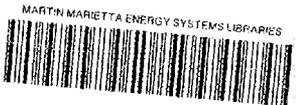


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ORNL/M-837

Environmental Surveillance Data Report for the Second Quarter of 1989

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- P. Y. Goldberg
- B. M. Horwedel
- I. L. McCollough
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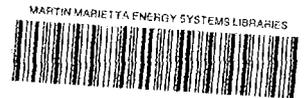
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ENVIRONMENTAL SURVEILLANCE DATA REPORT FOR
THE SECOND QUARTER OF 1989

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LIST OF ACRONYMS

AQCA	Air Quality Control Act
ATDD	Atmospheric Turbulence and Diffusion Division
CAA	Clean Air Act
CR	Clinch River
CRK	Clinch River kilometer
CWA	Clean Water Act
DOE	Department of Energy
DCG	derived concentration guide
DWL	Drinking Water Regulation Level
EMC	Environmental Monitoring and Compliance Section (ORNL)
EHP	Environmental and Health Protection Division (ORNL)
EPA	Environmental Protection Agency
HFIR	High Flux Isotope Reactor
ICP	inductively coupled plasma
JTU	Jackson Turbidity Units
MB	Melton Branch
NESHAPS	National Emission Standards for Hazardous Air Pollutants
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NWT	Northwest Tributary
ORGDP	Oak Ridge Gaseous Diffusion Plant
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
PAM	perimeter air monitoring
PCB	polychlorinated biphenyl
PWTP	Process Waste Treatment Facility
RAM	remote air monitoring
RCRA	Resource Conservation and Recovery Act
SARA	Superfund Amendments and Reauthorization Act
SE	standard error of the mean
SI	Systeme Internationale
STP	Sewage Treatment Plant
SWSA	Solid Waste Storage Area
SWMU	Solid Waste Management Unit
TOC	total organic carbon
TRU	Transuranium Processing Plant
TURF	Thorium Uranium Recycle Facility
WAG	waste area grouping
WOC	White Oak Creek
WOD	White Oak Dam

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EXECUTIVE SUMMARY

During the second quarter of 1989, over 3000 samples, which represent more than 6600 analyses and measurements, were collected by the Environmental Monitoring and Compliance Section. A network of real-time monitoring stations that telemeter 10-min averaged readings of radiation levels, total precipitation, flows, water quality parameters, and air quality parameters around Oak Ridge National Laboratory (ORNL) also reported data. In addition, three meteorological towers sent weather data at various heights to a host computer every 15 min.

The environmental monitoring program at ORNL was reviewed during the previous quarter and revisions are currently being implemented to reflect changing requirements and historical results.

Five isotopes, ^3H , ^{131}I , ^{133}I , ^{135}I , and ^{212}Pb were the primary isotopes emitted from ORNL stacks during this quarter. Approximately 54% of the ^3H released came from the Tritium Target Facility and 43% came from the Isotope Solid State Ventilation System. The Melton Valley Complex emitted virtually all of the radioactive iodines at levels that were about the same as that for the previous quarter. A spike of ^{131}I was detected at the Isotope Solid State Ventilation System in April. This is probably associated with the preparation of ^{131}I for charcoal filter testing at the High Flux Isotope Reactor. The ^{212}Pb source term for ORNL increased by 25% over the last quarter, mostly because of increased emissions from the Isotope Solid State Ventilation System. Osmium-191 emissions (1.3E6 Bq) were reduced during this quarter to 0.4% of the previous quarter's emissions. Data are not reported for noble gas or ^{125}I and ^{129}I emissions because of problems in data validation and analytical interferences.

Ambient air alpha activity appears slightly higher than the previous quarter because of a change in sampling frequency, whereas beta activity was lower. The ^{131}I concentrations were the same as the previous quarter except for a high value of 81E-8 Bq/L from station 36 for the sample collected on 10 April 1989. There were no increases in stack emissions of ^{131}I during this sampling period, indicating that the increased activity at station 36 was not associated with a release from ORNL. This concentration is less than 1% of the derived concentration guide (DCG) for ^{131}I . Tritium data are not reported for this quarter because of mechanical problems with the sampling equipment. Similar problems were experienced at some of the remote air monitoring stations.

The highest average concentrations of total radioactive strontium are found in First Creek and Melton Branch 1 (10 and 13 Bq/L, respectively). In all of the stream locations, the ratio of the average total radioactive strontium concentration to the DCG for ^{90}Sr is less than 35%. Solid Waste Storage Area (SWSA) 5 appears to be the primary contributor to total radioactive strontium in Melton Branch because the average strontium activity at the Melton Branch station located above SWSA 5 is less than 2% of the average strontium activity at the station downstream of SWSA 5. Radioactive strontium in First

Creek may be the result of old waste line leaks or previously contaminated soils.

The highest average ^3H concentrations in water (65,000 Bq/L) are found at the Melton Branch 1 station during May. Average concentrations of ^3H at this location were 88% of the DCG. Tritium contamination also appears to be coming from SWSA 5.

Effluents from the processes at ORNL are sampled for radioactivity. The highest total radioactive strontium concentrations (3.3 Bq/L) were found in the discharge from the Sewage Treatment Plant. The previous quarter's strontium activity at the Process Waste Treatment Plant has subsided from a maximum of 13 Bq/L to an average of 0.79 Bq/L. The concentration of ^{60}Co averaged 84 Bq/L at the High Flux Isotope Reactor (HFIR) ponds (45% of DCG). Average ^{137}Cs concentrations were highest (81 Bq/L, 80% of DCG) in the discharge from the PWTP.

There were a total of 16 noncompliances associated with the National Pollutant Discharge Elimination System (NPDES) permit. Six of them were total suspended solids violations associated with the Sewage Treatment Plant and parking lot runoff. The Vehicle Cleaning Facility had five violations, each of which was for a different parameter.

Water samples were collected at 12 sites and analyzed for polychlorinated biphenyls (PCBs). All concentrations of PCBs were below the Environmental Protection Agency's acute criteria and the analytical quantitation limit.

WAG 1 groundwater concentrations exceeded drinking water standards for the following analytes: barium(1), cadmium(3), chromium(1), fluoride(2), gross alpha(1), radioactive strontium(4), trichloroethane(1), tritium(1), and vinyl chloride(2). WAG 6 groundwater concentrations exceeded drinking water standards for carbon tetrachloride(1), fecal coliform(1), trichloroethane(1), tritium(7), and 1,2,-dichloroethane(1).

Milk samples from within the immediate environs of ORNL showed that concentrations of ^{131}I and radioactive strontium were always within the lowest range of the Federal Radiation Council guidelines. The effective dose equivalents from consumption of this milk is less than 1% of the DCG.

1. INTRODUCTION

The Environmental Monitoring and Compliance Section (EMC) within the Environmental and Health Protection Division (EHP) at the Oak Ridge National Laboratory (ORNL) is responsible for the development and implementation of an environmental program to (1) ensure compliance with all federal, state, and Department of Energy (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.

The current environmental program is designed primarily to meet regulatory requirements and the DOE directives and to provide a continuity of data on environmental media at unregulated locations. The major legislation affecting the environmental program at the DOE facilities includes the Clean Water Act (CWA), the Clean Air Act (CAA), the Resource Conservation and Recovery Act (RCRA), and the Superfund Amendments and Reauthorization Act (SARA). In November of 1988, DOE finalized Order 5400.1, "General Environmental Protection Program," that establishes the requirements, authorities, and responsibilities for DOE operations for ensuring compliance with applicable federal, state, and local environmental protection laws and regulations. This order sets forth the requirements for both radiological and nonradiological monitoring. DOE's Draft Order 5400.XX, "Radiation Protection of the Public and the Environment," specifies the guidelines for releases of radionuclides to various media. Definitive radiological monitoring requirements have been established, and additional guidance on recommended procedures and activities is provided in DOE 5400.XY, "Radiological Effluent Monitoring and Environmental Surveillance."

Environmental monitoring, as defined by DOE's Draft Order 5400.XY, consists of two major activities: effluent monitoring and environmental surveillance. Effluent monitoring is the collection and analysis of samples, or measurements of liquid and gaseous effluents. Environmental surveillance is the collection and analysis of samples, or direct measurement of air, water, soil, foodstuff, biota, and other media from DOE sites and their environs.

Although DOE's Draft Order 5400.XX and 5400.XY have not been finalized, ORNL is evaluating the requirements and is revising the environmental program to reflect changing requirements. During this quarter, the effluent monitoring and environmental surveillance programs were reviewed to increase the precision of the measurements and to increase the efficiency of the program. Several changes were recommended that will be reflected in subsequent quarters. Changes that occurred during this quarter will be described in the appropriate section.

Monthly or quarterly summaries are presented in this report for each of the media sampled. The summary tables generally give the number of samples collected during the period and the maximum, minimum, average, and standard error of the average (SE) values of parameters for which determinations were made. This value is based on multiple samples collected throughout the period. It includes the random uncertainty over time and space associated with sampling, analysis, and the intrinsic variability of the media. The random uncertainty is a statement of precision (or imprecision), a measure of the reproducibility or scatter in a set of successive measurements, and an

indication of the stability of the average value for the parameter. When differences in the magnitudes of the observations are small, the SE is small and the precision is said to be high; when the differences are large, the SE is large and the precision is low. Average values have been compared where possible to applicable guidelines, criteria, or standards as a means of evaluating the impact of effluent releases or environmental concentrations.

In some of the tables, radionuclide concentrations are compared with derived concentration guides (DCGs) as published in Draft DOE Order 5400.XX. These concentration guides were established for drinking water and inhaled air and are guidelines for the protection of the public. Draft DOE Order 5400.XX defines a DCG as the concentration of a radionuclide in air or water for which, under conditions of continuous exposure by one exposure pathway (i.e., drinking water, inhaling air, or submersion) for 1 year, a "reference man" would receive the most restrictive of (1) an effective dose equivalent of 100 mrem (2) a dose equivalent of 5 rem to any tissue, including skin and lens of the eye. A "reference man" is a hypothetical human who is assumed to inhale 8400 m³ of air in a year and to drink 730 L of water in a year. When there are multiple DCGs for a given isotope, the most restrictive value is used for comparisons. When the percentage of the DCG is less than 0.01, the percentage is reported as "<0.01." When total radioactive Sr is measured, it is compared with the DCG for ⁹⁰Sr, which is the most restrictive value.

Radioactivity measurements are reported as the net activity (the difference between the gross activity and background activity). Because of the intrinsic uncertainties associated with making radiation measurements, it is possible to subtract a background value from a sample result and get a negative number. Radiation measurements are reported in units of becquerel (Bq). A Bq is a Systeme Internationale (SI) unit equivalent to 1 disintegration per second.

Chemical (nonradionuclide) results that are below the analytical detection limit are expressed as "less than" (<) values. In computing the average values, "less than" results are assigned the detection limit. The average value is expressed as less than the computed value when at least one of the results used for the average is less than the detection limit.

2. AIR

Airborne emissions from Department of Energy (DOE) facilities are regulated under the provisions of the Clean Air Act (CAA), DOE Orders, and the Tennessee Air Quality Control Act (AQCA). The U.S. Environmental Protection Agency (EPA) has the authority and responsibility for enforcing the regulations associated with the CAA and has delegated this authority to the state of Tennessee for nonradioactive air pollutants. Regulatory criteria for CAA are promulgated in 40 CFR 61, the National Emission Standards for Hazardous Air Pollutants (NESHAPS). The DOE Orders are enforced at the local level by the Environmental and Health Protection (EHP) Division. The orders that address air emissions are 5400.1, 5400.XX (draft), and 5400.XY (draft).

The Oak Ridge National Laboratory (ORNL) has monitoring requirements for radioactive emissions only. These are NESHAPS standards based on calculated dose (25 mrem whole-body, 75 mrem critical-organ) to off-site individuals. Additionally, the DOE Orders require that the collective dose be calculated for the population within 80 km of the site.

The monitoring and surveillance of airborne emissions at ORNL is a two-tiered program. The first tier consists of source-term-emissions sampling and quantification for each of the stacks at the facility that is an emission point for processes involving radioactive materials. These data are used for calculating the annual dose associated with operations at the facility. The second tier consists of ambient-air sampling systems located within the boundary of the facility, on the reservation perimeter, and at remote locations assumed to be unaffected by facility operations. These data are used to measure directly the impact of ORNL on the surrounding area and provide empirical data for assessing the inhalation pathways of exposure.

2.1 AIRBORNE EMISSIONS

Airborne emissions are monitored at ORNL for the purpose of complying with the CAA of 1970 and the Tennessee AQCA. The major gaseous emission point sources for the Laboratory consist of eight stacks. They are:

<u>Building</u>	<u>Description</u>
2026	Radioactive Materials Analytical Laboratory
3020	Radiochemical Processing Plant
3039	Duct 1 - 3500 and 4500 Areas Cell Ventilation Systems Duct 2 - Central Off-Gas and Scrubber System Duct 3 - Isotope Solid State Ventilation System Duct 4 - 3025 and 3026 Areas Cell Ventilation Systems
7025	Tritium Target Fabrication Facility
7830	Hydrofracture Facility
7911	Melton Valley Complex (High Flux Isotope Reactor and the Radiochemical Engineering Design Center)
7512	Molten Salt Reactor Facility
6010	Electron Linear Accelerator Facility

The locations of the stacks are shown in Fig. 1. Each of these point sources is provided with a variety of surveillance instrumentation, including radiation alarms, near-real-time monitors, and continuous sample collectors. Only data resulting from the analysis of the continuous samples are used in this report. The other equipment does not provide data of sufficient accuracy and precision to support the quantitation of emission source terms.

Data are presented for all stacks except for the Electron Linear Accelerator Facility (Building 6010) and the Melton Valley Storage Tanks (Building 7830). Continuous sampling equipment is not currently installed at Building 6010. A stack improvement project is scheduled for 1989 that will provide continuous samplers at this stack. The sampling system at Building 7830 has been upgraded in preparation for the In-Tank Evaporation Project. Data reporting for this stack will resume next quarter.

The sampling systems generally consist of in-stack sampling probes, sample transport piping, a 47-mm-diameter particulate filter, a 47-mm-diameter by 25-mm-thick activated-charcoal canister, a silica-gel tritium trap, flow measurement and totalizing instruments, a sampling pump, and return piping to the stack. The sampling system for the Tritium Target Facility is configured with a tritium trap only. The sampling systems at Buildings 2026, 3020, and 7512 have not been upgraded and do not have tritium traps.

The sampling media are collected and evaluated weekly. The particulate filters are analyzed for gross alpha and gross beta activity. Gross alpha and gross beta measurements are made 8 days after the samples are collected to reduce the contribution of short-lived natural radionuclides to the measurement. The silica-gel samples are analyzed for tritium. The charcoal canisters are analyzed by gamma spectroscopy. Because of the prevalence of iodine isotopes in the point-source emissions, values are reported for ^{131}I and ^{133}I each week. Data for other gamma-emitting isotopes are opportunistically captured. If an isotope is present at a concentration above the analytical instrument background, the value is reported. Consequently, 13 data values are typically associated with gross alpha, gross beta, ^{131}I , and ^{133}I measurements. This is the number of samples for the quarter. There are nine values for each tritium emission sampler as a result of changing from weekly to biweekly analyses in the middle of the quarter. Subsequent quarters will have either six or seven tritium values per sampler. Many of the other isotopes reported are represented by less than 13 values because they were not detected in all of the sampling events.

The current convention for data at the instrument detection limit is to treat them the same as all other data. The instrument background is subtracted from the actual instrument signal, and the result is reported. This practice can result in negative numbers. Results reported in this manner may be reduced with summary statistics without incurring the difficulties of performing calculations on "less than" values.

All data are rounded to two significant digits and presented as $1\text{E}6$ Bq. Negative sample values are converted into negative emissions. These values represent the random uncertainty associated with quantifying emissions. While negative emissions values can be used to infer the total measurement system

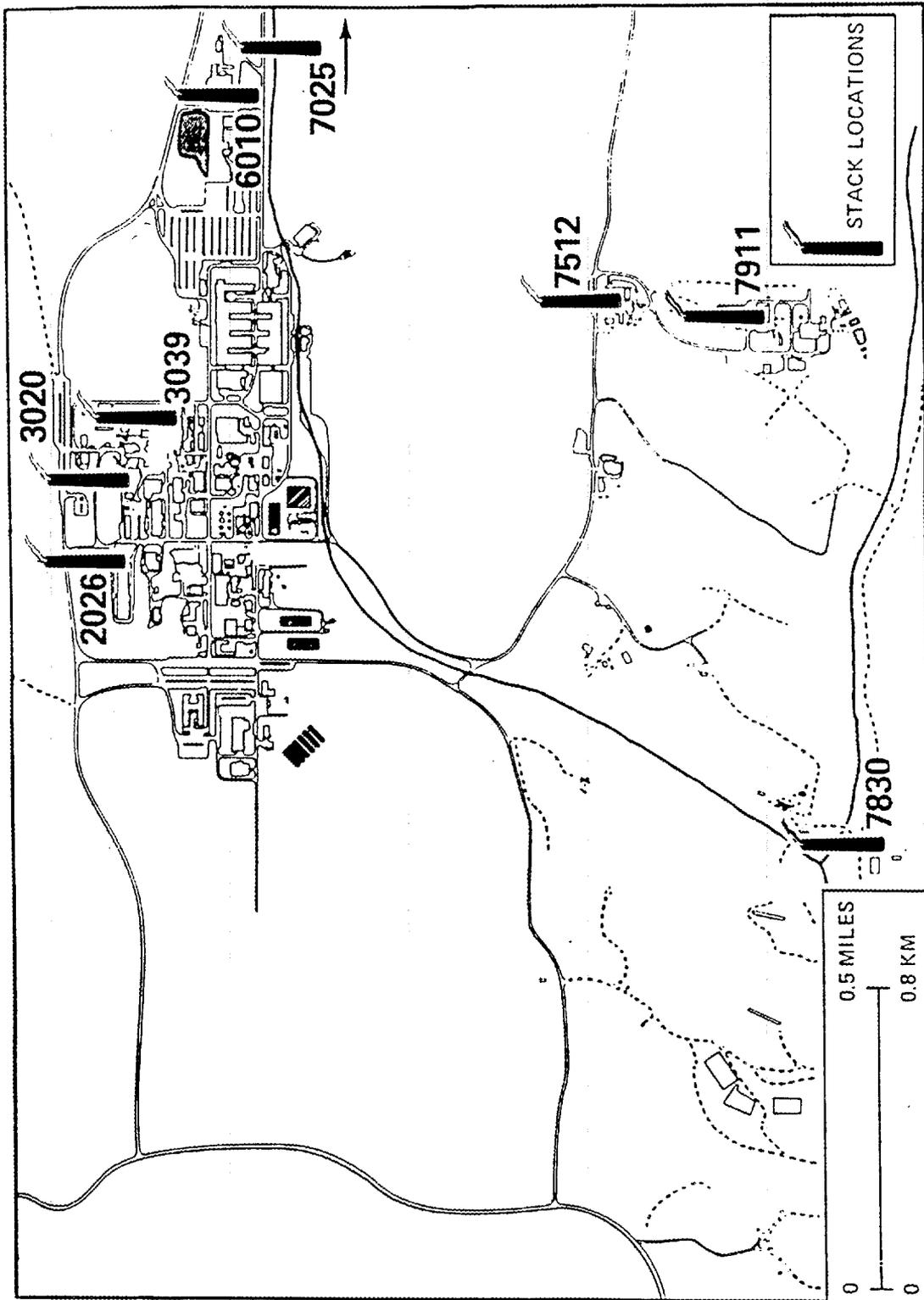


Fig. 1. Location map of major stacks (emission points) at ORNL.

uncertainty for a given isotope, the inference must be isotope specific. The uncertainty for each isotope is unique; therefore, extrapolating across isotopes is not valid.

Tables 1 through 9 present summaries of the weekly emissions data. Included are the number of samples in which a particular analyte was measured, the maximum and minimum values for the quarter, and the average. If an analyte has two or more values, then the standard error is also provided. Tables 10 through 18 present the emission totals by month and for the quarter by stack and analyte.

On upgraded systems in which sample flow totalizers have been installed, weekly sample data are multiplied by a conversion factor that is the ratio of the stack or duct discharge for the sampling period divided by the total sample flow for the sample period. For the older sampling systems, the conversion factor consists of the average stack discharge rate divided by the average sampling rate.

The airborne emissions for the Laboratory consist primarily of ^3H , ^{131}I , ^{133}I , ^{135}I , and ^{212}Pb . Tritium came mostly from the Tritium Target Fabrication Facility (54%, $1.0\text{E}13$ Bq) and the Isotope Solid State Ventilation System (43%, $8.3\text{E}12$ Bq). A discrepancy has been identified between the tritium releases from the 3039 area as determined by sample results and tritium releases based on inventory loss calculations. The sample results appear to grossly underestimate the emissions. Sources of this error are being investigated.

The Melton Valley Complex emitted virtually all of the total ^{131}I ($1.9\text{E}8$ Bq), ^{133}I ($2.3\text{E}8$ Bq), and ^{135}I ($2.1\text{E}8$ Bq) associated with fission products. These levels are consistent with the previous quarter. A spike of ^{131}I ($2.3\text{E}8$ Bq), was detected in April from the Isotope Solid State Ventilation System. This is probably associated with the preparation of ^{131}I for charcoal filter testing at the High Flux Isotope Reactor.

Ninety-five percent of the ^{212}Pb came from four locations: Central Off-gas and Scrubber System (29%, $3.2\text{E}8$ Bq); Radioactive Materials Analytical Laboratory (25%, $2.9\text{E}8$ Bq); Melton Valley Complex (11%, $1.2\text{E}8$ Bq); and Isotope Solid State Ventilation System (30%, $3.4\text{E}8$ Bq). The total ^{212}Pb source term for the second quarter shows an increase over the first quarter because of a $3.2\text{E}8$ Bq spike in April in the Isotope Solid State Ventilation System. The 3025 and 3026 cell ventilation systems released 95% of the ^{191}Os ($1.3\text{E}6$ Bq). The second-quarter osmium release from this facility is 0.4% of the source term from the first quarter ($3.0\text{E}8$ Bq).

Data are not presented in this report for noble gas or ^{125}I and ^{129}I emissions. A program is being developed to validate the noble gas data, and analytical methods are being investigated that will address spectral interferences associated with the detection and quantitation of the iodines. It is hoped that this data will be available for the next quarterly report (third quarter, 1989).

Table 1. Summary of weekly emissions at the Radioactive Materials Analytical Laboratory, Building 2026,^a April-June 1989

Analysis	Number of samples	Total (10 ⁶ Bq/week)			Standard error ^b
		Max	Min	Av	
¹³⁷ Cs	4	0.042	0.013	0.031	0.0069
Gross alpha	13	0.12	0.0026	0.032	0.0097
Gross beta	13	0.21	0.0069	0.062	0.019
¹³¹ I	13	0.0095	-0.0040	0.0010	0.0012
¹³³ I	13	0.0095	-0.0090	0.0003	0.0012
¹³⁵ I	7	0.034	-0.040	-0.0030	0.0092
²¹² Pb	9	85	6.0	32	10

^aSee Fig. 1.

^bStandard error of the average of more than two samples.

Table 2. Summary of weekly emissions at the Radiochemical Processing Plant ventilation stack, Building 3020,^a April-June 1989

Analysis	Number of samples	Total (10 ⁶ Bq/week)			Standard error ^b
		Max	Min	Av	
Gross alpha	13	0.0075	0.0001	0.0017	0.00058
Gross beta	13	0.12	0.0014	0.0016	0.0089
¹³¹ I	13	0.018	-0.0050	0.0036	0.0016
¹³³ I	13	0.011	-0.0090	-0.0005	0.0018
¹³⁵ I	1	-0.040	-0.040	-0.040	
²¹² Pb	2	15	1.8	8.2	6.4

^aSee Fig. 1.

^bStandard error of the average of more than two samples.

Table 3. Summary of weekly emissions at the 3500 and 4500 area cell ventilation systems, Building 3039, Duct 1,^a April-June 1989

Analysis	Number of samples	Total (10 ⁶ Bq/week)			Standard error ^b
		Max	Min	Av	
Gross alpha	13	0.015	-0.0002	0.0018	0.0011
Gross beta	13	1.2	0.0058	0.12	0.092
³ H ^c	9	16,000	22	2,200	1,800
¹³¹ I	13	0.0059	-0.0030	0.0015	0.00069
¹³³ I	13	0.0031	-0.0009	0.0008	0.00035
¹³⁵ I	13	0.0088	-0.010	-0.0020	0.0019
²¹² Pb	13	3.6	0.69	2.8	0.22

^aSee Fig. 1.

^bStandard error of the average of more than two samples.

^cSources of error being investigated.

Table 4. Summary of weekly emissions at the central off-gas and scrubber system Building 3039, Duct 2,^a April-June 1989

Analysis	Number of samples	Total (10 ⁶ Bq/week)			Standard error ^b
		Max	Min	Av	
¹⁹⁴ Au	3	3.1	2.2	2.7	0.27
Gross alpha	13	0.0018	0.0000	0.0007	0.00016
Gross beta	13	0.017	0.0000	0.0049	0.0013
³ H ^c	9	490	29	250	61
¹³¹ I	13	0.056	-0.0003	0.0070	0.0041
¹³³ I	13	0.32	-0.0010	0.030	0.025
¹³⁵ I	13	0.0049	-0.050	-0.0060	0.0039
¹⁹¹ Os	1	0.075	0.075	0.075	
²¹² Pb	13	110	8.9	25	7.4
¹⁰⁶ Ru	1	0.95	0.95	0.95	

^aSee Fig. 1.

^bStandard error of the average of more than two samples.

^cSources of error being investigated.

Table 5. Summary of weekly emissions at the isotope-solid state ventilation system, Building 3039, Duct 3,^a April-June 1989

Analysis	Number of samples	Total (10 ⁶ Bq/week)			Standard error ^b
		Max	Min	Av	
¹⁹⁴ Au	1	1.5	1.5	1.5	
⁸² Br	7	0.12	0.022	0.056	0.011
⁶⁰ Co	12	6.8	0.020	0.64	0.56
Gross alpha	13	0.13	0.0002	0.010	0.0096
Gross beta	13	1.4	0.0073	0.12	0.11
³ H ^c	9	3,900,000	2,300	920,000	450,000
¹³¹ I	13	230	0.011	19	18
¹³³ I	13	0.026	-0.0020	0.0048	0.0019
¹³⁵ I	13	0.013	-3.0	-0.20	0.20
²¹² Pb	13	310	0.91	26	24
¹²⁵ Sb	2	0.21	0.059	0.13	0.073
⁷⁵ Se	12	31	0.018	2.7	2.6

^aSee Fig. 1.

^bStandard error of the average of more than two samples.

^cSources of error being investigated.

Table 6. Summary of weekly emissions at the 3025 and 3026 area cell ventilation system, Building 3039, Duct 4,^a April-June 1989

Analysis	Number of samples	Total (10 ⁶ Bq/week)			Standard error ^b
		Max	Min	Av	
Gross alpha	13	0.0035	0.0001	0.0006	0.00024
Gross beta	13	5.2	0.0056	2.0	0.48
³ H ^c	13	570,000	420	73,000	62,000
¹³¹ I	13	0.013	-0.0010	0.0010	0.0010
¹³³ I	13	0.0020	-0.0040	-0.0002	0.00044
¹³⁵ I	13	0.013	-0.020	0.0002	0.0027
¹⁹¹ Os	10	0.49	0.011	0.13	0.052
²¹² Pb	7	0.079	0.035	0.058	0.0067
¹²⁵ Sb	1	0.035	0.035	0.035	

^aSee Fig. 1.

^bStandard error of the average of more than two samples.

^cSources of error being investigated.

Table 7. Summary of weekly emissions at the Tritium Target
Fabrication Facility, Building 7025,^a April-June 1989

Analysis	Number of samples	Total (10 ⁶ Bq/week)			Standard error ^b
		Max	Min	Av	
³ H ^c	9	6,200,000	32,000	1,200,000	680,000

^aSee Fig. 1.

^bStandard error of the average of more than two samples.

^cSources of error being investigated.

Table 8. Summary of weekly emissions at the Melton Valley Complex,
Building 7911,^a April-June 1989

Analysis	Number of samples	Total (10 ⁶ Bq/week)			Standard error ^b
		Max	Min	Av	
¹³⁸ Cs	1	0.51	0.51	0.51	
Gross alpha	13	0.0013	-0.000076	0.0002	0.000094
Gross beta	13	0.031	0.0017	0.0083	0.0020
³ Hc	9	2900	-1000	330	360
¹³¹ I	13	32	2.2	15	4.4
¹³² I	2	3.3	3.1	3.2	0.090
¹³³ I	13	34	9.8	18	2.0
¹³⁴ I	1	4.0	4.0	4.0	
¹³⁵ I	13	28	11	16	1.5
²¹² Pb	13	24	5.1	9.0	1.5
⁷⁵ Se	1	0.053	0.053	0.053	

^aSee Fig. 1.

^bStandard error of the average of more than two samples.

^cSources of error being investigated.

Table 9. Summary of weekly emissions at the Molten Salt Reactor Facility, Building 7512,^a April-June 1989

Analysis	Number of samples	Total (10 ⁶ Bq/week)			Standard error ^b
		Max	Min	Av	
Gross alpha	13	0.0007	0.0000	0.0001	0.000067
Gross beta	13	0.0012	0.0000	0.0004	0.00010
¹³¹ I	13	0.0017	-0.0020	-0.0003	0.00030
¹³³ I	13	0.0031	-0.0020	0.0003	0.00033
¹³⁵ I	3	0.0026	-0.0010	0.0006	0.0011

^aSee Fig. 1.

