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NIAGARA FALLS STORAGE SITE ENVIRONMENTAL MONITORING REPORT

Lewiston, New York

Calendar Year 1984

July 1985

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ENVIRONMENTAL MONITORING REPORT
CALENDAR YEAR 1984

JULY 1985

Prepared for

UNITED STATES DEPARTMENT OF ENERGY

OAK RIDGE OPERATIONS OFFICE

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By

Bechtel National, Inc.

Advanced Technology Division

Oak Ridge, Tennessee

Bechtel Job No. 14501

ABSTRACT

During 1984, an environmental monitoring program was continued at the Niagara Falls Storage Site, a United States Department of Energy (DOE) surplus facility located in Niagara County, New York presently used for the storage of radioactive residues, contaminated soils and rubble. The monitoring program measured radon gas concentrations in air; uranium and radium concentrations in surface water, groundwater, and sediments; and external gamma exposure rates. Environmental samples collected were analyzed to determine compliance with applicable standards. Radiation doses to the public were also calculated.

During 1984, annual average radon concentrations at the site boundary and exclusion area locations of the site were below the DOE Concentration Guide (CG) for uncontrolled areas. Annual average uranium and radium-226 concentrations in groundwater and surface water were below the DOE CG for release to uncontrolled areas. Sediment samples generally showed average concentrations of uranium and radium-226 lower than those measured in past years. External gamma exposure rates were below the DOE Radiation Protection Standards. All radiation doses to the public were within DOE standards.

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ABBREVIATIONS

Ci	Curie
cm/s	centimeters per second
ft	foot
g	gram
gal	gallon
in.	inch
kg	kilogram
m/s	meters per second
mg/l	milligrams per liter
mi	mile
mrem	millirem
uR/h	microRoentgens per hour
pCi/g	picocuries per gram
pCi/l	picocuries per liter
yd^3	cubic yards

1.0 INTRODUCTION

This report presents the findings of the environmental monitoring conducted at the Niagara Falls Storage Site (NFSS) during calendar year 1984. The NFSS is part of the United States Department of Energy (DOE) Surplus Facilities Management Program (SFMP), one of four remedial action programs under the direction of the DOE Division of Remedial Action Projects (DRAP). In addition to the basic site, radioactively contaminated vicinity properties located adjacent to or near the NFSS are the responsibility of the Formerly Utilized Sites Remedial Action Program (FUSRAP), another DOE program under the direction of DRAP.

1.1 LOCATION AND DESCRIPTION

The NFSS occupies approximately 191 acres located in northwestern New York within the Town of Lewiston (Niagara County). The site lies approximately 4 mi south of Lake Ontario, 10 mi north of the city of Niagara Falls and is located in a generally rural setting. Nearby populated areas include the Towns of Lewiston (population: 16,200), Niagara (population: 9,650), and Porter (population: 7,250) (Ref. 1). The NFSS and its regional setting are shown in Figure 1-1.

The site is generally level but slopes gently to the northwest at elevations between 318 and 321 ft above mean sea level (m.s.l.). The site is poorly drained because of the flatness of the terrain and soil characteristics. Soils at NFSS are predominantly silt loams underlain by a clayey glacial till. Sand-gravel inclusions are frequent. Bedrock lies 30 to 50 feet beneath the surface and consists of the thick (1,200 feet) Queenston shale.

All surface water from the site currently discharges via the Central Drainage Ditch and its tributary ditches into Fourmile Creek, located northwest of the site. Groundwater is present in an aquifer at the bedrock surface (the primary aquifer beneath the site), in sand-gravel lenses and in saturated clay zones at depths of 5 to 20 feet. Groundwater level contours indicate a slope of the primary aquifer to

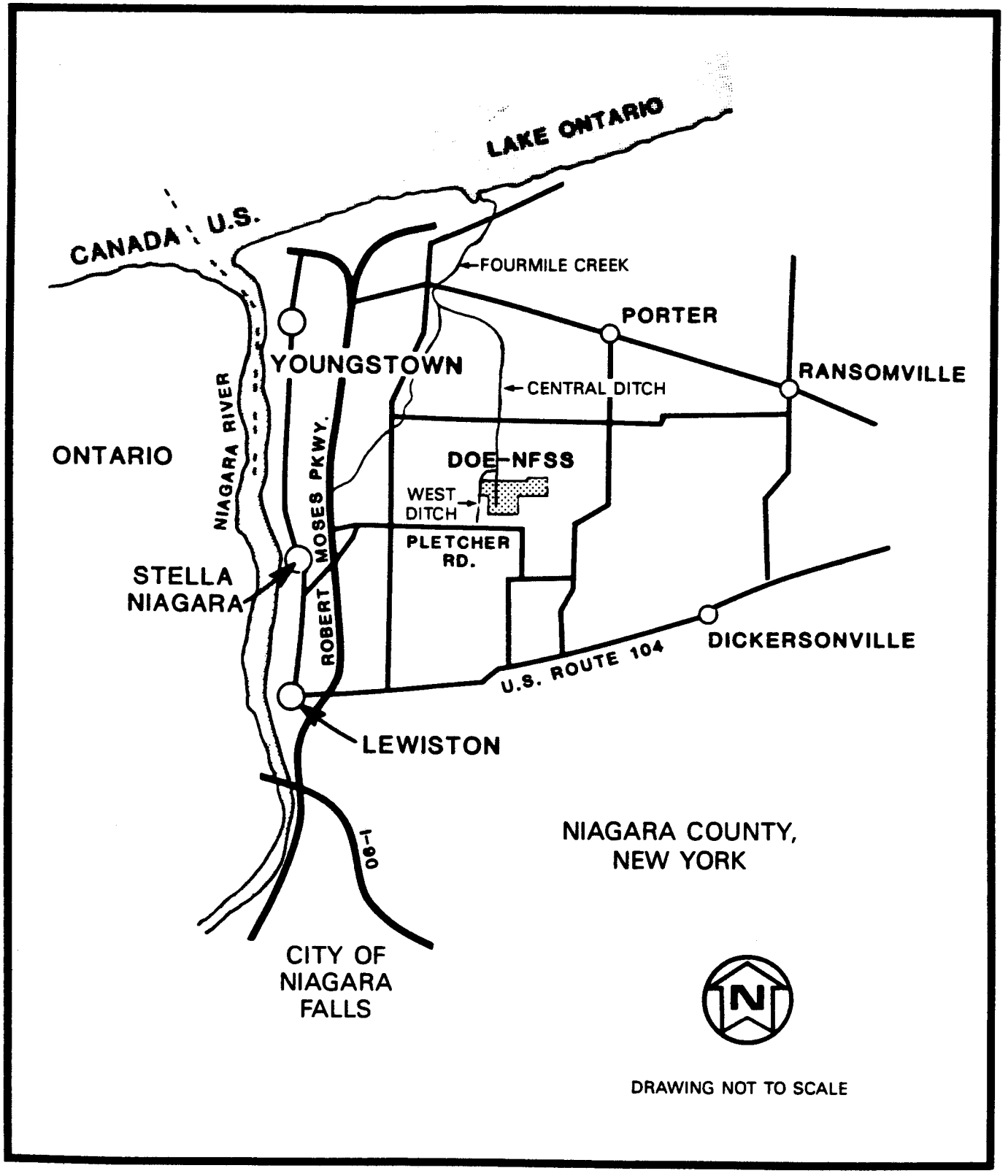

FIGURE 1-1 THE REGIONAL SETTING OF THE NIAGARA FALLS STORAGE SITE (NFSS)

the north-northwest of approximately 10 feet per mile. The groundwater discharges into the northern reaches of the Niagara River close to Lake Ontario (Ref. 2).

1.2 SITE HISTORY

The NFSS is a remnant of an original 1,511-acre site which was used by the World War II Manhattan Engineer District (MED) project and was a portion of the Department of the Army's Lake Ontario Ordnance Works (LOOW). Except for non-radioactive boron-10 enriching operations during the periods 1954 to 1958 and 1964 to 1971, the site's major use from 1944 to the present has been for storage of radioactive residues produced as by-products of uranium production during the MED project and subsequent Atomic Energy Commission (AEC) projects.

The first materials to arrive at the site were low-grade residues and by-products from the Linde Air Products Division in Tonawanda, New York (the L-30, L-50, and R-10 residues) and from the Middlesex Sampling Plant in Middlesex, New Jersey (the F-32 residues). The L-30 and L-50 residues were stored in Buildings 411, 413, and 414, while the F-32 residues were stored in the Recarbonation Pit directly west of Building 411. The R-10 residues, as well as associated iron cake, were stored in an open area north of Building 411 at NFSS, subject to environmental processes which transported contaminants into the soil and drainageways, resulting in the contamination of other portions of the site and off-site drainageways. The small quantity of Middlesex Sands resulting from decontamination activities at the Middlesex Sampling Plant, were stored in Building 410. In 1949, pitchblende residues (the K-65 residues) resulting from uranium extraction conducted at a St. Louis plant were transported to the LOOW in drums. Some of these were stored outdoors along existing roads and rail lines; others were stored in Building 410. From 1950 to 1952, the K-65 residues were transferred to a renovated concrete water tower (Building 434).

The weight and volume of the residues and sands stored at NFSS are summarized in Table 1-1. Buildings and other features of the NFSS

prior to recent interim remedial actions are illustrated in Figure 1-2.

In 1979, Battelle Columbus Laboratories was subcontracted to perform a comprehensive radiological survey of the NFSS. Battelle published its findings in June 1981 (Ref. 3), and the report served as the basis for initial interim remedial action planning at the site. Bechtel National, Inc. (BNI) was chosen by DOE as the Project Management Contractor (PMC) for the NFSS project in 1981. As part of its duties as PMC, BNI maintains the security of the site, performs maintenance as required, carries out the environmental monitoring program, and helps plan and execute the interim remedial action program for the site. Daily inspections of the site are performed by the BNI Site Operations Supervisor permanently stationed at the facility. Access to the site is controlled by a 7-ft-high fence which encloses the DOE property.

Since 1980, various steps have been taken at the NFSS to minimize potential radiological risks and prevent migration of residues. In the fall of 1980, the vent at the top of Building 434 (the former water tower in which the K-65 residues are stored) was capped to reduce radon emissions to the environment. Also during 1980, all pipes penetrating the walls of the residue storage buildings were sealed or resealed as necessary to prevent radionuclide migration. In mid-1981, because radon levels at the site's western boundary were exceeding DOE limits, the site fence was re-located approximately 150 m (500 ft) to the west, creating an exclusion area to protect the public from exposure to the higher radon levels. Radon levels at the site's new boundary were well below applicable guidelines.

Also in 1981, remedial action was performed on a triangular-shaped area located just off the NFSS in an area bounded by Vine and O Streets and Castle Garden Road. Approximately 450 yd^3 of contaminated material were excavated from this vicinity property and were relocated to the R-10 waste storage area.

To further reduce the levels of radon emanating from the site, in 1982 Buildings 413 and 414 (used for storing the L-50 residues) were

TABLE 1-1

RESIDUES STORED AT THE NFSS, 1984[a]

Residue	Weight (tons)	Volume (yd^3)
K-65	3,891	4,080
L-30	8,227	7,960
L-50	1,878	2,150
F-32	138	440
R-10	8,235	9,400
Middlesex Sands	2	229

[a]Battelle, 1981 (Ref. 3).

