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ENVIRONMENTAL SURVEILLANCE DATA REPORT FOR
THE SECOND QUARTER OF 1993

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LIST OF ACRONYMS AND ABBREVIATIONS

BMAP	Biological Monitoring and Abatement Program
BMP	best management practice
BNAE	Base neutral/acid extractable
BNI	Bechtel National, Inc.
CAA	Clean Air Act
CFR	Code of Federal Regulations
CLP	Contract Laboratory Program
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
EC	Environmental Compliance Section of OECD
EDE	effective dose equivalent
EMP	Environmental Monitoring Plant
EPA	U.S. Environmental Protection Agency
ESD	Environmental Sciences Division
ESP	Environmental Surveillance and Protection Section of OECD
FFCA	Federal Facilities Compliance Agreement
ICP	inductively coupled plasma
ICP/MS	ICP mass spectrometry
ISC	Industrial Source Complex
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
RAM	remote air monitoring
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
TIC	tentatively identified compound
TWQ	Tennessee Water Quality
Total rad Sr	total radioactive strontium (Sr-89 + Sr-90)
WAG	waste area grouping
WOC	White Oak Creek

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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, DOE/EH-0173T" (referenced hereafter as the Regulatory Guide).

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 ingested water and inhaled air and are guidelines for the protection of the public. DOE Order 5400.5 defines a DCG as the concentration of a radionuclide in air or water for which, under conditions of continuous exposure by one exposure pathway (i.e., drinking water, inhaling air, submersion) for one year, a "reference man" would receive the most restrictive of (1) an effective dose equivalent of 100 mrem or (2) a dose equivalent of 5 rem to any tissue, including skin and lens of the eye. A "reference man" is a hypothetical human who is assumed to inhale 8400 m³ of air in a year and to drink 730 L of water in a year. When there are multiple DCGs for a given isotope, the most restrictive value is used for comparisons. When the percent of DCG is less than 0.01, the value 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, 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. In some cases, 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 radionuclide data throughout the report follow the convention of flagging data that are statistically significant with an * (asterisk). Radionuclide 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. "<" indicates the value for an analyte (excluding organics) was not quantifiable at the analytical detection limit; "U" indicates the value for an organic analyte was undetected at the analytical detection limit; "J" indicates the value was estimated by the laboratory; "B" indicates the compound 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; "JB" indicates the value was estimated and found in the associated laboratory blank; and "H" indicates the holding time was exceeded by the laboratory.

In non-radiological 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 SURFACE WATER AND NPDES

The Oak Ridge National Laboratory (ORNL) site is located in the 17 km² White Oak Creek (WOC) watershed, with the exception of two small effluent points in the 7600 area that discharge directly into Melton Hill Lake. 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. WOL, about two-thirds of a mile long and less than a tenth of a mile wide, is retained by a low and wide earthen dam (WOD) which supports White Wing Road (State Highway 95). The lake settles out some sediment and the dam retains historical deposits. The structure at the dam features flow measurement and limited effluent control. In 1992, a coffer-cell and gabion retention structure was completed at the confluence of WOC and Clinch River. This flow-through structure retains sediment deposits in the WOC embayment and prevents their transport into and down the Clinch River toward Watts Bar Lake. 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).

The following water sections are discussed in detail:

Surface Water

Reference Surface Water

National Pollutant Discharge Monitoring System (NPDES)

2.1 SURFACE WATER

Martha M. Stevens and Melinda C. Salmons

2.1.1 Program Description

Water samples are collected for radiological analyses at off-site and on-site locations. Sampling points include background or reference locations, streams on the ORNL site, and 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 2.1.

2.1.2 Procedure and Results

Treated water samples are collected weekly at the Kingston and Gallaher potable water treatments plants (Fig. 2.1) and are analyzed quarterly. Table 2.2 contains the concentrations measured at the Gallaher water treatment plant and Table 2.3 contains the concentrations measured at the Kingston water treatment plant during this quarter. National Primary Drinking Water Standards (DWS) (40 CFR 141, as amended) are used as reference values. If drinking water standards have not been established, then 4% of the Derived Concentration Guides (DCGs) are used as reference values. The concentration is expressed as a percentage of the reference value (when one exists and when the concentration is significantly greater than zero) in the last column of these tables. At Gallaher, gross beta and total rad Sr were significantly greater than zero but at levels no greater than 18% of the reference value. At Kingston, Cs-137, gross beta, and total rad Sr were significantly greater than zero but at levels no greater than 8.8% of the reference value. No test of significance was possible for the total uranium measurement at each site, but the concentrations at Gallaher and Kingston are less than 0.8% 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.

For this quarter, the sum of DCG percentages for each of the effluent points and ambient water stations is less than 100% with the exception of Melton Branch 1 (110%). At Melton Branch 1, tritium was 50% of DCG and total rad Sr was 60% of DCG. It is believed that the unusually dry weather is a major contributor to this increase.

In the event that an annual sum of DCG percentages exceeds 100%, an analysis of the best available technology to reduce the signature will be conducted as specified in DOE Order 5400.5.

Table 2.1 Summary of collection and analysis frequencies of surface and effluent water samples for radiological 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 2.1. (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	Gamma scan, Gross beta ^b	Quarterly	Grab	Quarterly

^aIf gross alpha >1 Bq/L, analyze for Am-241, Cm-244, Pu-238, Pu-239, Th-228, Th-230, Th-232, U-234, U-235, and U-238.

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

Fig. 2.1. Location map of Gallaher and Kingston sampling points.

Table 2.2. Summary of radionuclide concentrations at the Gallaher Water Treatment Plant^a, April-June 1993

Analyte	Concentration	Reference Value ^b	Percent of Reference Value ^c
Metals (mg/L)			
Uranium, total ^d	0.00017	e	e
Radionuclides (Bq/L) ^f			
Co-60	0.0020	7.4	e
Cs-137	-0.0030	4.44	e
Gross alpha	0.0020	0.555	e
Gross beta	0.10*	1.85	5.4
H-3	11	740	e
Pu-238	0.00040	0.0592	e
Pu-239	-0.0036	0.0444	e
Total rad Sr	0.052*	0.296	18
Total U ^{d,g}	0.0042	0.74	e

^aLocation is shown in Fig. 2.1.

^bNational Primary Drinking Water Standard (DWS) (from 40 CFR 141, as amended) or 4% of the Derived Concentration Guides (DCGs) (from DOE Order 5400.5). Because no drinking water standards are established for Co-60, Cs-137, Pu-238, Pu-239 and Total U, 4% of the DCG is given as a reference value for these radionuclides. The value for total rad Sr is based upon the Sr-90 limit. The value for gross beta is a regulatory guide for assessing compliance without further analysis.

^cConcentration as a percentage of the reference value. Calculated only when a reference exists and the concentration is significantly greater than zero.

^dNo test for significance is possible.

^eNot applicable.

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

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

Table 2.3. Summary of radionuclide concentrations at the Kingston Water Treatment Plant^a, April-June 1993

Analyte	Concentration	Reference Value ^b	Percent of Reference Value ^c
Metals (mg/L)			
Uranium, total ^d	0.00014	e	e
Radionuclides (Bq/L) ^f			
Co-60	0.0040	7.4	e
Cs-137	0.013*	4.44	0.29
Gross alpha	0.00060	0.555	e
Gross beta	0.058*	1.85	3.1
H-3	4.0	740	e
Pu-238	0.00035	0.0592	e
Pu-239	0.000040	0.0444	e
Total rad Sr	0.026*	0.296	8.8
Total U ^{d,g}	0.0034	0.74	e

^aLocation is shown in Fig. 2.1.

^bNational Primary Drinking Water Standard (DWS) (from 40 CFR 141, as amended) or 4% of the Derived Concentration Guides (DCGs) (from DOE Order 5400.5). Because no drinking water standards are established for Co-60, Cs-137, Pu-238, Pu-239 and Total U, 4% of the DCG is given as a reference value for these radionuclides. The value for total rad Sr is based upon the Sr-90 limit. The value for gross beta is a regulatory guide for assessing compliance without further analysis.

^cConcentration as a percentage of the reference value. Calculated only when a reference exists and the concentration is significantly greater than zero.

^dNo test for significance is possible.

^eNot applicable.

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

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

Melton Hill Dam and White Oak Creek 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 on-site streams: White Oak Creek, Melton Branch, First Creek, Fifth Creek, Northwest Tributary, and Raccoon Creek (Fig. 2.2). 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, and
- Raccoon Creek.

The five NPDES stations are

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

Summary statistics for radionuclide concentrations at the six ambient stations are given in Table 2.4. The average concentration is expressed as a percentage of the DCG (when one exists and the average concentration is significantly greater than zero) in the last column of this table. As shown in Table 2.4, gross alpha and gross beta at White Oak Creek headwaters were significantly greater than zero but do not have a DCG. No radionuclide measurements at Melton Hill Dam were significantly greater than zero. Only two ambient stations showed average radionuclide concentrations greater than 5% of the appropriate DCG with no average radionuclide concentration exceeding 23% of its DCG. Total rad Sr was the only radionuclide concentration greater than 5% of DCG at the two ambient stations.

Locations that are sampled for nonradioactive chemicals under the requirements of the NPDES Permit (see Section 2.3) are also sampled for radionuclides (Fig. 2.2). Radiological analysis and the frequency of analysis are given in Table 2.1. Table 2.5 contains a summary of the concentrations for each of these NPDES 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, Nonradiological Wastewater Treatment Facility, Melton Branch 1, White Oak Creek, and White Oak Dam; tritium at Melton Branch 1 and White Oak Dam; and Cs-137 at the Nonradiological Wastewater Treatment Facility. No radionuclide average concentration at the NPDES points exceeded 60% of its DCG.

The quantity of 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

Fig. 2.2. ORNL surface water, NPDES, and reference sampling locations.

Table 2.4. Radionuclide concentrations in surface waters around ORNL,^a
April-June 1993

Radionuclide	N det/ N total	Concentration (Bq/L)				DCG ^e	Percent DCG ^f
		Max ^b	Min ^b	Av ^c	Standard error ^d		
<i>Melton Hill Dam</i>							
Co-60	0/3	0.70	-0.30	0.17	0.29	185	g
Cs-137	0/3	0.50	-0.70	0.033	0.37	111	g
Gross alpha	2/3	0.18*	0	0.081	0.053	g	g
Gross beta	3/3	0.88*	0.22*	0.51	0.19	g	g
<i>White Oak Creek Headwaters</i>							
Co-60	1/3	1.9*	0.10	0.93	0.52	185	g
Cs-137	0/3	0.90	-0.50	0.033	0.44	111	g
Gross alpha	1/3	0.080	0.041	0.062*	0.011	g	g
Gross beta	3/3	0.80*	0.38*	0.53*	0.14	g	g
<i>7500 Road Bridge</i>							
Co-60	0/3	0.50	-0.10	0.30	0.20	185	g
Cs-137	3/3	16*	2.3*	7.7	4.2	111	g
H-3	3/3	580*	260*	380*	99	74,000	0.52
Total rad Sr	3/3	3.5*	2.8*	3.0*	0.23	37	8.2
<i>First Creek</i>							
Co-60	1/3	1.4*	-1.0	0.37	0.71	185	g
Cs-137	1/3	1.8*	0.50	0.97	0.42	111	g
Total rad Sr	3/3	11*	4.2*	8.4*	2.1	37	23
<i>Fifth Creek</i>							
Co-60	0/3	1.2	-0.30	0.53	0.44	185	g
Cs-137	1/3	1.9*	-0.80	0.67	0.79	111	g
Total rad Sr	3/3	1.4*	0.88*	1.1*	0.16	37	2.9
<i>Melton Branch 2</i>							
Co-60	1/3	1.4*	-0.60	0.10	0.65	185	g
Cs-137	0/3	-0.20	-0.60	-0.43	0.12	111	g
H-3	3/3	1,100*	260*	600	250	74,000	g
Total rad Sr	2/3	0.21*	0.051	0.13	0.046	37	g

Table 2.4. (continued)

Radionuclide	N det/ N total	Concentration (Bq/L)			Standard error ^d	DCG ^e	Percent DCG ^f
		Max ^b	Min ^b	Av ^c			
Northwest Tributary							
Co-60	2/3	1.9*	-1.1	0.60	0.89	185	g
Cs-137	2/3	2.1*	0.80	1.5*	0.38	111	1.3
Total rad Sr	3/3	2.0*	0.58*	1.3*	0.41	37	3.6
Raccoon Creek							
Co-60	0/3	0.90	-0.90	0.23	0.57	185	g
Cs-137	0/3	1.2	-0.90	-0.067	0.64	111	g
Total rad Sr	3/3	1.6*	0.17*	0.78	0.43	37	g

^aLocations are shown in Fig. 2.2.

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

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

^dStandard error of the mean.

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

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

gNot applicable.

Table 2.5. Radionuclide concentrations at ORNL NPDES locations,^a
April-June 1993

Radionuclide	N det/ N total	Concentration (Bq/L)				DCG ^e	Percent DCG ^f
		Max ^b	Min ^b	Av ^c	Standard error ^d		
Sewage Treatment Plant (X01)							
Co-60	0/3	0.90	0.20	0.63	0.22	185	g
Cs-137	0/3	0.70	0.40	0.50*	0.10	111	0.45
Gross beta	3/3	24*	11*	17*	3.8	g	g
Total rad Sr	3/3	12*	5.0*	8.5*	2.0	37	23
Nonradiological Wastewater Treatment Facility (X12)							
Co-60	0/3	1.1	-1.4	0.067	0.75	185	g
Cs-137	3/3	83*	49*	64*	10	111	58
Gross alpha	3/3	0.38*	0.17*	0.28*	0.061	g	g
Gross beta	3/3	120*	59*	85*	18	g	g
H-3	3/3	4,000*	2,300*	3,000*	510	74,000	4.1
Total rad Sr	3/3	4.3*	3.9*	4.0*	0.13	37	11
Melton Branch 1 (X13)							
Co-60	0/3	0.50	0.10	0.27	0.12	185	g
Cs-137	0/3	0.80	0.10	0.50	0.21	111	g
H-3	3/3	47,000*	29,000*	37,000*	5,200	74,000	50
Total rad Sr	3/3	29*	15*	22*	4.1	37	60
White Oak Creek (X14)							
Co-60	0/3	0.030	-0.30	-0.16	0.098	185	g
Cs-137	2/3	5.1*	1.3	3.7*	1.2	111	3.3
H-3	3/3	1,400*	380*	860*	300	74,000	1.2
Total rad Sr	3/3	5.2*	3.3*	4.2*	0.55	37	11

Table 2.5. (continued)

Radionuclide	N det/ N total	Concentration (Bq/L)				DCG ^e	Percent DCG ^f
		Max ^b	Min ^b	Av ^c	Standard error ^d		
White Oak Dam (X15)							
Co-60	8/13	0.34*	-0.020	0.16*	0.034	185	0.085
Cs-137	13/13	2.8*	0.69*	1.5*	0.17	111	1.3
Gross alpha	13/13	0.34*	0.098*	0.24*	0.020	g	g
Gross beta	13/13	23*	13*	19*	0.85	g	g
H-3	3/3	7,400*	4,300*	6,300*	1,000	74,000	8.6
Total rad Sr	3/3	10*	7.0*	8.0*	0.98	37	22

^aLocations are shown in Fig. 2.2.

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

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

^dStandard error of the mean.

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

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

^gNot applicable.

Branch and at White Oak Dam), and the Clinch River (as measured at Melton Hill Dam) are given in Table 2.6. 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 0.0024 to 0.0059.

Amounts of radioactivity released to or into 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 2.7-2.9. 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 Table 2.7, average radionuclide concentrations for April that were greater than 5% of the DCG were: total rad Sr at Melton Branch 1, Nonradiological Wastewater Treatment Facility, Sewage Treatment Plant, White Oak Creek, and White Oak Dam; tritium at Melton Branch 1, White Oak Dam, and Nonradiological Wastewater Treatment Facility; and Cs-137 at Nonradiological Wastewater Treatment Facility. In Table 2.8, average radionuclide concentrations for May that were greater than 5% of the DCG were: total rad Sr at Melton Branch 1, Nonradiological Wastewater Treatment Facility, Sewage Treatment Plant, White Oak Creek, and White Oak Dam; tritium at Melton Branch 1 and White Oak Dam; and Cs-137 at Nonradiological Wastewater Treatment Facility. In Table 2.9, average radionuclide concentrations for June that were greater than 5% of the DCG were: total rad Sr at Melton Branch 1, Nonradiological Wastewater Treatment Facility, Sewage Treatment Plant, White Oak Creek, and White Oak Dam; tritium at Melton Branch 1 and White Oak Dam; and Cs-137 at Nonradiological Wastewater Treatment Facility.

Table 2.6. Stream^a flows, April-June 1993

Month	Flow (10 ⁹ L)				Average Ratio ^e
	Melton Branch 1	White Oak Creek ^b	White Oak Dam ^c	Clinch River ^d	
April	0.32	0.88	1.2	520	0.0046
May	0.10	0.37	0.59	110	0.0059
June	0.061	0.31	0.50	250	0.0024

^aLocations are shown in Fig. 2.2.

^bWhite Oak Creek above its confluence with Melton Branch.

^cWhite Oak Creek at White Oak Dam.

^dClinch River at Melton Hill Dam.

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

Table 2.7. Radionuclide concentrations and releases at ORNL NPDES surface water stations,^a April 1993

Radionuclide	Flow (10 ⁶ L)	Discharge ^b (10 ¹⁰ Bq)	Concentration ^c (Bq/L)	DCG ^d (Bq/L)	Percent DCG ^e
<i>Melton Branch 1 (03/31-04/28)</i>					
Co-60	320	f	0.20	185	f
Cs-137	320	f	0.80	111	f
H-3	320	920	29,000*	74,000	39
Total rad Sr	320	0.48	15*	37	41
<i>Nonradiological Wastewater Treatment Facility (03/31-04/28)</i>					
Co-60	53	f	1.1	185	f
Cs-137	53	0.26	49*	111	44
Gross alpha	53	0.0020	0.38*	f	f
Gross beta	53	0.63	120*	f	f
H-3	53	21	4,000*	74,000	5.4
Total rad Sr	53	0.020	3.9*	37	11
<i>Sewage Treatment Plant (03/31-04/29)</i>					
Co-60	24	f	0.90	185	f
Cs-137	24	f	0.40	111	f
Gross beta	24	0.058	24*	f	f
Total rad Sr	24	0.029	12*	37	32
<i>White Oak Creek (03/31-04/28)</i>					
Co-60	870	f	0.030	185	f
Cs-137	870	0.41	4.7*	111	4.2
H-3	870	120	1,400*	74,000	1.9
Total rad Sr	870	0.35	4.0*	37	11
<i>White Oak Dam (03/31-04/28)</i>					
H-3	1,100	830	7,400*	74,000	10
Total rad Sr	1,100	0.80	7.1*	37	19

Table 2.7. (continued)

Radionuclide	Flow (10^6 L)	Discharge ^b (10^{10} Bq)	Concentration ^c (Bq/L)	DCG ^d (Bq/L)	Percent DCG ^e
<i>White Oak Dam^g (04/01-05/01)</i>					
Co-60	1,200	0.018	0.15*	185	0.084
Cs-137	1,200	0.18	1.5*	111	1.4
Gross alpha	1,200	0.029	0.26*	f	f
Gross beta	1,200	2.3	20*	f	f

^aLocations are shown in Fig. 2.2.

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

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

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

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

^fNot applicable.

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

Table 2.8. Radionuclide concentrations and releases at ORNL NPDES surface water stations,^a May 1993

Radionuclide	Flow (10 ⁶ L)	Discharge ^b (10 ¹⁰ Bq)	Concentration ^c (Bq/L)	DCG ^d (Bq/L)	Percent DCG ^e
<i>Melton Branch 1 (04/28-06/02)</i>					
Co-60	120	f	0.10	185	f
Cs-137	120	f	0.60	111	f
H-3	120	570	47,000*	74,000	64
Total rad Sr	120	0.28	23*	37	62
<i>Nonradiological Wastewater Treatment Facility (04/28-06/02)</i>					
Co-60	59	f	-1.4	185	f
Cs-137	59	0.36	60*	111	54
Gross alpha	59	0.0018	0.30*	f	f
Gross beta	59	0.35	59*	f	f
H-3	59	16	2,700*	74,000	3.6
Total rad Sr	59	0.025	4.3*	37	12
<i>Sewage Treatment Plant (04/29-05/27)</i>					
Co-60	22	f	0.80	185	f
Cs-137	22	f	0.70	111	f
Gross beta	22	0.037	17*	f	f
Total rad Sr	22	0.019	8.5*	37	23
<i>White Oak Creek (04/28-06/02)</i>					
Co-60	430	f	-0.30	185	f
Cs-137	430	f	1.3	111	f
H-3	430	35	810*	74,000	1.1
Total rad Sr	430	0.23	5.2*	37	14
<i>White Oak Dam (04/28-06/02)</i>					
H-3	690	500	7,300*	74,000	9.9
Total rad Sr	690	0.69	10*	37	27

Table 2.8. (continued)

Radionuclide	Flow (10^6 L)	Discharge ^b (10^{10} Bq)	Concentration ^c (Bq/L)	DCG ^d (Bq/L)	Percent DCG ^e
<i>White Oak Dam^g (05/01-06/01)</i>					
Co-60	590	0.0097	0.16*	185	0.088
Cs-137	590	0.078	1.3*	111	1.2
Gross alpha	590	0.015	0.25*	f	f
Gross beta	590	1.2	20*	f	f

^aLocations are shown in Fig. 2.2.

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

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

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

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

^fNot applicable.

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

Table 2.9. Radionuclide concentrations and releases at ORNL NPDES surface water stations,^a June 1993

Radionuclide	Flow (10 ⁶ L)	Discharge ^b (10 ¹⁰ Bq)	Concentration ^c (Bq/L)	DCG ^d (Bq/L)	Percent DCG ^e
<i>Melton Branch 1 (06/02-06/30)</i>					
Co-60	56	f	0.50	185	f
Cs-137	56	f	0.10	111	f
H-3	56	200	36,000*	74,000	49
Total rad Sr	56	0.16	29*	37	78
<i>Nonradiological Wastewater Treatment Facility (06/02-06/30)</i>					
Co-60	52	f	0.50	185	f
Cs-137	52	0.43	83*	111	75
Gross alpha	52	0.00089	0.17*	f	f
Gross beta	52	0.39	75*	f	f
H-3	52	12	2,300*	74,000	3.1
Total rad Sr	52	0.020	3.9*	37	11
<i>Sewage Treatment Plant (05/27-06/30)</i>					
Co-60	32	f	0.20	185	f
Cs-137	32	f	0.40	111	f
Gross beta	32	0.035	11*	f	f
Total rad Sr	32	0.016	5.0*	37	14
<i>White Oak Creek (06/02-06/30)</i>					
Co-60	280	f	-0.20	185	f
Cs-137	280	0.15	5.1*	111	4.6
H-3	280	11	380*	74,000	0.51
Total rad Sr	280	0.094	3.3*	37	8.9
<i>White Oak Dam (06/02-06/30)</i>					
H-3	470	200	4,300*	74,000	5.8
Total rad Sr	470	0.33	7.0*	37	19

Table 2.9. (continued)

Radionuclide	Flow (10^6 L)	Discharge ^b (10^{10} Bq)	Concentration ^c (Bq/L)	DCG ^d (Bq/L)	Percent DCG ^e
<i>White Oak Dam^g (06/01-07/01)</i>					
Co-60	500	0.0073	0.15*	185	0.079
Cs-137	500	0.074	1.5*	111	1.3
Gross alpha	500	0.010	0.20*	f	f
Gross beta	500	0.81	16*	f	f

^aLocations are shown in Fig. 2.2.

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

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

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

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

^fNot applicable.

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

2.2 REFERENCE SURFACE WATER

Melinda C. Salmons

2.2.1 Program Description

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 with 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. 2.2). The other sampling location is WOC headwaters above the point where ORNL discharges to White Oak Creek (Fig. 2.2). The sampling and analysis plan for the reference locations can be found in Table 2.10.

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 pollutants 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 2.5 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 2.1.

2.2.2 Results

The results for the inorganic, organic, and classical pollutants are found in Table 2.11. There were no high levels of organic compounds detected by the TOC analysis at either location, as indicated by the average value of 2.0 mg/L at Melton Hill Dam and by the average value of 0.76 mg/L at White Oak Creek 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) spectrometry equipment can accurately measure, this compound can cause a spectral interference with other elements. The sample must then be diluted to bring the interfering element 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.

