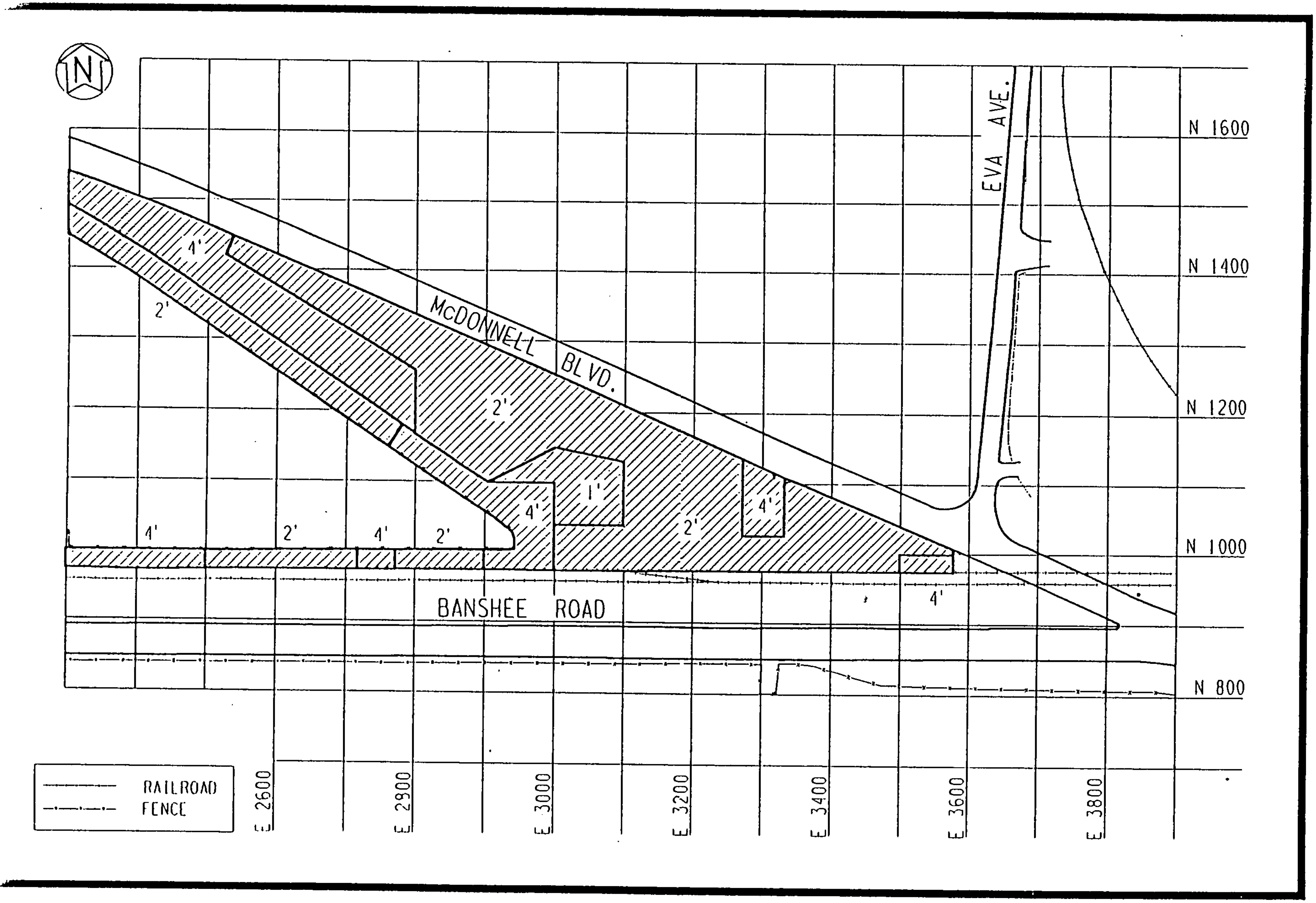


FIGURE 7-6 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT THE DITCHES TO THE NORTH AND SOUTH OF SLAPS (CONT.)

