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April 30, 1993
BVY 93 - 46

United States Nuclear Regulatory Commission
ATTN: Document Control Desk
Washington, DC 20555

References: a. License No. DPR-28 (Docket No. 50-271)

Subject: Vermont Yankee Annual Radiological Environmental Surveillance Report

Dear Sir:

Enclosed please find one copy of the Annual Radiological Environmental Surveillance Report for Vermont Yankee Nuclear Power Station, submitted in accordance with Technical Specification 6.7.C.3. This report contains a summary and analysis of the radiological environmental data collected for the calender year 1992.

Should you have any questions regarding this submittal, please contact this office.

Very truly yours,

VERMONT YANKEE NUCLEAR POWER CORPORATION

Leonard A. Tremblay, Jr.

Leonard A. Tremblay, Jr.
Senior Licensing Engineer

cc: USNRC Region I Administrator
USNRC Resident Inspector - VYNPS
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VERMONT YANKEE NUCLEAR POWER CORPORATION

VERMONT YANKEE NUCLEAR POWER STATION

VERNON, VERMONT

VERMONT YANKEE NUCLEAR POWER STATION

ANNUAL RADIOLOGICAL ENVIRONMENTAL SURVEILLANCE REPORT

January - December 1992

April 1993

Prepared by:
Yankee Atomic Electric Company
Environmental Engineering Department
580 Main Street
Bolton, Massachusetts 01740

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1. INTRODUCTION

This report summarizes the findings of the Radiological Environmental Monitoring Program (REMP) conducted by Vermont Yankee Nuclear Power Corporation in the vicinity of the Vermont Yankee Nuclear Power Station in Vernon, Vermont during the calendar year 1992. It is submitted annually in compliance with plant Technical Specification 6.7.C.3.

The remainder of this report is organized as follows:

Section 2: Provides an introductory explanation to the background radioactivity and radiation that is detected in the Vermont Yankee environs.

Section 3: Provides a brief description of the Vermont Yankee Nuclear Power Station site and its environs.

Section 4: Provides a description of the overall REMP program design. Included is a summary of the Radiological Effluent Technical Specification Requirements for REMP sampling, tables listing all locations sampled or monitored (by TLD) in 1992 with compass sectors and distances from the plant, and maps showing the location of each of the sampling and TLD monitoring locations. Tables listing Lower Limit of Detection requirements and Reporting Levels are also included.

Section 5: Consists of the summarized data as required by VYNPS Technical Specifications. The tables are in the format specified by the NRC Radiological Assessment Branch Technical Position on Environmental Monitoring (Reference 1). Also included is a summary of the environmental TLD measurements for 1992.

Section 6: Provides the results of the 1992 monitoring program. The performance of the program in meeting regulatory requirements as given in the Technical Specifications is discussed, and the data acquired during the year are analyzed.

Section 7: Provides an overview of the Quality Assurance programs used at the Yankee Atomic Environmental Laboratory. As required by Technical Specifications, the results of the EPA Intercomparison Program are given.

Section 8: Summarizes the requirements and the results of the 1992 Land Use Census.

Section 9: Gives an overall summary of the results of the 1992 Radiological Environmental Monitoring Program.

2. **Naturally Occurring and Man-Made Background Radioactivity**

Radiation or radioactivity potentially detected in the Vermont Yankee environment can be grouped into three categories. The first is "naturally-occurring" radiation and radioactivity. The second is "man-made" radioactivity from sources other than the Vermont Yankee plant. The third potential source of radioactivity is due to emissions from the Vermont Yankee plant. For the purposes of the Vermont Yankee REMP, the first two categories are classified as "background" radiation, and are the subject of discussion in this section of the report. The third category is the one that the REMP is designed to detect and evaluate.

2.1 Naturally Occurring Background Radioactivity

Natural radiation and radioactivity in the environment, which provide the major source of human radiation exposure, may be subdivided into three separate sub-categories: "primordial radioactivity", "cosmogenic radioactivity" and "cosmic radiation". "Primordial radioactivity" is made up of those radionuclides that were created with the universe and that have a sufficiently long half-life to be still present on the earth. Included in this category are the radionuclides that these elements have decayed into. A few of the more important radionuclides in this category are Uranium-238 (U-238), Thorium-228 (Th-228), Rubidium-87 (Rb-87), Potassium-40 (K-40), Radium-226 (Ra-226), and Radon-222 (Rn-222). Uranium-238 and Thorium-228 are readily detected in soil and rock, whether through direct field measurements or through laboratory analysis of samples. Radium-226 in the earth can find its way from the soil into ground water, and is often detectable there. Radon-222 is one of the components of natural background in the air we breath, and its daughter products are detectable on air sampling filters. Potassium-40 comprises about 0.01 percent of all natural potassium in the earth, and is consequently detectable in most biological substances, including the human body. There are many more primordial radionuclides found in the environment in addition to the major ones discussed above (Reference 2).

The second sub-category of naturally-occurring radiation and radioactivity is "cosmogenic radioactivity". This is produced through the nuclear interaction of high energy cosmic radiation with elements in the earth's atmosphere, and to a much lesser degree in the earth's crust. These radioactive elements are then incorporated into the entire geosphere and atmosphere, including the earth's soil, surface rock, biosphere, sediments, ocean floors, polar ice and atmosphere. The major radionuclides in this

category are Carbon-14 (C-14), Hydrogen-3 (H-3 or Tritium), Sodium-22 (Na-22), and Beryllium-7 (Be-7). Beryllium-7 is the one most readily detected, and is found on air sampling filters and occasionally in biological media (Reference 2).

The third sub-category of naturally-occurring radiation and radioactivity is "cosmic radiation". This consists of high energy atomic and sub-atomic particles of extra-terrestrial origin and the secondary particles and radiation that are produced through their interaction in the earth's atmosphere. The primary radiation comes mostly from outside of our solar system, and to a lesser degree from the sun. We are protected from most of this radiation by the earth's atmosphere, which absorbs the radiation. Consequently, one can see that with increasing elevation one would be exposed to more cosmic radiation as a direct result of a thinner layer of air for protection. This "direct radiation" is detected in the field with gamma spectroscopy equipment, high pressure ion chambers and thermoluminescent dosimeters (TLDs).

2.2 Man-Made Background Radioactivity

The second source of "background" radioactivity in the Vermont Yankee environment is from "man-made" sources not related to the power plant. The most recent contributor to this category was the fallout from the Chernobyl accident in April of 1986, which was detected in the Vermont Yankee environment and much of the world. A much greater contributor to this category, however, has been fallout from atmospheric nuclear weapons tests. Tests were conducted from 1945 through 1980 by the United States, the Soviet Union, the United Kingdom, China and France, with the large majority of testing occurring during the periods 1954-1958 and 1961-1962. (A test ban treaty was signed in 1963 by the United States, Soviet Union and United Kingdom, but not by France and China.) The most recent test, conducted by the People's Republic of China, occurred in October of 1980. Much of the fallout detected today is due to this explosion and the last large scale one, done in November of 1976 (Reference 3).

The radioactivity produced by these detonations was deposited worldwide. The amount of fallout deposited in any given area is dependent on many factors, such as the explosive yield of the device, the latitude and altitude of the detonation, the season in which it occurred, and the timing of subsequent rainfall which washes fallout out of the tropospheric portion (Reference 4). Most of this fallout has decayed into stable elements, but the residual radioactivity is still readily detectable in environmental

samples worldwide. The two predominant radionuclides are Cesium-137 (Cs-137) and Strontium-90 (Sr-90). They are found in soil and in vegetation, and since cows and goats graze large areas of vegetation, these radionuclides are also readily detected in milk.

Other potential "man-made" sources of environmental "background" radioactivity include other nuclear power plants, coal-fired power plants, national defense installations, hospitals, research laboratories and industry. These collectively are insignificant on a global scale when compared to the sources discussed above (natural and fallout).

3. GENERAL PLANT AND SITE INFORMATION

The Vermont Yankee Nuclear Power Station is located in the town of Vernon, Vermont in Windham County. The 130-acre site is on the west shore of the Connecticut River, immediately upstream of the Vernon Hydroelectric Station. The land is bounded on the north, south and west by privately-owned land, and on the east by the Connecticut River. The surrounding area is generally rural and lightly populated, and the topography is flat or gently rolling.

Construction of the single 540 megawatt BWR (Boiling Water Reactor) plant began in 1967. The pre-operational Radiological Environmental Monitoring Program, designed to measure environmental radiation and radioactivity levels in the area prior to station operation, began in 1970. Commercial operation began on November 30, 1972.

4. PROGRAM DESIGN

The Radiological Environmental Monitoring Program (REMP) for the Vermont Yankee Nuclear Power Station (VYNPS) was designed with specific objectives in mind. These are:

- To provide an early indication of the appearance or accumulation of any radioactive material in the environment caused by the operation of the station.

- To provide assurance to regulatory agencies and the public that the station's environmental impact is known and within anticipated limits.

- To verify the adequacy and proper functioning of station effluent controls and monitoring systems.

- To provide standby monitoring capability for rapid assessment of risk to the general public in the event of unanticipated or accidental releases of radioactive material.

The program was initiated in 1970, approximately two years before the plant began commercial operation in 1972. It has been in operation continuously since that time, with improvements made periodically over those years.

The current program is designed to meet the intent of NRC Regulatory Guide 4.1, Programs for Monitoring Radioactivity in the Environs of Nuclear Power Plants, NRC Regulatory Guide 4.8, Environmental Technical Specifications for Nuclear Power Plants, the NRC Branch Technical Position of November 1979 entitled An Acceptable Radiological Environmental Monitoring Program, as well as NRC NUREG-0473, Radiological Effluent Technical Specifications for BWR's. The environmental TLD program has been designed and tested around NRC Regulatory Guide 4.13, Performance, Testing and Procedural Specifications for Thermoluminescence Dosimetry: Environmental Applications. The quality assurance program is designed around the guidance given in NRC Regulatory Guide 4.15, Quality Assurance for Radiological Monitoring Programs (Normal Operations) - Effluent Streams and the Environment.

The minimal sampling requirements of the REMP are given in Technical Specification 3.9.C, which is summarized in Table 4.1 of this report. The identification of the required sampling locations is given in the Offsite Dose Calculation Manual (ODCM), Chapter 4. The complete list of locations

used during 1992 is given in Tables 4.2 and 4.3 of this report. These sampling and monitoring locations are shown graphically on the maps in Figures 4.1 through 4.6.

The Vermont Yankee Chemistry Department conducts the radiological environmental monitoring program. They collect all airborne, terrestrial and ground water samples, and contract with Aquatec, Inc. to collect all fish, river water and sediment samples. All TLD badges are posted and retrieved by the Vermont Yankee Chemistry Department, and are read out by the Yankee Atomic Environmental Laboratory.

4.1 Monitoring Zones

The REMP is designed to allow comparison of levels of radioactivity in samples from the area possibly influenced by the plant to levels found in areas not influenced by the plant. Monitoring locations within the first zone are called "indicators." Those within the second zone are called "controls." The distinction between the two zones, depending on the type of sample or sample pathway, is based on one or more of several factors, such as site meteorological history, meteorological dispersion calculations, relative direction from the plant, river flow, and distance. Analysis of survey data from the two zones aids in determining if there is a significant difference between the two areas. It can also help in differentiating between radioactivity or radiation due to plant releases and that due to other fluctuations in the environment, such as atmospheric nuclear weapons test fallout or seasonal variations in the natural background.

4.2 Pathways Monitored

Four pathway categories are monitored by the REMP. They are the Airborne, Waterborne, Ingestion and Direct Radiation Pathways. Each of these four categories is monitored by the collection of one or more sample media, which are listed below, and are described in more detail in this section:

Airborne Pathway
- Air Particulate Sampling
- Charcoal Cartridge (Radioiodine) Sampling

Waterborne Pathways
- River Water Sampling

Ground Water Sampling
Sediment Sampling

Ingestion Pathways
Milk Sampling
Silage Sampling
Mixed Grass Sampling
Fish Sampling

Direct Radiation Pathway
TLD Monitoring

4.3 Descriptions of Monitoring Programs

4.3.1 Air Sampling

Continuous air samplers are installed at six locations. (Five are required by VYNPS Technical Specifications.) The sampling pumps at these locations operate continuously at a flow rate of approximately one cubic foot per minute. Airborne particulates are collected by passing air through a 47 mm glass-fiber filter. A dry gas meter is incorporated into the sampling stream to measure the total volume of air sampled in a given interval. The entire system is housed in a weatherproof structure. The filters are collected biweekly, and to allow for the decay of radon daughter products, they are held for at least 100 hours at the Laboratory before being analyzed for gross-beta radioactivity (indicated as GR-B in the data tables). The biweekly filters are composited (by location) at the Laboratory for a quarterly gamma spectroscopy analysis.

If the gross-beta activity on an air particulate sample is greater than ten times the yearly mean of the control samples, Technical Specification 3.9.C requires a gamma isotopic analysis on the individual sample. Whenever the main plant stack effluent release rate of I-131 is equal to or greater than 0.1 uCi/sec, weekly air particulate is required, pursuant to Technical Specification 3.9.C.

4.3.2 Charcoal Cartridge (Radioiodine) Sampling

Continuous air samplers are installed at six locations. (Five are required by Technical Specifications.) The sampling pumps at these locations operate continuously at a flow rate of approximately one cubic foot per minute. A 60 cc TEDA impregnated charcoal cartridge is located downstream of the air particulate filter described above. A dry gas meter is incorporated into the sampling stream to measure the total volume of air sampled in a given interval. The entire system is housed in a weatherproof structure. These cartridges are collected and analyzed biweekly for I-131.

Whenever the main plant stack effluent release rate of I-131 is equal to or greater than 0.1 uCi/sec, weekly charcoal cartridge sampling is required, pursuant to Technical Specification 3.9.C.

4.3.3 River Water Sampling

An automatic compositing sampler is maintained at the downstream sampling location by the Vermont Yankee Chemistry Department staff, and the pump delivering river water to the sampler is maintained by Aquatec, Inc. The sampler is controlled by a timer that collects an aliquot of river water at least every two hours. An additional grab sample is collected monthly at the upstream control location. All river water samples are preserved with HCl and $NaHSO_3$, or HNO_3, to prevent the plate out of radionuclides on the container walls. Each sample is analyzed for gamma-emitting radionuclides. Although not required by VYNPS Technical Specifications, a gross-beta analysis is performed on each sample. The monthly composite or grab samples are composited again (by location) at the Laboratory for a quarterly H-3 analysis.

4.3.4 Ground Water Sampling

Grab samples are collected quarterly from two indicator and one control location. (Only one indicator and one control is required by VYNPS Technical Specifications.) All ground water samples are preserved with HCl and $NaHSO_3$, or HNO_3, to prevent the plate out of radionuclides on the container walls. Each sample was analyzed for gamma-emitting radionuclides and H-3. Although not required by VYNPS Technical Specifications, a gross-beta analysis is also performed on each sample.

4.3.5 Sediment Sampling

Sediment grab samples are collected semiannually from two locations by Aquatec, Inc. At the downriver shoreline, station SE-11, one grab is collected. At the North Storm Drain Outfall, station SE-12, multiple grab samples are collected. Each sample is analyzed at the Laboratory for gamma-emitting radionuclides.

4.3.6 Milk Sampling

When milk animals are identified as being on pasture feed, milk samples are collected twice per month from that location. Throughout the rest of the year, and for the full year where animals are not on pasture, milk samples are collected on a monthly schedule. Three locations are chosen as a result of the annual Land Use Census, based on meteorological dispersion

calculations. The fourth location is a control, which is located sufficiently far away from the plant to be outside any potential influence from it. Other samples are typically collected from locations of interest.

Immediately after collection, each milk sample is refrigerated until delivery to the Laboratory. Each sample is analyzed for gamma-emitting radionuclides. Following a chemical separation, a separate low-level I-131 analysis is performed to meet the Lower Limit of Detection requirements in the Technical Specifications. Although not required by Technical Specifications, Sr-89 and Sr-90 analyses are also performed on quarterly composited samples.

4.3.7 Silage Sampling

At each milk sampling location, a silage sample is collected at the time of harvest, if available. One sample is shipped to the Laboratory without preservative, where it is analyzed for gamma-emitting radionuclides. Although not required by Technical Specifications, a separate silage sample is preserved with NaOH, and is then shipped to the Laboratory for a separate I-131 analysis.

4.3.8 Mixed Grass Sampling

At each air sampling station, a mixed grass sample is collected quarterly, when available. Enough grass is clipped to provide the minimal sample weight needed to achieve the required Lower Limits of Detection. One sample is shipped to the Laboratory without preservative, where it is analyzed for gamma-emitting radionuclides. Although not required by Technical Specifications, a separate grass sample is preserved with NaOH, and is then shipped to the Laboratory for a separate I-131 analysis.

4.3.9 Fish Sampling

Fish samples are collected semiannually at two locations (upstream of the plant and in Vernon Pond) by Aquatec, Inc. The species typically collected are yellow perch, smallmouth bass and largemouth bass. The fish samples are frozen and delivered to the Laboratory where the edible portions are analyzed for gamma-emitting radionuclides.

4.3.10 TLD Monitoring

Direct gamma radiation exposure was continuously monitored with the use of thermoluminescent dosimeters (TLDs). Specifically, Panasonic UD-801AS1 and UD-814AS1 calcium sulfate dosimeters were used, with a total of five elements in place at each monitoring location. Each pair of dosimeters is sealed in a plastic bag, which is in turn housed in a plastic-screened container. This container is attached to an object such as a fence or utility pole. A total of 40 stations are required by Technical Specifications. Of these, 24 must be read out quarterly, while those from the remaining 16 incident response (outer ring) stations need only be de-dosed (annealed) quarterly, unless a gaseous release LCO was exceeded during the period. Although not required by Technical Specifications, the TLDs from the 16 outer ring stations are read out quarterly along with the other stations's TLDs. In addition to the TLDs required by Technical Specifications, eleven more are typically posted at or near the Site Boundary. The plant staff posts and retrieves all TLDs, while the Yankee Atomic Environmental Laboratory processes them.

TABLE 4.1

Radiological Environmental Monitoring Program
(as required by Tech. Spec. Table 3.9.3)*

Exposure Pathway and/or Sample Media	Collection			Analysis	
	Number of Sample Locations	Routine Sampling Mode	Collection Frequency	Analysis Type	Analysis Frequency
1. Direct Radiation (TLDs)	40	Continuous	Quarterly	Gamma; Outer Ring - de-dose only, unless gaseous release LCO was exceeded	Each TLD
2. Airborne (Particulates and Radioiodine)	5	Continuous	Semimonthly	Particulate Sample: Gross Beta	Each Sample
				Gamma Isotopic	Quarterly Composite (by location)
				Radioiodine Canister: I-131	Each Sample
3. Waterborne					
a. Surface Water	2	Downstream: Automatic composite. Upstream: grab.	Monthly	Gamma Isotopic Tritium (H-3)	Each Sample Quarterly Composite
b. Ground Water	2	Grab	Quarterly	Gamma Isotopic Tritium (H-3)	Each Sample Each Sample
c. Shoreline Sediment	2	Grab	Upstream: Semiannually. N.Storm Drain Outfall: As specified in ODCM.	Gamma Isotopic	Each Sample

TABLE 4.1
(continued)

Radiological Environmental Monitoring Program
(as required by Tech. Spec. Table 3.9.3)*

Exposure Pathway and/or Sample Media	Collection			Analysis	
	Nominal Number of Sample Locations	Routine Sampling Mode	Nominal Collection Frequency	Analysis Type	Analysis Frequency
4. Ingestion					
a. Milk	4	Grab	Monthly (Semimonthly when on pasture)	Gamma Isotopic I-131	Each sample Each sample
b. Fish	2	Grab	Semiannually	Gamma Isotopic on edible portions	Each sample
c. Vegetation					
- Grass sample	1 at each air sampling station	Grab	Quarterly when available	Gamma Isotopic	Each sample
- Silage sample	1 at each milk sampling station	Grab	At harvest	Gamma Isotopic	Each sample

* See Technical Specification Table 3.9.3 for complete footnotes.

TABLE 4.2

Radiological Environmental Monitoring Locations (non-TLD) in 1992
Vermont Yankee Nuclear Power Station

Exposure Pathway	Station Code	Station Description	Zone*	Distance From Plant (km)	Direction From Plant
1. Airborne					
	AP/CF-11	River Sta. No. 3.3	I	1.9	SSE
	AP/CF-12	N. Hinsdale, NH	I	3.6	NNW
	AP/CF-13	Hinsdale Substation	I	3.1	E
	AP/CF-14	Northfield, MA	I	11.3	SSE
	AP/CF-15	Tyler Hill Road	I	3.2	WNW
	AP/CF-21	Spofford Lake	C	16.1	NNE
2. Waterborne					
a. Surface	WR-11	River Sta. No. 3.3	I	1.9	Down-river
	WR-21	Rt. 9 Bridge	C	12.8	Up-river
b. Ground	WG-11	Plant Well	I	--	On-site
	WG-12	Vernon Nursing Well	I	2.0	SSE
	WG-22	Skibniowsky Well	C	14.3	N
c. Sediment	SE-11	Shoreline Downriver	I	0.8	SSE
	SE-12	North Storm Drain Outfall	I	0.15	E
3. Ingestion					
a. Milk	TM-11	Miller Farm	I	0.8	WNW
	TM-12	Dominick	I	5.2	E
	TM-13	Newton Farm	I	5.1	SSE
	TM-14	Brown Farm	I	2.1	S
	TM-15	Gayland Farm	I	4.7	WNW/NW
	TM-17	Gaines Farm	I	8.2	SW
	TM-18	Blodgett Farm	I	3.4	SE
	TM-19	Mitchell	I	4.0	NNE
	TM-24	County Farm	C	22.5	N

TABLE 4.2
(continued)

Radiological Environmental Monitoring Locations (non-TLD) in 1992
Vermont Yankee Nuclear Power Station

Exposure Pathway	Station Code	Station Description	Zone*	Distance From Plant (km)	Direction From Plant
3. Ingestion, (continued)					
b. Fish	FH-11	Vernon Pond	I	--	**
	FH-21	Rt. 9 Bridge	C	12.8	Upriver
c. Mixed Grass	TG-11	River Sta. No. 3.3	I	1.9	SSE
	TG-12	N. Hinsdale, NH	I	3.6	NNW
	TG-13	Hinsdale Substation	I	3.1	E
	TG-14	Northfield, MA	I	11.3	SSE
	TG-15	Tyler Hill Rd.	I	3.2	WNW
	TG-21	Spofford Lake	C	16.1	NNE
c. Silage	TC-11	Miller Farm	I	0.8	WNW
	TC-12	Dominick	I	5.2	E
	TC-13	Newton Farm	I	5.1	SSE
	TC-14	Brown Farm	I	2.1	S
	TC-15	Gayland Farm	I	4.7	WNW/NW
	TC-17	Gaines Farm	I	8.2	SW
	TC-18	Blodgett Farm	I	3.4	SE
	TC-19	Mitchell Farm	I	4.0	NNE
	TC-24	County Farm	C	22.5	N

* I = Indicator Stations; C = Control Stations
** Fish samples are collected anywhere in Vernon Pond, which is adjacent to the plant (see Figure 4.1).

TABLE 4.3

Radiological Environmental Monitoring Locations (TLD) in 1992
Vermont Yankee Nuclear Power Station

Station Code	Station Description	Zone*	Distance From Plant (km)	Direction From Plant
DR-1	River Sta. No. 3.3	I	1.6	SSE
DR-2	N. Hinsdale, NH	I	3.9	NNW
DR-3	Hinsdale Substation	I	3.0	E
DR-4	Northfield, MA	I	11.0	SSE
DR-5	Spofford Lake	C	16.3	NNE
DR-6	Vernon School	I	0.46	WSW
DR-7	Site Boundary	SB	0.27	W
DR-8	Site Boundary	SB	0.25	SW
DR-9	Inner Ring	I	2.1	N
DR-10	Outer Ring	O	4.6	N
DR-11	Inner Ring	I	2.0	NNE
DR-12	Outer Ring	O	3.6	NNE
DR-13	Inner Ring	I	1.4	NE
DR-14	Outer Ring	O	4.3	NE
DR-15	Inner Ring	I	1.4	ENE
DR-16	Outer Ring	O	2.9	ENE
DR-17	Inner Ring	I	1.2	E
DR-18	Outer Ring	O	3.0	E
DR-19	Inner Ring	I	3.5	ESE
DR-20	Outer Ring	O	5.3	ESE
DR-21	Inner Ring	I	1.8	SE
DR-22	Outer Ring	O	3.2	SE
DR-23	Inner Ring	I	1.8	SSE
DR-24	Outer Ring	O	3.9	SSE
DR-25	Inner Ring	I	2.0	S
DR-26	Outer Ring	O	3.7	S
DR-27	Inner Ring	I	1.0	SSW
DR-28	Outer Ring	O	2.2	SSW
DR-29	Inner Ring	I	0.7	WSW
DR-30	Outer Ring	O	2.3	SW

TABLE 4.3
(continued)

Radiological Environmental Monitoring Locations (TLD) in 1992
Vermont Yankee Nuclear Power Station

Station Code	Station Description	Zone*	Distance From Plant (km)	Direction From Plant
DR-31	Inner Ring	I	0.8	W
DR-32	Outer Ring	O	5.0	WSW
DR-33	Inner Ring	I	0.9	WNW
DR-34	Outer Ring Road	O	4.9	W
DR-35	Inner Ring	I	1.4	WNW
DR-36	Outer Ring	O	4.7	WNW
DR-37	Inner Ring	I	3.0	NW
DR-38	Outer Ring	O	7.7	NW
DR-39	Inner Ring	I	3.2	NNW
DR-40	Outer Ring	O	5.8	NNW
DR-41**	Site Boundary	SB	0.38	SSW
DR-42**	Site Boundary	SB	0.60	S
DR-43**	Site Boundary	SB	0.42	SSE
DR-44**	Site Boundary	SB	0.21	SE
DR-45**	Site Boundary	SB	0.12	NE
DR-46**	Site Boundary	SB	0.29	NNW
DR-47**	Site Boundary	SB	0.51	NNW
DR-48**	Site Boundary	SB	0.82	NW
DR-49**	Site Boundary	SB	0.27	WNW
DR-50**	Gov. Hunt House	I	0.34	SSW
DR-51**	Site Boundary	SB	0.27	W

* I = Inner Ring TLD; O = Outer Ring Incident Response TLD; C = Control TLD; SB = Site Boundary TLD.

** This location is not considered a requirement of Technical Specification Table 3.9.3.

TABLE 4.4
Environmental Lower Limit of Detection (LLD) Sensitivity Requirements

Analysis	Water (pCi/l)	Airborne Particulates or Gases (pCi/m3)	Fish (pCi/kg)	Milk (pCi/l)	Vegetati on (pCi/kg)	Sediment (pCi/kg -dry)
Gross-Beta	4	0.01				
H-3	3000					
Mn-54	15		130			
Fe-59	30		260			
Co-58,60	15		130			
Zn-65	30		260			
Zr-Nb-95	15					
I-131		0.07		1	60	
Cs-134	15	0.05	130	15	60	150
Cs-137	18	0.06	150	18	80	180
Ba-La-140	15			15		

(Several explanatory footnotes are given in Tech. Spec. Table 4.12-1.

