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HEALTH PHYSICS REGIONAL MONITORING

Semiannual Report,

July through December 1961

May 1962

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WORKS TECHNICAL DEPARTMENT

E. I. du PONT de NEMOURS & COMPANY

EXPLOSIVES DEPARTMENT - ATOMIC ENERGY DIVISION

SAVANNAH RIVER PLANT

[redacted]

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Contents

Abstract

Radioactivity in the environs of the Savannah River Plant was measured during the six-month period ending December 31, 1961. There was a decrease in the amount released of alpha emitters, nonvolatile beta emitters, and radioiodine from Plant facilities to the environs, via the stacks, stream effluents, and seepage basins. Filterable beta emitters in atmospheric samples were attributed almost entirely to fallout from Soviet weapons tests. Weapons - produced radioiodine in milk was the principal source of radiation exposure.

Introduction

Under a program established by the Du Pont Company in June 1951, the Savannah River Plant site and surrounding region are systematically monitored for radioactivity. The environmental monitoring program accumulates information that is useful both as a measure of the effectiveness of Plant controls and as an authoritative record of environmental conditions. This report, covering the period from July through December 1961, is one of a series of reports relating to the environmental monitoring program.

Data Reporting

Survey data were averaged for the six-month period and compared with the previous six-month averages ("Health Physics Regional Monitoring Semiannual Report," DPSP 62-25-2, February 1962). In reporting data, "Avg" or "Total" refer to the average or total for this six-month report period, while "Prev Avg" or "Prev Total" refer to the average or total for the preceding six-month period. Unless otherwise specified, "Max" refers to the greatest concentration observed in a single sample collected during this report period.

Sensitivity and Standard Deviation of Laboratory Analyses

The sensitivity of laboratory analyses refers to the minimum amount of radioactivity that can be detected by the radiochemical analytical techniques in use. It is based on statistical counting error (90% confidence level) and is influenced by sample size, counter efficiency, and counter background. No self-absorption corrections have been applied to the alpha and nonvolatile beta results. See the table at the bottom of page 2. The standard deviations, calculated from spike recovery values, are applicable to the six-month averages of data in this report.

Where samples were analyzed by gamma spectrometry, the lower level of detection of a given isotope varied with: (1) background of each individual channel grouping, and (2) geometry and volume of sample analyzed. For this reason no average sensitivities are given. Furthermore, no differentiation was made in most cases between nuclides emitting gamma rays of nearly the same energy. Thus, data are reported as $Ru^{103,106}$, $Ce^{141,144}$, Fe^{59}/Co^{60}, etc; and such notation does not mean that both isotopes were necessarily present. The differentiation between individual isotopes in most groupings can be made, if required, by: (1) approximate age estimates of the radioactive material at the time of release, (2) chemical separations, and (3) decay and beta absorption studies.

Analysis	Samples	Sensitivity	Standard Deviation, %	Spike Value
Alpha	Water	$0.23 \pm 0.12 \times 10^{-15}$ c/ml	11	45×10^{-15} c/ml
	Mud	$0.23 \pm 0.12 \times 10^{-12}$ c/g	-	-
	Vegetation	$0.12 \pm 0.06 \times 10^{-12}$ c/g	-	-
	Air	$0.04 \pm 0.02 \times 10^{-14}$ µc/cc	-	-
Beta	Water	$4.2 \pm 2.7 \times 10^{-15}$ c/ml	-	-
	Mud	$4.2 \pm 2.7 \times 10^{-12}$ c/g	-	-
	Vegetation	$2.1 \pm 1.3 \times 10^{-12}$ c/g	-	-
	Biological Specimens	$2 \pm 2 \times 10^{-12}$ c/g*	-	-
	Air	$0.62 \pm 0.40 \times 10^{-14}$ µc/cc	-	-
TBP Extraction	Water	$0.33 \pm 0.17 \times 10^{-15}$ c/ml	28	45×10^{-15} c/ml
	Mud	$0.40 \pm 0.21 \times 10^{-12}$ c/g	52	45×10^{-12} c/g
	Vegetation	$0.04 \pm 0.03 \times 10^{-12}$ c/g	31	4.5×10^{-12} c/g
Radioiodine	Water	$8.8 \pm 5.6 \times 10^{-15}$ c/ml	11	300×10^{-15} c/ml
	Vegetation	2.2×10^{-12} c/g	-	20×10^{-12} c/g
	Air	$1.8 \pm 1.1 \times 10^{-14}$ µc/cc	-	-
	Milk	$5.4 \pm 1.0 \times 10^{-15}$ c/ml	15	3000×10^{-15} c/ml
Tritium	Water	$4.0 \pm 0.3 \times 10^{-12}$ c/ml	3	2500×10^{-12} c/ml
	Air	0.06×10^{-9} µc/cc**	-	-
Radiocesium	Water	$4.4 \pm 2.9 \times 10^{-15}$ c/ml	13	600×10^{-15} c/ml
Radiostrontium	Water	$6.3 \pm 4.0 \times 10^{-15}$ c/ml	14	230×10^{-15} c/ml
Strontium-90	Water	$0.10 \pm 0.06 \times 10^{-15}$ c/ml	8	230×10^{-15} c/ml
	Milk	$1.58 \pm 0.33 \times 10^{-15}$ c/ml	7	47×10^{-15} c/ml

* Approximate average; sample size varied.

** Approximate average; varied with absolute humidity.

Summary

The total quantity of radioactive waste released by the Savannah River Plant into the atmosphere, effluent streams, and earthen seepage basins during the six-month period is shown in the following table. The radioactivity discharged to effluent streams does not reflect miscellaneous releases of tritium (ie, P-Area cooling water containing R-Area releases, heat exchanger leakage moderator to cooling water, sump discharges, etc).

	Atmosphere	Effluent Stream	Seepage Basin
Alpha, mc	7.0	43	231
Nonvolatile Beta, c	0.7	105	76
Radioiodine, c	1.3	10	0.5
Tritium, kc	434.3	28.4	13.1

Releases of nonvolatile beta from the F and H-Area stacks in July through December decreased by factors of 7 and 6, respectively, over releases during the previous six-month period. Decreases in the F-Area release resulted from a suspension of the Purex process dissolving (June to September) and from the processing of aged SCRUP material (September to December). The decrease in nonvolatile beta released from H Area reflected a decline in the radioruthenium release rate, which was unusually high in January and February 1961.

Fallout from Soviet nuclear testing activities caused abrupt increases in atmospheric radioactivity concentrations. In August, just prior to the arrival of fresh fallout, average filterable beta level in air was the lowest in Plant history (2×10^{-14} μc/cc). Although maximum filterable beta levels in air (up to 2000×10^{-14} μc/cc) were observed in September during the first week of fallout arrival, maximum deposition of the debris by rainfall occurred considerably later due to the paucity of rainfall during and immediately following the test series which began September 1. Initial fallout in the vicinity of the Plant was predominantly BaLa-140 and Np-239.

The disassembly basin discharges from the reactor areas to effluent streams (a total of 113 curies of beta activity, excluding tritium and S-35) were the lowest since July-December 1955, and represented a 2-fold decrease as compared with January-June 1961 releases. Of this total, radioanalyses of weir samples revealed Cr-51 as the predominant long-lived radionuclide. S-35 was detected in disassembly basin releases during the fourth quarter of 1961 and nonvolatile beta activity and tritium were detected in the river at the Highway 301 crossing. The Plant-contributed radioactivity in transport at this location during the six-month period was calculated to be approximately 59 curies of nonvolatile beta and 34,500 curies of tritium. Concentrations of alpha activity were negligible both in stream and river water and only detectable in low volume effluents from the 300, 700, and 200 Areas.

Radioactivity was present in biological samples, including terrestrial animals, avian, and aquatic specimens. The uptake of radioactivity by Savannah River fish was generally confined to low level concentrations of radiostrontium in the bones. However, a few river fish contained low level concentrations of Cs-137 and Zn-65 in the bones and fleshy tissues. Higher concentrations of these isotopes were present in reactor-effluent fish. Radioactivity was detectable in river algae collected 60 miles below the Plant site. The reactor effluent systems and atmospheric fallout were the primary sources of radioactivity for terrestrial animals indigenous to the Plant site. Radioiodine was found in the thyroid glands, and low level concentrations of nonvolatile beta emitters were present in the bones and fleshy tissues of these animals. Only low level concentrations of radioactivity were found in waterfowl collected from Par Pond.

Radioactivity Releases and Environmental Effects

Atmosphere

Releases of alpha emitters, nonvolatile beta emitters, radioiodine, and tritium from individual Plant areas to the atmosphere during the report period are compared to releases during the previous six-month period in the following table. The individual isotopes comprising the F and H-Area nonvolatile beta totals are reported in Appendix A, table 1.

Radioactivity Released to the Atmosphere

	Alpha, mc		Nonvolatile Beta, mc		Radioiodine, c		Tritium, c	
Area	Total	Prev Total	Total	Prev Total	Total	Prev Total	Total	Prev Total
F	4.4	14.2	143	1006	0.8	160	-	-
H	2.5	1.3	513	2923	0.5	0.05	332,400	322,000
R	-	-	0.98	0.22	-	-	8,077	9,460
P	-	-	1.24	0.51	-	-	35,090	17,600
L	-	-	1.66	0.61	-	-	21,673	19,700
K	-	-	1.06	0.64	-	-	19,236	17,200
C	-	-	1.06	0.19	-	-	16,175	22,800
TNX	-	-	-	-	-	-	261	1,450
773-A	0.11	0.11	33	61	0.015	0.33	371	2,300
Total →	7.0	15.6	695	3992	1.3	160.3	434,283	412,510

Resumption of HM process dissolving in H Area on August 12 was accompanied by increased releases of radioruthenium from the Building 291-H stack. Analyses of stack sampling filters by gamma spectrometry indicated that a total of 117 mc was released on August 13, 14, and 15. The ratio of the 0.51 and 0.62 Mev photopeaks suggested that the ruthenium was primarily the longer-lived isotope Ru-106, which was attributed to old deposits of ruthenium in the dissolver off-gas system.

Migration of atmospheric fission fallout from Soviet nuclear tests into the building ventilation systems was reflected in the nonvolatile beta discharged from the reactor area stacks. An estimated 20,000 curies of tritium was released via the P-Area stack during November and December. These abnormal releases were attributed to unusual heat exchanger leaks that occurred during the period. The stack-released nonvolatile beta activity from Building 235-F, a special product facility which began operations in February 1961, was primarily atmospheric fission fallout. The nonvolatile beta and alpha activities released from the Building 235-F stack were <1 mc and <1 μc, respectively, during the six-month period.

Air samples were collected continuously from 20 air monitoring stations shown in figure 1, and in addition, from monitoring stations operated at Savannah and Macon, Georgia, and at Columbia and Greenville, South Carolina. Analyses were made for gross alpha and filterable beta, radioiodine, and tritium.

Except for tritium, no airborne radioactivity could be attributed to stack releases. Prior to the resumption of the Soviet nuclear tests which began in September 1961, the concentration of filterable beta in air at all locations (including F and H Areas) reached the lowest level observed in Plant history (monthly average of 2×10^{-14} μc/cc in August). Environmental effects due to fallout are discussed in the section "Soviet Test Fallout Summary."

While the average tritium content in air at H Area was 10.4×10^{-9} μc/cc (50% of public zone RCG), dispersal reduced tritium air concentrations at the Plant perimeter and 25-mile-radius locations to 0.3 and 0.1×10^{-9} μc/cc, respectively. The abnormal tritium concentration observed at H Area during August (42.7×10^{-9} μc/cc) significantly increased the average concentration for the report period and apparently was the result of higher than usual releases of tritium (see H-Area stack releases, Appendix A, table 1) combined with unfavorable meteorological conditions. The concentrations of radioactivity in air are summarized in Appendix B, table 1.

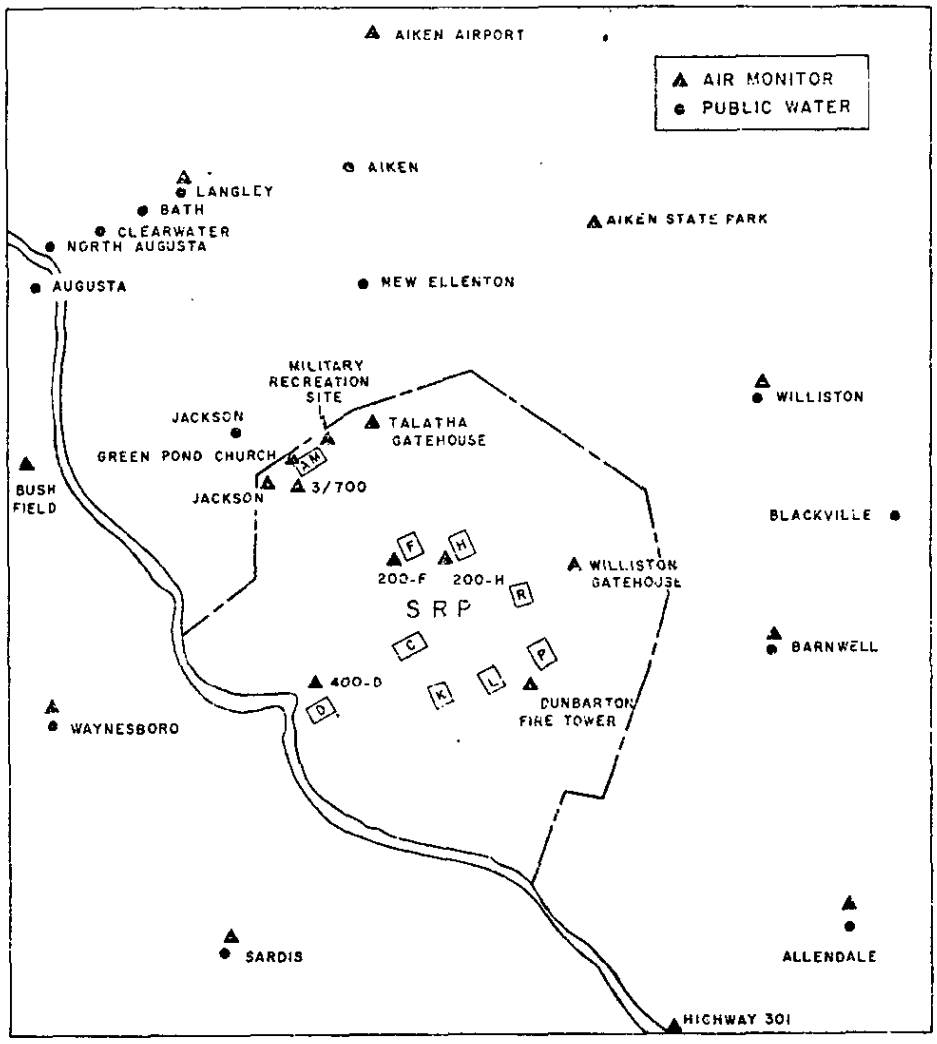

FIGURE 1. CONSTANT AIR MONITORING STATIONS AND PUBLIC WATER SAMPLING LOCATIONS

Gamma Radiation Levels

A summary of environmental gamma dose measurements, made with Landsverk L-65 pocket chambers and a modified L-60 electrometer, is given in Appendix B, table 2. No significant radiation levels due to Plant operations were observed at the individual area perimeters or at the constant air monitor buildings. The highest average dose rate observed was 0.59 mr/24 hours at H Area.

Rainwater

Results of analyses of weekly rainwater samples collected continuously at each monitoring station shown in figure 1 are summarized in Appendix B, table 3. Radioactivity in rainwater consisted predominantly of fallout from nuclear weapons tests. Fallout in rainwater (during the week ending September 19) was detected at essentially the same time as that in air samples; however, maximum concentrations in rainwater occurred much later than those in air. The average nonvolatile beta activity in rainwater during the week ending December 28 was the highest experienced as a result of the recent Soviet nuclear testing; however, a maximum concentration of 5900×10^{-15} c/ml was observed in a single sample collected during the week ending November 22. The maximum concentration of fallout activity in rainwater previously measured at SRP was $194{,}000 \times 10^{-15}$ c/ml, which occurred in March 1956 as a result of weapons tests in Nevada.

Radioactivity deposited on the Plant site, estimated from the analyses of rainwater samples and rainfall measurements at five monitoring stations, is shown in the following table. During weeks in which no rain occurred, nonvolatile beta deposition was estimated from radioactivity collected in an open pan of water near Building 735-A.