^bStandard error of the average of more than two samples.

Table 10. Monthly airborne emissions at the Radioactive Materials Analytical Laboratory, Building 2026,^a April-June 1989

Analysis	Emissions per month (10 ⁶ Bq)			Total (10 ⁶ Bq)
	April	May	June	
¹³⁷ Cs	0.040	0.083		0.12
Gross alpha	0.18	0.17	0.060	0.42
Gross beta	0.36	0.32	0.13	0.81
¹³¹ I	0.012	-0.00060	0.0019	0.013
¹³³ I	0.0059	-0.0080	0.0066	0.0044
¹³⁵ I	-0.020	-0.050	0.047	-0.020
²¹² Pb	110	83	97	290

^aSee Fig. 1.

Table 11. Monthly airborne emissions at the Radiochemical Processing Plant ventilation stack, Building 3020,^a April-June 1989

Analysis	Emissions per month (10 ⁶ Bq)			Total (10 ⁶ Bq)
	April	May	June	
Gross alpha	0.0061	0.011	0.0059	0.023
Gross beta	0.035	0.15	0.017	0.20
¹³¹ I	0.013	0.017	0.018	0.047
¹³³ I	0.0023	-0.010	0.0011	-0.0070
¹³⁵ I		-0.040		-0.040
²¹² Pb	15	1.8		16

^aSee Fig. 1.

Table 12. Monthly airborne emissions at the 3500 and 4500 area cell ventilation systems, Building 3039, Duct 1,^a April-June 1989

Analysis	Emissions per month (10 ⁶ Bq)			Total (10 ⁶ Bq)
	April	May	June	
Gross alpha	0.019	0.0022	0.0018	0.023
Gross beta	1.4	0.095	0.027	1.6
³ H ^b	410	2,500	16,000	19,000
¹³¹ I	0.0095	0.0027	0.0073	0.019
¹³³ I	0.0040	0.0068	-0.00001	0.011
¹³⁵ I	0.013	-0.030	-0.0040	-0.030
²¹² Pb	13	14	11	37

^aSee Fig. 1.

^bSources of error being investigated.

Table 13. Monthly airborne emissions at the central off-gas and scrubber system, Building 3039, Duct 2,^a April-June 1989

Analysis	Emissions per month (10 ⁶ Bq)			Total (10 ⁶ Bq)
	April	May	June	
¹⁹⁴ Au			8.1	8.1
Gross alpha	0.0016	0.0030	0.0045	0.0090
Gross beta	0.027	0.029	0.0074	0.063
³ H ^b	1300	630	300	2300
¹³¹ I	0.0070	0.016	0.068	0.090
¹³³ I	0.0073	0.012	0.37	0.38
¹³⁵ I	-0.060	-0.020	0.0061	-0.080
¹⁹¹ Os		0.075		0.075
²¹² Pb	170	94	53	320
¹⁰⁶ Ru			0.95	0.95

^aSee Fig. 1.

^bSources of error being investigated.

Table 14. Monthly airborne emissions at the isotope-solid state ventilation system, Building 3039, Duct 3,^a April-June 1989

Analysis	Emissions per month (10 ⁶ Bq)			Total (10 ⁶ Bq)
	April	May	June	
194			1.5	1.5
⁸² Br	0.049	0.24	0.10	0.39
⁶⁰ Co	7.2	0.29	0.22	7.7
Gross alpha	0.13	0.0020	0.0022	0.13
Gross beta	1.5	0.060	0.052	1.6
³ H ^b	2,400,000	5,800,000	99,000	8,300,000
¹³¹ I	240	0.98	0.068	240
¹³³ I	0.035	0.011	0.016	0.062
¹³⁵ I	-3.0	-0.0080	-0.040	-3.0
²¹² Pb	320	8.0	4.4	340
¹²⁵ Sb		0.21	0.059	0.26
⁷⁵ Se	32	0.27	0.17	32

^aSee Fig. 1.

^bSources of error being investigated.

Table 15. Monthly airborne emissions at the 3025 and 3026 area cell ventilation systems, Building 3039, Duct 4,^a April-June 1989

Analysis	Emissions per month (10 ⁶ Bq)			Total (10 ⁶ Bq)
	April	May	June	
Gross alpha	0.0017	0.0054	0.0015	0.0087
Gross beta	14	6.7	5.3	26
³ H ^b	26,000	620,000	15,000	660,000
¹³¹ I	-0.00040	0.00050	0.013	0.013
¹³³ I	0.00064	0.0025	-0.0060	-0.0030
¹³⁵ I	0.028	0.0043	-0.030	0.0033
¹⁹¹ Os	0.88	0.12	0.30	1.3
²¹² Pb	0.23	0.13	0.053	0.41
¹²⁵ Sb			0.035	0.035

^aSee Fig. 1.

^bSources of error being investigated.

Table 16. Monthly airborne emissions at the Tritium Target
Fabrication Facility, Building 7025,^a April-June 1989

Analysis	Emissions per month (10 ⁶ Bq)			Total (10 ⁶ Bq)
	April	May	June	
³ H ^b	160,000	2,000,000	8,200,000	10,000,000

^aSee Fig. 1.

^bSources of error being investigated.

Table 17. Monthly airborne emissions at the Melton Valley complex,
Building 7911,^a April-June 1989

Analysis	Emissions per month (10 ⁶ Bq)			Total (10 ⁶ Bq)
	April	May	June	
¹³⁸ Cs			0.51	0.51
Gross alpha	0.0024	0.00086	0.00016	0.0034
Gross beta	0.054	0.030	0.024	0.11
³ H ^b	-800	910	2900	3000
¹³¹ I	61	77	53	190
¹³² I		3.1	3.3	6.4
¹³³ I	74	85	70	230
¹³⁴ I			4.0	4.0
¹³⁵ I	72	78	65	210
²¹² Pb	47	34	37	120
⁷⁵ Se			0.053	0.053

^aSee Fig. 1.

^bSources of error being investigated.

Table 18. Monthly airborne emissions at the Molten Salt
Reactor Facility, Building 7512,^a April-June 1989

Analysis	Emissions per month (10 ⁶ Bq)			Total (10 ⁶ Bq)
	April	May	June	
Gross alpha	0.0011	0.00028	0.00087	0.0023
Gross beta	0.0036	0.01011	0.0018	0.0064
¹³¹ I	-0.00130	-0.00080	-0.00030	-0.0040
¹³³ I	0.0017	0.0015	0.0018	0.0050
¹³⁵ I	0.0026	-0.0010	0.00057	0.0019

^aSee Fig. 1.

2.2 AMBIENT AIR

Most gaseous wastes from ORNL are released to the atmosphere from stacks. Radioactivity may be present in gaseous waste streams as a solid (particulates), an absorbable gas (e.g., iodine), or 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 the monitoring of stack effluents, atmospheric concentrations of materials can be continuously monitored at 27 stations around ORNL, the Oak Ridge Reservation, and the surrounding vicinity. Locations of these stations are shown in Figs. 2 through 4. These air monitoring stations are categorized into three groups according to their geographical locations:

1. The ORNL perimeter air monitoring (PAM) network consists of stations 3, 4, 7, 9, 20, 21, and 22. These stations are located at or near the ORNL boundary (shown in Fig. 2).
2. The DOE Oak Ridge Reservation (reservation PAMs) network consists of stations 8, 23, 31, 33, 34, 36, and 40-46 (Fig. 3). Stations 8 and 31 through 45 have the capability to perform both sampling and continuous monitoring. Station 46 is currently being redeveloped to collect real-time data.
3. The remote air monitoring (RAM) network consists of stations 51-53 and 55-58. All of these stations are located within a 120-km radius of ORNL outside the DOE Oak Ridge Reservation (Fig. 4).

Several of the ORNL and reservation PAM stations have real-time monitors for five radiation parameters (gross alpha, gross beta, iodine, gross gamma, and noble gas) and are also equipped with three process sensors that are used to calculate the volume of the sample collected. A central processor collects 10-min average readings and transmits the data to a VAX computer for further analysis and reporting. Local data concentrators check 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.

Airborne radioactive particulates are collected by pumping a continuous flow of air through a paper filter and then through a charcoal cartridge. 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 to 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 h after collection. The initial and final dates, time on and off, and flow rates are recorded when a sample is mounted or removed. The total volume of air that flowed through the sampler at each station is calculated using this information. The flow rates are set

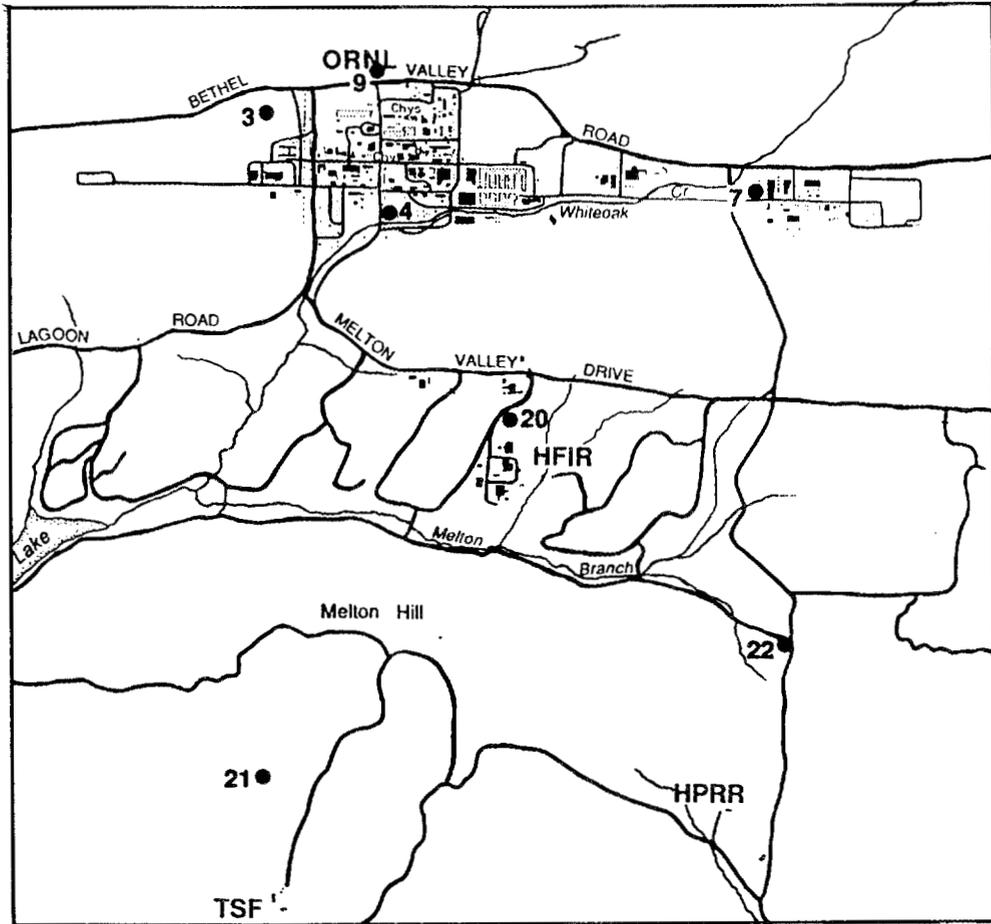


Fig. 2. Location map of ORNL perimeter air monitoring stations.

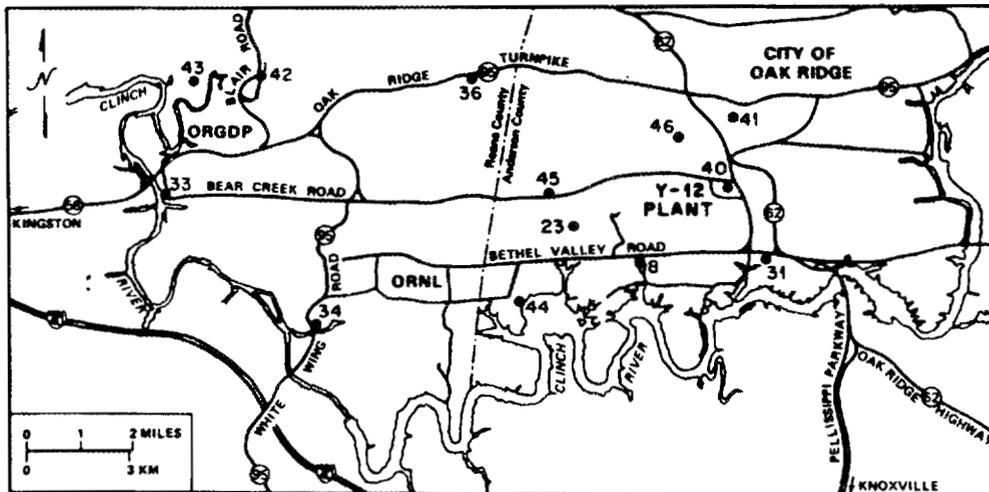


Fig. 3. Location map of Oak Ridge Reservation air monitoring stations.

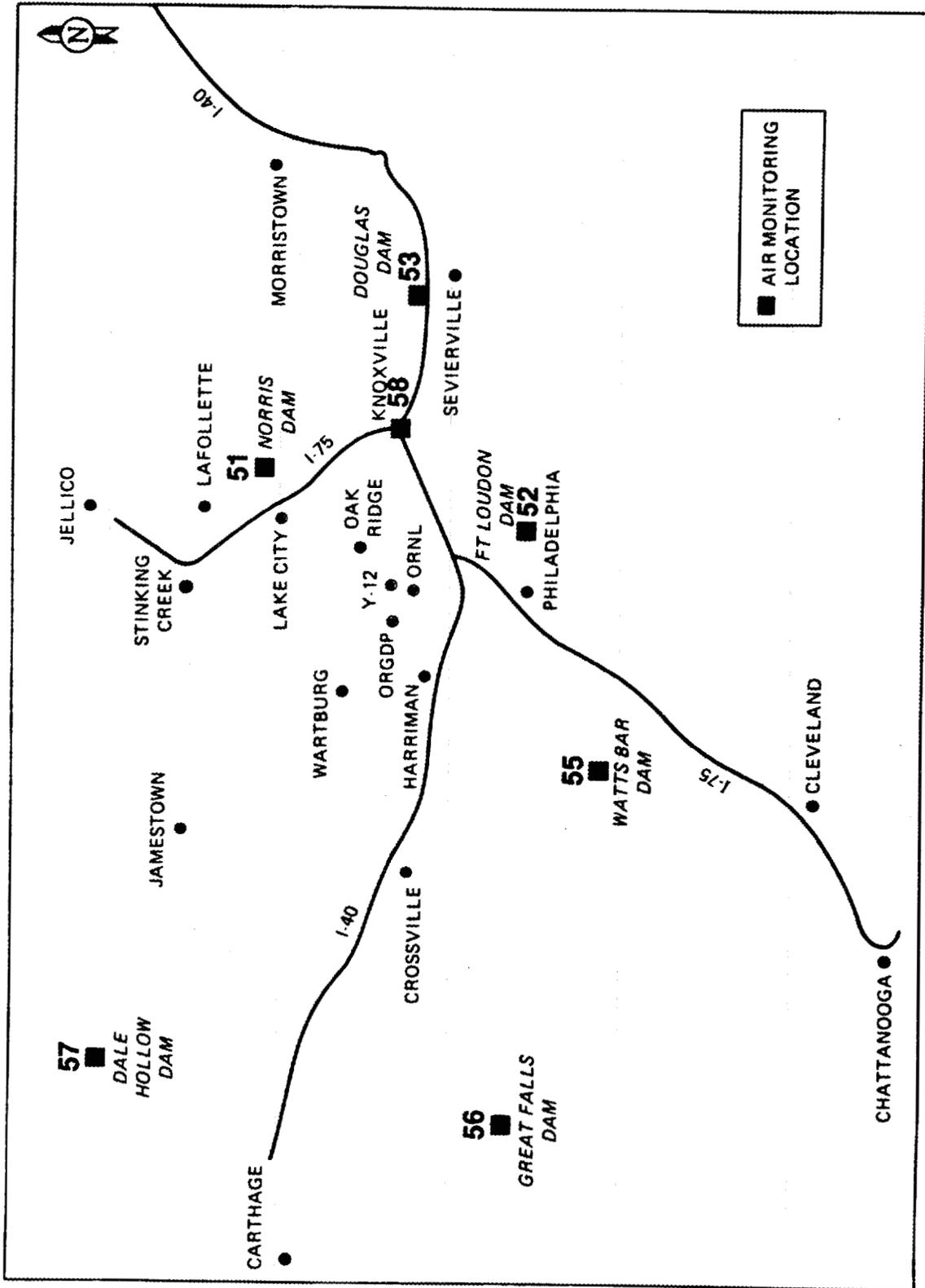


Fig. 4. Location map of the remote air monitoring stations.

between 2.0 and 3.0 ft³/min to minimize artifacts from extremely high or low flow rates. The concentration of radionuclides in air is calculated by dividing the total activity per sample by the total volume of air. After a review of historical data and an evaluation of program requirements, filter papers and charcoal cartridges were no longer collected at stations 4, 8, 31, 33, 36, 42, and 43 after May 1, 1989. Filter paper sampling at stations 51, 53, and 55-57 was dropped on May 1, 1989. To increase the precision of the measurements and because the isotopes are all long-lived, composite air filters will be prepared annually, rather than quarterly, for analysis of specific isotopes. These data will be reported in the report for fourth quarter.

Concentrations of gross alpha, gross beta, and atmospheric ¹³¹I are summarized in Tables 19-21. Instrument background concentrations of ¹³¹I, gross alpha, and gross beta have been subtracted from the measured concentrations. Negative values represent concentrations below the instrument background level. Flow data at the remote stations have been unreliable and highly variable this year. Stations 52 and 58 do not appear in the gross alpha and gross beta tables because they had no valid flow values for this quarter.

Alpha activity appears to be slightly higher than last quarter. This is the result of changing the sampling period from weekly to biweekly. The weekly results were consistently at the analytical instrument background levels. The sampling period has been increased to 2 weeks, thereby doubling the total sample volume and increasing the sample activity sufficiently to discriminate it from analytical background. There is little difference in the average for the three networks. Average beta activity was slightly lower than for the preceding quarter. Values for the ORNL stations and for reservation stations were similar to values for the remote stations.

Iodine-131 concentrations (Table 21) were similar to concentrations from the previous quarter. Although there are some higher values this quarter, the maximum value, 81, at station 36 is only 0.0054% of the derived concentration guideline for ¹³¹I.

Monthly samples for atmospheric tritium are routinely collected from ORNL PAM station 3 and 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. Because of some problems in calculating the volume of air sampled, this table will not be reported this quarter.

2.3 EXTERNAL GAMMA RADIATION

External gamma radiation measurements are made to determine if routine radioactive effluents from ORNL are increasing external gamma radiation levels significantly above normal background.

Table 19. Long-lived gross alpha activity in air, April-June 1989

Location	Number of samples	Concentration (10^{-8} Bq/L)			Standard error ^a
		Max	Min	Av	
<i>ORNL PAM Stations^b</i>					
3	6	4.7	1.9	3.1	0.48
4	2	3.1	2.4	2.7	0.36
7	6	3.7	2.1	2.8	0.24
9	3	2.9	1.9	2.5	0.34
20	2	3.5	2.9	3.2	0.28
21	6	5.1	2.5	3.5	0.49
22	6	4.7	3.2	3.7	0.23
—					
Network Summary	31	5.1	1.9	3.2	0.16
<i>Reservation PAM Stations^c</i>					
23	6	4.6	2.4	3.4	0.33
31	2	4.8	4.0	4.4	0.41
33	2	3.7	3.5	3.6	0.12
34	6	4.0	1.7	2.8	0.37
36	2	3.5	2.9	3.2	0.30
40	4	5.8	1.9	4.2	0.86
41	5	4.5	2.2	3.2	0.45
42	2	4.6	3.7	4.2	0.46
43	2	3.7	2.3	3.0	0.73
44	6	4.6	2.4	3.3	0.37
45	5	4.5	1.8	3.2	0.50
46	5	4.7	1.4	3.6	0.56
—					
Network Summary	47	5.8	1.4	3.4	0.15

Table 19 (continued)

Location	Number of samples	Concentration (10^{-8} Bq/L)			Standard error ^a
		Max	Min	Av	
<i>RAM Stations^d</i>					
53	2	4.0	3.5	3.8	0.24
55	1	2.2	2.2	2.2	
56	1	3.3	3.3	3.3	
57	1	5.7	5.7	5.7	
Network Summary	5	5.7	2.2	3.7	0.58
Overall Summary	83	5.8	1.4	3.3	0.11

^aStandard error of the mean.

^bSee Fig. 2.

^cSee Fig. 3.

^dSee Fig. 4.

Table 20. Long-lived gross beta activity in air, April-June 1989

Location	Number of samples	Concentration (10^{-8} Bq/L)			Standard error ^a
		Max	Min	Av	
<i>ORNL PAM Stations^b</i>					
3	6	110	65	83	6.8
4	2	98	62	80	18
7	6	81	49	68	5.8
9	3	75	62	69	3.7
20	2	100	71	88	16
21	6	99	63	80	5.4
22	6	92	67	79	3.2
—					
Network Summary	31	110	49	77	2.6
<i>Reservation PAM Stations^c</i>					
23	6	92	62	76	4.9
31	2	87	66	77	10
33	2	98	61	79	18
34	6	77	34	59	7.4
36	2	62	48	55	7.2
40	4	80	48	63	6.9
41	5	80	42	61	7.4
42	2	94	64	79	15
43	2	57	38	47	9.7
44	6	83	54	66	5.4
45	5	87	42	63	9.9
46	5	95	40	69	8.9
—					
Network Summary	47	98	34	66	2.5

Table 20 (continued)

Location	Number of samples	Concentration (10^{-8} Bq/L)			Standard error ^a
		Max	Min	Av	
<i>RAM Stations^d</i>					
53	2	80	61	70	9.7
55	1	33	33	33	
56	1	94	94	94	
57	1	73	73	73	
Network Summary	5	94	33	68	10
Overall Summary	83	110	33	70	1.9

^aStandard error of the mean.

^bSee Fig. 2.

^cSee Fig. 3.

^dSee Fig. 4.

Table 21. ^{131}I concentrations in air, April-June 1989

Location	Number of samples	Concentration (10^{-8} Bq/L)			Standard error ^a	Percentage DCG ^b
		Max	Min	Av		
<i>ORNL PAM Stations^c</i>						
3	6	49	0.64	12	7.7	< 0.01
4	2	1.3	0.64	0.96	0.32	< 0.01
7	6	5.0	-14	-1.6	2.7	< 0.01
9	3	32	10	24	6.8	< 0.01
20	2	1.3	-4.8	-1.8	3.0	< 0.01
21	6	1.4	-3.3	-0.91	0.71	< 0.01
22	6	7.9	-9.0	-1.6	2.4	< 0.01
Network Summary	31	49	-14	3.7	2.2	< 0.01
<i>Reservation PAM Stations^d</i>						
23	6	1.4	-2.9	-1.1	0.83	< 0.01
31	2	1.4	1.4	1.4	0.0055	< 0.01
33	2	10	-0.71	4.7	5.4	< 0.01
34	6	13	-29	0.26	6.1	< 0.01
36	2	81	-0.72	40	41	< 0.01
40	4	8.6	-7.4	0.27	3.3	< 0.01
41	5	5.0	-3.6	-0.87	1.5	< 0.01
42	2	5.4	-3.9	0.74	4.7	< 0.01
43	2	1.4	-3.3	-1.0	2.4	< 0.01
44	6	2.1	-14	-2.9	2.5	< 0.01
45	5	-1.6	-16	-5.9	2.6	< 0.01
46	5	21	-5.1	5.1	4.7	< 0.01
Network Summary	47	81	-29	1.3	2.0	< 0.01
Overall Summary	78	81	-29	2.3	1.5	< 0.01

^aStandard error of the mean.

^bPercentage DCG = average value \times 100/derived concentration guide (DCG).
The DCG for ^{131}I is 1.5×10^{-2} Bq/L.

^cSee Fig. 2.

^dSee Fig. 3.

Table 22. External gamma radiation measurements at ORNL
and reservation perimeter air monitoring
stations, April-June 1989

Location	Number of samples ^a	Concentration (nC/kg/h)			Standard error ^b
		Max	Min	Av	
<i>ORNL PAM Stations^c</i>					
03	2,108	2.6	1.6	1.7	0.0017
07	771	2.6	1.4	1.8	0.0098
20	623	13	1.9	2.3	0.019
Network Summary	3,502	13	1.4	1.9	0.0056
<i>Reservation PAM Stations^d</i>					
08	2,063	2.7	1.6	1.8	0.0022
31	1,772	61	1.9	2.1	0.047
33	1,381	3.8	1.6	1.9	0.0039
34	629	13	1.7	2.2	0.026
36	1,209	5.6	1.7	1.8	0.0042
40	1,212	2.7	1.7	2.0	0.0034
41	1,328	3.9	1.5	1.6	0.0038
44	2,165	2.4	1.5	1.7	0.0022
Network summary	11,759	61	1.5	1.9	0.0075

^aReal-time readings were collected at all stations at 10-min intervals. The number of samples indicate the total number of valid hourly averages during the quarter.

^bStandard error of the mean.

^cSee Fig. 2.

^dSee Fig. 3.

Average gamma radiation measurements are recorded at 10-min intervals at ORNL and PAM stations 3, 7, 20, 8, 31, 33, 34, 36, 40, 41, and 44 (Figs. 2 and 3). From these data, hourly averages are computed. Table 22 summarizes the valid hourly measurements for the second quarter of 1989. Environmental surveillance for external gamma has been discontinued at location 4 because it is located next to the Process Waste Treatment Plant. The external gamma signature of this facility does not represent environmental levels at the ORNL facility boundary. The current program uses locations 3, 7, and 20 as perimeter monitoring locations for ORNL. Typical values for cities in the United States are usually between 1.3 and 5.2 nC/kg/h (50 and 200 nGy/h, respectively) according to the recent issues of *EPA Environmental Radiation Data*. The median value for cities in the contiguous United States for all four quarters of 1987 was 2.4 nC/kg/h (93 nGy/h), with 75% of the values being between 1.9 and 3.9 nC/kg/h (75 and 150 nGy/h). The distribution is positively skewed. All of the values given in Table 22 are close to this range of background values except for the maximum reading at station 31 (61 nC/kg/h). This value occurred during a 2-h period in mid-June. No apparent reason could be ascertained for the readings during that time frame. A check of the instrumentation showed that it was functioning properly during that interval. Reading from station 31 returned to normal levels approximately 2 h after the initial rise.

3. WATER

The Oak Ridge National Laboratory (ORNL) site is drained by two main streams, White Oak Creek (WOC) and Melton Branch. With the exception of two small discharges from the 7600 area into Melton Hill Lake, all ORNL effluents discharge to these two streams or their tributaries. WOC flows through Bethel Valley where Fifth Creek, First Creek, and the Northwest Tributary join it (Fig. 5). WOC continues through a gap in Chestnut Ridge into Melton Valley where it is joined by Melton Branch, which drains Melton Valley. Water quality in these streams is affected primarily by wastewater discharges and by groundwater transport of contaminants from land disposal of wastes. WOC empties into White Oak Lake, which is controlled by White Oak Dam (WOD), and is the last sampling point before effluents leave the ORNL site. The majority of the drainage or liquid effluent from ORNL flows into the Clinch River by way of WOC. The Clinch River flows southwest from Virginia to its mouth near Kingston, Tennessee, where it joins with the Tennessee River. Process effluents discharged to these streams are handled in a number of ways which include: treatment [Process Waste Treatment Plant (PWTP), Coal Yard Runoff], holding basins [190 ponds, High Flux Isotope Reactor/Transuranium Processing Plant (HFIR/TRU) ponds], and direct discharge to the stream. Sanitary effluent is discharged to WOC after treatment at the Sewage Treatment Plant. Below WOD, WOC is affected by water levels in the Clinch River which are controlled by Melton Hill Dam.

Surveillance of the water environment consists of the collection of surface water, effluent and sediment samples required under the National Pollutant Discharge Elimination System (NPDES) permit, and groundwater from WAG 1 and WAG 6. Samples are analyzed for radionuclides and nonradioactive chemicals.

3.1 SURFACE WATER

White Oak Creek drains an area of 17 km² in Bethel and Melton valleys and is the largest stream flowing through ORNL. After entering Melton Valley, WOC is joined by its major tributary, Melton Branch (MB). White Oak Dam, located 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.

