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ENVIRONMENTAL SURVEILLANCE DATA REPORT FOR THE FOURTH 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	U.S. Environmental Protection Agency
EC	Environmental Compliance Section of OECD
ESP	Environmental Surveillance and Protection Section of OECD
ICP	inductively coupled plasma
LLW	low-level waste
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 on 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 m^3 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 instrument 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 tested for differences 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 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.

Some nonradionuclide results are returned from the laboratory with prefixes associated with the values. "<" (less than) or "U" (undetected) indicates the value was below the analytical detection limit; "J" indicates the value was estimated by the laboratory; "B" indicates the value was found in the laboratory blank; "E" indicates the value exceeded the calibration range; "Y" indicates the value exceeded the calibration range and was diluted and reanalyzed, and was not detected or quantified at that level, respectively.

In statistical summaries, when at least one of the results contributing to the average is less than the detection limit, the average value is identified with the ~ (tilde) prefix.

Results obtained in the laboratory are often reported as "less than" or "below detection." In these situations the detection limit is reported along with the "less than" designation. The sample mean and standard error of the mean are affected by these values; they become "biased"--biased high for the mean and low for the standard error of the mean. That is, the sample standard error of the mean is estimating something smaller than the true standard error.

A further consequence of the bias is an increased likelihood that a population mean will be declared greater than zero in a statistical test using the biased sample mean and standard error. A statistically significant result may be a consequence of the number of values below the detection limit. If, however, there were a number of values above the detection limit, the conclusion that the true mean is greater than zero may be valid even though the estimate of true mean is biased.

2.0 AIR

The Department of Energy (DOE) Oak Ridge facilities are subject to regulations issued by the Tennessee Department of Environment and 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 regulations 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 Joan F. Hughes

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 3025 and 3026 areas cell ventilation system
7911	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. Some sources 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 were upgraded to meet the criteria in NESHAP regulations and DOE orders. 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, flow measurement and totalizing instruments, a sampling pump, and a sample return line to the stack. The present sampling system at stack 3020 does not have a tritium trap. All

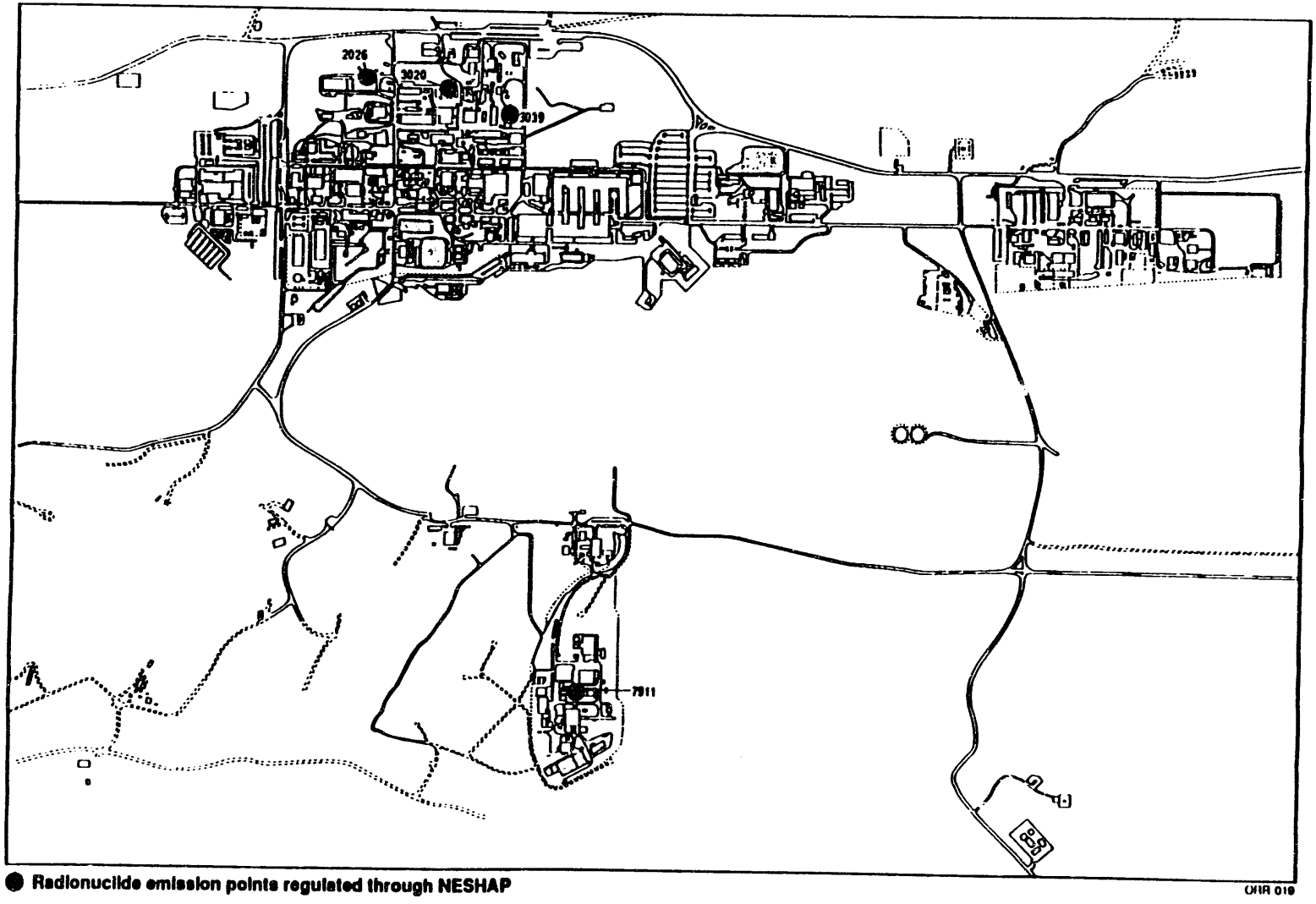

Fig. 1. Locations of major stacks (emission points) at ORNL.

sampling has been completed for the year. Results have not yet been received from the ORNL Analytical Chemistry Division. The data for the stack program will be reported as an addendum to this report as soon as the data is completed.

2.2 AMBIENT AIR

Laurice V. Hamilton and Joan F. Hughes

2.2.1 Program Description

The objectives for the ambient program are (1) to sample at locations that are 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, 37, 38, 39, 40, 42, 46, and 48.

Fig. 4. The Remote Air Monitoring (RAM) network consists of stations 51 and 52.

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, 37, 38, 39, 40, 42, 46, 48, 51, and 52 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 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 is mounted or removed. The total volume of air that flowed through the sampler is obtained from a flow totalizer. The concentration of radionuclides in air is calculated by dividing the total activity per sample by the total volume of air sampled.

The sampling system is currently being upgraded. In addition, hi-volume air samplers will 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.

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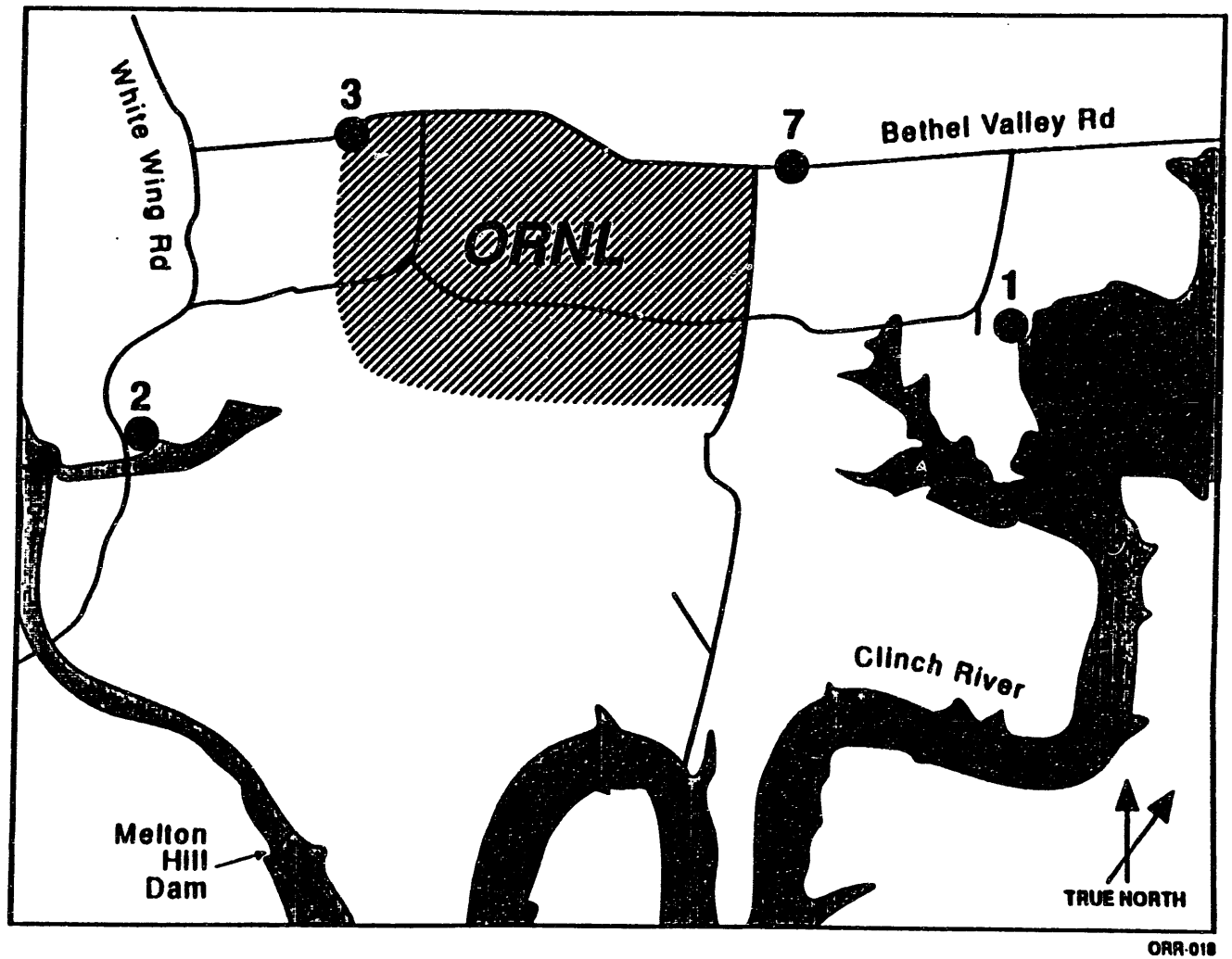

Fig. 2. ORNL perimeter air monitoring locations.

ORNL-DWG 92-13895

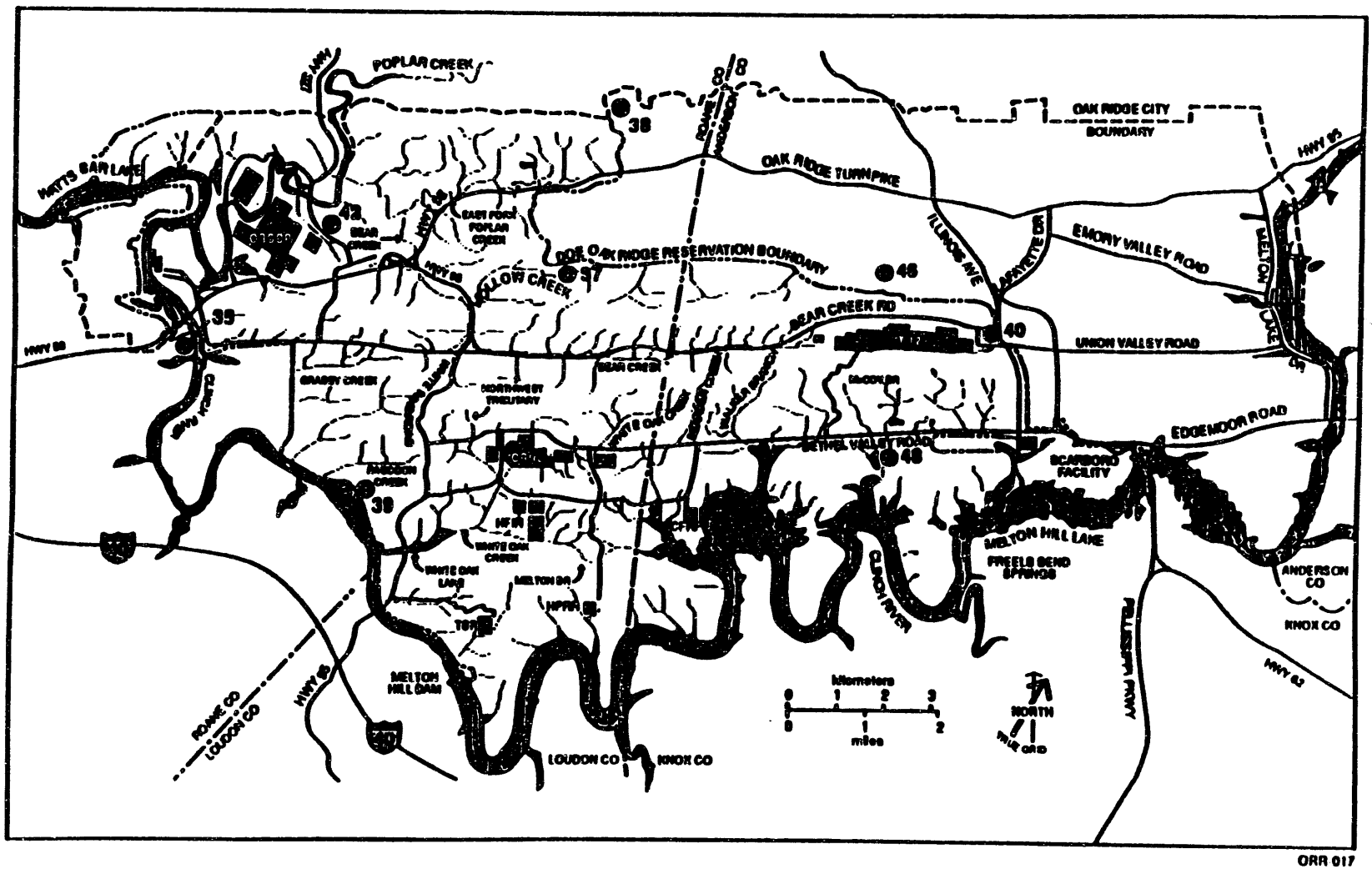

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Fig. 3. ORR perimeter air monitoring locations.

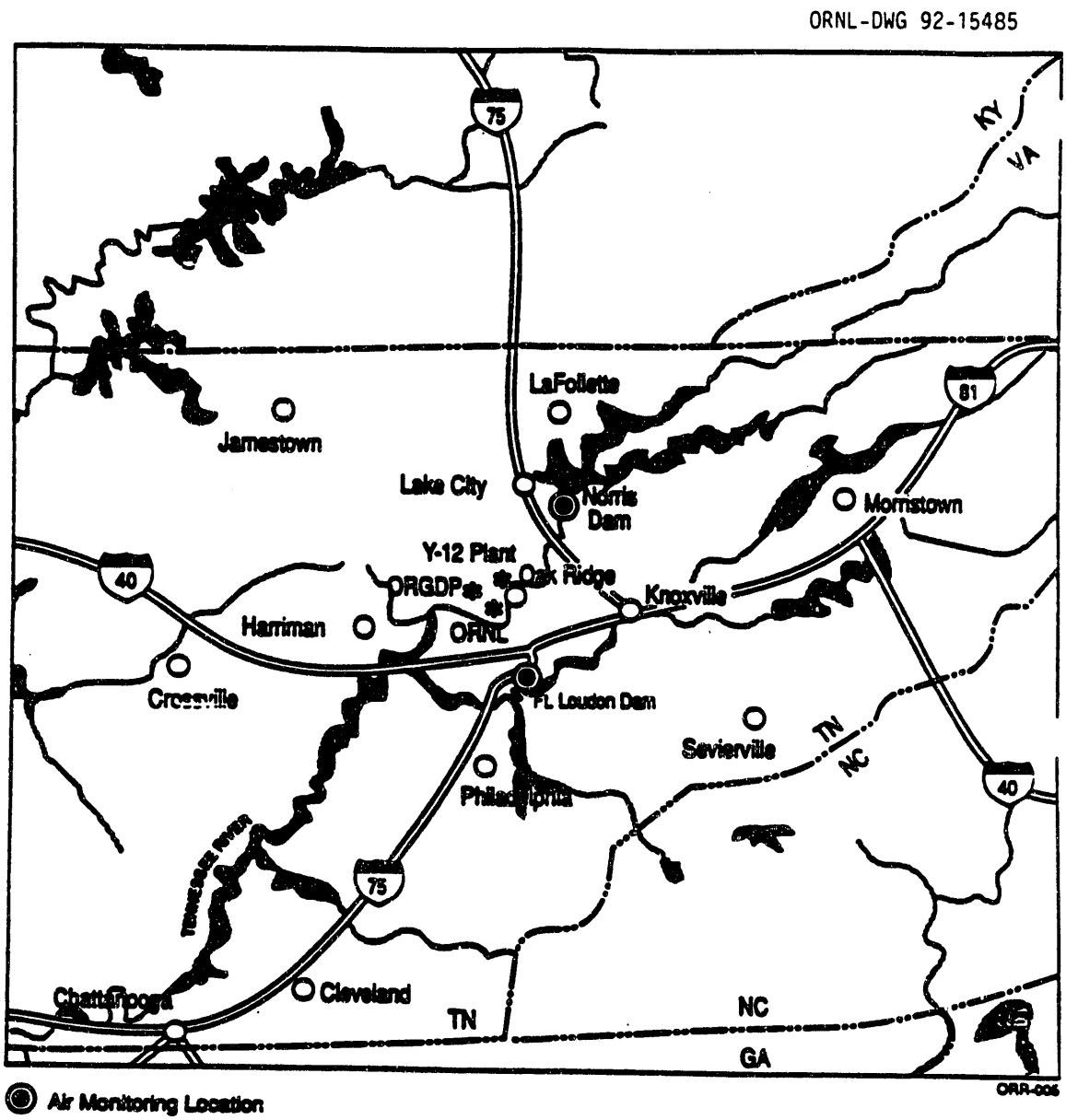

Fig. 4. ORR remote air monitoring locations.

2.2.2 Procedures and Results

In the fourth quarter, 32 out of 32 adsorbable gas samples were collected yielding a 100% collection rate (Table 1). Out of the 32 samples, there was one value for I-131 that was distinguishable from zero.

All ambient tritium samples were collected yielding a 100% collection rate. The results are summarized in Table 2.

In 1992, composites of particulate filters were prepared at the end of the fourth quarter. Results have not yet been received from the ORNL Analytical Chemistry Division. The data for the annual composites will be reported as an addendum to this report as soon as the data is completed.

2.3 EXTERNAL GAMMA RADIATION

Laurice Hamilton and Betsy Horwedel

2.3.1 Program Description

At ORNL and the reservation perimeter air monitoring stations, external gamma radiation measurements (exposure rates) were recorded on a near real-time data acquisition system until February 1992. 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, which means that the host computer was not collecting data from the station, 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 stations 39, 40, 42, 46, and 48, which are five of the ten ambient air stations. In addition, external gamma measurements were still collected at the DOE museum (station 41). After the relocation, the external gamma measurements were 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

Typical values for cities in the United States are usually between 1.5 and 4.2 nC/kg/h (nanocoulomb per kilogram per hour) according to recent issues of EPA Environmental Radiation Data. The median value for cities in the contiguous United States for the first three quarters of 1989 was 2.4 nC/kg/h. The last value given for Knoxville (July-September 1989) was 2.4 nC/kg/h. All of the values given in Table 2 are within the above range of background values. Table 3 summarizes the weekly measurements from October-December 1992.

Table 1. Ambient air concentrations of I-131 at ORNL air monitoring stations,[a] October-December 1992

Station	Number Collected	Number Possible	Number Detected
1	8	8	0
2	8	8	0
3	8	8	0
7	8	8	1
Overall Summary	32	32	1

[a]See Fig. 2.

Table 2. Atmospheric tritium concentrations at ambient air stations, October-December 1992

Station[a]	N det/ N total	Concentration (10^{-4} Bq/L) Max	Min	Av[b]	Standard error[c]	Percent of DCG[d]
3	3/3	5.0	1.7	3.3*	0.95	<0.01
37	3/3	31	3.9	14	8.7	e
38	3/3	10	4.7	6.7*	1.7	0.018
39	3/3	240	18	100	70	e
40	2/3	4.8	0.80	2.2	1.3	e
42	3/3	18	6.7	11*	3.7	0.030
46	3/3	19	1.2	8.0	5.3	e
48	2/3	10	1.1	4.9	2.8	e
51	2/3	3.4	0.50	1.8	0.83	e
52	2/3	72	1.3	25	23	e
Overall Summary	26/30	240	0.50	18*	8.2	0.048

[a]Station locations are shown in Fig. 2.
[b]Average concentrations significantly greater than zero are identified by an *.
[c]Standard error of the mean.
[d]Percent of DCG = Average/DCG x 100. The DCG for tritium is 3.7 Bq/L.
[e]Not applicable.

Table 3. External gamma radiation measurements at reservation perimeter air monitoring stations,[a] October-December 1992

Station	Number of Readings	Exposure rate (nC/kg/h)[b]				Equivalent Dose (μSv/h)
		Max	Min	Av	Standard error[c]	
39	13	2.8	2.6	2.7	0.018	0.090
40	13	2.2	2.1	2.1	0.010	0.071
41	13	1.2	1.2	1.2	0.0024	0.041
42	4	1.9	1.9	1.9	0.0079	0.065
46	13	2.3	2.2	2.2	0.011	0.076
48	13	2.2	1.8	1.9	0.032	0.065
Overall Summary	69	2.8	1.2	2.0	0.056	0.069

[a]See Fig. 2.
[b]Nanocoulomb per kilogram per hour.
[c]Standard error of the mean.

3.0 WATER

The Oak Ridge National Laboratory (ORNL) site is located in the 17 km^2 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 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 receiving water for the watershed is the Clinch River embayment of Watts Bar Lake.

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 at 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, WAGs 4, 5, 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

Melinda C. Salmons

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, analyses that are conducted, and frequencies of sample collection and analysis for all radiological samples is provided in Table 4.

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 5 contains the concentrations measured at these stations during this quarter. At Gallaher, gross beta, tritium, and total rad Sr were significantly greater than zero but at levels no greater than 9.7% of the Environmental Protection Agency (EPA) primary drinking water standards (40 CFR 141, as amended). Cs-137 and Pu-238 at Gallaher were significantly greater than zero; drinking water standards for Cs-137 and Pu-238 have not been established. At Kingston,

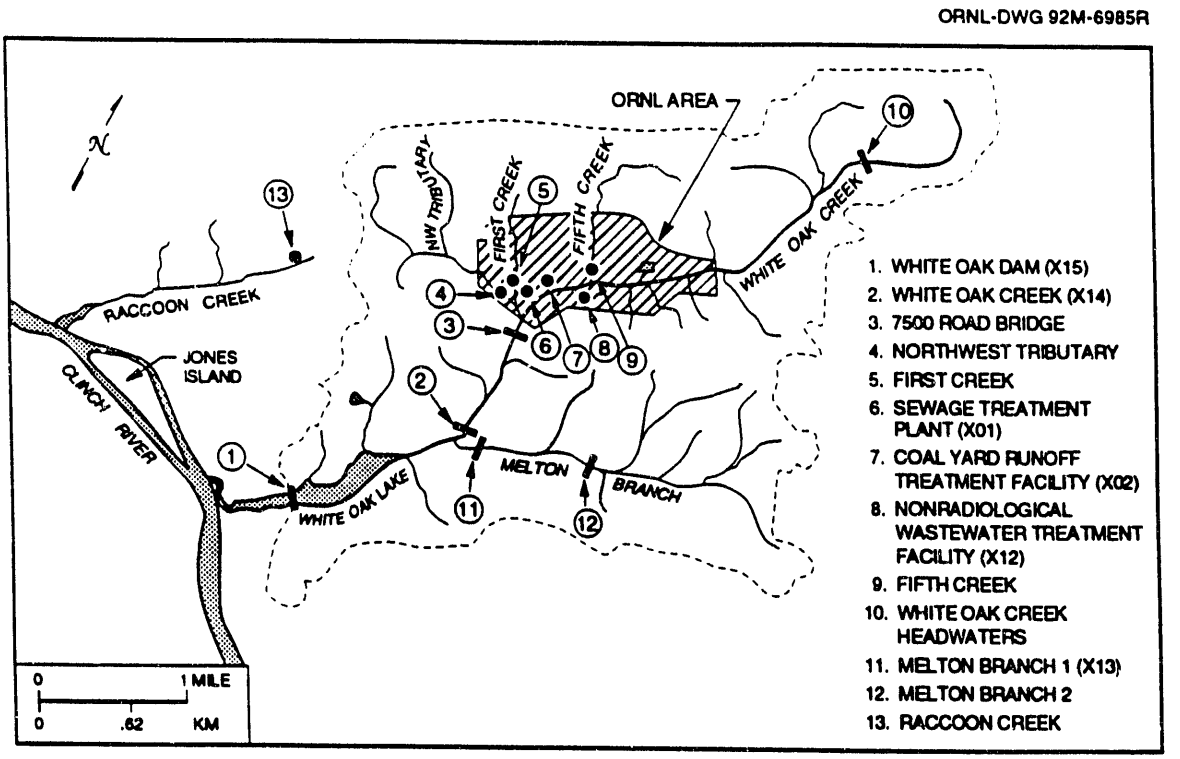

Fig. 5. ORNL surface water, NPDES, and reference sampling locations.

