7. ORR Environmental Monitoring Programs

Environmental monitoring is a major activity on the ORR. Environmental monitoring encompasses two activities, effluent monitoring and environmental surveillance. Effluent monitoring consists of the collection and analysis of samples at their emission point to determine and quantify released contaminants. Environmental surveillance consists of the collection and analysis of samples of air, water, vegetation, biota, and other media from the ORR and its surroundings. Data from environmental monitoring activities are used to assess exposures to members of the public and to assess effects on the local population and the environment.

7.1 METEOROLOGICAL MONITORING

Nine 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, which would be used in the event of accidental releases from a facility. Data from the towers are also used to support various research and engineering projects. Meteorological data, quality assurance notes, wind field graphics, and additional weather imagery are archived on site.

7.1.1 Description

The nine meteorological towers, depicted in Fig. 7.1, consist of one 100-m (330-ft) tower (MT5) and one 60-m (200-ft) tower (MT6) at the Y-12 Complex, one 100-m (330-ft) tower (MT2) and two 30-m (100-ft) towers (MT3 and MT4) at ORNL, and one 60-m (200-ft) tower (MT1) and one 30-m (100-ft) tower (MT7) at the ETTP. Additionally, ETTP has two satellite towers, M (208A) and N (208B), both 10 m (30 ft) high.

Meteorological data are collected at different altitudes (10, 30, 60, and 100 m) to assess the vertical structure of the atmosphere, particularly with respect to wind shear and stability. Stable boundary layers and significant wind shear zones (related to local ridge-and-valley terrain as well as the Great Valley) can significantly affect the movement of a plume after a facility release (Bowen et al. 2000). All of the towers collect data at the 10-m level. Additionally, selected towers collect data at the 30-, 60-, and 100-m levels. At each measurement level, temperature, wind speed, and wind direction are measured. Data needed to determine atmospheric stability (a measure of vertical mixing properties of the atmosphere) are measured at most towers. Barometric pressure is measured at one or more towers at each facility (MT1, MT2, MT5, and MT7). Precipitation is measured at MT5 and MT6 at the Y-12 Complex, at MT1 and MT7 at the ETTP, and at MT2 at ORNL; solar radiation is measured at MT5 and MT6 at the Y-12 Complex, MT1 and MT7 at the ETTP, and MT2 at ORNL.

Data from the towers at each site are collected by a dedicated control computer. The towers are polled, and data are archived on both hard disk and compact disk. Values collected at 1-min, 15-min, and hourly intervals are stored at two locations (ETTP for Y-12, ORNL for ORNL and ETTP). Long-term archives are kept of 1-min data at ORNL and ETTP and for all sites for 15-min and hourly data. The meteorological monitoring data from the ORR are summarized monthly for wind roses and daily as data tables. Quarterly calibrations of the instruments are conducted for each site on the ORR by an outside contractor.

Fifteen-minute and hourly data are used directly at each site for emergency-response purposes, such as input to dispersion models. Annual dose estimates are calculated from archived data (hourly values). Data quality is checked continuously against predetermined data constraints, and out-of-range parameters are marked invalid and are excluded from the dispersion models. Additionally, records of data problems/errors are routinely kept for all nine tower sites.

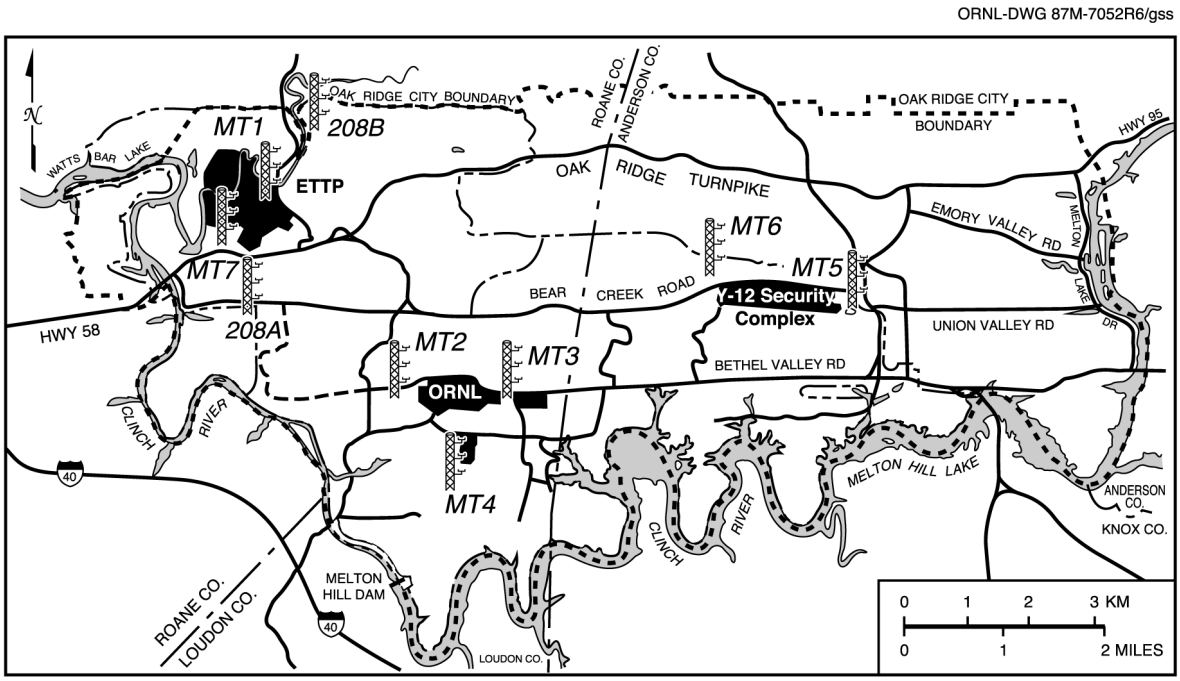

Fig. 7.1. The ORR meteorological monitoring network.

7.1.2 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 ridge axes, with limited cross-ridge flow within local valley bottoms. These conditions are dominant over the entire reservation, with the exception of the ETTP, which is located in a relatively open valley bottom and thus has more varied flow.

On the reservation, low-speed winds dominate near the surface level. This characteristic is typical of most near surface measurements but is amplified by the nearby ridges. Winds sometimes accelerate near ridge top level (Birdwell 2003).

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. However, high roughness values (caused by terrain and obstructions such as trees and buildings) may represent a partial mitigation of these factors through the increased turbulence (mixing) that may result. Such 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 systems and the uneven, but occasionally intense, summer rainfall associated with thunderstorms.

The average data recovery rate (a measure of acceptable data) across locations used for modeling during 2002 was 98.9%. The maximum data recovery rate was near 100.0% at ORNL MT4. The minimum data recovery rate was approximately 95.1% at ETTP MT1.

7.2 EXTERNAL GAMMA RADIATION MONITORING

External gamma radiation monitoring is conducted to determine whether radioactive effluents from the ORR are increasing external radiation levels significantly above normal background levels. The data also provide a means for comparing results from year to year and establishing trends.