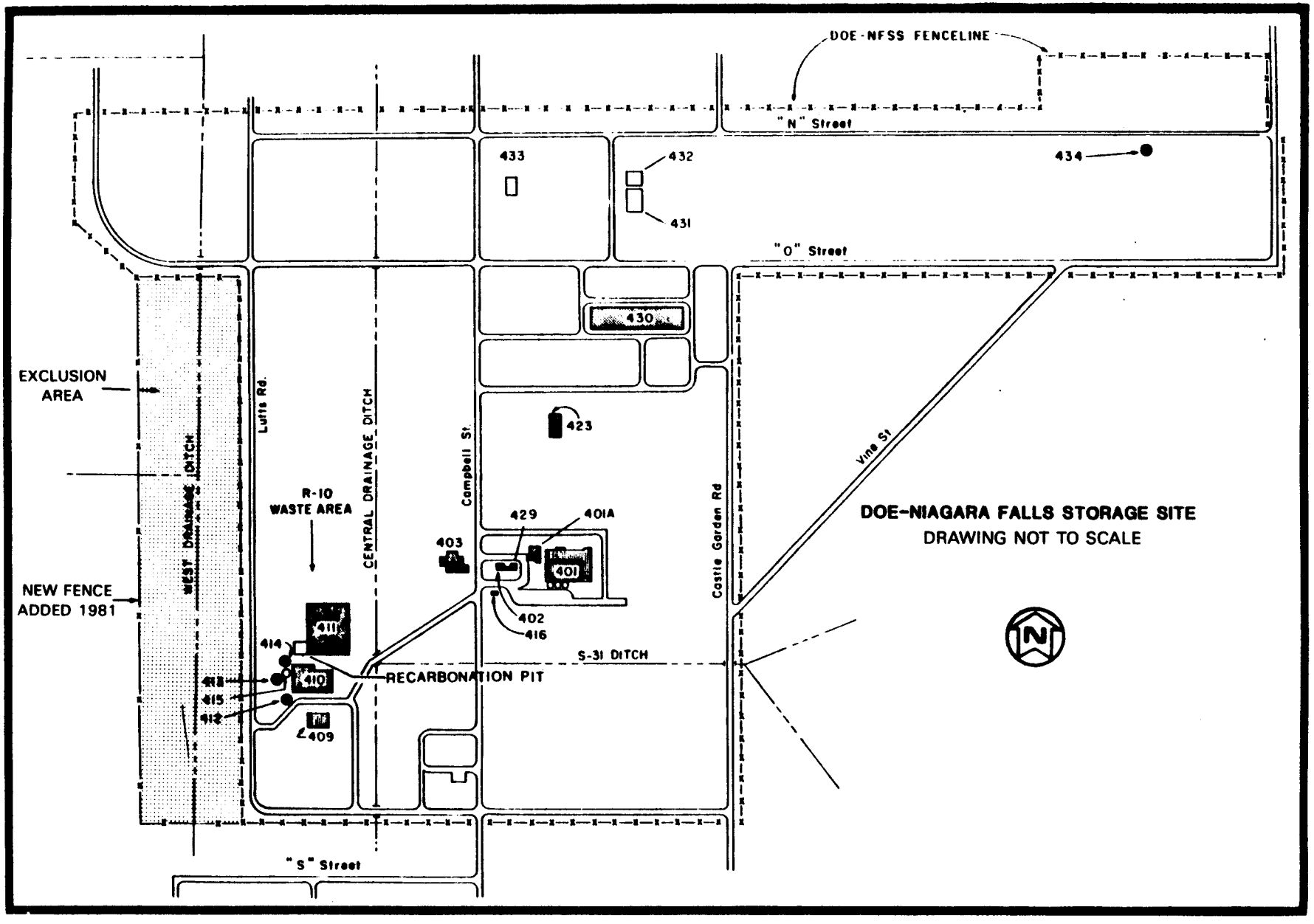

FIGURE 1-2 DIAGRAM OF THE NFSS SHOWING STRUCTURES AND FEATURES OF THE SITE PRIOR TO INTERIM REMEDIAL ACTIONS

upgraded and sealed. Also in 1982, to prevent further migration of residues, contaminated soil near the R-10 pile was moved onto the pile, and a dike and cutoff wall were constructed around the R-10 area. The R-10 pile was then covered with an ethylene propylene diene monomer (EPDM) liner, which resulted in a marked reduction in radon emanations from the R-10 area.

1.3 AREA ENVIRONMENTAL CONDITIONS

The climate of the NFSS is classified as humid continental, with considerable moderating influence from Lake Ontario. The normal temperature range is 25°F to 76°F, with a mean annual temperature of 48°F. Mean annual precipitation is 32 in. Snowfall averages 56 in. per year, accounting for about ten percent of the annual total precipitation.

Wind speeds and directions measured at the site during 1984 are shown in Figure 1-3. The data show that the wind originates predominantly from a 45° sector that includes west, west-southwest and southwest directions approximately 42 percent of the time. Wind speeds in this sector ranged from calm (less than 1 mph) to as high as 25 mph, with the most common wind speeds between 4 to 11 mph.

1.4 1984 SITE ACTIVITIES

During 1984, interim remedial actions involved the excavation of approximately 27,000 yd^3 of contaminated materials from on-site and off-site contaminated areas and off-site drainage areas. These materials were relocated to the interim Waste Containment Area (formerly the R-10 waste storage area). Other 1984 activities included: preparation of Building 411 to accept the K-65 residues; transfer of approximately 93 percent of the K-65 residues from Building 434 to Building 411; demolition of Building 410; demolition of the upper section of Building 415; and the discharge of approximately 2,500,000 gallons of construction water in accordance with the permit requirements of the New York Department of Environmental Conservation (NYDEC).

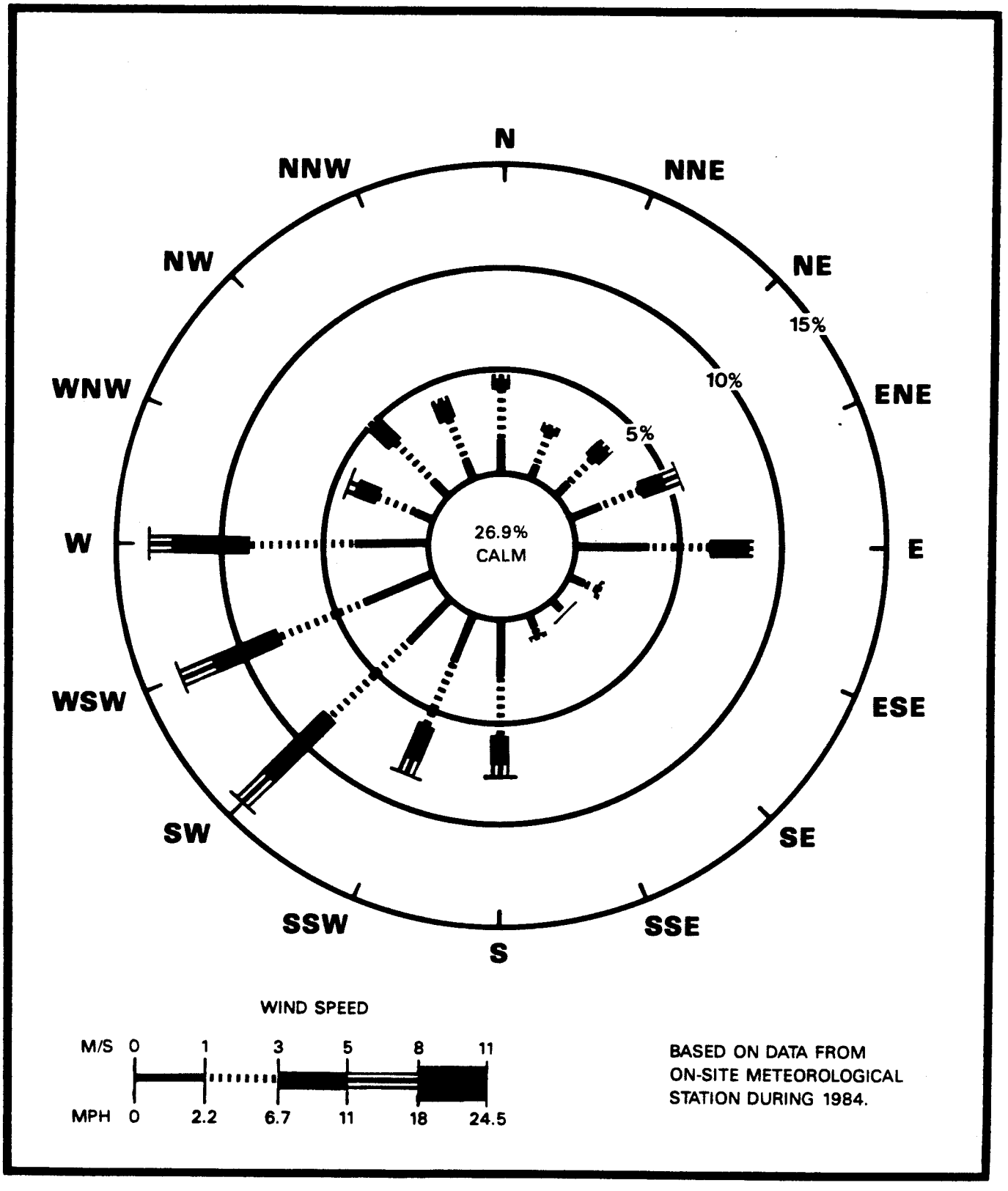

FIGURE 1-3 ANNUAL WIND ROSE FOR NFSS, 1984

2.0 SUMMARY OF MONITORING RESULTS

During 1984, the environmental monitoring program at the NFSS continued to sample air, water, and sediments, and external gamma rates were monitored to determine the site's compliance with DOE Concentration Guides (CGs) provided in DOE Order 5480.1A, Chapter XI (Ref. 4). The CGs in most cases represent the concentration of a radionuclide in air or water that would limit the dose to the most highly exposed individual to equal to or less than accepted radiation protection standards. The DOE CGs for radionuclides of concern at NFSS and the DOE Radiation Protection Standard (RPS) values are included in Appendix A of this report. Radiation doses were calculated to determine hypothetical exposure levels, which were compared to the DOE RPS.

Radon gas concentrations at all site boundary and exclusion area monitoring locations were below the DOE CG annual average of 3 pCi/l. Annual averages ranged from 0.34 to 1.04 pCi/l. The highest annual average recorded at the site was equal to 35 percent of the CG. Comparison of 1984 with 1983 radon concentrations shows similar radon levels.

In surface waters, all samples had uranium and radium-226 concentrations below the DOE CGs for release to uncontrolled areas. Uranium levels were 3 percent or less of the CG of 600 pCi/l. Radium-226 levels were 1 percent or less of the CG of 30 pCi/l.

For groundwater, the highest annual average concentration of uranium covering a complete year of sampling was 55 pCi/l in an on-site well. This is 9 percent of the DOE CG of 600 pCi/l for uranium released to uncontrolled areas. The highest uranium concentration at any off-site well was only 1 percent of the CG. The highest annual average concentration of radium-226 was 0.4 pCi/l, or 1 percent of the DOE CG of 30 pCi/l for radium-226 released to uncontrolled areas. The highest annual average concentration of uranium in sediment at any sampling location was 2.2 pCi/g. The highest annual average concentration of radium-226 in sediments was

1.0 pCi/g. While there are no specific limits for radionuclides in sediments, these levels are well below the DOE FUSRAP proposed guidelines for cleanup of soils containing these radionuclides (Ref. 6).

The highest annual average external gamma exposure rate recorded at the site boundary was 28.2 uR/h. This equals approximately 50 percent of the DOE RPS of 60 uR/h (Ref. 4), and may be compared to the normal background range of 10-15 uR/h (Ref. 5).

Radiological doses received by a hypothetical maximally exposed individual were calculated. Two exposure pathways were quantified: ingestion of contaminated surface or groundwater, and exposure to external gamma radiation. The dose to the maximally exposed individual from ingestion of groundwater would result in a 50 year dose commitment to the bone surface, which is the critical organ, of less than 5 mrem. For comparison, ingestion of water containing concentrations of uranium equal to the DOE CG for uncontrolled areas (600 pCi/l) would result in a committed dose of 490 mrem.

External gamma radiation from radioactive materials at the NFSS contributed 15.7 uR/h to the measured exposure rate. This produces a dose of 33 mrem to the total body, compared to the DOE Radiation Protection Standard of 500 mrem/yr.

Results of the 1984 monitoring show that the NFSS presently is in compliance with all DOE CG and RPS limits.

3.0 DATA COLLECTION, ANALYSIS, AND EVALUATION

This section provides the results of 1984 environmental monitoring at the NFSS, including the sampling, monitoring, and analytical procedures and the extent of conformance with applicable DOE CGs and standards. The CGs in most cases represent the concentration of a radionuclide in air or water that would limit the dose to the most highly exposed individual to equal to or less than accepted radiation protection standards. Radiation doses were calculated to determine hypothetical exposure levels, which were compared to the DOE RPS values. DOE CGs for radionuclides of concern at NFSS and DOE RPS values are included in Appendix A of this report.

The average values listed in the individual tables are the arithmetic average of the sum of individual results. Individual sources of error (i.e., analytical error, sampling error, etc.) were not estimated. In computing the averages, where values are less than the limit of sensitivity of the analytical method, values are considered as being equal to the limit of sensitivity and the "average" value is reported without the notation "less than."

During 1984, air, water, and sediment samples were collected by site personnel and external radiation exposure rates were measured to determine the radioactivity concentrations in the environs of the site. Supplemental radon monitoring was conducted at the NFSS and off-site areas by Mound Laboratory, operated for DOE by Monsanto Research Corporation, Miamisburg, Ohio.

Supplemental radon and external gamma monitoring was conducted for the transfer of the radioactive K-65 residues from Building 434 to Building 411 within the Waste Containment Area. A summary of the results of this program is provided in Appendix B.

3.1 RADON GAS SAMPLING

Thirty-four radon gas detectors are maintained on-site and at site boundary locations at the NFSS, with three of the detectors (31, 32,

and 33) designated as quality control stations. The locations of the radon monitors are shown in Figure 3-1.

The radon gas monitors are Terradex Type-F Track-Etch detectors. Detectors are obtained from the Terradex Corporation, placed at the sample locations and collected by site personnel, then returned to Terradex for analytical services.

Table 3-1 reports the average concentrations of radon gas in the air recorded at site boundary monitoring locations and the exclusion area (established in 1981 when a portion of the site's western fence line was relocated further west). Annual average concentrations ranged from 0.34 to 1.04 pCi/l, with the highest annual average equal to 35 percent of the DOE CG of 3 pCi/l annual average. Radon levels were consistent from 1983 to 1984. Annual averages in 1983 ranged from 0.37 to 0.89 pCi/l; in 1984, averages ranged from 0.34 to 1.04 pCi/l. Radon levels measured during monitoring conducted for the K-65 residue transfer are provided in Appendix B.

