5. Environmental Surveillance

M. A. Bogle, M. L. Coffey, K. G. Hanzelka, J. F. Hughes, H. B. McElhoe, L. L. Cunningham, and M. M. Stevens

Abstract

Annual environmental surveillance is a major activity on the ORR. Environmental surveillance consists of the collection and analysis of samples of air, water, soil, foodstuffs, biota, and other media from the reservation and its surroundings. External radiation is also measured. Samples are analyzed for chemical content and for the presence of radioisotopes. Data collected from environmental surveillance activities are used to demonstrate compliance with applicable standards, to assess exposures to members of the public, and to assess effects (if any) on the local population and the environment.

5.1 ANTICIPATED ENVIRONMENTAL SURVEILLANCE PROGRAM CHANGES

As noted in Chap. 2, the EMP is in the midst of significant revision. The revisions will be implemented in 1997. Consequently, many of the programs described in the following sections will change, and information reported in the 1997 *Oak Ridge Reservation Annual Site Environmental Report for 1997* (ASER) will differ from this year's report.

5.2 METEOROLOGICAL MONITORING

Seven meteorological towers provide data on meteorological conditions and on the transport and diffusion qualities of the atmosphere on the ORR. Data collected at the towers are used in routine dispersion modeling to predict impacts from facility operations and as input to emergency response atmospheric models used in the event of accidental releases from a facility. Data from the towers are also used to support various research and engineering projects.

5.2.1 Description

The seven meteorological towers, depicted in Fig. 5.1, consist of one 330-ft (100-m) tower (MT5) and one 200-ft (60-m) tower (MT6) at the Y-12 Plant, one 330-ft tower (MT2) and two 100-ft towers (MT3 and MT4) at ORNL, and one 200-ft tower (MT1) and one 100-ft (MT7) tower at the ETTP.

Data are collected at different levels to determine the vertical structure of the atmosphere and the possible effects of vertical variations on releases from facilities. At all towers, data are collected at 32.8 ft and at the top of the tower. At the 330-ft towers, data are collected at an intermediate 100-ft level as well. At each measuring level on each tower, temperature, wind speed, and wind direction are measured. Humidity and data needed to determine atmospheric stability (a measure of the dispersive capability of the atmosphere) are also measured at each tower. Barometric pressure is measured at one tower at each facility. Precipitation is measured at MT1 and MT7 at the ETTP and at MT2 at ORNL; solar radiation is measured at MT2.

Data from the towers at each site are collected by a dedicated control computer. The towers are polled, and the data are filed on disk. Fifteen-minute and hourly values are stored at each site

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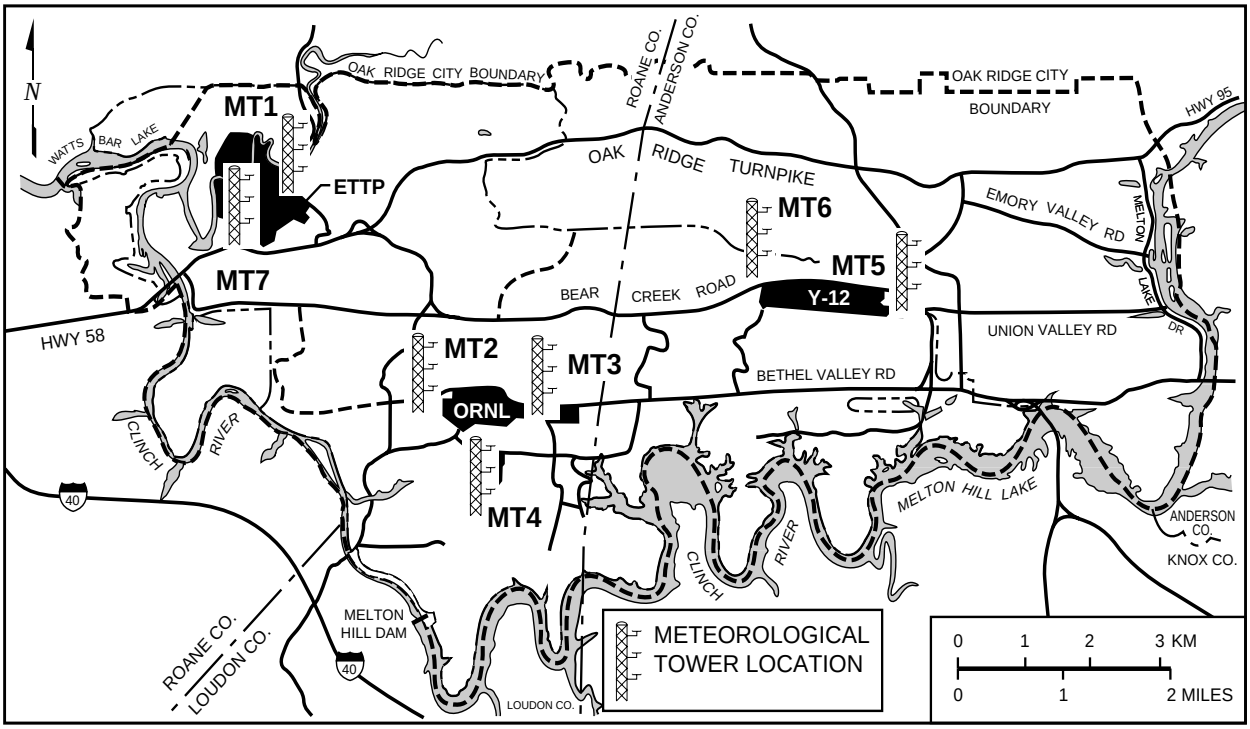

Fig. 5.1. The ORR meteorological monitoring network.

for a running 24-hour period, but only hourly data are routinely stored beyond 24 hours. The meteorological monitoring data from all towers are summarized quarterly at the Y-12 Plant and monthly at ORNL and the ETTP. Quarterly calibration of the instruments is conducted for each site by an outside contractor.

Fifteen-minute and hourly data are used directly at each site computer for emergency-response purposes such as input to dispersion models. Annual dose estimates are calculated from archived data (either hourly values or summary tables of atmospheric conditions). Data quality is checked continuously against predetermined data constraints, and out-of-range parameters are marked invalid and are not input to the dispersion models.

5.2.2 Results

Prevailing winds are generally up-valley from the southwest and west-southwest or down-valley from the northeast and east-northeast. This pattern is the result of the channeling effect of the ridges flanking the site. Winds in the valleys tend to follow the ridges, with limited cross-ridge flow. These conditions are dominant over the entire reservation, with the exception of the ETTP, which is located in a relatively open area that has a more varied flow. Weaker valley flows are noted in this area, particularly in locations near the Clinch River.

On the reservation, low-speed winds predominate at the surface level. This characteristic is noted at all tower locations, as is the increase in wind speed at the height at which measurements are made. This activity is typical of tower locations and is important when selecting appropriate data for input to dispersion studies.

The atmosphere over the reservation is dominated by stable conditions on most nights and in early morning hours. These conditions, coupled with the low wind speeds and channeling effects of the valleys, result in poor dilution of material emitted from the facilities. These features are captured in the data input to the dispersion models

and are reflected in the modeling studies conducted for each facility.

Precipitation data from tower MT2 are used in stream-flow modeling and in certain research efforts. The data indicate the variability of regional precipitation: the high winter rainfall amounts resulting from frontal storms and the uneven, but occasionally intense, summer rainfall associated with thunderstorms.

The average data recovery rate (a measure of acceptable data) across all locations and at the 16 tower levels was 97.6% in 1996. The maximum data recovery was 99.7% at Y-12 MT5 at 100 m, and the minimum was 88.7% at ETTP MT1 at 60 m.

5.3 EXTERNAL GAMMA RADIATION MONITORING

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

5.3.1 Data Collection and Analysis

External gamma measurements are recorded weekly at six ambient air stations from resident external gross gamma monitors (Fig. 5.2). Each consists of a dual-range, high-pressure ion chamber sensor and digital electronic count-rate meter and totalizer. Totalizing consists of multiplying the count rate by the time of exposure to obtain total dose. The doses are analyzed for average and median values, which are compared with national median values.

5.3.2 Results

Table 5.1 presents the following data for individual stations: number of data values collected, maximum value, minimum value, average value, and standard error of the mean. The median value for the ORR in 1996 was 7.7 μR/hour, while the median value for cities in the United States during 1989 was 9.3 μR/hour (EPA 1990). Any contribution to the external gamma signature by the DOE facilities is not distinguishable at the ORR perimeter air monitoring station (PAM) locations.

5.4 AMBIENT AIR MONITORING

In addition to exhaust stack monitoring conducted at the DOE Oak Ridge installations, ambient air monitoring is performed to measure radiological and other selected parameters directly in the ambient air adjacent to the facilities. Ambient air monitoring provides direct measurement of airborne concentrations of radionuclides and other hazardous pollutants in the environment surrounding the facilities, allows facility personnel to determine the relative level of contaminants at the monitoring locations during an emergency, verifies that the contributions of fugitive and diffuse sources are insignificant, and serves as a check on dose-modeling calculations.

The following sections discuss the ambient air monitoring networks for the ORR, the Y-12 Plant, ORNL, and the ETTP.

5.4.1 ORR Ambient Air Monitoring

The objectives of the ORR ambient air monitoring program are to perform surveillance of airborne radionuclides at the reservation perimeter and to collect reference data from remote locations. The ORR PAM network includes stations 35, 37, 38, 39, 40, 42, 46, and 48 (Fig. 5.3); the remote air monitoring (RAM) network that provides reference information consists of stations 51 (Norris Dam) and 52 (Fort Loudoun Dam). Sampling was conducted at each ORR station during 1996 to quantify levels of alpha-, beta-, and gamma-emitting radionuclides and tritium.

Atmospheric dispersion modeling was used to select appropriate sampler locations. The locations selected are those most likely to be affected

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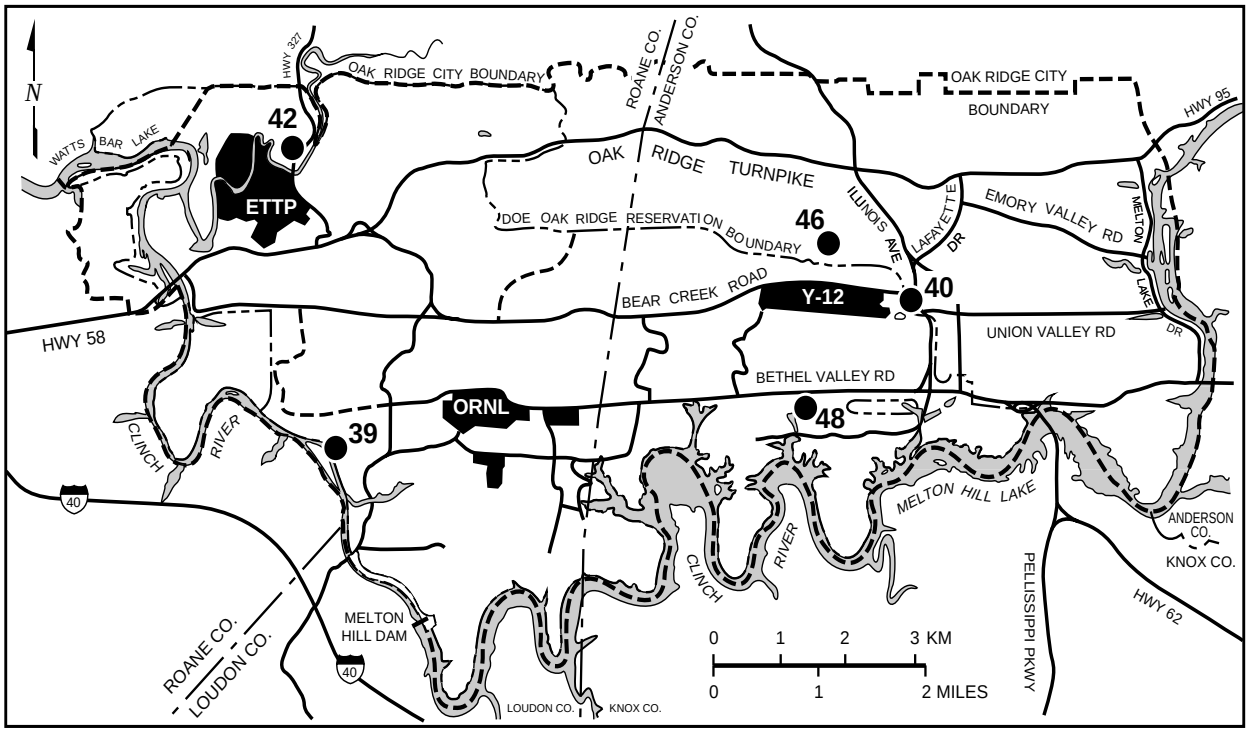

Fig. 5.2. External gamma radiation monitoring locations on the ORR. Location 51, at Norris Dam, 26 miles northeast of ORNL, is not shown on this map.

Table 5.1. External gamma averages, 1996

Location	Number of data values collected	Measurement (μR/hour)[a]			Standard error of mean
		Min	Max	Mean	
39	50	6.1	10.4	8.4	0.74
40	52	2.8	14.5	7.5	1.49
42	53	0.1	8.4	6.3	1.92
46	52	0.1	13.6	7.9	1.94
48	52	0.1	20.1	7.2	2.30
51	51	2.3	34.4	8.5	4.56

[a]To convert microroentgens per hour to milliroentgens per year, multiply by 8.760.

by routine releases from the Oak Ridge facilities. Therefore, it is predicted that no residence or business in the vicinity of the ORR would be affected by undetected releases of radioactive materials. To provide an estimate of background radionuclide concentrations, two additional stations are located at sites not affected by releases from the ORR.

The sampling system consists of two separate instruments. The particulates are captured using a high-volume air sampler on glass fiber filters. The filters are collected weekly, composited every

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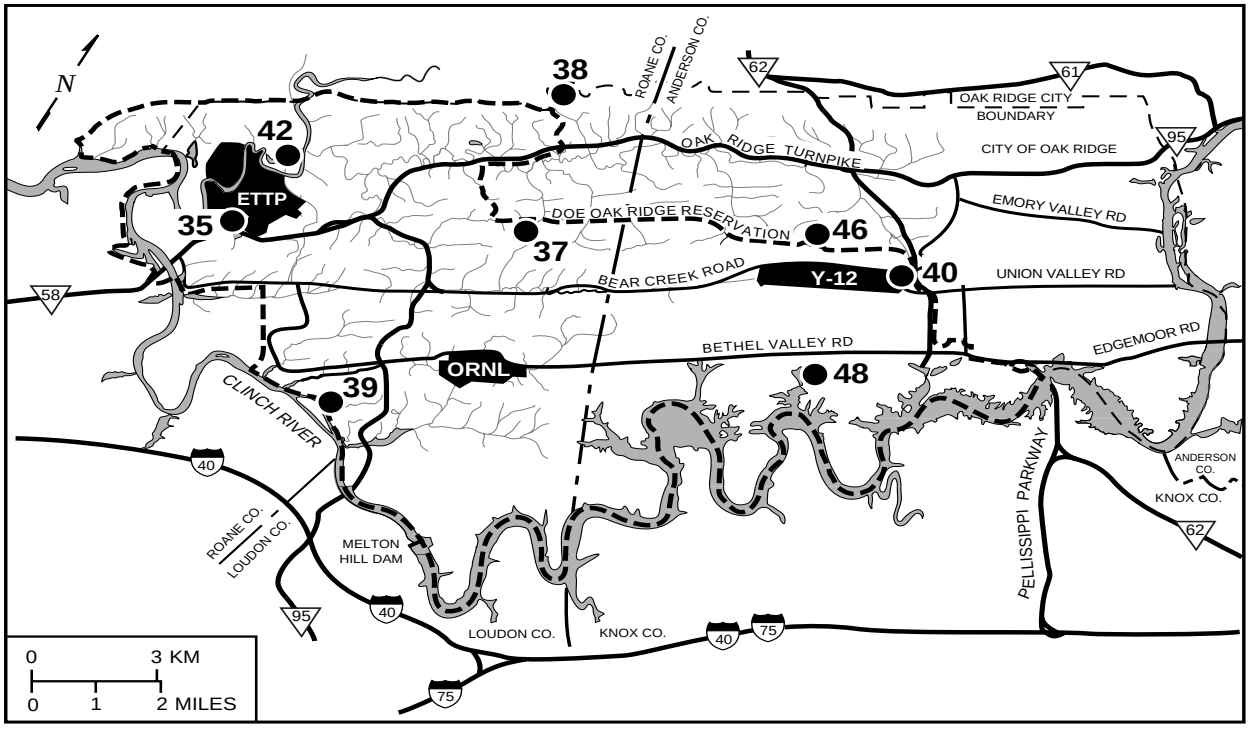

Fig. 5.3. Location of ORR perimeter air monitoring stations.

filters are collected weekly, composited every 4 weeks, then submitted to the laboratory for isotopic analysis. The second system is designed to collect tritiated water vapor. The sampler consists of a prefilter followed by an adsorbent trap consisting of indicating silica gel. The samples are collected weekly, composited monthly, then submitted to the laboratory for tritium analysis.