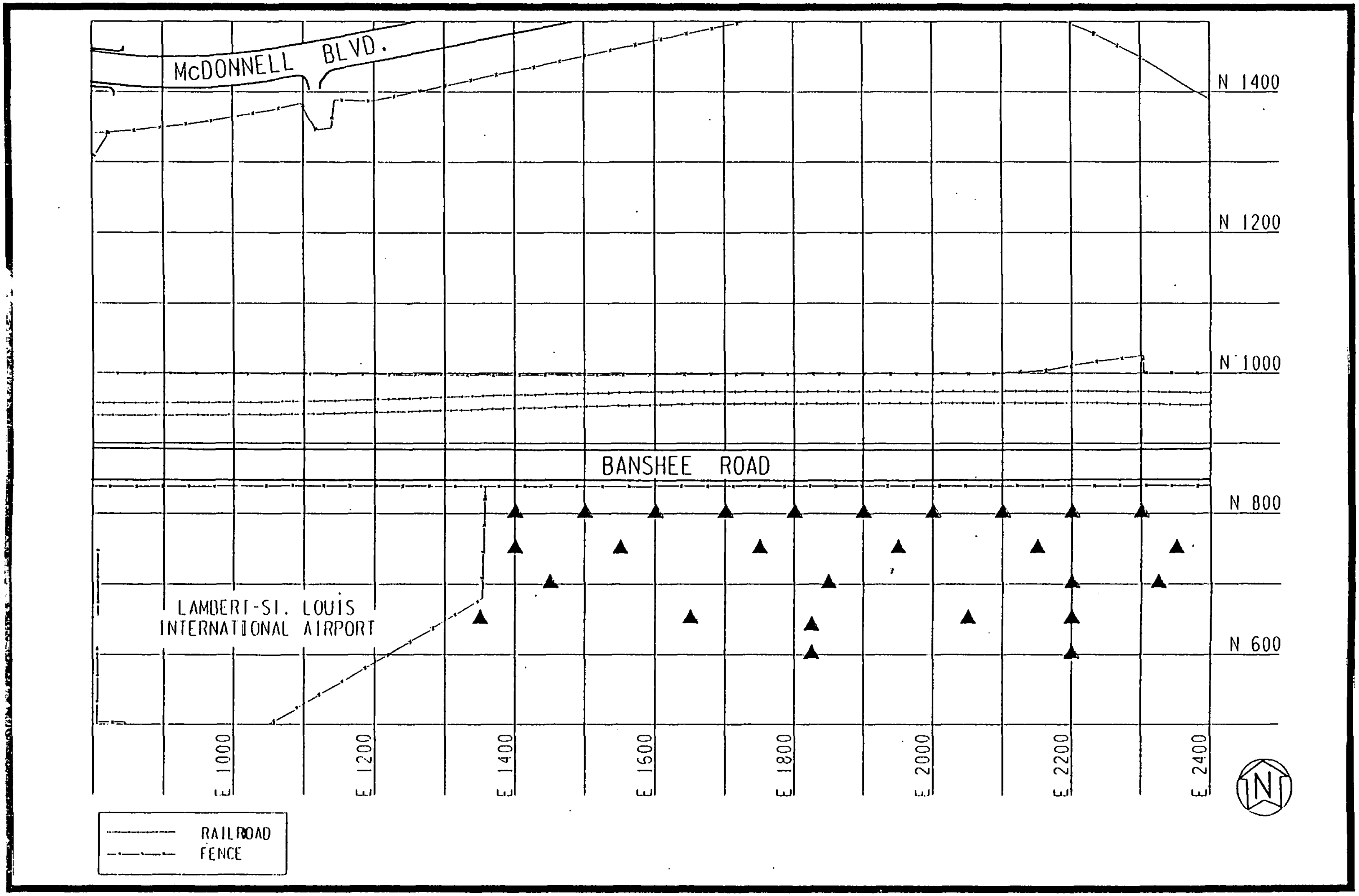


FIGURE 7-7 SURFACE SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF THE ST. LOUIS AIRPORT AUTHORITY PROPERTY

S34WMS39.DGN

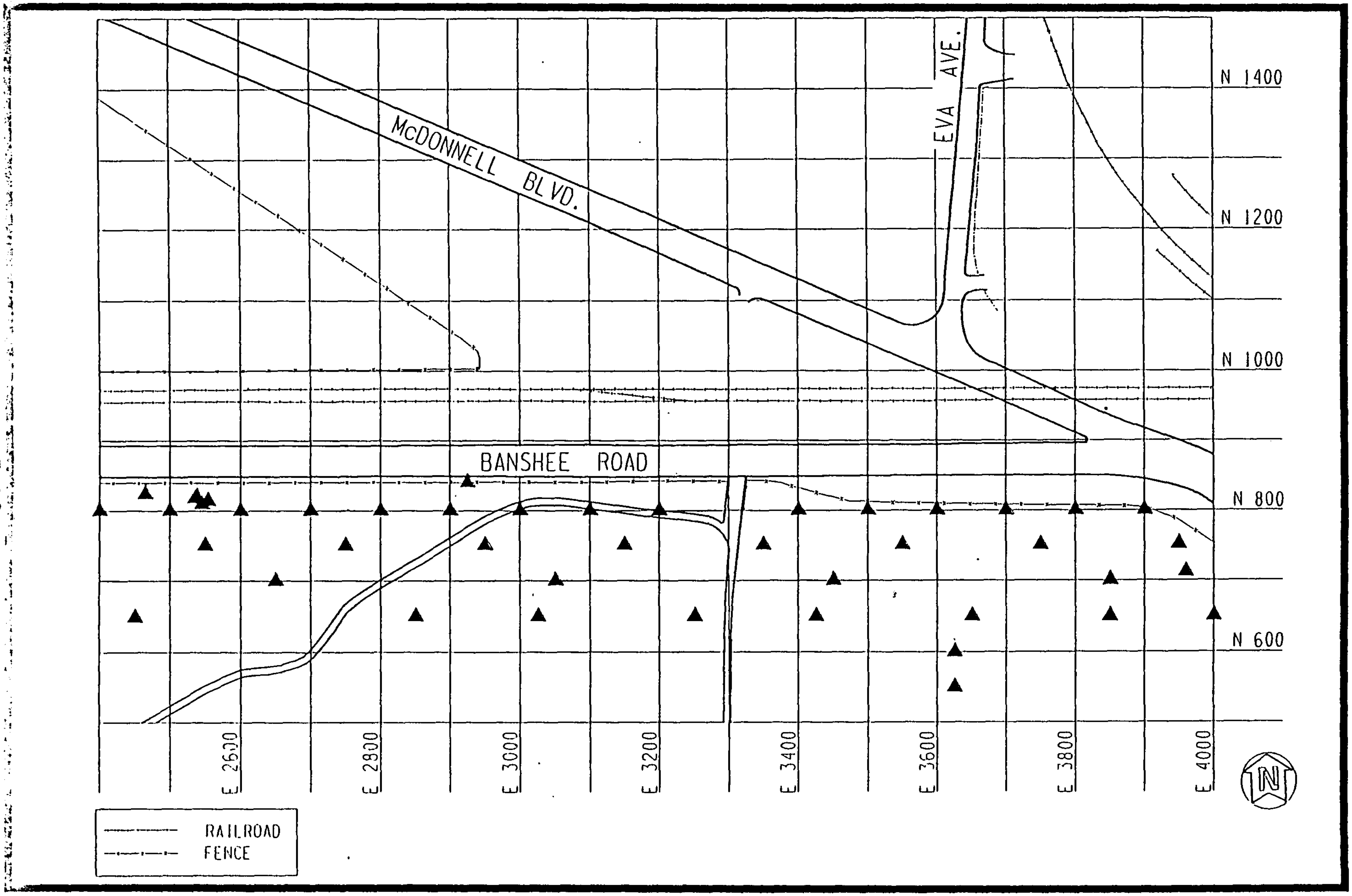


FIGURE 7-7 SURFACE SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF THE ST. LOUIS AIRPORT AUTHORITY PROPERTY (CONT.)