7.2.1 Data Collection and Analysis

External gamma measurements (exposure rates) are recorded weekly at six ambient air stations from resident external gross gamma monitors (Fig. 7.2). 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 exposure.

7.2.2 Results

Table 7.1 summarizes the data collected at each station during the year. The mean observed exposure rate for the reservation network for the year was 4.2×10^{-3} mrem/h, which is not statistically different from the average of 3.7×10^{-3} mrem/h measured at the reference location. A person exposed to the mean exposure rate for 1 year could have received an effective dose equivalent of about 35 mrem.

7.3 AMBIENT AIR MONITORING

In addition to exhaust stack monitoring conducted at the DOE Oak Ridge installations, ambient air monitoring is performed to measure radiological parameters directly in the ambient air adjacent to the facilities. Ambient air monitoring also allows determining the levels of contaminants at the monitoring locations during an emergency, verifies that 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. Other air monitoring programs are discussed in the site-specific chapters, Chap. 4 (ETTP), Chap. 5 (ORNL), and Chap. 6 (the Y-12 Complex).

7.3.1 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 a remote location not affected by activities on the ORR. The ORR perimeter air monitoring network includes stations 35, 37, 38, 39, 40, 42, 46, and 48 (Fig. 7.3). Reference samples are collected from Station 52 (Fort Loudoun Dam). Sampling was conducted at each ORR station during 2002 to quantify levels of alpha-, beta-, and gamma-emitting radionuclides and ^{3}H.

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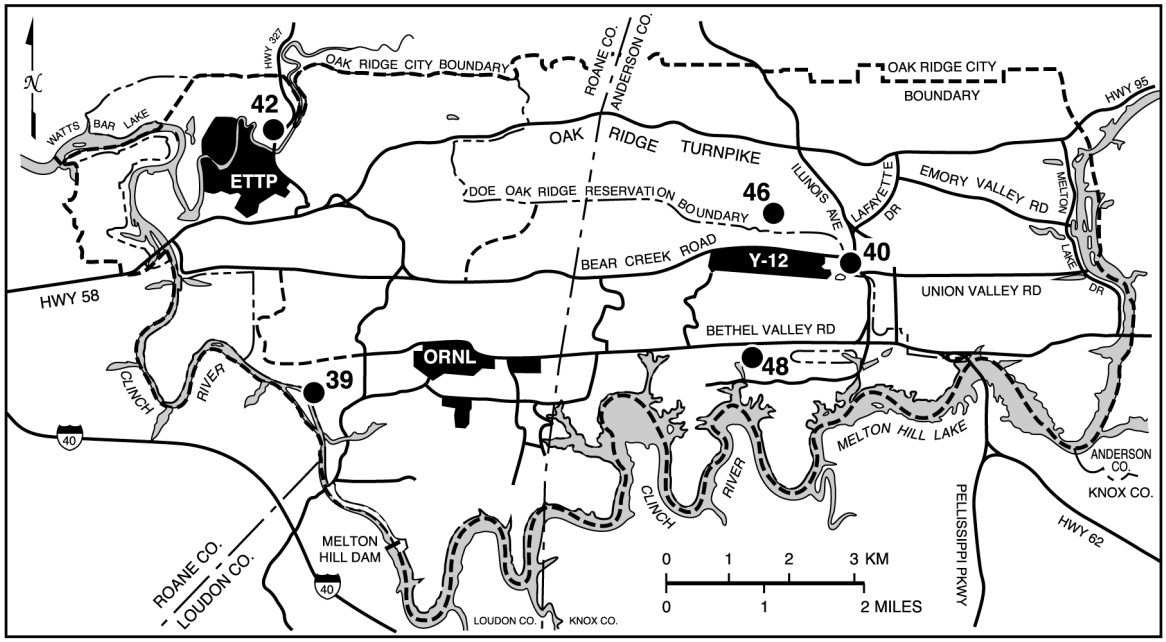

Fig. 7.2. External gamma radiation monitoring locations on the ORR. Location 52, at Fort Loudoun Dam, approximately 15 miles southwest of ORNL, is not shown.

Table 7.1. External gamma averages for the Oak Ridge Reservation, 2002

Monitoring location	Number of data values collected	Measurement (μR/h)[a]			Standard error of mean
		Min	Max	Mean	
39	53	6	7.1	6.3	0.00003
40	53	5	5.9	5.5	0.00002
42	53	4.2	5	4.6	0.00003
46	53	5.3	6.4	5.9	0.00004
48	53	4.3	5.2	4.6	0.00002
52	53	2.4	6.2	4.9	0.00008

[a]To convert microroentgens per hour (μR/h) to milliroentgens per year, multiply by 8.760.

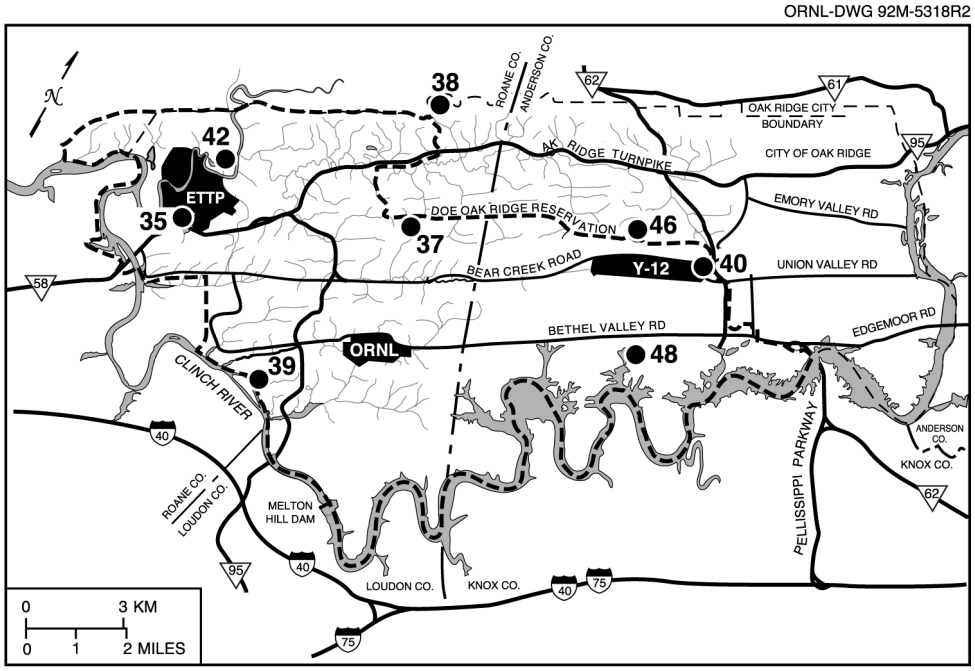

Fig. 7.3. Locations of ORR perimeter air monitoring stations. Location 52, at Fort Loudoun Dam, approximately 15 miles southwest of ORNL, is not shown.