	Nonvolatile Beta, mc/mi^2	Radioiodine, mc/mi^2	Tritium, c/mi^2
July	5.3	0.6	1.2
August	4.7	0.7	10.8
September	53	4.7	1.9
October	27	-	1.7
November	118	7.0	3.8
December	241	9.5	13.8
Total →	449	22.5	33.2
Previous Total →	30.1	8.2	17.4

Cesium and strontium fallout in rainwater at the F-Area and Green Pond Church monitoring stations was collected by an ion exchange method and analyzed. Cumulative data for the six-month period are as follows:

	$Cs^{134,137}$, mc/mi^2		$Sr^{89,90}$, mc/mi^2	
	Total	Prev Total	Total	Prev Total
F Area	14	4.5	59	2.1
Green Pond Church (Plant Perimeter)	14	1.4	96	1.1

Measurements of Sr-90 in rainwater, which were initiated in November 1961, indicated a deposition totaling 1.5 mc/mi^2 (average of the two sites) in November and December. Assuming the radiostrontium deposition of 0.05 mc/mi^2 per inch of rainfall in January-June to be entirely due to Sr-90, the November-December Sr-90 deposition rate of 0.22 mc/mi^2 per inch of rainfall indicated a 4-fold increase.

Vegetation

Concentrations of radioactivity in vegetation samples, collected from locations shown in figures 2 and 3, represent negligible Plant contribution. The influence of Soviet fallout on radioactivity on vegetation is discussed in the section, "Soviet Test Fallout Summary." Analytical results of all samples are shown in Appendix B, table 4.

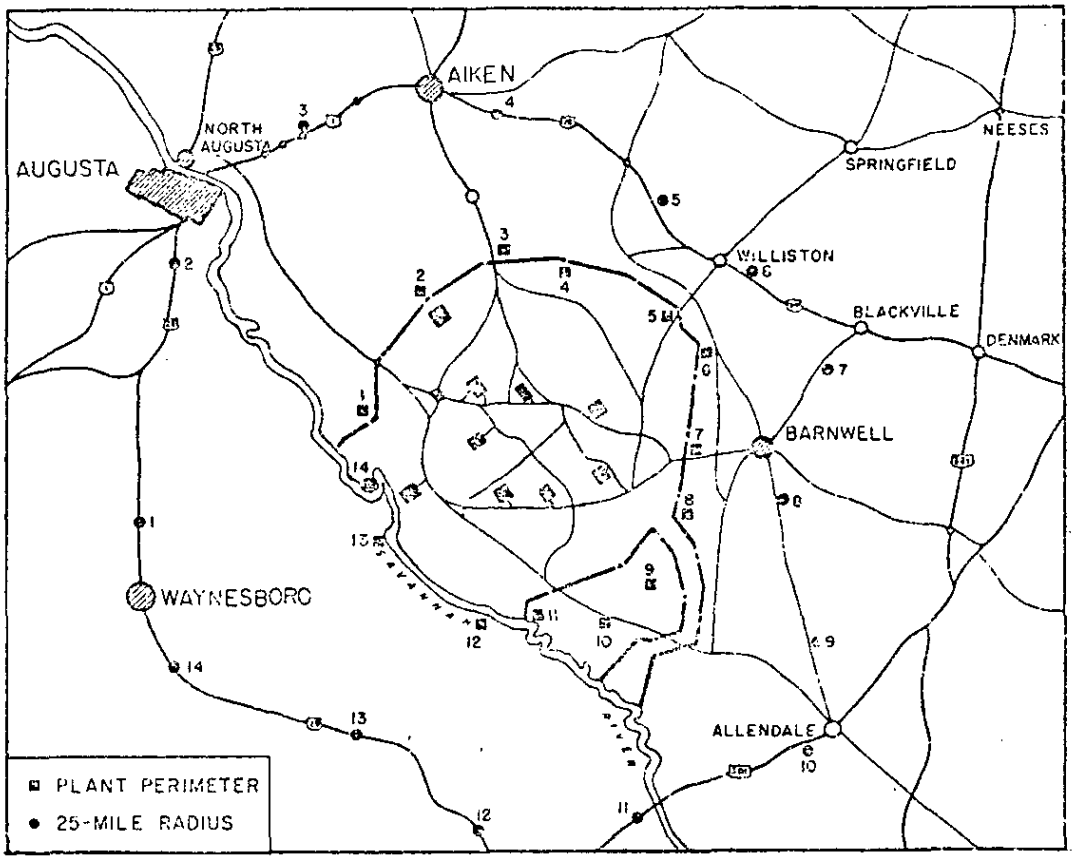

FIGURE 2. VEGETATION SAMPLE LOCATIONS

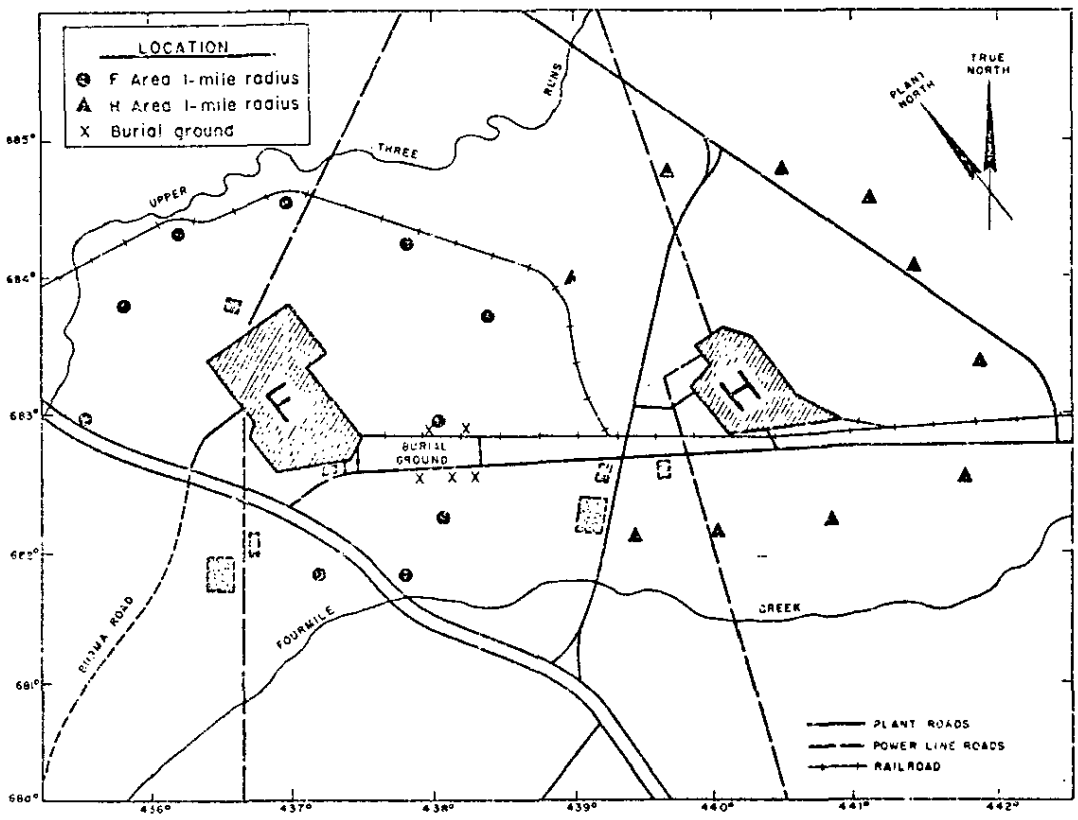

FIGURE 3. VEGETATION SAMPLE LOCATIONS IN F AND H AREAS

Milk

Samples of milk were collected weekly from farms at Talatha, Snelling, and Pleasant Mount, and from dairies at Aiken, North Augusta, and Langley. The average concentration of radioiodine (summarized in Appendix B, table 5) was 105×10^{-15} c/ml as compared to 31×10^{-15} c/ml during the previous six-month period. Radioiodine-contaminated milk is discussed in the section "Soviet Test Fallout Summary."

Regional milk produced by dairy herds and by farm cows was analyzed quarterly for Sr-90 content. The average concentrations shown in Appendix B, table 5, were essentially the same as those observed during the two previous quarters. Milk samples from a small dairy in Aiken, South Carolina and a farm at Snelling, South Carolina were analyzed weekly for Sr-90 during September, October, and November to ascertain if Sr-90 from the Soviet atmospheric nuclear tests had appeared in local milk. The Sr-90 content of these milk samples showed no effect from the Russian tests.

Soviet Test Fallout Summary

Resumption of Soviet nuclear tests (31 announced detonations from September 1 through November 4) resulted in increases in weekly averages of filterable beta activity in air from 2×10^{-14} µc/cc for the week ending September 12 to 2000×10^{-14} µc/cc for the week ending September 19. Fission products from the Soviet tests were first detected in the atmosphere on September 17, seventeen days after the first announced detonation. Filterable beta activity in air (September 16, 17, and 18), as measured at Building 735-A, reached a maximum of 7800×10^{-14} µc/cc; the highest previous concentration measured at SRP was 2900×10^{-14} µc/cc for a one-week period in August 1957.

Specific isotopes in the initial fallout were quantitatively identified by the Health Physics Section Chemistry Methods Group. Radiochemical separations were made on an eight-hour air sample obtained in F Area during the period of highest fallout concentration (26,400 ft^3 of air sampled between 5 PM on September 17 and 1 AM

on September 15 containing 17 × 10^{-10} uc/cc filterable beta). Chemical separations were used to facilitate gamma spectrometric analyses. About 73% of the gross filterable beta activity was accounted for by the separations. The relative abundance of radionuclides in the F-Area air sample is illustrated in figure 4.

The first week following the appearance of fallout was the period of highest average beta concentrations in air, maximum number of particulates per adhesive paper, and maximum radioiodine contamination on vegetation. Radioactivity in air, milk, and vegetation, prior to and following the arrival of the fresh fission radioactivity is shown in figures 5 through 8. Fallout deposition data (nonvolatile beta by rain and particle collection on adhesive papers) are presented in figures 9 and 10.

The decrease of radioiodine on vegetation and in milk following the first-week maximum reflects the decrease in atmospheric concentrations and short half lives of I-131 and I-132. The increases in nonvolatile beta on vegetation in November, particle deposition per adhesive paper, and total ground deposition were a result of increased rainfall.

Adhesive papers contained particles ranging to 687 × 10^{-12} c/particle in beta activity. Isotopes in select particles, as identified by gamma spectrometry, were Zr-Nb^{95} (predominant), $Ce^{141,144}$, $Ru^{103,106}$, $BaLa^{140}$, and possibly Np^{239}. Particle deposition at the Plant perimeter from November 13 through November 30 may have been influenced by the dispersion of particles from inside the Building 291-H stack (Ru-contaminated ammonium nitrate) which occurred during this period. Prior to the arrival of the Soviet tests, there were no radioactive particles detected on the adhesive paper monitors.

Analyses of milk samples from routine sample locations showed I-131 contamination (1700 × 10^{-12} c/ml maximum) from fresh fission fallout comparable to that experienced during the F-Area radioiodine release in May-June 1961 (1100 × 10^{-12} c/ml maximum). Of particular interest was the exposure to young children resulting from consumption of

(Text continued on page 21.)

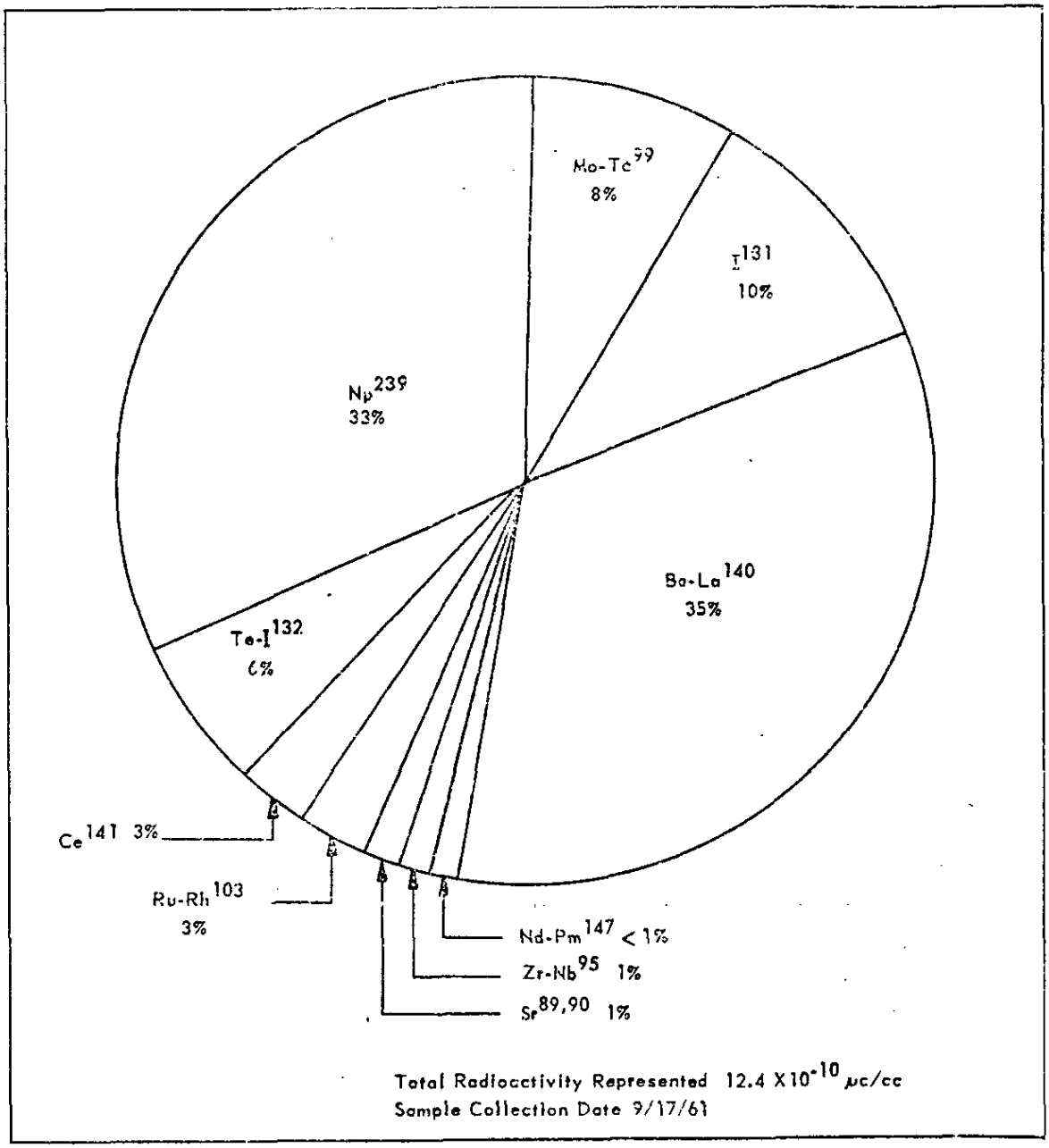

FIGURE 4. RELATIVE ABUNDANCE OF RADIONUCLIDES IN SOVIET FALLOUT
(Corrected to Date of Collection)