Samples are collected for radiological analyses at off-site and on-site locations, at background or reference locations, from streams on the ORNL site, and from all process discharge point sources. A summary of locations, parameters analyzed, and frequencies of sample collection and analysis for all radiological samples is provided in Table 23. Treated water samples are collected weekly at the Kingston and Oak Ridge Gaseous Diffusion Plant (ORGDP, Gallaher) potable water treatments plants (Fig. 6) and are analyzed quarterly. Changes in the sampling procedures were implemented during this quarter. In early May, sampling stations 190 Ponds, 1500 Area, and 2000 Area were combined. At the end of May, stations HFIR Ponds and TRU Ponds were combined. Tritium and total Sr analysis frequencies for WOD were changed from weekly to monthly. For Kingston and Gallaher, total uranium analysis was substituted for specific uranium isotope analysis. This section contains summaries of results

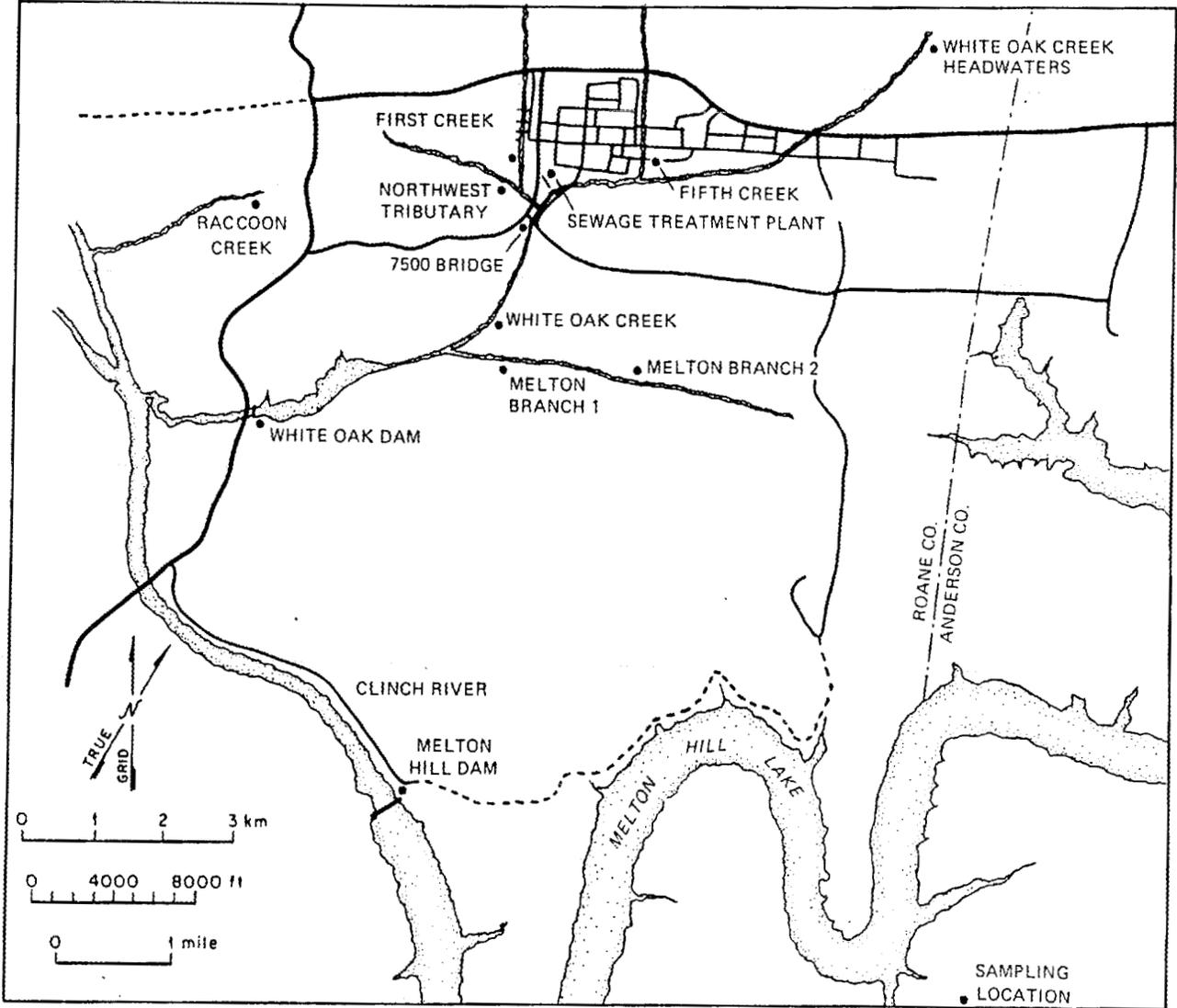


Fig. 5. Location map of ORNL streams and sampling stations.

Table 23. Summary of collection and analysis frequencies of surface, pond, and effluent water samples

Station	Parameter	Collection frequency	Type	Analysis frequency
190 Ponds, 3544	Gamma scan, gross alpha gross beta, total Sr ^a	Weekly	Flow proportional	Monthly
3518	Gross alpha, gross beta	Weekly	Flow proportional	Monthly
STP	Gamma scan, gross beta, total Sr ^a	Daily	Flow proportional	Monthly
7500 Bridge, MB1 MB2, WOC	Gamma scan, total Sr, ^a ³ H	Weekly	Flow proportional	Monthly
First Creek, Fifth Creek, Raccoon Creek	Gamma scan, total Sr ^a	Weekly	Grab	Monthly
Gallaher-Process	³ H, gamma scan, gross alpha, gross beta, ²³⁸ Pu ²³⁹ Pu, total Sr, ^a U isotopes	Weekly	Time proportional	Quarterly
Gallaher-Process	¹³¹ I	5 times/ quarter	Grab	5 times/ quarter
Kingston	³ H, gamma scan, gross alpha, gross beta, ²³⁸ Pu, ²³⁹ Pu, total Sr, ^a U isotopes	Weekly	Grab	Quarterly
Melton Hill Dam	Gamma scan, gross alpha, ^b gross beta ^c	Weekly	Flow proportional	Monthly
NWT	Gamma scan, total Sr ^a	Weekly	Flow proportional	Monthly
TRU Ponds/TURF/ HFIR storage tanks	Gamma scan, gross alpha, gross beta	After discharge	Flow proportional	Monthly
WOC Headwaters	Gamma scan, gross alpha, ^b gross beta ^c	Weekly	Flow proportional	Monthly

Table 23 (continued)

Station	Parameter	Collection frequency	Type	Analysis frequency
WOD	^{241}Am , ^{244}Cm , gamma scan, gross beta, total Sr, ^a ^{238}Pu , ^{239}Pu , ^3H	Weekly	Flow proportional	Weekly

^aTotal radioactive Sr (^{89}Sr + ^{90}Sr).

^bIf gross alpha >1.0 Bq/L then analyze for ^{241}Am , ^{244}Cm , ^{238}Pu , ^{239}Pu , ^{228}Th , ^{230}Th , ^{233}Th , ^{234}U , ^{235}U , and ^{238}U .

^cIf gross beta >30 Bq/L then analyze for total radioactive strontium.

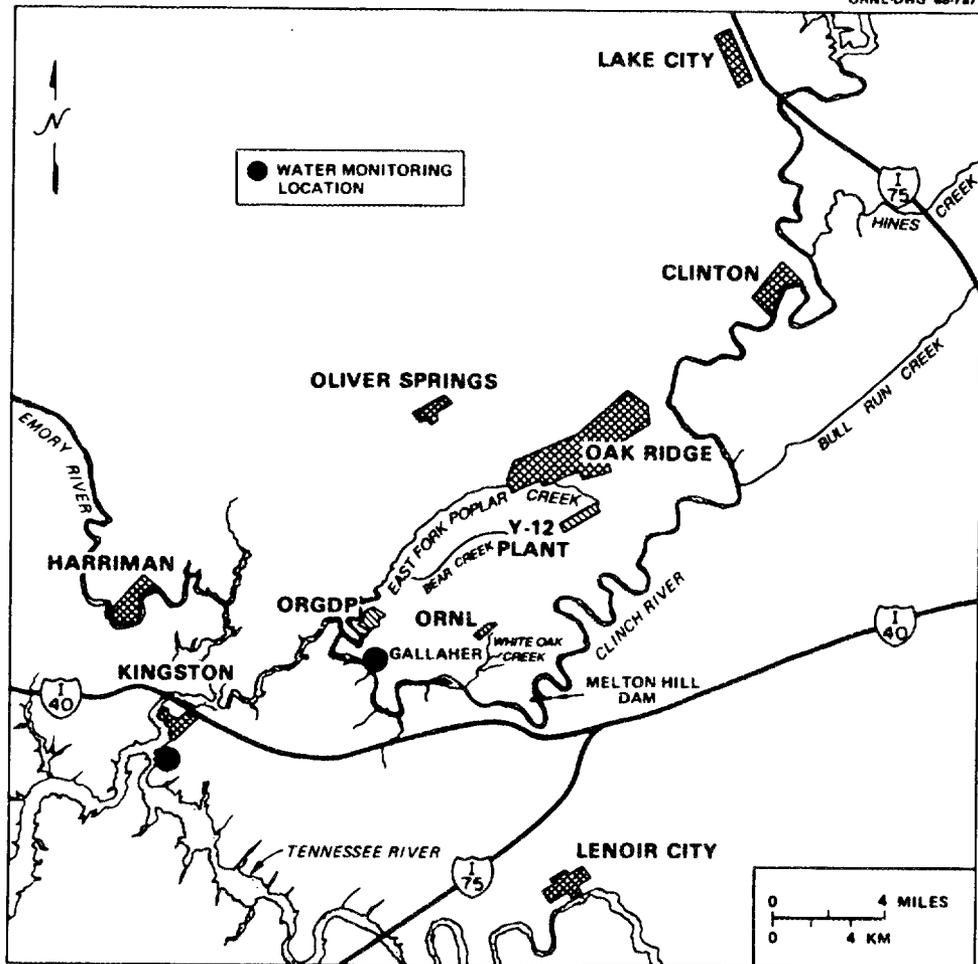


Fig. 6. Location map of Gallaher and Kingston sampling points.

of samples collected from each of these types of locations and reflects the changes made during the quarter. The results for Kingston and Gallaher were not available when this document was prepared but will appear in the next quarterly report.

Melton Hill Dam and WOC headwater, two locations above ORNL discharge points, serve as references for other water sampling locations at the ORNL site. Water samples are collected from six streams: WOC, MB, First Creek, Fifth Creek, Northwest Tributary, and Raccoon Creek (Fig. 5). Summary statistics for each radionuclide at each surface water sampling location are given in Table 24.

Draft DOE Order 5400.XX, Chapter II, 2.a., requires comparison of annual average radionuclide concentrations with the derived concentration guide (DCG) values. According to the Draft DOE Order, a DCG for water is the concentration of a particular radionuclide for which a "reference man" under continuous exposure (ingestion) for 1 year would receive the most restrictive of (1) an effective dose equivalent of 1 milliSievert (1 mSv = 100 mrem) or (2) a dose equivalent of 50 mSv to any particular tissue. Although the DCGs apply at the point of discharge to a receiving stream prior to dilution in the stream, average quarterly stream concentrations were compared with the DCGs as a guideline. Average concentrations of each parameter are expressed as a percentage of the DCG in Table 24. All parameters, with the exception of total radioactive Sr, were less than 2% of the DCG. Average total radioactive Sr concentration was highest in First Creek (average of 10 Bq/L), which was 28% of the DCG for ⁹⁰Sr.

Locations that are sampled for nonradioactive chemicals under the requirements of the NPDES permit (see Sect. 3.2) are also sampled for radionuclides (Fig. 7). Parameters analyzed and the frequency of analysis are given in Table 23. Table 25 gives a summary of the quarterly concentrations for each of these locations. The average concentration is expressed as a percentage of the DCG in the last column of this table. No parameter average concentration exceeded 80% of its DCG.

The discharge of radioactive contaminants from ORNL is affected by the stream flows. Flows in MB (as measured at station MB1), WOC (as measured at the confluence of MB and at WOD), and the Clinch River (as measured at Melton Hill Dam) are given in Table 26. The flow in Melton Branch is about one-third that in WOC. The ratio of WOC flow to Clinch River flow is also given in Table 26. The average ratios given were calculated daily and averaged for the month. This ratio gives an indication of the dilution factor that is expected for potential contaminants entering the Clinch River from WOC. The ratio for the quarter ranged from 150 to 500. Clinch River flows are regulated by a series of TVA dams, one of which is Melton Hill Dam.

Discharges of radioactivity into WOC at the Sewage Treatment Plant, at the confluence of WOC and MB, at WOD and into MB were calculated from concentration and flow. A single flow-proportional sample was obtained weekly at each of WOD, WOC, MB1, and Sewage Treatment Plant (STP) stations and analyzed at (roughly) monthly intervals. (WOD monthly analyses were done for tritium and total Sr only.) The discharge during that period was calculated as the product of the flow-weighted concentration and the total flow for the

Table 24. Radionuclide concentrations in surface waters around ORNL, ^a April-June 1989

Radionuclide	Number of samples	Concentration (Bq/L)				Standard error ^b	Derived Concentration Guide (DCG) ^c	Percentage of DCG ^d
		Max	Min	Av				
<i>Melton Hill Dam</i>								
²⁴¹ Am	1	0.013	0.013	0.013	NA ^e	1.1	1.2	
²⁴⁴ Cm	1	0.0090	0.0090	0.0090	NA	2.2	0.41	
⁶⁰ Co	3	0.10	-0.17	-0.013	0.081	190	<0.001	
¹³⁷ Cs	3	-0.010	-0.30	-0.16	0.084	110	<0.001	
Gross alpha	3	0.31	0.14	0.22	0.050	NA	NA	
Gross beta	3	1.4	0.10	0.67	0.38	NA	NA	
²³⁸ Pu	1	0.0010	0.0010	0.0010	NA	1.5	0.068	
²³⁹ Pu	1	0.0010	0.0010	0.0010	NA	1.1	0.090	
Total Srf.	1	0.0	0.0	0.0	NA	37	<0.001	
³ H	1	46	46	46	NA	74,000	0.062	
<i>White Oak Creek Headwaters</i>								
²⁴¹ Am	1	-0.0030	-0.0030	-0.0030	NA	1.1	<0.001	
²⁴⁴ Cm	1	0.013	0.013	0.013	NA	2.2	0.59	
⁶⁰ Co	3	-0.030	-1.9	-0.67	0.61	190	<0.001	
¹³⁷ Cs	3	0.23	-0.40	-0.077	0.18	110	<0.001	
Gross alpha	3	0.24	0.14	0.19	0.029	NA	NA	
Gross beta	3	1.7	0.10	0.80	0.47	NA	NA	
²³⁸ Pu	1	0.0015	0.0015	0.0015	NA	1.5	0.10	
²³⁹ Pu	1	0.0010	0.0010	0.0010	NA	1.1	0.090	
Total Srf.	1	0.030	0.030	0.030	NA	37	0.081	
³ H	1	23	23	23	NA	74,000	0.031	

Table 24 (continued)

Radionuclide	Number of samples	Concentration (Bq/L)				Standard error ^b	Derived Concentration Guide (DCG) ^c	Percentage of DCG ^d
		Max	Min	Av				
<i>7500 Bridge</i>								
⁶⁰ Co	3	0.30	0.13	0.22	0.050	190	0.12	
¹³⁷ Cs	3	3.1	0.95	2.0	0.62	110	1.8	
Total Sr ^f	3	2.6	1.8	2.1	0.25	37	5.7	
³ H	3	450	180	300	79	74,000	0.41	
<i>First Creek</i>								
⁶⁰ Co	3	2.1	-0.28	0.59	0.76	190	0.32	
¹³⁷ Cs	3	0.50	-0.020	0.21	0.15	110	0.19	
Total Sr ^f	3	13	7.4	10	1.6	37	28	
<i>Fifth Creek</i>								
⁶⁰ Co	3	0.80	-0.060	0.29	0.26	190	0.16	
¹³⁷ Cs	3	0.10	-0.70	-0.21	0.25	110	<0.001	
Total Sr ^f	3	1.3	0.050	0.85	0.40	37	2.3	

Table 24 (continued)

Radionuclide	Number of samples	Concentration (Bq/L)			Standard error ^b	Derived Concentration Guide (DCG) ^c	Percentage of DCG ^d
		Max	Min	Av			
<i>Melton Branch 2</i>							
⁶⁰ Co	3	2.0	0.070	0.95	0.56	190	0.52
¹³⁷ Cs	3	0.30	-0.070	0.093	0.11	110	0.084
Total Sr ^f	3	0.48	0.050	0.22	0.13	37	0.60
³ H	3	180	71	130	32	74,000	0.17
<i>Northwest Tributary</i>							
⁶⁰ Co	3	0.16	-0.90	-0.25	0.33	190	<0.001
¹³⁷ Cs	3	0.90	-0.010	0.36	0.28	110	0.32
Total Sr ^f	3	2.3	1.8	2.1	0.15	37	5.7
<i>Raccoon Creek</i>							
⁶⁰ Co	3	0.60	-0.41	0.047	0.30	190	0.025
¹³⁷ Cs	3	0.29	-0.23	0.087	0.16	110	0.078
Total Sr ^f	3	0.78	0.57	0.70	0.066	37	1.9

^aSee Fig. 5.

^bStandard error of the mean.

^cDerived concentration guide for ingestion of water. From DOE Order 5400.XX.

^dAverage concentration as a percentage of the DCG.

^eNA = not applicable.

^fTotal radioactive Sr (⁸⁹Sr + ⁹⁰Sr).

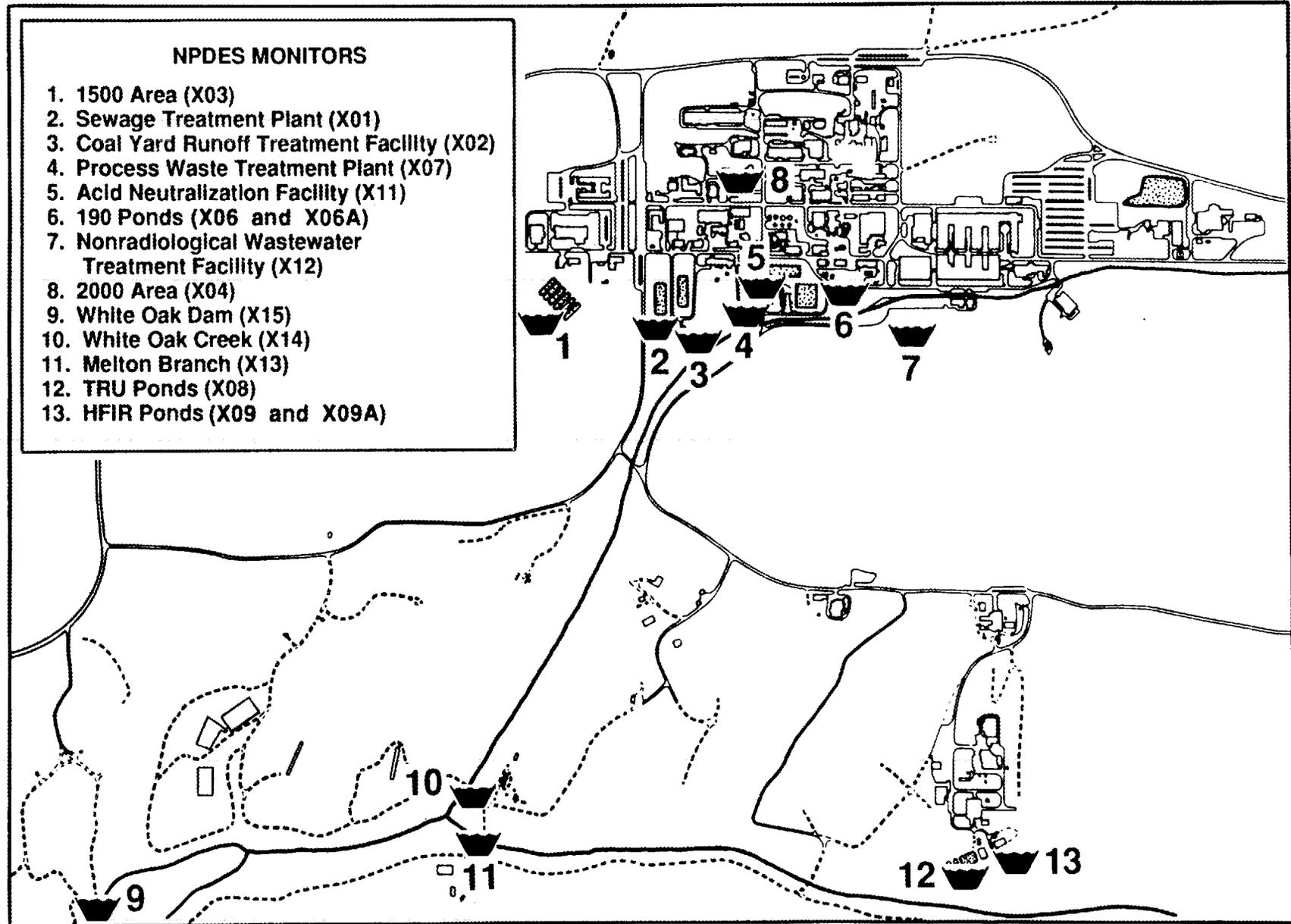


Fig. 7. Location map of NPDES monitoring points.

Table 25. Radionuclide concentrations at ORNL NPDES locations,^a April-June 1989

Radionuclide	Number of samples	Concentration (Bq/L)					Derived Concentration Guide (DCG) ^c	Percentage of DCG ^d
		Max	Min	Av	Standard error ^b	Standard error ^b		
<i>Sewage Treatment Plant (X01)</i>								
⁶⁰ Co	3	2.0	-0.10	0.68	0.66	190	0.37	0.37
¹³⁷ Cs	3	0.18	-0.70	-0.17	0.27	110	<0.001	<0.001
Gross beta	3	7.4	6.4	6.9	0.29	NA ^e	NA	NA
Total Sr ^f	3	4.2	2.3	3.3	0.55	37	8.9	8.9
<i>1500 Area (X03)</i>								
Gross alpha	1	0.51	0.51	0.51	NA	NA	NA	NA
Gross beta	1	0.30	0.30	0.30	NA	NA	NA	NA
<i>2000 Area (X04)</i>								
⁶⁰ Co	1	-0.30	-0.30	-0.30	NA	190	<0.001	<0.001
¹³⁷ Cs	1	1.3	1.3	1.3	NA	110	1.2	1.2
Gross beta	1	0.70	0.70	0.70	NA	NA	NA	NA
Total Sr ^f	1	0.16	0.16	0.16	NA	37	0.43	0.43
<i>190 Ponds (X06)</i>								
⁶⁰ Co	1	-0.90	-0.90	-0.90	NA	190	<0.001	<0.001
¹³⁷ Cs	1	0.20	0.20	0.20	NA	110	0.18	0.18
Gross alpha	1	0.50	0.50	0.50	NA	NA	NA	NA
Gross beta	1	1.3	1.3	1.3	NA	NA	NA	NA

Table 25 (continued)

Radionuclide	Number of samples	Concentration (Bq/L)				Standard error ^b	Derived Concentration Guide (DCG) ^c	Percentage of DCG ^d
		Max	Min	Av				
<i>190 Ponds, 1500 Area and 2000 Area (X06A)</i>								
⁶⁰ Co	2	0.010	-0.45	-0.22	0.23	190	<0.001	
¹³⁷ Cs	2	0.26	0.16	0.21	0.050	110	0.19	
Gross alpha	2	0.23	0.20	0.22	0.015	NA	NA	
Gross beta	2	1.4	0.10	0.75	0.65	NA	NA	
Total Srf	2	0.25	0.14	0.20	0.055	37	0.53	
<i>Process Waste Treatment Plant (X07)</i>								
⁶⁰ Co	3	2.6	0.50	1.5	0.61	190	0.79	
¹³⁷ Cs	3	99	81	89	5.4	110	80	
Gross alpha	3	5.2	0.50	2.2	1.5	NA	NA	
Gross beta	3	77	61	68	4.8	NA	NA	
Total Srf	3	1.2	0.57	0.79	0.21	37	2.1	

Table 25 (continued)

Radionuclide	Number of samples	Concentration (Bq/L)			Standard error ^b	Derived Concentration Guide (DCG) ^c	Percentage of DCG ^d
		Max	Min	Av			
<i>TRU/TURF and HFIR Ponds (X09A)</i>							
⁶⁰ Co	2	140	28	84	56	190	45
¹³⁷ Cs	2	0.85	0.80	0.83	0.025	110	0.74
¹⁵² Eu	1	25	25	25	NA	740	3.4
¹⁵⁴ Eu	1	36	36	36	NA	740	4.9
¹⁵⁵ Eu	2	19	3.3	11	7.9	3,700	0.30
Gross alpha	2	0.55	0.17	0.36	0.19	NA	NA
Gross beta	2	130	86	110	22	NA	NA
<i>Acid Neutralization Facility (X11)</i>							
Gross alpha	3	0.32	0.10	0.23	0.068	NA	NA
Gross beta	3	2.7	0.80	1.9	0.56	NA	NA

Table 25 (continued)

Radionuclide	Number of samples	Concentration (Bq/L)			Standard error ^b	Derived Concentration Guide (DCG) ^c	Percentage of DCG ^d
		Max	Min	Av			
<i>Melton Branch 1 (X13)</i>							
⁶⁰ Co	3	1.8	0.43	1.1	0.40	190	0.60
¹³⁷ Cs	3	0.26	-0.50	-0.070	0.23	110	<0.001
Total Srf	3	16	10	13	1.7	37	35
³ H	3	65,000	33,000	51,000	9,500	74,000	69
<i>White Oak Creek (X14)</i>							
⁶⁰ Co	3	0.12	0.030	0.083	0.027	190	0.045
¹³⁷ Cs	3	2.1	1.3	1.7	0.23	110	1.5
Total Srf	3	5.4	3.9	4.7	0.44	37	13
³ H	3	3,000	1,900	2,500	320	74,000	3.4

Table 25 (continued)

Radionuclide	Number of samples	Concentration (Bq/L)				Standard error ^b	Derived Concentration Guide (DCG) ^c	Percentage of DCG ^d
		Max	Min	Av				
White Oak Dam (X15)								
²⁴¹ Am	5	0.058	0.0050	0.027	0.011	1.1	2.4	
²⁴⁴ Cm	5	0.064	0.010	0.024	0.010	2.2	1.1	
⁶⁰ Co	13	0.72	-0.50	0.34	0.086	190	0.18	
¹³⁷ Cs	13	7.9	-0.40	2.6	0.63	110	2.3	
Gross alpha	4	0.52	0.0	0.17	0.12	NA	NA	
Gross beta	9	20	12	15	0.79	NA	NA	
²³⁸ Pu	5	0.0050	-0.0025	0.00088	0.0012	1.5	0.059	
²³⁹ Pu	5	0.0026	-0.011	-0.00078	0.0026	1.1	<0.001	
Total Sr ^f	7	7.3	5.5	6.0	0.24	37	16	
³ H	7	14,000	7,500	11,000	880	74,000	14	

^aSee Fig. 7.

^bStandard error of the mean.

^cDerived concentration guide for ingestion of water. From DOE Order 5400.XX.

^dAverage concentration as a percent of the DCG.

^eNA = not applicable.

^fTotal radioactive Sr (⁸⁹Sr + ⁹⁰Sr).

Table 26. Stream^a flows, April-June 1989

Month	Flow (10 ⁹ L)				Average Ratio ^d
	Melton Branch 1	White Oak Creek ^b	White Oak Dam ^c	Clinch River	
April	0.26	0.9	0.88	120	150
May	0.3	0.97	0.94	430	500
June	0.56	1.8	2.3	710	390

^aSee Fig. 5.

^bWhite Oak Creek at confluence of Melton Branch.

^cWhite Oak Creek at White Oak Dam.

^dFlow ratios Clinch River:White Oak Creek at White Oak Dam are calculated daily and averaged for the month.

Table 27. Radionuclide concentrations and releases at ORNL,^a April 1989

Radionuclide	Flow (10 ⁶ L)	Discharge (10 ¹⁰ Bq)	Concentration (Bq/L)	Concentration Guide (DCG) ^b (Bq/L)	Percentage of DCG ^c
<i>Melton Branch 1 (04/04-05/03)</i>					
⁶⁰ Co	220	0.025	1.1	190	0.59
¹³⁷ Cs	220	-0.011	-0.50	110	<0.001
Total Sr ^d	220	0.29	13	37	35
³ H	220	1,200	55,000	74,000	74
<i>Sewage Treatment Plant (04/04-05/03)</i>					
⁶⁰ Co	23	0.0045	2.0	190	1.1
¹³⁷ Cs	23	-0.0016	-0.70	110	<0.001
Gross beta	23	0.016	7.0	NA ^e	NA
Total Sr ^d	23	0.0095	4.2	37	11
<i>White Oak Creek (04/04-05/03)</i>					
⁶⁰ Co	800	0.0080	0.10	190	0.054
¹³⁷ Cs	800	0.17	2.1	110	1.9
Total Sr ^d	800	0.39	4.9	37	13
³ H	800	210	2,600	74,000	3.5
<i>White Oak Dam^f (04/01-05/01)</i>					
²⁴¹ Am	880	0.0029	0.032	1.1	2.9
²⁴⁴ Cm	880	0.0021	0.024	2.2	1.1
⁶⁰ Co	880	0.022	0.25	190	0.14
¹³⁷ Cs	880	0.18	2.1	110	1.9
Gross beta	880	1.3	15	NA	NA
²³⁸ Pu	880	0.00014	0.0016	1.5	0.11
²³⁹ Pu	880	-0.000053	-0.00060	1.1	<0.001
Total Sr ^d	880	0.53	6.0	37	16
³ H	880	980	11,000	74,000	15

^aSee Fig 5.

^bDerived concentration guide for ingestion of water. From Draft DOE Order 5400.XX.

^cConcentration as a percentage of the DCG.

^dTotal radioactive Sr (⁸⁹Sr + ⁹⁰Sr).

^eNA = not applicable.

^fConcentration is a flow-weighted average of the weekly samples. Discharge is the total for the month.

