5. ORNL Environmental Monitoring Programs

Compliance and environmental monitoring programs required by federal and state regulations and by DOE orders are conducted for air, water, and a variety of environmental media. These programs include regulatory and monitoring activities for ORNL site facilities and other locations in Bethel Valley, Melton Valley, and the ORR.

5.1 ORNL Radiological Airborne Effluent Monitoring

Airborne discharges from DOE Oak Ridge facilities, both radioactive and nonradioactive, are subject to regulation by EPA and the TDEC Division of Air Pollution Control. Radioactive emissions are regulated by EPA under NESHAP regulations in 40 CFR 61, Subpart H, and by the rules of the TDEC Division of Air Pollution Control, 1200-3-11.08. (See Appendix F, Table F.1 for a list of radionuclides and their radioactive half-lives.)

Radioactive airborne discharges at ORNL consist primarily of ventilation air from radioactively contaminated or potentially contaminated areas, vents from tanks and processes, and ventilation for hot cell operations and reactor facilities. These airborne emissions are treated and then filtered with high-efficiency particulate air filters and/or charcoal filters before discharge. Radiological airborne emissions from ORNL consist of solid particulates, adsorbable gases (e.g., iodine), tritium, and nonadsorbable gases (e.g., noble gases). The major radiological emission point sources for ORNL consist of the following five stacks located in Bethel and Melton Valleys (Fig. 5.1):

- 2026 Radioactive Materials Analytical Laboratory;
- 3020 Radiochemical Development Facility;
- 3039 central off-gas and scrubber system, which includes 3500 and 4500 areas' cell ventilation system, isotope solid-state ventilation system, 3025 and 3026 areas' cell ventilation system, 3042 ventilation system, and 3092 central off-gas system;
- 7503 (formerly 7512) Molten Salt Reactor Experiment Facility; and
- 7911 Melton Valley complex, which includes the HFIR and the Radiochemical Engineering Development Center (REDC).

In 2004, there were 24 minor point/group sources, and emission calculations/estimates were made for each of them.

5.1.1 Sample Collection and Analytical Procedure

Each of the five major point sources is equipped with a variety of surveillance instrumentation. Only data resulting from analysis of the continuous samples are used in this report. ORNL in-stack source-sampling systems comply with criteria in the American National Standards Institute (ANSI) standard ANSI N 13.1 (ANSI 1969). The sampling systems generally consist of a multipoint in-stack sampling probe, a sample transport line, a particulate filter, activated charcoal cartridges, a silica-gel cartridge (if required), flow-measurement and totalizing instruments, a sampling pump, and a return line to the stack. In addition to that instrumentation, the system at Stack 7911 includes a high-purity germanium detector with a NOMAD™ analyzer, which allows continuous isotopic identification and quantification of radioactive noble gases (e.g., ^{41}Ar) in the effluent stream. The sample probes are annually removed, inspected, and cleaned.

Velocity profiles are performed quarterly following the criteria in EPA Method 2 at major and some minor sources. The profiles provide accurate stack flow data for subsequent emission-rate calculations. An annual leak-check program is carried out to verify the integrity of the sample transport system.

ORNL 2005-01879

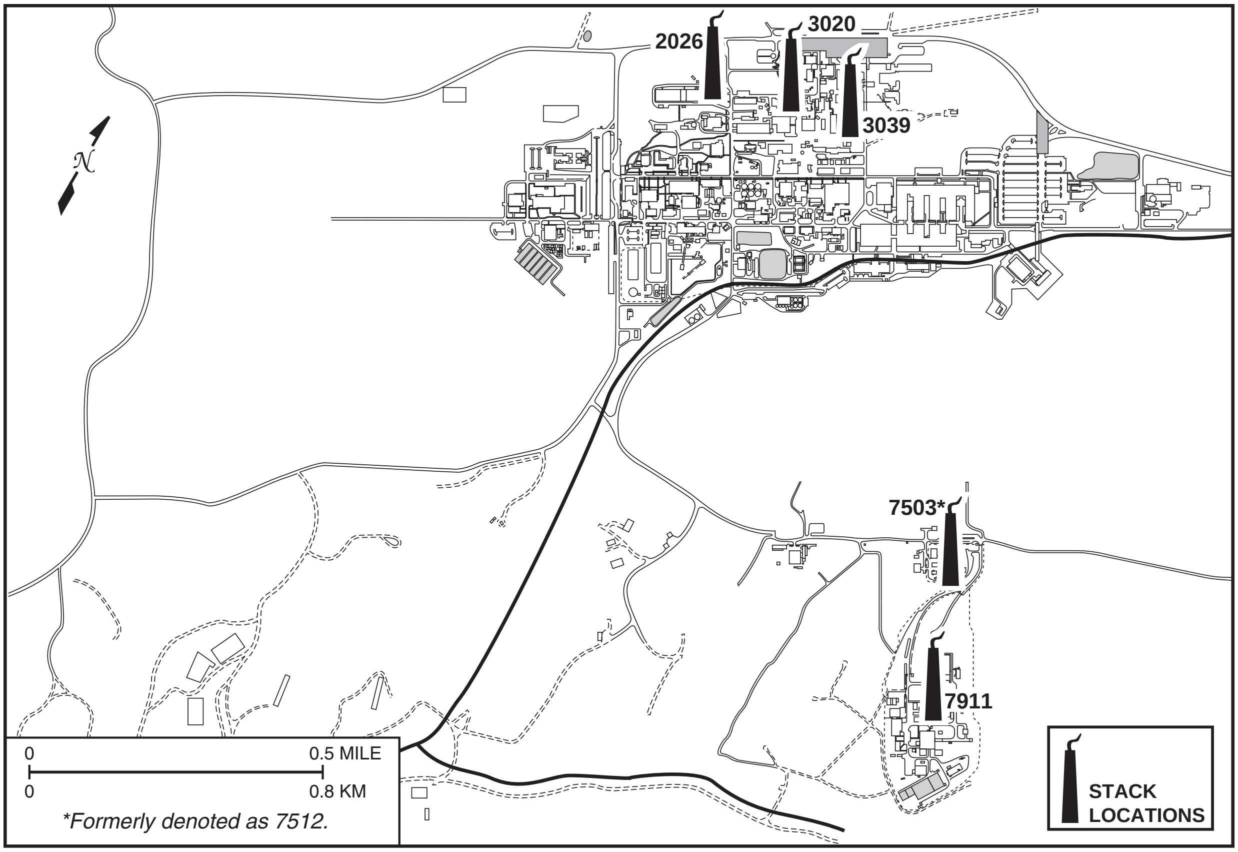

Fig. 5.1. Locations of major stacks (rad emission points) at ORNL.

In addition to the major sources, ORNL has a number of minor sources that have the potential to emit radionuclides to the atmosphere. A minor source is defined as any ventilation system or component such as a vent, a laboratory hood, room exhaust, or stack that does not meet the approved regulatory criteria for a major source but that is located in or vents from a radiological control area as defined by Radiological Support Services of the ORNL Operational Safety Services Division. A variety of methods are used to determine the emissions from the various minor sources. Methods used for minor source-emission calculations comply with criteria agreed upon by EPA. These minor sources are evaluated on a one- to five-year basis. Emissions, major and minor, are compiled annually to determine the overall ORNL source term and associated dose.

The charcoal cartridges, particulate filters, and silica-gel traps are collected weekly to biweekly. The use of charcoal cartridges is a standard method for capturing and quantifying radioactive iodine in airborne emissions. Gamma spectrometric analysis of the charcoal samples quantifies the adsorbable gases. Analysis is performed weekly to biweekly. Particulate filters are held for eight days prior to a weekly gross alpha and gross beta analysis to minimize the contribution from short-lived isotopes such as ^{220}Rn and its daughter products. At Stack 7911, a weekly gamma scan is conducted to better detect short-lived gamma isotopes. The weekly to biweekly filters are then composited quarterly and are analyzed for alpha-, beta-, and gamma-emitting isotopes. Compositing provides a better opportunity for quantification of these low-concentration isotopes. Silica-gel traps are used to capture tritium water vapor. Analysis is performed weekly to biweekly. At the end of the year, each sample probe is rinsed, and the rinsate is collected and submitted for isotopic analysis identical to that of the particulate filter. The data from the charcoal cartridges, silica gel, probe wash, and the quarterly filter composites are compiled to give the annual emissions for each major source and some minor sources.

5.1.2 Results

Annual radioactive airborne emissions for ORNL major sources in 2004 are presented in Table 5.1. All data presented were determined to be statistically different from zero at the 95% confidence level. Any number not statistically different from zero was not included in the emission calculation. Because measuring a radionuclide requires a process of counting random radioactive emissions from a sample, the same result may not be obtained if the sample is analyzed repeatedly. This deviation is referred to as the "counting uncertainty." Statistical significance at the 95% confidence level means that there is a 5% chance that the results could be erroneous.

Historical trends for tritium and iodine-131 are presented in Figs. 5.2 and 5.3, respectively. The tritium emissions for 2004 totaled approximately 87 Ci (Fig. 5.2), which is a decrease from 2003, but consistent with emissions from 2002. The iodine-131 emissions for 2004 (also decreased from 2003) totaled 0.05 Ci (Fig. 5.3). The major contributor to the off-site dose at ORNL historically is ^{41}Ar, which is emitted as a nonadsorbable gas from the 7911 Melton Valley complex stack. However, due to a long maintenance period in 2001 and changes in HFIR operations, ^{138}Cs has remained the major contributor to the off-site dose since 2001. Emissions of ^{41}Ar result from HFIR operations and research activities. Emissions of ^{138}Cs result from REDC research activities, which also exhaust through the 7911 Melton Valley complex stack. The ^{41}Ar emissions for 2004 were 2030 Ci; ^{138}Cs emissions were 1720 Ci (Fig. 5.4). Even though the curie amount of ^{41}Ar exceeded that of ^{138}Cs, the resultant dose from ^{138}Cs dominated the off-site dose. The calculated radiation dose to the maximally exposed off-site individual from all radiological airborne release points at ORNL during 2004 was 0.12 mrem. This dose is well below the NESHAP standard of 10 mrem and is less than 0.04% of the 300 mrem that the average individual receives from natural sources of radiation. (See Section 8.1.2.1 for an explanation of how the airborne radionuclide dose was determined.)

5.2 ORNL Nonradiological Airborne Emissions Monitoring

In 2004, TDEC issued a Title V permit for nine ORNL emission sources. ORNL also holds two construction permits, one for two boilers located at the SNS, and one for the Central Exhaust Facility at the SNS (see Appendix E, Table E.2). The ORNL Steam Plant (six boilers) and four small package-unit boilers account for 75% of ORNL's allowable emissions. The ORNL steam plant is subject to permitting requirements for fuel monitoring and hourly and annual emissions limits for criteria pollutants. In addition, Boiler 6, a 125-MBtu/h boiler, is subject to 40 CFR 60 Subpart Db continuous emission monitoring requirements for NO_x and opacity. During calendar year (CY) 2004, no permit limits were exceeded.

In October 2004, TDEC issued an NOV for failure to apply for a permit to construct the SNS Central Exhaust Facility within the timeframe required by regulations. No further action, such as a fine or hearing was required by TDEC.

For the period from July 1, 2003, through June 30, 2004, ORNL paid $40,041.30 in annual emission fees to TDEC. These fees are based on allowable emissions (actual emissions are lower than allowable emissions). During 2004, TDEC and EPA inspected all permitted emissions sources; all were found to be in compliance.

As required by Title VI of the CAA Amendments of 1990, actions have been implemented to comply with the prohibition against releasing ozone-depleting substances during maintenance activities performed on refrigeration equipment. In addition, service requirements for refrigeration systems (including motor vehicle air conditioners), technician certification requirements, and labeling requirements have been implemented. ORNL has implemented a plan to phase out the use of all Class I ozone-depleting substances. All critical applications of Class I ozone-depleting substances have been eliminated, replaced, or retrofitted with other materials. Work is progressing as funding becomes available for noncritical applications with no disruption of service.

Another UT-Battelle-operated facility, the National Transportation Research Center, is in

Table 5.1. Major sources of radiological airborne emissions at ORNL, 2004 (Ci)

Isotope	Stack				
	X-2026	X-3020	X-3039	X-7503[a]	X-7911
^{228}Ac	5.83E-08		5.61E-07	3.61E-08	3.93E-07
^{110m}Ag		2.49E-08			
^{241}Am	4.88E-07	1.48E-07	2.87E-07	5.43E-09	
^{242}Am				5.90E-10	
^{243}Am				5.90E-10	
^{41}Ar					2.03E+03
^{139}Ba			1.97E-03		4.62E-01
^{140}Ba	3.90E-07				1.47E-04
^{7}Be	1.03E-07	4.53E-07	1.12E-05	7.71E-08	5.31E-07
^{212}Bi	1.22E-07				
^{214}Bi			3.18E-07		2.02E-07
^{252}Cf					9.13E-09
^{244}Cm	1.29E-06	2.89E-08	1.62E-07	3.99E-08	6.21E-08
^{246}Cm	6.41E-09	4.27E-09		2.59E-09	
^{57}Co		1.56E-08	1.27E-06		
^{60}Co			6.66E-06		
^{134}Cs				7.29E-09	
^{137}Cs	3.12E-06	1.01E-06	2.91E-04		4.67E-06
^{138}Cs					1.72E+03
^{152}Eu			1.84E-06		
^{155}Eu	8.14E-08		3.75E-07		
^{59}Fe					1.97E-07
^{3}H	3.26E-02		1.94E+01	1.43E+00	6.64E+01
^{203}Hg					1.31E-07
^{131}I	7.76E-06		1.15E-06		4.70E-02
^{132}I					8.25E-01
^{133}I					2.88E-01
^{134}I					1.01E+00
^{135}I					1.00E+00
^{40}K				1.50E-07	1.38E-06
^{85}Kr					2.16E+02
^{85m}Kr					5.23E-02
^{87}Kr					8.95E+01
^{88}Kr					4.76E+01
^{89}Kr					2.94E+01
^{140}La					1.58E-04
^{94}Nb					5.49E-08
^{95}Nb					1.15E-07
^{239}Np			6.65E-07		
^{147}Nd				1.17E-06	
^{191}Os			2.43E-01		
^{210}Pb	2.93E-06			2.36E-06	
^{212}Pb	6.12E-01		1.09E+00	9.04E-02	7.99E-02
^{214}Pb					1.20E-07
^{238}Pu	4.92E-08	2.52E-08	3.16E-08	2.89E-09	9.11E-10
^{239}Pu	1.24E-07	1.63E-07	9.13E-07	8.57E-09	1.54E-09
^{244}Pu	6.37E-09	3.51E-09	1.69E-08	1.92E-09	1.57E-08
^{228}Ra	5.83E-08		5.61E-07	3.61E-08	3.93E-07
^{75}Se			3.96E-03		

Table 5.1 (continued)

Isotope	Stack				
	X-2026	X-3020	X-3039	X-7503[a]	X-7911
^{90}Sr	3.86E-07	7.70E-07	8.90E-05	1.21E-08	5.00E-06
^{228}Th	4.05E-08	5.29E-09	1.10E-08	2.70E-09	1.59E-08
^{230}Th	1.43E-08	9.00E-10	2.52E-08	1.91E-09	3.83E-08
^{232}Th	1.46E-09	1.20E-09	8.44E-09	8.10E-10	1.17E-08
^{234}Th			2.74E-06		
^{234}U	1.79E-07	8.12E-08	2.22E-07	1.24E-08	2.98E-08
^{235}U	2.75E-09	3.96E-09	2.02E-08	6.68E-10	1.86E-09
^{238}U	2.90E-09	4.61E-09	3.40E-08	1.95E-09	1.44E-08
^{131m}Xe					1.57E+00
^{133}Xe					6.37E-03
^{133m}Xe					4.43E+00
^{135}Xe					5.79E+01
^{135m}Xe					2.58E+02
^{137}Xe					1.42E+02
^{138}Xe					2.33E+02
^{90}Y	3.86E-07	7.70E-07	8.90E-05	1.21E-08	5.00E-06

[b]Formerly 7512.

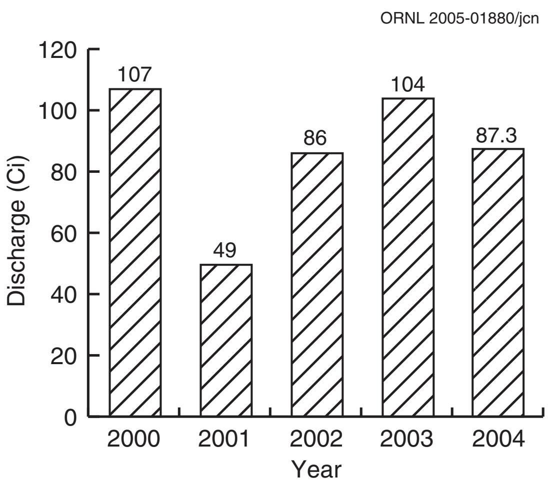

Fig. 5.2. Total discharges of ^{3}H from ORNL to the atmosphere, 2000–2004.

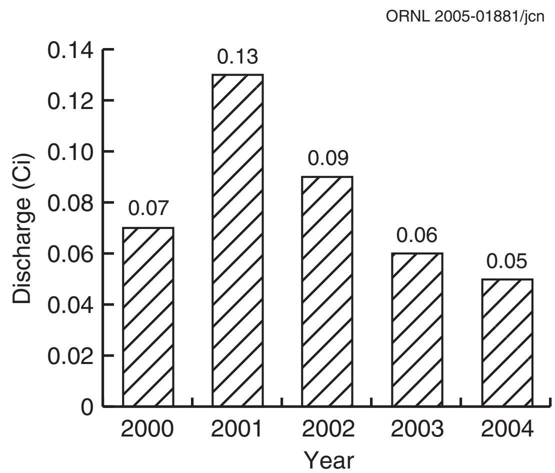

Fig. 5.3. Total discharges of ^{131}I from ORNL to the atmosphere, 2000–2004.

Knox County and is permitted with the local regulatory agency there.

5.2.1 Results

The primary sources of nonradioactive emissions at ORNL include the steam plant, boilers 1–6 on the main ORNL site, two boilers located at the 7600 complex, and two boilers located at the SNS site. These units use fossil fuels; therefore, criteria pollutants are emitted.

