CHAPTER 2 ENVIRONMENTAL DESCRIPTION

Chapter 2 describes the existing environmental conditions at the Clinch River Nuclear (CRN) Site, vicinity, and region. The environmental descriptions provide sufficient detail to identify those environmental resources that have the potential to be affected by the construction, operation, or decommissioning of two or more Small Modular Reactors (SMRs). The level of detail is commensurate with level of information associated with an Early Site Permit Application (ESPA). This chapter is divided into eight subsections:

- Site Location (Section 2.1)
- Land (Section 2.2)
- Water (Section 2.3)
- Ecology (Section 2.4)
- Socioeconomics (Section 2.5)
- Geology (Section 2.6)
- Meteorology and Air Quality (Section 2.7)
- Noise (Section 2.8)
- Related Federal Project Activities (Section 2.9)

2.1 SITE LOCATION

The Tennessee Valley Authority (TVA) proposes to demonstrate that the approximately 935-acre (ac) Clinch River Nuclear (CRN) Site is a suitable site for the construction and operation of two or more small modular reactors (SMRs). The CRN Site is located in Roane County in eastern Tennessee. The property is owned by the federal government and is managed by TVA (Reference 2.1-1). TVA is the named applicant for the Clinch River SMR Project. The regional setting for the CRN Site is depicted in Figure 2.1-1. The CRN Site and immediate vicinity (6-mile [mi] radius) are shown in Figure 2.1-2.

The proposed site configuration, including the location of the surrogate plant as defined by the plant parameter envelope (see Subsection 3.1.2 for a description), is presented in Figure 2.1-3. The CRN Site center point is listed in Tables 2.1-1 and 2.1-2 and shown on Figure 2.1-2. The center point of the CRN Site is located approximately 11 mi southwest of the City of Oak Ridge, Tennessee business district. The center point of the CRN Site is approximately 25 mi west-southwest of downtown Knoxville, Tennessee; 24 mi west-northwest of Maryville/Alcoa, Tennessee; and 30 mi north-northeast of Athens, Tennessee. (Reference 2.1-2; Reference 2.1-3)

The nearest population center to the CRN Site, as defined by Title 10 of the Code of Federal Regulations 100.3, is the City of Oak Ridge, Tennessee. The Site is located within the Oak Ridge city limits. The City of Oak Ridge, Tennessee is also the largest city whose boundary lines are located within 10 mi of the CRN Site. (Reference 2.1-4; Reference 2.1-3)

Although the urbanized area of Oak Ridge, Tennessee is within 10 mi north of the CRN Site, the majority of the city's incorporated area within the 10-mi radius of the CRN Site is occupied by federally-owned land, including the U.S. Department of Energy's (DOE's) Oak Ridge Reservation. The next closest communities from the center point of the CRN Site are the cities of Kingston, Tennessee (7.2 mi to the west) and Lenoir City, Tennessee (approximately 8.9 mi to the southeast). Oak Ridge, Tennessee is the only urbanized area located within the CRN Site vicinity (6-mi radius). (Reference 2.1-3)

A principal arterial, Interstate 40, is located south of the CRN Site as shown in Figure 2.1-1. Two rural, principal arterials frame the CRN Site on the north as shown in Figure 2.1-2. Tennessee State Highway (TN) 58 is located northwest of the CRN Site and TN 95 is located to the northeast. The CRN Site is accessed from either of these roadways via Bear Creek Road. No known major roadway improvements are planned for the area. The City of Oak Ridge has supported several studies related to the possible development of a general aviation airport at the East Tennessee Technology Park (Reference 2.1-5). A rail spur (EnergySolutions Heritage Railroad) is located approximately 2.5 mi north-northwest of the center point of the CRN Site, northwest of TN 58 (Reference 2.1-6).

The CRN Site is located on a peninsula on the north shore of the Clinch River arm of Watts Bar Reservoir (Figure 2.1-2), between approximately Clinch River Mile (CRM) 14.5 and CRM 19.

(Reference 2.1-7; Reference 2.1-8) There is an inactive DOE barge terminal at CRM 13.1, near Bear Creek Road and the TN 58 ramp approximately 1.3 mi northwest of the primary CRN Site entrance (Reference 2.1-9). A former barge terminal that was used for construction of TN 58 is located between the TN 58 bridge and the CRN Site entrance. A barge terminal was approved to be constructed in association with the Clinch River Breeder Reactor Project (CRBRP) in the 1970s and 1980s. This terminal was proposed within the CRN Site south of the mouth of Grassy Creek but was never constructed (Reference 2.1-10; Reference 2.1-11). The Grassy Creek Habitat Protection Area is located adjacent to the northern boundary of the CRN Site as shown in Figure 2.1-2.

The majority of the CRN Site is within the 7.5 minute Elverton Quadrangle. The eastern portion of the site is in the Bethel Valley Quadrangle. The site is bracketed by the Petros and Windrock Quadrangles to the north, the Lovell Quadrangle to the east, the Lenoir City and Cave Creek Quadrangles to the south, and the Harriman Quadrangle to the west. (Reference 2.1-12; Reference 2.1-13)

2.1.1 References

Reference 2.1-1. Executive Office of the President and Bureau of the Budget, "Order Transferring to the Tennessee Valley Authority the Use, Possession, and Control of Certain Lands from the Atomic Energy Commission WBR-1790," March 24, 1998.

Reference 2.1-2. U.S. Census Bureau, "2010 Census - Urbanized Area Reference Map: Knoxville, TN," March 10, 2012.

Reference 2.1-3. Enercon, Figure 1: Site Vicinity Map, Prepared for Tennessee Valley Authority, February 13, 2013.

Reference 2.1-4. U.S. Census Bureau, State and County QuickFacts, Oak Ridge, TN, Website: http://quickfacts.census.gov/qfd/states/47/4755120.html, January 10, 2013.

Reference 2.1-5. City of Oak Ridge, Tennessee, 2013 State and Federal Legislative Agenda, Website: http://www.oakridgetn.gov/images/uploads/Documents/Featured%20Projects/2013%20State%20%20Federal%20Agenda%20final.pdf, January 14, 2013.

Reference 2.1-6. U.S. Environmental Protection Agency, "Clinch River NEPAssist, Railroads Map," 2013.

Reference 2.1-7. Tennessee Valley Authority, "Final Environmental Impact Statement Watts Bar Reservoir Land Management Plan Loudon, Meigs, Rhea, and Roane Counties, Tennessee," February, 2009.

Reference 2.1-8. Watts Bar - Clinch Watershed Team, Final Watts Bar Reservoir Land Management Plan, Panel 4; Alternative B "Preferred", January 23, 2009.

Reference 2.1-9. Tennessee Valley Authority, Tennessee and Cumberland River Terminal Directory, Website: http://www.tva.com/river/navigation/pdf/terminal_list.pdf, 2013.

Reference 2.1-10. U.S. Department of Energy, Tennessee Valley Authority, and Project Management Corporation, "Clinch River Breeder Reactor Plant DOE/TVA/PMC Site Redress Planning Task Force Report," January, 1984.

Reference 2.1-11. Project Management Corporation, "Clinch River Breeder Reactor Plant Environmental Report Volume II," 1982.

Reference 2.1-12. U.S. Geological Survey, Elverton Quadrangle Tennessee 7.5-Minute Series, 2013.

Reference 2.1-13. U.S. Geological Survey, Bethel Valley Quadrangle Tennessee 7.5-Minute Series, 2013.

Table 2.1-1
CRN Site Center Point in Longitude and Latitude (Decimal Degrees)

Longitude	Latitude
-84.380927	35.890889

Table 2.1-2
CRN Site Center Point in Tennessee State Plane Projection
(NAD27 UTM Zone 16 Meters)

Easting	Northing
736,407.140357	3,974,815.263382

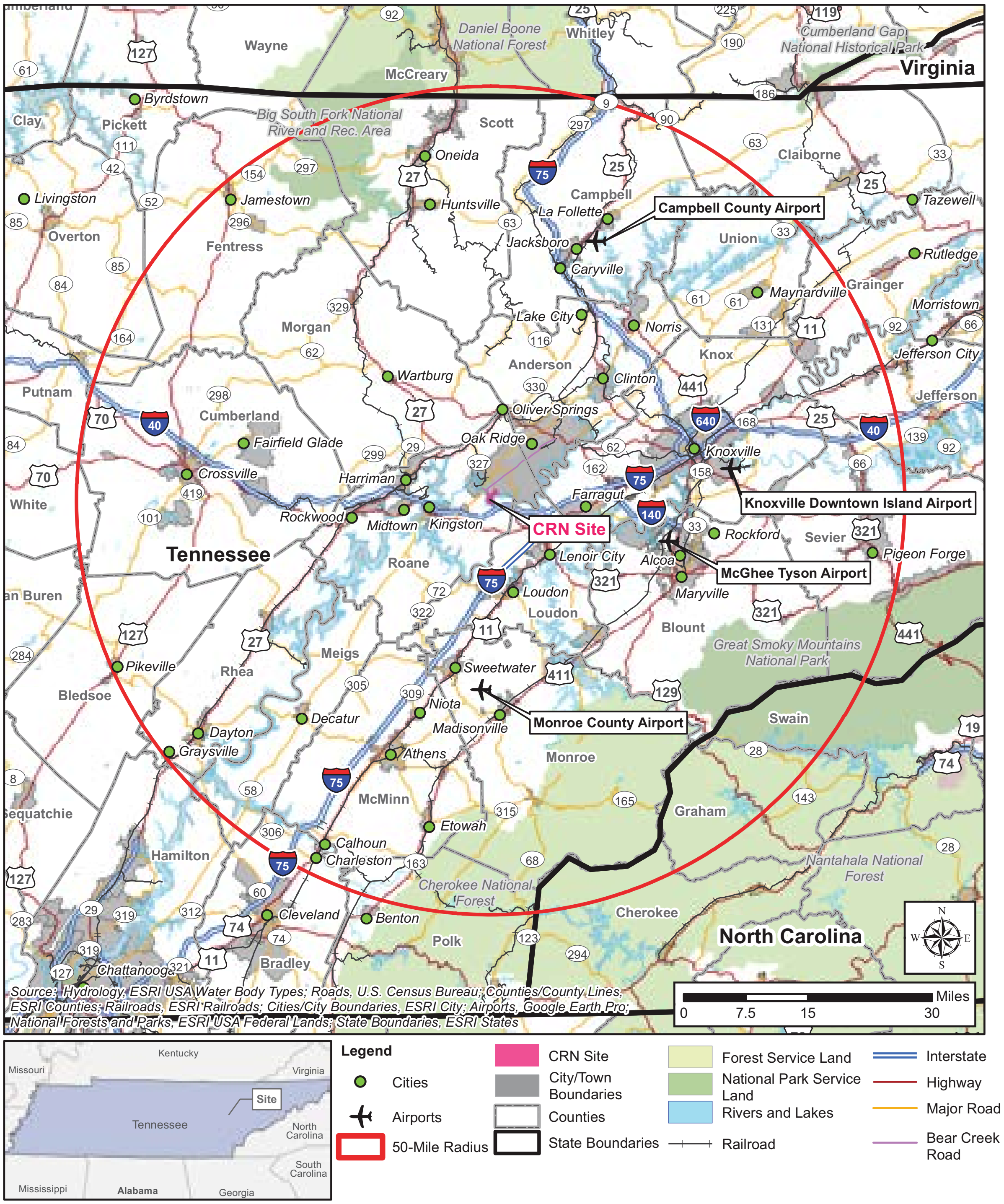
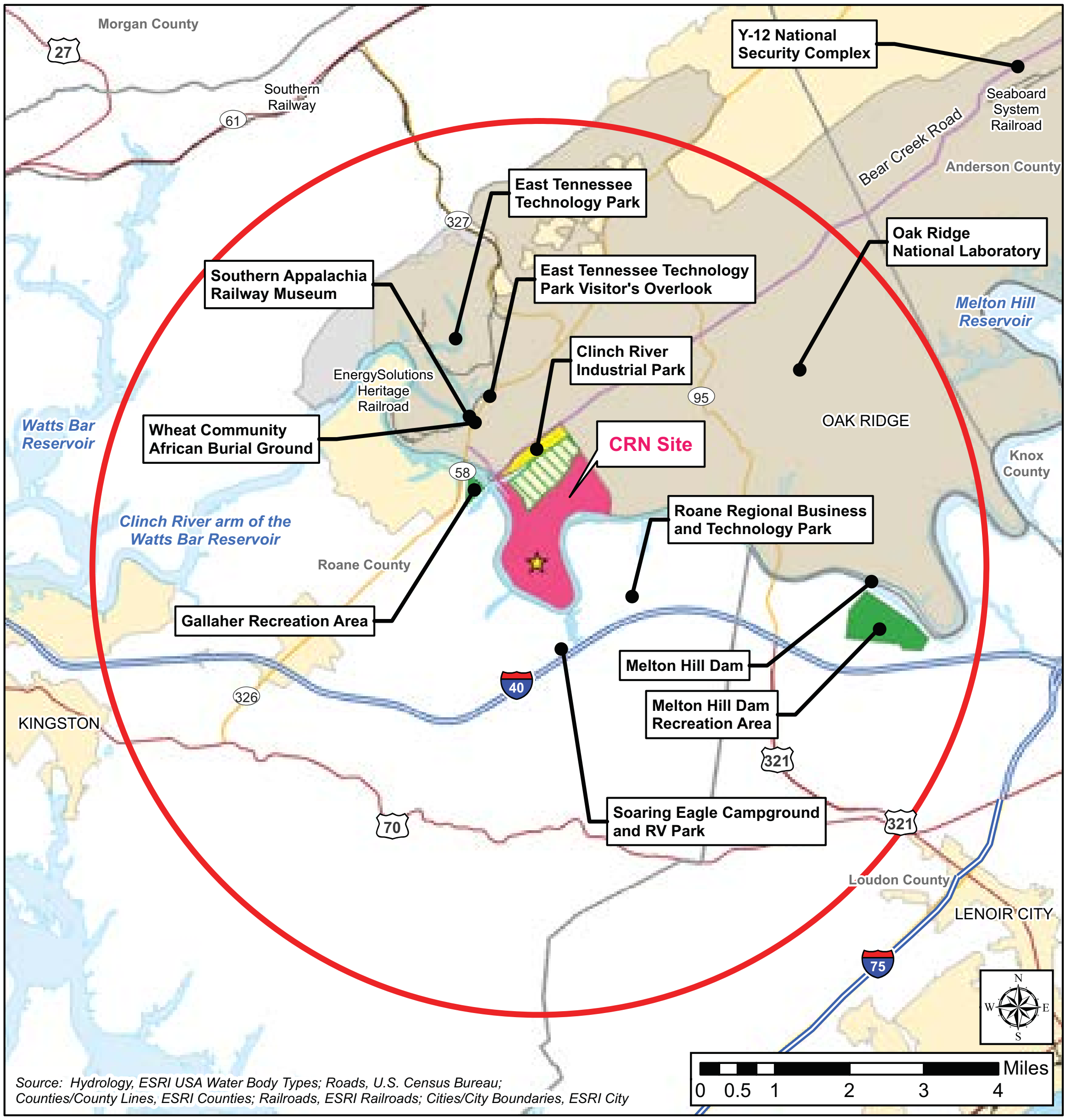


Figure 2.1-1. CRN Site 50-Mile Regional Map



Legend

CRN Site Center Point	Counties	Oak Ridge Reservation Boundary	Highway
6-Mile Radius	Rivers and Lakes	Clinch River Industrial Area	Major Road
CRN Site	Grassy Creek Habitat Protection Area	Railroad	Bear Creek Road
Town/City Boundaries	Recreation Areas	Interstate	

Figure 2.1-2. CRN Site 6-Mile Vicinity Map

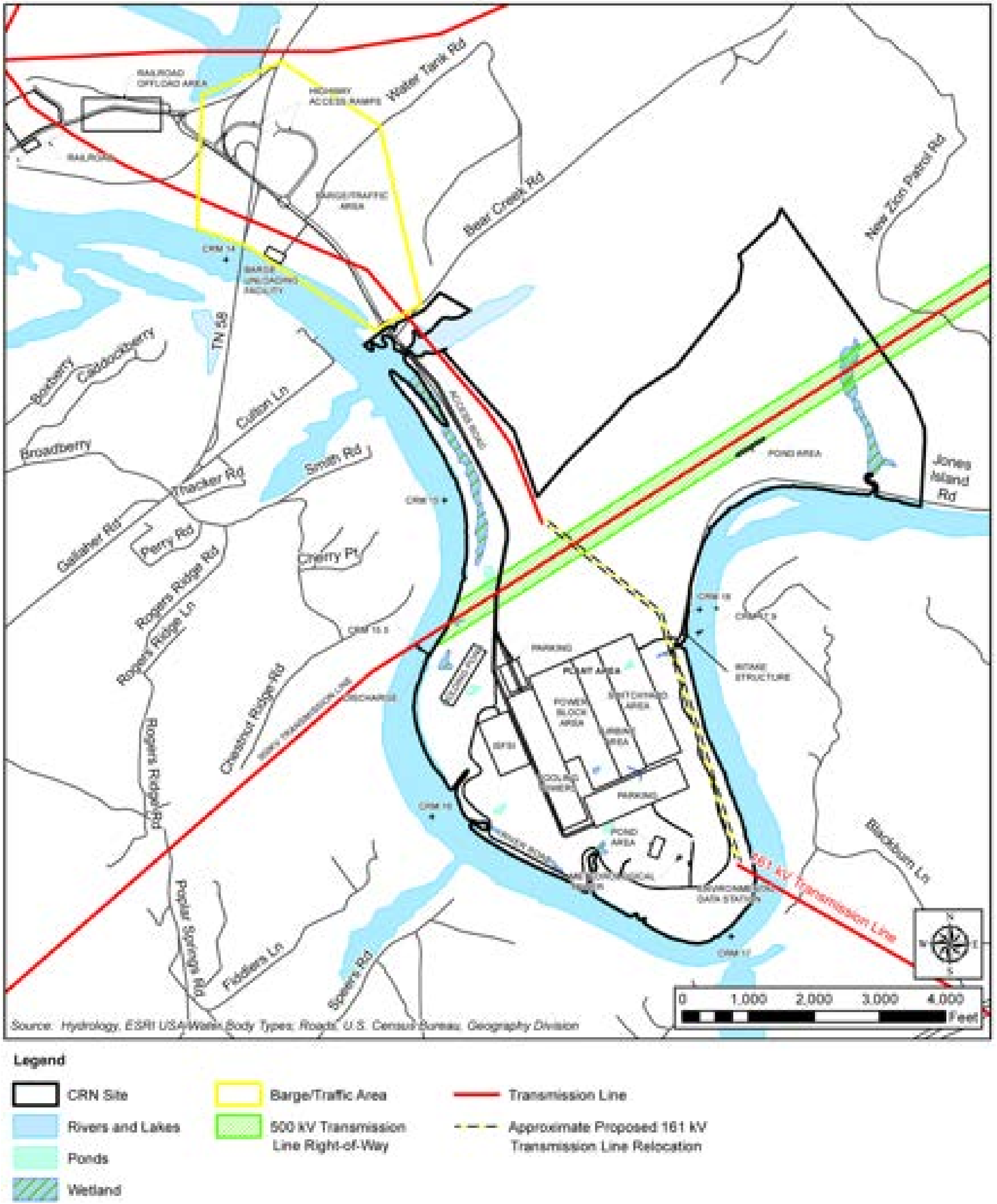


Figure 2.1-3. CRN Site Layout

2.2 LAND

This section describes the Clinch River Nuclear (CRN) Site and land use in the vicinity and region of the CRN Site. The CRN Site is located in Roane County in eastern Tennessee (Figure 2.1-1), and is accessible by road and river. Interstate (I-) 40 connects Knoxville and Kingston, Tennessee, and its closest point to the CRN Site is approximately 0.6 miles (mi) southeast of the nearest site boundary, across the Clinch River arm of Watts Bar Reservoir (Figure 2.1-2). Additional interstate highways in the CRN Site region include I-75, I-640, and I-140 (Figure 2.1-1). Nearby state roads include Tennessee State Highway (TN) 58, TN 95, TN 327, TN 61, TN 70, and TN 321 (Figure 2.1-2). A privately-owned rail spur (EnergySolutions Heritage Railroad) is located approximately 2.5 mi north-northwest of the center of the CRN Site, northwest of TN 58 (Reference 2.2-1). The CRN Site is accessed from TN 58 or TN 95 via Bear Creek Road (Figure 1.1-2).

2.2.1 The Site and Vicinity

2.2.1.1 The Site

The center of the CRN Site is located approximately 10.7 mi southwest of the City of Oak Ridge, Tennessee, business district (Figure 1.1-1) and lies within the Oak Ridge city limits. The CRN Site center point is approximately 25.2 mi west-southwest of downtown Knoxville, Tennessee. The Clinch River arm of the Watts Bar Reservoir surrounds the CRN Site on the south, west, and much of the eastern sides. The majority of the CRN Site is located on a peninsula on the north bank of the Clinch River arm of the Watts Bar Reservoir, located between approximately Clinch River mile (CRM) 14.5 and CRM 19 (Reference 2.2-2). The primary entrance to the CRN Site is located adjacent to the Clinch River arm of the Watts Bar Reservoir along Bear Creek Road (Figure 2.2-1). The emergency egress road for the CRN Site intersects with the Jones Island Road on the Oak Ridge Reservation (ORR). The proposed configuration for the CRN Site is provided in Figure 2.1-3.

The Clinch River Property is the approximately 1200 acres (ac) of land adjacent to the Clinch River arm of the Watts Bar Reservoir owned by the federal government and managed by the Tennessee Valley Authority (TVA). The Clinch River Property includes the CRN Site, which is approximately 935 ac, and the Grassy Creek Habitat Protection Area (HPA). The Grassy Creek HPA is located north of the CRN Site as shown in Figure 2.2-1.

TVA directs the land management activities at the Clinch River Property in accordance with the Watts Bar Land Management Plan (Reference 2.2-3). TVA manages the property and mineral rights of the Clinch River Property. There are no known mineral resources, including oil and natural gas, within or adjacent to the CRN Site that are being exploited or are of any known value. The only known resource of value located within the CRN Site is limestone (which is not currently being exploited), and TVA owns the mineral rights for the CRN Site. (Reference 2.2-4)

Historic property uses on the CRN Site included several small farmsteads scattered across the CRN Site and the Clinch River Breeder Reactor Project (CRBRP) (Reference 2.2-5; Reference 2.2-6). Portions of the CRN Site were disturbed during the proposed CRBRP, as described in the CRN Site Land Use and Recreation Technical Report (Reference 2.2-7). The CRN Site was selected as the location for construction of a liquid metal fast breeder reactor in 1972. Site preparation for the CRBRP began in 1982 and was nearly complete in late 1983. (Reference 2.2-8) Approximately 240 ac of the current CRN Site were disturbed during site preparation for the CRBRP (Reference 2.2-9). CRBRP site preparation activities included leveling a ridge that originally reached 880 feet (ft) above mean sea level (msl) to 780 msl, excavation of the construction area, and installation of various structures and pads (Reference 2.2-8). The excavated area totaled approximately 24 ac in extent and extended to as much as 100 ft in depth (Reference 2.2-10). Approximately three million cubic yards of earth and rock were excavated during the CRBRP site preparation. Structures installed at the CRBRP site included a cement crane pad, quality control test laboratory, construction shops, concrete batch plants, and sediment ponds. An approximately 6450 foot long 8-inch (in.) water line from the U.S. Department of Energy's (DOE's) Bear Creek Filtration Plant was also installed at the CRBRP site. (Reference 2.2-8; Reference 2.2-9) The project was terminated in late 1983 and CRBRP site redress plans were developed and implemented. Measures to stabilize the CRBRP site included reseeding of grass, and planting of trees, mulching cleared areas, installation of straw bales in shallow ditches, installation of small berms of riprap in larger ditches, installation of culverts to direct water from steep slopes, and modification of the holding ponds for long-term stability (Reference 2.2-11). Portable buildings and structures were removed from the CRBRP site with the exception of the crane pad and meteorological tower (Reference 2.2-12). The approximately 6450 foot long 8-in. water line was terminated at a hydrant and left in place (Reference 2.2-13). The 80 foot by 80 foot crane pad was left in place (Reference 2.2-9; Reference 2.2-7) The excavated area was partially backfilled in a manner to sustain site drainage. Rock bolts within the excavated area were left in place. Level areas of the CRBRP site were graded and compacted. (Reference 2.2-14) The meteorological tower was removed by TVA in October 2013 (Reference 2.2-7).

The current Clinch River Property topography includes steep hills and flat meadows as shown in Figure 2.2-1. A series of roughly parallel ridges of gradually lower elevations stretches from the Chestnut Ridge, near the CRN Site entrance and in the Grassy Creek HPA, to approximately the center of the peninsula. The ridges within the CRN Site footprint are approximately 860 to 940 msl in elevation. Several small drainages descend from these ridges to the Clinch River arm of the Watts Bar Reservoir. The southeastern portion of the peninsula is a relatively flat plateau, with an elevation of approximately 780 msl. The plateau was created during the construction activities associated with the CRBRP. A few small hills are located in this portion of the CRN Site. The large depression from previous excavation work conducted as part of the former CRBRP is also located in this area. The northeastern portion of the CRN Site consists of interspersed rolling hills and meadows. Elevations in this part of the CRN Site range from approximately 780 msl at the meadows to 940 msl at the peaks of the hills. (Reference 2.2-7)

The CRN Site currently consists primarily of undeveloped land. Based on the U.S. Geological Survey (USGS) land-cover classification standards and the 2011 National Land Cover Database (NLCD), land use and land cover on ORR Site 3 is categorized and shown in Table 2.2-1 and Figure 2.2-2. Forested land (deciduous, evergreen, and mixed forest) accounts for approximately 48 percent of the CRN Site. Wetlands (emergent herbaceous and woody wetlands) occupy approximately 9 percent of the CRN Site. Other vegetated undeveloped land (grassland/herbaceous and shrub/scrub) occupies approximately 5 percent of the CRN Site. Land classified as cultivated crops and pasture/hay occupy approximately 27 percent of the CRN Site. Open water and barren land occupy approximately 4 percent of the CRN Site. Developed areas (high, medium, and low intensity, or open space) occupy approximately 7 percent of the CRN Site.

Modern soil survey data produced by the U.S. Department of Agriculture (USDA) in which prime farmland soils are classified are not available for the CRN Site or the adjacent ORR. A 1942 Soil Survey for Roane County includes the CRN Site and ORR. The 1942 Roane County soil survey provides soil productivity classifications based on soil suitability for various uses including cropland, pasture, and forest. Figure 2.2-3 shows the soil types on and around the CRN Site. The area previously impacted by the CRBRP excavations is shown on Figure 2.2-3. These soils have been disturbed. Table 2.2-2 lists the 1942 soil type classifications on the CRN Site and the ORR. Table 2.2-3 lists the 2009 soil types on non-federal lands in the area.

The modern prime farmland classification of soils should be similar to the first-class (good to excellent cropland) 1942 classification. There are no first-class soils within the CRN Site or in the immediate vicinity on the ORR. The only project activities using soils currently planned for the areas included in the 2009 soil survey would be the use of borrow pits for onsite fill, which are discussed in Subsection 2.2.3.

A Farmland Conversion Impact Rating (Form AD-1006) was completed by TVA in consultation with the USDA's Natural Resources Conservation Service to quantify the potential impacts to prime farmland. The impact rating considers the acreage of prime farmland to be converted, the relative abundance of prime farmland in the surrounding county, and other criteria such as distance from urban support services and built-up areas, potential effects of conversion on the local agricultural economy, and compatibility with existing agricultural use. Sites with a total score of at least 160 have the potential to adversely affect prime farmland. The impact rating score for the CRN Site was 102 points (Environmental Report Appendix A).

Limited infrastructure development and structures are present on the CRN Site. Near the center of the peninsula on the plateau, TVA has installed a gravel parking lot and several mobile trailers and support structures, for use as office and storage space. The Hensley Cemetery, a small private cemetery, is located on the south side of the peninsula along River Road (Figure 2.2-1). TVA currently does and would continue to maintain this cemetery. Family access to this cemetery is allowed and would continue to be allowed in the future. As described in Subsection 2.2.2, two power transmission lines cross the CRN Site (Reference 2.2-7).

Potable water for the CRN Site is provided by the City of Oak Ridge, Tennessee, Public Works Department. Wastewater from the site is treated by the City of Oak Ridge. Solid waste is managed by TVA's solid waste disposal vendor.

As manager of federal lands around TVA reservoirs, TVA establishes land use zones within reservoir management plans. The CRN Site zones were established under the policies set forth in the 2009 Watts Bar Reservoir Land Management Plan and the 2011 TVA Natural Resource Plan. The majority of the CRN Site is designated as Zone 2 – Project Operations. A strip along the reservoir shoreline is designated Zone 3 – Sensitive Resource Management. The Grassy Creek HPA (adjacent to the CRN Site) is designated Zone 3 – Sensitive Resource Management/Natural Area. (Reference 2.2-3)

The Federal Emergency Management Agency (FEMA) develops Flood Insurance Rate Maps to determine which areas are Special Flood Hazard Areas subject to inundation by the 1 percent annual chance flood. FEMA defines the 1 percent annual chance flood (100-yr flood), also known as the base flood, as the flood which has a 1 percent chance of being equaled or exceeded in any given year. FEMA also maps areas of minimal flood hazard as those potentially subject to the 0.2 percent annual chance flood (500-yr flood). The majority of the CRN Site lies outside both the 1-percent annual flood and 0.2 percent annual flood zones (Figure 2.2-9). Portions of the Barge/Traffic area (on the south site of Bear Creek Road) lie within both the 1-percent and 0.2-percent annual flood zones. Flooding potential exists in the immediate vicinity of the CRN Site along the banks of the Clinch River arm of Watts Bar Reservoir at elevations up to 752 ft. (Reference 2.2-30; Reference 2.2-31)

2.2.1.2 The Site Vicinity

The CRN Site is located entirely within Roane County. The northwestern portion of Loudon County and part of the southwestern portion of Anderson County are included within the CRN Site vicinity, defined as a 6-mi radius from the center of the CRN Site (Figure 2.1-2).

The vicinity of the CRN Site is primarily rural, consisting of forest and pasture/hay (Figure 2.2-4). Based on the USGS land-cover classification standards and the 2011 NLCD, land use and land cover in the CRN Site vicinity is categorized and shown in Table 2.2-1 and Figure 2.2-4. Forested land (deciduous, evergreen, or mixed forest) accounts for approximately 54 percent of the CRN Site vicinity. Wetlands (emergent herbaceous or woody wetlands) occupy approximately 3 percent of the CRN Site vicinity. Other vegetated undeveloped land (grassland/herbaceous or shrub/scrub) totals approximately 5 percent of the CRN Site vicinity. Land classified as cultivated crops and pasture/hay total approximately 20 percent of the CRN Site vicinity. Open water or barren land occupy approximately 4 percent of the CRN Site vicinity. The remaining approximately 14 percent of the CRN Site vicinity is classified as developed (high, medium, or low intensity, or open space).

Approximately 18,000 ac or 7.5 percent soils in the surveyed portions of Roane County could be considered prime farmland (Reference 2.2-15). According to the Watts Bar Reservoir Land

Management Plan, which describes existing land use for TVA-managed land on Watts Bar Reservoir, including the CRN Site, there are approximately 2900 ac of prime farmland located on reservoir lands (Reference 2.2-3).

Several commercial/industrial properties are located on north of the CRN Site along Bear Creek Road in the Clinch River Industrial Park, as depicted in Figure 2.1-2. A portion of these properties are located on TVA land designated Zone 5 – Industrial. The 161-kilovolt (kV) transmission line exits the CRN Site near the entrance gate and connects with a power substation located just outside the gate (Figure 2.2-1) (Reference 2.2-7).

The CRN Site is bounded on the northeastern side by the ORR (Reference 2.2-7). Land within the ORR is used for multiple purposes. Much of the ORR is undeveloped and consists of forested areas, grasslands and old agricultural fields, bottomlands and wetlands, utility corridors, and ridges in which a number of caves are present (Reference 2.2-16). The National Environmental Research Park and the Oak Ridge State Wildlife Management Area are both located within the ORR. These areas include wildlife management and habitat management plans. (Reference 2.2-16) Facilities within the ORR currently include the Oak Ridge National Laboratory (ORNL), the Y-12 National Security Complex, and the East Tennessee Technology Park (ETTP; Figure 2.1-2). Land uses surrounding the facilities include safety, security, and emergency planning zones; research and education areas; cleanup and remediation sites; environmental regulatory monitoring areas; wildlife management; biosolids land application; protection of cultural and historic resources; wildland fire prevention; land stewardship activities; restoration infrastructure; and public areas. The ORR 10-year (yr) site plan for land use management across the reservation was published in 2007. The 10-yr plan indicates that ORR will, in most cases, expand and build on current land uses. The 10-yr site plan includes the results of a 2002 land use planning focus group report. (Reference 2.2-17; Reference 2.2-18) In 2002, ORR identified potential surplus land in the northwest portion of the reservation (including areas northwest of the Clinch River Industrial Park and surrounding the ETTP). A focus group reviewed the land use planning associated with this potential surplus land, the public and stakeholders participated in the process. The focus group concluded with three recommendations related to ORR land use planning. The first recommendation was for the preservation of areas designated for green space/conservation within the potential surplus land area. The second recommendation was to expand the land use planning process for the remainder of the ORR. The third recommendation called for the use of a biodiversity analysis in addition to the socioeconomic impact analysis that was conducted. (Reference 2.2-19)

The south bank of the Clinch River arm of the Watts Bar Reservoir, from the Melton Hill Dam upstream of the CRN Site to beyond TN 58 downstream of the CRN Site, is largely residential with some small private pastures and farm fields. Many residences include several acres of property. The area is sparsely wooded. (Reference 2.2-7)

The Roane Regional Business and Technology Park is located approximately one-half mile east of the CRN Site, on Industrial Park Road, adjacent to I-40. This business park occupies approximately 655 ac and has several operating facilities and vacant space. Current tenants include food distribution, tool, engineering, ceramics, roofing, energy, engine parts, and automotive companies. The industrial park also contains sites available for development. (Reference 2.2-20)

Several recreational areas are located in the immediate CRN Site vicinity. These include Melton Hill Dam Recreation Area, the Soaring Eagle Campground and RV Park, the Gallaher Recreation Area, the ORR which is a Tennessee Wildlife Management Area, the ETTP Visitor's Overlook, the Southern Appalachia Railway Museum, the Wheat Community African Burial Ground, several hiking trails and greenways, and boating and fishing activities on the Clinch River arm of Watts Bar Reservoir and Melton Hill Reservoir (Figure 2.1-2). (Reference 2.2-7) Recreational land use is discussed in detail in Subsection 2.5.2.5 Aesthetics and Recreation.

The CRN Site is located within the city limits of Oak Ridge, Tennessee, making Oak Ridge the closest city in the vicinity of the CRN Site. The City of Oak Ridge has an extensive zoning ordinance and plan. However, although the CRN Site is within the city limits, Oak Ridge zoning ordinances do not apply to federal property.

No operating airports or ports are located within the 6-mi CRN Site vicinity.

2.2.2 The Region

The CRN Site region is defined as the area within a 50 mi radius of the center of the CRN Site (Figure 2.1-1). There are 33 counties at least partially within 50-mi of the center point of the CRN Site. Three of these counties are in North Carolina, two are in Kentucky, and the rest are in Tennessee (Figure 1.1-1). The largest city in the 50-mi radius is Knoxville, Tennessee. As of the 2010 Census, the population of Knoxville was 178,874 persons. All of the other cities and towns in the region have populations of less than 50,000. Other than Knoxville, only three cities have populations of over 20,000: Oak Ridge (29,330), Maryville (27,601) and Farragut (20,676), Tennessee.

Four interstate highways traverse the region, I-40, I-75, I-640, and I-140 (Figure 2.1-1). Subsection 2.5.2.2, Transportation, provides a description of the transportation network in the vicinity of the CRN Site. The Clinch River provides a navigable corridor between Clinton, Tennessee and Kingston, Tennessee, where it joins with the Tennessee River (Watts Bar Reservoir) and thus ultimately provides transport to the Gulf of Mexico (Reference 2.2-21). The Clinch River (Melton Hill Reservoir) is designated a state scenic river from above the Melton Hill Dam to below the Norris Dam (Reference 2.2-22). The closest commercial airports located within the CRN region are the McGhee Tyson Airport and the Knoxville Downtown Island Airport (Figure 2.1-1).

Based on the USGS land-cover classification standards and the 2011 NLCD, land use and land cover in the CRN Site vicinity is categorized and shown in Table 2.2-1 and Figure 2.2-5. Forested land (deciduous, evergreen, or mixed forest) accounts for approximately 62 percent of the region. Wetlands (emergent herbaceous or woody wetlands) occupy less than 1 percent of the region. Other vegetated undeveloped land (grassland/herbaceous or shrub/scrub) totals approximately 8 percent of the region. Land classified as cultivated crops and pasture/hay totals approximately 16 percent of the region. Open water or barren land occupy approximately 3 percent of the region. The remaining approximately 11 percent of the region is classified as developed (high, medium, or low intensity, or open space). According to the USDA, in 2007 Anderson County's top crop in terms of acreage was forage (9160 ac) and the top livestock inventory items were cattle and calves, producing a total of 4.4 million dollars of agricultural products that year (Reference 2.2-23). In Roane County, the top crop was also forage (11,383 ac) and the top livestock items were cattle and calves, producing a total of 5.1 million dollars of agricultural products (Reference 2.2-24). In Loudon County the top crop is forage (21,136 ac) and the top livestock items are also cattle and calves, producing 60 million dollars of agricultural products (Reference 2.2-25). Knox County has a similar agricultural regime, with forage the top crop (21,673 ac) and cattle and calves the top livestock, producing a total of 19 million dollars of agricultural products (Reference 2.2-26).

Federal lands in the region include the ORR, the Watts Bar Dam Reservation, the Melton Hill Dam Reservation, Great Smoky Mountains National Park, Cherokee National Forest, Big South Fork National River and Recreational Area, and Daniel Boone National Forest. Most of these federal lands offer camping, fishing, swimming, boating, and other recreational activities for visitors. The ORR includes three DOE campuses with distinct missions. The ORNL is the DOE's largest multi-purpose laboratory conducting research in advanced materials exploration, alternative fuels, climate change, and supercomputing. Two of the laboratory's more significant facilities include the Spallation Neutron Source facility, a center for neutron science research, and the High Flux Isotope Reactor, an 85-megawatt high flux reactor-based source of neutrons. The Y-12 Complex mission includes modernizing defense systems and reducing nuclear stockpiles worldwide. The East Tennessee Technology Park is located on the site of a former uranium enrichment complex, which is currently being remediated, revitalized, and transitioned into a private sector business/industrial park. Seasonal hunting activities are available on the ORR as well. (Reference 2.2-27)

2.2.3 Transmission Corridors and Offsite Areas

There are currently two transmission corridors crossing the CRN Site (Figure 2.2-6). The Kingston FP - Ft Loudoun HP 161 kV No.1 transmission line crosses the CRN Site from the southeastern tip of the peninsula to the northwestern corner of the CRN Site near the entrance gate. The Bull Run FP-Watts Bar NP 500 kV transmission line transverses the CRN Site northeast to southwest.

Onsite and offsite transmission lines are to be modified for the project. Onsite transmission lines are to be modified by relocating the 161 kV line to accommodate placement of the CRN facility. Offsite transmission lines are modified through the establishment of a 69kV underground transmission line from the Bethel Valley Substation to the CRN facility and upgrades needed to support stability of the TVA power grid. This 69 kV transmission line is to be placed within the existing 500 kV line right-of-way (Figure 2.2-6). Transmission line segments requiring upgrades are shown in Figure 2.2-7. Ten 161 kV transmission lines over a distance of 191 mi would require uprating. An additional sixteen 161 kV transmission lines over a distance of 122 mi would require uprates or reconductoring. Modifications related to uprating and reconductoring would affect a total of 2317 and 1476 ac respectively. Finally, one section of a 12.7 mi long transmission line would require rebuilding covering a total of 154 ac. All actions related to offsite transmission line modifications would occur within the existing transmission line rights-of-way. Figure 2.2-10 shows the federal and tribal lands, wildlife areas and refuges, wilderness areas, and parks in the vicinity of these offsite transmission lines. Detailed information regarding changes associated with the transmission lines, including lengths of individual segments affected, is discussed in Section 3.7.

Additional offsite areas include the rail offloading area, the Barge/Traffic Area, and several existing borrow pits. TVA anticipates utilizing the EnergySolutions Heritage Railroad rail siding near the CRN Site for deliveries. The refurbishment of this rail siding is addressed in the DOE's *Environmental Assessment, Transfer of Land and Facilities Within the East Tennessee Technology Park and Surrounding Area, Oak Ridge, Tennessee (DOE/EA-1640)* (Reference 2.2-28).

Roadway improvements are required in the Barge/Traffic Area and an existing barge terminal (that was used for TN 58 construction) in that area is to be refurbished (Figure 2.2-6). Based on the USGS land-cover classification standards and the 2011 NLCD, land use and land cover in the Barge/Traffic Area is categorized and shown in Table 2.2-1 and Figure 2.2-5. Forested land (deciduous, evergreen, or mixed forest) accounts for approximately 53 percent of the Barge/Traffic Area. Wetlands (emergent herbaceous or woody wetlands) occupy approximately 5 percent of the Barge/Traffic Area. Other vegetated undeveloped land (grassland/herbaceous or shrub/scrub) totals less than 1 percent of the Barge/Traffic Area. Land classified as cultivated crops and pasture/hay total approximately 16 percent of the Barge/Traffic Area. Open water or barren land occupy approximately 5 percent of the Barge/Traffic Area. The remaining approximately 21 percent of the Barge/Traffic Area is classified as developed (high, medium, or low intensity, or open space). The Barge/Traffic Area and the rail offloading area are located within the 6 mi CRN Site vicinity.

Fill material will be required for the CRN Site. In addition to potentially using borrow material from the CRN Site, offsite borrow sources may be used. The volume of fill material and selection of the source for fill material will be dependent on the backfill plan and the required material properties identified by analyses performed in support of the COLA. Material excavated from portions of the CRN Site will be characterized in accordance with the backfill plan to determine whether the material has the characteristics and provides the needed quantities for use as fill on the site. If additional fill material is need from offsite, the borrow source(s) will be selected based on material properties and quantities available at the potential source locations. The soil quality at each potential borrow site will be required to meet the criteria for acceptability for use as fill material at the CRN Site.

Offsite borrow areas that have been identified for possible use are shown in Figure 2.2-8. At least two of the borrow sites identified in Figure 2.2-8 are currently being utilized in support of other TVA projects. The total acreage of these nine potential borrow sites is 227 ac. The combined volume of fill material present in the disturbed and fully permitted offsite borrow areas is anticipated to meet the volume of fill material that would be needed for the CR SMR Project. Therefore, it is unlikely that any existing borrow areas would need to be expanded beyond currently permitted boundaries or that any new borrow areas would need to be opened to accommodate the CR SMR Project.

The borrow pits are located within the 50 mi CRN Site region.

2.2.4 References

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Reference 2.2-8. Breeder Reactor Corporation, "Final Report The Clinch River Breeder Reactor Plant Project," January, 1985.

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Reference 2.2-10. U.S. Department of Energy, Tennessee Valley Authority, and Project Management Corporation, "Clinch River Breeder Reactor Plant DOE/TVA/PMC Site Redress Planning Task Force Report," January, 1984.

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Table 2.2-1
USGS Land-Use Categories for the CRN Site and Surrounding Areas

USGS Description	CRN Site		Barge/Traffic Area		6-Mile Radius		50-Mile Radius	
	CRN Site (ac)	Percent of Land Use (%)	Barge/ Traffic Area (ac)	Percent of Land Use (%)	Vicinity (ac)	Percent of Land Use (%)	Region (ac)	Percent of Land Use (%)
Barren Land (Rock/Sand/Clay)	20	2	1	<1	255	<1	15,396	<1
Cultivated Crops	8	1	4	2	94	<1	57,767	1
Deciduous Forest	320	34	102	50	33,452	46	2,393,380	48
Developed, High Intensity	1	<1	2	1	658	1	18,187	<1
Developed, Medium Intensity	6	1	16	8	2996	4	144,325	3
Developed, Low Intensity	19	2	21	10	1323	2	56,021	1
Developed, Open Space	42	4	4	2	4933	7	327,463	7
Emergent Herbaceous Wetlands	0	0	2	1	24	<1	1682	<1
Evergreen Forest	67	7	7	3	3595	5	321,477	6
Grassland/Herbaceous	26	3	1	1	2942	4	277,539	6
Mixed Forest	62	7	0	0	2152	3	391,240	8
Open Water	16	2	9	4	2353	3	136,732	3
Pasture/Hay	245	26	28	14	15,139	21	746,414	15
Shrub/Scrub	20	2	0	0	507	1	113,803	2
Woody Wetlands	83	9	9	3	1967	3	22,033	<1
Total	**935**	**100**	**203**	**100**	**72,389**	**100**	**5,023,459**	**100**

Note: The offsite portion of the 69-kV underground transmission line would be installed within an approximately 210-ac portion of an existing 500-kV transmission line right-of-way that is entirely within the 6-mi vicinity radius.

Table 2.2-2 (Sheet 1 of 2)
1942 Soil Survey for Roane County, Tennessee

Soil	Description	Productivity Classification
Al	Atkins very fine sandy loam	Fourth-class
As	Armuchee silt loam	Fifth-class
Av	Apison very fine sandy loam	Second-class
Avk	Apison very fine sandy loam, eroded slope phase	Fifth-class
Avr	Apison very fine sandy loan, eroded phase	Fifth-class
Cc	Clarksville cherty silt loam	Third-class
Cch	Clarksville cherty silt loam, smooth phase	Third-class
Ccl	Clarksville cherty silt loam, hilly phase	Fourth-class
Ccz	Clarksville cherty silt loam, steep phase	Fifth-class
Clx	Colbert silt loam, slope phase	Fourth-class
Cs	Colbert silty clay loam	Fourth-class
Fc	Fullerton cherty silt loam	Third-class
Fch	Fullerton cherty silt loam, smooth phase	Second-class
Fcl	Fullerton cherty silt loam, hilly phase	Fourth-class
Fcr	Fullerton cherty silt loam, eroded phase	Third-class
Fct	Fullerton cherty silt loam, eroded hilly phase	Fifth-class
Fcz	Fullerton cherty silt loam, steep phase	Fifth-class
Gs	Greendale silt loam	Second-class
Jg	Jefferson gravelly fine sandy loam	Third-class
Jgx	Jefferson gravelly fine sandy loam, slope phase	Third-class
Ls	Lehew strong (or stoney) fine sandy loam	Fifth-class
Lv	Leadvale very fine sandy loam	Second-class
Ml	Melvin silt loam	Fourth-class
Nvc	Nolichucky very fine sandy loam	Second-class
Nvr	Nolichucky very fine sandy loam, eroded phase	Third-class
Pl	Pope loamy fine sand	Third-class
Pv	Pope very fine sandy loam	Second-class
Rg	Roane gravelly loam	Third-class
Rga	Rough gullied land, apison soil material	Fifth-class
Rgf	Rough gullied land, Fullerton soil material	Fifth-class
RsC	Rolling stony land, Colbert and Talbott soil material	Fourth-class
Rs	Rough stony land	Fifth-class
RsT	Rough stony land, Talbott soil material	Fifth-class
Sv	Sequatchie very fine sandy loam	Second-class
Ts	Talbott silty clay loam	Third-class
Tsh	Talbott silty clay loam, smooth phase	Second-class
Tsl	Talbott silty clay loam, hilly phase	Fifth-class

Table 2.2-2 (Sheet 2 of 2)
1942 Soil Survey for Roane County, Tennessee

Soil	Description	Productivity Classification
Us	Upshur silty clay loam, valley phase	Fourth-class
Ws	Wolftever silt loam	Second-class
Wsx	Wolftever silt loam, slope phase	Second-class
Wvb	Waynseboro very fine sandy loam, eroded hill phase	Fourth-class
Wvx	Waynseboro very fine sandy loam, slope phase	Third-class

Notes:
First-class = good to excellent cropland
Second-class = fair to good cropland
Third-class = poor to fair cropland
Fourth-class = best suited to pasture, poorly adapted to cropland
Fifth-class = best suited to forest

Source: (Reference 2.2-29)

Table 2.2-3
2009 Soil Survey for Roane County, Tennessee

Soil	Description	Prime Farmland
AeD	Allen loam, 12 to 20 percent slopes	No
AmC	Armuchee silt loam, 5 to 12 percent slopes	No
AmD	Armuchee silt loam, 12 to 20 percent slopes	No
AmE	Armuchee silt loam, 20 to 35 percent slopes	No
Bg	Bloomingdale silty clay loam, occasionally flooded	No
CbD	Colbert-Lyerly-Rock outcrop complex, 5 to 20 percent slopes	No
DeC	Dewey silt loam, 6 to 15 percent slopes	No
DeD	Dewey silt loam, 15 to 25 percent slopes	No
EtC	Etowah silt loam, 6 to 12 percent slopes	No
FuC	Fullerton-Pailo complex, 5 to 12 percent slopes	No
FuD	Fullerton-Pailo complex, 12 to 20 percent slopes	No
FuE	Fullerton-Pailo complex, 20 to 35 percent slopes	No
MnC	Minvale gravelly silt loam, 5 to 12 percent slopes	No
MoD	Montevallo channery silt loam, 12 to 20 percent slopes	No
MoE	Montevallo channery silt loam, 20 to 35 percent slopes	No
TeC	Townley silt loam, 5 to 12 percent slopes	No
TeD	Townley silt loam, 12 to 20 percent slopes	No
WaC	Waynesboro loam, 5 to 12 percent slopes	No
WaD	Waynesboro loam, 12 to 20 percent slopes	No
CaB	Capshaw silt loam, 2 to 5 percent slopes	Yes
EtB	Etowah loam, 2 to 6 percent slopes	Yes
Ha	Hamblen silt loam, occasionally flooded	Yes
WaB	Waynesboro loam, 2 to 5 percent slopes	Yes
WhB	Whitwell loam, 1 to 4 percent slopes, occasionally flooded	Yes

Source: (Reference 2.2-15)

