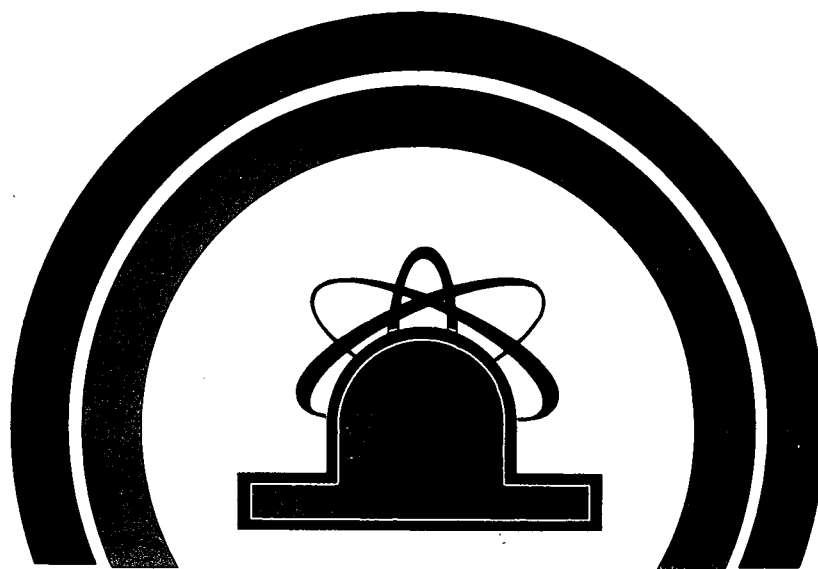


Environmental Surveillance Report

January 1, 1988 — December 31, 1988



**H.B. ROBINSON
STEAM ELECTRIC PLANT**

Unit No. 2

CAROLINA POWER & LIGHT COMPANY

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Shearon Harris Energy & Environmental Center
Carolina Power & Light Company
New Hill, North Carolina

ENVIRONMENTAL RADIOLOGICAL MONITORING REPORT

FOR

H.B. ROBINSON STEAM ELECTRIC PLANT

JANUARY 1, 1988, THROUGH DECEMBER 31, 1988

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1.0 SUMMARY

The Radiological Environmental Surveillance Program was conducted in accordance with the Robinson Technical Specification, Off-Site Dose Calculation Manual, and approved procedures.

The purpose of the Radiological Environmental Surveillance Program is to measure any accumulation of radioactivity in the environment, to determine whether this radioactivity is the result of the operation of the H.B. Robinson Plant, and to assess the potential dose to off-site populations based on the cumulative measurement of radiation of plant origin. Over 1,228 sample analyses and measurements were taken during the year. Detectable radioactivity resulting from plant operation was found in 28 of the 1,228 analyses.

1. Radioactivity in environmental samples which could be attributed to plant operations in 1988 is as follows:

<u>Sample Media</u>	<u>Radio-nuclide</u>	<u>Average Concentration and Occurrence Fraction</u>	<u>Maximum Individual Dose (mrem/yr)</u>
Fish	Cs-134	39.9 pCi/kg wet (3/4)	0.124
Shoreline sediment (ash pond)	Cs-137	134 pCi/kg dry (2/2)	0.0004
Surface water	H-3	1,990 pCi/l (23/24)	0.004

2. All detectable radionuclides in the samples for 1988 were less than technical specifications' reportable levels.
3. Environmental analyses performed during 1988 demonstrate that the H.B. Robinson Steam Electric Plant continues to operate with minimum impact on the environment and little dose to the general public.

The following locations are used as control locations and are intended to indicate conditions away from the H.B. Robinson Plant influence.

Florence
(Sample Location 1)

Thermoluminescent Dosimetry Area Monitors
Airborne Iodine and Particulate Samples

Black Creek Above Lake Robinson at US 1
(Sample Location 41)

Surface Water

Lake Bee or May Lake
(Sample Location 47)

Fish

Lyndale's Farm
(Sample Location 53)

Milk

10 miles W. Bethune
(Sample Location 52)

Broadleaf Vegetation

> 5 miles from plant with
lowest deposition rate (D/Q)
(Sample Location 49)

Food Crop

A statistical summary of all the data gathered in 1988 has been compiled in Table 1-1.

ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM SUMMARY

H.B. Robinson Steam Electric Plant
Darlington County, South Carolina

Docket Numbers - 50-261
Calendar Year 1988

Medium or Pathway Sampled or Measured (Unit of Measurement)	Type and Total No. of Measurements Performed	Typical Lower Limit of Detection (LLD) (1)	All Indicator Locations (2) Mean Range	Location w/Highest Annual Mean		Control Location Mean Range (2)
				Name, Distance, and Direction	Mean Range (2)	
Air Cartridge (pCi/m ³)	1-131 364 ⁽³⁾	1.0E-2	All less than LLD		All less than LLD	All less than LLD
Air Particulate (pCi/m ³)	Gross Beta 364 ⁽³⁾	1.3E-3	1.62E-2 (313/313) 8.31E-3 - 3.11E-2	Site Boundary 0.3 mile SSE	2.56E-2 (4/4) 1.88E-2 - 3.11E-2	1.59E-2 (51/51) 7.86E-3 - 2.27E-2
	Gamma 29	N/A	All less than LLD		All less than LLD	All less than LLD
Broadleaf Vegetation (pCi/g) wet	Gamma 59 ⁽⁴⁾	1.5E-2	1.78E-1 (28/36) 3.43E-2 - 9.91E-1	CP&L Property 0.25 mile NNE	1.99E-1 (13/18) 3.43E-2 - 5.88E-1	1.74E-1 (18/23) 1.95E-2 - 8.18E-1
	Cs-137					
Fish (pCi/g) wet Bottom-Feeder	Gamma 6	1.7E-2	3.22E-2 (3/4) 1.61E-2 - 4.57E-2	Prestwood Lake 4.9 miles ESE	4.57E-2 (1/2) Single Value	All less than LLD
	Cs-134					
	Cs-137	1.8E-2	1.46E-1 (4/4) 1.06E-1 - 2.17E-1	Prestwood Lake 4.9 miles ESE	1.61E-1 (2/2) 1.06E-1 - 2.17E-1	1.16E-1 (2/2) 1.03E-1 - 1.29E-1
	K-40	5.0E-1	2.69E+0 (4/4) 2.29E+0 - 2.97E+0	Lake Robinson site varies	2.89E+0 (2/2) 2.82E+0 - 2.97E+0	2.76E+0 (2/2) 2.47E+0 - 3.06E+0
Fish (pCi/g) wet Free-Swimmer	Gamma 6	1.7E-2	5.29E-2 (3/4) 3.20E-2 - 6.88E-2	Lake Robinson site varies	6.88E-2 (1/2) Single value	All less than LLD
	Cs-134					
	Cs-137	1.8E-2	1.90E-1 (4/4) 1.03E-1 - 2.91E-1	Prestwood Lake 4.9 miles ESE	2.33E-1 (2/2) 1.76E-1 - 2.91E-1	2.59E-1 (2/2) 2.24E-1 - 2.95E-1
	K-40	5.0E-1	2.59E+0 (4/4) 2.32E+0 - 2.81 E+0	Lake Robinson site varies	2.62E+0 (2/2) 2.62E+0 - 2.63+0	2.89E+0 (2/2) 2.85E+0 - 2.94E+0
Food Products (pCi/g) wet	Gamma 2	N/A	All less than LLD		All less than LLD	All less than LLD

ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM SUMMARY

H.B. Robinson Steam Electric Plant
Darlington County, South Carolina

Docket Numbers - 50-261
Calendar Year 1988

Medium or Pathway Sampled or Measured (Unit of Measurement)	Type and Total No. of Measurements Performed	Typical Lower Limit of Detection (LLD) (1)	All Indicator Locations (2) Mean Range	Location w/Highest Annual Mean		Control Location Mean Range (2)
				Name, Distance, and Direction	Mean Range (2)	
Groundwater (pCi/l)	Gamma 33(5)	N/A	All less than LLD		All less than LLD	No control
	Tritium 30	1.2E+3	All less than LLD		All less than LLD	No control
Milk (pCi/l)	I-131 52	3.0E-1	All less than LLD		All less than LLD	All less than LLD
	Gamma 52	N/A	All less than LLD		All less than LLD	All less than LLD
Shoreline Sediment (pCi/g) dry	Gamma 4	3.6E-2	1.34E-1 (2/4) 1.01E-1 - 1.67E-1	Ash Pond 0.9 mile NNW	1.34E-1 (2/2) 1.01E-1 - 1.67E-1	No control
	Cs-137					
Surface Water (pCi/l)	Gamma 36	N/A	All less than LLD		All less than LLD	All less than LLD
	Tritium 36	1.2E+3	1.99E+3 (23/24) 1.18E+3 - 2.78E+3	SC-23 at Black Creek 0.6 mile ESE	2.05E+3 (12/12) 1.36E+3 - 2.78E+3	All less than LLD
TLD (mrem/wk)	TLD 155(6)	1 mR	1.05E+0 (151/151) 1.00E+1 - 1.90E+0	Intersection of SR 31-51 and 16-12 4.4 miles SSW	1.77E+0 (3/3) 1.70E+0 - 1.90E+0	1.10E+0 (4/4) 1.00E+0 - 1.30E+0

FOOTNOTES:

1. The Lower Limit of Detection (LLD) is the smallest concentration of radioactive material in a sample that will yield a net count above system background which will be detected with 95 percent probability with only 5 percent probability of falsely concluding that a blank observation represents a "real" signal.
2. Mean and range are based on detectable measurements only. The fractions of detectable measurements at specific locations are indicated in parentheses.
3. Air particulate and charcoal cartridges are collected weekly for a possible total of 364 (7 locations x 52 weeks) samples. Missing samples are discussed in Section 4.1.
4. Broadleaf vegetation samples are collected monthly when available from three locations for a possible total of 108 samples. The 24 missing samples are discussed in Section 4.2.
5. Groundwater samples are collected monthly from three locations for a possible total of 36 samples. The three missing samples and the three missing additional tritium analyses are discussed in Section 4.3.
6. TLDs are collected quarterly from 39 locations for a possible total of 156 analyses. The missing TLD is discussed in Section 4.4.

2.0 GENERAL INFORMATION

The following report summarizes the radiological environmental data for the H.B. Robinson Steam Electric Plant during the calendar year 1988. The surveillance requirements for this report were performed by the requirements of the Radiological Effluent Technical Specifications (RETS) which were implemented on January 1, 1985.

2.1 Plant and Location

The H.B. Robinson Steam Electric Plant is located in northeastern South Carolina near Hartsville and approximately 25 miles northwest of Florence. This site includes a fossil-fueled plant, Unit 1, which was placed in service in 1960 and a pressurized water nuclear power reactor, Unit 2, which entered commercial operation on March 7, 1971. The Robinson Impoundment (hereafter referred to as Lake Robinson) on the plant site was created for Unit 1 and is also a cooling reservoir for Unit 2. Lake Robinson has an area of 2250 acres with plant intake at the south end adjacent to the dam. Following condenser use, the water is returned by a 4.2-mile canal to the north end of Lake Robinson near the mouth of Black Creek which flows into the lake from the north.

2.2 Radiological Impact Considerations

Potential population exposure due to plant operations is most significant in the liquid release fish-man pathway. Two additional pathways are also potentially important. These are the airborne radioiodine-pasture-milk pathway and the direct external radiation exposure to individuals on the ground from plumes of noble gases. Contact with Lake Robinson, including boating and immersion (swimming), constitutes an insignificant dose to man.

2.3 Environmental Monitoring Program

The required environmental sampling is defined by technical specifications. The program, as implemented by the plant, is described in the ODCM. The objectives of the program are to monitor the specific elements of exposure pathways. The sampling media and release pathways are listed below.

