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Subject: ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT

Dear Sir/Madam:

Enclosed please find the 1996 Yankee Atomic Annual Radiological Environmental Operating Report. This report summarizes the findings of the Radiological Environmental Monitoring Program conducted by Yankee Atomic Electric company in the vicinity of the Yankee Nuclear Power Station in Rowe, Massachusetts. This information is submitted in accordance with Technical Specification 6.8.2.a.

We trust that this information is satisfactory; however, should you have any questions, please contact us.

Sincerely,

YANKEE ATOMIC ELECTRIC COMPANY

J. A. Kay

J. A. Kay
Principal Licensing Engineer

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YANKEE NUCLEAR POWER STATION

ANNUAL RADIOLOGICAL ENVIRONMENTAL OPERATING REPORT

January - December 1996

April 1997

Prepared by:
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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 Yankee Atomic Electric Company in the vicinity of the Yankee Nuclear Power Station (YNPS) in Rowe, Massachusetts during the calendar year 1996. It is submitted annually in compliance with plant Technical Specification 6.8.2.a.

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 YNPS environs.

Section 3: Provides a brief description of the YNPS site and its environs.

Section 4: Provides a description of the overall REMP program design. Included is a summary of the Offsite Dose Calculation Manual (ODCM) Requirements for REMP sampling, tables listing all locations sampled or monitored in 1996, with compass sectors and distances from the plant, and maps showing each REMP location. Tables listing Lower Limit of Detection requirements and Reporting Levels are also included.

Section 5: Consists of the summarized data as required by the ODCM. The tables are in the format specified by the NRC Branch Technical Position on Environmental Monitoring (Reference 1). Also included is a summary of environmental TLD measurements for 1996.

Section 6: Provides the results of the 1996 monitoring program. The performance of the program in meeting regulatory requirements as given in the Technical Specifications and ODCM 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 (YAEL). As required by the ODCM, the results of the EPA and Analytic's, Inc. Intercomparison Programs are given.

Section 8: Summarizes the requirements and the results of the 1996 Land Use Census.

Section 9: Gives an overall summary of the results of the 1996 Radiological Environmental Monitoring Program.

2. NATURALLY OCCURRING AND MAN-MADE BACKGROUND RADIOACTIVITY

Radiation or radioactivity potentially detected in the YNPS 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 YNPS. The third potential source of radioactivity is due to emissions from YNPS. For the purposes of the YNPS 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, radioactivity from plant emissions, is the one that the REMP is primarily 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-232 (Th-232), Potassium-40 (K-40), Radium-226 (Ra-226), and Radon-222 (Rn-222). Uranium-238 and Thorium-232 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 best detected in the field with high pressure ion chambers.

2.2 Man-Made Background Radioactivity

The second source of "background" radioactivity in the YNPS 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 YNPS environment and other parts 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. Atmospheric testing, was conducted by the People's Republic of China last in October 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 from the troposphere (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 Yankee Nuclear Power Station (YNPS) is located on a 2200 acre site in a predominantly rural area of northwestern Massachusetts, three-quarters of a mile south of the Vermont border. The plant resides in the town of Rowe, Massachusetts, approximately 9 miles east-northeast of North Adams, Massachusetts. The surrounding area is heavily forested and lightly populated. Hills bounding the river valley rise 500 to 1000 feet above the site, reaching elevations of 2100 feet.

The Deerfield River is used extensively for hydroelectric power generation both upstream and downstream of YNPS. Sherman Dam, immediately adjacent to YNPS, operates as a hydroelectric generating station. Sherman Pond, the impoundment behind this dam, has been used as a source of cooling water for YNPS.

YNPS was voluntarily shut down on October 1, 1991 and ceased power operation on February 26, 1992 after 32 years of reliable operation. The plant has begun the process of decommissioning which will eventually entail the disassembly and removal of the plant components and structures. This process will take place in strict conformance with USNRC regulations. Oversight will also continue from the U.S. Environmental Protection Agency, the Massachusetts Department of Environmental Protection, Massachusetts Department of Public Health, and Massachusetts Emergency Management Administration.

The radiological environmental monitoring program for YNPS continued to operate through 1996, and will continue throughout the decommissioning period.

4. PROGRAM DESIGN

The Radiological Environmental Monitoring Program for the YNPS was designed with specific objectives in mind. These were:

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

- To provide assurance to regulatory agencies and the public that the environmental impact from YNPS 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.

These objectives will continue to be in force, to varying degrees, throughout decommissioning activities at the YNPS site. Due to the shutdown status of the plant, and due to the relatively low quantities of radioactive material now on the site, some of the objectives have a different degree of importance than in the past.

The radiological environmental monitoring program was initiated in 1958, approximately two years before the plant began commercial operation in 1960. It has been in operation continuously since that time, with improvements made periodically over those years.

The current program was 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*; and NRC NUREG-0472, *Radiological Effluent Technical Specifications for PWR's*. The environmental TLD program was designed and tested around NRC Regulatory Guide 4.13, *Performance, Testing and Procedural Specifications for Thermoluminescence Dosimetry: Environmental Applications*. The quality assurance program was designed around the guidance given in NRC Regulatory Guide 4.15, *Quality Assurance for Radiological Monitoring Programs (Normal Operations) - Effluent*

Streams and the Environment.

Prior to August 1992, the requirements for the Radiological Environmental Monitoring Program (REMP) were given in the YNPS Technical Specifications. In August 1992, the REMP requirements were removed from the Technical Specifications and placed in the Offsite Dose Calculation Manual (ODCM) (Reference 5) pursuant to NRC Generic Letter 89-01 (Reference 6). ODCM controls are cited in this report when specific REMP requirements are discussed.

The minimal sampling requirements of the REMP are given in Table 4.1 of the ODCM, which is summarized in Table 4.1 of this report. The identification of the required sampling locations is given in Table 4.4 of the ODCM, as well as in Tables 4.2 and 4.3 of this report. The sampling and monitoring locations are shown graphically on the maps in Figures 4.1 through 4.7.

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. The first area is called Zone 1, and its monitoring locations are called "indicators." The second area is called Zone 2, and its monitoring locations 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 activities 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 direct radiation, airborne, waterborne, and ingestion 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
- Storm Drain Water Sampling
- Sediment Sampling

Ingestion Pathways
- Milk Sampling
- Fish Sampling
- Food Product and Broad Leaf Vegetation Sampling

Direct Radiation Pathway
- TLD Monitoring

4.3 Descriptions of Monitoring Programs

4.3.1 Air Sampling

Continuous air samplers are installed at seven locations, five of which are required by the YNPS ODCM. 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 weekly, and to allow for the decay of radon daughter products, they are held for at least 100 hours at the YAEL before being analyzed for gross-beta radioactivity (indicated as GR-B in the data tables). The weekly filters are composited (by location) at the YAEL for a quarterly gamma spectroscopy analysis.

4.3.2 Charcoal Cartridge (Radioiodine) Sampling

Continuous air samplers are installed at seven locations, five of which are required by the YNPS ODCM. The sampling pumps at these locations operate continuously at a flow rate of approximately one cubic foot per minute. A 60cc 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 weekly for I-131.

4.3.3 River Water Sampling

Automatic compositing samplers are located at one upstream and one downstream sampling location. The samplers are controlled by timers that collect an aliquot of river water at least every two hours. An additional grab sample is collected monthly at Sherman Pond. All river water samples are preserved with HCl and $NaHSO_3$, or HNO_3, to prevent the plate out of potentially-present radionuclides on the container walls. Each sample is analyzed for gross-beta and gamma-emitting radionuclides. These monthly composites or grabs are composited quarterly, by location, at the YAEL for a H-3 analysis.

4.3.4 Ground Water Sampling

Grab samples are collected monthly from two on-site locations. The ODCM requires a minimum of a quarterly collection. All ground water samples are preserved with HCl and $NaHSO_3$ to prevent the plate out of potentially-present radionuclides on the container walls. Each sample is required by the ODCM to be analyzed for gamma-emitting radionuclides and H-3. Samples are also analyzed for gross beta activity which is not an ODCM requirement.

4.3.5 Storm Drain Water Sampling

Grab samples are collected monthly from the West Storm Drain. This is not an ODCM required sampling location. This water is comprised of non-radioactive secondary side plant effluents, as well as groundwater and precipitation (including snow melt) draining from the west side of the plant facility. All storm drain water samples are preserved with HCl and $NaHSO_3$, or HNO_3, to prevent the plate out of potentially-present radionuclides on the container walls. Each sample is analyzed for gross-beta and gamma-emitting radionuclides, as well as H-3.

4.3.6 Sediment Sampling

Shoreline sediment cores are collected semiannually from two locations, one upstream and one downstream of the plant. At each location, six two-inch inner diameter plastic coring tubes are driven into the sediment at least six inches deep. The cores are carefully extracted and kept in an upright position and frozen prior to delivery to the YAEL. At the Laboratory, the frozen cores are cut into 5 cm (two-inch) segments. For each location, the 0-5 cm segments are blended into a single sample, as are the 5-10 cm and 10-15 cm segments. These composite samples are then analyzed for gamma-emitting radionuclides.

An additional bottom sediment core is collected semiannually in Sherman Pond near the plant discharge. A Wildco K. B. Core Sampler, fitted with a plastic coring tube, is dropped from a boat. Six cores are collected here, and are processed and analyzed as described above.

4.3.7 Milk Sampling

From January 1 through June 1, and again from November 1 through December 31, milk samples are collected monthly. During the "grazing season", which runs from June 1 to November 1, samples are collected once per two weeks. Immediately after collection, each milk sample is preserved with an appropriate amount of formaldehyde. Methimazole is also added to prevent protein binding of any radioiodine. 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 ODCM. Although not required by the ODCM, Sr-89 and Sr-90 analyses are also performed on quarterly composited samples.

Beginning in mid August of 1995, only one indicator location was available within five miles as a result of the farm at location TM-14 no longer having a cow. Although not required, mixed grass samples have been collected at location TM-14 since August 1995 and into 1996, in lieu of milk. One control location is also included which is located sufficiently far away from the plant to be outside any potential influence from it.

4.3.8 Fish Sampling

Fish samples are collected semiannually at two locations (upstream of the plant and in Sherman Pond). A gill net is set overnight from a boat, and mixed species of fish are removed the following day. The species typically collected are yellow perch, smelt, pickerel, trout, bullheads or suckers. The fish samples are frozen and delivered to the YAEL where the edible portions are analyzed for gamma-emitting radionuclides.

4.3.9 Food Products and Broadleaf Vegetation Sampling

Food Products are collected annually (at harvest) at three locations. The samples are either tuberous vegetables, above-ground vegetables, or fruit. Two indicator locations are chosen as a result of the annual Land Use Census, based on meteorological dispersion calculations. The third location is a control, which is located sufficiently far away from the plant to be outside any potential influence from it. Immediately after collection, each unwashed food product sample is preserved with an appropriate amount of NaOH. The edible portions of the samples are then analyzed at the YAEL for gamma-emitting radionuclides.

An additional sample of edible broadleaf vegetation is collected at a single location (as determined from the Land Use Census) and is preserved as above. A separate low-level I-131 analysis is performed on this sample to meet the Lower Limit of Detection requirements in the ODCM.

In addition to the above food products, optional maple syrup samples are collected annually, as described below.

4.3.10 Maple Syrup Sampling

Maple syrup is an important commercial product in northern New England, including the YNPS plant environs. Because of this, samples are collected annually from two or three locations. (There is no ODCM requirement.) These samples are collected from the syrup manufacturer as a finished product, that is, following the boiling down of the maple sap. Since the samples have already been boiled down as part of the syrup production process, no preservatives are needed in the samples. Following collection, the samples are analyzed at the YAEL for gamma-emitting radionuclides. It should be noted that because of the boiling down and filtering of the sap, the resulting radionuclide measurements do not represent actual environmental concentrations. It is estimated that the resulting syrup has been concentrated by a factor of from 15 to 120 times the original sap, depending mostly on the time of the season that the sap was collected.

4.3.11 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 tree, fence or utility pole. TLDs are posted at 40 locations, with 38 of these stations required by the ODCM. Of the 38, 22 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 Control was exceeded during the period. Although not required by the ODCM, the TLDs from the 16 outer ring stations are read out quarterly along with the other stations's TLDs. The plant staff posts and retrieves all TLDs, while the YAEL processes them.

TABLE 4.1

Radiological Environmental Monitoring Program
(as required by ODCM Table 4.1)

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)	38 Includes 16 Outer Ring Incident Response TLDs	Continuous	Quarterly	Gamma Dose; Outer Ring - de-dose only, unless gaseous release Control was exceeded	Each TLD
2. Airborne (Particulates and Radioiodine)	5	Continuous	Weekly	Particulate Sample: Gross Beta	Each Sample
				Gamma Isotopic	Quarterly Composite (by location)
				Radioiodine Canister: I-131	Each Sample
3. Waterborne					
a. Surface Water	2	Composite (aliquot every 2 hours)	Monthly	Gross Beta Gamma Isotopic Tritium (H-3)	Each Sample Each Sample Quarterly Composite
b. Ground Water	2	Grab	Quarterly	Gamma Isotopic Tritium (H-3)	Each Sample Each Sample
c. Shoreline Sediment	1	Grab	Semiannually	Gamma Isotopic	Each Sample

TABLE 4.1
(continued)

Radiological Environmental Monitoring Program
(as required by ODCM Table 4.1)

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	3	Grab	Monthly (Once per 2 weeks when on pasture)	Gamma Isotopic I-131	Each sample Each sample
b. Fish	2	Grab	Semiannually (or seasonal if appropriate)	Gamma Isotopic on edible portions	Each sample
c. Food Products					
Tuberous or above-ground vegetables, or fruit	3	Grab	At harvest	Gamma Isotopic on edible portion	Each sample
Broad leaf vegetation	1	Grab	At harvest	I-131	Each sample

TABLE 4.2

Radiological Environmental Monitoring Locations (non-TLD) in 1996
Yankee Nuclear Power Station

ExposurePathway	Station Code	Station Description	Zone*	Distance From Plant (km)	Direction From Plant
1. Airborne					
	AP/CF-11	Observation Stand	1	0.5	NW
	AP/CF-12	Monroe Bridge	1	1.1	SW
	AP/CF-13	Rowe School	1	4.2	SE
	AP/CF-14	Harriman Station	1	3.2	N
	AP/CF-21	Williamstown, MA	2	22.2	W
	AP/CF-31	YAEC Visitor's Center	1	0.8	SW
	AP/CF-32	Heartwellville, VT	2	12.6	NNW
2. Waterborne					
a. Surface	WR-11	Bear Swamp Lower Reservoir	1	6.3	Down-river
	WR-21	Harriman Reservoir	2	10.1	Up-river
	WR-31	Sherman Pond	1	0.1	N
b. Ground	WG-11	Plant Potable	1	On-site	--
	WG-12	Sherman Spring	1	0.2	NW
c. Storm Drain	WW-52	West Storm Drain	1	On-site	--
d. Sediment	SE-11	No. 4 Station	1	36.2	Down-river
	SE-21	Harriman Reservoir	2	10.1	Up-river
	SE-91	Sherman Pond	1	0.1	N
3. Ingestion					
a. Milk	TM-13	Whitingham, VT	1	8.4	ENE
	TM-14**	Rowe, MA	1	3.2	SE
	TM-21	Williamstown, MA	2	21	WSW
b. Fish	FH-11	Sherman Pond	1	1.5	Near Dischg.
	FH-21	Harriman Reservoir	2	10.1	Up-river

TABLE 4.2
(continued)

Radiological Environmental Monitoring Locations (non-TLD) in 1996
Yankee Nuclear Power Station

ExposurePathway	Station Code	Station Description	Zone*	Distance From Plant (km)	Direction From Plant
3. Ingestion, (continued)					
c. Food Products	TF/TV-11	Monroe Bridge, MA	1	1.3	SW
	TF-13	Monroe, MA	1	1.9	WNW
	TF-21	Williamstown, MA	2	21.0	WSW
	MS-33	Rowe, MA (Maple syrup)	1	1.0	S
	MS-45	Florida, MA (Maple syrup)	2	10.5	WSW

* 1 = Indicator Stations; 2 = Control Stations
** Grass samples designated as TC-14 have been collected since milk became unavailable in August 1995.

TABLE 4.3

Radiological Environmental Monitoring Locations (TLD) in 1996
Yankee Nuclea: Power Station

Station Code	Station Description	Zone*	Distance From Plant (km)	Direction From Plant
GM-1	YAEC Visitors' Center	1	0.8	SW
GM-2	Observation Stand	1	0.5	NW
GM-3	Rowe School	1	4.2	SE
GM-4	Harriman Station	1	3.2	N
GM-5	Monroe Bridge	1	1.1	SW
GM-6	Readsboro Road Barrier	1	1.3	N
GM-7	Whitingham Line	1	3.5	NE
GM-8	Monroe Hill Barrier	1	1.8	S
GM-9	Dunbar Brook	1	3.2	SW
GM-10	Cross Road	1	3.5	E
GM-11	Adams High Line	1	2.1	WNW
GM-12	Readsboro, VT	1	5.5	NNW
GM-13	Restricted Area Fence	F	0.08	WSW
GM-14	Restricted Area Fence	F	0.11	WNW
GM-15	Restricted Area Fence	F	0.08	NNW
GM-16	Restricted Area Fence	F	0.13	NNE
GM-17	Restricted Area Fence	F	0.14	ENE
GM-18	Restricted Area Fence	F	0.14	ESE
GM-19	Restricted Area Fence	F	0.16	SE
GM-20	Restricted Area Fence	F	0.16	SSE
GM-21	Restricted Area Fence	F	0.11	SSW
GM-22	Heartwellville, VT	2	12.6	NNW
GM-23	Williamstown Substation	2	22.2	W
GM-24	Harriman Dam	O	7.3	N
GM-25	Whitingham, VT	O	7.7	NNE
GM-26	Sadoga Road	O	7.6	NE
GM-27	Number 9 Road	O	7.6	ENE
GM-28	Number 9 Road	O	6.0	E
GM-29	Route 8A	O	8.2	ESE
GM-30	Route 8A	O	9.4	SE

TABLE 4.3
(continued)

Radiological Environmental Monitoring Locations (TLD) in 1996
Yankee Nuclear Power Station

Station Code	Station Description	Zone*	Distance From Plant (km)	Direction From Plant
GM-31	Legate Hill Road	O	7.6	SSE
GM-32	Rowe Road	O	7.9	S
GM-33	Zoar Road	O	6.9	SSW
GM-34	Fife Brook Road	O	6.4	SW
GM-35	Whitcomb Summit	O	8.6	WSW
GM-36	Tilda Road	O	6.6	W
GM-37	Turner Hill Road	O	6.7	WNW
GM-38	West Hill Road	O	6.6	NW
GM-39	Route 100	O	6.8	NNW
GM-40	Readsboro Road	1	0.5	W

* 1 = Indicator TLD; 2 = Control TLD; O = Outer Ring Incident Response TLD; F = Fenceline TLD.

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)	Food Product (pCi/kg)	Sediment (pCi/kg - dry)
Gross-Beta	4	0.01				
H-3	2000					
Mn-54	15		130			
Fe-59	30		260			
Co-58,60	15		130			
Zn-65	30		260			
Zr-Nb-95	15					
I-131	1*	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		

* LLD for drinking water.

** LLD for leafy vegetation.

Additional explanatory footnotes are given in ODCM Table 4.3.

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)
H-3	30000 *				
Mn-54	1000		30000		
Fe-59	400		10000		
Co-58	1000		30000		
Co-60	300		10000		
Zn-65	300		20000		
Zr-Nb-95	400				
I-131	2	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 non-drinking water pathways.

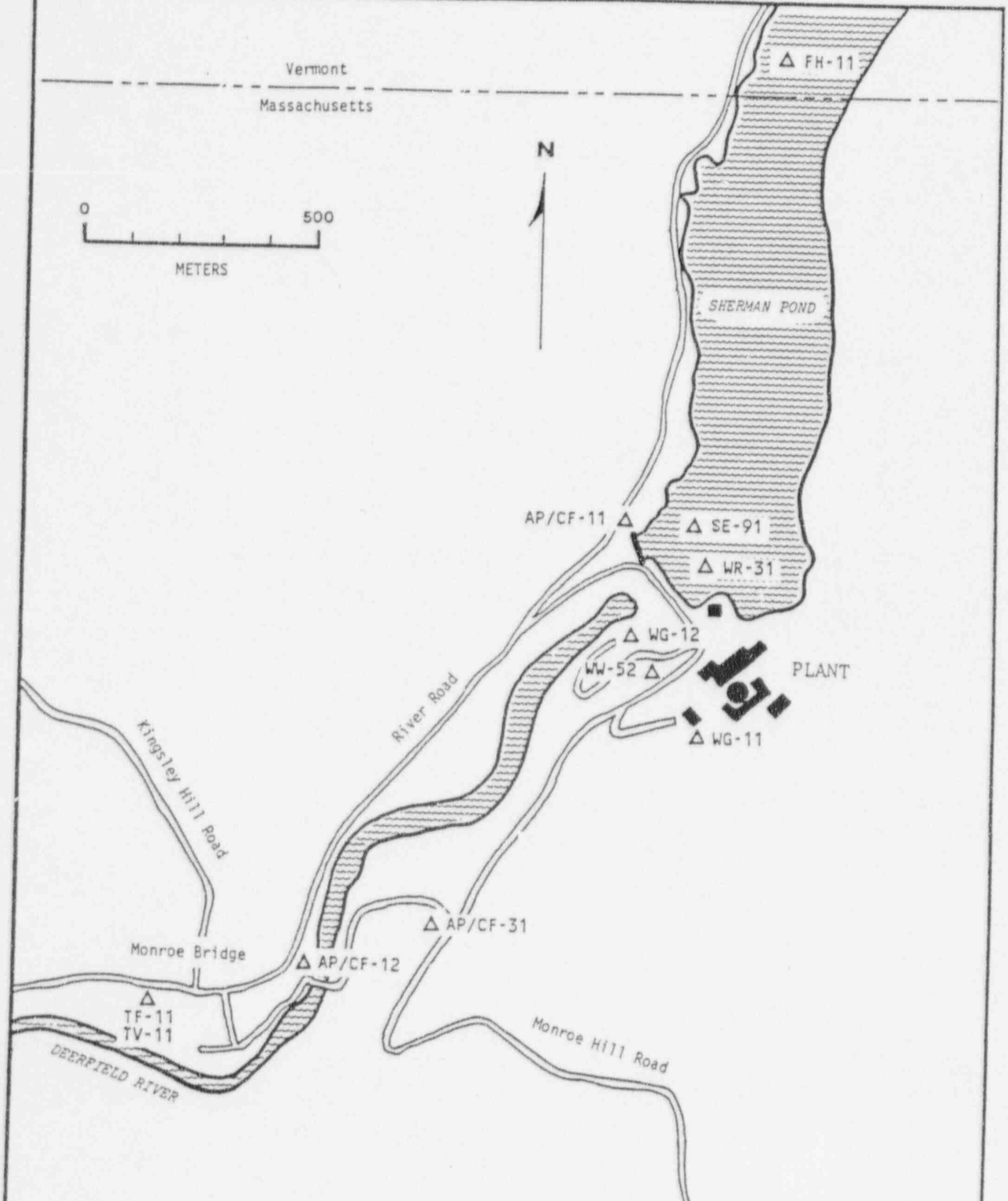


Figure 4.1 Radiological Environmental Sampling Locations Within 1 Mile of YNPS

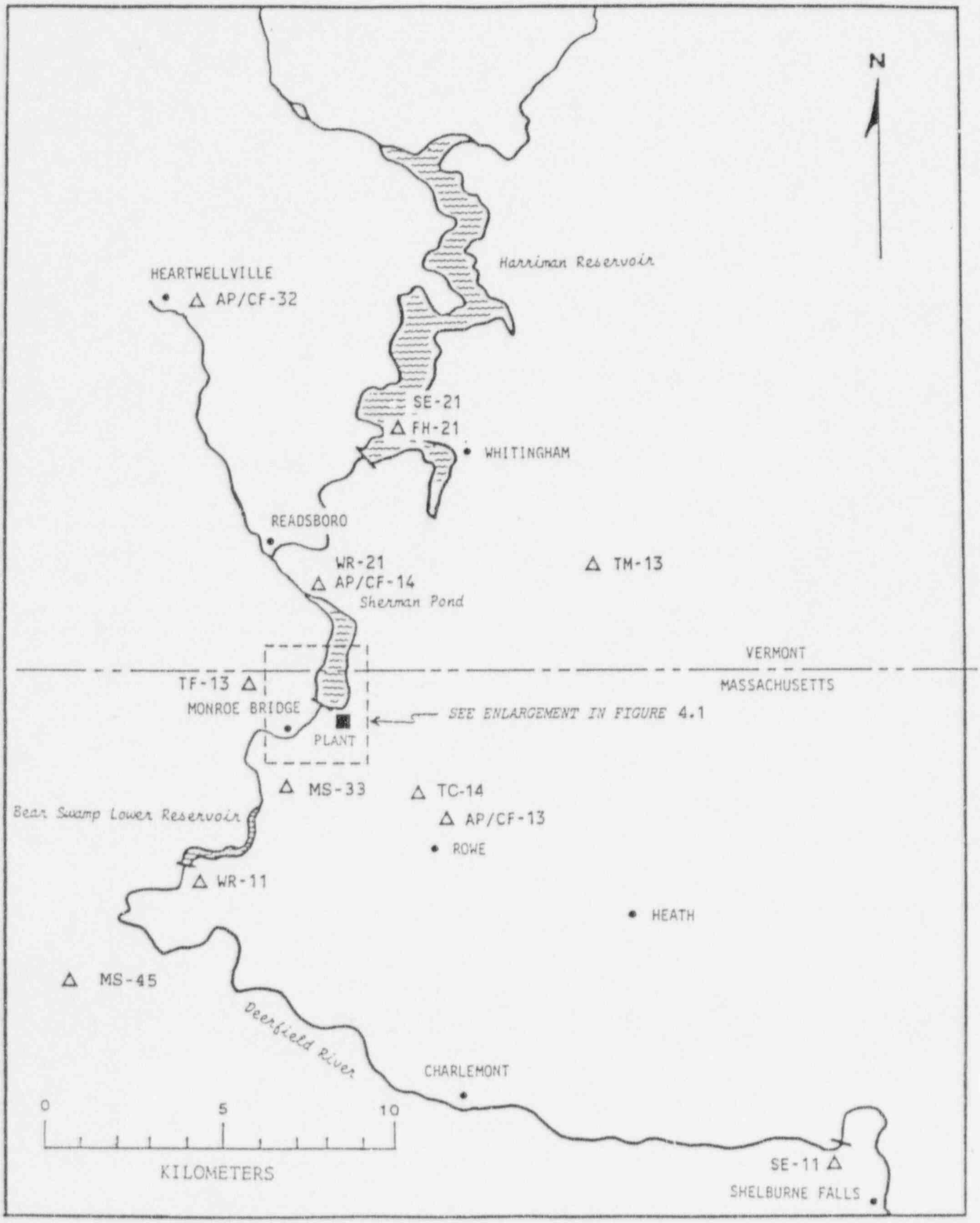


Figure 4.2 Radiological Environmental Sampling Locations Within 12 Miles of YNPS

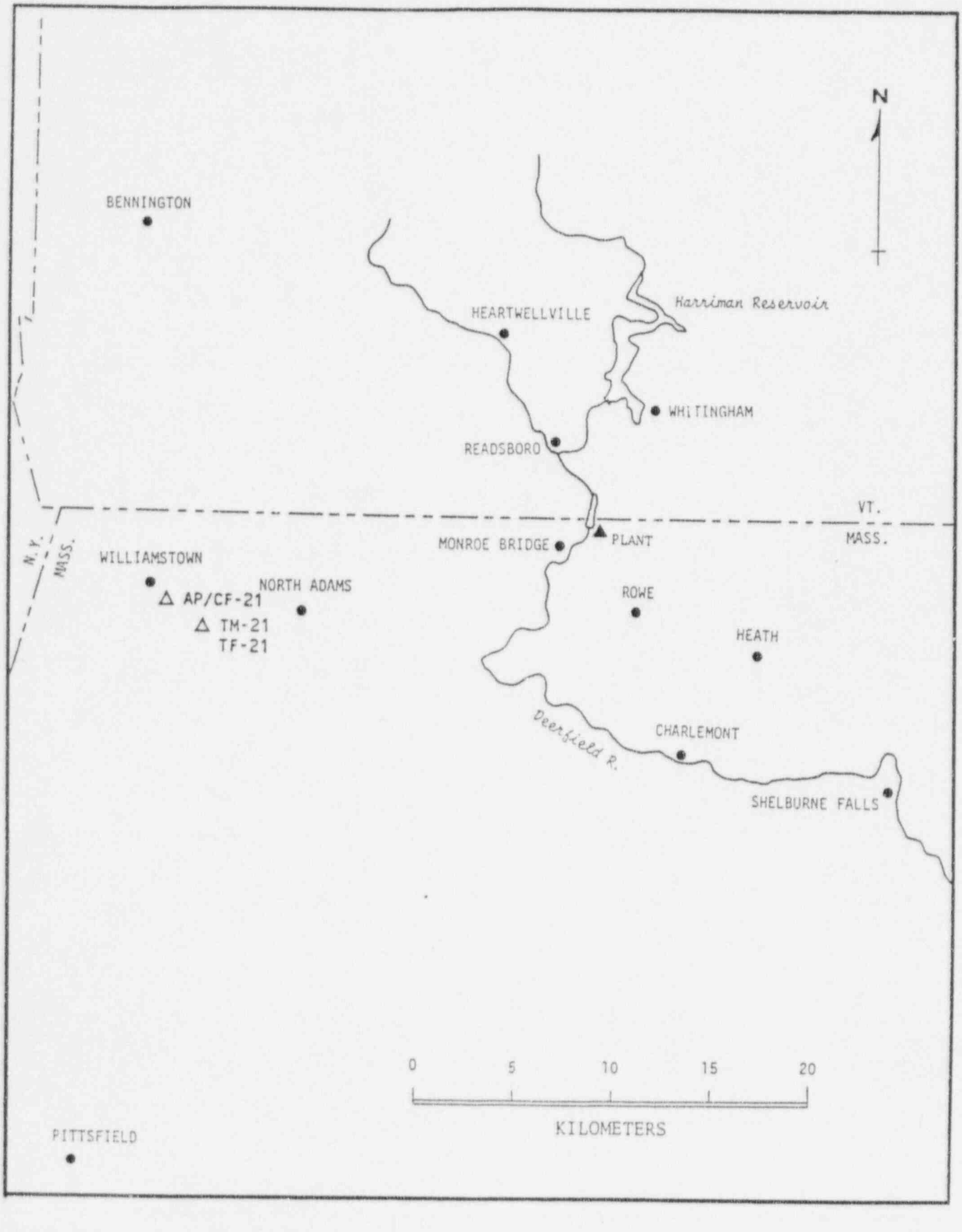


Figure 4.3 Radiological Environmental Sampling Locations Outside 12 Miles of YNPS

