ATSDR
AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY

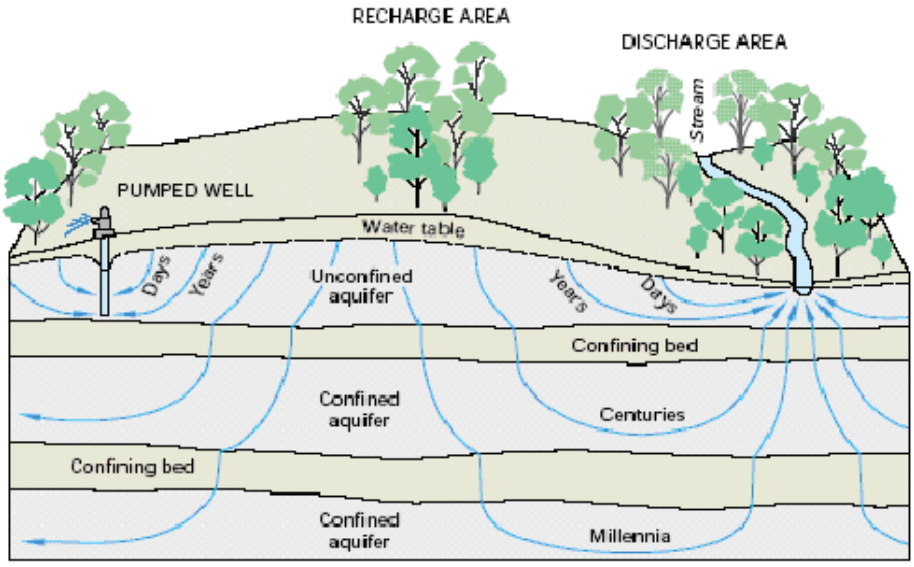
A Summary of ATSDR's Evaluation of Potential Exposures to Contaminated Off-Site Groundwater from the Oak Ridge Reservation

About the Oak Ridge Reservation

In 1942, as part of the Manhattan Project, the federal government established the Oak Ridge Reservation (ORR) in Anderson and Roane Counties in eastern Tennessee. The ORR's mission was to research, develop, and produce special radioactive materials for nuclear weapons. Four facilities were built at that time: the X-10 site (formerly known as the Clinton Laboratories and now part of the Oak Ridge National Laboratory [ORNL]); the Y-12 plant (now known as the Y-12 National Security Complex); the K-25 site (formerly known as the Oak Ridge Gaseous Diffusion Plant, and now referred to as the East Tennessee Technology Park [ETTP]); and the S-50 site (now part of the ETTP). The Y-12 plant, K-25 site, and S-50 site were created to enrich uranium. The X-10 site was created to demonstrate processes for producing and separating plutonium. Since the end of World War II, the role of the ORR has broadened to include a variety of nuclear research and production projects essential to national security.

The ORR is located in the city of Oak Ridge, approximately 15 miles west of Knoxville. The Clinch River forms the ORR's southern and western borders. The ORR currently comprises some 35,000 acres. The three major U.S. Department of Energy (DOE) installations—the ETTP, ORNL, and the Y-12 National Security Complex—occupy about 30 percent of that acreage. In 1980, the remaining 70 percent was established as a National Environmental Research Park, to provide protected land for environmental science research and education and to demonstrate that energy technology development and a quality environment can coexist.

In 1989, the U.S. Environmental Protection Agency (EPA) added the ORR to the National Priorities List because, over the years, the ORR operations have generated a variety of radioactive and nonradioactive waste. A portion of this waste remains in old waste sites, which occupy 5 to 10 percent of the ORR, and some pollutants have been released into the environment.



Flow times from points of recharge to points of discharge can range from days to millennia. At the ORR, shallow groundwater has short flow paths with relatively quick travel times to surface water.

ENVIRONMENTAL HEALTH TERMS

Contaminant—A substance that is either present in an environment where it does not belong or is present at levels that might cause harmful health effects.

Exposure—Contact with a substance by swallowing, breathing, or touching the skin or eyes. Exposure may be short-term (acute), intermediate, or long-term (chronic).

Groundwater—Water beneath the earth's surface in the spaces between soil particles and between rock surfaces.

Hazardous waste—Potentially harmful substances that have been released or discarded into the environment.

Health effects—A change in body function or cell structure that might lead to disease or health problems.

Public health assessment—An ATSDR document that examines levels of hazardous substances at a hazardous waste site to determine whether people could be harmed by coming in contact with those substances.

Who is ATSDR?

What is ATSDR's mission?
ATSDR's mission is to serve the public by using the best science, taking responsive public health actions, and providing trusted health information to prevent harmful exposures and diseases related to toxic substances.

The Agency for Toxic Substances and Disease Registry (ATSDR) is the principal federal public health agency charged with evaluating the human **health effects** of **exposure** to hazardous substances in the environment. Congress created ATSDR to implement the health-related sections of the 1980 Superfund law and other laws that protect the public from **hazardous waste** and environmental spills of hazardous substances.

