Environmental Surveillance Report

January 1, 1979 - December 31, 1979

BRUNSWICK
STEAM ELECTRIC PLANT
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

BRUNSWICK STEAM ELECTRIC PLANT

JANUARY 1, 1979, THROUGH DECEMBER 31, 1979

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1.0 INTRODUCTION

The following report summarizes the Environmental Radiological Monitoring conducted for the Brunswick Steam Electric Plant during the calendar year 1979. This is the third year in which the program's sample analyses and data interpretation have been entirely performed by Carolina Power & Light Company.

1.1 PLANT AND LOCATION

The Brunswick Steam Electric Plant (BSEP) includes two units, both boiling water reactors, which are designed to generate a total of 1,642 MW (net). Unit 2 first achieved criticality on March 21, 1975, and went into commercial production on November 3, 1975. Unit 1 achieved criticality on November 22, 1976, and went into commercial production on March 18, 1977.

The BSEP is located in the southeastern corner of North Carolina, in Brunswick County, approximately 2.5 miles north of Southport. This location is near the mouth of the Cape Fear River which is a source of condenser cooler water. An intake canal extends approximately three miles east of the plant to the Cape Fear River, and the discharge canal proceeds southwest and south for approximately six miles to the Atlantic Ocean. The discharge canal passes under the Intercoastal Waterway by inverted siphon, proceeds to a pumping basin at the shoreline, and is carried out into the

ocean by a 2,000 ft. pipeline. Supplemental or alternate cooling methods are still under litigation.

Elevation of the plant areas ranges from sea level to 30 ft. (MSL) and extensive swamps and marshes occur in the area. Beaches, within 20 miles of the plant, are a source of recreation, and fishing and boating are popular. Within 50 miles of the plant, less than half the land is used for agriculture with small truck, dairy, and poultry farms along with crops, including corn, soybeans, and tobacco. Most of the industrial activity is in the Wilmington area (approximately 16 miles north of BSEP). Sunny Point Army Terminal is located approximately 4.5 miles north of the BSEP and primarily transfers munitions, received by truck and rail, to ships. A ship channel in the Cape Fear River allows traffic to Wilmington and the Atlantic Intercoastal Waterway intercepts the ship channel at Southport.

1.2 ENVIRONMENTAL MONITORING PROGRAM

The significant elements of the preoperational dose estimates were used to establish both the preoperational and operational surveillance programs. The program that evolved during preoperational surveillance and was incorporated into the Brunswick Environmental Technical Specifications is detailed in Table 1-1. Figures 1.1 and 1.2 show the environmental monitoring locations.

Below is a tabulation of the specific methods used in monitoring the various pathways of exposure to man.

Gaseous Effluent Path

Submersion Dose and Other External Dose	Thermoluminescent Dosimetry Area Monitors
Vegetation Path	Vegetation Samples Soil Samples Air Samples
Milk Path	Milk Samples Vegetation and Cattle Feed Samples Air Samples
Inhalation Path	Air Samples

Liquid Effluent Path

Fish and Shellfish Path	Water Samples Bottom Sediment Samples Aquatic Vegetation Samples Zooplankton Samples Benthic Organisms Fish Samples Oyster Samples Shrimp Samples
Water and Shoreline Exposure	Thermolumincescent Dosimetry Area Monitors Water Samples Bottom Sediment Samples Soil and Beach Sand
Drinking Water Path	Ground Water Samples