Atmospheric dispersion modeling was used to select appropriate sampler locations. The locations selected are those likely to be affected most by releases from the Oak Ridge facilities. Therefore, in the event of a release, no residence or business in the vicinity of the ORR should receive a radiation dose greater than doses calculated at the sampled locations. To provide an estimate of background radionuclide concentrations, an additional station is located at Fort Loudoun Dam, a site not affected by releases from the ORR.

The sampling system consists of two separate instruments. Particulates are captured on glass-fiber filters in a high-volume air sampler. The filters are collected weekly, composited quarterly, 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 or biweekly, composited quarterly, then submitted to the laboratory for ^{3}H analysis.

The ORR ambient air network (Fig. 7.3) provides appropriate monitoring for all facilities within the reservation and thus 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 Complex operation. Station 40 monitors the east end of the Y-12 Complex, and Station 37 monitors the overlap of Y-12 Complex, ORNL, and ETTP emissions.

7.3.2 Results

Data from the ORR ambient air stations are analyzed to assess the impact to air quality of DOE operations on the entire reservation. The background station provides information on reference concentrations of radionuclides and gross parameters for the region. Comparisons of ORR ambient air station sampling data and data collected from reference Station 52 show that there were no statistically significant differences in the average concentrations of the radionuclides of interest (Table 7.2). Each measured radionuclide concentration is also compared to appropriate DCGs, which serve as reference values for conducting environmental protection programs at DOE sites. All radionuclide concentrations measured at the ORR ambient air stations were less than 1% of applicable DCGs.

Table 7.3 represents the average concentration of three isotopes of uranium at each station for sampling years 1999, 2000, 2001, and 2002. There are no statistically significant differences between any of the concentrations for the three uranium isotopes when comparing the perimeter network averages with the concentrations measured at the reference station (Station 52).

Table 7.2. Radionuclide concentrations at Oak Ridge Reservation perimeter air monitoring stations, 2002[a,b]

Isotope	Air monitoring station								
	35	37	38	39	40	42	46	48	52[c]
^{241}Am	5.11E–13	–3.35E–13	9.40E–14	1.02E–12	1.44E–12	3.88E–13	6.06E–13	9.14E–13	1.43E–13
^{7}Be	5.83E–08[d]	6.08E–08[d]	6.67E–08[d]	5.56E–08[d]	5.98E–08[d]	5.63E–08[d]	6.41E–08[d]	7.42E–08[d]	6.81E–08[d]
^{141}Ce	6.05E–11	*e*	*e*	*e*	*e*	*e*	*e*	*e*	*e*
^{244}Cm	–1.87E–13	3.35E–13	1.97E–13	6.81E–13	–3.40E–13	*e*	5.89E–14	–2.08E–13	1.94E–13
^{137}Cs	5.53E–11	8.19E–12	1.11E–11	3.20E–11	1.55E–12	2.79E–11	1.96E–11[d]	1.13E–11	2.38E–11
^{3}H	7.17E–06	7.64E–07	8.52E–07	3.69E–06	3.95E–07	1.47E–06	2.38E–07	1.16E–06	–4.26E–07
^{40}K	3.82E–09[d]	3.64E–09[d]	3.78E–09[d]	3.41E–09[d]	3.34E–09[d]	3.74E–09[d]	3.80E–09[d]	3.17E–09[d]	3.80E–09[d]
^{237}Np	4.50E–11	4.43E–11	4.51E–11	4.49E–11	4.48E–11	4.45E–11	4.44E–11	4.39E–11	4.44E–11
^{238}Pu	–1.28E–13	2.18E–13	4.27E–14	2.04E–13	–4.25E–14	–3.79E–13	1.01E–13	–2.33E–13	1.18E–13
^{239}Pu	4.17E–13	3.19E–13	2.48E–13	1.45E–12	1.61E–13	7.58E–14	1.85E–13	2.99E–13	2.86E–13
^{99}Tc	3.24E–09	3.19E–09	2.65E–09	2.64E–09	2.63E–09	2.36E–09	2.10E–09	2.08E–09	2.10E–09
^{228}Th	7.84E–13	7.13E–13	9.40E–13	6.47E–13	1.61E–12	1.10E–12	1.01E–12	1.33E–12	1.43E–12
^{230}Th	1.19E–12	1.93E–12	1.80E–12	8.51E–13	1.27E–12	1.26E–12	1.26E–12	1.41E–12	1.35E–12
^{232}Th	5.96E–13	8.13E–13	1.03E–12	9.36E–13	5.10E–13	6.40E–13	5.72E–13	1.33E–12	1.26E–12
$^{89/90}$Sr	–5.98E–13	2.81E–12	4.95E–13	3.02E–12[d]	2.46E–13	4.51E–13	2.50E–12	2.88E–12	1.80E–12[d]
^{234}U	1.97E–11[d]	9.31E–12[d]	1.40E–11[d]	7.10E–12[d]	2.62E–11[d]	2.36E–11[d]	2.31E–11[d]	9.28E–12[d]	1.24E–11[d]
^{235}U	1.60E–12[d]	1.05E–12[d]	1.77E–12	3.33E–13[d]	1.51E–12[d]	2.48E–12	1.19E–12[d]	6.76E–13[d]	9.26E–13[d]
^{238}U	2.11E–11[d]	8.33E–12[d]	1.11E–11[d]	7.09E–12[d]	1.30E–11[d]	2.43E–11[d]	1.38E–11[d]	8.21E–12[d]	8.20E–12[d]

[a]All values are mean concentrations.
[b]Units are picocuries per milliliter.
[c]Reference location.
[d]Statistically significant average at 95% confidence level.
[e]Not reported.