Table 4. Summary of collection and analysis frequencies of surface and effluent water samples for radionuclide analysis

Station	Analysis	Collection Frequency	Sample Type	Analysis Frequency
STP	Gamma scan, Gross beta, Total rad Sr	Weekly	Flow proportional composite	Monthly
7500 Road Bridge, MB1, MB2, WOC	Gamma scan, H-3, Total rad Sr	Weekly	Flow proportional composite	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 composite	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 composite	Monthly
NRWTF	Gamma scan, Gross alpha, Gross beta, H-3, Total rad Sr	Weekly	Flow proportional composite	Monthly
NWT	Gamma scan, Total rad Sr	Weekly	Flow proportional composite	Monthly
WOC Headwaters	Gamma scan, Gross alpha[a], Gross beta[b]	Weekly	Flow proportional composite	Monthly
WOD	Gamma scan, Gross alpha[a], Gross beta[b]	Weekly	Flow proportional composite	Weekly

Table 4. (continued)

Station	Analysis	Collection Frequency	Sample Type	Analysis Frequency
WOD	H-3, Total rad Sr	Weekly	Flow proportional composite	Monthly
Category I Outfalls	Gross beta[b]	Annually	Grab	Annually
Category II Outfalls	Gross beta[b]	Quarterly	Grab	Quarterly
Category III Outfalls	Gamma scan, Gross beta[b]	Quarterly	Grab	Quarterly

[a]If 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.
[b]If gross beta >30 Bq/L, analyze for total rad Sr.

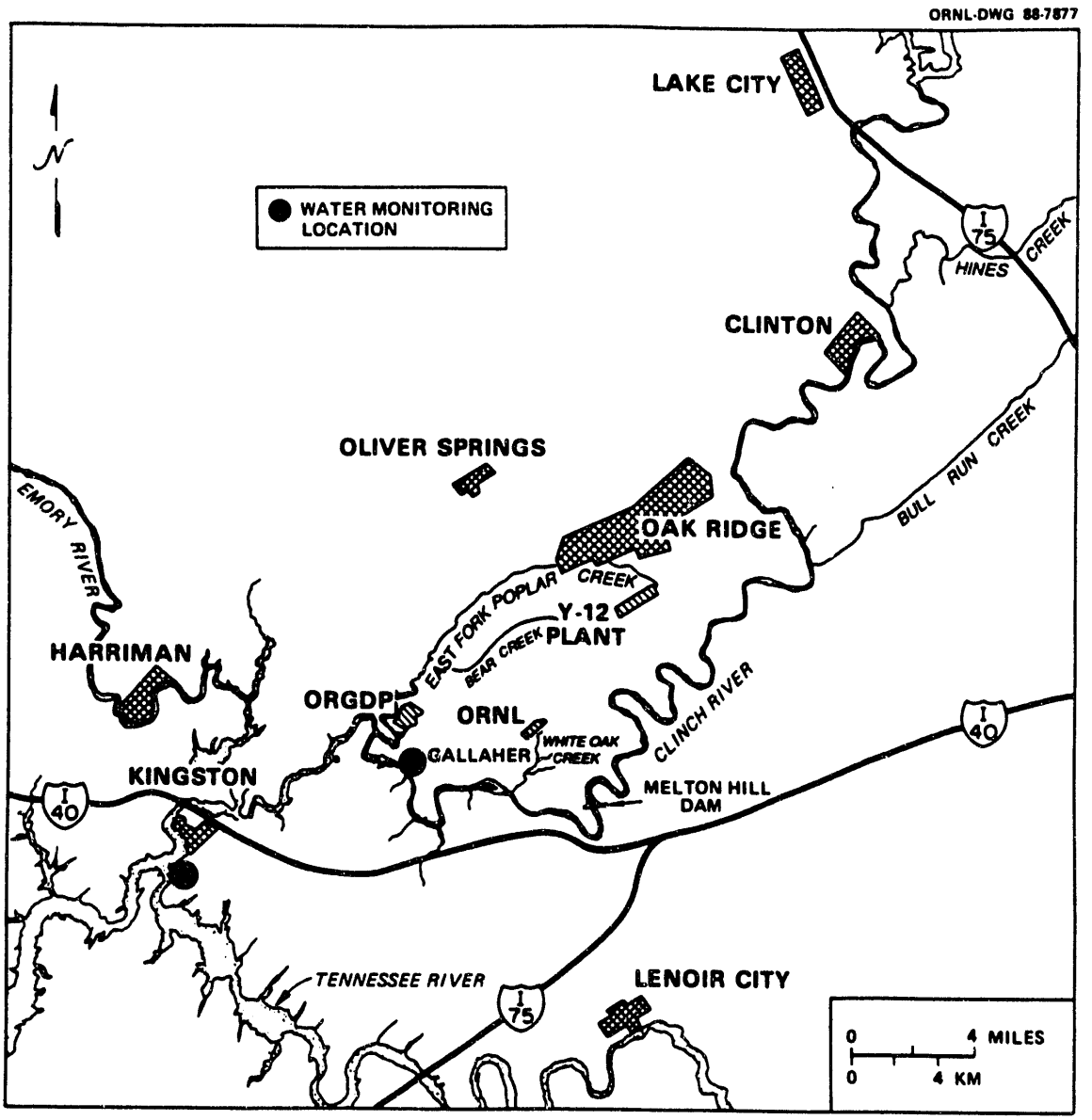

Fig. 6. Location map of Gallaher and Kingston sampling points.

Table 5. Summary of radionuclide concentrations in water off-site ORNL, October-December 1992

Radionuclide	Concentration[a] (Bq/L)	Drinking Water Standard[b] (DWS) (Bq/L)	Percent DWS[c]
	Gallaher[d]		
Co-60	0.022	e	e
Cs-137	0.040*	e	e
Gross alpha	0.0080	0.555	e
Gross beta	0.18*	1.85	9.7
Pu-238	0.0026*	e	e
Pu-239	0.00010	e	e
Total rad Sr	0.020*	0.296	6.8
Total U[f] (mg/L)	0.00025	e	e
Total U[fg]	0.0061	e	e
H-3	37*	740	5.0
	Kingston[d]		
Co-60	0.011	e	e
Cs-137	0.019*	e	e
Gross alpha	0.033*	0.555	5.9
Gross beta	0.12*	1.85	6.5
Pu-238	-0.00015	e	e
Pu-239	0.00018	e	e
Total rad Sr	0.0046*	0.296	1.6
Total U[f] (mg/L)	0.00010	e	e
Total U[fg]	0.0025	e	e
H-3	19	740	e

[a]Concentrations significantly greater than zero are identified by an *.
[b]National 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.
[c]Concentration as a percentage of the DWS.
[d]See Fig. 6.
[e]Not applicable.
[f]No test for significance is possible.
[g]Activity derived from mass assuming natural abundance of U-234, U-235 and U-238.

gross beta, gross alpha, and total rad Sr were significantly greater than zero but at levels no greater than 6.5% of the Environmental Protection Agency (EPA) drinking water standards. Cs-137 at Kingston was significantly greater than zero; drinking water standards for Cs-137 have not been established. No test of significance was possible for the total uranium measurement at each site, but the concentrations at Gallaher and Kingston are less than 1.1% of the gross alpha standard. The total uranium measurement is converted to an activity by assuming natural abundance of uranium isotopes U-234, U-235, and U-238.

Derived concentration guides (DCGs) 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 DOE Order 5400.5 and are used here as a means of standardized comparison for effluent points with different isotope signatures. The calculation of percent of the 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 that a sum ever exceeds 100%, an analysis of the best available technology to reduce the signature would be conducted as specified in DOE Order 5400.5.

Melton Hill Dam and WOC headwaters, two locations above ORNL discharge points, serve as references for other water sampling locations at the ORNL site. Water samples are collected from the reference sites and from six streams on-site: White Oak Creek, Melton Branch, First Creek, Fifth Creek, Northwest Tributary, and Raccoon Creek (Fig. 5). Sampling for radiological analyses is conducted at six ambient stations around ORNL and at five NPDES locations. The six ambient stations are

- 7500 Road Bridge
- First Creek
- Fifth Creek
- Melton Branch 2
- Northwest Tributary
- Raccoon Creek

The five NPDES stations are

- Sewage Treatment Plant (X01)
- Nonradiological Wastewater Treatment Facility (X12)
- Melton Branch 1 (X13)
- White Oak Creek (X14)
- White Oak Dam (X15)

Summary statistics for each radionuclide at each surface water sampling location are given in Table 6. The average concentration is expressed as a percentage of the DCG (when one exists) in the last column of this table. As

Table 6. Radionuclide concentrations in surface waters around ORNL,[a] October-December 1992

Radionuclide	N det/ N total	Concentration (Bq/L) Max[b]	Min[b]	Av[c]	Standard error[d]	DCG[e]	Percent DCG[f]
			Melton Hill Dam				
Co-60	0/3	0.40	-0.10	0.14	0.14	185	g
Cs-137	0/3	0.50	-0.28	0.21	0.25	111	g
Gross alpha	2/3	0.080*	-0.0050	0.046	0.026	g	g
Gross beta	2/3	0.25*	0.040	0.15	0.061	g	g
			White Oak Creek Headwaters				
Co-60	0/3	0.50	-0.11	0.26	0.19	185	g
Cs-137	0/3	0.20	-0.10	0.087	0.094	111	g
Gross alpha	1/3	0.088*	-0.010	0.031	0.029	g	g
Gross beta	3/3	0.54*	0.16*	0.32	0.11	g	g
			7500 Road Bridge				
Co-60	0/3	0.40	0.040	0.28	0.12	185	g
Cs-137	3/3	5.4*	2.6*	3.6*	0.92	111	3.2
Total rad Sr	3/3	2.9*	2.5*	2.6*	0.13	37	7.1
H-3	3/3	690*	220*	420*	140	74,000	0.57
			First Creek				
Co-60	0/3	0.50	-0.40	0.070	0.26	185	g
Cs-137	0/3	0.40	-0.17	0.14	0.17	111	g
Total rad Sr	3/3	18*	7.8*	11*	3.3	37	31
			Fifth Creek				
Co-60	0/3	0.70	0.12	0.47	0.18	185	g
Cs-137	1/3	0.58*	-0.20	0.26	0.24	111	g
Total rad Sr	3/3	1.5*	1.0*	1.2*	0.15	37	3.2
			Melton Branch 2				
Co-60	1/3	0.25*	-0.50	-0.050	0.23	185	g
Cs-137	0/3	0.60	0.20	0.37*	0.12	111	0.34
Total rad Sr	3/3	0.13*	0.062*	0.088*	0.021	37	0.24
H-3	3/3	800*	420*	670*	120	74,000	0.90

Table 6. (continued)

Radionuclide	N det/ N total	Concentration (Bq/L) Max[b]	Min[b]	Av[c]	Standard error[d]	DCG[e]	Percent DCG[f]
			Northwest Tributary				
Co-60	0/3	0.040	-0.30	-0.12	0.099	185	g
Cs-137	0/3	0.40	0.050	0.18	0.11	111	g
Total rad Sr	3/3	2.5*	1.6*	2.1*	0.26	37	5.6
			Raccoon Creek				
Co-60	0/3	0.40	-0.10	0.14	0.14	185	g
Cs-137	0/3	0.10	-0.10	-0.0067	0.058	111	g
Total rad Sr	3/3	1.4*	0.30*	0.74	0.33	37	g

[a]Locations are shown in Fig. 5.

[b]Individual concentrations significantly greater than zero are identified by an *.

[c]Average concentrations significantly greater than zero are identified by an *.

[d]Standard error of the mean.

[e]Derived concentration guide for ingestion of water. From DOE Order 5400.5.

[f]Average concentration as a percentage of the DCG, calculated only when a DCG exists and the average concentration is significantly greater than zero.

[g]Not applicable.

shown in Table 6, no radionuclide measurements at Melton Hill Dam nor WOC headwaters were significantly greater than zero. Only three ambient stations showed average radionuclide concentrations greater than 5% of the appropriate DCG with no average radionuclide concentration exceeding 31% of its DCG. Total rad Sr was the only radionuclide concentration greater than 5% of DCG at the three ambient stations.

Locations that are sampled for nonradioactive chemicals under the requirements of the NPDES Permit (see Section 3.3) are also sampled for radionuclides (Fig. 5). Radiological analysis and the frequency of analysis are given in Table 4. Table 7 contains a summary of the concentrations for each of these locations during this quarter. Average radionuclide concentrations that are significantly greater than zero and greater than 5% of DCG are: total rad Sr at the Sewage Treatment Plant, Melton Branch 1, White Oak Creek, and White Oak Dam; tritium at Melton Branch 1, Nonradiological Wastewater Treatment Facility and White Oak Dam; and Cs-137 at the Nonradiological Wastewater Treatment Facility. No radionuclide average concentration at the NPDES points exceeded 33% of its DCG.

The discharge of radioactive contaminants from ORNL is affected by the stream flows. Monthly flows in Melton Branch (as measured at station Melton Branch 1), White Oak Creek (as measured above its confluence with Melton Branch and at White Oak Dam), and the Clinch River (as measured at Melton Hill Dam) are given in Table 8. Clinch River flows are regulated by a series of Tennessee Valley Authority dams, one of which is Melton Hill Dam. The flow in Melton Branch is usually less than one-third of that in White Oak Creek. The monthly ratio of flow in White Oak Creek (measured at White Oak Dam) to flow in the Clinch River (measured at Melton Hill Dam) is reported in the last column of the table. The ratios given were calculated daily and averaged for the month. If complete mixing is assumed, this ratio gives an indication of the dilution factor that may be expected for potential contaminants entering the Clinch River from White Oak Creek. In this quarter, the ratio values ranged from 0.005 to 0.01.

Amounts of radioactivity in White Oak Creek at the Sewage Treatment Plant, Nonradiological Wastewater Treatment Facility, White Oak Creek, Melton Branch 1, and White Oak Dam stations are calculated from concentration and flow and reported in Tables 9-11. A single flow-proportional sample was obtained weekly at each station. From the weekly samples, 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. In addition, at weekly intervals, flow-proportional samples are obtained at WOD and analyzed for radionuclides other than H-3 and total rad Sr. 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. As shown in Tables 9-11, average radionuclide concentrations that are significantly greater than zero and greater than 5% of DCG are: total rad Sr at Melton Branch 1,

Table 7. Radionuclide concentrations at ORNL NPDES locations,[a] October-December 1992

Radionuclide	N det/ N total	Concentration (Bq/L) Max[b]	Min[b]	Av[c]	Standard error[d]	DCG[e]	Percent DCG[f]
Sewage Treatment Plant (X01)							
Co-60	1/3	1.1	0.33*	0.61	0.25	185	g
Cs-137	0/3	0.50	-0.40	0.0067	0.26	111	g
Gross beta	3/3	21*	17*	19*	1.2	g	g
Total rad Sr	3/3	9.5*	7.3*	8.5*	0.64	37	23
Nonradiological Wastewater Treatment Facility (X12)							
Co-60	0/3	0.60	-0.50	0.11	0.32	185	g
Cs-137	3/3	42*	28*	37*	4.5	111	33
Gross alpha	3/3	0.26*	0.17*	0.22*	0.027	g	g
Gross beta	3/3	29*	14*	23*	4.5	g	g
Total rad Sr	3/3	3.5*	0.48*	1.5	0.98	37	g
H-3	3/3	5,200*	3,400*	4,100*	550	74,000	5.6
Melton Branch 1 (X13)							
Co-60	1/3	0.32*	-0.20	0.073	0.15	185	g
Cs-137	0/3	0.20	0.020	0.11	0.052	111	g
Total rad Sr	3/3	16*	9.5*	12*	2.1	37	32
H-3	3/3	25,000*	23,000*	24,000*	580	74,000	32
White Oak Creek (X14)							
Co-60	0/3	0.60	-0.15	0.32	0.24	185	g
Cs-137	2/3	3.5*	0.50	1.9	0.88	111	g
Total rad Sr	3/3	5.5*	3.1*	4.3*	0.69	37	12
H-3	3/3	3,400*	2,000*	2,700*	410	74,000	3.6

Table 7. (continued)

Radionuclide	N det/ N total	Concentration (Bq/L) Max[b]	Min[b]	Av[c]	Standard error[d]	DCG[e]	Percent DCG[f]
			White Oak Dam (X15)				
Co-60	2/13	0.26	-0.070	0.083*	0.029	185	0.045
Cs-137	13/13	5.1*	0.73*	2.2*	0.38	111	2.0
Gross alpha	13/13	0.46*	0.050*	0.22*	0.031	g	g
Gross beta	13/13	21*	7.3*	14*	1.0	g	g
Total rad Sr	3/3	7.6*	6.0*	6.6*	0.52	37	18
H-3	3/3	6,600*	5,600*	6,100*	290	74,000	8.3

[a]Locations are shown in Fig. 5.
[b]Individual concentrations significantly greater than zero are identified by an *.
[c]Average concentrations significantly greater than zero are identified by an *.
[d]Standard error of the mean.
[e]Derived concentration guide for ingestion of water. From DOE Order 5400.5.
[f]Average concentration as a percentage of the DCG, calculated only when a DCG exists and the average concentration is significantly greater than zero.
[g]Not applicable.

Table 8. Stream[a] flows, October-December 1992

Month	Flow (10^9 L)				Average Ratio[e]
	Melton Branch 1	White Oak Creek[b]	White Oak Dam[c]	Clinch River[d]	
October	0.076	0.35	0.45	210	0.0050
November	0.35	0.70	0.92	290	0.010
December	0.51	1.1	1.6	470	0.0040

[a]See Fig. 5.
[b]White Oak Creek above its confluence with Melton Branch.
[c]White Oak Creek at White Oak Dam.
[d]Clinch River at Melton Hill Dam.
[e]Flow ratios White Oak Creek:Clinch River at White Oak Dam are calculated daily and averaged for the month.

Table 9. Radionuclide concentrations and releases at ORNL NPDES surface water stations,[a] October 1992

Radionuclide	Flow (10^6 L)	Discharge[b] (10^{10} Bq)	Concentration[c] (Bq/L)	DCG[d] (Bq/L)	Percent DCG[e]
		Melton Branch 1 (09/30-10/28)			
Co-60	62	0.0020	0.32*	185	0.17
Cs-137	62	f	0.020	111	f
Total rad Sr	62	0.10	16*	37	43
H-3	62	160	25,000*	74,000	34
		Nonradiological Wastewater Treatment Facility (09/30-10/28)			
Co-60	44	f	0.22	185	f
Cs-137	44	0.19	42*	111	38
Gross alpha	44	0.0011	0.24*	f	f
Gross beta	44	0.062	14*	f	f
Total rad Sr	44	0.0029	0.66*	37	1.8
H-3	44	23	5,200*	74,000	7.0
		Sewage Treatment Plant (09/30-10/29)			
Co-60	22	0.00072	0.33*	185	0.18
Cs-137	22	f	-0.080	111	f
Gross beta	22	0.037	17*	f	f
Total rad Sr	22	0.019	8.7*	37	24
		White Oak Creek (09/30-10/28)			
Co-60	300	f	-0.15	185	f
Cs-137	300	0.049	1.6*	111	1.4
Total rad Sr	300	0.094	3.1*	37	8.4
H-3	300	61	2,000*	74,000	2.7
		White Oak Dam (09/30-10/28)			
Total rad Sr	380	0.23	6.0*	37	16
H-3	380	220	5,600*	74,000	7.6

Table 9. (continued)

Radionuclide	Flow (10^6 L)	Discharge[b] (10^{10} Bq)	Concentration[c] (Bq/L)	DCG[d] (Bq/L)	Percent DCG[e]
		White Oak Dam[g] *(10/01-11/01)*			
Co-60	450	f	0.056	185	f
Cs-137	450	0.072	1.6*	111	1.5
Gross alpha	450	0.0080	0.18*	f	f
Gross beta	450	0.57	13*	f	f

[a]Locations are shown in Fig. 5.

[b]Discharges are calculated from flow and concentration and are listed when concentrations are significantly greater than zero.

[c]Concentrations significantly greater than zero are identified by an *.

[d]Derived concentration guide for ingestion of water. From DOE Order 5400.5.

[e]Average concentration as a percentage of the DCG, calculated only when a DCG exists and the average concentration is significantly greater than zero.

[f]Not applicable.

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

Table 10. Radionuclide concentrations and releases at ORNL NPDES surface water stations,[a] November 1992

Radionuclide	Flow (10^6 L)	Discharge[b] (10^{10} Bq)	Concentration[c] (Bq/L)	DCG[d] (Bq/L)	Percent DCG[e]
Melton Branch 1 (10/28-11/24)					
Co-60	270	f	-0.20	185	f
Cs-137	270	f	0.10	111	f
Total rad Sr	270	0.27	10*	37	27
H-3	270	620	23,000*	74,000	31
Nonradiological Wastewater Treatment Facility (10/28-11/24)					
Co-60	47	f	-0.50	185	f
Cs-137	47	0.19	41*	111	37
Gross alpha	47	0.0012	0.26*	f	f
Gross beta	47	0.14	29*	f	f
Total rad Sr	47	0.0023	0.48*	37	1.3
H-3	47	16	3,400*	74,000	4.6
Sewage Treatment Plant (10/29-11/24)					
Co-60	25	f	0.40	185	f
Cs-137	25	f	-0.40	111	f
Gross beta	25	0.049	20*	f	f
Total rad Sr	25	0.018	7.3*	37	20
White Oak Creek (10/28-11/24)					
Co-60	590	f	0.50	185	f
Cs-137	590	0.21	3.5*	111	3.2
Total rad Sr	590	0.26	4.3*	37	12
H-3	590	200	3,400*	74,000	4.6
White Oak Dam (10/28-11/24)					
Total rad Sr	760	0.47	6.1*	37	16
H-3	760	500	6,600*	74,000	8.9

Table 10. (continued)

Radionuclide	Flow (10^6 L)	Discharge[b] (10^{10} Bq)	Concentration[c] (Bq/L)	DCG[d] (Bq/L)	Percent DCG[e]
		White Oak Dam[g] *(11/01-12/01)*			
Co-60	920	f	0.060	185	f
Cs-137	920	0.23	2.5*	111	2.2
Gross alpha	920	0.018	0.20*	f	f
Gross beta	920	1.3	14*	f	f

[a]Locations are shown in Fig. 5.
[b]Discharges are calculated from flow and concentration and are listed when concentrations are significantly greater than zero.
[c]Concentrations significantly greater than zero are identified by an *.
[d]Derived concentration guide for ingestion of water. From DOE Order 5400.5.
[e]Average concentration as a percentage of the DCG, calculated only when a DCG exists and the average concentration is significantly greater than zero.
[f]Not applicable.
[g]Concentration 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] December 1992

Radionuclide	Flow (10^6 L)	Discharge[b] (10^{10} Bq)	Concentration[c] (Bq/L)	DCG[d] (Bq/L)	Percent DCG[e]
Melton Branch 1 (11/24-12/30)					
Co-60	590	f	0.10	185	f
Cs-137	590	f	0.20	111	f
Total rad Sr	590	0.56	9.5*	37	26
H-3	590	1,400	24,000*	74,000	32
Nonradiological Wastewater Treatment Facility (11/24-12/30)					
Co-60	65	f	0.60	185	f
Cs-137	65	0.18	28*	111	25
Gross alpha	65	0.0011	0.17*	f	f
Gross beta	65	0.16	25*	f	f
Total rad Sr	65	0.023	3.5*	37	9.5
H-3	65	25	3,800*	74,000	5.1
Sewage Treatment Plant (11/24-12/30)					
Co-60	31	f	1.1	185	f
Cs-137	31	f	0.50	111	f
Gross beta	31	0.065	21*	f	f
Total rad Sr	31	0.029	9.5*	37	26
White Oak Creek (11/24-12/30)					
Co-60	1,200	f	0.60	185	f
Cs-137	1,200	f	0.50	111	f
Total rad Sr	1,200	0.67	5.5*	37	15
H-3	1,200	310	2,600*	74,000	3.5
White Oak Dam (11/24-12/30)					
Total rad Sr	1,800	1.3	7.6*	37	21
H-3	1,800	1,100	6,200*	74,000	8.4

Table 11. (continued)

Radionuclide	Flow (10^6 L)	Discharge[b] (10^{10} Bq)	Concentration[c] (Bq/L)	DCG[d] (Bq/L)	Percent DCG[e]
		White Oak Dam[g] *(12/01-01/01)*			
Co-60	1,600	0.032	0.20*	185	0.11
Cs-137	1,600	0.51	3.1*	111	2.8
Gross alpha	1,600	0.058	0.36*	f	f
Gross beta	1,600	2.6	16*	f	f

[a]Locations are shown in Fig. 5.

[b]Discharges are calculated from flow and concentration and are listed when concentrations are significantly greater than zero.

[c]Concentrations significantly greater than zero are identified by an *.

[d]Derived concentration guide for ingestion of water. From DOE Order 5400.5.

[e]Average concentration as a percentage of the DCG, calculated only when a DCG exists and the average concentration is significantly greater than zero.

[f]Not applicable.

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

Nonradiological Wastewater Treatment Facility, Sewage Treatment Plant, White Oak Creek, and White Oak Dam; tritium at Melton Branch 1, Nonradiological Wastewater Treatment Facility, and White Oak Dam; and Cs-137 at Nonradiological Wastewater Treatment Facility and White Oak Creek.

