6. Oak Ridge Reservation Environmental Monitoring Program

In addition to environmental monitoring conducted at the three major Oak Ridge DOE installations, reservationwide environmental monitoring is performed to measure radiological and nonradiological parameters directly in environmental media adjacent to the facilities. Data from the ORR-wide environmental monitoring program 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 this program is presented in Chapter 7.

Because of differing permit reporting requirements and instrument capabilities, various units of measurement are used in this report. The list of units of measure and conversion factors provided on pages xxvii and xxviii is intended to help readers convert numeric values presented herein as needed for specific calculations and comparisons.

6.1 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 are used for simulated and potential accidental releases from a facility. Data from the towers are also used to support various research and engineering projects.

6.1.1 Description

The nine meteorological towers on ORR are described in Table 6.1 and depicted in Fig. 6.1. In this document, the individual towers are designated by "MT" followed by a numeral; however, other commonly used names for the sites are provided in Table 6.1. Meteorological data are collected at different levels above the ground (2, 10, 15, 30, 33, 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 (associated with the local ridge-and-valley terrain as well as the Great Valley of Eastern Tennessee; see Appendix B) can significantly affect the movement of a plume after a facility release (Bowen et al. 2000). Data are collected at the 10 m level at all towers except MT3, MT9, and MT11, where data are collected at 15 m or 25 m. Additionally, at selected towers data are collected at the 30-, 33-, 60-, and 100-m levels. At each measurement level, temperature, wind speed, and wind direction are measured. Atmospheric stability (a measure of vertical mixing properties of the atmosphere) is measured at most towers. Barometric pressure is measured at one or more of the towers at each ORR plant (MT1, MT2, MT7, and MT9). Precipitation is measured at MT6 and MT9 at the Y-12 Complex, at MT1 and MT7 at ETTP, and at MT2 and MT4 at ORNL. Solar radiation is measured at MT6 and MT9 at the Y-12 Complex, at MT1 and MT7 at ETTP, and at MT2 at ORNL. Data are collected at 1-, 15-, and 60-min intervals. Quarterly calibrations of the instruments are managed by UT-Battelle and B&W Y-12.

In addition to the meteorological towers, sonic detection and ranging (SODAR) devices have been installed at the east end of the Y-12 Complex and at tower MT2 at ORNL. These devices use acoustic waves to estimate wind direction, wind speed, and turbulence at altitudes higher than the meteorological towers can measure (generally from 100 to 600 m above ground level. Although the SODAR measurements are less accurate than meteorological tower measurements, the SODAR devices provide useful information regarding stability, upper air wind conditions, and mixing depth. Mixing depth represents the thickness of the air layer adjacent to the ground over which an emitted or entrained inert nonbuoyant tracer will be mixed (by turbulence) within a time scale of about 1 h or less.

Table 6.1. Oak Ridge Reservation meteorological towers

Tower	Alternate tower names	Location (lat., long.)	Altitude (m MSL[a])	Measurement heights (m)
		ETTP		
MT1	"K," 1208	35.93317N, -84.38833W	253	10, 60
MT7	"L," 1209	35.92522N, -84.39414W	233	10, 30
		ORNL		
MT2	"C," 1057	35.92559N, -84.32379W	261	10, 30, 100
MT3	"B," 6555	35.93273N, -84.30254W	256	15, 30
MT4	"A," 7571	35.92185N, -84.30470W	263	10, 30
MT10	"M," 208A	35.90947N, -84.38796W	237	10
		Y-12 Complex		
MT6	"W," West	35.98058N, -84.27358W	326	2, 10, 30, 60
MT9	"Y," PSS Tower	35.98745N, -84.25363W	290	2, 15, 33
MT11	"S," South Tower	35.98190 N,-84.25504W	352	25

[a]Mean sea level.

Abbreviations

ETTP = East Tennessee Technology Park
ORNL = Oak Ridge National Laboratory
Y-12 Complex = Y-12 National Security Complex

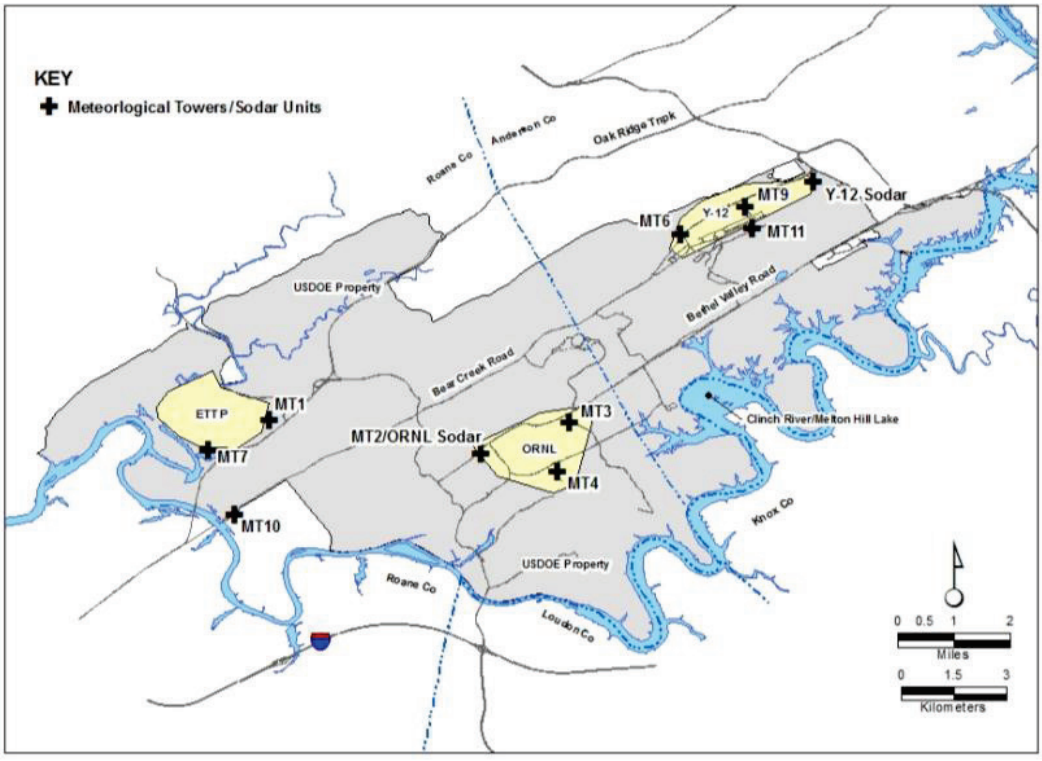

Fig. 6.1. The Oak Ridge Reservation meteorological monitoring network (SODAR: sonic detection and ranging wind profiler).