<u>Sampling Media</u>	<u>Release Pathway</u>
Glass Fiber Filter	Gaseous
Iodine Collection Cartridge	Gaseous
TLDs	Gaseous
Surface Water	Liquid
Groundwater	Liquid
Shoreline Sediment	Liquid
Milk	Gaseous and liquid (when irrigating)
Fish	Liquid
Food Crops	Gaseous
Broadleaf Vegetation (when there is no milk locations within 5 miles of plant site)	Gaseous

SYMBOL	SAMPLE TYPE	
AC	AIR CARTRIDGE	1-7, 55
AP	AIR PARTICULATE	1-7, 55
SS	SHORELINE SEDIMENT	44 67
GW	GROUNDWATER	40 42 43
BL	BROADLEAF VEGETATION	50 51 52
SW	SURFACE WATER	40 41
TL	TLD	1-39
MK	MILK	53 54
FI	FISH	46 46 47
FC	FOOD PRODUCTS	49 54

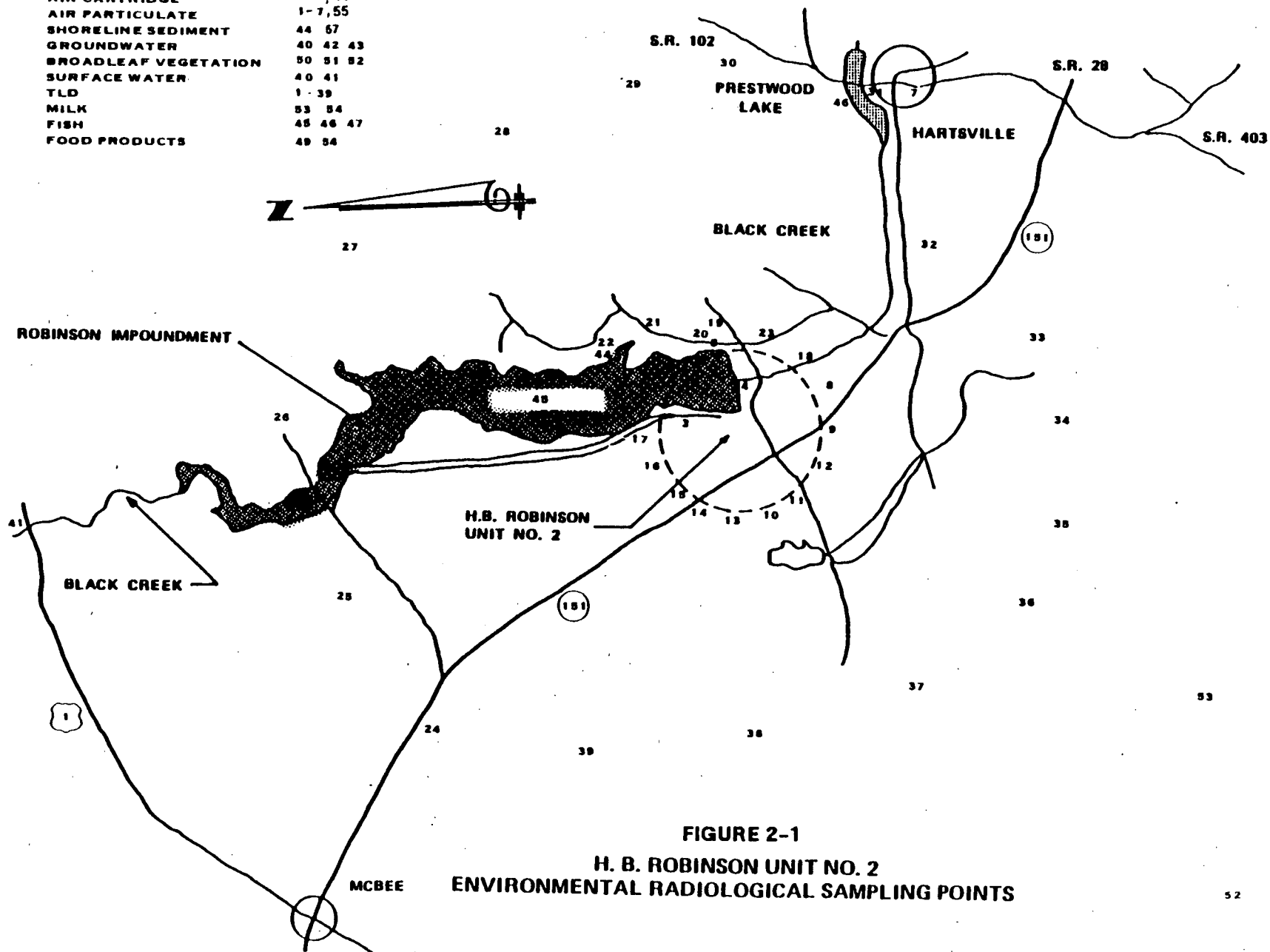


FIGURE 2-1
H. B. ROBINSON UNIT NO. 2
ENVIRONMENTAL RADIOLOGICAL SAMPLING POINTS

2-3

47

49 Varies

52

SYMBOL	SAMPLE TYPE	
AC	AIR CARTRIDGE	1-7, 55
AP	AIR PARTICULATE	1-7, 55
SS	SHORELINE SEDIMENT	44 57
GW	GROUNDWATER	40 42 43
BL	BROADLEAF VEGETATION	30 31 32
SW	SURFACE WATER	40 41
TLD		1-39
MILK		53 54
FISH		45 46 47
FOOD PRODUCTS		48 54 58

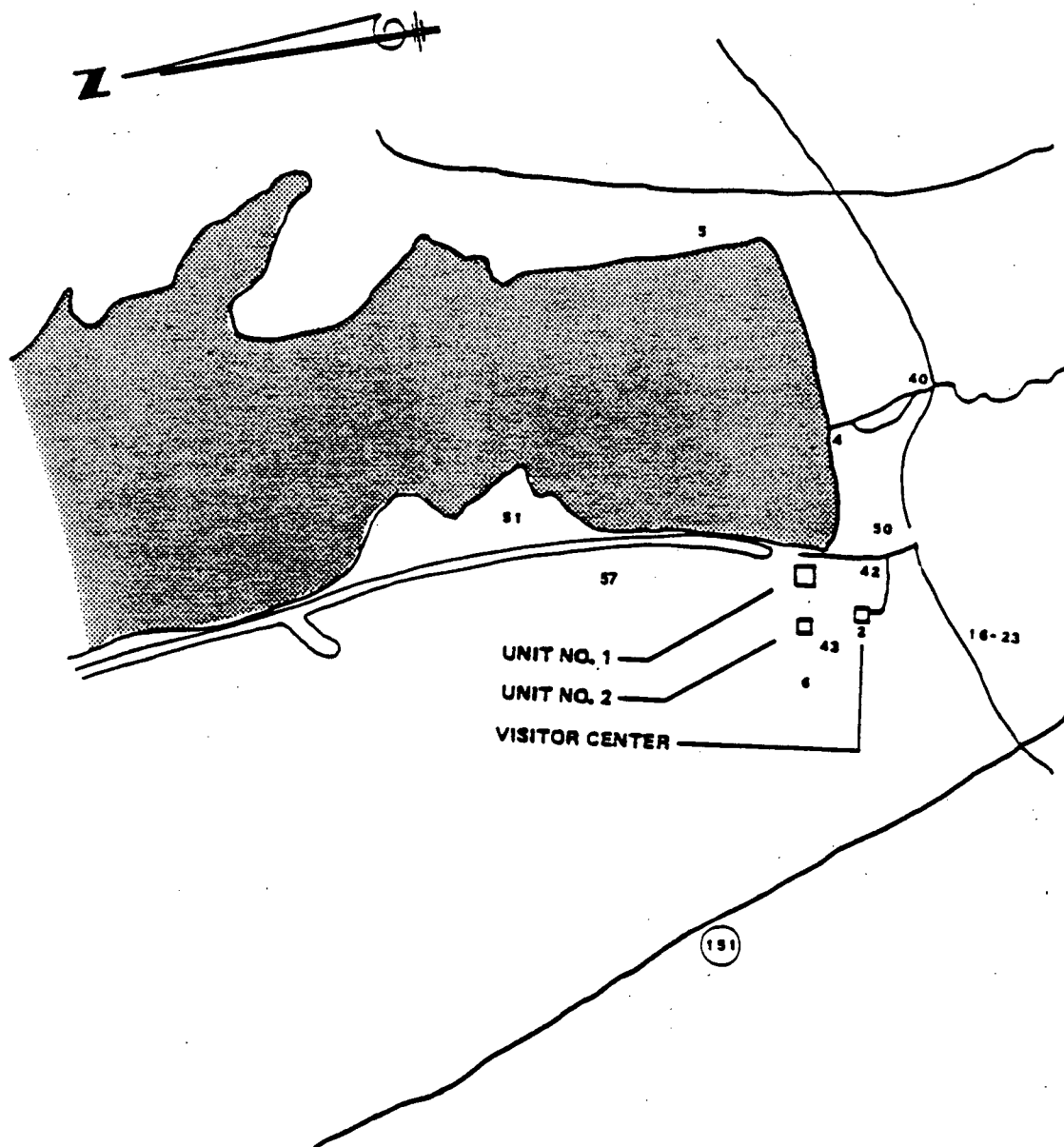


FIGURE 2-2
H. B. ROBINSON UNIT NO. 2
ENVIRONMENTAL RADIOLOGICAL SAMPLING POINTS
ON SITE

TABLE 2-1

ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM
H.B. ROBINSON STEAM ELECTRIC PLANT

<u>Sample Type</u>	<u>Sampling Point and Description</u>	<u>Sampling Frequency</u>	<u>Approximate Sample Size</u>	<u>Sample Analysis</u>
Air Cartridge (AC)	1--26 miles ESE Florence--Control	Weekly	800 cu m	Iodine
	2--0.2 mile S Information Center			
	3--0.7 mile N Microwave Tower			
	4--0.4 mile ESE Spillway			
	5--0.9 mile ENE Johnson's Landing			
	6--0.3 mile SW Information Center			
	7--6.3 miles ESE Hartsville			
	55--0.3 miles SSE Site Boundary*			
Air Particulate (AP)	1--26 miles ESE Florence--Control	Weekly	800 cu m	Weekly--Gross Beta Quarterly--Composite- Gamma
	2--0.2 mile S Information Center			
	3--0.7 mile N Microwave Tower			
	4--0.4 mile ESE Spillway			
	5--0.9 mile ENE Johnson's Landing			
	6--0.3 mile SW Information Center			
	7--6.3 miles ESE Hartsville			
	55--0.3 miles Site Boundary*			

*This location was added November 1988.

TABLE 2-1 (cont.)

<u>Sample Type</u>	<u>Sampling Point and Description</u>	<u>Sampling Frequency</u>	<u>Approximate Sample Size</u>	<u>Sample Analysis</u>
External Radiation Dose (TL)	1--26 miles ESE Florence--Control	Quarterly	Not Applicable	TLD Readout
	2--0.2 mile S Information Center			
	3--0.7 mile N Microwave Tower			
	4--0.4 mile ESE Spillway			
	5--0.9 mile ENE Johnson's Landing			
	6--0.3 mile SW Information Center			
	7--6.3 miles ESE Hartsville			
	8--0.8 mile SSE Oak Tree Near Trans- mission Lines			
	9--1.0 mile S Second Pole From SC-151			
	10--1.0 mile WSW on Power Pole at Church of God Cemetery			
	11--1.0 mile SW 4th Pole From Old Camden Road			
	12--1.2 miles SSW Tree at 2nd Inter- section of Dirt Road			
	13--1.0 mile W Pine Tree on Corner Where Road Splits			
	14--0.9 mile WNW Power Pole at Pine Ridge Church			
	15--1.0 mile NW Pine Tree Adjacent to CP&L Ash Pond			
	16--1.0 mile NNW Darlington Co. IC Turbine Plant			
	17--1.1 miles N Pine Tree Beside Dis- charge Canal Road			
	18--0.7 mile SE Near Old Railroad Trestle at Black Creek			
	19--1.0 mile E Power Pole on Road 16-23			
	20--1.3 miles ENE Power Pole 47 on Road 16-39			
	21--1.4 miles NE Near Atkinson's Boat Landing Sign			

TABLE 2-1 (cont.)

<u>Sample Type</u>	<u>Sampling Point and Description</u>	<u>Sampling Frequency</u>	<u>Approximate Sample Size</u>	<u>Sample Analysis</u>
External Radiation Dose (TL) (cont.)	22--1.9 miles NNE Shady Rest Club on Light Pole	Quarterly	Not Applicable	TLD Readout
	23--1.2 miles ESE Power Pole 41E-5 on Road 16-39			
	24--5.0 miles NW 5th Pole from SR 151 on Road 13-711			
	25--4.6 miles NNW Fence Line off Road 13-346			
	26--5.0 miles N Power Pole 32J-6 on Road 13-346			
	27--5.0 miles NNE Road 13-763			
	28--4.8 miles NE Power Pole 30-4-A on Road 13-39			
	29--4.1 miles Transmission Pole Near Road 16-20			
	30--4.6 miles E Pole at Johnson's Fence and Awning Co.			
	31--4.6 miles ESE Pole 1122 on Lake-shore Drive			
	32--4.5 miles SE Transmission Tower at End of Kalber Drive			
	33--4.6 miles SSE Power Pole 25-4 on Road 16-493			
	34--4.6 miles S Transmission Pole Nearest Road 16-772			
	35--4.4 miles SSW Intersection of Roads 31-51 and 16-12			
	36--4.7 miles SW Pole on Dirt Road 3/4 mile From 16-85			
	37--5.0 miles WSW Transmission Tower Nearest Clay Road			
	38--4.9 miles W Pole Beside Union Church			
	39--5.0 miles WNW Pole in Middle of Field			

TABLE 2-1 (cont.)