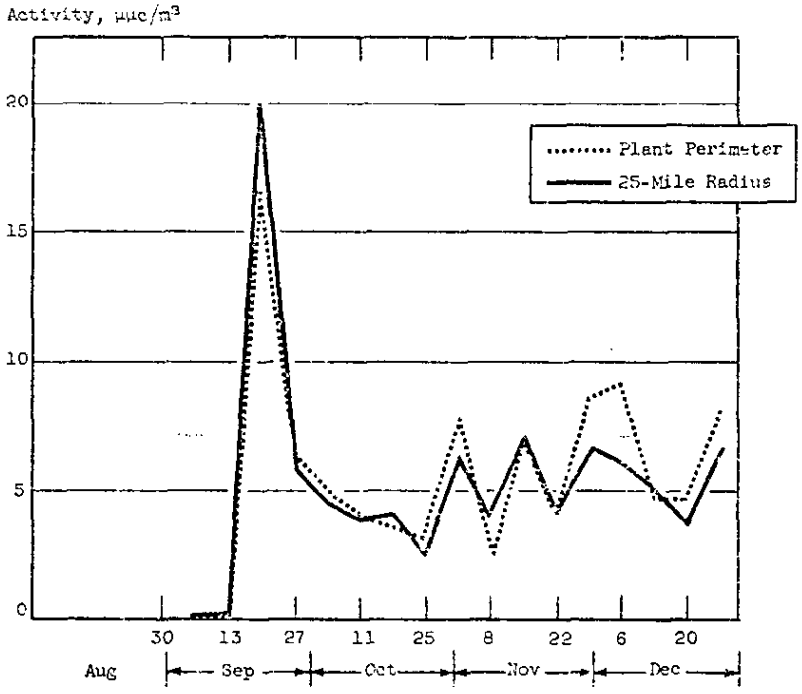

FIGURE 5. FILTERABLE BETA IN AIR

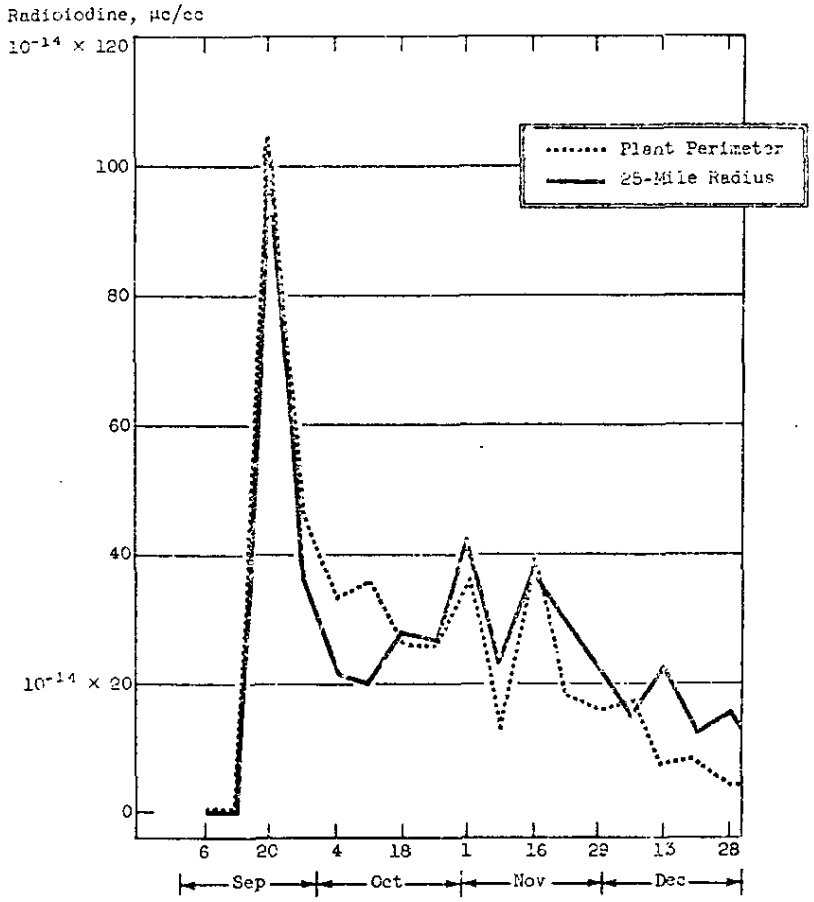

FIGURE 6. RADIOIODINE IN AIR

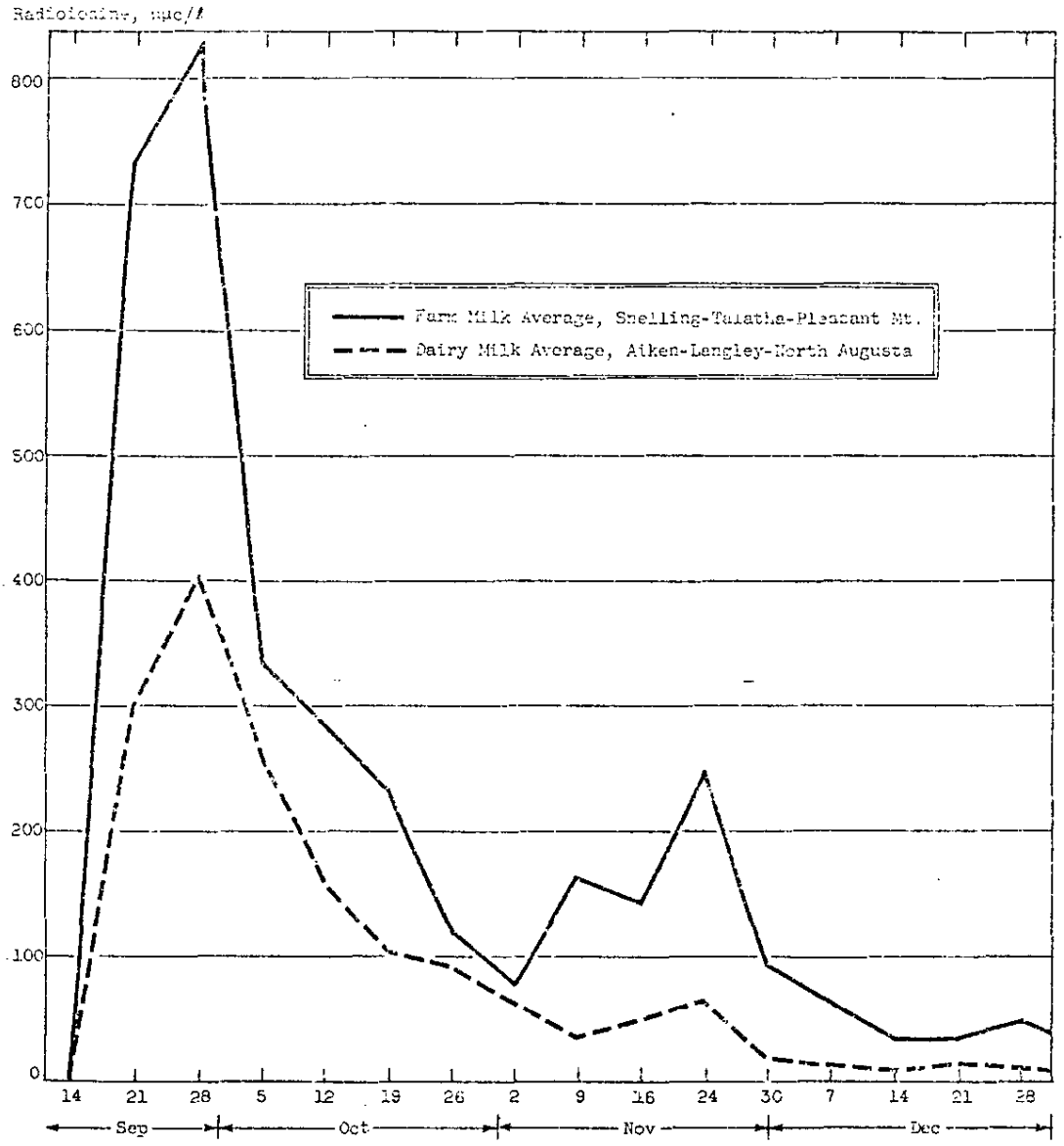

FIGURE 7. RADIOIODINE IN MILK

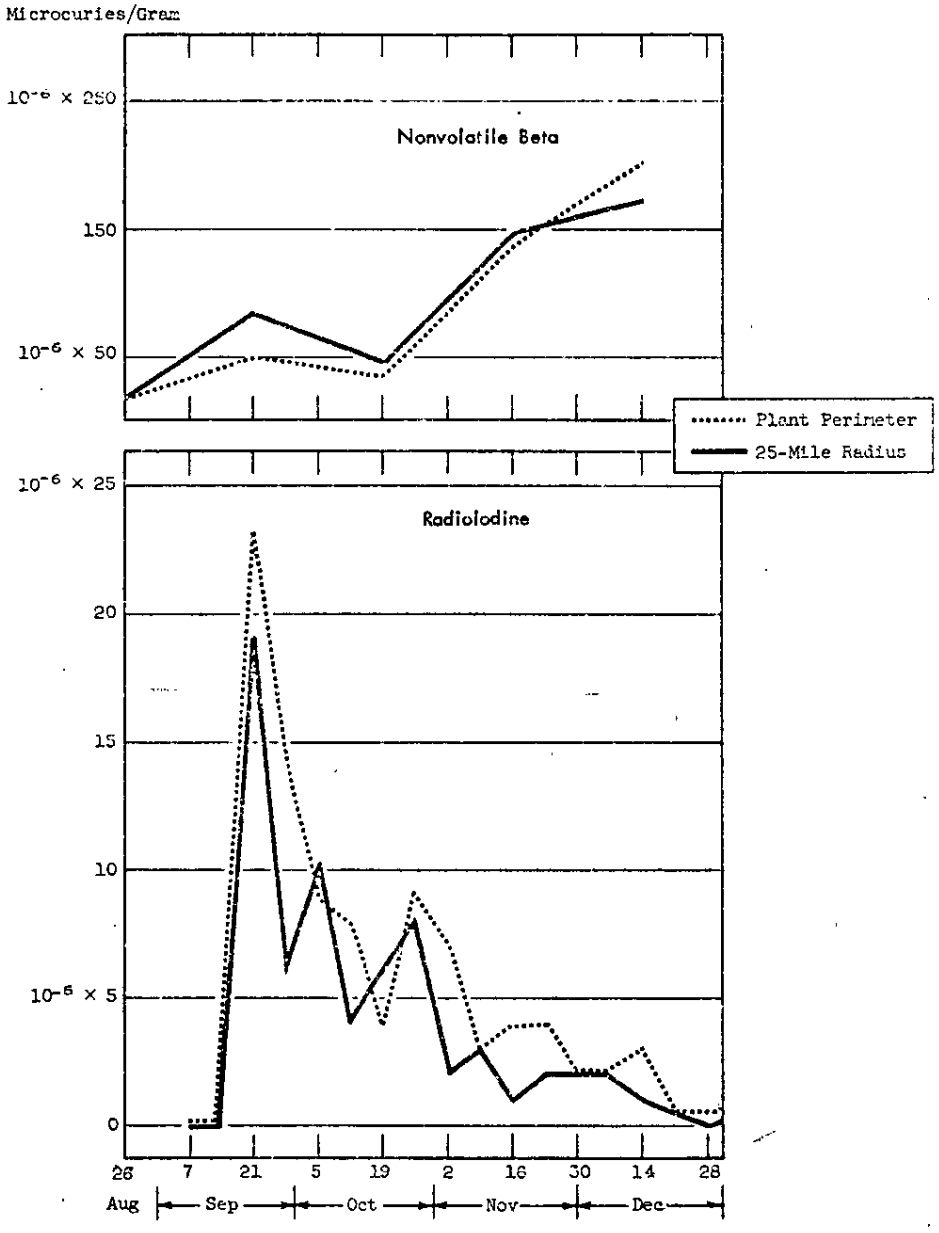

FIGURE 8. RADIOACTIVITY ON VEGETATION

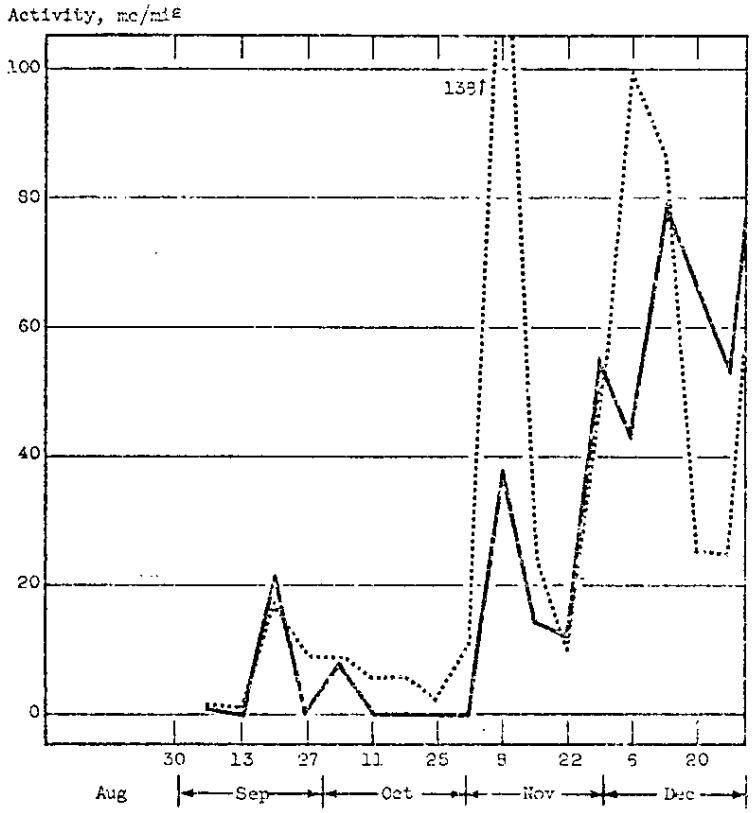

FIGURE 9. FALLOUT DEPOSITION ON PLANT

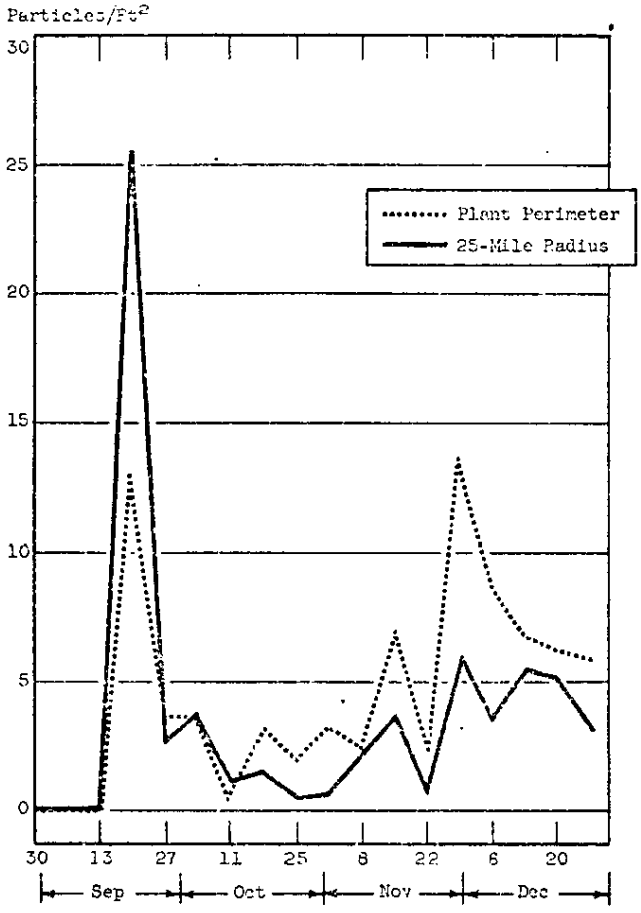

FIGURE 10. FALLOUT PARTICLE DEPOSITIONS ON ADHESIVE PAPERS

I-131 contaminated milk in the vicinity of the Plant for the calendar year. The cumulative thyroid dose due to consumption of contaminated dairy milk (resulting from both Plant release of radioiodine in early June and Soviet tests fallout) was well below the 500 mrem per year recommended by the Federal Radiation Council, as shown in the following table. The calculations were based on average concentrations in dairy milk, a child's thyroid weighing 2 grams, and consumption of one liter of milk daily. An adult consuming one liter of milk daily would have received only 10% of a child's exposure, since an adult thyroid weighs about 20 grams.

1961	Average Population Dose to a Child, mrem	Source
June	63	Plant Release
September	102	Weapons Tests Fallout
October	93	Weapons Tests Fallout
November	27	Weapons Tests Fallout
December	6	Weapons Tests Fallout
1961 Total →	291	

Concentrations of radioiodine in milk during January through May and July through August were below the limit of detection.

Plant Drinking Water

Samples of drinking water were collected monthly from operating areas and quarterly from other domestic water systems. Results of analyses are summarized in Appendix B, table 9. Maximum concentrations of both alpha (36×10^{-15} c/ml) and nonvolatile beta (51×10^{-15} c/ml) activities were observed in Barricade 2 drinking water. These concentrations were attributed to naturally occurring radioactivity. Drinking water samples contained no detectable tritium activity.

Public Drinking Water

Samples of public drinking water were collected monthly from the 14 surrounding towns shown in figure 1. Analytical results are summarized

in Appendix B, table J.O. Public drinking water samples contained no detectable tritium activity.

Streams and the Savannah River

The amount of alpha emitters, nonvolatile beta emitters, radioiodine, and tritium released from individual Plant areas to effluent streams during July-December are compared to releases during January-June in the following table. The individual isotopes comprising the releases from the Reactor Areas are reported in Appendix A, table 2.

Radioactivity Released to Effluent Streams

	Alpha, mc		Nonvolatile Beta, c		Radioiodine, c		Tritium, c	
Area	Total	Prev Total	Total	Prev Total	Total	Prev Total	Total	Prev Total
F	3.3	3.7	1.7	1.13	-	-	5	5
H	5.5	4.3	0.2	0.20	-	-	1,300	710
R*	**	**	35.9	22.44	7.49†	1.41	6,900	3,300
P*	**	**	14.4	39.47	0.39	2.20	4,300	5,900
L*	**	**	17.8	71.46	0.48	6.55	3,600	7,100
K*	**	**	20.8	36.52	0.90	5.04	7,000	5,600
C*	**	**	13.8	58.13	0.75	3.56	5,300	4,800
300	34	80	-	-	-	-	-	-
Total →	43	88	104.6	229.4	10.01	18.76	28,400	27,400

* Disassembly basin weirs only.

** Naturally occurring alpha emitters in Savannah River water pass through the Reactor Areas in the cooling water. The total alpha discharged in Reactor Area effluents during the six-month period was estimated to be 400 millicuries. Since this activity did not originate from Plant operations, it is not included in the table.

† Reflects the discharge of a failed Mark V-B element during the R:9-10 outage.

The principal source of radioactivity released from the Reactor Areas was disassembly basin water, purged at a rate of 1000 to 2000 gpm. Reactor Area releases showed a substantial reduction of gamma

emitting radionuclides associated with the discharge of enriched fuel elements during the latter half of 1961. The decrease may be ascribed to the continued pD control of reactor moderator, which resulted in less corrosion in the primary cooling system. Approximately 73% of the total beta activity (excluding tritium) released from all Reactor Areas (the lowest six-month total since July-December 1955) was due to radioisotopes having half lives greater than 15 days.

