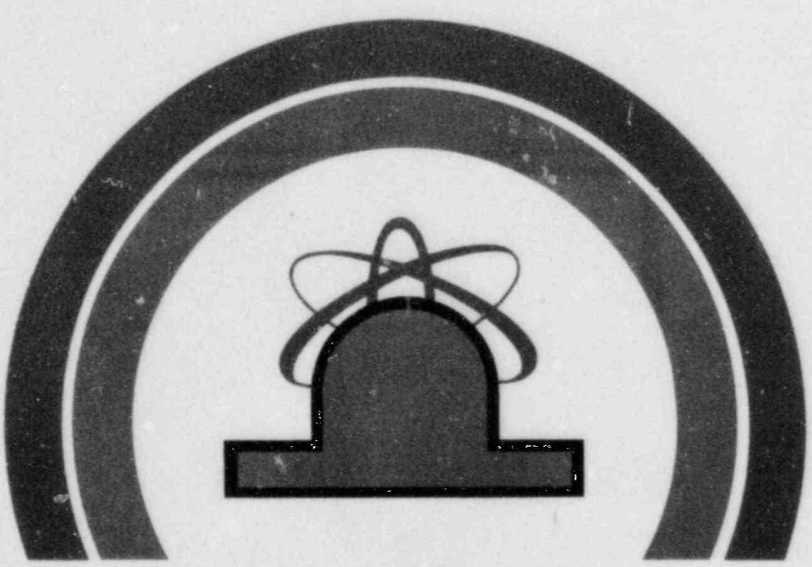
Environmental Surveillance Report

January 1, 1984 — December 31, 1984



BRUNSWICK
STEAM ELECTRIC PLANT
CAROLINA POWER & LIGHT COMPANY

Shearon Harris Energy & Environmental Center

Carolina Power & Light Company

New Hill, North Carolina

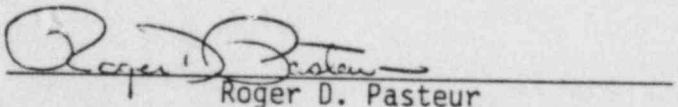
ENVIRONMENTAL RADIOLOGICAL MONITORING REPORT

FOR

BRUNSWICK STEAM ELECTRIC PLANT

JANUARY 1, 1984, THROUGH DECEMBER 31, 1984

Prepared By:

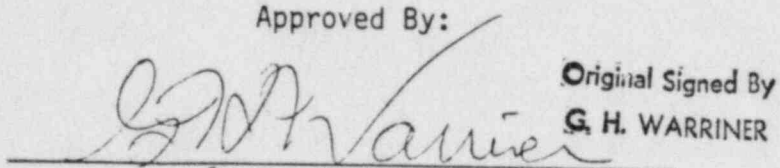


Roger D. Pasteur
Senior Specialist - Environmental

Reviewed By:

Ronald L. Shearin
Project Specialist - Environmental

Approved By:



George H. Warriner
Principal Specialist - Environmental

TABLE OF CONTENTS

1.0 INTRODUCTION

The 1984 Annual Radiological Environmental Operating Report for the Brunswick Steam Electric Plant (BSEP) has been prepared in accordance with Technical Specification 6.9.1.7. This report is being submitted in accordance with Technical Specification 6.9.1.6 and applies to both BSEP Units 1 and 2 (Licenses DPR-071 and DPR-062, respectively).

The Brunswick Steam Electric Plant (BSEP) consists of two boiling water reactors with a design rating of 1642 MWe net. Commercial production was initiated by Unit 2 on November 3, 1975, and by Unit 1 on March 18, 1977.

The BSEP is located approximately 2.5 miles north of Southport, North Carolina. This location is near the mouth of the Cape Fear River, which is the source of condenser cooling water. The cooling water is then discharged into the Atlantic Ocean.

The plant site lies at sea level to 30 feet (MSL) surrounded by extensive swamps and marshes. Recreational beaches are located within 20 miles of the plant. Fishing and boating are popular activities in the area. Within 50 miles of the plant, less than half of the land is used for agriculture. The agricultural activities include small truck farms, cattle, and poultry farms as well as farms producing corn, soybeans, and tobacco. Most of the industrial activity is in the Wilmington area, approximately 16 miles north of BSEP. Sunny Point Military Ocean Terminal is located approximately 4.5 miles north of BSEP. Pfizer Chemical Company, located 1.5 miles southeast of BSEP, manufactures citric acid. A shipping channel in the Cape Fear River intercepts the Atlantic Intracoastal Waterway near Southport.

2.0 PROGRAM SUMMARY

2.1 The purposes of the Environmental Radiological Monitoring Program are:

- To measure any accumulation of radioactivity in the environment and to assess whether this radioactivity is the result of the operation of the BSEP.

- To provide an evaluation of the environmental impact of operating releases of radioactive materials from the BSEP.

- To compare population doses from environmental sample data with corresponding doses predicted in the Final Environmental Statement.

2.2 Technical Specification Monitoring--The sampling program developed during preoperational surveillance provided the basis for the environmental monitoring program required by the BSEP Technical Specifications. Details of this sampling program, including sampling type, distance, and direction from the plant site, are listed in Table 2-1. Maps, including the sampling locations with respect to the plant, are shown in Figures 2-1 through 2-5. Types of samples collected include air cartridge (iodine), air particulate, fish and invertebrates, food crops, milk, shoreline sediment, surface water, and direct radiation monitoring.

2.3 Non-Technical Specification Monitoring--To supplement the environmental monitoring program, additional surveillance of bottom sediments and groundwater was performed. Table 2-1 lists these sample locations with the sample type, distance, and location from the plant site and is denoted by double asterisks (**).

Beginning in the third quarter of 1980, groundwater samples have been taken from 17 wells at the Southport-Brunswick County Landfill to monitor for transport of radioactive material into the groundwater system.

Following the discovery of elevated activity levels in the discharge canal sediments in September 1982, a monthly bottom sediment sampling

program was instituted. Bottom sediment samples were collected from the intake and discharge canals and the Atlantic Ocean. The Technical Specifications requirements for discharge canal sediments sampling were deleted by a January 1984 amendment to BSEP Technical Specifications. The expanded bottom sediment sampling program was discontinued at the end of January 1984. However, spot sampling was conducted in 1984 to ensure that conditions have not changed. The results are reported in Table 2-2. The results of future samplings will be reported if significant increases in the discharge canal sediment activity are observed.

TABLE 2-1

ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM

BRUNSWICK STEAM ELECTRIC PLANT

Sample Type	Sampling Point and Description	Sampling Frequency	Sample Size	Sample Analysis
Air Cartridge (AC)	64--1.0 mile SW Visitors Center 65--0.6 mile NE PMAC 66--1.0 mile S substation--construction road 67--2.3 miles SSW Southport substation 68--23 miles NNE Sutton Plant* 69--4.9 miles SSW Caswell Beach at ocean discharge pumps 70--0.1 mile SW discharge weir 71--0.9 mile NW Bethel Church Cemetery 72--0.6 mile SE Spoil Pond	Weekly	10,000 cu ft (300 cu m)	Iodine
Air Particulate (AP)	64--1.0 mile SW Visitors Center 65--0.6 mile NE PMAC 66--1.0 mile S substation--construction road 67--2.3 miles SSW Southport substation 68--23 miles NNE Sutton Plant* 69--4.9 miles SSW Caswell Beach at ocean discharge pumps 70--0.1 mile SW discharge weir 71--0.9 mile NW Bethel Church Cemetery 72--0.6 mile SE Spoil Pond	Weekly	10,000 cu ft (300 cu m)	Gross Beta--Weekly Composite Gamma--Quarterly

*Control Station

TABLE 2-1 (Continued)

Sample Type	Sampling Point and Description	Sampling Frequency	Sample Size	Sample Analysis
Bottom Sediment (SD)**	108--1.5 miles SNE intake canal control* 109--0.1 mile SW discharge canal near plant 110--5.0 miles SSW discharge canal at Caswell Beach pumping station 111--5.5 miles SSW Atlantic Ocean 0.5 mile E of plant discharge 112--5.5 miles SSW Atlantic Ocean near plant discharge 113--5.5 miles SW Atlantic Ocean 0.5 mile W of plant discharge	Semiannual	500 grams	Gamma
Fish (FI)	78--5.5 miles SSW Atlantic Ocean 79--5.5 miles SSW Atlantic Ocean 80--5.5 miles SSW Atlantic Ocean 81--Atlantic Ocean; control; location not specified*	Semiannually when in season	500 grams (wet)	Gamma
Food Crop (FC)	82--0.7 mile NE intake canal 83--0.6 mile SW discharge canal 84--10 miles control; location not specified* 85--0.9 mile NW Bethel Church Cemetery 86--0.6 mile SE Spoil Pond	Monthly when available	500 grams (wet)	I-131, Gamma
Groundwater (GW)**	87-103--4.4 miles WSW Brunswick County Landfill 104-107--0.3 to 0.4 miles NNE BSEP Landfill	Quarterly	2 liters	Gamma
Milk (MS)	76--0.7 mile SE Stevens' Farm 77--14.5 miles NNW Johnson's Farm*	Semimonthly	2 gallons	I-131, Gamma
Shoreline Sediment (SS)	75--4.9 miles SSW discharge; beach	Semiannually	500 grams	Gamma
Surface Water (SW)	73--0.7 mile NE intake canal* 74--4.9 miles SSW discharge Canal at stilling pond	Composite Sample	Monthly	Gamma--Monthly

*Control Station

**Not required by technical specifications.

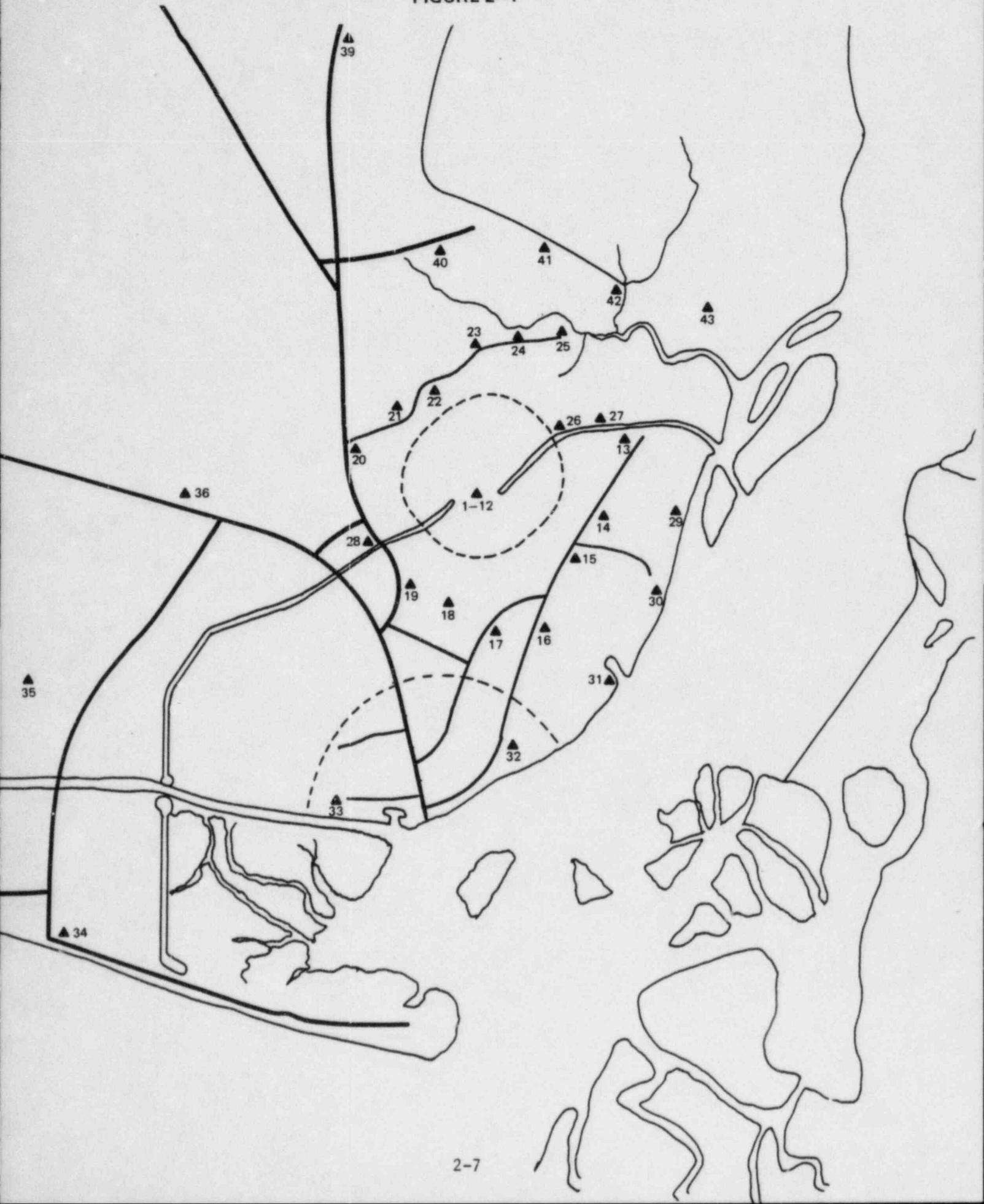
TABLE 2-1 (Continued)

