7. ORR Environmental Monitoring Program

In addition to environmental monitoring conducted at the three major Oak Ridge DOE installations, reservation-wide surveillance monitoring is performed to measure radiological and nonradiological parameters directly in environmental media adjacent to the facilities. Data from the ORR surveillance programs are analyzed to assess the environmental impact of DOE operations on the entire reservation and the surrounding area. Dose assessment information based on data from ORR surveillance programs is given in Chapter 8.

7.1 Meteorological Monitoring

Eight 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.

7.1.1 Description

The eight meteorological towers are depicted in Fig. 7.1:

Tower	Height (m)
Y-12 Complex	
MT5/East	100
MT6/West	60
ORNL	
MT2/C	100
MT3/B	30
MT4/A	30
ETTP	
MT1/K (1208)	60
MT7/L (1209)	30
ORNL/ETTP	
M (208A)	10

Meteorological data are collected at different altitudes (10, 30, 60, and 100 m above ground) 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; see Sect. 1.3) 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 of the towers at each facility (MT1, MT2, MT5, and MT7). Precipitation is measured at Towers MT5 and MT6 at the Y-12 Complex, Towers MT1 and MT7 at the ETTP, and at Tower MT2 at ORNL. Solar radiation is measured at Towers MT5 and MT6 at the Y-12 Complex, Towers MT1 and MT7 at the ETTP, and Tower MT2 at ORNL.

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

Fifteen-minute and hourly data are used directly at each site for emergency-response purposes, such as for 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 compli-

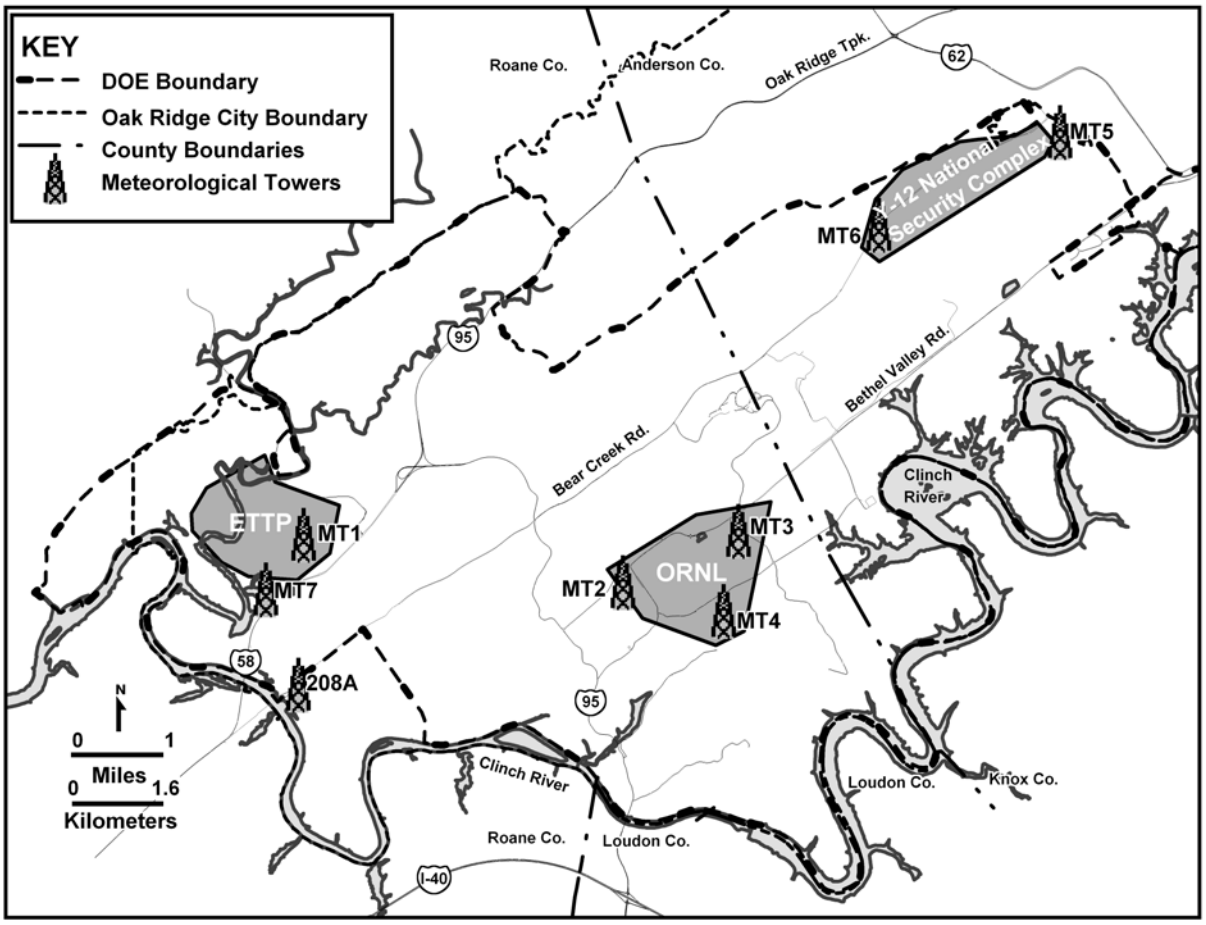

Fig. 7.1. The ORR meteorological monitoring network.

ance modeling. Records of data problems and errors are routinely kept for all eight tower sites.

7.1.2 Meteorological Impacts on Modeling 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 ORR sites. Winds in the valleys tend to follow the ridge axes, with limited cross-ridge flow within local valley bottoms. These conditions are dominant over most of the reservation, with the exception of the ETTP, which is located in a relatively open valley bottom (which results in 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 (see Sect. 1.3).

The atmosphere over the reservation is dominated by stable conditions on most nights and during much of the morning hours. These conditions, when 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 partially mitigate these factors through the increased turbulence (mixing) that results. 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/C are used in stream-flow modeling and in certain research efforts. The data indicate the variability

of regional precipitation: the high winter rainfall resulting from frontal systems and the uneven, but occasionally intense, summer rainfall associated with thunderstorms. Unlike the previous 3 years (which had above normal precipitation), 2005 yielded precipitation totals of 43.49 inches at Tower MT2 / C and 46.22 inches at Tower MT1 / K(1208) (approximately 10–15% below the 30-year mean).