<u>Sample Type</u>	<u>Sampling Point and Description</u>	<u>Sampling Frequency</u>	<u>Approximate Sample Size</u>	<u>Sample Analysis</u>
Surface Water (SW)	40--0.6 mile ESE Black Creek at Road 16-23 41--7.2 miles NNW Black Creek--Control 57-- Ash Pond	Monthly Composite	4 liters	Gamma Tritium
Groundwater (GW)	40--0.6 mile ESE Artesian Well 42--Unit 1 Deep Well 43--Unit 2 Deep Well	Monthly	4 liters	Gamma Tritium
Milk (MK)	53--9.0 miles SW Lyndale Farm--Control 54--10.1 miles E Auburndale Plantation	Semimonthly when animals are on pasture; monthly at other times	8 liters	Iodine Gamma
Fish (FI)	45--Site Varies Within Lake Robinson 46--4.9 miles ESE Prestwood Lake 47--13.0 miles NNW Bee Lake or 12.5 miles NW May Lake--Control	Semiannually	500 grams	(Edible Portion) Gamma
Shoreline Sediment (SS)	44--1.9 miles NNE Shady Rest Club 57--Ash Pond*	Semiannually	500 grams	Gamma

*This location was added in 1981.

TABLE 2-1 (cont.)

<u>Sample Type</u>	<u>Sampling Point and Description</u>	<u>Sampling Frequency</u>	<u>Approximate Sample Size</u>	<u>Sample Analysis</u>
Food Products (FC)	49--> 5 miles in Least D/Q Sector Control	Annual at Harvest	500 grams	Gamma
	54--10.1 miles E Auburndale Plantation			
Broadleaf Vegetation (BL)	50--0.25 mile SSE CP&L Property	Monthly when Available	500 grams	Gamma
	51--0.25 mile NNE CP&L Property			
	52--10 miles W Bethune--Control			

3.0 INTERPRETATIONS AND CONCLUSIONS

3.1 Air Sampling

Air samples collected during 1988 have measurable gross beta activity in 311 of 311 samples, at an average concentration of $1.62\text{E-}2$ pCi/m³ and $1.59\text{E-}2$ pCi/m³ for the indicator and control locations, respectively. These are consistent with preoperational data obtained for the H.B. Robinson Plant and are typical of naturally occurring radionuclides. Figures 3-1 through 3-7 compare indicator and control location to preoperational gross beta activity. The average preoperational gross beta activity of 0.14 pCi/m³ is from the Preoperational Environmental Monitoring Report (January 1, 1970, through September 30, 1970) prepared by Eberline Instrument Corporation. The figures demonstrate that there were no significant deviations between indicator and control locations and that these stations' gross beta concentrations are less than concentrations measured during preoperational monitoring.

The quarterly composite gamma analyses for air particulate samples for all quarters revealed no anthropogenic radionuclides.

All 311 air cartridge samples from indicator and control locations had iodine-131 (I-131) activities which were less than the LLD.

3.2 Broadleaf Vegetation

Broadleaf vegetation sampling is accomplished by collecting oak, persimmon, hickory, wild cherry, maple, willow oak, and sassafras leaves. Three species of samples, when available, are collected monthly at three locations (one control and two locations at site boundary using site historical meteorology

with the highest calculated annual average ground level deposition). Broadleaf sampling is conducted since no milk animals are located within the area influenced by the plant, a radius approximately five miles, and is used to simulate dose to an individual via the milk pathway.

Cesium-137 was the only radionuclide detected during 1988 at an average concentration of 174 pCi/kg (18 of 23 analyses) for the control location and 178 pCi/kg (28 of 36 analyses) for the indicator locations. Using a T test at 99.5 percent confidence level, the average concentrations for the indicator stations are comparable to the average concentrations at the control station. Based on the T test and frequency of detection, these activities are not attributed to plant operations and reflect the accumulation of debris from nuclear testing. In addition, Table 3.1 shows that the higher concentration of cesium-137 activity appears to be more dependent on species rather than different locations.

Table 3-1

Cesium-137 in Broadleaf Vegetation
(pCi/kg Wet Weight \pm 2 Sigma Error)

Wild Cherry

<u>DATE</u>	<u>Control Location</u>	<u>0.25 mi. SSE</u>	<u>0.25 mi. NNE</u>
5/5	≤ 25	64 ± 30	87 ± 28
6/7	30 ± 21	82 ± 21	34 ± 21
7/8	≤ 20	83 ± 17	58 ± 24
8/9	21 ± 15	53 ± 15	≤ 20
9/6	≤ 20	≤ 21	≤ 20
10/6	≤ 21	≤ 21	≤ 22

Oak

5/5	94 ± 21	421 ± 36
6/7	818 ± 52	347 ± 46
8/9	515 ± 42	588 ± 44
9/6	137 ± 30	313 ± 34

Maple

5/5	≤ 22	362 ± 36
-----	-----------	--------------

Willow Oak

5/5	171 ± 30	64 ± 27
6/7	267 ± 36	≤ 35

Hickory

5/5	20 ± 15	37 ± 13
-----	-------------	-------------

Table 3-1 (cont.)

Persimmons

<u>DATE</u>	<u>Control Location</u>	<u>0.25 mi. SSE</u>	<u>0.25 mi. NNE</u>
6/7	60 + 18	58 + 18	54 + 14
7/8	63 + 19	58 + 17	< 17
8/9	67 + 17	70 + 19	108 + 18
9/6	55 + 18	46 + 16	39 + 16
10/6	46 + 16	67 + 18	≤ 19

Sassafras

7/8	205 + 30	991 + 58	117 + 26
8/9	179 + 22	223 + 34	
9/6	199 + 24	157 + 31	
10/6	178 + 24	330 + 36	64 + 24

3.3 Fish

Samples of free-swimming and bottom-feeding fish were collected from Lake Robinson, Prestwood Lake, and Bee Lake or May Lake (control) during May and November. Gamma isotopic analyses were performed on the edible portions revealing cesium-137 (Cs-137) and cesium-134 (Cs-134) activity. Using a T-test at 99.5 percent confidence level for comparing the Cs-137 concentrations in Robinson Lake and Prestwood Lake (indicator locations) to Bee Lake (control location) reveals no influence from plant operations is indicated (see Table 3.2).

Table 3-2

Cesium-137 Concentrations in Fish Samples
(pCi/kg wet weight \pm 2 Sigma Error)

Free Swimmers

	<u>Bee Lake</u>	<u>Robinson</u>	<u>Prestwood</u>
May	295 \pm 42	191 \pm 42	291 \pm 34
November	224 \pm 42	103 \pm 24	176 \pm 30

Bottom Feeders

May	129 \pm 26	140 \pm 28	217 \pm 32
November	103 \pm 30	121 \pm 28	106 \pm 24

Cesium-134 activity was detected in three of four fish samples from Lake Robinson and three of four fish samples from Prestwood Lake. The average concentration of Cs-134 in fish from Lake Robinson was 39.9 pCi/kg (wet) and the average concentration in fish from Prestwood Lake was 45.2 pCi/kg (wet). These average concentrations are based on samples with detectable measurements only and include both free-swimmers and bottom-feeders. The cesium-134 activity in fish samples from Bee Lake or May Lake (control location) was all less than the lower

limit of detection ranging from ≤ 23.5 pCi/kg (wet) to ≤ 33.6 pCi/kg (wet). Using 21 kg/yr consumption rate for an adult, dose conversion factor of $1.48E-4$ mrem/pCi, the methodology in Regulatory Guide 1.109, cesium-134 activity at a concentration of 39.9 pCi/kg (wet) from Lake Robinson would yield a dose to the liver (most critical organ) of 0.124 mrem/yr. Plant operations during 1988 released $2.078E-3$ Ci of Cs-134 at a liquid flow rate of $936 \text{ ft}^3/\text{sec}$ with a mixing ratio of 0.817 for Lake Robinson. Using the bioaccumulation factor of 2000 pCi/kg/ pCi/l, dose conversion factor of $1.48E-4$ mrem/pCi, consumption rate of 21 kg/yr, and the methodology from Regulatory Guide 1.109 the dose to the most critical organ (adults liver) is 0.0129 mrem. This compares favorably with the dose to the most critical organ (liver) of 0.124 mrem/yr derived from environmental sample results and is well within the 10CFR50 appendix limit of 10.0 mrem/yr.

3.4 Groundwater

Groundwater is sampled monthly and analyzed for tritium and gamma-emitting radionuclides at three locations. All analyses were less than the lower limit of detection.

3.5 Milk and Food Crop Samples

Milk and food (corn) samples from the Auburndale Plantation (10.1 miles east) are collected and analyzed for the purpose of evaluating the potential dose via irrigation-grass-feed/food crop-cow-milk-man pathway. All analyses at this location were less than the lower limit of detection. Milk samples were also collected from Lyndale Dairy (Mk-53--control location) which is located 9.0 miles southwest of site and is not under the influence of plant operations. All gamma analyses were also less than the lower limit of detection. See Figures 3-8 and 3-9 for iodine-131 lower limit of detection by organic extraction versus time.

3.6 Shoreline Sediment

Shoreline sediment samples are collected semiannually from a downstream area with existing recreational value. This location is at the Shady Rest Club on Lake Robinson, 1.9 miles NNE. For this location, gamma-emitting radionuclide activities were less than the lower limit of detection.

An additional shoreline sediment sample is collected from the ash pond. This sample is not for evaluating routine releases but for trending long-term impact from disposal of slightly contaminated fly ash/soil from the settling ponds. The ash pond area is controlled by the licensee and is generally not accessible to members of the public. The only radionuclide detected was Cs-137 in 2 of 2 samples at an average concentration of 134 pCi/kg dry weight (see Figure 3-10).

A typical sample had a wet weight of 3.201 kg/ft^2 and a wet weight to dry weight ratio of 1.15. Using these factors and the average concentration of 134 pCi/kg dry weight would equal $5,278 \text{ pCi/m}^2$. Using the methodology in Regulatory Guide 1.109, the external total body dose factor for cesium-137 for standing on contaminated ground ($4.2\text{E-}9 \text{ mrem/hr/pCi/m}^2$), teenager usage of 67 hr/yr, shore-width factor of 0.3, and $5,278 \text{ pCi/m}^2$ would yield an annual dose of $4.46\text{E-}4 \text{ mrem/yr}$. There are no other pathways for exposure at this site and the probability of a teenager spending 64 hr/yr at this location is remote.

3.7 Surface Water

Surface water composite samples are analyzed monthly for gamma-emitting radionuclides and tritium. All gamma-emitting radionuclide activities were less than the lower limit of detection (< LLD). There are two sample indicator locations for Robinson. One is for evaluating routine releases and the other for

trending long-term impact from disposal of slightly contaminated fly ash/soil in the ash ponds (see Figure 3-11). Tritium was detected in 23 of 24 ash pond supernate samples with an average concentration of $1.99\text{E}+3$ pCi/liter. The other indicator location with the higher concentration was at Secondary Road S-16-23 with an average concentration of $2.05\text{E}+3$ pCi/liter. This location is used for evaluating routine releases (see Figure 3-12). The average concentration is in excellent agreement with the model used for calculating liquid releases from the plant site. For 1988, Robinson released 536.27 curies of tritium. Using their 1988 average flow rate of $936\text{ ft}^3/\text{sec}$, mixing ratio of 0.833, a reconcentration factor of 3.85 for the completely mixed impoundment model, and the NRC-approved LADTAP-2 computer code, the average lake tritium concentration is calculated to be $2.06\text{E}+3$ pCi/l. The only significant dose from tritium in the liquid pathway would be from eating fish. Using the methodology in Regulatory Guide 1.109, an adult consumption rate of 21 kg/yr, bioaccumulation factor of 0.90 pCi/kg of fish/pCi/liter of water, and the ingestion dose factor for the adult total body of $1.05\text{E}-7$ mrem/pCi ingested, would yield a dose of $4.07\text{E}-3$ mrem/yr for the maximum individual.

3.8 Thermoluminescent Dosimetry (TLD) Area Monitors

The average dose rate of all indicator locations was 1.05 mrem/wk which is comparable to the control location average of 1.10 mrem/wk. The location with the highest reading was near the intersection of Secondary Roads S-31-51 and S-16-12, 4.4 miles SSW. This location had an average dose rate of 1.77 mrem/wk with a range of 1.70 to 1.90 mrem/wk. This location has a history of being approximately 60 percent higher than the average of all indicator locations and its value is attributed to local geologic anomalies and not to plant operations.

The TLDs are generally located in two concentric rings. The first ring consists of TLDs within 3 miles of the plant (approximate average is 1.0 mile) and the second ring consists of those TLDs greater than 3 miles (approximate average is 5 miles). To assess direct radiation from the Robinson Plant to members of the public, a one-sided t-test was performed. The test was to determine if the average dose rate of the TLD inner ring exceeded that of outer ring. The results of the test showed statistically that the inner ring did not receive a higher dose than the outer ring. Therefore, no measurable effect from plant operations was detected (see Figure 3-13).

