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ENVIRONMENTAL SURVEILLANCE DATA REPORT FOR
THE FIRST QUARTER OF 1992

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LIST OF ACRONYMS AND ABBREVIATIONS

BMP	Best management practice
CAA	Clean Air Act
CFR	Code of Federal Regulations
CWA	Clean Water Act
CYRTF	Coal Yard Runoff Treatment Facility
DCG	derived concentration guide
DOE	U.S. Department of Energy
DWL	drinking water limit
DWS	drinking water standard
EPA	Environmental Protection Agency
EC	Environmental Compliance Section of OECD
ESP	Environmental Surveillance and Protection Section of OECD
ICP	inductively coupled plasma
MB	Melton Branch
MHD	Melton Hill Dam
N det	Number of detected samples
N total	Total number of samples
NESHAP	National Emission Standards for Hazardous Air Pollutants
NPDES	National Pollutant Discharge Elimination System
NRWTF	Nonradiological Wastewater Treatment Facility
NWT	Northwest Tributary
OECD	Office of Environmental Compliance and Documentation
ORNL	Oak Ridge National Laboratory
ORR	Oak Ridge Reservation
PAM	Perimeter Air Monitoring
PCB	polychlorinated biphenyl
PWTP	Process Waste Treatment Plant
QA/QC	Quality assurance/Quality control
RCRA	Resource Conservation and Recovery Act
SAS	SAS Institute, Inc.
STP	Sewage Treatment Plant
SWMU	Solid Waste Management Unit
SWSA	Solid Waste Storage Area
TDEC	Tennessee Department of Environment and Conservation
Total rad Sr	Total radioactive strontium (Sr-89 + Sr-90)
WAG	Waste Area Grouping
WOC	White Oak Creek
WOD	White Oak Dam
WOL	White Oak Lake

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1.0 INTRODUCTION

The Environmental Surveillance and Protection Section within the Office of Environmental Compliance and Documentation 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) reporting requirements to quantitatively demonstrate 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 DOE directives and to provide a continuity of data on environmental media at unregulated locations. The major legislation affecting the environmental programs that assess off-site impacts of the DOE facilities includes the Clean Water Act, the Clean Air Act, the Resource Conservation and Recovery Act, and the Superfund Amendments and Reauthorization Act. 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 Order 5400.5, "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 the "Environmental Regulatory Guide for Radiological Effluent Monitoring and Environmental Surveillance (the Regulatory Guide)" DOE/EH-0173T.

Environmental monitoring, as defined by the Regulatory Guide, 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 measurements of air, water, soil, foodstuff, biota, and other media from DOE sites and their environs.

Monthly or quarterly summaries are presented in this report for each medium sampled. All data are rounded to two significant digits. The summary tables generally give the number of samples collected during the period and the maximum, minimum, average, and standard error of the mean (SE) values of parameters for which determinations were made. The SE is based upon 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 DOE Order 5400.5. These concentration guides were established for drinking water and inhaled air and are guidelines for the protection of the public. DOE Order 5400.5 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, submersion) for one year, a "reference man" would receive the most restrictive of (1) an effective dose equivalent of 100 mrem or (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 DCG is less than 0.01%, the percent is reported as "<0.01." When total radioactive strontium is measured, it is compared to the DCG for Sr-90, which is the most restrictive value.

Radioactivity measurements are reported as the net activity, or 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. Results that include the negative values can be evaluated statistically without incurring the difficulties associated with performing calculations on "less than" (<) values. Radiation measurements are reported in units of becquerel (Bq). A Bq is a Systeme Internationale (SI) unit equivalent to one disintegration per second.

Single measurement values and multiple value summaries are tested for their difference from zero using the standard normal distribution (z value) or the t distribution (t value) and a one-tailed test with 95% confidence level. Occasionally, the result will be declared as different from zero by the statistical test when in fact it is not. The frequency of this error is directly related to the confidence level of the test. With a specified 95% confidence level there is a 5% error rate, wrongly declaring a result greater than zero 5% of the time. This is a commonly used confidence level that represents a compromise between incorrectly declaring that a value is greater than zero and incorrectly declaring that a value is equal to zero.

The lower confidence limit for a single radioactivity measurement is computed by multiplying the counting standard deviation by 1.645 (z value for a one-tailed test at a 95% confidence level) and subtracting that from the sample result. If that difference is equal to or greater than zero, the result is said to be significantly greater than zero. Otherwise it is said to be not significantly greater than zero.

Multiple value summaries are of two types: averages and sums. An average is tested for difference from zero using the standard error of the mean and the appropriate t value with n-1 degrees of freedom. All sources of variation, counting uncertainty in the case of radionuclide measurements, laboratory preparation, sampling variance and population variation, are inherently

estimated by the calculated standard error used in this test. As a result, inference is on the whole process that generated the measurements. Sums of radioactivity measurements are test for difference from zero using only the propagated counting uncertainties. The 95% lower bound on the sum is the calculated sum minus 1.645 times the square root of the summed counting variances. Estimates of the sampling and population variability are not available in this situation. As a result, inference is on the observed sum, not on an underlying population from which the observations were taken.

Presentations of radioactivity data throughout the report follow the convention of flagging data that are statistically significant with an * (asterisk). Data that are not significantly different from zero are presented without a flag.

Chemical (nonradionuclide) results that are below the analytical detection limit are expressed as "less than" (<) or as "undetected" (U) values. The average value is expressed with a ~ (tilde) when at least one of the results used for the average is less than the detection limit.

2.0 AIR

The Department of Energy (DOE) Oak Ridge facilities are subject to regulations issued by the Tennessee Department Environment Conservation (TDEC) Air Pollution Control Board and the Environmental Protection Agency (EPA) as well as DOE orders. Nonradioactive emission sources are regulated by TDEC, and radioactive emission sources are regulated by EPA under the National Emission Standards for Hazardous Air Pollutants (NESHAP). The authority for these regulations is derived from the Tennessee Air Quality Control Act (TAQC) and the Clean Air Act (CAA).

The TDEC air pollution control rules regulate pollution sources to protect the public health and welfare and the environment. These rules include regulations for maximum allowable ambient air concentrations of certain pollutants, open burning, pollution sources such as coal-fired boilers and processes, fugitive emission sources, performance standards for new sources, and hazardous air pollutants. State-issued permits are required for air pollution sources with the exception of certain very small emission sources that are specifically exempt from permit requirements.

The EPA rules for radioactive emission sources limit the amount of exposure to radioactivity to the nearest or the most affected member of the public. The EPA sets the limit on exposure to radioactivity by first determining (1) a safe exposure level and (2) then adding a margin of safety. The dose, to the most affected member of the public, is determined by EPA-approved radioactive emissions dose modeling. The NESHAP regulations were reissued in December 1989. The ORR is currently not in compliance with the stack sampling criteria. A Federal Facility Compliance Agreement (FFCA) was signed in May 1992 by the DOE field office manager and is being implemented to achieve full compliance by December 1992.

DOE regulations governing airborne emissions are established in DOE orders 5400.1 and 5400.5 and DOE/ESH-0173T. Using the criteria in NESHAP regulations and DOE orders, major effluent sources are defined as emission points with the potential to discharge radionuclides in quantities that could cause an annual effective dose equivalent of 0.1 mrem/year or greater to a member of the public. Potential emissions are calculated for a source by assuming the loss of pollution control equipment while the source is otherwise operating normally.

ORNL has a comprehensive air pollution control and monitoring program to ensure that airborne discharges meet regulatory requirements and do not adversely affect ambient air quality. Air pollution controls include exhaust gas scrubbers, baghouses, and exhaust filtration systems designed to remove airborne pollution from the exhaust gases before their release to the atmosphere. Process modifications and material substitutions are also made in an effort to minimize air emissions. In addition, administrative controls play a role in regulating emissions. ORNL has developed an emissions inventory program that includes stack sampling to determine the amounts of pollutants that are not removed by the air

pollution control equipment. (Ambient air monitoring is also conducted around the facilities and at three locations within surrounding East Tennessee communities to assess the impacts of ORR operations on the ambient air quality of the region.)

2.1 AIRBORNE EMISSIONS

Laurice V. Hamilton and Betsy M. Horwedel

2.1.1 Program Description

The major gaseous emission point sources for ORNL consist of the following four stacks located in Bethel and Melton Valleys:

Building	Description
2026	High Radiation Level Analytical Laboratory
3020	Radiochemical Processing Plant
3039	3500 and 4500 areas cell ventilation system Central off-gas and scrubber system Isotope solid state ventilation system
7911	3025 and 3026 areas cell ventilation system Melton Valley complex (High Flux Isotope Reactor, Radiochemical Engineering Development Center)

Fig. 1 shows the locations of the four main stacks whose emissions are routinely quantified.

Discharges from each stack are unique because of the wide variety of research activities performed at ORNL. Radiological emissions from ORNL typically consist of particulates, adsorbable gases (e.g., iodine), tritium, and nonabsorbable gases (e.g., xenon).

Gaseous effluents at ORNL originate from ventilation air from contaminated or potentially contaminated areas, vents from tanks and processes, and ventilation for reactor facilities. Many sources, mostly nonradioactive, are permitted by the TDEC Air Pollution Control Board. Most gaseous emissions are treated and filtered before discharge to the atmosphere. Typically, contaminated and potentially contaminated gaseous wastes are treated, then filtered with HEPA and/or charcoal filters before discharge to ensure that any radioactivity released is within acceptable levels.

2.1.2 Procedures and Results

Sampling systems are being upgraded to meet the criteria in NESHAP regulations and DOE orders and will be completed by September 30, 1992. In general the present sampling systems consist of in-stack sampling probes, sample transport lines, a particulate filter, an activated charcoal canister, a silica-gel tritium trap,

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flow measurement and totalizing instruments, a sampling pump, and a sample return line to the stack. The present sampling systems at stacks 2026 and 3020 do not have tritium traps.

Due to major program changes, data for 1st quarter will be presented in a future report.

2.2 AMBIENT AIR

Laurice V. Hamilton and Betsy M. Horwedel

2.2.1 Program Description

The objectives for the ambient program are (1) to sample at stations that were most likely to show impacts of airborne emissions from the operation of ORNL, (2) to maintain surveillance of airborne radionuclides at the ORR perimeter, and (3) to collect reference data from remote locations. Figs. 2-4 show the stations that are in the ORNL Ambient Air Program. The specific stations associated with each of these objectives are as follows:

Fig. 2. The ORNL Perimeter Air Monitoring (PAM) network includes stations 1, 2, 3, and 7.

Fig. 3. The DOE ORR PAM network includes stations 35, 39, 37, 38, 46, 40, 48, and 42.

Fig. 4. The Remote Air Monitoring (RAM) network consists of stations 52 and 58.

Annual composites of particulate air filters from each station are analyzed for specific radionuclides. Annual compositing of the particulate air filters for analysis of long-lived isotopes has been adopted because the data from previous years showed very low concentrations of these radionuclides. Stations 3 and 48 are equipped with tritium collection systems. Airborne radioactive particulates are sampled biweekly by pumping a continuous flow of air through a 47-mm (1.88-in.) diameter paper filter. Airborne adsorbable gases are collected biweekly (at ORNL PAM stations only) using a canister containing activated charcoal that is downstream of the particulate filter. The charcoal canister is analyzed within 24 hours after collection. The initial and final dates, time on and off, and flow rates are recorded when a sample medium is mounted or removed. The total volume of air that flowed through the sampler is obtained from a flow totalizer, with the exception of tritium. The concentration of radionuclides in air is calculated by dividing the total activity per sample by the total volume of air sampled.

Data summaries for isotopic identification of particulates on the air filters will be included in the 4th Quarter Report.

The sampling system is currently being upgraded. Tritium samplers will be installed at all sampling locations. In addition, hi-volume air samplers will

ORR-018

Fig. 2. ORNL perimeter monitoring locations.

Fig. 3. ORR perimeter monitoring locations.

099-017

ORNL-DWG 92-15485

Fig. 4. ORR remote air monitoring locations.

be used at all ORR locations. These new samplers will provide a more concentrated particulate sample which will allow for better quantification of each isotope with more frequent analysis.

2.2.2 Procedures and Results

Concentrations of atmospheric I-131 and atmospheric tritium for first quarter are summarized in Tables 1 and 2.

2.3 EXTERNAL GAMMA RADIATION

Laurice Hamilton and Betsy Horwedel

2.3.1 Program Description

Until February 1992, external gamma radiation measurements (exposure rates) were recorded on a near real-time data acquisition system at ORNL and reservation perimeter air monitoring stations. The locations of these PAMs are shown in Fig. 2. The readings were averaged at 10-minute intervals and stored in a database on the host computer. From these data, hourly averages were computed and also stored in a database. Readings were marked as invalid by the system if less than 75% of the data were available for the computation of the average as well as if the data are out of a predefined range. If a station had been marked off poll, no readings were returned to the data acquisition system for inclusion in the databases.

In mid February, the station locations were changed to coincide with the new ambient air locations. External gamma measurements are recorded at five of the ten ambient air stations; 39, 40, 42, 46, and 48. In addition, external gamma measurements are still collected at the DOE museum (station 41). However, no data was collected at station 46 this quarter because of equipment malfunction. After the relocation, the external gamma measurements are recorded weekly in the field. The readings for the quarter are entered into SAS data sets and a statistical evaluation completed. The equivalent dose rate is calculated using the average reading for each station during the quarter.

2.3.2 Procedures and Results

The valid hourly readings for the quarter are queried from the data acquisition system database and processed by a statistical program to produce a table of valid hourly measurements. Table 3 summarizes the measurements for the first quarter of 1992 for the real-time system. Table 4 summarizes the weekly measurements from February through March 1992.

Table 1. Atmospheric adsorbable gas concentrations at ORNL air monitoring stations,^a January-March 1992

Station	N det/ N total	Concentration (10^{-8} Bq/L)			Standard error ^c	Percent of DCG ^d
		Max	Min	Av ^b		
1	0/4	4.8	-19	-10	3.1	<0.01
2	0/4	15	2.9	8.1*	2.8	<0.01
3	0/3	8.6	5.9	3.6	4.8	<0.01
7	0/4	4.6	-16	2.9	4.8	<0.01
Overall Summary	0/15	15	-19	0.67	2.6	<0.01

^aSee Fig. 2.

^bAverage concentrations significantly greater than zero are identified by an *.

^cStandard error of the mean.

^dPercent of DCG = Mean/DCG x 100. The DCG for I-131 is 1.5×10^{-2} Bq/L.

Table 2. Atmospheric tritium concentrations at ambient air stations,
January-March 1992

Station ^a	N det/ N total	Concentration (10^{-4} Bq/L)			Standard error ^c	Percent of DCG ^d
		Max	Min	Av ^b		
3	3/3	17	1.7	7.2	5.1	0.019
8	3/3	13	1.1	5.6	3.6	0.015
Overall Summary	6/6	17	1.1	6.4*	2.8	0.017

^aStation locations are shown in Fig. 2.

^bAverage concentrations significantly greater than zero are identified by an *.

^cStandard error of the mean.

^dPercent of DCG = Mean/DCG x 100. The DCG for tritium is 3.7 Bq/L.