Table 2.10. Sampling and analysis plan for Melton Hill Dam
and White Oak Creek Headwaters

Analyte	Collection frequency	Sample type	Analysis frequency
Anions			
Fluoride	Monthly	Flow proportional composite	Monthly
Nitrate, as N	Monthly	Flow proportional composite	Monthly
Sulfate, as SO ₄	Monthly	Flow proportional composite	Monthly
Field Measurements			
Conductivity	Monthly	Grab, instant read	Monthly
Dissolved oxygen	Monthly	Grab, instant read	Monthly
pH	Monthly	Grab, instant read	Monthly
Temperature	Monthly	Grab, instant read	Monthly
Turbidity	Monthly	Grab, instant read	Monthly
Metals			
Aluminum	Monthly	Flow proportional composite	Monthly
Arsenic	Monthly	Flow proportional composite	Monthly
Cadmium	Monthly	Flow proportional composite	Monthly
Chromium	Monthly	Flow proportional composite	Monthly
Copper	Monthly	Flow proportional composite	Monthly
Iron	Monthly	Flow proportional composite	Monthly
Lead	Monthly	Flow proportional composite	Monthly
Manganese	Monthly	Flow proportional composite	Monthly
Nickel	Monthly	Flow proportional composite	Monthly
Phosphorus	Monthly	Flow proportional composite	Monthly
Silver	Monthly	Flow proportional composite	Monthly
Zinc	Monthly	Flow proportional composite	Monthly
Others			
Oil and grease	Monthly	Grab	Monthly
Total dissolved solids	Monthly	Grab	Monthly
Total organic carbon	Monthly	Grab	Monthly
Total suspended solids	Monthly	Flow proportional composite	Monthly

Table 2.11. Surface water analyses at reference locations,
April-June 1993

Analyte	N det/ N total	Concentration (mg/L)			Standard error ^c
		Max ^a	Min ^a	Av ^b	
Melton Hill Dam ^d					
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	27	20	22	2.3
Field Measurements					
Conductivity (mS/cm)	3/3	0.35	0.28	0.31	0.023
Dissolved oxygen (ppm)	3/3	11	8.2	9.1	0.72
pH (SU)	3/3	7.9	7.6	7.8	0.10
Temperature (°C)	3/3	21	9.0	15	3.3
Turbidity (NTU)	3/3	25	8.0	18	5.0
Metals					
Aluminum, total	3/3	1.6	0.17	0.68	0.46
Arsenic, total	0/3	< 0.050	< 0.050	~ 0.050	0
Cadmium, total	0/3	< 0.0050	< 0.0050	~ 0.0050	0
Chromium, total	0/3	< 0.0040	< 0.0040	~ 0.0040	0
Copper, total	1/3	0.017	< 0.0070	~ 0.010	0.0033
Iron, total	3/3	2.0	0.17	0.81	0.60
Lead, total	0/3	< 0.050	< 0.050	~ 0.050	0
Manganese, total	3/3	0.79	0.021	0.30	0.25
Nickel, total	0/3	< 0.010	< 0.010	~ 0.010	0
Phosphorus, total	3/3	0.40	0.30	0.37	0.033
Silver, total	0/3	< 0.0050	< 0.0050	~ 0.0050	0
Zinc, total	2/3	0.067	< 0.0050	~ 0.030	0.019
Others					
Oil and grease	0/3	< 2.0	< 2.0	~ 2.0	0
Total dissolved solids	3/3	210	150	170	19
Total organic carbon	3/3	2.2	1.8	2.0	0.12
Total suspended solids	3/3	120	8.0	49	37

Table 2.11. (continued)

Analyte	N det/ N total	Concentration (mg/L)			Standard error ^c
		Max ^a	Min ^a	Av ^b	
White Oak Creek Headwaters ^d					
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	3.0	2.2	2.5	0.24
Field Measurements					
Conductivity (mS/cm)	3/3	0.24	0.18	0.20	0.019
Dissolved oxygen (ppm)	3/3	11	11	11	0.088
pH (SU)	3/3	7.7	7.6	7.7	0.033
Temperature (°C)	3/3	13	11	12	0.70
Turbidity (NTU)	3/3	18	10	13	2.7
Metals					
Aluminum, total	3/3	1.0	0.069	0.41	0.29
Arsenic, total	0/3	< 0.050	< 0.050	~ 0.050	0
Cadmium, total	0/3	< 0.0050	< 0.0050	~ 0.0050	0
Chromium, total	0/3	< 0.0040	< 0.0040	~ 0.0040	0
Copper, total	0/3	< 0.0070	< 0.0070	~ 0.0070	0
Iron, total	3/3	1.0	0.095	0.42	0.29
Lead, total	0/3	< 0.050	< 0.050	~ 0.050	0
Manganese, total	3/3	0.11	0.010	0.047	0.032
Nickel, total	0/3	< 0.010	< 0.010	~ 0.010	0
Phosphorus, total	2/3	0.30	< 0.20	~ 0.27	0.033
Silver, total	0/3	< 0.0050	< 0.0050	~ 0.0050	0
Zinc, total	1/3	0.015	< 0.0050	~ 0.0083	0.0033
Others					
Oil and grease	0/3	< 2.0	< 2.0	~ 2.0	0
Total dissolved solids	3/3	170	69	110	28
Total organic carbon	3/3	0.80	0.70	0.76	0.032
Total suspended solids	2/3	52	< 5.0	~ 21	16

^aPrefix "<" indicates the value of an analyte (excluding organics) was not quantifiable at the analytical detection limit.

^bPrefix "~" indicates that estimated values were used in the calculation of the average.

^cStandard error of the mean.

^dLocations are shown in Fig. 2.2.

2.3 NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM REQUIREMENTS

Martha M. Stevens and Pamela Y. Goldberg

2.3.1 Program Description

The ORNL NPDES permit (TN0002941) became effective on April 1, 1986. The existing permit expired in March 1991. A new permit application was submitted in September 1990 and awaits action from TDEC. Recent indications from TDEC are that a renewed permit will be issued in 1994.

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. Numeric and aesthetic effluent limits have been placed on the following outfalls: Sewage Treatment Plant (X01); Coal Yard Runoff Treatment Facility (X02); Nonradiological Wastewater Treatment Facility (X12); Category I outfalls; Category II outfalls; and Cooling Systems. The ambient locations are Melton Branch (X13), White Oak Creek (X14), and White Oak Dam (X15). Category III outfalls are monitored and carry aesthetic limits. Sampling and analysis frequencies at these locations can be found in the Oak Ridge Reservation Environmental Report for 1992 (Section 4, Vol. 2).

2.3.2 Procedure and Results

Quarterly summary statistics for the second quarter of 1993 are given for each sampling location in Tables 2.12-2.20. Table 2.21 contains summary statistics for radionuclide concentrations at the category outfalls. Although there is no NPDES requirement for radiological monitoring at Category III outfalls, concentrations at five Category III outfalls are monitored to support planning for remediation recommendations at WAG 1.

Data collected for the NPDES permit are also summarized monthly for reporting to DOE and the state of Tennessee. These summaries are submitted to DOE in the Monthly Discharge Monitoring Reports and are available upon request.

Compliance with the NPDES permit for the second quarter is summarized for each major effluent location shown in Fig. 2.2. Table 2.22 details the permit requirements and compliance record for each outfall for the second quarter of 1993. The table lists the discharge points, effluent analytes, permit limits, number of noncompliances, number of samples, and percent of compliance for the second quarter. The percent of compliances is determined by the equation below.

$$\% \text{ compliance} = 100 - [(\text{number of noncompliances} / \text{number of samples}) \times 100]$$

Table 2.12. NPDES Permit Number TN 0002941, April-June 1993,
ORNL discharge point X01 (Sewage Treatment Plant)^a

Flow rates (1x10⁶ L/d)-Max: 2.0, Min: 0.49, Avg: 0.89

Analyte	N det/ N total	Concentration (mg/L)			Standard error ^d
		Max ^b	Min ^b	Av ^c	
Field Measurements					
Chlorine, total residual	39/39	0.31	0.070	0.17	0.010
Dissolved oxygen	63/63	11	7.2	8.6	0.098
Downstream pH (SU)	13/13	7.9	7.2	7.6	0.043
pH (SU)	13/13	7.4	7.0	7.2	0.037
Temperature (°C)	76/76	25	8.5	20	0.40
Metals					
Copper, total	0/3	< 0.0070	< 0.0070	~ 0.0070	0
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	0.15	0.045	0.085	0.033
Others					
Ammonia, as N	39/39	0.73	0.040	0.29	0.037
Biochemical oxygen demand	0/39	< 5.0	< 5.0	~ 5.0	0
Cyanide, total	0/3	< 0.0020	< 0.0020	~ 0.0020	0
Fecal coliform (col/100 mL) ^e	26/39	3,600	< 1.0	~ 6.0	1.5
Oil and grease	5/39	6.0	< 2.0	~ 2.2	0.13
Phenolics, total recoverable	0/3	< 0.0010	< 0.0010	~ 0.0010	0
Total suspended solids	1/39	< 5.0	1.0	~ 4.9	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

^aSee Fig. 2.2.

^bPrefix "<" indicates the value of an analyte (excluding organics) was not quantifiable at the analytical detection limit and "U" indicates the value of an organic analyte was undetected at the analytical detection limit.

^cPrefix "~" indicates that estimated values were used in the calculation of the average.

^dStandard error of the mean.

^eThe geometric mean is computed rather than the average.

Table 2.13. NPDES Permit Number TN 0002941, April-June 1993,
ORNL discharge point X02 (Coal Yard Runoff Treatment Facility)^a

Flow rates (1×10^6 L/d)-Max: 0.34, Min: 0, Avg: 0.027

Analyte	N det/ N total	Concentration (mg/L)			Standard error ^d
		Max ^b	Min ^b	Av ^c	
Anions					
Sulfate, as SO ₄	3/3	1,300	730	990	160
Field Measurements					
Downstream pH (SU)	63/63	8.0	7.4	7.8	0.016
pH (SU)	63/63	7.6	6.9	7.3	0.021
Temperature (°C)	63/63	27	11	21	0.61
Metals					
Arsenic, total	0/11	< 0.050	< 0.050	~ 0.050	0
Cadmium, total	0/11	< 0.0050	< 0.0050	~ 0.0050	0
Chromium, total	2/11	0.015	< 0.0040	~ 0.0058	0.0012
Copper, total	1/11	0.0070	< 0.0070	~ 0.0070	0
Iron, total	11/11	0.41	0.20	0.29	0.020
Lead, total	1/11	0.051	< 0.050	~ 0.050	0.000091
Manganese, total	11/11	0.14	0.036	0.083	0.011
Nickel, total	1/11	0.016	< 0.010	~ 0.011	0.00055
Selenium, total	0/11	< 0.050	< 0.050	~ 0.050	0
Silver, total	0/11	< 0.0050	< 0.0050	~ 0.0050	0
Zinc, total	6/11	0.082	< 0.0050	~ 0.021	0.0075
Others					
Oil and grease	6/11	12	< 2.0	~ 5.2	1.1
Total suspended solids	2/11	11	< 5.0	~ 5.7	0.56

^aSee Fig. 2.2.

^bPrefix "<" indicates the value of an analyte (excluding organics) was not quantifiable at the analytical detection limit.

^cPrefix "~" indicates that estimated values were used in the calculation of the average.

^dStandard error of the mean.

Table 2.14. NPDES Permit Number TN 0002941, April-June 1993,
ORNL discharge point X12 (Nonradiological Wastewater Treatment Facility)^a

Flow rates (1x10⁶ L/d)-Max: 2.4, Min: 1.3, Avg: 2.8

Analyte	N det/ N total	Concentration (mg/L)			Standard error ^d
		Max ^b	Min ^b	Av ^c	
Anions					
Fluoride	13/13	2.2	0.60	1.3	0.12
Nitrate, as N	13/13	19	1.6	6.6	1.4
Sulfate, as SO ₄	13/13	290	120	200	11
Field Measurements					
Downstream pH (SU)	63/63	8.2	7.2	7.8	0.024
pH (SU)	e	7.6	7.1	7.4	0.014
Temperature (°C)	63/63	25	15	20	0.37
Metals					
Arsenic, total	3/13	< 0.050	< 0.00050	~ 0.027	0.0071
Cadmium, total	0/13	< 0.0050	< 0.00050	~ 0.0029	0.00065
Chromium, total	10/13	0.018	< 0.00050	~ 0.0067	0.0014
Copper, total	10/13	0.022	< 0.00050	~ 0.011	0.0015
Iron, total	9/13	0.16	< 0.050	~ 0.087	0.010
Lead, total	5/13	< 0.050	< 0.00050	~ 0.028	0.0069
Mercury, total	0/13	< 0.000050	< 0.000050	~ 0.000050	0
Nickel, total	6/13	< 0.010	0.0014	~ 0.0065	0.0011
Phosphorus, total	12/13	0.42	0.070	~ 0.30	0.030
Selenium, total	3/13	< 0.050	< 0.00050	~ 0.027	0.0071
Silver, total	0/13	< 0.0050	< 0.00050	~ 0.0029	0.00065
Zinc, total	13/13	0.051	0.0032	0.027	0.0032
Others					
Biochemical oxygen demand	0/13	< 5.0	< 5.0	~ 5.0	0
Cyanide, total	2/13	0.0060	< 0.0020	~ 0.0023	0.00031
Oil and grease	2/13	4.0	< 2.0	~ 2.2	0.17
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 2.14. (continued)

Analyte	N det/ N total	Concentration (mg/L)			Standard error ^d
		Max ^b	Min ^b	Av ^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

^aSee Fig. 2.2.

^bPrefix "<" indicates the value of an analyte (excluding organics) was not quantifiable at the analytical detection limit and "U" indicates the value for an organic analyte was undetected at the analytical detection limit.

^cPrefix "~" indicates that estimated values were used in the calculation of the average.

^dStandard error of the mean.

^epH monitoring is continuous.

Table 2.15. NPDES Permit Number TN 0002941, April-June 1993,
ORNL discharge point X13 (Melton Branch 1)^a

Flow rates (1×10^6 L/d)-Max: 31, Min: 1.2, Avg: 5.5

Analyte	N det/ N total	Concentration (mg/L)			Standard error ^d
		Max ^b	Min ^b	Av ^c	
Anions					
Fluoride	3/3	1.3	0.30	0.87	0.30
Nitrate, as N	0/3	< 1.0	< 1.0	~ 1.0	0
Sulfate, as SO ₄	3/3	190	22	100	48
Field Measurements					
Chlorine, total residual	0/13	< 0.010	< 0.010	~ 0.010	0
Conductivity (mS/cm)	3/3	0.72	0.37	0.53	0.10
Dissolved oxygen	13/13	9.5	7.0	8.2	0.26
pH (SU)	3/3	7.6	7.4	7.5	0.067
Temperature (°C)	16/16	22	10	17	0.97
Turbidity (NTU)	3/3	19	7.0	11	3.8
Metals					
Aluminum, total	3/3	0.67	0.46	0.56	0.062
Arsenic, total	0/3	< 0.050	< 0.050	~ 0.050	0
Cadmium, total	0/3	< 0.0050	< 0.0050	~ 0.0050	0
Chromium, total	0/3	< 0.0040	< 0.0040	~ 0.0040	0
Copper, total	1/3	0.0078	< 0.0070	~ 0.0073	0.00027
Iron, total	3/3	0.60	0.26	0.47	0.10
Lead, total	0/3	< 0.050	< 0.050	~ 0.050	0
Manganese, total	3/3	0.25	0.070	0.15	0.054
Mercury, total	0/3	< 0.000050	< 0.000050	~ 0.000050	0
Nickel, total	0/3	< 0.010	< 0.010	~ 0.010	0
Phosphorus, total	3/3	0.82	0.20	0.51	0.18
Silver, total	0/3	< 0.0050	< 0.0050	~ 0.0050	0
Zinc, total	3/3	0.091	0.026	0.065	0.020
Others					
Ammonia, as N	3/3	0.060	0.040	0.047	0.0067
Biochemical oxygen demand	0/3	< 5.0	< 5.0	~ 5.0	0
Oil and grease	6/13	17	< 2.0	~ 4.9	1.5
Phenolics, total recoverable	0/3	< 0.0010	< 0.0010	~ 0.0010	0
Total dissolved solids	3/3	530	140	340	110
Total organic carbon	3/3	3.1	2.0	2.6	0.33
Total suspended solids	3/3	44	7.0	26	11

Table 2.15. (continued)

Analyte	N det/ N total	Concentration (mg/L)			Standard error ^d
		Max ^b	Min ^b	Av ^c	
PCBs					
Total aroclors	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

^aSee Fig. 2.2.

^bPrefix "<" indicates the value of an analyte (excluding organics) was not quantifiable at the analytical detection limit and "U" indicates the value of an organic analyte was undetected at the analytical detection limit.

^cPrefix "~" indicates that estimated values were used in the calculation of the average.

^dStandard error of the mean.

Table 2.16. NPDES Permit Number TN 0002941, April-June 1993,
ORNL discharge point X14 (White Oak Creek)^a

Flow rates (1×10^6 L/d)-Max: 75, Min: 7.9, Avg: 18

Analyte	N det/ N total	Concentration (mg/L)			Standard error ^d
		Max ^b	Min ^b	Av ^c	
Anions					
Fluoride	3/3	1.0	0.40	0.67	0.18
Nitrate, as N	1/3	2.3	< 1.0	~ 1.4	0.43
Sulfate, as SO ₄	3/3	50	26	38	6.9
Field Measurements					
Chlorine, total residual	0/13	< 0.010	< 0.010	~ 0.010	0
Conductivity (mS/cm)	3/3	0.38	0.26	0.33	0.036
Dissolved oxygen	13/13	10	7.1	8.6	0.26
pH (SU)	3/3	7.8	7.7	7.8	0.033
Temperature (°C)	16/16	22	12	18	0.87
Turbidity (NTU)	3/3	17	6.0	10	3.4
Metals					
Aluminum, total	3/3	0.088	0.067	0.078	0.0061
Arsenic, total	0/3	< 0.050	< 0.050	~ 0.050	0
Cadmium, total	0/3	< 0.0050	< 0.0050	~ 0.0050	0
Chromium, total	0/3	< 0.0040	< 0.0040	~ 0.0040	0
Copper, total	0/3	< 0.0070	< 0.0070	~ 0.0070	0
Iron, total	2/3	0.15	< 0.050	~ 0.10	0.029
Lead, total	0/3	< 0.050	< 0.050	~ 0.050	0
Manganese, total	3/3	0.045	0.025	0.033	0.0058
Mercury, total	0/3	< 0.000050	< 0.000050	~ 0.000050	0
Nickel, total	0/3	< 0.010	< 0.010	~ 0.010	0
Phosphorus, total	3/3	0.50	0.20	0.40	0.098
Silver, total	0/3	< 0.0050	< 0.0050	~ 0.0050	0
Zinc, total	3/3	0.058	0.021	0.035	0.011
Others					
Ammonia, as N	3/3	0.040	0.020	0.030	0.0058
Biochemical oxygen demand	0/3	< 5.0	< 5.0	~ 5.0	0
Oil and grease	3/13	3.0	< 2.0	~ 2.2	0.10
Phenolics, total recoverable	0/3	< 0.0010	< 0.0010	~ 0.0010	0
Total dissolved solids	3/3	310	140	240	52
Total organic carbon	3/3	2.0	1.5	1.8	0.15
Total suspended solids	0/3	< 5.0	< 5.0	~ 5.0	0

Table 2.16. (continued)

Analyte	N det/ N total	Concentration (mg/L)			Standard error ^d
		Max ^b	Min ^b	Av ^c	
PCBs					
Total aroclors	0/3	U 0.0020	U 0.0020	~ 0.0020	0
Volatile organics					
Chloroform	3/3	J 0.0017	J 0.0010	~ 0.0012	0.00023
Trichloroethene	0/3	U 0.0050	U 0.0050	~ 0.0050	0

^aSee Fig. 2.2.

^bPrefix "<" indicates the value of an analyte (excluding organics) was not quantifiable at the analytical detection limit; "U" indicates the value of an organic analyte was undetected at the analytical detection limit; and "J" indicates the value was estimated by the laboratory.

^cPrefix "~" indicates that estimated values were used in the calculation of the average.

^dStandard error of the mean.

Table 2.17. NPDES Permit Number TN 0002941, April-June 1993,
ORNL discharge point X15 (White Oak Dam)^a

Flow rates (1×10^6 L/d)-Max: 110, Min: 11, Avg: 26

Analyte	N det/ N total	Concentration (mg/L)			Standard error ^d
		Max ^b	Min ^b	Av ^c	
Anions					
Fluoride	3/3	0.50	0.30	0.43	0.067
Nitrate, as N	0/3	< 1.0	< 1.0	~ 1.0	0
Sulfate, as SO ₄	3/3	42	22	35	6.4
Field Measurements					
Chlorine, total residual	1/13	0.040	< 0.010	~ 0.012	0.0023
Conductivity (mS/cm)	3/3	0.40	0.30	0.36	0.029
Dissolved oxygen	13/13	11	7.0	9.3	0.42
pH (SU)	3/3	8.3	7.8	8.0	0.15
Temperature (°C)	16/16	26	11	20	1.2
Turbidity (NTU)	3/3	23	14	18	2.6
Metals					
Aluminum, total	3/3	1.9	0.40	1.1	0.46
Arsenic, total	0/3	< 0.050	< 0.050	~ 0.050	0
Cadmium, total	0/3	< 0.0050	< 0.0050	~ 0.0050	0
Chromium, total	3/3	0.014	0.0090	0.011	0.0017
Copper, total	1/3	0.0084	< 0.0070	~ 0.0075	0.00047
Iron, total	3/3	2.0	0.66	1.2	0.40
Lead, total	0/3	< 0.050	< 0.050	~ 0.050	0
Manganese, total	3/3	0.18	0.11	0.15	0.021
Mercury, total	0/3	< 0.000050	< 0.000050	~ 0.000050	0
Nickel, total	0/3	< 0.010	< 0.010	~ 0.010	0
Phosphorus, total	3/3	0.52	0.30	0.41	0.064
Silver, total	0/3	< 0.0050	< 0.0050	~ 0.0050	0
Zinc, total	3/3	0.059	0.023	0.044	0.011
Others					
Ammonia, as N	3/3	0.20	0.020	0.087	0.057
Biochemical oxygen demand	0/3	< 5.0	< 5.0	~ 5.0	0
Oil and grease	8/13	36	< 2.0	~ 5.8	2.5
Total dissolved solids	3/3	310	170	230	42
Total organic carbon	3/3	3.4	2.2	3.0	0.41
Total suspended solids	3/3	71	12	35	18

Table 2.17. (continued)

Analyte	N det/ N total	Concentration (mg/L)			Standard error ^d
		Max ^b	Min ^b	Av ^c	
PCBs					
Total aroclors	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

^aSee Fig. 2.2.

^bPrefix "<" indicates the value of an analyte (excluding organics) was not quantifiable at the analytical detection limit and "U" indicates the value of an organic analyte was undetected at the analytical detection limit.

^cPrefix "~" indicates that estimated values were used in the calculation of the average.

^dStandard error of the mean.

Table 2.18. NPDES Permit Number TN 0002941, April-June 1993,
ORNL Category II outfalls

Analyte	N det/ N total	Concentration (mg/L)			Standard error ^c
		Max	Min ^a	Av ^b	
Field Measurements					
Downstream pH (SU)	43/43	8.2	7.6	7.9	0.023
Flow	43/43	0.12	0.00022	0.012	0.0035
pH (SU)	43/43	8.0	6.9	7.6	0.035
Temperature (°C)	43/43	28	11	21	0.42
Temperature, Downstream (°C)	10/10	25	16	20	0.90
Others					
Oil and grease	10/43	17	< 2.0	~ 3.2	0.52
Total suspended solids	17/43	97	< 5.0	~ 13	2.8

^aPrefix "<" indicates the value of an analyte (excluding organics) was not quantifiable at the analytical detection limit.

^bPrefix "~" indicates that estimated values were used in the calculation of the average.

^cStandard error of the mean.

Table 2.19. NPDES Permit Number TN 0002941, April-June 1993,
ORNL Category III outfalls

Analyte	N det/ N total	Concentration (mg/L)			Standard error ^a
		Max	Min	Av	
Field Measurements					
Flow	14/14	0.14	0.00029	0.026	0.011
pH (SU)	14/14	8.0	7.5	7.7	0.033
Temperature (°C)	14/14	21	12	15	0.58

^aStandard error of the mean.

Table 2.20. NPDES Permit Number TN 0002941, April-June 1993,
ORNL Cooling Systems

Analyte	N det/ N total	Concentration (mg/L)			Standard error ^c
		Max	Min ^a	Av ^b	
Field Measurements					
Chlorine, total residual	5/7	0.18	< 0.010	~ 0.059	0.022
Downstream pH (SU)	7/7	8.0	7.7	7.8	0.040
Flow	7/7	0.18	0.0042	0.034	0.025
pH (SU)	7/7	8.5	7.5	8.1	0.15
Temperature (°C)	7/7	26	15	19	1.4
Metals					
Chromium, total	3/7	0.14	< 0.0040	~ 0.031	0.019
Copper, total	5/7	0.19	< 0.0070	~ 0.076	0.029
Zinc, total	7/7	0.37	0.033	0.15	0.045

^aPrefix "<" indicates the value of an analyte (excluding organics) was not quantifiable at the analytical detection limit.

^bPrefix "~" indicates that estimated values were used in the calculation of the average.

^cStandard error of the mean.

Table 2.21. Radionuclide concentrations at ORNL category outfalls,
April-June 1993

Radionuclide	N det/ N total	Concentration (Bq/L)			Standard error ^c	DCG ^d	Percent DCG ^e
		Max ^a	Min ^a	Av ^b			
Category II outfalls							
Gross beta	30/40	28*	0.020	2.4*	1.0	f	f
Category III outfalls ^g							
Co-60	3/5	0.83*	0.020	0.32*	0.14	185	0.17
Cs-137	3/5	7.2*	-0.030	1.6	1.4	111	f
Gross beta	5/5	290*	1.7*	110	58	f	f
Total rad Sr ^h	3/3	100*	27*	60	21	37	f

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

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

^cStandard error of the mean.