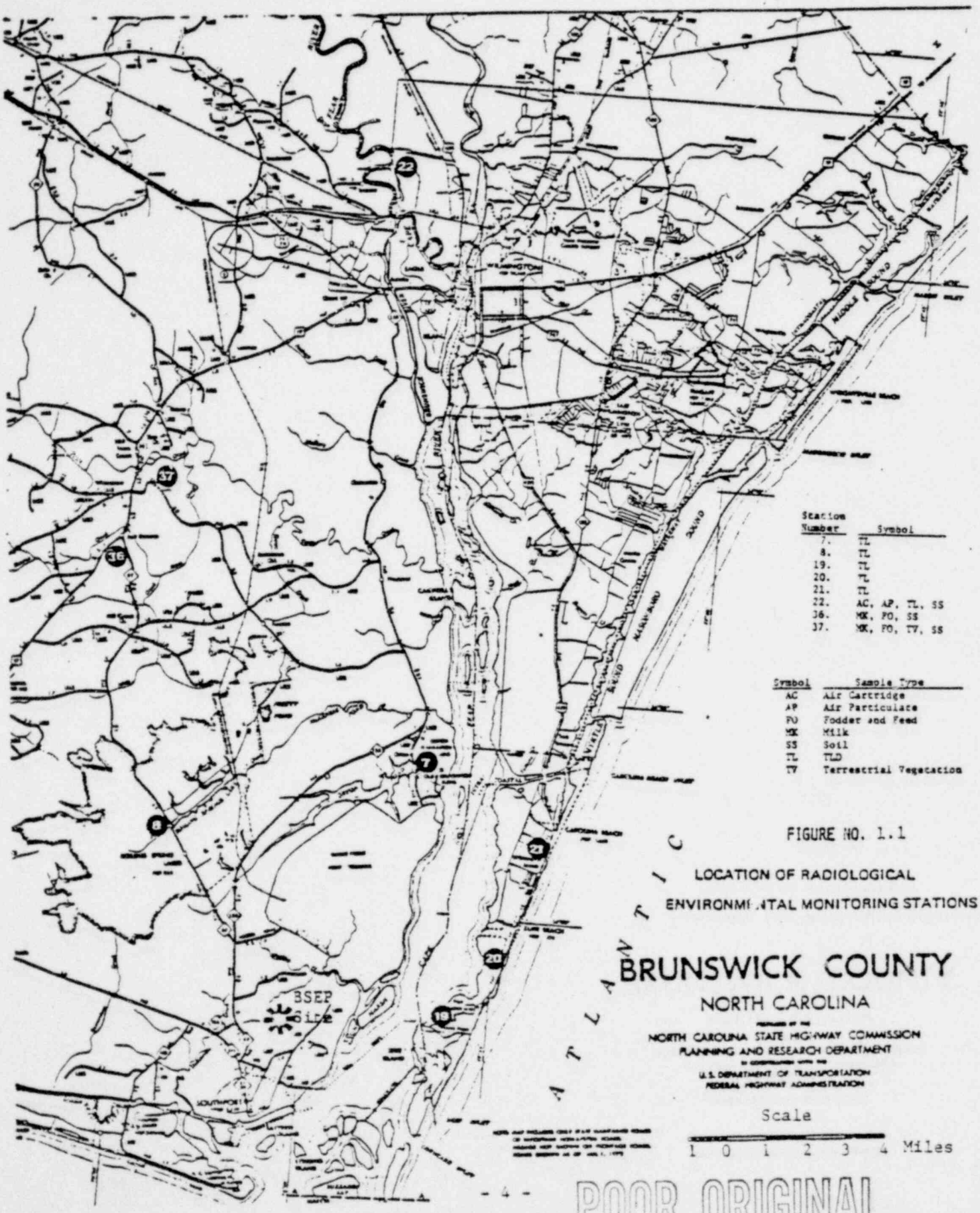


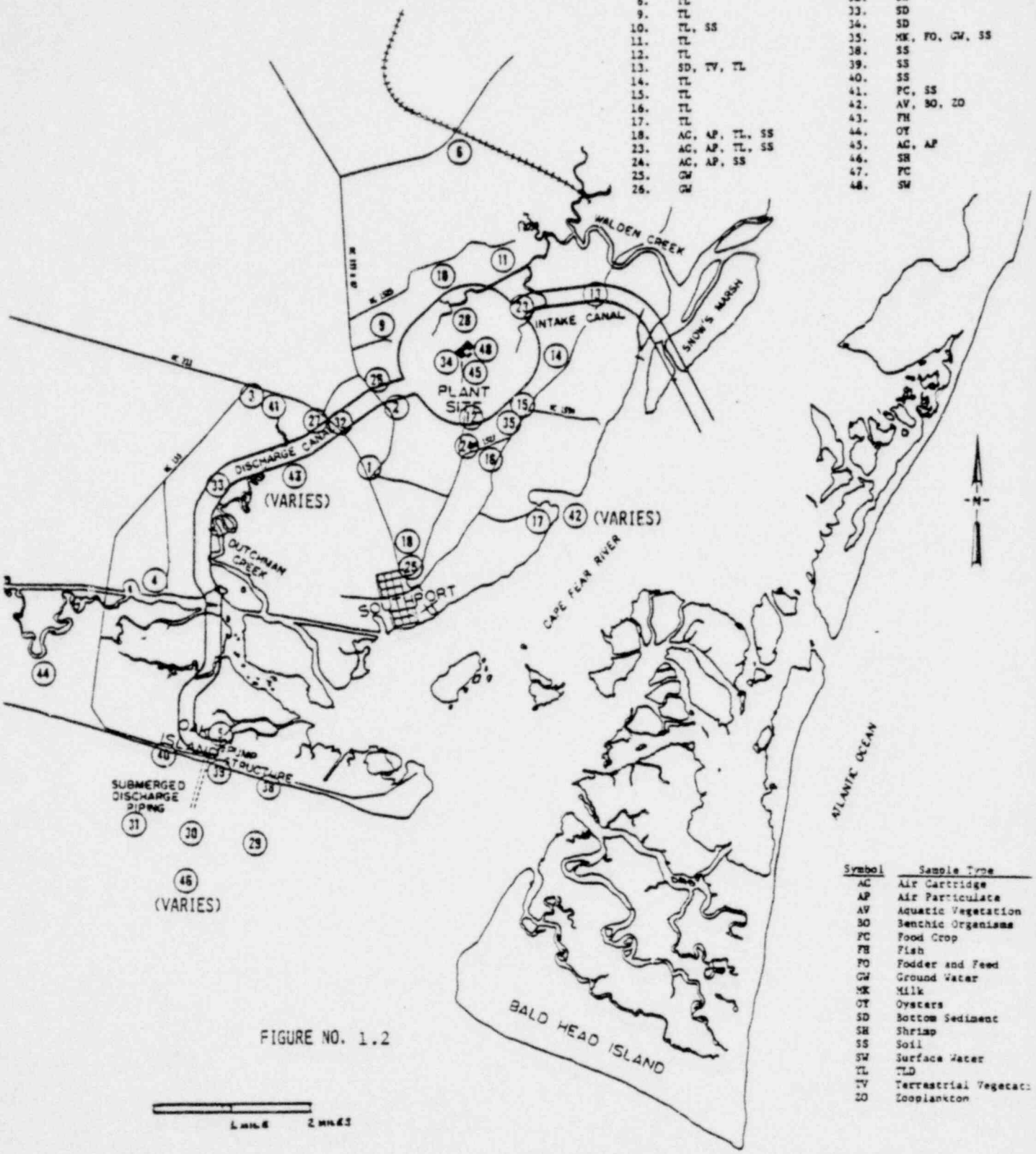
FIGURE NO. 1.1

LOCATION OF RADIOLOGICAL ENVIRONMENTAL MONITORING STATIONS

POOR ORIGINAL

Station Number	Symbol
1.	TL
2.	AC, AP, TV, TL, SS
3.	TL
4.	TL
5.	AC, AP, GW, TL
6.	TL
9.	TL
10.	TL, SS
11.	TL
12.	TL
13.	SD, TV, TL
14.	TL
15.	TL
16.	TL
17.	TL
18.	AC, AP, TL, SS
23.	AC, AP, TL, SS
24.	AC, AP, SS
25.	GW
26.	GW

Station Number	Symbol
27.	GW, TV, SS
28.	GW
29.	BO, SD, SW, ZO, AV
30.	BO, SD, SW, ZO, AV.
31.	BO, SD, SW, ZO, AV
32.	SW
33.	SD
34.	SD
35.	MK, FO, GW, SS
38.	SS
39.	SS
40.	SS
41.	FC, SS
42.	AV, BO, ZO
43.	FH
44.	OY
45.	AC, AP
46.	SH
47.	FC
48.	SW



Symbol	Sample Type
AC	Air Cartridge
AP	Air Particulate
AV	Aquatic Vegetation
BO	Benthic Organisms
FC	Food Crop
FH	Fish
FO	Fodder and Feed
GW	Ground Water
MK	Milk
OY	Oysters
SD	Bottom Sediment
SH	Shrimp
SS	Soil
SW	Surface Water
TL	TLD
TV	Terrestrial Vegetat:
ZO	Zooplankton

FIGURE NO. 1.2

LOCATION OF RADIOLOGICAL ENVIRONMENTAL MONITORING STATIONS

POOR ORIGINAL

TABLE 1-1

ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM
BRUNSWICK STEAM ELECTRIC PLANT

Sample Type	Sampling Point and Description	Sampling Frequency	Sample Size	Sample Analysis
Air Cartridge (AC)	2-Information Center 5-Caswell Beach at Pump Station 18-Southport near CP&L Substation 22-Sutton Plant* 23-Projected Maximum Annual Concentration Point - NE 24-CP&L Substation on Construction Access Road 45-On Site	Weekly	300 cu. m.	Iodine
Air Particulate (AP)	2-Information Center 5-Caswell Beach at Pump Station 18-Southport near CP&L Substation 22-Sutton* 23-Projected Maximum Annual Concentration Point - NE 24-CP&L Substation on Construction Access Road 45-On Site	Weekly	300 cu. m.	Weekly-Gross Beta Quarterly Composite-Gamma and Sr-89,90
Aquatic Vegetation (AV)	29-Ocean - 0.5 Mile East of Discharge Outfall 30-Ocean near Discharge Outfall 31-Ocean - 0.5 mile West of Discharge Outfall 42-Lower Cape Fear River Away from Plant Discharge*	Semiannual	500 grams	Gamma and Sr-89,90

*Control Station

TABLE 1-1 (cont'd)

Sample Type	Sampling Point and Description	Sampling Frequency	Sample Size	Sample Analysis
Benthic Organism (BO)	29-Ocean - 0.5 mile East of Discharge Outfall 30-Ocean near Discharge Outfall 31-Ocean - 0.5 mile West of Discharge Outfall 42-Lower Cape Fear River away from Plant Discharge*	Semiannual	500 grams	Gamma and Sr-89, 90
Bottom Sediment (SD)	13-River Road at Intake Canal* 29-Ocean - 0.5 mile East of Discharge Outfall 30-Ocean near Discharge Outfall 31-Ocean - 0.5 mile West of Discharge Outfall 33-Discharge Canal at Stilling Pond 34-Discharge Canal near the Plant	Semiannual	500 grams	Gamma and Sr-89,90
Fish (FH)	30-Ocean near Discharge Outfall 43-Discharge Canal	Quarterly	500 grams	Gamma
Fodder and Feed (FO)	35-Stevens Farm 36-Lewis Farm 37-Johnson Farm*	Monthly (during growing season)	500 grams	Gamma
Food Crop (FC)	41-Highway 211 - 0.25 mile East of Highway 133 47-Site Varies*	Three per growing season	500 grams	Gamma

*Control Station

TABLE 1-1 (cont'd)

Sample Type	Sampling Point and Description	Sampling Frequency	Sample Size	Sample Analysis
Ground Water (GW)	5-Caswell Beach at Pump Station 25-Southport* 26-Highway 87 - West Side of Discharge Canal 27-Highway 211 - West Side of Discharge Canal 28-BSEP - On Site - Well #1 35-Stevens Farm	Quarterly	4 liters	Gamma and Tritium
Milk (MK)	35-Stevens Farm 36-Lewis Farm 37-Johnson Farm*	Weekly	8 liters	Weekly--Iodine Monthly Composite - Gamma and Sr-89,90
Oyster (OY)	44-Lower Cape Fear River	Semiannual	500 grams	Gamma
Shrimp (SH)	46-Ocean near Discharge	Semiannual	500 grams	Gamma and Sr-89,90
Soil (SS)	2-Information Center 10-State Road 1525 at RR Crossing 18-Southport near CP&L Substation 22-Sutton Plant 23-Projected Maximum Annual Concentration Point - NE 24-CP&L Substation on Construction Access Road	Every Three Years	500 grams	Gamma and Sr-89,90

*Control Station

TABLE 1-1 (cont'd)