3.1.1 Supplemental Radon Monitoring

Mound Laboratories also performed radon monitoring at NFSS during 1984 at 12 locations on the site perimeter, 2 locations in the exclusion area, and 30 off-site locations. Mound's program uses passive environmental radon monitors (PERMs), which have a thermoluminescent dosimeter (TLD) as the detection element. The TLDs are changed on a weekly basis.

Figure 3-2 shows the locations of the 14 site boundary/exclusion area PERMs and 22 of the off-site locations. The remaining 8 off-site locations are shown in Figure 3-3. The results from the on-site monitors are presented in Table 3-2. Annual averages ranged from 0.23 to 0.45 pCi/l, with the highest annual average equal to 14 percent of the DOE CG of 3 pCi/l annual average for uncontrolled areas.

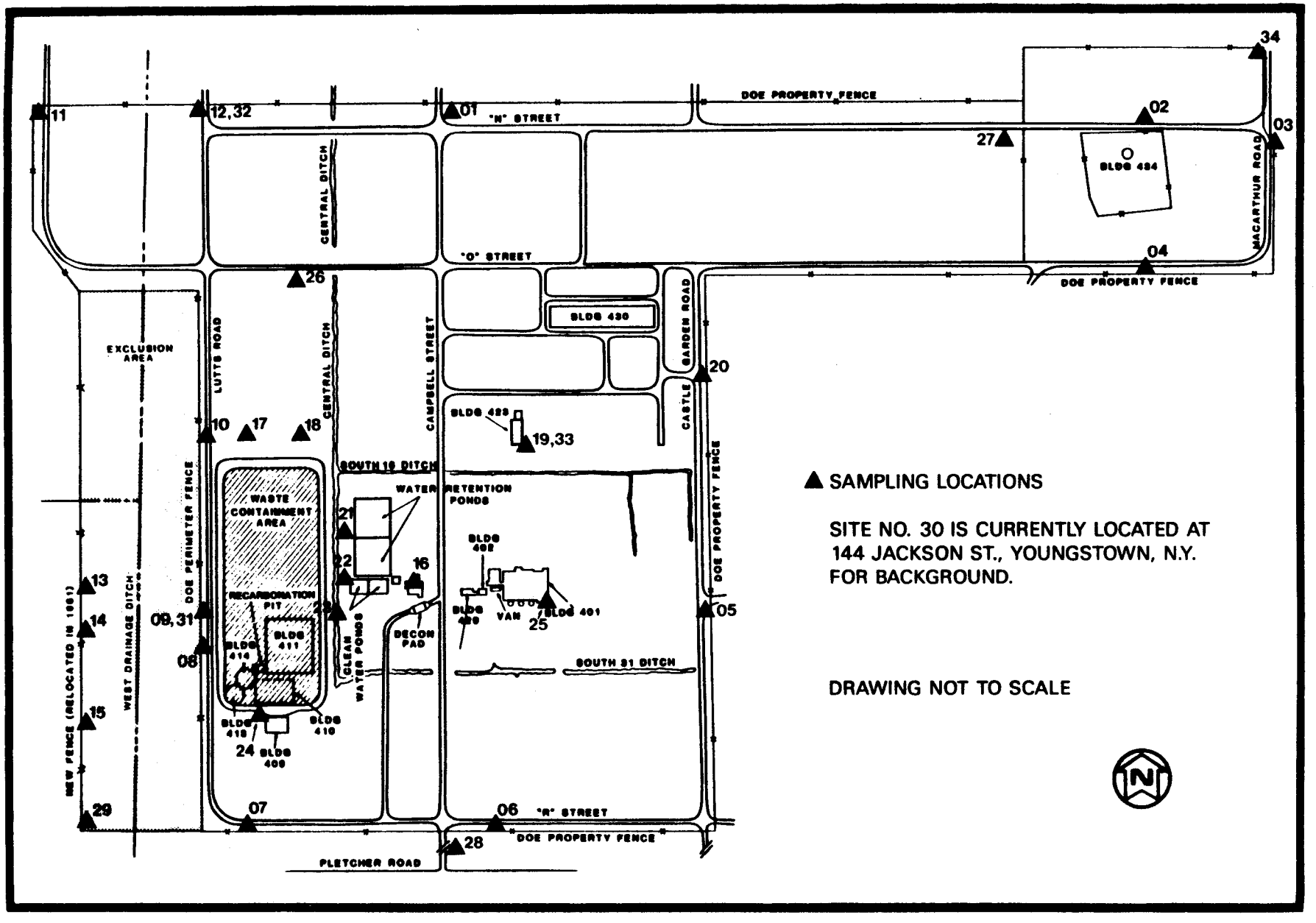

FIGURE 3-1 RADON AND EXTERNAL GAMMA MONITORING LOCATIONS AT NFSS

TABLE 3-1

MONTHLY AND ANNUAL AVERAGE RADON-222 CONCENTRATIONS AT SITE BOUNDARY AND EXCLUSION AREA LOCATIONS AT NFSS USING TERRADEX MONITORS, 1984[a]

Month	Sampling Location[b]																				
	1	3	4	5	6	7	8	9	10	11	12	13	14	15	20	28	29	30[d]	31	32	34
	Concentrations in picocuries per liter (pCi/l)																				
January	0.62	0.30	0.70	0.54	0.06	0.22	0.38	0.54	0.54	0.30	0.62	0.22	0.46	0.30	0.22	0.54	0.30	0.30	0.30	0.30	0.14
February	0.48	0.35	0.35	0.66	0.66	0.35	0.48	0.72	0.66	0.23	0.35	0.56	0.25	0.55	0.83	1.78	0.51	1.35	0.66	2.14	0.35
March	0.77	0.88	0.54	0.13	0.43	0.54[c]	1.11[c]	0.43[c]	0.43	0.54	0.77[c]	3.73	1.50	2.01[c]	0.20	0.13	0.64	0.60	1.00	0.43	0.43
April	0.40	0.58	0.23	0.49	0.58	0.23	0.58	0.15	0.32	0.49	0.06	0.49	0.32	0.40	0.06	0.32	0.40	0.16	2.07	0.37	0.40
May	0.37	0.83	0.37	0.21	0.29	0.06	0.99	0.44	0.13	0.44	0.60	0.91	0.21	0.13	0.37	0.13	0.21	0.06	0.13	0.37	0.52
June	1.03	0.88	0.43	0.43	0.65	0.88	0.58	1.48	0.58	0.50	0.43	0.20	0.13	0.43	0.88	0.58	0.13	5.62	1.26	2.16	1.41
July	0.39	0.26	0.26	0.12	0.60	0.32	0.81	0.46	0.60	0.19	0.53	0.24	0.11	0.50	0.26	0.60	0.18	0.60	0.39	0.53	0.32
August	2.28	0.97	1.78	1.37	0.87	0.57	0.77	0.97	0.77	0.57	0.37	0.39	0.91	0.18	0.47	0.57	0.81	0.67	0.37	0.67	0.37
September	0.56	0.27	0.42	0.34	0.34	0.20	0.27	0.27	0.27	0.12	0.34	0.35	0.05	0.28	0.49	0.49	0.73	0.50	0.56	0.34	0.20
October	2.62	1.66	0.70	1.18	0.78	0.38	1.26	0.94	0.22	0.46	0.78	0.83	0.75	0.75	0.94	0.30	0.60	1.37	1.26	1.02	0.38
November	0.08	0.68	0.60	0.28	0.50	0.43	0.35	0.58	0.58	0.21	0.21	0.35	0.43	0.28	0.13	0.43	0.20	0.43	0.13	0.68	0.60
December	0.52	0.29	0.44	0.38	0.06	0.06	1.22	0.22	0.72	0.06	0.21	0.30	0.46	0.06	0.54	0.46	0.30	0.62	0.31	3.47	0.37
Annual Average	0.89	0.66	0.57	0.51	0.49	0.35	0.73	0.60	0.49	0.34	0.44	0.71	0.47	0.49	0.45	0.53	0.42	1.02	0.70	1.04	0.46
No. of Measurements	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
Percent of Standard[e]	30	22	19	17	16	12	24	20	16	11	15	24	16	16	15	18	14	34	23	35	15

[a]Measurements are total radon concentrations and background has not been subtracted. Sampling locations 8, 9, 10 and 31 are at the site's original boundary and are now in a controlled area. Sampling locations 13, 14 and 15 are located at the perimeter of the new exclusion area established October 1, 1981.

[b]Sampling locations are shown in Figure 3-1.

[c]Exposure time 14 to 21 days.

[d]Background detector located at 144 Jackson St. Youngstown, New York. Detector believed to have been exposed inside a building during the month of June and the radon-222 values recorded cannot be used to estimate natural background.

[e]The DOE CG limit for radon-222 is 3.0 pCi/l annual average for uncontrolled areas. Percentage has been rounded to the nearest whole number.