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

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

^fNot applicable.

^gRadionuclide concentrations are monitored at outfalls 302, 304, 341, 342, and 368 only.

^hTotal radioactive strontium analyzed when gross beta > 30 Bq/L.

Table 2.22. NPDES compliance at ORNL, April-June 1993

Discharge Point	Effluent analytes	Permit Limits					Permit Compliance		
		Monthly avg (kg/d)	Daily max (kg/d)	Monthly avg (mg/L)	Daily max (mg/L)	Daily min (mg/L)	Number of noncompliances	Number of samples	Percent of compliance
X01 (Sewage Treatment Plant)	Ammonia, as N (summer)	3.5	5.2	4	6		0	26	100
	Ammonia, as N (winter)	7.8	11.8	9	13.5		0	13	100
	Biochemical oxygen demand (summer)	8.7	13.1	10	15		0	26	100
	Biochemical oxygen demand (winter)	17.4	26.2	20	30		0	13	100
	Chlorine, total residual				0.5		0	39	100
	Dissolved oxygen					6.0	0	63	100
	Fecal coliform (col/100 mL) ^a			1000	5000		0	39	100
	Oil and grease	8.7	13.1	10	15		0	39	100
	pH (SU)				9.0	6.0	0	13	100
	Total suspended solids	26.2	39.2	30	45		0	39	100
X02 (Coal Yard Runoff Treatment Facility)	Chromium, total			0.2	0.2		0	11	100
	Copper, total			1.0	1.0		0	11	100
	Iron, total			1.0	1.0		0	11	100
	Oil and grease			15	20		0	11	100
	pH (SU)				9.0	6.0	0	63	100
	Selenium, total			0.22	0.95		0	11	100
	Temperature (°C)				30.5		0	63	100
	Total suspended solids				50		0	11	100
	Zinc			1.0	1.0		0	11	100
X12 (Nonradiological Wastewater Treatment Facility)	Cadmium, total	0.79	2.09	0.26	0.69		0	13	100
	Chromium, total	5.18	8.39	1.71	2.77		0	13	100
	Copper, total	6.27	10.24	2.07	3.38		0	13	100
	Cyanide, total	1.97	3.64	0.65	1.20		0	13	100
	Lead, total	1.30	2.09	0.43	0.69		0	13	100
	Nickel, total	7.21	12.06	2.38	3.98		0	13	100
	Oil and grease	30.3	45.4	10	15		0	13	100
	pH (SU)				9.0	6.0	0	6	100
	Silver, total	0.73	1.30	0.24	0.43		0	13	100
	Temperature (°C)				30.5		0	63	100
	Total suspended solids	93.9	182	31	60		0	13	100
	Total toxic organics		6.45		2.13		0	13	100
	Zinc, total	4.48	7.91	1.48	2.61		0	13	100

Table 2.22. (continued)

Discharge Point	Effluent analytes	Permit Limits					Permit Compliance		
		Monthly avg (kg/d)	Daily max (kg/d)	Monthly avg (mg/L)	Daily max (mg/L)	Daily min (mg/L)	Number of noncompliances	Number of samples	Percent of compliance
Category I outfalls ^c	Oil and grease			10	15		0	0	d
	pH (SU)				9.0	6.0	0	0	d
	Temperature (°C)				30.5		0	0	d
	Total suspended solids			30	50		0	0	d
Category II outfalls	Downstream Temperature (°C) ^e				30.5		0	10	100
	Oil and grease			10	15		1	40	97.5
	pH (SU)				9.0	6.0	0	40	100
	Total suspended solids			30	50		1	40	97.5
Cooling Systems	Chlorine, total residual				0.2		0	7	100
	Chromium, total				1.0		0	7	100
	Copper, total			0.5	1.0		0	7	100
	pH (SU)				9.0	6.0	0	7	100
	Temperature (°C)			35	38		0	7	100
	Zinc, total			0.5	1.0		0	7	100

^aColonies per 100 mL.^bpH monitoring is continuous.^cCategory I outfalls are monitored annually by the NPDES Permit year of April 1-March 31.^dNo samples were collected during April-June 1993.^eDownstream temperature is monitored such that the stream temperature standards stated in the General Water Quality Criteria for the Definition and Control of Pollution in the Waters of Tennessee, as amended, are not violated as a result of this discharge.

3.0 GROUNDWATER

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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 of the SWMUs 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. 3.1.

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 3.1 contains a listing of all of the analytes sought in groundwater at ORNL during second quarter 1993 and the drinking water limit and DOE DCG associated with each. Not all substances shown in Table 3.1 were analyzed in each sample. Table 3.1, used in conjunction with the sampling plan synopsis provided for each WAG, can be used to determine the respective specific analyte lists. Beginning with the sampling of WAG 1 in second quarter 1993, filtered samples are collected for analysis of radionuclides only. EPA recommends that samples not be filtered and DOE recommends filtering samples intended for radionuclide analysis. 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. Rinsate blanks are not collected because dedicated sampling equipment is utilized.

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). See Section 1.0 for a general discussion of summary tables and the techniques used to produce them.

Fig. 3.1. ORNL WAGs.

Table 3.1. Analytes sought and applicable standards in groundwater at ORNL in WAGs 1, 5, and 6 during April-June 1993

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, as N	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 3.1. (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)				
pH (SU)		(6.5, 8.5)	(6.0, 9.0)	

Table 3.1. (continued)

Analyte	National Primary Drinking Water	National Secondary Drinking Water	Tennessee Primary Drinking Water	4% of DOE DCG ^a
Redox (mV)				
Temperature (°C)			30.5	
Turbidity (NTU) ^c	1.0			
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		0.10	
Cobalt				
Copper	1.3 ^d	1.0		
Iron		0.30		
Lead	0.015 ^d		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 3.1. (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) ^e				
Co-60				7.4
Cs-137				4.44
Gross alpha	0.555			
Gross beta	1.85 ^f			
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 ^g			
Bromoform	100 ^g			
Bromomethane				
Carbon disulfide				
Carbon tetrachloride	5.0		5.0	
Chlorobenzene	100			
Chloroethane	200			
Chloroform	100 ^g			
Chloromethane				
Dibromochloromethane	100 ^g			
Ethylbenzene	700			
Methylene chloride				
Styrene	100			
Tetrachloroethene	5.0			

Table 3.1. (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				

^a4% 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.

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

^cJTU and NTU are roughly equivalent in the range of 25 to 1,000 JTU.

^dNational primary drinking water action level, which is applicable to community water systems and non-transient, non-community water systems.

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

^fRegulatory guide for assessing compliance without further analysis.

^gLimit for total trihalomethanes (bromodichloromethane + bromoform + chloroform + dibromochloromethane).

This reference value may be a drinking water limit, DOE DCG, 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.

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

3.1 WAG 1

3.1.1 Program Description

The sites at Waste Area Grouping (WAG) 1 are currently remedial investigation sites regulated under RCRA 3004(U). ORNL has sampled WAG 1 every year since 1988 and has plans to continue sampling every year.

WAG 1 consists of an area covering much of the ORNL main plant site (Fig 3.2). It contains many types of SWMUs listed by EPA in the definition of a SWMU (tanks, ponds, waste water treatment facilities, leak sites, spill sites, landfills). Most of the WAG 1 sites were used to collect and to store low-level waste (LLW) in tanks, ponds, and waste treatment facilities, but some also include landfills and spill and leak sites identified during the last 40 years.

Twenty-seven wells comprise the groundwater perimeter well network at WAG 1 (wells 806-830, 946, 947); the up-gradient wells for WAG 1 are 814, 818, and 819. Table 3.2 shows the parameters measured at WAG 1.

3.1.2 Procedure and Results

Perimeter wells at WAG 1 were sampled May 19-June 25, 1993. A summary of the analytical results by well type (i.e., up-gradient and down-gradient) is presented in Table 3.3; Table 3.4 presents the data which exceed some reference criteria.

Well 812 continues to show gross alpha and gross beta activity. Current and past isotopic identification of the gross alpha activity indicate that this is attributable to uranium-234 and uranium-238. The gross beta activity is attributable mainly to the total radioactive strontium and its daughters.

Fig. 3.2. Location map of groundwater quality wells at WAG 1.

Table 3.2. Parameters measured in groundwater at ORNL WAGs 1 and 5 during second quarter 1993

Inorganic Compounds	Field Measurements
Alkalinity	Dissolved oxygen
Anions	pH
bromide	Redox
chloride	Specific conductance
fluoride	Temperature
nitrate, as N	Turbidity
phosphate	
sulfate, as SO ₄	Organic Compounds
Metals by ICP	Total organic carbon
Metals by atomic absorption	Total organic halides
antimony	Total compound list
arsenic	
lead	Radionuclides
mercury	Gamma emitting isotopes
selenium	Co-60
thallium	Cs-137
Total dissolved solids	Gross alpha
Total suspended solids	Gross beta
	H-3
	Total rad Sr

Table 3.3. ORNL WAG 1 groundwater summary statistics from
May 19-June 25, 1993

Analyte	N det/ N total	Concentration			Standard error ^c
		Max ^a	Min ^a	Av ^b	
Down-gradient Well Type					
Anions (mg/L) -- Unfiltered					
Bromide	1/23	1.1	< 1.0	~ 1.0	0.0043
Chloride	20/23	110	< 2.0	~ 18	5.0
Fluoride	7/23	3.2	< 0.10	~ 0.41	0.16
Nitrate	2/23	10	< 1.0	~ 1.5	0.41
Sulfate, as SO ₄	19/23	120	< 10	~ 34	6.0
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered					
Benzyl butyl phthalate	6/23	U 5.0	JB 1.0	~ 4.1	0.33
Bis(2-ethylhexyl) phthalate	12/23	B 47	JB 2.0	~ 11	2.8
Diethyl phthalate	5/23	5.0	JB 2.0	~ 4.6	0.21
Field Measurements -- Unfiltered					
Conductivity (mS/cm)	23/23	1.3	0.32	0.67	0.051
Dissolved oxygen (ppm)	23/23	13	9.5	11	0.18
pH (SU)	23/23	9.1	6.8	7.3	0.097
Redox (mV)	23/23	630	110	350	32
Temperature (°C)	23/23	22	13	16	0.38
Turbidity (JTU)	23/23	2,100	2.1	230	95
Metals (mg/L) -- Unfiltered					
Aluminum	10/23	3.0	< 0.050	~ 0.50	0.17
Antimony	2/23	0.0070	< 0.0050	~ 0.0051	0.000095
Arsenic	1/23	0.011	< 0.010	~ 0.010	0.000043
Barium	23/23	0.67	0.012	0.13	0.30
Boron	9/23	1.0	< 0.080	~ 0.19	0.051
Calcium	23/23	150	1.1	82	8.2
Chromium	5/23	0.0086	< 0.0040	~ 0.0046	0.00028
Iron	19/23	11	< 0.050	~ 2.1	0.64
Magnesium	23/23	98	0.50	19	3.9
Manganese	21/23	5.7	< 0.0010	~ 1.0	0.38
Mercury	1/23	0.000060	< 0.000050	~ 0.000050	0.00000043
Nickel	4/23	0.024	< 0.010	~ 0.011	0.00063
Potassium	12/23	5.8	< 1.0	~ 1.7	0.25
Silicon	23/23	12	3.2	5.7	0.45
Sodium	23/23	280	2.0	37	15
Vanadium	7/23	0.0049	< 0.0020	~ 0.0024	0.00017

Table 3.3. (continued)

Analyte	N det/ N total	Concentration			
		Max ^a	Min ^a	Av ^b	Standard error ^c
Metals (mg/L) -- Unfiltered					
Zinc	9/23	0.052	< 0.0050	~ 0.0098	0.0022
Others -- Unfiltered					
Alkalinity (mg/L)	23/23	470	180	310	16
Total organic carbon (mg/L)	23/23	3.4	0.50	1.4	0.17
Total organic halides (μg/L)	14/23	120	< 5.0	~ 19	5.1
Total suspended solids (mg/L)	11/23	130	< 5.0	~ 14	5.5
Radionuclides (Bq/L) -- Filtered ^d					
Co-60	4/23	0.46*	-0.060	0.081*	0.024
Cs-137	1/23	0.14	-0.17	0.014	0.015
Gross alpha	9/23	7.5*	-0.023	0.37	0.32
Gross beta	15/23	400*	-0.030	18	17
H-3	22/23	570*	6.0	110*	29
Th-230	1/1	0.25*	0.25*	0.25	e
Th-232	1/1	0.021*	0.021*	0.021	e
Total rad Sr	10/23	280*	-0.0010	13	12
U-234	1/1	6.7*	6.7*	6.7	e
U-235	1/1	0.20*	0.20*	0.20	e
U-238	1/1	1.1*	1.1*	1.1	e
Radionuclides (Bq/L) -- Unfiltered ^d					
Co-60	3/23	0.58*	-0.20	0.048	0.032
Cs-137	1/23	0.22*	-0.080	0.061*	0.014
Gross alpha	7/23	18*	-0.063	0.84	0.78
Gross beta	21/23	530*	0.040	24	23
H-3	20/23	630*	-6.0	110*	31
Th-228	1/1	0.039*	0.039*	0.039	e
Th-230	1/1	0.29*	0.29*	0.29	e
Th-232	1/1	0.038*	0.038*	0.038	e
Total rad Sr	10/23	260*	-0.040	12	11
U-234	1/1	15*	15*	15	e
U-235	1/1	0.23*	0.23*	0.23	e
U-238	1/1	0.40*	0.40*	0.40	e
Volatile Organics (μg/L) -- Unfiltered					
1,1,1-Trichloroethane	1/23	16	U 5.0	~ 5.5	0.48
1,2-Dichloroethene	1/23	7.4	U 5.0	~ 5.1	0.10
Carbon disulfide	3/23	U 5.0	J 1.4	~ 4.6	0.22

Table 3.3. (continued)

Analyte	N det/ N total	Concentration			Standard error ^c
		Max ^a	Min ^a	Av ^b	
Volatile Organics (µg/L) -- Unfiltered					
Chloroform	2/23	15	U 5.0	~ 5.5	0.44
Trichloroethene	1/23	U 5.0	J 4.4	~ 5.0	0.026
Up-gradient Well Type					
Anions (mg/L) -- Unfiltered					
Chloride	2/3	13	< 2.0	~ 6.7	3.3
Fluoride	1/3	1.2	< 0.10	~ 0.47	0.37
Nitrate	1/3	5.4	< 1.0	~ 2.5	1.5
Sulfate, as SO ₄	3/3	34	13	25	6.2
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered					
4-Methylphenol	1/3	U 5.0	J 3.0	~ 4.3	0.67
Field Measurements -- Unfiltered					
Conductivity (mS/cm)	3/3	0.77	0.59	0.67	0.054
Dissolved oxygen (ppm)	3/3	10	7.5	9.1	0.86
pH (SU)	3/3	8.1	7.1	7.5	0.30
Redox (mV)	3/3	670	290	430	120
Temperature (°C)	3/3	16	15	15	0.24
Turbidity (JTU)	3/3	340	8.4	120	110
Metals (mg/L) -- Unfiltered					
Aluminum	1/3	4.2	< 0.050	~ 1.4	1.4
Barium	3/3	0.21	0.080	0.15	0.037
Boron	1/3	0.25	< 0.080	~ 0.14	0.057
Calcium	3/3	110	35	83	24
Chromium	1/3	0.0063	< 0.0040	~ 0.0048	0.00077
Iron	2/3	5.5	< 0.050	~ 1.9	1.8
Magnesium	3/3	28	10	21	5.6
Manganese	3/3	0.17	0.0060	0.061	0.055
Nickel	1/3	0.024	< 0.010	~ 0.015	0.0045
Selenium	1/3	< 0.0050	0.0040	~ 0.0047	0.00033
Silicon	3/3	9.5	6.0	7.7	1.0
Sodium	3/3	37	5.3	19	9.3
Vanadium	1/3	0.0082	< 0.0020	~ 0.0041	0.0021
Zinc	1/3	0.0054	< 0.0050	~ 0.0051	0.00013

Table 3.3. (continued)

Analyte	N det/ N total	Concentration			
		Max ^a	Min ^a	Av ^b	Standard error ^c
Others -- Unfiltered					
Alkalinity (mg/L)	3/3	300	240	280	20
Total organic carbon (mg/L)	3/3	1.2	0.50	0.84	0.20
Total suspended solids (mg/L)	2/3	170	< 5.0	~ 64	54
Radionuclides (Bq/L) -- Filtered ^d					
Gross beta	2/3	0.18*	0.050	0.12*	0.038
H-3	3/3	110*	31*	71*	23
Radionuclides (Bq/L) -- Unfiltered ^d					
Cs-137	2/3	0.22*	0.030	0.13	0.055
Gross beta	1/3	0.18*	0.010	0.073	0.054
H-3	3/3	97*	34*	68*	18

^aPrefix "<" indicates the value for an analyte (excluding organics) was not quantifiable at the analytical detection limit; "B" indicates the compound was found in the laboratory blank; "J" indicates the value was estimated by the laboratory; "JB" indicates the value was estimated by the laboratory and the compound was found in the laboratory blank; and "U" indicates the value for an organic analyte was undetected at the analytical detection limit.

^bThe ~ prefix indicates that estimated values were used in the calculation of the average.

^cStandard error of the mean.

^dIndividual and average radionuclide concentrations significantly greater than zero are identified by an *.

^eCalculation can not be performed using only one value.

Table 3.4. ORNL WAG 1 groundwater constituents that exceed a reference value from sampling period May 19-June 25, 1993

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Well 806, Sampling Date 24MAY93 Ground Elevation 774.94 ft, Water Elevation 772.74				
Anions (mg/L) -- Unfiltered				
Chloride	4.0	c	2.0	D
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Pentachlorophenol	U 25	c	1	2
Metals (mg/L) -- Unfiltered				
Iron	11	c	0.3	3
Lead	< 0.020	c	0.015	2
Manganese	4.3	c	0.05	3
Others -- Unfiltered				
Alkalinity (mg/L)	220	c	1.0	D
Total organic carbon (mg/L)	1.9	c	0.50	D
Total suspended solids (mg/L)	20	c	5.0	D
Radionuclides (Bq/L) -- Filtered ^d				
Gross beta	11*	1.0	1.85	2
Total rad Sr	4.2*	0.20	0.296	2
Radionuclides (Bq/L) -- Unfiltered ^d				
Gross beta	9.7*	0.70	1.85	2
Total rad Sr	4.0*	0.20	0.296	2
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 807, Sampling Date 24MAY93 Ground Elevation 774.53 ft, Water Elevation 770.56				
Anions (mg/L) -- Unfiltered				
Chloride	5.0	c	2.0	D
Sulfate, as SO ₄	57	c	10	D
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Pentachlorophenol	U 25	c	1	2

Table 3.4. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Metals (mg/L) -- Unfiltered				
Iron	4.0	c	0.3	3
Lead	< 0.020	c	0.015	2
Manganese	5.7	c	0.05	3
Others -- Unfiltered				
Alkalinity (mg/L)	470	c	1.0	D
Total organic carbon (mg/L)	3.0	c	0.50	D
Total organic halides (µg/L)	10	c	5.0	D
Total suspended solids (mg/L)	7.0	c	5.0	D
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 808, Sampling Date 26MAY93				
Ground Elevation 774.50 ft, Water Elevation 770.64				
Anions (mg/L) -- Unfiltered				
Bromide	1.1	c	1.0	D
Chloride	110	c	2.0	D
Fluoride	2.4	c	0.10	D
Sulfate, as SO ₄	94	c	10	D
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Pentachlorophenol	U 25	c	1	2
Metals (mg/L) -- Unfiltered				
Lead	< 0.020	c	0.015	2
Others -- Unfiltered				
Alkalinity (mg/L)	400	c	1.0	D
Total organic carbon (mg/L)	0.95	c	0.50	D
Total organic halides (µg/L)	19	c	5.0	D
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1

Table 3.4. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Well 809, Sampling Date 26MAY93				
Ground Elevation 776.74 ft, Water Elevation 773.37				
Anions (mg/L) -- Unfiltered				
Chloride	49	c	2.0	D
Fluoride	0.50	c	0.10	D
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Pentachlorophenol	U 25	c	1	2
Metals (mg/L) -- Unfiltered				
Aluminum	0.35	c	0.2	3
Iron	9.0	c	0.3	3
Lead	< 0.020	c	0.015	2
Manganese	0.96	c	0.05	3
Others -- Unfiltered				
Alkalinity (mg/L)	370	c	1.0	D
Total organic carbon (mg/L)	1.9	c	0.50	D
Total organic halides (µg/L)	32	c	5.0	D
Total suspended solids (mg/L)	46	c	5.0	D
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 810, Sampling Date 28MAY93				
Ground Elevation 790.19 ft, Water Elevation 786.04				
Anions (mg/L) -- Unfiltered				
Chloride	13	c	2.0	D
Sulfate, as SO ₄	34	c	10	D
BNAE Organics-TICs (µg/L) -- Unfiltered				
Unknown-6.98	J 6.0	c	c	T
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Pentachlorophenol	U 25	c	1	2

Table 3.4. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Metals (mg/L) -- Unfiltered				
Lead	< 0.020	c	0.015	2
Manganese	0.080	c	0.05	3
Others -- Unfiltered				
Alkalinity (mg/L)	330	c	1.0	D
Total organic carbon (mg/L)	1.2	c	0.50	D
Others -- Unfiltered				
Total organic halides (µg/L)	38	c	5.0	D
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 811, Sampling Date 28MAY93				
Ground Elevation 791.00 ft, Water Elevation 788.97				
Anions (mg/L) -- Unfiltered				
Chloride	38	c	2.0	D
Fluoride	3.2	c	0.10	D
Sulfate, as SO ₄	120	c	10	D
BNAE Organics-TICs (µg/L) -- Unfiltered				
Unknown-6.98	J 6.0	c	c	T
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Pentachlorophenol	U 25	c	1	2
Field Measurements -- Unfiltered				
pH (SU)	9.1	c	(6.5, 8.5)	3
Metals (mg/L) -- Unfiltered				
Lead	< 0.020	c	0.015	2
Others -- Unfiltered				
Alkalinity (mg/L)	430	c	1.0	D
Total organic carbon (mg/L)	0.88	c	0.50	D
Total organic halides (µg/L)	13	c	5.0	D

Table 3.4. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 812, Sampling Date 01JUN93 Ground Elevation 803.19 ft, Water Elevation 798.64				
Anions (mg/L) -- Unfiltered				
Chloride	11	c	2.0	D
Fluoride	0.20	c	0.10	D
Nitrate	4.5	c	1.0	D
Sulfate, as SO ₄	28	c	10	D
BNAE Organics-TICs (µg/L) -- Unfiltered				
Unknown-6.99	J 6.0	c	c	T
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Pentachlorophenol	U 25	c	1	2
Metals (mg/L) -- Unfiltered				
Lead	< 0.020	c	0.015	2
Others -- Unfiltered				
Alkalinity (mg/L)	190	c	1.0	D
Total organic carbon (mg/L)	0.73	c	0.50	D
Total organic halides (µg/L)	24	c	5.0	D
Total suspended solids (mg/L)	6.0	c	5.0	D
Radionuclides (Bq/L) -- Filtered ^d				
Gross alpha	7.5*	0.60	0.555	2
Gross beta	400*	10	1.85	2
Total rad Sr	280*	10	0.296	2
U-234	6.7*	0.30	0.74	4
U-238	1.1*	0.10	0.888	4
Radionuclides (Bq/L) -- Unfiltered ^d				
Gross alpha	18*	1.0	0.555	2
Gross beta	530*	10	1.85	2
Total rad Sr	260*	10	0.296	2
U-234	15*	1.0	0.74	4

Table 3.4. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Volatile Organics-TICs (µg/L) -- Unfiltered				
Ethane,1,1,2-trichloro-1,2,2	J 8.4	c	c	T
Unknown-24.07	J 5.1	c	c	T
Well 813, Sampling Date 02JUN93				
Ground Elevation 848.86 ft, Water Elevation 799.31				
Anions (mg/L) -- Unfiltered				
Chloride	6.9	c	2.0	D
Sulfate, as SO ₄	25	c	10	D
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Pentachlorophenol	U 25	c	1	2
Metals (mg/L) -- Unfiltered				
Aluminum	1.0	c	0.2	3
Iron	0.75	c	0.3	3
Lead	< 0.020	c	0.015	2
Others -- Unfiltered				
Alkalinity (mg/L)	180	c	1.0	D
Total organic halides (µg/L)	31	c	5.0	D
Total suspended solids (mg/L)	130	c	5.0	D
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 814, Sampling Date 19MAY93				
Ground Elevation 877.00 ft, Water Elevation 809.60				
Anions (mg/L) -- Unfiltered				
Chloride	13	c	2.0	D
Nitrate	5.4	c	1.0	D
Sulfate, as SO ₄	13	c	10	D