The ORR ambient air network (Fig. 5.3) provides appropriate monitoring for all facilities within the reservation, which eliminates the necessity for site-specific ambient air programs. As part of the ORR network, an ambient air monitoring station located in the Scarboro Community of Oak Ridge (Station 46) measures off-site impacts of the Y-12 Plant operation and is located near the theoretical area of maximum public pollutant concentrations as calculated by air-quality modeling. Station 40 of the ORR network monitors the east end of the Y-12 Plant, and Station 37 monitors the overlap of the Y-12 Plant, ORNL, and ETTP emissions.

5.4.1.1 Results

Data from the ORR PAM stations are analyzed to assess the impact to air quality of operations on the entire reservation. The RAM stations provide information on reference concentrations of radionuclides and gross parameters for the region. A comparison of ORR PAM station sampling data with those from the RAM stations shows that ORR operations do not significantly affect local air quality (Tables 5.2 and 5.3).

Table 5.4 represents the average concentration of three isotopes of uranium at each station for sampling years 1993, 1994, 1995, and 1996.

5.4.2 Y-12 Plant Ambient Air Monitoring

In 1994, Y-12 Plant personnel issued *Evaluation of the Ambient Air Monitoring Program at the Oak Ridge Y-12 Plant* (MMES 1994) and worked with the DOE and TDEC in reviewing the ambient air program for applicability and useful-

Table 5.2. ORR environmental surveillance multimedia by station[a,b]

Media	^{7}Be	^{60}Co	^{137}Cs	^{40}K	^{3}H	^{234}U	^{235}U	^{238}U	Gross alpha	Gross beta
					Station 35					
Air filter	1.6E–13	1.1E–16	1.6E–16	*c*	1.0E–11	2.2E–17	1.3E–18	3.4E–17	2.8E–15	6.3E–15
Tomatoes	*c*	8.1E–03	*c*	3.0E+00	*c*	*c*	*c*	*c*	*c*	1.7E+00
Lettuce	*d*	*d*	*d*	3.2E+00	*c*	*c*	*c*	6.8E–07	*d*	1.7E+00
Turnips	*d*	*d*	*d*	2.4E+00	*c*	*c*	*c*	*c*	*d*	1.6E+00
Soil	*c*	*d*	*d*	1.4E+01	*c*	5.4E–01	*d*	5.4E–01	1.8E+00	*d*
					Station 37					
Air filter	1.6E–13	8.3E–17	1.3E–16	*c*	9.3E–12	2.0E–17	7.2E–19	2.1E–17	2.8E–15	5.7E–15
Tomatoes	*d*	*d*	*d*	2.2E+00	*c*	*c*	*c*	*c*	*d*	1.5E+00
Lettuce	*d*	*d*	*d*	3.4E+00	*c*	5.1E–07	*c*	4.9E–07	*d*	1.8E+00
Turnips	*d*	*d*	*d*	2.6E+00	*c*	*c*	*c*	*c*	*d*	2.2E+00
Soil	*c*	*d*	*d*	1.7E+01	*c*	5.3E–01	*d*	8.5E–01	3.0E+00	*d*
					Station 38					
Air filter	1.5E–13	2.3E–17	4.1E–17	*c*	3.7E–12	1.6E–17	9.2E–19	2.0E–17	2.4E–15	5.5E–15
Tomatoes	*d*	*d*	*d*	3.2E+00	*c*	*c*	*c*	*c*	*d*	2.1E+00
Lettuce	*d*	*d*	*d*	2.8E+00	*c*	9.7E–07	6.5E–07	1.3E–06	5.1E–02	1.6E+00
Turnips	*d*	*d*	2.0E–03	2.3E+00	*c*	*c*	*c*	*c*	*d*	2.0E+00
Soil	*c*	*d*	*d*	1.8E+01	*c*	*d*	*d*	*d*	2.6E+00	*d*
					Station 39					
Air filter	1.2E–13	3.3E–17	4.6E–17	*c*	7.5E–12	1.4E–17	6.2E–19	1.2E–17	2.2E–15	4.2E–15
Tomatoes	*d*	*d*	*d*	3.8E+00	*c*	*c*	*c*	*c*	*d*	1.9E+00
Lettuce	*d*	*d*	*d*	3.4E+00	*c*	*c*	*c*	1.1E–06	*d*	1.9E+00
Turnips	*d*	4.1E–03	*d*	3.1E+00	*c*	*c*	*c*	*c*	*d*	2.5E+00
Soil	*c*	*d*	*d*	1.7E+01	*c*	3.5E–01	*d*	3.7E–01	2.3E+00	*d*
					Station 40					
Air filter	1.6E–13	9.1E–17	5.2E–17	*c*	9.2E–12	4.6E–17	1.8E–18	1.7E–17	2.8E–15	5.7E–15
Tomatoes	*d*	*d*	*d*	2.7E+00	*c*	*c*	*c*	*c*	*d*	1.5E+00
Lettuce	*d*	6.5E–03	3.8E–03	3.3E+00	*c*	7.3E–07	*c*	7.0E–07	4.6E–02	2.1E+00
Turnips[e]	*d*	*d*	*d*	2.1E+00	*c*	*c*	*c*	*c*	*d*	1.5E+00
Soil	*c*	*d*	*d*	1.9E+01	*c*	*d*	*d*	1.1E+00	2.5E+00	*d*

Table 5.2 (continued)

Media	^{7}Be	^{60}Co	^{137}Cs	^{40}K	^{3}H	^{234}U	^{235}U	^{238}U	Gross alpha	Gross beta
					Station 42					
Air filter	1.3E–13	1.8E–17	2.9E–17	*c*	5.2E–12	1.8E–17	1.3E–18	2.0E–17	2.2E–15	4.6E–15
Tomatoes	*d*	*d*	*d*	3.0E+00	*c*	*c*	*c*	*c*	*d*	1.7E+00
Lettuce	*d*	8.9E–03	*d*	3.2E+00	*c*	1.0E–06	*c*	1.7E–06	4.3E–02	2.1E+00
Turnips	*d*	*d*	*d*	2.2E+00	*c*	*c*	*c*	*c*	*d*	1.7E+00
Soil	*c*	*d*	*d*	1.5E+01	*c*	3.3E–01	4.9E–01	8.7E–01	*d*	*d*
					Station 46					
Air filter	1.5E–13	5.7E–17	1.3E–16	*c*	1.0E–11	2.3E–17	1.1E–18	1.9E–17	2.3E–15	4.9E–15
Tomatoes	*d*	*d*	*d*	2.7E+00	*c*	*c*	*c*	*c*	*d*	1.7E+00
Lettuce	*d*	*d*	*d*	2.8E+00	*c*	*c*	*c*	*d*	*d*	1.6E+00
Turnips	*d*	*d*	6.2E–03	2.2E+00	*c*	*c*	*c*	*c*	*d*	1.5E+00
Soil	*c*	*d*	*d*	1.5E+01	*c*	5.0E–02	*d*	3.0E–01	3.0E+00	*d*
					Station 48					
Air filter	1.6E–13	3.3E–17	5.4E–17	*c*	8.2E–12	2.8E–17	6.9E–19	1.3E–17	2.7E–15	5.6E–15
Tomatoes	*d*	*d*	*d*	3.2E+00	*c*	*c*	*c*	*c*	*d*	1.6E+00
Lettuce	*d*	5.1E–03	*d*	3.6E+00	*c*	4.1E–07	*c*	1.6E–06	*d*	2.3E+00
Turnips	*d*	*d*	3.8E–03	2.0E+00	*c*	*c*	*c*	*c*	3.2E–02	1.7E+00
Soil	*c*	*d*	*d*	1.7E+01	*c*	3.8E–01	*d*	9.5E–01	1.9E+00	*d*
					Station 51					
Air filter	1.6E–13	7.4E–17	2.2E–17	*c*	9.2E–12	8.5E–18	3.8E–19	7.2E–18	2.7E–15	5.2E–15
Tomatoes	*d*	*d*	*d*	3.0E+00	*c*	*c*	*c*	*c*	*d*	2.1E+00
Lettuce	*d*	*d*	*d*	3.2E+00	*c*	4.9E–07	*c*	*d*	*d*	1.9E+00
Turnips	*d*	*d*	*d*	2.9E+00	*c*	*c*	*c*	*c*	*d*	1.6E+00
Soil	*c*	*d*	*d*	1.6E+01	*c*	*d*	*d*	*d*	2.3E+00	*d*
					Station 52					
Air filter	1.5E–13	5.0E–17	1.1E–17	*c*	6.6E–12	9.4E–18	1.4E–18	9.3E–18	1.8E–15	4.7E–15

[a]All values represent the mean number for each of the media and each isotope.
[b]Values for air filters are given in microcuries per milliliter. Values for all other media are given in picocuries per gram.
[c]Not applicable.
[d]Not detected.
[e]Flag.

Table 5.3. ORR environmental surveillance multimedia by media[a,b]

Station	^{7}Be	^{60}Co	^{137}Cs	^{40}K	^{3}H	^{234}U	^{235}U	^{238}U	Gross alpha	Gross beta
					Air filters (μCi/mL)					
35	1.6E–13	1.1E–16	1.6E–16	*c*	1.0E–11	2.2E–17	1.3E–18	3.4E–17	2.8E–15	6.3E–15
37	1.6E–13	8.3E–17	1.3E–16	*c*	9.3E–12	2.0E–17	7.2E–19	2.1E–17	2.8E–15	5.7E–15
38	1.5E–13	2.3E–17	4.1E–17	*c*	3.7E–12	1.6E–17	9.2E–19	2.0E–17	2.4E–15	5.5E–15
39	1.2E–13	3.3E–17	4.6E–17	*c*	7.5E–12	1.4E–17	6.2E–19	1.2E–17	2.2E–15	4.2E–15
40	1.6E–13	9.1E–17	5.2E–17	*c*	9.2E–12	4.6E–17	1.8E–18	1.7E–17	2.8E–15	5.7E–15
42	1.3E–13	1.8E–17	2.9E–17	*c*	5.2E–12	1.8E–17	1.3E–18	2.0E–17	2.2E–15	4.6E–15
46	1.5E–13	5.7E–17	1.3E–16	*c*	1.0E–11	2.3E–17	1.1E–18	1.9E–17	2.3E–15	4.9E–15
48	1.6E–13	3.3E–17	5.4E–17	*c*	8.2E–12	2.8E–17	6.9E–19	1.3E–17	2.7E–15	5.6E–15
51	1.6E–13	7.4E–17	2.2E–17	*c*	9.2E–12	8.5E–18	3.8E–19	7.2E–18	2.7E–15	5.2E–15
52	1.5E–13	5.0E–17	1.1E–17	*c*	6.6E–12	9.4E–18	1.4E–18	9.3E–18	1.8E–15	4.7E–15
					Tomatoes (pCi/g)					
35	*c*	8.1E–03	*c*	3.0E+00	*c*	*c*	*c*	*c*	*c*	1.7E+00
37	*d*	*d*	*d*	2.2E+00	*c*	*c*	*c*	*c*	*d*	1.5E+00
38	*d*	*d*	*d*	3.2E+00	*c*	*c*	*c*	*c*	*d*	2.1E+00
39	*d*	*d*	*d*	3.8E+00	*c*	*c*	*c*	*c*	*d*	1.9E+00
40	*d*	*d*	*d*	2.7E+00	*c*	*c*	*c*	*c*	*d*	1.5E+00
42	*d*	*d*	*d*	3.0E+00	*c*	*c*	*c*	*c*	*d*	1.7E+00
46	*d*	*d*	*d*	2.7E+00	*c*	*c*	*c*	*c*	*d*	1.7E+00
48	*d*	*d*	*d*	3.2E+00	*c*	*c*	*c*	*c*	*d*	1.6E+00
51	*d*	*d*	*d*	3.0E+00	*c*	*c*	*c*	*c*	*d*	2.1E+00
					Lettuce (pCi/g)					
35	*d*	*d*	*d*	3.2E+00	*c*	*c*	*c*	6.8E–07	*d*	1.7E+00
37	*d*	*d*	*d*	3.4E+00	*c*	5.1E–07	*c*	4.9E–07	*d*	1.8E+00
38	*d*	*d*	*d*	2.8E+00	*c*	9.7E–07	6.5E–07	1.3E–06	5.1E–02	1.6E+00
39	*d*	*d*	*d*	3.4E+00	*c*	*c*	*c*	1.1E–06	*d*	1.9E+00
40	*d*	6.5E–03	3.8E–03	3.3E+00	*c*	7.3E–07	*c*	7.0E–07	4.6E–02	2.1E+00
42	*d*	8.9E–03	*d*	3.2E+00	*c*	1.0E–06	*c*	1.7E–06	4.3E–02	2.1E+00
46	*d*	*d*	*d*	2.8E+00	*c*	*c*	*c*	*d*	*d*	1.6E+00
48	*d*	5.1E–03	*d*	3.6E+00	*c*	4.1E–07	*c*	1.7E–06	*d*	2.3E+00
51	*d*	*d*	*d*	3.2E+00	*c*	4.9E–07	*c*	*d*	*d*	1.9E+00

Table 5.3 (continued)

Station	^{7}Be	^{60}Co	^{137}Cs	^{40}K	^{3}H	^{234}U	^{235}U	^{238}U	Gross alpha	Gross beta
					Turnips (pCi/g)					
35	*d*	*d*	*d*	2.4E+00	*c*	*c*	*c*	*c*	*d*	1.6E+00
37	*d*	*d*	*d*	2.6E+00	*c*	*c*	*c*	*c*	*d*	2.2E+00
38	*d*	*d*	2.0E–03	2.3E+00	*c*	*c*	*c*	*c*	*d*	2.0E+00
39	*d*	4.1E–03	*d*	3.1E+00	*c*	*c*	*c*	*c*	*d*	2.5E+00
40	*d*	*d*	*d*	2.1E+00	*c*	*c*	*c*	*c*	*d*	1.5E+00
42	*d*	*d*	*d*	2.2E+00	*c*	*c*	*c*	*c*	*d*	1.7E+00
46	*d*	*d*	6.2E–03	2.2E+00	*c*	*c*	*c*	*c*	*d*	1.5E+00
48	*d*	*d*	3.8E–03	2.0E+00	*c*	*c*	*c*	*c*	3.2E–02	1.7E+00
51	*d*	*d*	*d*	2.9E+00	*c*	*c*	*c*	*c*	*d*	1.6E+00
					Soil (pCi/g)					
35	*c*	*d*	*d*	1.4E+01	*c*	5.4E–01	*d*	5.4E–01	1.8E+00	*d*
37	*c*	*d*	*d*	1.7E+01	*c*	5.3E–01	*d*	8.5E–01	3.0E+00	*d*
38	*c*	*d*	*d*	1.8E+01	*c*	*d*	*d*	*d*	2.6E+00	*d*
39	*c*	*d*	*d*	1.7E+01	*c*	3.5E–01	*d*	3.7E–01	2.3E+00	*d*
40	*c*	*d*	*d*	1.9E+01	*c*	*d*	*d*	1.1E+00	2.5E+00	*d*
42	*c*	*d*	*d*	1.5E+01	*c*	3.3E–01	4.9E–01	8.7E–01	*d*	*d*
46	*c*	*d*	*d*	1.5E+01	*c*	5.0E–02	*d*	3.0E–01	3.0E+00	*d*
48	*c*	*d*	*d*	1.7E+01	*c*	3.8E–01	*d*	9.5E–01	1.9E+00	*d*
51	*c*	*d*	*d*	1.6E+01	*c*	*d*	*d*	*d*	2.3E+00	*d*

[a]All values represent the mean number for each of the media and each isotope.
[b]Values for air filters are given in microcuries per milliliter. Values for all other media are given in picocuries per gram.
[c]Not applicable.
[d]Not detected.