Sample Type	Sampling Point and Description	Sampling Frequency	Sample Size	Sample Analysis
Soil (SS) cont.	27-Highway 211 - West Side of Discharge Canal 35-Stevens Farm 36-Lewis Farm 37-Johnson Farm* 41-Highway 211 - 0.25 mile East of Highway 133	Every Three Years	500 grams	Gamma and Sr-89, 90
	38-Caswell Beach - 0.5 mile East of Discharge Pipe 39-Caswell Beach at Discharge Pipe 40-Caswell Beach - 0.5 mile West of Discharge Pipe	Semiannual	500 grams	Gamma and Sr-89, 90
Surface Water (SW)	29-Ocean - 0.5 mile East of Discharge Outfall 30-Ocean near Discharge Outfall 31-Ocean - 0.5 mile West of Discharge Outfall 32-Discharge Canal 48-Intake Canal*	Monthly	4 liters	Monthly - Gross Beta, Tritium and Gamma Quarterly Composite-Sr-89, 90
Terrestrial Vegetation (TV)	2-Information Center 13-River Road at Intake Canal 27-Highway 211 - West side of Discharge Canal 37-Johnson Farm*	Quarterly	500 grams	Gamma
External Radiation (TL)	1-Junction of Highways 87 and 211 2-Information Center 3-Junction of Highways 211 and 133 4-Standard Products Access Road Off Highway 133 near Intercoastal Waterway	Quarterly	Not Applicable	TLD Readout

*Control Station

TABLE 1-1 (cont'd)

Sample Type	Sampling Point and Description	Sampling Frequency	Sample Size	Sample Analysis
External Radiation (TL) cont.	5-Caswell Beach at Pump Station 6-Sunny Point Access Road and RR Crossing 7-Entrance to Old Brunswick Town 8-Highway 87 at Boiling Springs Lake 9-Exclusion Boundary, Dirt Road which intersects Highways 87 and 133 10-State Road 1525 at RR Crossing 11-Eastern End of State Road 1525 12-Exclusion Boundary on Construction Access Road 13-River Road at Intake Canal 14-River Road Opposite I.D. Smith Residence 15-River Road and State Road 1534 16-River Road and Site of Old Brown & Root Construction Office 17-Southport - Fort Fisher Ferry Slip 18-Southport near CP&L Substation 19-Fort Fisher Ferry Slip 20-Kure Beach - Across from AFB Housing 21-Carolina Beach 22-Sutton Plant* 23-Projected Maximum Annual Concentration Point - NE	Quarterly	Not Applicable	TLD Readout
Zooplankton (ZO)	29-Ocean - 0.5 mile East of Discharge Outfall 30-Ocean near Discharge Outfall 31-Ocean - 0.5 mile West of Discharge Outfall 42-Lower Cape Fear River Away from Plant Discharge*	Semiannual	10 grams	Gamma and Sr-89,90

*Control Station

2.0 PROGRAM SUMMARY

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 Brunswick Plant.

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

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

The Brunswick Plant's preoperational radiological monitoring was conducted from July 24, 1972, until plant startup in March, 1975, and data therefrom were reported to the Nuclear Regulatory Commission in June, 1975.

The following locations are designated as the Control Locations for the respective measurements and are intended to indicate conditions away from Brunswick Plant influence:

L. V. SUTTON PLANT - 23 Mi. NNE
(Sample Station 22)

Thermoluminescent Dosimetry Area Monitors
Air Particulate Samples
Charcoal Cartridge Samples - Airborne I-131

INTAKE CANAL
(Sample Stations 48 and 13)

Surface Water Samples (48) at Plant
Bottom Sediment Samples (13) at River Road

SOUTHPORT WATER SUPPLY
(Sample Station 25)

Groundwater Samples

JOHNSON FARM - 14.5 Mi. NNW
(Sample Station 37)

Terrestrial Vegetation Samples
Cattle Fodder and Feed Samples
Soil Samples
Milk Samples

VARIABLE LOCATION AWAY FROM PLANT
(Sample Station 42)

Plankton Samples
Benthos Samples
Aquatic Vegetation Samples

VARIABLE LOCATION AWAY FROM PLANT
(Sample Station 47)

Food Crop Samples

No control locations are designated for shrimp, oysters, or fish. Table 2-1 summarizes the results of the environmental radiological monitoring program for calendar year of 1979.

TABLE 2-1

ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM SUMMARY

Brunswick Steam Electric Plant
Brunswick County, North Carolina

Docket Numbers - 50-324 and 325
Calendar Year 1979

Medium or Pathway Sampled or Measured (Unit of Measurement)	Type & Total # of Measurements Performed	Minimum Detectable Activity (MDA) (1)	All Indicator Locations (2) Mean Range	Location w/Highest Annual Mean: Name Distance & Direction	Location w/Highest Annual Mean: Mean Range (2)	Control Locations Mean Range (2)	# of Non-routine Reported Measurements (3)
Air Cartridge (pCi/m^3)	I-131 371(4)	7.00 E-2	All less than MDA	All less than MDA		All less than MDA	0
Air Particulate (pCi/m^3)	Gross Beta 371(4)	2.00 E-2	3.87 E-2 (318/318) 9.92 E-3 - 1.38 E-1	On Site 0.07 mi. NNW	4.32 E-2 (53/53) 1.66 E-2 - 1.38 E-1	3.81 E-2 (53/53) 1.24 E-2 - 8.38 E-2	0
	Sr-89 28	2.00 E-2	All less than MDA	All less than MDA		All less than MDA	0
	Sr-90 28	5.26 E-4	5.81 E-4 (9/24) 3.67 E-4 - 9.49 E-4	Projected Max. Annual Conc. Point NE 0.6 mi. NE	9.49 E-4 (1/4) (single value)	All less than MDA	0
	Gamma 28 Mn-54	1.29 E-3	2.81 E-3 (1/24) (single value)	On Site 0.07 mi. NNW	2.81 E-3 (1/4) (single value)	All less than MDA	0
	Co-60	3.00 E-3	4.02 E-3 (1/24) (single value)	On Site 0.07 mi. NNW	4.02 E-3 (1/4) (single value)	All less than MDA	0

TABLE 2-1

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Calendar Year 1979

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Air Particulate (pCi/m^3)	Gamma 28 Cs-137	1.30 E-3	1.58 E-3 (3/24) 1.08 E-3 - 1.97 E-3	Southport near CP&L Substation 2.3 mi. SW	1.97 E-3 (1/4) (single value)	All less than MDA	0
Aquatic Vegetation(5) (pCi/gram dry)	Sr-89 2(5)	3.60 E-1	All less than MDA	All less than MDA		All less than MDA	0
	Sr-90 2	1.81 E-1	All less than MDA	All less than MDA		All less than MDA	0
	Gamma 2	N/A	All less than MDA	All less than MDA		All less than MDA	0
Benthic Organism (pCi/gram dry)	Sr-89 8	1.00 E-1	All less than MDA	All less than MDA		All less than MDA	0
	Sr-90 8	4.30 E-2	8.86 E-2 (2/6) 5.12 E-2 - 1.26 E-1	Ocean - 0.5 mile East of Discharge Outfall 5.7 mi. SSW	1.26 E-1 (1/2) (single value)	9.48 E-2 (1/2) (single value)	0

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Benthic Organism (pCi/gram dry)	Gamma (6) 9						
	Mn-54	6.50 E-2	7.49 E-1 (1/7) (single value)	Discharge Canal 1.5 mi. WSW	7.49 E-1 (1/1) (single value)	All less than MDA	0
	Co-60	6.50 E-2	1.95 E-1 (1/7) (single value)	Discharge Canal 1.5 mi. WSW	1.95 E-1 (1/1) (single value)	All less than MDA	0
	Ag-110m	6.00 E-2	1.26 E-1 (1/7) (single value)	Discharge Canal 1.5 mi. WSW	1.26 E-1 (1/1) (single value)	All less than MDA	0
Bottom Sediment (pCi/gram dry)	Sr-89 12	5.00 E-1	All less than MDA	All less than MDA		All less than MDA	0
	Sr-90 12	5.00 E-1	All less than MDA	All less than MDA		All less than MDA	0
	Gamma 12						
	Mn-54	2.30 E-2	7.83 E-2 (2/10) 3.66 E-2 - 1.20 E-1	Discharge Canal at Stilling Pond 4.9 mi. SSW	1.20 E-1 (1/2) (single value)	All less than MDA	0