The average data recovery rate (a measure of acceptable data) across locations used for modeling during 2005 was 98.4% for ORNL sites (Towers MT2, MT3, MT4), 98.7% for ETTP sites (Towers MT1, MT7), and 99.6% for Y12 sites (Tower West).

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 for 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 a 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 2005 was 5.4 μR/h, and the average at the reference location was 4.6 μR/h. Exposure rates from background sources in Tennessee range from 2.9 to 11 μR/h. The measured ORR exposure rate was within the range of normal background levels in Tennessee, indicating that activities on the ORR do not increase external gamma levels in the area above normal background levels.

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 provides a means to verify that contributions of fugitive and diffuse sources are insignificant, serves as a check on dose-modeling calculations, and would allow determination of contaminant levels at monitoring locations in the event of an emergency.

The following sections discuss the ambient air monitoring networks for the ORR. Other air monitoring programs are discussed in the site-specific chapters.

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 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 2005 to quantify levels of alpha-, beta-, and gamma-emitting radionuclides and ^{3}H.

Atmospheric dispersion modeling was used to select appropriate sampling 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.

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, and 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.

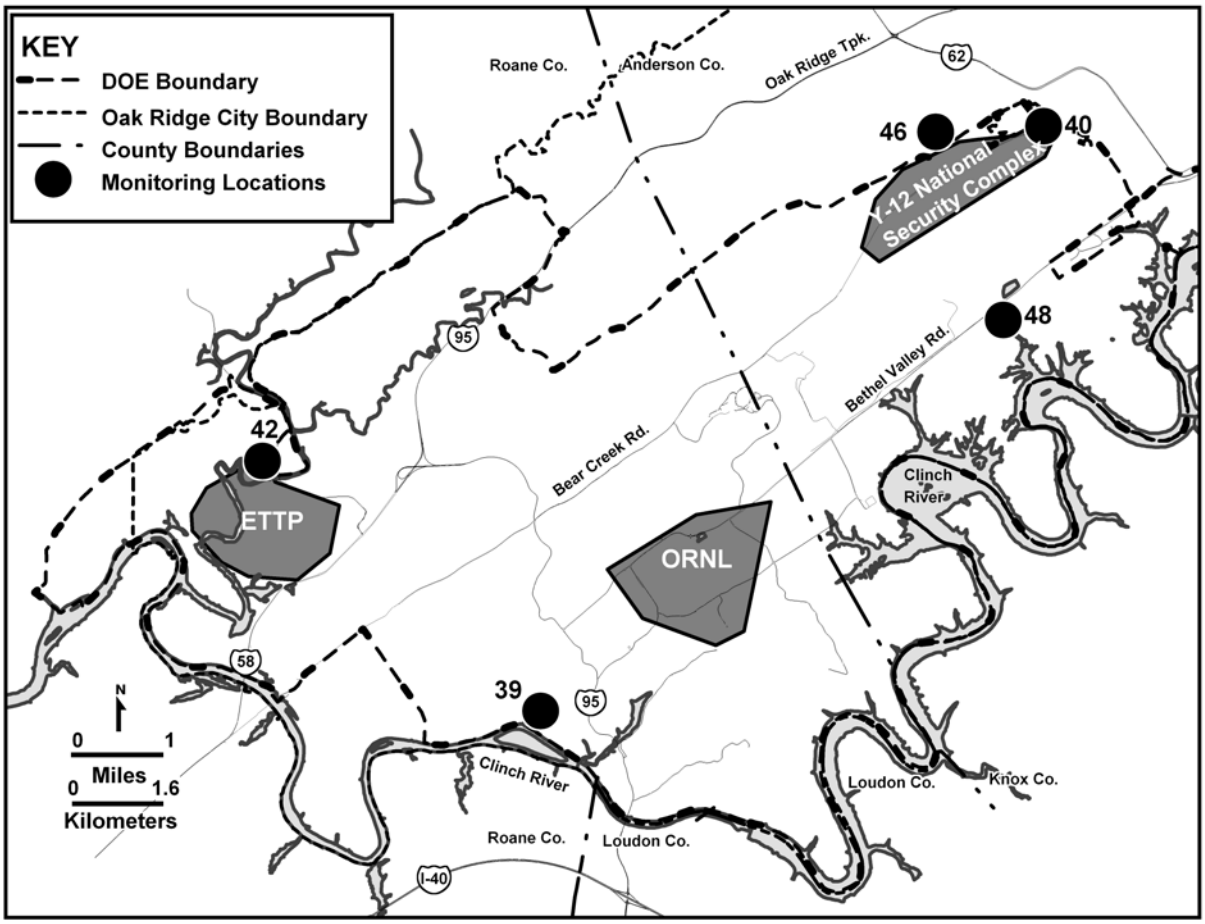

Fig. 7.2. External gamma radiation monitoring locations on the ORR.

Table 7.1. External gamma averages for the ORR, 2005

Monitoring location	Number of data values collected	Measurement (μR/h)[a]			Standard error of mean
		Min	Max	Mean	
39	52	5.3	6.6	5.9	0.00004
40	52	4.6	6.0	5.5	0.00003
42	52	4.0	5.2	4.7	0.00004
46	52	5.3	6.4	6.1	0.00003
48	52	4.4	6.2	4.6	0.00004
52	52	3.5	4.8	4.6	0.00003

