ORNL/M-175

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OAK RIDGE NATIONAL LABORATORY

MARTIN MARIETTA

Environmental Surveillance Data Report for the Fourth Quarter of 1986

OPERATED BY
MARTIN MARIETTA ENERGY SYSTEMS, INC.
FOR THE UNITED STATES
DEPARTMENT OF ENERGY

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ENVIRONMENTAL SURVEILLANCE DATA REPORT FOR THE FOURTH QUARTER OF 1986

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EXECUTIVE SUMMARY

During the fourth quarter of 1986, over 1900 samples which represent more than 6500 analyses and measurements were collected by the Department of Environmental Management. Eleven real-time air monitoring stations and three real-time water monitoring stations which telemeter 10-minute averaged readings on radiation levels, total rainfall, flows, and water quality parameters around ORNL also reported data.

Greater than 60% of the tritium discharges over White Oak Dam could be attributed to the releases into Melton Branch. Tritium discharges in this area are believed to be due primarily to releases from Solid Waste Storage Area 5 (SWSA 5). Characterization of SWSA 5, particularly the tritium releases, will be one of the highest priorities of the Remedial Investigation Feasibility Study subcontract scheduled to be awarded in early 1987.

Under the requirements of the National Pollutant Discharge Elimination System permit, for the period October 1 through December 1986, approximately 800 samples were collected from 87 physical locations and approximately 2500 analyses were performed. During this period, permit limits were exceeded on sixteen occasions. The compliance was 99.3% during this period.

Groundwater samples from three deep wells around the ORNL surface impoundment areas 3524 and 7900 were also collected during this quarter. The sampling is required by the Tennessee Department of Health and Environment under interim status provisions for RCRA facilities. Further sampling of these sites will be determined based on an evaluation of the first year data. The groundwater wells in SWSAs 4, 5, and 6, and the pits and trenches areas were also analyzed for radionuclides.

Bluegill were collected from Clinch River Kilometers (CRKs) 8.0, 33.3, and 40.0 and analyzed for radionuclides. In addition, fish from CRK 33.3 and 40.0 were analyzed for mercury and PCBs. The highest concentrations of constituents were in fish collected from CRK 33.3 which is at ORNL's discharge point. The concentrations of mercury and PCBs in fish were lower than the limits set by the Food and Drug Administration.

Annual soil and grass sample analyses from the ORNL perimeter, Oak Ridge reservation, and remote stations were also completed in the fourth quarter of 1986. These samples are analyzed for radiological parameters of concern utilizing a variety of analytical techniques. Concentrations of most parameters were similar to levels measured in 1985. Cesium-137 concentrations in grass at the remote stations were elevated in 1986, possibly due to the world-wide fallout from the Chernobyl nuclear incident. Plutonium-239 concentrations in soil were also elevated at some of the remote and perimeter locations. This may also be due to fallout from Chernobyl.

INTRODUCTION

The Department of Environmental Management (DEM) within the Environmental and Occupational Safety Division (E&OS) at the Oak Ridge National Laboratory (ORNL) is responsible for environmental surveillance to: (1) assure compliance with all Federal, State, and DOE requirements for the prevention, control, and abatement of environmental pollution, (2) monitor the adequacy of containment and effluent controls, and (3) assess impacts of releases from ORNL facilities on the environment.

To meet these objectives, the DEM has implemented a surveillance program that consists of both monitoring and sampling of environmental constituents. Monitoring provides continuous data for rapid screening of parameters. Sampling followed by laboratory analyses is usually recommended for routine surveillance rather than continuous monitoring. In general, monitoring systems are less sensitive and as a result have much higher detection levels than laboratory analysis. Laboratory analysis provides a quantitative estimate of concentrations or activities at environmental levels.

The surveillance program for 1986 includes sampling and monitoring of air, water from surface streams and point sources, groundwater, fish, grass, soil, and milk for radioactive and nonradioactive materials. Surveillance points are located on-site to quantify discharges from ORNL facilities, and off-site to determine public exposures and to establish background reference levels.

The purpose of this report is to provide Laboratory and Central Management personnel with the most recent information on environmental conditions. It is intended strictly as a data report. Each quarter a report that summarizes all environmental monitoring data from the various media will be prepared. Results for quarterly composited air and water samples have been reported only for the previous quarter because of the time required to process, analyze, and verify the data. The data for calendar year 1986 are being consolidated in an annual report to DOE containing information on all three Oak Ridge facilities.

Summaries of data will be presented for each month and quarter where there are multiple observations. The summary tables give the number of samples collected at each station or location and the maximum, minimum, and average values of parameters for which analyses were done. The 95% confidence coefficients (CCs) were calculated and where possible, average values were compared with applicable guidelines, criteria, or standards as a means of evaluating the impact of effluent releases on environmental concentrations. Some averages have been rounded and reported to only two significant digits.

During 1986, the Low-Level Counting Facility at ORNL began reporting radionuclide measurements in a manner different from that of previous years. Prior to 1986, data below the minimum detectable limit were reported as "less than" (<) the detection limit. This year, the measured results which may be negative (values less than instrument background) are reported. Under this system, apparent decreases may be attributed to the reporting of negative values and the subsequent inclusion of these data into the averaging.

Nonradionuclide results that are below the analytical detection limit are expressed as "less than" (<). In computing average values, less than results are assigned the detection limit. The average value is expressed as less than the computed value when all samples for the period are less than the detection limit.

The Four-Plant Analytical Committee is reviewing the standardization of reporting of less than detectable values and their recommendations will be incorporated in these reports as they become policy.

AIR

Most gaseous wastes from ORNL are released to the atmosphere through stacks. Radioactivity may be present in gaseous waste streams as a solid (particulates), as an absorbable gas (iodine), or as a nonabsorbable species (noble gas). Gaseous wastes that may contain radioactivity are processed to reduce the radioactivity to acceptable levels before they are discharged. In addition to monitoring stack effluents, atmospheric concentrations of materials occurring in the general environment around ORNL, the Oak Ridge Reservation, and the vicinity are monitored continuously by an air monitoring network of 24 stations. Relative locations of these stations are shown in Figures 1-2. These air monitoring stations are categorized into three groups according to their geographical locations:

(1) The ORNL perimeter air monitoring network (ORNL PAMs) consists of stations 3, 7, 9, 21, and 22. These stations are located at or near the ORNL boundary (shown in Figure 1). Stations 21 and 22 are used only for external gamma radiation measurements; there is no sampling equipment. These stations are currently being upgraded to provide sampling capability.

(2) The DOE Oak Ridge reservation network (Reservation PAMs) consists of stations 8, 23, 31, 33, 34, 36, 40-46 (Figure 1). During the latter part of 1985 and early 1986, ten of the Reservation PAMs were upgraded. Stations 32 through 46 have the capability to perform both sampling and continuous monitoring. Station 46 is a new real-time monitoring location installed this quarter in the Scarboro community in Oak Ridge.

(3) The remote air monitoring network (RAMs) consists of stations 51-53 and 55-57. These stations are located within a 120 km radius of ORNL outside of the DOE Oak Ridge Reservation (Figure 2).

At each real-time monitoring station, there are monitors for five radiation parameters (gross alpha, gross beta, iodine, gross gamma, and noble gas), a rain gauge, and three process sensors that are used to calculate the volume of the sample collected. A central processor collects 10-minute average readings and transmits the data to a VAX computer for further analysis and reporting. The central processor checks the values against alarm limits. All alarms are reported to a printer as they occur. The primary purpose of the monitoring system is to determine if radiation levels on the Reservation are above background levels. If radiation levels appear to be higher than normal, additional sampling can be initiated to provide quantitative measures of concentrations in the atmosphere. In addition, sampling is done at each station to quantify levels of iodine, gross alpha, and gross beta. The real-time monitoring system is the only measure of noble gases in the area.

ORNL-DWG. 86-17411

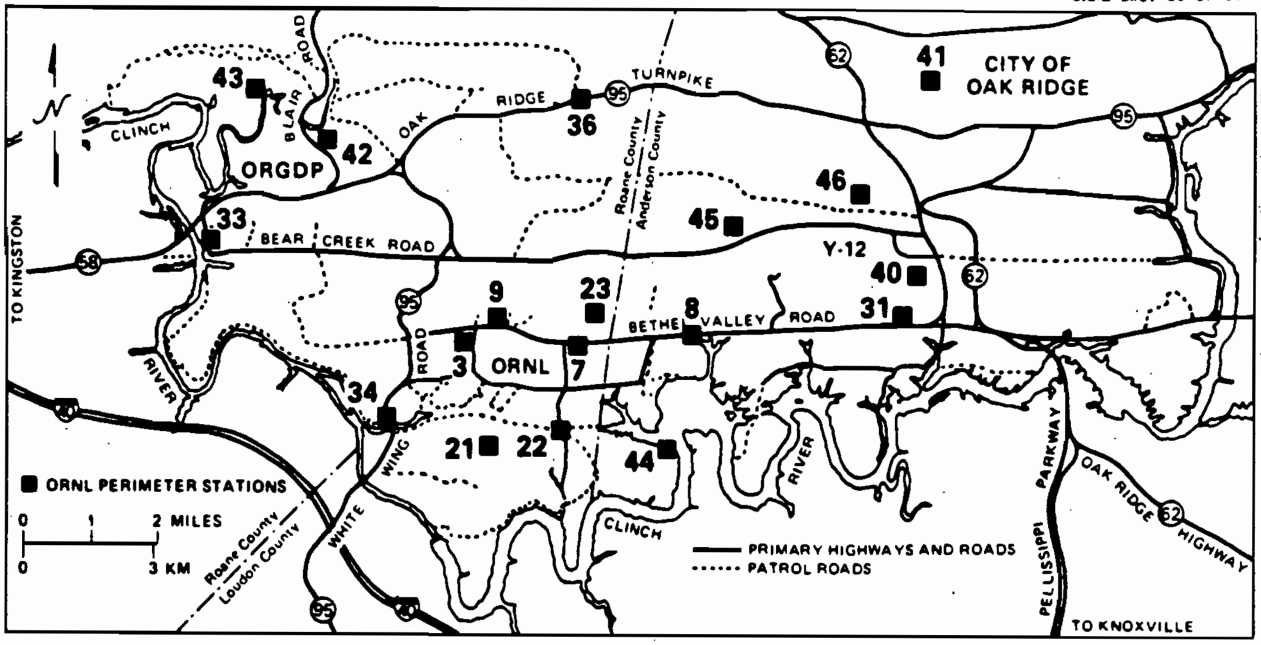

Figure 1 Location map of the ORNL perimeter and Oak Ridge Reservation air monitoring stations

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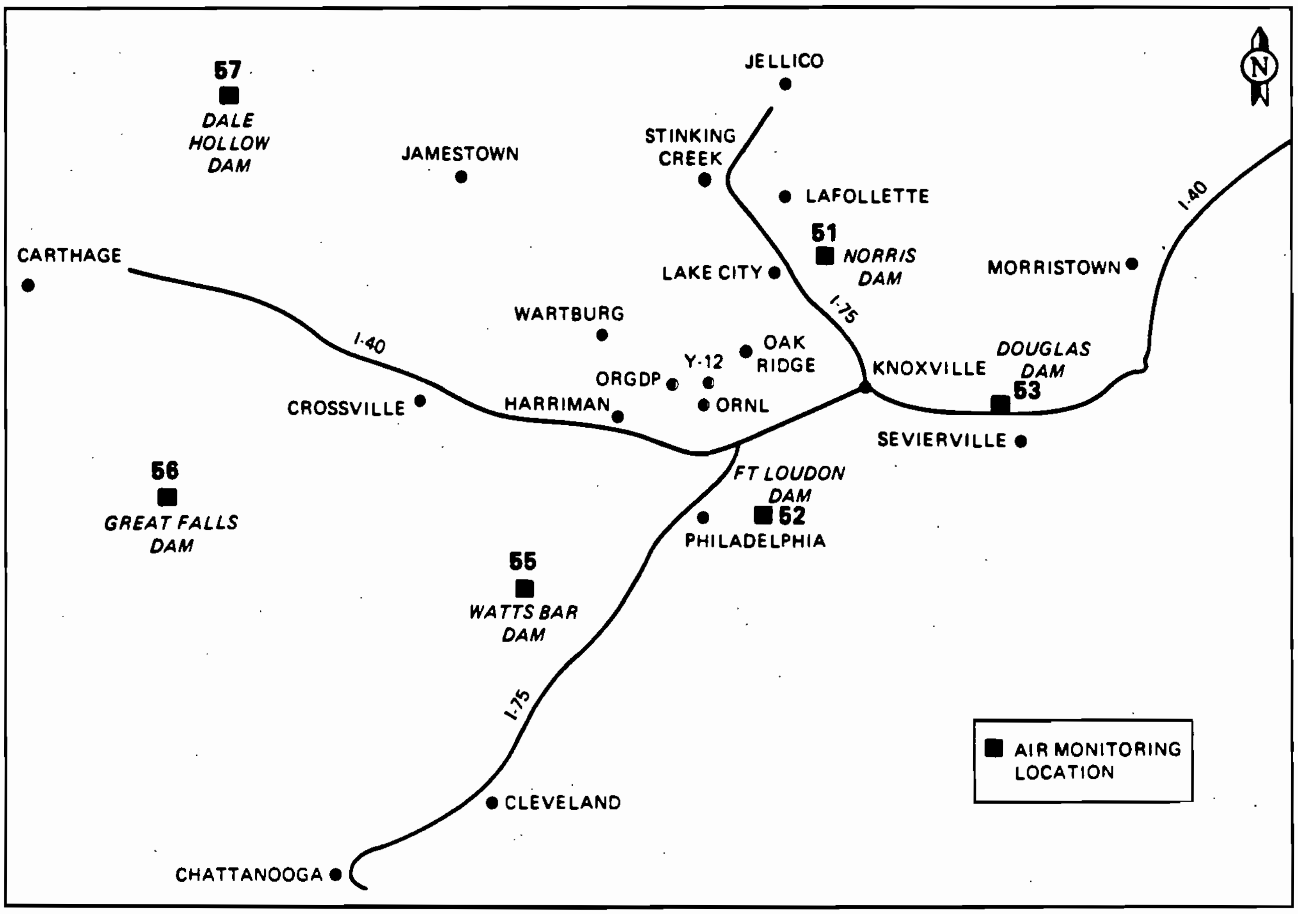

Figure 2 Location map of the remote air monitoring stations

Airborne radioactive particulates are collected weekly by pumping a continuous flow of air through a paper filter and then through a charcoal cartridge. Between February and April, the air particulate sampling apparatus at all sampling stations was upgraded. The new apparatus is easier to handle and gives a higher counting efficiency. The filter papers are collected and analyzed weekly for gross alpha and gross beta activities. To minimize artifacts from short-lived radionuclides, the filter papers are analyzed 3-4 days after collection. The airborne ^{131}I is collected weekly using a cartridge that is packed with activated charcoal. The charcoal cartridges are analyzed within 24 hours after collection. The initial and final dates, time on and off, and flow rates are recorded when a sampler is mounted or removed. The total volume of air which flowed through the sampler at each station is calculated using this information. The flowrates at stations 3-46 are set between 1.5 and 3.0 CFM to minimize artifacts from extremely high or low flowrates. Flowrates at stations 50-57 are set between 3 and 7 CFM and flowrates outside of these ranges are removed from data analysis. The concentration of radionuclides in air is calculated by dividing the total activity per sample by the total volume of air.

Monthly (October-December) concentrations of gross alpha, gross beta, and atmospheric ^{131}I are summarized in Tables 1-6. Instrument background concentrations of ^{131}I, gross alpha, and gross beta have been subtracted from the measured concentrations in Tables 1-6. Negative values represent concentrations below the instrument background level. Since the third quarter, a new counter has been used for analyzing weekly gross alpha and gross beta activities on filter papers. This new instrument gives a higher efficiency and is more sensitive. This improvement in sensitivity has significantly lowered the maximum and minimum values for gross alpha and minimum values for gross beta (Tables 1-3).

The charcoal samples collected weekly at the air monitoring stations showed no significant difference from the third quarter.

Monthly samples for atmospheric tritium are collected from two ORNL PAM stations (3 and 7) and one Reservation PAM station (8). Atmospheric tritium in the form of water vapor is removed from the air by silica gel. The silica gel is heated in a distillation flask to remove the moisture and the distillate is counted in a liquid scintillation counter. The concentration of tritium in the air is calculated by dividing total activity accumulated per month by total volume of air sampled. A quarterly summary of the atmospheric tritium concentration is presented in Table 7. Tritium concentration in air showed no significant difference from the past three quarters.

For the first quarter of 1986, composite air filters were analyzed from ORNL PAMs (stations 3, 7, and 9), Reservation PAMs (excluding stations 36, 40, and 41), RAMs (stations 51-53 and 55-57), and from individual stations (36, 40, and 41). Filters from both the old and new sampling apparatus were combined for subsequent analysis. Due to the importance and visibility of the White Oak Dam station (or station 34), starting with the second quarter, filters from this station were analyzed separately. Due to special interest in data from the Y-12 area, filters from stations 40 and 45 were composited and analyzed separately starting with the third quarter. Starting with the fourth quarter, station 46 (Scarboro) is in operation. Due to the visibility at this station, samples from this station were composited and analyzed

Table 1. Long-lived gross alpha and gross beta activities in air

October 1986

Location	Gross alpha: No. of samples	Max	Min	Av	95%cc[a]	Gross beta: No. of samples	Max	Min	Av	95%cc[a]
	Concentration (10^{-8} Bq/L)									
ORNL PAM Stations[b]										
3	5	0	-9.7	-7.8	3.9	5	97	13	76	33
7	3	13	-9.7	-2.2	15	3	180	78	120	57
9	4	10	-7.8	1.3	10	4	170	52	100	52
Network summary	12	13	-9.7	-3.3	5.3	12	180	13	96	26
Reservation PAM Stations[b]										
8	4	0	-7.8	-1.9	3.9	4	220	110	150	48
23	5	26	-7.8	3.8	12	5	210	47	120	56
31	4	17	-9.2	-0.54	13	4	200	52	130	63
33	5	0	-13	-8.4	4.4	5	140	26	84	38
34	4	10	-7.8	-1.3	8.6	4	150	93	120	29
36	4	10	-7.8	-1.3	8.6	4	130	52	93	39
40	3	10	-7.8	-1.7	12	3	120	88	100	24
41	5	16	-7.8	-1.6	9.1	5	200	16	95	60
42	5	16	-7.8	0	8.5	5	160	52	100	48
43	5	0	-9.7	-7.8	3.9	5	100	52	87	18
44	5	0	-9.8	-1.6	3.1	5	130	65	88	24
45	4	0	-13	-6.5	7.5	4	120	58	93	30
46	1	12	12	12		1	150	150	150	
Network summary	54	26	-13	-2.2	2.3	54	220	16	100	12

Table 1. (Continued)

October 1986

	Concentration (10^{-8} Bq/L)									
	Gross alpha					Gross beta				
Location	No. of samples	Max	Min	Av	95%cc[a]	No. of samples	Max	Min	Av	95%cc[a]
RAM Stations[c]										
51	5	13	0	7.6	5.4	5	16	0	7.9	5.7
52	5	10	0	2.6	4.0	5	1.9	-2.8	-0.73	1.6
53	5	19	0	4.9	7.1	5	23	-5.4	6.5	9.5
55	4	5.8	0	3.0	2.4	4	8.5	-6.8	1.7	6.8
56	5	9.3	0	4.5	3.8	5	21	6.0	15	5.1
57	5	13	2.2	7.8	4.9	5	39	6.5	19	11
Network summary	29	19	0	5.1	2.0	29	39	-6.8	8.4	3.8
Overall summary	95	26	-13	-0.10	1.8	95	220	-6.8	74	12

[a] 95% confidence coefficient about the average of more than two samples.

[b] See Figure 1.

[c] See Figure 2.