TABLE 4.5

Reporting Levels for Radioactivity Concentrations In Environmental Samples

Analysis	Water (pCi/l)	Airborne Particulates or Gases (pCi/m3)	Fish (pCi/kg)	Milk (pCi/l)	Food Product (pCi/kg)	Sediment (pCi/kg-dry)
H-3	20,000*					
Mn-54	1000		30,000			
Fe-59	400		10,000			
Co-58	1000		30,000			
Co-60	300		10,000			3000**
Zn-65	300		20,000			
Zr-Nb-95	400					
I-131		0.9		3	100	
Cs-134	30	10	1000	60	1000	
Cs-137	50	20	2000	70	2000	
Ba-La-140	200			300		

* Reporting Level for drinking water pathways. For non-drinking water, a value of 30,000 may be used.

** Reporting Level for grab samples taken at the North Storm Drain Outfall only.

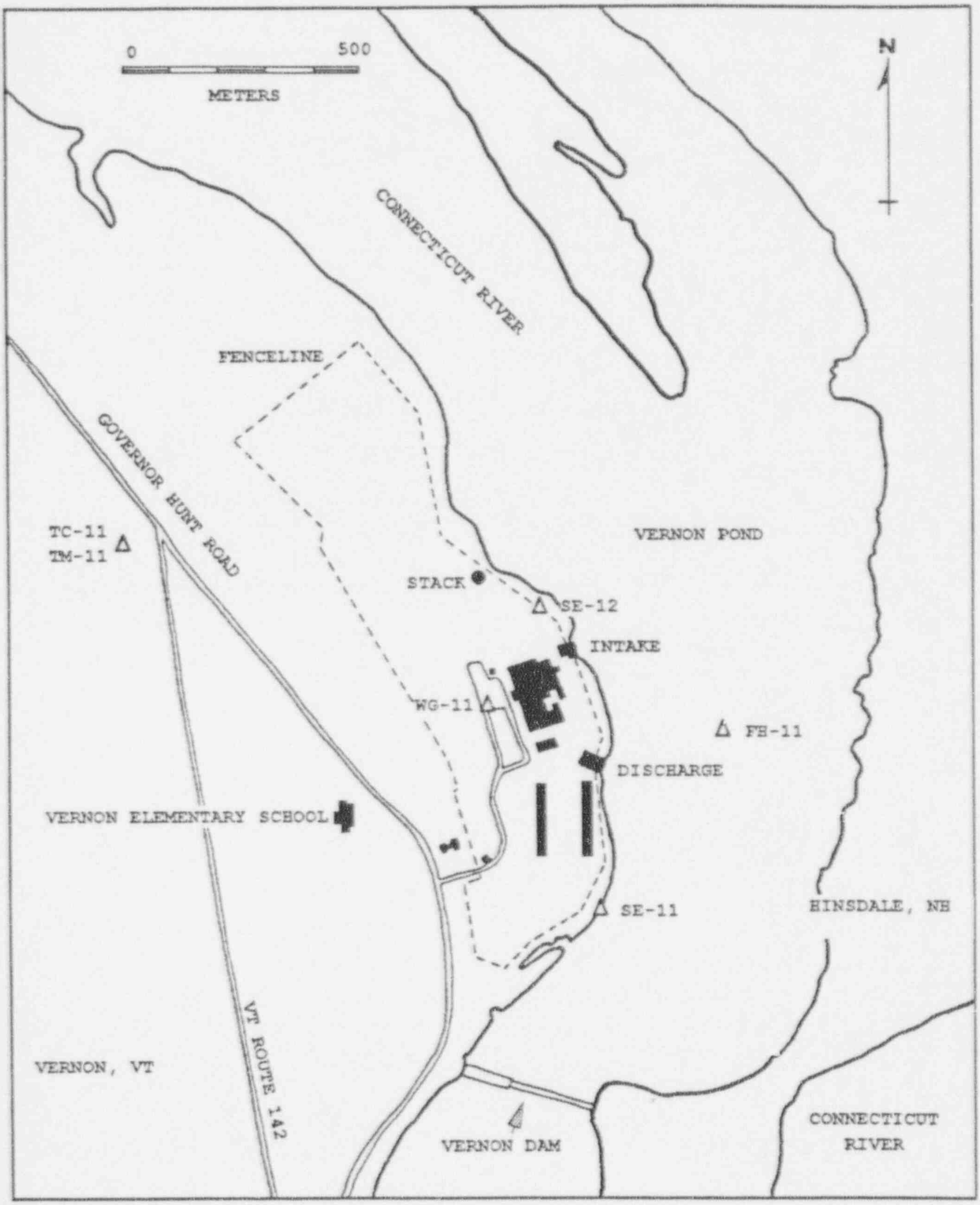


Figure 4.1 Radiological Environmental Sampling Locations Within Close Proximity to Plant

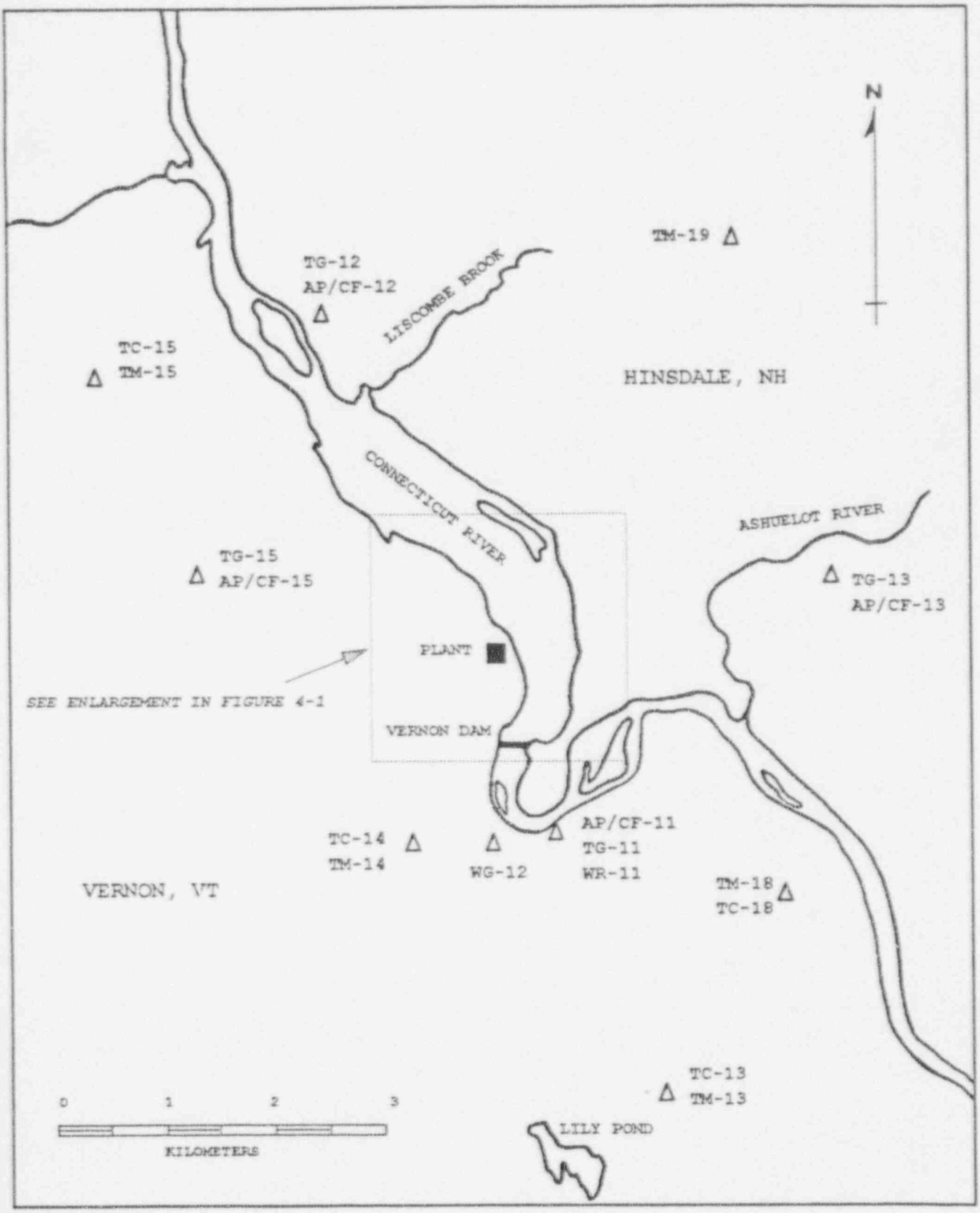


Figure 4.2 Radiological Environmental Sampling Locations Within 5 Kilometers of Plant

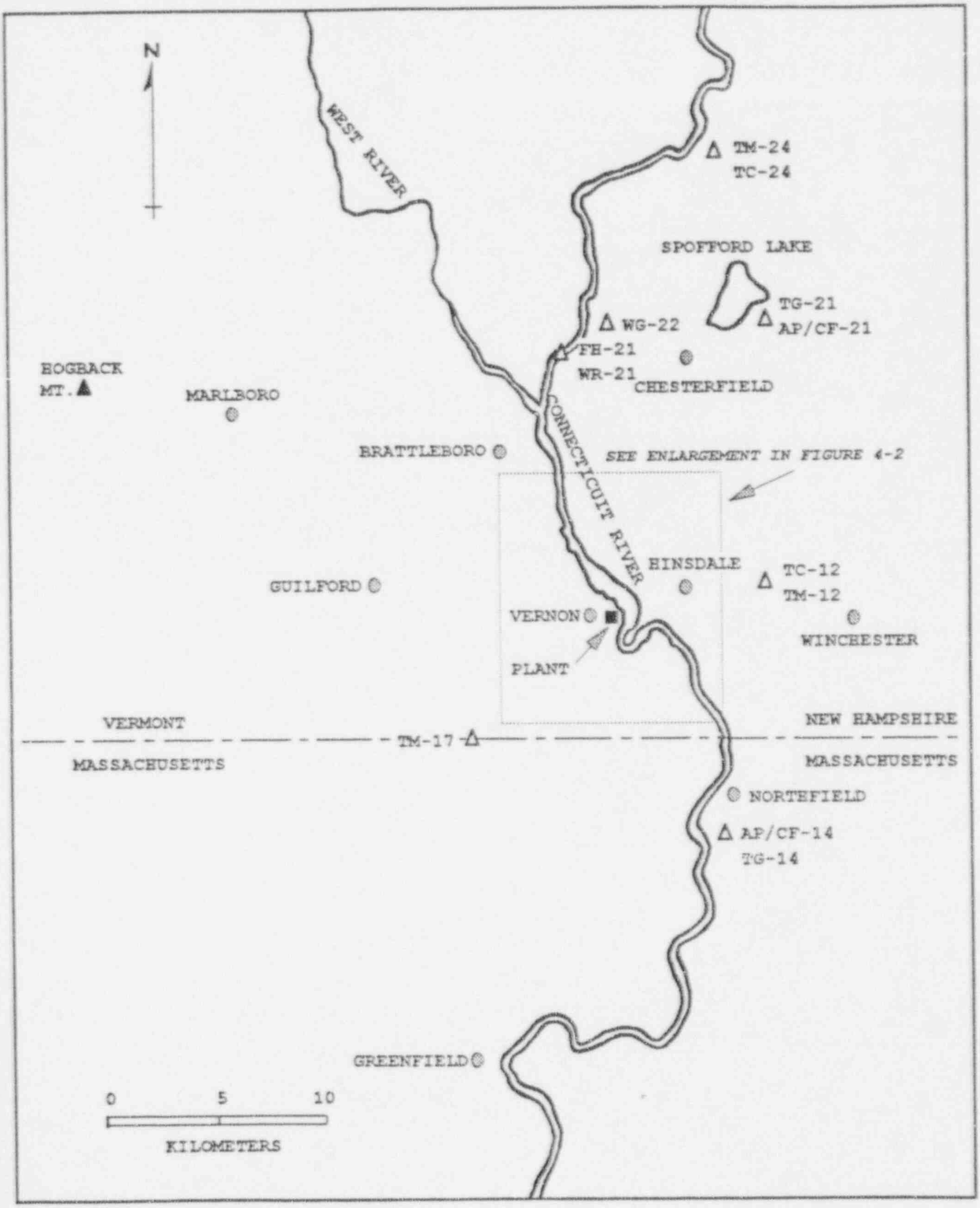


Figure 4.3 Radiological Environmental Sampling Locations Greater than Five Miles from Plant

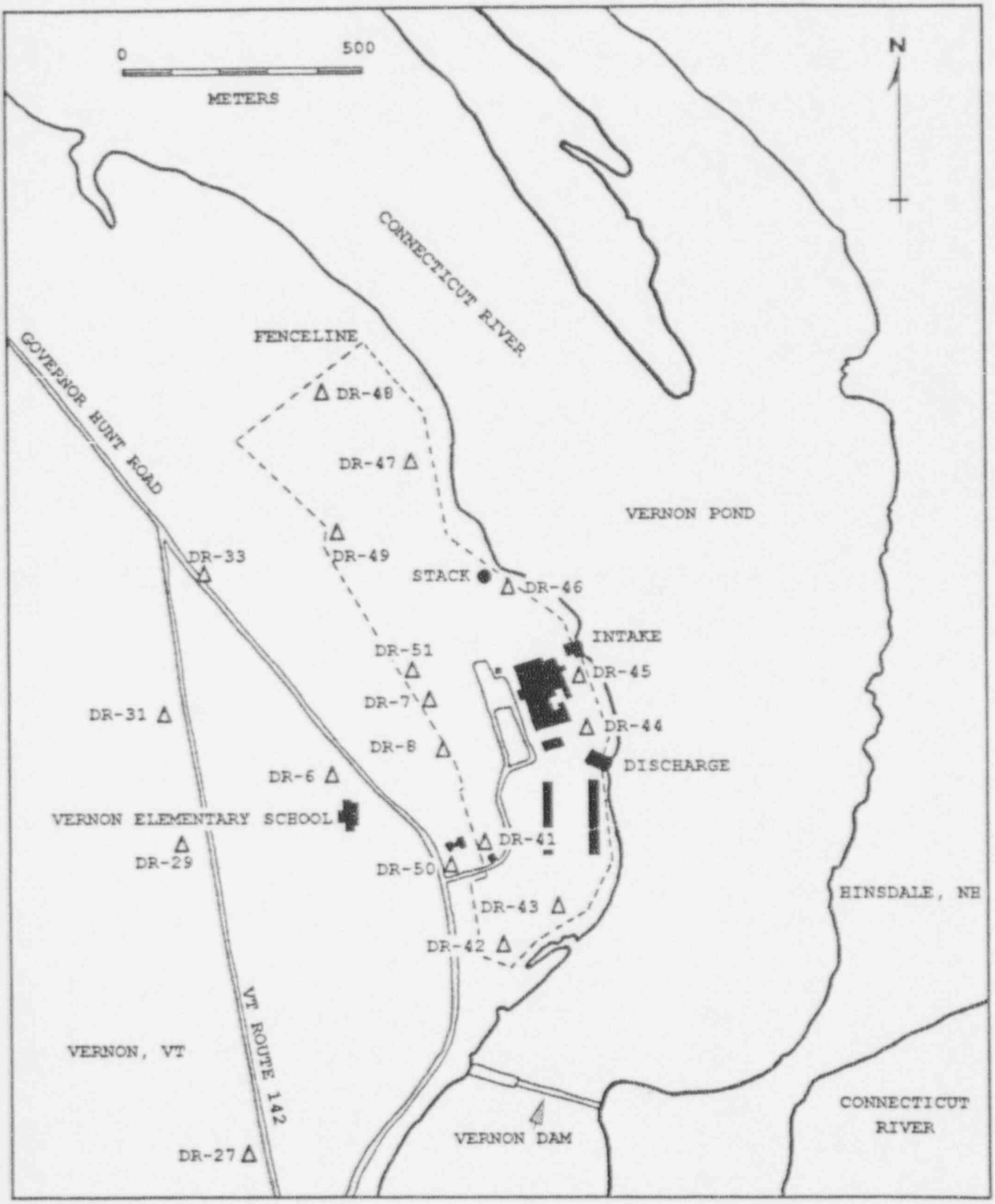


Figure 4.4 TLD Monitoring Locations in Close Proximity to Plant

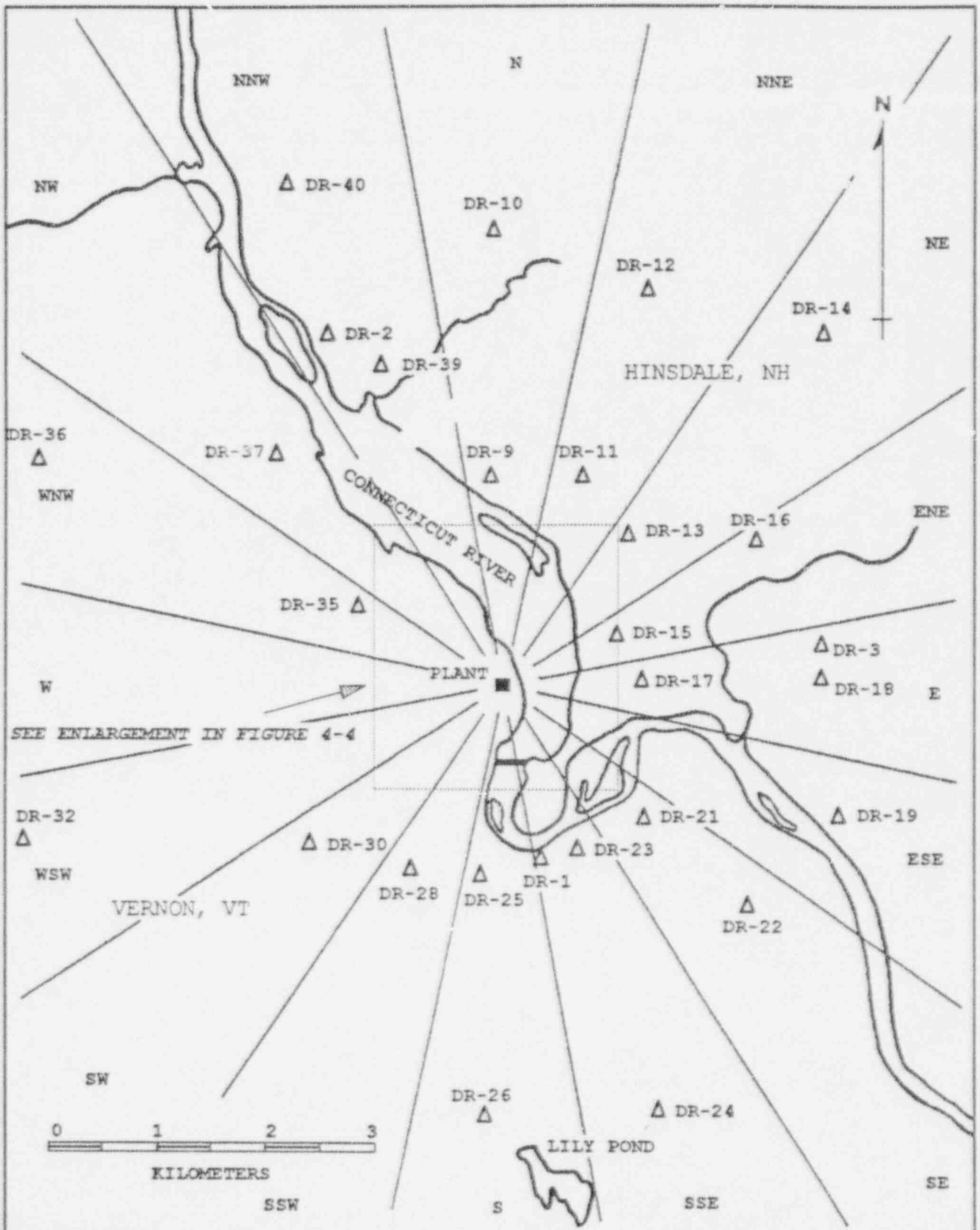


Figure 4.5 TLD Monitoring Locations Within 5 Kilometers from Plant

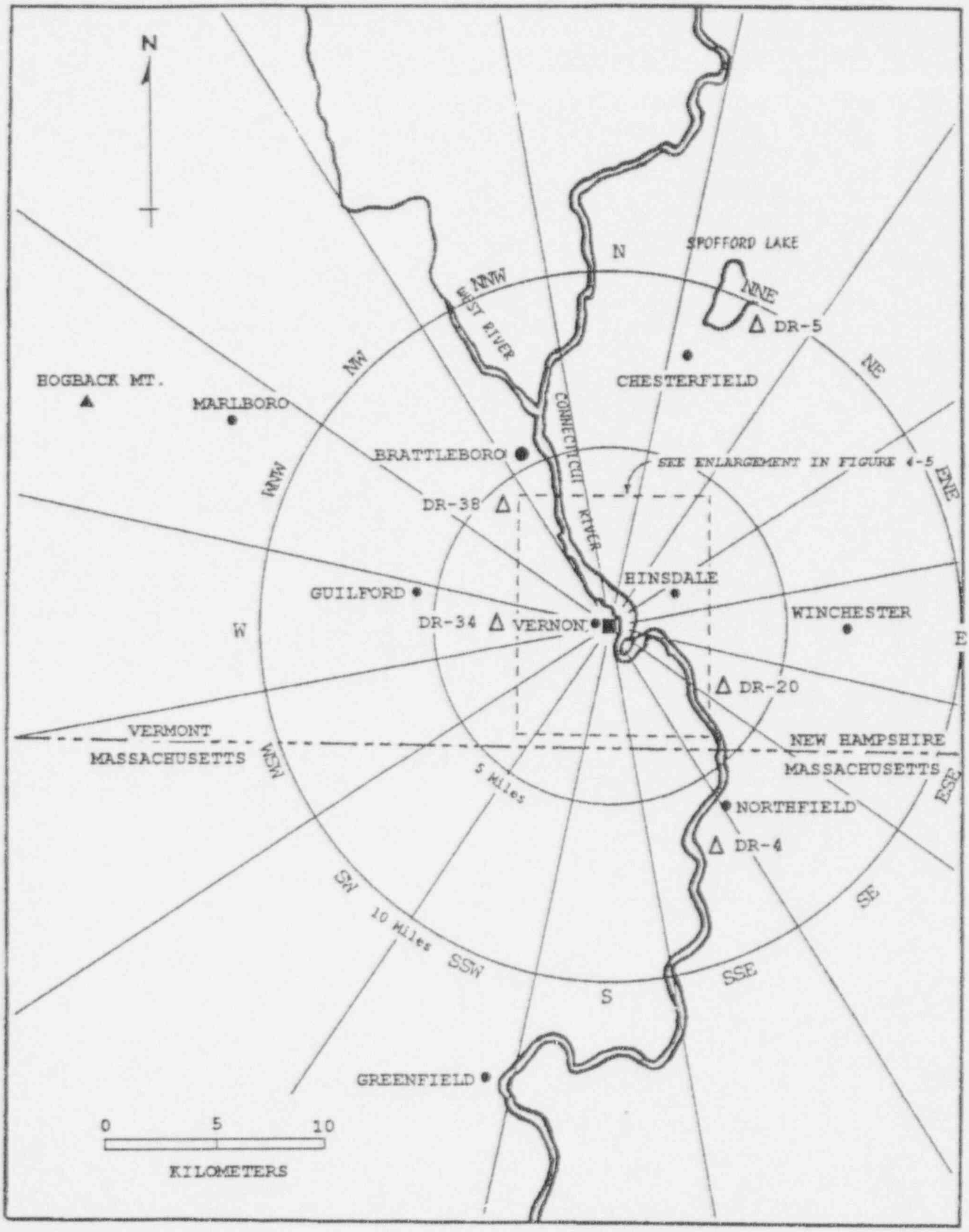


Figure 4.6 TLD Monitoring Locations Greater than 5 Kilometers from Plant

5. RADIOLOGICAL DATA SUMMARY TABLES

This section summarizes the analytical results of the environmental samples which were collected during 1992. These results, shown in Table 5.1, are presented in a format similar to that prescribed in the NRC's Radiological Assessment Branch Technical Position on Environmental Monitoring (Reference 1). The results are ordered by sample media type and then by radionuclide. The units for each media type are also given.

The left-most column contains the radionuclide of interest, the total number of analyses for that radionuclide in 1992, and the number of measurements which exceeded the Reporting Levels found in Table 3.9.4 of the VYNPS Technical Specifications. The latter are classified as "Non-routine" measurements. The second column lists the required Lower Limit of Detection (LLD) for those radionuclides which have detection capability requirements as specified in the plant's Radiological Effluent Technical Specifications (Table 4.9.3). The absence of a value in this column indicates that no LLD is specified in the Technical Specifications for that radionuclide in that media. The target LLD for any analysis is typically 30-40 percent of the most restrictive required LLD. On rare occasions the required LLD is not met. This is usually due to malfunctions in sampling equipment, which results in low sample volume. Such cases are addressed in Section 6.2.

For each radionuclide and media type, the remaining three columns summarize the data for the following categories of monitoring locations: (1) the Indicator stations, which are within the range of influence of the plant and which could conceivably be affected by its operation; (2) the station which had the highest mean concentration during 1992 for that radionuclide; and (3) the Control stations, which are beyond the influence of the plant. Direct radiation monitoring stations (using TLDs) are grouped into Inner Ring, Outer ring, Site Boundary and Control stations.

In each of these columns, for each radionuclide, the following statistical values are given:

- The mean value of all concentrations, with all values that are less than the a posteriori LLD for that analysis having been converted to zero, pursuant to footnote (f) of Technical Specification Table 4.9.3.

- The standard error of the mean.

- The lowest and highest concentration, with all values that are less than the *a posteriori* LLD having been converted to zero, pursuant to footnote (f) of Technical Specification Table 4.9.3.

- The "No. Detected," or the number of positive measurements, divided by the total number of measurements. (A concentration which is greater than three times the standard deviation of that count, based on random uncertainty only, is considered "positive.")

Each single radioactivity measurement datum in this report is based on a single measurement and is reported as a concentration plus or minus a one standard deviation uncertainty. The standard deviation on each measurement represents only the random uncertainty associated with the radioactive decay process (counting statistics), and not the propagation of all possible uncertainties in the analytical procedure.

Pursuant to VYNPS Technical Specification Table 4.9.3 (footnote f), any concentration below the *a posteriori* LLD for its analysis is averaged as a zero. Where a range of values is reported in the tables of this section, values less than their LLD are also reported as zero. To be consistent with Laboratory reporting practices and normal data review practices used by Vermont Yankee, a "positive measurement" is considered to be one whose concentration is greater than three times its associated standard deviation, based on the random uncertainty as discussed above. This use of counting statistics for the determination of the presence or radioactivity, rather than the use of an LLD as a cut-off, is consistent with industry practices.