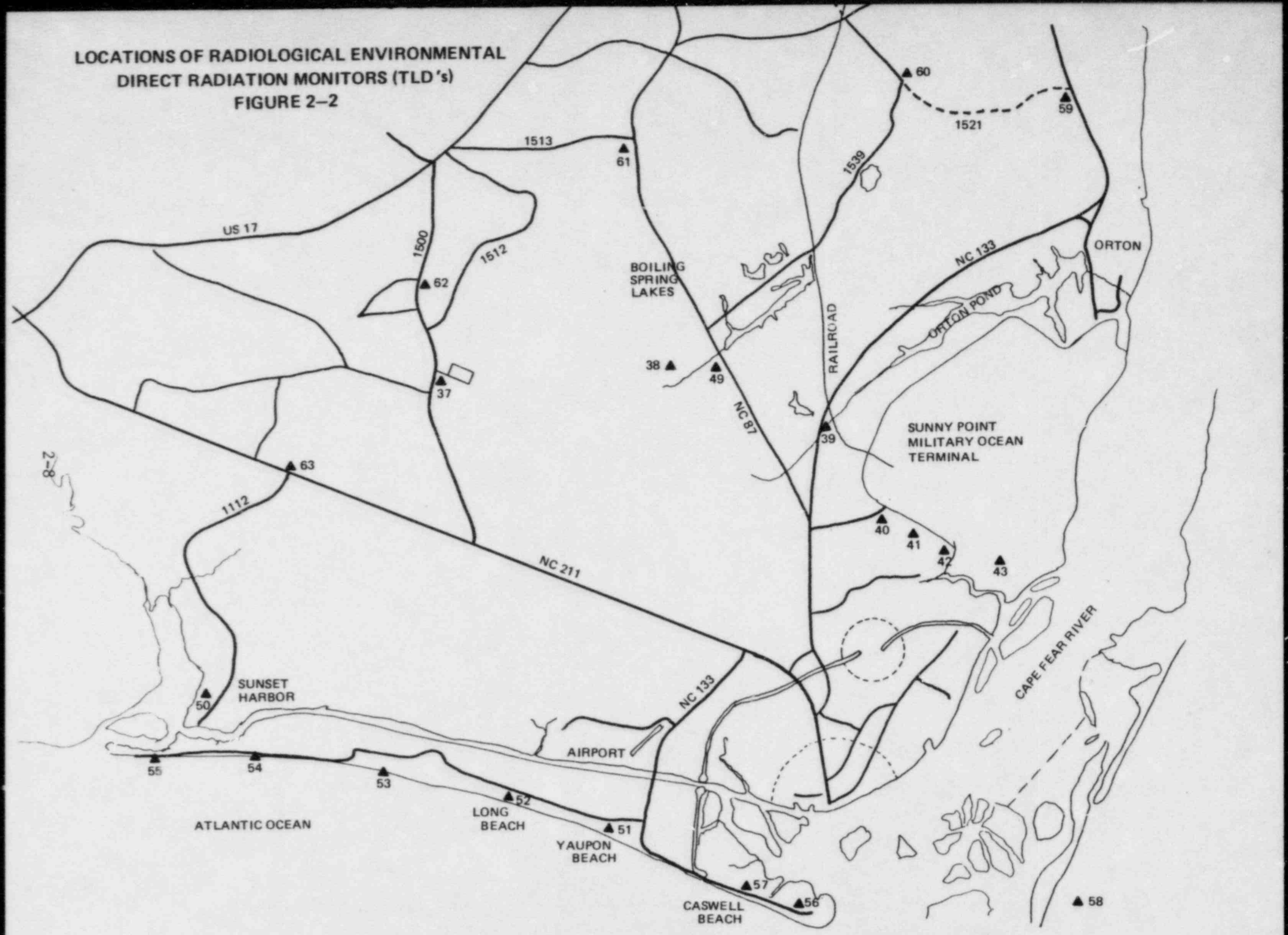
Sample Type		Sampling Point and Description		Sampling Frequency	Sample Size	Sample Analysis
Direct Radiation (TL)	13	1.1 miles E	Refer to Figures 1-1, 1-2, 1-3, 1-4, and 1-5	Quarterly	Not Applicable	TLD Readout
	14	1.0 mile ESE				
	15	0.9 mile SE				
	16	1.1 miles SSE				
	17	1.1 mile S				
	18	1.0 mile S				
	19	1.0 mile SW				
	20	1.2 miles W				
	21	1.0 mile WNW				
	22	0.9 mile NW				
	23	0.9 mile NNW				
	24	1.0 mile N				
	25	1.2 mile NNE				
	26	0.5 mile NE				
	27	0.9 mile ENE				
	28	1.0 mile WSW				
	29	1.5 miles ESE				
	30	1.7 miles SE				
	31	2.0 miles SSE				
	32	2.1 miles S				
	33	2.9 miles SSW				
	34	5.3 miles SW				
	35	4.6 miles WSW				
	36	3.0 miles W				
	37	8.7 miles WNW				
	38	5.9 miles NW				
	39	3.8 miles NNW				
	40	2.3 miles N				
	41	2.0 miles NNE				
	42	2.0 miles NE				
	43	2.6 miles ENE				
	44	5.7 miles E near Kure Beach				
	45	4.3 miles E at Ferry Slip N.H. Co.				
	46	5.5 miles ENE at Ft. Fisher AFB				
	47	7.2 miles ENE at Kure Beach				
	48	9.3 miles NE at Carolina Beach				
	49	5.5 miles NW at Boiling Spring Lakes				
	50	11.0 miles W at Sunset Harbor				
	51	5.3 miles SW at Yaupon Beach				
	52	6.9 miles WSW at Long Beach				
	53	8.5 miles WSW at Ocean Crest Pier				
	54	10.9 miles WSW at Long Beach Pier				
	55	12.0 miles WSW at Blue Water Point				
	56	4.5 miles S at Ft. Caswell Bapt. Assy.				
	57	4.8 miles SSW at Caswell Beach				
	58	5.3 miles SSE at Bald Head Island				
	59	10.0 miles NNE Hwy. 133 at SR 1521				
	60	9.5 miles N SR 1539 at SR 1521				
	61	9.5 miles NE Hwy. 87 at SR 1513				
	62	10.0 miles WNW Midway Road at SR 1508				
	63	11.0 miles W Hwy. 211 at SR 1112				

Following is a tabulation of the specific methods used in monitoring the gaseous effluent and liquid effluent pathways of exposure to man.

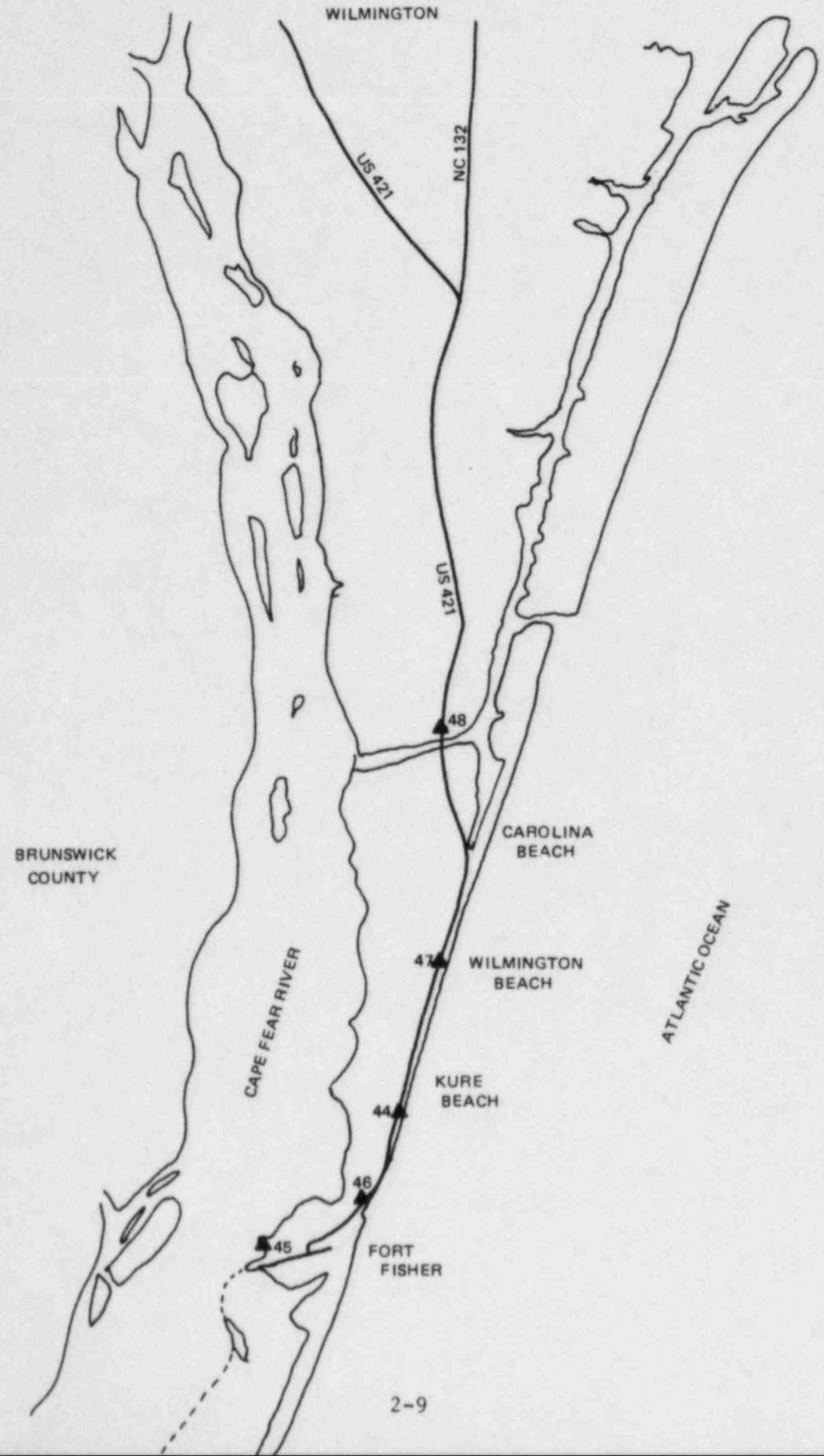
Pathway of Exposure to Man	Media Sampled
External Dose	TLD
Ingestion Pathway	Food Crops Milk Samples
	Fish and Invertebrates Samples
	Sediment (Shoreline and Bottom)
	Groundwater
	Surface Water
Inhalation	Air Samples