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Bottom Sediment (pCi/gram dry)	Gamma 12						
	Co-60	3.00 E-2	7.46 E-2 (4/10) 3.57 E-2 - 1.19 E-1	Ocean Near Discharge Outfall 5.7 mi. SSW	1.19 E-1 (1/2) (single value)	All less than MDA	0
	Ru-106	2.43 E-1	8.95 E-1 (1/10) (single value)	Ocean - 0.5 mi. West of Discharge Outfall 5.7 mi. SSW	8.95 E-1 (1/2) (single value)	All less than MDA	0
	Cs-137	2.80 E-2	1.65 E-1 (2/10) (1.09 E-1 - 2.20 E-1)	Ocean - 0.5 mi. West of Discharge Outfall 5.7 mi. SSW	2.20 E-1 (1/2) (single value)	All less than MDA	0
	Ce-144	1.99 E-1	1.31 E+0 (1/10) (single value)	Ocean - 0.5 mi. West of Discharge Outfall 5.7 mi. SSW	1.31 E+0 (1/2) (single value)	All less than MDA	0
Fish(6) (pCi/gram dry)	Gamma(6) 9						
	Mn-54	6.50 E-2	7.61 E-1 (2/9) 7.46 E-1 - 7.75 E-1	Discharge Canal 1.5 mi. WSW	7.61 E-1 (2/5) 7.46 E-1 - 7.75 E-1	No Control	0

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Fish(6)	Gamma(6)						
(pCi/gram dry)	9						
	Co-58	6.00 E-2	1.41 E-1 (2/9) 9.04 E-2 - 1.91 E-1	Discharge Canal 1.5 mi. WSW	1.41 E-1 (2/5) 9.04 E-2 - 1.91 E-1	No Control	0
	Co-60	6.50 E-2	5.91 E-1 (3/9) 1.95 E-1 - 8.43 E-1	Discharge Canal 1.5 mi. WSW	5.91 E-1 (3/5) 1.95 E-1 - 8.43 E-1	No Control	0
	Cs-134	6.50 E-2	4.43 E-2 (1/9) (single value)	Discharge Canal 1.5 mi. WSW	4.43 E-2 (1/5) (single value)	No Control	0
	Cs-137	7.00 E-2	1.32 E-1 (2/9) 6.17 E-2 - 2.03 E-1	Discharge Canal 1.5 mi. WSW	2.03 E-1 (1/5) (single value)	No Control	0
Fodder and Feed	Gamma(7)						
(pCi/gram dry)	32						
	Co-60	6.50 E-2	5.72 E-2 (2/20) 4.29 E-2 - 7.15 E-2	Lewis Farm 13.0 mi. NNW	7.15 E-2 (1/12) (single value)	All less than MDA	0
	Cs-137	7.00 E-2	1.66 E-1 (15/20) 3.18 E-2 - 3.65 E-1	Stevens Farm 0.6 mi. SE	1.97 E-1 (8/9) 7.99 E-2 - 3.65 E-1	9.12 E-2 (5/12) 6.10 E-2 - 1.21 E-1	0

TABLE 2-1

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Fodder and Feed (pCi/gram dry)	Gamma(7) 32						
	Ce-141	6.50 E-2	1.02 E-1 (1/20) (single value)	Lewis Farm 13.0 mi. NNW	1.02 E-1 (1/12) (single value)	All less than MDA	0
Food Crop (pCi/gram dry)	Gamma 6	N/A	All less than MDA	All less than MDA		All less than MDA	0
Groundwater (pCi/l)	Tritium 24	1.20 E+2	All less than MDA	All less than MDA		All less than MDA	0
	Gamma 24	N/A	All less than MDA	All less than MDA		All less than MDA	0
Milk (pCi/l)	I-131 147(8)	5.00 E-1	All less than MDA	All less than MDA		All less than MDA	0
	Sr-89 33(9)	3.50 E+0	All less than MDA	All less than MDA		All less than MDA	0
	Sr-90 33(9)	2.00 E+0	5.80 E+0 (20/21) 1.51 E+0 - 1.40 E+1	Stevens Farm 0.6 mi. SE	6.49 E+0 (9/9) 2.89 E+0 - 9.93 E+0	4.69 E+0 (10/12) 3.56 E+0 - 6.32 E+0	0

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Milk (pCi/l)	Gamma 34(10)						
	Cs-137	9.00 E+0	2.86 E+1 (18/22) 7.50 E+0 - 6.40 E+1	Stevens Farm 0.6 mi. SE	3.09 E+1 (10/10) 2.24 E+1 - 4.31 E+1	7.23 E+0 (1/12) (single value)	0
Oyster (pCi/gram dry)	Gamma 2	N/A	All less than MDA	All less than MDA		No Control	0
Shrimp (pCi/gram dry)	Sr-89 2	1.10 E-1	All less than MDA	All less than MDA		No Control	0
	Sr-90 2	5.00 E-2	All less than MDA	All less than MDA		No Control	0
	Gamma(6) 3						
	Mn-54	6.50 E-2	1.80 E-1 (1/3) (single value)	Discharge Canal 1.5 mi. WSW	1.80 E-1 (1/1) (single value)	No Control	0
	Co-60	6.50 E-2	1.62 E-1 (1/3) (single value)	Dishcarge Canal 1.5 mi. WSW	1.62 E-1 (1/1) (single value)	No Control	0

TABLE 2-1

ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM SUMMARY

Brunswick Steam Electric Plant
Brunswick County, North Carolina

Docket Numbers - 50-324 and 325
Calendar Year 1979

Medium or Pathway Sampled or Measured (Unit of Measurement)	Type & Total # of Measurements Performed	Minimum Detectable Activity (MDA) (1)	All Indicator Locations (2) Mean Range	Location w/Highest Annual Mean: Name, Distance & Direction	Location w/Highest Annual Mean: Mean Range (2)	Control Locations Mean Range (2)	# of Non-routine Reported Measurements (3)
Soil(11) (pCi/gram dry)	Sr-89 6	5.00 E-1	2.62 E-1 (1/6) (single value)	Caswell Beach at Discharge Pipe 5.1 mi. SSW	2.62 E-1 (1/2) (single value)	No Control	0
	Sr-90 6	5.00 E-1	All less than MDA	All less than MDA		No Control	0
	Gamma 6 Cs-134	3.50 E-2	4.14 E-1 (1/6) (single value)	Caswell Beach at Discharge Pipe 5.1 mi. SSW	4.14 E-1 (1/2) (single value)	No Control	0
Surface Water (pCi/l)	Gross Beta 60	1.23 E+2	3.72 E+2 (48/48) 8.40 E+1 - 6.13 E+2	Ocean 0.5 mi. West of Discharge Outfall 5.7 mi. SSW	4.44 E+2 (12/12) 2.66 E+2 - 5.86 E+2	2.23 E+2 (12/12) 7.40 E+1 - 5.14 E+2	0
	Sr-89 20	5.00 E+0	All less than MDA	All less than MDA		All less than MDA	0
	Sr-90 20	5.00 E+0	All less than MDA	All less than MDA		All less than MDA	0
	Tritium 60	3.50 E+2	All less than MDA	All less than MDA		All less than MDA	0

TABLE 2-1

ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM SUMMARY

Brunswick Steam Electric Plant
Brunswick County, North Carolina

Docket Numbers - 50-324 and 325
Calendar Year 1979

Medium or Pathway Sampled or Measured (Unit of Measurement)	Type & Total # of Measurements Performed	Minimum Detectable Activity (MDA) (1)	All Indicator Locations (2) Mean Range	Location w/Highest Annual Mean: Name, Distance & Direction	Location w/Highest Annual Mean: Mean Range (2)	Control Locations Mean Range (2)	# of Non-routine Reported Measurements (3)
Surface Water (pCi/l)	Gamma 60	N/A	All less than MDA	All less than MDA		All less than MDA	0
Terrestrial[12] vegetation (pCi/gram dry)	Gamma 17[12]						
	Mn-54	6.50 E-2	1.65 E-1 (6/12) 1.43 E-1 - 2.13 E-1	Information Center 1.0 mi. SW	1.75 E-1 (4/4) 1.54 E-1 - 2.13 E-1	5.10 E-2 (2/5) 4.82 E-2 - 5.38 E-2	0
	Co-60	6.50 E-2	1.08 E-1 (5/12) 9.43 E-2 - 1.29 E-1	Information Center 1.0 mi. SW	1.14 E-1 (3/4) 9.98 E-2 - 1.29 E-1	All less than MDA	0
	Cs-137	7.00 E-2	1.34 E-1 (11/12) 4.92 E-2 - 2.66 E-1	River Road at Intake Canal 1.3 mi. ENE	1.80 E-1 (4/4) 1.17 E-1 - 2.66 E-1	5.14 E-1 (5/5) 1.64 E-1 - 1.03 E+0	0
	Ce-144	2.65 E-1	3.82 E-1 (4/12) 3.70 E-1 - 4.02 E-1	River Road at Intake Canal 1.3 mi. ENE	4.02 E-1 (1/4) (single value)	4.59 E-1 (4/5) 3.17 E-1 - 5.34 E-1	0
TLD (millirem per week)	TLD Readout 87[13]	3.00 E-1	9.28 E-1 (83/83) 7.20 E-1 - 1.38 E+0	Southport Near CP&L Substation 2.1 mi. SSW	1.22 E+0 (4/4) 1.10 E+0 - 1.38 E+0	8.23 E-1 (4/4) 7.30 E-1 - 9.60 E-1	0