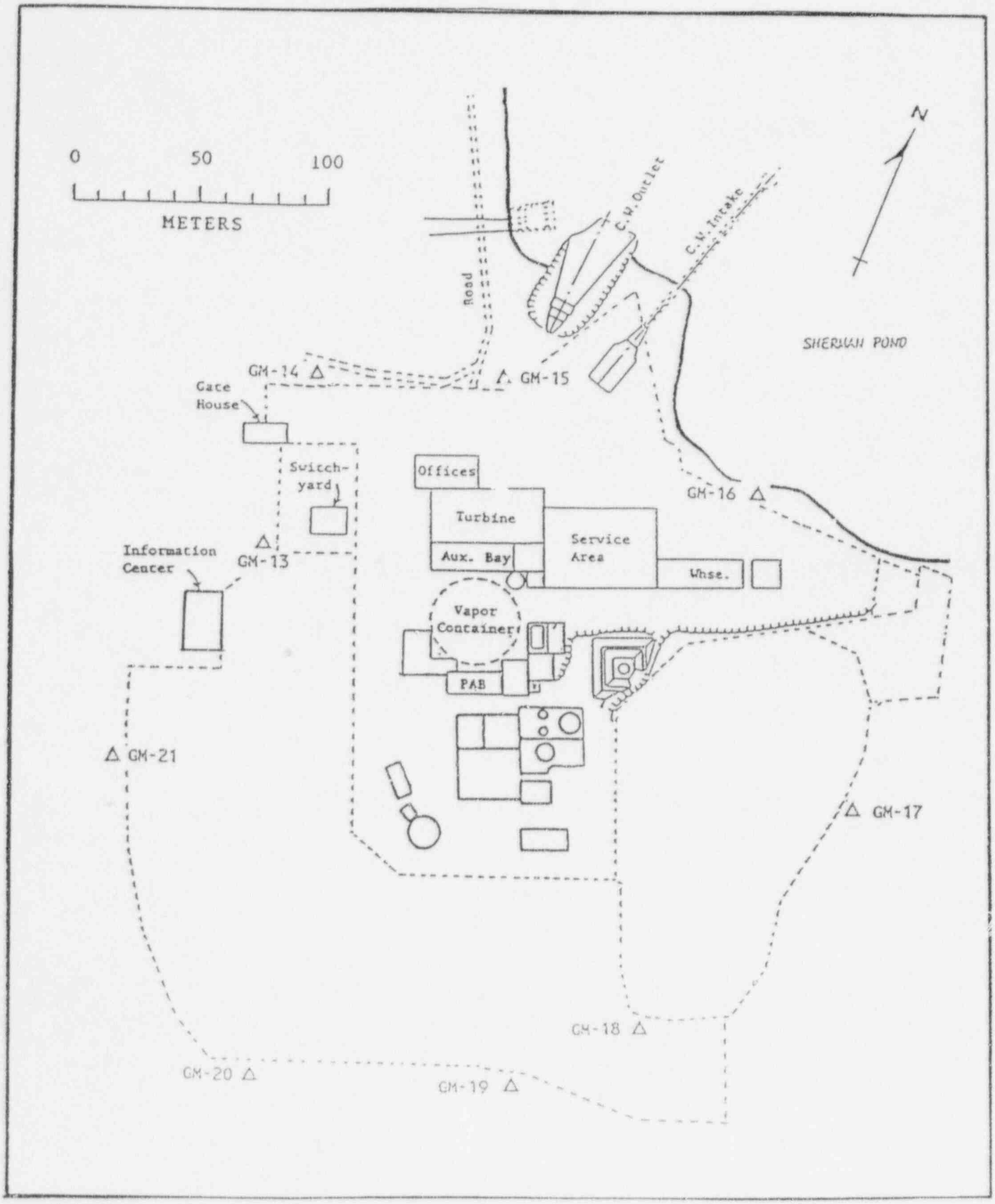


Figure 4.4 Environmental TLD Monitoring Locations at the YNPS Industrial Area Fence

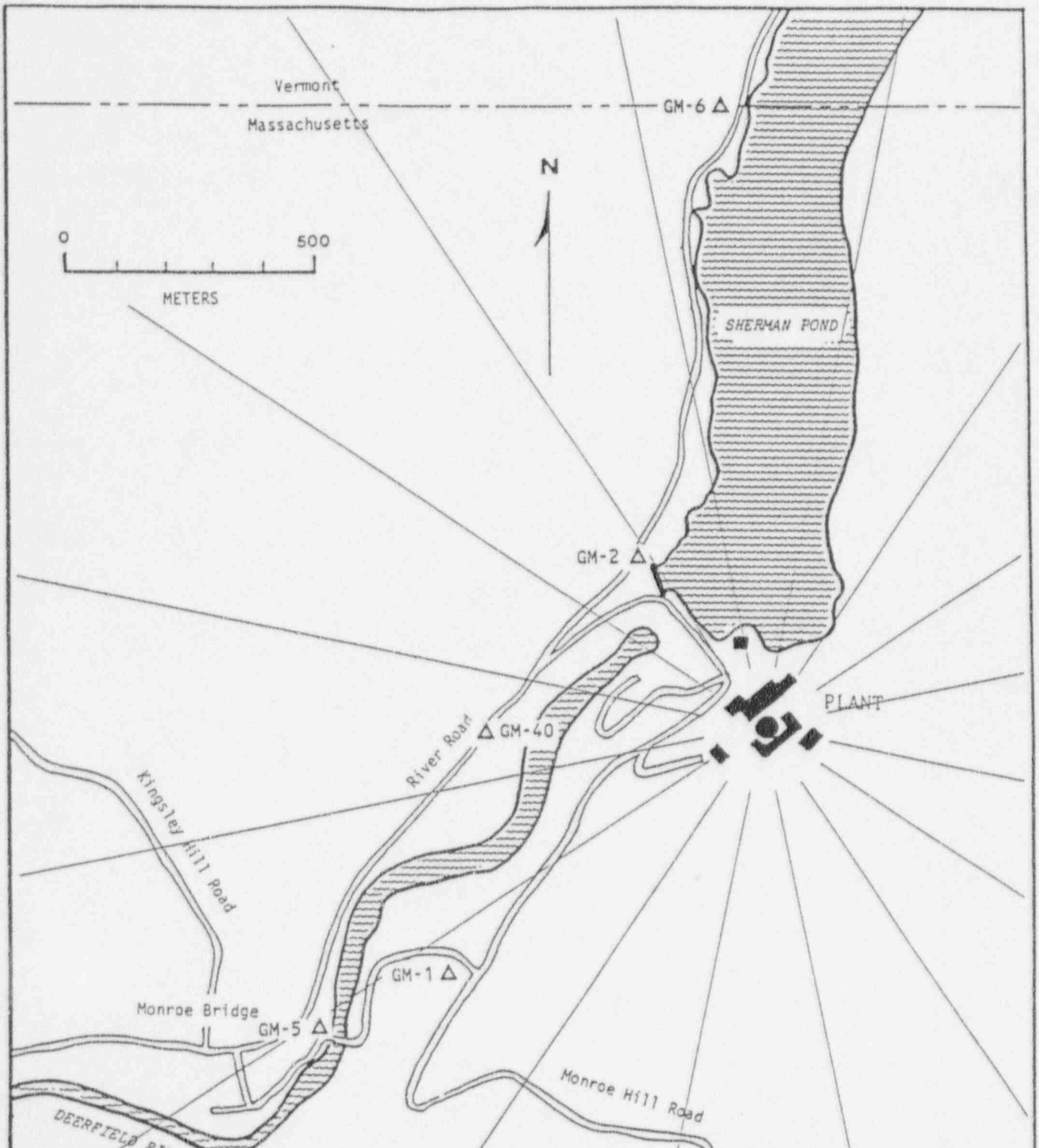


Figure 4.5 Environmental TLD Monitoring Locations Within 1 Mile of YNPS

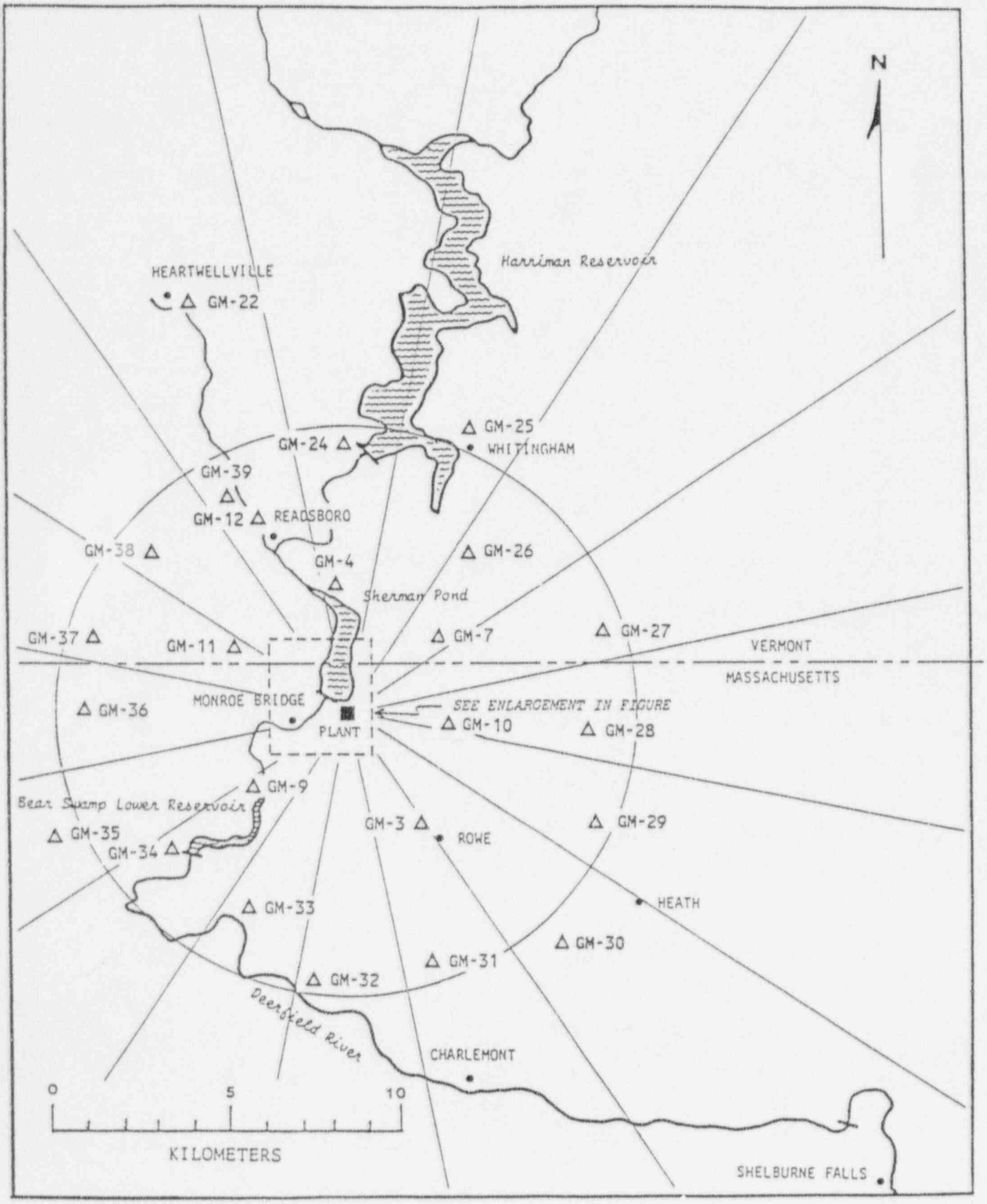


Figure 4.6 Environmental TLD Monitoring Locations Within 12 Miles of YNPS

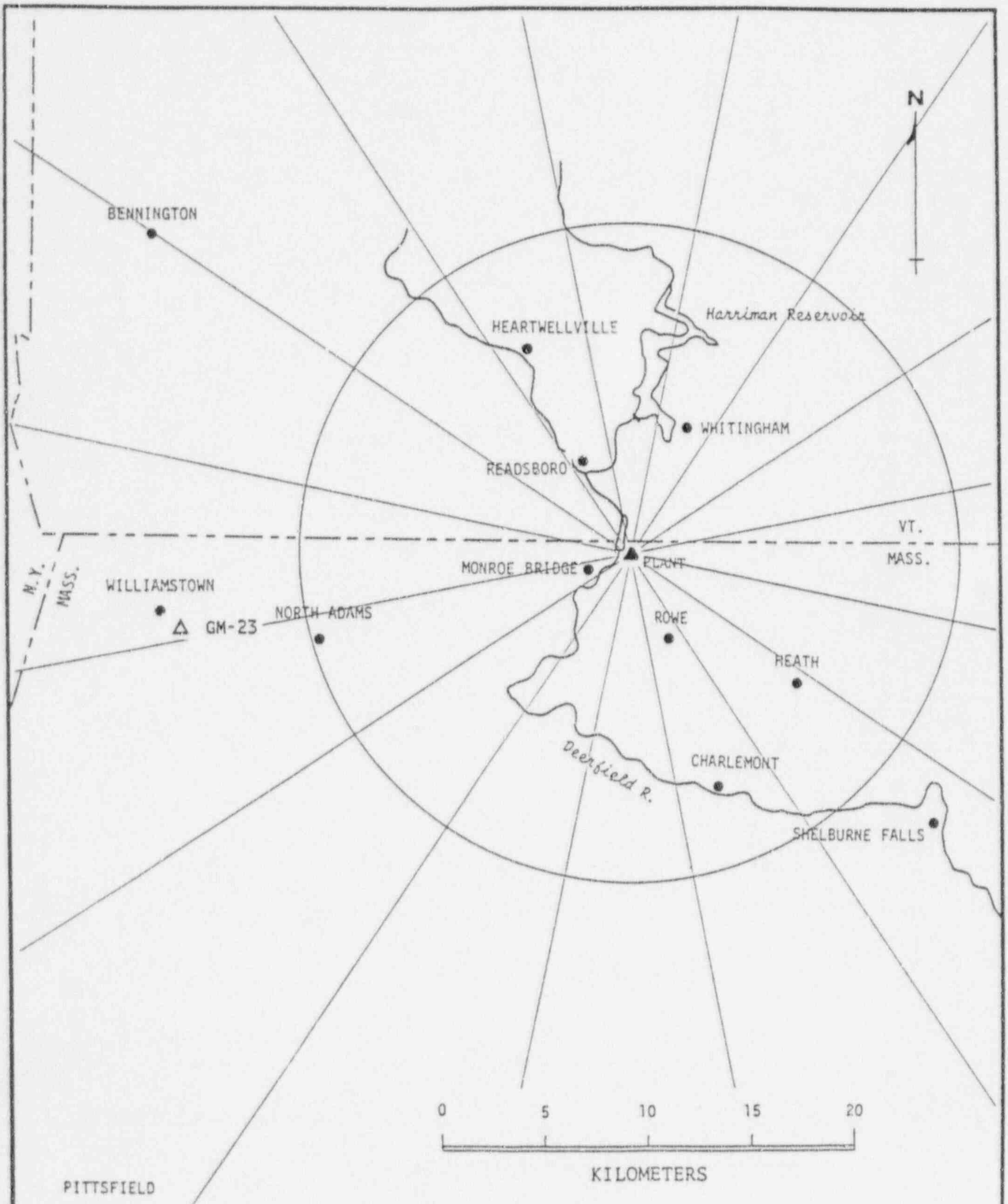


Figure 4.7 Environmental TLD Monitoring Locations Outside of 12 Miles from YNPS

5. RADIOLOGICAL DATA SUMMARY TABLES

This section summarizes the analytical results of the environmental samples that were collected during 1996. 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 for the pathways described in Section 4.2 and 4.3. The units for each media type are also given. Table 5.2 provides the same information for TLD direct radiation measurements.

The left-most column contains the radionuclide of interest, the total number of analyses for that radionuclide in 1996, and the number of measurements which exceeded the Reporting Levels found in Table 4.2 of the YNPS ODCM. 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 ODCM Table 4.3. The absence of a value in this column indicates that no LLD is specified in the ODCM for that radionuclide in that media. The target LLD for any analysis is typically 30-40 percent of the most restrictive required LLD. Occasionally the required LLD is not met. This is usually due to malfunctions in sampling equipment, which result 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 or Zone 1 stations, which are within the range of influence of the plant and which could conceivably be affected by plant activities; (2) the station which had the highest mean concentration during 1996 for that radionuclide; and (3) the Control or Zone 2 stations, which are beyond the influence of the plant. Direct radiation monitoring stations (using TLDs) are grouped into Indicator, Outer Ring, Fenceline and Control stations.

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

- The mean value of all concentrations including negative values and values that are not considered "detectable"

- The lowest and highest concentration.

- The number of detectable measurements divided by the total number of measurements.

A sample is considered to yield a "detectable measurement" when the concentration exceeds three times its associated standard deviation. 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.

The radionuclides reported in this section represent those that: 1) had a Reporting Level listed in Table 4.2 of the ODCM or, a LLD requirement in Table 4.3 of the ODCM or 2) had a positive measurement of radioactivity, whether it was naturally-occurring or man-made; or 3) were of specific interest for any other reason. The radionuclides that are routinely analyzed and reported by the YAEL in a gamma spectroscopy analysis were: Th-232, 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 appear as a "detectable measurement" during 1996.

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
Yankee Nuclear Power Station, Rowe,MA
(January - December 1996)

MEDIUM: Air Particulates (AP)   UNITS: pCi/cubic meter

Radionuclides* (No. Analyses) Non-Routine**		Required LLD	Indicator Stations Mean Range No. Detected***	Station With Highest Mean Sta.	 Mean Range No. Detected***	Control Stations Mean Range No. Detected***
GR-B	(371) (0)	0.01	1.9E -2 (7.2 - 42.8)E -3 (265/ 265)	12	2.1E -2 (7.2 - 42.8)E -3 (53/ 53)	1.7E -2 (3.6 - 33.5)E -3 (106/ 106)
Be-7	(28) (0)		9.8E -2 (6.0 - 14.9)E -2 (20/ 20)	11	1.0E -1 (7.8 - 12.2)E -2 (4/ 4)	9.4E -2 (6.4 - 12.3)E -2 (8/ 8)
Co-58	(28) (0)		-2.8E -5 (-7.1 - 10.4)E -4 (0/ 20)	31	2.2E -4 (-2.5 - 10.4)E -4 (0/ 4)	-9.0E -5 (-7.0 - 3.7)E -4 (0/ 8)
Co-60	(28) (0)		4.0E -5 (-9.2 - 8.3)E -4 (0/ 20)	32	3.9E -4 (-1.6 - 6.7)E -4 (0/ 4)	2.6E -4 (-1.6 - 6.7)E -4 (0/ 8)
Cs-134	(28) (0)	0.05	-1.3E -4 (-5.9 - 3.0)E -4 (0/ 20)	32	3.7E -5 (-1.4 - 10.7)E -5 (0/ 4)	2.2E -5 (-2.4 - 1.5)E -4 (0/ 8)
Cs-137	(28) (0)	0.06	-6.0E -5 (-6.1 - 3.7)E -4 (0/ 20)	11	7.2E -5 (-3.5 - 3.7)E -4 (0/ 4)	3.8E -5 (-8.2 - 17.3)E -5 (0/ 8)

Table 5.1

Radiological Environmental Program Summary

Yankee Nuclear Power Station, Rowe,MA

(January - December 1996)

MEDIUM: Charcoal Cartridge (CF) UNITS: pCi/cubic meter

Radionuclides* (No. Analyses) Non-Routine**		Required LLD	Indicator Stations: Mean, Range, No. Detected***	Station With Highest Mean: Sta.	Station With Highest Mean: Mean, Range, No. Detected***	Control Stations: Mean, Range, No. Detected***
I-131	(371)	0.07	-2.5E -4	12	2.3E -3	1.6E -4
	(0)		(-3.1 - 2.6)E -2		(-2.9 - 2.6)E -2	(-2.3 - 1.9)E -2
			(0/ 265)		(0/ 53)	(0/ 106)

Table 5.1
Radiological Environmental Program Summary
Yankee Nuclear Power Station, Rowe,MA
(January - December 1996)

MEDIUM: Ground Water (WG)   UNITS: pCi/kg

Radionuclides* (No. Analyses) Non-Routine**		Required LLD	Indicator Stations Mean Range No. Detected***	Station With Highest Mean Sta.	 Mean Range No. Detected***	Control Stations Mean Range No. Detected***
GR-B	(26) (0)	4	4.5E 0 (3.4 - 9.4)E 0 (26/ 26)	12	4.9E 0 (3.4 - 9.4)E 0 (13/ 13)	NO DATA
H-3	(26) (0)	2000	1.6E 2 (-1.6 - 4.9)E 2 (3/ 26)	12	2.7E 2 (1.3 - 4.9)E 2 (3/ 13)	NO DATA
Mn-54	(26) (0)	15	-6.4E -2 (-1.4 - 2.6)E 0 (0/ 26)	12	3.2E -2 (-1.4 - 1.7)E 0 (0/ 13)	NO DATA
Co-58	(26) (0)	15	-6.3E -1 (-3.2 - 1.6)E 0 (0/ 26)	12	-2.9E -1 (-1.6 - 1.6)E 0 (0/ 13)	NO DATA
Fe-59	(26) (0)	30	2.9E -1 (-5.9 - 5.9)E 0 (0/ 26)	11	1.3E 0 (-1.9 - 5.9)E 0 (0/ 13)	NO DATA
Co-60	(26) (0)	15	3.6E -2 (-2.1 - 1.7)E 0 (0/ 26)	12	1.0E -1 (-1.1 - 1.7)E 0 (0/ 13)	NO DATA
Zn-65	(26) (0)	30	1.5E 0 (-4.6 - 12.3)E 0 (0/ 26)	11	3.5E 0 (-3.3 - 12.3)E 0 (0/ 13)	NO DATA
Zr-95	(26) (0)	15	-2.7E -1 (-2.7 - 3.5)E 0 (0/ 26)	12	-2.7E -1 (-2.7 - 3.5)E 0 (0/ 13)	NO DATA
I-131	(26) (0)	1	1.5E -1 (-5.2 - 9.7)E 0 (0/ 26)	11	7.8E -1 (-4.1 - 9.7)E 0 (0/ 13)	NO DATA
Cs-134	(26) (0)	15	-8.2E -1 (-8.3 - 2.3)E 0 (0/ 26)	12	-4.9E -1 (-5.2 - 2.3)E 0 (0/ 13)	NO DATA
Cs-137	(26) (0)	18	-2.5E -2 (-2.3 - 2.8)E 0 (0/ 26)	12	4.6E -2 (-2.2 - 1.6)E 0 (0/ 13)	NO DATA
Ba-140	(26) (0)	15	-3.0E -1 (-3.3 - 4.1)E 0 (0/ 26)	11	5.7E -1 (-3.3 - 4.1)E 0 (0/ 13)	NO DATA

Table 5.1

Radiological Environmental Program Summary

Yankee Nuclear Power Station, Rowe,MA

(January - December 1996)