Actual and allowable emissions from these sources are compared in Table 5.2. Actual emissions were calculated from fuel usage and EPA emission factors. All ORNL emission sources operated in compliance with permit conditions during 2004.

5.3 ORNL Ambient Air Monitoring

The objectives of the ORNL ambient air monitoring program are to collect samples at perimeter air monitoring (PAM) stations most likely to show impacts of airborne emissions from the operation of ORNL and to provide for

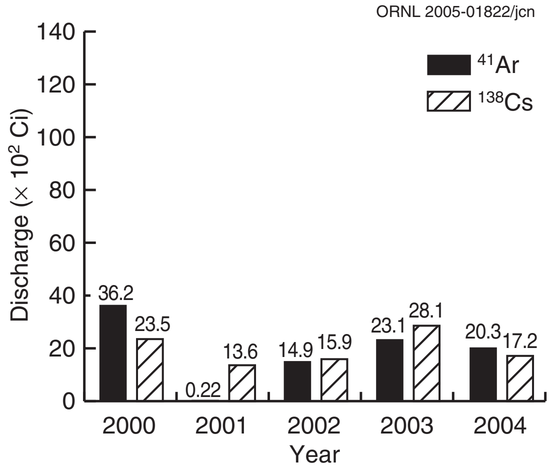

Fig. 5.4. Total discharges of ^{41}Ar and ^{138}Cs from ORNL to the atmosphere, 2000–2004.

Table 5.2. Actual vs allowable air emissions from ORNL steam production, 2004

Pollutant	Emissions (tons per year)		Percentage of allowable
	Actual	Allowable	
SO_2	14	1277	1.1%
PM	3	71	4.4%
CO	35	196	17.8%
VOC	2	14	15.0%
NO_X	74	380	19.6%

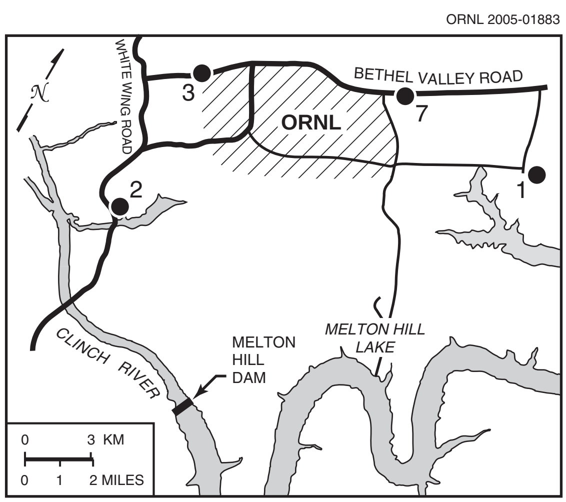

Fig. 5.5. Locations of ambient air monitoring stations at ORNL.

emergency response capability. Four stations, identified as Stations 1, 2, 3, and 7 (Fig. 5.5) make up the ORNL PAM network. Sampling is conducted at each ORNL station to quantify levels of tritium; adsorbable gases (e.g., iodine); and gross alpha-, beta-, and gamma-emitting radionuclides (Table 5.3).

The sampling system consists of a low-volume air sampler for particulate collection in a 47-mm glass-fiber filter. The filters are collected biweekly, composited annually, then submitted to the laboratory for analysis. Following the filter is a charcoal cartridge used to collect adsorbable gases (e.g., iodine). The charcoal cartridges are analyzed biweekly by gamma spectroscopy for adsorbable gas quantification. A silica-gel column is used for collection of tritium as tritiated water. These samples are collected biweekly or weekly. The silica gel from each station is composited quarterly and is then submitted to the laboratory for tritium analysis.

5.3.1 Results

The ORNL PAM stations are designed to provide data for collectively assessing the specific impact of ORNL operations on local air quality. Sampling data from the ORNL PAM stations (Table 5.3) are compared with the DCGs for air established by DOE as reference values for conducting radiological environmental protection programs at DOE sites. (DCGs are listed in DOE Order 5400.5.) Average radionuclide concentrations measured for the ORNL network were less than 1% of the applicable DCG in all cases.

5.4 Liquid Discharges—ORNL Radiological Monitoring Summary

ORNL monitors radioactivity at NPDES outfalls that have a potential to discharge radioactivity and at three in-stream monitoring stations under a radiological monitoring plan required by Part III, Section J, of the ORNL NPDES permit. The current version of the plan was implemented on November 1, 1999. Table 5.4 contains the details of the locations, frequency, and target analyses for monitoring of dry-weather discharges and in-stream monitoring locations. Monitoring of radioactivity in ef-

Table 5.3. Radionuclide concentrations measured at ORNL perimeter air monitoring stations, 2004 (pCi/mL)

Parameter	Av concentration	No. detected/total
	Station 1	
^{7}Be	2.13E-08	1/1
^{3}H	2.67E-06	0/4
^{40}K	2.70E-07	15/26
^{234}U	1.49E-11	1/1
^{235}U	-2.45E-13	1/1
^{238}U	1.06E-11	1/1
^{Tot}U	2.52E-11	1/1
	Station 2	
^{7}Be	1.89E-08	1/1
^{3}H	2.03E-05	4/4
^{40}K	2.86E-07	15/26
^{234}U	1.51E-11	1/1
^{235}U	1.69E-12	1/1
^{238}U	1.39E-11	1/1
^{Tot}U	3.07E-11	1/1
	Station 3	
^{7}Be	1.83E-08	1/1
^{3}H	2.10E-06	1/4
^{40}K	3.33E-07	22/26
^{234}U	1.35E-11	1/1
^{235}U	1.10E-12	1/1
^{238}U	1.07E-11	1/1
^{Tot}U	2.54E-11	1/1
	Station 7	
^{7}Be	1.84E-08	1/1
^{3}H	2.49E-06	1/4
^{40}K	3.09E-07	19/26
^{234}U	2.04E-11	1/1
^{235}U	1.81E-12	1/1
^{238}U	1.77E-11	1/1
^{Tot}U	3.99E-11	19/26

fluents occurs at three ORNL treatment facilities: the Sewage Treatment Plant, the Coal Yard Runoff Treatment Facility (CYRTF), and the Process Waste Treatment Complex (PWTC).

Other effluents monitored in 2004 included 23 category discharges, which are relatively minor discharges that receive little or no treatment prior to discharge. Wastewaters discharged through category outfalls are primarily storm water runoff, cooling water, groundwater, and steam condensate. Some category outfalls listed in Table 5.4 were not sampled in 2004, either because they are no longer in service or because they were not discharging or were otherwise not able to be sampled during sampling attempts. The three in-stream locations monitored under the Radiological Monitoring Plan are X13 on Melton Branch, X14 on White Oak Creek, and X15 at White Oak Dam (Fig. 5.6).

The DOE DCG values are used in this section as a means of standardized comparison for effluent points with different radioisotope signatures. Annual average concentrations were compared to DCG concentrations if a DCG existed for that parameter (there are no DCGs for gross alpha and gross beta activities) and if there was at least one individual measurement that indicated detectable activity [i.e., one individual measurement where the measured concentration

Table 5.4. ORNL National Pollutant Discharge Elimination System Radiological Monitoring Plan

Location	Frequency	Gross alpha[a]	Gross beta[a]	Gamma scan	Tritium	Total rad Sr	Isotopic uranium
Outfall 001	Annually	X					
Outfall 080[b]	Monthly	X	X	X	X	X	
Outfall 081	Annually		X				
Outfall 085	Quarterly	X	X			X[c]	X[c]
Outfall 086	When discharges		X		X		
Outfall 087	Annually		X	X			
Outfall 203	Annually		X				
Outfall 204	Quarterly	X	X			X	
Outfall 205	Annually		X				
Outfall 207	Quarterly	X	X	X		X	
Outfall 211	Quarterly		X			X	
Outfall 217	Annually		X				
Outfall 219	Annually		X				
Outfall 234	Annually	X					
Outfall 241[b]	Annually		X				
Outfall 265	Annually		X	X			
Outfall 281	Quarterly	X	X	X	X		
Outfall 282	Quarterly	X	X				
Outfall 284	Annually		X				
Outfall 290	Annually			X			
Outfall 302	Monthly	X	X	X	X	X	
Outfall 304	Monthly	X	X	X	X	X	
Outfall 365	Quarterly	X	X				
Outfall 368	Quarterly	X	X	X			
Outfall 381[d]	Quarterly		X	X	X		
Outfall 382[e]	Annually		X	X			
Outfall 383	Annually		X		X		
Sewage Treatment Plant (X01)	Monthly	X	X			X	
Coal Yard Runoff Treatment Facility (X02)	Monthly	X	X				
Process Waste Treatment Complex (X12)	Monthly	X	X	X	X	X	X
Melton Branch 1 (X13)	Monthly	X	X	X	X	X	
White Oak Creek (X14)	Monthly	X	X	X	X	X	
White Oak Dam (X15)	Monthly	X	X	X	X	X	

[a]Isotopic analyses are performed to identify contributors to gross activities when results exceed screening criteria described in the Radiological Monitoring Plan, June 1999.

[b]No discharge present.

[c]Added to the plan November 2004.

[d]Physically removed in late 2004; eliminated as part of the HFIR ponds remediation project

[e]No longer discharges (plugged).

was greater than or equal to the measurement's minimum detectable activity (MDA)]. For analyses that cannot differentiate between two radioisotopes (e.g., $^{89/90}$Sr) and for radioisotopes that have more than one DCG for different gastrointestinal tract absorption factors, the most restrictive (lowest) DCG was used in the comparisons. DCGs are not intended for comparison to in-stream values. However, they are useful as a frame of reference, so in-stream values were also compared to DCGs. The comparison of effluent and in-stream concentrations to DCGs for ingestion of water does not imply that effluents

ORNL 2005-01884

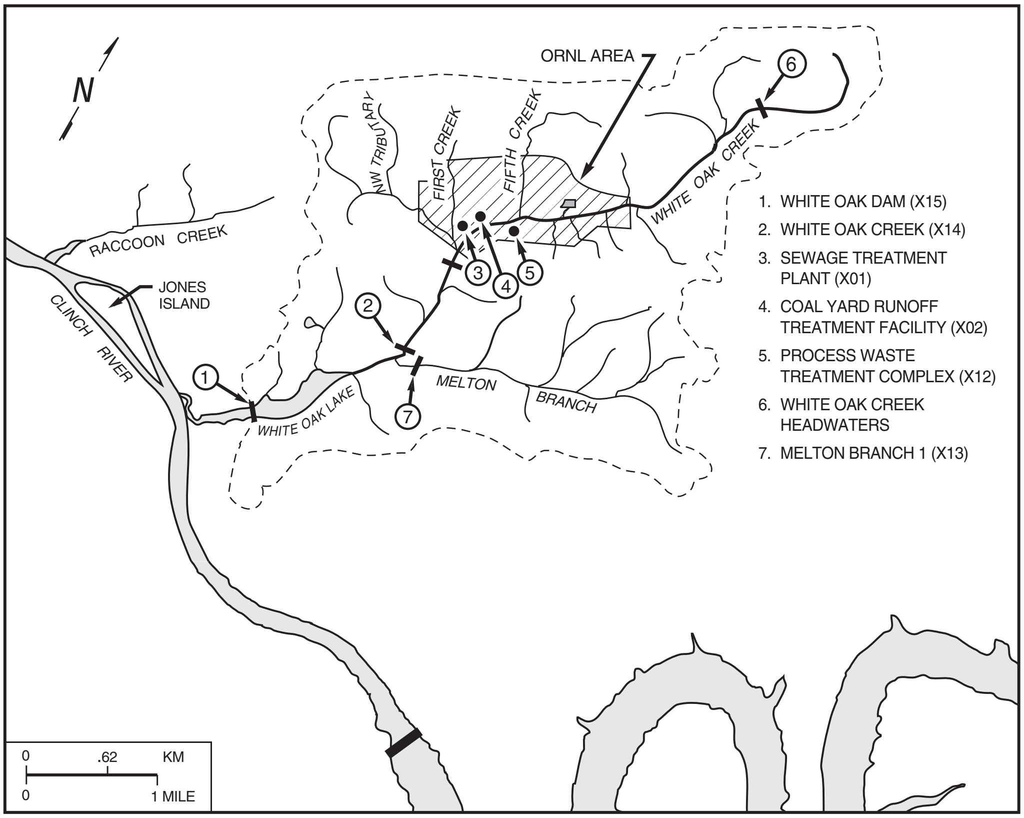

Fig. 5.6. ORNL surface water, National Pollutant Discharge Elimination System, and reference sampling locations.

from ORNL outfalls or ORNL ambient-water-sampling stations are sources of drinking water. In 2004, no NPDES outfall had measured annual average concentrations of radioactivity equaling or exceeding 100% of DCG concentrations. (As required by DOE Order 5400.5, where more than one radionuclide was detected at an outfall, the DCG percentages of the individually measured radionuclides were summed and the sum of percentages was compared with 100%.) The annual average concentration of at least one radionuclide exceeded 4% of the relevant DCG concentration at nine NPDES outfalls (X01, X12, 085, 086, 087, 204, 282, 302, and 304) and at in-stream sampling locations X13 and X15 (Fig. 5.7). Four percent of the DCG is roughly equivalent to the 4-mrem dose limit on which the EPA radionuclide drinking water standards are based (4% of a DCG is a convenient comparison point, but it should not be concluded that ORNL effluents or ambient waters are direct sources of drinking water). The annual average concentration of $^{89/90}$Sr in the ORNL Sewage Treatment Plant Discharge (outfall X01) was 13% of the DCG. Concentrations of four radionuclides measured in the discharge from the PWTC (outfall X12) were greater than 4% of the DCG: ^{137}Cs (30%), $^{89/90}$Sr (11%), $^{233/234}$U (5.4%), and ^{3}H (tritium) (4.2%). Seven category outfalls had measured concentrations of a parameter that were greater than 4% of a DCG: outfall 085 ($^{89/90}$Sr, 47%; $^{233/234}$U, 5.4%), outfall 086 (^{3}H, 4.2%), outfall 087 (^{137}Cs, 43%), outfall 204 (^{137}Cs, 14%; $^{89/90}$Sr, 8.8%), outfall 282 ($^{89/90}$Sr, 40%), outfall 302 ($^{89/90}$Sr, 11%) and outfall 304 ($^{89/90}$Sr, 17%). At the in-stream monitoring station on Melton Branch (Location X13), ^{3}H and $^{89/90}$Sr were measured at concentrations exceeding 4% of the DCG (33% and 41%, respectively). At the X15 monitoring station at White Oak Dam, ^{3}H was measured at 4.8% of the DCG, and $^{89/90}$Sr was measured at 12% of the DCG.

The amounts of radioactivity in stream water passing White Oak Dam, the final monitoring point on White Oak Creek before the stream

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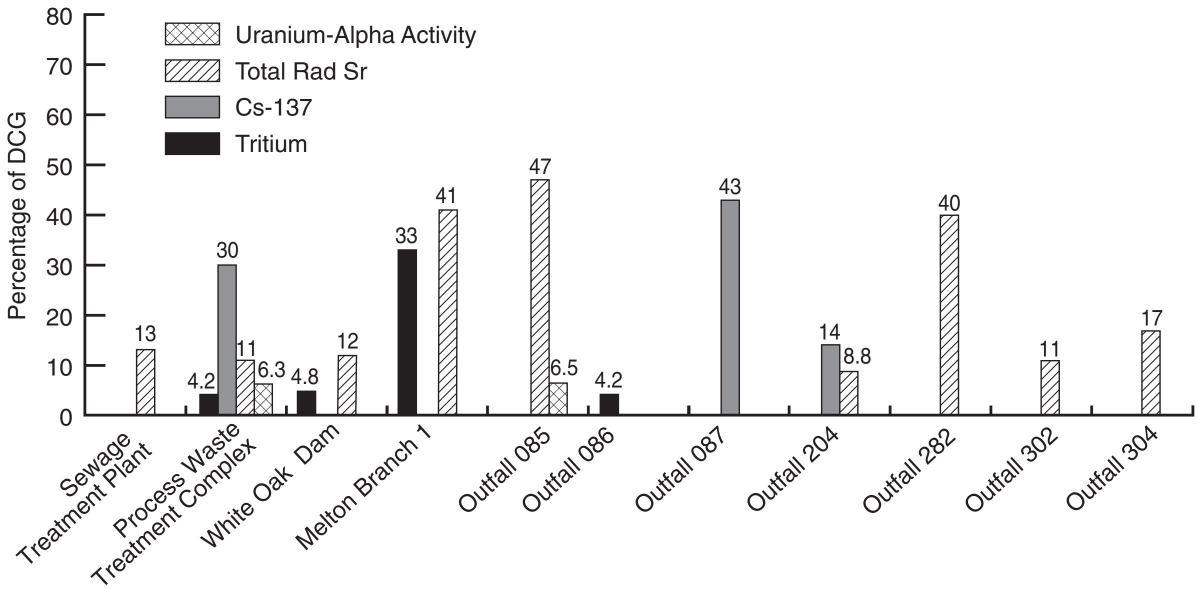

Fig. 5.7. Radionuclides at ORNL sampling sites having average concentrations greater than 4% of the relevant derived concentration guides in 2004.

flow leaves ORNL, were calculated from concentration and flow. The total annual discharges (or amounts) of radioactivity released at White Oak Dam during each of the past five years are shown in Figs. 5.8 through 5.13. In general, the amounts of radioactivity passing this monitoring station in 2004 were similar to previous years. However, the discharge of ^{137}Cs was more similar to the peak observed in 2002 than it was to other recent years' discharges. The elevated level of ^{137}Cs discharge that was observed in 2002 was theorized to be caused by disturbances in the White Oak Creek watershed associated with environmental restoration activities, primarily remediation of the former Intermediate Holding Pond area. Accelerated remediation of Melton Valley waste sites in 2004, which included installation of hydrologic isolation caps over extensive areas, resulted in significant disturbances in the White Oak Creek watershed. The higher-than-normal level of ^{137}Cs transport is likely associated with these disturbances.