Table 3. Real-Time External gamma radiation measurements at reservation perimeter air monitoring stations,^a January-February 1992

Station	Number of Samples ^c	Exposure rate (nC/kg/h) ^b			Standard error ^e	Equivalent Dose (μSv/h)
		Max	Min	Av ^d		
ORNL PAM Stations						
7	841	2.1	0.91	1.6*	0.0086	0.061
20	1387	3.2	2.1	2.3*	0.0025	0.089
Overall summary	2228	3.2	0.91	2.0*	0.0083	0.079
Reservation PAM Stations						
8	231	2.3	1.7	1.8*	0.0065	0.070
33	758	2.7	1.9	2.2*	0.0055	0.084
41	254	1.6	1.2	1.3*	0.0036	0.050
42	1440	15	1.7	1.9*	0.0094	0.073
44	1438	2.5	1.7	1.8*	0.0020	0.071
45	1440	2.9	1.8	1.9*	0.0024	0.074
46	885	150	1.8	3.1*	0.18	0.12
Overall summary	6446	150	1.2	2.1*	0.025	0.080

^aSee Fig. 2.

^bNanocoulomb per kilogram per hour.

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

^dAverage exposure rates significantly greater than zero are identified by an *.

^eStandard error of the mean.

Table 4. External gamma radiation measurements at reservation perimeter air monitoring stations,^a February-March 1992

Station	Number of Samples	Exposure rate (nC/kg/h) ^b				Equivalent Dose (μ Sv/h)
		Max	Min	Av ^c	Standard error ^d	
39	6	2.7	2.7	2.7*	0.0037	0.10
40	6	2.1	2.1	2.1*	0.0036	0.080
41	6	1.3	1.0	1.2*	0.041	0.048
42	5	1.9	1.9	1.9*	0.0031	0.074
48	6	1.8	1.8	1.8*	0.0054	0.069
Overall Summary	29	2.7	1.0	1.9*	0.088	0.075

^aSee Fig. 2.

^bNanocoulomb per kilogram per hour.

^cAverage exposure rates significantly greater than zero are identified by an *.

^dStandard error of the mean.

3.0 WATER

The Oak Ridge National Laboratory (ORNL) site is located in the 17 km² White Oak Creek (WOC) watershed, with the exception of two small effluent points in the 7600 area that discharge directly into Melton Hill Lake. A sketch of the watershed and sampling station locations is shown in Fig. 5. The major tributary to WOC is Melton Branch (MB). Upper WOC drains Bethel Valley in the vicinity of ORNL; receiving inputs from Fifth Creek, First Creek, and Northwest Tributary (NWT) prior to crossing the gap in Haw Ridge and flowing Southwest to White Oak Lake (WOL). Melton Branch drains Melton Valley and joins WOC less than a mile from WOL. The present final point of control for the watershed is at White Oak Dam (WOD), which is the structure that forms WOL. The lake is about two-thirds of a mile long and less than a tenth of mile wide. The purpose of the lake is to serve as a settling basin and catchment in the event of contaminant releases from the ORNL facility. The receiving water for the watershed is Watts Bar Lake of the Clinch River.

Water quality in these streams is affected primarily by effluent discharges, surface runoff, subsurface storm flow, and groundwater transport of contaminants from historically disposed wastes. The average flow for the watershed is 14 CFS (9 MGD), of which 1 CFS (0.67 MGD) is attributed to the major National Pollutant Discharge Elimination System (NPDES) effluent points, and 3 CFS (2 MGD) is attributed to cooling towers and blowdown. The base flow during drought is estimated to be 1.75 CFS (1.14 MGD).

Surveillance of the water environment consists of the collection of surface water, effluent and sediment samples required under the NPDES Permit, and groundwater from Waste Area Groupings 1-9, 11 and 17. Of the WAGs, only WAG 1 and Solid Waste Storage Area (SWSA) 6 within WAG 6 were sampled during this quarter. Samples are analyzed for radionuclides and nonradioactive chemicals.

3.1 SURFACE WATER

Dennis A. Wolf

3.1.1 Program Description

Water samples are collected for radiological analyses at off-site and on-site locations, at background or reference locations, in 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 5.

3.1.2 Procedure and Results

Treated water samples are collected weekly at the Kingston and Gallaher potable water treatments plants (Fig. 6) and are analyzed quarterly. Table 6 contains the concentrations measured at these stations during this quarter. At Gallaher, gross beta and H-3 were significantly greater than zero; gross beta was 26% and H-3 was 4.2% of the Environmental Protection Agency

ORNL-DWG 92M-6985

Fig. 5. ORNL surface water, NPDES, and reference sampling stations.

Table 5. Summary of collection and analysis frequencies of surface and effluent water samples for radionuclide analysis

Station	Parameter	Collection Frequency	Sample Type	Analysis Frequency
STP	Gamma scan, gross beta, total rad Sr	Weekly	Flow proportional	Monthly
7500 Bridge, MB1, MB2, WOC	Gamma scan, H-3, total rad Sr	Weekly	Flow proportional	Monthly
First Creek, Fifth Creek, Raccoon Creek	Gamma scan, total rad Sr	Weekly	Grab	Monthly
Gallaher	Gamma scan, gross alpha, gross beta, H-3, Pu-238, Pu-239, total rad Sr, total U	Weekly	Time proportional	Quarterly
Kingston	Gamma scan, gross alpha, gross beta, H-3, Pu-238, Pu-239, total rad Sr, total U	Weekly	Grab	Quarterly
MHD	Gamma scan, gross alpha ^a , gross beta ^b	Weekly	Flow proportional	Monthly
NRWTF	Gamma scan, gross alpha, gross beta, H-3, total rad Sr	Weekly	Flow proportional	Monthly
NWT	Gamma scan, total rad Sr	Weekly	Flow proportional	Monthly
WOC Headwaters	Gamma scan, gross alpha ^a , gross beta ^b	Weekly	Flow proportional	Monthly
WOD	Gamma scan, gross alpha ^a , gross beta ^b	Weekly	Flow proportional	Weekly
WOD	H-3, total rad Sr	Weekly	Flow proportional	Monthly

^aIf gross alpha >1 Bq/L, analyze for Am-241, Cm-244, Pu-238, Pu-239, Th-228, Th-230, Th-233, U-234, U-235, and U-238.

^bIf gross beta >30 Bq/L, analyze for total rad Sr.

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

Table 6. Summary of radionuclide concentrations in water off-site ORNL, January-March 1992

Radionuclide	Concentration ^a (Bq/L)	Drinking Water Standard ^b (DWS) (Bq/L)	Percent DWS ^c
<i>Gallaher Water Treatment Plant^d</i>			
Co-60	0.070	e	e
Cs-137	-0.050	e	e
Gross alpha	-0.0070	0.555	e
Gross beta	0.48*	1.85	26
Pu-238	0.00060	e	e
Pu-239	-0.00023	e	e
Total rad Sr	0.10	0.296	e
Total U ^f (mg/L)	0.00024	e	e
Total U ^{fg}	0.0059	e	e
H-3	31*	740	4.2
<i>Kingston Water Treatment Plant^d</i>			
Co-60	0.020	e	e
Cs-137	0.010	e	e
Gross alpha	0.070*	0.555	13
Gross beta	0.13*	1.85	7.0
Pu-238	-0.00038	e	e
Pu-239	-0.00042	e	e
Total rad Sr	-0.010	0.296	e
Total U ^f (mg/L)	0.00013	e	e
Total U ^{fg}	0.0032	e	e
H-3	1.0	740	e

^aConcentrations significantly greater than zero are identified by an *.

^bNational Primary Drinking Water Standard. From 40 CFR 141, as amended. The value for total rad Sr is based upon the Sr-90 limit. The value for gross beta is a regulatory guide for assessing compliance without further analysis.

^cConcentration as a percentage of the DWS.

^dSee Fig. 6.

^eNot applicable.

^fNo test for significance is possible.

^gActivity derived from mass assuming natural abundance of U-234, U-235, and U-238.

(EPA) drinking water standards. At Kingston, gross alpha and gross beta were significantly greater than zero, at levels 13% and 7% of the drinking water standards. No test of significance was possible for the single total uranium measurement (the uranium fluorometric measurement is converted to an activity by assuming natural abundance of uranium isotopes U-234, U-235 and U-238) at each site, but the concentrations at Gallaher and Kingston are less than 0.3% of the gross alpha standard.

Derived concentration guides (DCG) are estimates of the rate of exposure to a given radioisotope via one exposure pathway that would result in an effective dose equivalent of 100 mrem (1 mSv) per year to "reference man," as defined by the International Commission of Radiation Protection Publication 23. These values have been published in draft 10 CFR 834 and are used here as a means of standardized comparison for effluent points with different isotope signatures. The calculation of percent DCG does not imply that effluent points or ambient water sampling stations at ORNL are sources of drinking water.

The sum of DCG percentages for each of the effluent points and ambient water stations is less than 100%. In the event a sum ever exceeds 100%, an analysis of the best available technology to reduce the signature would be conducted as specified in 10 CFR 834.

Melton Hill Dam and WOC headwaters, two locations above ORNL discharge points, serve as background or baseline references for other water sampling locations at the ORNL site. Water samples are collected there and 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 7. Only average gross beta at Melton Hill Dam (0.20 Bq/L) and average Co-60 (0.33 Bq/L) at WOC headwaters were significantly greater than zero.

Average total radioactive Sr concentration at First Creek (5.6 Bq/L) and at 7500 bridge (3.5 Bq/L) were 15% and 10% of the DCG for Sr-90, respectively. Otherwise, all average radionuclide concentrations at First Creek, Fifth Creek, Northwest Tributary, Raccoon Creek, MB2, and 7500 bridge were no greater than 5% of the respective DCGs.

Locations that are sampled for nonradioactive chemicals under the requirements of the NPDES Permit (see Section 3.2) are also sampled for radionuclides (Fig. 5). Parameters measured, frequency of collection, and the frequency of analysis are given in Table 5. Table 8 contains a summary of the concentrations for each of these locations during this quarter. The average concentration is expressed as a percentage of the DCG (when one exists) in the last column of this table. No parameter average concentration at the NPDES points exceeded 54% of its DCG. Average values of total radioactive Sr were significantly greater than zero at MBI (16 Bq/L, 43% of DCG), WOD (9.6 Bq/L, 26% of DCG), at STP (8.5 Bq/L, 23% of DCG), and at WOC (5.8 Bq/L, 16% of DCG). Average H-3 concentrations at MBI (40,000 Bq/L) and at WOD (11,000 Bq/L) were 54% and 15% of the H-3 DCG, respectively. Average Cs-137 at NRWTF (49 Bq/L) was 44% of its DCG. All other concentrations were no greater than 5% of the DCGs.

Table 7. Radionuclide concentrations in surface waters around ORNL,^a
January-March 1992

Radionuclide	N det/ N total	Concentration (Bq/L)				DCG ^e	Percent DCG ^f
		Max ^b	Min ^b	Av ^c	Standard error ^d		
Melton Hill Dam							
Co-60	1/3	2.3*	0.50	1.2	0.57	185	g
Cs-137	0/3	0.90	-0.10	0.33	0.30	111	g
Gross alpha	1/3	0.10*	0.010	0.042	0.029	g	g
Gross beta	1/3	0.31*	0.12	0.20*	0.056	g	g
White Oak Creek Headwaters							
Co-60	0/3	0.50	0.20	0.33*	0.088	185	0.18
Cs-137	0/3	0.60	-0.80	0.067	0.44	111	g
Gross alpha	0/3	0.071	0.0010	0.038	0.020	g	g
Gross beta	3/3	0.55*	0.19*	0.32	0.11	g	g
7500 Bridge							
Co-60	0/3	0.30	-0.30	-0.10	0.20	185	g
Cs-137	2/3	3.1*	1.3	2.4*	0.55	111	2.1
Total rad Sr	3/3	5.1*	2.2*	3.5*	0.85	37	9.5
H-3	3/3	280*	110*	220*	54	74,000	0.29
First Creek							
Co-60	0/3	0.30	-0.60	-0.13	0.26	185	g
Cs-137	0/3	0.50	-0.20	0.067	0.22	111	g
Total rad Sr	3/3	6.8*	4.5*	5.6*	0.66	37	15
Fifth Creek							
Co-60	1/3	1.6*	0.20	0.93	0.41	185	g
Cs-137	1/3	1.9*	-0.40	0.57	0.69	111	g
Total rad Sr	3/3	1.2*	0.83*	0.96*	0.12	37	2.6
Melton Branch 2							
Co-60	0/3	1.1	-0.10	0.50	0.35	185	g
Cs-137	0/3	0.30	-0.70	-0.10	0.31	111	g
Total rad Sr	3/3	0.23*	0.11*	0.17*	0.035	37	0.45
H-3	3/3	230*	190*	210*	12	74,000	0.29

Table 7. (continued)

Radionuclide	N det/ N total	Concentration (Bq/L)				DCG ^e	Percent DCG ^f
		Max ^b	Min ^b	Av ^c	Standard error ^e		
Northwest Tributary							
Co-60	0/3	0.70	0.40	0.53*	0.088	185	0.29
Cs-137	0/3	0.10	-0.90	-0.43	0.29	111	g
Total rad Sr	3/3	1.9*	1.7*	1.8*	0.058	37	4.9
Raccoon Creek							
Co-60	1/3	1.4*	-0.10	0.60	0.44	185	g
Cs-137	0/3	0.20	-0.70	-0.13	0.28	111	g
Total rad Sr	2/3	0.58*	0.11	0.38	0.14	37	g

^aLocations are shown in Fig. 5.

^bIndividual concentrations significantly greater than zero are identified by an

*,

^cMean concentrations significantly greater than zero are identified by an *.

^dStandard error of the mean.

^eDerived concentration guide for ingestion of water. From DOE Order 5400.5.

^fMean concentration as a percentage of the derived concentration guide (DCG), calculated only when a DCG exists and the mean concentration is significantly greater than zero.

^gNot applicable.

Table 8. Radionuclide concentrations at ORNL NPDES locations,^a January-March 1992

Radionuclide	N det/ N total	Concentration (Bq/L)				DCG ^e	Percent DCG ^f
		Max ^b	Min ^b	Av ^c	Standard error ^d		
Sewage Treatment Plant (X01)							
Co-60	0/3	0.80	0.30	0.60*	0.15	185	0.32
Cs-137	0/3	0.50	0.040	0.21	0.14	111	g
Gross alpha	0/1	0.024	0.024	0.024	g	g	g
Gross beta	3/3	21*	18*	20*	1.0	g	g
Total rad Sr	3/3	9.1*	7.5*	8.5*	0.52	37	23
Nonradiological Wastewater Treatment Facility (X12)							
Co-60	0/3	1.2	0.10	0.60	0.32	185	g
Cs-137	3/3	78*	29*	49*	15	111	44
Gross alpha	3/3	1.0*	0.78*	0.86*	0.069	g	g
Gross beta	3/3	84*	74*	78*	3.1	g	g
Total rad Sr	3/3	28*	3.7*	18	7.3	37	g
H-3	3/3	3,400*	1,700*	2,600*	500	74,000	3.6
Melton Branch 1 (X13)							
Co-60	0/3	0.60	-0.90	-0.23	0.44	185	g
Cs-137	0/3	0.40	0.10	0.23	0.088	111	g
Total rad Sr	3/3	19*	13*	16*	1.7	37	43
H-3	3/3	48,000*	36,000*	40,000*	4,000	74,000	54
White Oak Creek (X14)							
Co-60	0/3	0.50	0.20	0.37*	0.088	185	0.20
Cs-137	2/3	2.2*	1.1*	1.6*	0.33	111	1.4
Total rad Sr	3/3	7.4*	4.9*	5.8*	0.79	37	16
H-3	3/3	3,800*	3,200*	3,500*	180	74,000	4.8
White Oak Dam (X15)							
Co-60	7/12	0.77*	0.050	0.28*	0.056	185	0.15
Cs-137	12/12	7.1*	0.56*	2.9*	0.64	111	2.6

Table 8. (continued)

Radionuclide	N det/ N total	Concentration (Bq/L)				DCG ^e	Percent DCG ^f
		Max ^b	Min ^b	Av ^c	Standard error ^d		
Gross alpha	12/12	0.51*	0.22*	0.33*	0.028	g	g
Gross beta	12/12	25*	15*	18*	0.75	g	g
Total rad Sr	3/3	12*	8.3*	9.6*	1.2	37	26
H-3	3/3	13,000*	9,200*	11,000*	1,100	74,000	15

^aLocations are shown in Fig. 5.