Table 7.3. Uranium concentrations in ambient air on the Oak Ridge Reservation

Isotope	Concentration (10^{-15} μCi/mL)			
	1999	2000	2001	2002
		Station 35		
^{234}U	2.0E–02	9.8E–03	2.07E–02	1.97E–02
^{235}U	1.5E–03	6.8E–04	7.60E–04	1.60E–03
^{238}U	2.3E–02	1.1E–02	3.00E–02	2.11E–02
		Station 37		
^{234}U	2.7E–02	8.5E–03	1.22E–02	9.31E–03
^{235}U	6.9E–04	4.4E–04	9.96E–04	1.05E–03
^{238}U	2.1E–02	1.1E–02	1.36E–02	8.33E–03
		Station 38		
^{234}U	1.5E–02	7.9E–03	1.69E–02	1.40E–02
^{235}U	1.1E–03	1.1E–03	7.92E–04	1.77E–03
^{238}U	1.9E–02	9.5E–03	2.69E–02	1.11E–02
		Station 39		
^{234}U	8.9E–03	7.6E–03	8.12E–03	7.10E–03
^{235}U	7.7E–04	5.7E–04	1.51E–03	3.33E–04
^{238}U	9.7E–03	8.5E–03	7.65E–03	7.09E–03
		Station 40		
^{234}U	3.5E–02	2.8E–02	4.98E–02	2.62E–02
^{235}U	1.0E–03	1.8E–03	2.08E–03	1.51E–03
^{238}U	2.0E–02	1.2E–02	1.65E–02	1.30E–02
		Station 42		
^{234}U	2.2E–02	1.6E–02	2.37E–02	2.36E–02
^{235}U	9.3E–04	1.3E–03	1.13E–03	2.48E–03
^{238}U	2.5E–02	1.3E–02	3.48E–02	2.43E–02
		Station 46		
^{234}U	2.8E–02	2.4E–02	2.74E–02	2.31E–02
^{235}U	2.9E–03	1.9E–03	1.23E–03	1.19E–03
^{238}U	2.4E–02	1.4E–02	1.85E–02	1.38E–02
		Station 48		
^{234}U	2.1E–02	1.2E–02	1.13E–02	9.28E–03
^{235}U	7.1E–04	7.9E–04	5.31E–04	6.76E–04
^{238}U	1.9E–02	1.2E–02	1.09E–02	8.21E–03
		Station 52		
^{234}U	9.9E–02	6.2E–03	8.17E–03	1.24E–02
^{235}U	2.0E–03	7.8E–04	5.71E–04	9.26E–04
^{238}U	3.4E–02	9.2E–03	6.97E–03	8.20E–03

7.4 SURFACE WATER MONITORING

7.4.1 ORR Surface Water Monitoring

Surface water samples are collected and analyzed from 21 locations around the ORR to assess the impact of past and current DOE operations on the quality of local surface water. This program is conducted in addition to the surface water monitoring required by NPDES permits for individual DOE ORR facilities; sampling location, frequency, and analytical parameters vary between the two programs. Sampling locations include streams downstream of ORR waste sources, reference points on streams and reservoirs upstream of waste sources, and public water intakes (see Fig. 7.4 and Table 7.4).

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. A few sites are also checked for volatile organic compounds and/or PCBs. Samples at three Clinch River sites are analyzed for metals. Table 7.4 lists the specific locations and their sampling frequencies and parameters.

Most of these 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 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.

7.4.2 Results

Comparisons of surface water sample results from locations upstream of DOE inputs with surface water results from samples obtained downstream of DOE inputs show that there were no statistically significant differences in any of the

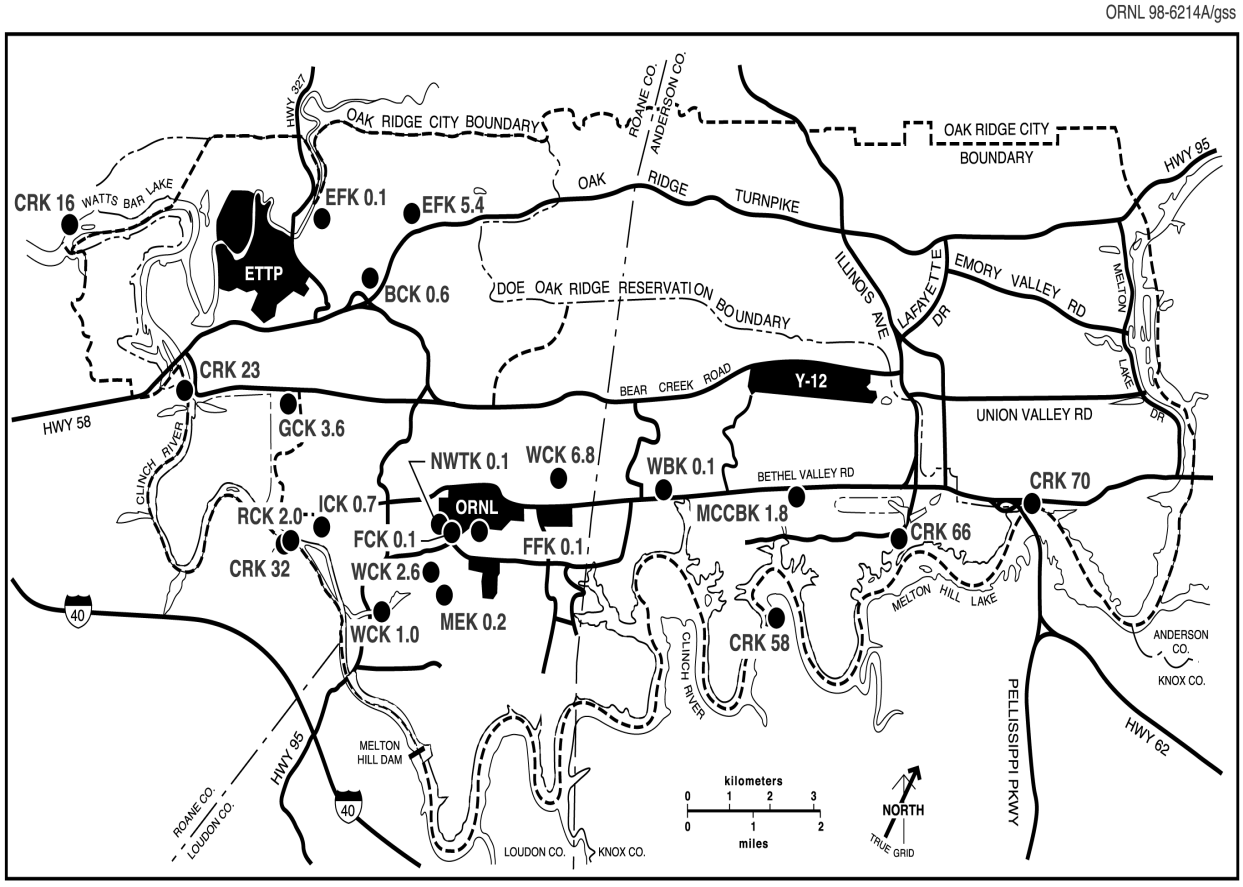

Fig. 7.4. Locations of ORR surface water surveillance sampling stations.

Table 7.4. Oak Ridge Reservation surface water sampling locations, frequencies, and parameters, 2002

Location[a]	Description	Frequency	Parameters
BCK 0.6	Bear Creek downstream from Y-12 Complex inputs	Semiannually (Apr, Oct)	Gross alpha, gross beta, gamma scan, field measurements[b]
CRK 16	Clinch River downstream from all DOE ORR inputs	Monthly	Volatiles, metals, gross alpha, gross beta, gamma scan, field measurements[b]
CRK 23	Water supply intake for the ETTP	Monthly	Gross alpha, gross beta, total radioactive strontium, gamma scan, ^{3}H, 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]
CRK 70	Solway Bridge	Monthly	Volatiles, metals, gross alpha, gross beta, total radioactive strontium, gamma scan, ^{3}H, 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]

Table 7.4 (continued)

Location[a]	Description	Frequency	Parameters
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 CK 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., BCK 0.6 = 0.6 km along Bear Creek).
[b]Field measurements consist of dissolved oxygen, pH, and temperature.

parameters of interest. Radionuclides were detected above minimum detectable activity at all surface water locations in 2002. The highest levels of gross beta, total radioactive strontium, and ^{3}H continue to be at Melton Branch kilometer (MEK) 0.2, White Oak Creek at White Oak Dam (WCK 1.0), and WCK 2.6 (see Table C.3 in Appendix C). These data are consistent with historical data and with the processes or legacy activities nearby or upstream from these locations.