MEDIUM: River Water (WR) UNITS: pCi/kg

Radionuclides*	(No. Analyses) / Non-Routine**	Required LLD	Indicator Stations Mean	Indicator Stations Range	Indicator Stations No. Detected***	Station With Highest Mean Sta.	Station With Highest Mean Mean	Station With Highest Mean Range	Station With Highest Mean No. Detected***	Control Stations Mean	Control Stations Range	Control Stations No. Detected***
GR-B	(37) (0)	4	1.3E 0	(6.7 - 19.2)E -1	(17/ 25)	21	1.4E 0	(4.6 - 26.8)E -1	(9/ 12)	1.4E 0	(4.6 - 26.8)E -1	(9/ 12)
H-3	(16) (0)	2000	-6.2E 0	(-5.4 - 2.9)E 2	(0/ 12)	31	3.1E 1	(-3.3 - 2.9)E 2	(0/ 4)	-4.4E 1	(-1.5 - 1.7)E 2	(0/ 4)
Mn-54	(41) (0)	15	-3.0E -3	(-2.1 - 1.7)E 0	(0/ 29)	91	8.3E -1	(2.7 - 15.2)E -1	(0/ 4)	-3.0E -1	(-2.7 - 1.5)E 0	(0/ 12)
Co-58	(41) (0)	15	-1.4E -1	(-2.2 - 2.8)E 0	(0/ 29)	11	7.0E -2	(-1.8 - 2.8)E 0	(0/ 12)	-2.3E -1	(-2.6 - 2.3)E 0	(0/ 12)
Fe-59	(41) (0)	30	6.0E -1	(-7.5 - 8.2)E 0	(0/ 29)	31	1.3E 0	(-3.8 - 8.2)E 0	(0/ 13)	7.2E -1	(-3.3 - 3.9)E 0	(0/ 12)
Co-60	(41) (0)	15	3.3E -1	(-2.3 - 2.7)E 0	(0/ 29)	91	1.6E 0	(4.2 - 23.5)E -1	(0/ 4)	-3.7E -1	(-2.9 - 0.9)E 0	(0/ 12)
Zn-65	(41) (0)	30	-1.5E -1	(-5.4 - 8.0)E 0	(0/ 29)	91	7.0E -1	(-7.8 - 227.3)E -2	(0/ 4)	-3.6E -1	(-5.4 - 14.4)E 0	(0/ 12)
Zr-95	(41) (0)	15	1.7E -1	(-3.9 - 4.6)E 0	(0/ 29)	21	7.9E -1	(-3.1 - 2.7)E 0	(0/ 12)	7.9E -1	(-3.1 - 2.7)E 0	(0/ 12)
I-131	(41) (0)		-4.6E -1	(-8.2 - 2.6)E 0	(0/ 29)	91	1.5E -1	(-3.6 - 2.2)E 0	(0/ 4)	1.0E -1	(-2.0 - 3.6)E 0	(0/ 12)
Cs-134	(41) (0)	15	-3.4E -1	(-4.6 - 3.4)E 0	(0/ 29)	31	-9.0E -2	(-4.6 - 3.4)E 0	(0/ 13)	-1.3E 0	(-7.1 - 0.3)E 0	(0/ 12)
Cs-137	(41) (0)	18	-4.2E -2	(-2.6 - 1.9)E 0	(0/ 29)	31	1.8E -1	(-1.4 - 1.8)E 0	(0/ 13)	1.5E -1	(-1.3 - 2.9)E 0	(0/ 12)
Ba-140	(41) (0)	15	-9.8E -1	(-5.2 - 2.7)E 0	(0/ 29)	21	-5.5E -2	(-2.7 - 2.3)E 0	(0/ 12)	-5.5E -2	(-2.7 - 2.3)E 0	(0/ 12)

Table 5.1

Radiological Environmental Program Summary

Yankee Nuclear Power Station, Rowe,MA

(January - December 1996)

MEDIUM: Storm Drain Water (WW) UNITS: pCi/kg

Radionuclides* (No. Analyses) Non-Routine**	Required LLD	Indicator Stations Mean Range No. Detected***	Station With Highest Mean Sta.	 Mean Range No. Detected***	Control Stations Mean Range No. Detected***
GR-B (13) (0)		1.7E 0 (1.1 - 2.5)E 0 (13/ 13)	52	1.7E 0 (1.1 - 2.5)E 0 (13/ 13)	NO DATA
H-3 (13) (0)		2.0E 2 (-2.1 - 71.0)E 1 (0/ 13)	52	2.0E 2 (-2.1 - 71.0)E 1 (0/ 13)	NO DATA
Mn-54 (13) (0)		4.4E -1 (-4.4 - 20.6)E -1 (0/ 13)	52	4.4E -1 (-4.4 - 20.6)E -1 (0/ 13)	NO DATA
Co-58 (13) (0)		-2.4E -1 (-1.8 - 2.1)E 0 (0/ 13)	52	-2.4E -1 (-1.8 - 2.1)E 0 (0/ 13)	NO DATA
Fe-59 (13) (0)		1.2E -1 (-3.1 - 4.9)E 0 (0/ 13)	52	1.2E -1 (-3.1 - 4.9)E 0 (0/ 13)	NO DATA
Co-60 (13) (0)		7.2E -1 (-1.4 - 4.3)E 0 (0/ 13)	52	7.2E -1 (-1.4 - 4.3)E 0 (0/ 13)	NO DATA
Zn-65 (13) (0)		-7.9E -1 (-4.2 - 5.8)E 0 (0/ 13)	52	-7.9E -1 (-4.2 - 5.8)E 0 (0/ 13)	NO DATA
Zr-95 (13) (0)		2.3E -1 (-2.2 - 3.2)E 0 (0/ 13)	52	2.3E -1 (-2.2 - 3.2)E 0 (0/ 13)	NO DATA
I-131 (13) (0)		-8.1E -1 (-5.7 - 5.7)E 0 (0/ 13)	52	-8.1E -1 (-5.7 - 5.7)E 0 (0/ 13)	NO DATA
Cs-134 (13) (0)		-3.7E -2 (-2.7 - 2.9)E 0 (0/ 13)	52	-3.7E -2 (-2.7 - 2.9)E 0 (0/ 13)	NO DATA
Cs-137 (13) (0)		1.2E -1 (-1.2 - 2.5)E 0 (0/ 13)	52	1.2E -1 (-1.2 - 2.5)E 0 (0/ 13)	NO DATA
Ba-140 (13) (0)		-7.4E -1 (-5.0 - 2.5)E 0 (0/ 13)	52	-7.4E -1 (-5.0 - 2.5)E 0 (0/ 13)	NO DATA

Table 5.1

Radiological Environmental Program Summary

Yankee Nuclear Power Station, Rowe,MA

(January - December 1996)

MEDIUM: Sediment (SE) UNITS: pCi/kg dry

Radionuclides* (No. Analyses) Non-Routine**		Required LLD	Indicator Stations: Mean / Range / No. Detected***	Station With Highest Mean: Sta.	Mean / Range / No. Detected***	Control Stations: Mean / Range / No. Detected***
Be-7	(18) (0)		-1.8E 1 (-3.8 - 4.8)E 2 (0/ 12)	91	3.3E 0 (-3.7 - 4.8)E 2 (0/ 6)	-3.1E 1 (-5.0 - 2.0)E 2 (0/ 6)
K-40	(18) (0)		1.8E 4 (1.3 - 2.4)E 4 (12/ 12)	91	2.1E 4 (1.9 - 2.4)E 4 (6/ 6)	1.3E 4 (1.0 - 1.8)E 4 (6/ 6)
Co-58	(18) (0)		-1.1E 1 (-4.8 - 4.2)E 1 (0/ 12)	11	2.4E 0 (-1.9 - 4.2)E 1 (0/ 6)	-9.5E 0 (-1.9 - 0.0)E 1 (0/ 6)
Co-60	(18) (0)		2.1E 1 (-6.6 - 62.2)E 0 (1/ 12)	91	3.6E 1 (1.0 - 6.2)E 1 (1/ 6)	-6.0E -1 (-1.0 - 1.3)E 1 (0/ 6)
Cs-134	(18) (0)	150	-1.0E 1 (-7.5 - 1.5)E 1 (0/ 12)	11	3.2E 0 (-4.7 - 15.5)E 0 (0/ 6)	-2.5E 1 (-9.6 - 0.6)E 1 (0/ 6)
Cs-137	(18) (0)	180	8.0E 2 (2.1 - 25.1)E 2 (12/ 12)	91	1.3E 3 (6.4 - 25.1)E 2 (6/ 6)	1.7E 1 (-1.0 - 3.8)E 1 (0/ 6)
Th-232	(18) (0)		1.2E 3 (6.7 - 18.9)E 2 (12/ 12)	91	1.5E 3 (1.1 - 1.9)E 3 (6/ 6)	3.8E 2 (2.4 - 5.3)E 2 (5/ 6)

Table 5.1

Radiological Environmental Program Summary

Yankee Nuclear Power Station, Rowe,MA

(January - December 1996)

MEDIUM: Milk (TM) UNITS: pCi/kg

Radionuclides* (No. Analyses) Non-Routine**		Required LLD	Indicator Stations: Mean / Range / No. Detected***	Station With Highest Mean: Sta.	Station With Highest Mean: Mean / Range / No. Detected***	Control Stations: Mean / Range / No. Detected***
K-40	(40) (0)		1.4E 3 (1.3 - 1.5)E 3 (20/ 20)	13	1.4E 3 (1.3 - 1.5)E 3 (20/ 20)	1.4E 3 (1.2 - 1.5)E 3 (20/ 20)
Sr-89	(8) (0)		-7.3E -1 (-3.2 - 1.6)E 0 (0/ 4)	21	-1.3E -1 (-2.6 - 2.6)E 0 (0/ 4)	-1.3E -1 (-2.6 - 2.6)E 0 (0/ 4)
Sr-90	(8) (0)		9.3E -1 (0.0 - 1.8)E 0 (2/ 4)	13	9.3E -1 (0.0 - 1.8)E 0 (2/ 4)	6.5E -1 (0.0 - 1.4)E 0 (1/ 4)
I-131	(40) (0)	1	1.3E -1 (-5.7 - 224.5)E -2 (0/ 20)	13	1.3E -1 (-5.7 - 224.5)E -2 (0/ 20)	-8.4E -2 (-2.5 - 0.2)E 0 (0/ 20)
Cs-134	(40) (0)	15	-6.0E -3 (-2.2 - 1.9)E 0 (0/ 20)	13	-6.0E -3 (-2.2 - 1.9)E 0 (0/ 20)	-1.6E -1 (-2.6 - 2.3)E 0 (0/ 20)
Cs-137	(40) (0)	18	7.5E -1 (-2.9 - 3.4)E 0 (0/ 20)	13	7.5E -1 (-2.9 - 3.4)E 0 (0/ 20)	3.7E -1 (-2.0 - 4.7)E 0 (0/ 20)
Ba-140	(40) (0)	15	2.1E -1 (-3.6 - 2.8)E 0 (0/ 20)	13	2.1E -1 (-3.6 - 2.8)E 0 (0/ 20)	-5.0E -1 (-6.7 - 3.3)E 0 (0/ 20)

Table 5.1

Radiological Environmental Program Summary

Yankee Nuclear Power Station, Rowe,MA

(January - December 1996)

MEDIUM: Mixed Vegetation in lieu of TM-14 milk sample (TC) UNITS: pCi/kg

Radionuclides* (No. Analyses) Non-Routine**		Required LLD	Indicator Stations Mean Range No. Detected***	Station With Highest Mean Sta.	Mean Range No. Detected***	Control Stations Mean Range No. Detected***
Be-7	(3)		2.0E 3	14	2.0E 3	NO DATA
	(0)		(1.1 - 3.2)E 3		(1.1 - 3.2)E 3	
			(3/ 3)		(3/ 3)	
K-40	(3)		3.5E 3	14	3.5E 3	NO DATA
	(0)		(3.2 - 4.1)E 3		(3.2 - 4.1)E 3	
			(3/ 3)		(3/ 3)	
Co-58	(3)		-9.4E 0	14	-9.4E 0	NO DATA
	(0)		(-2.4 - 0.3)E 1		(-2.4 - 0.3)E 1	
			(0/ 3)		(0/ 3)	
Co-60	(3)		2.8E -1	14	2.8E -1	NO DATA
	(0)		(-6.6 - 7.5)E 0		(-6.6 - 7.5)E 0	
			(0/ 3)		(0/ 3)	
I-131	(3)		3.8E 1	14	3.8E 1	NO DATA
	(0)		(-4.1 - 15.6)E 1		(-4.1 - 15.6)E 1	
			(0/ 3)		(0/ 3)	
Cs-134	(3)		-2.2E 0	14	-2.2E 0	NO DATA
	(0)		(-1.1 - 0.8)E 1		(-1.1 - 0.8)E 1	
			(0/ 3)		(0/ 3)	
Cs-137	(3)		2.6E 1	14	2.6E 1	NO DATA
	(0)		(1.9 - 3.6)E 1		(1.9 - 3.6)E 1	
			(0/ 3)		(0/ 3)	
Ba-140	(3)		2.4E 1	14	2.4E 1	NO DATA
	(0)		(1.8 - 553.2)E -1		(1.8 - 553.2)E -1	
			(0/ 3)		(0/ 3)	
Th-232	(3)		1.7E 1	14	1.7E 1	NO DATA
	(0)		(-5.3 - 12.1)E 1		(-5.3 - 12.1)E 1	
			(0/ 3)		(0/ 3)	

Table 5.1
Radiological Environmental Program Summary
Yankee Nuclear Power Station, Rowe,MA
(January - December 1996)

MEDIUM: Fish (FH) UNITS: pCi/kg

Radionuclides* (No. Analyses) Non-Routine**		Required LLD	Indicator Stations Mean Range No. Detected***	Station With Highest Mean Sta.	Mean Range No. Detected***	Control Stations Mean Range No. Detected***
K-40	(4) (0)		2.0E 3 (1.7 - 2.2)E 3 (2/ 2)	21	2.6E 3 (2.2 - 3.0)E 3 (2/ 2)	2.6E 3 (2.2 - 3.0)E 3 (2/ 2)
Mn-54	(4) (0)	130	4.5E -1 (-6.7 - 7.6)E 0 (0/ 2)	11	4.5E -1 (-6.7 - 7.6)E 0 (0/ 2)	-6.2E 0 (-1.2 - 0.0)E 1 (0/ 2)
Co-58	(4) (0)	130	7.6E 0 (-9.3 - 161.3)E -1 (0/ 2)	11	7.6E 0 (-9.3 - 161.3)E -1 (0/ 2)	-8.2E 0 (-1.1 - -0.5)E 1 (0/ 2)
Fe-59	(4) (0)	260	-2.4E 1 (-4.4 - -0.5)E 1 (0/ 2)	21	5.9E 0 (3.3 - 8.4)E 0 (0/ 2)	5.9E 0 (3.3 - 8.4)E 0 (0/ 2)
Co-60	(4) (0)	130	6.2E 0 (-3.5 - 128.2)E -1 (0/ 2)	21	1.3E 1 (2.9 - 23.7)E 0 (0/ 2)	1.3E 1 (2.9 - 23.7)E 0 (0/ 2)
Zn-65	(4) (0)	260	7.0E 0 (-1.2 - 2.6)E 1 (0/ 2)	21	3.6E 1 (2.8 - 4.3)E 1 (0/ 2)	3.6E 1 (2.8 - 4.3)E 1 (0/ 2)
Cs-134	(4) (0)	130	1.1E 1 (9.5 - 13.3)E 0 (0/ 2)	21	1.2E 1 (2.4 - 21.7)E 0 (0/ 2)	1.2E 1 (2.4 - 21.7)E 0 (0/ 2)
Cs-137	(4) (0)	150	1.9E 0 (-1.5 - 1.9)E 1 (0/ 2)	21	3.3E 1 (2.6 - 4.0)E 1 (0/ 2)	3.3E 1 (2.6 - 4.0)E 1 (0/ 2)

Table 5.1

Radiological Environmental Program Summary

Yankee Nuclear Power Station, Rowe,MA

(January - December 1996)

MEDIUM: Food Crop (TF) UNITS: pCi/kg

Radionuclides* (No. Analyses) Non-Routine**		Required LLD	Indicator Stations Mean Range No. Detected***	Sta.	Station With Highest Mean Mean Range No. Detected***	Control Stations Mean Range No. Detected***
K-40	(3) (0)		2.6E 3 (1.1 - 4.2)E 3 (2/ 2)	11	4.2E 3 (1/ 1)	7.9E 2 (0/ 1)
Co-58	(3) (0)		1.1E 1 (-1.3 - 23.8)E 0 (0/ 2)	13	2.4E 1 (0/ 1)	1.0E 1 (0/ 1)
Co-60	(3) (0)		-4.8E 0 (-1.2 - 0.2)E 1 (0/ 2)	21	5.6E 0 (0/ 1)	5.6E 0 (0/ 1)
I-131	(4) (0)		5.1E 0 (-8.2 - 13.6)E 0 (0/ 3)	21	1.2E 1 (0/ 1)	1.2E 1 (0/ 1)
Cs-134	(3) (0)	60	-6.3E 0 (-1.3 - 0.0)E 1 (0/ 2)	21	5.7E 0 (0/ 1)	5.7E 0 (0/ 1)
Cs-137	(3) (0)	80	1.4E 1 (-9.6 - 284.2)E -1 (0/ 2)	13	2.8E 1 (0/ 1)	1.8E 1 (0/ 1)

Table 5.1

Radiological Environmental Program Summary

Yankee Nuclear Power Station, Rowe,MA

(January - December 1996)

MEDIUM: Maple Syrup (MS) UNITS: pCi/kg

Radionuclides* (No. Analyses) Non-Routine**		Required LLD	Indicator Stations Mean Range No. Detected***	Station With Highest Mean Sta.	Mean Range No. Detected***	Control Stations Mean Range No. Detected***
K-40	(2) (0)		2.7E 3 (1/ 1)	33	2.7E 3 (1/ 1)	1.5E 3 (1/ 1)
Co-58	(2) (0)		-1.5E 0 (0/ 1)	45	-7.9E -1 (0/ 1)	-7.9E -1 (0/ 1)
Co-60	(2) (0)		9.1E -1 (0/ 1)	45	1.9E 0 (0/ 1)	1.9E 0 (0/ 1)
I-131	(2) (0)		1.1E 1 (0/ 1)	45	2.5E 1 (0/ 1)	2.5E 1 (0/ 1)
Cs-134	(2) (0)		1.6E 0 (0/ 1)	33	1.6E 0 (0/ 1)	1.3E 0 (0/ 1)
Cs-137	(2) (0)		2.0E 1 (1/ 1)	33	2.0E 1 (1/ 1)	1.5E 1 (1/ 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 which may be of interest for some other specific reason. 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 ODCM Table 4.2.

*** The fraction of sample analyses yielding detectable measurements (i.e. > 3 standard deviations) is shown in parentheses.

TABLE 5.2

ENVIRONMENTAL TLD DATA SUMMARY
YANKEE NUCLEAR POWER STATION, ROWE, MA
(JANUARY - DECEMBER 1996)

INDICATOR TLDs	OUTER RING TLDs	FENCELINE TLDs	CONTROL TLDs
MEAN RANGE (NO. MEASUREMENTS)*	MEAN RANGE (NO. MEASUREMENTS)*	MEAN RANGE NO. MEASUREMENTS)*	MEAN RANGE (NO. MEASUREMENTS)*
6.6 ± 0.8 4.5 - 8.4 (52)	6.7 ± 1.1 4.6 - 8.8 (63)	8.9 ± 1.4 7.3 - 13.7 (36)	7.2 ± 0.8 5.4 - 8.1 (8)

OFFSITE STATION WITH HIGHEST MEAN

STA. NO.	MEAN RANGE (NO. MEASUREMENTS)*
GM-34	8.6 ± 0.4 7.9 - 8.9 (4)

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

TABLE 5.3

ENVIRONMENTAL TLD MEASUREMENTS
1996
(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.
GM-01	YNPS Visitor's Center	5.5 ± 0.3	6.9 ± 0.3	6.4 ± 0.3	6.9 ± 0.3	6.4
GM-02	Observation Stand	5.8 ± 0.3	6.2 ± 0.4	6.6 ± 0.3	6.9 ± 0.4	6.4
GM-03	Rowe School	4.5 ± 0.2	5.5 ± 0.3	5.5 ± 0.3	5.6 ± 0.3	5.3
GM-04	Harriman Station	5.4 ± 0.2	5.8 ± 0.3	5.6 ± 0.3	6.0 ± 0.3	5.7
GM-05	Monroe Bridge	6.7 ± 0.2	7.3 ± 0.3	7.2 ± 0.4	7.6 ± 0.4	7.2
GM-06	Readsboro Rd. Barrier	5.5 ± 0.3	6.9 ± 0.3	7.1 ± 0.3	7.1 ± 0.4	6.7
GM-07	Whitingham Line	6.1 ± 0.2	7.3 ± 0.3	7.5 ± 0.3	7.4 ± 0.3	7.1
GM-08	Monroe Hill Barrier	5.5 ± 0.2	6.1 ± 0.3	6.4 ± 0.3	6.3 ± 0.3	6.1
GM-09	Dunbar Brook	6.1 ± 0.3	7.3 ± 0.3	7.2 ± 0.3	7.2 ± 0.3	7.0
GM-10	Cross Rd.	5.7 ± 0.3	6.6 ± 0.3	6.7 ± 0.3	6.8 ± 0.6	6.5
GM-11	Adams High Line	6.2 ± 0.4	7.6 ± 0.4	6.4 ± 0.3	6.2 ± 0.3	6.6
GM-12	Readsboro, VT	7.8 ± 0.4	8.4 ± 0.4	7.8 ± 0.3	8.0 ± 0.3	8.0
GM-13	Restr. Area Fence	8.9 ± 0.4	9.6 ± 0.5	9.1 ± 0.4	9.1 ± 0.4	9.2
GM-14	Restr. Area Fence	7.7 ± 0.4	8.9 ± 0.3	8.2 ± 0.3	7.9 ± 0.3	8.2
GM-15	Restr. Area Fence	7.5 ± 0.4	7.9 ± 0.4	8.0 ± 0.4	7.7 ± 0.3	7.8
GM-16	Restr. Area Fence	7.3 ± 0.4	7.6 ± 0.3	7.4 ± 0.3	7.6 ± 0.3	7.5
GM-17	Restr. Area Fence	7.7 ± 0.4	7.9 ± 0.3	7.7 ± 0.3	7.5 ± 0.4	7.7
GM-18	Restr. Area Fence	11.0 ± 0.4	10.0 ± 0.4	9.8 ± 0.4	9.1 ± 0.4	10.0
GM-19	Restr. Area Fence	13.7 ± 0.5	10.8 ± 0.5	9.8 ± 0.3	8.8 ± 0.3	10.8
GM-20	Restr. Area Fence	9.9 ± 0.4	9.6 ± 0.4	9.0 ± 0.3	8.4 ± 0.4	9.2
GM-21	Restr. Area Fence	12.2 ± 0.5	10.0 ± 0.5	9.5 ± 0.4	8.5 ± 0.4	10.1
GM-22	Heartwellville, VT	5.4 ± 0.3	7.2 ± 0.3	7.0 ± 0.3	7.2 ± 0.3	6.7
GM-23	Williamstown Subst.	7.0 ± 0.3	8.1 ± 0.3	7.8 ± 0.3	7.5 ± 0.3	7.6
GM-24	Harriman Dam	6.2 ± 0.3	7.9 ± 0.4	8.2 ± 0.4	8.4 ± 0.3	7.7
GM-25	Whitingham, VT	5.8 ± 0.3	6.3 ± 0.3	6.2 ± 0.3	6.5 ± 0.3	6.2
GM-26	Sadoga Rd.	5.1 ± 0.2	7.1 ± 0.4	7.1 ± 0.3	*	6.4
GM-27	Number 9 Rd.	4.9 ± 0.2	6.3 ± 0.3	6.2 ± 0.3	6.4 ± 0.3	6.0
GM-28	Number 9 Rd.	6.2 ± 0.3	7.1 ± 0.3	7.0 ± 0.3	7.0 ± 0.3	6.8
GM-29	Route 8A	4.6 ± 0.3	4.9 ± 0.2	5.0 ± 0.2	4.8 ± 0.2	4.8
GM-30	Route 8A	5.1 ± 0.3	5.9 ± 0.3	5.9 ± 0.3	5.7 ± 0.3	5.7
GM-31	Legate Hill Rd.	5.5 ± 0.2	6.5 ± 0.4	6.3 ± 0.3	6.4 ± 0.3	6.2
GM-32	Rowe Rd.	5.4 ± 0.3	6.4 ± 0.4	6.4 ± 0.2	6.3 ± 0.4	6.1
GM-33	Zoar Rd.	6.3 ± 0.4	6.8 ± 0.4	7.0 ± 0.4	7.0 ± 0.3	6.8
GM-34	Fife Brook Rd.	7.9 ± 0.3	8.7 ± 0.3	8.7 ± 0.4	8.9 ± 0.4	8.6
GM-35	Whitcomb Summit	5.4 ± 0.2	7.3 ± 0.4	7.5 ± 0.3	7.2 ± 0.3	6.9
GM-36	Tilda Rd.	5.6 ± 0.2	7.0 ± 0.4	7.4 ± 0.4	7.1 ± 0.3	6.8
GM-37	Turner Hill Rd.	6.0 ± 0.5	7.2 ± 0.3	7.4 ± 0.3	7.2 ± 0.3	7.0
GM-38	West Hill Rd.	6.0 ± 0.3	8.1 ± 0.4	8.2 ± 0.3	8.2 ± 0.3	7.6
GM-39	Route 100	7.3 ± 0.4	8.8 ± 0.6	8.6 ± 0.3	8.6 ± 0.4	8.3
GM-40	Readsboro Rd.	5.7 ± 0.2	7.1 ± 0.3	7.0 ± 0.3	6.9 ± 0.4	6.7

* TLD not returned.

6. ANALYSIS OF ENVIRONMENTAL RESULTS

6.1 Sampling Program Deviations

ODCM Control 4.1 allows for deviations "if specimens are unobtainable due to hazardous conditions, seasonal unavailability or to malfunction of automatic sampling equipment." Several minor deviations were noted in the REMP during 1996. These deviations did not compromise the program's effectiveness and in fact are considered insignificant with respect to what is normally anticipated for any radiological environmental monitoring program. These specific deviations were:

1. The pump at air sampling station AP/CF-12 seized up during the week of October 15 to October 22, resulting in a low sample volume. The pump was replaced on October 22.

2. The pump at air sampling station AP-12 was found to be pulling a low sample volume on October 29 (for the week October 22 to October 29). The pump was replaced.

3. The circuit breaker tripped at air sampling station AP-32 during the week of October 29 to November 5, resulting in a low sample volume. The breaker was reset.

4. The milk sample station TM-14, in Rowe, continued to be unavailable during 1996. (It initially became unavailable on approximately August 1, 1995 when there was no longer a cow at this farm.) No other milk sampling location was available within 5 miles of the plant to serve as a replacement during 1996. In lieu of the milk samples, mixed grass samples were collected at this location on August 29, September 10 and October 1. (These are not required by the ODCM.) On October 31, 1996, Revision 11 to the ODCM was issued, requiring milk samples at only two locations (currently TM-13, Whitingham, VT and TM-21, Williamstown, MA).