^bIndividual concentrations significantly greater than zero are identified by an *.

^cMean concentrations significantly greater than zero are identified by an *.

^dStandard error of the mean.

^eDerived concentration guide for ingestion of water. From DOE Order 5400.5.

^fMean concentration as a percentage of the derived concentration guide (DCG), calculated only when a DCG exists and the mean concentration is significantly greater than zero.

^gNot applicable.

The discharge of radioactive contaminants from ORNL is affected by the stream flows. Flows in MB (as measured at station MB1), WOC (as measured above its confluence with MB and at WOD), and the Clinch River (as measured at Melton Hill Dam) are given in Table 9. Clinch River flows are regulated by a series of Tennessee Valley Authority dams, one of which is Melton Hill Dam. The flow in MB is usually less than one-third that in WOC. The ratio of Clinch River flow to WOC flow measured at WOD is also reported in Table 9. The 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 0.0036 to 0.016.

Discharges of radioactivity into WOC at the STP, at the NRWTF, above 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 the WOD, WOC, MB1, NRWTF, and STP stations. A flow-weighted composite is made and analyzed monthly. The discharge for the period is calculated as the product of the flow-weighted concentration and the total flow for the sampling period (Tables 10-12). In addition, weekly flow-proportional samples were obtained at WOD and analyzed for radionuclides other than H-3 and total Sr, at weekly intervals. The average concentration during the calendar month was calculated as a weighted sum of all concentrations obtained for sampling periods overlapping the calendar month. The weights were proportional to the calendar period total flow attributable to the sampling periods. This average concentration was multiplied by the calendar month total flow to arrive at the discharge.

Each average flow-weighted concentration was compared with an existing DCG. Cobalt-60 concentrations at any of these stations did not exceed 0.2% of the DCG during this quarter. Cesium-137 concentrations ranged up to 3.3% of the DCG at stations other than the NRWTF; concentrations there ranged from 26% to 70% of the DCG. Total radioactive Sr concentrations were fairly constant at STP (20%-25%), WOC (13%-20%), MB1 (35%-51%), and WOD (22%-32%). At the NRWTF the concentrations ranged from 10% to 70% of the DCG for Sr-90. Where measured, H-3 concentrations were no greater than 5.1% of the DCG, except at MB1 (49%-65%) and WOD (12%-18%).

3.2 NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM REQUIREMENTS

Pamela Y. Goldberg and Charles K. Valentine, Jr.

3.2.1 Program Description and Results

ORNL's current NPDES permit requires that point-source outfalls be sampled prior to their discharge into receiving waters or before mixing with any other wastewater stream. There are ambient sampling points that are located in the streams as reference points or for additional information.

Quarterly summary statistics for the first quarter of 1992 are given for each sampling location in Tables 13 through 22.

Table 9. Stream^a flows, January-March 1992

Month	Flow (10 ⁹ L)				Average Ratio ^d
	Melton Branch 1	White Oak Creek ^b	White Oak Dam ^c	Clinch River	
January	0.34	0.94	1.3	610	0.0036
February	0.24	0.66	0.97	210	0.016
March	0.26	0.80	1.1	170	0.012

^aSee Fig. 5.

^bWhite Oak Creek at confluence of Melton Branch.

^cWhite Oak Creek at White Oak Dam.

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

Table 10. Radionuclide concentrations and releases at ORNL NPDES surface water stations,^a January 1992

Radionuclide	Flow (10 ⁶ L)	Discharge ^b (10 ¹⁰ Bq)	Concentration ^c (Bq/L)	DCG ^d (Bq/L)	Percent DCG ^e
<i>Melton Branch 1 (12/31-01/29)</i>					
Co-60	330	f	-0.90	185	f
Cs-137	330	f	0.10	111	f
Total rad Sr	330	0.43	13*	37	35
H-3	330	1,200	36,000*	74,000	49
<i>Nonradiological Wastewater Treatment Facility (12/31-01/29)</i>					
Co-60	47	f	0.10	185	f
Cs-137	47	0.18	39*	111	35
Gross alpha	47	0.0036	0.78*	f	f
Gross beta	47	0.35	76*	f	f
Total rad Sr	47	0.10	22*	37	59
H-3	47	7.9	1,700*	74,000	2.3
<i>Sewage Treatment Plant (12/31-01/30)</i>					
Co-60	17	f	0.70	185	f
Cs-137	17	f	0.50	111	f
Gross alpha	17	f	0.024	f	f
Gross beta	17	0.035	21*	f	f
Total rad Sr	17	0.015	9.1*	37	25
<i>White Oak Creek (12/31-01/29)</i>					
Co-60	910	f	0.20	185	f
Cs-137	910	0.20	2.2*	111	2.0
Total rad Sr	910	0.47	5.2*	37	14
H-3	910	350	3,800*	74,000	5.1
<i>White Oak Dam (12/31-1/29)</i>					
Total rad Sr	1,200	1.0	8.3*	37	22
H-3	1,200	1,300	11,000*	74,000	15

Table 10. (continued)

Radionuclide	Flow (10 ⁶ L)	Discharge ^b (10 ¹⁰ Bq)	Concentration ^c (Bq/L)	DCG ^d (Bq/L)	Percent DCG ^e
<i>White Oak Dam^g (01/01-02/01)</i>					
Co-60	1,300	0.028	0.22	185	0.12
Cs-137	1,300	0.25	2.0*	111	1.8
Gross alpha	1,300	0.048	0.39*	f	f
Gross beta	1,300	2.3	18*	f	f

^aLocations are shown in Fig. 5.

^bDischarges are calculated from flow and concentration and are listed when concentrations are significantly greater than zero.

^cConcentrations significantly greater than zero are identified by an *.

^dDerived concentration guide for ingestion of water. From DOE Order 5400.5.

^eMean concentration as a percentage of the DCG, calculated only when a DCG exists and the mean concentration is significantly greater than zero.

^fNot applicable.

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

Table 11. Radionuclide concentrations and releases at ORNL NPDES surface water stations,^a February 1992

Radionuclide	Flow (10 ⁶ L)	Discharge ^b (10 ¹⁰ Bq)	Concentration ^c (Bq/L)	DCG ^d (Bq/L)	Percent DCG ^e
<i>Melton Branch 1 (01/29-02/26)</i>					
Co-60	190	f	-0.40	185	f
Cs-137	190	f	0.20	111	f
Total rad Sr	190	0.30	16*	37	43
H-3	190	900	48,000*	74,000	65
<i>Nonradiological Wastewater Treatment Facility (01/29-02/26)</i>					
Co-60	52	f	0.50	185	f
Cs-137	52	0.15	29*	111	26
Gross alpha	52	0.0052	1.0*	f	f
Gross beta	52	0.43	84*	f	f
Total rad Sr	52	0.14	28*	37	76
H-3	52	14	2,800*	74,000	3.8
<i>Sewage Treatment Plant (01/30-02/28)</i>					
Co-60	14	f	0.30	185	f
Cs-137	14	f	0.040	111	f
Gross beta	14	0.024	18*	f	f
Total rad Sr	14	0.012	9.0*	37	24
<i>White Oak Creek (01/29-02/26)</i>					
Co-60	530	f	0.50	185	f
Cs-137	530	0.058	1.1*	111	0.99
Total rad Sr	530	0.39	7.4*	37	20
H-3	530	190	3,600*	74,000	4.9
<i>White Oak Dam (01/29-02/26)</i>					
Total rad Sr	810	0.97	12*	37	32
H-3	810	1,100	13,000*	74,000	18

Table 11. (continued)

Radionuclide	Flow (10 ⁶ L)	Discharge ^b (10 ¹⁰ Bq)	Concentration ^c (Bq/L)	DCG ^d (Bq/L)	Percent DCG ^e
<i>White Oak Dam^g (02/01-03/01)</i>					
Co-60	970	0.036	0.37*	185	0.20
Cs-137	970	0.32	3.3*	111	3.0
Gross alpha	970	0.035	0.36*	f	f
Gross beta	970	2.0	21*	f	f

^aLocations are shown in Fig. 5.

^bDischarges are calculated from flow and concentration and are listed when concentrations are significantly greater than zero.

^cConcentrations significantly greater than zero are identified by an *.

^dDerived concentration guide for ingestion of water. From DOE Order 5400.5.

^eMean concentration as a percentage of the DCG, calculated only when a DCG exists and the mean concentration is significantly greater than zero.

^fNot applicable.

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

Table 12. Radionuclide concentrations and releases at ORNL NPDES surface water stations,^a March 1992

Radionuclide	Flow (10 ⁶ L)	Discharge ^b (10 ¹⁰ Bq)	Concentration ^c (Bq/L)	DCG ^d (Bq/L)	Percent DCG ^e
<i>Melton Branch 1 (02/26-03/25)</i>					
Co-60	270	f	0.60	185	f
Cs-137	270	f	0.40	111	f
Total rad Sr	270	0.52	19*	37	51
H-3	270	980	36,000*	74,000	49
<i>Nonradiological Wastewater Treatment Facility (02/26-03/25)</i>					
Co-60	51	f	1.2	185	f
Cs-137	51	0.40	78*	111	70
Gross alpha	51	0.0042	0.81*	f	f
Gross beta	51	0.38	74*	f	f
Total rad Sr	51	0.019	3.7*	37	10
H-3	51	17	3,400*	74,000	4.6
<i>Sewage Treatment Plant (02/28-03/26)</i>					
Co-60	15	f	0.80	185	f
Cs-137	15	f	0.10	111	f
Gross beta	15	0.031	21*	f	f
Total rad Sr	15	0.011	7.5*	37	20
<i>White Oak Creek (02/26-03/25)</i>					
Co-60	810	f	0.40	185	f
Cs-137	810	f	1.4	111	f
Total rad Sr	810	0.40	4.9*	37	13
H-3	810	260	3,200*	74,000	4.3
<i>White Oak Dam (02/26-03/25)</i>					
Total rad Sr	1,100	0.92	8.4*	37	23
H-3	1,100	1,000	9,200*	74,000	12

Table 12. (continued)

Radionuclide	Flow (10 ⁶ L)	Discharge ^b (10 ¹⁰ Bq)	Concentration ^c (Bq/L)	DCG ^d (Bq/L)	Percent DCG ^e
<i>White Oak Dam^g (03/01-04/01)</i>					
Co-60	1,100	0.031	0.29*	185	0.16
Cs-137	1,100	0.38	3.6*	111	3.3
Gross alpha	1,100	0.039	0.37*	f	f
Gross beta	1,100	1.8	17*	f	f

^aLocations are shown in Fig. 5.

^bDischarges are calculated from flow and concentration and are listed when concentrations are significantly greater than zero.

^cConcentrations significantly greater than zero are identified by an *.

^dDerived concentration guide for ingestion of water. From DOE Order 5400.5.

^eMean concentration as a percentage of the DCG, calculated only when a DCG exists and the mean concentration is significantly greater than zero.

^fNot applicable.

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

Table 13. NPDES discharge point X01,^a January-March 1992

Analyte	N det/ N total	Concentration (mg/L)			Standard error ^c
		Max	Min	Av ^b	
Field Measurements:					
Chlorine, total residual	38/38	0.38	0.010	0.22*	0.013
Dissolved oxygen (ppm)	63/63	15	7.5	11*	0.18
Downstream pH (SU)	13/13	8.0	7.5	<i>d</i>	<i>d</i>
Flow (Mgd)	63/63	0.23	0.083	0.14*	0.0036
pH (SU)	13/13	7.9	7.2	<i>d</i>	<i>d</i>
Temperature (°C)	76/76	19	8.9	15*	0.20
Metals:					
Copper, total	0 /3	<0.0070	<0.0070	<0.0070*	0
Mercury, total	0 /3	<0.00005	<0.00005	<0.00005*	0
Silver, total	0 /3	<0.0050	<0.0050	<0.0050*	0
Zinc, total	3 /3	0.070	0.027	0.051*	0.013
Others:					
Ammonia (as N)	38/38	0.29	0.040	0.086*	0.012
Biochemical oxygen demand	2 /38	6.0	<5.0	<5.0*	0.026
Cyanide, total	0 /3	<0.0020	<0.0020	<0.0020*	0
Fecal Coliform (col/100 mL) ^e	10/38	6.0	<1.0	<1.3*	0.17
Oil and grease	8 /38	94	<2.0	<6.1*	2.5
Phenolics, total recoverable	0 /3	<0.0010	<0.0010	<0.0010*	0
Total suspended solids	3 /38	9.0	<5.0	<5.2*	0.12
Volatile Organics:					
Bromodichloromethane	1 /3	<0.0050	~0.0010	~0.0037	0.0013
Trichloroethene	0 /3	<0.0050	<0.0050	<0.0050*	0

^aSee Fig. 5.^bAverage concentrations significantly greater than zero are identified by an *.^cStandard error of the mean.^dNot applicable.^eThe geometric mean is computed rather than the average.

Table 14. NPDES discharge point X02,^a January-March 1992

Analyte	N det/ N total	Concentration (mg/L)			Standard error ^c
		Max	Min	Av ^b	
Anions:					
Sulfate (as SO ₄)	3 /3	1400	910	1100*	140
Field Measurements:					
Downstream pH (SU)	63/63	8.4	7.1	d	d
Flow (Mgd)	63/63	0.078	0	0.0094*	0.0025
pH (SU)	63/63	8.2	6.1	d	d
Temperature (°C)	63/63	18	4.0	10*	0.37
Metals:					
Arsenic, total	0 /5	<0.050	<0.050	<0.050*	0
Cadmium, total	0 /5	<0.0050	<0.0050	<0.0050*	0
Chromium, total	5 /5	0.017	0.0042	0.0083*	0.0023
Copper, total	2 /5	0.0075	<0.0070	<0.0071*	0.000097
Iron, total	5 /5	0.57	0.25	0.39*	0.061
Lead, total	0 /5	<0.050	<0.050	<0.050*	0
Manganese, total	5 /5	0.055	0.014	0.031*	0.0078
Nickel, total	1 /5	0.0048	<0.0040	<0.0042*	0.00016
Selenium, total	6 /6	0.020	0.0060	0.011*	0.0020
Silver, total	0 /5	<0.0050	<0.0050	<0.0050*	0
Zinc, total	0 /5	<0.0050	<0.0050	<0.0050*	0
Others:					
Oil and grease	1 /6	2.0	<2.0	<2.0*	0
Total suspended solids	5 /6	8.0	<5.0	<6.5*	0.56

^aSee Fig. 5.^bAverage concentrations significantly greater than zero are identified by an *.^cStandard error of the mean.^dNot applicable.