Table 5.4. Uranium concentrations in ambient air on the ORR

Isotope	Concentration (10^{-15} µCi/mL)			
	1993	1994	1995	1996
		Station 35		
^{234}U	4.2E–02	3.5E–02	1.5E–02	2.2E–02
^{235}U	1.1E–02	3.0E–03	4.4E–04	1.3E–03
^{238}U	2.2E–02	2.4E–02	1.8E–02	3.4E–02
		Station 37		
^{234}U	5.4E–02	3.5E–02	1.3E–02	2.0E–02
^{235}U	9.0E–03	3.0E–03	1.4E–03	7.2E–04
^{238}U	1.8E–02	1.9E–02	1.3E–02	2.1E–02
		Station 38		
^{234}U	3.7E–02	2.9E–02	1.1E–02	1.6E–02
^{235}U	7.0E–03	4.0E–03	2.7E–04	9.2E–04
^{238}U	1.7E–02	1.6E–02	1.1E–07	2.0E–02
		Station 39		
^{234}U	4.1E–02	2.7E–02	1.1E–02	1.4E–02
^{235}U	1.0E–02	5.0E–03	1.1E–03	6.2E–04
^{238}U	1.6E–02	9.0E–03	9.1E–03	1.2E–02
		Station 40		
^{234}U	1.1E–01	8.9E–02	5.1E–02	4.6E–02
^{235}U	1.0E–03	9.0E–03	3.4E–03	1.8E–03
^{238}U	2.1E–02	1.6E–02	1.6E–02	1.7E–02
		Station 42		
^{234}U	2.5E–02	1.9E–02	1.1E–02	1.8E–02
^{235}U	3.0E–03	2.0E–03	1.3E–03	1.3E–03
^{238}U	2.2E–02	1.5E–02	1.1E–02	2.0E–02
		Station 46		
^{234}U	1.0E–01	4.4E–02	2.6E–02	2.3E–02
^{235}U	1.2E–02	6.0E–03	1.7E–03	1.1E–03
^{238}U	1.8E–02	1.5E–02	1.1E–02	1.9E–02
		Station 48		
^{234}U	5.2E–02	2.3E–02	1.3E–02	2.8E–02
^{235}U	1.0E–02	1.0E–03	1.0E–03	6.9E–04
^{238}U	2.1E–02	1.1E–02	9.5E–03	1.3E–02
		Station 51		
^{234}U	4.3E–02	1.0E–02	7.2E–03	8.5E–03
^{235}U	9.0E–03	2.0E–03	2.7E–03	3.8E–04
^{238}U	1.4E–02	6.0E–03	5.9E–03	7.2E–03
		Station 52		
^{234}U	3.3E–02	1.6E–02	1.2E–02	9.4E–03
^{235}U	7.0E–03	2.0E–02	2.2E–03	1.4E–03
^{238}U	1.6E–02	6.0E–03	8.9E–03	9.3E–03

ness of the data. There are no federal regulations, state regulations, or DOE orders that require this monitoring. All ambient air monitoring systems at the Y-12 Plant are operated as a BMP. With the reduction of plant operations and improved emission and administrative controls, levels of measured pollutants have decreased significantly during the past several years. In addition, processes that result in the emission of enriched and depleted uranium are equipped with stack samplers that have been reviewed and approved by the EPA to meet requirements of the NESHAP regulations. ORR air sampling stations, operated by ORNL in accordance with DOE orders, are located around the reservation. Their locations ensure that areas of potentially high exposure to the public are monitored continuously for parameters of concern.

With agreement from TDEC personnel, the ambient air sampling program at the Y-12 Plant was significantly reduced, effective at the end of 1994. All fluoride, total suspended particulates (TSPs), and particulate matter less than 10 microns in diameter (PM10) sampling was discontinued, and all but 3 of the 12 uranium samplers were shut down. The mercury sampling program was continued to monitor ambient air level concentrations through 1996 but may be curtailed in the near future because of decreasing monitoring budgets.

In 1996, three low-volume uranium particulate monitoring stations and four mercury monitoring stations were operated by the Y-12 Plant. The locations of these monitoring stations are shown in Fig. 5.4.

5.4.2.1 Uranium

Samples for routine measurement of uranium particulate were collected by pulling ambient air through a square 14-cm (5.5-in.) filter, which was analyzed by the Y-12 Plant Analytical Services Organization for total uranium and for the percentage of ^{235}U. Prior to 1993, the samples were analyzed for gross alpha and beta and for activity levels of specific uranium isotopes; however, in 1993 the analysis program for radionuclides was revised as described in the EMP to obtain total uranium particulate and the percentage of ^{235}U. In this manner, uranium concentrations in ambient air could be better correlated to stack emission data, which are also measured as total uranium mass. For 1996, the average 7-day concentration of uranium at the three monitored locations ranged from a low of 0.000002 $\mu g/m^3$ at Station 5 to a high of 0.00157 $\mu g/m^3$ at Station 4 (Table 5.5).

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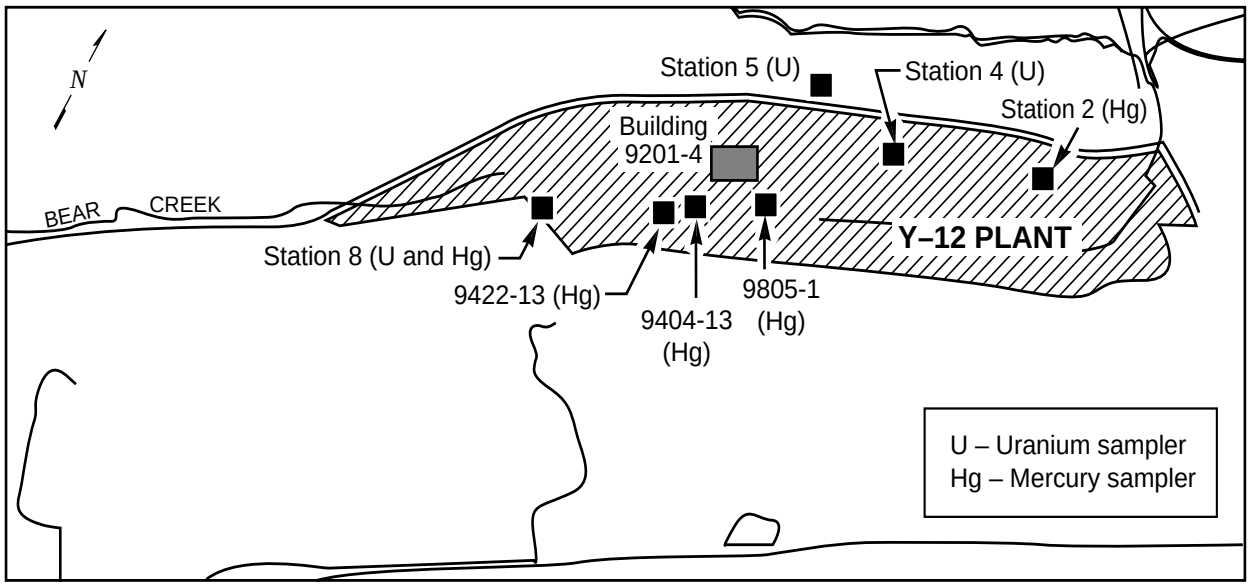

Fig. 5.4. Locations of ambient air monitoring stations at the Y-12 Plant.

Table 5.5. Uranium mass in ambient air at the Y-12 Plant, 1996

Station No.	No. of samples	7-day concentration ($\mu g/m^3$)		
		Max	Min	Av
4	51	0.00157	0.000004	0.00009
5	51	0.00029	0.000002	0.00006
8	52	0.00091	0.000020	0.00009

5.4.2.2 Mercury

In 1986, the Oak Ridge Y-12 Plant established a monitoring program to measure on-site mercury vapor concentrations in ambient air. Outdoor airborne mercury vapor at the Y-12 Plant is primarily the result of vaporization from mercury-contaminated soils, releases from burning coal at the Y-12 Steam Plant, and fugitive emissions from Building 9201-4, a former lithium isotope separation facility contaminated with mercury. When originally established, the goals of the monitoring program were to establish a historical data base of mercury concentration in ambient air at the Y-12 Plant, identify spatial and temporal trends in mercury vapor concentrations at the Y-12 Plant, and demonstrate protection of the environment and human health from releases of mercury from the Y-12 Plant to the atmosphere. With the purchase and installation in late 1995 of near-continuous mercury vapor monitors that provide mercury vapor data for periods as short as five minutes, a goal of developing a better understanding of the nature and sources of fugitive mercury emissions at the Y-12 Plant was added.

Four outdoor ambient mercury monitoring stations (stations on the east and west ends of the plant and two stations near Building 9201-4) were established at the Y-12 Plant in 1986. All are presently still operating except for one of the sites near Building 9201-4. This site, formerly located near Building 9404-13, was relocated in 1996 to a site approximately 30 meters south and west of the old location. The new site was chosen in order to have access to a nearby instrument shed, Building 9422-13, for housing a mercury vapor analyzer. A control, or reference site, was established in 1988 at Rain Gage No. 2 on Chestnut Ridge in the Walker Branch Watershed. This reference site was discontinued after collecting data for approximately 20 months to establish background concentrations and a seasonal pattern.

Because no established or EPA-approved method for measuring mercury vapor in ambient air existed when the program was initiated in 1986, ESD staff developed a method to meet the needs of the monitoring program for the Y-12 Plant. At each of the monitoring sites, airborne mercury vapor is pulled through a Teflon filter and flow-limiting orifice before being adsorbed onto iodated charcoal packed in a glass sampling tube. The charcoal sampling tubes are routinely changed every seven days. Average air concentration of mercury vapor for each seven-day sampling period is calculated by dividing the total quantity of mercury collected on the charcoal by the total volume of air pulled through the charcoal trap over the seven-day period.

In late 1995, Tekran™ Model 2537A Mercury Vapor Analyzers were installed at Ambient Station No. 8 and Building 9422-13 and in September, 1996, at Ambient Station No. 2. The analyzer at Building 9422-13 was removed in early 1996 until recurrent computer and analyzer problems could be solved. These new Tekran mercury vapor analyzers are self-calibrating, include mass-flow controllers, and can provide almost continuous analysis of mercury vapor in air at levels less than 1 ng/cm^3 at time intervals as short as five minutes. Plans (pending available funding) are for a Tekran analyzer to be reinstalled at the Building 9422-13 location and a for fourth analyzer to be installed at a not-yet-determined location near the present charcoal trap monitoring site at Building 9805-1.

The new analyzers at both Ambient Station No. 2 and Ambient Station No. 8 are presently being operated simultaneously with the existing monitoring system (i.e., the iodated charcoal traps) to verify comparability of the measurements. As the reliability and comparability of data of the Tekrans is established, the use of the

iodated charcoal traps will be phased out. The Tekran monitors provide data on demand and, because of their high sensitivity, provide data averaged over much shorter time intervals than the charcoal trap data (i.e., minutes instead of days). Figure 5.5 shows a plot of mercury vapor concentrations recorded by a Tekran analyzer at 30-min intervals over a three-month period in 1996 at Ambient Station No. 2. This plot represents approximately 4000 data points and provides important temporal information. This information, when combined with synoptic meteorologic data (i.e., wind speed and direction), could be used to better understand the nature and location of fugitive mercury emissions. Preliminary analysis of data collected at the two existing Tekran sites has already shown a strong correlation between wind direction and mercury vapor concentration with higher mercury vapor concentrations measured at a site when the prevailing wind direction is from the former mercury-use areas at the Y-12 Plant.

Preliminary results given in Table 5.6 show average mercury vapor concentration for the same time period during which both monitoring methods were operational. The average concentration recorded by the two Tekran analyzers is slightly higher than that calculated using the charcoal trap method, although a paired *t*-test analysis of the Station No. 2 data demonstrates that the means are not significantly different. A paired *t*-test analysis of the Station No. 8 averages, however, indicated a significant difference in the means at this site. The volume of air sampled by the Tekran analyzers, which have mass flow controllers, is corrected to standard temperature and pressure, unlike the charcoal traps. This could explain the small though significant difference between the two means. A statistical comparison of data collected by the two monitoring methods is being continued into 1997 for these two sites. Plans are to do a similar comparison at one of the sites located south of Building 9201-4, where mercury vapor levels are significantly higher.

As reported in previous ORR ASERs, annual average mercury vapor concentrations have declined in recent years when compared with concentrations measured during the early years of the monitoring program (1986 through 1988). This trend continues through 1996 (see Table 5.7). Of the three sites still operational since 1986, all three recorded significantly lower annual averages (Student's *t*-test at the 1% level) for mercury vapor concentration when compared with the 1986 through 1988 average. In addition, 1996 averages for the three sites are lower, although not significantly, than those recorded for 1995. Mercury vapor concentrations recorded at Building 9422-13 are approximately half of concentrations recorded previously at the Building 9404-13 site that it replaced. The decrease in ambient mercury recorded at the Y-12 site since 1989 is thought to be related to the reduction in coal burned at the Y-12 steam plant beginning in 1989 and to the completion prior to 1989 of several major engineering projects [e.g., New Hope Pond closure, the

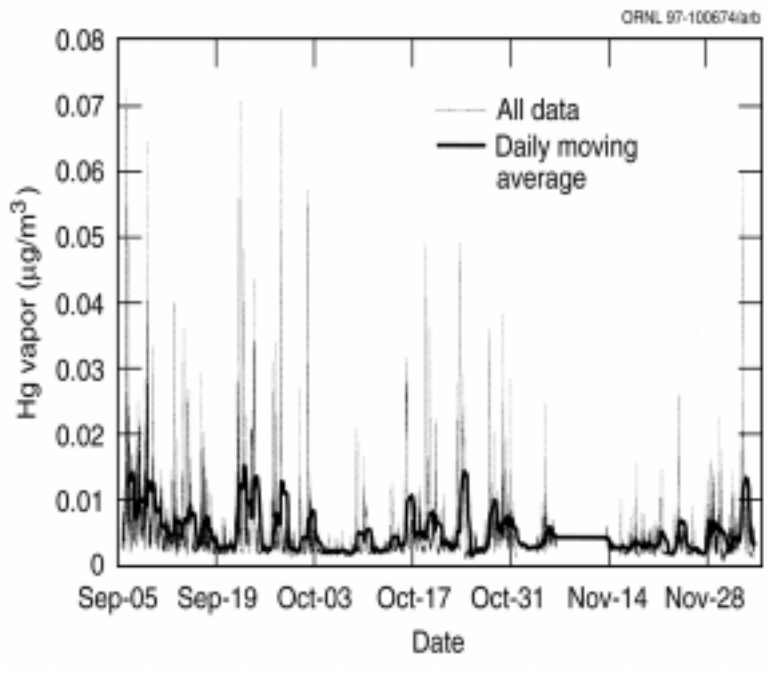

Fig. 5.5. Time trends in mercury vapor concentration at Ambient Station No. 2 from September through early December 1996, as measured by a Tekran Model 2537A Mercury Vapor Analyzer.

Table 5.6. Comparison of average mercury vapor concentrations at the two Y-12 Plant monitoring sites with both Tekran and charcoal trap monitoring systems[a]

Ambient air monitoring site	N	Average mercury vapor concentration (µg/m³)	
		Tekran analyzer	Iodated charcoal traps
Ambient Station No. 2	15	0.0049	0.0046
Ambient Station No. 8	49	0.0067	0.0059

[a]The two averages for a site are calculated from data collected by the Tekran analyzer and charcoal traps for the same time period.