What is ATSDR doing at the Oak Ridge Reservation?

People living near the ORR want to know whether their health could be affected by historical releases of **contaminants** to **groundwater**. ATSDR conducted a **public health assessment** to evaluate whether the releases could be harmful to people who live in communities near the reservation. ATSDR accomplished this by evaluating available groundwater monitoring data, as well as demographic and current and historic land and groundwater use information. ATSDR also worked with the Oak Ridge Reservation Health Effects Subcommittee to address specific community concerns about site-related public health issues pertaining to exposure to off-site groundwater.

ATSDR uses the public health assessment process to evaluate previous studies and environmental data to determine whether releases of hazardous substances from the ORR could have affected the health of people in communities near the reservation. The public health assessment is the primary public health process that ATSDR uses to

- ***Identify*** off-site populations who could have been exposed to hazardous substances,
- ***Determine*** the potential health effects of exposure,
- ***Address*** the health concerns of people in the community, and
- ***Recommend*** any necessary follow-up public health actions to address exposure.

What other ORR issues is ATSDR evaluating?

In addition to the public health assessment evaluating potential exposures to contaminated off-site groundwater from the ORR, ATSDR scientists are conducting public health assessments on the following ORR-related issues:

- Uranium releases from the Y-12 plant
- TSCA incinerator
- Radionuclide releases from the X-10 site to White Oak Creek
- Iodine-131 releases from the X-10 site
- PCBs
- Screening for current chemical exposures
- Uranium and fluoride releases from the K-25 site
- Mercury releases from the Y-12 plant

What conclusion did ATSDR reach about health effects related to off-site exposures to contaminated substances released to the groundwater from the ORR?

ATSDR's public health assessment concluded that no human exposures to off-site contaminated groundwater have occurred in the past, no exposures are currently occurring, and no exposures are likely to occur in the future. The contaminated groundwater originating from the Y-12 complex is the only confirmed off-site **groundwater plume**. Because nearly all groundwater beneath the ORR ends up as surface water before leaving the site, and because no private wells pump groundwater in this area, ATSDR concluded **no completed exposure pathways** are available for the ingestion of, or direct contact with, off-site groundwater. Residential well monitoring has established that private wells have been unaffected by contamination from ORR activities.

Although extensive groundwater contamination exists throughout the ORR, ATSDR concluded that no public health hazard arises from off-site exposure to ORR-contaminated groundwater because no one is being exposed.

The **volatile organic compound (VOC)** groundwater contaminant plume, extending east-northeast from the Y-12 complex, is the only confirmed contaminant plume migrating across the ORR boundary. This carbon tetrachloride-dominated plume consists of several contaminant plumes that have commingled and migrated off site into Union Valley. Institutional controls were set forth in the 1997 Interim Record of Decision for Union Valley, which ensure that the public's health is protected while final remedial actions are developed and implemented. If necessary, the Record of Decision also identifies or prohibits future activities that could accelerate the rate of contaminant migration or increase the extent of the contaminant plume. These institutional controls help to ensure that no one is exposed to contaminated groundwater—now or in the future. While these selected actions do not provide for a reduction in toxicity, mobility, or volume of contamination, ATSDR concluded that they are protective of public health to the extent that they limit or prevent community exposure to contaminated groundwater in Union Valley.

ATSDR concluded that no exposure to contaminated groundwater emanates from the ORR. Therefore, off-site groundwater does not pose a public health hazard.

ATSDR also concluded that no exposure for ingestion or direct contact with off-site contaminated groundwater originates from the ORR. Sufficient evidence exists that no human exposures to off-site contaminated groundwater have occurred in the past, no exposures are currently occurring, and no exposures are likely to occur in the future. ATSDR also examined the possibility of vapor intrusion of VOCs into an off-site office building that partially overlies the VOC plume. Conservative modeling results estimate indoor vapor concentrations several orders of magnitude below levels of health concern.

ENVIRONMENTAL HEALTH TERMS

Groundwater plume—A volume of a substance that moves away from the source.

No completed exposure pathway (incomplete exposure pathway)—An exposure pathway is the route a substance takes from its source to its end point, and how people can come into contact with it. An exposure pathway has five parts: a source of contamination, an environmental media, a point of exposure, a route of exposure, and a receptor population. When any part is absent, the exposure pathway is termed an "incomplete exposure pathway."

Volatile organic compound (VOC) — Organic compounds that evaporate readily into the air.

ENVIRONMENTAL HEALTH TERMS

Bedrock—The solid rock that underlies loose material, such as soil, sand, clay, or gravel.

Surface water—Water on the surface of the earth, such as in lakes, rivers, streams, ponds, and springs.

Watershed—The region draining into a river, river system, or other body of water.