LOCATIONS OF RADIOLOGICAL ENVIRONMENTAL
DIRECT RADIATION MONITORS (TLD's)
FIGURE 2–1

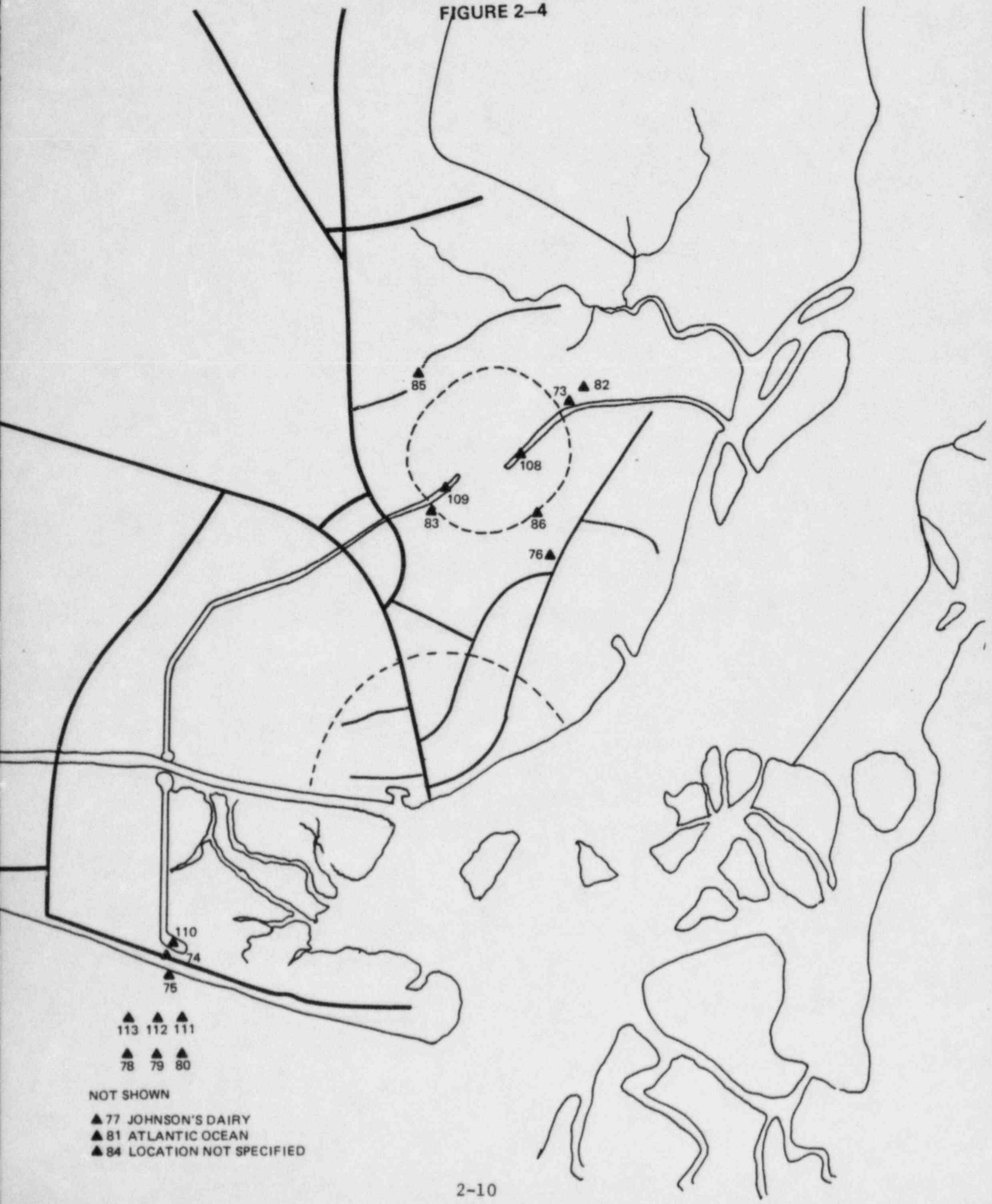



LOCATIONS OF RADIOLOGICAL ENVIRONMENTAL
DIRECT RADIATION MONITORS (TLD's)
FIGURE 2–2
1513
61
60
1521
59
1539
US 17
1500
1512
62
BOILING
SPRING
LAKES
NC 133
ORTON
ORTON POND
RAILROAD
38
49
37
NC 87
39
SUNNY POINT
MILITARY OCEAN
TERMINAL
63
1112
40
41
42
43
NC 211
SUNSET
HARBOR
50
NC 133
CAPE FEAR RIVER
AIRPORT
55
54
53
52
LONG
BEACH
ATLANTIC OCEAN
51
YAUPON
BEACH
57
56
CASWELL
BEACH
58
2-8

LOCATIONS OF RADIOLOGICAL ENVIRONMENTAL
DIRECT RADIATION MONITORS (TLD's)
FIGURE 2–3

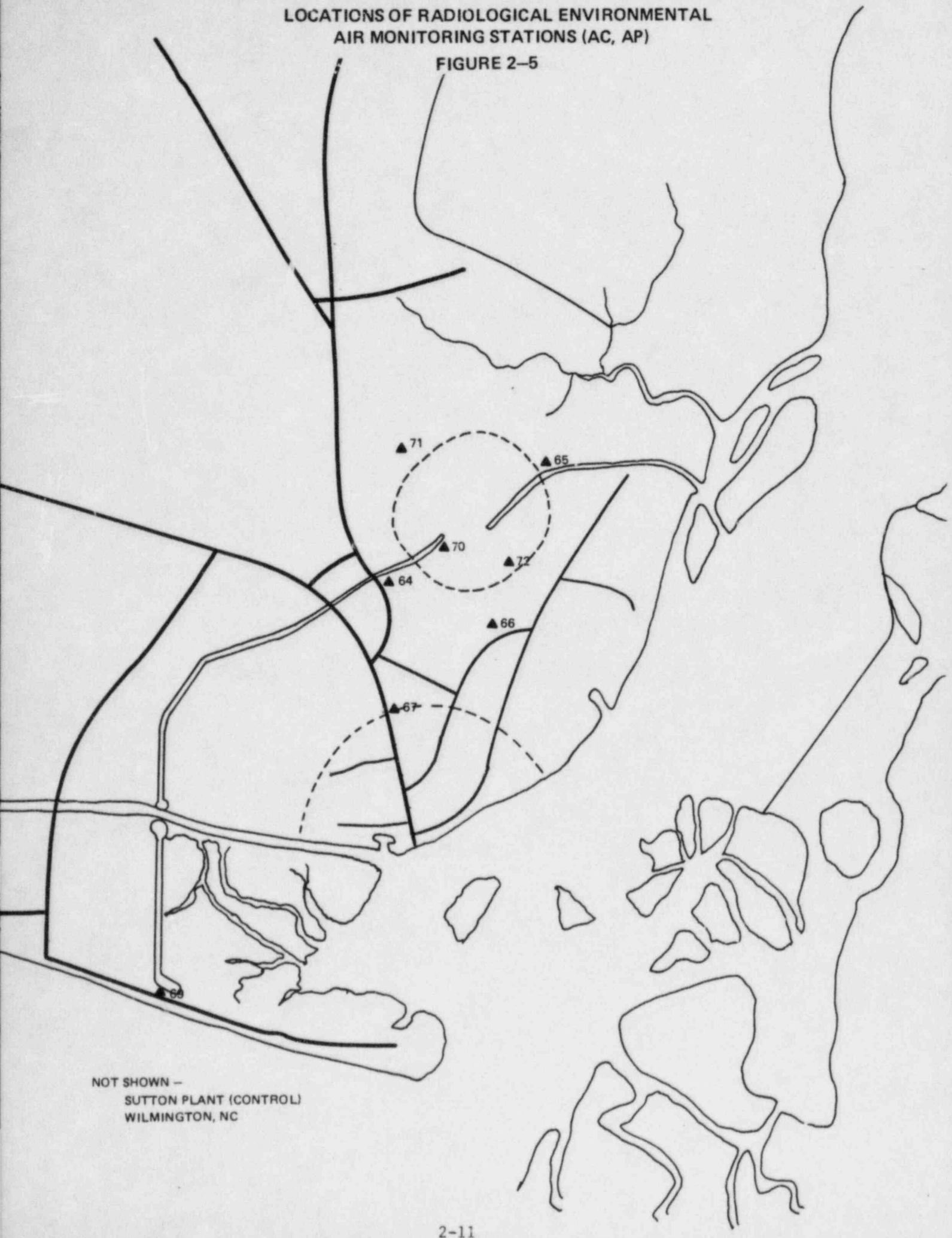


LOCATIONS OF RADIOLOGICAL ENVIRONMENTAL
WATERBORNE AND INGESTION PATHWAY STATIONS
(SW, SS, MS, FI, FC)
FIGURE 2–4



LOCATIONS OF RADIOLOGICAL ENVIRONMENTAL
AIR MONITORING STATIONS (AC, AP)

FIGURE 2–5



NOT SHOWN –
SUTTON PLANT (CONTROL)
WILMINGTON, NC

TABLE 2-2

ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM SUMMARY

Brunswick Steam Electric Plant
Brunswick County, North Carolina

Docket Numbers - 50-324 and 325
Calendar Year 1984

Medium or Pathway Sampled or Measured (Unit of Measurement)	Type and Total No. of Measurements Performed	Lower Limit of Detection LLD (1)	All Indicator Locations (2) Mean Range	Location w/Highest Annual Mean Name, Distance, and Direction	Mean Range (2)	Control Locations Mean Range (2)
Air Cartridge (pCi/m^3)	I-131 (3) 475	3.00E-2	All less than LLD	All less than LLD		All less than LLD
Air Particulate (pCi/m^3)	Gross Beta 475 (3)	4.00E-3	1.83E-2 (420/422) 5.97E-3 - 1.37E-1	PMAC-Intake Canal 0.6 mile NE	1.97E-2 (51/53) 8.09E-3 - 3.62E-2	1.64E-2 (53/53) 5.50E-3 - 3.36E-2
	Gamma (10) 36 Co-60	2.00E-3	9.81E-3 (1/4) (Single Value)	Spoil Pond 0.6 mile SE	9.81E-3 (1/4) (Single value)	All less than LLD
Bottom Sediment (pCi/g, dry)	Gamma (10) 18 (4) Co-60	3.30E-2	5.98E+0 (6/15) 2.19E-1 - 1.70E+1	Discharge Canal at Stilling Pond 4.9 miles SSW	1.10E+1 (3/3) 5.18E+0 - 1.70E+1	All less than LLD
	Cs-137	2.10E-2	4.14E-1 (5/15) 7.08E-2 - 6.18E-1	Discharge Canal at Stilling Pond 4.9 miles SSW	5.68E-1 (3/3) 4.82E-1 - 6.18E-1	3.35E-1 (3/3) 2.13E-1 - 4.70E-1
	Mn-54	1.80E-2	8.97E-1 (5/15) 7.03E-2 - 2.61E+0	Discharge Canal at Stilling Pond 4.9 miles SSW	1.40E+0 (3/3) 6.77E-1 - 2.61E+0	All less than LLD
Fish and Invertebrates (pCi/g, dry)	Gamma (10) 12 Cs-137	2.30E-2	7.24E-2 (1/6) (Single value) 5.0 miles SSW	Atlantic Ocean at Discharge	7.24E-2 (1/2) (Single Value)	3.32E-2 (1/6) (Single Value)