Data are collected in real time at 1 min, 15 min, and hourly intervals for emergency-response purposes, including dispersion modeling at the ORNL and Y-12 Complex Emergency Operations Centers.

Annual dose estimates are calculated from the archived hourly data. Data quality is checked continuously against predetermined data constraints, and out-of-range parameters are marked invalid and are excluded from compliance modeling. Quality assurance records of data problems and errors are routinely kept for all nine tower sites.

6.1.2 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 often 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 ORR, with the exception of the ETTP, which is located in a relatively open valley bottom (resulting in slightly more varied flow).

On the ORR, low-speed winds dominate near the surface. This characteristic is typical of most near-surface measurements (as influenced by nearby ridges and mountains). Winds sometimes accelerate at ridgetop level, particularly when winds are not exactly parallel to the ridges (see Appendix B).

The atmosphere over the ORR is dominated by stable conditions on most nights and for a few hours after sunrise. 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 increased turbulence processes (atmospheric mixing). 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 resulting from frontal systems and the uneven, but occasionally intense, summer rainfall associated with thunderstorms. The total precipitation in Oak Ridge (town site) during 2011 (1,805 mm or 71.05 in.) was well above the long-term average of 1,343 mm (52.85 in.), yielding a 40% surplus compared with the 30-year means (1981–2010).

The average data recovery rates (a measure of acceptable data) across locations used for modeling during 2011 were greater than 99.8% for ORNL sites (towers MT2, MT3, MT4, and MT10); ranged from 94.4 to 99.7% for ETTP sites (towers MT1 and MT7); and exceeded 99.4% for Y-12 sites (towers MT6, MT9, and MT11). Nearly all data recovery locations exceeded the required 90% per quarter recovery rate. The exception was tower MT7 for the fourth quarter at the 30-meter level for wind speed (88% recovery). In this case, the minimum wind speed instrument threshold was around 0.5 m/s (1 mph) instead of the usual 0.2 m/s (0.4 mph). Replacement data were estimated with a high level of accuracy from 10-meter data interpolation and/or comparisons to nearby towers MT1 and MT10. It should also be noted that data from the new Y-12 tower MT11, which began full-time operations on September 16, 2012, was not available for the entire calendar year.

6.2 External Gamma Radiation Monitoring

6.2.1 Data Collection and Analysis

External gamma measurements (exposure rates) are recorded weekly at six ambient air stations from resident external gross gamma monitors (Fig. 6.2). 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.

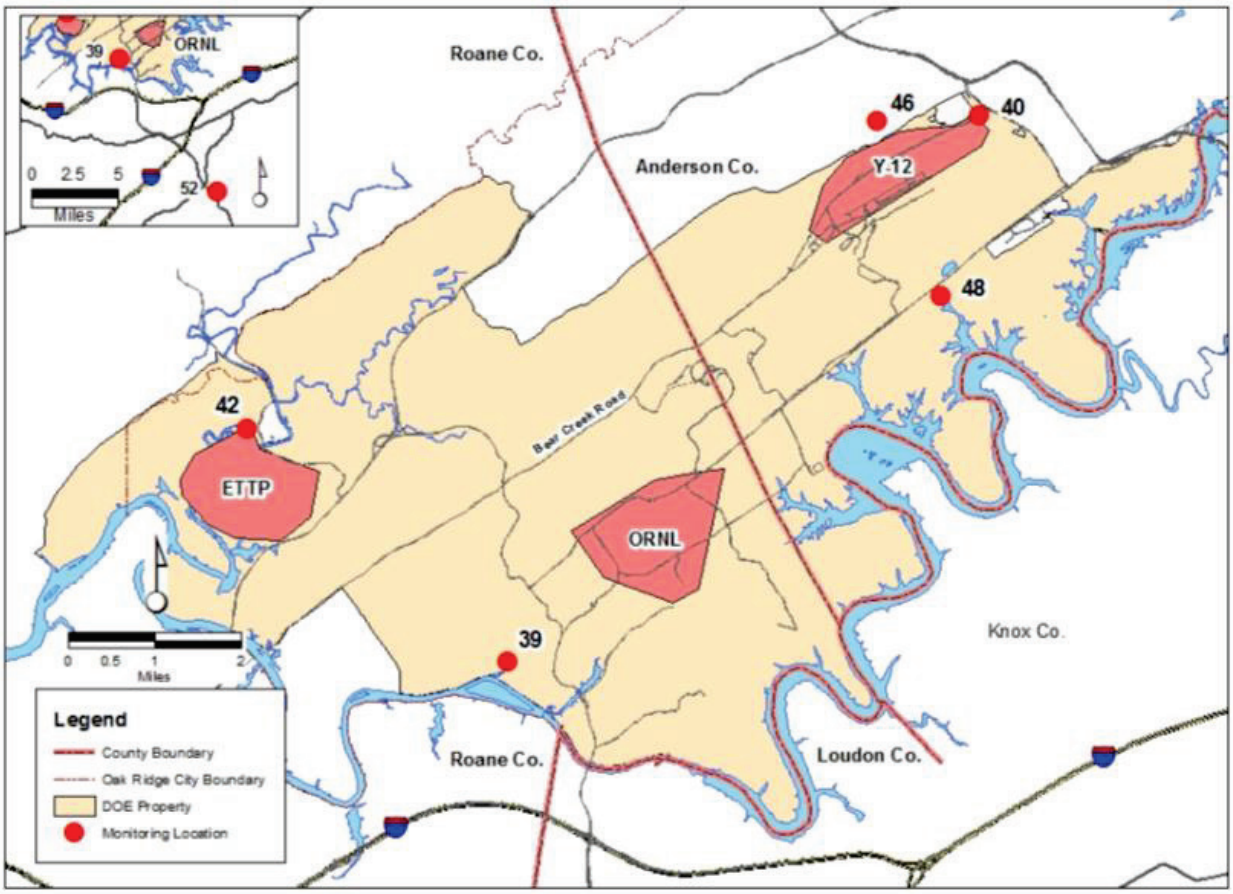

Fig. 6.2. External gamma radiation monitoring locations on the Oak Ridge Reservation.

6.2.2 Results

Table 6.2 summarizes the data collected at each station during the year. The mean observed exposure rate for the reservation network for 2011 was 8.2 μR/h, and the average at the reference location was 7.0 μR/h. Exposure rates from background sources in Tennessee range from 2.9 to 11 μR/h.

