6. Oak Ridge Reservation Environmental Monitoring Program

Environmental monitoring is performed on ORR to measure radiological and nonradiological parameters directly in environmental media adjacent to the facilities. Data from the 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.

Due to different permit reporting requirements and instrument capabilities, this report uses various units of measurement. The lists of units of measure and conversion factors on pages xxvii and xxviii are included to help readers convert numeric values presented herein as needed for specific calculations and comparisons.

6.1 Meteorological Monitoring

Ten meteorological towers provide data on meteorological conditions and on the transport and diffusion qualities of the atmosphere on 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 actual accidental releases from a facility. Data from the towers are also used to support various research and engineering projects.

6.1.1 Data Collection and Analysis

The 10 meteorological towers on ORR are described in Table 6.1 and are depicted in Figure 6.1. In this document, the individual ORR-managed towers are designated by "MT" followed by a numeral. Other commonly used names for these sites are also provided in Table 6.1. Meteorological data are collected at different levels above the ground (2, 10, 15, 30, 33, 35, and 60 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 and 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 or 15 m level at most towers, but the wind measurement height is 25 m for MT11 and 20 m for MT13. Data are collected at some towers at 30, 33, 35, and 60 m levels. Temperature, relative humidity, and precipitation are measured at some sites at 2 m, but wind speed and wind direction typically are not. Atmospheric stability (a measure of the vertical mixing properties of the atmosphere) is measured at most towers; however, measurements involving vertical temperature profiles (i.e., measurements made by the solar radiation delta-T method) limit accurate determination of nighttime stability to the 60 m towers. Stability is also calculated for most sites using the sigma phi method, which relies heavily on the measurement of the standard deviation of vertical wind speed using three-dimensional sonic wind monitors. Barometric pressure is measured at one or more of the towers at each ORR plant (MT2, MT4, MT6, MT7, MT9, MT12, and MT13). Precipitation is measured at MT6 and MT9 at the Y-12 Complex; at MT7 and MT13 at ETTP; and at MT2, MT3, MT4, and MT12 at ORNL. Solar radiation is measured at MT6 and MT9 at the Y-12 Complex, MT7 at ETTP, and at MT2 and MT12 at ORNL. Instrument calibrations are managed by UT-Battelle and are performed every 6 months by an independent auditor (Holian Environmental).

Table 6.1. Oak Ridge Reservation meteorological towers

Tower	Alternate tower names	Location (lat., long.)	Altitude (m above MSL)	Measurement heights (m)
		ETTP		
MT7	L, 1209	35.92522N, -84.39414W	233	2, 15, 30
MT13	J, YEOC	35.93043N, -84.39346W	237	20
		ORNL		
MT2	D,[a] 1047	35.92559N, -84.32379W	261	2, 15, 35, 60
MT3	B, 6555	35.93273N, -84.30254W	256	15, 30
MT4	A, 7571	35.92185N, -84.30470W	266	15, 30
MT10	M, 208A	35.90947N, -84.38796W	244	10
MT12	F	35.95285N, -84.30314W	354	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	35.98190N, -84.25504W	352	25

[a] Tower "C" before May 2014.

Acronyms:
ETTP = East Tennessee Technology Park
MSL = mean sea level
ORNL = Oak Ridge National Laboratory
PSS = plant shift superintendent
Y-12 Complex = Y-12 National Security Complex
YEOC = Y-12 Complex Emergency Operations Center

Sonic detection and ranging (SODAR) devices have been installed at the east end of the Y-12 Complex and adjacent to Tower MT2 at ORNL. The SODAR devices use acoustic waves to estimate wind direction, wind speed, and turbulence at altitudes higher than the reach of meteorological towers (40 m up to 800 m above ground level). Although SODAR measurements are somewhat less accurate than measurements made on the meteorological towers, the SODAR devices provide useful information regarding stability, upper air winds, 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 could potentially be mixed by turbulence within 1 h or less.

Meteorological data are collected in real time for 1 min, 15 min, and hourly average intervals for emergency response purposes and for 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 as invalid and are excluded from compliance modeling. Appropriate substitution data are identified when possible. Quality assurance records of missing and erroneous data are routinely kept for the 10 ORR towers.

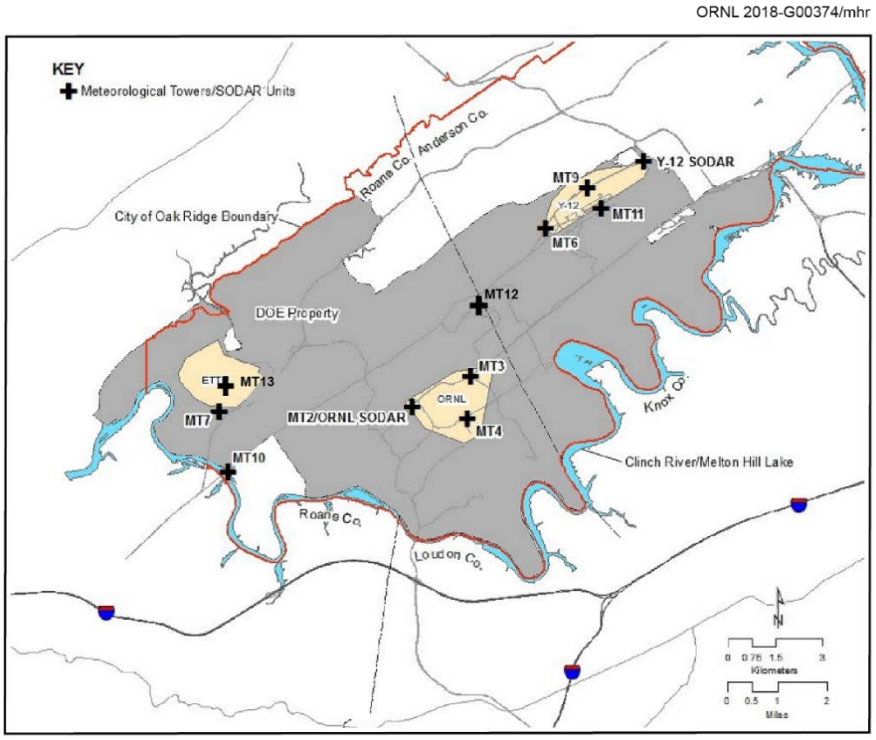


Figure 6.1. The Oak Ridge Reservation meteorological monitoring network, including sonic detection and ranging (SODAR) devices

6.1.2 Results

Prevailing winds are generally up-valley from the southwest and west-southwest or down-valley from the northeast and east-northeast, a pattern that typically results from channeling effects produced by the parallel ridges flanking ORR sites. Winds in the valleys tend to follow the ridge axes, limiting cross-ridge flow within local valley bottoms. These conditions dominate over most of ORR, but flow variation is greater at ETTP, which is located within a less-constrained open valley bottom.

On ORR, low wind speeds dominate near the valley surfaces, largely because of the decelerating influence of nearby ridges and mountains. Wind acceleration sometimes is observed at ridgetop level, particularly when flow is not parallel to the ridges (see Appendix B).

The atmosphere over ORR is often dominated by stable conditions at night and for a few hours after sunrise. These conditions, when coupled with low wind speeds and channeling effects in the valleys, result in poor dilution of emissions from the facilities. However, high roughness values (caused by terrain and obstructions such as trees and buildings) may significantly mitigate these factors through an increase in turbulence (atmospheric mixing). These features are captured in dispersion model data input and are reflected in 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 frequent air mass thunderstorms. The total precipitation at ORNL during 2019 (1,846.4 mm or 72.93 in.) was almost 40 percent above the long-term average of 1,337.5 mm (52.64 in.). The average annual wind data recovery rates (a measure of acceptable data) across locations used for modeling during 2019 were greater

than 99.6 percent for wind sensors at ORNL sites MT2, MT3, MT4, MT10, and MT12. Annual wind data recovery from Y-12 meteorological towers during 2019 exceeded 99.8 percent (towers MT6, MT9, and MT11). At ETTP, annual wind data recovery exceeded 98.8%.

6.2 External Gamma Radiation Monitoring

6.2.1 Data Collection and Analysis

External gamma exposure rates are continuously recorded by dual-range Geiger-Müller tube detectors co-located with ORR ambient air stations. Figure 6.2 shows locations that were monitored during 2019, and Table 6.2 summarizes the data for each station.