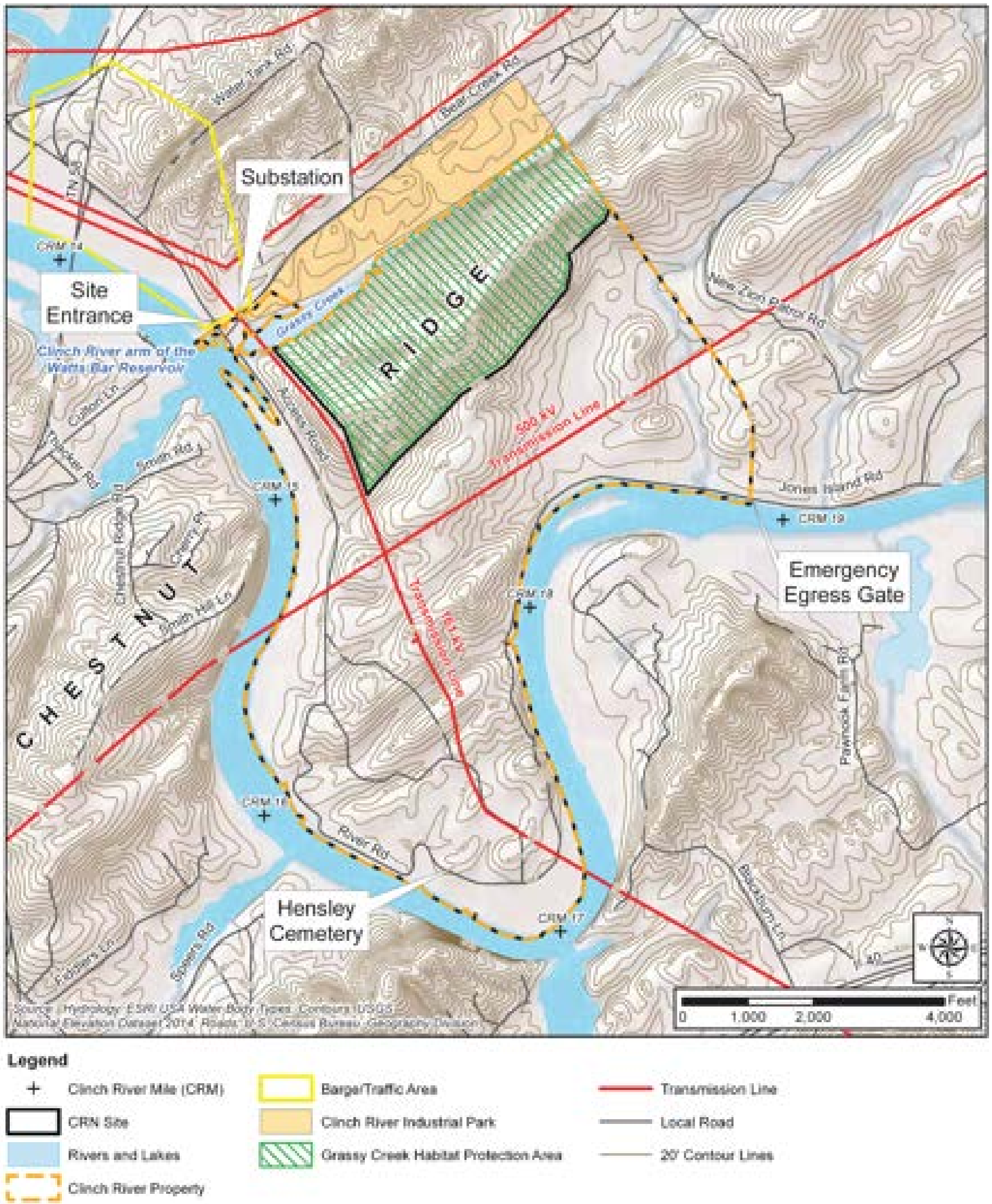


Figure 2.2-1. CRN Site Topographic Map

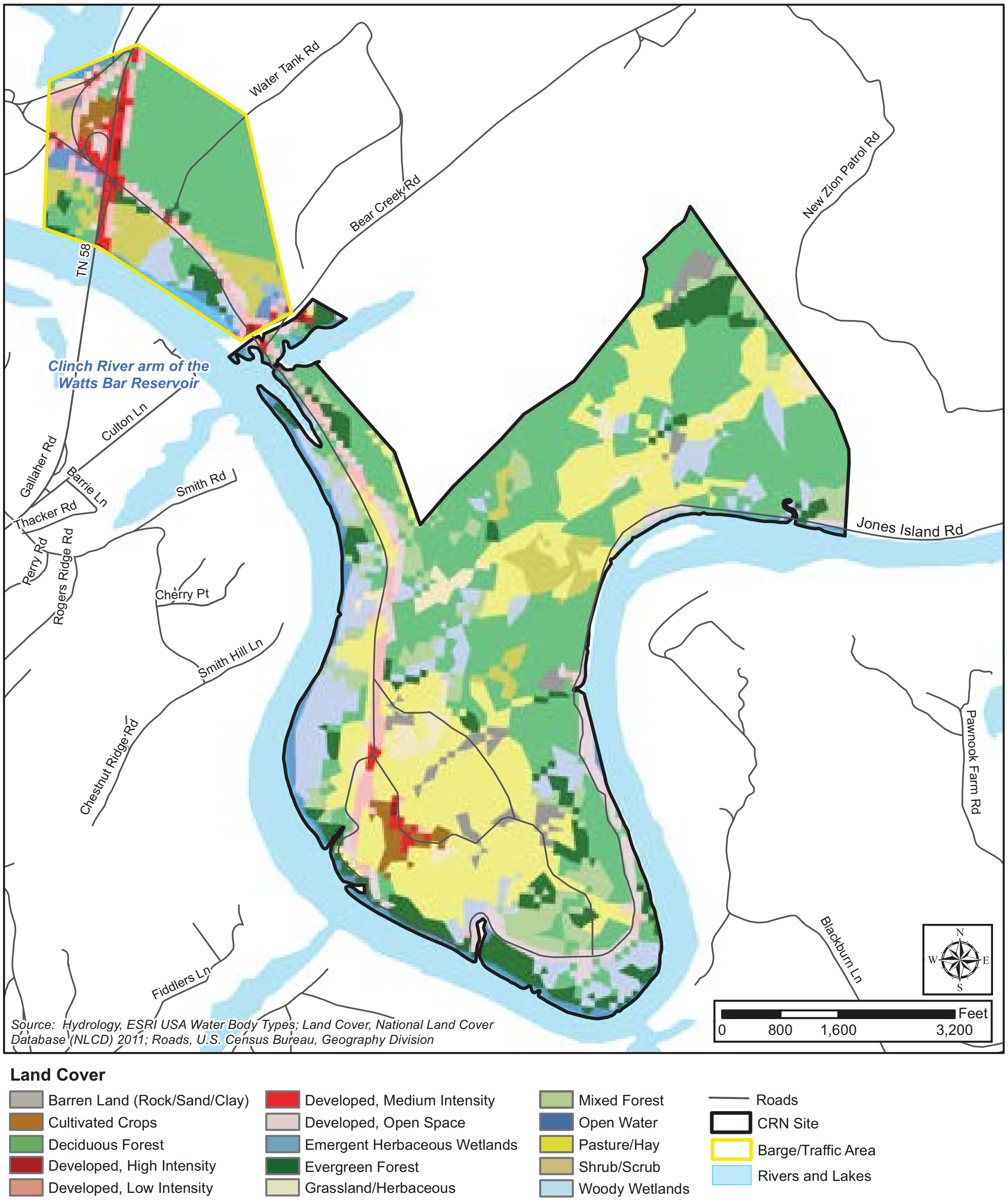


Figure 2.2-2. CRN Site Land Cover Types

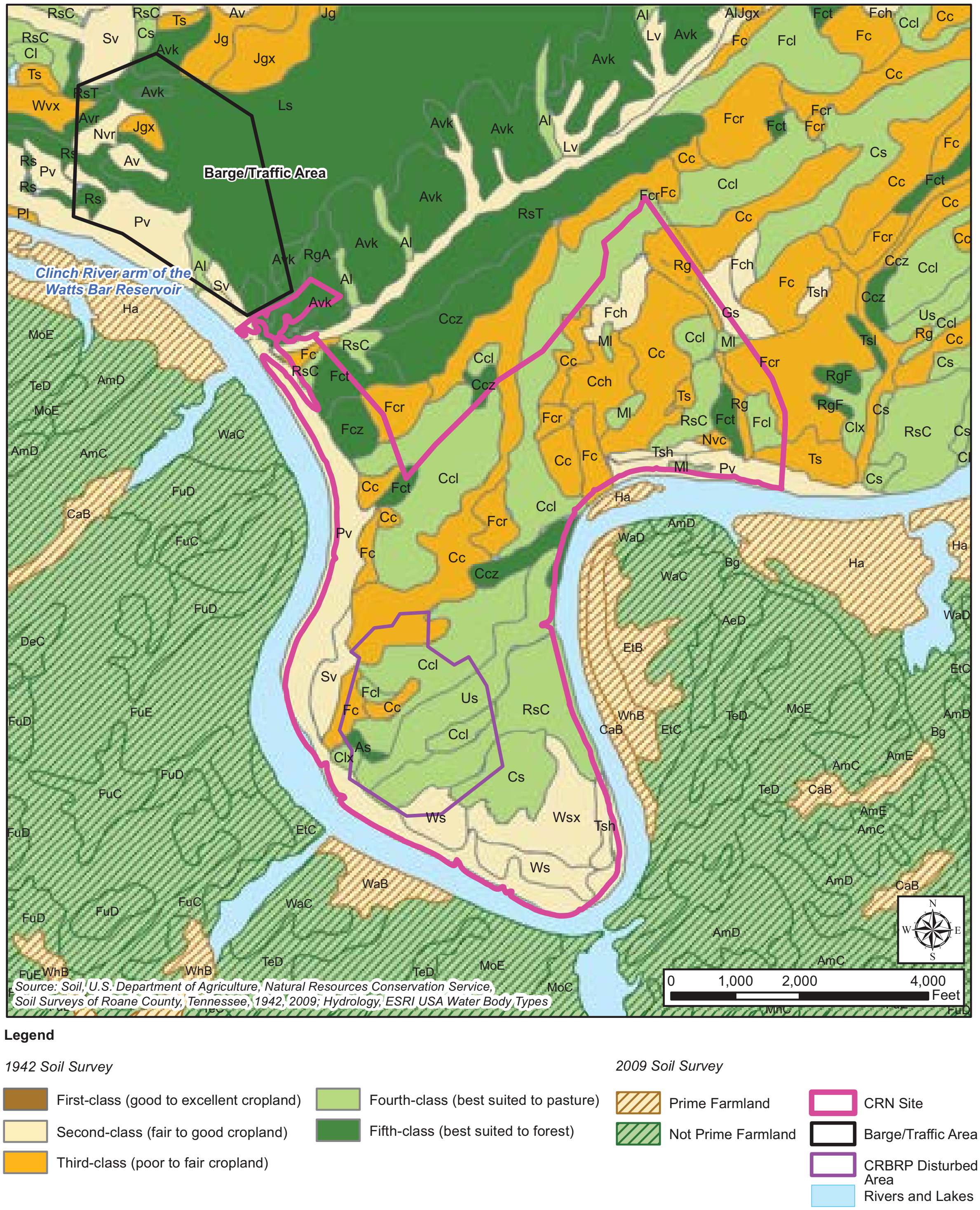


Figure 2.2-3. CRN Site Prime Farmland Soils

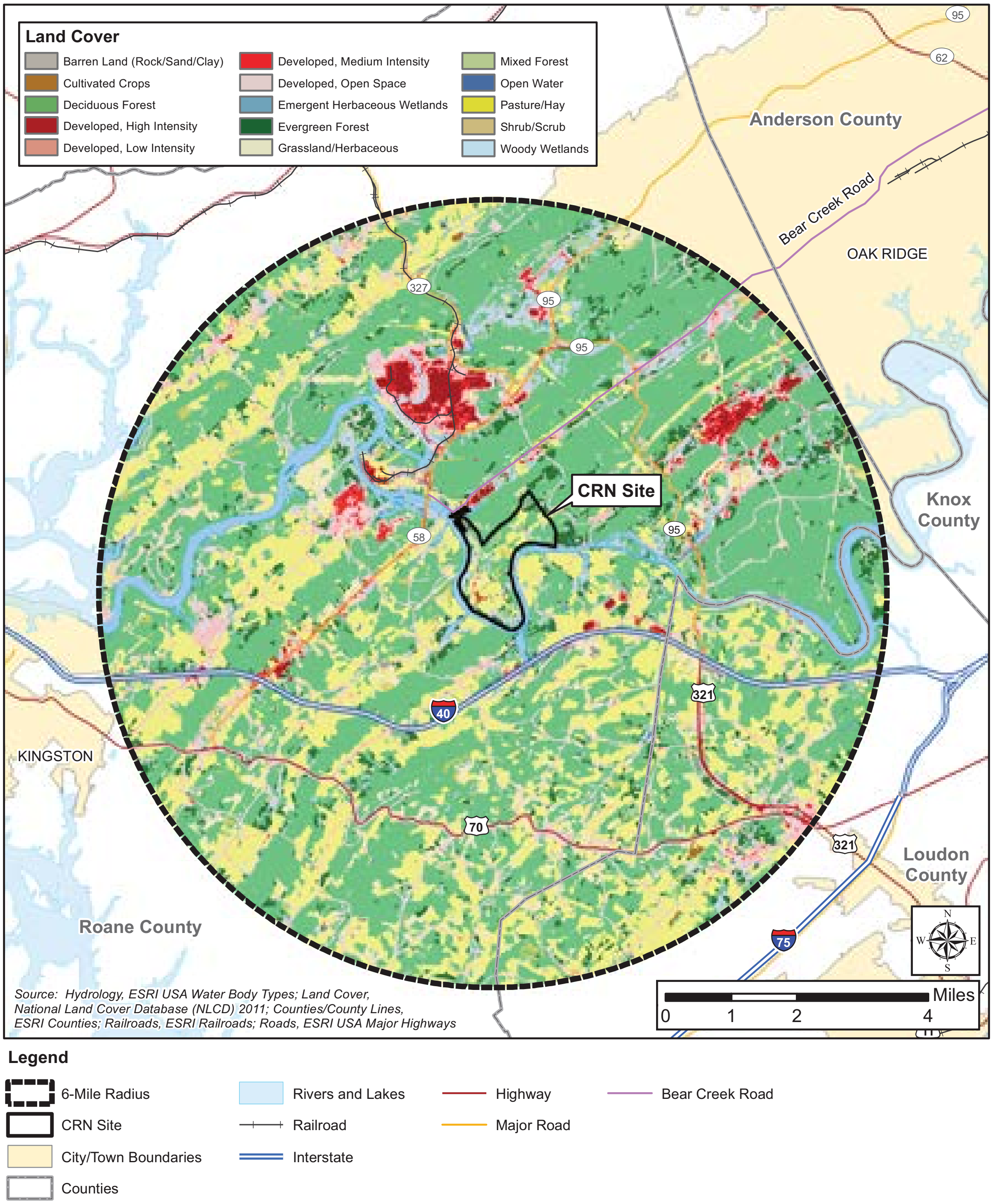


Figure 2.2-4. CRN Site 6-Mile Vicinity Land Cover Map

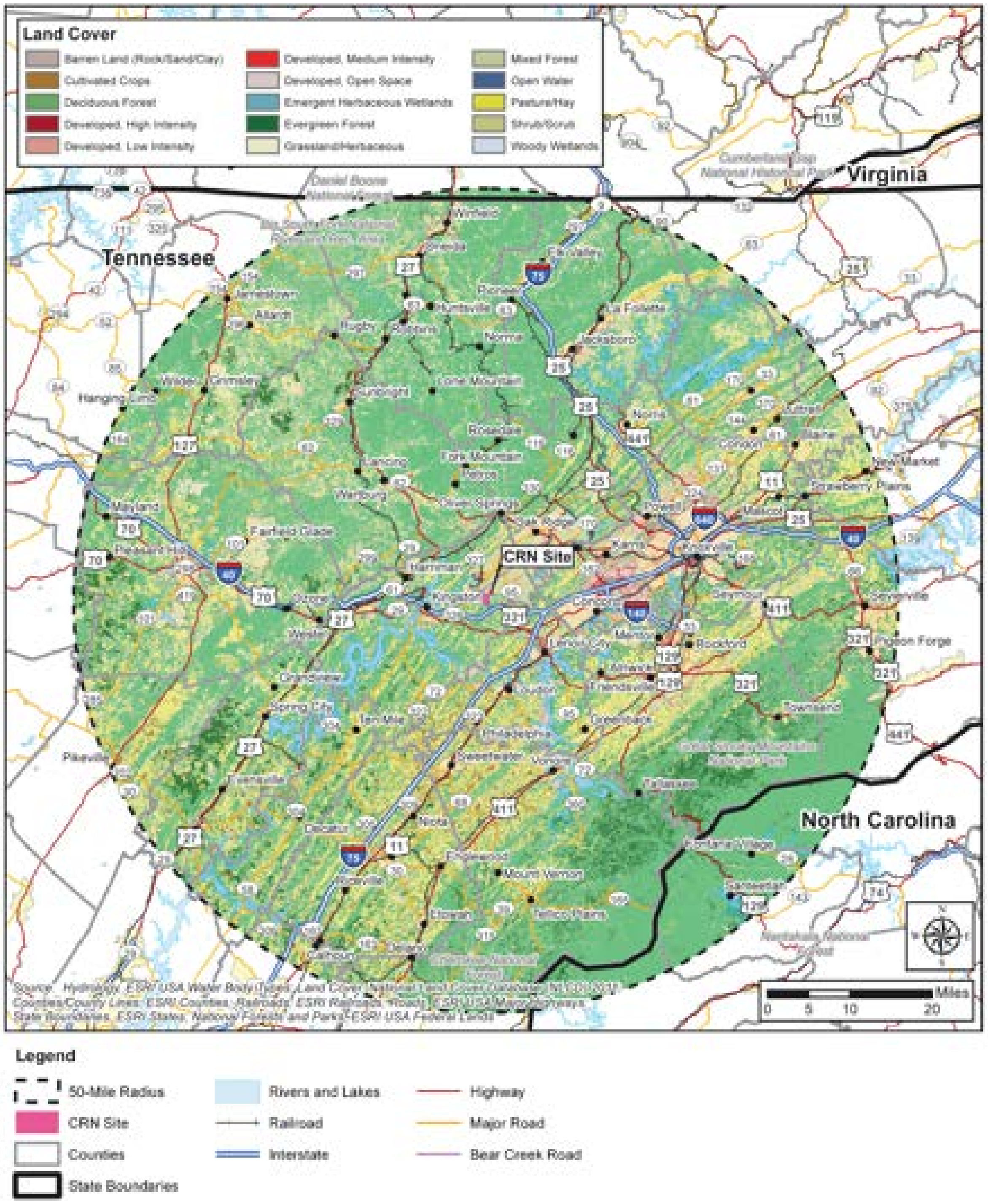


Figure 2.2-5. CRN Site 50-Mile Regional Land Cover Map

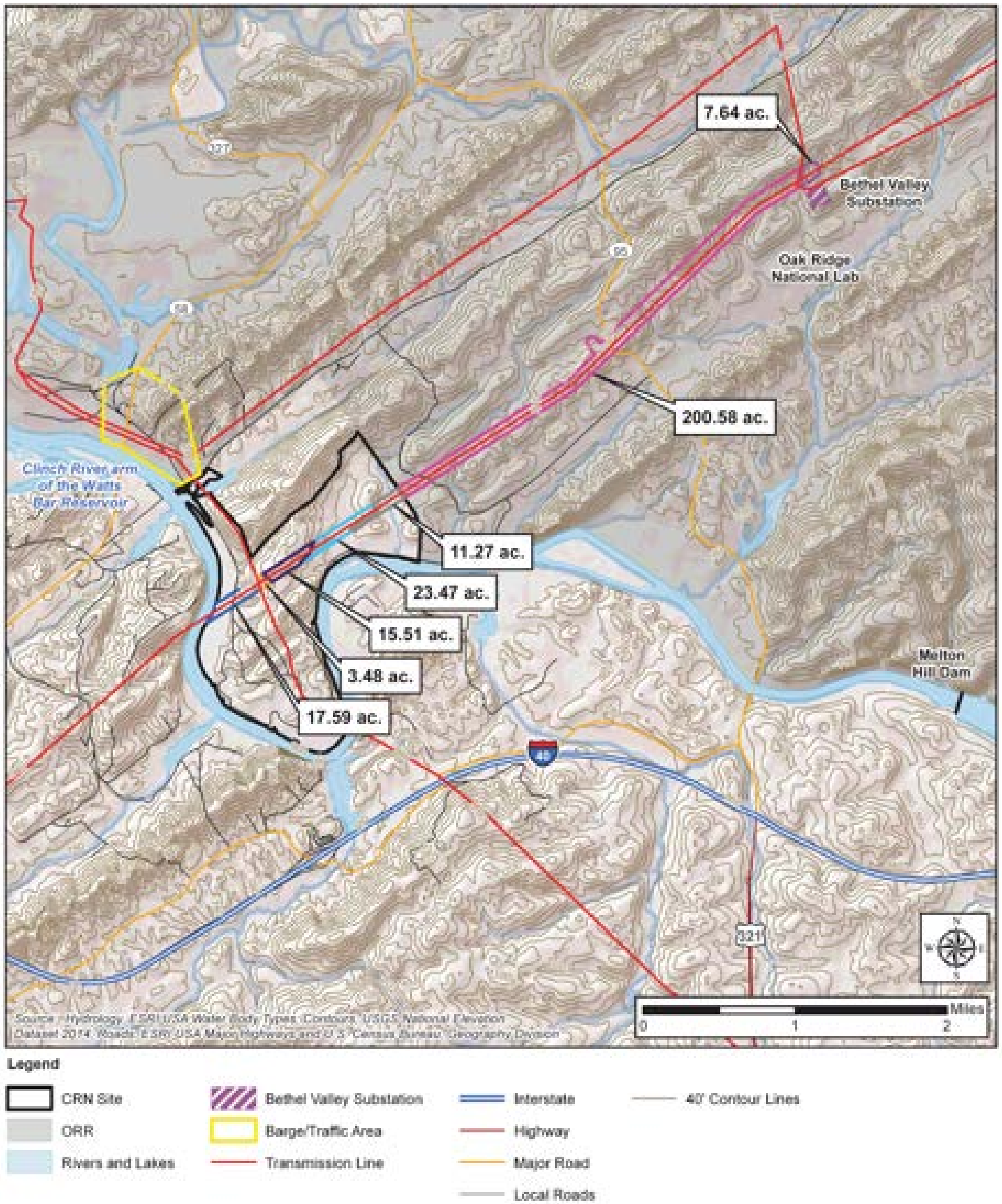


Figure 2.2-6. CRN Site Vicinity Transmission Lines

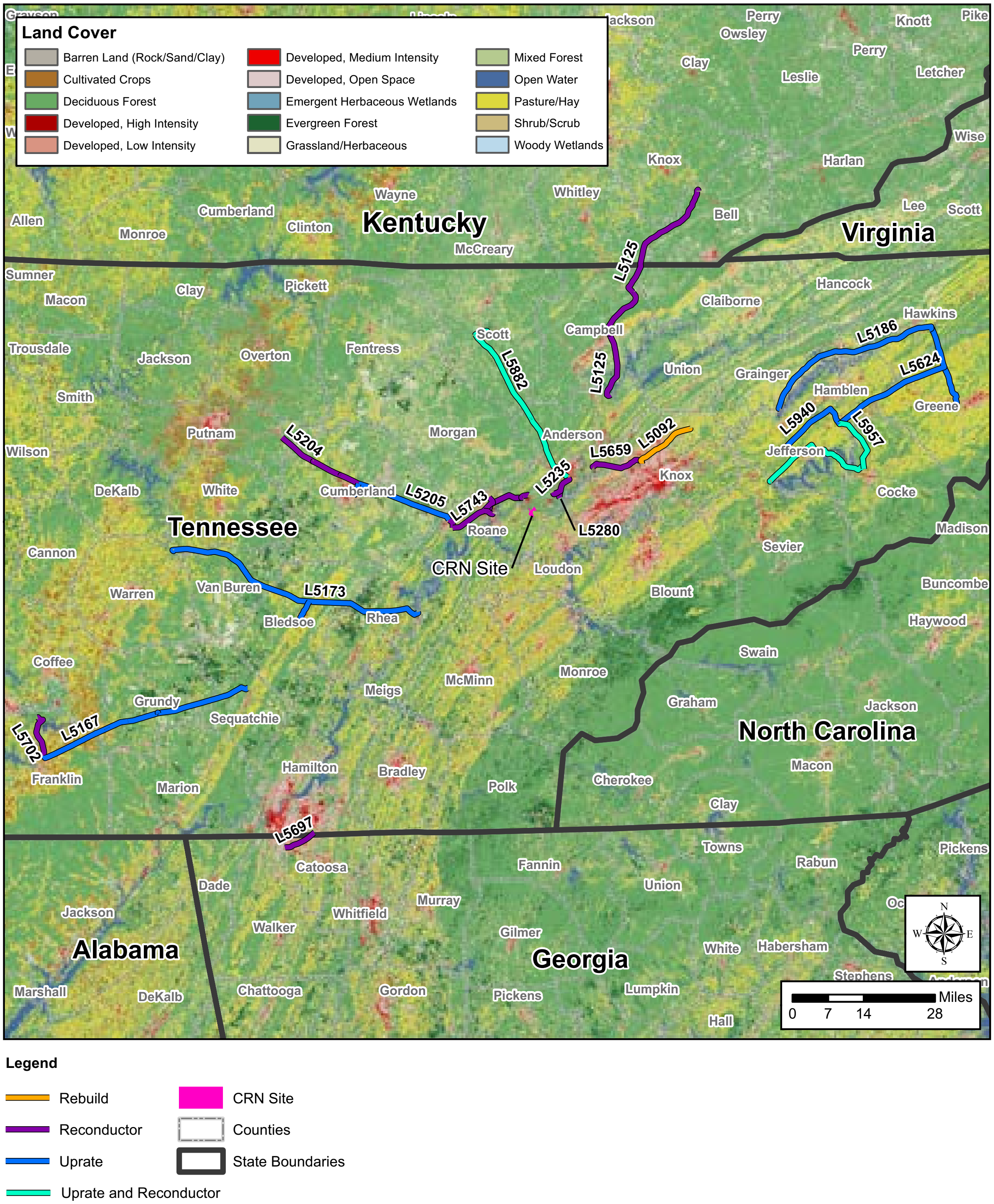
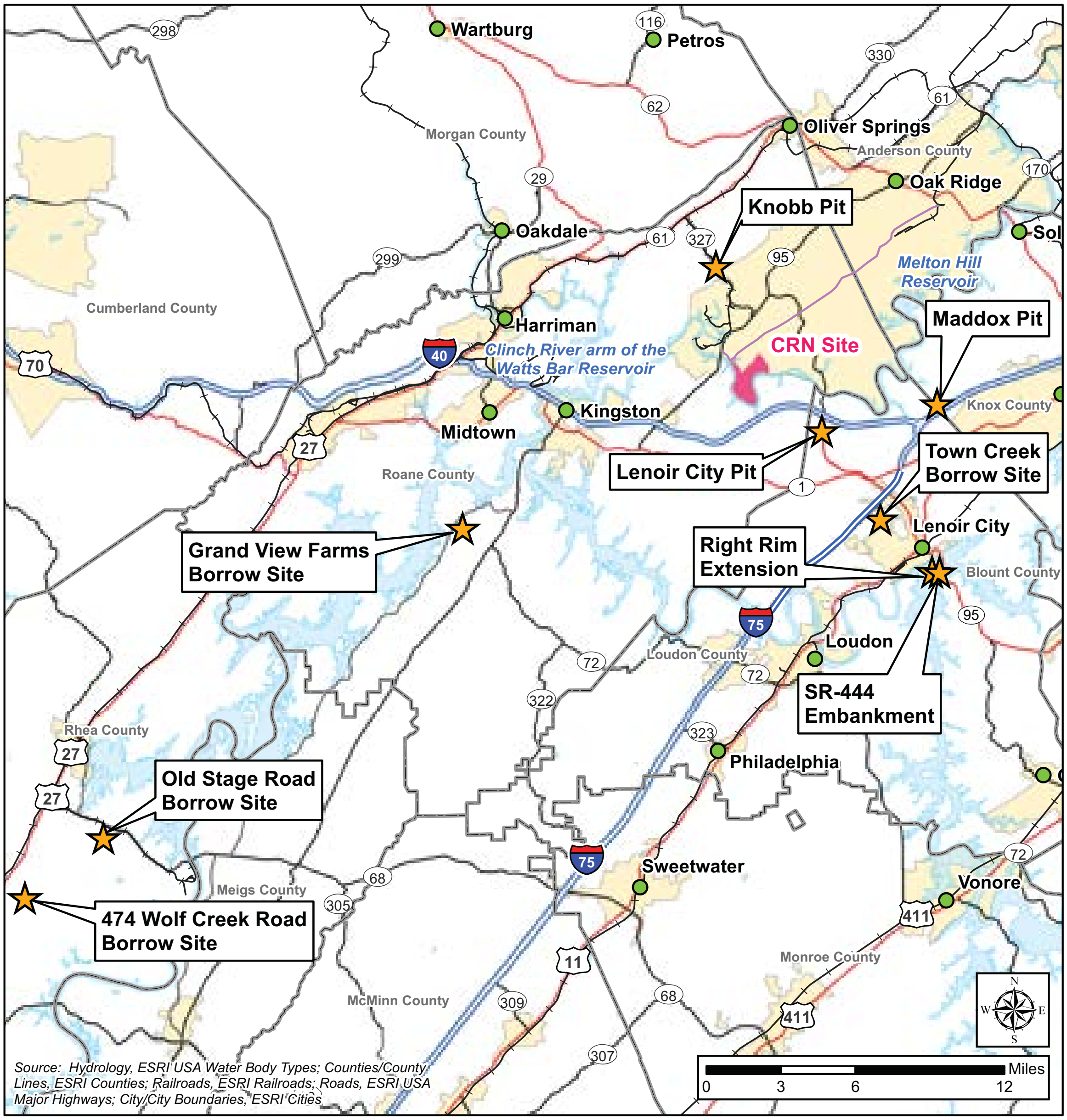


Figure 2.2-7. Transmission Line Segments Requiring Upgrades



Legend

Borrow Sites	Counties
CRN Site	Railroad
Rivers and Lakes	Interstate
City/Town Boundaries	Highway
	Major Road
	Bear Creek Road

Figure 2.2-8. CRN Site Borrow Areas

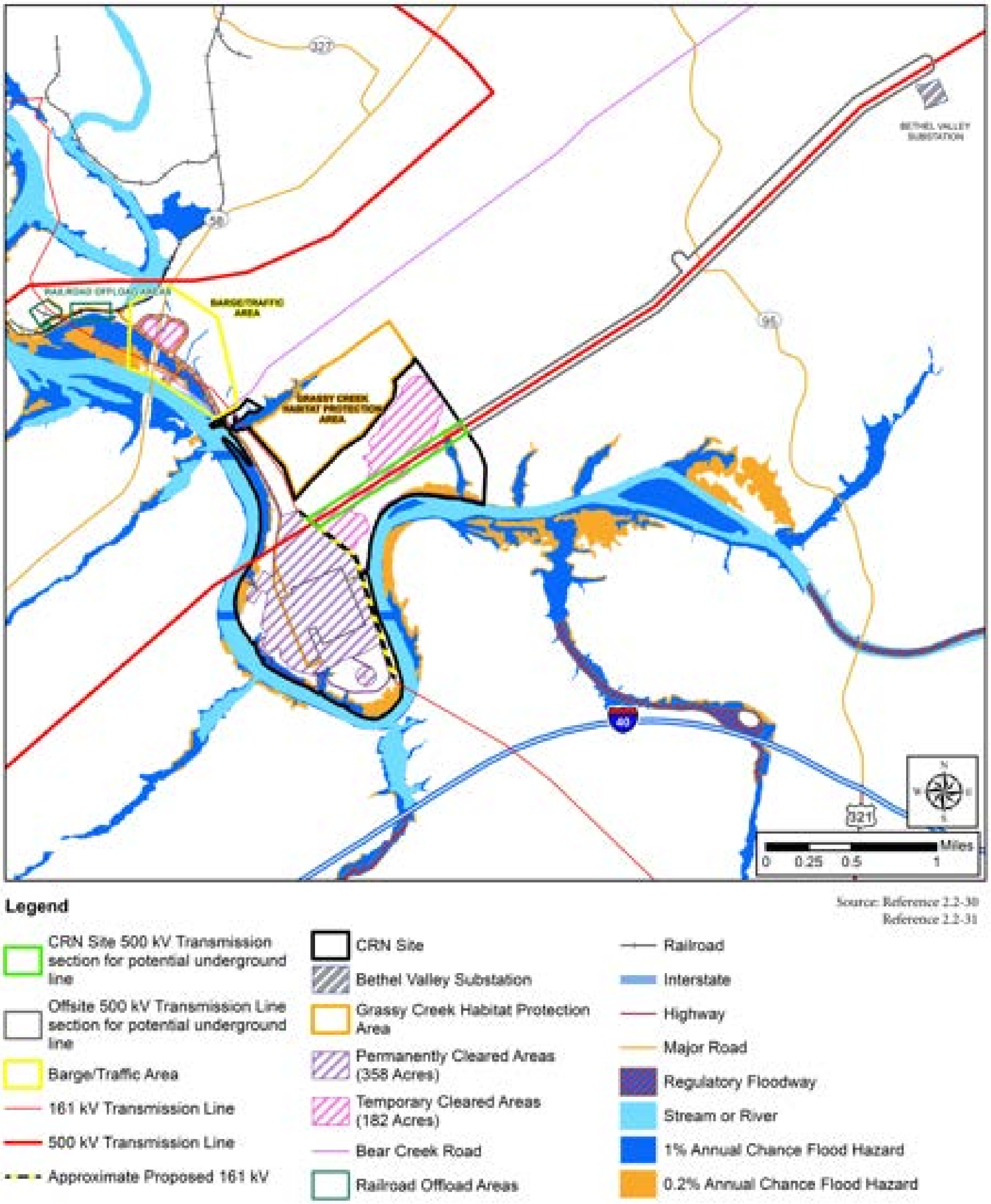


Figure 2.2-9. CRN Site Flood Hazard Map

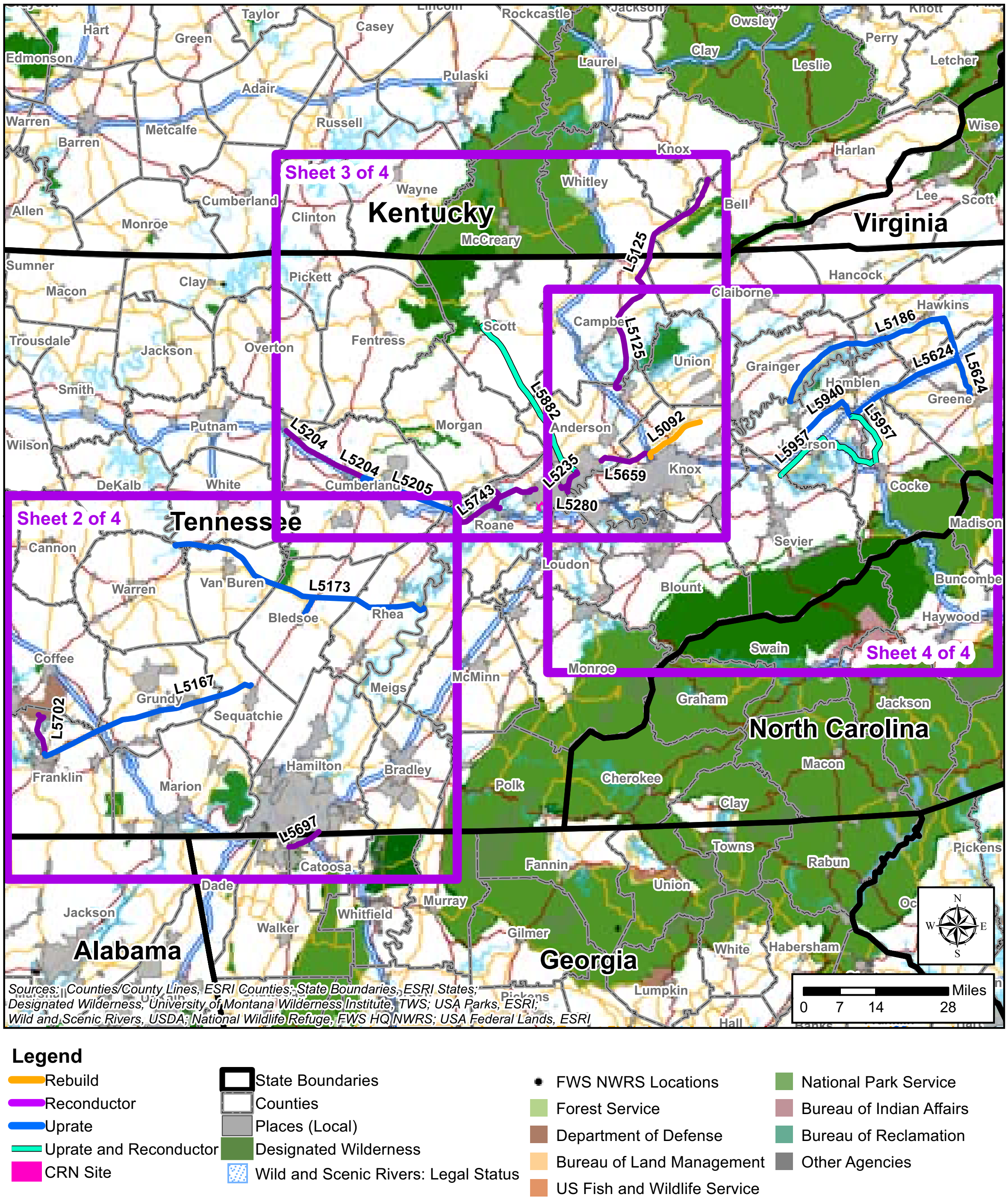


Figure 2.2-10. (Sheet 1 of 4) Transmission Segments Requiring Upgrades with Federal Lands, Parks, Wildlife Refuges and Wilderness Areas

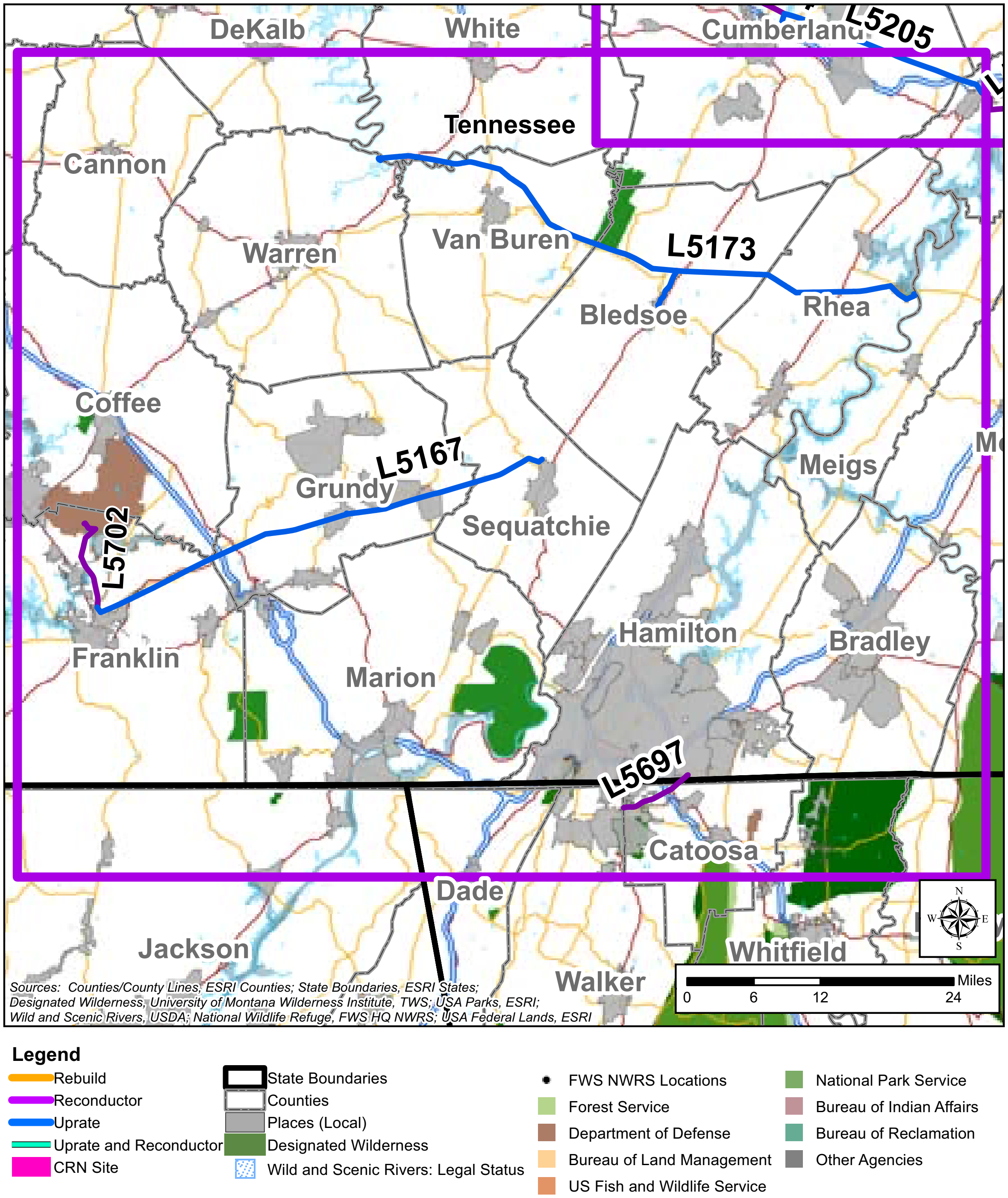


Figure 2.2-10. (Sheet 2 of 4) Transmission Segments Requiring Upgrades with Federal Lands, Parks, Wildlife Refuges and Wilderness Areas

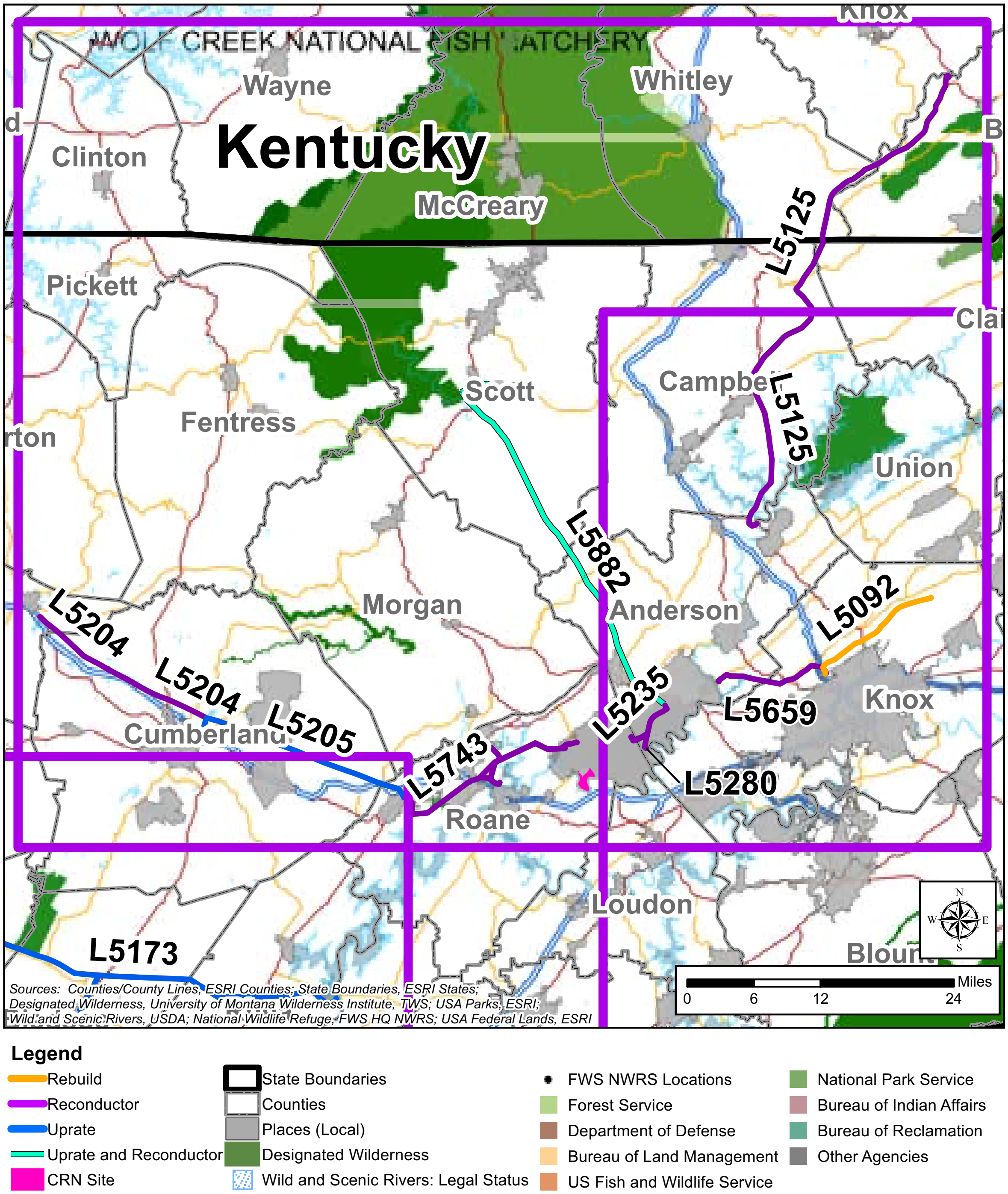


Figure 2.2-10. (Sheet 3 of 4) Transmission Segments Requiring Upgrades with Federal Lands, Parks, Wildlife Refuges and Wilderness Areas

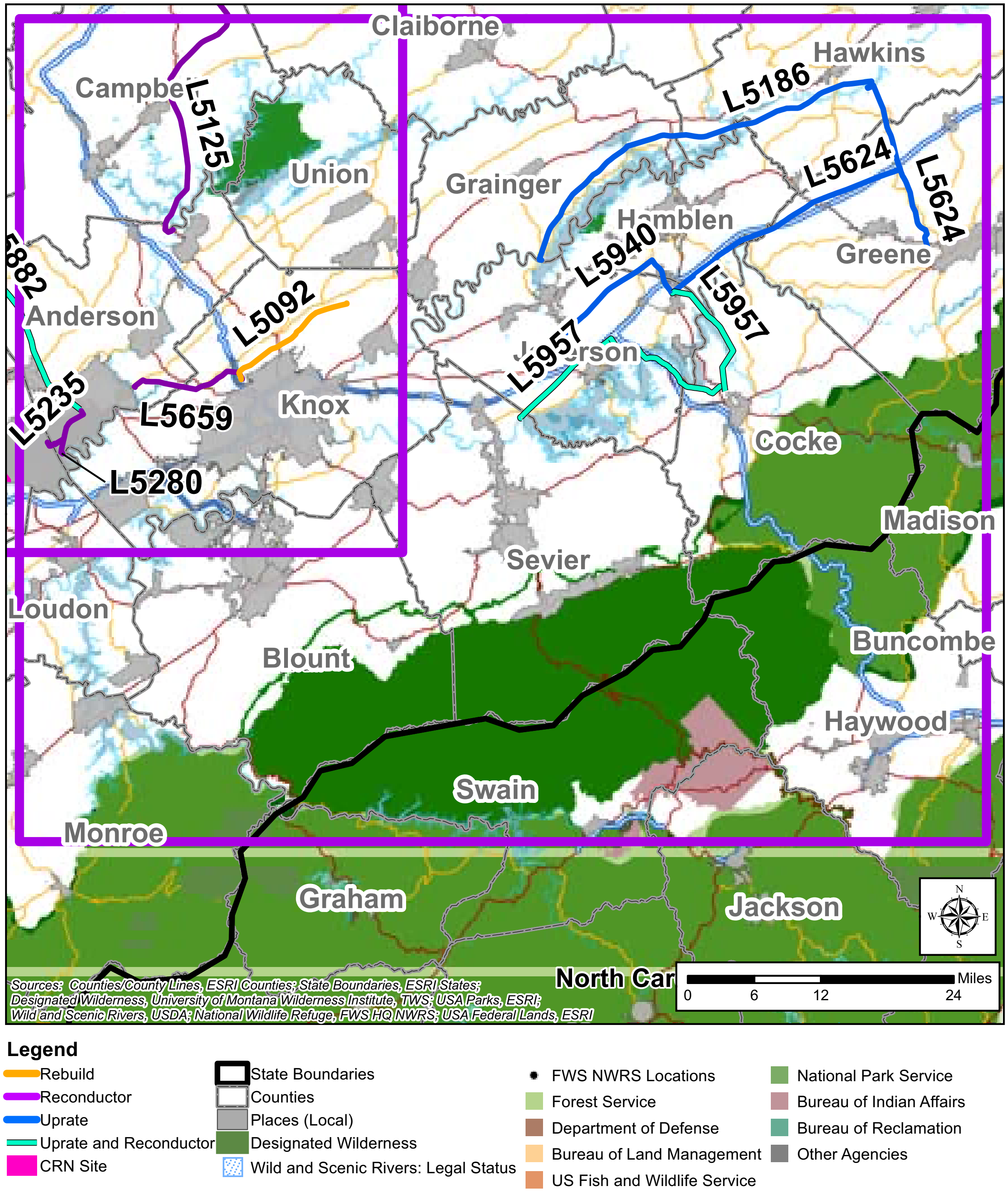


Figure 2.2-10. (Sheet 4 of 4) Transmission Segments Requiring Upgrades with Federal Lands, Parks, Wildlife Refuges and Wilderness Areas

2.3 WATER

This section describes the physical, chemical, biological, and hydrological characteristics of surface water and groundwater in the vicinity of the Clinch River Nuclear (CRN) Site that may affect water supply or that may be reasonably assumed to be affected by the construction and operation of two or more small modular reactors (SMRs). The following lists the Section 2.3 subsections, with descriptions:

- Subsection 2.3.1 provides a detailed description of the surface water bodies and groundwater aquifers that can affect the CRN Site water supply and effluent disposal or may be affected by construction or operation of the SMRs.
- Subsection 2.3.2 describes surface water and groundwater uses in the vicinity of the facility that can affect or be affected by the construction and operation of two or more SMRs.
- Subsection 2.3.3 provides detailed water quality information regarding the surface water and groundwater in the vicinity of the CRN Site.

2.3.1 Hydrology

This subsection presents descriptions of the surface water and groundwater resources that could be affected by the construction and operation of two or more SMRs. The physical and hydrologic water resource characteristics of the site and region are summarized below.

2.3.1.1 Surface Water

The CRN Site is located on a peninsula created by a bend in the Clinch River arm of Watts Bar Reservoir (Figure 2.3.1-1). The CRN Site is located between approximately Clinch River Mile (CRM) 14.5 and approximately CRM 19.0 and is approximately 10.7 miles (mi) southwest of the City of Oak Ridge, Tennessee. Within the CRN Site, the proposed surface water intake is located at CRM 17.9, and the proposed discharge is located at approximately CRM 15. 5. The Barge/Traffic Area is located between CRN 14.0 and CRN 14.5.

The location of the CRN Site and Barge/Traffic Area with respect to major surface water features is shown in Figure 2.3.1-1. The upstream boundary of the CRN Site is located approximately 4.1 mi downstream of Melton Hill Dam, which is located at CRM 23.1. The CRN Site is located approximately 8.2 mi east of the confluence of the Tennessee and Clinch Rivers, with the downstream boundary of the site about 14.5 mi upstream of the confluence. The confluence of the two rivers is located at CRM 0 on the Clinch River, and at Tennessee River Mile (TRM) 567.8 on the Tennessee River (Reference 2.3.1-1). Further downstream on Watts Bar Reservoir, Watts Bar Dam is located at TRM 529.9 or 52.4 mi downstream of the CRN Site (Reference 2.3.1-2). Regulated releases of surface water to Watts Bar Reservoir are made not only from Melton Hill Dam but also Fort Loudoun Dam located at TRM 602.3, and Tellico Dam located near TRM 601.1.

As shown on Figure 2.3.1-1, a number of creeks located in the vicinity of the CRN Site discharge into the reservoir (Figure 2.3.1-1). Upstream of the CRN Site, between Melton Hill Dam at CRM 23.1 and the intake at CRM 17.9, three streams enter the reservoir. These include: Whiteoak Creek, entering the reservoir from the north at CRM 21.0; Raccoon Creek, entering the reservoir from the north at CRM 19.5; and Paw Paw Creek, entering the reservoir from the south at CRM 19.3. Within the reach of the CRN Site, four streams enter the reservoir. These include: Caney Creek, entering the reservoir from the south at CRM 17.0; Poplar Springs Creek, entering the reservoir from the south at CRM 16.2; Bear Creek, entering Poplar Creek and subsequently entering the reservoir at CRM 12, and Grassy Creek entering the reservoir from the north at CRM 14.5. One other prominent tributary, the Emory River, enters the reservoir between the CRN Site and the Tennessee River. The Emory River enters the reservoir from the north, at CRM 4.5 (Reference 2.3.1-3).

2.3.1.1.1 Hydrologic Setting

2.3.1.1.1.1 Tennessee River Watershed

The headwaters of the Tennessee River watershed originate in the mountains of western Virginia and North Carolina, eastern Tennessee, and northern Georgia. The Tennessee River is formed by the confluence of the Holston and the French Broad Rivers near Knoxville, Tennessee. The river flows to the southwest and receives water from three principal tributaries: Little Tennessee, Clinch, and Hiwassee Rivers. As the Tennessee River flows south, west, and then north, two other major tributaries, the Elk and Duck rivers, contribute to the flow that eventually joins the Ohio River at Paducah, Kentucky. (Reference 2.3.1-4)

The Tennessee River and its tributaries have a drainage area of approximately 41,910 square (sq) mi and pass through 125 counties that cover much of Tennessee and parts of Alabama, Kentucky, Georgia, Mississippi, North Carolina, and Virginia (Reference 2.3.1-5). The drainage area from the point of headwater origination to Chattanooga, Tennessee, is approximately 21,400 sq mi; west of Chattanooga to the Ohio River, the drainage area is approximately 19,500 sq mi (Reference 2.3.1-4).

The Tennessee River watershed is subdivided by the U.S. Geological Survey (USGS) into 32 hydrologic units, each identified by a hydrologic unit code (HUC). The USGS divides the Tennessee River Basin into two subbasins: the Upper Tennessee River Basin and the Lower Tennessee River Basin. The boundary between these subbasins is TRM 465 on the mainstem of the Tennessee River at Chattanooga, Tennessee. (Reference 2.3.1-5)

The CRN Site is located in the Upper Tennessee River Basin. The Upper Tennessee River Basin contains some of the most rugged terrain in the eastern United States, including the Great Smoky Mountains range. The Upper Tennessee River Basin encompasses approximately 21,400 sq mi and includes the entire drainage area of the Tennessee River and its tributaries upstream from the USGS gaging station in Chattanooga, Tennessee. It also includes parts of four states: Tennessee, 11,500 sq mi; North Carolina, 5480 sq mi; Virginia, 3130 sq mi; and

Georgia, 1280 sq mi. Parts of three physiographic provinces (Cumberland Plateau, Valley and Ridge, and Blue Ridge) compose the Upper Tennessee River Basin. Elevations range from 621 feet (ft) above mean sea level (msl) at Chattanooga to 6684 ft msl at Mount Mitchell, which is located just northeast of Asheville, North Carolina, and is the highest point in the eastern United States. (Reference 2.3.1-6)

2.3.1.1.1.2 Tennessee River Management

The Tennessee River system, managed by the Tennessee Valley Authority (TVA), is a network of dams and reservoirs that generates power, controls flooding, provides recreational opportunities, and boosts the regional and national economies. The Tennessee River system has approximately 11,000 mi of public shoreline, and under Section 26a of the TVA Act, TVA has the authority to regulate land use and development along the shoreline. TVA owns or operates 49 dams and reservoirs in the mainstem Tennessee and Cumberland watersheds, including nine dams on the Tennessee River (Reference 2.3.1-7). The dams and reservoirs are operated year-round by TVA for the purposes of navigation, flood control, power generation, water supply, water quality, and recreation. Operation of the reservoirs is linked to rainfall and runoff patterns in the watershed. (Reference 2.3.1-8)

2.3.1.1.1.3 Clinch River Watershed

The Clinch River originates in Southwest Virginia and flows to the southwest while receiving water from a number of tributaries, including the Powell River, above Norris Dam. The Clinch River is more than 300 mi long, formed by the junction of two forks in southwestern Virginia and flowing generally southwest across eastern Tennessee towards its confluence with the Tennessee River at Kingston, Tennessee. The Clinch River watershed has a drainage area of approximately 4413 sq mi. (Reference 2.3.1-5)

The CRN Site lies within the Lower Clinch River Watershed (USGS HUC 06010207). Surrounding the Lower Clinch River Watershed are the Powell, Holston, Lower French Broad, Tennessee River (Watts Bar Reservoir), and Emory watersheds. The Lower Clinch River Watershed includes portions of eight counties in East Tennessee including Anderson, Campbell, Grainger, Knox, Loudon, Morgan, Roane, and Union. (Reference 2.3.1-9)

2.3.1.1.1.4 Clinch River Management

The CRN Site includes approximately 935 acres (ac) of land on the north side of the Clinch River arm of the Watts Bar Reservoir between approximately CRM 14.5 and CRM 19.0. The upstream boundary of the CRN Site is approximately 4.1 mi downstream of Melton Hill Dam, which is located at CRM 23.1. The portion of the Clinch River below Melton Hill Dam is part of Watts Bar Reservoir, an impoundment created by Watts Bar Dam, located on the Tennessee River at TRM 529.9, approximately 52.35 mi downstream of the CRN Site (Reference 2.3.1-2).

There are four dams upstream of the CRN Site which may affect the hydrology of the site:

- Norris Dam located at CRM 79.8
- Melton Hill Dam located at CRM 23.1
- Whiteoak Dam and Whiteoak Creek Embayment Sediment Control Dam, on Whiteoak Creek located near CRM 21.0 (Reference 2.3.1-3; Reference 2.3.1-10)

Norris Dam is located approximately 60.8 mi upstream from the CRN Site, and forms the Norris Reservoir. Norris Reservoir is the confluence of the Powell and Clinch River basins, and it is one of the largest of TVA's 10 tributary storage reservoirs (Reference 2.3.1-11). The dam was completed in 1936 and is 265 ft high and stretches 1860 ft across the Clinch River. It is a hydroelectric facility with two generating units with a net dependable capacity of 110 megawatts (MWe). With normal rainfall throughout the year, the water level in the reservoir fluctuates approximately 29 ft from summer to winter to provide seasonal flood storage. (Reference 2.3.1-12)

Melton Hill Dam is located on the Clinch River at CRM 23.1, approximately 4.1 river mi upstream of the CRN Site, and forms the Melton Hill Reservoir (Reference 2.3.1-3). The dam was completed in 1963 and is 103 ft high and stretches 1020 ft across the Clinch River. Melton Hill Dam is a hydroelectric facility with two generating units. These two generating units are capable of producing a net dependable capacity of 79 MWe. Melton Hill Reservoir has the only dam in the tributary reservoir system with a navigation lock, which has a 75- by 400-ft chamber and a maximum lift of 60 ft. (Reference 2.3.1-13)

Unlike most of TVA's multipurpose tributary projects, Melton Hill Dam does not provide any significant flood damage reduction benefits, nor does it provide any significant seasonal flow regulation because of the little useful storage volume available. The average weekly discharge from Melton Hill Dam over its lifetime (1962-present) is 4832 cubic ft per second (cfs) with a maximum weekly discharge of 25,455 cfs. Figure 2.3.1-3 shows the expected flow frequency of the weekly average flow from Melton Hill Dam based on 100 years (yr) of reservoir and system simulation conducted for the development of the current reservoir operating policy. The minimum discharge requirement for Melton Hill is 400 cfs average daily flow, but the frequency of this minimum flow continuing for as long as seven days is less than 0.1 percent as shown in Figure 2.3.1-3. (Reference 2.3.1-11)

The two dams on Whiteoak Creek are located near its confluence with the Clinch River arm of the Watts Bar Reservoir, near CRM 21.0. The primary dam is Whiteoak Dam, constructed in 1943 to contain radioactive sediment and minimize the spread of contamination from past activities on what is now the U.S. Department of Energy (DOE) Oak Ridge Reservation (ORR). Whiteoak Dam forms the 25-ac Whiteoak Lake, which has a drainage area of 6.0 sq mi. immediately downstream of the Whiteoak Dam is Whiteoak Creek Embayment, which is separated from the Clinch River arm of the Watts Bar Reservoir by Whiteoak Creek Embayment Sediment Control Dam. The Sediment Control Dam was constructed in 1992 in order to maintain a constant water level and prevent fluctuations in water level in Whiteoak Creek Embayment due to storm flows and TVA power operations. (Reference 2.3.1-14)

Two other dams, neither located on the Clinch River, affect the surface water hydrology of the Watts Bar Reservoir at the CRN Site. These are:

- Watts Bar Dam, located at TRM 529.9 (Reference 2.3.1-2)
- Fort Loudoun Dam located at TRM 602.3.

Watts Bar Dam is located on the Tennessee River at TRM 529.9, approximately 52.35 river mi downstream of the CRN Site (Reference 2.3.1-2). Construction on the Watts Bar Dam began 1939 and was completed in 1942. Watts Bar Dam is 112 ft high and stretches 2960 ft across the Tennessee River. All outflows from Watts Bar Reservoir are controlled by releases at Watts Bar Dam. Watts Bar Dam has one lock that is 60 ft by 360 ft and lifts and lowers barges as high as 70 ft from the Watts Bar Reservoir to the Chickamauga Reservoir. The net dependable capacity at Watts Bar Dam is 182 MWe. In addition to forming the navigable reservoir on the Tennessee River, the Watts Bar Dam also creates a slack-water channel for navigation more than 20 mi up the Clinch River to the Melton Hill Dam, and 12 mi up the Emory River. (Reference 2.3.1-7)

Regulated releases of surface water enter Watts Bar Reservoir not only by releases from Melton Hill Dam but also from Fort Loudoun Dam, located on the Tennessee River at TRM 602.3. Construction on Fort Loudoun Dam began in 1940 and was completed in 1943. Fort Loudoun Dam is 122 ft high and stretches 4190 ft across the Tennessee River. The Fort Loudoun lock is 60 ft by 360 ft, and raises and lowers river craft approximately 70 ft between the Fort Loudoun Reservoir and the Watts Bar Reservoir. The net dependable capacity of Fort Loudoun’s four units is 162 MWe. Fort Loudoun Reservoir is connected by a short canal to Tellico Reservoir on the nearby Little Tennessee River. Water is diverted through the canal to Fort Loudoun for power production. The canal also offers commercial barges access to Tellico Reservoir without the need for a lock. (Reference 2.3.1-15)

Just downstream of Fort Loudoun Dam, at approximately TRM 601.1, Tellico Dam also can provide regulated releases to Watts Bar Reservoir from the Little Tennessee River. However, Tellico Dam contains only a spillway (i.e., no hydro capabilities), which is operated very rarely, only in extreme flood events.

2.3.1.1.1.5 Local Site Drainage

The CRN Site covers approximately 935 ac and is bounded to the west, south, and east by the Clinch River arm of Watts Bar Reservoir and to the north by the DOE ORR. As stated in Subsection 2.2.1.1 and shown in Figure 2.2-1, a series of roughly parallel ridges of gradually lower elevations stretches from the Chestnut Ridge, near the CRN Site entrance and in the Grassy Creek Habitat Protection Area (HPA), to approximately the center of the peninsula.

In addition to the Clinch River arm of the Watts Bar Reservoir, TVA identified four perennial streams and one intermittent stream on the CRN Site, and one perennial stream and three intermittent streams in the Barge/Traffic Area[1]. Hydrologic flow within all of these streams is affected by precipitation and stormwater runoff. In addition, hydrologic flow within the Clinch River arm of the Watts Bar Reservoir (stream S02) and a tributary to the reservoir (stream S04) are affected by water levels within the reservoir. Hydrologic flow within streams S01, S06, and S08 is also affected by discharge from springs. (Reference 2.3.1-16) Descriptions of these streams are included in Subsection 2.4.2.1.3 and Table 2.4.2-5, and their locations are shown in Figure 2.4.1-2.

TVA also identified 19 ephemeral streams/wet-weather conveyances (WWCs) on the CRN Site, and 15 WWCs at the Barge/Traffic Area (Reference 2.3.1-16). WWCs are natural or constructed drainages that have flow conditions only in direct response to precipitation and stormwater runoff (Reference 2.3.1-17). Descriptions of these WWCs are included in Subsection 2.4.2.1.3 and Table 2.4.2-5, and their locations are shown in Figure 2.4.1-2.

Six man-made ponds were identified on the CRN Site, and two ponds were identified in the Barge/Traffic Area. The ponds on the CRN Site were constructed as part of a stormwater management system, and their hydrology is caused by precipitation and stormwater runoff. (Reference 2.3.1-16) Descriptions of these ponds are included in Subsection 2.4.2.1.3 and Table 2.4.2-5, and their locations are shown in Figure 2.4.1-2.

2.3.1.1.1.6 Local Wetland Areas

TVA identified and delineated 12 wetlands on the CRN Site. Each wetland is described in Subsection 2.4.1.2 and shown on Figure 2.4.1-2. Hydrologic flow within each of these wetlands is affected by precipitation and stormwater runoff. In addition, hydrologic flow within wetlands W003, W005, W007, W008, and W011 is influenced by water levels within the Clinch River arm of the Watts Bar Reservoir. Hydrologic flow within four wetlands (W005, W008, W009, and W010) is also affected by groundwater discharge. (Reference 2.3.1-18) TVA also identified and delineated five wetlands at the Barge/Traffic Area. Hydrologic flow within these wetlands is also affected by precipitation and stormwater runoff. In addition, hydrologic flow within one of these wetlands (W017) is influenced by water levels within the Clinch River arm of the Watts Bar Reservoir (Reference 2.3.1-19).

2.3.1.1.2 Reservoir Characteristics

Three separate reservoirs can potentially affect, or be affected, by SMR operations. The impoundments are:

- Melton Hill Reservoir
- Watts Bar Reservoir

[1] Surveys were conducted on the portions of the Barge/Traffic Area (101-ac.) with the highest potential for disturbance that had not been previously surveyed.

- Fort Loudoun Reservoir

Melton Hill Dam, located on the Clinch River 4.1 mi upstream of the CRN Site, impounds Melton Hill Reservoir and releases water into the Clinch River arm of the Watts Bar Reservoir. The Clinch River arm of the Watts Bar Reservoir is the source and receiving water body for CR SMR plant operations. Fort Loudoun Dam, on the mainstem of the Tennessee River, releases water from Fort Loudon Reservoir into Watts Bar Reservoir. Therefore, operation of the Fort Loudoun Dam can affect water levels and other characteristics of the Watts Bar Reservoir.

2.3.1.1.2.1 Reservoir Description

Under flood conditions, TVA's water management objective for Melton Hill, Watts Bar and Fort Loudon Reservoirs and most other dams within the system is to operate the reservoir system to minimize flood damage by timing turbine discharges, gate openings, and spillway discharges as required.

Melton Hill Reservoir is on the Clinch River, extends almost 57 mi upstream from Melton Hill Dam to Norris Dam, and drains approximately 628 sq mi. Figure 2.3.1-1 illustrates the location of Melton Hill Dam and Melton Reservoir relative to the CRN Site. The reservoir provides nearly 193 mi of shoreline and 5470 ac of water surface for recreation. (Reference 2.3.1-13) It is a run-of-river reservoir, meaning water is passed through the reservoir without being stored long-term and allows barge traffic up to Clinton, Tennessee. Melton Hill Reservoir is a multipurpose reservoir providing for navigation, hydroelectric power production, water supply, water quality, and recreation. The average residence time for water in the reservoir is approximately 11 days (Reference 2.3.1-8). Actual elevations of the reservoir immediately upstream of the dam are measured continuously. The elevation range of normal operation fluctuates between 793 and 795 ft msl (Reference 2.3.1-13).

Watts Bar Dam forms the Watts Bar Reservoir. Watts Bar Reservoir is located on the Tennessee River and extends approximately 72.4 mi upstream from Watts Bar Dam to Fort Loudoun Dam (Reference 2.3.1-2). The reservoir drains approximately 17,310 sq mi and has 722 mi of shoreline and over 39,090 ac of water surface. The reservoir has a flood-storage capacity of 379,000 ac-ft. (Reference 2.3.1-7) The average residence time for water in the reservoir is approximately 17 days (Reference 2.3.1-8).

Discharging from Melton Hill Dam, the Clinch River forms only a small portion of the Watts Bar Reservoir. The Tennessee River below Fort Loudoun Dam comprises the main body of the reservoir. The water elevation in Watts Bar Reservoir is controlled by releases from Watts Bar Dam. The water elevation in Watts Bar Reservoir is generally maintained between 735 ft msl and 741 ft msl. (Reference 2.3.1-11)

The CRN Site Probable Maximum Flood (PMF) elevation is 799.9 ft National Geodetic Vertical Datum of 1929 (NGVD29). The combined effect maximum flood level is 806.0 ft NGVD29.

Fort Loudoun Reservoir is the uppermost in the chain of nine TVA reservoirs that form a continuous navigable channel on the Tennessee River. The average residence time for water in the reservoir is approximately 10 days (Reference 2.3.1-8). The reservoir has 379 mi of shoreline and 14,600 ac of water surface. It has a flood storage capacity of 111,000 ac-ft. To maintain the water depth required for navigation, Fort Loudoun Reservoir is kept at a minimum winter elevation of 807 ft. The typical summer operating elevation is between 812 and 813 ft. (Reference 2.3.1-15)

River flow direction at the CRN Site can be upstream, downstream, or quiescent, depending on the modes of operation of Melton Hill Dam, Watts Bar Dam, and Fort Loudoun Dam. Flow reversal may occur from an abrupt shutdown of Melton Hill and Watts Bar Dams and by releasing water from Fort Loudoun Dam. (Reference 2.3.1-11)

2.3.1.1.2.2 Reservoir Operating Rules

TVA adopted its current reservoir operating policy in 2004 based upon the comprehensive Reservoir Operations Study (ROS), which was conducted in cooperation with the U.S. Army Corps of Engineers (USACE) and the U.S. Fish and Wildlife Service (USFWS) as well as representatives of other agencies and members of the public. Two of the features of the operating policy pertinent to this discussion are that it was designed to meet the future off-stream water needs in the Tennessee Valley as well as maintain minimum stream flow at critical locations in the Valley. (Reference 2.3.1-11)

The operating policy requires TVA to store water in tributary reservoirs during the spring when there is relatively high surface water flow into the reservoir system for release during the summer when there is relatively little surface water flow into the system. An important requirement of the operating policy is to meet minimum flow targets. Each of the 10 major tributary projects has such a target. There are also system minimum flow targets on main-stem projects. Chickamauga and Kentucky are projects with key system minimum flow targets. (Reference 2.3.1-11)

The individual tributary project minimum releases provide for instream flow uses such as aquatic habitat in the tailwaters below the projects. These project minimum flows plus additional flow from local tributaries and Chickamauga or Kentucky Dams comprise the system minimum flow. When the surface water flow from local tributaries is too low to meet the governing system minimum flow target, the tributary project releases are increased until the governing system minimum flow target is reached. (Reference 2.3.1-11)

Because rainfall varies across the watershed from year to year, there are some years when reservoirs on one tributary river have relatively less water in them than reservoirs on another tributary river. The operating policy requires TVA to balance the drawdown from all the tributary projects, which slows the drawdown on reservoirs at relatively low levels and increases the drawdown on reservoirs at relatively high levels. (Reference 2.3.1-11)

TVA uses Operating Guides for each reservoir to determine the timing and volume of releases from the dams. The Operating Guides are based on decades of operating experience, and are developed to provide seasonal variation in water levels to accommodate flood waters. The Operating Guides provide a daily target for the water elevation in each reservoir. The operating guide for the Headwater Elevation (HWEL) at Watts Bar Dam is shown in Figure 2.3.1-4. In the winter, TVA targets a pool elevation at Watts Bar Dam between approximately 735 ft and 737 ft msl. Between late March and mid-May, the reservoir is filled to the summer operating range, targeting a pool elevation between approximately 740 ft and 741 ft msl. Between late October and early December the pool is returned to the winter operating range.

2.3.1.1.2.3 Intake and Discharge Description

As shown in Figure 2.3.1-1, water for the plant cooling system is withdrawn from the Clinch River arm of the Watts Bar Reservoir by an intake structure located near CRM 17.9. Heated water from the plant is returned to the reservoir by a discharge structure located at about CRM 15.5.

2.3.1.1.2.4 Flow

To evaluate the hydrothermal impact of the proposed SMRs on Watts Bar Reservoir, TVA conducted a Hydrothermal Task Force study which evaluated the historical data regarding water flow in the reservoir. The following subsection is adapted from the Hydrothermal Task Force Report, and describes the flow information relevant to the analysis of hydrothermal impacts.

The release from Melton Hill Dam is the main source of water for the Clinch River arm of the Watts Bar Reservoir at the CRN Site. The current operating policy of the TVA river system, implemented in 2004, is defined by the TVA Reservoir Operations Study, or ROS (Reference 2.3.1-8). Historical river data used in the hydrothermal analyses was limited to ROS years, beginning in 2004. This is because the operating policy of the TVA river system for the period of operation of the SMRs is expected to be the same as the current ROS operating policy. Under the ROS operating policy, the daily average releases from Melton Hill Dam for 2004 through 2013 are shown in Figure 2.3.1-5. For this period, the overall average release, and consequently the expected approximate average river flow past the CRN Site, is approximately 4670 cfs. The maximum Melton Hill Dam daily average release observed for this period is approximately 21,700 cfs. The minimum single-day average release may be 0 cfs.

The ROS guideline for the minimum daily average release from Melton Hill Dam is 400 cfs. Shown in Figure 2.3.1-6 is the percentile for the Melton Hill Dam daily average release shown in Figure 2.3.1-5. Approximately 60 percent of the time, the scheduled daily average release for Melton Hill Dam is less than the overall average flow (i.e., less than 4670 cfs). The minimum daily average release of 0 cfs cited above occurred on Monday, December 22, 2008, the day of the coal ash spill in the Emory River at the Kingston Fossil Plant, located approximately 14 mi downstream of the CRN Site. Since the Kingston ash spill, TVA has maintained the 400 cfs minimum daily average release for Melton Hill Dam.

The powerhouse at Melton Hill Dam contains two hydro generating units. The operation of the hydro units can provide a minimum release of between approximately 4000 cfs and 5000 cfs (one unit at minimum load) and a maximum release of between approximately 21,000 cfs and 23,000 cfs (two units at maximum load). On an hourly basis, Melton Hill Dam releases usually are scheduled in keeping with TVA's desire to provide low cost power. In this context, and due to the high flexibility and low fuel cost for hydropower, the Melton Hill Dam daily allotment of water is usually dispatched during those hours when the price for power is at or near the daily peak. In this manner, little or no releases are made during other hours of the day. This scheduling pattern is known as hydro peaking. Figure 2.3.1-7 shows the percentile for Melton Hill Dam hourly releases for the period 2004 through 2013 (i.e., since implementation of the current TVA reservoir operating policy). Approximately 50 percent of the time there are no hourly releases from Melton Hill Dam (i.e., flow of 0 cfs). When the daily allotment of water from Melton Hill Dam is very low (e.g., when dry conditions dictate a daily average flow approaching the ROS minimum of 400 cfs) the daily allotment can be provided by only one hour of hydro operation per day. If this type of operation is provided in the first hour of one day and the last hour of the following day, there can be up to 46 continuous hours of no releases from Melton Hill Dam. Although this is possible when following the current operating policy, such usually does not occur in practice. Figure 2.3.1-8 shows the average annual frequency of no release events from Melton Hill Dam for the period 2004 through 2013. On the average, the number of no release events per year is approximately 425. The average duration of these events is approximately 11.25 hours (hr). On the average, the number of no release events lasting more than 24 hr is only approximately 9 per yr. Events with no Melton Hill Dam releases for periods in excess of 36 hr are extremely rare, on the average less than one event per year.

2.3.1.1.2.5 Regional Surface Water Evaporation

Mean monthly, seasonal, and annual pan evaporation for the Tennessee River Basin was evaluated using the National Oceanic and Atmospheric Administration *Mean Monthly, Seasonal and Annual Pan Evaporation for the United States* technical report. Table 2.3.1-1 lists average pan evaporation based on estimates of monthly evaporation derived from hydrometeorological measurements, using a form of the Penman equation described by Kohler, et. al. in 1955.

Using data from Table 2.3.1-1, average annual evaporation in Tennessee is 52.01 inches (in.), and average annual evaporation for the Knoxville station near the CRN Site is 50.61 in.

2.3.1.1.2.6 Water Surface Elevation and Current Patterns

The water surface elevation (WSEL) for the section of the Clinch River arm of the Watts Bar Reservoir adjacent to the CRN Site, in general, follows the pool elevation at Watts Bar Dam. The current pattern in the river is usually in the downstream direction. Figure 2.3.1-9 shows the daily average WSEL measured at the CRN Site (at CRM 16.1) and the daily average HWEL measured at the Watts Bar Hydro plant. The data are for 2013. The daily average WSEL at CRM 16.1 varies between 736 and 744.5 ft above mean sea level, a range of approximately 8.5 ft. The WSEL follows the general trend of daily average HWEL at Watts Bar Dam. However, differences occur between the WSEL at the CRN Site and WSEL at Watts Bar Dam due to hydraulic conditions between the site and Watts Bar Dam. At the CRN Site, the surface water flow from Melton Hill Dam provides the greatest influence on local variations in WSEL. During periods when the daily average release from Melton Hill Dam was in excess of approximately 5000 cfs (e.g., late January and early February 2013), it was not uncommon for the WSEL at the CRN Site to rise 1.0 ft or more above the HWEL at Watts Bar Dam. This dynamic also occurs at smaller time scales. For example, on an hourly basis, peaking operations at Melton Hill Dam can cause the WSEL at the CRN Site to rise above the HWEL at Watts Bar Dam. Sloshing of the reservoir from peaking operations at the Watts Bar, Melton Hill, and Fort Loudoun hydro plants also can cause the opposite to occur, with the WSEL at the CRN Site falling below the HWEL at Watts Bar Dam. During these events, the current pattern in the Clinch River arm of the Watts Bar Reservoir is reversed, with flow moving upstream rather than downstream.

Figure 2.3.1-10 shows the maximum, minimum, and average values of the daily midnight HWEL at Watts Bar Dam for the period of record from 2004 through 2013 (the years encompassing the current ROS operating policy). Large rainfall/runoff (flood) events caused the HWEL at Watts Bar Dam to spike above the target operating ranges. Such events are apparent in Figure 2.3.1-10.

2.3.1.1.2.7 Temperature and Water Velocity Measurements

For the ROS operating period including 2004 and 2008 through 2013, Figure 2.3.1-11 shows an estimate of the hourly water temperature in the tailwater below Melton Hill Dam. The data is a composite of information from several locations. These include: (1) monitors on the taildeck at Melton Hill Dam, (2) monitors for the generator cooling water inside the dam, (3) a monitor in the tailrace about 0.5 miles downstream of the dam (CRM 22.6), and (4) a monitor in the river about 19.2 mi downstream (CRM 3.9). Composite data are used because no single monitor provides valid data throughout the entire period of record. For years 2005, 2006, and 2007, equipment outages with the Melton Hill Dam taildeck monitors resulted in no usable data for those years. Composite data from the other locations are used primarily for 2004 and the first part of 2008. Almost all of the data after May 2008 are from the monitor in the tailrace about 0.5 mi downstream of the Melton Hill Dam.

In general, the water temperature for the portion of the Clinch River arm of the Watts Bar Reservoir immediately below Melton Hill Dam depends not only on meteorology, but also on the manner of operation of TVA facilities located upstream. Norris Dam, located at CRM 79.8, provides significant storage of cold water from winter and spring rainfall/runoff. Therefore, the manner of operation of Norris throughout the summer impacts the arrival of cold water at Melton Hill Dam. The Bull Run Fossil Plant, located at CRM 47.0, adds heat to Melton Hill Reservoir, thereby contributing to temperature stratification behind Melton Hill Dam. With this, scheduling of the number, magnitude, and duration of operation of the two hydro units at Melton Hill Dam affects the character of the withdrawal zone for the hydro intakes, and consequently the temperature of the water released downstream. All of these factors are represented in the variability exhibited by the data in Figure 2.3.1-11. Because the basic operating policy of ROS is expected to continue in the future, the data in Figure 2.3.1-11 are considered adequate for estimating the potential range in release water temperature from Melton Hill Dam. The record encompassing 2004 and 2008 through 2013 includes a year of extreme drought (2008), a year of extreme rainfall (2013), a year of extreme summer heating (2010), and a year of extreme winter cooling (2011).

Figure 2.3.1-12 shows the daily maximum, minimum, and average values of the hourly temperature data presented in Figure 2.3.1-11. The data suggest hourly release temperatures from Melton Hill Dam range between approximately 39 degrees Fahrenheit (°F) in the winter and 75°F in the summer. The minimum reading occurred in 2010 and the maximum reading occurred in 2012. The proposed discharge structure for the CRN Site is located approximately 7.65 mi downstream of Melton Hill Dam. Depending on meteorology, the surface water in this reach may be cooled or warmed before it arrives at the SMR discharge. To examine the potential magnitude of this cooling and warming, 2013 data were examined for hourly water temperature measurements collected from the Melton Hill Dam tailrace monitor at CRM 22.6 and a temporary monitor installed at CRM 16.1. The percentile for the change in water temperature between the upstream (CRM 22.6) and downstream (CRM 16.1) monitor locations is shown in Figure 2.3.1-13. As shown, the change in hourly temperature generally varied between about -1°F to +3°F. As a result, for examining thermal impacts on the Clinch River arm of the Watts Bar Reservoir, the ambient temperature of the surface water was assumed to range between a minimum of 38°F (winter) and maximum of 78°F (summer).

In 2013, the temperature profile of the reservoir was also measured at CRM 13.0, 16.1, and 19.0, in order to evaluate the thermal regime and the presence of thermal stratification in the reach of the reservoir near the CRN Site. CRM 16.1 is near the proposed discharge location, and CRM 19.0 is approximately 1 mi upstream of the proposed intake location. Data were collected on a 15-minute basis. The profile at CRM 13.0 included measurements at depths of 3 ft, 10 ft, 20 ft, and at a bottom anchor. The measurements at CRM 16.1 were made at depths of 5, 10, and 15 ft. The measurements at CRM 19.0 were made at 3, 10, and 15 ft. At CRM 13.0, the water temperature differences between the 3 ft sensor and the bottom were generally on the order of 2-4°F during the summer months and typically less than a degree during the winter months. The largest temperature gradient at all three locations occurred within the surface layer of the river. At the two upstream locations, the gradient between the surficial and deeper depths was even smaller than at CRM 13.0. The temperature difference at CRM 13.0 from the 10-ft depth to the bottom was minimal, typically on the order of 0.1 to 0.3°F. The temperature gradient in summer often had a typical diurnal pattern, with a temperature peak occurring in the afternoon due to surficial warming during the hottest time of the day. This daily temperature gradient was then either flushed out by daily dam releases, or its heat dissipated with nighttime atmospheric cooling.

2.3.1.1.2.8 Bathymetry

In support of the hydrologic evaluation of the CRN Site, TVA performed hydrographic surveys of the Watts Bar Reservoir from CRM 13 to CRM 21. The surveys were performed in June 2013, using an automated sounding system operating at 200 khz. The survey consisted of 762 transects across the reservoir, and an additional 96 transects across the Emory River arm of the Watts Bar Reservoir.

A prominent feature of the bathymetry of the reservoir near the CRN Site is the presence of a submerged island near CRM 15.9. The bathymetry at this location is shown in Figure 2.3.1-14. The conceptual plot plan for the CR SMR Project originally planned for the discharge to be located at CRM 15.9, directly adjacent to this feature. Based on TVA's hydrothermal modeling for the SMR discharge, TVA noted that the presence of this feature would encumber the mixing of the thermal effluent, resulting in a thermal plume hugging the shoreline. As a result, TVA modified the discharge location to approximately CRM 15.5, which is downstream of the island and in a location where the bathymetry would not interfere with mixing.

2.3.1.1.2.9 Erosion and Sediment Transport

There are currently no site-specific data available on erosion and sediment transport in the vicinity of the CRN Site as evaluations rely on specific characteristics of the final plant design. This information is to be developed as the facility design is completed, and is evaluated as part of the combined license application.

2.3.1.2 Groundwater

Regional and local groundwater resources that could be affected by the construction and operation of the CRN Site are described in this subsection. Note that all references to elevation given in this subsection are to North American Vertical Datum of 1988 (NAVD 88) unless otherwise specified.

2.3.1.2.1 Description and Onsite Use

This subsection describes the regional and local groundwater resources that could be affected by the construction and operation of the CRN Site.

The hydrogeologic conceptual model presented in this subsection was developed from multiple conceptual hydrogeologic models that vary in scale and hydrostratigraphic framework. Considerations of the scale and framework were not mutually exclusive, but were intertwined during a series of steps designed to develop a tenable site hydrogeologic conceptual model. Five steps were involved in the development of the scale-dependent conceptual models, and include:

1. A regional "desktop" study based on published state, Federal (including TVA and DOE ORR studies) and other sources.

2. A review of documentation to address the previously proposed, demonstration Clinch River Breeder Reactor Project (CRBRP) to be constructed at the site, including site-specific studies performed for the purpose of the CRBRP (Reference 2.3.1-20).
3. Review of preliminary SMR plant layout, plot plans and excavation plans for the CRN Site.
4. A site-specific geotechnical, geologic, and hydrogeologic field study conducted for the proposed CRN Site (Reference 2.3.1-21).
5. An evaluation of site-specific data in conjunction with regional and local information.

The first step of site model conceptualization involved formulating an understanding of the hydrogeologic conditions near the CRN Site including the ORR and surrounding areas. Regional geologic and hydrogeologic information available from the USGS, Tennessee Department of Environment and Conservation (TDEC), DOE, TVA, and other sources were reviewed to identify the hydrogeologic framework of the area. The second step involved a review of documentation addressing local hydrogeologic conditions such as that available from the DOE and the subsurface studies performed in support of CRBRP previously proposed at the CRN Site. The third step was a review of the preliminary CR SMR plant layout, plot plans and excavation plans developed for the conceptual placement of the SMRs that could be constructed at the CRN Site.

During the fourth step, a site-specific subsurface investigation (SI) was implemented at the proposed CRN Site. The hydrogeologic aspects of the SI were based on the preliminary conceptual model (developed as described above) and were modified when appropriate during the field program (as field data were collected and evaluated), as the understanding of site-specific conditions for SMR construction evolved.

The fifth step involved analysis of the SI field data with the regional and local information. From this effort, site-specific data were integrated with existing CRN Site information and local and regional information to formulate the conceptual site model described in the following sections. The conceptual model was then evaluated to determine potential changes to the hydrogeologic system as the result of constructing and operating the SMR units.

2.3.1.2.1.1 Physiography and Geomorphology

The CRN Site is located in Roane County, Tennessee, within the City of Oak Ridge (Figure 2.3.1-15). The CRN Site is approximately 10.7 mi southwest of the center of the City of Oak Ridge, with the site and the city center separated by the ORR. The City of Kingston is approximately 7.2 mi west of the CRN Site. The closest major metropolitan center is Knoxville, approximately 25.2 mi to the east-northeast of the CRN Site.

The site is located on a peninsula formed by a meander of the Clinch River arm of the Watts Bar Reservoir between approximately river miles 14.5 and 19. Headwaters of the Clinch River are in Tazewell County, Virginia. From its headwater, the Clinch River flows approximately 350 mi in a southwesterly direction to its confluence with the Tennessee River near Kingston, Tennessee, approximately 6 mi west of the CRN Site. The Clinch River basin is in an area of comparatively narrow parallel ridges and somewhat broader intervening valleys oriented in a northeast-southwest direction. The northwestern boundary of the basin is formed by the Cumberland Mountains, which range up to 4200 ft in elevation; the southeastern boundary follows Clinch Mountain and Black Oak Ridge with elevations ranging up to 4700 ft. (Reference 2.3.1-20)

Water levels in the Clinch River arm of the Watts Bar Reservoir, which surrounds the CRN Site to the east, south, and west, are regulated by TVA. The water elevation in Watts Bar Reservoir is generally maintained between 735 ft msl and 741 ft msl (Reference 2.3.1-11). Plant grade is at an elevation of approximately 821 ft NAVD 88; placing the SMRs about 80 ft above the water level of the river.