TABLE 2-1

ENVIRONMENTAL RADIOLOGICAL MONITORING PROGRAM SUMMARY

Brunswick Steam Electric Plant
Brunswick County, North Carolina

Docket Numbers - 50-324 and 325
Calendar Year 1979

Medium or Pathway Sampled or Measured (Unit of Measurement)	Type & Total # of Measurements Performed	Minimum Detectable Activity (MDA) (1)	All Indicator Locations (2) Mean Range	Location w/Highest Annual Mean: Name, Distance & Direction	Location w/Highest Annual Mean: Mean Range (2)	Control Locations Mean Range (2)	# of Non-routine Reported Measurements (3)
Zooplankton (pCi/gram dry)	Sr-89 8	3.00 E+0	All less than MDA	All less than MDA		All less than MDA	0
	Sr-90 8	3.00 E+0	All less than MDA	All less than MDA		All less than MDA	0
	Gamma 8						
	Co-60	2.00 E-1	6.71 E-1 (2/6)	Ocean - 0.5 mi. West of Discharge Outfall	1.06 E+0 (1/2)	All less than MDA	0
			2.82 E-1 - 1.06 E+0	5.7 mi. SSW	(single value)		

Footnotes:

1. Minimum detectable concentration is calculated based on three standard deviations above background, using typical sample size in a given counting time. Due to counting statistics and varying volumes, occasionally lower minimum detectable activities are achieved.

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

3. Measurements in excess, at the 99.5% confidence level, of ten times the control station value or ten times the minimum detectable activity (MDA), whichever is larger.

4. Air particulate and charcoal cartridge samples were collected every Monday. There were 53 Mondays in 1979, therefore having a total of 371 samples instead of having 364 samples.

5. Collections of aquatic vegetation samples were attempted, but except for two cases, these attempts were unsuccessful since there were no permanent beds of same at the required sampling stations.

6. Fish (resampled), benthos, and shrimp samples were collected from the discharge canal on May 8, 1979, for gamma analysis in addition to the technical specifications (see Section 3.5).

7. No fodder samples were available at Station 35 (Stevens' Farm) during January, February, March, and December.

8. Milk samples were collected every Monday. There were 53 Mondays in 1979, therefore having a possibility of 159 samples. No milk samples were available at Station 35 (Stevens' cow) from July 2 through September 10, 1979, (11 weeks) due to cow being dry. One weekly sample from Station 35 was lost in analysis (October 1) due to high fat content.

9. No milk was available at Station 35 for the months of July and August. The September "composite" consisted of two weekly samples.

10. No milk was available at Station 35 for the months of July and August. The September "composite" consisted of two weekly samples. The month of November strontium was lost in analysis due to high fat content.

11. Soil samples which are required to be collected at three-year intervals were last collected and analyzed in 1978.

12. Terrestrial vegetation at Station 37 was resampled during the first quarter of 1979. Both samples were included in the statistics.

13. Four TLDs were missing from the field, and one was ruined due to wetting.

3.0 INTERPRETATION AND CONCLUSIONS

3.1 AIR SAMPLES

The gross beta results for air particulate samples collected during the year of 1979 are below the preoperational levels. All indicator station activities averaged 3.87 E-2 pCi/m^3 compared to 9.83 E-2 pCi/m^3 which is computed over the entire preoperational monitoring period. The 1979 average activity of control station samples also decreased to 3.81 E-2 pCi/m^3 which is a more meaningful comparison to the indicator stations due to yearly weather conditions (amount of rainfall) and other sources of activity (fallout from nuclear testing) that occurred during the preoperational program.

Comparing the control station to all indicator stations shows results similar to the observations made during preoperational testing with the exception of Station 2 (Information Center) (see Table 3-11). The second half of 1979, Station 2 revealed gross beta activity higher than the control station at a frequency of 18 out of 27 weeks. The largest difference observed was 2.1 times the control station with relative counting errors of $\geq$ 65%. Gross beta results are primarily used for screening and long-term trend and not for dose measurements.

TABLE 3-1

Gross Beta Air Particulate Six-Month Averages for Comparison of Preoperational Data to 1979 Data

Stations	1st Half '79 pCi/m^3	2nd Half '79	1st Half '73	2nd Half '73	1st Half '74	2nd Half '74
AP-2 Information Center	4.3 E-2	4.1 E-2	1.5 E-2	2.9 E-2	1.7 E-1	1.1 E-1
AP-5 Caswell Beach @ Pump Station	3.6 E-2	2.7 E-2	1.5 E-2	2.8 E-2	1.6 E-1	1.1 E-1
AP-18 Southport near CP&L Substation	4.2 E-2	3.7 E-2	1.6 E-2	2.4 E-2	1.5 E-1	1.1 E-1
AP-22 Sutton Plant (Control Station)	4.1 E-2	3.5 E-2	1.7 E-2	3.2 E-2	1.6 E-1	1.0 E-1
AP-23 PMAC	4.5 E-2	3.9 E-2	Not in Use	3.1 E-2	1.6 E-1	1.2 E-1
AP-24 CP&L Substation on Construction Access Road	3.7 E-2	3.2 E-2	Not in Use	3.4 E-2	1.7 E-1	1.1 E-1
AP-45 On Site	4.8 E-2	3.9 E-2	1.6 E-2 (2 Samples Only)	3.1 E-2	1.8 E-1	1.1 E-1

The quarterly composite gamma and strontium analysis for the air particulate samples revealed only two fission products (strontium-90 and cesium-137) and two activation products (cobalt-60 and manganese-54) for 1979. Using a t-test at 99.5% confidence level, the control station is comparable to all indicator locations as summarized in Table 3-2. The strontium-90 and cesium-137 are not attributed to operations of Brunswick Plant since they were observed sporadically at similar concentrations throughout the preoperational surveillance period.

TABLE 3-2

Summary of Average Concentration and Frequency of Detection for Radionuclides in Quarterly Composite Gamma Scans for Air Particulate Filters

	Sr-90 pCi/m^3 Indicator Locations	Control
First Quarter	4.45 E-4 (3/6)	<4.35 E-4
Second Quarter	6.75 E-4 (5/6)	<5.53 E-4
Third Quarter	5.19 E-4 (1/6)	<6.03 E-4
	Cs-137 pCi/m^3 Indicator Locations	**Control**
First Quarter	1.70 E-3 (1/6)	<1.30 E-3
Second Quarter	1.97 E-3 (1/6)	<1.30 E-3
Fourth Quarter	1.08 E-3 (1/6)	<1.30 E-3
	Mn-54 pCi/m^3 Indicator Locations	**Control**
First Quarter	2.81 E-3 (1/6)	<1.29 E-3
	Co-60 pCi/m^3 Indicator Locations	**Control**
First Quarter	4.02 E-3	<3.00 E-3

The first quarter of 1979 composites of the air particulate samples at Station 45 (On Site) revealed manganese-54 and cobalt-60 activity at the concentrations of 2.81 E-3 pCi/m^3 and 4.02 E-3 pCi/m^3, respectively. These radionuclides are attributed to Brunswick operations. Using the assumptions of Regulatory Guide 1.109, an inhalation dose to the critical organs and total body may be calculated (see Table 3-3). The average air activity for manganese-54 and cobalt-60 at the concentrations of 1.417 E-3 and 3.085 E-3, respectively, were computed from the air particulate data including minimum detectable activity concentrations for dose calculations.