3.2 REFERENCE SURFACE WATER

Melinda C. Salmons

3.2.1 Program Description

Natural surface waters are sampled at locations upstream of the various facilities on the ORR. Data from these samples can be used to assess water quality prior to the impacts of the ORR. The term "reference" is used instead of "background" because the latter typically implies an environmental medium that is pristine, or unaffected by human activities. The Clinch River is the major surface water system that is affected by the ORR. This river integrates many human activities upstream of the reservation. The net impact of the ORR can be evaluated by comparing the reference data to information from samples collected downstream of the facilities. Monthly surface water samples are collected at two sampling locations for the purpose of determining contamination levels before the influence of ORNL. One sampling location is Melton Hill Dam above ORNL's discharge point into the Clinch River (Fig. 5). The other sampling location is WOC headwaters above the point where ORNL discharges to White Oak Creek (Fig. 5).

Analyses were performed to detect classical, inorganic, and organic pollutants in the water. Classical pollutants are indicated by conductivity, temperature, turbidity, pH, total dissolved solids, total suspended solids, and oil and grease (O&G). Inorganic parameters are indicated by metal and anion analyses. The presence of organic pollutants is indicated by results from total organic carbon (TOC) analysis. If the TOC result is greater than 5 mg/L, analyses for volatile and semivolatile organic compounds will be conducted. Water samples analyzed for inorganics and total suspended solids were collected flow-proportionally at each location. All other samples are grab samples taken once per month.

In addition, samples are collected and analyzed for radionuclides. Results are reported in Section 3.1.

3.2.2 Results

The results for the inorganic, organic, and classical pollutants are found in Table 12. There were no high levels of organic compounds detected by the TOC analysis at either location, as indicated by the average value of 1.9 mg/L at Melton Hill Dam and by the average value of 2.4 mg/L at WOC headwaters.

Inorganic analytical results can show a wide range of detection limits. This results from a dilution that must be made to some of the water samples. When a given sample contains an element in a concentration that is higher than the inductively coupled plasma (ICP) equipment can accurately measure, this compound can cause a spectral interference with other elements. The sample

Table 12. Surface water analyses at reference locations, October-December 1992

Analyte	N det/ N total	Concentration (mg/L) Max	Min	Av[a]	Standard error[b]
		Melton Hill Dam[c]			
Anions					
Fluoride	0/3	< 0.10	< 0.10	~ 0.10	0
Nitrate (as N)	0/3	< 1.0	< 1.0	~ 1.0	0
Sulfate (as SO_4)	3/3	34	22	27*	3.7
Field Measurements					
Conductivity (mS/cm)	3/3	2.4	0.90	1.7*	0.44
Dissolved oxygen (ppm)	3/3	9.7	7.8	8.5*	0.62
Temperature (°C)	3/3	18	9.8	14*	2.3
Turbidity (NTU)	3/3	38	15	30*	7.7
pH (SU)	3/3	7.8	7.4	7.6*	0.12
Metals					
Aluminum, total	3/3	0.36	0.051	0.17	0.096
Antimony, total	0/3	< 0.050	< 0.050	~ 0.050	0
Arsenic, total	0/3	< 0.010	< 0.010	~ 0.010	0
Barium, total	3/3	0.037	0.031	0.034*	0.0017
Beryllium, total	0/3	< 0.0010	< 0.0010	~ 0.0010	0
Boron, total	0/3	< 0.080	< 0.080	~ 0.080	0
Cadmium, total	0/3	< 0.0050	< 0.0050	~ 0.0050	0
Calcium, total	3/3	40	36	38*	1.2
Chromium, total	1/3	0.0097	< 0.0040	~ 0.0059*	0.0019
Cobalt, 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	0.38	0.061	0.18	0.099
Lead, total	0/3	< 0.050	< 0.050	~ 0.050	0
Lithium, total[d]	2/3	< 15	0.0031	~ 5.0	5.0
Magnesium, total	3/3	10	9.3	9.7*	0.21
Manganese, total	3/3	0.13	0.010	0.083	0.037
Molybdenum, total	0/3	< 0.040	< 0.040	~ 0.040	0
Nickel, total	0/3	< 0.010	< 0.010	~ 0.010	0
Phosphorus, total	0/3	< 0.30	< 0.30	~ 0.30	0
Selenium, total	0/3	< 0.0050	< 0.0050	~ 0.0050	0
Silicon, total	3/3	2.5	2.3	2.4*	0.067
Silver, total	0/3	< 0.0050	< 0.0050	~ 0.0050	0
Sodium, total[e]	2/3	5.4	4.5	~ 5.0*	0.26
Strontium, total	3/3	0.10	0.091	0.094*	0.0030

Table 12. (continued)

Analyte	N det/ N total	Concentration (mg/L) Max	Min	Av[a]	Standard error[b]
Tin, total	0/3	< 0.050	< 0.050	~ 0.050	0
Titanium, total	0/3	< 0.020	< 0.020	~ 0.020	0
Vanadium, total	0/3	< 0.0020	< 0.0020	~ 0.0020	0
Zinc, total	3/3	0.11	0.012	0.074	0.031
Zirconium, total	0/3	< 0.020	< 0.020	~ 0.020	0
Others					
Oil and grease	1/3	2.0	< 2.0	~ 2.0	0
Total dissolved solids	3/3	200	150	170*	17
Total organic carbon	3/3	2.0	1.9	1.9*	0.033
Total suspended solids	1/3	27	< 5.0	~ 12	7.3
White Oak Creek Headwaters[c]					
Anions					
Fluoride	0/3	< 0.10	< 0.10	~ 0.10	0
Nitrate (as N)	0/3	< 1.0	< 1.0	~ 1.0	0
Sulfate (as SO_4)	3/3	4.1	2.8	3.3*	0.42
Field Measurements					
Conductivity (mS/cm)	3/3	2.1	0.80	1.3*	0.39
Dissolved oxygen (ppm)	3/3	10	8.5	9.4*	0.52
Temperature (°C)	3/3	14	8.9	12*	1.6
Turbidity (NTU)	3/3	63	11	35	15
pH (SU)	3/3	8.2	7.2	7.7*	0.29
Metals					
Aluminum, total	3/3	0.33	0.12	0.21*	0.062
Antimony, total	0/3	< 0.050	< 0.050	~ 0.050	0
Arsenic, total	0/3	< 0.010	< 0.010	~ 0.010	0
Barium, total	3/3	0.093	0.061	0.082*	0.011
Beryllium, total	0/3	< 0.0010	< 0.0010	~ 0.0010	0
Boron, total	0/3	< 0.080	< 0.080	~ 0.080	0
Cadmium, total	0/3	< 0.0050	< 0.0050	~ 0.0050	0
Calcium, total	3/3	28	22	26*	1.9
Chromium, total	1/3	0.0093	< 0.0040	~ 0.0058*	0.0018
Cobalt, 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	0.30	0.17	0.22*	0.042
Lead, total	0/3	< 0.050	< 0.050	~ 0.050	0

Table 12. (continued)

Analyte	N det/ N total	Concentration (mg/L) Max	Min	Av[a]	Standard error[b]
Lithium, total[d]	1/3	< 15	< 0.0010	~ 5.0	5.0
Magnesium, total	3/3	13	9.4	11*	1.1
Manganese, total	3/3	0.020	0.010	0.013*	0.0033
Molybdenum, total	0/3	< 0.040	< 0.040	~ 0.040	0
Nickel, total	0/3	< 0.010	< 0.010	~ 0.010	0
Phosphorus, total	0/3	< 0.30	< 0.30	~ 0.30	0
Selenium, total	0/3	< 0.0050	< 0.0050	~ 0.0050	0
Silicon, total	3/3	4.4	3.3	3.8*	0.33
Silver, total	0/3	< 0.0050	< 0.0050	~ 0.0050	0
Sodium, total[e]	2/3	< 5.0	0.47	~ 2.0	1.5
Strontium, total	3/3	0.036	0.023	0.031*	0.0042
Tin, total	0/3	< 0.050	< 0.050	~ 0.050	0
Titanium, total	0/3	< 0.020	< 0.020	~ 0.020	0
Vanadium, total	0/3	< 0.0020	< 0.0020	~ 0.0020	0
Zinc, total	3/3	0.090	0.012	0.03*	0.026
Zirconium, total	0/3	< 0.020	< 0.020	~ 0.020	0
Others					
Oil and grease	0/3	< 2.0	< 2.0	~ 2.0	0
Total dissolved solids	3/3	140	110	130*	8.8
Total organic carbon	3/3	4.7	1.2	2.4	1.2
Total suspended solids	2/3	10	< 5.0	~ 7.0*	1.5

[a]Average concentrations significantly greater than zero are identified by an *.

[b]Standard error of the mean.

[c]See Fig. 5.

[d]Note that the analytical detection limit for lithium for October and November was 0.001 mg/L. For December, the detection limit was 15 mg/L.

[e]Note that the analytical detection limit for sodium for October and November was 0.05 mg/L. For December, the detection limit was 5 mg/L.

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

3.3 NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM REQUIREMENTS

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

3.3.1 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 (Fig. 5). There are ambient sampling points that are located in the streams as reference points or for additional information.

Quarterly summary statistics for the quarter of 1992 are given for each sampling location in Tables 13 through 21.

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 Report and are available upon request. Noncompliances are provided in Table 22.

3.3.2 Noncompliances

3.3.2.1 October 1992

3.3.2.1.1 Inappropriate and/or Unpermitted Discharges

On October 13, 1992, a truck was rinsed in the vicinity of a storm drain catch basin associated with outfall 302 in which approximately 20 gallons of rinse water entered the catch basin. No detrimental effects were noted in White Oak Creek (the receiving stream) and personnel were counseled on BMP controls.

3.3.2.1.2 Exceedences of NPDES Permit Limits

The TSS exceedences that occurred at the Category II outfalls 230 and 234 were attributed to residual dust and dirt being conveyed through these outfalls by storm water runoff.

3.3.2.2 November 1992

3.3.2.2.1 Inappropriate and/or Unpermitted Discharges

On November 19, 1992, a small quantity of oil (estimated at a tablespoon) flowed from a utility sump located near the 4510 Cooling Tower through a sump drain pipe into White Oak Creek. The release resulted in an oil sheen on the surface along one side of the creek. The sump was cleaned out and an oil boom will be installed in the sump at the drain pipe outlet, to preclude further release of any oil in the sump.

Table 13. NPDES discharge point X01,[a] October-December 1992

Analyte	N det/ N total	Concentration (mg/L) Max	Min	Av[b]	Standard error[c]
Field Measurements					
Chlorine, total residual	40/40	0.43	0.10	0.21*	0.013
Dissolved oxygen (ppm)	62/62	12	6.6	9.2*	0.14
Downstream pH (SU)	13/13	8.2	7.1	d	d
Flow (Mgd)	62/62	0.36	0.12	0.22*	0.0053
pH (SU)	13/13	7.9	7.4	d	d
Temperature (°C)	75/75	23	11	17*	0.36
Metals					
Copper, total	2/3	0.010	< 0.0070	~ 0.0084*	0.00088
Mercury, total	0/3	< 0.000050	< 0.000050	~ 0.000050	0
Silver, total	0/3	< 0.0050	< 0.0050	~ 0.0050	0
Zinc, total	3/3	0.071	0.055	0.062*	0.0047
Others					
Ammonia (as N)	40/40	0.63	0.030	0.11*	0.020
Biochemical oxygen demand	0/40	< 5.0	< 5.0	~ 5.0	0
Cyanide, total	0/3	< 0.0020	< 0.0020	~ 0.0020	0
Fecal Coliform (col/100 mL)[e]	27/40	95	< 1.0	~ 2.7*	1.2
Oil and grease	13/40	9.0	< 2.0	~ 2.7*	0.24
Phenolics, total recoverable	0/3	< 0.0010	< 0.0010	~ 0.0010	0
Total suspended solids	3/40	9.0	< 5.0	~ 5.1*	0.10
Volatile Organics					
Bromodichloromethane	0/3	U 0.0050	U 0.0050	~ 0.0050	0
Trichloroethene	0/3	U 0.0050	U 0.0050	~ 0.0050	0

[a]See Fig. 5.
[b]Average concentrations significantly greater than zero are identified by an *.
[c]Standard error of the mean.
[d]Not applicable.
[e]The geometric mean is computed rather than the average.

Table 14. NPDES discharge point X02,[a] October-December 1992

Analyte	N det/ N total	Concentration (mg/L) Max	Min	Av[b]	Standard error[c]
Anions					
Sulfate (as SO_4)	3/3	2,100	1,500	1,800*	170
Field Measurements					
Downstream pH (SU)	60/60	8.3	7.0	d	d
Flow (Mgd)	62/62	0.083	0	0.014*	0.0025
pH (SU)	60/60	8.2	6.4	d	d
Temperature (°C)	60/60	19	5.3	12*	0.55
Metals					
Arsenic, total	0/10	< 0.050	< 0.050	~ 0.050	0
Cadmium, total	0/10	< 0.0050	< 0.0050	~ 0.0050	0
Chromium, total	2/10	0.011	< 0.0040	~ 0.0052*	0.00082
Copper, total	2/10	0.012	< 0.0070	~ 0.0077*	0.00052
Iron, total	10/10	0.34	0.083	0.17*	0.025
Lead, total	0/10	< 0.050	< 0.050	~ 0.050	0
Manganese, total	10/10	0.065	0.0048	0.026*	0.0067
Nickel, total	1/10	0.015	< 0.010	~ 0.011*	0.00050
Selenium, total	10/10	0.10	0.014	0.053*	0.0078
Silver, total	1/10	0.015	< 0.0050	~ 0.0060*	0.0010
Zinc, total	9/10	0.075	< 0.0050	~ 0.024*	0.0065
Others					
Oil and grease	4/10	3.0	< 2.0	~ 2.1*	0.10
Total suspended solids	7/10	10	< 5.0	~ 6.3*	0.60

[a]See Fig. 5.
[b]Average concentrations significantly greater than zero are identified by an *.
[c]Standard error of the mean.
[d]Not applicable.

Table 15. NPDES discharge point X12,[a] October-December 1992

Analyte	N det/ N total	Concentration (mg/L) Max	Min	Av[b]	Standard error[c]
Anions					
Fluoride	13/13	2.4	1.2	1.8*	0.11
Nitrate (as N)	11/13	16	< 1.0	~ 3.3*	1.1
Sulfate (as SO_4)	13/13	350	68	250*	19
Field Measurements					
Downstream pH (SU)	62/62	8.4	7.3	d	d
Flow (Mgd)	62/62	0.54	0.35	0.46*	0.0060
pH (SU)	[e]	7.8	7.1	d	d
Temperature (°C)	62/62	23	12	16*	0.36
Metals					
Arsenic, total	0/13	< 0.050	< 0.050	~ 0.050	0
Cadmium, total	0/13	< 0.0050	< 0.0050	~ 0.0050	0
Chromium, total	3/13	0.0099	< 0.0040	~ 0.0053*	0.00069
Copper, total	1/13	0.023	< 0.0070	~ 0.0082*	0.0012
Iron, total	1/13	2.0	< 0.050	~ 0.20	0.15
Lead, total	0/13	< 0.050	< 0.050	~ 0.050	0
Mercury, total	0/13	< 0.000050	< 0.000050	~ 0.000050	0
Nickel, total	2/13	0.013	< 0.010	~ 0.010*	0.00023
Phosphorus, total	5/13	0.40	< 0.20	~ 0.22*	0.015
Selenium, total	0/13	< 0.050	< 0.050	~ 0.050	0
Silver, total	1/13	0.019	< 0.0050	~ 0.0061*	0.0011
Zinc, total	13/13	1.3	0.017	0.14	0.097
Others					
Biochemical oxygen demand	0/13	< 5.0	< 5.0	~ 5.0	0
Cyanide, total	0/13	< 0.0020	< 0.0020	~ 0.0020	0
Oil and grease	4/13	11	< 2.0	~ 3.5*	0.80
Phenolics, total recoverable	0/13	< 0.0010	< 0.0010	~ 0.0010	0
Total suspended solids	0/13	< 5.0	< 5.0	~ 5.0	0
Total toxic organics	0/13	< 0.010	< 0.010	~ 0.010	0

Table 15. (continued)

Analyte	N det/ N total	Concentration (mg/L) Max	Min	Av[b]	Standard error[c]
Volatile Organics					
1,1-Dichloroethane	0/13	U 0.0050	U 0.0050	~ 0.0050	0
Benzene	0/13	U 0.0050	U 0.0050	~ 0.0050	0
Bromodichloromethane	0/13	U 0.0050	U 0.0050	~ 0.0050	0
Chlorobenzene	0/13	U 0.0050	U 0.0050	~ 0.0050	0
Chloroform	0/13	U 0.0050	U 0.0050	~ 0.0050	0
Methylene chloride	0/13	U 0.0050	U 0.0050	~ 0.0050	0
Tetrachloroethene	0/13	U 0.0050	U 0.0050	~ 0.0050	0
Trichloroethene	0/13	U 0.0050	U 0.0050	~ 0.0050	0

[a]See Fig. 5.
[b]Average concentrations significantly greater than zero are identified by an *.
[c]Standard error of the mean.
[d]Not applicable.
[e]pH monitoring is continuous.

Table 16. NPDES discharge point X13,[a] October-December 1992

Analyte	N det/ N total	Concentration (mg/L) Max	Min	Av[b]	Standard error[c]
Anions					
Fluoride	3/3	3.1	0.70	1.8	0.70
Nitrate (as N)	1/3	1.4	< 1.0	~ 1.1*	0.13
Sulfate (as SO_4)	3/3	320	75	190	70
Field Measurements					
Chlorine, total residual	0/13	< 0.010	< 0.010	~ 0.010	0
Conductivity (mS/cm)	3/3	2.3	1.3	1.7*	0.30
Dissolved oxygen (ppm)	13/13	12	7.7	9.7*	0.34
Flow (Mgd)	62/62	18	0.31	2.5*	0.38
pH (SU)	3/3	8.0	7.0	d	d
Temperature (°C)	16/16	18	6.2	11*	0.85
Turbidity (NTU)	3/3	15	7.0	10*	2.4
Metals					
Aluminum, total	3/3	2.9	0.22	1.2	0.87
Arsenic, total	0/3	< 0.050	< 0.050	~ 0.050	0
Cadmium, total	0/3	< 0.0020	< 0.0020	~ 0.0020	0
Chromium, total	2/3	0.015	< 0.0040	~ 0.0083	0.0034
Copper, total	3/3	0.025	0.012	0.016*	0.0043
Iron, total	3/3	2.6	0.34	1.1	0.73
Lead, total	0/3	< 0.0040	< 0.0040	~ 0.0040	0
Mercury, total	0/3	< 0.000050	< 0.000050	~ 0.000050	0
Manganese, total	3/3	0.44	0.19	0.31*	0.072
Nickel, total	1/3	0.011	< 0.010	~ 0.010*	0.00033
Phosphorus, total	3/3	1.2	0.40	0.79*	0.22
Silver, total	0/3	< 0.0050	< 0.0050	~ 0.0050	0
Zinc, total	3/3	0.11	0.080	0.097*	0.0088
Others					
Ammonia (as N)	3/3	0.070	0.040	0.053*	0.0088
Biochemical oxygen demand	0/3	< 5.0	< 5.0	~ 5.0	0
Oil and grease	5/13	6.0	< 2.0	~ 2.8*	0.41
Phenolics, total recoverable	0/3	< 0.0010	< 0.0010	~ 0.0010	0
Total dissolved solids	3/3	640	300	440*	99
Total organic carbon	3/3	7.6	3.2	5.0*	1.3
Total suspended solids	3/3	81	6.0	32	25

Table 16. (continued)

Analyte	N det/ N total	Concentration (mg/L) Max	Min	Av[b]	Standard error[c]
PCBs					
PCB, total	0/3	U 0.0020	U 0.0020	~ 0.0020	0
Volatile Organics					
Chloroform	0/3	U 0.0050	U 0.0050	~ 0.0050	0
Trichloroethene	1/3	U 0.0050	J 0.0020	~ 0.0040*	0.0010

[a]See Fig. 5.
[b]Average concentrations significantly greater than zero are identified by an *.
[c]Standard error of the mean.
[d]Not applicable.

Table 17. NPDES discharge point X14,[a] October-December 1992

Analyte	N det/ N total	Concentration (mg/L) Max	Min	Av[b]	Standard error[c]
Anions					
Fluoride	3/3	0.90	0.60	0.74*	0.087
Nitrate (as N)	3/3	2.0	1.0	1.3*	0.33
Sulfate (as SO_4)	3/3	62	51	56*	3.3
Field Measurements					
Chlorine, total residual	0/13	< 0.010	< 0.010	~ 0.010	0
Conductivity (mS/cm)	3/3	2.0	1.3	1.7*	0.20
Dissolved oxygen (ppm)	13/13	11	8.7	10*	0.23
Flow (Mgd)	62/62	28	2.1	5.7*	0.63
pH (SU)	3/3	7.6	7.6	d	d
Temperature (°C)	16/16	18	9.5	13*	0.70
Turbidity (NTU)	3/3	8.0	8.0	8.0	0
Metals					
Aluminum, total	3/3	0.28	0.058	0.19	0.066
Arsenic, total	0/3	< 0.050	< 0.050	~ 0.050	0
Cadmium, total	0/3	< 0.0020	< 0.0020	~ 0.0020	0
Chromium, total	1/3	0.0099	< 0.0040	~ 0.0060*	0.0020
Copper, total	1/3	0.0070	< 0.0070	~ 0.0070	0
Iron, total	2/3	0.25	< 0.050	~ 0.15	0.058
Lead, total	0/3	< 0.0040	< 0.0040	~ 0.0040	0
Mercury, total	0/3	< 0.000050	< 0.000050	~ 0.000050	0
Manganese, total	3/3	0.038	0.023	0.032*	0.0046
Nickel, total	0/3	< 0.010	< 0.010	~ 0.010	0
Phosphorus, total	3/3	0.38	0.20	0.29*	0.052
Silver, total	0/3	< 0.0050	< 0.0050	~ 0.0050	0
Zinc, total	3/3	0.065	0.029	0.044*	0.011
Others					
Ammonia (as N)	3/3	0.080	0.040	0.063*	0.012
Biochemical oxygen demand	0/3	< 5.0	< 5.0	~ 5.0	0
Oil and grease	4/13	6.0	< 2.0	~ 2.6*	0.33
Phenolics, total recoverable	0/3	< 0.0010	< 0.0010	~ 0.0010	0
Total dissolved solids	3/3	250	240	250*	4.9
Total organic carbon	3/3	3.3	1.7	2.5*	0.46
Total suspended solids	1/3	6.0	< 5.0	~ 5.3*	0.33

Table 17. (continued)

Analyte	N det/ N total	Concentration (mg/L) Max	Min	Av[b]	Standard error[c]
PCBs					
PCB, total	0/3	U 0.0020	U 0.0020	~ 0.0020	0
Volatile Organics					
Chloroform	3/3	J 0.0020	J 0.0010	~ 0.0017*	0.00033
Trichloroethene	0/3	U 0.0050	U 0.0050	~ 0.0050	0

[a]See Fig. 5.
[b]Average concentrations significantly greater than zero are identified by an *.
[c]Standard error of the mean.
[d]Not applicable.

Table 18. NPDES discharge point X15,[a] October-December 1992

Analyte	N det/ N total	Concentration (mg/L) Max	Min	Av[b]	Standard error[c]
Anions					
Fluoride	3/3	0.96	0.60	0.79*	0.10
Nitrate (as N)	0/3	< 1.0	< 1.0	~ 1.0	0
Sulfate (as SO_4)	3/3	59	53	55*	2.0
Field Measurements					
Chlorine, total residual	0/13	< 0.010	< 0.010	~ 0.010	0
Conductivity (mS/cm)	3/3	2.8	1.4	1.9*	0.45
Dissolved oxygen (ppm)	13/13	12	7.8	9.8*	0.40
Flow (Mgd)	62/62	46	2.7	7.9*	0.96
pH (SU)	3/3	7.7	7.1	d	d
Temperature (°C)	16/16	18	5.6	12*	1.0
Turbidity (NTU)	3/3	30	12	18*	6.0
Metals					
Aluminum, total	3/3	0.99	0.35	0.58	0.20
Arsenic, total	0/3	< 0.010	< 0.010	~ 0.010	0
Cadmium, total	0/3	< 0.0020	< 0.0020	~ 0.0020	0
Chromium, total	3/3	0.014	0.0048	0.0099*	0.0027
Copper, total	1/3	0.0076	< 0.0070	~ 0.0072*	0.00020
Iron, total	3/3	0.90	0.46	0.69*	0.13
Lead, total	0/3	< 0.0040	< 0.0040	~ 0.0040	0
Mercury, total	2/3	0.000060	0.000010	~ 0.000040	0.000015
Manganese, total	3/3	0.20	0.099	0.14*	0.031
Nickel, total	0/3	< 0.010	< 0.010	~ 0.010	0
Phosphorus, total	3/3	0.30	0.20	0.27*	0.033
Silver, total	0/3	< 0.0050	< 0.0050	~ 0.0050	0
Zinc, total	3/3	0.034	0.015	0.024*	0.0055
Others					
Ammonia (as N)	3/3	0.28	0.12	0.18*	0.049
Biochemical oxygen demand	0/3	< 5.0	< 5.0	~ 5.0	0
Oil and grease	4/13	6.0	< 2.0	~ 2.8*	0.42
Total dissolved solids	3/3	290	140	220*	45
Total organic carbon	3/3	5.8	2.5	3.9*	0.98
Total suspended solids	3/3	17	10	14*	2.2

Table 18. (continued)

Analyte	N det/ N total	Concentration (mg/L) Max	Min	Av[b]	Standard error[c]
PCBs					
PCB, total	0/3	U 0.0020	U 0.0020	~ 0.0020	0
Volatile Organics					
Chloroform	0/3	U 0.0050	U 0.0050	~ 0.0050	0
Trichloroethene	0/3	U 0.0050	U 0.0050	~ 0.0050	0

[a]See Fig. 5.
[b]Average concentrations significantly greater than zero are identified by an *.
[c]Standard error of the mean.
[d]Not applicable.