S34[illegible]DGN

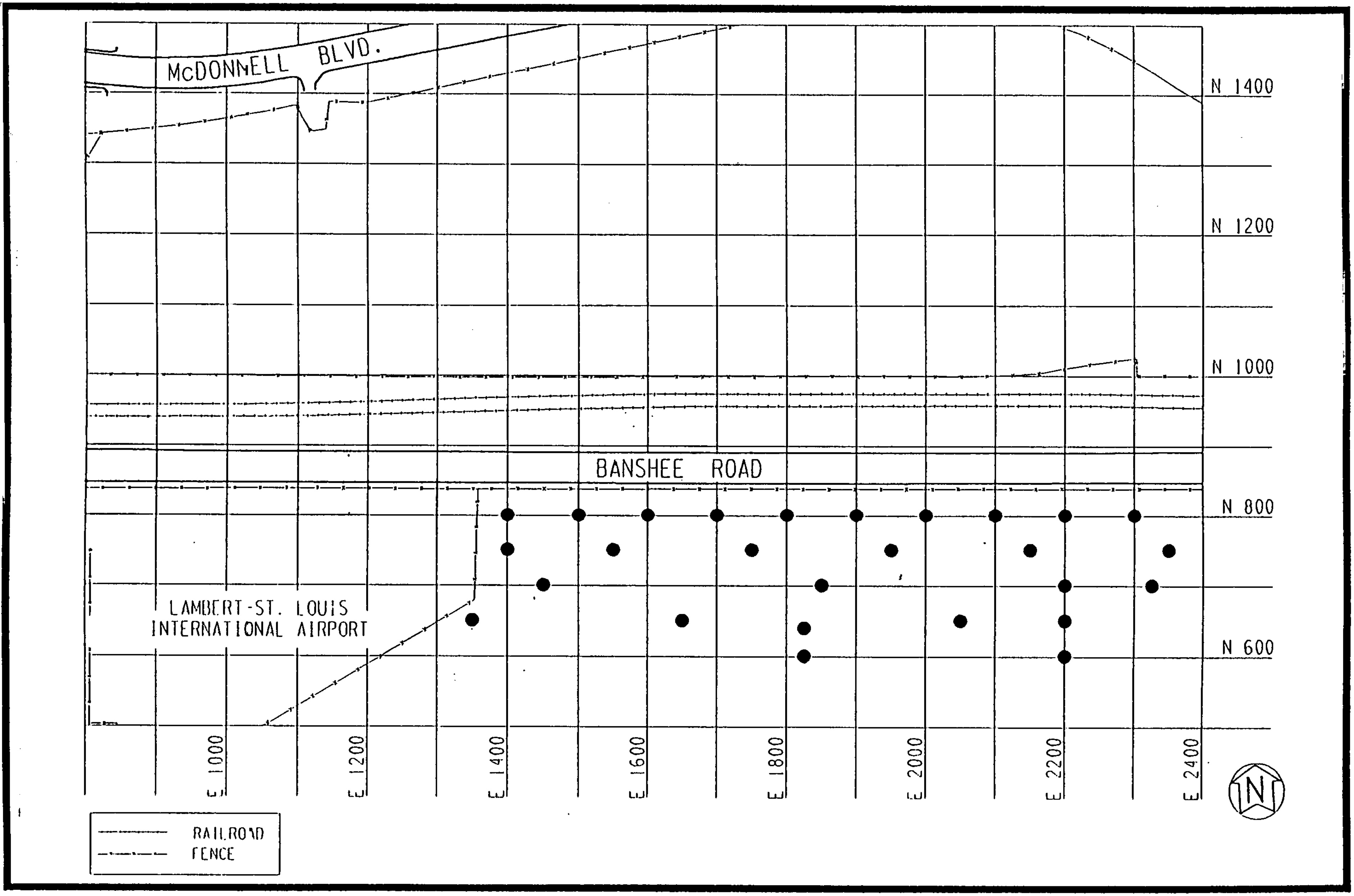


FIGURE 7-8 SUBSURFACE SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF THE ST. LOUIS AIRPORT AUTHORITY PROPERTY

