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Environmental Surveillance Data Report for the Third Quarter of 1986

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ORNL/M-174

ENVIRONMENTAL SURVEILLANCE DATA REPORT FOR THE THIRD QUARTER OF 1986

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Prepared by the
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Environmental and Occupational Safety Division
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Oak Ridge, Tennessee 37831
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EXECUTIVE SUMMARY

During the third quarter of 1986, over 1900 samples which represent over 6700 analyses and measurements were collected by the Department of Environmental Management. Eleven real-time air monitoring stations which telemeter 10-minute averaged readings on radiation levels and total rainfall around ORNL also reported data. Three real-time water monitoring stations that transmit flow and water quality data were put into operation.

The ^{131}I concentrations in air and milk which were significantly elevated during the second quarter by the Chernobyl nuclear incident have returned to normal. When compared to the second quarter, no significant differences were observed in the average concentrations of ^{90}Sr in milk and air in the immediate Oak Ridge and remote areas.

Greater than 80% 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 problem, will be one of the highest priorities of the Remedial Investigation Feasibility Study subcontract scheduled to be awarded in early 1987.

A new National Pollutant Discharge Elimination System (NPDES) permit was issued to ORNL by the state of Tennessee and the EPA in April. Under the requirements of this permit, for the period July 1 through September 30, 1986, approximately 800 samples were collected from 183 physical locations and approximately 2600 analyses were performed. During this period, permit limits were exceeded on twenty-six occasions.

Groundwater samples from four deep wells around the ORNL surface impoundment areas 3524, 3539-40, 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 Miles (CRMs) 5.0, 20.8, and 25 and analyzed for radionuclides. In addition, fish from CRM 20.8 and 25.0 were analyzed for mercury and PCBs. The highest concentrations of constituents were in fish collected from CRM 20.8 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.

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 are 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. At the end of the calendar year, the data will be 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. Each air station has 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. It currently has no sampling capability.

(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 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, tritium, gross alpha, and gross beta. The real-time monitoring system is the only measure of noble gases in the area.

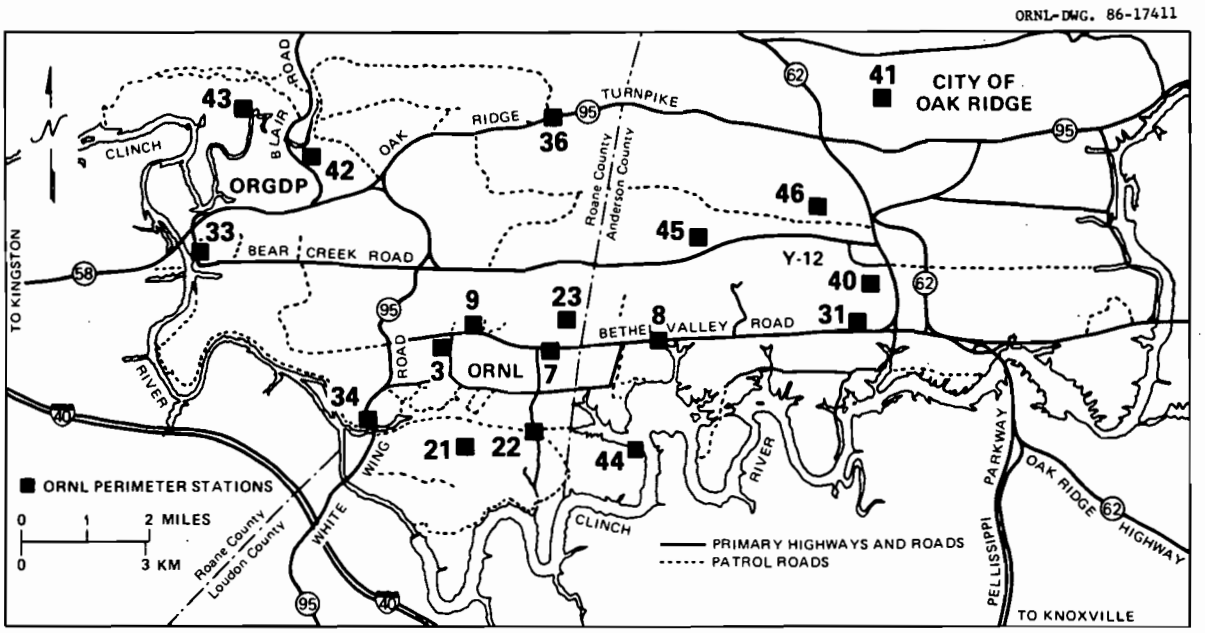

Fig. 1 Location map of the ORNL perimeter and Oak Ridge Reservation air monitoring stations

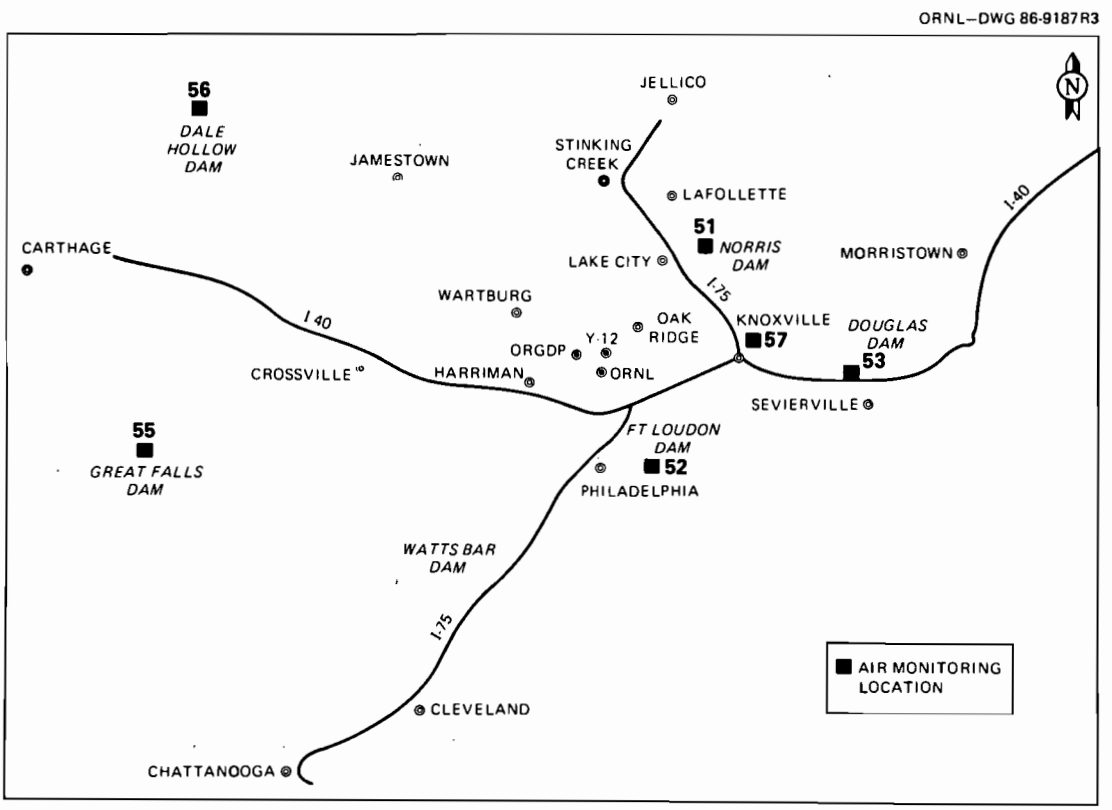

Fig. 2 Location map of the remote air monitoring stations

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 3-45 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 (July-September) 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. Beginning this 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 a significant decrease in ^{131}I concentrations, indicating that the higher radioactivity levels observed in the Oak Ridge area during the second quarter as a result of the cloud from the Chernobyl incident are not continuing. The elevated ^{131}I concentration at station 43 (see Table 4) is caused by a high reading during week 31. This is presumed to be an artifact because there were no similar increases at other stations. Unfortunately, due to the short half-life of ^{131}I, verification is not possible. Station 9 is missing from the tables containing July and August data because the flow rate for the sampling apparatus is either above (> 3.0 CFM) or below (< 1.5 CFM) the sampling volume required to produce accurate results. By setting these upper and lower limits on flow rate, the bias is eliminated from the calculation of the concentration.

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.

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

July 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	2	-1.2	-1.3	-1.3		2	49	45	47	
7	5	19	-1.2	5.0	8.2	5	110	18	73	34
Network summary	7	19	-1.3	3.2	6.1	7	110	18	66	25
Reservation PAM Stations[b]										
8	5	16	-1.0	7.2	7.4	5	170	78	100	34
23	3	3.2	-1.3	0.63	2.7	3	150	24	92	75
31	5	6.0	-1.0	1.7	3.2	5	130	78	100	22
33	4	7.6	-1.3	1.2	4.2	4	76	39	64	17
34	5	6.5	-1.3	1.4	3.4	5	78	12	33	24
36	5	21	5.2	8.7	6.0	5	130	67	89	21
40	5	24	-1.8	8.8	10	5	130	31	82	33
41	2	15	-1.7	6.7		2	91	43	67	
42	5	6.0	-1.0	0.50	2.8	5	93	42	67	18
43	5	19	-1.5	5.9	7.5	5	120	52	91	31
44	4	19	-1.2	7.9	8.7	4	79	17	62	30
45	3	6.0	-0.91	1.4	4.6	3	73	43	60	17
Network summary	51	24	-1.8	4.4	2.0	51	170	12	77	9.7

Table 1. (Continued)

July 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)									
	RAM Stations[c]									
51	5	8.0	0	2.9	3.0	5	14	4.0	7.2	3.6
52	5	8.8	0	3.0	4.2	5	2.9	-13	-8.2	7.5
53	5	5.6	0	1.4	2.8	5	25	-2.9	11	12
55	4	7.9	0	4.0	4.6	4	11	-0.26	5.4	5.8
56	4	11	5.4	8.6	2.5	4	38	7.9	19	14
57	5	17	0	7.8	6.5	5	19	0.22	15	7.5
Network summary	28	17	0	4.7	1.9	28	38	-13	8.5	4.6
Overall summary	86	24	-1.8	4.4	1.4	86	170	-13	55	9.4

[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

August 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]
					ORNL PAM Stations[b]					
3	4	15	-11	3.5	12	4	190	15	71	82
7	4	0	-13	-6.4	6.7	4	97	39	62	26
Network summary	8	15	-13	-1.5	7.3	8	190	15	66	40
					Reservation PAM Stations[b]					
8	4	15	-10	3.3	11	4	100	67	84	15
23	4	22	-10	0.7	15	4	140	52	98	38
31	2	5.9	0	2.9		2	100	71	87	
33	4	26	0	6.5	13	4	86	15	51	37
34	4	12	-10	-0.29	11	4	84	16	39	31
36	4	16	-1.0	5.9	7.9	4	78	59	70	8.0
40	4	0	-9.6	-4.5	4.8	4	77	29	58	20
41	3	8.6	-17	-8.6	17	3	52	26	43	17
42	3	0	-10	-6.9	6.9	3	62	47	52	10
43	4	39	-13	6.9	24	4	97	32	55	31
44	2	0	-15	-7.6		2	82	23	53	
45	1			-1.7		1			43	
Network summary	39	39	-17	0.42	3.9	39	140	15	62	9.3

Table 2. (Continued)

August 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)									
	RAM Stations[c]									
51	4	9.1	0	3.9	4.6	4	32	0.17	11	14
52	4	2.8	0	0.69	1.4	4	-6.2	-14	-9.5	3.1
53	3	4.9	0	2.6	2.9	3	8.5	-5.6	-0.70	9.2
55	4	8.1	0	3.8	3.4	4	2.6	-5.3	-0.32	3.5
56	3	5.4	2.4	3.5	1.9	3	19	-1.2	6.0	13
57	4	6.5	0	3.6	2.7	4	11	-0.38	5.3	5.3
Network summary	22	9.1	0	3.0	1.2	22	32	-14	2.0	4.3
Overall summary	69	39	-17	1.0	2.4	69	190	-14	43	9.8

[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

September 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]
					ORNL PAM Stations[b]					
3	4	-9.7	-15	-11	2.7	4	65	13	30	24
7	4	0	-9.7	-7.3	4.9	4	140	52	83	38
9	4	0	-15	-7.7	6.2	4	120	45	99	37
Network summary	12	0	-15	-8.7	2.7	12	140	13	71	25
					Reservation PAM Stations[b]					
8	4	0	-12	-5.0	6.0	4	160	36	110	51
23	4	0	-7.8	-1.9	3.9	4	130	54	95	33
31	3	0	-9.7	-3.2	6.5	3	140	69	110	43
33	4	0	-13	-9.7	6.5	4	130	43	88	37
34	2	-7.8	-12	-9.9		2	48	26	37	
36	4	0	-12	-6.9	5.0	4	97	73	80	11
40	3	8.6	0	5.8	5.8	3	130	40	75	51
41	3	0	-7.8	-2.6	5.2	3	190	54	110	82
42	4	10	-7.5	0.72	7.3	4	110	65	83	19
43	4	-9.7	-15	-11	2.7	4	100	7.6	72	44
44	4	14	-12	1.1	12	4	86	35	61	23
Network summary	39	14	-15	-3.9	2.4	39	190	7.6	85	12

Table 3. (Continued)

September 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)									
RAM Stations[c]										
51	4	3.2	0	2.3	1.5	4	6.5	-6.5	1.9	3.4
52	4	7.4	3.2	4.4	2.0	4	3.4	-11	-6.2	6.6
53	3	3.0	0	1.0	2.0	3	5.4	-2.7	1.9	4.8
55	3	10	0	4.3	6.2	3	-2.1	-2.9	-2.5	0.49
56	4	9.0	0	3.9	3.8	4	13	1.5	8.3	5.3
57	4	6.5	0	3.2	2.8	4	6.5	2.2	4.0	2.2
Network summary	22	10	0	3.2	1.2	22	13	-11	1.4	2.6
Overall summary	73	14	-15	-2.5	1.7	73	190	-11	57	12

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

[b] See Figure 1.