TABLE 3-3

Maximum Inhalation Exposure From
Environmental Air Particulate Data
mRem Per Year

	Liver	Kidney	Lung	GI-LLi	Total Body
Adult	9.16 E-5	1.39 E-5	2.04 E-2	9.88 E-4	5.46 E-5
Teenager	1.18 E-4	1.80 E-5	2.97 E-2	8.94 E-4	7.31 E-5
Child	1.01 E-4	1.42 E-5	5.15 E-2	3.29 E-4	8.34 E-5
Infant	6.06 E-5	7.06 E-6	1.53 E-2	1.08 E-4	1.20 E-4

3.2 MILK SAMPLES

Weekly milk samples analyzed radiochemically for iodine-131 revealed no measurable activity for the year of 1979.

Radiostrontium analyses of monthly composited milk samples revealed no detectable strontium-89 activity. The 1979

strontium-90 activity at the average concentration of 5.80 pCi/l for the indicator stations is comparable to the control station's averaged concentration of 4.69 pCi/l. These concentrations are comparable to the average concentration of 9.0 pCi/l observed during the preoperational period.

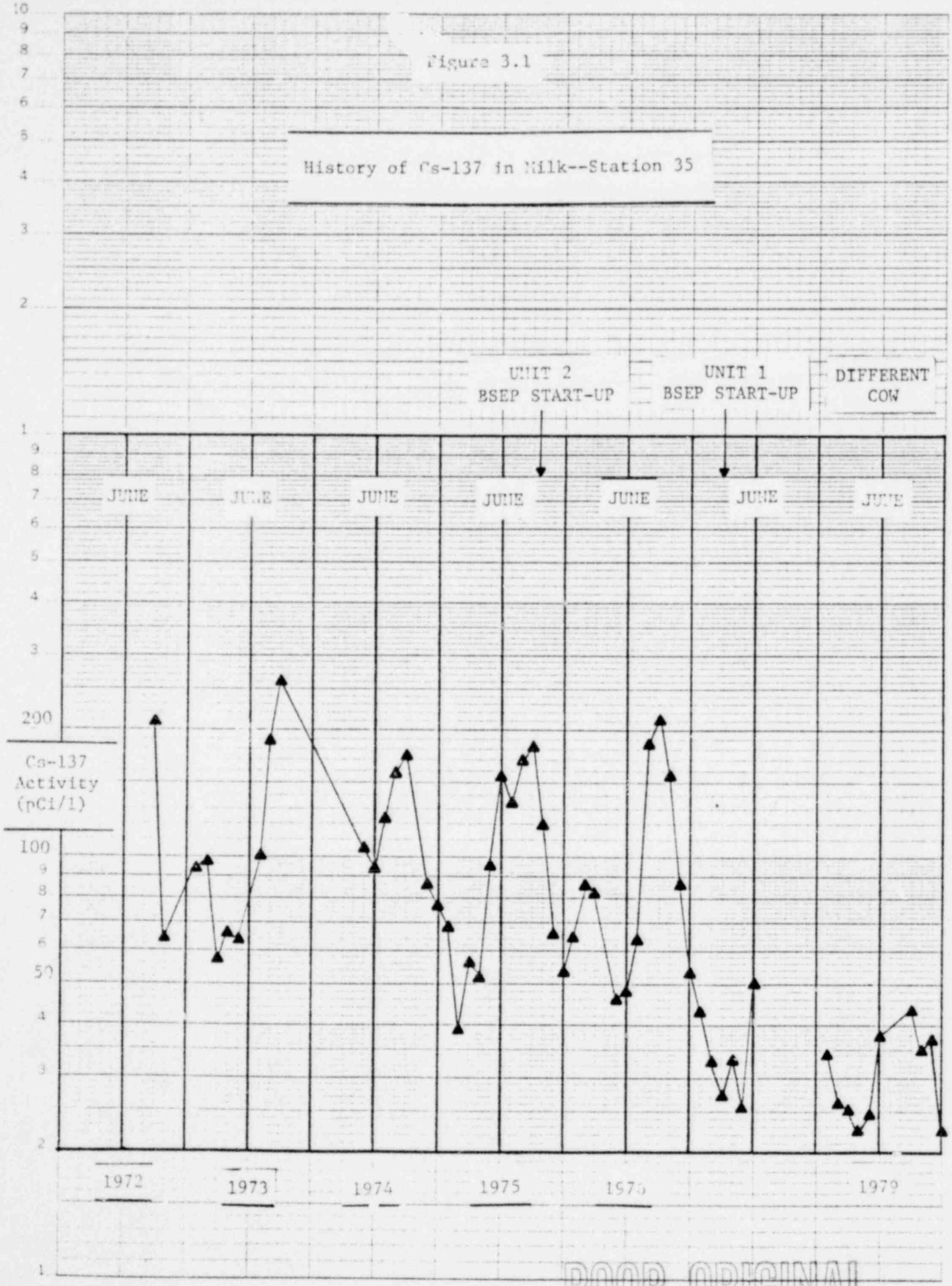
Gamma isotopic analyses of monthly composited milk samples reexhibited the same general trend for September and October as during the preoperational period. Milk Station 35 (Stevens Farm) continued to show higher levels of cesium-137 in milk (10 of 10 samples) averaging 30.8 pCi/l, compared to the control station (1 of 12) at the concentration of 7.23 pCi/l. Figure 3.1 details the history of cesium-137 measurements at the Stevens Farm during the preoperation phase in comparison to 1979 results. The source of activity cannot be attributed to Brunswick Plant effluents. The other milk station (Station 36) also showed levels of cesium-137 in milk (8 of 12 samples) averaging 25.8 pCi/l for 1979. The absence of other accompanying fission products (strontium-89, higher concentrations of strontium-90, iodine-131, barium-lanthanum-140) at this station as well as the Stevens Farm (0.6 mile southeast of Brunswick Plant) eliminates the Brunswick Plant as the source of the radioactivity.

3.3 VEGETATION

Terrestrial vegetation (pine needles, leaves, grass) and fodder samples (cattle feed, pasture grass) revealed

Figure 3.1

History of Cs-137 in Milk--Station 35



POOR ORIGINAL

manganese-54, cobalt-60, cesium-137, cerium-141, and cerium-144 activity. Using a t-test at 95% confidence level, the control station (Station 37) is comparable to all indicator locations as summarized in Table 3-4.

TABLE 3-4

Summary of Detectable Radionuclides for 1979 in Terrestrial Vegetation and Fodder Crops

Terrestrial Vegetation
Mean (Frequency)
pCi/gram (dry)

	Mn-54	Co-60	Cs-137	Ce-144
Information Center (TV-2)	0.175 (4/4)	0.114 (3/4)	0.115 (3/4)	0.373 (1/4)
River Road @ Intake Canal (TV-13)	<0.065 (0/4)	<0.065 (0/4)	0.180 (4/4)	0.402 (1/4)
Highway 211 - W. Side of Discharge Canal (TV-27)	0.144 (2/4)	0.098 (2/4)	0.102 (4/4)	0.377 (2/4)
Johnson Farm Control Station (TV-37)	0.051 (2/5)	<0.065 (0/5)	0.514 (5/5)	0.459 (4/5)

Fodder Crops
Mean (Frequency)
pCi/gram (dry)

	Co-60	Cs-137	Ce-141
Stevens Farm (FO-35)	0.043 (1/8)	0.198 (8/8)	<0.065 (0/12)
Lewis Farm (FO-36)	0.0715 (1/12)	0.131 (7/12)	0.102 (1/12)
Johnson Farm Control Station (FO-37)	<0.065 (0/12)	0.091 (5/12)	<0.065 (0/12)

The terrestrial vegetation sample (pine needles) collected on January 1, 1979, at Station 37 (Control Station) revealed manganese-54 and cesium-137 at the concentrations of 5.38 E-2 pCi/g (dry) and 1.03 E+0 pCi/g (dry), respectively. This station was resampled on January 22 for verification. Again, manganese-54 and cesium137 activity was found in pine needles at the concentrations of 4.82 E-2 pCi/g (dry) and 7.84 E-1 pCi/g (dry), respectively. Since there was no other logical source for manganese-54 and elevated concentrations of cesium-137 in comparison to the indicator stations, Station 37 appeared to be an undesirable location for a control station. The concentrations of manganese-54 and cesium-137 appeared to have been due to Brunswick's operations. Further investigation revealed that this was not necessarily the case due to:

(1) The NNW meteorological sector has the lowest annual (D/Q) deposition factor.