Table 5.7. 1996 results of the Y-12 Plant ambient air mercury monitoring program compared with average results from 1995 and 1986–88

Ambient air monitoring site	No.	Mercury vapor concentration (µg/m³)				
		1996 max	1996 min	1996 av[a]	1995 av[a]	1986–88 av[a]
Station No. 2 (east end of Y-12 Plant)	51	0.010	<0.002	0.004	0.005	0.010
Station No. 8 (west end of Y-12 Plant)	52	0.016	<0.002	0.006	0.007	0.033
Bldg. 9422-13 (SW of Bldg. 9201-4)	51	0.100	0.008	0.030	N/A[b]	N/A[b]
Bldg. 9805-1 (SE of Bldg. 9201-4)	28[c]	0.112	0.006	0.058	0.066	0.099
Reference site, rain gage No. 2 (1988[d])	47	0.016	0.002	0.006	0.006	N/A
(1989[e])	47	0.015	<0.001	0.005	0.005	N/A

[a]The NESHAP 30-day average standard equals 1 µg/m³. The American Conference of Governmental Industrial Hygienists 8-hour day, 40-hour work week standard equals 50 µg/m³.
[b]New site.
[c]Electrical outage during utility upgrades (e.g., transformer replacement).
[d]Data for February 9 through December 31, 1988.
[e]Data for January 1 through October 31, 1989.

Perimeter Intrusion Detection Assessment System (PIDAS), RMPE, and Utility Systems Restoration] that may have caused a temporary increase in mercury air concentrations when contaminated soil and sediment were disturbed. More recently, mercury cleanup and closure activities have been conducted at several sites within the mercury-use areas, including Building. 9201-4. Table 5.7 presents average mercury vapor data for 1995 and 1996, data from the1986 through 1988 period, and data from the reference or control site collected using the charcoal trap monitoring method.

Figure 5.6 shows the trends in mercury concentrations for the four active ambient air mercury monitoring sites since the inception of the program in 1986. (The results for the new site at Building 9422-13 are combined with the results for Building 9404-13.)

Ambient mercury concentrations at the two monitoring sites near Building 9201-4 continue to

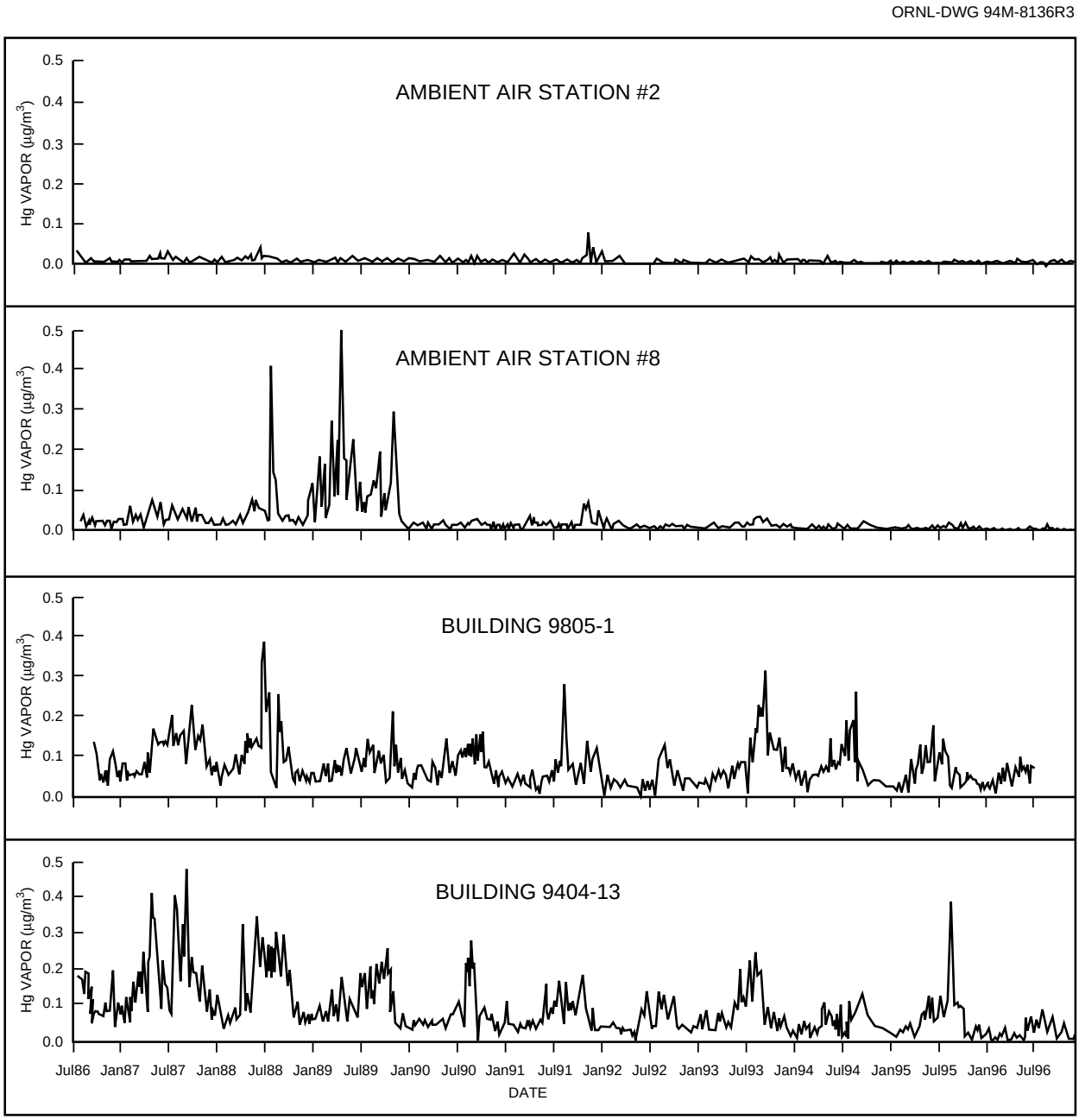

Fig. 5.6. Time trends in mercury vapor concentrations (iodated charcoal trap monitoring method) for the four active airborne mercury monitoring sites at the Oak Ridge Y-12 Plant (1986 through 1996). Results for the new site established in 1996 at Bldg. 9422-13 are combined with results for Building 9404-13.

be elevated above natural background in 1996 (see Fig. 5.4); however, results indicate that the concentrations of mercury vapor are well below the NESHAP guideline of 1 µg/m^3 (30-day average) and the American Conference of Governmental Industrial Hygienists (ACGIH) threshold limit value of 50 µg/m^3 (time-weighted average for 8-hour workday and 40-hour work week). Average concentrations at the two monitoring sites located at the east and west end of the Y-12 Plant are

presently as low as levels measured at the reference site on Chestnut Ridge.

5.4.3 ORNL Ambient Air Monitoring

The objectives of the ORNL ambient air monitoring program are to collect samples at stations that are most likely to show impacts of airborne emissions from the operation of ORNL and to provide for emergency response capability. The specific stations associated with these objectives are 1, 2, 3, and 7 (Fig. 5.7). Sampling is conducted at each ORNL station to quantify levels of adsorbable gas (e.g., iodine); beryllium; and gross alpha-, beta-, and gamma-emitting radionuclides (Table 5.8).

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

5.4.3.1 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 5.8) is compared with air sampling data from the reference stations at Norris Dam (51) and Fort Loudoun (52) (Table 5.2). Comparison of the data in

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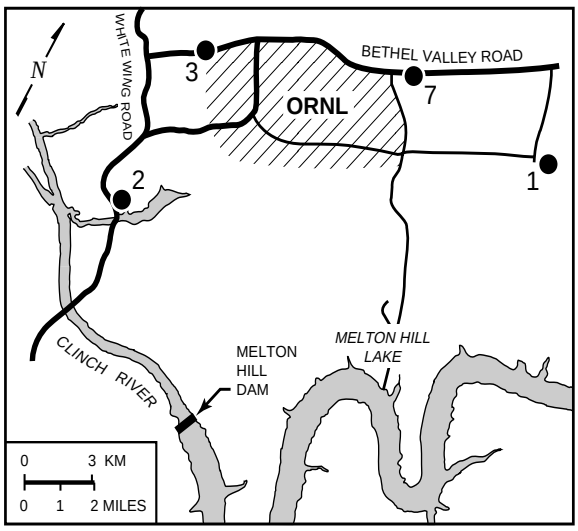

Fig. 5.7. Locations of ambient air monitoring stations at ORNL.

Table 5.8. Radionuclide concentrations measured at ORNL perimeter air monitoring stations, 1996 (µCi/mL)[a]

Parameter	Station			
	1	2	3	7
^{241}Am	*b*	*b*	9.3E–18	4.9E–18
^{7}Be	1.2E–14	9.4E–15	1.5E–14	1.1E–14
^{244}Cm	*b*	9.4E–18	*b*	*b*
^{60}Co	*b*	*b*	*b*	*b*
^{137}Cs	5.7E–17	*b*	2.6E–17	*b*
^{3}H	4.3E–11	6.6E–11	1.5E–11	5.7E–11
^{131}I	4.0E–15	4.1E–15	1.4E–15	1.3E–15
^{133}I	*b*	3.2E–15	3.5E–15	2.7E–15
^{135}I	5.3E–14	*b*	2.5E–14	9.7E–14
^{212}Pb	*b*	*b*	3.0E–14	*b*
^{238}Pu	9.9E–18	4.5E–18	*b*	*b*
^{239}Pu	*b*	*b*	4.4E–18	4.1E–18
^{90}Sr	*b*	*b*	*b*	*b*
^{228}Th	5.4E–16	1.4E–16	3.6E–16	1.5E–16
^{230}Th	2.1E–15	7.0E–16	8.2E–16	5.8E–16
^{232}Th	4.3E–16	1.5E–16	2.2E–16	4.9E–16
^{234}U	3.0E–17	2.4E–17	2.5E–17	3.3E–17
^{235}U	5.1E–18	*b*	*b*	*b*
^{238}U	3.0E–17	2.6E–17	3.3E–17	4.5E–17

[a] 1 µCi = 3.7E+4 Bq.
[b] Not detected.

the two tables shows that ORNL has not had a significant impact on local air quality.

5.4.4 ETTP Ambient Air Monitoring

The ETTP ambient air monitoring program is designed to monitor selected pollutants for the ongoing monitoring of plant operations' impact on the immediate environment. Specific locations were selected to determine pollutant concentrations in the prevailing site upwind and downwind directions and to obtain radiological measurements in the direction of both the nearest and most exposed member of the public. The locations of these monitoring stations are shown in Fig. 5.8.

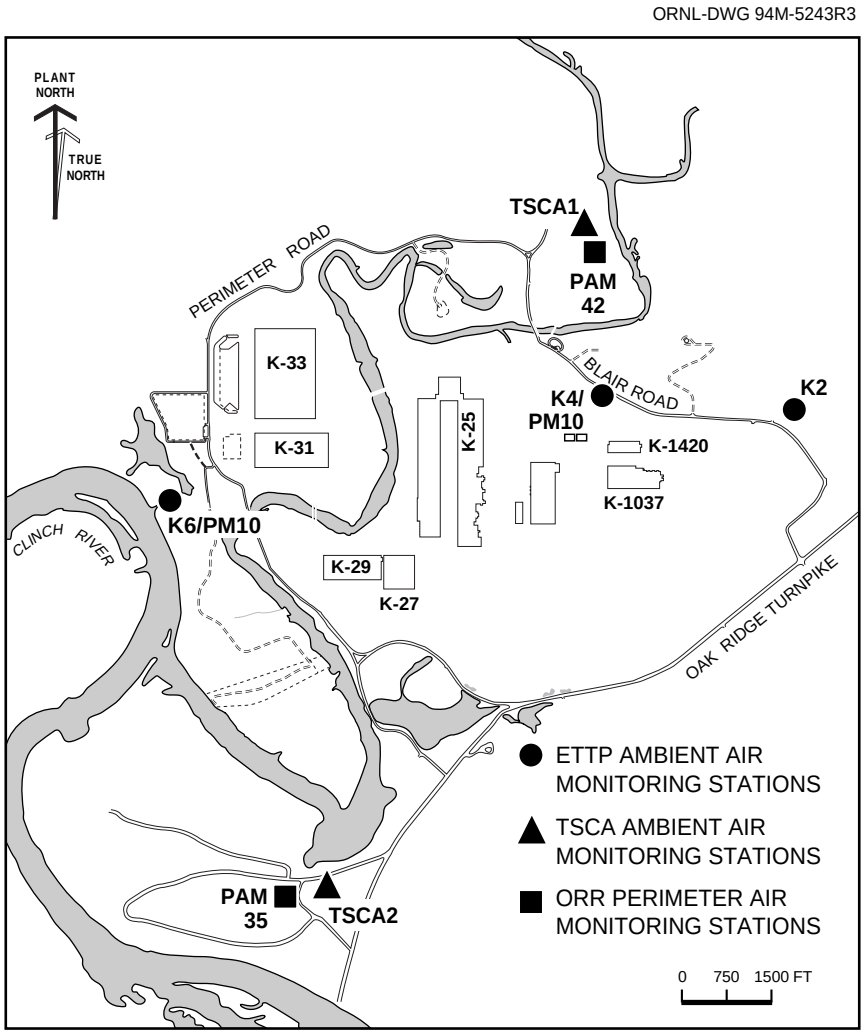

Fig. 5.8. Locations of ambient air monitoring stations at the ETTP.

The ETTP ambient air monitoring program complies with all requirements of DOE orders. The CAA regulations are referenced by DOE orders as guidance with respect to ambient air concentrations of certain air contaminants. These regulations specify 24-hour, quarterly, and annual standards for defined pollutants.

The ambient air program sampling schedule and monitoring capabilities for airborne particulate matter, uranium, and metals are listed in Table 5.9. All parameters are chosen with consideration of existing and proposed regulations and the nature of operations in and around the ETTP. Changes in emissions, wind profile, site activities, or any other parameter that may alter the potential impact of ETTP activities on the environment or community may warrant periodic changes of pollutants measured, number of stations, or relocation of existing stations.

During this reporting period, the network was modified with respect to ETTP operations. All sampling was discontinued at stations K1, K3, K5, and K7. Additionally, all high-volume (HV) sampling for TSP was discontinued to reflect the state and federal withdrawal of TSP ambient air quality standards. To supplement the existing sampling for particulate matter smaller than 10 microns in diameter (PM10) at station K4, a second PM10 sampler was installed at station K6. The two PM10 samplers are located in the prevailing upwind and downwind directions with respect to the ETTP, and operate on the same 24-hour sample every sixth day schedule.

HV sampling for uranium continues at stations K2 and K6, representing samples in the prevailing wind direc-

Table 5.9. Summary of collection and analysis frequencies of samples collected at ETTP perimeter ambient air monitoring stations, 1996

Parameter	Sampling locations	Sampling period	Collection frequency	Analysis frequency[a]
		Criteria pollutants		
PM10	K4, 6	24 hour	Every sixth day[b]	Weekly
Lead	K2, 6	Continuous	Weekly	Monthly
		Hazardous air pollutants carcinogen metals		
Arsenic	K2, 6	Continuous	Weekly	Monthly
Beryllium	K2, 6	Continuous	Weekly	Monthly
Cadmium	K2, 6	Continuous	Weekly	Monthly
Chromium (total)	K2, 6	Continuous	Weekly	Monthly
		Organic compounds		
PCBs	TSCA 1, 2	*c*	*c*	*c*
Furan	TSCA 1, 2	*c*	*c*	*c*
Dioxin	TSCA 1, 2	*c*	*c*	*c*
Hexachlorobenzene	TSCA 1, 2	*c*	*c*	*c*
		Radionuclides		
Uranium (total)	K2, 6	Continuous	Weekly	Monthly
	PAM-35, 42	Continuous	Weekly	Quarterly
	TSCA 1, 2	Continuous	*c*	*c*

[a]"Weekly" frequency is analysis of each 24-hour sample; "monthly" and "quarterly" are composite sample analyses of all weekly samples over the identified period.

[b]24-hour sample every sixth day from midnight to midnight.

[c]Activated automatically only if a TSCA Incinerator operational upset occurs. Samples are then immediately submitted for analysis.

tions. Additional uranium monitoring coverage is supplied by the ORR PAM stations 35 and 42. The PAM locations represent coverage in the direction of the nearest and the most exposed individuals as defined by DOE Order 5400.5. Sampling for HAP carcinogen metals and lead continues at stations K2 and K6. The HV sampling schedule was modified at the beginning of this reporting period to correspond with PAM operations. This includes changing from the previous periodic grab sampling to continuous sampling with samples collected on a weekly basis.

5.4.4.1 Results

No standards were exceeded, and there were no significant elevations of pollutant concentrations associated with site operations. Sampling results assessing specific site activities' impact on air quality show that the ETTP and the project-specific operations did have a measurable but not a significant impact on local air quality. These data also support the state classification of this area, including the ETTP, as in attainment for PM10. Table 5.9 lists selected parameters measured during 1996.