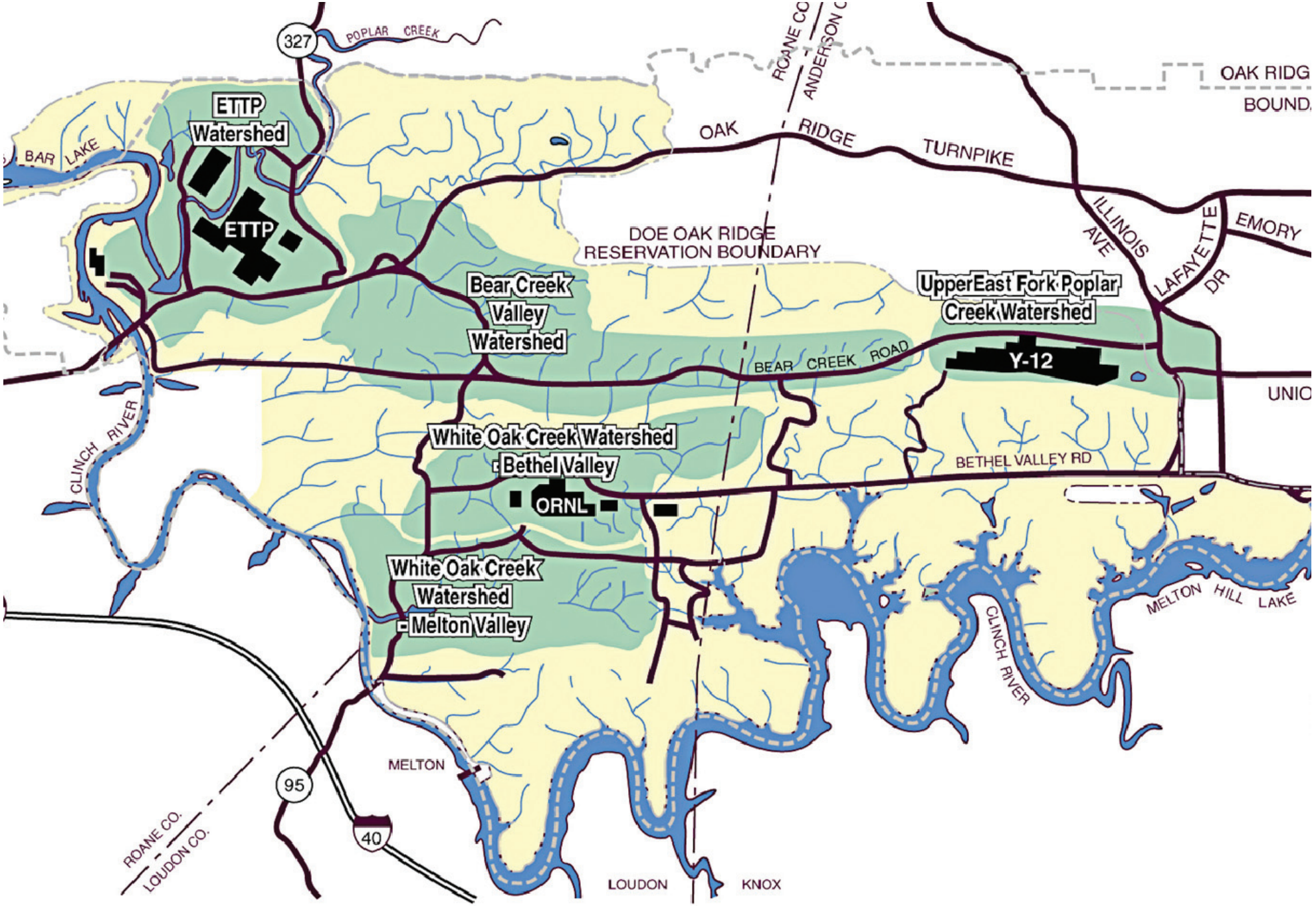
Evaluation of the Major ORR Hydrologic Watersheds

To evaluate contaminants released into the environment, the ORR is separated into five large tracts of land typically associated with the major hydrologic watersheds. The **watersheds** were grouped for analysis based on their similar hydrogeology and the nature of ORR operations in each watershed. ATSDR evaluated the following five major hydrologic watersheds on the ORR:

ATSDR concluded that on-site contaminated groundwater does not likely migrate beneath and away from streams and rivers either in fractures, solution channels, or other conduits in the bedrock. Almost all groundwater beneath the ORR ends up as surface water before leaving the site boundary.

- ETTP Watershed
- Bethel Valley Watershed
- Melton Valley Watershed
- Bear Creek Valley Watershed
- Upper East Fork Poplar Creek Watershed

ATSDR concluded that it is unlikely that contaminated groundwater at the ORR will flow beneath, and continue to flow away from, streams and rivers that surround the site. The sources of groundwater contamination on the ORR are primarily in the shallow subsurface groundwater, where extensive interconnections occur between groundwater and **surface water**. Before leaving the site boundary, almost all groundwater beneath the ORR ends up as surface water. Also, the silty-clay at the bottom of the streambeds likely impedes downward groundwater movement. Furthermore, the incised meander of the Clinch River in the **bedrock** is a major topographic feature that prevents ORR groundwater from passing beneath the river into areas off the ORR.