The CRN Site is located in eastern Tennessee near the western boundary of the Valley and Ridge Physiographic Province. The Valley and Ridge Physiographic Province is characterized by folded and faulted sedimentary geologic units of Paleozoic age, which produces a series of valleys and ridges. This province extends south through Georgia and Alabama and north to Pennsylvania and New Jersey (Reference 2.3.1-22).

In eastern Tennessee, the processes of folding, faulting, and erosion have resulted in a series of northeast trending ridges and valleys. Compressive forces from the southeast have caused these rocks to yield, first by folding and subsequently by repeated breaking along a series of thrust faults (Reference 2.3.1-22). This successive faulting has resulted in several outcropping units in the area that occur in parallel belts aligned roughly with the topography. The folding/faulting process has produced a repeated sequence of outcropping units. Major units present in the area include, from youngest to oldest, the Chickamauga Group, the Knox Group, the Conasauga Group, and the Rome Formation. All are composed primarily of Ordovician and Cambrian carbonate rocks. The dip of these formations is to the southeast in nearby Melton Valley in ORR (east of the CRN Site). Rock units generally strike between 50 and 60 degrees northeast, while dips vary with proximity to faults (Reference 2.3.1-23). Dips in Melton Valley are more gentle (10 to 20 degrees) away from the fault and steeper close to faults (45 to 90 degrees) (Reference 2.3.1-23). The extent of the Appalachian Ridge and Valley Region in eastern Tennessee is shown in Figure 2.3.1-16.

The topography of the site has been altered by anthropogenic changes. In 1972, the site was selected for permitting and construction of the CRBRP (Reference 2.3.1-24). Site preparation for the CRBRP began in September 1982. A Limited Work Authorization was granted by the U.S. Nuclear Regulatory Commission (NRC) in May 1983. Excavation for the nuclear island was completed in September 1983. Approximately three million cubic yards of earth and rock were excavated from the site (Reference 2.3.1-24). The Secretary of Energy issued a statement in October 1983 that the department would terminate the project. In November of that year, an agreement was reached by the DOE, TVA, the affected utilities and project stakeholders to begin an orderly termination of the project (Reference 2.3.1-24).

The topography of the site prior to alteration as the result of the CRBRP site preparation is described in the CRBRP Preliminary Safety Analysis Report (PSAR) (Reference 2.3.1-20). A representation of the pre-construction topography and site geology is shown in Figure 2.3.1-17. The site was characterized as a series of parallel ridges separated by long, narrow valleys extending in a northeast-southwest direction. It was reported that there were no perennial streams on the site; however, after a heavy rain, surface water flowed from the ridges into the valleys and subsequently into the river. It was anticipated that construction of the CRBRP would not significantly alter the drainage pattern of the site (Reference 2.3.1-20).

The topography of the approximately 935-ac CRN Site is shown in Figure 2.3.1-18 as a hillshade map based on a recent Light Detection and Ranging (LiDAR) survey of the site area. Areas of disturbance as the result of CRBRP site preparation and excavation can be seen by the flattened hillshade areas in Figure 2.3.1-19. The ground surface elevation varies from approximately 740 ft at the Clinch River arm of the Watts Bar Reservoir to over 1100 ft along Chestnut Ridge at the northwestern site boundary. At the CRN Site Powerblock Area (Figure 2.3.1-18), the ground surface elevation is approximately 800 ft with the exception of the CRBRP partially backfilled excavation area.

A more detailed discussion of the regional and local surface water features and geologic descriptions are presented in Subsection 2.3.1.1 and Section 2.6., respectively.

2.3.1.2.1.2 Regional Hydrogeology and Groundwater Aquifers

As previously stated, the Valley and Ridge Physiographic Province is characterized by a sequence of folded and faulted, northeast-trending Paleozoic sedimentary rocks that form a series of alternating valleys and ridges. The Valley and Ridge Province in the eastern part of Tennessee is underlain by rocks that are primarily Cambrian and Ordovician in age. Minor Silurian, Devonian, and Mississippian rocks also are present in the province. In general, soluble carbonate rocks and easily eroded shale underlie the valleys in the province, and more erosion-resistant siltstone, sandstone, and some cherty dolomite underlie ridges (Reference 2.3.1-22).

The arrangement of the northeast-trending valleys and ridges and the broad expanse of the Cambrian and the Ordovician rocks are the result of a combination of folding, thrust faulting, and erosion. Compressive forces from the southeast have caused these rocks to yield, first by folding and subsequently by repeatedly breaking along a series of thrust faults (Reference 2.3.1-22). The result of this faulting is that geologic formations can be repeated several times across the faults. In eastern Tennessee, the thrust faults are closely spaced and are more responsible than the folds for the present distribution of the rocks. Following the folding and thrusting, erosion produced the sequence of ridges and valleys on the present land surface.

The principal aquifers in the Valley and Ridge Province consist of carbonate rocks that are Cambrian, Ordovician, and Mississippian in age as shown in Figure 2.3.1-20. These aquifers are typically present in valleys and rarely present on broad, dissected ridges; and underlie more than half of the Valley and Ridge Province in Tennessee. Most of the carbonate-rock aquifers are directly connected to sources of recharge, such as rivers or lakes, and solution activity has enlarged the original openings in the carbonate rocks. Other types of rocks in the province can yield large quantities of water to wells where they are fractured or contain solution openings or are directly hydraulically connected to sources of recharge (Reference 2.3.1-22).

Groundwater in aquifers primarily is stored in and moves through fractures, bedding planes, and solution openings in the rocks. These types of openings are secondary features that developed after the rocks were deposited and lithified. Little primary porosity and permeability remain in these rocks after the process of lithification. Some groundwater moves through primary pore spaces between the particles that constitute the alluvium along streams and the residuum of weathered material that overlies most of the rocks in the area (Reference 2.3.1-22).

In the carbonate rocks, the fractures and bedding planes have been enlarged by dissolution of part of the rocks. Slightly acidic water, especially that circulating in the upper 200 to 300 ft of the zone of saturation, dissolves some of the calcite and dolomite that compose the principal aquifers. Most of this dissolution takes place along fractures and bedding planes where the largest volumes of acidic groundwater flow (Reference 2.3.1-22).

Groundwater movement in the Valley and Ridge Province in eastern Tennessee is localized, in part, by the repeating lithology created by thrust faulting and, in part, by streams. Major streams are parallel to the northeast-trending valleys and ridges, and tributary streams are perpendicular to the valleys and ridges. Older rocks (primarily the Conasauga Group and the Rome Formation) have been displaced upward over the top of younger rocks (the Chickamauga and the Knox Groups) along thrust fault planes, forming a repeating sequence of permeable and less permeable hydrogeologic units. The repeating sequence, coupled with the stream network, divides the area into a series of adjacent, isolated, shallow groundwater flow systems. Within these local flow systems, most of the groundwater movement takes place within 300 ft of land surface. In recharge areas, most of the groundwater flows across the strike of the rocks. The water moves from the ridges where the water levels are high toward lower water levels adjacent to major streams that flow parallel to the long axes of the valleys as shown on Figure 2.3.1-21. Most of the groundwater is discharged directly to local springs or streams, but some of it moves along the strike of the rocks, following highly permeable fractures, bedding planes, and solution zones to finally discharge at more distant springs or streams. Although fracture zones locally are present in the clastic rocks, the highly permeable zones, which are primarily present in the carbonate rocks, act as collectors and conduits for the water (Reference 2.3.1-22).

The most important aquifers in the Valley and Ridge Province in eastern Tennessee are the carbonate rocks underlying the majority of the province. The Knox Group is the most important aquifer in eastern Tennessee. Of particular interest, near the CRN Site, are the Chickamauga Group and the Knox Group (Reference 2.3.1-20). Most of the carbonate-rock aquifers are directly connected to surface water such as rivers and lakes. Other types of rocks can yield large quantities of water to wells where they are fractured, contain solution openings, or are hydraulically connected to a source of recharge (Reference 2.3.1-22).

Secondary porosity features, in the form of bedding planes, fractures, and solution openings, comprise the primary flow pathways in the Valley and Ridge Province, as most rocks in the province have low primary porosity. Regolith layers are composed of clayey soils and saprolite. Typical conceptual cross sections in the province consist of a storm-flow zone near the surface, a less permeable vadose zone, and a groundwater zone consisting of fractured bedrock with fracture density decreasing with depth (Reference 2.3.1-25). Groundwater flow is generally from recharge areas at high elevation (ridges) to local streams and rivers at lower elevations. The repeating geological sequences described above along with the regional stream network can create a series of adjacent, isolated, shallow groundwater flow systems (Reference 2.3.1-22).

Long-term average annual precipitation is approximately 50 in. in the vicinity of the CRN Site, with an estimated long-term average runoff of 25 to 30 in. (Reference 2.3.1-22). Most of the precipitation that percolates downward becomes groundwater recharge to the shallow aquifers; a small portion enters the deep aquifer. Mixing at depth in carbonate formations have also been studied (Reference 2.3.1-26).

Well yields in the Valley and Ridge Province vary from 1 to 2500 gallons per minute (gpm) (Reference 2.3.1-22). The largest yields are from wells completed in Ordovician and Cambrian carbonate rocks (e.g., the Knox Group). Wells completed in the middle and lower parts of the Chickamauga Group, the Knox Group, and the upper part of the Conasauga Group have reported yields around 500 gpm in some locations. The median yield of wells completed in the principal aquifers range from about 11 to 350 gpm (Reference 2.3.1-22).

Spring discharges also vary greatly across the Valley and Ridge Province, ranging from about 1 to 5000 gpm, with median discharges from the principal aquifers varying from 20 to 175 gpm (Reference 2.3.1-22). The largest spring discharges issue from limestone formations of the Chickamauga Group; springs from the Knox Group have reported discharges as high as 4000 gpm (Reference 2.3.1-22). Spring discharges can be highly dependent on rainfall with some springs discharging as much as 10 times more water during high precipitation events as compared to periods of little rainfall (Reference 2.3.1-22). Wet-weather perched water tables and intermittent springs have been noted to occur (Reference 2.3.1-25).

Groundwater on the ORR, which is adjacent to the CRN Site, occurs in the unsaturated zone as transient, shallow subsurface storm flow as well as within the deeper saturated zone (Reference 2.3.1-27). An unsaturated zone of variable thickness separates the stormflow zone and water table. Adjacent to surface water features or in valley floors, the water table is found at shallow depths where the stormflow and unsaturated zones are undistinguishable. Along the ridge tops or near high topographic areas, the unsaturated zone is thick, and the water table often lies at considerable depths (approximately 50 to more than 150 ft).

Recharge of the groundwater system is reported to be strongly seasonal at the ORR. The amount of water that recharges the groundwater zone is highly variable depending on the shallow soil characteristics, permeability and degree of regolith fracturing beneath the soil, and the presence of dolines and man-made paved or covered areas. Higher recharge is expected in areas of karst hydrogeology such as the Knox aquifer. In the ORR aquitards, groundwater is transmitted through fractures (Reference 2.3.1-27).

The chemical quality of water in the freshwater parts of the Valley and Ridge aquifers is similar for shallow wells and springs. The water is hard, a calcium-magnesium-bicarbonate type, and typically has a dissolved-solids concentration of 170 parts per million (ppm) or less. The ranges of concentrations are thought to be indicators of the depth and rate at which groundwater flows through the carbonate-rock aquifers. In general, the smaller values for a constituent represent water that is moving rapidly along shallow, short flow paths from recharge areas to points of discharge. This water has been in the aquifers for a short time and has accordingly dissolved only small quantities of aquifer material. Conversely, the larger values represent water that is moving more slowly along deep, long flow paths. Such water has been in contact with aquifer minerals for a longer time and thus has had greater opportunity to dissolve the minerals. Also, water that moves into deeper parts of the aquifers can mix with saltwater (brine) that might be present at depth (Reference 2.3.1-22).

The chemical characteristics of the groundwater in the ORR aquitards range from a mixed-cation-bicarbonate water type at shallow depths to a sodium-bicarbonate water type at deeper depths, to sodium-calcium-chloride water type as evidenced from very deep wells. These chloride-rich waters appear to be a zone of dilution on top of deeper saline sodium-calcium-chloride brines, similar to those encountered within the Conasauga Group at depths greater than 1000 ft in Melton Valley (Reference 2.3.1-26). The Knox aquifer is characterized by a calcium-magnesium-bicarbonate water type.

The hydrogeologic conditions at the CRN Site are similar to those observed at the ORR with the exception of land disturbance areas resulting from earlier site work performed for the CRBRP where excavations and fill material are present.

2.3.1.2.1.3 Local Hydrogeology

Description of the local hydrogeology is based on information from the adjacent ORR. The hydrogeology of the ORR is defined by two broad hydrogeologic groups: the Knox aquifer consisting of the Knox Group and the Maynardville Limestone and the ORR aquitards, which include the Chickamauga Group, Conasauga Group, and the Rome Formation (Reference 2.3.1-28). In the vertical dimension, the Knox aquifer and the ORR aquitards are subdivided into:

- The stormflow zone, which is a thin region at the surface where transient, precipitation generated flow accounts for 90 percent or more of the water moving through the subsurface.
- The vadose zone is the unsaturated zone above the water table, which varies in thickness from nearly non-existent along stream channels to greater than 100 ft beneath ridges underlain by the Knox aquifer.

- The groundwater zone, which is continuously saturated and is the region where most of the remaining 10 percent of subsurface flow occurs. This zone is typically encountered near the top of bedrock.
- The aquiclude is a zone within the bedrock, within which water movement, if it occurs, probably is on the scale of thousands of years or more.

2.3.1.2.1.3.1 *Chickamauga Group*

The Middle to Upper Ordovician age Chickamauga Group consists of limestone, shale, and siltstone. In eastern Tennessee it is subdivided into upper, middle, and lower parts. The upper part of the Chickamauga consists of 700 to 1000 ft of limestone and shale. The middle and lower parts, together range in thickness from about 2000 to 6000 ft, consisting of limestones, shales, and siltstone (Reference 2.3.1-20). However, due to thrust faulting, the entire Chickamauga Group sequence is frequently not present (Figure 2.3.1-20) The lower and middle parts of the Chickamauga Group are generally considered to be better aquifers than the upper part (Reference 2.3.1-20). Figure 2.3.1-22 presents the subdivisions of the Chickamauga Group based on the stratigraphy of Bethel Valley in the ORR (Reference 2.3.1-29). The unit designations developed by Stockdale were used during the CRBRP investigation (Reference 2.3.1-30). The formation names shown on the figure are the names used in this investigation.

Groundwater in the Chickamauga Group is largely restricted to fractures which have been enlarged by solutioning. The fracturing of the formation by folding has resulted in a system of cavities which are more or less interconnected. The quality of water in the Chickamauga Group is varied and is influenced by local topography, local land-use patterns, depth below ground surface at which the formation is encountered, and small scale geologic considerations (Reference 2.3.1-20). Many springs occur at the shale-limestone contacts and where solution-widened joints or fractures extend to ground surface in topographic lows. In the lower and middle parts of the Chickamauga limestones, small springs are common, and several can yield more than 450 gpm. Wells in these rocks usually have low yields when located on hills or other topographic highs and have larger yields when located near permanent streams. In the upper part of the Chickamauga limestones, some springs can yield more than 100 gpm (Reference 2.3.1-20).

2.3.1.2.1.3.2 *Knox Group*

The Upper Cambrian to Lower Ordovician age Knox Group is the most important aquifer in eastern Tennessee. The Knox Group consists of 2000 to 3000 ft thickness of dolomites, limestones, and sandstones. The Knox Group in eastern Tennessee is subdivided into five formations:

- Mascot Dolomite
- Kingsport Formation
- Longview Dolomite

- Chepultepec Dolomite
- Copper Ridge Dolomite (Reference 2.3.1-29)

The occurrence of water is controlled by the extent of solution enlargement of fractures (that are the result of ancient folding and faulting). Numerous springs are found in these rocks and the water is generally of good quality. The yield of water to wells ranges from small to large. Generally the largest fractures and thus greatest well yields are found in the first few hundred ft of formation depth (Reference 2.3.1-20).

2.3.1.2.1.3.3 *Conasauga Group*

The Middle to Upper Cambrian age Conasauga Group shows lithofacies changes along north-south trending belts from clastics in the west to carbonates in the east. The site area falls within the central area of the group, which exhibits an interfingering of clastic and carbonate deposits. Six formations can be identified within the group:

- Maynardville Limestone
- Nolichucky Shale
- Dismal Gap formation (formerly Maryville Limestone)
- Rogersville Shale
- Friendship formation (formerly Rutledge Limestone)
- Pumpkin Valley Shale

The Conasauga Group has an average thickness of approximately 1800 ft in Melton and Bear Creek Valleys. The Maynardville Limestone is associated with the overlying Knox Group and functions as a single hydrologic unit known as the Knox aquifer. The remainder of the group is considered to be an aquitard (Reference 2.3.1-29).

2.3.1.2.1.3.4 *Rome Formation*

The Early Cambrian age Rome Formation is the oldest bedrock unit exposed in the site area. The Rome Formation consists of mixed siliciclastic and carbonate rocks. The lithologies represented in the formation include sandstone, siltstone, and shale with dolomite and dolomitic sandstone intervals. Studies have suggested that the true stratigraphic thickness of this formation is between 300 and 400 ft. This formation is considered to be an aquitard (Reference 2.3.1-29).

2.3.1.2.1.3.5 *Unconsolidated Deposits*

The unconsolidated deposits in the CRN Site area typically consist of four types: residuum, colluvium, alluvium, and anthropogenic materials.

Residuum

The residuum is composed of the remains of bedrock weathering. In the site area bedrock weathers to a clayey residual soil, which locally contains chert gravel. During the CRBRP investigation, the thickness of the residuum was found to vary from 1 to 78 ft, depending on the type of underlying bedrock (Reference 2.3.1-20).

Colluvium

Colluvium is an unconsolidated deposit sometimes found at the toe of a slope, and it represents material that has been moved by gravity. Colluvial deposits are generally identified by a lack of residual rock structure (bedding or joints) with disoriented rock fragments. This material tends to have more rock fragments than either residuum or alluvium. Colluvial deposits may be reworked by surface water action resulting in a hybrid colluvium-alluvium mixture (Reference 2.3.1-29).

Alluvium

The alluvium includes deposits by the Clinch River and smaller tributary streams. During the CRBRP investigation, alluvial terrace deposits were identified on the site. These deposits consisted of silty clay with thin layers of rounded quartz, chert, and quartzite gravel. Additionally a sand and clay alluvial layer was found to occur in the Clinch River floodplain, with a thickness of approximately 32 ft (Reference 2.3.1-20).

Anthropogenic Materials

Anthropogenic materials are primarily associated with artificial backfill. These materials include overburden and shot-rock (i.e., rock that has been excavated by blasting). Materials were excavated during site preparation for the CRBRP. These materials were moved and placed to facilitate laydown and parking area construction and to implement the site redress plan, when the project was canceled (Reference 2.3.1-24).

2.3.1.2.1.3.6 *Summary of Local Hydrogeology*

Figure 2.3.1-23 shows the vertical relationship of the bedrock subdivisions for the Knox aquifer and the ORR aquitards. The figure indicates that fracture frequency decreases and the concentrations of sodium and chloride increase in the groundwater with increasing depth.

Numerous groundwater investigations have been performed at the ORR providing hydrogeologic property data for the bedrock units. Testing has included slug tests, packer tests, aquifer pumping tests, and tracer tests (Appendix 2.3-A). Figure 2.3.1-24 summarizes the hydraulic conductivity test results (box and whisker plot and hydraulic conductivity versus depth) by geologic formation and by depth below ground surface. The hydraulic conductivity by depth graph suggests that at approximately 100 ft below ground surface (bgs), hydraulic conductivities decrease with depth, although this trend is less obvious in the Knox aquifer, since both fracturing and solutioning are active in this unit. Figure 2.3.1-25 summarizes the results of selected aquifer pumping tests performed on the ORR (presented in Appendix 2.3-A). The statistics presented on the figure indicate a geometric mean transmissivity of 32.5 feet squared per day (ft^2/d) and a storage coefficient of 5.9 x 10^{-4} ft^2/d for the Conasauga Group tests.

Additional hydrogeologic parameters for the stormflow and groundwater zones on the ORR are summarized on Table 2.3.1-2. The information presented in Table 2.3.1-2 suggests the transmissivity values for the ORR aquitards are approximately one order of magnitude less than those of the Knox aquifer.

2.3.1.2.1.4 Site Specific Hydrogeology

Site specific hydrogeology has been investigated during the CRBRP licensing effort and preparation for the early site permit application.

2.3.1.2.1.4.1 *CRBRP Investigation*

As part of the licensing activities for the CRBRP, the site was investigated by drilling 129 borings, installing 37 observation wells, installing 11 piezometers, and performing 117 bedrock packer permeability tests in boreholes. The investigation also included collection of groundwater level data and performing a survey of local groundwater users (Reference 2.3.1-20). Abandoned wells from the CRBRP were identified on site. The identified CRBRP wells will be evaluated for closure in accordance with applicable TVA and TDEC requirements.

The CRBRP SI identified four bedrock joint set orientations at the site:

- N52°E 37°SE
- N52°E 58°NW
- N25°W 80°SW
- N65°W 75°NE (Reference 2.3.1-20)

The predominant joint set is oriented N52°E 37°SE, which corresponds with the bedding plane partings in bedrock. The N52°E 58°NW joint set has a joint spacing of between one and six ft (Reference 2.3.1-20).

The results of the CRBRP packer hydraulic conductivity tests are shown on Figure 2.3.1-26 (and presented in Appendix 2.3-B), includes summary plots (box and whisker and hydraulic conductivity vs. depth) of the packer test results. The results can be classified in three groups: the Chickamauga long interval tests (test section length 40 ft and greater), the Chickamauga discrete interval tests (test section length less than 40 ft), and the Knox Group tests. The CRBRP packer-test-derived hydraulic conductivity results are similar to hydraulic conductivity test results from the ORR. Both sets of results indicate a decreasing trend in hydraulic conductivity at depths greater than approximately 100 ft bgs.

Water level measurements on the site indicated fluctuation in water levels as much as 20 ft. Maximum water levels were observed in January and February and minimum water levels were observed in October and November. Movement of groundwater is described as generally from topographically high areas to topographic lows; however, this pattern is modulated by the extent of weathering in the bedrock. Ultimately, the Clinch River acts as a sink for site groundwater flow. The investigation concluded that major ridges on the site may be regarded as approximate locations of groundwater divides (Reference 2.3.1-20).

2.3.1.2.1.4.2 *CRN Site Investigation*

The CRN Site field investigation included drilling 82 borings, installing 3 test pits, installing 44 wells, and performing in-situ/ex-situ tests on soil, rock, and groundwater. Groundwater characterization activities included monitoring groundwater levels and performing packer tests in boreholes, slug tests in monitoring wells, an aquifer pumping test, and groundwater geochemical sampling. Groundwater level monitoring is discussed in Subsections 2.3.1.2.2.2 and 2.3.1.2.2.3, aquifer properties are discussed in Subsection 2.3.1.2.2.4, and geochemical results are discussed in Subsection 2.3.3.2.

The locations of observation wells installed during this investigation are shown on Figure 2.3.1-18 and well installation details are provided on Table 2.3.1-3. The figure and table include permanent observation wells (OW prefix) and supplemental wells (PT-OW and PT-PW prefixes) installed for the aquifer pumping test. Well suffixes of “U,” “L,” and “D” were assigned to wells to designate the upper, lower, and deeper monitoring zones respectively. The screened depth intervals for the site observation wells for the upper monitoring zone range from 15 to 105 ft bgs, the lower monitoring zone range from 89 to 178 ft bgs, and the deeper monitoring zone range from 176 to 297 ft bgs.

A three-well cluster was installed east of the OW-101 well cluster, at boring location MP-422 (OW-422 U, L and D). During well completion, groundwater contamination was observed in OW-422L, and TVA notified TDEC and provided it with results of well sampling. The contamination was determined to be non-radiological petroleum products. Due to the contamination in OW-422L, this well cluster (OW-422 U, L and D) was not developed; however, it remains in place, locked and under TVA control. TVA has no plans to perform any additional work in the location, and TDEC will make a determination regarding the disposition of the well. Because the wells were not developed and monitoring of water levels in these wells was not performed, the OW-422 well series is not included in the discussion of site observation wells. Well clusters OW-428 and OW-429 (installed north and south of the OW-422 cluster) were installed to provide replacement geological/groundwater data.

Additional as-built information for the site wells is presented in the “Data Report for Geotechnical Exploration and Testing” (Reference 2.3.1-21). All permanent observation wells at the CRN Site were sampled after well development and no evidence of petroleum products was observed in the wells. The contamination seems to be restricted to the immediate well OW-422 area since no evidence of petroleum products were observed before and after the 72-hr pumping test conducted near the OW-423 U, L, and D well cluster (up dip of OW-422L). The hydrogeology of the CRN Site is expected to be similar to the hydrogeology of the ORR as a result of the site's physical proximity and similarity in geology. The primary differences are in the storm-flow and vadose zones at the CRN Site. The extensive excavation and reworking of unconsolidated and weathered bedrock materials associated with the CRBRP site preparation has either significantly modified or obliterated these zones at the CRN Site.

2.3.1.2.1.5 Groundwater Sources and Sinks

This subsection describes the regional, local, and site-specific discharge and recharge areas, mechanisms, and characteristics of the different aquifer units.

2.3.1.2.1.5.1 *Groundwater Discharge*

Natural discharge of the Valley and Ridge Province aquifers is primarily through streams, rivers, springs and evapotranspiration. In the site area, the Clinch River acts as a sink to which all groundwater at the site migrates (Reference 2.3.1-20).

Studies performed by the DOE for the Melton Valley offsite monitoring system, which is located approximately two miles east of the CRN Site, investigated the groundwater flow relationship with the Clinch River (Reference 2.3.1-31). Figure 2.3.1-27 presents a section through the river showing the head distribution. This head distribution suggests discharge to the Clinch River from the surrounding groundwater system.

2.3.1.2.1.5.2 *Groundwater Recharge*

Groundwater recharge is derived primarily from precipitation. Although periodic recharge from the Clinch River during high stages of the river may also be occurring, this is not considered to represent a significant part of the recharge to the aquifer. Recharge is most effective in those areas where the overburden soils are thin and permeable. Recharge may also occur through sinkholes that penetrate relatively thick and impervious formations (Reference 2.3.1-20).

2.3.1.2.2 Groundwater Sources

This subsection contains information pertaining to sole-source aquifers, groundwater flow directions and hydraulic gradients, seasonal and long-term variations of groundwater levels, hydraulic conductivity and effective porosity of the geologic formations. This information has been organized into five subcategories: (1) identification of sole source aquifers, (2) groundwater flow directions, (3) temporal groundwater trends, (4) aquifer properties, and (5) hydrogeochemical characteristics.

2.3.1.2.2.1 Sole Source Aquifers

A sole-source aquifer is defined as the sole or principal source of drinking water that supplies 50 percent or more of drinking water for an area, with no reasonable available alternative sources should the aquifer becomes contaminated. Figure 2.3.1-28 shows the location of sole-source aquifers in U.S. Environmental Protection Agency (EPA) Region 4, which encompasses Tennessee. Because surface water is abundant in the area, the EPA's Sole Source Aquifer Program has not identified any sole source aquifers in Tennessee as shown in Figure 2.3.1-28 (Reference 2.3.1-32). The identified sole-source aquifers in EPA Region 4 are beyond the boundaries of the local and regional hydrogeologic systems associated with the CRN Site. Therefore, the CRN Site will not impact any identified sole-source aquifer.

2.3.1.2.2.2 Temporal Groundwater Trends

The USGS maintains a network of observation wells in Tennessee to monitor trends in water levels. The closest permanent observation well is approximately 48 mi southeast of the CRN Site as shown on Figure 2.3.1-29 (Reference 2.3.1-33). This observation well is screened in the Great Smoky Group aquifer and is approximately 220 ft deep. The well indicates typical annual fluctuations of between 1 and 3 ft. The USGS also presents data from a manual water level measurement well located approximately 0.5 mi east of the CRN Site as shown on Figure 2.3.1-30 (Reference 2.3.1-34). This well is screened in the Valley and Ridge aquifer and is approximately 610 ft deep. The period of record is only approximately 3 months; however the hydrograph shows an approximate 5 ft range of water levels fluctuations. Neither of these USGS wells monitor the hydrogeologic units relevant to the site.

During the CRBRP investigation, periodic water level measurements were made in the site observation wells and piezometers. Examination of these measurements suggests an annual fluctuation of 10 to 25 ft with maximum water levels occurring in January and February and minimum water levels occurring in October and November (Reference 2.3.1-20).

The CRN Site hydrogeologic characterization program consisted of two years of groundwater level measurements in site observation wells. This included periodic manual measurements in all wells (except the OW-422 well cluster), beginning September 23, 2013, and continuous measurements from a recording pressure transducer in the following wells, beginning on November 23 and 24, 2013:

- OW-101
- OW-202
- OW-409
- OW-417
- OW-423

Figure 2.3.1.-31 presents hydrographs for the site well clusters, along with Clinch River (Watts Bar Reservoir) stage and site precipitation data for comparison. Water level responses from wells OW-101D, OW-409U, OW-416U/L, OW-420L, and OW-421D show correspondence to the Watts Bar Reservoir stage with periodic deviations that appear to be associated with

precipitation events. All of the site wells show a response to precipitation events, with OW-417L and OW-421U showing the most subdued response to precipitation. The location of well clusters OW-417 and OW-421 in proximity to the Clinch River may explain the subdued responses in these wells.

Observation wells OW-202L, OW-421L, OW-421D, OW-428U, OW-428L, and OW-428D show water level artifacts from well installation, development, and water sampling; these wells are excluded for the purpose of characterizing the range of fluctuation. The range of water level elevation fluctuations in the site observation wells was from approximately 1ft (OW-421U) to 25 ft (OW-409U). These fluctuations appear to be associated with precipitation events. The large magnitude of fluctuation at OW-409U may be further indication that this well is located in a recharge area.

2.3.1.2.2.3 Groundwater Flow Directions

Groundwater flow directions in the ORR are generally characterized as from the ridge tops to drainages within the adjacent valley or as a subdued replica of topography. Figure 2.3.1-32 presents conceptual block flow diagrams for Bethel Valley, which has similar geology as the CRN Site (Reference 2.3.1-35). The figure indicates localized influences such as springs, discontinuity orientations (fractures and bedding planes), man-made features (pipelines, tank farms, and building basements), and solution features have an impact on flow directions.

Groundwater flow directions were evaluated during the CRBRP PSAR by preparing two groundwater contour maps, one for December 24, 1973 and one for January 2, 1974 (Reference 2.3.1-20). Both maps indicate a general flow direction toward the southeast or southwest in the area of the proposed nuclear island. An average hydraulic gradient of approximately 0.007 feet per foot (ft/ft) is reported for the two maps (Reference 2.3.1-20). It should be noted that these maps were prepared using water level measurements from observation wells with long screened intervals and thus the equipotentials represent a vertically averaged head.

The CRN Site investigation included synoptic measurements of groundwater levels in the site observation wells. These measurements were used to prepare maximum potentiometric surface maps for the site. The maximum potentiometric surface maps used the maximum groundwater level elevation at each well cluster. Figures 2.3.1-33 through 2.3.1-42 present the potentiometric surface maps. The maps indicate a southwest to southeast flow direction in the area of the proposed CRN Site Powerblock Area. Hydraulic gradients were measured along selected flow lines on each figure. Table 2.4.12-8 in the Site Safety Analysis Report (SSAR) presents the horizontal hydraulic gradients for the ten potentiometric surface maps. The horizontal hydraulic gradients range from 0.03 to 0.12 ft/ft. Horizontal gradients were also evaluated using just the upper site observation wells for the eight quarters (December 2013, March 2014, May 2014, August 2014, November 2014, February 2015, May 2015, and August 2015), resulting in horizontal gradients ranging from 0.05 to 0.17 ft/ft. For comparison the average hydraulic gradient between the maximum water level at OW-101U and OW-202U and the Clinch River arm of the Watts Bar Reservoir is 0.05 ft/ft. This is derived based on a shortest distance of 1400 ft from the power block area to the edge of the Clinch River arm of the Watts Bar Reservoir; lowest stage of the reservoir at 735 ft NAVD88 (during the monitoring period); and the maximum water levels at OW-101U and OW-202U of 798.99 and 800.30 ft NAVD88. Due to the complexity of the subsurface hydrogeologic conditions at the CRN Site, the maximum potentiometric groundwater elevation at each well cluster is used, representing a single hydrogeological unit. Given that the “U,” “L,” and “D” wells generally screened within different hydrogeologic units, the “maximum potentiometric surface” maps do not represent a true potentiometric surface. These maps can, however, be considered bounding in terms of depicting the maximum groundwater elevations at the site.

Vertical hydraulic gradients were determined at each well cluster to evaluate the potential for vertical movement in the subsurface. The average vertical hydraulic gradients range from -0.69 to 1.03 ft/ft (Appendix 2.3-C). A negative vertical hydraulic gradient indicates an upward flow potential and a positive one indicates a downward flow potential. The upward flow potential would suggest groundwater discharge and the downward flow potential would suggest groundwater recharge. A majority of the wells with upward flow potential are located on the western and eastern sides of the site suggesting discharge towards incised site drainage features or to the Clinch River. The exception to this is well cluster OW-409U/L, which is located near the center of the site. This cluster may be indicating groundwater discharge to the adjacent CRBRP excavation. The cluster with the highest downward flow potential is OW-429U/L, suggesting a recharge area. Figure 2.3.1-43 represents the spatial variation of equipotential in the vertical plane in a cross-section along the strike of the bedding plane based on June 13, 2014 observations. Groundwater discharges from the higher equipotential area (at OW-202) to the Clinch River arm of the Watts Bar Reservoir, with OW-202 at the center of the CRS peninsula as a likely location of the groundwater divide.

2.3.1.2.2.4 Aquifer Properties

Aquifer properties at the CRN Site were determined by in-situ testing and from laboratory testing of rock core and soil samples collected during the investigation. The following sections present the results of this testing.

2.3.1.2.2.4.1 *Hydrogeological Parameters*

The primary hydrogeological properties of interest at the site are the hydraulic conductivity and effective porosity of the bedrock. Hydraulic conductivity was evaluated qualitatively through fracture frequency analysis and quantitatively through in-situ testing. The in-situ tests performed were borehole packer tests, well slug tests, and an aquifer pumping test. Effective porosity is based on a series of studies performed on the ORR.

Fracture Frequency Analysis

Fracture frequency analysis was performed by plotting the open fractures identified on the acoustic televiewer borehole geophysical logs. Figure 2.3.1-44 presents the resulting frequency distribution histogram. The histogram shows three general areas: 1) from elevation 812 to 712 ft NAVD 88, a pervasively fractured zone; 2) from elevation 712 to 612 ft NAVD 88, a moderately fractured zone; and 3) from 612 to 487 ft NAVD 88, a slightly fractured zone. It should be noted that the upper elevation of the pervasively fractured zone is somewhat biased, since most boreholes were cased into the top of bedrock prior to performing the geophysical surveys, and thus the number of open fractures at the top of rock is not accurately represented and are likely under-reported. Figure 2.3.1-45 presents an example geophysical log demonstrating this bias.

The fracture distribution identified at the CRN Site is consistent with observations at the ORR. In nearby Melton and Bethel Valleys, the transition from fractured to less fractured bedrock occurs at approximately 150 ft bgs (Reference 2.3.1-28). Figure 2.3.1-24, which is a plot of ORR hydraulic conductivity test results, indicates a generalized decrease in hydraulic conductivity at approximately 100 ft bgs.

Borehole Packer Tests

A borehole packer test is a constant head test of an isolated interval in a borehole to determine the hydraulic conductivity. For the CRN Site investigation, a double packer arrangement was used to isolate the test zone. A total of 41 packer tests were performed in 12 open boreholes during the field investigation. Of these tests, 5 exhibited evidence of flow by-passing around the packers and 14 had flow rates less than the quantifiable rate for the test, and thus were not analyzed. Table 2.3.1-5 presents the test results.

The tests were performed and interpreted using USACE method 381-80 (Reference 2.3.1-36). The borehole packer test results were arranged by geologic unit and are presented in a box and whisker plot on Figure 2.3.1-46. Summary statistics for these tests are included on the figure. The results were also compared with the packer tests performed during the CRBRP investigation as shown on Figure 2.3.1-46. In general the two data sets agree; however, the CRBRP Chickamauga long interval and CRBRP Knox tests exhibit an order of magnitude, or more, lower range of values. This may in part be due to the deeper test intervals selected during the CRBRP investigation. The upper range of values is similar for both data sets.

The CRN packer results were plotted versus depth below ground surface as shown on Figure 2.3.1-47. The results show a similar pattern as the CRBRP tests (Figure 2.3.1-26) and the ORR hydraulic conductivity tests (Figure 2.3.1-24). The hydraulic conductivities decrease below 150 ft bgs. This is most probably the result of the decreased frequency of open fractures below this depth.

Well Slug Tests

The slug test method involves creating a sudden water level displacement in the well and observing the water level change as it returns to the pre-test level. Slug tests were performed in selected site observation wells. Observation wells excluded from testing include OW-202U, OW-402U, and OW-429L because of low water levels in the wells and OW-428D because the well was still recovering from development activities. Slug tests used either a solid slug or pneumatic slug to induce the water level change. Two tests were performed in each well, one where the water level was raised in the well and allowed to fall back to the pre-test level (falling head) and one test where the water level in the well was lowered and allowed to rise back to the pre-test level (rising head). A recording pressure transducer was placed in the well to monitor the water level changes. Slug test results were entered into the AQTESOLV (HydroSOLVE 2007) computer program and the Bouwer and Rice method was used for interpretation (Reference 2.3.1-37; Reference 2.3.1-38).

The slug test solution is a porous medium method and is applied to fractured bedrock. Porous medium slug test method results were compared with discrete fracture interval method results (Reference 2.3.1-39). Their comparison found that using porous medium methods, the results were on the same order of magnitude as the results for the discrete fracture interval methods. A porous medium assumption is appropriate in highly fractured materials and where fluid exchange between the fractures and the rock matrix is either very limited or very rapid (Reference 2.3.1-40). The observation wells were located in the most fractured intervals identified in the borehole logs. Information from the ORR on Table 2.3.1-2 indicates that a matrix hydraulic conductivity of 2.8 x 10^{-7} ft/d is representative of the ORR Aquitards, which includes the Chickamauga Group. This matrix hydraulic conductivity suggests that the rock matrix is not contributing significantly to flow. These studies suggest that the use of the porous medium assumption is reasonable for the CRN Site tests.

Table 2.3.1-6 presents the results of the slug test interpretations. Examination of the table indicates that the test results from four wells (OW-202L, OW-401D, OW-415U, and OW-421D) could not be interpreted. Additionally, the results from five wells (OW-409U, OW-415L, OW-421L, OW-423D, and OW-429U) had one test (falling or rising head) that could not be interpreted. For those wells with one test, the average hydraulic conductivity is equivalent to the results of the test (falling or rising head) that could be interpreted.

Figure 2.3.1-48 presents the slug test results graphically. The figure includes a box and whisker plot of hydraulic conductivity by observation well monitoring zone and a scatter plot of hydraulic conductivity versus depth below ground surface. The box and whisker plot indicates that the hydraulic conductivities in the upper and lower zones are similar, while those in the deep zone are lower. The scatter plot of hydraulic conductivity versus depth below ground surface in general shows a pattern of decreasing range in hydraulic conductivity with depth similar to plots in Figure 2.3.1-26 and Figure 2.3.1-47. Figure 2.3.1-49 is a box and whisker plot comparing the slug test results with the CRN Site packer test results for the two major geologic units (Chickamauga Group and Knox Group) present at the site. The figure indicates a similar central tendency in the results of both tests, but the slug tests have a much broader range of values. The breadth of this range may be due to the longer test intervals for the slug tests as compared to the packer test intervals.

Aquifer Pumping Test

An aquifer pumping test was performed at the CRN Site. The aquifer pumping test array consisted of a pumping well (PT-PW) and nine proximal observation wells (PT-OW-U1, PT-OW-L1, PT-OW-U2, PT-OW-L2, PT-OW-U3, PT-OW-L3, OW-423U, OW-423L, and OW-423D) as shown on Figure 2.3.1-18. The installation completion data for these wells are included on Table 2.3.1-3. The pumping well was screened in the Fleanor and Eidson members of the Lincolnshire formation and the Blackford formation. The upper zone observation wells were screened in the Eidson member of the Lincolnshire formation and the lower and deep zone observation wells were screened in the Blackford formation. The aquifer thickness was taken to be 155 ft, which represents the difference between the static water level in the pumping well and the bottom elevation of the primary flow zone. (A review of the geologic log cores did not identify an overlying confining bed; it is presumed that leakage is derived from an underlying confining bed.) A constant rate pumping test was performed in the pumping well for a period of 72 hr with an average pumping rate of 14.5 gpm.

Pumping and observation well responses were reviewed and diagnostic plots of each well were prepared. Based on a review of the observation well water level responses, a portion of the observation wells were discarded from further analysis, because they were outside the radius of influence of the pumping well or they were completed in different hydrogeologic unit. Interpretation of the diagnostic plots for the results that were retained indicated that a leaky aquifer model most accurately represents the observed response. The water level response and pumping rate data were entered into the AQTESOLV (HydroSOLVE 2007) computer program for analysis (Reference 2.3.1-38). The solution method used was that presented in Hantush and Jacob (Reference 2.3.1-41).

Table 2.3.1-7 presents the results of the constant rate pumping test interpretation. Examination of the results suggests the maximum transmissivity and hydraulic conductivity is observed at OW-423L, which is oriented with the N52°E strike of the bedding planes relative to the pumping well. The observation wells (PT-OW-U2 and PT-OW-L2) oriented perpendicular (N38°W) to the strike of the bedding planes show approximately an order of magnitude lower transmissivity and hydraulic conductivity. Comparison of the results of this aquifer pumping test with tests performed on the ORR, as shown on Figure 2.3.1-25, indicates that the transmissivities are within the same range, but the storage coefficient values have a greater range for the CRN Site aquifer pumping test.

Effective Porosity

Table 2.3.1-8 summarizes the results of petrophysical testing of rock samples to determine the effective porosity of rock from the Conasauga and Knox Groups on the ORR. The test methods used include helium, mercury, and immersion-saturation porosimetry. The authors indicate that the immersion-saturation method would produce the results that most accurately approach the true value of effective porosity. The average effective porosity of bedrock determined from these tests is approximately 4 percent.

2.3.1.2.2.4.2 *Geotechnical Parameters*

During the CRN Site investigation, soil and rock samples were collected and tested. Interpretation of the test results has resulted in best estimates of properties of the different materials that are present or may be present in the future at the site. Table 2.3.1-9 summarizes the estimates of parameters important to radionuclide transport.

2.3.1.2.2.4.3 *Summary of Aquifer Properties*

Hydrogeologic testing information for the CRN Site area were obtained from 1) published bedrock aquifer testing from the ORR area; 2) CRBRP investigation packer tests; 3) CRN Site packer tests; 4) CRN Site slug tests: and 5) the CRN Site aquifer pumping test. The Conasauga Group, Knox Group, and the Chickamauga Group are the three major geologic strata in which the hydrogeologic testing were undertaken. Evaluation of these results suggests that hydraulic conductivity, in the bedrock, generally decreases with depth irrespective of the lithology.

Additional petrophysical testing, such as bulk density and porosity testing have been performed at the ORR and at the site. The results of these tests show generally uniform properties in the bedrock units.

2.3.1.2.2.5 Hydrogeochemical Characteristics

Site specific groundwater chemical data was collected from selected CRN onsite observation wells and compared to existing hydrogeochemical data from the surrounding area. Results and evaluation of these data sets are presented in Subsection 2.3.3.2.

2.3.1.2.3 Subsurface Groundwater Pathways

The CRN Site is surrounded on three sides by the Clinch River arm of the Watts Bar Reservoir, which is interpreted to be the discharge area for site groundwater. The most likely pathway for groundwater flow is recharge in the upland areas of the site with discharge to the Clinch River arm of the Watts Bar Reservoir. An alternate groundwater pathway is recharge in the upland areas with seepage to onsite drainages and surface water discharge into the Clinch River arm of the Watts Bar Reservoir. It is very unlikely that there is shallow groundwater flow underneath the Clinch River arm of the Watts Bar Reservoir and exposure to water users on the opposite side of the Reservoir. This conclusion is based on 1) the absence of cavities and contiguous fractures below elevation 720 ft, 2) the head relationships observed at the Melton Valley Exit Pathway monitoring wells (Reference 2.3.1-31), and 3) the observed vertical hydraulic gradients demonstrate that the Clinch River arm of the Watts Bar Reservoir acts as a hydrologic sink. This is further supported by the following observations:

- There is no evidence of contiguous cavities or fractures originating from the power block area and extending below the Clinch River arm of the Watts Bar Reservoir, based on geologic core analysis from subsurface investigations;
- The CRBRP excavation, completed to an elevation of 714 ft NGVD29 and 6 ft below the invert elevation of the Clinch River arm of the Watts Bar Reservoir, showed no evidence of any continuous groundwater flow; this is likely due to an absence of cavities and continuous fractures below elevation 720 ft;
- Only 5 percent of the observed cavities fall below elevation 718.4 ft with the average elevation of observed cavities being 782.6 ft; and
- An analysis of site-specific geologic core analysis, fracture frequency analysis, and groundwater vertical gradient data provides no evidence supporting a pathway for radionuclide transport occurring underneath the Clinch River arm of the Watts Bar Reservoir within the shallow groundwater system.

<u>Advective Transport</u>

Advective transport in groundwater is assumed to occur in an equivalent porous medium. This assumption is based on the findings of the aquifer pumping test and other hydraulic conductivity tests and is restricted to the shallow groundwater system. In the deeper groundwater system, that is not pervasively fractured, discrete fractures control the movement of groundwater. However, as discussed in Subsection 2.3.1.2.1.2 and shown on Figure 2.3.1-23, greater than 90 percent of groundwater flow occurs in the shallow zone.

The porous medium flow is represented by Darcy's law, when written in terms of linear velocity is:

$$v = -K/n_e \times dh/dl$$

Where:

v	=	linear groundwater velocity [L/T]
K	=	hydraulic conductivity [L/T]
n_e	=	effective porosity
dh/dl	=	hydraulic gradient (change in head over change in length) (Reference 2.3.1-42)

The travel time (T) is determined by dividing the distance to the receptor (D) (Clinch River arm of the Watts Bar Reservoir) by the linear groundwater velocity (v):

$$T = D/v$$

Table 2.3.1-10 presents a summary of these parameters and the linear velocity and travel time determined from these parameters. Using the representative parameter values, a travel time of 359 days is determined (Table 2.3.1-10).

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Reference 2.3.1-46. Dorsch, J., "Effective Porosity and Density of Carbonate Rocks (Maynardville Limestone and Copper Ridge Dolomite) within Bear Creek Valley on the Oak Ridge Reservation Based on Modern Petrophysical Techniques," ORNL/GWPO-026, U.S. Department of Energy under contract DE-AC05-96OR22464, Oak Ridge National Laboratory Environmental Services Division, February, 1997.

Reference 2.3.1-47. Tennessee Valley Authority, "Preliminary Information on Clinch River Site for LMBFR Demonstration Plant," Atomic Energy Commission, August 23, 1972.

Table 2.3.1-1
Monthly Means of Estimated Pan Evaporation Computed from Meteorological Measurements Using a Form of the Penman Equation[1]

State	Station Name	Station Index No.	Latitude & Longitude	May - Oct	Nov - Apr	Annual	Record Began Mo/Yr	Latest Data Mo/Yr
Tennessee	Bristol WB Airport	1094	36° 28', 82° 23'	30.34	14.36	44.70	Nov-59	Dec-70
	Chattanooga WB Airport	1656	35° 01', 85° 11'	33.99	15.95	49.94	May-61	Oct-79
	Knoxville WB Airport	4950	35° 49', 83° 58'	34.57	16.04	50.61	Dec-41	Dec-79
	Memphis WE Airport	5954	35° 03', 89° 58'	41.97	19.40	61.37	May-66	Oct-79
	Nashville WB Airport	6402	36° 07', 86° 40'	37.34	16.07	53.41	Oct-36	Nov-48
	Average			35.64	16.36	52.01		

[1] Evaporation measured in inches.

Source: (Reference 2.3.1-43)

Table 2.3.1-2 (Sheet 1 of 2)
Summary of Hydrogeologic Properties on the ORR

Residuum/Stormflow Zone		
Property	**Conditions**	**Value**
Stormflow Zone Thickness	Grassland	0.2 to 0.4 m
	Forest	0.6 to 2.0 m
Infiltration rate	Grassland	1.1 m/d
	Forest	8.8 m/d
Total Porosity	General	0.4
Specific Yield	General	0.035
Hydraulic Conductivity	General	9.2 m/d
Hydraulic Gradient	General	0.075
Discharge Rate	General	0 to 110 L/sec·km^2
Groundwater Zone		
Property	**Knox aquifer**	**ORR aquitards**
Thickness		
Permeable interval	------	1.5 m
Low-permeability interval	------	12 m
Water table fluctuation	5.3 m	1.5 m
Total porosity (matrix)	-------	9.6×10^{-3}
Fracture porosity	-------	5.0×10^{-4}
Specific yield	3.3×10^{-3}	2.3×10^{-3}
Fractures		
Spacing	-------	35 cm
Aperture	0.25 mm	0.12 mm
Unfractured rock matrix hydraulic conductivity	-------	8.7×10^{-8} m/d

Table 2.3.1-2 (Sheet 2 of 2)
Summary of Hydrogeologic Properties on the ORR

Groundwater Zone (continued)		
Property	**Knox aquifer**	**ORR aquitards**
Low-permeability intervals		
Transmissivity	-------	1.1 x 10-3 m^2/d
Hydraulic conductivity	-------	4.0 x 10-4 m/d
Permeable intervals		
Transmissivity	1.0 m^2/d	0.12 m^2/d
Hydraulic conductivity	-------	0.068 m/d
Continuum		
Transmissivity	7.0 m^2/d	0.75 m^2/d
Hydraulic conductivity	-------	0.18 m/d
Hydraulic gradient	0.02	0.05
Average recharge	65 mm	20 mm
Maximum discharge	1030 L/min·km^2	280 L/min·km^2
Average discharge	120 L/min·km^2	38 L/min·km^2

Source: (Reference 2.3.1-44)

Table 2.3.1-3 (Sheet 1 of 6)
Well Construction Summary

Well	Northing (NAD 83)	Easting (NAD 83)	Geologic Unit[1]	Top of Casing Elevation (NAVD 88)	Top of Concrete Elevation (NAVD 88)	Ground Surface Elevation (NAVD 88)	Top of Bentonite Seal	
							Depth below Ground (ft)	Elevation (NAVD 88)
OW-101U	570235.5	2448339.3	Benbolt	803.72	800.73	800.58	15.0	785.6
OW-101L	570262.0	2448370.8	Rockdell	803.48	800.81	800.66	126.6	674.1
OW-101D	570274.9	2448386.4	Rockdell	803.57	800.82	800.65	219.2	581.5
OW-202U	570946.0	2448081.1	Fleanor	815.38	812.11	811.83	4.3	807.5
OW-202L	570934.2	2448064.9	Fleanor	815.05	812.23	811.97	141.1	670.9
OW-202D	570909.7	2448033.7	Eidson	815.00	812.21	812.10	260.0	552.1
OW-401U	571967.9	2447619.9	Newala	820.48	817.55	817.39	5.2	812.2
OW-401L	571973.8	2447628.0	Newala	820.57	817.47	817.22	126.7	690.5
OW-401D	571941.2	2447589.7	Newala	821.28	818.41	818.17	215.6	602.6
OW-409U	570557.1	2448130.3	Rockdell	809.70	807.12	806.91	44.4	762.5
OW-409L	570570.8	2448143.3	Rockdell	809.51	806.82	806.67	82.7	724.0
OW-415U	569590.2	2448180.2	Bowen/Benbolt	787.22	784.41	784.13	19.5	764.6
OW-415L	569564.4	2448148.1	Benbolt	786.75	783.93	783.65	146.9	636.8
OW-416U	569990.0	2447535.9	Rockdell	812.82	809.82	809.54	67.6	741.9
OW-416L	569965.2	2447504.9	Rockdell	812.73	809.72	809.43	98.4	711.0
OW-417U	569927.1	2446646.9	Fleanor	775.03	772.36	772.20	40.4	731.8
OW-417L	569903.0	2446614.6	Fleanor	775.71	772.78	772.65	81.8	690.9
OW-418U	570526.8	2447065.0	Eidson	812.94	810.30	810.01	78.0	732.0
OW-418L	570506.0	2447038.8	Blackford	814.41	811.80	811.44	124.9	686.5
OW-419U	571283.4	2446716.1	Newala	803.13	800.21	799.98	48.8	751.2
OW-419L	571257.7	2446683.4	Newala	802.72	799.89	799.75	90.5	709.3
OW-420U	572009.6	2446886.0	Newala	805.70	803.10	802.85	15.0	787.9
OW-420L	572021.1	2446902.0	Newala	806.15	803.31	803.07	120.0	683.1
OW-421U	570557.7	2446471.7	Blackford	808.27	805.55	805.36	41.2	764.2
OW-421L	570544.2	2446455.6	Blackford/ Newala	807.81	805.05	804.78	92.4	712.4
OW-421D	570520.1	2446424.4	Newala	805.20	802.63	802.49	165.2	637.3
OW-422U	570450.2	2448763.8	Benbolt	804.90	---	802.40	9.7	792.7
OW-422L	570438.1	2448748.1	Benbolt	803.70	---	801.70	147.3	654.4
OW-422D	570444.3	2448756.2	Rockdell	805.40	---	802.10	281.2	520.9
OW-423U	571494.1	2448309.5	Eidson	800.21	797.53	797.41	31.5	765.9
OW-423L	571481.6	2448293.2	Blackford	801.13	798.33	798.02	127.9	670.1
OW-423D	571457.9	2448262.0	Blackford	802.86	800.13	799.89	236.9	563.0

**Table 2.3.1-3 (Sheet 2 of 6)
Well Construction Summary**

Well	Top of Filter Pack		Well Casing Diameter (inches)	Well Casing Schedule	Well Material	Screen Slot Size (inches)	Top of Screen	
	Depth below Ground (ft)	Elevation (NAVD 88)					Depth below Ground (ft)	Elevation (NAVD 88)
OW-101U	21.4	779.2	2	40	PVC	0.020	26.0	774.6
OW-101L	133.6	667.1	2	80	PVC	0.020	138.0	662.7
OW-101D	225.8	574.9	2	80	PVC	0.020	230.5	570.2
OW-202U	11.1	800.7	2	40	PVC	0.020	15.7	796.1
OW-202L	147.0	665.0	2	80	PVC	0.020	150.5	661.5
OW-202D	273.0	539.1	2	80	PVC	0.020	276.4	535.7
OW-401U	10.5	806.9	2	40	PVC	0.020	15.2	802.2
OW-401L	130.8	686.4	2	80	PVC	0.020	135.2	682.0
OW-401D	221.9	596.3	2	80	PVC	0.020	226.6	591.6
OW-409U	52.4	754.5	2	40	PVC	0.020	54.9	752.0
OW-409L	86.6	720.1	2	40	PVC	0.020	89.1	717.6
OW-415U	24.1	760.0	2	40	PVC	0.020	28.1	756.0
OW-415L	151.9	631.8	2	80	PVC	0.020	154.9	628.8
OW-416U	71.8	737.7	2	40	PVC	0.020	75.4	734.1
OW-416L	107.6	701.8	2	40	PVC	0.020	110.6	698.8
OW-417U	46.7	725.5	2	40	PVC	0.020	50.0	722.2
OW-417L	91.5	681.2	2	40	PVC	0.020	95.0	677.7
OW-418U	90.1	719.9	2	40	PVC	0.020	95.0	715.0
OW-418L	133.6	677.8	2	80	PVC	0.020	136.8	674.6
OW-419U	54.4	745.6	2	40	PVC	0.020	57.2	742.8
OW-419L	101.0	698.8	2	40	PVC	0.020	104.5	695.3
OW-420U	21.2	781.7	2	40	PVC	0.020	26.0	776.9
OW-420L	127.4	675.7	2	40	PVC	0.020	130.9	672.2
OW-421U	51.4	754.0	2	40	PVC	0.020	55.0	750.4
OW-421L	101.0	703.8	2	40	PVC	0.020	104.8	700.0
OW-421D	172.8	629.7	2	80	PVC	0.020	175.7	626.8
OW-422U	17.9	784.5	2	40	PVC	0.020	21.0	781.4
OW-422L	155.2	646.5	2	80	PVC	0.020	158.0	643.7
OW-422D	286.2	515.9	2	80	PVC	0.020	290.0	512.1
OW-423U	39.1	758.3	2	40	PVC	0.020	42.2	755.2
OW-423L	136.6	661.4	2	80	PVC	0.020	139.6	658.4
OW-423D	244.2	555.7	2	80	PVC	0.020	248.1	551.8

Table 2.3.1-3 (Sheet 3 of 6)
Well Construction Summary

Well	Bottom of Screen		Bottom of Well Cap		Bottom of Borehole	
	Depth below Ground (ft)	Elevation (NAVD 88)	Depth below Ground (ft)	Elevation (NAVD 88)	Depth below Ground (ft)	Elevation (NAVD 88)
OW-101U	46.0	754.6	46.5	754.1	50.0	750.6
OW-101L	158.0	642.7	158.5	642.2	161.0	639.7
OW-101D	250.5	550.2	251.0	549.7	261.5	539.2
OW-202U	35.7	776.1	36.2	775.6	39.0	772.8
OW-202L	170.5	641.5	171.0	641.0	173.0	639.0
OW-202D	296.4	515.7	296.9	515.2	303.0	509.1
OW-401U	35.2	782.2	35.7	781.7	37.5	779.9
OW-401L	155.2	662.0	155.7	661.5	159.3	657.9
OW-401D	246.6	571.6	247.1	571.1	251.7	566.5
OW-409U	74.9	732.0	75.4	731.5	78.0	728.9
OW-409L	109.1	697.6	109.6	697.1	112.0	694.7
OW-415U	48.1	736.0	48.6	735.5	51.1	733.0
OW-415L	174.9	608.8	175.4	608.3	177.4	606.3
OW-416U	95.4	714.1	95.9	713.6	97.5	712.0
OW-416L	130.6	678.8	131.1	678.3	133.0	676.4
OW-417U	70.0	702.2	70.5	701.7	73.1	699.1
OW-417L	115.0	657.7	115.5	657.2	118.0	654.7
OW-418U	105.0	705.0	105.5	704.5	108.0	702.0
OW-418L	156.8	654.6	157.3	654.1	160.0	651.4
OW-419U	77.2	722.8	77.7	722.3	79.6	720.4
OW-419L	124.5	675.3	125.0	674.8	126.5	673.3
OW-420U	46.0	756.9	46.5	756.4	48.5	754.4
OW-420L	150.9	652.2	151.4	651.7	152.4	650.7
OW-421U	75.0	730.4	75.5	729.9	78.0	727.4
OW-421L	124.8	680.0	125.3	679.5	128.0	676.8
OW-421D	195.7	606.8	196.2	606.3	198.0	604.5
OW-422U	41.0	761.4	41.5	760.9	44.0	758.4
OW-422L	178.0	623.7	178.5	623.2	181.0	620.7
OW-422D	310.0	492.1	310.5	491.6	313.0	489.1
OW-423U	62.2	735.2	62.7	734.7	65.0	732.4
OW-423L	159.6	638.4	160.1	637.9	163.0	635.0
OW-423D	268.1	531.8	268.6	531.3	273.0	526.9

Table 2.3.1-3 (Sheet 4 of 6)
Well Construction Summary

Well	Northing (NAD 83)	Easting (NAD 83)	Geologic Unit[1]	Top of Casing Elevation (NAVD 88)	Top of Concrete Elevation (NAVD 88)	Ground Surface Elevation (NAVD 88)	Top of Bentonite Seal	
							Depth below Ground (ft)	Elevation (NAVD 88)
OW-428U	570781.4	2448710.6	Rockdell	807.78	804.57	804.33	24.4	779.9
OW-428L	570767.9	2448696.6	Rockdell	807.06	804.18	803.86	100.5	703.4
OW-428D	570741.9	2448666.5	Rockdell	807.03	804.02	803.73	172.2	631.5
OW-429U	569989.1	2448606.2	Bowen/ Benbolt	799.17	796.41	796.21	27.8	768.4
OW-429L	569965.3	2448576.5	Benbolt	799.49	796.52	796.26	136.1	660.2
PT-OW-U1	571512.5	2448235.3	Eidson	801.52	798.71	798.55	19.8	778.8
PT-OW-L1	571493.2	2448235.2	Blackford	803.13	800.09	799.77	129.7	670.1
PT-OW-U2	571489.5	2448182.4	Eidson	805.31	802.60	802.19	32.9	769.3
PT-OW-L2	571478.7	2448192.1	Blackford	804.32	801.22	800.89	124.8	676.1
PT-OW-U3	571418.4	2448310.6	Eidson	801.65	799.31	799.17	24.6	774.6
PT-OW-L3	571420.6	2448290.2	Blackford	803.12	800.41	800.07	127.5	672.6
PT-PW	571432.2	2448229.1	Eidson/ Blackford	804.03	802.41	802.06	29.4	772.7

Table 2.3.1-3 (Sheet 5 of 6)
Well Construction Summary

Well	Top of Filter Pack		Well Casing Diameter (inches)	Well Casing Schedule	Well Material	Screen Slot Size (inches)	Top of Screen	
	Depth below Ground (ft)	Elevation (NAVD 88)					Depth below Ground (ft)	Elevation (NAVD 88)
OW-428U	34.4	769.9	2	40	PVC	0.020	40.4	763.9
OW-428L	110.2	693.7	2	40	PVC	0.020	115.2	688.7
OW-428D	185.2	618.5	2	80	PVC	0.020	190.2	613.5
OW-429U	31.8	764.4	2	40	PVC	0.020	36.8	759.4
OW-429L	140.1	656.2	2	80	PVC	0.020	145.1	651.2
PT-OW-U1	36.8	761.8	2	40	PVC	0.020	41.8	756.8
PT-OW-L1	134.9	664.9	2	40	PVC	0.020	139.7	660.1
PT-OW-U2	37.0	765.2	2	40	PVC	0.020	42.0	760.2
PT-OW-L2	135.0	665.9	2	40	PVC	0.020	139.8	661.1
PT-OW-U3	34.1	765.1	2	40	PVC	0.020	42.6	756.6
PT-OW-L3	135.5	664.6	2	40	PVC	0.020	140.5	659.6
PT-PW	34.6	767.5	6	40	PVC	0.020	39.3	762.8

Table 2.3.1-3 (Sheet 6 of 6)
Well Construction Summary

Well	Bottom of Screen		Bottom of Well Cap		Bottom of Borehole	
	Depth below Ground (ft)	Elevation (NAVD 88)	Depth below Ground (ft)	Elevation (NAVD 88)	Depth below Ground (ft)	Elevation (NAVD 88)
OW-428U	60.4	743.9	60.9	743.4	63.0	741.3
OW-428L	135.2	668.7	135.7	668.2	138.0	665.9
OW-428D	210.2	593.5	210.7	593.0	213.0	590.7
OW-429U	56.8	739.4	57.3	738.9	60.0	736.2
OW-429L	165.1	631.2	165.6	630.7	168.0	628.3
PT-OW-U1	61.8	736.8	62.3	736.3	65.0	733.6
PT-OW-L1	159.7	640.1	160.2	639.6	163.0	636.8
PT-OW-U2	62.0	740.2	62.5	739.7	65.0	737.2
PT-OW-L2	159.8	641.1	160.3	640.6	163.0	637.9
PT-OW-U3	62.6	736.6	63.1	736.1	65.0	734.2
PT-OW-L3	160.5	639.6	161.0	639.1	163.0	637.1
PT-PW	169.3	632.8	171.8	630.3	173.0	629.1

[1] Geologic units from Table B.1.2 in the Clinch River Data Report (Reference 2.3.1-21)

Table 2.3.1-4 (Sheet 1 of 5)
Horizontal Hydraulic Gradients

September 24, 2013 Potentiometric Surface Map

Direction	Length (ft)	Elevation at the Well or Contour (upgradient) (ft NAVD 88)	Elevation at the Well or Contour (downgradient) (ft NAVD 88)	Head Difference (ft)	Horizontal Hydraulic Gradient (ft/ft)
Section 1	266	810.0	780.0	30.0	0.11
Section 2	582	810.0	760.0	50.0	0.09
Section 3	162	810.0	798.7	11.3	0.07
Section 4	830	770.0	740.0	30.0	0.04
Section 5	273	790.0	760.0	30.0	0.11
Section 6	700	800.0	750.0	50.0	0.07

Note: Based on Figure 2.3.1-33; Maximum Water Levels in Each Nested Well Cluster

December 20, 2013 Potentiometric Surface Map

Direction	Length (ft)	Elevation at the Well or Contour (upgradient) (ft NAVD 88)	Elevation at the Well or Contour (downgradient) (ft NAVD 88)	Head Difference (ft)	Horizontal Hydraulic Gradient (ft/ft)
Section 1	227	805.0	785.0	20.0	0.09
Section 2	423	795.0	765.0	30.0	0.07
Section 3	332	805.0	795.0	10.0	0.03
Section 4	650	775.0	745.0	30.0	0.05
Section 5	96	775.0	765.0	10.0	0.10
Section 6	351	795.0	765.0	30.0	0.09
Section 7	253	785.0	775.0	10.0	0.04

Note: Based on Figure 2.3.1-34; Maximum Water Levels in Each Nested Well Cluster

Table 2.3.1-4 (Sheet 2 of 5)
Horizontal Hydraulic Gradients

January 13, 2014 Potentiometric Surface Map

Direction	Length (ft)	Elevation at the Well or Contour (upgradient) (ft NAVD 88)	Elevation at the Well or Contour (downgradient) (ft NAVD 88)	Head Difference (ft)	Horizontal Hydraulic Gradient (ft/ft)
Section 1	266	810	790	20	0.08
Section 2	629	800	760	40	0.06
Section 3	389	810	800	10	0.03
Section 4	646	780	750	30	0.05
Section 5	189	790	770	20	0.11
Section 6	398	780	760	20	0.05

Note: Based on Figure 2.3.1-35; Maximum Water Levels in Each Nested Well Cluster

March 16, 2014 Potentiometric Surface Map

Direction	Length (ft)	Elevation at the Well or Contour (upgradient) (ft NAVD 88)	Elevation at the Well or Contour (downgradient) (ft NAVD 88)	Head Difference (ft)	Horizontal Hydraulic Gradient (ft/ft)
Section 1	401	810	780	30	0.07
Section 2	653	810	760	50	0.08
Section 3	339	810	800	10	0.03
Section 4	707	790	750	40	0.06
Section 5	128	780	770	10	0.08
Section 6	686	810	760	50	0.07
Section 7	306	780	770	10	0.03

Note: Based on Figure 2.3.1-36; Maximum Water Levels in Each Nested Well Cluster

Table 2.3.1-4 (Sheet 3 of 5)
Horizontal Hydraulic Gradients

May 15, 2014 Potentiometric Surface Map

Direction	Length (ft)	Elevation at the Well or Contour (upgradient), ft NAVD 88	Elevation at the Well or Contour (downgradient), ft NAVD 88	Head Difference (ft)	Horizontal Hydraulic Gradient (ft/ft)
Section 1	329	810	780	30	0.09
Section 2	564	810	760	50	0.09
Section 3	318	810	800	10	0.03
Section 4	588	780	750	30	0.05
Section 5	85	780	770	10	0.12
Section 6	539	810	760	50	0.09
Section 7	191	780	770	10	0.05

Note: Based on Figure 2.3.1-37; Maximum Water Levels in Each Nested Well Cluster

August 18, 2014 Potentiometric Surface Map

Direction	Length (ft)	Elevation at the Well or Contour (upgradient), ft NAVD 88	Elevation at the Well or Contour (downgradient), ft NAVD 88	Head Difference (ft)	Horizontal Hydraulic Gradient (ft/ft)
Section 1	394	810	780	30	0.08
Section 2	696	810	760	50	0.07
Section 3	356	810	800	10	0.03
Section 4	591	780	750	30	0.05
Section 5	97	780	770	10	0.10
Section 6	948	810	750	60	0.06
Section 7	255	780	770	10	0.04

Note: Based on Figure 2.3.1-38; Maximum Water Levels in Each Nested Well Cluster

**Table 2.3.1-4 (Sheet 4 of 5)
Horizontal Hydraulic Gradients**

November 4, 2014 Potentiometric Surface Map

Direction	Length (ft)	Elevation at the Well or Contour (upgradient), ft NAVD 88	Elevation at the Well or Contour (downgradient), ft NAVD 88	Head Difference (ft)	Horizontal Hydraulic Gradient (ft/ft)
Section 1	319	810	780	30	0.09
Section 2	736	810	750	60	0.08
Section 3	275	810	800	10	0.04
Section 4	430	780	750	30	0.07
Section 5	120	780	770	10	0.08
Section 6	841	810	750	60	0.07
Section 7	286	780	770	10	0.04

Note: Based on Figure 2.3.1-39; Maximum Water Levels in Each Nested Well Cluster

February 12, 2015 Potentiometric Surface Map

Direction	Length (ft)	Elevation at the Well or Contour (upgradient), ft NAVD 88	Elevation at the Well or Contour (downgradient), ft NAVD 88	Head Difference (ft)	Horizontal Hydraulic Gradient (ft/ft)
Section 1	399	810	780	30	0.08
Section 2	609	810	760	50	0.08
Section 3	335	810	800	10	0.03
Section 4	492	780	750	30	0.06
Section 5	107	780	770	10	0.09
Section 6	609	810	760	50	0.08
Section 7	259	780	770	10	0.04

Note: Based on Figure 2.3.1-40; Maximum Water Levels in Each Nested Well Cluster

Table 2.3.1-4 (Sheet 5 of 5)
Horizontal Hydraulic Gradients

May 19, 2015 Potentiometric Surface Map

Direction	Length (ft)	Elevation at the Well or Contour (upgradient), ft NAVD 88	Elevation at the Well or Contour (downgradient), ft NAVD 88	Head Difference (ft)	Horizontal Hydraulic Gradient (ft/ft)
Section 1	293	810	780	30	0.10
Section 2	693	810	750	60	0.09
Section 3	243	810	800	10	0.04
Section 4	349	780	750	30	0.09
Section 5	208	780	760	20	0.10
Section 6	929	810	750	60	0.06
Section 7	285	780	770	10	0.04

Note: Based on Figure 2.3.1-41; Maximum Water Levels in Each Nested Well Cluster

August 10, 2015 Potentiometric Surface Map

Direction	Length (ft)	Elevation at the Well or Contour (upgradient), ft NAVD 88	Elevation at the Well or Contour (downgradient), ft NAVD 88	Head Difference (ft)	Horizontal Hydraulic Gradient (ft/ft)
Section 1	296	810	780	30	0.10
Section 2	682	810	750	60	0.09
Section 3	230	810	800	10	0.04
Section 4	250	770	750	20	0.08
Section 5	111	780	770	10	0.09
Section 6	520	810	760	50	0.10
Section 7	260	780	770	10	0.04

Note: Based on Figure 2.3.1-42; Maximum Water Levels in Each Nested Well Cluster

Mean Horizontal Hydraulic Gradient = 0.07 ft/ft
Minimum Horizontal Hydraulic Gradient = 0.03 ft/ft
Maximum Horizontal Hydraulic Gradient = 0.12 ft/ft

Table 2.3.1-5 (Sheet 1 of 3)
Borehole Packer Test Results Summary

Boring	Zone	Geologic Unit Formation	Depth (ft below ground)	Estimated Transmissivity (ft^2/day)	Estimated Hydraulic Conductivity (ft/day)	Analysis Notes
MP-101	Z1	Chickamauga Benbolt	27.5 to 35.0	7	0.9	None
MP-101	Z2	Chickamauga Rockdell	145.0 to 152.5	20	3	None
MP-202	Z1	Chickamauga Fleanor member	41.7 to 49.2	Low	Low	Low/negligible flow suggests low hydraulic conductivity.
MP-202	Z2	Chickamauga Fleanor member	153.0 to 160.5	2	0.3	None
MP-202	Z3	Chickamauga Fleanor member	182.0 to 189.5	Low	Low	Low/negligible flow suggests low hydraulic conductivity.
MP-401	Z2	Knox Newala	28.0 to 35.5	Low	Low	Low/negligible flow suggests low hydraulic conductivity.
MP-401	Z3	Knox Newala	77.0 to 84.5	Low	Low	Low/negligible flow suggests low hydraulic conductivity.
MP-401	Z4	Knox Newala	237.0 to 244.5	3	0.4	Test results indicate higher transmissivity value for higher pressures. Possible explanations for the test behavior include fracture dilation or fracture washout.
MP-415	Z1	Chickamauga Bowen	27.5 to 35.0	High	High	High flow rates (exceeding 80 gpm) with pressure increase in the transducer above the test interval. The target test pressure in the interval was not achieved and the test was aborted. The high flow rates suggest high hydraulic conductivity.
MP-415	Z2	Chickamauga Benbolt	162.5 to 170.0	Low	Low	Low/negligible flow suggests low hydraulic conductivity.
MP-415	Z3	Chickamauga Benbolt	252.5 to 260.0	Low	Low	Low/negligible flow suggests low hydraulic conductivity.
MP-416	Z2	Chickamauga Rockdell	89.0 to 96.5	1	0.2	Flow for this test was low, behavior suggests non-linear flow.