S34WMS39.DGN

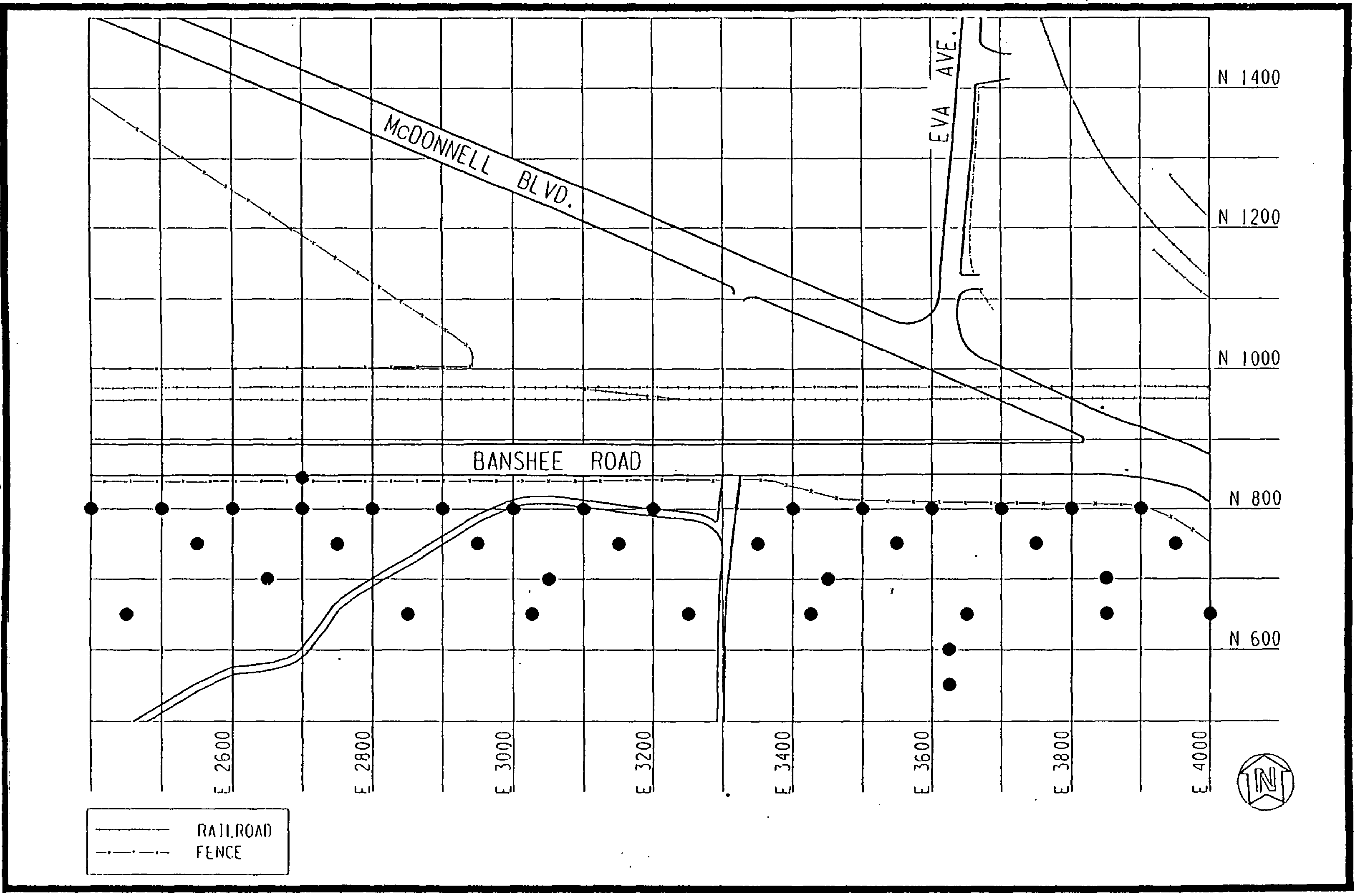


FIGURE 7-8 SUBSURFACE SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF THE ST. LOUIS AIRPORT AUTHORITY PROPERTY (CONT.)