The radionuclides reported in this section represent those that: 1) had an LLD requirement in Table 4.9.3 of the Technical Specifications, or a Reporting Level listed in Table 3.9.4, or 2) had a positive measurement of radioactivity, whether it was naturally-occurring or man-made; or 3) were of special interest for any other reason. The radionuclides that were routinely analyzed and reported by the Laboratory (in a gamma spectroscopy analysis) were: AcTh-228, Ag-110m, Ba-140, Be-7, Ce-141, Ce-144, Co-57, Co-58, Co-60, Cr-51, Cs-134, Cs-137, Fe-59, I-131, I-133, K-40, Mn-54, Mo-99, Np-239, Ru-103, Ru-106, Sb-124, Se-75, TeI-132, Zn-65 and Zr-95. In no case did a radionuclide not shown in Table 5.1 of this report appear as a "detectable measurement" during 1992.

Data from direct radiation measurements made by TLDs are provided in Table 5.2 in a format essentially the same as above. The complete listing of quarterly TLD data is provided in Table 5.3.

TABLE 5.1

RADIOLOGICAL ENVIRONMENTAL PROGRAM SUMMARY
VERMONT YANKEE NUCLEAR POWER STATION, VERNON, VT
(JANUARY - DECEMBER 1992)

RADIONUCLIDES* (NO. ANALYSES) (NON-ROUTINE)**	REQUIRED LLD	INDICATOR STATIONS MEAN RANGE NO. DETECTED***	STATION WITH HIGHEST MEAN STA. NO.	STATION WITH HIGHEST MEAN MEAN RANGE NO. DETECTED***	CONTROL STATIONS MEAN RANGE NO. DETECTED***
MEDIUM: AIR PARTICULATES (AP)				**UNITS: pCi/cubic meter**	
GR-B (162) (0)	.01	(1.9 ± 0.0)E -2 (0.0 - 3.2)E -2 *(134/135)*	12	(2.0 ± 0.1)E -2 (1.4 - 2.9)E -2 *(27/ 27)*	(1.7 ± 0.1)E -2 (6.7 - 23.3)E -3 *(27/ 27)*
BE-7 (24) (0)		(8.5 ± 0.5)E -2 (4.9 - 13.0)E -2 *(20/ 20)*	15	(9.4 ± 1.0)E -2 (7.2 - 12.0)E -2 *(4/ 4)*	(8.5 ± 0.6)E -2 (7.1 - 9.9)E -2 *(4/ 4)*
CO-60 (24) (0)		(0.0 ± 0.0)E 0 *(0/ 20)*	11	(0.0 ± 0.0)E 0 *(0/ 4)*	(0.0 ± 0.0)E 0 *(0/ 4)*
CS-134 (24) (0)	.05	(0.0 ± 0.0)E 0 *(0/ 20)*	11	(0.0 ± 0.0)E 0 *(0/ 4)*	(0.0 ± 0.0)E 0 *(0/ 4)*
CS-137 (24) (0)	.06	(5.9 ± 6.0)E -5 (0.0 - 1.2)E -3 *(0/ 20)*	12	(3.0 ± 3.0)E -4 (0.0 - 1.2)E -3 *(0/ 4)*	(0.0 ± 0.0)E 0 *(0/ 4)*
MEDIUM: CHARCOAL FILTERS (CF)				**UNITS: pCi/cubic meter**	
I-131 (162) (0)	.07	(1.4 ± 1.4)E -4 (0.0 - 1.9)E -2 *(0/135)*	12	(7.1 ± 7.1)E -4 (0.0 - 1.9)E -2 *(0/ 27)*	(0.0 ± 0.0)E 0 *(0/ 27)*
MEDIUM: RIVER WATER (WR)				**UNITS: pCi/kg**	
GR-B (25) (0)	4.	(2.1 ± 0.2)E 0 (0.0 - 3.1)E 0 *(12/ 13)*	11	(2.1 ± 0.2)E 0 (0.0 - 3.1)E 0 *(12/ 13)*	(2.0 ± 0.2)E 0 (0.0 - 2.7)E 0 *(11/ 12)*
K-40 (25) (0)		(0.0 ± 0.0)E 0 *(0/ 13)*	11	(0.0 ± 0.0)E 0 *(0/ 13)*	(0.0 ± 0.0)E 0 *(0/ 12)*

NOTE: Footnotes may be found at the end of Table 5.1.

TABLE 5.1

RADIOLOGICAL ENVIRONMENTAL PROGRAM SUMMARY
VERMONT YANKEE NUCLEAR POWER STATION, VERNON, VT
(JANUARY - DECEMBER 1992)

RADIONUCLIDES* (NO. ANALYSES) (NON-ROUTINE)**	REQUIRED LLD	INDICATOR STATIONS MEAN RANGE NO. DETECTED***	STATION WITH HIGHEST MEAN STA. NO.	STATION WITH HIGHEST MEAN MEAN RANGE NO. DETECTED***	CONTROL STATIONS MEAN RANGE NO. DETECTED***
MEDIUM: RIVER WATER (WR), continued				UNITS: pCi/kg	
MN-54 (25) (0)	15.	(0.0 ± 0.0)E 0 *(0/ 13)*	11	(0.0 ± 0.0)E 0 *(0/ 13)*	(0.0 ± 0.0)E 0 *(0/ 12)*
CO-58 (25) (0)	15.	(0.0 ± 0.0)E 0 *(0/ 13)*	11	(0.0 ± 0.0)E 0 *(0/ 13)*	(0.0 ± 0.0)E 0 *(0/ 12)*
FE-59 (25) (0)	30.	(0.0 ± 0.0)E 0 *(0/ 13)*	11	(0.0 ± 0.0)E 0 *(0/ 13)*	(0.0 ± 0.0)E 0 *(0/ 12)*
CO-60 (25) (0)	15.	(0.0 ± 0.0)E 0 *(0/ 13)*	11	(0.0 ± 0.0)E 0 *(0/ 13)*	(0.0 ± 0.0)E 0 *(0/ 12)*
ZN-65 (25) (0)	30.	(0.0 ± 0.0)E 0 *(0/ 13)*	11	(0.0 ± 0.0)E 0 *(0/ 13)*	(0.0 ± 0.0)E 0 *(0/ 12)*
ZR-95 (25) (0)	15.	(0.0 ± 0.0)E 0 *(0/ 13)*	11	(0.0 ± 0.0)E 0 *(0/ 13)*	(0.0 ± 0.0)E 0 *(0/ 12)*
CS-134 (25) (0)	15.	(0.0 ± 0.0)E 0 *(0/ 13)*	11	(0.0 ± 0.0)E 0 *(0/ 13)*	(0.0 ± 0.0)E 0 *(0/ 12)*
CS-137 (25) (0)	18.	(0.0 ± 0.0)E 0 *(0/ 13)*	11	(0.0 ± 0.0)E 0 *(0/ 13)*	(0.0 ± 0.0)E 0 *(0/ 12)*
BA-140 (25) (0)	15.	(0.0 ± 0.0)E 0 *(0/ 13)*	11	(0.0 ± 0.0)E 0 *(0/ 13)*	(0.0 ± 0.0)E 0 *(0/ 12)*

NOTE: Footnotes may be found at the end of Table 5.1.

TABLE 5.1

RADIOLOGICAL ENVIRONMENTAL PROGRAM SUMMARY
VERMONT YANKEE NUCLEAR POWER STATION, VERNON, VT
(JANUARY - DECEMBER 1992)

RADIONUCLIDES* (NO. ANALYSES) (NON-ROUTINE)**	REQUIRED LLD	INDICATOR STATIONS: MEAN / RANGE / NO. DETECTED***	STATION WITH HIGHEST MEAN: STA. NO.	STATION WITH HIGHEST MEAN: MEAN / RANGE / NO. DETECTED***	CONTROL STATIONS: MEAN / RANGE / NO. DETECTED***
MEDIUM: RIVER WATER (WR), continued		**UNITS: pCi/kg**			
H-3 (9) (0)	3000.	(0.0 ± 0.0)E 0 *(0/ 5)*	11	(0.0 ± 0.0)E 0 *(0/ 5)*	(0.0 ± 0.0)E 0 *(0/ 4)*
MEDIUM: GROUND WATER (WG)		**UNITS: pCi/kg**			
GR-B (14) (0)	4.	(5.8 ± 1.2)E 0 (0.0 - 1.2)E 1 *(9/ 10)*	11	(7.7 ± 0.5)E 0 (6.6 - 9.6)E 0 *(5/ 5)*	(2.2 ± 0.2)E 0 (1.7 - 2.5)E 0 *(4/ 4)*
MN-54 (12) (0)	15.	(0.0 ± 0.0)E 0 *(0/ 8)*	11	(0.0 ± 0.0)E 0 *(0/ 4)*	(0.0 ± 0.0)E 0 *(0/ 4)*
CO-58 (12) (0)	15.	(0.0 ± 0.0)E 0 *(0/ 8)*	11	(0.0 ± 0.0)E 0 *(0/ 4)*	(0.0 ± 0.0)E 0 *(0/ 4)*
FE-59 (12) (0)	30.	(0.0 ± 0.0)E 0 *(0/ 8)*	11	(0.0 ± 0.0)E 0 *(0/ 4)*	(0.0 ± 0.0)E 0 *(0/ 4)*
CO-60 (12) (0)	15.	(0.0 ± 0.0)E 0 *(0/ 8)*	11	(0.0 ± 0.0)E 0 *(0/ 4)*	(0.0 ± 0.0)E 0 *(0/ 4)*
ZN-65 (12) (0)	30.	(0.0 ± 0.0)E 0 *(0/ 8)*	11	(0.0 ± 0.0)E 0 *(0/ 4)*	(0.0 ± 0.0)E 0 *(0/ 4)*
ZR-95 (12) (0)	15.	(0.0 ± 0.0)E 0 *(0/ 8)*	11	(0.0 ± 0.0)E 0 *(0/ 4)*	(0.0 ± 0.0)E 0 *(0/ 4)*

NOTE: Footnotes may be found at the end of Table 5.1.

TABLE 5.1

RADIOLOGICAL ENVIRONMENTAL PROGRAM SUMMARY
VERMONT YANKEE NUCLEAR POWER STATION, VERNON, VT
(JANUARY - DECEMBER 1992)

RADIONUCLIDES* (NO. ANALYSES) (NON-ROUTINE)**	REQUIRED LLD	INDICATOR STATIONS MEAN RANGE NO. DETECTED***	STATION WITH HIGHEST MEAN STA. NO.	 MEAN RANGE NO. DETECTED***	CONTROL STATIONS MEAN RANGE NO. DETECTED***
MEDIUM: GROUND WATER (WG), continued UNITS: pCi/kg					
CS-134 (12) (0)	15.	(0.0 ± 0.0)E 0 *(0/ 8)*	11	(0.0 ± 0.0)E 0 *(0/ 4)*	(0.0 ± 0.0)E 0 *(0/ 4)*
CS-137 (12) (0)	18.	(0.0 ± 0.0)E 0 *(0/ 8)*	11	(0.0 ± 0.0)E 0 *(0/ 4)*	(0.0 ± 0.0)E 0 *(0/ 4)*
BA-140 (12) (0)	15.	(0.0 ± 0.0)E 0 *(0/ 8)*	11	(0.0 ± 0.0)E 0 *(0/ 4)*	(0.0 ± 0.0)E 0 *(0/ 4)*
H-3 (12) (0)	3000.	(0.0 ± 0.0)E 0 *(0/ 8)*	11	(0.0 ± 0.0)E 0 *(0/ 4)*	(0.0 ± 0.0)E 0 *(0/ 4)*
MEDIUM: SEDIMENT (SE) UNITS: pCi/kg (dry)					
BE-7 (82) (0)		(2.6 ± 1.3)E 1 (0.0 - 6.9)E 2 *(1/ 82)*	11	(3.5 ± 3.5)E 2 (0.0 - 6.9)E 2 *(1/ 2)*	NO DATA
K-40 (82) (0)		(1.3 ± 0.0)E 4 (7.8 - 17.1)E 3 *(82/ 82)*	12	(1.3 ± 0.0)E 4 (8.6 - 17.1)E 3 *(80/ 80)*	NO DATA
CO-58 (82) (0)		(0.0 ± 0.0)E 0 *(0/ 82)*	11	(0.0 ± 0.0)E 0 *(0/ 2)*	NO DATA
CO-60 (82) (0)		(3.0 ± 1.9)E 1 (0.0 - 1.5)E 3 *(9/ 82)*	12	(3.1 ± 1.9)E 1 (0.0 - 1.5)E 3 *(9/ 80)*	NO DATA

NOTE: Footnotes may be found at the end of Table 5.1.

TABLE 5.1

RADIOLOGICAL ENVIRONMENTAL PROGRAM SUMMARY
VERMONT YANKEE NUCLEAR POWER STATION, VERNON, VT
(JANUARY - DECEMBER 1992)

RADIONUCLIDES* (NO. ANALYSES) (NON-ROUTINE)**	REQUIRED LLD	INDICATOR STATIONS MEAN RANGE NO. DETECTED***	STATION WITH HIGHEST MEAN STA. NO.	STATION WITH HIGHEST MEAN MEAN RANGE NO. DETECTED***	CONTROL STATIONS MEAN RANGE NO. DETECTED***
MEDIUM: SEDIMENT (SE), cont.				UNITS: pCi/kg (dry)	
CS-134 (82) (0)	150.	(0.0 ± 0.0)E 0 *(0/ 82)*	11	(0.0 ± 0.0)E 0 *(0/ 2)*	NO DATA
CS-137 (82) (0)	180.	(1.8 ± 0.1)E 2 (0.0 - 3.4)E 2 *(76/ 82)*	12	(1.8 ± 0.1)E 2 (0.0 - 3.4)E 2 *(74/ 80)*	NO DATA
ACTH228 (82) (0)		(8.8 ± 0.2)E 2 (4.2 - 13.4)E 2 *(82/ 82)*	11	(8.9 ± 2.5)E 2 (6.4 - 11.4)E 2 *(2/ 2)*	NO DATA
MEDIUM: MILK (TM)				UNITS: pCi/kg	
SR-89 (26) (0)		(0.0 ± 0.0)E 0 *(0/ 22)*	11	(0.0 ± 0.0)E 0 *(0/ 4)*	(0.0 ± 0.0)E 0 *(0/ 4)*
SR-90 (26) (0)		(2.1 ± 0.5)E 0 (0.0 - 6.8)E 0 *(14/ 22)*	12	(4.8 ± 0.9)E 0 (2.5 - 6.8)E 0 *(4/ 4)*	(0.0 ± 0.0)E 0 *(0/ 4)*
K-40 (114) (0)		(1.4 ± 0.0)E 3 (1.1 - 2.2)E 3 *(96/ 96)*	12	(1.9 ± 0.0)E 3 (1.6 - 2.1)E 3 *(18/ 18)*	(1.3 ± 0.0)E 3 (1.2 - 1.4)E 3 *(18/ 18)*
I-131 (114) (0)	1.	(9.6 ± 9.6)E -3 (0.0 - 9.2)E -1 *(0/ 96)*	12	(5.1 ± 5.1)E -2 (0.0 - 9.2)E -1 *(0/ 18)*	(0.0 ± 0.0)E 0 *(0/ 18)*
CS-134 (114) (0)	15.	(0.0 ± 0.0)E 0 *(0/ 96)*	11	(0.0 ± 0.0)E 0 *(0/ 18)*	(0.0 ± 0.0)E 0 *(0/ 18)*

NOTE: Footnotes may be found at the end of Table 5.1.

TABLE 5.1

RADIOLOGICAL ENVIRONMENTAL PROGRAM SUMMARY
VERMONT YANKEE NUCLEAR POWER STATION, VERNON, VT
(JANUARY - DECEMBER 1992)

RADIONUCLIDES* (NO. ANALYSES) (NON-ROUTINE)**	REQUIRED LLD	INDICATOR STATIONS: MEAN / RANGE / NO. DETECTED***	STATION WITH HIGHEST MEAN: STA. NO.	STATION WITH HIGHEST MEAN: MEAN / RANGE / NO. DETECTED***	CONTROL STATIONS: MEAN / RANGE / NO. DETECTED***
MEDIUM: MILK (TM), cont.				**UNITS: pCi/kg**	
CS-137 (114) (0)	18.	(2.7 ± 0.7)E 0 (0.0 - 3.7)E 1 *(21/ 96)*	12	(1.3 ± 0.2)E 1 (0.0 - 3.7)E 1 *(17/ 18)*	(0.0 ± 0.0)E 0 *(0/ 18)*
BA-140 (114) (0)	15.	(0.0 ± 0.0)E 0 *(0/ 96)*	11	(0.0 ± 0.0)E 0 *(0/ 18)*	(0.0 ± 0.0)E 0 *(0/ 18)*
MEDIUM: SILAGE (TC)				**UNITS: pCi/kg**	
BE-7 (8) (0)		(2.9 ± 1.3)E 2 (0.0 - 8.9)E 2 *(4/ 7)*	19	(8.9 ± 1.4)E 2 *(1/ 1)*	(3.8 ± 0.9)E 2 *(1/ 1)*
K-40 (8) (0)		(5.0 ± 0.9)E 3 (1.5 - 7.9)E 3 *(7/ 7)*	12	(7.9 ± 0.4)E 3 *(1/ 1)*	(6.5 ± 0.4)E 3 *(1/ 1)*
I-131 (8) (0)	60.	(0.0 ± 0.0)E 0 *(0/ 7)*	11	(0.0 ± 1.1)E 1 *(0/ 1)*	(0.0 ± 10.0)E 0 *(0/ 1)*
CS-134 (8) (0)	60.	(0.0 ± 0.0)E 0 *(0/ 7)*	11	(0.0 ± 6.8)E 0 *(0/ 1)*	(0.0 ± 1.1)E 1 *(0/ 1)*
CS-137 (8) (0)	80.	(0.0 ± 0.0)E 0 *(0/ 7)*	11	(0.0 ± 5.6)E 0 *(0/ 1)*	(0.0 ± 9.7)E 0 *(0/ 1)*
BA-140 (8) (0)		(0.0 ± 0.0)E 0 *(0/ 7)*	11	(0.0 ± 1.1)E 1 *(0/ 1)*	(0.0 ± 2.1)E 1 *(0/ 1)*

NOTE: Footnotes may be found at the end of Table 5.1.

TABLE 5.1

RADIOLOGICAL ENVIRONMENTAL PROGRAM SUMMARY
VERMONT YANKEE NUCLEAR POWER STATION, VERNON, VT
(JANUARY - DECEMBER 1992)

RADIONUCLIDES* (NO. ANALYSES) (NON-ROUTINE)**	REQUIRED LLD	INDICATOR STATIONS MEAN RANGE NO. DETECTED***	STATION WITH HIGHEST MEAN STA. NO.	STATION WITH HIGHEST MEAN MEAN RANGE NO. DETECTED***	CONTROL STATIONS MEAN RANGE NO. DETECTED***
MEDIUM: MIXED GRASS (TG)				UNITS: pCi/kg	
BE-7 (18) (0)		(7.7 ± 2.1)E 2 (0.0 - 2.3)E 3 *(9/ 15)*	11	(1.2 ± 0.5)E 3 (6.2 - 22.7)E 2 *(3/ 3)*	(7.7 ± 1.8)E 2 (4.1 - 9.7)E 2 *(3/ 3)*
K-40 (18) (0)		(5.3 ± 0.4)E 3 (3.9 - 9.8)E 3 *(15/ 15)*	14	(7.0 ± 1.4)E 3 (5.2 - 9.8)E 3 *(3/ 3)*	(5.9 ± 0.5)E 3 (5.1 - 6.8)E 3 *(3/ 3)*
I-131 (18) (0)	60.	(0.0 ± 0.0)E 0 *(0/ 15)*	11	(0.0 ± 0.0)E 0 *(0/ 3)*	(0.0 ± 0.0)E 0 *(0/ 3)*
CS-134 (18) (0)	60.	(0.0 ± 0.0)E 0 *(0/ 15)*	11	(0.0 ± 0.0)E 0 *(0/ 3)*	(0.0 ± 0.0)E 0 *(0/ 3)*
CS-137 (18) (0)	80.	(9.5 ± 7.0)E 0 (0.0 - 9.9)E 1 *(2/ 15)*	[illegible]	(3.3 ± 3.3)E 1 (0.0 - 9.9)E 1 *(1/ 3)*	(0.0 ± 0.0)E 0 *(0/ 3)*
MEDIUM: FISH (FH)				UNITS: pCi/kg	
K-40 (4) (0)		([illegible].6 ± 0.3)E 3 (2.2 - 2.9)E 3 *(2/ 2)*	21	(3.2 ± 0.0)E 3 (3.1 - 3.2)E 3 *(2/ 2)*	(3.2 ± 0.0)E 3 (3.1 - 3.2)E 3 *(2/ 2)*
MN-54 (4) (0)	130.	(0.0 ± 0.0)E 0 *(0/ 2)*	11	(0.0 ± 0.0)E 0 *(0/ 2)*	(0.0 ± 0.0)E 0 *(0/ 2)*
CO-58 (4) (0)	130.	(0.0 ± 0.0)E 0 *(0/ 2)*	11	(0.0 ± 0.0)E 0 *(0/ 2)*	(0.0 ± 0.0)E 0 *(0/ 2)*

NOTE: Footnotes may be found at the end of Table 5.1.

TABLE 5.1

RADIOLOGICAL ENVIRONMENTAL PROGRAM SUMMARY
VERMONT YANKEE NUCLEAR POWER STATION, VERNON, VT
(JANUARY - DECEMBER 1992)

RADIONUCLIDES* (NO. ANALYSES) (NON-ROUTINE)**	REQUIRED LLD	INDICATOR STATIONS: MEAN RANGE NO. DETECTED***	STATION WITH HIGHEST MEAN: STA. NO.	STATION WITH HIGHEST MEAN: MEAN RANGE NO. DETECTED***	CONTROL STATIONS: MEAN RANGE NO. DETECTED***
		MEDIUM: FISH (FH), cont.		UNITS: pCi/kg	
FE-59 (4) (0)	260.	(0.0 ± 0.0)E 0 *(0/ 2)*	11	(0.0 ± 0.0)E 0 *(0/ 2)*	(0.0 ± 0.0)E 0 *(0/ 2)*
CO-60 (4) (0)	130.	(0.0 ± 0.0)E 0 *(0/ 2)*	11	(0.0 ± 0.0)E 0 *(0/ 2)*	(0.0 ± 0.0)E 0 *(0/ 2)*
ZN-65 (4) (0)	260.	(0.0 ± 0.0)E 0 *(0/ 2)*	11	(0.0 ± 0.0)E 0 *(0/ 2)*	(0.0 ± 0.0)E 0 *(0/ 2)*
CS-134 (4) (0)	130.	(0.0 ± 0.0)E 0 *(0/ 2)*	11	(0.0 ± 0.0)E 0 *(0/ 2)*	(0.0 ± 0.0)E 0 *(0/ 2)*
CS-137 (4) (0)	150.	(1.3 ± 1.3)E 1 (0.0 - 2.7)E 1 *(1/ 2)*	11	(1.3 ± 1.3)E 1 (0.0 - 2.7)E 1 *(1/ 2)*	(0.0 ± 0.0)E 0 *(0/ 2)*

NOTE: Footnotes may be found at the end of Table 5.1.

Footnotes to Table 5.1:

* The only radionuclides reported in this table are those with LLD requirements, those for which positive radioactivity was detected, and those that were of some other special interest. See Section 5 of this report for a discussion of other radionuclides that were analyzed.

** Non-Routine refers to those radionuclides that exceeded the Reporting Levels in Technical Specification Table 3.9.4.

*** The fraction of sample analyses yielding detectable measurements (i.e. the concentration is greater than three times its standard deviation) is shown in parentheses.

TABLE 5.2

ENVIRONMENTAL TLD DATA SUMMARY
VERMONT YANKEE NUCLEAR POWER STATION, VERNON, VT
(JANUARY - DECEMBER 1992)

INNER RING TLDs MEAN RANGE (NO. MEASUREMENTS)*	OUTER RING TLDs MEAN RANGE (NO. MEASUREMENTS)*	OFFSITE STATION WITH HIGHEST MEAN MEAN RANGE (NO. MEASUREMENTS)*	CONTROL TLDs MEAN RANGE (NO. MEASUREMENTS)*
6.7 ± 0.4 5.8 - 7.9 (85)	6.8 ± 0.7 5.2 - 8.6 (64)	DR-36 7.9 ± 0.6 7.3 - 8.6 (4)	6.7 ± 0.4 6.4 - 7.2 (4)

SITE BOUNDARY TLD WITH HIGHEST MEAN MEAN RANGE (NO. MEASUREMENTS)*	SITE BOUNDARY TLDs MEAN RANGE (NO. MEASUREMENTS)*
DR-45 15.4 ± 1.7 13.2 - 17.4 (4)	8.4 ± 2.3 6.6 - 17.4 (47)

* Each "measurement" is based typically on quarterly readings from five TLD elements.