The ORNL Radiological Monitoring Plan also includes monitoring of radioactivity at category outfalls during storm conditions. There were 102 outfalls targeted for periodic storm water sampling when the plan was developed. Since that time, one of those outfalls was physically removed (outfall 115) and another was plugged (outfall 382). The storm water outfalls were grouped into eight different categories with the knowledge that outfalls may move from one category to another as storm water data are collected. The storm water categories were defined by the availability of historic data and, when data were available, by the levels of radioactivity detected in past monitoring. The goal set for storm water monitoring in the Radiological Monitoring Plan is to perform monitoring at the rate of 20 outfalls per NPDES permit year (February 3 to February 2). The plan set frequency goals rather than strict requirements because opportunities for storm water sampling are dependent on the weather.

Monitoring of storm water runoff through NPDES-permitted outfalls for radioactivity is conducted on an NPDES permit-year basis; however, storm water results are discussed on a CY basis in this report. A total of 28 storm water outfalls were monitored in CY 2004.

When storm water monitoring locations are selected, outfalls are chosen so that various areas of the ORNL site are represented. Storm water samples are analyzed for gross alpha, gross beta, and tritium activities. A gamma scan is also routinely performed. Under the Radiological Monitoring Plan, additional analyses are added when there is enough gross alpha and/or gross beta activity in an outfall's discharges to indicate

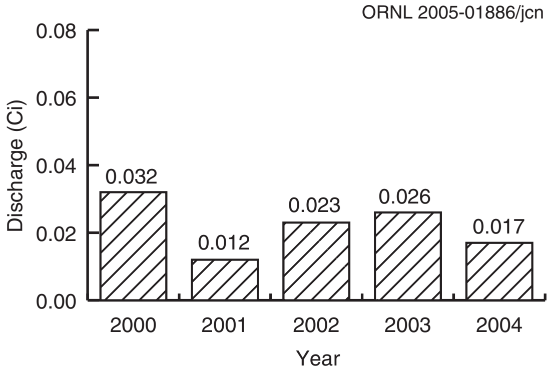

Fig. 5.8. Cobalt-60 discharges at White Oak Dam, 2000–2004.

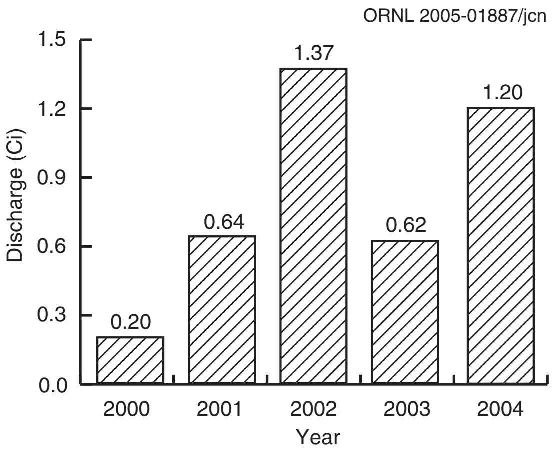

Fig. 5.9. Cesium-137 discharges at White Oak Dam, 2000–2004.

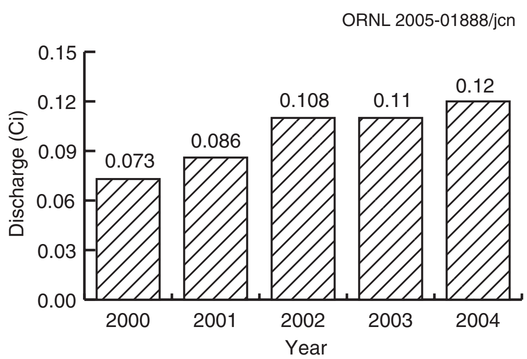

Fig. 5.10. Gross alpha discharges at White Oak Dam, 2000–2004.

that DCG levels may be exceeded. In 2004, no storm water discharges required additional analyses.

Of the 140 individual storm water sample results collected in 2004, 109 (78%) were less than the minimum detectable activities of the tests. Concentrations of radioactivity in storm

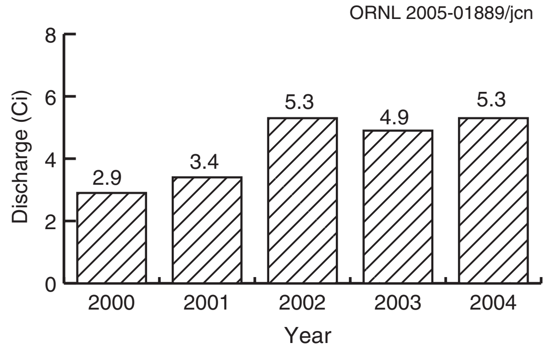

Fig. 5.11. Gross beta discharges at White Oak Dam, 2000–2004.

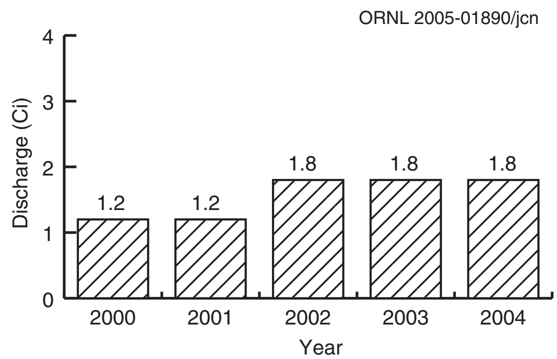

Fig. 5.12. Total radioactive strontium discharges at White Oak Dam, 2000–2004.

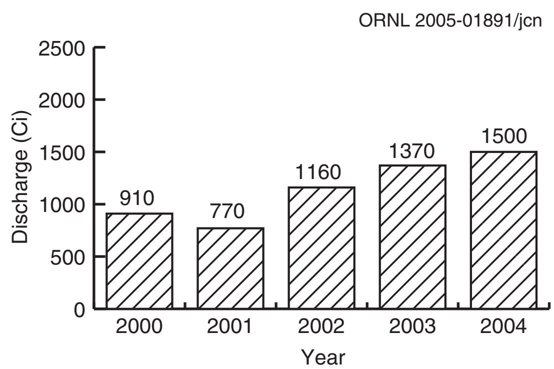

Fig. 5.13. Tritium discharges at White Oak Dam, 2000–2004.

water discharges were compared to DCGs if a DCG existed for that parameter (there are no DCGs for gross alpha and gross beta activities) and if the concentration was greater than or equal to the MDA for the measurement. No outfalls had measurements of radionuclide concentrations in storm water that were greater than 4% of DCG levels.

5.5 ORNL NPDES Summary

5.5.1 NPDES Permit Monitoring

ORNL submitted the application for renewal of NPDES Permit TN0002941 on June 1, 2001, fulfilling the requirement that an application be made six months prior to permit expiration. The December 6, 1996, ORNL NPDES Permit expired in December 2001, and the limits and conditions of that permit remain in effect until renewal by TDEC. Data collected as required by the permit are submitted to the state of Tennessee in the monthly NPDES Discharge Monitoring Report. The 1996 NPDES permit includes 164 separate outfalls and monitoring points.

The ORNL NPDES Permit requires that point-source outfalls be sampled before they are discharged into receiving waters or before they mix with any other wastewater stream (see Fig. 5.6). Under the existing permit, there are numeric and narrative effluent limits applied at the following locations:

- X01—Sewage Treatment Plant;
- X02—CYRTF;
- X12—PWTC;
- X13—Melton Branch (MB1);
- X14—White Oak Creek;
- X15—White Oak Dam;
- in-stream chlorine monitoring points (X16–X26);
- steam condensate outfalls;
- groundwater from building foundation drains;
- Category I outfalls (storm drains, water discharged under best management practices, groundwater, steam, and water condensate);
- Category II outfalls (storm drains, water discharged under best management practices, groundwater, steam, and water condensate);
- Category III outfalls (storm drains, water discharged under best management practices, groundwater, steam, water condensate, cooling water, and cooling tower blowdown);
- Category IV outfalls (storm drains, water discharged under best management practices, groundwater, steam, water condensate, cooling water, and cooling tower blowdown); and
- cooling systems (cooling water and cooling tower blowdown).

Permit limits and compliance statistics are shown in Table 5.5. In-stream data collection points X-13, X-14, and X-15 are not included in the table because only flow measurements and narrative conditions are required under the ORNL NPDES Permit at those three points. Permit noncompliances in 2004 are discussed below and are shown in Appendix D.

During 2004, ORNL experienced five instances of noncompliance with numeric NPDES permit limits. Based on approximately 6500 compliance measurements and analyses, the rate of compliance with the ORNL NPDES permit was approximately 99.9%. The instances of nonconformance occurred at the CYRTF and the ORNL Sewage Treatment Plant. The CYRTF exceedances occurred during work to optimize treatment chemistry, and were corrected by further adjustments to the treatment process. The Sewage Treatment Plant exceedance was caused by disposal of an excess of propylene glycol solution to the Sewage Treatment Plant. Corrective actions included re-evaluation of subcontractor oversight and work planning. Figure 5.14 shows the number and types of noncompliances at each respective location.

Under the NPDES permit, ORNL conducts several monitoring plans and programs. These include the Radiological Monitoring Plan, the Chlorine Control Strategy, and the Storm Water Pollution Prevention Plan. These are discussed in the following sections.

5.5.1.1 Radiological Monitoring Plan

In 2004, ORNL continued to sample and analyze under the revised Radiological Monitoring Plan implemented on November 1, 1999. Results for the 2004 monitoring are presented in Sect. 5.4.

5.5.1.2 Chlorine Control Strategy

The NPDES permit regulates the discharge of chlorinated water at ORNL by setting either total residual chlorine concentration limits or total residual oxidant mass-loading action levels on outfalls, depending on the outfall's location and the volume of its discharge. At ORNL, total

Table 5.5. National Pollutant Discharge Elimination System (NPDES) compliance at ORNL, 2004
(NPDES permit effective February 3, 1997)

Effluent parameters[a]	Permit limits: Monthly avg (kg/d)	Daily max (kg/d)	Monthly avg (mg/L)	Daily max (mg/L)	Daily min (mg/L)	Permit compliance: Number of noncompliances	Number of samples	Percentage of compliance[b]
X01 (Sewage Treatment Plant)								
LC_{50} for *Ceriodaphnia* (%)					41.1	0	4	100
LC_{50} for fathea minnows (%)					41.1	0	4	100
Ammonia, as N (summer)	2.84	4.26	2.5	3.75		0	78	100
Ammonia, as N (winter)	5.96	8.97	5.25	7.9		0	78	100
Carbonaceous BOD	8.7	13.1	10	15		1[c]	155	99.4
Dissolved oxygen					6	0	156	100
Fecal coliform (col/100 mL)			1000	5000		0	156	100
NOEC for *Ceriodaphnia* (%)					12.3	0	4	100
NOEC for fathead minnows (%)					12.3	0	4	100
Oil and grease	8.7	13.1	10	15		0	156	100
pH (std. units)				9	6	0	156	100
Total residual chlorine			0.038	0.066		0	156	100
Total suspended solids	26.2	39.2	30	45		0	156	100
X02 (Coal Yard Runoff Treatment Facility)								
LC_{50} for *Ceriodaphnia* (%)					4.2	0	4	100
LC_{50} for fathead minnows (%)					4.2	0	4	100
Copper, total			0.07	0.11		2[d]	24	91.7
Iron, total			1.0	1.0		2[e]	24	91.7
NOEC for *Ceriodaphnia* (%)					1.3	0	0[f]	100
NOEC for fathead minnows (%)					1.3	0	0[f]	100
Oil and grease			10	15		0	52	100
pH (std. units)				9.0	6	0	52	100
Selenium, total			0.22	0.95		0	24	100
Silver, total				0.008		0	24	100
Total suspended solids				50		0	52	100
Zinc, total			0.87	0.95		0	24	100
X12 (Process Waste Treatment Complex)								
LC50 for *Ceriodaphnia* (%)					100	0	4	100
LC50 for fathead minnows (%)					100	0	4	100
Cadmium, total	0.79	2.09	0.008	0.034		0	52	100

Table 5.5 (continued)

Effluent parameters[a]	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	Percentage of compliance[b]
Chromium, total	5.18	8.39	0.22	0.44		0	52	100
Copper, total	6.27	10.24	0.07	0.11		0	52	100
Cyanide, total	1.97	3.64	0.008	0.046		0	4	100
Lead, total	1.3	2.09	0.028	0.69		0	52	100
Nickel, total	7.21	12.06	0.87	3.98		0	52	100
NOEC for *Ceriodaphnia* (%)					30.9	0	4	100
NOEC for fathead minnows (%)					30.9	0	4	100
Oil and grease	30.3	45.4	10	15		0	52	100
pH (std. units)				9.0	6.0	0	156	100
Silver, total	0.73	1.3		0.008		0	52	100
Temperature (ºC)				30.5		0	156	100
Total toxic organics		6.45		2.13		0	12	100
Zinc, total	4.48	7.91	0.87	0.95		0	52	100
Instream chlorine monitoring points								
Total residual oxidant			0.011	0.019		0	264	100
Steam condensate outfalls								
pH (std. units)				9.0/8.5	6.0/6.5	0	12	100
Groundwater/ pumpwater outfalls								
pH (std. units)				9.0/8.5	6.0/6.5	0	4	100
Cooling tower blowdown outfalls								
pH (std. units)				9.0	6.0	0	4	100
Category I outfalls								
pH (std. units)				9.0	6.0	0	18	100
Category II outfalls								
pH (std. units)				9.0	6.0	0	24	100
Category III outfalls								
pH (std. units)				9.0	6.0	0	54	100
Category IV outfalls								
pH (std. units)				9.0	6.0	0	336	100
Cooling tower blowdown/ cooling water outfalls								
pH (std. units)				9.0	6.0	0	48	100
Total residual oxidant			0.011	0.019		0	48	100

[a] LC_{50} = the concentration (as a percentage of full-strength wastewater) that kills 50% of the test species in 96 h. NOEC = no-observed-effect concentration; the concentration as a percentage of full-strength wastewater that caused no reduction in *Ceriodaphnia* survival or reproduction or fathead minnow survival or growth.

[b] Percentage compliance = 100 – [(number of noncompliances/number of samples) * 100].

[c] A required analysis was not quanitifed.

[d] One incident caused two reportable noncompliances.

[e] One incident caused two reportable noncompliances.

[f] Insufficient discharge for chronic test and determination of no-observed-effect concentration for each of the quarterly tests.

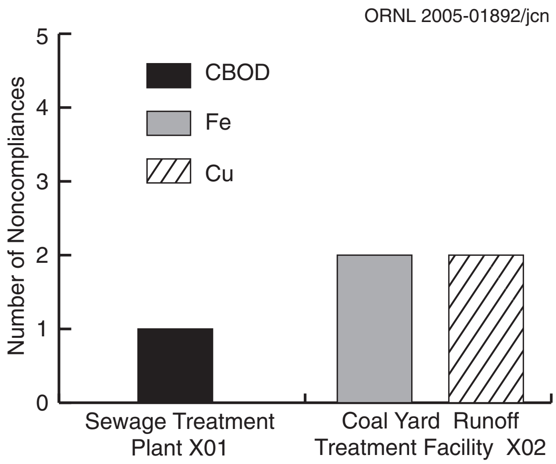

Fig. 5.14. ORNL National Pollutant Discharge Elimination System permit limit noncompliances in 2004.

residual oxidant measurements may include both chlorine and bromine residuals. Most outfalls with total residual oxidant mass-loading action levels are monitored semiannually; the rest of them are monitored either weekly, semimonthly, or quarterly. A number of outfalls that do not have dry-weather total residual oxidant discharges were dropped from the Chlorine Control Strategy during the duration of the NPDES permit. Outfalls included in the Chlorine Control Strategy have a mass-loading action level for total residual oxidants that requires ORNL to reduce or eliminate total residual oxidants in the discharge if they exceed the action level. The action level is 1.2 g/d and is calculated by multiplying the instantaneously measured concentration by the instantaneous flow rate of the outfall.

ORNL monitored 140 measurable dry-weather discharges during 2004 at 25 outfalls. No outfalls exceeded the action level. A report detailing monitoring results, corrective actions, and proposed modifications is submitted to TDEC annually.

5.5.1.3 Storm Water Pollution Prevention Plan

The Storm Water Pollution Prevention Plan is a requirement of the ORNL NPDES Permit to document existing material management practices and to evaluate the vulnerability of those practices in contributing pollutants to area streams via storm water runoff. The plan consists of four major components:

1. assessment and mapping of outdoor material storage/handling at ORNL,
2. characterization of storm water runoff by monitoring,
3. training of employees, and
4. implementation of measures to minimize storm water pollution in areas of ORNL that may be vulnerable.

These four components of the plan were initiated in 1997 and are reviewed and updated by the facility at least annually. The plan was last updated in June 2004. This update includes observations and data from the previous year. ORNL has a storm water pollution prevention program that includes an inspection program, the analysis of storm water data collected as part of the NPDES program, training for ORNL employees and contractors, and an annual review and revision of the program document. (The document is available to personnel on the ORNL site via the ORNL internal web.)

For sampling purposes, ORNL categorizes its storm water outfalls into four broad groups based on common land uses or pollutant sources and storm water pollutant potential. These four groups are further subdivided based on permit categorizations that have different monitoring schedule requirements. The permit requires that Category I and II outfalls be characterized over a five-year period and that Category III and IV outfalls be characterized over a three-year period. The outfalls chosen to be sampled were thought to be representative of the group or were thought to be more vulnerable to runoff pollution. Other factors considered in selecting representative outfalls from each group include interest in a particular runoff quality at an outfall and ease of obtaining a representative sample. A rotation of representative outfalls occurs each sampling period as directed by the permit. The results of the storm water outfall effluent sampling as of 2004 are provided in Attachment 6.0 of the Storm Water Pollution Prevention Plan.

The EPA Nationwide Urban Runoff Program was developed to expand the understanding of urban runoff pollution by instituting data collection and applied research projects in the urban areas of the United States. Urban stormwater runoff pollutant-loading factors for ten standard water quality constituents, called “event mean concentrations” (EMCs), were developed for the 1983 program's final report. Program findings were again updated in 1999 by using results of storm water data collected by the U.S. Geological Survey and the NPDES Storm Water Program to refine the EMCs.