5.4.4.2 Criteria Pollutant Levels

Daily PM10 analyses were performed on all 24-hour samples. A summary of all PM10 measurements is presented in Table 5.10. For 1996, the 24-hour PM10 concentrations ranged from 1.79 to 47.11 $\mu g/m^3$. The highest measured value was 31.4% of the Tennessee 24-hour primary and secondary standards (i.e., 150 $\mu g/m^3$). These levels are not an environmental concern.

Annual PM10 arithmetic averages of 24-hour measurements are presented in Table 5.10. The highest averaged PM10 annual result was 18.65 $\mu g/m^3$. This value was only 37.3% of the Tennessee and national annual primary and secondary standards for PM10 (i.e., 50 $\mu g/m^3$). Historical data show that this level is typical of annual measurements and is of no environmental concern (see Fig. 5.9 for five-year PM10 trend).

Quarterly lead results were determined from analyses of monthly composites of continuous weekly samples for each station. The total masses of lead were determined by the inductively coupled plasma mass spectrometry (ICP-MS) analytical technique. This technique was initiated in 1993, replacing a graphite furnace atomic absorption method (thus simplifying all metals analyses to one method). A summary of lead measurement results are presented in Table 5.11 and are compared with the Tennessee and national quarterly standard of 1.5 $\mu g/m^3$. There are no 24-hour, monthly, or annual ambient air criteria pollutant standards for lead. The maximum monthly lead result was 0.007641 $\mu g/m^3$. This value was only 0.51% of the quarterly standard for lead. No lead concentration levels of environmental concern were measured (see Fig. 5.10 for five-year lead trend).

5.4.4.3 Hazardous Air Pollutant Carcinogen Metal Levels

Analyses of HAP carcinogen metals (arsenic, beryllium, cadmium, and chromium) were performed on a monthly composite of continuous weekly samples from each station. The total mass of each selected metal was determined by ICP-MS analytical technique. This technique was initiated in 1993, replacing a flame atomic absorption method. The ICP-MS analytical technique simplified all chemical analyses to one method. There are no Tennessee or national ambient air quality standards for HAP carcinogen metals. However, monthly composite arsenic concentration results for all measurement sites ranged from 0.000238 to 0.000611 $\mu g/m^3$. Monthly composite beryllium concentration results ranged from less than 0.000012 to 0.000075 $\mu g/m^3$. Monthly composite cadmium concentration results for all measurement sites ranged from 0.000090 to 0.001331$\mu g/m^3$. Monthly composite chromium concentration results for all measurement sites ranged from less than 0.000148 to 0.004855 $\mu g/m^3$. An annual summary of all HAP carcinogen metals measurement results are in Table 5.12.

Table 5.10. PM10 particulates in ambient air at the ETTP, 1996

Station	Number of samples	Annual summary of PM10 concentrations ($\mu g/m^3$)			Max percentage of standard[a]	
		Annual av	24-hour max	24-hour min	Annual	24-hour
K4	51	18.13	46.97	1.79	36.3	31.3
K6	55	18.65	47.11	5.89	37.3	31.4
All stations	106	18.39	47.11	1.79	36.8	31.4

[a]PM10 Tennessee and national primary and secondary standards are 150 $\mu g/m^3$ per 24 hours and 50 $\mu g/m^3$ per year arithmetic average.

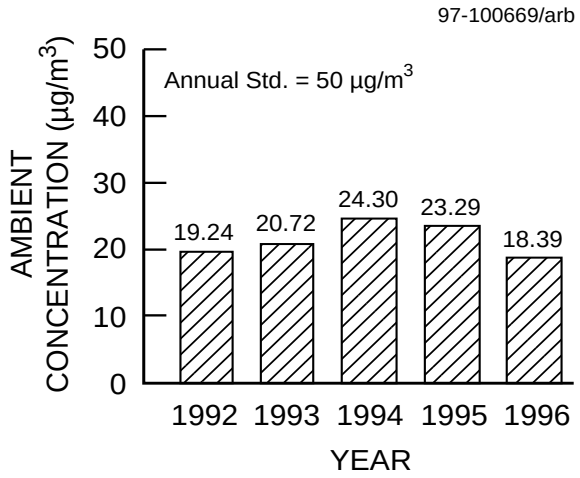

Fig. 5.9. Ambient air monitoring five-year trend results for PM10 at the ETTP.

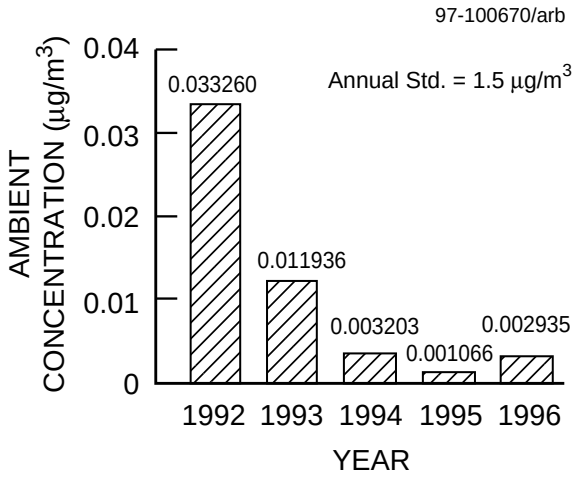

Fig. 5.10. Ambient air monitoring 5-year trend results for lead at the ETTP.

Table 5.11. Lead concentrations in ambient air at the ETTP, 1996

Station	Quarterly averages of monthly composites (µg/m³)				Max monthly result	Min monthly result	Max percentage of quarterly standard[a,b]
	1	2	3	4			
K2	0.004483	0.002316	0.003066	0.001588	0.006763	0.001588	0.45
K6	0.004942	0.002355	0.003119	0.001608	0.007641	0.001608	0.51
Quarterly av	0.004712	0.002335	0.003092	0.001598	0.007202	0.001598	0.48
Quarterly max	0.004942	0.02355	0.003119	0.001608	0.007641	0.001588	0.51
Annual average for all stations = 0.002935 µg/m³							

[a]Tennessee and national air quality standard for lead is 1.5 µg/m³ quarterly arithmetic average.
[b]Conservative comparison of the maximum monthly result with the quarterly standard.

5.4.4.4 Radionuclide Levels

Of the radionuclides, only uranium was measured as a monthly composite of continuous weekly samples from each station. The total uranium mass for each composite sample was determined by ICP-MS analytical technique. The uranium concentration for all measurement sites ranged from a low of 0.000014 to 0.001295 μg/m³ at Station K2 (Table 5.13). Station K2 is in the prevailing downwind direction of the ETTP. The annual average values for all stations were less than 1% of the annual standard of 0.15 μg/m³ (1.0E-1 pCi/m³) for naturally occurring uranium. No uranium concentration levels of environmental concern were measured (see Fig. 5.11 for five-year uranium trend).

5.4.4.5 Organic Compound Levels

Currently, measurements of selected semi-volatile organics are performed only during an operational upset of the TSCA Incinerator. Four

Table 5.12. HAP carcinogen metals in ambient air[a] at the ETTP, 1996

Parameter	Number of samples (all stations)	Annual summary of monthly composites (µg/m³)		
		Annual av[b]	Monthly max	Monthly min
Arsenic	51	0.000474	0.000811	0.000238
Beryllium	51	0.000024	0.000075	<0.000012
Cadmium	51	0.000411	0.001331	0.000090
Chromium	51	0.001082	0.004855	0.000148

[a]There are no Tennessee or national ambient air quality standards. However, EPA has identified arsenic, beryllium, cadmium, and chromium as HAP carcinogen metals.
[b]Average of all station measurements.

Table 5.13. Uranium in ambient air at the ETTP, 1996

Station	Number of samples	Annual summary of monthly composite sampling (µg/m³)		
		Annual av	Monthly max[a]	Monthly min[a]
K2	53	0.000386	0.001295	0.000015
K6	52	0.000083	0.000394	0.000013
PAM35	47	0.000069	0.000258	0.000023
PAM42	48	0.000044	0.000107	0.000014
All stations	200	0.000146	0.001295	0.000014

[a]The annual standard for natural occurring uranium is 1E-01 pCi/m³, which is equivalent to 0.15 µg/m³.

upsets occurred during waste burning operations in 1996 that activated the TSCA ambient air stations. The upsets resulted in three measurements of PCBs, furans, dioxin, and hexachlorobenzene. Sampling and analytical results showed that there was no detectable off-site impact as a result of these events beyond that which would result from normal background levels. Ambient air samples for one event were not analyzed because the incinerator was not feeding waste at the time of the operational upset.

5.4.4.6 Five-Year Trends

Five-year summaries of ETTP ambient air monitoring data are shown in Figs. 5.9, 5.10, and 5.11 for PM10, lead, and uranium. Other measured pollutant trends are discussed in this section. Variations of PM10 measurements were insignificant and most likely reflect background concentration variations of air quality. Lead measurement variations from 1992 through 1993 were primarily caused by changes in analytical techniques. From 1993 to the present, lead levels have been declining and most likely reflect the

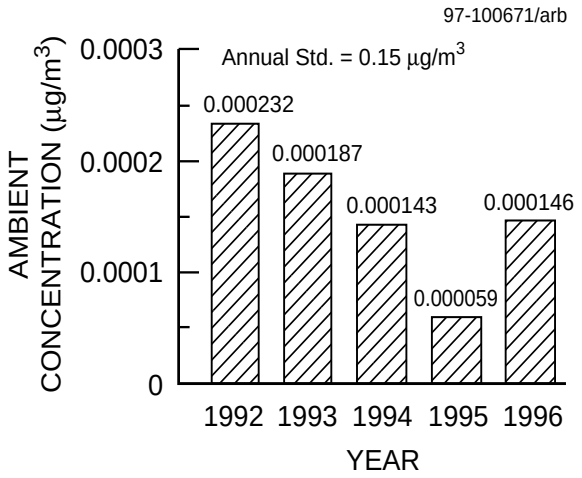

Fig. 5.11. Ambient air monitoring five-year trend results for uranium at the ETTP.

reduction of lead and lead compounds in motor vehicle fuels. No variations caused by ETTP activities could be differentiated from background levels of this pollutant. Arsenic, beryllium, and cadmium measurements were initiated in 1993. Arsenic variations in 1995 and 1996 were coincidental to demolition activities that affected structural materials treated with arsenic compounds. Measurements of beryllium have been at or near analytical detection limits. Cadmium concentration variations occurred during 1992 and 1995. Variations of chromium measurements from 1992 through 1994 show no identifiable ETTP contribution. Changes in analytical techniques were responsible for most of the variations up to 1994. Chromium variations in 1995 and 1996 were coincidental to demolition activities that affected structural materials that had long-term exposure to chromium compounds.

5.5 SURFACE WATER MONITORING

5.5.1 ORR Surface Water Monitoring

Under the ORR EMP, samples are collected and analyzed from 22 locations around the ORR to assess the impact of past and current DOE operations on the quality of local surface water. Sample locations are on streams downstream of ORR waste sources, at reference points on streams and reservoirs upstream of waste sources, on reference streams off site, and at public water intakes (Fig. 5.12). Sampling locations include the following:

- Bear Creek downstream from Y-12 Plant inputs (BCK 0.6),
- Bear Creek downstream from Y-12 Plant burial grounds (BCK 9.4),
- Clinch River downstream from all DOE inputs [Clinch River kilometer (CRK) 16],
- water supply intake for the ETTP (CRK 23),
- Clinch River downstream from ORNL (CRK 32),
- water supply intake for Knox County (CRK 58),
- Melton Hill Reservoir above city of Oak Ridge water intake (CRK 66),
- Melton Hill Reservoir at Oak Ridge Marina (CRK 80),
- Melton Hill Reservoir above all DOE inputs at the Anderson County Filtration Plant (CRK 84),
- EFPC downstream from floodplain (EFK 5.4),
- EFPC downstream from Y-12 Plant (EFK 23.4),
- Hinds Creek (reference site for EFPC) (HC),
- Melton Branch downstream from ORNL [Melton Branch kilometer (MEK) 0.2],
- Melton Branch upstream from ORNL (MEK 2.1),
- Mitchell Branch downstream from ETTP Site [Mitchell Branch kilometer (MIK) 0.1],
- Mitchell Branch upstream from ETTP (MIK 1.4),
- Poplar Creek downstream from ETTP [Poplar Creek kilometer (PCK) 2.2],
- Poplar Creek upstream from ETTP and EFPC (PCK 22),
- water supply intake for city of Kingston [Tennessee River kilometer (TRK) 915],
- WOL at WOD [White Oak Creek kilometer (WCK) 1.0],

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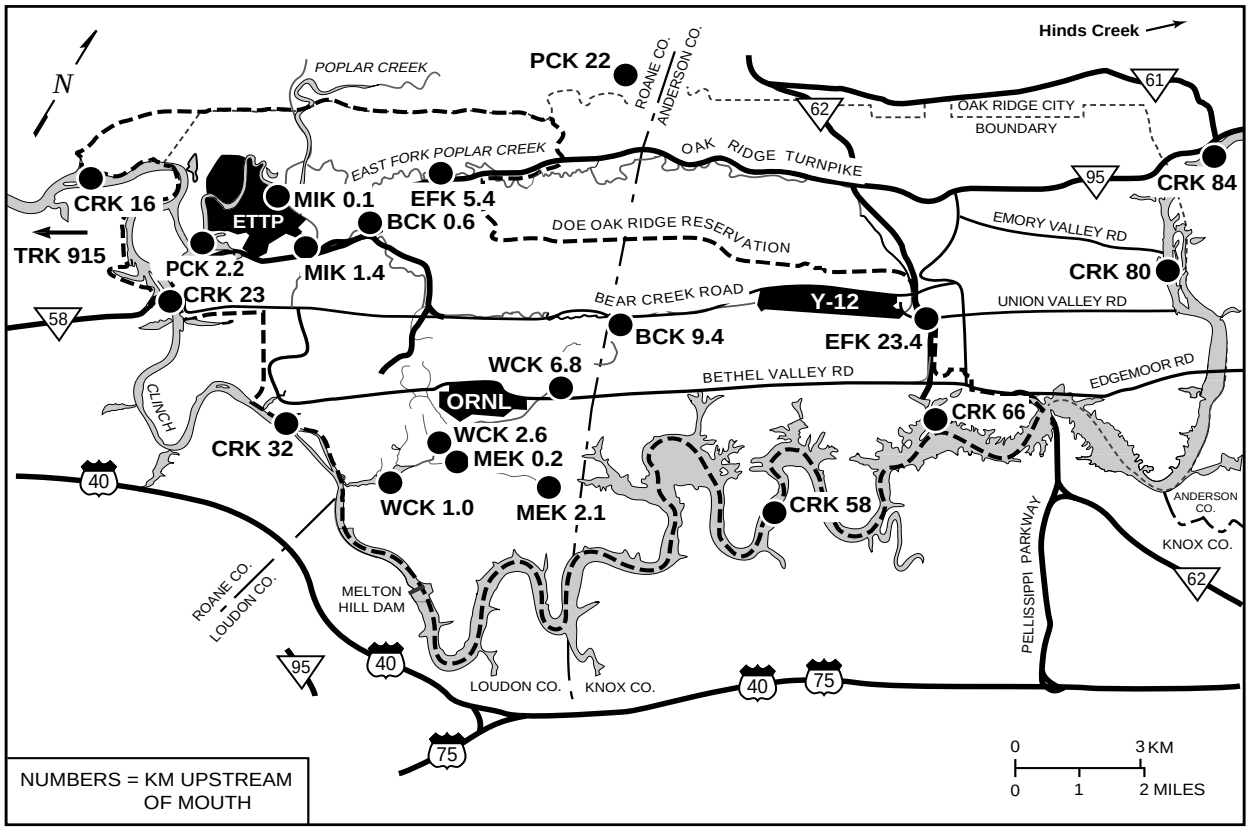

Fig. 5.12. Locations of ORR surface water surveillance sampling stations.

- WOC downstream from ORNL (WCK 2.6), and
- WOC upstream from ORNL (WCK 6.8).

Water quality measurements serve as guides to the general health of the environment. The sampling and analysis in this program are conducted in addition to requirements mandated in NPDES permits for individual ORR DOE facilities. Although there is some overlap of sampling sites in the NPDES and environmental monitoring plan programs, frequency and analytical parameters vary.