TABLE 5.3

ENVIRONMENTAL TLD MEASUREMENTS
1992
(Micro-R per Hour)

Sta. No.	Description	1ST QUARTER EXP. ± S.D.	2ND QUARTER EXP. ± S.D.	3RD QUARTER EXP. ± S.D.	4TH QUARTER EXP. ± S.D.	ANNUAL AVE. EXP.
DR-01	River Sta. No. 3.3	6.7 ± 0.4	6.1 ± 0.4	6.2 ± 0.3	6.0 ± 0.4	6.3
DR-02	N. Hinsdale, NH	6.7 ± 0.2	6.2 ± 0.3	6.5 ± 0.3	6.3 ± 0.2	6.4
DR-03	Hinsdale Substation	7.9 ± 0.3	7.6 ± 0.2	7.7 ± 0.3	7.4 ± 0.2	7.7
DR-04	Northfield, MA	6.5 ± 0.3	6.0 ± 0.2	6.4 ± 0.2	5.8 ± 0.2	6.2
DR-05	Spofford Lake, NH	7.2 ± 0.4	6.4 ± 0.2	6.7 ± 0.3	6.5 ± 0.3	6.7
DR-06	Vernon School	7.0 ± 0.3	*	6.8 ± 0.3	6.7 ± 0.2	6.8
DR-07	Site Boundary	7.8 ± 0.3	8.0 ± 0.3	8.5 ± 0.4	8.0 ± 0.3	8.1
DR-08	Site Boundary	8.1 ± 0.4	7.9 ± 0.3	8.8 ± 0.4	8.3 ± 0.3	8.3
DR-09	Inner Ring	6.8 ± 0.4	6.3 ± 0.3	6.5 ± 0.3	6.3 ± 0.4	6.5
DR-10	Outer Ring	6.3 ± 0.4	5.2 ± 0.3	5.6 ± 0.3	5.3 ± 0.3	5.6
DR-11	Inner Ring	6.5 ± 0.3	5.8 ± 0.2	6.1 ± 0.3	5.9 ± 0.2	6.1
DR-12	Outer Ring	6.3 ± 0.3	5.7 ± 0.2	6.0 ± 0.3	5.8 ± 0.2	6.0
DR-13	Inner Ring	7.1 ± 0.3	6.1 ± 0.3	6.6 ± 0.3	6.5 ± 0.3	6.6
DR-14	Outer Ring	7.8 ± 0.3	7.4 ± 0.2	7.7 ± 0.2	7.4 ± 0.3	7.6
DR-15	Inner Ring	7.6 ± 0.4	6.4 ± 0.3	*	6.6 ± 0.3	6.9
DR-16	Outer Ring	7.5 ± 0.3	6.7 ± 0.3	6.9 ± 0.3	6.9 ± 0.3	7.0
DR-17	Inner Ring	7.2 ± 0.5	6.2 ± 0.2	6.5 ± 0.3	6.3 ± 0.3	6.6
DR-18	Outer Ring	7.1 ± 0.3	6.6 ± 0.3	7.0 ± 0.3	6.8 ± 0.3	6.9
DR-19	Inner Ring	7.3 ± 0.3	6.8 ± 0.3	7.1 ± 0.2	6.8 ± 0.3	7.0
DR-20	Outer Ring	7.9 ± 0.3	7.5 ± 0.3	7.8 ± 0.3	7.5 ± 0.3	7.7
DR-21	Inner Ring	7.2 ± 0.3	6.7 ± 0.3	7.0 ± 0.3	7.0 ± 0.3	7.0
DR-22	Outer Ring	7.3 ± 0.3	6.5 ± 0.2	7.1 ± 0.4	6.8 ± 0.5	6.9
DR-23	Inner Ring	8.3 ± 0.3	6.4 ± 0.3	6.7 ± 0.3	6.7 ± 0.2	7.0
DR-24	Outer Ring	6.2 ± 0.3	5.6 ± 0.3	5.8 ± 0.2	5.9 ± 0.4	5.9
DR-25	Inner Ring	7.0 ± 0.2	6.3 ± 0.2	6.7 ± 0.3	6.4 ± 0.4	6.6
DR-26	Outer Ring	6.9 ± 0.3	6.7 ± 0.2	6.9 ± 0.3	6.7 ± 0.3	6.8
DR-27	Inner Ring	6.8 ± 0.3	6.6 ± 0.2	6.9 ± 0.3	6.7 ± 0.4	6.8
DR-28	Outer Ring	7.0 ± 0.3	6.8 ± 0.2	7.3 ± 0.3	6.7 ± 0.3	7.0
DR-29	Inner Ring	7.0 ± 0.3	6.4 ± 0.3	6.9 ± 0.3	6.7 ± 0.2	6.8
DR-30	Outer Ring	6.6 ± 0.3	6.1 ± 0.2	6.6 ± 0.3	6.8 ± 0.3	6.5
DR-31	Inner Ring	7.0 ± 0.3	6.4 ± 0.2	6.9 ± 0.3	6.7 ± 0.3	6.8
DR-32	Outer Ring	6.8 ± 0.3	6.1 ± 0.2	6.7 ± 0.3	6.7 ± 0.3	6.6
DR-33	Inner Ring	7.0 ± 0.3	6.5 ± 0.2	7.2 ± 0.3	7.0 ± 0.3	6.9
DR-34	Outer Ring	7.5 ± 0.4	7.1 ± 0.3	7.4 ± 0.2	7.0 ± 0.2	7.3
DR-35	Inner Ring	7.1 ± 0.4	6.4 ± 0.2	6.8 ± 0.3	6.5 ± 0.2	6.7
DR-36	Outer Ring	7.6 ± 0.3	7.3 ± 0.3	8.1 ± 0.4	8.6 ± 0.4	7.9
DR-37	Inner Ring	7.1 ± 0.3	6.8 ± 0.3	6.9 ± 0.3	6.6 ± 0.3	6.9
DR-38	Outer Ring	7.4 ± 0.4	6.8 ± 0.4	7.2 ± 0.2	6.7 ± 0.2	7.0
DR-39	Inner Ring	7.1 ± 0.3	6.5 ± 0.4	6.8 ± 0.3	6.3 ± 0.2	6.7
DR-40	Outer Ring	7.1 ± 0.3	6.4 ± 0.4	6.5 ± 0.3	6.4 ± 0.2	6.6

TABLE 5.3, continued

SUMMARY OF 1992 ENVIRONMENTAL TLD MEASUREMENTS
(Micro-R per Hour)

Sta. No.	Description	1ST QUARTER EXP. S.D.	2ND QUARTER EXP. S.D.	3RD QUARTER EXP. S.D.	4TH QUARTER EXP. S.D.	ANNUAL AVE. EXP.
DR-41	Site Boundary	7.7 ± 0.4	7.4 ± 0.3	8.0 ± 0.3	7.4 ± 0.3	7.6
DR-42	Site Boundary	6.9 ± 0.3	6.6 ± 0.4	7.1 ± 0.3	6.8 ± 0.3	6.9
DR-43	Site Boundary	7.3 ± 0.3	7.1 ± 0.3	7.5 ± 0.3	7.3 ± 0.3	7.3
DR-44	Site Boundary	7.9 ± 0.4	7.1 ± 0.3	8.5 ± 0.4	7.9 ± 0.3	7.9
DR-45	Site Boundary	13.2 ± 0.5	15.6 ± 0.7	15.4 ± 0.9	17.4 ± 0.7	15.4
DR-46	Site Boundary	8.7 ± 0.3	8.3 ± 0.4	8.7 ± 0.3	8.6 ± 0.3	8.6
DR-47	Site Boundary	8.1 ± 0.3	7.7 ± 0.3	8.2 ± 0.4	7.9 ± 0.3	8.0
DR-48	Site Boundary	7.5 ± 0.4	6.9 ± 0.3	7.1 ± 0.4	7.0 ± 0.4	7.1
DR-49	Site Boundary	7.0 ± 0.3	*	6.9 ± 0.3	6.6 ± 0.3	6.8
DR-50	Governor Hunt House	7.4 ± 0.3	6.8 ± 0.3	7.4 ± 0.3	7.1 ± 0.4	7.2
DR-51	Site Boundary	8.1 ± 0.3	7.9 ± 0.2	8.4 ± 0.4	8.2 ± 0.5	8.2

* Data not available due to missing TLDs.

6. **ANALYSIS OF ENVIRONMENTAL RESULTS**

6.1 Sampling Program Deviations

Radiological Effluent Technical Specification 3.9.C allows for deviations "if specimens are unobtainable due to hazardous conditions, seasonal unavailability, malfunction of automatic sampling equipment and other legitimate reasons." In 1992, several deviations were noted in the REMP. These deviations did not compromise the program's effectiveness and in fact are considered typical with respect to what is normally anticipated for any radiological environmental monitoring program. The specific deviations for 1992 were:

a. An improperly installed air particulate filter at Station AP-11 resulted in an incomplete sample for the period January 7 to January 21, 1992.

b. During the sample period January 7 through January 21, 1992, the pump at station AP/CF-14 failed, resulting in an incomplete sample. The pump was replaced.

c. Upon sample collection at Station AP/CF-12 on July 21, 1992 (for the sample period July 7-21), the dry gas meter was found to be inoperable. Since there was no volume measurement available, the average volume for the past five weeks was used with air particulate and charcoal filter measurements.

d. Upon sample collection at Station AP-21 on August 18, 1992 (for the sample period August 4-18), the air particulate filter was found to be torn, apparently due to vandalism.

e. The automatic compositing sampler at Station WR-11 was out of service from approximately 2300 on March 11 through 1800 on March 20, 1992. The cause for the interrupted water flow was not known.

f. The automatic compositing sampler at Station WR-11 was out of service from 044 o· March 28 through 1000 on April 2, 1992. Faulty pump installation was the suspected cause.

g. Water flow to the automatic compositing sampler at Station WR-11 was interrupted from the afternoon of April 25 through 1600 on April 27, 1992. Sediment had clogged the sampling lines.

h. Water flow to the automatic compositing sampler at WR-11 was interrupted at approximately 0600 on August 4, 1992, apparently due to an electrical storm. The sampler was placed back in service at approximately 1330 on August 7, 1992.

i. The automatic compositing sampler at Station WR-11 went out of service, or began providing inadequate sample volumes, at an undetermined time during the period September 16 to October 13, 1992. (Only a partial sample was available.) The pump was put back in service on October 13, 1992, at which time a grab sample of water was collected for analysis.

j. Due to the lack of growing vegetation during the winter season, mixed grass samples were not collected during the first and fourth quarters of 1992. A total of three samples were collected at each location during the second and third quarters of 1992.

k. Thermoluminescent dosimeters (TLDs) were discovered missing on three occasions, as follows: DR-06 for the second quarter, DR-49 for the second quarter, and DR-15 for the third quarter.

6.2 Comparison of Achieved LLDs with Requirements

Table 4.9.3 of the VYNPS Technical Specifications (also shown in Table 4.4 of this report) gives the required Lower Limits of Detection (LLDs) for environmental sample analyses. On occasion, an LLD is not achievable due to a situation such as a low sample volume caused by sampling equipment malfunction. In such a case, Technical Specification 6.7.C.3 requires a discussion of the situation. At the Yankee Atomic Environmental Laboratory, the target LLD for any analysis is typically 30-40 percent of the most restrictive required LLD. Expressed differently, the typical sensitivities achieved for each analysis are at least 2.5 to 3 times greater than that required by VYNPS Technical Specifications.

For each analysis having an LLD requirement in Technical Specification Table 4.9.3, the a posteriori (after the fact) LLD calculated for that analysis was compared with the required LLD. Of the over 7400 analyses performed during 1992, of which approximately 1300 had an LLD requirement in Technical Specification Table 4.9.3, all met the requirement.

6.3 Comparison of Results with Reporting Levels

Technical Specification Table 3.9.4 requires written notification to the NRC (within 30 days) whenever a Reporting Level in that table is exceeded. Reporting Levels are the environmental concentrations that relate to the ALARA design dose objectives of 10 CFR 50, Appendix I. It should be noted that environmental concentrations are averaged over calendar quarters for the purposes of this comparison, and that Reporting Levels apply only to measured levels of radioactivity due to plant effluents. During 1992, no Reporting Levels were exceeded.

6.4 Changes in Sampling Locations

VYNPS Technical Specification 6.7.C.3 states that if "new environmental sampling locations are identified in accordance with Specification 3.9.D, the new locations shall be identified in the next annual Radiological Environmental Surveillance Report." Two changes were made in sampling locations during 1992, as described below (both were included in Revision 13 to the Vermont Yankee Offsite Dose Calculation Manual):

a. The Blodgett Farm (TM-18 and TC-18) was chosen to replace the Newton Farm (TM-13 and TC-13) for milk and silage sampling due to

better sample availability at the former location.

b. The Miller Farm (TM-11 and TC-11) was chosen to replace the Gayland Farm (TM-15 and TC-15) as the required milk and silage sampling location. This followed a dose re-evaluation done in early 1992 for the purpose of including the latest results from the turbine building vent monitor. This was strictly an administrative change in the ODCM, since sampling was carried out at both locations prior to and after the change.

6.5 Data Analysis by Media Type

The 1992 REMP data for each media type is discussed below. Whenever a specific measurement result is presented, it is given as the concentration plus or minus one standard deviation. This standard deviation represents only the random uncertainty associated with the radioactive decay process (counting statistics), and not the propagation of all possible uncertainties in the analytical procedure. An analysis is considered to yield a "detectable measurement" when the concentration exceeds three times the standard deviation for that analysis. With respect to data plots, all net concentrations are plotted as reported, without regard to whether the value is "detectable" or "non-detectable."

6.5.1 Airborne Pathways

6.5.1.1 Air Particulates

The bi-weekly air particulate filters from each of the six sampling sites were analyzed for gross-beta radioactivity. At the end of each quarter, the thirteen weekly filters from each sampling site were composited for a gamma analysis. The results of the weekly air particulate sampling program are shown in Table 5.1 and Figures 6.1 and 6.2.

As shown in Figures 6.1, there is no significant difference between the quarterly average concentrations at the indicator (near-plant) stations and the control (distant from plant) stations. Also notable in the Figure is a distinct annual cycle, with the minimum concentration in the second quarter, and the maximum concentration in the first quarter. The peak seen in the second quarter of 1986 is airborne contamination resulting from the Chernobyl accident, as detected by the Vermont Yankee monitoring program.

Figures 6.2 through 6.6 show the weekly gross beta concentration at each air particulate sampling location alongside the same for the control air particulate sampling location at AP-21 (Spofford Lake, NH). Small differences are evident, and are expected, between individual sampling locations. It can also be seen that the gross-beta measurements on air particulate filters fluctuate significantly over the course of a year. The measurements from control station AP-21 vary similarly, indicating that these fluctuations are due to regional changes in naturally-occurring airborne radioactive materials, and not due to Vermont Yankee operations. Two data points displayed on these Figures should be noted and explained as follows (more complete discussions are in Section 6.1):

a. On Figure 6.2, the low data point in January for AP-11 was due to an improperly installed air particulate filter.

b. On Figures 6.2 through 6.6, the low data point in August for the AP-21 Control sampler was due to a torn particulate filter.

The only other radionuclide detected on air particulate filters was Be-7, a naturally-occurring cosmogenic radionuclide.

6.5.1.2 Charcoal Cartridges

The bi-weekly charcoal cartridges from each of the six air sampling sites were analyzed for I-131. The results of these analyses are summarized in Table 5.1. As in previous years, no I-131 was detected in any charcoal cartridge.

6.5.2 Waterborne Pathways

6.5.2.1 River Water

Aliquots of river water were automatically collected at least every two hours from the Connecticut River downstream from the plant discharge area. Monthly grab samples were also collected at the upstream control location, also on the Connecticut River. The composited samples at WR-11 were collected monthly and sent to the Yankee Atomic Environmental Laboratory, along with the WR-21 grab samples, for analysis. Table 5.1 shows that gross-beta measurements were positive in most samples, as would be expected, due to naturally-occurring radionuclides in the water. The mean concentrations at the indicator and control locations were not

significantly different in 1992. Both mean concentrations were consistent with those detected in previous years, as shown in Figure 6.7. No gamma-emitting radionuclides attributable to VYNPS operations were detected in any of the samples.

For each sampling site, the monthly samples were composited into quarterly samples for Tritium (H-3) analyses. None of the samples contained detectable quantities of H-3.

6.5.2.2 Ground Water

Quarterly ground water samples were collected from two indicator locations (only one is required by VYNPS Technical Specifications) and one control location during 1992. Table 5.1 and Figure 6.8 show that gross-beta measurements were positive in most samples. This is due to naturally-occurring radionuclides in the water. The levels at all sampling locations, including the higher levels at station WG-11, were consistent with that detected in previous years. The one exception to this in 1992 was the May 14 sample from WG-12. It had a gross-beta concentration in the May 14 sample that was higher than normal for that location. This was possibly explained by the incorrect addition of preservative chemicals. A re-sample on June 29 showed a gross-beta concentration typical for that location. No gamma-emitting radionuclides or Tritium (H-3) were detected in any of the samples.

6.5.2.4 Sediment

Semiannual sediment grab samples were collected from two locations during 1992. A single sample was collected from SE-11 on May 20 and again on October 15. Forty (40) grab samples were collected from a gridded area at the North Storm Drain Outfall (SE-12) on May 20 and again on October 14-15. As would be expected, naturally-occurring K-40 and Ac-Th-228 were detected in all samples. Naturally-occurring Be-7 was detected in one sample.

In addition to the above radionuclides, Cs-137 was detected in most samples, as was expected. The levels measured at both locations were consistent with what has been measured in the previous several years and with that detected at other New England locations that are monitored as part of other Yankee-affiliated environmental monitoring programs. This Cs-137 is attributed to nuclear weapons testing fallout that has persisted in the environment. This is further substantiated by the fact that there

has only been one liquid release from Vermont Yankee during the period 1982 through 1992. No Cs-137 was detected in the sample of that release water.

Co-60 was also detected in nine of the eighty samples from station SE-12. This radioactivity is due to plant operations and is localized within a small area near the west shore of Vernon Pond. Its presence has been monitored for several years. The Co-60 level, as shown in Table 5.1, appear to have increased since 1991. This is due to a concentration in a single grab sample taken on May 20, 1992. The concentration, when averaged over the entire original sample, was determined to be 1500 ± 80 pCi/kg (dry). It is known that the Co-60 distribution in the sediment at this location is not homogeneous, and that occasional measurements of this magnitude are not unlikely. It is important to note that this concentration did not exceed the Reporting Level of 3000 pCi/kg, and that the other 39 grab samples taken at the same time were typical of the concentrations at this location.

It should also be noted that the mean values in Table 5.1 are weighted heavily toward station SE-12, since 80 of the 82 samples collected in 1992 were from that location. No Co-60 has been detected at station SE-11, which is downstream of the plant discharge structure and the North Storm Drain Outfall (SE-12).

6.5.3 Ingestion Pathways

6.5.3.1 Milk

Milk samples from cows or goats at several local farms were collected monthly during 1992. Semimonthly collections were made at five of these locations during the "pasture season" since the milking cows or goats were identified as being fed pasture grass during that time. Each sample was analyzed for I-131 and other gamma-emitting radionuclides. Quarterly composites (by location) were analyzed for Sr-89 and Sr-90.

As was expected, naturally-occurring K-40 was detected in all samples. Also expected were Cs-137 and Sr-90. Cs-137 was detected in 21 out of 96 indicator samples. Sr-90 was detected in 14 out of 22 indicator samples. Although both Cs-137 and Sr-90 are a by-product of plant operations, the levels detected in milk are due to worldwide fallout from nuclear weapons tests, and to a much lesser degree from fallout from the Chernobyl incident. These two radionuclides are present throughout the natural environment as a result of atmospheric nuclear weapons testing that started primarily in the late 1950's and continued through 1980. They may be found

in soil and vegetation, as well as anything that feeds upon vegetation, directly or indirectly. The Cs-137 and Sr-90 levels shown in Table 5.1 and Figures 6.9 and 6.10 are consistent with those detected at other New England farms that are monitored as part of other Yankee-affiliated environmental monitoring programs.

As shown in these figures, the levels are also consistent with those detected in previous year near the VYNPS plant, with one exception. The goat milk from TM-12 has elevated levels of Cs-137 and to a lesser degree, Sr-90. (The same can be said about the goat milk from TM-19.) It has been shown in the past that Cs-137 and Sr-90 levels in cow or goat milk can vary substantially from one farm to the next, due primarily to the differences in feeding habits of the animals. It is also known that goats have a much higher transfer coefficient from vegetation to milk for strontium and cesium. This means that for a given amount of Cs-137 or Sr-90 in the vegetation, the concentration in the milk will typically be higher for a goat than for a cow (Reference 5).

6.5.3.2 Silage

A silage sample was collected from the required milk sampling stations on October 21 and 22, and for TM-17 on November 4. Each of these was analyzed for gamma-emitting radionuclides. As expected with all biological media, naturally-occurring K-40 was detected in all samples. Naturally-occurring Be-7 was also detected in many samples. No gamma-emitting radionuclides were detected in the silage samples.

6.5.3.3 Mixed Grass

Mixed grass samples were collected at each of the air sampling stations on three occasions during 1992. As expected with all biological media, naturally-occurring K-40 was detected in all samples. Naturally-occurring Be-7 was also detected in most samples. Cs-137 was detected in two indicator samples: 44 ± 11 pCi/kg at station TG-15 on May 26, and 99 ± 22 pCi/kg at station TG-12 on July 22. Although Cs-137 is a by-product of plant operations, the levels detected in grass are due to worldwide fallout from nuclear weapons tests, and to a much lesser degree from fallout from the Chernobyl incident. These two radionuclides are present throughout the natural environment as a result of atmospheric nuclear weapons testing that started primarily in the late 1950's and continued through 1980. They may be found in soil and vegetation, as well as anything that feeds upon

vegetation, directly or indirectly. The Cs-137 levels in grass shown in Table 5.1 are consistent with those detected at other New England locations that are monitored as part of other Yankee-affiliated environmental monitoring program. They are also consistent with levels detected at these two locations in 1991 and in previous years. Furthermore, no airborne Cs-137 was detected at either of the continuous air samplers located at these two locations.

6.5.3.2 Fish

Semiannual samples of fish were collected from two locations during 1992. The edible portions of each of these were analyzed for gamma-emitting radionuclides. As expected in biological matter, naturally-occurring K-40 was detected in all samples.

As shown in Table 5.1, Cs-137 was detected in one of the two indicator samples. This radioactivity is attributed to global nuclear weapons testing fallout. This level of Cs-137 is typical of what has been detected at both the control and indicator stations in previous years, as can be seen in Figure 6.11. No other radionuclides were detected.

6.5.4 Direct Radiation Pathway

Direct radiation was continuously measured at 51 locations surrounding the Vermont Yankee plant with the use of thermoluminescent dosimeters (TLDs). These are collected every calendar quarter for readout at the Yankee Atomic Environmental Laboratory. The complete summary of data may be found in Table 5.3.

From Tables 5.2 and 5.3 and Figure 6.12, it can be seen that the Inner and Outer Ring TLD mean exposure rates were not significantly different in 1992. This indicates no significant overall increase in direct radiation exposure rates in the plant vicinity. It can also be seen from these tables that the Control TLD mean exposure rate was not significantly different than that at the Inner and Outer Rings.

Figure 6.12 also shows an annual cycle at both indicator and control locations. The lowest point of the cycle occurs during the winter months. This is due primarily to the attenuating effect of the snow cover on radon emissions and on direct irradiation by naturally-occurring radionuclides in the soil. Differing amounts of these naturally-occurring radionuclides in

the underlying soil, rock or nearby building materials result in different radiation levels between one field site and another.

Upon examining Figure 6.16, as well as Table 5.2, it is evident that in 1992 station DR-45 had a higher average exposure rate than any other station. This location is on-site, and the higher exposure rates are due to plant operations in the immediate vicinity of the TLDs. There is no significant dose potential to the surrounding population or any real individual from these sources since they are located on the back side of the plant site, between the facility and the river. The same can be said for station DR-46, which has shown higher exposure rates in previous years.