Table 3.4. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Pentachlorophenol	U 25	c	1	2
Metals (mg/L) -- Unfiltered				
Aluminum	4.2	c	0.2	3
Iron	5.5	c	0.3	3
Lead	< 0.020	c	0.015	2
Manganese	0.17	c	0.05	3
Others -- Unfiltered				
Alkalinity (mg/L)	290	c	1.0	D
Total organic carbon (mg/L)	0.83	c	0.50	D
Total organic halides (µg/L)	~ 7.3	c	5.0	D
Total suspended solids (mg/L)	170	c	5.0	D
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 815, Sampling Date 02JUN93 Ground Elevation 823.99 ft, Water Elevation 816.22				
Anions (mg/L) -- Unfiltered				
Chloride	11	c	2.0	D
Sulfate, as SO ₄	20	c	10	D
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Pentachlorophenol	U 25	c	1	2
Metals (mg/L) -- Unfiltered				
Aluminum	1.9	c	0.2	3
Iron	0.84	c	0.3	3
Lead	< 0.020	c	0.015	2
Others -- Unfiltered				
Alkalinity (mg/L)	320	c	1.0	D
Total organic carbon (mg/L)	0.78	c	0.50	D
Total organic halides (µg/L)	8.3	c	5.0	D
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1

Table 3.4. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Well 816, Sampling Date 03JUN93 Ground Elevation 823.44 ft, Water Elevation 816.46				
Anions (mg/L) -- Unfiltered				
Chloride	7.4	c	2.0	D
BNAE Organics-TICs (µg/L) -- Unfiltered				
Dicarboxylicacidderivative-2	J 130	c	c	T
Unknown-25.91	J 92	c	c	T
Unknown-28.4	J 18	c	c	T
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Pentachlorophenol	U 25	c	1	2
Metals (mg/L) -- Unfiltered				
Aluminum	2.2	c	0.2	3
Iron	0.79	c	0.3	3
Lead	< 0.020	c	0.015	2
Others -- Unfiltered				
Alkalinity (mg/L)	290	c	1.0	D
Total organic carbon (mg/L)	0.58	c	0.50	D
Total suspended solids (mg/L)	7.0	c	5.0	D
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 818, Sampling Date 20MAY93 Ground Elevation 851.55 ft, Water Elevation 811.23				
Anions (mg/L) -- Unfiltered				
Sulfate, as SO ₄	28	c	10	D
BNAE Organics-TICs (µg/L) -- Unfiltered				
Unknownhydrocarbon-28.19	J 5.0	c	c	T
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Pentachlorophenol	U 25	c	1	2

Table 3.4. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Metals (mg/L) -- Unfiltered				
Lead	< 0.020	c	0.015	2
Others -- Unfiltered				
Alkalinity (mg/L)	300	c	1.0	D
Total organic carbon (mg/L)	1.2	c	0.50	D
Total suspended solids (mg/L)	15	c	5.0	D
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 819, Sampling Date 21MAY93				
Ground Elevation 827.83 ft, Water Elevation 804.28				
Anions (mg/L) -- Unfiltered				
Chloride	5.0	c	2.0	D
Fluoride	1.2	c	0.10	D
Sulfate, as SO ₄	34	c	10	D
BNAE Organics-TICs (µg/L) -- Unfiltered				
Unknown-7.07	J 4.0	c	c	T
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Pentachlorophenol	U 25	c	1	2
Metals (mg/L) -- Unfiltered				
Lead	< 0.020	c	0.015	2
Others -- Unfiltered				
Alkalinity (mg/L)	240	c	1.0	D
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 820, Sampling Date 04JUN93				
Ground Elevation 807.35 ft, Water Elevation 800.43				
Anions (mg/L) -- Unfiltered				
Chloride	3.5	c	2.0	D
Sulfate, as SO ₄	43	c	10	D

Table 3.4. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
BNAE Organics-TICs (µg/L) -- Unfiltered				
Dicarboxylicacidderivative-2	J 98	c	c	T
Unknown-25.9	J 71	c	c	T
Unknown-28.37	J 16	c	c	T
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Pentachlorophenol	U 25	c	1	2
Metals (mg/L) -- Unfiltered				
Aluminum	3.0	c	0.2	3
Iron	1.1	c	0.3	3
Lead	< 0.020	c	0.015	2
Others -- Unfiltered				
Alkalinity (mg/L)	320	c	1.0	D
Total organic carbon (mg/L)	0.98	c	0.50	D
Total organic halides (µg/L)	8.5	c	5.0	D
Total suspended solids (mg/L)	26	c	5.0	D
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 821, Sampling Date 10JUN93				
Ground Elevation 808.55 ft, Water Elevation 799.07				
Anions (mg/L) -- Unfiltered				
Chloride	8.4	c	2.0	D
Fluoride	0.60	c	0.10	D
Sulfate, as SO ₄	20	c	10	D
BNAE Organics-TICs (µg/L) -- Unfiltered				
1,1'-Sulfonylbis[4-chloro--2	J 69	c	c	T
Unknown-6.05	J 6.0	c	c	T
Unknown-6.27	J 9.0	c	c	T
Unknown-6.58	J 6.0	c	c	T
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Bis(2-ethylhexyl) phthalate	B 33	c	5.0	D
Pentachlorophenol	U 25	c	1	2

Table 3.4. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Metals (mg/L) -- Unfiltered				
Lead	< 0.020	c	0.015	2
Others -- Unfiltered				
Alkalinity (mg/L)	290	c	1.0	D
Total organic carbon (mg/L)	0.68	c	0.50	D
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 822, Sampling Date 14JUN93 Ground Elevation 797.58 ft, Water Elevation 795.67				
Anions (mg/L) -- Unfiltered				
Chloride	6.5	c	2.0	D
Sulfate, as SO ₄	50	c	10	D
BNAE Organics-TICs (µg/L) -- Unfiltered				
Unknown-25.8	J 47	c	c	T
Unknown-28.26	J 25	c	c	T
Unknown-7.85	J 7.0	c	c	T
Unknown-8.07	J 7.0	c	c	T
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Bis(2-ethylhexyl) phthalate	B 29	c	5.0	D
Pentachlorophenol	U 25	c	1	2
Metals (mg/L) -- Unfiltered				
Iron	1.6	c	0.3	3
Lead	< 0.020	c	0.015	2
Others -- Unfiltered				
Alkalinity (mg/L)	290	c	1.0	D
Total organic carbon (mg/L)	0.80	c	0.50	D
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1

Table 3.4. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Well 823, Sampling Date 14JUN93				
Ground Elevation 799.51 ft, Water Elevation 793.13				
Anions (mg/L) -- Unfiltered				
Chloride	40	c	2.0	D
Sulfate, as SO ₄	70	c	10	D
BNAE Organics-TICs (µg/L) -- Unfiltered				
1,1'-Sulfonylbis[4-chloro--2	J 40	c	c	T
Unknown-28.26	J 20	c	c	T
Unknown-7.84	J 7.0	c	c	T
Unknown-8.07	J 8.0	c	c	T
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Bis(2-ethylhexyl) phthalate	B 24	c	5.0	D
Pentachlorophenol	U 25	c	1	2
Metals (mg/L) -- Unfiltered				
Aluminum	1.3	c	0.2	3
Iron	2.3	c	0.3	3
Lead	< 0.020	c	0.015	2
Manganese	0.85	c	0.05	3
Others -- Unfiltered				
Alkalinity (mg/L)	300	c	1.0	D
Total organic carbon (mg/L)	1.6	c	0.50	D
Total organic halides (µg/L)	20	c	5.0	D
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 824, Sampling Date 14JUN93				
Ground Elevation 787.05 ft, Water Elevation 780.31				
Anions (mg/L) -- Unfiltered				
Chloride	16	c	2.0	D
Sulfate, as SO ₄	12	c	10	D

Table 3.4. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
BNAE Organics-TICs (µg/L) -- Unfiltered				
1,1'-Sulfonylbis[4-chloro--2	J 140	c	c	T
Unknown-22.11	J 4.0	c	c	T
Unknown-26.44	J 14	c	c	T
Unknown-6.28	J 13	c	c	T
Unknown-6.59	J 5.0	c	c	T
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Bis(2-ethylhexyl) phthalate	B 47	c	5.0	D
Pentachlorophenol	U 25	c	1	2
Metals (mg/L) -- Unfiltered				
Iron	1.3	c	0.3	3
Lead	< 0.020	c	0.015	2
Manganese	0.58	c	0.05	3
Others -- Unfiltered				
Alkalinity (mg/L)	350	c	1.0	D
Total organic carbon (mg/L)	1.7	c	0.50	D
Total organic halides (µg/L)	23	c	5.0	D
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 825, Sampling Date 16JUN93				
Ground Elevation 787.96 ft, Water Elevation 778.37				
Anions (mg/L) -- Unfiltered				
Chloride	6.9	c	2.0	D
Fluoride	0.60	c	0.10	D
Sulfate, as SO ₄	19	c	10	D
BNAE Organics-TICs (µg/L) -- Unfiltered				
1,1'-Sulfonylbis[4-chloro--2	J 5.0	c	c	T
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Pentachlorophenol	U 25	c	1	2
Metals (mg/L) -- Unfiltered				
Lead	< 0.020	c	0.015	2

Table 3.4. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Others -- Unfiltered				
Alkalinity (mg/L)	250	c	1.0	D
Total organic carbon (mg/L)	1.4	c	0.50	D
Total organic halides (µg/L)	12	c	5.0	D
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 826, Sampling Date 15JUN93 Ground Elevation 788.07 ft, Water Elevation 780.64				
Anions (mg/L) -- Unfiltered				
Chloride	11	c	2.0	D
BNAE Organics-TICs (µg/L) -- Unfiltered				
1,1'-Sulfonylbis[4-chloro--2	J 93	c	c	T
Unknown-6.05	J 6.0	c	c	T
Unknown-6.27	J 10	c	c	T
Unknown-6.58	J 7.0	c	c	T
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Bis(2-ethylhexyl) phthalate	B 44	c	5.0	D
Pentachlorophenol	U 25	c	1	2
Metals (mg/L) -- Unfiltered				
Iron	7.7	c	0.3	3
Lead	< 0.020	c	0.015	2
Manganese	1.5	c	0.05	3
Others -- Unfiltered				
Alkalinity (mg/L)	350	c	1.0	D
Total organic carbon (mg/L)	3.0	c	0.50	D
Total organic halides (µg/L)	120	c	5.0	D
Total suspended solids (mg/L)	12	c	5.0	D
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Volatile Organics-TICs (µg/L) -- Unfiltered				
Sulphurdioxide(dot)-4.23	J 13	c	c	T

Table 3.4. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Well 827, Sampling Date 21JUN93				
Ground Elevation 784.63 ft, Water Elevation 778.32				
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Pentachlorophenol	U 25	c	1	2
Metals (mg/L) -- Unfiltered				
Lead	< 0.020	c	0.015	2
Manganese	0.096	c	0.05	3
Others -- Unfiltered				
Alkalinity (mg/L)	180	c	1.0	D
Total organic carbon (mg/L)	0.88	c	0.50	D
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 828, Sampling Date 22JUN93				
Ground Elevation 814.11 ft, Water Elevation 776.76				
Anions (mg/L) -- Unfiltered				
Nitrate	10	c	1.0	D
Sulfate, as SO ₄	20	c	10	D
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Pentachlorophenol	U 25	c	1	2
Metals (mg/L) -- Unfiltered				
Lead	< 0.020	c	0.015	2
Others -- Unfiltered				
Alkalinity (mg/L)	390	c	1.0	D
Total organic carbon (mg/L)	0.90	c	0.50	D
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1

Table 3.4. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Well 829, Sampling Date 23JUN93 Ground Elevation 775.56 ft, Water Elevation 771.58				
Anions (mg/L) -- Unfiltered				
Sulfate, as SO ₄	38	c	10	D
BNAE Organics-TICs (µg/L) -- Unfiltered				
1,1'-Sulfonylbis[4-Chloro--2	J 5.0	c	c	T
Unknown-6.1	J 4.0	c	c	T
Unknown-6.4	J 6.0	c	c	T
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Bis(2-ethylhexyl) phthalate	B 6.0	c	5.0	D
Pentachlorophenol	U 25	c	1	2
Metals (mg/L) -- Unfiltered				
Iron	0.99	c	0.3	3
Lead	< 0.020	c	0.015	2
Manganese	2.8	c	0.05	3
Others -- Unfiltered				
Alkalinity (mg/L)	300	c	1.0	D
Total organic carbon (mg/L)	2.0	c	0.50	D
Radionuclides (Bq/L) -- Filtered ^d				
Total rad Sr	0.68*	0.21	0.296	2
Radionuclides (Bq/L) -- Unfiltered ^d				
Total rad Sr	0.65*	0.15	0.296	2
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 830, Sampling Date 23JUN93 Ground Elevation 778.35 ft, Water Elevation 771.55				
Anions (mg/L) -- Unfiltered				
Chloride	13	c	2.0	D
Sulfate, as SO ₄	52	c	10	D

Table 3.4. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
BNAE Organics-TICs (µg/L) -- Unfiltered				
1,1'-Sulfonylbis[4-chloro--2	J 5.0	c	c	T
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Pentachlorophenol	U 25	c	1	2
Metals (mg/L) -- Unfiltered				
Iron	4.1	c	0.3	3
Lead	< 0.020	c	0.015	2
Manganese	5.7	c	0.05	3
Others -- Unfiltered				
Alkalinity (mg/L)	350	c	1.0	D
Total organic carbon (mg/L)	3.4	c	0.50	D
Total suspended solids (mg/L)	8.0	c	5.0	D
Radionuclides (Bq/L) -- Filtered ^d				
Gross beta	3.1*	0.50	1.85	2
Total rad Sr	1.6*	0.20	0.296	2
Radionuclides (Bq/L) -- Unfiltered ^d				
Gross beta	3.0*	0.50	1.85	2
Total rad Sr	1.4*	0.20	0.296	2
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 946, Sampling Date 24JUN93				
Ground Elevation 777.74 ft, Water Elevation 771.03				
Anions (mg/L) -- Unfiltered				
Chloride	6.9	c	2.0	D
Sulfate, as SO ₄	23	c	10	D
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Pentachlorophenol	U 25	c	1	2
Metals (mg/L) -- Unfiltered				
Aluminum	0.83	c	0.2	3
Iron	1.6	c	0.3	3

Table 3.4. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Metals (mg/L) -- Unfiltered				
Lead	< 0.020	c	0.015	2
Manganese	1.2	c	0.05	3
Others -- Unfiltered				
Alkalinity (mg/L)	200	c	1.0	D
Total organic carbon (mg/L)	1.1	c	0.50	D
Total suspended solids (mg/L)	8.0	c	5.0	D
Radionuclides (Bq/L) -- Filtered ^d				
Total rad Sr	0.50*	0.17	0.296	2
Radionuclides (Bq/L) -- Unfiltered ^d				
Total rad Sr	0.49*	0.17	0.296	2
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 947, Sampling Date 25JUN93				
Ground Elevation 778.82 ft, Water Elevation 769.71				
Anions (mg/L) -- Unfiltered				
Chloride	31	c	2.0	D
Fluoride	0.30	c	0.10	D
Sulfate, as SO ₄	13	c	10	D
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Pentachlorophenol	U 25	c	1	2
Metals (mg/L) -- Unfiltered				
Lead	< 0.020	c	0.015	2
Others -- Unfiltered				
Alkalinity (mg/L)	270	c	1.0	D
Total organic carbon (mg/L)	1.1	c	0.50	D
Total organic halides (µg/L)	33	c	5.0	D

Table 3.4. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Volatile Organics ($\mu\text{g/L}$) -- Unfiltered				
Vinyl chloride	U 10	c	2	1

^aPrefix "<" indicates the value for an analyte (excluding organics) was not quantifiable at the analytical detection limit; "B" indicates the compound was found in the laboratory blank; "J" indicates the value was estimated by the laboratory; "JB" indicates the value was estimated by the laboratory and the compound was found in the laboratory blank; and "U" indicates the value for an organic analyte was undetected at the analytical detection limit.

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

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

^cNot applicable.

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

Well 830 shows gross beta activity attributable to total radioactive strontium. Well 806 continues to show gross beta activity, primarily attributable to total radioactive strontium and its daughters.

3.2 WAG 5

3.2.1 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. 3.3). 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.

In addition to the parameters listed in Table 3.2, total kjeldahl nitrogen, total cyanide, and total sulfide were also measured at WAG 5 in second quarter.

3.2.2 Procedure and Results

Perimeter wells at WAG 5 were sampled April 5-30, 1993. Sampling was conducted in conjunction with Bechtel National, Inc. (BNI) staff in support of the WAG 5 Environmental Restoration effort. Organic, metal, total kjeldahl nitrogen, total sulfide, and cyanide analyses were performed by the analytical laboratories contracted by BNI. All other analyses were performed by ORNL

Fig. 3.3. Location map of groundwater quality wells at WAG 5.

Analytical Services Organization (ASO) laboratories. Result data were shared between ESP and BNI. See Section 3.4 for a discussion of a comparison study utilizing results from this sampling event.

A summary of all of the analytical results by well type (i.e., up-gradient and down-gradient) is presented in Table 3.5; Table 3.6 presents the data which exceed some reference criteria.

Historically, wet chemistry data (total kjeldahl nitrogen, sulfide, and cyanide) have been reported by ORNL laboratories as either detected with no qualifier or non-detected with the associated "<" qualifier. The non-detected data supplied by BNI for the WAG 5 wet chemistry parameters were noted in these results by a "U" qualifier. Metals data reported by ORNL laboratories consist of detected parameters with no qualifier or non-detected data reported with a "<" qualifier. BNI metal analyses consist of detected parameters with the associated laboratory qualifiers (null and B) and non-detected parameters with the associated "U" qualifier. Non-detected metal compounds were reported to the instrument detection limit (IDL) for BNI data.

The results for the organic, metal, total kjeldahl nitrogen, total sulfide, and cyanide analyses were verified and validated (i.e., full Comprehensive Environmental Response, Compensation, and Liability Act validation) by BNI. All of the pesticide and PCB, metals, total kjeldahl nitrogen, sulfide, and cyanide results were verified and determined to be valid (a total of 1,870 results). Of the BNAE results, 1,416 of 1,430 results were verified and determined to be valid; 14 (1%) were determined not to be valid. Of the volatile organic results, 755 of 770 results were verified and determined to be valid; 15 (2%) were determined not to be valid.

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, 972, 981, 978, 968, 970, 971, 977, 976, 975, 969, 974, and 973 at values ranging from 900 to 10,000,000 Bq/L. Gross beta activity was detected at wells 979, 973, 969, and 975 at values ranging from 3.1 to 19 Bq/L; the associated total rad Sr values at those wells ranged from 3.7 to 19 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 45 to 3,300 $\mu\text{g/L}$; trichloroethene ranged from 6.0 to 38 $\mu\text{g/L}$; and vinyl chloride ranged from 4.7 to 2,700 $\mu\text{g/L}$; at wells 973, 969, 975, and 968. Trichloroethene at well 973 was not detected above drinking water standards, and well 978 had 25 $\mu\text{g/L}$ of benzene detected.

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

Table 3.5. ORNL WAG 5 groundwater summary statistics from April 5-30, 1993

Analyte	N det/ N total	Concentration			Standard error ^c
		Max ^a	Min ^a	Av ^b	
Down-gradient Well Type					
Anions (mg/L) -- Unfiltered					
Chloride	14/20	27	0.10	~ 6.6*	1.9
Sulfate, as SO ₄	11/20	280	< 10	~ 45*	17
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered					
Bis(2-ethylhexyl) phthalate	5/20	YB 3,100	U 10	~ 170	150
Field Measurements -- Unfiltered					
Conductivity (mS/cm)	20/20	1.3	0.46	0.86*	0.065
Dissolved oxygen (ppm)	20/20	15	8.6	11*	0.34
pH (SU)	20/20	9.0	6.2	7.2*	0.13
Redox (mV)	20/20	670	320	470*	23
Temperature (°C)	20/20	15	12	14*	0.20
Turbidity (JTU)	20/20	490	1.0	56*	25
Metals (mg/L) -- Filtered					
Aluminum	13/20	0.49	U 0.019	~ 0.064*	0.024
Antimony	1/20	U 0.019	U 0.0050	~ 0.017*	0.0011
Arsenic	1/20	U 0.0035	U 0.0015	~ 0.0025*	0.00014
Barium	20/20	0.89	B 0.019	~ 0.27*	0.060
Beryllium	4/20	U 0.0020	U 0.00030	~ 0.00056*	0.00014
Boron	20/20	1.5	B 0.031	~ 0.19*	0.075
Calcium	20/20	180	B 2.4	~ 96*	11
Copper	6/20	U 0.010	U 0.0027	~ 0.0043*	0.00059

Table 3.5. (continued)

Analyte	N det/ N total	Concentration			Standard error ^c
		Max ^a	Min ^a	Av ^b	
Metals (mg/L) -- Filtered					
Iron	19/20	1.2	B 0.0089	~ 0.30*	0.083
Lead	16/20	0.0051	U 0.0012	~ 0.0026*	0.00025
Magnesium	20/20	37	B 0.95	~ 18*	2.0
Manganese	20/20	1.3	B 0.0010	~ 0.21*	0.073
Mercury	1/20	U 0.00020	U 0.00010	~ 0.00012*	0.0000090
Nickel	5/20	B 0.028	U 0.0042	~ 0.0078*	0.0016
Potassium	20/20	8.2	B 0.91	~ 2.2*	0.37
Silicon	20/20	14	1.8	8.4*	0.66
Sodium	20/20	130	B 4.1	~ 22*	6.5
Vanadium	1/20	U 0.010	U 0.0021	~ 0.0033*	0.00065
Zinc	5/20	B 0.018	U 0.0048	~ 0.0065*	0.00081
Metals (mg/L) -- Unfiltered					
Aluminum	19/20	1.9	U 0.019	~ 0.33*	0.13
Arsenic	2/20	U 0.0075	U 0.0020	~ 0.0029*	0.00027
Barium	20/20	0.98	B 0.019	~ 0.28*	0.062
Beryllium	1/20	U 0.0020	U 0.00030	~ 0.00056*	0.00014
Boron	20/20	1.5	B 0.030	~ 0.19*	0.073
Calcium	20/20	180	B 2.8	~ 97*	11
Chromium	1/20	0.015	U 0.0033	~ 0.0049*	0.00075
Copper	8/20	U 0.010	U 0.0027	~ 0.0050*	0.00064
Iron	20/20	2.0	B 0.031	~ 0.59*	0.12
Lead	14/20	0.0049	U 0.0012	~ 0.0024*	0.00024
Magnesium	20/20	36	B 1.1	~ 18*	1.9
Manganese	20/20	1.3	B 0.0035	~ 0.24*	0.076
Mercury	5/20	0.00042	U 0.00010	~ 0.00014*	0.000017

Table 3.5. (continued)

Analyte	N det/ N total	Concentration			Standard error ^c
		Max ^a	Min ^a	Av ^b	
Metals (mg/L) -- Unfiltered					
Nickel	7/20	B 0.022	U 0.0042	~ 0.0081*	0.0014
Phosphorus	2/20	U 0.16	U 0.045	~ 0.052*	0.0057
Potassium	20/20	8.1	B 0.92	~ 2.3*	0.36
Selenium	1/20	U 0.018	U 0.0020	~ 0.0058*	0.0013
Silicon	20/20	14	1.9	8.7*	0.64
Sodium	20/20	130	B 4.2	~ 22*	6.5
Thallium	1/20	B 0.013	U 0.0012	~ 0.0034*	0.00076
Vanadium	2/20	U 0.010	U 0.0021	~ 0.0033*	0.00065
Zinc	6/20	0.050	U 0.0048	~ 0.0085*	0.0023
Others -- Filtered					
Alkalinity (mg/L)	20/20	550	150	320*	27
Total dissolved solids (mg/L)	20/20	750	220	420*	33
Others -- Unfiltered					
Alkalinity (mg/L)	20/20	560	150	320*	27
Cyanide, total (mg/L)	1/20	0.049	U 0.0020	~ 0.011*	0.0020
Nitrogen, total Kjeldahl (mg/L)	16/20	0.68	U 0.010	~ 0.26*	0.046
Phenolics, total recoverable (mg/L)	2/20	0.014	< 0.0010	~ 0.0017*	0.00065
Total organic carbon (mg/L)	19/20	4.6	< 0.50	~ 1.3*	0.22
Total organic halides (µg/L)	4/20	1,200	< 5.0	~ 77	61
Total suspended solids (mg/L)	9/20	440	2.0	~ 48*	27
Radionuclides (Bq/L) -- Filtered ^d					
Am-241	7/20	0.019*	-0.0070	0.0026*	0.0013
C-14	9/20	100*	-8.0	18*	6.3

Table 3.5. (continued)

Analyte	N det/ N total	Concentration			Standard error ^c
		Max ^a	Min ^a	Av ^b	
Radionuclides (Bq/L) -- Filtered ^d					
Cm-244	7/20	0.59*	-0.0057	0.058	0.037
Co-60	3/20	0.88*	-0.15	0.087	0.051
Cs-137	2/20	0.31*	-0.060	0.053*	0.019
Gross alpha	9/20	1.0*	-0.067	0.13*	0.059
Gross beta	14/20	19*	-0.0060	2.6*	1.3
H-3	16/20	10,000,000*	-130	730,000	510,000
Pu-238	3/20	0.020	-0.0025	0.0034*	0.0015
Pu-239	2/20	0.0047*	-0.0073	-0.0018	0.00072
Total rad Sr	8/20	19*	-0.042	1.5	0.99
U-234	19/20	0.025*	0.0013	0.016*	0.0015
U-235	8/20	0.011*	-0.0038	0.0033*	0.00065
U-238	11/20	0.010*	-0.0010	0.0045*	0.00069
Radionuclides (Bq/L) -- Unfiltered ^d					
Am-241	5/20	0.061*	-0.0081	0.0043	0.0031
C-14	8/16	92*	-10	19*	7.5
Cm-244	9/20	0.67*	-0.0083	0.061	0.040
Co-60	4/20	1.2*	-0.090	0.13*	0.065
Cs-137	1/20	0.19	-0.15	0.033*	0.019
Gross alpha	7/20	0.92*	-0.028	0.11*	0.051
Gross beta	14/20	36*	0.017	3.7*	2.0
H-3	16/20	10,000,000*	-140	720,000	510,000
Pu-238	3/20	0.021*	-0.0061	0.0021	0.0014
Total rad Sr	10/20	20*	-0.022	1.6	1.0
U-234	19/20	0.050*	0.00090	0.021*	0.0030
U-235	8/20	0.012*	-0.0011	0.0038*	0.00070
U-238	13/20	0.015*	-0.00046	0.0047*	0.00080