5. TLDs were lost, apparently due to vandalism, during the fourth quarter at station GM-26.

6.2 Comparison of Achieved LLDs with Requirements

Table 4.3 of the ODCM (reproduced as Table 4.4 in this report) gives the required Lower Limits of Detection (LLDs) for environmental sample analyses. On occasion, an LLD is not achieved due to situations such as a low sample volume caused by sampling equipment malfunction. In such a case, Control 7.1 of the ODCM requires a discussion of the situation in the Annual Radiological Environmental Operating Report. At the YAEL, 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 better than that required by the YNPS ODCM.

For each analysis having an LLD requirement in ODCM Table 4.3, the *a posteriori* or after the fact LLD calculated for that analysis was compared with the required LLD. Of the 1800 analyses performed with a specified LLD requirement, all met the requirement in 1996 with the exception discussed below.

Table 4.3 of the ODCM, assigns an LLD of 1.0 pCi/liter for I-131 in drinking water. This drinking water LLD was required from the time of implementation of the ODCM in 1983 through the issuance of Revision 11 on October 31, 1996. Given the short half-life of this nuclide, Revision 11 removed the I-131 LLD requirement due to the absence of this radionuclide at the site following the reactor's shutdown in 1992. An internal audit conducted in 1996 identified that the 1 pCi/liter LLD requirement had not been met between 1983 and 1996 for samples from the on-site well at WG-11. Although this well had not been viewed as the primary source of drinking water since bottled water had been available on-site up to 1993, the potential existed for water from this well to have been ingested through the use of on-site sinks. The average LLD achieved during this period has been 9.5pCi/liter. The presence of I-131 should not have been expected at WG-11 given the following considerations.

- Sherman Spring, which is 600 feet down-gradient of the Vapor Container area, is used as a ground water REMP sampling location. It has had no I-131 detected in samples, although it has historically contained detectable levels of H-3. I-131 LLD for these samples has been 4-24 pCi/liter. This site would be the best indicator for I-131 in the ground water if that nuclide had been present.

- The well at WG-11 is 525 feet up-gradient of the Vapor Container area. No H-3 has not been detected in any of the samples from this location during the period in question.

The presence of H-3 in this case is a very reliable indicator of migration of radioactivity from plant sources to these ground water sampling locations.

Given the distance of WG-11 from the plant and the ground water velocity of approximately 500-1000ft/year in the down-gradient direction it is unlikely that I-131 would have traveled up-gradient to this well before decaying away or that any levels of I-131 could have exceeded the reporting level of 2 pCi/liter since the sampling requirement went into effect in 1983.

6.3 1996 Results Compared Against Reporting Levels

ODCM Control 4.1.a. requires the written notification to the NRC within 30 days whenever a Reporting Level in ODCM Table 4.2 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 1996, no Reporting Levels were exceeded.

6.4 Data Analysis by Media Type

The 1996 REMP data for each media type are discussed below. These are arranged in the same order as in Table 5.1, and are further categorized by pathway. Graphical plots of monitoring data are shown at the end of this section in Figures 6.1 to 6.26. With respect to data plots, all values are plotted, whether they are "detectable" or "non-detectable."

6.4.1 Airborne Pathways

6.4.1.1 Air Particulates

The weekly air particulate filters from each of the seven operating 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 through 6.6.

As shown in Figure 6.1, there has been no significant difference between the quarterly average concentration at the indicator (near-plant) stations and the control (distant from plant) stations. Also notable is a distinct annual cycle, with the minimum concentration in the second quarter, and the maximum concentration in the first quarter.

Figures 6.2 through 6.6 show the weekly gross beta concentration at each air particulate sampling location required by the ODCM along with the control air particulate sampling location at AP-21 (Williamstown, MA). It can be readily 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 YNPS operations. Table 5.1 shows that the mean concentration from indicator stations, on the average, are similar to those from control locations, further supporting this conclusion. All of the annual concentrations were consistent with gross beta measurements of air particulate filters performed in 1996 throughout New England as part of other Yankee affiliated environmental monitoring programs, and ranged from 1.6E-2 - 2.1E-2 pCi/meter^3. Gamma isotopic analyses performed on the air particulate filters from weeks 43, 44, and 45 did not detect any radionuclides that could be attributed to plant effluents.

The only radionuclide detected on the quarterly gamma isotopic analysis of the composited air particulate filters was Be-7, a naturally-occurring cosmogenic radionuclide.

6.4.1.2 Charcoal Cartridges

The weekly charcoal cartridges from each of the seven operating 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.

6.4.2 Waterborne Pathways

6.4.2.1 Ground Water

Monthly ground water samples were collected from two on-site locations during 1996. (Only quarterly samples are required by ODCM Table 4.1.) Table 5.1 shows that gross-beta measurements were positive in all samples. This is due to naturally-occurring radionuclides in the water. The December sample contained a confirmed gross beta concentration of 9.5 ± 0.9 pCi/kg. An aliquot of this sample was filtered through a 0.45 micron tuffryn filter and the resulting gross beta concentration of the filtered water was 5.1 ± 0.7 pci/kg. The solids were analyzed for gamma emitting nuclides, to a Cs-137 and Co-60 LLD of approximately 2 pCi/kg, and resulted in no gamma emitting radionuclides being detected.

The elevated first half semiannual average gross-beta concentration in 1992 at WG-11, as seen in Figure 6.7, was due to naturally occurring radionuclides in water which was trucked in from an off-site source. A detailed discussion can be found in the Annual Radiological Environmental Operating Reports for 1992 and 1993.

H-3 was detected in three out of thirteen WG-12 (Sherman Spring) samples, as shown in Table 5.1 and Figure 6.8. The water from Sherman Spring leaves the ground on YNPS property and flows into the Deerfield River. Neither the Deerfield River nor Sherman Spring are used for drinking water. The maximum monthly concentration at WG-12 in 1996 was 493 ± 114 pCi/kg, and the mean value was 270 pCi/kg. These H-3 levels are due to early plant operations and have been detected in previous samples from this location. The concentration of H-3 at this location has decreased steadily for many years. The maximum concentration of 493 pCi/kg is approximately two percent of the NRC Reporting Level of 30,000 pCi/kg for the non-drinking water pathway.

No gamma-emitting radionuclides were detected in any of the ground water samples.

6.4.2.2 River Water

Aliquots of river water were automatically collected every two hours from the Deerfield River downstream from the plant, as well as at the Harriman Reservoir control location. These composited samples were collected monthly and sent to the YAEL for analysis. Monthly grab samples were also collected at Sherman Pond near the discharge area.

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 historical concentrations at the indicator and control locations have not been significantly different, as shown in Figure 6.9 except during the last half of 1992 when the levels at WR-11 were slightly elevated relative to the control. This was attributed to naturally occurring radioactivity and is discussed in the 1992 and 1993 Annual Radiological Environmental Operating Reports.

No gamma-emitting radionuclides attributable to activities at YNPS were detected in any of the samples. For each sampling site, the monthly samples were composited into quarterly samples for H-3 analyses. No H-3 was detected in river water samples during 1996.

Beginning in July 1994, a split sampling program was undertaken in cooperation with the Massachusetts Department of Public Health (MDPH). Water samples were collected at the discharge point and then split with the MDPH, at their discretion. During 1996, four samples were split and analyzed by the YAEL and the MDPH laboratory. A gamma spectroscopy and H-3 analyses were performed on each sample. No radioactivity was detected in any of the 1996 samples, as analyzed at the YAEL. In Figure 4.1 and Table 4.2, this sample location is identical to WR-31. In the data of Table 5.1, this location is labeled as WR-91 to distinguish it from routine REMP samples collected from WR-31.

6.4.2.3 Storm Drain Water

Monthly grab samples were collected from the West Storm Drain (WW-52) during 1996. Each sample was analyzed for gross-beta and gamma-emitting radionuclides and H-3. Gross-beta measurements were positive in all of the samples, as would be expected. The levels are consistent with those from previous years. No gamma-emitting radionuclides or H-3 were detected in any of the samples.

6.4.2.4 Sediment

Semiannual sediment core samples were collected from three locations during 1996. Each set of samples was segmented by depth (0-5, 5-10, 10-15 cm) and analyzed for gamma-emitting radionuclides. As would be expected, naturally-occurring K-40 and Th-232 were detected in most of the samples.

In addition to the naturally-occurring radionuclides, Cs-137 was detected in most segments. The results from the 0-5 cm depth segment from downstream location SE-11 was consistent with what has been measured in the previous several years (see Figure 6.10) and is attributed to nuclear weapons testing fallout. The Cs-137 in the 5-10 cm and 10-15 cm depth segments at SE-11 are bounded by levels previously reported at the control location (SE-21). The levels and the distribution of the Cs-137 in the core segments indicate nuclear weapons testing fallout as the origin. At both the indicator and the control location, the character of the sediment is highly dependent on the specific location sampled, which in turn is dependent on the water level in Harriman Reservoir or on the Deerfield River shoreline at the time of sampling. The diverse character of the sediment at either location and the fact that Cs-137 tends to bind more to sediment containing organic matter than to sandy and rocky sediment leads to a wide range of Cs-137 concentrations, as shown in Figure 6.10 and 6.11.

Table 5.1 and Figure 6.12 show the levels of Cs-137 at station SE-91. These samples were collected from a deep water location near the plant discharge in Sherman Pond. Although much of the Cs-137 in this sediment is due to global nuclear weapons testing fallout, some of the Cs-137 in these samples is likely due to effluents released from monitored plant discharges. It is believed that the higher Cs-137 levels at SE-91, whether due to fallout or plant effluents, are related to the physical make-up of the sediment (rich organic "mud") at the bottom of Sherman Pond.

Co-60 has been detected in the past in the deep water sediment at SE-91. With respect to 1996 samples, the 0-5 cm segment from the core taken in May 1996 at SE-91 showed a Co-60 concentration of 62 ± 12 pCi/kg-dry. The 5-10 cm and 10-15 cm segments and the sample collected in October contained no detectable Co-60 . This sample, as all others at SE-91, were collected in deep water, well away from the shoreline and is attributed to licensed plant discharges in past years. None of this radioactivity is involved in any significant pathway of exposure to man.

6.4.3 Ingestion Pathways

6.4.3.1 Milk

Milk samples from cows at two local farms were collected twice-per-month during the 1996 pasture season, and monthly during the remainder of the year. 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 expected, naturally-occurring K-40 was detected in all samples. Also expected was Cs-137 and Sr-90. No Cs-137 was detected in either the indicator or control samples in 1996 although it has been detected in previous years as shown in Figure 6.13. It should be noted that the annual average Cs-137 concentration in Figure 6.13 was calculated using all the measured concentrations regardless of whether they were considered "detectable" or not or whether they were positive or negative. Sr-90 was detected in two out of four indicator samples, and one out of four control samples. This data is shown in Figure 6.14. Figures 6.13 and 6.14 also include data from TM-12, which was part of the sampling program until February 1993, when it went out of business.

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 6.13 and 6.14 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 years near YNPS.

Milk became unavailable at station TM-14 in mid-August 1995 and because no replacement sampling locations were available within five miles of the plant, mixed "roadside" grass was collected in lieu of a milk sample at that location. In 1996 three samples were collected and are categorized as TC-14. The data are shown in Table 5.1 under the category Mixed Vegetation (TC). The naturally occurring radionuclides, Be-7 and K-40 were detected in all of the samples. No other gamma emitting radionuclides were detected.

6.4.3.2 Fish

Semiannual samples of fish were collected from two locations during 1996. 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. No other gamma emitting radionuclides were detected in 1996 fish sampl[illegible] in many of the previous years, the 1996 average Cs-137 concentrations shown on Fig[illegible].15 are not considered detectable or "positive" measurements. The radioactivity detected in previous years at both indicator and control locations shown on Figure 6.15 is attributed to global nuclear weapons testing fallout.

6.4.3.3 Food Products/Broad Leaf Vegetation

The food crops collected in 1996 consisted of samples of blackberries, cucumbers and kale. Each was analyzed for gamma-emitting radionuclides. K-40 was detected in two out of three samples. No other radionuclides were detected.

A sample of kale was collected in 1996 at Station TV-11 to satisfy the broad leaf vegetation sampling requirement. This sample was analyzed for low-level I-131 to meet the broad leaf vegetation LLD specified in ODCM Table 4.3. The results are included in Table 5.1 under "Food Crop (TF). No I-131 was detected in the sample.

6.4.3.4 Maple Syrup

Processed maple syrup samples were collected from an indicator and control location in April 1996. These samples had been concentrated, relative to the original tree sap, by boiling (see

Section 4.3.10). Naturally occurring K-40 was detected in both samples, as was Cs-137. The concentrations of Cs-137 in 1996 samples are consistent with that detected in both indicator and control samples in previous years, and is attributed to global nuclear weapons testing fallout. This radioactivity has been detected in most samples since collection was started in 1972.

6.4.4 Direct Radiation Pathway

Direct radiation is continuously measured at 40 locations surrounding YNPS with the use of thermoluminescent dosimeters (TLDs). These are collected every calendar quarter for readout at the YAEL.

As can be seen in Figures 6.16 to 6.26, there is a distinct 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 radionuclides in the underlying soil, rock or nearby building materials result in different radiation levels between one field site and another. This explains why the control TLD station at the Fife Brook Road station (GM-34, 6.4 km from the plant) had the highest mean exposure for 1996 and previous years, as can be seen in Tables 5.2 and 5.3, as well as in Figure 6.22.

From Table 5.2 and 5.3, it can be seen that the mean exposure rates for the Indicator, Outer Ring and Control categories were not significantly different in 1996. This indicates that there was no significant overall increase in direct radiation exposure rates in the plant vicinity. As shown in Figures 6.16 to 6.26, the levels in 1996 are consistent with those of previous years.

It should be noted that the "Fenceline" TLDs shown in Figures 6.24 and 6.25 and summarized in Tables 5.2 and 5.3 are located on the fence surrounding the Radiation Control Area on the YNPS site, and are influenced by licensed plant activities. The fenceline is well within the YNPS property bounds.