In a comparison of recent ORNL data from 18 storm water outfalls with data from the Nationwide Urban Runoff Program, most values for the 10 water quality constituents measured are well below the EMCs. Patterns of values exceeding the EMCs can be generalized by exceedances of copper or zinc. Copper is found naturally in the soils and could also occur from coal-burning activities or corrosion of copper pipes. Zinc can be attributed to vehicular degradation. There were also a few exceedances of suspended solids that can probably be attributed to the numerous construction projects in and around the main ORNL campus.

5.5.2 Results and Progress in Implementing Programs and Corrective Actions: ORNL Sink and Drain Survey Program

In 1997, ORNL completed a comprehensive verification of the routing of all wastewater discharges from points of entry such as sinks and floor drains. As a result, more than 9000 sink and drain records were produced and are stored in a central database. ORNL has continued its efforts annually and in 2004 continued an annual division-by-division recertification of ORNL sinks and drains to ensure that they continue to discharge to the proper wastewater collection systems. Program management continues to communicate sink and drain responsibilities to the ORNL site population.

5.6 ORNL Wastewater Biomonitoring

Under the NPDES permit, wastewaters from the Sewage Treatment Plant, the CYRTF, and the PWTC were evaluated for toxicity. The results of the toxicity tests of wastewaters from the three treatment facilities are given in Table 5.6. Table 5.6 provides, for each wastewater, the month the test was conducted, the wastewater's no-observed-effect concen-tration (NOEC), and the concentration that kills 50% of the test organisms (LC_{50}) for fathead minnows (*Pimephales promelas*) and daphnia (*Ceriodaphnia dubia*). The NOEC is the highest concentration tested that does not significantly reduce survival or growth of fathead minnows or survival or reproduction of *Ceriodaphnia*. The 96-h LC_{50} is the concentration of wastewater that kills 50% of the test organisms in 96 h. The NPDES permit defines the limits for the biomonitoring tests. For the X01 (Sewage Treatment Plant) discharge, toxicity is demonstrated if more than 50% lethality of the test organisms

Table 5.6. Toxicity test results of ORNL wastewaters, 2004

Test date	Test species	NOEC[a]	LC_{50}[b]
Sewage Treatment Plant (outfall X01)			
February	*Ceriodaphnia*	41.1	>41.1
	Fathead minnow	41.1	>41.1
May	*Ceriodaphnia*	41.1	>41.1
	Fathead minnow	41.1	>41.1
August	*Ceriodaphnia*	41.1	>41.1
	Fathead minnow	41.1	>41.1
November	*Ceriodaphnia*	41.1	>41.1
	Fathead minnow	41.1	>41.1
Coal Yard Runoff Treatment Facility (outfall X02)			
February	*Ceriodaphnia*	NA[c]	>4.2[d]
	Fathead minnow	NA[c]	>4.2[d]
May	*Ceriodaphnia*	NA[c]	>4.2[d]
	Fathead minnow	NA[c]	>4.2[d]
August	*Ceriodaphnia*	NA[c]	>4.2[d]
	Fathead minnow	NA[c]	>4.2[d]
November	*Ceriodaphnia*	NA[c]	>4.2[d]
	Fathead minnow	NA[c]	>4.2[d]
Process Waste Treatment Complex (outfall X12)			
February	*Ceriodaphnia*	100	>100
	Fathead minnow	100	>100
May	*Ceriodaphnia*	100	>100
	Fathead minnow	100	>100
August	*Ceriodaphnia*	100	>100
	Fathead minnow	100	>100
October–	*Ceriodaphnia*	100	>100
November	Fathead minnow	100	>100

[a]NOEC = no-observed-effect concentration; the concentration (as percentage of full-strength wastewater) that caused no reduction in *Ceriodaphnia* survival or reproduction or fathead minnow survival or growth.

[b]LC_{50} = the concentration (as percentage of full-strength wastewater) that kills 50% of the test species in 96 h.

[c]Insufficient duration of discharge for chronic test and determination of NOEC.

[d]48-h LC_{50}.

occurs in 96 h in 41.1% effluent or if the NOEC is less than 12.3%. For the X02 discharge (CYRTF), toxicity is demonstrated if more than 50% lethality of the test organisms occurs in 96 h in 4.2% effluent or if the NOEC is less than 1.3%. Because of the batch mode of discharge at the CYRTF, the limit for the NOEC only applies if the facility discharges for a sufficient length of time. For the X12 discharge (PWTC), toxicity is demonstrated if more than 50% lethality of the test organisms occurs in 96 h in 100% effluent (LC_{50}) or if the NOEC is less than 30.9%.

During 2004, the Sewage Treatment Plant, CYRTF, and PWTC were each tested four times. Numeric biomonitoring limits in the NPDES permit were not exceeded during 2004.

5.7 ORNL Biological Monitoring and Abatement Program

As a condition of the NPDES permit issued to ORNL in April 1986, the BMAP was set forth to assess the condition of aquatic life in White Oak Creek, the Northwest Tributary of White Oak Creek, Melton Branch, Fifth Creek, and First Creek (Loar et al. 1991); the BMAP continued as a condition of the most recent NPDES permit that was effective February 3, 1997 (Kszos et al. 1997). The program addresses the following objectives as described in the NPDES permit part III (I).

- Temperature loadings shall be within state water criteria for protection of fish and aquatic life for warm summer conditions. This should be verified and reported annually (see Table 5.5).
- In-stream water analysis for mercury shall be part of the BMAP so that it can be determined whether mercury at the site is being contributed to the stream and, if so, whether it will impact fish and aquatic life or violate the recreation criteria.
- Sediment and oil and grease from storm discharges shall not create stream impacts.
- The status of PCB contamination in fish tissue in the White Oak Creek watershed shall be determined.
- The Chlorine Control Strategy's protection of the stream in the main plant area shall be assessed.
- In addition, the BMAP shall continue studies evaluating the receiving streams' biological communities throughout the duration of the permit.

5.7.1 Bioaccumulation Studies

The bioaccumulation task for the BMAP addresses two NPDES permit requirements at ORNL: (1) evaluate whether mercury at the site is contributing to a stream such that it will impact fish and aquatic life or violate the recreational criteria (in-stream water analyses for mercury should be part of this activity), and (2) monitor the status of PCB contamination in fish tissue in the White Oak Creek watershed.

5.7.1.1 Mercury in Water

Water samples were collected from White Oak Creek at four sites on six occasions in FY 2004. Stream conditions were representative of seasonal baseflow (dry-weather) conditions at the time of the sampling on all dates except March 10, 2004, which represented the continuing influence of heavy rains two days earlier.
The spatial pattern of aqueous mercury in White Oak Creek showed a clear pattern of decreasing with distance from the main ORNL complex (Fig. 5.15), as it has in previous monitoring. The annual mean concentration of total waterborne mercury in White Oak Creek above the PWTC [White Oak Creek kilometer (WCK) 4.1] was 169 ± 57 ng/L. Waterborne mercury at that site exceeded the Tennessee Water Quality Standard of 51 ng/L on all sampling dates. At the Bethel Valley Integration Point (near the 7500 Bridge), the mean mercury concentration in 2004 was 68 ± 18 ng/L. In White Oak Lake, mercury concentrations averaged 34 ± 8 ng/L, with no values exceeding the Tennessee Water Quality Standard. The annual mean mercury concentration in water at the upstream reference site for White Oak Creek (WCK 6.8) was typical of uncontaminated streams, averaging 2.2 ± 1.0 ng/L. Mercury concentrations in White Oak Creek have exhibited no trends of increasing or decreasing over the past five years (Fig. 5.15).

Bioaccumulation

For the 2004 sampling year, fish were collected from White Oak Creek for contaminant analysis in the spring. To provide data directly applicable to assessing human health concerns, redbreast sunfish (*Lepomis auritus*) were col-

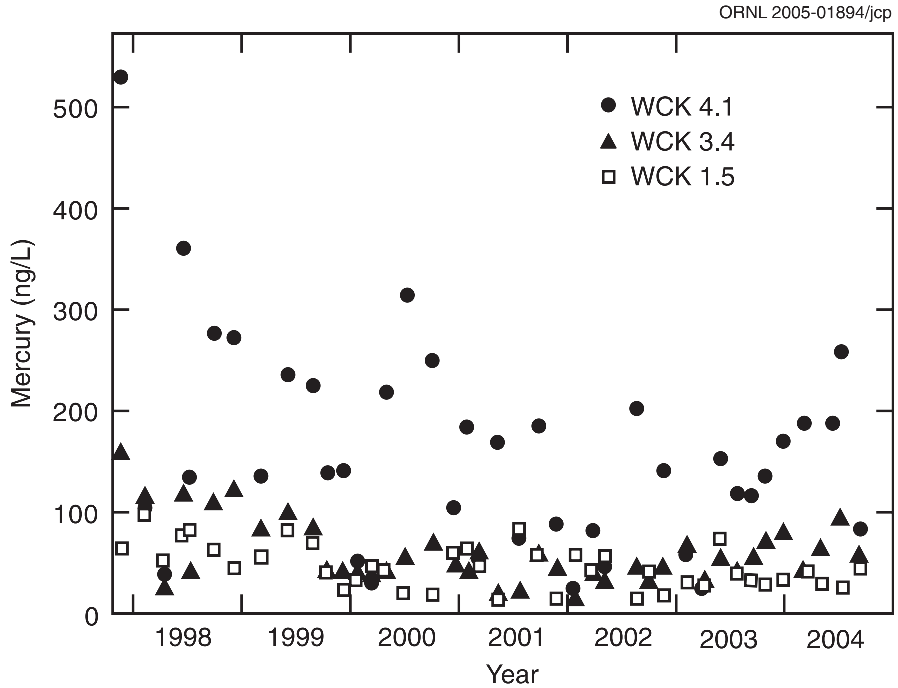

Fig. 5.15. Total mercury in water vs time, 1998–2004, at three sites in the White Oak Creek watershed downstream from ORNL.

lected from WCK 2.9, and bluegill (*Lepomis macrochirus*) and largemouth bass (*Micropterus salmoides*) were collected from WCK 1.5 (White Oak Lake). Collections were restricted to fish of a size large enough to be taken by sport fisherman (> 50 g for sunfish, and > 500 g for bass). Fillet tissue was taken from six individual fish of each species for both mercury and PCB analysis.

Fish collected from White Oak Creek exhibited elevated levels of mercury in 2004, as expected based upon the levels of mercury detected in the water (Table 5.7). Mean mercury concentrations in redbreast sunfish fillets from WCK 2.9 were approximately fourfold higher than was typical of fish from the Hinds Creek reference site, and exceeded the EPA's criterion for mercury in fish tissue of 0.3 ng/L. Mercury levels in bluegill and largemouth bass collected in White Oak Lake were about twofold higher than is typical of these species in local reservoirs, but only the mean concentration in largemouth bass exceeded EPA's fish tissue criterion. A plot of mercury concentrations in fish versus time (Fig. 5.16) suggests that mercury concentrations are increasing, but this is inconsistent with aqueous mercury which showed no temporal trend (Fig. 5.15). However, mean mercury concentrations in each species at each site remain within ranges present in 1986.

Mean PCB concentrations in White Oak Creek fish collected in 2004 are reported in Table 5.7. Since 1985, the BMAP has used sunfish to evaluate changes in PCB exposure over time. Sunfish are short-lived and do not move far from their home territory during their life. Therefore, they provide a site-specific and recent measure of contaminant exposure. The presence of PCBs in fish from WCK 2.9 since the mid 1980s indicates continuing sources upstream. However, trends over the past six years suggest that PCB concentrations are declining in White Oak Creek (Fig. 5.17), although mean values remain within historical ranges, and large year-to-year fluctuations are typical of PCBs in fish in White Oak Creek and other streams on the DOE reservation. Mean PCB concentrations in sunfish from White Oak Lake have generally been higher than those of sunfish from White Oak Creek, suggesting that resuspension and redissolution of PCBs from sediments or stormflow transport of particle-based PCBs from upstream sources may be significant processes in maintaining PCB contamination in fish from White Oak Lake.

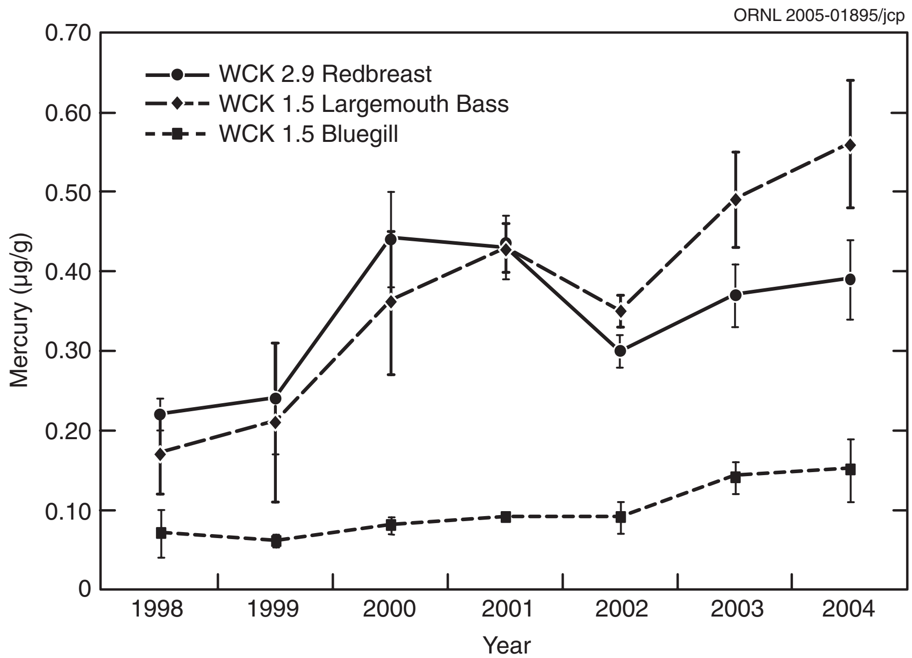

Fig. 5.16. Temporal trends in mercury concentrations in fish, 1998–2004.

Table 5.7. Total mercury and polychlorinated biphenyl (Aroclor 1254 + 1260) concentrations in fish (mean ± SE; range in parenthesis) from sites in White Oak Creek, White Oak Lake, and a reference stream, Hinds Creek, April 2004[a]

Note: N = 6 individual fish for each site/species combination, and samples are of fillet tissue only

Site[a]	Species[b]	Mercury (µg/g)	PCBs (µg/g)
WCK 2.9	Redbreast sunfish	0.39±0.05 (0.24–0.55)	0.19±0.04 (0.10–0.30)
White Oak Lake	Bluegill	0.15±0.04 (0.08–35)	0.34±0.08 (0.11–0.65)
White Oak Lake	Largemouth bass	0.56±0.09 (0.16–0.67)	0.78±0.17 (0.28–1.39)
Hinds Creek	Redbreast sunfish	0.11±0.02 (0.06–0.16)	<0.03

[a]WCK = White Oak Creek kilometer.

[b]Largemouth bass (*Micrpterus salmoides*), bluegill (*Lepomis macrochirus*), and redbreast sunfish (*Lepomis auritus*).

5.7.2 Ecological Surveys

Benthic Macroinvertebrate Communities

Monitoring of the benthic macroinvertebrate communities in White Oak Creek, First Creek, and Fifth Creek continued in 2004. Benthic macroinvertebrate samples are collected at sites upstream and downstream of the influence of ORNL operations. These sites include impacted and unimpacted (reference sites) locations. The objectives of the benthic macroinvertebrate community task are to (1) help assess ORNL's compliance with the current NPDES permit requirements and (2) evaluate and verify the effectiveness of pollution abatement and remedial actions taken at ORNL.

Results for April 2004 showed that the benthic macroinvertebrate communities in First Creek, Fifth Creek, and White Oak Creek downstream of effluent discharges continue to exhibit characteristics of varying degrees of impairment (Figs. 5.18, 5.19, and 5.20). Relative to reference sites, total taxonomic richness and taxonomic richness of the pollution-intolerant taxa continue to be low at the downstream sites. However, except for lower Fifth Creek [Fifth Creek kilometer (FFK) 0.2], these downstream

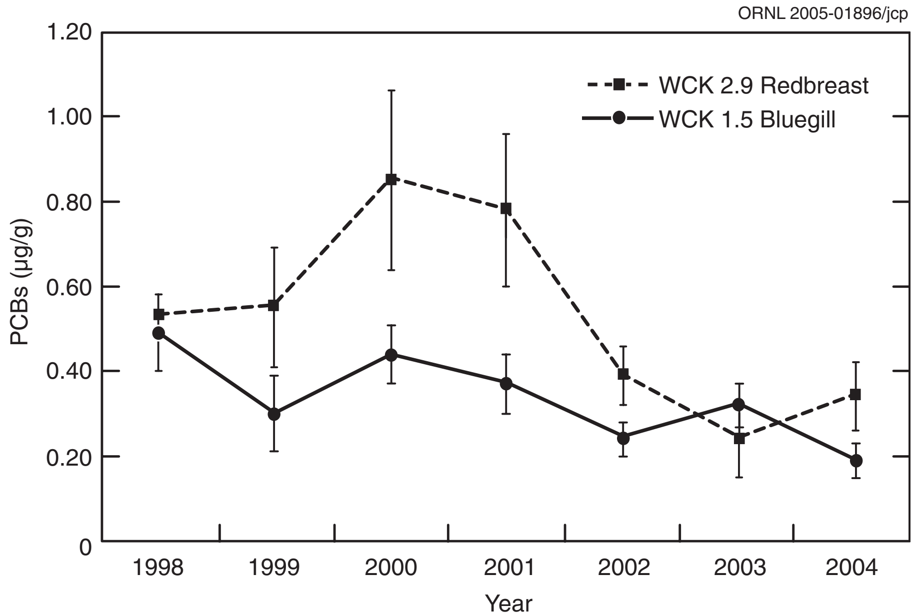

Fig. 5.17. Temporal trends in PCB concentrations in fish, 1998–2004.

sites either exhibited further recovery or no additional change. The macroinvertebrate community in lower First Creek [First Creek kilometer (FCK) 0.1] appears to have stabilized in the past 8 years, as no major trends of change have occurred (Fig. 5.18). In lower Fifth Creek (FFK 0.2), no major change in trends was observed in total taxonomic richness, but richness of the pollution-intolerant taxa decreased for the second consecutive year at FFK 0.2, a trend that was opposite to that exhibited at the reference site (FFK 1.0). Thus, it is possible that there was a new disturbance in lower Fifth Creek after 2002.