TABLE 2-2

ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM SUMMARY

Brunswick Steam Electric Plant
Brunswick County, North Carolina

Docket Numbers - 50-324 and 325
Calendar Year 1984

Medium or Pathway Sampled or Measured (Unit of Measurement)	Type and Total No. of Measurements Performed	Lower Limit of Detection LLD (1)	All Indicator Locations (2) Mean Range	Location w/Highest Annual Mean Name, Distance, and Direction	Mean Range (2)	Control Locations Mean Range (2)
Broadleaf Vegetation (pCi/g, wet)	Gamma (10) 50 Cs-137	8.00E-3	9.65E-3 (1/48) (Single Value)	Bethel Church Road 0.9 mile NW	9.65E-3 (1/12) (Single Value)	4.41E-2 (1/2) (Single Value)
Groundwater (pCi/l)	Gamma (10) 84 (5)	N/A	All less than LLD	All less than LLD		No Control
Milk (pCi/l)	I-131 4 (6)	3.00E-1	Not Sampled (6)	Not Sampled (6)		All less than LLD
	Gamma (10)	N/A	Not Sampled (6)	Not Sampled (6)		All less than LLD
Sediments - Shoreline (pCi/g, dry)	Gamma (10) 2	N/A	All less than LLD	All less than LLD		No Control
Surface Water (pCi/l)	Gamma (10) 24	N/A	All less than LLD	All less than LLD		All less than LLD
	Tritium 8	5.20E+2	All less than LLD	All less than LLD		All less than LLD
TLD (millirem per week)	TLD Readout 199 (7)	1 mR (8) (9)	9.82E-1 (199/199) 6.00E-1 - 1.50E+0	PMAC - Intake Canal 0.5 mile NE	1.15E+0 (4/4) 1.0E+0 - 1.3E+0	No Control

FOOTNOTES TO TABLE 2-2

1. Lower limit of detection (LLD) is calculated based on 4.66 standard deviations above background using typical sample size in a given counting time. Due to counting statistics and varying volumes, occasionally lower LLDs are achieved. See Table 6-1.

2. Mean and range are based on detectable measurements only. The fractions of detectable measurements at specific locations are indicated in parenthesis.

3. Air particulate and charcoal cartridges were collected weekly. There were 53 weeks in 1984 times 9 air monitor stations for a total of 477 samples. Listed below are the two samples that were collected but not used for this report due to low volumes.

   a. Location 64 (February 6, 1984)--motor failure.

   b. Location 64 (October 29, 1984)--blown fuse.

4. Bottom sediment samples are required semiannually at six locations for a total of 12 samples. However, due to increased concentrations of radionuclides, additional sampling was performed for a total of 18 samples. Gamma analyses were performed on the samples.

5. Seventeen groundwater stations at the Brunswick County landfill require quarterly gamma analysis for a total of 68 samples. Four stations at the Brunswick Steam Electric Plant landfill require gamma analysis quarterly for a total of 16 samples.

6. Milk samples were not available after January 1984 from Locations 76 and 77. The cow at Location 76, Stevens' Farm, was dry. In August 1984 the cow was sold to Mr. Fred Smith, who maintains beef cattle only. Location 77, Johnson's Farm, was sold in January 1984. Four samples were collected in January 1984 prior to the sale of the dairy.

7. Fifty-one environmental TLD locations are sampled quarterly for a possible total of 204 samples. Five TLDs were missing in 1984 and are discussed in Section 5.4. This yields a total of 199 environmental TLD samples for 1984.

8. Dependent on ambient background conditions.

9. Minimum sensitivity is approximately 1 mR. Refer to Section 6.5 for additional information.

10. Summary of gamma analysis results in this report does not include the following naturally occurring isotopes since most environmental samples contained some or all of these: Be-7, K-40, Tl-208, Pb-212, Bi-212, Bi-214, Pb-214, Ra-226, Ac-228, and Th-234.

3.0 INTERPRETATIONS AND CONCLUSIONS

3.1 Air Samples

The gross beta results for air particulate samples collected during the year of 1984 are below the preoperational levels. All indicator station activities averaged 1.77E-2 pCi/m^3 compared to 9.83E-2 pCi/m^3 over the entire preoperational monitoring period. The 1984 average activity of control station samples was 1.64E-2 pCi/m^3. The gross beta plots in Figures 3-1 through 3-8 show each indicator station in comparison to the control station. They verify no significant changes in the indicator location activities in comparison to data from previous years as shown in Table 3-1.

The particulate sample collected for the week of September 10-16, 1984, from Location 72, 0.6 mile SE, Spoil Pond, revealed cobalt-60 at a concentration of 9.81E-3 picocuries per cubic meter. Due to gusting winds and high wind velocities associated with Hurricane Diana which entered the Southport area on September 12, 1984, some slightly contaminated particulate matter became airborne and was subsequently collected on the filter. The deposition was an isolated incident and was not seen again at this location or any other location. Given below are the dose calculations associated with this sample calculated as per Regulatory Guide 1.109 for the maximum exposed individual:

Annual organ dose (mrem/yr) = intake (m^3/yr) x annual average concentration (pCi/m^3) x inhalation dose factor (mrem/pCi)

Adult lung dose = 8,000 x 9.81E-3 ÷ 52 x 7.46E-4 = 1.13E-3 mrem/yr

Teen lung dose = 8,000 x 9.81E-3 ÷ 52 x 1.09E-3 = 1.65E-3 mrem/yr

Child lung dose = 3,700 x 9.81E-3 ÷ 52 x 1.91E-3 = 1.33E-3 mrem/yr

Infant lung dose = 1,400 x 9.81E-3 ÷ 52 x 3.22E-3 = 8.50E-4 mrem/yr

As the calculations indicate, the maximum dose received is 1.65E-3 mrem/yr, which is not a significant contribution to the annual dose.

Determination of I-131 in air via charcoal was made using gamma spectrometry. No iodine-131 was detected for the entire year.

3.2 Milk Samples

The current milk sampling program requires semimonthly sampling from two locations. They are Stevens' farm, Location 76, and Johnson's dairy, Location 77. The single cow located at the Stevens' farm produced no milk in 1984. As of August 1984, the cow was sold to Mr. Fred Smith who maintains the herd of beef cattle for Pfizer Chemical Company. Discussions with Mr. Smith indicated that he had no plans to use the cow for milking in the future.

In January 1984 four milk samples were collected from the Johnson's dairy. The sampling program in effect through January 1984 required weekly samples to be collected. The dairy was sold in late January 1984 and is no longer a functional dairy. The iodine-131 and gamma analyses revealed all values were less than LLD.

3.3 Vegetation--Food Crop

The Technical Specifications require vegetation sampling from two sectors with historically higher D/Q values and at one location > 15 km to serve as a control location. Four gardens are maintained on the site boundary to satisfy the first requirement. Of the 48 samples from these gardens, only one location, Bethel Church Road, 0.9 mile NW, revealed activity, cesium-137, at a concentration of 9.65E-3 pCi/gram, wet. This value may be compared to the single value of Cs-137 seen at a control location of 4.41E-2 pCi/gram, wet. Note that the control activity was approximately four times greater than the indicator location. Therefore, this measurable activity was not attributed to BSEP plant operations.

3.4 Soil--Shoreline Sediment

The Technical Specifications require one sample location for shoreline sediment located on the beach of the Atlantic Ocean near the ocean discharge location of the Caswell Beach pumping station. All values from the gamma isotopic analyses were less than LLD.

Additional sampling on bottom sediments from the intake and discharge canals has been performed in a manner similar to the programs in 1982 and 1983. The isotopes found in the bottom sediment that may be attributed to plant operations are cobalt-60 (Co-60), manganese-54 (Mn-54), and cesium-137 (Cs-137). The location with the highest concentration is at the stilling pond at the Caswell Beach pumping station. The stilling pond has consistently had the highest concentrations since expanded surveillance has been performed on the canal system. Although the highest concentration of Co-60 (17 pCi/gram) was measured in 1984, no trend indicating a significant buildup of activity in the canal system is indicated. The Co-60 activity appears to be consistent with sampling deviation seen in previous samplings. As shown by Figure 3-9, the average Co-60 concentration is 5-8 pCi/gram for the period from 1982 through 1984. The activity of the bottom sediment in the discharge canal is not seen as a health hazard.

3.5 Surface Water

Surface water is sampled monthly from two locations and analyzed for tritium and gamma-emitting radionuclides. In all samples, activities were less than LLD.

3.6 Fish and Invertebrates

Fish and invertebrate samples are collected semiannually when in season and analyzed for gamma-emitting radionuclides. Fish are collected as (1) free swimmers and (2) bottom feeders. Invertebrates may include shrimp, oysters, and crabs.

The gamma analyses for fish collected in the Atlantic Ocean near the discharge of the Caswell Beach pumping station revealed a single incident of Cs-137 with a concentration of 7.24E-2 pCi/g, dry. This may be compared to samples obtained during preoperational testing when Cs-137 was detected in 5 of 23 samples with an average concentration of 1.7E-1 pCi/gram. Table 3-2 provides dose assignments from the Cs-137 in the fish sample. The Cs-137 concentration of 7.24E-2 pCi/g, dry, corresponds to 1.68E-2 pCi/g, wet. As indicated, the organ doses are less than 0.04 mrem/yr; and the total body dose is 0.025. The limits for organ and total body doses are 20 mrem/yr and 6 mrem/yr, respectively, as per 10CFR50, Appendix I.

3.7 Groundwater

Groundwater samples are collected and analyzed quarterly for gamma-emitting radionuclides. All were found to be less than LLD.

3.8 External Radiation Dose (TLD)

Environmental dosimetry data did not show any significant changes from previous years' data. Location 26, PMAC (0.5 mile NE), showed the highest average dose as indicated in Table 2-2.

3.9 Summary

All samples analyzed met the LLD requirements as established by Technical Specification 6.9.1.7.h and Table 4.12.1-1. In summary, the analyses from the environmental media surrounding the Brunswick Plant confirm that the environmental impact of the plant during 1984 was nominal.

TABLE 3-1

GROSS BETA AIR PARTICULATE ACTIVITY AVERAGES FOR SIX-MONTH PERIODS
COMPARISON OF PREOPERATIONAL DATA, 1983 DATA, AND 1984 DATA (pCi/m^3)

Location	1st/73	2nd/73	1st/74	2nd/74	1st/83	2nd/83	1st/84	2nd/84
AP-64	1.5E-2	2.9E-2	1.7E-1	1.1E-1	1.9E-2	2.2E-2	1.7E-2	2.1E-2
AP-65	--	3.1E-2	1.6E-1	1.2E-1	1.8E-2	2.2E-2	1.7E-2	2.2E-2
AP-66	--	3.4E-2	1.7E-1	1.1E-1	1.7E-2	2.0E-2	1.7E-2	1.9E-2
AP-67	1.6E-2	3.2E-2	1.5E-1	1.1E-1	1.7E-2	2.3E-2	1.7E-2	2.0E-2
AP-68	1.7E-2	3.2E-2	1.6E-1	1.0E-1	1.6E-2	1.9E-2	1.5E-2	1.8E-2
AP-69	1.5E-2	2.8E-2	1.6E-1	1.1E-1	1.2E-2	1.8E-2	1.5E-2	1.9E-2
AP-70	1.6E-2	3.1E-2	1.8E-1	1.1E-1	1.9E-2	1.9E-2	1.8E-2	2.0E-2
AP-71	--	--	--	--	1.7E-2	1.8E-2	1.6E-2	2.3E-2
AP-72	--	--	--	--	1.7E-2	1.9E-2	1.6E-2	1.9E-2

TABLE 3-2

DOSE COMMITMENTS FROM FISH AND INVERTEBRATES

Assumptions are based on the maximum exposed individual. Calculations are modeled from Regulatory Guide 1.109. The Cs-137 concentration is 7.24E-2 pCi/g, dry, and 1.68E-2 pCi/g, wet.