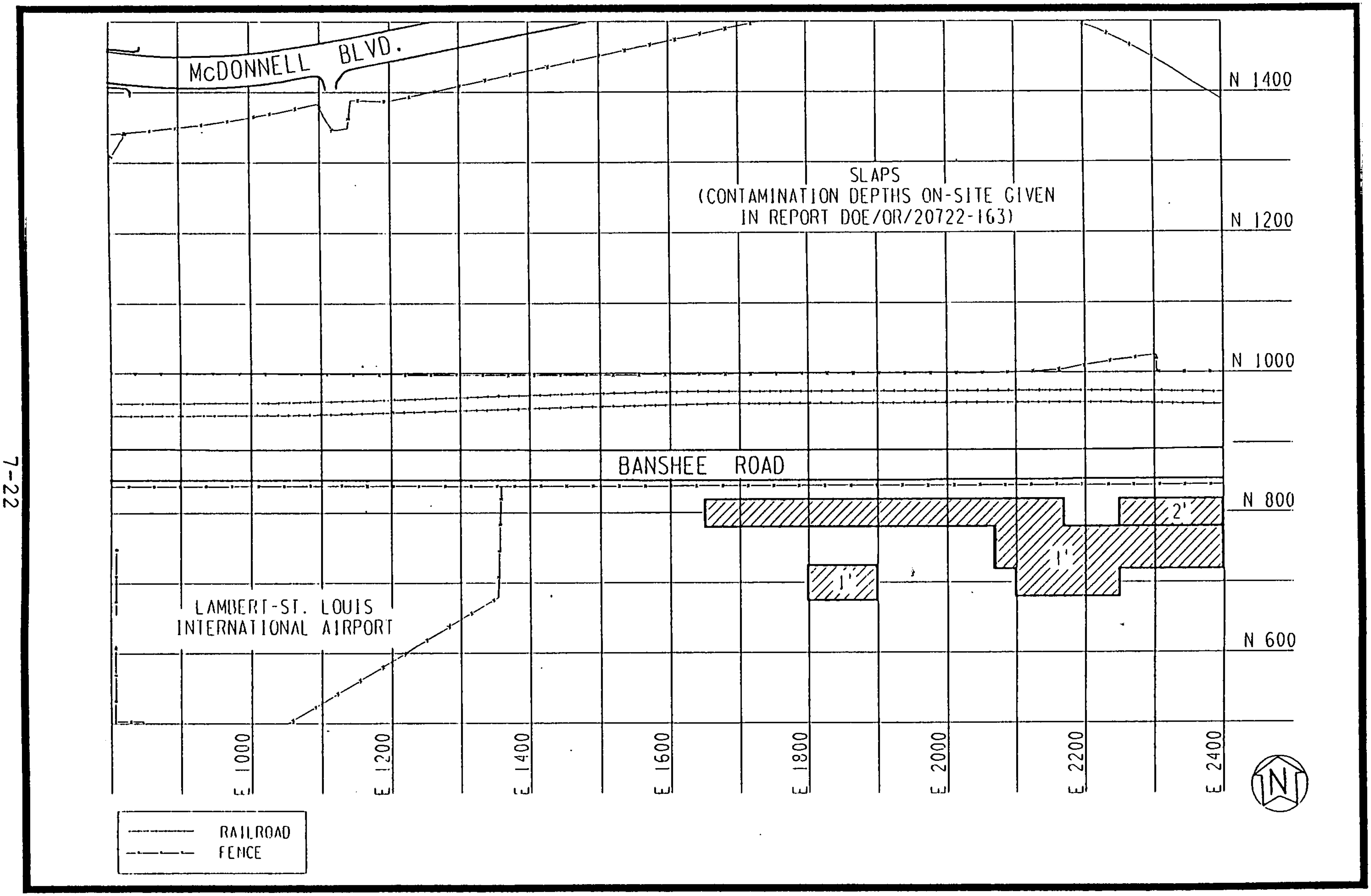


FIGURE 7-9 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT THE ST. LOUIS AIRPORT AUTHORITY PROPERTY

S34WHS39.DGN

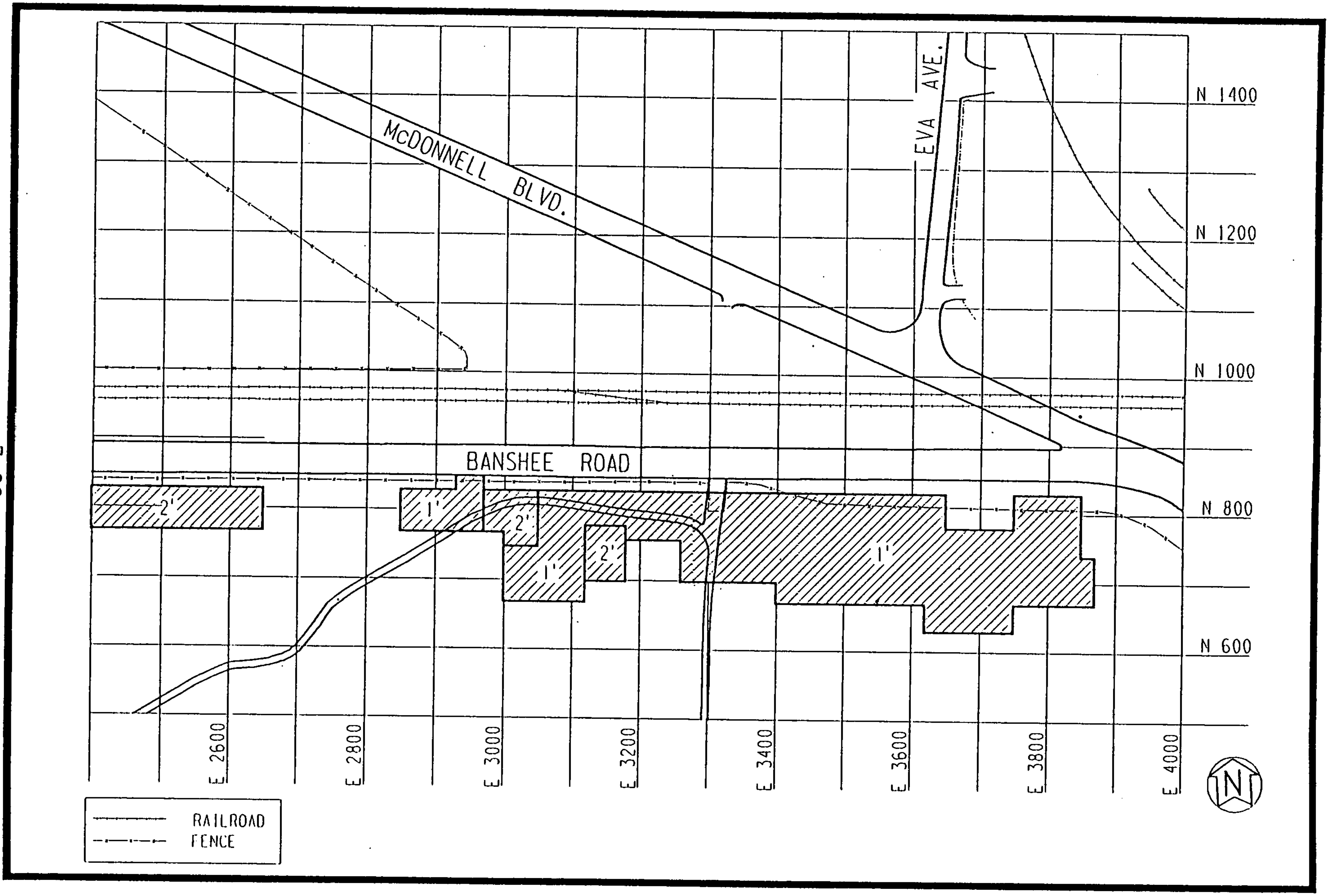


FIGURE 7-9 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT THE ST. LOUIS AIRPORT AUTHORITY PROPERTY (CONT.)