The calculational method used to determine net dose on the environmental TLDs was modified for the fourth quarter data. This modification provides for a more accurate estimation of that portion of the TLD dose that is extraneous to the environmental exposure. The modification will be applied in the future background subtract calculations. The new calculational method was applied to the first, second, and third quarter of 1988 data for comparison. A comparison of the new method versus the old method reveals 9.0, 13.8, and 4.9 percent difference for first, second, and third quarters, respectively. These differences did not warrant corrections of data for the first three quarters, 1988.

CP&L ENVIRONMENTAL SURVEILLANCE
GROSS BETA ACTIVITY FOR
AIR PARTICULATE SAMPLES
PLANT=HBR SAMPLE POINT=0002

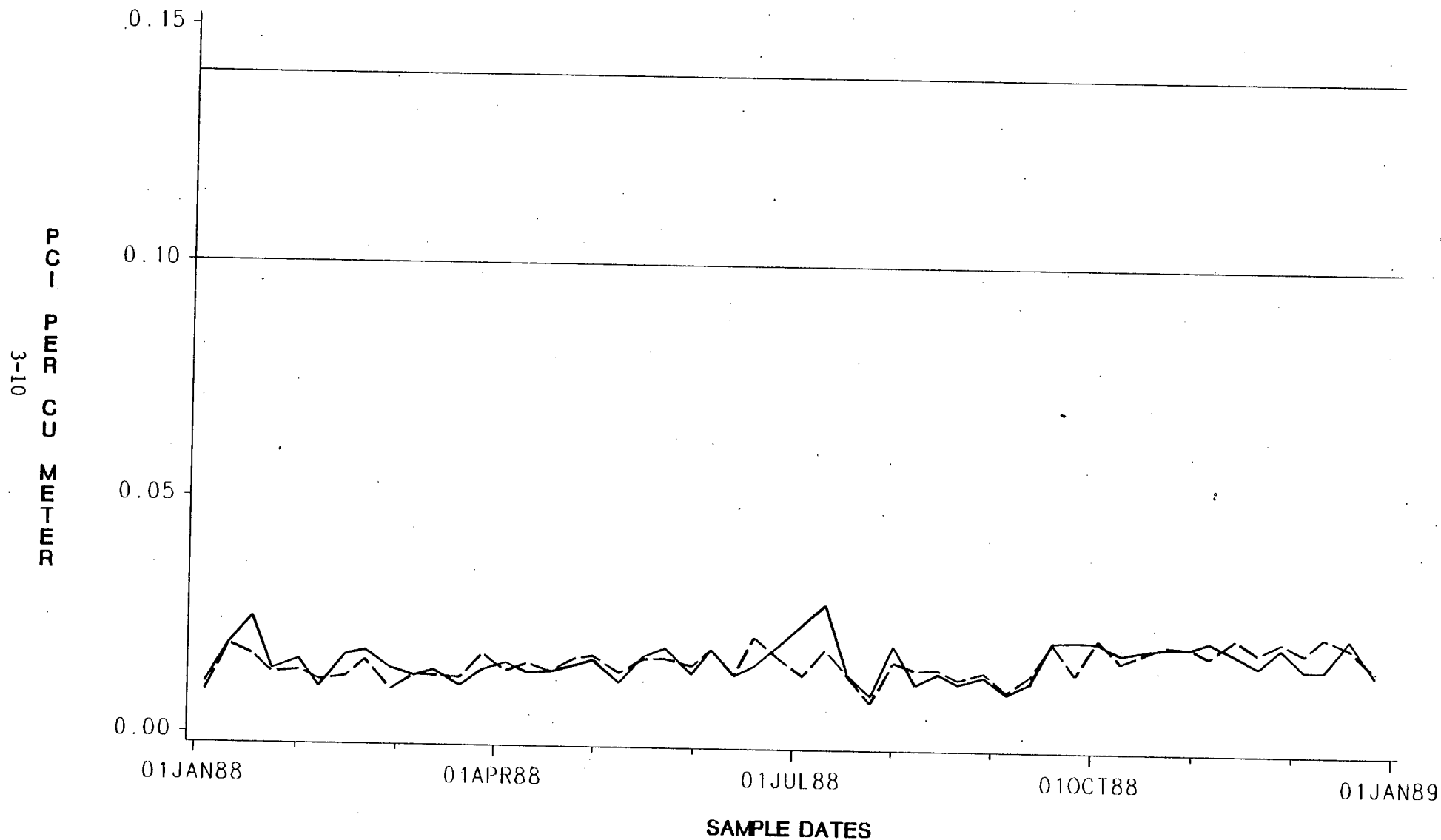
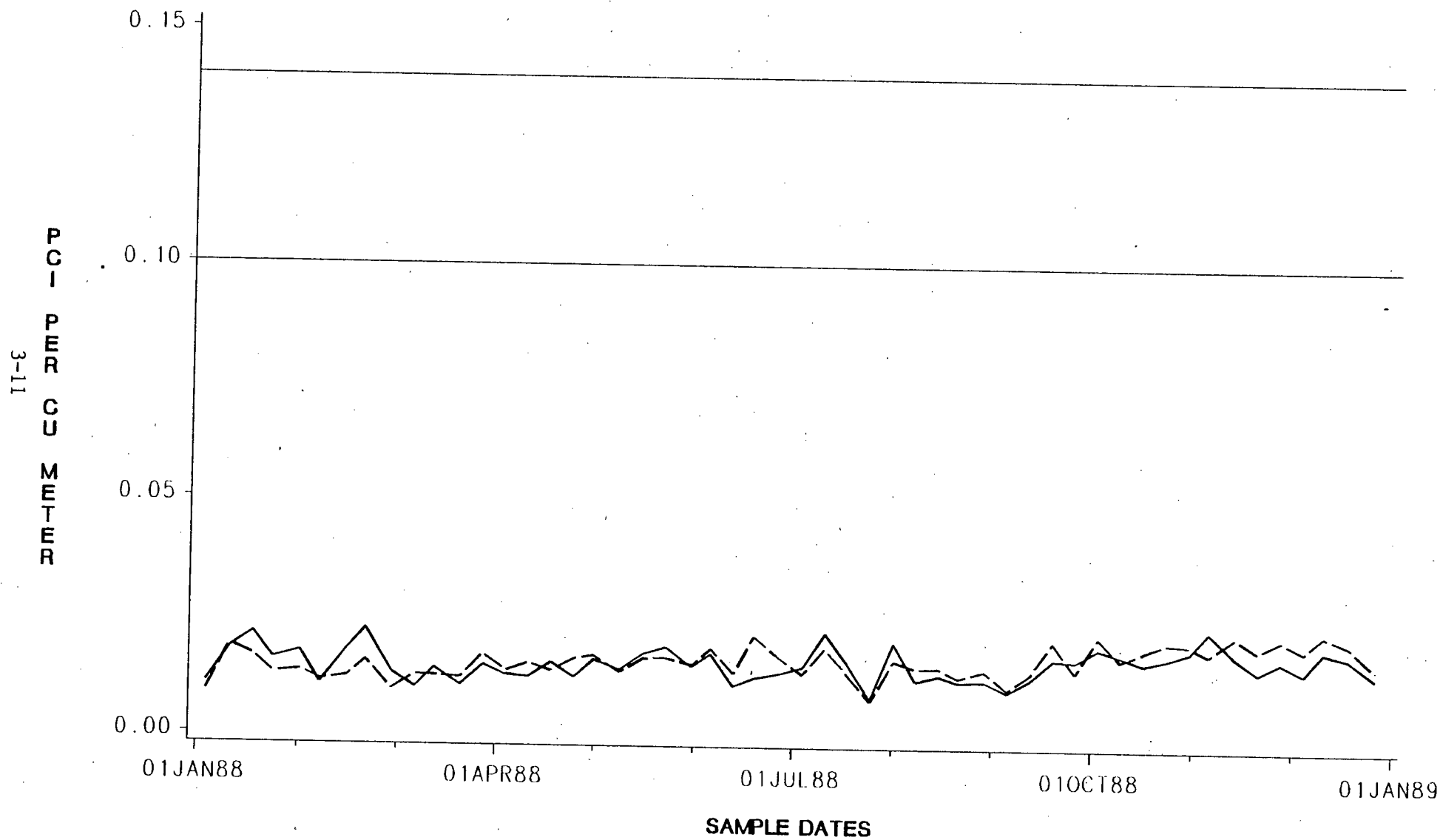


Figure 3-1

CP&L ENVIRONMENTAL SURVEILLANCE
GROSS BETA ACTIVITY FOR
AIR PARTICULATE SAMPLES
PLANT=HBR SAMPLE POINT=0003



SOLID LINE FOR SAMPLE STATION
BROKEN LINE FOR CONTROL STATION

PRE-OP AVERAGE=0.14
ISOTOPIC ANALYSIS REQUIRED ABOVE 0.10

Figure 3-2

CP&L ENVIRONMENTAL SURVEILLANCE
GROSS BETA ACTIVITY FOR
AIR PARTICULATE SAMPLES
PLANT=HBR SAMPLE POINT=0004

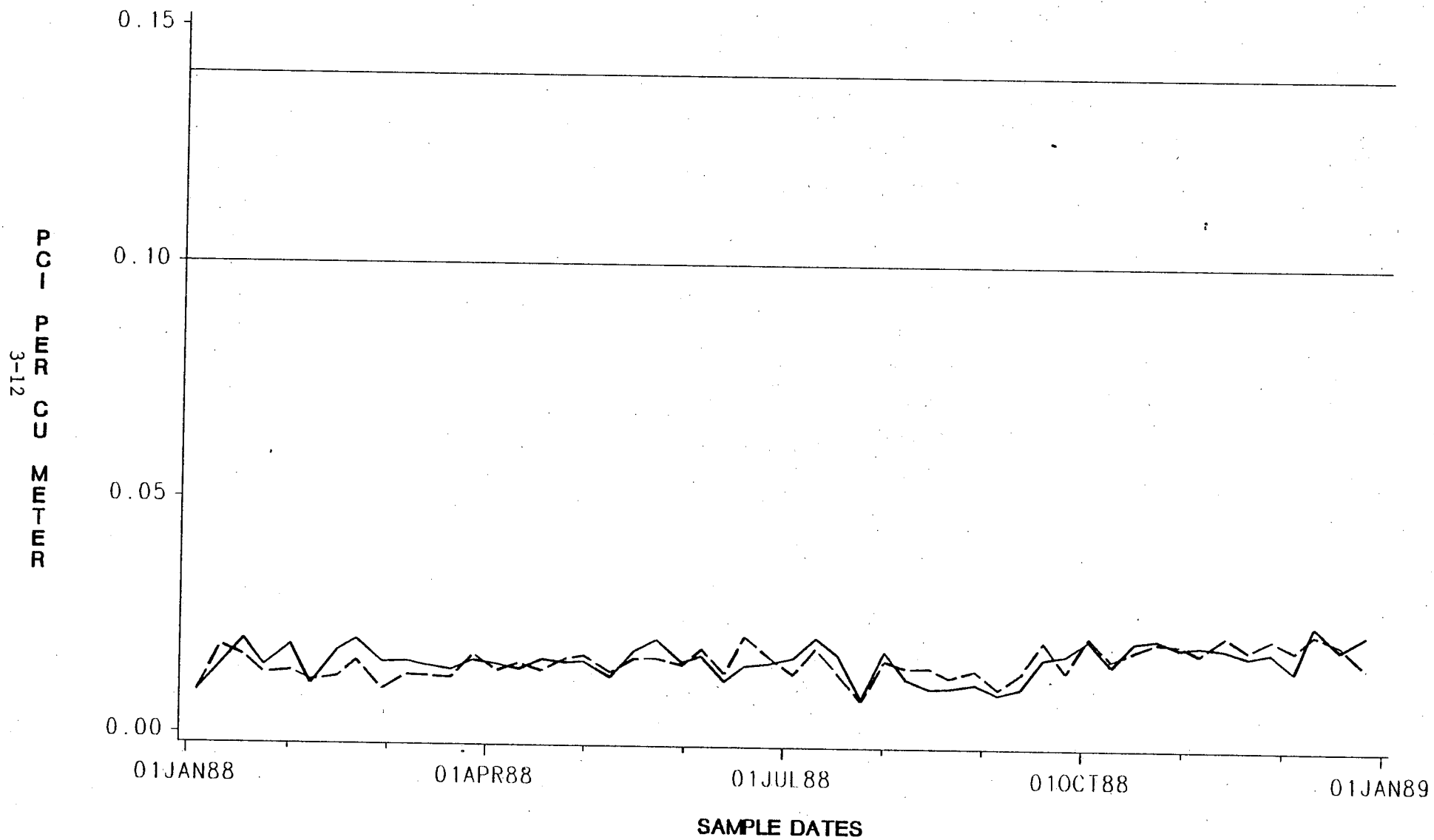
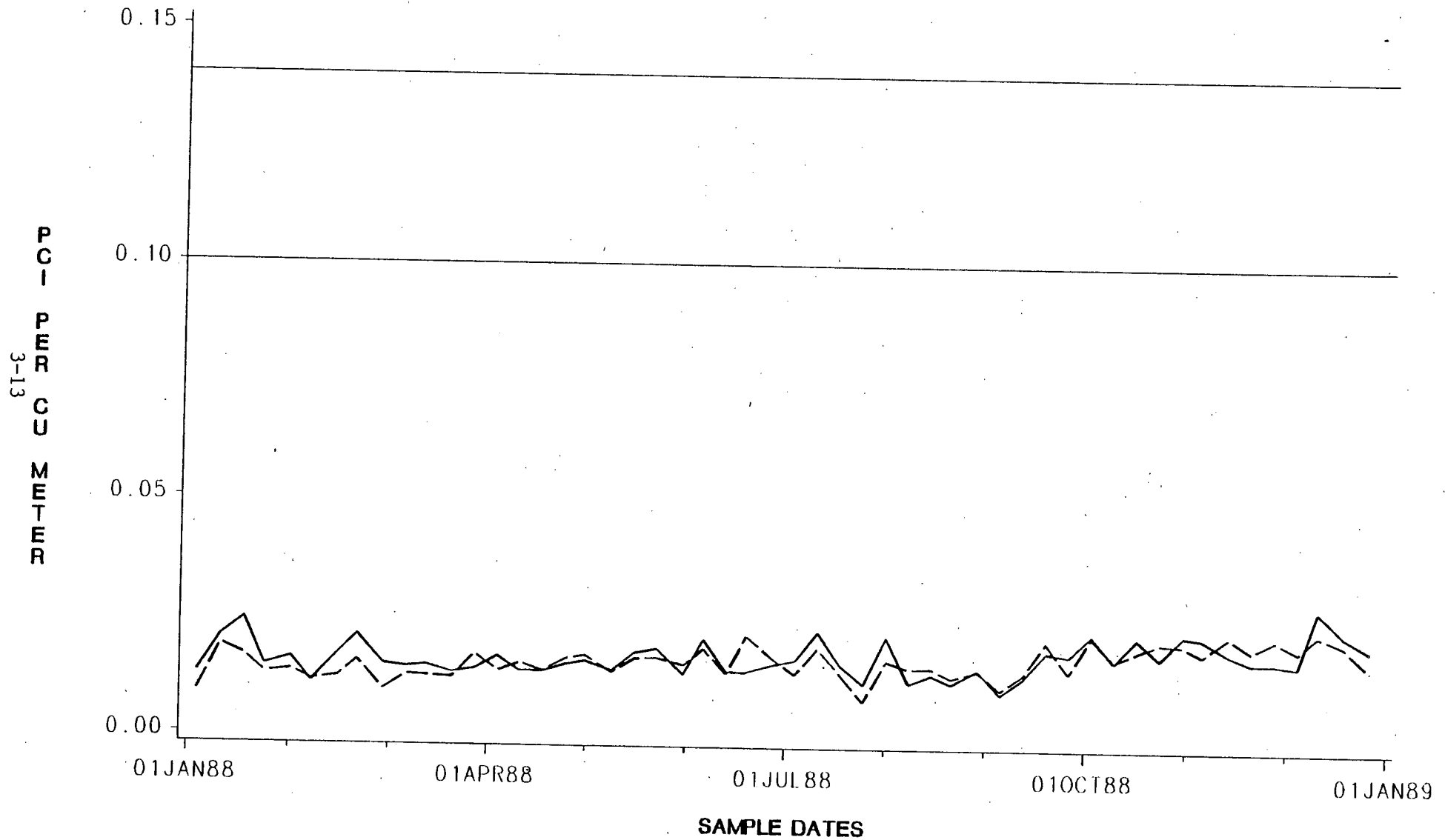