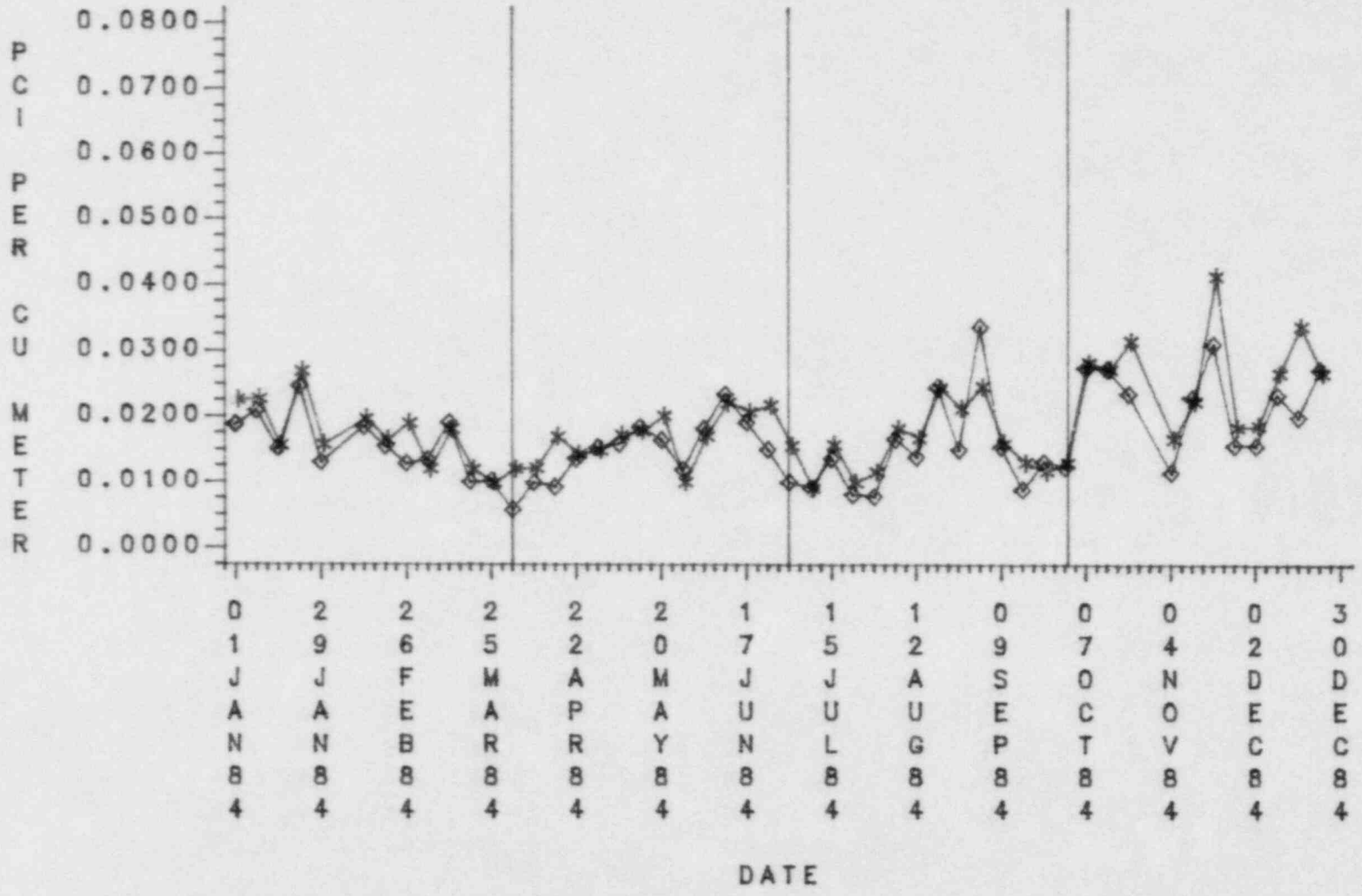
	Child	Teen	Adult	
Consumption (kg/yr)	6.9	16	21	
Ingestion factors (mrem/pCi)	--	--	--	
Bone	3.27E-4	1.12E-4	7.97E-5	
Liver	3.13E-4	1.49E-4	1.09E-4	
Total Body	4.62E-5	5.19E-5	7.14E-5	
				Limits 10CFR50 App. I (mrem/yr)
Dose (mrem/yr)				
Bone	0.038	0.030	0.028	20
Liver	0.036	0.040	0.038	20
Total Body	0.005	0.014	0.025	6

GROSS BETA ACTIVITIES
AIR PARTICULATE SAMPLES

BOTTOM SEDIMENT ACTIVITY

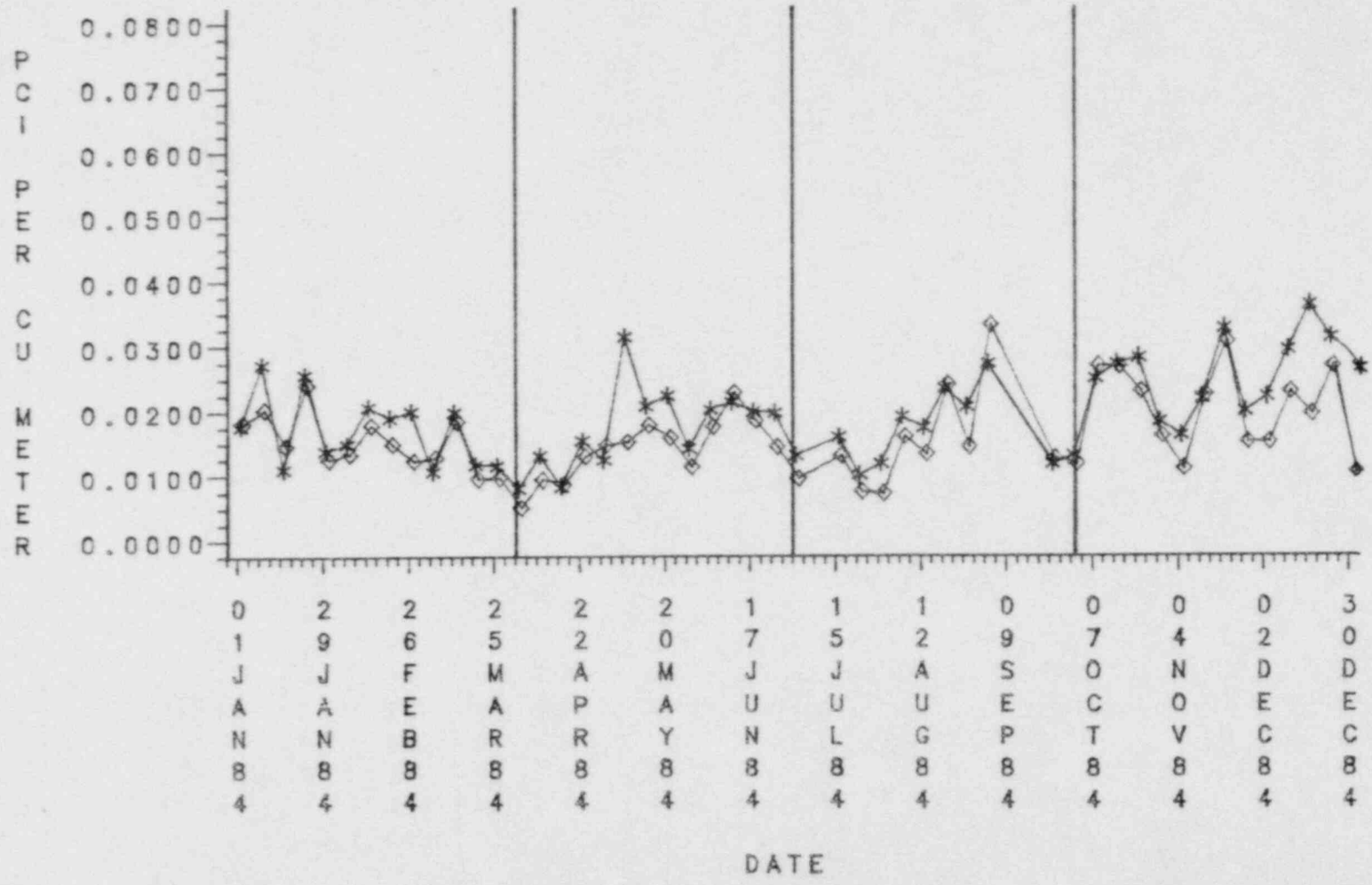
CP&L ENVIRONMENTAL SURVEILLANCE
GROSS BETA ACTIVITY FOR
AIR PARTICULATE SAMPLES
* FOR SAMPLE STATION
◇ FOR CONTROL STATION

PLANT SAMPLE COLLECTED FOR=BSEP POINT SAMPLE COLLECTED FROM=0064



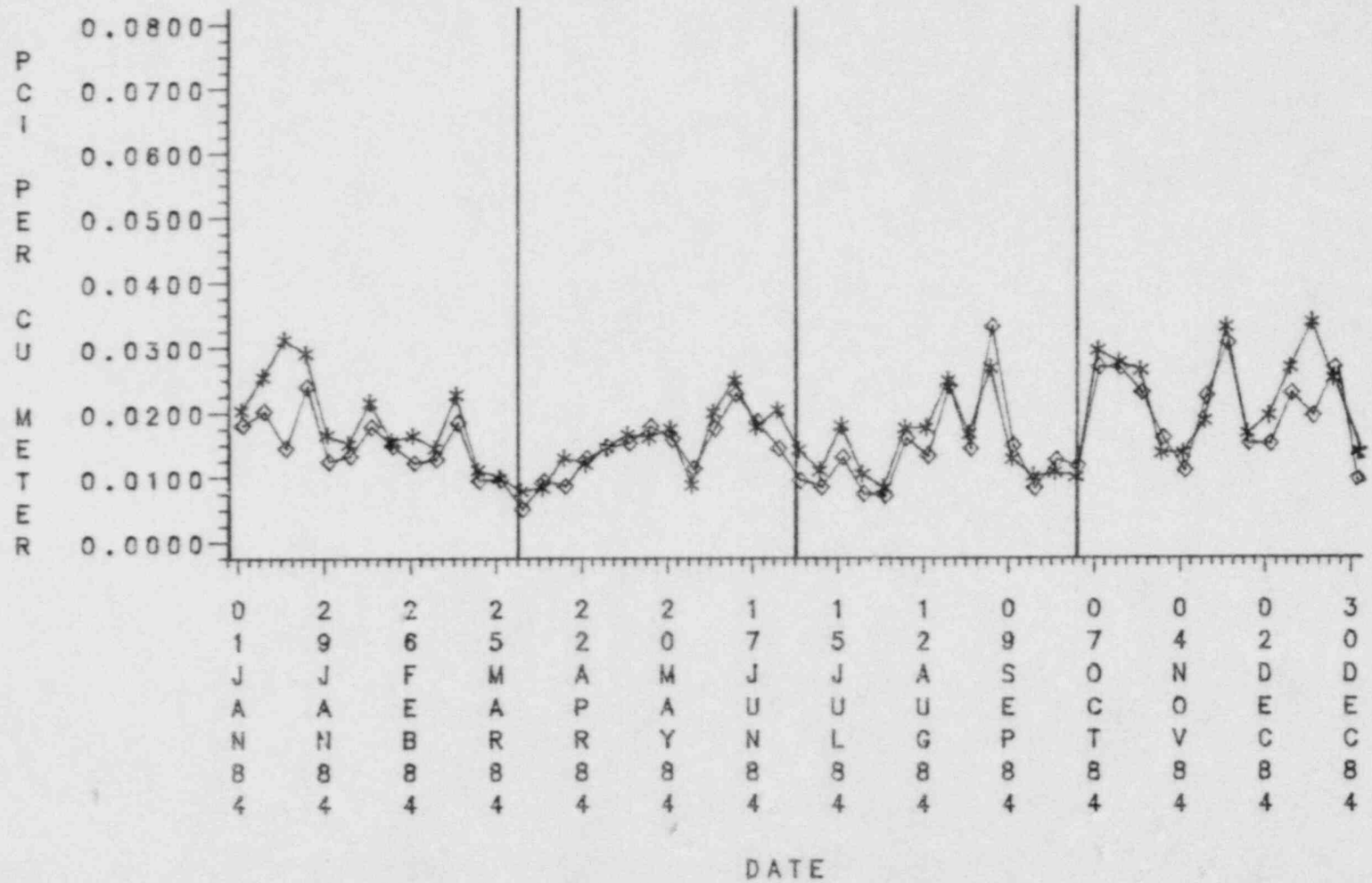
CP&L ENVIRONMENTAL SURVEILLANCE
GROSS BETA ACTIVITY FOR
AIR PARTICULATE SAMPLES
* FOR SAMPLE STATION
◇ FOR CONTROL STATION