Table 19. NPDES category II outfalls,[a] October-December 1992

Analyte	N det/ N total	Concentration (mg/L) Max	Min	Av[b]	Standard error[c]
Field Measurements					
Downstream pH (SU)	41/41	8.3	7.3	d	d
Downstream Temperature (°C)	10/10	24	9.3	16*	1.5
Flow (Mgd)	41/41	0.13	0.00029	0.030*	0.0054
pH (SU)	41/41	8.6	7.1	d	d
Temperature (°C)	41/41	65	7.8	18*	1.4
Others					
Oil and grease	19/41	14	< 2.0	~3.8*	0.53
Total suspended solids	17/41	330	< 5.0	~19*	8.1
Radionuclides (Bq/L)					
Gross beta	41/41	65	-0.040	2.8*	1.6
Total rad Sr	1/1	54	54	54	d

[a]See Fig. 5.
[b]Average concentrations significantly greater than zero are identified by an *.
[c]Standard error of the mean.
[d]Not applicable.

Table 20. NPDES category III outfalls,[a] October-December 1992

Analyte	N det/ N total	Concentration (mg/L) Max	Min	Av[b]	Standard error[c]
Field Measurements					
Flow (Mgd)	16/16	0.14	0.00022	0.020*	0.0095
pH (SU)	16/16	9.0	7.0	d	d
Temperature (°C)	16/16	23	12	16*	0.78
Radionuclides (Bq/L)					
Co-60	5/5	0.46	-0.030	0.23*	0.099
Cs-137	5/5	16	0.010	3.5	3.1
Gross beta	5/5	280	0.53	100	48
Total rad Sr	4/4	160	29	71	31

[a]See Fig. 5.
[b]Average concentrations significantly greater than zero are identified by an *.
[c]Standard error of the mean.
[d]Not applicable.

Table 21. NPDES cooling towers,[a] October-December 1992

Analyte	N det/ N total	Concentration (mg/L) Max	Min	Av[b]	Standard error[c]
Field Measurements					
Chlorine, total residual	7/10	0.15	< 0.010	~ 0.078*	0.017
Downstream pH (SU)	10/10	8.5	8.0	d	d
Flow (Mgd)	10/10	0.19	0.0026	0.043	0.024
pH (SU)	10/10	8.8	7.8	d	d
Temperature (°C)	10/10	33	20	26*	1.3
Metals					
Chromium, total	2/10	0.027	< 0.0040	~ 0.0078*	0.0026
Copper, total	8/10	0.22	< 0.0070	~ 0.077*	0.024
Zinc, total	10/10	0.29	0.0022	0.12*	0.032

[a]See Fig. 5.
[b]Average concentrations significantly greater than zero are identified by an *.
[c]Standard error of the mean.
[d]Not applicable.

Table 22. NPDES permit limit noncompliances, October-December 1992

Location	Limit Violated	Date	mg/L	
			Permit Limit	Value
Category II				
Outfall 230	Total suspended solids	30OCT92	50	53
Outfall 234	Total suspended solids	30OCT92	50	55
Outfall 216	Total suspended solids	02NOV92	50	89
Outfall 250	Total suspended solids	24NOV92	50	327

3.3.2.2.2 Exceedences of NPDES Permit Limits

The TSS exceedences that occurred at the Category II outfalls 216 and 250 were attributed to residual dust and dirt being conveyed through these outfalls by storm water runoff.

3.3.2.3 December 1992

3.3.2.3.1 Inappropriate and/or Unpermitted Discharges

On December 29, 1992, an ORNL potable water pipe broke in the 3000 Area of the ORNL main complex in Bethel Valley, which discharges into Fifth Creek at outall 267. The break caused a release of approximately 50 gallons per minute for approximately 3 hours. The broken pipe was valved off as soon as it was discovered and repaired.

3.3.2.3.2 Exceedences of NPDES Permit Limits

No exceedences

3.4 MERCURY IN THE AQUATIC ENVIRONMENT

Betsy M. Horwedel and Martha M. Stevens

3.4.1 Program Description

In the mercury monitoring program at ORNL, samples of surface water and stream sediment in the Bethel and Melton valleys are collected semiannually and analyzed for mercury content. This monitoring is conducted to comply with the CWA and ORNL's NPDES permit. The primary purpose of this effort is to identify, locate, and minimize all mercury contamination in ORNL discharge to the aquatic environment.

In earlier years, before stringent regulations came into effect, some contaminants reached various streams primarily as the results of accidental spills or leakages. The majority of the mercury spills occurred from 1954 through 1963, during a period when ORNL was involved with OREX and METALLEX separation processes. Most of this activity occurred in around buildings 4501, 4505, and 3592. These processes are no longer in operation at ORNL. During the time of operation, an unknown number of mercury spills took place. The spills were cleaned up; however, some quantities of mercury escaped and reached the surrounding environment. The sampling locations have been placed in areas surrounding known mercury spills. Sampling locations have also been placed near outfalls from building areas with a past history of mercury concern and outfalls from storage areas, spill areas, road, and parking lot drains. Additional sampling locations have been placed downstream from the outfalls and drains to determine the extent to which any mercury is being transported in the surface water and sediment. The surface water sampling locations are shown on Fig. 7. The sediment sampling locations are shown on Fig. 8. A total of 39 surface water samples and 27 sediment samples were taken from 13 surface water locations and 9 sediment locations. The surface

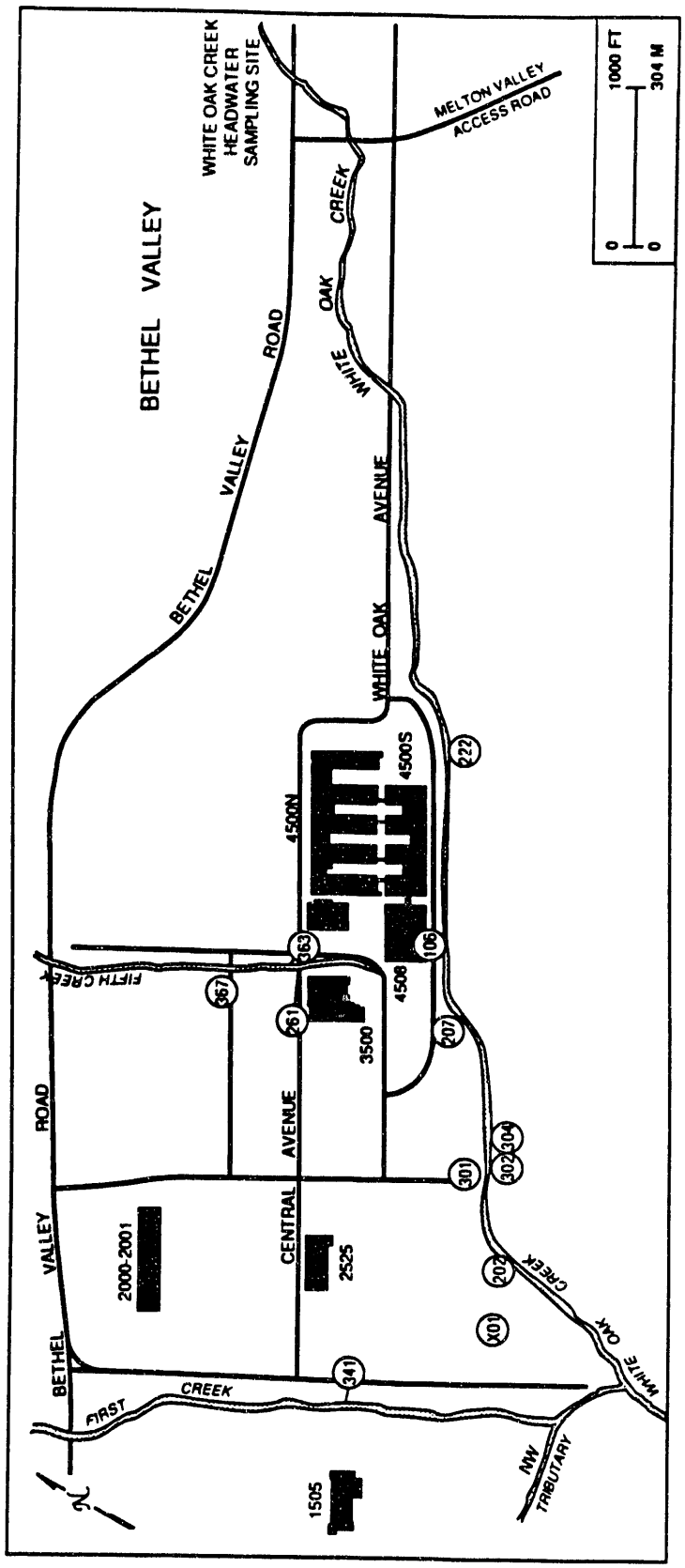

Fig. 7. Water sampling locations for mercury monitoring in the ORNL main plant area.

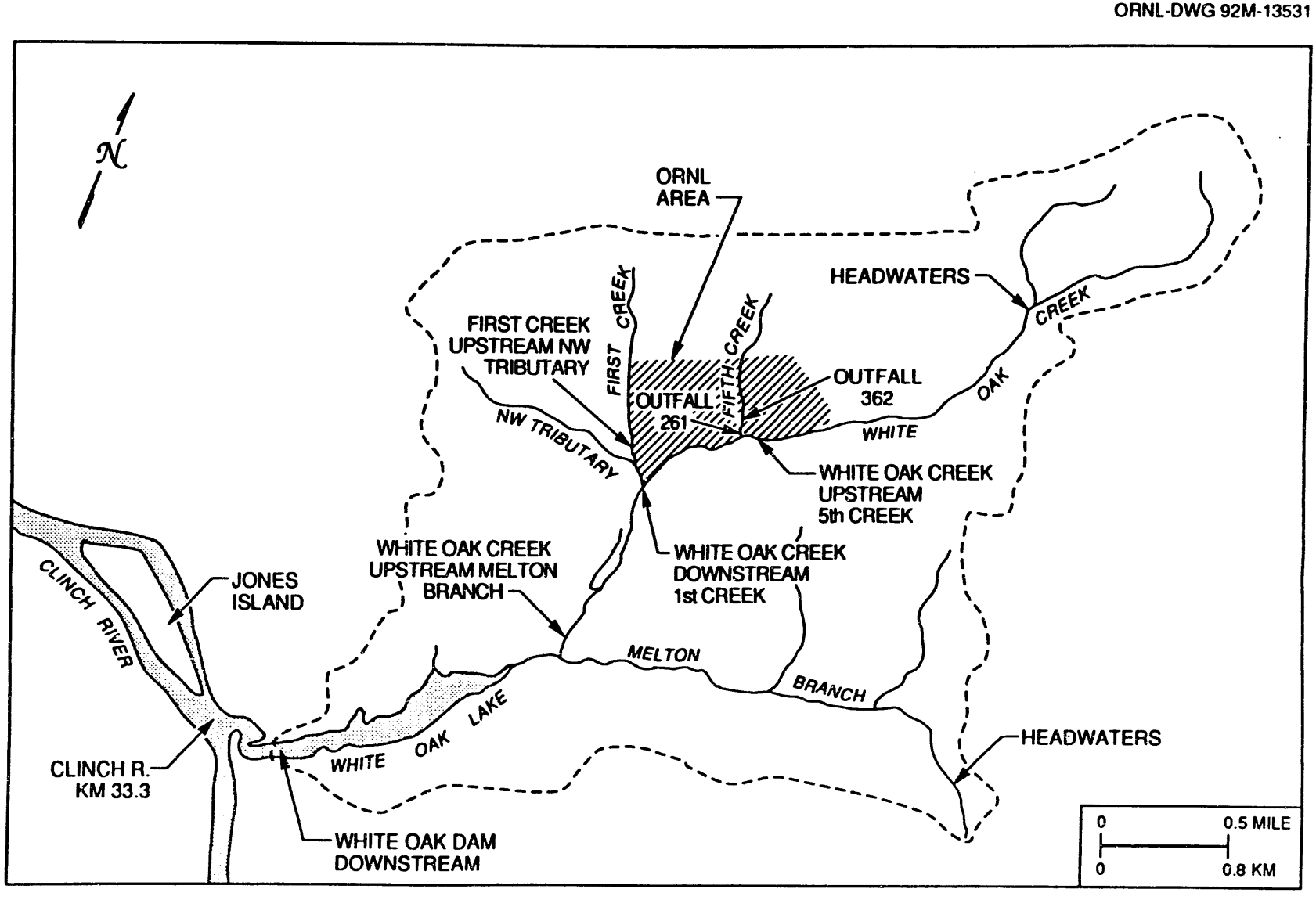

Fig. 8. Sediment sampling locations for mercury monitoring in the ORNL environs.

water samples were collected by the manual grab method and placed in 1-L polyethylene bottles with polyethylene caps. The sediment samples were also collected by the manual grab method and placed in glass containers. In the laboratory, the samples were analyzed for total mercury content by manual cold vapor atomic absorption.

3.4.2 Results

Table 23 shows the maximum, minimum, and average concentrations of mercury in surface water sampled in December 1992. The standard error of the mean is also included. The Tennessee Water Quality (TWQ) Standard for the protection of fish and aquatic life is 2.4 μg/L (ppb) for the acute criteria. The percentage TWQ column shows the reported maximum concentration as a percentage of this limit for each sampling location. Mercury was not detected at 6 out of the 13 sampling locations. The highest value reported was 0.22 μg/L at outfall 106 on WOC. The average concentrations at all other sampling locations were less than 0.16 μg/L.

Table 24 shows the maximum, minimum, and average concentrations of mercury in sediment sampled in December 1992. The standard error of the mean is also included. There is no established state or EPA standard for mercury in sediment. The highest concentrations of mercury were measured in the samples from Fifth Creek, with averages of 88 μg/g and 37 μg/g at the two locations. Two sites on White Oak Creek had average concentrations of 2.8 μg/g and 1.2 μg/g. Average concentrations of mercury at all other sampling locations were much lower; they ranged from 0.026 μg/g to 0.31 μg/g.

3.5 GROUNDWATER

Regis S. Loffman

Groundwater at ORNL is monitored to comply with 3004(U) of RCRA and DOE Orders 5400.1 and 5400.5. The monitoring also provides data needed 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. The location of the WAGs is shown in Fig. 9.

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 site perimeter to detect possible site groundwater contaminant migration.

Table 23. Mercury concentrations in water, December 1992

Stream[a]	Site	N det/ N total	Concentration (μg/L) Max	Min	Av[b]	Standard error[c]	Percent of TWQ standard[d]
1st Creek	341	0/3	< 0.050	< 0.050	~ 0.050	0	< 2.1
5th Creek	261	0/3	< 0.050	< 0.050	~ 0.050	0	< 2.1
	363	0/3	< 0.050	< 0.050	~ 0.050	0	< 2.1
	367	0/3	< 0.050	< 0.050	~ 0.050	0	< 2.1
WOC	106	3/3	0.22	0.20	0.21*	0.0058	9.2
	202	3/3	0.12	0.11	0.11*	0.0033	5.0
	207	3/3	0.17	0.16	0.16*	0.0033	7.1
	222	0/3	< 0.050	< 0.050	~ 0.050	0	< 2.1
	301	3/3	0.14	0.12	0.13*	0.0067	5.8
	302	3/3	0.14	0.13	0.13*	0.0033	5.8
	304	3/3	0.15	0.14	0.14*	0.0033	6.3
	HDW[e]	0/3	< 0.050	< 0.050	~ 0.050	0	< 2.1
	X01	3/3	0.070	0.070	0.070	0	2.9

[a]See Fig. 7.
[b]Average concentrations significantly greater than zero are identified by an *.
[c]Standard error of the mean.
[d]Maximum concentration as a percentage of TWQ Standard, 2.4 μg/L, for the protection of fish and aquatic life.
[e]Headwaters site.

Table 24. Mercury concentrations in sediment, December 1992

Stream	Site[a]	N det/ N total	Concentration (μg/g) Max	Min	Av[b]	Standard error[c]
1st Creek	Upstream NWT	3/3	0.048	0.039	0.044*	0.0026
5th Creek	Outfall 261	3/3	211	6.6	88	63
	Outfall 362	3/3	61	23	37*	12
MB	Headwaters	3/3	0.015	0.012	0.014*	0.00088
WOC	Upstream 5th Creek	3/3	1.3	1.1	1.2*	0.052
	Downstream 1st Creek	3/3	3.1	2.3	2.8*	0.27
	Headwaters	3/3	0.79	0.069	0.31	0.24
	Upstream MB	3/3	0.038	0.017	0.026*	0.0063
	Downstream WOD	3/3	0.067	0.032	0.045*	0.011

[a]See Fig. 8.
[b]Average concentrations significantly greater than zero are identified by an *.
[c]Standard error of the mean.

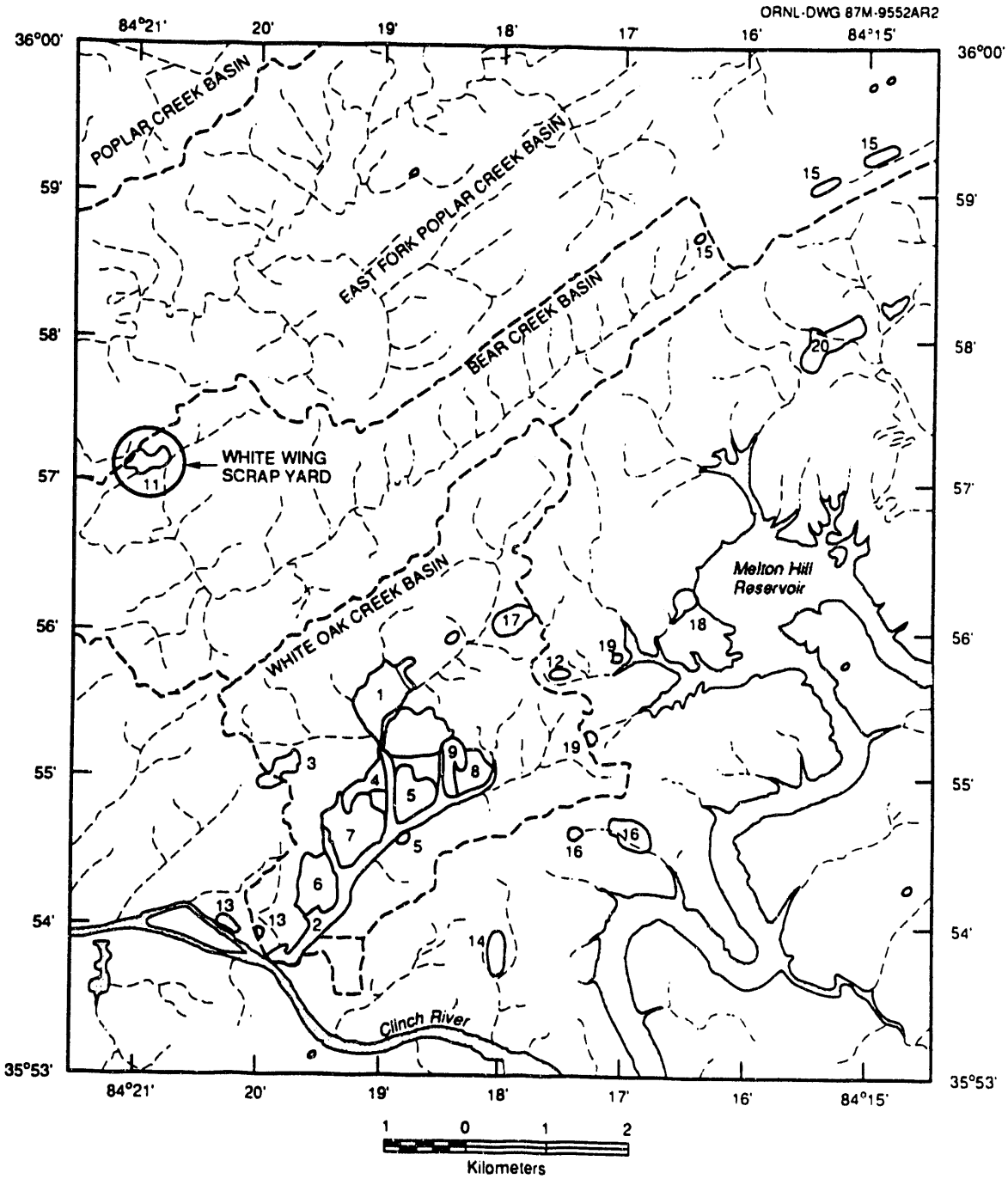

Fig. 9. ORNL WAGs.

Table 25 contains a listing of all of the analytes sought in groundwater at ORNL during quarter 1992 and the regulatory limits associated with each. Not all substances shown in Table 25 were analyzed for in each sample. Table 25, used 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 for comparisons. It should be emphasized that use of drinking water limits for comparison does not imply that members of the public 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 the quarter. The first table is a summary table presented by well type (i.e., down-gradient and up-gradient). 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 below 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), and "Y" (value from reanalysis after dilution when the calibration range was exceeded).

The second table contains WAG-specific values that exceed a reference value. This reference value may be a regulatory limit, or, for organic analytes which do not have regulatory limits, five times 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 (see Section 1.0 for discussion).

With respect to the volatile organic results, a number of the wells show vinyl chloride results of "U 10 μg/L" which appear to exceed the primary drinking water standard of 2 μg/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 μg/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. (A similar explanation can be applied to pentachlorophenol results.)

Table 25. Analytes sought and applicable standards in groundwater at ORNL in WAGs 4, 5, and 6 during October-December 1992

Analyte	National Primary Drinking Water	National Secondary Drinking Water	Tennessee Primary Drinking Water	4% of DOE DCG[a]
Anions (mg/L)				
Bromide				
Chloride		250		
Fluoride	4.0	2.0		
Nitrate	10			
Phosphate				
Sulfate (as SO_4)		250		
Base/Neutral/Acid Extractable Organics[b] (μg/L)				
1,2,4-Trichlorobenzene				
1,2-Dichlorobenzene	600			
1,3-Dichlorobenzene				
1,4-Dichlorobenzene	75	5.0	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 25. (continued)

Analyte	National Primary Drinking Water	National Secondary Drinking Water	Tennessee Primary Drinking Water	4% of DOE DCG[a]
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	1.0			
Phenanthrene				
Phenol				
Pyrene				
Field Measurements				
Conductivity (mS/cm)				
Dissolved oxygen (ppm)				
Redox (mV)				

Table 25. (continued)

Analyte	National Primary Drinking Water	National Secondary Drinking Water	Tennessee Primary Drinking Water	4% of DOE DCG[a]
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	0.0050		0.010	
Calcium				
Chromium	0.10		0.050	
Cobalt				
Copper		1.0		
Iron		0.30		
Lead	0.05		0.050	
Lithium				
Magnesium				
Manganese		0.050		
Mercury	0.0020		0.0020	
Molybdenum				
Nickel				
Phosphorus				
Potassium				
Selenium	0.050		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 25. (continued)

Analyte	National Primary Drinking Water	National Secondary Drinking Water	Tennessee Primary Drinking Water	4% of DOE DCG[a]
Total dissolved solids (mg/L)		500	500	
Total organic carbon (mg/L)				
Total organic halides (μg/L)				
Total suspended solids (mg/L)				
Radionuclides (Bq/L)[c]				
Co-60				7.4
Cs-137				4.44
Gross alpha	0.555			
Gross beta	1.85[d]			
H-3	740			2,960
Total rad Sr	0.296			1.48
Volatile Organics (μg/L)[b]				
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	70			
1,2-Dichloropropane	5.0			
2-Butanone				
2-Hexanone				
4-Methyl-2-pentanone				
Acetone				
Benzene	5.0		5.0	
Bromodichloromethane	100[e]			
Bromoform	100[e]			
Bromomethane				
Carbon disulfide				
Carbon tetrachloride	5.0		5.0	
Chlorobenzene	100			
Chloroethane	200			
Chloroform	100[e]			
Chloromethane				
Dibromochloromethane	100[e]			
Ethylbenzene	700			
Methylene chloride				
Styrene	100			
Tetrachloroethene	5.0			

Table 25. (continued)

Analyte	National Primary Drinking Water	National Secondary Drinking Water	Tennessee Primary Drinking Water	4% of DOE DCG[a]
Toluene	1,000			
Trichloroethene	5.0		5.0	
Vinyl acetate				
Vinyl chloride	2.0		2.0	
Xylene, total	10,000			
cis-1,3-Dichloropropene				
trans-1,3-Dichloropropene				

[a]4% of the DOE DCG to represent the DOE criterion of 4 mrem effective dose equivalent from ingestion of drinking water. See discussion in Section 1.0.
[b]Divide μg/L by 1000 to convert to mg/L.
[c]Divide Bq/L by 0.037 to convert to pCi/L.
[d]Regulatory guide for assessing compliance without further analysis.
[e]Limit for total trihalomethanes (bromodichloromethane + bromoform + chloroform + dibromochloromethane).

3.5.1 WAG 4

3.5.1.1 Program Description

The sites at Waste Area Grouping (WAG) 4 are currently remedial investigation sites regulated under RCRA 3004(u). ORNL has sampled WAG 4 since 1991 and has plans to continue sampling every year.

WAG 4 is located in Melton Valley approximately 0.8 km (0.5 mile) southwest of the main ORNL plant site (Fig. 10). It is comprised of the SWSA 4 waste disposal area, liquid low-level waste (LLW) transfer lines and the experimental Pilot Pit Area (Area 7811).