Table 2. Long-lived gross alpha and gross beta activities in air

November 1986

Location	Gross alpha No. of samples	Gross alpha Max	Gross alpha Min	Gross alpha Av	Gross alpha 95%cc[a]	Gross beta No. of samples	Gross beta Max	Gross beta Min	Gross beta Av	Gross beta 95%cc[a]
					Concentration (10^{-8} Bq/L)					
ORNL PAM Stations[b]										
3	4	13	-13	0	11	4	100	0	34	49
7	4	13	0	3.2	6.5	4	120	32	71	39
9	4	16	-10	3.9	11	4	100	26	52	36
Network summary	12	16	-13	2.4	5.2	12	120	0	52	24
Reservation PAM Stations[b]										
8	3	16	-13	0.86	16	3	78	10	49	40
23	4	31	10	17	9.8	4	120	0	69	52
31	4	0	-13	-3.2	6	4	140	0	78	62
33	3	13	-8.6	1.4	13	3	26	0	11	16
34	4	26	0	6.5	13	4	160	10	58	67
36	4	16	-10	1.3	11	4	140	52	88	37
40	4	0	-10	-2.6	5.2	4	110	5.2	48	48
41	4	10	-10	0	8.5	4	110	41	82	31
42	4	10	-10	0	8.5	4	88	36	65	25
43	4	19	0	4.9	9.7	4	100	0	41	46
44	4	16	-10	1.3	11	4	83	31	57	23
45	4	32	0	19	16	4	52	0	18	23
46	4	8.6	0	2.2	4.3		95	0	43	50
Network summary	50	32	-13	3.9	3.2	50	160	0	55	12

Table 2. (Continued)

November 1986

	Concentration (10^{-8} Bq/L)									
	Gross alpha					Gross beta				
Location	No. of samples	Max	Min	Av	95%cc[a]	No. of samples	Max	Min	Av	95%cc[a]
RAM Stations[c]										
51	4	7.8	4.3	6.2	2.0	4	37	18	26	11
52	4	18	0	6.9	8.6	4	13	0	9.5	6.3
53	4	3.1	0	1.5	1.7	4	50	11	25	18
55	3	13	6.7	10	3.8	3	78	27	53	30
56	3	20	2.9	9.7	11	3	52	32	41	12
57	4	4.5	0	2.2	2.6	4	52	21	32	14
Network summary	22	20	0	5.7	2.6	22	78	0	30	8.3
Overall summary	84	32	-13	4.1	2.1	84	160	0	48	8.7

[a] 95% confidence coefficient about the average of more than two samples.

[b] See Figure 1.

[c] See Figure 2.

Table 3. Long-lived gross alpha and gross beta activities in air

December 1986

Concentration (10^{-8} Bq/L)

Location	Gross alpha					Gross beta				
	No. of samples	Max	Min	Av	95%cc[a]	No. of samples	Max	Min	Av	95%cc[a]
					ORNL PAM Stations[b]					
3	4	13	-13	3.2	12	4	140	32	73	44
7	4	0	-13	-9.7	6.5	4	91	52	70	18
9	4	9.4	-10	-0.24	8.1	4	160	67	99	42
Network summary	12	13	-13	-2.2	5.9	12	160	32	80	21
					Reservation PAM Stations[b]					
8	4	-13	-13	-13	0	4	110	78	94	13
23	3	16	13	14	1.7	3	120	65	92	35
31	3	-13	-13	-13	0	3	140	91	120	33
33	4	0	-10	-7.7	5.1	4	99	65	80	16
34	4	0	-13	-8.4	5.7	4	130	73	94	26
36	4	0	-13	-6.1	7.1	4	99	83	91	7.8
40	4	0	-13	-3.2	6.5	4	97	52	70	22
41	2	0	-13	-6.5	13	2	140	140	140	2.2
42	4	0	-10	-5.2	6.0	4	100	67	88	18
43	4	0	-13	-3.2	6.5	4	120	52	78	29
44	4	10	-10	-4.7	10	4	130	40	83	45
45	4	13	-13	0	11	4	97	13	63	37
46	3	8.6	0	2.9	5.8	3	120	69	88	29
Network summary	47	16	-13	-4.4	2.5	47	140	13	88	8.3

Table 3. (Continued)

December 1986

Location	Gross alpha No. of samples	Max	Min	Av	95%cc[a]	Gross beta No. of samples	Max	Min	Av	95%cc[a]
				Concentration (10^{-8} Bq/L)						
RAM Stations[c]										
51	4	3.4	0	0.85	1.7	4	45	29	39	6.8
52	4	0	0	0	0	4	47	9.8	31	18
53	3	2.8	0	0.93	1.9	3	31	25	27	3.4
55	3	14	0	5.7	8.2	3	60	6.8	32	31
56	4	23	5.7	12.0	7.6	4	72	26	40	21
57	4	7.1	0	3.9	2.9	4	54	30	42	10
Network summary	22	23	0	4.0	2.5	22	72	6.8	36	6.5
Overall summary	81	23	-13	-1.8	2.0	81	160	6.8	73	7.8

[a] 95% confidence coefficient about the average of more than two samples.

[b] See Figure 1.

[c] See Figure 2.

Table 4. Iodine - 131 concentrations in air

October 1986

Location	No. of samples	Concentration (10^{-8} Bq/L) Max	Min	Av	95%cc[a]
		ORNL Perimeter Stations[b]			
3	5	4.7	-5.3	-0.56	3.9
7	3	2.6	-4.7	-0.70	4.3
9	4	9.8	-2.8	4.1	5.7
Network summary	12	9.8	-5.3	0.98	2.8
		Reservation Perimeter Stations[b]			
8	4	7.7	-5.7	0.46	5.9
23	5	4.2	-5.3	0.74	4.0
31	4	14	5.3	9.9	3.6
33	5	11	-4.7	2.4	6.2
34	4	6.3	-5.7	1.1	5.2
36	4	7.1	2.1	4.3	2.0
40	3	6.3	2.0	4.2	2.5
41	5	2.8	-2.1	0.14	2.0
42	5	13	-2.1	5.1	5.6
43	5	8.8	2.6	6.3	2.2
44	5	5.6	-3.9	1.3	3.2
45	4	16	-7.0	2.3	10
46	1	0	0	0	
Network summary	54	16	-7.0	3.0	1.5
Overall summary	66	16	-7.0	2.6	1.3

[a] 95% confidence coefficient about the average of more than two samples.

[b] See Figure 1.

Table 5. Iodine - 131 concentrations in air

November 1986

Location	No. of samples	Concentration (10^{-8} Bq/L) Max	Min	Av	95%cc[a]
		ORNL Perimeter Stations[b]			
3	4	-2.5	-4.7	-3.1	1.1
7	4	11	0	3.9	4.6
9	4	5.8	-6.3	0.28	5.5
Network summary	12	11	-6.3	0.34	2.8
		Reservation Perimeter Stations[b]			
8	3	9.6	2.1	4.6	5.0
23	4	8.4	3.8	5.5	2.1
31	4	24	7.0	13	7.6
33	3	7.9	0	3.5	4.7
34	4	9.5	0	3.4	4.2
36	4	3.4	-4.2	6.4	18
40	4	2.4	-3.8	0.11	3.3
41	4	0	-6.3	-2.1	3.0
42	4	13	-3.8	4.8	7.2
43	4	-2.6	-5.3	-4.5	1.3
44	4	5.8	2.1	3.0	1.8
45	4	5.3	0	3.9	2.6
46	4	3.5	-1.6	1.3	2.6
Network summary	50	34	-6.3	3.3	2.0
Overall summary	62	34	-6.3	2.7	1.7

[a] 95% confidence coefficient about the average of more than two samples.

[b] See Figure 1.

Table 6. Iodine - 131 concentrations in air

December 1986

Location	No. of samples	Concentration (10^{-8} Bq/L) Max	Min	Av	95%cc[a]
		ORNL Perimeter Stations[b]			
3	4	2.5	-2.5	-1.2	2.5
7	4	2.5	0	1.8	1.2
9	4	14	-1.8	6.0	6.7
Network summary	12	14	-2.5	2.2	2.8
		Reservation Perimeter Stations[b]			
8	4	7.2	0	4.8	3.4
23	3	5.8	-2.5	1.1	4.9
31	3	7.2	-2.5	3.2	5.8
33	3	5.8	-3.8	1.4	5.0
34	4	7.2	-3.8	1.8	5.5
36	4	2.0	-6.4	-2.5	4.2
40	4	-2.5	-7.2	-4.8	1.9
41	2	6.4	-2.5	2.0	8.8
42	4	9.5	-3.8	0.95	5.9
43	4	14	-2.5	4.7	6.9
44	4	0	-2.0	-0.96	1.1
45	4	7.2	-5.3	1.1	5.2
46	3	3.9	-3.2	1.3	4.5
Network summary	47	14	-7.2	0.98	1.4
Overall summary	59	14	-7.2	1.2	1.3

[a] 95% confidence coefficient about the average of more than two samples.

[b] See Figure 1.

Table 7. Tritium activity in air

October - December 1986

Location[a]	No. of samples	Concentration (10^{-4} Bq/L) Max	Min	Av	95%cc[b]
3	3	34	5.6	16	18
7	3	22	6.3	14	8.9
8	3	15	0	9.2	9.3
Overall summary	9	34	0	13	6.7

[a] See Figure 1.

[b] 95% confidence coefficient about the average of more than two samples.

separately. All other samples were composited the same way as in the first quarter. The results of specific radionuclide analyses of composited air filters for the third and fourth quarters are given in Tables 8 and 9, respectively. As expected, the short lived and most long lived radionuclides showed a significant decrease in the third quarter. The short lived radionuclides found in the second quarter were not detected in the third quarter. This indicates that the elevated radioactivity levels observed in Oak Ridge during the second quarter as a result of the cloud from the Chernobyl incident are not continuing. The ^{90}Sr concentrations at the ORNL and Reservation PAMs were slightly higher in the third quarter than the second quarter. It is worth noting that the ^{90}Sr concentration at the ORNL PAMs was found to be unreasonably high in the first quarter (1200×10^{10} Bq/L), compared with 240×10^{10} Bq/L and 410×10^{10} Bq/L for second and third quarters respectively. Further investigation showed that it was due to some unexplainable sample analysis problems. The ^{90}Sr concentration for the first quarter was subsequently found to be 310×10^{10} Bq/L.

Table 8. Long-lived radioactivity in composited air filters for the third quarter

July - September 1986

	Concentration (10^{-10} Bq/L)							
	Location[a]							
Radionuclide	ORNL PAMs	Reservation PAMs	RAMs	Station 34	Station 36	Station 40	Station 41	Station 45
^{137}Cs	< 25	20	28	< 70	< 44	< 54	< 130	< 220
^{238}Pu	< 0.63	< 0.20	< 0.09	< 4.2	< 2.2	< 1.1	< 2.7	< 4.4
^{239}Pu	< 0.63	< 0.20	< 0.18	< 4.2	< 1.1	< 1.1	< 2.7	< 4.4
^{90}Sr	410	47	10	110	66	120	240	< 390
^{228}Th	1.5	0.80	9.2	2.2	2.9	2.4	3.7	< 13
^{230}Th	2.3	0.71	7.4	2.2	9.0	4.8	< 2.7	15
^{232}Th	2.2	0.69	9.2	< 1.4	3.3	1.3	1.6	4.4
^{234}U	88	310	14	58	180	330	110	150
^{235}U	5.9	18	0.75	1.5	10	16	8.0	12
^{238}U	16	63	10	14	42	57	29	61

[a] See Figures 1 and 2.
[b] ND = Not detected in gamma scan.

Table 9. Long-lived radioactivity in composited air filters for the fourth quarter

October - December 1986

	Concentration (10^{-10} Bq/L)								
	Location[a]								
	ORNL	Reservation		Station	Station	Station	Station	Station	Station
Radionuclide	PAMs	PAMs	RAMs	34	36	40	41	45	46
^{60}Co	< 44	< 18	< 10	< 83	< 84	< 96	< 92	< 110	< 120
^{137}Cs	< 49	< 18	< 8.3	< 83	< 72	< 82	< 79	< 92	< 110
^{40}K	2100	860	2600	2100	1800	< 1400	< 1300	3100	< 150
^{238}Pu	< 0.44	< 0.18	< 0.10	< 2.4	< 1.2	< 1.4	< 1.3	< 1.5	< 1.5
^{239}Pu	< 0.44	< 0.18	< 0.10	< 1.2	< 1.2	< 1.4	< 2.6	< 1.5	< 1.5
^{90}Sr	16	10	18	12	19	62	< 28	75	85
^{228}Th	20	8.6	20	27	36	37	34	48	42
^{230}Th	9.3	3.9	14	4.8	4.8	6.9	5.2	9.2	15
^{232}Th	7.1	3.6	18	3.6	4.8	2.7	2.6	6.1	3.0
^{234}U	200	270	22	76	84	370	210	740	210
^{235}U	15	23	0.31	9.5	12	32	20	58	17
^{238}U	53	36	17	14	22	40	45	100	29

[a] See Figure 1 and 2.

[b] ND = Not detected in gamma scan.

EXTERNAL GAMMA RADIATION

External gamma radiation measurements are made to confirm that routine radioactive effluents from ORNL are not increasing external radiation levels significantly above normal background.

Currently, external gamma radiation measurements are made monthly at the ORNL PAM stations (Figure 1) and at Reservation PAM stations 8 and 23 (Figure 1), quarterly at sites along the bank of the Clinch River (Figure 3), and semiannually at the RAM stations (Figure 2). Measurements along the bank of the Clinch River, from the mouth of White Oak Creek for several hundred yards downstream, are made to evaluate gamma radiation levels resulting from ORNL effluent releases and "sky shine" from an experimental radioactive cesium plot located near the river bank. Measurements at these sites are made using thermoluminescent dosimeters (TLDs). Three dosimeters are placed in each container and the containers are suspended one meter above the ground. Measurements from each dosimeter are averaged for the month, quarter, or semiannual period. Since April, real-time readings of external gamma radiation have been collected at 10-minute intervals for all Reservation PAM stations (except stations 8 and 23) and monthly averages are calculated based on the real-time readings. The external gamma radiation at stations 8 and 23 are measured monthly using TLDs. Summaries of external gamma radiation measurements are provided in Tables 10-11.

External gamma radiation levels measured at the ORNL and Reservation perimeter stations and along the Clinch River were similar to the respective third quarter levels.

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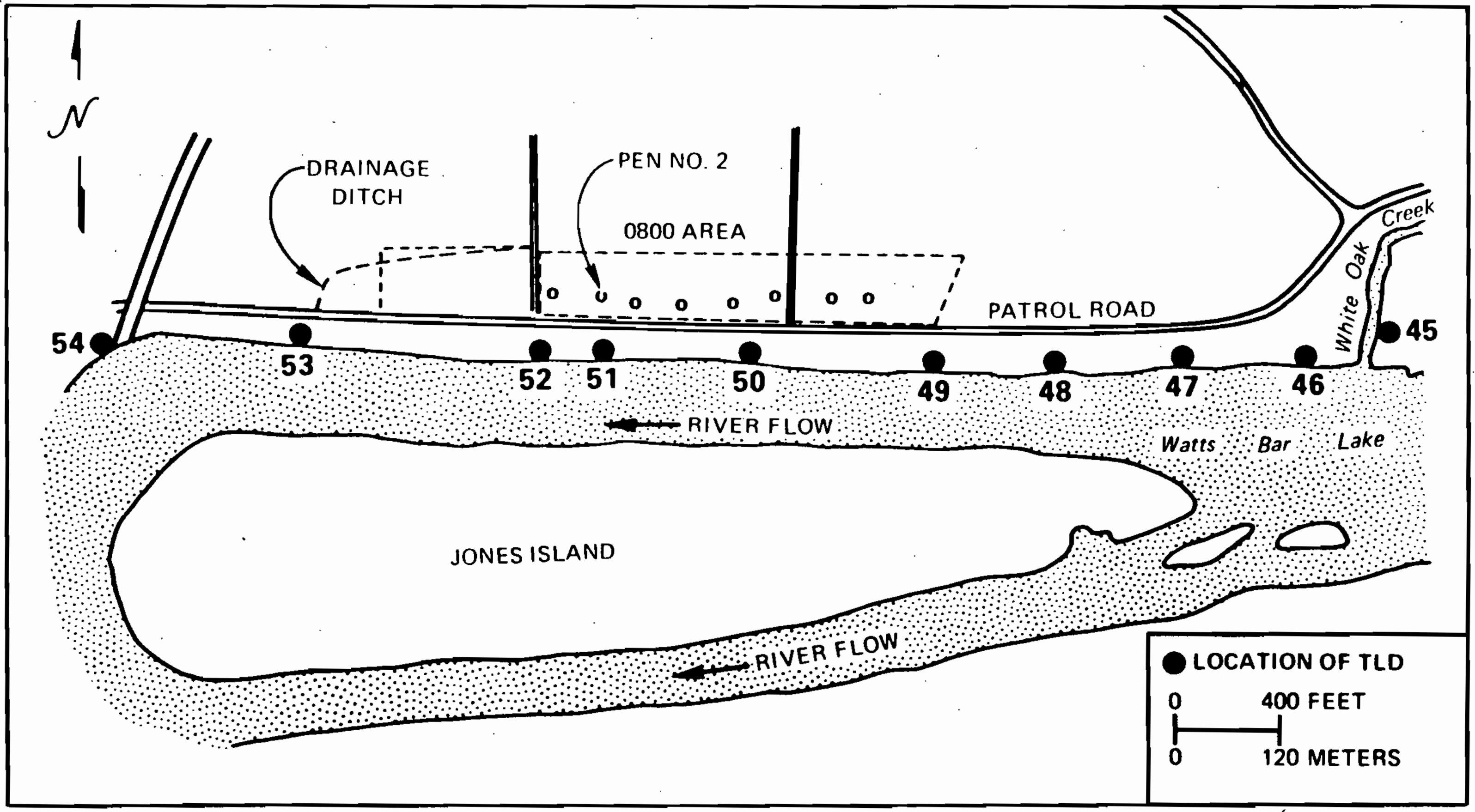

Figure 3 Location map of TLDs along the Clinch River

Table 10. External gamma radiation measurements at ORNL and reservation perimeter air monitoring stations

October - December 1986

Location	No. of samples[a]	Concentration (μR/h) Max	Min	Av	95%cc[b]
		ORNL PAM Stations			
3	3	8.0	3.0	5.7	2.9
7	3	10	1.3	5.8	5.0
9	3	17	2.3	8.7	9.0
21	3	16	1.3	7.7	9.0
22	3	20	3.3	10	10
Network summary	15	20	1.3	7.6	3.0
		Reservation PAM Stations			
8	3	13	1.7	6.9	6.8
23	3	16	1.0	7.2	8.8
31	68	8.8	7.3	7.8	0.06
33	75	8.9	6.9	7.8	0.08
34	87	10	7.7	8.6	0.11
36	84	8.1	6.9	7.4	0.05
40	82	9.0	7.6	8.1	0.05
41	90	8.5	7.8	8.1	0.02
42	89	8.4	7.0	7.5	0.05
43	43	8.1	6.6	7.2	0.10
44	90	8.1	6.8	7.3	0.05
45	83	8.3	7.0	7.4	0.05
46	68	9.9	8.9	9.3	0.05
Network summary	865	16	1.0	7.9	0.05

[a] Individual dosimeters at locations 3,7,8,9,21,22 and 23 are averaged for each station. The number of samples indicates the number of months of data.

Real-time readings were collected at stations 31,33,34,36,40-46, at 10-minute intervals. The number of samples indicates the total number of days.

[b] 95% confidence coefficient about the average of more than two samples.

Table 11. External gamma radiation measurements along the Clinch River

October - December 1986

Location[a]	No. of Samples[b]	Concentration (μR/h)
45	1	5.5
46	1	8.0
47	1	4.0
48	1	6.5
49	ND[c]	-
50	1	25
51	1	23
52	1	16
53	1	7.5
54	1	4.0
Quarterly average	9	11

[a] See Figure 3.

[b] Individual dosimeters are averaged for each station. The number of samples indicates the number of quarters of data.

[c] No data - the TLD from this location was found to be missing at the time the TLDs were retrieved from the field.

WATER

The majority of the drainage or liquid effluent from ORNL flows into the Clinch River by way of White Oak Creek (WOC). The Clinch River flows southwest from Virginia to its mouth near Kingston, Tennessee, where it joins with the Tennessee River.

Runoff from the majority of the sites at ORNL, including that from the burial grounds, reaches WOC either directly or via one of its tributaries, such as Melton Branch (MB). Concentrations of contaminants in WOC are affected by White Oak Dam (WOD) which controls the stream's flow. Flow in WOC may also be augmented by discharges from the ORNL cooling towers and Sewage Treatment Plant. Below WOD, WOC is affected by water levels in the Clinch River which are controlled by Melton Hill Dam, shown in Figure 4.

Surveillance of the water environment consists of the collection of surface water samples, samples required under the National Pollutant Discharge Elimination System (NPDES) permit, and water from wells around surface impoundments, Solid Waste Storage Areas (SWSAs), and pits and trenches. Samples are analyzed for radionuclides and nonradioactive chemicals.