Remediation efforts by BJC have resulted in decreases in levels of gross alpha, gross beta, and total radioactive strontium at the First Creek location. The levels are seasonal; for example, they are lower in the spring (wet season) because of dilution. Uranium isotopes, including ^{233}U, ^{234}U, ^{235}U, and ^{238}U, were determined to be the primary alpha emitters. These phenomena are related to radiologically contaminated groundwater whose source is leakage to backfill and soil from Tank W-1A, an underground radioactive waste storage tank located in the North Tank Farm within the main ORNL facilities complex. Work conducted in 1998 indicates that there is infiltration of storm drains that discharge into Outfall 341, which discharges into First Creek. BJC began pumping a well south of the North Tank Farm in 2000 to remediate the groundwater; one of the consequences of this effort is the decline in radionuclides detected in surface water at First Creek, *2001 Remediation Effectiveness Report/CERCLA 5-Year Review for the U.S. Department of Energy Oak Ridge Reservation, Oak Ridge, Tennessee* (DOE 2001f).

Three locations were monitored for volatile organic compounds in 2002; none were detected.

Two locations, one on Northwest Tributary (NWTK 0.1) and one on Raccoon Creek (RCK 2.0), also had elevated levels of gross beta and total radioactive strontium. Results at both locations have a seasonal pattern. Concentrations at Northwest Tributary are higher in the spring, whereas concentrations at Raccoon Creek are higher in the fall. Both of these locations are impacted by contaminated groundwater from SWSA 3.

7.5 ORR 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 (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. 7.5). 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), and White Oak Creek downstream from ORNL (WCK 2.6) (Fig. 7.5). These samples are filtered, and the residue (settleable

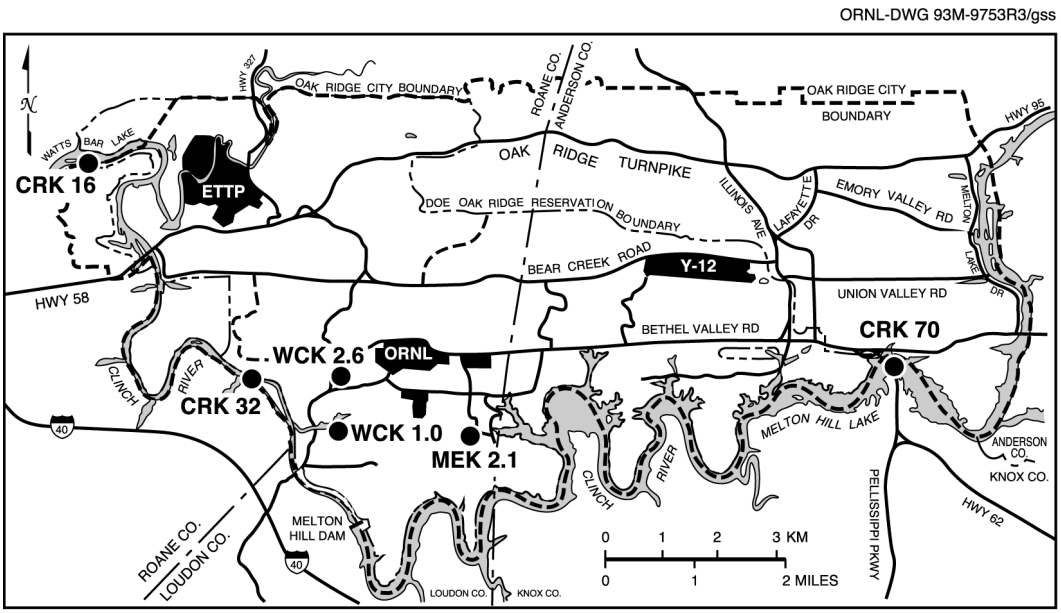

Fig. 7.5. ORR environmental monitoring plan sediment sampling locations.

solids) is analyzed for gross alpha, gross beta, and gamma emitters.

7.5.1 Results

Potassium-40, which is a naturally occurring radionuclide, was detected in sediments at all three locations; ^{137}Cs was also detected in the sample collected at CRK 32.

Heavy-rain-event sampling took place in January and March 2002. At the upstream location (MEK 2.1), gross alpha was detected from the January rain event; no other radionuclides were detected at this location during either event. Gross alpha, gross beta, and ^{137}Cs were detected at the location downstream from ORNL (WCK 2.6) and at White Oak Dam during both rain events. The highest concentration of both radionuclides were found at White Oak Dam and WCK 2.6 during the January event.

7.6 FOOD

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

7.6.1 Hay

Hay from five areas on the ORR and one area immediately adjacent to the reservation is sampled annually. In previous years, hay from these six areas (Fig. 7.6) has been sold for silage, and each has the potential for deposition of airborne materials from ORR sources. Areas 1, 2, and 3 are within the predicted air plume for an ORNL source and could be affected by ETTP sources. Areas 4, 5, and 6 are within the predicted air plumes for ETTP, ORNL, and Y-12 sources. Individual samples are collected from all six sites, and a composite from Areas 1, 2, and 3 and a composite from Areas 2, 4, and 5 are submitted for laboratory analyses. In addition, a sample from Area 6 is submitted separately because this location best represents the combined plumes from all three sites. A reference sample is collected from a site near Norris Dam (Area 7, not shown on Fig. 7.6), which is outside the influence of ORR sources.