SWSA 4 was opened for routine burial of solid radioactive contaminated wastes in 1951. From 1955 to 1963, Oak Ridge was designated by the Atomic Energy Commission as the Southern Regional Burial Ground; as such, SWSA 4 received a wide variety of poorly characterized wastes (including radioactive waste) from approximately 50 agencies. These solid wastes consisted of paper, clothing, equipment, filters, animal carcasses, and related laboratory wastes. Approximately 50% of the waste was received from sources outside of Oak Ridge facilities. Wastes were placed in trenches, shallow auger holes, and in piles on the ground, for covering at a later date.

Liquid LLW was transported from storage tanks at the main ORNL complex to waste pits and trenches in Melton Valley (WAG 7), and later to the hydrofracture site, through underground transfer lines from 1954 to 1975. The Pilot Pit Area (Area 7811) was constructed for use in pilot-scale radioactive waste disposal studies from 1955 to 1959; three large concrete cylinders containing experimental equipment remain embedded in the ground. A control building and asphalt pad have been used for storage through the years.

Fifteen wells comprise the groundwater perimeter well network at WAG 4 (wells 948-962); the up-gradient wells for WAG 4 are 950-953.

Table 26 shows the parameters measured at WAG 4.

3.5.1.2 Results

Perimeter wells at WAG 4 were sampled October 26-November 23, 1992. 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 that exceed some reference criteria.

Tritium was the most significant radiological contaminant detected in the down-gradient wells at WAG 4. It was detected at levels of most concern at wells 960, 954, 956, 955, 957, and 958 at values ranging from 2,700 to 290,000 Bq/L. Gross beta activity was detected highest at well 956 at 51 Bq/L; the associated total rad Sr at the well was 32 Bq/L. Gross alpha activity was detected at a number of the wells and well 956 had the highest level, 6.1 Bq/L.

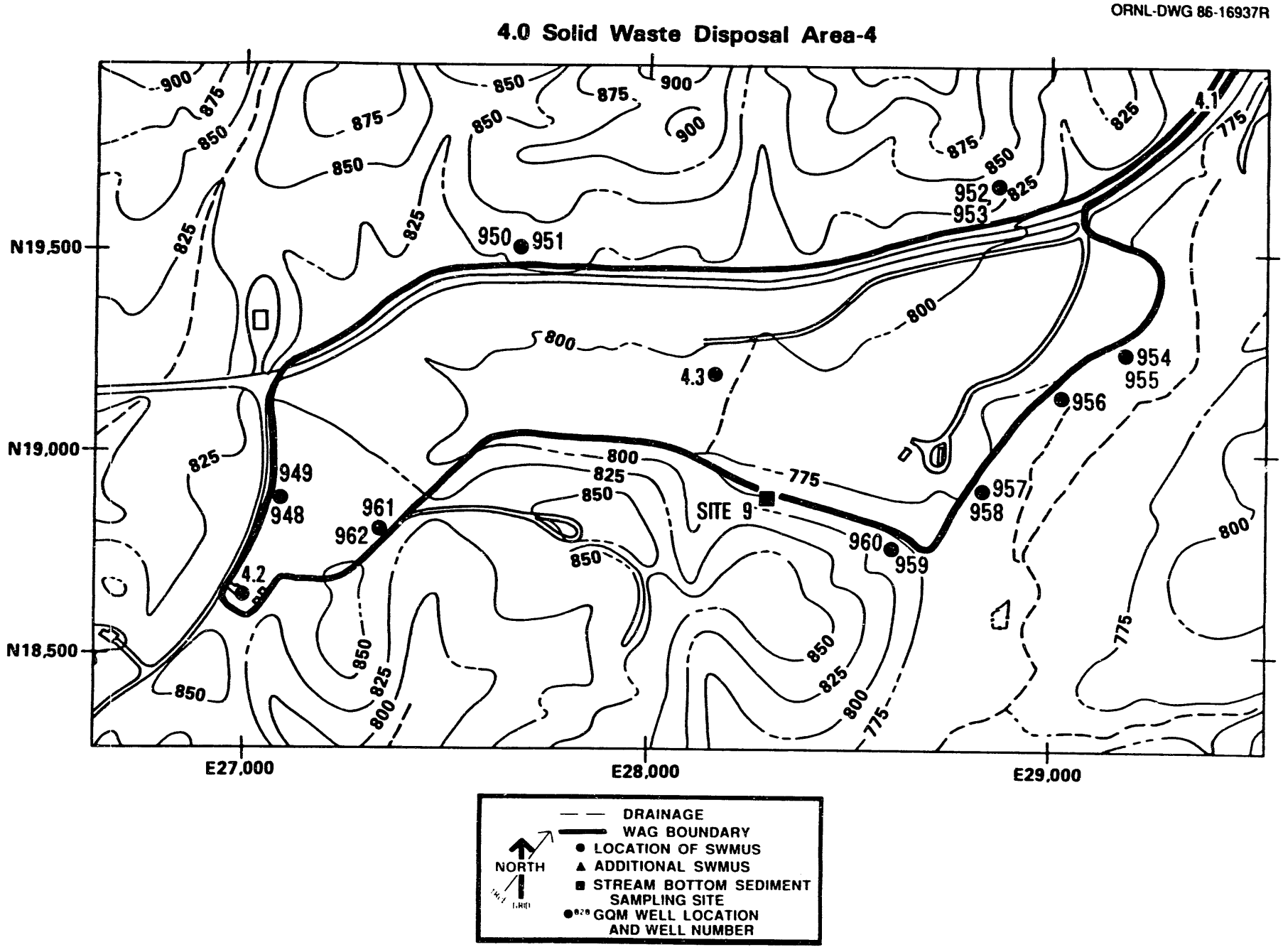

Fig. 10. Location map showing water quality wells at WAG 4.

Table 26. Parameters measured in groundwater at ORNL WAGs 4 and 5 during quarter 1992

Inorganic Compounds
- Alkalinity
- Anions
  - bromide
  - chloride
  - fluoride
  - nitrate
  - phosphate
  - sulfate
- Metals by ICP
- Metals by atomic absorption
  - antimony
  - arsenic
  - lead
  - mercury
  - selenium
  - silver
  - thallium
- Total dissolved solids
- Total suspended solids

Field Measurements
- Dissolved oxygen
- pH
- Redox
- Specific conductance
- Temperature
- Turbidity

Organic Compounds
- Total organic carbon
- Total organic halides
- Total compound list

Radionuclides
- Gamma emitting isotopes
  - Co-60
  - Cs-137
- Gross alpha
- Gross beta
- H-3
- Total rad Sr

Table 27. ORNL WAG 4 groundwater summary statistics from October 26-November 23, 1992

Analyte	N det/ N total	Concentration			
		Max[a]	Min[a]	Av[b]	Standard error[c]
Down-gradient Well Type					
Anions (mg/L) -- Unfiltered					
Bromide	3/11	1.9	< 1.0	~ 1.1*	0.084
Chloride	11/11	270	3.2	65*	25
Fluoride	2/11	6.2	< 0.10	~ 0.92	0.56
Nitrate	1/11	27	< 0.10	~ 3.2	2.4
Phosphate	1/11	< 3.0	< 0.30	~ 1.3*	0.27
Sulfate (as SO_4)	9/11	310	< 1.0	~ 74*	28
Field Measurements -- Unfiltered					
Conductivity (mS/cm)	11/11	1.4	0.34	0.76*	0.11
Dissolved oxygen (ppm)	11/11	9.5	6.2	7.3*	0.29
Redox (mV)	11/11	600	290	410*	26
Temperature (°C)	11/11	17	13	15*	0.33
Turbidity (JTU)	11/11	340	6.3	50	29
pH (SU)	11/11	9.2	6.8	7.8*	0.26
Metals (mg/L) -- Filtered					
Aluminum	3/11	0.14	< 0.050	~ 0.060*	0.0077
Antimony	1/11	0.0065	< 0.0050	~ 0.0051*	0.00014
Barium	11/11	0.58	0.017	0.16*	0.059
Boron	6/11	0.65	< 0.080	~ 0.23*	0.063
Calcium	11/11	130	1.5	63*	14
Iron	8/11	23	< 0.050	~ 2.8	2.1
Magnesium	11/11	30	0.22	14*	2.9
Manganese	11/11	3.5	0.0027	0.51	0.31
Nickel	4/11	0.14	< 0.010	~ 0.044*	0.016
Potassium	11/11	4.6	1.7	2.9*	0.37
Selenium	2/11	0.0078	< 0.0050	~ 0.0054*	0.00029
Silicon	11/11	16	4.1	8.7*	1.3
Sodium	11/11	380	9.4	110*	39
Vanadium	2/11	0.0037	< 0.0020	~ 0.0023*	0.00021
Zinc	2/11	0.012	< 0.0050	~ 0.0062*	0.00078

Table 27. (continued)

Analyte	N det/ N total	Concentration			
		Max[a]	Min[a]	Av[b]	Standard error[c]
Down-gradient Well Type					
Metals (mg/L) -- Unfiltered					
Aluminum	5/11	0.55	< 0.050	~ 0.10*	0.044
Barium	11/11	0.56	0.019	0.15*	0.057
Boron	6/11	0.60	< 0.080	~ 0.22*	0.059
Calcium	11/11	130	1.5	61*	14
Chromium	2/11	0.0083	< 0.0040	~ 0.0047*	0.00050
Iron	11/11	23	0.13	2.9	2.1
Magnesium	11/11	29	0.26	13*	2.8
Manganese	11/11	3.4	0.0037	0.49	0.30
Nickel	5/11	0.14	< 0.010	~ 0.043*	0.015
Potassium	11/11	4.7	1.4	2.8*	0.34
Silicon	11/11	14	4.0	8.2*	1.1
Sodium	11/11	380	8.9	110*	39
Vanadium	1/11	0.0041	< 0.0020	~ 0.0022*	0.00019
Zinc	10/11	0.057	< 0.0050	~ 0.017*	0.0043
Others -- Filtered					
Alkalinity (mg/L)	11/11	510	120	330*	39
Total dissolved solids (mg/L)	11/11	970	240	520*	65
Others -- Unfiltered					
Alkalinity (mg/L)	11/11	500	120	340*	38
Total organic carbon (mg/L)	10/11	11	< 0.50	~ 2.0*	0.95
Total organic halides (μg/L)	3/11	1,100	< 5.0	~ 140	100
Total suspended solids (mg/L)	3/11	36	< 5.0	~ 8.6*	2.8
Radionuclides (Bq/L) -- Filtered					
Co-60	1/11	0.11*	-0.070	0.015	0.017
Cs-137	1/11	0.096*	-0.010	0.031*	0.011
Gross alpha	11/11	4.1*	0.091*	0.65*	0.35
Gross beta	11/11	39*	0.20*	4.4	3.5
H-3	9/11	280,000*	-17	48,000	30,000
Total rad Sr	2/11	28*	-0.044	2.6	2.5
Radionuclides (Bq/L) -- Unfiltered					
Co-60	1/11	0.20*	-0.020	0.053*	0.020
Cs-137	1/11	0.44*	-0.060	0.041	0.043
Gross alpha	11/11	6.1*	0.11*	0.84	0.53

Table 27. (continued)

Analyte	N det/ N total	Concentration			
		Max[a]	Min[a]	Av[b]	Standard error[c]
Down-gradient Well Type					
Radionuclides (Bq/L) -- Unfiltered					
Gross beta	10/11	51*	0.22*	5.3	4.6
H-3	10/11	290,000*	-16	49,000	31,000
Total rad Sr	4/11	32*	-0.039	3.1	2.9
Volatile Organics (μg/L) -- Unfiltered					
1,1,1-Trichloroethane	1/11	U 5.0	J 2.0	~ 4.7*	0.27
1,1-Dichloroethene	2/11	10	U 5.0	~ 5.8*	0.55
1,2-Dichloroethane	1/11	7.0	U 5.0	~ 5.2*	0.18
1,2-Dichloroethene	2/11	Y 930	U 5.0	~ 160	110
Acetone	1/11	B 17	U 10	~ 11*	0.64
Carbon disulfide	2/11	U 5.0	J 2.0	~ 4.6*	0.28
Trichloroethene	2/11	140	U 5.0	~ 22	13
Vinyl chloride	2/11	Y 1,000	U 10	~ 120	90
Up-gradient Well Type					
Anions (mg/L) -- Unfiltered					
Chloride	4/4	2.9	2.0	2.5*	0.19
Sulfate (as SO_4)	4/4	55	16	27*	9.3
Base/Neutral/Acid Extractable Organics (μg/L) -- Unfiltered					
Di-n-butylphthalate	1/4	U 10	B 2.0	~ 8.0*	2.0
N-Nitrosodiphenylamine	1/4	U 10	B 4.0	~ 8.5*	1.5
Field Measurements -- Unfiltered					
Conductivity (mS/cm)	4/4	0.46	0.060	0.24*	0.097
Dissolved oxygen (ppm)	4/4	9.4	6.8	8.1*	0.53
Redox (mV)	4/4	520	430	460*	19
Temperature (°C)	4/4	15	15	15*	0.064
Turbidity (JTU)	4/4	120	6.3	45	26
pH (SU)	4/4	7.6	6.9	7.2*	0.17
Metals (mg/L) -- Filtered					
Barium	4/4	0.22	0.038	0.15*	0.039
Calcium	4/4	61	14	38*	13
Iron	3/4	8.8	< 0.050	~ 4.2	2.4
Magnesium	4/4	12	7.4	10*	1.1

Table 27. (continued)

Analyte	N det/ N total	Concentration			
		Max[a]	Min[a]	Av[b]	Standard error[c]
Up-gradient Well Type					
Metals (mg/L) -- Filtered					
Manganese	4/4	3.2	0.51	1.7*	0.68
Potassium	4/4	4.3	1.4	2.8*	0.78
Silicon	4/4	19	14	16*	1.0
Sodium	4/4	21	7.3	12*	3.1
Vanadium	1/4	0.0021	< 0.0020	~ 0.0020*	0.000025
Zinc	1/4	0.016	< 0.0050	~ 0.0078*	0.0028
Metals (mg/L) -- Unfiltered					
Aluminum	2/4	0.39	< 0.050	~ 0.15	0.080
Barium	4/4	0.22	0.044	0.15*	0.037
Calcium	4/4	60	14	36*	12
Iron	4/4	8.5	0.16	4.3	2.2
Magnesium	4/4	12	6.1	9.2*	1.2
Manganese	4/4	2.7	0.48	1.5*	0.57
Potassium	4/4	4.2	0.90	2.6*	0.83
Silicon	4/4	17	12	14*	0.94
Sodium	4/4	21	6.2	11*	3.2
Zinc	4/4	0.044	0.012	0.023*	0.0074
Others -- Filtered					
Alkalinity (mg/L)	4/4	210	80	140*	34
Total dissolved solids (mg/L)	4/4	270	150	210*	31
Others -- Unfiltered					
Alkalinity (mg/L)	4/4	200	83	140*	33
Total organic carbon (mg/L)	2/4	0.55	< 0.50	~ 0.51*	0.013
Total suspended solids (mg/L)	2/4	34	< 5.0	~ 12	7.3
Radionuclides (Bq/L) -- Filtered					
Co-60	1/4	0.14*	-0.010	0.043	0.034
Gross beta	2/4	0.28*	0.040	0.13*	0.053
H-3	2/4	27*	-5.0	12	7.8

Table 27. (continued)

Analyte	N det/ N total	Concentration			
		Max[a]	Min[a]	Av[b]	Standard error[c]
Up-gradient Well Type					
Radionuclides (Bq/L) -- Unfiltered					
Gross alpha	1/4	0.070*	0.015	0.036*	0.012
Gross beta	4/4	0.18*	0.12*	0.17*	0.015
H-3	1/4	36*	-12	9.0	10
Total rad Sr	1/4	0.16*	0.018	0.073*	0.031

[a]Prefixes containing J, B, E, Y, U or < mean that the value was estimated, found in the laboratory blank, exceeded the calibration range, exceeded the calibration range and was diluted and reanalyzed, 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 *.

[b]Average concentrations significantly greater than zero are identified by an *.

[c]Standard error of the mean.

[d]Not applicable.

Table 28. ORNL WAG 4 groundwater constituents that exceed a reference value from sampling period October 26-November 23, 1992

Analyte	Concentration		Reference value	Reference source[b]
	Value[a]	Uncertainty		
Well 948, Sampling Date 05NOV92 *Ground Elevation 828.69 ft, Water Elevation 808.71*				
Anions (mg/L) -- Unfiltered				
Sulfate (as SO_4)	36	c	1.0	D
Base/Neutral/Acid Extractable Organics-TICs (µg/L) -- Unfiltered				
Unknown-7.53	J 5.0	c	c	T
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Pentachlorophenol	U 50	c	1	2
Metals (mg/L) -- Filtered				
Iron	0.53	c	0.3	3
Manganese	0.043	c	0.0010	D
Sodium	9.4	c	5.0	D
Metals (mg/L) -- Unfiltered				
Iron	0.79	c	0.3	3
Manganese	0.037	c	0.0010	D
Sodium	8.9	c	5.0	D
Zinc	0.020	c	0.0050	D
Others -- Unfiltered				
Total organic carbon (mg/L)	0.73	c	0.50	D
Radionuclides (Bq/L) -- Filtered				
Gross beta	2.8*	0.30	1.85	2
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 949, Sampling Date 05NOV92 *Ground Elevation 827.40 ft, Water Elevation 816.34*				
Anions (mg/L) -- Unfiltered				
Sulfate (as SO_4)	25	c	1.0	D

Table 28. (continued)

Analyte	Concentration		Reference value	Reference source[b]
	Value[a]	Uncertainty		
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Pentachlorophenol	U 50	c	1	2
Metals (mg/L) -- Filtered				
Iron	0.13	c	0.050	D
Manganese	0.23	c	0.05	3
Sodium	14	c	5.0	D
Metals (mg/L) -- Unfiltered				
Aluminum	0.054	c	0.050	D
Iron	0.28	c	0.050	D
Manganese	0.23	c	0.05	3
Sodium	14	c	5.0	D
Zinc	0.018	c	0.0050	D
Others -- Unfiltered				
Total organic carbon (mg/L)	1.8	c	0.50	D
Volatile Organics (µg/L) -- Unfiltered				
1,2-Dichloroethane	7.0	c	5	1
Vinyl chloride	U 10	c	2	1
Well 950, Sampling Date 26OCT92				
Ground Elevation 836.99 ft, Water Elevation 821.71				
Anions (mg/L) -- Unfiltered				
Sulfate (as SO_4)	19	c	1.0	D
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Pentachlorophenol	U 50	c	1	2
Metals (mg/L) -- Filtered				
Iron	8.8	c	0.3	3
Manganese	2.5	c	0.05	3
Sodium	9.0	c	5.0	D
Vanadium	0.0021	c	0.0020	D
Metals (mg/L) -- Unfiltered				
Iron	8.5	c	0.3	3
Manganese	2.4	c	0.05	3

Table 28. (continued)

Analyte	Concentration		Reference value	Reference source[b]
	Value[a]	Uncertainty		
Metals (mg/L) -- Unfiltered				
Sodium	8.4	c	5.0	D
Zinc	0.012	c	0.0050	D
Volatile Organics (μg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 951, Sampling Date 29OCT92				
Ground Elevation 836.00 ft, Water Elevation 821.82				
Anions (mg/L) -- Unfiltered				
Sulfate (as SO_4)	16	c	1.0	D
Base/Neutral/Acid Extractable Organics (μg/L) -- Unfiltered				
Pentachlorophenol	U 50	c	1	2
Metals (mg/L) -- Filtered				
Iron	0.086	c	0.050	D
Manganese	0.51	c	0.05	3
Sodium	11	c	5.0	D
Zinc	0.016	c	0.0050	D
Metals (mg/L) -- Unfiltered				
Iron	0.16	c	0.050	D
Manganese	0.48	c	0.05	3
Sodium	11	c	5.0	D
Zinc	0.022	c	0.0050	D
Others -- Unfiltered				
Total organic carbon (mg/L)	0.55	c	0.50	D
Volatile Organics (μg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 952, Sampling Date 28OCT92				
Ground Elevation 817.55 ft, Water Elevation 808.43				
Anions (mg/L) -- Unfiltered				
Sulfate (as SO_4)	19	c	1.0	D

Table 28. (continued)

Analyte	Concentration		Reference value	Reference source[b]
	Value[a]	Uncertainty		
Base/Neutral/Acid Extractable Organics-TICs (µg/L) -- Unfiltered				
Unknown-30.84	J 4.0	c	c	T
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Pentachlorophenol	U 50	c	1	2
Metals (mg/L) -- Filtered				
Iron	8.1	c	0.3	3
Manganese	3.2	c	0.05	3
Sodium	7.3	c	5.0	D
Metals (mg/L) -- Unfiltered				
Aluminum	0.13	c	0.050	D
Iron	7.5	c	0.3	3
Manganese	2.7	c	0.05	3
Sodium	6.2	c	5.0	D
Zinc	0.044	c	0.0050	D
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 953, Sampling Date 03NOV92				
Ground Elevation 816.89 ft, Water Elevation 808.38				
Anions (mg/L) -- Unfiltered				
Sulfate (as SO_4)	55	c	1.0	D
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Pentachlorophenol	U 50	c	1	2
Metals (mg/L) -- Filtered				
Manganese	0.62	c	0.05	3
Sodium	21	c	5.0	D
Metals (mg/L) -- Unfiltered				
Aluminum	0.39	c	0.2	3
Iron	1.0	c	0.3	3
Manganese	0.65	c	0.05	3
Sodium	21	c	5.0	D
Zinc	0.014	c	0.0050	D

Table 28. (continued)

Analyte	Concentration		Reference value	Reference source[b]
	Value[a]	Uncertainty		
Others -- Unfiltered				
Total suspended solids (mg/L)	34	c	5.0	D
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 954, Sampling Date 10NOV92				
Ground Elevation 768.70 ft, Water Elevation 765.16				
Anions (mg/L) -- Unfiltered				
Fluoride	6.2	c	4	2
Sulfate (as SO_4)	180	c	1.0	D
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Pentachlorophenol	U 50	c	1	2
Field Measurements -- Unfiltered				
pH (SU)	8.8	c	(6.5, 8.5)	3
Metals (mg/L) -- Filtered				
Aluminum	0.067	c	0.050	D
Boron	0.50	c	0.080	D
Manganese	0.0069	c	0.0010	D
Nickel	0.035	c	0.010	D
Sodium	380	c	5.0	D
Zinc	0.012	c	0.0050	D
Metals (mg/L) -- Unfiltered				
Aluminum	0.078	c	0.050	D
Boron	0.46	c	0.080	D
Iron	0.13	c	0.050	D
Manganese	0.0037	c	0.0010	D
Nickel	0.041	c	0.010	D
Sodium	380	c	5.0	D
Zinc	0.022	c	0.0050	D
Others -- Filtered				
Total dissolved solids (mg/L)	970	c	500	1

Table 28. (continued)

Analyte	Concentration			
	Value[a]	Uncertainty	Reference value	Reference source[b]
Others -- Unfiltered				
Total organic carbon (mg/L)	1.3	c	0.50	D
Total organic halides (µg/L)	290	c	5.0	D
Radionuclides (Bq/L) -- Filtered				
H-3	3,200*	100	740	2
Radionuclides (Bq/L) -- Unfiltered				
Gross alpha	0.99*	0.54	0.555	2
H-3	3,300*	100	740	2
Volatile Organics (µg/L) -- Unfiltered				
1,1-Dichloroethene	9.0	c	7	1
1,2-Dichloroethene	Y 830	c	70	2
Trichloroethene	52	c	5	1
Vinyl chloride	Y 220	c	2	1
Well 955, Sampling Date 09NOV92				
Ground Elevation 768.72 ft, Water Elevation 761.60				
Anions (mg/L) -- Unfiltered				
Phosphate	1.2	c	0.30	D
Sulfate (as SO_4)	68	c	1.0	D
Base/Neutral/Acid Extractable Organics-TICs (µg/L) -- Unfiltered				
Unknown-7.53	J 4.0	c	c	T
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Pentachlorophenol	U 50	c	1	2
Metals (mg/L) -- Filtered				
Boron	0.11	c	0.080	D
Iron	1.1	c	0.3	3
Manganese	0.40	c	0.05	3
Nickel	0.14	c	0.010	D
Sodium	72	c	5.0	D
Zinc	0.011	c	0.0050	D

Table 28. (continued)

Analyte	Concentration			
	Value[a]	Uncertainty	Reference value	Reference source[b]
Metals (mg/L) -- Unfiltered				
Boron	0.11	c	0.080	D
Iron	1.1	c	0.3	3
Manganese	0.37	c	0.05	3
Nickel	0.14	c	0.010	D
Sodium	71	c	5.0	D
Zinc	0.012	c	0.0050	D
Others -- Filtered				
Total dissolved solids (mg/L)	570	c	500	1
Others -- Unfiltered				
Total organic carbon (mg/L)	1.5	c	0.50	D
Radionuclides (Bq/L) -- Filtered				
Gross alpha	0.63*	0.20	0.555	2
Gross beta	3.5*	0.40	1.85	2
H-3	17,000*	1,000	740	2
Total rad Sr	0.72*	0.12	0.296	2
Radionuclides (Bq/L) -- Unfiltered				
H-3	17,000*	1,000	740	2
Total rad Sr	1.5*	0.10	0.296	2
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 956, Sampling Date 13NOV92				
Ground Elevation 774.04 ft, Water Elevation 770.45				
Base/Neutral/Acid Extractable Organics-TICs (µg/L) -- Unfiltered				
Unknown-17.1	J 43	c	c	T
Unknown-18.68	J 6.0	c	c	T
Unknown-19.86	J 270	c	c	T
Unknown-21.88	J 7.0	c	c	T
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Pentachlorophenol	U 50	c	1	2

Table 28. (continued)