Table 15. NPDES discharge point X12,^a January-March 1992

Analyte	N det/ N total	Concentration (mg/L)			Standard error ^c
		Max	Min	Av ^b	
Anions:					
Fluoride	12/12	1.8	1.0	1.4*	0.063
Nitrate	12/12	14	1.6	5.3*	1.2
Sulfate (as SO ₄)	12/12	310	190	260*	10
Field Measurements:					
Downstream pH (SU)	63/63	8.3	7.3	d	d
Flow (Mgd)	63/63	0.60	0.33	0.47*	0.0079
pH (SU)	e	7.8	7.2	d	d
Temperature (°C)	63/63	20	10	14*	0.24
Metals:					
Arsenic, total	0 /12	<0.050	<0.050	<0.050*	0
Cadmium, total	0 /12	<0.0050	<0.0050	<0.0050*	0
Chromium, total	4 /12	0.0082	<0.0040	<0.0051*	0.00046
Copper, total	0 /12	<0.0070	<0.0070	<0.0070*	0
Iron, total	1 /12	0.13	<0.050	<0.057*	0.0067
Lead, total	0 /12	<0.050	<0.050	<0.050*	0
Mercury, total	0 /12	<0.00005	<0.00005	<0.00005*	0
Nickel, total	0 /12	<0.011	<0.0040	<0.0050*	0.00060
Phosphorus, total	7 /13	<0.50	0.040	0.28	0.035
Selenium, total	0 /12	<0.070	<0.050	<0.052*	0.0017
Silver, total	0 /12	<0.020	<0.0050	<0.0063*	0.0013
Zinc, total	10/12	0.028	<0.0050	<0.018*	0.0023
Others:					
Biochemical oxygen demand	0 /12	<5.0	<5.0	<5.0*	0
Cyanide, total	0 /12	<0.0020	<0.0020	<0.0020*	0
Oil and grease	4 /12	6.0	<2.0	<2.5*	0.34
Phenolics, total recoverable	0 /12	<0.0010	<0.0010	<0.0010*	0
Total suspended solids	1 /12	10	<5.0	<5.4*	0.42
Total toxic organics	0 /12	<0.010	<0.010	<0.010*	0

Table 15. (continued)

Analyte	N det/ N total	Concentration (mg/L)			Standard error ^c
		Max	Min	Av ^b	
Volatile Organics:					
1,1-Dichloroethane	0 /13	<0.0050	<0.0050	<0.0050*	0
Benzene	2 /13	<0.0050	~0.0010	~0.0046*	0.00031
Bromodichloromethane	0 /13	<0.0050	<0.0050	<0.0050*	0
Chlorobenzene	0 /13	<0.0050	<0.0050	<0.0050*	0
Chloroform	1 /13	<0.0050	~0.0010	~0.0047*	0.00031
Methylene chloride	2 /13	<0.0050	~0.0020	~0.0045*	0.00031
Tetrachloroethene	0 /13	<0.0050	<0.0050	<0.0050*	0
Trichloroethene	0 /13	<0.0050	<0.0050	<0.0050*	0

^aSee Fig. 5.

^bAverage concentrations significantly greater than zero are identified by an *.

^cStandard error of the mean.

^dNot applicable.

^epH monitoring is continuous.

Table 16. NPDES discharge point X13,^a January-March 1992

Analyte	N det/ N total	Concentration (mg/L)			Standard error ^c
		Max	Min	Av ^b	
Anions:					
Fluoride	3 /3	1.2	0.60	0.80*	0.20
Nitrate (as N)	2 /3	0.50	<0.10	<0.30	0.12
Sulfate (as SO ₄)	3 /3	110	37	74*	21
Field Measurements:					
Chlorine, total residual	0 /13	<0.010	<0.010	<0.010*	0
Conductivity (mS/cm)	3 /3	0.80	0.33	0.56*	0.13
Dissolved oxygen (ppm)	13/13	14	9.6	12*	0.36
Flow (Mgd)	63/63	21	0.65	2.6*	0.42
pH (SU)	3 /3	7.9	7.4	^d	^d
Temperature (°C)	16/16	15	5.3	9.6*	0.63
Turbidity (NTU)	3 /3	20	10	16*	3.2
Metals:					
Aluminum, total	3 /3	0.96	0.11	0.51	0.25
Arsenic, total	0 /3	<0.050	<0.050	<0.050*	0
Cadmium, total	0 /3	<0.0050	<0.0020	<0.0030*	0.0010
Chromium, total	1 /3	0.0067	<0.0040	<0.0049*	0.00090
Copper, total	0 /3	<0.0070	<0.0070	<0.0070*	0
Iron, total	3 /3	0.74	0.12	0.42	0.18
Lead, total	0 /3	<0.0050	<0.0040	<0.0043*	0.00033
Mercury, total	0 /3	<0.00005	<0.00005	<0.00005*	0
Manganese, total	3 /3	0.11	0.068	0.096*	0.014
Nickel, total	0 /3	<0.0040	<0.0040	<0.0040*	0
Phosphorus, total	1 /3	0.50	<0.20	<0.30*	0.10
Silver, total	0 /3	<0.0050	<0.0050	<0.0050*	0
Zinc, total	3 /3	0.018	0.0095	0.013*	0.0026
Others:					
Ammonia (as N)	3 /3	0.050	0.040	0.043*	0.0033
Biochemical oxygen demand	1 /3	6.0	<5.0	<5.3*	0.33
Oil and grease	6 /13	41	<2.0	<7.0*	3.0
Phenolics, total recoverable	0 /3	<0.0010	<0.0010	<0.0010*	0
Total dissolved solids	3 /3	330	250	280*	27
Total organic carbon	3 /3	2.5	2.4	2.4*	0.033
Total suspended solids	2 /3	24	<5.0	<17	5.9

Table 16. (continued)

Analyte	N det/ N total	Concentration (mg/L)			Standard error ^c
		Max	Min	Av ^b	
PCBs:					
PCB, total	0 /3	<0.0020	<0.0020	<0.0020*	0
Volatile Organics:					
Chloroform	0 /3	<0.0050	<0.0050	<0.0050*	0
Trichloroethene	0 /3	<0.0050	<0.0050	<0.0050*	0

^aSee Fig. 5.^bAverage concentrations significantly greater than zero are identified by an *.^cStandard error of the mean.^dNot applicable.

Table 17. NPDES discharge point X14,^a January-March 1992

Analyte	N det/ N total	Concentration (mg/L)			Standard error ^c
		Max	Min	Av ^b	
Anions:					
Fluoride	3 /3	1.1	0.70	0.90*	0.12
Nitrate (as N)	3 /3	1.2	0.70	0.90*	0.15
Sulfate (as SO ₄)	3 /3	37	29	32*	2.4
Field Measurements:					
Chlorine, total residual	0 /13	<0.010	<0.010	<0.010*	0
Conductivity (mS/cm)	3 /3	0.80	0.23	0.46	0.18
Dissolved oxygen (ppm)	13/13	13	9.2	12*	0.35
Flow (Mgd)	63/63	30	2.9	7.1*	0.64
pH (SU)	3 /3	7.8	7.6	^d	^d
Temperature (°C)	16/16	16	7.4	11*	0.58
Turbidity (NTU)	3 /3	10	6.0	8.7*	1.3
Metals:					
Aluminum, total	3 /3	0.20	0.075	0.13*	0.036
Arsenic, total	0 /3	<0.050	<0.050	<0.050*	0
Cadmium, total	0 /3	<0.0050	<0.0020	<0.0030*	0.0010
Chromium, total	0 /3	<0.0040	<0.0040	<0.0040*	0
Copper, total	0 /3	<0.0070	<0.0070	<0.0070*	0
Iron, total	3 /3	0.19	0.063	0.11	0.039
Mercury, total	0 /3	<0.00005	<0.00005	<0.00005*	0
Manganese, total	3 /3	0.031	0.015	0.023*	0.0046
Nickel, total	0 /3	<0.0040	<0.0040	<0.0040*	0
Phosphorus, total	1 /3	0.49	<0.20	<0.30*	0.097
Lead, total	0 /3	<0.0050	<0.0040	<0.0043*	0.00033
Silver, total	0 /3	<0.0050	<0.0050	<0.0050*	0
Zinc, total	3 /3	0.012	0.0064	0.0098*	0.0017
Others:					
Ammonia (as N)	3 /3	0.050	0.040	0.043*	0.0033
Biochemical oxygen demand	0 /3	<5.0	<5.0	<5.0*	0
Oil and grease	5 /13	200	<2.0	<24	15
Phenolics, total recoverable	0 /3	<0.0010	<0.0010	<0.0010*	0
Total dissolved solids	3 /3	200	150	180*	14
Total organic carbon	3 /3	2.1	1.6	1.8*	0.17
Total suspended solids	1 /3	15	<5.0	<8.3	3.3

Table 17. (continued)

Analyte	N det/ N total	Concentration (mg/L)			Standard error ^c
		Max	Min	Av ^b	
PCBs:					
PCB, total	0 /3	<0.0020	<0.0020	<0.0020*	0
Volatile Organics:					
Chloroform	2 /3	<0.0050	~0.0020	~0.0030*	0.0010
Trichloroethene	0 /3	<0.0050	<0.0050	<0.0050*	0

^aSee Fig. 5.^bAverage concentrations significantly greater than zero are identified by an *.^cStandard error of the mean.^dNot applicable.

Table 18. NPDES discharge point X15,^a January-March 1992

Analyte	N det/ N total	Concentration (mg/L)			Standard error ^c
		Max	Min	Av ^b	
Anions:					
Fluoride	3 /3	0.70	0.40	0.60*	0.10
Nitrate (as N)	3 /3	0.90	0.50	0.70*	0.12
Sulfate (as SO ₄)	3 /3	48	29	37*	5.7
Field Measurements:					
Chlorine, total residual	0 /13	<0.010	<0.010	<0.010*	0
Conductivity (mS/cm)	3 /3	0.70	0.28	0.51*	0.12
Dissolved oxygen (ppm)	13/13	14	9.0	11*	0.40
Flow (Mgd)	63/63	51	4.5	10*	1.0
pH (SU)	3 /3	8.0	7.7	^d	^d
Temperature (°C)	16/16	17	4.3	10*	0.76
Turbidity (NTU)	3 /3	27	9.0	19*	5.2
Metals:					
Aluminum, total	3 /3	0.95	0.50	0.67*	0.14
Arsenic, total	0 /3	<0.010	<0.010	<0.010*	0
Cadmium, total	0 /3	<0.0050	<0.0020	<0.0030*	0.0010
Chromium, total	2 /3	0.016	<0.0040	<0.012*	0.0038
Copper, total	0 /3	<0.0070	<0.0070	<0.0070*	0
Iron, total	3 /3	1.3	0.58	0.84*	0.23
Lead, total	0 /3	<0.0050	<0.0040	<0.0043*	0.00033
Mercury, total	2 /3	0.00007	<0.00005	<0.000057*	0.0000067
Manganese, total	3 /3	0.13	0.069	0.096*	0.018
Nickel, total	0 /3	<0.0040	<0.0040	<0.0040*	0
Phosphorus, total	1 /3	0.50	<0.20	<0.30*	0.10
Silver, total	0 /3	<0.0050	<0.0050	<0.0050*	0
Zinc, total	2 /3	0.044	<0.0050	<0.023	0.011
Others:					
Ammonia (as N)	3 /3	0.080	0.050	0.060*	0.010
Biochemical oxygen demand	0 /3	<5.0	<5.0	<5.0*	0
Oil and grease	9 /13	42	<2.0	<14*	3.6
Total dissolved solids	3 /3	220	190	210*	7.8
Total organic carbon	3 /3	2.2	1.8	2.0*	0.12
Total suspended solids	3 /3	20	10	15*	2.9

Table 18. (continued)

Analyte	N det/ N total	Concentration (mg/L)			Standard error ^c
		Max	Min	Av ^b	
PCBs:					
PCB, total	0 /3	<0.0020	<0.0020	<0.0020*	0
Volatile Organics:					
Chloroform	0 /3	<0.0050	<0.0050	<0.0050*	0
Trichloroethene	0 /3	<0.0050	<0.0050	<0.0050*	0

^aSee Fig. 5.^bAverage concentrations significantly greater than zero are identified by an *.^cStandard error of the mean.^dNot applicable.

Table 19. NPDES category I outfalls,^a January-March 1992

Analyte	N det/ N total	Concentration (mg/L)			Standard error ^c
		Max	Min	Av ^b	
Field Measurements:					
Downstream pH (SU)	2 /2	7.8	7.6	d	d
Flow (Mgd)	2 /2	0.0043	0.00036	0.0023	0.0020
pH (SU)	2 /2	7.7	7.6	d	d
Temperature (°C)	2 /2	10	9.8	9.9*	0.10
Others:					
Oil and grease	2 /2	200	120	160	38
Total suspended solids	2 /2	11	5.0	8.0	3.0
Radionuclides:					
Gross beta	1 /2	99	-0.40	49	50
Total rad Sr	1 /1	63	63	63	

^aSee Fig. 5.^bAverage concentrations significantly greater than zero are identified by an *.^cStandard error of the mean.^dNot applicable.

Table 20. NPDES category II outfalls,^a January-March 1992

Analyte	N det/ N total	Concentration (mg/L)			Standard error ^c
		Max	Min	Av ^b	
Field Measurements:					
Downstream pH (SU)	43/43	8.6	7.1	d	d
Flow (Mgd)	43/43	0.17	0.00036	0.030*	0.0064
pH (SU)	43/43	8.9	7.0	d	d
Temperature (°C)	43/43	58	8.1	14*	1.3
Others:					
Oil and grease	25/43	180	<2.0	<26*	5.8
Total suspended solids	22/43	120	<5.0	<20*	3.8
Radionuclides:					
Gross beta	20/43	190	-0.70	4.7	4.4
Total rad Sr	1 /1	130	130	130	

^aSee Fig. 5.^bAverage concentrations significantly greater than zero are identified by an *.^cStandard error of the mean.^dNot applicable.

Table 21. NPDES category III outfalls,^a January-March 1992

Analyte	N det/ N total	Concentration (mg/L)			Standard error ^c
		Max	Min	Av ^b	
Field Measurements:					
Flow (Mgd)	15/15	0.17	0.00036	0.025*	0.012
pH (SU)	15/15	8.9	7.7	^d	^d
Temperature (°C)	15/15	32	5.4	11*	1.6

^aSee Fig. 5.^bAverage concentrations significantly greater than zero are identified by an *.^cStandard error of the mean.^dNot applicable.

Table 22. NPDES cooling towers,^a January-March 1992

Analyte	N det/ N total	Concentration (mg/L)			Standard error ^c
		Max	Min	Av ^b	
Field Measurements:					
Chlorine, total residual	7 /7	0.17	0.030	0.13*	0.020
Downstream pH (SU)	7 /7	8.3	8.0	_d	_d
Flow (Mgd)	7 /7	0.19	0.0043	0.060	0.032
pH (SU)	7 /7	8.8	8.0	_d	_d
Temperature (°C)	7 /7	37	3.7	19*	4.1
Metals:					
Chromium, total	7 /7	0.042	0.0079	0.018*	0.0045
Copper, total	4 /7	0.11	<0.0070	<0.057	0.017
Zinc, total	7 /7	0.32	0.050	0.19*	0.034

^aSee Fig. 5.^bAverage concentrations significantly greater than zero are identified by an *.^cStandard error of the mean.^dNot applicable.

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 23 through 25. A brief summary of the noncompliances follows.