[c] See Figure 2.

Table 4. Iodine - 131 in Air

July 1986

Location	No. of samples	Concentration (10^{-8} Bq/L) Max	Min	Av	95%cc[a]
		ORNL Perimeter Stations[b]			
3	2	0	-2.5	-1.2	
7	5	12	-2.2	5.9	4.7
Network summary	7	12	-2.5	3.8	4.2
		Reservation Perimeter Stations[b]			
8	5	5.8	-5.6	0.034	3.6
23	3	12	-2.5	2.5	9.8
31	5	15	-2.3	3.1	6.5
33	4	0	-6.1	-3.3	2.7
34	5	7.2	0	1.9	2.8
36	5	13	-2.0	5.9	5.5
40	5	7.4	0	2.3	2.7
41	2	3.3	-11	-3.9	
42	5	7.7	-4.2	2.5	4.8
43	5	60	-2.3	17	22
44	4	12	-1.3	4.1	6.2
45	3	4.1	-3.5	0.20	4.4
Network summary	51	60	-11	3.2	2.7
Overall summary	58	60	-11	3.3	2.4

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

[b] See Figure 1.

Table 5. Iodine - 131 in Air

August 1986

Location	No. of samples	Concentration (10^{-8} Bq/L) Max	Min	Av	95%cc[a]
		ORNL Perimeter Stations[b]			
3	4	8.2	-3.1	0.47	5.2
7	4	16	-1.5	6.2	7.1
Network summary	8	16	-3.1	3.3	4.6
		Reservation Perimeter Stations[b]			
8	4	7.4	-4.2	0.088	5.0
23	4	6.3	-3.7	0.31	4.3
31	2	9.6	0	4.8	9.6
33	4	2.0	-8.2	-4.1	4.9
34	4	2.6	-4.8	-1.9	3.4
36	4	9.8	0	2.8	4.7
40	4	3.9	0	1.9	2.1
41	3	9.3	-7.0	1.6	9.5
42	3	7.0	1.4	3.3	3.7
43	4	1.8	-5.3	-0.49	3.3
44	2	4.2	2.1	3.1	
45	1			-7.0	
Network summary	39	9.8	-8.2	0.45	1.5
Overall summary	47	16	-8.2	0.94	1.5

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

[b] See Figure 1.

Table 6. Iodine - 131 in Air

September 1986

Location	No. of samples	Concentration (10^{-8} Bq/L) Max	Min	Av	95%cc[a]
		ORNL Perimeter Stations[b]			
3	4	14	0	4.5	6.4
7	4	5.3	0	1.8	2.5
9	4	6.1	-5.6	2.9	5.7
Network summary	12	14	-5.6	3.1	2.8
		Reservation Perimeter Stations[b]			
8	4	5.6	-4.2	0.70	4.1
23	4	1.6	-6.5	-1.3	3.8
31	3	6.6	2.3	4.7	2.5
33	4	9.3	-8.2	-1.5	8.1
34	2	-1.4	-1.6	-1.5	
36	4	7.0	-4.2	2.1	5.2
40	3	8.2	-4.1	0.97	7.4
41	3	4.9	-1.4	1.9	3.7
42	4	8.0	-1.4	4.9	4.2
43	4	2.0	-8.8	-1.7	4.8
44	4	1.3	-4.9	-0.9	2.9
45					
Network summary	39	9.3	-8.8	0.74	1.5
Overall summary	51	14	-8.8	1.3	1.3

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

[b] See Figure 1.

Table 7. Tritium activity in air

July - September 1986

Location[a]	No. of samples	Concentration (10^{-4} Bq/L) Max	Min	Av	95%cc[b]
3	3	4.4	2.4	3.6	1.2
7	3	22	7.7	13	9.4
8	3	2.6	0.7	1.8	1.1
Overall summary	9	22	0.7	6.0	4.4

[a] See Figure 1.

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

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 were analyzed 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 second quarter are given in Table 8. As expected, due to the Chernobyl incident, radioactivities for all locations in the second quarter were generally higher than the previous quarter. Three relatively short lived radionuclides (^{134}Cs, ^{103}Ru, and ^{106}Ru) were also found in the second quarter. The concentration of ^{90}Sr at ORNL PAMs is 240 x 10^{-10} Bq/L which is approximately a 10-fold increase from last year's quarterly averages (23 x 10^{-10} Bq/L). During the same period, the ^{90}Sr concentration in milk showed no significant difference from 1985.

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

April - June 1986

Radionuclide	Concentration (10^{-10} Bq/L) Location[a] ORNL PAMs	Reservation PAMs	RAMs	Station 34	Station 36	Station 40	Station 41
^{134}Cs	7600	500	190	ND[b]	590	930	1100
^{137}Cs	15000	1100	420	980	860	1900	2800
^{238}Pu	< 0.28	0.01	< 0.06	< 0.67	0.27	< 0.54	0.98
^{239}Pu	0.69	< 0.80	0.01	0.62	0.81	1.2	< 0.16
^{103}Ru	12000	770	260	ND[b]	590	1900	1800
^{106}Ru	6000	450	190	ND[b]	ND[b]	780	1200
^{90}Sr	240	27	68	< 150	120	97	390
^{228}Th	48	11	8.8	5.7	17	17	29
^{230}Th	48	10	9.2	6.7	15	16	21
^{232}Th	53	13	10	5.7	17	14	23
^{234}U	140	160	12	34	81	840	230
^{235}U	19	15	0.99	3.5	6.5	51	29
^{238}U	76	47	10	22	32	110	88

[a] See Figures 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 at the remote air monitoring stations and two are placed in containers at the other locations. 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 are in Tables 9-11.

External gamma radiation levels measured at the ORNL and Reservation perimeter stations were similar to the respective second quarter levels. The average value for stations along the Clinch River was less than the two previous quarters. The second quarter value, which was higher than previous years, may have been elevated by the Chernobyl incident.

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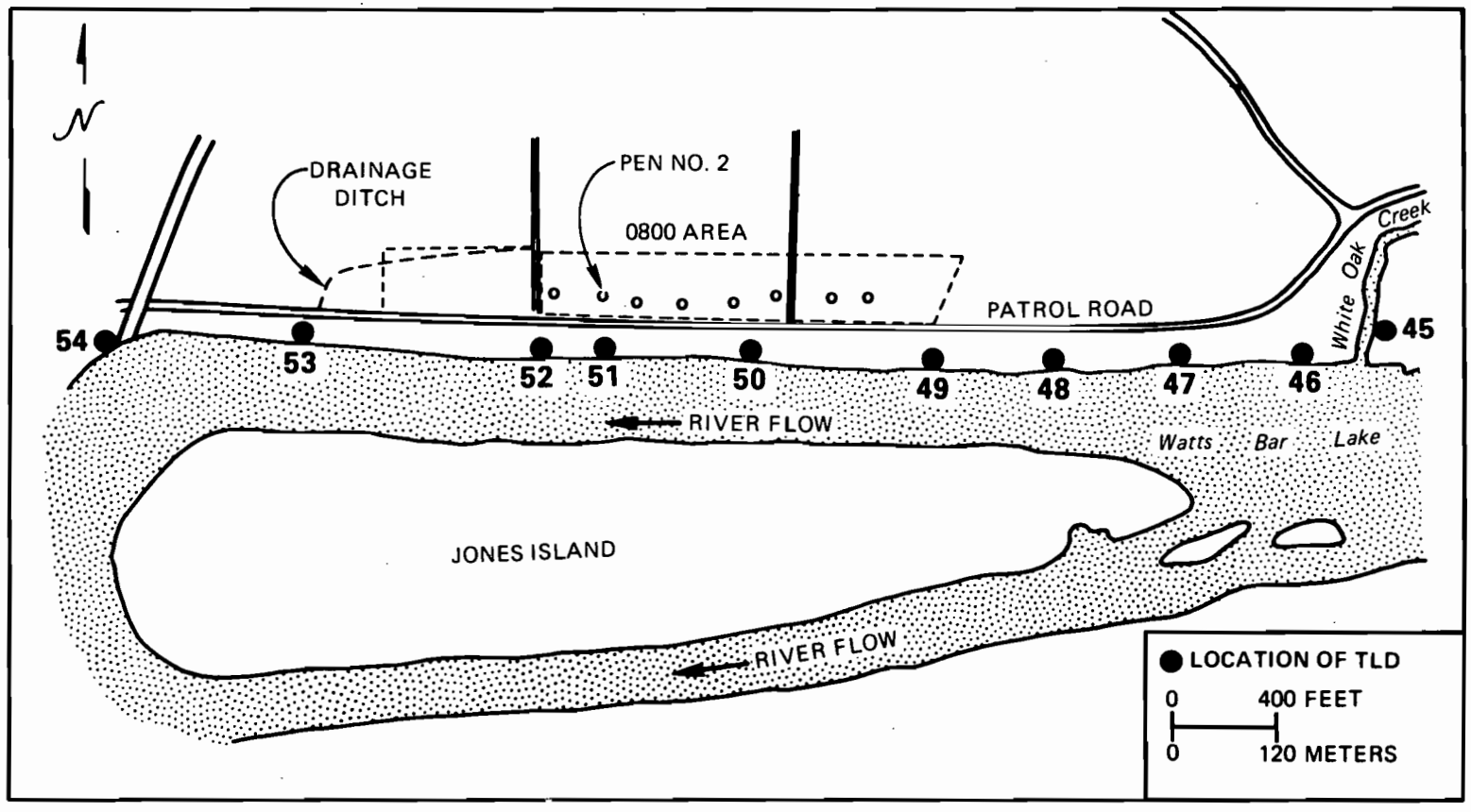

Fig. 3 Location map of TLDs along the Clinch River

Table 9. External gamma radiation measurements at ORNL and reservation perimeter air monitoring stations

July - September 1986

Location	No. of samples[a]	Concentration (μR/h) Max	Min	Av	95%cc[b]
		ORNL PAM Stations			
3	2	13	7.3	10	
7	2	9.7	8.3	9.0	
9	2	11	7.7	9.2	
21	2	11	9.3	10	
22	2	11	10	11	
Network summary	10	13	7.3	9.8	1.1
		Reservation PAM Stations			
8	2	7.7	5.7	6.7	
23	2	8.0	6.3	7.2	
31	45	11	7.3	7.9	0.2
33	41	8	7.3	7.6	0.06
34	60	10	7.7	8.8	0.15
36	75	8.0	7.1	7.4	0.04
40	84	8.6	7.5	8.1	0.05
41	77	8.8	7.9	8.1	0.03
42	76	7.9	7.0	7.4	0.05
43	65	7.7	6.3	7.1	0.05
44	87	8.2	6.9	7.2	0.04
45	52	7.7	6.9	7.2	0.04
46	6	9.3	9.0	9.2	0.07
Network summary	672	13	5.7	7.7	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. No data available for the month of July.

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 10. External gamma radiation measurements at remote stations

January - August 1986

Location[a]	No. of Samples[b]	Concentration (μR/h)
51	1	5.3
52	1	7.1
53	1	6.7
55	1	4.5
56	1	5.4
57	1	5.8
58	1	11
Network Average		6.5

[a] See Figure 2.

[b] Individual dosimeters are averaged for each station. The number of samples indicate the number of semi-annual periods of data.

Table 11. External gamma radiation measurements along the Clinch River

July - September 1986

Location[a]	No. of Samples[b]	Concentration (μR/h)
45	1	7.3
46	1	10
47	1	5.3
48	1	6.7
49	1	14
50	1	25
51	1	25
52	1	1.9
53	1	9.7
54	1	5.7
Quarterly average		13

[a] See Figure 3.