Table 6.2. External gamma (exposure rate) averages for the Oak Ridge Reservation, 2011

Monitoring location	Number of data values collected	Measurement (μR/h)[a]		
		Min	Max	Mean
39	51	0	10.0	9.0
40	52	7.7	9.6	8.2
42	52	6.3	8.2	7.5
46	52	8.3	9.4	8.8
48	52	6.9	9.8	7.6
52	52	6.6	7.5	7.0

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

6.3 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 (Fig. 6.3). Ambient air monitoring 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.

Fig. 6.3. Oak Ridge Reservation ambient air station.

Ambient air monitoring conducted by individual site programs is discussed in Chapters 3–5. An ORR ambient air monitoring program complements these individual site programs and permits the impacts of ORR operations to be assessed on an integrated basis. This program is discussed in detail in the following sections.

6.3.1 Oak Ridge Reservation 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. 6.4). Reference samples are collected from Station 52 (Fort Loudoun Dam). Sampling was conducted at each ORR station during 2011 to quantify levels of alpha-, beta-, and gamma-emitting radionuclides.

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 by high-volume air samples equipped with glass-fiber filters. The filters are collected weekly, composited quarterly, and then submitted to an analytical laboratory to quantify gross alpha and beta activity and to determine the concentrations of specific isotopes of interest on the ORR. The second system is designed to collect tritiated water vapor. The sampler consists of a prefilter followed by an adsorbent trap that contains indicating silica gel. The samples are collected weekly or biweekly, composited quarterly, and then submitted to an analytical laboratory for tritium analysis.

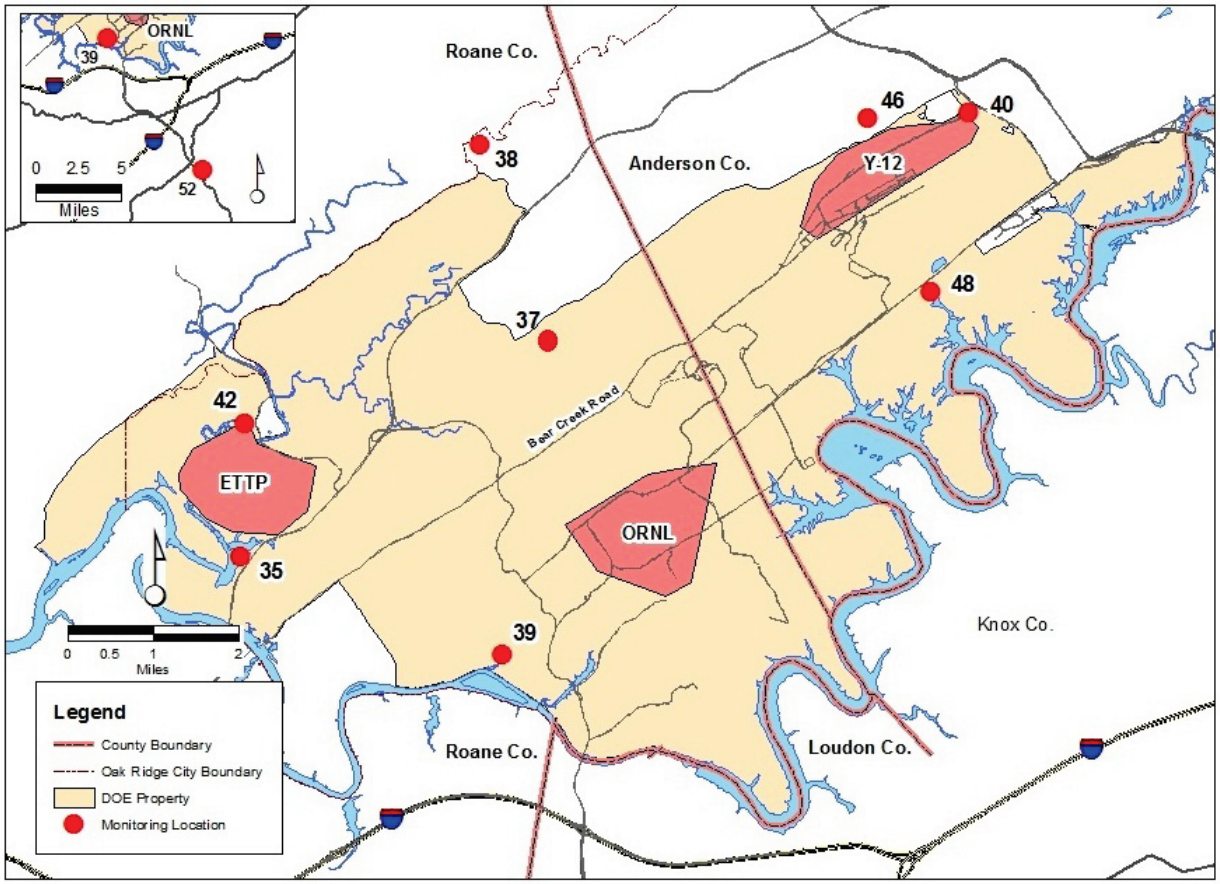

Fig. 6.4. Locations of Oak Ridge Reservation perimeter air monitoring stations.

6.3.2 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 DCSs for air established by DOE as guidelines for controlling exposure to members of the public. All radionuclide concentrations measured at the ORR ambient air stations during 2011 were less than 1% of applicable DCSs, indicating that activities on the reservation are not adversely affecting local air quality. 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 ^{7}Be or ^{40}K. The concentrations of ^{3}H, ^{234}U, ^{235}U, and ^{238}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 6.3. As shown in Table 6.3, small concentrations of ^{131}I and ^{137}Cs were detected in March and April 2011. These concentrations were consistent with levels detected by EPA across the United States following the March 2011 nuclear accident in Fukushima, Japan.