Table 3.5. (continued)

Analyte	N det/ N total	Concentration			Standard error ^c
		Max ^a	Min ^a	Av ^b	
Volatile Organics (µg/L) -- Unfiltered					
1,1,1-Trichloroethane	1/20	U 5.0	J 1.0	~ 4.8*	0.20
1,1-Dichloroethane	4/20	U 5.0	J 1.0	~ 4.5*	0.26
1,1-Dichloroethene	1/20	5.0	U 5.0	~ 5.0	0
1,2-Dichloroethene	5/20	Y 3,300	J 2.0	~ 180	160
Acetone	1/20	12	U 10	~ 10*	0.10
Benzene	1/20	25	U 5.0	~ 6.0*	1.0
Methylene chloride	2/20	JB 5.0	U 5.0	~ 5.0	0
Tetrachloroethene	1/20	U 5.0	J 1.7	~ 4.8*	0.17
Trichloroethene	5/20	38	J 2.0	~ 7.6*	2.0
Vinyl chloride	4/20	Y 2,700	J 4.7	~ 150	130
Xylene, total	1/20	U 5.0	J 2.0	~ 4.9*	0.15
Up-gradient Well Type					
Anions (mg/L) -- Unfiltered					
Chloride	1/2	< 2.0	0.20	~ 1.1	0.90
Phosphate	1/2	< 3.0	1.2	~ 2.1	0.90
Sulfate, as SO ₄	2/2	15	15	15	0
Field Measurements -- Unfiltered					
Conductivity (mS/cm)	2/2	0.59	0.49	0.54*	0.050
Dissolved oxygen (ppm)	2/2	9.4	8.3	8.9*	0.55
Redox (mV)	2/2	570	530	550*	24
Temperature (°C)	2/2	14	12	13*	0.75
Turbidity (JTU)	2/2	11	10	11*	0.50
pH (SU)	2/2	7.4	6.8	7.1*	0.29

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Table 3.5. (continued)

Analyte	N det/ N total	Concentration			Standard error ^c
		Max ^a	Min ^a	Av ^b	
Metals (mg/L) -- Filtered					
Aluminum	1/2	B 0.11	U 0.019	~ 0.066	0.046
Barium	2/2	B 0.14	B 0.14	~ 0.14*	0.0015
Boron	2/2	B 0.029	B 0.022	~ 0.025*	0.0033
Calcium	2/2	74	70	72*	2.2
Iron	1/2	B 0.076	U 0.0084	~ 0.042	0.034
Lead	2/2	B 0.0026	B 0.0014	~ 0.0020	0.00060
Magnesium	2/2	12	B 2.8	~ 7.3	4.4
Manganese	2/2	0.027	B 0.0030	~ 0.015	0.012
Phosphorus	1/2	0.25	U 0.045	~ 0.15	0.10
Potassium	2/2	B 1.1	B 0.52	~ 0.83	0.30
Silicon	2/2	12	7.5	9.8	2.3
Sodium	2/2	7.4	5.9	6.6*	0.74
Metals (mg/L) -- Unfiltered					
Aluminum	2/2	0.41	B 0.052	~ 0.23	0.18
Barium	2/2	B 0.15	B 0.14	~ 0.14*	0.0045
Boron	2/2	B 0.046	B 0.025	~ 0.035	0.011
Calcium	2/2	73	72	73*	0.50
Iron	2/2	0.57	B 0.018	~ 0.29	0.27
Lead	2/2	0.0044	B 0.0026	~ 0.0035	0.00090
Magnesium	2/2	12	B 3.0	~ 7.2	4.3
Manganese	2/2	0.077	B 0.0048	~ 0.041	0.036
Nickel	1/2	B 0.0045	U 0.0042	~ 0.0044*	0.00015
Phosphorus	1/2	0.27	U 0.045	~ 0.16	0.11
Potassium	2/2	B 1.2	B 0.48	~ 0.86	0.38
Silicon	2/2	13	7.7	10	2.5
Sodium	2/2	7.3	6.1	6.7*	0.57

Table 3.5. (continued)

Analyte	N det/ N total	Concentration			Standard error ^c
		Max ^a	Min ^a	Av ^b	
Others -- Filtered					
Alkalinity (mg/L)	2/2	230	210	220*	13
Total dissolved solids (mg/L)	2/2	270	240	260*	14
Others -- Unfiltered					
Alkalinity (mg/L)	2/2	230	210	220*	10
Nitrogen, total Kjeldahl (mg/L)	2/2	0.38	0.21	0.30	0.085
Total organic carbon (mg/L)	2/2	0.73	0.73	0.73	0
Total organic halides (μg/L)	1/2	< 5.3	< 5.0	~ 5.1*	0.13
Total suspended solids (mg/L)	1/2	55	< 5.0	~ 30	25
Radionuclides (Bq/L) -- Filtered ^d					
Am-241	1/2	0.0026*	0.0017	0.0022	0.00045
Co-60	1/2	0.21*	-0.090	0.060	0.15
Gross beta	1/2	0.17*	-0.0020	0.084	0.086
H-3	2/2	50*	46*	48*	2.0
Total rad Sr	1/2	0.046*	-0.012	0.017	0.029
U-234	2/2	0.026*	0.022*	0.024*	0.0020
U-238	1/2	0.0052*	0.0026	0.0039	0.0013
Radionuclides (Bq/L) -- Unfiltered ^d					
Gross alpha	1/2	0.051*	0.033	0.042	0.0090
H-3	2/2	41*	35*	38*	3.0
Total rad Sr	1/2	0.040*	0.010	0.025	0.015

Table 3.5. (continued)

Analyte	N det/ N total	Concentration			Standard error ^c
		Max ^a	Min ^a	Av ^b	
Radionuclides (Bq/L) -- Unfiltered ^d					
U-234	2/2	0.019*	0.014*	0.017*	0.0025
U-235	1/2	0.0057*	0.0021	0.0039	0.0018
U-238	1/2	0.0054*	0.0019	0.0037	0.0018

^aPrefix "<" indicates the value for an analyte (excluding organics) was not quantifiable at the analytical detection limit; "B" (non-metals) indicates the compound was found in the laboratory blank; "B" (metals) indicates that the reported value is less than the contract-required detection limit but greater than the instrument detection limit; "J" indicates the value was estimated by the laboratory; "Y" indicates the value exceeded calibration and the sample was diluted and reanalyzed; "YB" indicates the value exceeded calibration and the sample was diluted and reanalyzed and the compound was found in the laboratory blank; and "U" indicates the value for an organic analyte was undetected at the analytical detection limit.

^bThe ~ prefix indicates that estimated values were used in the calculation of the average.

^cStandard error of the mean.

^dIndividual and average radionuclide concentrations significantly greater than zero are identified by an *.

**Table 3.6. ORNL WAG 5 groundwater constituents that exceed a reference value
from sampling period April 5-30, 1993**

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Well 963, Sampling Date 08APR93 Ground Elevation 838.15 ft, Water Elevation 799.29				
Anions (mg/L) -- Unfiltered Sulfate, as SO ₄	140	c	10	D
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered Pentachlorophenol	U 50	c	1	2
Metals (mg/L) -- Filtered				
Aluminum	B 0.021	c	0.2	3
Barium	B 0.023	c	c	M
Beryllium	B 0.00032	c	c	M
Boron	0.10	c	c	M
Calcium	82	c	c	M
Copper	B 0.0049	c	c	M
Iron	0.25	c	c	M
Lead	B 0.0015	c	c	M
Magnesium	30	c	c	M
Manganese	0.28	c	0.05	3
Nickel	B 0.011	c	c	M
Potassium	B 3.7	c	c	M
Silicon	12	c	c	M
Sodium	15	c	c	M

Table 3.6. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Metals (mg/L) -- Unfiltered				
Aluminum	B 0.036	c	0.2	3
Barium	B 0.024	c	c	M
Boron	0.13	c	c	M
Calcium	82	c	c	M
Copper	B 0.0090	c	c	M
Iron	0.25	c	c	M
Lead	B 0.0024	c	c	M
Magnesium	30	c	c	M
Manganese	0.27	c	0.05	3
Nickel	B 0.016	c	c	M
Potassium	B 3.8	c	c	M
Silicon	12	c	c	M
Sodium	16	c	c	M
Zinc	B 0.0068	c	c	M
Others -- Unfiltered				
Nitrogen, total Kjeldahl (mg/L)	0.54	c	0.010	D
Total organic carbon (mg/L)	0.60	c	0.50	D
Total suspended solids (mg/L)	11	c	5.0	D
Pesticides and PCBs (µg/L) -- Unfiltered				
Toxaphene	U 5.0	c	3	2
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1

Table 3.6. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Well 964, Sampling Date 07APR93 Ground Elevation 831.51 ft, Water Elevation 811.52				
Anions (mg/L) -- Unfiltered Sulfate, as SO ₄	220	c	10	D
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Bis(2-ethylhexyl) phthalate	18	c	10	D
Pentachlorophenol	U 50	c	1	2
Metals (mg/L) -- Filtered				
Aluminum	B 0.028	c	0.2	3
Barium	B 0.019	c	c	M
Boron	B 0.046	c	c	M
Calcium	140	c	c	M
Iron	1.0	c	0.3	3
Lead	B 0.0014	c	c	M
Magnesium	31	c	c	M
Manganese	1.3	c	0.05	3
Potassium	B 1.9	c	c	M
Silicon	10	c	c	M
Sodium	14	c	c	M
Metals (mg/L) -- Unfiltered				
Aluminum	B 0.039	c	0.2	3
Arsenic	B 0.0033	c	c	M

Table 3.6. (continued)

Analyte	Concentration			Reference source ^b
	Value ^a	Uncertainty	Reference value	
Metals (mg/L) -- Unfiltered				
Barium	B 0.019	c	c	M
Boron	B 0.044	c	c	M
Calcium	140	c	c	M
Iron	0.95	c	0.3	3
Lead	B 0.0020	c	c	M
Magnesium	30	c	c	M
Manganese	1.3	c	0.05	3
Nickel	B 0.0049	c	c	M
Potassium	B 1.9	c	c	M
Silicon	11	c	c	M
Sodium	14	c	c	M
Others -- Filtered				
Total dissolved solids (mg/L)	660	c	500	1
Others -- Unfiltered				
Nitrogen, total Kjeldahl (mg/L)	0.38	c	0.010	D
Total organic carbon (mg/L)	1.1	c	0.50	D
Pesticides and PCBs (μg/L) -- Unfiltered				
Toxaphene	U 5.0	c	3	2
Volatile Organics (μg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1

Table 3.6. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Well 965, Sampling Date 06APR93				
Ground Elevation 812.20 ft, Water Elevation 801.11				
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Bis(2-ethylhexyl) phthalate	56	c	10	D
Pentachlorophenol	U 50	c	1	2
Metals (mg/L) -- Filtered				
Aluminum	U 0.019	c	0.2	3
Barium	B 0.11	c	c	M
Boron	B 0.031	c	c	M
Calcium	86	c	c	M
Iron	B 0.0089	c	c	M
Lead	B 0.0027	c	c	M
Magnesium	9.6	c	c	M
Manganese	B 0.0037	c	c	M
Potassium	B 1.2	c	c	M
Silicon	6.9	c	c	M
Sodium	B 4.1	c	c	M
Metals (mg/L) -- Unfiltered				
Aluminum	1.3	c	0.2	3
Barium	B 0.12	c	c	M
Boron	B 0.030	c	c	M
Calcium	85	c	c	M
Iron	1.4	c	0.3	3

Table 3.6. (continued)

Analyte	Concentration			Reference source ^b
	Value ^a	Uncertainty	Reference value	
Metals (mg/L) -- Unfiltered				
Lead	B 0.0028	c	c	M
Magnesium	9.7	c	c	M
Manganese	0.041	c	c	M
Potassium	B 1.6	c	c	M
Selenium	U 0.018	c	0.01	1
Silicon	8.4	c	c	M
Sodium	B 4.2	c	c	M
Others -- Unfiltered				
Nitrogen, total Kjeldahl (mg/L)	0.36	c	0.010	D
Total organic carbon (mg/L)	0.85	c	0.50	D
Pesticides and PCBs (μg/L) -- Unfiltered				
Toxaphene	U 5.0	c	3	2
Volatile Organics (μg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 966, Sampling Date 06APR93 Ground Elevation 809.70 ft, Water Elevation 809.24				
Anions (mg/L) -- Unfiltered				
Sulfate, as SO ₄	15	c	10	D

Table 3.6. (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				
Aluminum	B 0.11	c	c	M
Barium	B 0.14	c	c	M
Boron	B 0.029	c	c	M
Calcium	74	c	c	M
Iron	B 0.076	c	c	M
Lead	B 0.0014	c	c	M
Magnesium	12	c	c	M
Manganese	0.027	c	c	M
Potassium	B 1.1	c	c	1
Selenium	U 0.018	c	0.01	M
Silicon	7.5	c	c	M
Sodium	7.4	c	c	M
Metals (mg/L) -- Unfiltered				
Aluminum	0.41	c	0.2	3
Barium	B 0.14	c	c	M
Boron	B 0.025	c	c	M
Calcium	72	c	c	M
Iron	0.57	c	0.3	3
Lead	0.0044	c	c	M
Magnesium	12	c	c	M
Manganese	0.077	c	0.05	3

Table 3.6. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Metals (mg/L) -- Unfiltered				
Nickel	B 0.0045	c	c	M
Potassium	B 1.2	c	c	M
Silicon	7.7	c	c	M
Sodium	7.3	c	c	M
Others -- Unfiltered				
Nitrogen, total Kjeldahl (mg/L)	0.38	c	0.010	D
Total organic carbon (mg/L)	0.73	c	0.50	D
Total suspended solids (mg/L)	55	c	5.0	D
Pesticides and PCBs (µg/L) -- Unfiltered				
Toxaphene	U 5.0	c	3	2
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 967, Sampling Date 05APR93				
Ground Elevation 852.20 ft, Water Elevation 832.26				
Anions (mg/L) -- Unfiltered				
Sulfate, as SO ₄	15	c	10	D
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Pentachlorophenol	U 50	c	1	2

Table 3.6. (continued)

Analyte	Concentration			Reference source ^b
	Value ^a	Uncertainty	Reference value	
Metals (mg/L) -- Filtered				
Aluminum	U 0.019	c	0.2	3
Barium	B 0.14	c	c	M
Boron	B 0.022	c	c	M
Calcium	70	c	c	M
Lead	B 0.0026	c	c	M
Magnesium	B 2.8	c	c	M
Manganese	B 0.0030	c	c	M
Phosphorus	0.25	c	c	M
Potassium	B 0.52	c	c	M
Selenium	U 0.018	c	0.01	1
Silicon	12	c	c	M
Sodium	5.9	c	c	M
Metals (mg/L) -- Unfiltered				
Aluminum	B 0.052	c	c	M
Barium	B 0.15	c	c	M
Boron	B 0.046	c	c	M
Calcium	73	c	c	M
Iron	B 0.018	c	c	M
Lead	B 0.0026	c	c	M
Magnesium	B 3.0	c	c	M
Manganese	B 0.0048	c	c	M
Phosphorus	0.27	c	c	M
Potassium	B 0.48	c	c	M
Selenium	U 0.018	c	0.01	1

Table 3.6. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Metals (mg/L) -- Unfiltered				
Silicon	13	c	c	M
Sodium	6.1	c	c	M
Others -- Unfiltered				
Nitrogen, total Kjeldahl (mg/L)	0.21	c	0.010	D
Total organic carbon (mg/L)	0.73	c	0.50	D
Total organic halides (µg/L)	~ 5.3	c	5.0	D
Pesticides and PCBs (µg/L) -- Unfiltered				
Toxaphene	U 5.0	c	3	2
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 968, Sampling Date 30APR93 Ground Elevation 809.26 ft, Water Elevation 803.34				
Anions (mg/L) -- Unfiltered				
Sulfate, as SO ₄	31	c	10	D
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Pentachlorophenol	U 50	c	1	2
Metals (mg/L) -- Filtered				
Aluminum	0.49	c	0.2	3
Barium	B 0.11	c	c	M

Table 3.6. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Metals (mg/L) -- Filtered				
Boron	B 0.035	c	c	M
Calcium	82	c	c	M
Copper	B 0.0055	c	c	M
Iron	B 0.031	c	c	M
Lead	B 0.0012	c	c	M
Magnesium	16	c	c	M
Manganese	0.060	c	0.05	3
Potassium	B 1.4	c	c	M
Silicon	5.4	c	c	M
Sodium	7.6	c	c	M
Vanadium	B 0.0024	c	c	M
Zinc	B 0.014	c	c	M
Metals (mg/L) -- Unfiltered				
Aluminum	B 0.038	c	0.2	3
Barium	B 0.11	c	c	M
Boron	B 0.035	c	c	M
Calcium	85	c	c	M
Iron	B 0.031	c	c	M
Magnesium	16	c	c	M
Manganese	0.042	c	c	M
Potassium	B 1.4	c	c	M
Silicon	5.4	c	c	M
Sodium	7.9	c	c	M
Zinc	B 0.011	c	c	M

Table 3.6. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Others -- Unfiltered				
Nitrogen, total Kjeldahl (mg/L)	0.12	c	0.010	D
Pesticides and PCBs (µg/L) -- Unfiltered				
Toxaphene	U 5.0	c	3	2
Radionuclides (Bq/L) -- Filtered ^d				
H-3	12,000*	1,000	740	2
Radionuclides (Bq/L) -- Unfiltered ^d				
H-3	12,000*	1,000	740	2
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 969, Sampling Date 29APR93				
Ground Elevation 785.75 ft, Water Elevation 779.91				
Anions (mg/L) -- Unfiltered				
Chloride	2.0	c	1.0	D
Sulfate, as SO ₄	15	c	10	D
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Pentachlorophenol	U 50	c	1	2

Table 3.6. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Metals (mg/L) -- Filtered				
Aluminum	B 0.10	c	c	M
Arsenic	B 0.0024	c	c	M
Barium	B 0.20	c	c	M
Boron	1.5	c	c	M
Calcium	120	c	c	M
Magnesium	11	c	c	M
Manganese	0.19	c	0.05	3
Potassium	B 1.7	c	c	M
Silicon	8.8	c	c	M
Sodium	12	c	c	M
Zinc	B 0.0073	c	c	M
Metals (mg/L) -- Unfiltered				
Aluminum	0.30	c	0.2	3
Barium	B 0.20	c	c	M
Boron	1.5	c	c	M
Calcium	120	c	c	M
Iron	0.23	c	c	M
Magnesium	11	c	c	M
Manganese	0.21	c	0.05	3
Nickel	B 0.020	c	c	M
Potassium	B 1.8	c	c	M
Silicon	9.0	c	c	M
Sodium	12	c	c	M
Zinc	B 0.0074	c	c	M

Table 3.6. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Others -- Unfiltered				
Nitrogen, total Kjeldahl (mg/L)	0.16	c	0.010	D
Total organic carbon (mg/L)	1.5	c	0.50	D
Total suspended solids (mg/L)	440	c	5.0	D
Pesticides and PCBs (µg/L) -- Unfiltered				
Toxaphene	U 5.0	c	3	2
Radionuclides (Bq/L) -- Filtered ^d				
Gross beta	17*	1.0	1.85	2
H-3	800,000*	10,000	740	2
Total rad Sr	6.5*	0.30	0.296	2
Radionuclides (Bq/L) -- Unfiltered ^d				
Gross beta	16*	1.0	1.85	2
H-3	560,000*	10,000	740	2
Total rad Sr	5.4*	0.30	0.296	2
Volatile Organics (µg/L) -- Unfiltered				
1,2-Dichloroethene	57	c	5.0	D
Trichloroethene	38	c	5	1
Vinyl chloride	J 4.7	c	2	1
Well 970, Sampling Date 29APR93				
Ground Elevation 784.60 ft, Water Elevation 782.02				
Anions (mg/L) -- Unfiltered				
Sulfate, as SO ₄	15	c	10	D

Table 3.6. (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				
Aluminum	B 0.035	c	0.2	3
Barium	B 0.15	c	c	M
Boron	0.24	c	c	M
Calcium	46	c	c	M
Iron	0.14	c	c	M
Lead	0.0033	c	c	M
Magnesium	26	c	c	M
Manganese	B 0.012	c	c	M
Potassium	B 4.2	c	c	M
Silicon	11	c	c	M
Sodium	46	c	c	M
Zinc	B 0.0075	c	c	M
Metals (mg/L) -- Unfiltered				
Aluminum	1.9	c	0.2	3
Barium	B 0.15	c	c	M
Boron	0.24	c	c	M
Calcium	46	c	c	M
Copper	B 0.0078	c	c	M
Iron	0.22	c	c	M
Lead	B 0.0024	c	c	M
Magnesium	25	c	c	M
Manganese	0.065	c	0.05	3

Table 3.6. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Metals (mg/L) -- Unfiltered				
Mercury	B 0.00012	c	c	M
Phosphorus	B 0.056	c	c	M
Potassium	B 4.1	c	c	M
Selenium	U 0.017	c	0.01	1
Silicon	10	c	c	M
Sodium	45	c	c	M
Zinc	B 0.013	c	c	M
Others -- Unfiltered				
Nitrogen, total Kjeldahl (mg/L)	0.28	c	0.010	D
Total organic carbon (mg/L)	0.68	c	0.50	D
Total organic halides (μg/L)	110	c	5.0	D
Total suspended solids (mg/L)	350	c	5.0	D
Pesticides and PCBs (μg/L) -- Unfiltered				
Toxaphene	U 5.0	c	3	2
Radionuclides (Bq/L) -- Filtered ^d				
H-3	39,000*	1,000	740	2
Radionuclides (Bq/L) -- Unfiltered ^d				
H-3	38,000*	1,000	740	2
Volatile Organics (μg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1

Table 3.6. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Well 971, Sampling Date 27APR93 Ground Elevation 775.89 ft, Water Elevation 769.51				
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Pentachlorophenol	U 50	c	1	2
Metals (mg/L) -- Filtered				
Aluminum	B 0.024	c	0.2	3
Barium	0.71	c	c	M
Boron	0.051	c	c	M
Calcium	170	c	c	M
Iron	1.0	c	0.3	3
Lead	B 0.0022	c	c	M
Magnesium	14	c	c	M
Manganese	0.077	c	0.05	3
Mercury	B 0.00019	c	c	M
Nickel	B 0.0055	c	c	M
Potassium	B 1.4	c	c	M
Silicon	8.9	c	c	M
Sodium	6.3	c	c	M
Metals (mg/L) -- Unfiltered				
Aluminum	B 0.042	c	0.2	3
Barium	0.70	c	c	M
Boron	B 0.045	c	c	M
Calcium	170	c	c	M
Iron	1.0	c	0.3	3

Table 3.6. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Metals (mg/L) -- Unfiltered				
Lead	B 0.0012	c	c	M
Magnesium	14	c	c	M
Manganese	0.076	c	0.05	3
Mercury	0.00042	c	c	M
Nickel	B 0.0052	c	c	M
Potassium	B 1.4	c	c	M
Silicon	8.9	c	c	M
Sodium	6.2	c	c	M
Vanadium	B 0.0022	c	c	M
Others -- Filtered				
Total dissolved solids (mg/L)	540	c	500	1
Others -- Unfiltered				
Nitrogen, total Kjeldahl (mg/L)	0.30	c	0.010	D
Total organic carbon (mg/L)	2.2	c	0.50	D
Pesticides and PCBs (μg/L) -- Unfiltered				
Toxaphene	U 5.0	c	3	2
Radionuclides (Bq/L) -- Filtered ^d				
H-3	43,000*	1,000	740	2
Radionuclides (Bq/L) -- Unfiltered ^d				
H-3	43,000*	1,000	740	2

Table 3.6. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 972, Sampling Date 27APR93				
Ground Elevation 774.55 ft, Water Elevation 773.16				
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Pentachlorophenol	U 50	c	1	2
Metals (mg/L) -- Filtered				
Aluminum	B 0.047	c	0.2	3
Barium	0.34	c	c	M
Boron	0.13	c	c	M
Calcium	26	c	c	M
Iron	B 0.030	c	c	M
Magnesium	20	c	c	M
Manganese	B 0.0056	c	c	M
Potassium	B 2.5	c	c	M
Silicon	9.9	c	c	M
Sodium	15	c	c	M
Metals (mg/L) -- Unfiltered				
Aluminum	B 0.032	c	0.2	3
Barium	0.34	c	c	M
Boron	0.12	c	c	M
Calcium	27	c	c	M
Iron	B 0.074	c	c	M