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

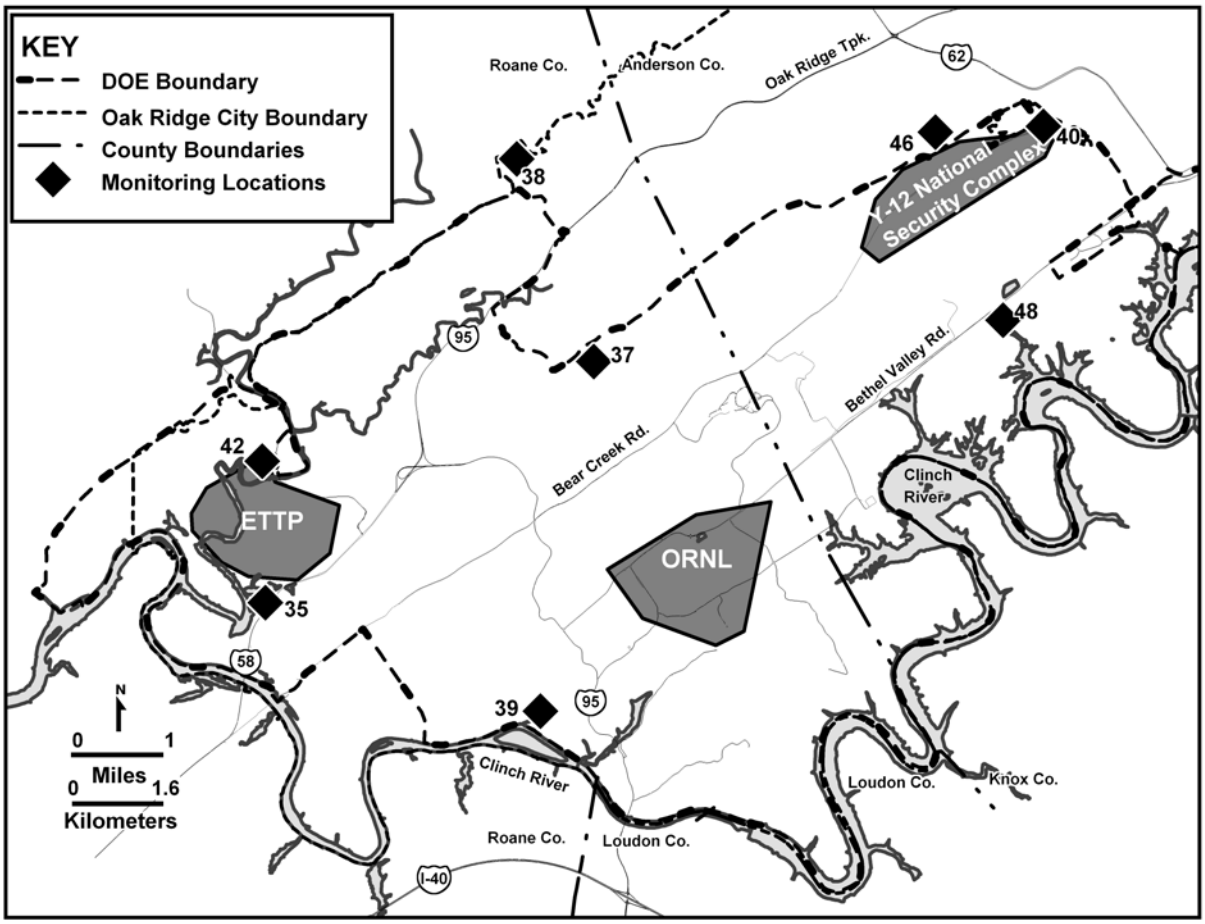

Fig. 7.3. Locations of ORR perimeter air monitoring stations.

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 of DOE operations on the local air quality. Each measured radionuclide concentration is compared with appropriate derived concentration guides (DCGs), which serve as references 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. Statistical significance testing is also performed to compare average radionuclide concentrations measured at ORR ambient air stations with concentrations measured at the reference location. This test reflects the mathematical probability of certain outcomes but is not an indication of environmental significance. There were no calculated statistical differences in average concentrations of ^{3}H, ^{7}Be, ^{238}U or ^{40}K. The concentrations of ^{234}U and ^{235}U at the ORR ambient air stations were slightly higher than those observed at the background location at the 95% confidence level. A summary of radionuclide concentrations measured at the ambient air stations is presented in Table 7.2. Table 7.3 represents the average concentration of three isotopes of uranium at each station for sampling years 2002, 2003, 2004, and 2005.

Table 7.2. Average radionuclide concentrations at ORR perimeter air monitoring stations, 2005 (pCi/mL)[a]

Parameter	No. detected/ no. total	Average	Min	Max
		Station 35		
^{7}Be	4/4	4.90E-08	4.20E-08	5.79E-08
^{40}K	0/4	2.35E-10	–4.45E-11	4.69E-10
Tritium	1/4	4.99E-06	5.73E-07	1.09E-05
^{234}U	4/4	1.24E-11	6.35E-12	1.86E-11
^{235}U	3/4	1.01E-12	4.63E-13	1.40E-12
^{238}U	4/4	2.16E-11	8.21E-12	5.66E-11
		Station 37		
^{7}Be	4/4	5.10E-08	3.95E-08	5.91E-08
^{40}K	0/4	9.15E-11	–2.19E-10	4.08E-10
Tritium	0/4	1.57E-06	–8.82E-07	4.44E-06
^{234}U	4/4	8.01E-12	5.50E-12	9.28E-12
^{235}U	1/4	9.22E-13	3.86E-13	1.48E-12
^{238}U	4/4	1.03E-11	6.60E-12	1.39E-11
		Station 38		
^{7}B	4/4	5.33E-08	4.79E-08	6.29E-08
^{40}K	0/4	1.26E-10	-9.53E-12	2.83E-10
Tritium	0/4	2.03E-06	4.71E-07	5.15E-06
^{234}U	4/4	6.21E-12	4.17E-12	7.61E-12
^{235}U	2/4	5.72E-13	–5.88E-14	9.95E-13
^{238}U	4/4	7.50E-12	4.07E-12	1.16E-11
		Station 39		
^{7}Be	4/4	4.05E-08	3.60E-08	4.75E-08
^{40}K	0/4	1.63E-10	–5.10E-11	4.06E-10
Tritium	1/4	3.80E-06	2.80E-07	5.76E-06
^{234}U	4/4	4.58E-12	3.28E-12	5.40E-12
^{235}U	1/4	5.74E-13	1.87E-13	1.19E-12
^{238}U	4/4	4.40E-12	3.74E-12	5.37E-12
		Station 40		
^{7}Be	4/4	4.97E-08	3.51E-08	5.99E-08
^{40}K	0/4	5.65E-11	–2.70E-10	3.42E-10
Tritium	0/4	1.61E-06	1.55E-07	3.57E-06
^{234}U	4/4	2.85E-11	1.58E-11	5.26E-11
^{235}U	2/4	1.43E-12	6.76E-13	2.56E-12
^{238}U	4/4	8.73E-12	6.79E-12	1.19E-11
		Station 42		
^{7}Be	4/4	4.03E-08	2.76E-08	5.10E-08
^{40}K	0/4	2.14E-10	4.14E-11	3.41E-10
Tritium	0/4	5.61E-07	–9.71E-07	2.60E-06
^{234}U	4/4	7.51E-12	5.93E-12	8.73E-12
^{235}U	1/4	4.58E-13	0	8.66E-13
^{238}U	4/4	1.03E-11	3.82E-12	2.15E-11