Table 6.3. Average radionuclide concentrations at Oak Ridge Reservation perimeter air monitoring stations, 2011

Parameter	N detected/N total	Concentration (pCi/mL)[a,b]		
		Average	Minimum	Maximum
		Station 35		
^{7}Be	4/4	3.25E-08	2.33E-08	4.13E-08
^{134}Cs	1/4	2.53E-11	0	1.01 E-10
^{131}I	1/4	[c]	[c]	3.81E-10
^{40}K	0/4	1.46E-10	-9.05E-10	8.07E-10
^{3}H	0/4	3.26E-06	8.84E-07	6.32E-06
^{234}U	4/4	1.33E-11	3.58E-12	2.55E-11
^{235}U	2/4	6.61E-13	6.86E-14	1.21E-12
^{238}U	4/4	3.51E-12	2.67E-12	4.94E-12
		Station 37		
^{7}Be	4/4	2.69E-08	2.30E-08	3.28E-08
^{134}Cs	1/4	[c]	[c]	8.54E-11
^{131}I	1/4	[c]	[c]	4.38E-10
^{40}K	0/4	-4.92E-11	-4.16E-10	4.36E-10
^{90}Sr	0/1	6.15E-12	6.15E-12	6.15E-12
^{3}H	0/4	2.68E-07	-1.67E-06	1.17E-06
^{234}U	4/4	3.90E-12	2.58E-12	4.61E-12
^{235}U	0/4	1.65E-13	1.36E-14	2.89E-13
^{238}U	3/4	1.42E-12	9.77E-13	1.85E-12
		Station 38		
^{7}Be	4/4	3.12E-08	2.37E-08	3.96E-08
^{134}Cs	1/4	[c]	[c]	8.72E-11
^{131}I	1/4	[c]	[c]	2.95E-10
^{40}K	0/4	-2.31 E-10	-6.87E-10	1.36E-10
^{3}H	0/4	1.26E-06	-1.11E-06	6.1 5E-06
^{234}U	4/4	3.52E-12	1.95E-12	5.53E-12
^{235}U	1/4	-5.66E-14	-6.79E-13	2.66E-13
^{238}U	4/4	2.32E-12	1.71 E-12	2.93E-12
		Station 39		
^{7}Be	4/4	2.91 E-08	2.21 E-08	3.58E-08
^{131}I	1/4	[c]	[c]	5.66E-10
^{40}K	0/4	-3.78E-10	-6.78E-10	-1.29E-10
^{3}H	0/4	1.90E-07	-1.39E-06	2.04E-06
^{234}U	4/4	2.78E-12	1.82E-12	4.40E-12
^{235}U	1/4	723E-14	-1A6E-13	189E-13
^{238}U	4/4	2.00E-12	1.23E-12	2.78E-12
		Station 40		
^{7}Be	4/4	2.96E-08	2.28E-08	3.43E-08
^{134}Cs	1/4	[c]	[c]	1.07E-10
^{131}I	1/4	[c]	[c]	2.64E-10
^{40}K	0/4	1.51E-10	-2.98E-10	9.08E-10
^{90}Sr	0/1	4.26E-12	426E-12	4.26E-12
^{3}H	0/4	1.53E-06	-723E-07	4.52E-06
^{234}U	4/4	145E-11	4.68E-12	2.20E-11

Table 6.3. (continued)

Parameter	N detected/N total	Concentration (pCi/mL)[a,b]		
		Average	Minimum	Maximum
^{235}U	2/4	6.53E-13	4.51E-13	7.82E-13
^{238}U	4/4	3.13E-12	1.60E-12	4.48E-12
		Station 42		
^{7}Be	4/4	3.26E-08	2.52E-08	4.11E-08
^{134}Cs	1/4	[c]	[c]	1.27E-10
^{137}Cs	1/4	[c]	[c]	9.43E-11
^{131}I	1/1	6.67E-10	6.67E-10	6.67E-10
^{40}K	0/4	5.04E-11	-3.87E-10	7.75E-10
^{3}H	0/4	3.42E-06	5.30E-07	7.77E-06
^{234}U	4/4	9.38E-12	4.25E-12	1.49E-11
^{235}U	3/4	7.49E-13	2.97E-13	1.02E-12
^{238}U	4/4	3.68E-12	2.34E-12	6.44E-12
		Station 46		
^{7}Be	4/4	3.69E-08	150E-08	4.45E-08
^{134}Cs	1/4	[c]	[c]	1.54E-10
^{137}Cs	1/4	[c]	[c]	1.01E-10
^{131}I	1/1	8.44E-10	8.44E-10	8.44E-10
^{40}K	1/4	2.49E-10	-5.05E-10	1.14E-09
^{3}H	0/4	2.82E-06	-1.08E-07	6.61E-06
^{234}U	4/4	7.68E-12	6.38E-12	9.62E-12
^{235}U	1/4	3.23E-13	-540E-14	7.32E-13
^{238}U	4/4	3.39E-12	2.30E-12	4.68E-12
		Station 48		
^{7}Be	4/4	3.36E-08	2.17E-08	4.18E-08
^{134}Cs	1/4	[c]	[c]	6.97E-11
^{131}I	1/4	[c]	[c]	4.47E-10
^{40}K	0/4	-7.97E-11	-3.34E-10	8.21E11
^{90}Sr	0/1	&21E-12	821E-12	821E-12
^{3}H	0/4	2.26E-06	9.78E-07	4.63E-06
^{234}U	4/4	3.20E-12	2.10E-12	4.39E-12
^{235}U	0/4	1.01 E-13	641E-14	1.45E-13
^{238}U	4/4	3.22E-12	2.28E-12	5.47E-12
		Station 52		
^{7}Be	4/4	3.87E-08	2.52E-08	5.27E-08
^{134}Cs	2/2	[c]	[c]	1.53E-10
^{131}I	1/4	[c]	[c]	2.97E-10
^{40}K	0/4	-1.17E-10	-5.43E-10	6.35E-10
^{3}H	0/4	9.26E-07	-1.62E-06	3.25E-06
^{234}U	4/4	3.55E-12	1.59E-12	6.44E-12
^{235}U	0/4	3.06E-13	-2.58E-14	6.40E-13
^{238}U	4/4	3.44E-12	1.43E-12	6.02E-12

[a]Units are picocuries per milliliter.

[b]Radiological results are reported after background activity has been subtracted. In cases where background activity exceeds the sample activity, negative values will result.

[c]Parameter detected in one or more of four quarterly analyses for gamma emitters. When parameter is not detected, no result is provided by the analytical test; therefore, average and minimum values are not reported.

6.4 Surface Water Monitoring

6.4.1 Oak Ridge Reservation Surface Water Monitoring

The ORR surface water monitoring program consists of sample collection and analysis from five locations on the Clinch River, including public water intakes (Fig. 6.5). This program is conducted in conjunction with site-specific surface water monitoring activities to enable an assessment of the impacts of past and current DOE operations on the quality of local surface water.