(2) Manganese-54 and cesium-137 concentrations released in comparison to the concentrations of other radionuclides released during this time period were equal to and considerably lower, respectively.

(3) In comparison to previous data, the fourth quarter of 1976, the cesium-137 activity was 0.453 pCi/g (dry); the annual average cesium-137 concentrations for 1977 and 1978 were 0.461 pCi/g (dry) and 0.606 pCi/g (dry), respectively. These activities were attributed to nuclear testing by the People's Republic of China on

September 26, November 17, 1976, September 17, 1977, and March 14, 1978. For the same sample location there were no elevated concentrations of cesium-137 in the other sample media (fodder, milk, etc.).

(4) "The flux of cosmic rays incident on matter activates the material through a variety of spallation or neutron capture reactions. In spallation the incident cosmic radiation releases one or more nucleons, resulting in a residual radionuclide that is equal to or lighter than the target nuclide. Neutron capture, on the other hand, produces a radionuclide that is one mass unit heavier than the target atom.

The target matter may be extraterrestrial or terrestrial. Since the rate of influx of extraterrestrial dust to the earth is estimated to be about 1.0 E+7 kg per year with typical radionuclide concentrations of less than 450 pCi/kg, the extraterrestrially produced radionuclides (Be-7, Na-22, Cr-51, Mn-54, Co-57, Co-50, and Co-60) have atmospheric concentrations which are small."[1] Manganese-54 activity was detected in pine needles during preoperational testing at Station 2 (Information Center) at the concentration of

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[1] National Council on Radiation Protection and Measurements, Natural Background in the United States, NCRP Report No. 45, Washington, DC 1975.

0.11 pCi/g on July 2, 1974. The occurrence and concentration of manganese-54 at the control station plus the similar observation made during preoperational testing indicates a source other than the Brunswick Plant.

Cattle fodder and feed (pasture grass) sampled monthly for 1979 exhibited cesium-137 activity in 20 of 32 samples averaging 0.147 pCi/g (dry). These concentrations were lower than the preoperational average of 1.44 pCi/g.

Terrestrial vegetation samples at Station 2 (Information Center) and Station 27 (Highway 211, West Side of Discharge Canal) revealed low levels of manganese-54 and cobalt-60 activity. Cobalt-60 was detected in 1 of 8 cattle feed (fodder) samples at Station 35 (Stevens Farm). These radionuclides are attributed to Brunswick Plant, but the impact on the environment and the dose to man are insignificant when considering that the concentrations of these radionuclides are less than three times the minimum detectable activity.

Food crops (squashes and cucumbers) sampled during the growing season (June-August) contained no fission or activation products within the analytical detection limits.

3.4 SURFACE WATER

Radiostrontium, gamma isotopic, and tritium analyses of surface water samples during 1979 all yielded less than the minimum detectable activity.

The 1979 annual average of the monthly gross beta activities for all indicator stations (372 pCi/l) was approximately 66% higher than the annual average for the control station (223 pCi/l). Similar relationships were observed in 1976, 1977, and 1978 and are comparable to that observed during the preoperational surveillance program when the all-indicator annual average was 21% higher than that of the control station. Interpretation of surface water surveillance results is complicated by two interrelated factors which are tide and sampling methods. As established during the preoperational surveillance program, the gross activity of surface water can vary over an order of magnitude from that in relatively fresh water to that in seawater. The salinity of plant intake canal water has been observed to vary from 3 to 30 parts per thousand as a result of tidal action in the Cape Fear estuary. The sampling method employed for the offshore ocean sampling points (Stations 29, 30, and 31) was one monthly grab sample. The intake canal (Station 48, control) was sampled by weekly grab sample composited for monthly analysis. The discharge canal (Station 32) was sampled by automatic sampler which drew six daily aliquots composited for monthly analysis. Grab samples of the offshore ocean stations were generally not taken concurrently with grab samples of the intake canal. The submerged ocean outfall of the discharge canal is designed to provide a rapid tenfold dilution within an area of about 300 by 1,000 yards. Further dilution is provided by the tidal and eddy drift currents in

the area which averages 0.7 feet per second. These considerations severely limit the usefulness of the three offshore ocean surface water sampling stations as indicators of plant-contributed radioactivity. A more meaningful comparison of the data at hand can be made between the discharge canal (Station 32) annual average gross beta activity and that of the intake canal (Station 48). The 1979 annual average gross beta activity for Station 32 is 238 pCi/l, about 7% greater than that of the intake canal. A 7% increase for average gross beta activity from the intake to the discharge canal is comparable when considering the sampling method and the salinity of the water.

3.5 BENTHOS, SHRIMP, OYSTERS, AND FISH

Benthic organisms collected semiannually and analyzed for radiostrontium and gamma emitters as per technical specification closely paralleled the corresponding preoperational results. Only 3 of 8 samples taken showed strontium-90 at an average concentration of 0.091 pCi/g which compares with the preoperational data of 0.141 pCi/g in 3 of 33 samples. Gamma analysis revealed no detectable radioactivity for 1979.

Shrimp samples collected semiannually and analyzed for radiostrontium and gamma emitters at Station 46 (Ocean and Discharge) revealed no measurable radioactivity.

Oysters collected semiannually and analyzed for gamma emitters revealed no measurable radioactivity.

Fish samples collected quarterly and analyzed for gamma emitters at Station 30 (Ocean near Discharge Outfall) are comparable to preoperational results. Only 1 of 4 samples taken revealed cesium-137 activity at the concentration of 0.022 pCi/g. Cesium-137 was detected in 5 of 23 samples at an average concentration of 0.17 pCi/g which ranged from 0.035 pCi/g to 0.42 pCi/g during preoperational testing.

The gamma analysis for fish samples collected first and fourth quarters of 1979 revealed no detectable radioactivity at Station 43 (Discharge Canal). Fish samples collected on April 13 (second quarter) revealed manganese-54, cobalt-58, cobalt-60, cesium-134, and cesium-137 activity. The discharge canal was resampled on May 8, 1979, which also included benthic organisms (crabs) and shrimp (even though they are not required by the technical specifications) in order to evaluate the worse potential dose available to man through the aquatic transport pathway using environmental sample data (see Table 3-5). No oyster samples were available.

TABLE 3-5

Summary of Radioactivity Observed
in Fish, Crab, and Shrimp Samples
From Discharge Canal (Second Quarter 1979)

	Activity (pCi/g wet)			
	Fish	Fish	Crabs	Shrimp
Collection Date	4/13/79	5/8/79	5/8/79	5/8/79
Mn-54	0.150	0.149	0.169	0.040
Co-58	0.018	0.037	<MDA	<MDA
Co-60	0.169	0.142	0.044	0.036
Cs-134	0.009	<MDA	<MDA	<MDA
Cs-137	0.041	<MDA	<MDA	<MDA
Ag-110m	<MDA	<MDA	0.028	<MDA

The dose for the maximum exposed individual to an adult's fish, crab, and shrimp consumption using the highest concentration in the above samples and assumption of Regulatory Guide 1.109 is summarized in Table 3-6.

TABLE 3-6

Dose (mrem/yr) Computed From
Fish, Crab, and Shrimp Samples

Organ	Dose
Liver	0.188
Kidney	0.333
Gi-LLi	0.225
Total Body	0.105

These doses are based on one individual eating 46.3 pounds of fish, 11 pounds of crabs, and 11 pounds of shrimp, all in one year from the discharge canal. These doses are well within the plant design objectives.

3.6 ZOOPLANKTON

Zooplankton contained no measurable strontium isotopes during 1979. The gamma scans revealed cobalt-60 in 2 of 8 samples at an average concentration of 0.671 pCi/g (dry). All samples consisted of a large water fraction, and an attempt was made to separate water from the residue by filtration. It became apparent that significant water fraction and the relative amount of plankton per sample was highly variable. Consultation with aquatic ecologists who perform plankton inventories showed that the measures represent the state of the art. Classification was performed by microscopic examination of slides; the "biomass" inventories of plankton rely upon simple mechanical separation. These inventories represent plankton, plus other organisms such as algae, and concentrations of dissolved and suspended material once the filter has been dried. The cobalt-60 activities observed are attributed to Brunswick's operation, but the concentrations were questionable in units of pCi/g in zooplankton. Dose assessments to man cannot be made using Regulatory 1.109 and it appears to be insignificant in comparison to other aquatic sample media.