FIGURE 6.1

GROSS-BETA MEASUREMENTS ON AIR PARTICULATE FILTERS
QUARTERLY AVERAGES

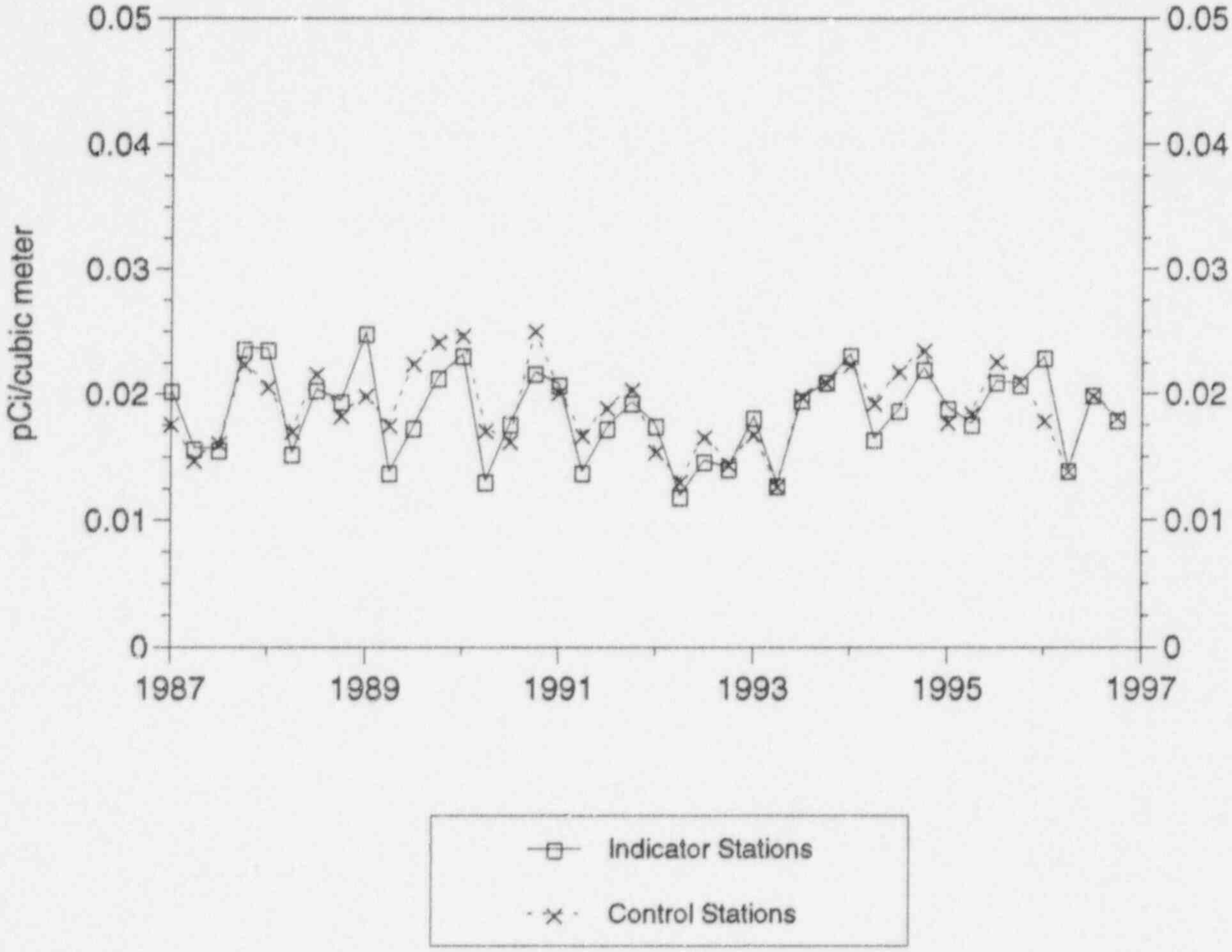


FIGURE 6.2

GROSS-BETA MEASUREMENTS ON AIR PARTICULATE FILTERS

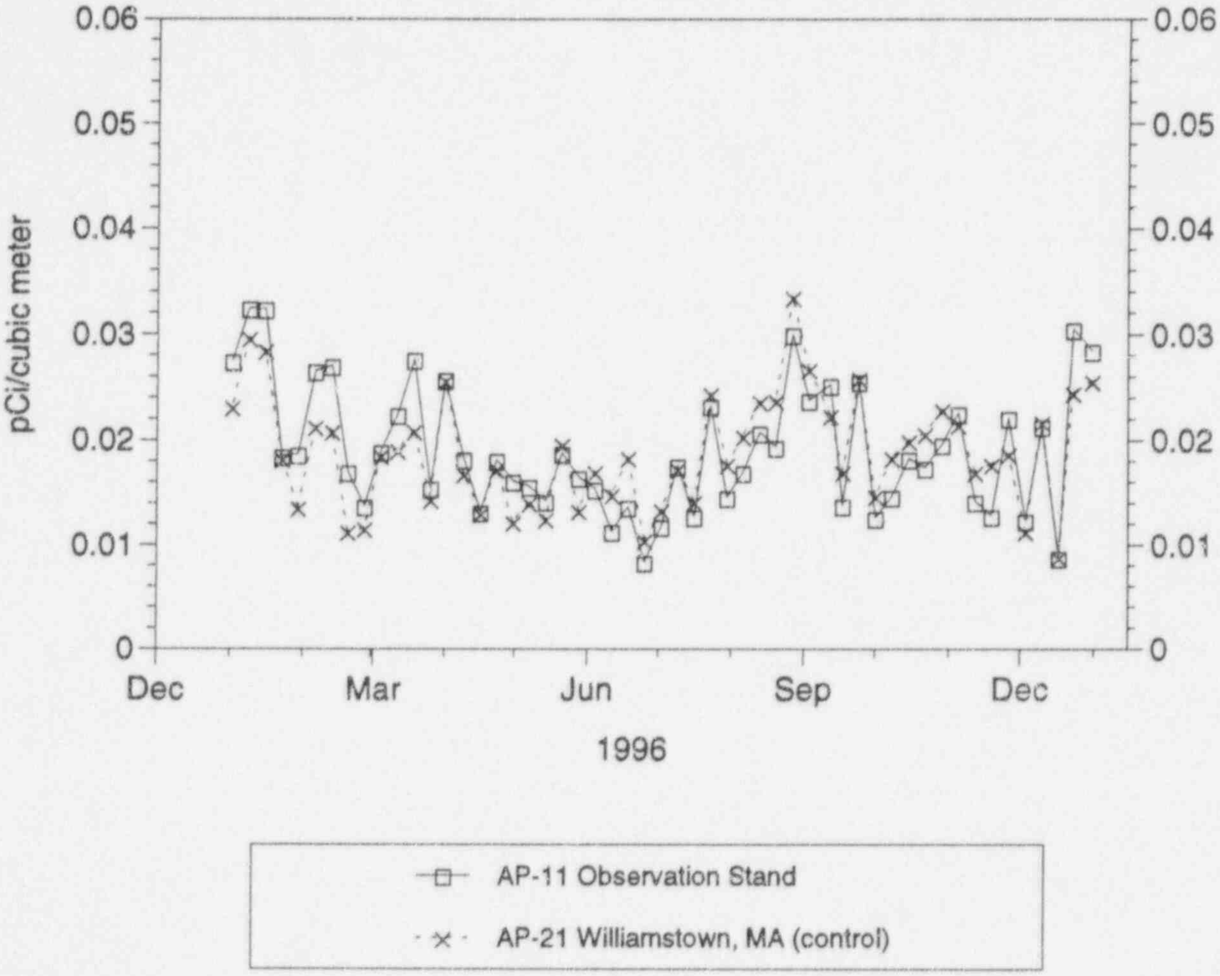


FIGURE 6.3

GROSS-BETA MEASUREMENTS ON AIR PARTICULATE FILTERS

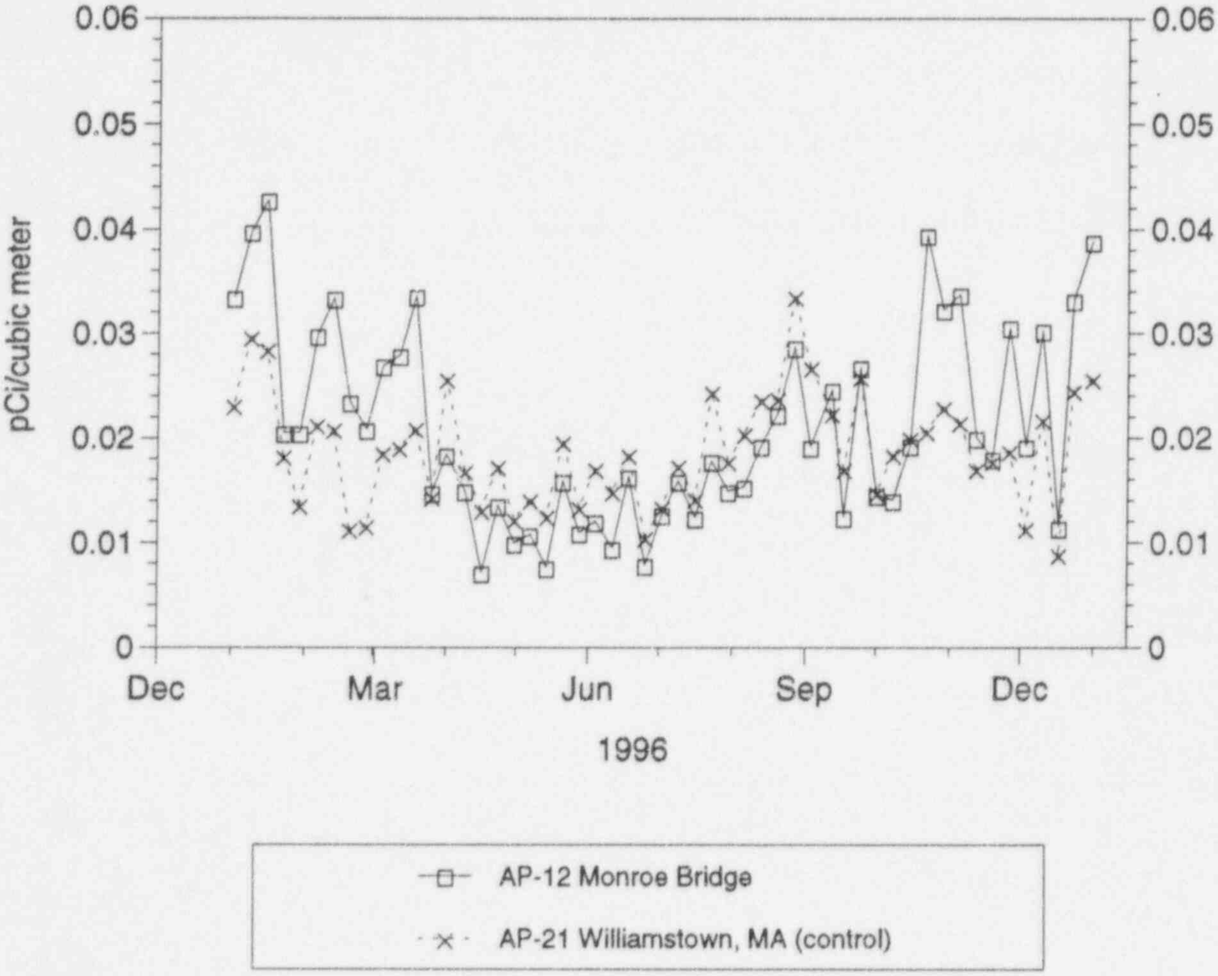


FIGURE 6.4

GROSS-BETA MEASUREMENTS ON AIR PARTICULATE FILTERS

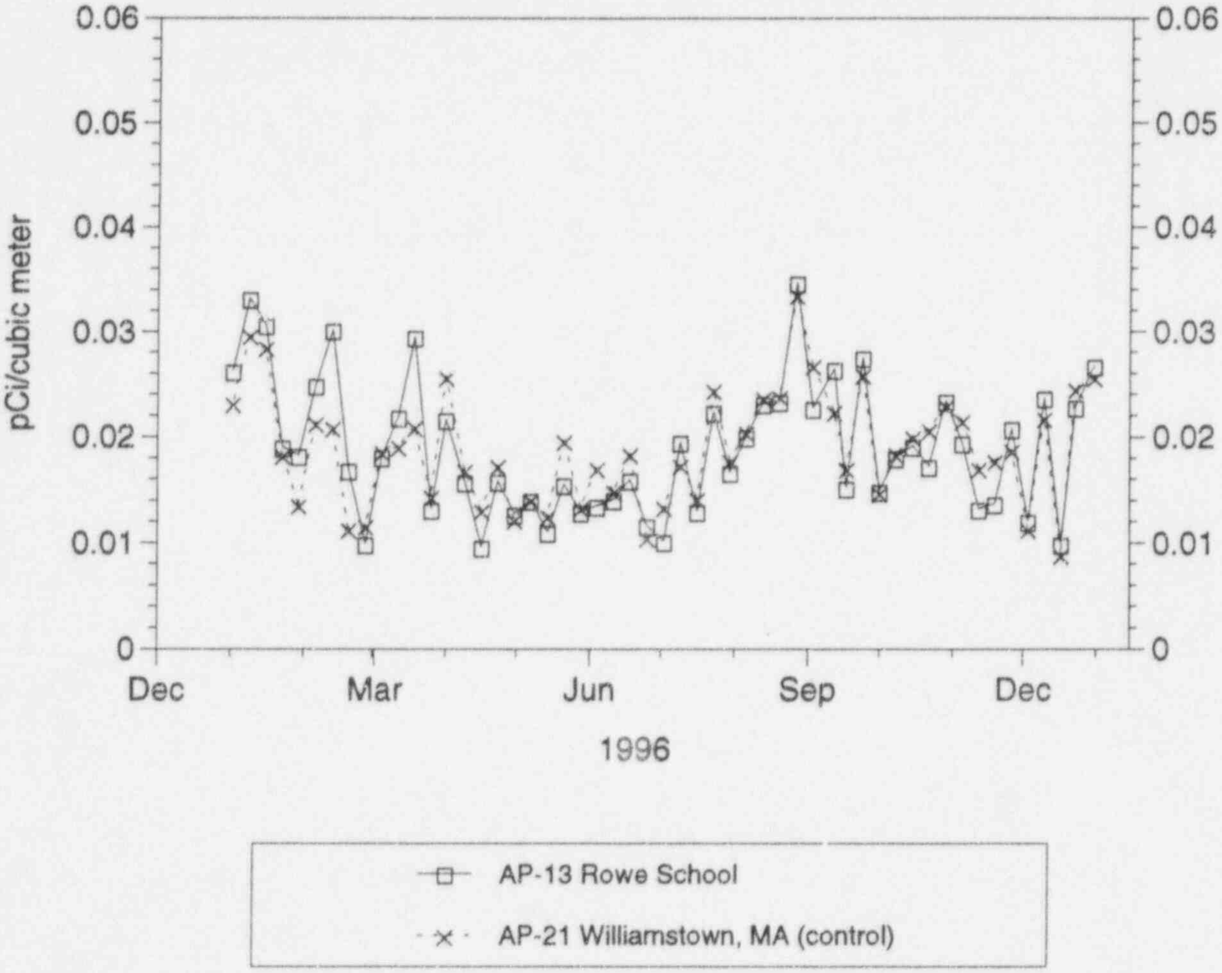


FIGURE 6.5

GROSS-BETA MEASUREMENTS ON AIR PARTICULATE FILTERS

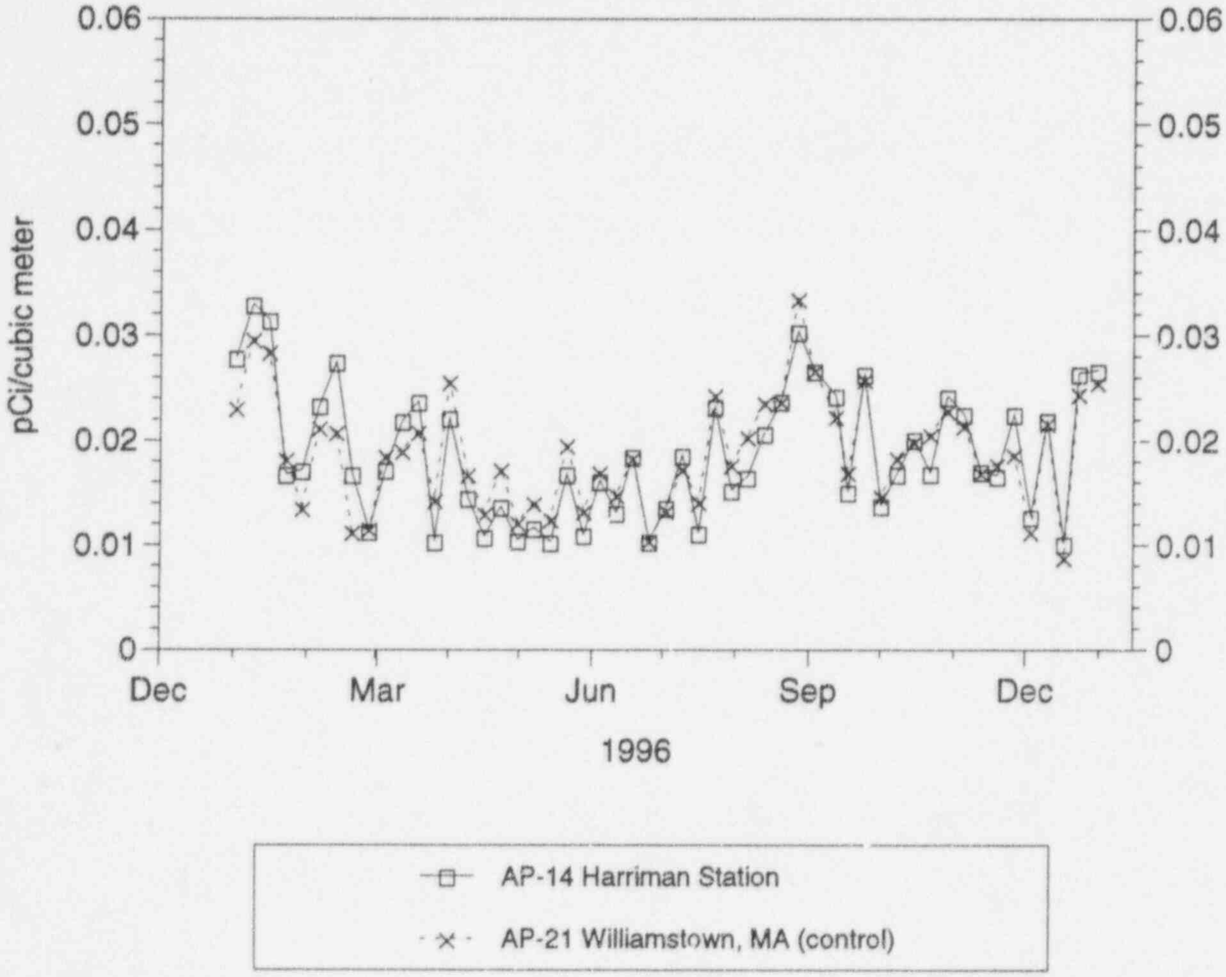


FIGURE 6.6

GROSS-BETA MEASUREMENTS ON AIR PARTICULATE FILTERS

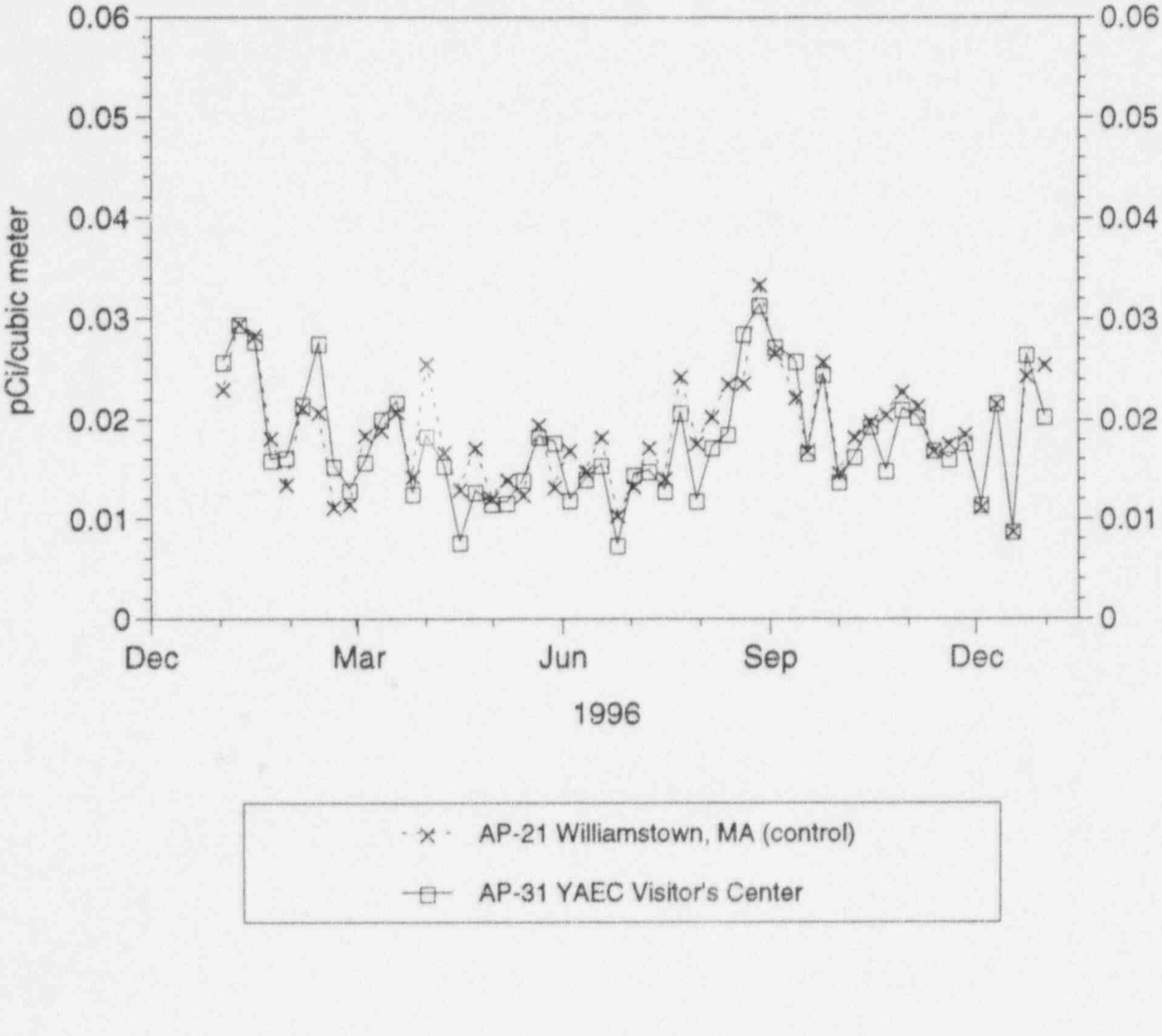


FIGURE 6.7

GROSS-BETA MEASUREMENTS OF GROUND WATER
SEMI-ANNUAL AVERAGES

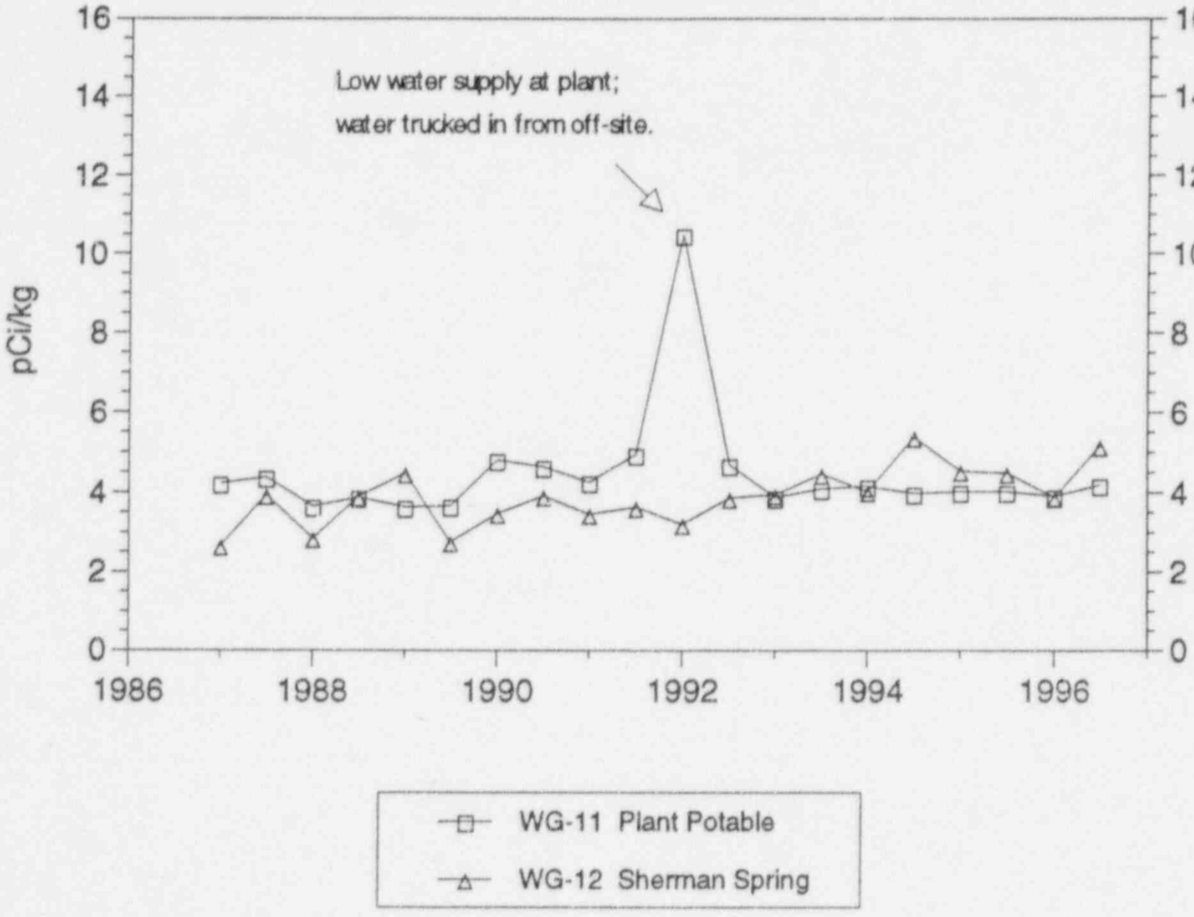


FIGURE 6.8

H-3 IN GROUND WATER
STATION WG-12, SHERMAN SPRING

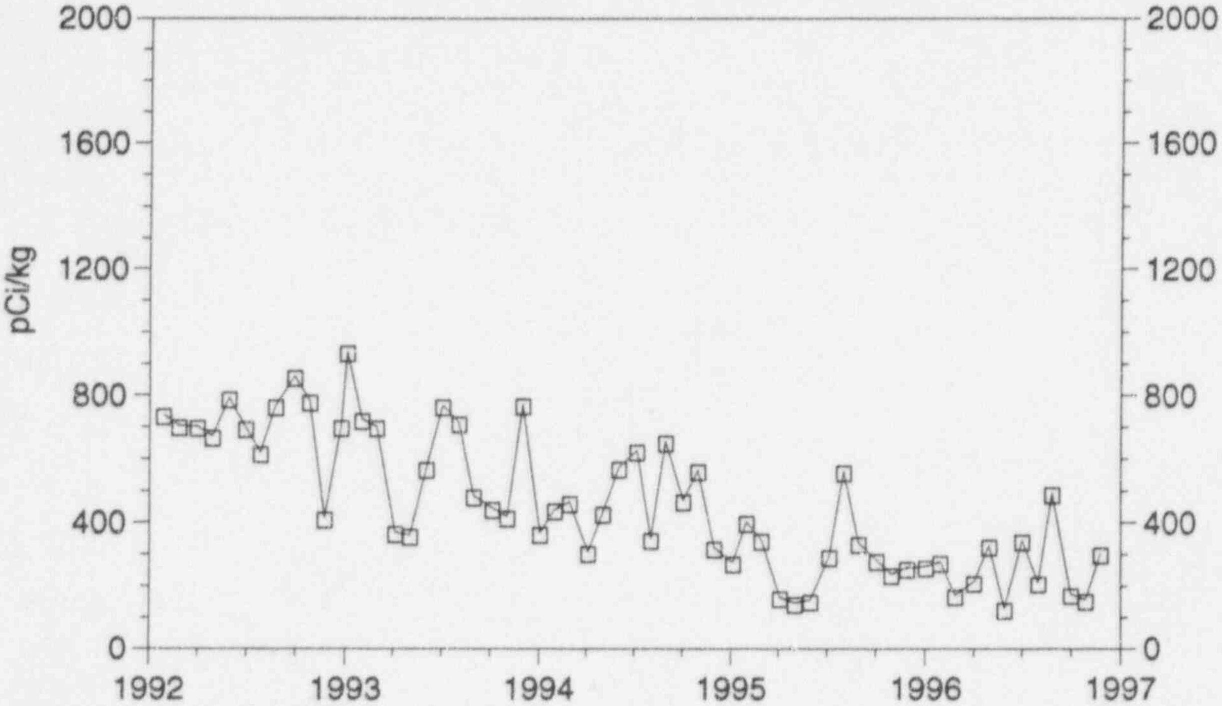


FIGURE 6.9