PLANT SAMPLE COLLECTED FOR=BSEP POINT SAMPLE COLLECTED FROM=0065



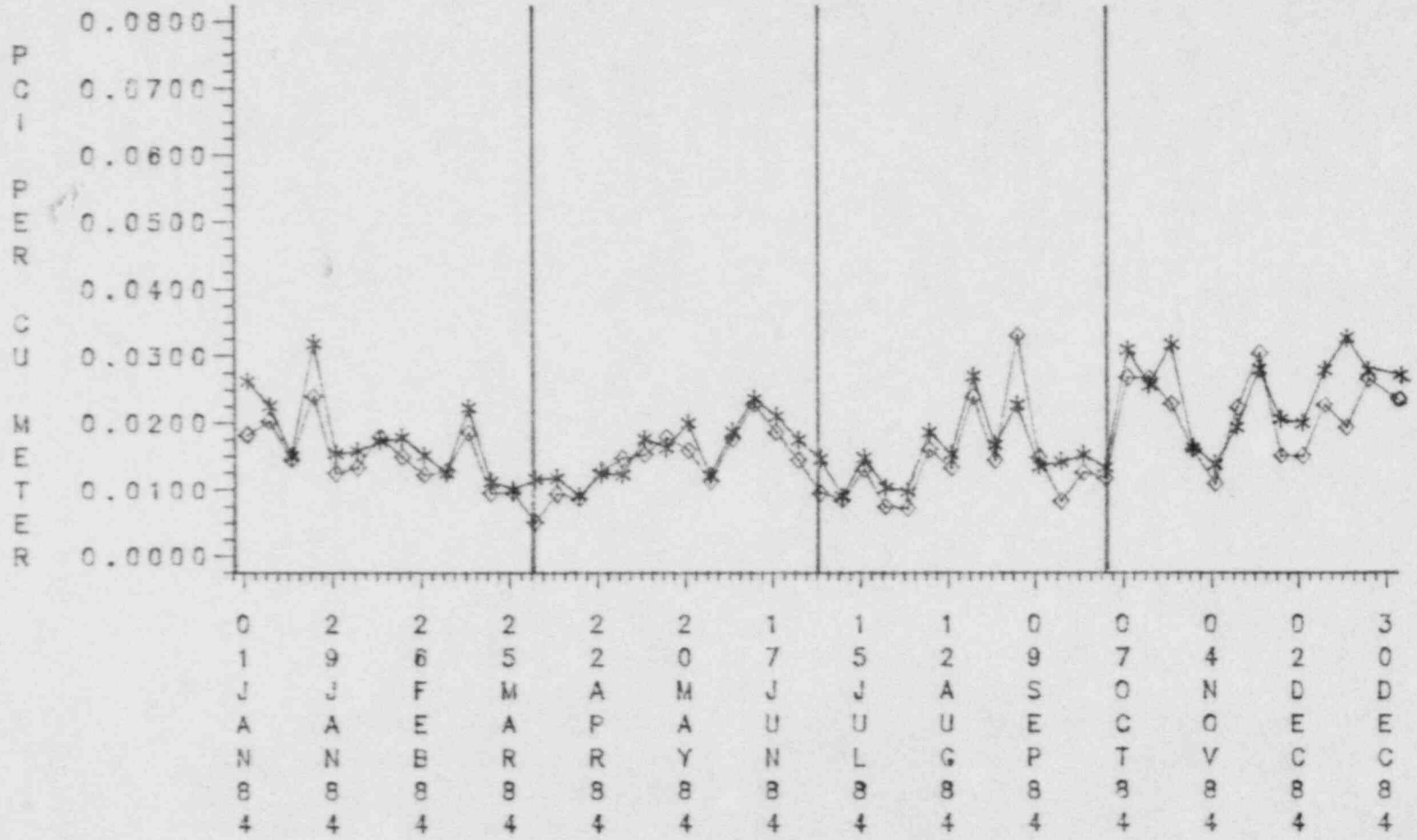
CP&L ENVIRONMENTAL SURVEILLANCE
GROSS BETA ACTIVITY FOR
AIR PARTICULATE SAMPLES
* FOR SAMPLE STATION
◇ FOR CONTROL STATION

PLANT SAMPLE COLLECTED FOR=BSEP POINT SAMPLE COLLECTED FROM=0066



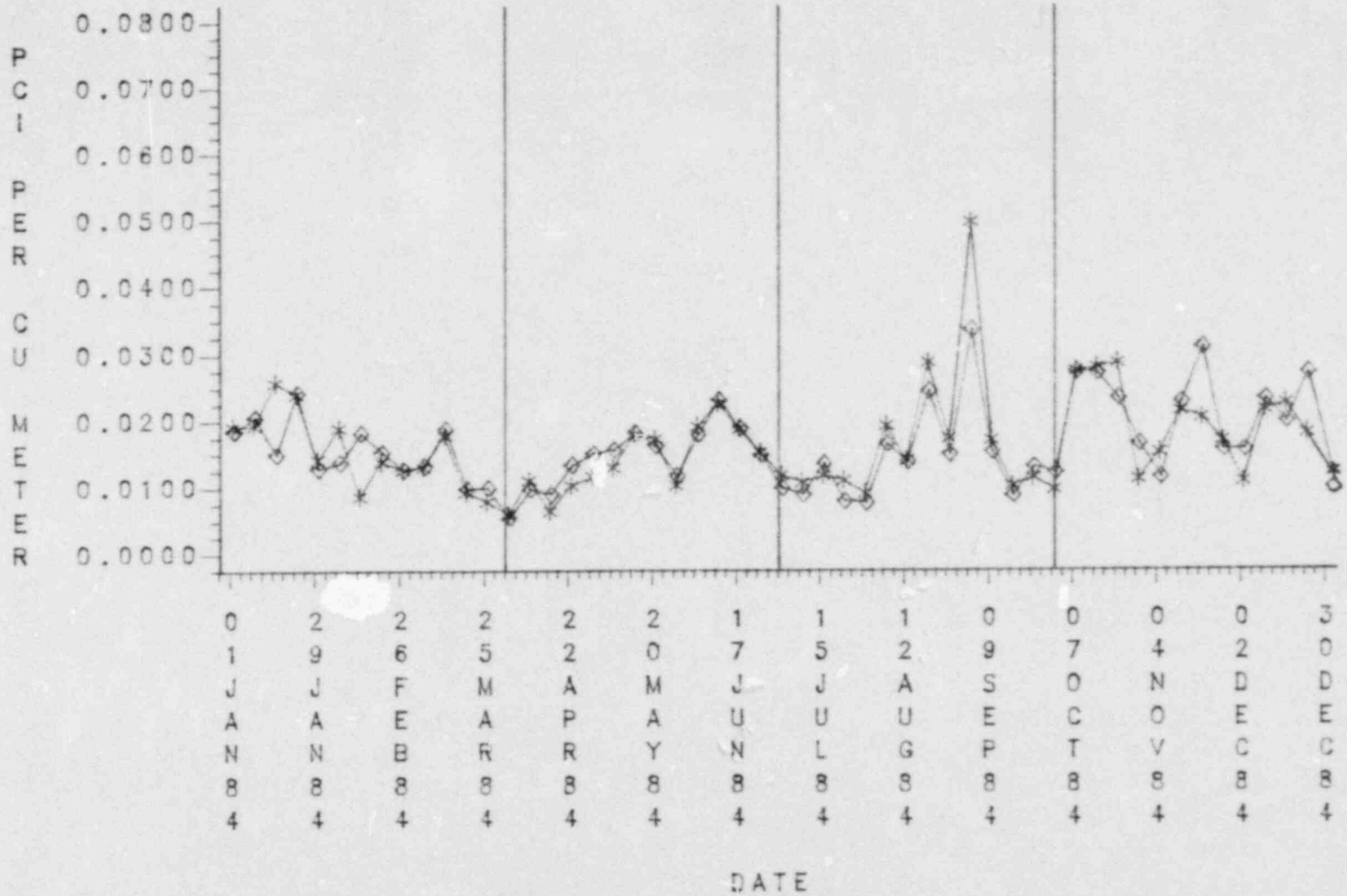
CP&L ENVIRONMENTAL SURVEILLANCE
GROSS BETA ACTIVITY FOR
AIR PARTICULATE SAMPLES
* FOR SAMPLE STATION
◇ FOR CONTROL STATION

PLANT SAMPLE COLLECTED FOR=BSEP POINT SAMPLE COLLECTED FROM=0067



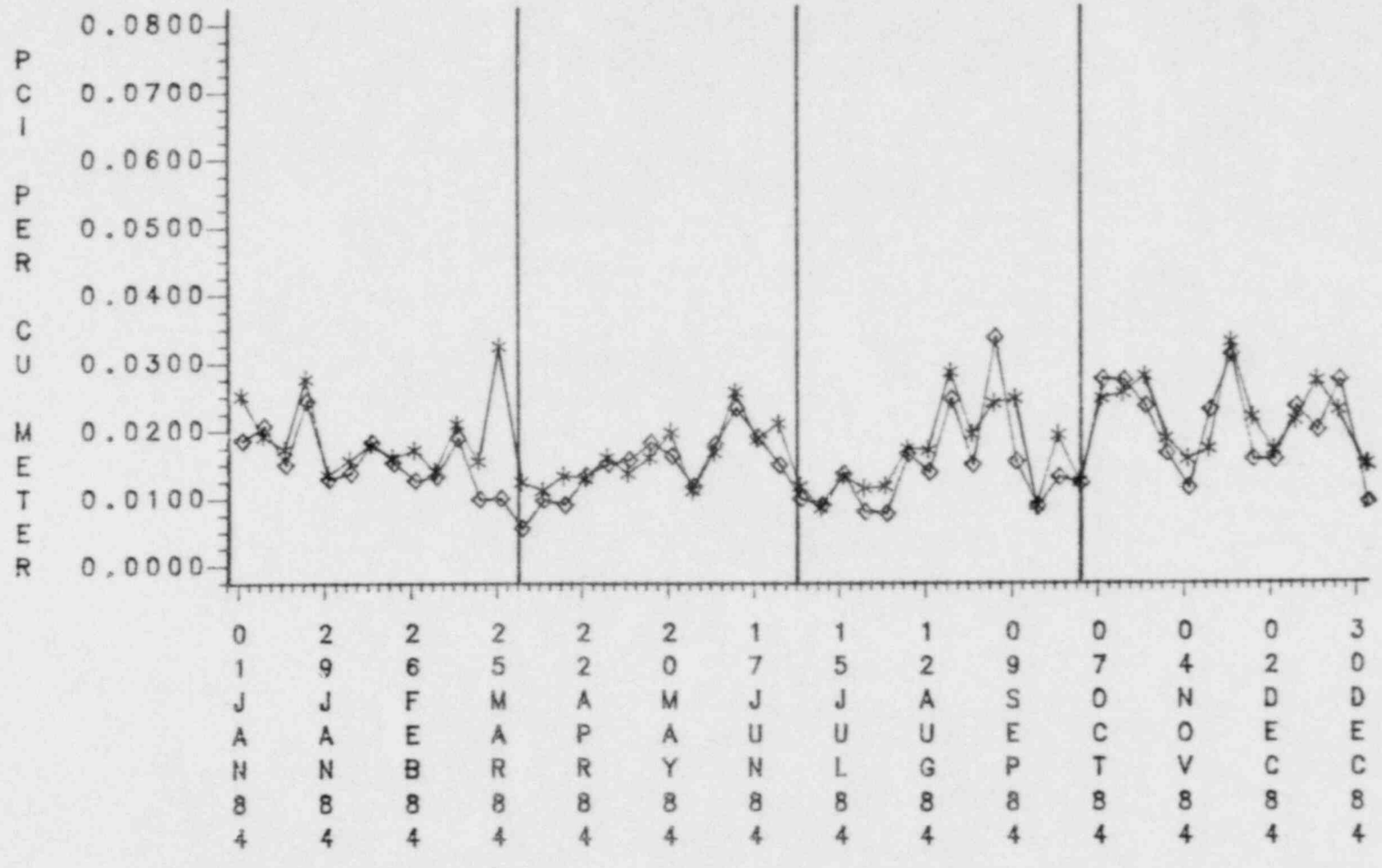
CP&L ENVIRONMENTAL SURVEILLANCE
GROSS BETA ACTIVITY FOR
AIR PARTICULATE SAMPLES
* FOR SAMPLE STATION
◇ FOR CONTROL STATION