Table 28. Radionuclide concentrations and releases at ORNL,^a May 1989

Radionuclide	Flow (10 ⁶ L)	Discharge (10 ¹⁰ Bq)	Concentration (Bq/L)	Concentration Guide (DCG) ^b (Bq/L)	Percentage of DCG ^c
<i>Melton Branch I (05/03-06/06)</i>					
⁶⁰ Co	310	0.056	1.8	190	0.97
¹³⁷ Cs	310	0.0081	0.26	110	0.23
Total Sr ^d	310	0.50	16	37	43
³ H	310	2,000	65,000	74,000	88
<i>Sewage Treatment Plant (05/03-06/06)</i>					
⁶⁰ Co	27	0.00035	0.13	190	0.070
¹³⁷ Cs	27	0.00049	0.18	110	0.16
Gross beta	27	0.017	6.4	NA ^e	NA
Total Sr ^d	27	0.0063	2.3	37	6.2
<i>White Oak Creek (05/03-06/06)</i>					
⁶⁰ Co	1,100	0.013	0.12	190	0.065
¹³⁷ Cs	1,100	0.17	1.6	110	1.4
Total Sr ^d	1,100	0.41	3.9	37	11
³ H	1,100	200	1,900	74,000	2.6
<i>White Oak Dam^f (05/01-06/01)</i>					
⁶⁰ Co	940	0.052	0.55	190	0.30
¹³⁷ Cs	940	0.36	3.9	110	3.5
<i>White Oak Dam (05/03-06/06)</i>					
Total Sr ^d	1,000	0.60	5.9	37	16
³ H	1,000	920	9,000	74,000	12

^aSee Fig. 5.

^bDerived concentration guide for ingestion of water. From Draft DOE Order 5400.XX.

^cConcentration as a percentage of the DCG.

^dTotal radioactive Sr (⁸⁹Sr + ⁹⁰Sr).

^eNA = not applicable.

^fConcentration is a flow-weighted average of the weekly samples. Discharge is the total for the month.

Table 29. Radionuclide concentrations and releases at ORNL,^a June 1989

Radionuclide	Flow (10 ⁶ L)	Discharge (10 ¹⁰ Bq)	Concentration (Bq/L)	Concentration Guide (DCG) ^b (Bq/L)	Percentage of DCG ^c
<i>Melton Branch 1 (06/06-06/30)</i>					
⁶⁰ Co	530	0.023	0.43	190	0.23
¹³⁷ Cs	530	0.0016	0.030	110	0.027
Total Sr ^d	530	0.53	10	37	27
³ H	530	1,700	33,000	74,000	45
<i>Sewage Treatment Plant (06/06-06/30)</i>					
⁶⁰ Co	27	-0.00027	-0.10	190	<0.001
¹³⁷ Cs	27	0.000027	0.010	110	0.0090
Gross beta	27	0.020	7.4	NA ^e	NA
Total Sr ^d	27	0.0092	3.4	37	9.2
<i>White Oak Creek (06/06-06/30)</i>					
⁶⁰ Co	1,700	0.0050	0.030	190	0.016
¹³⁷ Cs	1,700	0.22	1.3	110	1.2
Total Sr ^d	1,700	0.90	5.4	37	15
³ H	1,700	500	3,000	74,000	4.1
<i>White Oak Dam^f (06/01-07/01)</i>					
⁶⁰ Co	2,300	0.075	0.33	190	0.18
¹³⁷ Cs	2,300	0.64	2.8	110	2.5
<i>White Oak Dam (06/06-06/30)</i>					
Total Sr ^d	2,100	1.3	6.0	37	16
³ H	2,100	1,600	7,500	74,000	10

^aSee Fig. 5.

^bDerived concentration guide for ingestion of water. From Draft DOE Order 5400.XX.

^cConcentration as a percentage of the DCG.

^dTotal radioactive Sr (⁸⁹Sr + ⁹⁰Sr).

^eNA = not applicable.

^fConcentration is a flow-weighted average of the weekly samples. Discharge is the total for the month.

sampling period (Tables 27-29). In addition, weekly flow proportional samples were obtained at WOD and analyzed (for radionuclides other than tritium and total Sr) at (roughly) weekly intervals. The average concentration during the calendar month was calculated as a weighted sum of all concentrations obtained for sampling periods intersecting (either partially or completely) the calendar month. The weights were proportional to the calendar period total flow attributable to the sample period intervals. This average concentration was multiplied by the calendar month total flow to arrive at the discharge.

Each average flow-weighted concentration was compared with a corresponding DCG. In most cases, all parameter concentrations are less than 17% of the corresponding DCG. However, the percentages for total radioactive Sr and tritium at MBI are higher but less than 89% of the DCG. Concentrations at MBI ranged from 27 to 43% of the DCG for total radioactive Sr and from 45 to 88% of the DCG for tritium. Total radioactive Sr and tritium concentrations, respectively, ranged from 11 to 43% and 2.6 to 88% of the DCG at all four locations.

Monthly surface water samples were collected at two sampling locations for the purpose of determining background contamination levels before the influence of ORNL. Because of inductively coupled plasma (ICP) analysis problems, only one month of gallium results are available. One sample was taken at Melton Hill Dam above ORNL's discharge point into the Clinch river (Fig. 5). The other sample location was at White Oak Creek headwaters, above the point where ORNL discharges to White Oak Creek (Fig. 5). Analyses were performed to detect both organic and inorganic compounds in the water. The results of these analyses will help determine which compounds ORNL may be discharging and help in the minimization of potentially hazardous discharges. Sixteen months of monitoring have revealed no quantifiable amounts of organic compounds at either location. This has prompted the decision to discontinue the sampling and analysis for organic compounds. Starting this quarter, total organic compounds (TOC) will be measured instead of the full set of organic analyses. TOC provides a measure of organic compounds present in the sample. If a significant amount of TOC is detected, a more complete organic analysis will be performed. Organic compounds were measured in April, however this will be the last month of full organic analysis.

The organics and PCBs at both sampling locations were collected by the manual grab method. The inorganics, oil and grease, and dissolved solids were collected flow-proportionally by a sampling station at each location. All grab samples were taken once per month.

Tables 30 and 31 contain a summary of the analytical results. Table 30 lists inorganic compounds and other conventional pollutants, and Table 31 lists organic compounds. The column "Percentage DWL" is included to show the average concentration as a percentage of the National Primary or Secondary Drinking Water Regulation level, where available. Many of the inorganic analytical results show a wide range of detection limits. This results from a dilution that must be made to some of the water samples. When a given sample contains an element in a concentration that is higher than the ICP equipment can accurately measure, this compound can cause a spectral interference with other elements. The sample must then be diluted to bring the interfering element

Table 30. Inorganic and conventional pollutants in surface water analyses at reference locations,^a April-June 1989

Parameter	Number of samples	Concentration (mg/L)			Standard error ^b	Percentage DWL ^c
		Max	Min	Av		
<i>Melton Hill Dam</i>						
Aluminum-total	3	1.3	0.14	0.81	0.34	
Ammonia (as N)	1	0.050	0.050	0.050		
Antimony-total	3	<0.040	<0.030	<0.03	0.0033	
Arsenic-total	3	<0.060	<0.050	<0.053	0.0033	<110
Barium-total	3	0.060	0.011	0.035	0.014	3.5
Beryllium-total	3	<0.0004	<0.0003	<0.0003	0.000033	
Biochemical oxygen demand	1	<5.0	<5.0	<5.0		
Boron-total	3	<0.080	<0.080	<0.080	0	
Cadmium-total	3	0.012	<0.0020	<0.0053	0.0033	<53
Calcium-total	3	42	31	37	3.2	
Chromium-total	3	0.016	<0.0030	<0.0084	0.0039	<16
Cobalt-total	3	0.0042	<0.0030	<0.0037	0.00037	
Copper-total	3	<0.010	<0.010	<0.010	0	<1.0
Dissolved solids-total	3	170	120	130	16	
Fluoride-total	3	<1.0	<1.0	<1.0	0	
Gallium-total	2	<0.30	<0.30	<0.30	0	
Iron-total	3	1.4	0.12	0.87	0.38	290
Lead-total	3	<0.050	<0.030	<0.037	0.0066	<73
Lithium-total	3	<15	<0.20	<5.3	4.8	
Magnesium-total	3	11	8.5	9.8	0.72	
Manganese-total	3	0.30	0.032	0.18	0.078	350
Molybdenum-total	3	<0.040	<0.040	<0.040	0	
Nickel-total	3	0.018	<0.0060	<0.010	0.0040	
Nitrate	3	<5.0	<5.0	<5.0	0	<50
Oil and grease	3	4.0	<2.0	<2.7	0.66	
Organic carbon-total	4	2.2	1.3	1.7	0.19	
Oxygen (dissolved)	3	8.3	4.4	6.8	1.2	
Phosphorus-total	4	<0.30	<0.10	<0.25	0.050	
Recoverable phenolics-total	1	<0.0010	<0.0010	<0.0010		
Selenium-total	3	<0.080	<0.060	<0.073	0.0066	<730
Silicon-total	3	3.3	0.74	2.4	0.83	
Silver-total	3	<0.0050	<0.0050	<0.0050	0	<10
Sodium-total	3	6.9	<2.0	<4.0	1.4	
Strontium-total	3	0.092	0.068	0.083	0.0076	
Sulfate (as SO ₄)	3	23	20	2	1.0	8.8
Suspended solids-total	3	61	<5.0	<24	18	
Tin-total	3	<0.050	<0.050	<0.050	0	
Titanium-total	3	<0.020	<0.020	<0.020	0	
Vanadium-total	3	<0.0040	<0.0004	<0.0028	0.0012	

Table 30 (continued)

Parameter	Number of samples	Concentration (mg/L)			Standard error ^B	Percentage DWL ^C
		Max	Min	Av		
Zinc-total	3	<0.0080	<0.0080	<0.0080	0	<0.16
Zirconium-total	3	<0.020	<0.020	<0.020	0	
Conductivity, mS/cm	3	0.80	0.20	0.47	0.17	
Temperature, °C	3	19	13	16	1.7	
Turbidity, NTU	3	8.2	1.2	4.1	2.0	
pH, standard units	3	8.4	7.7	7.9	0.23	
<i>White Oak Creek</i>						
Aluminum-total	3	4.5	<0.050	<1.6	1.4	
Ammonia (as N)	1	0.050	0.050	0.050		
Antimony-total	3	<0.040	<0.030	<0.037	0.0033	
Arsenic-total	3	<0.060	<0.050	<0.053	0.0033	<110
Barium-total	3	0.097	0.077	0.087	0.0057	8.6
Beryllium-total	3	<0.0004	<0.0003	<0.0003	0.000033	
Biochemical oxygen demand	1	<5.0	<5.0	<5.0		
Boron-total	3	<0.080	<0.080	<0.080	0	
Cadmium-total	3	0.012	<0.0020	<0.0053	0.0033	<53
Calcium-total	3	25	23	24	0.57	
Chromium-total	3	0.022	<0.0030	<0.011	0.0057	<21
Cobalt-total	3	0.0074	0.0032	0.0048	0.0013	
Copper-total	3	<0.010	<0.010	<0.010	0	<1.0
Dissolved solids-total	3	140	52	92	26	
Fluoride-total	3	<1.0	<1.0	<1.0	0	
Gallium-total	2	<0.30	<0.30	<0.30	0	
Iron-total	3	5.5	0.19	2.0	1.7	650
Lead-total	3	<0.050	<0.030	<0.037	0.0066	<73
Lithium-total	3	<15	<0.20	<5.3	4.8	
Magnesium-total	3	12	8.7	11	0.97	
Manganese-total	3	0.97	0.058	0.36	0.30	730
Molybdenum-total	3	<0.040	<0.040	<0.040	0	
Nickel-total	3	0.022	<0.0060	<0.011	0.0053	
Nitrate	3	<5.0	<5.0	<5.0	0	<50
Oil and grease	3	<2.0	<2.0	<2.0	0	
Organic carbon-total	4	0.90	0.50	0.75	0.086	
Oxygen (dissolved)	3	9.5	8.0	8.0	0.43	
Phosphorus-total	4	<0.30	<0.10	<0.25	0.050	
Recoverable phenolics-total	1	<0.0010	<0.0010	<0.0010		
Selenium-total	3	<0.080	<0.060	<0.073	0.0066	<730
Silicon-total	3	4.3	3.5	3.8	0.24	
Silver-total	3	0.0054	<0.0050	<0.0051	0.00013	<10

Table 30 (continued)

Parameter	Number of samples	Concentration (mg/L)			Standard error ^b	Percentage DWL ^c
		Max	Min	Av		
Sodium-total	3	2.0	2.0	2.0	0	
Strontium-total	3	0.019	0.014	0.017	0.0015	
Sulfate (as SO ₄)	3	<5.0	<5.0	<5.0	0	<2.0
Suspended solids-total	3	25	<5.0	<12	6.6	
Tin-total	3	<0.050	<0.050	<0.050	0	
Titanium-total	3	0.053	<0.020	<0.031	0.011	
Vanadium-total	3	<0.0040	<0.0004	<0.0028	0.0012	
Zinc-total	3	<0.0080	<0.0080	<0.0080	0	<0.16
Zirconium-total	3	<0.020	<0.020	<0.020	0	
Conductivity, mS/cm	3	0.30	0.10	0.20	0.057	
Temperature, °C	3	16	12	13	1.2	
Turbidity, NTU	3	8.6	1.6	4.9	2.0	
pH, standard units	3	8.2	7.1	7.8	0.35	

^aSee Fig. 5.

^bStandard error of the mean.

^cAverage concentration as a percentage of National Primary or Secondary Drinking Water Regulation level.

Table 31. Organic surface water analyses at reference locations,^a
April-June 1989

Parameter	Number of samples	Concentration (µg/L)			Percentage DWL ^b
		Max	Min	Av	
<i>Melton Hill Dam</i>					
1,1,1-Trichloroethane	1	<5.0	<5.0	<5.0	<2.5
1,1,2,2-Tetrachloroethane	1	<5.0	<5.0	<5.0	
1,1,2-Trichloroethane	1	<5.0	<5.0	<5.0	
1,1-Dichloroethane	1	<5.0	<5.0	<5.0	
1,1-Dichloroethene	1	<5.0	<5.0	<5.0	
1,2-Dichloroethane	1	<5.0	<5.0	<5.0	<1.0
1,2-Dichloroethene	1	<5.0	<5.0	<5.0	
1,2-Dichloropropane	1	<5.0	<5.0	<5.0	
2-Butanone	1	<10	<10	<10	
2-Hexanone	1	<10	<10	<10	
4-Methyl-2-pentanone	1	<10	<10	<10	
Acetone	1	<10	<10	<10	
Benzene	1	<5.0	<5.0	<5.0	<100
Bromodichloromethane	1	<5.0	<5.0	<5.0	
Bromoform	1	<5.0	<5.0	<5.0	
Bromomethane	1	<10	<10	<10	
Carbon disulfide	1	<5.0	<5.0	<5.0	
Carbon tetrachloride	1	<5.0	<5.0	<5.0	<100
Chlorobenzene	1	<5.0	<5.0	<5.0	
Chloroethane	1	<10	<10	<10	
Chloroform	1	<5.0	<5.0	<5.0	
Chloromethane	1	<10	<10	<10	
Dibromochloromethane	1	<5.0	<5.0	<5.0	
Ethylbenzene	1	<5.0	<5.0	<5.0	
Methylene chloride	1	-0.90	-0.90	-0.90	
PCB-1016	1	<0.60	<0.60	<0.60	
PCB-1221	1	<0.60	<0.60	<0.60	
PCB-1232	1	<0.60	<0.60	<0.60	
PCB-1242	1	<0.60	<0.60	<0.60	
PCB-1248	1	<0.60	<0.60	<0.60	
PCB-1254	1	<1.1	<1.1	<1.1	
PCB-1260	1	<1.1	<1.1	<1.1	
Styrene	1	<5.0	<5.0	<5.0	
Tetrachloroethene	1	<5.0	<5.0	<5.0	
Toluene	1	<5.0	<5.0	<5.0	
Trichloroethene	1	<5.0	<5.0	<5.0	
Vinyl acetate	1	<10	<10	<10	
Vinyl chloride	1	<10	<10	<10	
Xylene-total	1	<5.0	<5.0	<5.0	

Table 31 (continued)

Parameter	Number of samples	Concentration ($\mu\text{g/L}$)			Percentage DWL ^b
		Max	Min	Av	
<i>White Oak Creek</i>					
cis-1,3-Dichloropropene	1	<5.0	<5.0	<5.0	
trans-1,3-Dichloropropene	1	<5.0	<5.0	<5.0	
1,1,1-Trichloroethane	1	<5.0	<5.0	<5.0	<2.5
1,1,2,2-Tetrachloroethane	1	<5.0	<5.0	<5.0	
1,1,2-Trichloroethane	1	<5.0	<5.0	<5.0	
1,1-Dichloroethane	1	<5.0	<5.0	<5.0	
1,1-Dichloroethene	1	<5.0	<5.0	<5.0	
1,2-Dichloroethane	1	<5.0	<5.0	<5.0	<1.0
1,2-Dichloroethene	1	<5.0	<5.0	<5.0	
1,2-Dichloropropane	1	<5.0	<5.0	<5.0	
2-Butanone	1	<10	<10	<10	
2-Hexanone	1	<10	<10	<10	
4-Methyl-2-pentanone	1	<10	<10	<10	
Acetone	1	~2.0	~2.0	~2.0	
Benzene	1	<5.0	<5.0	<5.0	~100
Bromodichloromethane	1	<5.0	<5.0	<5.0	
Bromoform	1	<5.0	<5.0	<5.0	
Bromomethane	1	<10	<10	<10	
Carbon disulfide	1	<5.0	<5.0	<5.0	
Carbon tetrachloride	1	<5.0	<5.0	<5.0	<100
Chlorobenzene	1	<5.0	<5.0	<5.0	
Chloroethane	1	<10	<10	<10	
Chloroform	1	<5.0	<5.0	<5.0	
Chloromethane	1	<10	<10	<10	
Dibromochloromethane	1	<5.0	<5.0	<5.0	
Ethylbenzene	1	<5.0	<5.0	<5.0	
Methylene chloride	1	-0.90	-0.90	-0.90	
PCB-1016	1	<0.60	<0.60	<0.60	
PCB-1221	1	<0.60	<0.60	<0.60	
PCB-1232	1	<0.60	<0.60	<0.60	
PCB-1242	1	<0.60	<0.60	<0.60	
PCB-1248	1	<0.60	<0.60	<0.60	
PCB-1254	1	<1.1	<1.1	<1.1	
PCB-1260	1	<1.1	<1.1	<1.1	
Styrene	1	<5.0	<5.0	<5.0	
Tetrachloroethene	1	<5.0	<5.0	<5.0	
Toluene	1	<5.0	<5.0	<5.0	
Trichloroethene	1	<5.0	<5.0	<5.0	

Table 31 (continued)

Parameter	Number of samples	Concentration ($\mu\text{g/L}$)			Percentage DWL ^b
		Max	Min	Av	
Vinyl acetate	1	<10	<10	<10	
Vinyl chloride	1	<10	<10	<10	
Xylene-total	1	<5.0	<5.0	<5.0	
cis-1,3-Dichloropropene	1	<5.0	<5.0	<5.0	
trans-1,3-Dichloropropene	1	<5.0	<5.0	<5.0	

^aSee Fig. 5.

^bAverage concentration as a percentage of National Primary or Secondary Drinking Water Regulation level.

into a range that the equipment can accurately measure. The resulting analytical values from the ICP process must be adjusted by the dilution factor. This dilution factor must also be applied to the detection limit value for each given element.

There were no abnormally high levels of organic compounds found at either location, with most of the results below analytical reporting limits. Most inorganic compounds were also below the National Primary and Secondary Drinking Water regulation levels. Arsenic, iron, and selenium all show high percentage DWL. This is the result of high analytical reporting limits for these analytes. The average concentration of manganese at Melton Hill Dam was found to be 350% of the National Secondary Drinking Water Limit, which is 0.05 mg/L. The average concentration of manganese at WOC was 730% of the drinking water limit. The average concentration of iron at Melton Hill Dam was 290% of the National Secondary Drinking Water Limit, and at WOC this figure was 650%. Because the standard error of these averages are all high, the drinking water limits fall within 95% confidence intervals about the averages of the two analytes. More samples would be required to determine if the drinking water standards for these elements have actually been exceeded.

3.2 NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM REQUIREMENTS

ORNL's current NPDES permit requires that ten point-source outfalls be sampled prior to their discharge into receiving waters or before mixing with any other wastewater stream. One of these points, the Nonradiological Wastewater Treatment Plant, will not be in operation until March 1990. In addition, there are three sampling locations that are located in the streams as reference points or for additional information and one (ORR Resin Regeneration Facility) that was taken out of operation in December 1986. These thirteen sampling locations are shown in Fig. 7. There are approximately 150 additional locations that include storm drains, parking lot and roof drains, cooling tower drains, storage area drains, condensate drains, untreated process drains, and miscellaneous facilities that are sampled less frequently than the point-source outfalls or surface streams.

Quarterly summary statistics for the second quarter of 1989 are given for each sampling location in Tables 32 through 50. Monitoring of the ORR Resin Regeneration Facility is no longer required because the permitted operation has been discontinued.

Data collected for the NPDES permit are also summarized monthly for reporting to DOE and the state of Tennessee. These summaries are submitted to DOE in the Monthly Discharge Monitoring Reports and are available upon request. Noncompliances are provided in Tables 51 through 53. A brief summary of the noncompliances follows.

April 1989

The total suspended solids violations on April 11 and April 25 at the STP could not be attributed to any certain cause. The STP and filters were functioning properly around the time of the exceedances.

Table 32. NPDES discharge point X01,^a April-June 1989

Parameter	Number of samples	Concentration (mg/L)			Standard error ^b
		Max	Min	Av	
Ammonia (as N)	39	0.47	0.019	0.092	0.015
Biochemical oxygen demand	39	<5.0	<5.0	<5.0	0
Bromodichloromethane	3	-0.0020	-0.00090	-0.0013	0.00035
Chlorine-total residual	39	0.45	<0.010	<0.24	0.020
Copper-total	3	<0.010	<0.010	<0.010	0
Cyanide-total	3	<0.0020	<0.0020	<0.0020	0
Downstream pH, standard units	13	8.1	7.1	NA ^d	NA
Fecal coliform, col/100 mL ^c	40	60	<1.0	<1.6	1.2
Flow, Mgd	64	0.44	0.15	0.23	0.0072
Mercury-total	3	<0.00005	<0.00005	<0.00005	0
Oil and grease	39	7.0	<2.0	<2.2	0.14
Oxygen-dissolved	64	9.4	6.4	8.0	0.092
pH, standard units	13	8.0	6.6	NA	NA
Recoverable phenolics-total	3	<0.0010	<0.0010	<0.0010	0
Silver-total	3	<0.0050	<0.0050	<0.0050	0
Suspended solids-total	39	73	<2.0	<8.9	2.3
Trichloroethene	3	<0.0050	<0.0050	<0.0050	0
Zinc-total	3	0.081	0.025	0.058	0.017

^aSee Fig. 7.

^bStandard error of the mean.

^cGeometric mean.

^dNA = not applicable.

Table 33. NPDES discharge point X02,^a April-June 1989

Parameter	Number of samples	Concentration (mg/L)			Standard error ^b
		Max	Min	Av	
Arsenic-total	13	0.15	<0.060	<0.11	0.0075
Cadmium-total	13	0.017	<0.0020	<0.0080	0.0015
Chromium-total	13	0.036	<0.0030	<0.016	0.0030
Copper-total	13	<0.010	<0.010	<0.010	0
Downstream pH, standard units	63	8.3	6.8	NA ^c	NA
Flow, Mgd	64	0.12	0	0.026	0.0040
Iron-total	13	0.24	<0.010	<0.10	0.020
Lead-total	13	<0.050	<0.030	<0.036	0.0027
Manganese-total	13	0.047	0.0024	0.022	0.0030
Nickel-total	13	0.021	<0.0060	<0.010	0.0014
Oil and grease	13	11	<2.0	<3.1	0.76
pH, standard units	63	8.6	6.1	NA	NA
Selenium-total	13	<0.080	<0.060	<0.074	0.0027
Silver-total	13	0.0073	<0.0050	<0.0057	0.00023
Sulfate (as SO ₄)	3	1200	940	1100	76
Suspended solids-total	13	7.0	<5.0	<5.2	0.15
Temperature, °C	63	30	11	21	0.57
Zinc-total	13	0.023	<0.0080	<0.012	0.0016

^aSee Fig. 7.

^bStandard error of the mean.

^cNA = not applicable.

Table 34. NPDES discharge point X03,^a April-June 1989

Parameter	Number of samples	Concentration (mg/L)			Standard error ^b
		Max	Min	Av	
Arsenic-total	2	<0.060	<0.060	<0.060	0
Cadmium-total	2	0.012	0.0092	0.011	0.0014
Chromium-total	2	0.014	0.011	0.013	0.0015
Copper-total	2	<0.010	<0.010	<0.010	0
Downstream pH, standard units	4	7.8	7.0	NA ^c	NA
Flow, Mgd	1	0.0094	0.0094	0.0094	
Iron-total	2	0.078	<0.010	<0.044	0.034
Lead-total	2	<0.050	<0.050	<0.050	0
Nickel-total	2	0.017	0.0090	0.013	0.0040
Oil and grease	2	<2.0	<2.0	<2.0	0
Organic carbon-total	2	4.5	3.8	4.2	0.35
pH, standard units	4	8.1	7.2	NA	NA
Phosphorus-total	2	0.60	0.50	0.55	0.050
Suspended solids-total	2	<5.0	<5.0	<5.0	0
Temperature, °C	4	23	16	19	1.7
Zinc-total	2	0.096	0.077	0.087	0.0095

^aSee Fig. 7.

^bStandard error of the mean.

^cNA = not applicable.

Table 35. NPDES discharge point X04,^a April-June 1989

Parameter	Number of samples	Concentration (mg/L)			Standard error ^b
		Max	Min	Av	
Arsenic-total	2	<0.060	<0.060	<0.060	0
Cadmium-total	2	0.012	0.012	0.012	0
Chromium-total	2	0.015	0.013	0.014	0.0010
Copper-total	2	<0.010	<0.010	<0.010	0
Downstream pH, standard units	4	8.0	7.0	NA ^c	NA
Flow, Mgd	1	0.034	0.034	0.034	
Lead-total	2	<0.050	<0.050	<0.050	0
Nickel-total	2	0.017	0.015	0.016	0.0010
Oil and grease	2	3.0	<2.0	<2.5	0.50
Organic carbon-total	2	1.5	1.4	1.5	0.050
pH, standard units	4	8.2	6.1	NA	NA
Phosphorus-total	2	0.30	0.20	0.25	0.050
Silver-total	2	<0.0050	<0.0050	<0.0050	0
Suspended solids-total	2	<5.0	<5.0	<5.0	0
Temperature, °C	4	21	15	17	1.3
Zinc-total	2	0.13	0.070	0.10	0.030

^aSee Fig. 7.

^bStandard error of the mean

^cNA = not applicable.

Table 36. NPDES discharge point X06,^a April-June 1989

Parameter	Number of samples	Concentration (mg/L)			Standard error ^b
		Max	Min	Av	
Arsenic-total	2	<0.060	<0.060	<0.060	0
Cadmium-total	2	0.013	0.011	0.012	0.0010
Chromium-total	2	0.024	0.017	0.021	0.0035
Copper-total	2	0.035	<0.010	<0.023	0.013
Downstream pH, standard units	4	8.2	7.4	NA ^c	NA
Flow, Mgd	1	0.16	0.16	0.16	
Lead-total	2	0.11	<0.050	<0.080	0.030
Nickel-total	2	0.017	0.016	0.017	0.00050
Oil and grease	2	<2.0	<2.0	<2.0	0
Organic carbon-total	2	5.2	2.6	3.9	1.3
pH, standard units	4	8.1	6.8	NA	NA
Selenium-total	2	<0.060	<0.060	<0.060	0
Sulfate (as SO ₄)	2	22	22	22	0
Suspended solids-total	2	<5.0	<5.0	<5.0	0
Temperature, °C	4	21	13	17	1.8
Zinc-total	2	0.070	0.059	0.065	0.0055

^aSee Fig. 7.

^bStandard error of the mean.

^cNA = not applicable.

Table 37. NPDES discharge point X06A,^a April-June 1989

Parameter	Number of samples	Concentration (mg/L)			Standard error ^b
		Max	Min	Av	
Arsenic-total	4	<0.050	<0.050	<0.050	0
Cadmium-total	4	0.011	<0.0020	<0.0065	0.0026
Chromium-total	4	0.025	<0.0030	<0.013	0.0058
Copper-total	4	0.094	0.032	0.063	0.013
Downstream pH, standard units	9	8.2	7.2	NA ^c	NA
Flow, Mgd	2	0.20	0.18	0.19	0.012
Iron-total	4	0.34	0.082	0.22	0.054
Lead-total	4	<0.030	<0.030	<0.030	0
Mercury-total	4	0.0014	0.00073	0.00095	0.00015
Nickel-total	4	0.0066	<0.0060	<0.0062	0.00015
Oil and grease	4	3.0	<2.0	<2.3	0.25
Organic carbon-total	4	10	3.0	6.0	1.5
pH, standard units	9	8.3	6.9	NA	NA
Phosphorus-total	4	0.60	0.40	0.53	0.048
Selenium-total	4	<0.080	<0.080	<0.080	0
Silver-total	4	0.036	0.0062	0.014	0.0072
Sulfate, (as SO ₄)	4	28	25	27	0.65
Suspended solids-total	4	<5.0	<5.0	<5.0	0
Temperature, °C	9	24	17	21	0.74
Zinc-total	4	0.12	0.071	0.098	0.010

^aSee Fig. 7.