FIGURE 6.1
GROSS-BETA MEASSUREMENTS ON AIR PARTICULATE FILTERS
QUARTERLY AVERAGE CONCENTRATIONS

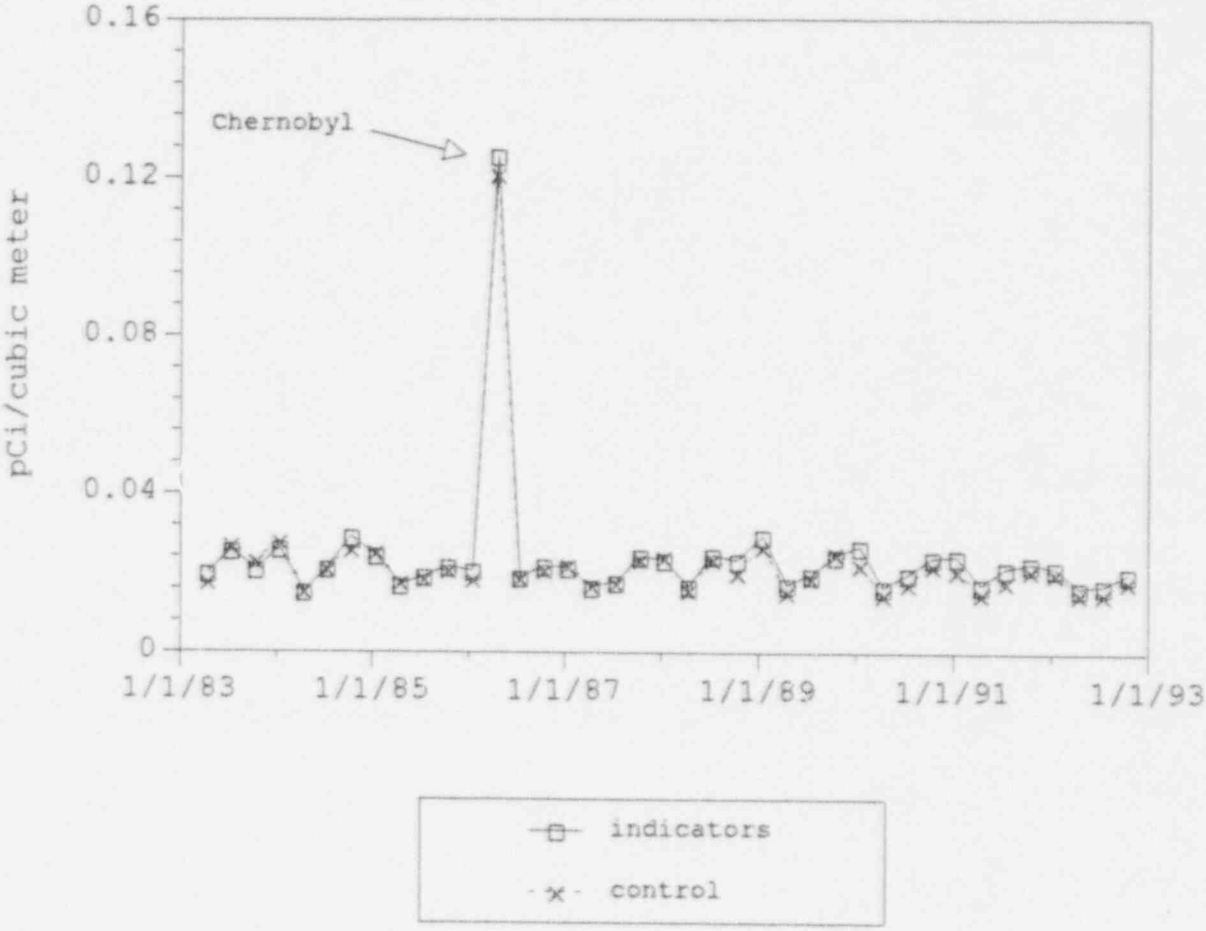


FIGURE 6.2
GROSS-BETA MEASUREMENTS ON AIR PARTICULATE FILTERS

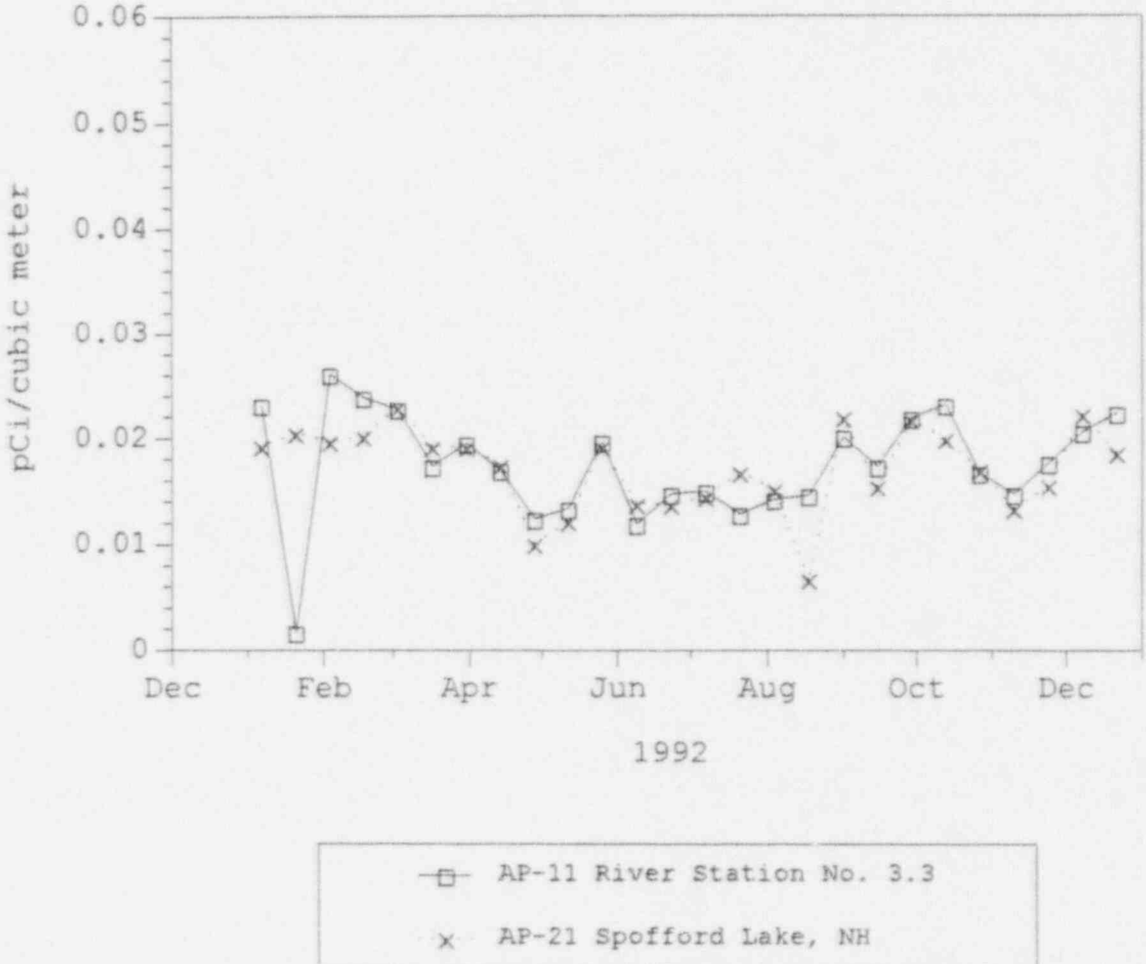


FIGURE 6.3
GROSS-BETA MEASUREMENTS ON AIR PARTICULATE FILTERS

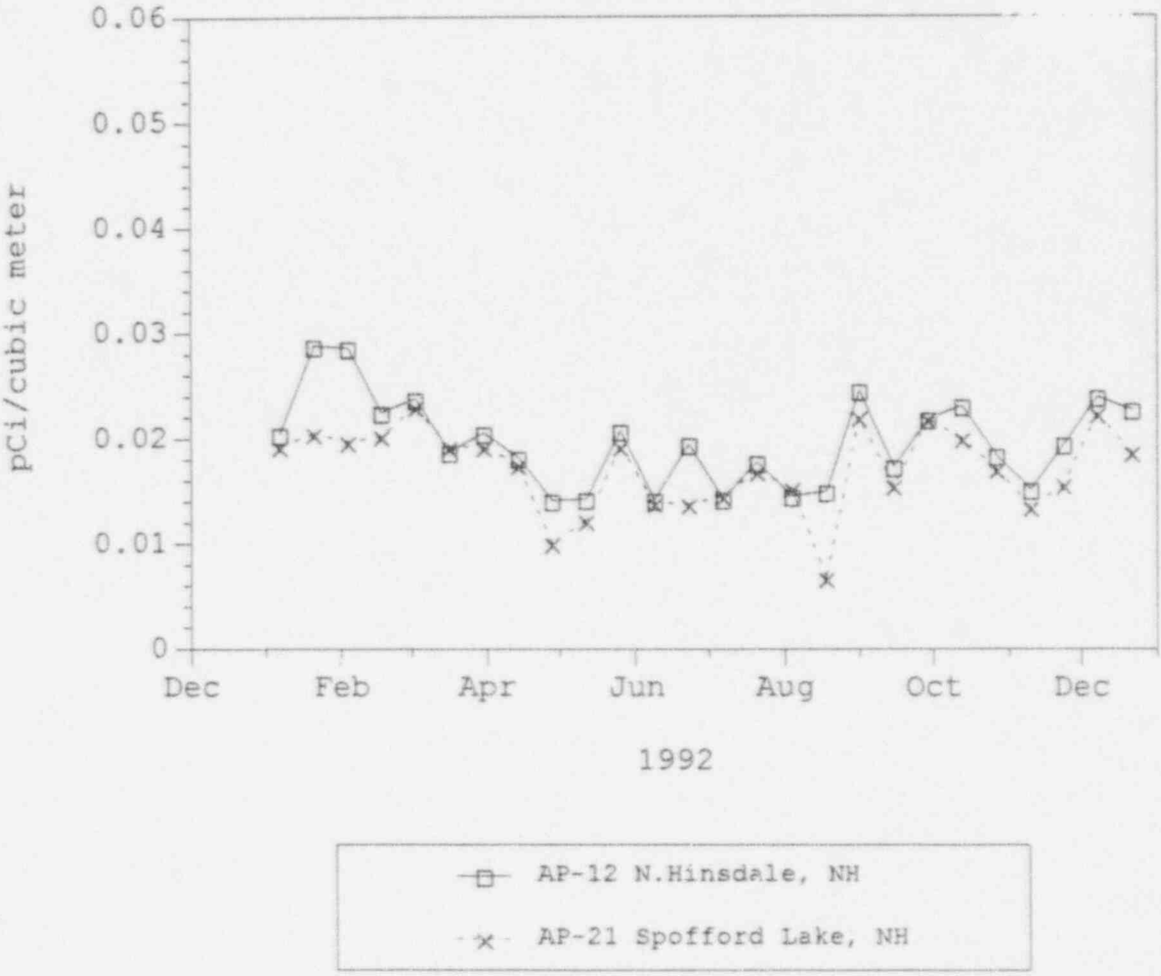


FIGURE 6.4

GROSS-BETA MEASUREMENTS ON AIR PARTICULATE FILTERS

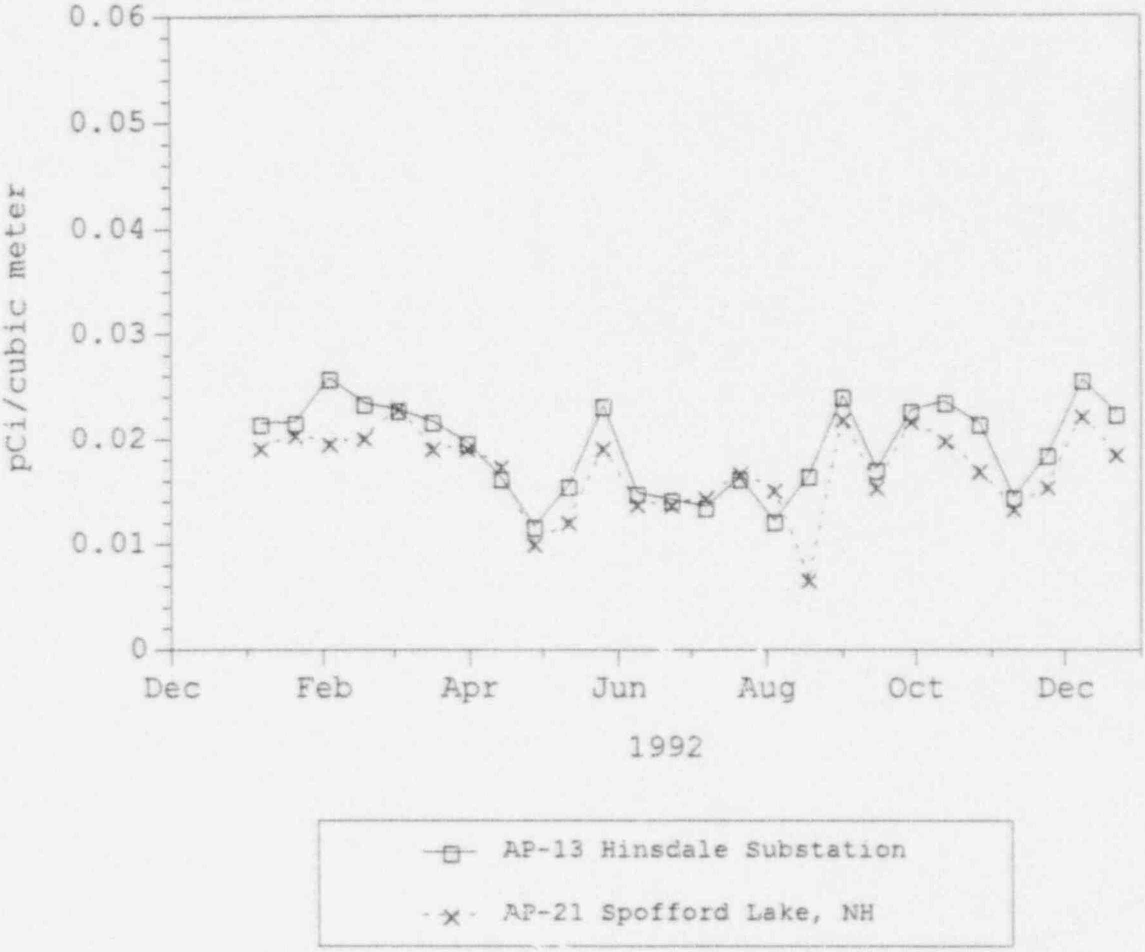


FIGURE 6.5
GROSS-BETA MEASUREMENTS ON AIR PARTICULATE FILTERS

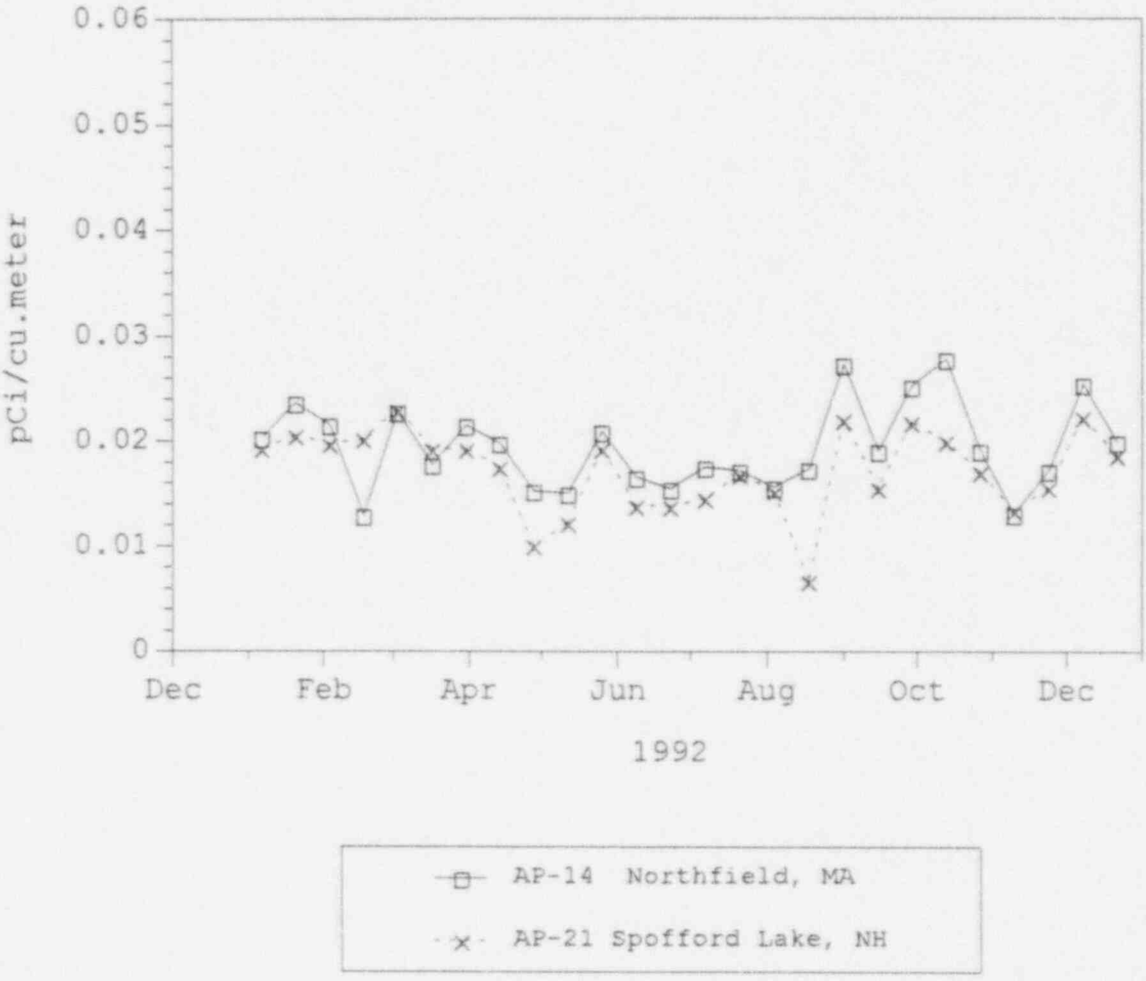


FIGURE 6.6
GROSS-BETA MEASUREMENTS ON AIR PARTICULATE FILTERS

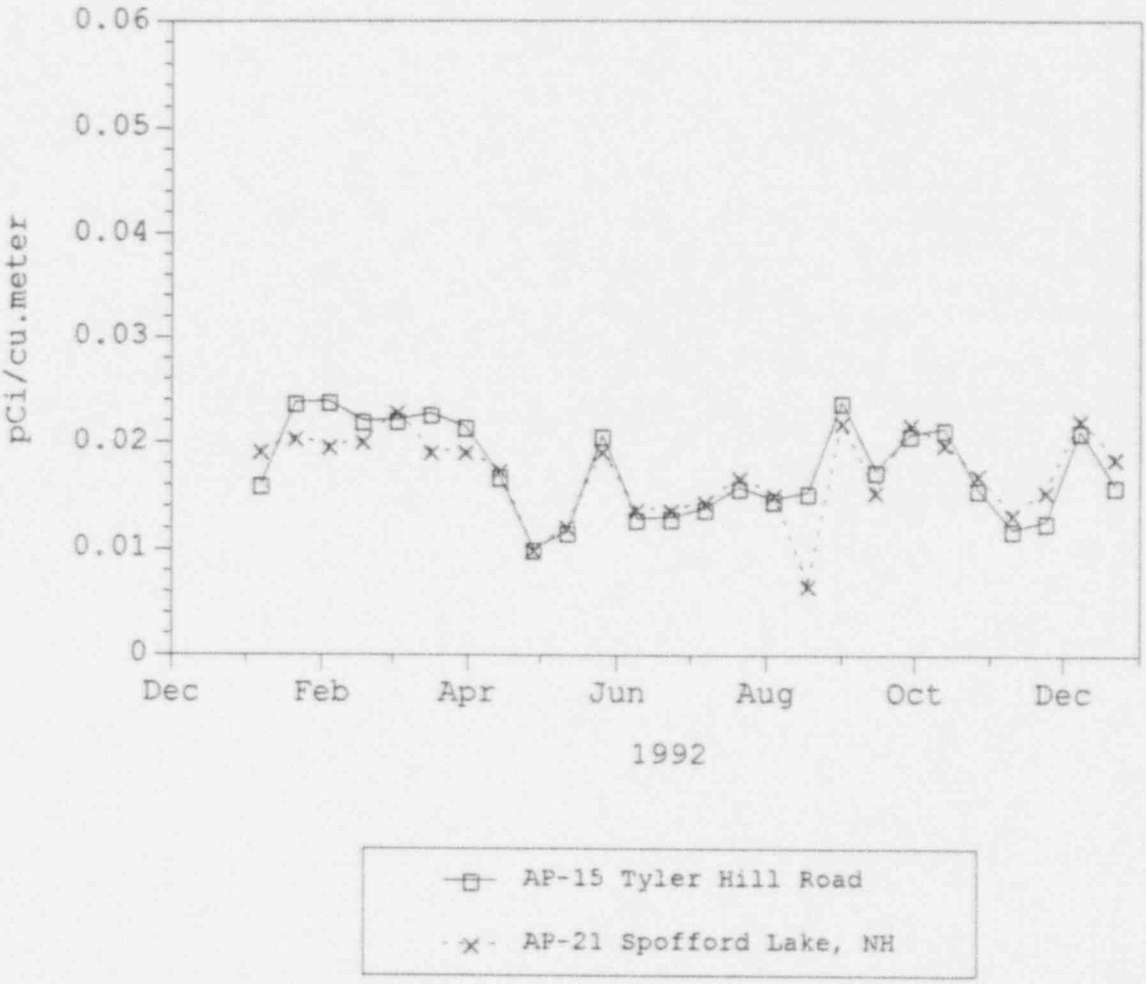


FIGURE 6.7
GROSS-BETA MEASUREMENTS ON RIVER WATER
SEMI-ANNUAL AVERAGE CONCENTRATIONS

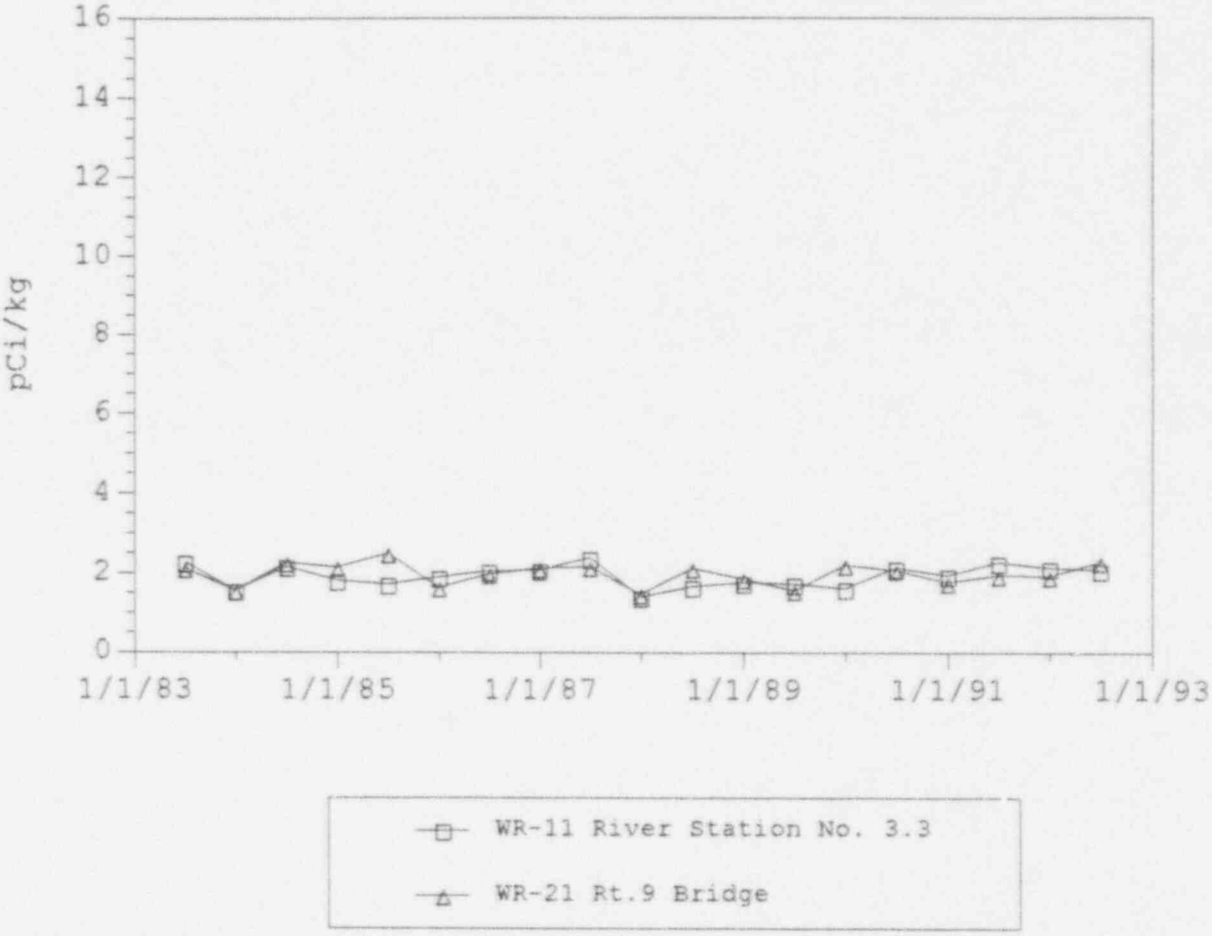


FIGURE 6.8
GROSS-BETA MEASUREMENTS ON GROUND WATER