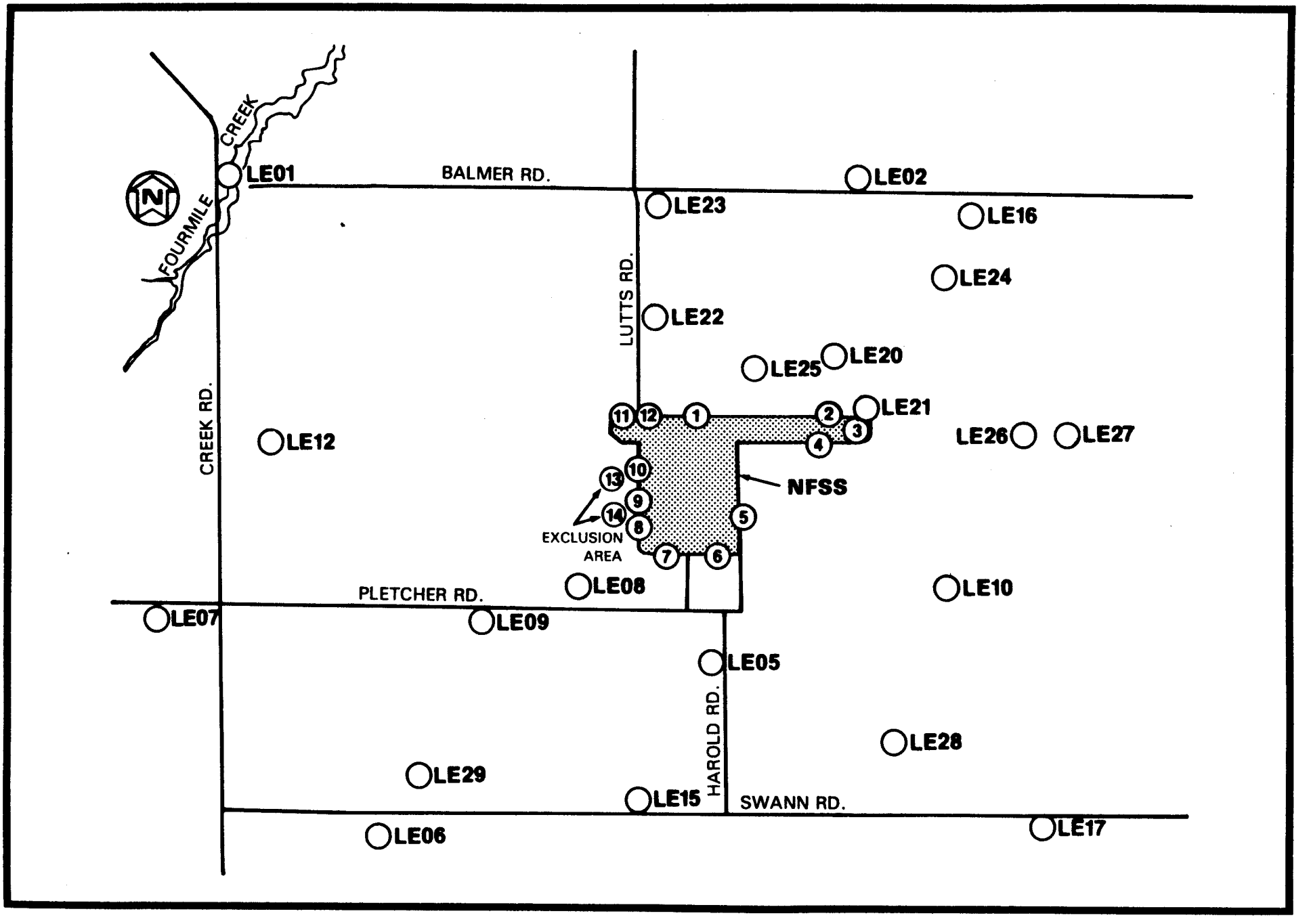

FIGURE 3-2 SITE BOUNDARY, EXCLUSION AREA, AND 22 OFF-SITE PERM LOCATIONS

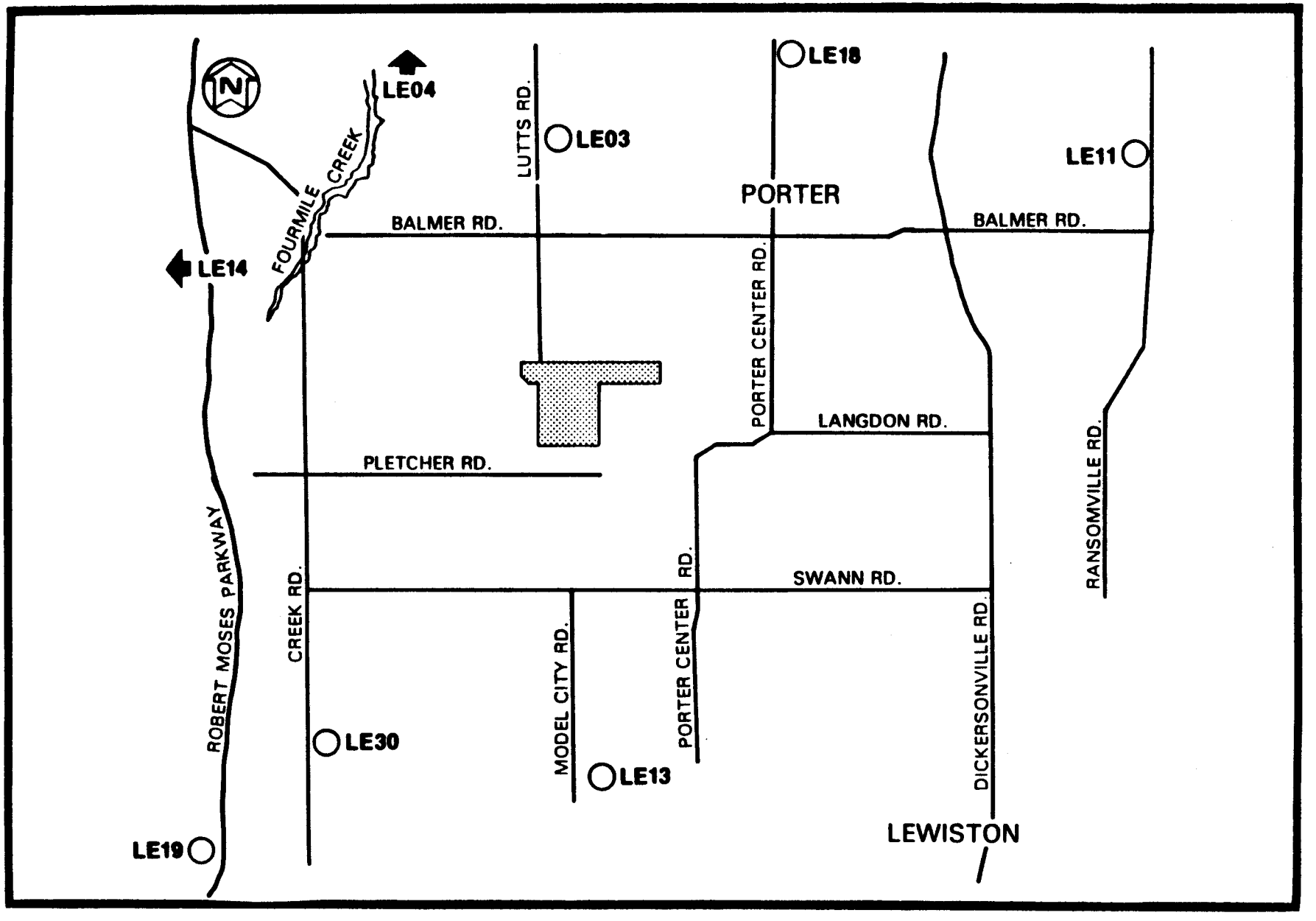

FIGURE 3-3 LOCATION OF EIGHT OFF-SITE PERMS 2000 METERS OR FURTHER FROM NFSS

TABLE 3-2

SUMMARY OF RADON-222 DATA FOR SITE BOUNDARY AND EXCLUSION AREA LOCATIONS, USING PASSIVE ENVIRONMENTAL RADON MONITORS, NFSS, 1984[a]

Sampling Location[b]	Concentration (pCi/l)							Percent of Standard[c] (Annual Average)
	Quarterly Averages				Minimum	Maximum	Average	
	1st	2nd	3rd	4th				
1	0.25	0.22	0.48	0.46	0.22	0.48	0.37	12
2	0.22	0.28	0.68	0.48	0.22	0.68	0.45	14
3	0.22	0.33	0.46	0.38	0.22	0.46	0.36	12
4	0.28	0.32	0.46	0.34	0.28	0.46	0.35	12
5	0.19	0.22	0.46	0.39	0.19	0.46	0.32	11
6	0.17	0.25	0.50	0.36	0.17	0.50	0.33	11
7	0.22	0.28	0.48	0.39	0.22	0.48	0.36	11
8[d]	0.39	0.29	0.52	0.48	0.29	0.52	0.43	14
9[d]	0.49	0.36	0.45	0.41	0.36	0.49	0.43	14
10[d]	0.18	0.30	0.41	0.43	0.18	0.43	0.33	11
11	0.18	0.20	0.38	0.41	0.18	0.41	0.31	10
12	0.22	0.21	0.48	0.42	0.21	0.48	0.35	11
13	0.18	0.21	0.49	0.37	0.18	0.49	0.31	10
14	0.18	0.24	0.42	0.49	0.18	0.49	0.35	11
Background	0.16	0.19	0.29	0.25	0.16	0.29	0.23	7

[a]Measurements by Mound Laboratory, Monsanto Research Corporation. These measurements are total radon concentrations and background has not been subtracted.

[b]Sampling locations are shown in Figure 3-2.

[c]The DOE CG for radon-222 is 3 pCi/l annual average for uncontrolled areas.

[d]Monitoring locations are within a controlled area where members of the public cannot enter.

Results from the 30 off-site PERMs are presented in Table 3-3. Annual averages for off-site monitors ranged from 0.20 to 0.37 pCi/l. The highest annual average is equal to 11 percent of the DOE CG for release of radon to uncontrolled areas. The average natural background for the NFSS area, measured by Mound Laboratory with PERMs, was 0.22 pCi/l.

3.2 WATER SAMPLING

During 1984, sampling was performed to determine the concentrations of uranium and radium in surface water and groundwater at both on-site and off-site locations. On-site sampling locations are shown in Figure 3-4 and off-site locations are shown in Figure 3-5. The results of analyses for uranium for all sampling locations are presented in Table 3-4 and radium results are presented in Table 3-5.

During 1984, groundwater samples were collected quarterly from 16 on-site wells and annually from 3 off-site wells. Wells BH-5, BH-48, BH-49, BH-51, BH-53, BH-64, BH-67, BH-69, and BH-70 monitor the lower aquifer. Wells BH-68 and BH-71 monitor the bedrock aquifer. Wells A-42, A-50, and A-52 monitor the upper aquifer around the interim waste storage area. Well BH 48 is a background upgradient monitoring location and well BH-61 is a downgradient monitoring location.

Groundwater samples were collected 24 hours after the wells had been pumped "dry" or two casing volumes had been removed. Samples were collected using an airlift system the first and second quarters. Potential problems resulting from air pressure resulted in the use of a hand bailer the third and fourth quarters. Samples were analyzed by Eberline Analytical Corporation (EAC) for total uranium (by fluorometry) and dissolved radium-226 (by radon emanation).

Results of analyses for concentrations of uranium in groundwater are included in Table 3-4, and radium results are included in Table 3-5. Because of the limited size of the site, the proximity of the wells to the site boundary, and the lack of control over movement of

TABLE 3-3

SUMMARY OF RADON-222 DATA FOR OFF-SITE LOCATIONS,

USING PASSIVE ENVIRONMENTAL RADON MONITORS, NFSS, 1984[a]

Sampling Location[b]	Concentration (pCi/l)							Percent of Standard (Annual Average)
	Quarterly Averages				Minimum	Maximum	Average	
	1st	2nd	3rd	4th				
LE01[c]	0.16	0.20	0.35	0.28	0.16	0.35	0.25	8
LE02	0.18	0.17	0.42	0.31	0.17	0.42	0.27	9
LE03	0.20	0.21	0.49	0.36	0.20	0.49	0.32	10
LE04[c]	0.14	0.24	0.27	0.23	0.14	0.27	0.22	7
LE05	0.17	0.19	0.42	0.38	0.17	0.42	0.31	10
LE06	0.17	0.18	0.35	0.26	0.17	0.35	0.25	8
LE07[c]	0.17	0.19	0.34	0.35	0.17	0.35	0.27	9
LE08	0.23	0.24	0.49	0.41	0.23	0.49	0.37	11
LE09	0.21	0.25	0.52	0.38	0.21	0.52	0.36	11
LE10	0.20	0.25	0.44	0.36	0.20	0.44	0.33	10
LE11[c]	0.17	0.18	0.28	0.24	0.17	0.28	0.22	7
LE12	0.18	0.27	0.31	0.29	0.18	0.31	0.27	9
LE13[c]	0.20	0.21	0.27	0.21	0.20	0.27	0.22	7
LE14[c]	0.16	0.19	0.27	0.23	0.16	0.27	0.22	7
LE15	0.14	0.17	0.28	0.31	0.14	0.31	0.23	8
LE16	0.18	0.28	0.39	0.30	0.18	0.39	0.29	10
LE17[c]	0.15	0.17	0.34	0.28	0.15	0.34	0.24	8
LE18[c]	0.13	0.15	0.26	0.22	0.13	0.26	0.20	6
LE19[c]	0.15	0.16	0.23	0.30	0.15	0.30	0.20	7
LE20	0.20	0.19	0.29	0.30	0.19	0.30	0.26	8
LE21	0.23	0.34	0.37	0.35	0.23	0.37	0.32	11
LE22	0.15	0.20	0.36	0.36	0.15	0.36	0.27	9
LE23	0.15	0.20	0.49	0.37	0.15	0.49	0.31	10
LE24	0.20	0.18	0.30	0.34	0.18	0.34	0.26	9
LE25	0.17	0.16	0.48	0.33	0.16	0.48	0.29	10
LE26	0.18	0.22	0.50	0.34	0.18	0.50	0.32	10
LE27	0.18	0.23	0.48	0.38	0.18	0.48	0.32	11
LE28	0.17	0.18	0.36	0.33	0.17	0.36	0.27	9
LE29	0.15	0.17	0.37	0.28	0.15	0.37	0.25	8
LE30[c]	0.16	0.21	0.26	0.28	0.16	0.28	0.23	8
Background	0.16	0.19	0.29	0.25	0.16	0.29	0.22	7

[a]Measurements by Mound Laboratory, Monsanto Research Corporation.

[b]Sampling locations are shown in Figures 3-3 and 3-4.

[c]These locations form a control group for measuring background radon levels. Values ranged from 0.13 to 0.35 pCi/l and averaged .22 pCi/l for 1984 average natural background. The DOE CG for radon-222 is 3 pCi/l annual average for uncontrolled areas.