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

WATER

Most 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.

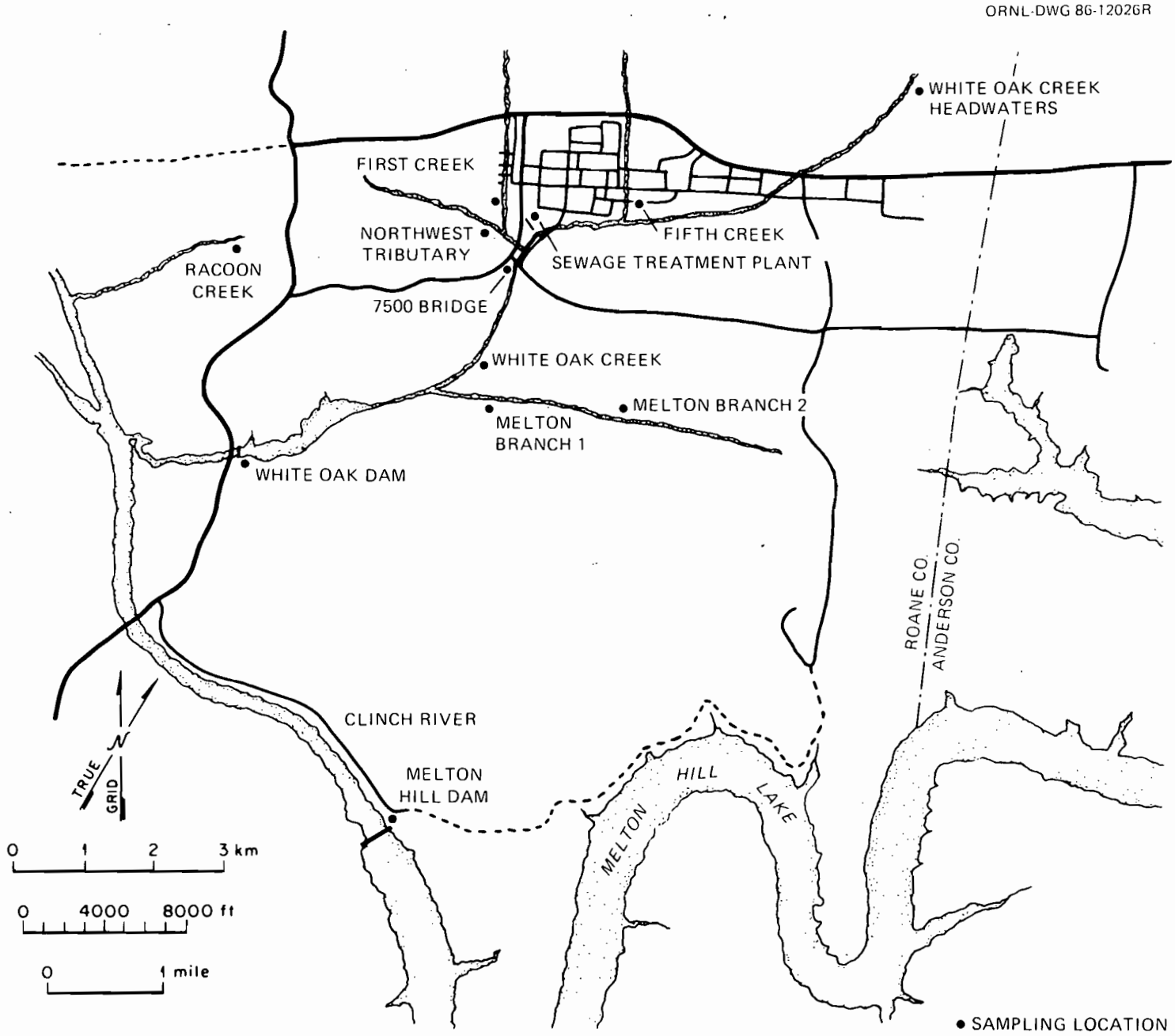

Fig. 4 Location map of ORNL streams and sampling stations

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 (NWT), 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 13-15. The 95% confidence coefficients about the averages are not appropriate and have not been presented for stations with less than three samples. Concentrations of ^{90}Sr and total Sr (^{89}Sr and ^{90}Sr) are presented in Tables 13-14. Samples collected during the month of July and three weeks of August were analyzed for ^{90}Sr while those collected later were analyzed for total Sr. The change in the analytical method for strontium was instituted by the Analytical Chemistry Division to comply with the method recommended by EPA.

Flows in the Clinch River as measured at Melton Hill Dam and in WOC as measured at WOD and the ratio of these flows are presented in Table 16.

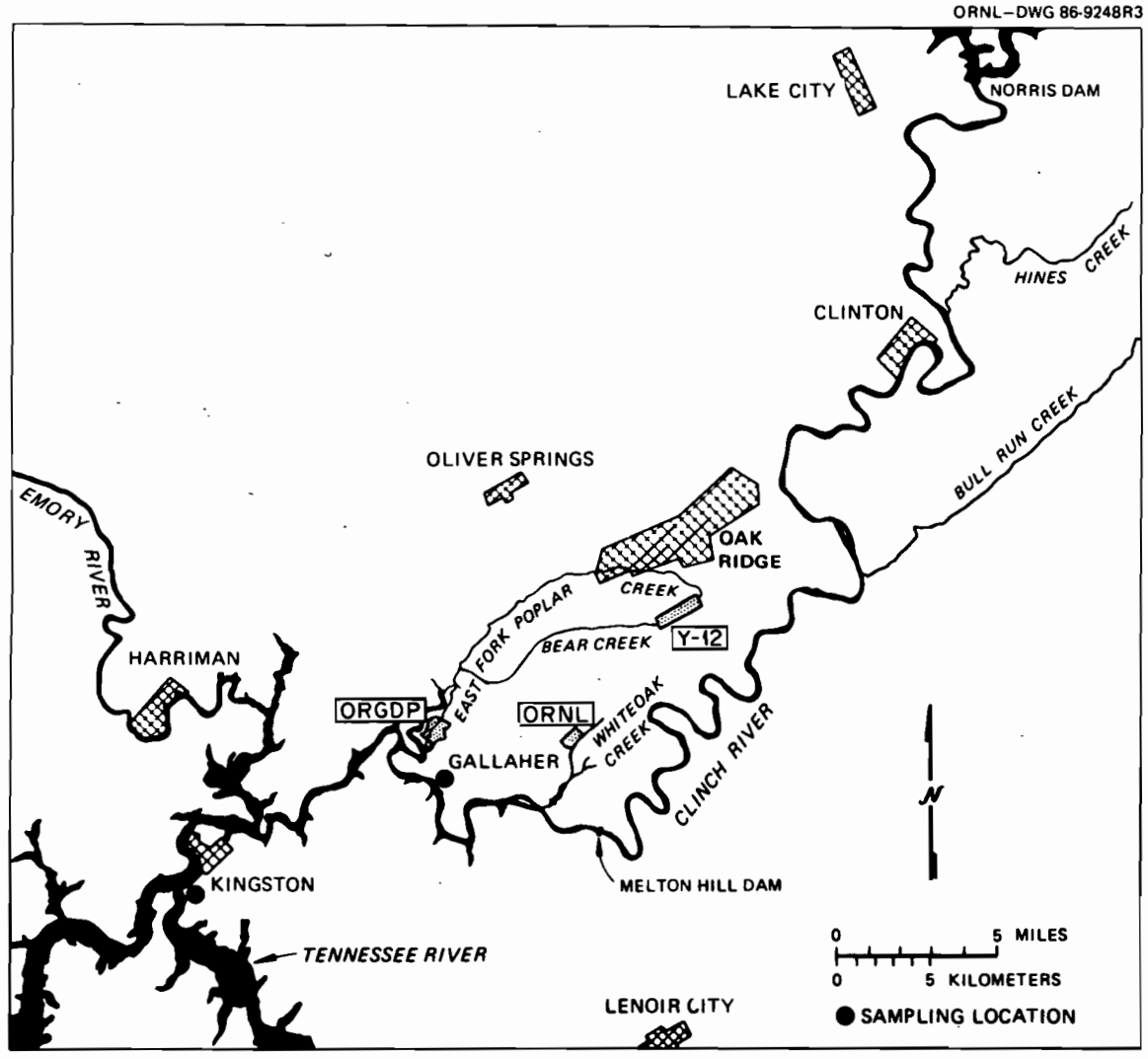

Fig. 5 Location map of Gallaher and Kingston sampling points

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, 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

Table 13. Radionuclide concentrations in water

July - September 1986

Radionuclide	No. of samples	Concentration (Bq/L) Max	Min	Av	95%cc[a]
		First Creek[b]			
^{60}Co	3	< 0.30	< 0.10	< 0.20	0.12
^{137}Cs	3	< 1.0	< 0.20	< 0.53	0.48
^{90}Sr	1			30	
Total Sr	2	35	26	31	
		Fifth Creek[b]			
^{60}Co	3	< 0.30	< 0.10	< 0.20	0.12
^{137}Cs	3	< 0.30	< 0.10	< 0.23	0.13
^{90}Sr	1			1.3	
Total Sr	2	1.5	1.3	1.4	
		7500 Bridge[b]			
^{60}Co	3	< 0.60	< 0.20	< 0.37	0.24
^{137}Cs	3	8.4	4.3	6.5	2.4
^{3}H	3	300	130	210	97
^{90}Sr	1			2.8	
Total Sr	2	5.7	3.9	4.8	
		Melton Branch 1[b]			
^{60}Co	3	8.3	6.0	7.4	1.4
^{137}Cs	3	< 0.40	< 0.10	< 0.32	0.20
^{3}H	3	55000	19000	36000	21000
^{90}Sr	1			5.4	
Total Sr	2	6.6	2.3	4.5	
		Melton Branch 2[b]			
^{60}Co	3	13	4.2	8.7	5.1
^{137}Cs	3	< 0.40	< 0.10	< 0.27	0.18
^{3}H	3	6300	4500	5500	1000
^{90}Sr	1			0.10	
Total Sr	2	0.72	0.12	0.42	

Table 13. (Continued)

July - September 1986

Radionuclide	No. of samples	Concentration (Bq/L) Max	Min	Av	95%cc[a]
		Melton Hill Dam [b]			
^{60}Co	3	< 0.30	< 0.10	< 0.17	0.13
^{137}Cs	3	< 0.30	< 0.10	< 0.17	0.13
^{3}H	3	120	120	120	0
Pu	3	0.0010	0.0010	0.0010	0.00033
^{90}Sr	1			< 0.10	
Total Sr	2	0.26	0.040	0.13	
^{228}Th	3	0.0020	< 0.00020	0.0010	0.00093
^{230}Th	3	0.0020	< 0.00020	0.0010	0.00095
^{232}Th	3	0.0010	< 0.00020	0.0010	0.00047
Trans Pu	3	0.0020	0.0010	0.0015	0.00060
^{234}U	3	0.018	0.014	0.016	0.0023
^{235}U	3	0.0031	0.00060	0.0016	0.0015
^{238}U	3	0.12	0.022	0.077	0.058
		Northwest Tributary[b]			
^{60}Co	3	< 0.20	< 0.10	< 0.17	0.067
^{137}Cs	3	0.30	< 0.10	0.20	0.12
^{90}Sr	1			0.11	
Total Sr	2	0.33	0.10	0.22	
		Raccoon Creek[b]			
^{60}Co	3	< 0.20	< 0.10	< 0.17	0.067
^{137}Cs	3	< 0.20	< 0.10	< 0.17	0.067
^{90}Sr	1			6.6	
Total Sr	2	6.2	5.8	6.0	
		Sewage Treatment Plant[b]			
^{60}Co	3	< 0.30	< 0.20	< 0.26	0.061
^{137}Cs	3	< 0.31	< 0.30	< 0.30	0.067
^{90}Sr	1			3.7	
Total Sr	2	3.9	3.8	3.9	
		White Oak Creek[b]			
^{60}Co	3	< 0.30	< 0.20	< 0.27	0.067
^{137}Cs	3	7.2	4.5	6.2	1.7
^{3}H	3	220	130	180	51
^{90}Sr	1			3.6	
Total Sr	2	5.8	5.3	5.6	

Table 13. (Continued)