Figure 3-3

CP&L ENVIRONMENTAL SURVEILLANCE
GROSS BETA ACTIVITY FOR
AIR PARTICULATE SAMPLES
PLANT=HBR SAMPLE POINT=0005

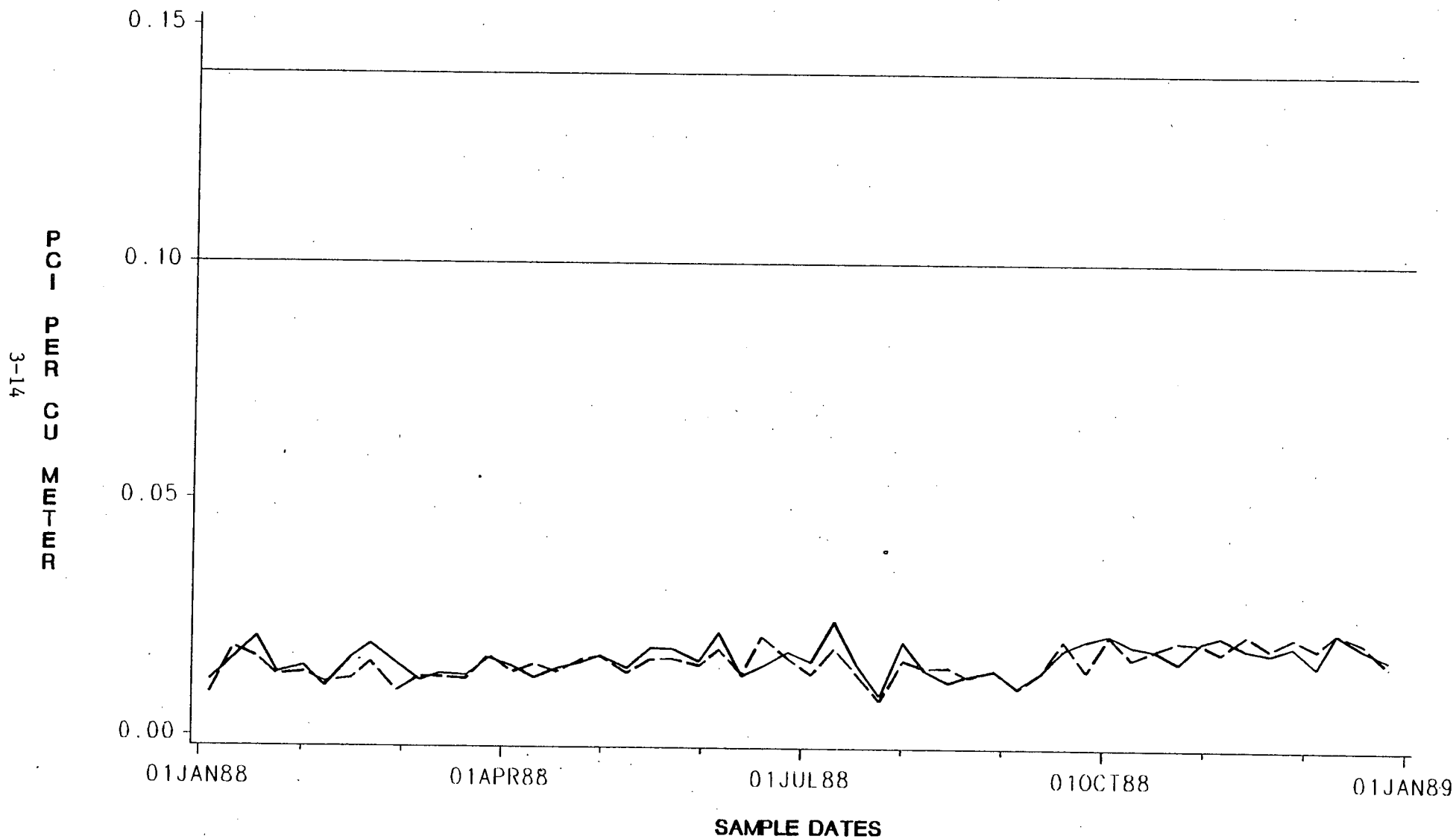


SOLID LINE FOR SAMPLE STATION
BROKEN LINE FOR CONTROL STATION

PRE-OP AVERAGE=0.14
ISOTOPIC ANALYSIS REQUIRED ABOVE 0.10

Figure 3-4

CP&L ENVIRONMENTAL SURVEILLANCE
GROSS BETA ACTIVITY FOR
AIR PARTICULATE SAMPLES
PLANT=HBR SAMPLE POINT=0006

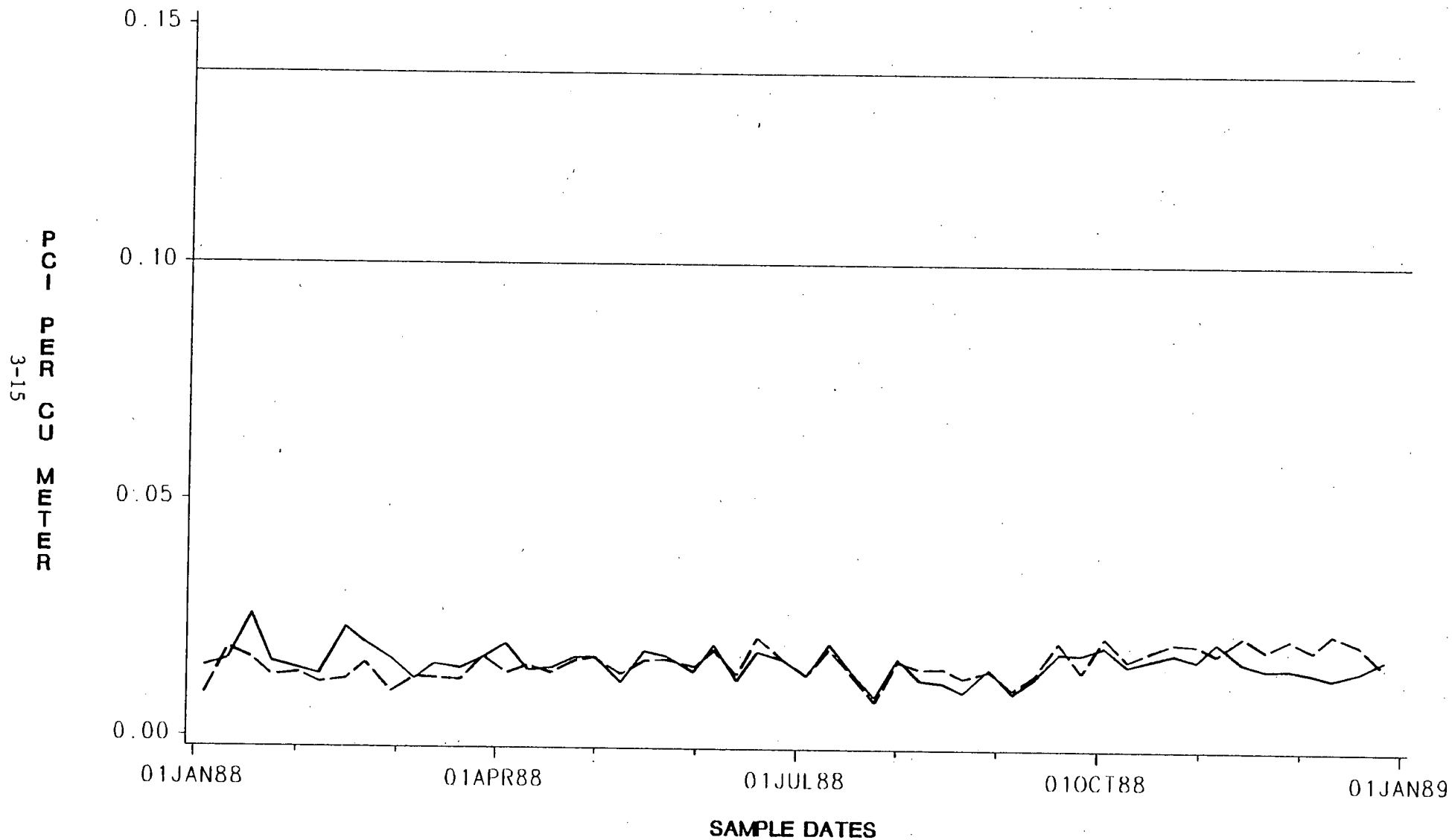


SOLID LINE FOR SAMPLE STATION
BROKEN LINE FOR CONTROL STATION

PRE-OP AVERAGE=0.14
ISOTOPIC ANALYSIS REQUIRED ABOVE 0.10

Figure 3-5

CP&L ENVIRONMENTAL SURVEILLANCE
GROSS BETA ACTIVITY FOR
AIR PARTICULATE SAMPLES
PLANT=HBR SAMPLE POINT=0007

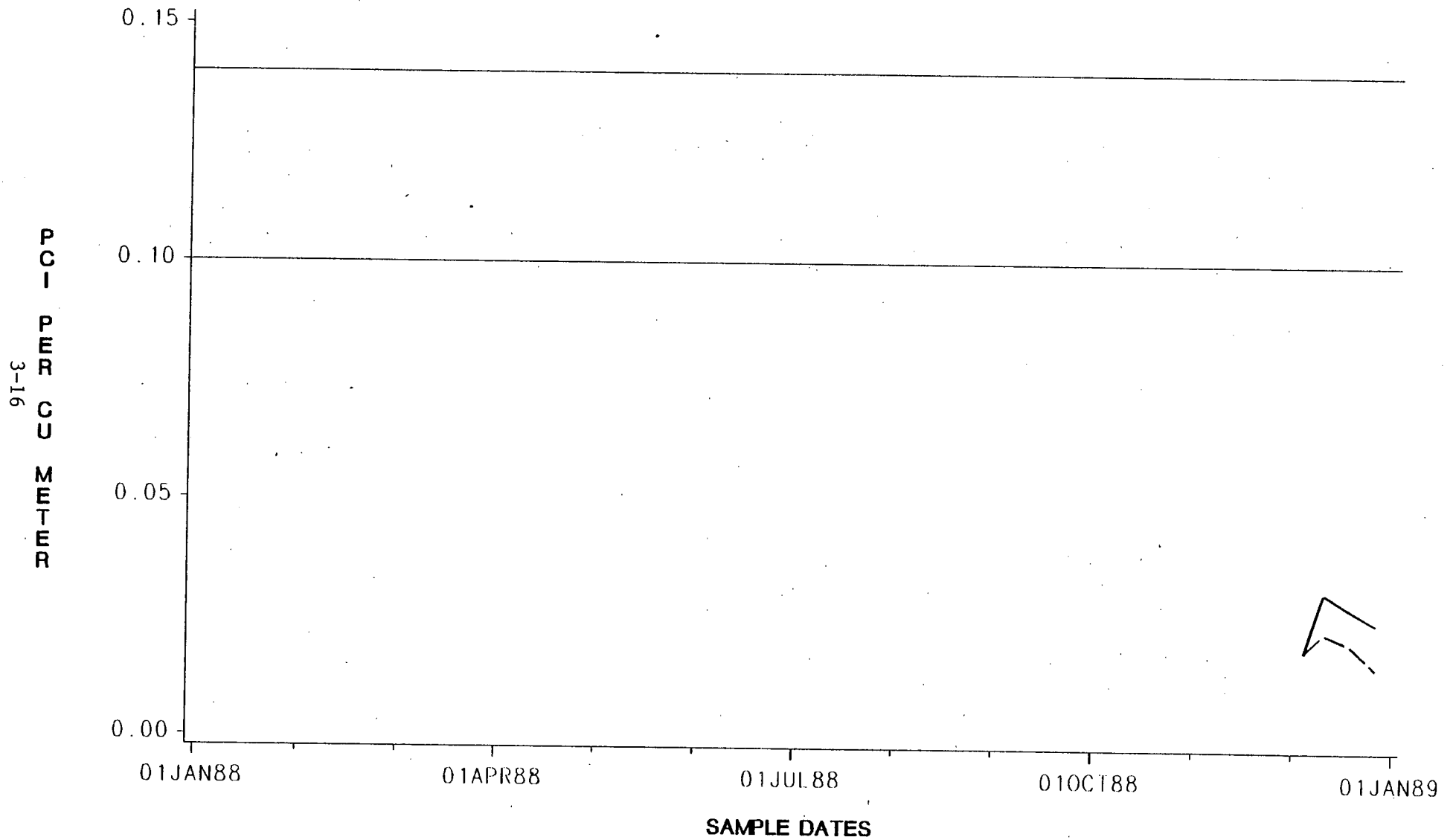