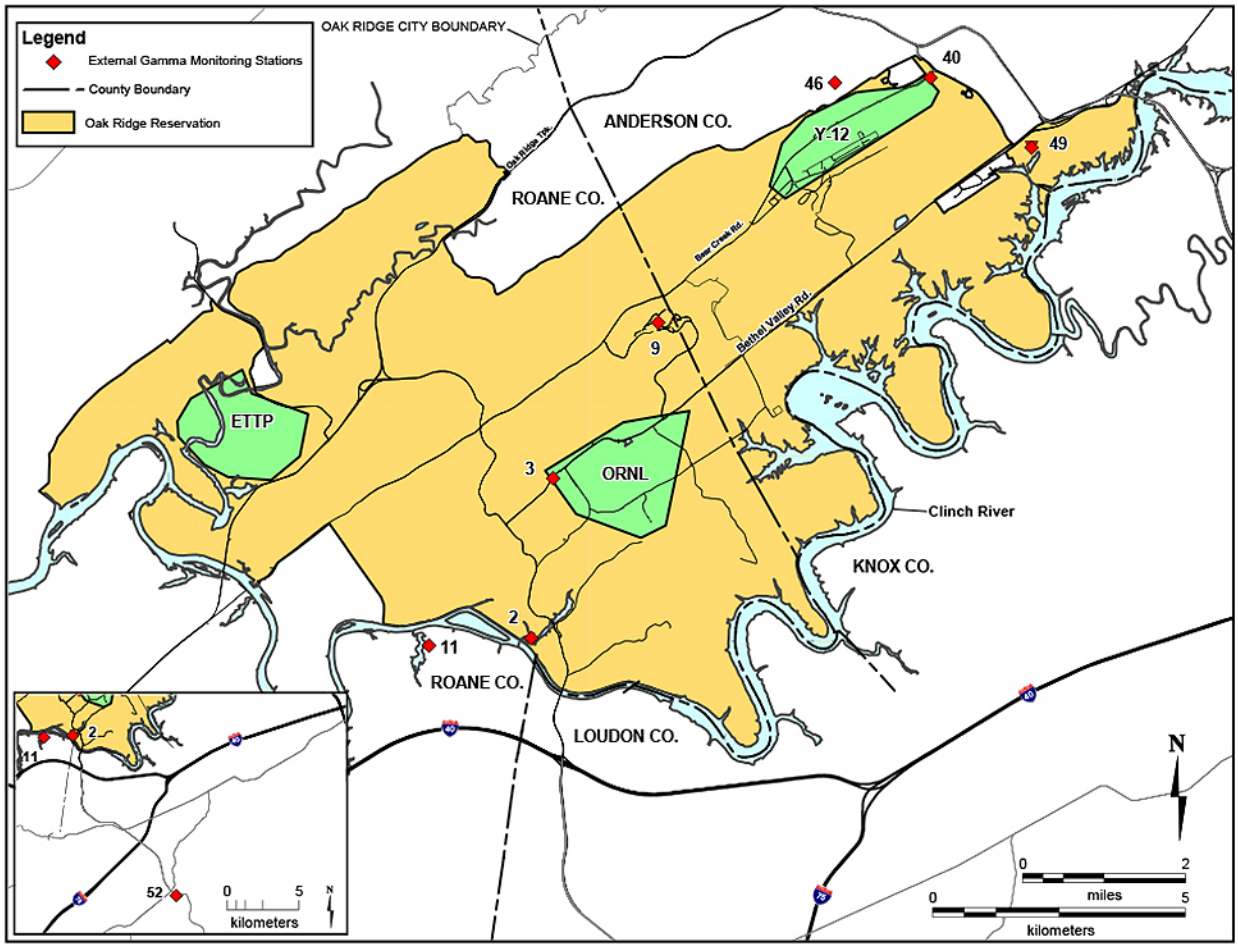


Figure 6.2. External gamma radiation monitoring locations on the Oak Ridge Reservation

6.2.2 Results

The mean exposure rate for the reservation network in 2019 was 9.9 µR/h, and the mean rate at the reference location was 9.1 µR/h. Background direct radiation exposure rates have been collected at an off-site location for many years. From 2009 through 2018 (the preceding 10 years), the exposure rates at the background off-site location ranged from 5.6 to 11.4 µR/h. The average exposure rate for the ORR network for those years was 7.9 µR/h (rounded to 8 µR/h).

Table 6.2. External gamma (exposure rate) averages for the Oak Ridge Reservation, 2019

Monitoring location	Number of data points (daily)	Measurement (μR/h)[a]		
		Min	Max	Mean
02	323	8.5	10.6	9.2
03	354	8.9	10.6	9.4
09	361	8.7	12.5	9.4
11	365	10.0	12.0	10.7
40	364	9.2	11.4	10.0
46	347	10.0	12.1	10.8
49	363	9.1	11.2	9.7
52	361	8.5	10.6	9.1

[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 ORR installations (see chapters 3, 4, and 5), ambient air monitoring is performed to measure radiological parameters directly in the ambient air adjacent to the facilities (Figure 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.

Figure 6.3. Oak Ridge Reservation ambient air station

6.3.1 Data Collection and Analysis

Ambient air monitoring conducted by individual site programs is discussed in chapters 3, 4, and 5. The ORR ambient air monitoring program complements the individual site programs and permits the impacts of ORR operations to be assessed on an integrated basis.

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 ORR. The perimeter air monitoring network was established in the early 1990s. Since then

there have been significant operational changes on ORR (e.g., addition of Spallation Neutron Source and Transuranic Waste Processing Center operations and shutdown of the Toxic Substances Control Act Incinerator), and significant cleanup and remediation projects have been completed. The network was modified in 2016 to better reflect current DOE activities and operations. The stations monitored in 2019 are shown in Figure 6.4. Reference samples are collected from Station 52 (Fort Loudoun Dam). Sampling was conducted at each ORR station during 2019 to quantify levels of alpha-, beta-, and gamma-emitting radionuclides.

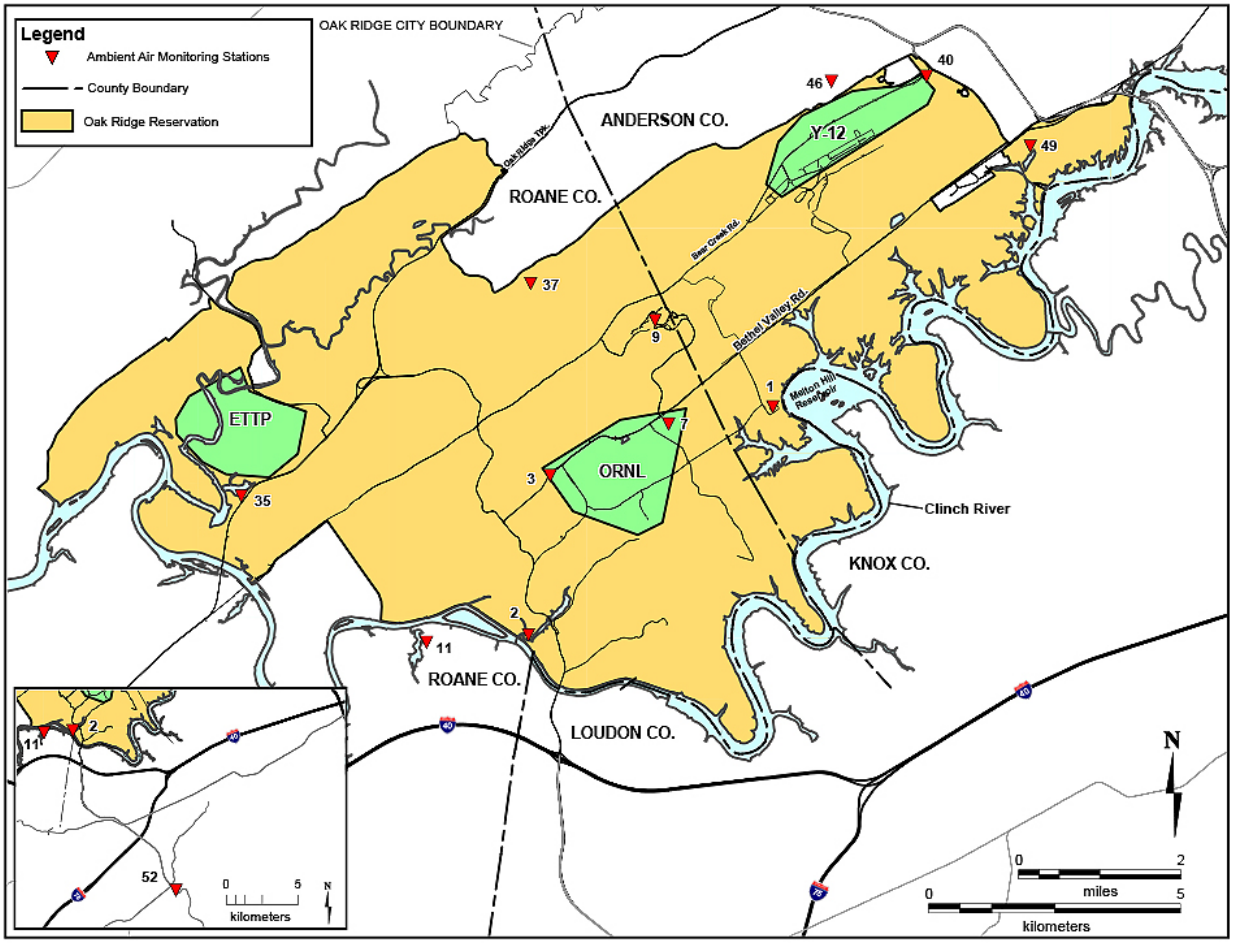


Figure 6.4. Locations of Oak Ridge Reservation perimeter air monitoring stations

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 near 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 samplers 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 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.