ETTP Watershed
ETTP
Bear Creek Valley Watershed
UpperEast Fork Poplar Creek Watershed
Y-12
White Oak Creek Watershed
Bethel Valley
ORNL
White Oak Creek Watershed
Melton Valley
DOE OAK RIDGE RESERVATION BOUNDARY
OAK RIDGE TURNPIKE
BEAR CREEK ROAD
BETHEL VALLEY RD
POPLAR CREEK
BAR LAKE
CLINCH RIVER
MELTON HILL LAKE
MELTON
ROANE CO.
LOUDON CO.
LOUDON
KNOX
ILLINOIS AVE
LAFAYETTE DR
EMORY
327
95
40

OPERATIONAL HISTORY OF THE K-25 SITE IN THE ETTP WATERSHED

1944
S-50 plant separated uranium by liquid thermal diffusion.

1945
S-50 plant closed.

1945-1964
K-25 site enriched weapons-grade uranium through gaseous diffusion.

1965-1985
K-25 site used uranium hexafluoride in the gaseous diffusion process to manufacture commercial grade uranium.

1976-Present
K-25 site maintains the Toxic Substances Control Act (TSCA) incinerator, which is the only facility in the country authorized to incinerate wastes with radioactive and hazardous contaminants containing polychlorinated biphenyls.

1985
Gaseous diffusion operations ceased.

1987
K-25 site was closed.

1996-present
Reindustrialization has been the focus of the K-25 site which now houses two business centers – Heritage Center and Horizon Center.

ETTP Watershed

The 1,700-acre K-25 site, which includes the former S-50 plant (37 acres), is now called the ETTP. The ETTP site is close to the ORR's western border and is situated along Poplar Creek, near the creek's confluence with the Clinch River.

Groundwater Contamination in the ETTP Watershed

Around the ETTP, monitoring wells have been installed at known exit points for groundwater discharge to surface waters. In this way, the migration of known contaminant plumes and contaminant concentrations in these areas can be monitored. VOC concentrations have shown a general decreasing trend at exit point monitoring wells.

Well Location	Well Type	Sampling Result
Near the confluence of Mitchell Branch and Poplar Creek	Bedrock well and unconsolidated zone monitoring well	No detectable levels of VOCs were detected.
Between K-901 holding pond and the Clinch River	Exit point monitoring wells	Low concentrations of trichloroethylene (TCE), 1,2-dichloroethylene (1,2-DCE), chloroform, gross alpha, and gross beta activity were detected. All levels were below their respective maximum contaminant levels (MCLs).
Southwest of K-27 building along Poplar Creek	Unconsolidated zone monitoring wells	Groundwater VOC concentrations range from 20 µg/L to 130 µg/L.
North of K-27 building along Poplar Creek	Monitoring well	TCE degradation products, such as cis-1,2-DCE and vinyl chloride, were present.

The distant portions of the VOC plumes near Mitchell Branch and north of the K-27 building are largely composed of TCE degradation products (e.g., cis-1,2-DCE and vinyl chloride). This may indicate that the source of contamination is either upgradient or has been eliminated. It could also be a result of increased biodegradation in those particular areas. Using monitoring data collected from known and suspected exit point locations in 2003, ATSDR found that contaminant concentrations (mainly VOCs) have either remained constant or have decreased from previous years. These steady or decreasing groundwater contaminant concentrations have also resulted in a decreased impact on the ETTP perimeter surface waters.

Lead, manganese, and boron occur naturally in groundwater and were detected above comparison values (CVs) in a few samples outside the ORR at seeps, springs, and residential wells. Because neither lead nor manganese could be detected in samples collected concurrently at adjacent sampling locations, it is unlikely that these substances are associated with groundwater contamination at ETTP. Similarly, boron was detected above its CV in one sample only. Concurrent sampling at adjacent wells revealed concentrations well below the CV. As part of the Water Resources Restoration Program for ETTP, exit pathway monitoring wells are continually sampled.

Groundwater contamination at ETTP does not migrate off site; rather, it is discharged into surface water, which is monitored by DOE. ATSDR has determined that no public health hazards are associated with contaminated groundwater from ETTP because no one is being exposed.

Public Health Implications

Groundwater movement beneath streams and rivers in the area of the ORR is limited. Cracks and fissures in the karst rock formations underlying the ORR significantly decrease with depth. This further limits migration of contaminants to shallow plumes intercepted by surface water in the form of seeps, springs, or as base flow for creeks and streams. Also, site-related contaminants have not been detected in seeps, springs, monitoring wells, or residential wells beyond the ORR boundaries near ETTP. Therefore, ATSDR concludes that the public is not exposed to groundwater contamination from ETTP.