3.7 BOTTOM SEDIMENT AND AQUATIC VEGETATION

Bottom sediment samples collected semiannually at six locations are analyzed for radiostrontium and gamma emitters. There were only five radionuclides detected during 1979 (see Table 3-7).

TABLE 3-7

Average Concentration and (Frequency) of Detectable Radionuclides in 1979 Bottom Sediment Samples

Sample Station	Mn-54	Co-60	Cs-137	Ce-144	Ru-106
30	*<MDA	0.12 (1/2)	0.11 (1/2)	<MDA	<MDA
31	<MDA	<MDA	0.22 (1/2)	1.30 (1/2)	0.90 (1/2)
33	0.12 (1/2)	0.07 (2/2)	<MDA	<MDA	<MDA
34	0.04 (1/2)	0.04 (1/2)	<MDA	<MDA	<MDA

*MDA - Minimum Detectable Activity

These radionuclides are attributed to Brunswick Plant. Bottom sediments are not consumed by man; therefore, no dose commitment estimates are given. However, it is documentation of trends in plant effluent. The concentrations observed during 1979 are comparable to activities observed in 1978.

Aquatic vegetation samples collected semiannually and analyzed for radiostrontium and gamma emitters revealed no measurable radioactivity.

3.8 SOIL AND GROUNDWATER

Soil (beach sand) samples collected semiannually and analyzed for radiostrontium and gamma emitters revealed no measurable radioactivity except for one sample location. On January 3, 1979, Station 39 (Caswell Beach at Discharge Pipes) revealed strontium-89 and cesium-134 at the concentration of 0.262 pCi/g (dry) and 0.414 pCi/g (dry), respectively. These radionuclides appear to be attributed to Brunswick Plant. However, the

sample collected on July 5, 1979, at Station 39 revealed no measurable radioactivity.

Groundwater samples showed no fission or activation products for the year.

3.9 EXTERNAL RADIATION DOSE

Environmental dosimetry data does not show any significant changes from the corresponding data of the past seven years except Station 18 (Southport near CP&L Substation), which revealed the highest annual dose (63 mrem/yr). This is approximately 48% higher than observed at the control station (43 mrem/yr). In January of 1979, the TLD was relocated approximately 150 feet (inside the substation) due to the power pole (where the TLD is normally placed) being removed. The higher dose readings in comparison to other TLD locations are due to crushed stones, concrete pads, and low X rays from high voltage transformers. Excluding Station 18, Station 23 (Projected Maximum Annual Concentration Point) continued to show the highest average doses (59 mrem/yr), which has been noted in previous reports.

4.0 MISSED SAMPLES AND ANALYSES

4.1 AQUATIC VEGETATION

Aquatic vegetation samples were not collected at Sample Stations 29, 30, and 31 during 1979. Collection of aquatic vegetation samples were attempted, but except

for Station 49 (Low Cape Fear River Away From Plant Discharge), these attempts were unsuccessful since there were no permanent beds of same at the required sampling stations.

4.2 FODDER AND FEED

Fodder and feed samples from Sample Station 35 were not available during January, February, March, or December 1979. Attempts were made to collect these samples, but nothing was growing at this location.

4.3 MILK

Five milk samples in July, four samples in August, and two samples in September, from Sample Station 35 were missed due to the cow being dry. Three weekly samples--January 29, April 23, and October 1, 1979--were lost in analysis due to high fat content. However, gamma scans were performed on January 29 and April 23 weekly samples which revealed iodine-131 less than minimum detectable concentrations of 6.39 pCi/l and 4.63 pCi/l, respectively. The month of November strontium was lost in analysis due to high fat content.

4.4 ENVIRONMENTAL TLDs

The following thermoluminescent dosimeter results were missing in 1979:

Quarter	Sample Station	Reason
1st	10	Lost in field
1st	19	Due to wetting
2nd	16	Lost in field
3rd	21	Due to wetting
4th	16	Replacement badge was never sent to BSEP

5.0 ANALYTICAL PROCEDURES

5.1 GROSS BETA

Gross beta radioactivity measurements are made utilizing a Beckman Widebeta II proportional counter. The minimum detectable levels (99% confidence level) are approximately 0.82 pCi per sample.

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

Water samples are evaporated to a low volume, transferred onto a 2-inch tared stainless steel planchet, evaporated to total dryness, then counted on the Widebeta II with appropriate self-absorption correction, based upon sample weight.

5.2 TRITIUM

Liquid samples requiring tritium analysis are first distilled. Five milliliters of the distillate are mixed with 10 ml of liquid scintillation cocktail and counted on a liquid scintillation counter for 100 minutes. The sensitivities are approximately 320 pCi/liter at a 99% confidence level.

5.3 IODINE-131

Iodine-131 airborne concentrations are quantified by the Ge(Li)-ND4420 gamma spectrometry system. The cartridges are placed in a special Marinelli beaker and counted as a unit. If any iodine-131 is detected, 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. The minimum detectable concentration at time of count is less than 0.5 pCi/sample at a 99% confidence level.

5.4 STRONTIUM-89, 90

Strontium is removed from environmental samples by the following methods: (1) leached with dilute acid from air filters, sediment, and soil; (2) direct precipitation from both fresh and saline water; and (3) absorption as Sr^{+2} from milk and vegetation onto a cation exchange resin column.

In all cases, strontium is precipitated as strontium carbonate, collected on a tared filter, dried, and counted on the Widebeta II.

5.5 GAMMA SPECTROMETRY Ge-(Li)

Gamma spectrum analysis utilizes a lithium-drifted germanium detector with a thin aluminum window housed in a steel and lead shield. The analyzer system is a Nuclear Data 4420 with ND812 computer. Table 5-1 summarizes minimum detectable concentrations derived from instrument sensitivity, based upon a blank sample background at 99% confidence level.

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

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

Bottom sediment and soil are dried, weighed, and then analyzed in a marinelli beaker.

After cleaning, fish samples are boiled in order to separate the flesh from the bone. Oysters and shrimp are separated from any shell. These samples are then dried at 100°C and ground to produce a homogeneous mixture. These are placed in a polyethylene beaker and analyzed.

Zooplankton, benthic organisms, and terrestrial and aquatic vegetation are dried at 100°C, ground, and placed in containers to be analyzed.

TABLE 5-1

Typical Minimum Detectable Concentrations
Ge-Li Gamma Spectrometry

Air Samples	
Cs-134	1.6×10^{-2} pCi/M^3
Cs-137	1.6×10^{-2}
Ba-140	5.2×10^{-2}
La-140	3.2×10^{-2}
Other Expected Gamma Emitters	1.2×10^{-2} to 1.2×10^{-1}

Water Samples	
Cr-51	80 pCi/l
Co-58	8
Co-60	8
Mn-54	8
Cs-134	9
Cs-137	9
Ba-140	30
La-140	20
Other Expected Gamma Emitters	8 to 80

Soil and Bottom Sediments	
Cs-134	35 pCi/kg (dry)
Cs-137	35
Cr-51	280
Co-58	30
Co-60	30
Mn-54	30
Other Expected Gamma Emitters	30 to 300

Fish, Shrimp, Oysters, Benthos, and Vegetation	
I-131	13 pCi/kg (wet)
Cs-134	14
Cs-137	13
Cr-51	110
Co-58	12
Co-60	13
Mn-54	12
Other Expected Gamma Emitters	11 to 120

5.6 THERMOLUMINESCENT DOSIMETRY

Each area monitoring station includes a polyethylene packet, within which is an opaque polyethylene bag containing five each calcium sulfate dosimeters, 12 mm diameter by 0.4 mm thick. The packet is light, tight, and weatherproof.

A standard annealing cycle is used to prepare the dosimeters. Following receipt from the field, each dosimeter is read under nitrogen flow, utilizing Teledyne TLD-7300 Readers. This instrument integrates the light photons emitted from traps de-excited above 150°C. The lower energy traps are automatically eliminated through a preheat cycle. Calibration is checked monthly using dosimeters irradiated to known doses. Prior to, during, and following the measurement of each dosimeter batch, the instrument is checked through use of an internal constant light source as a secondary standard. The instrument background through dark current and other electronic noise is never greater than ten mrem equivalent and is typically two mrem equivalent.

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