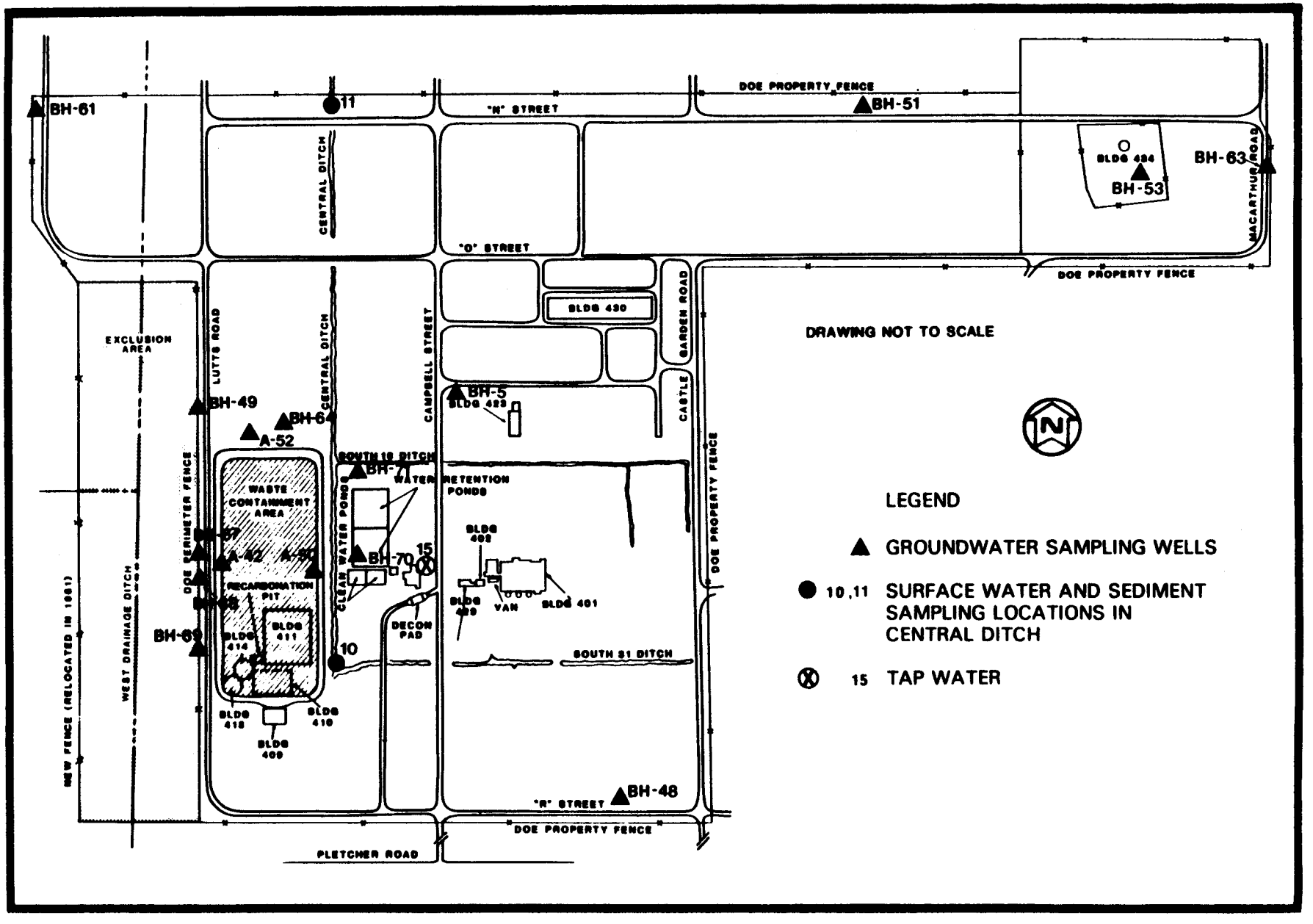

FIGURE 3-4 ON-SITE SURFACE WATER AND GROUNDWATER SAMPLING LOCATIONS

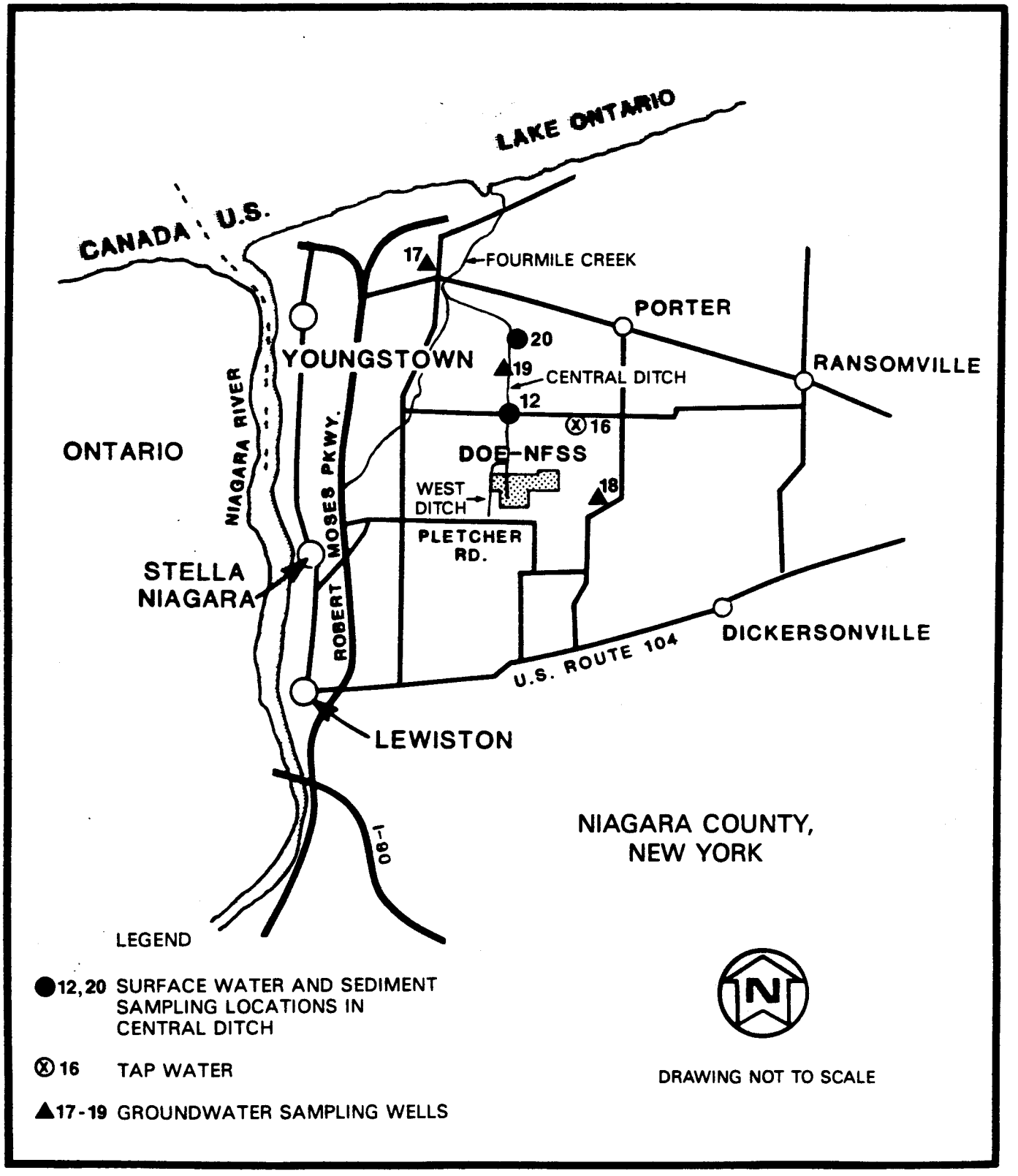

FIGURE 3-5 OFF-SITE WATER SAMPLING LOCATIONS

TABLE 3-4

DISSOLVED URANIUM CONCENTRATIONS IN NFSS WATER SAMPLES, 1984

Sampling Location[a]	Concentration (pCi/l) Quarter 1st	2nd	3rd	4th	Minimum	Maximum	Average	Percent of Standard[b] (Annual Average)
On-Site Groundwater								
BH-5	3	3	3	3	3	3	3	0.5
BH-48	5	9	7	4	4	9	6	1.0
BH-49	3	3	3	3	3	3	3	0.5
BH-51	5	9	8	6	5	9	7	1.0
BH-53	3	3	4	3	3	4	3	0.5
BH-61	3	3	6	3	3	6	4	0.7
BH-63	-c-	-c-	3	3	3	3	3	0.5
BH-64	10	14	11	17	10	17	13	2.0
BH-67	3	3	3	-d-	3	3	3	0.5
BH-68	16	20	41	14	14	41	23	4.0
BH-69	3	-e-	-e-	3	3	3	3	0.5
BH-70	5	13	6	3	3	13	7	1.0
BH-71	3	4	5	3	3	5	4	0.7
A-42	61	49	55	55	49	61	55	9.0
A-50	5	5	5	3	3	5	5	0.8
A-52	-f-	-f-	-f-	73	73	73	73	12.0
Off-Site Groundwater								
17[g]	3	--	--	--	3	3	3	0.5
18[g]	7	--	--	--	7	7	7	1.0
19[g]	-h-	--	--	--	--	--	-h-	-h-
On-Site Surface Water								
10	15	16	30	14	14	30	19	3
11	3	3	3	-i-	3	3	3	0.5
Off-Site Surface Water								
12	9	-i-	3	11	3	11	8	1
20	8	20	3	10	3	20	10	2

TABLE 3-4

(Continued)

Sampling Location[a]	Concentration (pCi/l) Quarter 1st	2nd	3rd	4th	Minimum	Maximum	Average	Percent of Standard[b] (Annual Average)
On-Site Tap Water								
15	3	3	3	3	3	3	3	0.5
Off-Site Tap Water								
16[g]	3	--	--	--	3	3	3	0.5

[a]Sampling locations are shown in Figures 3-4 and 3-5.

[b]The DOE CG for uranium in water released to uncontrolled areas is 600 pCi/l. For conversions, 1 mg uranium equals 667 pCi total activity. For controlled areas, the CG is 20,000 pCi/l. The CG for uncontrolled areas was used to calculate percent of standard.

[c]Well damaged 1st/2nd quarter.

[d]Surface water entering well, no sample collected.

[e]Well damaged 2nd/3rd quarter.

[f]Well not functioning until 4th quarter.

[g]Sampling performed annually during first quarter.

[h]Sample lost in shipment.

[i]No sample collected.

TABLE 3-5

DISSOLVED RADIUM-226 CONCENTRATIONS IN NFSS WATER SAMPLES, 1984

Sampling Location[a]	Concentration (pCi/l) Quarterly Averages 1st	2nd	3rd	4th	Minimum	Maximum	Average	Percent of Standard[b] (Annual Average)
On-Site Groundwater								
BH-5	0.2	0.1	0.2	0.3	0.1	0.3	0.2	0.7
BH-48	0.4	<0.1	0.5	0.7	<0.1	0.7	0.4	1.0
BH-49	0.4	0.2	<0.1	<0.1	<0.1	0.4	0.2	0.7
BH-51	0.2	0.2	<0.1	0.7	<0.1	0.7	0.3	1.0
BH-53	0.3	0.2	0.1	0.2	0.1	0.3	0.2	0.7
BH-61	0.6	<0.1	<0.1	<0.1	<0.1	0.6	0.2	0.7
BH-63	-c-	-c-	0.2	0.5	0.2	0.5	0.4	1.0
BH-64	0.3	0.3	<0.1	0.2	<0.1	0.3	0.2	0.8
BH-67	0.4	<0.1	<0.1	-d-	<0.1	0.4	0.2	0.7
BH-68	<0.1	0.2	0.2	0.3	<0.1	0.3	0.2	0.7
BH-69	0.4	-e-	-e-	0.1	0.1	0.4	0.2	0.7
BH-70	<0.1	0.3	<0.1	0.2	<0.1	0.3	0.2	0.7
BH-71	0.4	0.2	<0.1	0.2	<0.1	0.4	0.2	0.7
A-42	0.4	0.8	0.1	0.3	0.1	0.8	0.4	1.0
A-50	0.4	0.5	<0.1	0.4	<0.1	0.5	0.4	1.0
A-52	-f-	-f-	-f-	0.1	0.1	0.1	0.1	0.3
Off-Site Groundwater								
17[g]	0.3	—	—	—	0.3	0.3	0.3	0.3
18[g]	<0.1	—	—	—	<0.1	<0.1	<0.1	0.3
19[g]	-h-	—	—	—	—	—	—	—
On-Site Surface Water								
10	0.5	<0.1	<0.1	0.2	<0.1	0.5	0.2	0.7
11	0.2	<0.1	<0.1	-i-	<0.1	0.2	0.1	0.3
Off-Site Surface Water								
12	0.8	-i-	<0.1	0.2	<0.1	0.8	0.4	1.0
20	0.9	0.2	<0.1	0.2	0.1	0.9	0.3	1.0

TABLE 3-5

(Continued)

Sampling Location[a]	Concentration (pCi/l) Quarterly Averages 1st	2nd	3rd	4th	Minimum	Maximum	Average	Percent of Standard[b] (Annual Average)
On-Site Tap Water								
15	<0.1	<0.1	<0.1	0.1	<0.1	0.1	0.1	0.3
Off-Site Tap Water								
16[g]	0.3	—	—	—	0.3	0.3	0.3	1.0

[a]Sampling locations are shown in Figure 3-5, 3-6, and 3-7.

[b]The DOE CG for radium-226 in water released to uncontrolled areas is 30 pCi/l. For controlled areas, the CG is 400 pCi/l. The CG for uncontrolled areas was used to calculate percent of standard.

[c]Well damaged 1st/2nd quarter.

[d]Surface water entering well, no sample collected.

[e]Well damaged 2nd/3rd quarter.

[f]Well not functioning until 4th quarter.

[g]Sampling performed annually.

[h]Sample collected, lost in transit.

[i]No sample collected.

groundwater, the DOE CGs for release of water to uncontrolled areas were used in computing percent of standard. The highest annual average concentration of uranium in groundwater covering a complete year of sampling was 55 pCi/l, measured at on-site well A-42. This reading is 9 percent of the DOE CG for uranium released to uncontrolled areas. A single sample from well A-52, taken during the fourth quarter, showed a concentration of 73 pCi/l. The highest uranium concentration at any off-site well was 1.0 percent of the CG.

The highest annual average concentration of radium in groundwater was 0.4 pCi/l, measured at 4 on-site wells. This concentration is equal to 1 percent of the DOE CG for radium in water released to uncontrolled areas.

Surface water samples were collected quarterly from the Central Ditch at locations 10, 11, 12, and 20. Locations 12 and 20 are off-site, 1 mi and 2 mi downstream, respectively, from the NFSS northern boundary. Samples were collected using a grab sampling technique and were analyzed for total uranium (by fluorometry) and dissolved radium-226 (by radon emanation).