Analyte	Concentration			
	Value[a]	Uncertainty	Reference value	Reference source[b]
Metals (mg/L) -- Filtered				
Antimony	0.0065	c	0.0050	D
Boron	0.13	c	0.080	D
Iron	23	c	0.3	3
Manganese	3.5	c	0.05	3
Nickel	0.10	c	0.010	D
Sodium	27	c	5.0	D
Metals (mg/L) -- Unfiltered				
Boron	0.12	c	0.080	D
Iron	23	c	0.3	3
Manganese	3.4	c	0.05	3
Nickel	0.085	c	0.010	D
Sodium	27	c	5.0	D
Zinc	0.013	c	0.0050	D
Others -- Filtered				
Total dissolved solids (mg/L)	510	c	500	1
Others -- Unfiltered				
Total organic carbon (mg/L)	11	c	0.50	D
Total suspended solids (mg/L)	36	c	5.0	D
Radionuclides (Bq/L) -- Filtered				
Gross alpha	4.1*	1.4	0.555	2
Gross beta	39*	4.0	1.85	2
H-3	5,200*	100	740	2
Total rad Sr	28*	1.0	0.296	2
Radionuclides (Bq/L) -- Unfiltered				
Gross alpha	6.1*	1.7	0.555	2
Gross beta	51*	4.0	1.85	2
H-3	5,300*	100	740	2
Total rad Sr	32*	1.0	0.296	2
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Volatile Organics-TICs (µg/L) -- Unfiltered				
Ethane,1,1'-oxybis--6.7	J 8.0	c	c	T

Table 28. (continued)

Analyte	Concentration		Reference value	Reference source[b]
	Value[a]	Uncertainty		
Well 957, Sampling Date 20NOV92				
Ground Elevation 767.00 ft, Water Elevation 765.04				
Anions (mg/L) -- Unfiltered				
Bromide	1.3	c	0.10	D
Chloride	270	c	250	3
Fluoride	2.1	c	0.010	D
Sulfate (as SO_4)	48	c	1.0	D
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Pentachlorophenol	U 50	c	1	2
Field Measurements -- Unfiltered				
pH (SU)	9.2	c	(6.5, 8.5)	3
Metals (mg/L) -- Filtered				
Aluminum	0.057	c	0.050	D
Boron	0.41	c	0.080	D
Manganese	0.0047	c	0.0010	D
Selenium	0.0078	c	0.0050	D
Sodium	280	c	5.0	D
Vanadium	0.0037	c	0.0020	D
Metals (mg/L) -- Unfiltered				
Aluminum	0.090	c	0.050	D
Boron	0.41	c	0.080	D
Chromium	0.0078	c	0.0040	D
Iron	0.28	c	0.050	D
Manganese	0.0082	c	0.0010	D
Nickel	0.020	c	0.010	D
Sodium	290	c	5.0	D
Zinc	0.0087	c	0.0050	D
Others -- Filtered				
Total dissolved solids (mg/L)	710	c	500	1
Others -- Unfiltered				
Total organic carbon (mg/L)	0.98	c	0.50	D
Total organic halides (µg/L)	96	c	5.0	D

Table 28. (continued)

Analyte	Concentration		Reference value	Reference source[b]
	Value[a]	Uncertainty		
Radionuclides (Bq/L) -- Filtered				
H-3	220,000*	10,000	740	2
Radionuclides (Bq/L) -- Unfiltered				
H-3	220,000*	10,000	740	2
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 958, Sampling Date 23NOV92				
Ground Elevation 767.03 ft, Water Elevation 762.06				
Anions (mg/L) -- Unfiltered				
Bromide	1.3	c	0.10	D
Sulfate (as SO_4)	17	c	1.0	D
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Pentachlorophenol	U 50	c	1	2
Metals (mg/L) -- Filtered				
Boron	0.37	c	0.080	D
Iron	0.41	c	0.3	3
Manganese	0.21	c	0.05	3
Nickel	0.14	c	0.010	D
Selenium	0.0069	c	0.0050	D
Sodium	150	c	5.0	D
Metals (mg/L) -- Unfiltered				
Boron	0.35	c	0.080	D
Iron	0.43	c	0.3	3
Manganese	0.20	c	0.05	3
Nickel	0.13	c	0.010	D
Sodium	150	c	5.0	D
Others -- Filtered				
Total dissolved solids (mg/L)	640	c	500	1
Others -- Unfiltered				
Total organic carbon (mg/L)	1.8	c	0.50	D
Total organic halides (µg/L)	1,100	c	5.0	D

Table 28. (continued)

Analyte	Concentration		Reference value	Reference source[b]
	Value[a]	Uncertainty		
Radionuclides (Bq/L) -- Filtered				
H-3	280,000*	10,000	740	2
Radionuclides (Bq/L) -- Unfiltered				
H-3	290,000*	10,000	740	2
Volatile Organics (μg/L) -- Unfiltered				
1,1-Dichloroethene	10	c	7	1
1,2-Dichloroethene	Y 930	c	70	2
Trichloroethene	140	c	5	1
Vinyl chloride	Y 1,000	c	2	1
Well 959, Sampling Date 11NOV92				
Ground Elevation 770.75 ft, Water Elevation 764.78				
Anions (mg/L) -- Unfiltered				
Bromide	1.9	c	0.10	D
Nitrate	27	c	10	2
Sulfate (as SO_4)	310	c	250	3
Base/Neutral/Acid Extractable Organics (μg/L) -- Unfiltered				
Pentachlorophenol	U 50	c	1	2
Field Measurements -- Unfiltered				
pH (SU)	9.1	c	(6.5, 8.5)	3
Metals (mg/L) -- Filtered				
Aluminum	0.14	c	0.050	D
Boron	0.65	c	0.080	D
Iron	0.060	c	0.050	D
Manganese	0.0027	c	0.0010	D
Sodium	230	c	5.0	D
Vanadium	0.0037	c	0.0020	D
Metals (mg/L) -- Unfiltered				
Aluminum	0.55	c	0.2	3
Boron	0.60	c	0.080	D
Iron	0.48	c	0.3	3
Manganese	0.0058	c	0.0010	D

Table 28. (continued)

Analyte	Concentration		Reference value	Reference source[b]
	Value[a]	Uncertainty		
Metals (mg/L) -- Unfiltered				
Sodium	220	c	5.0	D
Vanadium	0.0041	c	0.0020	D
Zinc	0.013	c	0.0050	D
Others -- Filtered				
Total dissolved solids (mg/L)	610	c	500	1
Others -- Unfiltered				
Total organic carbon (mg/L)	1.0	c	0.50	D
Total suspended solids (mg/L)	10	c	5.0	D
Radionuclides (Bq/L) -- Filtered				
Gross alpha	0.87*	0.48	0.555	2
Radionuclides (Bq/L) -- Unfiltered				
Gross alpha	0.72*	0.43	0.555	2
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 960, Sampling Date 12NOV92				
Ground Elevation 770.94 ft, Water Elevation 763.03				
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Pentachlorophenol	U 50	c	1	2
Metals (mg/L) -- Filtered				
Iron	0.23	c	0.050	D
Manganese	0.10	c	0.05	3
Sodium	18	c	5.0	D
Metals (mg/L) -- Unfiltered				
Iron	0.29	c	0.050	D
Manganese	0.097	c	0.05	3
Sodium	17	c	5.0	D
Zinc	0.012	c	0.0050	D
Radionuclides (Bq/L) -- Filtered				
H-3	2,600*	100	740	2

Table 28. (continued)

Analyte	Concentration		Reference value	Reference source[b]
	Value[a]	Uncertainty		
Radionuclides (Bq/L) -- Unfiltered				
H-3	2,700*	100	740	2
Volatile Organics (μg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 961, Sampling Date 06NOV92				
Ground Elevation 837.66 ft, Water Elevation 814.91				
Anions (mg/L) -- Unfiltered				
Sulfate (as SO_4)	39	c	1.0	D
Base/Neutral/Acid Extractable Organics (μg/L) -- Unfiltered				
Pentachlorophenol	U 50	c	1	2
Metals (mg/L) -- Filtered				
Manganese	0.061	c	0.05	3
Sodium	22	c	5.0	D
Metals (mg/L) -- Unfiltered				
Aluminum	0.075	c	0.050	D
Chromium	0.0083	c	0.0040	D
Iron	0.26	c	0.050	D
Manganese	0.060	c	0.05	3
Sodium	21	c	5.0	D
Zinc	0.057	c	0.0050	D
Others -- Unfiltered				
Total organic carbon (mg/L)	0.60	c	0.50	D
Volatile Organics (μg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 962, Sampling Date 09NOV92				
Ground Elevation 835.77 ft, Water Elevation 822.28				
Anions (mg/L) -- Unfiltered				
Sulfate (as SO_4)	92	c	1.0	D

Table 28. (continued)

Analyte	Concentration		Reference value	Reference source[b]
	Value[a]	Uncertainty		
Base/Neutral/Acid Extractable Organics (μg/L) -- Unfiltered				
Pentachlorophenol	U 50	c	1	2
Metals (mg/L) -- Filtered				
Iron	5.1	c	0.3	3
Manganese	1.1	c	0.05	3
Sodium	13	c	5.0	D
Metals (mg/L) -- Unfiltered				
Iron	5.2	c	0.3	3
Manganese	0.99	c	0.05	3
Sodium	12	c	5.0	D
Zinc	0.010	c	0.0050	D
Others -- Unfiltered				
Total organic carbon (mg/L)	0.58	c	0.50	D
Total suspended solids (mg/L)	9.0	c	5.0	D
Volatile Organics (μg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1

[a]Prefixes containing J, B, E, Y, U or < mean that the value was estimated, found in the laboratory blank, exceeded the calibration range, exceeded the calibration range and was diluted and reanalyzed, 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 *.

[b]If 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 the laboratory detection limit.
T A tentatively identified compound (TIC).

[c]Not applicable.

Volatile organic compounds were detected in a few of the down-gradient wells. The most significant VOCs were 1,2-dichloroethene, trichloroethene, and vinyl chloride. They were detected at levels well above drinking water standards for these compounds at wells 954 and 958. The concentration of 1,2 dichloroethene was 830 and 930 μg/L; trichloroethene was 52 and 140 μg/L; and vinyl chloride was 220 and 1,000 μg/L; at wells 954 and 958 respectively.

The up-gradient wells showed little evidence of radiological or organic contamination.

Nitrate was detected at well 959 and fluoride at well 954 at levels which exceeded drinking water standards.

3.5.2 WAG 5

3.5.2.1 Program Description

The sites at Waste Area Grouping (WAG) 5 are currently remedial investigation sites regulated under RCRA 3004(u). ORNL has sampled WAG 5 since 1990 and has plans to continue sampling every year.

WAG 5 is located directly south of the main ORNL plant in Melton Valley (Fig. 11). WAG 5 is within the White Oak Mountain thrust block and is underlain by strata of the Middle to Late Cambrian Conasauga Group. This WAG contains 28 sites, 13 of which are tanks that were used to store liquid LLW prior to disposal by the hydrofracture process. WAG 5 also includes the surface facilities constructed in support of both the old and new hydrofracture facilities. The largest land areas in WAG 5 are devoted to SWSA 5 and the Transuranic (TRU) Waste Storage Area. The remaining sites are support facilities for ORNL's hydrofracture operations, two LLW pipeline leak/spill sites, and an impoundment in SWSA 5 used to dewater sludge from the original Process Waste Treatment Plant (PWTP). At present, LLW tanks at the new hydrofracture facility are being used to store evaporator concentrates pending a decision regarding ultimate disposal of these wastes.

SWSA 5 was used to dispose of solid LLW generated at ORNL from 1959 to 1973. From 1959 to 1963 the burial ground served as the Southeastern Regional Burial Ground for the AEC. At the time SWSA 6 burial operations were initiated, a portion of the site, approximately 10 acres, was set aside for the retrievable storage of TRU wastes.

The WAG 5 boundary includes the old and new hydrofracture installations. Because Melton Branch flows between the old and new hydrofracture facilities, the new hydrofracture facility has a separate boundary.

Twenty-two wells comprise the groundwater perimeter well network at WAG 5 (wells 963-984); the up-gradient wells for WAG 5 are wells 966 and 967.

Table 26 shows the parameters measured at WAG 5.

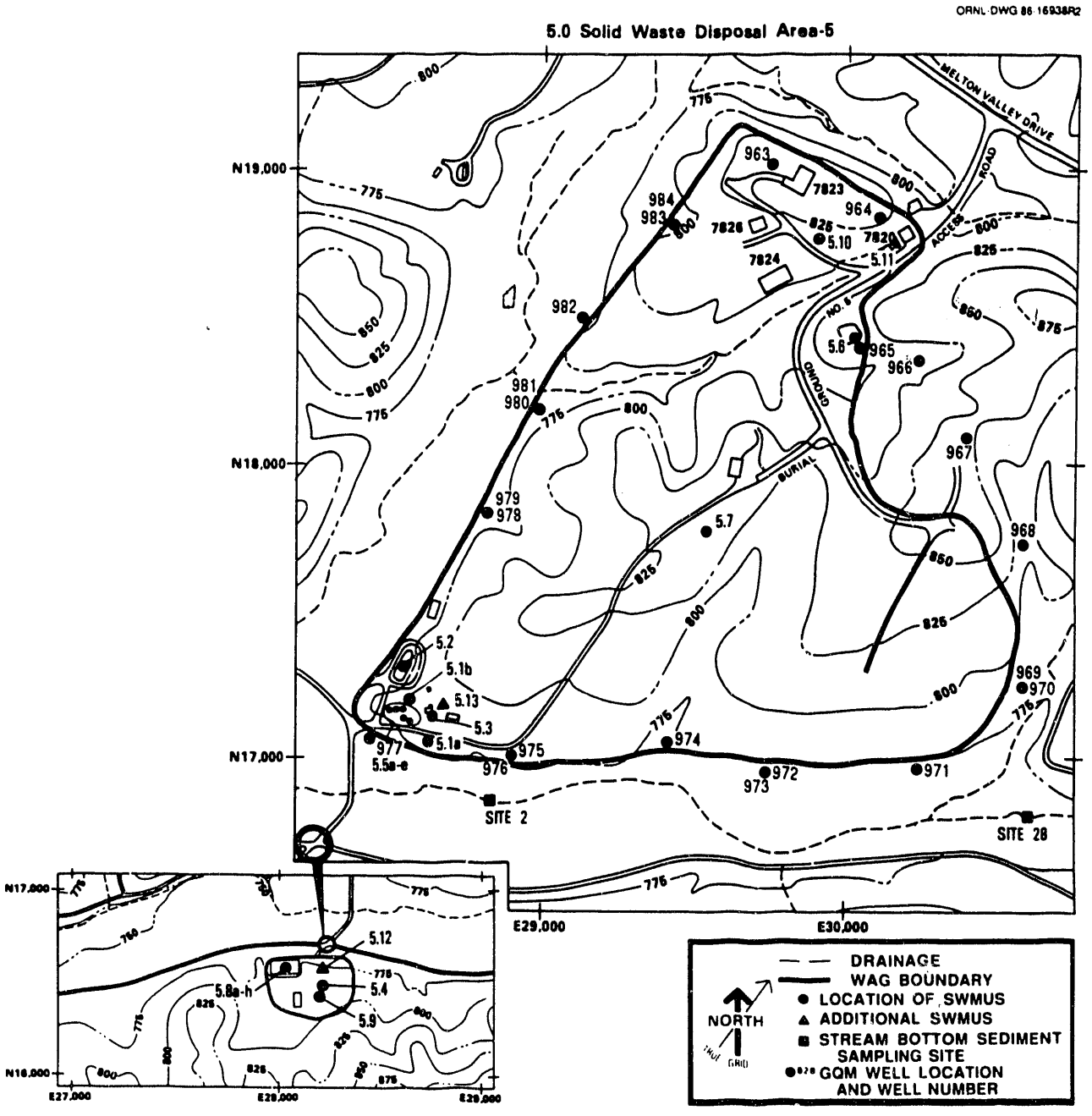

Fig. 11. Location map showing water quality wells at WAG 5.

3.5.2.2 Results

Perimeter wells at WAG 5 were sampled September 23-October 21, 1992. Wells 964, 970, and 976 each took several days to sample because the wells took a long time to recover. A summary of the analytical results by well type (i.e., up-gradient and down-gradient) is presented in Table 29; Table 30 presents the data which exceed some reference criteria.

The results at WAG 5 were very similar to those at WAG 4. Tritium was the most significant radiological contaminant detected in the down-gradient wells at WAG 5. It was detected at levels of most concern at wells 979, 981, 978, 968, 971, 970, 976, 977, 975, 969, 974, and 973 at values ranging from 840 to 9,000,000 Bq/L. Gross beta activity was detected at wells 971, 973, 975, and 969 at values ranging from 4.9 to 61 Bq/L; the associated total rad Sr values at those wells ranged from 2.5 to 33 Bq/L.

Volatile organic compounds were detected in a few of the down-gradient wells. The most significant VOCs were 1,2-dichloroethene, trichloroethene, and vinyl chloride. Concentration levels of 1,2-dichloroethene ranged from 68 to 5,200 μg/L; trichloroethene ranged from 9.0 to 26 μg/L; and vinyl chloride ranged from 10 to 6,400 μg/L; at wells 973, 969, 975, and 978. Well 973 did not have trichloroethene detected above drinking water standards and well 978 had 33 μg/L of benzene detected.

The up-gradient wells showed little evidence of radiological or organic contamination.

3.5.3 WAG 6

3.5.3.1 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 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. 12 shows the groundwater monitoring well network. (The figure does not show wells 1242 and 1243; 1242 is located between wells 844 and 841; 1243 is located between wells 840 and 841.) The up-gradient wells for SWSA 6 are wells 831, 832, 846, 855, 856, 857, 858. Eight of the wells at SWSA 6 (wells 840-844, 847, 1242, 1243) are monitored quarterly for ten volatile organic

Table 29. ORNL WAG 5 groundwater summary statistics from September 23-October 21, 1992

Analyte	N det/ N total	Concentration			
		Max[a]	Min[a]	Av[b]	Standard error[c]
Down-gradient Well Type					
Anions (mg/L) -- Unfiltered					
Chloride	20/20	37	1.5	13*	2.4
Sulfate (as SO_4)	19/20	320	< 2.0	~ 48*	19
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered					
Bis(2-chloroethyl) ether	1/20	U 10	J 2.0	~ 9.6*	0.40
Field Measurements -- Unfiltered					
Conductivity (mS/cm)	20/20	0.74	0.16	0.45*	0.039
Dissolved oxygen (ppm)	20/20	10	5.1	7.7*	0.27
Redox (mV)	20/20	640	370	480*	19
Temperature (°C)	20/20	19	12	15*	0.35
Turbidity (JTU)	20/20	710	8.4	240*	64
pH (SU)	20/20	8.4	6.0	7.1*	0.15
Metals (mg/L) -- Filtered					
Barium	20/20	1.0	0.018	0.28*	0.063
Boron	9/20	1.5	< 0.080	~ 0.21*	0.074
Calcium	20/20	190	1.8	100*	12
Iron	12/20	2.5	< 0.050	~ 0.44*	0.14
Magnesium	20/20	41	0.71	18*	2.2
Manganese	19/20	1.5	< 0.0010	~ 0.30*	0.093
Nickel	4/20	0.030	< 0.010	~ 0.012*	0.0011
Potassium	20/20	8.7	1.2	2.4*	0.38
Silicon	20/20	14	2.4	9.0*	0.63

Table 29. (continued)

Analyte	N det/ N total	Concentration			
		Max[a]	Min[a]	Av[b]	Standard error[c]
Metals (mg/L) -- Filtered					
Sodium	20/20	140	4.5	23*	6.8
Vanadium	4/20	0.0023	< 0.0020	~ 0.0020*	0.000018
Zinc	4/20	0.012	< 0.0050	~ 0.0055*	0.00037
Metals (mg/L) -- Unfiltered					
Aluminum	8/20	1.2	< 0.050	~ 0.22*	0.077
Barium	20/20	0.91	0.017	0.28*	0.062
Boron	9/20	1.4	< 0.080	~ 0.20*	0.069
Calcium	20/20	170	2.1	95*	10
Chromium	1/20	0.0065	< 0.0040	~ 0.0041*	0.00013
Cobalt	1/20	0.0068	< 0.0040	~ 0.0041*	0.00014
Iron	20/20	2.5	0.088	0.78*	0.14
Magnesium	20/20	38	0.76	17*	2.0
Manganese	20/20	1.5	0.0061	0.31*	0.092
Nickel	8/20	0.035	< 0.010	~ 0.014*	0.0015
Potassium	20/20	8.2	1.4	2.4*	0.36
Silicon	20/20	14	2.4	8.7*	0.58
Sodium	20/20	140	5.0	22*	6.9
Vanadium	4/20	0.0027	< 0.0020	~ 0.0021*	0.000050
Zinc	20/20	0.028	0.0086	0.016*	0.0013
Others -- Filtered					
Alkalinity (mg/L)	20/20	550	5.5	310*	29
Total dissolved solids (mg/L)	20/20	710	190	400*	35

Table 29. (continued)

Analyte	N det/ N total	Concentration			
		Max[a]	Min[a]	Av[b]	Standard error[c]
Others -- Unfiltered					
Alkalinity (mg/L)	20/20	550	5.7	310*	29
Phenolics, total recoverable (mg/L)	1/20	0.016	< 0.0010	~ 0.0018*	0.00075
Total organic carbon (mg/L)	20/20	8.7	0.75	2.1*	0.42
Total organic halides (μg/L)	4/20	680	< 5.0	~ 49	34
Total suspended solids (mg/L)	7/20	77	< 5.0	~ 13*	4.6
Radionuclides (Bq/L) -- Filtered					
Co-60	3/20	1.1*	-0.10	0.081	0.060
Cs-137	2/20	0.22*	-0.080	0.027*	0.014
Gross alpha	12/20	0.94*	-0.041	0.13*	0.050
Gross beta	16/20	61*	0.040	5.9	3.4
H-3	17/20	8,900,000*	9.0	670,000	460,000
Total rad Sr	8/20	33*	-0.046	2.9	1.8
Radionuclides (Bq/L) -- Unfiltered					
Co-60	5/20	1.3*	-0.040	0.12*	0.066
Cs-137	3/20	0.49*	-0.080	0.055*	0.026
Gross alpha	10/20	1.0*	-0.0050	0.12*	0.052
Gross beta	16/20	51*	-0.030	5.9*	3.2
H-3	17/20	9,000,000*	1.4	670,000	460,000
Total rad Sr	9/20	22*	-0.047	2.6*	1.4
Volatile Organics (μg/L) -- Unfiltered					
1,1-Dichloroethane	4/20	5.0	J 1.0	~ 4.7*	0.22
1,1-Dichloroethene	1/20	5.0	U 5.0	~ 5.0	0
1,2-Dichloroethane	1/20	U 5.0	J 4.0	~ 5.0*	0.050

Table 29. (continued)

Analyte	N det/ N total	Concentration			
		Max[a]	Min[a]	Av[b]	Standard error[c]
Volatile Organics (μg/L) -- Unfiltered					
1,2-Dichloroethene	6/20	Y 5,200	U 5.0	~ 280	260
Acetone	1/20	U 10	JB 6.0	~ 9.8*	0.20
Benzene	2/20	33	J 1.0	~ 6.2*	1.4
Carbon disulfide	2/20	9.0	J 3.0	~ 5.1*	0.23
Chloroethane	1/20	U 10	J 2.0	~ 9.6*	0.40
Tetrachloroethene	1/20	U 5.0	J 2.0	~ 4.9*	0.15
Toluene	1/20	U 5.0	J 1.0	~ 4.8*	0.20
Trichloroethene	5/20	26	J 3.0	~ 7.0*	1.3
Vinyl chloride	5/20	Y 6,400	J 8.0	~ 330	320
Xylene, total	1/20	U 5.0	J 2.0	~ 4.9*	0.15
Up-gradient Well Type					
Anions (mg/L) -- Unfiltered					
Chloride	2/2	3.2	1.7	2.4	0.77
Nitrate	1/2	< 1.0	0.47	~ 0.74	0.27
Phosphate	1/2	< 1.0	0.77	~ 0.89*	0.12
Sulfate (as SO_4)	2/2	20	7.3	14	6.3
Field Measurements -- Unfiltered					
Conductivity (mS/cm)	2/2	0.33	0.23	0.28	0.051
Dissolved oxygen (ppm)	2/2	8.5	8.4	8.5*	0.050
Redox (mV)	2/2	650	550	600*	52
Temperature (°C)	2/2	15	15	15*	0.41
Turbidity (JTU)	2/2	19	8.4	14	5.3
pH (SU)	2/2	7.5	7.2	7.4*	0.15

Table 29. (continued)

Analyte	N det/ N total	Concentration			
		Max[a]	Min[a]	Av[b]	Standard error[c]
Metals (mg/L) -- Filtered					
Barium	2/2	0.14	0.13	0.13*	0.0075
Calcium	2/2	79	76	77*	1.1
Magnesium	2/2	11	3.3	7.1	3.8
Manganese	2/2	0.024	0.0084	0.016	0.0080
Potassium	2/2	1.3	0.52	0.89	0.36
Silicon	2/2	12	7.8	10	2.3
Sodium	2/2	7.2	6.0	6.6*	0.64
Metals (mg/L) -- Unfiltered					
Aluminum	1/2	0.17	< 0.050	~ 0.11	0.059
Barium	2/2	0.14	0.14	0.14*	0.0015
Calcium	2/2	72	70	71*	1.1
Iron	2/2	0.26	0.070	0.17	0.096
Magnesium	2/2	10	3.2	6.7	3.6
Manganese	2/2	0.060	0.0070	0.033	0.026
Potassium	2/2	1.4	0.79	1.1	0.29
Silicon	2/2	12	7.6	9.6	2.0
Sodium	2/2	7.2	6.0	6.6*	0.58
Zinc	2/2	0.046	0.017	0.031	0.015
Others -- Filtered					
Alkalinity (mg/L)	2/2	230	220	220*	7.5
Total dissolved solids (mg/L)	2/2	260	230	250*	13

Table 29. (continued)

Analyte	N det/ N total	Concentration			
		Max[a]	Min[a]	Av[b]	Standard error[c]
Others -- Unfiltered					
Alkalinity (mg/L)	2/2	230	210	220*	14
Total organic carbon (mg/L)	2/2	1.2	0.93	1.0*	0.11
Total suspended solids (mg/L)	1/2	43	< 5.0	~ 24	19
Radionuclides (Bq/L) -- Filtered					
Gross alpha	1/2	0.055*	0.012	0.034	0.022
Gross beta	1/2	0.11*	0.020	0.065	0.045
Total rad Sr	1/2	0.52*	0.022	0.27	0.25
Radionuclides (Bq/L) -- Unfiltered					
Gross beta	1/2	0.14*	0.050	0.095	0.045
H-3	1/2	30*	15	23	7.5
Total rad Sr	1/2	0.092*	-0.0020	0.045	0.047

[a]Prefixes containing J, B, E, Y, U or < mean that the value was estimated, found in the laboratory blank, exceeded the calibration range, exceeded the calibration range and was diluted and reanalyzed, 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 *.