SEMI-ANNUAL AVERAGE CONCENTRATIONS

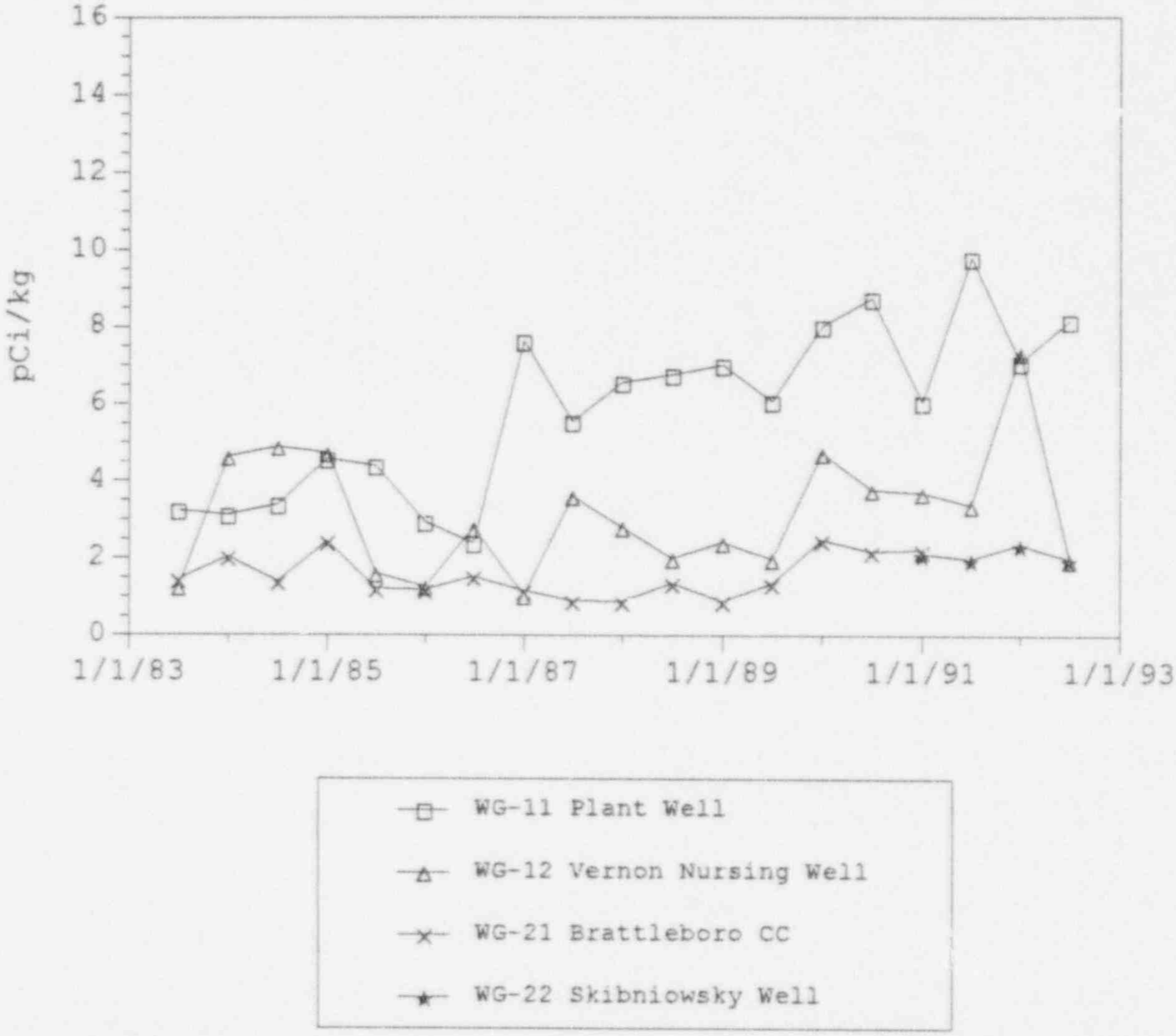


FIGURE 6.9
CESIUM-137 IN MILK
ANNUAL AVERAGE CONCENTRATIONS

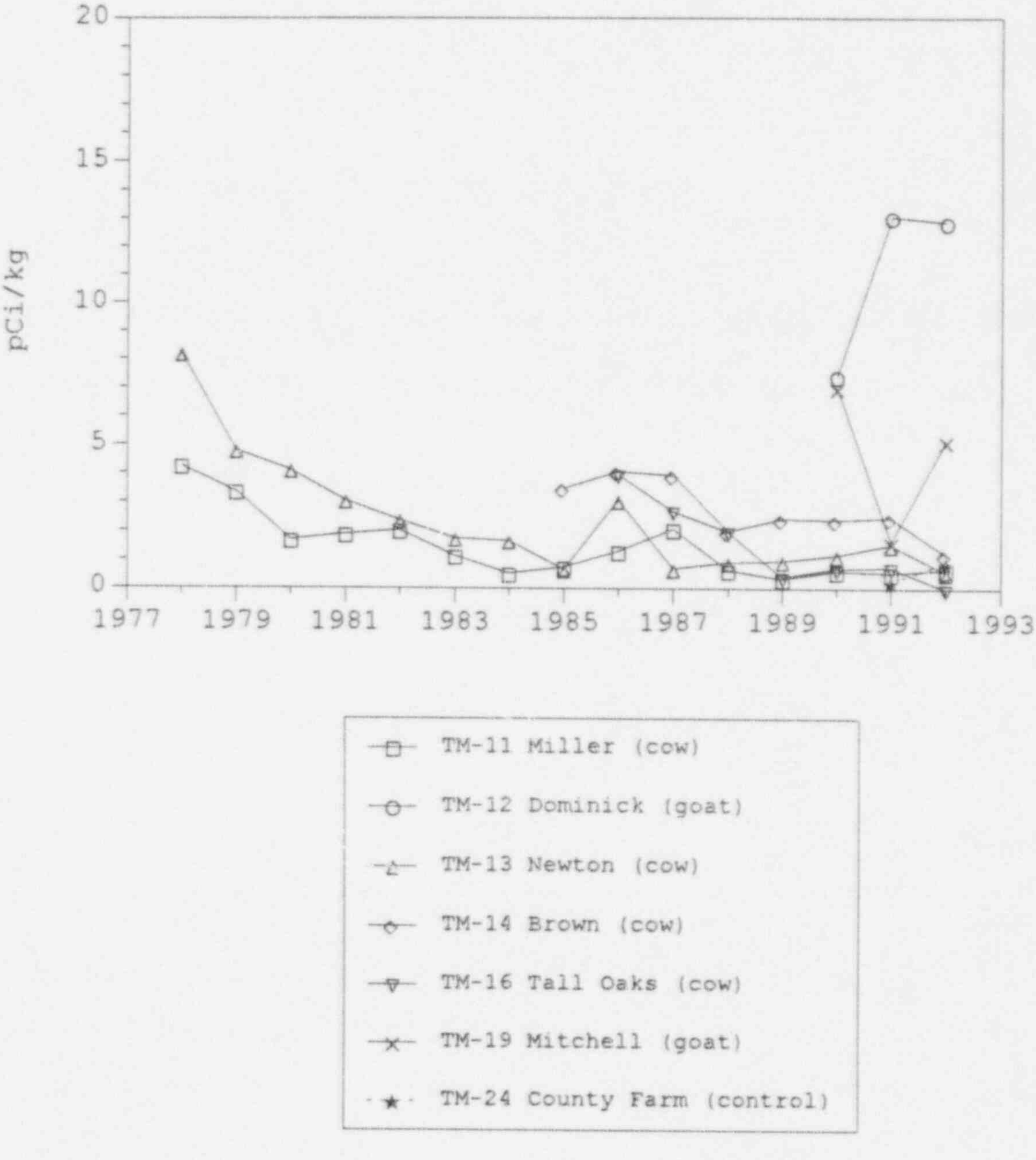


FIGURE 6.10
STRONTIUM 90 IN MILK
ANNUAL AVERAGE CONCENTRATIONS

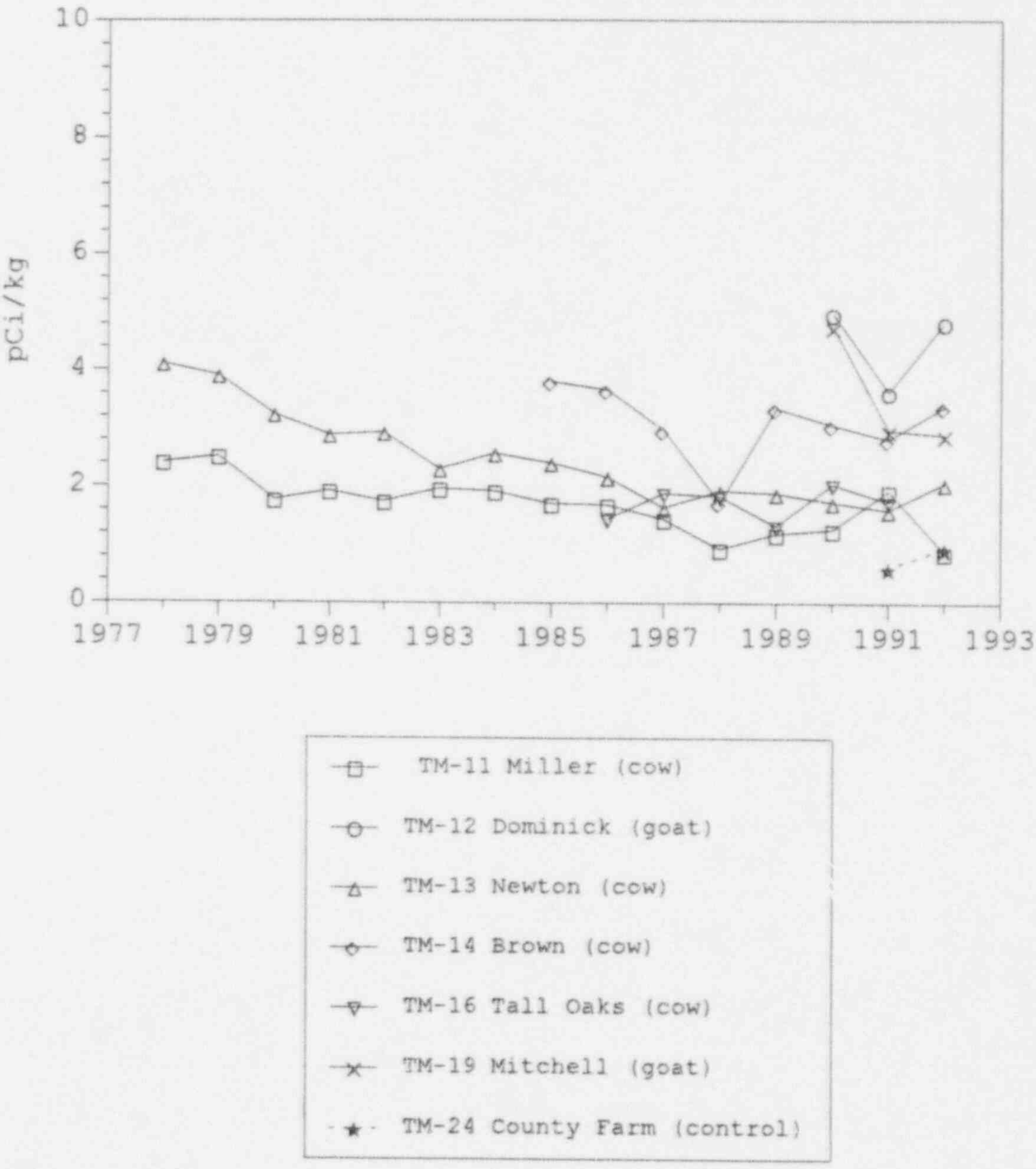


FIGURE 6.11
CESIUM-137 IN FISH
ANNUAL AVERAGE CONCENTRATIONS

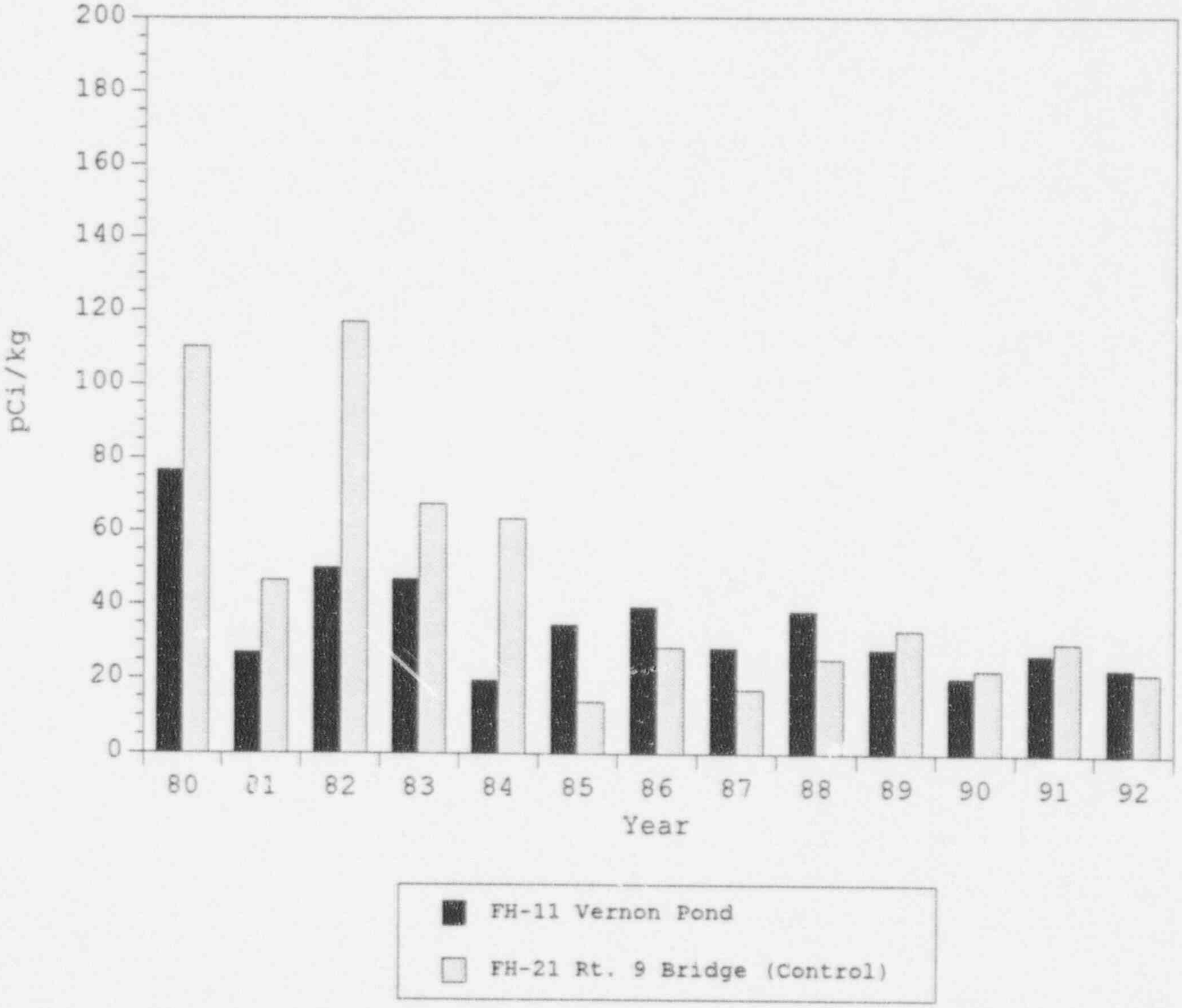


FIGURE 6.12
EXPOSURE RATE AT INNER RING, OUTER RING AND CONTROL TLD'S

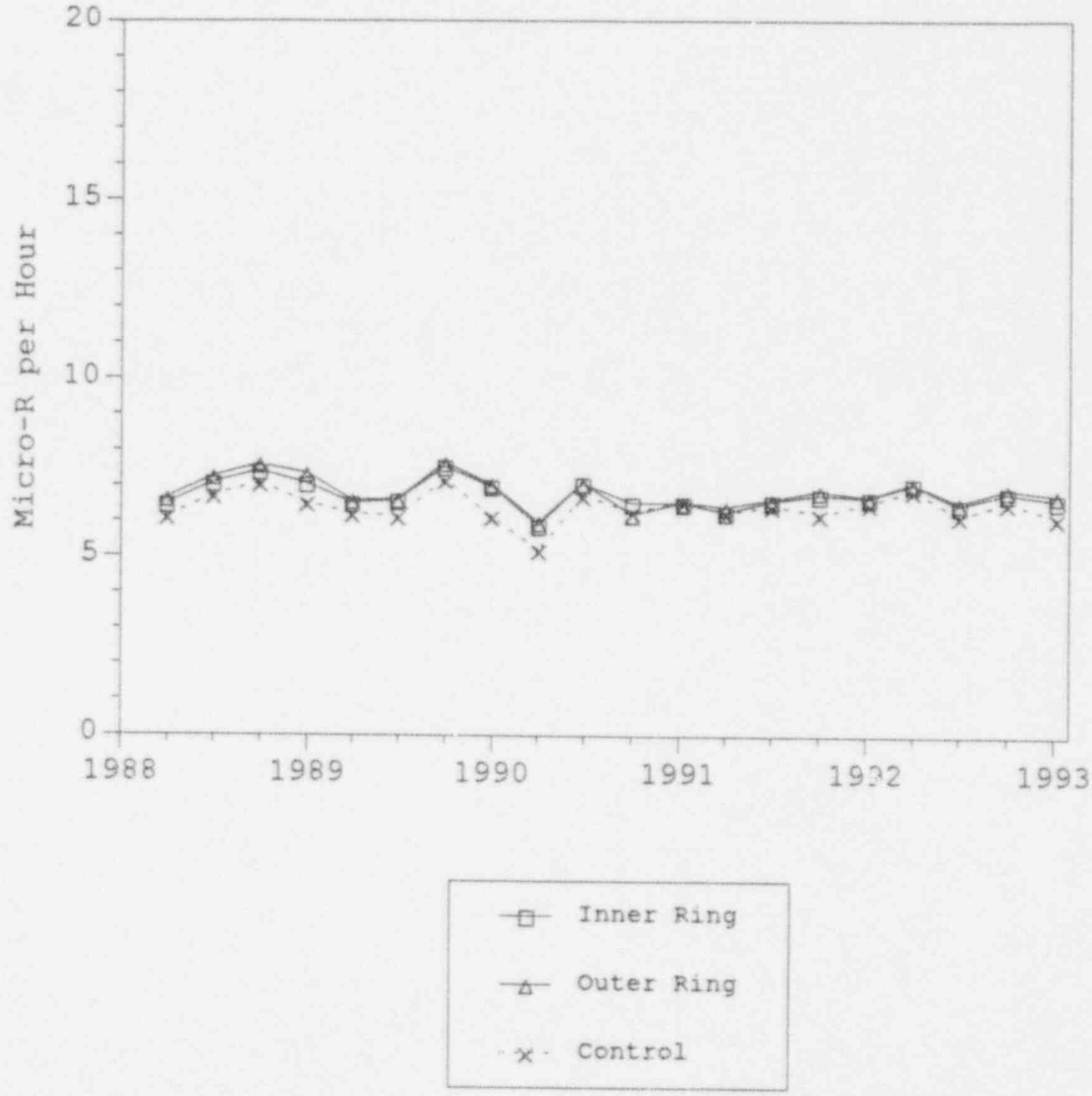


FIGURE 6.13
EXPOSURE RATE AT INDICATOR TLDS, DR 01-03

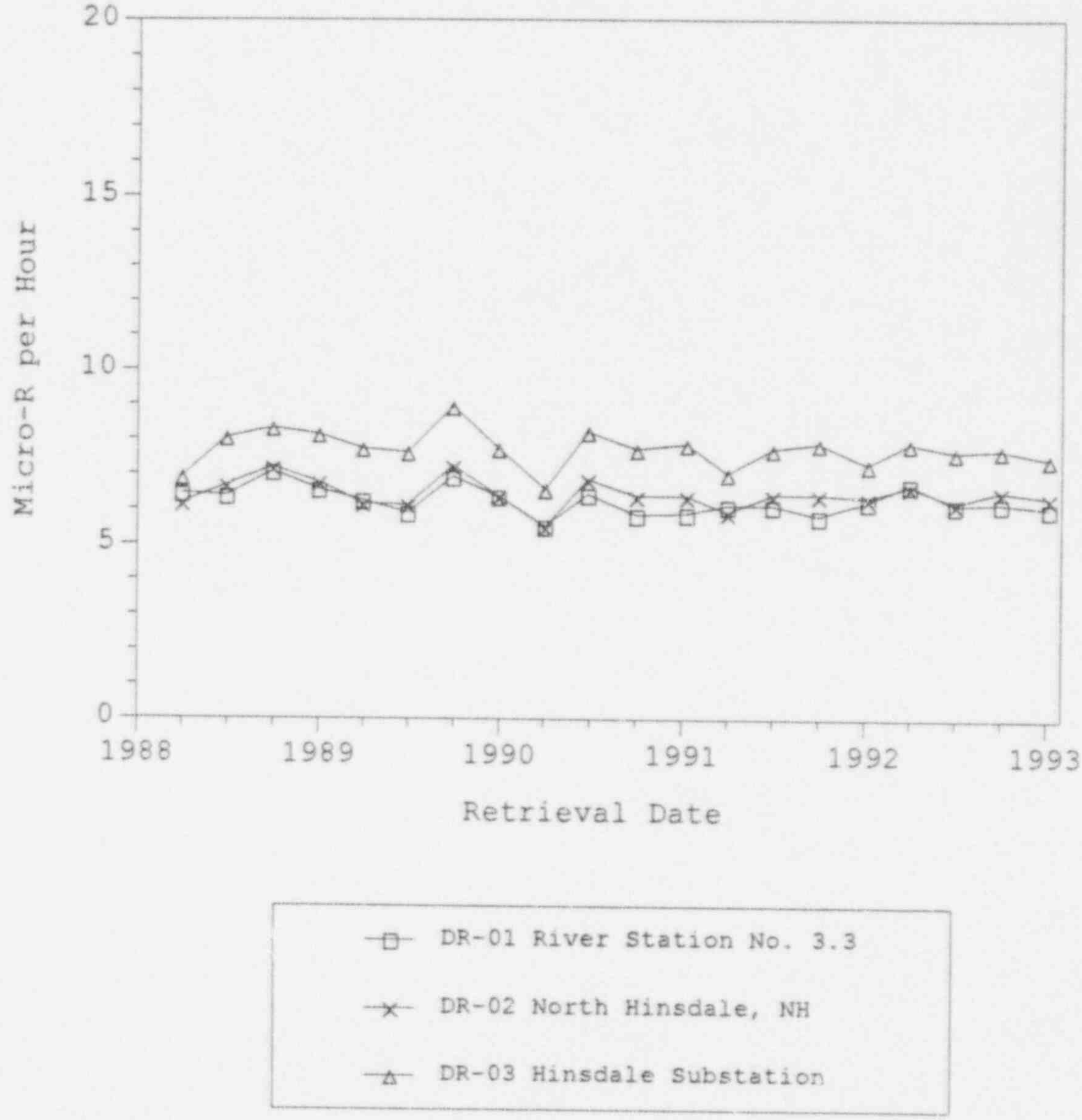


FIGURE 6.14
EXPOSURE RATE AT INDICATOR TLDS, DR 04, 06, 50

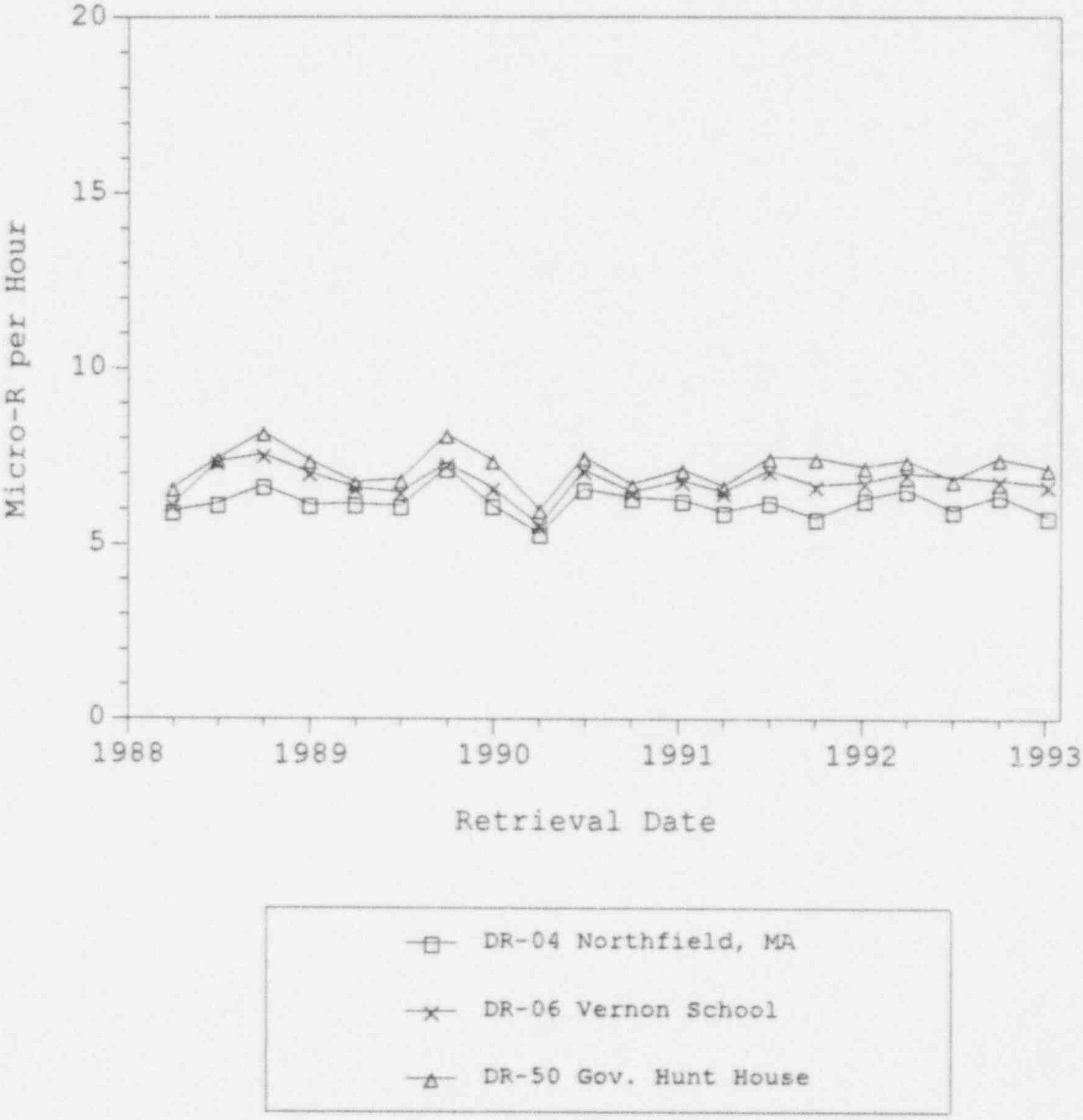


FIGURE 6.15
EXPOSURE RATE AT SITE BOUNDARY TLDS, DR 07-08, 41-42

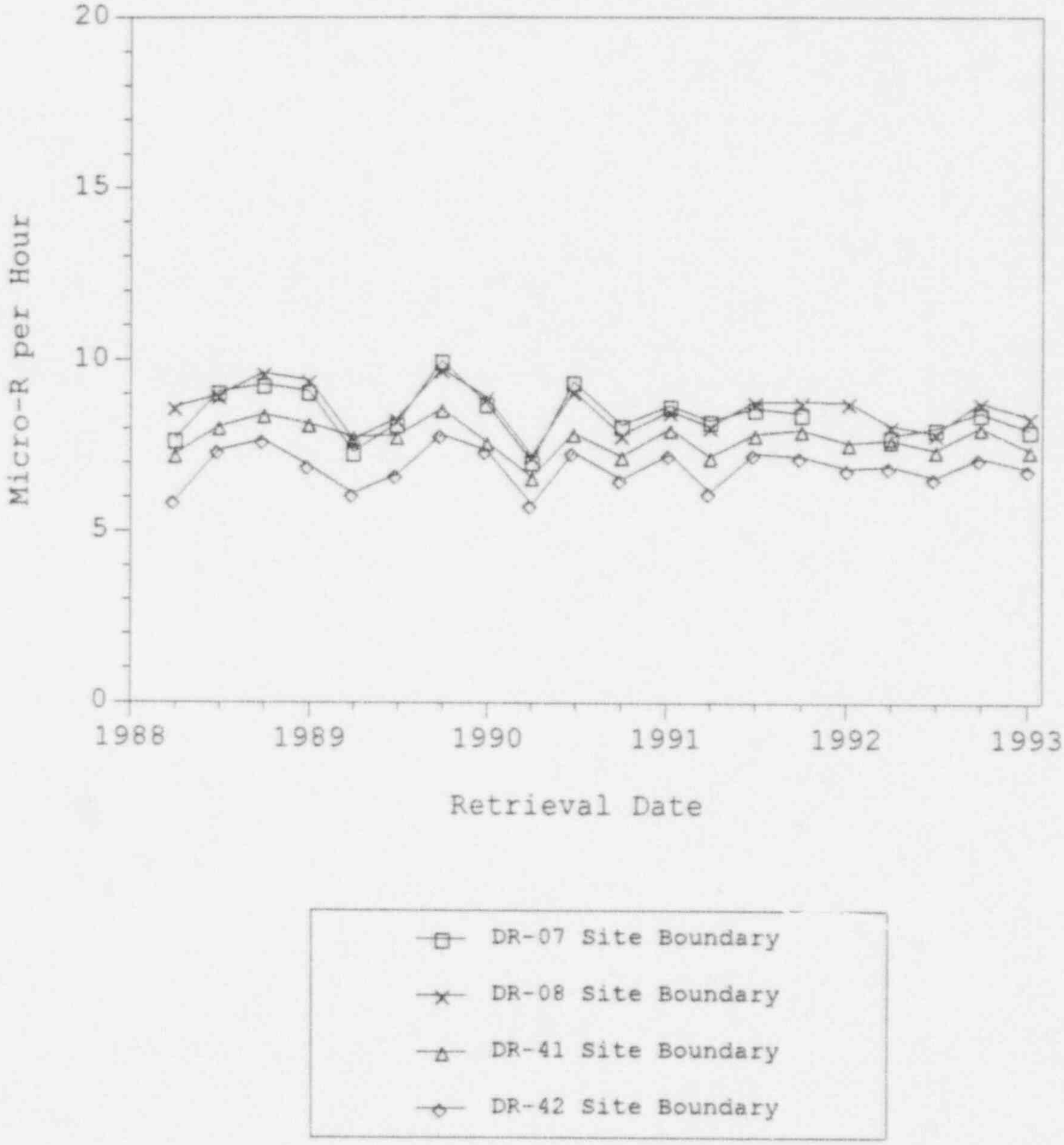


FIGURE 6.16
EXPOSURE RATE AT SITE BOUNDARY TLDS, DR 43-46