Sampling frequency under the EMP is bimonthly, with half of the sites being sampled one month and the other half in the following month. Grab samples are collected and analyzed for general water quality parameters, total metals, and volatile organics. They are also screened for radioactivity and analyzed for specific radionuclides when appropriate.

In 1994, the collection of semiannual composite samples from WOC at WOD (WCK 1.0) and the Clinch River downstream from all DOE inputs (CRK 16) was implemented. These samples are analyzed for isotopic uraniums, thoriums, and transuranics. This program was discontinued in 1996; samples were collected one time in June.

Most of these sampling locations are classified by Tennessee for certain uses (e.g., domestic water supplies or recreational use). Tennessee water quality criteria for domestic water supplies, for freshwater fish and aquatic life, and for recreation (water and organisms), are used as references for locations where they are applicable. Out of the 79 parameters analyzed at each of the 22 locations, chromium at WOD (WCK 1.0), arsenic at the Melton Hill Reservoir at the Oak Ridge Marina (CRK 80), zinc at WOC upstream from

ORNL (WCK 6.8), and mercury at the water supply intake for Knox County (CRK 58) are the only parameters that exceeded a reference value in 1996. Of these, chromium at WOD has been historically detected at elevated levels.

The Tennessee water quality criteria do not include criteria for radionuclides. Radionuclides were detected (statistically significant at a 95% confidence interval) at all of these surface water locations in 1996. The following observations are made from examining three years of historic data. Bear Creek downstream from the Y-12 Plant Burial Grounds (BCK 9.4) has consistently had the highest levels of gross alpha activity and, associated with the alpha activity, total uranium and uranium isotopes. BCK 9.4 also has elevated levels of gross beta activity. The highest levels of gross beta, total radioactive strontium, and tritium have been at Melton Branch downstream from ORNL (MEK 0.2), WOC at WOD (WCK 1.0) and WOC downstream from ORNL (WCK 2.6). These data are consistent with the processes or legacy activities nearby or upstream from these locations. The results for the June composites at CRK 16 and WCK 1.0 are consistent with the bimonthly samples collected from these locations.

5.5.2 Y-12 Plant Surface Water Monitoring

Routine surface water surveillance monitoring, above and beyond that required by the NPDES permit, is performed as a BMP. (See Chap. 4 for results of radiological monitoring and NPDES monitoring at the Y-12 Plant.) The Y-12 Environmental Compliance Organization staff monitor the surface water as it exits from each of the three hydrogeologic regimes that serve as an exit pathway for surface water (Fig. 5.13). Modifications were made to the routine BMP program (sampling frequency and number of parameters) in the fall of 1996 to meet budget constraints.

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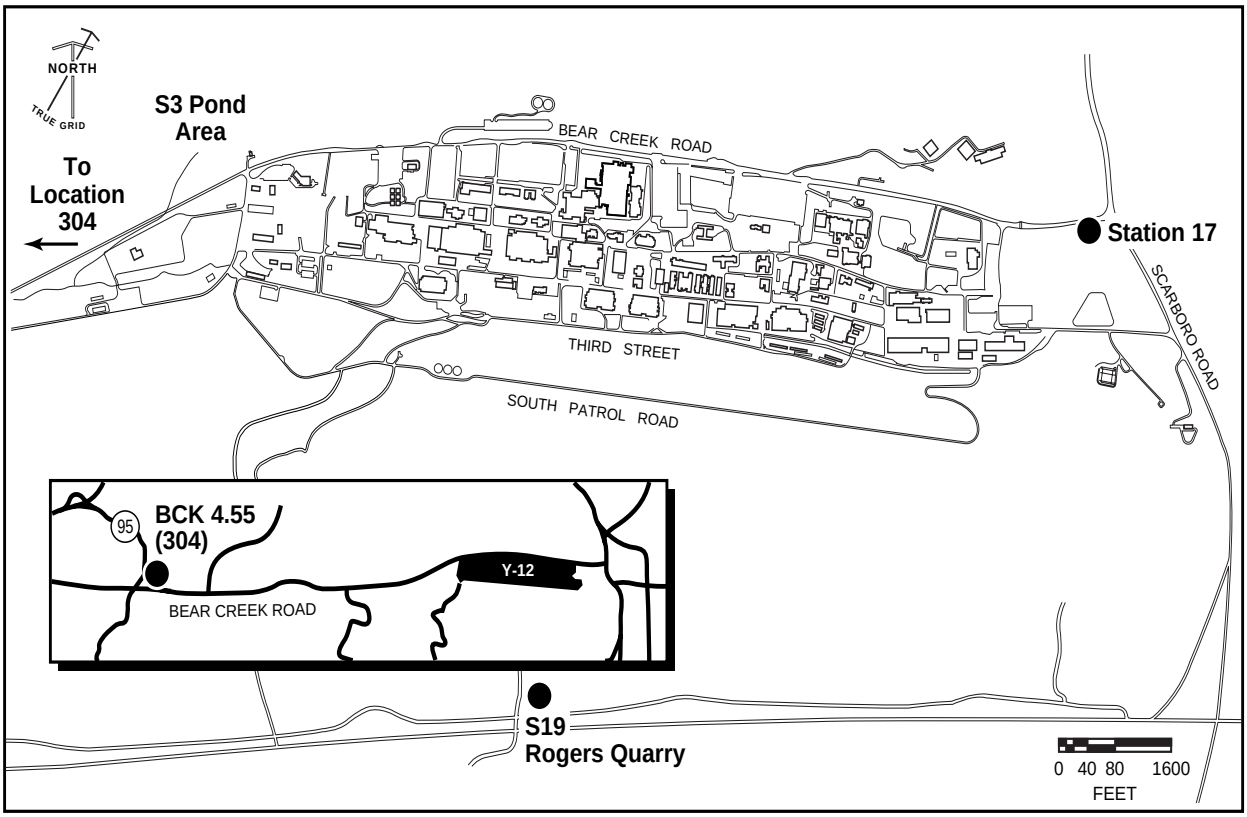

Fig. 5.13. Locations of Y-12 Plant surface water surveillance sampling stations.

Monitoring is conducted in EFPC at Station 17 (9422-1) near the junction of Scarboro and Bear Creek roads. The present sampling program consists of two 48-hour composites plus a three-day weekend composite. These samples are analyzed for mercury, ammonia-N, inductively coupled plasma (ICP) metals, and TSS.

Monitoring is conducted in Bear Creek at BCK 4.55 (former NPDES station 304), which is at the western boundary of the Y-12 Plant area of responsibility. A surveillance sample (a seven-day composite sample) is collected monthly for mercury, anions (sulfate, chloride, ortho-phosphate, nitrate, nitrite), metals by ICP, total phenols, and TSS.

The exit pathway from the Chestnut Ridge regime is monitored via NPDES location S19 (former NPDES station 302) at Rogers Quarry. S19 is an in-stream location of McCoy Branch and is sampled monthly (a 24-hr composite) for ICP metals. The NPDES requirement for this location is to monitor and report metals data only. As part of the surface water BMP surveillance activity, data from this location, as well as that from Station 17 and Bear Creek km 4.55, are compared with state water quality criteria.

In addition to these exit pathway locations, a network of real-time monitors is located at in-stream locations along UEFPC and at key points on the storm drain system that flows to the creek. The stations are available for real-time water quality measurements, such as pH, temperature, dissolved oxygen, conductivity, and chlorine. The locations are noted in Fig. 5.14. Not all stations are operated on a routine basis, but all are available as necessary and as available funding allows.

For nonradiological parameters that are sampled, and detected above the analytical method reporting detection limit, the data are compared with Tennessee water quality criteria. The most restrictive of either the fresh water fish and aquatic life "criterion maximum concentration" (CMC) or the "recreation concentration for organisms only" standard (10^{-5} risk factor for carcinogens) is used. This comparison serves as a record of water quality and the comparison to state water quality criteria limits is for informational purposes only; as such, no attempt is made to achieve the lowest possible detection limit for all parameters.

More than 200 surface water surveillance samples were collected in 1996. Comparisons with Tennessee water quality criteria indicate that only mercury and zinc, from samples collected at Station 17, were detected at values exceeding a criteria maximum. Results are shown in Table 5.14. Of all the parameters measured in the surface water as a BMP, mercury is the only demonstrated contaminant of concern (see Chap. 4, "RMPE: Phase II," for details on activities to reduce mercury discharges).

Six zinc measurements from Station 17 exceeded the fish and aquatic life standard (0.117 mg/L) in 1996 as opposed to twenty-six measurements in 1995. The source of the zinc is believed to be a zinc additive present in once-through cooling water. The contribution of

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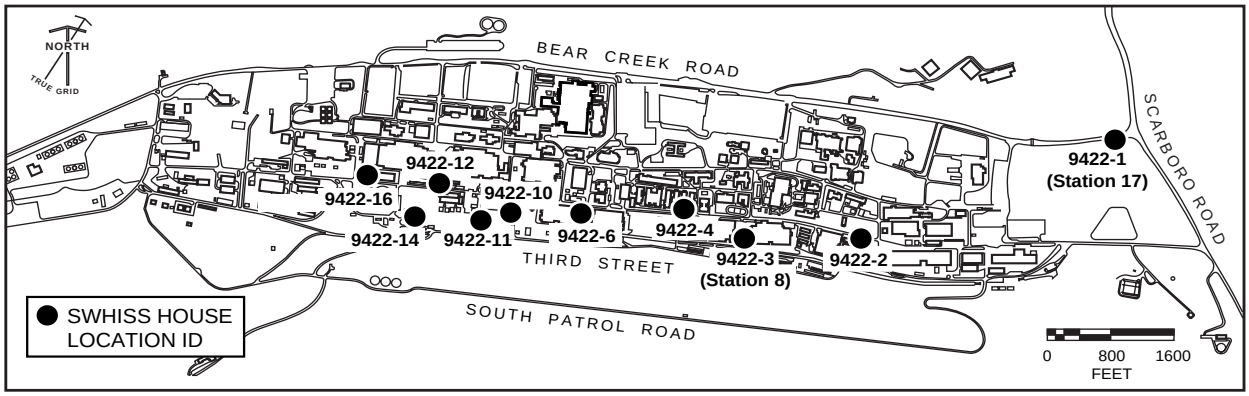

Fig. 5.14. Surface Water Hydrological Information Support System monitoring locations.

Table 5.14. Surface water surveillance measurements exceeding Tennessee Water Quality Criteria at the Y-12 Plant, 1996[a]

Parameter detected	Location	Number of samples	Concentration (mg/L)			Water quality criteria (mg/L)	Number of measurements exceeding criteria
			Detection limit	Max	Av		
Mercury	Station 17	526	0.0002	0.0066	<0.0008	0.00015	526
Zinc	Station 17	218	0.01	0.18	0.05	0.117[b]	6

[a]Appendix G, Errata, contains a revised version of this table for the 1995 ASER. The water quality value for thallium (0.0063 mg/L) was inadvertently applied to zinc in the 1995 report.

[b]The standard is a function of total hardness. This value corresponds to a total hardness value of 100 mg/L.

zinc to the toxicity of the stream is being evaluated as part of the Toxicity Identification Evaluations (toxicity tests with *Ceriodaphnia dubia*) in order to achieve the NPDES toxicity limitations for the headwaters for EFPC.

Additional surface-water sampling is conducted on Bear Creek in accordance with the Y-12 Plant Groundwater Protection Program (GWPP) to monitor trends throughout the Bear Creek Hydrogeologic Regime (see Chap. 7).

5.5.3 ORNL Reference Surface Water Monitoring

The net impact of ORNL activities on surface waters is evaluated by comparing data from samples collected at reference locations with information from samples collected downstream of the facility. Monthly surface water samples are collected at two reference sampling locations to determine contamination levels before the influence of WOC, the primary discharge point into Watts Bar Lake from the ORNL plant site. One sampling location is Melton Hill Dam above ORNL's main discharge point into the Clinch River. The other sampling location is WOC headwaters above any ORNL discharge points to WOC (Fig. 4.14).

Analyses were performed to detect radioactivity and conventional, inorganic, and organic pollutants in the water. Conventional pollutants are indicated by measurements of conductivity, temperature, turbidity, pH, total dissolved solids, TSS, and oil and grease. Inorganic parameters are indicated by analyses for metals and anions. The presence of organic pollutants is indicated by results from total organic carbon analysis.

In an effort to provide a basis for evaluation of analytical results and for assessment of surface water quality, Tennessee General Water Quality Criteria (TWQC) have been used as reference values. The TWQC for Domestic Water Supply have been used at Melton Hill whereas TWQC criteria for Fish and Aquatic Life have been used at WOC headwaters.

There is reasonably good agreement between parameters measured at WOC headwaters and those at Melton Hill Dam. The average concentration is expressed as a percentage of the reference value when the parameter is a contaminant, the parameter is detected, and a reference value exists. Only one parameter met these criteria; zinc at WOC headwaters was 11% of the reference value.

Radiological data are compared with DOE DCGs. The average concentration for a radionuclide is expressed as a percentage of its DCG when a DCG exists and when the average concentration is significantly greater than zero. At the reference locations, only one average for 1996 met the criteria; the average concentration of ^{60}Co at Melton Hill Dam was less than 1% of its DCG.

5.5.4 ORNL Radiological Liquid Effluent Monitoring Program Under the EMP

In 1994 monitoring for gamma activity and tritium was added at the ORNL NPDES Category I and Category II outfalls. Category I outfalls are storm drains; Category II outfalls are storage area drains, once-through cooling water, cooling-tower blowdown, and condensate drains. With the exception of total radioactive strontium at the Category II outfalls (reported in Sect. 4.2.1.2), radionuclides detected at the remaining outfalls in 1996 were <1% of the DCG for the respective radionuclide.

5.5.5 ETTP Surface Water Monitoring

Surface water surveillance is currently conducted at five locations at the ETTP (Fig. 5.15). In late 1996, an internal review of results obtained from ETTP sampling locations was conducted. Because of this review, a sixth location at West Fork Poplar Creek (WFPC) was deleted from the monitoring program. Because both K-1710 and WFPC are located upstream of the ETTP, the K-1710 location was chosen to be used as the single upstream reference point. Monitoring at WFPC ceased in November 1996. Station K-716 is located downstream from most ETTP operations and provides information on the cumulative effects of ETTP as well as those upstream. The remaining sampling locations are at points where drainage in the major surface water basins converges before discharging to Poplar Creek (K-1007-B and K-1700) or to the Clinch River (K-901-A).

Samples are analyzed monthly for radionuclides. Quarterly samples are collected and analyzed for general water quality parameters, selected metals, and organic compounds. In addition, samples from K-901-A and K-1007-B are analyzed monthly for PCBs. Samples from the remaining locations are analyzed quarterly for PCBs. Radionuclide results are compared with the DCGs. Nonradiological results are compared with Tennessee water quality standards (WQSs) for fish and aquatic life. The WQSs use the numeric values given in the TWQC, which are a subset of the WQSs.

In most instances, results of the analyses for nonradiological parameters are well below the applicable standards. Heavy metals were occasionally detected but always in very low concentrations. In addition, natural conditions cause periodic exceedences of WQSs for dissolved oxygen. During 1996, Aroclor 1254 was detected at K-1007-B, K-901-A, and K-1700 on several occasions. However, in all cases the reported values were below the lowest calibration point for the analytical method. No other PCBs were detected at these or any other ETTP surface water surveillance monitoring locations.