S 40.DGN

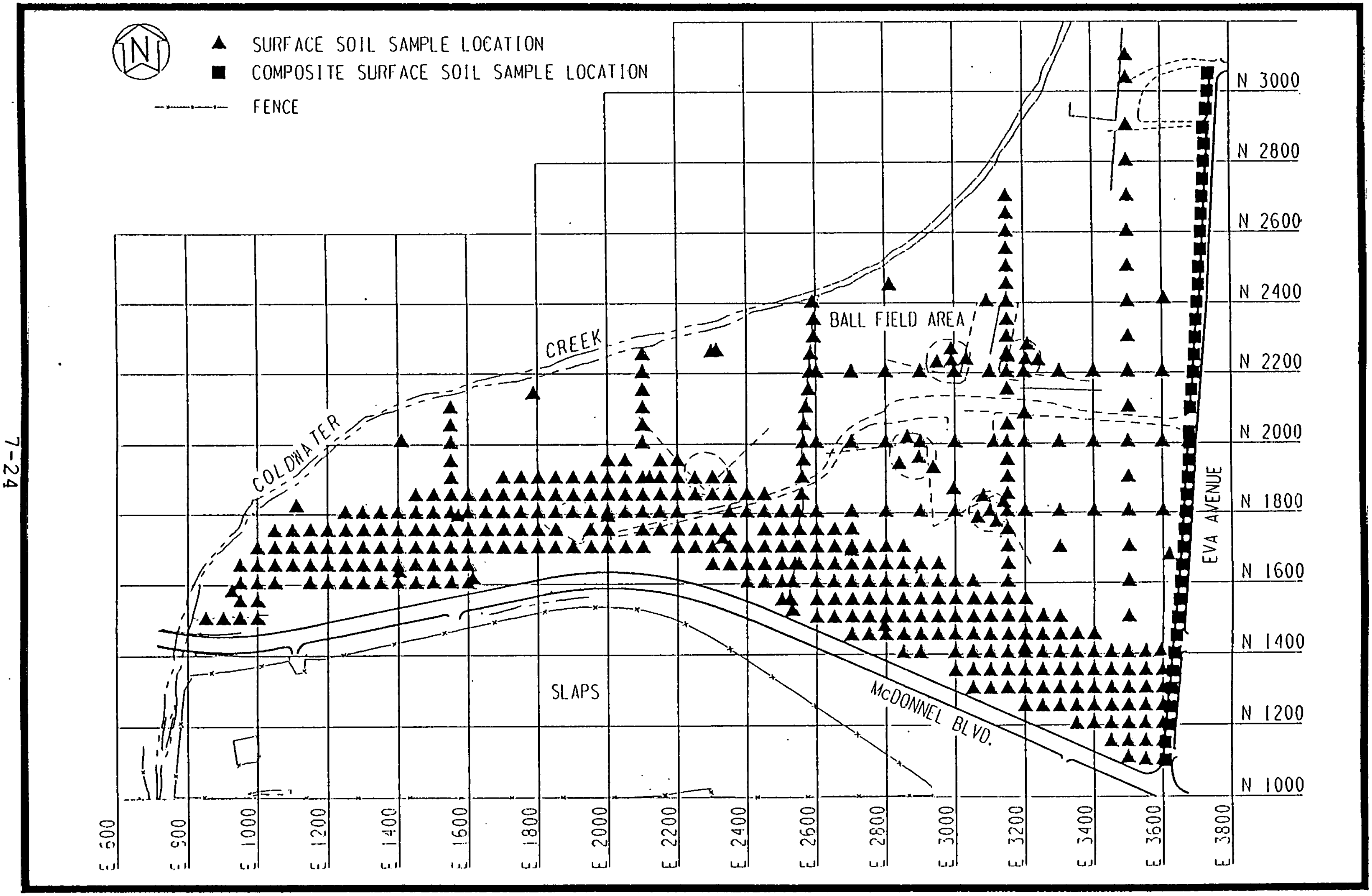


FIGURE 7-10 SURFACE SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF THE BALL FIELD AREA