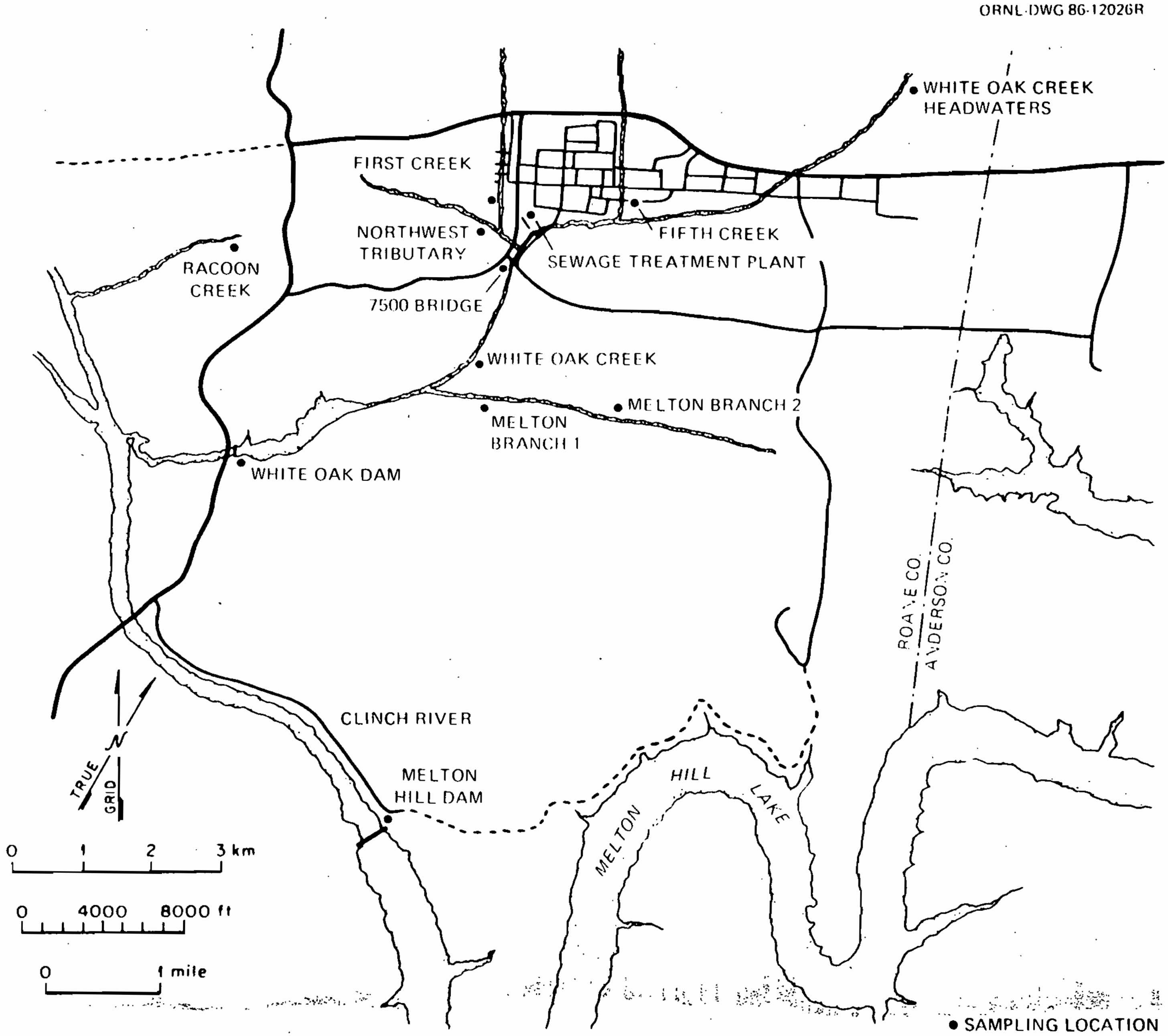

Fig. 4 Location map of ORNL streams and sampling stations

Surface Water

White Oak Creek drains an area of 17 km^2 in Bethel and Melton Valleys and is the largest stream flowing through ORNL. Run-off from sites at ORNL reaches WOC either directly or via one of its tributaries. After entering Melton Valley, WOC is joined by its major tributary, MB, at WOC kilometer 2.49. White Oak Dam, located one kilometer above the mouth of WOC, forms White Oak Lake and serves as a point for monitoring flow and discharges of contaminants from the ORNL site. Major discharges to WOC include (1) treated domestic (sanitary) waste from the Sewage Treatment Plant (STP); (2) cooling tower blowdown; (3) cooling water; (4) demineralizer regeneration waste; (5) surface drainage from the main Laboratory area (including drainage from several Solid Waste Storage Areas, SWSAs); (6) discharges from the low-level radioactive waste collection and ion exchange treatment system; and (7) discharges from process building areas. Major discharges to MB include discharges from Solid Waste Storage Area 5, blowdown from the recirculating cooling water system at the High Flux Isotope Reactor, and discharges from the 7900 waste pond system.

To determine discharges of radionuclides from ORNL processes, flow and concentration data from ORNL streams are recorded. Water samples are collected regularly from the following stations: First Creek, Fifth Creek, 7500 Bridge, Melton Branch 1 (MB1), Melton Branch 2 (MB2), Melton Hill Dam, Northwest Tributary (NW1), Raccoon Creek, STP, WOC, White Oak Creek Headwaters, and WOD (Figure 4). In addition, process water samples are collected from the sanitary waste treatment plants at the Oak Ridge Gaseous Diffusion Plant (ORGDP - Gallaher) and at Kingston (Figure 5). ORNL tap water is also sampled. Samples collected from Melton Hill Dam, WOC Headwaters, and ORNL tap are considered as background or reference samples.

Table 12 summarizes the sampling and analysis frequencies, the parameters analyzed, and the type of sample collected at each of these stations. Flow proportional samples at 7500 Bridge are collected and analyzed daily as an early warning of discharges of radioactivity from ORNL processes. Another sample is collected weekly and analyzed monthly for additional parameters. The flow proportional samples from WOD are collected and analyzed weekly while those from WOC, MB1, STP, and Melton Hill Dam are collected weekly, composited, and analyzed monthly. Grab samples from First Creek, Fifth Creek, MB2, NWT, Raccoon Creek, and WOC Headwaters are collected weekly, composited, and analyzed monthly. The time proportional samples from ORGDP and the grab samples from Kingston and ORNL tap water are composited and analyzed quarterly. Summaries of radionuclide concentrations are presented in Tables 13-16. The 95% confidence coefficients about the averages are not appropriate and have not been presented for stations with less than three samples. Concentrations of total Sr (^{89}Sr and ^{90}Sr) are presented in Tables 13-14.

Flows in the Clinch River (as measured at Melton Hill Dam) and in WOC (as measured at WOD) and the ratios of these flows, are presented in Table 17. The average ratios presented in the table were calculated weekly and averaged for the month. The average ratio for December is very different from a ratio of the total flows for the month due to the extremely high water the second

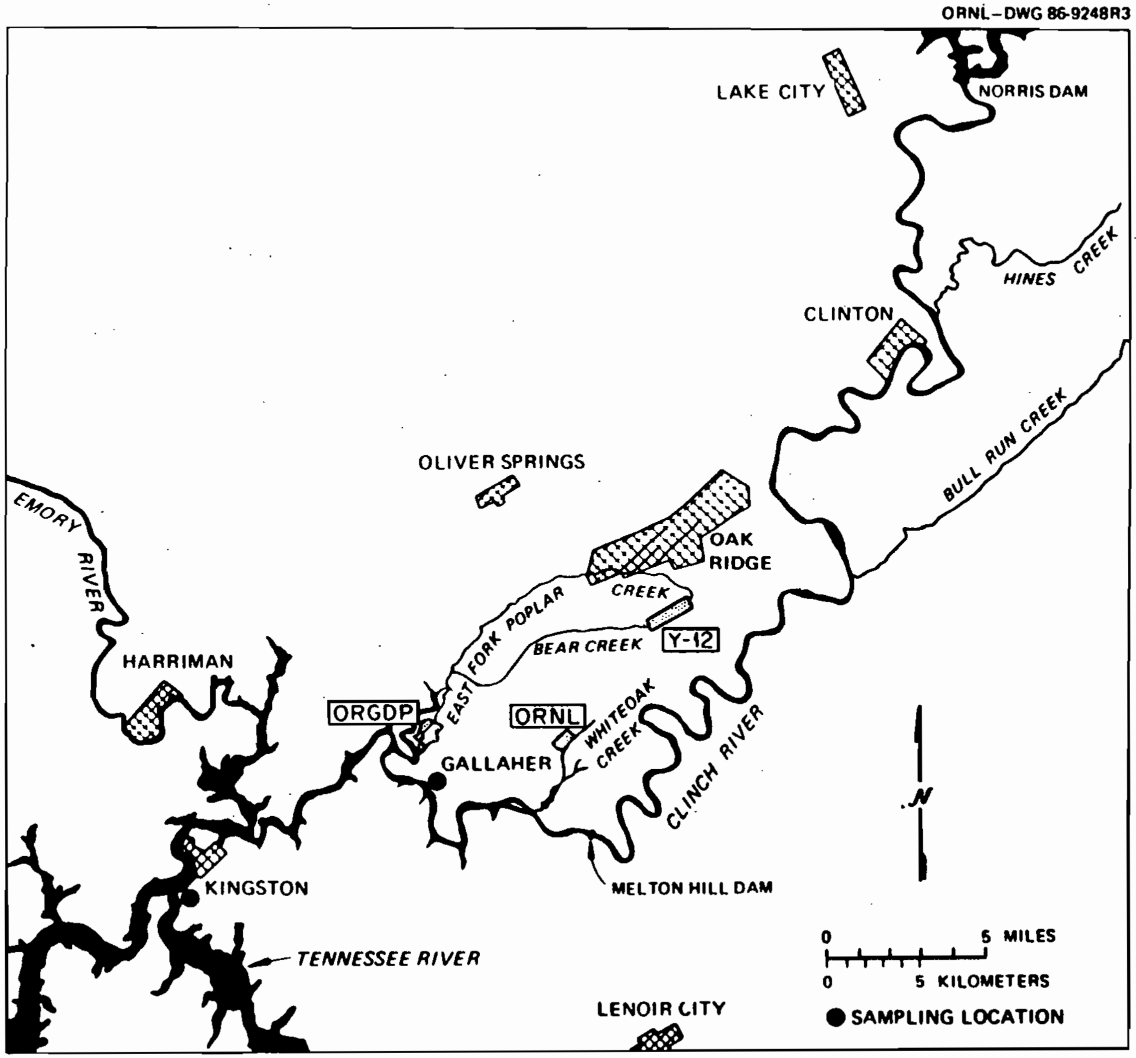

Fig. 5 Location map of Gallaher and Kingston sampling points

Table 12. Summary of collection and analysis frequencies of surface and tap water samples

Station	Parameter	Collection frequency	Type	Analysis frequency
7500 Bridge	Gross alpha, gross beta, gamma scan, ^{90}Sr	Daily	Flow Proportional	Daily
7500 Bridge, MB1,	Gamma scan, ^{90}Sr, ^{3}H	Weekly	Flow Proportional	Monthly
First Creek, Fifth Creek, NWT, Raccoon Creek,	Gamma scan, ^{90}Sr	Weekly	Grab	Monthly
Kingston	^{3}H	Weekly	Grab	Monthly
	Gamma scan, ^{90}Sr, Pu, TransPu[a], U	Monthly	Grab	Quarterly
MB2	Gamma scan, ^{90}Sr, ^{3}H	Weekly	Grab	Monthly
Melton Hill Dam	Gamma scan, ^{90}Sr, Pu, TransPu, ^{3}H, Th, U	Weekly	Flow Proportional	Monthly
ORGDP	^{3}H	Weekly	Time Proportional	Monthly
	Gamma scan, ^{90}Sr, Pu	Monthly	Time Proportional	Quarterly
ORNL tap	Gamma scan, ^{90}Sr, Pu TransPu, U	Daily	Grab	Quarterly
STP	Gamma scan, ^{90}Sr	Weekly	Flow Proportional	Monthly
WOC	Gamma scan, ^{90}Sr, ^{3}H	Weekly	Flow Proportional	Monthly
WOC Headwaters	Gamma scan, ^{90}Sr, Pu, TransPu, ^{3}H	Weekly	Grab	Monthly
WOD	Gross alpha, gross beta, gamma scan, ^{90}Sr, Pu, TransPu, ^{3}H	Weekly	Flow Proportional	Weekly

[a] Trans-plutonium.

Table 13. Radionuclide concentrations in water

October - December 1986

Radionuclide	No. of samples	Concentration (Bq/L) Max	Min	Av	95%cc[a]
		First Creek[b]			
^{60}Co	3	< 0.40	< 0.30	< 0.33	0.067
^{137}Cs	3	< 0.40	< 0.20	< 0.30	0.12
Total Sr	3	37	12	22	15
		Fifth Creek[b]			
^{60}Co	3	< 0.40	< 0.30	< 0.33	0.067
^{137}Cs	3	< 0.30	< 0.20	0.27	0.067
Total Sr	3	2.0	0.91	1.3	0.70
		7500 Bridge[b]			
^{60}Co	3	5.1	< 0.30	2.7	2.8
^{137}Cs	3	5.4	2.2	3.6	1.9
^{3}H	3	190	120	160	46
Total Sr	3	4.7	3.1	3.7	1.0
		Melton Branch 1[b]			
^{60}Co	3	2.7	2.5	2.6	0.10
^{137}Cs	3	< 0.40	< 0.30	< 0.30	0.10
^{3}H	3	71000	33000	53000	22000
Total Sr	3	9.4	8.8	9.0	0.40
		Melton Branch 2[b]			
^{60}Co	3	6.8	1.1	3.3	3.5
^{137}Cs	3	< 0.40	< 0.20	< 0.30	0.12
^{3}H	3	6400	1300	4400	3200
Total Sr	3	0.16	0.070	0.12	0.050

Table 13. Radionuclide concentrations in water (Continued)

October – December 1986

Radionuclide	No. of samples	Concentration (Bq/L) Max	Min	Av	95%cc[a]
		Melton Hill Dam[b]			
^{60}Co	3	< 0.30	< 0.20	< 0.23	0.067
^{137}Cs	3	< 0.30	< 0.10	< 0.20	0.12
^{3}H	3	< 120	< 120	< 120	0
Pu	3	< 0.0010	< 0.0010	< 0.0010	0
^{228}Th	3	0.030	< 0.010	0.020	0.012
^{230}th	3	< 0.020	< 0.0020	< 0.011	0.010
^{232}Th	3	0.020	0.0010	0.010	0.011
Total Sr	3	0.29	0.11	0.17	0.12
Trans Pu	3	0.0080	0.0020	0.0040	0.0037
^{234}U	3	0.031	0.0050	0.017	0.015
^{235}U	3	0.010	< 0.0010	0.0040	0.0057
^{238}U	3	0.027	0.0030	0.018	0.015
		Northwest Tributary[b]			
^{60}Co	3	< 0.40	< 0.20	< 0.30	0.12
^{137}Cs	3	< 0.40	< 0.20	< 0.30	0.12
Total Sr	3	2.5	1.2	1.8	0.76
		Racoon Creek[b]			
^{60}Co	3	< 0.40	< 0.20	< 0.30	0.12
^{137}Cs	3	< 0.40	< 0.20	< 0.30	0.12
Total Sr	3	3.9	1.9	2.6	1.3
		Sewage Treatment Plant[b]			
^{60}Co	3	< 0.50	< 0.20	< 0.30	0.20
^{137}Cs	3	0.68	< 0.30	0.49	0.22
Total Sr	3	5.9	4.1	4.8	1.1

Table 13. Radionuclide concentrations in water (Continued)

October - December 1986

Radionuclide	No. of samples	Concentration (Bq/L) Max	Min	Av	95%cc[a]
		White Oak Creek[b]			
^{60}Co	3	5.6	< 0.30	3.1	3.1
^{137}Cs	3	8.0	3.1	4.8	3.2
^{3}H	3	2000	530	1500	920
Total Sr	3	6.3	5.4	5.7	0.60
		White Oak Creek Headwaters[b]			
^{60}Co	3	< 0.30	< 0.10	< 0.23	0.13
^{137}Cs	3	< 0.30	< 0.10	< 0.20	0.12
^{3}H	3	< 120	< 120	< 120	0
Pu	3	< 0.0010	< 0.0010	< 0.0010	0
^{228}Th	3	0.025	< 0.020	0.022	0.0033
^{230}Th	3	0.020	0.0010	0.014	0.013
^{232}Th	3	< 0.020	< 0.010	< 0.017	0.0067
Total Sr	3	0.34	0.010	0.20	0.20
Trans Pu	3	0.0030	< 0.0010	0.0020	0.0012
^{234}Pu	3	0.030	0.0020	0.013	0.017
^{235}U	3	0.0030	0.0010	0.0020	0.0014
^{238}U	3	0.016	0.0040	0.0090	0.0071
		White Oak Dam[b]			
^{60}Co	13	7.6	0.40	1.8	1.2
^{137}Cs	13	17	1.1	4.2	2.4
Gross alpha	13	7.5	0.50	2.2	1.1
Gross beta	13	84	13	25	10
^{3}H	13	18000	2100	8400	2800
Pu	12	0.20	0.0020	0.030	0.040
Total Sr	13	9.0	4.8	6.6	0.53
Trans Pu	12	0.60	0.010	0.13	0.10

[a] 95% confidence coefficient about the average of more than two samples

[b] See Figure 4.

Table 14. Radionuclide concentrations in water at 7500 Bridge[a]

October - December 1986

Radionuclide	No. of samples	Concentration (Bq/L) Max	Min	Av	95% cc[b]
		October			
^{60}Co	22	0.74	< 0.30	0.41	0.044
^{137}Cs	22	22	3.8	10	1.8
^{24}Na	4	3.2	1.3	2.1	0.89
Total Sr	23	9.6	2.1	4.8	0.88
		November			
^{60}Co	18	28	< 0.30	3.0	3.3
^{137}Cs	18	9.3	< 1.0	4.8	1.0
Total Sr	18	7.2	2.4	3.7	0.67
		December			
^{60}Co	21	8.9	0.39	2.4	0.87
^{137}Cs	21	7.0	2.0	3.4	0.53
Total Sr	21	15	2.2	4.3	1.3

[a] See Figure 4.

[b] 95% confidence coefficient about the average of more than two samples.

Table 15. Quarterly concentrations of radionuclides in surface streams and tap water

July - September 1986

Radionuclide	Concentration (Bq/L)
Gallaher[a]	
^{60}Co	< 0.020
^{137}Cs	< 0.020
Gross alpha	0.040
Gross beta	0.34
^{3}H	10
Pu[b]	< 0.00011
Total Sr	0.031
^{234}U	0.0053
^{235}U	0.00010
^{236}U	0.000021
^{238}U	0.0027
Kingston[a]	
^{60}Co	< 0.010
^{137}Cs	< 0.020
Gross alpha	0.080
Gross beta	0.24
^{3}H	7.0
Pu[b]	< 0.00011
Total Sr	0.039
^{234}U	0.0052
^{235}U	0.00017
^{236}U	0.000050
^{238}U	0.0030
ORNL Tap Water	
^{60}Co	< 0.020
^{137}Cs	< 0.020
Gross alpha	0.070
Gross beta	0.22
Pu[b]	< 0.00011
Total Sr	0.028
^{234}U	0.00039
^{235}U	0.000014
^{236}U	< 0.0000020
^{238}U	0.00029

[a] See Figure 4.

[b] Total Pu (^{239}Pu + ^{240}Pu).

Table 16. Quarterly concentrations of radionuclides in surface streams and tap water

October - December 1986

Radionuclide	Concentration (Bq/L)
Gallaher[a]	
^{60}Co	< 0.034
^{137}Cs	< 0.010
Gross alpha	0.060
Gross beta	0.23
^{3}H	39
Pu[b]	< 0.00011
Total Sr	0.058
^{234}U	0.0041
^{235}U	0.00012
^{236}U	< 0.0000050
^{238}U	0.0025
Kingston[a]	
^{60}Co	< 0.010
^{137}Cs	< 0.010
Gross alpha	0.020
Gross beta	0.12
^{3}H	21
Pu[b]	0.00011
Total Sr	0.022
^{234}U	0.0026
^{235}U	0.000079
^{236}U	0.0000090
^{238}U	0.0015
ORNL Tap Water	
^{60}Co	< 0.010
^{137}Cs	< 0.010
Gross alpha	0.020
Gross beta	0.21
Pu[b]	0.00011
Total Sr	0.013
^{234}U	0.0038
^{235}U	0.00011
^{236}U	< 0.0000040
^{238}U	0.0023

[a] See Figure 4.