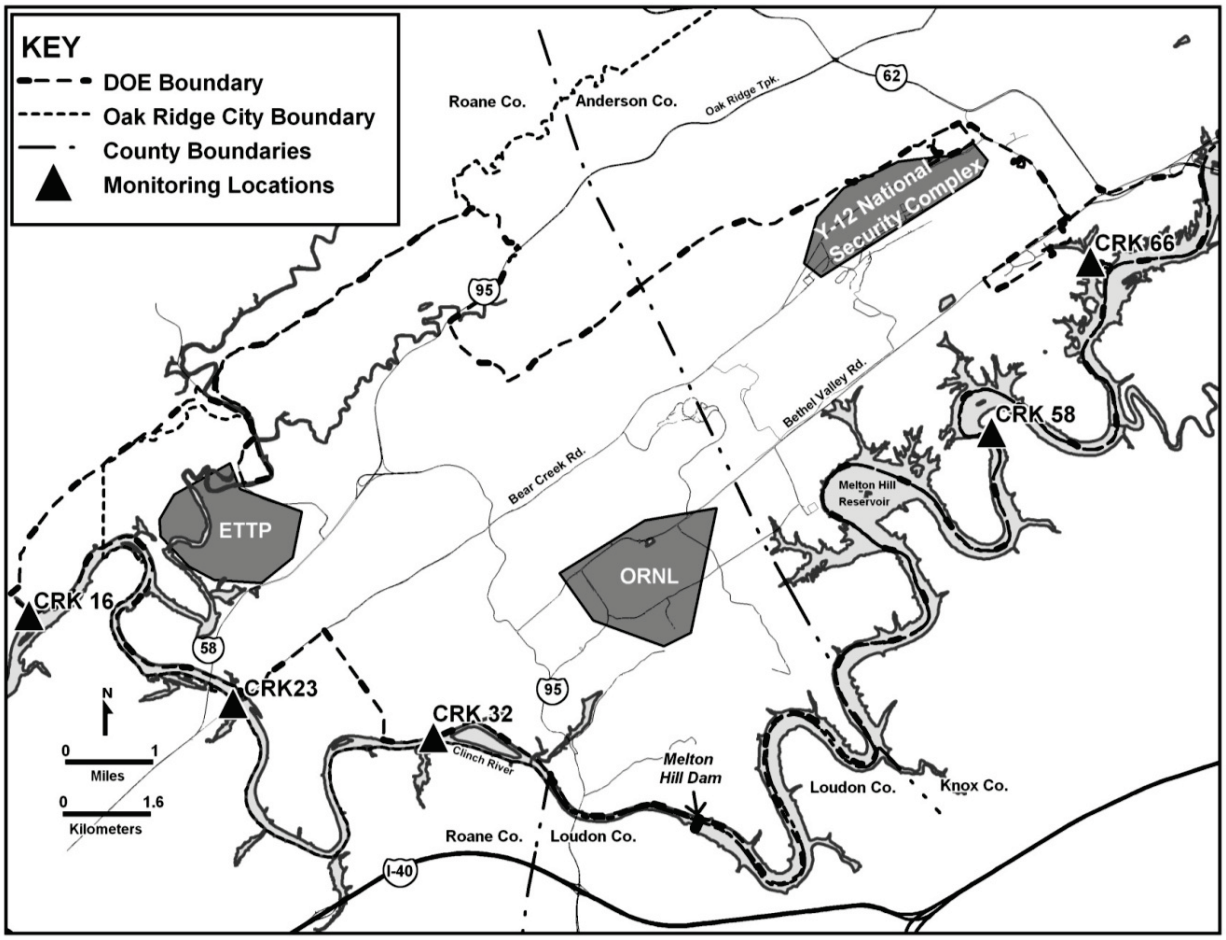

Fig. 6.5. Oak Ridge Reservation surface water surveillance sampling locations.

Grab samples are collected quarterly at all five locations and are analyzed for general water quality parameters, screened for radioactivity, and analyzed for mercury and specific radionuclides when appropriate. Table 6.4 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 WQC associated with these classifications are used as references where applicable (TDEC 2008). The Tennessee WQC do not include criteria for radionuclides. Four percent of the DOE DCS is used for radionuclide comparison because this value is roughly equivalent to the 4 mrem dose limit from ingestion of drinking water on which the EPA radionuclide drinking water standards are based.

Table 6.4. Oak Ridge Reservation surface water sampling locations, frequencies, and parameters, 2011

Location[a]	Description	Frequency	Parameters
CRK 16	Clinch River downstream from all DOE ORR inputs	Quarterly	Mercury, gross alpha, gross beta, gamma scan, ^{3}H, field measurements[b]
CRK 23	Water supply intake for the ETTP	Quarterly	Mercury, gross alpha, gross beta, gamma scan, ^{3}H, field measurements[b]
CRK 32	Clinch River downstream from ORNL	Quarterly	Gross alpha, gross beta, gamma scan, total radioactive strontium, ^{3}H, field measurements[b]
CRK 58	Water supply intake for Knox County	Quarterly	Gross alpha, gross beta, gamma scan, ^{3}H, field measurements[b]
CRK 66	Melton Hill Reservoir above city of Oak Ridge water intake	Quarterly	Mercury, gross alpha, gross beta, gamma scan, total radioactive strontium, ^{3}H, field measurements[b]

[a]Locations indicate bodies of water and distances (e.g., Clinch River kilometer 16 is 16 km upstream from the confluence of the Clinch River with the Tennessee River, Watts Bar Reservoir).

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

Abbreviations

CRK = Clinch River kilometer
DOE = US Department of Energy
ETTP = East Tennessee Technology Park
ORNL = Oak Ridge National Laboratory
ORR = Oak Ridge Reservation

6.4.2 Results

A comparison of 2011 sampling results for surface water collected upstream of DOE inputs and for that collected downstream of DOE inputs shows no statistically significant difference for any of the radionuclides; none of the radionuclides at any location were detected above 4% of the respective DCS or the 4 mrem dose limit, which is the MCL for beta and photon emitters in community drinking water systems (CFR 2005). There were no mercury detections above MCLs at any of the three designated sampling locations.

6.5 Food

Vegetation samples are collected from areas that could be affected by activities on the reservation. The samples are analyzed to evaluate the potential radiation doses that could be received by people who consume local food crops. Food crop monitoring data are also used to monitor trends in environmental contamination and possible long-term accumulation of radionuclides.

6.5.1 Vegetables

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

6.5.1.1 Results

Samples were analyzed for gross alpha, gross beta, gamma emitters, and uranium isotopes. No gamma-emitting radionuclides were detected above MDA, with the exception of the naturally occurring radionuclides ^{7}Be and ^{40}K. Concentrations of radionuclides detected above MDA are shown in Table 6.5.