The DOE CG for release of uranium to uncontrolled areas (600 pCi/l) would apply to surface water sample locations 11, 12, and 20. Concentrations at these locations were less than 3 percent of the CG. Location 10, on-site in a controlled area, had one quarterly average of 30 pCi/l and an annual average concentration of 19 pCi/l. The DOE CG for uranium in water in controlled areas is 20,000 pCi/l.

The concentrations of radium in surface water at all sampling locations were one percent or less of the DOE CG for radium of 30 pCi/l in water released to uncontrolled areas.

Water was also sampled from taps supplied by a municipal water system. Location 15 samples the water on-site, and Location 16 samples the water off-site after the water line has passed through the NFSS. The concentrations of uranium and radium at both locations were one percent or less of the respective DOE CG.

3.3 SEDIMENT SAMPLING

During 1984, sediment samples consisting of approximately 500-gram composites were collected on-site and off-site at surface water sampling Locations 10, 11, 12 and 20 (see Figures 3-4 and 3-5).

The analysis results for uranium, based on dry weight, are presented in Table 3-6. Quarterly analyses results for uranium ranged from 0.9 pCi/g to 2.8 pCi/g. The highest concentration was recorded during the fourth quarter at Sampling Location 10. The highest annual average for uranium concentrations also was recorded at Location 10. This location is in the on-site portion of the Central Ditch from which contaminated materials were excavated during 1983 and 1984.

Results of analyses for radium are presented in Table 3-7. The highest single reading, 1.6 pCi/g, and the highest annual average, 1.0 pCi/g, were both obtained from Location 20.

There are no specific limits for uranium or radium in sediments. However, cleanup of NFSS and the Central Ditch is conducted to the DOE FUSRAP proposed guidelines for radionuclides in soil. For comparative purposes, these proposed guidelines are 5 pCi/g in the upper 6 in. and 15 pCi/g below 6 in. for radium, and 75 pCi/g for uranium in soil (Ref. 6).

3.4 EXTERNAL GAMMA EXPOSURE RATES

External gamma exposure rates were measured at 34 monitoring locations, 19 of which are located on the site boundary and the perimeter of the exclusion area. Two of the monitoring locations are located off-site, and the remainder are on-site. All locations correspond to radon (Terradex) detector locations, as shown in Figure 3-1.

The external gamma exposure rates are measured using lithium fluoride (LiF) thermoluminescent dosimeters (TLDs), exchanged quarterly. Each monitor contains five TLD chips, the responses of which are averaged.

TABLE 3-6

URANIUM CONCENTRATIONS IN NFSS SEDIMENT SAMPLES, 1984

Sampling Location[a]	Concentration (pCi/g)[b] Quarterly Results 1st	2nd	3rd	4th	Minimum	Maximum	Average
On-Site							
10	1.9	1.6	2.7	2.8	1.6	2.8	2.2
11	1.3	1.4	1.4	1.8	1.3	1.8	1.5
Off-Site							
12	1.1	1.8	1.1	1.2	1.1	1.8	1.3
20	1.8	-c-	1.2	0.9	0.9	1.8	1.3

[a]Sampling locations are shown in Figures 3-4 and 3-5.

[b]There are no specific limits for uranium in sediment. For comparative purposes, however, cleanup of the Central Ditch is conducted following the DOE FUSRAP proposed guideline for cleanup for uranium in soil (75 pCi/g) (Ref. 6).

[c]Sample collected but lost in transit.

TABLE 3-7

RADIUM-226 CONCENTRATIONS IN NFSS SEDIMENT SAMPLES, 1984

Sampling Location	Concentration (p/Ci/g)[b] Quarterly Results 1st	2nd	3rd	4th	Minimum	Maximum	Average
On-Site							
10	0.5 ± 0.1	0.7 ± 0.1	1.3 ± 0.1	1.1 ± 0.1	0.5	1.3	0.9
11	1.2 ± 0.1	0.6 ± 0.1	1.2 ± 0.1	1.1 ± 0.1	0.6	1.2	1.0
Off-Site							
12	0.8 ± 0.1	0.8 ± 0.1	1.1 ± 0.1	1.1 ± 0.1	0.8	1.1	1.0
20	1.6 ± 0.2	-c-	1.0 ± 0.1	0.4 ± 0.1	0.4	1.6	1.0

[a]Sampling locations are shown in Figures 3-4 and 3-5.

[b]There are no specific limits for radium in sediment. For comparative purposes, however, cleanup of the Central Ditch is conducted following the DOE FUSRAP proposed guideline for cleanup for radium in soil which is 5 pCi/g in the upper 6 inches and 15 pCi/g below the upper 6 inches (Ref. 6).

[c]Sample collected but lost in transit.

The results for the 19 site perimeter and 2 off-site external gamma monitoring locations are presented in Table 3-8. Annual average exposure rates at all but seven of the monitoring locations were within the normal background range of 10 to 15 uR/h (Ref. 5). Two of the locations (8 and 9) are located within the exclusion area where members of the public would not be exposed. Of the five locations where members of the public would be exposed, the highest annual average was recorded at Location 4, located near Building 434. This reading, 28.2 uR/h, was more than twice background for the area but only approximately 49 percent of the DOE RPS of 60 uR/h (Ref. 4).

3.5 RADIOLOGICAL EXPOSURE

To assess the impact of the radioactive materials stored at the NFSS on members of the general public, the radiological exposure of a hypothetical, maximally exposed individual was evaluated. An appraisal of potential pathways suggested that ingestion of water containing natural uranium and radium-226 and external gamma irradiation were the principal exposure modes. Inhalation of radon and its radioactive daughters is also a pathway; however, an accurate, quantitative determination of dose is not possible because of uncertainties concerning the distribution of exposure. In Section 3.1, measured radon concentrations are compared to applicable DOE concentration guidelines, with the highest annual average equal to about 35 percent of the applicable CG.

For each of the pathways considered, most organs in the body receive some radiological exposure. However, depending on the method of internal deposition and the chemical characteristics of the radionuclides, some organs receive a higher exposure than others. These are called "critical organs" because the effect of the exposure is maximized in them.

Radium and uranium taken into the body via ingestion tend to migrate and incorporate into the bone, which is the critical organ for this pathway. Conversion of measured concentrations in water to an

TABLE 3-8

EXTERNAL GAMMA EXPOSURE RATES FOR NFSS, 1984[a,b]

Sampling Location[c]	No. of Measurements	Exposure Rate (uR/h)		
		Minimum	Maximum	Average
1	4	11.3	15.2	13.3
3	4	18.1	28.4	22.7
4	4	18.5	37.4	28.2
5	4	16.9	20.9	18.6
6	4	10.2	14.8	13.0
7	4	10.4	15.4	12.5
8	4	15.1	23.7	19.0
9	4	14.4	18.6	16.0
10	4	9.9	14.7	12.3
11	4	9.1	12.2	10.9
12	4	9.7	12.8	11.7
13	4	10.2	23.8	13.8
14	3[d]	9.0	11.5	10.5
15	4	8.6	11.7	9.9
20	4	20.7	26.6	23.6
28[e]	4	9.5	15.0	12.0
29	4	10.7	14.4	12.5
30[e,f]	4	11.2	14.4	12.4
31	4	11.4	17.1	14.2
32	4	10.4	11.4	10.8
34	4	16.0	19.7	18.1

[a]Site boundary, exclusion areas, and off-site monitoring locations only. Background has not been subtracted.

[b]Reported at the 95 percent confidence level.

[c]Sampling locations are shown in Figure 3-1.

[d]TLD missing 4th quarter.

[e]Off-site monitoring location.

[f]Located at 144 Jackson St., Youngstown, New York.

internal dose to the bone requires several assumptions. An intake rate must be postulated. For these calculations, the maximum water intake rate (730 ml of tap water per day) of Reference Man was used (Ref. 7). Radionuclide intakes were converted to internal doses to the bone using the methodology described in ICRP 26 and 30 (Refs. 8 and 9). This methodology, which represents the most current dose conversion techniques, differs from the dose calculation techniques used in prior years. Therefore, a direct year-to-year comparison of doses is not meaningful. Instead, to more accurately compare the relative radiological impacts on members of the public, concentrations of radionuclides for each year rather than calculated doses should be the basis for comparison. All reported doses are 50 year dose commitments. The 50 year dose commitment is a concept which provides for the fact that an intake of a radionuclide with a long half-life (such as uranium and radium) may result in an internal exposure for many years.

Gamma radiation from external sources is assumed to irradiate the body uniformly. The total body is therefore the critical organ for external gamma exposure. Internal organs are assumed to be exposed to the same level as the entire body. Exposures of organs resulting from internal and external sources are additive.

3.5.1 Identification of Hypothetical, Maximally Exposed Individual

To identify the hypothetical individual in the vicinity of the NFSS who would receive the highest dose from on-site radioactive materials, the combined dose from ingestion of water and exposure to external gamma radiation was calculated at various monitoring locations. From these calculations, it was determined that the highest overall dose would be received by an individual directly to the east of the site. Since this is not a residential area, the doses were based on an estimated 40 hour per week exposure period. For conservatism, the 730 ml/day water ingestion rate of Reference Man was used.

3.5.2 Radiological Dose to Hypothetical, Maximally Exposed Individual

Exposure to external gamma radiation contributed the majority of the dose received by the maximally exposed individual. The exposure rate measured by TLD at monitoring Location 4 was 28.2 uR/h. The background exposure rate is approximately 12.5 uR/h (Ref. 5). The radioactive materials at the NFSS, therefore, contributed 15.7 uR/h to the measured exposure rate. Exposure to this radiation for 40 hours per week for 52 weeks per year would result in a dose to the total body of 33 mrem. DOE Radiation Protection Standards limit the total body dose of members of the general public to 500 mrem/yr.

BH-63 is the groundwater monitoring location nearest to external gamma monitoring Location 4. The yearly average uranium and radium-226 concentrations at BH-63 were 3 and 0.4 pCi/l, respectively. Ingestion of this water would result in a 50 year dose commitment of less than 5 mrem to the critical organ which is the bone surface. Because of the insignificance of this dose, no attempt was made to separately quantify the contribution of materials on the NFSS and natural background radionuclides. This can be compared to the 490 mrem dose that would be received if water were ingested that contained uranium concentrations equal to the DOE CG for uncontrolled areas (600 pCi/l).

3.6 QUALITY ASSURANCE

Established procedures were followed in the collection and analysis of environmental samples during 1984. Bechtel personnel working at the site collected and prepared samples. Sample analyses, conducted by EAC, were governed by an internal quality control program which consists of duplicate, spike, and blank samples. EAC's internal quality control results are compared monthly with EPA crosscheck program results. Sample analyses conducted by the Terradex Corporation were also governed by an internal quality control program.

4.0 ENVIRONMENTAL PROTECTION PERMITS

4.1 WATER

Surface water discharges from NFSS are regulated by the New York State Department of Environmental Conservation (NYDEC), under the New York State Pollutant Discharge Elimination System (SPDES). Permit No. NY-0110469 was issued May 1, 1983 and is in effect for a period of five years.

During 1984, 2.6 million gallons of site wastewater were released in seven separate discharge events. Discharges consisted of runoff water from the interim Waste Containment Area, wash water from the vehicle decontamination facility, and construction wastewater. Water was discharged to the Central Drainage Ditch, which is a tributary of Fourmile Creek. Each discharge request was reviewed and approved by NYDEC.

All water discharged was analyzed before and during release for the applicable permit parameters, presented in Table 4-1. For radioactivity, the DOE limits of 600 pCi/l for uranium and 30 pCi/l for radium-226 were applicable. All water released was within SPDES permit parameter limits and DOE Order 5480.1A radioactive release criteria for uncontrolled areas.

4.2 SOLID AND HAZARDOUS WASTE

NFSS residues and wastes are excluded from regulation by the RCRA under the exclusion for "source, special nuclear or by-product material." RCRA EP toxicity testing on the L-30 and K-65 residues conducted in 1984 indicated that EP toxicity concentration criteria for some heavy metals were exceeded. Specifically, the K-65 sludges exceeded maximum concentrations for the characteristic EP toxicity for lead and may also exceed maximum concentrations for arsenic, cadmium, chromium, mercury, selenium, and silver. The NFSS L-30 sludges exceeded the maximum concentration for the characteristic EP toxicity for lead and may also exceed the maximum concentration

TABLE 4-1

1984 SPDES PERMIT PARAMETERS

(PER DISCHARGE EVENT)

	BAT[a]	Water[b] Quality	Units
Flow	288,000	--	Gallons per day
Suspended Solids	50.0	--	mg/l
pH (Range)	6.0-9.0	--	SU
Arsenic, Total	0.33	0.05	mg/l
Barium, Total	0.42	--	mg/l
Cerium, Total	0.10	--	mg/l
Chromium, Total	0.15	0.05	mg/l
Cobalt, Total	0.10	0.005	mg/l
Copper, Total	0.10	--	mg/l
Fluoride, Total	4.20	1.5	mg/l
Iron, Total	0.42	0.3	mg/l
Lanthanium, Total	0.10	--	mg/l
Lead, Total	0.10	0.03	mg/l
Lithium, Total	0.42	--	mg/l
Manganese, Total	0.10	--	mg/l
Nickel, Total	0.10	0.03	mg/l
Strontium, Total	0.42	--	mg/l
Vanadium, Total	0.40	--	mg/l
Zirconium, Total	0.10	--	ml/l
Settleable Solids	0.30	--	mg/l
Heptachlor	--	0.003	ug/l
Benzene Hexachloride (Lindane)	2.0	0.0006	ug/l
Asbestos[c]	--	--	millionfibers/l

Note: All values are based on grab samples.