[b] Total Pu (^{239}Pu + ^{240}Pu).

Table 17. Flow for Clinch River and White Oak Creek

October - December 1986

	Flow (10^9 Liters)		
Month	Clinch River[a]	White Oak Creek[a]	Average Ratio[a]
October	310	0.77	420
November	200	0.88	290
December	290	1.5	350

[a] See Figure 4.

[b] Ratio of Clinch River to White Oak Creek flow is calculated weekly and averaged for the month.

week in December. Rainfall data collected during that week indicated several consecutive days (December 8 - 12) of heavy rainfall. The rainfall for that period was more than 3.5 inches. It is believed that the heavy rainfall in a one-week period caused the total weekly flow to increase from less than 340 million liters to 970 million liters. Total flows per day at MB1, WOC, and WOD, are calculated by subtracting consecutive daily flow recorder readings and multiplying by a factor for conversion to liters. Clinch River flow is recorded daily by personnel of the Tennessee Valley Authority and forwarded monthly to the Department of Environmental Management. Low flow and high flow readings are recorded for WOC and MB1 and are summed to estimate total flow. Three flows: low, medium, and high are recorded at WOD and summed to give total flow. The weekly total flow is determined by averaging the total flow for the week and multiplying by the number of days in the week.

The discharge of radionuclides at WOD, WOC, MB1, and the STP is calculated by multiplying the concentration (in Bq/L) by the flow (in liters). At WOC, MB1, and the STP, a single flow proportional sample is analyzed monthly to estimate radionuclide concentrations. At WOD, weekly flow proportional samples are analyzed. Radionuclide discharges at WOC, MB1, and the STP are calculated by dividing the concentration in the monthly composite sample by the total flow for the month at each station (Tables 18-20). However, at WOD, weekly radionuclide discharges are calculated by dividing the weekly composite sample concentration by the total weekly flow. Monthly discharges of radionuclides at WOD are then calculated by averaging the weekly discharges and multiplying by the number of weeks per month (Tables 18-20). A flow weighted concentration at WOD for the month is calculated by dividing the total radionuclide discharge for the month by the total monthly flow (Tables 18-20).

The concentrations of ^{60}Co at 7500 Bridge, WOC, and WOD are significantly higher than their respective concentrations observed during the third quarter. The increase was caused by a higher than usual level of ^{60}Co which was released from the WC-10 Tank Farm Storage area into WOC through the Process Waste Treatment Plant. The average concentration of ^{137}Cs is higher in WOC (Table 13) than at the other sites. Most of the ^{3}H is derived from SWSA 5 near the MB1 station and the highest concentrations of the radionuclide are observed there (Table 13). The highest concentrations of total Sr, which are found at the First Creek station, are probably due to leakage from burst pipes. The suspected pipe breaks in this area are being addressed in the short-term by placing a liner inside the pipes. There is a long-term project to replace selected piping in the ORNL complex.

Tritium and ^{90}Sr are the radionuclides of greatest concern in terms of radiation doses to the public from drinking water. In the fourth quarter of 1986, greater than 60% of the ^{3}H discharges over WOD could be accounted for by the discharges of ^{3}H over the MB1 weir (Tables 18-20). The ^{3}H values measured at MB1 are thought to be due primarily to releases from SWSA 5. Tritium values measured at MB1 weir, which is below the area where SWSA 5 discharges to Melton Branch, are generally more than an order of magnitude higher than values measured at the MB2 weir above the SWSA 5 area.

Characterization of SWSA 5 and particularly the ^{3}H releases in SWSA 5 will be one of the highest priorities of the Remedial Investigation Feasibility

Table 18. Discharges of radionuclides in water

October 1986

Radionuclide	Flow (10^6 Liters)	Concentration (Bq/L)	Discharge (10^4 mega Bq)
		Melton Branch 1[a]	
^{60}Co	57	2.7	0.015
^{137}Cs	57	< 0.30	0.0017
^{3}H	57	33000	180
Total Sr	57	8.9	0.050
		Sewage Treatment Plant[a]	
^{60}Co	30	< 0.20	0.0060
^{137}Cs	30	0.68	0.0020
Total Sr	30	4.5	0.013
		White Oak Creek[a]	
^{60}Co	640	< 0.30	0.019
^{137}Cs	640	8.0	0.51
^{3}H	640	530	34
Total Sr	640	5.4	0.35
		White Oak Dam[a,b]	
^{60}Co	770	< 0.58	0.044
^{137}Cs	770	4.6	0.35
Gross alpha	770	2.1	0.16
Gross beta	770	19	1.4
^{3}H	770	3900	300
Total Sr	770	6.9	0.53
Transuranics	770	0.060	0.0047

[a] See Figure 4.

[b] Concentration is a flow weighted average of the weekly samples. Discharge is the total for the month.

Table 19. Discharges of radionuclides in water

November 1986

Radionuclide	Flow (10^6 Liters)	Concentration (Bq/L)	Discharge (10^4 mega Bq)
		Melton Branch 1[a]	
^{60}Co	120	2.5	0.029
^{137}Cs	120	< 0.40	0.0047
^{3}H	120	55000	640
Total Sr	120	8.8	0.10
		Sewage Treatment Plant[a]	
^{60}Co	20	< 0.50	0.00098
^{137}Cs	20	< 0.50	0.00098
Total Sr	20	4.1	0.0080
		White Oak Creek[a]	
^{60}Co	670	5.6	0.38
^{137}Cs	670	3.1	0.21
^{3}H	670	1900	130
Total Sr	670	5.4	0.36
		White Oak Dam[a,b]	
^{60}Co	880	< 3.8	0.33
^{137}Cs	880	4.6	0.41
Gross alpha	880	2.7	0.24
Gross beta	880	35	3.0
^{3}H	880	11000	970
Total Sr	880	6.4	0.57
Transuranics	880	0.30	0.026

[a] See Figure 4.

[b] Concentration is a flow weighted average of weekly samples. Discharge is the total for the month.

Table 20. Discharges of radionuclides in water

December 1986

Radionuclide	Flow (10^6 Liters)	Concentration (Bq/L)	Discharge (10^4 mega Bq)
		Melton Branch 1[a]	
^{60}Co	350	2.7	0.094
^{137}Cs	350	< 0.30	0.010
^{3}H	350	71000	2400
Total Sr	350	9.4	0.33
		Sewage Treatment Plant[a]	
^{60}Co	22	< 0.20	0.00044
^{137}Cs	22	< 0.30	0.00066
Total Sr	22	5.9	0.013
		White Oak Creek[a]	
^{60}Co	1100	3.4	0.37
^{137}Cs	1100	3.2	0.35
^{3}H	1100	2000	210
Total Sr	1100	6.3	0.68
		White Oak Dam [a,b]	
^{60}Co	1500	2.7	0.41
^{137}Cs	1500	1.7	0.26
Gross alpha	1500	1.3	0.20
Gross beta	1500	20	3.0
^{3}H	1500	13000	2000
Total Sr	1500	6.8	1.0
Transuranics	1500	0.10	0.016

[a] See Figure 4.

[b] Concentration is a flow weighted average of the weekly sample. Discharge is the total for the month.

Study (RI/FS) subcontract. This characterization which is scheduled to begin in April, 1987, is necessary in order to comply with Resource Conservation and Recovery Act (RCRA) requirements and to determine the measures necessary to most effectively reduce the flow of ^{3}H and/or other contaminants from SWSA 5.

The average ^{3}H discharges at WOD, WOC, and MB1 were more than six times higher than their respective third quarter discharges (Tables 18-20). The increases in the ^{3}H discharges were due to increases in the concentrations and the flows at the sites. Strontium discharges from ORNL, unlike ^{3}H which comes primarily from SWSA 5, are much more diffuse. They are primarily the result of discharges from the plant area, burial grounds, and floodplains with lesser amounts also being contributed by process discharges. Most of the strontium discharged from ORNL can be attributed to discharges into WOC occurring above the WOC monitoring station.

Strontium concentrations and discharges at White Oak Dam were higher than those observed in the third quarter. The concentrations of strontium at White Oak Dam were within the normal range of 5.0 to 8.0 Bq/L and the total discharge was more than two times higher than that observed during the third quarter. This can be attributed to the increased levels of precipitation, since it is believed that at ORNL a significant portion (> 50%) of the strontium discharges, during periods of normal rainfall, are the result of run-off.

New real-time monitoring systems were installed at WOD, MB1, and WOC stations. These stations transmit flow (in gallons per minute) over each of the weirs and water quality data (pH, temperature, turbidity, dissolved oxygen, and conductivity) for ten minute intervals. Monthly averages will be incorporated into this report in the future.

National Pollutant Discharge Elimination System (NPDES) Requirements

Under the requirements of the Clean Water Act, a new NPDES permit was issued to ORNL and became effective on April 1, 1986. Prior to that time, only three stations were sampled for compliance with permit limits. These points were in two major drainage areas (White Oak Creek and Melton Branch) and at the Sewage Treatment Plant. The new permit has over 183 stations and is designed to monitor point sources at their point of discharge into receiving streams (Figure 6). In addition, there are some sampling locations that are located in the streams as reference points or for additional information. The sampling locations and permit requirements are described below:

1. Point Source Outfalls - These outfalls are discernable, confined, and discrete conveyances from which a process stream is discharged to receiving waters. The effluent must be monitored before it reaches the receiving water, or mixes with any other wastewater stream. Point source outfalls include:

NPDES Number	Location	M*	L*
X01	Sewage Treatment Plant		X**
X02	Coal Yard Runoff Treatment Facility		X**
X03	1500 Area	X**	
X04	2000 Area	X**	
X06	190 Ponds (3539 and 3540)	X**	
X07	Process Waste Treatment Plant	X**	
X08	TRU Ponds	X**	
X09	HFIR Ponds	X**	
X10	ORR Resin Regeneration Facility	X**	
X11	Acid Neutralization Facility	X**	
X12	Nonradiological Wastewater Treatment Plant		X***

* M = monitoring only, L = concentration or mass limits
** pH is limited at all outfalls
*** March 1990 compliance

Composite samples are collected by either automatic samplers or as grab samples. New monitoring stations were installed at X02, X04, X06, X08, X09, X10, and X11.

2. Ambient Monitoring Stations - Because of historical data and in order to obtain information on total ORNL discharges before they enter the Clinch River, Melton Branch 1, White Oak Creek and White Oak Dam have been placed on the permit for monitoring purposes only. All three of these ambient stations have newly constructed (1984) weirs and monitoring stations. White Oak Dam has two gates which can be lowered in case of potentially hazardous releases.

3. Category I Outfalls - Storm Drains - There are 35 discharge pipes to receiving streams which have been characterized by ORNL and identified in the NPDES permit as storm drains. These outfalls are not contaminated by any known activity and do not discharge through any

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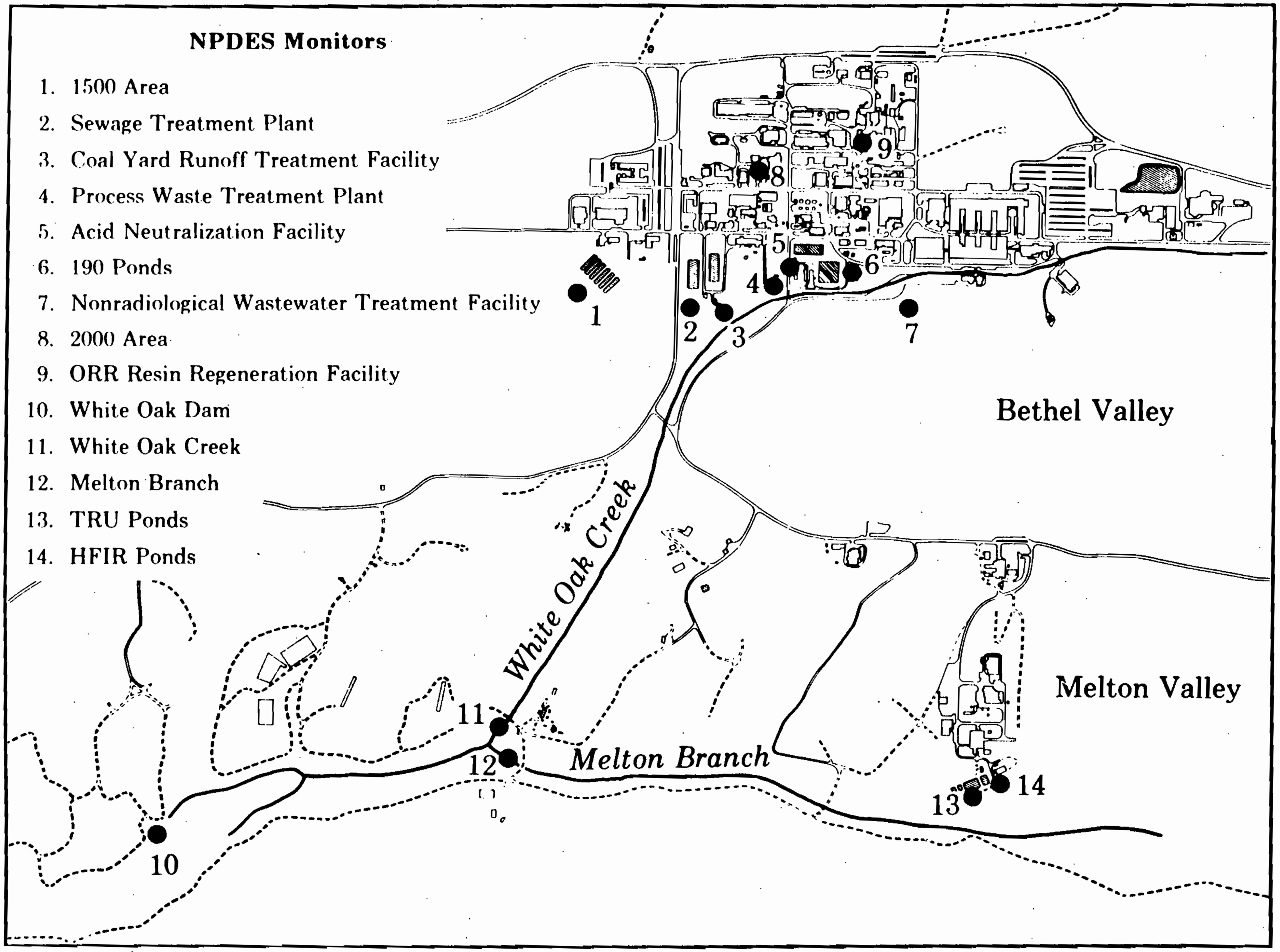

Figure 6 Location map of NPDES monitoring points

oil/water separator or other treatment equipment or facility. Limits have been placed on the following parameters: pH, temperature, oil and grease, and total suspended solids. Samples are taken from the nearest accessible point prior to actual discharge or mixing with receiving waters.

4. Category II Outfalls - The following discharge pipes have been characterized by ORNL and identified in the NPDES permit as Category II Outfalls:

   44 parking lot and roof drains
   8 condensate drains
   7 cooling tower drains
   2 storage area drains

   These outfalls are considered to be contaminated by ORNL activities, but are not discharged through any oil/water separator or other treatment equipment or facility. Limits have been placed on the following parameters: pH, temperature, oil and grease, and total suspended solids.

5. Category III Outfalls - Untreated Process Drains - There are 32 discharge pipes which have been characterized by ORNL and identified in the NPDES permit as untreated process drains. These outfalls are actually either Category I or Category II Outfalls, but because of inflow/infiltration, cross-connects, or improper disposal of chemicals have become contaminated with pollutants. Further characterization and determination of the source of the pollutants is underway with the goal of eliminating any untreated process discharge to receiving waters. The only limitation placed on these outfalls is pH.

6. Miscellaneous Source Outfalls - These outfalls have not been assigned serial numbers but are specific to special categories identified by the EPA. Facilities which have been placed in these categories are:

   4 cooling towers
   1 Boiler (Building 2519, Central Steam Plant)
   1 Vehicle and Equipment Cleaning Facility (Building 7002)
   1 Painting and Corrosion Control Facility (Building 7007)
   1 Vehicle and Equipment Maintenance Facility (Building 7002)
   4 Photographic Laboratories (Buildings 1500, 4500N, 7934, 7601)
   1 Firefighter Training Area (outside Building 2500)

   Limitations have been placed on all Miscellaneous Source Outfalls.

7. The NPDES permit contains provisions for designing and implementing a number of "special" monitoring plans. These are the Mercury Assessment Plan, Radiological Monitoring Plan, Monitoring Plan for PCBs in the Aquatic Environment, and the ORNL Biological Monitoring and Abatement Plan.

Phase I of the Mercury Assessment Plan has been completed. A draft report summarizing the effort has been submitted.

The Toxicity Control Monitoring Plan and the Biological Monitoring Program and Abatement Plan are ongoing projects.

Table 21 lists the parameters whose values exceeded those specified by the NPDES permit. Eleven out of the sixteen violations during the fourth quarter were due to total suspended solids (TSS). These violations are a result of runoff from natural drains (Category I) and parking lot drains (Category II) and are not from any ORNL processes or plant discharges. These locations are sampled during a rain event and it is likely that this type of TSS violation will continue.

The fecal coliform violations at the STP are due to the low limits of chlorine which are required at the facility. This problem is being monitored and steps have been discussed which would allow for increased concentrations of chlorine to be used, but would not violate the permit discharge limits for the chemical.

Table 21. Parameters whose values exceed NPDES compliance limits

October - December 1986

Station	Parameter	Concentration (mg/L) Daily maxmium
	October 1986	
Sewage Treatment Plant	Fecal Coliform	1,100[a]
Sewage Treatment Plant	Fecal Coliform	600[a]
Equipment Facilities (Bldg. 7002)	Oil and Grease	40
Category II-227	Total Suspended Solids	102
Cooling Systems	Chlorine	0.78
Category II	Total Suspended Solids	53
Category II	Total Suspended Solids	118
Category II	Total Suspended Solids	73
	November 1986	
Category I-104	Total Suspended Solids	264
Category I-112	Total Suspended Solids	97
Category II-116	Total Suspended Solids	85
Paint Facility (Bldg. 7007)	Total Suspended Solids	41
Paint Facility (Bldg. 7007)	Total Suspended Solids	50

Table 21. Parameters whose values exceed NPDES compliance limits (Continued)

October - December 1986

Station	Parameter	Concentration (mg/L) Daily maxmium
	December 1986	
Sewage Treatment Plant	Total Suspended Solids	89.6[b]
Sewage Treatment Plant	Total Suspended Solids	110
Vehicle Cleaning (Bldg. 7002)	Fecal Coliform	218[c]

[a] Colonies per 100 mL.

[b] Kilograms per day.

[c] Daily average.

Groundwater

The Environmental Protection Agency (EPA) has established regulations in 40 CFR, Part 265, Subpart F, which requires the owners/operators of hazardous waste facilities to monitor the groundwater beneath those facilities. The ORNL facility has a groundwater network consisting of 22 wells located adjacent to three impoundment areas: 3524, 7900, and 3539-40 (Figures 7-8). The 3524 area consists of wells 31-001, 31-002, 31-003, 31-004, 31-013, and 31-015. The 7900 area consists of wells 32-001, 32-002, 32-003, 32-004, 32-005, 33-001, 33-002, and 33-003. The 3539-40 area consists of wells 31-005, 31-006, 31-007, 31-008, 31-009, 31-010, 31-011, and 31-012. The wells are also classified as upgradient (reference) or downgradient depending on their location relative to the general direction of groundwater flow. The upgradient wells (31-001, 31-007, 31-009, 32-001, 33-001) were located so as to provide groundwater samples that would not be affected significantly by possible leakage from the impoundment. The downgradient wells (those not listed as upgradient) were located immediately adjacent to the waste management facility. Information on the well installation is given in Table 22. All elevations (ground surface, bottom of bore hole, bottom and top of well screen) are given in meters above sea level. The pipe and screen materials were of threaded stainless steel and the diameter of each ranged from 5 cm to 10 cm. Three volumes of water were pumped from each well before sampling. Samples collected at these wells represent the quality of groundwater at the point of compliance.

Water samples were collected once from deep wells 31-013, 31-015, and 32-004 and analyzed for the parameters listed below. The data required by EPA and the State of Tennessee fall into one of three categories:

(1) Drinking water parameters (As, Ba, Cd, Cr, F, Pb, Hg, NO_3, Se, Ag, endrin, lindane, methoxychlor, toxaphene, 2,4-D, 2,4,5-TP Silvex, Ra, gross alpha, gross beta, and fecal coliform);

(2) Water quality parameters (Cl, Fe, Mn, phenols, Na, and SO_4); or

(3) Groundwater contamination parameters (pH, specific conductance total organic carbon, and total organic halides).