July - September 1986

Radionuclide	No. of samples	Concentration (Bq/L) Max	Min	Av	95%cc[a]
		White Oak Creek Headwaters[b]			
^{60}Co	3	< 0.20	< 0.10	< 0.13	0.067
^{137}Cs	3	< 0.30	< 0.10	< 0.17	0.13
^{3}H	3	120	120	120	0
Pu	3	0.0010	0.0010	0.0010	0.00013
^{90}Sr	1			0.17	
Total Sr	2	0.10	0.080	0.090	
^{228}Th	3	0.0010	< 0.00020	0.00040	0.00037
^{230}Th	3	0.0013	0.00050	0.0010	0.00048
^{232}Th	3	0.00040	< 0.00020	0.00030	0.00012
Trans Pu	3	0.0020	0.0010	0.0016	0.00053
^{234}U	3	0.021	0.012	0.016	0.0052
^{235}U	3	0.0050	0.0010	0.0024	0.0026
^{238}U	3	0.10	0.023	0.070	0.049
		White Oak Dam[b]			
^{60}Co	13	1.3	< 0.30	0.65	0.19
^{137}Cs	13	12	0.63	4.3	1.9
Gross alpha	13	4.0	0.60	2.2	0.62
Gross beta	13	24	10	18	2.4
^{3}H	13	4000	1500	2800	460
Pu	13	0.062	0.0030	0.020	0.010
^{90}Sr	8	5.4	3.1	4.6	0.53
Total Sr	5	8.0	4.2	5.9	1.5
Trans Pu	13	0.10	0.0020	0.040	0.017

[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]

July - September 1986

Radionuclide	No. of samples	Concentration (Bq/L) Max	Min	Av	95% cc[b]
		July			
^{60}Co	18	0.49	< 0.10	0.27	0.043
^{137}Cs	18	17	2.6	8.5	1.9
^{24}Na	2	1.0	0.48	0.74	
^{90}Sr	20	7.1	1.9	2.8	0.49
		August			
^{60}Co	18	< 0.90	< 0.20	< 0.37	0.076
^{137}Cs	18	24	6.6	13	2.4
^{90}Sr	21	31	1.6	5.6	2.7
		September			
^{60}Co	21	5.3	< 0.20	0.62	0.47
^{137}Cs	21	23	1.4	10	2.8
^{131}I	3	0.53	< 0.20	0.39	0.20
^{90}Sr	1			6.0	
Total Sr	20	16	2.3	6.1	1.7

[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

April - June 1986

Radionuclide	Concentration (Bq/L)
Gallaher[a]	
^{60}Co	< 0.0060
^{137}Cs	< 0.0050
Gross alpha	0.18
Gross beta	0.57
^{3}H	53
Pu[b]	< 0.00011
^{90}Sr	0.14
^{234}U	0.0053
^{235}U	0.00016
^{236}U	< 0.0000062
^{238}U	0.0032
Kingston[a]	
^{60}Co	< 0.0030
^{137}Cs	< 0.0030
Gross alpha	0.038
Gross beta	0.15
^{3}H	14
Pu[b]	< 0.00011
^{90}Sr	0.0070
^{234}U	0.0047
^{235}U	0.00016
^{236}U	0.000066
^{238}U	0.0031
ORNL Tap Water	
^{60}Co	< 0.0050
^{137}Cs	< 0.0040
Gross alpha	0.038
Gross beta	0.14
Pu[b]	< 0.00011
^{90}Sr	0.042
^{234}U	0.0059
^{235}U	0.00016
^{236}U	< 0.0000064
^{238}U	0.0033

[a] See Figure 5.

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

Table 16. Flows for Clinch River and White Oak Creek

July - September 1986

Month	Flow (10^9 Liters)		Average Ratio[b]
	Clinch River[a]	White Oak Creek[a]	
July	250	0.72	360
August	170	0.56	300
September	240	0.57	450

[a] See Figure 4.

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

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 17-19). 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 17-19). 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 17-19).

The concentrations of ^{60}Co appear to be highest at Melton Branch stations 1 and 2 (Table 13) while ^{137}Cs concentrations are highest in WOC (Table 13). Most of the ^{3}H is derived from SWSA 5 near the MB1 station and the highest concentrations of that radionuclide are observed there (Table 13). The highest concentrations of ^{90}Sr are found at the First Creek station due to probable 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 third quarter of 1986, greater than 80% of the ^{3}H discharges over WOD could be accounted for by the discharges of ^{3}H over the MB1 weir (Tables 17-19). 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 problem in SWSA 5 will be one of the highest priorities of the Remedial Investigation Feasibility 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.

Table 17. Discharges of radionuclides in water

July 1986

Radionuclide	Flow (10^6 Liters)	Concentration (Bq/L)	Discharge (10^4 mega Bq)
		Melton Branch 1[a]	
^{60}Co	57	8.0	0.046
^{137}Cs	57	< 0.10	0.00060
^{3}H	57	33000	190
^{90}Sr	57	5.4	0.031
		Sewage Treatment Plant[a]	
^{60}Co	22	0.28	0.00062
^{137}Cs	22	0.31	0.00069
^{90}Sr	22	3.7	0.0081
		White Oak Creek[a]	
^{60}Co	680	0.20	0.014
^{137}Cs	680	7.2	0.49
^{3}H	680	220	15
^{90}Sr	680	3.6	0.24
		White Oak Dam[a,b]	
^{60}Co	720	0.74	0.053
^{137}Cs	720	3.5	0.25
Gross alpha	720	2.2	0.16
Gross beta	720	18	1.3
^{3}H	720	2900	210
^{90}Sr	720	4.5	0.32
Transuranics	720	0.040	0.0030

[a] See Figure 4.

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

Table 18. Discharges of radionuclides in water

August 1986

Radionuclide	Flow (10^6 Liters)	Concentration (Bq/L)	Discharge (10^4 mega Bq)
		Melton Branch 1[a]	
^{60}Co	38	6.0	0.023
^{137}Cs	38	< 0.40	< 0.0015
^{3}H	38	19000	73
Total Sr	38	2.3	0.0087
		Sewage Treatment Plant[a]	
^{60}Co	22	< 0.30	< 0.00060
^{137}Cs	22	0.30	0.00060
Total Sr	22	3.8	0.0085
		White Oak Creek[a]	
^{60}Co	530	< 0.30	0.016
^{137}Cs	530	6.8	0.36
^{3}H	530	130	6.9
Total Sr	530	5.3	0.28
		White Oak Dam[a,b]	
^{60}Co	560	< 0.79	< 0.044
^{137}Cs	560	5.8	0.32
Gross alpha	560	2.0	0.11
Gross beta	560	19	1.1
^{3}H	560	2200	130
Total Sr[c]	560	6.0	0.34
Transuranics	560	0.10	0.0055

[a] See Figure 4.

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

[c] Concentration is an average of three samples analyzed for ^{90}Sr and one sample analyzed for total Sr.

Table 19. Discharges of radionuclides in water

September 1986

Radionuclide	Flow (10^6 Liters)	Concentration (Bq/L)	Discharge (10^4 mega Bq)
		Melton Branch 1[a]	
^{60}Co	40	8.3	0.034
^{137}Cs	40	< 0.40	< 0.0016
^{3}H	40	55000	220
Total Sr	40	6.6	0.027
		Sewage Treatment Plant[a]	
^{60}Co	22	< 0.20	< 0.00040
^{137}Cs	22	< 0.30	< 0.00060
Total Sr	22	3.9	0.0086
		White Oak Creek[a]	
^{60}Co	530	< 0.30	< 0.016
^{137}Cs	530	4.5	0.24
^{3}H	530	180	9.6
Total Sr	530	5.8	0.31
		White Oak Dam[a,b]	
^{60}Co	570	< 0.55	< 0.032
^{137}Cs	570	4.6	0.26
Gross alpha	570	2.3	0.13
Gross beta	570	17	0.99
^{3}H	570	3400	200
Total Sr	570	6.0	0.32
Transuranics	570	0.070	0.0040

[a] See Figure 4.

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

Tritium discharges at WOD, WOC, STP, and MB1 were two to four times lower than their respective second quarter discharges Table (17-19). The decreases in the ^3H discharges were due primarily to lower measured concentrations. Strontium discharges from ORNL, unlike ^3H 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 similar to those observed in the second quarter. The concentrations and discharges of strontium at White Oak Dam during the second and third quarters have been below normal. This can be attributed to the lower than normal 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

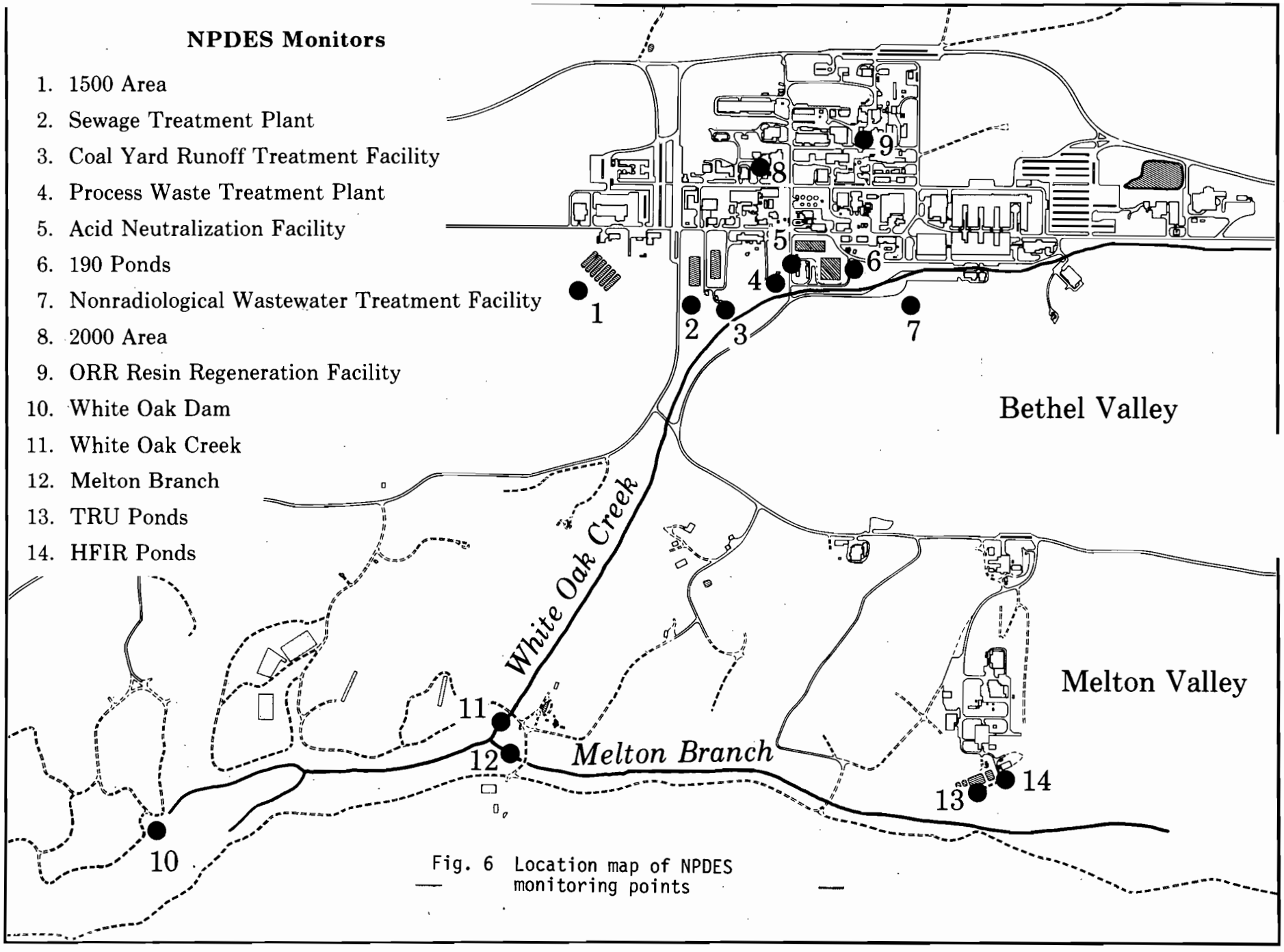

Fig. 6 Location map of NPDES monitoring points

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.

The mercury, PCB, and radiological monitoring plan have been developed. Their implementation is scheduled for January 1, 1987. The Biological Monitoring Plan is being conducted by the Environmental Sciences Division.

Data collected for the NPDES permit are summarized monthly and submitted to DOE. These data are available upon request. Values outside the specified permit limits (noncompliances) are given in Table 20.

Most total suspended solids and oil and grease noncompliances at Category II Outfalls can be attributed to the extremely dry weather experienced during the third quarter. Flows from these outfalls are usually dependent upon rainfall via parking lot drains, and samples must be collected either during or right after a rain event. All Category II Outfalls were sampled on August 11, 1986. According to the U.S. Department of Commerce data, the last significant rainfall preceding August 11 occurred on July 13 (28 days). Due to the lack of rainfall, sufficient buildup of dirt, dust, oil, etc., will occur which increases the potential for total suspended solids and oil and grease violations. A check was made by the Department of Environmental Management after the August 11 violations were reported and each of the oil and grease violations could be directly related to a parking lot grate near an area where a considerable amount of motor oil/grease had accumulated.