6.3.2 Results

Data from the ORR ambient air network are analyzed to assess the impact of DOE operations on the local air quality. Each measured radionuclide concentration (Table 6.3) is compared with derived concentration standards (DCSs) for air established by DOE as guidelines for controlling exposure to members of the public (DOE 2011). All radionuclide concentrations measured at the ORR ambient air stations during 2019 were less than 1 percent of applicable DCSs.

Table 6.3. Radionuclide concentrations at Oak Ridge Reservation perimeter air monitoring stations, 2019

Parameter	N detected/N total	Concentration (pCi/mL)[a]		
		Average	Minimum	Maximum
		Station 1		
^{7}Be	4/4	4.90E-08	2.55E-08	8.27E-08
^{40}K	0/4	-4.79E-10[b]	-1.11E-09[b]	-1.95E-11[b]
Tritium	0/4	5.46E-06	3.00E-06	6.96E-06
^{234}U	4/4	2.21E-12	9.03E-13	5.21E-12
^{235}U	0/4	1.81E-13	1.20E-13	2.32E-13
^{238}U	4/4	1.79E-12	1.15E-12	2.43E-12
		Station 2		
^{7}Be	4/4	4.62E-08	3.39E-08	7.77E-08
^{40}K	0/4	-5.77E-10[b]	-9.71E-10[b]	-2.88E-10[b]
Tritium	0/4	3.76E-06	9.60E-07	6.34E-06
^{234}U	4/4	2.00E-12	1.54E-12	2.38E-12
^{235}U	1/4	4.62E-13	5.31E-14	1.21E-12
^{238}U	4/4	2.04E-12	8.25E-13	4.59E-12
		Station 3		
^{7}Be	4/4	3.29E-08	2.60E-08	3.79E-08
^{40}K	0/4	-2.78E-11[b]	-3.59E-10[b]	7.35E-10
Tritium	1/4	2.41E-06	-3.38E-06[b]	6.15E-06
^{234}U	4/4	1.74E-12	1.17E-12	2.82E-12
^{235}U	1/4	2.21E-13	6.67E-14	3.54E-13
^{238}U	3/4	1.41E-12	4.08E-13	2.68E-12
		Station 9		
^{7}Be	4/4	3.62E-08	2.73E-08	4.81E-08
^{40}K	0/4	-2.77E-10[b]	-5.74E-10[b]	1.60E-10
Tritium	4/4	4.53E-05	2.20E-05	8.94E-05
^{234}U	3/4	4.04E-12	1.16E-12	5.80E-12
^{235}U	1/4	4.23E-13	1.44E-13	9.17E-13
^{238}U	4/4	2.18E-12	1.11E-12	4.26E-12
		Station 11		
^{7}Be	4/4	3.51E-08	1.93E-08	4.35E-08
^{40}K	0/4	-1.12E-10[b]	-2.37E-10[b]	1.02E-10
Tritium	0/4	2.30E-06	1.23E-06	4.17E-06
^{234}U	4/4	1.67E-12	1.48E-12	1.94E-12
^{235}U	0/4	2.44E-13	1.40E-13	3.85E-13
^{238}U	3/4	1.51E-12	6.48E-13	3.40E-12

Table 6.3 Radionuclide concentrations at Oak Ridge Reservation perimeter air monitoring stations, 2019 (continued)

Parameter	N detected/N total	Concentration (pCi/mL)[a]		
		Average	Minimum	Maximum
	Station 35			
^{7}Be	4/4	4.21E-08	2.86E-08	7.02E-08
^{40}K	0/4	-3.60E-10[b]	-9.07E-10[b]	-1.26E-11[b]
^{99}Tc	1/4	5.55E-11	-4.26E-11	3.15E-10
Tritium	1/4	5.16E-06	2.51E-06	6.70E-06
^{234}U	4/4	2.46E-12	1.53E-12	4.52E-12
^{235}U	1/4	3.34E-13	2.01E-13	5.56E-13
^{238}U	4/4	3.38E-12	9.54E-13	9.43E-12
	Station 37			
^{7}Be	4/4	3.96E-08	3.04E-08	5.59E-08
^{214}Bi	2/4	7.19E-11	0.00E+00	1.68E-10
^{40}K	0/4	-2.54E-10[b]	-4.60E-10[b]	1.91E-10
Tritium	0/4	3.15E-06	8.97E-07	4.37E-06
^{234}U	4/4	1.80E-12	1.09E-12	2.77E-12
^{235}U	2/4	3.03E-13	1.81E-14	5.81E-13
^{238}U	3/4	1.90E-12	7.23E-13	3.62E-12
	Station 40			
^{7}Be	4/4	4.03E-08	2.56E-08	5.79E-08
^{40}K	0/4	1.48E-13	-6.05E-10[b]	2.14E-10
Tritium	0/4	2.57E-06	2.18E-07	4.34E-06
^{234}U	4/4	9.66E-12	4.43E-12	1.57E-11
^{235}U	2/4	6.55E-13	3.15E-13	1.24E-12
^{238}U	4/4	3.22E-12	1.49E-12	5.00E-12
	Station 46			
^{7}Be	4/4	2.85E-08	1.97E-08	3.27E-08
^{40}K	0/4	-7.91E-11[b]	-3.37E-10[b]	3.69E-10
Tritium	0/4	2.17E-06	-4.40E-07[b]	4.84E-06
^{234}U	4/4	3.48E-12	2.30E-12	4.02E-12
^{235}U	0/4	3.36E-13	1.28E-13	6.03E-13
^{238}U	4/4	1.90E-12	8.59E-13	3.09E-12
	Station 49			
^{7}Be	4/4	3.38E-08	1.97E-08	4.53E-08
^{40}K	0/4	-1.55E-10[b]	-3.37E-10[b]	1.43E-10
Tritium	0/4	2.22E-06	1.88E-07	3.83E-06
^{234}U	4/4	2.72E-12	1.32E-12	4.54E-12
^{235}U	2/4	3.51E-13	2.27E-13	5.67E-13
^{238}U	4/4	1.51E-12	1.03E-12	2.18E-12

Table 6.3 Radionuclide concentrations at Oak Ridge Reservation perimeter air monitoring stations, 2019 (continued)

Parameter	N detected/N total	Concentration (pCi/mL)[a]		
		Average	Minimum	Maximum
		Station 52[c]		
^{7}Be	4/4	3.65E-08	2.19E-08	5.43E-08
^{40}K	0/4	-1.55E-10[b]	-6.55E-10[b]	7.36E-11
^{99}Tc	1/4	1.16E-10	-4.56E-11[b]	5.70E-10
Tritium	0/4	2.71E-07	-6.90E-07[b]	2.67E-06
^{234}U	4/4	1.56E-12	8.36E-13	2.46E-12
^{235}U	1/4	1.90E-13	-1.64E-14[b]	5.19E-13
^{238}U	4/4	1.48E-12	1.09E-12	2.27E-12

[a] 1 pCi = 3.7×10^{-2} Bq.
[b] A negative concentration of radioactivity is reported by the laboratory when the sample count rate minus the background count rate is negative (i.e., the background count rate was greater than the sample count rate).When the background activity is subtracted from the sample activity to obtain a net value, a negative value results.
[c] Station 52 is the reference location.

6.4 Surface Water Monitoring

The ORR surface water monitoring program consists of sample collection and analysis from four locations on the Clinch River, including public water intakes (Figure 6.5). The 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.

6.4.1 Data Collection and Analysis

Grab samples are collected quarterly at all four 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.