^bStandard error of the mean.

^cNA = not applicable.

Table 38. NPDES discharge point X07,^a April-June 1989

Parameter	Number of samples	Concentration (mg/L)			Standard error ^b
		Max	Min	Av	
Arsenic-total	6	<0.060	<0.050	<0.053	0.0021
Cadmium-total	6	0.012	<0.0020	<0.0076	0.0019
Chromium-total	6	0.030	<0.0030	<0.012	0.0041
Copper-total	6	<0.010	<0.010	<0.010	0
Downstream pH, standard units	13	8.2	6.7	NA ^c	NA
Flow, Mgd	64	0.31	0.031	0.18	0.0067
Lead-total	6	<0.050	<0.030	<0.037	0.0042
Nickel-total	6	0.014	<0.0060	<0.0088	0.0017
Nitrate	6	37	<5.0	<12	5.1
Oil and grease	6	<2.0	<2.0	<2.0	0
Organic carbon-total	6	2.4	0.40	1.4	0.30
pH, standard units	13	8.4	6.2	NA	NA
Silver-total	6	<0.0050	<0.0050	<0.0050	0
Sulfate (as SO ₄)	6	320	250	280	12
Suspended solids-total	6	<5.0	<5.0	<5.0	0
Temperature, °C	13	27	13	21	1.0
Total toxic organics	6	0.025	0	0.0058	0.0042
Zinc-total	6	0.014	<0.0080	<0.0098	0.0012

^aSee Fig. 7.

^bStandard error of the mean.

^cNA = not applicable.

Table 39. NPDES discharge point X08,^a April-June 1989

Parameter	Number of samples	Concentration (mg/L)			Standard error ^b
		Max	Min	Av	
Arsenic-total	1	<0.050	<0.050	<0.050	
Cadmium-total	1	<0.0020	<0.0020	<0.0020	
Chromium-total	1	0.12	0.12	0.12	
Copper-total	1	0.092	0.092	0.092	
Downstream pH, standard units	1	7.7	7.7	NA ^c	NA
Flow, Mgd	1	0.00032	0.00032	0.00032	
Lead-total	1	<0.030	<0.030	<0.030	
Nickel-total	1	0.018	0.018	0.018	
Nitrate	1	<0.50	<0.50	<0.50	
Oil and grease	1	3.0	3.0	3.0	
Organic carbon-total	1	80	80	80	
pH, standard units	1	7.6	7.6	NA	NA
Sulfate (as SO ₄)	1	10	10	10	
Suspended solids-total	1	38	38	38	
Temperature, °C	1	28	28	28	
Zinc-total	1	0.77	0.77	0.77	

^aSee Fig. 7.

^bStandard error of the mean.

^cNA = not applicable.

Table 40. NPDES discharge point X09,^a April-June 1989

Parameter	Number of samples	Concentration (mg/L)			Standard error ^b
		Max	Min	Av	
Arsenic-total	3	<0.060	<0.050	<0.053	0.0033
Cadmium-total	3	0.018	<0.0020	<0.0073	0.0053
Chromium-total	3	0.078	<0.0030	<0.028	0.025
Copper-total	3	0.055	0.014	0.038	0.012
Downstream pH, standard units	3	8.1	7.6	NA ^c	NA
Flow, Mgd	3	0.0081	0.0032	0.0054	0.0014
Lead-total	3	<0.050	<0.030	<0.037	0.0067
Nickel-total	3	0.013	<0.0060	<0.0094	0.0020
Nitrate	2	<5.0	<5.0	<5.0	0
Oil and grease	3	24	4.0	11	6.5
Organic carbon-total	3	8.1	4.6	5.8	1.2
pH, standard units	3	8.6	7.3	NA	NA
Sulfate (as SO ₄)	3	110	20	66	26
Suspended solids-total	3	14	<5.0	<8.0	3.0
Temperature, °C	3	24	7.0	18	5.4
Zinc-total	3	0.11	0.052	0.074	0.018

^aSee Fig. 7.

^bStandard error of the mean.

^cNA - not applicable.

Table 41. NPDES discharge point X09A,^a April-June 1989

Parameter	Number of samples	Concentration (mg/L)			Standard error ^b
		Max	Min	Av	
Arsenic-total	8	<0.050	<0.050	<0.050	0
Cadmium-total	8	0.014	<0.0020	<0.0083	0.0019
Chromium-total	8	0.031	0.0066	0.017	0.0030
Copper-total	8	0.12	0.036	0.073	0.011
Downstream pH, standard units	8	9.6	7.6	NA ^c	NA
Flow, Mgd	8	0.0037	0.0012	0.0023	0.00026
Lead-total	8	<0.030	<0.030	<0.030	0
Nickel-total	8	0.0096	<0.0060	<0.0065	0.00045
Nitrate	7	11	0.80	6.3	1.4
Oil and grease	8	4.0	<2.0	<2.3	0.25
Organic carbon-total	8	2.7	1.1	1.8	0.19
pH, standard units	8	11	7.3	NA	NA
Sulfate (as SO ₄)	7	210	22	67	26
Suspended solids-total	8	51	<5.0	<16	7.4
Temperature, °C	8	30	21	25	0.96
Zinc-total	8	0.16	0.090	0.12	0.0073

^aSee Fig. 7.

^bStandard error of the mean.

^cNA = not applicable.

Table 42. NPDES discharge point X11,^a April-June 1989

Parameter	Number of samples	Concentration (mg/L)			Standard error ^b
		Max	Min	Av	
Arsenic-total	6	0.12	<0.050	<0.090	0.011
Cadmium-total	6	0.012	<0.0020	<0.0082	0.0020
Chromium-total	6	0.031	<0.0030	<0.021	0.0051
Copper-total	6	0.013	<0.010	<0.011	0.00050
Downstream pH, standard units	13	9.0	7.3	NA ^c	NA
Flow, Mgd	3	0.024	0.021	0.022	0.00091
Lead-total	6	<0.050	<0.030	<0.037	0.0042
Nickel-total	6	0.023	<0.0060	<0.015	0.0032
Nitrate	13	13	3.5	6.1	0.75
Oil and grease	6	<2.0	<2.0	<2.0	0
Organic carbon-total	13	6.9	2.0	5.2	0.40
pH, standard units	13	7.8	6.5	NA	NA
Phosphorus-total	6	5.7	2.3	4.6	0.52
Sulfate (as SO ₄)	13	2800	620	1700	220
Suspended solids-total	6	30	12	18	2.6
Temperature, °C	13	25	16	20	0.75
Zinc-total	6	1.1	0.26	0.77	0.12

^aSee Fig. 7.^bStandard error of the mean.^cNA = not applicable.

Table 43. NPDES discharge point X13,^a April-June 1989

Parameter	Number of samples	Concentration (mg/L)			Standard error ^b
		Max	Min	Av	
Aluminum-total	3	<2.0	0.51	1.0	0.48
Ammonia (as N)	3	0.040	0.019	0.029	0.0061
Arsenic-total	3	<0.060	<0.050	<0.053	0.0033
Biochemical oxygen demand	3	<5.0	<5.0	<5.0	0
Cadmium-total	3	<0.0020	<0.0020	<0.0020	0
Chlorine-total residual	13	<0.010	<0.010	<0.010	0
Chloroform	3	<0.0050	<0.0050	<0.0050	0
Chromium-total	3	0.021	<0.0030	<0.015	0.0058
Conductivity, mS/cm	3	1.3	0.35	0.75	0.28
Copper-total	3	<0.010	<0.010	<0.010	0
Dissolved solids-total	3	250	120	200	41
Flow, Mgd	64	17	0.68	3.2	0.43
Fluoride-total	3	<1.0	<1.0	<1.0	0
Iron-total	3	0.75	0.27	0.46	0.15
Lead-total	3	0.0050	<0.0040	<0.0043	0.00033
Manganese-total	3	0.24	0.12	0.18	0.035
Mercury-total	3	0.00010	<0.00005	<0.000067	0.000017
Nickel-total	3	0.010	<0.0060	<0.0073	0.0013
Nitrate	3	<5.0	<5.0	<5.0	0
Oil and grease	13	20	<2.0	<5.3	1.6
Organic carbon-total	3	5.1	2.3	3.2	0.93
Oxygen-dissolved	13	13	5.5	9.0	0.58
PCB-total	3	<0.00050	<0.00050	<0.00050	0
pH, standard units	3	8.0	7.1	NA ^c	NA
Phosphorus-total	3	0.10	0.10	0.10	0
Recoverable phenolics-total	3	0.0030	<0.0010	<0.0017	0.00067
Silver-total	3	<0.0050	<0.0050	<0.0050	0
Sulfate (as SO ₄)	3	26	14	20	3.5
Suspended solids-total	3	86	<5.0	<32	27
Temperature, °C	16	26	13	17	0.86
Trichloroethene	3	<0.0050	~0.00070	~0.0036	0.0014
Turbidity, JTU ^d	3	91	59	77	9.4
Zinc-total	3	0.031	<0.0080	<0.017	0.0070

^aSee Fig. 7.^bStandard error of the mean.^cNA = not applicable.^dMeasured in Jackson Turbidity Units.

Table 44. NPDES discharge point X14,^a April-June 1989

Parameter	Number of samples	Concentration (mg/L)			Standard error ^b
		Max	Min	Av	
Aluminum-total	3	<2.0	0.31	0.88	0.56
Ammonia (as N)	3	0.050	0.023	0.035	0.0079
Arsenic-total	3	<0.060	<0.050	<0.053	0.0033
Biochemical oxygen demand	3	>34	<5.0	<15	9.7
Cadmium-total	3	<0.0020	<0.0020	<0.0020	0
Chlorine-total residual	13	<0.010	<0.010	<0.010	0
Chloroform	3	~0.0040	~0.00060	~0.0025	0.0010
Chromium-total	3	0.022	<0.0030	<0.014	0.0058
Conductivity, mS/cm	3	1.2	0.34	0.68	0.26
Copper-total	3	<0.010	<0.010	<0.010	0
Dissolved solids-total	3	280	160	210	34
Flow, Mgd	64	33	4.2	11	0.95
Fluoride-total	3	1.0	<1.0	<1.0	0
Iron-total	3	0.96	0.088	0.40	0.28
Lead-total	3	<0.0040	<0.0040	<0.0040	0
Manganese-total	3	0.12	0.019	0.070	0.029
Mercury-total	3	0.00010	<0.00005	<0.000067	0.000017
Nickel-total	3	0.0083	<0.0060	<0.0068	0.00077
Nitrate	3	<5.0	<5.0	<5.0	0
Oil and grease	13	13	<2.0	<3.6	0.90
Organic carbon-total	3	6.9	1.3	3.7	1.7
Oxygen-dissolved	13	19	6.1	9.1	0.89
PCB-total	3	<0.00050	<0.00050	<0.00050	0
pH, standard units	3	8.5	6.6	NA ^c	NA
Phosphorus-total	3	0.40	0.10	0.30	0.10
Recoverable phenolics-total	3	0.0040	<0.0010	<0.0020	0.0010
Silver-total	3	<0.0050	<0.0050	<0.0050	0
Sulfate (as SO ₄)	3	67	20	40	14
Suspended solids-total	3	41	<5.0	<17	12
Temperature, °C	16	25	13	18	0.77
Trichloroethene	3	<0.0050	~0.00060	~0.0035	0.0015
Turbidity, JTU ^d	3	92	72	81	5.8
Zinc-total	3	0.061	<0.0080	<0.036	0.015

^aSee Fig. 7.^bStandard error of the mean.^cNA = not applicable.^dMeasured in Jackson Turbidity Units.

Table 45. NPDES discharge point X15,^a April-June 1989

Parameter	Number of samples	Concentration (mg/L)			Standard error ^b
		Max	Min	Av	
Aluminum-total	3	<2.0	0.68	1.1	0.43
Ammonia (as N)	3	0.060	0.019	0.039	0.012
Arsenic-total	3	<0.060	<0.050	<0.053	0.0033
Biochemical oxygen demand	3	>34	<5.0	<15	9.7
Cadmium-total	3	<0.0020	<0.0020	<0.0020	0
Chlorine-total residual	13	<0.010	<0.010	<0.010	0
Chloroform	3	-0.0020	-0.0010	-0.0013	0.00033
Chromium-total	3	0.028	<0.0030	<0.019	0.0082
Conductivity, mS/cm	3	1.5	0.32	0.94	0.34
Copper-total	3	<0.010	<0.010	<0.010	0
Dissolved solids-total	3	240	180	220	21
Flow, Mgd	64	46	4.6	14	1.4
Fluoride-total	3	1.0	<1.0	<1.0	0
Iron-total	3	0.97	0.50	0.70	0.14
Lead-total	3	<0.0040	<0.0040	<0.0040	0
Manganese-total	3	0.080	0.062	0.073	0.0056
Mercury-total	3	0.00006	<0.00005	<0.000053	0.0000033
Nickel-total	3	0.019	<0.0060	<0.010	0.0043
Nitrate	3	<5.0	<5.0	<5.0	0
Oil and grease	13	13	<2.0	<3.2	0.86
Organic carbon-total	3	2.9	2.0	2.3	0.28
Oxygen-dissolved	13	14	5.2	8.2	0.66
PCB-total	3	<0.00050	<0.00050	<0.00050	0
pH, standard units	3	8.9	6.7	NA ^c	NA
Phosphorus-total	3	0.30	0.20	0.23	0.033
Silver-total	3	<0.0050	<0.0050	<0.0050	0
Sulfate (as SO ₄)	3	47	22	34	7.2
Suspended solids-total	3	12	5.0	9.0	2.1
Temperature, °C	16	28	12	19	0.92
Trichloroethene	3	<0.0050	-0.00070	-0.0036	0.0014
Turbidity, JTU ^d	3	240	25	120	64
Zinc-total	3	0.039	<0.0080	<0.026	0.0092

^aSee Fig. 7.^bStandard error of the mean.^cNA = not applicable.^dMeasured in Jackson Turbidity Units.

Table 46. NPDES miscellaneous source VC7002,^a April-June 1989

Parameter	Number of samples	Concentration (mg/L)			Standard error ^b
		Max	Min	Av	
Biochemical oxygen demand	3	230	5.0	87	71
Fecal coliform, col/100 mL	3	90	<2.0	<46	25
Flow, Mgd	35	0.00030	3.3000E-07	0.000072	0.000012
Oil and grease	3	220	<2.0	<73	71
pH, standard units	4	11	6.8	NA ^c	NA
Recoverable phenolics-total	3	>5.4	0.016	>1.8	1.8
Suspended solids-total	3	1500	<5.0	<520	510

^aVehicle and Equipment Cleaning Facility, Building 7002.

^bStandard error of the mean.

^cNA = not applicable.

Table 47. NPDES cooling towers,^a April-June 1989

Parameter	Number of samples	Concentration (mg/L)			Standard error ^b
		Max	Min	Av	
Chlorine-total residual	11	0.81	<0.010	<0.14	0.087
Chromium-total	11	0.043	0.013	0.026	0.0027
Copper-total	11	0.41	<0.010	<0.11	0.047
Downstream pH, standard units	9	9.0	7.9	NA ^c	NA
Flow, Mgd	11	0.18	0.0013	0.022	0.016
pH, standard units	11	9.0	8.1	NA	NA
Temperature, °C	11	33	14	21	1.7
Zinc-total	11	1.0	0.034	0.37	0.082

^aORNL.^bStandard error of the mean.^cNA = not applicable.

Table 48. NPDES miscellaneous outfalls,
April-June 1989

Parameter	Concentration (mg/L)	
	EF7002 ^a	SP2519 ^b
Flow		0.011
Oil and grease	74	
pH	7.6	9.8
Temperature		28

^aVehicle and Equipment Maintenance Facility,
Building 7002.

^bCentral Steam Plant, Building 2519.

Table 49. NPDES discharge point category II outfalls,^a April-June 1989

Parameter	Number of samples	Concentration (mg/L)			Standard error ^b
		Max	Min	Av	
Downstream pH, standard units	34	7.9	7.0	NA ^c	NA
Flow, Mgd	34	0.19	0.000029	0.031	0.0077
Oil and grease	34	14	<2.0	<3.2	0.52
pH, standard units	34	8.4	6.7	NA	NA
Suspended solids-total	34	1100	<5.0	<70	42
Temperature, °C	34	57	14	21	1.4

^aORNL.

^bStandard error of the mean.

^cNA = not applicable.

Table 50. NPDES discharge point category III outfalls,^a April-June 1989

Parameter	Number of samples	Concentration (mg/L)			Standard error ^b
		Max	Min	Av	
Flow, Mgd	22	0.22	0.00020	0.027	0.011
pH, standard units	22	8.4	4.6	NA ^c	NA

^aORNL.

^bStandard error of the mean.

^cNA = not applicable.

Table 51. NPDES noncompliances, April 1989

Station	Parameter	Daily maximum concentration (mg/L)	Permit limit (mg/L)
Sewage Treatment Plant (X01)	Total suspended solids	73.0	45.0
Sewage Treatment Plant (X01)	Total suspended solids, kg/day	59.0	39.2
Cooling Tower 6000 (CS6000)	Chlorine	0.62	0.2
Cooling Tower 2539 (CS2539)	Chlorine	0.81	0.2
Sewage Treatment Plant (X01)	Total suspended solids	51.0	45.0

Table 52. NPDES noncompliances, May 1989

Station	Parameter	Daily maximum concentration (mg/L)	Permit limit (mg/L)
Category II Outfall 214	Total suspended solids	931	50
Category II Outfall 225	Total suspended solids	1148	50
Category II Outfall 285	Total suspended solids	86	50
Equipment Maintenance Facility (EF7002)	Oil and grease	74	15
Steam Plant boilers (SP2519)	pH ^a	9.8	9.0
Vehicle Cleaning Facility (VC7002)	pH ^a	11.1	9.0
Vehicle Cleaning Facility (VC7002)	Total recoverable phenolics	>5.43	2.0
Vehicle Cleaning Facility (VC7002)	Oil and grease	216	10
Vehicle Cleaning Facility (VC7002)	Biochemical oxygen demand	228	45
Vehicle Cleaning Facility (VC7002)	Total suspended solids	1542	40

^aMeasured in standard units.

Table 53. NPDES noncompliances, June 1989

Station	Parameter	Daily maximum concentration (mg/L)	Permit limit (mg/L)
HFIR Process Waste Basin (X09)	pH ^a	11.3	9.0

^aMeasured in standard units.

The chlorine noncompliance at cooling tower 6000 on April 13 was attributed to the fact that the timer that governs biocide feed had been changed in the field to feed three batches per day vs a continuous, low-level feed. Plant and Equipment supervisory personnel indicated to Environmental Monitoring and Compliance personnel that the feed problem would be corrected immediately.

The chlorine violation on April 14 at cooling tower 2539 was attributed to the fact that a bromine biocide was being used in the tower and operating personnel had not been made aware that the limit of 0.2 mg/L applied, regardless of the halogen compound involved. Operating personnel are now implementing a switch to a chlorine-based biocide for that tower.

May 1989

Construction activity in the areas drained by the Category II outfalls (parking lot, street, and storage area drains) was the contributing factor to the total suspended solids and oil and grease noncompliances at those outfalls on May 1. Residual oil, loose soil, and other particulate matter was carried to the drains by precipitation runoff. Construction personnel involved with the subject projects were contacted to develop and implement the necessary measures, such as placement of silt fences or straw bales, to protect the drains from further impairment.

The oil and grease exceedance on May 5 at the Equipment and Vehicle Facility (EF7002) was attributed to an inadequate performance of a grease trap that serves the effluent from that facility. ORNL personnel are initiating a study to investigate options for more thorough treatment of the effluent from EF7002.

The pH limit exceedance at the steam plant (SP2519) on May 5 was attributed to effluent produced by the steam plant's boiler blowdown and boiler drainage systems. Because the boilers must be operated with softened water at an elevated pH, the wastewater from the boilers is typically of high pH as well. ORNL personnel are in the process of characterizing the situation and are considering options for the most environmentally acceptable treatment and/or discharge method for the stream.

An inadequate grease trap at the Vehicle Cleaning Facility (VC7002) was the cause for the pH, total recoverable phenolics, oil and grease, total suspended solids, and biochemical oxygen demand noncompliances at that facility on May 18. Corrective action alternatives are being evaluated.

June 1989

The pH exceedance on July 14 at the HFIR Process Waste Basin (X09A) was attributed to an operational error resulting in discharge of effluent before neutralization. Procedures are being revised to prevent a recurrence.

3.3 POLYCHLORINATED BIPHENYLS (PCBs) IN THE AQUATIC ENVIRONMENT

Water samples were collected from various locations along WOC, MB, Northwest Tributary (NWT) and the Clinch River (CR) to determine PCB concentrations in these areas (Fig. 8). A total of twelve sites were sampled; eight on WOC (including one at WOD), one on MB, one on NWT and two on the CR. Two samples per site were taken for water during April through June, 1989. This was done to comply with the Clean Water Act (CWA) and is an integral part of ORNL's NPDES activities. Water samples are being analyzed quarterly for aroclors 1016, 1221, 1232, 1242, 1248, 1254, and 1260. Sediment samples are being analyzed for the same aroclors semiannually.

Water samples were taken by the manual grab method and placed in amber glass containers. The samples were cooled to 4°C; the water samples can be held for a maximum of 7 days before extraction. The samples were analyzed by a gas chromatographic procedure and measured by electron capture detector. This provides a method to determine individual aroclors, as well as total PCB content.

The Environmental Protection Agency (EPA) acute criteria for the protection of fish and aquatic life is 2.0 µg/L for PCBs. The results from these samples will be used to help detect sources of PCB contamination and provide a history of PCB concentrations in the ORNL area.

The concentrations of PCBs in water during April through June 1989 were below the analytical quantitation limit at all sampling sites (Table 54). Analyses were performed for seven aroclors of PCBs, all of which were below the quantitation limit. The quantitation limit for PCB aroclors 1016, 1221, 1232, 1242, and 1248 is 0.5 µg/L. The quantitation limit for PCB aroclors 1254 and 1260 is 1.0 µg/L. Estimated values for aroclor-1254 were found at locations WOC5, NWT1, and MB7. Mass spectral data indicated the presence of this aroclor at these locations that met the identification criteria, but the resulting values were less than the quantitation limit. Further, more detailed investigation will be performed during the July through September period to determine if aroclor-1254 is actually being detected at these sites.

3.4 GROUNDWATER

Groundwater in waste area grouping (WAG) 6 is monitored in order to comply with Federal Regulation 40 CFR, Part 265, and Tennessee's Hazardous Waste Management Rule 1200-1-11.05 for interim status facilities, while groundwater in WAG 1 is monitored to comply with 3004(U) of the Resource Conservation and Recovery Act (RCRA). Monitoring in both WAGs is necessary to meet data needs for remediation activities. WAGs are geographically contiguous and/or hydrologically defined areas, and each WAG contains small distinct drainage areas within which similar contaminants may have been introduced. A WAG may contain one or more Solid Waste Management Units (SWMUs).

WAG 1 consists of an area covering much of the ORNL main site (Figs. 9 through 13). It contains many types of Solid Waste Management Units (tanks, ponds, waste treatment facilities, leak sites, spill sites, landfills) listed by EPA

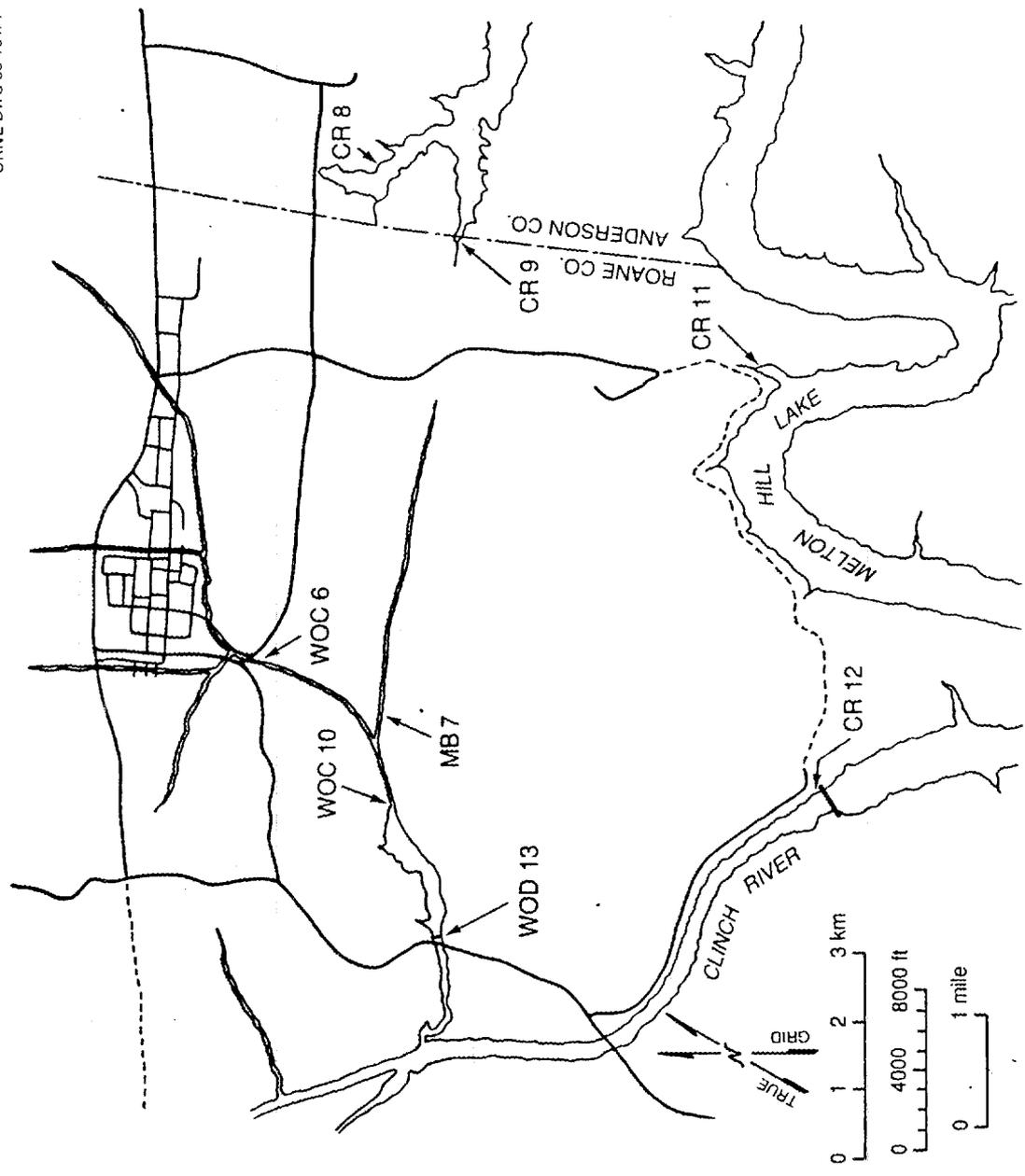


Fig. 8. Location map of PCB sampling points.