Dissolved oxygen measurements regularly fall below the minimum WQS during the summer months because of increased temperature (and

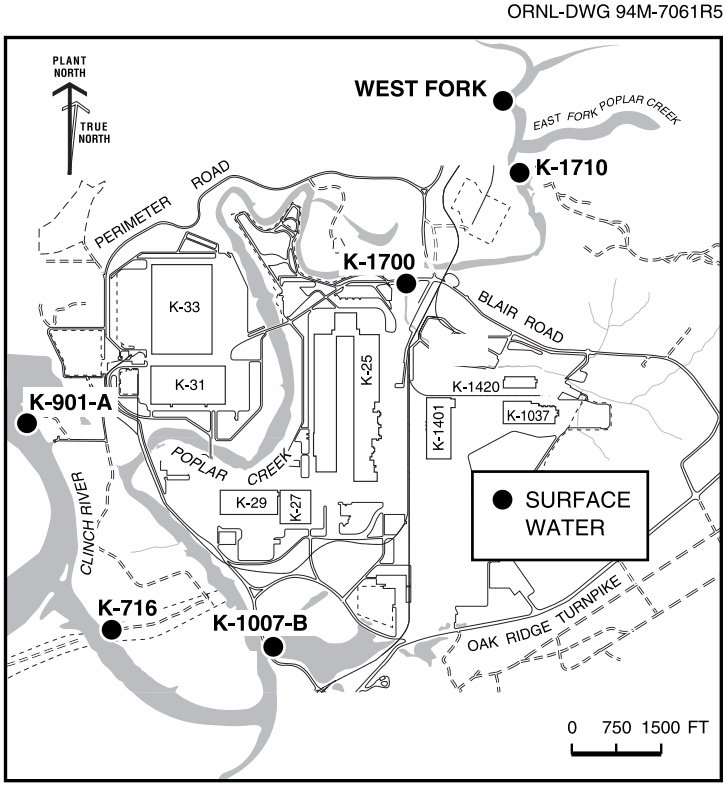

Fig. 5.15. Monitoring locations for surface water at the ETTP.

therefore lower solubility of the gas) and increased biological activity. Similarly, increased photosynthesis during the summer months causes an increase in the pH of area waterways, sometimes exceeding the maximum WQS. Water bodies in the vicinity of the ETTP are regularly inspected for signs of stress on aquatic organisms during these periods. No evidence that these conditions have a negative impact on the aquatic communities was discovered during 1996. For most of the analyses, results are below detection limits for the instrument and method. Moreover, analytical results for samples collected upstream of the ETTP are chemically similar in most respects to those collected below the ETTP.

The sum of the fractions of the DCGs for all locations remained below the annual limit, as required by DOE Order 5400.5 (Fig. 5.16). The highest sum of the fractions, 1.4% of the allowable sum of the fractions of the DCGs, was reported for sampling location K-1700. These results are still well below the conservative limits established by the order. The 1996 radiological data do not indicate any significant radiological effects from ETTP operations on perimeter surface waters.

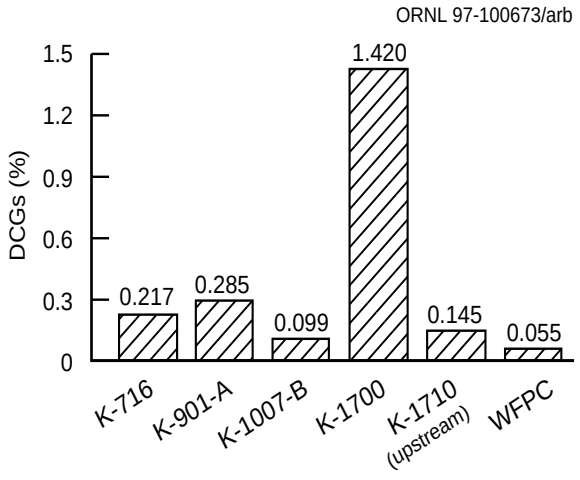

Fig. 5.16. Percentage of DCGs for ETTP surface water monitoring locations. (Results for January through October.)

5.5.6 Off-Site Treated Water Monitoring

The ORNL program for assessing impacts to the Clinch and Tennessee rivers uses empirical data from samples taken at the Kingston and Gallaher potable water treatment plants (Fig. 5.17). In 1996, composite samples of treated water samples were collected monthly and analyzed quarterly for total uranium and specific radionuclides.

Federal and state drinking water standards (DWSs) (40 CFR Parts 141 and 143 and TWQC for Domestic Water Supply) were used as reference values. If a DWS for a radionuclide has not been established, then 4% of the DOE DCG for that radionuclide is used as the reference value. The average radionuclide concentration is expressed as a percentage of the reference value when a reference exists and when the average is significantly greater than zero. In 1996, there were no average radionuclide concentrations greater than 4% of reference values at the Kingston Water Treatment Plant and none greater than 25% of reference values at the Gallaher Water Treatment Plant. The laboratory method used for total uranium does not permit a test of significance for the maximum and minimum, but the average concentrations of uranium at both Gallaher and Kingston were <0.9% of the gross alpha standard (15 pCi/L). The total uranium measurement is converted to an activity by assuming natural abundance of uranium isotopes ^{234}U, ^{235}U, and ^{238}U.

5.6 SOIL

Soil is an integrating medium that can contain pollutants originally released to the air and can thus provide a measure of pollutant deposition from the atmosphere. Soil sampling and analysis are used to evaluate long-term accumulation trends.

Soil plots consisting of a known mixture of soil were erected at nine of the ambient air stations in the fall of 1992 (eight perimeter stations

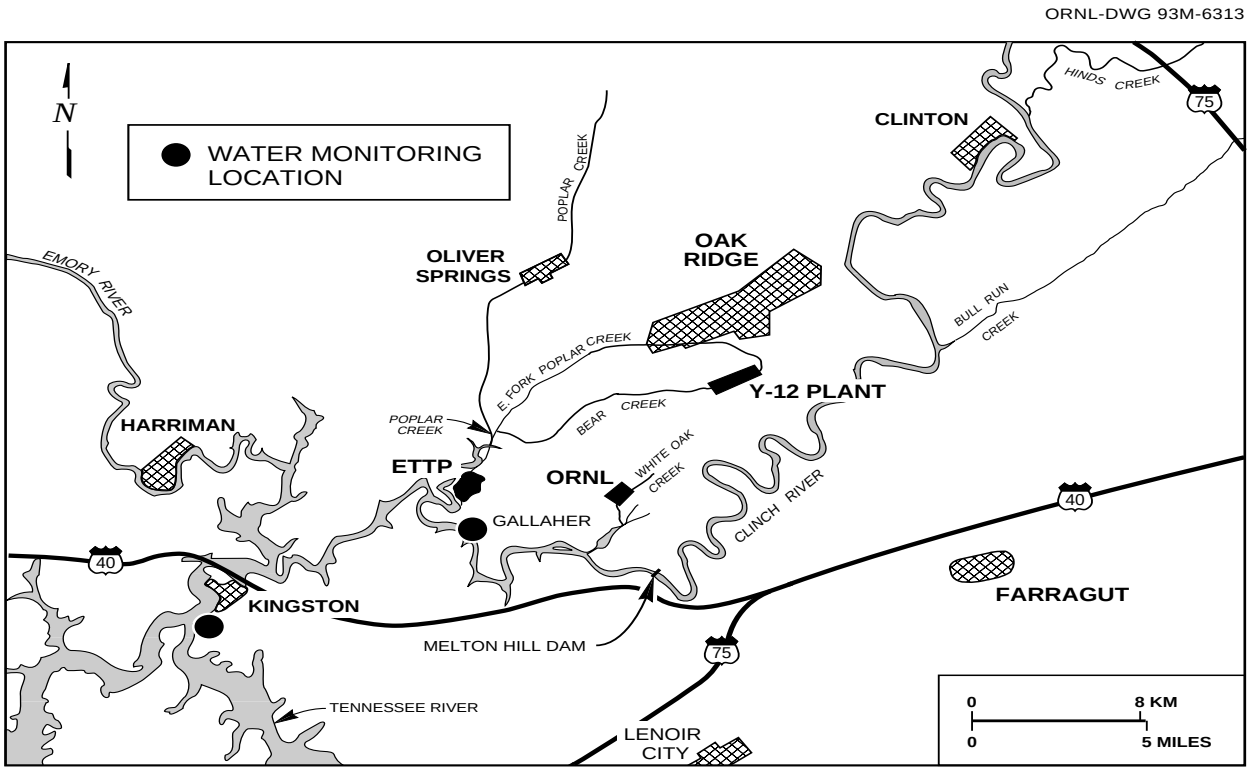

Fig. 5.17. Sampling locations for off-site treated water.

and the remote station at Norris Dam; see Fig. 5.3). These soil plots eliminate the differences in the mechanics of transport in the different types of soil found naturally on the ORR. The soil plot program is described in detail in the EMP.

Vertical composite samples were collected at the nine stations once during 1996. Samples were analyzed for gross alpha and beta activity, gamma emitters, and uranium. Soil sampling results are presented in Tables 5.2 and 5.3.

5.7 ORR SEDIMENT

Stream and lake sediments act as a record of some aspects of water quality by concentrating and storing certain contaminants. Annually, under the EMP, sediment samples are collected at 16 sites near surface water and biological monitoring locations in and around the reservation (Fig. 5.18). The sampling sites are as follows:

- Bear Creek downstream from all DOE inputs (BCK 0.6),
- Bear Creek downstream from Y-12 Plant burial grounds (BCK 9.4),
- Clinch River downstream from all DOE inputs (CRK 16),
- Clinch River downstream from ORNL (CRK 32),
- Melton Hill Reservoir at Oak Ridge Marina (CRK 80),
- Melton Hill Reservoir above all DOE inputs at the Anderson County Filtration Plant (CRK 84),
- EFPC downstream from floodplain (EFK 5.4),
- EFPC downstream from the Y-12 Plant (EFK 23.4),
- Hinds Creek (reference site for EFPC) (HC),
- Melton Branch upstream from ORNL (MEK 2.1),
- Mitchell Branch downstream from ETTP (MIK 0.1),

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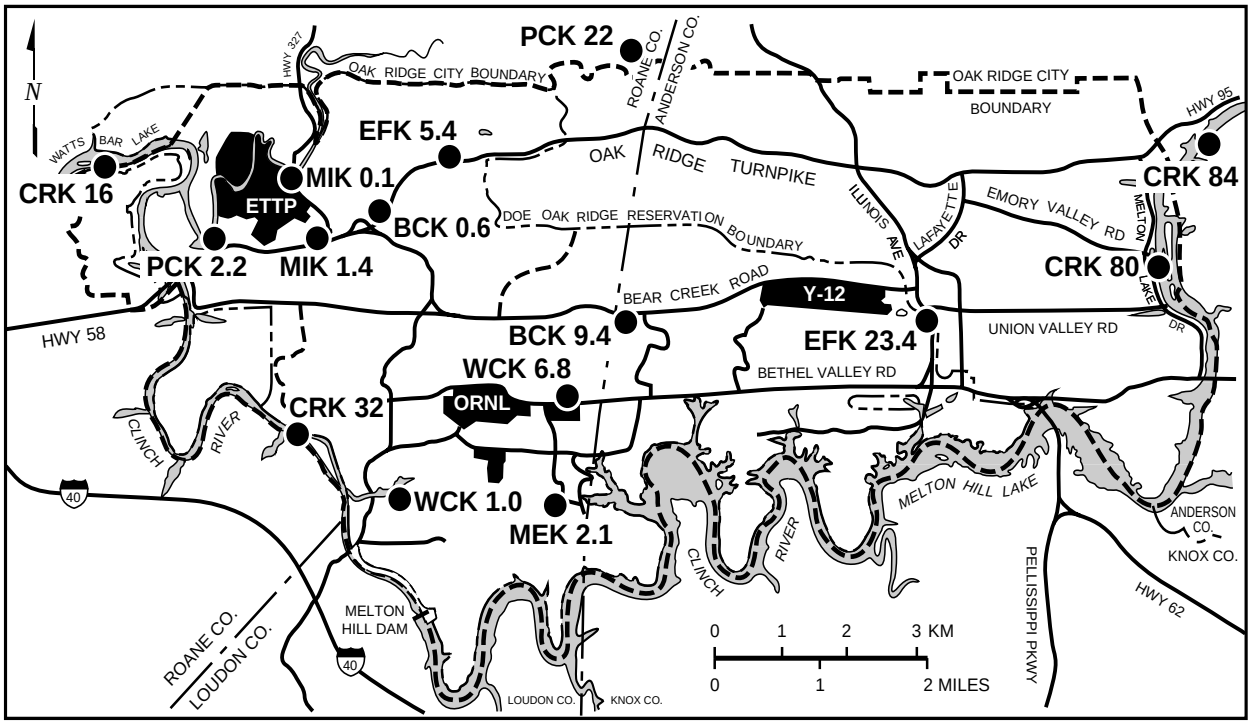

Fig. 5.18. ORR environmental monitoring plan sediment sampling locations.

- Mitchell Branch upstream from ETTP (MIK 1.4),
- Poplar Creek downstream from ETTP (PCK 2.2),
- Poplar Creek upstream from ETTP and EFPC (PCK 22),
- White Oak Lake at White Oak Dam (WCK 1.0), and
- White Oak Creek upstream from ORNL (WCK 6.8).

Sediments are effective at concentrating and storing contaminants that have a high affinity for organic and inorganic surfaces, but they also contain naturally occurring organic and inorganic chemicals. In analytical measurements, the naturally occurring chemicals in sediment lead to higher backgrounds and less sensitivity than those found in water samples. Sediments are best analyzed for substances that are concentrated and retained in sediment, resulting in sensitive, time-integrated measurements of contamination. The program was initiated in 1993, and the locations are sampled annually. Samples were analyzed for total metals, chlorinated pesticides, PCBs, semivolatile organic compounds, and selected radionuclides.

By examining the four years' worth of data available from this program, a few observations may be made. There is no evidence of PCBs at the Clinch River locations (CRK 16, 32, 80, and 84), the Melton Branch location (MEK 2.1), and Poplar Creek upstream from the ETTP and EFPC (PCK 22). PCBs, in particular Aroclor-1254 and Aroclor-1260, have consistently been detected downstream from the Y-12 Plant at EFK 23.4, and lower levels of PCBs have been detected at EFK 5.4. In general, estimated levels have been detected at the remaining sediment sampling locations. In 1996, Aroclor-1254 was detected at BCK 0.6 (140 μg/kg), BCK 9.4 (230 μg/kg), HC (110 μg/kg), MIK 0.1 (2600 μg/kg), and WCK 6.8 (230 μg/kg); in previous years, this has either not been detected or detected at estimated levels at these locations.

Metals have been detected at all of the locations. Those that are especially higher at a particular location are mercury at EFK 23.4 and EFK 5.4 and barium at MEK 2.1.

The locations where radionuclides have been detected at consistently higher concentrations are WCK 1.0 (^{60}Co and ^{137}Cs) and MIK 0.1 (gross alpha and beta, ^{99}Tc, and alpha-emitting isotopes of plutonium, neptunium, and uranium). In 1996, the radionuclide concentrations at MIK 0.1 were noticeably less than those in previous years. It is possible that nearby remediation efforts are responsible for these reductions; however, one sampling event is not enough to support a definitive conclusion.

In most cases, these observations reflect the processes occurring nearby or upstream of the particular sampling location, which is what one would expect.

5.8 FOOD

Collection and analysis of vegetation samples serves three purposes: to evaluate potential radiation doses received by people consuming food crops; to predict possible concentrations in meat, eggs, and milk from animals consuming grains; and to monitor trends in environmental contamination and possible long-term accumulation of radionuclides.

5.8.1 Hay

Hay is cut on the ORR and sold to area farmers for fodder. Six areas from which hay is cut have been identified as potential depositional areas for airborne materials from ORR sources (Fig. 5.19). Areas 1, 2, and 3 are within the predicted air plume for an ORNL source and could also be affected by the ETTP. Baled hay was collected from each of these three sites and composited for analysis. Areas 2, 4, 5, and 6 are within the predicted air plume for the ETTP, an ORNL, and a Y-12 Plant source. Baled hay was collected from each of these sites and composited for laboratory analysis. Area 6 best represents the combined plumes from all three sites; baled hay was collected from this site. Area 7, not shown on Fig. 5.19, represents a reference site near the Norris Dam ambient air station (Station 51).

5.8.1.1 Results

Hay samples were collected during June 1996, and samples were analyzed for gross alpha and beta, gamma emitters, iodine, and fluorides. Table 5.15 summarizes the results of the sampling effort. There was one statistically significant gross beta result of 7.3E-09 pCi/kg in the composite for Areas 1, 2, and 3 and one of 6.0E–09 in the Areas 2, 4, and 5 composite. There were no other significant radiological results in the 1996 hay samples.

5.8.2 Vegetables

Tomatoes, lettuce, and turnips were grown in nine soil plots established at the ORR ambient air stations as shown in Fig. 5.3.

5.8.2.1 Results

Samples were analyzed for gross alpha emitters, gross beta emitters, gamma emitters, and isotopic uranium. Table 5.2 summarizes the results of the sampling effort. The analytical results indicate that overall radionuclide concentrations in tomatoes, lettuce, and turnips do not vary significantly when compared with samples collected at reference Station 51.