GROSS-BETA MEASUREMENTS OF RIVER WATER
SEMI-ANNUAL AVERAGES

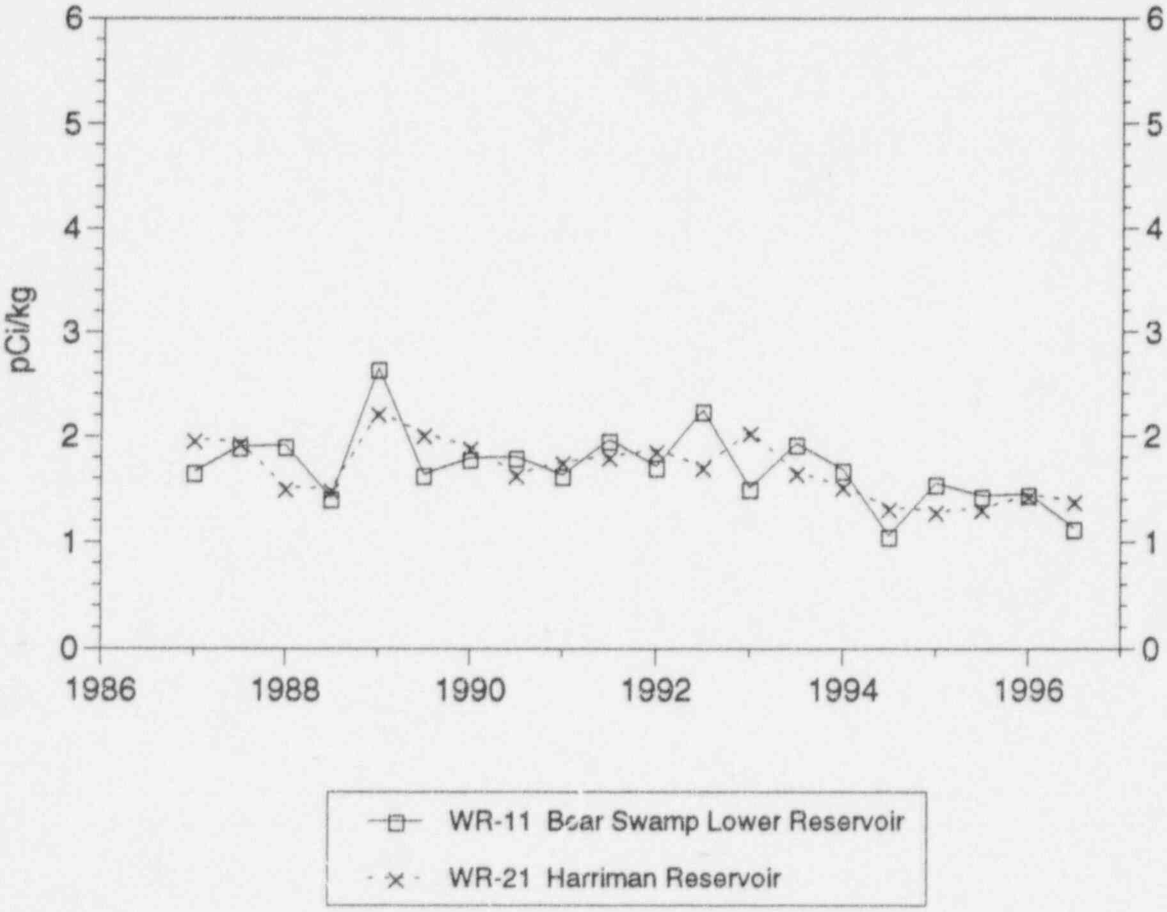


FIGURE 6.10

CESIUM -137 IN SHORELINE SEDIMENT
STATION SE-11, NO.4 STATION

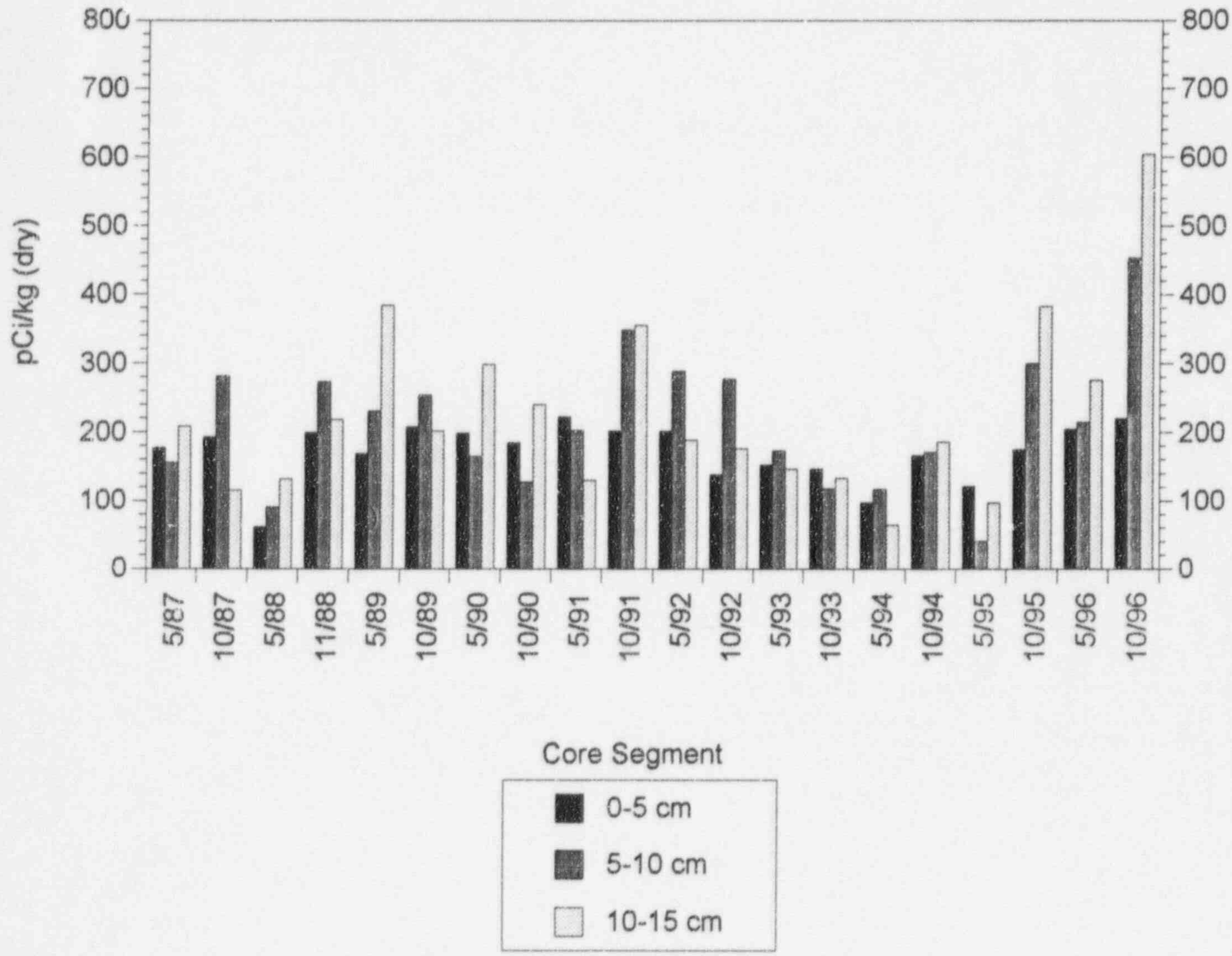


FIGURE 6.11

CESIUM - 137 IN SHORELINE SEDIMENT
STATION SE - 21, HARRIMAN RESERVOIR

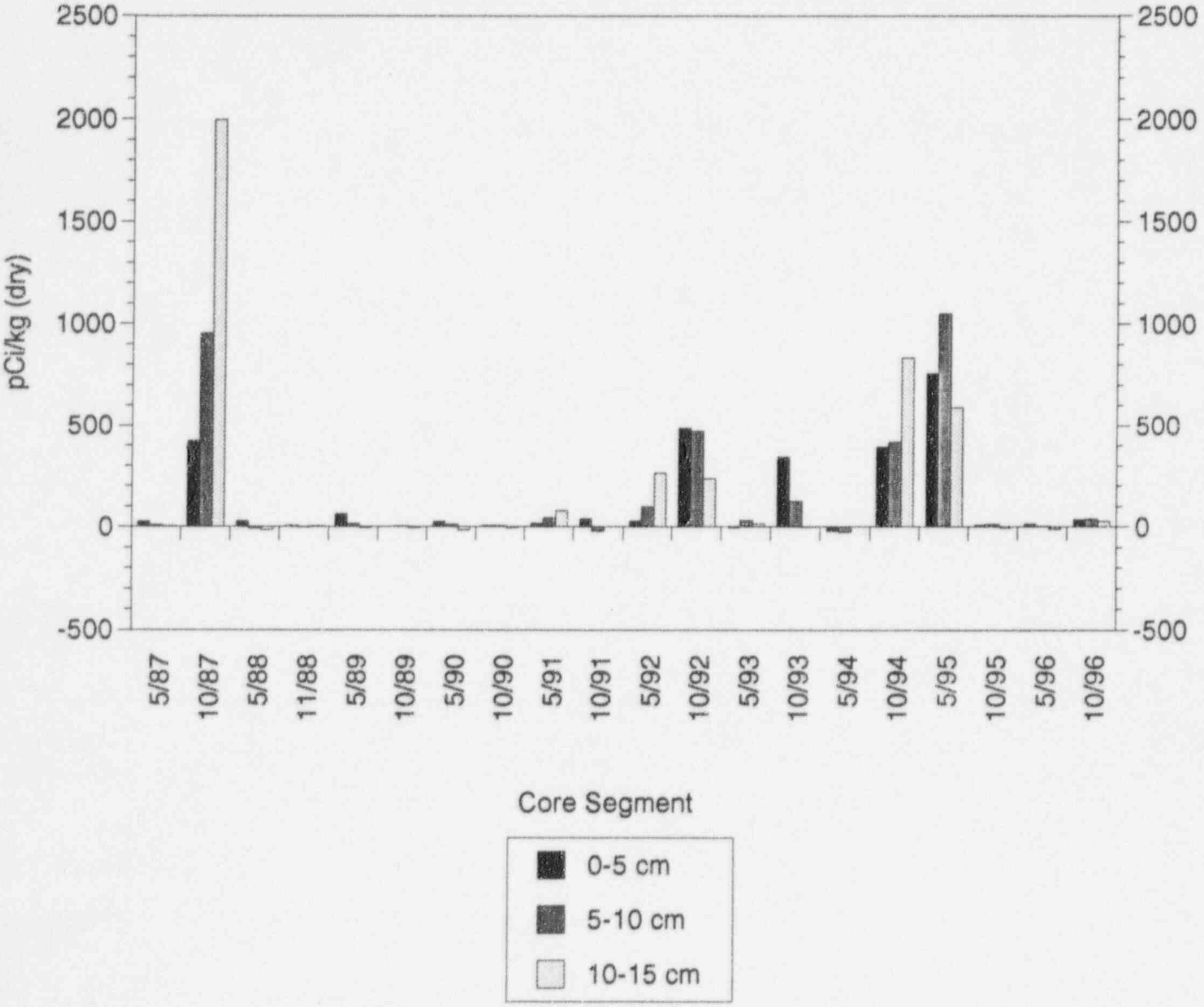


FIGURE 6.12

CESIUM - 137 IN BOTTOM SEDIMENT
STATION SE - 91, SHERMAN POND

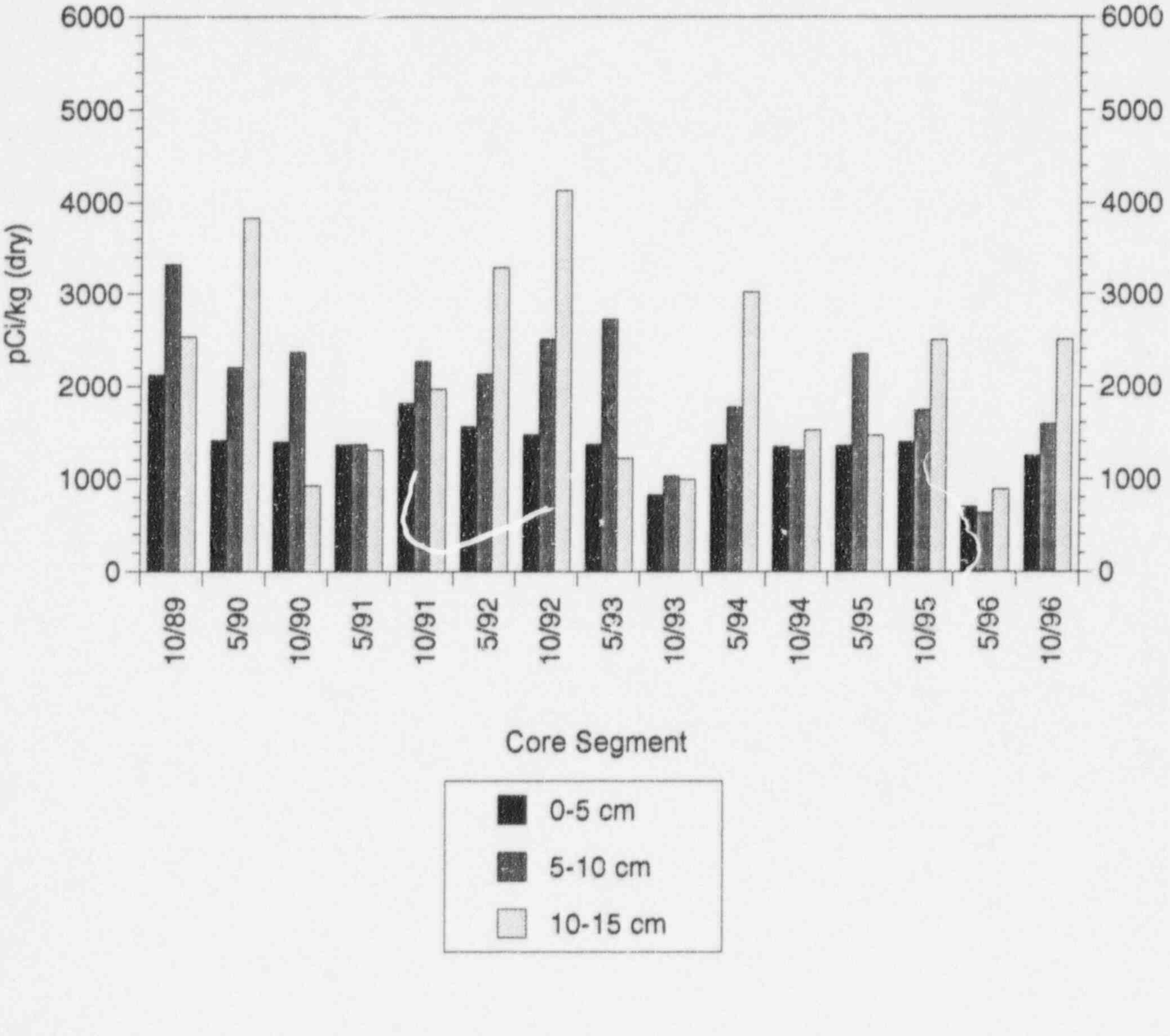


FIGURE 6.13

CESIUM - 137 IN MILK
ANNUAL AVERAGES

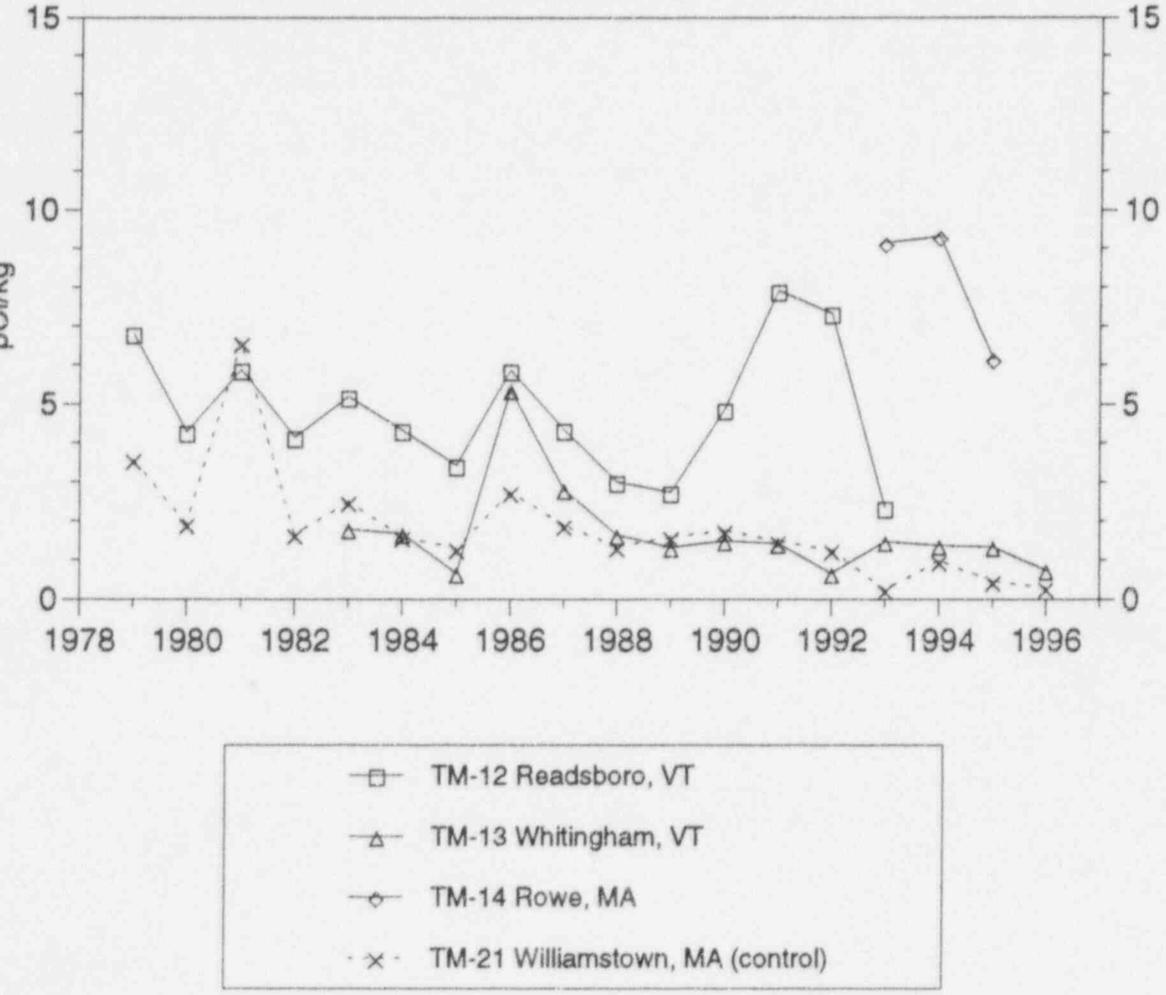


FIGURE 6.14

STRONTIUM - 90 IN MILK
ANNUAL AVERAGES

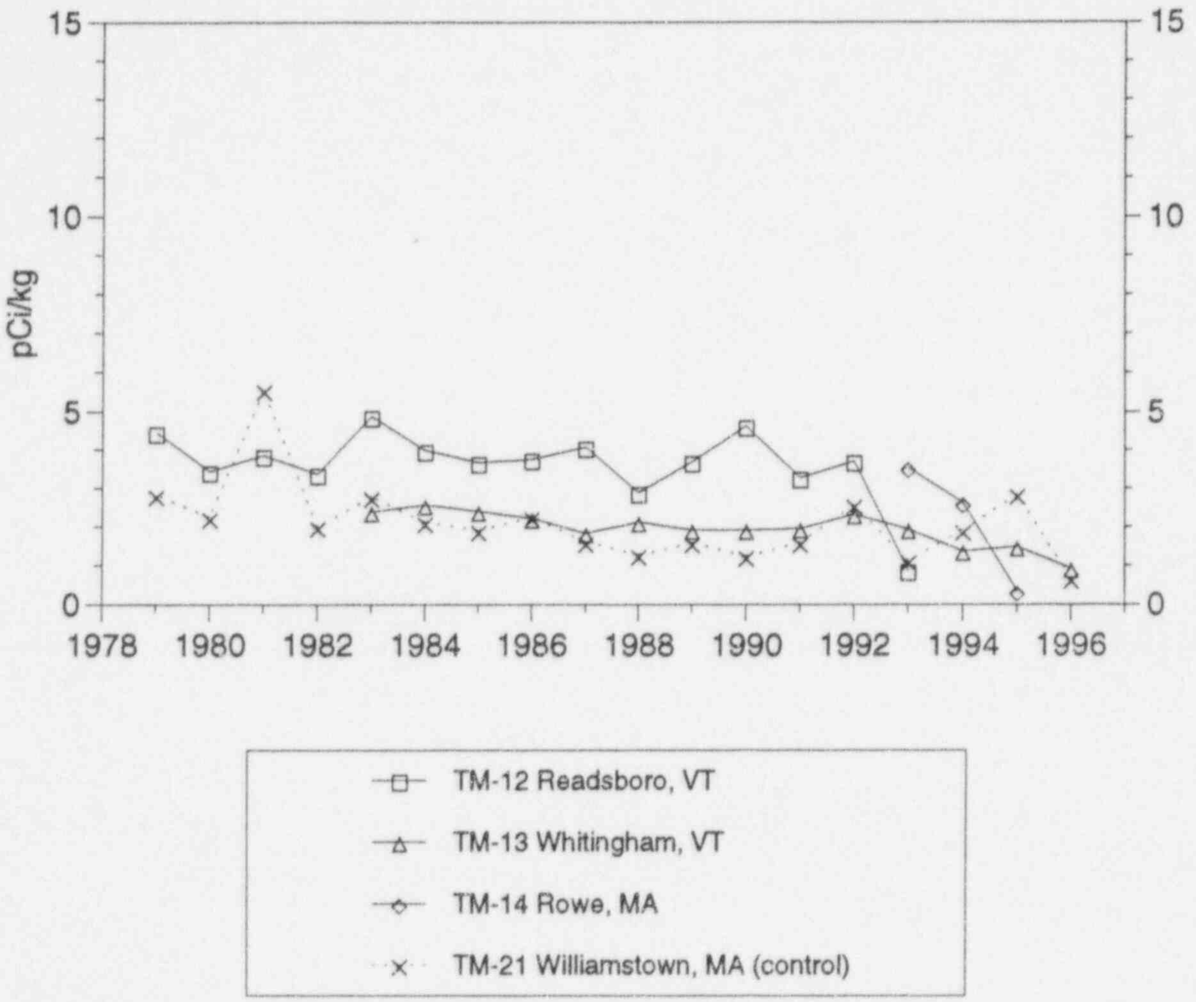


FIGURE 6.15

CESIUM - 137 IN FISH
ANNUAL AVERAGE CONCENTRATIONS

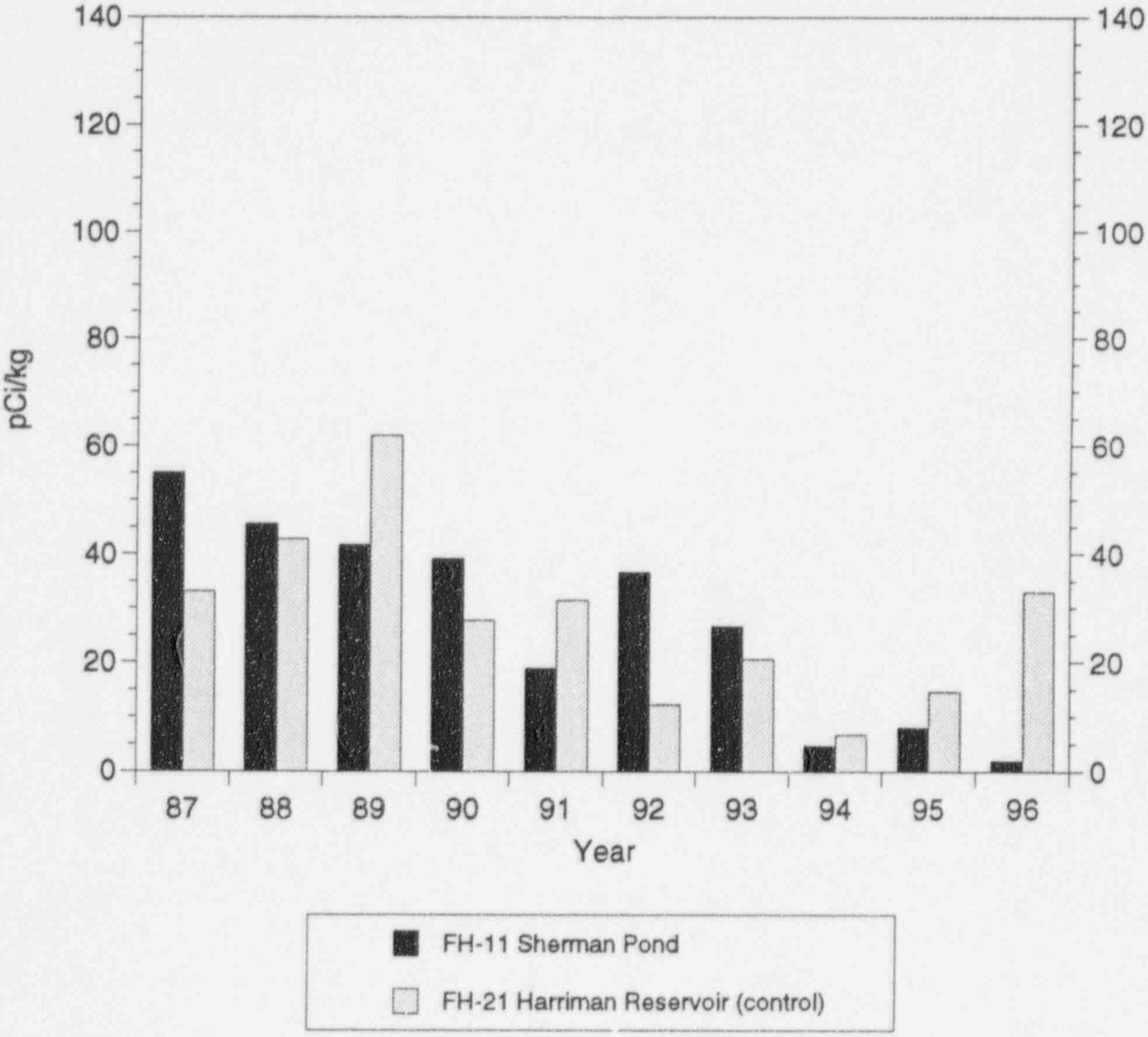


FIGURE 6.16

EXPOSURE RATE AT INDICATOR, OUTER RING AND CONTROL TLD'S

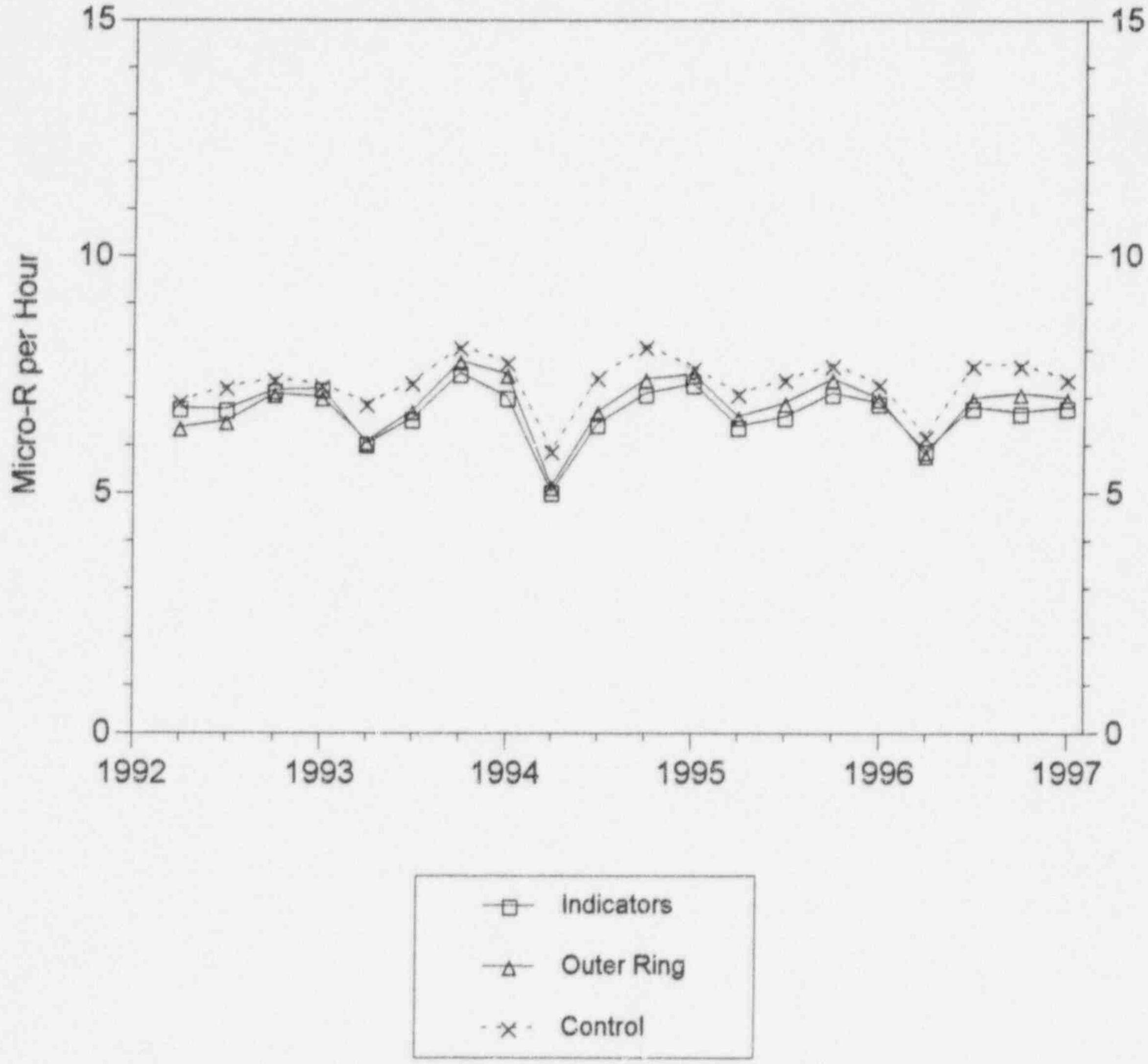


FIGURE 6.17

EXPOSURE RATE AT INDICATOR TLDS, GM 01 - 04