7.6.1.1 Results

Hay samples were collected during August 2002, and samples were analyzed for gross alpha, gross beta, gamma emitters, and uranium isotopes. None of the locations had gamma-emitting radionuclides that were detected above minimum

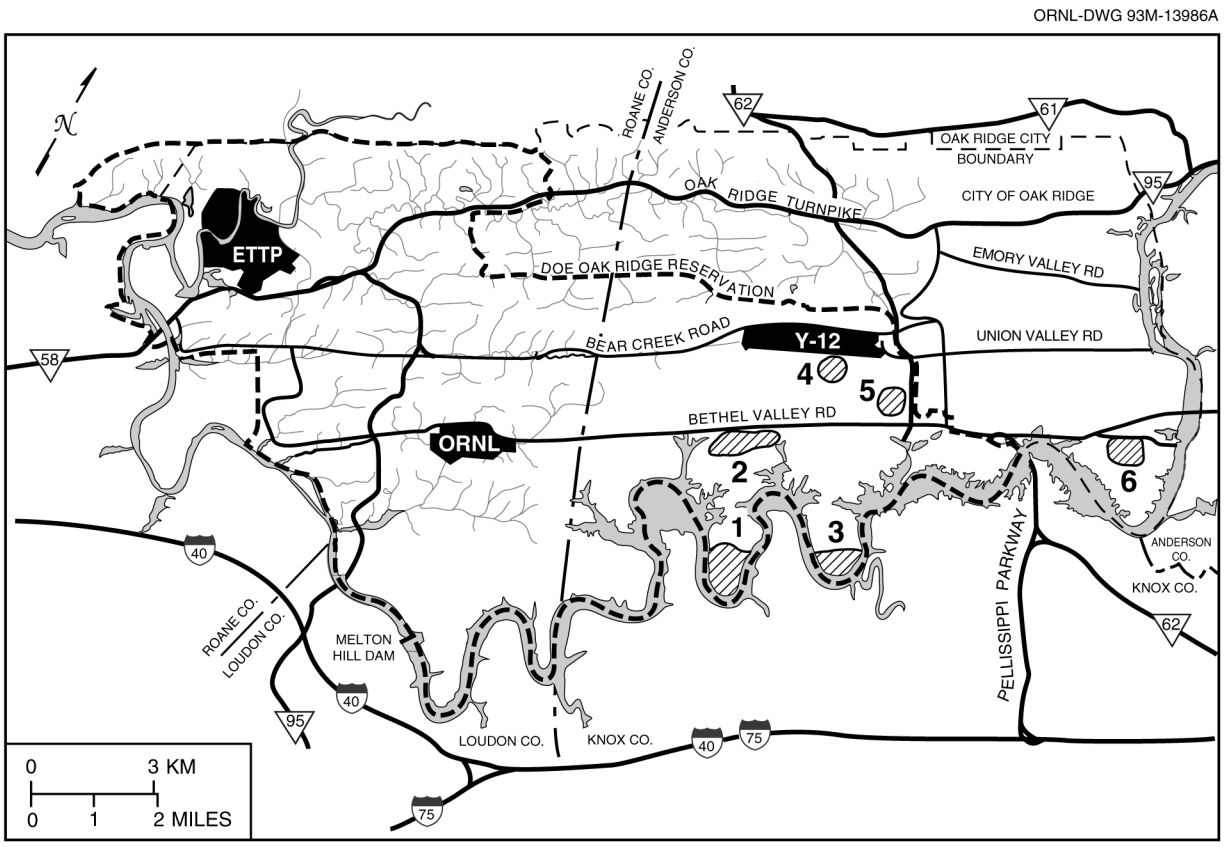

Fig. 7.6. Hay sampling locations on the ORR, indicated by numbered areas. Area 7 is a reference location at Norris Dam and is not shown.

detectable activity, with the exception of naturally occurring radionuclides ^{7}Be and ^{40}K. Concentrations of uranium isotopes are shown in Table 7.5.

7.6.2 Vegetables

Tomatoes, lettuce, and turnips were purchased from local farmers near the ORR. The locations were chosen based on availability and on their likelihood of being affected by routine releases from the Oak Ridge facilities.

7.6.2.1 Results

Samples were analyzed for gross alpha, gross beta, gamma emitters, and uranium isotopes. None of the vegetables had gamma-emitting radionuclides that were detected above minimum detectable activity, with the exception of naturally occurring radionuclides ^{7}Be and ^{40}K. Concentrations of uranium isotopes are shown in Table 7.6.

Table 7.5. Concentrations of uranium isotopes detected in hay, 2002 (pCi/kg)[a,b]

^{234}U	^{235}U	^{238}U
Area 1-2-3 composite		
0.92	*c*	0.51
Area 2-4-5 composite		
0.92	0.11	0.44
Area 6		
1.90	0.16	0.77
Area 7-Norris reference location		
0.83	0.19	0.67

[a]Detected radionuclides are detected above minimum detectable activity.

[b]1 pCi = 3.7E-02 Bq.

[c]Radionuclide was not detected above minimum detectable activity.

Table 7.6. Concentrations of uranium isotopes detected in vegetables, 2002 (pCi/kg)[a,b]

	^{234}U	^{235}U	^{238}U
Lettuce			
East of Y-12, #1	*c*	*c*	*c*
East of Y-12, Claxton	*c*	*c*	*c*
Northeast of Y-12, Scarboro No. 1	*c*	*c*	*c*
Northeast of Y-12, Scarboro No. 2	*c*	*c*	*c*
South of ORNL	*c*	*c*	*c*
West of ETTP			
Tomato			
East of Y-12, No. 1	0.59	*c*	*c*
East of Y-12, Claxton	0.31	*c*	*c*
Northeast of Y-12, Scarboro No. 1	0.57	*c*	0.22
Northeast of Y-12, Scarboro No. 2	0.17	0.10	0.10
South of ORNL	0.43	*c*	*c*
West of ETTP	0.42	*c*	*c*
Turnip			
East of Y-12, Claxton	1.40	*c*	0.38
Northeast of Y-12, Scarboro No. 1	1.40	*c*	0.71
Northeast of Y-12, Scarboro No. 2	3.0	*c*	1.7
South of ORNL	1.2	*c*	0.61
West of ETTP	1.9	*c*	1.1

[a]Detected radionuclides are detected above the minimum detectable activity.
[b]1 pCi = 3.7E–02 Bq.
[c]Value was not detected above the minimum detectable activity.

7.6.3 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 2002 milk-sampling program consisted of grab samples collected every other month from three locations (Fig. 7.7). One is a commercial dairy in Powell that processes milk from various locations in east Tennessee; the second dairy is in Claxton, and the third is in Maryville (a reference location). Milk samples are analyzed for gamma emitters and for total radioactive strontium (^{89}Sr + ^{90}Sr) by chemical separation and low-background beta counting. Liquid scintillation is used to analyze for ^{3}H.

7.6.3.1 Results

Concentrations of radionuclides detected above minimum detectable activity in milk are presented in Table 7.7. Total radioactive strontium (^{89}Sr + ^{90}Sr) was detected at each of the locations: once at Claxton and twice each at Maryville and Powell.