Table 6.5. Concentrations of radionuclides detected in vegetables, 2011 (pCi/kg)[a]

Location	Gross alpha	Gross beta	^{7}Be	^{40}K	^{234}U	^{235}U	^{238}U
			Lettuce				
East of ORR (Claxton vicinity)	0.000041	0.0032	*b*	0.0037	*b*	*b*	*B*
North of ETTP	0.00012	0.0046	*b*	0.0053	*b*	*b*	*B*
Northeast of Y-12 Complex, Scarboro #2	0.000041	0.0030	*b*	0.0041	*b*	*b*	*B*
Southwest of ORNL, Lenoir City #1	0.000045	0.0042	*b*	0.0056	0.0000086	*b*	0.0000064
Southwest of ORNL, Lenoir City #2	0.000065	0.0047	*b*	0.0054	*b*	*b*	*B*
Reference location, Maryville	0.000174	0.0033	*b*	0.0035	*b*	*b*	*B*
			Tomato				
East of ORR (Claxton vicinity)	*b*	0.00084	*b*	*b*	*b*	*b*	*B*
North of ETTP	*b*	0.00072	*b*	0.0030	*b*	*b*	*B*
Northeast of Y-12, Scarboro #2	*b*	0.00036	*b*	0.0019	*b*	*b*	*B*
Southwest of ORNL, Lenoir City #1	0.00012	0.00083	*b*	*b*	*b*	*b*	*B*
Southwest of ORNL, Lenoir City #2	0.000023	0.00060	*b*	*b*	*b*	*b*	*B*
Reference location, Maryville	*b*	0.00038	*b*	*b*	*b*	*b*	*B*
			Turnips				
East of ORR (Claxton vicinity)	*b*	0.0011	*b*	0.0030	*b*	*b*	*B*
North of ETTP	*b*	0.00090	*b*	*b*	*b*	*b*	*B*
Northeast of Y-12, Scarboro #2	*b*	0.00086	*b*	0.0019	*b*	*b*	*B*
Southwest of ORNL, Lenoir City #1	*b*	0.0009	*b*	0.0028	*b*	*b*	0.0000035
Southwest of ORNL, Lenoir City #2	0.000017	0.00079	*b*	*b*	*b*	*b*	*B*
Reference location, Maryville	*b*	0.00062	*b*	*b*	*b*	*b*	*B*

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

Abbreviations
ETTP = East Tennessee Technology Park
ORNL = Oak Ridge National Laboratory
ORR = Oak Ridge Reservation
Y-12 Complex = Y-12 National Security Complex

6.5.2 Milk

Radionuclides can be transferred from the environment to people via such food chains 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 on which a cow can graze daily, the rapid transfer of milk from producer to consumer, and the importance of milk in the diet.

The 2011 milk sampling program consisted of grab samples collected every other month from a dairy in Claxton and one reference location in Maryville (Fig. 6.6). 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 tritium.

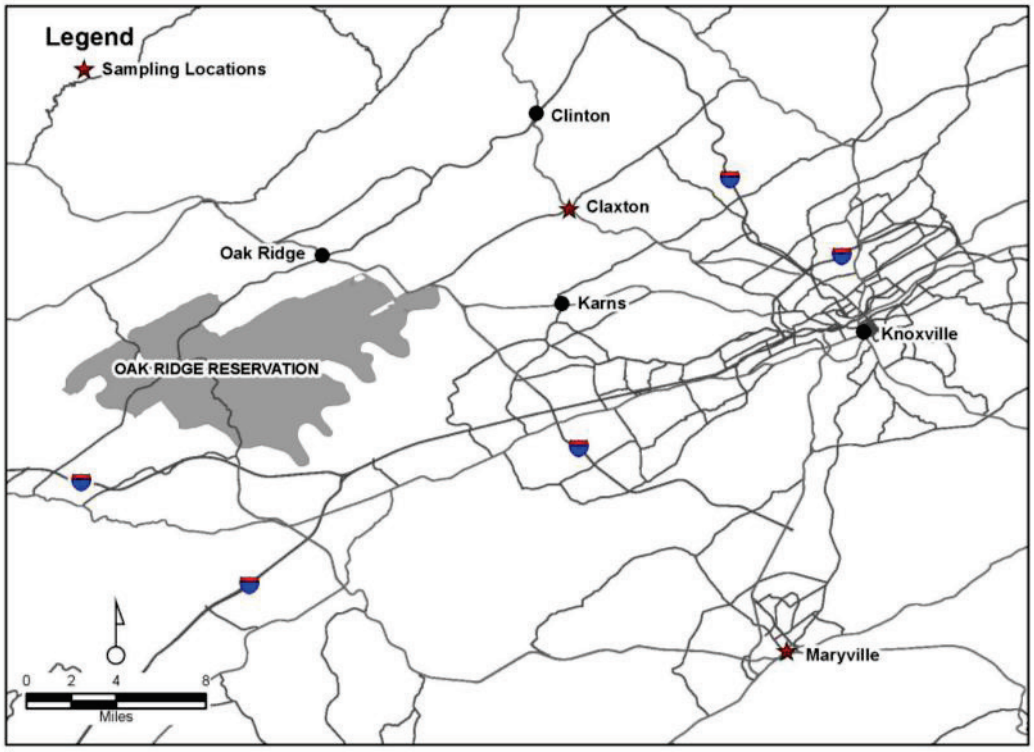

Fig. 6.6. Milk sampling locations in the vicinity of the Oak Ridge Reservation.

6.5.2.1 Results

Concentrations of radionuclides detected above MDA in milk are presented in Table 6.6.

Table 6.6. Concentration of radionuclides detected in raw milk, 2011

Analysis	No. detected/ no. total	Detected concentration (pCi/L)[a]			Standard error of mean
		Max	Min	Avg	
		Claxton			
Potassium-40	6/6	1,500[b]	1,000[b]	1,300[b]	66
Total rad Sr	2/6	2.6[b]	1.1[b]	1.8[b]	0.24
		Reference location			
Potassium-40	6/6	1,500[b]	1,200[b]	1,300[b]	52
Total rad Sr	1/6	3.0[b]	0.53	1.5[b]	0.35

[a]Detected radionuclides are those above minimum detectable activity.
1 pCi = 3.7×10^{12} Bq.

[b]Individual and average concentrations significantly greater than zero at the 95% confidence level.

6.6 Fish

Members of the public could be exposed to contaminants originating from DOE ORR activities through consumption of fish caught in area waters. This potential exposure pathway is monitored by annually collecting fish from three locations on the Clinch River and analyzing edible fish flesh for specific contaminants. The locations are as follows (Fig. 6.7):

- 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).