Table 2.3.1-5 (Sheet 2 of 3)
Borehole Packer Test Results Summary

Boring	Zone	Geologic Unit Formation	Depth (ft below ground)	Estimated Transmissivity (ft^2/day)	Estimated Hydraulic Conductivity (ft/day)	Analysis Notes
MP-416	Z3	Chickamauga Rockdell	109.0 to 116.5	8	1	None
MP-416	Z4	Chickamauga Rockdell	205.0 to 212.5	Low	Low	Low/negligible flow suggests low hydraulic conductivity.
MP-417	Z1	Chickamauga Fleanor member	61.5 to 69.0	10	2	Some response was observed in the transducers above and below the test interval. Flow did not increase in highly non-linear fashion, suggesting an indirect connection to the borehole outside the test interval.
MP-417	Z2	Chickamauga Fleanor member	84.0 to 91.5	3	0.5	None
MP-417	Z3	Chickamauga Eidson member	210.5 to 218.0	3	0.4	None
MP-418A	Z1	Chickamauga Eidson member	86.0 to 93.5	40	5	None
MP-418A	Z2	Chickamauga Blackford	139.0 to 146.5	1	0.2	None
MP-418A	Z3	Chickamauga Blackford	240.0 to 247.5	0.3	0.04	None
MP-419	Z1	Knox Newala	210.0 to 217.5	1	0.2	None
MP-419	Z2	Knox Newala	135.0 to 142.5	Low	Low	Low/negligible flow suggests low hydraulic conductivity.
MP-419	Z3	Knox Newala	120.0 to 127.5	2	0.3	None
MP-419	Z4	Knox Newala	109.0 to 116.5	Low	Low	Low/negligible flow suggests low hydraulic conductivity.
MP-420	Z2	Knox Newala	79.0 to 86.5	2	0.2	None

Table 2.3.1-5 (Sheet 3 of 3)
Borehole Packer Test Results Summary

Boring	Zone	Geologic Unit Formation	Depth (ft below ground)	Estimated Transmissivity (ft^2/day)	Estimated Hydraulic Conductivity (ft/day)	Analysis Notes
MP-420	Z3	Knox Newala	100.0 to 107.5	10	2	None
MP-420	Z4	Knox Newala	132.5 to 140.0	8	1	None
MP-420	Z5	Knox Newala	166.0 to 173.5	5	0.7	None
MP-420	Z6	Knox Newala	186.0 to 193.5	10	1	None
MP-421	Z1	Chickamauga Blackford	57.0 to 64.5	1	0.2	None
MP-421	Z2	Chickamauga Blackford	99.0 to 106.5	Low	Low	Low/negligible flow suggests low hydraulic conductivity.
MP-421	Z3	Knox Newala	121.0 to 128.5	0.8	0.1	None
MP-421	Z4	Knox Newala	228.0 to 235.5	Low	Low	Low/negligible flow suggests low hydraulic conductivity.
MP-422	Z1	Chickamauga Benbolt	31.5 to 39.0	Low	Low	Low/negligible flow suggests low hydraulic conductivity.
MP-422	Z2	Chickamauga Benbolt	50.0 to 57.5	Low	Low	Low/negligible flow suggests low hydraulic conductivity.
MP-422	Z3	Chickamauga Benbolt	170.0 to 177.5	Low	Low	Low/negligible flow suggests low hydraulic conductivity.
MP-423	Z2	Chickamauga Eidson member	68.5 to 76.0	5	0.7	Much higher flows in later portion of test, which achieved the highest test pressure. There was no response in the transducers above or below the test interval, indicating that there was no hydraulic connection outside the test interval. Possible explanations for the test behavior include fracture dilation or fracture washout.

Notes: Hydraulic conductivity values were computed based on unrounded transmissivity values; both values were then rounded to one significant figure.
Low – qualitative indication of low transmissivity and hydraulic conductivity.
High – qualitative indication of high transmissivity and hydraulic conductivity.

Table 2.3.1-6 (Sheet 1 of 2)
Well Slug Test Results Summary

Well Name	Test Type	Falling Head Hydraulic Conductivity Estimate (ft/day)	Rising Head Hydraulic Conductivity Estimate (ft/day)	Test Average Hydraulic Conductivity (ft/day)	Geologic Unit Formation	Analysis Notes
OW-101D	Pneumatic	0.13	0.063	0.097	Chickamauga Group Rockdell	None
OW-101L	Pneumatic	7.6	7.5	7.6	Chickamauga Group Rockdell	None
OW-101U	Pneumatic	0.049	0.053	0.051	Chickamauga Group Benbolt	None
OW-202D	Solid	0.068	0.024	0.046	Chickamauga Group Eidson Member	None
OW-202L	Solid	--	--	--	Chickamauga Group Fleanor	Both tests discarded – Static water level discrepancy and normalized head never reaches 0.3 to 0.2
OW-401D	Solid	--	--	--	Knox Group Newala	Not analyzed – Head does not change after initiation
OW-401L	Pneumatic	0.059	0.092	0.076	Knox Group Newala	None
OW-401U	Pneumatic	0.089	0.065	0.077	Knox Group Newala	None
OW-409L	Pneumatic	0.069	0.061	0.065	Chickamauga Group Rockdell	None
OW-409U	Solid	--	0.14	0.14	Chickamauga Group Rockdell	Falling head not analyzed – Irregular response
OW-415L	Pneumatic	--	0.29	0.29	Chickamauga Group Benbolt	Falling head discarded – Normalized head never reaches 0.3 to 0.2
OW-415U	Solid	--	--	--	Chickamauga Group Bowen/Benbolt	Not analyzed – Irregular response
OW-416L	Pneumatic	0.61	0.48	0.54	Chickamauga Group Rockdell	None
OW-416U	Pneumatic	1.2	1.1	1.2	Chickamauga Group Rockdell	None
OW-417L	Pneumatic	0.31	0.44	0.38	Chickamauga Group Fleanor Member	None

Table 2.3.1-6 (Sheet 2 of 2)
Well Slug Test Results Summary

Well Name	Test Type	Falling Head Hydraulic Conductivity Estimate (ft/day)	Rising Head Hydraulic Conductivity Estimate (ft/day)	Test Average Hydraulic Conductivity (ft/day)	Geologic Unit Formation	Analysis Notes
OW-417U	Pneumatic	2.2	1.6	1.9	Chickamauga Group Fleanor Member	None
OW-418L	Pneumatic	0.16	0.14	0.15	Chickamauga Group Blackford	None
OW-418U	Pneumatic	0.21	0.21	0.21	Chickamauga Group Eidson Member	None
OW-419L	Pneumatic	2.7	3.6	3.2	Knox Group Newala	None
OW-419U	Pneumatic	11	13	12	Knox Group Newala	None
OW-420L	Solid	0.062	0.048	0.055	Knox Group Newala	None
OW-421D	Solid	--	--	--	Knox Group Newala	Not analyzed – Irregular early-time response
OW-421L	Solid	--	0.00055	0.00055	Knox/Chickamauga Newala/Blackford	Falling head not analyzed – Head does not decrease after initiation
OW-421U	Solid	0.066	0.036	0.051	Chickamauga Group Blackford	None
OW-423D	Pneumatic	0.039	--	0.039	Chickamauga Group Blackford	Rising head discarded – Normalized head never reaches 0.3 to 0.2
OW-423L	Solid	0.10	0.095	0.098	Chickamauga Group Blackford	None
OW-423U	Pneumatic	2.3	0.66	1.5	Chickamauga Group Eidson Member	None
OW-428L	Solid	0.012	0.0022	0.0071	Chickamauga Group Rockdell	None
OW-428U	Solid	0.0016	0.012	0.0068	Chickamauga Group Rockdell	None
OW-429U	Solid	0.0035	--	0.0035	Chickamauga Group Bowen/Benbolt	Rising head discarded – Normalized head never reaches 0.3 to 0.2

Table 2.3.1-7
CRN Constant Rate Aquifer Pumping Test Results

Well Name	Orientation Relative to Pumping Well	Transmissivity Pumping Period T_p (ft^2/d)	Transmissivity Recovery Period T_r (ft^2/d)	Storage Coefficient Pumping Period (dimensionless)	Hydraulic Conductivity $(T_p+T_r)/2/155$ ft (ft/d)
PT-OW-U1	N7°E	10.6	7	5.37×10^{-4}	0.06
PT-OW-L1	N7°E	129.3	128.7	3.10×10^{-3}	0.8
PT-OW-U2	N38°W	28.4	22.2	4.83×10^{-2}	0.2
PT-OW-L2	N38°W	28.1	30.3	2.28×10^{-3}	0.2
PT-OW-L3	S7°E	11.8	8.0	2.73×10^{-4}	0.06
OW-423L[1]	N52°E	410.1	391.1	8.1×10^{-3}	2.6

[1] A storage coefficient of 8.9×10^{-10} was reported for the pumping period of observation well OW-423L and is considered a nonrealistic value; however, for the same well in the recovery period, a value of 8.1×10^{-3} was reported – the recovery period derivative data exhibited less noise.

Table 2.3.1-8 (Sheet 1 of 5)
Rock Effective Porosity Measurements on the Oak Ridge Reservation

Borehole	Group	Unit[1]	Depth (m)	Depth (ft)	Effective Porosity (%)				Grain Density		Bulk Density		Data Source[3]
					Helium	Mercury	Immersion[2]	Other	(g/cm^3)	(pcf)	(g/cm^3)	(pcf)	
Joy-1	Conasauga	Pumpkin Valley Shale	201.2	660	---	---	0.46	---	---	---	---	---	A
Joy-1	Conasauga	Pumpkin Valley Shale	219.2	719	---	---	1.1	---	---	---	---	---	A
Joy-1	Conasauga	Pumpkin Valley Shale	244.2	801	---	---	1.9	---	---	---	---	---	A
05MW013A	Conasauga	Dismal Gap	52.1	171	---	---	---	0.4	---	---	---	---	A
05MW013A	Conasauga	Dismal Gap	52.7	173	---	---	---	0.1	---	---	---	---	A
05MW013A	Conasauga	Dismal Gap	57.9	190	---	---	---	1.1	---	---	---	---	A
05MW013A	Conasauga	Dismal Gap	58.5	192	---	---	---	0.4	---	---	---	---	A
05MW013A	Conasauga	Dismal Gap	65.1	214	---	---	---	0.3	---	---	---	---	A
05MW013A	Conasauga	Dismal Gap	66.1	217	---	---	---	1.5	---	---	---	---	A
05MW013A	Conasauga	Dismal Gap	71.8	236	---	---	---	0.7	---	---	---	---	A
05MW013A	Conasauga	Dismal Gap	73	240	---	---	---	0.1	---	---	---	---	A
05MW013A	Conasauga	Dismal Gap	77	253	---	---	---	2.0	---	---	---	---	A
05MW013A	Conasauga	Dismal Gap	80.2	263	---	---	---	0.8	---	---	---	---	A
05MW013A	Conasauga	Dismal Gap	81.7	268	---	---	---	1.9	---	---	---	---	A
05MW013A	Conasauga	Dismal Gap	83.5	274	---	---	---	2.7	---	---	---	---	A
05MW013A	Conasauga	Dismal Gap	93.9	308	---	---	---	1.5	---	---	---	---	A
05MW013A	Conasauga	Dismal Gap	94.6	310	---	---	---	1.9	---	---	---	---	A
05MW013A	Conasauga	Rogersville Shale	105.8	347	---	---	---	3.4	---	---	---	---	A
05MW013A	Conasauga	Rogersville Shale	107.3	352	---	---	---	1.8	---	---	---	---	A
05MW013A	Conasauga	Rogersville Shale	115.9	380	---	---	---	1.3	---	---	---	---	A
05MW013A	Conasauga	Rogersville Shale	116.3	382	---	---	---	0.9	---	---	---	---	A
05MW013A	Conasauga	Rogersville Shale	122.7	403	---	---	---	1.0	---	---	---	---	A
05MW013A	Conasauga	Rogersville Shale	130.8	429	---	---	---	2.3	---	---	---	---	A
05MW013A	Conasauga	Rogersville Shale	132.6	435	---	---	---	1.3	---	---	---	---	A
05MW013A	Conasauga	Rogersville Shale	135.3	444	---	---	---	1.4	---	---	---	---	A

Table 2.3.1-8 (Sheet 2 of 5)
Rock Effective Porosity Measurements on the Oak Ridge Reservation

Borehole	Group	Unit[1]	Depth (m)	Depth (ft)	Effective Porosity (%)				Grain Density		Bulk Density		Data Source[3]
					Helium	Mercury	Immersion[2]	Other	(g/cm^3)	(pcf)	(g/cm^3)	(pcf)	
05MW013A	Conasauga	Rogersville Shale	138.1	453	---	---	---	2.1	---	---	---	---	A
05MW013A	Conasauga	Rogersville Shale	141.4	464	---	---	---	1.7	---	---	---	---	A
05MW013A	Conasauga	Rogersville Shale	141.7	465	---	---	---	1.6	---	---	---	---	A
05MW013A	Conasauga	Rogersville Shale	147.2	483	---	---	---	0.8	---	---	---	---	A
05MW013A	Conasauga	Rogersville Shale	151.5	497	---	---	---	0.6	---	---	---	---	A
GW-133	Conasauga	Dismal Gap	41.07	135	11.4	3.8	7.67	---	2.73	170	2.64	165	A
GW-133	Conasauga	Dismal Gap	67.18	220	12.7	4.9	11.47	---	2.78	174	2.71	169	A
GW-133	Conasauga	Dismal Gap	80.52	264	10.2	3.1	11.83	---	2.74	171	2.73	170	A
GW-133	Conasauga	Dismal Gap	114.53	376	7.6	3.4	11.51	---	2.74	171	2.70	169	A
GW-133	Conasauga	Rogersville Shale	138.73	455	11.5	3	10.9	---	2.72	170	2.67	167	A
GW-133	Conasauga	Rogersville Shale	163.12	535	12.7	3.5	11.03	---	2.75	172	2.71	169	A
GW-133	Conasauga	Rogersville Shale	165.56	543	19.2	4.4	9.75	---	2.81	175	2.74	171	A
GW-132	Conasauga	Friendship	45.95	151	---	---	9.16	---	---	---	---	---	A
GW-132	Conasauga	Friendship	65.33	214	5.1	2.9	9.39	---	2.73	170	2.72	170	A
GW-132	Conasauga	Pumpkin Valley Shale	90.73	298	9.3	3.8	9.24	---	2.77	173	2.70	169	A
GW-132	Conasauga	Pumpkin Valley Shale	102.97	338	10.7	3.0	10.35	---	2.76	172	2.72	170	A
GW-132	Conasauga	Pumpkin Valley Shale	130.71	429	---	---	11.41	---	---	---	---	---	A
GW-132	Conasauga	Pumpkin Valley Shale	130.76	429	6.3	4.5	9.43	---	2.82	176	2.72	170	A
GW-132	Conasauga	Pumpkin Valley Shale	187.83	616	3.8	3.1	11.44	---	2.78	174	2.77	173	A
GW-134	Conasauga	Nolichucky Shale	44.45	146	9.9	2.7	9.46	---	2.73	170	2.69	168	A
GW-134	Conasauga	Nolichucky Shale	58.27	191	12.2	3.4	11.52	---	2.78	174	2.70	169	A
GW-134	Conasauga	Nolichucky Shale	80.29	263	3.2	3.8	12.04	---	2.79	174	2.71	169	A
GW-134	Conasauga	Nolichucky Shale	99.80	327	2.9	4.3	13.29	---	2.79	174	2.69	168	A
GW-134	Conasauga	Nolichucky Shale	109.53	359	4.9	4.3	15.87	---	2.76	172	2.77	173	A
GW-134	Conasauga	Nolichucky Shale	151.59	497	3.9	4.0	9.16	---	2.79	174	2.70	169	A
GW-134	Conasauga	Nolichucky Shale	158.27	519	4.7	5.1	11.60	---	2.70	169	2.68	167	A

Table 2.3.1-8 (Sheet 3 of 5)
Rock Effective Porosity Measurements on the Oak Ridge Reservation

Borehole	Group	Unit[1]	Depth (m)	Depth (ft)	Effective Porosity (%)				Grain Density		Bulk Density		Data Source[3]
					Helium	Mercury	Immersion[2]	Other	(g/cm^3)	(pcf)	(g/cm^3)	(pcf)	
GW-134	Conasauga	Nolichucky Shale	171.86	564	14.7	4.2	11.95	---	2.79	174	2.67	167	A
GW-134	Conasauga	Nolichucky Shale	181.14	594	4.1	3.7	11.74	---	2.77	173	2.69	168	A
GW-134	Conasauga	Nolichucky Shale	201.19	660	10.4	3.2	10.57	---	2.80	175	2.67	167	A
WOL-1	Conasauga	Nolichucky Shale	12.04	40	---	---	13.00	---	---	---	---	---	A
WOL-1	Conasauga	Nolichucky Shale	26.67	88	4.4	4.2	3.67	---	2.83	177	2.74	171	A
WOL-1	Conasauga	Nolichucky Shale	38.41	126	5.3	4.1	---	---	2.79	174	2.71	169	A
WOL-1	Conasauga	Nolichucky Shale	57.38	188	6.0	5.2	10.81	---	2.82	176	2.72	170	A
WOL-1	Conasauga	Nolichucky Shale	99.90	328	10.9	3.2	11.80	---	2.77	173	2.71	169	A
WOL-1	Conasauga	Dismal Gap	243.84	800	15.4	3.4	7.43	---	2.79	174	2.67	167	A
WOL-1	Conasauga	Friendship	320.09	1050	7.8	3.5	6.84	---	2.79	174	2.74	171	A
WOL-1	Conasauga	Pumpkin Valley Shale	352.60	1157	3.5	3.2	5.35	---	2.79	174	2.76	172	A
0.5MW012A	Conasauga	Dismal Gap	38.34	126	---	---	5.41	---	---	---	---	---	A
0.5MW012A	Conasauga	Dismal Gap	51.44	169	3.9	3.1	12.84	---	2.77	173	2.72	170	A
0.5MW012A	Conasauga	Rogersville Shale	83.10	273	11.8	4.2	4.58	---	2.81	175	2.73	170	A
0.5MW012A	Conasauga	Rogersville Shale	118.10	387	---	---	9.59	---	---	---	---	---	A
0.5MW012A	Conasauga	Rogersville Shale	135.13	443	3.7	4.5	7.97	---	2.78	174	2.70	169	A
0.5MW012A	Conasauga	Friendship	148.10	486	3.6	4.5	6.44	---	2.78	174	2.68	167	A
GW-131	Knox	Copper Ridge Dolomite	127.76	419	0.59	---	1.02	---	2.83	177	2.82	176	B
GW-131	Knox	Copper Ridge Dolomite	134.80	442	0.22	---	0.56	---	2.82	176	2.81	175	B
GW-131	Knox	Copper Ridge Dolomite	136.96	449	1.13	---	1.30	---	2.82	176	2.79	174	B
GW-131	Knox	Copper Ridge Dolomite	148.69	488	2.77	---	1.82	---	2.83	177	2.75	172	B
GW-131	Knox	Copper Ridge Dolomite	149.23	490	1.25	---	1.03	---	2.84	177	2.80	175	B
GW-131	Knox	Copper Ridge Dolomite	151.56	497	2.40	---	2.43	---	2.86	179	2.79	174	B
GW-131	Knox	Copper Ridge Dolomite	154.28	506	2.17	---	3.62	---	2.79	174	2.73	170	B
GW-131	Conasauga	Maynardville Limestone	183.72	603	0.45	---	0.45	---	2.82	176	2.81	175	B

Table 2.3.1-8 (Sheet 4 of 5)
Rock Effective Porosity Measurements on the Oak Ridge Reservation

Borehole	Group	Unit[1]	Depth (m)	Depth (ft)	Effective Porosity (%)				Grain Density		Bulk Density		Data Source[3]
					Helium	Mercury	Immersion[2]	Other	(g/cm^3)	(pcf)	(g/cm^3)	(pcf)	
GW-131	Knox	Copper Ridge Dolomite	159.56	523	1.19	---	2.04	---	2.80	175	2.77	173	B
GW-131	Knox	Copper Ridge Dolomite	175.16	575	1.62	---	1.65	---	2.84	177	2.79	174	B
GW-131	Knox	Copper Ridge Dolomite	179.05	587	0.81	---	0.54	---	2.81	175	2.79	174	B
GW-131	Conasauga	Maynardville Limestone	188.93	620	0.61	---	0.54	---	2.70	169	2.69	168	B
GW-131	Conasauga	Maynardville Limestone	195.45	641	1.12	---	0.88	---	2.78	174	2.75	172	B
GW-131	Conasauga	Maynardville Limestone	205.92	676	1.06	---	0.67	---	2.78	174	2.75	172	B
GW-131	Conasauga	Maynardville Limestone	206.35	677	8.13	---	4.52	---	2.85	178	2.62	164	B
GW-131	Conasauga	Maynardville Limestone	217.02	712	0.37	---	0.24	---	2.71	169	2.70	169	B
GW-131	Conasauga	Maynardville Limestone	231.27	759	0.37	---	0.22	---	2.73	170	2.72	170	B
GW-131	Conasauga	Maynardville Limestone	236.88	777	0.22	---	0.21	---	2.71	169	2.71	169	B
GW-131	Conasauga	Maynardville Limestone	248.26	815	0.22	---	1.45	---	2.72	170	2.72	170	B
GW-131	Conasauga	Maynardville Limestone	258.62	848	0.37	---	0.22	---	2.71	169	2.70	169	B
GW-131	Conasauga	Maynardville Limestone	266.27	874	0.37	---	0.31	---	2.71	169	2.70	169	B
GW-131	Conasauga	Maynardville Limestone	268.28	880	0.45	---	0.31	---	2.76	172	2.75	172	B
GW-131	Conasauga	Maynardville Limestone	290.04	952	0.22	---	0.17	---	2.73	170	2.73	170	B
GW-131	Conasauga	Maynardville Limestone	294.44	966	0.22	---	0.29	---	2.72	170	2.72	170	B
GW-131	Conasauga	Maynardville Limestone	301.60	990	0.30	---	0.30	---	2.72	170	2.72	170	B
GW-131	Conasauga	Maynardville Limestone	311.56	1022	0.52	---	0.62	---	2.72	170	2.71	169	B
GW-131	Conasauga	Maynardville Limestone	326.49	1071	0.22	---	0.44	---	2.71	169	2.70	169	B
GW-131	Conasauga	Maynardville Limestone	333.60	1094	0.22	---	0.51	---	2.71	169	2.71	169	B
GW-135	Knox	Copper Ridge Dolomite	155.85	511	0.21	---	0.34	---	2.84	177	2.83	177	B
GW-135	Knox	Copper Ridge Dolomite	177.78	583	0.48	---	0.81	---	2.83	177	2.81	175	B
GW-135	Knox	Copper Ridge Dolomite	184.53	605	0.55	---	1.72	0.3[4]	2.79	174	2.78	174	B
GW-135	Knox	Copper Ridge Dolomite	186.23	611	1.47	---	2.91	0.5[4]	2.80	175	2.76	172	B
GW-135	Knox	Copper Ridge Dolomite	189.74	623	0.92	---	1.39	---	2.83	177	2.80	175	B
GW-135	Knox	Copper Ridge Dolomite	193.09	633	1.53	---	1.81	1.0[4]	2.82	176	2.78	174	B

Table 2.3.1-8 (Sheet 5 of 5)
Rock Effective Porosity Measurements on the Oak Ridge Reservation

Borehole	Group	Unit[1]	Depth (m)	Depth (ft)	Effective Porosity (%)				Grain Density		Bulk Density		Data Source[3]
					Helium	Mercury	Immersion[2]	Other	(g/cm³)	(pcf)	(g/cm³)	(pcf)	
GW-135	Knox	Copper Ridge Dolomite	202.49	664	4.99	---	3.41	1.3[4]	2.87	179	2.72	170	B
GW-135	Conasauga	Maynardville Limestone	212.24	696	0.10	---	0.24	0.3[4]	2.74	171	2.73	170	B
GW-135	Conasauga	Maynardville Limestone	223.11	732	3.34	---	2.18	1.4[4]	2.84	177	2.75	172	B
GW-135	Conasauga	Maynardville Limestone	227.25	746	4.10	---	1.31	2.3[4]	2.84	177	2.72	170	B
GW-135	Conasauga	Maynardville Limestone	234.44	769	1.79	---	1.84	1.7[4]	2.84	177	2.79	174	B
GW-135	Conasauga	Maynardville Limestone	243.46	799	0.10	---	0.14	1.2[4]	2.70	169	2.70	169	B
GW-135	Conasauga	Maynardville Limestone	249.53	819	0.46	---	0.24	0.4[4]	2.76	172	2.75	172	B
GW-135	Conasauga	Maynardville Limestone	255.40	838	0.34	---	0.29	2.3[4]	2.70	169	2.69	168	B
GW-135	Conasauga	Maynardville Limestone	268.91	882	0.28	---	0.26	0.2[4]	2.75	172	2.75	172	B
GW-135	Conasauga	Maynardville Limestone	290.53	953	0.36	---	0.29	0.8[4]	2.75	172	2.74	171	B
GW-135	Conasauga	Maynardville Limestone	306.58	1006	0.24	---	0.26	0.4[4]	2.74	171	2.73	170	B
GW-135	Conasauga	Maynardville Limestone	314.96	1033	0.14	---	0.24	0.3[4]	2.70	169	2.70	169	B
GW-135	Conasauga	Maynardville Limestone	318.01	1043	0.56	---	0.29	0.2[4]	2.74	171	2.72	170	B
GW-135	Conasauga	Maynardville Limestone	324.08	1063	0.17	---	0.60	0.4[4]	2.71	169	2.70	169	B
GW-135	Conasauga	Maynardville Limestone	345.49	1133	0.15	---	0.46	0.2[4]	2.71	169	2.70	169	B
GW-135	Conasauga	Maynardville Limestone	365.02	1198	0.06	---	0.34	0.3[4]	2.73	170	2.73	170	B
				Number of tests	83	33	90	46	83	83	83	83	

[1] Unit names for Maryville Limestone and Rutledge Limestone changed to current usage of Dismal Gap and Friendship respectively.
[2] Some values represent the average of several tests.
[3] Data Sources:
A — (Reference 2.3.1-45)
B — (Reference 2.3.1-46)
[4] Results from a sample approximately collocated with the other results.

	Effective Porosity (%)				Grain Density		Bulk Density	
	Helium	Mercury	Immersion	Other	(g/cm³)	(pcf)	(g/cm³)	(pcf)
Average	3.85	3.79	4.67	1.11	2.77	173	2.73	170
Minimum	0.06	2.7	0.14	0.1	2.70	169	2.62	164
Maximum	19.2	5.2	15.87	3.4	2.87	179	2.83	177

Table 2.3.1-9
Representative Soil and Rock Properties Important to Radionuclide Transport

Group	Unit	Material	Total Unit Weight		Specific Gravity	
			Best Estimate (pcf)	Range (pcf)	Best Estimate	Range
unconsolidated	Existing Fill/Residual Soil	Silt and Clay	120	NA	2.75	NA
	New Granular Backfill[1]	well graded Sand	135	NA	2.70	NA
	Weathered Rock	Limestone/Siltstone	140	NA	NA	NA
Chickamauga	Benbolt formation	Limestone/Siltstone	168	163-170	2.70	2.62-2.72
	Rockdell formation	Limestone	168	160-169	2.69	2.57-2.71
	Fleanor member	Siltstone	168	166-176	2.70	2.67-2.83
	Eidson member	Limestone	168	164-169	2.69	2.64-2.71
	Blackford formation	Limestone/Siltstone	168	164-169	2.68	2.64-2.71
Knox	Newala formation	Dolomite	175	161-177	2.80	2.59-2.84

1 based on Tennessee Department of Transportation Type A specification

Note:
NA = information not available

Table 2.3.1-10
Groundwater Linear Velocity and Travel Time

Property	Representative Value	Source
Hydraulic Conductivity (ft/d)	2.6	Maximum calculated value as documented in SSAR Table 2.4.12-6 (observation well OW-423L)
Horizontal Hydraulic Gradient (ft/ft)	0.07	Mean value as presented in SSAR Table 2.4.12-8
Effective Porosity (decimal)	0.0467	Mean value determined in SSAR Table 2.4.12-7, using the Immersion test method results which the referenced author identified as the test method that yields results that most accurately approaches the true effective porosity value.
Distance to Receptor (ft)	1400	Shortest distance from edge of power block area to Clinch River arm of the Watts Bar Reservoir (Figure 2.3.1-19)

Calculated Values	
Linear Velocity (ft/d)	3.90
Travel Time (days)	359
Travel Time (years)	0.98

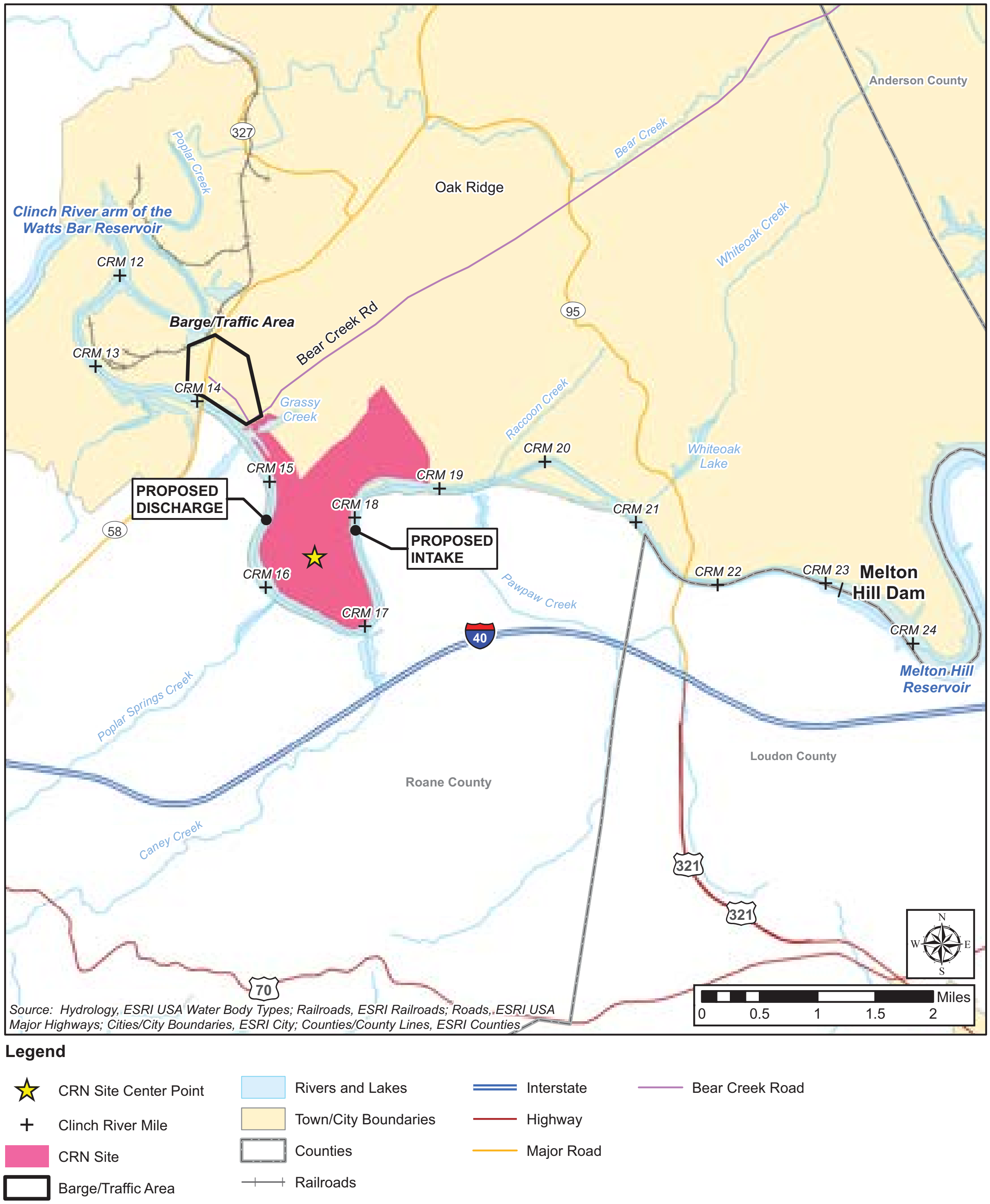


Figure 2.3.1-1. CRN Site Vicinity Water Resources

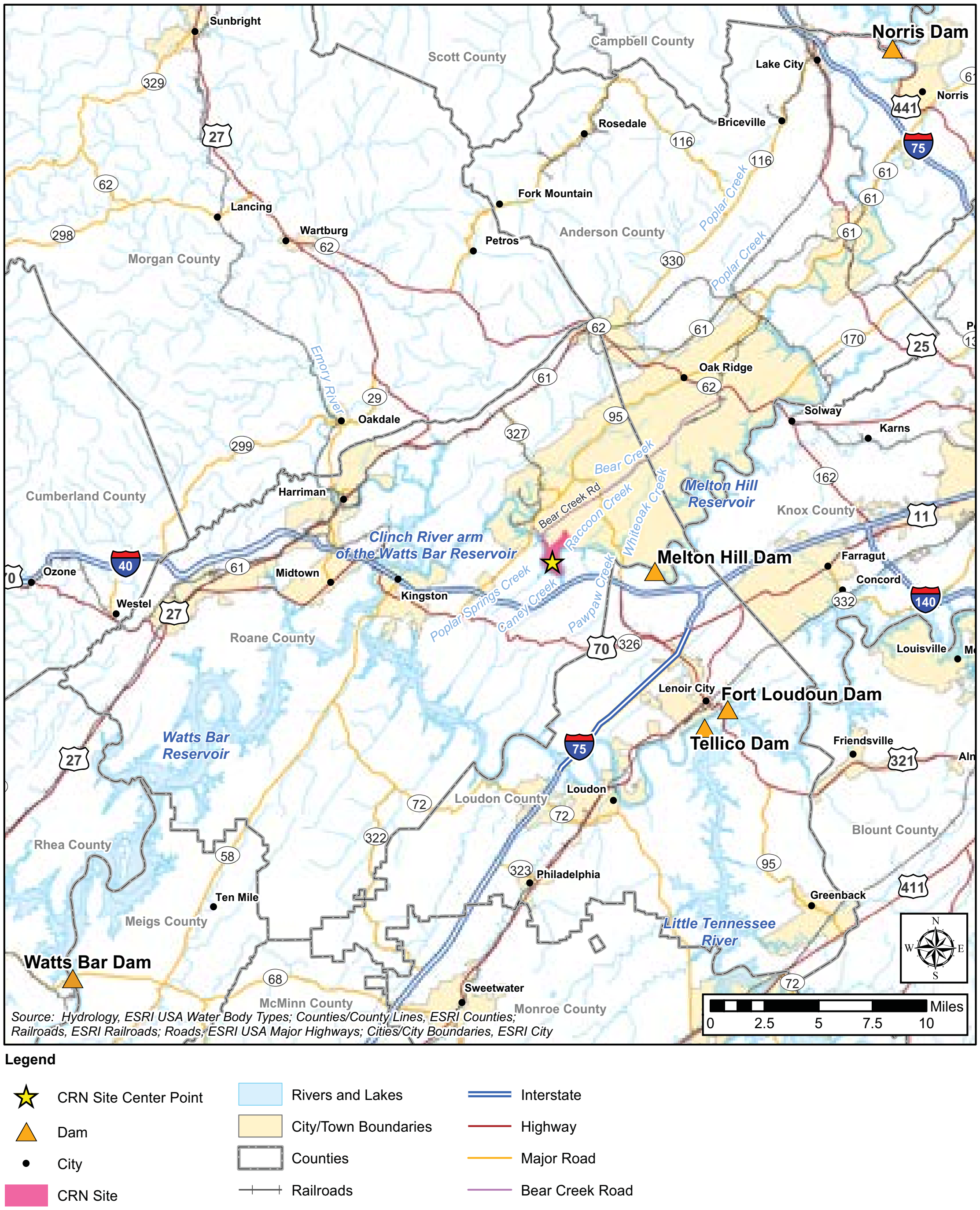


Figure 2.3.1-2. CRN Site Regional Water Resources

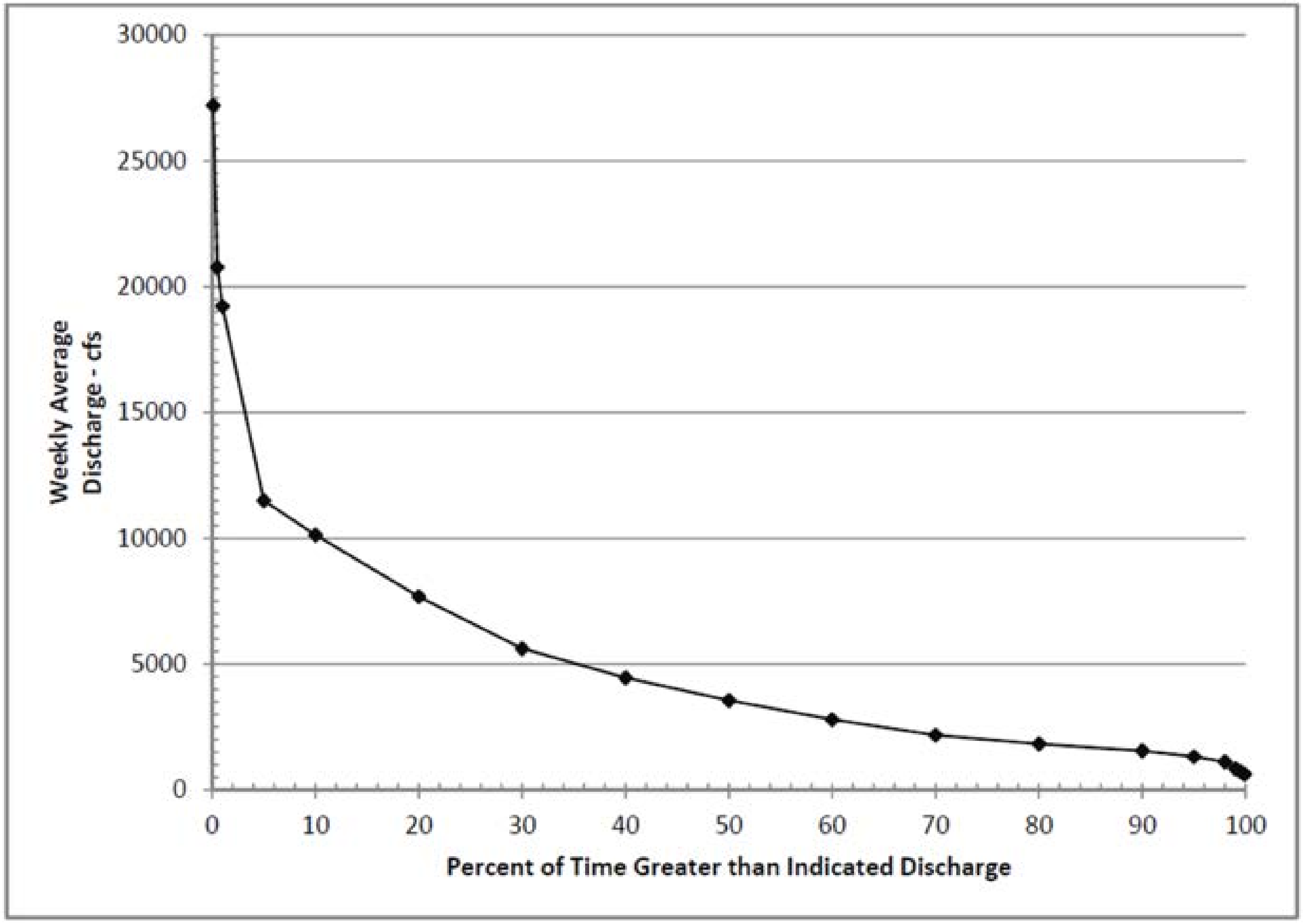


Figure 2.3.1-3. Melton Hill Dam Weekly Discharge Frequency

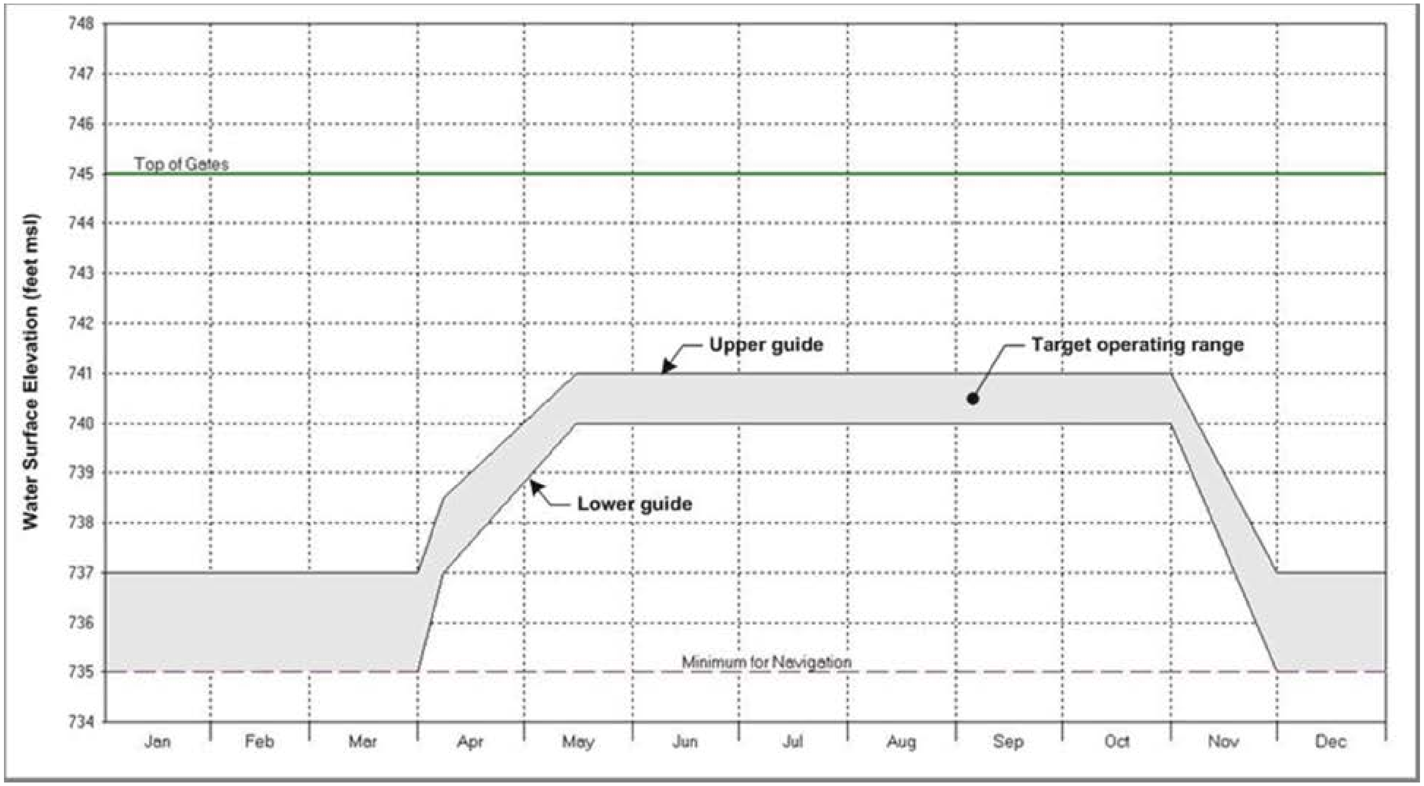


Figure 2.3.1-4. Operating Guide for Headwater Elevation at Watts Bar Dam

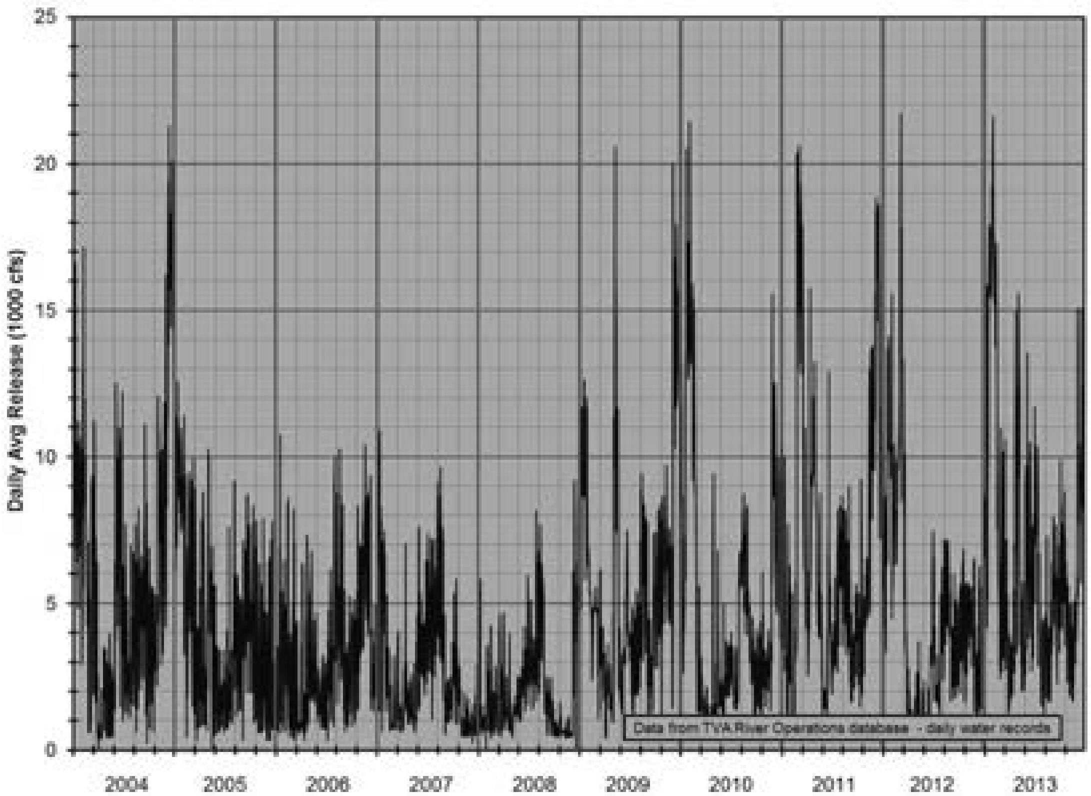


Figure 2.3.1-5. Daily Average Release from Melton Hill Dam

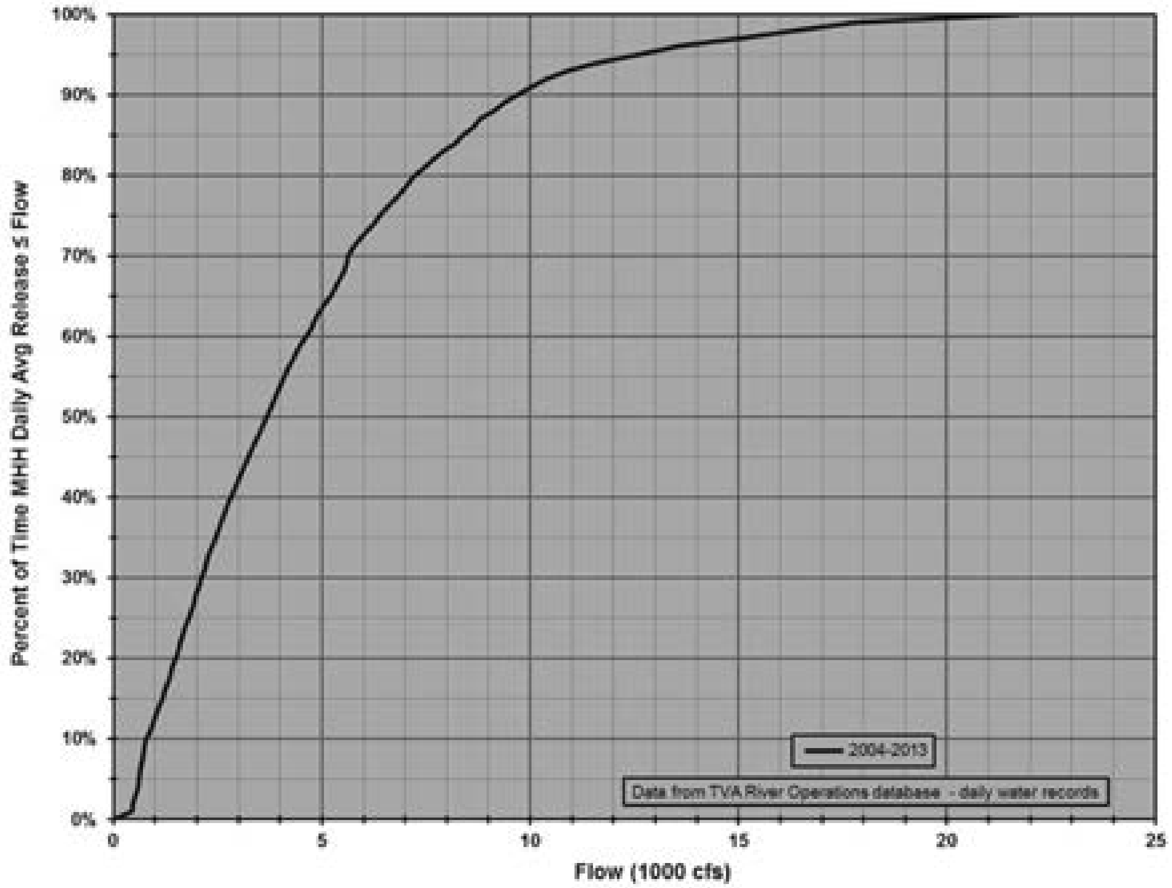


Figure 2.3.1-6. Percentile for Daily Average Release from Melton Hill Dam

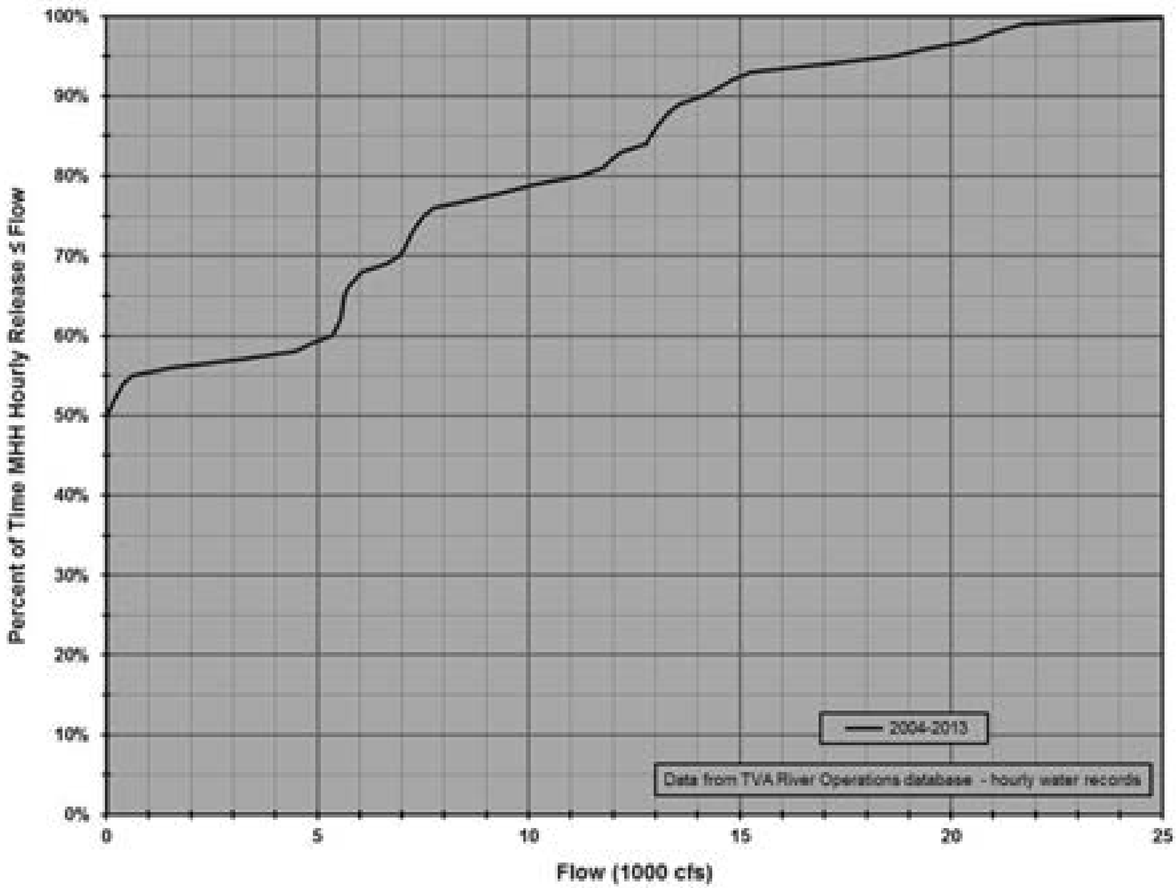


Figure 2.3.1-7. Percentile for Hourly Average Release from Melton Hill Dam

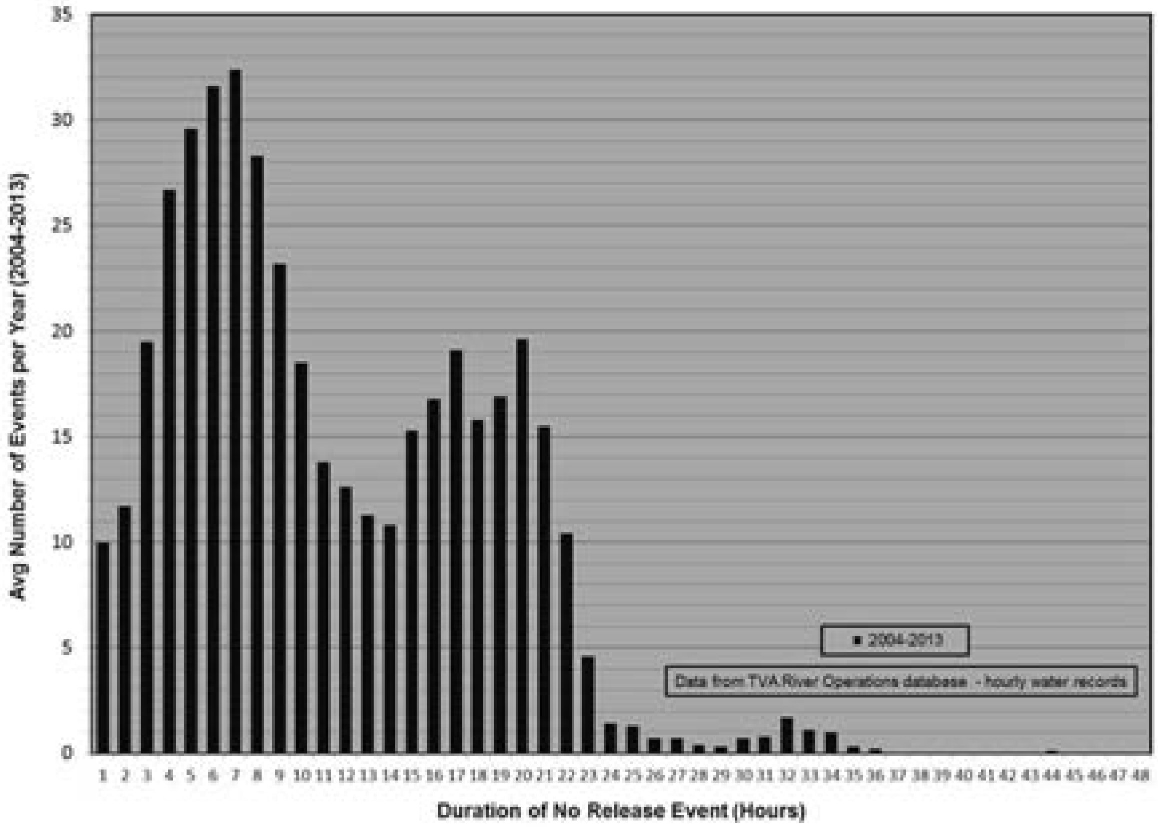


Figure 2.3.1-8. Average Annual Frequency of No Release Events from Melton Hill Dam

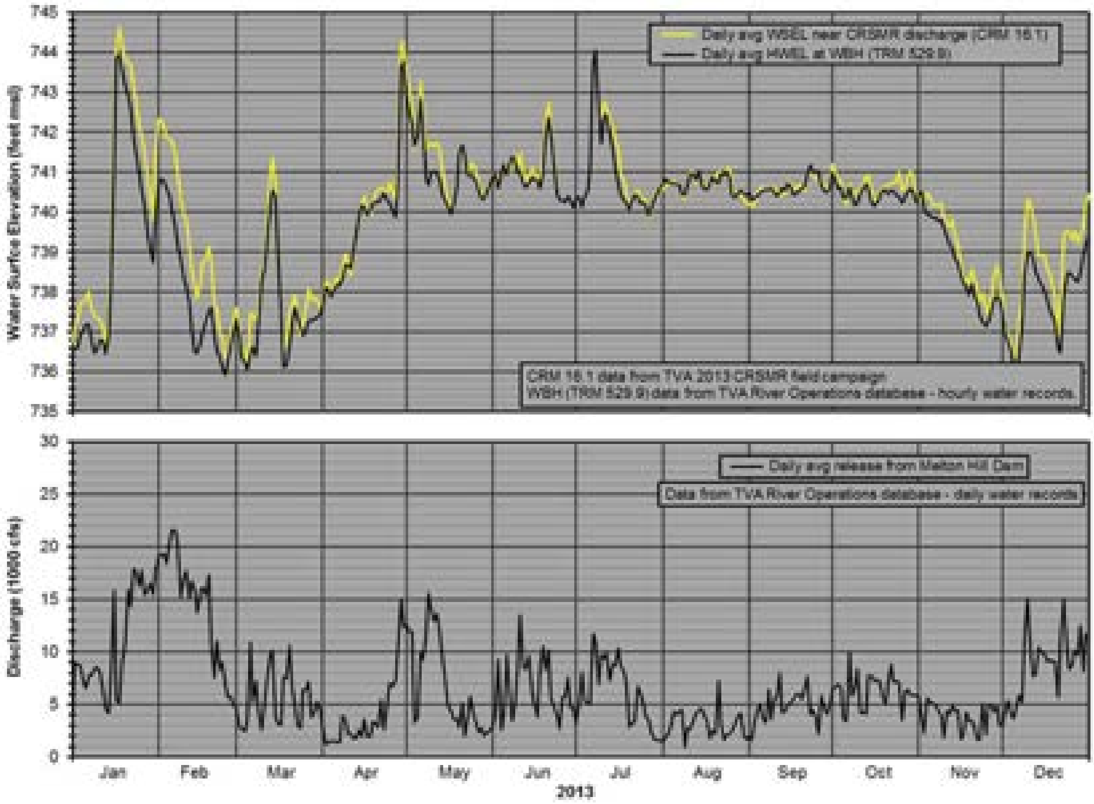


Figure 2.3.1-9. WSEL Measurements at CR SMR and WBH, and Discharge Measurements at Melton Hill Dam

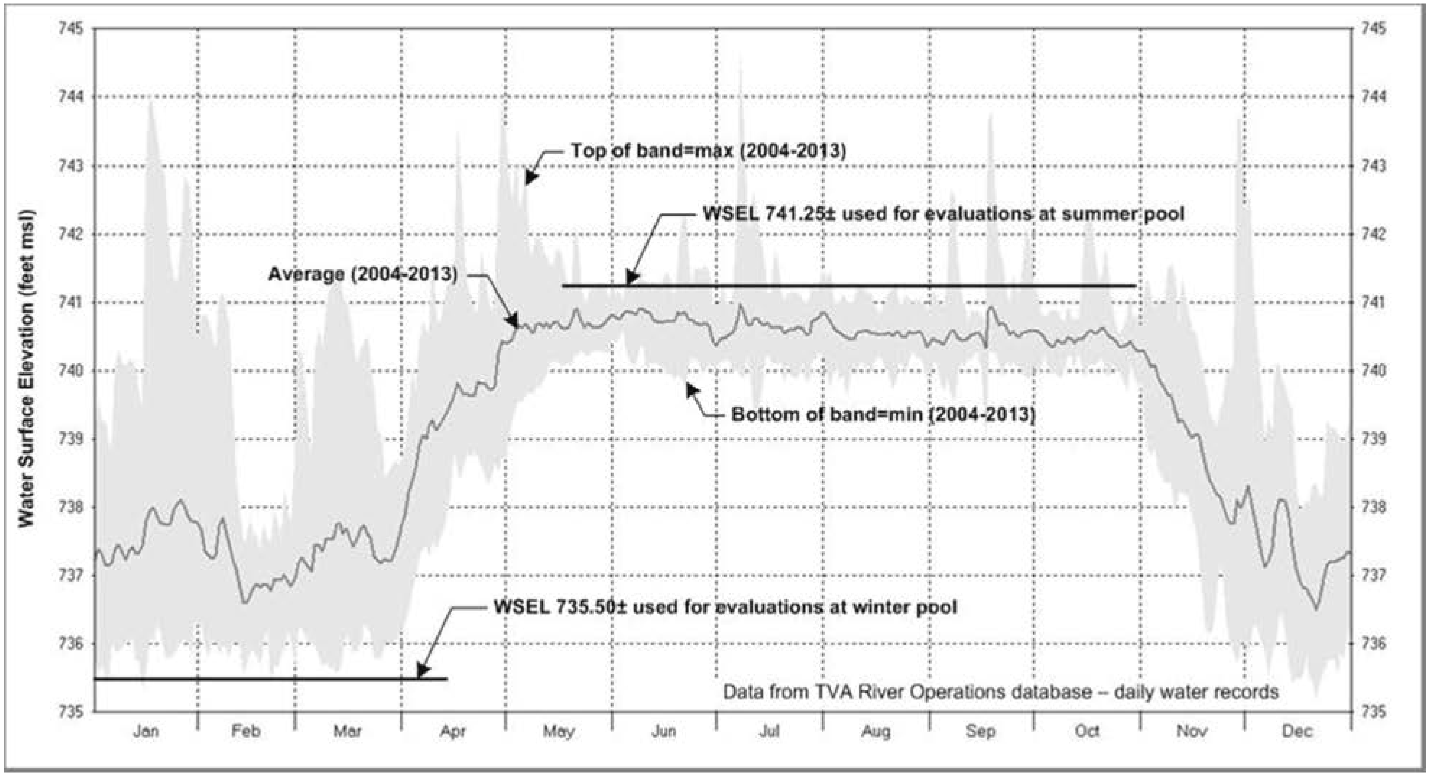


Figure 2.3.1-10. Headwater Elevation at Watts Bar Dam, Showing Max, Min, and Average Values of Daily Midnight Readings, 2004-2013