[a]Best Available Technology limits.

[b]Water quality discharge limits at the point of discharge based on zero flow in the Central Drainage Ditch. Water meeting BAT limits must be diluted by stream flow to levels less than water quality limits.

[c]Measured for presence only. No permit parameter, but must be reported as part of the Discharge Monitoring Report requirements.

for selenium. The NFSS K-65 liquid exceeds maximum concentration for the characteristic of EP toxicity for selenium (Ref. 10). However, plans for long term management of the residues and wastes by DOE are in substantive compliance with 40 CFR 192 (and therefore, 40 CFR 264), as well as DOE's FUSRAP guidelines for radioactive materials.

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APPENDIX A
ENVIRONMENTAL STANDARDS

The applicable Radioactivity Concentration Guides (CGs) provide the limits for maximum permissible radioactivity both on-site (controlled area) and beyond the external perimeter of the site (uncontrolled area). The CGs for the common radionuclides at NFSS are presented in Table A-1, and DOE Radiation Protection Standards are presented in Table A-2. Both tables are derived from DOE Order 5480.1A, Chapter XI.

TABLE A-1
RADIOACTIVITY CONCENTRATION GUIDES FOR THE NFSS

Radionuclide	Transport Media	Controlled Area	Uncontrolled Area
Uranium-Natural	Water (soluble)	20,000 pCi/l (30 mg/l)	600 pCi/l (1 mg/l)[a]
Radium-226	Water (soluble)	400 pCi/l	30 pCi/l
Radon-222	Air	100 pCi/l	3 pCi/l

[a]For conversions, 1 mg uranium equals 667 pCi of total activity.

TABLE A-2
DOE STANDARDS FOR RADIATION PROTECTION OF THE PUBLIC

Type of Exposure	Maximum Dose to an Individual in the Population	Average Dose to a Sample of Exposed Population
Whole body, gonads, or bone marrow	500 mrem/yr	170 mrem/yr
Other organs	1500 mrem/yr	500 mrem/yr

[a]Annual dose equivalent or dose commitment above natural background and excluding medical radiation exposures.

APPENDIX B

SUMMARY OF THE CONSTRUCTION MONITORING PROGRAM FOR RADON AND EXTERNAL GAMMA RADIATION DURING K-65 RESIDUE TRANSFER

1.0 INTRODUCTION

During the latter half of 1984, uranium ore residues (K-65 residues) were transferred from Building 434 (also known as the K-65 Tower) to Building 411 within the Waste Containment Area. Because these residues contain high levels of radium-226, there was considered to be an increased risk for both workers and the environment. Consequently, during the residue transfer operation, additional on-site and off-site monitoring was implemented to measure radon concentrations and external gamma radiation levels (Ref. 1).

The existing PERM and Terradex Track-Etch programs shown in Figures B-1 and B-2 were supplemented with 29 additional off-site Track-Etch stations shown in Figure B-3. In addition, 6 Track-Etch stations were added to the existing 34 on-site Track-Etch stations. Four of these stations were established on Building 434; the locations of the other two stations, numbered 126 and 135, are shown in Figure B-2. Nineteen of the 29 off-site Track-Etch stations duplicate PERM locations, primarily to establish the technical adequacy of the two systems. Each Track-Etch station also included an environmental thermoluminescent dosimeter (TLD) to measure direct gamma radiation.

An electronic radon gas monitor (RGM) was located at PERM location number LE27 (Track Etch station number 130), as shown in Figure B-1. This monitor provided hourly readings of airborne radon concentrations. RGM data were collected, evaluated, and reported on a weekly basis.

2.0 SUMMARY OF MONITORING RESULTS

Monitoring results for the period from July through December 1984 are summarized in Table B-1 and are reported in detail for July through October in Reference 1. Specific conditions noted during this period and November and December are described below.

- The average off-site airborne radon-222 concentration during the measurement period was 0.62 pCi/l, within a range of 0.10 pCi/l to 4.94 pCi/l. Figure B-4 demonstrates variations in the average value on a monthly basis. All of these values include a background concentration of 0.19 pCi/l of radon-222 measured by PERMs for the NFSS area as reported by Rudy, et al (Ref. 2).

- The average off-site direct gamma exposure rate during the measurement period was 18 uR/h, within a range from 6 uR/h to 31 uR/h. These values include an average background gamma exposure rate of 12.5 uR/h, reported by the U.S. Environmental Protection Agency (Ref. 3). Figure B-5 demonstrates variations in the average on a monthly basis.

- The average RGM reading for the measurement period was 0.68 pCi/l, which may be compared to a value of 0.74 pCi/l reported for the adjacent Track Etch station (number 130) and to the overall off-site Track Etch average of 0.62 pCi/l.