Table 7.2. (continued)

Parameter	No. detected/ no. total	Average	Min	Max
		Station 46		
^{7}Be	4/4	4.74E-08	3.87E-08	5.34E-08
^{40}K	0/4	3.93E-10	1.99E-10	5.76E-10
Tritium	0/4	2.54E-06	–7.99E-08	5.76E-06
^{234}U	4/4	1.82E-11	8.00E-12	2.92E-11
^{235}U	3/4	1.10E-12	4.40E-13	1.69E-12
^{238}U	4/4	1.04E-11	4.94E-12	1.65E-11
		Station 48		
^{7}Be	4/4	4.53E-08	2.19E-08	5.53E-08
^{40}K	0/4	2.28E-10	–2.73E-10	5.54E-10
Tritium	0/4	1.49E-06	–4.29E-07	3.66E-06
^{234}U	4/4	7.63E-12	1.67E-12	1.24E-11
^{235}U	2/4	5.01E-13	0	1.06E-12
^{238}U	4/4	6.06E-12	3.72E-12	7.84E-12
		Station 52		
^{7}Be	4/4	4.56E-08	2.60E-08	6.12E-08
^{40}K	0/4	2.34E-10	–9.10E-12	3.63E-10
Tritium	0/4	1.31E-06	–2.46E-08	3.09E-06
^{234}U	4/4	5.03E-12	4.41E-12	6.02E-12
^{235}U	2/4	5.31E-13	3.74E-13	6.88E-13
^{238}U	4/4	3.95E-12	2.84E-12	5.19E-12

1 pCi = 3.7×10^{-2} Bq.

7.4 Surface Water Monitoring

7.4.1 ORR Surface Water Monitoring

The ORR surface water monitoring program includes sample collection and analysis from three locations on the Clinch River. This program is conducted in conjunction with the ORNL surface water monitoring activities discussed in Chapter 5 to enable an assessment of the impacts of past and current DOE operations on the quality of local surface water. These programs are conducted in addition to the surface water monitoring required by National Pollutant Discharged Elimination System permits for individual DOE ORR facilities; sampling location, frequency, and analytical parameters vary among them. 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 at all locations and are analyzed for general water quality parameters, screened for radioactivity, and analyzed for metals and specific radionuclides when appropriate. Samples from two of the sites are also checked for volatile organic compounds, and one is checked for polychlorinated biphenyls (PCBs). Table 7.4 lists the specific locations and associated sampling frequencies and parameters.

The sampling locations are classified by the state of Tennessee for recreation and domestic use. Tennessee water quality criteria associated with these classifications are used as references where they are applicable (TDEC 2004). The Tennessee water quality criteria do not include criteria for radionuclides.

7.4.2 Results

Comparison of surface water sample results from locations upstream of DOE inputs with results from surface water samples obtained

Table 7.3. Uranium concentrations in ambient air on the ORR[a]

Isotope	Concentration (10^{-15} µCi/mL)			
	2002	2003	2004	2005
	Station 35			
^{234}U	2.0E–02	6.9E–02	2.38E–02	1.24E-02
^{235}U	1.6E–03	3.6E–03	1.36E–03	1.10E-03
^{238}U	2.1E–02	2.3E–02	1.56E–02	2.16E-02
	Station 37			
^{234}U	9.3E–03	9.1E–03	1.24E–02	8.01E-03
^{235}U	1.1E–03	4.6E–04	5.40E–04	9.22E-04
^{238}U	8.3E–03	5.6E–03	7.90E–03	1.01E-02
	Station 38			
^{234}U	1.4E–02	1.3E–02	9.47E–03	6.21E-03
^{235}U	1.8E–03	8.1E–04	6.17E–04	5.72E-04
^{238}U	1.1E–02	8.3E–03	8.50E–03	7.50E-03
	Station 39			
^{234}U	7.1E–03	5.1E–03	4.84E–03	4.58E-03
^{235}U	3.3E–04	2.8E–04	4.36E–04	5.74E-04
^{238}U	7.1E–03	3.9E–03	4.03E–03	4.40E-03
	Station 40			
^{234}U	2.6E–02	3.1E–02	3.83E–02	2.85E-02
^{235}U	1.5E–03	1.4E–03	1.43E–03	1.43E-03
^{238}U	1.3E–02	7.8E–03	7.74E–03	8.73E-03
	Station 42			
^{234}U	2.4E–02	7.0E–02	2.00E–02	7.51E-03
^{235}U	2.5E–03	3.9E–03	1.06E–03	4.58E-04
^{238}U	2.4E–02	2.8E–02	1.31E–02	1.03E-02
	Station 46			
^{234}U	2.3E–02	1.6E–02	2.09E–02	1.82E-02
^{235}U	1.2E–03	8.4E–04	1.47E–03	1.10E-03
^{238}U	1.4E–02	7.8E–03	9.88E–03	1.04E-02
	Station 48			
^{234}U	9.3E–03	8.0E–03	7.31E–03	7.63E-03
^{235}U	6.8E–04	4.9E–04	6.15E–04	5.01E-04
^{238}U	8.2E–03	5.9E–03	5.93E–03	6.60E-03
	Station 52			
^{234}U	1.2E–02	3.9E–03	5.00E–03	5.03E-03
^{235}U	9.3E–04	3.2E–04	3.72E–04	5.31E-03
^{238}U	8.2E–03	3.4E–03	4.26E–03	3.95E-03

[a] 1 µCi = 3.7×10^4 Bq.

downstream of DOE inputs shows that there were no statistically significant differences in any of the parameters of interest. Radionuclides were not detected above 4% of the respective DCG at any location. Acetone, a common laboratory contaminant, was detected in a few samples in 2005. Toluene, a volatile organic compound that is not a common laboratory contaminant, was detected in the April samples at low, estimated levels.