At the sampling locations, the Clinch River is classified by the State of Tennessee for multiple uses, including recreation and domestic supply. These two designated uses have numeric Tennessee Water Quality Criteria (WQCs) related to protection of human health. These WQCs are used as references where applicable (TDEC 2014). The Tennessee WQCs do not include criteria for radionuclides. Four percent of the DOE DCS is used for radionuclide comparison.

6.4.2 Results

In 2019, as has been the case since 2009, there were no statistical differences in radionuclide concentrations in surface water samples collected from the Clinch River upstream and downstream of DOE inputs. No radionuclides were detected above 4 percent of the respective DCSs.

Mercury was not detected in 2019 in samples from any of the three sampling locations where mercury samples are collected, Clinch River kilometer (CRK) 66, CRK 32, and CRK 16.

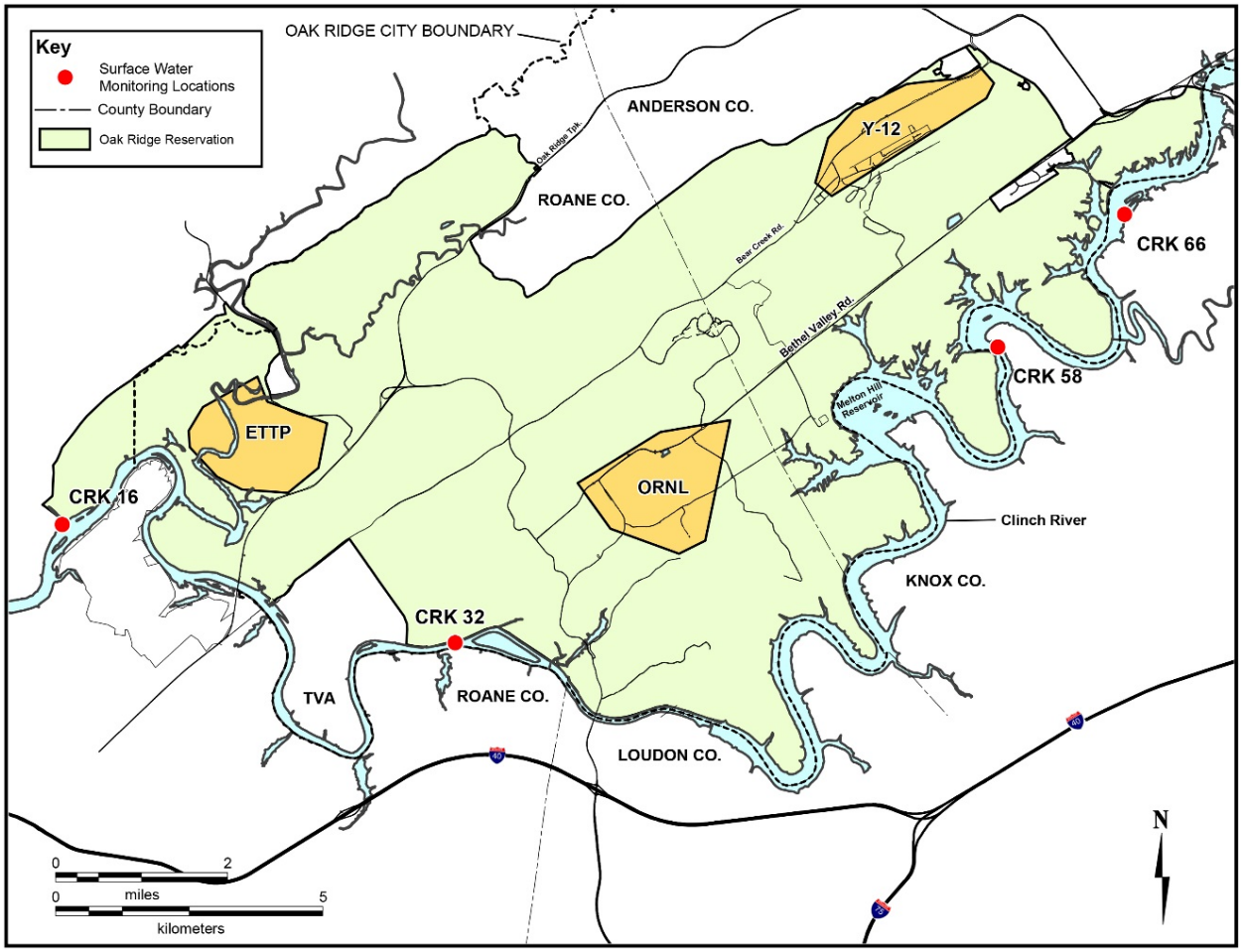


Figure 6.5. Oak Ridge Reservation surface water surveillance sampling locations

Table 6.4. Oak Ridge Reservation surface water sampling locations, frequencies, and parameters, 2019

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 32	Clinch River downstream from ORNL	Quarterly	Mercury, 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 the water body and distances upstream of the confluence of the Clinch and Tennessee Rivers (e.g., CRK 16 is 16 km upstream from the confluence of the Clinch River with the Tennessee River in the Watts Bar Reservoir).
[b] Field measurements consist of dissolved oxygen, pH, and temperature.

Acronyms:
CRK = Clinch River kilometer
DOE = US Department of Energy
ORNL = Oak Ridge National Laboratory
ORR = Oak Ridge Reservation

6.5 Groundwater Monitoring

Work continued in 2019 to implement key recommendations from the *Groundwater Strategy for the U.S. Department of Energy Oak Ridge Reservation* (DOE 2013), which was agreed to in 2014 by DOE, EPA, and the Tennessee Department of Environment and Conservation (TDEC). During 2019 the ORR Groundwater Program transitioned from previous tasks, including off-site groundwater quality assessment and regional-scale groundwater flow model development, to planning continued off-site monitoring and development of site-scale groundwater flow models for the ORNL site.

6.5.1 Off-Site Groundwater Assessment

During FY 2019 the Oak Ridge Office of Environmental Management (OREM) continued to collect and analyze samples from the off-site groundwater monitoring well array west of the Clinch River adjacent to Melton Valley. In addition, exit pathway groundwater monitoring in Melton Valley is conducted as part of the OREM program, including sampling at six multiport monitoring wells in western Melton Valley (wells 4537, 4538, 4539, 4540, 4541, and 4542). Results of this monitoring are summarized in the 2020 remediation effectiveness report (DOE 2020).

DOE completed an off-site groundwater assessment project and issued a final report on the off-site groundwater study in October 2017 (DOE 2017). The project was a cooperative effort among the parties to the ORR Federal Facility Agreement to investigate off-site groundwater quality and potential movement. As follow-on work from the off-site groundwater assessment, DOE conducts annual sampling and analysis of groundwater from several off-site residential wells and springs.

6.5.2 Regional and Site-Scale Flow Model

During FY 2017 DOE completed a project to construct and calibrate a regional-scale groundwater flow model that encompasses ORR and adjacent areas. The regional model provides an underlying framework to support creation of smaller, site-scale groundwater flow models for use in planning and monitoring effectiveness of future cleanup decisions and actions. During FY 2019 DOE developed more refined groundwater flow models for the ORNL site to support the *Bethel Valley Final Groundwater Record of Decision Remedial Investigation Work Plan*, which will be published during FY 2020. The new models can be used for evaluating groundwater contaminant migration in the vicinity of Bethel and Melton Valleys.

6.6 Food

Food sources are analyzed to evaluate potential radiation doses to consumers of local food crops, fish, and harvested game and to monitor trends in environmental contamination and possible long-term accumulation of radionuclides. Samples of hay, vegetables, milk, fish, deer, Canada geese, and turkeys are usually collected every year from areas that could be affected by activities on the reservation and from off-site reference locations. Milk was not collected in 2019 because the dairy that had supplied milk samples went out of business in 2016. The areas identified as potential areas of impact from DOE activities will be checked during 2020 for dairy operations.

The wildlife administrative release limits associated with deer, turkey, and geese harvested on ORR are conservative and were established based on the "as low as reasonably achievable" (ALARA) principle to ensure that doses to consumers are managed at 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 and as low as can be

reasonably achieved. An administrative release limit of 5 pCi/g ^{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 that consumption pathway. In addition, a conservative administrative limit of 1.5 times background for gross beta activity has been established, a threshold that is near the detection limit for field measurements of $^{89/90}$Sr in deer leg bone.

6.6.1 Hay

Hay is sampled because eating beef and drinking milk obtained from "hypothetical" cattle that eat hay is an environmental pathway to potential radiation doses to consumers.

6.6.1.1 Data Collection and Analysis

Hay is collected and analyzed from one location on ORR. Hay samples collected on ORR during May and July 2019 were analyzed for gross alpha, gross beta, gamma emitters, and uranium isotopes.