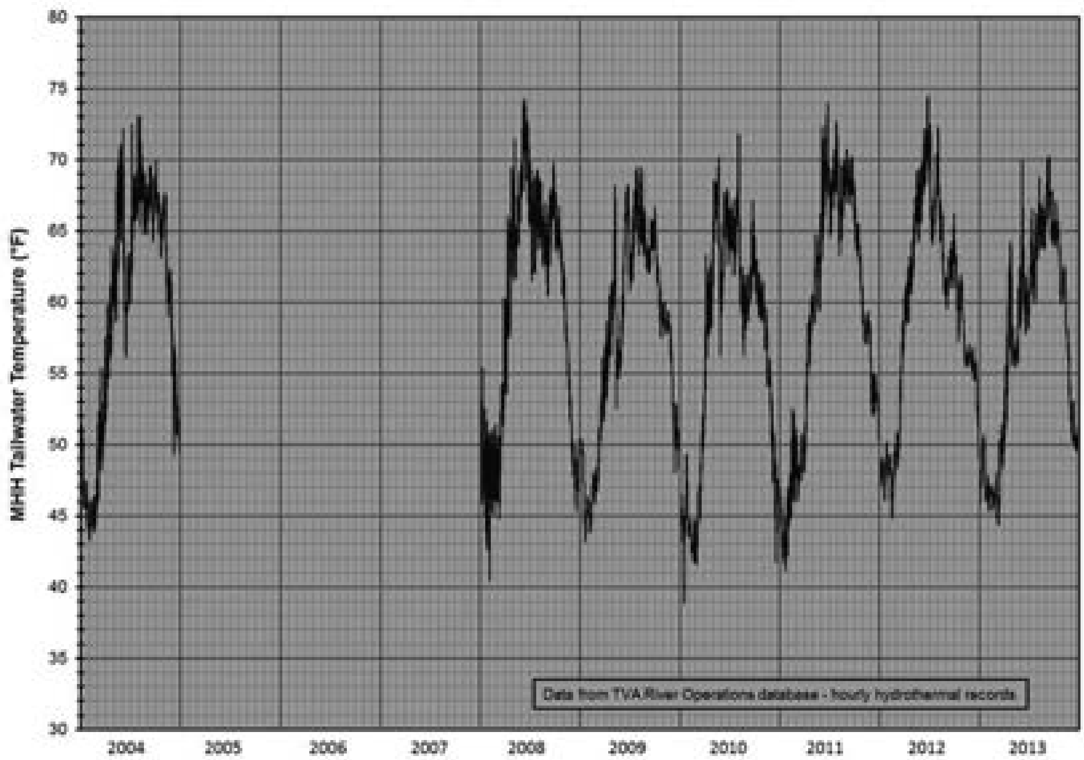


Figure 2.3.1-11. Hourly Water Temperature for Tailwater Below Melton Hill Dam

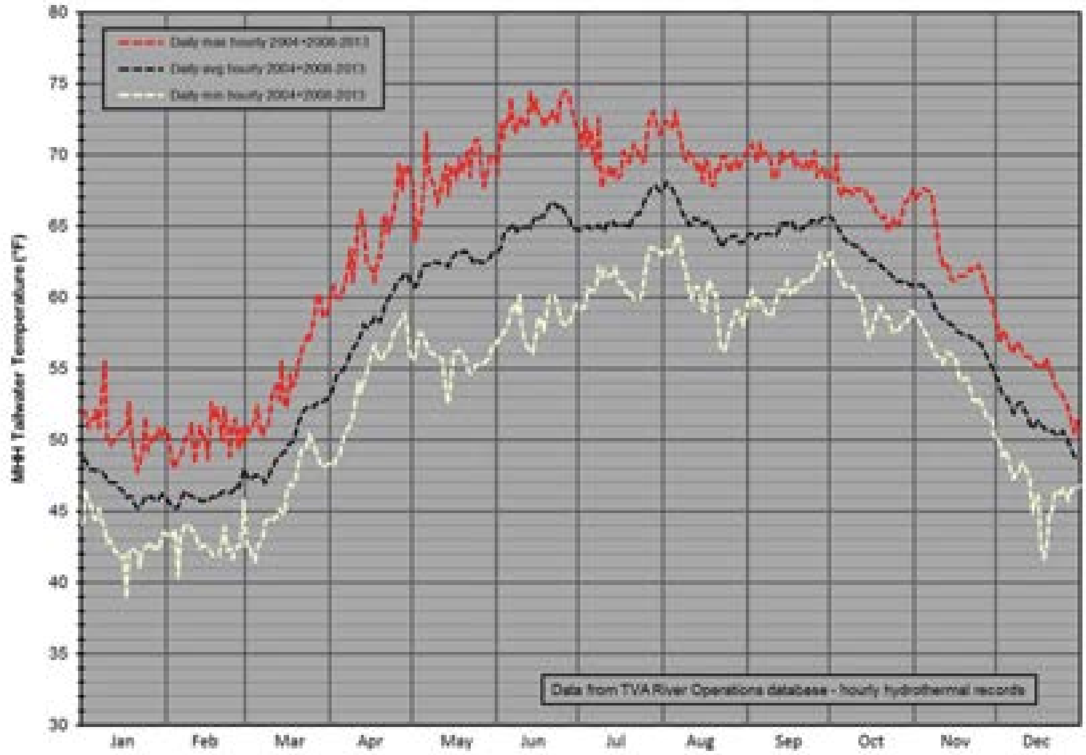


Figure 2.3.1-12. Daily Maximum, Minimum, and Average Hourly Water Temperature for Tailwater Below Melton Hill Dam

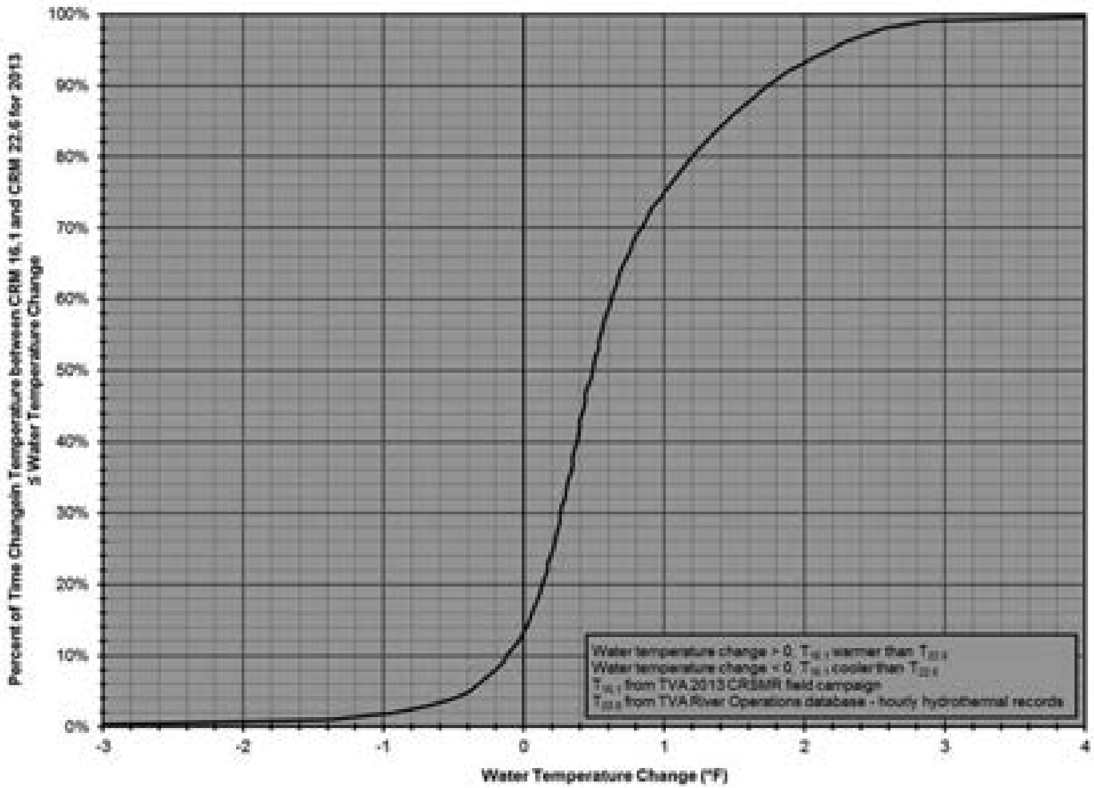


Figure 2.3.1-13. Percentile for Change in Hourly Water Temperature between CRM 16.1 and CRM 22.6/MHH Tailwater

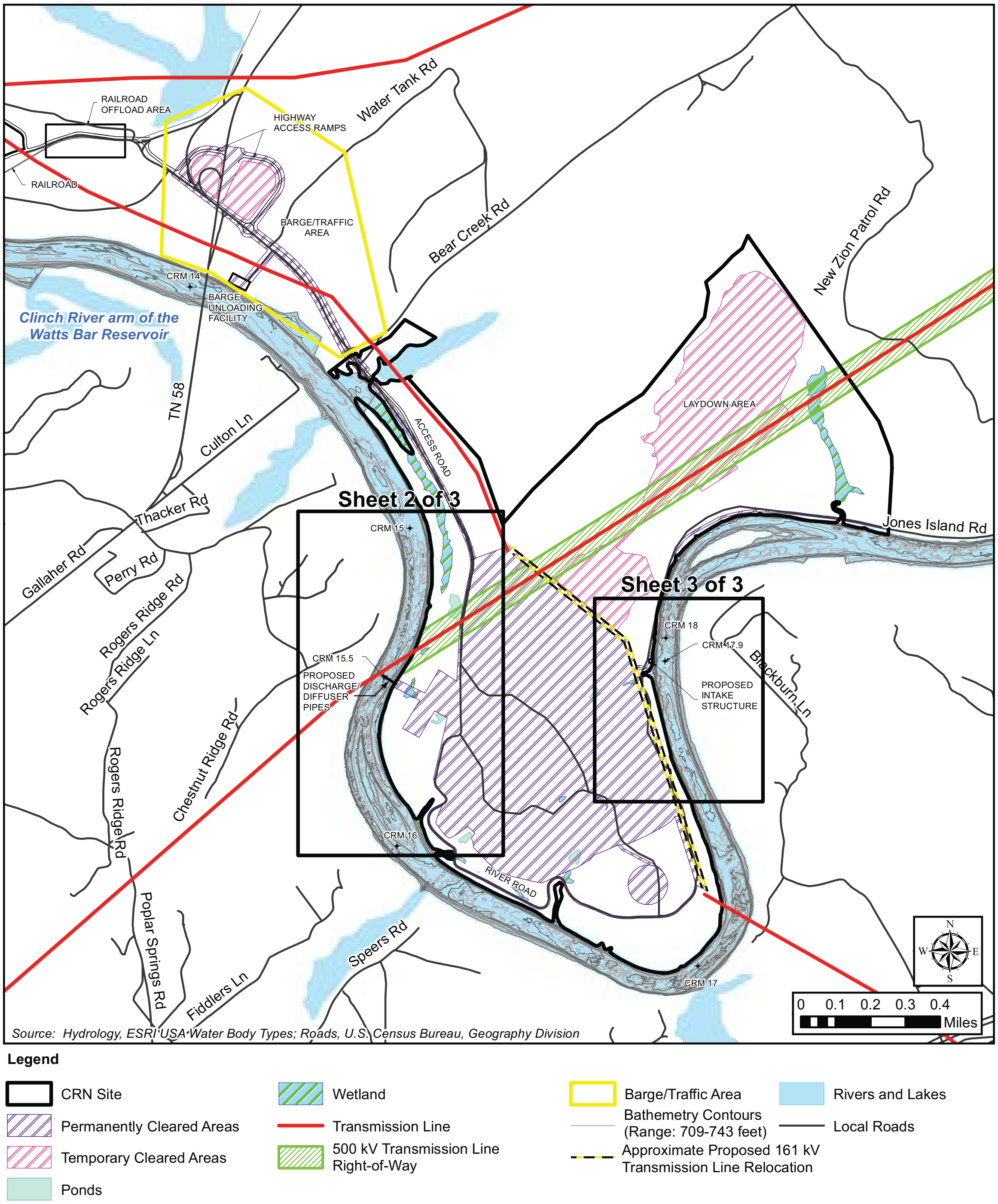


Figure 2.3.1-14. (Sheet 1 of 3) CRN Site Bathemetry

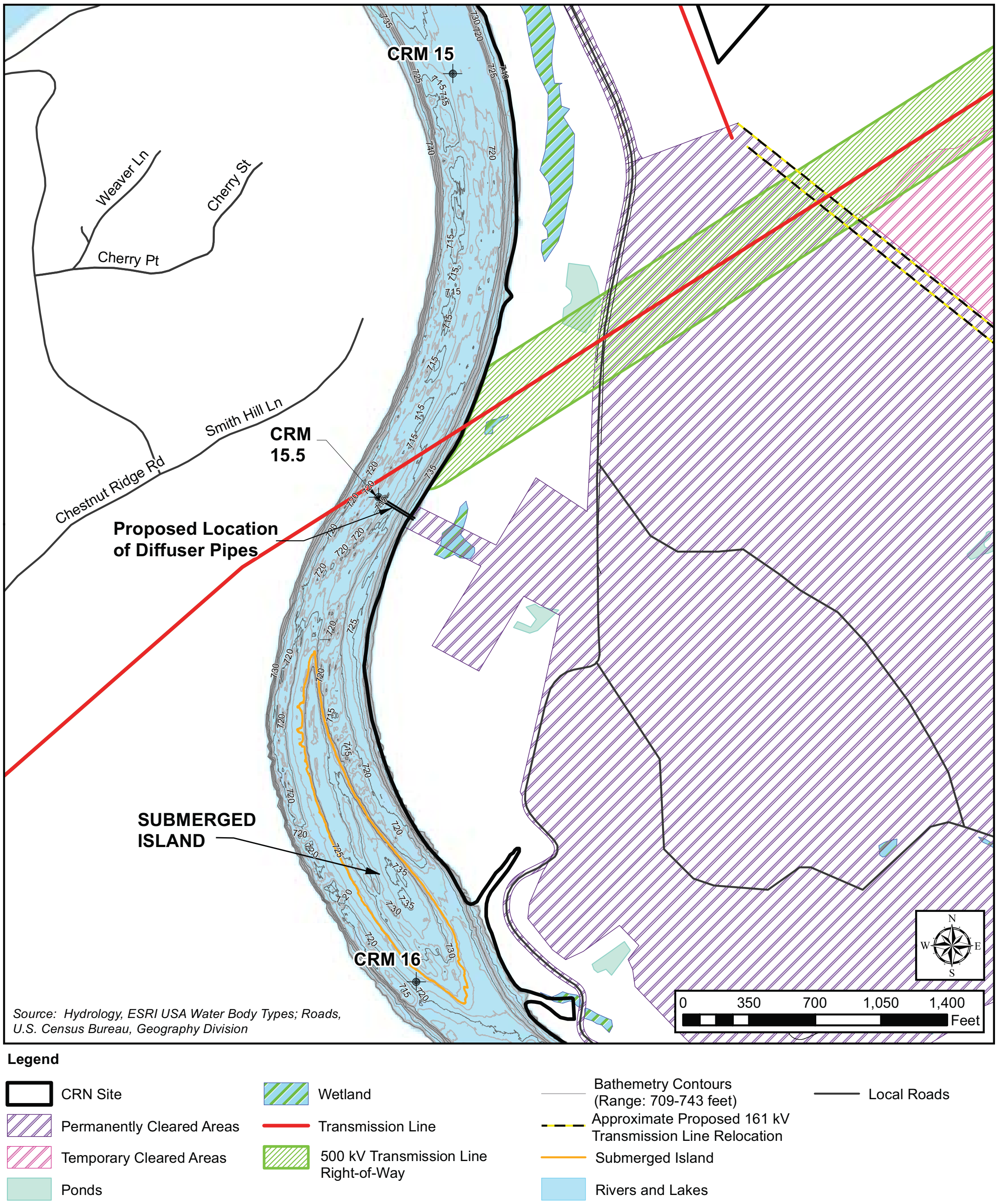


Figure 2.3.1-14. (Sheet 2 of 3) CRN Site Bathemetry

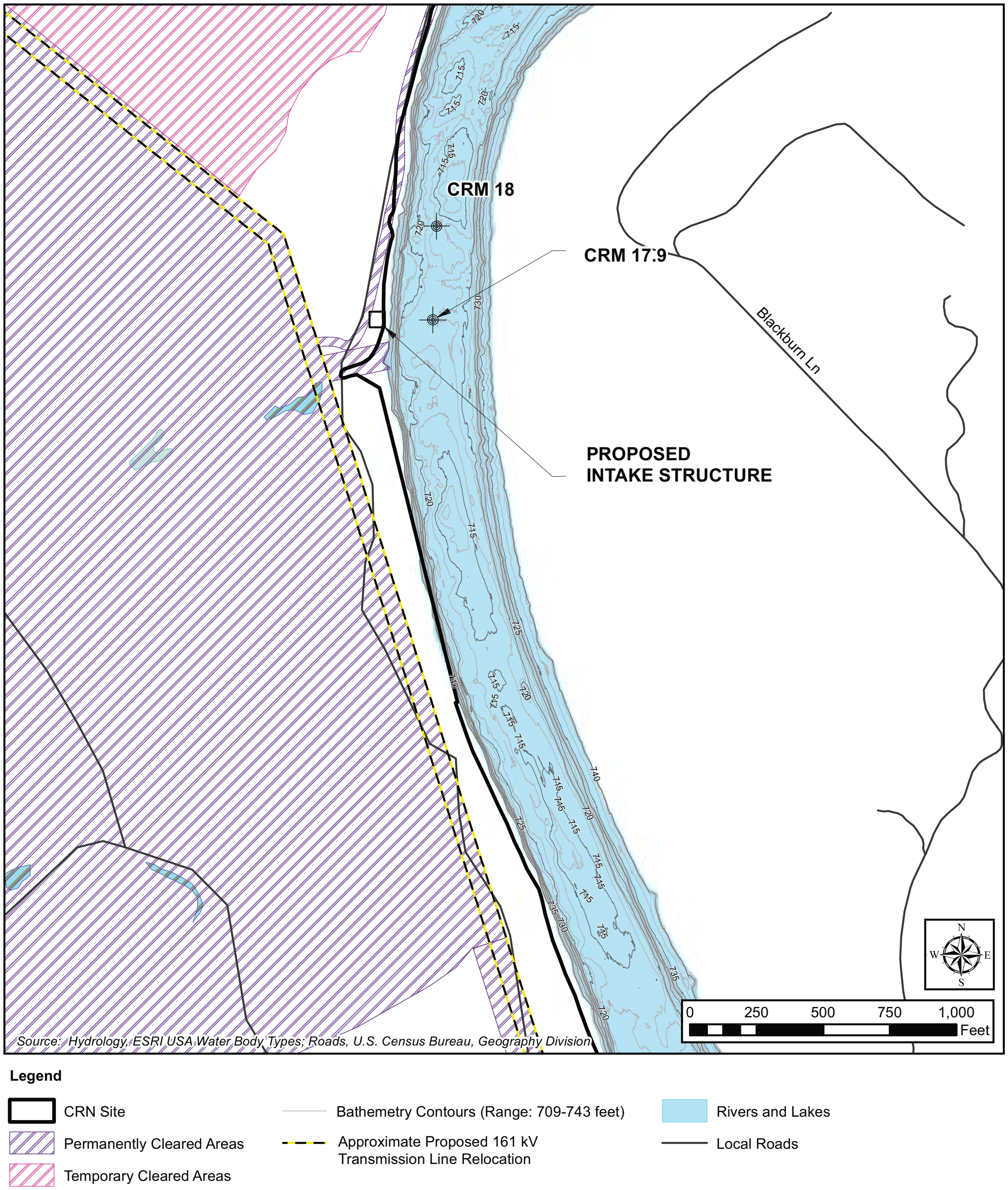


Figure 2.3.1-14. (Sheet 3 of 3) CRN Site Bathemetry

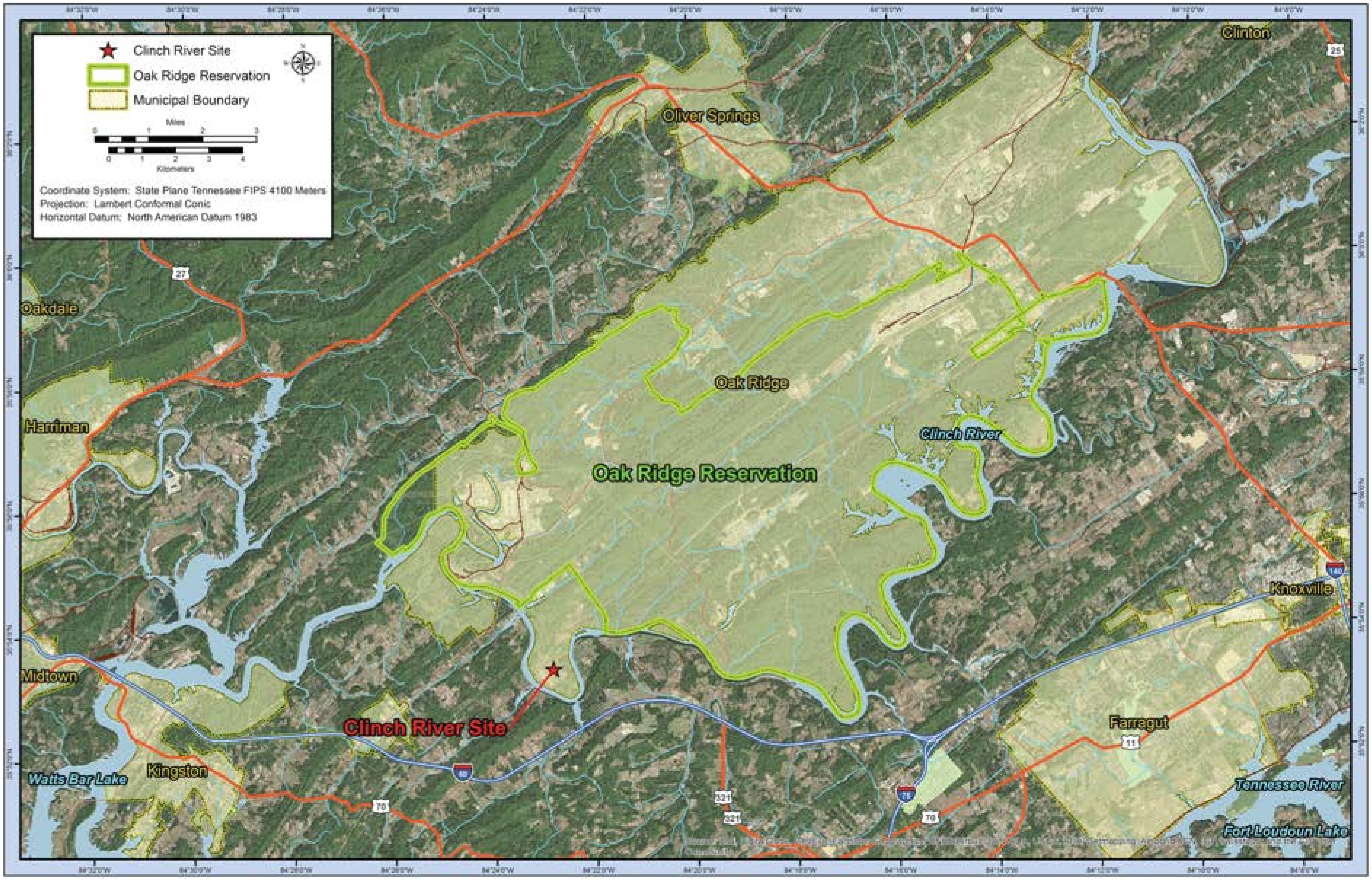


Figure 2.3.1-15. Location Map - ORR and CRN Site

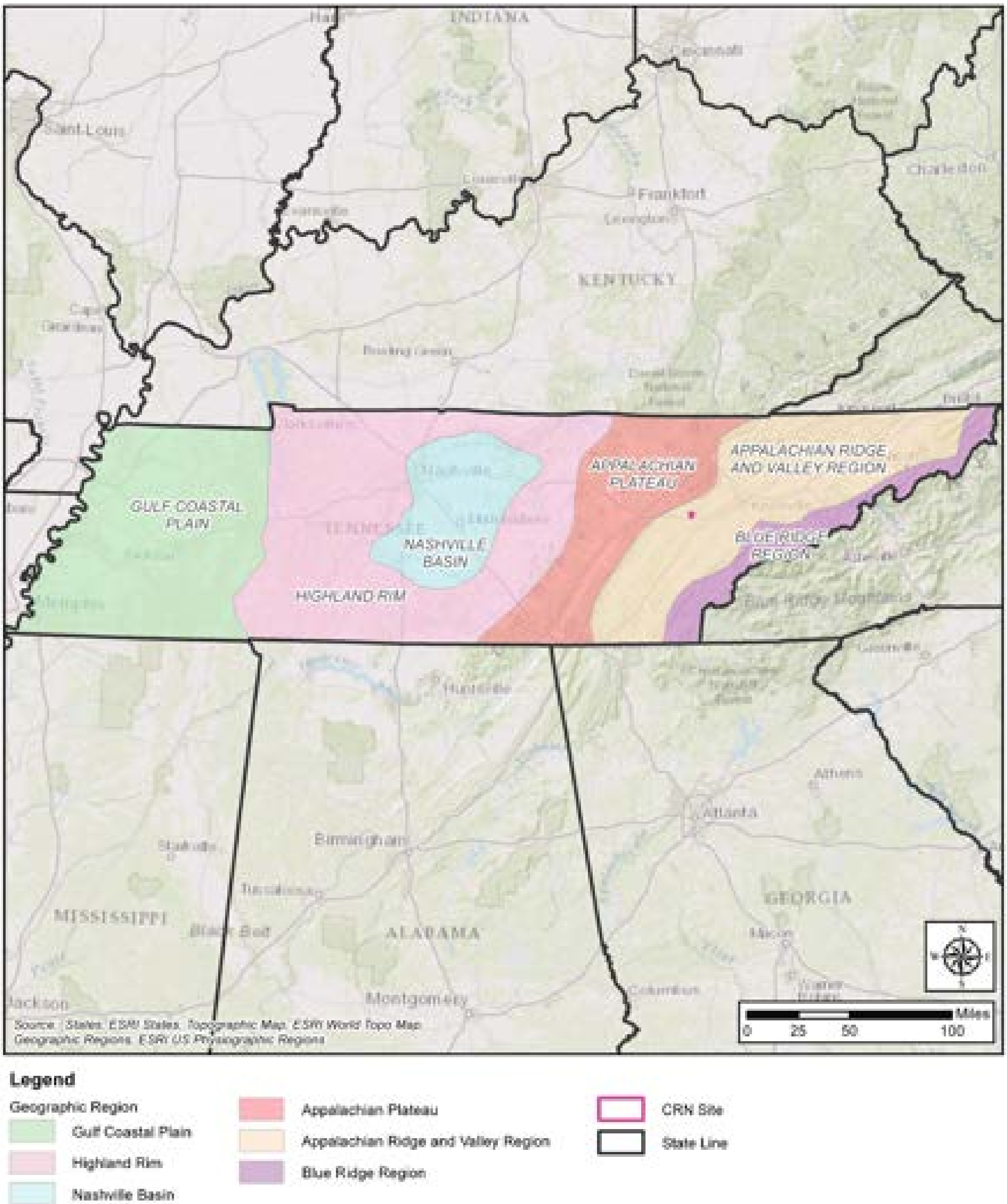


Figure 2.3.1-16. Geographic Regions of Tennessee

Adapted from: (Reference 2.3.1-47)
1 inch = 4000 ft
Contour Interval = 20 ft

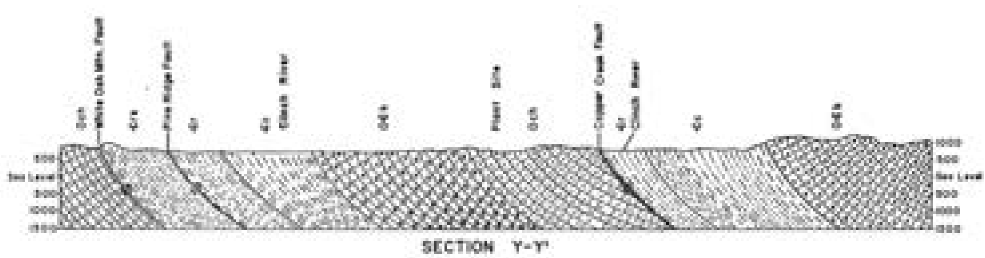


Figure 2.3.1-17. Preconstruction Topographic and Geologic Map and Cross-Section of the CRBRP Project

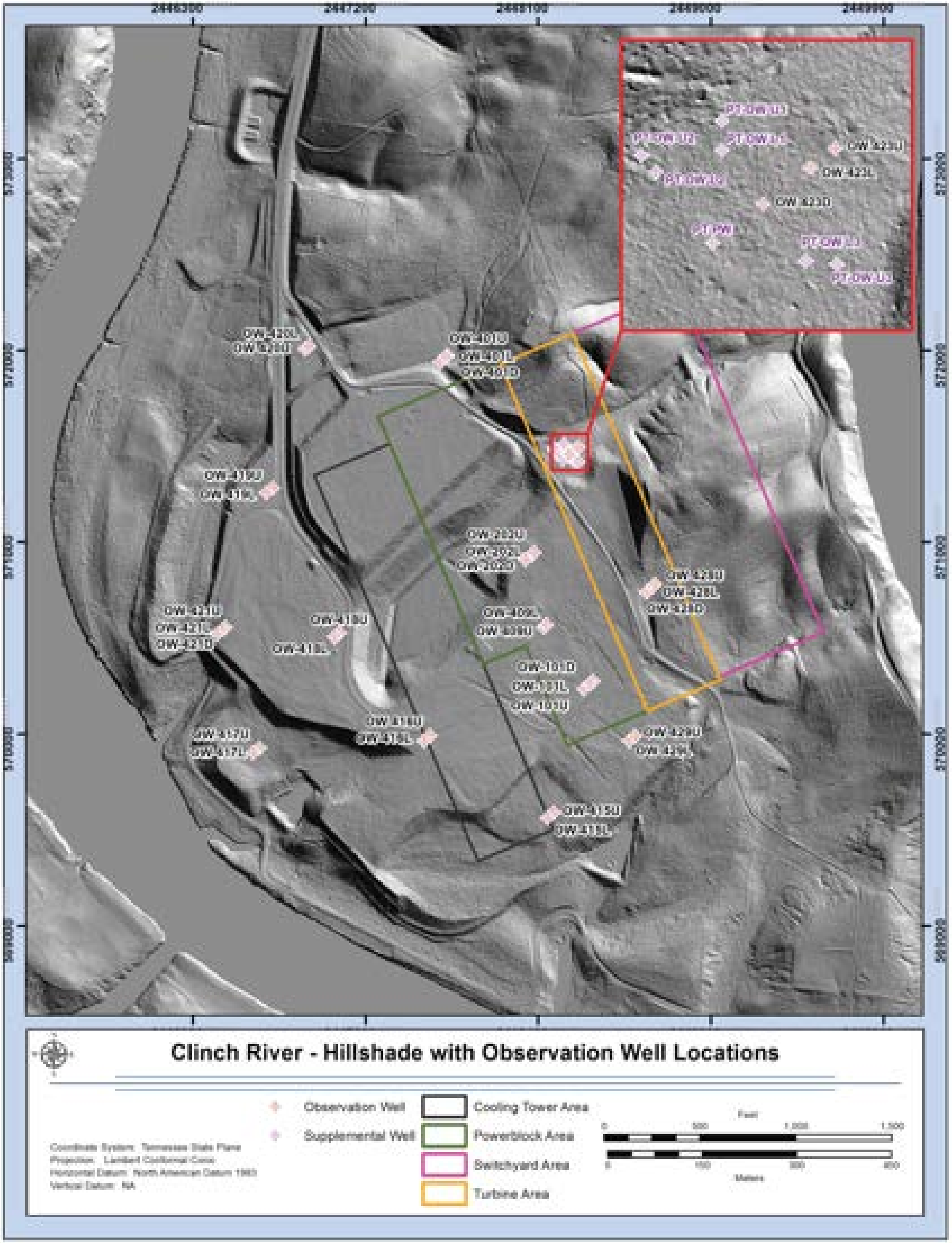


Figure 2.3.1-18. Current Site Topography and Observation Well Locations

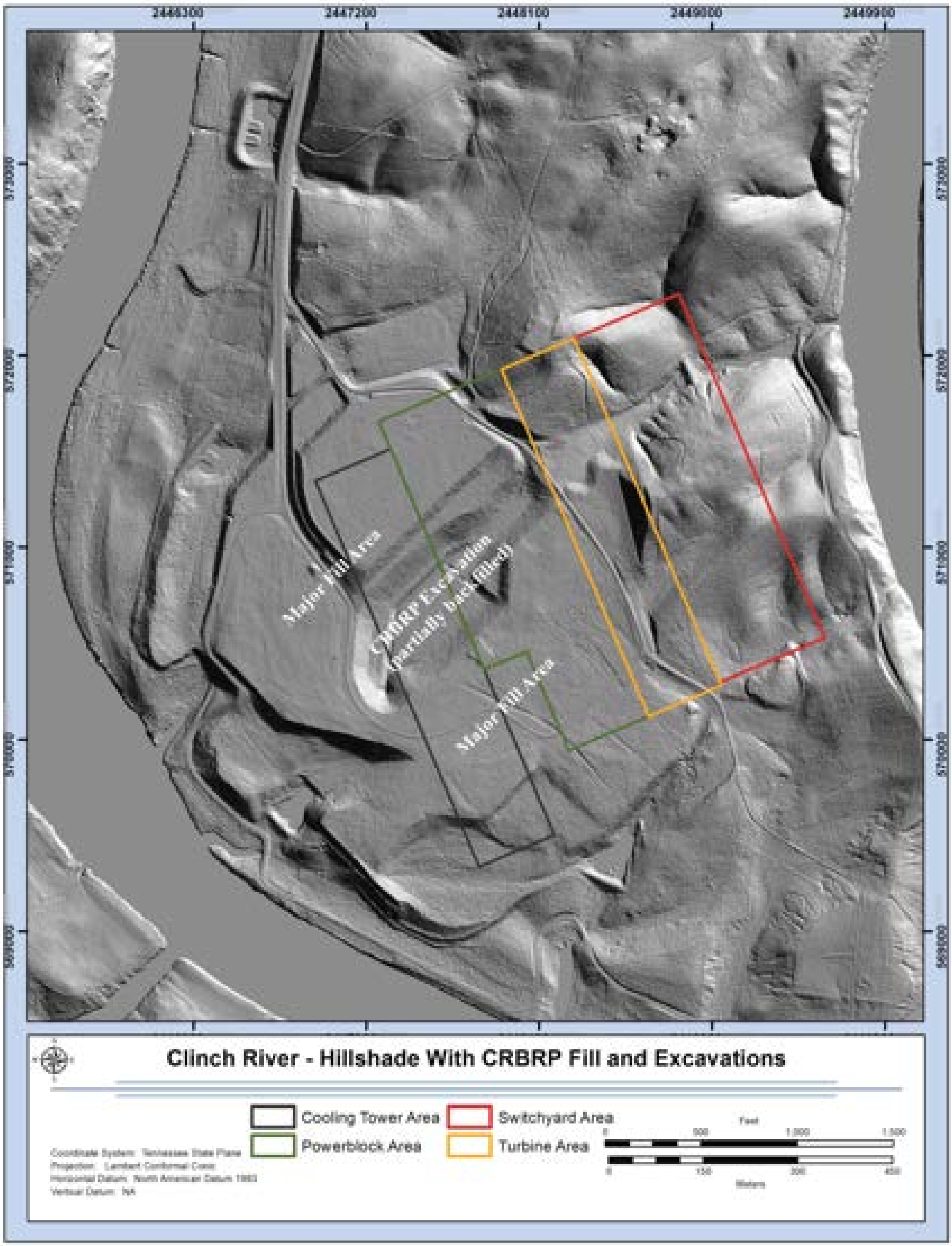
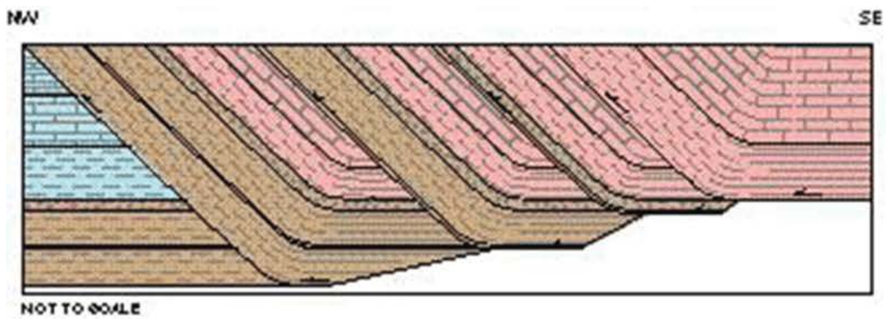
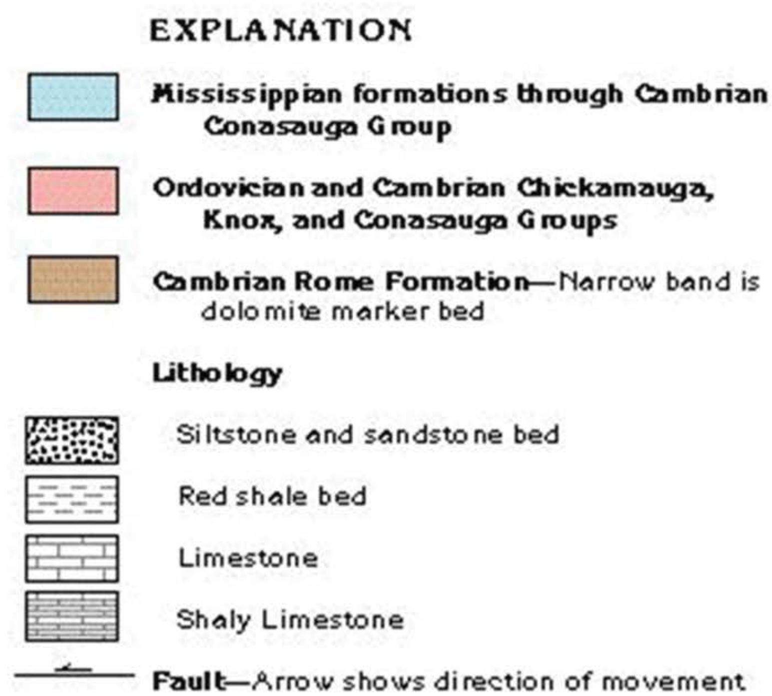


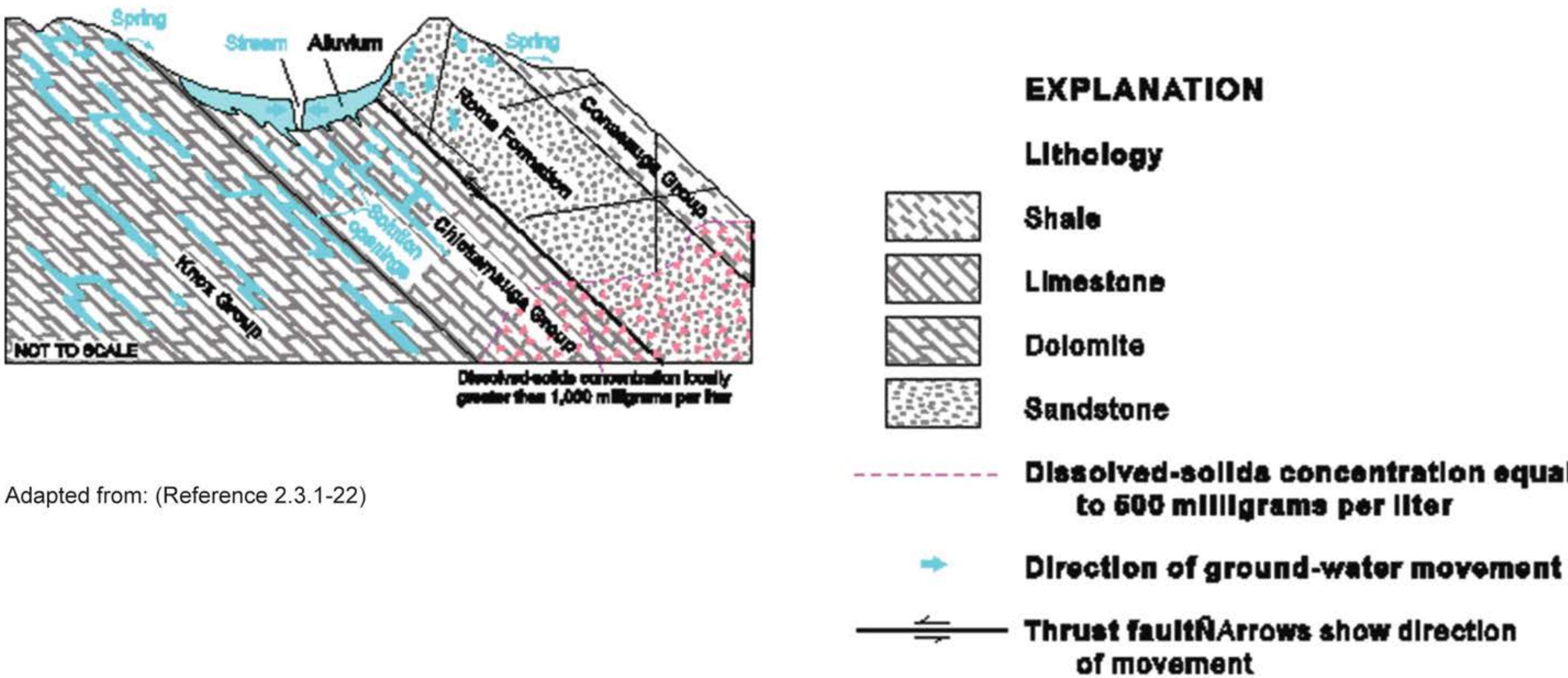
Figure 2.3.1-19. CRBRP Fill and Excavation Areas





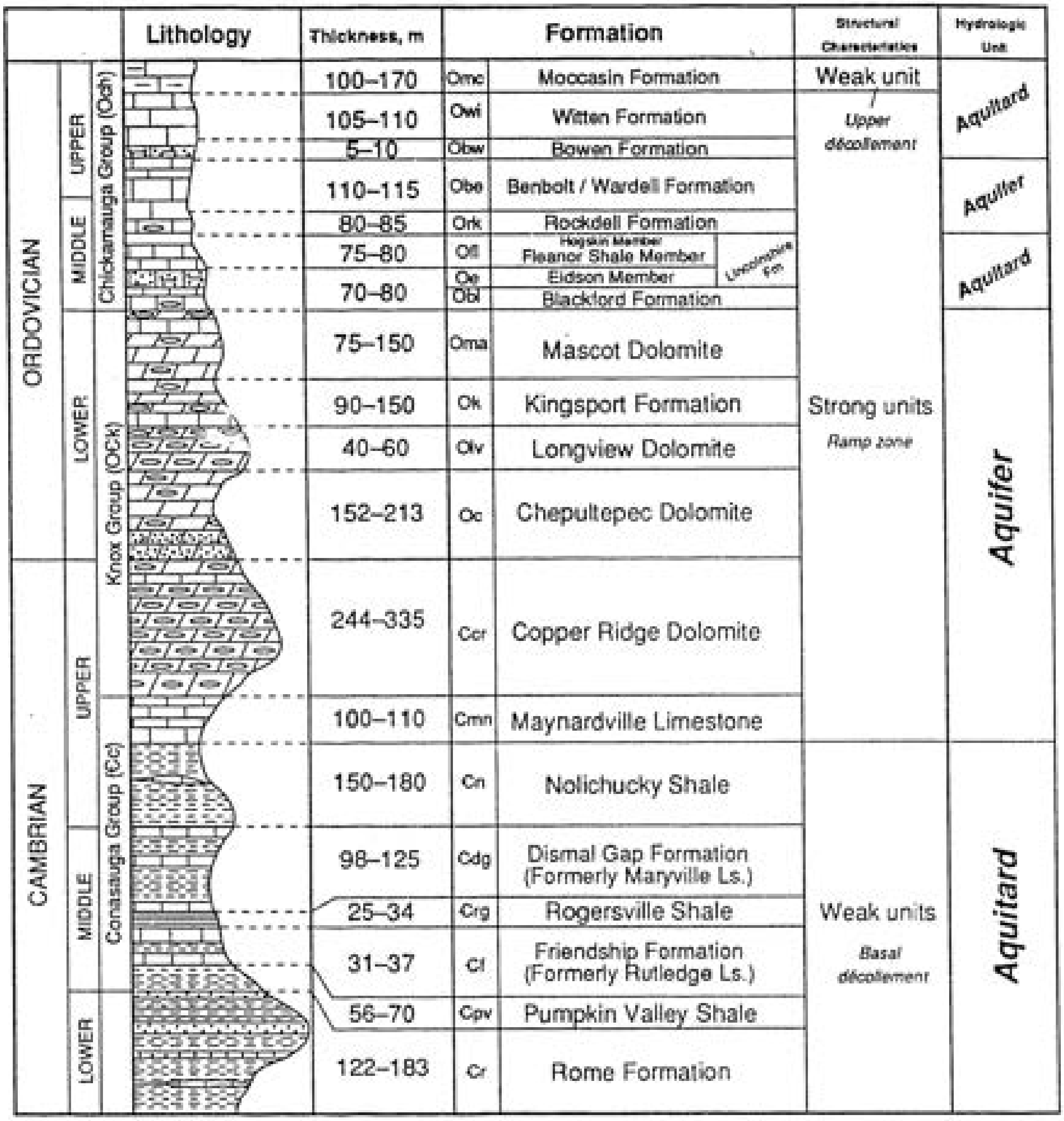
Adapted from: (Reference 2.3.1-22)

Figure 2.3.1-20. Cambrian and Ordovician Aquifers



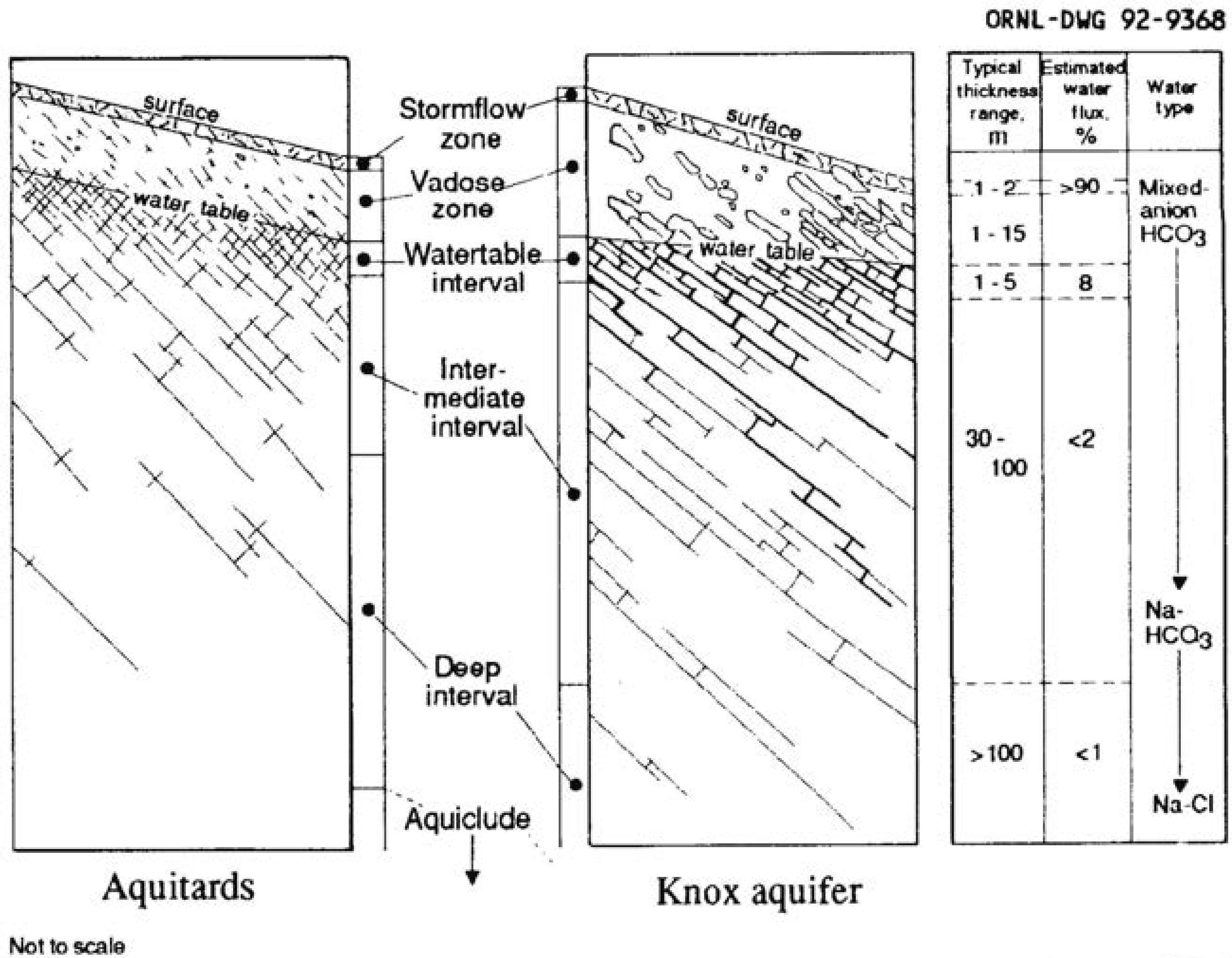
Adapted from: (Reference 2.3.1-22)

Figure 2.3.1-21. Typical Cross-Section of the East Tennessee Aquifer System



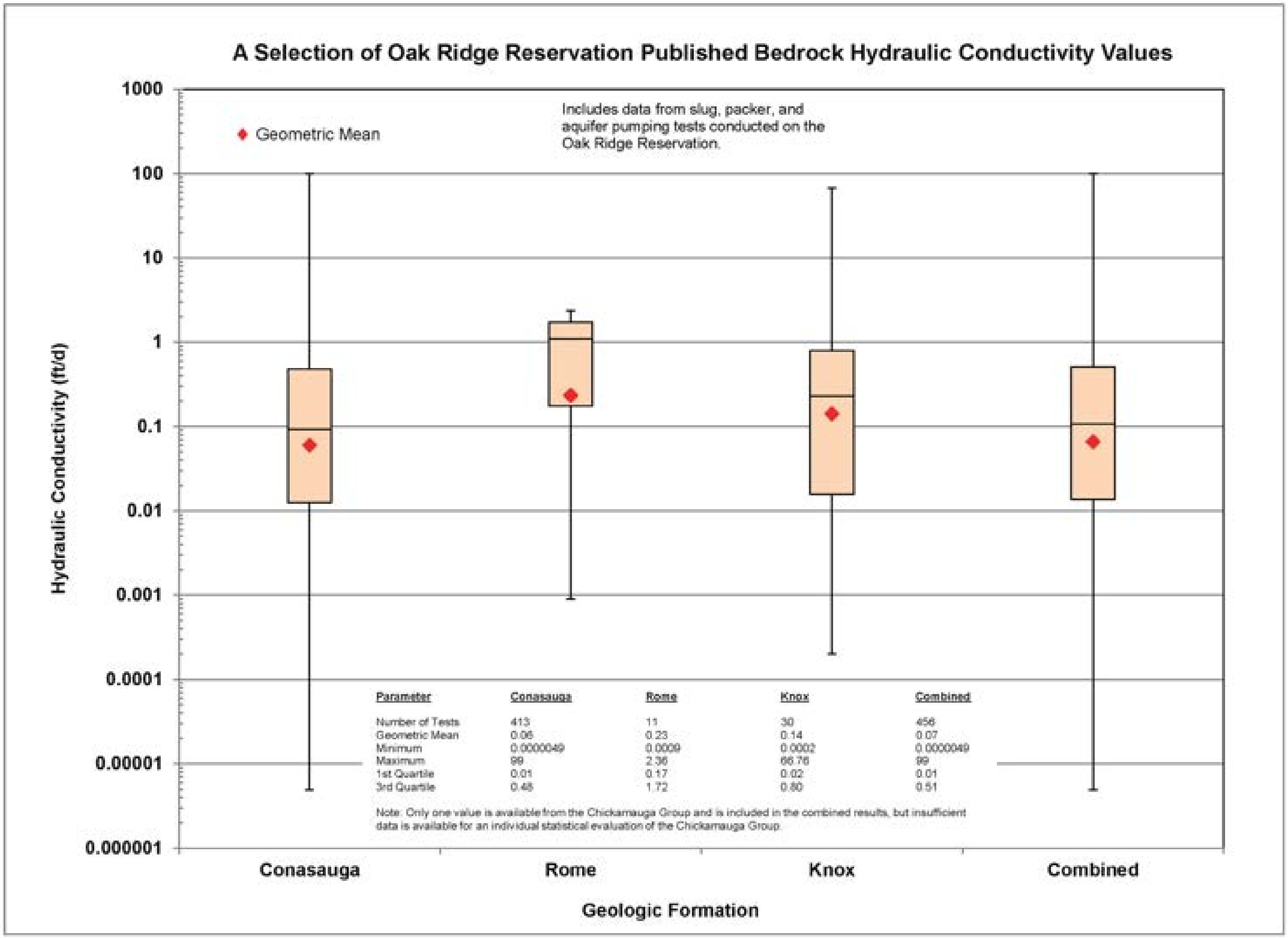
Source: (Reference 2.3.1-29).

Figure 2.3.1-22. Site Area Hydrogeostratigraphy



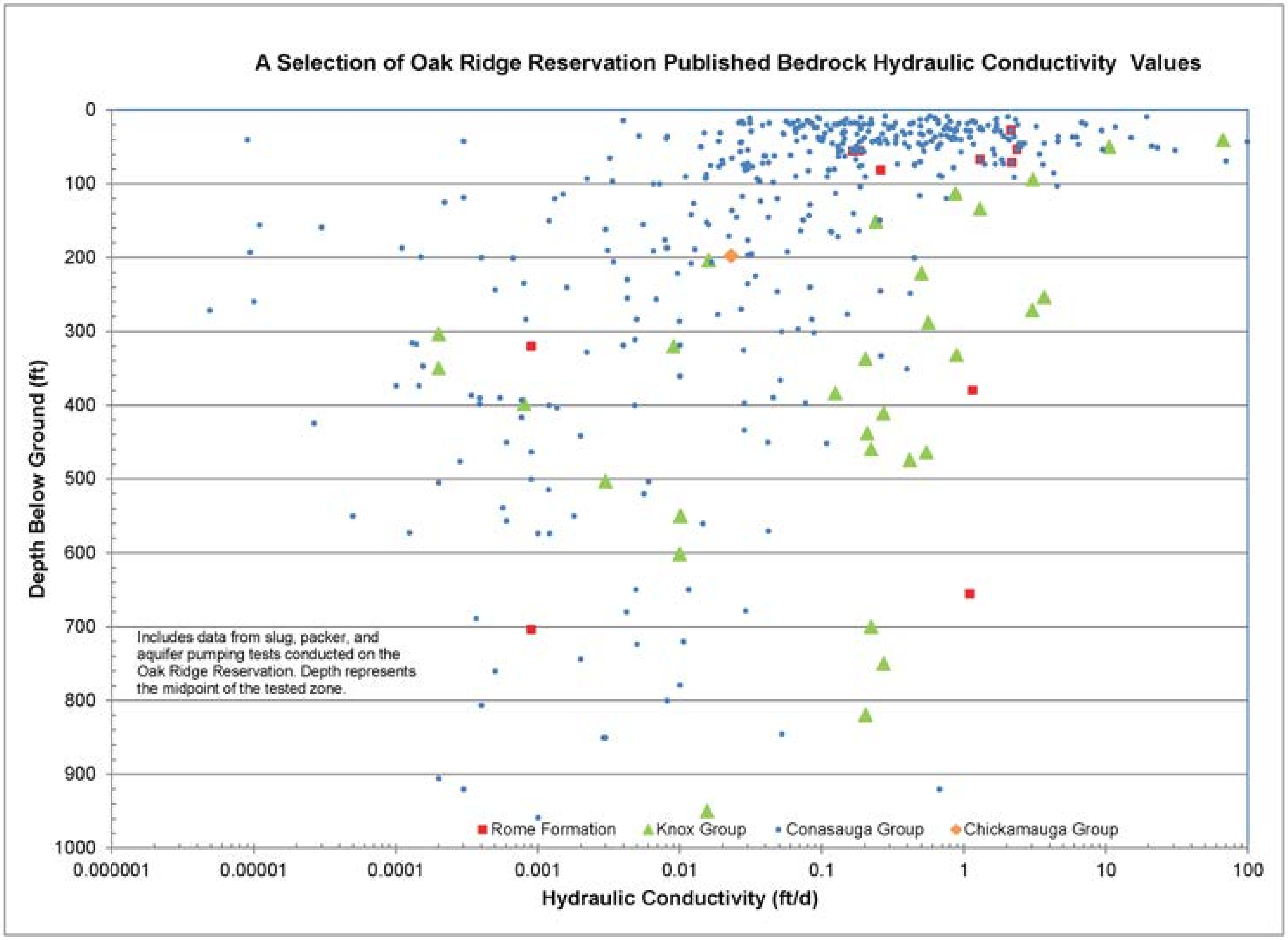
Source: (Reference 2.3.1-28)

Figure 2.3.1-23. ORR Vertical Flow Conceptualization



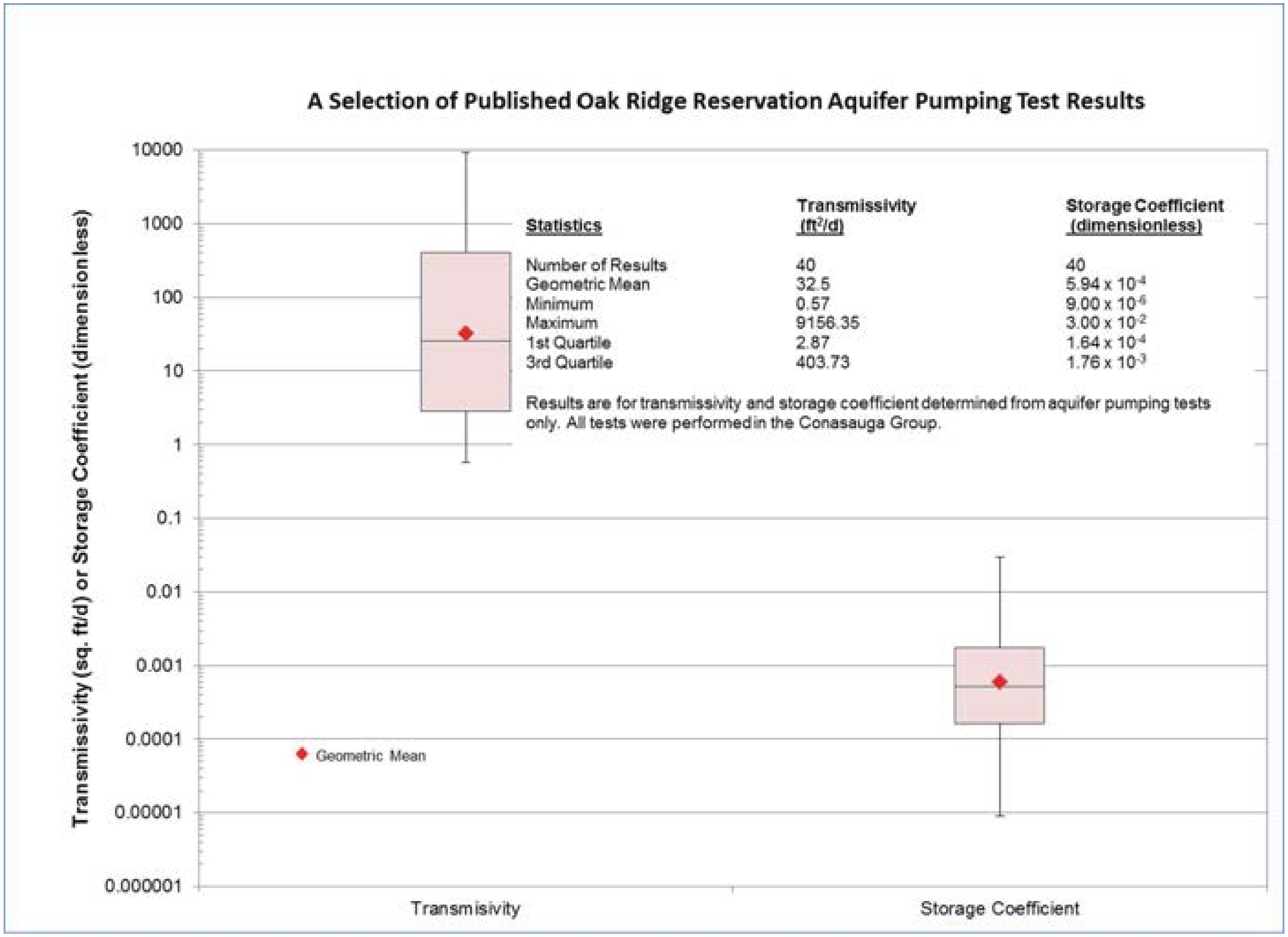
a) Box and whisker plot of hydraulic conductivity tests by geologic formation. Data presented in Appendix 2.3-A

Figure 2.3.1-24. (Sheet 1 of 2) ORR Historic Bedrock Hydraulic Conductivity Test Data



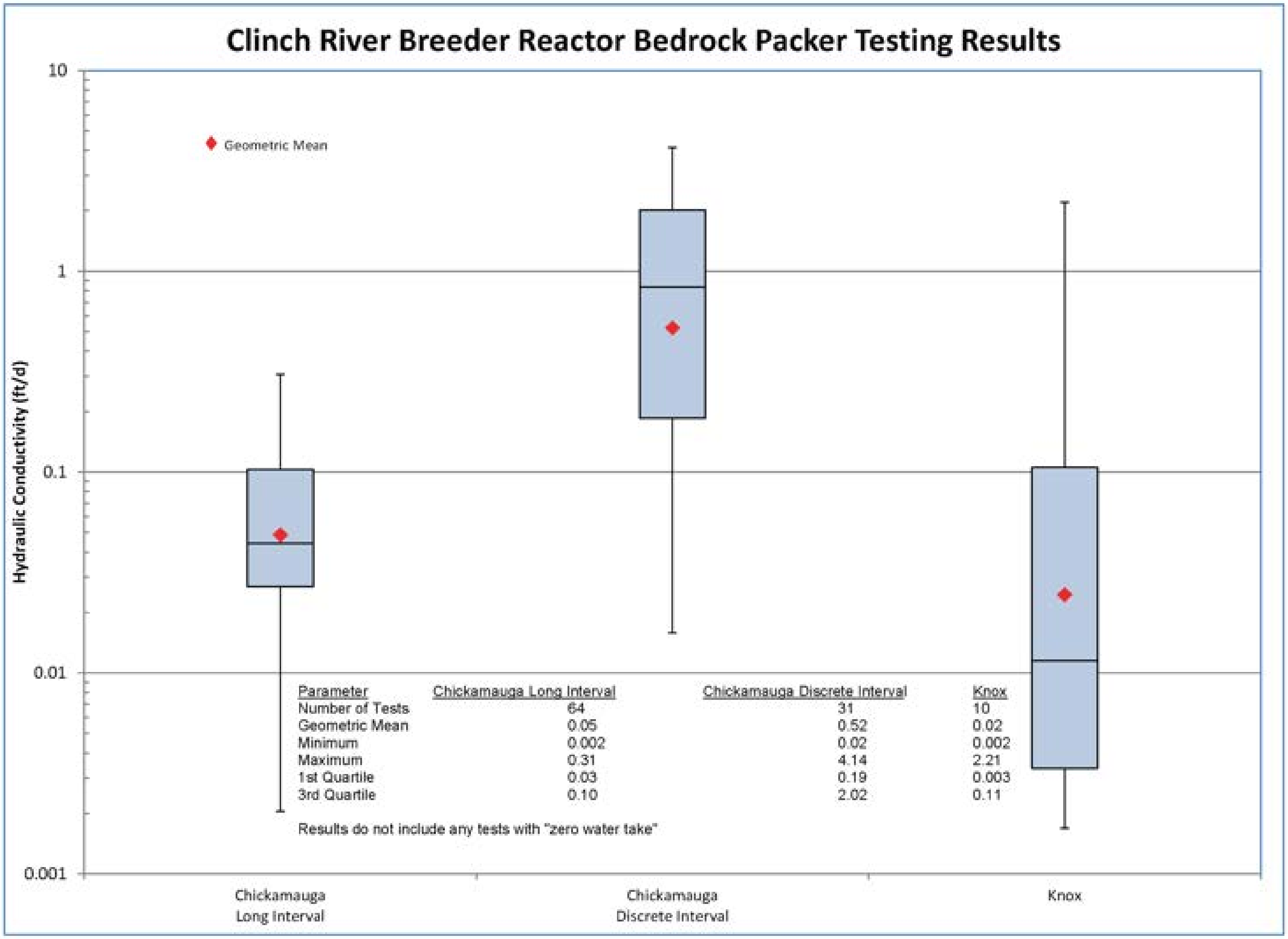
b) Scatter plot of hydraulic conductivity versus depth. Data presented in Appendix 2.3-A

Figure 2.3.1-24. (Sheet 2 of 2) ORR Historic Bedrock Hydraulic Conductivity Test Data



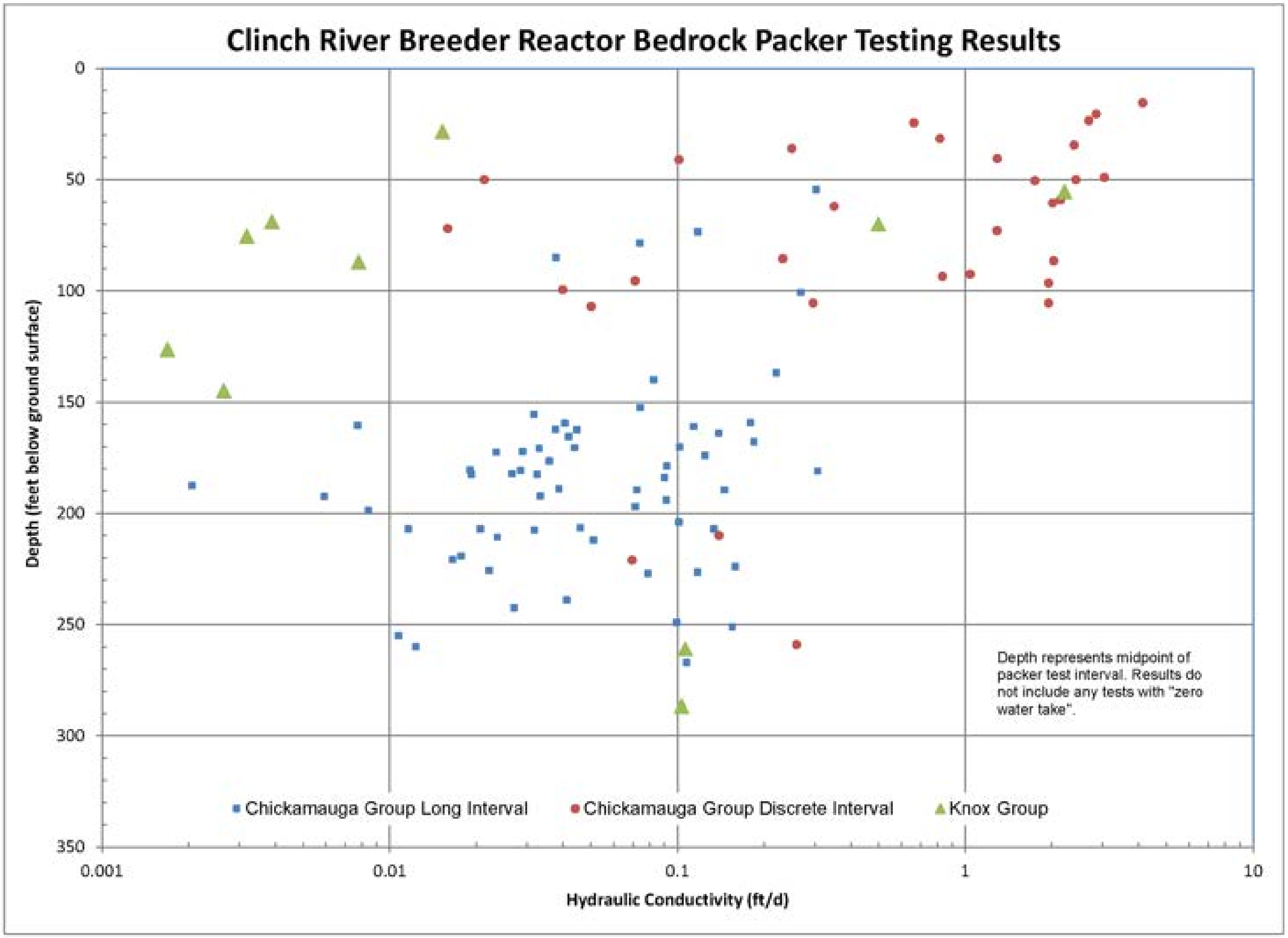
Data presented in Appendix 2.3-A

Figure 2.3.1-25. ORR Aquifer Pumping Test Results



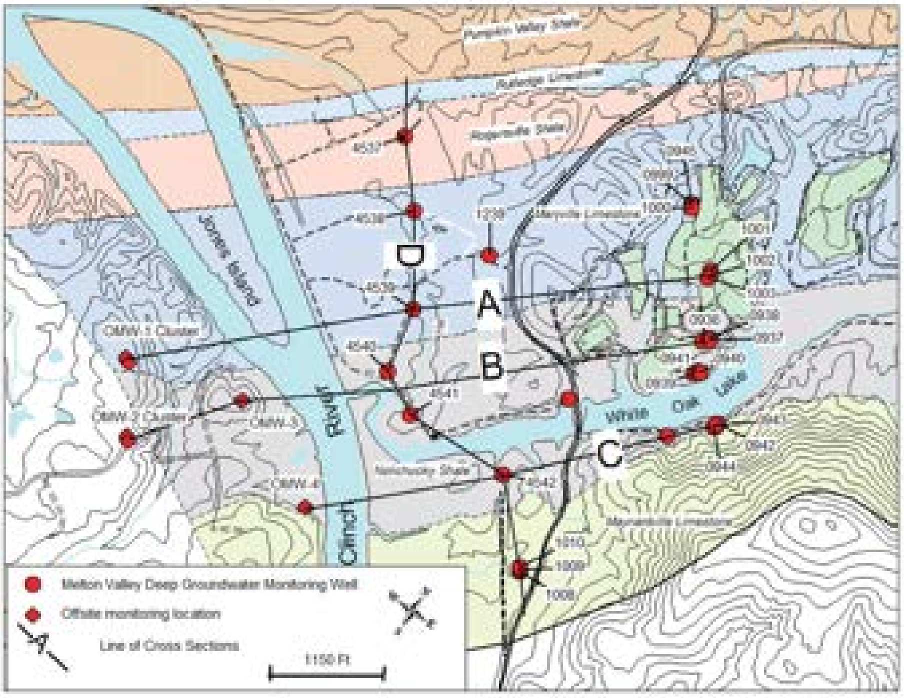
a) Box and whisker plot of CRBRP bedrock packer test results. Data presented in Appendix 2.3-B