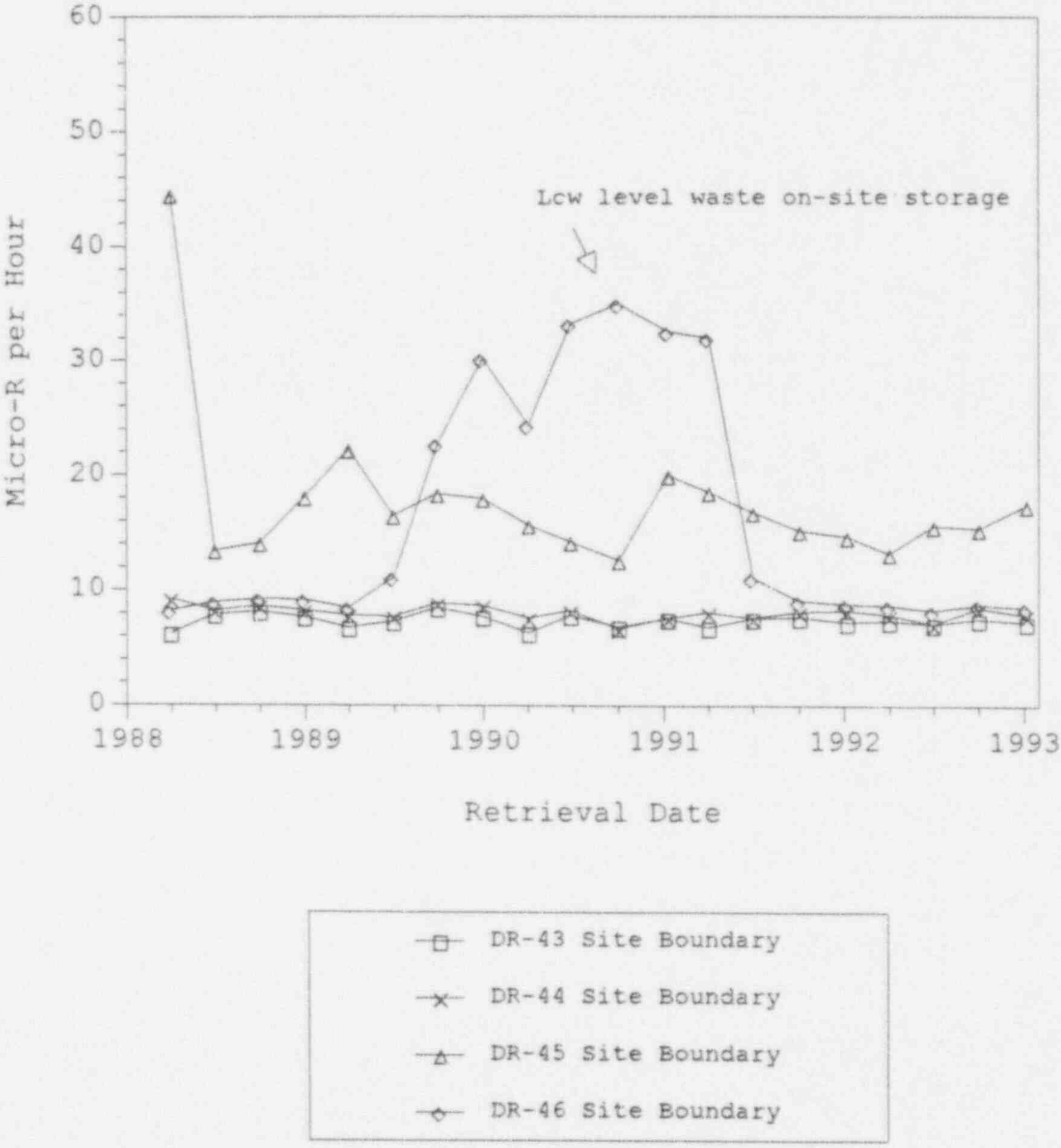


FIGURE 6.17
EXPOSURE RATE AT SITE BOUNDARY TLDS, DR 47-49, 51

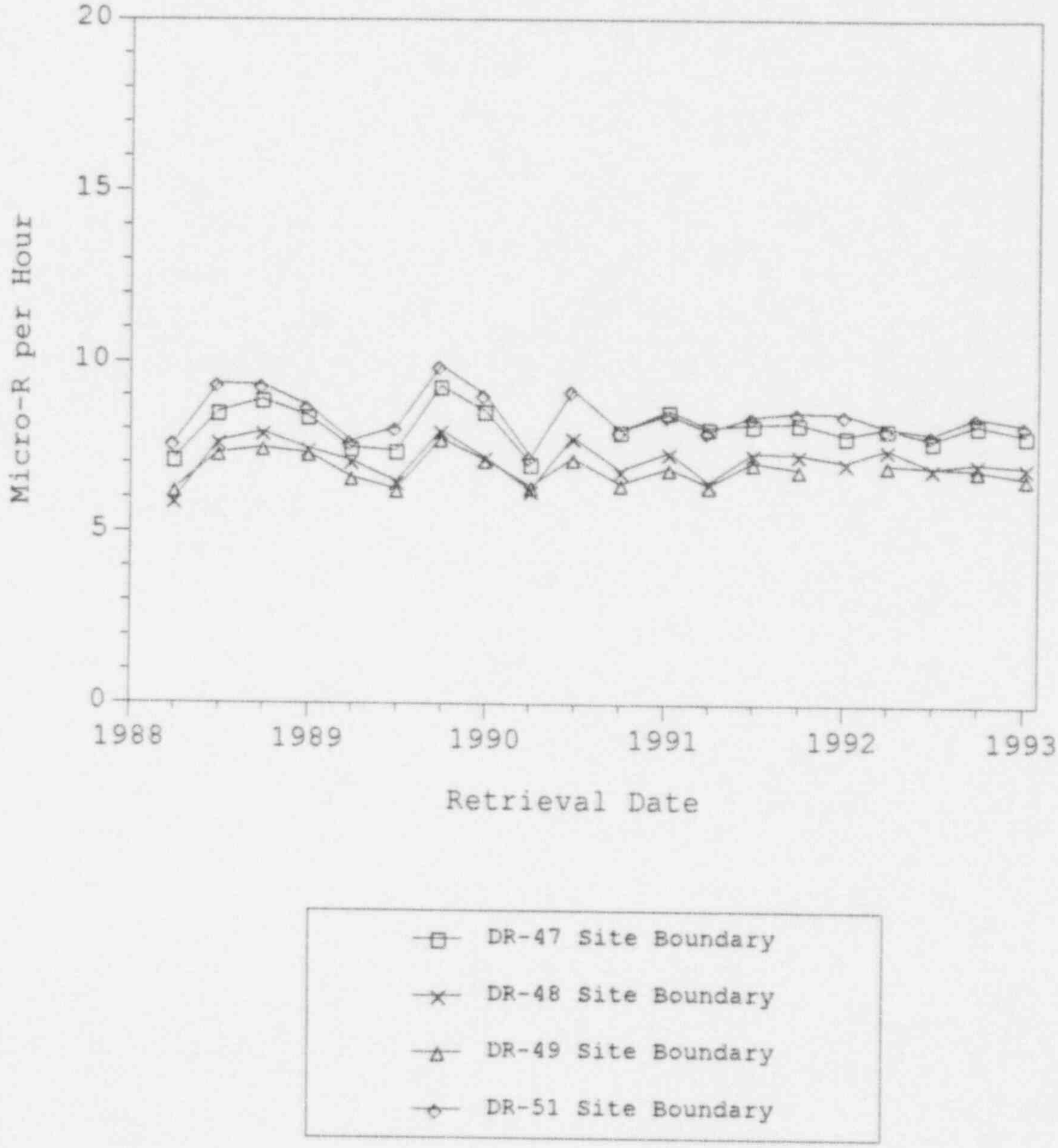


FIGURE 6.18
EXPOSURE RATE AT INNER RING TLDS, DR 09-15 (Odd)

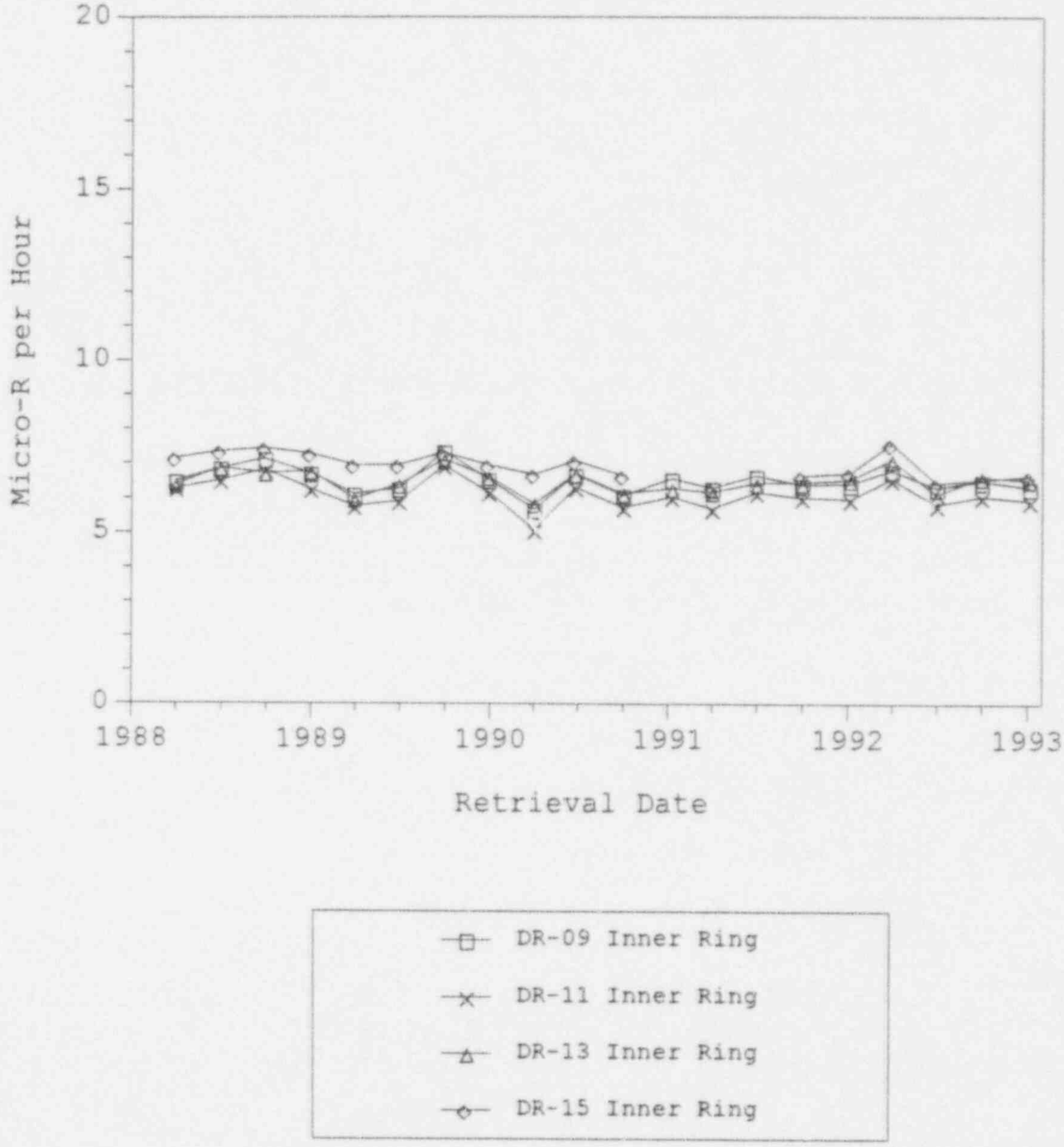


FIGURE 6.19
EXPOSURE RATE AT INNER RING TLDS, DR 17-23 (Odd)

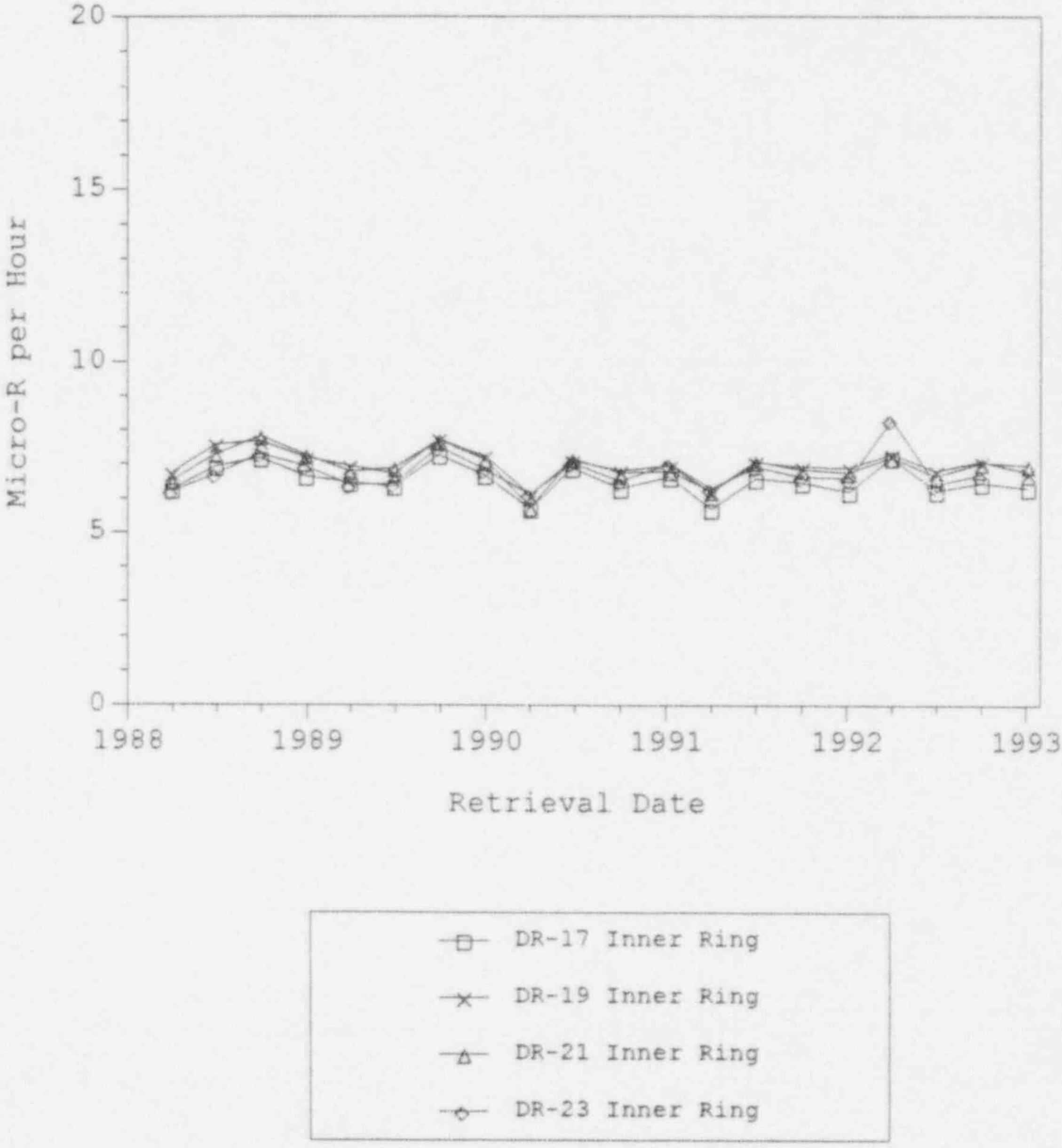


FIGURE 6.20
EXPOSURE RATE AT INNER RING TLDS, DR 25-31 (Odd)

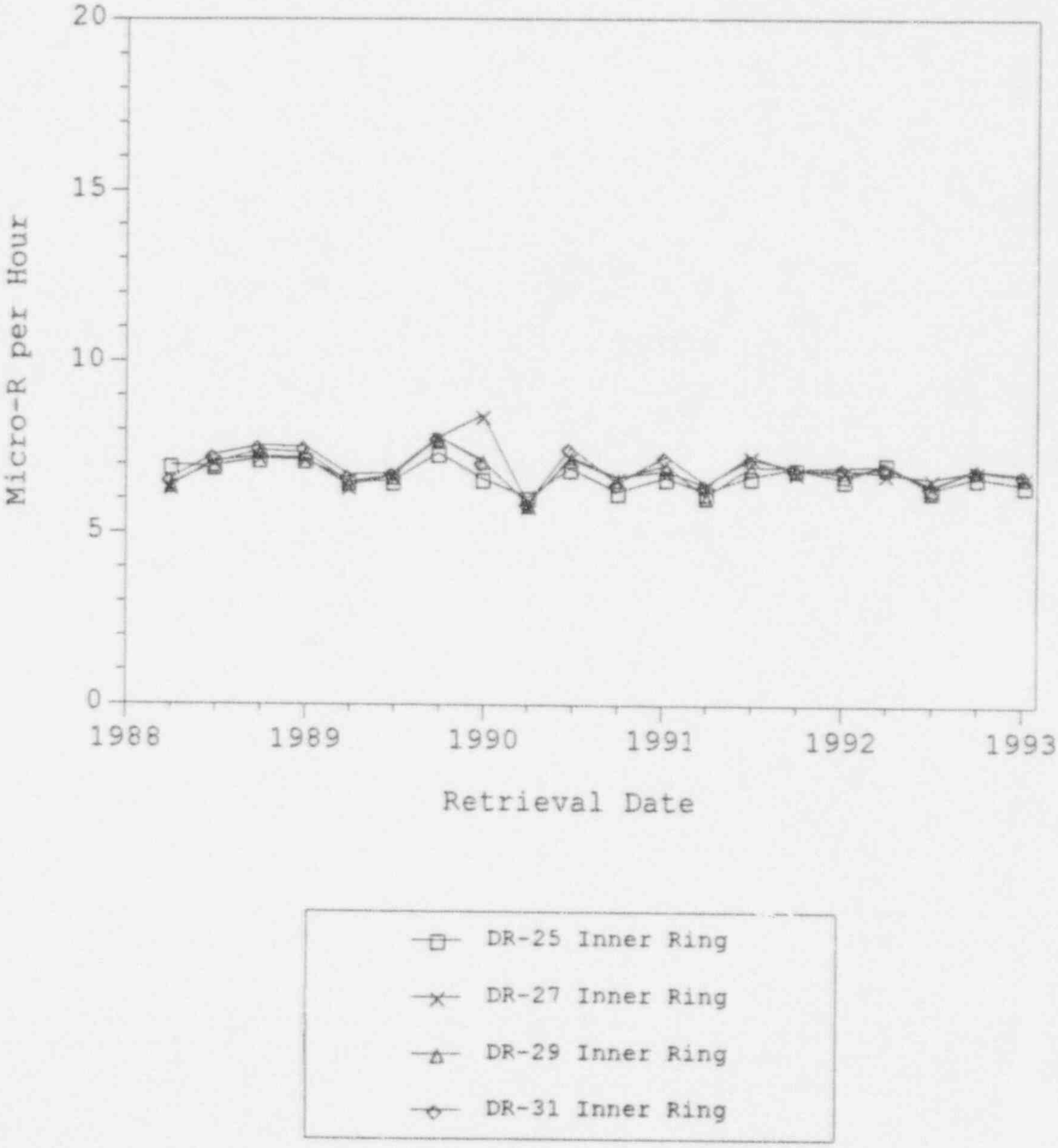


FIGURE 6.21
EXPOSURE RATE AT INNER RING TLDS, DR 33-39 (Odd)

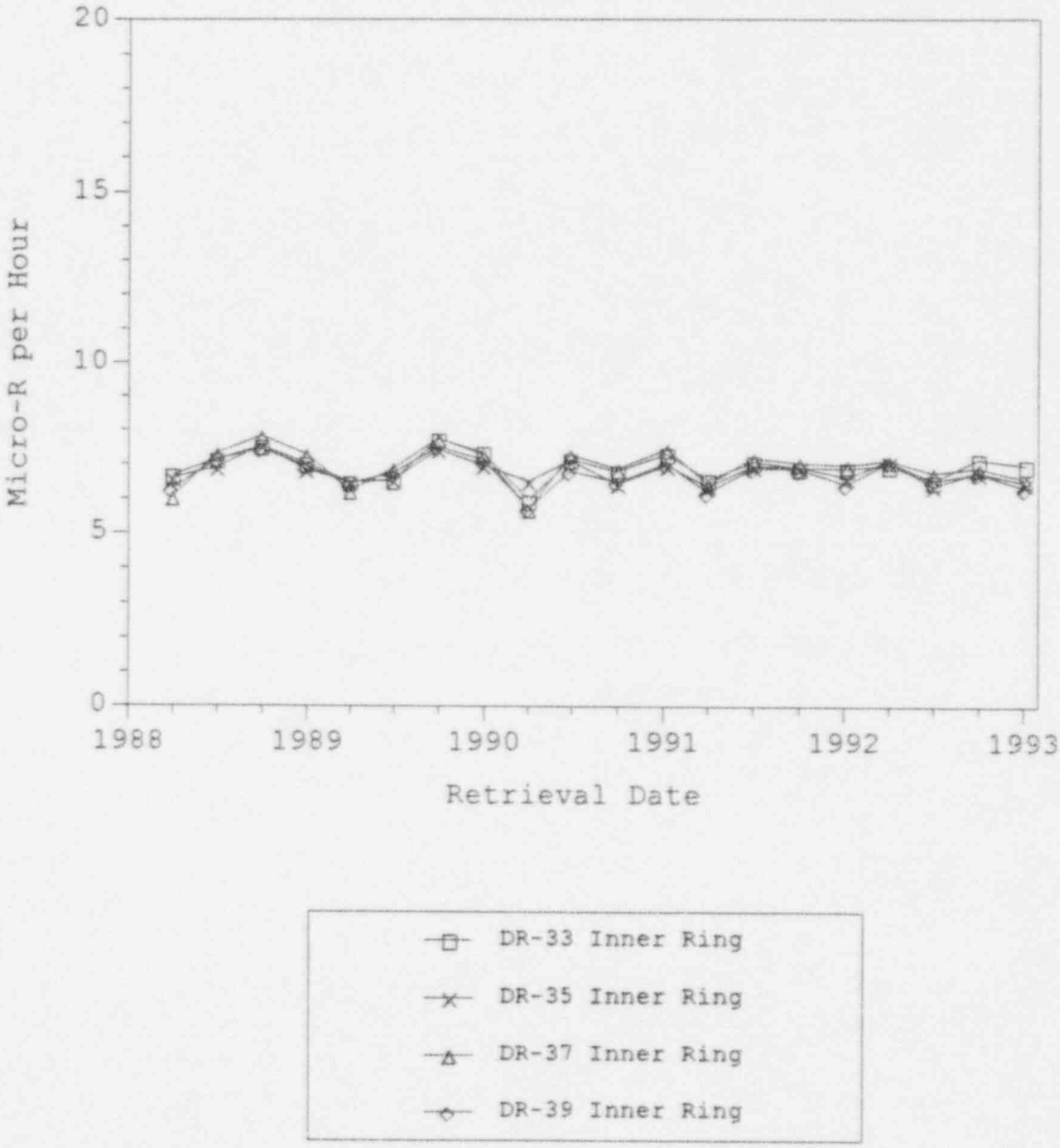


FIGURE 6.22
EXPOSURE RATE AT OUTER RING TLDS, DR 10-16 (Even)

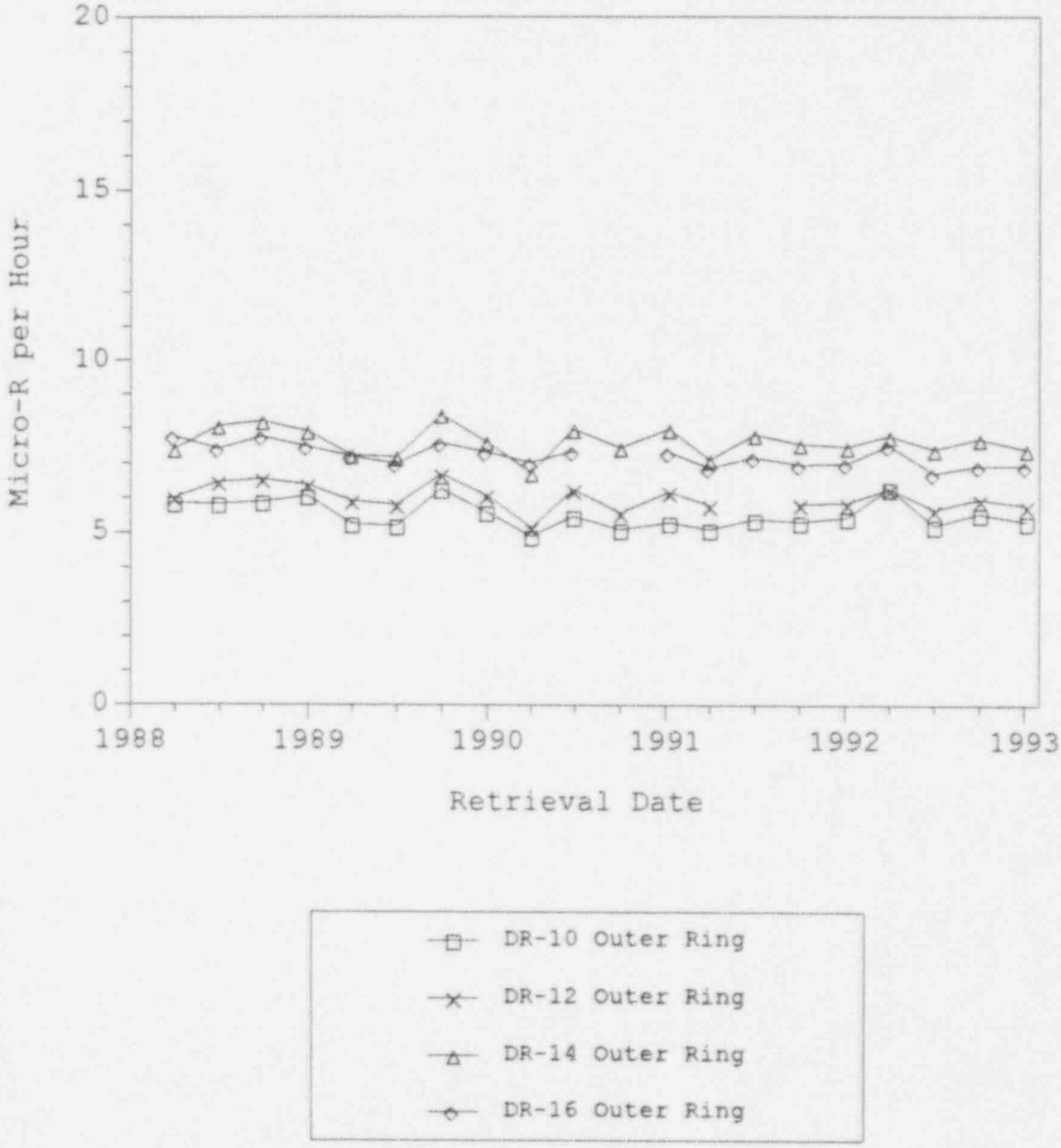


FIGURE 6.23
EXPOSURE RATE AT OUTER RING TLDS, DR 18-24 (Even)

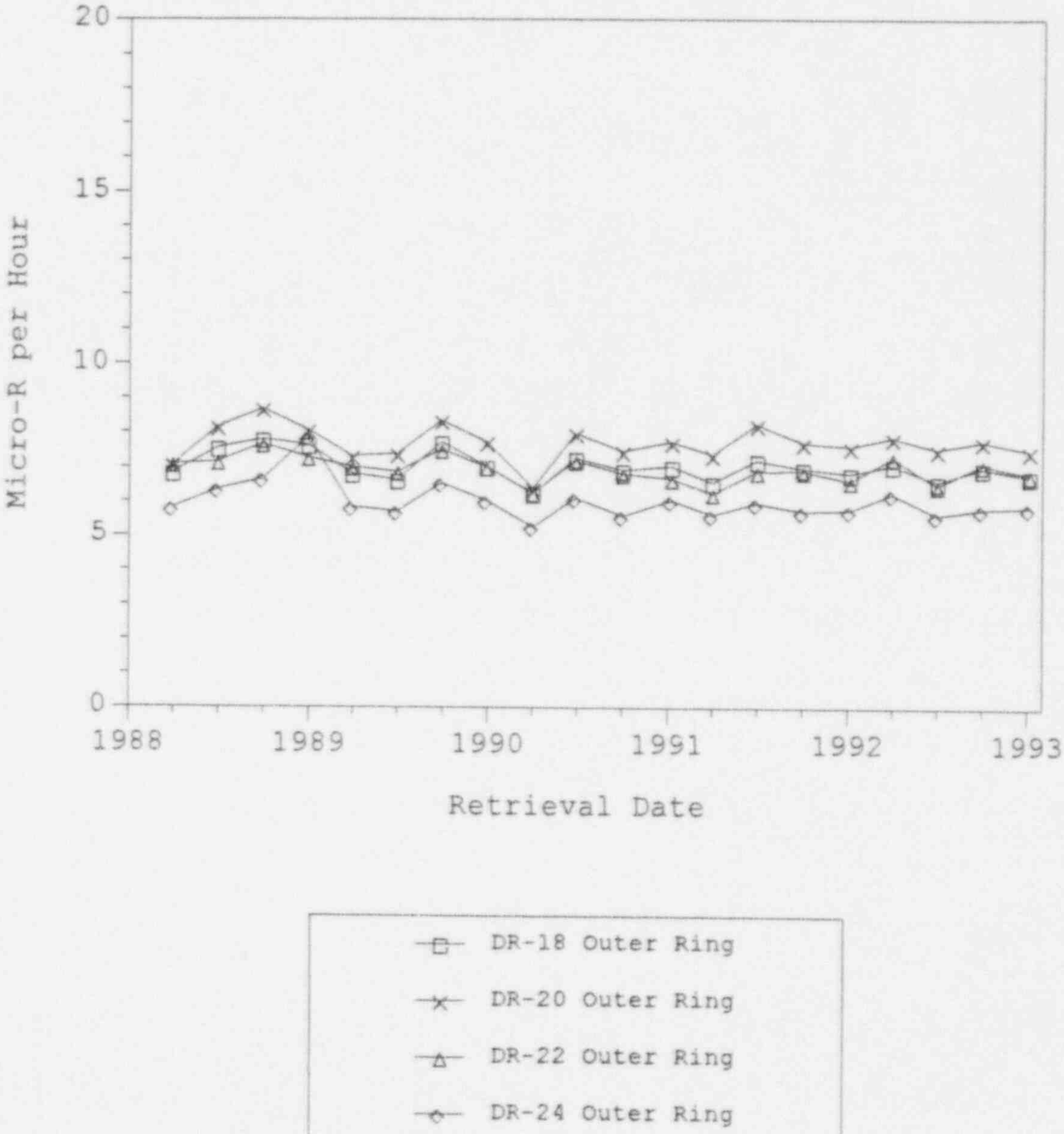


FIGURE 6.24
EXPOSURE RATE AT OUTER RING TLDS, DR 26-32 (Even)