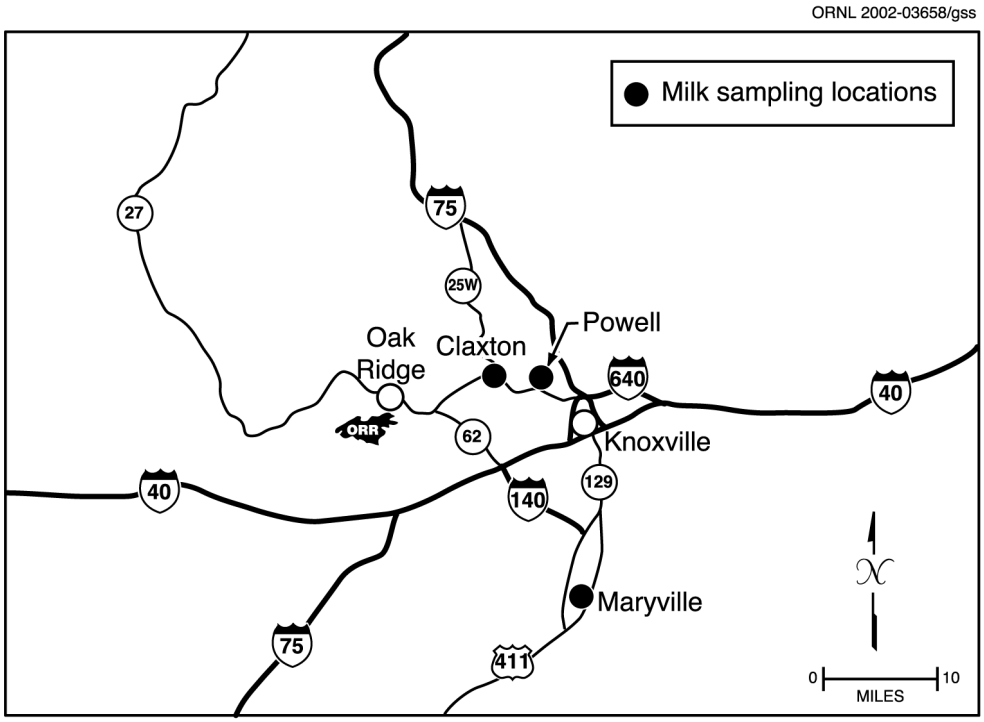

Fig. 7.7. Milk sampling locations in the vicinity of the ORR.

Table 7.7. Concentration of radionuclides detected in raw milk, 2002

Analysis	No. detected/ no. total	Detected concentration (pCi/L)[a,b]			Standard error of mean
		Max	Min	Avg	
		Claxton			
Total rad Sr	1/6	1.6*	0.29	1.0*	0.18
		Maryville			
Total rad Sr	2/6	1.2*	0.55*	0.86*	0.1
		Powell			
Total rad Sr	2/6	1.4	0.69*	1.1*	0.11

[a]1 pCi = 3.7×10^{-2} Bq. Detected radionuclides are those detected above minimum detectable activity.

[b]Individual and average concentrations significantly greater than zero at the 95% confidence level are identified by an asterisk (*).

7.7 FISH

Members of the public could potentially be exposed to contaminants originating from DOE-ORO activities through consumption of fish caught in area waters. This exposure pathway is monitored by collecting fish from three locations on the Clinch River annually and analyzing edible fish flesh. The locations are as follows (see Fig. 7.8):

- Clinch River upstream from all DOE ORR inputs (CRK 70),
- Clinch River downstream from ORNL (CRK 32), and
- Clinch River downstream from all DOE ORR inputs (CRK 16).

Sunfish (*Lepomis macrochirus*, *L. auritus*, and *Ambloplites rupestris*) and catfish (*Ictalurus punctatus*) are collected from each of the three

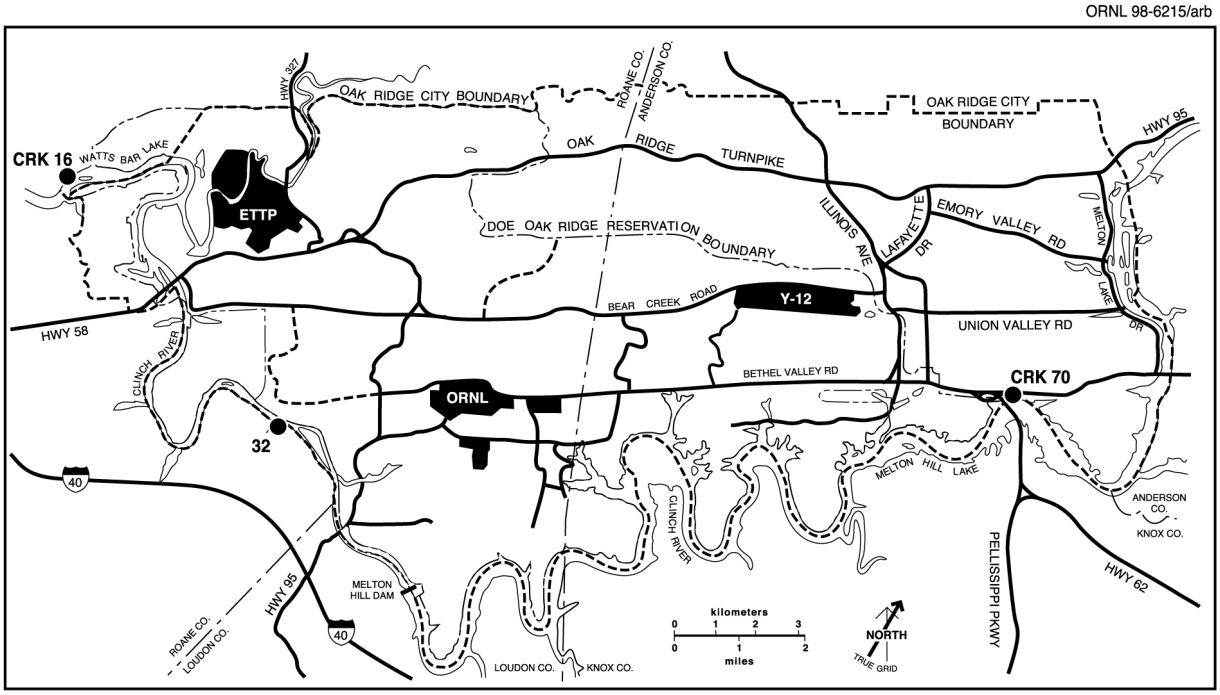

Fig. 7.8. Fish sampling locations for the ORR.

locations, filleted, and frozen. In 2002, two composite samples of each species at each location were analyzed for selected metals, pesticides, PCBs, and ^{3}H, and two samples of each species at each location were analyzed for gross alpha, gross beta, and gamma-emitting radionuclides and for total radioactive strontium.

7.7.1 Results

In 2002, most nonradiological parameters analyzed in sunfish and catfish were undetected or were detected in only a few samples. TDEC adopted the EPA method for establishing fish consumption advisories for carcinogenic contaminants found in fish collected in waters designated for recreation and domestic water supply. There is a "do not consume" fish advisory (applicable to typical fishermen consumers) for catfish in Melton Hill Reservoir (in its entirety) because of PCB contamination and a precautionary fish advisory (applicable to atypical consumers, those persons who, because of physiological factors or previous exposures, are more sensitive to specific pollutants; this may include pregnant or nursing women, children, and subsistence fishermen) for catfish in the Clinch River arm of Watts Bar Reservoir because of PCB contamination (TDEC 1993).