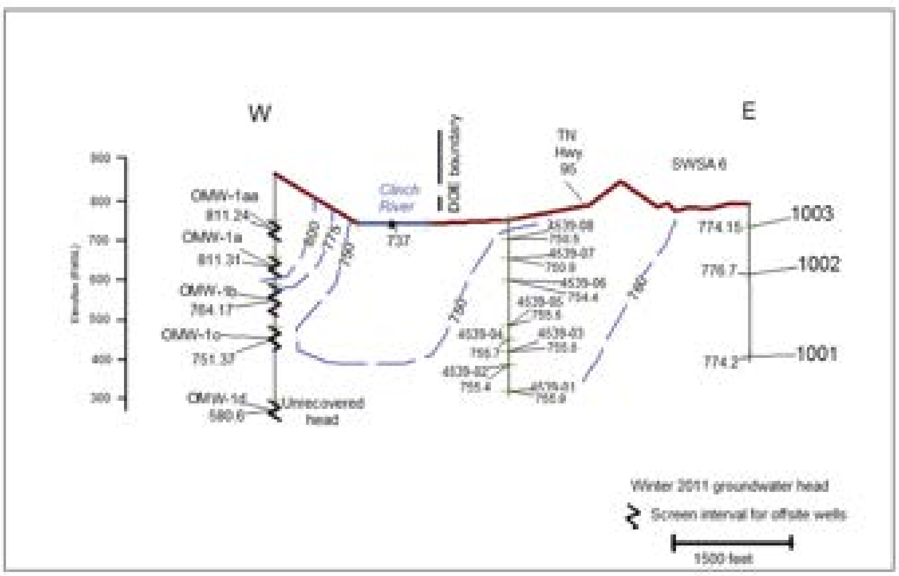
Figure 2.3.1-26. (Sheet 1 of 2) CRBRP Bedrock Packer Hydraulic Conductivity Tests



b) Hydraulic conductivity versus depth plot of CRBRP bedrock packer test results. Data presented in Appendix 2.3-B

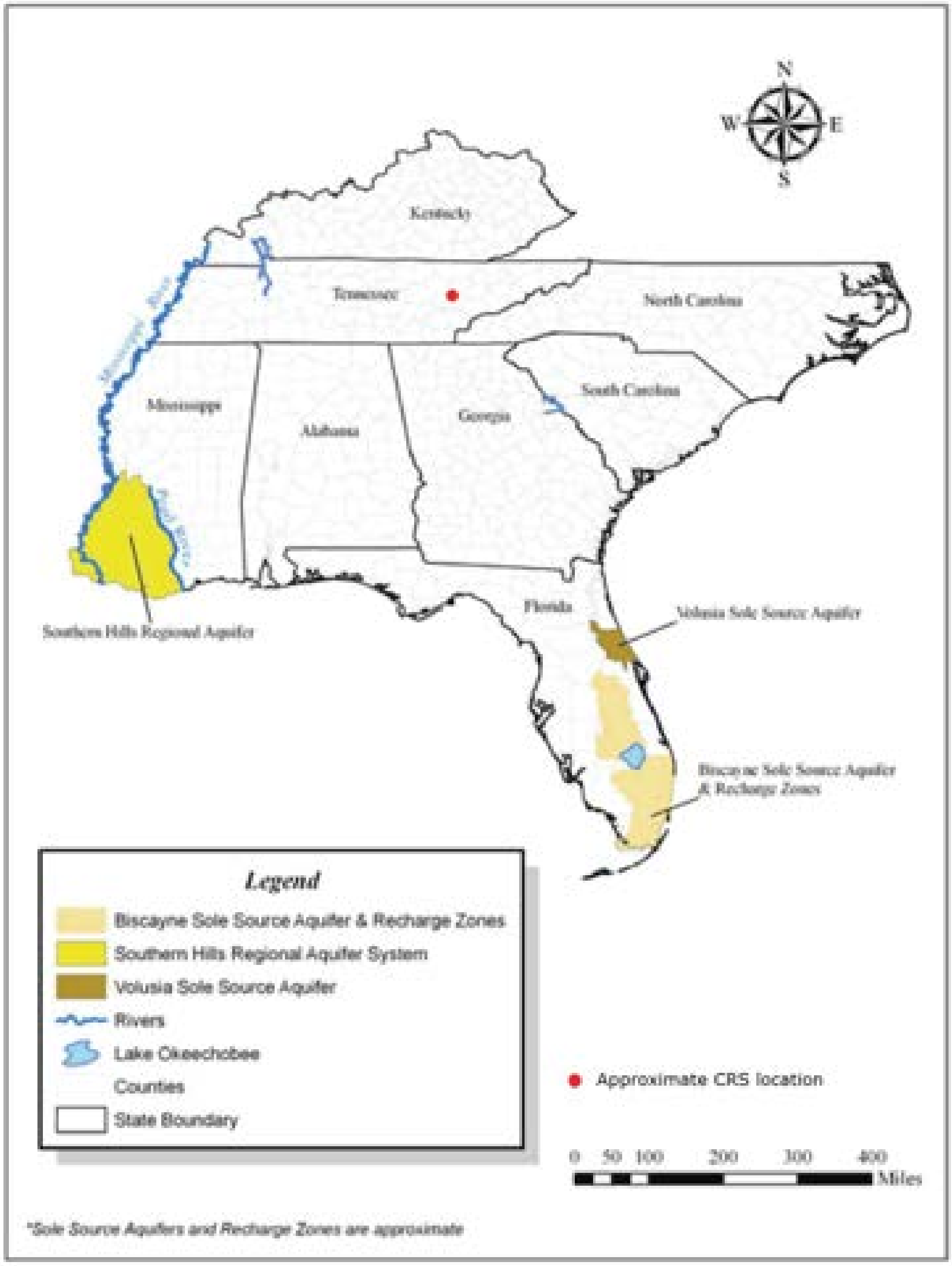
Figure 2.3.1-26. (Sheet 2 of 2) CRBRP Bedrock Packer Hydraulic Conductivity Tests


Hydrologic Cross Section Alignments


Hydrologic Cross Section A

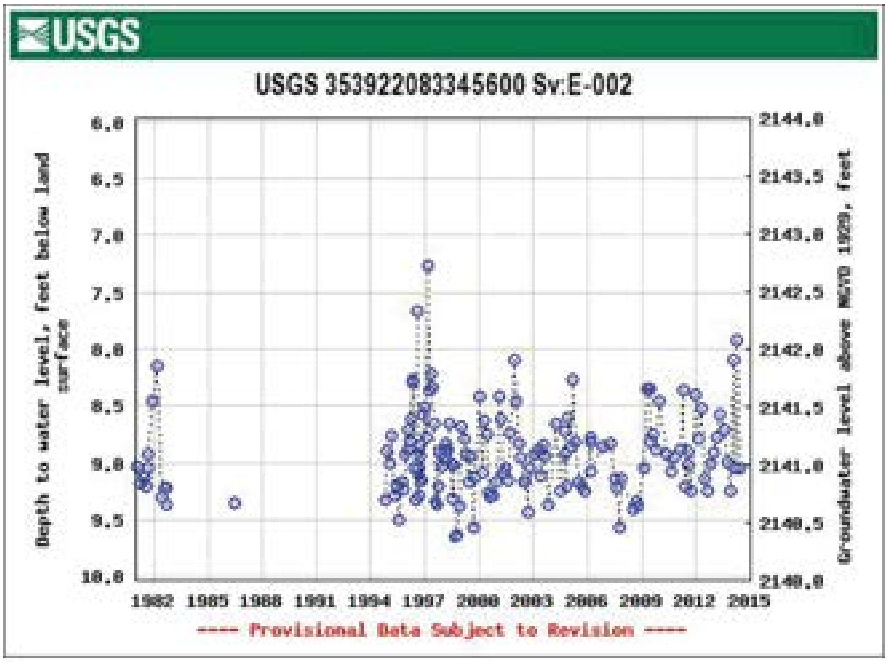
Source: (Reference 2.3.1-31)

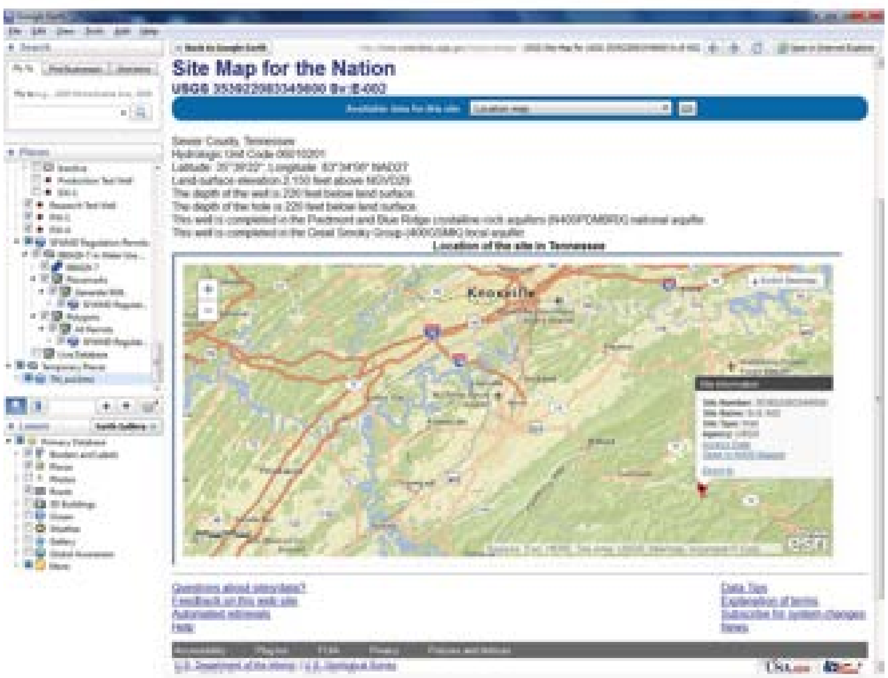
Figure 2.3.1-27. Groundwater Levels Adjacent to the Clinch River



Source: (Reference 2.3.1-32)

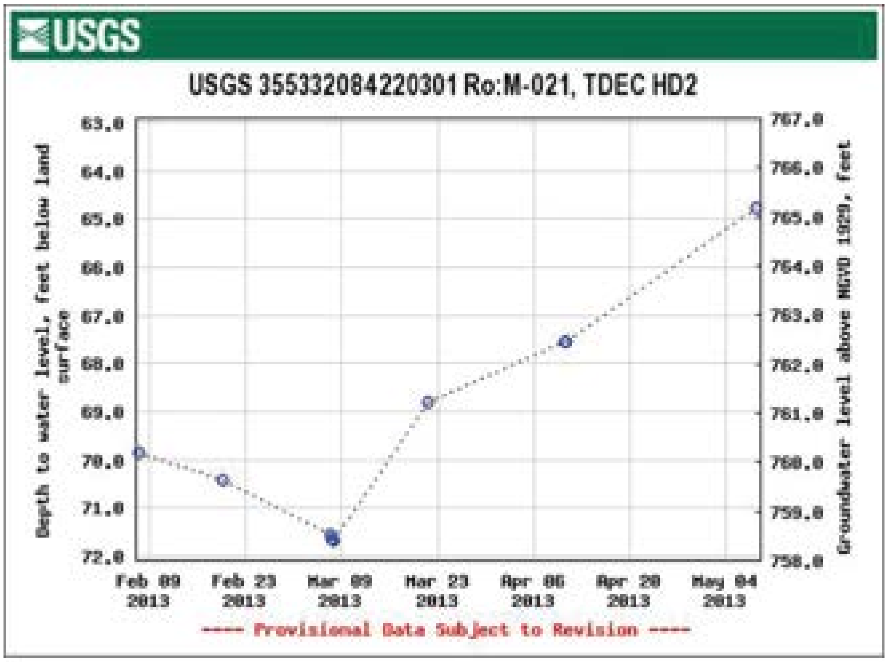
Figure 2.3.1-28. Sole Source Aquifers in EPA Region IV

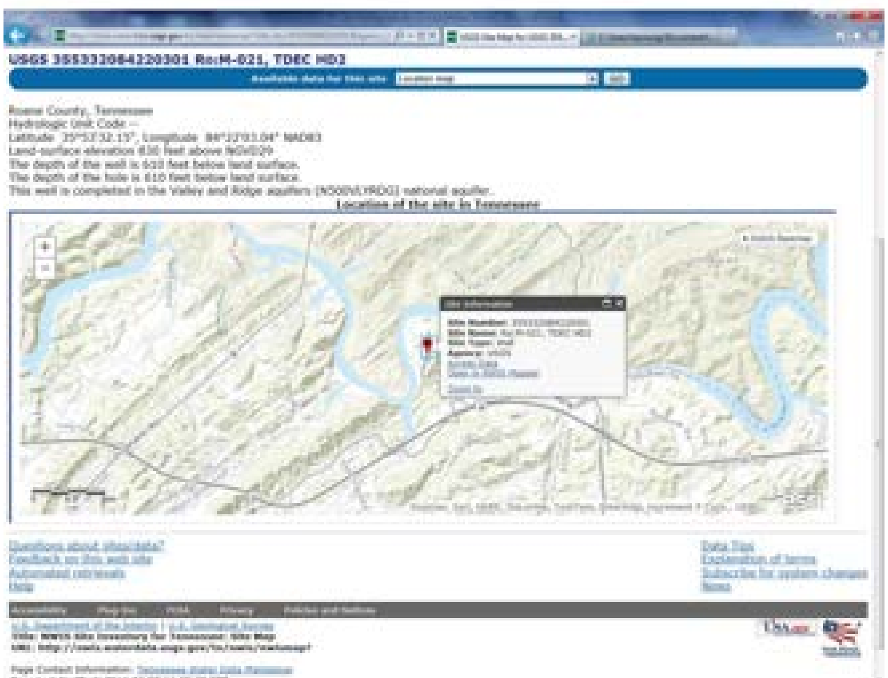




Source: (Reference 2.3.1-23)

Figure 2.3.1-29. U.S. Geological Survey Regional Hydrograph





Source: (Reference 2.3.1-34)

Figure 2.3.1-30. U.S. Geological Survey Hydrograph Near the CRN Site

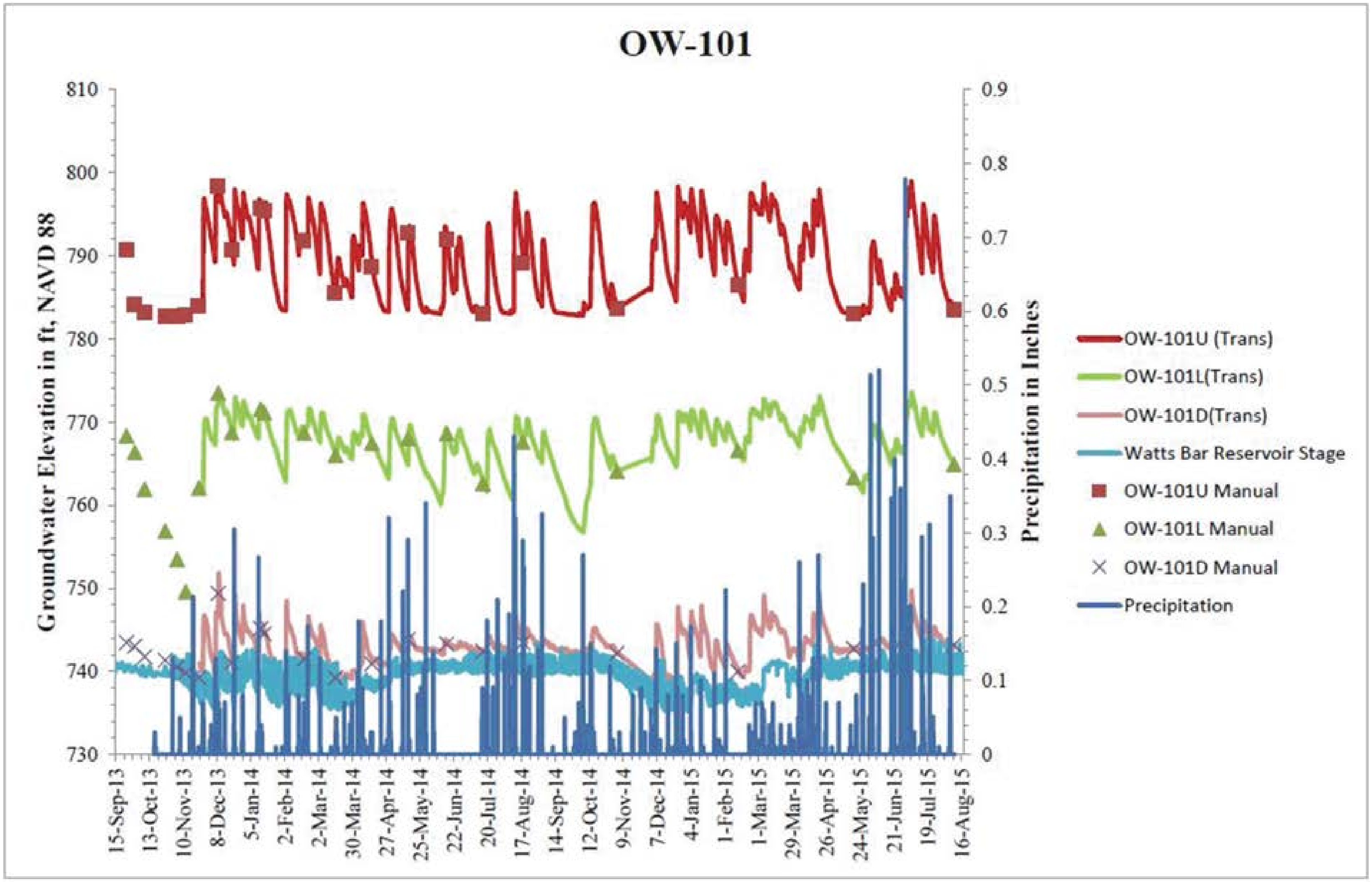


Figure 2.3.1-31. (Sheet 1 of 14) Hydrograph of OW-101 Well Cluster

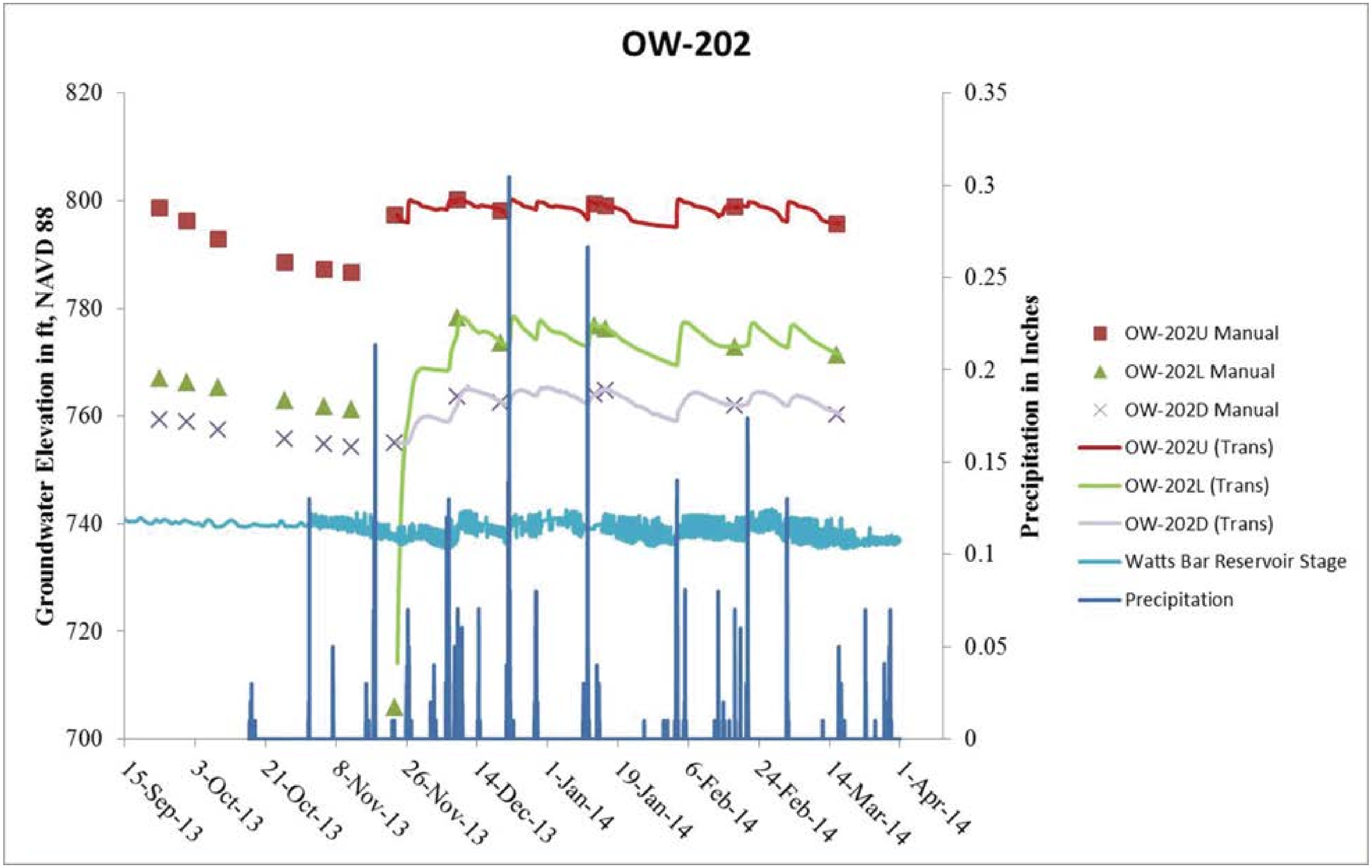


Figure 2.3.1-31. (Sheet 2 of 14) Hydrograph of OW-202 Well Cluster

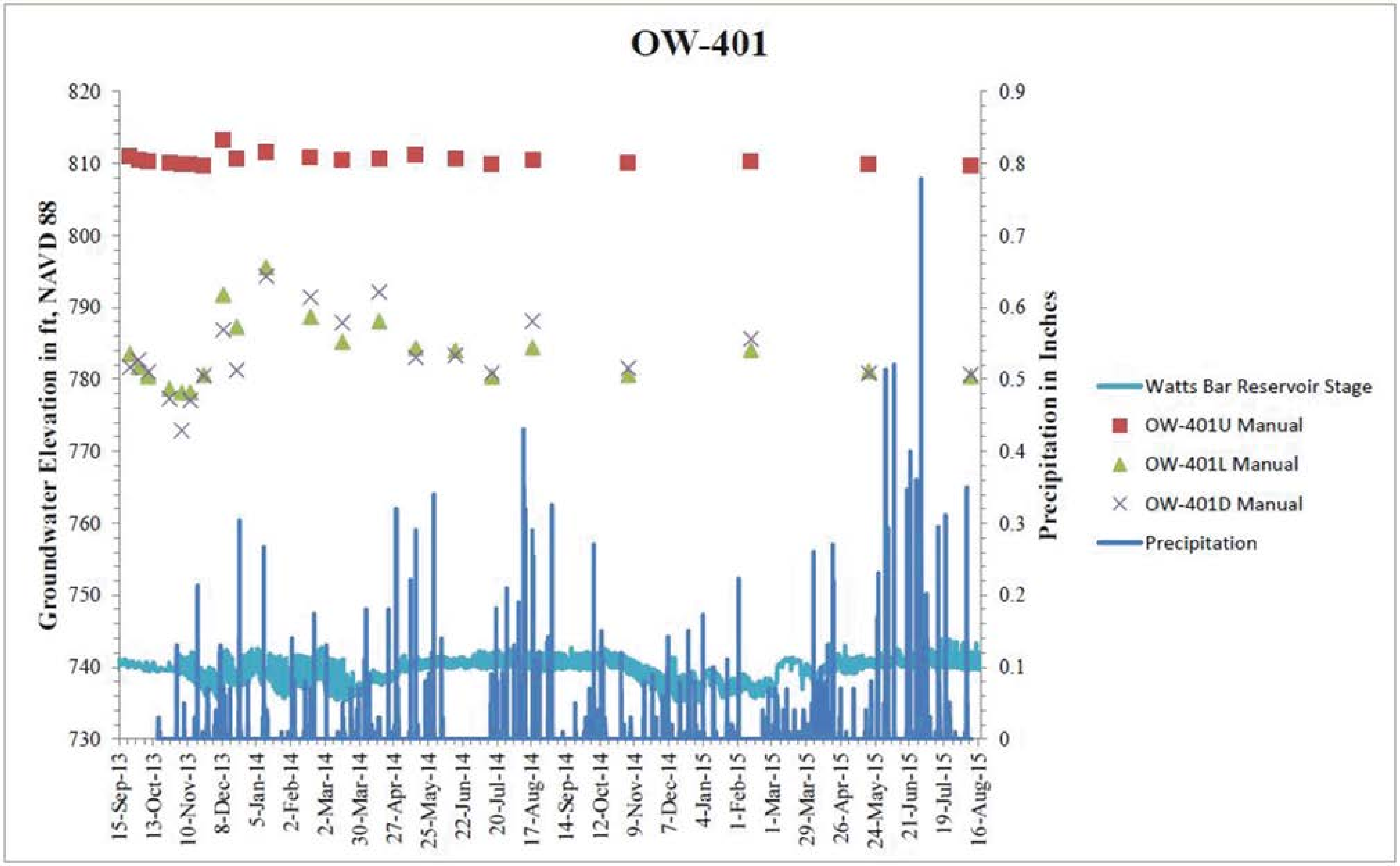


Figure 2.3.1-31. (Sheet 3 of 14) Hydrograph of OW-401 Well Cluster

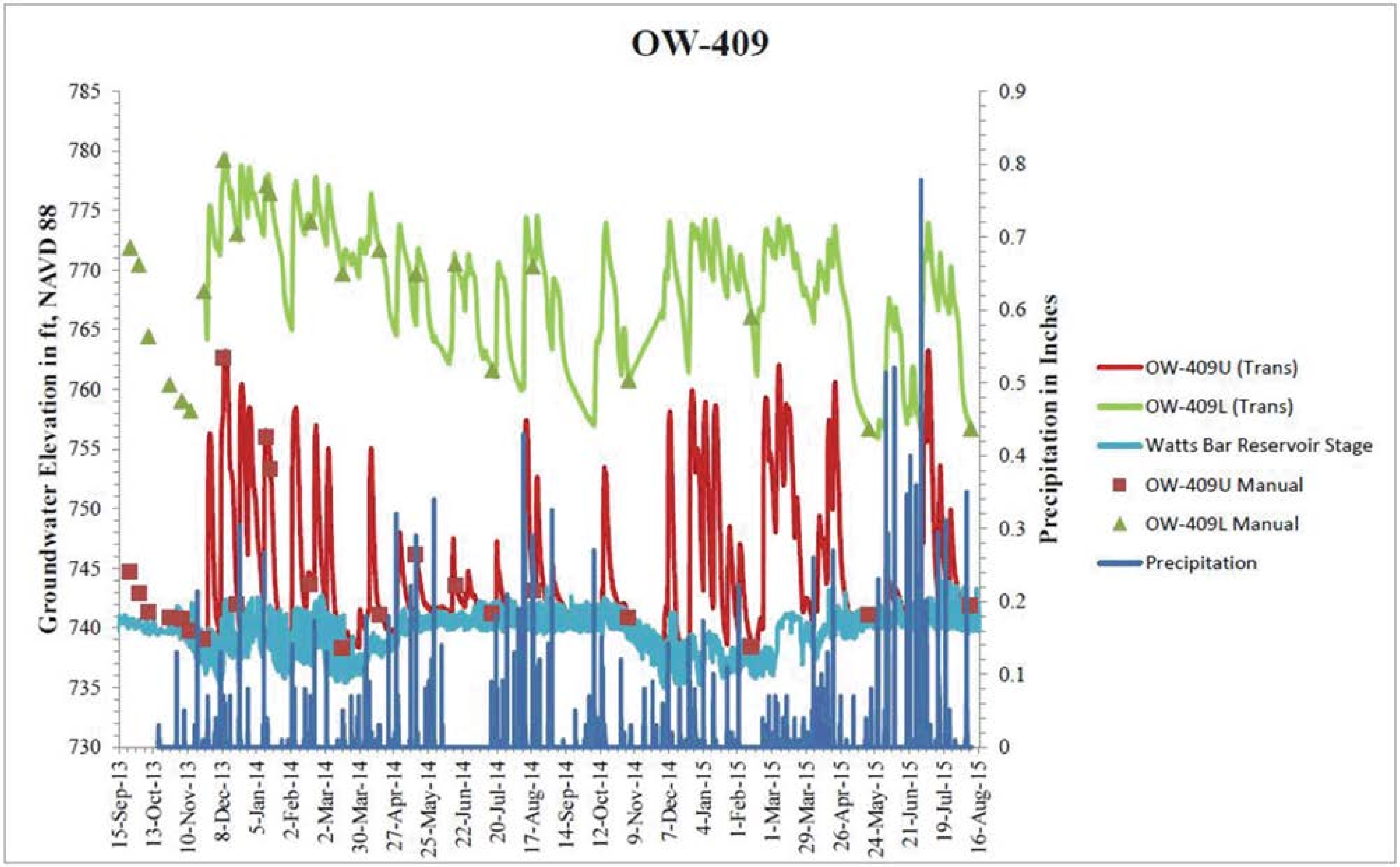


Figure 2.3.1-31. (Sheet 4 of 14) Hydrograph of OW-409 Well Cluster

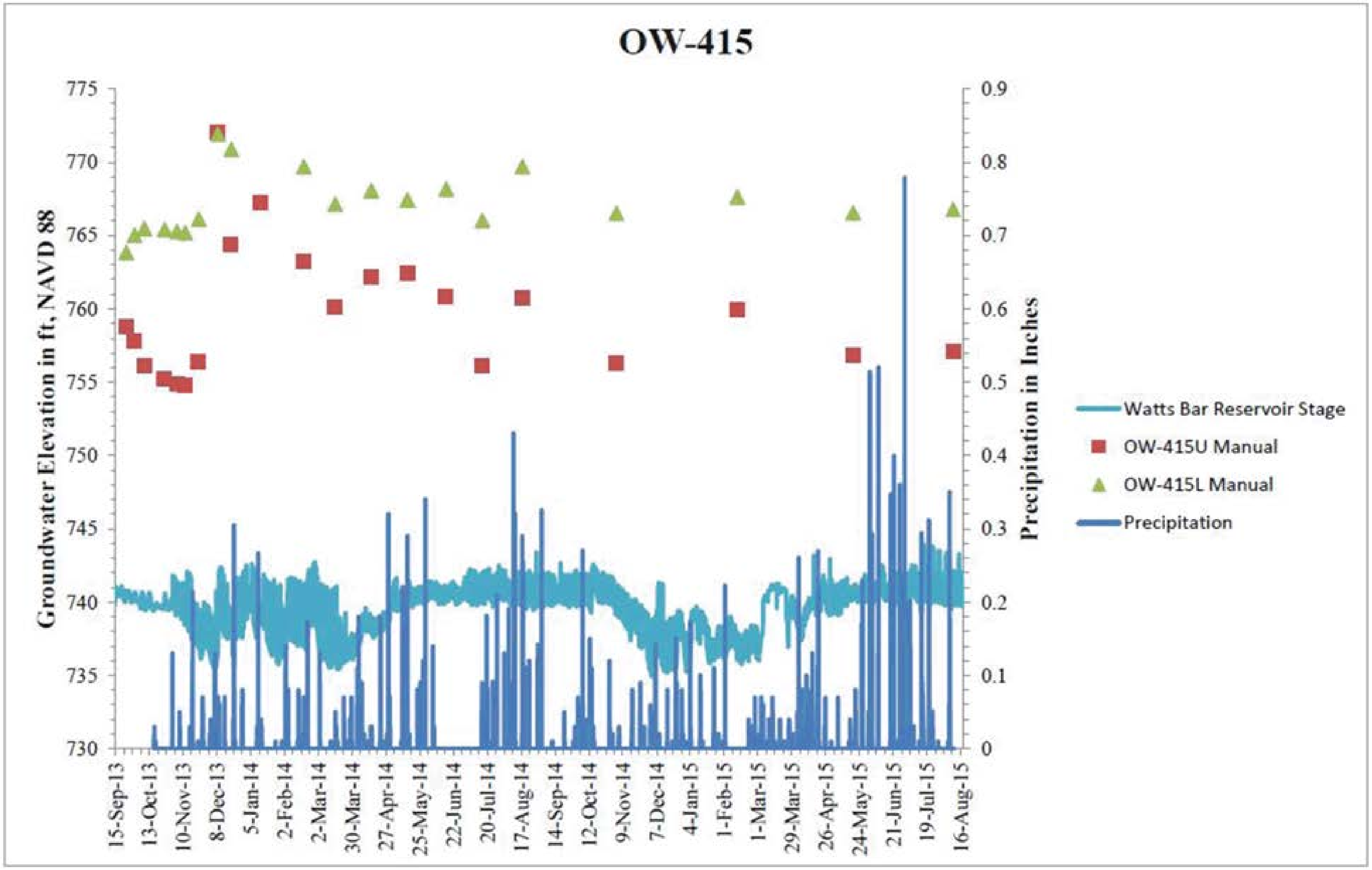


Figure 2.3.1-31. (Sheet 5 of 14) Hydrograph of OW-415 Well Cluster

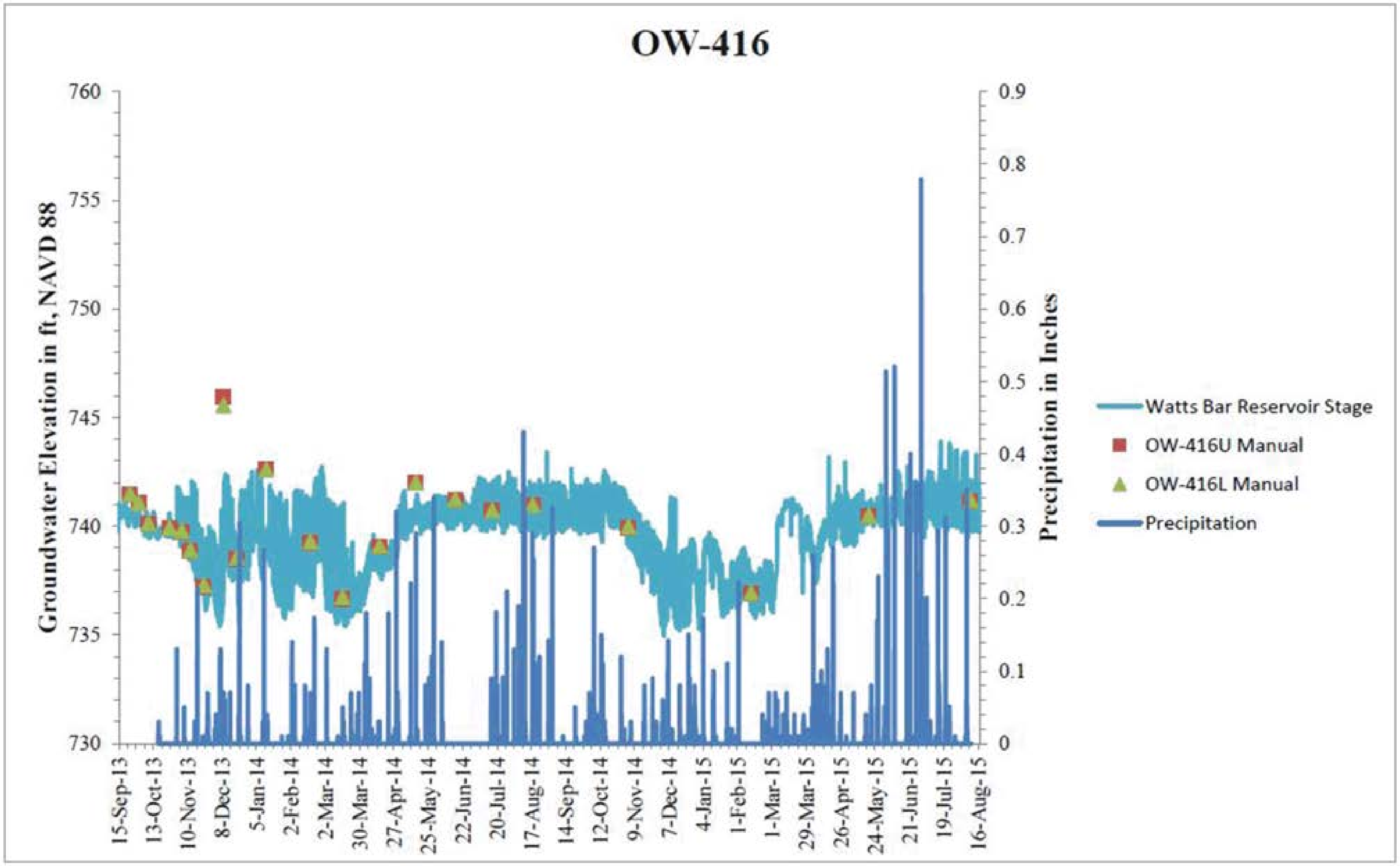


Figure 2.3.1-31. (Sheet 6 of 14) Hydrograph of OW-416 Well Cluster

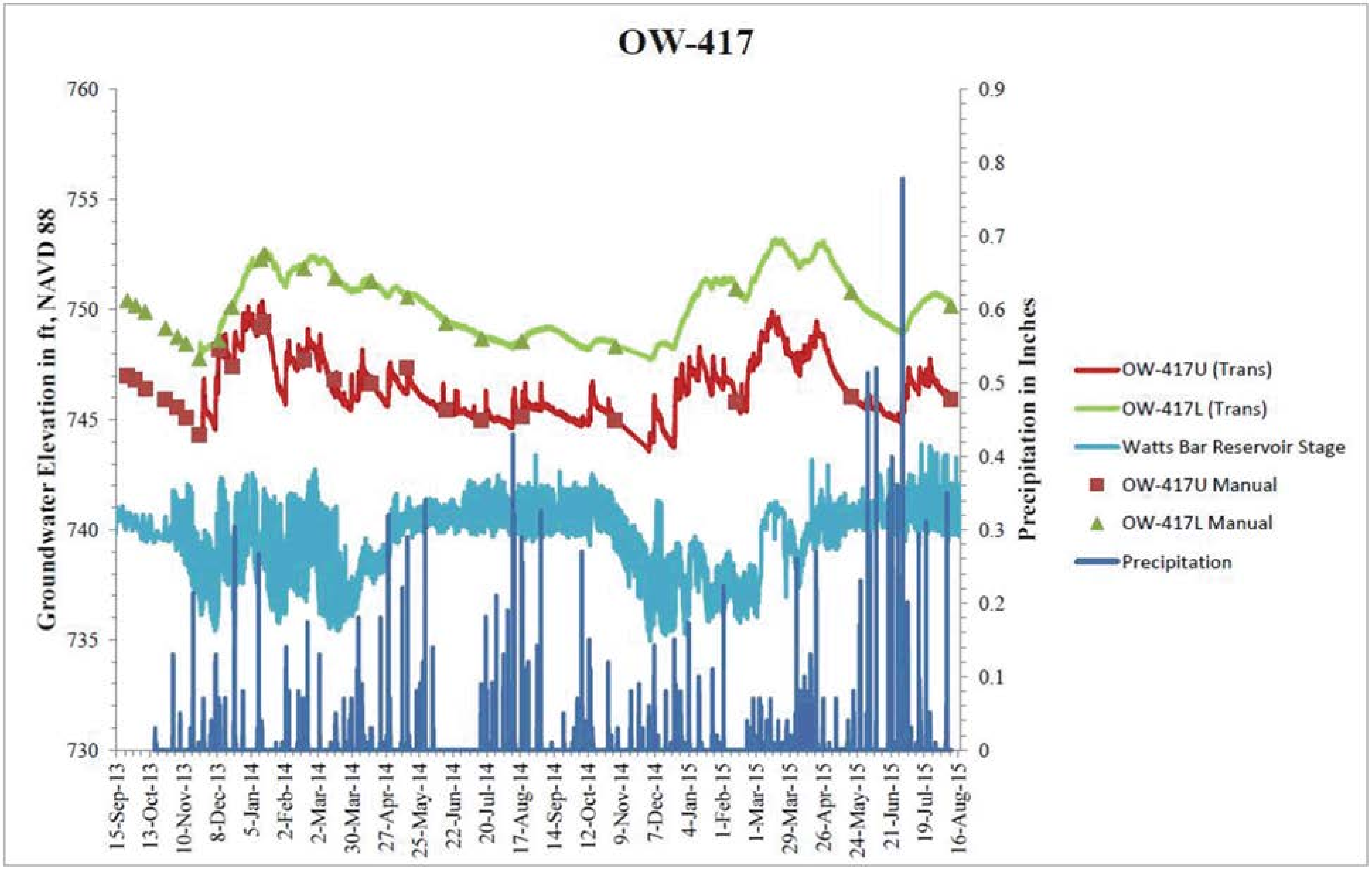


Figure 2.3.1-31. (Sheet 7 of 14) Hydrograph of OW-417 Well Cluster

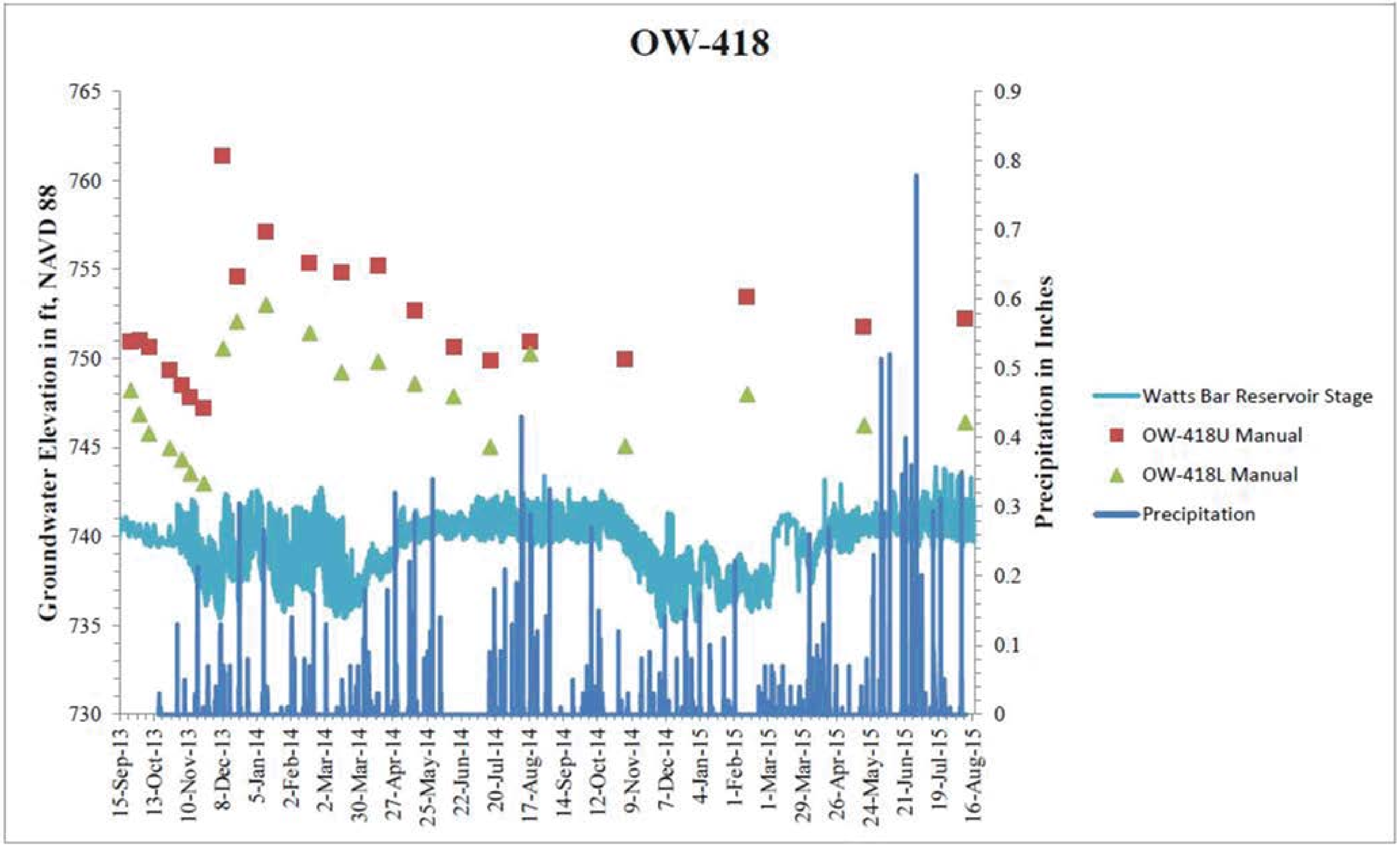


Figure 2.3.1-31. (Sheet 8 of 14) Hydrograph of OW-418 Well Cluster

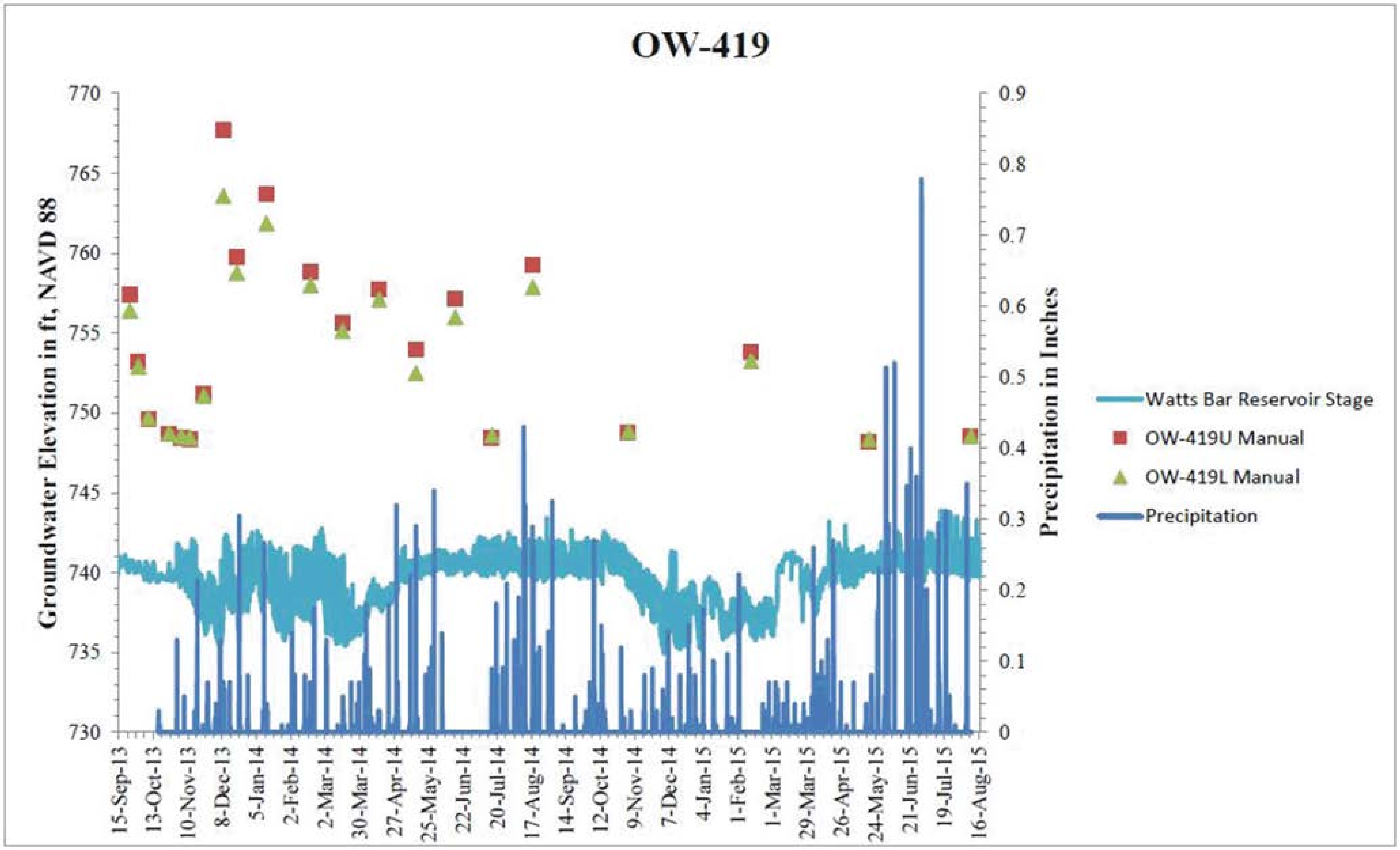


Figure 2.3.1-31. (Sheet 9 of 14) Hydrograph of OW-419 Well Cluster

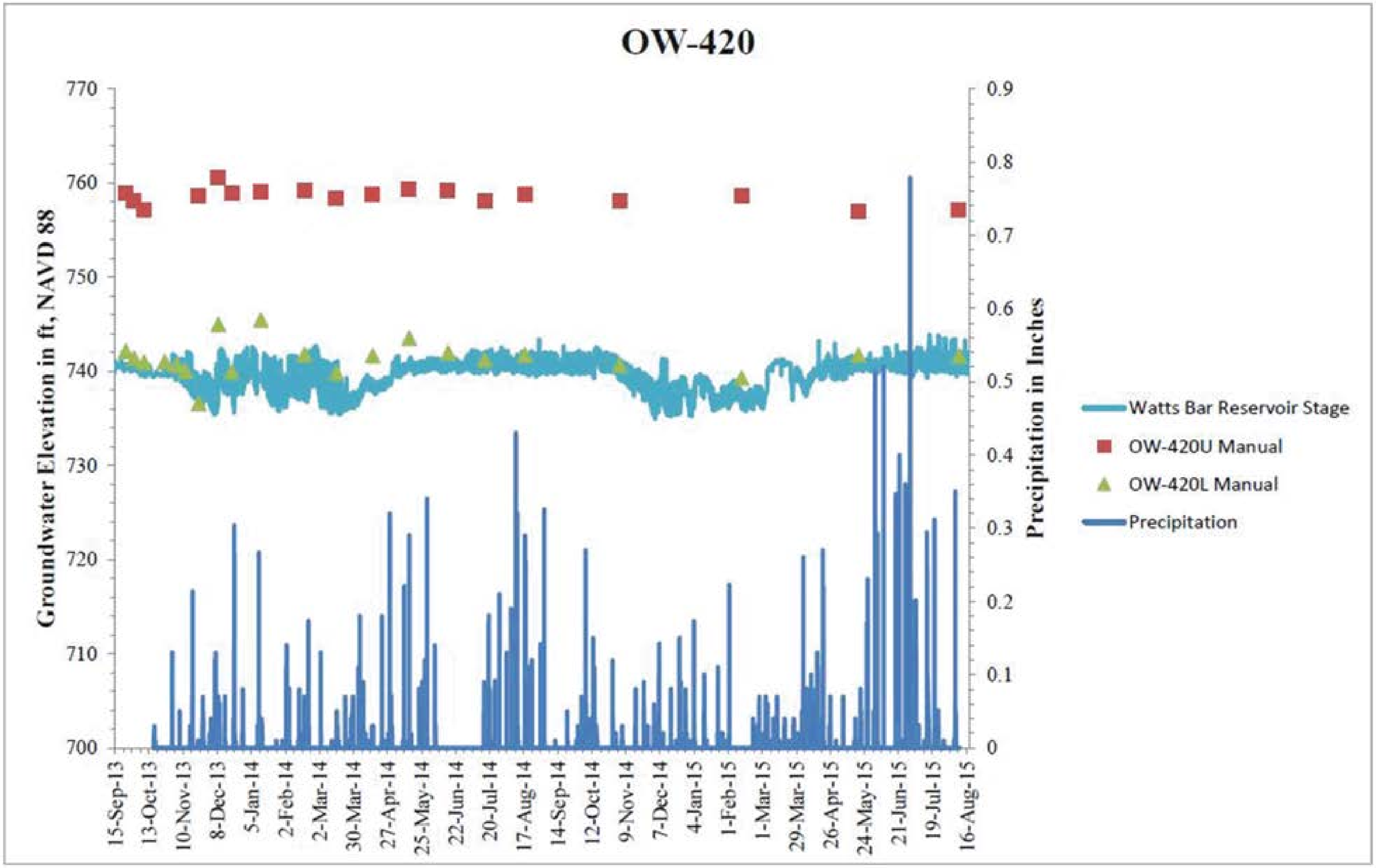


Figure 2.3.1-31. (Sheet 10 of 14) Hydrograph of OW-420 Well Cluster

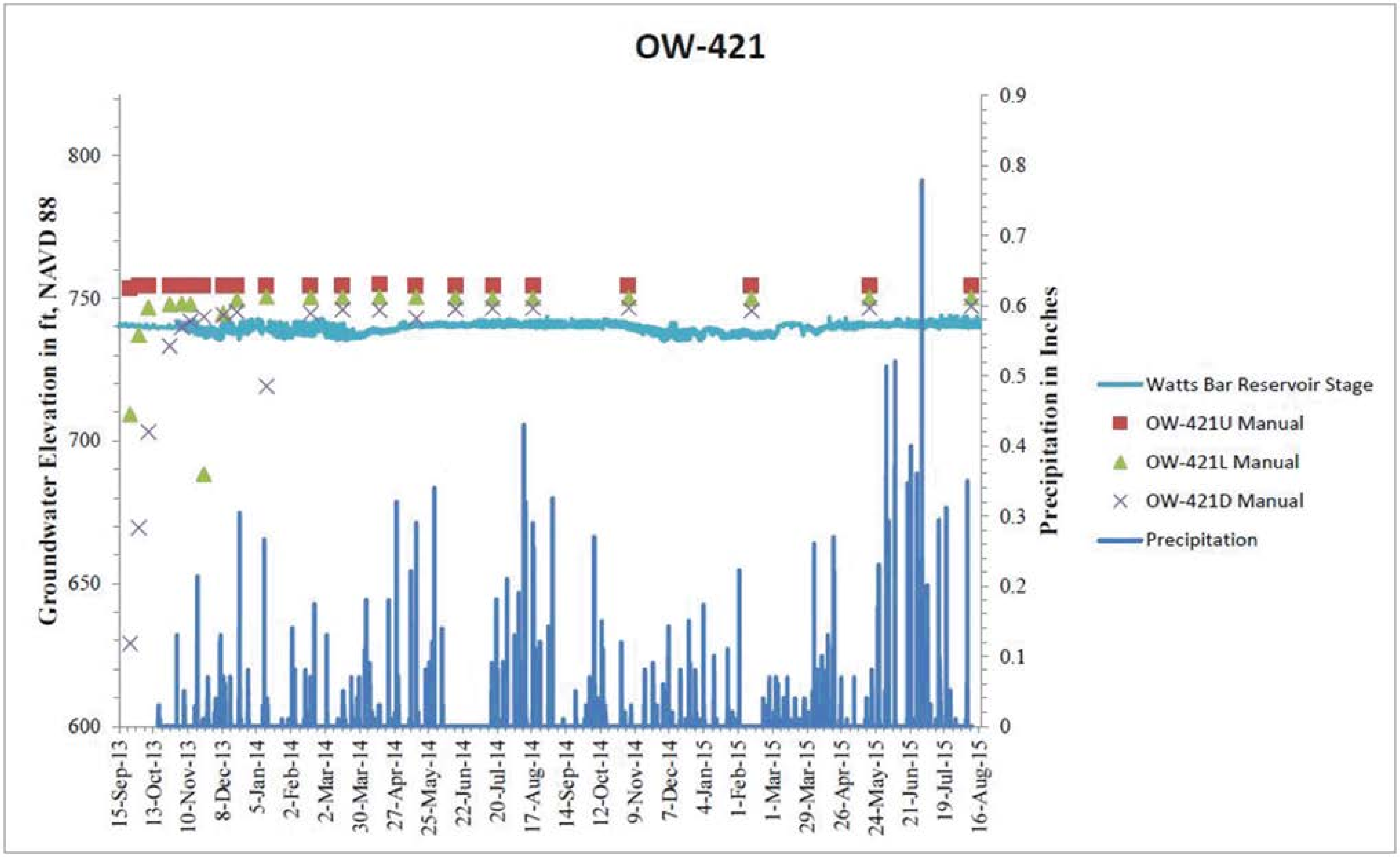


Figure 2.3.1-31. (Sheet 11 of 14) Hydrograph of OW-421 Well Cluster

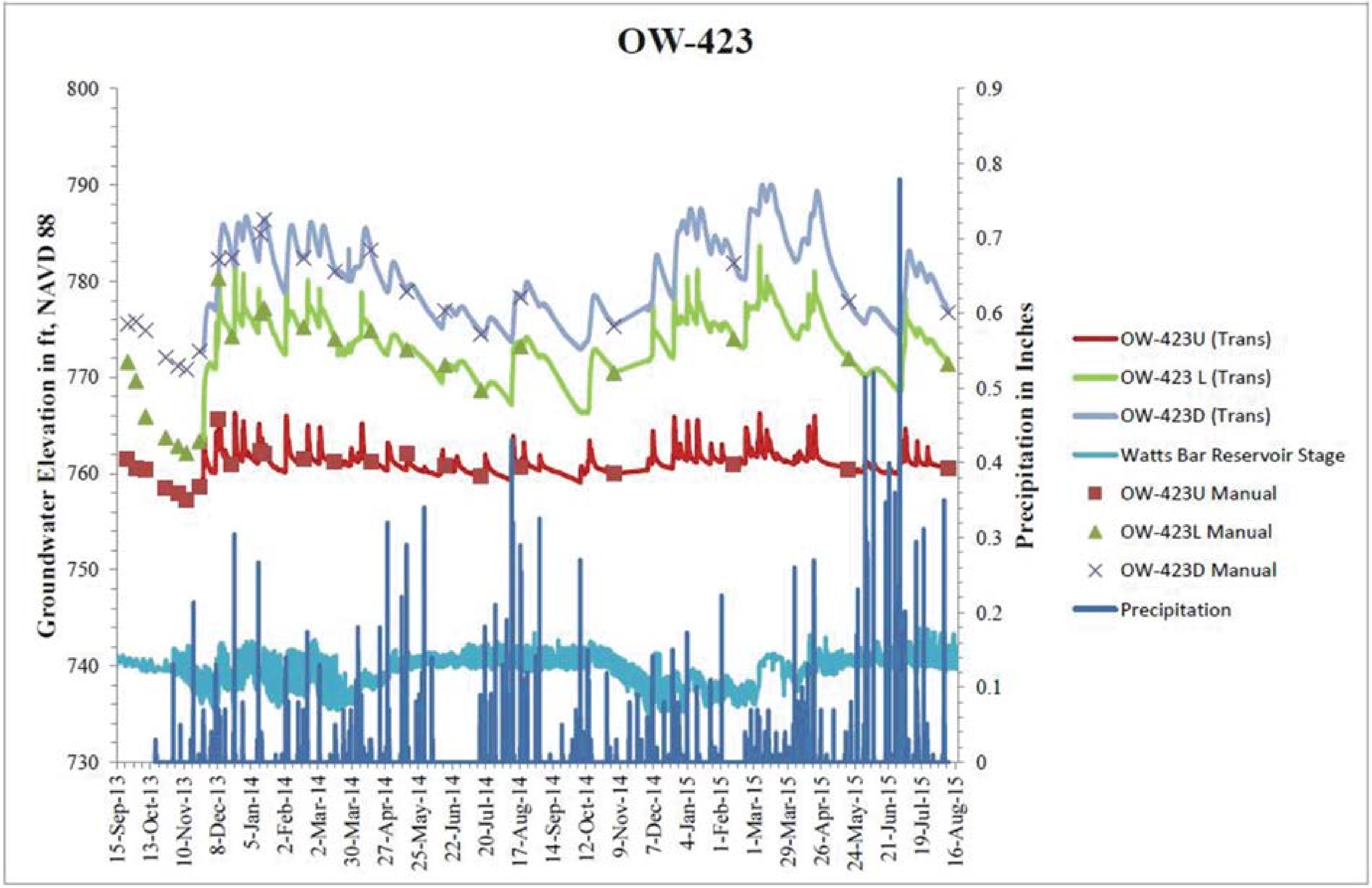


Figure 2.3.1-31. (Sheet 12 of 14) Hydrograph of OW-423 Well Cluster

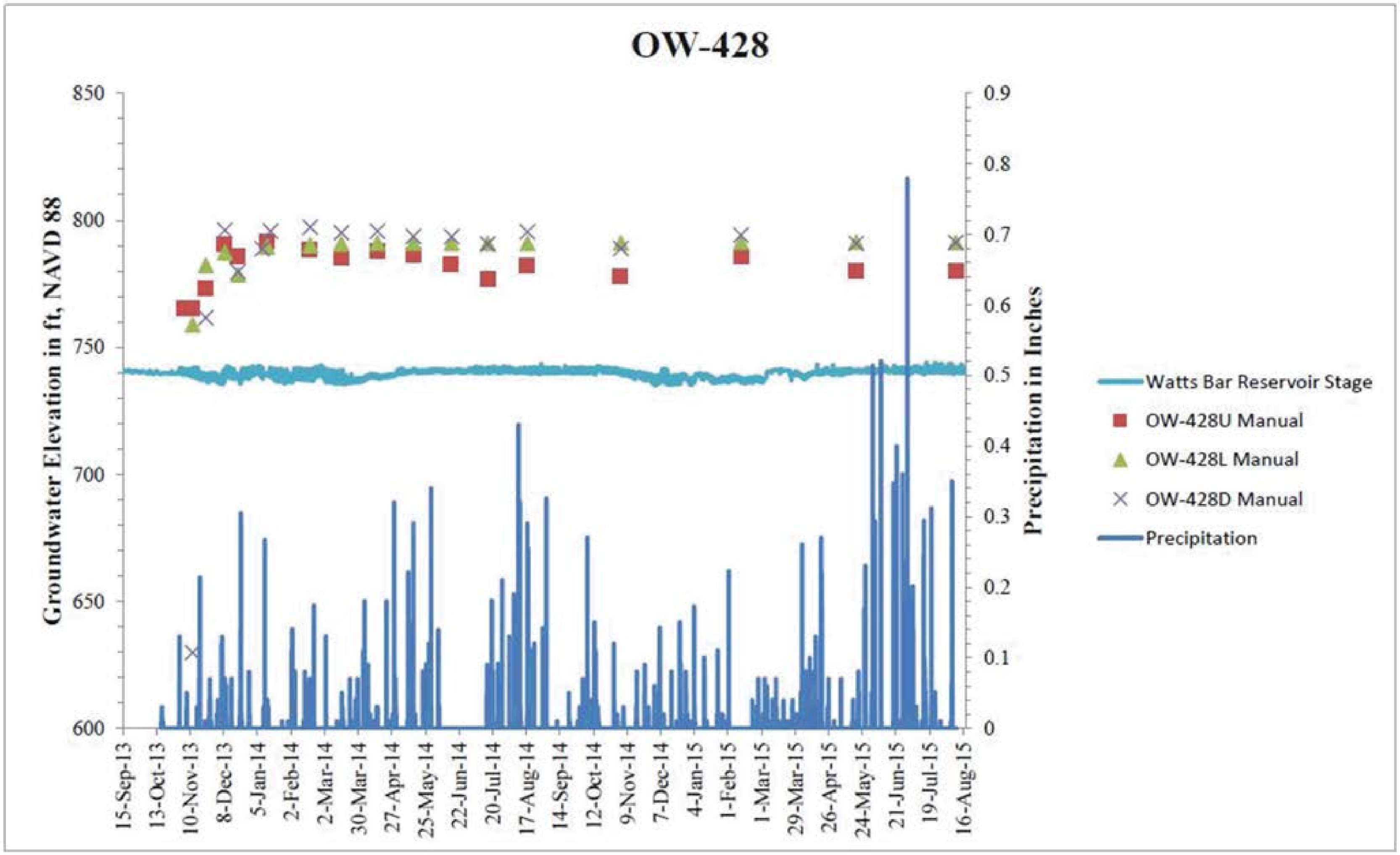


Figure 2.3.1-31. (Sheet 13 of 14) Hydrograph of OW-428 Well Cluster

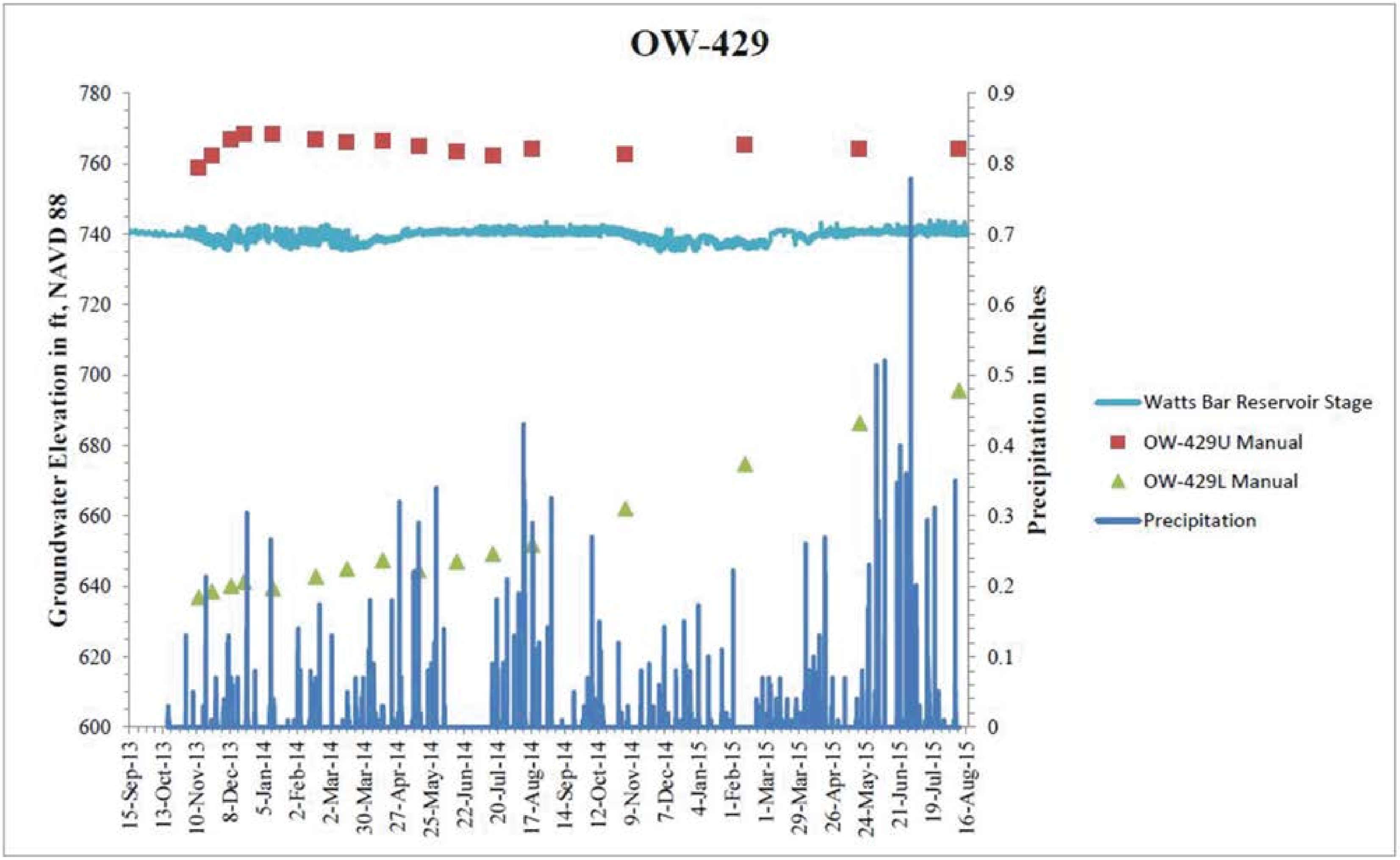
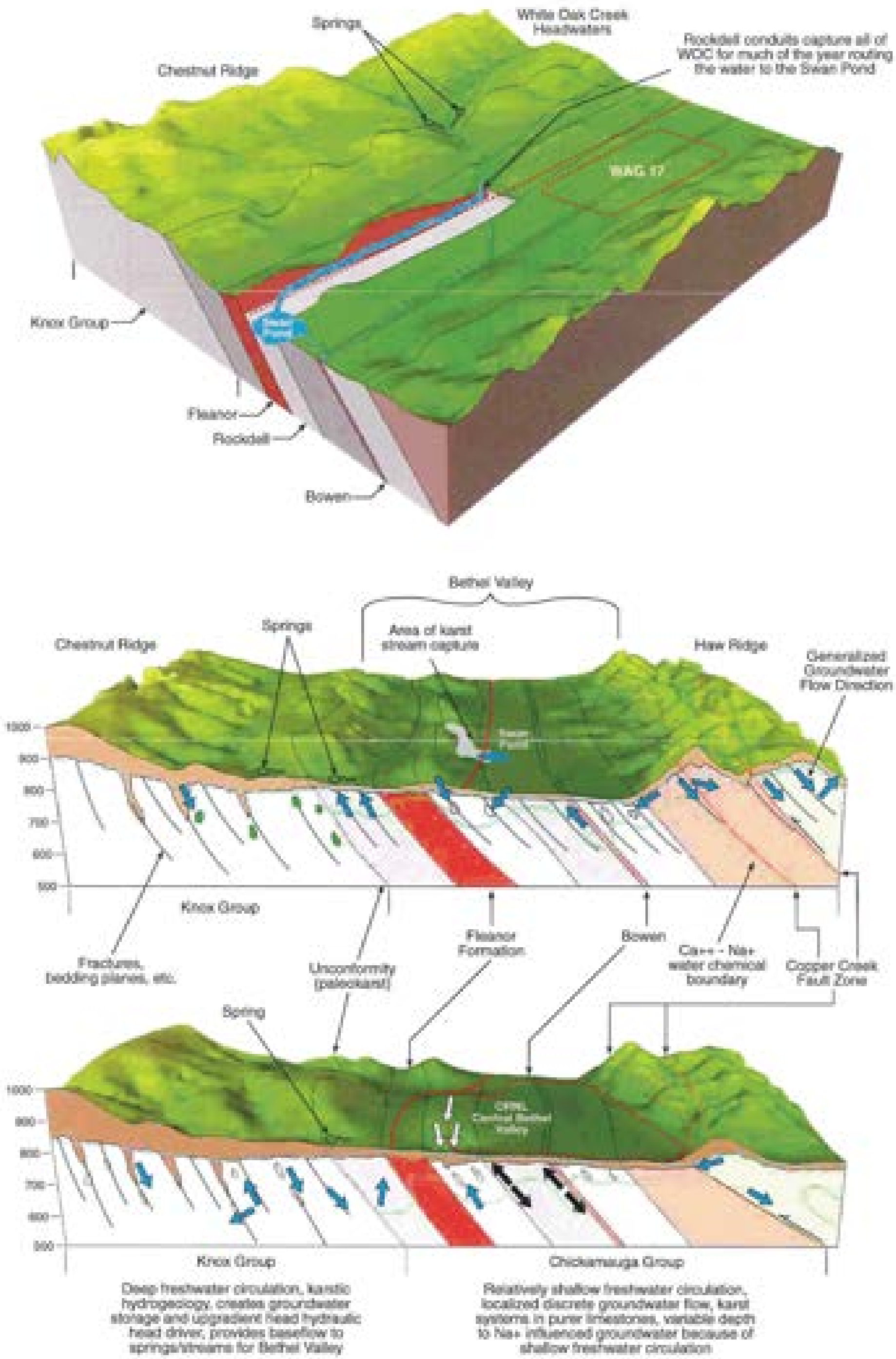