In accordance with the regulations, a minimum of four measurements per well were recorded for pH, specific conductance, and temperature. Four measurements were recorded for total organic carbon and total organic halides while only one measurement was recorded on the other parameters. Summary of the total concentrations for total metals and other parameters are given in Tables 23-24. The concentrations of total metals include the concentrations of metals in the liquid as well as in any sediment in the samples. Samples collected for dissolved metals are filtered to remove particulate matter and the concentrations are determined on the liquid. Summary concentrations of dissolved metals are given in Table 25.

The analytical values were compared to the EPA Interim Primary Drinking Water Standards. The values for gross beta at all wells exceeded the calculated standard (Table 26). The EPA Interim Primary Drinking Water

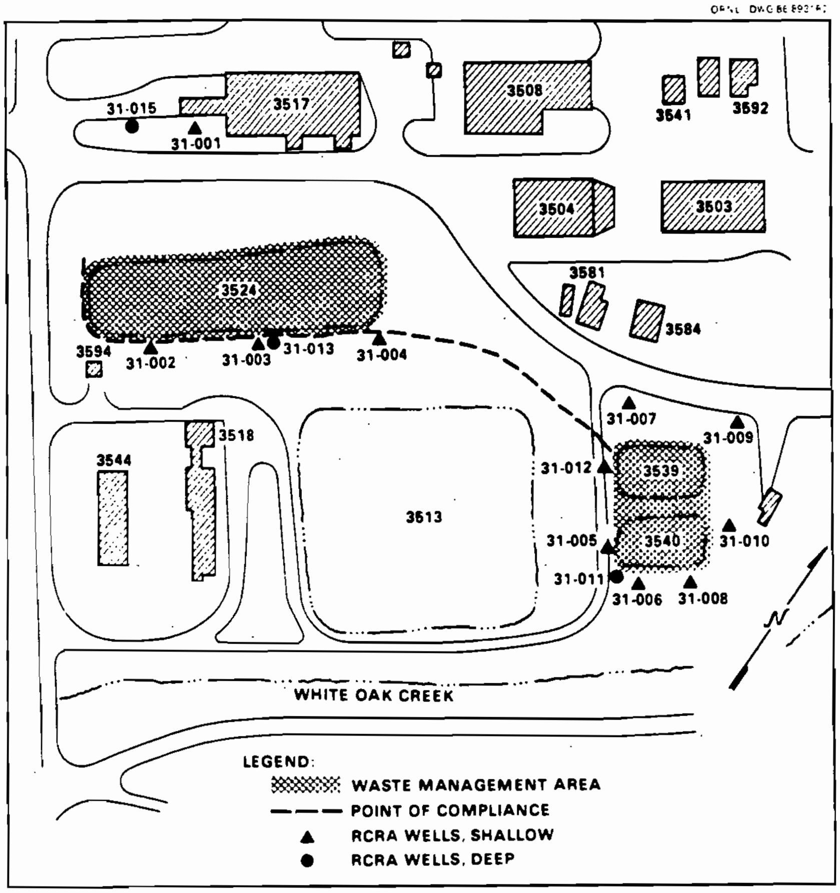

Fig. 7 Locations of sampling wells around ponds 3524, 3539, and 3540

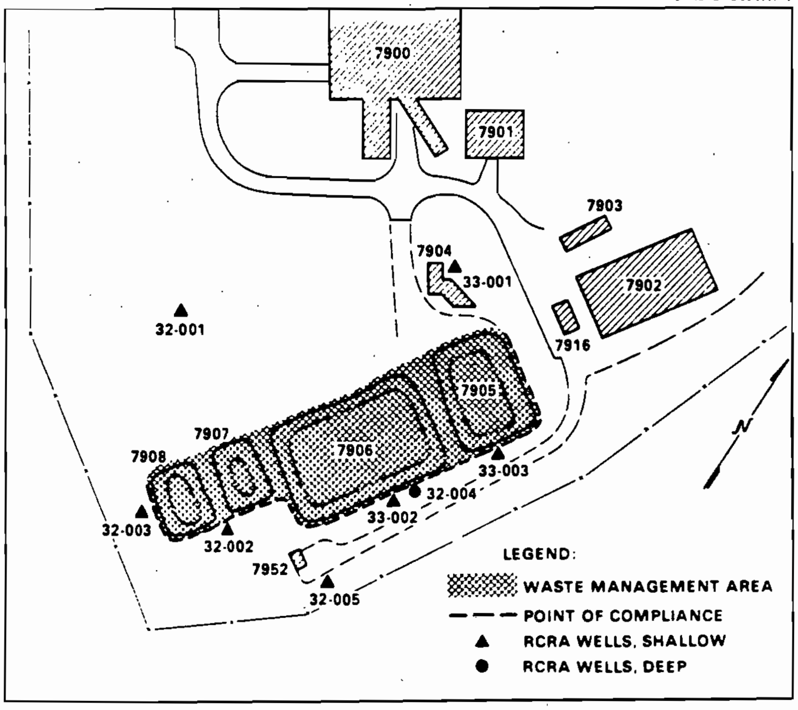

Fig. 8 Locations of sampling wells around ponds 7905, 7906, 7907, and 7908

Table 22. RCRA well specifications

Well ID	Installation date	Geological unit formation	Ground surface elevation (M)	Bottom of bore hole elevation (M)	Bottom of wells screen elevation (M)	Top of wells Screen elevation (M)
			3524 Area			
31-001	08/14/85	Chickamauga	242.3	235.4	235.4	237.0
31-002	08/13/85	Chickamauga	238.6	234.8	234.8	236.4
31-003	08/18/85	Chickamauga	239.4	235.4	235.4	237.0
31-004	08/11/85	Chickamauga	238.9	235.0	235.2	236.8
31-013	11/08/85	Chickamauga	238.8	223.2	223.5	226.6
31-015	10/26/85	Chickamauga	242.3	233.3	233.3	234.8
			3539-40 Area			
31-005	08/09/85	Chickamauga	240.0	235.1	235.2	236.9
31-006	08/09/85	Chickamauga	240.2	234.8	235.1	236.7
31-007	08/08/85	Chickamauga	241.7	235.3	235.5	237.2
31-008	08/08/85	Chickamauga	240.3	235.4	235.5	237.1
31-009	08/07/85	Chickamauga	241.5	235.0	235.1	236.7
31-010	08/21/85	Chickamauga	241.2	235.6	235.7	237.3
31-011	10/24/85	Chickamauga	240.2	224.7	224.7	228.2
31-012	08/20/85	Chickamauga	240.2	234.9	235.0	236.6
			7900 Area			
32-001	07/19/85	Conasauga	248.2	239.4	240.1	241.8
32-002	08/05/85	Conasauga	244.2	238.1	238.1	239.7
32-003	08/23/85	Conasauga	246.0	239.5	239.6	241.3
32-004	11/06/85	Conasauga	245.1	229.6	229.9	232.9
32-005	08/22/85	Conasauga	244.5	237.2	237.2	238.9
33-001	07/29/85	Conasauga	247.3	239.8	240.4	242.0
33-002	08/05/85	Conasauga	245.2	238.8	238.8	240.4
33-003	08/01/85	Conasauga	246.0	239.6	239.6	241.3

Table 23. Concentrations of parameters in wells around 3524[a]

December 1986

Parameter	No. of samples	Concentration (mg/L)[b] Max	Min	Av	95% cc[c]
2,4,5-TP Silvex	2	< 0.010	< 0.010	< 0.010	
2,4-D	2	< 0.010	< 0.010	< 0.010	
Ag	2	< 0.0050	< 0.0050	< 0.0050	
As	2	< 0.010	< 0.010	< 0.010	
Ba	2	< 1.0	< 1.0	< 1.0	
Cd	2	< 0.0020	< 0.0020	< 0.0020	
Cl	2	8.7	4.8	6.7	
Cr	2	< 0.020	< 0.020	< 0.020	
Endrin	2	< 0.00020	< 0.00020	< 0.00020	
F	2	< 1.0	< 1.0	< 1.0	
Fe	2	0.36	0.21	0.28	
Fecal coliform[d]	2	0	0	0	
Gross alpha[e]	2	0.21	0.040	0.12	
Gross beta[e]	2	1.5	1.1	1.3	
Hg	2	< 0.00010	< 0.00010	< 0.00010	
Lindane	2	< 0.0020	< 0.0020	< 0.0020	
Methoxychlor	2	< 0.0080	< 0.0080	< 0.0080	
Mn	2	0.26	0.010	0.13	
Na	2	27	20	23	
NO_3	2	< 5.0	< 5.0	< 5.0	
Pb	2	< 0.020	< 0.020	< 0.020	
pH[f]	14	8.2	6.5	7.5	0.22
Phenols	2	< 0.0010	< 0.0010	< 0.0010	
Ra (Total)[e]	2	0.039	0.012	0.026	
Se	2	< 0.0050	< 0.0050	< 0.0050	
SO_4	2	250	13	130	
Specific conductance[g]	14	0.60	0.50	0.56	0.027
Temperature[h]	14	20	16	18	0.67
Total organic carbon	8	1.6	0.79	1.2	0.29
Total organic halides	8	0.020	< 0.010	0.015	0.003
Toxaphene	2	< 0.0050	< 0.0050	< 0.0050	

[a] See Figure 7.
[b] Values for all metals are total concentrations.
[c] 95% confidence coefficient about the average of more than two samples.
[d] Units are colonies per 100 mL.
[e] Units are Bq/L.
[f] Value in pH units.
[g] Units are in mmhos/cm.
[h] Units are in °C.

Table 24. Concentrations of parameters in wells around 7900[a]

December 1986

Parameter	No. of samples	Concentration (mg/L)[b] Max	Min	Av	95% cc[c]
2,4,5-TP Silvex	1			< 0.010	
2,4-D	1			< 0.010	
Ag	1			< 0.0050	
As	1			< 0.010	
Ba	1			1.0	
Cd	1			< 0.0020	
Cl	1			8.0	
Cr	1			< 0.020	
Endrin	1			< 0.00020	
F	1			< 1.0	
Fe	1			0.43	
Fecal coliform[d]	1			0	
Gross alpha[e]	1			0.14	
Gross beta[e]	1			1.0	
Hg	1			< 0.00010	
Lindane	1			< 0.0020	
Methoxychlor	1			< 0.0080	
Mn	1			0.14	
Na	1			8.7	
NO_3	1			< 5.0	
Pb	1			< 0.020	
pH[f]	7	8.4	7.6	8.0	0.21
Phenols	1			< 0.0010	
Ra (Total)[e]	1			0.012	
Se	1			< 0.0050	
SO_4	1			32	
Specific conductance[g]	7	0.50	0.50	0.5	0
Temperature[h]	7	16	14	15	0.25
Total organic carbon	4	0.54	0.53	0.538	0.005
Total organic halides	4	< 0.010	< 0.010	< 0.010	0
Toxaphene	1			< 0.0050	

[a] See Figure 8.
[b] Values for all metals are total concentrations.
[c] 95% confidence coefficient about the average of more than two samples.
[d] Units are colonies per 100 mL.
[e] Units are Bq/L.
[f] Value in pH units.
[g] Units are in mmhos/cm.
[h] Units are in °C.

Table 25. Concentrations of dissolved metals in wells around 3524 and 7900[a]

December 1986

Parameter	No of samples	Concentration (mg/L) Max	Min	Av
		3524		
Ag	2	< 0.0050	< 0.0050	< 0.0050
As	2	< 0.010	< 0.010	< 0.010
Ba	2	< 1.0	< 1.0	< 1.0
Cd	2	< 0.0020	< 0.0020	< 0.0020
Cr	2	< 0.020	< 0.020	< 0.020
Fe	2	0.17	0.15	0.16
Hg	2	< 0.00010	< 0.00010	< 0.00010
Mn	2	0.26	< 0.010	0.14
Na	2	27	20	23
Pb	2	< 0.020	< 0.020	< 0.020
Se	2	< 0.0050	< 0.0050	< 0.0050
		7900		
Ag	1			< 0.0050
As	1			< 0.010
Ba	1			< 1.0
Cd	1			< 0.0020
Cr	1			0.020
Fe	1			0.15
Hg	1			< 0.00010
Mn	1			0.14
Na	1			8.7
Pb	1			< 0.020
Se	1			< 0.005010

[a] See Figures 7 and 8.

Table 26. Concentrations of parameters whose values exceed standards in groundwater wells on the ORNL site

December 1986

Area	Well[a] ID	Date	Parameter Gross Beta (Bq/L)
	Standard[b]		0.13
3524	31-013	12/09/86	1.5
	31-015	12/09/86	1.1
7900	32-004	12/10/86	1.0

[a] See Figures 7 and 8.

[b] EPA Interim Primary Drinking Water Standard.

Standard for gross beta is an annual dose equivalent of four millirem. A concentration was calculated from this dose based on ingestion of 2.2 L of water per day. All gross beta was assumed to be ^{90}Sr which is a worst case analysis. Its dose conversion factor of 1.438 rem per microcurie was used to calculate the concentration.

Groundwater was sampled from wells in the Solid Waste Storage Areas (SWSAs) 4, 5, 6 and the pits and trenches area at ORNL (Figs. 9-12). The reference well is hydraulically upgradient from the waste storage area (well 189, Fig. 9). It should be considered only as a reference well and not as a background well because it is located in SWSA 4 and does receive surface runoff. The groundwater samples were analyzed for ^{60}Co, ^{137}Cs, ^{3}H, gross alpha and beta activities and total strontium. Data on the concentrations of radionuclides measured in the monitoring and reference wells are presented in Table 27. The 95% confidence coefficient was not calculated because the distribution of the radionuclide concentrations does not appear to be normally distributed.

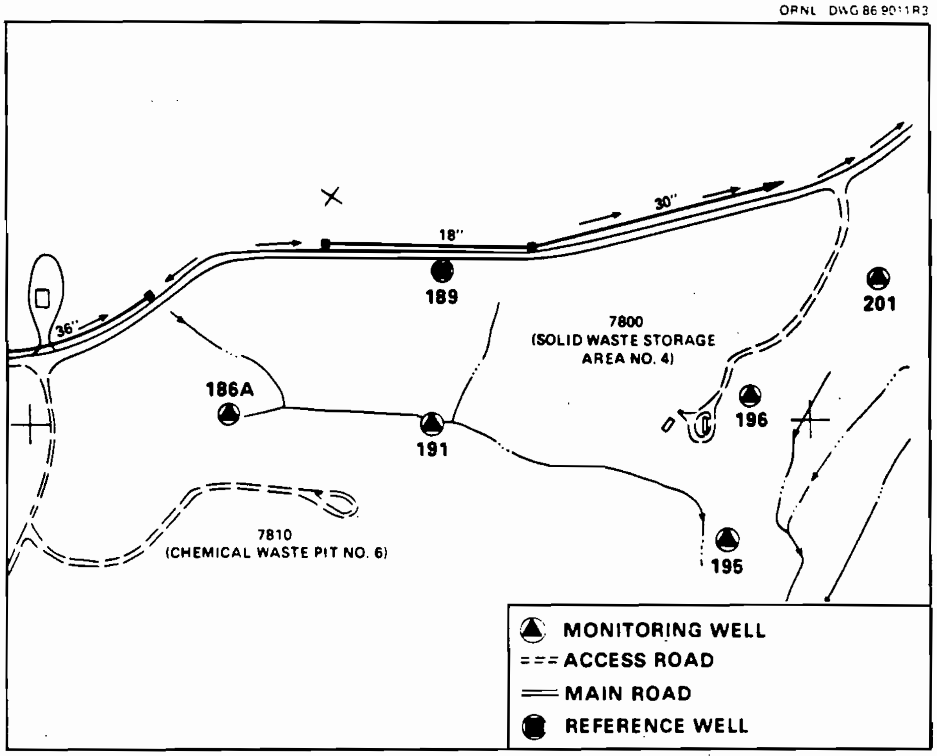

Fig. 9 Locations of sampling wells in Solid Waste Storage Area 4

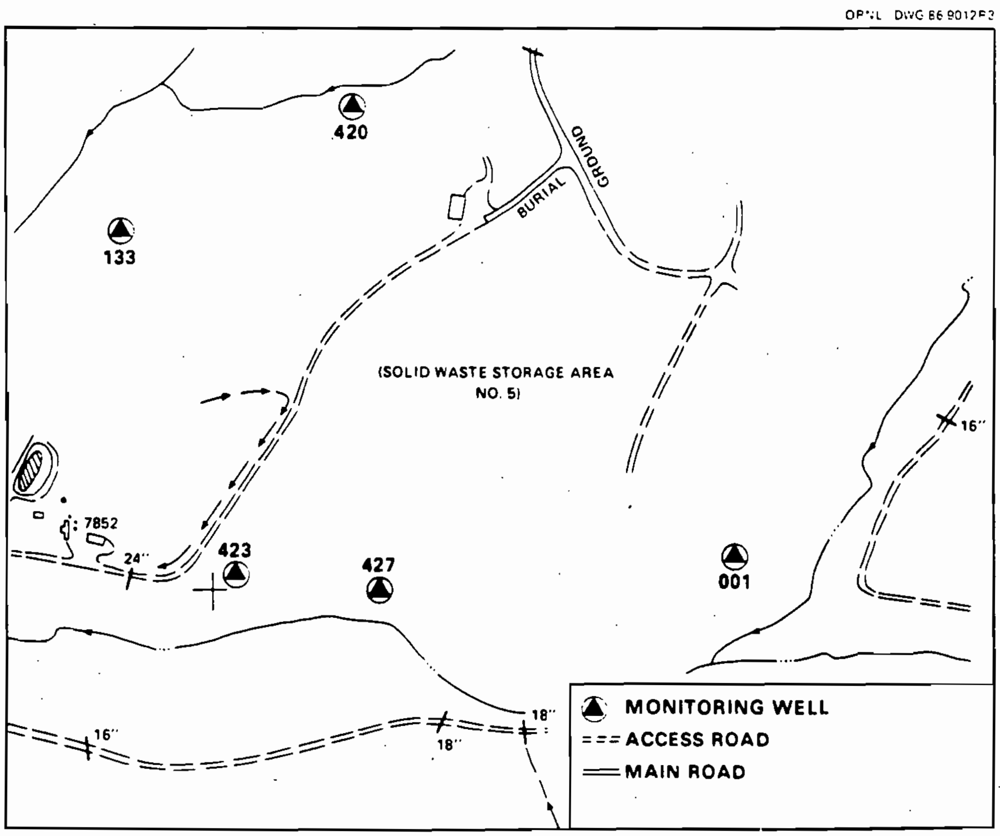

Fig. 10 Locations of sampling wells in Solid Waste Storage Area 5

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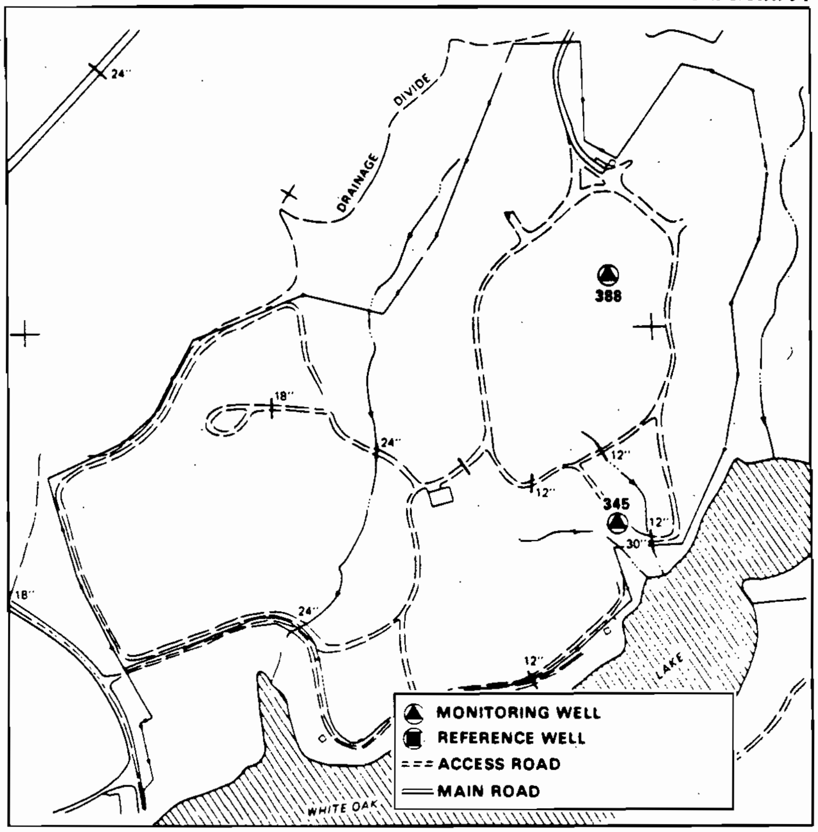