6.6.1.2 Results

Radionuclides detected in hay are shown in Table 6.5. Statistically significant concentrations of gross alpha activity, gross beta activity, ^{7}Be, ^{40}K, ^{234}U, and ^{238}U were detected at that sampling location for at least one of the two collection events.

Table 6.5. Concentrations of radionuclides detected in hay, 2019 (pCi/kg)[a]

Collection	Gross alpha	Gross beta	^{7}Be	^{40}K	^{234}U	^{235}U	^{238}U
May	*b*	7,840	*b*	11,600	4.7	*b*	*b*
July	160	12,400	*b*	*b*	*b*	*b*	2.7

[a] Detected radionuclides are those at or above minimum detectable activity. 1 pCi = 3.7×10^{-2} Bq.
[b] Value was less than or equal to minimum detectable activity.

6.6.2 Vegetables

6.6.2.1 Data Collection and Analysis

Tomatoes, turnip greens, and turnips were purchased in 2019 from farms near ORR and from reference locations outside the potential DOE impact area. The locations were chosen based on availability and on the likelihood of effects from routine releases from the Oak Ridge facilities. Samples were analyzed for gross alpha, gross beta, gamma emitters, and uranium isotopes.

6.6.2.2 Results

Analytical results for vegetable samples are provided in Table 6.6. No gamma-emitting radionuclides were detected above the minimum detectable activity, except for the naturally occurring radionuclides ^{7}Be and ^{40}K.

Table 6.6. Concentrations of radionuclides detected in vegetables, 2019 (pCi/kg)[a]

Location	Gross alpha	Gross beta	^{7}Be	^{40}K	^{234}U	^{235}U	^{238}U
			Turnips				
North of Y-12	128	5,100	*b*	8,300	7.3	1.9	7.9
South of ORNL	*b*	1,300	*b*	1,800	2.5	*b*	*b*
West of ETTP	*b*	700	*b*	2,100	3.3	*b*	*b*
Reference location	*b*	1,100	*b*	*b*	*b*	*b*	*b*
			Turnip Greens				
North of Y-12	*b*	3,500	*b*	5,300	3.0	*b*	1.8
South of ORNL	*b*	3,900	*b*	6,300	*b*	*b*	2.8
East of ORNL	*b*	3,800	*b*	5,500	8.8	*b*	9.1
West of ETTP	150	2,400	2,100	3,500	21	1.5	18
Reference location	180	2,000	2,800	4,700	32	3.6	32
			Tomatoes				
East of Y-12, Claxton vicinity	33	1,700	*b*	*b*	5.9	*b*	*b*
North of Y-12	22	2,300	*b*	2,000	*b*	*b*	*b*
South of ORNL	*b*	2,000	*b*	2,300	*b*	*b*	*b*
East of ORNL	43	1,600	*b*	*b*	3.6	*b*	*b*
West of ETTP	*b*	1,000	*b*	*b*	3.0	*b*	*b*
Reference location	134	1,800	*b*	*b*	*b*	2.2	*b*

[a] Detected radionuclides are those at or above minimum detectable activity. 1 pCi = 3.7×10^{-2} Bq.
[b] Value was less than or equal to minimum detectable activity.

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

6.6.3 Milk

Milk is a potentially significant exposure pathway to humans for 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.

6.6.3.1 Data Collection and Analysis

The one dairy that had been supplying milk samples to ORNL went out of business in 2016. During the 3 years since, surveys to locate dairies in areas that could receive deposition from ORR activities were conducted; however, no dairies were identified to replace the one that closed.

6.6.3.2 Results

When a dairy or dairies in potential ORR deposition areas are located, milk-sampling and analyses will resume.

6.6.4 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 annually by

collecting fish from three locations on the Clinch River and by analyzing edible flesh for specific contaminants. The locations are as follows (Figure 6.6):

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

6.6.4.1 Data Collection and Analysis

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 2019, a composite sample of each of those species at each location was analyzed for selected metals, polychlorinated biphenyls (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. Once every five years, additional radiological analyses are performed to confirm the dosing model (see Chapter 7). In 2019, additional radionuclides detected included neptunium, plutonium, thorium, and uranium isotopes. Results are presented in Table 6.7.

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. TDEC has issued a "do not consume" advisory for catfish in the Melton Hill Reservoir in its entirety, not just in areas that could be affected 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 2020). TDEC also issues advisories for consumption of fish when mercury levels are over 0.3 ppm; the three locations on the Clinch River where ORR fish are collected do not have mercury "do not consume" advisories waters (Denton 2007). See additional information **here**.

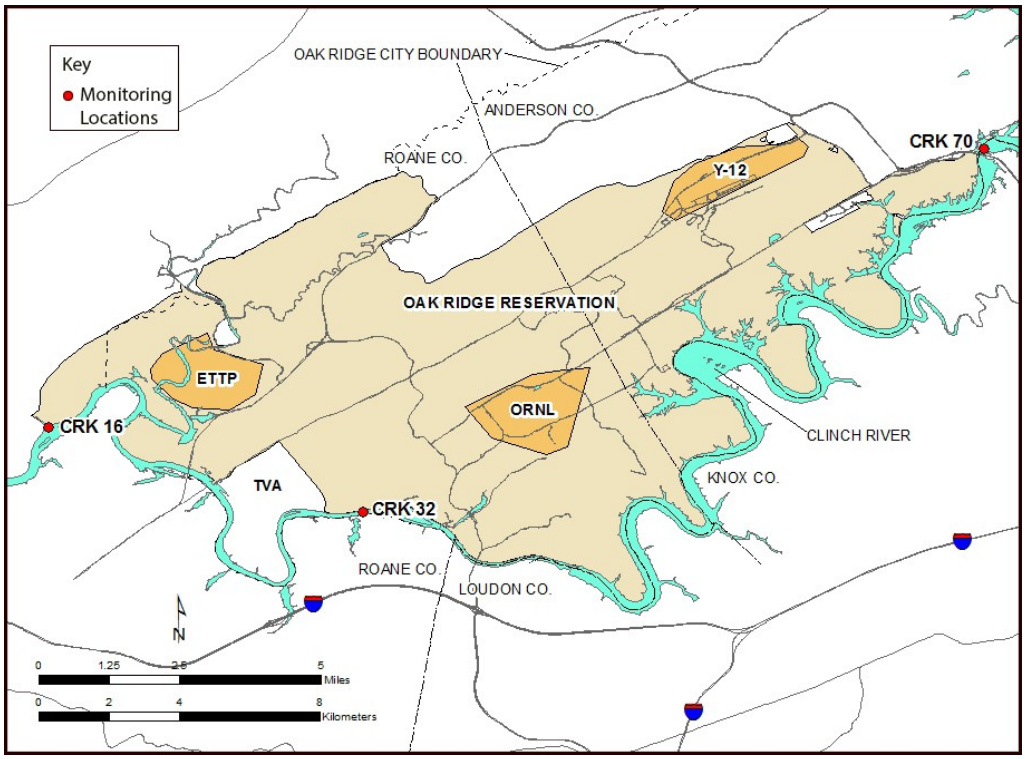


Figure 6.6. Fish-sampling locations for the Oak Ridge Reservation Surveillance Program

6.6.4.2 Results

PCBs, specifically Aroclor-1260, and mercury were detected in both sunfish and catfish at all three locations in 2019. These results are consistent with the TDEC advisories. Detected PCBs, mercury, and radionuclide concentrations are shown in Table 6.7.

Table 6.7. Tissue concentrations in catfish and sunfish for detected mercury, PCBs, and radionuclides, 2019[a]

Parameter	Catfish	Sunfish
Clinch River downstream from all DOE ORR inputs (CRK 16)		
Metals (mg/kg)		
Hg	0.045	0.042
Pesticides and PCBs (µg/kg)		
PCB-1260	310	J9.9[b]
Radionuclides (pCi/g)		
Alpha activity	0.15	*c*
Beta activity	2.7	1.4
^{40}K	3	2
Tritium	0.15	0.18
^{241}Am	0.039	*c*
^{237}Np	*c*	0.011
$^{239/240}$Pu	0.094	0.0095
^{234}U	0.031	0.014
^{238}U	*c*	0.015
Clinch River downstream from ORNL (CRK 32)		
Metals (mg/kg)		
Hg	0.033	J0.022[b]
Pesticides and PCBs (µg/kg)		
PCB-1260	97	J12[b]
Radionuclides (pCi/g)		
Beta activity	1.2	0.89
^{40}K	3.2	2.6
Tritium	0.18	0.15
^{237}Np	0.018	*c*
^{238}Pu	*c*	0.0057
^{228}Th	0.052	*c*
^{230}Th	0.029	*c*
^{234}U	*c*	0.015
Clinch River (Solway Bridge) upstream from all DOE ORR inputs (CRK 70)		
Metals (mg/kg)		
Hg	0.1	0.034
Pesticides and PCBs (µg/kg)		
PCB-1260	92	J11[b]
Radionuclides (pCi/g)		
Alpha activity	*c*	0.11
Beta activity	0.92	1.8

Table 6.7. Tissue concentrations in catfish and sunfish for detected mercury, PCBs, and radionuclides, 2019[a] (continued)

Parameter	Catfish	Sunfish
^{40}K	2.0	2.6
Tritium	0.24	0.25
^{238}Pu	*c*	0.0038
$^{239/240}$Pu	0.039	0.0038
^{234}U	0.022	0.023

[a] Only parameters that were detected for at least one species are listed in the table.
[b] "J" indicates that the result is an estimated value.
[c] Value was less than or equal to minimum detectable activity.