The fecal coliform noncompliances at the Sewage Treatment Plant are thought to be due to the lower chlorine concentrations required under the new NPDES permit. The old permit allowed concentrations up to 2 mg/L while the current permit regulates chlorine concentrations to below 0.5 mg/L. These lower concentrations of chlorine have not effectively killed the fecal coliform bacteria. The plant operators are currently adjusting the levels of chlorine in order to maintain permit limits for chlorine while controlling the fecal coliform bacteria.

The permit noncompliances resulting from the operation of the cooling systems are being studied to develop new strategies for minimizing the impact of those operations on the environment. These studies include acceptable methods of algae and bacterial control and disinfection systems. Until studies are complete and improvements are made, infrequent violations will continue to occur.

Noncompliances in suspended solids at the paint facilities may be due to ineffective filters. These are being investigated to see if maintenance or replacement is required. In addition, samples are being analyzed from the vehicle cleaning and paint facilities to further determine pollutants that might be in these effluent streams. Based on the results of this study, efforts will be made to reduce the pollutants discharged or collect the effluent for further treatment before discharge.

Table 20. Parameters whose values exceed NPDES compliance limits

July - September 1986

Station	Parameter	Concentration (mg/L) Monthly average	Daily average	Daily maximum
	July 1986			
Sewage Treatment Plant	Dissolved Oxygen	5.4		
Sewage Treatment Plant	Fecal Coliform			2,600
Cooling System 3025E	Temperature			38.1
Cooling System 3026	Zinc			1.2
Cooling System 7619	Zinc			1.3
Painting and Corrosion Control Facility 7007	Total Suspended Solids			65
	August 1986			
TRU/TURF Process Waste Basin	pH upper limit			9.4
Category II - 202	Total Suspended Solids			221
Category II - 213	Total Suspended Solids			306
Category II - 216	Total Suspended Solids			1137
Category II - 233	Total Suspended Solids			78
Category II - 265	Oil & Grease			18
Fifth Creek	Visible Oil Sheen			

Table 20. (Continued)

July - September 1986

Station	Parameter	Concentration (mg/L) Monthly average	Daily average	Daily maximum
Vehicle Cleaning (Bldg. 7002)	Total Suspended Solids			71
Painting Facilities (Bldg. 7007)	Total Suspended Solids			66
Sewage Treatment Plant	Oil & Grease			51
Sewage Treatment Plant	Oil & Grease	45		
Coal Yard Runoff	Total Suspended Solids			54
Coal Yard Runoff	Iron, total		11	45
	September 1986			
Painting Facilities (Bldg. 7007)	Total Suspended Solids			148
Vehicle Cleaning (Bldg. 7002)	Fecal Coliform		231	
Sewage Treatment Plant	Fecal Coliform			540
Painting Facilities (Bldg. 7007)	Total Suspended Solids	93		
Vehicle Cleaning (Bldg. 7002)	Total Suspended Solids		29	71

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 21. 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 twice from deep wells 31-013, 31-015, and 32-004 and once from deep well 31-011 which was dry during the second sampling period in September. The samples were 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 22-24. 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 several of the wells exceeded the standards for Ba, gross alpha, Pb, and radium (Table 26). The values for

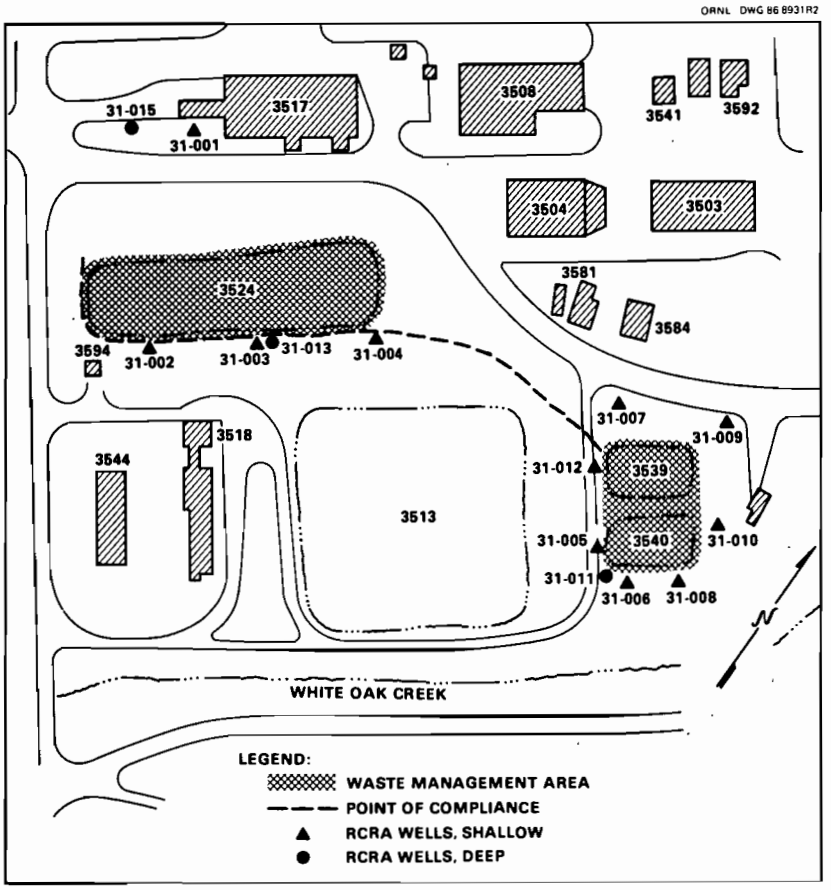

Fig. 7 Locations of sampling wells around ponds 3524, 3539, and 3540

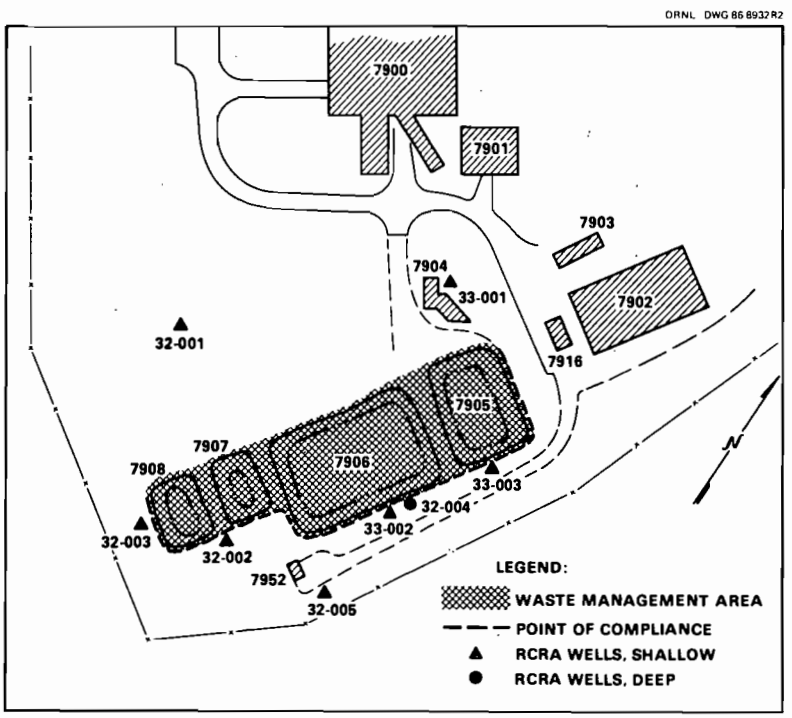

Fig. 8 Locations of sampling wells around ponds 7905, 7906, 7907, and 7908

Table 21. 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 22. Concentrations of parameters in wells around 3524[a]

August - September 1986

Parameter	No. of samples	Concentration (mg/L)[b] Max	Min	Av	95% cc[c]
2,4,5-TP Silvex	4	< 0.010	< 0.010	< 0.010	0
2,4-D	4	< 0.010	< 0.010	< 0.010	0
Ag	4	< 0.0050	< 0.0050	< 0.0050	0
As	4	< 0.010	< 0.010	< 0.010	0
Ba	4	< 1.0	< 1.0	< 1.0	0
Cd	4	< 0.0020	< 0.0020	< 0.0020	0
Cl	4	10	5.2	7.4	2.4
Cr	4	< 0.020	< 0.020	< 0.020	0
Endrin	4	< 0.00020	< 0.00020	< 0.00020	0
F	4	< 1.0	< 1.0	< 1.0	0
Fe	4	0.38	0.26	0.33	0.051
Fecal coliform[d]	4	0	0	0	0
Gross alpha[e]	4	0.20	0.080	0.14	0.053
Gross beta[e]	4	1.4	0.52	0.97	0.50
Hg	4	< 0.00010	< 0.00010	< 0.00010	0
Lindane	4	< 0.0020	< 0.0020	< 0.0020	0
Methoxychlor	4	< 0.0080	< 0.0080	< 0.0080	0
Mn	4	0.28	0.010	0.13	0.13
Na	4	24	17	22	2.9
NO_3	4	< 5.0	< 5.0	< 5.0	0
Pb	4	<0.020	< 0.020	< 0.020	0
pH[f]	28	8.2	7.0	7.4	0.010
Phenols	4	0.0010	< 0.0010	< 0.0010	0
Ra (Total)[e]	4	0.030	0.0040	0.015	0.011
Se	4	< 0.0050	< 0.0050	< 0.0050	0
SO_4	4	100	11	57	50
Specific conductance[g]	28	0.35	0.17	0.27	0.027
Temperature[h]	28	24	18	21	0.78
Total organic carbon	16	3.6	0.76	2.0	0.52
Total organic halides	16	0.022	0.010	0.014	0.0023
Toxaphene	4	< 0.0050	< 0.0050	< 0.0050	0

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 23. Concentrations of parameters in wells around 3539-40[a]

August - September 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			1.3	
Cd	1			< 0.0020	
Cl	1			2.7	
Cr	1			< 0.050	
Endrin	1			< 0.00020	
F	1			< 1.0	
Fe	1			0.050	
Fecal coliform[d]	1			0	
Gross alpha[e]	1			0.92	
Gross beta[e]	1			13	
Hg	1			< 0.00010	
Lindane	1			< 0.0020	
Methoxychlor	1			< 0.0080	
Mn	1			0.10	
Na	1			200	
NO_3	1			< 5.0	
Pb	1			0.26	
pH[f]	14	13	12.5	13	0.085
Phenols	1			< 0.0010	
Ra (Total)[e]	1			0.21	
Se	1			< 0.0050	
SO_4	1			14	
Specific conductance[g]	14	10	0.52	8.5	1.8
Temperature[h]	14	22	19	20	0.70
Total organic carbon	4	16	15	16	0.45
Total organic halides	4	0.035	< 0.025	< 0.031	0.0044
Toxaphene	1			< 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]

August - September 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	6.8	6.5	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	0.32	0.28	0.30	
Fecal coliform[d]	2	0	0	0	
Gross alpha[e]	2	0.47	0.10	0.29	
Gross beta[e]	2	0.97	0.62	0.80	
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	0.13	0.11	0.12	
Na	2	8.5	7.7	8.1	
NO_3	2	5.0	< 5.0	< 5.0	
Pb	2	< 0.020	0.020	< 0.020	
pH[f]	14	8.3	7.6	7.9	0.11
Phenols	2	< 0.0010	< 0.0010	< 0.0010	
Ra (Total)[e]	2	0.027	0.0090	0.018	
Se	2	< 0.0050	< 0.0050	< 0.0050	
SO_4	2	28	23	26	
Specific conductance[g]	14	0.080	0.010	0.030	0.013
Temperature[h]	14	20	17	18	0.46
Total organic carbon	8	0.82	0.62	0.72	0.054
Total organic halides	8	< 0.010	< 0.010	< 0.010	0
Toxaphene	2	< 0.0050	< 0.0050	< 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, 3539-40, and 7900[a]

August - September 1986

Parameter	No. of samples	Concentration (mg/L) Max	Min	Av	95% cc[b]
		3524			
Ag	4	< 0.0050	< 0.0050	< 0.0050	0
As	4	< 0.010	< 0.010	< 0.010	0
Ba	4	< 1.0	< 1.0	< 1.0	0
Cd	4	< 0.0020	< 0.0020	< 0.0020	0
Cr	4	< 0.020	< 0.020	< 0.020	0
Fe	4	0.11	< 0.050	0.088	0.026
Hg	4	< 0.00010	< 0.00010	< 0.00010	0
Mn	4	0.25	< 0.010	0.12	0.13
Na	4	24	17	21	3.3
Pb	4	< 0.020	< 0.020	< 0.020	0
Se	4	< 0.0050	< 0.0050	< 0.0050	0
		3539-40			
Ag	1				< 0.0050
As	1				< 0.010
Ba	1				1.1
Cd	1				< 0.0020
Cr	1				0.050
Fe	1				< 0.050
Hg	1				< 0.00010
Mn	1				< 0.010
Na	1				200
Pb	1				0.28
Se	1				< 0.0050
		7900			
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	0.070	< 0.050	0.060	
Hg	2	< 0.00010	< 0.00010	< 0.00010	
Mn	2	0.10	0.090	0.095	
Na	2	8.5	7.7	8.1	
Pb	2	< 0.020	< 0.020	< 0.020	
Se	2	< 0.0050	< 0.0050	< 0.0050	

[a] See Figures 7 and 8.
[b] 95% confidence coefficient about the average of more than two samples.