Bethel Valley Watershed and Melton Valley Watershed

The X-10 site, now known as the ORNL, is about 10 miles southwest of the city center of Oak Ridge and encompasses approximately 26,580 acres. The ORNL is situated within the Bethel Valley and Melton Valley watersheds. The main laboratory at ORNL is located along Bethel Valley Road, within Bethel Valley. The ORNL also contains remote facilities and waste storage areas in Melton Valley. White Oak Creek begins in Bethel Valley, flows south along the eastern border of the plant, and travels through a gap in Haw Ridge before entering Melton Valley.

The major operations at ORNL take place within the Bethel Valley watershed. The main plant, key research facilities, primary administrative offices, and various waste sites are situated in Bethel Valley. Over the past 60 years, X-10 releases have contaminated the Bethel Valley watershed. Mobile contaminants primarily leave the Bethel Valley watershed via White Oak Creek. These contaminants travel from the Bethel Valley watershed to the Melton Valley watershed, where further contaminants enter White Oak Creek. Then the contaminants discharged to White Oak Creek are released over White Oak Dam and into the Clinch River.

Groundwater Contamination in the Bethel Valley Watershed

For the purpose of environmental investigation and remediation, the Bethel Valley area was subdivided into four regions: Raccoon Creek, West Bethel Valley, Central Bethel Valley, and East Bethel Valley. The Raccoon Creek area lies on the westernmost portion of the valley, west of Highway 95. West Bethel Valley lies east of Highway 95 and west of the ORNL main plant area. The Raccoon Creek area does not have any known contaminant source areas. West Bethel Valley, however, contains a solid waste storage area (SWSA 3) and adjacent landfills (covering approximately 18 acres) that have resulted in soil and groundwater contamination in both West Bethel Valley and Raccoon Creek. From 1946 to 1951, radiological wastes from DOE facilities all over the country were stored in SWSA 3. Over the years, seasonal surface water infiltration and heavy rain events have resulted in contaminant leaching from SWSA 3 and from the adjacent landfills.

The Raccoon Creek and the West Bethel Valley areas have relatively small, defined contaminant release areas, whereas the Central and East Bethel Valley areas have extensive soil and groundwater contamination. The Central Bethel Valley area contains the main ORNL plant and has over 150 sites that have been identified for environmental restoration. The leading areas of concern in terms of groundwater contamination in the Central Bethel Valley area are the Corehole 8 plume and building sumps, which have tested positive for mercury contamination. The Corehole 8 plume is regularly monitored.

The Corehole 8 plume identified at ORNL in 1991, is contaminated with Strontium-90 (90Sr). The source of the Corehole 8 plume is the W-1A tank in the North Tank Farm. This tank was commissioned in 1951, to receive low-level liquid waste from Buildings 3019, 3019B, and 2026. Tank use was discontinued in 1986, because of leaks in the transfer lines. Soil samples around the W-1A tank revealed extremely high levels of transuranic waste. The tank remains in place, however, because it was determined that removal would result in workers receiving a high radioactive dose rate.

In 1994, a removal site evaluation revealed that contaminated groundwater was leaching into ORNL's storm drain system and was releasing into First Creek. First Creek is a stream that feeds into White Oak Creek and ultimately flows into the Clinch River. Additional evaluation indicated that the contaminated groundwater was seeping into the storm drain system via three catch basins on the western portion of ORNL. By March 1995, a groundwater collection and transmission system was installed at the Corehole 8 plume to prevent groundwater infiltration. Through this system, groundwater is treated by ORNL's Process Waste Treatment Plant and then released through a National Pollutant Discharge Elimination System outfall.

OPERATIONAL HISTORY OF THE X-10 SITE IN THE BETHEL VALLEY AND MELTON VALLEY WATERSHEDS

1943
X-10 site was built as a "pilot plant" to demonstrate the production and separation of plutonium and the development of separation processes for additional radionuclides.

Post-World War II
X-10 site engaged in non-weapons-related activities, such as the physical and chemical separation of nuclear products; creation and assessment of nuclear reactors; and radionuclide production for global use in medical, industrial, and research disciplines.

1950s-1960s
X-10 site became a worldwide research center to study nuclear energy and to investigate the physical and life sciences related to nuclear energy.

1958-1987
Oak Ridge Research Reactor operated to support various scientific experiments at the X-10 site.

ENVIRONMENTAL HEALTH TERMS

Comparison value (CV)—Calculated concentration of a substance in air, water, food, or soil that is unlikely to cause harmful health effects in exposed people. The CV is used as a screening level tool during the public health assessment process. Substances found in amounts greater than their CVs might be selected for further evaluation in the public health assessment process.

French drain—A ditch filled with gravel, rock, or perforated pipe that redirects surface and groundwater away from an area.

Karst—An area of irregular limestone in which erosion has produced fissures, sinkholes, underground streams, and caverns.