553WM518.DGN

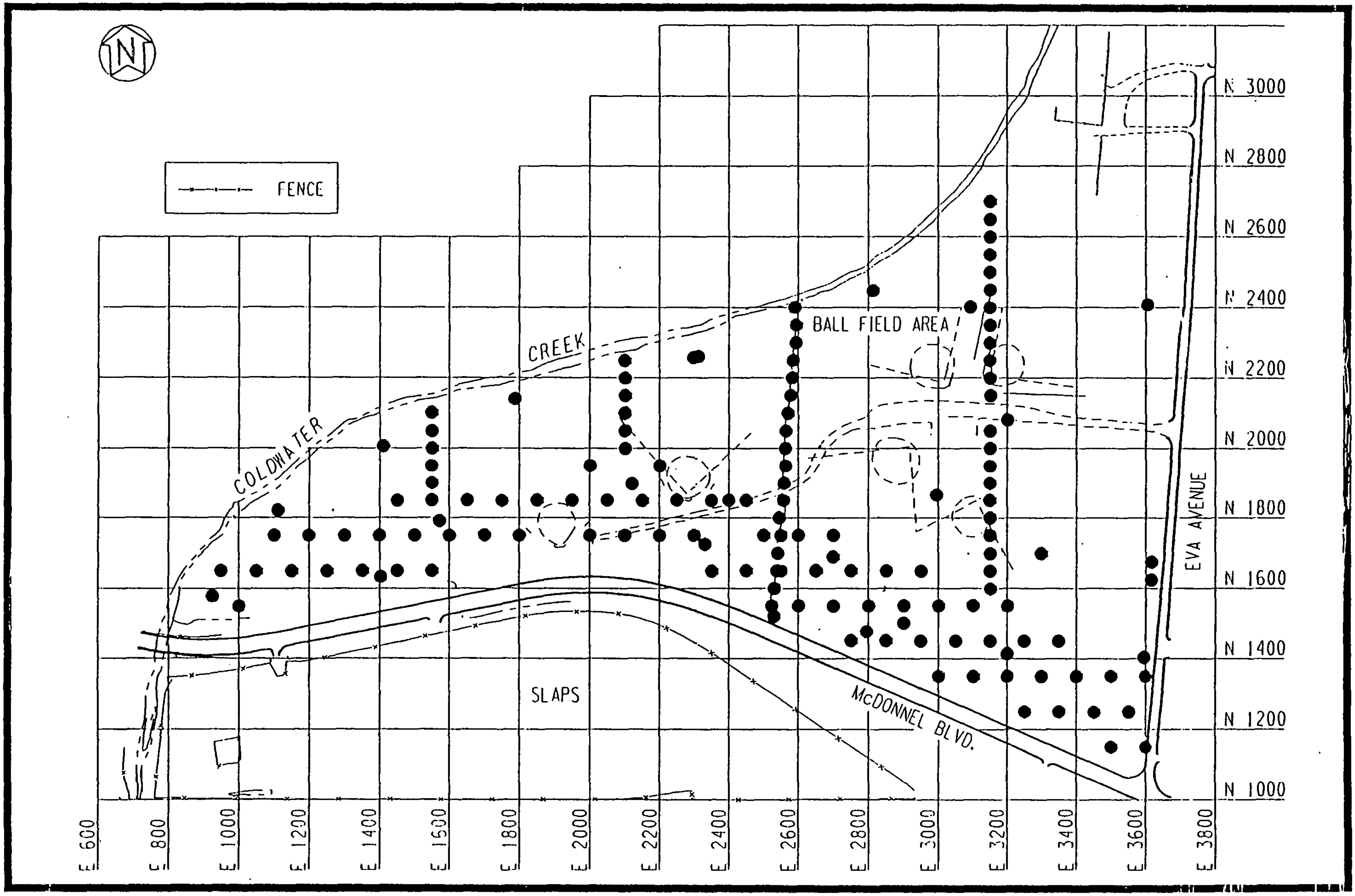
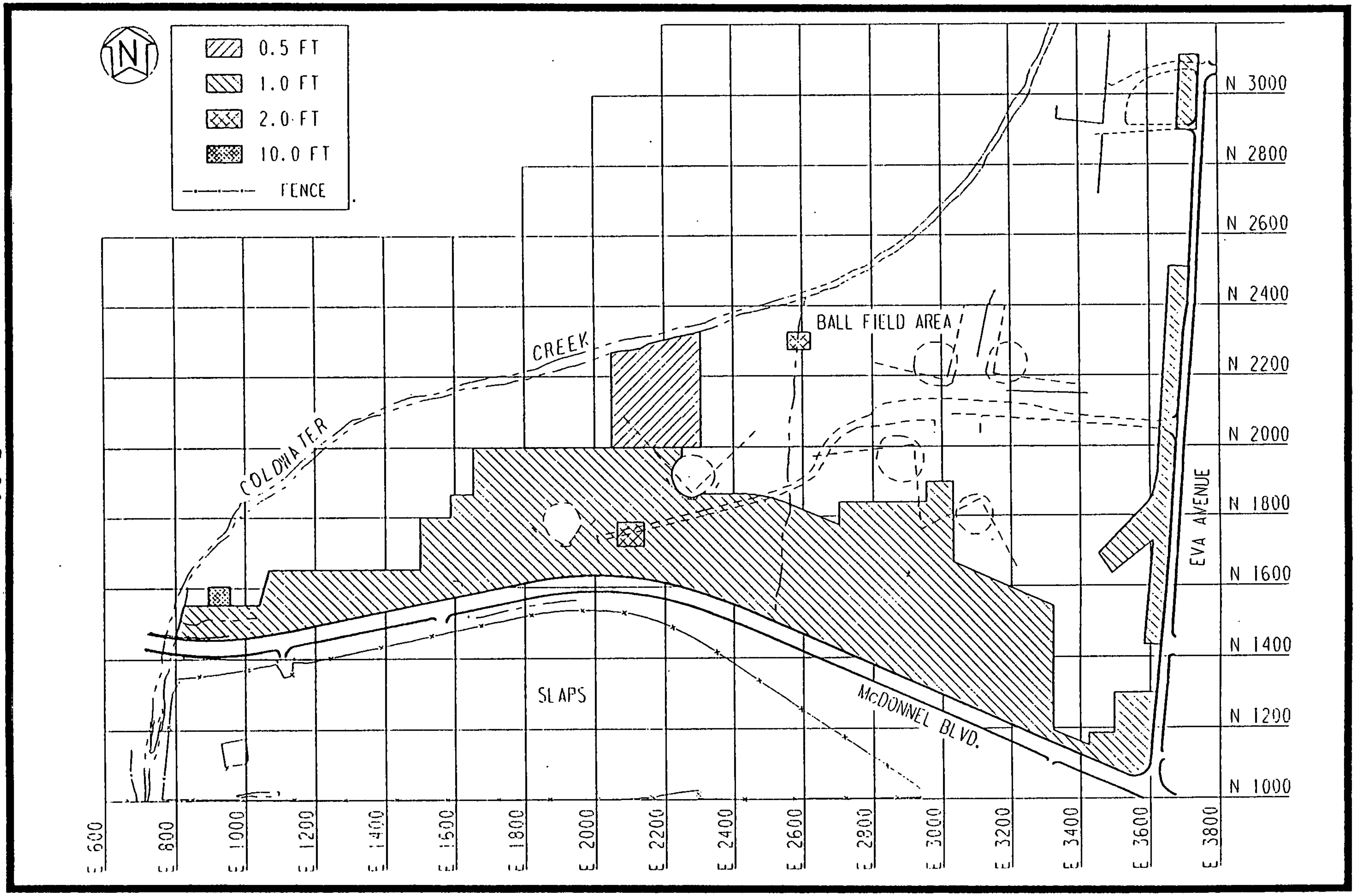


FIGURE 7-11 SUBSURFACE SOIL SAMPLING LOCATIONS FOR RADIOLOGICAL CHARACTERIZATION OF THE BALL FIELD AREA

S 8.DGN



7-26

FIGURE 7-12 AREAS AND DEPTHS OF RADIOACTIVE CONTAMINATION AT THE BALL FIELD AREA

S53WMS18.DGN