In White Oak Creek immediately adjacent to the main ORNL complex (WCK 3.9), total taxonomic richness and richness of the pollution-sensitive taxa showed further increases in 2004, a trend that began after 1998, suggesting that slow recovery continues (Fig. 5.20). Relative to 2003, there were increases in both richness metrics at WCK 2.3 in 2004, but between-year fluctuations in these metrics have been considerable since 1994, and both metrics increased at WCK 6.8 and WBK 1.0. Thus, it is not clear if the change at WCK 2.3 in 2004 was an indication of further improvement or just natural fluctuation.

Fish Communities

Monitoring of the fish communities in White Oak Creek and its major tributaries continued in 2004. Samples were taken at 11 sites in the spring and fall; sites closest to ORNL facilities were emphasized.

In White Oak Creek, the fish community continued to display characteristics of degraded conditions, with sites closest to the outfalls having lower species richness (number of species), fewer pollution-sensitive species, more pollution-tolerant species, and higher density (number of fish per square meter) than similar-sized reference streams. Densities at White Oak Creek sites have generally decreased since 2001 (Fig. 5.21), especially at sites adjacent to Building 4515 (WCKs 3.9 and 4.4). In the past, these sites had very high densities (~14–17 fish/m^2) that were at least tenfold higher than at the larger reference sites. Often in recovering streams, as fish density declines species richness will increase reflecting an overall improvement. However, in White Oak Creek there has not been a corresponding increase in species richness as density has decreased. The low species richness seen in White Oak Creek watershed, relative to off-site reference locations, is partially a result of barriers that limit immigration of new species from the Clinch River drainage.

Species richness of fish in tributaries to White Oak Creek remained low in 2004 relative to reference streams not in the White Oak Creek watershed. The density of fish communities of First Creek and Melton Branch showed little change in 2004 relative to 2003; sites adjacent to

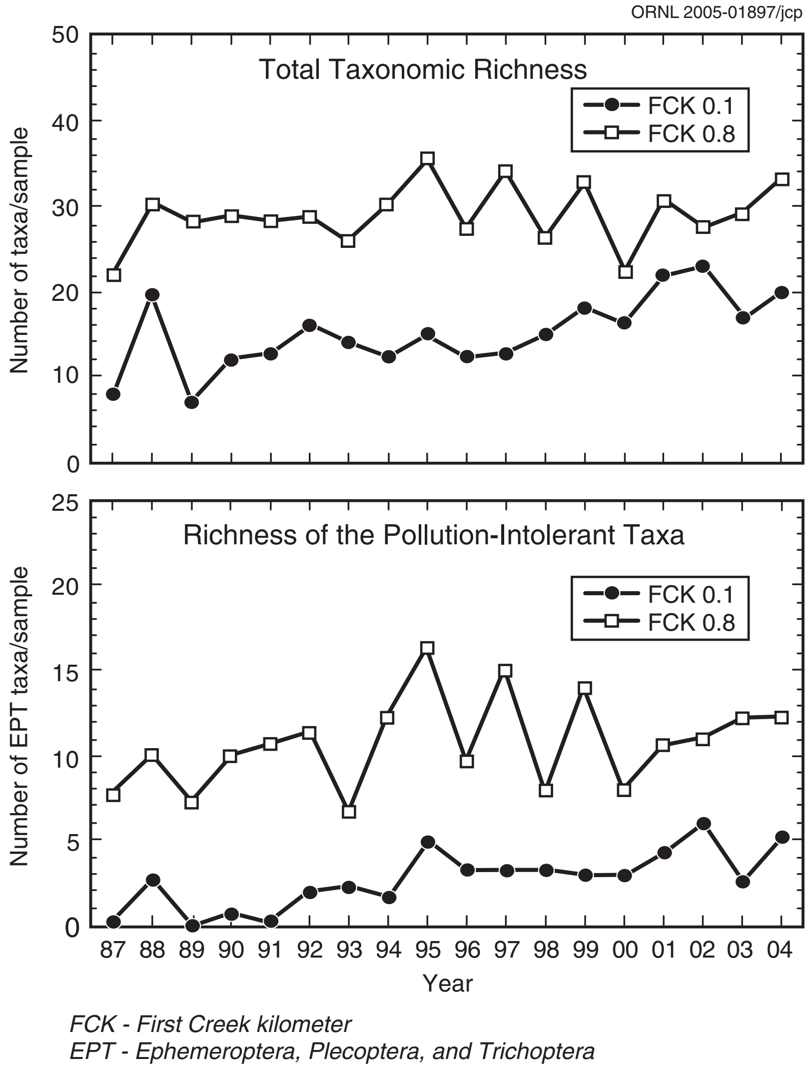

Fig. 5.18. Taxonomic richness and richness of the pollution-intolerant taxa of the benthic macroinvertebrate communities in White Oak Creek during April sampling periods, 1987–2004.

and downstream of ORNL outfalls remained somewhat impacted relative to reference streams. The fish community in Fifth Creek, in contrast, has shown a notable decline in abundance at the downstream site (FFK 0.2) since fall 2002 (Fig. 5.22).

5.8 ORNL Surface Water Monitoring at NPDES Reference Location

White Oak Creek headwaters were monitored in 2004 as a background or reference location for ORNL NPDES surface water monitoring.

In an effort to provide a basis for evaluation of analytical results and for assessment of nonradiological surface water quality, Tennessee General Water Quality Criteria have been used as reference values. The criteria for fish and aquatic life have been used at White Oak Creek headwaters. (See Appendix C, Table C.2, for Tennessee General Water Quality Criteria for all parameters in water. See Tables 2.3 and 3.4 in *Environmental Monitoring on the Oak Ridge Reservation: 2004 Results* (DOE 2005b) for surface water analyses.)

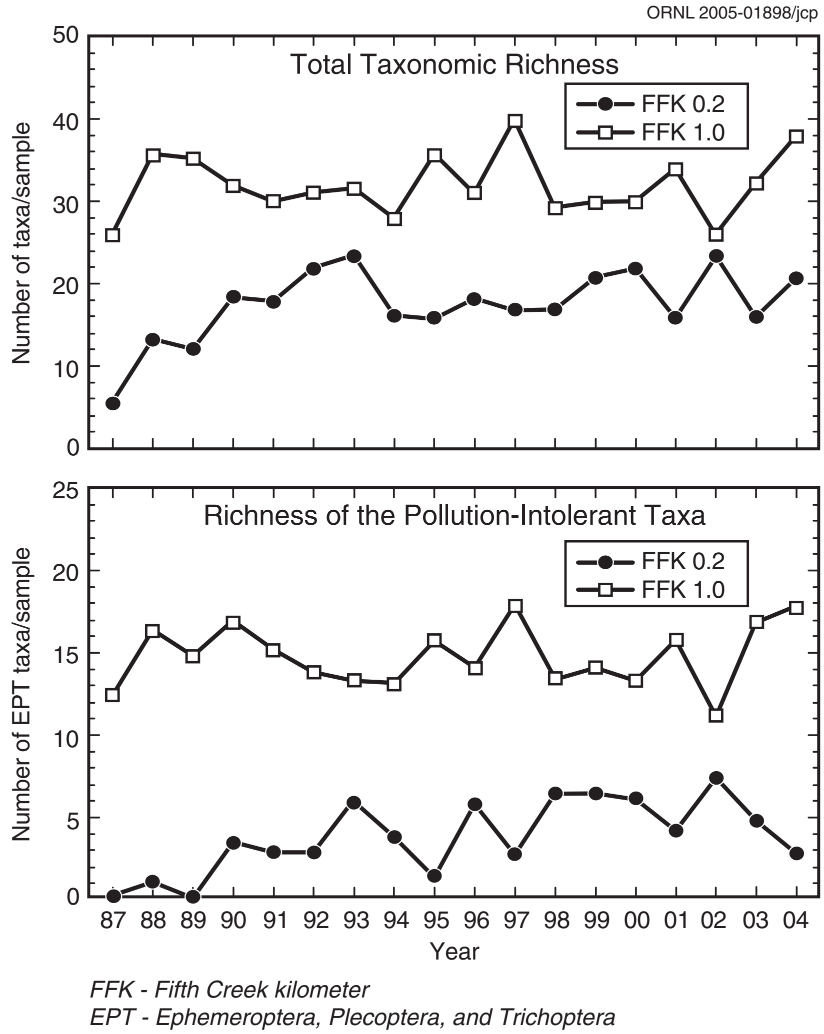

Fig. 5.19. Taxonomic richness and richness of the pollution-intolerant taxa in the benthic macroinvertebrate communities in First Creek during April sampling periods, 1987–2004.

5.9 ORNL Surface Water Surveillance Monitoring

The ORNL surface water monitoring program includes sample collection and analysis from 18 locations at ORNL and around the ORR. This program is conducted in conjunction with the ORR surface water monitoring activities discussed in Sect. 7.4 to enable an assessment of the impacts of past and current DOE operations on the quality of local surface water. These programs are conducted in addition to the surface water monitoring required by NPDES permits at ORNL facilities; sampling location, frequency, and analytical parameters vary among them. Sampling locations include streams downstream of ORNL waste sources, reference points on streams and reservoirs upstream of waste sources, and public water intakes (see Fig. 5.23).

Sampling frequency and parameters vary by site. Grab samples are collected and analyzed for general water quality parameters at all locations and all are screened for radioactivity and analyzed for specific radionuclides when appropriate. White Oak Lake at White Oak Dam is also checked for VOCs, PCBs, and metals. Table 5.8 lists the specific locations and their sampling frequencies and parameters.

Ten of the 18 sampling locations are classified by the state of Tennessee for certain uses (e.g., domestic water supplies or recreational use). Tennessee water quality criteria for domestic water supplies, for freshwater fish and

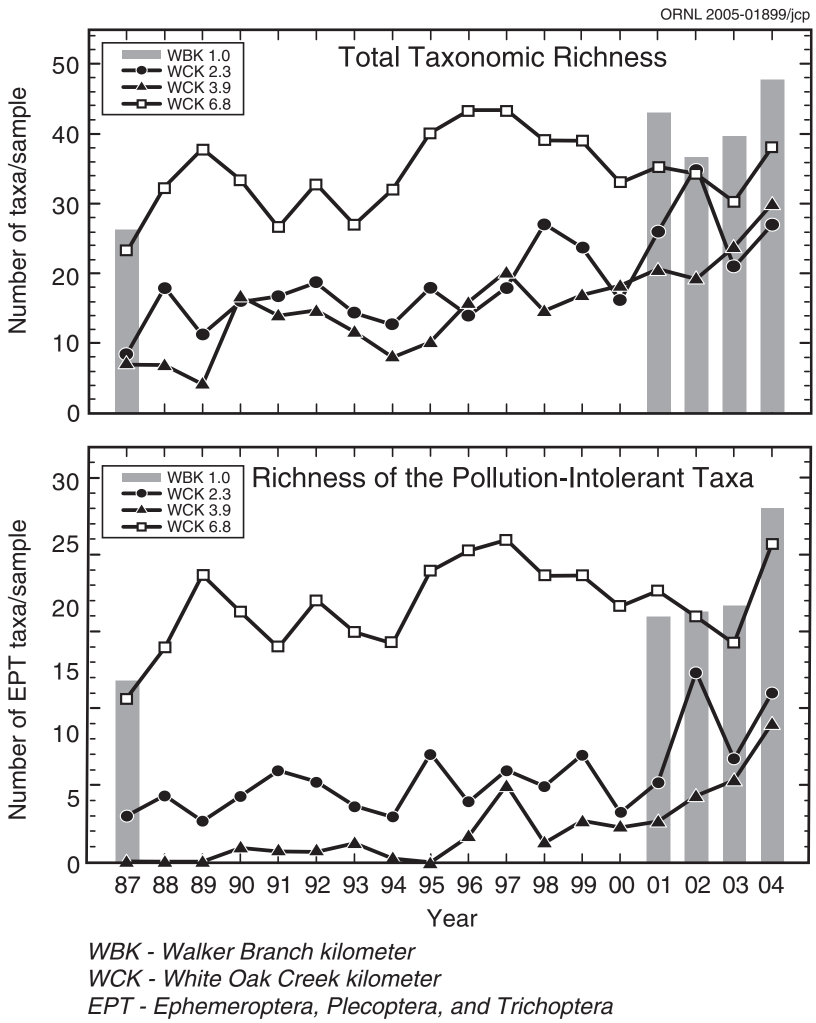

Fig. 5.20. Taxonomic richness and richness of the pollution-intolerant taxa in the benthic macroinvertebrate communities in Fifth Creek during April sampling periods, 1987–2004.

aquatic life, and for recreation (water and organisms) are used as references for locations where they are applicable. The Tennessee water quality criteria do not include criteria for radionuclides.

5.9.1 Results

Radionuclides were detected above MDAs at all surface water locations in 2004. The levels of gross beta, total radioactive strontium, and tritium continue to be highest at Melton Branch kilometer (MEK) 0.2, White Oak Creek at White Oak Dam (WCK 1.0), and WCK 2.6. These data are consistent with historical data and with the processes or legacy activities nearby or upstream from these locations.

Remediation efforts by Bechtel Jacobs Company (BJC), including removal of contaminated soil in the North Tank Farm and pumping groundwater from Well 4411 to a treatment system have resulted in decreases in levels of gross alpha, gross beta, and total radioactive strontium at the First Creek location. Although greatly diminished from concentrations measured in the mid 1990s, the levels remain seasonally variable because of dilution in First Creek flow. Ongoing monitoring and investigations performed during the Bethel Valley Groundwater Engineering Study confirm that there is infiltration of approximately 2.5 gpm of plume water into storm drains that discharge into outfall 341, which discharges into First Creek. The Groundwater Engineering Study is performing investigations to implement a more efficient plume management strategy to further reduce contaminant discharge

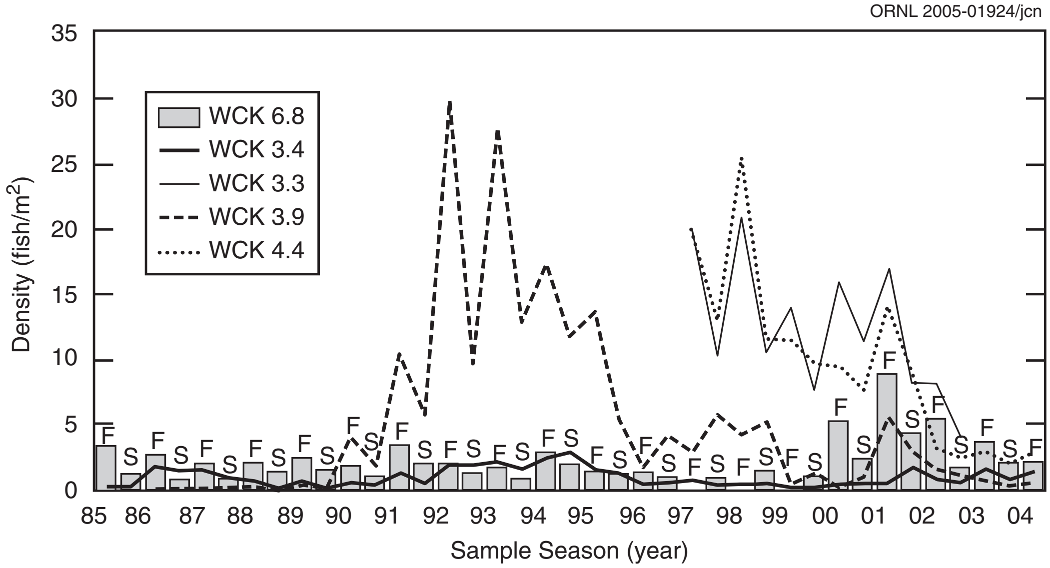

Fig. 5.21. Density (fish per cubic meter) estimates for spring (S) and fall (F) samples at White Oak Creek, 1985–2004.

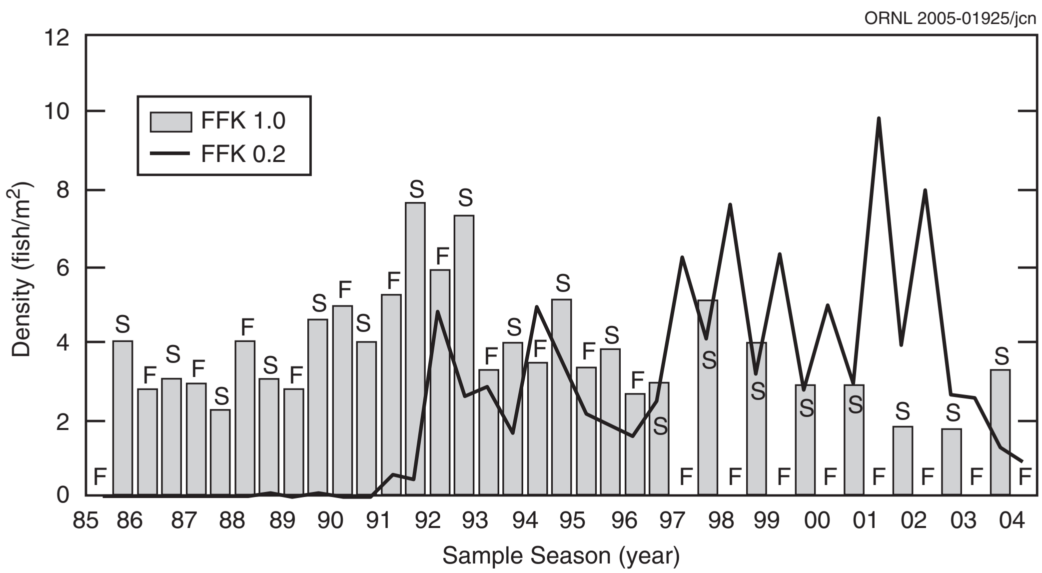

Fig. 5.22. Density (fish per cubic meter) estimates for spring (S) and fall (F) at White Oak Creek, 1985–2004.

to First Creek and to minimize the volume of groundwater that requires collection and treatment.