7.5 Food

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

7.5.1 Hay

Hay is sampled annually from five areas on the ORR and from one area immediately adjacent to the reservation (Fig. 7.5) that have 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; a composite sample from Areas 1, 2, and 3 and a composite sample from Areas 2, 4, and 5 are submitted for laboratory analyses. In addition, a sample from Area 6 is submitted separately because it 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. 7.5), which is outside the influence of ORR sources.

7.5.1.1 Results

Hay samples were collected during June 2005, 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 detectable activity (MDA), with the exception of the naturally occurring radionuclides ^{7}Be and ^{40}K. Concentrations of radionuclides detected above MDA in hay are shown in Table 7.5.

7.5.2 Vegetables

Tomatoes, lettuce, and turnips were purchased from local farmers near the ORR. The locations were chosen based on availability and

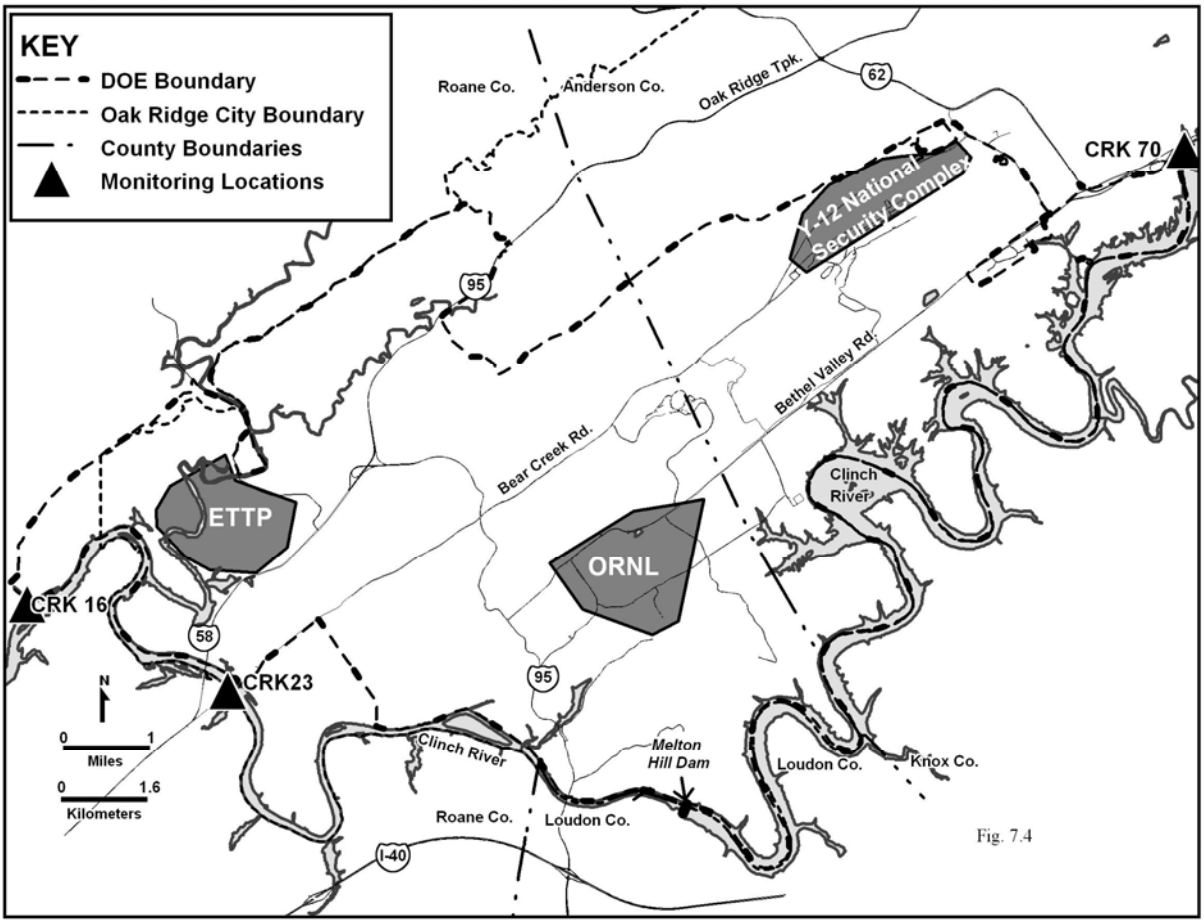

Fig. 7.4. Locations of ORR surface water surveillance sampling stations.

Table 7.4. ORR surface water sampling locations, frequencies, and parameters, 2005

Location[a]	Description	Frequency	Parameters
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 70	Solway Bridge	Monthly	Volatiles, metals, gross alpha, gross beta, total radioactive strontium, gamma scan, ^{3}H, field measurements[b]

[a]Locations indicate bodies of water and km designation (e.g., CRK 16 = 16 km upstream from the confluence of the Clinch and the Tennessee rivers).