3.2.2 Noncompliances

3.2.2.1 January 1992

3.2.2.1.1 Inappropriate and/or Unpermitted Discharges

On January 16, 1992, a potable (chlorinated) water pipe leak resulted in a release of approximately 1500 gallons of water at the Oak Ridge Research Reactor, Building 3042. The water flowed into Fifth Creek within the ORNL main complex via storm drain pipe Outfall 368. The chlorine content of the water entering the storm drain was measured as approximately 0.3 mg/L which would not be expected to cause any environmental impact on Fifth Creek. ORNL personnel responded to the water leak and valved the broken section out immediately upon discovery. The leak was repaired on January 24, 1992, and normal service was restored.

On January 21, 1992, a "milky" coloration was temporarily noted in effluent from an unnumbered outfall pipe (roof drain) that originates in the High Temperature Materials Laboratory, Building 4515. The pipe is being investigated by ORNL personnel and if the source of the milky-colored discharge can be found through the sample analysis and drain checking, corrective measures will be taken to prevent further recurrence.

On January 29, 1992, ORNL personnel determined that seepage from the south berm of Surface Impoundment 3515, which reaches White Oak Creek, was water from inside the impoundment and should technically be considered a wastewater discharge. Through sample analysis and dye-testing, it was verified that the seepage was coming from within the impoundment which was migrating adjacent to an overflow pipe that was plugged in 1989. ORNL personnel repaired the seep on February 6, 1992, by excavating around the impoundment side of the plugged pipe and filling in the area with bentonite, compacting the area, and installing sod over the excavation for erosion protection.

On January 30, 1992, an ORNL construction subcontractor inadvertently pumped a small volume of water from around freshly poured concrete in the course of dewatering an excavation in the ORNL main facility complex. The pumped water was being managed using BMPs to minimize sediment content before the water entered a drainage ditch which terminates in NPDES Outfall 204; however, it was not intended that water from around the poured concrete be pumped. Pumping was stopped as soon as it became apparent that concrete-bearing water was being pumped. Reminders were issued to construction personnel and construction management indicating discharge to storm drains of concrete-bearing water from concrete pouring or cleanup work is unacceptable.

Table 23. NPDES permit limit noncompliances, January 1992

Permit Location	Limit Violated	Limit			Value
Category I					
Outfall 101	Oil and grease	15.0	mg/L	daily max	119
Outfall 114	Oil and grease	15.0	mg/L	daily max	195
Category II					
Outfall 204	Oil and grease	15.0	mg/L	daily max	24
Outfall 209	Oil and grease	15.0	mg/L	daily max	23
Outfall 281	Oil and grease	15.0	mg/L	daily max	16
Outfall 283	Oil and grease	15.0	mg/L	daily max	21
	Total suspended solids	50.0	mg/L	daily max	64
Outfall 285	Oil and grease	15.0	mg/L	daily max	82

Table 24. NPDES permit limit noncompliances, February 1992

Permit Location	Limit Violated	Limit			Value
Category II					
Outfall 203	Oil and grease	15.0	mg/L	daily max	45
Outfall 207	Oil and grease	15.0	mg/L	daily max	17
Outfall 214	Oil and grease	15.0	mg/L	daily max	63
	Total suspended solids	50.0	mg/L	daily max	122
Outfall 216	Oil and grease	15.0	mg/L	daily max	61
Outfall 223	Oil and grease	15.0	mg/L	daily max	59
Outfall 224	Oil and grease	15.0	mg/L	daily max	41

Table 24. (continued)

Permit Location	Limit Violated	Limit			Value
Outfall 230	Oil and grease	15.0	mg/L	daily max	184
	Total suspended solids	50.0	mg/L	daily max	87
Outfall 231	Oil and grease	15.0	mg/L	daily max	81
Outfall 233	Oil and grease	15.0	mg/L	daily max	98
	Total suspended solids	50.0	mg/L	daily max	58
Outfall 234	Oil and grease	15.0	mg/L	daily max	21
Outfall 244	Oil and grease	15.0	mg/L	daily max	31
Outfall 249	Oil and grease	15.0	mg/L	daily max	38
Outfall 269	Oil and grease	15.0	mg/L	daily max	115
Sewage Treatment Plant (X01)	Oil and grease	15.0	mg/L	daily max	22
	Oil and grease	13.1	kg/D	daily max	16.8

Table 25. NPDES permit limit noncompliances, March 1992

Permit Location	Limit Violated	Limit			Value
Sewage Treatment Plant (X01)	Oil and grease	15.0	mg/L	daily max	18
	Oil and grease	15.0	mg/L	daily max	94
	Oil and grease	13.1	kg/D	daily max	60.6
	Oil and grease	10.0	kg/D	monthly avg	10.0

3.2.2.1.2 Exceedences of NPDES Permit Limits

The O&G and TSS exceedences that were noted at several Category I (storm) and Category II (parking lot, roof, storage area, and cooling water) drains were attributed to storm water runoff flushing of parking lots or streets.

3.2.2.2 February 1992

3.2.2.2.1 Inappropriate and/or Unpermitted Discharges

On February 10, 1992, the pH of the water in the ORNL White Oak Creek (WOC) Embayment rose to 10.6 standard units briefly after a grout release which occurred in the course of installing the WOC Embayment Sediment Barrier. Grouting activities were interrupted as soon as the release was observed.

On February 26, 1992, approximately one pint of hydraulic fluid was released to WOC Embayment and a sheen was temporarily visible on the surface of the Clinch River near the WOC Embayment mouth when a hydraulic hose ruptured on a jet-grouting unit. All measures have been taken to minimize the occurrence of hydraulic line failure.

3.2.2.2.2 Exceedences of NPDES Permit Limits

On February 27, 1992, an O&G exceedence occurred which resulted in a calculated Kg/d mass-load exceedence, thus two exceedences occurred at the Sewage Treatment Plant (STP). No certain cause has been established for the exceedence.

The O&G and TSS exceedences that were noted at several Category II (parking lot, roof, storage area, and cooling water) drains were attributed to storm water runoff flushing of parking lots or streets.

3.2.2.3 March 1992

3.2.2.3.1 Inappropriate and/or Unpermitted Discharges

On March 3, 1992, an underground sanitary sewer pipeline became clogged and overflowed to the ground surface through a manhole near Building 4500-N. Approximately 30 gallons of sewer water flowed approximately 50 feet across a grassy area and entered a storm drain catch basin that drains into WOC. ORNL personnel immediately placed straw bales around the storm drain catch basin to slow and filter the sewer water that was reaching the basin and curtailed water and restroom usage in the affected buildings upon discovery of the situation. ORNL personnel cleared the pipeline and normal service was restored.

On March 18, 29, and 31, 1992, oil drips from a jet-grouting unit resulted in three small visible sheens on WOC. Oil containment booms were placed on the surface of WOC as a safeguard against spills and releases.

3.2.2.3.2 Exceedences of NPDES Permit Limits

On March 3 and 12, 1992, two O&G exceedences occurred at STP. Based on the two O&G values, mass load and monthly average limits were also exceeded. ORNL personnel are in the process of implementing more stringent influent criteria at the STP.

3.3 GROUNDWATER

Regis S. Loffman and Dennis A. Wolf

Groundwater at ORNL is monitored to comply with 3004(U) of RCRA and to meet data needs for remediation activities. Because of the large number of Solid Waste Management Unit (SWMU) sites at ORNL located close to one another and the proven hydrologic interconnections between many of these units, individual monitoring and assessment was shown to be impractical. Therefore, the concept of waste area groupings (WAGs) has been developed to evaluate potential sources of releases to the environment. A WAG is a group of multiple sites that are geographically contiguous and/or hydrologically defined areas, and each WAG contains small, distinct drainage areas within which similar contaminants may have been introduced. Fig. 7 shows the location of the WAGs.

Groundwater quality monitoring wells at ORNL are designated as up-gradient perimeter or down-gradient perimeter depending on their location relative to the general direction of groundwater flow. Up-gradient wells are located to provide groundwater samples that are not expected to be affected by possible leakage from the site. Down-gradient wells are positioned along the perimeter of the site to detect possible groundwater contaminant migration from the site.

Table 26 contains a listing of all of the analyses conducted on groundwater at ORNL during first quarter 1992 and the regulatory limits associated with each. Not all parameters were quantified for each sample; however, Table 26 in conjunction with the sampling plan synopsis provided for each WAG can be used to determine the respective specific analyte lists. Groundwater and its related quality are not regulated like other environmental media (e.g., surface water by NPDES, air by CAA). Consequently, there are no mandated groundwater quality criteria. In an effort to provide a basis for evaluation of analytical results and for assessing groundwater quality at ORNL WAGs, drinking water limits and DOE DCGs have been used to analyze the analytical data. It should be emphasized that while drinking water limits are used herein it is unrealistic to assume that members of the public are going to drink groundwater from ORNL WAGs.

Duplicate, field blank, and trip blank samples are also collected with each WAG as part of the groundwater QA/QC program.

Two types of tables are presented which depict the monitoring parameters' values for each WAG sampled during first quarter 1992. The first table is a summary table presented by well type (i.e., down-gradient and up-gradient).

Fig. 7. ORNL WAGs.

Table 26. Analytes sought and applicable standards in groundwater at ORNL in WAGs 1 and 6 during January-March, 1992

Analyte	National Primary Drinking Water	National Secondary Drinking Water	Tennessee Primary Drinking Water	DOE	DCG
Anions (mg/L)					
Bromide					
Chloride		250			
Fluoride	4.0	2.0			
Nitrate	10				
Phosphate					
Sulfate (as SO ₄)		250			
Base/Neutral/Acid Extractable Organics^a (μg/L)					
1,2,4-Trichlorobenzene					
1,2-Dichlorobenzene					
1,3-Dichlorobenzene					
1,4-Dichlorobenzene	75				
2,4,5-Trichlorophenol					
2,4,6-Trichlorophenol					
2,4-Dichlorophenol					
2,4-Dimethylphenol					
2,4-Dinitrophenol					
2,4-Dinitrotoluene					
2,6-Dinitrotoluene					
2-Chloronaphthalene					
2-Chlorophenol					
2-Methylnaphthalene					
2-Methylphenol					
2-Nitroaniline					
2-Nitrophenol					
3,3'-Dichlorobenzidine					
3-Nitroaniline					
4,6-Dinitro-2-methylphenol					
4-Bromophenylphenyl ether					
4-Chloro-3-methylphenol					
4-Chloroaniline					
4-Chlorophenylphenyl ether					
4-Methylphenol					
4-Nitroaniline					
4-Nitrophenol					
Acenaphthene					
Acenaphthylene					

Table 26. (continued)

Analyte	National Primary Drinking Water	National Secondary Drinking Water	Tennessee Primary Drinking Water	DOE DCG
Anthracene				
Benzo(a)anthracene				
Benzo(a)pyrene				
Benzo(b)fluoranthene				
Benzo(ghi)perylene				
Benzo(k)fluoranthene				
Benzoic acid				
Benzyl alcohol				
Benzyl butyl phthalate				
Bis(2-chloroethoxy) methane				
Bis(2-chloroethyl) ether				
Bis(2-chloroisopropyl) ether				
Bis(2-ethylhexyl) phthalate				
Chrysene				
Di-n-butylphthalate				
Di-n-octylphthalate				
Dibenzo(a,h)anthracene				
Dibenzofuran				
Diethyl phthalate				
Dimethyl phthalate				
Fluoranthene				
Fluorene				
Hexachlorobenzene				
Hexachlorobutadiene				
Hexachlorocyclopentadiene				
Hexachloroethane				
Indeno(1,2,3-cd)pyrene				
Isophorone				
N-Nitrosodi-n-propylamine				
N-Nitrosodiphenylamine				
Naphthalene				
Nitrobenzene				
Pentachlorophenol				
Phenanthrene				
Phenol				
Pyrene				
Field Measurements				
Conductivity (mS/cm)				
Dissolved oxygen (ppm)				
Redox (mV)				

Table 26. (continued)

Analyte	National Primary Drinking Water	National Secondary Drinking Water	Tennessee Primary Drinking Water	DOE	DCG
Temperature (°C)			30.5		
Turbidity (JTU)	1.0				
pH (SU)		(6.5, 8.5)	(6.0, 9.0)		
Metals (mg/L)					
Aluminum		0.20			
Antimony					
Arsenic	0.050		0.050		
Barium	2.0				
Beryllium					
Boron					
Cadmium	0.010		0.010		
Calcium					
Chromium	0.050		0.050		
Cobalt					
Copper		1.0			
Iron		0.30			
Lead	0.050		0.050		
Lithium					
Magnesium					
Manganese		0.050			
Mercury	0.0020		0.0020		
Molybdenum					
Nickel					
Phosphorus					
Potassium					
Selenium	0.010		0.010		
Silicon					
Silver		0.10	0.050		
Sodium					
Strontium					
Thallium					
Tin					
Titanium					
Vanadium					
Zinc		5.0			
Zirconium					
Others					
Alkalinity (mg/L)					
Phenolics, total recoverable (mg/L)					

Table 26. (continued)

Analyte	National Primary Drinking Water	National Secondary Drinking Water	Tennessee Primary Drinking Water	DOE	DCG
Total dissolved solids (mg/L)		500	500		
Total organic carbon (mg/L)					
Total organic halides ($\mu\text{g/L}$)					
Total suspended solids (mg/L)					
Radionuclides (Bq/L) ^b					
Co-60					7.4
Cs-137					4.44
Gross alpha	0.555				
Gross beta	1.85				
H-3	740			2,960	
Total rad Sr	0.296				1.48
Volatile Organics ($\mu\text{g/L}$) ^a					
1,1,1-Trichloroethane	200		200		
1,1,2,2-Tetrachloroethane					
1,1,2-Trichloroethane					
1,1-Dichloroethane					
1,1-Dichloroethene	7.0		7.0		
1,2-Dichloroethane	5.0		5.0		
1,2-Dichloroethene					
1,2-Dichloropropane					
2-Butanone					
2-Hexanone					
4-Methyl-2-pentanone					
Acetone					
Benzene	5.0		5.0		
Bromodichloromethane	100				
Bromoform	100				
Bromomethane					
Carbon disulfide					
Carbon tetrachloride	5.0		5.0		
Chlorobenzene					
Chloroethane	200				
Chloroform	100				
Chloromethane					
Dibromochloromethane	100				
Ethylbenzene					
Methylene chloride					
Styrene					
Tetrachloroethene					

Table 26. (continued)

Analyte	National Primary Drinking Water	National Secondary Drinking Water	Tennessee Primary Drinking Water	DOE DCG
Toluene				
Trichloroethene	5.0		5.0	
Vinyl acetate				
Vinyl chloride	2.0		2.0	
Xylene, total				
cis-1,3-Dichloropropene				
trans-1,3-Dichloropropene				

^aDivide $\mu\text{g/L}$ by 1000 to convert to mg/L .

^bDivide Bq/L by 0.037 to convert to pCi/L .

The table contains the number of detected values and the total number of samples; the maximum, minimum, and average of all values; and the standard error of the mean. Various prefixes with different meanings precede the maxima and minima, "U" (analyte was undetected and the instrument was calibrated at the associated value), "<" (the analyte was not able to be quantified above the associated value), "J" (below quantification, estimated), "B" (found in the associated laboratory blank), "JB" (estimated and found in the associated laboratory blank), "E" (value exceeded instrument calibration range, estimated), "Y" (value from reanalysis after dilution when calibration range was exceeded).