Fig. 11 Locations of sampling wells in Solid Waste Storage Area 6

ORNL-DWG 86 9014R3

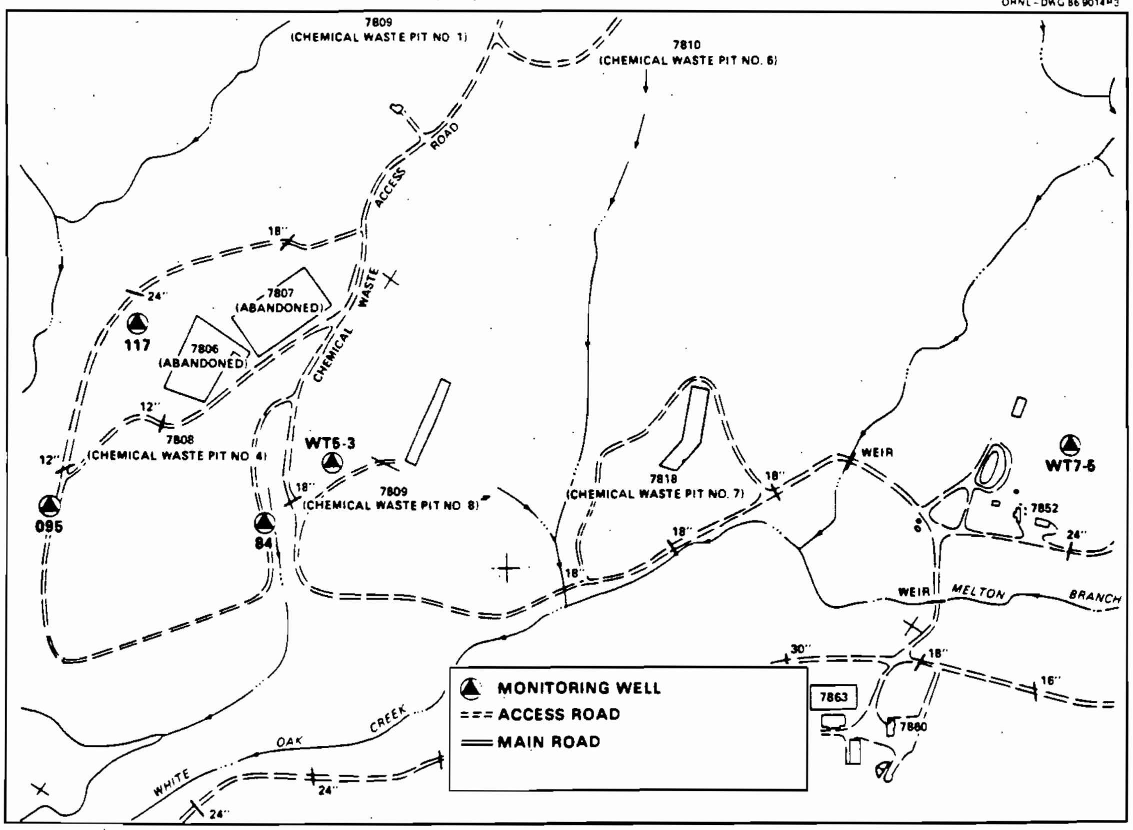

Fig. 12 Locations of sampling wells in pits and trenches

Table 27. Groundwater monitoring of radionuclides around ORNL solid waste storage areas

Parameter	Number of wells sampled	Concentration (Bq/L) Max	Min	Av
		Solid Waste Storage Area 4[a]		
^{60}Co	5	< 0.3	< 0.2	< 0.26
^{137}Cs	5	< 0.3	< 0.2	< 0.26
Gross alpha	5	73	1.3	28
Gross beta	5	2300	47	760
^{3}H	5	76000	2200	19000
Total Sr	5	1400	30	470
		Solid Waste Storage Area 5[b]		
^{60}Co	5	< 0.2	< 0.09	< 0.18
^{137}Cs	5	0.07	0.011	0.044
Gross alpha	5	1.5	0.4	0.84
Gross beta	5	1200	2.0	240
^{3}H	5	1800000	760	400000
Total Sr	5	630	0.11	130
		Solid Waste Storage Area 6[c]		
^{60}Co	2	< 0.3	< 0.3	< 0.3
^{137}Cs	2	< 0.2	< 0.2	< 0.2
Gross alpha	2	0.9	0.6	0.75
Gross beta	2	3.8	2.3	3.1
^{3}H	2	850	590	720
Total Sr	2	0.87	0.33	0.6
		Pits and Trenches[d]		
^{60}Co	5	110	0.2	26
^{137}Cs	5	0.3	0.03	0.10
Gross alpha	5	40	0.4	8.7
Gross beta	5	580	1.8	170
^{3}H	5	3400	1200	1900
Total Sr	5	2.7	0.18	0.82
		Reference Well[e]		
^{60}Co	1	< 0.3	< 0.3	< 0.3
^{137}Cs	1	< 0.2	< 0.2	< 0.2

Table 27. Groundwater monitoring of radionuclides around ORNL solid waste storage areas

(Continued)

Parameter	Number of wells sampled	Concentration (Bq/L) Max	Min	Av
		Reference Well[e] (Continued)		
Gross alpha	1	1.5	1.5	1.5
Gross beta	1	2.0	2.0	2.0
^{3}H	1	< 19	< 19	< 19
Total Sr	1	0.34	0.34	0.34

[a] See Figure 9.

[b] See Figure 10.

[c] See Figure 11.

[d] See Figure 12.

[e] See Figure 13.

METEOROLOGICAL PROCESSES

The ORNL meteorological system consists of three towers (A, B, and C) with sensors mounted at two levels (10 and 30 meters) for Towers A and B and three levels (10, 30, and 100 meters) for Tower C. Locations of meteorological towers at ORNL are shown in Figure 13. Data from the sensors are acquired, stored, edited, and formatted by a data collection system consisting of a central processor and remote data logger. One-minute averages are processed into fifteen-minute averages which are kept for one day. The fifteen-minute averages are processed into hourly averages which are stored for at least one year.

Examination of quarterly wind roses (Figures 14-20) reveals that the prevailing winds are almost equally split into two directions that are 180° apart; one prevailing direction is from the SW to WSW sector, and the other prevailing direction is from the NE to ENE sector. The winds are strongly aligned along these directions because of the channeling effect induced by the ridge and valley structure of the area. Another feature observed from the wind roses is that the wind speeds increase with height (tower level) at each of the towers. On the average, the wind speeds can be expected to increase steadily from ground level to 100 meters.

ORNL-DWG 86-9142R2

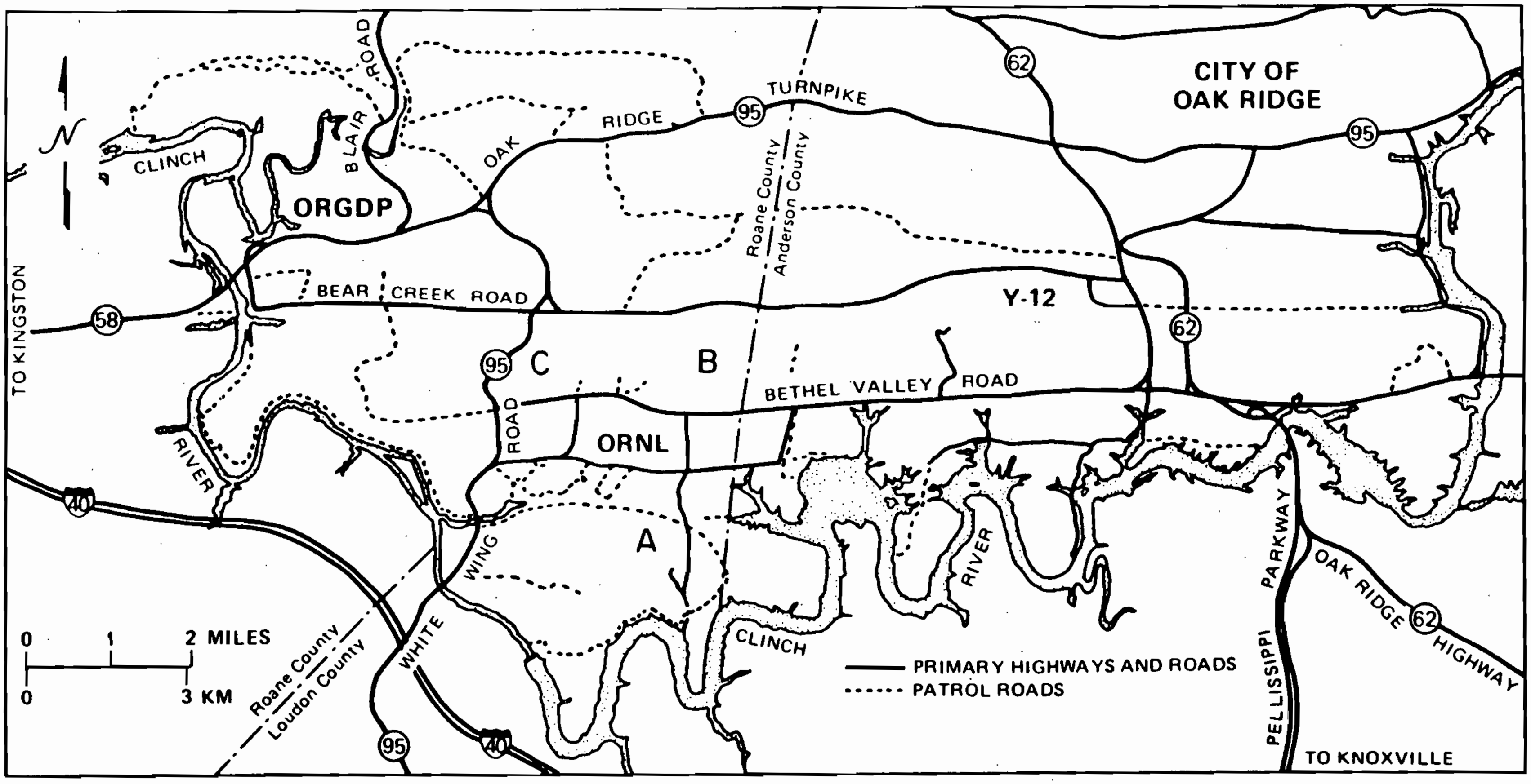

Fig. 13 Locations of meteorological towers at ORNL

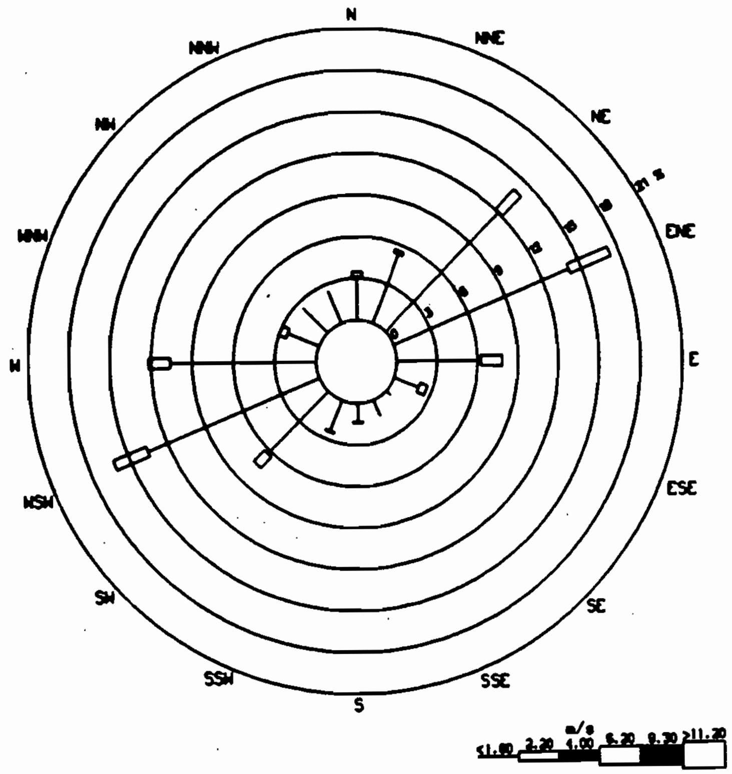

Fig. 14 Wind rose at 10-m level of meteorological tower A, October - December 1986

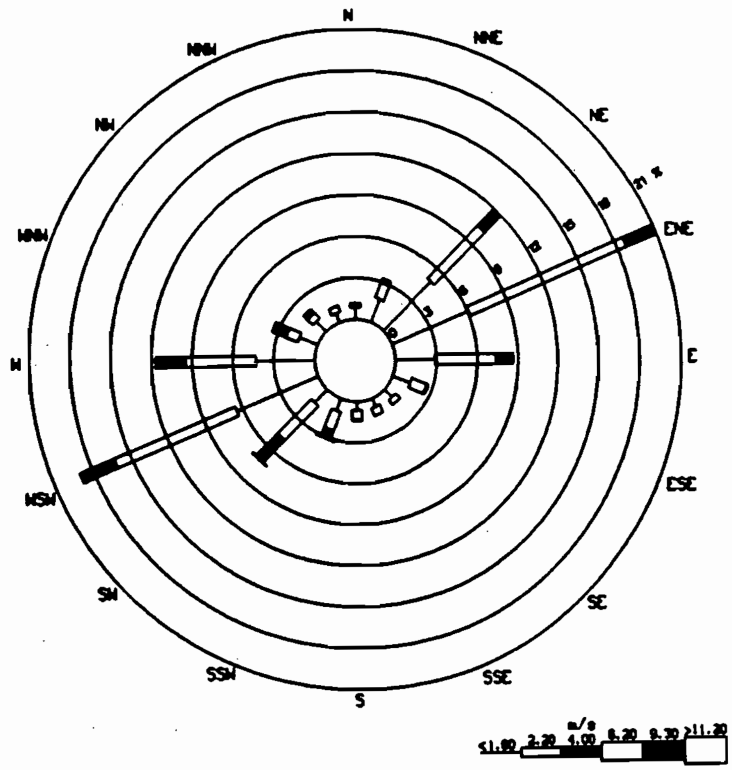

Fig. 15 Wind rose at 30-m level of mete)rological tower A, October - December 1986

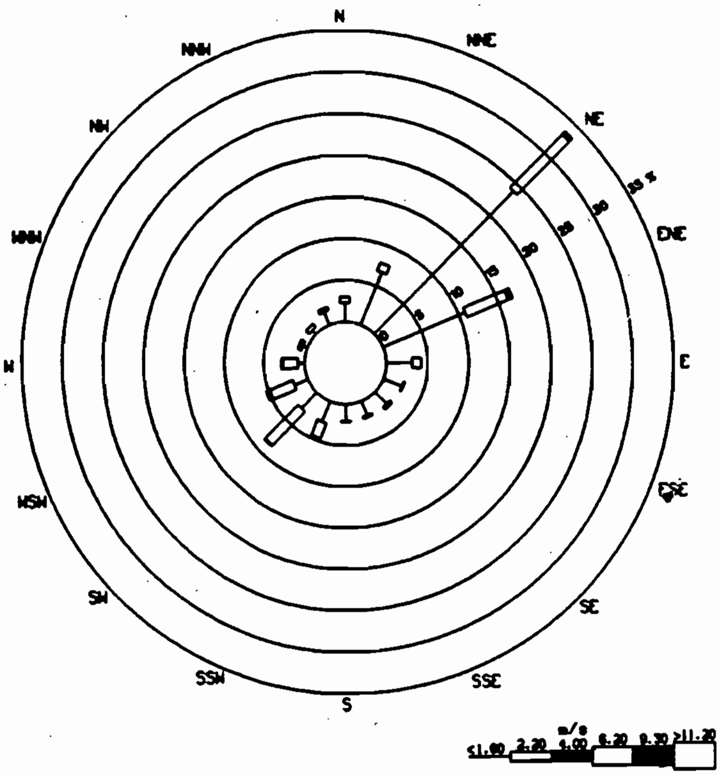

Fig. 16 Wind rose at 10-m level of meteorological tower B, October - December 1986

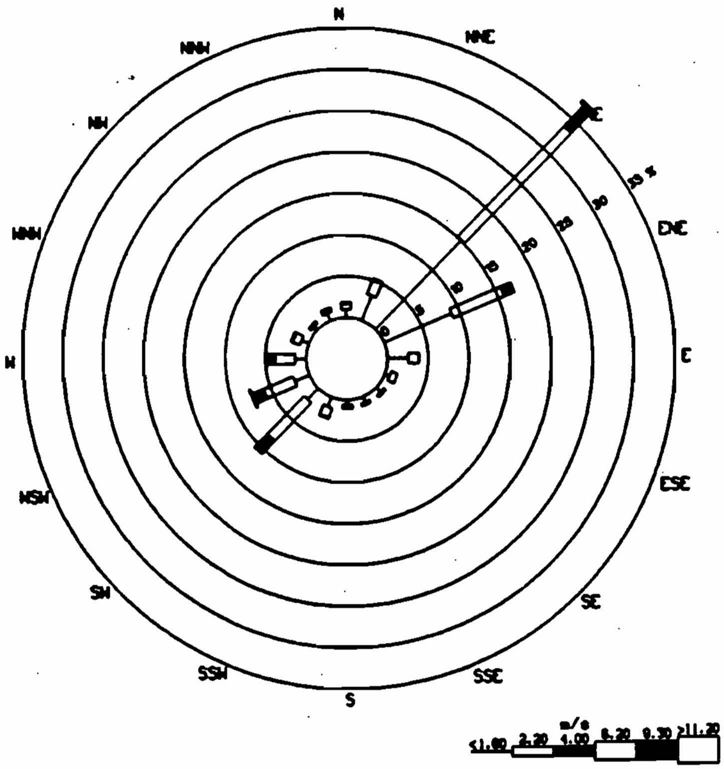

Fig. 17 Wind rose at 30-m level of meteorological tower B, October - December 1986

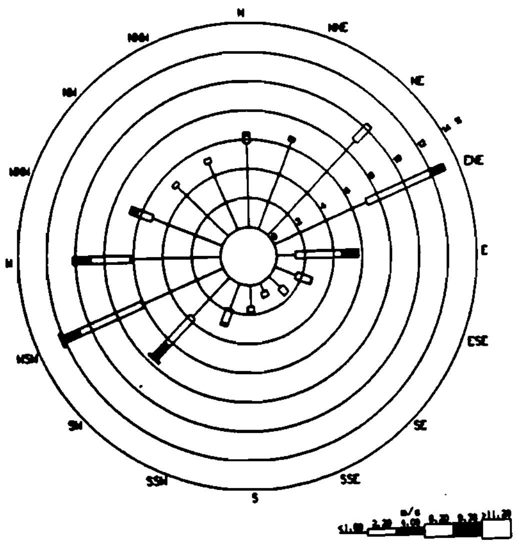

Fig. 18 Wind rose at 10-m level of meteorological tower C, October - December 1986

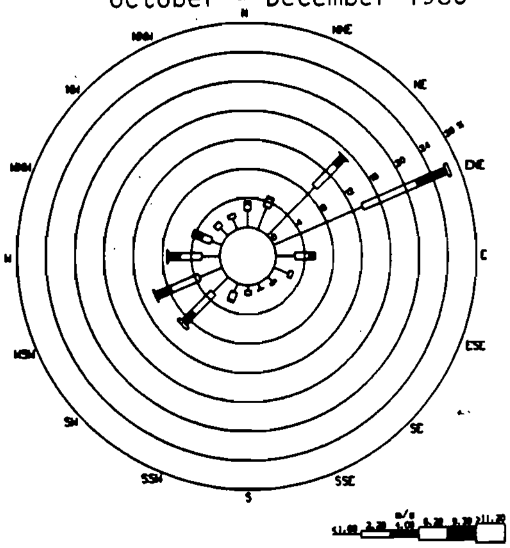

Fig. 19 Wind rose at 30-m level of meteorological tower C, October - December 1986

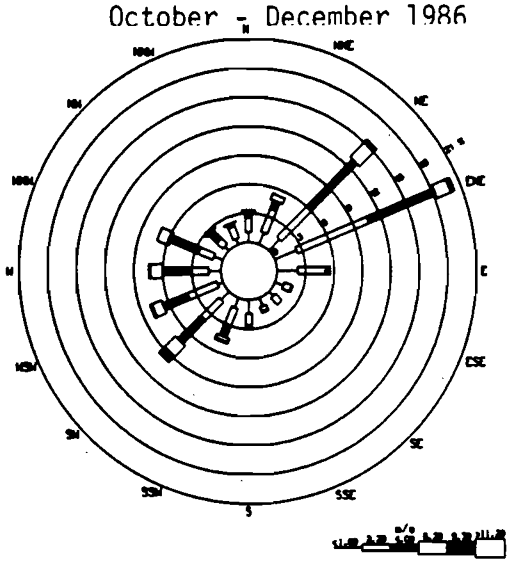

Fig. 20 Wind rose at 100-m level of meteorological tower C, October - December 1986

Milk

Raw milk from five locations and one dairy within a radius of 80 km of Oak Ridge is monitored for ^{131}I and ^{90}Sr. During this quarter, a new location was added, station 8 in the Solway community, approximately 16 km east of Oak Ridge. A replacement cow for station 6 was also located. Samples are collected every two weeks from the stations located near the Oak Ridge area (Fig. 21). Three other stations are more remote with respect to the Oak Ridge facilities and are usually sampled semi-annually (Fig. 22). None of the remote stations were sampled during this period. Prior to October 15, samples were analyzed by ion exchange and low-level beta counting. After this date, the ^{131}I was analyzed by gamma spectroscopy and the ^{90}Sr by chemical separation and low-level beta counting. These changes resulted in a greater than two-fold increase in the lower limit of detection for ^{131}I. The results are compared with intake guidelines (Tables 28-29) specified by the Federal Radiation Council (FRC).