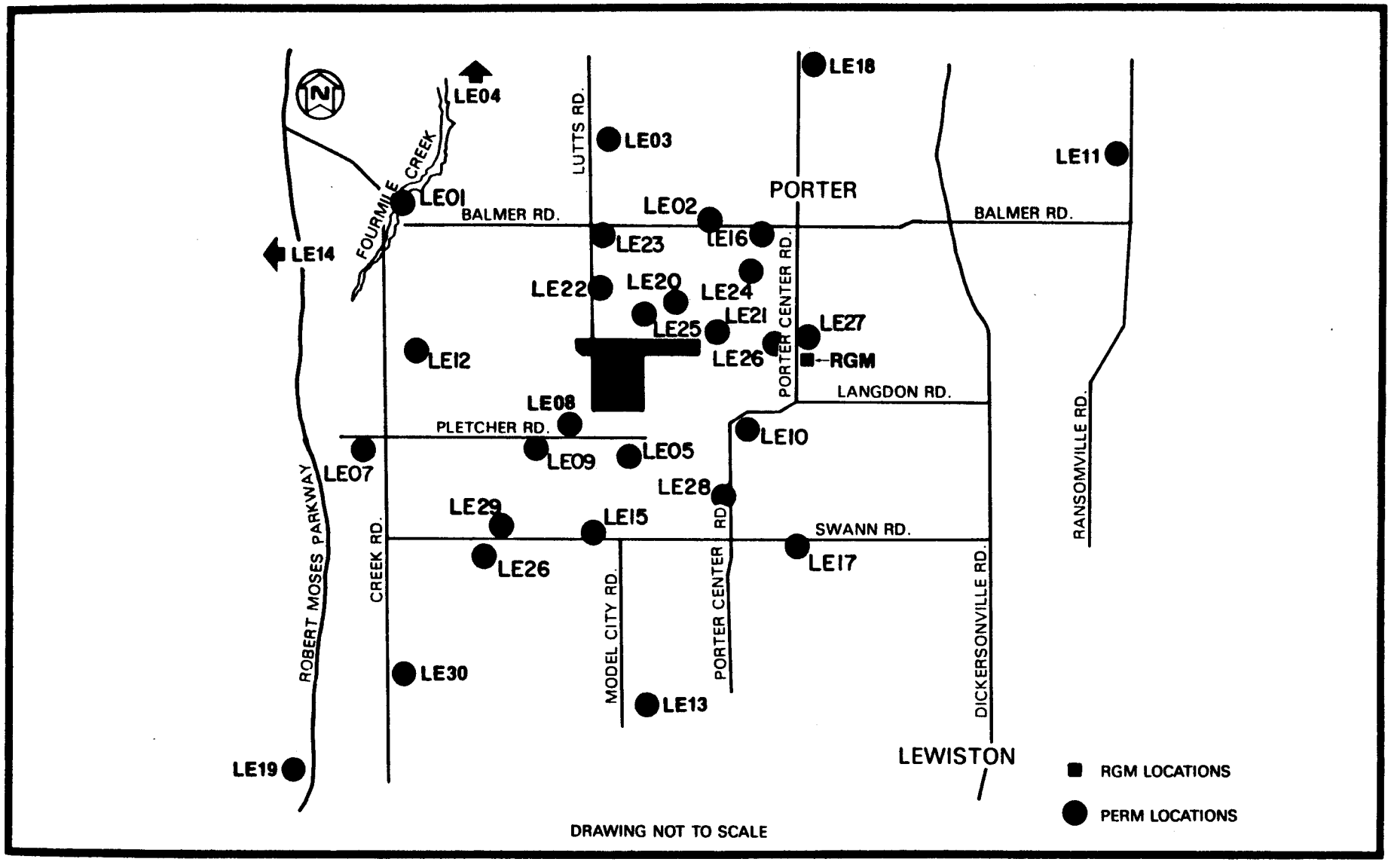

FIGURE B-1 MONSANTO RESEARCH CORPORATION OFF-SITE MONITORING LOCATIONS

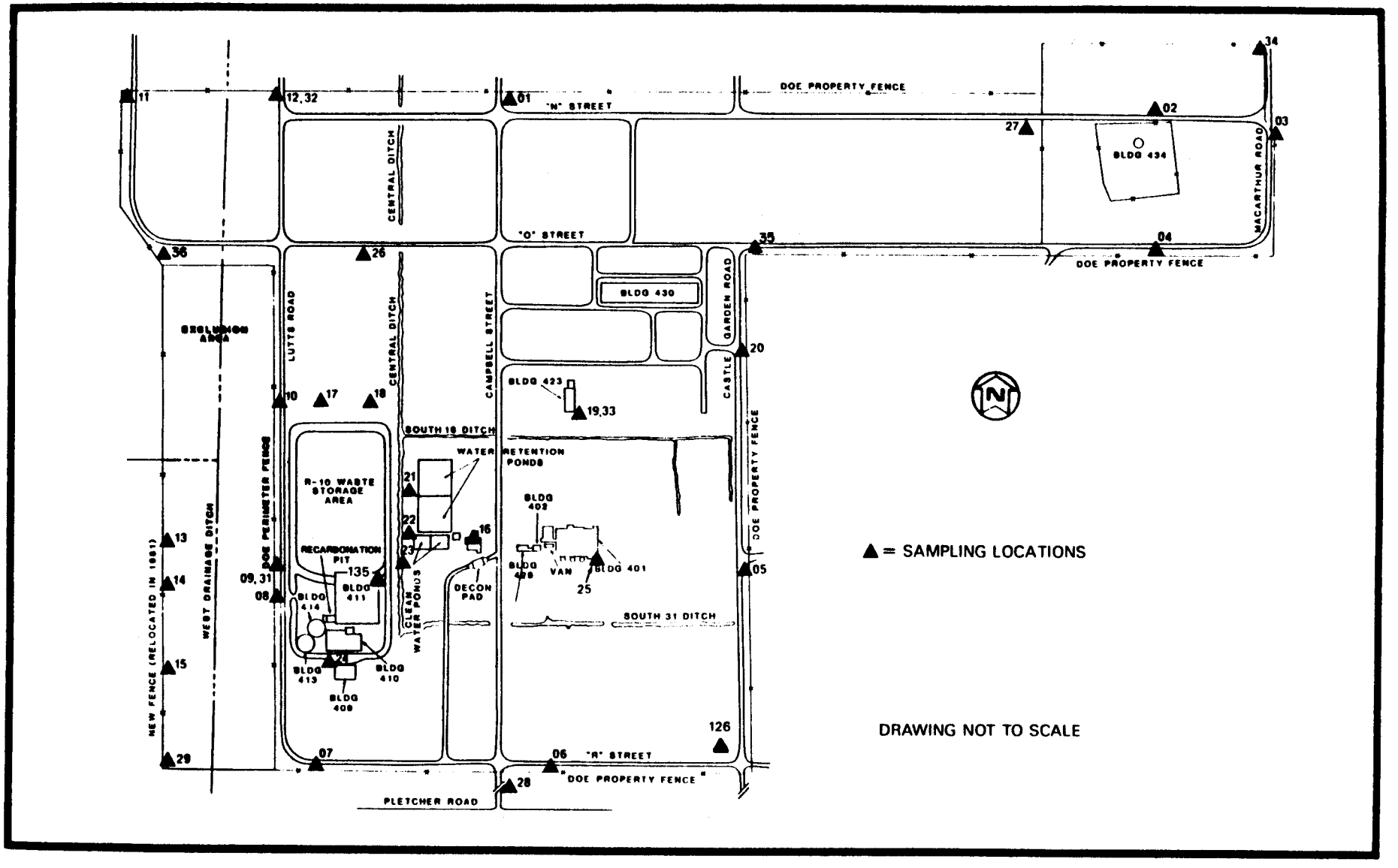

FIGURE B-2 ON-SITE MONITORING STATIONS

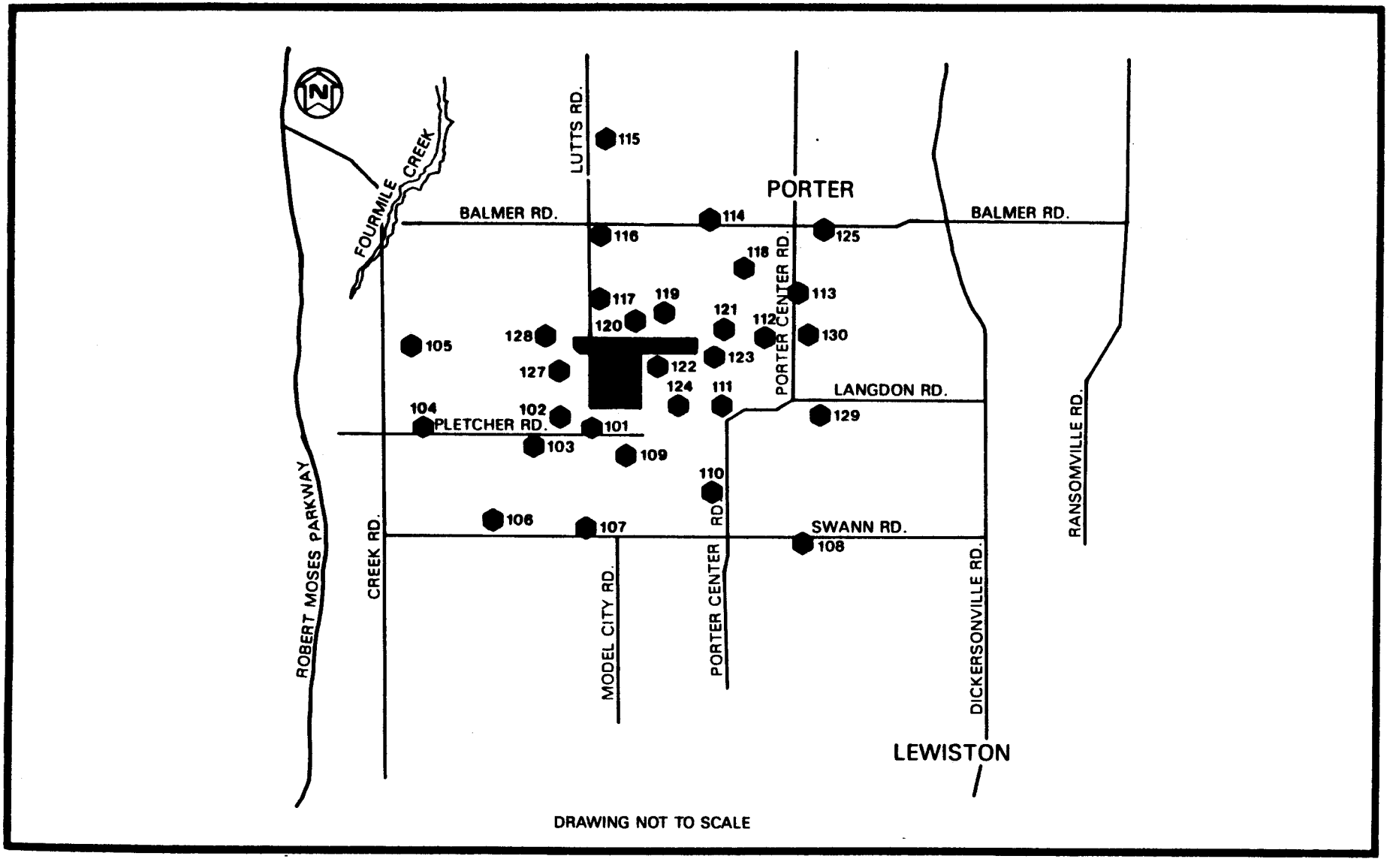

FIGURE B-3 RADON (TRACK ETCH) AND DIRECT GAMMA (TLD) OFF-SITE MONITORING LOCATIONS

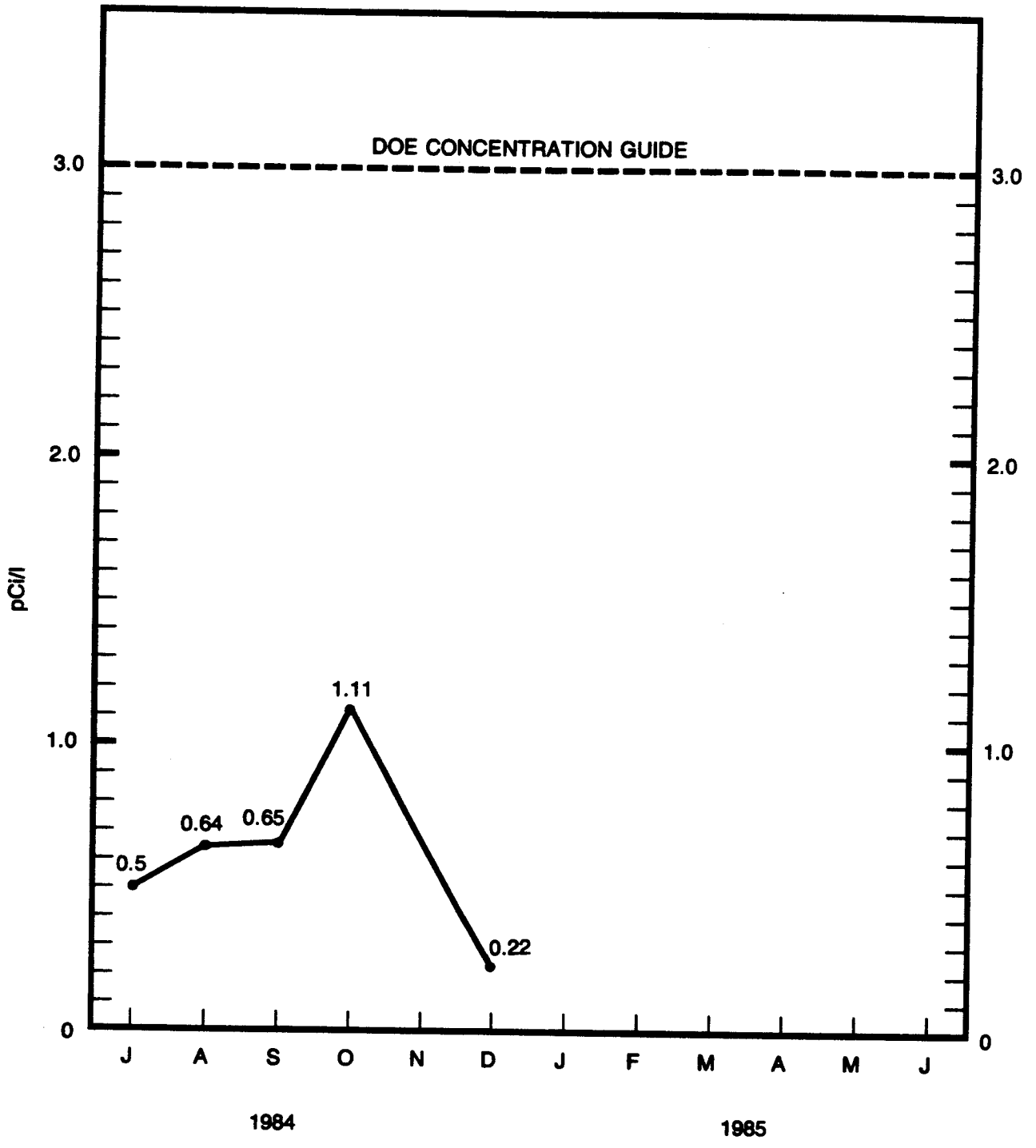

FIGURE B-4 MONTHLY AVERAGE RADON-222 CONCENTRATIONS

L11/F-0103

TABLE B-1

RESULTS OF OFF-SITE CONSTRUCTION ENVIRONMENTAL MONITORING FOR RADON-222 AND DIRECT GAMMA RADIATION, JULY THROUGH DECEMBER, NFSS, 1984

Monitoring Station Number	Concentrations[a] of Radon-222 (pCi/l)	Gamma Radiation[a] Exposure Rate (uR/h)
1	1.57	19
2	1.37	18
3	0.74	17
4	0.57	18
5	0.57	16
6	0.42	22
7	0.43	16
8	0.43	17
9	0.56	18
10	0.50	18
11	0.65	16
12	0.61	16
13	0.49	16
14	0.42	14
15	1.27	18
16	0.49	17
17	0.48	17
18	0.51	17
19	0.45	17
20	0.38	18
21	0.46	19
22	0.36	22
23	0.71	22
24	0.39	17
25	0.56	17
27	0.95	22
28	0.89	21
29	0.41	20
30	0.74	23

[a]These values may be compared with DOE guideline values of 3 pCi/l for radon-222 (when averaged over a year) and 60 uR/h for gamma radiation exposure rates.

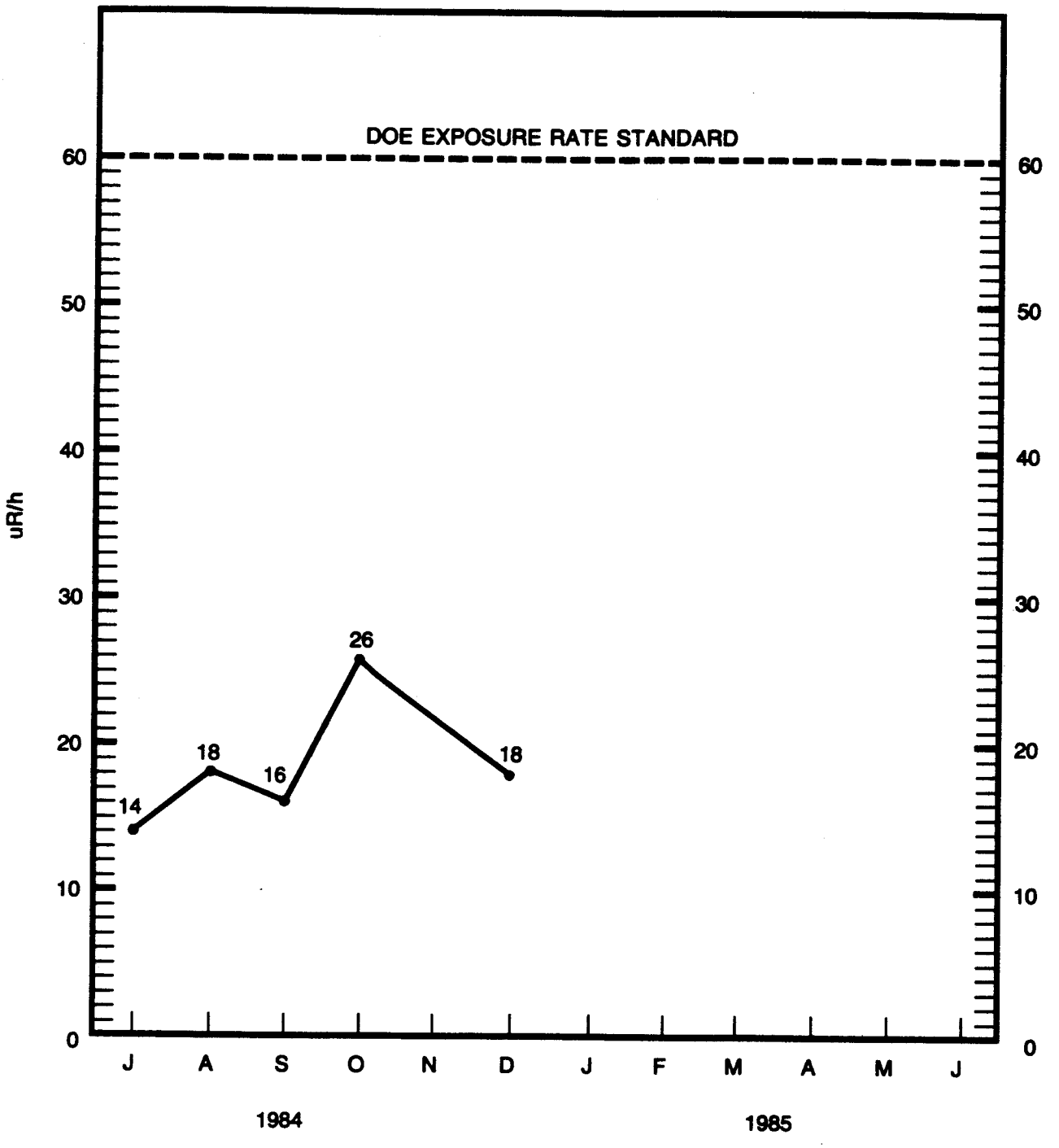

FIGURE B-5 MONTHLY AVERAGE GAMMA EXPOSURE RATE

APPENDIX B REFERENCES

1. Bechtel National, Inc. Construction Environmental Monitoring Report for the Niagara Falls Storage Site, DOE/OR/20722-46, prepared for the U.S. Department of Energy (monthly reports), July-October 1984.

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3. Klement, A. W., Jr., et al. Estimates of Ionizing Radiation Doses in the United States 1960-2000, ORP/CSD 72-1, U.S. Environmental Protection Agency, Rockville, MD, 1972.