PLANT SAMPLE COLLECTED FOR=BSEP POINT SAMPLE COLLECTED FROM=0069



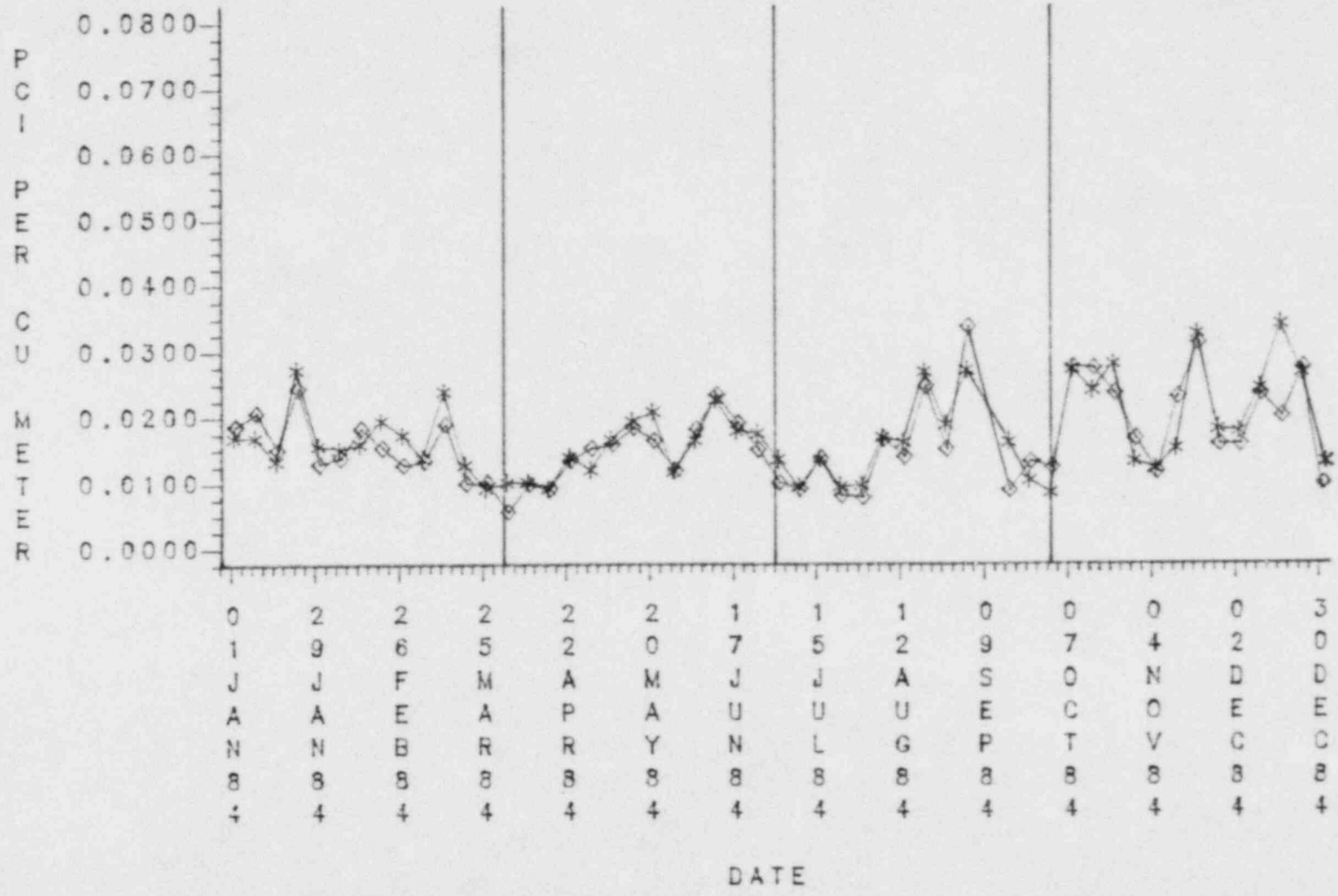
CP&L ENVIRONMENTAL SURVEILLANCE
GROSS BETA ACTIVITY FOR
AIR PARTICULATE SAMPLES
* FOR SAMPLE STATION
◇ FOR CONTROL STATION

PLANT SAMPLE COLLECTED FOR=BSEP POINT SAMPLE COLLECTED FROM=0070



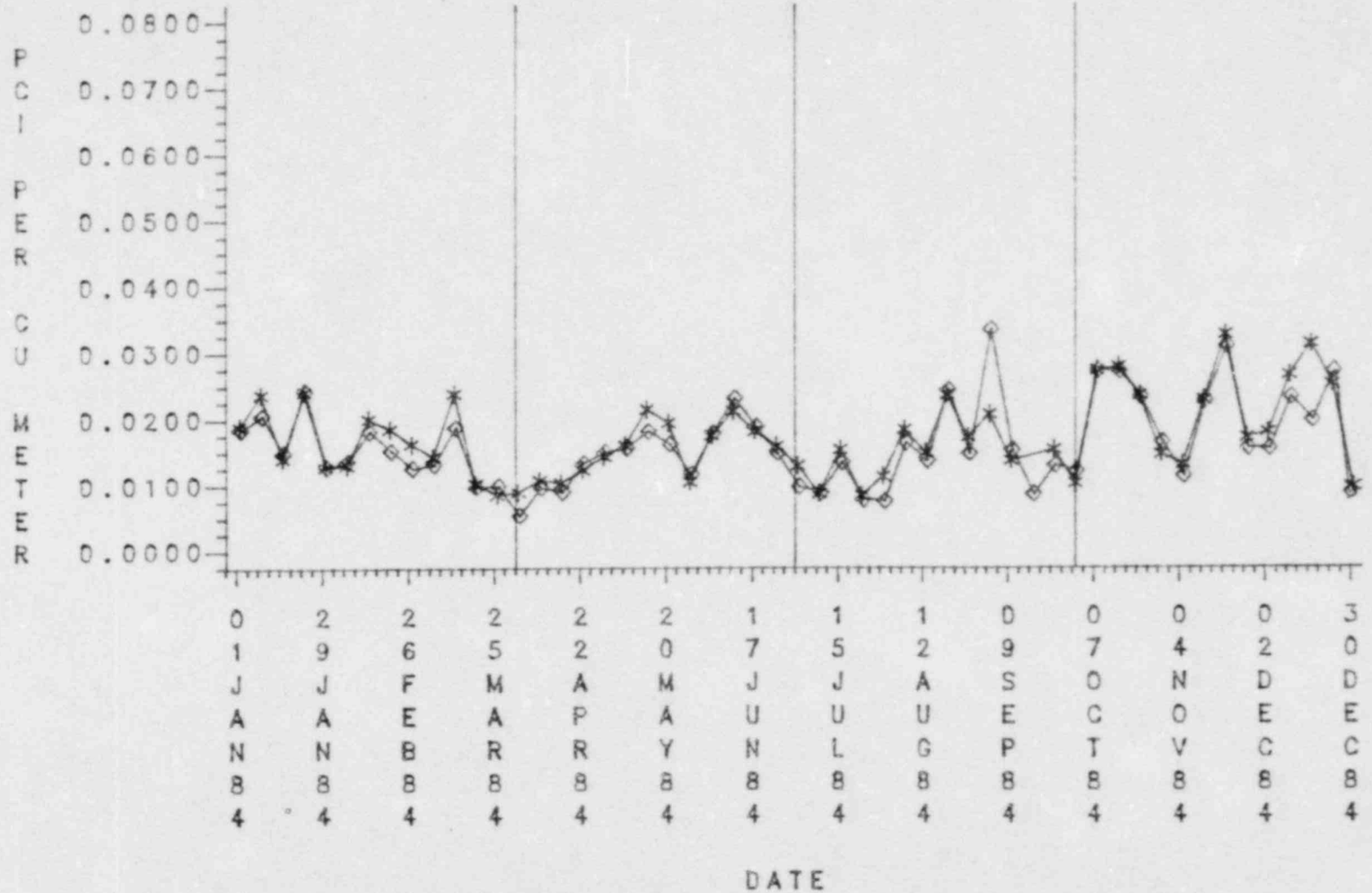
CP&L ENVIRONMENTAL SURVEILLANCE
GROSS BETA ACTIVITY FOR
AIR PARTICULATE SAMPLES
* FOR SAMPLE STATION
◇ FOR CONTROL STATION