VOCs were detected at White Oak Creek at White Oak Dam in 2004: some chloroform and toluene, and two common laboratory contaminants, acetone and 2-butanone. The toluene was detected at low levels and, although not a common laboratory contaminant, probably was due to laboratory contamination because it was also detected in the laboratory blanks.

Two locations, one on Northwest Tributary [Northwest Tributary kilometer (NWTK) 0.1] and one on Raccoon Creek [Raccoon Creek kilometer (RCK) 2.0], also had elevated levels of gross beta and total radioactive strontium. Historically, results at both locations have a seasonal pattern; concentrations at Northwest Tributary are usually higher in the spring, whereas concentrations at Raccoon Creek are usually higher in the fall. This pattern has been disrupted in the past several years. The apparent

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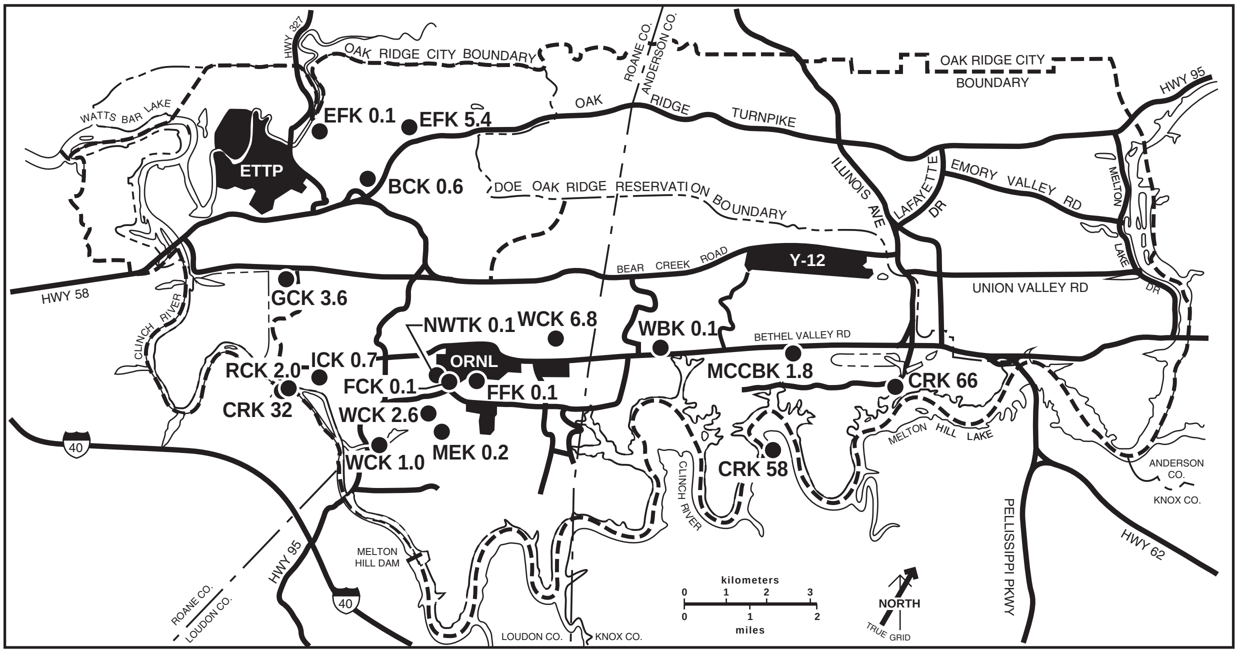

Fig. 5.23. ORNL surface water sampling locations.

change in rainfall precipitation patterns since the fall of 2000 probably accounts for the change in the seasonality pattern. Both of these locations are impacted by contaminated groundwater from SWSA 3.

5.10 ORNL Sediment

Stream and lake sediments act as a record of some aspects of water quality by concentrating and storing certain contaminants. Sampling sites for sediment are the Clinch River downstream from all DOE inputs [Clinch River kilometer (CRK) 16], the Clinch River downstream from ORNL (CRK 32), and the Clinch River at the Solway Bridge, upstream from all DOE inputs (CRK 70) (Fig. 5.24). The locations are sampled annually, and gamma scans are performed on the samples.

In addition, two samples per year containing settleable solids are collected in conjunction with a heavy rain event to characterize sediments that exit ORNL during a storm event. The sampling locations are Melton Branch upstream from ORNL (MEK 2.1), White Oak Lake at White Oak Dam (WCK 1.0), White Oak Creek downstream from ORNL (WCK 2.6), and White Oak Creek Headwaters as a reference location (Fig. 5.24). These samples are filtered, and the residue (settleable solids) is analyzed for gross alpha, gross beta, and gamma emitters.

5.10.1 Results

Potassium-40, a naturally occurring radionuclide, was detected in sediments at all three locations; ^{7}Be, also naturally occurring, was detected in sediments at CRK 16; and ^{137}Cs was also detected in the samples collected at CRK 16 and CRK 32.

Heavy-rain-event sampling took place in September and October 2004. The concentrations of radionuclides associated with each of these rain events are variable, which is common for these types of samples.

5.11 Groundwater Monitoring at ORNL

5.11.1 Background

The groundwater monitoring program at ORNL consists of a network of wells of two basic types and functions: (1) water quality monitoring wells built to RCRA specifications and used for site characterization and compliance purposes and (2) piezometer wells used to characterize groundwater flow conditions. The DOE

Table 5.8. ORNL surface water sampling locations, frequencies, and parameters, 2004

Location[a]	Description	Frequency	Parameters
BCK 0.6	Bear Creek downstream from DOE inputs	Semiannually (Apr, Oct)	Gross alpha, gross beta, gamma scan, field measurements[b]
CRK 32	Clinch River downstream from ORNL	Monthly	Gross alpha, gross beta, gamma scan, total radioactive strontium, ^{3}H, field measurements[b]
CRK 58	Water supply intake for Knox County	Monthly	Gross alpha, gross beta, gamma scan, field measurements[b]
CRK 66	Melton Hill Reservoir above city of Oak Ridge water intake	Monthly	Gross alpha, gross beta, gamma scan, field measurements[b]
EFK 0.1	East Fork Poplar Creek prior to entering Poplar Creek	Semiannually (Apr, Oct)	Gross alpha, gross beta, gamma scan, field measurements[b]
EFK 5.4	East Fork Poplar Creek downstream from floodplain	Semiannually (Apr, Oct)	Gross alpha, gross beta, gamma scan, field measurements[b]
MEK 0.2	Melton Branch downstream from ORNL	Bimonthly (Jan, Mar, May, Jul, Sep, Nov)	Gross alpha, gross beta, gamma scan, total radioactive strontium, ^{3}H, field measurements[b]
WCK 1.0	White Oak Lake at White Oak Dam	Monthly	Volatiles, metals, PCBs, gross alpha, gross beta, gamma scan, total radioactive strontium, ^{3}H, field measurements[b]
WCK 2.6	White Oak Creek downstream from ORNL	Bimonthly (Jan, Mar, May, Jul, Sep, Nov)	Gross alpha, gross beta, gamma scan, total radioactive strontium, ^{3}H, field measurements[b]
WCK 6.8	White Oak Creek upstream from ORNL	Quarterly (Feb, May, Aug, Nov)	Gross alpha, gross beta, total radioactive strontium, gamma scan, ^{3}H, field measurements[b]
WBK 0.1	Walker Branch prior to entering CRK 53.4	Semiannually (Apr, Oct)	Gross alpha, gross beta, gamma scan, field measurements[b]
GCK 3.6	Grassy Creek upstream of SEG and IT Corp. at CRK 23	Semiannually (Apr, Oct)	Lead, gross alpha, gross beta, gamma scan, field measurements[b]
ICK 0.7	Ish Creek prior to entering CRK 30.8	Semiannually (Apr, Oct)	Gross alpha, gross beta, gamma scan, field measurements[b]
MCCBK 1.8	McCoy Branch prior to entering CRK 60.3	Semiannually (Apr, Oct)	Gross alpha, gross beta, gamma scan, field measurements[b]
RCK 2.0	Raccoon Creek sampling station prior to entering CRK 31	Semiannually (Apr, Oct)	Gross alpha, gross beta, total radioactive strontium, gamma scan, ^{3}H, field measurements[b]
NWTK 0.1	Northwest Tributary prior to the confluence with First Creek	Semiannually (Apr, Oct)	Gross alpha, gross beta, total radioactive strontium, gamma scan, ^{3}H, field measurements[b]
FCK 0.1	First Creek prior to the confluence with Northwest Tributary	Semiannually (Apr, Oct)	Gross alpha, gross beta, total radioactive strontium, gamma scan, ^{3}H, field measurements[b]
FFK 0.1	Fifth Creek just upstream of White Oak Creek (ORNL)	Semiannually (Apr, Oct)	Gross alpha, gross beta, total radioactive strontium, gamma scan, ^{3}H, field measurements[b]

[a]Locations identify bodies of water and locations on them (e.g., CRK 32 = 32 km upstream from the confluence of the Clinch and the Tennessee Rivers).

[b]Field measurements consist of dissolved oxygen, pH, and temperature.

ORNL 2005-01901

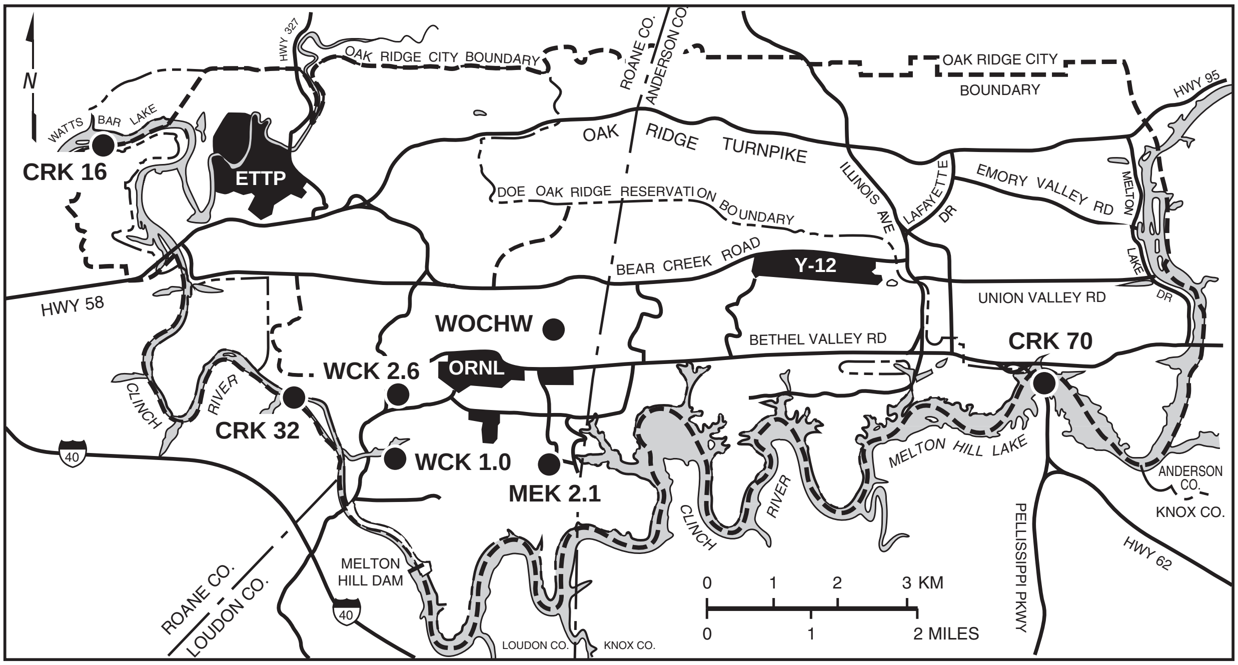

Fig. 5.24. ORNL sediment sampling locations.

Environmental Management and Enrichment Facilities Program, formerly the Environmental Restoration Program, provides comprehensive cleanup of sites where past R&D and waste management activities have resulted in contamination of the environment. The Environmental Management and Enrichment Facilities Program is managed by BJC for DOE. Impacts on groundwater at ORNL are also monitored by UT-Battelle via the Groundwater Exit Pathway Monitoring Program. The program comprises the majority of groundwater surveillance monitoring at ORNL by UT-Battelle for the DOE Office of Science. UT-Battelle also provides surveillance monitoring services for the HFIR and SNS sites.

Individual monitoring and assessment programs are impractical for each of the waste management and R&D sites because their boundaries are indistinct, and there are hydrologic interconnections among many of them. Consequently, the concept of waste area groupings (WAGs) was developed in the late 1980s to facilitate evaluation of potential sources of releases to the environment. A WAG is a grouping of multiple sites that are geographically contiguous and/or that occur within geohydrologically defined areas. WAGs and a watershed-based remediation approach established by BJC allow establishment of suitably comprehensive groundwater and surface water monitoring and remediation programs in a far shorter time than that required to deal with every facility, site, or solid waste management unit individually. At ORNL, 20 WAGs were identified by the RCRA Facility Assessment conducted in 1987. Water quality monitoring wells were established around the perimeters of the WAGs determined to have a potential for release of contaminants. Fig. 5.25 shows the location of each of the 20 WAGs.

Groundwater quality monitoring wells for the WAGs are designated as hydraulically upgradient or downgradient (perimeter), depending on their location relative to the general direction of groundwater flow. Upgradient wells are located to provide groundwater samples that are not expected to be affected by possible leakage from the site. Downgradient wells are positioned along the perimeter of the site to detect possible groundwater contaminant migration from the site. No groundwater quality monitoring wells were installed for the WAG 10 grout sheets.

In 1996, DOE established the Integrated Water Quality Program to conduct long-term environmental monitoring throughout the ORR. The Water Resources Restoration Program suc-

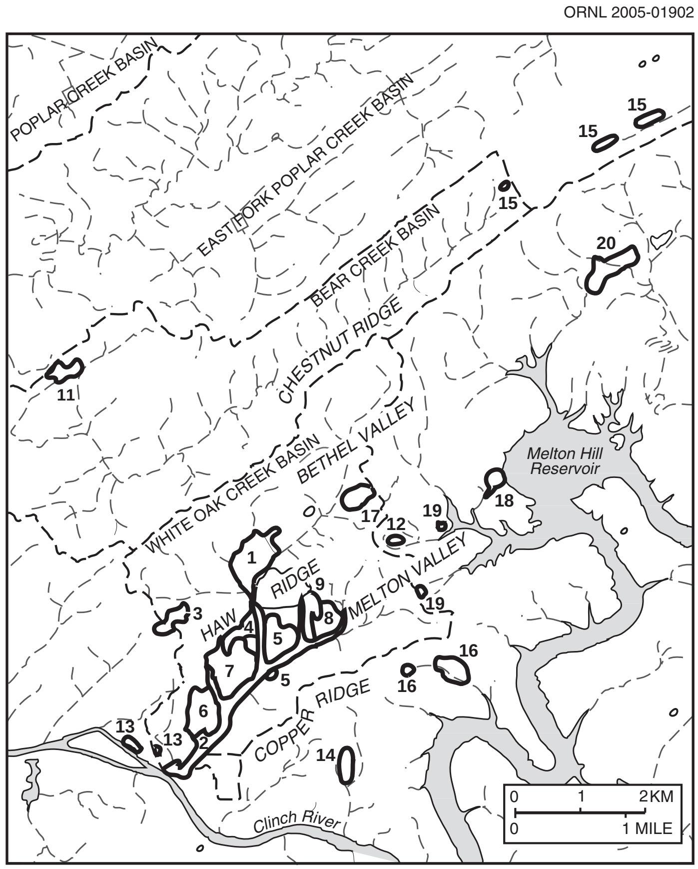

Fig. 5.25. Locations of ORNL waste area groupings.

ceeded the Integrated Water Quality Program in fall 1999. The Integrated Water Quality Program was managed by the Environmental Restoration Program at the time of its initiation. The Water Resources Restoration Program is currently managed by the Environmental Management and Enrichment Facilities Program through BJC and is the vehicle for DOE to carry out the regulatory requirement from the Federal Facility Agreement to conduct postremedial action monitoring. The Water Resources Restoration Program has shifted away from the WAG concept to more of a watershed approach to remediation, which resulted in the assignment of two watersheds to ORNL: Bethel Valley and Melton Valley.

The ORNL groundwater program was reviewed in 1996, and modifications included transfer of monitoring responsibility for some of the WAGs to the Water Resources Restoration Program. A summary of the ORNL groundwater surveillance program, presented in Table 5.9, indicates whether WAGs are within Bethel Valley or Melton Valley. To provide continuity with previous annual site environmental reports and to allow comparison of activities and sampling results, the WAG concept is used in the following discussions. In the current ORNL program, groundwater quality wells are sampled on an annual basis (Table 5.9).

Monitoring results for remedial actions (under Water Resources Restoration Program purview) that are in progress or that have been completed within specific WAGs during 2004 are reported annually in the *Environmental Management and Enrichment Facilities Program Remediation Effectiveness Report* (DOE 2005a). Additionally, in the case of WAG 6, which is regulated under both RCRA and CERCLA, specific monitoring results and interpretations required by RCRA are reported in the annual *Groundwater Quality Assessment Report for Solid Waste Storage Area 6* (BJC 2004a), which is issued in February of each year.