Monitoring well—A well used to obtain water quality samples or measure groundwater levels. It is not used to supply drinking water.

Groundwater Contamination in the Melton Valley Watershed

Melton Valley served as the U.S. Atomic Energy Commission's Southern Regional Burial Ground for wastes for ORNL and over 50 other facilities. Solid and liquid radioactive wastes from ORNL were disposed of at Melton Valley, and experimental facilities were operated within this watershed. The major burial grounds are SWSA's 4, 5, and 6. Wastes were predominantly buried in unlined trenches and auger holes. Consequently, discharges from Melton Valley's waste areas have produced secondary contamination sources that include sediment, groundwater, and soil contamination. Furthermore, contaminants discharged from Melton Valley travel off the reservation through surface water and flow into the Clinch River. As a result, the greatest impact to off-site receptors is from surface water contaminated with 90Sr, tritium (3H), and cesium-137 (137Cs) flowing across the White Oak Dam. The three primary release areas in Melton Valley are the SWSA 4 Seep area, and SWSA 5 Seeps C and D.

Primary Release Area	Location	Percent Contamination Contributed	Remediation Technique	Result
SWSA 4 Seep Area	ORNL	25% of 90Sr discharged over White Oak Dam; two seeps produced 70% of 90Sr discharged from SWSA 4	Grouting technique to reduce 90Sr released from SWSA 4 trenches into White Oak Creek	As of 2001, 90Sr releases were reduced by 33%
SWSA 5 Seep C	Southern portion of waste area grouping 5 (WAG 5)	20-30% of 90Sr detected at White Oak Dam between 1993 and 1994	**French drain** and filtration system	Samples taken in 2000 and 2001, indicated >99% of 90Sr was prevented from entering Melton Branch and potential off-site locations.
SWSA 5 Seep D	Southern portion of WAG 5	7% of 90Sr detected at White Oak Dam between 1993 and 1994	Groundwater treatment unit	Samples taken in 2000 and 2001, indicated >99% of 90Sr was prevented from entering Melton Branch and potential off-site locations.

In a few samples outside the ORR at seeps, springs, and **monitoring wells**, thallium, iron, and boron were detected above **comparison values (CVs)**. Thallium has been detected sporadically off site near ORNL. While no subsequent sampling has occurred at the specific locations, concurrent sampling from adjacent locations did not detect thallium. Iron and boron were not detected in subsequent sampling events. No contamination has been detected in residential wells near ORNL.

No site-related contamination from operations in Bethel or Melton Valleys has been found in the groundwater beyond the ORR boundaries. For this reason ATSDR has determined that no public health hazards are associated with ORNL-contaminated groundwater.

Groundwater in Bethel Valley and Melton Valley has short flow paths to surface water, namely, First Creek, Raccoon Creek, the Northwest Tributary, and White Oak Creek. Contaminated groundwater has not migrated past the ORR boundary. Remediation of groundwater in Bethel Valley and Melton Valley is ongoing. In general, contaminant concentrations have either decreased or have remained steady.

Public Health Implications

Groundwater movement beneath streams and rivers in the ORR area is limited. Cracks and fissures in the karst rock formations underlying the ORR significantly decrease with depth. This further limits migration of contaminants to shallow plumes intercepted by surface water, either by seeps and springs or as base flow for creeks and streams. Also, site-related contaminants have not been detected beyond the ORR boundaries near ORNL in seeps, springs, monitoring wells, or residential wells. Therefore, ATSDR concludes that the public is not being exposed to groundwater contamination from ORNL.

Bear Creek Watershed and Upper East Fork Poplar Creek Watershed

The Bear Creek watershed and the Upper East Fork Poplar Creek watershed comprise a large portion of Bear Creek Valley, which is bordered by Chestnut Ridge and Pine Ridge. The 825-acre Y-12 plant is located in Bear Creek Valley and lies predominantly in the Upper East Fork Poplar Creek watershed.

Completion of remedial actions in Bear Creek Valley has resulted in a substantial reduction in contaminants. The short- and long-term goals set forth in the Record of Decision, in terms of land use and risk to residents, are being met.

Groundwater Contamination in the Bear Creek Valley Watershed

Bear Creek Valley was divided into three zones to establish and evaluate performance standards for each zone, in terms of resulting land and resource uses and residential risks following remediation. Throughout much of the ORR, there is a very high interconnectivity between surface water and groundwater. Gaining and losing reaches of Bear Creek occur along the entire Bear Creek Valley. Often, the contamination of surface water results in increasing contaminant concentrations in the shallow groundwater and vice versa.