Table 3.6. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Metals (mg/L) -- Unfiltered				
Magnesium	20	c	c	M
Manganese	B 0.0055	c	c	M
Potassium	B 2.4	c	c	M
Silicon	9.8	c	c	M
Sodium	15	c	c	M
Pesticides and PCBs (µg/L) -- Unfiltered				
Toxaphene	U 5.0	c	3	2
Radionuclides (Bq/L) -- Filtered ^d				
H-3	1,100*	100	740	2
Radionuclides (Bq/L) -- Unfiltered ^d				
H-3	990*	60	740	2
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 973, Sampling Date 26APR93				
Ground Elevation 774.34 ft, Water Elevation 769.32				
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Pentachlorophenol	U 50	c	1	2

Table 3.6. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Metals (mg/L) -- Filtered				
Aluminum	B 0.13	c	c	M
Barium	0.84	c	c	M
Boron	0.45	c	c	M
Calcium	140	c	c	M
Iron	1.2	c	0.3	3
Magnesium	16	c	c	M
Manganese	0.29	c	0.05	3
Nickel	B 0.028	c	c	M
Potassium	B 2.0	c	c	M
Silicon	9.3	c	c	M
Sodium	55	c	c	M
Zinc	B 0.011	c	c	M
Metals (mg/L) -- Unfiltered				
Aluminum	B 0.14	c	c	M
Barium	0.85	c	c	M
Boron	0.45	c	c	M
Calcium	140	c	c	M
Iron	1.4	c	0.3	3
Magnesium	16	c	c	M
Manganese	0.27	c	0.05	3
Nickel	B 0.022	c	c	M
Potassium	B 1.9	c	c	M
Silicon	9.4	c	c	M
Sodium	55	c	c	M

Table 3.6. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Others -- Filtered				
Total dissolved solids (mg/L)	590	c	500	1
Others -- Unfiltered				
Cyanide, total (mg/L)	0.049	c	0.0020	D
Nitrogen, total Kjeldahl (mg/L)	0.13	c	0.010	D
Phenolics, total recoverable (mg/L)	0.014	c	0.0010	D
Total organic carbon (mg/L)	4.6	c	0.50	D
Total organic halides (μg/L)	84	c	5.0	D
Total suspended solids (mg/L)	30	c	5.0	D
Pesticides and PCBs (μg/L) -- Unfiltered				
Toxaphene	U 5.0	c	3	2
Radionuclides (Bq/L) -- Filtered ^d				
Cm-244	0.48*	0.030	0.0888	4
Gross alpha	1.0*	0.30	0.555	2
Gross beta	12*	1.0	1.85	2
H-3	10,000,000*	1,000,000	740	2
Total rad Sr	3.7*	0.20	0.296	2
Radionuclides (Bq/L) -- Unfiltered ^d				
Am-241	0.061*	0.014	0.0444	4
Cm-244	0.47*	0.040	0.0888	4
Gross alpha	0.92*	0.26	0.555	2
Gross beta	14*	1.0	1.85	2
H-3	10,000,000*	1,000,000	740	2

Table 3.6. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Radionuclides (Bq/L) -- Unfiltered ^d				
Total rad Sr	4.2*	0.20	0.296	2
Volatile Organics (µg/L) -- Unfiltered				
1,2-Dichloroethene	63	c	5.0	D
Vinyl chloride	28	c	2	1
Volatile Organics-TICs (µg/L) -- Unfiltered				
Diethyl ether	J 11	c	c	T
Freon 113	J 23	c	c	T
Isopropyl ether	J 7.4	c	c	T
Well 974, Sampling Date 23APR93 Ground Elevation 770.81 ft, Water Elevation 763.42				
Anions (mg/L) -- Unfiltered				
Chloride	20	c	1.0	D
BNAE Organics-TICs (µg/L) -- Unfiltered				
Diacetone alcohol	J 39	c	c	T
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Pentachlorophenol	U 50	c	1	2
Metals (mg/L) -- Filtered				
Aluminum	B 0.17	c	c	M
Antimony	B 0.0056	c	c	M

Table 3.6. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Metals (mg/L) -- Filtered				
Barium	0.28	c	c	M
Boron	0.089	c	c	M
Calcium	100	c	c	M
Iron	0.28	c	c	M
Magnesium	12	c	c	M
Manganese	0.38	c	0.05	3
Potassium	B 1.6	c	c	M
Silicon	5.7	c	c	M
Sodium	14	c	c	M
Zinc	B 0.018	c	c	M
Metals (mg/L) -- Unfiltered				
Aluminum	0.29	c	0.2	3
Barium	0.30	c	c	M
Boron	0.11	c	c	M
Calcium	100	c	c	M
Iron	0.83	c	0.3	3
Magnesium	13	c	c	M
Manganese	0.85	c	0.05	3
Potassium	B 1.6	c	c	M
Silicon	6.1	c	c	M
Sodium	14	c	c	M
Thallium	B 0.013	c	c	M
Zinc	B 0.015	c	c	M

Table 3.6. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Others -- Unfiltered				
Total organic carbon (mg/L)	1.6	c	0.50	D
Pesticides and PCBs (µg/L) -- Unfiltered				
Toxaphene	U 5.0	c	3	2
Radionuclides (Bq/L) -- Filtered ^d				
H-3	3,000,000*	100,000	740	2
Total rad Sr	0.63*	0.12	0.296	2
Radionuclides (Bq/L) -- Unfiltered ^d				
H-3	3,000,000*	100,000	740	2
Total rad Sr	0.65*	0.12	0.296	2
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Volatile Organics-TICs (µg/L) -- Unfiltered				
1,3,6-Trioxocane	J 7.3	c	c	T
Well 975, Sampling Date 22APR93				
Ground Elevation 783.14 ft, Water Elevation 770.50				
Anions (mg/L) -- Unfiltered				
Chloride	9.0	c	1.0	D

Table 3.6. (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				
Aluminum	B 0.035	c	0.2	3
Barium	0.44	c	c	M
Boron	0.21	c	c	M
Calcium	180	c	c	M
Iron	0.46	c	0.3	3
Lead	0.0035	c	c	M
Magnesium	16	c	c	M
Manganese	0.13	c	0.05	3
Nickel	B 0.011	c	c	M
Potassium	B 1.6	c	c	M
Silicon	9.9	c	c	M
Sodium	15	c	c	M
Metals (mg/L) -- Unfiltered				
Aluminum	B 0.047	c	0.2	3
Barium	0.46	c	c	M
Boron	0.22	c	c	M
Calcium	180	c	c	M
Iron	0.51	c	0.3	3
Lead	B 0.0025	c	c	M
Magnesium	17	c	c	M
Manganese	0.13	c	0.05	3
Mercury	B 0.00011	c	c	M

Table 3.6. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Metals (mg/L) -- Unfiltered				
Nickel	B 0.012	c	c	M
Potassium	B 1.7	c	c	M
Silicon	10	c	c	M
Sodium	15	c	c	M
Others -- Filtered				
Total dissolved solids (mg/L)	600	c	500	1
Others -- Unfiltered				
Nitrogen, total Kjeldahl (mg/L)	0.14	c	0.010	D
Total organic carbon (mg/L)	2.2	c	0.50	D
Total organic halides (μg/L)	40	c	5.0	D
Pesticides and PCBs (μg/L) -- Unfiltered				
Toxaphene	U 5.0	c	3	2
Radionuclides (Bq/L) -- Filtered ^d				
Gross beta	19*	1.0	1.85	2
H-3	260,000*	10,000	740	2
Total rad Sr	19*	1.0	0.296	2
Radionuclides (Bq/L) -- Unfiltered ^d				
Gross beta	36*	1.0	1.85	2
H-3	260,000*	10,000	740	2
Total rad Sr	20*	1.0	0.296	2

Table 3.6. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Volatile Organics (µg/L) -- Unfiltered				
1,2-Dichloroethene	45	c	5.0	D
Trichloroethene	6.0	c	5	1
Vinyl chloride	36	c	2	1
Well 976, Sampling Date 22APR93				
Ground Elevation 783.96 ft, Water Elevation 768.14				
Anions (mg/L) -- Unfiltered				
Chloride	22	c	1.0	D
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Pentachlorophenol	U 50	c	1	2
Metals (mg/L) -- Filtered				
Aluminum	U 0.019	c	0.2	3
Barium	0.32	c	c	M
Boron	B 0.041	c	c	M
Calcium	55	c	c	M
Iron	0.13	c	c	M
Lead	B 0.0027	c	c	M
Magnesium	15	c	c	M
Manganese	B 0.011	c	c	M
Potassium	B 2.1	c	c	M
Silicon	11	c	c	M
Sodium	7.7	c	c	M

Table 3.6. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Metals (mg/L) -- Unfiltered				
Aluminum	U 0.019	c	0.2	3
Barium	0.33	c	c	M
Boron	B 0.044	c	c	M
Calcium	56	c	c	M
Copper	B 0.0040	c	c	M
Iron	0.17	c	c	M
Lead	B 0.0026	c	c	M
Magnesium	15	c	c	M
Manganese	B 0.011	c	c	M
Mercury	B 0.00014	c	c	M
Potassium	B 2.2	c	c	M
Silicon	11	c	c	M
Sodium	7.8	c	c	M
Zinc	0.050	c	c	
Pesticides and PCBs (µg/L) -- Unfiltered				
Toxaphene	U 5.0	c	3	2
Radionuclides (Bq/L) -- Filtered ^d				
H-3	220,000*	10,000	740	2
Radionuclides (Bq/L) -- Unfiltered ^d				
H-3	230,000*	10,000	740	2
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1

Table 3.6. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Well 977, Sampling Date 20APR93 Ground Elevation 764.73 ft, Water Elevation 758.96				
Anions (mg/L) -- Unfiltered				
Chloride	8.0	c	1.0	D
Sulfate, as SO ₄	27	c	10	D
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Bis(2-ethylhexyl) phthalate	YB 3,100	c	10	D
Pentachlorophenol	U 50	c	1	2
Field Measurements -- Unfiltered				
pH (SU)	6.2	c	(6.5, 8.5)	3
Metals (mg/L) -- Filtered				
Aluminum	U 0.019	c	0.2	3
Barium	B 0.055	c	c	M
Boron	0.099	c	c	M
Calcium	47	c	c	M
Iron	B 0.019	c	c	M
Lead	B 0.0022	c	c	M
Magnesium	11	c	c	M
Manganese	0.11	c	0.05	3
Potassium	B 0.91	c	c	M
Silicon	1.8	c	c	M
Sodium	12	c	c	M

Table 3.6. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Metals (mg/L) -- Unfiltered				
Aluminum	B 0.12	c	c	M
Barium	B 0.056	c	c	M
Boron	0.099	c	c	M
Calcium	46	c	c	M
Copper	B 0.0043	c	c	M
Iron	0.21	c	c	M
Lead	B 0.0024	c	c	M
Magnesium	11	c	c	M
Manganese	0.12	c	0.05	3
Potassium	B 0.92	c	c	M
Silicon	1.9	c	c	M
Sodium	11	c	c	M
Others -- Unfiltered				
Nitrogen, total Kjeldahl (mg/L)	0.11	c	0.010	D
Total organic carbon (mg/L)	1.1	c	0.50	D
Total suspended solids (mg/L)	7.0	c	5.0	D
Pesticides and PCBs (µg/L) -- Unfiltered				
Toxaphene	U 5.0	c	3	2
Radionuclides (Bq/L) -- Filtered ^d				
H-3	170,000*	10,000	740	2
Total rad Sr	0.36*	0.090	0.296	2

Table 3.6. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Radionuclides (Bq/L) -- Unfiltered ^d				
H-3	170,000*	10,000	740	2
Total rad Sr	0.41*	0.10	0.296	2
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 978, Sampling Date 20APR93 Ground Elevation 764.84 ft, Water Elevation 764.13				
Anions (mg/L) -- Unfiltered				
Chloride	27	c	1.0	D
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Pentachlorophenol	U 50	c	1	2
Metals (mg/L) -- Filtered				
Aluminum	B 0.021	c	0.2	3
Barium	0.89	c	c	M
Beryllium	B 0.00031	c	c	M
Boron	B 0.033	c	c	M
Calcium	170	c	c	M
Copper	B 0.0030	c	c	M
Iron	0.54	c	0.3	3
Lead	B 0.0028	c	c	M
Magnesium	25	c	c	M
Manganese	0.84	c	0.05	3

Table 3.6. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Metals (mg/L) -- Filtered				
Potassium	B 1.6	c	c	M
Silicon	9.4	c	c	M
Sodium	8.3	c	c	M
Metals (mg/L) -- Unfiltered				
Aluminum	B 0.076	c	c	M
Barium	0.98	c	c	M
Boron	0.086	c	c	M
Calcium	170	c	c	M
Copper	B 0.0037	c	c	M
Iron	0.85	c	0.3	3
Lead	B 0.0024	c	c	M
Magnesium	26	c	c	M
Manganese	0.80	c	0.05	3
Potassium	B 1.7	c	c	M
Silicon	10	c	c	M
Sodium	8.7	c	c	M
Others -- Filtered				
Total dissolved solids (mg/L)	590	c	500	1
Others -- Unfiltered				
Nitrogen, total Kjeldahl (mg/L)	0.11	c	0.010	D
Total organic carbon (mg/L)	2.4	c	0.50	D
Total organic halides (µg/L)	1,200	c	5.0	D

Table 3.6. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Pesticides and PCBs (µg/L) -- Unfiltered				
Toxaphene	U 5.0	c	3	2
Radionuclides (Bq/L) -- Filtered ^d				
H-3	2,100*	100	740	2
Radionuclides (Bq/L) -- Unfiltered ^d				
H-3	2,100*	100	740	2
Volatile Organics (µg/L) -- Unfiltered				
1,2-Dichloroethene	Y 3,300	c	70	2
Benzene	25	c	5	1
Trichloroethene	27	c	5	1
Vinyl chloride	Y 2,700	c	2	1
Well 979, Sampling Date 19APR93				
Ground Elevation 764.88 ft, Water Elevation 760.66				
Anions (mg/L) -- Unfiltered				
Chloride	22	c	1.0	D
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Pentachlorophenol	U 50	c	1	2
Metals (mg/L) -- Filtered				
Aluminum	U 0.019	c	0.2	3
Barium	0.39	c	c	M

Table 3.6. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Metals (mg/L) -- Filtered				
Boron	0.054	c	c	M
Calcium	100	c	c	M
Copper	B 0.0030	c	c	M
Iron	0.26	c	c	M
Lead	B 0.0026	c	c	M
Magnesium	25	c	c	M
Manganese	0.020	c	c	M
Potassium	B 3.4	c	c	M
Selenium	U 0.015	c	0.01	1
Silicon	14	c	c	M
Sodium	10	c	c	M
Metals (mg/L) -- Unfiltered				
Aluminum	B 0.038	c	0.2	3
Barium	0.41	c	c	M
Boron	0.069	c	c	M
Calcium	110	c	c	M
Copper	B 0.0044	c	c	M
Iron	0.29	c	c	M
Lead	B 0.0024	c	c	M
Magnesium	25	c	c	M
Manganese	0.019	c	c	M
Mercury	B 0.00011	c	c	M
Potassium	B 3.5	c	c	M
Silicon	14	c	c	M
Sodium	11	c	c	M

Table 3.6. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Others -- Unfiltered				
Nitrogen, total Kjeldahl (mg/L)	0.30	c	0.010	D
Phenolics, total recoverable (mg/L)	0.0010	c	0.0010	D
Total organic carbon (mg/L)	1.0	c	0.50	D
Total organic halides (µg/L)	~ 6.5	c	5.0	D
Pesticides and PCBs (µg/L) -- Unfiltered				
Toxaphene	U 5.0	c	3	2
Radionuclides (Bq/L) -- Filtered ^d				
H-3	900*	60	740	2
Radionuclides (Bq/L) -- Unfiltered ^d				
Gross beta	3.1*	0.30	1.85	2
H-3	900*	60	740	2
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 980, Sampling Date 16APR93				
Ground Elevation 762.19 ft, Water Elevation 760.11				
Anions (mg/L) -- Unfiltered				
Chloride	3.5	c	1.0	D
Sulfate, as SO ₄	22	c	10	D

Table 3.6. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Base/Neutral/Acid Extractable Organics ($\mu\text{g/L}$) -- Unfiltered				
Pentachlorophenol	U 50	c	1	2
Field Measurements -- Unfiltered				
pH (SU)	9.0	c	(6.5, 8.5)	3
Metals (mg/L) -- Filtered				
Aluminum	U 0.019	c	0.2	3
Barium	B 0.094	c	c	M
Boron	0.39	c	c	M
Calcium	B 2.4	c	c	M
Iron	B 0.022	c	c	M
Lead	0.0045	c	c	M
Magnesium	B 0.95	c	c	M
Manganese	B 0.0010	c	c	M
Potassium	B 1.5	c	c	M
Silicon	4.5	c	c	M
Sodium	130	c	c	M
Metals (mg/L) -- Unfiltered				
Aluminum	B 0.19	c	c	M
Arsenic	B 0.0025	c	c	M
Barium	B 0.10	c	c	M
Boron	0.39	c	c	M
Calcium	B 2.8	c	c	M
Copper	B 0.0071	c	c	M
Iron	0.16	c	c	M

Table 3.6. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Metals (mg/L) -- Unfiltered				
Lead	0.0049	c	c	M
Magnesium	B 1.1	c	c	M
Manganese	B 0.0043	c	c	M
Potassium	B 1.6	c	c	M
Selenium	0.0051	c	c	M
Silicon	4.6	c	c	M
Sodium	130	c	c	M
Others -- Unfiltered				
Total organic carbon (mg/L)	0.60	c	0.50	D
Pesticides and PCBs (µg/L) -- Unfiltered				
Toxaphene	U 5.0	c	3	2
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 981, Sampling Date 14APR93				
Ground Elevation 761.53 ft, Water Elevation 758.88				
Anions (mg/L) -- Unfiltered				
Chloride	3.5	c	1.0	D
Sulfate, as SO ₄	21	c	10	D
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Pentachlorophenol	U 50	c	1	2

Table 3.6. (continued)

Analyte	Concentration			Reference source ^b
	Value ^a	Uncertainty	Reference value	
Metals (mg/L) -- Filtered				
Aluminum	U 0.019	c	0.2	3
Barium	B 0.12	c	c	M
Boron	0.086	c	c	M
Calcium	72	c	c	M
Iron	0.37	c	0.3	3
Lead	0.0051	c	c	M
Magnesium	11	c	c	M
Manganese	0.30	c	0.05	3
Potassium	B 1.5	c	c	M
Silicon	7.9	c	c	M
Sodium	18	c	c	M
Metals (mg/L) -- Unfiltered				
Aluminum	0.27	c	0.2	3
Barium	B 0.12	c	c	M
Boron	0.084	c	c	M
Calcium	70	c	c	M
Iron	0.80	c	0.3	3
Lead	0.0044	c	c	M
Magnesium	11	c	c	M
Manganese	0.34	c	0.05	3
Potassium	B 1.5	c	c	M
Silicon	8.0	c	c	M
Sodium	17	c	c	M

Table 3.6. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Others -- Unfiltered				
Nitrogen, total Kjeldahl (mg/L)	0.68	c	0.010	D
Total organic carbon (mg/L)	0.73	c	0.50	D
Total suspended solids (mg/L)	20	c	5.0	D
Pesticides and PCBs (µg/L) -- Unfiltered				
Toxaphene	U 5.0	c	3	2
Radionuclides (Bq/L) -- Filtered ^d				
H-3	1,500*	100	740	2
Radionuclides (Bq/L) -- Unfiltered ^d				
H-3	1,600*	100	740	2
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 982, Sampling Date 14APR93				
Ground Elevation 774.81 ft, Water Elevation 769.80				
Anions (mg/L) -- Unfiltered				
Sulfate, as SO ₄	16	c	10	D
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Pentachlorophenol	U 50	c	1	2

Table 3.6. (continued)

Analyte	Concentration			Reference source ^b
	Value ^a	Uncertainty	Reference value	
Metals (mg/L) -- Filtered				
Aluminum	U 0.019	c	0.2	3
Barium	B 0.16	c	c	M
Boron	B 0.032	c	c	M
Calcium	96	c	c	M
Iron	B 0.013	c	c	M
Lead	0.0045	c	c	M
Magnesium	13	c	c	M
Manganese	B 0.0091	c	c	M
Potassium	B 1.1	c	c	M
Silicon	6.1	c	c	M
Sodium	8.5	c	c	M
Metals (mg/L) -- Unfiltered				
Aluminum	1.8	c	0.2	3
Barium	B 0.18	c	c	M
Boron	B 0.048	c	c	M
Calcium	98	c	c	M
Chromium	0.015	c	c	M
Iron	2.0	c	0.3	3
Lead	0.0045	c	c	M
Magnesium	14	c	c	M
Manganese	0.034	c	c	M
Nickel	B 0.011	c	c	M
Phosphorus	B 0.046	c	c	M
Potassium	B 1.7	c	c	M
Silicon	8.5	c	c	M

Table 3.6. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Metals (mg/L) -- Unfiltered				
Sodium	8.8	c	c	M
Vanadium	B 0.0025	c	c	M
Others -- Unfiltered				
Nitrogen, total Kjeldahl (mg/L)	0.11	c	0.010	D
Total organic carbon (mg/L)	0.80	c	0.50	D
Total suspended solids (mg/L)	36	c	5.0	D
Pesticides and PCBs (μg/L) -- Unfiltered				
Toxaphene	U 5.0	c	3	2
Radionuclides (Bq/L) -- Filtered ^d				
Cm-244	0.59*	0.040	0.0888	4
Gross alpha	0.74*	0.21	0.555	2
Radionuclides (Bq/L) -- Unfiltered ^d				
Cm-244	0.67*	0.040	0.0888	4
Gross alpha	0.57*	0.18	0.555	2
Volatile Organics (μg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1

Table 3.6. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Well 983, Sampling Date 12APR93 Ground Elevation 788.44 ft, Water Elevation 783.88				
Anions (mg/L) -- Unfiltered				
Chloride	3.0	c	1.0	D
Sulfate, as SO ₄	29	c	10	D
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Pentachlorophenol	U 50	c	1	2
Metals (mg/L) -- Filtered				
Aluminum	B 0.020	c	0.2	3
Barium	B 0.097	c	c	M
Beryllium	B 0.00032	c	c	M
Boron	B 0.048	c	c	M
Calcium	80	c	c	M
Copper	B 0.0055	c	c	M
Iron	B 0.012	c	c	M
Lead	B 0.0027	c	c	M
Magnesium	12	c	c	M
Manganese	B 0.0024	c	c	M
Potassium	B 1.2	c	c	M
Silicon	5.0	c	c	M
Sodium	6.2	c	c	M

Table 3.6. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Metals (mg/L) -- Unfiltered				
Aluminum	B 0.080	c	c	M
Barium	B 0.096	c	c	M
Boron	B 0.032	c	c	M
Calcium	79	c	c	M
Copper	B 0.0045	c	c	M
Iron	B 0.092	c	c	M
Magnesium	12	c	c	M
Manganese	B 0.0035	c	c	M
Potassium	B 1.2	c	c	M
Selenium	U 0.017	c	0.01	1
Silicon	5.1	c	c	M
Sodium	6.0	c	c	M
Others -- Unfiltered				
Nitrogen, total Kjeldahl (mg/L)	0.52	c	0.010	D
Total organic carbon (mg/L)	0.73	c	0.50	D
Pesticides and PCBs (μg/L) -- Unfiltered				
Toxaphene	U 5.0	c	3	2
Volatile Organics (μg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1

Table 3.6. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Well 984, Sampling Date 13APR93 Ground Elevation 788.77 ft, Water Elevation 784.31				
Anions (mg/L) -- Unfiltered				
Sulfate, as SO ₄	280	c	250	3
Base/Neutral/Acid Extractable Organics (µg/L) -- Unfiltered				
Pentachlorophenol	U 50	c	1	2
Metals (mg/L) -- Filtered				
Aluminum	B 0.030	c	0.2	3
Barium	B 0.020	c	c	M
Beryllium	B 0.00032	c	c	M
Boron	0.19	c	c	M
Calcium	140	c	c	M
Copper	B 0.0050	c	c	M
Iron	0.27	c	c	M
Lead	B 0.0028	c	c	M
Magnesium	37	c	c	M
Manganese	0.26	c	0.05	3
Nickel	B 0.0049	c	c	M
Potassium	8.2	c	c	M
Selenium	U 0.017	c	0.01	1
Silicon	11	c	c	M
Sodium	32	c	c	M

Table 3.6. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Metals (mg/L) -- Unfiltered				
Aluminum	B 0.029	c	0.2	3
Barium	B 0.020	c	c	M
Beryllium	B 0.00032	c	c	M
Boron	0.11	c	c	M
Calcium	140	c	c	M
Iron	0.29	c	c	M
Lead	B 0.0024	c	c	M
Magnesium	36	c	c	M
Manganese	0.27	c	0.05	3
Potassium	8.1	c	c	M
Selenium	U 0.017	c	0.01	1
Silicon	11	c	c	M
Sodium	32	c	c	M
Others -- Filtered				
Total dissolved solids (mg/L)	750	c	500	1
Others -- Unfiltered				
Nitrogen, total Kjeldahl (mg/L)	0.68	c	0.010	D
Total organic carbon (mg/L)	0.88	c	0.50	D
Pesticides and PCBs (µg/L) -- Unfiltered				
Toxaphene	U 5.0	c	3	2

Table 3.6. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Volatile Organics (µg/L) -- Unfiltered Vinyl chloride	U 10	c	2	1

^aPrefix "<" indicates the value for an analyte (excluding organics) was not quantifiable at the analytical detection limit; "B" (non-metals) indicates the compound was found in the laboratory blank; "B" (metals) indicates that the reported value is less than the contract-required detection limit but greater than the instrument detection limit; "Y" indicates the value exceeded calibration and the sample was diluted and reanalyzed; "YB" indicates the value exceeded calibration and the sample was diluted and reanalyzed and the compound was found in the laboratory blank; and "U" indicates the value for an organic analyte was undetected at the analytical detection limit.