Concentrations of ^{90}Sr are shown in Table 28. The average concentration of ^{90}Sr at all stations in the immediate Oak Ridge area was less than 0.073 Bq/L which is within Range I of the FRC guidelines, as were the average concentrations for each individual station.

Concentrations of ^{131}I are shown in Table 29. The average concentration of ^{131}I for all stations in the immediate Oak Ridge area was 0.0079 Bq/L, which is within Range I of the FRC guidelines.

ORNL-DWG 85-9421R4

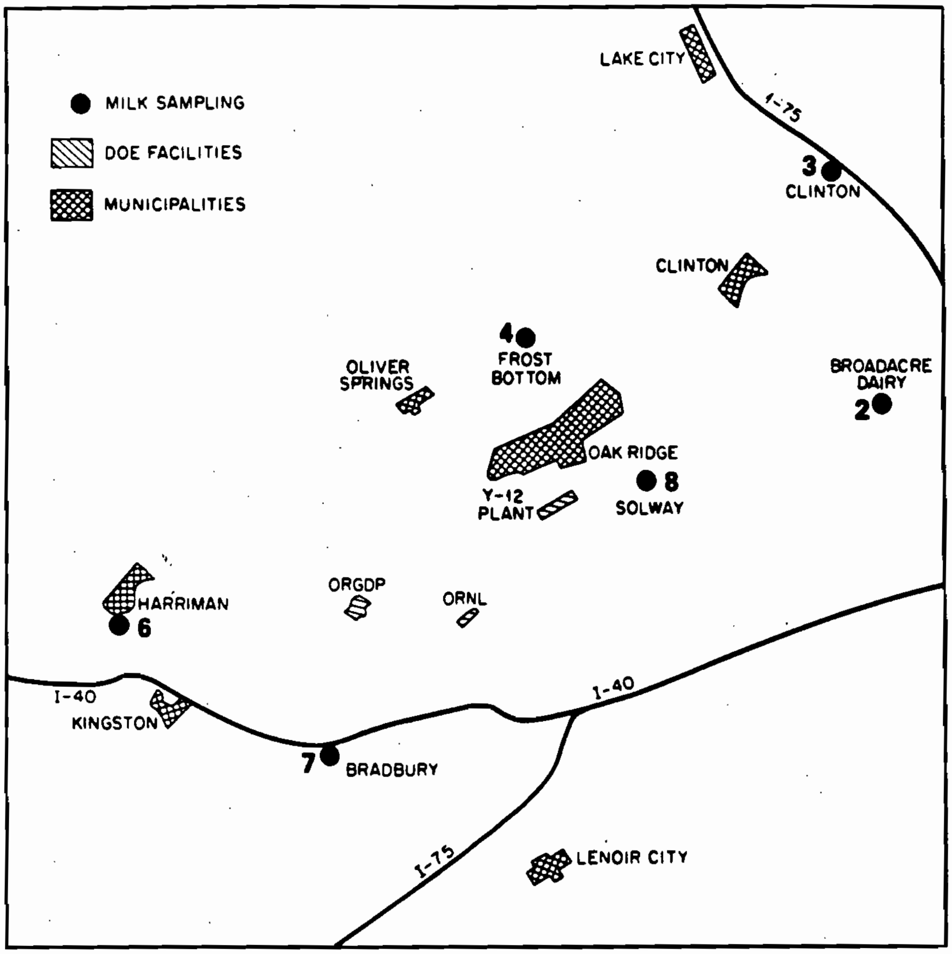

Fig. 21 Locations of milk sampling stations near the Oak Ridge facilities

ORNL-DWG 86-9187R

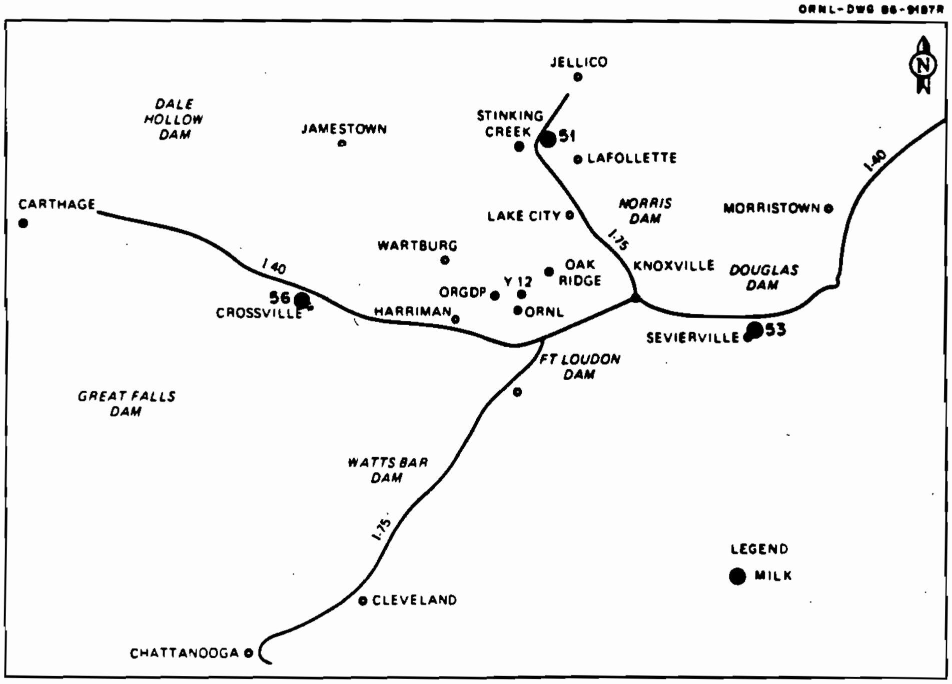

Fig. 22 Locations of milk sampling stations remote from the Oak Ridge facilities

Table 28. Concentrations of ^{90}Sr in milk[a]

Station	No. of samples	Concentration (Bq/L) Max	Min	Av	95%cc[b]	Comparison with standard[c]
		Immediate Environs[d]				
2	6	0.15	0.036	0.089	0.033	Range I
3	6	0.14	0.047	0.093	0.031	Range I
4	6	0.31	0.060	0.14	0.080	Range I
6	3	0.25	0.052	0.17	0.12	Range I
7	6	0.27	0.050	0.12	0.064	Range I
8	3	0.30	0.050	0.18	0.14	Range I
Network summary	30	0.31	0.036	0.073	0.028	Range I

[a] Raw milk samples; Station 2 is a dairy.

[b] 95% confidence coefficient about the average of more than two samples.

[c] Applicable FRC standard assuming 1 L/d intake: Range 1, 0-0.74 Bq/L, adequate surveillance required to confirm calculated intakes; Range II 0.74-7.4 Bq/L, active surveillance required; and Range III, > 7.4 Bq/L, positive control required.

[d] See Figure 21.

Table 29. Concentrations of ^{131}I in milk[a]

Station	No. of samples	Concentration (Bq/L) Max	Min	Av	95%cc[b]	Comparison with standard[c]
		Immediate Environs[d]				
2	6	< 0.08	< 0.03	< 0.072	0.017	Range I
3	6	< 0.08	< 0.03	< 0.072	0.017	Range I
4	6	< 0.08	< 0.03	< 0.072	0.017	Range I
6	3	< 0.08	< 0.080	< 0.080	0.00	Range I
7	6	< 0.08	< 0.03	< 0.072	0.017	Range I
8	3	< 0.08	< 0.080	< 0.080	0.00	Range I
Network summary	30	< 0.08	< 0.03	< 0.073	0.0063	Range I

[a] Raw milk samples; station 2 is a dairy.

[b] 95% confidence coefficient about the average.

[c] Applicable FRC standard assuming 1 L/d intake: Range I, 0-0.37 Bq/L, adequate surveillance required to confirm calculated intakes; Range II, 0.37-3.7 Bq/L, active surveillance required; and Range III, > 3.7 Bq/L, positive control required.

[d] See Figure 21.

FISH

Bluegill from three Clinch River locations were collected semi-annually for tissue analyses of radionuclides, mercury, and PCBs (Fig. 23). Sampling locations include the following river kilometers (CRK): (1) 40.0. which is above Melton Hill Dam and serves as a background location. It is above all of the Oak Ridge DOE facilities' outfalls; (2) 33.3, which is ORNL's discharge point from White Oak Creek to the Clinch River; and (3) 8.0 which is downstream from both ORNL and ORGDP.

The primary radionuclides of concern at ORNL due to fish consumption are ^{90}Sr and ^{137}Cs. These two result in the highest dose to man from ingestion of fish. Radionuclide concentrations were determined on at least one composite of 6-10 fish per sampling period. Mercury and PCB concentrations were measured in six individual fish from each sampling location. Scales, head, and entrail are removed from each fish before samples are obtained. Composite samples were ashed and analyzed by gamma spectroscopy and radiochemical techniques for the radionuclides that contribute most of the potential radionuclide dose to humans.

Summary statistics of concentrations of radionuclides found in bluegill during 1986 are given in Table 30. For the background location (CRK 40.0), and the location downstream from ORNL and ORGDP (CRK 8.0), the average concentrations of all radionuclides analyzed for are similar to past years (Table 30). Cobalt-60 concentrations in fish collected near ORNL's discharge point (CRK 33.3) are also similar to 1985. Strontium-90 and ^{137}Cs concentrations in bluegill were lower in 1986 than in past years. The high ^{90}Sr concentrations measured in 1985 were probably due to the release that occurred from ORNL during late 1985. The highest concentrations of all radionuclides were found at ORNL's discharge point (CRK 33.3, Fig. 23).

There were no statistically significant differences in the concentrations of mercury in bluegill between 1986 and 1985 (Table 31). The highest concentrations were at CRK 33.3 and CRK 8.0, below the background location. The concentrations in individual fish and the average concentration for each location were less than 13% of the FDA's action level of 1000 ng/g.

Concentrations of PCB-1254 in bluegill from CRK 40.0 and of PCB-1260 in fish from CRK 8.0 and CRK 40.0 were statistically lower than those found in carp in 1985 (Table 32). PCB concentrations in bluegill during 1986 were similar to those measured during 1984 at CRK 33.3 and CRK 25.0. Concentrations in fish collected at CRK 8.0 during 1986 were lower than in 1984. During 1984, one of the fish analyzed had 9.1 μg/g of PCB which elevated the average for the year. All concentrations of PCBs (individual types and the sum) were less than 5% of the FDA's tolerance level for fish.

ORNL-DWG 86-8811R5

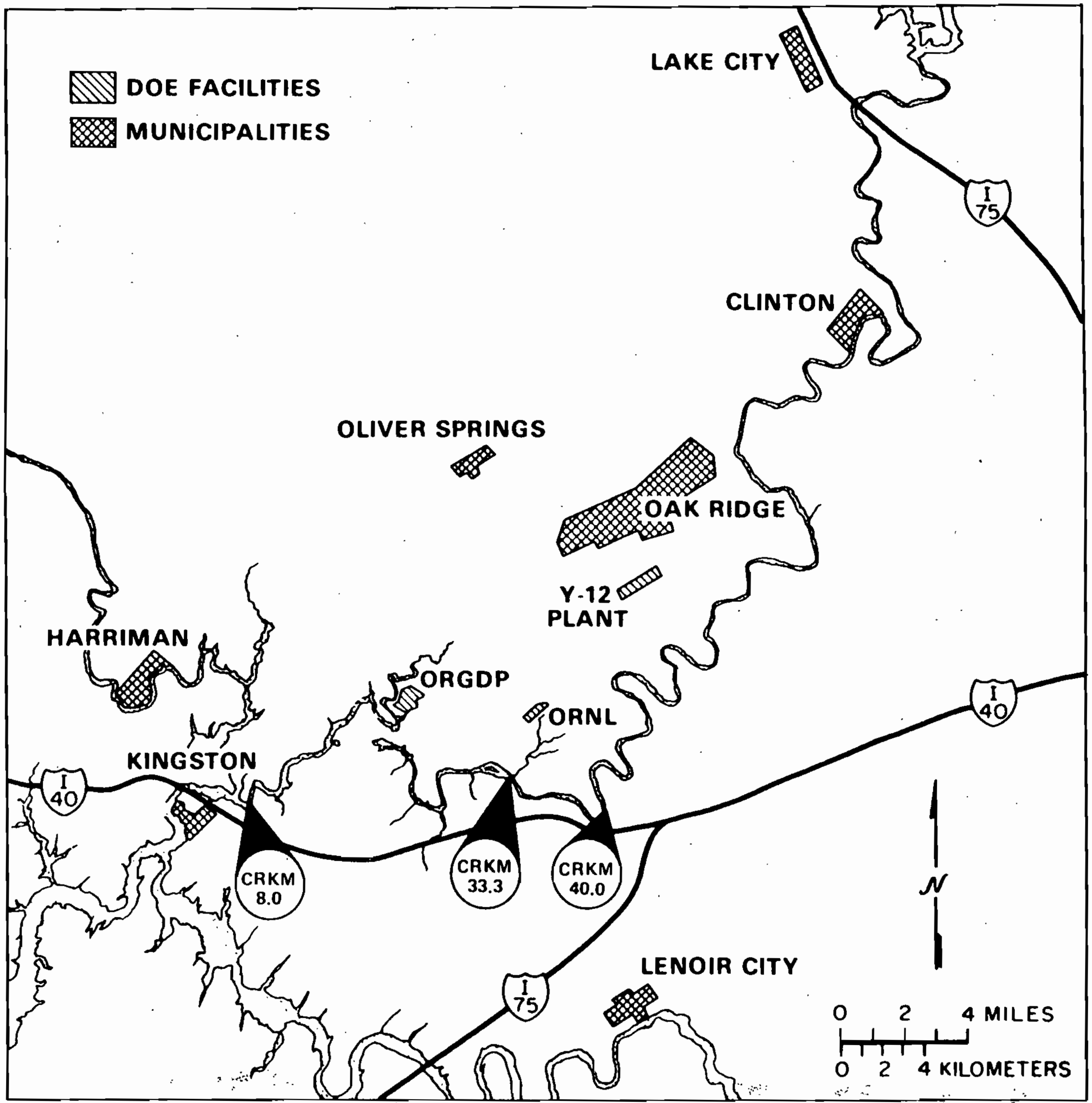

Fig. 23 Locations of fish sampling points

Table 30. 1986 radionuclide concentrations in Clinch River bluegill

Location[a]	Radionuclide	No. of Samples[b]	Concentration (Bq/kg wet wt) Max	Min	Av	95%cc[c]
CRK 8.0	^{60}Co	5	0.35	< 0.20	< 0.29	0.065
	^{137}Cs	5	3.2	2.5	2.8	0.28
	^{90}Sr	5	0.85	0.29	0.61	0.21
CRK 33.3	^{60}Co	4	0.76	< 0.29	< 0.47	0.20
	^{137}Cs	4	25	6.4	15	7.7
	^{90}Sr	4	1.4	0.76	1.1	0.27
CRK 40.0	^{60}Co	5	< 0.25	< 0.026	< 0.16	0.076
	^{137}Cs	5	0.46	< 0.010	< 0.18	0.15
	^{90}Sr	5	0.33	0.026	0.22	0.10

[a] See Figure 23.

[b] A sample is a composite of 6-10 fish.

[c] 95% confidence coefficient about the average.

Table 31. 1986 mercury concentrations in Clinch River bluegill

Location[a]	No. of Fish Sampled	Concentration (μg/g wet wt) Max	Min	Av	95%cc[b]	Percentage of Action Level[c]
CRK 8.0	6	180	49	130	37	13
CRK 33.3	12	250	30	97	30	9.7
CRK 40.0	12	45	17	28	5.2	2.8

[a] See Figure 23.

[b] 95% confidence coefficient about the average.

[c] Percentage of Food and Drug Administration action level of mercury in fish (1000 μg/g) for the average concentration. Source: Reference 4.

Table 32. 1986 PCB concentrations in Clinch River bluegill

Location[a]	PCB Type	No. of Fish Sampled	Concentration (μg/g wet wt) Max	Min	Av	95%cc[b]	Percentage of Tolerance[c]
CRK 8.0	1254	6	0.05	0.02	0.04	0.01	2.0
	1260	6	0.094	< 0.01	< 0.02	0.01	1.0
CRK 33.3	1254	12	0.11	< 0.01	< 0.04	0.02	2.0
	1260	12	0.50	0.01	0.07	0.08	3.5
CRK 40.0	1254	12	0.05	< 0.01	< 0.02	0.01	1.0
	1260	12	0.02	< 0.01	< 0.01	0.0	0.5

[a] See Figure 23.

[b] 95% confidence coefficient about the average.

[c] Percentage of Food and Drug Administration tolerance for PCBs in fish (2 μg/g wet wt) for the average

SOIL

Soil samples were collected annually at the ORNL perimeter locations (Fig. 1), the ORR locations (Fig. 1). and at the remote locations (Fig. 2). At all locations, except the remote ones, samples were collected at 90 degree angles to the air monitoring stations and designated as the north, south, east, and west areas. From each of these areas, two 1-square meter plots were sampled. From each plot, five aliquots were taken with an 8-cm cup setter used on golf courses. Aliquots from the two plots were composited for analysis for a total of four samples per location. At the remote locations, a 1-square meter plot was sampled. From each plot, five aliquots were collected with an 8-cm cup setter. These samples were composited for analysis. Only the top 2 cm of soil was analyzed for radionuclides. All samples were dried prior to analysis.

Tables 33-39 gives summary statistics for concentrations of radionuclides in soil samples from the ORNL perimeter locations and the ORR locations. There were no statistically significant differences in the soil concentrations of ^{90}Sr, ^{137}Cs, ^{238}Pu, ^{235}U, and ^{238}U between the ORNL perimeter and the ORR locations (Tables 33, 34, 36, 38, and 39). Uranium concentrations in soil were highest around Y-12 stations 40 and 45 (Fig. 1, Tables 37-39). Concentrations of ^{239}Pu in soil were significantly higher at the ORNL perimeter station 3, just west of ORNL (Table 35).

Table 40 gives the results from sampling the remote locations. The ^{238}Pu concentrations at most of the remote locations appeared higher during 1986 than during 1985. All other radionuclides were similar to the 1985 levels.

Table 33. 1986 ^{137}Cs concentrations in soil from ORNL perimeter and Oak Ridge Reservation stations

Location	No. of samples	Concentration (Bq/kg dry wt)			
		Max	Min	Av	95%cc[a]
		ORNL Perimeter Stations[b]			
3	4	92	14	50	39
7	4	110	15	39	47
9	4	71	34	52	17
Network summary	12	110	14	47	19
		Oak Ridge Reservation Stations[b]			
8	4	92	25	61	28
23	4	50	14	29	16
31	4	59	27	38	15
33	4	64	22	44	17
34	4	44	< 1.0	< 19	21
36	4	48	5.0	25	18
40	4	22	11	18	5.1
41	4	6.4	1.6	3.4	2.2
42	4	27	5.4	14	11
43	4	45	2.8	18	19
44	4	51	2.9	17	23
45	4	61	1.1	25	28
46	4	25	8.4	16	7.2
Network summary	52	92	< 1.0	< 25	5.9

[a] 95% confidence coefficient about the average of more than two samples.