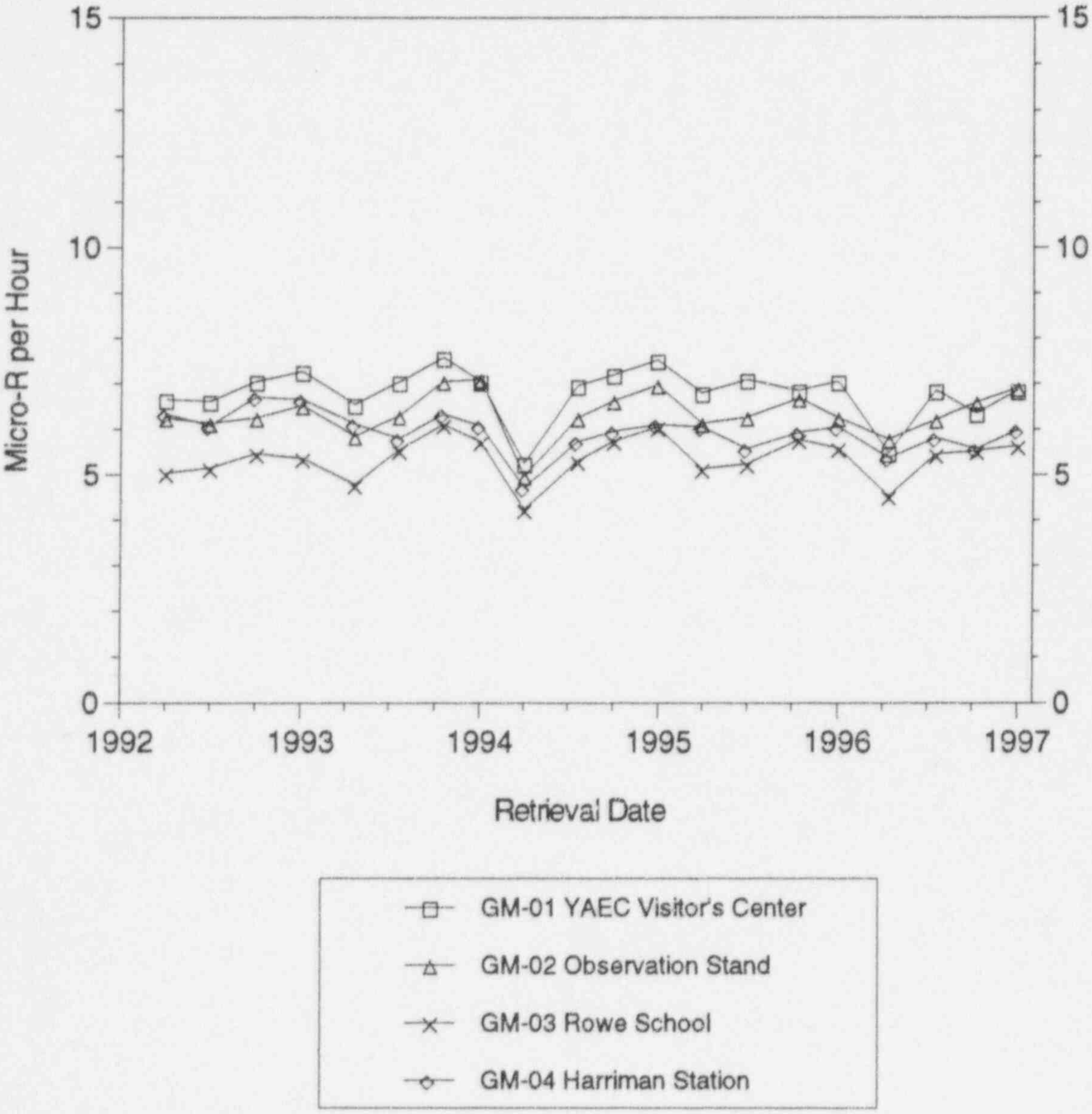


FIGURE 6.18

EXPOSURE RATE AT INDICATOR TLDS, GM 05 - 08

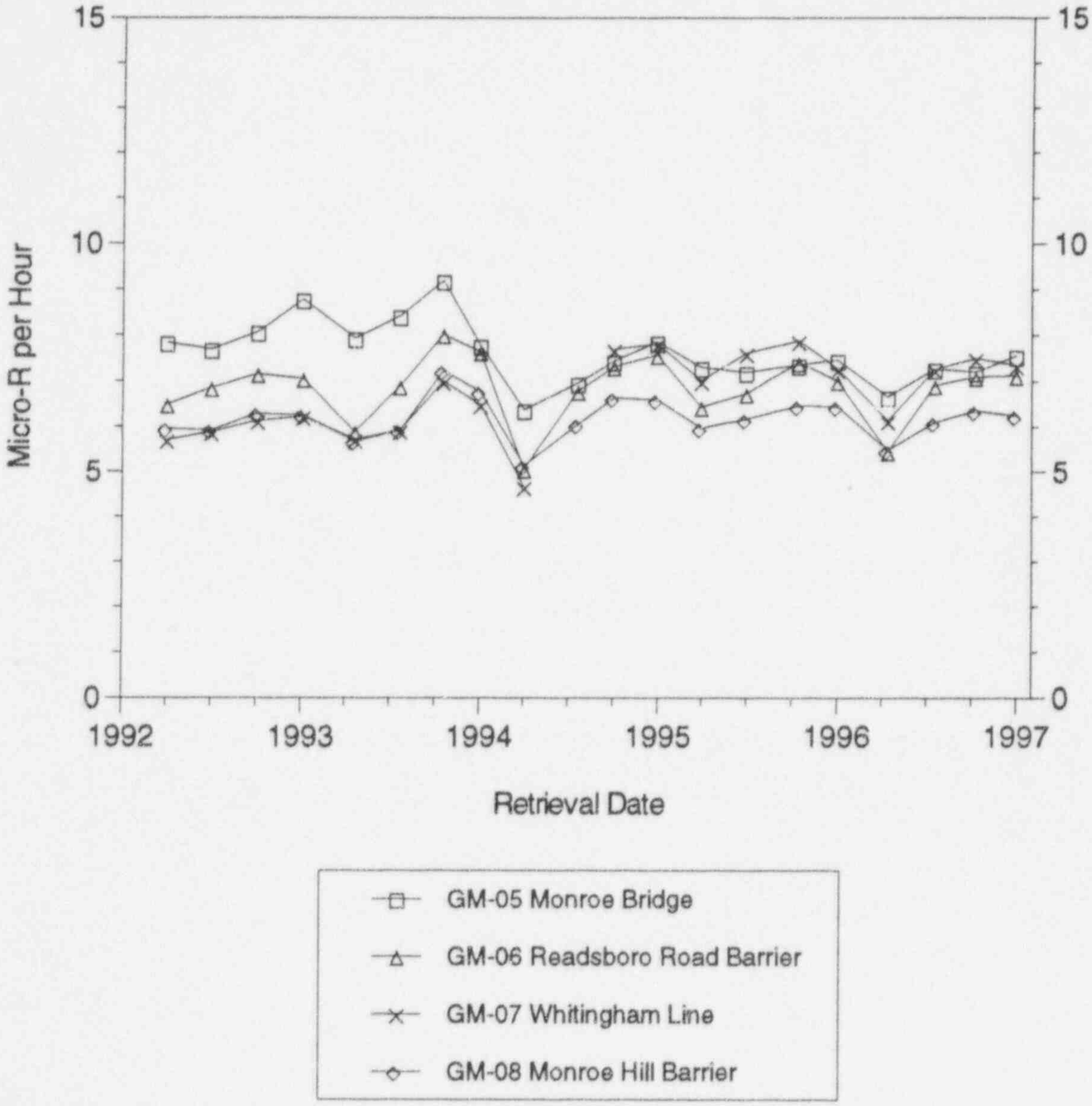


FIGURE 6.19

EXPOSURE RATE AT INDICATOR TLDS, GM 09 - 12, 40

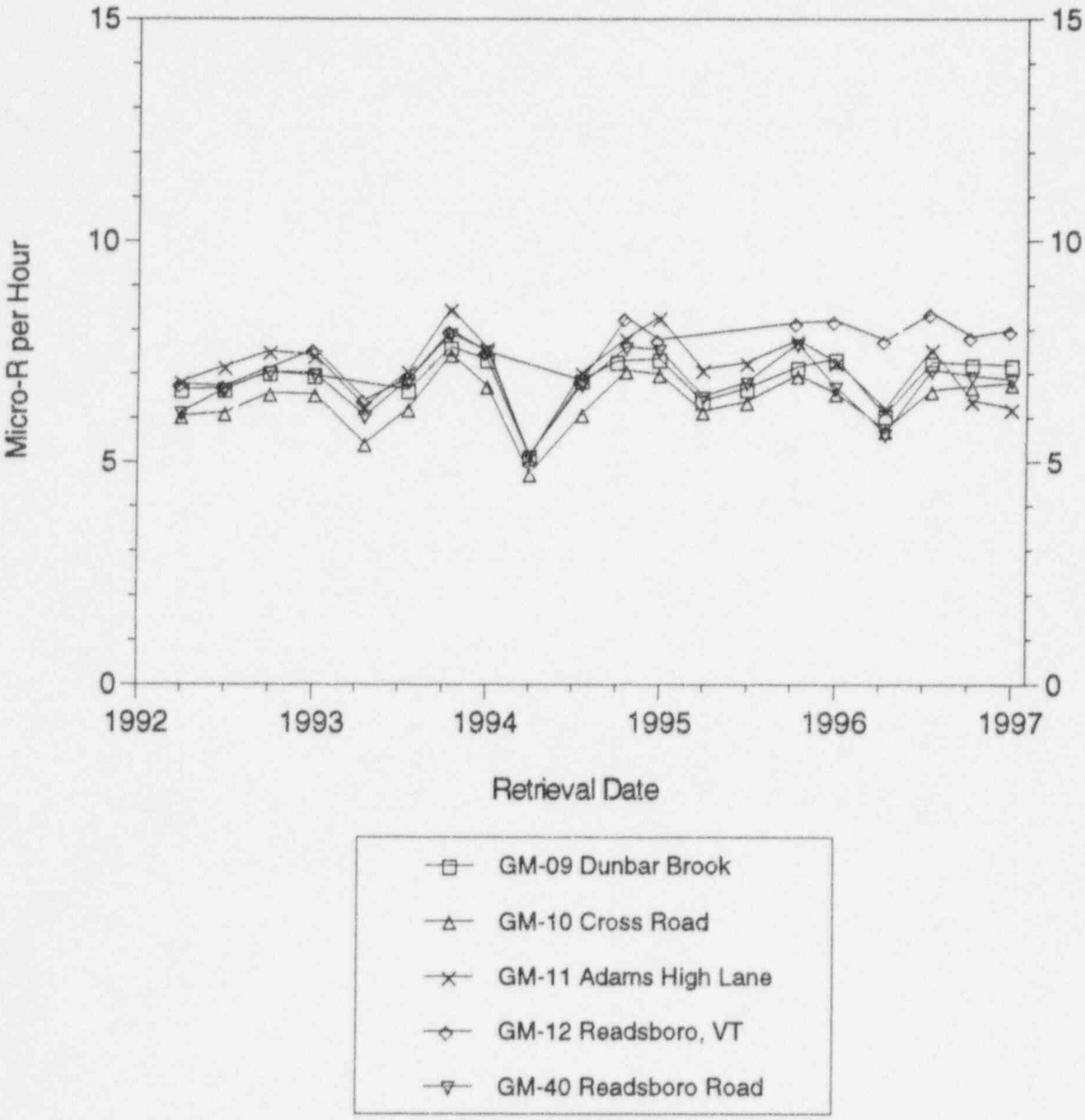


FIGURE 6.20

EXPOSURE RATE AT INDICATOR TLDS, GM 24 - 27

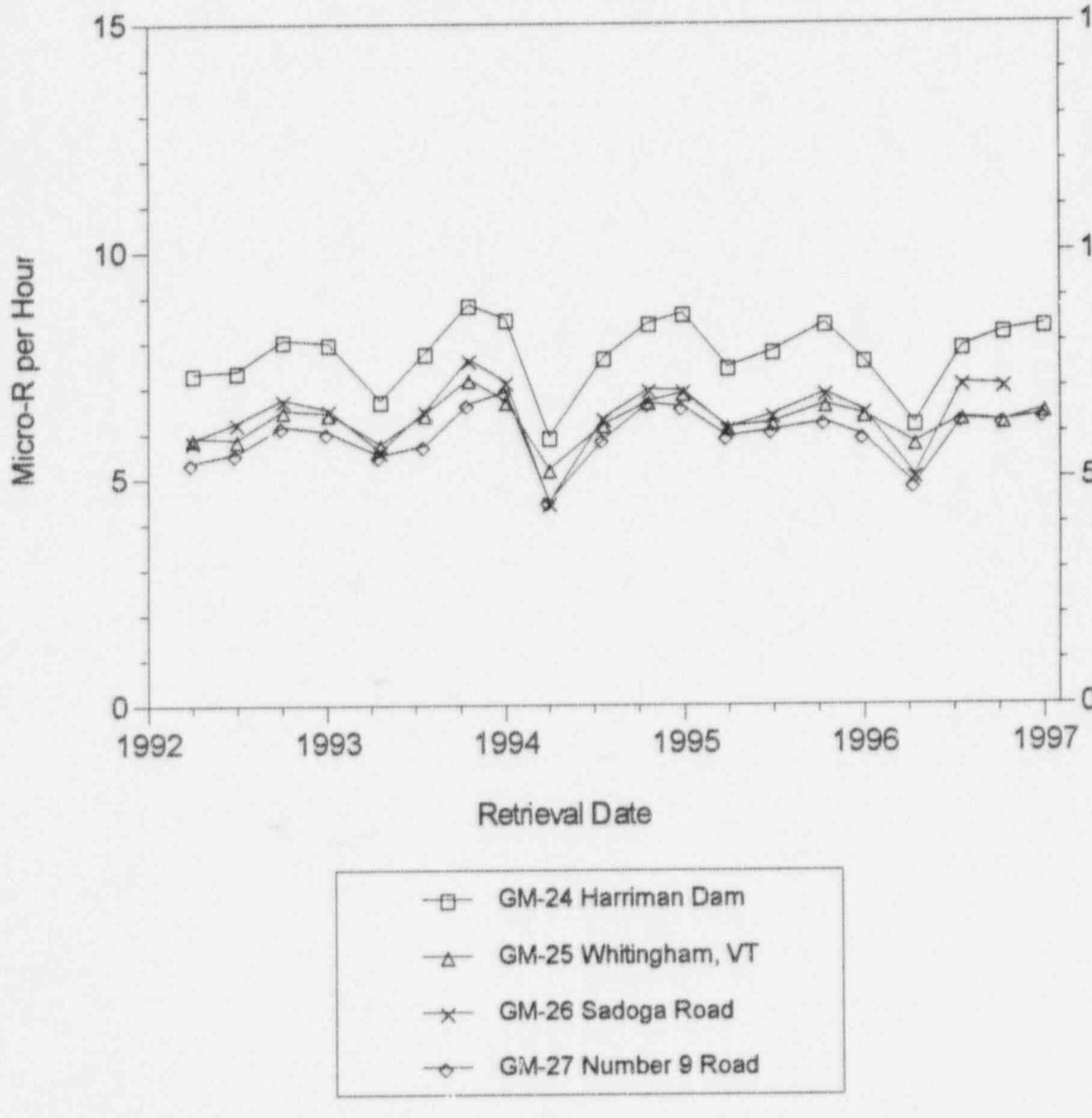


FIGURE 6.21

EXPOSURE RATE AT INDICATOR TLDS, GM 28 - 31

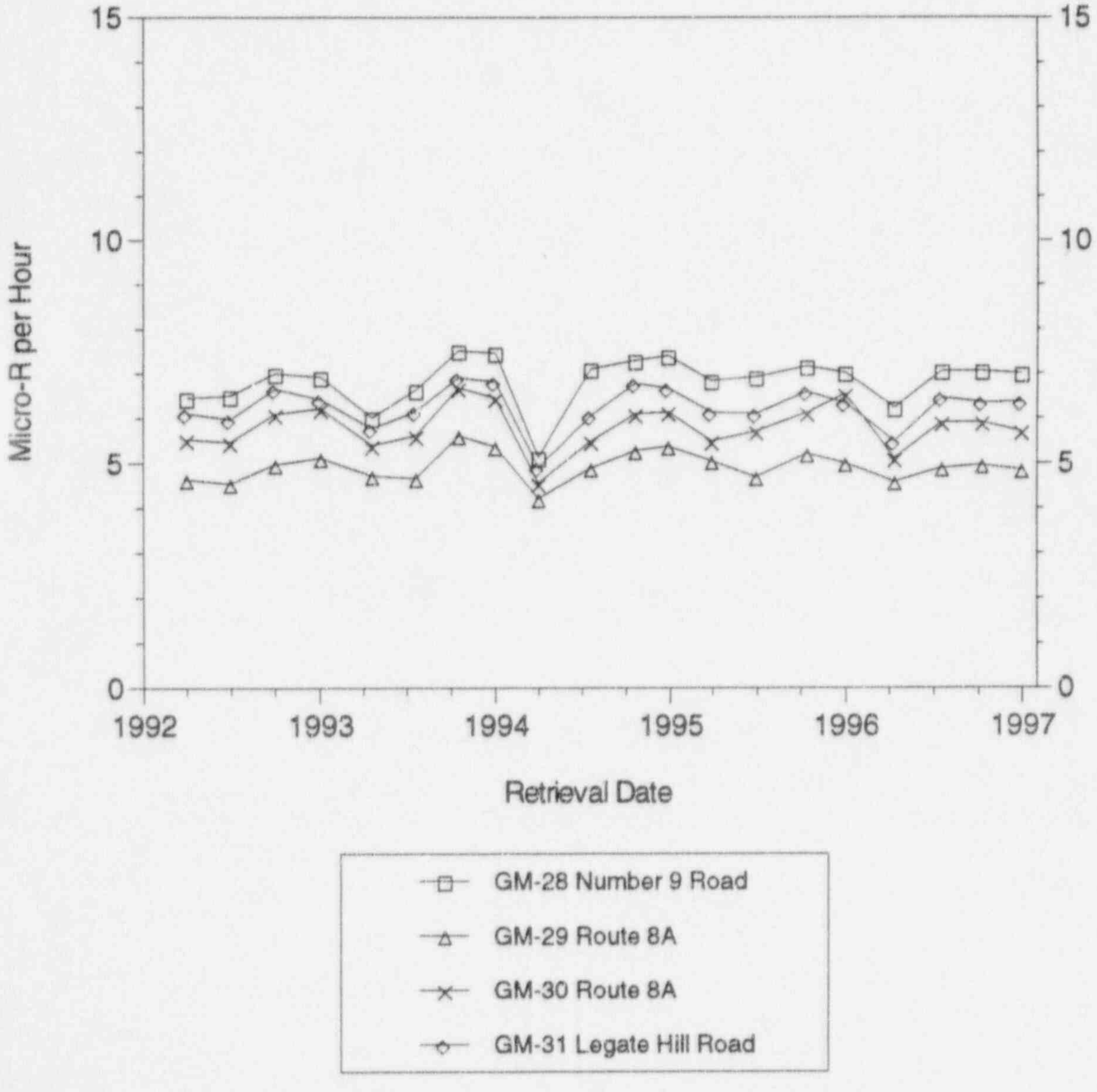


FIGURE 6.22

EXPOSURE RATE AT INDICATOR TLDS, GM 32 - 35

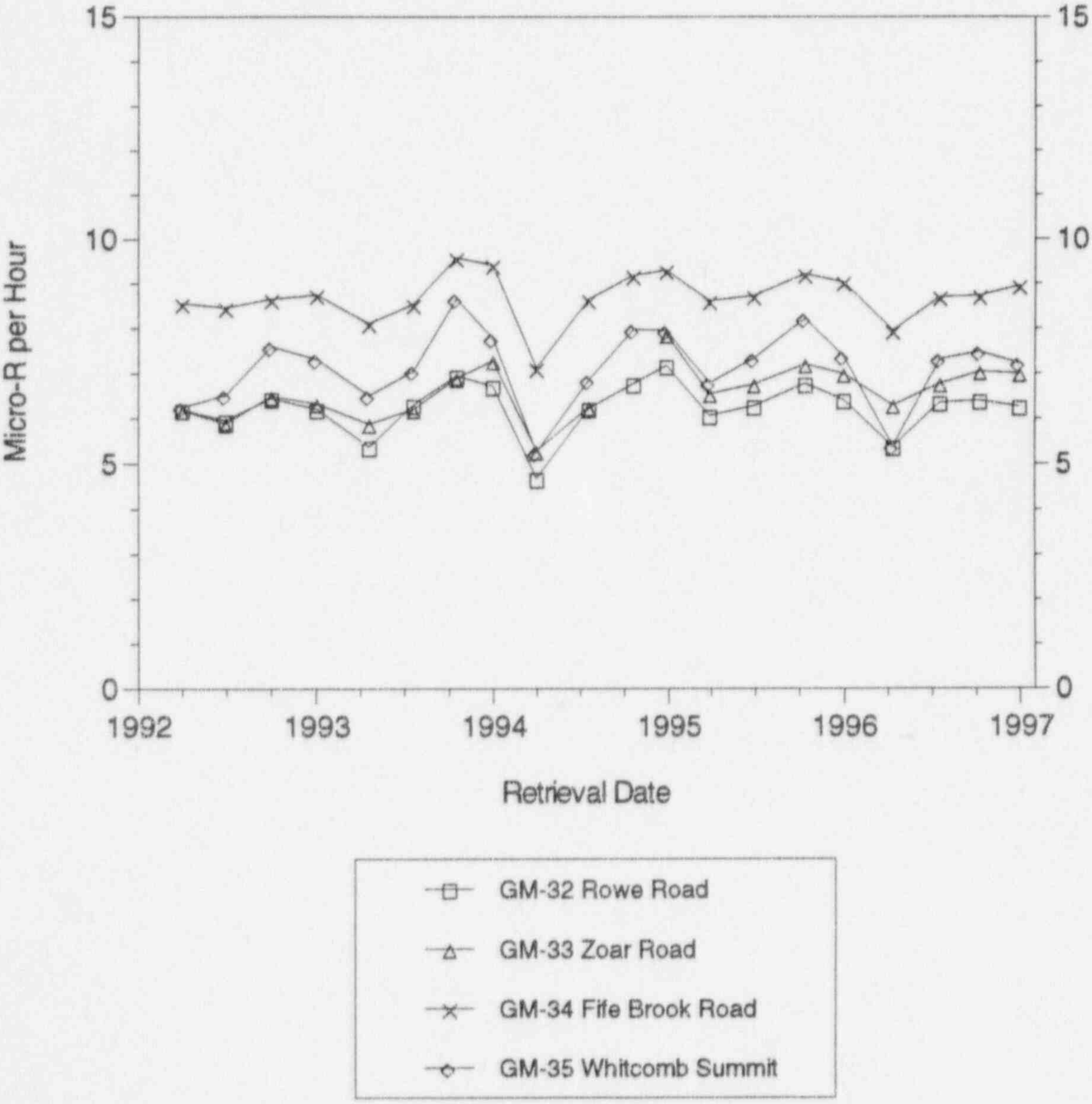


FIGURE 6.23

EXPOSURE RATE AT OUTER RING TLDS, GM 36-39

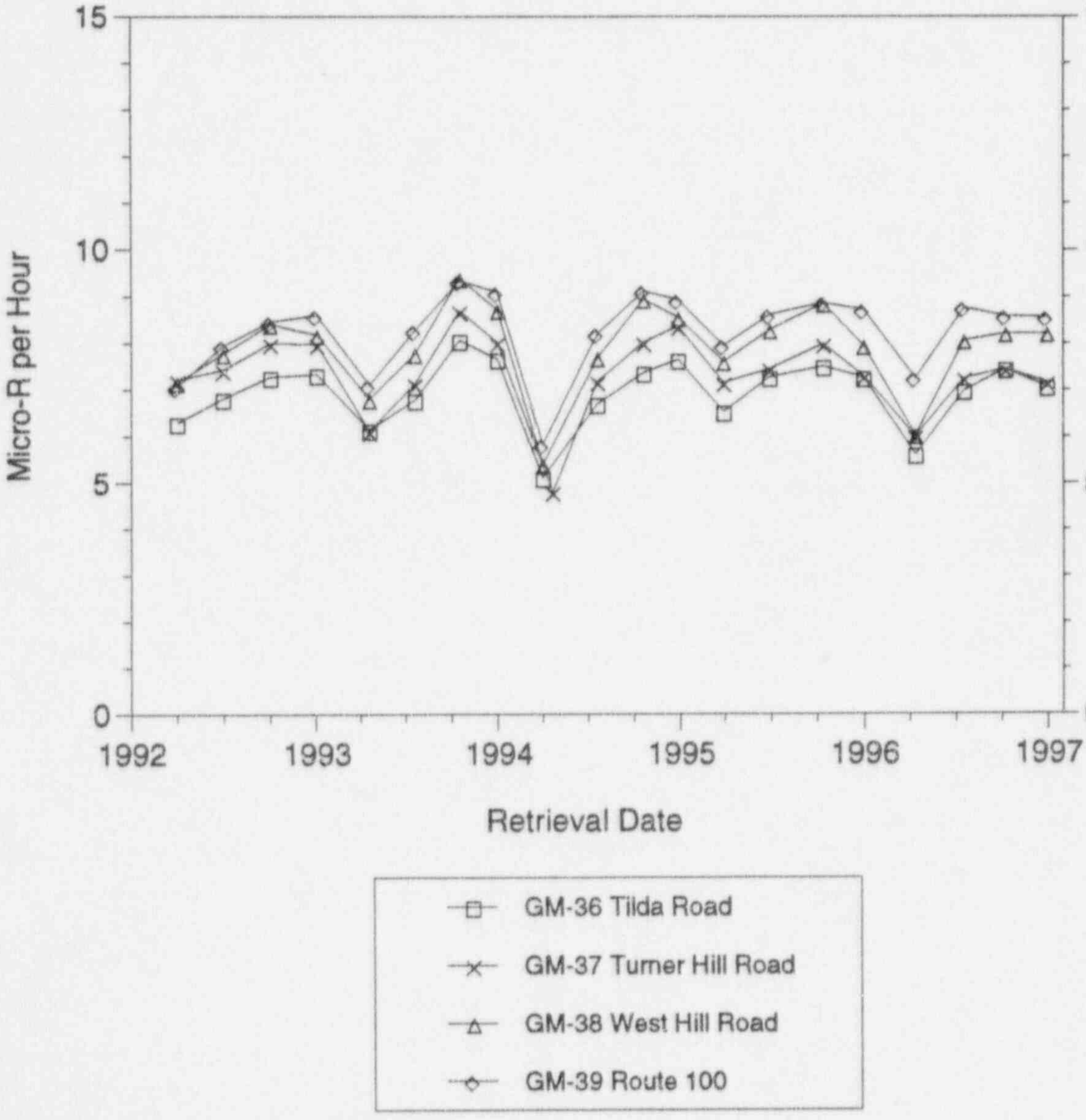


FIGURE 6.24

EXPOSURE RATE AT INDICATOR TLDS, GM 13 - 16

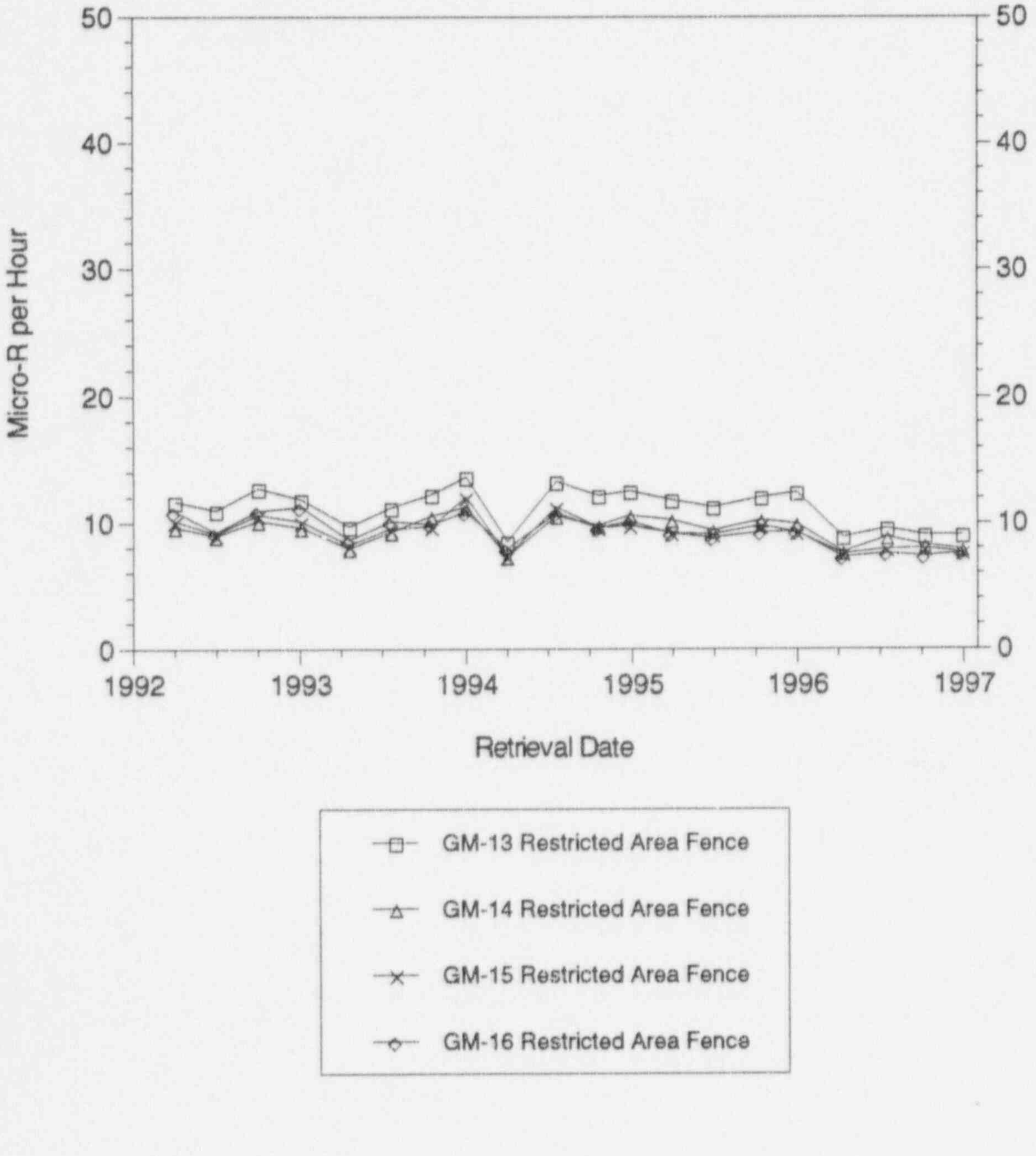


FIGURE 6.25

EXPOSURE RATE AT INDICATOR TLDS, GM 17 - 21

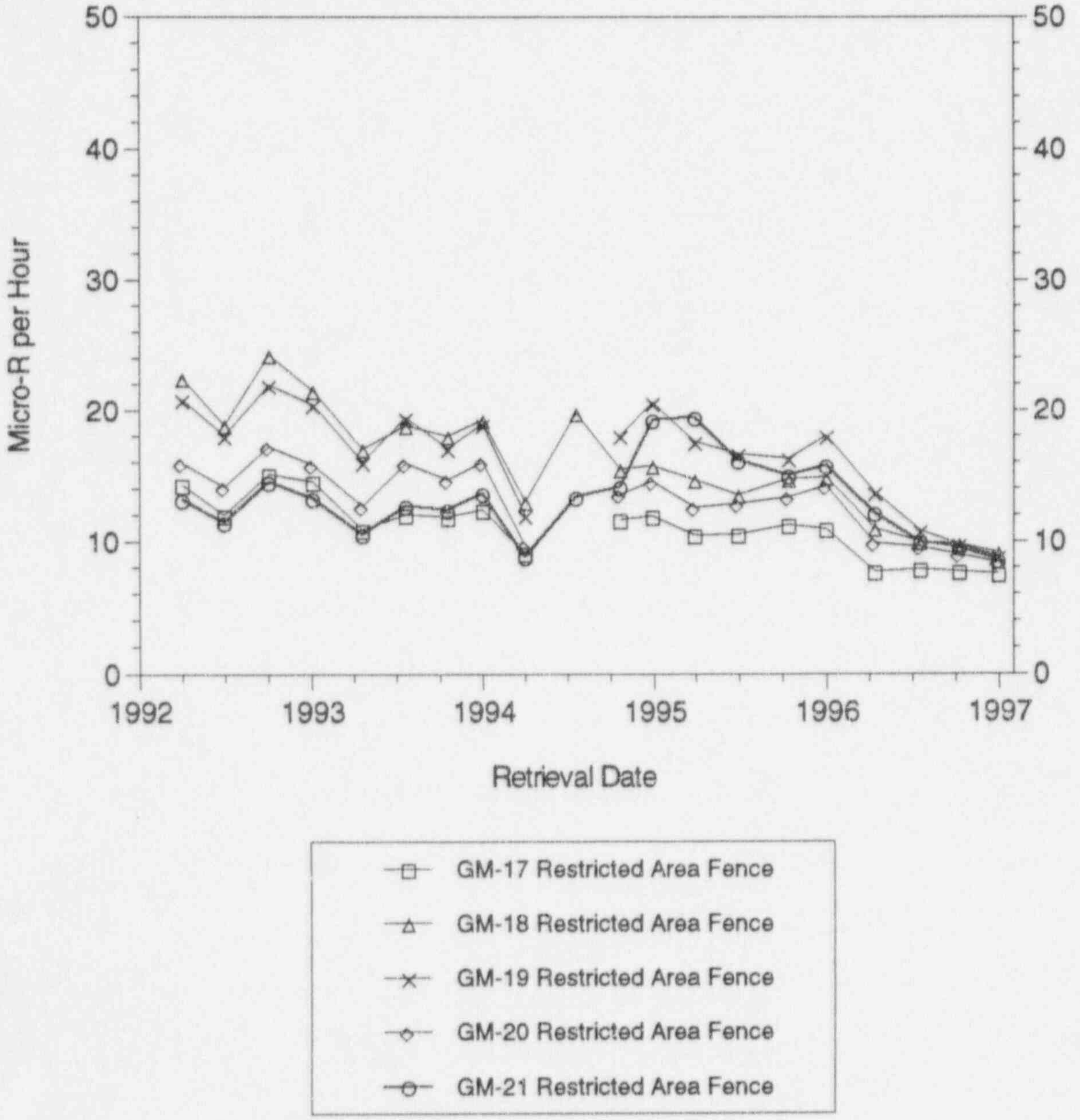
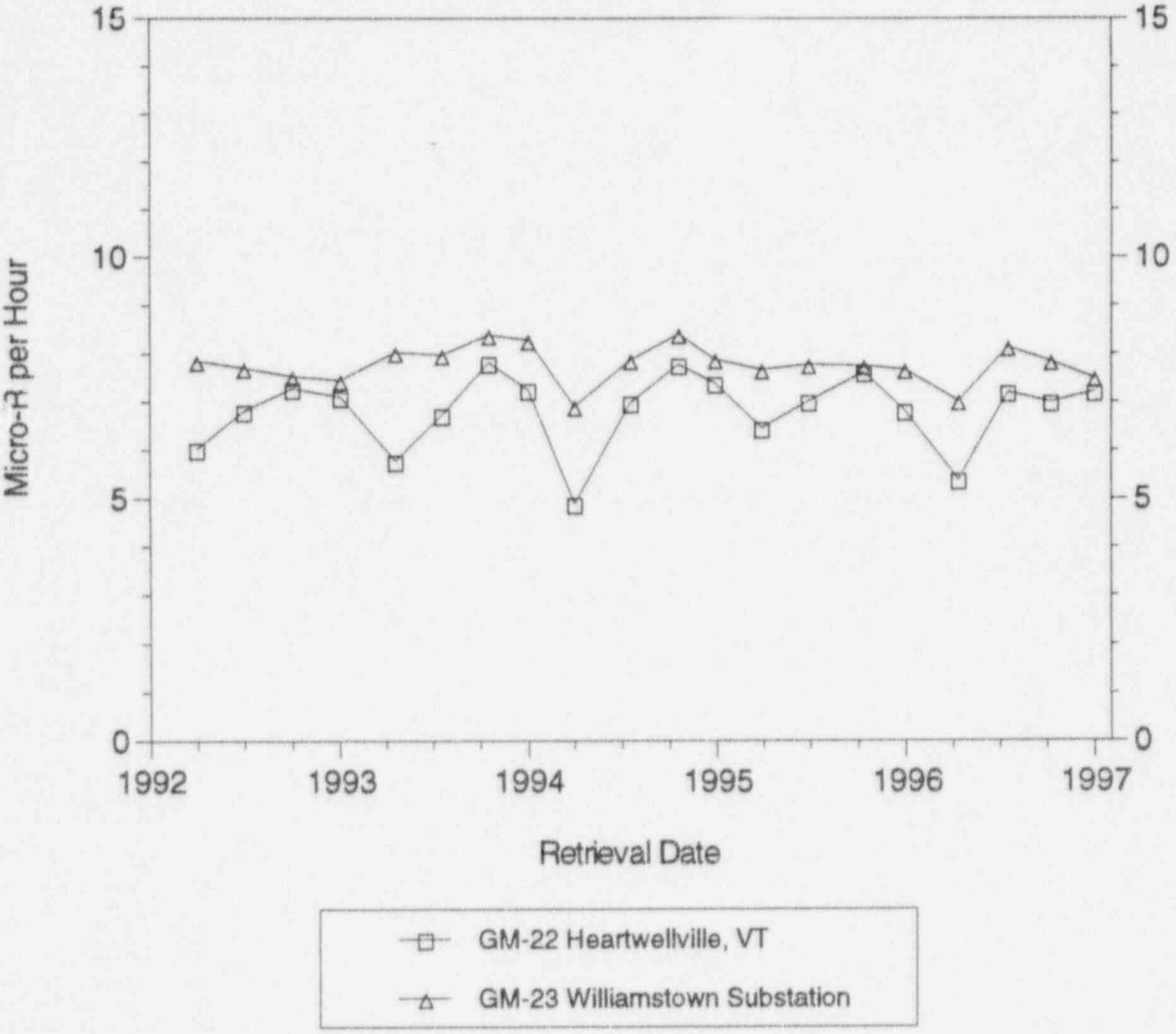