Aroclor-1260 was detected in the sunfish samples at all three locations; 4,4'-DDE, a pesticide, was detected in one of the two sunfish composite samples collected at CRK 32, downstream from ORNL. Aroclor-1260 was detected in the catfish composite samples collected at all three locations. Aldrin, a pesticide, was detected in the two catfish composite samples (and in the associated laboratory blanks) collected at CRK16, downstream from all DOE inputs.

7.8 WHITE-TAILED DEER

The seventeenth annual deer hunts managed by DOE and TWRA were held on the ORR during the final quarter of 2002. Due to security concerns, no deer hunts were held on the ORR during 2001. ORNL staff, TWRA personnel, and student members of the Wildlife Society (University of Tennessee Chapter) performed most of the necessary operations at the checking station.

The 2002 hunts were held on three weekends. Shotgun/muzzle loader and archery hunts were held October 19–20, November 9–10, and

December 7–8 with about 650 shotgun/muzzle loader permitted hunters and 350 archery permitted hunters for each hunt. During the November 9–10 hunt, the Tower Shielding area was opened for an archery-only hunt. However, the Park City Road area, Chestnut Ridge area, and Poplar Creek Road area were opened for an archery-only hunt on all three weekends. For the 2002 hunt, a limit of one deer, either sex, was established for all hunt areas.

The year's total harvest was 421 deer. From the total harvest of 421 animals, 297 (70.5%) were bucks and 124 (29.5%) were does. The heaviest buck had ten antler points and weighed 211 lb (95.7 kg). The greatest number of antler points (12) was found on three bucks. The heaviest doe weighed 118 lb (53.5 kg). An elk was harvested on the ORR during the October 19 hunt. The elk was field analyzed and released to the University of Tennessee Veterinary school for study.

Since 1985, 8263 deer have been harvested. Of these only 168 (2.0%) have been retained due to potential radiological contamination. The heaviest buck was 218 lb (98.9 kg) (harvested in 1998) and the average weight is 85.8 lb (38.9 kg). The oldest deer harvested was 12 years old; the average age is 1.9 years. See the ORNL wildlife webpage: http://www.ornl.gov/rmal/huntinfo.htm for additional information.

7.8.1 Results

In the 2002 hunts, 421 deer were harvested. Of the deer harvested, three (0.7%) were retained for exceeding the administrative release limits (1.5 × background for beta activity in bone (~20 pCi/g) or 5 pCi/g (0.19 Bq/g) of ^{137}Cs in edible tissue). The three retained deer exceeded the limit for beta-particle activity in bone. The maximum weight of the released deer was 211 lb (95.7 kg) and the average weight was 93.7 lb (42.5 kg). The average ^{137}Cs concentration in the released deer was 0.2 pCi/g (0.007 Bq/g), and the maximum ^{137}Cs concentration in the released deer was 1.7 pCi/g (0.06 Bq/g). The elk was field screened, and the measured ^{137}Cs concentration in tissue was 0.22 pCi/g (0.008 Bq/g).

It is assumed that about 55% of the field weight is edible meat; therefore, the average deer would yield about 51.5 lb (23.4 kg) of meat. Based on the average weight, the total harvest of edible meat (418 released deer) is estimated to be about 21,527 lb (9763 kg).

7.9 FOWL

A couple of species observed in 2002 appear to be previously undocumented on the ORR; these were the greater white-fronted goose (*Anser albifrons*) and Ross's goose (*Chen rossii*). One greater white-fronted goose was observed at the ETTP Central Neutralization Facility and one Ross's goose was observed on the ORNL Swan Pond. In addition, a semipalmated plover (*Charadrius semipalmatus*) was also observed on the ORR (ETTP K901-A pond) in 2002. This is a migrant that has not been detected here for nearly 50 years, with the last documented report of this species on the ORR dating to the early 1950s.

7.9.1 Waterfowl Surveys—Canada Geese

The consumption of Canada geese is a potential pathway for exposure of members of the public to radionuclides released from Oak Ridge operations because open hunts for Canada geese are held in counties adjacent to the ORR each year. To determine concentrations of gamma-emitting radionuclides accumulated by waterfowl that feed and live on the ORR, Canada geese are rounded up each summer and are subjected to noninvasive gross radiological surveys. At a minimum, three geese, selected from the different round-up locations, are sacrificed to conduct further radiological analysis. The 2002 ORR roundup was conducted on June 20 and 21.

From the roundup, 105 geese were subjected to live whole-body gamma scans. These geese were collected from ETTP (31), ORNL (47), Union Valley (7), and Oak Ridge Marina (20). Three of the 105 geese exceeded the administrative release limits.

7.9.1.1 Results

The average ^{137}Cs concentration in the released geese was 1.3 pCi/g (0.048 Bq/g). The maximum ^{137}Cs concentration in the released geese was 7.5 pCi/g (0.28 Bq/g). Three geese had measured radiological contaminant levels in

excess of the 5 pCi/g administrative limit for ^{137}Cs. All three were goslings rounded up at the ORNL Sewage Treatment Plant. These goslings were not sacrificed because their low body weight contributed to the elevated ^{137}Cs concentrations (expected to be abated by rapid weight gain) and because the administrative limits were established on the consumption of venison from deer. These three goslings were banded should future studies be required. Three adult geese were sacrificed for radiological analyses. The average weight of the geese screened during the roundup was about 9.04 lb (4.1 kg). The maximum goose weight was about 13.7 lb (6.2 kg).

7.9.2 Turkey Monitoring

Two wild turkey hunts managed by DOE and TWRA were held on the reservation April 6–7, 2002, and April 13–14, 2002. Hunting was open for both shotguns and archery. Thirty-eight turkeys were harvested; 6 (15.8%) were juveniles and 32 (84.2%) were adults. The average weight was about 18.6 lb (8.4 kg). The largest tom weighed 22.8 lb (10.3 kg) and had 1.2-in. spurs and a 10.4-in. beard. The longest beard (11.1 in.) was measured on a tom weighing 18.1 lb (8.2 kg).

Since 1997, 344 turkeys have been harvested. Of these, only 2 (0.58%) have been retained due to potential radiological contamination. The heaviest turkey was 24.6 lb (11.2 kg) and the average weight is 18.6 lb (8.4 kg). The longest spur on a turkey harvested on the ORR was 1.5 in. (average 0.8 in.); the longest beard was 13.5 in. (average 9.2 in.). See the ORNL wildlife webpage (http://www.ornl.gov/rmal/huntinfo.htm) for additional information.

7.9.2.1 Results

In 2002, a total of 38 birds was harvested, and none exceeded the administrative release limits established for radiological contamination. The average ^{137}Cs concentration in the released turkeys was 0.1 pCi/g (0.004 Bq/g), and the maximum ^{137}Cs concentration in the released birds was 0.3 pCi/g (0.01 Bq/g).

It is assumed that about 50% of the field weight is edible meat; therefore, the average turkey would yield about 9.3 lb (4.2 kg) of meat. Based on the average weight, the total harvest of edible meat (38 released birds) is estimated to be about 353.4 lb (160.3 kg).