Figure 2.3.1-31. (Sheet 14 of 14) Hydrograph of OW-429 Well Cluster



Source: (Reference 2.3.1-35)

Figure 2.3.1-32. Bethel Valley Flow Conceptualization

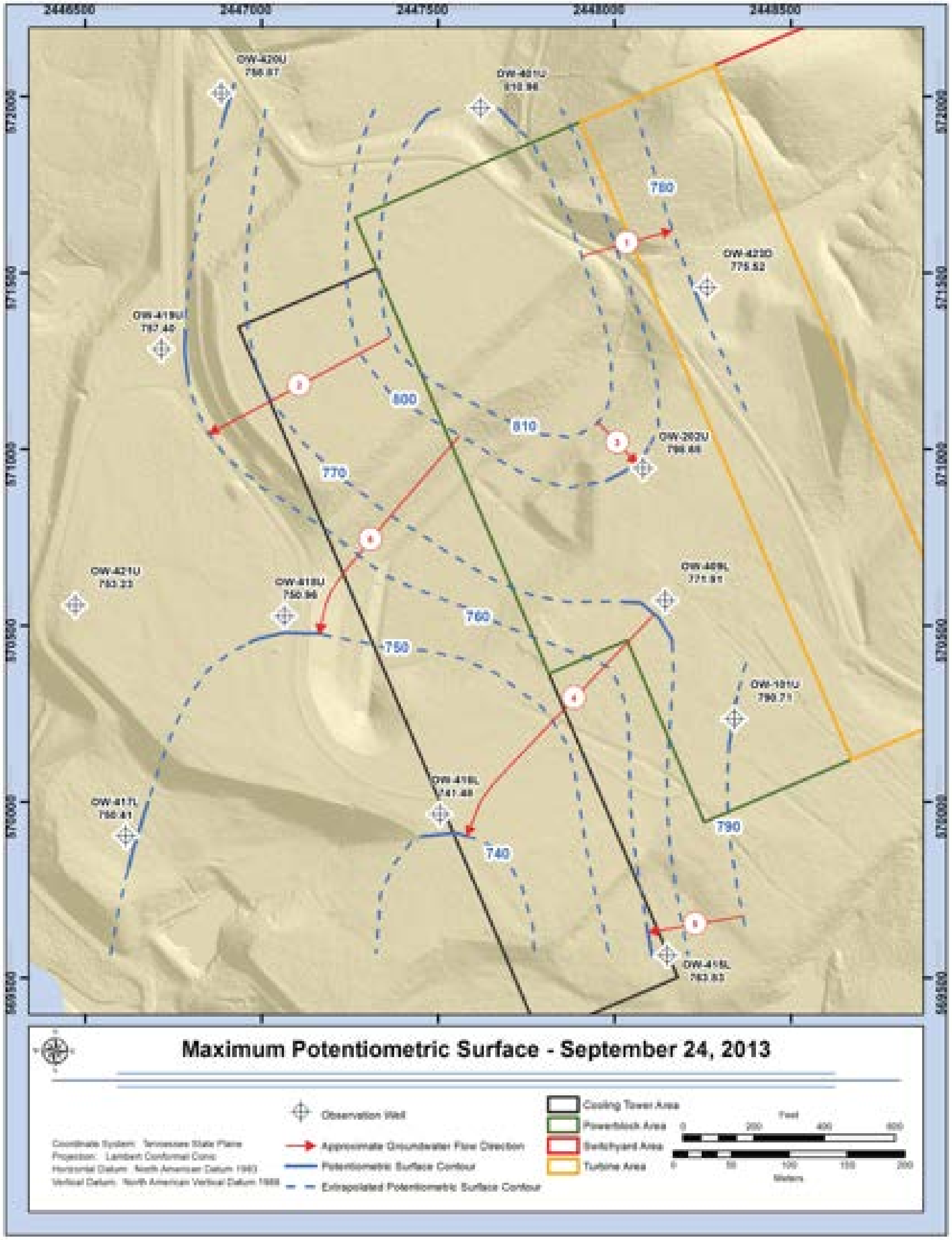


Figure 2.3.1-33. Potentiometric Surface Map for September 24, 2013

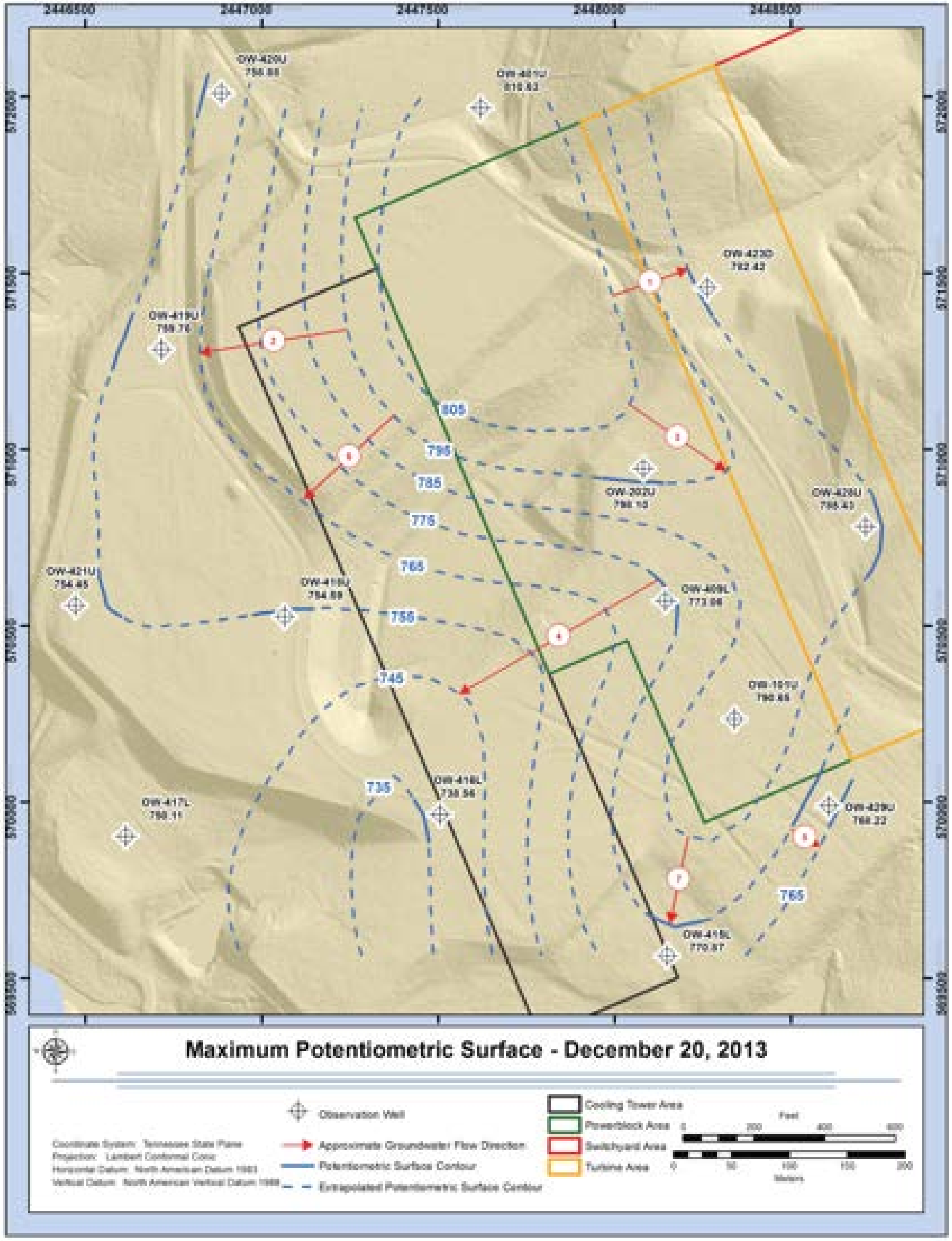


Figure 2.3.1-34. Potentiometric Surface Map for December 20, 2013

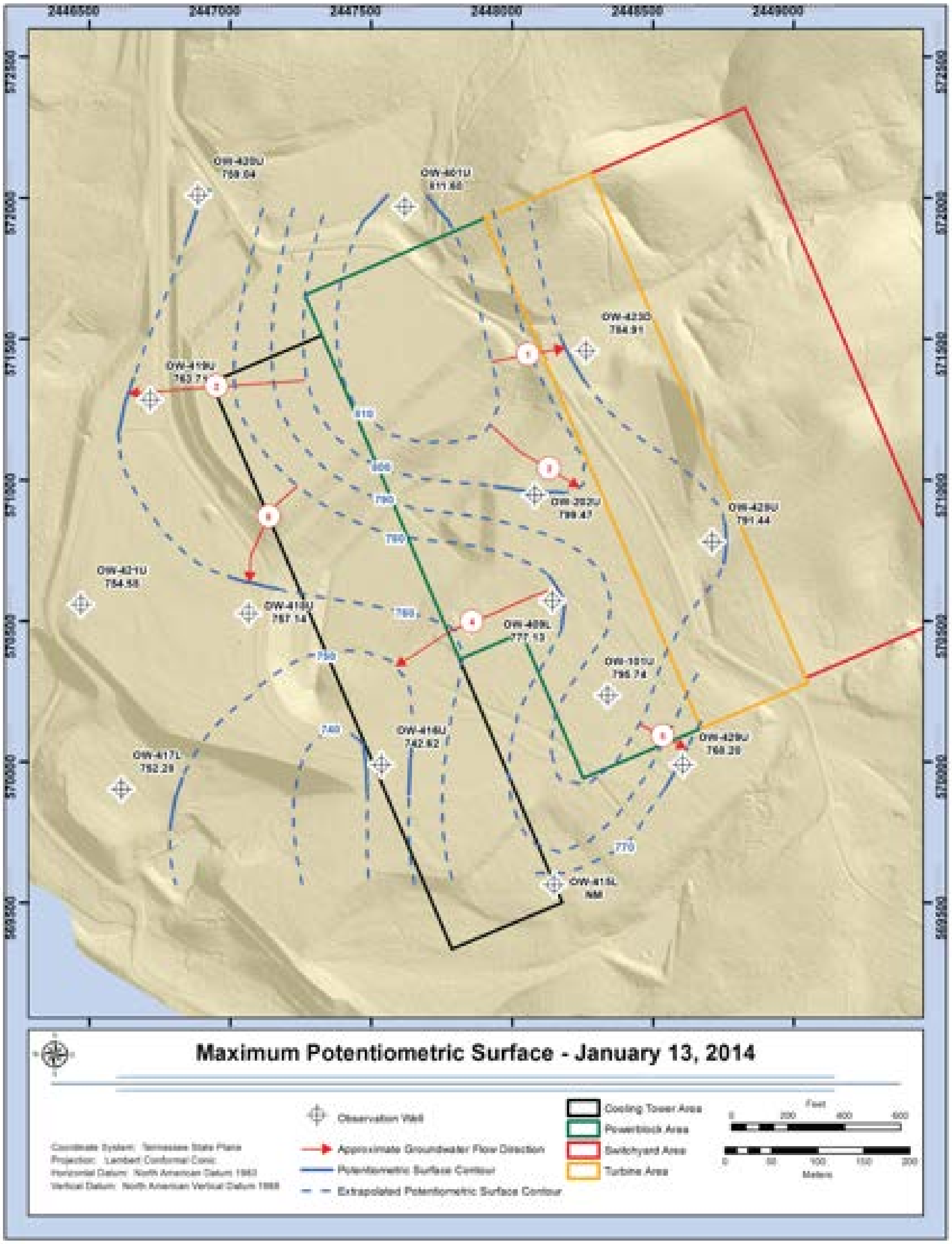


Figure 2.3.1-35. Potentiometric Surface Map for January 13, 2014

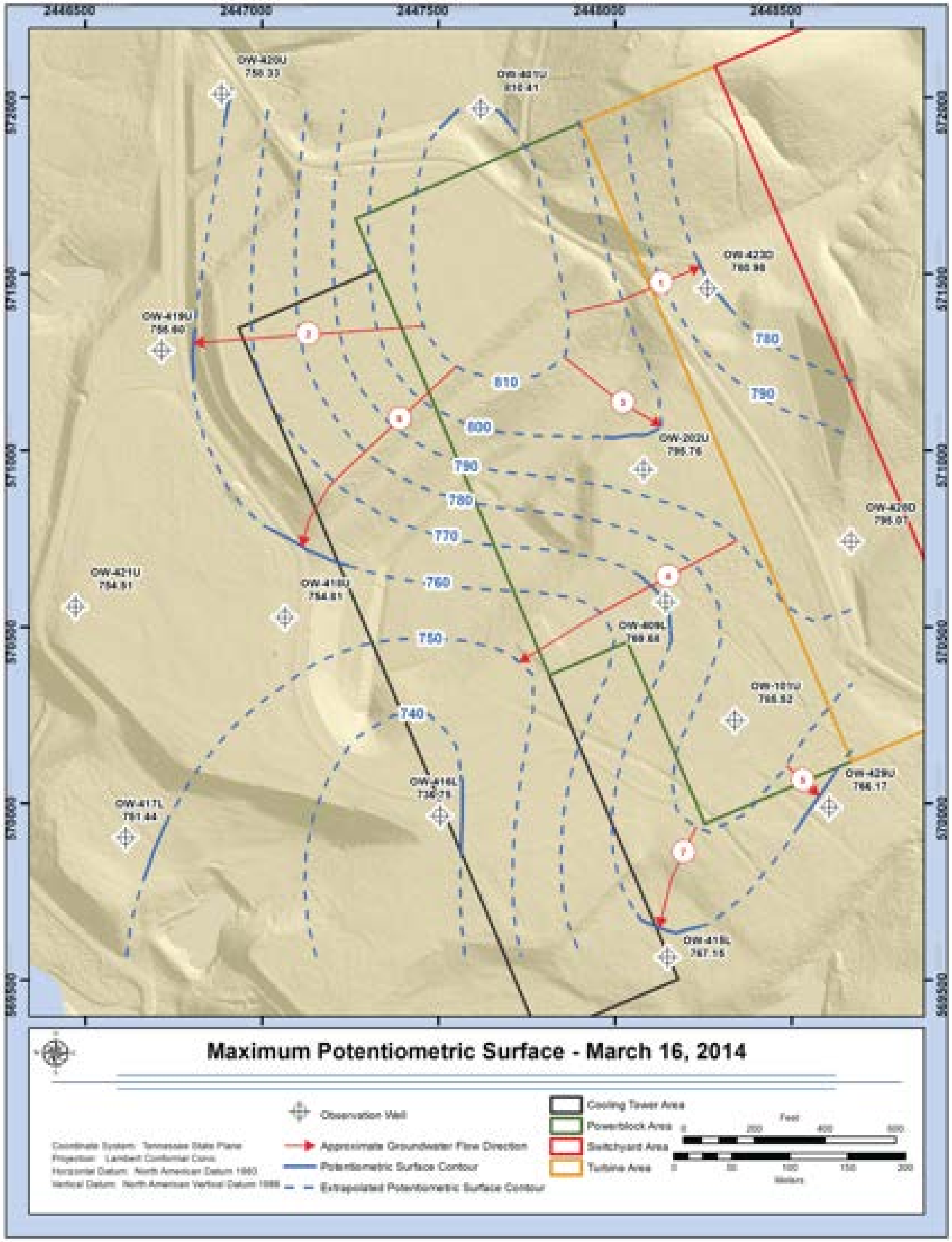


Figure 2.3.1-36. Potentiometric Surface Map for March 16, 2014

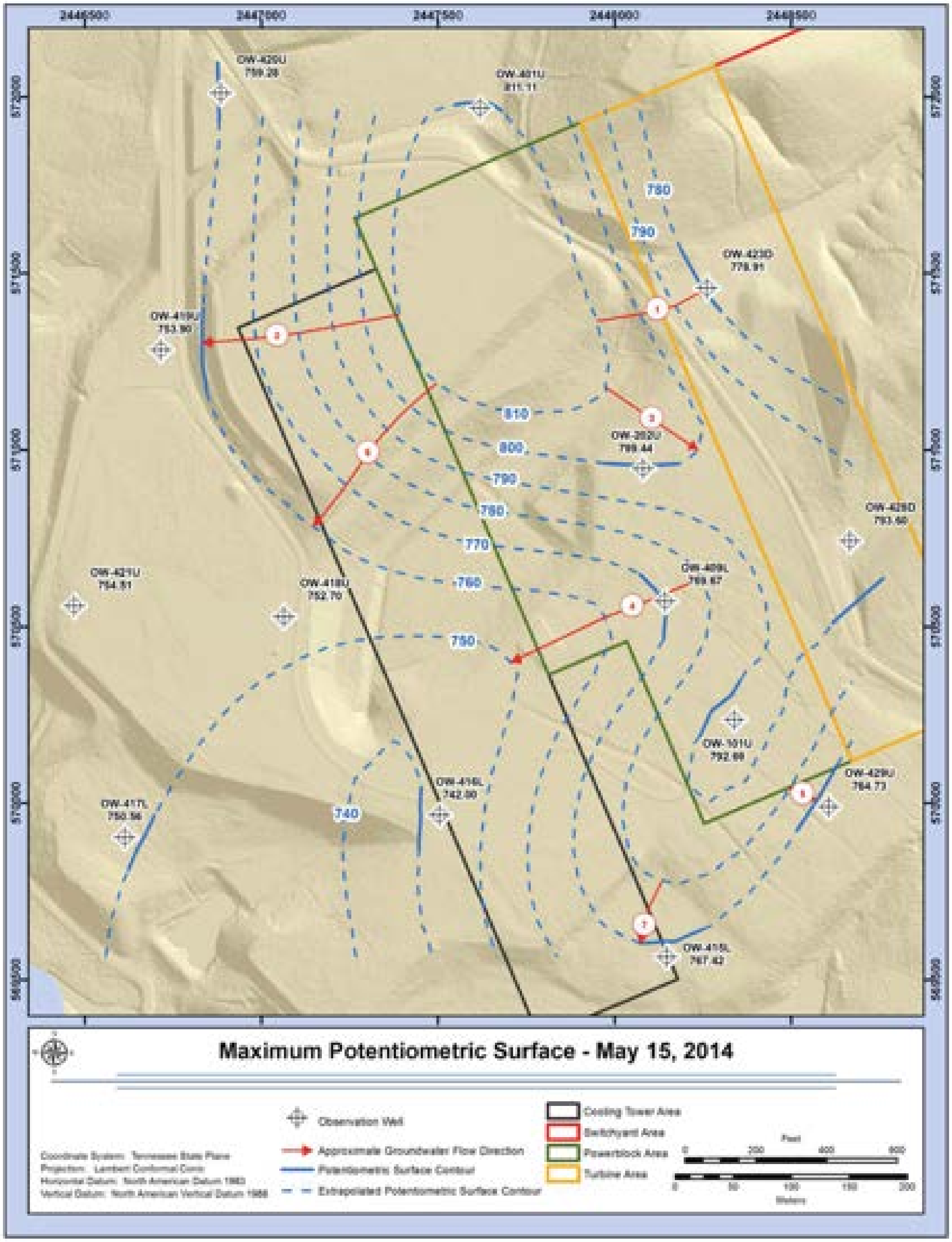


Figure 2.3.1-37. Potentiometric Surface Map for May 15, 2014

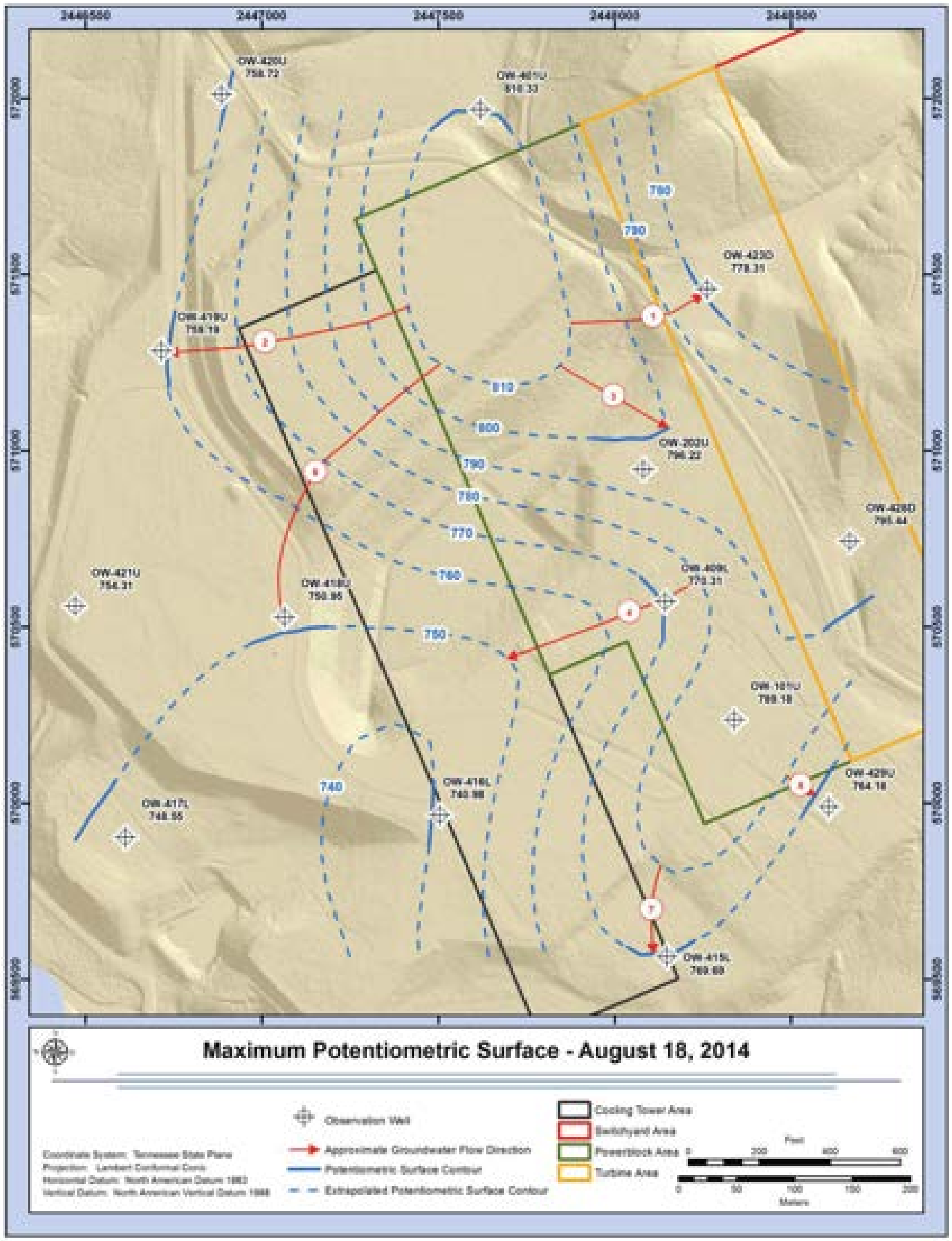


Figure 2.3.1-38. Potentiometric Surface Map for August 18, 2014

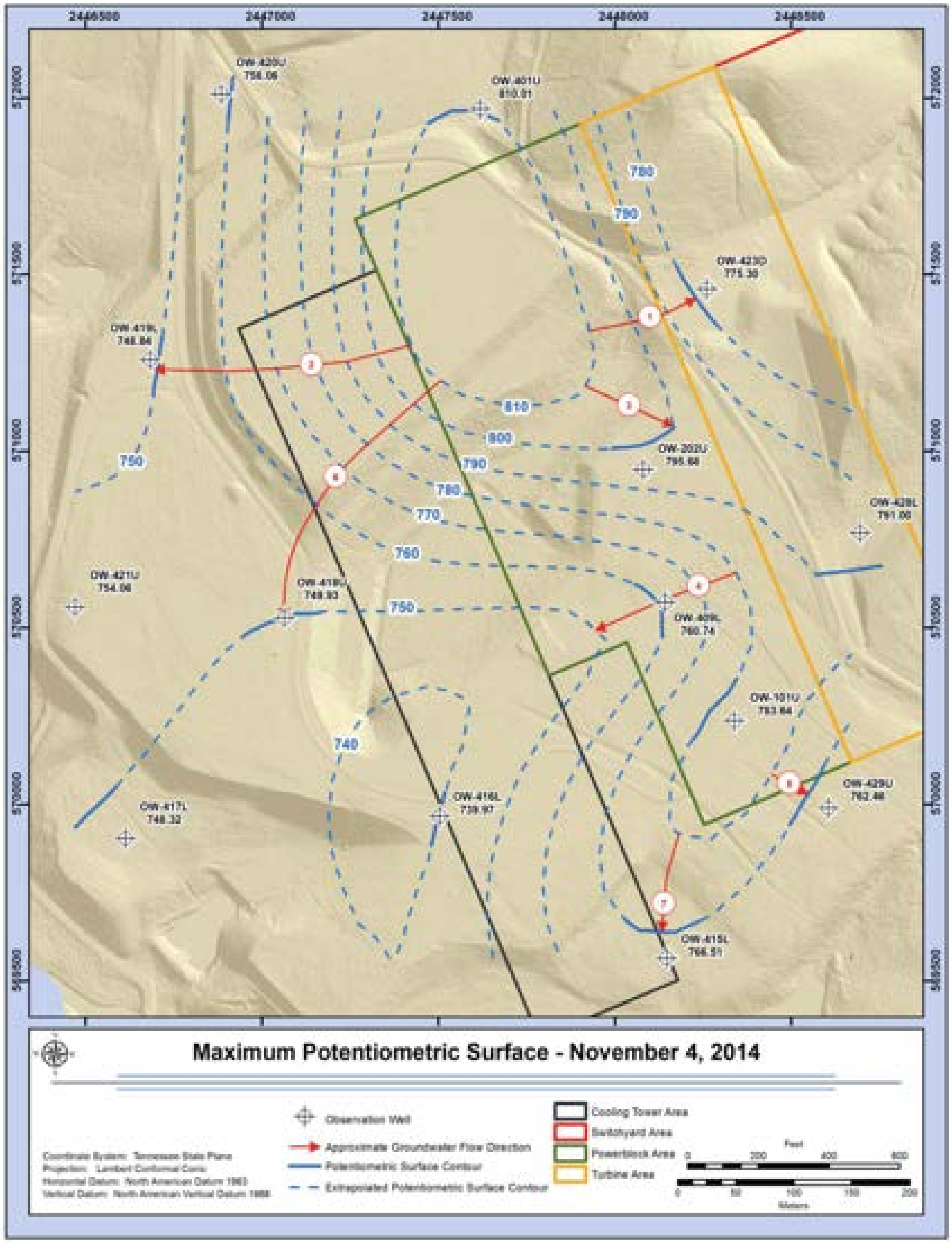


Figure 2.3.1-39. Potentiometric Surface Map for November 4, 2014

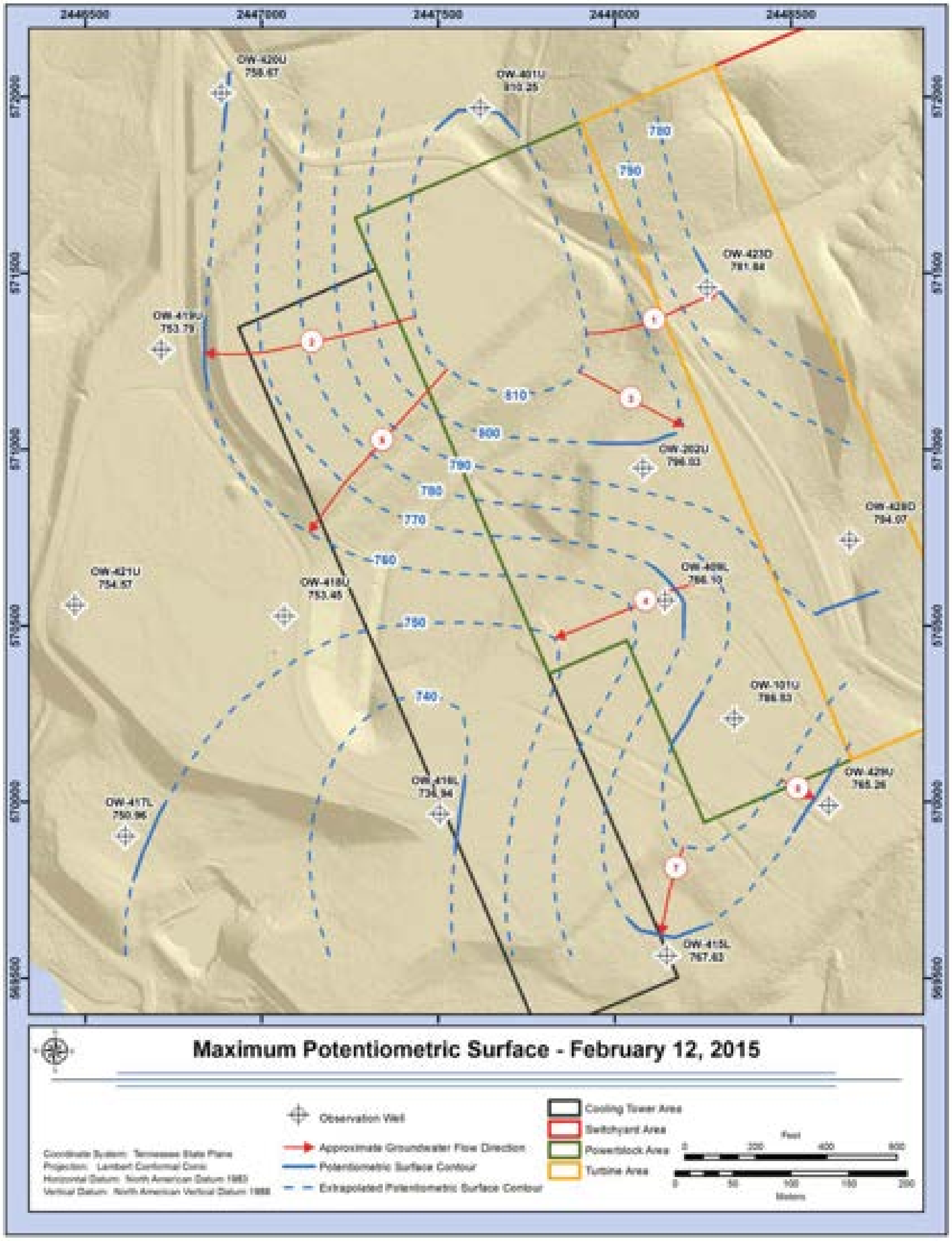


Figure 2.3.1-40. Potentiometric Surface Map for February 12, 2015

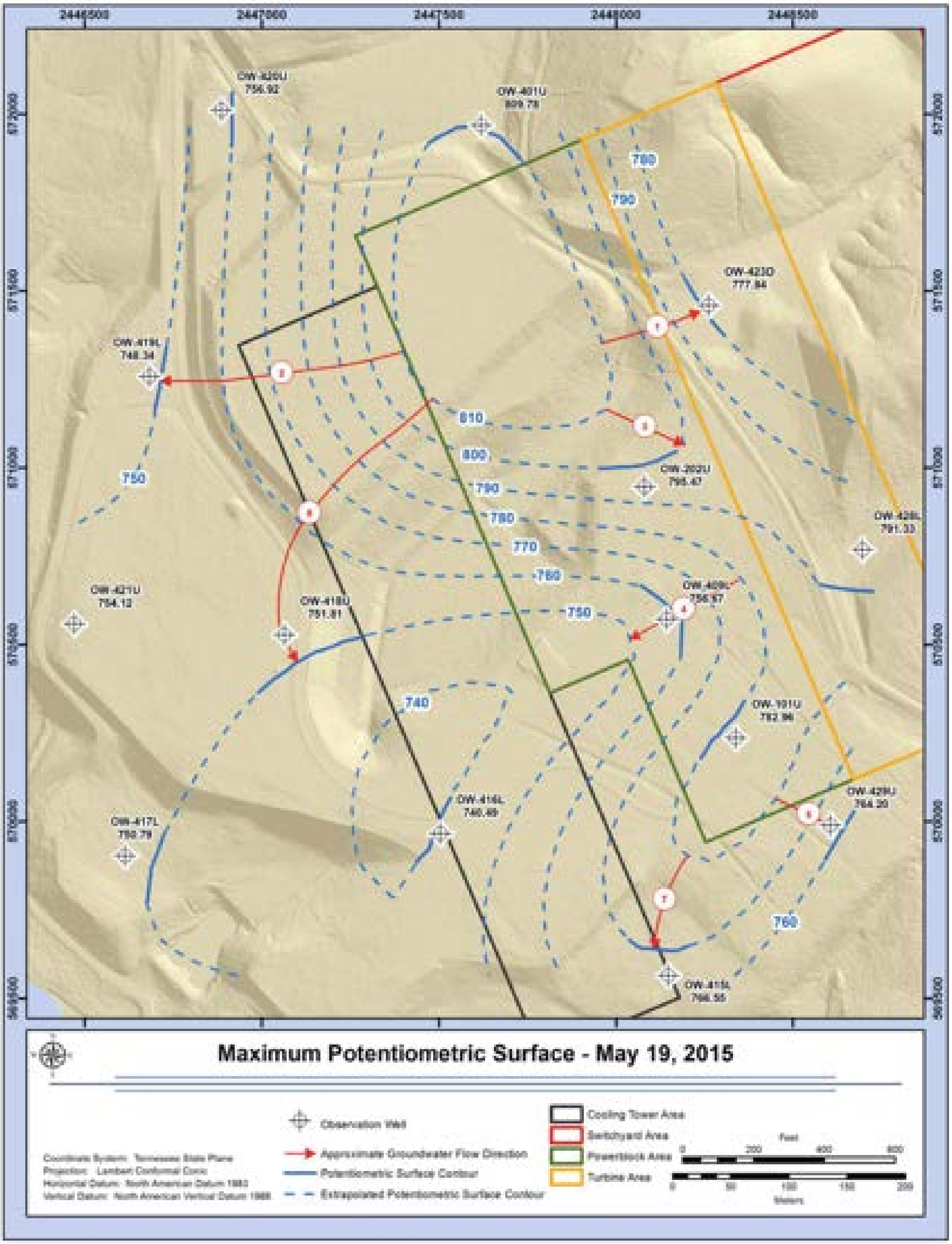


Figure 2.3.1-41. Potentiometric Surface Map for May 19, 2015

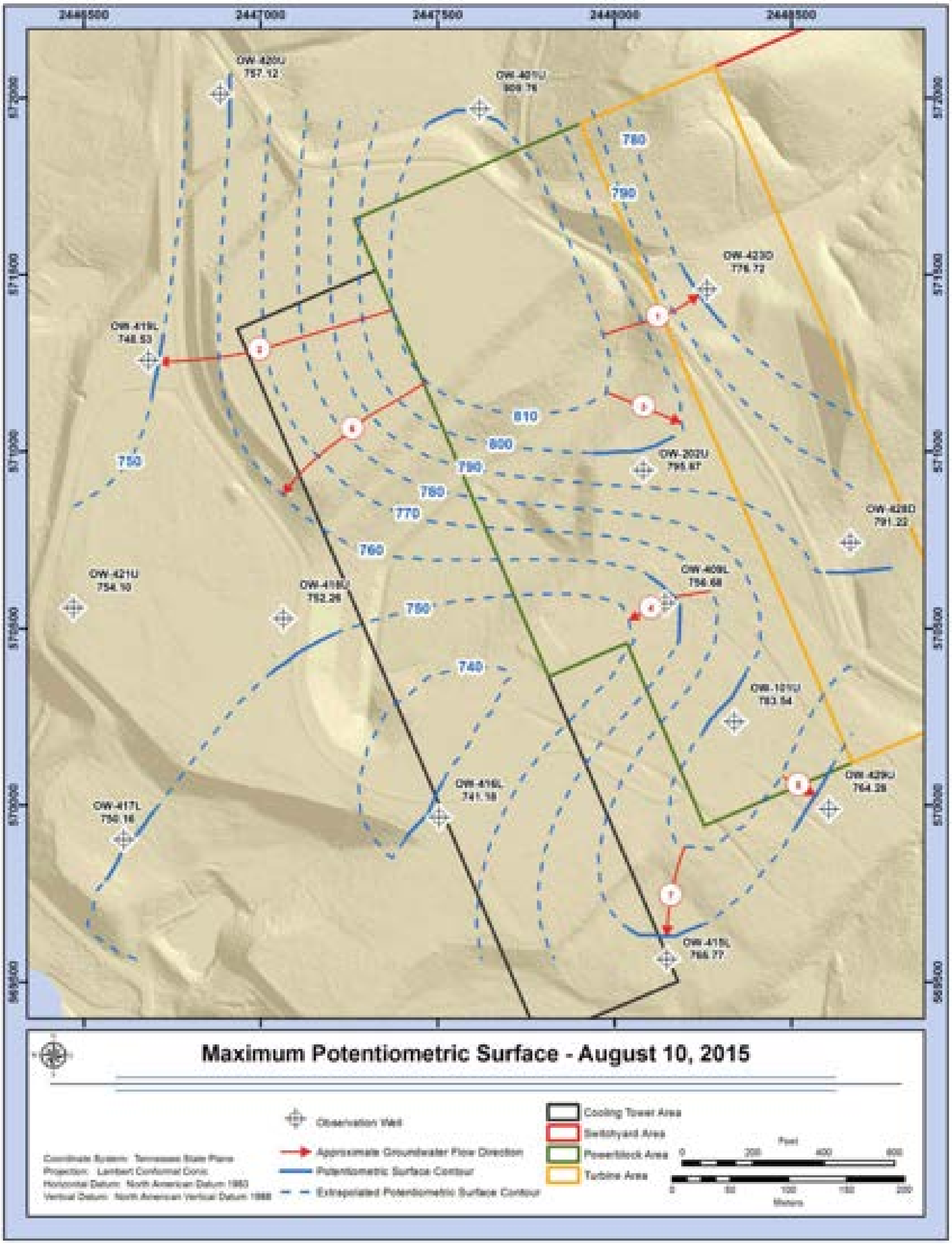


Figure 2.3.1-42. Potentiometric Surface Map for August 10, 2015

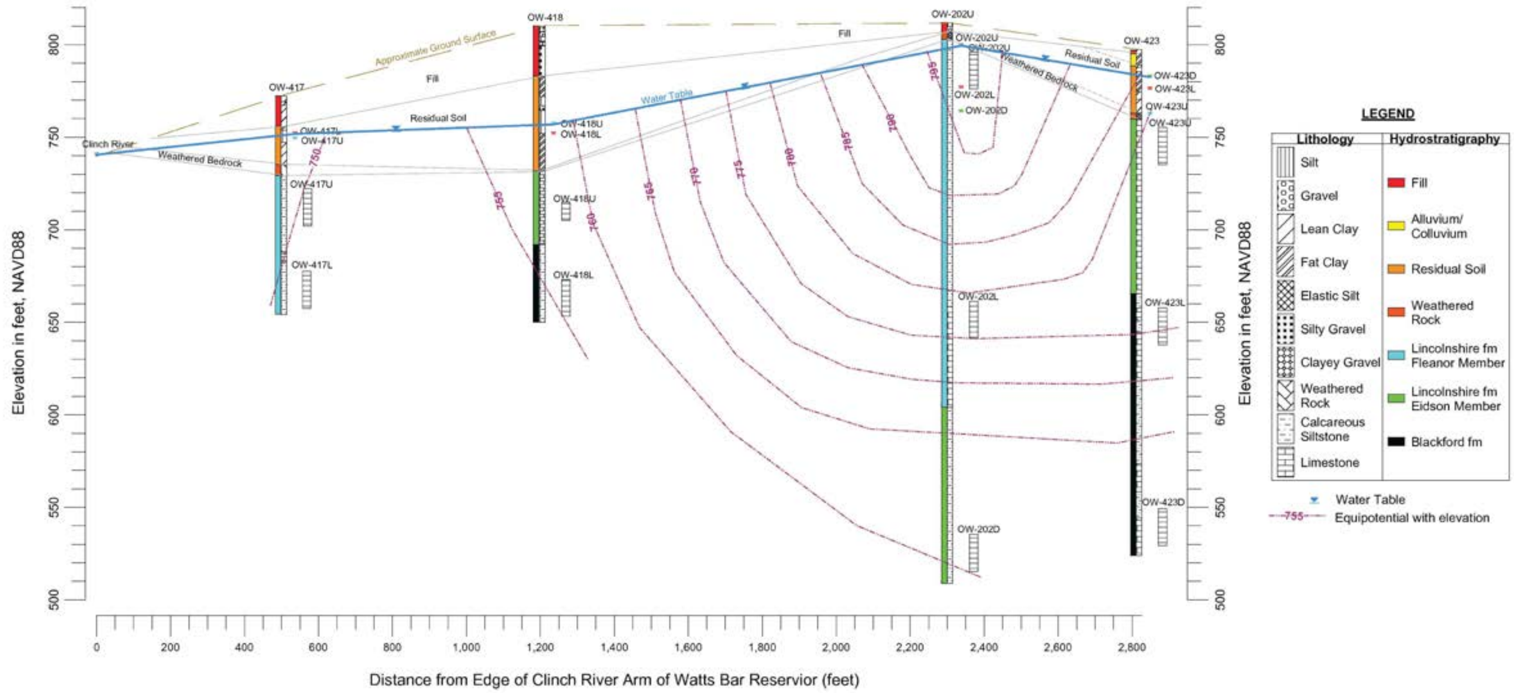


Figure 2.3.1-43. Snapshot in Time Showing Equipotential Lines in the Vertical Plane Along the Strike of the Bedding Plane on June 13, 2014

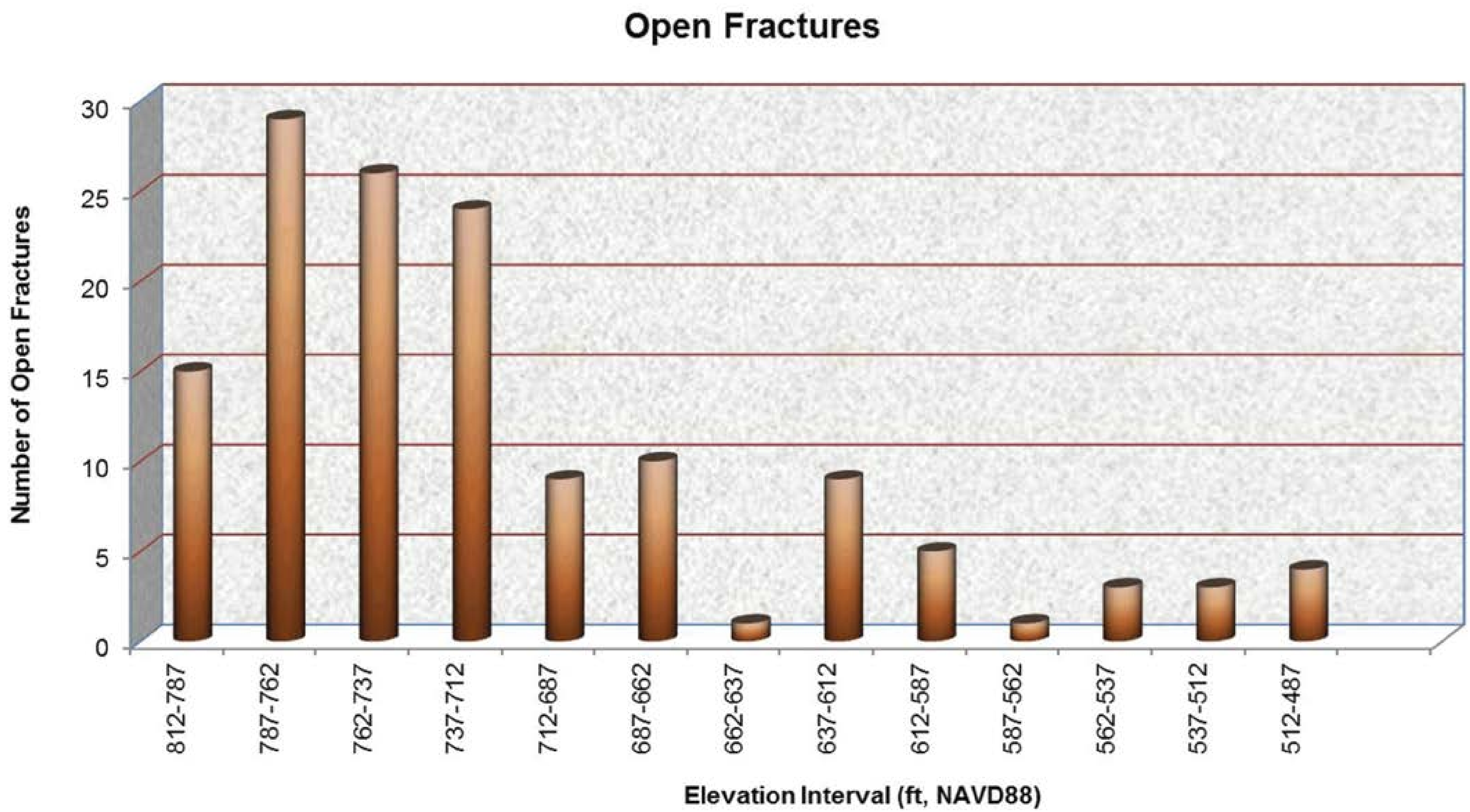
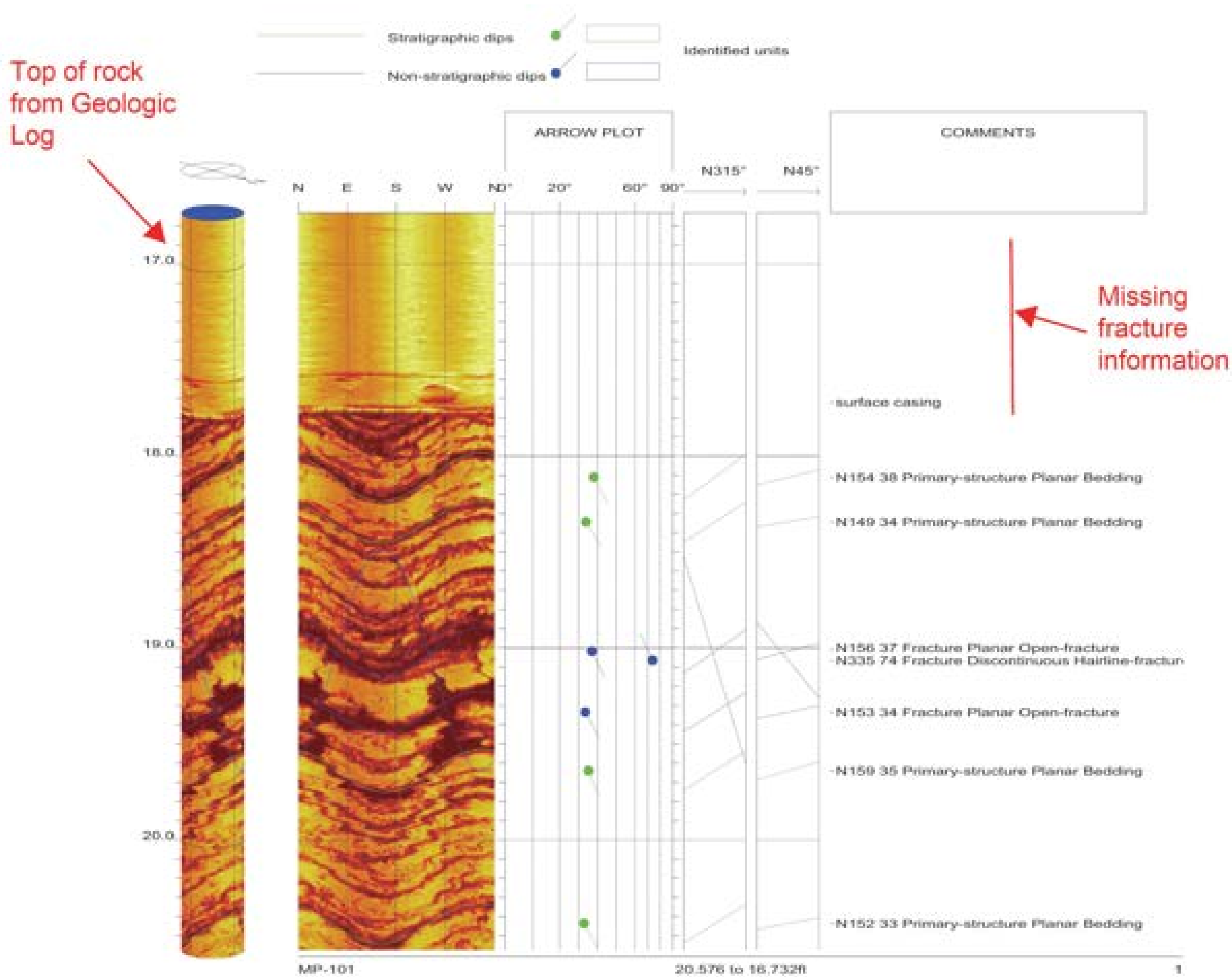
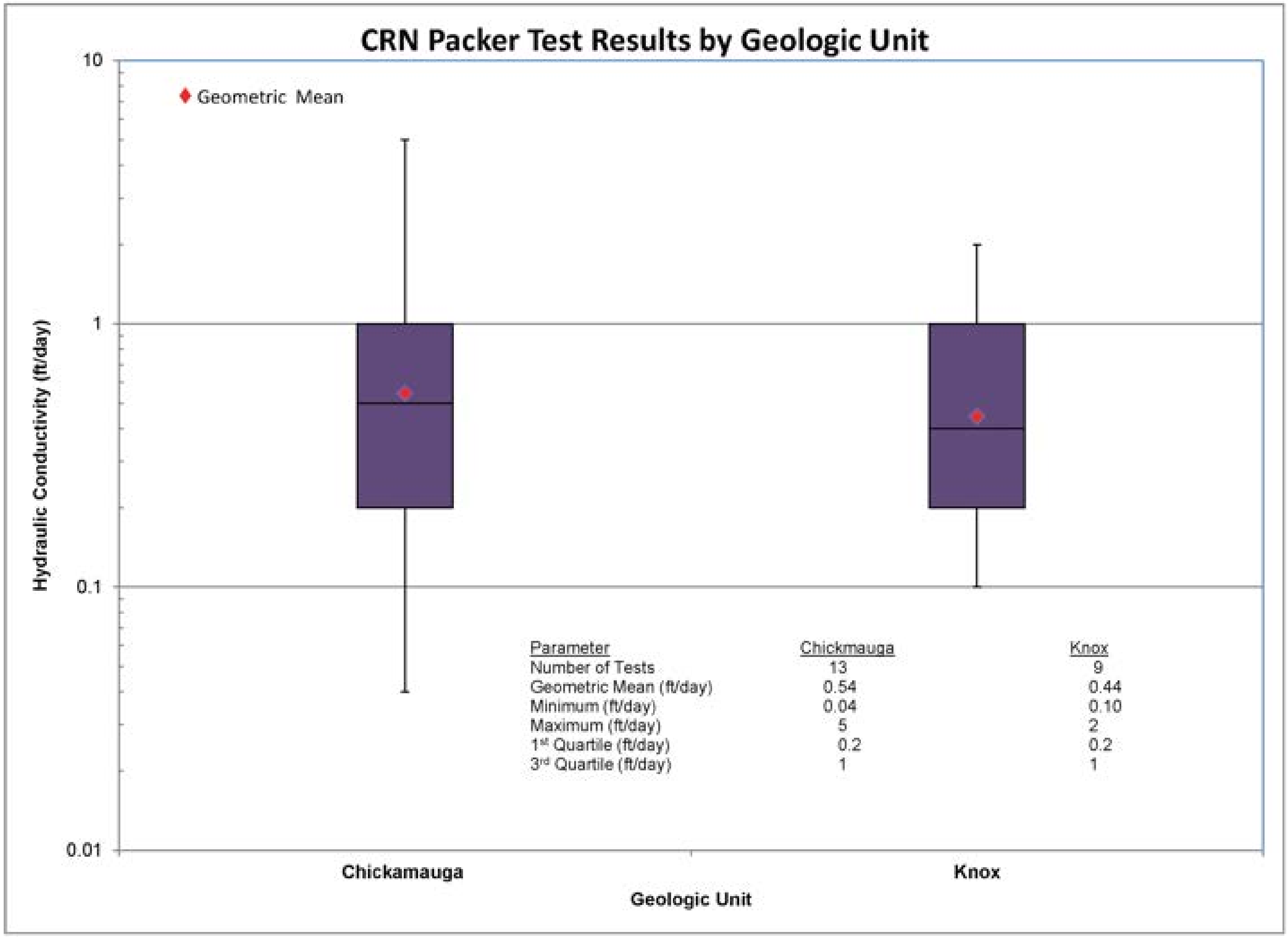


Figure 2.3.1-44. Fracture Frequency Histogram



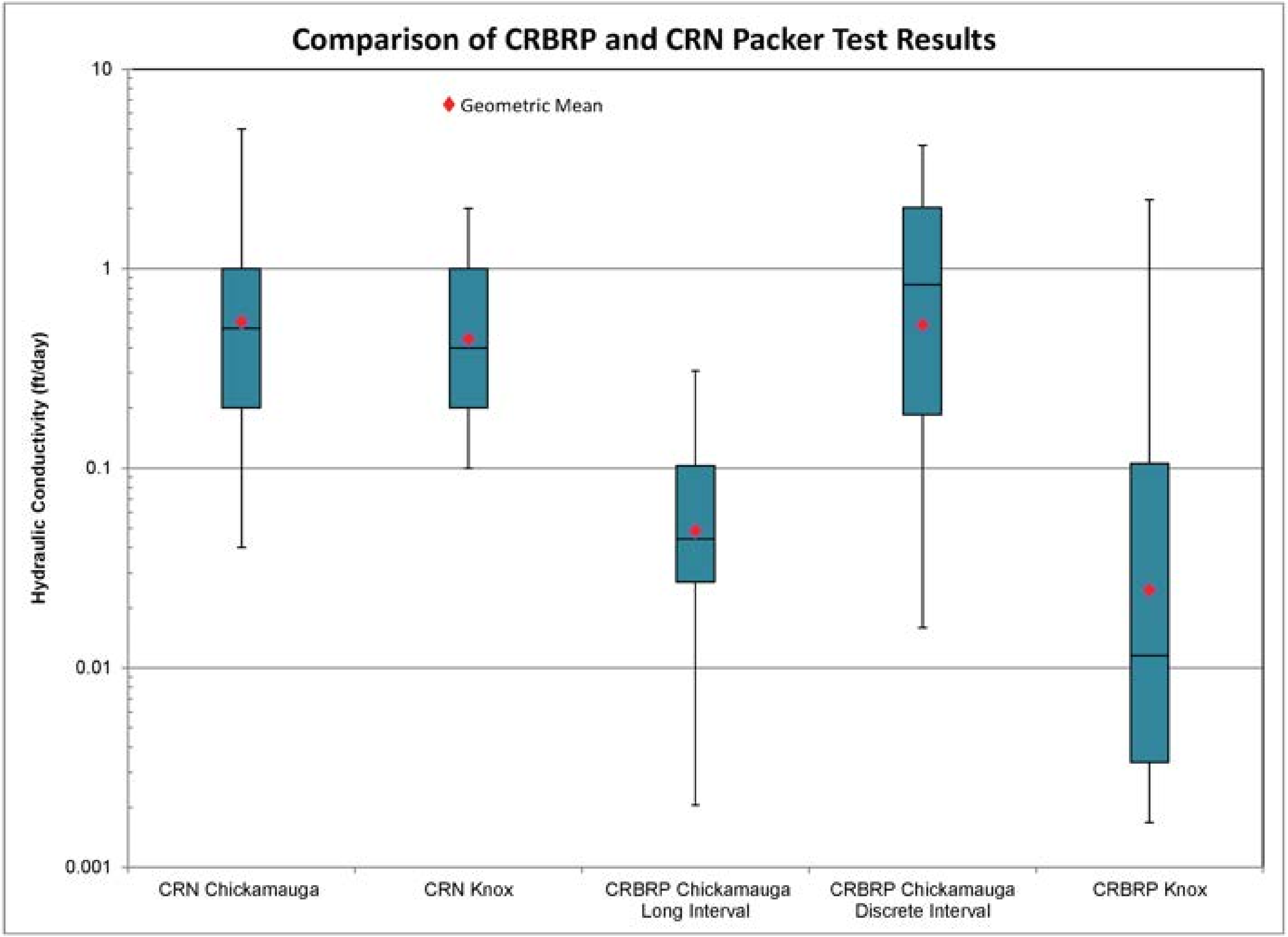
Adapted from: (Reference 2.3.1-21)

Figure 2.3.1-45. Example Acoustic Televiewer Geophysical Log



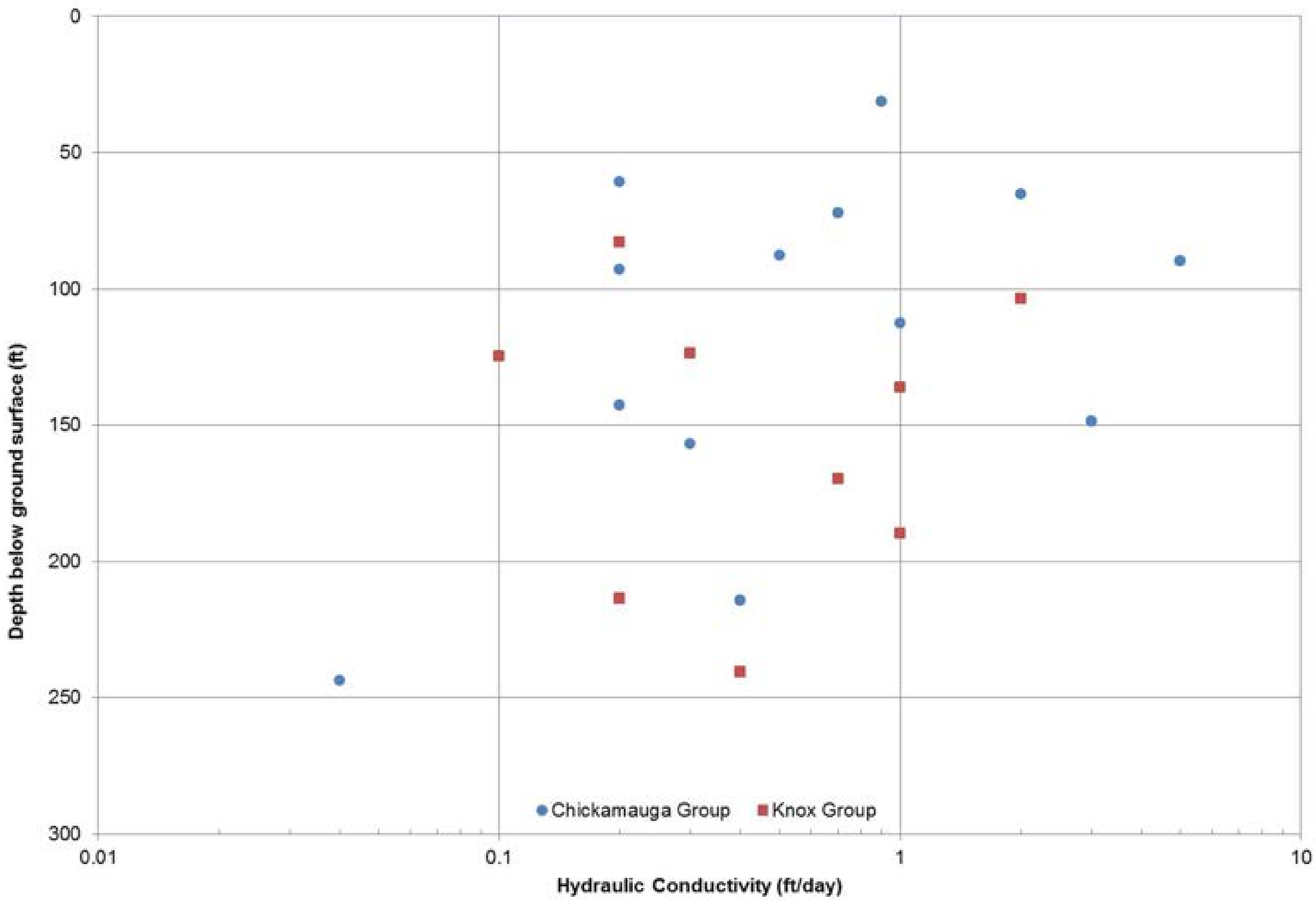
a) Box and whisker plot of CRN packer test results by geologic unit. Data from Table 2.3.1-5 and Appendix 2.3-B

Figure 2.3.1-46. (Sheet 1 of 2) Clinch River Nuclear Borehole Packer Test Results Box and Whisker Plots



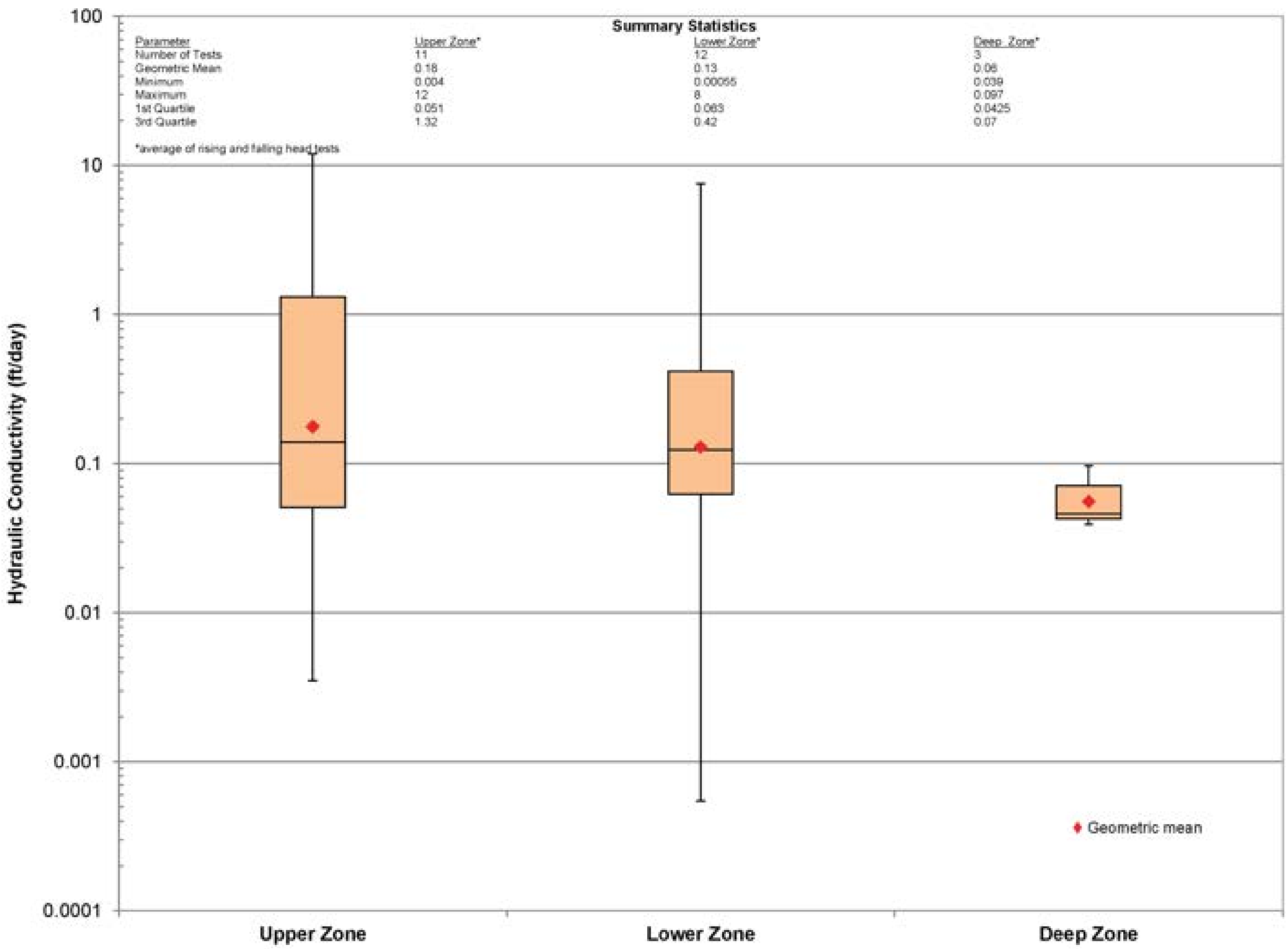
b) Box and whisker plot comparing CRN packer test results with CRBRP packer test results. Data from Table 2.3.1-5 and Appendix 2.3-B

Figure 2.3.1-46. (Sheet 2 of 2) Clinch River Nuclear Borehole Packer Test Results Box and Whisker Plots



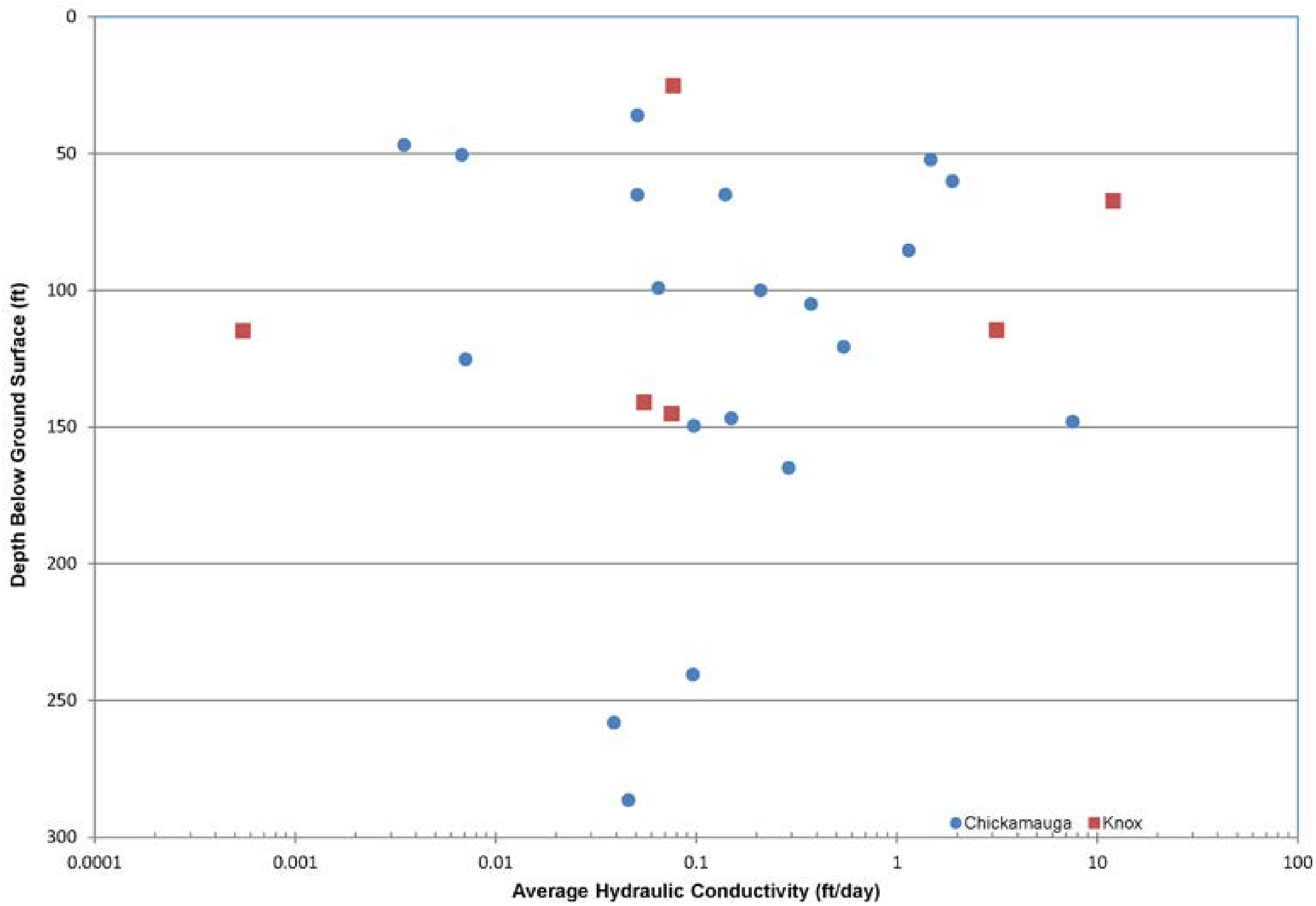
Data from Table 2.3.1-5

Figure 2.3.1-47. Scatter Plot of Clinch River Nuclear Packer Test Hydraulic Conductivity Results with Depth



a) Box and whisker plot of slug test hydraulic conductivity by observation well monitoring zone. Data from Table 2.3.1-6

Figure 2.3.1-48. (Sheet 1 of 2) Slug Test Results for CRN Site



b) Scatter plot of slug test hydraulic conductivity with depth below ground surface. Data from Table 2.3.1-6

Figure 2.3.1-48. (Sheet 2 of 2) Slug Test Results for CRN Site

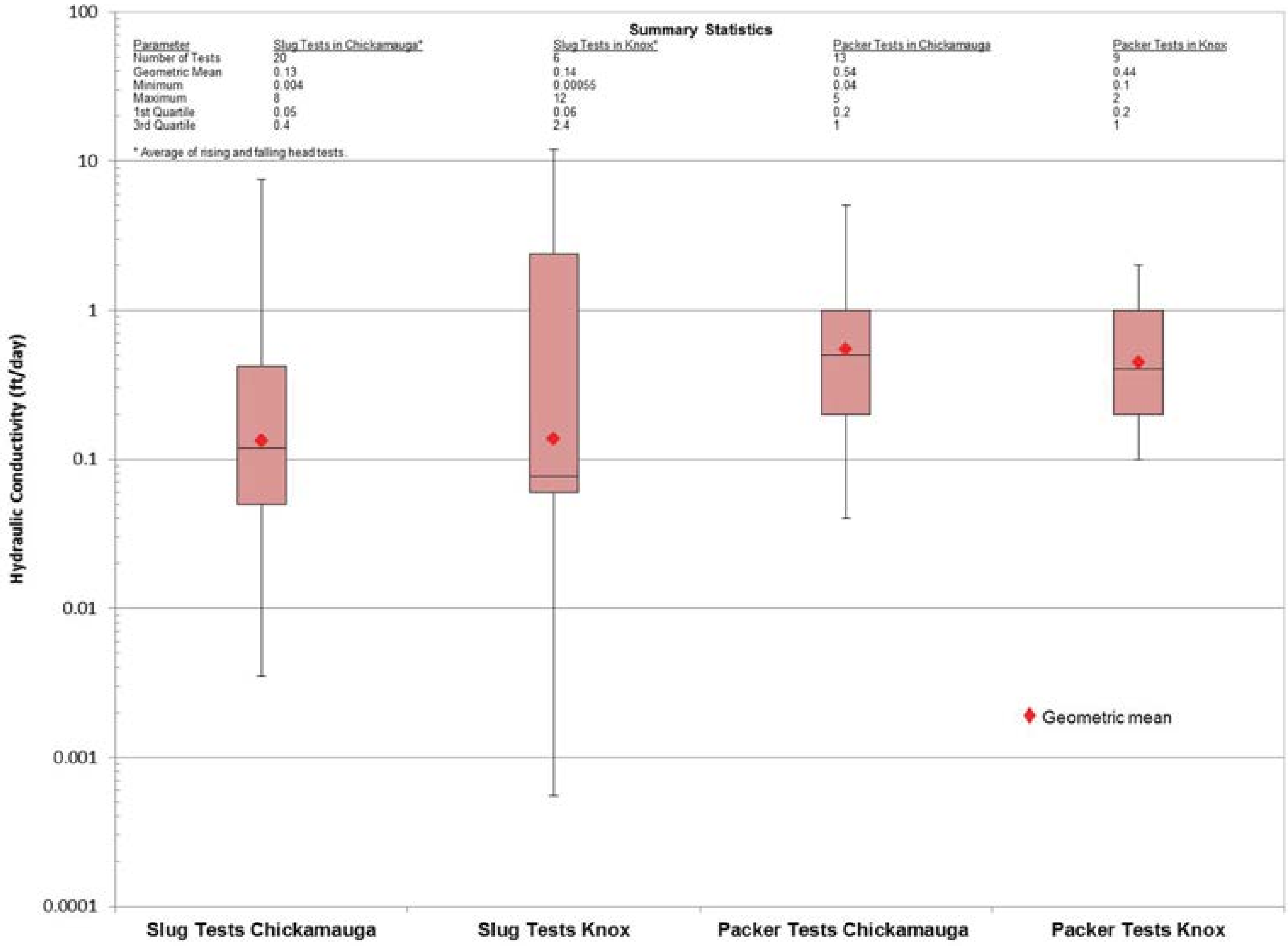


Figure 2.3.1-49. Comparison of Slug and Packer Test Results

2.3.2 Water Use

This subsection describes surface water and groundwater uses in the vicinity of the Clinch River Nuclear (CRN) Site which can affect or be affected by the construction and operation of two or more small modular reactors (SMRs). Information provided in this subsection includes descriptions of the types of consumptive and non-consumptive water uses, identification of water use withdrawal and discharge locations, and qualification of water withdrawals and returns. In addition, a detailed assessment of local area facility water use is discussed in this subsection.