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

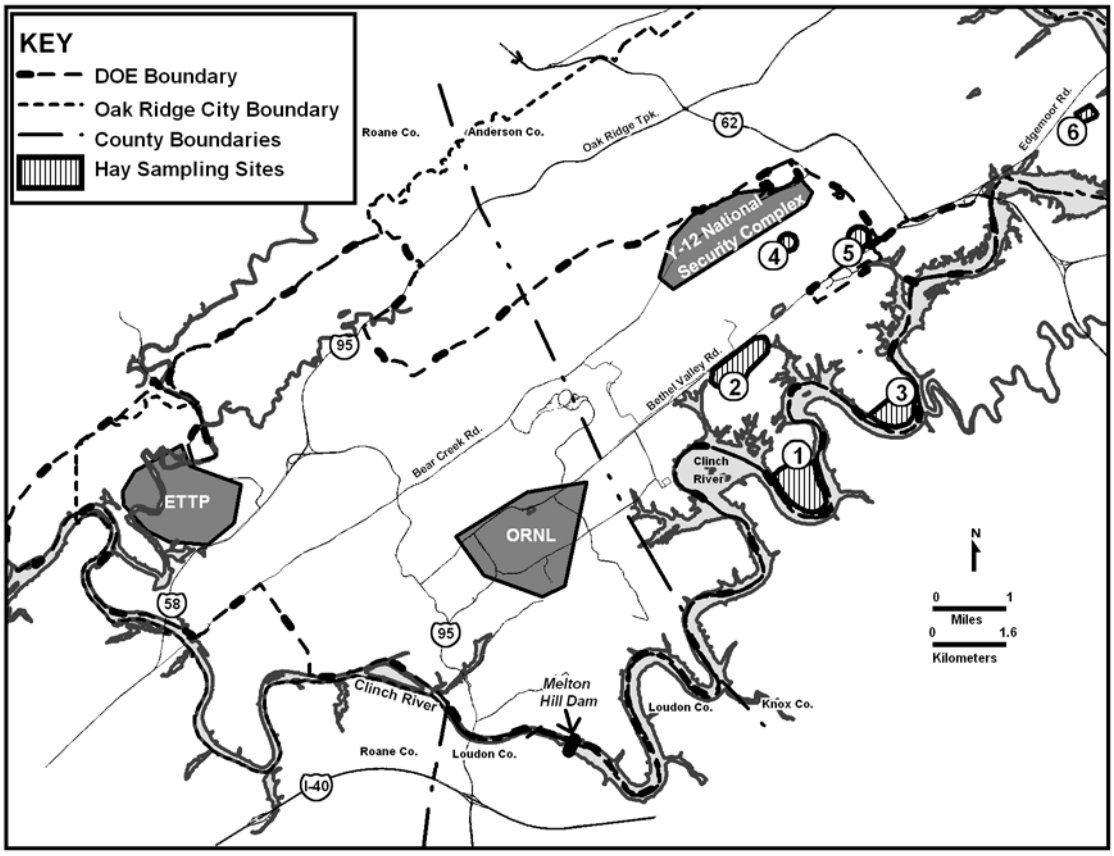

Fig. 7.5. Hay sampling locations on the ORR, indicated by numbered areas.

Table 7.5. Concentrations of radionuclides detected in hay, 2005 (pCi/kg)[a]

Gross alpha	Gross beta	^{7}Be	^{40}K	^{234}U	^{235}U	^{238}U
Area 1-2-3 composite						
b	0.011	*b*	0.017	*b*	*b*	*b*
Area 2-4-5 composite						
0.000083	0.0099	*b*	0.028	0.0000080	*b*	0.0000057
Area 6						
0.00012	0.0094	0.010	0.017	*b*	*b*	0.0000090
Area 7–Norris reference location						
b	0.0092	*b*	0.023	*b*	*b*	0.0000021

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

[b]Value was not detected above the minimum detectable activity.

on their likelihood of being affected by routine releases from the Oak Ridge facilities.

7.5.2.1 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 MDA, with the exception of the naturally occurring radionuclide ^{40}K. Concentrations of radionuclides detected above MDA are shown in Table 7.6.

7.5.3 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 2005 milk-sampling program consisted of grab samples collected every other month from three locations (Fig. 7.6). 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.

7.5.3.1 Results

Concentrations of radionuclides detected above MDA in milk are presented in Table 7.7. Total radioactive strontium (^{89}Sr + ^{90}Sr) was detected at least once at each of the locations.

7.6 Fish

Members of the public could 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. 7.7):

- Clinch River upstream from all DOE ORR inputs [Clinch River kilometer (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 locations, filleted, and frozen. In 2005, two composite samples of flesh from each species at each location were analyzed for selected metals, pesticides, PCBs, ^{3}H, gross alpha, gross beta, and gamma-emitting radionuclides and for total radioactive strontium.

7.6.1 Results

The Tennessee Department of Environment and Conservation (TDEC) has adopted the Environmental Protection Agency 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 for catfish in the Clinch River arm of Watts Bar Reservoir because of PCB contamination (TDEC 2002). This advisory is 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.

In 2005, mercury and radionuclides were detected in both sunfish and catfish at all locations. The 2005 results also show pesticides and PCBs detected in both species of fish at all locations. The pesticides 4,4'-DDE, alpha chlordane, and gamma chlordane were detected in all of the catfish composites from all of the locations. The pesticide 4,4'-DDD was found in both catfish composite samples from CRK 16, in none of the catfish composite samples from CRK 32, and in one of the catfish composite samples from CRK 70. PCB-1254 and PCB-1260 were found in all of the catfish composite samples from all of the locations. The pesticide 4,4'-DDE was found in

Table 7.6. Concentrations of radionuclides detected in vegetables, 2005 (pCi/kg)[a]

Location	Gross alpha	Gross beta	^{40}K	^{234}U	^{235}U	^{238}U
Lettuce						
East of Y-12, #1	*b*	0.0027	0.0043	0.0000086	0.0000032	*b*
East of Y-12, Claxton	0.000046	0.0024	0.0047	0.0000076	*b*	0.0000040
Northeast of Y-12, Scarboro #1	0.000049	0.0021	0.0038	0.0000094	*b*	0.000011
Northeast of Y-12, Scarboro #2	0.00014	0.0023	0.0065	0.000012	0.0000045	0.0000073
Southeast of ORNL	0.00014	0.0033	0.0044	0.0000088	0.0000059	0.0000092
West of ETTP	0.000044	0.0031	0.0034	0.0000088	*b*	0.0000040
Tomato						
East of Y-12, #1	0.000070	0.0019	0.0026	0.0000080	*b*	*b*
East of Y-12, Claxton	0.00005	0.0013	0.0015	*b*	*b*	*b*
Northeast of Y-12, Scarboro #1	*b*	0.0015	0.0029	*b*	*b*	*b*
Northeast of Y-12, Scarboro #2	*b*	0.0014	*b*	0.0000063	*b*	0.0000071
Southeast of ORNL	0.000021	0.0014	*b*	*b*	*b*	*b*
West of ETTP	*b*	0.0016	0.0024	*b*	*b*	*b*
Turnip						
East of Y-12, #1	*b*	0.0014	0.0026	*b*	*b*	0.0000065
East of Y-12, Claxton	*b*	0.0013	0.0023	*b*	*b*	*b*
Northeast of Y-12, Scarboro #1	*b*	0.0016	0.0029	0.0000046	*b*	*b*
Northeast of Y-12, Scarboro #2	*b*	0.002	0.0052	0.0000070	*b*	*b*
Southeast of ORNL	*b*	0.0021	0.0038	*b*	*b*	*b*
West of ETTP	*b*	0.0021	0.0026	*b*	*b*	*b*

[a]Detected radionuclides are detected above the minimum detectable activity. 1 pCi = 3.7×10^{-2} Bq.
[b]Value was not detected above the minimum detectable activity.

both sunfish composite samples from CRK 16 and CRK 32; and 4,4'-DDD was found in both sunfish composite samples from CRK 32. PCB-1260 was found in all of the sunfish composite samples from all of the locations. TDEC has issued a fish advisory for the Melton Hill Reservoir in its entirety because of PCB contamination, and the 2005 ORR fish data at upstream and downstream locations are consistent with the advisory.