UT-Battelle's WAG perimeter monitoring network and the ORNL plant perimeter groundwater surveillance program involved 49 wells in

Table 5.9. Summary of the ORNL groundwater surveillance program, 2004[a]

WAG	Regulatory status	Wells		Frequency and last date sampled in 2004	Locations	Parameters
		Upgradient	Downgradient			
			Bethel Valley			
1	CERCLA and DOE Orders 450.1 and 5400.5	3	24	Annually, March 2004	4 wells	Radionuclides[b] and field measurements[c]
3	DOE Orders 450.1 and 5400.5	3	12	*d*	*d*	*d*
17	DOE Orders 450.1 and 5400.5	4	4	Annually, March 2004	All wells	Volatile organics, radionuclides,[b] and field measurements[c]
			Melton Valley			
2	CERCLA and DOE Orders 450.1 and 5400.5	12	8	Annually, April 2004	4 wells 16 wells	Full set[e] and field measurements[c] Radionuclides[b] and field measurements[c]
4	CERCLA and DOE Orders 450.1 and 5400.5	4	11	*d*	*d*	*d*
5	CERCLA and DOE Orders 450.1 and 5400.5	2	20	*d*	*d*	*d*
6	RCRA/CERCLA and DOE Orders 450.1 and 5400.5	7	17	*f*	*f*	*f*
7	CERCLA and DOE Orders 450.1 and 5400.5	2	14	*d*	*d*	*d*
8 and 9	DOE Orders 450.1 and 5400.5	2	9	Annually, April 2004	All wells	Radionuclides[b] and field measurements[c]
			White Wing Scrap Yard			
11	DOE Orders 450.1 and 5400.5	6	5	*d*	*d*	*d*

[a]Abbreviations
CERCLA = Comprehensive Environmental Response, Compensation, and Liability Act
DOE = U.S. Department of Energy
RCRA = Resource Conservation and Recovery Act
WAG = waste area grouping.

[b]Gross alpha and beta, ^{3}H, ^{137}Cs, ^{60}Co, and total radioactive strontium.

[c]Standard field measurements: pH, conductivity, turbidity, oxidation/reduction potential, temperature, and dissolved oxygen.

[d]Water Resources Restoration Program (formerly Integrated Water Quality Program) samples selected wells for various purposes; other wells are inactive.

[e]Volatile organics, metals, gross alpha and beta, ^{3}H, ^{137}Cs, ^{60}Co, and total radioactive strontium.

[f]Sampled by Environmental Management and Enrichment Facilities and data reported in the *Groundwater Quality Assessment Report for Solid Waste Storage Area 6 at Oak Ridge National Laboratory, Oak Ridge, Tennessee CY 2004*, BJC/OR-2105. Bechtel Jacobs Company LLC. Oak Ridge, Tennessee (BJC 2004a).

2004. The ORNL exit pathway program is designated to monitor groundwater at locations thought to be likely exit pathways for groundwater affected by activities at ORNL. The program was initiated in 1993 and was reviewed in 1996, which resulted in White Oak Creek and Melton Valley being the focus of the program (Fig. 5.26). A summary of the current program is presented in Table 5.10.

Four of the ten wells that make up ORNL's exit pathway monitoring program are also part of the WAG perimeter monitoring program. These four wells are located within WAG 2, and 2004 data from these four wells were used in conjunction with data from the six exit pathway wells for evaluating groundwater concentrations exiting the ORNL site via the White Oak Dam area. The results of the plant perimeter and exit pathway monitoring programs are discussed in the following sections.

None of the ORNL WAGs monitored under UT-Battelle's surveillance groundwater monitoring program are regulated under RCRA permits; therefore, no permit standards exist with which to compare sampling results. WAG 6 is monitored under a combined RCRA/CERCLA regulatory strategy and is not monitored under the UT-Battelle surveillance groundwater monitoring program. In an effort to provide a basis for evaluation of analytical results and for assessment of groundwater quality monitored by UT-Battelle at the ORNL WAGs, federal drinking water standards, and Tennessee Water Quality Criteria for domestic water supplies are used as reference values in the following discussions. When no federal or state standard has been established for a radionuclide, then 4% of the DOE DCG is used. Although drinking water standards are used, it is important to realize that no members of the public consume groundwater from ORNL WAGs, nor do any groundwater wells furnish drinking water to personnel at ORNL.

Trend analyses were performed on data generated from surveillance of exit pathway wells or wells that monitor areas or facilities actively managed by UT-Battelle where organic, heavy metal (RCRA metals), or radiological contaminants exceeded their respective reference values during 2004. Naturally occurring inorganic contaminants (metals such as aluminum, iron, manganese, and zinc) whose 2004 concentrations

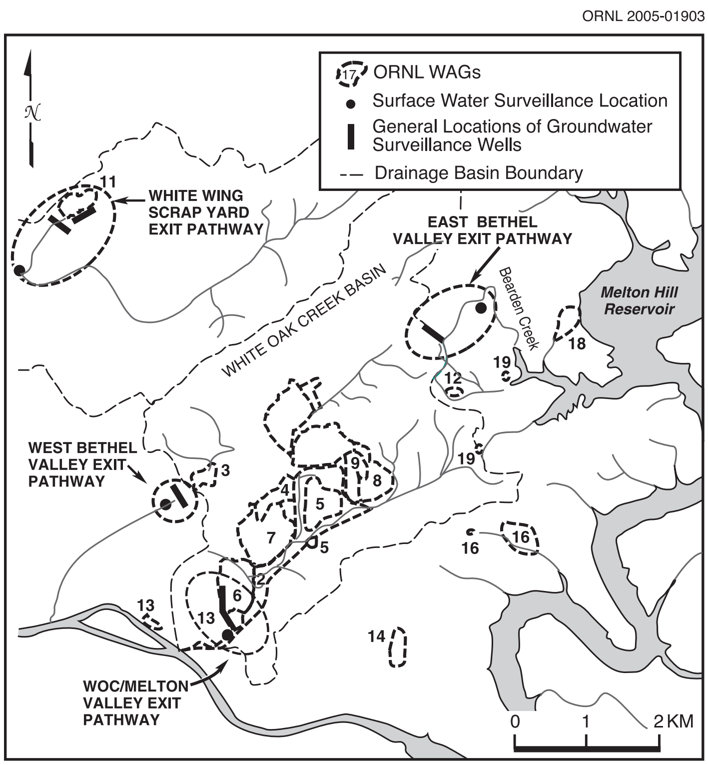

Fig. 5.26. Groundwater exit pathways on the ORR that are likely to be affected by Oak Ridge operations.

Table 5.10. Summary of the ORNL plant perimeter surveillance program, 2004[a]

Exit pathway	WAG	Number of wells	Surface water locations	Parameters
White Oak Creek/ Melton Valley	6 and 2[b]	10	White Oak Creek at White Oak Dam	Volatile organics, ICP metals, ^{3}H, total radioactive strontium, gross alpha and beta, ^{60}Co, and ^{137}Cs

[a]Abbreviations
ICP = inductively coupled plasma
WAG = waste area grouping
[b]Four wells are part of the ORNL WAG 2 perimeter network.

exceeded their reference values were not subjected to trend analysis because these constituents are commonly found in the soil and rock composing the earth's crust and are regularly found in groundwater samples collected from wells at ORNL. The trend analyses were performed using historical data collected from 1991 through the 2004 monitoring period.

5.11.2 Bethel Valley

Bethel Valley, located in the southeastern portion of the ORR, lies between two prominent, parallel, northeast-southwest trending ridges, Chestnut Ridge to the north and Haw Ridge to the south. Research and development facilities have been located within it for 50 years, and it contains the main ORNL facilities complex, including buildings, reactors, surface impoundments, and buried waste tank farms with transfer pipelines. In most instances, groundwater flow in Bethel Valley is from the northeast to southwest (i.e., parallel to the strike direction), and contaminant plumes generally enter the surface water system.

5.11.2.1 WAG 1 Area

WAG 1, the ORNL main plant area, contains about one-half of the remedial action sites identified to date by the Environmental Management and Enrichment Facilities Program. WAG 1 lies within the Bethel Valley portion of the White Oak Creek drainage basin. The boundaries of the basin extend to the southeast and northeast along Chestnut and Haw Ridges. The WAG boundary extends to the water gap in Haw Ridge. The total area of the basin in Bethel Valley is about 2040 acres. Bedrock beneath the main plant area is composed of limestone, siltstone, and calcareous shale facies of the Ordovician Chickamauga Group.

Many of the WAG 1 sites were used to collect and store low-level waste in tanks, ponds, and waste treatment facilities, but some sites also include landfills and contaminated sites resulting from spills and leaks that have occurred over the last 50 years. Because of the nature of cleanup and repair, it is not possible to determine which spill or leak sites still represent potential sources of release. Most of the solid waste management units are related to ORNL's past waste management operations.

WAG 1 Results

UT-Battelle activities to monitor groundwater discharging from WAG 1 include sampling four wells (807, 808, 809, and 830) in the southwest area of WAG 1, near the water gap in Haw Ridge that separates Bethel Valley from Melton Valley. These four wells are located downgradient of the main plant facilities in WAG 1. Shallow groundwater flow within WAG 1 is southward toward White Oak Creek. In 2004, these wells were sampled for radiological contaminants (gross alpha, gross beta, total radioactive strontium, tritium, and gamma-emitting radionuclides). The radiological contaminant concentrations in these wells in 2004 did not exceed reference values used for comparison. Recent Environmental Management and Enrichment Facilities Program activities associated with the WAG 1 area are summarized in the annual Water Resources Restoration Program *Remediation Effectiveness Report* (DOE 2005a).

5.11.2.2 WAG 3 Area

WAG 3 is located in Bethel Valley, about 0.6 mile west of the main plant area. WAG 3 is composed of three solid waste management units: SWSA 3, the Closed Scrap Metal Area (1562), and the Contractors' Landfill (1554).

SWSA 3 and the Closed Scrap Metal Area are inactive landfills known to contain radioactive solid wastes and surplus materials generated at ORNL from 1946 to 1979. Burial of solid waste ceased at this site in 1951; however, the site continued to be used as an aboveground scrap metal storage area until 1979. Sometime during the period from 1946 to 1949, radioactive solid wastes removed from SWSA 2 were buried at this site. In 1979, most of the scrap metal stored aboveground at SWSA 3 was either transferred to other storage areas or buried on site in a triangle-shaped disposal area immediately south of SWSA 3.

Records of the composition of radioactive solid waste buried in SWSA 3 were destroyed in a fire in 1961. Sketches and drawings of the site indicate that alpha and beta-gamma wastes were segregated and buried in separate areas or trenches. Chemical wastes were probably also buried in SWSA 3 because there are no records of disposal elsewhere. Although the information is sketchy, the larger scrap metal equipment (such as tanks and drums) stored on the surface at this site was also probably contaminated. Because only a portion of this material is now buried in the Closed Scrap Metal Area, it is not possible to estimate the amount of contamination that exists in this solid waste management unit.

The Contractors' Landfill was opened in 1975 and is now closed. It was used to dispose of various uncontaminated construction materials. No contaminated waste or asbestos was allowed to be buried at the site. ORNL disposal procedures required that only non-RCRA, nonradioactive solid wastes be buried in the Contractors' Landfill.

WAG 3 Results

Groundwater monitoring in WAG 3 is performed under the Water Resources Restoration Program. Recent Environmental Management and Enrichment Facilities Program activities associated with the WAG 3 area are summarized in the annual Water Resources Restoration Program *Remediation Effectiveness Report* (DOE 2005a).

5.11.2.3 WAG 17 Area

WAG 17 (7000 Area) is located about 1 mile directly east of the ORNL main plant area and is situated on a relatively flat limb of the northwest-facing slope of Haw Ridge. It has served as the major craft and machine shop area for ORNL since the late 1940s. The area includes the receiving and shipping departments, machine shops, carpenter shops, paint shops, lead-melting facilities, garage facilities, welding facilities, and material storage areas needed to support ORNL's routine and experimental operations. WAG 17 is composed of 18 solid waste management units. A former septic tank is now used as a sewage collection/pumping station for the area. Photographic waste tanks have been removed. Four old petroleum USTs were removed during the period from 1987 to 1990, and closure approval for them was received from TDEC in 1997. Two relatively new USTs were registered with TDEC and are used to store diesel fuel and gasoline at the ORNL gas station.

WAG 17 Results

Upgradient and downgradient wells surround WAG 17. The upgradient wells (1196, 1197, 1198, and 1199) are located on the eastern boundary of WAG 17, and the downgradient wells (1200, 1201, 1202, and 1203) are located on its western boundary. General groundwater flow is to the north and west toward White Oak Creek. A portion of the area's groundwater flow is to the southeast toward an unnamed tributary to Bearden Creek. In 2004, these wells were sampled for radiological contaminants (gross alpha, gross beta, total radioactive strontium, tritium, and gamma-emitting radionuclides) and VOCs. The radiological contaminant concentrations in 2004 were below their respective reference values. In 2004, several VOCs were observed to exceed their respective reference values in Well 1201. Included in this suite were 1,1-dichloroethene, benzene, tetrachloroethene, trichloroethene, and vinyl chloride. Trichloroethene was observed to exceed its reference value in Well 1202.

Trend analysis was performed on those organic contaminants that exceeded their respective reference values during 2004. The trend analysis was performed using historical data collected through 2004. No statistically significant trends were observed for 1,1-dichloroethene, tetrachloroethene, trichloro-ethene, or vinyl chloride in Well 1201. A statistically significant downward trend was observed for benzene in Well 1201 (at a level of significance of 0.01). A statistically significant upward trend was detected for trichloroethene in Well 1202 (at a significance level of 0.05). The presence of the organic contaminants at the western periphery of WAG 17 is related to continued discharges of legacy contamination associated with past usage of cleaning solvents and operation of garage facilities within WAG 17. Recent Environmental Management and Enrichment Facilities Program activities associated with the WAG 17 area are summarized in the annual Water Resources Restoration Program *Remediation Effectiveness Report* (DOE 2005a).

5.11.3 Melton Valley

Melton Valley is the second of the two valleys that comprise ORNL. Melton Valley is of primary importance on the ORR because it is one of the major waste storage areas on the reservation. In addition to containing surface structures, it is the location of shallow waste burial trenches and auger holes, landfills, tanks, impoundments, seepage pits, hydrofracture wells and grout sheets, and waste transfer pipelines and associated leak sites. As with plumes in Bethel Valley, groundwater plumes within Melton Valley generally enter the surface water system where contaminants are frequently encountered.

5.11.3.1 WAG 2 Area

WAG 2 is composed of White Oak Creek discharge points and includes the associated floodplain and subsurface environment. It represents the major drainage system for ORNL and the surrounding facilities.

In addition to natural drainage, White Oak Creek has received treated and untreated effluents and reactor cooling water from ORNL activities since 1943. Controlled releases include those from the PWTC, the Sewage Treatment Plant, and a variety of process waste holding ponds throughout the ORNL main plant area (WAG 1). It also receives groundwater discharge and surface drainage from WAGs 1, 4, 5, 6, 7, 8, and 9 (see Fig. 5.25).

WAG 2 represents a source of continuing contaminant release (radionuclides and/or chemical contaminants) to the Clinch River. Although it is known that WAG 2 receives groundwater contamination from other WAGs, the extent to which it may be contributing to groundwater contamination has yet to be completely resolved.

WAG 2 Results

Many of the wells sampled within WAG 2 monitor discharges to White Oak Creek and are therefore classified as downgradient wells. These wells are generally located to the southwest and downstream of the main plant area of ORNL. Downgradient wells monitored during 2004 include 1152, 1154, 1155, 1156, 1185, 1186, 1187, 1188, 1189, 1190, 1191, 1192, 1193, 1194, 1195, 1244, and 1245. Upgradient wells are located upslope and to the south of the main plant area of ORNL. Upgradient wells monitored during 2004 include 1150, 1151, and 1153. In 2004, the following wells were sampled for metals, volatile organic compounds, and radiological contaminants (gross alpha, gross beta, total radioactive strontium, tritium, and gamma-emitting radionuclides): 1189, 1190, 1191, and 1192 (all four wells are WAG 2 and exit pathway wells); all other WAG 2 wells were sampled for radiological contaminants only. Three radiological contaminant constituents exceeded their respective reference values in 2004: tritium in Well 1152, gross beta activity, total radioactive strontium, and tritium in Well 1191; and tritium in Well 1190. Statistically downward trends are observed (at a significance level of 0.01) for tritium in Well 1190 as well as for gross beta, total radioactive strontium, and tritium in Well 1191. Because Well 1152 is located downgradient of the HFIR complex, trend analysis was performed on its historical tritium data collected through 2004. A statistically significant upward trend continues to be observed for tritium in Well 1152 (at a level of significance of 0.01). The upward trend in tritium concentration is likely due to the tritium leak from the HFIR process waste drain line, which was discovered in 2000.

The presence of the radiological contaminants is related to continued discharges of legacy contamination associated with past waste disposal activities within the WAGs that drain into WAG 2. Several metal contaminants exceeded their respective reference values during 2004, but these metals (e.g., aluminum, iron, and manganese) are commonly found in the soil and rock composing the earth's crust. In particular, nickel exceeded its reference value in well 1189 during 2004. A statistically significant upward trend (at a level of significance of 0.05) is observed in the nickel historical data. No VOCs were present above their respective detection limits in 2004. Recent Environmental Management and Enrichment Facilities Program activities associated with the WAG 2 area are summarized in the annual Water Resources Restoration Program *Remediation Effectiveness Report* (DOE 2005a).

5.11.3.2 WAG 4 Area

WAG 4 is located in Melton Valley about 0.8 km southwest of the main ORNL plant site. It comprises the SWSA 4 waste disposal area, LLLW transfer lines, and the experimental Pilot Pit Area (Area 7811).

SWSA 4 was opened for routine burial of solid radioactive wastes in 1951. From 1955 to 1959, SWSA 4 was designated by the Atomic Energy Commission as the Southern Regional Burial Ground. As such, SWSA 4 received a wide variety of poorly characterized solid wastes (including radioactive waste) from about 50 sources. These wastes consisted of paper, clothing, equipment, filters, animal carcasses, and related laboratory wastes. About 50% of the waste was received from sources outside of Oak Ridge facilities. Wastes were placed in trenches, shallow auger holes, and in piles on the ground for covering at a later date.

From 1954 to 1975, LLLW was transported from storage tanks at the main ORNL complex to waste pits and trenches in Melton Valley (WAG 7), and later to the hydrofracture disposal sites through underground transfer lines. The Pilot Pit Area was constructed for use in pilot-scale radioactive waste disposal studies from 1955 to 1959; three large concrete cylinders containing experimental equipment remain embedded in the ground.

WAG 4 Results

Groundwater monitoring in WAG 4 was transferred to the Integrated Water Quality Program (now the Water Resources Restoration Program) in 1996. Recent Environmental Management and Enrichment Facilities Program activities associated with the WAG 4 area are summarized in the annual Water Resources Restoration Program *Remediation Effectiveness Report* (DOE 2005a).