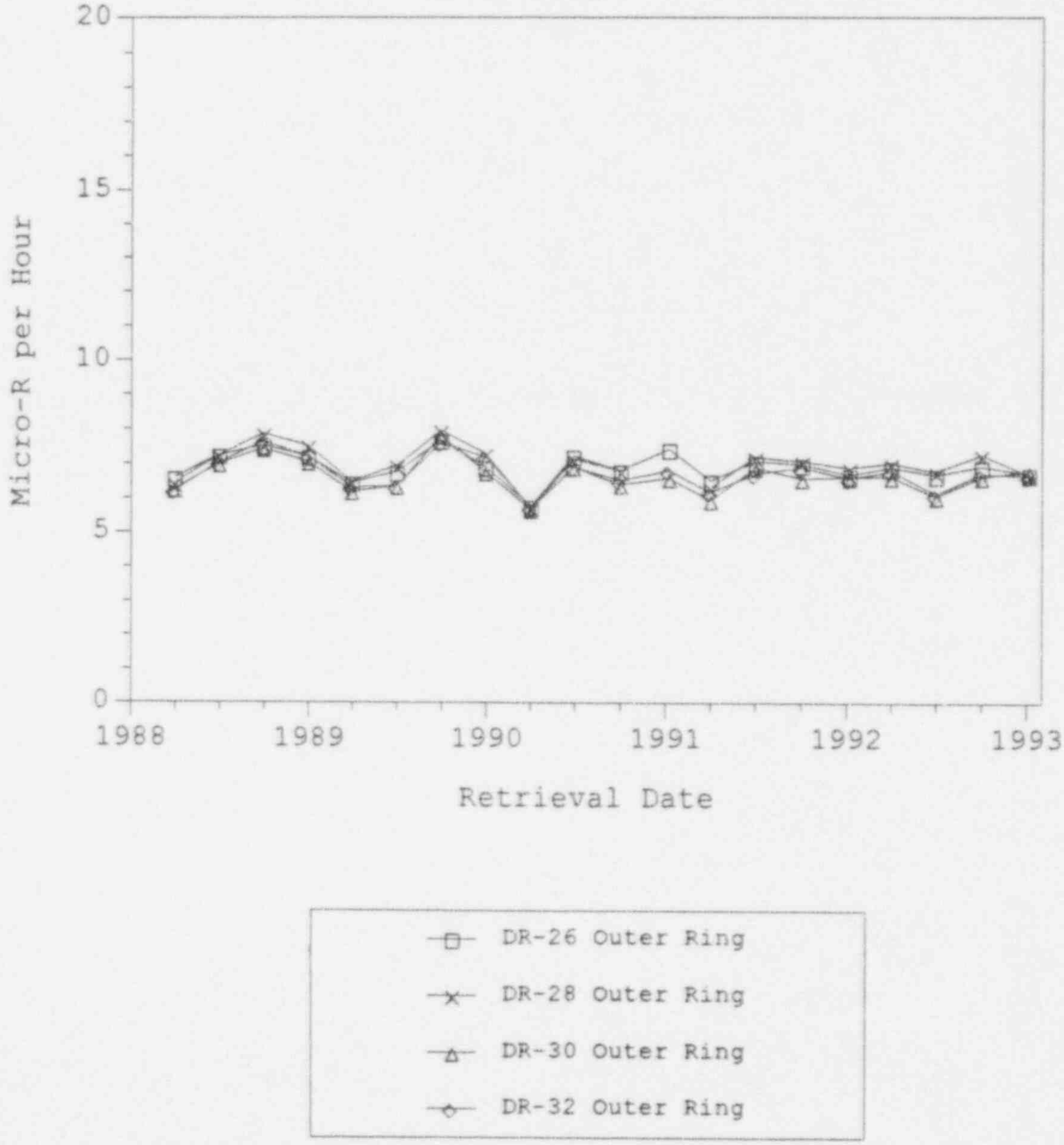


FIGURE 6.25

EXPOSURE RATE AT OUTER RING TLDS, DR 34-40 (Even)

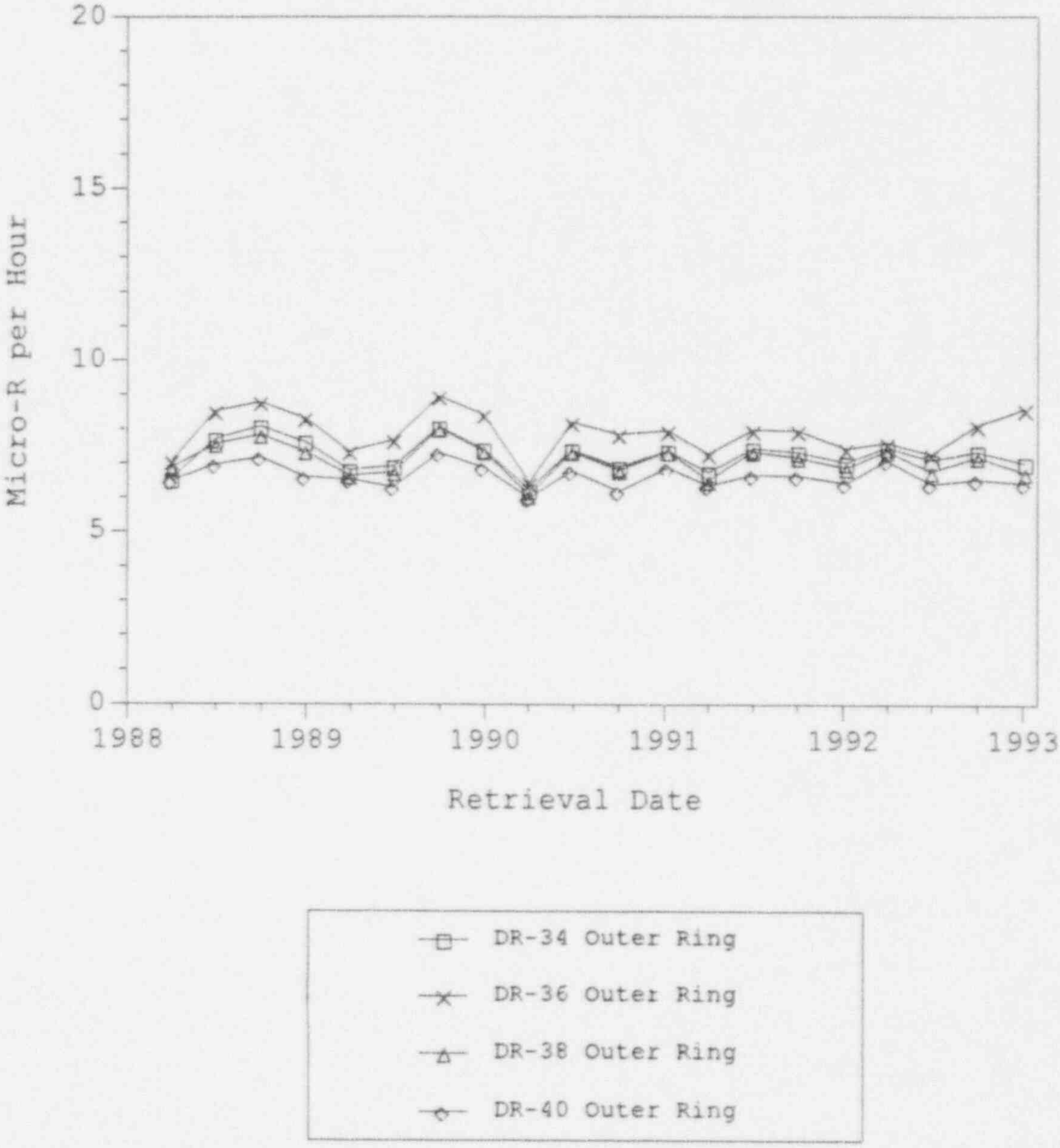
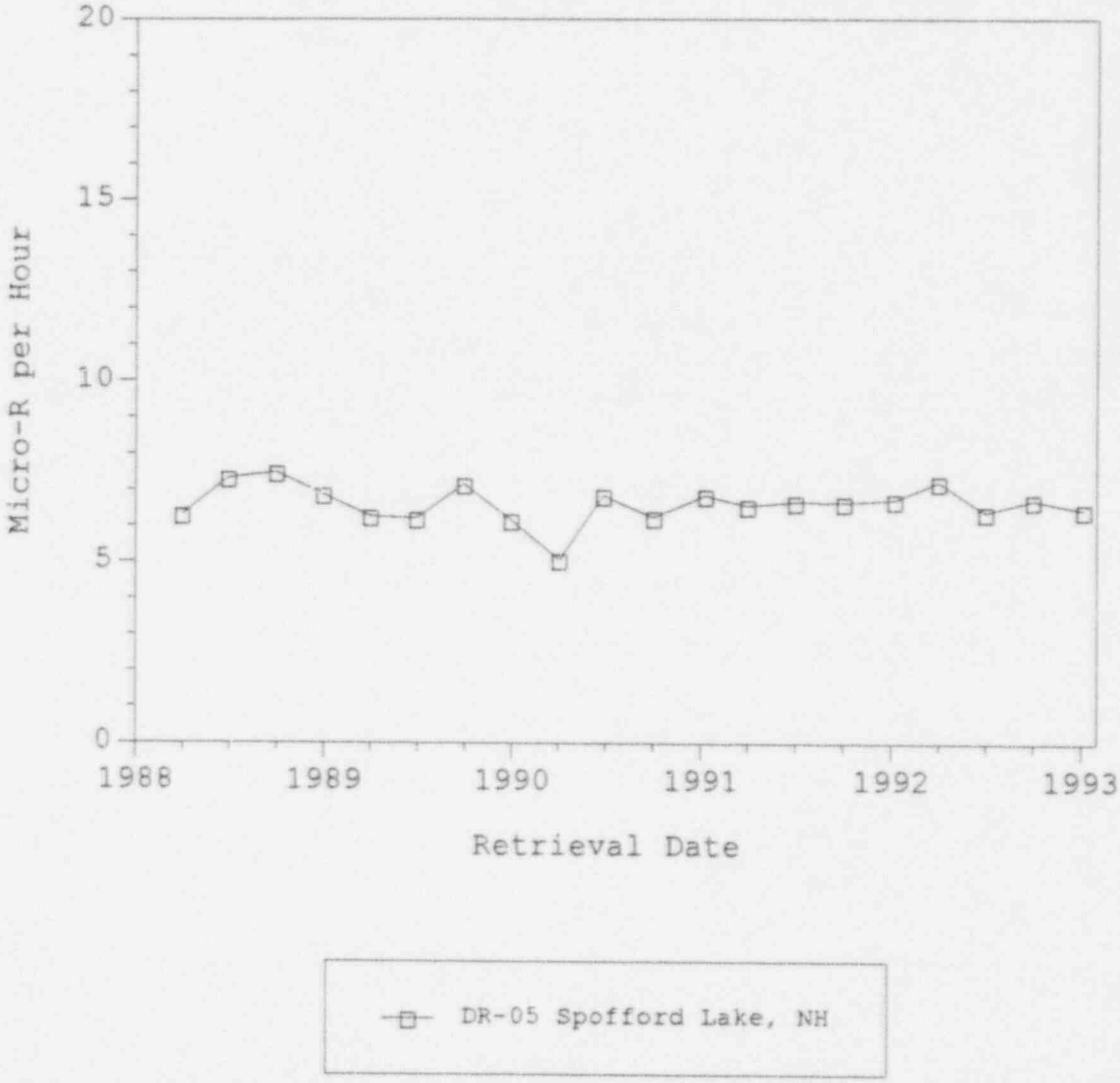


FIGURE 6.26
EXPOSURE RATE AT CONTROL TLD DR-05



7. **QUALITY ASSURANCE PROGRAM**

The quality assurance program at the Yankee Atomic Environmental Laboratory is designed to serve two overall purposes: 1) Establish a measure of confidence in the measurement process to assure the licensee, regulatory agencies and the public that the analytical results are accurate and precise; and 2) Identify deficiencies in the sampling and/or measurement process to those responsible for these operations so that corrective action can be taken. Quality assurance is applied to all steps of the measurement process, including the collection, reduction, evaluation and reporting of data, as well as the record keeping of the final results. Quality control is a part of the quality assurance program. It provides a means to control and measure the characteristics of measurement equipment and processes, relative to established requirements.

The Yankee Atomic Environmental Laboratory employs a thorough quality assurance program to ensure reliable environmental monitoring data. The program includes the use of written, approved and controlled procedures for all work activities, a nonconformance and corrective action tracking system, systematic internal audits, audits from external groups, a laboratory quality control program, and a complete training and retraining system. The Intralaboratory Quality Control program at the Laboratory and the EPA third party interlaboratory program are discussed in more detail below. Also discussed is the environmental TLD quality assurance program and the blind duplicate quality assurance program conducted by the Laboratory Quality Control Audit Committee.

7.1 Intralaboratory Quality Control Program

The Yankee Atomic Environmental Laboratory conducts an extensive intralaboratory quality control program to assure the validity and reliability of non-TLD analytical data. Included are the internal process control program and the National Institute of Standards and Technology (NIST) Measurement Assurance Program. These together comprise about ten to fifteen percent of the laboratory sample throughput. The records of the quality control program are reviewed by the responsible cognizant individual, and corrective measures are taken whenever applicable.

For the internal process control program and the NIST Measurement Assurance Program, there were 566 analyses for accuracy and 615 for precision in 1992. Of the 566 analyses for accuracy reviewed during this period, 98.6% met the Laboratory acceptance criteria for accuracy, while 1.4% (8 out of

566 analyses) were identified as outside the Laboratory acceptance criteria. Of the 615 analyses for precision during 1992, 100% met the Laboratory acceptance criteria for precision. Table 7.1 shows a summary of the results of this program.

7.2 EPA Intercomparison Program

To further verify the accuracy and precision of the Laboratory analyses via an independent outside third party, the Yankee Atomic Environmental Laboratory participates in the U.S. Environmental Protection Agency's Environmental Radioactivity Laboratory Intercomparison Studies Program for those available species and matrices routinely analyzed by the Laboratory. Participation in this program is required by VYNPS Technical Specification 3.9.E. Each sample supplied by the EPA is analyzed in triplicate, and the results are returned to the EPA within a specified time frame. When the know values are returned to the Laboratory, the Laboratory and EPA results are then evaluated against specific Laboratory and EPA acceptance criteria. When the results of the cross-check analysis fall outside of the control limit, an investigation is made to determine the cause of the problem and corrective measures are taken, as appropriate. Results of this program are provided in this report in compliance with Technical Specification 4.9.E.

For the EPA Intercomparison Program, there were 171 analyses for accuracy on 96 samples. The samples consisted of water, milk and air particulate filters. The analyses were for gamma-emitting radionuclides, gross-beta, strontium, iodine, plutonium and tritium. Table 7.2 shows a summary of the results for 1992. Of the 171 analyses for accuracy, all met the EPA mean value control limits. In addition to the above, six water samples and six air particulate filter samples were analyzed for gross-alpha. Since gross-alpha analyses are not routinely performed as part of the Vermont Yankee radiological environmental monitoring program, these results are not reported here.

In 1991, as reported in the 1991 Annual Radiological Environmental Operating Report, a set of Strontium analyses on three water samples (Laboratory Sample Nos. S97981, S97982 and S97983) did not meet the EPA mean value control limits. The mean value was 38.6 pCi/l and the EPA Control Limits were from 40.3 - 57.7 pCi/l. The Laboratory investigated this set of results under Yankee Laboratory Corrective Action Request YLCAR ASG-01-92. The sample set was reprocessed, but the Sr-89 results did not indicate the presence of statistically positive radioactivity since the achieved Minimum Detectable concentrations (MDCs) were either at or above

the Sr-89 "known" value of 49 pCi/l. The reprocessed analyses were thus inconclusive since the Sr-89 had decayed through four half-lives.

While no explanation was found for the low mean bias for the Sr-89 sample set, the YLCAR was closed out with the issuance of Memorandum EL 520/92, which describes the results of six EPA interlaboratory sample sets containing mixtures of both Sr-89 and Sr-90 analyzed subsequent to the original outlier EPA sample set S97981-S97983. All six EPA sample sets met both Laboratory and EPA acceptance criteria at similar Sr-89,90 ratios and activity levels.

7.3 Environmental TLD Quality Assurance Program

The Panasonic environmental TLD (thermoluminescent dosimeter) program at the Yankee Environmental Laboratory has its own quality assurance program. In addition to instrumentation checks performed by the Dosimetry Services Group (DSG), which represent approximately 10% of the TLDs processed, two independent test programs are performed for accuracy and precision. The first of these programs is performed by the in-house Dosimetry QA Officer, and the second involves the University of Michigan third-party testing program. Under these programs, dosimeters are irradiated to known doses (unknown to the DSG) and given to the DSG for read-out.

In 1992, out of 1428 TLDs processed at the Yankee Environmental Laboratory, 6.7% (96 TLDs) were processed as part of the performance testing program. Of these 96 TLDs, 72 were from the in-house Dosimetry QA Officer, and 24 were from the University of Michigan testing program. All of these (100%) met the acceptance criteria for accuracy and precision.

7.4 Blind Duplicate Quality Assurance Program

The Laboratory Quality Control Audit Committee (LQCAC) is comprised of one member from each of the five power plants that are serviced by the Yankee Atomic Environmental Laboratory. Two of the primary functions of the LQCAC are to conduct an annual audit of Laboratory operations and to coordinate the Blind Duplicate Quality Assurance Program. Under the Blind Duplicate Quality Assurance Program, paired samples are submitted from the five plants, including VYNPS. They are prepared from homogeneous environmental media at each respective plant, and are sent to the Laboratory for analysis. They are "blind" in that the identification of the matching sample is not identified to the Laboratory. The LQCAC analyzes the results

of the paired analyses to evaluate precision in Laboratory measurements.

A total of 51 paired samples were submitted under this program by the five participating plants during 1992. Paired measurements were evaluated for 26 gamma emitting radionuclides, H-3, Sr-89, Sr-90, I-131 and gross-beta. All measurements were evaluated, whether the results were considered statistically positive or not, and whether the net concentration was positive or negative. Of the 1273 paired duplicate measurements evaluated in 1992, 1271 (99.8%) fell within the established acceptance criteria. With the two paired measurements that did not meet the acceptance criteria, none had radioactivity that was considered statistically positive. The results of this program are summarized in Table 7.3 and 7.4.

TABLE 7.1

SUMMARY OF PROCESS CONTROL ANALYSIS RESULTS
January - December 1992

SAMPLE MEDIA	ACCURACY		PRECISION	
	NUMBER OF ANALYSES	NUMBER ANALYSES OUTSIDE ACCEPTANCE CRITERIA	NUMBER OF ANALYSES	NUMBER ANALYSES OUTSIDE ACCEPTANCE CRITERIA
AIR CHARCOAL				
Gamma	116	3	82	0
AIR FILTER				
Beta	221	0	221	0
Gamma	7	0	6	0
Strontium	6	0	6	0
MILK				
Gamma	72	3	103	0
Iodine	46	0	46	0
Strontium	31	0	31	0
WATER				
Gross-Beta	8	1	8	0
Gamma	12	0	12	0
Iodine	11	0	11	0
Strontium	16	1	16	0
Tritium	20	0	17	0
SOIL/SEDIMENT				
Gamma	0	0	56	0
TOTAL	566	8	615	0

TABLE 7.2

SUMMARY OF EPA INTERCOMPARISON ANALYSIS RESULTS
January - December 1992

SAMPLE MEDIA	NO. OF SAMPLES ANALYZED*	NO. OF ANALYSES	NO. OUTSIDE EPA CONTROL LIMITS**
AIR FILTER			
Beta	2	6	0
Gamma	2	6	0
Strontium	2	6	0
MILK			
Gamma	2	15	0
Iodine	2	6	0
Strontium	2	12	0
WATER			
Gross-Beta	3	9	0
Gamma	5	66	0
Iodine	2	6	0
Plutonium	2	6	0
Strontium	4	24	0
Tritium	3	9	0

* The number of EPA samples that were analyzed for the specified radionuclide. Each of these samples was analyzed in triplicate.

** The number of mean values (from triplicate samples) outside EPA Control Limits.

TABLE 7.3

SUMMARY OF BLIND DUPLICATE SAMPLES SUBMITTED
January - December 1992

TYPE OF SAMPLE	NUMBER OF PAIRED SAMPLES SUBMITTED
Cow Milk	20
Ground Water	8
River Water	4
Surface (Fresh) Water	1
Estuary Water	5
Sea Water	6
Irish Moss	2
Mussels	4
Food Product - Cranberries	1
TOTAL	51

TABLE 7.4

SUMMARY OF BLIND DUPLICATE RESULTS
January - December 1992

ANALYSIS TYPE	TOTAL ANALYSES*					
	MILK	WATER	FOOD PRODUCT	MARINE ALGAE	MUSSEL	TOTAL
Gamma	479 (0)	561 (2)	25 (0)	49 (0)	96 (0)	1210 (2)
Sr-89/90	8 (0)	--	--	--	--	8 (0)
H-3	--	12 (0)	--	--	--	12 (0)
Gross Beta	--	11 (0)	--	--	--	11 (0)
I-131	20 (0)	4 (0)	--	--	--	24 (0)

* The number of paired measurements that did not meet the acceptance criteria are given in parentheses. See text for details.

8. LAND USE CENSUS

VYNPS Technical Specification 3/4.9.D requires that a Land Use Census be conducted annually between the dates of June 1 and October 1. The Census identifies the locations of the nearest milk animal and the nearest residence in each of the 16 meteorological sectors within a distance of five miles of the plant. It also identifies the nearest milk animal (within three miles of the plant) to the point of predicted highest annual average D/Q value in each of the three major meteorological sectors due to elevated releases from the plant stack. The 1992 Land Use Census was conducted in accordance with the above Technical Specifications.

Immediately following the collection of field data, in compliance with Technical Specification 6.7.C.1.b, a dosimetric analysis is performed to compare the census locations to the "Critical Receptor" identified in the Offsite Dose Calculation Manual (ODCM). This Critical Receptor is the location that is used in the conservative Method 1 dose calculations found in the ODCM (i.e. the dose calculations done in compliance with Technical Specification 4.8.G.1). If a Census location has a 20% greater potential dose than that of the Critical Receptor, this fact must be announced in the Semiannual Effluent Release Report for that period. A re-evaluation of the Critical Receptor would also be done at that time. For the 1992 Census, no such locations were identified.

Pursuant to Technical Specification 3.9.D.2, a dosimetric analysis is then performed, using site specific meteorological data, to determine which milk animal locations would provide the optimal sampling locations. If any location has a 20% greater potential dose commitment than at a currently-sampled location, the new location is added to the routine environmental sampling program in replacement of the location with the lowest calculated dose (which is eliminated from the program). For the 1992 Census, two such milk animal locations were identified. These were the Mitchell and Dominick locations. Due to the small number of milk animals (goats) owned at each location, the owners would not be able to provide samples of sufficient size on a regular basis. Consequently, no changes were made in the Technical Specification-required milk sampling program as defined in Table 4.1 of the Offsite Dose Calculation Manual. The two locations identified above, however, were sampled as available.

The results of the 1992 Land Use Census are included in this report in compliance with Technical Specifications 4.9.D.1 and 6.7.C.3. The locations identified during the Census may be found in Table 8.1.

TABLE 8.1

1992 LAND USE CENSUS LOCATIONS*

SECTOR	NEAREST RESIDENCE Km (Mi)	NEAREST MILK ANIMAL Km (Mi)
N	1.6 (1.0)	----
NNE	1.6 (1.0)	4.0 (2.5) Goats
NE	1.3 (0.7)	----
ENE	0.97 (0.6)	----
E	0.97 (0.6)	5.2 (3.2) Goats
ESE	2.8 (1.75)	----
SE	1.8 (1.1)	3.4 (2.1) Cows
SSE	2.0 (1.3)	5.1 (3.2) Cows
S	0.5 (0.3)	2.1 (1.3) Cows
SSW	0.5 (0.3)	----
SW	0.5 (0.3)	8.2 (5.1) Cows
WSW	0.5 (0.3)	----
W	0.5 (0.3)	----
WNW	0.6 (0.4)	0.8 (0.5) Cows
NW	1.2 (0.8)	4.7 (2.9) Cows**
NNW	2.1 (1.3)	----

* Sector and distance relative to plant stack.
** This location overlaps the NW and WNW sectors.

9. SUMMARY

During 1992, as in all previous years of plant operation, a program was conducted to assess the levels of radiation or radioactivity in the Vermont Yankee Nuclear Power Station environment. Over 750 samples were collected (including TLDs) over the course of the year, with a total of over 7500 radionuclide or exposure rate analyses being performed on them. The samples included ground water, river water, sediment, fish, milk, silage and mixed grass. In addition to these samples, the air surrounding the plant was sampled continuously and the radiation levels were measured continuously with environmental TLDs.

Low levels of radioactivity from three sources were detected. Most samples had measurable levels of K-40, Be-7, AcTh-228 or radon daughter products. These are the most common of the naturally-occurring radionuclides. Many samples (milk and sediment in particular) had fallout radioactivity from atmospheric nuclear weapons tests conducted primarily from the late 1950's through 1980. Several samples of sediment had low levels of radioactivity resulting from emissions from the Vermont Yankee plant. These were all collected at the North Storm Drain Outfall. In all cases, the possible radiological impact was negligible with respect to exposure from natural background radiation. In no case did the detected levels exceed the most restrictive federal regulatory or plant license limits for radionuclides in the environment.

10. REFERENCES

1. USNRC Radiological Assessment Branch Technical Position, "An Acceptable Radiological Environmental Monitoring Program," Revision 1, November 1979.

2. NCRP Report No. 94, *Exposure of the Population in the United States and Canada from Natural Background Radiation*, National Council on Radiation Protection and Measurements, 1987.

3. *Ionizing Radiation: Sources and Biological Effects*, United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), 1982 Report to the General Assembly.

4. Kathren, Ronald L., *Radioactivity and the Environment - Sources, Distribution, and Surveillance*, Harwood Academic Publishers, New York, 1984.

5. Till, John E. and Robert H. Meyer, ed., *Radiological Assessment - A Textbook on Environmental Dose Analysis*, NUREG/CR-3332, U.S. Nuclear Regulatory Commission, Washington, D.C., 1983.