7.7 White-Tailed Deer

The twentieth annual deer hunts managed by DOE and the Tennessee Wildlife Resources Agency (TWRA) were held on the ORR during the final quarter of 2005. 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 2005 hunts were held on three weekends. Shotgun/muzzleloader and archery hunts were held November 12–13, December 3–4, and December 17–18. In 2005, there were about 500 shotgun/muzzleloader-permitted hunters and 525 archery-permitted hunters. The Tower Shielding area, Park City Road area, Chestnut Ridge area, and Poplar Creek Road area were opened for an archery-only hunt on all three weekends. There was a two-deer limit for the November and December hunts. Two deer could be harvested; however, only one antlered buck could be harvested. It had to have four or more 1-in. antler points on one side of the rack or an outside antler spread of 15 in. or larger.

The year's total harvest was 350 deer. From the total harvest of 350 animals, 153 (43.7%) were bucks and 197 (56.3%) were does. The heaviest buck had eight antler points and weighed 177 lb. The greatest number of antler points found on one buck was 13. The heaviest doe weighed 125 lb.

Since 1985, 9215 deer have been harvested. Of these only 183 (2.0%) have been retained as a result of potential radiological contamination. The heaviest buck was 218 lb (harvested in 1998), and the average weight is 85.6 lb. The

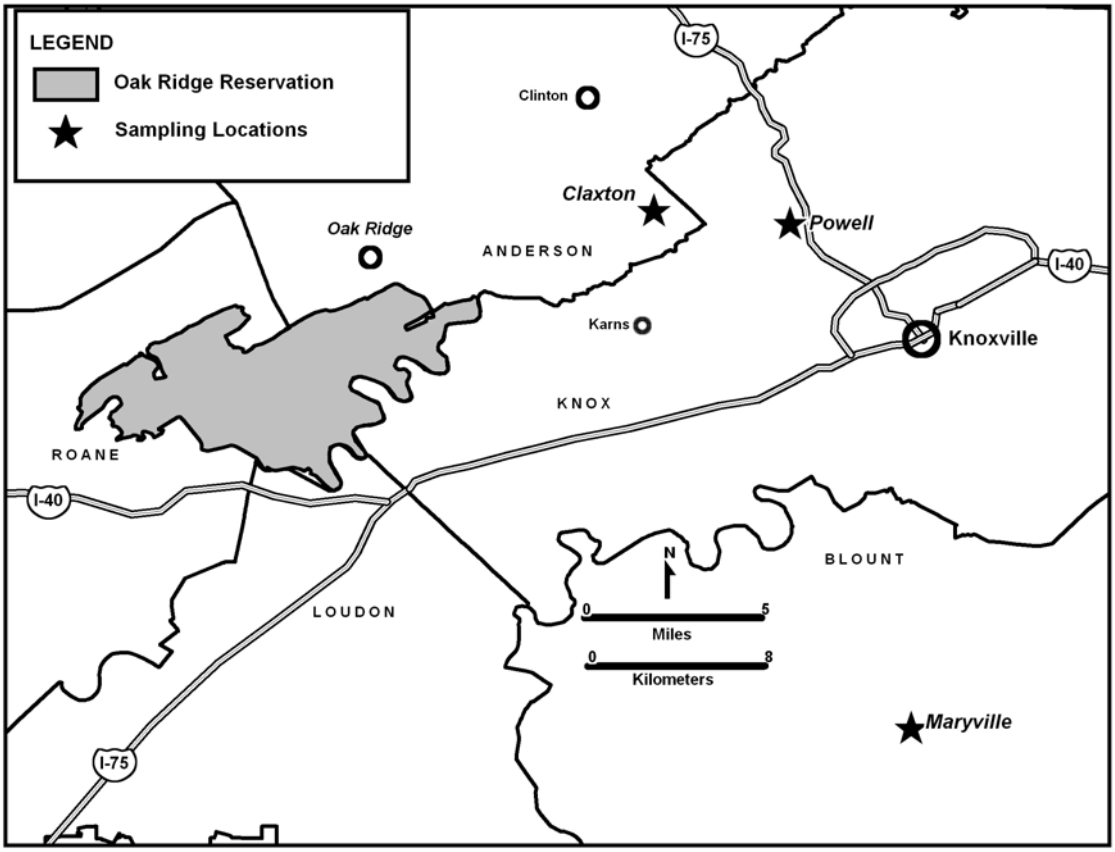

Fig. 7.6. Milk sampling locations in the vicinity of the ORR.