Table 54. PCB concentrations in surface water, April-June 1989

Location ^a	Analysis	Number of samples	Concentration (µg/L)			Standard error ^b
			Max	Min	Av	
WOC5	Aroclor-1016	2	<0.50	<0.50	<0.50	0
	Aroclor-1221	2	<0.50	<0.50	<0.50	0
	Aroclor-1232	2	<0.50	<0.50	<0.50	0
	Aroclor-1242	2	<0.50	<0.50	<0.50	0
	Aroclor-1248	2	<0.50	<0.50	<0.50	0
	Aroclor-1254	2	<1.0	-0.90	<0.95	0.050
	Aroclor-1260	2	<1.0	<1.0	<1.0	0
WOC4	Aroclor-1016	2	<0.50	<0.50	<0.50	0
	Aroclor-1221	2	<0.50	<0.50	<0.50	0
	Aroclor-1232	2	<0.50	<0.50	<0.50	0
	Aroclor-1242	2	<0.50	<0.50	<0.50	0
	Aroclor-1248	2	<0.50	<0.50	<0.50	0
	Aroclor-1254	2	<1.0	<1.0	<1.0	0
	Aroclor-1260	2	<1.0	<1.0	<1.0	0
WOC3	Aroclor-1016	2	<0.50	<0.50	<0.50	0
	Aroclor-1221	2	<0.50	<0.50	<0.50	0
	Aroclor-1232	2	<0.50	<0.50	<0.50	0
	Aroclor-1242	2	<0.50	<0.50	<0.50	0
	Aroclor-1248	2	<0.50	<0.50	<0.50	0
	Aroclor-1254	2	<1.0	<1.0	<1.0	0
	Aroclor-1260	2	<1.0	<1.0	<1.0	0
WOC2	Aroclor-1016	2	<0.50	<0.50	<0.50	0
	Aroclor-1221	2	<0.50	<0.50	<0.50	0
	Aroclor-1232	2	<0.50	<0.50	<0.50	0
	Aroclor-1242	2	<0.50	<0.50	<0.50	0
	Aroclor-1248	2	<0.50	<0.50	<0.50	0
	Aroclor-1254	2	<1.0	<1.0	<1.0	0
	Aroclor-1260	2	<1.0	<1.0	<1.0	0
NWT1	Aroclor-1016	2	<0.50	<0.50	<0.50	0
	Aroclor-1221	2	<0.50	<0.50	<0.50	0
	Aroclor-1232	2	<0.50	<0.50	<0.50	0
	Aroclor-1242	2	<0.50	<0.50	<0.50	0
	Aroclor-1248	2	<0.50	<0.50	<0.50	0
	Aroclor-1254	2	-0.30	-0.20	-0.25	0.050
	Aroclor-1260	2	<1.0	<1.0	<1.0	0

Table 54 (continued)

Location ^a	Analysis	Number of samples	Concentration (µg/L)			Standard error ^b
			Max	Min	Av	
WOC6	Aroclor-1016	2	<0.50	<0.50	<0.50	0
	Aroclor-1221	2	<0.50	<0.50	<0.50	0
	Aroclor-1232	2	<0.50	<0.50	<0.50	0
	Aroclor-1242	2	<0.50	<0.50	<0.50	0
	Aroclor-1248	2	<0.50	<0.50	<0.50	0
	Aroclor-1254	2	<1.0	<1.0	<1.0	0
	Aroclor-1260	2	<1.0	<1.0	<1.0	0
WOC10	Aroclor-1016	2	<0.50	<0.50	<0.50	0
	Aroclor-1221	2	<0.50	<0.50	<0.50	0
	Aroclor-1232	2	<0.50	<0.50	<0.50	0
	Aroclor-1242	2	<0.50	<0.50	<0.50	0
	Aroclor-1248	2	<0.50	<0.50	<0.50	0
	Aroclor-1254	2	<1.0	<1.0	<1.0	0
	Aroclor-1260	2	<1.0	<1.0	<1.0	0
WOC14	Aroclor-1016	2	<0.50	<0.50	<0.50	0
	Aroclor-1221	2	<0.50	<0.50	<0.50	0
	Aroclor-1232	2	<0.50	<0.50	<0.50	0
	Aroclor-1242	2	<0.50	<0.50	<0.50	0
	Aroclor-1248	2	<0.50	<0.50	<0.50	0
	Aroclor-1254	2	<1.0	<1.0	<1.0	0
	Aroclor-1260	2	<1.0	<1.0	<1.0	0
WOC13	Aroclor-1016	2	<0.50	<0.50	<0.50	0
	Aroclor-1221	2	<0.50	<0.50	<0.50	0
	Aroclor-1232	2	<0.50	<0.50	<0.50	0
	Aroclor-1242	2	<0.50	<0.50	<0.50	0
	Aroclor-1248	2	<0.50	<0.50	<0.50	0
	Aroclor-1254	2	<1.0	<1.0	<1.0	0
	Aroclor-1260	2	<1.0	<1.0	<1.0	0
MB7	Aroclor-1016	2	<0.50	<0.50	<0.50	0
	Aroclor-1221	2	<0.50	<0.50	<0.50	0
	Aroclor-1232	2	<0.50	<0.50	<0.50	0
	Aroclor-1242	2	<0.50	<0.50	<0.50	0
	Aroclor-1248	2	<0.50	<0.50	<0.50	0
	Aroclor-1254	2	<1.0	-0.10	<0.55	0.45
	Aroclor-1260	2	<1.0	<1.0	<1.0	0

Table 54 (continued)

Location ^a	Analysis	Number of samples	Concentration (µg/L)			Standard error ^b
			Max	Min	Av	
CR8	Aroclor-1016	2	<0.50	<0.50	<0.50	0
	Aroclor-1221	2	<0.50	<0.50	<0.50	0
	Aroclor-1232	2	<0.50	<0.50	<0.50	0
	Aroclor-1242	2	<0.50	<0.50	<0.50	0
	Aroclor-1248	2	<0.50	<0.50	<0.50	0
	Aroclor-1254	2	<1.0	<1.0	<1.0	0
	Aroclor-1260	2	<1.0	<1.0	<1.0	0
CR9	Aroclor-1016	2	<0.50	<0.50	<0.50	0
	Aroclor-1221	2	<0.50	<0.50	<0.50	0
	Aroclor-1232	2	<0.50	<0.50	<0.50	0
	Aroclor-1242	2	<0.50	<0.50	<0.50	0
	Aroclor-1248	2	<0.50	<0.50	<0.50	0
	Aroclor-1254	2	<1.0	<1.0	<1.0	0
	Aroclor-1260	2	<1.0	<1.0	<1.0	0

^aSee Fig. 8.

^bStandard error of the mean.

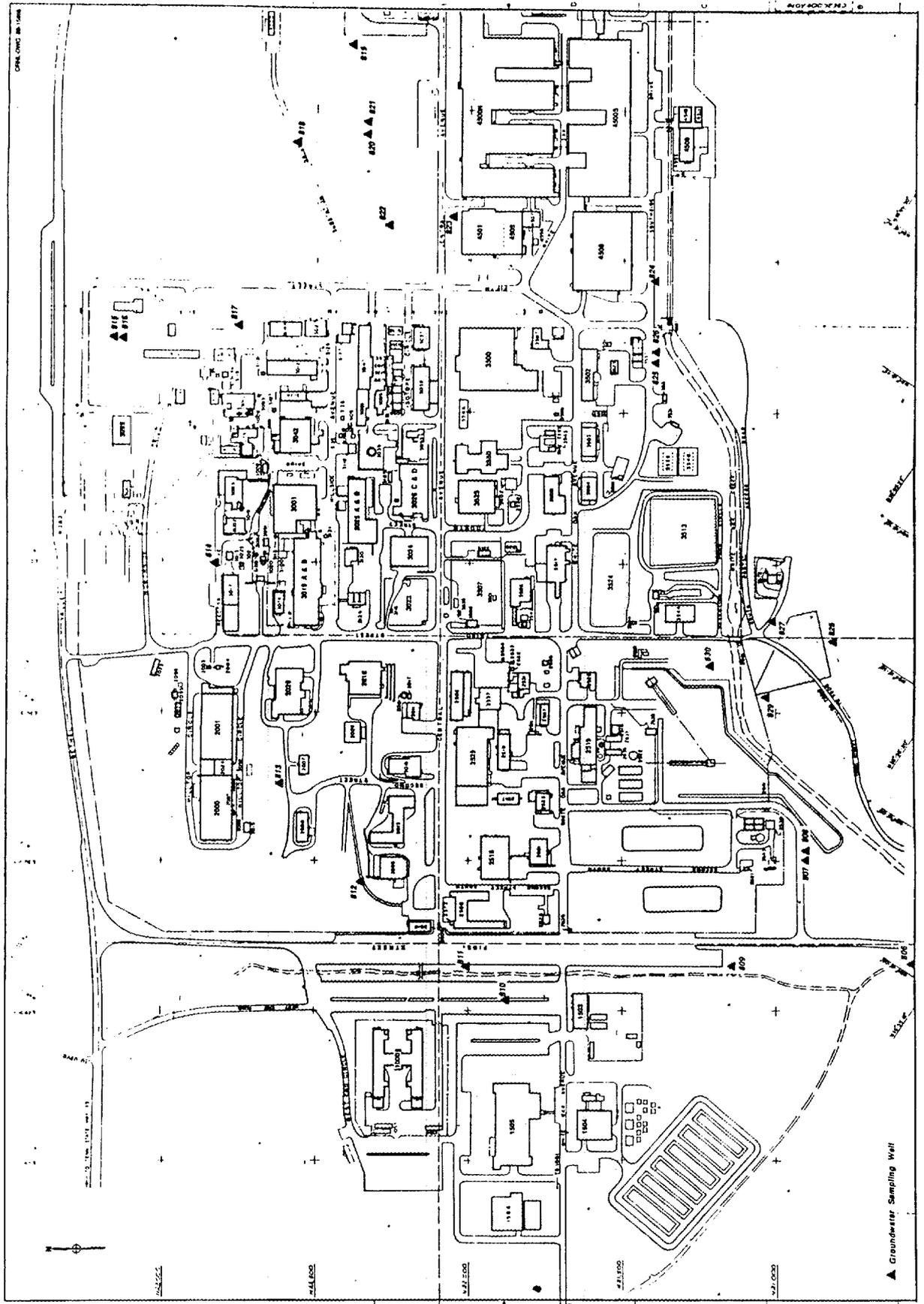


Fig. 9. Location map of WAG I.

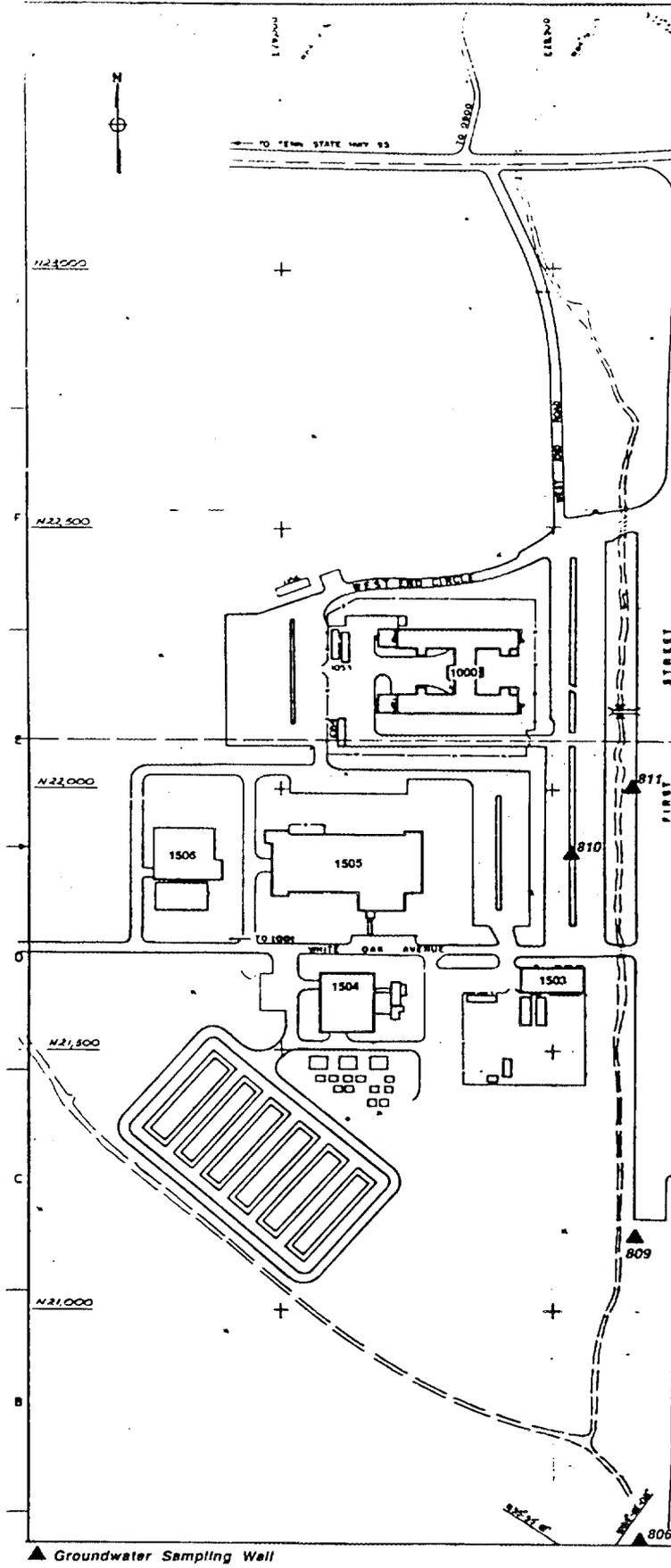


Fig. 10. Location map of wells in the 1000 area of WAG 1.

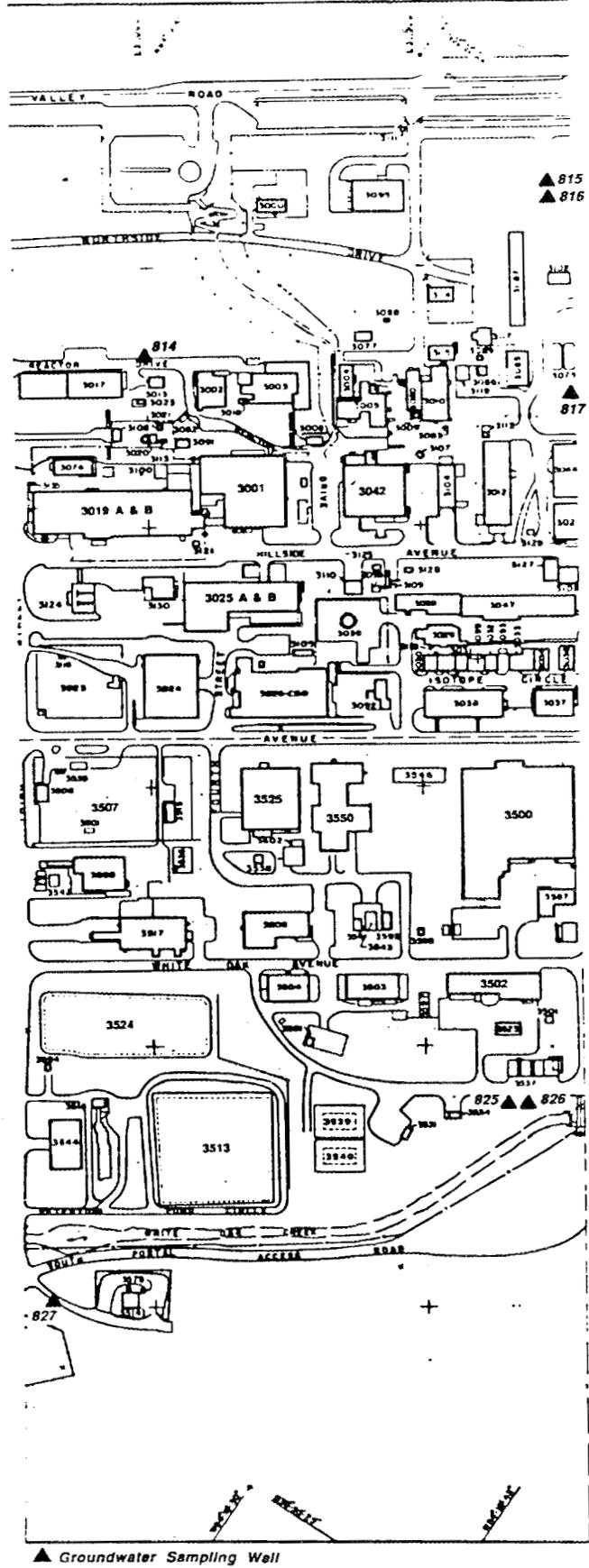


Fig. 12. Location map of wells in the 3000 area of WAG 1.

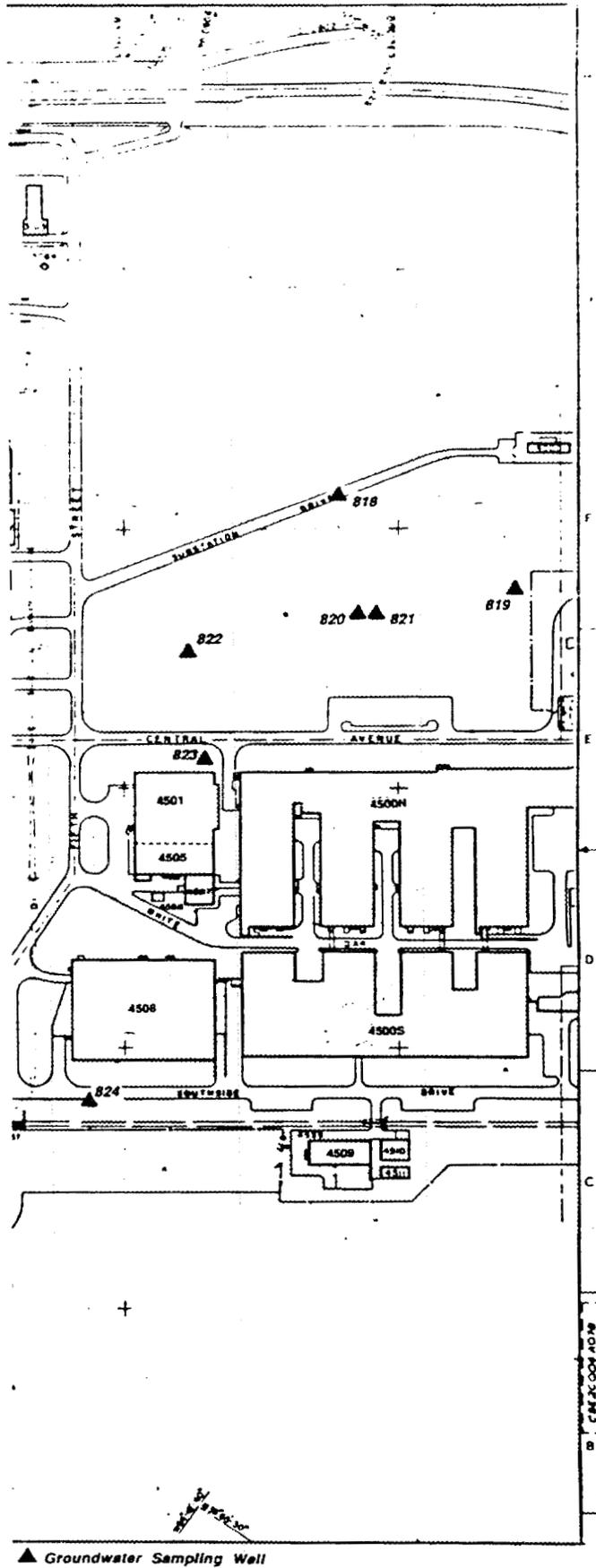


Fig. 13. Location map of wells in the 4000 area of WAG 1.

in the definition of a SWMU. A listing of the type and number of sites within WAG 1 is given in Table 55. WAG 6 is located about 1.5 km southwest of the ORNL main site (Fig. 14). It consists of three SWMUs: (1) Solid Waste Storage Area 6 (SWSA 6), (2) the Emergency Waste Basin, and (3) the Explosives Detonation Trench. SWSA 6 was opened for limited disposal in 1969, began fullscale operation in 1973, and is still active. In the course of its operation, SWSA 6 has received a broad spectrum of low-level waste (LLW) materials, including radioactive and chemical hazardous wastes. The Emergency Waste Basin was constructed to provide a temporary emergency diversion for process waste. The basin has not been used since its construction in 1962. The Explosives Detonation Trench is used for explosive and shock-sensitive chemicals requiring disposal.

The wells in WAG 6 are divided into three types: (1) upgradient wells, which are intended to provide reference information; (2) perimeter wells, which are intended to serve as downgradient boundary wells; and (3) internal site-characterization wells, which provide information about conditions within the site. Data from WAG 6 includes all three types of wells and data from WAG 1 includes only upgradient and perimeter wells.

WAG 1 data summaries for the sampling period ending during the second quarter of 1989 are presented in Table 56. Analyses for which no results were detected in any of the wells in the WAG were excluded from the summary tables. Table 57 is a summary of the wells in WAG 1, where one of the primary drinking water standards was exceeded. Similar tables are given for WAG 6 (Tables 58 and 59). The state of Tennessee guidelines require, for each well, four measurements of conductivity, pH, temperature, total organic carbon, and total organic halogens. In addition, per EPA guidelines, three field measurements (of conductivity, pH, and temperature) are made during the course of sampling to ensure that the well water has remained stable. Thus, the number of samples listed will be four, or seven, times the number of samples listed for the other contaminant indicators.

Most parameters of interest were at low or undetectable levels during the sampling period. Exceedances of primary drinking water standards for WAG 1 all involved perimeter wells (Table 57), except for cadmium in well 814. WAG 1 perimeter well numbers 808 and 811 had fluoride levels that exceeded the state limit (1.4 to 2.4 mg/L) but not the federal limits of 4.0 mg/L. Cadmium exceeded the primary drinking water limit in wells 809, 820, and 829. Other downgradient boundary wells with metal values exceeding the limits were found for barium in well 820 and chromium in well 812. An exceedance was also recorded for tritium at perimeter well 830. A notable strontium exceedance occurred at perimeter well 812 (located just northwest of Building 2069), and much lower strontium exceedances occurred at perimeter wells 806, 830, and 829. Gross alpha also exceeded the limit in well 812. Limits for organics were exceeded in well 813 (trichloroethene), and wells 825 and 830 (vinyl chloride).

Table 55. Listing of WAG 1 sites by type

Type of site	Number of sites
Collection and storage tanks (LLW)	
Inactive	22
Active	24
Leak/spill sites and contaminated soils	
Radioactive	30
Chemical	4
Ponds and impoundments	
Radioactive	6
Chemical	3
Waste treatment facilities	
Radioactive	2
Chemical and sewage waste	2
Solid waste storage areas	
Radioactive	3
Chemical and sewage waste	1
Miscellaneous facilities	
Chemical and sewage waste	2
Total	99

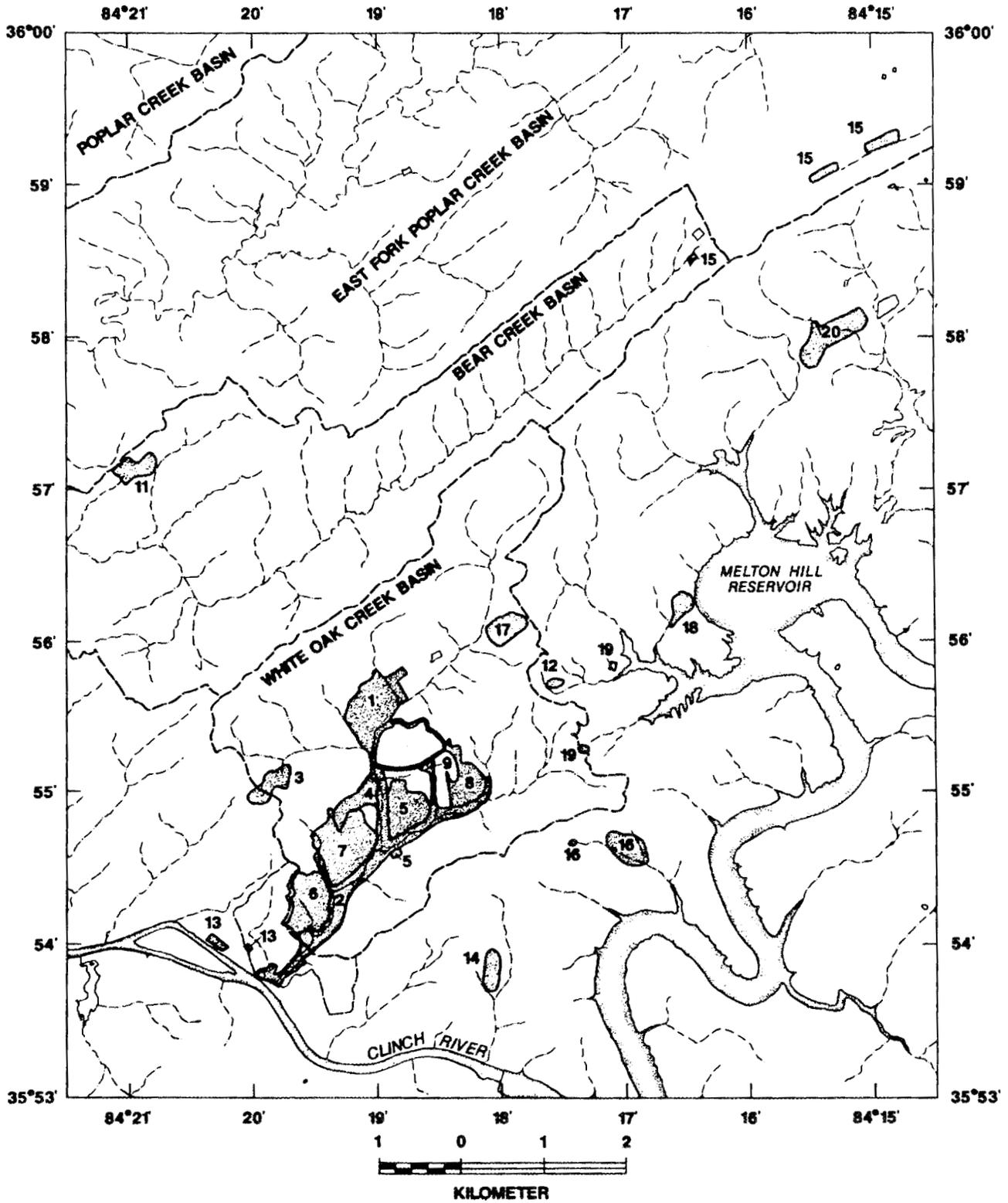


Fig. 14. Location map of ORNL WAGs.

Table 56. WAG 1^a groundwater summary statistics, April-June 1989

Parameter	Number of samples	Min	Value qualifier ^b	Av	Max	Value qualifier ^b
<i>Perimeter wells</i>						
Anions, mg/L						
Chloride	18	1.6		25	89	
Fluoride-total	18	1.0		1.2	3.9	
Nitrate (as N)	18	0.50	U	0.59	1.3	
Sulfate (as SO ₄)	18	5.0	U	47	180	
<i>Field measurements</i>						
pH, standard units	126	6.5		7.1	9.3	
Conductivity, mS/cm	126	0.24		0.61	1.3	
Temperature, °C	126	15		19	40 ^c	
<i>Metals, mg/L</i>						
Aluminum-dissolved	18	0.050	U	0.70	2.0	U
Aluminum-total	18	0.062		1.4	2.0	U
Barium-dissolved	18	0.022		0.13	0.34	
Barium-total	18	0.026		0.26	2.3	
Beryllium-dissolved	18	0.00040	U	0.0086	0.030	
Beryllium-total	18	0.00040	U	0.020	0.030	
Boron-dissolved	18	0.080	U	0.18	0.91	
Boron-total	18	0.080	U	0.19	0.99	
Cadmium-dissolved	18	0.0020	U	0.0043	0.011	
Cadmium-total	18	0.0020	U	0.0096	0.045	
Calcium-dissolved	18	1.3		98	190	
Calcium-total	18	1.2		92	170	

Table 56 (continued)

Parameter	Number of samples	Min	Value qualifier ^b	Av	Max	Value qualifier ^b
<i>Perimeter wells</i>						
Chromium-dissolved	18	0.0030	U	0.013	0.027	
Chromium-total	18	0.0087		0.024	0.11	
Cobalt-dissolved	18	0.0030	U	0.0038	0.0058	
Cobalt-total	18	0.0030	U	0.0034	0.0063	
Copper-total	18	0.010	U	0.010	0.011	
Iron-dissolved	18	0.010	U	1.8	11	
Iron-total	18	0.010	U	1.9	10	
Magnesium-dissolved	18	0.51		15	25	
Magnesium-total	18	0.51		14	24	
Manganese-dissolved	18	0.0030	U	1.8	8.6	
Manganese-total	18	0.011		1.7	7.8	
Mercury-dissolved	18	0.00010	U	0.0001	0.00010	U
Nickel-dissolved	18	0.0060	U	0.0060	0.0060	U
Nickel-total	18	0.0060	U	0.0081	0.029	
Silicon-dissolved	18	3.2		4.8	7.0	
Silicon-total	18	2.3		4.5	6.0	
Silver-dissolved	18	0.0050	U	0.0075	0.015	
Silver-total	18	0.0050	U	0.0073	0.015	
Sodium-dissolved	18	2.0	U	47	310	
Sodium-total	18	2.0	U	50	340	
Strontium-dissolved	18	0.075		0.60	2.6	
Strontium-total	18	0.068		0.56	2.4	
Zinc-dissolved	18	0.0080	U	0.0090	0.014	
Zinc-total	18	0.0080	U	0.017	0.12	

Table 56 (continued)

Parameter	Number of samples	Min	Value qualifier ^b	Av	Max	Value qualifier ^b
<i>Perimeter wells</i>						
Radioactivity measurements, Bq/L						
⁶⁰ Co	18	-0.23		-0.0039	0.24	
¹³⁷ Cs	18	-0.16		0.051	0.80	
Gross alpha	18	-0.011		0.28	4.8	
Gross beta	18	-0.0060		21	370	
Radioactive strontium-total ^d	18	-0.030		7.0	120	
Tritium	18	-6.0		140	1400	
Extractable organics, mg/L						
Bis(2-chloroisopropyl) ether	18	0.0030	J	0.0094	0.010	U
Bis(2-ethylhexyl) phthalate	18	0.0080	J	0.0099	0.010	U
Volatile organics, mg/L						
Acetone	18	0.0020	JB	0.0068	0.010	U
Benzene	18	0.00030	J	0.0045	0.0050	U
Carbon tetrachloride	18	0.0030	J	0.0049	0.0050	U
Chloroform	18	0.0030	J	0.0048	0.0050	U
Methylene chloride	18	0.0010	JB	0.0013	0.0020	JB
Trichloroethene	18	0.0030	J	0.0052	0.011	
Vinyl chloride	18	0.0060	J	0.011	0.028	
1,2-Dichloroethene	18	0.0050	U	0.0053	0.011	

Table 56 (continued)

Parameter	Number of samples	Min	Value qualifier ^b	AV	Max	Value qualifier ^b
<i>Upgradient wells</i>						
Anions, mg/L						
Chloride	6	3.1	U	8.0	19	U
Fluoride-total	6	1.0	U	1.0	1.0	U
Nitrate (as N)	6	0.50	U	0.82	2.0	
Sulfate(as SO ₄)	6	6.2		24	38	
Field measurements						
pH, standard units	42	6.8		7.2	7.9	
Conductivity, mS/cm	42	0.35		0.48	0.66	
Temperature, °C	42	15		17	21	
Metals, mg/L						
Aluminum-dissolved	6	0.050	U	0.61	2.0	U
Aluminum-total	6	0.25		1.5	2.7	
Barium-dissolved	6	0.041		0.13	0.26	
Barium-total	6	0.057		0.21	0.46	
Beryllium-dissolved	6	0.00040	U	0.0053	0.030	
Beryllium-total	6	0.00040	U	0.010	0.031	
Boron-dissolved	6	0.080	U	0.15	0.36	
Boron-total	6	0.080	U	0.14	0.33	
Cadmium-dissolved	6	0.0020	U	0.0033	0.0098	
Cadmium-total	6	0.0020	U	0.0048	0.011	
Calcium-dissolved	6	49		89	140	
Calcium-total	6	44		84	130	

Table 56 (continued)

Parameter	Number of samples	Min	Value qualifier ^b	Av	Max	Value qualifier ^b
<i>Upgradient wells</i>						
Chromium-dissolved	6	0.0030	U	0.013	0.027	
Chromium-total	6	0.012		0.017	0.027	
Cobalt-dissolved	6	0.0030	U	0.0040	0.0059	
Cobalt-total	6	0.0030	U	0.0048	0.0073	
Copper-total	6	0.010	U	0.010	0.010	U
Iron-dissolved	6	0.010	U	0.033	0.13	
Iron-total	6	0.038		0.64	1.3	
Magnesium-dissolved	6	12		24	32	
Magnesium-total	6	13		21	28	
Manganese-dissolved	6	0.0030	U	0.028	0.041	
Manganese-total	6	0.039		0.050	0.075	
Mercury-dissolved	6	0.00010	U	0.0001	0.00020	
Nickel-dissolved	6	0.0060	U	0.0062	0.0073	
Nickel-total	6	0.0060	U	0.0061	0.0066	
Silicon-dissolved	6	2.2		4.1	7.3	
Silicon-total	6	0.99		4.8	8.3	
Silver-dissolved	6	0.0050	U	0.0053	0.0060	
Silver-total	6	0.0050	U	0.0051	0.0053	
Sodium-dissolved	6	2.0	U	11	27	
Sodium-total	6	2.0	U	9.6	25	
Strontium-dissolved	6	0.15		0.61	1.8	
Strontium-total	6	0.17		0.55	1.6	
Zinc-dissolved	6	0.0080	U	0.012	0.023	
Zinc-total	6	0.012		0.017	0.024	

Table 56 (continued)

Parameter	Number of samples	Min	Value qualifier ^b	Av	Max	Value qualifier ^b
<i>Upgradient wells</i>						
Radioactivity measurements, Bq/L						
⁶⁰ Co	6	0.020		0.13	0.19	
¹³⁷ Cs	6	-0.020		0.072	0.25	
Gross alpha	6	-0.0030		0.046	0.17	
Gross beta	6	0.070		0.14	0.24	
Radioactive strontium-total	6	-0.030		0.063	0.13	
Tritium	6	-6.0		43	90	
Extractable organics, mg/L						
Bis(2-chloroisopropyl) ether	6	0.010	U	0.010	0.010	U
Bis(2-ethylhexyl) phthalate	6	0.010	U	0.010	0.010	U
Volatile organics, mg/L						
Acetone	6	0.0020	JB	0.0087	0.010	U
Benzene	6	0.0050	U	0.0050	0.0050	U
Carbon tetrachloride	6	0.0050	U	0.0050	0.0050	U
Chloroform	6	0.0050	U	0.0065	0.014	U

Table 56 (continued)

Parameter	Number of samples	Min	Value qualifier ^b	Av	Max	Value qualifier ^b
<i>Upgradient wells</i>						
Methylene chloride	6	0.0010	JB	0.0012	0.0020	JB
Trichloroethene	6	0.0050	U	0.0050	0.0050	U
Vinyl chloride	6	0.010	U	0.010	0.010	U
1,2-Dichloroethene	6	0.0050	U	0.0050	0.0050	U

^aSee Figs. 9 through 13.