Location	Land Use Goal	Groundwater Contamination	Current Status
Zone 1	Unrestricted use	Detectable concentrations of nitrate, technetium-99 (99Tc), gross alpha, and gross beta were detected. Uranium was not detected above the MCL.	Monitoring locations, schedule of sampling, and parameters to be monitored have all been established in accordance with the Record of Decision.
Zone 2	Short-term land use goals are recreational; long-term land use goals are unrestricted use	Samples collected at the integration point exceeded secondary MCLs for aluminum and manganese. In 2003, uranium was detected in the background range.	Zone 2 continues to meet the criteria for the remediation goal of recreational land use.
Zone 3	Long-term land use goals are industrial	Uranium, nitrate, manganese, and several VOCs have exceeded MCLs for many years following previously observed trends.	Groundwater cleanup criteria in Zone 3 have not been determined, but contaminant concentrations are being monitored and compared to MCLs for evaluation.

Groundwater Contamination in the Upper East Fork Poplar Creek Watershed

Groundwater contamination occurs beneath the entire Upper East Fork Poplar Creek watershed and extends east-northeast from the Y-12 complex, across the ORR boundary, into Union Valley. This VOC-contaminated plume consists of several plumes from a variety of sources. Although the sources of most of these contaminants cannot be confirmed, they are likely a result of various leaks and spills throughout the Y-12 facility. Carbon tetrachloride, the primary VOC in the contaminant plume, was used extensively in the 1940s in the electromagnetic uranium separation process.

The VOC plume in Union Valley is the only confirmed off-site groundwater contaminant plume that has migrated across the ORR boundary.

Areas in Union Valley overlying the known extent of the contaminant plume are zoned as "Industrial District 2." As a result of the potential for future business development, the 1997 Interim Record of Decision for Union Valley established institutional controls. Accordingly, DOE enters into license agreements with property owners so that DOE can notify them of the potential of contamination. This ensures that public health is protected while final remedial actions are developed and implemented. If necessary, it also identifies or prohibits future activities that could accelerate the rate of contaminant migration or increase the extent of the contaminant plume. These institutional controls will help to ensure that no one is exposed to contaminated groundwater—now or in the future.

OPERATIONAL HISTORY OF THE Y-12 COMPLEX IN THE BEAR CREEK AND UPPER EAST FORK POPLAR CREEK WATERSHEDS

1944-1947
Y-12 complex electromagnetically enriched uranium.

1952
Y-12 complex was converted to enrich lithium-6 using a column-exchange process and to fabricate components for thermo-nuclear weapons using high-precision machining and other specialized processes.

1992
Y-12 complex was used for weapons disassembly and weapon renovation operations.

Present
Y-12 complex is currently used by the National Nuclear Security Administration as the primary storage site for highly enriched uranium.

ENVIRONMENTAL HEALTH TERMS

Concentration—The amount of a substance present in a certain amount of soil, water, air, food, blood, hair, urine, or any other media.

Conservative—ATSDR uses the term "conservative" to refer to values that are protective of public health in essentially all situations.

Extraction well—A well through which contaminated groundwater is extracted, or pumped from the ground.

The uranium flux throughout the Bear Creek Valley watershed decreased markedly in 2002 and 2003. Three off-site monitoring wells near the Y-12 complex and within the known extent of the VOC groundwater contaminant plume contained 12 contaminants with at least one sample above CVs. The contaminants included the following: aluminum, arsenic, boron, carbon tetrachloride, chloroform, chromium, fluoride, iron, lead, tetrachloroethylene, thallium, and TCE. Of these contaminants, only carbon tetrachloride, chloroform, tetrachloroethylene, and TCE are VOCs. The following VOCs were either absent or detected at **concentrations** below the CVs in all subsequent samples: chloroform, tetrachloroethylene, and TCE. In addition, sampling of off-site residential wells near the Y-12 complex, including the nearest residential well (approximately 2.25 miles east of the known extent of the VOC plume) found no contaminants above CVs. In August 1999, DOE issued an action memorandum to initiate installation and testing of a groundwater **extraction well**. Since that time, the VOC groundwater plume in the Upper East Fork Poplar Creek watershed has been subjected to aggressive pump and treat remedial efforts. Actual pumping and treating of the plume to remove groundwater contamination began in June 2000.

Off-site Groundwater Exposure Pathways

The only confirmed groundwater contamination to have migrated off site was from the VOC-contaminated plume originating in the Y-12 complex. Because off-site groundwater contamination only occurs in the area immediately east of Y-12 in Union Valley, this is the only area where exposure scenarios were evaluated. ATSDR identified three possible exposure scenarios to the VOC plume: (1) withdrawal of groundwater for personal use from private groundwater wells, (2) the possibility of someone coming in direct contact with groundwater at seeps or springs in Union Valley, and (3) the inhalation of VOCs via vapor intrusion from the plume that is underneath an off-site office building east of the Y-12 complex.

Using currently available data, ATSDR detected two *incomplete exposure pathways* for off-site groundwater—withdrawal of groundwater from private groundwater wells and the possibility of someone coming in direct contact with groundwater at seeps or springs. The area east of the Y-12 complex (the only contaminated off-site area) is zoned for industrial purposes; therefore, no residences or private wells are in use in this area. In fact, the only groundwater withdrawal is from the dewatering operations of the quarry near the eastern end of Union Valley, and contamination has never been detected in the quarry groundwater. Further, because of the shallow water table at ORR and the high interconnectivity of the groundwater with the surface water, contaminated groundwater typically discharges to surface water.