S-35 which was detected in disassembly basin water during the 4th quarter of 1961, is not included in the Reactor Areas release summaries of this report. An imbalance between nonvolatile beta activity in reactor effluents and total estimated disassembly basins releases during October led to the identification of S-35 (see the Works Technical Progress Report for January 1962, DPSP 62-1-1). A problem in correlating the stream radioactivity with the disassembly basins releases (stream activity exceeded basins releases) concerned the methods used in determining the amounts of radioactivity. The gross beta technique was used to analyze stream water samples and the radioactivity was reported as nonvolatile beta equivalents of radium D and radium E. Disassembly basin weir releases were analyzed for absolute values of specific radioisotopes by gamma spectrometry and chemical analysis; the specific analyses did not include S-35. The nonvolatile beta assay techniques, however, did not permit quantitative measurement of S-35 because of the low energy beta emission and volatility of some forms of sulfur.

Specific analyses of weir samples indicated that disassembly basin releases included the following amounts of S-35.

Area	Period	S-35 Released in Disassembly Basin Water, curies
C	10/10-10/16	40
C	11/28-12/4	9
R	12/12-12/16	17

The Chemistry Methods group identified the S-35 by chemical analysis and isolation, the absence of gamma activity, and beta absorption

and decay studies. It was determined that reactor moderator, transferred to disassembly basins during discharge operations, was a minor source of S-35.

For measurement of radioactivity in Plant effluent streams and in the Savannah River, samples are collected continuously at 13 stream locations and 7 river locations as shown in figure 11. River mud samples collected monthly at 5 locations and weekly from two other locations (10 and 11) were analyzed for TBP extractable alpha. Analysis results are summarized in Appendix B, tables 6 through 8. Maximum concentrations of nonvolatile beta and tritium in Four Mile Creek, Pen Branch, and Steel Creek at the Road A locations coincided with fuel element discharge in the reactor areas. Analyses of water samples collected at the Road A intersection of each reactor effluent stream showed that the following amounts of radioactivity passed these locations. The flow of radioactivity passing river locations 2 (Control) and 10 (10 miles downstream from Plant) is presented for comparison.

	Radioactivity in Water, curies/6 months				
Location	Nonvolatile Beta	Tritium	Radio-iodine	Radio-strontium	Radio-cesium
Four Mile Creek	19.6	9,400	1.0	2.1	1.4
Pen Branch	16.2	7,000	0.6	3.2	2.0
Steel Creek	36.7	15,000	1.4	4.6	2.7
Lower Three Runs	1.4	1,400	-	0.2	0.3
Total at Road A Locations →	74.0	32,800	3.0	10.1	6.4
River 2	31.1	5,500	-	-	-
River 10	90.5	40,000	-	-	-

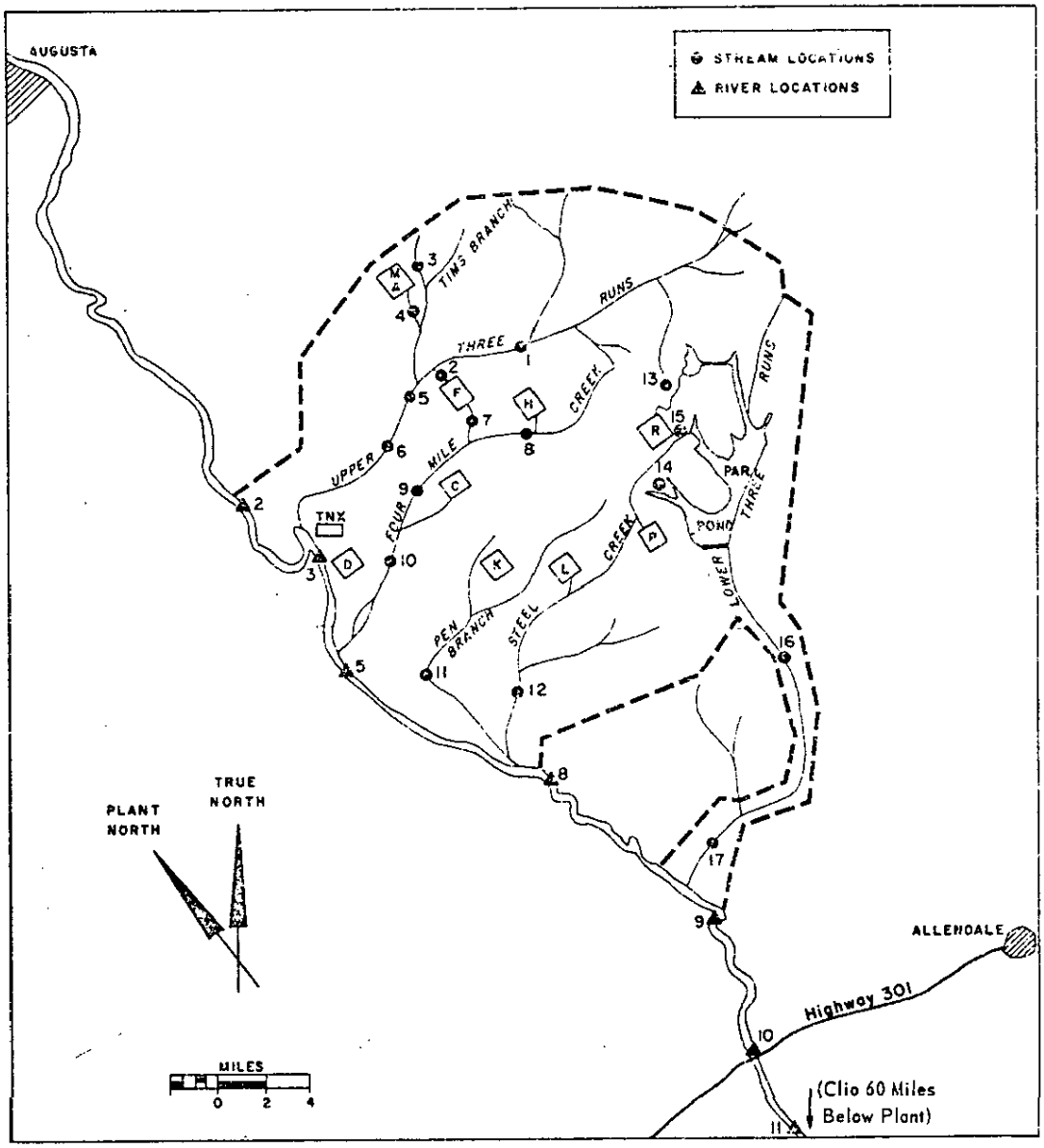

FIGURE 11. STREAM AND RIVER LOCATIONS

Apparent Plant Contribution →	Nonvolatile Beta	Tritium	Sr-90*
At Road A Stream Locations**	68.7	32,400	1.27
At River 10	59.4	34,500	1.31

* The total Sr-90 flow measured in stream water at Road A was as follows: Four Mile Creek, 0.24 curie; Pen Branch, 0.26 curie; Steel Creek, 0.30 curie; and Lower Three Runs, 0.24 curie. The total Sr-90 flow measured in river water was 1.52 curies at River Control and 2.83 curies at the Highway 301 location.

** Compensation was made for the estimated volume of river water used by the Plant facilities in calculating the Plant contributions at the Road A stream locations.

Decreased six-month average concentrations of radioactivity were noted in the 300-Area effluent and in the F-Area storm sewer effluent draining to the Upper Three Runs System. The approximate 7-fold decrease in nonvolatile beta activity in the storm sewer effluent was attributed to maintenance of the liquid level in an A-Line sump below points of leakage.

Seepage Basins

Alpha emitters, nonvolatile beta emitters, radioiodine, and tritium discharged to earthen seepage basins during July-December are compared to those discharged during January-June in the following table. Isotopic distribution of the nonvolatile beta discharged to the F and H-Area basins is shown in Appendix A, table 3.

Radioactivity Discharged to Seepage Basins

Area	Alpha, mc		Nonvolatile Beta, c		Radioiodine, c		Tritium, c	
	Total	Prev Total	Total	Prev Total	Total	Prev Total	Total	Prev Total
F	68	351	29.5	92.5	0.3	157		
H	144	85	29.5	36.8	0.2	0.1		
R	-	-	-	-	-	-	-	322
P	-	-	14.5	18.6	-	-	13	1,860
L*	-	-	-	0.02	-	-	32	-
K	-	-	-	-	-	-	-	-
C	-	-	3.2	16.8	-	-	13,034	42
3/700	19	10	0.04	0.03	-	-	-	-
Total →	231	446	76.7	164.8	0.5	157	13,066	12,248

* A total of 3391 curies of tritium and 14.5 curies of nonvolatile beta activity was released to the Oil and Chemical Disposal Pit in L Area.

Liquid volume input, seepage, and evaporation rates in liters per day for the F and H-Area basins are given below.

	F Area*	H Area*
Waste Input	1.3	2.2
Rain Input	0.7	0.6
Seepage and Evaporation	3.2	2.8

* Multiply these values by 10^5.

The radioactivity in Separations, 700, and TNX Areas seepage basins is shown in Appendix B, table 11.

The major sources of radioactivity released to the reactor area seepage basins resulted from handling of Chalk River reactor components in P Area, flushing a filter charge tank in L Area, and decontamination of heat exchangers in C Area. No radioactivity was released to the R and K-Area seepage basins during the report period. Radiochemical analysis revealed S-35 in C-Area seepage basin waste in September. A discrepancy between the total nonvolatile beta analysis and specific isotopic analysis prompted a study that led

to the identification of this radionuclide (see the Works Technical Progress Report for November 1961, DPSP 61-1-11). The maximum concentrations of radioactivity in reactor Area seepage basin water were observed in C-Area basin 1 as follows: alpha, 0.1×10^{-12} c/ml; nonvolatile beta, 2400×10^{-12} c/ml; and tritium, $165,000 \times 10^{-12}$ c/ml.

Ground Water

Ground water was monitored by analysis of samples collected from (1) wells surrounding F, H, and R-Area seepage basins (see figures 12 and 13), (2) wells near F and H Areas (Z and ZW wells, see figures 14 and 15), and (3) wells at the burial ground (see figure 16). The maximum nonvolatile beta concentration from analyses of 85 samples collected from the R-Area seepage basin wells was 86×10^{-15} c/ml in well A9, which is adjacent to basin 6. Radioactivity in Z, ZW, F-Area, and H-Area seepage basin well water is shown in Appendix B, tables 12 and 13.

All of the alpha activity detectable in F-Area and H-Area monitoring wells was attributed to natural uranium; no movement of plutonium into the ground water was detected. Wells in the perched water table in F Area, and wells 1, 3, and 5 in H Area showed the most significant concentrations of radioactivity. The average nonvolatile beta concentration in H-Area seepage basin well 3 ($13,000 \times 10^{-15}$ c/ml) was a 44-fold increase over any previous average at this location. Radiochemical analyses indicated that approximately 25% of the nonvolatile beta activity in F-Area wells was attributable to radiostrontium. Approximately 44% of the nonvolatile beta activity in well 5 in H Area was due to radiostrontium.

Well A37 in H Area is in a swamp bordering the H-Area effluent in the zone of most rapid movement of seepage basin water into the swamp. The tritium concentration in this well averaged $40,000 \times 10^{-12}$ c/ml. Radiochemical analyses indicated that practically all of the nonvolatile beta activity could be accounted for by isotopes of strontium. No movement of alpha emitters from the basins was detected in well A37.