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

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

^cNot applicable.

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

3.3 WAG 6

3.3.1 Program Description

Solid Waste Storage Area (SWSA) 6 is the only currently operating disposal area for low-level radioactive waste at ORNL. It 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 low-level radioactive wastes. In the course of its operation, SWSA 6 has received a broad spectrum of LLW materials. The Emergency Waste 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 and consequently has a unique set of parameters for which monitoring is conducted. Fig. 3.4 shows the groundwater monitoring well network. 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 compounds, alkalinity, gross alpha, total rad Sr, Co-60, Cs-137, tritium, alkalinity, and field parameters as part of this program. The remaining 16 wells are monitored semi-annually. During second quarter 1993 the eight "quarterly" SWSA 6 perimeter wells were monitored.

3.3.2 Procedure and Results

The eight "quarterly" RCRA perimeter assessment wells at SWSA 6 were sampled May 6-14, 1993. A summary of the analytical results for the assessment wells is presented in Table 3.7; Table 3.8 presents the data which 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 perimeter 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 841, 847, 844, 1242, 1243, and 843 with levels ranging from 3,400 to 61,000 Bq/L.

ORNL DWG 93-10223

Fig. 3.4. Location map of groundwater quality wells at WAG 6.

Table 3.7. ORNL WAG 6 groundwater summary statistics from May 6-14, 1993

Analyte	N det/ N total	Concentration			Standard error ^c
		Max ^a	Min ^a	Av ^b	
Down-gradient Well Type					
Field Measurements -- Unfiltered					
Conductivity (mS/cm)	8/8	1.0	0.41	0.75	0.072
Dissolved oxygen (ppm)	8/8	12	9.3	10	0.28
pH (SU)	8/8	7.3	6.7	7.0	0.065
Redox (mV)	8/8	690	340	490	46
Temperature (°C)	8/8	15	13	14	0.26
Turbidity (NTU)	8/8	130	10	74	16
Others -- Unfiltered					
Alkalinity (mg/L)	7/8	500	< 1.0	~ 300	55
Radionuclides (Bq/L) -- Filtered ^d					
Co-60	3/8	15*	-0.060	2.0	1.9
Cs-137	2/8	0.20*	0.010	0.11*	0.022
Gross alpha	4/8	0.37*	0.038	0.15*	0.049
H-3	8/8	61,000*	220*	15,000*	8,200
Total rad Sr	5/8	0.18*	0.040	0.12*	0.016
Volatile Organics (µg/L) -- Unfiltered					
1,1,1-Trichloroethane	1/8	U 5.0	J 2.0	~ 4.6	0.38
1,2-Dichloroethane	1/8	6.0	U 5.0	~ 5.1	0.13
1,2-Dichloroethene	2/8	7.0	J 3.0	~ 5.0	0.38
Acetone	1/8	35	U 10	~ 13	3.1
Carbon disulfide	2/8	14	J 3.0	~ 5.9	1.2
Carbon tetrachloride	1/8	30	U 5.0	~ 8.1	3.1
Chloroform	3/8	32	J 1.0	~ 7.5	3.5
Trichloroethene	2/8	150	J 3.0	~ 23	18

^aPrefix "<" indicates the value for an analyte (excluding organics) was not quantifiable at the analytical detection limit; "J" indicates the value was estimated by the laboratory; and "U" indicates the value for an organic analyte was undetected at the analytical detection limit.

^bThe ~ prefix indicates that estimated values were used in the calculation of the average.

^cStandard error of the mean.

^dIndividual and average radionuclide concentrations significantly greater than zero are identified by an *.

Table 3.8. ORNL WAG 6 groundwater constituents that exceed a reference value from sampling period May 6-14, 1993

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Well 840, Sampling Date 06MAY93				
Ground Elevation 766.94 ft, Water Elevation 748.21				
Others -- Unfiltered				
Alkalinity (mg/L)	180	c	1.0	D
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 841, Sampling Date 10MAY93				
Ground Elevation 766.04 ft, Water Elevation 755.45				
Others -- Unfiltered				
Alkalinity (mg/L)	280	c	1.0	D
Radionuclides (Bq/L) -- Filtered ^d				
H-3	3,400*	100	2,960	4
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 842, Sampling Date 07MAY93				
Ground Elevation 767.25 ft, Water Elevation 759.05				
Others -- Unfiltered				
Alkalinity (mg/L)	330	c	1.0	D
Volatile Organics (µg/L) -- Unfiltered				
1,2-Dichloroethane	6.0	c	5	1
Carbon tetrachloride	30	c	5	1
Chloroform	32	c	5.0	D
Trichloroethene	150	c	5	1
Vinyl chloride	U 10	c	2	1
Volatile Organics-TICs (µg/L) -- Unfiltered				
1,2,2-Trifluoro-ethane,1,1,2	J 10	c	c	T

Table 3.8. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Well 843, Sampling Date 10MAY93				
Ground Elevation 781.43 ft, Water Elevation 778.61				
Others -- Unfiltered				
Alkalinity (mg/L)	500	c	1.0	D
Radionuclides (Bq/L) -- Filtered ^d				
H-3	61,000*	1,000	2,960	4
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 844, Sampling Date 12MAY93				
Ground Elevation 780.95 ft, Water Elevation 770.68				
Others -- Unfiltered				
Alkalinity (mg/L)	380	c	1.0	D
Radionuclides (Bq/L) -- Filtered ^d				
H-3	4,400*	100	2,960	4
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 847, Sampling Date 06MAY93				
Ground Elevation 839.62 ft, Water Elevation 804.68				
Others -- Unfiltered				
Alkalinity (mg/L)	450	c	1.0	D
Radionuclides (Bq/L) -- Filtered ^d				
H-3	3,600*	100	2,960	4
Volatile Organics (µg/L) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 1242, Sampling Date 13MAY93				
Ground Elevation 775.11 ft, Water Elevation 759.10				
Radionuclides (Bq/L) -- Filtered ^d				
H-3	6,400*	100	2,960	4

Table 3.8. (continued)

Analyte	Concentration		Reference value	Reference source ^b
	Value ^a	Uncertainty		
Volatile Organics ($\mu\text{g/L}$) -- Unfiltered				
Vinyl chloride	U 10	c	2	1
Well 1243, Sampling Date 14MAY93 Ground Elevation 778.66 ft, Water Elevation 760.74				
Others -- Unfiltered				
Alkalinity (mg/L)	300	c	1.0	D
Radionuclides (Bq/L) -- Filtered ^d				
Co-60	15*	1.0	7.4	4
H-3	43,000*	1,000	2,960	4
Volatile Organics ($\mu\text{g/L}$) -- Unfiltered				
Vinyl chloride	U 10	c	2	1

^aPrefix "J" indicates the value was estimated by the laboratory and "U" indicates the value for an organic analyte was undetected at the analytical detection limit.

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

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

D The value exceeds the laboratory detection limit.

T A tentatively identified compound (TIC).

^cNot applicable.

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

3.4 SPECIAL STUDY
WAG 5 Spring 1993 Sampling Event
RPD Calculation Results Using ORNL and BNI Result Data

3.4.1 Background

As was discussed in Section 3.2, perimeter wells at WAG 5 were sampled April 5-30, 1993. Sampling was conducted by Environmental Surveillance and Protection (ESP) staff in conjunction with Bechtel National, Inc. (BNI) staff in support of the WAG 5 Environmental Restoration effort. Organic, metal, total kjeldahl nitrogen, total sulfide, and cyanide analyses were performed by analytical laboratories contracted by BNI. All other analyses were performed by ORNL Analytical Services Organization (ASO) laboratories. Result data were shared between ESP and BNI.

The results for the organic, metal, total kjeldahl nitrogen, total sulfide, and cyanide analyses were verified and validated (i.e., full CERCLA validation) by BNI. All of the pesticide and PCB, metals, total kjeldahl nitrogen, sulfide, and cyanide results were verified and determined to be valid (a total of 1,870 results). Of the BNAE results, 1,416 of 1,430 results were verified and determined to be valid; 14 (1%) were determined to not be valid. Of the volatile organic results, 755 of 770 results were verified and determined to be valid; 15 (2%) were determined to not be valid.

In the BNI data, results were qualified by the laboratory performing the analysis utilizing values which are analogous in meaning to the data qualifiers assigned by ORNL laboratories. As a result of the validation process, the data were further qualified. A result qualifier was assigned after validation by the person who reviewed the CLP package and a qualification code indicating the reason(s) for sample qualification was assigned. While there are many possible values for the result qualification code, the ones pertinent to this discussion are described in Table 3.9. The data were also marked for useability with three possible values: VI (verified/invalid), VV (verified/valid), and VL (verified/limited use).

3.4.2 Approach

In addition to the samples collected and analyzed as part of the sampling plan for the event, samples from four wells were submitted to ASO laboratories for metals and organics analyses. Relative percent difference (RPD) calculations were performed on the result data as a means to compare the BNI and ORNL results. The calculation is described by the following equation:

$$\text{RPD} = \frac{\text{absolute difference of (ORNL result - BNI result)}}{\frac{1}{2} (\text{ORNL result} + \text{BNI result})} \times 100$$

Table 3.9. Result qualification codes

Code	Meaning
<i>Inorganics</i>	
A	ICP Serial Dilution
B	Presumed contamination from blank analysis
E	Duplicate sample results were not within control limits
I	ICP interference check sample results were unsatisfactory
L	Laboratory Control Sample percent recoveries (%R) were not within control limits
P	Post Digestion Spike recovery was not within control limits
Q	Matrix Spike/Matrix Spike Duplicate recovery was poor or RPD was high
*	Furnace QC
<i>Organics</i>	
C	Percent relative standard deviation or percent difference was outside of QC limits
R	Relative response factor was <0.05
S	Surrogate recovery was outside of QC limits
T	Presumed contamination from trip blank
*	Unusual problems with the data that are described in the Data Summary

The RPD calculation was performed two times. The first time using ORNL result data and BNI laboratory result data; the second time using the ORNL result data and the BNI result data after the data had undergone validation. Only two of the results used in the comparison were indicated to be verified/invalid; the remainder were verified/valid. When one or both of the BNI and ORNL compounds was undetected, the RPD calculation was not performed.

3.4.3 Results and Conclusions

Table 3.10 summarizes the results of the RPD calculations. In both comparisons, approximately 10% (94/872, 89/872) of the potential pairs of results had RPD calculations performed. The remaining 90% for which the RPD analysis was not performed consisted mainly of pairs of results which were undetected by both the ORNL and BNI laboratories (569, 572). In both comparisons where the RPD calculations were performed, the majority of the differences were in the 0 to 10% and 10 to 20% ranges.

The numbers of high RPD values (>20%) were reduced when using the reviewer-qualified results. By examining the results which were determined to be undetected by the reviewer, this change can be attributed to laboratory contamination.

In the cases where both sets of samples (ORNL and BNI) were detected, the majority of the RPD calculations indicate only a small (<20%) difference in results. This can be attributed to the magnification of relative differences when considering small numbers (i.e., numbers at least less than 1, if not less than 0.1).

In general, the RPD analysis indicates that the ORNL and BNI results compare favorably and are supportive of a high level of confidence in the results from both sets of laboratories.

Each major source is equipped with a variety of surveillance instrumentation, including radiation alarms, near-real-time monitors, and continuous sample collectors. The data resulting from analysis of the continuous samples are used to quantify emission source terms with the single exception of noble gases, which cannot be quantitatively captured on a sampling medium, and are evaluated by means of an on-line detector.

In addition to major sources, ORNL has a number of minor sources that have the potential to emit radionuclides to the atmosphere. Included are any ventilation systems or components such as vents, lab hoods, room exhausts, and stacks that do not meet the criteria for a major source but are located in a vent or a radiological control area. A variety of methods are used to determine the emissions from various minor sources. All methods used for minor source emission calculations comply with the criteria agreed upon by EPA in the NESHAP Compliance Plan (QAP-X-92-ESHC/OECD-002) for the ORR. Minor sources will be evaluated on a 1-to-3 year basis depending upon the source.

The NESHAP regulation requires representative, continuous, and 40 CFR 60-APPA METHOD 1-5 emission sampling, using methods that comply with ANSI N13.1 (1969, R-1982) standards for any emission point with the potential to cause an annual public dose exceeding 0.1 mrem. A velocity profile program was initiated in 1992, whereby a velocity profile of each major stack is performed quarterly following the criteria in EPA Method 2 to ensure that the continuous samplers are sampling at acceptable isokinetic conditions and to obtain accurate stack flow data for subsequent emission rate calculations. The annual leak check program verifies the integrity of the sample transport system, including the sample media components and, the probe cleaning program ensures that all radioactive particulate matter removed as isokinetic samples are collected and analyzed.

4.1.2 Sampling Summary and Results

The charcoal cartridges, particulate filters, and silica gel traps are collected weekly. A summary of the analyses of these media for second quarter are shown in Table 4.1.

Charcoal canisters are used to capture radioactive iodines and other adsorbable gases in airborne emissions. Gamma spectrometric analysis of these samples quantifies the adsorbable gases.

Particulate filters are held for eight days prior to a gross alpha and gross beta analysis to minimize the contribution from short-lived isotopes such as Rn-220 and its daughter products. A weekly gamma scan of the 7911 filter is performed to better quantify short-lived gamma isotopes from the emissions. The weekly filters are composited quarterly and analyzed for alpha-, beta-, and gamma-emitting isotopes. The sample probes are also extracted from the stack at the end of each year for cleaning and sampling. The probe is carefully rinsed and the rinsate is collected and submitted to the laboratory for isotopic analysis identical to that of the particulate filters. The data from the charcoal cartridges, silica gel, probe wash, and the quarterly filter composites are compiled to give the annual emissions for each stack.

4.0 AIRBORNE EMISSIONS AND VELOCITY PROFILES

Airborne discharges from the Department of Energy's (DOE) Oak Ridge National Laboratory, both radioactive and nonradioactive, are subject to regulations promulgated by the U. S. Environmental Protection Agency (EPA), the Tennessee Department of Environment and Conservation (TDEC) Air Pollution Control Board, as well as DOE orders. Radioactive emissions are regulated by EPA Region-IV under the Clean Air Act's (CAA) National Emission Standards for Hazardous Air Pollutants (NESHAP) 40 CFR 61, subpart H. The nonradioactive emissions are regulated under the rules of the TDEC Division of Air Pollution Control.

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 NESHAP regulations limit the amount of annual radioactive exposure or dose to the most affected member of the public. In December 1989, the NESHAP regulations were reissued. Negotiations between EPA and DOE were initiated to bring the Oak Ridge Reservation (ORR) into full compliance with the new regulations. As a result of those negotiations, a Federal Facilities Compliance Agreement (FFCA) was signed in December 1991 by the DOE field office manager and was implemented at ORNL. The ORNL fulfilled all of its FFCA commitments and achieved compliance status by December 1992. On March 26, 1992, EPA Region-IV certified that the DOE Oak Ridge Office (DOE-ORO) had completed all actions required by the FFCA and is considered in compliance with the Radionuclide NESHAP regulations, 40 CFR 61, Subpart H.

DOE regulations governing airborne emissions are established in DOE orders 5400.1 and 5400.5 and DOE/EH-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. Airborne discharges at ORNL consist primarily of ventilation air from tanks, process off-gas, and ventilation for reactor facilities. 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 two locations within the surrounding East Tennessee communities to assess the impacts of ORR operations on the ambient air quality of the region (see Section 5.10).

4.1 AIRBORNE EMISSIONS

Laury V. Hamilton and Samuel E. Gheesling

4.1.1 Program Description

Airborne discharges at ORNL consist primarily of ventilation air from radioactively contaminated areas, vents from tanks, processes, and ventilation for reactor facilities. Many of the sources, mostly nonradioactive, are permitted by the TDEC Air Pollution Control Board. The allowable levels of pollutant emissions from permitted sources are based on 9748 tons/year (1992) of regulated pollutants. Most airborne emissions are treated and filtered before discharge to the atmosphere. Typically, radioactively contaminated and potentially contaminated airborne emissions are treated, then filtered with HEPA and/or charcoal filters before discharge to ensure that any radioactive emissions are as low as reasonably achievable.

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

The major radiological 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, and 3025 and 3026 areas cell ventilation system
7911	Melton Valley complex (High Flux Isotope Reactor and Radiochemical Engineering Development Center)

Figure 4.1 shows the locations of the four main stacks whose emissions are routinely quantified.

● Radionuclide emission points regulated through NESHAP

ORNL 018

Fig. 4.1. Locations of major stacks (emission points) at ORNL.

Each major source is equipped with a variety of surveillance instrumentation, including radiation alarms, near-real-time monitors, and continuous sample collectors. The data resulting from analysis of the continuous samples are used to quantify emission source terms with the single exception of noble gases, which cannot be quantitatively captured on a sampling medium, and are evaluated by means of an on-line detector.

In addition to major sources, ORNL has a number of minor sources that have the potential to emit radionuclides to the atmosphere. Included are any ventilation systems or components such as vents, lab hoods, room exhausts, and stacks that do not meet the criteria for a major source but are located in a vent or a radiological control area. A variety of methods are used to determine the emissions from various minor sources. All methods used for minor source emission calculations comply with the criteria agreed upon by EPA in the NESHAP Compliance Plan (QAP-X-92-ESHC/OECD-002) for the ORR. Minor sources will be evaluated on a 1-to-3 year basis depending upon the source.

The NESHAP regulation requires representative, continuous, and 40 CFR 60-APPA METHOD 1-5 emission sampling, using methods that comply with ANSI N13.1 (1969, R-1982) standards for any emission point with the potential to cause an annual public dose exceeding 0.1 mrem. A velocity profile program was initiated in 1992, whereby a velocity profile of each major stack is performed quarterly following the criteria in EPA Method 2 to ensure that the continuous samplers are sampling at acceptable isokinetic conditions and to obtain accurate stack flow data for subsequent emission rate calculations. The annual leak check program verifies the integrity of the sample transport system, including the sample media components and, the probe cleaning program ensures that all radioactive particulate matter removed as isokinetic samples are collected and analyzed.

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Table 4.1 ORNL major stack effluent summary for April-June 1993

Isotope	Total activity for major sources (curies)				
	2026	3020	3039	7911	7830 ^a
Am-241	6.4E-07	1.2E-08	2.0E-08	4.9E-09	7.3E-11
Ba-140	b	b	b	9.5E-05	b
Be-7	b	b	4.8E-06	b	3.1E-08
Cm-244	1.4E-05	6.2E-08	4.4E-06	3.0E-08	4.6E-10
Co-60	2.7E-08	b	3.0E-07	b	b
Cs-134	2.7E-08	b	2.6E-07	4.6E-07	b
Cs-137	2.2E-05	9.9E-08	9.9E-06	b	7.1E-09
Eu-152	b	b	b	b	b
Eu-154	1.4E-07	b	b	b	b
Eu-155	2.5E-07	b	b	b	b
H-3	9.5E-03	b	1.5E+01	1.2E+01	7.1E-02
I-130	b	b	b	b	b
I-131	b	b	1.2E-02	9.3E-03	b
I-132	b	b	b	4.2E-02	b
I-133	b	b	9.7E-06	4.4E-02	2.3E-07
I-135	b	1.1E-05	1.1E-04	1.1E-01	5.1E-06
Os-191	b	b	2.6E-06	b	b
Pb-212	3.8E-02	8.3E-03	2.2E-02	2.3E-02	1.1E-03
Pu-238	4.2E-07	3.1E-09	2.7E-09	2.4E-09	3.5E-11
Pu-239	1.3E-06	1.4E-08	5.4E-08	1.5E-08	4.2E-11
Th-228	2.7E-07	2.3E-09	1.3E-08	3.9E-09	9.5E-11
Th-230	1.6E-09	7.2E-10	1.5E-09	2.8E-09	2.7E-11
Th-232	b	1.0E-09	1.8E-09	b	1.8E-11
Total rad Sr	3.1E-06	8.2E-08	5.1E-06	1.4E-06	7.9E-10
U-234	1.6E-06	9.2E-09	2.5E-08	5.5E-09	1.7E-10
U-235	7.3E-09	b	b	b	b
U-238	7.1E-09	1.8E-09	3.0E-09	1.1E-09	3.4E-11

^a7830 is classified as a minor source but due to marginal emission levels, 7830 is sampled as a major source.

^bNot detected.

4.2 VELOCITY PROFILES

Joan C. Gideon and Laury V. Hamilton

4.2.1 Program Description

In order to obtain a representative stack sample, samples are collected isokinetically, where the gas velocity in the probe is the same as the velocity in the stack. The velocity measurements are used to determine the near isokinetic sampling rates and to calculate total emissions. Stack flow measurements are determined according to SOP-ESP-003.039 (Velocity Measurements for Stacks and Ducts) and to guidelines established by EPA found in 40 CFR 60, Appendix A.

4.2.2 Procedure and Results

Stack 2026 sampling system consists of a five nozzle sample probe, sample transport line, filter, two charcoal canisters, a catalytic converter for tritium, a silica gel cartridge, two mass flow controllers and two pumps. The particulate sample flow rate was set to 2.80 cubic feet per minute, a rate that is near isokinetic with the stack flow (Fig. 4.2). The stack flow varied by 15.8% during the last three quarters. The second quarter profile and results are shown in Fig. 4.3.

Stack 3020 sampling system consists of a six nozzle sample probe, filter, two charcoal canisters, one mass flow controller, and one pump. The isokinetic sample flow rate was set to 2.85 cubic feet per minute. The stack flow varied by 1.6% during the last three quarters. The second quarter profile and results are shown in Fig. 4.4.

Stack 3039 sampling system is the same as described for stack 2026, with the exception of an eight nozzle sample probe. The stack flow measurements were not collected due to difficulty in measuring low flows. The sample flow rate was set to 2.87 cubic feet per minute, a rate that is near isokinetic with the stack flow measured in the third and fourth quarters of 1992 (Fig. 4.2).

Stack 7911 sampling system is the same as for 2026 and 3039, with the exception of a six nozzle sample probe. In addition to the sampling system, there is a real-time monitor for noble gas emissions. The sample flow rate was set to 1.72 cubic feet per minute, a rate that is within isokinetic limits of the stack flow (Fig. 4.2). The stack flow varied by 20.6% during the last four quarters. The second quarter profile and results are shown in Fig. 4.5.

Stack 7025 sampling system consists of a two nozzle sample probe, sample transport line, a catalytic converter, a silica gel cartridge, and pump. Tritium gas is the only constituent sampled, therefore near isokinetic conditions are not necessary for this stack. The site is profiled annually to measure stack flow for emission calculations.

Stack 7830-1 sampling system consists of a one nozzle sample probe, sample transport line, filter, two charcoal canisters, a catalytic converter, a silica gel cartridge, two mass flow controllers and two pumps. This stack is

ISOKINETIC CALCULATIONS FOR SAMPLE FLOW

MAJOR SOURCES PROFILED QUARTERLY												
STACK	DATE QUARTER	VELOCITY ft/sec	STACK ACFM	STACK SCFM	STACK AVG SCFM	HIGH/LOW % VARIANC	STACK DIA (in)	# OF NOZZLES	NOZZLE DIA	NOZZLE AREA insq	NEAR ISOKINETIC SAMPLE FLOW SCFM	SAMPLE FLOW SET POINT
2026	09-92	37.9	21,384	20,826			41.5	5	0.224	0.197	3.03	2.80
	12-92	32.8	18,471	18,186			41.5	5	0.224	0.197	2.65	
	03-93	35.04	19,748	19,650			41.5	5	0.224	0.197	2.86	
	04-93	32.83	18,503	18,324	19,246	15.77%	41.5	5	0.224	0.197	2.67	
3020	10-92	18.9	36,697	35,503			77	6	0.281	0.372	2.84	2.85
	01-93	18.57	36,115	36,078			77	6	0.281	0.372	2.88	
	05-93	19.03	36,923	35,604	35,728	1.62%	77	6	0.281	0.372	2.85	
3039	08-91*	6.95	113,357	110,846			223.5	8	0.406	1.036	2.93	2.87
	12-92	6.71	109,274	106,701	108,774	3.88%	223.5	8	0.406	1.036	2.82	
7911	08-92**	9.74	57,137	55,838			135	6	0.318	0.477	1.86	1.72
	12-92	8.77	52,322	50,977			135	6	0.318	0.477	1.70	
	03-93	9.11	54,334	53,172			135	6	0.318	0.477	1.77	
	05-93	8.01	47,781	46,312	51,575	20.57%	135	6	0.318	0.477	1.54	
MINOR SOURCES PROFILED ANNUALLY												
7025	11-92	43.7	2,058	2,085			12	2	0.087	0.012	0.22	0.22
7830-1-NE	12-92	22.7	505	499			8.25	1	0.546	0.234	2.18	2.18
7830-2-NW	12-92	24	536	529			8.25	1	0.546	0.234	2.31	2.31
7830-SW	12-92	0	0	0			11	n/a	n/a	n/a	n/a	
7830-SE	12-92	20.3	803	800			11	n/a	n/a	n/a	n/a	
3544	06-93	63.6	2,406	2,298			10.75	1	0.37	0.108	2.72	2.72
7512	12-92**	27.18	691,577	705,290								
2000	11-92**	29.45	6,641	6,639			26.25	n/a	n/a			

- * profiled by IT
- ** profiled by K-25

Fig. 4.2. Quarterly profile of major sources and annual profiles of minor sources.