5.11.3.3 WAG 5 Area

WAG 5 contains 33 solid waste management units, 13 of which are tanks that were used to store LLLW 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 the areas devoted to transuranic waste in SWSA 5 South and SWSA 5 North. 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 Wastewater Treatment Facility. Currently, 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 South was used to dispose of solid LLW generated at ORNL from 1959 to 1964. During this time, the burial ground served as the Southern Regional Burial Ground for the Atomic Energy Commission. At the time SWSA 5 burial operations were initiated, about 10 acres of the site were set aside for the retrievable storage of transuranic wastes.

The WAG 5 boundary includes the Old Hydrofracture Facility and the New Hydrofracture Facility. Because Melton Branch flows between these facilities, the New Hydrofracture Facility has a separate boundary.

WAG 5 Results

Groundwater monitoring in WAG 5 was transferred to the Water Resources Restoration Program in 1996. Recent Environmental Management and Enrichment Facilities Program activities associated with the WAG 5 area are summarized in the annual Water Resources Restoration Program *Remediation Effectiveness Report* (DOE 2005a).

5.11.3.4 WAG 6 Area

WAG 6 consists of four solid waste management units: (1) SWSA 6, (2) Building 7878, (3) the explosives detonation trench, and (4) Building 7842. SWSA 6 is located in Melton Valley, northwest of White Oak Lake and southeast of Lagoon Road and Haw Ridge. The site is about 2 km south of the main ORNL complex. Waste burials at this 68-acre site were initiated in 1973, when SWSA 5 was closed. Various radioactive and chemical wastes were buried in trenches and auger holes. SWSA 6 is the only currently operating disposal area for LLW at ORNL. The emergency waste basin was constructed in 1961 to provide storage of liquid wastes that could not be released from ORNL to White Oak Creek. The basin, located northwest of SWSA 6, has a capacity of 15 million gal but has never been used. Radiological sampling of the small drainage from the basin has shown the presence of some radioactivity. The source of this contamination is not known.

WAG 6 was among the first WAGs to be investigated at ORNL by the Environmental Management and Enrichment Facilities Program. Several RCRA interim status units (having received RCRA-regulated hazardous waste) are located in WAG 6. Environmental monitoring is carried out under CERCLA and RCRA.

WAG 6 Results

Recent Environmental Management and Enrichment Facilities Program activities associated with the WAG 6 area are summarized in the annual Water Resources Restoration Program *Remediation Effectiveness Report* (DOE 2005a).

5.11.3.5 WAG 7 Area

WAG 7 is located in Melton Valley about 1.6 km south of the ORNL main plant area. The major sites in WAG 7 are the seven pits and trenches used from 1951 to 1966 for disposal of LLLW. WAG 7 also includes a decontamination facility, three leak sites, a storage area containing shielded transfer tanks and other equipment, and seven fuel wells used to dispose of acid solutions primarily containing enriched uranium from Homogeneous Reactor Experiment fuel.

WAG 7 Results

Groundwater monitoring in WAG 7 was transferred to the Integrated Water Quality Program (now the Water Resources Restoration Program) in 1996. Recent Environmental Management and Enrichment Facilities Program activities associated with the WAG 7 area are summarized in the annual Water Resources Restoration Program *Remediation Effectiveness Report* (DOE 2005a).

5.11.3.6 WAG 8 and 9 Areas

Because of the small number of groundwater monitoring wells in WAGs 8 and 9, they are sampled together. The analytical results for the two WAGs are also reported together. Wells monitored within WAGs 8 and 9 include 1087, 1088, 1089, 1090, 1091, 1092, 1093, 1094, and 1095. Wells monitored within WAG 9 include 1096 and 1097.

WAG 8, located in Melton Valley, south of the main plant area, is composed of 36 solid waste management units associated with the reactor facilities in Melton Valley. The solid waste management units consist of active LLLW collection and storage tanks, leak/spill sites, a contractors' soils area, radioactive waste ponds and impoundments, and chemical and sewage waste treatment facilities. WAG 8 includes the MSRE facility, the HFIR, and the REDC. A removal action was initiated at MSRE during 1995 to remove filtration devices contaminated with uranium.

Radioactive wastes from WAG 8 facilities are collected in on-site LLLW tanks and are periodically pumped to the main plant area (WAG 1) for storage and treatment. The waste includes demineralizer backwash, regeneration effluents, decontamination fluids, experimental coolant, and drainage from the compartmental areas of filter pits.

Monitoring of the tritium plume attributed to the release of tritium from the HFIR foundation drain in 2000 continued during 2004 under the aegis of the *Annual Monitoring Plan for the High Flux Isotope Reactor Site–Monitoring Period 2000–2004* (Bonine 2003) and *Annual Monitoring Plan for the High Flux Isotope Reactor Site – Monitoring Period 2004–2005* (Bonine 2004). The primary purpose of the monitoring program outlined in the annual monitoring plans (AMPs) is to provide continued early detection of releases to groundwater from HFIR operational activities or system failures. Additional objectives are to track the mass of the tritium plume in the vicinity of HFIR and to monitor potential sources of groundwater contamination located hydraulically upgradient of the HFIR. Based on observations of tritium plume behavior during the 2003/2004 monitoring period, changes were made to the 2003/2004 AMP to optimize the monitoring process during the 2004/2005 monitoring period. These changes were outlined in the 2004/2005 AMP.

Overall trends in tritium concentration continued to decrease at all monitoring points sampled during 2004. However, the historical (2000 through 2004) tritium concentrations at Well 661 continued to show a statistically significant upward trend. During 2004 no tritium was discovered to have been discharged to the environment from the HFIR or from sources upgradient of the HFIR.

WAGs 8 and 9 Results

Wells in WAGs 8 and 9 were sampled for total radioactive strontium, tritium, gross alpha, gross beta, and gamma-emitting radionuclides in 2004. A total of four radiological constituents exceeded their respective reference values during 2004 in wells located in WAGs 8 and 9. Gross alpha and beta activity and total radioactive strontium exceeded their reference values in samples collected from Well 1087. The reference value for tritium was also exceeded in 2004 in 1090. Recent Environmental Manage-ment and Enrichment Facilities Program activities associated with the WAGs 8/9 area are summarized in the annual Water Resources Restoration Program *Remediation Effectiveness Report* (DOE 2005a).

5.11.3.7 WAG 10 Area

WAG 10 consists of the Old Hydrofracture Facility grout sheets, the New Hydrofracture Facility, and the New Hydrofracture Facility grout sheets. The surface facilities are also associated with WAGs 5, 7, and 8.

Hydrofracture Experiment Site 1, located within the boundary of WAG 7 (south of Lagoon Road), was the site of the first experimental injection of grout (October 1959) in a testing program for observing the fracture pattern created in the shale and for identifying potential operating problems. Injected waste was water-tagged with cesium-137 and cerium-141. Grout consisted of diatomaceous earth and cement.

Hydrofracture Experiment Site 2 is located about 0.5 mile south of the 7500 (experimental reactor) area in WAG 8. The second hydrofracture experiment was designed to duplicate, in scale, an actual disposal operation; however, radioactive tracers were used instead of actual waste. Cement, bentonite, and water tagged with ^{137}Cs were used in formulating the grout.

The Old Hydrofracture Facility is located about 1.0 mile southwest of the main ORNL complex, near the southwest corner of WAG 5. Commissioned in 1964, the facility was used to dispose of liquid radioactive waste in impermeable shale formations at depths of 800 to 1000 ft by hydrofracture methods. Wastes used in the disposal operations included concentrated LLLW from the gunite tanks in WAG 2, ^{90}Sr, ^{137}Cs, ^{244}Cm, transuranics, and other (unidentified) radionuclides.

The New Hydrofracture Facility, constructed to replace the Old Hydrofracture Facility, is located 900 ft southwest of the Old Hydrofracture Facility, on the south side of Melton Branch. Wastes used in the injections were concentrated LLLW and sludge removed from the gunite tanks, ^{90}Sr, ^{137}Cs, ^{244}Cm, transuranics, and other nuclides. Recent Environmental Management and Enrichment Facilities Program activities associated with the WAG 10 area are summarized in the annual Water Resources Restoration Program *Remediation Effectiveness Report* (DOE 2005a).

5.11.3.8 Melton Valley Exit Pathway Results

Ten monitoring wells are located on the groundwater exit pathway for Melton Valley. Four of these wells (1189, 1190, 1191, and 1192) are also part of the WAG 2 groundwater monitoring program and have been discussed in Sect. 5.11.3.1. Consequently, only six wells (860, 857, 858, 859, 1236, and 1239) will be discussed in this section. The six exit pathway wells were monitored for VOCs, metals, gross alpha and beta, tritium, total radioactive strontium, and gamma emitters during 2004. The only contaminant exceeding its reference value during 2004 was lead in well 857; however, the historical lead data exhibit a statistically significant downward trend (at a significance level of 0.2). Recent Environmental Management and Enrichment Facilities Program activities associated with the Melton Valley Exit Pathway area are summarized in the annual Water Resources Restoration Program *Remediation Effectiveness Report* (DOE 2005a).

5.11.4 White Wing Scrap Yard

5.11.4.1 White Wing Scrap Yard (WAG 11) Area

The White Wing Scrap Yard (WAG 11), a largely wooded area of about 30 acres, is located in the McNew Hollow area on the western edge of East Fork Ridge. It is 1.4 km (0.9 mile) east of the junction of White Wing Road and the Oak Ridge Turnpike. Geologically, the White Oak thrust fault bisects WAG 11. Lower-Cambrian-age strata of the Rome Formation occur southwest of the fault and overlie the younger Ordovician-age Chickamauga Limestone northeast of the fault. There is only one solid waste management unit in WAG 11.

The White Wing Scrap Yard was used for aboveground storage of contaminated material from ORNL, the ETTP, and the Y-12 National Security Complex. The material stored at the site by ORNL consisted largely of contaminated steel tanks; trucks; earth-moving equipment; assorted large pieces of steel, stainless steel, and aluminum; and reactor cell vessels removed during cleanup of Building 3019. TDEC, EPA, and DOE agreed to an interim record of decision that required the removal of surface debris from the site. This work was completed in 1994.

The area began receiving material (primarily metal, glass, concrete, and trash with alpha, beta, and gamma contamination) in the early 1950s. Information regarding possible hazardous waste contamination has not been found. The precise dates of material storage are uncertain, as is the time when the area was closed to further storage. In 1966, efforts were begun to clean up the area by disposing of contaminated materials in SWSA 5 and by the sale of uncontaminated material to an outside contractor for scrap. Cleanup continued at least into 1970, and removal of contaminated soil began in the same year. Some scrap metal, concrete, and other trash are still located in the area. Numerous radioactive areas, steel drums, and PCB-contaminated soil were identified during surface radiological investigations conducted in 1989 and 1990 at WAG 11. The amount of material or contaminated soil remaining in the area is not known.

White Wing Scrap Yard (WAG 11) Results

Groundwater monitoring in WAG 11 was transferred to the Integrated Water Quality Program (now the Water Resources Restoration Program) in 1996. Recent Environmental Management and Enrichment Facilities Program activities associated with the WAG 11 area are summarized in the annual Water Resources Restoration Program *Remediation Effectiveness Report* (DOE 2005a).

5.12 Well Plugging and Abandonment at ORNL

The purpose of the ORNL well plugging and abandonment program is to remove unneeded wells and boreholes as possible sources of cross-contamination of groundwater from the surface or between geological formations. Because of the complex geology and groundwater pathways at ORNL, it has been necessary to drill many wells and boreholes to establish the information base needed to predict groundwater properties and behavior. However, many of the wells established before the 1980s were not constructed to serve current long-term monitoring requirements. Where existing wells do not meet monitoring requirements, they become candidates for plugging and abandonment.

During 2004, BJC completed plugging and abandonment of two hydrofracture-related wells. Approximately 450 non-hydrofracture wells were plugged. Two WAG perimeter wells were replaced (Well 1080 and Well 0971) because construction activities required the existing wells to be plugged (personal communication, Ketelle to Bonine, 2005).

5.13 Modernization and Reindustrialization Activities at ORNL

Modernization activities continued at the main ORNL campus, the State of Tennessee Joint Institute for Computational Sciences, and the DOE-sponsored Research Support Center (cafeteria and visitors' center) were completed next to the private-sector facilities in the East Campus area. Planning activities for the Multi-program Research Facility (MRF), the final private-sector facility of Modernization–Phase 1 started in earnest, with design expected to be completed and construction started in early 2005. The MRF will be a 200,000-ft^2 office and light laboratory facility. The design of the 30,000-ft^2 State of Tennessee Joint Institute for Biological Sciences also commenced in 2004. Construction of this office and biological laboratory facility began in 2005. Outside the main campus, construction of 7825 High Bay was completed, and construction of the Center for Nanophase Material Sciences continues on a 2005 completion schedule. Efforts to dispose of legacy materials, equipment, and facilities continue, with over 100,000 ft^{2}of aging, excess facilities vacated.

5.14 Spallation Neutron Source

DOE prepared and issued a final environmental impact statement (SNS 1999a and 1999b) and a record of decision to construct and operate the SNS. This state-of-the-art pulsed-neutron facility is under construction on Chestnut Ridge at ORNL. A mitigation action plan was developed to document the goals and objectives by which the potential environmental impacts from construction and operation identified in the environmental impact statement will be mitigated. The SNS Project is on schedule and within budget, and in 2004 significant progress was made on the target building, accelerator tunnel, central laboratory and office complex, and site infrastructure. Construction of the SNS is currently approximately 95% complete, and technical components of the accelerator are being installed and commissioned. The facility will become operational in FY 2006.

On November 3, 2003, the TDEC Division of Water Pollution Control issued an NPDES permit that became effective on December 1, 2003. It authorized DOE to discharge cooling tower blowdown and heating, ventilation, and air-conditioning condensate water from the SNS to a storm water detention pond that discharges to White Oak Creek at approximate stream mile 4.2 through outfall 435. Furthermore, the pond emergency spillway, designated as outfall 437, will discharge in large storm runoff situations to mile 0.6 of a tributary to White Oak Creek. The SNS began discharging blowdown waters to the detention pond in December 2, 2003. Since that time, the SNS has been fully compliant with all permit limits (see Table 5.11).

Potential adverse impacts of SNS construction and operations were identified for wetlands, protected species, cultural resources, transportation infrastructure, and research projects in the Walker Branch Watershed. Mitigation measures were identified for each of the potential subjects. Construction of the SNS access roads affected wetlands. Routes were evaluated, and improving the Chestnut Ridge Road was selected as the action affecting the smallest area of wetlands. Construction affected 0.055 acres, and careful attention to erosion control and equipment movement limited impacts to other nearby wetland areas. The SNS developed a wetlands mitigation plan to compensate for the impacts to the 0.055 acres by restoring 0.138 acres (a mitigation ratio of 2.511) of wetlands located in the same watershed. TDEC accepted the wetlands mitigation plan on June 29, 2000, and the 0.138 acres of wetlands were restored in August 2000. This mitigation action is complete, and the restored areas are routinely monitored to ensure the survival rate of the indigenous shrubs and vegetation planted in the restored area. No significant impacts on the wetlands have resulted from construction activities. The wetlands mitigation activities were evaluated and reported in 2002, 2003, and 2004. These reviews have found that the SNS mitigation wetland is functioning as a viable wetland community. The site has the necessary wetland vegetation, soils, and hydrology to be classified as a jurisdictional wetland.

No federally listed or proposed threatened or endangered species were identified in the site surveys of the SNS. However, construction and operation of the SNS could affect protected species that were not identified during the site sur-

Table 5.11. National Pollutant Discharge Elimination System (NPDES) compliance at SNS, 2004
(NPDES permit effective December 1, 2003)

Effluent parameters	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	Percentage of compliance[a]
pH (std. units)				9	6.5	0	104	100
Total residual chlorine			0.011	0.019		0	104	100

[a]Percentage compliance = 100 – [(number of noncompliances/number of samples) * 100].

veys. Definitive surveys were conducted during three seasons (spring, summer, and fall) in 1999 to ensure that any protected species, including those that can be identified only during flowering, would be noted. No protected species were identified during these surveys, and this mitigation action is complete.

No prehistoric or historic sites listed on or eligible for inclusion on the *National Register of Historic Places* (National Park Service 2003) were identified on the SNS site. A survey of cultural resources was conducted for the access road rights-of-way, and no significant cultural resources were located or disturbed. This mitigation action is complete for the SNS roads and utility corridors. The TVA power line upgrades associated with the SNS have been evaluated for cultural resources, and no issues were identified.

Emissions of water vapor and CO_2 during construction and operation of the SNS could impact the research activities at the Walker Branch Watershed, located approximately 0.75 mile east of the SNS on Chestnut Ridge. The emissions would affect a small amount of the data collected at Walker Branch Watershed, and a committee was established in 1999 to evaluate the impacts of the SNS. The committee reviewed the impacts and potential mitigation measures and determined that establishing a satellite monitoring location in an area not affected by SNS was the preferred solution. The satellite tower will be established before SNS operates to allow development of statistical correlations between the locations, thereby preserving the quality of the data. The location of the satellite tower was identified in FY 2001, and plans to develop the site are under way by the Walker Branch researchers. Funding for the tower and instruments has been provided to the researchers, and this corrective action is now closed.

Incorporating superconducting accelerator technology at SNS was evaluated in a supplement to the final environmental impact statement in 2000. The impacts of the technology on the Walker Branch Watershed were evaluated and were found to be not significant; the change to superconducting was determined to have no significant environmental impacts. Funding for the satellite tower has been provided by SNS, and this mitigation action is complete.

5.14.1 Monitoring at the SNS Site

A baseline groundwater monitoring program was initiated at the SNS site during 2004 under the auspices of the *Draft Baseline Groundwater Monitoring Plan for the SNS Site: Monitoring Period 2004–2006* (Bonine, Ketelle, and Trotter 2004). This monitoring program was instituted during the period prior to startup of the SNS and will continue during SNS operations. A total of six springs/seeps and one surface water body were sampled on a quarterly basis during 2004. The parameters of interest included tritium, ^{14}C, gross alpha and beta activity, and gamma emitters (^{22}Na, ^{26}Al, ^{54}Mn, ^{40}K, etc). Results of the monitoring program indicate no significant concentrations of any of these parameters in groundwater at the SNS site during 2004.