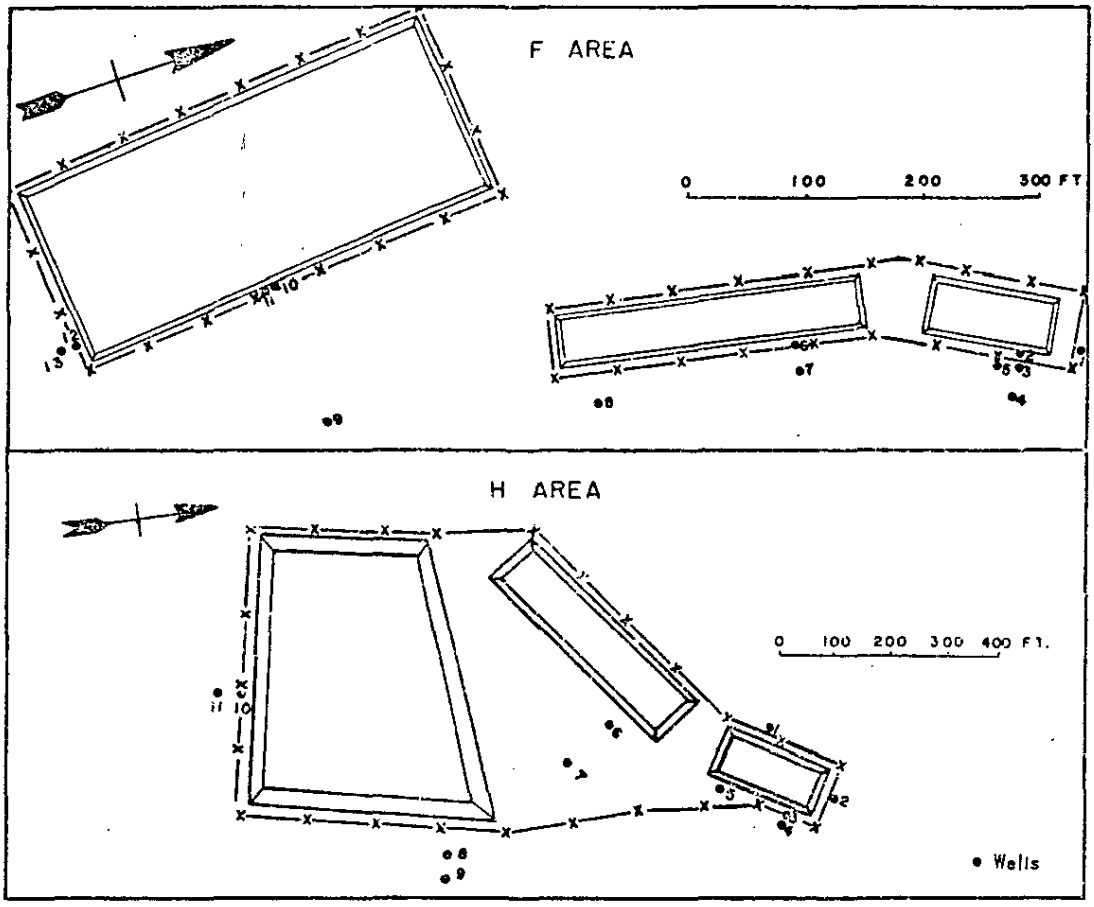

FIGURE 12. SEEPAGE-BASIN MONITORING WELLS IN F AND H AREAS

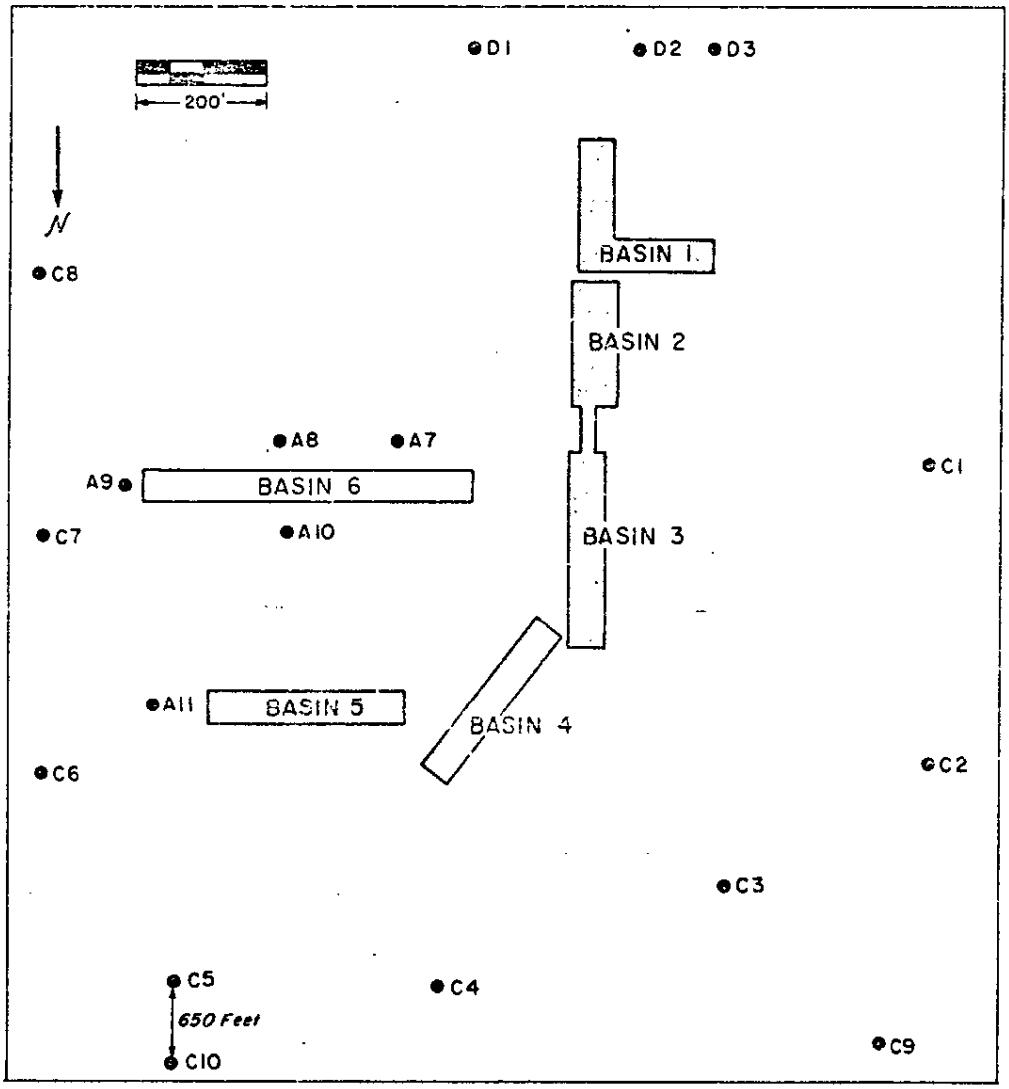

FIGURE 13. R-AREA SEEPAGE BASINS AND MONITORING WELLS

Denotes Backfilled Basins

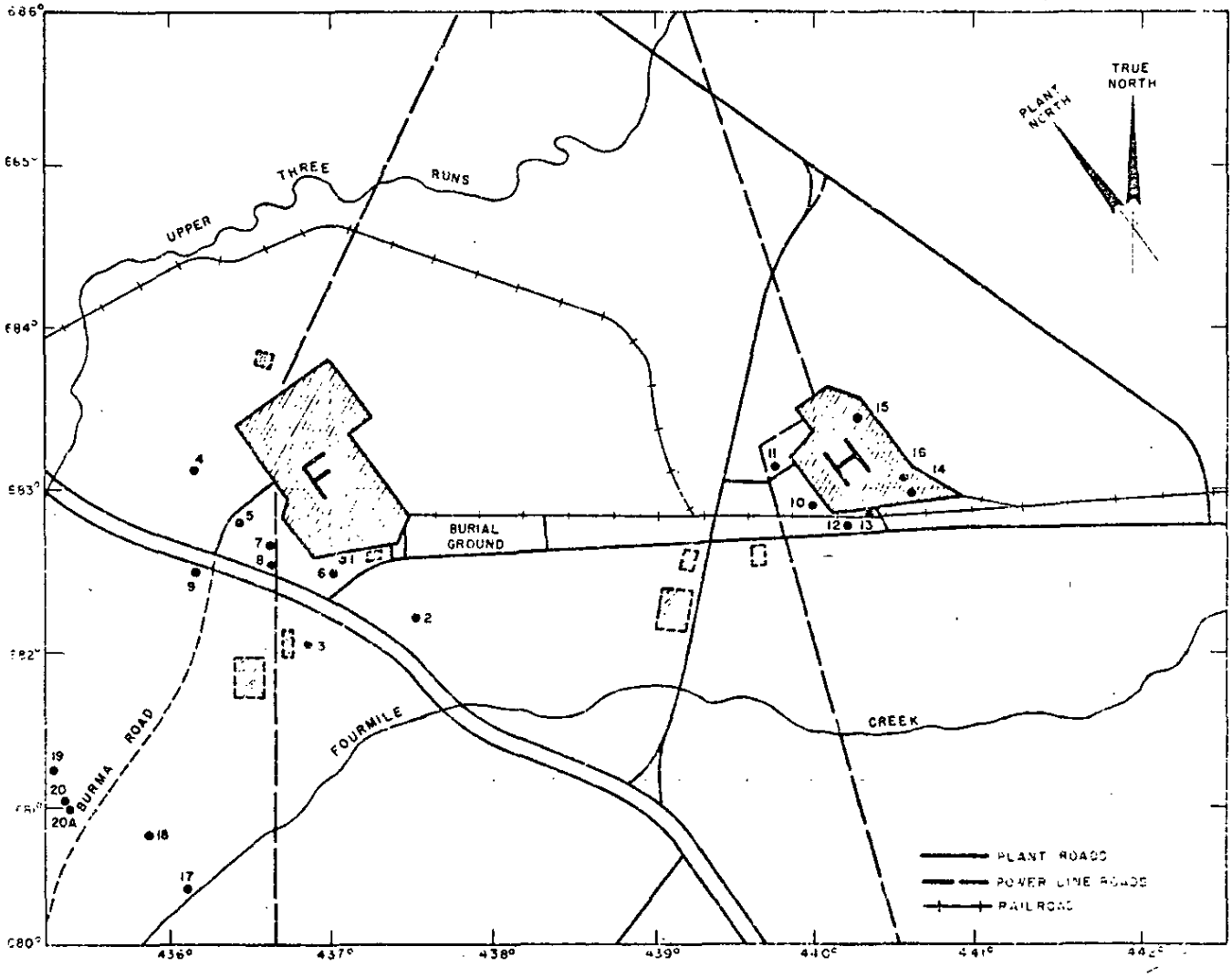

FIGURE 14. Z WELL LOCATIONS

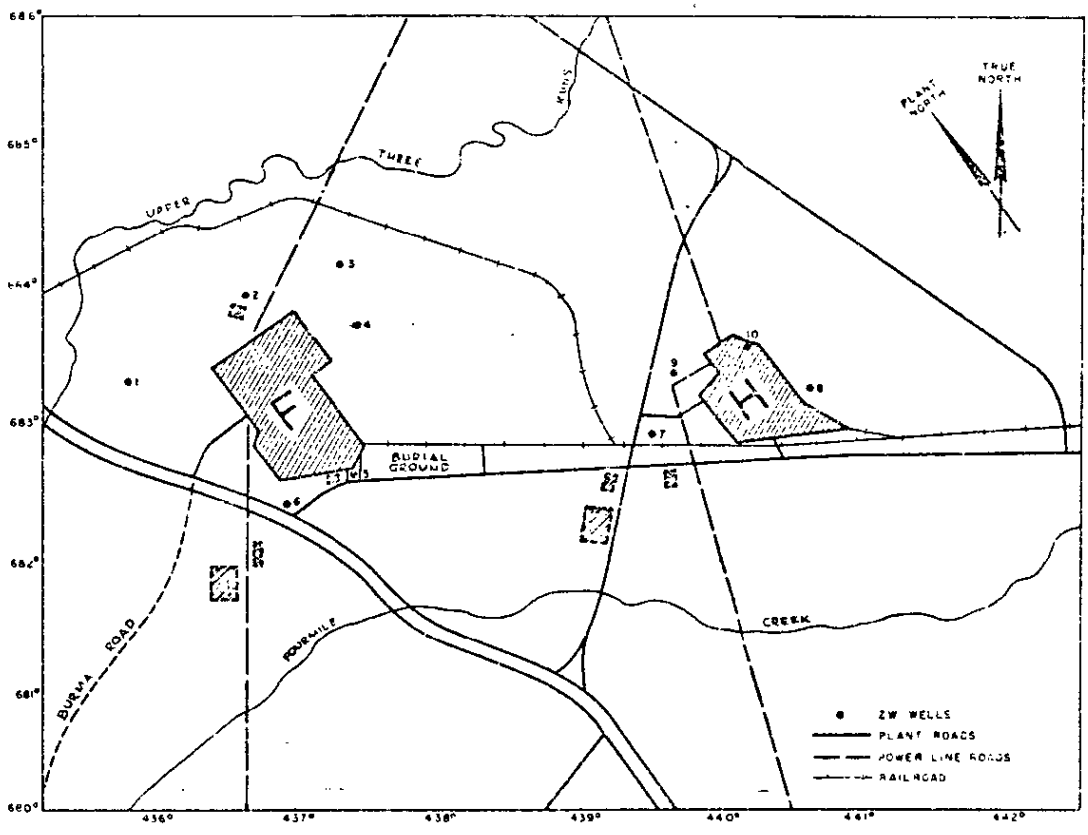

FIGURE 15. ZW WELLS, F AND H AREAS

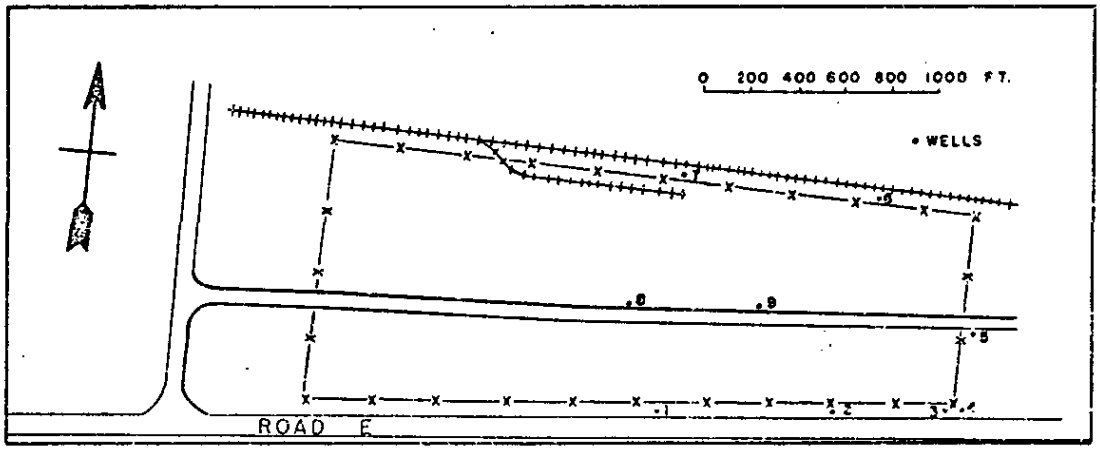

FIGURE 16. BURIAL GROUND WELLS

241-H Tank Farm

Analytical results obtained from ground water monitoring at 241-H Upper Tank Farm are summarized in the following table (see well locations in figure 17). The twelve HPM wells are installed at 20-foot intervals at a distance one foot from the outer edge of the concrete pad on which the four tanks in the Upper Tank Farm are constructed. The HP wells are the initial wells which were drilled five feet from the tank 16 encasement (down to the concrete pad) following the detection of radioactivity from the annulus of tank 16 in September 1960. Wells TW3 and TW4 were installed during construction of the 241-H Upper Tank Farm.

Nonvolatile Beta in Upper Tank Farm Wells, c/ml (multiply by 1×10^{-15})

	HPM Average	HP1	HP5	HP8	TW3	TW4
Maximum	39	430	150	230	420,000	550
Average	30	340	110	220	201,000	350
Previous Average	30	130	100	230	4,100	380

The increase of radioactivity in TW3 (beginning June 1961) followed the pumping of the soil shrinkage system from riser No. 5 (TA 5-6). This pumping caused movement of ground water from the vicinity of tank 16 to the center of the system, the location of both riser No. 5 and TW3. Negligible concentrations of radioactivity were observed in water collected weekly from a pre-existing test well in the center of the Lower Tank Farm.

Biological Specimens

TERRESTRIAL

The reactor effluent systems (including Par Pond) and atmospheric fallout from weapons tests were the primary sources of radioactivity in terrestrial animals collected from the Plant site during the report period. Although the exposed R-Area seepage basins were backfilled late in 1960, the nonvolatile beta concentrations in the

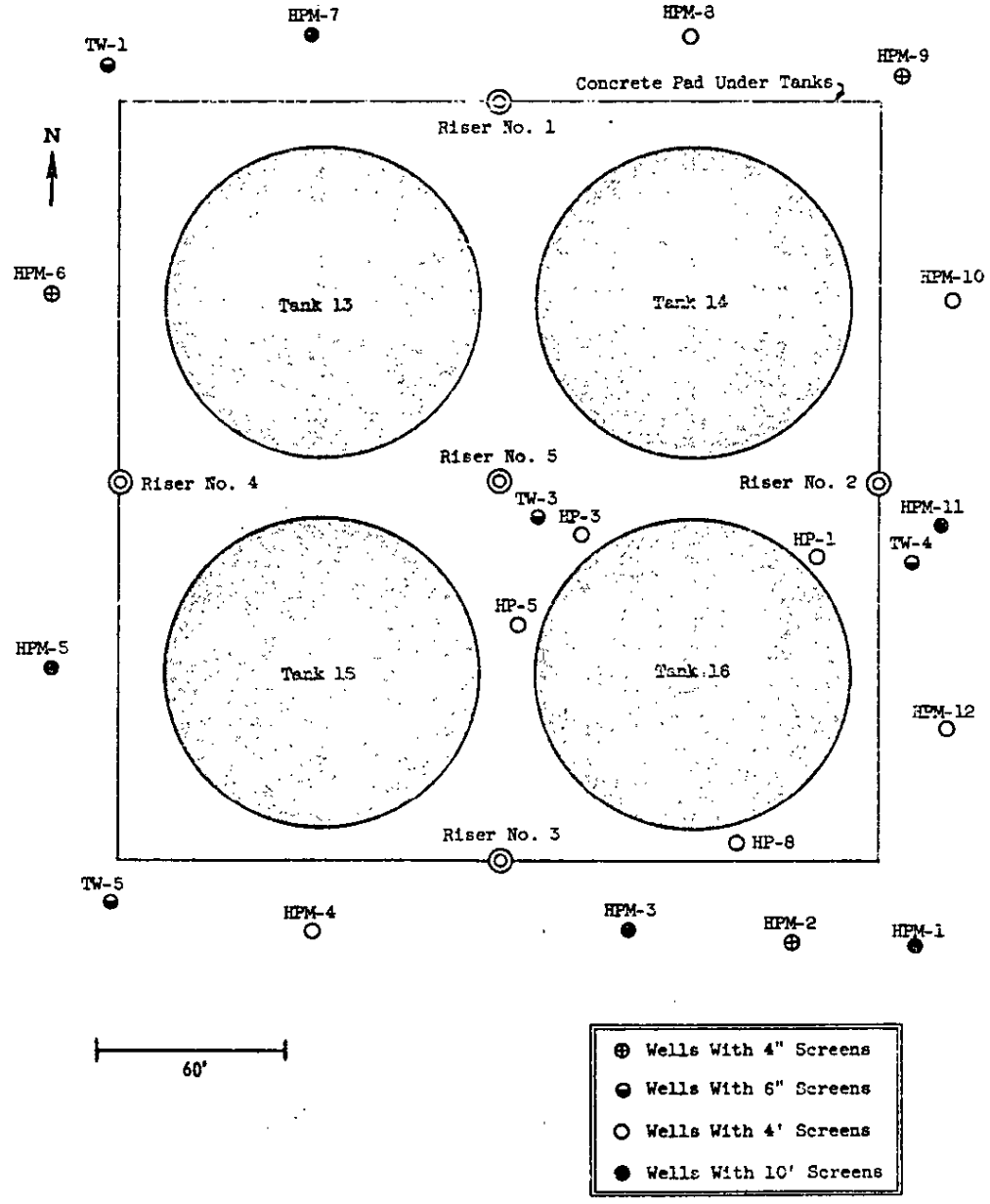

FIGURE 17. BUILDING 241-H UPPER TANK FARM

bones and flesh of animals collected within a half-mile radius of the basins were generally slightly higher than found in animals collected at random from the Plant site. This may be due to ingestion of food and water from the basins prior to being backfilled or from Par Pond. The primary isotopes in the bones and flesh of all animals, except the raccoon, were radiostrontium ($Sr^{89,90}$) and radiocesium ($Cs^{134,137}$). The primary isotope in the bones and flesh of the raccoon, a semiaquatic feeder, was radiozinc (Zn-65). The nonvolatile beta concentrations found in these specimens are presented in the following table.

Nonvolatile Beta in Terrestrial Animals (wet weight), c/g (multiply by 1×10^{-12})

Species	No. of Samples	Bone Max	Bone Avg	Flesh Max	Flesh Avg
R-Area Basin					
Rabbit	7	100	55	20	10
Raccoon	4	40	30	15	10
Fox	1	-	10	-	7
Bobcat	2	8	7	8	7
Other Plant Locations					
Rabbit	16	35	20	10	4
Raccoon	1	-	10	-	9
Fox	2	10	8	4	4
Deer	3	10	7	5	4
Opossum	1	-	8	-	3

Concentrations of I-131 may be several times greater in the thyroid of animals than in their food. Consequently, the radioassay of thyroids of indigenous terrestrial animals and local cattle is useful in the study of effects of low level I-131 emissions. Radioiodine from Soviet weapons tests was detectable in the thyroid glands of terrestrial animals collected from the Plant site. Data are shown in the following table. Comparative analyses were also run on three cattle thyroids obtained from an Augusta abattoir. The herbivore thyroids contained higher concentrations of I-131 than the carnivore thyroids.