[b]Average concentrations significantly greater than zero are identified by an *.

[c]Standard error of the mean.

[d]Not applicable.

Table 30. ORNL WAG 5 groundwater constituents that exceed a reference value from sampling period September 23-October 21, 1992

Analyte	Concentration		Reference value	Reference source[b]
	Value[a]	Uncertainty		
Well 963, Sampling Date 28SEP92 *Ground Elevation 838.15 ft, Water Elevation 795.68*				
Anions (mg/L) -- Unfiltered				
Sulfate (as SO_4)	140	c	1.0	D
Base/Neutral/Acid Extractable Organics (μg/L) -- Unfiltered				
Pentachlorophenol	U 50	c	1	2
Metals (mg/L) -- Filtered				
Iron	0.55	c	0.3	3
Manganese	0.21	c	0.05	3
Nickel	0.020	c	0.010	D
Sodium	21	c	5.0	D
Vanadium	0.0022	c	0.0020	D
Metals (mg/L) -- Unfiltered				
Aluminum	0.052	c	0.050	D
Iron	0.71	c	0.3	3
Manganese	0.20	c	0.05	3
Nickel	0.022	c	0.010	D
Sodium	21	c	5.0	D
Zinc	0.014	c	0.0050	D
Others -- Unfiltered				
Total organic carbon (mg/L)	1.1	c	0.50	D

Table 30. (continued)

Analyte	Concentration		Reference value	Reference source[b]
	Value[a]	Uncertainty		
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 964, Sampling Date 29SEP92				
Ground Elevation 831.51 ft, Water Elevation 807.83				
Anions (mg/L) -- Unfiltered				
Sulfate (as SO_4)	230	c	1.0	D
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Pentachlorophenol	U 50	c	1	2
Metals (mg/L) -- Filtered				
Arsenic	< 0.10	c	0.05	1
Iron	1.2	c	0.3	3
Manganese	1.3	c	0.05	3
Sodium	15	c	5.0	D
Metals (mg/L) -- Unfiltered				
Iron	1.2	c	0.3	3
Manganese	1.2	c	0.05	3
Sodium	14	c	5.0	D
Zinc	0.017	c	0.0050	D
Others -- Filtered				
Total dissolved solids (mg/L)	710	c	500	1

Table 30. (continued)

Analyte	Concentration		Reference value	Reference source[b]
	Value[a]	Uncertainty		
Others -- Unfiltered				
Total organic carbon (mg/L)	1.5	c	0.50	D
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 965, Sampling Date 24SEP92				
Ground Elevation 812.20 ft, Water Elevation 795.26				
Anions (mg/L) -- Unfiltered				
Sulfate (as SO_4)	18	c	1.0	D
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Pentachlorophenol	U 50	c	1	2
Metals (mg/L) -- Filtered				
Manganese	0.0084	c	0.0010	D
Zinc	0.0056	c	0.0050	D
Metals (mg/L) -- Unfiltered				
Aluminum	1.2	c	0.2	3
Iron	1.5	c	0.3	3
Manganese	0.053	c	0.05	3
Sodium	5.0	c	5.0	D
Vanadium	0.0027	c	0.0020	D
Zinc	0.028	c	0.0050	D

Table 30. (continued)

Analyte	Concentration			
	Value[a]	Uncertainty	Reference value	Reference source[b]
Others -- Unfiltered				
Total organic carbon (mg/L)	1.2	c	0.50	D
Total suspended solids (mg/L)	11	c	5.0	D
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 966, Sampling Date 24SEP92				
Ground Elevation 809.70 ft, Water Elevation 807.84				
Anions (mg/L) -- Unfiltered				
Sulfate (as SO_4)	20	c	1.0	D
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Pentachlorophenol	U 50	c	1	2
Metals (mg/L) -- Filtered				
Manganese	0.024	c	0.0010	D
Sodium	7.2	c	5.0	D
Metals (mg/L) -- Unfiltered				
Aluminum	0.17	c	0.050	D
Iron	0.26	c	0.050	D
Manganese	0.060	c	0.05	3
Sodium	7.2	c	5.0	D
Zinc	0.017	c	0.0050	D

Table 30. (continued)

Analyte	Concentration		Reference value	Reference source[b]
	Value[a]	Uncertainty		
Others -- Unfiltered				
Total organic carbon (mg/L)	0.93	c	0.50	D
Total suspended solids (mg/L)	43	c	5.0	D
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 967, Sampling Date 23SEP92				
Ground Elevation 852.20 ft, Water Elevation 826.88				
Anions (mg/L) -- Unfiltered				
Nitrate	0.47	c	0.10	D
Phosphate	0.77	c	0.30	D
Sulfate (as SO_4)	7.3	c	1.0	D
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Pentachlorophenol	U 50	c	1	2
Metals (mg/L) -- Filtered				
Manganese	0.0084	c	0.0010	D
Sodium	6.0	c	5.0	D
Metals (mg/L) -- Unfiltered				
Iron	0.070	c	0.050	D
Manganese	0.0070	c	0.0010	D
Sodium	6.0	c	5.0	D
Zinc	0.046	c	0.0050	D

Table 30. (continued)

Analyte	Concentration		Reference value	Reference source[b]
	Value[a]	Uncertainty		
Others -- Unfiltered				
Total organic carbon (mg/L)	1.2	c	0.50	D
Radionuclides (Bq/L) -- Filtered				
Total rad Sr	0.52*	0.13	0.296	2
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 968, Sampling Date 02OCT92				
Ground Elevation 809.26 ft, Water Elevation 799.89				
Anions (mg/L) -- Unfiltered				
Sulfate (as SO_4)	31	c	1.0	D
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Pentachlorophenol	U 50	c	1	2
Metals (mg/L) -- Filtered				
Manganese	0.041	c	0.0010	D
Sodium	6.1	c	5.0	D
Metals (mg/L) -- Unfiltered				
Aluminum	0.23	c	0.2	3
Iron	0.51	c	0.3	3
Manganese	0.077	c	0.05	3
Sodium	6.1	c	5.0	D
Zinc	0.016	c	0.0050	D

Table 30. (continued)

Analyte	Concentration			
	Value[a]	Uncertainty	Reference value	Reference source[b]
Others -- Unfiltered				
Total organic carbon (mg/L)	1.2	c	0.50	D
Radionuclides (Bq/L) -- Filtered				
H-3	16,000*	1,000	740	2
Radionuclides (Bq/L) -- Unfiltered				
H-3	5,400*	100	740	2
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 969, Sampling Date 06OCT92				
Ground Elevation 785.75 ft, Water Elevation 779.38				
Anions (mg/L) -- Unfiltered				
Sulfate (as SO_4)	16	c	1.0	D
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Pentachlorophenol	U 50	c	1	2
Field Measurements -- Unfiltered				
pH (SU)	6.2	c	(6.5, 8.5)	3
Metals (mg/L) -- Filtered				
Boron	1.5	c	0.080	D
Manganese	0.47	c	0.05	3
Nickel	0.019	c	0.010	D

Table 30. (continued)

Analyte	Concentration			
	Value[a]	Uncertainty	Reference value	Reference source[b]
Metals (mg/L) -- Filtered				
Sodium	13	c	5.0	D
Zinc	0.0060	c	0.0050	D
Metals (mg/L) -- Unfiltered				
Aluminum	0.94	c	0.2	3
Boron	1.4	c	0.080	D
Cobalt	0.0068	c	0.0040	D
Iron	1.6	c	0.3	3
Manganese	0.59	c	0.05	3
Nickel	0.019	c	0.010	D
Sodium	13	c	5.0	D
Vanadium	0.0026	c	0.0020	D
Zinc	0.027	c	0.0050	D
Others -- Unfiltered				
Total organic carbon (mg/L)	2.6	c	0.50	D
Total suspended solids (mg/L)	66	c	5.0	D
Radionuclides (Bq/L) -- Filtered				
Gross beta	61*	2.0	1.85	2
H-3	630,000*	10,000	740	2
Total rad Sr	33*	1.0	0.296	2
Radionuclides (Bq/L) -- Unfiltered				
Gross beta	51*	2.0	1.85	2
H-3	610,000*	10,000	740	2
Total rad Sr	22*	1.0	0.296	2

Table 30. (continued)

Analyte	Concentration			
	Value[a]	Uncertainty	Reference value	Reference source[b]
Volatile Organics (µg/L) -- Unfiltered				
1,2-Dichloroethene	96	c	70	2
Trichloroethene	21	c	5	1
Vinyl chloride	J 10	c	2	1
Well 970, Sampling Date 06OCT92				
Ground Elevation 784.60 ft, Water Elevation 780.64				
Anions (mg/L) -- Unfiltered				
Sulfate (as SO_4)	17	c	1.0	D
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Pentachlorophenol	U 50	c	1	2
Metals (mg/L) -- Filtered				
Boron	0.22	c	0.080	D
Iron	0.12	c	0.050	D
Manganese	0.011	c	0.0010	D
Sodium	45	c	5.0	D
Zinc	0.0064	c	0.0050	D
Metals (mg/L) -- Unfiltered				
Boron	0.23	c	0.080	D
Iron	0.21	c	0.050	D
Manganese	0.011	c	0.0010	D
Sodium	46	c	5.0	D
Zinc	0.014	c	0.0050	D

Table 30. (continued)

Analyte	Concentration			
	Value[a]	Uncertainty	Reference value	Reference source[b]
Others -- Unfiltered				
Total organic carbon (mg/L)	1.2	c	0.50	D
Radionuclides (Bq/L) -- Filtered				
H-3	44,000*	1,000	740	2
Radionuclides (Bq/L) -- Unfiltered				
H-3	45,000*	1,000	740	2
Volatile Organics (μg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 971, Sampling Date 07OCT92				
Ground Elevation 775.89 ft, Water Elevation 769.07				
Anions (mg/L) -- Unfiltered				
Sulfate (as SO_4)	3.4	c	1.0	D
Base/Neutral/Acid Extractable Organics (μg/L) -- Unfiltered				
Pentachlorophenol	U 50	c	1	2
Metals (mg/L) -- Filtered				
Iron	2.5	c	0.3	3
Manganese	1.5	c	0.05	3
Sodium	6.4	c	5.0	D

Table 30. (continued)

Analyte	Concentration		Reference value	Reference source[b]
	Value[a]	Uncertainty		
Metals (mg/L) -- Unfiltered				
Iron	2.5	c	0.3	3
Manganese	1.5	c	0.05	3
Nickel	0.018	c	0.010	D
Sodium	6.4	c	5.0	D
Zinc	0.019	c	0.0050	D
Others -- Unfiltered				
Total organic carbon (mg/L)	3.6	c	0.50	D
Total organic halides (μg/L)	26	c	5.0	D
Total suspended solids (mg/L)	7.0	c	5.0	D
Radionuclides (Bq/L) -- Filtered				
Gross beta	3.5*	0.30	1.85	2
H-3	41,000*	1,000	740	2
Total rad Sr	1.7*	0.20	0.296	2
Radionuclides (Bq/L) -- Unfiltered				
Gross beta	4.9*	0.40	1.85	2
H-3	41,000*	1,000	740	2
Total rad Sr	2.5*	0.20	0.296	2
Volatile Organics (μg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Volatile Organics-TICs (μg/L) -- Unfiltered				
1,4-Dioxane-16.1	J 8.0	c	c	T

Table 30. (continued)

Analyte	Concentration		Reference value	Reference source[b]
	Value[a]	Uncertainty		
Well 972, Sampling Date 08OCT92 *Ground Elevation 774.55 ft, Water Elevation 771.34*				
Anions (mg/L) -- Unfiltered				
Sulfate (as SO_4)	7.2	c	1.0	D
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Pentachlorophenol	U 50	c	1	2
Metals (mg/L) -- Filtered				
Boron	0.11	c	0.080	D
Manganese	0.0074	c	0.0010	D
Sodium	16	c	5.0	D
Metals (mg/L) -- Unfiltered				
Boron	0.11	c	0.080	D
Iron	0.097	c	0.050	D
Manganese	0.0066	c	0.0010	D
Sodium	16	c	5.0	D
Zinc	0.018	c	0.0050	D
Others -- Unfiltered				
Total organic carbon (mg/L)	0.93	c	0.50	D
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 973, Sampling Date 07OCT92 *Ground Elevation 774.34 ft, Water Elevation 767.56*				
Anions (mg/L) -- Unfiltered				
Sulfate (as SO_4)	6.8	c	1.0	D
Base/Neutral/Acid Extractable Organics-TICs (µg/L) -- Unfiltered				
Phenolderivative-22.92	J 12	c	c	T
Unknown-19.89	J 10	c	c	T
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Pentachlorophenol	U 50	c	1	2
Field Measurements -- Unfiltered				
pH (SU)	6.4	c	(6.5, 8.5)	3
Metals (mg/L) -- Filtered				
Boron	0.46	c	0.080	D
Iron	1.2	c	0.3	3
Manganese	0.26	c	0.05	3
Nickel	0.030	c	0.010	D
Sodium	58	c	5.0	D
Metals (mg/L) -- Unfiltered				
Boron	0.43	c	0.080	D
Iron	1.2	c	0.3	3
Manganese	0.25	c	0.05	3

Table 30. (continued)

Analyte	Concentration		Reference value	Reference source[b]
	Value[a]	Uncertainty		
Metals (mg/L) -- Unfiltered				
Nickel	0.035	c	0.010	D
Sodium	57	c	5.0	D
Zinc	0.015	c	0.0050	D
Others -- Filtered				
Total dissolved solids (mg/L)	560	c	500	1
Others -- Unfiltered				
Phenolics, total recoverable (mg/L)	0.016	c	0.0010	D
Total organic carbon (mg/L)	8.7	c	0.50	D
Total organic halides (μg/L)	120	c	5.0	D
Radionuclides (Bq/L) -- Filtered				
Gross beta	12*	1.0	1.85	2
H-3	8,900,000*	100,000	740	2
Total rad Sr	5.1*	0.30	0.296	2
Radionuclides (Bq/L) -- Unfiltered				
Gross beta	12*	1.0	1.85	2
H-3	9,000,000*	100,000	740	2
Total rad Sr	5.2*	0.30	0.296	2
Volatile Organics (μg/L) -- Unfiltered				
1,2-Dichloroethene	85	c	70	2
Vinyl chloride	34	c	2	1

Table 30. (continued)

Analyte	Concentration		Reference value	Reference source[b]
	Value[a]	Uncertainty		
Volatile Organics-TICs (µg/L) -- Unfiltered				
1,1,2-Trifluoro--ethane,1,1-ox	J 10	c	c	T
Ethane,1,2-dichloro,-6.85	J 41	c	c	T
Methane,dichlorofluoro--6.4	J 19	c	c	T
Well 974, Sampling Date 09OCT92				
Ground Elevation 770.81 ft, Water Elevation 762.17				
Anions (mg/L) -- Unfiltered				
Sulfate (as SO_4)	9.7	c	1.0	D
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Pentachlorophenol	U 50	c	1	2
Metals (mg/L) -- Filtered				
Boron	0.082	c	0.080	D
Iron	0.45	c	0.3	3
Manganese	0.39	c	0.05	3
Sodium	15	c	5.0	D
Zinc	0.012	c	0.0050	D
Metals (mg/L) -- Unfiltered				
Aluminum	0.16	c	0.050	D
Boron	0.087	c	0.080	D
Iron	0.92	c	0.3	3
Manganese	0.42	c	0.05	3
Nickel	0.019	c	0.010	D

Table 30. (continued)

Analyte	Concentration		Reference value	Reference source[b]
	Value[a]	Uncertainty		
Metals (mg/L) -- Unfiltered				
Sodium	13	c	5.0	D
Zinc	0.026	c	0.0050	D
Others -- Unfiltered				
Total organic carbon (mg/L)	2.8	c	0.50	D
Total suspended solids (mg/L)	7.0	c	5.0	D
Radionuclides (Bq/L) -- Filtered				
H-3	3,000,000*	100,000	740	2
Total rad Sr	0.84*	0.16	0.296	2
Radionuclides (Bq/L) -- Unfiltered				
H-3	3,000,000*	100,000	740	2
Total rad Sr	0.81*	0.15	0.296	2
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 975, Sampling Date 09OCT92				
Ground Elevation 783.14 ft, Water Elevation 767.75				
Anions (mg/L) -- Unfiltered				
Sulfate (as SO_4)	5.7	c	1.0	D
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Pentachlorophenol	U 50	c	1	2

Table 30. (continued)

Analyte	Concentration			
	Value[a]	Uncertainty	Reference value	Reference source[b]
Field Measurements -- Unfiltered				
pH (SU)	6.4	c	(6.5, 8.5)	3
Metals (mg/L) -- Filtered				
Boron	0.22	c	0.080	D
Iron	0.14	c	0.050	D
Manganese	0.12	c	0.05	3
Nickel	0.016	c	0.010	D
Sodium	16	c	5.0	D
Metals (mg/L) -- Unfiltered				
Boron	0.21	c	0.080	D
Iron	0.36	c	0.3	3
Manganese	0.12	c	0.05	3
Nickel	0.020	c	0.010	D
Sodium	15	c	5.0	D
Vanadium	0.0025	c	0.0020	D
Zinc	0.023	c	0.0050	D
Others -- Filtered				
Total dissolved solids (mg/L)	560	c	500	1
Others -- Unfiltered				
Total organic carbon (mg/L)	4.0	c	0.50	D
Total organic halides (μg/L)	78	c	5.0	D

Table 30. (continued)

Analyte	Concentration		Reference value	Reference source[b]
	Value[a]	Uncertainty		
Radionuclides (Bq/L) -- Filtered				
Gross beta	36*	2.0	1.85	2
H-3	290,000*	10,000	740	2
Total rad Sr	17*	1.0	0.296	2
Radionuclides (Bq/L) -- Unfiltered				
Gross beta	44*	2.0	1.85	2
H-3	290,000*	10,000	740	2
Total rad Sr	20*	1.0	0.296	2
Volatile Organics (µg/L) -- Unfiltered				
1,2-Dichloroethene	68	c	5.0	D
Trichloroethene	9.0	c	5	1
Vinyl chloride	50	c	2	1
Well 976, Sampling Date 13OCT92				
Ground Elevation 783.96 ft, Water Elevation 764.36				
Anions (mg/L) -- Unfiltered				
Sulfate (as SO_4)	8.0	c	1.0	D
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Pentachlorophenol	U 50	c	1	2
Metals (mg/L) -- Filtered				
Iron	0.086	c	0.050	D
Manganese	0.010	c	0.0010	D
Sodium	8.2	c	5.0	D

Table 30. (continued)

Analyte	Concentration			
	Value[a]	Uncertainty	Reference value	Reference source[b]
Metals (mg/L) -- Unfiltered				
Iron	0.14	c	0.050	D
Manganese	0.0094	c	0.0010	D
Sodium	8.1	c	5.0	D
Zinc	0.015	c	0.0050	D
Others -- Unfiltered				
Total organic carbon (mg/L)	0.80	c	0.50	D
Radionuclides (Bq/L) -- Filtered				
H-3	190,000*	10,000	740	2
Radionuclides (Bq/L) -- Unfiltered				
H-3	180,000*	10,000	740	2
Volatile Organics (μg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 977, Sampling Date 29SEP92				
Ground Elevation 764.73 ft, Water Elevation 755.76				
Anions (mg/L) -- Unfiltered				
Sulfate (as SO_4)	25	c	1.0	D
Base/Neutral/Acid Extractable Organics (μg/L) -- Unfiltered				
Pentachlorophenol	U 50	c	1	2

Table 30. (continued)

Analyte	Concentration			
	Value[a]	Uncertainty	Reference value	Reference source[b]
Field Measurements -- Unfiltered				
pH (SU)	6.0	c	(6.5, 8.5)	3
Metals (mg/L) -- Filtered				
Boron	0.12	c	0.080	D
Manganese	0.32	c	0.05	3
Sodium	13	c	5.0	D
Metals (mg/L) -- Unfiltered				
Boron	0.12	c	0.080	D
Iron	0.088	c	0.050	D
Manganese	0.31	c	0.05	3
Nickel	0.011	c	0.010	D
Sodium	13	c	5.0	D
Zinc	0.0086	c	0.0050	D
Others -- Unfiltered				
Total organic carbon (mg/L)	2.5	c	0.50	D
Total suspended solids (mg/L)	6.0	c	5.0	D
Radionuclides (Bq/L) -- Filtered				
H-3	260,000*	10,000	740	2
Radionuclides (Bq/L) -- Unfiltered				
H-3	270,000*	10,000	740	2
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 978, Sampling Date 13OCT92 *Ground Elevation 764.84 ft, Water Elevation 761.12*				
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Pentachlorophenol	U 50	c	1	2
Field Measurements -- Unfiltered				
pH (SU)	6.4	c	(6.5, 8.5)	3
Metals (mg/L) -- Filtered				
Iron	0.82	c	0.3	3
Manganese	0.70	c	0.05	3
Sodium	8.8	c	5.0	D
Vanadium	0.0023	c	0.0020	D
Metals (mg/L) -- Unfiltered				
Iron	1.1	c	0.3	3
Manganese	0.68	c	0.05	3
Sodium	7.9	c	5.0	D
Vanadium	0.0022	c	0.0020	D
Zinc	0.015	c	0.0050	D
Others -- Filtered				
Total dissolved solids (mg/L)	580	c	500	1
Others -- Unfiltered				
Total organic carbon (mg/L)	3.2	c	0.50	D
Total organic halides (µg/L)	680	c	5.0	D

Table 30. (continued)

Analyte	Concentration		Reference value	Reference source[b]
	Value[a]	Uncertainty		
Radionuclides (Bq/L) -- Filtered				
H-3	2,400*	100	740	2
Radionuclides (Bq/L) -- Unfiltered				
H-3	2,400*	100	740	2
Volatile Organics (µg/L) -- Unfiltered				
1,2-Dichloroethene	Y 5,200	c	70	2
Benzene	33	c	5	1
Trichloroethene	26	c	5	1
Vinyl chloride	Y 6,400	c	2	1
Well 979, Sampling Date 01OCT92				
Ground Elevation 764.88 ft, Water Elevation 758.49				
Anions (mg/L) -- Unfiltered				
Sulfate (as SO_4)	9.2	c	1.0	D
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Pentachlorophenol	U 50	c	1	2
Metals (mg/L) -- Filtered				
Iron	0.20	c	0.050	D
Manganese	0.018	c	0.0010	D
Sodium	11	c	5.0	D

Table 30. (continued)

Analyte	Concentration		Reference value	Reference source[b]
	Value[a]	Uncertainty		
Metals (mg/L) -- Unfiltered				
Chromium	0.0065	c	0.0040	D
Iron	0.40	c	0.3	3
Manganese	0.019	c	0.0010	D
Sodium	11	c	5.0	D
Zinc	0.0087	c	0.0050	D
Others -- Unfiltered				
Total organic carbon (mg/L)	1.8	c	0.50	D
Radionuclides (Bq/L) -- Filtered				
H-3	840*	50	740	2
Radionuclides (Bq/L) -- Unfiltered				
H-3	800*	50	740	2
Volatile Organics (μg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 980, Sampling Date 19OCT92				
Ground Elevation 762.19 ft, Water Elevation 758.56				
Anions (mg/L) -- Unfiltered				
Sulfate (as SO_4)	24	c	1.0	D
Base/Neutral/Acid Extractable Organics (μg/L) -- Unfiltered				
Pentachlorophenol	U 50	c	1	2

Table 30. (continued)

Analyte	Concentration		Reference value	Reference source[b]
	Value[a]	Uncertainty		
Metals (mg/L) -- Filtered				
Boron	0.44	c	0.080	D
Sodium	140	c	5.0	D
Vanadium	0.0020	c	0.0020	D
Metals (mg/L) -- Unfiltered				
Aluminum	0.27	c	0.2	3
Boron	0.41	c	0.080	D
Iron	0.30	c	0.050	D
Manganese	0.0061	c	0.0010	D
Sodium	140	c	5.0	D
Zinc	0.017	c	0.0050	D
Others -- Unfiltered				
Total organic carbon (mg/L)	0.90	c	0.50	D
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 981, Sampling Date 15OCT92				
Ground Elevation 761.53 ft, Water Elevation 757.37				
Anions (mg/L) -- Unfiltered				
Sulfate (as SO_4)	32	c	1.0	D
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Pentachlorophenol	U 50	c	1	2