2026 2nd QUARTER VELOCITY PROFILE

Fig. 4.3. Stack 2026 second quarter profile and results.

3020 2nd QUARTER VELOCITY PROFILE

Fig. 4.4. Stack 3020 second quarter profile and results.

7911 2nd QUARTER VELOCITY PROFILE

Fig. 4.5. Stack 7911 second quarter profile and results.

considered a minor source and is profiled annually. Stacks 7830-SW and 7830-SE have no sampling system. Only one stack operates at a time while the other remains in standby. This is also classified as a minor source and is profiled annually.

Stack 7830-2 sampling system consists of one nozzle sample probe, sample transport line, filter, two charcoal canisters, one mass flow controller, and one pump. This stack is similar to 7830-1, but without tritium sampling features. Stack 7830-2 is considered a minor source and is profiled annually.

Stack 3544 has no continuous sampling system. This stack is classified as a minor source and is profiled annually. To verify 3544 as minor source, a three month continuous sampling program was completed during the second quarter. The particulate sample flow rate was set to 2.72 cubic feet per minute, a rate that is near isokenetic with stack flow (Fig. 4.2). The annual profile and results are shown in Fig. 4.6.

Stack 7512 has no continuous sampling system. This stack is classified as a minor source and is profiled and sampled annually.

3544 ANNUAL VELOCITY PROFILE

Fig. 4.6. Stack 3544 annual profile and results.

5.0 ENVIRONMENTAL MONITORING PLAN

In response to DOE Order 5400.1 entitled "General Environmental Protection Program," and DOE Order 5400.5 "Radiological Protection of the Public and the Environment," the Environmental Monitoring Plan (EMP) for the Oak Ridge Reservation was developed. As their titles imply, these DOE orders are intended to safeguard the environment and to protect members of the public from adverse health risk due to activities at DOE sites. One way in which the DOE intends to accomplish these goals is by requiring its facilities to perform routine effluent monitoring and environmental surveillance.

The EMP documents the rationale and design criteria for effluent monitoring and environmental surveillance programs on the Oak Ridge Reservation (ORR), and provides a central point of reference for these activities. In addition to documenting environmental monitoring programs that predated the EMP, the plan calls for additional monitoring efforts. Most of the monitoring and surveillance activities presented in previous sections of this report are also described in the EMP, but they continue to be funded under other programs. The EMP has become a program in itself, with its own funding, incorporating some of the monitoring efforts that were previously funded under other programs and additional monitoring requirements that were created by EMP directive.

The EMP covers the entire ORR and monitoring responsibilities are split among several groups. Presented in this section, are results from environmental surveillance activities that are now conducted under the EMP, and are implemented and managed by the Environmental Surveillance and Protection (ESP) Section of ORNL's Office of Environmental Compliance and Documentation for the Oak Ridge Reservation.

The following EMP programs are discussed in detail:

Surface Water

Sediment

Aquatic Biota

ORNL Perimeter Groundwater

Offsite Groundwater

Soil

Hay

Food Crops

Milk

Ambient Air

External Gamma Radiation

5.1 SURFACE WATER

Martha M. Stevens and Melinda C. Salmons

5.1.1 Program Description

To assess the impact of past and present DOE operations on the quality of local surface water, samples are collected and analyzed from 22 locations (Fig. 5.1). Water quality measurements serve as a guide to the general health of the environment. This sampling is conducted in addition to requirements mandated in National Pollutant Discharge Elimination System (NPDES) permits for the ORR DOE facilities, but there is some overlap of sampling sites. Sample locations are on streams downstream of ORR waste sources, at reference points on streams and reservoirs upstream of waste sources, on reference streams offsite, and at public water intakes. Sampling frequency is bimonthly, with half of the sites being sampled one month and the other half in the following month. Samples are grab samples and are analyzed for general water quality parameters, total recoverable metals, and VOCs. They are also screened for radioactivity and analyzed for specific radionuclides when appropriate.

5.1.2 Procedure and Results

Sampling in this program was implemented at the end of the second quarter of 1993. Results will be reported in the fourth quarter 1993 report in order to present the data summaries effectively.

5.2 SEDIMENT

Martha M. Stevens and Pamela Y. Goldberg

5.2.1 Program Description

Stream and lake sediments act as a record of some aspects of water quality by concentrating and storing certain contaminants. Annually, sediment samples are collected at 16 sites near surface water and biological monitoring stations in and around the ORR (Fig. 5.2). Sediments are analyzed for total recoverable metals, chlorinated pesticides/PCBs, semi-volatile organic compounds and selected radionuclides. Sediment is collected from the upper 2 cm of deposition and composited.

5.2.2 Procedure and Results

Sampling in this program will be implemented during the third or fourth quarter of 1993.

Fig. 5.1. EMP surface water locations.

Fig. 5.2. EMP sediment locations.

5.3 AQUATIC BIOTA

Martha M. Stevens and Melinda C. Salmons

5.3.1 Program Description

Members of the public potentially could be exposed to contaminants originating from DOE activities through the consumption of fish caught in area waters. This exposure pathway is monitored by collecting fish and analyzing edible fish flesh from 14 locations annually. Sampling locations are located downstream of DOE activities, at upstream reference locations, and at one offsite reference location. Six larger river locations are sampled by the ESP Section (Fig. 5.3) and eight smaller creek locations are sampled by the ORNL's Environmental Sciences Division (ESD). Due to the limited number of fish available for sampling on the creek locations, different fish processing and analytical procedures are used by the ESD. Only results from sampling conducted by the ESP Section are presented in this report.

Sites sampled by the ESP Section are five sites on the Clinch River (CRK 84, CRK 80, CRK 66, CRK 32, and CRK 16) and one location on Poplar Creek (PCK 2.2). In 1993, six to eight channel catfish will be collected from each of two locations on the Clinch River: one location downstream of ORNL (CRK 32), and one location downstream from all DOE inputs (CRK 16).

Additional monitoring of wildlife on the ORR, both aquatic and terrestrial, is conducted under the Biological Monitoring and Abatement Program (BMAP), a requirement of facility NPDES permits. Some the work conducted under the BMAP is also a requirement of the EMP. This monitoring program is conducted by the ORNL's Environmental Sciences Division and reported annually in a separate report.

5.3.2 Procedure and Results

The radionuclides of primary concern in ORR impacted waters regarding fish consumption are total rad Sr and Cs-137. These isotopes typically result in the highest dose to humans from ingestion of fish. Because of this and because of the large number of available fish, bluegill were collected for tissue analysis to estimate concentrations for dose assessment models.

Bluegill (*Lepomis machrochirus*, *Lepomis auritus*, and *Ambloplites rupestris*) are collected from each location, filleted, and frozen. When enough fish have been collected for a location (typically 150-200), they are thawed and six of the largest are analyzed for selected metals, pesticides, and PCB's. The rest (separated into three composite samples) are ashed and analyzed for Co-60, Cs-137, and total rad Sr. Catfish will be analyzed for the same parameters as bluegill.

Sampling in this program will not be completed until fourth quarter 1993 or first quarter 1994.

Fig. 5.3. Fish sampling locations along Clinch River.

5.4 ORNL PERIMETER GROUNDWATER

Martha M. Stevens and Regis S. Loffman

5.4.1 Program Description

Monitoring for the possible migration of contaminants from ORR facilities in groundwater is stipulated in the EMP. These facility perimeter groundwater monitoring programs are conducted independently by each facility under the guidance of the EMP. The ORNL ESP Section monitors groundwater at four general locations that are thought to be likely exit pathways for groundwater affected by activities at the ORNL (Fig. 5.4). Samples are collected annually from 20 wells and four streams at these four exit pathways and are analyzed for VOCs, gross alpha, gross beta, H-3, total rad Sr, Co-60, and Cs-137.

5.4.2 Procedure and Results

The 20 wells included in the ORNL perimeter program are part of the routine groundwater sampling program (i.e., the WAGs discussed in Section 3) and the analyses performed in the WAG programs meet the requirements of the ORNL perimeter program. As such, data resulting from the routine WAG monitoring will be used for the perimeter program. The four streams which are part of the perimeter program will be sampled for the EMP purposes.

A summary of the results for the ORNL perimeter groundwater program will be provided in the fourth quarter 1993 report.

5.5 OFFSITE GROUNDWATER

Martha M. Stevens and Regis S. Loffman

5.5.1 Program Description

Facility perimeter groundwater monitoring programs are deemed to be sufficient for monitoring for contaminant migration from the ORR in groundwater, so the monitoring of offsite groundwater is not required to comply with the DOE orders. To this date, no contaminant movement to the offsite environment has been discovered. Monitoring of offsite drinking water wells is conducted to ease public concern and to supplement perimeter monitoring. Nineteen water wells are included in the program (Fig. 5.5). Sampling is conducted semiannually subject to access availability. Samples are analyzed for VOCs, anions, metals, gamma scan, gross alpha, gross beta, total rad Sr, Tc-99, H-3, and total uranium. Results are provided in individual reports to the well owners and presented in summary form in this report.

Fig. 5.4. ORNL perimeter groundwater exit pathways and general sampling locations.

Fig. 5.5. Current offsite groundwater sampling locations.

5.5.2 Procedure and Results

Offsite drinking water wells were sampled in February 1993. One of the wells was not sampled during this sampling round because it was not functioning. A summary of the February 1993 detected results from all wells is presented in Table 5.1. See Section 1.0 for a general discussion of summary tables and the techniques used to produce them.

In the February 1993 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. One well exceeded the drinking water standard for nitrate; however, the concentration measured was within ranges measured at that well in the past. Gross alpha was measured above the drinking water standard at one well. The value was .67 Bq/L with an associated counting uncertainty of .38 Bq/L. Gross alpha has been detected at this well only once in the past and at a level lower than this event. According to the analytical laboratory, the presence of high dissolved solids in the sample resulted in low efficiency of analysis and the "high" value for gross alpha. Based on this explanation and past results for the well, it is unlikely that gross alpha activity is a cause for concern at this well.

5.6 SOIL

Laury V. Hamilton

5.6.1 Program Description

Soil is an accumulator of airborne materials and materials in irrigation water. Contaminated soil could become a pathway for radioactive material to reach an offsite member of the public, either by direct contact, or indirectly through transfer from the soil to food crops. To correlate analytical results with ambient air monitoring, soil is collected annually from nine soil/vegetation plots at ambient air monitoring stations, eight located on the ORR (Fig. 5.6), and one at Norris Dam (Fig. 5.7). The vegetation and soil sampling plots are fenced and locked to prevent disturbances from mowing and herbicide application. Approximately 30 cm of soil is collected from the top of each plot and is thoroughly mixed prior to filling the sample containers. The soil samples are screened by gamma spectrometry, and are analyzed for isotopic uranium, plutonium, total rad Sr, thorium, and beryllium.

5.6.2 Procedure and Results

Samples are collected on an annual basis usually during the third quarter.

Table 5.1. ORNL offsite residential groundwater summary
statistics of detected results from
February 1993 sampling event

Analyte	N det/ N total	Concentration			Standard error ^b
		Max ^a	Min ^a	Av	
Anions (mg/L)					
Chloride	18/18	68	1.0	6.7	3.7
Fluoride	4/18	6.7	0.20	2.0	1.6
Nitrate	10/18	14	1.5	4.6	1.1
Sulfate, as SO ₄	18/18	46	1.0	10	2.9
Field Measurements					
Conductivity	18/18	1.9	0.12	0.46	0.088
pH	18/18	8.5	6.9	7.4	0.087
Temperature	18/18	16	7.1	12	0.54
Metals (mg/L)					
Barium	18/18	0.14	0.0025	0.066	0.011
Calcium	18/18	93	1.0	46	6.6
Cobalt	1/18	0.0044	0.0044	0.0044	c
Copper	12/18	0.047	0.0087	0.017	0.0034
Iron	5/18	0.27	0.052	0.17	0.041
Lead	2/18	0.0080	0.0043	0.0062	0.0019
Magnesium	18/18	35	0.42	13	2.3
Manganese	5/18	0.021	0.0024	0.0090	0.0033
Sodium	18/18	470	0.50	41	26
Uranium, total	12/18	0.0014	0.00010	0.00036	0.00011
Vanadium	1/18	0.0020	0.0020	0.0020	c
Zinc	15/18	0.56	0.0059	0.14	0.050
Radionuclides (Bq/L)					
Co-60	1/18	0.084*	0.084*	0.084	c
Gross alpha	13/18	0.67*	0.043*	0.15	0.045
Gross beta	17/18	0.64*	0.12*	0.28	0.031
H-3	1/18	45*	45*	45	c
Tc-99	4/18	0.45*	0.15*	0.25	0.068
Total rad Sr	5/18	0.099*	0.059*	0.083	0.0066
Volatile Organic Compounds (µg/L)					
Chloroform	1/18	B 6.0	B 6.0	~ 6.0	c

^aRadionuclide values that are significantly greater than zero are identified by an *.

^bStandard error of the mean.

^cNot applicable.

Fig. 5.6. ORR perimeter air monitoring, soil, and food crop locations.

Fig. 5.7. ORR remote air monitoring locations.

5.7 HAY

Laury V. Hamilton

5.7.1 Program Description

There is a potential for hay to accumulate airborne contaminants. Hay is cut on the ORR and sold to area farmers for fodder. Six areas from which hay is cut have been identified as potential depositional areas for airborne materials from ORR sources (Fig. 5.8). Three of the areas (areas 1, 2, and 3) could potentially be affected by airborne plumes from the ORNL and K-25 sites. Hay is collected from areas 1, 2 and 3 and composited into two samples. Four areas are within boundaries of the predicted airborne plumes from ORNL, K-25 and Y-12 sources. These areas are 2, 4, 5, and 6; area 6 is thought to be the best representation of the combined plumes from all three sites. Hay from areas 2, 4, and 5 are composited into two samples for analysis; and two composite samples are collected from area 6. When possible, baled hay is sampled. Composited hay samples are analyzed for gross alpha, gross beta, gamma spectroscopy (particularly iodine-129) and fluorides.

5.7.2 Procedure and Results

Hay samples were collected during the months of May and June in the second quarter of 1993. Table 5.2 summarizes the results of the sampling effort. The potassium-40 is a naturally occurring isotope and is found throughout the area. In addition, beryllium-7 is primarily a naturally occurring isotope and is located throughout the region.

5.8 FOOD CROPS

Laury V. Hamilton

5.8.1 Program Description

Potentially, food crops grown in the vicinity of the ORR could be a source of exposure to the public due to radioactive contaminants introduced via direct deposition from air, uptake from soil, or irrigation water. To monitor this potential exposure pathway, tomatoes, turnips, and turnip greens are cultivated and sampled annually at nine soil/vegetation plots at ambient air monitoring stations, eight located on the ORR (Fig. 5.6), and one at Norris Dam (Fig. 5.7). Tomatoes represent a root-plant-vegetable system. Turnips represent a root-vegetable system, and turnip greens represent a broad leaf vegetable system that in addition to root uptake, receives deposition from air. In case of crop failure, appropriate produce will be purchased from farms as close to ambient air monitoring stations as possible. Vegetation is analyzed for gross alpha, gross beta, gamma scan, tritium, and radionuclides which contribute 0.01 mrem or more to the ORR effective dose equivalent (EDE), and isotopic uranium.

Fig. 5.8. Hay sampling locations.

Table 5.2. Concentrations of radionuclides and flouride in hay for 1993

Isotope	Be-7 (Ci/kg)	Co-60 (Ci/kg)	Gross alpha (Ci/kg)	Gross beta (Ci/kg)	K-40 (ci/kg)	F (ug/g)
Area						
1-2-3	3.1E-09	3.0E-11	2.8E-10	7.0E-09	1.3E-08	1.1
2-4-5	5.5E-09	3.6E-11	1.0E-09	6.4E-09	1.4E-08	1.6
6	1.1E-08	a	3.4E-10	1.3E-08	8.5E-09	1.1

^aNot significant.

5.8.2 Procedure and Results

During the month of April, tomato plants were purchased from an area nursery and planted at the nine food crop locations. A total of 36 tomato plants were planted in nine plots consisting of four plants each. Samples were collected from the new soil, from the purchased plants, and of any fertilizer used during the growing season. It is anticipated that the plants will be harvested and the samples analyzed during the third quarter.

5.9 MILK

Laury V. Hamilton and Samuel E. Gheesling

5.9.1 Program Description

Radionuclides can be transferred from the environment to people via food chains such as the grass-cow-milk pathway. Milk is considered to be a potentially significant pathway due to the large daily grazing area of cows, the rapid transfer of milk to consumers, and the importance of milk in the diet. Milk samples are collected monthly from four residences and one commercial dairy (Fig. 5.9), and analyzed for I-131, tritium and total rad Sr.

5.9.2 Procedure and Results

Of the three isotopes, only total rad Sr was found to be present in the milk samples with values determined to be significantly different from zero. The concentrations in milk are shown in Table 5.3. Effective Dose Equivalents were calculated for a station when the sample from that station was statistically greater than zero. Such 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 77.5 L of milk is ingested at these concentrations during the quarter. Doses resulting from ingestion of this milk for an entire year (310 L) would be less than 1% of DOE's guideline of 1000 $\mu\text{Sv/yr}$.

5.10 AMBIENT AIR

Laury V. Hamilton

5.10.1 Program Description

In addition to stack monitoring and sampling at the DOE Oak Ridge installations, an ambient air monitoring program has been developed to measure radiological parameters in the ambient air at locations adjacent to the facilities. Ambient air monitoring provides: (1) direct measurement of airborne concentrations of radionuclides in the environment surrounding the facilities; (2) allows facility personnel to determine the level of contaminants at the monitoring locations during an emergency or release; (3) affirms that the contributions of fugitive and diffuse sources have an insignificant impact on the overall off-site dose; and (4) serves as a verification on the dose-modeling calculations.

Fig. 5.9. Milk sampling locations.

Table 5.3. Concentrations of total rad Sr in Milk, April-June 1993

Station	Significant Concentration (Bq/L)								
	April	Error ^a	Dose (μ Sv) ^b	May	Error ^a	Dose (μ Sv) ^b	June	Error ^a	Dose (μ Sv) ^b
Buttermilk	0.034	0.018	0.036	0.036	0.018	0.038	0.075	0.029	0.080
Broadacres	0.034	0.014	0.036	0.094	0.038	0.010	0.031	0.035	0.033
Clinton	0.033	0.020	0.035	0.029	0.020	0.031	0.060	0.050	0.075
Frost Bottom	0.057	0.019	0.061	0.056	0.021	0.060	0.170	0.034	0.071
Solway	c	c	c	0.160	0.040	0.170	c	c	c

^aError is the measurement error.

^bPotential 50-year committed effective dose equivalents from drinking 77.5L of milk during the quarter using average radionuclide concentrations at each location. A dose estimate is given only for statistics whose average value is statistically greater than zero.

^cNo sample.

The objectives for the ambient air program are (1) to sample at stations that are most likely to show impacts of airborne emissions from the operation of ORNL, (2) to maintain surveillance of airborne radionuclides at the ORNL and ORR perimeter, and (3) to collect reference data from remote locations.

The ORNL Perimeter Air Monitoring (PAM) network includes stations 1, 2, 3, and 7 (Fig. 5.10). The DOE ORR PAM network includes stations 35, 37, 38, 39, 40, 42, 46, and 48 (Fig. 5.6). The Remote Air Monitoring (RAM) network consists of stations 51 and 52 (Fig 5.7). The ORR ambient air sampling system was upgraded in April of 1993 to include high volume samplers at all locations. These new samplers will allow for better quantification of each isotope with more frequent analysis.

5.10.2 Procedures and Results

Particulates are sampled biweekly by pumping a continuous flow of air at approximately 2 cfm through a 47 mm (1.88 in.) diameter paper filter. The ORR filters were composited through mid-April after the high volume samplers became operational. A composite of the ORNL particulate air filters for 1993 will be analyzed, and the results will be reported in the fourth quarter report.

Stations 3, 35, 37, 38, 39, 40, 42, 46, 48, 51, and 52 are equipped with tritium collection systems. Tritium is collected as tritiated water with indicating silica gel used as the collection media. All ambient tritium samples were collected for the quarter yielding a 100% collection rate. The results are presented in Table 5.4.

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.

In the second quarter of 1993, 28 out of 28 adsorbable gas samples were collected, yielding a collection rate of 100%. There were no measurable amounts of I-131 in any sample that was distinguishable from zero. Collection results are shown in Table 5.5.

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Fig. 5.10. ORNL perimeter air monitoring locations.

Table 5.4. Ambient air concentrations of tritium, April-June 1993

Station	N det/ N total	Significant concentration (10^{-4} Bq/L)					
		27APR93	Percent of DCG ^b	25MAY93	Percent of DCG ^b	22JUN93	Percent of DCG ^b
3	2/3	8.5	0.023	11.0	0.030	c	c
35	2/3	3.1	<0.01	77.0	0.210	c	c
37	2/3	3.5	<0.01	0.57	<0.01	c	c
38	1/3	12.0	0.034	c	c	c	c
39	2/3	270.0	0.74	c	c	4.7	0.013
40	1/3	c	c	c	c	54.0	0.150
42	1/3	c	c	c	c	c	c
46	1/3	1.8	<0.01	c	c	c	c
48	2/3	2.6	<0.01	c	c	1.3 ^d	<0.01
51	2/3	5.2	0.014	23.0	0.062	c	c
52	2/3	30.0	0.082	c	c	3.5	<0.010

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^aStation locations are shown in Figs. 5.6 and 5.8.

^bPercent of DCG=Value/DCG x 100. The DCG for tritium is 3.7 Bq/L.

^cNot applicable.

^dDate for this sample was 08JUN93. No sample for Station 48 on 22JUN93.

Table 5.5. Ambient air collections of absorbable gases (activated charcoal cartridge filter media) at ORNL air monitoring stations, April-June 1993

Station	Number Collected	Number Possible	Number Detected
<i>I-131</i>			
1	7	7	0
2	7	7	0
3	7	7	0
7	7	7	1
Overall Summary	28	28	1
<i>I-133</i>			
1	7	7	1
2	7	7	0
3	7	7	1
7	7	7	0
Overall Summary	28	28	2
<i>I-135</i>			
1	7	7	0
2	7	7	0
3	7	7	0
7	7	7	0
Overall Summary	28	28	0
<i>Pb-212</i>			
1	7	7	1
2	7	7	1
3	7	7	0
7	7	7	0
Overall Summary	28	28	2

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5.11 EXTERNAL GAMMA RADIATION

Laury V. Hamilton

5.11.1 Program Description

Individuals could be externally exposed to gamma radiation from several sources originating from the ORR. Potential sources include storage areas, environmental contamination, and radiation generating facilities. Monitoring of external gamma radiation exposure is conducted at five of the ORR perimeter air monitoring stations and at one of the reference air monitoring stations. Monitoring sites were chosen by modeling, taking into consideration the location of known ORR sources of gamma radiation, average meteorological conditions, and the monitoring location's proximity to local communities or public highways.

5.11.2 Procedures and Results

External gamma measurements are recorded weekly at stations 39, 40, 42, 46, and 48, (Fig. 5.6). In addition, external gamma measurements are collected at the DOE American Museum of Science and Energy (Reference air station 41). The readings are statistically evaluated each quarter, and the equivalent dose rate is calculated from the average reading at each station during the quarter. Table 5.6 summarizes the weekly measurements from April-June 1993.

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 5.6 are within the above range of background values.

These measurements are taken with Reuter-Stokes Model 1012 gamma monitors featuring twin high pressure ion chambers and electronic data loggers calibrated to read directly in μR and in R. For this report the R values collected in the field are converted to the SI units of nC/kg/h, which is nanocoulombs of gamma energy per kilogram of equivalent human tissue per hour of exposure.

Table 5.6. External gamma radiation measurements at reservation perimeter air monitoring stations,^a April-June 1993

Station	Number of Readings	Exposure rate (nC/kg/h) ^b				Equivalent Dose (μ Sv/h)
		Max	Min	Av	Standard error ^c	
35	8	2.2	0.1	1.6	0.244	0.062
39	8	3.2	2.2	2.7	0.088	0.11
40	12	2.1	1.1	1.9	0.080	0.074
41	13	2.1	0.6	1.3	0.121	0.050
42	13	5.6	0.3	1.9	0.357	0.074
46	13	2.4	0.7	2.0	0.123	0.078
48	13	2.3	1.5	1.9	0.091	0.074
Overall Summary	80	5.6	0.1	1.9	0.124	0.074

^aSee Fig. 5.6.

^bNanocoulomb per kilogram per hour.

^cStandard error of the mean.

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