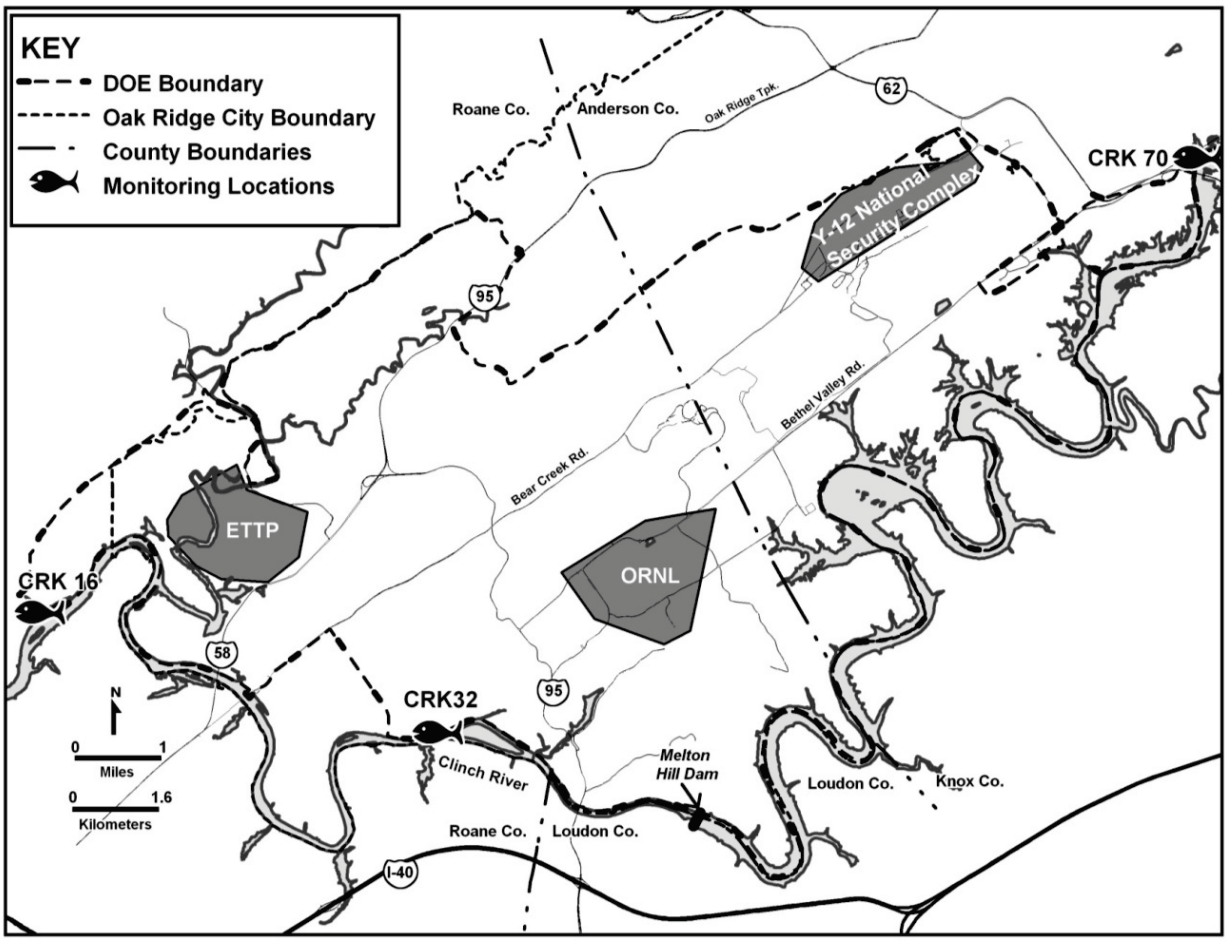

Fig. 6.7. Fish sampling locations for the Oak Ridge Reservation Surveillance Program.

Sunfish (*Lepomis macrochirus*, *L. auritus*, and *Ambloplites rupestris*) and catfish (*Ictalurus punctatus*) are collected from each of the three locations to represent both top-feeding and bottom-feeding-predator species. In 2011, a composite sample of each of these species at each location was analyzed for selected metals, PCBs, tritium, gross alpha, gross beta, gamma-emitting radionuclides, and total radioactive strontium. To accurately estimate exposure levels to consumers, only edible portions of the fish were submitted for analysis.

It should be noted that TDEC issues advisories on consumption of certain fish species caught in specified Tennessee waters. These advisories apply to fish that could contain potentially hazardous contaminants. A "do not consume" advisory has been issued by TDEC for catfish in the Melton Hill Reservoir in its entirety, not just in those areas that could be impacted by ORR activities, because of PCB contamination. Similarly, a precautionary advisory for catfish in the Clinch River arm of Watts Bar Reservoir has been issued because of PCB contamination (TDEC 2008).

6.6.1 Results

Detected PCBs, mercury, and radionuclides are shown in Table 6.7.

Table 6.7. Tissue concentrations in catfish and sunfish for mercury, detected PCBs, and detected radionuclides, 2011[a]

Parameter	Catfish[b]	Sunfish[b]
Clinch River downstream from all DOE ORR inputs (CRK 16)		
Metals (mg/kg)		
Mercury	0.046	0.14
Pesticides and PCBs (µg/kg)		
PCB-1260	240	50
Radionuclides (pCi/g)[c]		
Alpha activity	0.028[c]	0.052[c]
Beta activity	2.5[c]	2.3[c]
Potassium-40	1.7[c]	3.3[c]
Clinch River downstream from ORNL (CRK 32)		
Metals (mg/kg)		
Mercury	0.043	0.041
Pesticides and PCBs (µg/kg)		
PCB-1254	89	U20
PCB-1260	130	49
Radionuclides (pCi/g)[c]		
Alpha activity	0.000027	0.09[c]
Beta activity	2.7[c]	2.6[c]
Potassium-40	3.9[c]	4.1[c]
Strontium-90	0.028[c]	0.11[c]
Tritium	-0.28	6.1[c]
Clinch River (Solway Bridge) upstream from all DOE ORR inputs (CRK 70)		
Metals (mg/kg)		
Mercury	0.052	0.047
Pesticides and PCBs (µg/kg)		
PCB-1260	200	50
Radionuclides (pCi/g)[c]		
Beta activity	2.5[c]	2.6[c]
Potassium-40	3.0[c]	4.4[c]
Strontium-90	0.071[c]	0.019[c]

[a]Only parameters that were detected for at least one species are listed in the table. The sampling and analysis plan contains a complete list of analyses performed.

[b]Prefix "U" indicates that the value was undetected at the analytical detection limit.

[c]Radionuclide concentrations were significantly greater than zero. Detected radionuclides are at or above the MDA.

[d]Radiological results are reported after background activity has been subtracted. Negative values are reported when background activity exceeds sample activity.