Iodine-131 in Animal Thyroids (wet weight), c/g (multiply by 1×10^{-12})

Animal	No. of Samples	Maximum	Average
Rabbit	23	655	165
Deer	3	190	135
Fox	3	70	50
Raccoon	5	50	25
Bobcat	2	30	20
Opossum	1	-	10
Milch Cow	3	-	250*

* Calculated average of composite samples.

AVIAN

Five aquatic waterfowl (2 ring-neck ducks, 2 coots, and a ruddy-duck) were collected from Par Pond during December, approximately one month after their arrival at the pond. The highest concentrations of nonvolatile beta were in the bones and flesh of the coots, which feed primarily on animal matter. Radiozinc (Zn-65) and radiostrontium ($Sr^{89,90}$) were the predominant isotopes in the bones. Radiozinc and radiocesium were the primary isotopes in fleshy tissues. The nonvolatile beta concentrations contained in the three species were essentially the same as those found during the previous report period; concentrations of radioiodine in the thyroids were less than the sensitivity of analysis.

Nonvolatile Beta in Aquatic Waterfowl, c/g (multiply by 1×10^{-12})

Species	Bone		Flesh	
	Max	Avg	Max	Avg
Coot	50	30	30	20
Ring-Neck	20	20	15	10
Ruddy-Duck	-	7	-	5

AQUATIC

A total of 793 aquatic samples (514 fish, 273 algae samples, 4 clams, and 2 crayfish) were collected from the Plant effluents and the Savannah River. Fish and algae from reactor effluents were radioanalyzed to determine the maximum uptake of Plant-contributed radioactivity. Samples from the Savannah River were routinely analyzed to determine the concentrations of radioactivity in aquatic specimens accessible to the public.

Reactor Effluent. Radiostrontium ($Sr^{89,90}$), though not concentrated significantly by the fleshy tissues, was the primary beta emitter in the bones of fish collected from all four reactor effluents. Radiozinc (Zn-65) and radiocesium ($Cs^{134,137}$) were the predominant gamma emitters in the bones and fleshy tissues. However, the dominance and magnitude of specific nuclides in fish tissues varied significantly between effluents as shown in the following table. The higher average radiostrontium content in Par Pond and Lower Three Runs fish bones reflects radioactivity metabolized by fish indigenous to R Area effluent during the winter of 1957-58, following the [redacted] incident in R Area. The cause of the substantial reduction in radiozinc in Lower Three Runs, as compared to Par Pond, is under study. Steel Creek fish were exposed to radioactivity releases from both L and P Areas, whereas Four Mile Creek and Pen Branch fish reflect radioactivity released by C and K Areas, respectively.

Radioactivity in Effluent Fish (wet weight), c/g (multiply by 1×10^{-12})

	Monthly Composite	$Sr^{89,90}$ Max	$Sr^{89,90}$ Avg	$Cs^{134,137}$ Max	$Cs^{134,137}$ Avg	Zn-65 Max	Zn-65 Avg
Upper Three Runs (Control)							
Bone	4	6	4	*	*	*	*
Flesh	4	*	*	*	*	*	*
Four Mile Creek							
Bone	3	10	8	*	*	8	4
Flesh	3	*	*	2	1	1	1
Pen Branch							
Bone	2	12	12	6	3	24	24
Flesh	2	*	*	5	3	4	4
Steel Creek							
Bone	5	19	13	3	1	126	68
Flesh	5	*	*	7	5	12	8
Par Pond							
Bone	6	55	32	28	13	200	67
Flesh	6	*	*	31	28	24	14
Lower Three Runs (6 miles below dam)							
Bone	6	46	39	23	16	*	*
Flesh	6	*	*	50	28	*	*

* Less than sensitivity of analysis.

The nonvolatile beta concentrations in the bones and flesh of fish from Steel Creek increased 50% and 80%, respectively, during the report period. Lesser increases were also noted in the bones and flesh of fish from Par Pond. The higher concentrations are partially explained by increased tissue uptake of Zn-65. Comparisons between nonvolatile beta and total gamma indicated the presence of beta emitters other than radiostrontium in the bones and to a lesser degree in the fleshy tissues. Following a 12-month period of relative stability, a general decrease was observed in the nonvolatile beta concentrations in fish from Lower Three Runs. The sparse data collected from analyses of fish from Four Mile Creek and Pen Branch also indicated decreased concentrations during the report period.

Nonvolatile Beta in Effluent Fish (wet weight), c/g (multiply by 1×10^{-12})

	No. of Samples	Bone			Flesh		
		Max	Avg	Prev Avg	Max	Avg	Prev Avg
Upper Three Runs (Control)	16	15	7	10	6	4	4
Four Mile Creek	8	40	20	85	20	10	10
Pen Branch	6	115	40	150	20	10	20
Steel Creek	39	2340	260	175	280	55	30
Par Pond	144	630	145	115	115	35	30
Lower Three Runs							
1 Mile Below Dam	46	185	75	100	55	20	35
6 Miles Below Dam	40	210	60	100	45	20	30
14 Miles Below Dam	41	145	45	55	30	15	20

Radiostrontium ($Sr^{89,90}$) was the predominant radioisotope in the shell structures of clams and crayfish collected from Lower Three Runs (6 miles below the dam) in August. Radiocerium ($Ce^{141,144}$) and radiocesium ($Cs^{134,137}$) were the primary gamma emitters in the fleshy tissues of clams; radiocesium was the only radioisotope in the fleshy tissues of crayfish.

Average Nonvolatile Beta in Mollusks and Crustaceans (wet weight), c/g (multiply by 1×10^{-12})

	Clam		Crayfish	
	Shell	Flesh	Shell	Flesh
$Sr^{89,90}$	196	*	9	*
$Ce^{141,144}$	14	4	*	*
$Cs^{134,137}$	*	3	*	24

* Less than sensitivity of procedure.

Reactor effluent algae is routinely monitored because it has a high sorption for radioactivity and is an important link in the food chain of fish and man. Since algae concentrate radioactivity in the water by factors up to 10^4, they are good qualitative indicators of the radionuclide content of the water. The average nonvolatile beta concentrations in effluent algae collected during the report period were higher by a factor of 10^3 than those in effluent water. The

average concentrations in weekly samples collected at Road A are presented in the following table. Data indicated that the concentrations in reactor effluent algae vary inversely as a function of stream water dilution and the distance between the Reactor Area and Road A.

Effluent	Miles From Reactor Area	Nonvolatile Beta in Effluent Algae (dry weight), c/g (multiply by 1×10^{-12}) Max	Avg	Prev Avg
Upper Three Runs	Control	225	55	35
Four Mile Creek	4.0	4080	760	355
Pen Branch	2.5	5220	1370	765
Steel Creek	7.5	770	290	300
Lower Three Runs	18.0	145	95	85

Larger algae samples (10-30 grams dry weight) were collected monthly at each Road A location for gamma spectrometry and radiostrontium analyses. The average radioactivity concentrations in these samples are given in the following table. Although general quantitative comparisons may be made between the effluents, process conditions in the Reactor Areas varied at the time of sampling. The concentrations in Upper Three Runs algae may be due to atmospheric fallout and/or radioactivity released to Upper Three Runs by the F-Area storm sewer effluent.

Average Radioactivity in Effluent Algae (dry weight), c/g (multiply by 1×10^{-12})

	Upper Three Runs*	Four Mile Creek**	Pen Branch*	Steel Creek**	Lower Three Runs*	Par Pond, Roads 8 & G*
$Ce^{141,144}$	3	63	135	43	6	81
Cr^{51}	20	264	200	122	†	176
$Ru^{103,106}$	5	62	53	23	8	48
$Cs^{134,137}$	2	13	22	23	15	67
$Zr\text{-}Nb^{95}$	2	13	23	10	3	10
Mn^{54}	†	23	12	10	†	91
Zn^{65}	†	15	80	28	†	94
Fe^{59}/Co^{60}	†	31	28	22	†	56
$Sr^{89,90}$	†	7	6	†	8	7

* Five monthly samples.

** Three monthly samples.

† Less than sensitivity of analysis.

Savannah River. The uptake of radioactivity by river fish collected above, adjacent to, and below the Plant site was generally confined to low level concentrations of nonvolatile beta in the bones, with an occasional trace concentration in the fleshy tissue. The average concentrations in river fish during the report period are presented in the following table.

Nonvolatile Beta in Savannah River Fish (wet weight), c/g (multiply by 1×10^{-12})

River Location	No. of Samples	Bone			Flesh		
		Max	Avg	Prev Avg	Max	Avg	Prev Avg
Above Plant	22	17	8	13	8	4	4
Adjacent to Plant	91	56	13	17	13	5	5
Below Plant							
10 Miles	29	29	13	11	10	5	4
60 Miles	29	17	9	11	9	4	4

Radiostrontium was the primary beta emitter in the bones of river fish; no significant concentrations were in the fleshy tissues. With the exception of three fish collected near the mouth of Four

Mile Creek, there were only trace concentrations of Zn-65 and Cs-137 in the fleshy tissues of fish collected adjacent to the Plant site. The maximum concentrations of radioactivity in monthly composite bone and flesh samples are shown in the following table.

Nonvolatile Beta in Savannah River Fish (wet weight), c/g (multiply by 1×10^{-12})

Isotope	Above Plant		Adjacent to Plant		10 Miles Below Plant	
	Bone	Flesh	Bone	Flesh	Bone	Flesh
$Sr^{89,90}$	4.7	*	23.6	*	8.7	*
Zn^{65}	*	*	72.0	11.2	*	*
$Cs^{134,137}$	*	*	*	2.6	*	*

* Less than sensitivity of analysis.

The nonvolatile beta concentrations in Savannah River algae collected above, adjacent to, and below the Plant site were slightly higher due to fallout and Plant released radioactivity than those measured during the previous report period. The radioactivity in river algae is shown in the following table.

Nonvolatile Beta in River Algae (dry weight), c/g (multiply by 1×10^{-12})

River Location	Max	Avg	Prev Avg
Above Plant	115	40	20
Adjacent to Plant	2260	165	105
Below Plant			
10 Miles	155	65	45
60 Miles	95	55	35

The concentrations of specific radionuclides in larger algae samples collected from the river in December are shown in the following table.

Radioactivity in River Algae (dry weight), c/g (multiply by 1×10^{-2})

Isotope	Above Plant	10 Miles Below Plant	60 Miles Below Plant
$Ce^{141,144}$	82	15	84
Cr^{51}	*	43	*
$Ru^{103,106}$	40	50	45
Cs^{137}	*	*	*
$Zr\text{-}Nb^{95}$	6	14	6
Mn^{54}	*	*	*
Zn^{65}	*	*	*
Fe^{59}/Co^{60}	*	6	*
$Sr^{89,90}$	4	18	6

* Less than sensitivity of analysis.

Chemical Quality Of Water

Lower Three Runs and Savannah River

The chemical quality of the Savannah River both upstream (location 2) and downstream (location 10) from the Plant site during July-December is presented in the following table. Results of analyses of water from Lower Three Runs Creek at Road A are also presented. All data except those for dissolved oxygen and BOD represent the average analyses of water samples which are collected weekly. The dissolved oxygen and BOD values reflect the average of weekly determinations of the oxygen at the time of collection. The data indicate that SRP operations have no effect on the health of the river.

	Chemical Quality of Water								
	Lower Three Runs			River Upstream			River Downstream		
	Max	Min	Avg	Max	Min	Avg	Max	Min	Avg
Color (APHA)	45	15	29	70	10	33	80	10	33
pH	9.7	6.8	8.1	7.3	6.9	7.2	7.4	6.8	7.1
Methyl Orange, ppm $CaCO_3$	39	17	31	36	12	16	22	15	18
Dissolved Oxygen, ppm	12.2	5.7	7.6	10.4	6.3	8.5	10.8	6.4	7.8
Sulfide, ppm S	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
Hardness, ppm $CaCO_3$	42	21	30	14	9	12	16	9	13
Conductivity, umhos	99	64	79	77	45	53	35	43	56
Total dissolved Solids, ppm	61	22	50	50	19	38	51	22	40
BOD, ppm	1.8	0	0.6	3.0	0	0.6	1.3	0	0.6
Lignin, ppm	6.7	2.6	4.0	4.6	1.8	2.7	6.0	1.8	3.4
Surfactant, ppm	<0.02	<0.02	<0.02	0.04	<0.02	<0.02	0.03	<0.02	<0.02
Total Iron, ppm Fe	1.6	0.2	0.6	1.2	0.5	0.8	1.9	0.5	1.0
Chloride, ppm Cl	2.8	0.9	1.6	1.9	<0.1	1.1	2.1	0.9	1.4
Nitrite, ppm N	0.003	0.001	0.002	0.004	0.002	0.002	0.003	0.002	0.002
Nitrate, ppm N	0.05	0.02	0.03	0.08	0.02	0.04	0.08	0.02	0.04
Sulfate, ppm SO_4	6.6	<2.0	<2.7	5.6	<2.0	<2.7	6.9	<2.0	<3.1
Phosphate, ppm PO_4	15.1	0.7	6.7	19.9	0.4	4.8	16.8	0.7	4.4

Since the Lower Three Runs station at Road A is one-half mile downstream from the effluent of a wool scouring plant, a control location was established three miles upstream from the Road A location in November. A comprehensive study of aquatic organisms above and below the woolen mill effluent was made by the Philadelphia Academy of Natural Sciences in September. Data indicated that the aquatic insect populations below the effluent were substantially reduced during the first nine months of the woolen mill operation. Snail populations increased during this period, indicating a greater organic load to the stream.

DISSOLVED OXYGEN

Savannah River. Surveys of the Savannah River, from the Butler Creek entry to the Highway 301 bridge (see figure 18) are made each quarter to obtain dissolved oxygen profiles of the river during seasonal variations of flow and temperature. This report compares data obtained on August 23, under conditions of low river flow and median water temperature with data obtained on December 6, under conditions of low river flow and low water temperature.

The oxygen content of river water near Augusta, Georgia was depressed slightly on August 23 and more severely on December 6, due to subnormal dilution of sewage and industrial wastes by river flow. However, the dissolved oxygen content of the river returned to normal before reaching the Plant site. The oxygen content was depressed slightly as the river flowed past the Plant site due to increased water temperature. Although the low oxygen content of the Spirit Creek sample (4.0 ppm) collected on December 6 approached the toxic level for some forms of aquatic life, it did not adversely affect the general health of the river. Compensation for water temperature variation was made in calculating the percent saturation data presented in the following table.

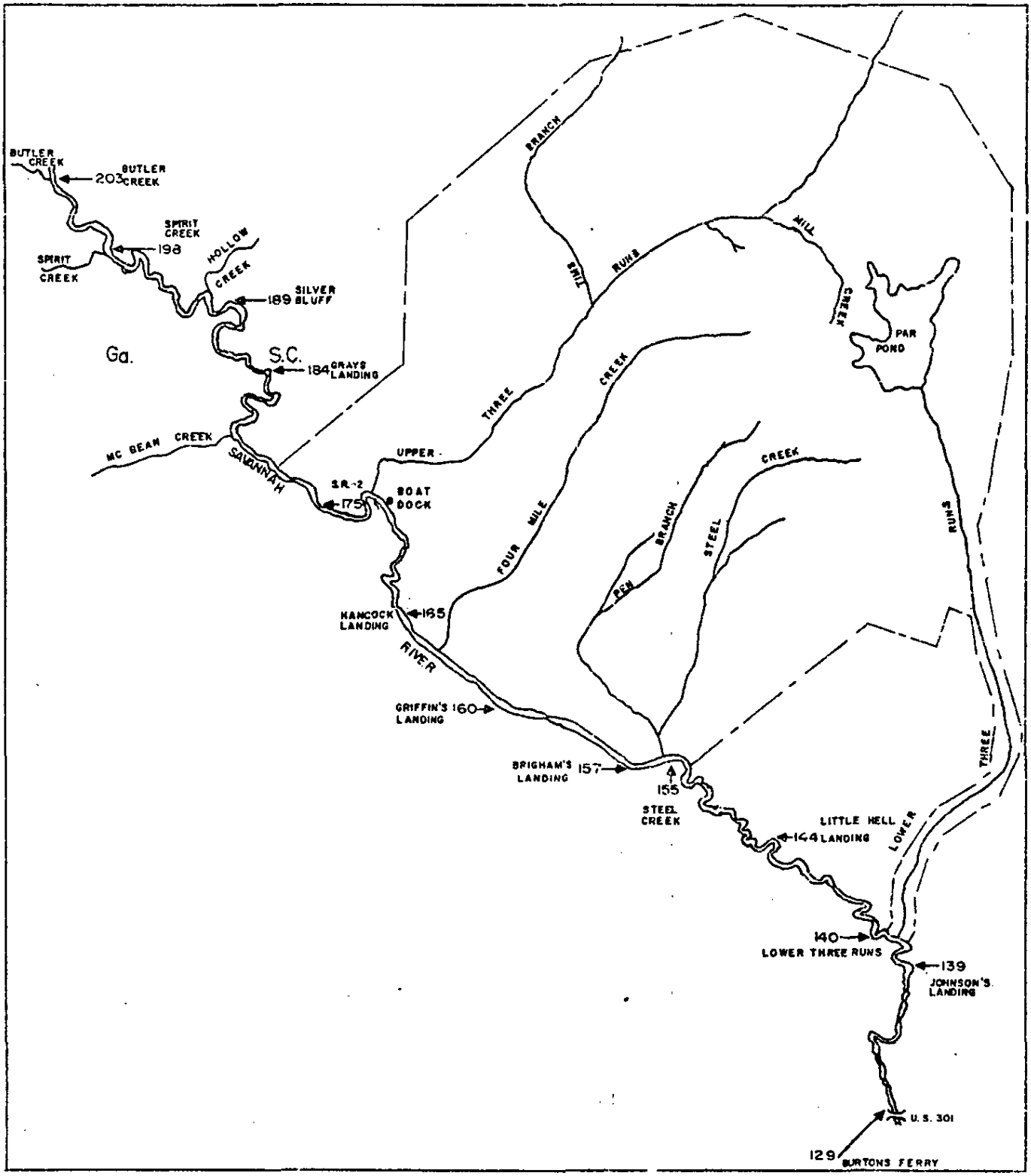

FIGURE 18. DISSOLVED OXYGEN SAMPLING LOCATIONS ALONG THE SAVANNAH RIVER. Numerical designations associated with sampling locations are number of river miles from Savannah, Georgia.