Table 7.7. Concentration of radionuclides detected in raw milk, 2005

Analysis	No. detected/ no. total	Detected concentration (pCi/L)[a,b]			Standard error of mean
		Max	Min	Avg	
Claxton					
Potassium-40	6/6	1300*	1100*	1300*	37
Total rad Sr	1/6	1.9*	0.39	0.86	0.22
Tritium	2/6	1100*	87	510*	150
Maryville					
Potassium-40	6/6	1500*	1200*	1400*	46
Total rad Sr	2/6	2.0*	0.2	1.1*	0.28
Tritium	2/6	980*	–180	390	200
Powell					
Potassium-40	6/6	1300*	1100*	1200*	32
Total rad Sr	1/6	2.2*	0.6	1.3*	0.26
Tritium	2/6	1100*	-60	490*	170

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

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

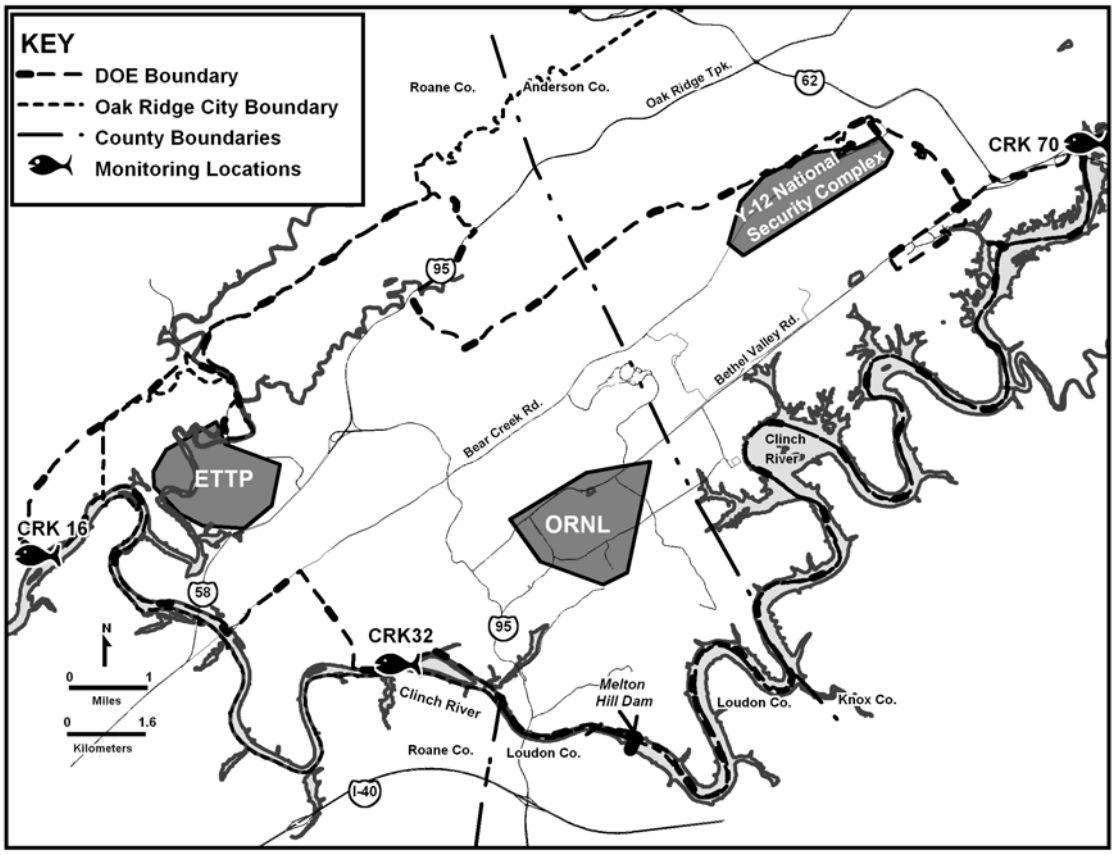

Fig. 7.7. Fish sampling locations for the ORR.

eldest deer harvested was 12 years old; the average age is 1.9 years. For more information, see the ORNL wildlife webpage: http://www.ornl.gov/sci/rmal/huntinfo.htm.

7.7.1 Results

In the 2005 hunts, 350 deer were harvested. Of the deer harvested, three (0.9%) were retained for exceeding the administrative release limits (1.5 times the background for beta activity in bone (~20 pCi/g) or 5 pCi/g of ^{137}Cs in edible tissue). The three retained deer exceeded the limit for beta-particle activity in bone. The average weight of the released deer was 84.53 lb; the maximum weight was 176.9 lb. The average ^{137}Cs concentration in the released deer was 0.48 pCi/g, and the maximum ^{137}Cs concentration in the released deer was 0.82 pCi/g.

It is assumed that 55% of the field weight is edible meat; therefore, the average deer would yield 46.5 lb of meat. Based on the average weight, the total harvest of edible meat (347 released deer) is estimated to be 16,133 lb.

7.8 Fowl

7.8.1 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 roundup locations, are sacrificed to conduct further radiological analysis. The 2005 ORR roundup was conducted on June 23 and 24.

From the roundup, 167 geese were subjected to live whole-body gamma scans. The geese were collected from ETTP (21), ORNL (117), Y-12 (8), and Clark Center Park (21). None exceeded the administrative release limits.

7.8.1.1. Results

The average ^{137}Cs concentration in the released geese was 0.23 pCi/g. The maximum ^{137}Cs concentration in the released geese was 0.79 pCi/g. The average weight of the geese screened during the roundup was 3.53 kg, and the maximum goose weight was 5.1 kg. Three adult geese were sacrificed for radiological analyses. Laboratory analyses of the sacrificed geese are used to verify that the field screening approach is an appropriate method for quantifying radionuclide concentrations.

7.8.2 Turkey Monitoring

Two wild turkey hunts managed by DOE and TWRA were held on the reservation April 9–10, 2005, and April 16–17, 2005. Hunting was open for both shotguns and archery. Thirty-eight turkeys were harvested, of which 10 (26.3%) were juveniles and 28 (73.7%) were adults. The average turkey weight was about 8.3 kg. The largest tom weighed 10.9 kg and had 1.5-in. spurs and a 11.0-in. beard. The longest beard (11.7 in.) was measured on a tom weighing 9.7 kg.

Since 1997, 458 turkeys have been harvested. Of these, only three (0.66%) have been retained because of potential radiological contamination. The heaviest turkey was 11.2 kg; the average weight is 8.4 kg. The longest spur on turkey harvested on the ORR was 1.5 in. (average 0.8 in.) and 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.

7.8.2.1 Results

In 2005, 38 birds were harvested, and one exceeded the administrative release limits established for radiological contamination. The average ^{137}Cs concentration in the released turkeys was 0.1 pCi/g, and the maximum ^{137}Cs concentration in the released birds was 0.3 pCi/g. It is assumed that about 50% of the field weight is edible meat; therefore, the average turkey would yield about 4.2 kg of meat. Based on the average weight, the total harvest of edible meat (37 released birds) is estimated to be about 154.4 kg.