Acronyms:

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

6.6.5 White-Tailed Deer

Three weekend quota deer hunts were held on ORR during the final quarter of 2019. The hunts took place November 2 and 3, November 9 and 10, and December 7 and 8. Each hunt was limited to 450 shotgun/ muzzleloader permittees and 600 archery permittees. UT-Battelle staff; Tennessee Wildlife Resources Agency (TWRA) personnel; and student members of the Wildlife Society, University of Tennessee (UT) chapter, performed most of the necessary operations at the checking station.

6.6.5.1 Data Collection and Analysis

Approximately 25,053 acres were available to deer hunters on the Oak Ridge Wildlife Management Area (ORWMA) in 2019 (15,227 acres for gun hunting and 9,826 acres for archery hunting). The ORWMA includes some properties not owned by DOE, including Haw Ridge Park (city of Oak Ridge), the Clinch River Small Modular Reactor Site (the Tennessee Valley Authority [TVA]), and the UT Arboretum.

6.6.5.2 Results

The total harvest in 2019 was 221 deer, of which 125 (~56.6 percent) were bucks and 96 (~43.4 percent) were does. The heaviest buck weighed 181 lb, was 4 years old, and had 13 antler points, which was the greatest number of antler points on any buck harvested. The heaviest doe weighed 112 lb and was 3.5 years old. The harvest was higher than it was in 2018 but still somewhat lower than it had been, which corresponds more with previous years. This is most likely due to the inclement weather during the last weekend hunt, which resulted in a lower hunter turnout than in years past. The outbreak of epizootic hemorrhagic disease in the Tennessee deer herds during the summer of 2017 impacted deer populations on the ORWMA, as evidenced by the number of 2017's dead deer reports and low harvest numbers.

Since 1985, 13,334 deer have been harvested from the ORWMA, of which 218 (~1.67 percent) have been retained because of potential radiological contamination. The heaviest buck ever harvested weighed 218 lb (1998), and the heaviest doe ever harvested weighed 139 lb (1985). The average weight of all harvested deer is ~86 lb. The oldest deer harvested was a doe estimated to be 12 years old (1989); the average age of all harvested deer is ~2 years. See ORR hunt information website **here** for more information.

None of the 221 deer harvested on ORR during the 2019 hunts were retained for exceeding the administrative release limit of 1.5 times background for beta activity in bone (~20 pCi/g $^{89/90}$Sr) or for exceeding 5 pCi/g ^{137}Cs in edible tissue.

6.6.6 Canada Geese

On the Three Bends Area of ORR (excluding the shoreline of Gallaher Bend), Canada goose hunting was allowed during the statewide season, one half-hour before sunrise until noon on 4 days during September and 4 days during October. The consumption of Canada geese is a potential pathway for exposing members of the public to radionuclides released from ORR operations.

6.6.6.1 Data Collection and Analysis

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.

6.6.6.2 Results

Thirty geese (15 adults, 15 goslings) were captured during the June 21, 2019, roundup on ORR. All 30 captured geese were subjected to live whole-body gamma scans. Gamma scan results for the 15 adult geese and 15 goslings showed that all were well below the administrative release limit of 5 pCi/g ^{137}Cs.

6.6.7 Turkey Monitoring

Two wild turkey hunts, managed by DOE and TWRA, were held on the reservation in 2019 (April 13 and 14 and April 27 and 28). Each hunt was limited to 225 hunters, preselected in a quota drawing. Approximately 21,879 acres were available to turkey hunters in 2019 because the 255 acres that were designated as archery-only in 2017 were eliminated and were converted to safety zones in 2018.

6.6.7.1 Data Collection and Analysis

Thirty-two male turkeys were harvested on the two hunts, of which 4 (~ 12.5 percent) were juveniles and 28 (~ 87.5 percent) were adults. The average weight of all turkeys harvested during spring 2019 hunts was ~18.9 lb, and the largest turkey weighed 23.6 lb. The average beard length was ~9.1 in., and the longest beard was 11.2 in. The average spur length was ~ 0.9 in., and the longest spur was 1.2 in. The largest turkey harvested to date on ORR weighed 25.7 lb (harvested in 2009).

6.6.7.2 Results

None of the 33 (32 in spring, 1 in fall) turkeys harvested in 2019 exceeded the administrative release limits established for radiological contamination. Since 1997, 924 turkeys have been harvested on spring turkey hunts. Eleven additional turkeys have been harvested (since 2012) by archery hunters during fall deer hunts. Of all turkeys harvested, only three (~< 0.34 percent) have been retained because of potential radiological contamination; one in 1997, one in 2001, and one in 2005. Additional information is available here.

6.7 Invasive Plant Management on the US DOE Oak Ridge Reservation

Invasive non-native plant species are among the greatest ecological threats across the country and around the world. Maintaining ecosystems, protecting natural areas, and ensuring functioning of facilities and their support infrastructures, power and communications rights-of-way, roadways, and waterways through

actively managing invasive plant incursions is crucial not only in nature, but in developed areas as well. Invasive plants can threaten forests, wetlands, cultural assets, and other resources through increased risk of fire, storm damage, and encroachment onto roads, railroads, power structures, waterways, and farmland. Invasive plants disrupt vital habitats of threatened and endangered species as well as other native wildlife and plant life by decreasing native plant diversity through crowding out native plants and disrupting natural plant-animal interactions.

The Federal Noxious Weed Act (1974) was amended and incorporated into the Federal Plant Protection Act (2000), which mandates federal agencies to develop and coordinate a management program for control of invasive plants on lands under each agency's respective jurisdiction. Each agency must adequately fund the publication of an integrated pest management plan that will meet the regulatory requirements of federal laws, executive orders, presidential memorandums, contracts, and agreements. Other federal directives regarding control of invasive plants and subsequent restoration practices include the following:

- Presidential Memorandum, "Environmentally and Economically Beneficial Practices on Federal Landscaped Ground" (1994), which was replaced in 2000 by Executive Order 13148, "Greening the Government Through Leadership in Environmental Management" (2000)
- "Federal Memorandum of Understanding to Establish a Federal Inter-agency Committee for the Management of Noxious and Exotic Weeds" (1994)
- Executive Order 13112, "Invasive Species" (1999)
- Presidential Memorandum, "Creating a Federal Strategy to Promote the Health of Honey Bees and Other Pollinators," (2014), which involves "creating a federal strategy to promote the health of honeybees and other pollinators," including control and removal of invasive plants and restoration and establishment of natural habitats
- Executive Order 13751, "Safeguarding the Nation from the Impacts of Invasive Species." (2016)

The DOE has maintained an invasive plant management plan on ORR since 2004. For details of federal and state laws and regulations driving the DOE plan, see *Invasive Plant Management Plan for the Oak Ridge Reservation* (*Invasive Plant Management Plan for the Oak Ridge Reservation* (Parr et al. 2004, Quarles et al. 2011, McCracken and Giffen 2017).

A technical report, *Assessment of Nonnative Invasive Plants in the DOE Oak Ridge National Environmental Research Park*" (Drake et al. 2002) details the results of extensive survey efforts. These and subsequent surveys have been done to identify invasive plant problems on ORR. The data are used to develop control plans identifying which invasive species to target and in which locations.

More than 1,100 species of plants are found on ORR, and of these approximately 170 plant species are non-native plants. Fifty-seven aggressive non-native (invasive) plant species have been identified on ORR, but control efforts are primarily focused on a subset of 10 species (see Table 6.8). The selected invasive species have been found across ORR in disturbed areas; on powerline and gas line rights-of-way; throughout riparian buffer zones; and along state highways, railroad lines, and remote-access fire roads. They have invaded natural areas to varying degrees, causing vast ecological harm in both plant and animal communities. Other invasive plant species are targets for control as well, using Early Detection/Rapid Response (DOI 2020) and in concert with control efforts on the 10 highly invasive species listed in Table 6.8.