River Location	Water Temp. °C 8/23	12/6	Dissolved Oxygen, ppm 8/23	12/6	Percent Saturation 8/23	12/6
Butler Creek*	22	15	5.6	9.2	63	91
Spirit Creek*	22	15	5.9	4.0	67	39
Silver Bluff	22	15	6.8	8.7	77	86
Grays Landing	22	15	7.0	8.6	79	85
SR No. 2	23	15	7.0	8.7	81	86
Hancock Landing	22	16	8.0	8.8	91	88
Griffin's Landing	23	17	7.4	8.8	85	90
Brigham's Landing	23	16	7.4	8.7	85	87
Steel Creek*	24	20	7.2	7.9	84	86
Little Hell Landing	24	17	7.2	8.3	84	85
Lower Three Runs*	24	17	7.2	8.3	84	85
Johnson's Landing	24	17	7.2	8.3	84	85
Highway 301	24	17	7.2	8.5	84	87

* Tributary samples were collected 100 yards below the confluence of the tributary and the river.

Reactor Effluents. Each Plant effluent is measured weekly at the Road A sample location to determine the minimum dissolved oxygen content of water returned to the river. Upper Three Runs, which is not a reactor effluent, is sampled as a control. Data showed that the minimum dissolved oxygen content of water returned to the river was adequate to support practically all forms of aquatic life. These data are supported by the abundance of aquatic organisms present in the lower reaches of the effluent streams and in the Savannah River. The slight reduction of the oxygen content of Lower Three Runs water is attributed to the effects of waste from the wool scouring plant one-half mile upstream from the Road A location.

Effluent	Dissolved Oxygen, ppm			Percent Saturation		
	Min	Avg	Prev Avg	Min	Avg	Prev Avg
Upper Three Runs	6.7	8.6	9.5	80	91	90
Four Mile Creek	4.8	5.7	6.1	81	91	92
Pen Branch	4.2	5.4	6.1	78	92	95
Steel Creek	4.8	5.6	6.0	84	93	92
Lower Three Runs	5.7	7.6	9.3	64	79	88

Appendix

[redacted]

APPENDIX A

RADIOACTIVE RELEASES

Table 1. Separations Areas Stack Releases

	Alpha, mc	Nonvolatile Beta, mc						Radioiodine, mc	Tritium, curies
		$Ru^{103,106}$	$Sr^{89,90}$	Zr-Nb^{95}	$Cs^{134,137}$	$Ce^{141,144}$	Total		
				F Area					
July	0.54	62.10	0.18	3.66	0.70	14.52	81.16	761.5	-
August	1.56	2.05	.27	19.15	1.31	2.20	24.98	47.0	-
September	0.98	7.26	.16	1.36	0.49	2.45	11.72	-	-
October	0.20	3.98	.25	4.19	2.70	2.00	13.12	-	-
November	0.92	2.40	.22	0.97	1.43	1.38	6.40	-	-
December	0.22	3.25	0.08	0.43	0.94	1.36	6.06	0.43	-
Total →	4.4	81.0	1.2	29.8	7.6	23.9	143	809	
				H Area					
July	0.48	127.90	0.30	1.15	6.14	2.27	137.76	-	58,400
August	.63	151.80	0.81	0.08	0.95	7.75	162.29	-	92,200
September	.24	10.63	1.32	2.52	2.77	14.40	31.64	-	54,500
October	.22	7.42	1.99	6.14	4.47	16.41	36.43	-	46,480
November	.54	82.96	0.94	4.51	4.47	6.24	99.12	-	37,400
December	0.42	30.58	0.39	1.52	0.94	3.27	45.70	539.3	43,400
Total →	2.5	420.3	5.8	16.8	19.7	50.3	513	539	332,380*

APPENDIX A

Table 2. Reactor Areas Disassembly Basin Releases, curies

	Long-Lived Isotopes (Exclusive of Tritium)									Short-Lived Isotopes					
	Ce^{144}	Cs^{137}	Sr^{89} + Y^{91}	Zr^{95}-Nb^{95}	Ce^{141}	Cs^{134}	Sr^{90} + Y^{90}	Ru^{103} + Rh^{103m}	Total	Mo-99	Np^{239}	I-131	Ba^{140}-La^{140}	Total	Tritium
R Area															
July	0.20	4.7	0.03	0.14	0.94	0.20	0.15	0.09	7.1	0.03	0.62	0.34	*	0.80	1907
August	.13	0.6	.02	.12	.53	.19	.11	0.37	2.3	*	0.19	0.32	*	0.51	121
September	.09	4.2	.04	.11	.52	.16	.07	0.32	5.5	.01	0.51	0.48	0.03	1.03	893
October	.01	1.2	.04	.06	.31	.09	.05	0.25	2.0	.02	0.72	0.10	*	0.84	1652
November	.06	0.8	.10	.18	.20	.08	.45	4.96	6.9	*	0.03	0.08	.01	0.12	154
December	.10	5.6	.16	.23	.47	.17	.22	0.58	7.5	.03	1.93	6.17	.50	8.63	2874
Total →	0.59	17.3	0.44	0.84	3.03	0.89	1.06**	7.19	31.3	0.09	4.00	7.49	0.54	12.12	6901
P Area															
July	0.04	1.0	0.02	0.00	0.21	0.05	0.06	0.33	1.8	*	*	*	*	*	20
August	.12	2.0	.04	.05	.19	.05	.11	0.34	2.9	0.20	0.29	0.12	0.36	0.97	1370
September	.05	0.4	.05	.02	.13	.07	.06	0.72	1.5	*	.31	*	*	.31	24
October	.02	1.4	.03	.08	.14	.02	.11	1.17	3.0	0.07	.28	.18	.11	.64	1636
November	.03	1.2	.05	.06	.11	.09	.10	0.32	2.0	0.16	.37	.08	.01	.62	1276
December	.03	0.4	.03	.07	.14	.05	.05	0.15	0.9	*	.11	.01	*	.12	19
Total →	0.29	6.4	0.20	0.34	0.92	0.33	0.51†	3.08	12.1	0.43	1.36	0.39	0.48	2.66	4345
L Area															
July	0.56	4.5	0.07	0.19	0.63	0.11	0.45	0.10	6.6	0.05	2.08	0.19	0.41	2.73	198
August	.06	0.5	.03	.04	.22	.07	.27	.03	1.2	*	.15	*	*	0.15	135
September	.04	0.2	.02	.03	.12	.06	.03	.08	0.6	*	.17	.02	*	0.19	59
October	.15	2.3	.05	.14	.18	.05	.87	.17	4.1	0.18	.36	.25	.53	1.32	2210
November	.02	0.3	.04	.05	.09	.07	.04	.11	0.7	*	.06	.02	.03	0.11	113
December	.01	0.1	.04	.06	.09	.09	*	.05	0.5	*	.06	*	.02	0.08	214
Total →	0.84	8.1	0.26	0.51	1.33	0.45	1.00††	0.54	13.7	0.23	2.88	0.48	0.99	4.58	3027
K Area															
July	1.08	0.8	0.03	0.30	0.48	0.00	0.46	0.09	3.4	*	1.36	0.05	0.11	1.52	219
August	.31	1.5	.08	.10	.16	.05	2.39	.10	4.7	1.30	.42	.00	1.47	3.79	2000
September	.07	0.6	.07	.03	.10	.04	0.40	.06	1.9	*	.54	*	0.20	0.74	101
October	.07	0.7	.04	.09	.17	.11	0.14	.37	1.7	0.30	.66	.14	*	1.10	1615
November	.03	0.7	.04	.05	.10	.05	0.04	.11	1.1	0.04	.21	.00	0.03	0.32	2855
December	.04	0.5	.04	.09	.19	.06	0.01	.11	1.1	0.02	.17	.05	0.03	0.27	75
Total →	1.60	5.0	0.30	0.72	1.20	0.40	3.44‡	1.33	14.0	1.66	3.36	0.90	1.82	7.74	6385
C Area															
July	0.50	1.1	0.07	0.09	0.19	0.04	0.09	0.09	2.2	*	0.35	*	0.09	0.44	73
August	.11	0.1	.01	.05	.09	.01	.07	.41	0.8	*	.16	0.01	*	0.17	15
September	-	0.2	.01	.05	.05	.04	.04	.16	0.5	*	.06	*	*	0.06	9
October	.19	3.7	.03	.10	.02	.05	.14	.12	4.3	0.08	.62	.61	.49	1.80	33
November	.02	0.4	.04	.04	.02	.04	.03	.18	0.8	*	.03	.03	*	0.06	2682
December	.03	2.0	.04	.10	.29	.08	.12	.27	3.0	0.04	.18	.10	.05	0.37	2538
Total →	0.85	7.5	0.20	0.43	0.66	0.26	0.49‡‡	1.23	11.6	0.12	1.40	0.75	0.63	2.90	3342

* No significant release.

** Includes 0.05 curie of Sr^{90} with a maximum monthly release of 0.27 curie.

† Includes 0.47 curie of Sr^{90} with a maximum monthly release of 0.12 curie.

†† Includes 0.35 curie of Sr^{90} with a maximum monthly release of 0.17 curie.

‡ Includes 0.48 curie of Sr^{90} with a maximum monthly release of 0.28 curie.

‡‡ Includes 0.42 curie of Sr^{90} with a maximum monthly release of 0.31 curie.

APPENDIX A

Table 3. Separations Areas Releases to Seepage Basin System

1961	Alpha, mc,	Nonvolatile Beta, c						Radiodine, c	Tritium, c
		Sr^{90}*	$Cs^{134,137}$	$Ce^{141,144}$	$Ru^{103,106}$	Zr-Nb^{95}	Total		
				F Area					
July	5.5	0.02	0.04	0.25	2.34	0.05	2.7	0.19	
August	2.6	.01	0.12	0.16	0.62	0.06	1.0	.01	
September	6.6	.21	0.50	0.22	0.49	0.37	1.8	**	
October	10.6	.15	0.92	0.38	0.53	0.89	2.9	.01	
November	18.5	.16	9.43	0.44	1.34	1.08	12.4	.05	
December	24.3	.24	3.57	1.66	1.19	2.03	8.7	.05	
Total →	68.1	0.79	14.58	3.11	6.51	4.48	29.5	0.31	
				H Area					
July†	-	-	-	-	-	-	-	-	
August	6.7	0.03	0.15	0.06	0.21	0.08	0.5	**	
September	19.9	.78	0.11	.04	0.44	0.56	1.9	0.02	
October	19.4	.02	0.21	.08	0.41	2.03	2.8	**	
November	44.0	.08	0.59	**	6.61	9.80	17.1	.16	
December	53.6	0.16	1.91	0.26	1.48	3.38	7.2	.01	
Total →	143.6	1.07	2.97	0.44	9.15	15.85	29.5	0.19	

* Essentially all of the radiostrontium released was attributed to Sr^{90}.

** No significant release.

† Trebler sampler inoperable.

APPENDIX B

ENVIRONMENTAL RADIOACTIVITY

Table 1. Radioactivity in Air, μc/cc (multiply by 1×10^{-14})

Location	Alpha			Filterable Beta			Radioiodine			Tritium*		
	Max	Avg	Prev Avg	Max	Avg	Prev Avg	Max	Avg	Prev Avg	Max	Avg	Prev Avg
F Area	0.14	0.08	0.10	1700	370	13	91	15	160	1.84	0.65	0.21
H Area	.15	.06	.07	1600	350	18	215	28	36	95.9	10.40	2.64
700 Area	.21	.06	.06	1800	370	6	97	14	6	2.10	0.28	0.25
Talatha Gatehouse	.12	.06	.08	1900	420	7	100	15	8	1.00	.31	.15
Williston Gatehouse	.11	.06	.07	1800	380	8	100	16	6	1.28	.36	.28
Gatehouse												
Dunbarton Fire Tower	.13	.05	.08	1600	380	7	150	28	2	0.94	.28	.20
400 Area	.14	.06	.11	1300	320	7	81	11	7	0.84	.27	.41
Aiken Airport	.15	.07	.07	2900	440	7	280	21	4	0.62	.13	.08
Allendale	.17	.07	.07	2100	380	8	120	20	3	0.75	.09	.07
Waynesboro	.11	.06	.06	1600	350	7	88	10	2	0.51	.12	.06
Langley	.15	.07	.06	2200	330	6	86	8	**	0.42	.08	.06
Williston	.19	.05	.08	1800	320	7	110	24	5	1.50	.16	.11
Barnwell	.14	.05	.08	1800	350	8	80	15	**	0.68	.11	.07
Sardis	.14	.06	.04	1700	360	5	81	17	**	0.62	.10	.04
Bush Field	.15	.06	.05	1800	320	7	130	30	3	0.48	.09	.05
Green Pond Church	.21	.08	.07	1400	310	6	53	9	2	0.92	.21	.13
Military Recreation Site	.11	.05	.05	1800	370	5	84	11	5	1.18	.22	.12
Jackson	.13	.06	.06	1500	320	7	71	8	4	0.80	.22	.13
Aiken State Park	.11	.06	.06	2100	340	6	150	29	**	0.53	.10	.07
Highway 301	.13	.06	.07	1700	380	7	40	8	**	0.25	0.09	0.05
Columbia, S. C.	.24	.10	.10	3100	420	5	†	†	†	†	†	†
Greenville, S. C.	.18	.06	.10	780	170	8	†	†	†	†	†	†
Macon, Ga.	.20	.08	.11	3300	370	8	†	†	†	†	†	†
Savannah, Ga.	0.22	0.08	0.07	3000	550	6	†	†	†	†	†	†

* Multiply values for tritium by 1×10^{-9}.
** Less than sensitivity of analysis.
† No sample.

APPENDIX B

Table 2. Gamma Radiation Levels

	Dose Rate, mr/24 hours	
	Avg	Prev Avg
F Area	0.53	0.64
H Area	.59	.78
R Area	.45	.33
P Area	.38	.48
L Area	.42	.49
K Area	.47	.56
C Area	.41	.57
TC Area	.34	.44
300/700 Area	.45	.63
Talatha Gatehouse	.30	.26
Williston Gatehouse	.32	.31
Dunbarton Fire Tower	.37	.28
400 Area	.49	.42
Green Pond Church	.33	.30
Military Recreation Site	.34	.28
Jackson	.21	.26
Aiken Airport	.26	.43
Allendale	.31	.32
Waynesboro	.46	.35
Bush Field	.40	.29
Langley	.34	.29
Williston	.36	.32
Barnwell	.33	.35
Sardis	.33	.30
Aiken State Park	.38	.30
Highway 301	0.46	0.34

APPENDIX B

Table 3. Radioactivity in Rainwater, c/ml (multiply by 1×10^{-15})

Location	Alpha			Nonvolatile Beta			Radioiodine			Tritium*		
	Max	Avg	Prev Avg	Max	Avg	Prev Avg	Max	Avg	Prev Avg	Max	Avg	Prev Avg
F Area	0.9	0.2	1.2	**	**	180	230	52	270	1100	88	22
H Area	20.2	2.1	0.7	2700	630	54	200	33	110	1400	130	430
700 Area	0.9	0.4	.5	3300	640	24	150	27	9	160	14	13
Talatha Gatehouse	0.8	.4	.4	5900	970	19	200	35	8	67	13	11
Williston Gatehouse	1.0	.4	.6	1900	490	15	130	20	6	110	22	6
Dunbarton Fire Tower	0.8	.4	.5	2900	650	18	220	29	14	230	30	9
400 Area	0.7	.3	.4	2300	490	18	150	28	16	54	16	9
Aiken Airport	0.6	.2	.4	2500	550	22	130	24	9	19	5	4
Allendale	1.2	.4	.4	1100	290	16	150	20	8	7	3	**
Waynesboro	0.8	.3	.3	2400	480	18	86	20	5	22	5	4
Langley	2.2	.9	.4	3700	670	13	110	22	4	19	5	**
Williston	2.0	.3	.3	2200	450	18	180	23	8	17	5	4
Barnwell	0.4	.1	.3	1300	260	24	170	26	5	14	5	4
Sardis	1.1	.3	.3	2000	460	20	170	32	4	22	5	**
Bush Field	0.6	.2	.3	1900	500	22	150	41	3	27	6	5
Aiken State Park	1.4	.2	.2	2500	530	14	63	13	3	170	15	4
Highway 301	2.0	.4	.2	1900	460	14	120	21	3	16	4	**
Green Pond Church	1.3	.6	.5	5700	510	17	380	47	4	130	18	18
Military Recreation Site	1.4	.3	.3	2500	760	22	120	22	3	38	10	7
Jackson	1.4	0.3	0.3	3000	560	18	250	36	3	110	13	7

* Multiply values for tritium by 1×10^{-12}.
** Less than sensitivity of analysis.