FIGURE 6.26

EXPOSURE RATE AT CONTROL TLDS, GM 22-23



7. QUALITY ASSURANCE PROGRAM

The quality assurance program at the YAEL 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 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, as part of the quality assurance program, provides a means to control and measure the characteristics of measurement equipment and processes, relative to established requirements.

The YAEL employs a comprehensive quality assurance program designed to monitor the quality of analytical processing to ensure reliable environmental monitoring data. The program includes the use of approved and controlled procedures for all work activities, a nonconformance and corrective action tracking system, systematic internal audits, audits by external groups, a laboratory quality control program, and a staff training and retraining system. Monitoring programs include the Intralaboratory Quality Control Program administered by the Laboratory QA Officer (used in conjunction with the National Institute of Standards and Technology's Measurement Assurance Program, NIST MAP) and third party interlaboratory programs administered by the EPA and Analytics, Inc. Together these programs are targeted to supply QC/QA sources at 5% of the routine sample analysis load. In addition the Laboratory Quality Control Audit Committee conducts a blind duplicate quality assurance program.

7.1 Intralaboratory Quality Control Program

The YAEL conducts an extensive intralaboratory quality control program to assure the validity and reliability of environmental analytical data. Process check samples are either samples submitted in duplicate to evaluate the precision of the measurements or are "spiked" with a known quantity of radioactive material to assess the bias in the measurement. The program is administered by the Laboratory QA Officer. A summary of the program process check results may be found in Table 7.1. For each of the three results falling in category 4 of the Bias Criteria, the mean bias for the set was within the ±15% and no further action was required.

7.2 Third Party Intercomparison Program

To further verify the accuracy and precision of the Laboratory analyses the YAEL participates in two independent third parties intercomparison programs. At the end of 1995 the U.S. Environmental Protection Agency stopped its Environmental Intercomparison Studies Program. To replace the mix of radionuclides and matrices which comprised this one program the Laboratory now participates in two third party programs, the U.S. EPA Performance Evaluation Study for radionuclides in water and the Analytics Inc. Environmental Cross Check Program for radionuclides in milk, water and on air filters. Participation in such programs and the reporting of results in this report is pursuant to ODCM Part B, Section 4.0 and Technical Specification 6.8.1.3.

Each sample supplied by the EPA or Analytics is analyzed in triplicate and the results are returned to the EPA or Analytics within a specified time frame. When the known values are returned to the Laboratory, the results are evaluated against specific Laboratory acceptance criteria and the EPA results are also evaluated against the EPA control limits. When the results of the cross-check analysis fall outside of the acceptance criteria or control limit, an investigation is initiated to determine the cause of the problem and if appropriate, corrective measures are taken.

For the EPA Intercomparison Program, 26 sample sets in a water matrix were analyzed. The analyses included gamma-emitting radionuclides, gross alpha, gross-beta, Sr-89, Sr-90, low level I-131, tritium (H-3), Ra-226, Ra-228 and Natural Uranium. Table 7.2 provides a summary of the results for 1996.

One result did not fall within the EPA control limits and is described below:

- The mean value for Gross Alpha in water (Reference date 7/19/96) of 10.82 pCi/L failed to fall within the EPA control limits of 13.8 - 35 pCi/L. An investigation was conducted (YLCAR IG-02-96) which indicated that the deposition of solids during processing was the likely root of the problem (EL 608/96). Subsequent processing of and EPA gross alpha set (Reference date 10/25/96) and a process check set (Reference date 01/22/97) yielded a mean bias of +1.6% and -2.9%, respectively. The Laboratory is continuing to investigate the development of a mass correction curve.

For the Analytics Inc. Cross Check Program, 18 sample sets in water, milk and air filter matrices were analysed. The analyses included gamma-emitting radionuclides, gross alpha, gross-beta, Sr-89, Sr-90, low level I-131, tritium (H-3), Ra-226, Ra-228 and Natural Uranium. Table 7.32 provides a summary of the results for 1996.

The Analytics results which failed to meet the criteria for acceptance are discussed below.

- YAEL Inquiry 3-96 was issued in response to the failure of the results for Mn-54 and Fe-59 in sample set E0717-162 (Reference date 2nd quarter, 1996) to meet the acceptance criteria of ±15%. The investigation determined that the root cause was differences in the filter spiking techniques used at the Laboratory and Analytics (EL 522/96 and EL 614/96). A mixed gamma filter calibration source was purchased and used to set up a calibration curve for the Analytics filter geometry. The mean bias was re-evaluated for all nuclides and was found to be +2.9%. No further action is considered necessary.

- The reported mean bias for the gross beta on air filter set E0902-162 failed to meet the criteria for agreement of ±15%. A corrective action request was issued on 3/18/97, YLCAR IG06-97.

7.3 Environmental TLD Quality Assurance Program

Performance documentation of the routine processing of the Panasonic environmental TLDs (thermoluminescent dosimeter) program at the YAEL is provided by the dosimetry quality assurance testing program.. This program includes the National Voluntary Laboratory Accreditation Program, independent third party performance testing by Battelle Pacific Northwest Labs and internal performance testing conducted by the Laboratory Quality Assurance Officer. Under these programs, dosimeters are irradiated to ANSI specified testing criteria and submitted for processing to the Dosimetry Services Group as "unknowns". The bias and precision of TLD processing is measured against this standard and is used to indicate trends and changes in performance. Instrumentation checks, although routinely performed by the Dosimetry Services Group and representing between 5-10% of the TLDs processed, are not presented in this report because they do not represent a true process check sample since the doses are known to the processor.

The YAEL processed 3232 environmental TLDs during 1996. Ninety-six independent performance tests were conducted. Of these 96 TLDs, 72 were submitted by the Dosimetry QA Officer and 24 were submitted as part of Battelle Pacific Northwest Laboratories testing program. All of these, or 100% met the acceptance criteria for accuracy and precision with an average bias during the first half of 1996 of 0.7±2.6 and -3.8±5.0 during the second half of 1996.

7.4 Blind Duplicate Quality Assurance Program

The Laboratory Quality Control Audit Committee (LQCAC) is comprised of one member from each of the five sponsor power plants that are serviced by the YAEL. 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 the Yankee Nuclear Power Station. 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.

Forty-nine paired samples were submitted under this program by the five participating plants during 1996. Paired measurements were evaluated for 26 gamma emitting radionuclides, H-3, Sr-89, Sr-90, I-131 and gross-beta. All measurements are evaluated, whether the results are statistically positive or not, and whether the net concentration is positive or negative. Of the 1283 paired measurements evaluated in 1996, 1273 (99.2%) fell within the established acceptance criteria. Only one of the ten measurements falling outside the acceptance is considered to have statistically positive gross beta activity and is being addressed by the Laboratory as corrective action YLCAR IG07-97.

The samples submitted through this program are listed in Table 7.4.

TABLE 7.1

ENVIRONMENTAL PROCESS CONTROL ANALYSIS RESULTS BY YANKEE ATOMIC ENVIRONMENTAL LABORATORY ACCEPTANCE CRITERIA, MEDIA, AND MEASUREMENT CATEGORIES JANUARY-DECEMBER, 1996

	Bias Criteria (1)				Precision Criteria (2)			
	1	2	3	4	1	2	3	4
I. Air Charcoal								
Gamma	42	5	3					
II. Air Filter								
Beta	97	4						
III. Milk								
Gamma	23	8	4	1	29	4	3	
Iodine (LL)	10	4	3	1	12	5	1	
IV. Water								
Gross Alpha			2	1		2		1
Gross Beta	4	2			6			
Gamma								
Iodine								
Radium								
Strontium								
Tritium								
V. Sediment/Soil								
Gamma					14	4	6	
Total Number in Range:	**176**	**23**	**12**	**3**	**61**	**15**	**10**	**1**
Percentage of Total Processed:	**82**	**11**	**6**	**1**	**70**	**17**	**11**	**1**
Sum of Analyses:		**214**				**87**		

(1) Percent Bias Criteria by Bias Category
- Bias Category = 1 > 0% and <= 5%
- Bias Category = 2 >5% and <= 10%
- Bias Category = 3 > 10% and <= 15%
- Bias Category = 4 Outside Criteria

(2) Precision Criteria by Precision Category
- Precision Category = 1 >0% and <= 5%
- Precision Category = 2 >5% and <= 10%
- Precision Category = 3 >10% and <= 15%
- Precision Category = 4 Outside Criteria

* Total may not equal 100 due to rounding

Table 7.2

Yankee Atomic Environmental Laboratory 1996 EPA Intercomparison Program					
NUCLIDE	MEDIA	REFERENCE DATE	E-LAB MEAN*	LOWER CONTROL LIMIT*	UPPER CONTROL LIMIT*
Co-60	Water	10/17/95	47.36	40.3	57.7
Cs-134	Water	10/17/95	36.96	31.3	48.7
Cs-137	Water	10/17/95	29.86	21.3	38.7
Nat. U	Water	10/17/95	26.5	21.8	32.2
Ra-226	Water	10/17/95	26	18.4	31.2
Ra-228	Water	10/17/95	21.1	11.7	29.7
Sr-89	Water	10/17/95	22.53	11.3	28.7
Sr-90	Water	10/17/95	9.74	1.3	18.7
Ba-133	Water	11/03/95	94.1	81.7	116.3
Co-60	Water	11/03/95	58.77	51.3	68.7
Cs-134	Water	11/03/95	36.55	31.3	48.7
Cs-137	Water	11/03/95	50.77	40.3	57.7
Sr-89	Water	01/23/96	79.2	64.3	81.7
Sr-90	Water	01/23/96	4.65	0	13.7
Zn-65	Water	11/03/95	126.6	102.4	147.6
H-3	Water	03/08/96	23429.8	18185.1	25818.9
Co-60	Water	04/16/96	31.4	22.3	39.7
Cs-134	Water	04/16/96	43.03	37.3	54.7
Cs-137	Water	04/16/96	49.02	41.3	58.7
Nat. U	Water	04/16/96	55.47	48.3	68.5
Ra-226	Water	04/16/96	3.6	2.1	3.9
Ra-228	Water	04/16/96	5.14	2.7	7.3
Sr-89	Water	04/16/96	46.07	34.3	51.7
Sr-90	Water	04/16/96	14.73	7.3	24.7
Ba-133	Water	06/07/96	734.63	614.9	875.1
Co-60	Water	06/07/96	95.99	90.3	107.7
Cs-134	Water	06/07/96	76.35	70.3	87.7
Cs-137	Water	06/07/96	198.1	179.7	214.3
Zn-65	Water	06/07/96	303.43	248	352
Nat. U	Water	06/21/96	19.02	15	25.4
Ra-226	Water	06/21/96	5.39	3.7	6.1
Ra-228	Water	06/21/96	8.07	5	13

* Units in pCi/Liter

Table 7.2, continued

Yankee Atomic Environmental Laboratory 1996 EPA Intercomparison Program					
NUCLIDE	MEDIA	REFERENCE DATE	E-LAB MEAN*	LOWER CONTROL LIMIT*	UPPER CONTROL LIMIT*
Sr-89	Water	07/12/96	24.37	16.3	33.7
Sr-90	Water	07/12/96	11.92	3.3	20.7
Alpha	Water	07/19/96	10.82	13.8	35
Beta	Water	07/19/96	40.53	36.1	53.5
H-3	Water	08/09/96	10227.8	8991.4	12766.6
Nat. U	Water	09/27/96	9.68	4.9	15.3
Ra-226	Water	09/27/96	13.22	10.4	17.6
Ra-228	Water	09/27/96	6.24	2.6	6.8
I-131LL	Water	10/04/96	28.24	16.6	37.4
Co-60	Water	10/15/96	13.71	6.3	23.7
Cs-134	Water	10/15/96	18.99	11.3	28.7
Cs-137	Water	10/15/96	30.02	21.3	38.7
Nat. U	Water	10/15/96	38.74	33.8	48
Ra-226	Water	10/15/96	9.07	7.3	12.5
Ra-228	Water	10/15/96	6.67	2.8	7.4
Sr-89	Water	10/15/96	11.8	1.3	18.7
Sr-90	Water	10/15/96	22.93	16.3	33.7
Alpha	Water	10/25/96	10.47	1.6	19
Beta	Water	10/25/96	34.6	28.2	47.2
Ba-133	Water	11/08/96	60.94	53.6	74.4
Co-60	Water	11/08/96	43.68	35.3	52.7
Cs-134	Water	11/08/96	10.65	2.3	19.7
Cs-137	Water	11/08/96	19.74	10.3	27.7
Zn-65	Water	11/08/96	34.46	26.3	43.7
Nat U	Water	12/06/96	4.71	0	10.2
Ra-226	Water	12/06/96	18.62	14.9	25.3
Ra-228	Water	12/06/96	10.5	5.7	14.7

* Units in pCi/Liter

Table 7.3

YAEL 1996 ANALYTICS CROSS-CHECK RESULTS

Sample: E0642-162; E0645-162 Sr89/90 — Quarter: 1st, 1996
Media: Milk — Units: pCi/L

Nuclide	Reported Value	Known Value	Ratio YAEL/ Analytics	Evaluation
Cr-51	875	858	1.02	Agreement
Mn-54	88	84	1.05	Agreement
Co-58	132	128	1.03	Agreement
Fe-59	235	223	1.05	Agreement
Co-60	207	204	1.01	Agreement
Zn-65	267	260	1.03	Agreement
Sr-89	35	31	1.13	Agreement
Sr-90	17	16	1.06	Agreement
I-131	11	13	0.85	Agreement
I-131LL	11.8	13	0.91	Agreement
Cs-134	155	154	1.01	Agreement
Cs-137	170	170	1	Agreement
Ce-141	237	234	1.01	Agreement

Sample: E0643-162; E0641-162 Alpha/Beta; E0644-162 Ra/U — Quarter: 1st, 1996
Media: Water — Units: pCi/L

Nuclide	Reported Value	Known Value	Ratio YAEL/ Analytics	Evaluation
Alpha	12	10	1.2	Agreement
Beta	118	107	1.03	Agreement
Cr-51	328	322	1.02	Agreement
Mn-54	30	31	0.97	Agreement
Co-58	48	48	1	Agreement
Fe-59	85	83	1.02	Agreement
Co-60	73	76	0.96	Agreement
Zn-65	90	97	0.93	Agreement
I-131	34	36	0.94	Agreement
Cs-134	55	58	0.95	Agreement
Cs-137	63	64	0.98	Agreement
Ce-141	88	88	1	Agreement
Ra-226	68	70	0.97	Agreement
Ra-228	49	49	1	Agreement
U-234	40	40	1	Agreement
U-238	42	41	1.02	Agreement

Table 7.3 Continued

YAEL 1996 ANALYTICS CROSS-CHECK RESULTS

Sample: E0717-162 | Quarter: 2nd, 1996
E0716-162 Alpha/Beta
E0719-162 Sr89/90
Media: Air Filter | Units: pCi/Filter

Nuclide	Reported Value	Known Value	Ratio YAEL/ Analytics	Evaluation
Alpha	41	40	1.03	Agreement
Beta	185	179	1.03	Agreement
Cr-51	1071	953	1.12	Agreement
Mn-54	597	508	1.18	Non-Agreement
Co-58	176	157	1.12	Agreement
Fe-59	151	131	1.15	Non-Agreement
Co-60	153	142	1.08	Agreement
Zn-65	110	98	1.12	Agreement
Sr-89	<MDC	44 pCi/Filter		-------
Sr-90	57	64	0.89	Agreement
Cs-134	281	282	1	Agreement
Cs-137	797	694	1.15	Agreement
Ce-141	380	363	1.05	Agreement

Sample: E0718-162 | Quarter: 2nd, 1996
E0720-162
Media: Milk | Units: pCi/L
Water H-3

Nuclide	Reported Value	Known Value	Ratio YAEL/ Analytics	Evaluation
H-3	4580	4915	0.93	Agreement
K-40	1350	1269	1.06	Agreement
Cr-51	581	563	1.03	Agreement
Mn-54	311	300	1.04	Agreement
Co-58	93	93	1	Agreement
Fe-59	82	77	1.06	Agreement
Co-60	84	84	1	Agreement
Zn-65	53	58	0.91	Agreement
I-131	16	15	1.07	Agreement
Cs-134	167	166	1.01	Agreement
Cs-137	409	410	1	Agreement
Ce-141	219	215	1.02	Agreement

Table 7.3 Continued

YAEL 1996 ANALYTICS CROSS-CHECK RESULTS

Sample: E0818-162 Quarter: 3rd, 1996
E0820-162 Sr89/90
Media: Milk Units: pCi/L

Nuclide	Reported Value	Known Value	Ratio YAEL/ Analytics	Evaluation
Cr-51	514	486	1.06	Agreement
Mn-54	189	180	1.05	Agreement
Co-58	132	131	1.01	Agreement
Fe-59	40.8	37	1.1	Agreement
Co-60	118	114	1.04	Agreement
Zn-65	73	70	1.04	Agreement
Sr-89	54	50	1.08	Agreement
Sr-90	22	22	1	Agreement
I-131	24.5	24	1.02	Agreement
Cs-134	226	222	1.02	Agreement
Cs-137	176	169	1.04	Agreement
Ce-141	325	318	1.02	Agreement

Sample: E0819-162 Quarter: 3rd, 1996
E0817-162 Alpha/Beta
E0821-162 Sr89/90
Media: Water Units: pCi/L

Nuclide	Reported Value	Known Value	Ratio YAEL/ Analytics	Evaluation
Alpha	77	74	1.04	Agreement
Beta	77	70	1.1	Agreement
Cr-51	650	646	1.01	Agreement
Mn-54	248	239	1.04	Agreement
Co-58	172	174	0.99	Agreement
Fe-59	51	50	1.02	Agreement
Co-60	155	151	1.03	Agreement
Zn-65	98	93	1.05	Agreement
Sr-89	47	40	1.18	Agreement
Sr-90	36	35	1.03	Agreement
I-131	49	50	0.98	Agreement
Cs-134	299	295	1.01	Agreement
Cs-137	226	225	1	Agreement
Ce-141	420	423	0.99	Agreement

Table 7.3 Continued

YAEL 1996 ANALYTICS CROSS-CHECK RESULTS

Sample:/Media	E0901-162 E0902-162 E0903-162	Milk Filter Sr-89,90 Water H-3	Quarter: Units:	4th, 1996 pCi/L pCi/Filter
Nuclide	Reported Value	Known Value	Ratio YAEL/ Analytics	Evaluation
Alpha	75	80	0.94	Agreement
Beta	199	170	1.17	Non-Agreement
H-3	2440	2686	0.91	Agreement
Cr-51	202	214	0.94	Agreement
Mn-54	217	206	1.05	Agreement
Co-58	120	121	0.99	Agreement
Fe-59	52	49	1.06	Agreement
Co-60	113	110	1.03	Agreement
Zn-65	94	93	1.01	Agreement
Sr-89	102	96	1.06	Agreement
Sr-90	72	77	0.94	Agreement
I-131	65	59	1.10	Agreement
I-131LL	56	59	0.95	Agreement
Cs-134	168	175	0.96	Agreement
Cs-137	194	195	0.99	Agreement
Ce-141	278	277	1.00	Agreement

TABLE 7.4

SUMMARY OF BLIND DUPLICATE SAMPLES SUBMITTED
January - December 1996

TYPE OF SAMPLE	NUMBER OF PAIRED SAMPLES SUBMITTED
Cow Milk	21
Ground Water	6
Surface Water	15
Irish Moss	2
Mussels	4
Food Product - Cranberries	1
TOTAL	49

8. LAND USE CENSUS

A Land Use Census is conducted annually between the dates of June 1 and October 1 to identify the locations of the nearest milk animal, the nearest residence and the nearest garden of greater than 500 square feet producing fresh leafy vegetables in each of the 16 meteorological sectors within a distance of five miles of the plant. Immediately following the collection of field data, in compliance with ODCM Control 4.2, a dosimetric analysis is performed to compare the census locations to the "Critical Receptor" identified in the 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 ODCM Surveillance Requirement 3.4). 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 which location to use as a Critical Receptor would also be done at that time. For the 1996 Census, no such locations were identified.

Pursuant to ODCM Control 4.2, a dosimetric analysis is then performed, using site specific meteorological data, to determine which milk and food product census 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 later eliminated from the program). For the 1996 Census, no such garden or milk animal locations were identified, and consequently no changes were mandated for the food product, broadleaf vegetation or milk sampling programs.

The Land Use Census was carried out and completed between the dates of June 1 and October 1, as required. The results of the 1996 Land Use Census are included in this report in compliance with ODCM Surveillance Requirement 4.2. The locations identified during the Census may be found in Table 8.1.

TABLE 8.1
1996 LAND USE CENSUS LOCATIONS

SECTOR	NEAREST RESIDENCE Km (Mi)	NEAREST GARDEN Km (Mi)	NEAREST MILK ANIMAL Km (Mi)
N	4.8 (3.0)	6.1 (3.8)	6.1 (3.8) (Cow)
NNE	4.4 (2.75)	4.7 (2.9)	*
NE	3.1 (1.9)	3.7 (2.3)	*
ENE	3.9 (2.4)	5.8 (3.6)	8.4 (5.2) (Cow)
E	3.0 (1.9)	3.4 (2.1)	*
ESE	3.2 (2.0)	3.7 (2.3)	3.5 (2.2) (Goat)
SE	2.3 (1.4)	3.5 (2.2)	3.2 (2.0) (Cow)
SSE	2.1 (1.3)	3.6 (2.3)	*
S	2.3 (1.4)	2.9 (1.8)	*
SSW	*	*	*
SW	1.3 (0.8)	7.9 (4.9)	*
WSW	1.3 (0.8)	1.3 (0.8)	*
W	1.9 (1.2)	2.7 (1.7)	6.9 (4.3) (Goat)
WNW	1.9 (1.2)	1.9 (1.2)	*
NW	2.4 (1.5)	4.6 (2.8)	*
NNW	2.9 (1.8)	3.9 (2.4)	*

* No location was identified within 5 miles of the plant.

9. SUMMARY

During 1996, as in all previous years since 1958, an environmenal monitoring program was conducted to assess the levels of radiation or radioactivity in the Yankee Nuclear Power Station environment. Over 1,000 samples were collected (including TLDs) over the course of the year, with a total of over 3,000 radionuclide or exposure rate analyses being performed on them. The samples included ground water, river water, storm drain water, sediment, fish, locally grown food products, mixed vegetation, maple syrup and milk. 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 naturally-occurring K-40, Be-7, Th-232 or radon daughter products. Many samples (milk, sediment and maple syrup) had fallout radioactivity from atmospheric nuclear weapons tests conducted primarily from the late 1950's through 1980. Several samples had low levels of radioactivity resulting from emissions from YNPS. These were all collected in the immediate vicinity of the plant or from on-site locations. In all cases, the possible radiological impact was negligible with respect to exposure from natural background radiation. In no case did the detected levels approach or 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. Letter, "Issuance of Amendment No. 146 to Facility Possession Only License No. DPR-3- Yankee Nuclear Power Station," M. Fairtile, NRC to J. Grant, Yankee Atomic Electric Company, dated November 5, 1992.

6. NRC Generic Letter 89-01, Subject: Implementation of Programmatic Controls for Radiological Effluent Technical Specifications in the Administrative Controls Section of the Technical Specifications and the Relocation of Procedural Details of RETS to the Offsite Dose Calculation Manual or to the Process Control Program. Dated January 31, 1989.