Table 30. (continued)

Analyte	Concentration		Reference value	Reference source[b]
	Value[a]	Uncertainty		
Metals (mg/L) -- Filtered				
Iron	0.61	c	0.3	3
Manganese	0.40	c	0.05	3
Sodium	16	c	5.0	D
Vanadium	0.0021	c	0.0020	D
Metals (mg/L) -- Unfiltered				
Iron	0.82	c	0.3	3
Manganese	0.39	c	0.05	3
Sodium	14	c	5.0	D
Zinc	0.011	c	0.0050	D
Others -- Unfiltered				
Total organic carbon (mg/L)	0.98	c	0.50	D
Radionuclides (Bq/L) -- Filtered				
H-3	2,000*	100	740	2
Radionuclides (Bq/L) -- Unfiltered				
H-3	2,000*	100	740	2
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	J 8.0	c	2	1

Table 30. (continued)

Analyte	Concentration		Reference value	Reference source[b]
	Value[a]	Uncertainty		
Well 982, Sampling Date 21OCT92 *Ground Elevation 774.81 ft, Water Elevation 767.70*				
Anions (mg/L) -- Unfiltered				
Sulfate (as SO_4)	24	c	1.0	D
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Pentachlorophenol	U 50	c	1	2
Metals (mg/L) -- Filtered				
Manganese	0.015	c	0.0010	D
Sodium	9.0	c	5.0	D
Metals (mg/L) -- Unfiltered				
Aluminum	0.91	c	0.2	3
Iron	1.2	c	0.3	3
Manganese	0.041	c	0.0010	D
Nickel	0.012	c	0.010	D
Sodium	8.1	c	5.0	D
Zinc	0.018	c	0.0050	D
Others -- Unfiltered				
Total organic carbon (mg/L)	0.80	c	0.50	D
Total suspended solids (mg/L)	77	c	5.0	D
Radionuclides (Bq/L) -- Filtered				
Gross alpha	0.94*	0.22	0.555	2

Table 30. (continued)

Analyte	Concentration		Reference value	Reference source[b]
	Value[a]	Uncertainty		
Radionuclides (Bq/L) -- Unfiltered				
Gross alpha	1.0*	0.20	0.555	2
Volatile Organics (μg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 983, Sampling Date 16OCT92				
Ground Elevation 788.44 ft, Water Elevation 781.87				
Anions (mg/L) -- Unfiltered				
Sulfate (as SO_4)	27	c	1.0	D
Base/Neutral/Acid Extractable Organics (μg/L) -- Unfiltered				
Pentachlorophenol	U 50	c	1	2
Metals (mg/L) -- Filtered				
Manganese	0.016	c	0.0010	D
Sodium	6.6	c	5.0	D
Metals (mg/L) -- Unfiltered				
Aluminum	0.10	c	0.050	D
Iron	0.15	c	0.050	D
Manganese	0.015	c	0.0010	D
Sodium	5.6	c	5.0	D
Zinc	0.011	c	0.0050	D

Table 30. (continued)

Analyte	Concentration		Reference value	Reference source[b]
	Value[a]	Uncertainty		
Others -- Unfiltered				
Total organic carbon (mg/L)	0.80	c	0.50	D
Total suspended solids (mg/L)	17	c	5.0	D
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 984, Sampling Date 20OCT92				
Ground Elevation 788.77 ft, Water Elevation 779.17				
Anions (mg/L) -- Unfiltered				
Sulfate (as SO_4)	320	c	250	3
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Pentachlorophenol	U 50	c	1	2
Metals (mg/L) -- Filtered				
Boron	0.092	c	0.080	D
Iron	0.61	c	0.3	3
Manganese	0.27	c	0.05	3
Sodium	29	c	5.0	D
Metals (mg/L) -- Unfiltered				
Boron	0.093	c	0.080	D
Iron	0.68	c	0.3	3
Manganese	0.26	c	0.05	3
Sodium	27	c	5.0	D
Zinc	0.010	c	0.0050	D

Table 30. (continued)

Analyte	Concentration			
	Value[a]	Uncertainty	Reference value	Reference source[b]
Others -- Filtered				
Total dissolved solids (mg/L)	710	c	500	1
Others -- Unfiltered				
Total organic carbon (mg/L)	0.75	c	0.50	D
Volatile Organics (μg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Volatile Organics-TICs (μg/L) -- Unfiltered				
Unknown-25.33	J 9.0	c	c	T

[a]Prefixes containing J, B, E, Y, U or < mean that the value was estimated, found in the laboratory blank, exceeded the calibration range, exceeded the calibration range and was diluted and reanalyzed, 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 *.

[b]If 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 the laboratory detection limit.
T A tentatively identified compound (TIC).

[c]Not applicable.

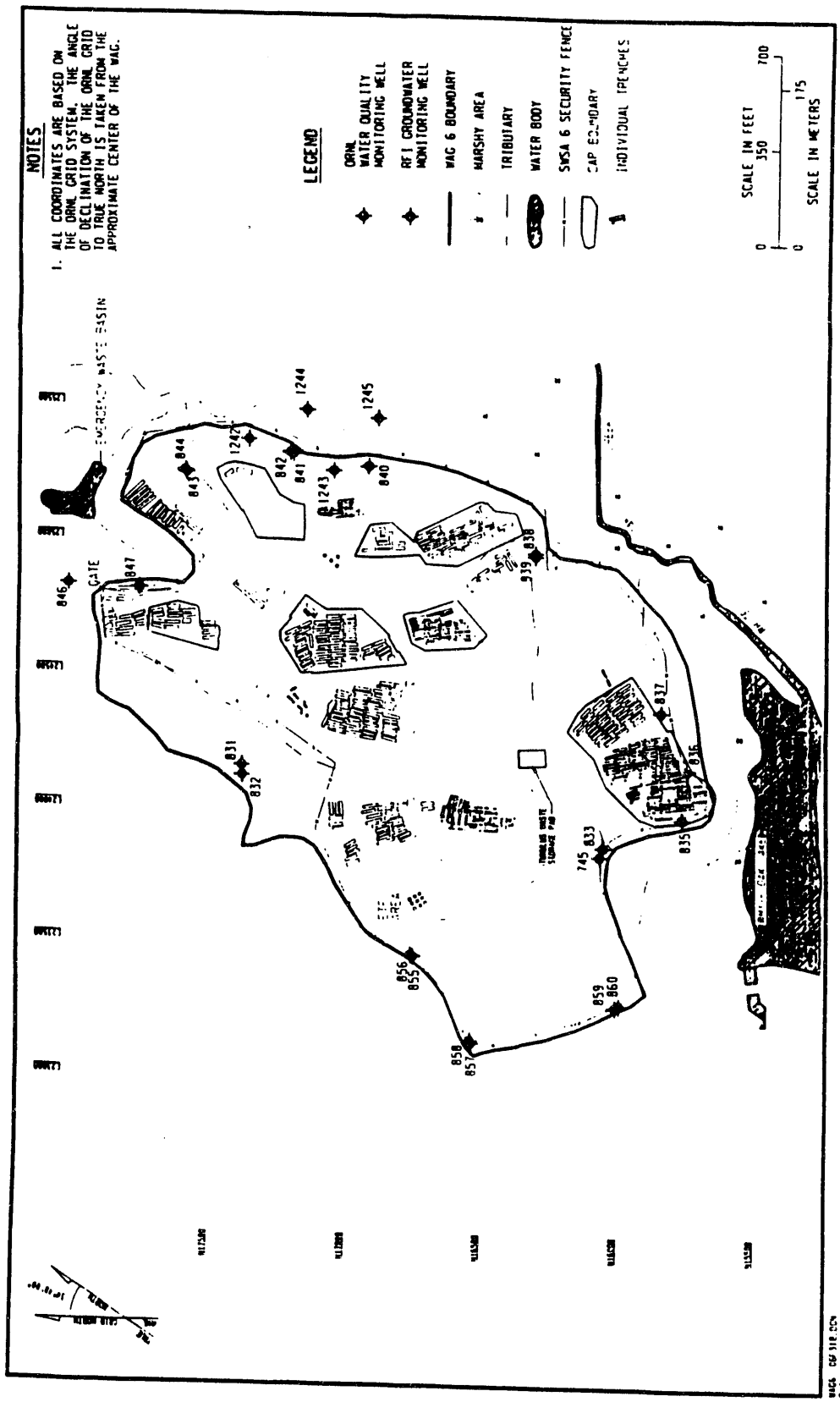

Fig. 12. Location map showing water quality wells at WAG 6.

compounds, alkalinity, gross-alpha, total rad Sr, Co-60, Cs-137, tritium, alkalinity, and field parameters as part of this program. Wells 1244 and 1245 used to be monitored quarterly as part of the SWSA 6 network. They were determined early in 1992 to not reflect groundwater conditions at SWSA 6, as recorded in "*Groundwater Quality Assessment Report For The Solid Waste Storage Area 6 At The Oak Ridge National Laboratory, 1991*", February 1992. They are now monitored as part of the WAG 2 network. The remaining 16 wells are monitored semiannually. During quarter 1992 only the eight "quarterly" wells were monitored.

3.5.3.2 Results

The eight "quarterly" perimeter assessment wells at SWSA 6 were sampled November 30-December 16, 1992. A summary of the analytical results for the assessment wells is presented in Table 31; Table 32 presents the data that exceed some reference criteria for all of the assessment wells.

Well 842 continues to exhibit the highest level of volatile organic contamination. It was the only SWSA 6 well which had significant volatile organic contaminant results for the quarter, including carbon tetrachloride, chloroform, 1,2-dichloroethane, and trichloroethene. Tritium levels were highest at wells 842, 844, 841, 847, 1242, 843, and 1243 with levels ranging from 2,100 to 57,000 Bq/L.

3.5.4 Off-Site

3.5.4.1 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 and to monitor potential impact of DOE-OR operations on the quality of these groundwater sources.

Twenty-one 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 are sampled semiannually, most recently in August 1992. Two USGS wells located in Union Valley were dropped from this program in 1991; they are now included in the Y-12 perimeter groundwater program. Two of the remaining nineteen wells were not sampled during this sampling round; one was not functioning and the other was not sampled because of a scheduling difficulty with the homeowner.

In the August 1992 event, samples of tap water were collected to represent quality of tap water from two major local sources of public utility-supplied drinking water. Duplicate and field blank samples are also collected as part of the off-site residential groundwater QA/QC program.

Table 31. ORNL WAG 6 groundwater summary statistics from November 30-December 16, 1992

Analyte	N det/ N total	Concentration			
		Max[a]	Min[a]	Av[b]	Standard error[c]
Field Measurements -- Unfiltered					
Conductivity (mS/cm)	8/8	0.89	0.34	0.59*	0.057
Dissolved oxygen (ppm)	8/8	7.0	6.0	6.4*	0.11
Redox (mV)	8/8	690	460	610*	31
Temperature (°C)	8/8	14	13	14*	0.24
Turbidity (JTU)	8/8	300	6.3	79*	38
pH (SU)	8/8	7.6	6.9	7.2*	0.090
Others -- Unfiltered					
Alkalinity (mg/L)	8/8	450	190	330*	29
Radionuclides (Bq/L) -- Filtered					
Co-60	3/8	12*	0.080	1.7	1.5
Cs-137	3/8	0.23*	-0.020	0.090*	0.031
Gross alpha	5/8	0.15*	-0.0030	0.083*	0.022
H-3	8/8	57,000*	240*	16,000*	8,200
Total rad Sr	2/8	0.10*	-0.047	0.023	0.017
Volatile Organics (μg/L) -- Unfiltered					
1,2-Dichloroethane	1/8	7.0	U 5.0	~ 5.3*	0.25
1,2-Dichloroethene	2/8	5.0	J 4.0	~ 4.9*	0.13
Bromodichloromethane	1/8	U 5.0	J 2.0	~ 4.6*	0.38
Carbon tetrachloride	1/8	38	U 5.0	~ 9.1*	4.1
Chloroform	2/8	36	J 3.0	~ 8.6*	3.9
Trichloroethene	2/8	190	J 4.0	~ 28	23

[a]Prefixes containing J, B, E, Y, U or < mean that the value was estimated, found in the laboratory blank, exceeded the calibration range, exceeded the calibration range and was diluted and reanalyzed, 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 *.

[b]Average concentrations significantly greater than zero are identified by an *.

[c]Standard error of the mean.

[d]Not applicable.

Table 32. ORNL WAG 6 groundwater constituents that exceed a reference value from sampling period November 30-December 16, 1992

Analyte	Concentration		Reference value	Reference source[b]
	Value[a]	Uncertainty		
Well 840, Sampling Date 11DEC92 *Ground Elevation 766.94 ft, Water Elevation 748.03*				
Volatile Organics (μg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 841, Sampling Date 10DEC92 *Ground Elevation 766.04 ft, Water Elevation 755.05*				
Radionuclides (Bq/L) -- Filtered				
H-3	3,500*	100	740	2
Volatile Organics (μg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 842, Sampling Date 02DEC92 *Ground Elevation 767.25 ft, Water Elevation 758.56*				
Radionuclides (Bq/L) -- Filtered				
H-3	2,100*	100	740	2
Volatile Organics (μg/L) -- Unfiltered				
1,2-Dichloroethane	7.0	c	5	1
Carbon tetrachloride	38	c	5	1
Chloroform	36	c	5.0	D
Trichloroethene	190	c	5	1
Vinyl chloride	U 10	c	2	1
Volatile Organics-TICs (μg/L) -- Unfiltered				
1,2,2-Trifluoroethane,1,1,2-tr[d]	J 12	c	c	T
Methane,trichlorofluoro--6.17	J 7.0	c	c	T
Well 843, Sampling Date 01DEC92 *Ground Elevation 781.43 ft, Water Elevation 776.46*				
Radionuclides (Bq/L) -- Filtered				
H-3	50,000*	1,000	740	2

Table 32. (continued)

Analyte	Concentration		Reference value	Reference source[b]
	Value[a]	Uncertainty		
Volatile Organics (μg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 844, Sampling Date 30NOV92				
Ground Elevation 780.95 ft, Water Elevation 769.69				
Radionuclides (Bq/L) -- Filtered				
H-3	2,500*	100	740	2
Volatile Organics (μg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 847, Sampling Date 04DEC92				
Ground Elevation 839.62 ft, Water Elevation 807.68				
Radionuclides (Bq/L) -- Filtered				
H-3	3,600*	100	740	2
Volatile Organics (μg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Volatile Organics-TICs (μg/L) -- Unfiltered				
Sulfurdioxide(dot)-4.33	J 33	c	c	T
Well 1242, Sampling Date 16DEC92				
Ground Elevation 775.11 ft, Water Elevation 760.83				
Radionuclides (Bq/L) -- Filtered				
H-3	13,000*	1,000	740	2
Volatile Organics (μg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 1243, Sampling Date 16DEC92				
Ground Elevation 778.66 ft, Water Elevation 760.65				
Radionuclides (Bq/L) -- Filtered				
Co-60	12*	1.0	7.4	4
H-3	57,000*	1,000	740	2

Table 32. (continued)

Analyte	Concentration			
	Value[a]	Uncertainty	Reference value	Reference source[b]
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Volatile Organics-TICs (µg/L) -- Unfiltered				
1-Hexanol,2-ethyl--27.77	J 6.0	c	c	T

[a]Prefixes containing J, B, E, Y, U or < mean that the value was estimated, found in the laboratory blank, exceeded the calibration range, exceeded the calibration range and was diluted and reanalyzed, 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 *.

[b]If 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 the laboratory detection limit.

T A tentatively identified compound (TIC).

[c]Not applicable.

[d]1,2,3-Trifluoroethane,1,1,2-trichloro--7.

The samples are analyzed for volatile organics; selected atomic absorption metals (As, Hg, Pb, Se); inductively coupled argon plasma metals; and anions (fluoride, chloride, sulfate, nitrate, and nitrite). Radiological analyzes include gross alpha, gross beta, total rad Sr, Tc-99, H-3, and radionuclides observed in a gamma scan. In the August 1992 event, total hardness analysis was performed for one well.

Five times 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). 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. See section 1.0 for discussion.

A summary of the results from all wells is presented in Table 33. The table contains the number of detected values and the total number of samples; the maximum, minimum, and average of all detected values; and the standard error of the mean. Results from analysis of the public drinking water samples is presented in Table 34.

3.5.4.2 Results

In the August 1992 sampling event, one well exceeded the drinking water standard for fluoride; this well, located deep in the Conasauga formation, has consistently shown high levels of fluoride.

Four of the locations were resampled in September to investigate results which indicated presence of volatile organic compounds in the water. Using this additional set of data, an examination of historical data, and consultation with the organic analysis laboratory, it was determined that the first set of results was affected by the sampling and analysis process itself. There was no volatile contamination at these four sites.

Neither of the tap water samples produced results exceeding any regulatory standards.

Table 33. ORNL off-site residential groundwater summary statistics from August 1992 sampling event

Analyte	N det/ N total	Concentration			
		Max[a]	Min[a]	Av[b]	Standard error[c]
Anions (mg/L)					
Chloride	17/17	79	1.2	8.1*	4.5
Fluoride	1/17	7.2	7.2	7.2	d
Nitrate	10/17	3.5	1.6	2.7*	0.20
Sulfate (as SO_4)	17/17	62	1.8	14*	4.1
Field Measurements					
Conductivity (mS/cm)	17/17	1.9	0.10	0.70*	0.15
Temperature (deg C)	17/17	24	15	18*	0.54
pH (standard units)	17/17	7.9	7.0	7.4*	0.067
Metals (mg/L)					
Barium	17/17	0.14	0.0036	0.079*	0.011
Calcium	17/17	98	1.7	46*	6.7
Copper	13/17	0.064	0.0035	0.015*	0.0044
Iron	7/17	0.80	0.055	0.22*	0.10
Lead	1/17	0.0077	0.0077	0.0077	d
Magnesium	17/17	36	0.71	15*	2.3
Manganese	11/17	0.32	0.00060	0.043	0.030
Mercury	1/17	0.000060	0.000060	0.000060	d
Sodium	17/17	120	0.53	17*	8.2
Uranium	8/17	0.0014	0.00018	0.00063*	0.00017
Vanadium	3/17	0.0014	0.0012	0.0013*	0.000058
Zinc	17/17	0.81	0.0077	0.13*	0.058
Others					
Total hardness (mg/L)	1/1	300	300	300	d
Radionuclides (Bq/L)					
Gross alpha	10/17	0.21*	0.054*	0.086*	0.015
Gross beta	10/17	0.36*	0.11*	0.23*	0.027
Tc-99	4/17	0.12*	0.078*	0.098*	0.0086
Total rad Sr	5/17	0.16*	0.077*	0.11*	0.014

[a]Radionuclide values that are significantly greater than zero are identified by an *.

[b]Average concentrations significantly greater than zero are identified by an *.

[c]Standard error of the mean.

[d]Not applicable.

Table 34. ORNL off-site residential groundwater summary statistics from local tap water, August 1992

Analyte	N det/ N total	Concentration			
		Max[a]	Min[a]	Av[b]	Standard error[c]
Anions (mg/L)					
Chloride	2/2	11	7.8	9.3*	1.5
Fluoride	1/2	1.1	1.1	1.1	d
Nitrate	2/2	2.4	2.4	2.4	0
Sulfate (as SO_4)	2/2	24	23	24*	0.45
Metals (mg/L)					
Barium	2/2	0.028	0.028	0.028	0
Calcium	2/2	35	35	35	0
Copper	1/2	0.026	0.026	0.026	d
Magnesium	2/2	9.0	8.7	8.9*	0.15
Manganese	2/2	0.0017	0.00080	0.0013	0.00045
Sodium	2/2	5.1	4.2	4.7*	0.45
Uranium	1/2	0.00015	0.00015	0.00015	d
Zinc	2/2	0.16	0.013	0.087	0.074
Radionuclides (Bq/L)					
Gross alpha	1/2	0.089*	0.089*	0.089	d

[a]Radionuclide values that are significantly greater than zero are identified by an *.

[b]Average concentrations that are significantly greater than zero are identified by an *.

[c]Standard error of the mean.

[d]Not applicable.

4.1 MILK

Joan F. Hughes

4.1.1 Program Description

Raw milk from three locations, including one dairy, within a radius of 80 km of Oak Ridge, is monitored for I-131 and total rad Sr. Samples are collected each month from the stations located near the Oak Ridge area (Fig. 13). Samples are analyzed for I-131 by gamma spectroscopy and for total rad Sr by chemical separation and low-level beta counting. Instrument background values are subtracted from the measured values of I-131 and total rad Sr in milk samples, and net activity concentrations are summarized.

4.1.2 Procedure and Results

None of the samples collected during the quarter contained statistically significant concentrations of I-131. The average concentrations of total rad Sr were significantly greater than zero at two of the three locations, and a summary of this data is presented in Table 35.

The 50-y committed effective dose equivalent (EDE) was calculated for a station when the average value obtained was statistically greater than zero. The significant measured average concentrations of total rad Sr (assuming 100% Sr-90) 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 310 days. Doses resulting from ingestion of milk were less than 1% of DOE's guideline of 1000 μSv.

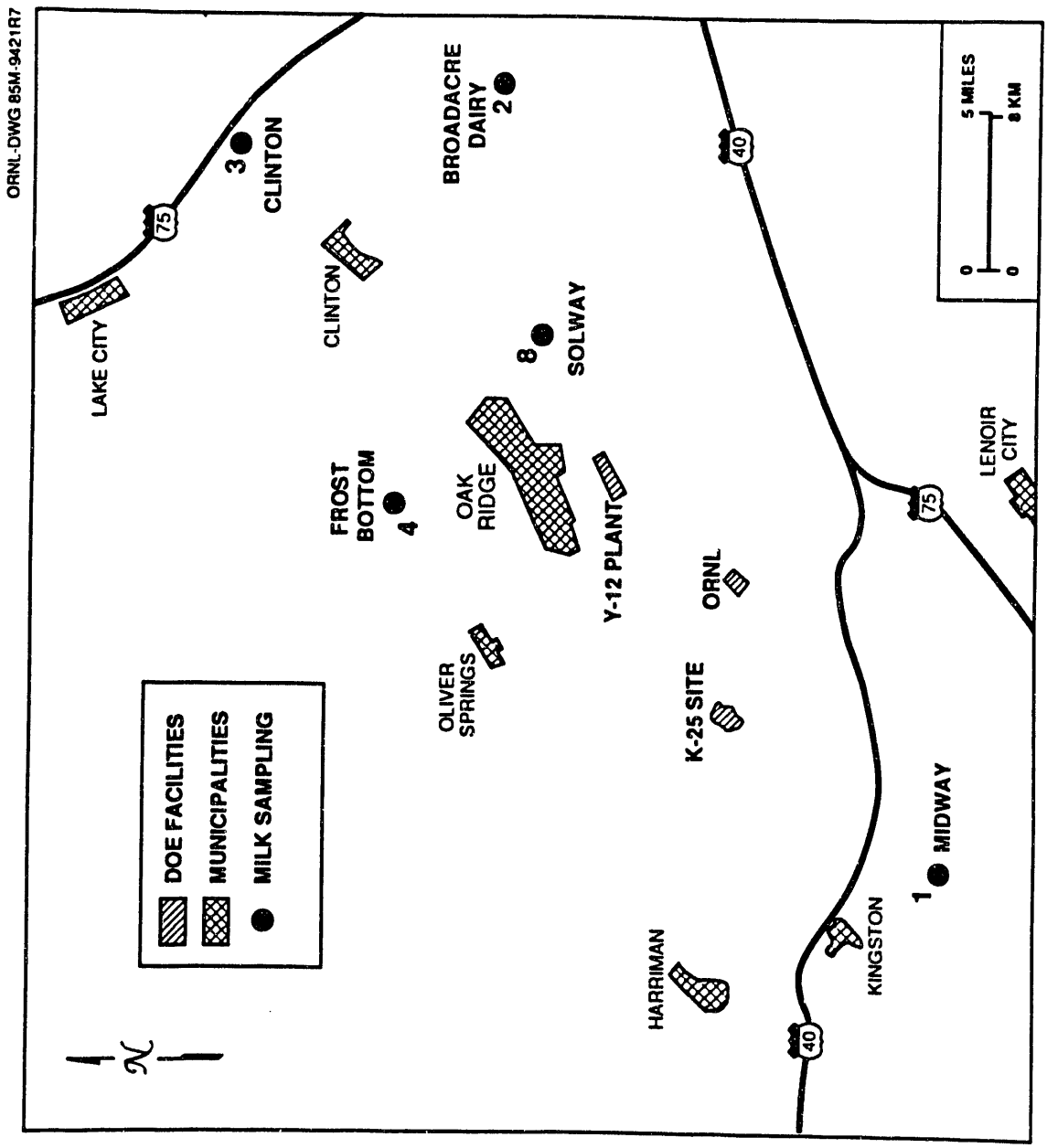

Fig. 13. Map showing milk sampling locations.

Table 35. Concentrations of total radioactive Sr in milk and calculated doses, October-December 1992

Station	Number of Samples	Concentration (Bq/L)				Dose (μSv)[c]
		Max	Min	Av[a]	Standard error[b]	
2	2	0.130	0.120	0.125*	0.005	1.36
3	3	0.240	0.020	0.116	0.064	
4	3	0.210	0.160	0.190*	0.015	2.07

[a]Average concentrations significantly greater than zero are identified by an *.

[b]Standard error of the mean.

[c]Potential 50-year committed effective dose equivalents from drinking 310L of milk per year containing average radionuclide concentrations at each location. Dose is estimated for stations whose average value is statistically greater than zero.

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