ATSDR has determined that ingestion and direct contact with off-site groundwater are incomplete exposure pathways and consequently do not pose any health risks to people.

An office building just east of the Y-12 complex partially overlies the VOC plume. As a result, a *potentially complete exposure pathway* is available for the inhalation of VOCs *via* vapor intrusion. Therefore, ATSDR evaluated the possibility of vapor intrusion into the workspaces within the office building. Because the vapor concentration of VOCs is unknown in the building, ATSDR used **conservative** default parameters and assumptions to model the VOC vapor intrusion into the office building. Using currently available data and the results of conservative modeling, the estimated VOC concentrations were determined to be several orders of magnitude below levels of health concern.

Contaminated Off-Site Groundwater

Pathway	Source of Contamination	Environmental Media	Point of Exposure	Route of Exposure	Receptor Population
Contacting groundwater from private wells in Union Valley	VOC plume from the Y-12 complex	Plume has migrated east, off site into Union Valley.	None. There are no residences deriving drinking water from private wells in this area.		
Incomplete Exposure Pathway					
Contacting groundwater from seeps and springs in Union Valley	VOC plume from the Y-12 complex	Plume has migrated off site and discharges at various seeps and springs throughout Union Valley.	Potential use of, or contact with, spring water from Union Valley	• Ingestion • Dermal contact • Inhalation	None likely. Seeps and springs feed Scarboro Creek, so isolated contact with groundwater before dilution in surface water is unlikely.
Incomplete Exposure Pathway					
Inhaling VOCs via vapor intrusion in the off-site office building in Union Valley	VOC plume from the Y-12 complex	Plume is the only confirmed off-site groundwater contamination originating at the ORR.	Working in the office building immediately east of Y-12	• Inhalation	Individuals working in the building.
Potentially Complete Exposure Pathway					

Public Health Implications

The exposure evaluation addressed three possible exposure scenarios for contacting contaminated groundwater originating from the Y-12 complex. Ingestion and direct contact with contaminated groundwater were eliminated because of the absence of a receptor population. Exposure to the contaminated groundwater is unlikely because of the absence of private wells and residences near the VOC plume in Union Valley. The third possible exposure pathway, vapor intrusion into an off-site office building overlying the VOC plume, was conservatively modeled with results indicating estimated vapor concentrations well below levels of health concern. Therefore, ATSDR concludes that the public is not being exposed to harmful groundwater contaminants from the Y-12 complex.

ATSDR has determined that no public health hazards are associated with contaminated groundwater from the Y-12 complex.

ELEMENTS OF AN EXPOSURE PATHWAY

Source of contamination—The place where a hazardous substance comes from, such as a landfill, waste pond, incinerator, storage tank, or drum.

Environmental media— Soil, water, air, biota (plants and animals), or any other parts of the environment that can contain contaminants.

Point of exposure— The place where someone can come into contact with a substance present in the environment.

Route of exposure— The way people come into contact with a hazardous substance. Three routes of exposure are breathing (inhalation), eating or drinking (ingestion), or contact with the skin (dermal contact).

Receptor population— People who could come into contact with hazardous substances.

Conclusions for ATSDR's Off-site Groundwater Evaluation

- Although extensive groundwater contamination exists throughout the ORR, ATSDR scientists have concluded that there is **no public health hazard** because no one is being exposed. Sufficient evidence exists that no human exposures to contaminated groundwater occurred in the past, no exposures occur currently, and no exposures are likely to occur in the future.
- It is unlikely that contaminated groundwater at the ORR will flow beneath and then continue to flow farther away from the streams and rivers that surround the site. The meander of the Clinch River in bedrock represents a major topographic feature that prevents groundwater from passing beneath the river.
- ATSDR evaluated the possibility of contaminant vapors entering the workspaces within the office building that partially overlies the contaminated off-site groundwater area. Based on currently available data and the results of conservative modeling, the estimated contaminant concentrations were determined to be below levels of health concern.

ATSDR's Recommendations

- Inform the community that ATSDR has evaluated off-site groundwater contamination from the ORR and has concluded that **no public health hazard** is associated with past and current releases.
- Initiate a regular, periodic residential well sampling program to assure that residential wells remain free of ORR site-related contaminants.
- Retain and enforce the institutional controls set forth in the Interim Record of Decision for Union Valley to prevent exposure to contaminated groundwater.

Where can I get more information?

You can get more detailed information from ATSDR's Web site at *http://www.atsdr.cdc.gov/*. You may also contact ATSDR headquarters toll free at 1-888-42ATSDR (1-888-422-8737) or contact Jack Hanley or Marilyn Palmer.

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