SOLID LINE FOR SAMPLE STATION
BROKEN LINE FOR CONTROL STATION

PRE-OP AVERAGE=0.14
ISOTOPIC ANALYSIS REQUIRED ABOVE 0.10

Figure 3-6

CP&L ENVIRONMENTAL SURVEILLANCE
GROSS BETA ACTIVITY FOR
AIR PARTICULATE SAMPLES
PLANT=HBR SAMPLE POINT=0055



SOLID LINE FOR SAMPLE STATION
BROKEN LINE FOR CONTROL STATION

PRE-OP AVERAGE=0.14
ISOTOPIC ANALYSIS REQUIRED ABOVE 0.10

Figure 3-7

CP&L ENVIRONMENTAL SURVEILLANCE
IODINE-131 ACTIVITY FOR
MILK SAMPLES
PLANT=HBR POINT=0053

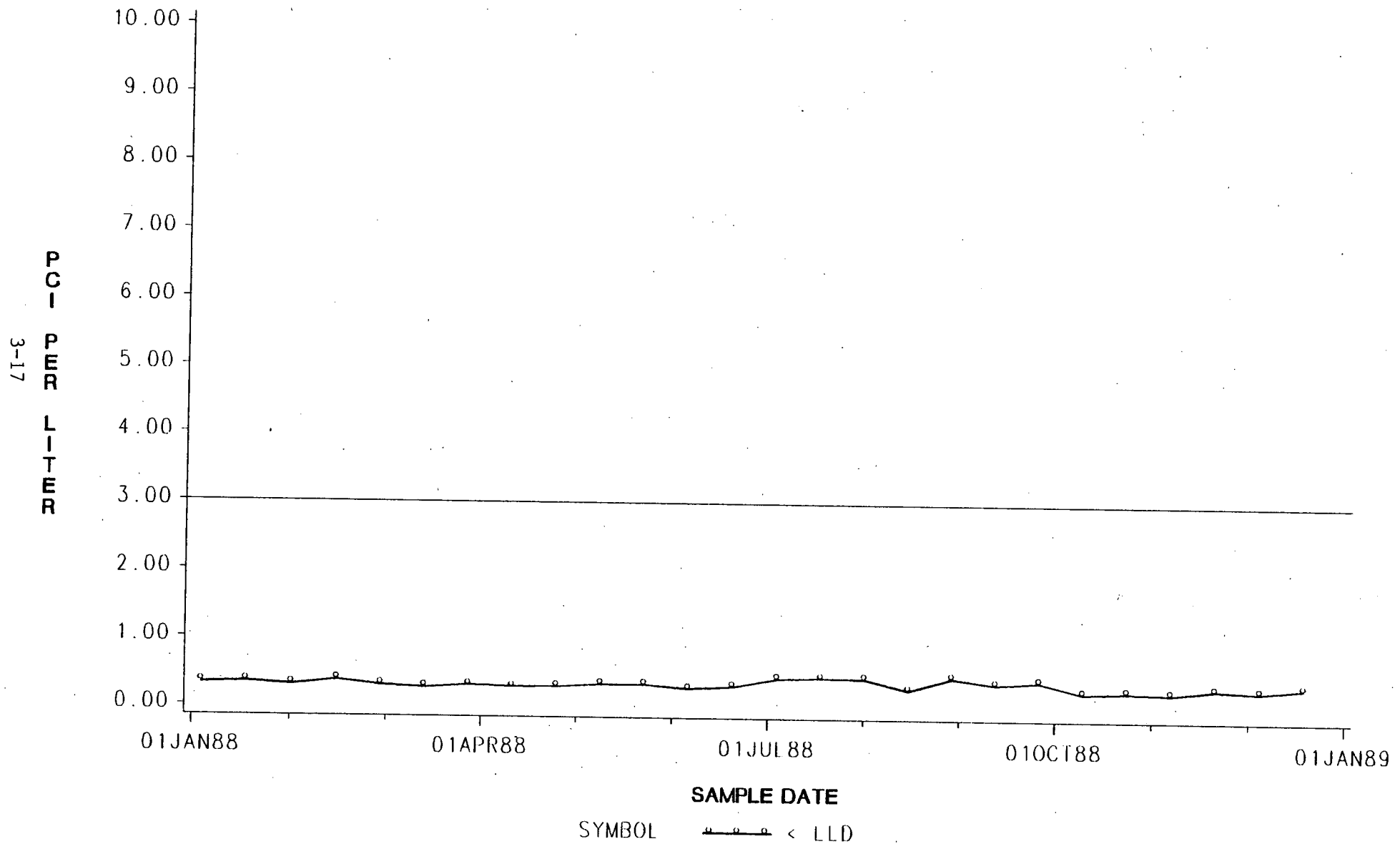


Figure 3-8

STATION '0053' IS THE CONTROL POINT

REPORTING LEVEL IS 3.0

CP&L ENVIRONMENTAL SURVEILLANCE
IODINE-131 ACTIVITY FOR
MILK SAMPLES
PLANT=HBR POINT=0054

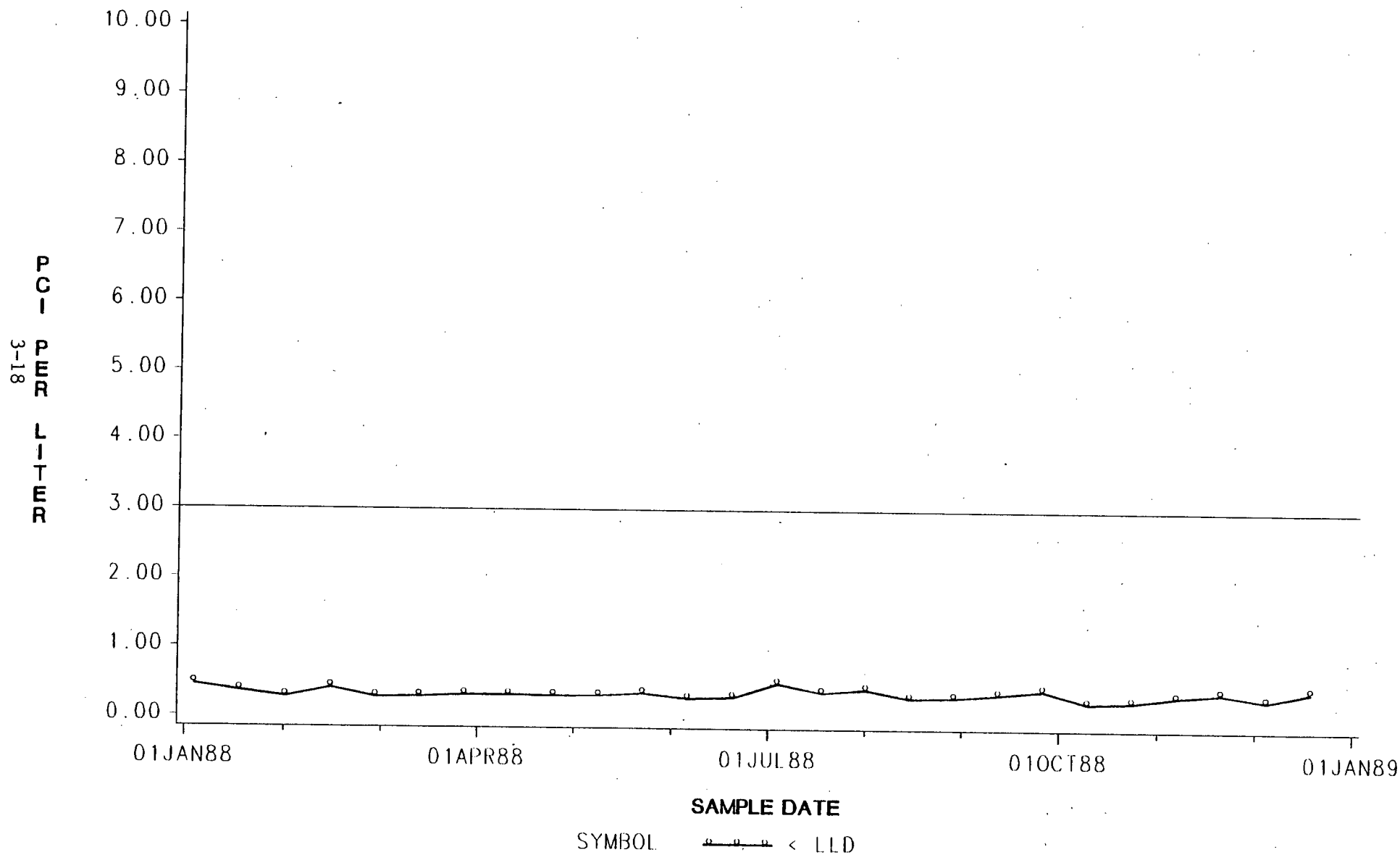
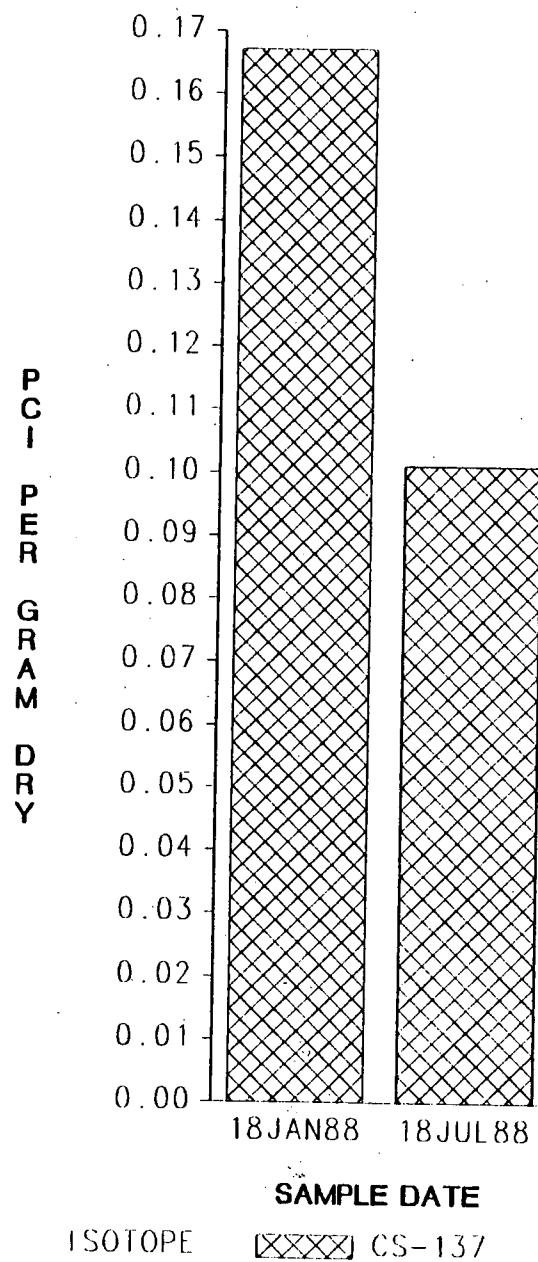