The 32,800-acre ORR consists mostly of undeveloped land, such as forested land, extensive areas of undisturbed wetlands, open waterways and riparian vegetation, and several hundred acres of grassland communities and fallow fields. Three major developed facilities lie within ORR boundaries—ORNL, the

Y-12 National Security Complex, and the East Tennessee Technology Park. Surrounding these developed facilities and woven throughout ORR are safety and security areas, utility corridors, access roads, research and education areas, cultural and historic preservation sites, contamination areas that are undergoing cleanup and remediation, regulatory and monitoring sites, emergency corridors, new facility construction and laydown areas, and public use areas. This multiplicity of land uses presents challenges for effectively preventing and managing invasive species.

Table 6.8. Ten most problematic invasive plants on the Oak Ridge Reservation

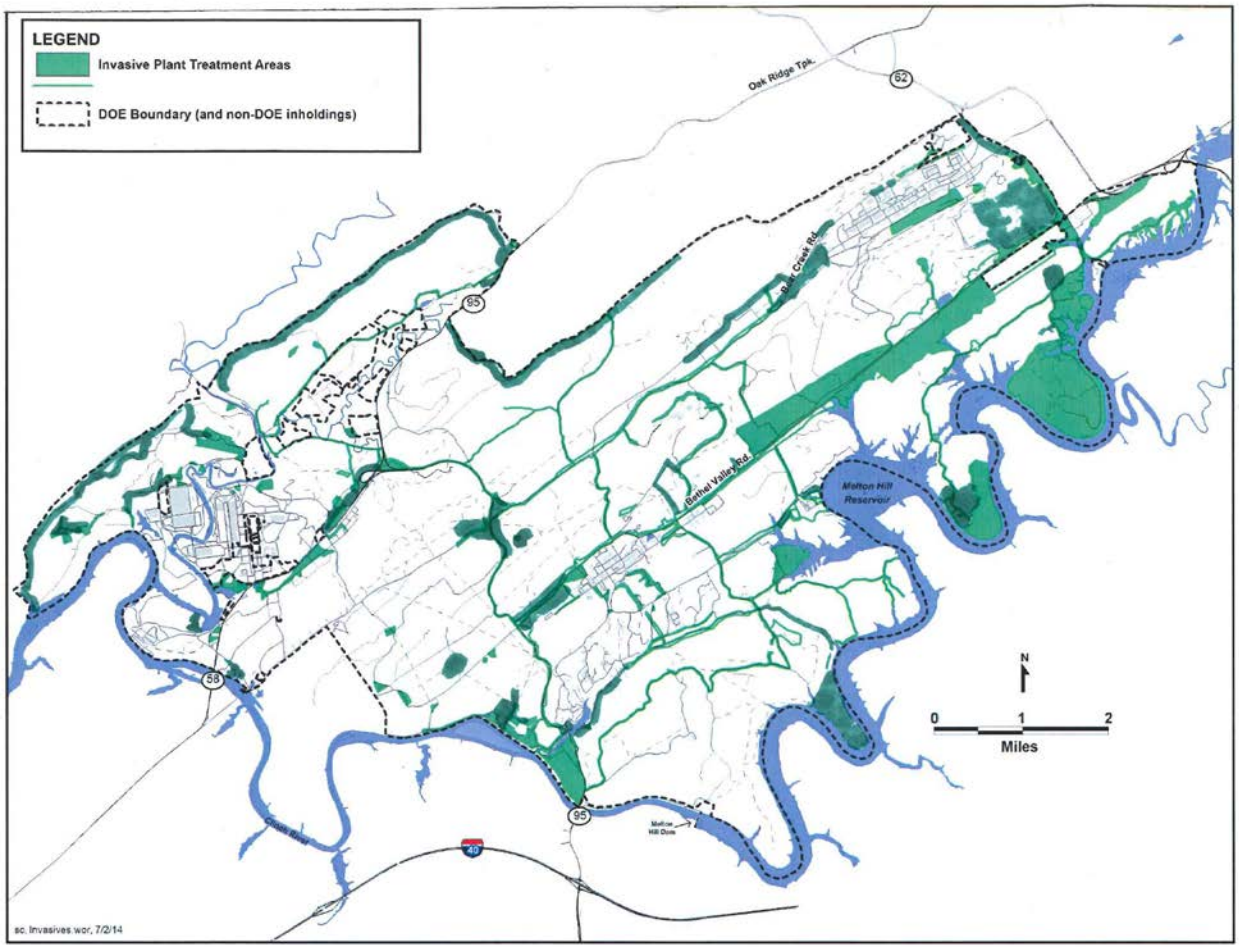
Common name	Scientific name
Japanese grass, Nepal grass	*Microstegium vimineum*
Japanese honeysuckle	*Lonicera japonica*
Chinese privet	*Ligustrum sinense*
Kudzu	*Pueraria montana*
Multiflora rose	*Rosa multiflora*
Tree-of-heaven	*Ailanthus altissima*
Autumn olive	*Elaeagnus umbellate*
Oriental bittersweet	*Celastrus orbiculatus*
Princess tree	*Paulownia tomentosa*
Winter creeper	*Euonymus fortunei*

Numerous DOE contractors have responsibilities for land management of portions of the Oak Ridge Reservation, as do other federal and state agencies, such as TVA and TWRA. The Natural Resources Management Team for ORR receives site-wide funding annually, a portion of which is designated for creation and implementation of an invasive plant management plan, mainly directed toward control efforts in natural areas and reference areas; however, efforts have included specific invasive plant incursions into locations within and surrounding campuses of developed facilities on ORR. The *Invasive Plant Management Plan for the Oak Ridge Reservation*, (Parr et al. 2004), and two subsequent revisions (Quarles et al. 2011 and McCracken et al. 2017) explain options for addressing the problem of invasive plants on ORR and discuss selection of appropriate control measures. Areas selected for invasive plant control tend to cover several acres or are spread out across portions of ORR. Use of selected herbicides is the most cost-effective treatment method in most cases, and the invasive plants present inform which herbicides will be most effective without causing harm to surrounding native plant and animal habitats.

Invasive plant control on ORR has been conducted annually from 2003, when the invasive plant management program began, through 2019. Table 6.9 indicates the extent of annual invasive plant treatments; Figure 6.7 shows the major treatment areas.

Table 6.9. Invasive plant control on the Oak Ridge Reservation, 2003–2019

Area treated	Year																
	03	04	05	06	07	08	09	10	11	12	13	14	15	16	17	18	19
Acres	98	136	125	254	236	427	526	884	806	615	329	950	629	952	542	507	450
Road miles															47	53	57



Areas shown in green have been treated for invasive plants between 2003 and 2019.

Figure 6.7. Map of cumulative invasive plant treatment areas on the Oak Ridge Reservation

Restoration of selected natural areas is done in addition to herbicide treatment of invasive plants. *The Native Grass Community Management Plan for the Oak Ridge Reservation* (Ryon et al. 2007) and the *Grassland Ecosystem Management Plan for the Oak Ridge Reservation* (Herold and McCracken 2007) discuss demonstration projects and larger grassland restoration projects across ORR. Demonstration projects have been done at the East Tennessee Technology Park, Y-12 National Security Complex, and ORNL. Native plant restoration projects totaling several hundred acres across ORR are located within the Oak Ridge National Environmental Research Park's natural areas.

Invasive Plant management and grassland restoration completed in 2019 at each of the three facilities on ORR include the following:

- ORNL
  - First Creek grassland area management
  - Demonstration plot at Spallation Drive and Bethel Valley Road management
  - Bethel Valley Road and Old Bethel Valley Road invasive plant control
  - Haw Ridge former steam line kudzu control
  - Park City Road/Price Road invasive plant treatment

  - Fire road invasive plant control
  - Three Bends Area invasive plant control

- Y-12
  - Y-12 Native Grassland Area invasive plant treatment
  - Bear Creek restoration site invasive plant treatment
  - Kudzu control on Pine Ridge and Chestnut Ridge overlooking Y-12 campus
  - Midway Turnpike invasive plant control
  - Bear Creek Road invasive plant control
  - Coal ash ponded area kudzu control
  - Fire road invasive plant control

- ETTP
  - EU-29 demonstration field invasive plant control
  - Powerhouse Trail privet control
  - Wheat Church Vista invasive plant control
  - Black Oak Ridge Conservation Easement kudzu and invasive plant control
  - Black Oak Ridge Conservation Easement greenway and trail invasive plant control

6.8 Fire Protection Management and Planning

Wildland fire management plays a major part in DOE's overall management of ORR. Responsibilities are laid out in DOE orders, policies, and directives. *ORR Wildland Fire Implementation Plan* (DOE ORO 2006) defines shared responsibilities of UT-Battelle, LLC (ORR Forester and ORNL Fire Department); the DOE roads and grounds contractor; the DOE Consolidated Service Center; the DOE ORNL Site Office Reservation Management; Y-12; ETTP; the City of Oak Ridge; and the State of Tennessee Division of Forestry.