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

August - September 1986

Area	Well[a] ID	Date	Parameters: Gross Beta (Bq/L)	Gross Alpha (Bq/L)	Ra (Bq/L)	Pb (mg/L)	Ba (mg/L)
	Standard[b]		0.13	0.56	0.19	0.050	1.0
3524	31-013	08/21/86	1.4				
		09/26/86	1.4				
	31-015	08/21/86	0.56				
		09/25/86	0.52				
3539-40	31-011	08/20/86	13	0.92	0.21	0.26 (total)	1.3 (total)
						0.28 (dissolved)	1.1 (dissolved)
7900	32-004	08/20/86	0.62				
		09/24/86	0.97				

[a] See Figures 7 and 8.

[b] EPA Interim Primary Drinking Water Standard.

gross beta at all wells exceeded the calculated standard. The EPA Interim Primary Drinking Water Standard for gross beta is an annual dose equivalent of four millirem. A concentration was calculated from this dose based on ingestion of 2.2L 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.

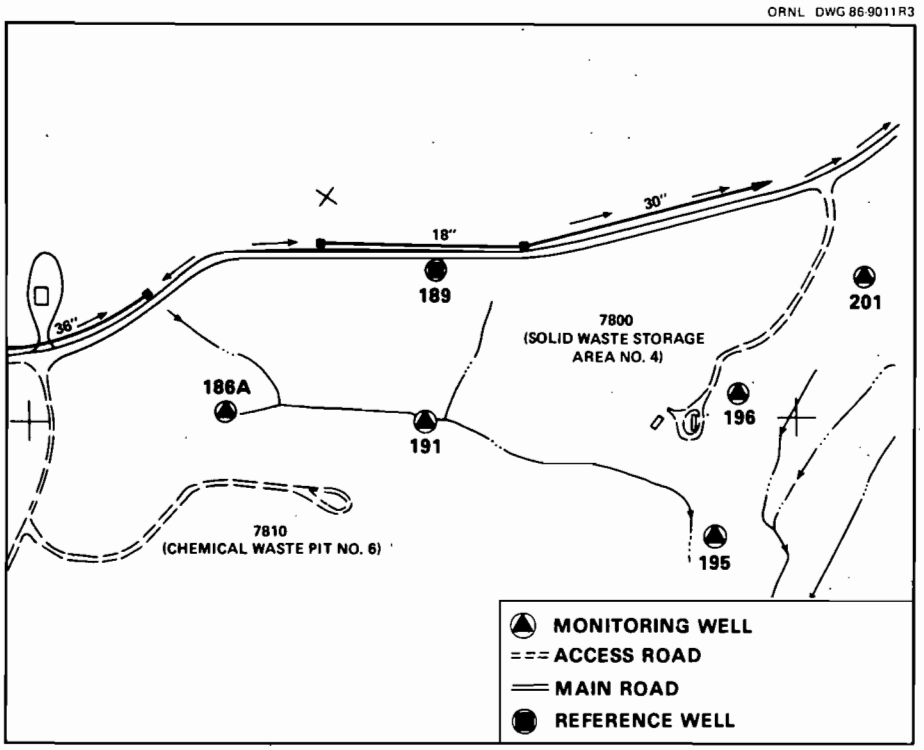

Fig. 9 Locations of sampling wells in Solid Waste Storage Area 4

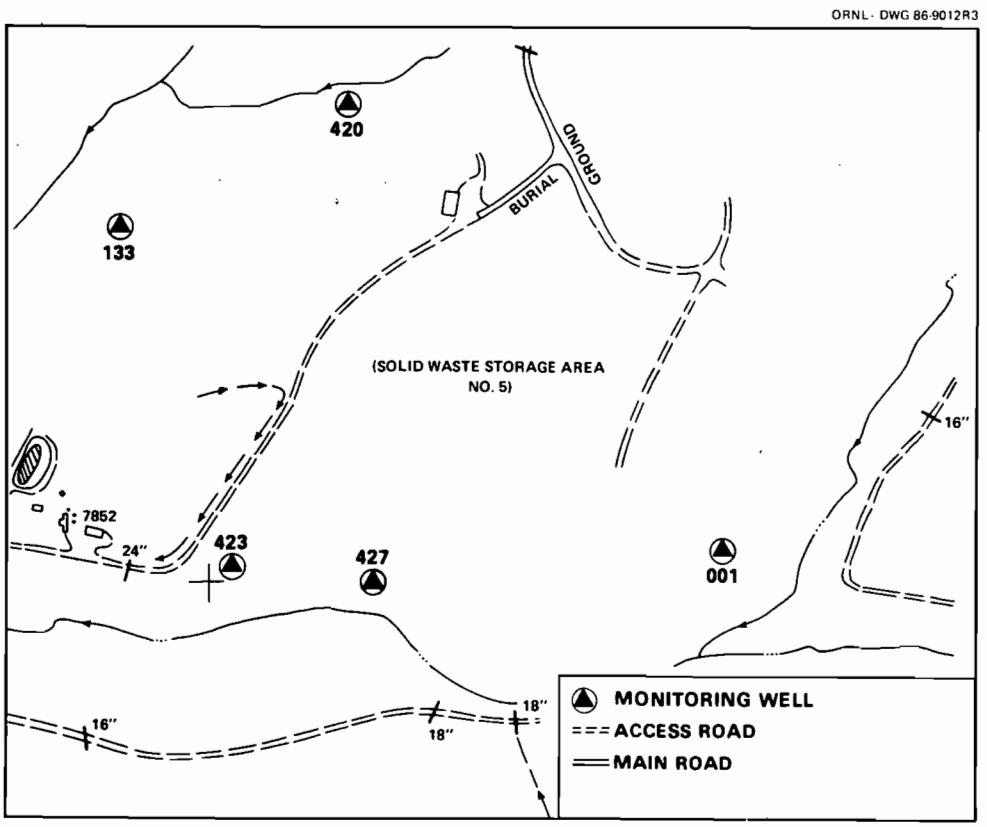

Fig. 10 Locations of sampling wells in Solid Waste Storage Area 5

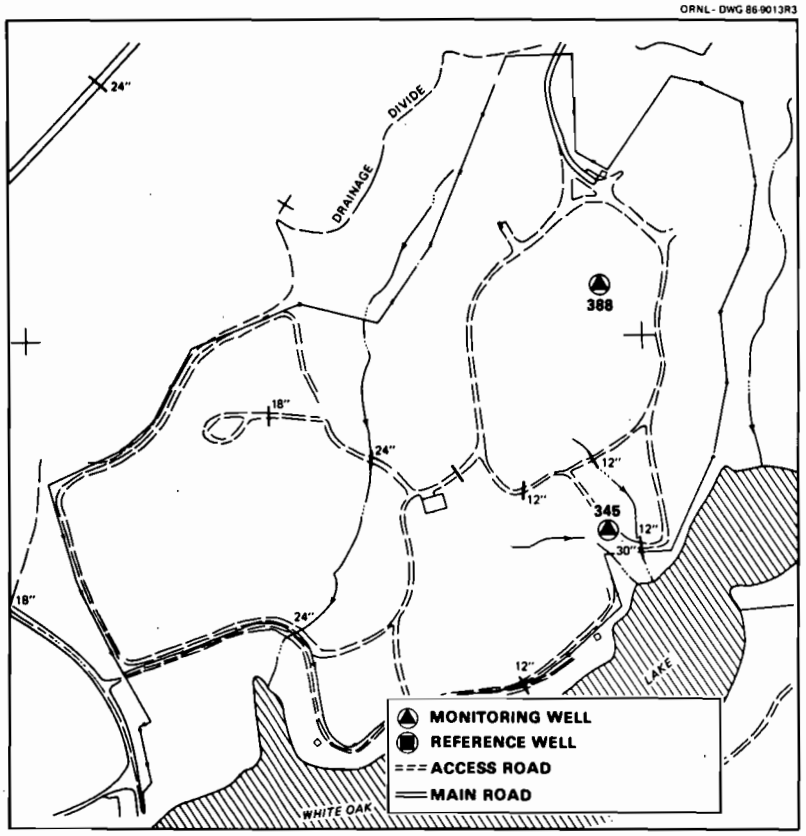

Fig. 11 Locations of sampling wells in Solid Waste Storage Area 6

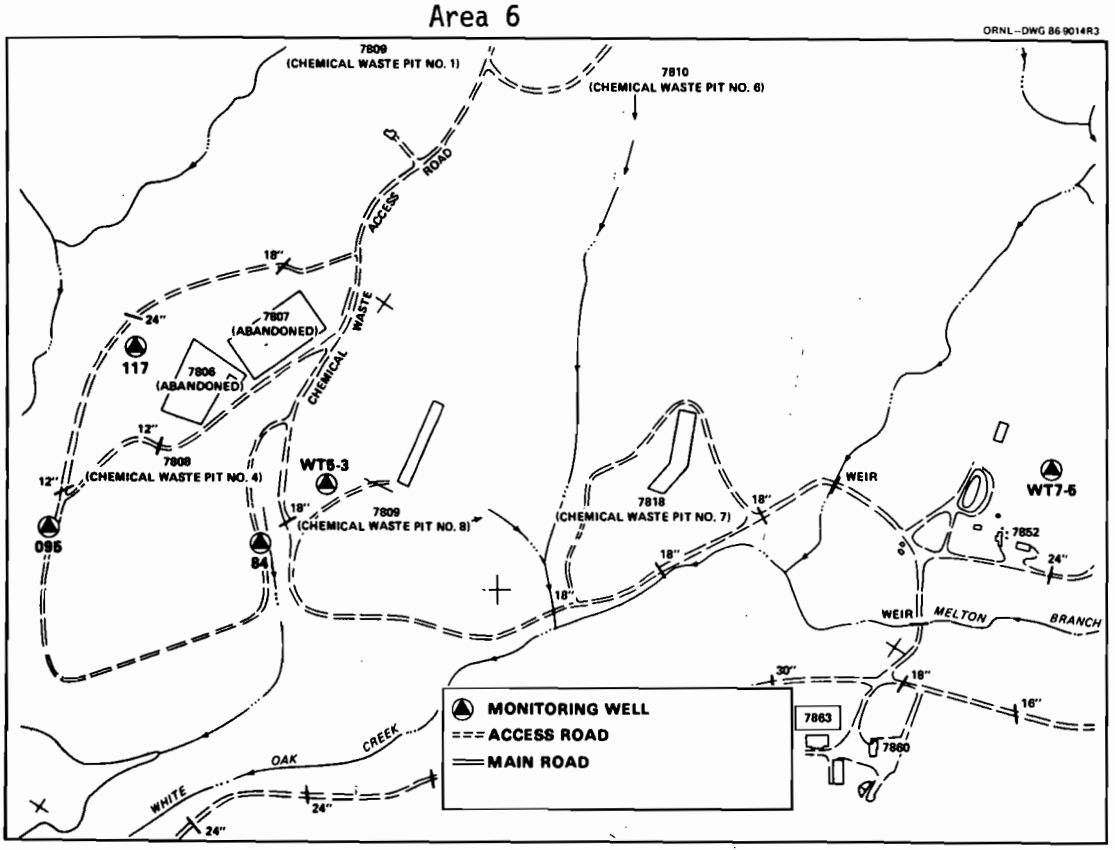

Fig. 12 Locations of sampling wells in pits and trenches

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

July 1986

Radionuclide	No. of Samples	Concentration (Bq/L) Maximum	Minimum	Average
		Solid Waste Storage Area 4[a]		
^{60}Co	5	< 0.30	< 0.20	< 0.26
^{137}Cs	5	< 0.30	< 0.20	< 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	0.20	< 0.090	0.18
^{137}Cs	5	< 0.070	0.011	0.044
Gross alpha	5	1.5	0.40	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	< 0.30	< 0.30	< 0.30
^{137}Cs	2	< 0.20	< 0.20	< 0.20
Gross alpha	2	0.90	0.60	0.75
Gross beta	2	3.8	2.3	3.1
^{3}H	2	850	590	720
Total Sr	2	0.87	0.33	0.60
		Pits and Trenches[d]		
^{60}Co	5	110	< 0.20	26
^{137}Cs	5	0.30	< 0.030	0.10
Gross alpha	5	40	0.40	9.0
Gross beta	5	580	1.8	170
^{3}H	5	3400	1200	1900
Total Sr	5	2.7	0.18	0.82

Table 27. (Continued)

Radionuclide	No. of Samples	Concentration (Bq/L) Maximum	Minimum	Average
		Reference Well[e]		
^{60}Co	1			< 0.30
^{137}Cs	1			< 0.20
Gross alpha	1			1.5
Gross beta	1			2
^{3}H	1			< 19
Total Sr	1			0.34

[a] See Figure 9.