[b] See Figure 1.

Table 34. 1986 ^{238}Pu concentrations in soil from ORNL perimeter and Oak Ridge Reservation stations

Location	No. of samples	Concentration (Bq/kg dry wt)			
		Max	Min	Av	95%cc[a]
		ORNL Perimeter Stations[b]			
3	4	0.25	0.037	0.099	0.10
7	4	0.086	0.001	0.037	0.042
9	4	0.092	0.010	0.036	0.039
Network summary	12	0.25	0.001	0.057	0.039
		Oak Ridge Reservation Stations[b]			
8	4	0.090	0.024	0.050	0.029
23	4	0.026	< 0.002	< 0.008	0.012
31	4	0.033	< 0.003	< 0.017	0.013
33	4	0.032	0.0004	0.017	0.013
34	4	< 0.020	< 0.020	< 0.020	0.0
36	4	0.028	< 0.002	< 0.019	0.012
40	4	0.11	< 0.010	< 0.060	0.052
41	4	< 0.030	< 0.010	< 0.020	0.008
42	4	0.18	< 0.002	< 0.086	0.092
43	4	0.24	< 0.0069	< 0.15	0.11
44	4	0.034	< 0.002	< 0.022	0.015
45	4	0.087	< 0.012	< 0.035	0.035
46	4	0.048	0.015	0.028	0.015
Network summary	52	0.24	0.0004	< 0.041	0.015

[a] 95% confidence coefficient about the average of more than two samples.

[b] See Figure 1.

Table 35. 1986 ^{239}Pu concentrations in soil from ORNL perimeter and Oak Ridge Reservation stations

Location	No. of samples	Concentration (Bq/kg dry wt)			
		Max	Min	Av	95%cc[a]
		ORNL Perimeter Stations[b]			
3	4	2.9	0.28	2.0	1.2
7	4	0.82	0.005	0.36	0.36
9	4	1.2	0.82	1.1	0.18
Network summary	12	2.9	0.005	1.1	0.55
		Oak Ridge Reservation Stations[b]			
8	4	1.5	0.36	0.91	0.47
23	4	0.84	0.30	0.54	0.22
31	4	1.1	0.41	0.62	0.32
33	4	1.3	0.34	0.83	0.41
34	4	0.71	< 0.002	< 0.30	0.35
36	4	0.88	0.04	0.49	0.35
40	4	0.33	0.16	0.27	0.075
41	4	0.07	< 0.02	< 0.038	0.024
42	4	0.63	0.17	0.31	0.22
43	4	0.92	0.0031	0.31	0.42
44	4	0.67	0.035	0.23	0.30
45	4	1.3	< 0.01	< 0.53	0.62
46	4	0.52	0.21	0.35	0.16
Network summary	52	1.5	< 0.002	< 0.44	0.11

[a] 95% confidence coefficient about the average of more than two samples.

[b] See Figure 1.

Table 36. 1986 ^{90}Sr concentrations in soil from ORNL perimeter and Oak Ridge Reservation stations

Location	No. of samples	Concentration (Bq/kg dry wt)			
		Max	Min	Av	95%cc[a]
		ORNL Perimeter Stations[b]			
3	4	7.9	4.0	6.1	2.1
7	4	7.0	2.7	4.3	2.0
9	4	16	10	13	2.5
Network summary	12	16	2.7	7.6	2.4
		Oak Ridge Reservation Stations[b]			
8	4	6.8	1.4	5.2	2.5
23	4	11	6.4	8.4	2.3
31	4	15	5.1	11	4.3
33	4	10	5.5	7.9	1.9
34	4	12	3.5	8.4	4.3
36	4	8.5	2.5	5.7	2.7
40	4	9.2	4.1	6.2	2.1
41	4	4.6	0.8	2.8	1.6
42	4	13	2.8	7.7	5.0
43	4	8.0	0.6	3.5	3.2
44	4	4.5	1.5	2.7	1.3
45	4	7.5	1.0	3.8	2.8
46	4	8.0	1.7	5.4	2.7
Network summary	52	15	0.6	6.0	0.99

[a] 95% confidence coefficient about the average of more than two samples.

[b] See Figure 1.

Table 37. 1986 ^{234}U concentrations in soil from ORNL perimeter and Oak Ridge Reservation stations

Location	No. of samples	Concentration (Bq/kg dry wt) Max	Min	Av	95%cc[a]
		ORNL Perimeter Stations[b]			
3	4	19	15	17	1.7
7	4	16	11	13	2.2
9	4	16	12	14	1.7
Network summary	12	19	11	15	1.5
		Oak Ridge Reservation Stations[b]			
8	4	28	18	23	4.8
23	4	44	18	28	11
31	4	37	14	23	10
33	4	17	10	13	3.2
34	4	11	8.4	9.6	1.2
36	4	15	11	13	1.8
40	4	200	100	150	44
41	4	15	11	13	2.1
42	4	20	12	15	3.7
43	4	16	12	14	2.1
44	4	11	3.5	8.5	3.6
45	4	150	19	64	62
46	4	34	18	28	7.3
Network summary	52	200	3.5	30	11

[a] 95% confidence coefficient about the average of more than two samples.

[b] See Figure 1.

Table 38. 1986 ^{235}U concentrations in soil from ORNL perimeter and Oak Ridge Reservation stations

Location	No. of samples	Concentration (Bq/kg dry wt)			
		Max	Min	Av	95%cc[a]
		ORNL Perimeter Stations[b]			
3	4	2.7	0.94	1.8	0.93
7	4	2.3	0.72	1.3	0.71
9	4	1.9	0.49	1.1	0.65
Network summary	12	2.7	0.49	1.4	0.44
		Oak Ridge Reservation Stations[b]			
8	4	1.3	0.86	1.0	0.20
23	4	1.7	1.1	1.4	0.28
31	4	1.7	0.83	1.1	0.40
33	4	1.1	0.51	0.82	0.28
34	4	0.4	0.041	0.27	0.16
36	4	0.65	0.47	0.56	0.075
40	4	15	4.5	9.4	5.0
41	4	1.6	0.48	0.77	0.55
42	4	1.2	0.55	0.87	0.28
43	4	0.87	0.46	0.65	0.17
44	4	0.91	0.26	0.58	0.29
45	4	14	0.6	5.2	6.1
46	4	2.7	1.3	1.9	0.60
Network summary	52	15	0.041	1.9	0.87

[a] 95% confidence coefficient about the average of more than two samples.

[b] See Figure 1.

Table 39. 1986 ^{238}U concentrations in soil from ORNL perimeter and Oak Ridge Reservation stations

Location	No. of samples	Concentration (Bq/kg dry wt)			
		Max	Min	Av	95%cc[a]
		ORNL Perimeter Stations[b]			
3	4	15	12	14	1.3
7	4	13	9.1	11	1.7
9	4	12	9.1	10	1.4
Network summary	12	15	9.1	12	1.1
		Oak Ridge Reservation Stations[b]			
8	4	22	9.4	14	5.4
23	4	50	19	33	13
31	4	23	8.8	13	6.5
33	4	13	7.2	9.6	2.9
34	4	8.5	6.4	7.3	0.91
36	4	12	7.4	9.6	1.9
40	4	52	27	40	14
41	4	10	6.4	8.5	1.7
42	4	12	8.7	10	1.4
43	4	11	8.0	9.1	1.3
44	4	9.0	2.3	6.3	3.1
45	4	220	11	82	97
46	4	22	13	17	4.4
Network summary	52	220	2.3	20	8.8

[a] 95% confidence coefficient about the average of more than two samples.

[b] See Figure 1.

Table 40. 1986 radioactivity in soil samples from the remote monitoring stations[a]

Location	Concentration (Bq/kg dry wt) ^{90}Sr	^{137}Cs	^{238}Pu	^{239}Pu	^{234}U	^{235}U	^{238}U
51	6.4	27	< 0.08	0.36	9.7	0.61	8.1
52	7.5	22	0.0044	0.33	17	2.2	14
53	7.5	53	0.019	0.92	26	1.2	22
55	8.9	39	0.057	0.63	13	0.56	11
56	4.5	23	0.029	0.38	9.7	2.1	8.8
57	4.3	27	0.012	0.49	14	1.8	10
58	8.1	40	< 0.01	0.54	14	0.90	11
Network average	6.7	33	< 0.03	0.52	15	1.3	12

[a] See Figure 2.

VEGETATION

Grass samples were collected annually at ORNL perimeter locations (Fig. 1), the ORR locations (Fig.1), and at the remote locations (Fig. 2). At all locations, except the remote ones, samples were collected at 90 degree angles to the air monitoring station for a total of four samples per location. At the remote stations, a single sample was collected near each station. After initial preparation, the samples were analyzed by gamma spectrometry and radiochemical techniques for a wide variety of radionuclides.

The summary statistics for radionuclides in grass at the ORNL perimeter and the ORR locations are given in Tables 41-47. There were no statistically significant differences in the concentrations of ^{137}Cs, ^{90}Sr, or ^{239}Pu in grass between the ORNL perimeter stations and the ORR stations (Tables 42, 43, and 47). Plutonium-238 was significantly higher at the ORNL perimeter stations than the ORR stations. The highest concentrations were measured at location 7 (see Fig. 1) which is close to ORNL and in one of the predominant wind directions from ORNL. Concentrations of ^{234}U and ^{235}U were significantly higher at the ORR stations than at the ORNL perimeter stations (Tables 44 and 45). No significant differences were noted for ^{238}U, probably due to the high variability among the samples from location 45 (Table 46). Uranium concentrations were highest at the two ORR locations on the east and west ends of Y-12 (locations 40 and 45, Fig. 1, Tables 44-46). Concentrations at all stations were similar to those for calendar year 1985.

Table 41. 1986 ^{238}Pu concentrations in grass from ORNL perimeter and Oak Ridge Reservation stations

Location	No. of samples	Concentration (Bq/kg dry wt)			
		Max	Min	Av	95%cc[a]
		ORNL Perimeter Stations[b]			
3	4	< 0.10	< 0.040	< 0.085	0.03
7	4	0.50	< 0.011	< 0.15	0.23
9	4	< 0.10	< 0.040	< 0.065	0.026
Network summary	12	0.50	< 0.011	< 0.10	0.075
		Oak Ridge Reservation Stations[b]			
8	4	0.10	< 0.020	< 0.055	0.033
23	4	0.020	< 0.001	< 0.011	0.01
31	4	0.054	< 0.01	< 0.021	0.022
33	4	0.026	< 0.007	< 0.016	0.01
34	4	0.018	< 0.005	< 0.0088	0.0062
36	4	0.020	< 0.001	< 0.011	0.0092
40	4	0.010	< 0.002	< 0.008	0.004
41	4	0.036	< 0.01	< 0.02	0.012
42	4	0.040	< 0.01	< 0.018	0.015
43	4	< 0.003	< 0.002	< 0.0025	0.00058
44	4	0.020	< 0.01	< 0.013	0.005
45	4	0.011	< 0.001	< 0.0035	0.005
46	4	0.021	< 0.0028	< 0.011	0.0075
Network summary	52	0.10	< 0.001	< 0.02	0.005

[a] 95% confidence coefficient about the average of more than two samples.

[b] See Figure 1.

Table 42. 1986 ^{239}Pu concentrations in grass from ORNL perimeter and Oak Ridge Reservation stations

Location	No. of samples	Concentration (Bq/kg dry wt)			
		Max	Min	Av	95%cc[a]
		ORNL Perimeter Stations[b]			
3	4	0.10	< 0.07	< 0.09	0.014
7	4	0.20	< 0.02	< 0.071	0.087
9	4	0.10	< 0.03	< 0.055	0.031
Network summary	12	0.20	< 0.02	< 0.07	0.029
		Oak Ridge Reservation Stations[b]			
8	4	0.59	< 0.03	< 0.20	0.26
23	4	< 0.03	< 0.01	< 0.018	0.0096
31	4	0.03	< 0.006	< 0.013	0.011
33	4	0.047	< 0.007	< 0.024	0.019
34	4	< 0.007	< 0.004	< 0.0055	0.001
36	4	0.013	< 0.001	< 0.004	0.006
40	4	0.34	< 0.01	< 0.02	0.01
41	4	0.02	< 0.001	< 0.01	0.0078
42	4	0.03	< 0.01	< 0.02	0.009
43	4	< 0.003	< 0.002	< 0.0025	0.00058
44	4	< 0.03	< 0.01	< 0.02	0.012
45	4	< 0.001	< 0.001	< 0.001	0.0
46	4	0.091	< 0.01	< 0.03	0.041
Network summary	52	0.6	< 0.001	< 0.03	0.023

[a] 95% confidence coefficient about the average of more than two samples.

[b] See Figure 1.

Table 43. 1986 ^{90}Sr concentrations in grass from ORNL perimeter and Oak Ridge Reservation stations

Location	No. of samples	Concentration (Bq/kg dry wt)			
		Max	Min	Av	95%cc[a]
		ORNL Perimeter Stations[b]			
3	4	9.5	6.1	8.3	1.5
7	4	8.0	3.9	5.5	1.8
9	4	17	7.3	12	5.1
Network summary	12	17	3.9	8.5	2.3
		Oak Ridge Reservation Stations[b]			
8	4	3.6	1.4	2.3	0.93
23	4	5.8	3.1	4.7	1.2
31	4	9.6	6.0	8.5	1.7
33	4	8.7	2.8	5.6	2.5
34	4	4.9	1.9	3.6	1.2
36	4	10	5.1	7.4	2.6
40	4	7.7	4.0	5.6	1.6
41	4	8.9	2.4	5.0	2.8
42	4	8.3	2.9	5.9	2.4
43	4	3.0	1.3	2.1	0.76
44	4	5.8	4.3	5.0	0.72
45	4	7.9	4.0	5.9	1.8
46	4	18	8.7	12	4.3
Network summary	52	18	1.3	5.7	0.88

[a] 95% confidence coefficient about the average of more than two samples.

[b] See Figure 1.

Table 44. 1986 ^{234}U concentrations in grass from ORNL perimeter and Oak Ridge Reservation stations

Location	No. of samples	Concentration (Bq/kg dry wt) Max	Min	Av	95%cc[a]
		ORNL Perimeter Stations[b]			
3	4	2.8	2.6	2.7	0.082
7	4	3.5	1.4	2.4	0.87
9	4	2.5	1.2	1.9	0.53
Network summary	12	3.5	1.2	2.3	0.37
		Oak Ridge Reservation Stations[b]			
8	4	2.7	1.5	2.2	0.53
23	4	5.6	4.8	5.1	0.36
31	4	2.4	1.3	1.8	0.51
33	4	2.0	1.1	1.5	0.40
34	4	1.6	0.64	1.1	0.40
36	4	2.1	1.1	1.5	0.42
40	4	21	15	18	3.5
41	4	5.7	2.9	4.1	1.3
42	4	2.5	1.6	2.0	0.37
43	4	1.8	0.94	1.2	0.41
44	4	1.7	1.2	1.5	0.24
45	4	26	13	17	6.1
46	4	7.9	4.9	6.2	1.3
Network summary	52	26	0.64	4.9	1.6

[a] 95% confidence coefficient about the average of more than two samples.

[b] See Figure 1.

Table 45. 1986 ^{235}U concentrations in grass from ORNL perimeter and Oak Ridge Reservation stations

Location	No. of samples	Concentration (Bq/kg dry wt)			
		Max	Min	Av	95%cc[a]
		ORNL Perimeter Stations[b]			
3	4	0.18	0.04	0.11	0.068
7	4	0.31	0.07	0.17	0.11
9	4	0.11	0.04	0.073	0.029
Network summary	12	0.31	0.04	0.12	0.047
		Oak Ridge Reservation Stations[b]			
8	4	0.11	0.02	0.08	0.041
23	4	0.61	0.27	0.39	0.15
31	4	0.21	0.10	0.16	0.053
33	4	0.19	0.037	0.10	0.065
34	4	0.11	0.024	0.075	0.036
36	4	0.18	0.002	0.10	0.08
40	4	1.5	0.52	0.95	0.44
41	4	0.75	0.29	0.43	0.21
42	4	0.36	0.24	0.29	0.051
43	4	0.31	0.10	0.21	0.10
44	4	0.12	0.08	0.099	0.02
45	4	1.5	0.66	0.96	0.37
46	4	0.6	0.27	0.44	0.14
Network summary	52	1.5	0.002	0.33	0.094

[a] 95% confidence coefficient about the average of more than two samples.

[b] See Figure 1.

Table 46. 1986 ^{238}U concentrations in grass from ORNL perimeter and Oak Ridge Reservation stations

Location	No. of samples	Concentration (Bq/kg dry wt)			
		Max	Min	Av	95%cc[a]
		ORNL Perimeter Stations[b]			
3	4	1.4	0.55	1.0	0.40
7	4	1.5	0.71	1.0	0.37
9	4	0.77	0.48	0.59	0.13
Network summary	12	1.5	0.48	0.87	0.21
		Oak Ridge Reservation Stations[b]			
8	4	1.4	0.44	0.83	0.44
23	4	1.1	0.83	0.94	0.12
31	4	0.77	0.25	0.52	0.24
33	4	0.64	0.28	0.48	0.15
34	4	0.47	0.20	0.36	0.12
36	4	0.56	0.34	0.42	0.096
40	4	2.7	1.4	1.9	0.56
41	4	2.8	0.36	1.3	1.1
42	4	0.94	0.35	0.68	0.3
43	4	0.44	0.26	0.32	0.08
44	4	1.0	0.47	0.65	0.24
45	4	23	2.5	7.8	10
46	4	3.6	1.4	2.4	0.91
Network summary	52	23	0.2	1.4	0.88

[a] 95% confidence coefficient about the average of more than two samples.

[b] See Figure 1.

Table 47. 1986 ^{137}Cs concentrations in grass from ORNL perimeter and Oak Ridge Reservation stations

Location	No. of samples	Concentration (Bq/kg dry wt) Max	Min	Av	95%cc[a]
		ORNL Perimeter Stations[b]			
3	4	5.3	1.6	3.2	1.9
7	4	< 1.6	< 1.3	< 1.4	0.16
9	4	1.5	1.2	1.3	0.12
Network summary	12	5.3	1.2	2.0	0.77
		Oak Ridge Reservation Stations[b]			
8	4	< 1.5	< 1.3	< 1.4	0.13
23	4	6.5	< 1.2	< 3.0	2.4
31	4	< 2.4	< 0.82	< 1.9	0.72
33	4	< 2.0	< 1.4	< 1.7	0.26
34	4	< 2.4	< 1.4	< 2.0	0.45
36	4	< 1.8	< 1.2	< 1.5	0.28
40	4	< 2.1	< 1.1	< 1.5	0.62
41	4	< 2.1	< 1.5	< 1.7	0.28
42	4	< 2.0	< 1.5	< 1.8	0.23
43	4	< 1.7	< 1.3	< 1.5	0.16
44	4	< 2.5	< 1.2	< 1.9	0.52
45	4	1.9	< 1.3	< 1.6	0.24
46	4	< 1.8	< 1.2	< 1.5	0.23
Network summary	52	6.5	< 0.82	< 1.8	0.22

[a] 95% confidence coefficient about the average of more than two samples.

[b] See Figure 1.

Table 48. 1986 radioactivity in grass samples from the remote monitoring stations[a]

Location	Concentration (Bq/kg dry wt)						
	^{90}Sr	^{137}Cs	^{238}Pu	^{239}Pu	^{234}U	^{235}U	^{238}U
51	4.2	1.6	< 0.01	< 0.01	1.1	0.15	0.43
52	17	4.7	< 0.01	< 0.01	3.4	0.066	0.59
53	5.0	< 1.0	0.0096	< 0.006	1.1	0.065	0.38
55	8.6	3.8	< 0.01	0.0021	2.4	0.14	0.79
56	7.8	6.1	< 0.01	0.025	13	0.85	4.8
57	8.8	3.2	0.0086	< 0.001	2.5	0.49	0.48
58	5.9	< 1.5	< 0.01	< 0.01	2.3	0.15	0.52
Network average	8.2	< 3.1	< 0.01	< 0.009	3.7	0.27	1.1

[a] See Figure 2.

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