The second table contains WAG-specific values which exceed a reference value. This reference value may be a regulatory limit or, for analytes which do not have regulatory limits, one time the laboratory detection limit was used as a rough rule for assessing the presence of contaminants (or ten times in the case of common organic laboratory contaminants). Tentatively identified compounds (TICs) are also presented in this table of exceedences.

All radionuclide values are corrected for background. A radionuclide value is determined to be significantly greater than zero when the value exceeds 1.645 times its estimated standard error.

A number of the wells show vinyl chloride results of "U 10 $\mu\text{g/L}$ " which appear to exceed the primary drinking water standard of 2 $\mu\text{g/L}$. A better way to interpret these results is that vinyl chloride was undetected and the instrument used in the analysis was able to accurately detect vinyl chloride at 10 $\mu\text{g/L}$ or above. It is unlikely but not guaranteed that vinyl chloride was present in the sample; an estimated value (i.e., a value less than 10, accompanied by a "J" prefix) would have been returned by the laboratory if the instrument detected vinyl chloride.

3.3.1 WAG 1

3.3.1.1 Program Description

The sites at WAG 1 are currently remedial action sites regulated under RCRA Part 3004(u). ORNL has sampled WAG 1 perimeter wells every year since 1988 and has plans to continue sampling every year.

WAG 1 consists of an area covering much of the ORNL main plant site (Figs. 8-12). It contains many types of SWMUs listed by EPA in the definition of a SWMU (tanks, ponds, waste water treatment facilities, leak sites, spill sites, landfills).

Parameters measured consisted of the Toxic Compound List for organics, metals by atomic absorption for mercury and potassium, metals by ICP/MS (antimony, arsenic, lead, mercury, selenium, silver, and thallium), metals by ICP, anions (bromide, chloride, fluoride, nitrate, phosphate, and sulfate), total organic halides, total organic carbon, total dissolved solids, total suspended solids, alkalinity, radionuclides (H-3, total radioactive Sr, gamma emitting isotopes, gross alpha, and gross beta), and field parameters (pH, specific conductance, temperature, dissolved oxygen, redox, and turbidity).

0001-006-89-15806

Fig. 8. Location map of WAG 1.

Fig. 9. Location map of wells in the 1000 area of WAG 1.

Fig. 10. Location map of wells in the 2000 area of WAG 1.

Fig. 11. Location map of wells in the 3000 area of WAG 1.

Fig. 12. Location map of wells in the 4000 area of WAG 1.

Twenty-seven wells comprise the groundwater perimeter well network at WAG 1; wells 814, 818, and 819 are the up-gradient wells for WAG 1.

3.3.1.2 Results

Perimeter wells at WAG 1 were sampled January 13 - February 24, 1992. Well 817 was dry and no samples were collected. A summary of the analytical results by well type (i.e., up-gradient and down-gradient) is presented in Table 27; Table 28 presents the data which exceed some reference criteria.

Well 812 continues to show gross alpha and gross beta activity. Past analyses have determined the gross alpha activity to be attributed to uranium isotopes. Isotopic identification was not performed during this sampling period. The gross beta activity is attributable mainly to the total radioactive strontium and its daughters.

Well 806 continues to show gross beta activity, primarily attributable to total radioactive strontium and its daughters. Well 830 continues to exhibit elevated levels of tritium.

3.3.2 SWSA 6

3.3.2.1 Program Description

Groundwater in Solid Waste Storage Area (SWSA) 6 is monitored to comply with Tennessee's Hazardous Waste Management Rule 1200-1-11-.05 (6) (a) 4. (iv). SWSA 6 is one of three SWMUs that make up WAG 6. WAG 6 is located about 1.5 km southwest of the ORNL main site. Besides SWSA 6, WAG 6 is made up of the Emergency Waste Basin and the Explosives Detonation Trench. SWSA 6 was opened for limited disposal in 1969, began full-scale operation in 1973, and it still receives radioactive wastes. In the course of its operation, SWSA 6 has received a broad spectrum of low-level waste (LLW) materials. The basin has not been used since its construction was completed in 1962. The Explosives Detonation Trench is used for explosive and shock-sensitive chemicals requiring disposal.

The wells at SWSA 6 are divided into three types: up-gradient perimeter, down-gradient perimeter, and internal site-characterization wells which provide information about conditions within the site. The SWSA 6 data reported here pertains only to the up- and down-gradient perimeter wells.

SWSA 6 is currently being monitored as part of RCRA assessment monitoring. Fig. 13 shows the groundwater monitoring well network. Ten of the wells at SWSA 6 (wells 840-844, 847, 1242-1245) are monitored quarterly for ten volatile organic compounds, alkalinity, gross-alpha, total radioactive strontium, Co-60, Cs-137, tritium, alkalinity, and field parameters as part of this program. The remaining 16 wells are monitored semi-annually. During first quarter 1992 these wells were monitored for indicator parameters only (TOX, TOC, gross alpha, gross beta, tritium, and field parameters).

Table 27. ORNL WAG 1 groundwater summary statistics from
January 13-February 24, 1992

Analyte	N det/ N total	Concentration			Standard error ^c
		Max ^a	Min ^a	Av ^b	
Down-gradient Well Type					
Anions (mg/L) -- Unfiltered					
Chloride	23/23	95	1.4	20*	4.8
Fluoride	15/23	3.6	< 0.10	~ 0.60*	0.17
Nitrate	3/23	8.0	< 1.0	~ 1.6*	0.36
Sulfate (as SO ₄)	22/23	110	< 1.0	~ 34*	6.7
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered					
Bis(2-chloroisopropyl) ether	1/23	U 10	J 0.10	~ 9.6*	0.43
N-Nitrosodi-n-propylamine	1/23	U 10	J 8.0	~ 9.9*	0.087
Pyrene	1/23	U 10	J 0	~ 9.6*	0.43
Field Measurements -- Unfiltered					
Conductivity (mS/cm)	23/23	1.1	0.22	0.47*	0.042
Dissolved oxygen (ppm)	23/23	12	1.9	5.7*	0.52
Redox (mV)	23/23	170	-81	100*	15
Temperature (°C)	23/23	19	4.6	14*	0.60
Turbidity (JTU)	23/23	1,000	40	380*	45
pH (SU)	23/23	9.0	6.7	7.3*	0.095
Metals (mg/L) -- Filtered					
Aluminum	7/23	0.074	< 0.050	~ 0.055*	0.0016
Antimony	1/23	0.012	< 0.0050	~ 0.0053*	0.00030
Barium	23/23	0.27	0.0015	0.097*	0.017
Boron	6/23	1.0	< 0.080	~ 0.18*	0.051
Calcium	23/23	130	0.94	79*	7.8
Chromium	15/23	0.017	< 0.0040	~ 0.0069*	0.00065
Copper	8/23	0.035	< 0.0070	~ 0.0096*	0.0013
Iron	9/23	14	< 0.050	~ 1.8*	0.79
Magnesium	23/23	29	0.43	16*	1.8
Manganese	13/23	5.2	< 0.0010	~ 0.88*	0.32
Nickel	7/23	0.024	< 0.0040	~ 0.0059*	0.0011
Potassium	23/23	7.3	0.36	2.0*	0.30
Silicon	23/23	7.5	2.6	4.7*	0.29
Sodium	18/23	270	< 5.0	~ 37*	15
Strontium	1/1	0.24	0.24	0.24	d
Vanadium	1/23	0.0020	< 0.0020	~ 0.0020*	0.0000013

Table 27. (continued)

Analyte	N det/ N total	Concentration			Standard error ^c
		Max ^a	Min ^a	Av ^b	
Metals (mg/L) -- Unfiltered					
Aluminum	12/23	0.85	< 0.050	~ 0.16*	0.040
Barium	23/23	0.30	0.012	0.11*	0.017
Boron	6/23	1.1	< 0.080	~ 0.19*	0.057
Calcium	23/23	160	1.2	83*	8.7
Chromium	17/23	0.033	< 0.0040	~ 0.0088*	0.0013
Iron	17/23	16	< 0.050	~ 2.1*	0.87
Magnesium	23/23	29	0.47	17*	1.8
Manganese	23/23	6.6	0.0015	0.96*	0.36
Nickel	9/23	0.024	< 0.0040	~ 0.0063*	0.0011
Potassium	23/23	7.6	0.29	1.7*	0.32
Silicon	23/23	8.4	2.7	5.0*	0.32
Sodium	19/23	280	< 5.0	~ 38*	15
Strontium	1/1	0.23	0.23	0.23	d
Vanadium	3/23	0.0025	< 0.0020	~ 0.0020*	0.000022
Zinc	3/23	0.039	< 0.0050	~ 0.0069*	0.0015
Others -- Filtered					
Alkalinity (mg/L)	23/23	470	110	290*	18
Total dissolved solids (mg/L)	23/23	700	180	410*	30
Others -- Unfiltered					
Alkalinity (mg/L)	23/23	470	110	290*	18
Total organic carbon (mg/L)	23/23	6.6	0.88	2.6*	0.31
Total organic halides (µg/L)	10/23	190	5.0	22*	8.0
Total suspended solids (mg/L)	13/23	34	< 5.0	~ 11*	1.9
Radionuclides (Bq/L) -- Filtered					
Co-60	2/23	0.90*	-0.80	0.17*	0.084
Cs-137	2/23	0.80	-1.0	0.13*	0.078
Gross alpha	13/23	11*	-0.023	0.55	0.48
Gross beta	15/23	470*	-0.15	21	20
H-3	19/23	1,100*	-86	140*	51
Total rad Sr	14/23	290*	0.010	13	13
Radionuclides (Bq/L) -- Unfiltered					
Cs-137	4/23	1.6*	-1.1	0.17	0.12
Gross alpha	13/23	11*	-0.024	0.55	0.48
Gross beta	20/23	510*	0.060	23	22
H-3	19/23	1,000*	-81	150*	50
Total rad Sr	13/23	310*	-0.015	14	13

Table 27. (continued)

Analyte	N det/ N total	Concentration			
		Max ^a	Min ^a	Av ^b	Standard error ^c
Volatile Organics (µg/L) -- Unfiltered					
Acetone	7/23	B 34	JB 3.0	~ 9.9*	1.2
Benzene	4/23	8.0	J 1.0	~ 5.0*	0.26
Carbon disulfide	5/23	13	JB 2.0	~ 5.0*	0.43
Chloroform	2/23	8.0	U 5.0	~ 5.1*	0.13
Methylene chloride	4/23	7.0	JB 1.0	~ 4.7*	0.26
Styrene	2/23	U 5.0	J 1.0	~ 4.7*	0.21
Trichloroethene	2/23	J 5.0	J 4.0	~ 5.0*	0.043
Vinyl chloride	1/23	22	U 10	~ 11*	0.52
Up-gradient Well Type					
Anions (mg/L) -- Unfiltered					
Chloride	3/3	9.2	2.4	5.3	2.0
Fluoride	2/3	0.60	0.20	~ 0.37*	0.12
Nitrate	2/3	5.6	< 1.0	~ 2.7	1.5
Sulfate (as SO ₄)	3/3	41	19	33*	7.0
Field Measurements -- Unfiltered					
Conductivity (mS/cm)	3/3	0.47	0.32	0.38*	0.042
Dissolved oxygen (ppm)	3/3	8.3	7.5	8.0*	0.25
Redox (mV)	3/3	160	3.3	99	49
Temperature (°C)	3/3	13	13	13*	0.045
Turbidity (JTU)	3/3	130	76	98*	15
pH (SU)	3/3	7.9	7.3	7.6*	0.18
Metals (mg/L) -- Filtered					
Aluminum	3/3	0.076	0.054	0.064*	0.0063
Barium	3/3	0.21	0.050	0.13	0.047
Boron	1/3	0.20	< 0.080	~ 0.12*	0.040
Calcium	3/3	110	37	77*	20
Chromium	3/3	0.010	0.0056	0.0078*	0.0013
Copper	2/3	0.012	< 0.0070	~ 0.0097*	0.0016
Magnesium	3/3	28	15	22*	3.8
Manganese	2/3	0.0031	< 0.0010	~ 0.0021*	0.00061
Nickel	2/3	0.0048	< 0.0040	~ 0.0043*	0.00026
Potassium	3/3	1.8	1.1	1.4*	0.23
Silicon	3/3	6.9	4.2	5.3*	0.82
Sodium	2/3	29	< 5.0	~ 14	7.5

Table 27. (continued)

Analyte	N det/ N total	Concentration			
		Max ^a	Min ^a	Av ^b	Standard error ^c
Metals (mg/L) -- Unfiltered					
Barium	3/3	0.23	0.059	0.14	0.049
Boron	1/3	0.21	< 0.080	~ 0.12	0.043
Calcium	3/3	110	41	82*	21
Chromium	3/3	0.010	0.0068	0.0086*	0.0010
Magnesium	3/3	30	17	24*	3.6
Manganese	3/3	0.0053	0.0034	0.0045*	0.00058
Potassium	3/3	1.1	0.86	0.94*	0.080
Silicon	3/3	7.3	4.5	5.5*	0.89
Sodium	2/3	33	< 5.0	~ 16	8.5
Vanadium	1/3	0.0025	< 0.0020	~ 0.0022*	0.00016
Zinc	1/3	0.0072	< 0.0050	~ 0.0057*	0.00073
Others -- Filtered					
Alkalinity (mg/L)	3/3	340	250	280*	31
Total dissolved solids (mg/L)	3/3	400	290	340*	34
Others -- Unfiltered					
Alkalinity (mg/L)	3/3	350	240	280*	33
Total organic carbon (mg/L)	3/3	2.0	1.1	1.4*	0.26
Radionuclides (Bq/L) -- Filtered					
Cs-137	1/3	0.20*	-0.050	0.047	0.078
Gross beta	2/3	0.25*	0.040	0.18	0.070
H-3	2/3	180*	-30	83	61
Total rad Sr	1/3	0.18*	0.10	0.14*	0.023
Radionuclides (Bq/L) -- Unfiltered					
Co-60	1/3	0.23*	0.010	0.12	0.064
Cs-137	1/3	0.25*	-0.080	0.12	0.10
Gross alpha	1/3	0.12*	0.027	0.070	0.027
Gross beta	2/3	0.43*	0.12	0.24	0.096
H-3	2/3	140*	-2.0	83	43
Total rad Sr	1/3	0.17*	0.020	0.10	0.044

Table 27. (continued)

Analyte	N det/ N total	Concentration			Standard error ^c
		Max ^a	Min ^a	Av ^b	
Volatile Organics (µg/L) -- Unfiltered					
1,1,1-Trichloroethane	1/3	U 5.0	J 3.0	~ 4.3*	0.67
Acetone	3/3	B 91	JB 4.0	~ 34	29
Benzene	2/3	6.0	J 1.0	~ 4.0	1.5
Carbon disulfide	3/3	32	JB 2.0	~ 13	9.5
Styrene	1/3	U 5.0	J 2.0	~ 4.0*	1.0

^aPrefixes containing J, B, E, U or < mean that the value was estimated, found in the laboratory blank, exceeded the calibration range, was not detected at that level, or was not quantified at that level, respectively. Radionuclide values that are significantly greater than zero are identified by an *.

^bAverage concentrations significantly greater than zero are identified by an *. The ~ prefix indicates that estimated values were used in the calculation of the average.

^cStandard error of the mean.

^dNot applicable.