^bOrganics: U = undetected; B = present in blank; J = below detection limit, but estimated; E = concentration exceeds the calibration range of the instrument. Inorganics: U = undetected; B = value < contract required detection limit > instrument detection limit; E = value is estimated because of the presence of interference.

^cWell 823 is near a steam line that is presumed to be leaking.

^dRadioactive strontium-total (⁸⁹Sr + ⁹⁰Sr).

Table 57. Groundwater sample analyses from monitoring wells in WAG 1,^a
 April-June 1989, whose values exceeded allowable concentrations
 under the primary drinking water standards^b

Well identifier	Parameter	Concentration	Primary limit ^{c,d}	Units of measurement
<i>Perimeter wells</i>				
820	Barium-total	2.3	1.0	mG/L
809	Cadmium-dissolved	0.011	0.010	mG/L
820	Cadmium-total	0.045	0.010	mG/L
829	Cadmium-total	0.011	0.010	mG/L
812	Chromium-total	0.11	0.050	mG/L
811	Fluoride-total	3.9	1.4	mG/L
808	Fluoride-total	1.6	1.4	mG/L
812	Gross alpha	4.8	0.56	Bq/L
812	Radioactive strontium-total ^e	120	0.30	Bq/L
806	Radioactive strontium-total ^e	3.2	0.30	Bq/L
830	Radioactive strontium-total ^e	1.3	0.30	Bq/L
829	Radioactive strontium-total ^e	0.50	0.30	Bq/L
813	Trichloroethene	0.011	0.0050	mG/L
830	Tritium	1400	740	Bq/L
825	Vinyl chloride	0.028	0.0020	mG/L
830	Vinyl chloride	0.0060	0.0020	mG/L
<i>Upgradient wells</i>				
814	Cadmium-total	0.011	0.010	mG/L

^aSee Figs. 9 through 13.

^bStandards are based on State of Tennessee Hazardous Waste Groundwater Regulations or EPA Federal Drinking Water Standards where no state standard exists.

^cSafe Drinking Water Act-National Primary Drinking Water Regulations, 40 CFR 141, as amended.

^dState of Tennessee Hazardous Waste Regulations TN 1200-1-11-05, Appendix 05/B.

^eRadioactive strontium-total (⁸⁹Sr + ⁹⁰Sr).

Table 58. WAG 6^a groundwater summary statistics, April-June 1989

Parameter	Number of samples	Min	Value qualifier ^b	Av	Max	Value qualifier ^b
<i>Perimeter wells</i>						
Anions, mg/L						
Chloride	15	1.0		5.5	16	
Fluoride-total	15	1.0	U	1.0	1.0	U
Nitrate (as N)	15	0.50	U	0.76	2.6	
Phosphate	15	5.0	U	5.0	5.0	U
Sulfate (as SO ₄)	15	5.0	U	20	85	
Field measurements						
pH, standard units	105	4.3		6.4	7.8	
Conductivity, mS/cm	105	0.010		0.30	0.82	
Temperature, °C	105	13		15	17	
Metals, mg/L						
Aluminum-total	15	0.050	U	0.33	0.67	
Beryllium-total	15	0.00030	U	0.0086	0.025	
Calcium-total	15	0.26		72	180	
Cobalt-total	15	0.0030	U	0.0034	0.0048	
Iron-dissolved	15	0.050	U	0.064	0.16	
Iron-total	15	0.050	U	1.1	4.8	
Magnesium-total	15	0.58		11	29	
Manganese-dissolved	15	0.010	U	0.024	0.10	
Manganese-total	15	0.010	U	0.035	0.10	
Nickel-total	15	0.0050	U	0.0092	0.019	
Silicon-total	15	3.7		8.1	13	

Table 58 (continued)

Parameter	Number of samples	Min	Value qualifier ^b	Av	Max	Value qualifier ^b
<i>Perimeter wells</i>						
Sodium-dissolved	15	1.7		9.8	45	
Sodium-total	15	1.0		9.3	42	
Strontium-total	15	0.0050	U	0.33	1.2	
Miscellaneous						
Alkalinity (as CaCO ₃)	15	7.5		200	430	
Fecal coliform, col/100 mL	15	1.0	U	4.3	50	
Turbidity, NTU	15	0.055		6.3	54	
Pesticides, mg/L						
2,4-D	15	0.00020	U	0.0023	0.012	
2,4,5-TP (Silvex)	15	0.00010	U	0.0001	0.00030	
Radioactivity measurements, Bq/L						
⁶⁰ Co	15	-0.080		0.77	11	
¹³⁷ Cs	15	-0.12		0.014	0.19	
Gross alpha	15	-0.0096		0.028	0.094	
Gross beta	15	-0.0020		0.56	6.8	
Radioactive strontium-total ^{c,d}	13	-0.050		0.025	0.13	
Radium-total ^c	13	-0.011		0.021	0.067	
Tritium	15	-0.59		4100	28000	

Table 58 (continued)

Parameter	Number of samples	Min	Value qualifier ^b	Av	Max	Value qualifier ^b
<i>Perimeter wells</i>						
Extractable organics, mg/L						
Organic carbon-total	60	0.50	U	0.94	4.6	
Organic halides-total	60	0.0050	U	0.042	0.59	
Recoverable phenolics-total	15	0.0010	U	0.0010	0.0010	U
Volatile organics, mg/L						
Acetone	15	0.0020	JB	0.0051	0.010	U
Benzene	15	0.0020	J	0.0048	0.0050	U
Carbon tetrachloride	15	0.00050	J	0.0098	0.082	
Chloroform	15	0.0020	J	0.011	0.097	
Chloromethane	15	0.0040	J	0.0096	0.015	
Methylene chloride	15	0.00090	JB	0.0023	0.0050	U
Tetrachloroethene	15	0.0020	J	0.0048	0.0050	U
Toluene	15	0.0020	JB	0.0043	0.0070	B
Trichloroethene	15	0.0010	J	0.037	0.49	
1,1-Dichloroethane	15	0.0050	U	0.0053	0.0090	
1,1,1-Trichloroethane	15	0.00040	J	0.0047	0.0050	U
1,2-Dichloroethane	15	0.0050	U	0.0076	0.044	
1,2-Dichloroethene	15	0.0050	U	0.0063	0.019	
4-Methyl-2-pentanone	15	0.010	U	0.010	0.010	U

Table 58 (continued)

Parameter	Number of samples	Min	Value qualifier ^b	Av	Max	Value qualifier ^b
<i>Site characterization wells^e</i>						
<i>Upgradient wells</i>						
Anions, mg/L						
Chloride	7	1.0		2.2	5.6	
Fluoride-total	7	1.0	U	1.0	1.0	U
Nitrate (as N)	7	0.50	U	0.50	0.50	U
Phosphate	7	5.0	U	5.0	5.0	U
Sulfate (as SO ₄)	7	5.0	U	71	330	
Field measurements						
pH, standard units	49	4.7		7.1	8.5	
Conductivity, mS/cm	49	0.040		0.37	0.97	
Temperature, °C	49	12		15	18	
Metals, mg/L						
Aluminum-total	7	0.080		0.36	0.66	
Beryllium-total	7	0.00030	U	0.021	0.025	
Calcium-total	7	0.10	U	79	170	
Cobalt-total	7	0.0030	U	0.0030	0.0031	
Iron-dissolved	7	0.050	U	0.13	0.63	
Iron-total	7	0.050	U	0.54	1.3	
Magnesium-total	7	1.0		18	54	
Manganese-dissolved	7	0.010	U	0.010	0.010	U
Manganese-total	7	0.010	U	0.023	0.040	
Nickel-total	7	0.0050	U	0.011	0.020	
Silicon-total	7	5.1		8.3	14	

Table 58 (continued)

Parameter	Number of samples	Min	Value qualifier ^b	Av	Max	Value qualifier ^b
<i>Upgradient wells</i>						
Sodium-dissolved	7	0.68		7.8	18	
Sodium-total	7	0.69		7.4	19	
Strontium-total	7	0.0050	U	0.16	0.40	
Miscellaneous						
Alkalinity (as CaCO ₃)	7	7.5		200	430	
Fecal coliform, col/100 mL	7	1.0	U	1.0	1.0	U
Turbidity, NTU	7	0.075		2.6	6.6	
Pesticides, mg/L						
2,4-D	7	0.00020	U	0.0007	0.0016	
2,4,5-TP (Silvex)	7	0.00010	U	0.0001	0.00020	
Radioactivity measurements, Bq/L						
⁶⁰ Co	7	-0.020		0.051	0.10	
¹³⁷ Cs	7	-0.020		0.033	0.090	
Gross alpha	7	0.0010		0.030	0.090	
Gross beta	7	0.029		0.11	0.31	
Radioactive strontium-total ^{c,d}	6	-0.051		0.013	0.11	
Radium-total ^c	6	-0.011		0.033	0.15	
Tritium	7	-6.0		16	72	

III

Table 58 (continued)

Parameter	Number of samples	Min	Value qualifier ^b	Av	Max	Value qualifier ^b
<i>Upgradient wells</i>						
Extractable organics, mg/L						
Organic carbon-total	28	0.50	U	0.75	1.2	
Organic halides-total	28	0.0050	U	0.0051	0.0070	
Recoverable phenolics-total	7	0.0010	U	0.0010	0.0010	U
Volatile organics, mg/L						
Acetone	7	0.0030	JB	0.020	0.093	B
Benzene	7	0.0050	U	0.0050	0.0050	U
Carbon tetrachloride	7	0.0050	U	0.0050	0.0050	U
Chloroform	7	0.0050	U	0.0050	0.0050	U
Chloromethane	7	0.010	U	0.010	0.010	U
Methylene chloride	7	0.00080	JB	0.0011	0.0020	JB
Tetrachloroethene	7	0.0030	J	0.0047	0.0050	U
Toluene	7	0.0050	U	0.0050	0.0050	U
Trichloroethene	7	0.0050	U	0.0050	0.0050	U

Table 58 (continued)

Parameter	Number of samples	Min	Value qualifier ^b	Av	Max	Value qualifier ^b
<i>Upgradient wells</i>						
1,1-Dichloroethane	7	0.0050	U	0.0050	0.0050	U
1,1,1-Trichloroethane	7	0.0050	U	0.0050	0.0050	U
1,2-Dichloroethane	7	0.0050	U	0.0050	0.0050	U
1,2-Dichloroethene	7	0.0050	U	0.0050	0.0050	U
4-Methyl-2-pentanone	7	0.0020	J	0.0089	0.010	U

^aSee Fig. 14.

^bOrganics: U = undetected; B = present in blank; J = below detection limit, but estimated; E = concentration exceeds the calibration range of the instrument. Inorganics: U = undetected; B = value < contract required detection limit > instrument detection limit; E = value is estimated because of the presence of interference.

^cSamples from wells 832, 844, and 860 were collected earlier than all other well samples in WAG 6 because EPA wanted split samples to analyze simultaneously. Gross radioactivities were measured to ensure that there was no contamination present before sending the samples offsite. As a result, isotopic analyses for radioactive strontium-total and radium-total were not performed on these wells.

^dRadioactive strontium-total (⁸⁹Sr + ⁹⁰Sr).

^eSamples from the site characterization wells were collected and analyzed by the RI/FS subcontractor. Results of these analyses were not available at the time of publication of this report and will be published later.

Table 59. Groundwater sample analyses from monitoring wells in WAG 6,^a
 April-June 1989, whose values exceeded allowable concentrations
 under the primary drinking water standards^b

Well identifier	Parameter	Concentration	Primary limit ^{c,d}	Units of measurement
<i>Perimeter wells</i>				
842	Carbon tetrachloride	0.082	0.0050	mG/L
838	Fecal coliform	50	1.0	col/100 mL
842	Trichloroethene	0.49	0.0050	mG/L
843	Tritium	28,000	740	Bq/L
842	Tritium	17,000	740	Bq/L
841	Tritium	8,000	740	Bq/L
847	Tritium	3,000	740	Bq/L
844	Tritium	2,400	740	Bq/L
839	Tritium	980	740	Bq/L
835	Tritium	970	740	Bq/L
842	1,2-Dichloroethane	0.044	0.0050	mG/L

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^aSee Fig. 14.

^bStandards are based on State of Tennessee Hazardous Waste Groundwater Regulations or EPA Federal Drinking Water Standards where no state standard exists.

^cSafe Drinking Water Act-National Primary Drinking Water Regulations, 40 CFR 141, as amended.

^dState of Tennessee Hazardous Waste Regulations TN 1200-1-11-05, Appendix 05/B.

Exceedances of the primary drinking water standard at WAG 6 are summarized in Table 59. Seven perimeter wells from WAG 6 had tritium exceedances of the primary drinking water limit during this quarter. Tritium concentrations at wells 842 and 843 were by far the highest of the perimeter wells. One perimeter well contained organics in excess of the EPA primary drinking water standards. Well 842 exceeded the standards for carbon tetrachloride, trichloroethene, and 1,2-dichloroethane, a breakdown product of trichloroethene. Well 841, a deeper well immediately adjacent to well 842 did not exceed the standard for any of these organics. Well 838, with a level of 50 colonies per 100 mL, exceeded the level for coliform.

No exceedances of the EPA primary drinking water limits were noted in any of the upgradient wells.

4. METEOROLOGICAL PROCESSES

Meteorological processes are continuously monitored at ORNL so that current weather conditions may be taken into account, as needed, in response to emergencies that may arise. Weather records are also kept for climatological studies and for supportive information in hydrologic modeling and monitoring, facility design, scheduling of construction activities, and interpretation of nonmeteorological data (e.g., total suspended solids in surface water) that may depend on recent weather conditions.

4.1 PRECIPITATION

Monthly precipitation totals for several sites are averaged to obtain representative monthly values for ORNL and the surrounding area. The stations included are indicated by three-character identifiers on the location map in Fig. 15. These stations provide data for climatological studies. Most of the other sites in Fig. 15 are represented by five-character identifiers, with the last two digits identifying the air monitoring station at which each gauge is located. Precipitation gauges located at the air monitoring stations report real-time data for short-term studies and emergency response situations. Much of the data summarized in this report comes from the precipitation measuring network of the Environmental Sciences Division of ORNL. In addition, the Atmospheric Turbulence and Diffusion Division (ATDD) of the National Oceanic and Atmospheric Administration (NOAA) maintains a weather station in the city of Oak Ridge (Illinois Avenue). Observations have been made at that station for a long enough period to provide 30-year (1951 through 1980) normals for comparison with amounts for the current year. Table 60 shows the total precipitation at ATDD and departure from ATDD long-term normal, along with the ORNL representative value, for each of the first 6 months of 1989.

4.2 WIND

The ORNL wind tower network consists of towers A and B, each with sensors mounted at 10 and 30 m, and tower C with sensors mounted at 10, 30, and 100 m. Locations of these towers are shown in Fig. 16. 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 vector averages of wind velocity are calculated in the conventional way and retained for 24-h. These velocities are processed into 15-min averages using a procedure that avoids the unrealistically low windspeed values obtained when appreciable winds of nearly opposite direction are vector averaged in the conventional way. This alternative averaging procedure involves calculating the mean (scalar) windspeed and multiplying it by a unit vector having the same direction as the conventionally calculated vector sum of the individual velocities. A similar calculation is used to convert the 15-min averages into hourly averages. The 15-min averages are retained for 1 day, and the hourly averages, from which wind roses in Figs. 17 through 23 are obtained, are stored for at least 1 year and eventually archived.

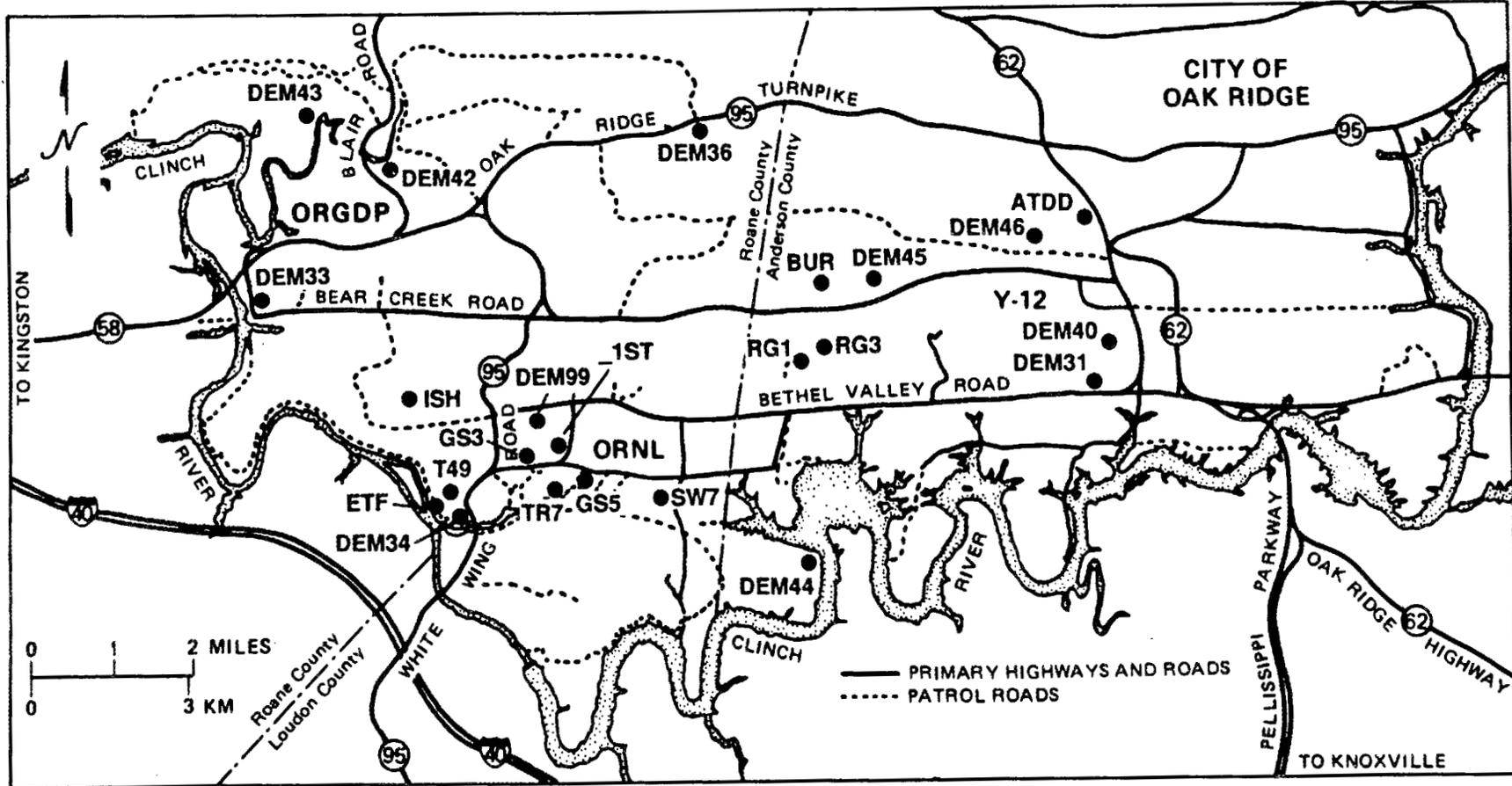


Fig. 15. Location map of precipitation gauges on or near the Oak Ridge Reservation.

Table 60. Precipitation for ORNL and nearby sites,^a January-June 1989

Month	Number of sites reporting	Precipitation (mm)		
		ORNL average ^b	ATDD	ATDD departure from normal
January	12	170	180	+43
February	12	140	130	+12
March	12	120	150	-4.6
April	10	63	70	-42
May	10	160	160	+48
June	10	240	280	+170

^aORNL data are stored in the ORNL Remedial Action Program data base; Larry Vorhees, Coordinator, 574-7309.

^bAverage of ORNL and United States Geological Service (USGS) sites reporting for each month; ATDD not included.

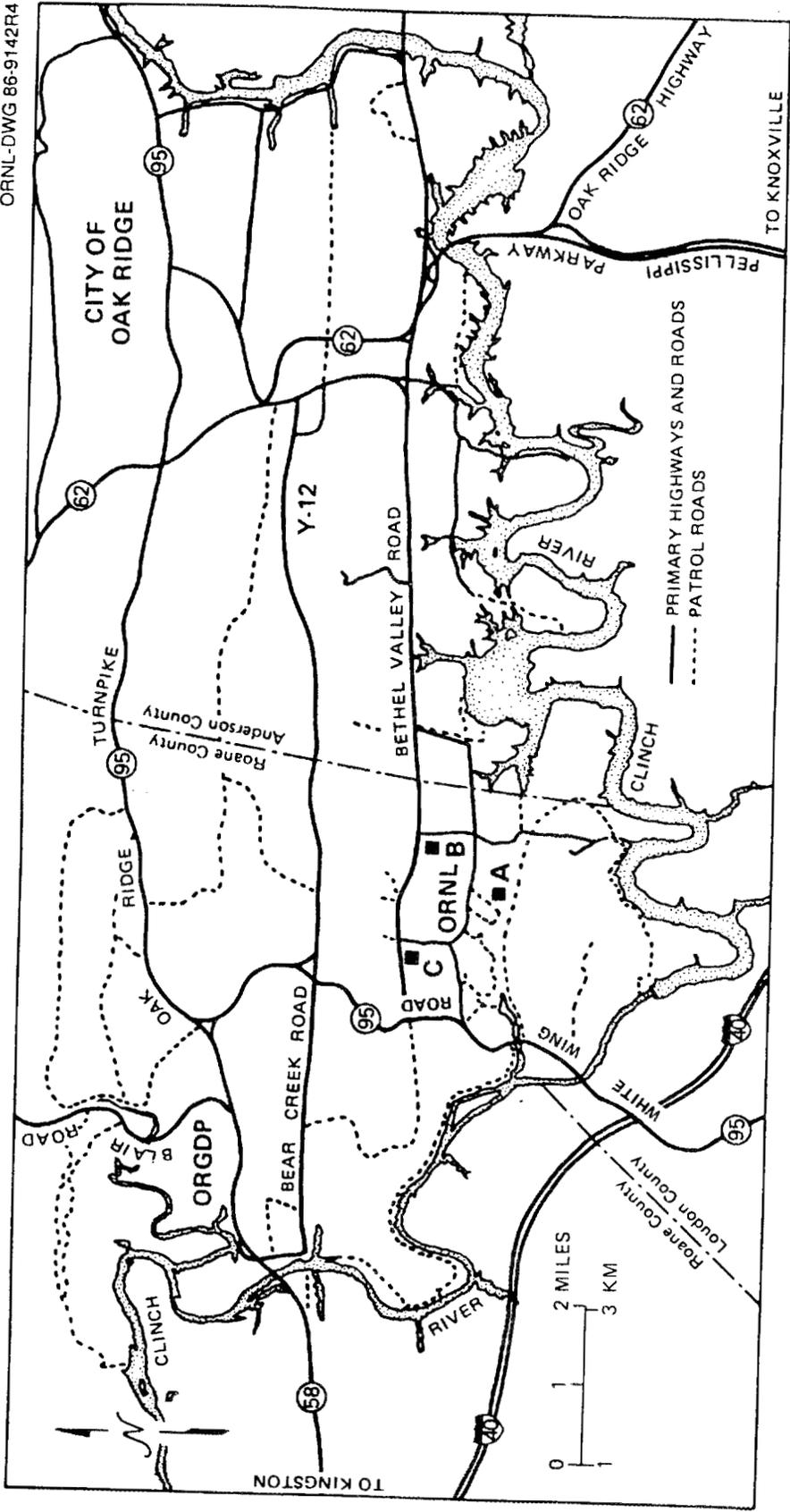


Fig. 16. Location map of meteorological towers at ORNL.

with 73.6% of possible data

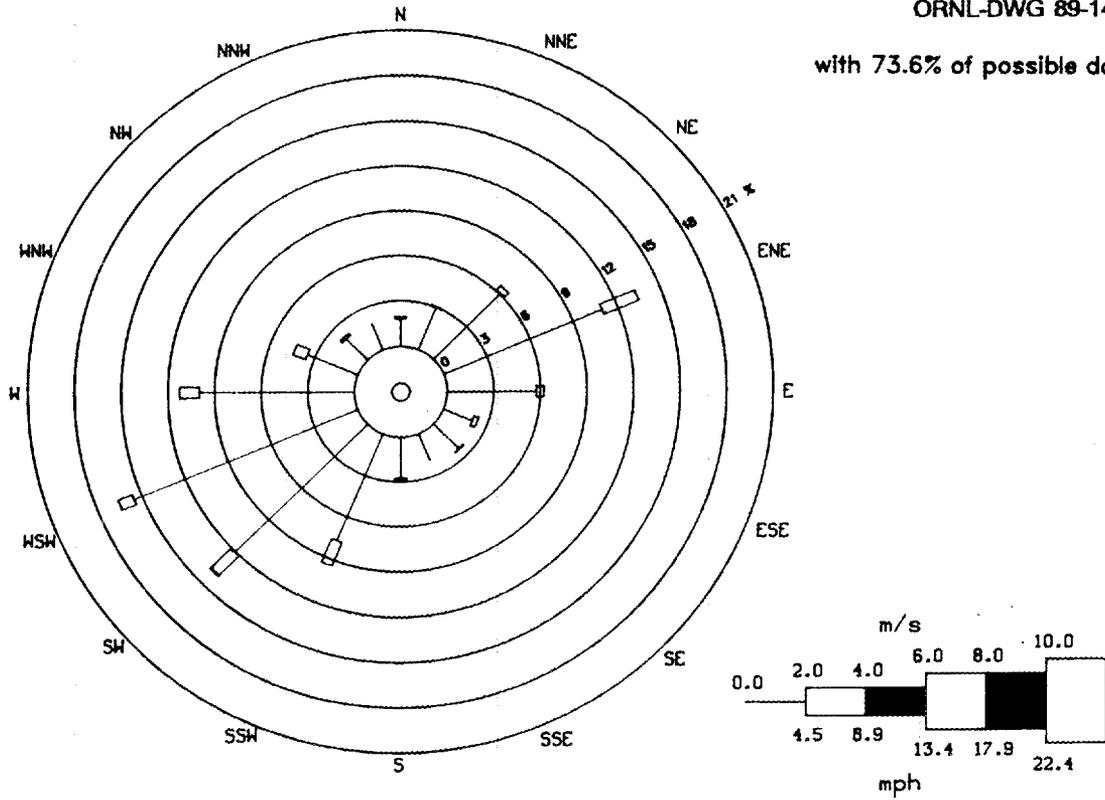


Fig. 17. Wind rose at 10-m level of meteorological tower A, April-June 1989.

with 75.0% of possible data

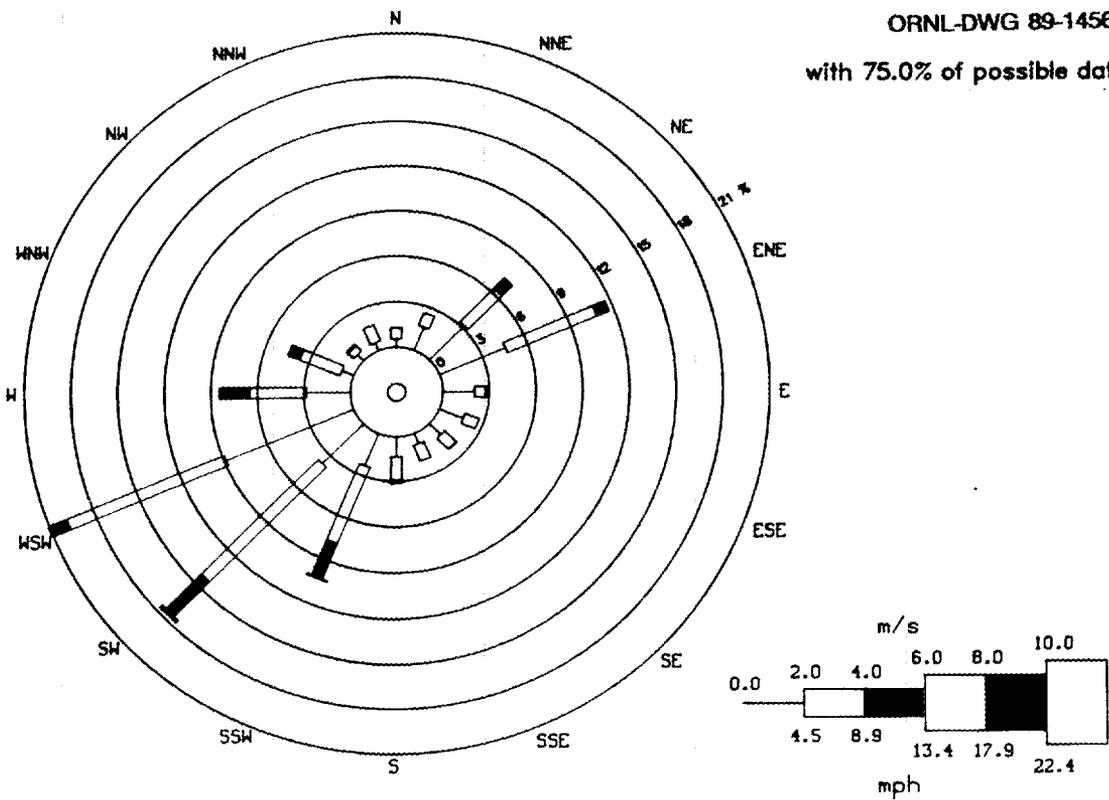


Fig. 18. Wind rose at 30-m level of meteorological tower A, April-June 1989.