Abbreviations

CRK = Clinch River kilometer
DOE = US Department of Energy
MDA = minimum detectable activity
ORNL = Oak Ridge National Laboratory
ORR = Oak Ridge Reservation
PCB = polychlorinated biphenyl

PCBs and mercury were detected in both sunfish and catfish at all three locations in 2011. Aroclor-1260 was detected in both species at all locations; Aroclor-1254 was observed only in catfish from CRK 32. These results are consistent with the TDEC advisories discussed above.

Radiological analyses for fish tissues sampled in 2011 showed few statistical differences (at the 95% confidence level) between the upstream and downstream locations, indicating that DOE activities on ORR are not significant contributors to the public radiological dose from fish consumption.

6.7 White-Tailed Deer

Three deer hunts were held on ORR during the final quarter of 2011. ORNL staff, Tennessee Wildlife Resources Agency (TWRA) personnel, and student members of the Wildlife Society (University of Tennessee chapter) performed most of the necessary operations at the checking station.

The 2011 hunts were held on three weekends. Shotgun/muzzleloader and archery hunts were held October 22–23, November 12–13, and December 10–11. In 2011 there were about 450 shotgun-/ muzzleloader–permitted hunters and 675 archery-permitted hunters. Areas adjacent to the Tower Shielding facility, Park City Road and Chestnut Ridge, and Poplar Creek Road were opened for an archery-only hunt on all three weekends. There was a two-deer limit for the November and December hunts; one could be an antlered buck.

The year's total harvest was 321 deer. From the total deer harvest, 177 (55.1%) were bucks and 144 (44.9%) were does. The heaviest buck had 12 antler points and weighed 183 lb. The greatest number of antler points found on one buck was 22. The heaviest doe weighed 127 lb.

Since 1985 11,377 deer have been harvested. Of these, only 203 (1.8%) have been retained as a result of potential radiological contamination. The heaviest buck was 218 lb (harvested in 1998); the average weight is 85.9 lb. The oldest deer harvested was 12 years old; the average age is 2.0 years. For more information, see http://www.ornl.gov/sci/rmal/huntinfo.htm.

6.7.1 Results

The wildlife administrative release limits associated with deer, turkey, and geese harvested on the ORR are conservative and were established based on as-low-as-reasonably-achievable (ALARA) principles to ensure that doses to consumers of wildlife harvested on the reservation are managed and controlled to levels well below regulatory dose thresholds. The ALARA concept is not a dose limit but rather a philosophy that has the objective of maintaining exposures to workers, members of the public, and the environment below regulatory limits. The administrative release limit of 5 pCi/g for ^{137}Cs is based on the assumption that one person consumes all of the meat from a maximum-weight deer, goose, or turkey. This limit ensures that members of the public who harvest wildlife on the reservation will not receive significant radionuclide doses from this consumption pathway. Similarly, the gross beta count administrative limit of 2.5 times background is near the detection limit for field measurements.

During the 2011 hunts, 321 deer were harvested on the ORR, and three (0.93%) 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 87 lb; the maximum weight was 183 lb. The average ^{137}Cs concentration in the released deer was 0.54 pCi/g; however, many of the ^{137}Cs concentrations were less than the minimum detection level. The maximum ^{137}Cs concentration in the released deer was 0.98 pCi/g.

The total field-dressed weight of the released deer was 27,654 lb. It is assumed that 55% of the field weight is edible meat; therefore, the total harvest of edible meat (321 released deer) is estimated to be 15,210 lb.

6.8 Fowl

6.8.1 Waterfowl Surveys—Canada Geese

The consumption of Canada geese is a potential pathway for exposure of members of the public to radionuclides released from ORR operations because open hunts for Canada geese are held each year on ORR and in counties adjacent to the reservation. To determine concentrations of gamma-emitting radionuclides accumulated by waterfowl that feed and live on ORR, Canada geese are rounded up each summer for noninvasive gross radiological surveys.

From the roundup in 2011, 49 geese were subjected to live whole-body gamma scans. The geese were collected from ORNL (4), Y-12 (10), and Clark Center Park (35). None exceeded the administrative release limits.

The 5 pCi/g administrative release limit that is applied to deer is also applied to geese. This limit assumes that one person consumes all of the meat from a maximum-weight goose. The administrative limits were established to keep doses ALARA and to provide consistent standards for releasing harvested wildlife.

6.8.1.1 Results

The average ^{137}Cs concentration in the released geese was about 0.18 pCi/g. However, most of the ^{137}Cs concentrations were less than the minimum detection level. The maximum ^{137}Cs concentration in the released geese was about 0.45 pCi/g. The average weight of the geese screened during the roundup was 8.7 lb, and the maximum goose weight was 11.2 lb. No geese were sacrificed for radiological analyses in 2011.

6.8.2 Turkey Monitoring

Three wild turkey hunts managed by DOE and TWRA were held on the reservation (April 9 and 10, April 16 and 17, and November 22 and 23, 2011). Hunting was open for both shotguns and archery. Sixty-two turkeys were harvested, of which 11 (18%) were juveniles and 51 (82%) were adults. The average turkey weight was about 18.3 lb. The largest tom weighed 23.1 lb. The longest beard was 13 inches, and the average was 8.5 inches. The longest spur was 1.3 in., and the average was 0.8 in.

Since 1997, 664 turkeys have been harvested. Of these, only three (0.5%) have been retained because of potential radiological contamination. The heaviest turkey was 25.7 lb; the average weight is 18.8 lb. The longest spur on a 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.). For additional information, see http://www.ornl.gov/rmal/huntinfo.htm.

The 5 pCi/g administrative release limit that is applied to deer and geese is also applied to turkey. This limit assumes that one person consumes all of the meat from a maximum-weight turkey. The administrative limits were established to keep doses ALARA and to provide consistent standards for releasing harvested wildlife.

6.8.2.1 Results

In 2011, none of the 62 turkeys harvested 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 turkeys was 0.2 pCi/g. Most of the ^{137}Cs concentrations were less than the minimum detection level. It is assumed that about 50% of the field weight is edible meat; therefore, the average turkey would yield about 9.2 lb of meat. Based on the individual weights, the total harvest of edible meat (62 released turkeys) is estimated to be about 568 lb. No turkeys were sacrificed for radiological analyses in 2011.

6.9 Quality Assurance

The activities associated with administration, sampling, data management, and reporting for the ORR environmental surveillance programs are performed by the UT-Battelle Environmental Protection and Waste Services Division. Project scope is established by a task team whose members represent DOE, UT-Battelle, B&W Y-12, and UCOR. UT-Battelle integrates quality assurance, environmental, and safety considerations into every aspect of ORR environmental monitoring. (See Section 5.8 for a discussion of UT-Battelle quality assurance program elements for environmental monitoring and surveillance activities.)

6.10 References

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