Table 28. ORNL WAG 1 groundwater constituents that exceed a reference value from January 13-February 24, 1992

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Well 806, Sampling Date 13JAN92				
Ground Elevation 774.94 ft, Water Elevation 773.08				
Metals (mg/L) -- Filtered				
Iron	11	c	0.3	3
Manganese	4.5	c	0.05	3
Metals (mg/L) -- Unfiltered				
Iron	11	c	0.3	3
Manganese	4.2	c	0.05	3
Radionuclides (Bq/L) -- Filtered				
Gross beta	10*	1.0	1.85	2
Total rad Sr	5.9*	0.60	0.296	2
Radionuclides (Bq/L) -- Unfiltered				
Gross beta	10*	1.0	1.85	2
Total rad Sr	6.0*	0.70	0.296	2
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Volatile Organics-TICs (µg/L) -- Unfiltered				
Sulfurdioxide-4.94	J 51	c	c	T
Well 807, Sampling Date 17JAN92				
Ground Elevation 774.53 ft, Water Elevation 770.64				
BNAE Organics-TICs (µg/L) -- Unfiltered				
Unknown-31.21	J 5.0	c	c	T
Unknown-33.92	J 9.0	c	c	T
Unknown-35.73	J 8.0	c	c	T
Unknown-38	J 6.0	c	c	T
Unknown-40.88	J 7.0	c	c	T
Unknown-44.56	J 6.0	c	c	T

Table 28. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Metals (mg/L) -- Filtered				
Iron	3.5	c	0.3	3
Manganese	5.2	c	0.05	3
Sodium	39	c	5.0	D
Metals (mg/L) -- Unfiltered				
Iron	4.0	c	0.3	3
Manganese	6.6	c	0.05	3
Sodium	43	c	5.0	D
Others -- Filtered				
Total dissolved solids (mg/L)	580	c	500	1
Others -- Unfiltered				
Total organic carbon (mg/L)	6.6	0.39	0.50	D
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 808, Sampling Date 21JAN92				
Ground Elevation 774.50 ft, Water Elevation 770.94				
BNAE Organics-TICs (µg/L) -- Unfiltered				
Unknown-31.18	J 5.0	c	c	T
Unknown-33.92	J 5.0	c	c	T
Metals (mg/L) -- Filtered				
Boron	1.0	c	0.080	D
Sodium	240	c	5.0	D
Metals (mg/L) -- Unfiltered				
Boron	1.1	c	0.080	D
Sodium	260	c	5.0	D
Others -- Filtered				
Total dissolved solids (mg/L)	640	c	500	1

Table 28. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Others -- Unfiltered				
Total organic halides (µg/L)	54	11	5.0	D
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 809, Sampling Date 22JAN92 Ground Elevation 776.74 ft, Water Elevation 773.23				
Metals (mg/L) -- Filtered				
Iron	14	c	0.3	3
Manganese	1.3	c	0.05	3
Metals (mg/L) -- Unfiltered				
Aluminum	0.31	c	0.2	3
Iron	16	c	0.3	3
Manganese	1.4	c	0.05	3
Sodium	28	c	5.0	D
Others -- Filtered				
Total dissolved solids (mg/L)	600	c	500	1
Others -- Unfiltered				
Total organic carbon (mg/L)	6.1	0.21	0.50	D
Total organic halides (µg/L)	190	58	5.0	D
Total suspended solids (mg/L)	34	c	5.0	D
Radionuclides (Bq/L) -- Filtered				
Total rad Sr	0.45*	0.21	0.296	2
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Volatile Organics-TICs (µg/L) -- Unfiltered				
Unknown-7.31	J 5.0	c	c	T

Table 28. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Well 810, Sampling Date 23JAN92				
Ground Elevation 790.19 ft, Water Elevation 787.24				
BNAE Organics-TICs (µg/L) -- Unfiltered				
Unknown-41.52	J 4.0	c	c	T
Unknown-43.22	J 4.0	c	c	T
Metals (mg/L) -- Unfiltered				
Manganese	0.074	c	0.05	3
Nickel	0.021	c	0.0040	D
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 811, Sampling Date 24JAN92				
Ground Elevation 791.00 ft, Water Elevation 789.77				
BNAE Organics-TICs (µg/L) -- Unfiltered				
Unknown-44.49	J 5.0	c	c	T
Field Measurements -- Unfiltered				
pH (SU)	9.0	0.029	(6.5, 8.5)	3
Metals (mg/L) -- Filtered				
Boron	0.82	c	0.080	D
Sodium	270	c	5.0	D
Metals (mg/L) -- Unfiltered				
Boron	0.85	c	0.080	D
Sodium	280	c	5.0	D
Others -- Filtered				
Total dissolved solids (mg/L)	700	c	500	1
Others -- Unfiltered				
Total organic halides (µg/L)	38	8.1	5.0	D

Table 28. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 812, Sampling Date 24FEB92				
Ground Elevation 803.19 ft, Water Elevation 798.63				
Metals (mg/L) -- Unfiltered				
Iron	0.53	c	0.3	3
Radionuclides (Bq/L) -- Filtered				
Gross alpha	11*	1.0	0.555	2
Gross beta	470*	10	1.85	2
Total rad Sr	290*	60	0.296	2
Radionuclides (Bq/L) -- Unfiltered				
Gross alpha	11*	1.0	0.555	2
Gross beta	510*	10	1.85	2
Total rad Sr	310*	50	0.296	2
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Volatile Organics-TICs (µg/L) -- Unfiltered				
1,2,2-Trifluoro-chloro-7.83	J 7.0	c	c	T
Well 813, Sampling Date 27JAN92				
Ground Elevation 848.86 ft, Water Elevation 798.74				
Radionuclides (Bq/L) -- Filtered				
Total rad Sr	0.66*	0.22	0.296	2
Volatile Organics (µg/L) -- Unfiltered				
Benzene	7.0	c	5	1
Vinyl chloride	U 10	c	2	1

Table 28. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Well 814, Sampling Date 14JAN92				
Ground Elevation 877.00 ft, Water Elevation 810.58				
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Volatile Organics-TICs (µg/L) -- Unfiltered				
Sulfurdioxide-4.92	J 350	c	c	T
Well 815, Sampling Date 29JAN92				
Ground Elevation 823.99 ft, Water Elevation 816.75				
Metals (mg/L) -- Unfiltered				
Aluminum	0.85	c	0.2	3
Iron	0.66	c	0.3	3
Manganese	0.061	c	0.05	3
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 816, Sampling Date 28JAN92				
Ground Elevation 823.44 ft, Water Elevation 817.21				
Metals (mg/L) -- Unfiltered				
Aluminum	0.50	c	0.2	3
Iron	0.35	c	0.3	3
Others -- Unfiltered				
Total suspended solids (mg/L)	29	c	5.0	D
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1

Table 28. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Well 818, Sampling Date 15JAN92				
Ground Elevation 851.55 ft, Water Elevation 816.23				
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 819, Sampling Date 16JAN92				
Ground Elevation 827.83 ft, Water Elevation 804.63				
Metals (mg/L) -- Filtered				
Sodium	29	c	5.0	D
Metals (mg/L) -- Unfiltered				
Sodium	33	c	5.0	D
Volatile Organics (µg/L) -- Unfiltered				
Benzene	6.0	c	5	1
Carbon disulfide	32	c	5.0	D
Well 820, Sampling Date 30JAN92				
Ground Elevation 807.35 ft, Water Elevation 801.93				
Metals (mg/L) -- Unfiltered				
Aluminum	0.25	c	0.2	3
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 821, Sampling Date 30JAN92				
Ground Elevation 808.55 ft, Water Elevation 800.28				
Metals (mg/L) -- Filtered				
Sodium	46	c	5.0	D

Table 28. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Metals (mg/L) -- Unfiltered				
Sodium	43	c	5.0	D
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 822, Sampling Date 29JAN92				
Ground Elevation 797.58 ft, Water Elevation 797.20				
Metals (mg/L) -- Unfiltered				
Iron	0.33	c	0.3	3
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 823, Sampling Date 31JAN92				
Ground Elevation 799.51 ft, Water Elevation 793.08				
Metals (mg/L) -- Filtered				
Manganese	0.49	c	0.05	3
Nickel	0.024	c	0.0040	D
Sodium	32	c	5.0	D
Metals (mg/L) -- Unfiltered				
Manganese	0.49	c	0.05	3
Nickel	0.024	c	0.0040	D
Sodium	31	c	5.0	D
Others -- Filtered				
Total dissolved solids (mg/L)	520	c	500	1
Others -- Unfiltered				
Total organic carbon (mg/L)	2.5	0.050	0.50	D
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1

Table 28. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Well 824, Sampling Date 12FEB92				
Ground Elevation 787.05 ft, Water Elevation 780.21				
Metals (mg/L) -- Filtered				
Manganese	0.75	c	0.05	3
Metals (mg/L) -- Unfiltered				
Manganese	0.64	c	0.05	3
Others -- Unfiltered				
Total organic carbon (mg/L)	3.2	0.10	0.50	D
Total organic halides (µg/L)	31	8.1	5.0	D
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Volatile Organics-TICs (µg/L) -- Unfiltered				
Unknown-31.15	J 6.0	c	c	T
Well 825, Sampling Date 13FEB92				
Ground Elevation 787.96 ft, Water Elevation 778.33				
Others -- Unfiltered				
Total organic halides (µg/L)	30	16	5.0	D
Volatile Organics (µg/L) -- Unfiltered			-	
Vinyl chloride	22	c	2	1
Well 826, Sampling Date 12FEB92				
Ground Elevation 788.07 ft, Water Elevation 780.44				
Metals (mg/L) -- Filtered				
Iron	7.6	c	0.3	3
Manganese	1.7	c	0.05	3

Table 28. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Metals (mg/L) -- Unfiltered				
Iron	8.4	c	0.3	3
Manganese	1.7	c	0.05	3
Others -- Filtered				
Total dissolved solids (mg/L)	510	c	500	1
Others -- Unfiltered				
Total organic carbon (mg/L)	4.6	0.24	0.50	D
Total organic halides (µg/L)	~ 27	29	5.0	D
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Volatile Organics-TICs (µg/L) -- Unfiltered				
Unknown-5.66	J 6.0	c	c	T
Unknown-5.76	J 7.0	c	c	T
Well 827, Sampling Date 14FEB92				
Ground Elevation 784.63 ft, Water Elevation 779.67				
Volatile Organics (µg/L) -- Unfiltered				
Benzene	8.0	c	5	1
Vinyl chloride	U 10	c	2	1
Well 828, Sampling Date 18FEB92				
Ground Elevation 814.11 ft, Water Elevation 777.84				
Others -- Unfiltered				
Total suspended solids (mg/L)	33	c	5.0	D
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1

Table 28. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Well 829, Sampling Date 14FEB92				
Ground Elevation 775.56 ft, Water Elevation 774.13				
Metals (mg/L) -- Filtered				
Iron	0.62	c	0.3	3
Manganese	1.6	c	0.05	3
Metals (mg/L) -- Unfiltered				
Iron	0.67	c	0.3	3
Manganese	1.6	c	0.05	3
Radionuclides (Bq/L) -- Filtered				
Total rad Sr	0.60*	0.26	0.296	2
Radionuclides (Bq/L) -- Unfiltered				
Total rad Sr	0.60*	0.26	0.296	2
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 830, Sampling Date 24FEB92				
Ground Elevation 778.35 ft, Water Elevation 771.64				
Metals (mg/L) -- Filtered				
Iron	2.0	c	0.3	3
Manganese	3.5	c	0.05	3
Metals (mg/L) -- Unfiltered				
Iron	2.4	c	0.3	3
Manganese	3.9	c	0.05	3
Others -- Filtered				
Total dissolved solids (mg/L)	510	c	500	1
Others -- Unfiltered				
Total organic carbon (mg/L)	4.6	0.17	0.50	D

Table 28. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Radionuclides (Bq/L) -- Filtered				
Gross beta	3.2*	0.30	1.85	2
H-3	1,100*	100	740	2
Total rad Sr	1.2*	0.30	0.296	2
Radionuclides (Bq/L) -- Unfiltered				
Gross beta	3.0*	0.30	1.85	2
H-3	1,000*	100	740	2
Total rad Sr	1.5*	0.30	0.296	2
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 946, Sampling Date 21FEB92				
Ground Elevation 777.74 ft, Water Elevation 771.89				
Metals (mg/L) -- Filtered				
Iron	1.1	c	0.3	3
Manganese	1.1	c	0.05	3
Metals (mg/L) -- Unfiltered				
Aluminum	0.32	c	0.2	3
Iron	1.4	c	0.3	3
Manganese	1.2	c	0.05	3
Radionuclides (Bq/L) -- Filtered				
Total rad Sr	0.78*	0.27	0.296	2
Radionuclides (Bq/L) -- Unfiltered				
Total rad Sr	0.73*	0.25	0.296	2
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1

Table 28. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Well 947, Sampling Date 20FEB92				
Ground Elevation 778.82 ft, Water Elevation 769.76				
Metals (mg/L) -- Filtered				
Boron	0.41	c	0.080	D
Sodium	51	c	5.0	D
Metals (mg/L) -- Unfiltered				
Boron	0.46	c	0.080	D
Sodium	55	c	5.0	D
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1

^aPrefixes containing J, B, E, U or < mean that the value was estimated, found in the laboratory blank, exceeded the calibration range, was not detected at that level, or was not quantified at that level, respectively. Radionuclide values that are significantly greater than zero are identified by an *.

^bIf a reference limit exists, the source is coded as:

- 1 Rules of Tennessee Department of Environment and Conservation, Division of Water Pollution Control, Chapter 1200-4-3, General Water Quality Criteria, as amended.
- 2 40CFR Part 141--National Primary Drinking Water Regulations, Subparts B and G, as amended.
- 3 40CFR Part 143--National Secondary Drinking Water Regulations, as amended.
- 4 DOE Order 5400.5, Chapter III, Derived Concentration Guides for Air and Water, as amended.

D The value exceeds 5 (10) times the laboratory detection limit.

T A tentatively identified compound (TIC).

^cNot applicable.

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Fig. 13. Location map of WAG 6.

3.3.2.2 Results

The 26 perimeter assessment wells at SWSA 6 were sampled February 27 - March 31, 1992. A summary of the analytical results for the assessment wells is presented in Table 29; Table 30 presents the data which exceed some reference criteria for all of the assessment wells.

Wells 842 and 844 exhibit the highest level of volatile organic contamination, including carbon tetrachloride, chloroform, 1,2-dichloroethane, and trichloroethene in 842 and carbon disulfide in 844. Tritium levels are highest at wells 1243, 843, 1242, 841, 842, and 847 with levels ranging from 3,600 to 67,000 Bq/L.

3.3.3 Off-Site

3.3.3.1 Program Description

Under the direction of the Energy Systems Environmental and Safety Activities (E&SA) Organization, ORNL implemented a long-term, off-site, residential drinking water quality monitoring program in 1989. The objective of the program is to document water quality from groundwater sources in areas adjacent to the ORR. It is also used to evaluate the impact of DOE-OR plant operations on the quality of these ground water sources.

Nineteen wells were selected on the basis of their proximity to the ORR and a representative distribution of sources from the different geologic formations of the area. The wells were sampled during February 10-21, 1992. Analytical parameters used for monitoring include volatile organics; selected atomic absorption metals (As, Hg, Pb, Se); inductively coupled argon plasma metals; anions (fluoride, chloride, sulfate, nitrate, and nitrite); total fluorometric uranium; and the radioactivity parameters gross alpha, gross beta, total radioactive strontium, Tc-99, H-3, and radionuclides observed in a gamma scan. These data are presented in Table 31.