ORNL-DWG 89-14561

with 75.0% of possible data

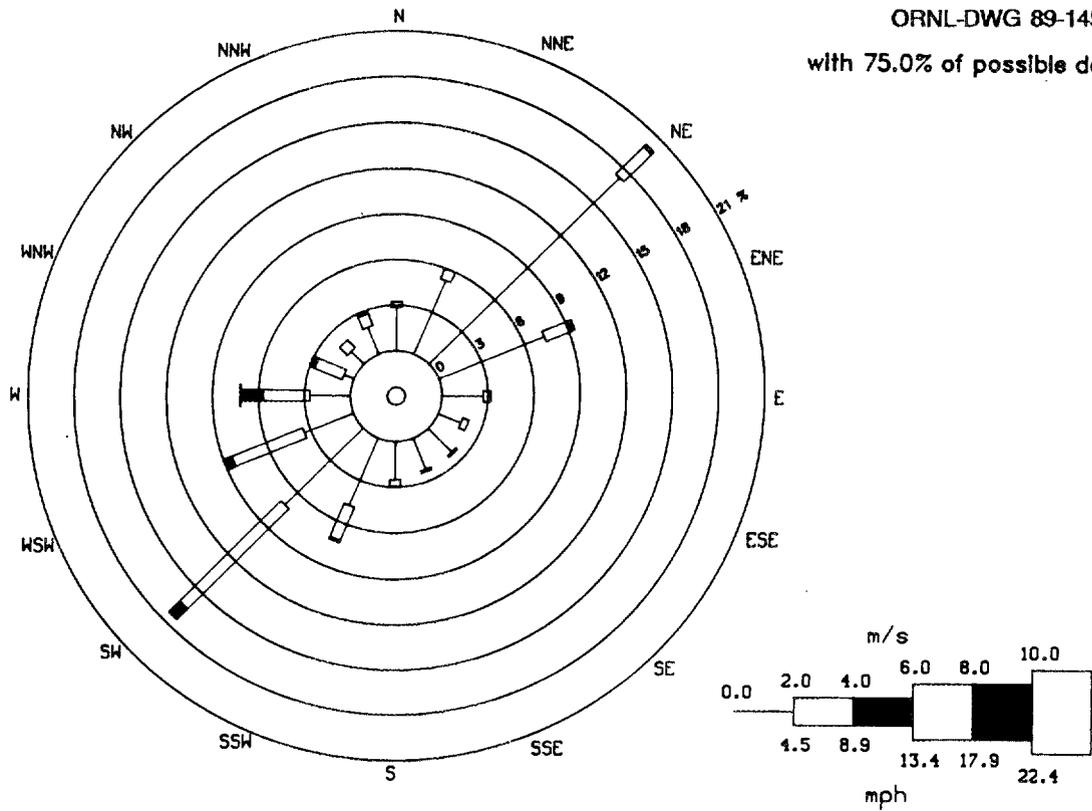


Fig. 19. Wind rose at 10-m level of meteorological tower B, April-June 1989.

ORNL-DWG 89-14562

with 75.0% of possible data

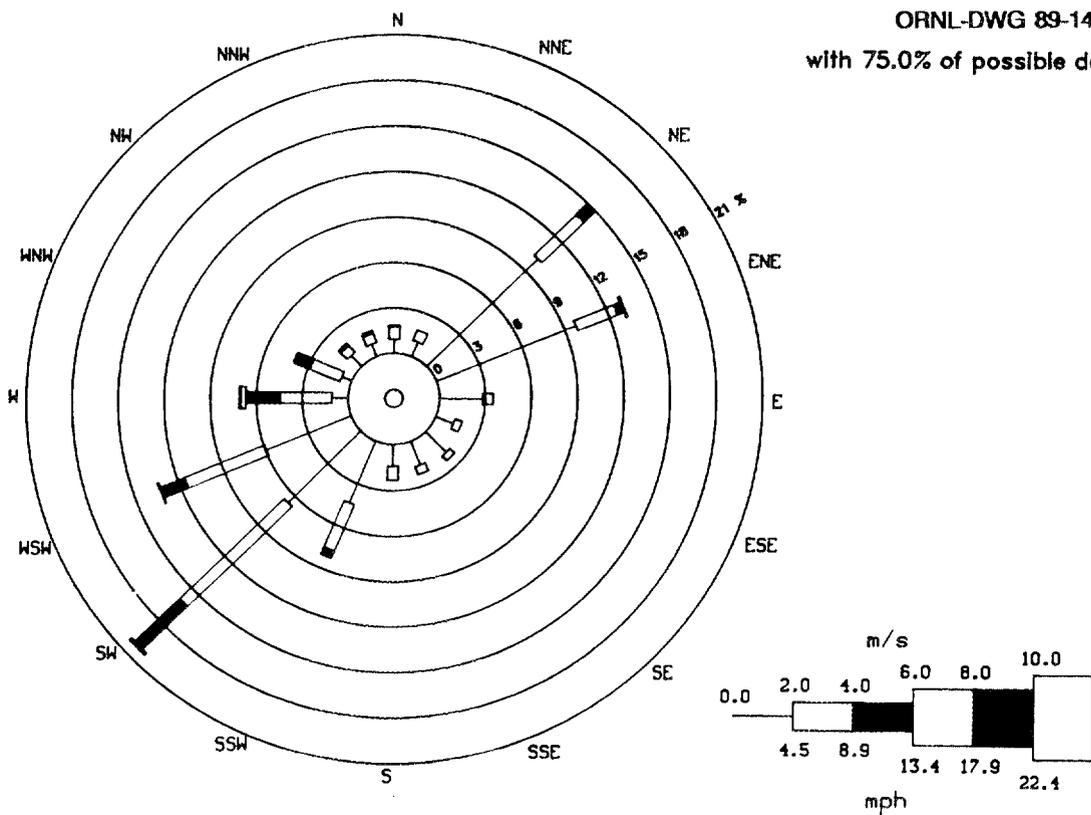


Fig. 20. Wind rose at 30-m level of meteorological tower B, April-June 1989.

ORNL-DWG 89-14563

with 61.2% of possible data

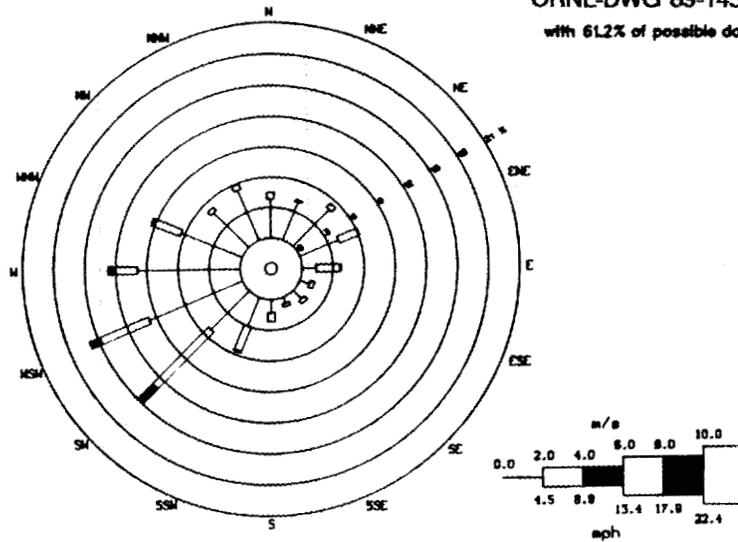


Fig. 21. Wind rose at 10-m level of meteorological tower C, April-June 1989.

ORNL-DWG 89-14564

with 60.8% of possible data

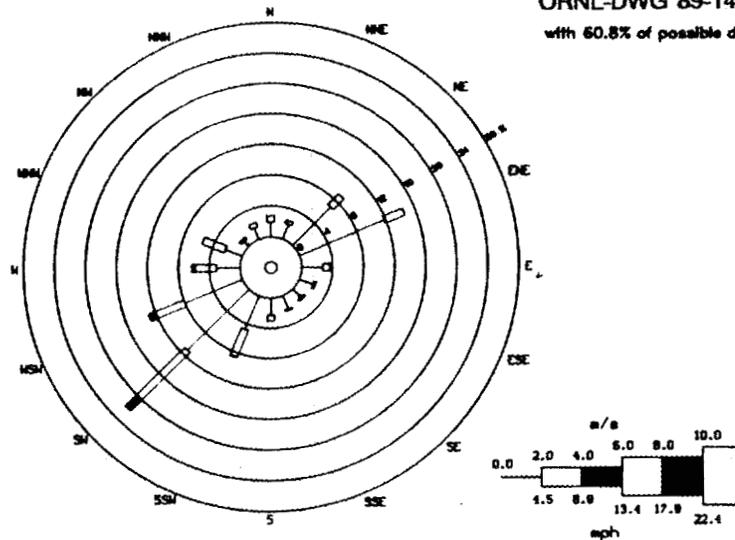


Fig. 22. Wind rose at 30-m level of meteorological tower C, April-June 1989.

ORNL-DWG 89-14565

with 66.2% of possible data

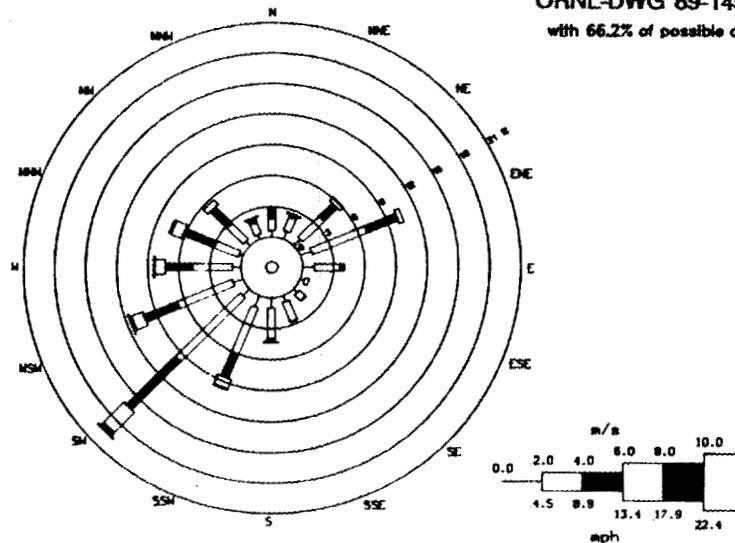


Fig. 23. Wind rose at 100-m level of meteorological tower C, April-June 1989.

Examination of quarterly wind roses 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 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. This channeling effect is least evident at 100-m elevation, where the winds are more south-southwesterly. 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 m.

5. BIOLOGICAL MONITORING

The environmental surveillance programs include biotic and abiotic environments that may be affected by the releases from the Oak Ridge DOE facilities or may provide pathways of exposure to people. Biological monitoring consists of milk and fish samples that are analyzed for radionuclides and nonradioactive chemicals.

Milk is a potentially significant pathway for the transfer of radionuclides from the point of release to humans because of the relatively large surface area that can be grazed daily by the cow, the rapid transfer of milk from producer to consumer, and the importance of milk in the diet. Strontium-90 and ^{131}I are radionuclides that are especially important in this atmosphere to pasture to cow to milk food chain.

Ingestion of fish is also a pathway for contaminant uptake in man. Bluegill are collected for tissue analysis to estimate concentrations for dose assessment models. Bluegill are selected for analysis because of the relatively high concentrations of radionuclides, PCBs, and mercury that have been measured in their tissue compared with several other types of fish.

5.1 MILK

Measured average concentrations of total radioactive Sr (assuming 100% ^{90}Sr) and ^{131}I in milk from each location were used to calculate the potential 50-year committed effective dose equivalents given in Tables 61 and 62. This calculation is based on the assumption that 1 L/day of milk is ingested of these concentrations for 365 days. Doses resulting from ingestion of milk were less than 1% of the DOE guideline of 1000 μSv .

Raw milk from four locations, including one dairy, within a radius of 80 km of Oak Ridge, is monitored for ^{131}I and total radioactive strontium. Samples were collected biweekly during April and collected monthly during May and June from the stations located near Oak Ridge (Fig. 24). Samples were not collected at the Solway station because the sample source (a cow) was pregnant. Samples are analyzed for ^{131}I by gamma spectroscopy and for total radioactive strontium by chemical separation and low-level beta counting.

Instrument background values are subtracted from the measured values of ^{131}I in milk samples, and actual results are reported. Values of ^{131}I for the second quarter were often less than instrument background, as is indicated by negative values in Table 61. The average concentration of ^{131}I at the stations in the immediate Oak Ridge area was 0.011 Bq/L.

Concentrations of total radioactive strontium are shown in Table 62. The average concentration of total radioactive strontium at the stations in the immediate Oak Ridge area was 0.16 Bq/L.

Table 61. Concentrations of ^{131}I in milk and calculated doses,^a
April-June 1989

Station	Number of samples	Concentration (Bq/L)			Standard error ^b	Dose (μSv) ^c
		Max	Min	Av		
<i>Immediate Environs^d</i>						
1	4	0.070	0.010	0.038	0.014	0.19
2	4	0.020	-0.040	-0.010	0.012	0
3	4	0.040	-0.010	0.015	0.010	0.075
4	4	0.020	-0.020	0	0.0091	0
Network summary	16	0.070	-0.040	0.011	0.0069	0.053

^aRaw milk samples; station 2 is a dairy.

^bStandard error of the mean.

^cPotential 50-year committed effective dose equivalents from drinking 365 L of milk per year using average radionuclide concentrations at each location.

^dSee Fig. 24.

Table 62. Concentrations of total radioactive strontium in milk and calculated doses,^a April-June 1989

Station	Number of samples	Concentration (Bq/L)			Standard error ^b	Dose (μ Sv) ^c
		Max	Min	Av		
<i>Immediate Environs^d</i>						
1	4	0.38	0.10	0.18	0.067	2.3
2	4	0.27	0.10	0.16	0.037	2.1
3	4	0.18	0.080	0.12	0.022	1.5
4	4	0.21	0.15	0.17	0.014	2.2
Network summary	16	0.38	0.080	0.16	0.019	2.0

^aRaw milk samples; station 2 is a dairy.

^bStandard error of the mean.

^cPotential 50-year committed effective dose equivalents from drinking 365 L of milk per year using average radionuclide concentrations at each location. All strontium is assumed to be ⁹⁰Sr.

^dSee Fig. 24

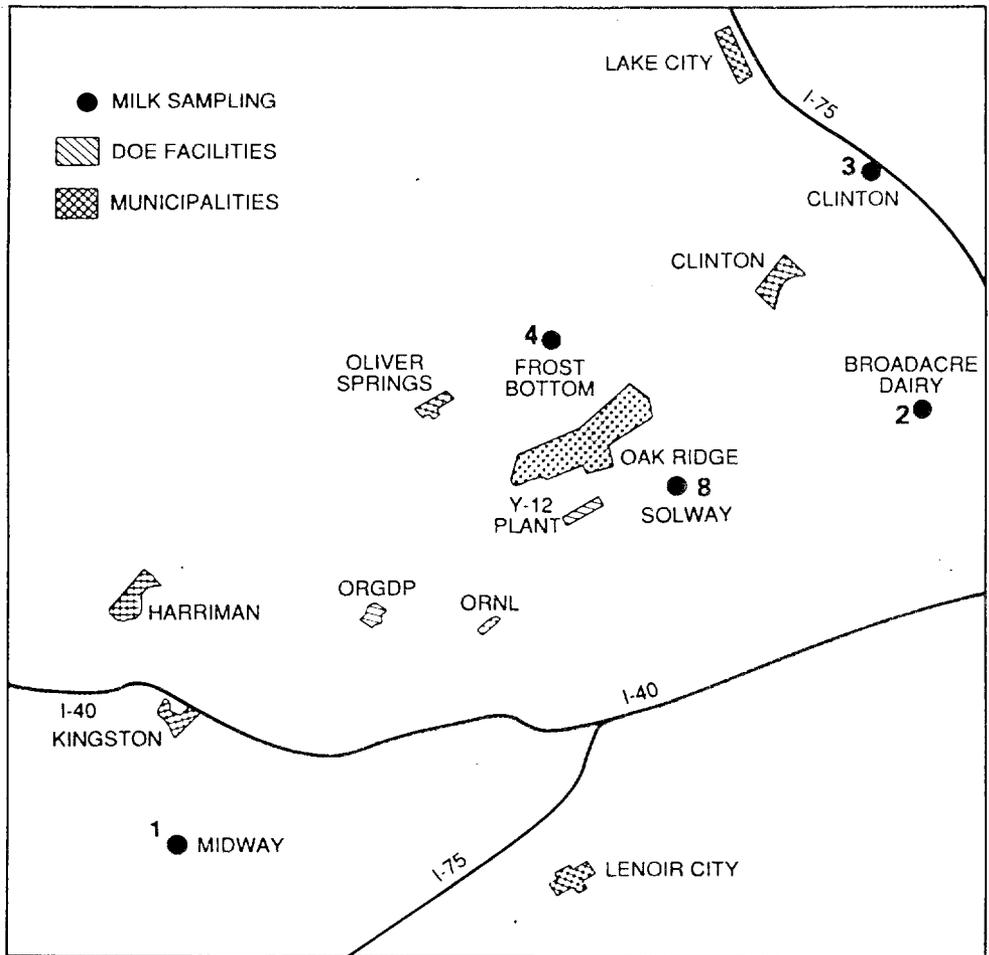


Fig. 24. Location map of milk sampling stations near the Oak Ridge facilities.

5.2 FISH

Bluegill from three Clinch River locations were collected during this quarter for tissue analyses of radionuclides, mercury, and PCBs (Fig. 25). Sampling is performed semiannually. The last sampling was reported in the fourth quarter of 1988. Sampling locations include the following Clinch River kilometers (CRK): (1) 40.0, which is above Melton Hill Dam and most of the Oak Ridge DOE facilities outfalls, serves as a background location; (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 Oak Ridge Gaseous Diffusion Plant (ORGDP).

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

Average mercury concentrations in fish from each of the three locations were not significantly different from the fourth quarter of 1988. Concentrations of mercury are shown in Table 63. The average concentration of mercury in fish were less than or equal to 15% of the FDA's action level of $1.0 \mu\text{g/g}$ wet weight.

The concentrations of PCBs in fish during the second quarter of 1989 were not significantly different from those measured during the fourth quarter of 1988. Concentrations of PCBs are shown in Table 64. All concentrations of PCBs (individual types and the sum) were less than 5% of the FDA's tolerance level of $2.0 \mu\text{g/g}$ wet weight for fish.

Summary statistics of radionuclides found in bluegill during the second quarter of 1989 are given in Table 65. Concentrations of ^{60}Co are highest at CRK 8.0 (0.18 Bq/kg). Concentrations of ^{137}Cs are highest at CRK 33.3 (4.5 Bq/kg). Concentrations of total radioactive Sr are highest at CRK 33.3 (0.62 Bq/kg). Radionuclide concentrations in bluegill during the second quarter are generally comparable to concentrations from the fourth quarter of 1988 (one exception being that possibly the labels on the vials for CRK 8.0 and CRK 40.0 were switched in the lab for the sampling date of November 1988). In tracking the samples through the analytical laboratory, we verified that the reported results matched the chain-of-custody and analytical request forms. We suspect that the samples were inadvertently switched during their preparation, prior to submission to the analytical laboratory.

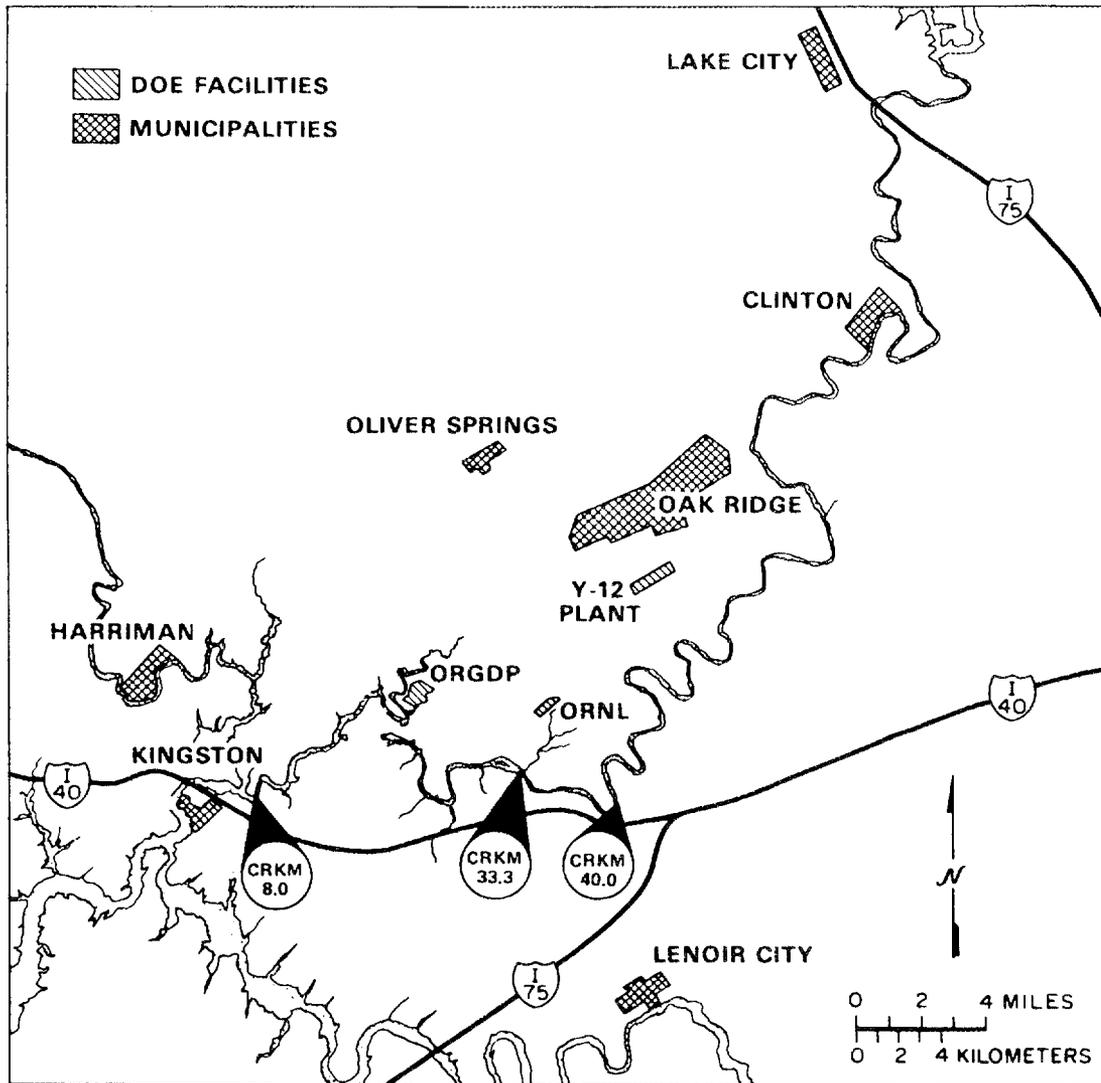


Fig. 25. Location map of fish sampling points.

Table 63. Mercury concentrations in Clinch River bluegill, April-June 1989

Location ^a	Number of fish sampled	Concentration ($\mu\text{g/g}$ wet wt)			Standard error ^b	Percentage of action level ^c
		Max	Min	Av		
CRK 8.0	6	0.35	0.070	0.15	0.044	15
CRK 33.3	6	0.13	0.030	0.057	0.016	5.7
CRK 40.0	6	0.040	0.020	0.028	0.0040	2.8

^aSee Fig. 25.

^bStandard error of the mean.

^cPercentage of the Food and Drug Administration action level of mercury in fish (1.0 $\mu\text{g/g}$) for the average concentration.

Table 64. PCB concentrations in Clinch River bluegill, April-June 1989

Location ^a	PCB type	Number of fish sampled	Concentration ($\mu\text{g/g}$ wet wt)			Standard error ^b	Percentage of tolerance ^c
			Max	Min	Av		
CRK 8.0	1254	6	0.03	0.01	0.025	0.0034	1.3
	1260	6	0.02	<0.01	<0.012	0.0017	0.58
CRK 33.3	1254	6	0.02	0.01	0.013	0.0021	0.67
	1260	6	0.02	<0.01	<0.012	0.0017	0.58
CRK 40.0	1254	6	0.01	<0.01	<0.010	0	0.50
	1260	6	0.01	<0.01	<0.010	0	0.50

^aSee Fig. 25.

^bStandard error of the mean.

^cPercentage of the Food and Drug Administration tolerance for PCBs in fish (2 $\mu\text{g/g}$ wet wt) for the average.

Table 65. Radionuclide concentrations in Clinch River bluegill, April-June 1989

Location ^a	Radionuclide	Number of samples ^b	Concentration (Bq/kg wet wt)			Standard error ^c
			Max	Min	Av	
CRK 8.0	⁶⁰ Co	3	0.23	0.13	0.18	0.030
	¹³⁷ Cs	3	2.0	1.7	1.9	0.092
	Total Sr ^d	3	0.16	0.012	0.11	0.049
CRK 33.3	⁶⁰ Co	3	0.17	0.035	0.10	0.038
	¹³⁷ Cs	3	6.5	1.5	4.5	1.5
	Total Sr ^d	3	0.83	0.22	0.62	0.20
CRK 40.0	⁶⁰ Co	3	0.072	-0.037	0.022	0.032
	¹³⁷ Cs	3	0.34	0.12	0.23	0.063
	Total Sr ^d	3	0.75	-0.0074	0.34	0.22

^aSee Fig. 25.

^bA sample is a composite of 6 to 10 fish.

^cStandard error of the mean.

^dTotal radioactive Sr (⁸⁹Sr and ⁹⁰Sr).

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