5.8.3 Milk

Ingestion is one of the pathways of exposure to radioactivity for humans. Radionuclides can be transferred from the environment to people via food chains such as the grass-cow-milk pathway. Milk is a potentially significant source to humans of some radionuclides deposited from airborne emissions because of the relatively large surface area that a cow can graze daily, the rapid transfer of milk from producer to consumer, and the importance of milk in the diet.

The 1996 milk sampling program consisted of monthly grab samples collected from five locations in the vicinity of the ORR (Fig. 5.20). Milk

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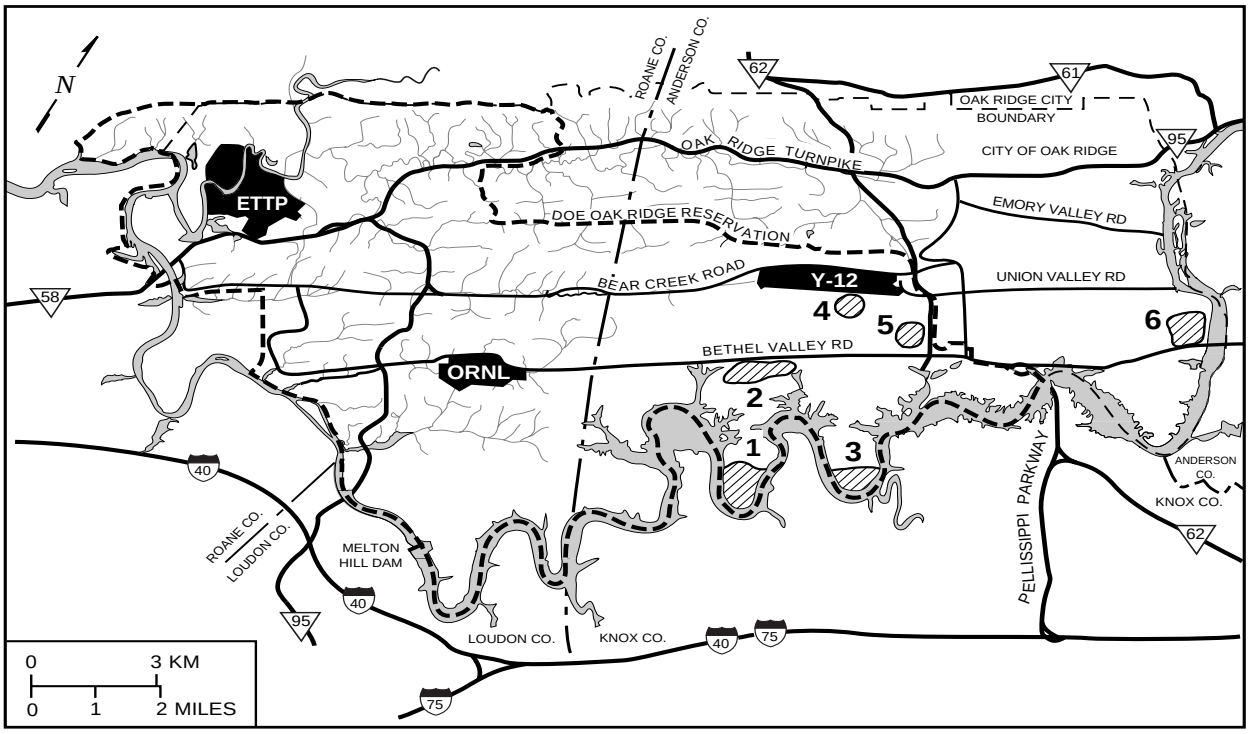

Fig. 5.19. Hay sampling locations on the ORR.

Table 5.15 Concentrations of radionuclides and fluoride in hay from the ORR, 1996[a]

	Area		
Analyte	1,2,3	2,4,5	6
Gross beta	7.3E–09	6.0E–09	*b*
Fluoride	3.1E+00	3.0E+00	3.2E+00

[a]All radionuclide data are given in picocuries per kilogram (1 pCi = 3.7E-02 Bq). Fluoride data are given in micrograms per gram.

[b]No significant result.

samples are analyzed at ORNL for radioactive iodine (^{131}I) by gamma spectrometry and for total radioactive strontium (^{89}Sr + ^{90}Sr) by chemical separation and low-background beta counting. Liquid scintillation is used to analyze for tritium (^{3}H).

5.8.3.1 Results

Radioactivity measurements are reported as the net activity (the difference between the gross activity and instrument background). A 95% confidence level is used to determine statistical significance. Concentrations of total radioactive strontium detected in milk are presented in Table 5.16. There were no detected concentrations of ^{131}I or ^{3}H. Average values for radioactive strontium were converted to EDEs and are presented in Chap. 6. of this report. Results are consistent with data from previous years.

5.8.4 Honey

Before 1995, honey from privately owned hives in the vicinity of the ORR was analyzed for radionuclides to determine whether a potential exposure pathway existed. In 1995, beehives were established on the reservation at strategic locations at the Y-12 Plant, ORNL, and the ETTP. Honey samples from the hives were analyzed in 1995 and 1996. The results of the radiological

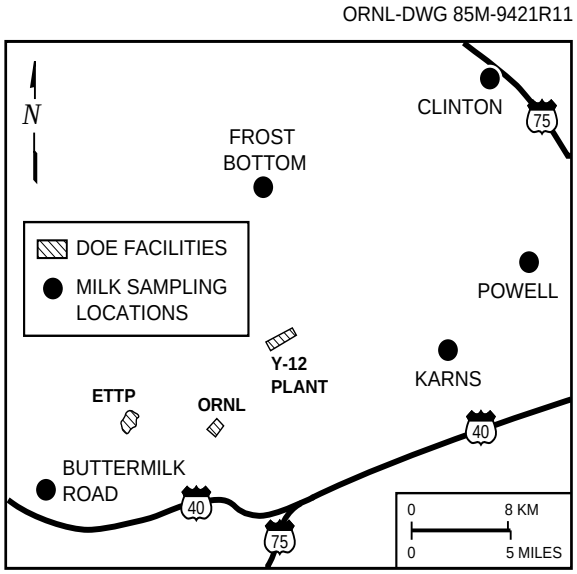

Fig. 5.20. Milk sampling locations in the vicinity of the ORR.

analysis of honey collected in 1996 from sites on the ORR are summarized in Table 5.17.

5.8.5 Fish

Members of the public potentially could be exposed to contaminants originating from DOE-ORO activities through consumption of fish caught in area waters. This exposure pathway is monitored under the EMP by collecting fish from six locations annually and analyzing edible fish flesh. Sampling takes place at six river locations. Because of the limited number and size of fish available for sampling on creek locations, different fish-processing and analytical procedures are used. Only results from sampling at river locations are presented in this report.

The river locations include five sites on the Clinch River and one location on Poplar Creek (Fig. 5.21):

- Melton Hill Reservoir above all DOE inputs at Anderson County Filtration Plant (CRK 84),
- Melton Hill Reservoir at Oak Ridge Marina (CRK 80),
- Melton Hill Reservoir above the city of Oak Ridge water intake (CRK 66),
- Clinch River downstream from ORNL (CRK 32),
- Clinch River downstream from all DOE inputs (CRK 16), and
- Poplar Creek downstream from the ETTP (PCK 2.2).

Sunfish (*Lepomis macrochirus*, *L. auritus*, and *Ambloplites rupestris*) are collected from each of the six river locations, filleted, and frozen. When enough fish have been collected (typically 150 to 200 per location), the samples are thawed and fillets from six of the largest are analyzed for selected metals, pesticides, and PCBs. The rest (separated into three composite samples) are ashed and analyzed for ^{60}Co, ^{137}Cs, and total radioactive strontium. To provide data from a second species, annual catfish sampling was initiated in 1993. Six to ten catfish are collected at the CRK 16 and CRK 32 locations, and a composite sample is analyzed for selected metals, pesticides, and PCBs. A composite sample is also ashed and analyzed for ^{60}Co, ^{137}Cs, and total radioactive strontium.

5.8.5.1 Results

In 1996, most parameters analyzed for in sunfish and catfish were undetected or detected in fewer than all samples. For PCBs, reported values for sunfish and catfish were below the U.S. Food and Drug Administration (FDA) tolerance of 2 ppm; for mercury, all reported values were below the FDA action level of 1 ppm. This has been true for all years of the program. When PCBs have been detected, they have been primarily Aroclor-1254 and Aroclor-1260, many at estimated low levels. Information regarding potential health impacts associated with chemical and radiological constituents detected in the sunfish and catfish is further discussed in Chap. 6.

5.8.6 White-Tailed Deer

The twelfth annual deer hunts managed by DOE and the TWRA were held on the ORR during the final quarter of 1996. ORNL staff, TWRA, and student members of the Wildlife and

Table 5.16. Concentrations of total radioactive strontium (^{89}Sr + ^{90}Sr) in raw milk, 1996 (pCi/L)[a]

Station	No. detected/ No. of samples	Concentration using all samples			Standard error of mean
		Max[b]	Min[b]	Av[b]	
Buttermilk Road	5/12	2.4*	–0.22	0.95*	0.21
Powell	7/11	3.2*	–3.5	1.3*	0.55
Clinton	8/10	3.0*	0.65	1.9*	0.22
Frost Bottom	6/11	4.1*	0.70	2.1*	0.35
Karns	10/12	4.6*	0.38	1.9*	0.35
Network summary	36/56	4.6	–3.5	1.6*	0.17

[a]1 pCi = 3.7E-02 Bq.
[b]Individual and average concentrations significantly greater than zero at the 95% confidence level are identified by an asterisk (*).

Table 5.17. Significant radiological results for honey sampled from hives on the ORR, 1996 (pCi/kg)[a]

Parameter	No. detected/ No. of samples	Concentration using all samples			Standard error of mean
		Max[b]	Min[b]	Av[b]	
^{137}Cs	2/3	1.8*	0.59	1.4*	0.40
Gross alpha	1/3	22*	–11	3.7	9.5
Gross beta	3/3	460*	240*	320*	72
^{40}K	3/3	920*	460*	700*	130

[a]1 pCi = 3.7E–02 Bq.
[b]Individual and average concentrations significantly greater than zero at the 95% confidence level are identified by an asterisk (*).

Fishery Society (University of Tennessee Chapter) performed most of the necessary operations at the checking station.

The 1996 hunts were held on three weekends. Shotgun/muzzle loader hunts were held on October 19–20 (1000 permitted hunters), November 9–10 (800 permitted hunters), and December 14–15 (1000 permitted hunters). During the November 9–10 hunt, the Tower Shielding/Park City Road was opened for an archery-only hunt with 350 permitted hunters. A few areas are also designated as "archery only" during the gun hunts and do not require special permitting. A two-deer limit (no more than one antlered) was established for the December 14–15 shotgun/muzzle loader hunt as well as the archery-only hunt held the weekend of November 9–10 at the Park City Road/Tower Shielding area.

From the total harvest of 464 animals, 240 (51.7%) were bucks and 224 (48.3%) were does. The heaviest buck had ten antler points and weighed 172 lb. The greatest number of antler points (14) was found on a buck weighing 141 lb. The heaviest doe weighed 113 lb.

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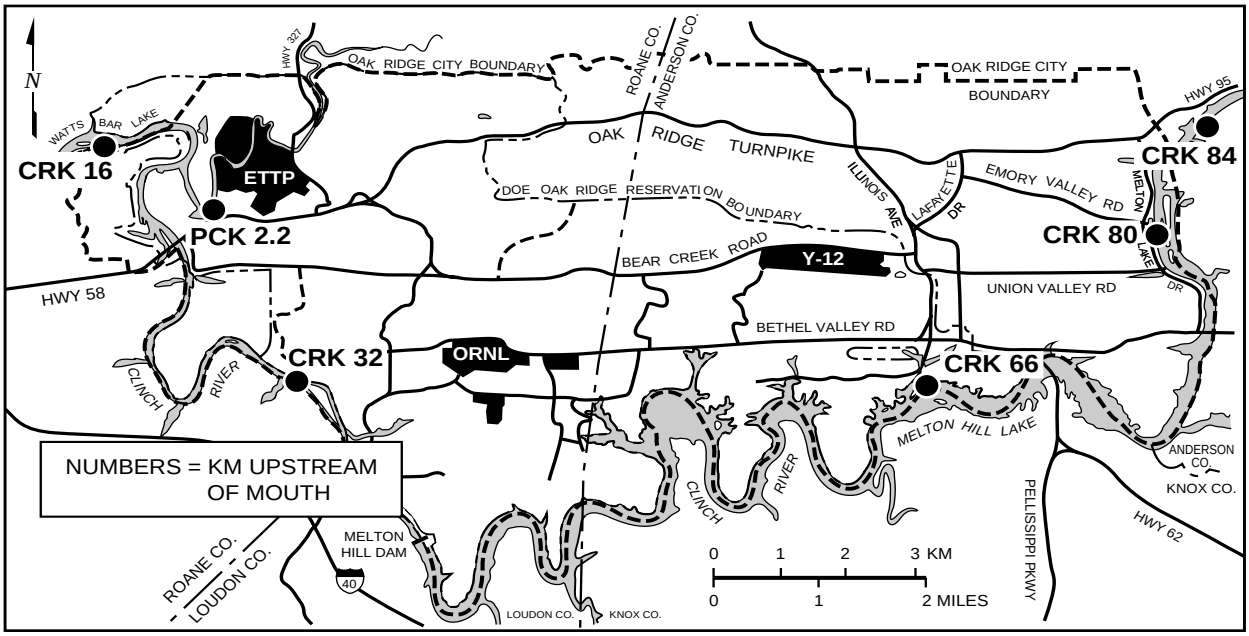

Fig. 5.21. Fish sampling locations along the Clinch River.

During the statewide juvenile hunt held November 9–10, a deer harvested from Jones Island was brought into the deer-checking station and was found to contain elevated beta activity in the bone and was voluntarily retained from the hunter.

5.8.6.1 Results

Of the 464 deer harvested, only two were confiscated because they exceeded established release limits (5 pCi/g for ^{137}Cs and/or 20 pCi/g for ^{90}Sr). The average concentration of ^{137}Cs (based on field data) in the deer released to the public was 0.19 pCi/g (7E-03 Bq/g). The deer confiscated during the 1996 hunt represent 0.4% of the total deer harvested. Since the hunts began in 1985, 6,349 deer have been harvested; a total of 149 (2.3%) were retained because of radiological contamination.

5.8.7 Resident Canada Geese

One objective of the ORR waterfowl program is to determine concentrations of gamma-emitting radionuclides accumulated by waterfowl associated with waste disposal areas. Radioactive elements found in waste material are the primary types of contaminants associated with the ORR.

The annual roundup of Canada geese took place June 25 and 26, 1996. During the roundup, whole-body gamma scans were conducted on 83 geese: 18 from ORNL, 42 from the ETTP, and 23 from Melton Hill Dam. Of the geese screened, only one was confiscated because ^{60}Co was detected. Of the nonconfiscated geese, 56 were released at Kentucky Lake, 23 were returned to Melton Hill Dam, one was released in the Solway area, and two died during the roundup.

The sampling areas are selected because of high geese congregation. The geese are highly mobile animals that range freely to sites on and

off the reservation. For that reason, the results in this report should be taken as an indication of the possible overall impact that the reservation has on the geese rather than as an evaluation of the collection sites.

5.8.7.1 Results

The average ^{137}Cs concentration in the nonconfiscated geese was 0.12 pCi/g (4.4E-03 Bq/g). The highest ^{137}Cs concentration, 1.8 pCi/g (0.07Bq/g), was found in a goose collected at ORNL. The average weight of the Canada geese screened during the roundup was about 3 kg (8 lb). The maximum goose weight was about 4 kg (9 lb).

5.8.8 Turkey Monitoring

Wild turkeys on the ORR have not been considered a potential pathway for radiation exposure to humans because in the past there have been no permitted hunts on the reservation or in the surrounding areas. However, two hunts on the reservation were approved for 1997, and hunts for surrounding counties have also been approved. During the first quarter of 1996, TWRA trapped eight wild turkeys on the reservation for relocation to Roane County in the Paint Rock area. Prior to relocation, a whole-body gamma scan of each turkey was conducted. In order to evaluate this pathway, studies to determine radionuclide concentrations in tissue, bone, and organs from wild turkeys on the ORR will be implemented in 1997.