3.3.3.2 Results

Only one of the wells had a parameter that exceeded a primary drinking water standard. The well is a deep one, drilled into the Conasauga geologic formation. The high measurements of fluoride and pH consistently seen in this well are typical of wells that penetrate the Conasauga group.

Table 29. ORNL SWSA 6 groundwater summary statistics from
February 27-March 31, 1992

Analyte	N det/ N total	Concentration			
		Max ^a	Min ^a	Av ^b	Standard error ^c
Quarterly Assessment Wells: Down-gradient Well Type					
Field Measurements -- Unfiltered					
Conductivity (mS/cm)	10/10	0.74	0.12	0.41*	0.055
Dissolved oxygen (ppm)	10/10	8.9	3.2	5.6*	0.46
Redox (mV)	10/10	200	140	170*	5.9
Temperature (°C)	10/10	14	10	13*	0.34
Turbidity (JTU)	10/10	440	13	69	41
pH (SU)	10/10	7.9	6.8	7.2*	0.10
Others -- Unfiltered					
Alkalinity (mg/L)	10/10	430	130	290*	31
Radionuclides (Bq/L) -- Filtered					
Co-60	2/10	28*	-1.6	4.1	2.9
Gross alpha	3/10	0.45*	-0.028	0.068	0.043
H-3	9/10	67,000*	15	14,000*	7,000
Total rad Sr	4/10	0.37*	-0.10	0.12*	0.044
Volatile Organics (µg/L) -- Unfiltered					
1,2-Dichloroethane	1/10	8.0	U 5.0	~ 5.3*	0.30
1,2-Dichloroethene	1/10	5.0	U 5.0	~ 5.0	0
Acetone	3/10	B 21	JB 2.0	~ 9.6*	1.6
Benzene	2/10	U 5.0	J 1.0	~ 4.4*	0.43
Carbon disulfide	1/10	31	U 5.0	~ 7.6*	2.6
Carbon tetrachloride	1/10	34	U 5.0	~ 7.9*	2.9
Chloroform	2/10	36	J 2.0	~ 7.8*	3.1
Methylene chloride	4/10	U 5.0	JB 1.0	~ 3.9*	0.53
Styrene	1/10	8.0	U 5.0	~ 5.3*	0.30
Trichloroethene	2/10	160	J 4.0	~ 20	16
Semi-Annual Assessment Wells: Down-gradient Well Type					
Field Measurements -- Unfiltered					
Conductivity (mS/cm)	9/9	0.33	0.010	0.16*	0.040
Dissolved oxygen (ppm)	9/9	7.1	3.7	5.2*	0.44
Redox (mV)	9/9	200	150	170*	5.7
Temperature (°C)	9/9	17	12	14*	0.46
Turbidity (JTU)	9/9	130	8.4	56*	15
pH (SU)	9/9	7.6	4.6	6.2*	0.42

Table 29. (continued)

Analyte	N det/ N total	Concentration			
		Max ^a	Min ^a	Av ^b	Standard error ^c
Others -- Unfiltered					
Total organic carbon (mg/L)	7/9	8.1	0.50	1.7*	0.81
Total organic halides (µg/L)	1/9	10	5.0	5.7*	0.60
Radionuclides (Bq/L) -- Filtered					
Gross beta	3/9	1.3*	0.040	0.25	0.13
H-3	5/9	1,200*	-39	340*	170
<i>Semi-Annual Assessment Wells: Up-gradient Well Type</i>					
Field Measurements -- Unfiltered					
Conductivity (mS/cm)	7/7	0.67	0.013	0.29*	0.10
Dissolved oxygen (ppm)	7/7	11	4.7	6.6*	0.87
Redox (mV)	7/7	180	130	160*	6.4
Temperature (°C)	7/7	14	12	13*	0.24
Turbidity (JTU)	7/7	980	99	440*	100
pH (SU)	7/7	8.2	5.2	7.0*	0.38
Others -- Unfiltered					
Total organic carbon (mg/L)	6/7	2.5	0.50	1.3*	0.36
Radionuclides (Bq/L) -- Filtered					
Gross beta	3/7	0.40*	0.060	0.17*	0.043
H-3	1/7	22*	-14	0.57	5.3

^aPrefixes containing J, B, E, U or < mean that the value was estimated, found in the laboratory blank, exceeded the calibration range, was not detected at that level, or was not quantified at that level, respectively. Radionuclide values that are significantly greater than zero are identified by an *.

^bAverage concentrations that are significantly greater than zero are identified by an *. The ~ prefix indicates that estimated values were used in the calculation of the average.

^cStandard error of the mean.

^dNot applicable.

Table 30. ORNL SWSA 6 groundwater constituents that exceed a reference value from February 27-March 31, 1992

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Well 835, Sampling Date 26MAR92				
Ground Elevation 759.93 ft, Water Elevation 746.18				
Field Measurements -- Unfiltered				
pH (SU)	5.3	0.037	(6.5, 8.5)	3
Others -- Unfiltered				
Total organic carbon (mg/L)	8.1	0.21	0.50	D
Well 836, Sampling Date 26MAR92				
Ground Elevation 763.32 ft, Water Elevation 746.11				
Field Measurements -- Unfiltered				
pH (SU)	5.0	0	(6.5, 8.5)	3
Well 837, Sampling Date 25MAR92				
Ground Elevation 771.12 ft, Water Elevation 746.85				
Field Measurements -- Unfiltered				
pH (SU)	4.8	0	(6.5, 8.5)	3
Well 840, Sampling Date 03MAR92				
Ground Elevation 766.94 ft, Water Elevation 748.13				
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 841, Sampling Date 02MAR92				
Ground Elevation 766.04 ft, Water Elevation 755.53				
Radionuclides (Bq/L) -- Filtered				
H-3	5,300*	100	2,960	4
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1

Table 30. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Well 842, Sampling Date 28FEB92				
Ground Elevation 767.25 ft, Water Elevation 759.31				
Radionuclides (Bq/L) -- Filtered				
H-3	3,600*	100	2,960	4
Volatile Organics (µg/L) -- Unfiltered				
1,2-Dichloroethane	8.0	c	5	1
Carbon tetrachloride	34	c	5	1
Trichloroethene	160	c	5	1
Vinyl chloride	U 10	c	2	1
Well 843, Sampling Date 28FEB92				
Ground Elevation 781.43 ft, Water Elevation 779.76				
Radionuclides (Bq/L) -- Filtered				
H-3	40,000*	1,000	2,960	4
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 844, Sampling Date 27FEB92				
Ground Elevation 780.95 ft, Water Elevation 771.44				
Volatile Organics (µg/L) -- Unfiltered				
Carbon disulfide	31	c	5.0	D
Vinyl chloride	U 10	c	2	1
Well 846, Sampling Date 20MAR92				
Ground Elevation 861.03 ft, Water Elevation 821.50				
Others -- Unfiltered				
Total organic carbon (mg/L)	2.5	0.14	0.50	D

Table 30. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Well 847, Sampling Date 03MAR92				
Ground Elevation 839.62 ft, Water Elevation 807.06				
Radionuclides (Bq/L) -- Filtered				
H-3	3,600*	100	2,960	4
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 857, Sampling Date 13MAR92				
Ground Elevation 847.18 ft, Water Elevation 791.89				
Field Measurements -- Unfiltered				
pH (SU)	5.2	0	(6.5, 8.5)	3
Well 859, Sampling Date 30MAR92				
Ground Elevation 777.91 ft, Water Elevation 765.28				
Field Measurements -- Unfiltered				
pH (SU)	4.6	0	(6.5, 8.5)	3
Well 1242, Sampling Date 04MAR92				
Ground Elevation 775.11 ft, Water Elevation 759.47				
Radionuclides (Bq/L) -- Filtered				
H-3	15,000*	1,000	2,960	4
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Volatile Organics-TICs (µg/L) -- Unfiltered				
1-Hexanol, 2-ethyl-28.73	J 10	c	c	T
2-Hexenal, 2-ethyl-28.35	J 5.0	c	c	T
Well 1243, Sampling Date 04MAR92				
Ground Elevation 778.66 ft, Water Elevation 761.56				
Radionuclides (Bq/L) -- Filtered				
Co-60	28*	3.0	7.4	4
H-3	67,000*	1,000	2,960	4

Table 30. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Volatile Organics ($\mu\text{g/L}$) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Volatile Organics-TICs ($\mu\text{g/L}$) -- Unfiltered				
1-Hexanol, 2-ethyl-28.73	J 13	c	c	T
Well 1244, Sampling Date 06MAR92 Ground Elevation 755.49 ft, Water Elevation 753.36				
Radionuclides (Bq/L) -- Filtered				
Co-60	12*	2.0	7.4	4
Volatile Organics ($\mu\text{g/L}$) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 1245, Sampling Date 06MAR92 Ground Elevation 753.03 ft, Water Elevation 753.75				
Volatile Organics ($\mu\text{g/L}$) -- Unfiltered				
Vinyl chloride	U 10	c	2	1

^aPrefixes containing J, B, E, U or < mean that the value was estimated, found in the laboratory blank, exceeded the calibration range, was not detected at that level, or was not quantified at that level, respectively. Radionuclide values that are significantly greater than zero are identified by an *.

^bIf a reference limit exists, the source is coded as:

- 1 Rules of Tennessee Department of Environment and Conservation, Division of Water Pollution Control, Chapter 1200-4-3, General Water Quality Criteria, as amended.
 - 2 40CFR Part 141--National Primary Drinking Water Regulations, Subparts B and G, as amended.
 - 3 40CFR Part 143--National Secondary Drinking Water Regulations, as amended.
 - 4 DOE Order 5400.5, Chapter III, Derived Concentration Guides for Air and Water, as amended.
- D The value exceeds 5 (10) times the laboratory detection limit.
T A tentatively identified compound (TIC).

^cNot applicable.

Table 31. ORNL off-site residential groundwater summary statistics from
February 10-21, 1992

Analyte	N det/ N total	Concentration			Standard error ^c
		Max ^a	Min ^a	Av ^b	
Anions (mg/L) -- unfiltered					
Chloride	9/19	47	1.0	5.0*	2.4
Fluoride	1/19	7.3	< 1.0	~ 1.3*	0.33
Nitrate	12/19	9.8	< 1.0	~ 2.5*	0.49
Sulfate (as SO4)	19/19	42	0.60	10*	3.1
Field Measurements -- unfiltered					
Conductivity (mS/cm)	19/19	1.7	0	0.59*	0.10
Temperature (°C)	19/19	17	4.4	12*	0.69
pH (SU)	19/19	8.6	7.0	7.5*	0.082
Metals (mg/L) -- unfiltered					
Barium	18/19	0.38	< 0.0010	~ 0.079*	0.019
Calcium	19/19	99	1.5	47*	6.3
Chromium	12/19	0.015	< 0.0040	~ 0.0074*	0.00086
Copper	7/19	0.058	< 0.0070	~ 0.012*	0.0028
Iron	6/19	0.29	< 0.050	~ 0.082*	0.014
Lead	2/19	0.0070	< 0.0040	~ 0.0043*	0.00018
Magnesium	19/19	36	0.58	14*	2.2
Manganese	15/19	0.037	< 0.0010	~ 0.0055*	0.0020
Nickel	3/19	0.0044	< 0.0040	~ 0.0040*	0.000028
Sodium	7/19	450	< 5.0	~ 41	24
Uranium	15/19	0.0026	< 0.00010	~ 0.00075*	0.00018
Zinc	13/19	0.88	< 0.0050	~ 0.13*	0.056
Radionuclides (Bq/L) -- unfiltered					
Co-60	2/19	1.4*	-2.2	0.14	0.18
Gross alpha	5/19	0.13*	-0.020	0.041*	0.010
Gross beta	7/19	0.68*	-0.15	0.12*	0.041
Tc-99	1/19	1.2*	-0.30	0.15	0.085
Total rad Sr	7/19	0.24*	-0.068	0.076*	0.019

Table 31. (continued)

Analyte	N det/ N total	Concentration			Standard error ^c
		Max ^a	Min ^a	Av ^b	
Volatile Organic Compounds (ug/L) -- unfiltered					
Chloroform	1/19	10	10	10*	0

^aPrefixes containing J, B, E, U or < mean that the value was estimated, found in the laboratory blank, exceeded the calibration range, was not detected at that level, or was not quantified at that level, respectively. Radionuclide values that are significantly greater than zero are identified by an *.

^bAverage concentrations significantly greater than zero are identified by an *. The ~ prefix indicates that estimated values and/or detection limits were used in the calculation of the mean.

^cStandard error of the mean.

^dNot applicable.

4.0 BIOLOGICAL MONITORING

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

Milk is a potentially significant pathway for the transfer of radionuclides from their 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. Total radioactive Sr and I-131 are radionuclides that are especially important in this atmosphere to pasture to cow to milk food chain. The milk samples are collected biweekly, except for May through September when the samples are collected monthly.

4.1 MILK

Joan F. Hughes

4.1.1 Program Description

Raw milk from five locations, including one dairy, within a radius of 80 km of Oak Ridge, is monitored for I-131 and total radioactive Sr. Samples are collected each month from the stations located near the Oak Ridge area (Fig. 14). Samples are analyzed for I-131 by gamma spectroscopy and for total radioactive Sr by chemical separation and low-level beta counting. Instrument background values are subtracted from the measured values of I-131 and total radioactive Sr in milk samples, and net activity concentrations are summarized.

4.1.2 Procedure and Results

Concentrations of I-131 are shown in Table 32. Values of I-131 for the first quarter were often less than instrument background, as is indicated by negative values. Concentrations of total radioactive Sr are shown in Table 33.

Dose was calculated for a station when the average value obtained was statistically greater than zero. The measured average concentrations of total radioactive Sr (assuming 100% Sr-90) and I-131 in milk were used to calculate the potential 50-y committed effective dose equivalents. This calculation is based on the assumption that 1 L/day of milk is ingested at these concentrations for 365 days. Doses resulting from ingestion of milk were less than 1% of DOE's guideline of 1000 μ Sv.

Fig. 14. Map showing milk sampling locations.

Table 32. Concentrations of I-131 in milk and calculated doses,
January-March 1992

Station	Number of Samples	Concentration (Bq/L)				Dose (μ Sv) ^c
		Max	Min	Av ^a	Standard error ^b	
1	2	0.03	-0.01	0.01	0.02	
2	3	0.01	-0.04	-0.0067	0.017	
3	3	0.02	-0.01	0.0063	0.0088	
4	3	0.02	0.01	0.017*	0.0033	0.083
8	3	0.04	-0.08	-0.021	0.035	

^aAverage concentrations significantly greater than zero are identified by an *.

^bStandard error of the mean.

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

^dSee Fig. 14.

Table 33. Concentrations of total radioactive Sr in milk and calculated doses, January-March 1992

Station	Number of Samples	Concentration (Bq/L)			Standard error ^b	Dose (μ Sv) ^c
		Max	Min	Av ^a		
1	2	0.078	0.047	0.063	0.016	
2	3	0.18	0.0040	0.089	0.051	
3	3	0.160	0.098	0.13*	0.018	1.6
4	3	0.220	0.086	0.15*	0.039	1.9
8	3	0.160	0.066	0.12*	0.027	1.5

^aAverage concentrations significantly greater than zero are identified by an *.

^bStandard error of the mean.

^cPotential 50-year committed effective dose equivalents from drinking 365L of milk per year using average radionuclide concentrations at each location. Dose is estimated for stations whose average value is statistically greater than zero.

^dSee Fig. 14.

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