[redacted]

APPENDIX B

Table 4. Radioactivity in Vegetation, c/g (multiply by 1×10^{-12})

Location	Alpha			Nonvolatile Beta			Radioiodine		
	Max	Avg	Prev Avg	Max	Avg	Prev Avg	Max	Avg	Prev Avg
F Area (at 1-mile radius)	0.1	0.1	0.2	72	23	15	8	3	250*
H Area (at 1 mile radius)	.2	.1	.3	300	50	14	7	3	12*
Plant Perimeter	.4	.1	.2	500	77	13	23	4	1.9
25-Mile Radius	0.5	0.1	0.2	270	77	11	19	3	1.5

* Samples collected in June.

Table 5. Radioactivity in Milk, c/ml

	Radioiodine (multiply by 1×10^{-15})			Tritium (multiply by 1×10^{-12})		
	Max	Avg	Prev Avg	Max	Avg	Prev Avg
Talatha	700	130	62	22	6	4
Snelling	350	88	10	18	6	11
Pleasant Mt	1700	210	*	10	**	*
Aiken	670	80	33	10	**	**
North Augusta	400	54	13	11	4	4
Langley	450	67	35	10	4	**

* No routine sample.
** Less than sensitivity of analysis.

	Sr^{90} in Milk (average), $\mu\mu c/\ell$			
	March	June	September	December
Farm Cow	20	30	31	31
Small Dairy	12	12	11	12
Major Distributor	12	13	13	12

[redacted]

APPENDIX B

Table 6. Radioactivity in Plant Stream Water, c/ml (multiply by 1×10^{-15})

Sample No.	Location	Alpha			Nonvolatile Beta			Tritium*		
		Max	Avg	Prev Avg	Max	Avg	Prev Avg	Max	Avg	Prev Avg
	Tims Branch - Upper Three Runs									
1	Control	3	3	1.5	38	10	7	**	**	**
2	F-Area Storm Sewer	120	13	32	9,000	650	4500	**	**	**
3	700-Area Effluent	210	48	20	610	190	120	14	4	†
4	300-Area Effluent	690	170	220	2,300	430	980	**	**	**
5	Road C	2.3	1.0	1.4	32	8	6	**	**	**
6	Road A	1.4	0.8	0.8	25	7	4	16	5	5
	Four Mile Creek									
7	F-Area Effluent	60	6.7	7.6	24,400	3400	2300	32	11	11
8	H-Area Effluent	3.2	1.4	7.1	140	53	50	450	330	180
9	Road B	1.6	0.6	0.6	1,000	180	270	**	**	**
10	Road A	0.7	0.3	0.4	4,500	230	260	1600	100	65
	Pen Branch									
11	Road A	0.4	0.2	0.1	1,200	120	190	400	32	55
	Steel Creek									
12	Road A	0.6	0.3	0.4	880	160	220	240	58	110
	Par Pond									
13	R-Area Effluent	1.1	0.4	0.6	670	210	170	330	100	100
14	Pump House	0.5	0.1	0.2	120	74	85	240	90	94
15	P-Area Cooling Water	0.6	0.2	*	120	73	*	100	75	*
	Lower Three Runs									
16	Patterson's Mill	0.9	0.2	0.2	80	51	38	85	45	37
17	Road A	0.4	0.1	0.1	46	27	24	37	24	17

Location	Radioiodine			Radiostrontium			Radiocesium		
	Max	Avg	Prev Avg	Max	Avg	Prev Avg	Max	Avg	Prev Avg
	Four Mile Creek								
F-Area Effluent	**	**	**	4,200	160	46	25	6	38
Road B	15	4	26	**	**	**	**	**	**
Road A	58	7	21	330	21	13	32	9	14
	Pen Branch								
Road A	11	4	57	110	20	22	70	13	8
	Steel Creek								
Road A	24	5	24	110	18	12	25	10	14
	Par Pond								
R-Area Effluent	640	34	19	53	10	9††	370	31	21††
Pump House	**	**	**	16	5	9	48	10	11
P-Area Cooling Water	**	**	**	**	**	**	**	**	**
	Lower Three Runs								
Patterson's Mill	**	**	**	14	7	8	30	15	13
Road A	**	**	**	11	5	8	15	7	8

* Multiply values for tritium by 1×10^{-12}.

** Not analyzed.

† Less than sensitivity of analyses.

†† Average for 5 months.

[redacted]

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Table 7. Radioactivity in Plant Stream Mud, c/g (multiply by 1×10^{-12})

Location	Alpha			Nonvolatile Beta		
	Max	Avg	Prev Avg	Max	Avg	Prev Avg
Upper Three Runs						
Control	1.4	0.5	0.6	35	7	7
F-Area Storm Sewer	2.7	0.8	0.9	650	250	370
700-Area Effluent	180*	81*	38*	90	24	29
300-Area Effluent	270*	95*	140*	140	39	120
Road C	2.9	0.9	1.1	29	9	13
Road A	1.3	0.5	0.3	48	7	7
Four Mile Creek						
F-Area Effluent	1.8	0.5	0.4	1200	300	170
H-Area Effluent	1.2	0.2	0.2	26	6	6
Road 3	0.5	0.2	0.4	170	86	48
Road A	1.5	0.8	0.9	200	49	56
Pen Branch						
Road A	0.9	0.3	0.3	89	22	43
Steel Creek						
Road A	1.3	0.8	0.5	94	33	45
Par Pond						
R-Area Effluent	1.0	0.4	0.2	53	15	6
Pump House	0.7	0.2	0.2	11	4	4
P-Area Cooling Water Effluent	1.1	0.4	**	15	6	**
Lower Three Runs						
Patterson's Mill	1.0	0.3	0.2	11	5	4
Road A	0.5	0.2	0.2	8	4	7

* TBP extractable alpha.
** Not analyzed.

[redacted]

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Table 8. Radioactivity in Savannah River Water, c/ml (multiply by 1×10^{-15})

Location	Alpha			Nonvolatile Beta			Tritium*		
	Max	Avg	Prev Avg	Max	Avg	Prev Avg	Max	Avg	Prev Avg
2	0.6	0.2	0.2	27	8	5	14	3	2
3	0.7	0.2	0.3	15	7	6	-	-	-
5	0.4	0.1	0.2	120	15	39	-	-	-
8	0.7	0.2	0.3	170	45	47	-	-	-
9	0.7	0.2	0.2	120	29	27	-	-	-
10	0.7	0.2	0.2	140	29	26	35	14	13
11	0.9	0.3	0.3	130	28	25	49	15	11

Location	Radioiodine			Radiostrontium			Radiocesium		
	Max	Avg	Prev Avg	Max	Avg	Prev Avg	Max	Avg	Prev Avg
2	-	-	-	-	-	-	-	-	-
8	-	-	-	11	5	12	11	4	6
9	-	-	-	9	4	9	8	3	6
10	17	4	7	7	3	8	7	3	4
11	-	-	-	11	3	9	8	3	5

Radioactivity in Savannah River Mud

Location	TBP Extractable Alpha*			Nonvolatile Beta*		
	Max	Avg	Prev Avg	Max	Avg	Prev Avg
2	2.7	1.3	2	21	15	15
3	3.1	1.5	2	21	14	15
5	2.3	1.4	4	28	17	18
8	3.2	1.5	3	24	15	16
9	4.5	2.0	3	23	13	10
10	6.0	2.1	2	26	15	13
11	2.4	1.1	1	22	7	6

* Multiply these values by 1×10^{-12}.

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Table 9. Radioactivity in Plant Drinking Water, c/ml (multiply by 1×10^{-15})

Location	Alpha			Nonvolatile Beta		
	Max	Avg	Prev Avg	Max	Avg	Prev Avg
F-Area	9.9	5.7	7.8	46	20	25
H-Area	8.5	7.1	4.4	27	21	15
3/700 Area	1.5	1.2	1.1	9	5	*
400 Area	1.7	1.4	1.3	14	10	7
TNX	1.5	1.0	1.7	28	11	7
Pump House 1	0.4	0.3	*	23	14	5
Pump House 2	0.8	0.6	*	8	7	5
R Area	1.1	0.3	0.3	10	5	*
P Area	1.3	0.8	1.5	12	6	*
L Area	0.3	0.1	*	10	5	*
K Area	0.5	0.3	*	8	5	4
C Area	0.5	0.2	0.2	9	7	*
Par Pond - Pump House	0.6	0.2	0.4	37	9	4
TC Area	7.9	4.4	1.4	23	14	4
Classification Yards	1.5	0.9	0.7	7	5	4
Central Shops	0.8	0.8	0.6	6	4	4
Barricade 1	1.8	1.4	1.2	19	13	*
Barricade 2	36	34	28	51	50	52
Barricade 3	0.2	0.2	0.3	4	4	*
Barricade 4	4.5	4.0	4.0	8	8	6
Barricade 5	*	*	*	4	*	*
Robbins Station	0.5	0.4	0.4	7	4	3
Donora Station Well	0.7	0.4	*	10	5	*

* Less than sensitivity of analysis.

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Table 10. Public Drinking Water, c/ml (multiply by 1×10^{-15})

Location	Alpha Max	Alpha Avg	Alpha Prev Avg	Nonvolatile Beta Max	Nonvolatile Beta Avg	Nonvolatile Beta Prev Avg
Allendale	*	*	0.1	8	4	*
Sardis	0.2	0.1	0.2	8	5	*
Waynesboro	0.2	0.1	0.1	14	6	*
Augusta	0.9	0.2	*	10	7	*
North Augusta	0.5	0.2	0.1	12	9	4.6
Clearwater	0.4	0.2	0.2	22	8	*
Bath	2.8	2.3	1.7	17	10	6.1
Langley	2.5	1.9	1.7	15	9	5.8
Jackson	7.7	4.2	3.4	25	15	10.6
New Ellenton	1.0	0.7	0.9	15	6	5.4
Aiken	2.6	2.0	2.2	12	8	4.4
Williston	1.8	1.6	1.4	12	8	4.3
Blackville	0.5	0.2	0.2	14	5	*
Barnwell	0.4	0.2	0.2	14	7	4.2

* Less than sensitivity of analysis.

Table 11. Radioactivity in Seepage Basin Water, c/ml (multiply by 1×10^{-12})

Basin No.	Alpha Max	Alpha Avg	Alpha Prev Avg	Nonvolatile Beta Max	Nonvolatile Beta Avg	Nonvolatile Beta Prev Avg	Radioiodine Max	Radioiodine Avg	Radioiodine Prev Avg	Tritium Max	Tritium Avg	Tritium Prev Avg
						F Area						
1	18.0	7.3	5.3	5000	2400	3000	210	56	38			
2	8.0	6.4	2.9	1800	1200	1200	440	110	20			
3	5.0	3.1	2.5	1400	800	380	160	42	5			
						H Area						
1	4.1	1.5	1.4	2300	600	700	5	3	4			
2	4.0	2.0	0.4	1800	750	280	4	3	4			
3	0.4	0.3	0.4	100	50	34	0.5	0.3	3			
						A Area						
1	0.8	0.3	1.4	6.2	2.8	15	-	-	-	6,900	4,500	1,200
						TNX						
1	13.0	2.8	5.7	32	10	16	-	-	-	26	13	80

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Table 12. Radioactivity in Ground Water, c/ml (multiply by 1×10^{-15})

Well No.	Alpha			Nonvolatile Beta		
	Max	Avg	Prev Avg	Max	Avg	Prev Avg
ZW Wells						
1	0.8	0.6	0.2	8	7	13
2	0.8	0.4	*	12	10	4
3	0.6	.5	0.4	7	7	*
4	1.0	.7	*	9	8	15
5	0.8	.6	*	8	7	20
6	0.3	.3	0.2	7	7	6
7	0.4	.4	*	8	7	10
8	0.8	.4	*	6	5	7
9	0.1	.2	*	4	3	6
10	1.0	0.7	0.2	18	11	6
Burial Ground Wells						
1	0.3	0.2	0.2	17	8	8
2	0.5	.3	.3	23	11	10
3	0.6	.2	.2	12	7	16
4	0.6	.4	.6	16	10	15
5	0.4	.2	.2	8	6	7
6	0.9	.3	.2	17	11	9
7	0.2	.2	.2	17	9	10
8	1.2	.7	.4	50	15	7
9	0.5	0.3	0.3	20	11	9

Tritium in Ground Water, c/ml (multiply by 1×10^{-12})

Well No.	Z Wells			ZW Wells			Burial Ground Wells		
	Max	Avg	Prev Avg	Max	Avg	Prev Avg	Max	Avg	Prev Avg
1	19	17	19	33	16	*	20	6	*
2	22	22	18	25	12	*	17	3	9
3	100	71	10	68	46	24	14	3	8
4	**	**	**	86	58	76	260	220	220
5	**	**	**	98	95	30	42	32	40
6	**	**	31	69	51	17	44	9	*
7	**	**	**	200	152	95	23	4	*
8	38	36	28	25	17	4	61	45	26
9	22	19	24	120	98	180	13	*	*
10	**	**	**	120	84	100			
11	47	44	53						
12	40	35	33						
13	*	*	6						
14	**	**	**						
15	95	94	102						
16	**	**	**						
17	*	*	2						
18	20	20	29						
19	*	*	2						
20	*	*	2						

* Less than sensitivity of analysis.

** Water sample unobtainable.

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Table 13. Radioactivity in F and H-Area Seepage Basin Wells, c/ml (multiply by 1×10^{-15})

Well No.	Distance from Basin, ft	Alpha			Nonvolatile Beta			*Radiostrontium			Tritium*		
		Max	Avg	Prev Avg	Max	Avg	Prev Avg	Max	Avg	Prev Avg	Max	Avg	Prev Avg
						F Area							
1**	34	3800	780	2100	160,000	85,000	130,000	18,000	6,200	100	130,000	87,000	81,000
2	5	0.8	0.4	0.5	500	200	95				43,000	18,000	1,700
3	29	0.6	0.4	0.6	750	420	330				92,000	75,000	11,000
4	73	0.6	0.2	0.2	770	490	1,100				320,000	110,000	2,000
5**	24	3.9	1.6	1.6	2,700	2,100	9,300				84,000	71,000	48,000
6**	6	1100	660	460	200,000	77,000	66,000	30,000	22,000	8,000	400,000	127,000	47,000
7**	46	1300	820	220	330,000	120,000	8,100	110,000	43,000	2,300	170,000	83,000	71,000
8	83	1.2	0.8	0.6	34	31	130				14,000	6,800	3,100
9	150	0.6	0.5	0.6	19	11	24				4,000	4,000	3,000
10**	9	720	380	560	710,000	450,000	143,000	280,000	130,000	14,000	100,000	71,000	44,000
11	9	4.1	1.1	0.9	78	38	23				8,400	6,600	48,000
12**	28	500	120	900	600,000	160,000	89,000	75,000	22,000	720	81,000	62,000	24,000
13**	89	†	†	43	†	†	41,000	†	†	760	†	†	21,000
						H Area							
1	24	85	32	15	38,000	9,600	590				73,000	34,000	49,000
2	20	1.0	0.4	0.8	200	56	120				120,000	65,000	87,000
3	15	3.7	2.0	1.0	42,000	13,000	290				100,000	120,000	147,000
4	45	0.8	0.4	0.8	220	70	17				4,800	1,600	2,000
5	13	630	310	41	66,000	190,000	78,000	270,000	80,000	13,000	540,000	190,000	87,000
6	6	0.8	0.3	0.4	220	120	220				77,000	72,000	4,000
7	46	0.7	0.4	0.4	150	55	21				3,200	1,800	3,000
8	18	0.2	0.1	0.3	270	110	91				28,000	21,000	58,000
9	78	0.4	0.2	0.2	120	38	35				17,000	10,000	14,000
10	19	0.4	0.2	0.4	150	72	120				22,000	18,000	25,000
11	78	0.4	0.1	0.2	210	130	100				22,000	18,000	17,000
A37	300	4.0	2.5	2.0	390	170	250	130	98	140	49,000	40,000	24,000

* Multiply values for tritium by 1×10^{-12}.

** Wells in perched water table.

† Sample unobtainable.