Figure 3-9

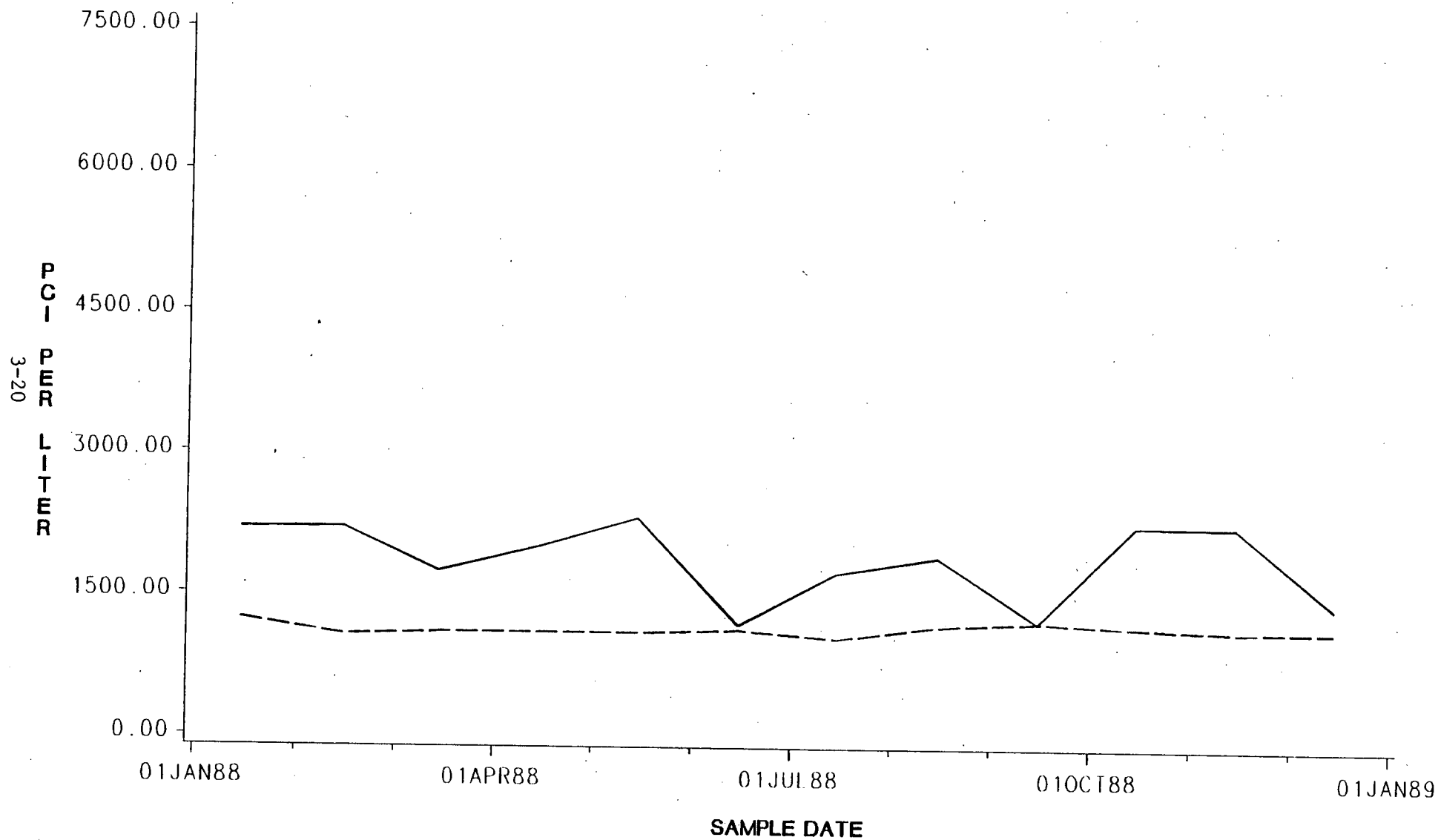
STATION '0053' IS THE CONTROL POINT

REPORTING LEVEL IS 3.0

CP&L ENVIRONMENTAL SURVEILLANCE
GAMMA ACTIVITY FOR
SHORELINE SEDIMENT SAMPLES
PLANT=HBR SAMPLE POINT=0057



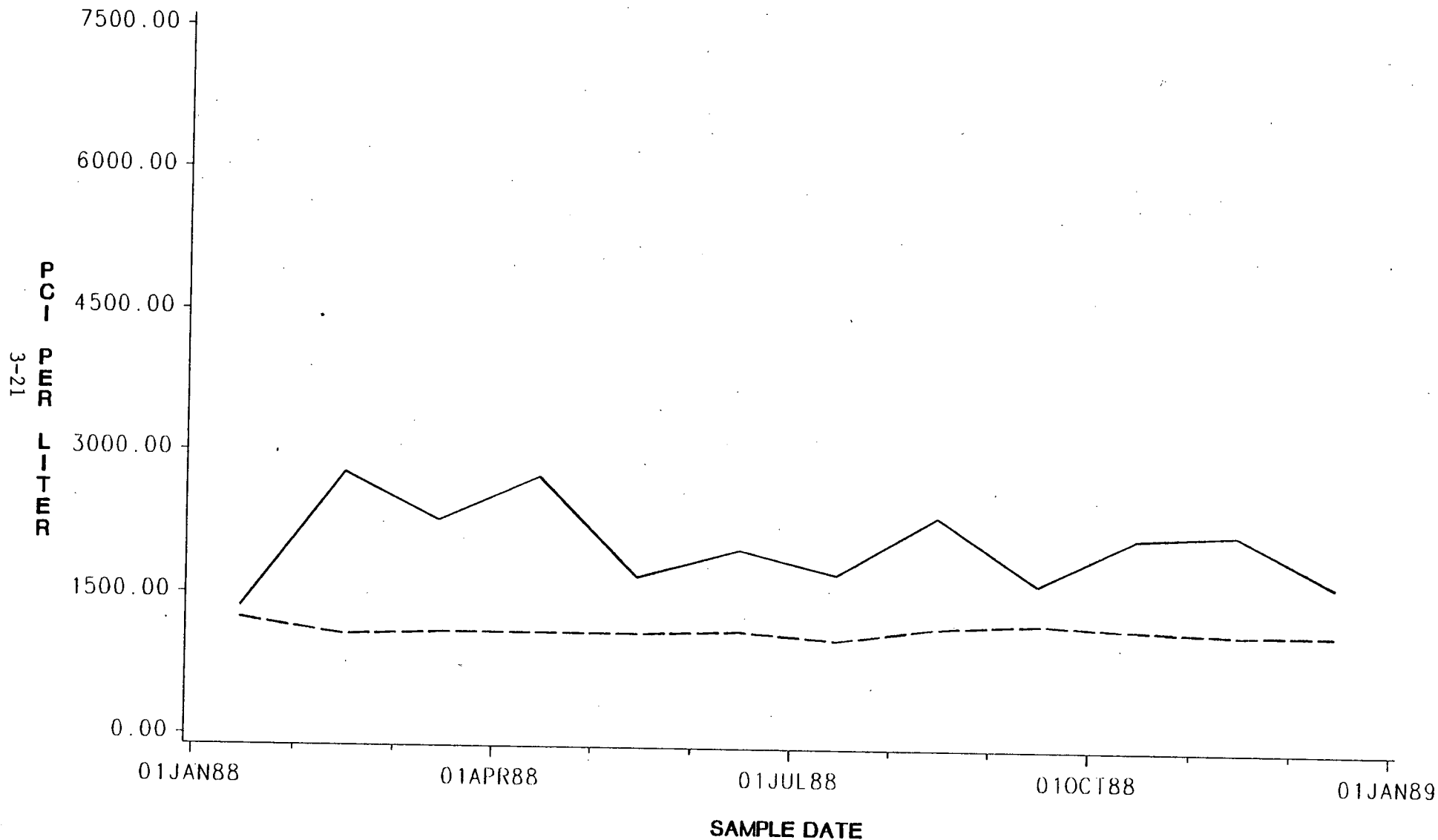
CP&L ENVIRONMENTAL SURVEILLANCE
TRITIUM ACTIVITY FOR
SURFACE WATER SAMPLES
PLANT=HBR SAMPLE POINT=0057