[b] See Figure 10.

[c] See Figure 11.

[d] See Figure 12.

[e] See Figure 9.

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 14-18) 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.

Wind roses for Tower B have not been included because the instrument malfunctioned. This tower was recently recalibrated and is now functioning properly.

ORNL-DWG 86-9142R2

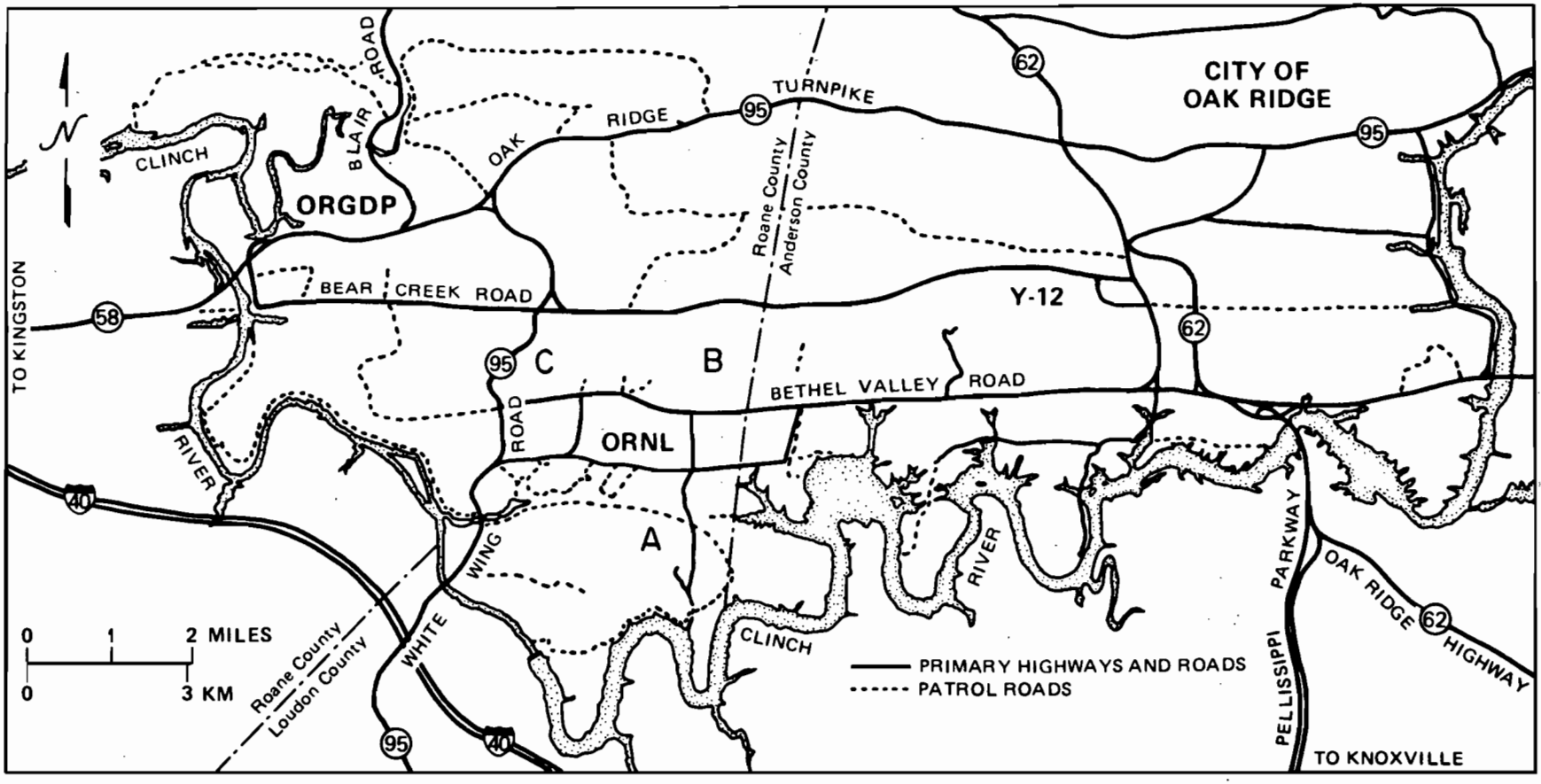

Fig. 13 Locations of meteorological towers at ORNL

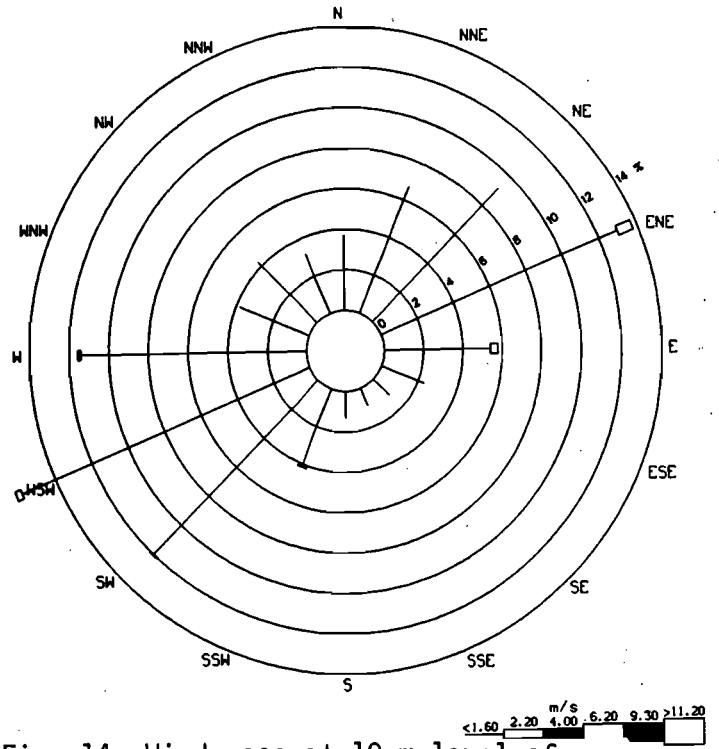

Fig. 14 Wind rose at 10-m level of meteorological tower A, July-September 1986

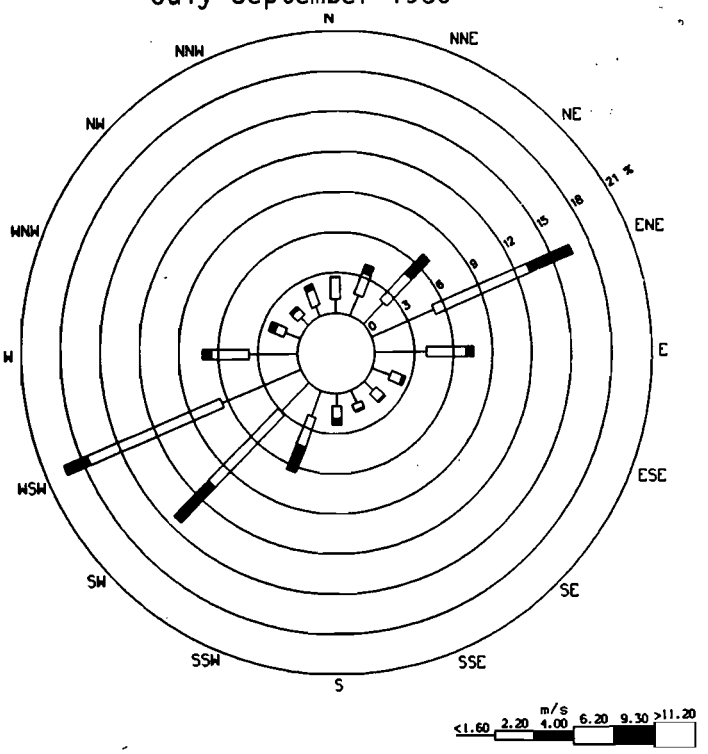

Fig. 15 Wind rose at 30-m level of meteorological tower A, July-September 1986

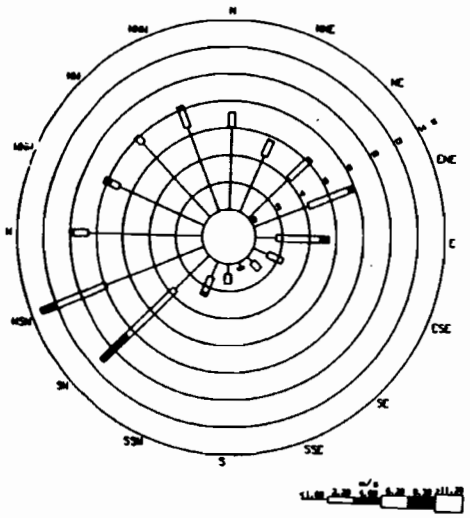

Fig. 16 Wind rose at 10-m level of meteorological tower C, July-September 1986

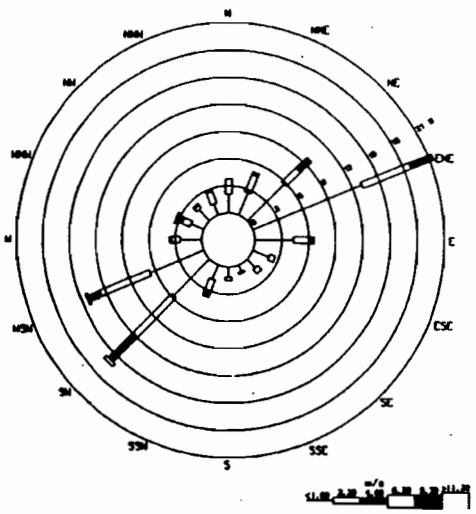

Fig. 17 Wind rose at 30-m level of meteorological tower C, July-September 1986

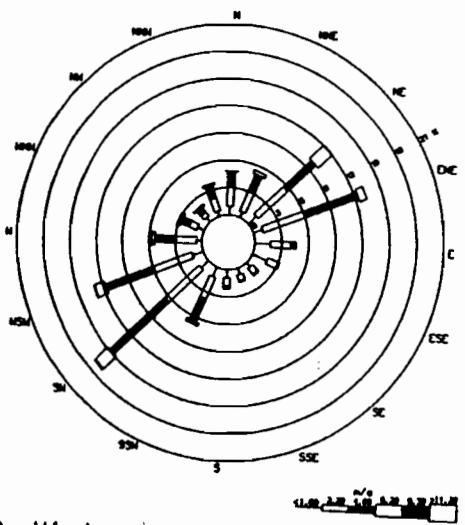

Fig.18 Wind rose at 100-m level of meteorological tower C, July-September 1986

Milk

Raw milk from six locations and one dairy within a radius of 80 km of Oak Ridge is monitored for ^{131}I and ^{90}Sr. Samples are collected every two weeks from four stations located near the Oak Ridge area (Figure 19). Three other stations are more remote with respect to the Oak Ridge facilities and are sampled at the rate of about one to two stations every quarter (Figure 20). Samples are analyzed by ion exchange and low level beta counting and 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 0.058 Bq/L which is within Range I of the FRC guidelines, as were the average concentrations for each individual station. The average concentration of ^{90}Sr for all stations in the area more remote from Oak Ridge was 0.047 Bq/L, which is within Range I of the FRC guidelines, and the average concentration for each individual remote station was also within the Range I category.

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 0.0088 Bq/L, which is within Range I of the FRC guidelines. The average concentration of ^{131}I for all remote stations was 0.016 Bq/L, which is within Range I of the FRC guidelines. The ^{131}I concentrations in milk, which were elevated during the second quarter by the Chernobyl nuclear incident, have returned to normal.