DOE actions associated with wildland fire management include the following:

- Development of burn plans and authorization by the reservation manager
- Conducting routine operational controlled burns
- Incorporation of wildland fire mitigation and response activities and procedures into the ORR land-use planning process
- Preparing and updating pre-fire planning maps. Ensuring that hard-copy maps of ORR are available for wildland fire response and mitigation
- Conducting wildland fire scenarios in emergency management exercises as necessary or appropriate. Developing after-action reports identifying areas of weakness or needs for improvement
- Development of stakeholder involvement plans in support of the wildland fire program
- Review of current wildland fire-potential data, including indications of wildland fire risk
- Preparing a wildland fire risk report, including a wildland fire hazard severity analysis based on the National Fire Protection Association *Standard for Wildland Fire Management* (NFPA 2018)
- Identifying equipment necessary to perform forest management activities and assignments

DOE maintains a detailed wildland fire management plan for ORR with an associated wildland fire management implementation plan. Specific responsibilities of different entities associated with wildland fire management on ORR are outlined in the plans. The DOE roads and grounds contractor has the

responsibility for establishing and maintaining the wildland fire roads, many of which delineate wildland management units (Figure 6.8), and maintaining barricades that control access to ORR secondary roads. The sites—ORNL, Y-12, and ETTP—are responsible for providing personnel and equipment for initial response to wildland fire events and for establishing incident command. The City of Oak Ridge has entered into a mutual aid agreement with DOE to provide assistance for wildland fire activities. The State of Tennessee Department of Agriculture Division of Forestry has entered into a memorandum of understanding to provide personnel who are trained and equipped to respond to wildland fires and heavy equipment, including fire plows, when requested to assist with wildland fires.

Because ORR is a large (32,800 acres), mainly forested property with access restrictions, it is a challenge for most site emergency personnel to maintain familiarity with all remote areas and back roads and to quickly recognize and size up concerns associated with those areas**.** The ORR wildland management unit pre-fire plans (PFPs) were therefore developed to serve on-site first responders and are designed both to aid those not familiar with an area and to assist the recall of those who are. Because DOE's wildfire strategy now relies on outside agencies for assistance with large or difficult wildfires, the plans also serve as guidance for those responders who may have little or no experience on ORR. The plans offer awareness of ORR's unique hazards and can help avoid inadvertent impacts to structural, cultural, environmental, and research assets.

The PFPs are a series of brief documents covering each of 28 ORR wildlife management units (Figure 6.8). Each plan summarizes access issues, assets, and hazard concerns within its area. Hard copies of the plans are intended to remain in responder vehicles for immediate reference during remote events. Terse and compact in format, the plans are easily updated, stored, and shared electronically. Pre-fire plan copies are also maintained at site fire departments and emergency operations centers and by shift superintendents and certain managers. The plans are meant to influence quick decisions but are not meant to dictate tactics.

The format of the PFPs includes a single-page synopsis that provides a wildlife management unit's unit identification number and name, general location within ORR, and its boundaries and size. The most important information or hazards are highlighted near the top of the form, followed by topical guidance on tactics, access, vegetation and fuels, water sources, topographic considerations, and hazards. Plan maps depict access, fuel types, water sources, and urban interface areas. Utilities, hazards, research areas, and sensitive resources are also depicted.

Gradually, the information within each plan may become outdated. PFPs are reviewed on a 3-year cycle and are updated as significant changes occur. The ORR forester is the point of contact for plan distribution.

Events during 2016 demonstrated that large fires, more frequent in the western states, can occur in the region containing ORR. As a result, issues related to its wildland/urban interface are a growing concern. These areas may feature relatively high housing density and increasing recreational use by the public. DOE has prioritized interface areas and has conducted controlled wildfire fuel reduction burns to limit fire spread to and from the community. Actions have also been taken in areas exposed to potential high-intensity wildfires due to the presence of dense pine forests, including harvests to thin or replace dense pine, mechanical treatments to proactively thin younger pine, and mulching heavy logging slash and insect-damaged timber to interrupt fuel beds.

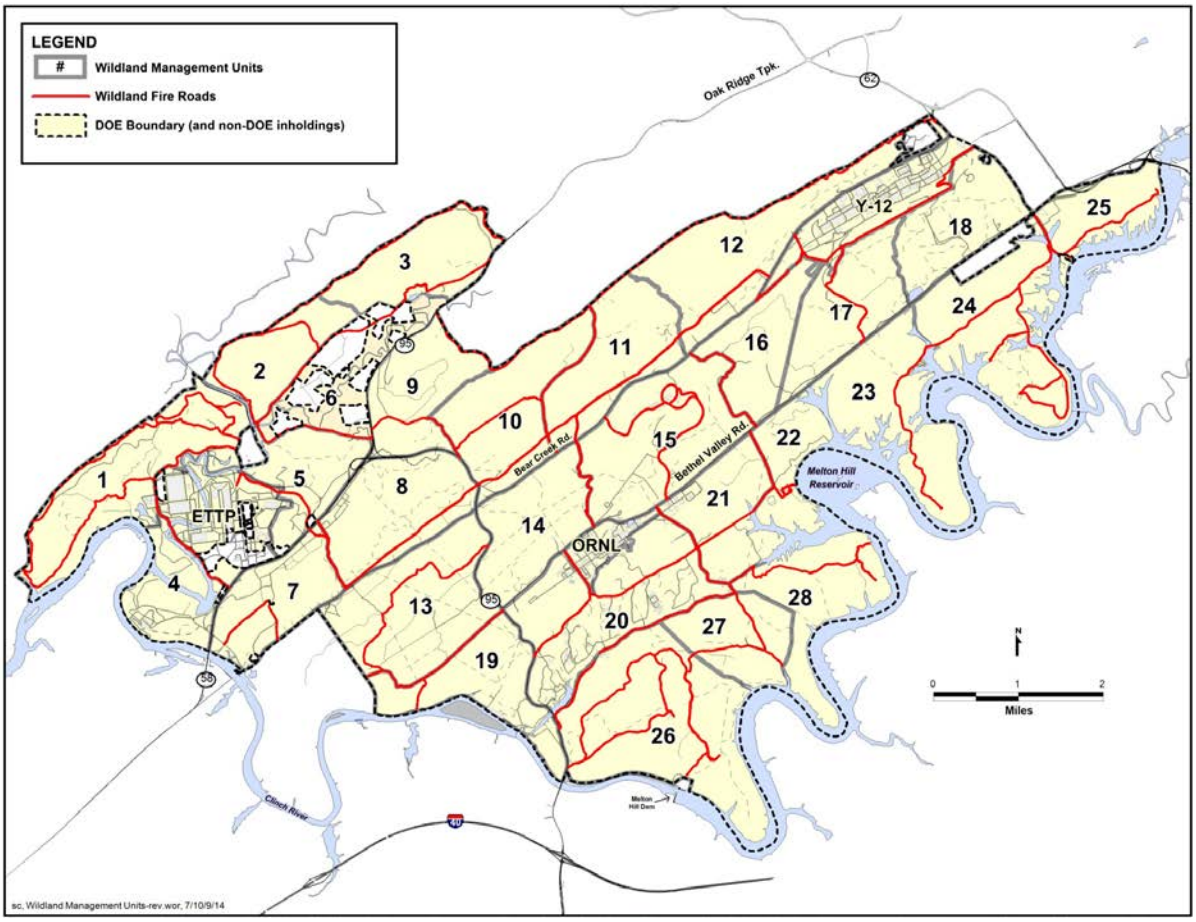


Figure 6.8. Wildland management units on the Oak Ridge Reservation

6.9 Quality Assurance

UT-Battelle performs the activities associated with administration, sampling, data management, and reporting for ORR environmental surveillance programs. Project scope is established by a task team whose members represent DOE; UT-Battelle; Consolidated Nuclear Security, LLC; and UCOR. UT-Battelle integrates quality assurance, environmental, and safety considerations into every aspect of ORR environmental monitoring. (See Chapter 5, Section. 5.7, for a detailed discussion of UT-Battelle quality assurance program elements for environmental monitoring and surveillance activities.)

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