SOLID LINE FOR SAMPLE STATION
BROKEN LINE FOR CONTROL STATION

SAMPLE DATA MAY OVERLAY CONTROL DATA

CP&L ENVIRONMENTAL SURVEILLANCE
TRITIUM ACTIVITY FOR
SURFACE WATER SAMPLES
PLANT=HBR SAMPLE POINT=0040

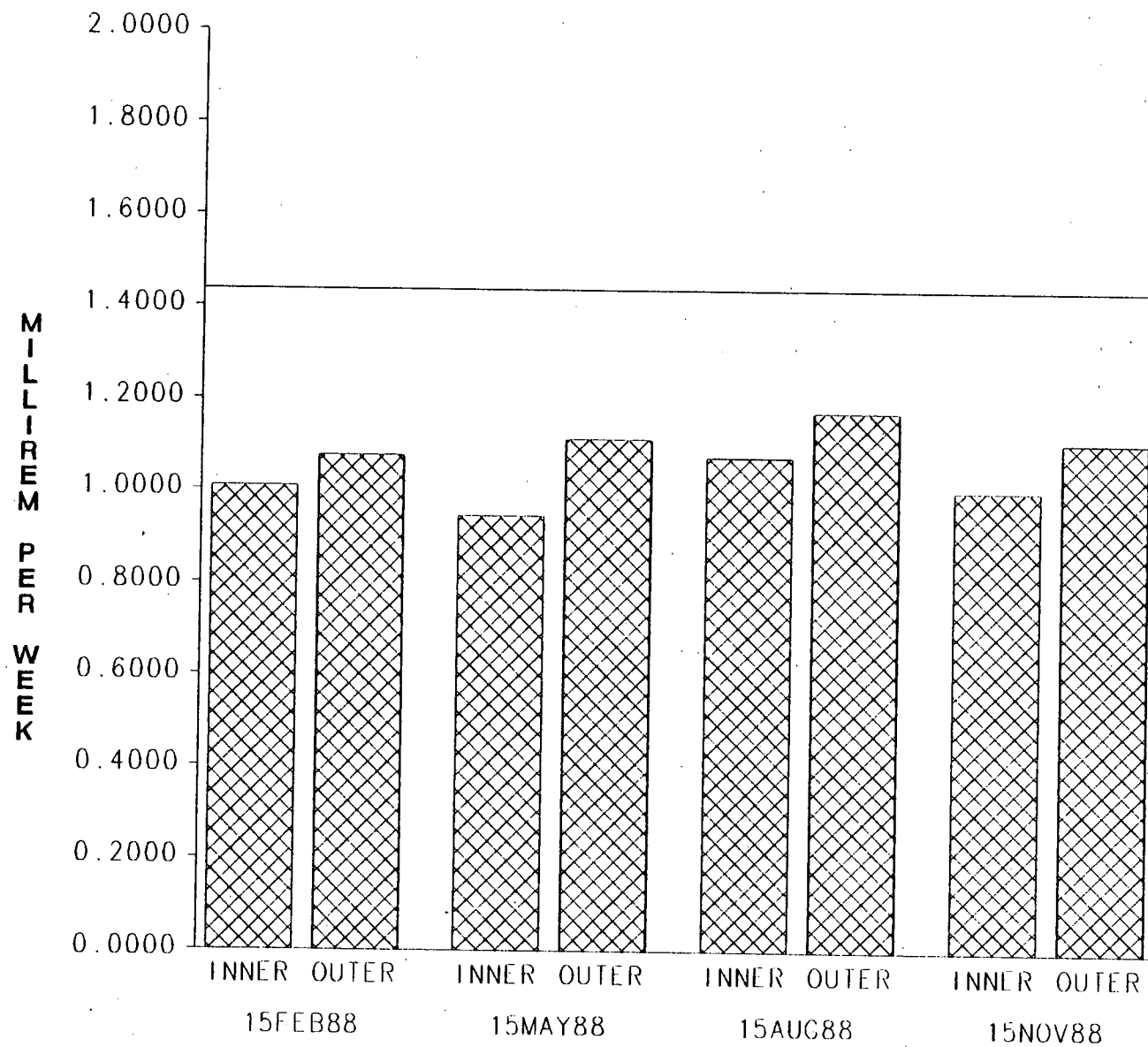


SOLID LINE FOR SAMPLE STATION
BROKEN LINE FOR CONTROL STATION

SAMPLE DATA MAY OVERLAY CONTROL DATA

Figure 3-12

CP&L ENVIRONMENTAL SURVEILLANCE
 TLD AVERAGES FOR
 INNER AND OUTER RING LOCATIONS
 PLANT=HBR



SAMPLE DATE
 DATE

AVERAGE(1983-1987)=1.4358

Figure 3-13

4.0 MISSED SAMPLES AND ANALYSES

4.1 Air Cartridge and Air Particulate

In November 1988 an air sampling station was added to the radiological environmental monitoring program. The purpose of this new location (AC/AP-55) was to be in verbatim compliance with the HBR Technical Specification 3.17.12, Table 3.17-1, which specifies "three samples from close to the three site boundary locations in different sectors of the highest calculated annual average ground level D/Q." This requirement was reviewed in December 1986. The D/Q values were evaluated based on July-December 1984 and January-June 1985 average D/Q values. At that time it was believed that the intent of the specifications were met. In October 1988, 12 years of meteorological data (1976-1987) were analyzed for annual average D/Q for both ground level and mixed-mode releases. These data indicate that the SSE sector has the highest annual D/Q values followed by S and SSW sectors. The first sample was collected from the SSE sector, AC/AP-55, on December 5, 1988.

Air particulate and charcoal cartridges are collected weekly. There were 52 weeks in 1988 times 8 air monitoring locations for a possible total of 416 samples each.

<u>Location</u>	<u>Date</u>	<u>Reason</u>
AC/AP-4	Jan. 11, 1988	Power cable cut.
AC/AP-6	Jan. 11, 1988	Low volume due to mechanical malfunction. Replaced sampler.
AC/AP-1	Mar. 13, 1988	Low volume due to mechanical malfunction.

<u>Location</u>	<u>Date</u>	<u>Reason</u>
AC/AP-2	July 4, 1988	Low volume due to blown transformer.
AC/AP-55	Jan. thru Nov.	Added 1st week Dec.

4.2 Broadleaf Vegetation

Broadleaf vegetation samples are collected monthly when available from three locations. Three different kinds of broadleaf vegetation should be collected from each location for a possible total of 108 samples compared to 59 samples collected. These samples were not collected due to seasonal availability during the following months:

January	March	November
February	April	December

4.3 Groundwater

<u>Location</u>	<u>Date</u>	<u>Reason</u>
GW 40, 42, 43 Tritium	Jan. 1988	Samples discarded before analysis completed during relocation of HE&EC environmental laboratory.
GW 42 Tritium and Gamma Scan	Oct., Nov., and Dec. 1988	No sample available. Pump on deep well was out of service.

4.4 Thermoluminescent Dosimeters (TLDs)

TLD Location 35, first quarter 1988, was missing in the field at the time of sample collection.

5.0 LAND-USE CENSUS

The 1988 land-use census was performed on May 10-11, 1988, in accordance with Technical Specification 3.17.2. The purpose of the survey was to identify the location of the nearest milk animal, the nearest resident, 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 5 miles.

Table 5-1 summarizes the locations of the nearest resident and garden with a 5-mile radius of the site in each of the 16 meteorological sectors. There were no changes in the land-use census from the previous year that would yield a potential higher dose to an individual from plant effluents. Therefore, no changes in the environmental program were warranted.

Table 5-1
Land-Use Census
Distances to Locations of Interest (miles)

Sector	Distance to Nearest Resident	Distance to Nearest Garden
N	2.90	2.90
NNE	1.30	1.80
NE	1.10	1.30
ENE	0.85	1.10
E	0.90	3.30
ESE	0.60	0.80
SE	0.30	2.25
SSE	0.30	2.20
S	0.30	0.30
SSW	0.30	0.30
SW	0.50	0.50
WSW	0.40	0.40
W	0.55	0.55
WNW	0.60	1.00
NW	1.35	1.35
NNW	2.80	2.80

No milk-producing animals are located within a 5-mile radius of the plant.

6.0 ANALYTICAL PROCEDURES

6.1 Gross Beta

Gross beta radioactivity measurements are made utilizing a Tennelec Low-Background Alpha/Beta Counting System. The LLD for air particulates is approximately 0.002 pCi/m^3 .

Air particulate samples are mounted in 2-inch stainless steel planchets and counted directly.

6.2 Tritium

Liquid samples requiring tritium analysis are first distilled. Five milliliters of the distillate are mixed with ten milliliters of liquid scintillation cocktail and counted on a liquid scintillation counter for 50 minutes. The LLD is approximately 1200 pCi/l .

6.3 Iodine-131

Iodine-131 airborne concentrations are quantified by the Ge(Li) gamma spectrometry systems. The cartridges are placed on the detector and each charcoal cartridge is counted individually with an approximate LLD of $1\text{E}-2 \text{ pCi/m}^3$.

Iodine-131 in milk is analyzed by use of anion-exchange resin, sodium hypochlorite leach, and organic extraction. Iodine is precipitated as silver iodide, collected on a tared filter, dried, and counted on a low-background beta counter. The routine LLD is approximately 0.3 pCi/liter .

6.4 Gamma Spectrometry Ge(Li)

Gamma spectrum analysis utilizes germanium or Ge(Li) detectors with thin aluminum windows housed in steel and lead shields. The analyzer system is the Nuclear Data 6685. Table 6-1 summarizes LLD

values derived from instrument sensitivity based upon a blank sample background.

Air particulate composites are placed in a Petri dish and analyzed directly.

Liquid samples, except milk, are boiled down to a small volume, transferred to a 250-ml polypropylene beaker with lid, and analyzed directly. One-liter samples of milk are analyzed in a Marinelli beaker.

Shoreline sediments are dried, weighed, and then analyzed in a Marinelli beaker.

Food products and broadleaf vegetation samples are weighed wet and analyzed in a Marinelli beaker.

Fish samples are cleaned, dressed, and placed in a Marinelli beaker for analysis.

6.5 Thermoluminescent Dosimetry (TLD)

Each area monitoring station includes a TLD packet, which is a polyethylene bag containing three calcium sulfate phosphors contained in a Panasonic UD-814 badge. The TLD is lighttight, and the bag is weather-resistant.

Dosimeters are machine annealed before field placement. Following exposure in the field, each dosimeter is read utilizing a Panasonic TLD reader. This instrument integrates the light photons emitted from traps deexcited above 150°C. The lower-energy traps are automatically eliminated through a preheat cycle. Calibration is checked regularly using dosimeters irradiated to known doses. Prior to the measurement of each dosimeter, the instrument is checked through use of an internal constant light source as a secondary standard. The minimum sensitivity of the dosimeters used is approximately 1 mR.

The exposure reported is corrected for exposure received in transit and during storage through the use of control dosimeters.

6.6 EPA Laboratory Intercomparison Program

The Radiological Environmental Laboratory at the Harris Energy & Environmental Center in New Hill, North Carolina, provides radio-analytical services for CP&L's nuclear plant environmental surveillance programs. The laboratory is a participant in the EPA cross-check program and uses its performance in this program as a major determinant of the accuracy and precision of its analytical results.

During 1988, 27 samples representing 4 major environmental media (water, milk, feed, and air filters) were analyzed. Data on the known activities and the normalized standard deviations, using the known value, for these 69 analyses have been received from the EPA. A comparison of the average of our reported values with the EPA known activity and its standard deviation can be summarized as follows:

<u>Standard Deviation (sigma)</u> <u>From Known Activity</u>	<u>Percent of Analyses</u>
≤ 1 standard deviation	58
≤ 2 standard deviation	86
≤ 3 standard deviation	94

Of the 69 determinations, 5 (7 percent) fell outside the 3 sigma control limit.

In October 1988, three of six isotopes in a gamma analysis were above three times the normalized standard deviations. These were Co-60 at + 5.89, Cs-134 at + 11.55, and Cs-137 at + 9.58. Cr-51, Zn-65, and Ru-106 were all less than one normalized standard deviation from the mean. It was found, upon investigation, that the sample had been contaminated during preparation and the importance

of cleanliness and care was reemphasized. Subsequent analyses of unknown samples for gamma emitters revealed no problems.

In November 1988, a sample was analyzed for gross alpha and contained Ra-222, Ra-228; and natural uranium was 3.29 normalized standard deviations above the mean. Investigation revealed that the wrong efficiency, 0.105 instead of 0.12, had been read from the self-absorption curve. Use of an efficiency of 0.12 would have resulted in 2.02 normalized standard deviations above the mean. Gross alpha analyses run after this sample yielded normalized standard deviations of -0.23 and -0.12.

In September 1988, gross beta on a sample analyzed for alpha and beta was +3.58 normalized standard deviations above the mean. Reanalysis of the sample yielded 10.0 pCi/l and 8 pCi/l compared with a true value of 10.0 pCi/l. Subsequent gross beta analyses yielded a +0.92 and a +1.15 normalized standard deviation.

6.7 Lower Limits of Detection (LLD)

All samples analyzed met the LLD required by Technical Specification 6.9.1.7 and Table 4.12.1-1. Typical "a priori" LLD values for the samples analyzed are listed in Table 6-1.

Table 6-1

Typical Lower Limits of Detection (a priori LLD)
Ge(Li) Gamma Spectrometry

Surface Water Samples*
(Freshwater)

Isotope	(LLD)
Cr-51	19 pCi/l
Mn-54	3
Co-58	3
Co-60	3
Zn-65	4
Nb-95	5
Zr-95	3
I-131	7
Cs-134	3
Cs-137	3
Ba-140	20
La-140	7
Other Expected Gamma Emitters	2 to 79

Surface Water Samples*
(Saline Water)

Isotope	(LLD)
Cr-51	34 pCi/l
Mn-54	4
Co-58	4
Co-60	5
I-131	12
Cs-134	5
Cs-137	4
Ba-140	25
La-140	12
Other expected Gamma Emitters	2 to 85

*The sample activities were decayed from the middle of the sampling period rather than from the end of the sampling period. This resulted in LLD values that appear higher than values calculated from the end of the period.

Table 6-1 (continued)

Air Particulates*
(Quarterly Composite)

Isotope	(LLD)
Cs-134	0.001 pCi/cubic meter
Cs-137	0.001
Ba-140	0.017
La-140	0.006
Other Expected Gamma Emitters	0.001 to .017

Groundwater Samples

Isotope	(LLD)
Cr-51	19 pCi/l
Mn-54	3
Co-58	3
Co-60	3
Cs-134	3
Cs-137	3
Ba-140	20
La-140	7
Other Expected Gamma Emitters	2 to 79

*The sample activities were decayed from the middle of the sampling period rather than from the end of the sampling period. This resulted in LLD values that appear higher than values calculated from the end of the period.

Table 6-1 (continued)

Milk
(gamma scan)

Isotope	(LLD)
Cr-51	27 pCi/l
Mn-54	4
Co-58	4
Co-60	6
I-131	4
Cs-134	5
Cs-137	5
Ba-140	16
La-140	5
Other Expected Gamma Emitters	2 to 95

Sediments
(Shoreline or Bottom)

Isotope	(LLD)
Cr-51	263 pCi/kg (dry weight)
Mn-54	50
Co-58	36
Co-60	36
Cs-134	61
Cs-137	39
Other Expected Gamma Emitters	28 to 618

Table 6-1 (continued)

Fish

Isotope	(LLD)
Cr-51	174 pCi/kg (wet weight)
Mn-54	13
Co-58	32
Co-60	38
Zn-65	62
I-131	28
Cs-134	33
Cs-137	29
Other Expected Gamma Emitters	13 to 668

Food Products and Vegetation

Isotope	(LLD)
Cr-51	105 pCi/kg (wet weight)
Mn-54	15
Co-58	17
Co-60	18
I-131	12
Cs-134	16
Cs-137	13
Other Expected Gamma Emitters	11 to 310