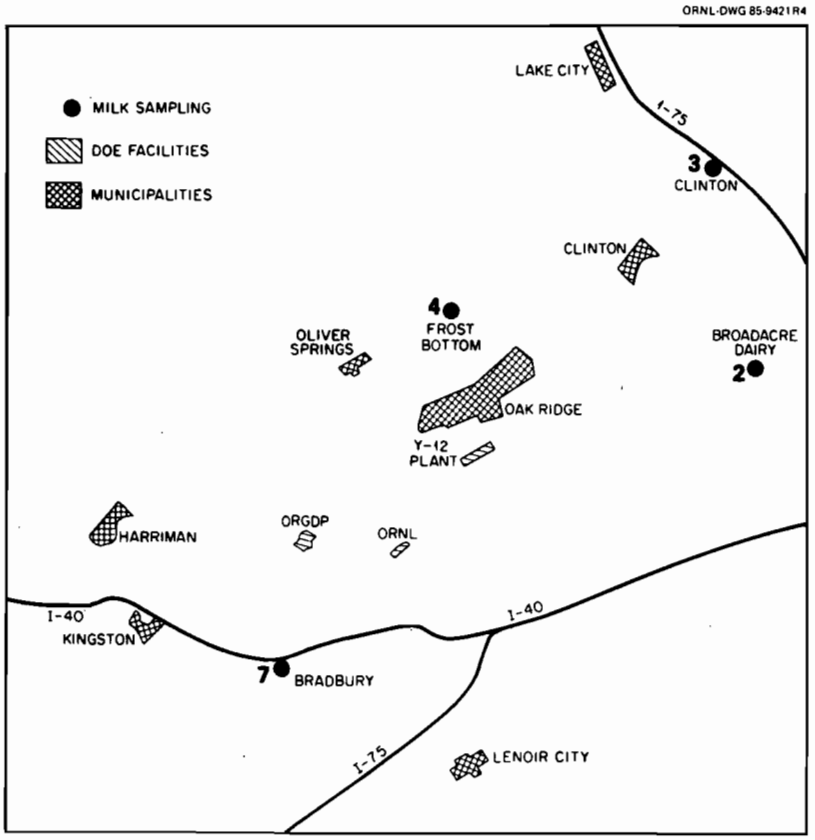

Fig. 19 Locations of milk sampling stations near the Oak Ridge facilities

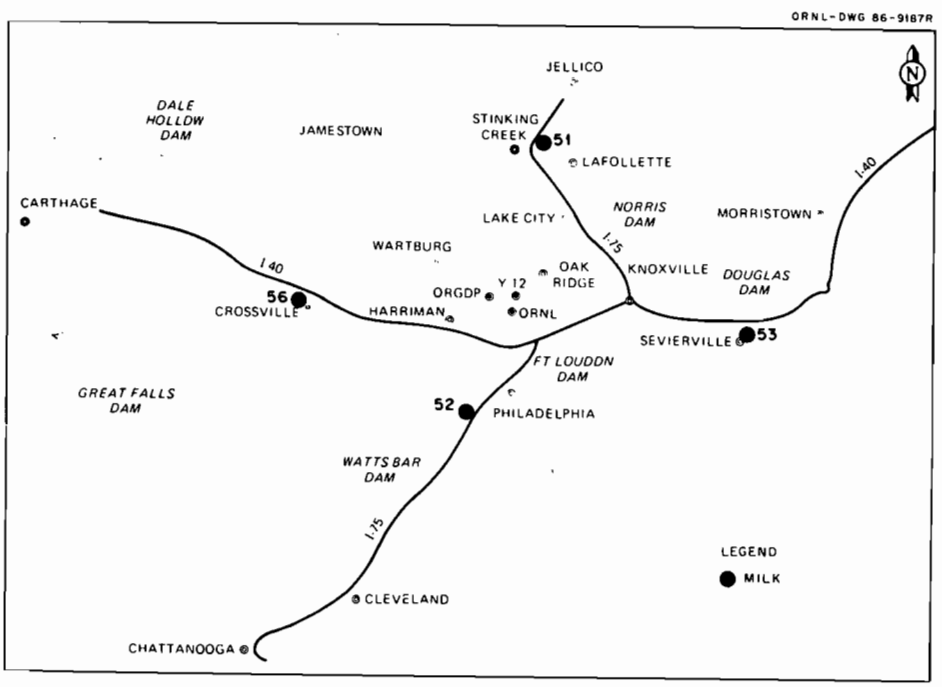

Fig. 20 Locations of milk sampling stations remote from the Oak Ridge facilities

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

August - September 1986

Station	No. of samples	Concentration (Bq/L) Max	Min	Av	95%cc[b]	Comparison with standard[c]
		Immediate Environs[d]				
2	6	0.06	0.03	0.045	0.0086	Range I
3	6	0.06	0.03	0.047	0.0099	Range I
4	6	0.12	0.05	0.068	0.022	Range I
7	6	0.09	0.06	0.073	0.0099	Range I
Network summary	24	0.12	0.03	0.058	0.013	Range I
		Remote Environs[e]				
51	1			0.06		Range I
53	1			0.03		Range I
56	1			0.05		Range I
Network summary	3	0.06	0.03	0.047	0.018	Range I

[a] Raw milk samples, except for Station 2, which 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 I, 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 19.

[e] See Figure 20.

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

August - September 1986

Station	No. of samples	Concentration (Bq/L) Max	Min	Av	95%cc[b]	Comparison with standard[c]
		Immediate Environs[d]				
2	6	0.02	0.003	0.0092	0.0049	Range I
3	6	0.017	0.004	0.0082	0.0040	Range I
4	6	0.019	0.003	0.0087	0.0048	Range I
7	6	0.02	0.001	0.0093	0.0056	Range I
Network summary	24	0.02	0.001	0.0088	0.0048	Range I
		Remote Environs[e]				
51	1			0.010		Range I
53	1			0.005		Range I
56	1			0.033		Range I
Network summary	3	0.033	0.005	0.016	0.017	Range I

[a] Raw milk samples, except for Station 2, which 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 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 19.

[e] See Figure 20.

Fish

Bluegill from the Clinch River are collected semi-annually for analyses of radionuclides (^{60}Co, ^{137}Cs, ^{90}Sr, and ^{40}K), mercury and polychlorinated biphenyls (PCBs). The three sampling locations along the Clinch River include river miles: (1) 25.0 which is above Melton Hill Dam and serves as a reference location (CRM 25.0); (2) 20.8 which is the point where discharges from White Oak Creek meet the Clinch River (CRM 20.8); and (3) 5.0 which is at Centers Ferry, downstream from ORGDP and ORNL (CRM 5.0) (Figure 21).

For the 1986 sampling period, the fish program was modified and bluegill was selected as a representative species. It has been shown to accumulate high levels of radionuclides, mercury, and PCBs. It is a sport fish which is abundant and a sufficient number of the fish can be collected.

Radionuclide concentrations are determined on a composite sample of 6-12 fish from each location. For river miles 25.0 and 5.0, two composite samples were analyzed from each location. A single composite sample was analyzed from river mile 20.8. Scales, heads, and entrails are removed from each fish before samples are obtained. A fresh flesh sample is taken for mercury and PCB determination. Composite flesh samples are ashed and analyzed by gamma spectrometry and radiochemical techniques for the radionuclides that contribute most to the potential radiation dose to humans. While the analyses are done on ashed samples, a conversion to wet weight is done for reporting. Mercury and PCBs are analyzed in samples from six randomly selected individual fish collected at CRM 20.8 and 25.0. The samples are scanned for all major PCB isomers. Those which predominate in the bluegill are PCB-1254 and PCB-1260.

The concentrations of radionuclides in Clinch River bluegill are shown in Table 30. The highest radionuclide concentrations were found in samples from CRM 20.8. In 1985, bluegill from CRM 20.8 also had the highest concentration of these radionuclides.

The highest concentrations of mercury and PCBs (Table 31) were found in fish collected from CRM 20.8. All values were below the Federal Drug Administration tolerance for both mercury (1000 ng/g) and PCBs (2 μg/g). Average values for 1986 samples were lower than 1985.

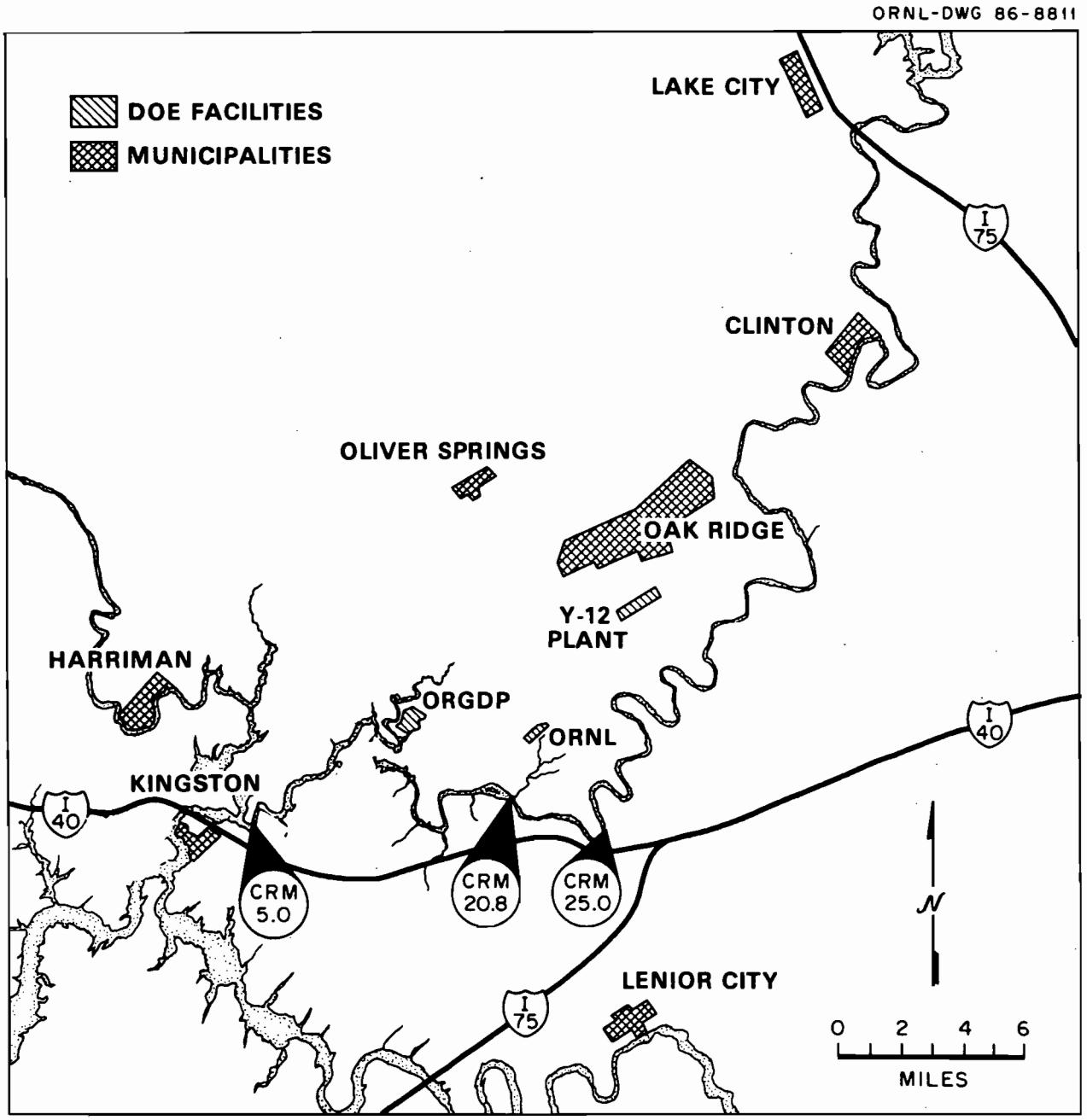

Fig. 21 Locations of fish sampling points

Table 30. Radionuclide concentrations of beta and gamma emitters in Clinch River bluegill[a]

June 1986

	Concentration (Bq/Kg wet wt.)			
Location[b]	^{60}Co	^{137}Cs	^{90}Sr	^{40}K
CRM 5.0[c]	< 0.19	2.5	0.41	111
CRM 20.8	< 0.41	15	1.2	123
CRM 25.0[c]	< 0.08	< 0.05	0.16	68

[a] Composite of 6-12 fish.

[b] See Figure 21.

[c] Average of two composites.

Table 31. PCB and mercury concentrations in Clinch River bluegill

June 1986

Location[a]	No. of Fish Sampled	Max	Min	Av	95% cc[b]	Percentage of A.L.[c]
			Concentration (µg/g wet wt.)			
			PCB - 1254			
CRM 20.8	6	0.07	< 0.01	0.02	0.02	< 1.0
CRM 25.0	6	< 0.01	< 0.01	< 0.01	0.0	< 0.5
			PCB - 1260			
CRM 20.8	6	0.50	0.02	0.12	0.15	6.0
CRM 25.0	6	< 0.02	< 0.01	< 0.01	0.003	< 0.5
			Concentration (ng/g wet wt.)			
			Mercury			
CRM 20.8	6	104	30	82	23	8.2
CRM 25.0	6	39	17	25	6	2.5

[a] See Figure 21.

[b] 95% confidence coefficient about the average.

[c] Percentage of Food and Drug Administration tolerance for PCBs in fish (2 µg/g wet wt.) or action level for mercury in fish (1000 ng/g wet wt.) for the average concentration.

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