PLANT SAMPLE COLLECTED FOR=BSEP POINT SAMPLE COLLECTED FROM=0071



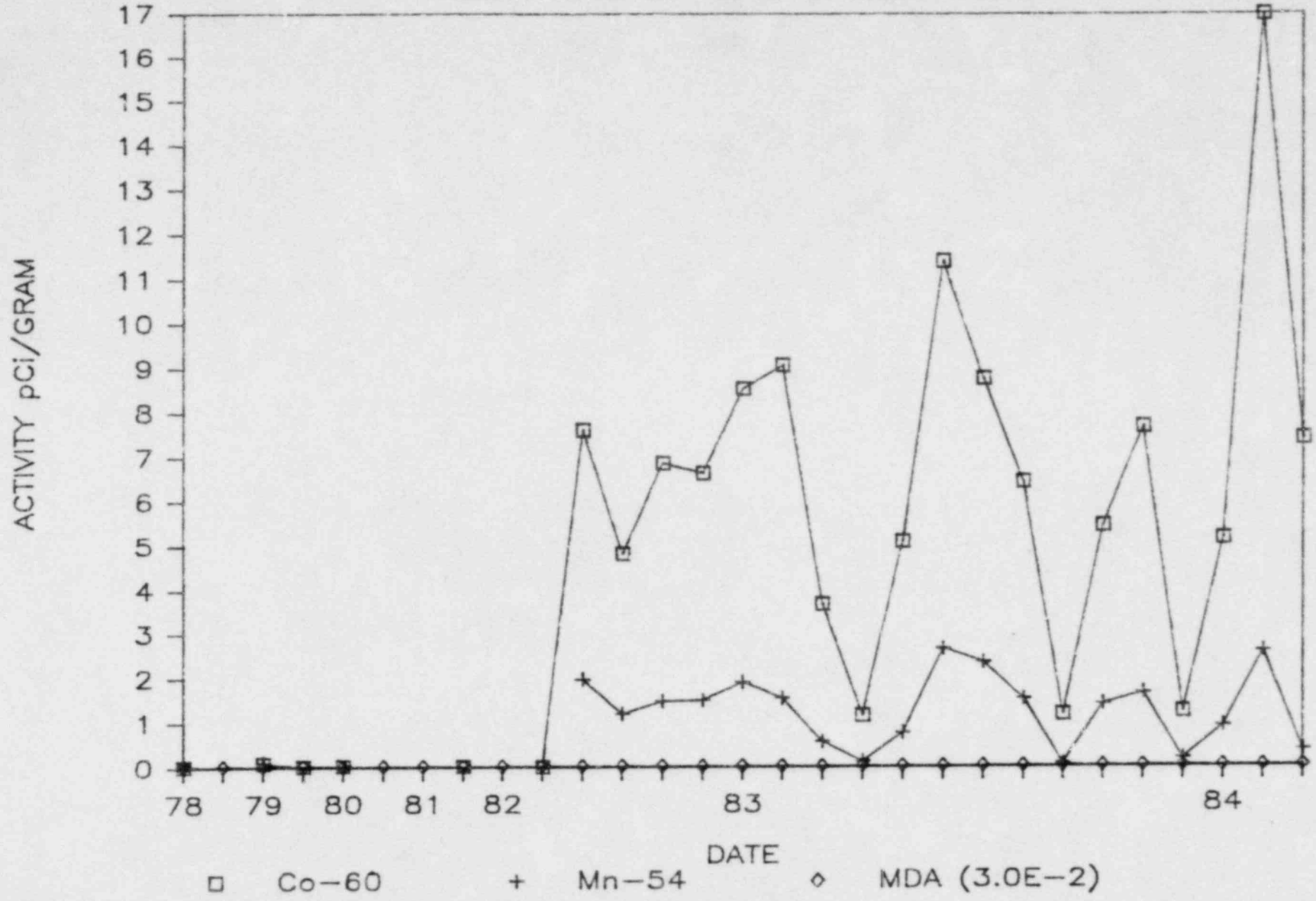
CP&L ENVIRONMENTAL SURVEILLANCE
GROSS BETA ACTIVITY FOR
AIR PARTICULATE SAMPLES
* FOR SAMPLE STATION
◇ FOR CONTROL STATION

PLANT SAMPLE COLLECTED FOR=BSEP POINT SAMPLE COLLECTED FROM=0072



BSEP BOTTOM SEDIMENT

DISCHARGE CANAL AT STILLING POND



4.0 ANNUAL LAND-USE CENSUS

The 1984 land-use census was performed in accordance with Technical Specification 3.12.2. The door-to-door method was used in conjunction with U.S. geological survey maps, state road maps, city of Southport maps, and personal knowledge of the area. The intent of the survey was to locate the nearest resident, garden, milk animal (cow or goat), and meat animal (beef, hog, or fowl) in each of the 16 compass sectors.

Table 4-1 summarizes the locations of the nearest milk cow, milk goat, meat animal, residence, and garden in each of the 16 compass sectors. Table 4-2 summarizes the locations of gardens greater than 50 square meters in size which are located within a three-mile radius of the plant.

TABLE 4-1

DISTANCE TO THE NEAREST SPECIAL LOCATIONS FOR THE BRUNSWICK STEAM ELECTRIC PLANT (MILES)

Sector	Residence (Miles)	Milk Cow	Milk Goat	Meat Animal	Garden
N	0.9	--	--	--	1.0
NNE	1.4	--	--	1.4	1.4
NE	--	--	--	--	--
ENE	--	--	--	--	--
E	1.3	--	--	1.1	--
ESE	1.6	--	--	0.9	1.6
SE	1.0	--	--	1.0	--
SSE	0.9	--	--	0.9	0.9
S	1.4	--	--	--	1.8
SSW	1.4	--	--	1.5	1.5
SW	1.0	--	--	1.0	1.0
WSW	1.1	--	--	1.8	1.1
W	0.9	--	--	--	0.9
WNW	0.9	--	--	--	0.9
NW	0.9	--	--	--	0.9
NNW	0.9	--	--	--	0.9

Distances are estimates from composite map--approximate error ± 0.1 miles.

TABLE 4-2

LISTING OF GARDENS WITHIN THREE MILES

Sector	Distance
N	1.0
NNE	1.4
ESE	1.6
SSE	0.9
S	1.8**
SSW	1.5**
SSW	1.6
SSW	1.7
SSW	1.9
SSW	2.0**
SSW	2.1**
SSW	2.2
SSW	2.3**
SSW	2.5
SW	1.0
WSW	1.1
WSW	1.5
WSW	2.8
W	0.9
W	1.0
W	1.1
W	2.3
WNW	0.9
WNW	1.1**
NW	0.9
NNW	0.9

**Multiple gardens located at this location.

5.0 MISSED SAMPLES AND ANALYSES

5.1 Air Cartridge and Air Particulate

The samples collected from the stations listed below with their respective dates were collected but not analyzed due to the reasons stated.

Location 64--February 6, 1984--low volume; sampler motor failure

Location 64--October 29, 1984--low volume; blown fuse

5.2 Food Crops

Samples were not available from Location 84, Control, from July through December

5.3 Milk

Milk samples were not available from Location 76, Stevens' farm. The cow was dry for the entire year and was sold in August 1984 to Mr. Fred Smith who operates the Pfizer Chemical Company beef herd. Milk samples were not available from Location 77 after January 1984. The farm was sold and is no longer an operational dairy.

5.4 TLD

Location 22--Second quarter--missing in field

Locations 51, 52--Third quarter--missing in field

Locations 19, 43--Fourth quarter--missing in field

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 is approximately 0.004 pCi/m^3 for air particulates.

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 10 milliliters of liquid scintillation cocktail and counted on a liquid scintillation counter for up to 300 minutes. The LLD is approximately 520 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.

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 beta-gamma coincidence system or by low-background beta counter. The 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 systems are Nuclear Data 4420 and 6685. Table 5-1

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

Air particulate composites are fitted into a petri dish and analyzed directly.

Liquid samples, except milk, are boiled down to a small volume, transferred to a polyethylene beaker, and analyzed directly.

Bottom and shoreline sediments are dried, weighed, and then analyzed in a marinelli beaker.

Food crops are weighed wet and analyzed in a marinelli beaker.

Fish samples are cleaned and dressed similar to meal preparation. These samples are then dried at 100°C and ground to produce a homogeneous mixture. These are placed in a polyethylene beaker and analyzed.

6.5 Thermoluminescent Dosimetry

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

Dosimeters are machine annealed before field placement. Following receipt from the field, each dosimeter is read utilizing Panasonic TLD readers. 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 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 radioanalytical 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 1984, 32 samples representing 4 major environmental media (water, milk, food, and air filters) and urine were analyzed. Data on the known activities and the 3σ control limits for 30 of the samples have been received from EPA. These 30 samples required triplicate determinations of the activity of 86 radionuclides. A comparison of the average of our reported values with the EPA known activity and its standard deviation can be summarized as follows:

Standard Deviation (σ) From Known Activity	Percent of Analyses
< 1σ	40
< 2σ	65
< 3σ	85

Of the 86 analyses, 13 (15 percent) fell outside the 3σ control limit. However, 6 of the 13 values involved strontium-90 analyses for which EPA reports an unusually tight 3σ value (i.e., 2.6 pCi/unit versus 8.7 pCi/unit for comparable activities of strontium-89, chromium-51, cobalt-60, cesium-137, zinc-65, ruthenium-106, cesium-134, cesium-137, gross alpha and gross beta, and 10.4 pCi/unit for iodine-131). If a larger 3σ value of 8.7 pCi/unit is applied to the Sr-90 activities, all 6 of the results fall within the EPA control limits. Because of the exceptionally narrow limits

for Sr-90, no corrective action toward the HE&EC analytical methods is considered necessary for a total of 92 percent of the laboratory's analyses.

The remaining 7 results which were beyond the control limits were randomly distributed in time and among nuclides. No trend developed and no corrective actions were deemed necessary. For example:

- One gross beta result on an April water sample was lower than the known activity by 18 percent, but subsequent analysis in May, July, September, and October were within limits.

- The Cs-137 activity reported for the June milk sample was 28 percent high. Subsequent Cs-137 analyses including the October milk sample was within control limits.

- A natural potassium value for a food sample was only 12 percent high but still outside the control limit.

- The Zn-65, Ru-106, and Cr-51 values in the October mixed gamma samples were 16 percent, 34 percent, and 38 percent high, respectively, while the other 3 components of the mixture Co-60, Cs-134, and Cs-137 were within 1-2σ of the known values.

- A single Cr-51 value in the January mixed gamma was 75 percent high. Cr-51 analyses are difficult because of the low gamma abundance (9.8 percent), low energy (320 keV), and the short half-life (27.8 days). The June sample activity was within limits, but as cited above, the October sample value was out of the control limit.

6.7 Lower Limits of Detection

All samples analyzed met the Lower Limits of Detection (LLD) required by Technical Specification 6.9.1.7.h and Table 4.12.1-1. Typical LLD values for the samples analyzed are listed in Table 6-1.

Table 6-1

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

Air Samples

	(LLD)
Cs-134	2.0E-3 pCi/m^3
Cs-137	1.0E-3
Ba-140	4.0E-3
La-140	1.0E-3
Other Expected Gamma Emitters	1.0E-3 to 2.0E-2

Water Samples

	(LLD)
Cr-51	16 pCi/l
Co-58	3
Co-60	4
Mn-54	2
Cs-134	3
Cs-137	3
Ba-140	7
La-140	3
Other Expected Gamma Emitters	3 to 50

Soil and Bottom Sediments

	(LLD)
Cs-134	2.4E-2 pCi/g (dry)
Cs-137	2.1E-2
Cr-51	9.1E-2
Co-58	1.8E-2
Co-60	3.3E-2
Mn-54	1.8E-2
Other Expected Gamma Emitters	1.0E-3 to 9.0E-2

Table 6-1 (Continued)

Fish and Vegetation

	(LLD)
I-131	7.0E-3 pCi/g (wet)
Cs-134	8.0E-3
Cs-137	8.0E-3
Cr-51	5.0E-3
Co-58	7.0E-3
Co-60	1.0E-2
Mn-54	7.0E-3
Other Expected Gamma Emitters	7.0E-3 to 7.0E-2

Shrimp, Benthos, and Oysters

	(LLD)
I-131	9.0E-3 pCi/g (wet)
Cs-134	1.0E-2
Cs-137	1.0E-2
Cr-51	6.0E-2
Co-58	1.0E-2
Co-60	1.0E-2
Mn-54	1.0E-2
Other Expected Gamma Emitters	8.0E-3 to 1.0E-1

CP&L

Carolina Power & Light Company

Brunswick Steam Electric Plant
P. O. Box 10429
Southport, NC 28461-0429

April 26, 1985

FILE: B09-13510C
SERIAL: BSEP/85-0804

Dr. J. Nelson Grace, Administrator
U.S. Nuclear Regulatory Commission
Suite 2900
101 Marietta Street NW
Atlanta, GA 30323

BRUNSWICK STEAM ELECTRIC PLANT UNITS 1 AND 2
DOCKET NO. 50-325 AND 50-324
LICENSE NO. DPR-71 AND DPR-62
ANNUAL ENVIRONMENTAL RADIOLOGICAL MONITORING REPORT

Dear Dr. Grace:

Enclosed are two copies of the Annual Environmental Radiological Monitoring Report for Brunswick Steam Electric Plant covering the period from January 1, 1984, through December 31, 1984.

This report is submitted in accordance with Brunswick Technical Specifications 6.9.1.6 and 6.9.1.7.

Very truly yours,

C. R. Dietz, General Manager
Brunswick Steam Electric Plant

KWP/ag

Enclosure

cc: NRC Document Control Desk

1/1 IE25