2.3.2.1 Surface Water

To evaluate surface water availability for the Clinch River (CR) SMR Project, Tennessee Valley Authority (TVA) conducted a Regional Surface Water Use Study (Reference 2.3.2-1).

2.3.2.1.1 Basin-wide Surface Water Use

Total surface water withdrawals for the Tennessee River watershed during 2010 were estimated to average 11,747 million gallons per day (mgd). The return flow was estimated to be 11,480 mgd, which represents 96.1 percent of the water withdrawn. The net water demand, which is the difference between the withdrawals and the returns, is a measure of consumptive use. Consumptive use is water that evaporates, transpires, or is consumed by humans, livestock, or crops. The net water demand in 2010 was 471 mgd, or 3.9 percent of the total withdrawals. (Reference 2.3.2-1)

Of the 11,747 mgd of surface water withdrawn from the Tennessee River system in 2010, thermoelectric power withdrawals were an estimated 10,046 mgd; industrial withdrawals were 1116 mgd; public supply withdrawals were 558 mgd; and irrigation withdrawals were 27 mgd. (Reference 2.3.2-1)

In 2010, net water demand was 52 mgd for thermoelectric, 75 mgd for industrial, 310 mgd for public supply, and 34 mgd for irrigation. By 2035, overall total water withdrawals are projected to decline approximately 21 percent to 9449 mgd. By category, water withdrawals are projected to increase as follows: industrial withdrawals increase 31 percent to 1502 mgd, public supply withdrawals increase 30 percent to 938 mgd, and irrigation withdrawals increase 35 percent to 46 mgd. Thermoelectric water withdrawal is expected to decline 31 percent to 6963 mgd, reflecting a change in both generating and cooling technologies for power plants. (Reference 2.3.2-1)

Table 2.3.2-1 shows historical off-stream water use in the Tennessee River watershed from 1995 to 2010 and projected water use to 2035. Total water use peaked in 2005 and has decreased since then, mostly due to decline in thermoelectric water use. Industrial and irrigation use has changed little from 1995 to 2010, but public supply has increased steadily, closely following population growth.

2.3.2.1.2 Water Use Regulation

The U.S. Environmental Protection Agency (EPA) has promulgated regulations that implement Section 316(b) of the Clean Water Act (CWA) for new and existing electric power producing facilities. Subpart I of Title 40 of the Code of Federal Regulations (40 CFR) Part 125 describes requirements applicable to cooling water intake structures for new facilities. Under the definitions in 40 CFR 125.83, the Watts Bar Reservoir would be considered a lake or reservoir, because it has a residence time greater than 7 days.

The impacts of the cooling water intake structures at the facility are regulated by the Tennessee Department of Environment and Conservation (TDEC), under Section 316(b) of the Federal Water Pollution Control Act (also known as the CWA), through limitations specified in the National Pollutant Discharge Elimination System (NPDES) permit for the facility. These CWA 316(b) requirements seek to protect water quality from the potential adverse impacts of water withdrawals through intake structures. Separately, TDEC implements state water registration requirements to gather information that helps the management of water resources.

2.3.2.1.3 Surface Water Use in the CRN Site Vicinity

For the Regional Surface Water Use Study, TVA’s 2010 Water Use database was queried for the seven-county area surrounding the CRN Site (Reference 2.3.2-1).. The results for water withdrawal are summarized in Table 2.3.2-2. Table 2.3.2-3 contains the individual data records from the query for withdrawals and Figure 2.3.2-1 shows the locations of the withdrawals.

As shown in Table 2.3.2-2, total 2010 withdrawal was 1478.91 mgd. Thermoelectric water use (1366.17 mgd) was by far the highest usage due to withdrawals for Bull Run, Kingston, and Watts Bar power plants. Public supply was the second highest water use (102.62 mgd).

Of the water intakes listed in Table 2.3.2-3, only the Oak Ridge Bear Creek Road facility has a Surface Water Protection Area which includes the CRN Site. Presently, Oak Ridge has plans to close down the Bear Creek Road facility.

TVA’s reservoir operating policy was designed to meet the off-stream water needs of the Tennessee Valley until the year 2030. The forecast of 2030 water needs was based on a water use estimate prepared using year 2000 data. The estimates used to develop the reservoir operating policy were a total withdrawal of 13,990 mgd with a return of 13,010 mgd with a net water demand of 980 mgd. The current watershed projection of water demand for 2035 indicates a total withdrawal of 9449 mgd with a return of 8737 mgd for a net water demand of 712 mgd. (Reference 2.3.2-1)

There is no hydroelectric power generation in the immediate vicinity of the CRN Site; however, the Melton Hill, Watts Bar, and Norris dams include hydroelectric generation plants. Both dams are multipurpose dams with operations that also include maintaining navigation channels, flood control, recreational opportunities, fisheries and aquatic habitat, and water quality. (Reference 2.3.2-2; Reference 2.3.2-3; Reference 2.3.2-4)

The Clinch River arm of Watts Bar Reservoir is host to various recreational activities, including canoeing, kayaking, boating, and fishing (Reference 2.3.2-5). Both commercial and recreational boating are available in the vicinity of the CRN Site. Recreational boat access and fishing opportunities are provided at the area boat ramps and public parks (Reference 2.3.2-6). These recreational activities are discussed in further detail in Subsection 2.5.2.5.

2.3.2.1.4 Surface Water Use for the Proposed SMR

The use of water for the proposed SMR is described in Section 3.3.

2.3.2.2 Groundwater Use

This section contains a description of the historical, current, and projected groundwater use at and in the vicinity of the CRN Site. Sole source aquifers within the region are also identified and discussed.

As discussed in Subsection 2.3.1.2.1.2, the principal aquifers in the Valley and Ridge Province consist of the carbonate rocks. Other types of rocks in the province can yield large quantities of water to wells where they are fractured, contain solution openings, or are directly hydraulically connected to sources of recharge (Reference 2.3.2-7).

Well yields in the Valley and Ridge Province vary from 1 to 2500 gallons per minute (gpm). The largest yields are from wells completed in Ordovician and Cambrian carbonate rocks (e.g., the Knox Group). The median yield of wells completed in the principal aquifers range from about 11 to 350 gpm (Reference 2.3.2-7).

Spring discharges also vary greatly across the Valley and Ridge Province, ranging from about 1 to 5000 gpm, with median discharges from the principal aquifers varying from 20 to 175 gpm. Spring discharges can be highly dependent on rainfall with some springs discharging as much as 10 times more water during high precipitation events as compared to periods of little rainfall (Reference 2.3.2-7). Wet-weather perched water tables and intermittent springs have been noted to occur.

Because surface water is abundant in the region, the EPA’s Sole Source Aquifer Program has not identified any sole source aquifers in Tennessee (Subsection 2.3.1.2). A sole-source aquifer is defined as the sole or principal source of drinking water that supplies 50 percent or more of drinking water for an area, with no reasonable available alternative sources should the aquifer becomes contaminated. The identified sole-source aquifers in EPA Region 4 are beyond the boundaries of the local and regional hydrogeologic systems associated with the CRN Site. Therefore, the CRN Site will not impact any identified sole-source aquifer.

2.3.2.2.1 Historical Groundwater Use

In support of the CRBRP licensing activities at the CRN Site, TVA conducted a survey (completed in June 1973) to locate wells and springs within a two-mile radius of the site (Reference 2.3.2-8). The TVA survey reported that 110 wells and springs were located within two miles of the CRN Site. All of the wells were located across the Clinch River from the site, and nearly all of the wells inspected were small domestic wells of limited capacity (Reference 2.3.2-8). Reported well flow rates were generally less than 10 gpm, and reported well depths ranged from approximately 20 to 700 feet (ft) below ground. The study concluded that due to the abundance of surface water supplies and the relatively low yield of bedrock aquifers in the area, future groundwater use is unlikely to be significantly different than the present groundwater use. Publicly available data regarding current and projected future residential well/spring use were not found at this time.

Water use in the Tennessee River Valley, which includes the Clinch River watershed, has been estimated for the years 2000, 2005, and 2010 (Reference 2.3.2-9; Reference 2.3.2-10; Reference 2.3.2-11). These reports tabulate water use on a variety of scales and serve as the primary basis for the estimation of present water use in the area of the CRN Site.

To characterize groundwater use in the area surrounding the site, data from these reports were totaled for Anderson, Knox, Loudon, Morgan, and Roane Counties (henceforth referred to as the “groundwater study area”). The CRN Site is located in northeast Roane County, while nearby population centers, including the cities of Oak Ridge and Knoxville, lie in the surrounding counties. Figure 2.3.2-2 shows the location of the site and the five counties that comprise the groundwater study area for water use characterization.

Surface water is the predominant source of water for all uses in the Tennessee Valley, accounting for 98.3 percent of total withdrawals in 2010 (Reference 2.3.2-11). Groundwater provided the remaining 1.7 percent, or about 205 mgd of withdrawals in the Tennessee Valley. In the groundwater study area, surface water accounted for 99.7 percent of total withdrawals in 2010.

In the Tennessee Valley, thermoelectric power generation uses water exclusively from surface water withdrawals and is the dominant use category in the Tennessee Valley, as well as in the groundwater study area. Water withdrawals in 2010 for use categories (i.e., industrial, public supply and irrigation) other than thermoelectric power generation, were 97 percent from surface water and 3 percent from groundwater in the study area (Reference 2.3.2-11).

In the groundwater study area, total groundwater withdrawals for 2010 were 3.5 mgd, up from 3.3 mgd in 2005 (Reference 2.3.2-11; Reference 2.3.2-10). This also reflects a decrease in groundwater withdrawals relative to the estimates of withdrawals for 1985, which indicated withdrawals of at least 5 mgd (Reference 2.3.2-7). Table 2.3.2-4 presents groundwater withdrawals for the five counties in the groundwater study area for 2000, 2005, and 2010 by category (industrial, public supply, and irrigation); total withdrawals by category are shown in

Figure 2.3.2-3. The largest category of use for groundwater withdrawals for the groundwater study area in 2010 was public water supply (66 percent), followed by industrial use (33 percent) and irrigation (less than 1 percent) (Reference 2.3.2-11).

As shown in Figure 2.3.2-3, there has been an increase in industrial use of groundwater and a decrease in groundwater use for public supply since 2000. These changes have primarily occurred in Knox County, which increased industrial use from 0.13 mgd to 1.13 mgd from 2000 to 2010 while reducing the use of groundwater as a source of public supply (Table 2.3.2-4). Only Roane County has seen an increase in reported groundwater withdrawals since 2000, almost exclusively for public supply. No groundwater withdrawals were reported for Morgan County.

2.3.2.2.2 Current Groundwater Use

The EPA’s Safe Drinking Water Information System (SDWIS) database was queried for the five counties in the groundwater study area to identify public drinking water systems that utilize groundwater for supply. The database query was performed in July of 2013 and classifies water systems into three categories:

- Community water systems, which serve the same people year round (e.g., homes)
- Non-transient non-community water systems, which serve the same people but not year round (e.g., schools that have their own water supply)
- Transient non-community water systems, which do not consistently serve the same people (e.g., rest stops, campgrounds) (Reference 2.3.2-12)

The SDWIS query includes the water system name, county, population served, and system category and the results are summarized in Table 2.3.2-5.

Three community water systems in the groundwater study area were identified that use groundwater as the primary source of supply (Table 2.3.2-5). The town of Norris, Tennessee, located about 40 mi northeast of the CRN Site in Anderson County, serves the largest population of the three systems, while Johnson University, located east of Knoxville and Creekside Mobile Homes in Loudon County serve the next two larger populations. Two water systems were classified as non-transient non-community water systems that rely on groundwater, both of which appear to be industrial users in Knox County. Four transient non-community systems were identified, consisting of two campgrounds, a marina, and a yacht club.

TVA has identified additional groundwater users that were not included in the results obtained from queries in SDWIS. These are also provided in Table 2.3.2-5.

TDEC produced a source water assessment report in 2003, which was submitted to the EPA in compliance with the 1996 Safe Drinking Water Acts Amendments. Appendix A of the assessment report lists water systems and sources by county. (Reference 2.3.2-13) This list indicates whether a water system uses multiple sources of water as opposed to the SDWIS database, which only reports the primary water source. However, TDEC does not indicate in what proportion the water sources are used (Reference 2.3.2-13). The community water systems that use groundwater (as of 2003) via wells or springs for at least part of their water supply are listed in Table 2.3.2-6. Groundwater intakes near the CRN Site are shown in Figure 2.3.2-4.

A later report by TDEC published in 2009 assesses Tennessee drinking water sources and potential threats to drinking water quality and quantity (Reference 2.3.2-14). The report states that a recent drought impacted 30 groundwater systems throughout the state, including the Oliver Springs Water Board in Roane County. The town of Oliver Springs is located approximately 2 mi northwest of Oak Ridge, Tennessee, and utilizes Bacon Spring for a portion of its water supply (Reference 2.3.2-14).

The report also notes the complicated geology of Middle and East Tennessee (karst, faulting, etc.) and urges additional assessment of groundwater resources in the state.

Information pertaining to individual wells in the vicinity of the CRN Site was obtained from the Tennessee Department of Environment and Conservation (TDEC), Division of Water Resources, Drinking Water Unit. This information was derived from water well driller reports submitted to TDEC following completion of water well drilling. Such reports include well location by either latitude and longitude or street address, date completed, static level, total depth, estimated yield, proposed use of well, casing depth, and finish type (i.e., open hole or screened). Figure 2.3.2-5 shows the location of individual wells within a 1.5-mile radius of the CRN Site, all of which are located in Roane County. Table 2.3.2-7 lists for each well the proposed use, estimated yield, total depth, casing depth, expected geologic unit in which the wells are located, and finish type. There are 32 residential wells, three commercial wells, and one farm well for a total of 36 individual wells. Estimated well yields range from 0.5 to 75 gallons per minute (three wells had no estimated well yield). Total depths range from 42 to 900 feet below grade, while casing depths range from 20 to 190 feet below grade. Twenty-eight of the wells are finished as open hole wells, while no finish type information was available for the remaining wells. The geologic unit in which wells are completed was inferred from regional geologic mapping, as this information was not available from TDEC. The actual geologic unit(s) from which a well obtains water may differ from what is shown in Table 2.3.2-7, depending on the exact well location and the well and casing depths.

2.3.2.2.3 Projected Groundwater Use

Bohac and Bowen provide general future water use projections through 2035 for the Tennessee Valley. Predictions include a decrease of 21 percent in total withdrawals (surface water and groundwater), mostly due to the retirement of aging power plants. Industrial and public supply water uses are expected to increase by 31 percent and 30 percent, respectively. Groundwater uses may not increase in kind since the vast majority of users in the Tennessee Valley rely on surface water as a primary source. No groundwater-specific projections for water use are available in Bohac and Bowen. (Reference 2.3.2-11)

The current surrogate CRN SMR plant design does not require groundwater as a source for cooling water, potable water, or other plant needs. Makeup water for the closed-cycle cooling system is sourced from the Clinch River arm of Watts Bar Reservoir, while potable and other water comes from the Oak Ridge Department of Public Works. In addition, surface disturbance at the site is not expected to affect the recharge zones for those users shown on Table 2.3.2-6 or for intakes shown on Figure 2.3.2-4.

2.3.2.2.4 CRN Groundwater Use Summary

Groundwater is not a primary source of water in the region as surface water is abundant and provides nearly all of the supply for users in the area. This abundant surface water coupled with relatively low productivity groundwater wells within a two-mile radius of the CRN Site, make it unlikely that significant differences from current usage will occur in the future.

Total groundwater withdrawals in the five counties surrounding the CRN Site have been fairly constant from 2000 to 2010, though the uses have changed and evolved in each county. The leading use of groundwater in the study area is for public supply, followed by industrial use. From 2000 to 2010, industrial use has increased while public supply withdrawals have decreased in the five counties surrounding the CRN Site.

Present and known future offsite groundwater users are sufficiently distant from the CRN Site such that withdrawals would not affect or be adversely affected by the plant.

The surrogate CRN plant design does not rely on groundwater for any part of its operating supply. Thus, there is no groundwater demand due to the surrogate CRN SMR plant. There are no current or projected groundwater users for the CRN Site.

Temporary dewatering is required to maintain a dry excavation for the construction of the foundations for the CRN plant structures. Dewatering is to be accomplished using similar techniques as were used during the CRBRP excavations. These techniques included installation of horizontal gravity drains in the excavated rock faces and pumping from sumps located around the perimeter of the excavation and at the base of the excavation. Grouting of localized areas was performed when higher water inflow was encountered (Reference 2.3.2-8). These dewatering methods are localized to the power block area excavation and to the areas immediately in the vicinity of the power block excavations.

2.3.2.3 References

Reference 2.3.2-1. Tennessee Valley Authority, "Clinch River Small Modular Reactor Site Regional Surface Water Use Study - Revision 2," April 24, 2015.

Reference 2.3.2-2. Tennessee Valley Authority, Watts Bar Reservoir Website, Website: http://www.tva.com/sites/wattsbarres.htm, 2015.

Reference 2.3.2-3. Tennessee Valley Authority, Melton Hill Reservoir, Website: http://www.tva.gov/sites/meltonhill.htm, 2013.

Reference 2.3.2-4. Tennessee Valley Authority, Norris Reservoir, Website: http://www.tva.gov/sites/norris.htm, 2015.

Reference 2.3.2-5. AECOM, "Final Clinch River Site Land Use and Recreation Technical Report - Revision 2," Greenville, SC, Tennessee Valley Authority, October, 2014.

Reference 2.3.2-6. Tennessee Valley Authority, Office of Environment and Research, Recreation Area Matrix - Watts Bar Reservoir, Website: http://www.tva.com/river/recreation/pdf/watts_bar_rec_matrix.pdf, 2011.

Reference 2.3.2-7. Lloyd, O. B. and Lyke, W. L., Ground Water Atlas of the United States: Segment 10, Illinois, Indiana, Kentucky, Ohio, Tennessee, USGS Hydrological Atlas 730-K, 1995.

Reference 2.3.2-8. Project Management Corporation, "Clinch River Breeder Reactor Project, Preliminary Safety Analysis Report," Volume 2, Amendment 68, May, 1982.

Reference 2.3.2-9. Hutson, S., Koroa, M. C., and Murphree, C. M., "Estimated Water Use in the Tennessee River Watershed in 2000 and Projections of Water Use to 2030," U.S. Geological Survey Water-Resources Investigation Report 03-4302, 89pp, 2004.

Reference 2.3.2-10. Bohac, C. E. and McCall, M. J., "Water Use in the Tennessee Valley for 2005 and Projected Use in 2030," Tennessee Valley Authority, River Operations and Renewables, 2008.

Reference 2.3.2-11. Bohac, C. E. and Bowen, A. K., "Water Use in the Tennessee Valley for 2010 and Projected Use in 2035," Tennessee Valley Authority, River Operations and Renewables, 2012.

Reference 2.3.2-12. U.S. Environmental Protection Agency, Safe Drinking Water Search for the State of Tennessee, Safe Drinking Water Database, Website: http://oaspub.epa.gov/enviro/sdw_form_v3.create_page?state_abbr=TN, 2013.

Reference 2.3.2-13. Tennessee Department of Environment and Conservation, Tennessee Source Water Assessment Report, August 2003, Website: http://www.tn.gov/environment/water/water-supply_source-assessment.shtml, August, 2003.

Reference 2.3.2-14. Tennessee Department of Environment and Conservation, TDEC Division of Water Pollution Control and Division of Water Supply, Protection of Potable Water Supplies in Tennessee Watersheds, Website: http://www.tn.gov/environment/water/water-supply_source-assessment.shtml, 2009.

Table 2.3.2-1
Trends of Estimated Water Use in the Tennessee River Watershed 1995 to 2035

Off-stream Use (mgd)	1995	2000	2005	2010	2035	Percent change 2010-2035
Total withdrawals	10,008	12,211	12,437	11,951	9449	-21
Thermoelectric	8010	10,276	10,531	10,046	6963	-31
Industrial	1030	1205	1179	1148	1502	31
Public supply	574	662	684	723	938	30
Irrigation	48	69	43	34	46	35
Source of water						
Surface	9750	11,996	12,237	11,747	NA	NA
Ground	258	215	200	204	NA	NA
Net water demand (consumptive use)	NA	649	432	471	712	51

Note:
NA = not available

Source: (Reference 2.3.2-1)

Table 2.3.2-2
2010 Surface Water Use in the Surface Water Review Area (mgd)

County	Thermoelectric	Industrial	Public Supply	Irrigation[1]	Total
Withdrawal					
Anderson	430.18	0.52	13.20	0.45	444.35
Knox	0	2.08	66.99	0.29	69.35
Loudon	0	5.65	11.23	0.57	17.45
Meigs	0	0	0	0	0
Morgan	0	0	1.13	0	1.13
Rhea	207.91	0	3.42	0.22	211.55
Roane	728.08	0.30	6.65	0.04	735.07
Total	1366.17	8.54	102.62	1.57	1478.91
Return					
Anderson	429.57	4.46	6.85	NA	440.88
Knox	0	3.14	57.78	NA	60.92
Loudon	0	4.00	8.85	NA	12.85
Meigs	0	0	0.33	NA	0.33
Morgan	0	0	0.65	NA	0.65
Rhea	191.40	0	3.01	NA	194.41
Roane	727.41	0.96	3.00	NA	731.37
Total	1348.38	12.56	80.47	NA	1441.41

[1] Includes known intakes and estimated irrigation from agricultural surveys.

Note:
NA = Not available

Source: (Reference 2.3.2-1)

Table 2.3.2-3 (Sheet 1 of 2)
Surface Water Withdrawals in Anderson, Knox, Loudon, Meigs, Morgan, Rhea, and Roane Counties

Name	County	User Type	Water Source	Average Annual Withdrawal 2010 (mgd)	Record #
Oak Ridge Dept. Of Public Works	Anderson	PS	Melton Hill Reservoir	8.07	6520
Centennial Golf Course	Anderson	IR	Melton Hill Reservoir	0.42	4427
Bull Run Fossil Plant	Anderson	TH	Melton Hill Reservoir	430.18	5833
Anderson County Utility Board	Anderson	PS	Melton Hill Reservoir	1.41	6775
Rexnord Corporation Link-Belt Bearing	Anderson	IN	Melton Hill Reservoir	0.52	4423
Clinton Utilities Board	Anderson	PS	Melton Hill Reservoir	2.26	5992
North Anderson County U D	Anderson	PS	Clinch River	1.46	6507
First UD Of Knox County	Knox	PS	Fort Loudoun Reservoir	12.70	6305
West Knox Utility District	Knox	PS	Melton Hill Reservoir	4.81	6307
Knox-Chapman Utility District	Knox	PS	Fort Loudoun Reservoir	4.00	6302
Knoxville Ub#1 Whitaker Plant	Knox	PS	Fort Loudoun Reservoir	35.96	6299
West Knox Utility District	Knox[1]	PS	Melton Hill Reservoir	0.76	6308
Hallsdale Powell U D	Knox[1]	PS	Melton Hill Reservoir	6.77	6203
Cemex, Inc.	Knox	IN	Holston River	1.95	4557
Northeast Knox U D	Knox	PS	Holston River	1.98	6510
Valley Proteins	Knox	IN	Lyons Creek	0.01	8892
Rinker Materials South Central - Midway Quarry	Knox	MI	Quarry Pit	0.07	4563
Rinker Materials South Central - I-75 Quarry	Knox	MI	Quarry Pit	0.04	4560
Rinker Materials South Central - I-75 Quarry	Knox	MI	Williams Branch	0.00	4561
Tellico Village Public Works	Loudon	PS	Tellico Reservoir	0.22	9622
Loudon Utilities Board	Loudon	PS	Watts Bar Reservoir	9.28	6352
Viskase Corp.	Loudon	IN	Watts Bar Reservoir	1.58	4569
Kimberly Clark Corporation	Loudon	IN	Watts Bar Reservoir	4.07	4568

Table 2.3.2-3 (Sheet 2 of 2)
Surface Water Withdrawals in Anderson, Knox, Loudon, Meigs, Morgan, Rhea, and Roane Counties

Name	County	User Type	Water Source	Average Annual Withdrawal 2010 (mgd)	Record #
Tennessee National, Llc	Loudon	IR	Watts Bar Reservoir	0.46	8830
Lenoir City Utility Board	Loudon	PS	Watts Bar Reservoir	1.72	6331
Plateau Utility District	Morgan	PS	Crooked Fork Creek	1.13	6717
Dayton Water Dept	Rhea	PS	Chickamauga Reservoir	2.94	6039
Watts Bar Nuclear Plant	Rhea	TH	Chickamauga Reservoir	52.81	7223
Watts Bar Nuclear Plant	Rhea	TH	Chickamauga Reservoir	155.10	7222
Spring City Water System	Rhea	PS	Watts Bar Reservoir	0.48	6463
Rockwood Water System	Roane	PS	Watts Bar Reservoir	2.48	6612
Lakeside Golf Course	Roane	IR	Watts Bar Reservoir	0.00	4614
Kingston Water System	Roane	PS	Watts Bar Reservoir	0.77	6295
Kingston Fossil Plant	Roane	TH	Watts Bar Reservoir	728.08	5835
Harriman Utility Board	Roane	PS	Watts Bar Reservoir	2.01	6217
Cumberland Utility District	Roane	PS	Watts Bar Reservoir	1.39	6540
Oak Ridge Country Club	Roane	IR	East Fork Poplar Creek	0.03	8955
Oak Ridge Bear Creek Plant	Roane	IN	Watts Bar Reservoir	0.30	9723

Notes:
Intake is in Anderson County
IN = Industrial
IR = Irrigation
PS = Public Supply
TH = Thermoelectric
MI = Mining

Source: (Reference 2.3.2-1)

Table 2.3.2-4
Groundwater Withdrawals from Five Counties Surrounding the CRN by Use Category

County	Year	Industrial (mgd)	Public Supply (mgd)	Irrigation (mgd)	Total Groundwater Withdrawal (mgd)
Anderson	2010	NR	0.22	0	0.22
	2005	0.12	0.28	0.12	0.52
	2000	NR	0.96	0.01	0.97
Knox	2010	1.13	NR	0.02	1.16
	2005	0.67	0.67	0.04	1.38
	2000	0.13	0.93	0.1	1.16
Loudon	2010	0.01	0.8	NR	0.81
	2005	0.02	0.35	NR	0.37
	2000	NR	1.2	NR	1.2
Morgan	2010	NR	NR	NR	NR
	2005	NR	NR	NR	NR
	2000	NR	NR	NR	NR
Roane	2010	NR	1.28	0	1.28
	2005	NR	1.03	0.01	1.03
	2000	NR	0.2	NR	0.2
Total	2010	1.14	2.3	0.02	3.5
	2005	0.79	2.33	0.18	3.3
	2000	0.13	3.29	0.11	3.5

Notes:
1. Data for each county for the years 2000, 2005 and 2010 come from (Reference 2.3.2-9; Reference 2.3.2-10; Reference 2.3.2-11), respectively; total values (shaded) are computed.
2. “NR” (None Recorded) indicates that no value was recorded. “NR” is treated as zero for the purposes of summation, as was done in the source documents listed above.
3. Figures for individual categories may not add up to totals because of independent rounding.

Table 2.3.2-5
Summary of Nearby Water Systems Using Groundwater for Supply

Water System	County	System Category
Norris Water Commission	Anderson	Community
Sequoyah Marina, LLC	Anderson	Transient non-community
Modine Manufacturing Company	Anderson	NA
Oak Ridge Country Club	Anderson	NA
Johnson University	Knox	Community
CEMEX Construction Materials Atlantic	Knox	Non-transient non-community
NYRSTAR TN Mines – Strawberry Plains, LLC	Knox	Non-transient non-community
Fort Loudoun Yacht Club	Knox	Transient non-community
Cornell Dubilier Foil, LLC	Knox	NA
Panasonic	Knox	NA
Rinker Materials South Central	Knox	NA
Tamko Building Products, Inc.	Knox	NA
Vinylex Corporation	Know	NA
Creekside Mobile Home S/D	Loudon	Community
Sweetwater Valley KOA	Loudon	Transient non-community
Cross Eyed Cricket Campground	Roane	Transient non-community

Notes:
NA = Not available

Table 2.3.2-6
Nearby Public Water Systems Using Groundwater for Supply

Community Water System	County	Population	Groundwater Source
Norris Water Commission[1]	Anderson	1801	Spring
North Anderson County Utility District	Anderson	10653	Spring
First Utility District Of Knox County	Knox	64230	Spring
Hallsdale Powell Utility District	Knox	57732	Springs
Creekside Mobile Home Subdivision[1]	Loudon	51	Wells
Lenoir City Utility Board	Loudon	16686	Spring
Loudon Utilities Board	Loudon	10297	Springs
Helton Estates Mobile Home Park[1]	Roane	82	Well
Kingston Water System	Roane	8384	Spring
Lewands Water System[1]	Roane	61	Wells
Oliver Springs Water Board	Roane	5323	Spring

[1] The system uses exclusively groundwater for its supply (i.e., no other source is listed) (Reference 2.3.2-13)

Note: The listed county reflects the location of the water system users, which is not necessarily the county from which all of the system's water is sourced due to intersystem transfers.

Source: (Reference 2.3.2-13)

Table 2.3.2-7 (Sheet 1 of 2)
Characteristics of Individual Wells Located Within a 1.5-mile Radius of the CRN Site

Well Number	Well Use	Estimated Yield (gpm)	Total Depth (feet)	Casing Depth (feet)	Geologic Unit	Finish Type
14500062	Residential	10	100	25	Nolichucky Shale	NR
14500100	Residential	10	92	45	Copper Ridge Dolomite	NR
14500274	Residential	10	195	75	Maynardville Limestone	NR
14501409	Residential	5	160	42	Nolichucky Shale	NR
14501415	Commercial	2	400	25	Nolichucky Shale	NR
14501867	Residential	NR	180	21	Dismal Group Formation (Maryville Limestone)	Open Hole
14501990	Residential	20	145	28	Dismal Group Formation (Maryville Limestone)	Open Hole
14502043	Residential	7	85	31	Dismal Group Formation (Maryville Limestone)	Open Hole
14502044	Residential	7	85	31	Dismal Group Formation (Maryville Limestone)	Open Hole
14502059	Residential	15	102	34	Dismal Group Formation (Maryville Limestone)	Open Hole
14502075	Residential	5	390	20	Dismal Group Formation (Maryville Limestone)	Open Hole
14502085	Farm	2	340	41	Dismal Group Formation (Maryville Limestone)	Open Hole
14502157	Commercial	2	500	62	Dismal Group Formation (Maryville Limestone)	Open Hole
14502179	Residential	20	275	105	Witten Formation	Open Hole
14502230	Residential	7	275	89	Dismal Group Formation (Maryville Limestone)	Open Hole
14509007	Residential	NR	NR	NR	Rockdell Formation	NR
14509008	Residential	NR	42	42	Maynardville Limestone	NR
20005513	Residential	3	526	126	Chepultepec Dolomite	Open Hole
20021254	Residential	9	300	62	Nolichucky Shale	NR
20022808	Residential	3	575	104	Chepultepec Dolomite	Open Hole
20053044	Residential	30	240	126	Maynardville Limestone	Open Hole
20061323	Residential	30	160	105	Copper Ridge Dolomite	Open Hole
20064090	Residential	1	320	105	Fleanor Shale	Open Hole
20074093	Residential	4	900	42	Pumpkin Valley Shale	Open Hole
20082006	Residential	0.5	610	126	Moccasin Formation	Open Hole
20083553	Residential	7	200	63	Moccasin Formation	Open Hole
20091942	Residential	50	220	190	Kingsport Formation.	Open Hole

Table 2.3.2-7 (Sheet 2 of 2)
Characteristics of Individual Wells Located Within a 1.5-mile Radius of the CRN Site

Well Number	Well Use	Estimated Yield (gpm)	Total Depth (feet)	Casing Depth (feet)	Geologic Unit	Finish Type
90001001	Residential	2	470	38	Nolichucky Shale	Open Hole
90002790	Residential	7	373	41	Nolichucky Shale	Open Hole
91002142	Residential	75	547	41	Nolichucky Shale	Open Hole
92003314	Residential	4	360	41	Copper Ridge Dolomite	Open Hole
92003730	Residential	3	503	104	Copper Ridge Dolomite	Open Hole
93000627	Residential	1	300	62	Nolichucky Shale	Open Hole
93003943	Residential	30	118	36	Copper Ridge Dolomite	Open Hole
96000454	Residential	3	465	126	Copper Ridge Dolomite	Open Hole
96002158	Commercial	3	305	75	Witten Formation	Open Hole

Note: NR denotes “Not Reported” and gpm is gallons per minute; the geologic units in which wells are completed was inferred from regional geological mapping; total depth and casing depth are measured from grade

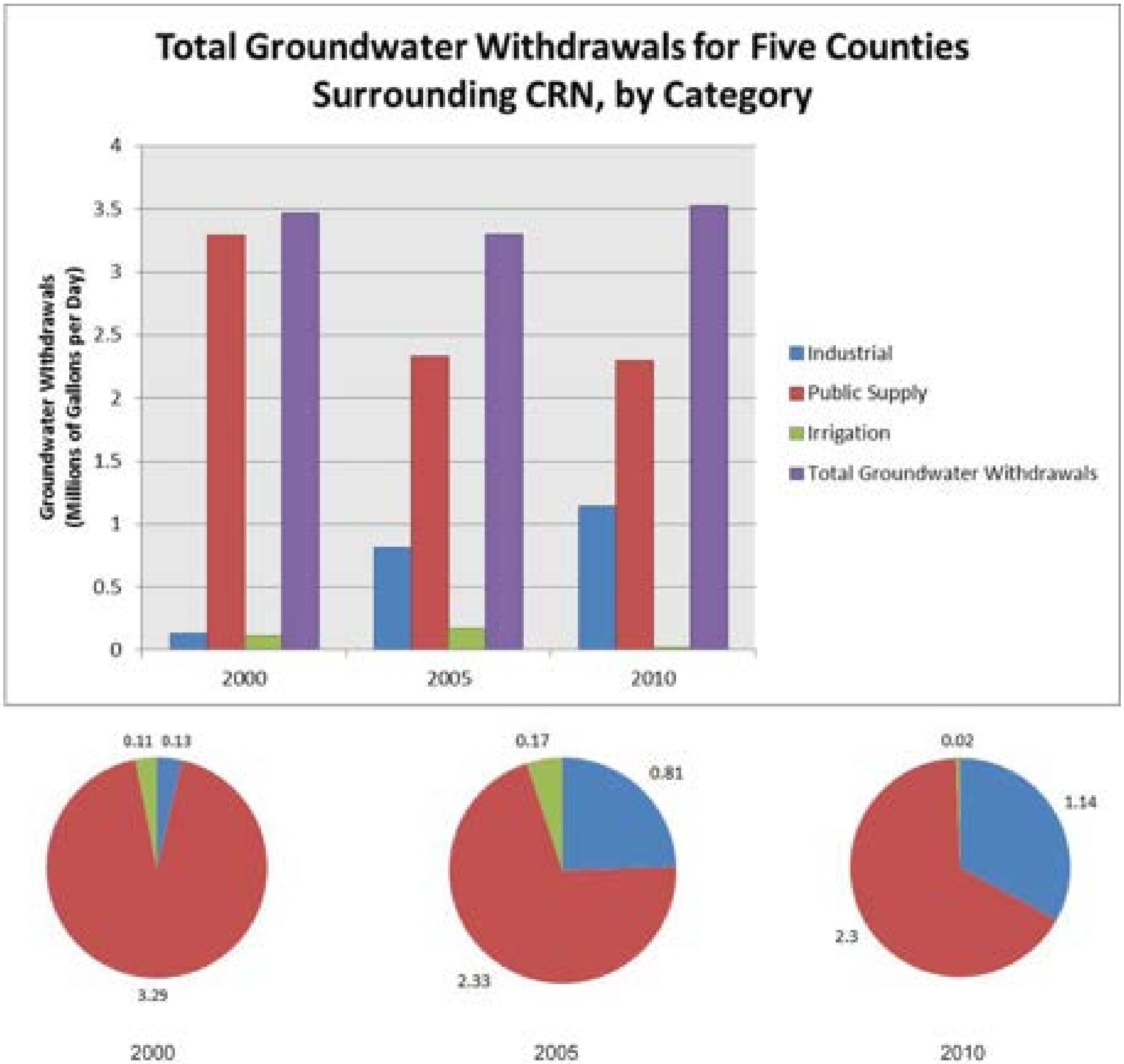
Exempted from Disclosure by Statute Withheld Under 10 CFR 2.390(a)(3)

(See Part 7 of this Early Site Permit Application)

Figure 2.3.2-1. Surface Water Intakes Near the CRN Site in Anderson, Knox, Loudon, Meigs, Morgan, Rhea, and Roane Counties

Note: Adapted from (Reference 2.3.2-11). Green shading shows the five counties included in the groundwater use study area.

Figure 2.3.2-2. Groundwater Use Study Areas



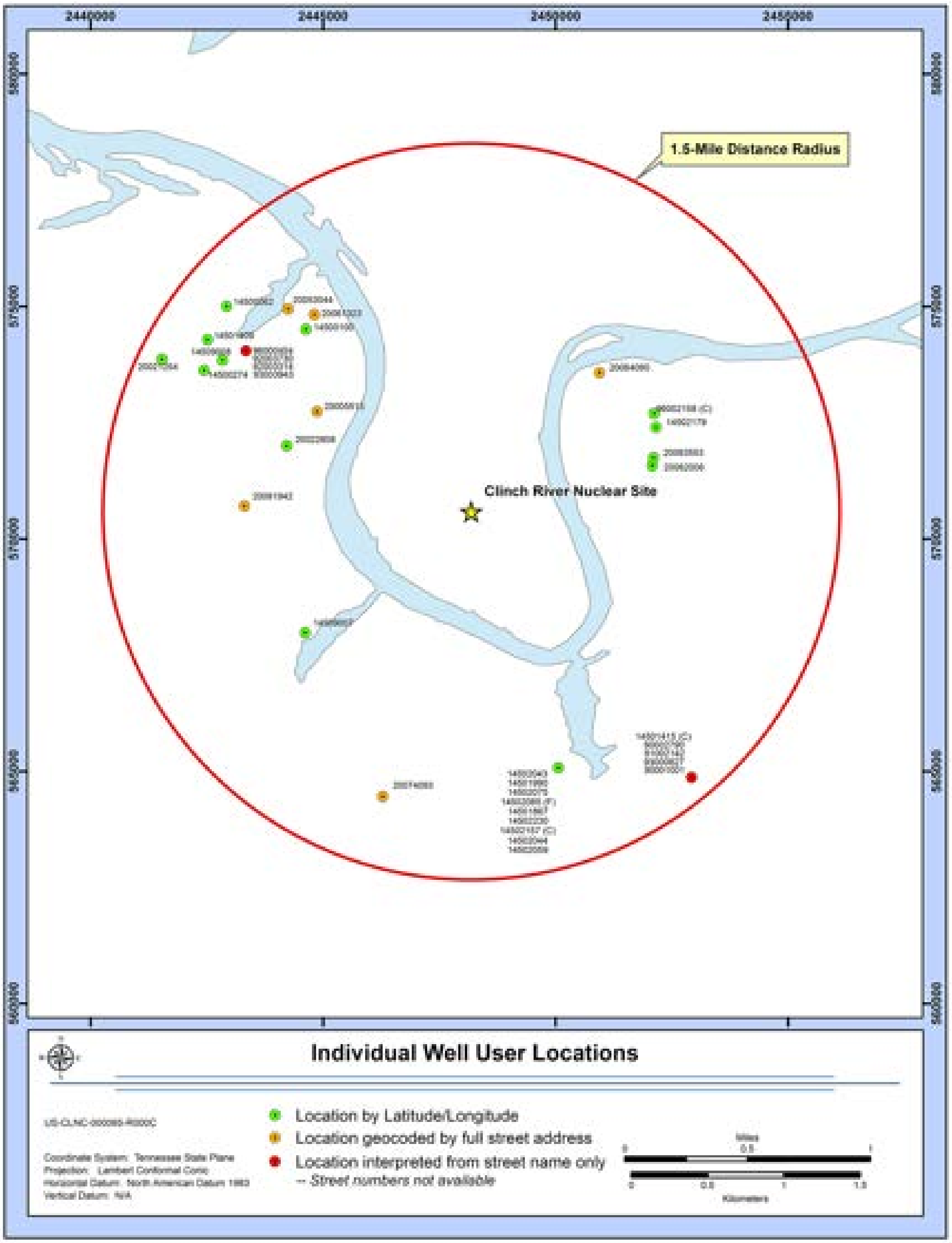
Note: Data for the years 2000, 2005 and 2010 from (Reference 2.3.2-9; Reference 2.3.2-10; Reference 2.3.2-11), respectively.

Figure 2.3.2-3. Groundwater Use by Category in the Groundwater Study Area for 2000, 2005, and 2010

Exempted from Disclosure by Statute Withheld Under 10 CFR 2.390(a)(3)

(See Part 7 of this Early Site Permit Application)

Figure 2.3.2-4. Groundwater Intakes Near the CRN Site in Anderson, Knox, Loudon, and Roane Counties



Note: (F) indicates farm well, (C) indicates commercial well.

Figure 2.3.2-5. Individual Well Locations Within a 1.5-mile Radius of the CRN Site

2.3.3 Water Quality

2.3.3.1 Surface Water

The proposed small modular reactors (SMRs) withdraw cooling water from the Clinch River arm of the Watts Bar Reservoir through an intake structure located near Clinch River Mile (CRM) 17.9. Heated water from the plant is to be returned to the Clinch River arm of the Watts Bar Reservoir by a discharge structure located near CRM 15.5.

2.3.3.1.1 Upper Tennessee River Basin

The water quality data in the Upper Tennessee River Basin from 1994 to 1998 was summarized by the U.S. Geological Survey (USGS) in 2000. The report evaluated concentrations and distribution of bacteria, nutrients, pesticides, and volatile organic compounds (VOCs) in surface water and sediment, the influence of industry and mining on water quality, and the effects of toxic spills and releases. The study was performed as part of the USGS National Water-Quality Assessment Program, which, as of 2000, had evaluated 36 study areas throughout the United States. The report compared water quality data from the Upper Tennessee River to data from the other study areas, as well as to national water quality benchmarks, such as those for drinking water quality and protection of aquatic organisms.

In general, the report concluded that surface water in the Upper Tennessee River Basin usually meets existing guidelines for drinking water, recreation, and the protection of aquatic life. Specific findings included:

- Bacteria levels frequently exceeded state standards in agricultural and urban areas. In agricultural areas, this was attributed to runoff from pasture land. In urban areas, this was attributed to wastewater infrastructure.
- Nutrients, including nitrogen and phosphorus, were found at elevated levels in some streams.
- Herbicides were detected in 98 percent of the stream samples collected, and insecticides were detected in 12 percent of samples. Concentrations were within drinking water standards, but exceeded aquatic life guidelines for some chemicals.
- Contamination from past industrial and mining activities was still present in many areas. Contamination had resulted in fish consumption advisories for polychlorinated biphenyls (PCBs), dioxin, and mercury. Semivolatile organic compounds (SVOCs) were found in sediment at concentrations that exceeded aquatic life guidelines, and were attributed to coal mining.
- Spills and releases had resulted in fish and mussel kills in many parts of the basin (Reference 2.3.3-1)

Specific findings were discussed for the Lower Clinch River Watershed, Watts Bar Reservoir, and Melton Hill Reservoir. Mercury was found to be a major contaminant in the drainages downstream from the Oak Ridge Reservation (ORR), including Whiteoak Creek watershed, and the lower Clinch River - Watts Bar Reservoir. Mercury, polychlorinated compounds (PCBs), and cesium-137 are known to have migrated to areas downstream of ORR. The State of Tennessee has posted a fish-consumption advisory for ORR drainages as well as Watts Bar Reservoir as a result of bioaccumulation of mercury and PCBs in some fish species. A fish-consumption advisory was also in place for Melton Hill reservoir due to the presence of PCBs and chlordane. (Reference 2.3.3-1)

2.3.3.1.2 State Monitoring and 303(d) List

The TDEC conducts monitoring of more than 7000 stations throughout the state, with 600 stations scheduled for sampling in fiscal year 2014-2015 (Reference 2.3.3-2). Water quality monitoring includes biological, chemical, and bacteriological analyses in wetlands, rivers, streams, reservoirs, and lakes.

There are 12 monitoring stations located on the Clinch River arm of the Watts Bar Reservoir, including four monitoring stations between Melton Hill Dam and the Clinch River Nuclear (CRN) Site, and eight stations between the CRN Site and the confluence of the Clinch River arm with the Tennessee River arm of the reservoir. The closest station is located directly adjacent to the CRN Site, on the eastern side of the peninsula near CRM 18. Another station is located directly adjacent to the Barge/Traffic Area. (Reference 2.3.3-3)

Section 303(d) of the federal Clean Water Act requires that states develop a list of surface water bodies that are “water quality limited” or are expected to exceed water quality standards in the next two years. Streams that are water quality limited have one or more characteristics that violate water quality standards. These streams are considered to be impaired by pollution, and cannot fully meet their designated uses. (Reference 2.3.3-4)

In 2014, TDEC issued its 303(d) list for the year 2012. Table 2.3.3-1 lists the water bodies near the CRN Site which are listed as impaired.

2.3.3.1.3 River and Reservoir Compliance Monitoring Program

TVA initiated a reservoir monitoring program, formerly called the Vital Signs Monitoring Program, in 1990 to provide information on the ecological health or integrity of major reservoirs in the Valley. Through the current Reservoir Ecological Health Program, TVA monitors ecological conditions at 69 sites on 31 reservoirs. Each site is sampled every other year unless a substantial change in the ecological health score occurs during a 2-year (yr) cycle. If that occurs, the site is sampled the next year to confirm that the change was not temporary. Roughly half the sites are sampled each year on an alternating basis. The program includes five ecological indicators (chlorophyll-a, dissolved oxygen (DO), sediment quality, benthic macroinvertebrates, and fish assemblage), which are monitored at up to four locations in each reservoir. To complete the ecological health scoring process, the 20 to 100 percent scoring range is divided into categories representing good, fair, and poor ecological health conditions relative to what is expected given the hydrogeomorphology of the reservoir. (Reference 2.3.3-5)

2.3.3.1.3.1 Melton Hill Reservoir

TVA monitors three locations on Melton Hill Reservoir: the deep, still water near the dam, called the forebay; the middle part of the reservoir; and the riverine area at the upper end of the reservoir, called the inflow. Monitoring is usually done on a two year cycle. The overall ecological condition of Melton Hill rated fair in 2012. Melton Hill received a good rating in 2006 and 2010 but rated fair in all other years monitored. The higher ecological health scores were primarily due to two indicators (chlorophyll and bottom life) rating near the upper end of their historic ranges. (Reference 2.3.3-6)

The following paragraphs summarize the result for the Melton Hill Reservoir Monitoring Program for 2012.

Dissolved Oxygen

In 2012, DO rated poor at the forebay and good at the mid-reservoir location. A large portion of the lower water column at the forebay had low DO concentrations in June, resulting in a poor rating. DO has rated good at the mid-reservoir location all years monitored and typically has rated good in the forebay unless there was an extended period with low flow. Low flow conditions can allow water to sit long enough that oxygen in the lower water column becomes depleted as it is used in the natural process of decomposition. This was the case in 2012 and in 2000, 2001, and 2008 when DO rated fair at the forebay location. (Reference 2.3.3-6)

Chlorophyll

In 2012, chlorophyll rated fair at the forebay and good at the mid-reservoir monitoring location. Annual average chlorophyll concentrations have fluctuated through time at the mid-reservoir, with no specific trend of increasing or decreasing. Chlorophyll concentrations have shown an overall trend of increasing at the forebay since monitoring began in 1991. Chlorophyll rated good at the forebay during the 1991 to 1996 time period. Since 1998, chlorophyll ratings have fluctuated between fair and poor at this location. Reservoir flows have played a part in the year-to-year fluctuations as low-flow conditions tend to allow more time for algal populations to become established. (Reference 2.3.3-6)

Fish

In 2012, the fish community rated good at the forebay, fair at the mid-reservoir, and poor at the inflow. Consistent with previous years, the fish assemblage at each monitoring location was characterized by lower numbers of fish and higher proportions of tolerant individuals than expected. As in most years, improved diversity at the mid-reservoir and forebay, respectively, resulted in higher ratings at these locations. (Reference 2.3.3-6)

Bottom life

In 2012, bottom life rated fair at the forebay and mid-reservoir locations and poor at the inflow. Over the period of the monitoring program from 1994 to 2012, scores for bottom life have fluctuated within the “low fair” to poor range at the forebay and within the poor range at the inflow location. Scores have improved, however, at the mid-reservoir location since 1994 with scores shifting from the low end of the fair range to the middle of the fair range and even rating good in 2006. The improved ratings were primarily due to an increase in the number of organisms less tolerant of poor conditions. (Reference 2.3.3-6)

Sediment

In 2012, sediment quality rated fair at the forebay because samples contained slightly more arsenic than would be expected to occur naturally. The mid-reservoir location rated good because no PCBs or pesticides were detected, and no metals had elevated concentrations. Arsenic, chlordane, copper, and PCBs have exceeded suggested limits in some previous years. (Reference 2.3.3-6)

2.3.3.1.3.2 Fort Loudoun Reservoir

TVA monitors three locations on Fort Loudoun Reservoir: the forebay; the middle part of the reservoir; and the inflow. Fort Loudoun Reservoir was monitored annually from 1994 through 2007. In 2008, TVA began monitoring Fort Loudoun every other year. The ecological health condition of Fort Loudoun Reservoir rated fair in 2011. Conditions were similar to most previous years. Low ratings for three indicators (chlorophyll, bottom life, and sediment quality) typically reduce the reservoir’s overall health score. In addition, DO has rated poor in some years. (Reference 2.3.3-7)

The following paragraphs summarize the result for the Fort Loudoun Reservoir Monitoring Program for 2011.

Dissolved Oxygen

In 2011, DO rated fair at the forebay and good at the mid-reservoir monitoring location. This indicator usually rates good at the mid-reservoir location, but ratings have varied between good, fair, and poor at the forebay, generally in response to reservoir flow conditions. TVA has installed aeration equipment to add oxygen to the deep water above Fort Loudoun Dam and to improve conditions immediately downstream. (Reference 2.3.3-7)

Chlorophyll

In 2011, average summer chlorophyll concentrations were high at both monitoring locations, resulting in poor ratings. High chlorophyll concentrations are a consistent issue on Fort Loudoun, rating poor at both sites in most previous years. (Reference 2.3.3-7)

Fish

In 2011, the fish assemblage rated “high fair” at all three monitoring locations. The variety of fish collected at each location was good, but catch rates were slightly lower than desired and composition was dominated by a few species such as gizzard shad, bluegill, and/or largemouth bass. The fish community typically scores good or at the upper end of the fair range at the forebay and mid-reservoir, while scores at the inflow have generally fluctuated within the fair range. (Reference 2.3.3-7)

Bottom life

In 2011, similar to previous years, bottom life rated poor at the forebay and inflow monitoring locations and fair at the mid-reservoir location. Relatively few organisms are usually collected from the forebay and inflow locations, and those collected are primarily species capable of tolerating poor conditions. Bottom life at the mid-reservoir location typically rates fair due to greater diversity, which includes a better representation of intolerant species such as mayflies. (Reference 2.3.3-7)

Sediment

In 2011, sediment quality rated fair at both the forebay and mid-reservoir monitoring locations because PCBs were detected. Sediment quality typically rates fair at both locations due to chlordane, PCBs, and/or zinc exceeding suggested limits. (Reference 2.3.3-7)

2.3.3.1.3.3 Watts Bar Reservoir

TVA monitors four locations on Watts Bar Reservoir: the forebay; the middle part of the reservoir; and the Tennessee and Clinch River inflow locations. Samples are usually collected on a two-year cycle. The overall ecological health condition for Watts Bar Reservoir rated fair in 2012. Ecological health scores for Watts Bar have fluctuated between a “high fair” and poor and have generally followed reservoir flow conditions. Flow conditions in 2012 were low during most of the summer months in response to the generally dry weather pattern. The indicator most responsive to flow is DO, which rated poor at the forebay in 2012. In addition, common problems are elevated chlorophyll concentrations, poor bottom life, and the presence of metals and/or organic contaminants in the sediments. (Reference 2.3.3-5)

The following paragraphs summarize the result for the Watts Bar Reservoir Monitoring Program for 2012.

Dissolved Oxygen

DO rated poor at the forebay and good at the mid-reservoir location. DO has rated good at the mid-reservoir location all years monitored except 2008 and 2010, when it rated fair and poor, respectively. Low DO levels (<2 milligrams per liter [mg/L]) have occurred in the lower water column at the mid-reservoir in several years, including 2012. However, the area affected was larger in 2010 than in other years, resulting in the only poor rating for this indicator at this location. Ratings have varied between good, fair, and poor at the forebay, primarily due to differences in reservoir flows. Poorer DO conditions typically occur as a result of reduced flows through the reservoir during dry conditions. TVA has installed aeration equipment to add oxygen to the deep water above Watts Bar Dam and to improve conditions immediately downstream. (Reference 2.3.3-5)

Chlorophyll

Chlorophyll rated poor at both locations monitored because of elevated concentrations. Annual average chlorophyll concentrations have fluctuated through time at the forebay, with no specific trend of increasing or decreasing. Chlorophyll concentrations have shown an overall trend of increasing at the mid-reservoir location since monitoring began in 1990. (Reference 2.3.3-5)

Fish

The fish assemblage rated good at the Tennessee inflow location and at the upper end of the fair range at other monitoring locations. At all locations, the percent composition of tolerant individuals was higher than expected and catch rates were lower than expected. Better fish diversity at the Tennessee inflow location contributed to the higher (good) rating. (Reference 2.3.3-5)

Bottom life

Bottom life rated good at the mid-reservoir, fair at the forebay and Clinch inflow locations, and poor at the Tennessee inflow location. Scores for bottom life in 2012 were similar to those of previous years at each monitoring location except the Clinch inflow location. Bottom life rated poor at the Clinch inflow location until 2004 when it received its first fair rating. Since 2004, bottom life at Clinch inflow location has scored within the fair to low-good range. Improvements in ratings at the Clinch inflow location are attributable to increases in the density and diversity of organisms in the samples collected from the reservoir bottom. (Reference 2.3.3-5)

Sediment

Sediment quality rated fair at the forebay and mid-reservoir locations because concentrations of arsenic exceeded suggested background levels. Sediment quality commonly rates fair at both locations due to one or more contaminants: PCBs, chlordane, and/or arsenic. Additionally, the concentration of copper was elevated in the sample collected at the mid-reservoir location in 2009, and lindane was detected in the sample collected at the forebay in 2006. (Reference 2.3.3-5)

2.3.3.1.4 Preapplication Monitoring Program

To support the evaluation of the suitability of the CRN Site and Barge/Traffic Area, TVA monitored the surface water on and in the immediate vicinity. This program consisted of characterization of surface water in the Clinch River arm of the Watts Bar Reservoir, as well as characterization of stormwater runoff on both the CRN Site and Barge/Traffic Area. The resulting data provides information to determine existing conditions for surface water. The parameters measured or analyzed include temperature, total metals, nutrients, acids/base/neutral compounds, PCBs, gross alpha, gross beta, radium 228, radium 226, oil and grease (O&G), pH, cyanide, phenols, biochemical oxygen demand (BOD), chemical oxygen demand (COD), total suspended solids (TSS), color, bromide, surfactants, total organic carbon (TOC), sulfide, sulfate, ammonia-N, fluoride, TOC, and hardness. Pesticide monitoring was included in the July 2013 sampling. (Reference 2.3.3-8) The locations of the samples are provided in Figure 2.3.3-1, and the results are provided in Tables 2.3.3-2 and 2.3.3-3. Tables 2.3.3-2 and 2.3.3-3 provide the maximum concentrations for quarterly stormwater and surface water samples, respectively, collected in July 2013; March, May, and November 2014; and February, April, and June, 2015. All sample results for the Clinch River arm of the Watts Bar Reservoir upstream and downstream of the CRN Site indicate that TDEC's most stringent numeric criteria are being met and that site runoff (should it occur) would not have a significant impact to water quality (Reference 2.3.3-8).

2.3.3.1.5 Biological Monitoring Program

As part of the biological monitoring to characterize the aquatic community near the CRN Site, TVA collected and analyzed surface water and sediment samples at selected locations on the Clinch River arm of the Watts Bar Reservoir between CRM 15.5 and 22.0. The locations of the samples are shown in Figure 2.3.3-1.

The biological monitoring program data were collected to characterize baseline conditions of the aquatic habitats and communities in the reservoir immediately upstream and downstream of the CRN Site. This program focused on ecological health, but included collection of surface water quality and sediment chemistry data, as indicators of ecological health. Surface water samples were collected at four mid-channel locations, including three upstream locations at CRM 18.5, 19.7, and 22.0, and one downstream location at CRM 15.5. The surface water samples were collected monthly from March to December 2011. The samples from each month (a total of 10 months) were analyzed for nutrients (Kjeldahl nitrogen, nitrate plus nitrite-nitrogen, ammonia-nitrogen, total phosphorus, and orthophosphate), TOC, alkalinity, hardness, water clarity (turbidity and TSS), and total dissolved solids (TDS). The samples from every second month (April, June, August, October, and December) were analyzed for total and dissolved metals. In June, 2011, sediment samples were collected at three of the locations, including CRM 15.5, 18.5, and 22.0. Sediment samples were also collected from one location in Melton Hill Reservoir in June, 2011, and from two locations in the Tennessee River arm of Watts Bar Reservoir in June, 2010, and June, 2011. The sediment samples were analyzed for metals and organochloride pesticides and PCBs. (Reference 2.3.3-9)

The results from the biological monitoring program samples collected between March 2011 and December 2011 are provided in Tables 2.3.3-4 through 2.3.3-8, and are discussed in the following paragraphs (Reference 2.3.3-8).

Nutrient concentrations typically were relatively high for nitrogen and moderate to low for phosphorus. Phosphorus concentrations were often low enough to be a limiting factor to phytoplankton, while nitrogen appeared to be underutilized. Chlorophyll a concentrations were low (<1.0–5.0 micrograms per liter [μg/L]). Concentrations were below detectable levels (1 μg/L) in approximately 53 percent of the samples, and only three of the 68 samples had concentrations greater than 2 μg/L. Secchi-disk transparency ranged from 1.5 to 6.2 meters (m). The average transparency was greater than 3 m (3.1m to 3.6 m) at each CRN Site sampling location (CRMs 15.5, 18.5, 19.7, and 22.0) in 2011, which is higher than typically observed in mainstream Tennessee River reservoirs. Turbidity ranged from 0.6 to 12 nephelometric turbidity units (NTU), with 68 percent of the values less than 4 NTUs. TSS ranged from 1 to 11 mg/L, with 85 percent of the values less than 4 mg/L. Phytoplankton populations were characterized by low abundance and appeared to be mainly the result of phytoplankton populations generated within Melton Hill Reservoir and transported downstream. Based on chlorophyll results, phytoplankton productivity in the sampled reach was very limited and phytoplankton populations were essentially in a senescent phase. Productivity was likely light-limited due to turbulence within the water column. Zooplankton assemblages were characterized by low abundance and diversity throughout the 10-month sampling period. As with phytoplankton, high turbulence and advection within the sampled reach likely limited zooplankton populations and affected their distribution. (Reference 2.3.3-8)

The typical pH was 7.5–7.9. All pH values were within the bounds of the State of Tennessee aquatic life criteria (6.5 to 9.0). The maximum water temperature was 79.6°F, well below the State of Tennessee criteria (86.9°F). Concentrations of metals in water were found to be below concentrations established by the State of Tennessee for protection of aquatic life. Ammonia concentrations were below the quantification limit (0.10 mg/L) in approximately 45 percent of the samples, while some samples had higher ammonia concentrations (0.16–0.19 mg/L) than generally expected. Ammonia concentrations typically are low (<0.15 mg/L) in aerated surface waters of TVA reservoirs; values greater than 0.15 mg/L are infrequent. PCBs and pesticides were not detected in the sediment samples collected near the CRN Site and metals concentrations were below EPA Region 4 ecological screening values for sediments. (Reference 2.3.3-8)

As discussed in Subsection 2.3.1.1.2.7, daily thermal gradients were documented to occur in the reservoir during summer due to surficial warming during the hottest time of the day. However, the warmer surface water was then either flushed out by daily dam releases from Melton Hill Dam, or its heat dissipated with nighttime atmospheric cooling. However, appreciable vertical gradients in DO concentrations existed at some locations during the July survey. Likewise, the slight deviation (4.87 mg/l) below the state water quality criterion for DO at CRM 15.5 in June 2011 may have resulted from periodic increases in flow mixing oxygenated water in the upper strata with oxygen-deficient water in the lower strata. (Reference 2.3.3-8)

Hourly hydro water releases from Melton Hill Dam typically range from no discharge to the maximum turbine capacity of approximately 20,000 cfs. However, intervals of 12 to 22 hr with no releases are common. Average hourly releases from Melton Hill Dam for April through

September of 2011 and 2013 were above average, but there were no hourly releases from Melton Hill Dam for about 42 percent of the time. By comparison, the percentage of hours with no releases is often in the range 60 to 70 percent. Therefore, data collected in 2011 and 2013 are likely more representative of conditions that exist during normal to above average flow conditions. During low flow years, the potential exists for greater spatial difference in temperatures and for increases in the magnitude and duration of stratification and resultant oxygen deficiencies. (Reference 2.3.3-8)

2.3.3.2 Groundwater

This subsection describes the quality characteristics of groundwater aquifers that could affect plant water use and effluent discharge or be impacted by construction and operation of the SMRs to be built at the CRN Site.

The CRN plant design does not require groundwater as a source for cooling water, potable water, or other plant needs. Circulating cooling water is sourced from the Clinch River arm of Watts Bar Reservoir, while potable and other water comes from the Oak Ridge Department of Public Works. Temporary dewatering is required to maintain a dry excavation for the construction of the required foundations for the CRN plant structures.

2.3.3.2.1 Hydrogeochemical Characteristics

2.3.3.2.1.1 Regional Hydrogeochemical Characteristics

As discussed in Subsection 2.3.1.2.1.2, the principal aquifers in the Valley and Ridge Province consist of carbonate rocks that are generally in communication with surface water features such as rivers or lakes. Other types of rocks in the province can yield water to wells where they are fractured or contain solution openings or are directly hydraulically connected to sources of recharge. Groundwater can also be present in the alluvium along streams and the residuum of weathered material that overlies most of the rocks in the area.

The chemical quality of water in the freshwater parts of the Valley and Ridge aquifers is similar for shallow wells and springs. The water is hard, a calcium-magnesium-bicarbonate type, and typically has a dissolved-solids concentration of 170 parts per million (ppm) or less. The ranges of concentrations are thought to be indicators of the depth and rate at which groundwater flows through the carbonate-rock aquifers. In general, the smaller values for a constituent represent water that is moving rapidly along shallow, short flow paths from recharge areas to points of discharge. This water has been in the aquifers for a short time and has accordingly dissolved only small quantities of aquifer material. Conversely, the larger values represent water that is moving more slowly along deep, long flow paths. Such water has been in contact with aquifer minerals for a longer time and thus has had greater opportunity to dissolve the minerals. Also, water that moves into deeper parts of the aquifers can mix with saltwater (brine) that might be present at depth (Reference 2.3.3-10).

The chemical characteristics of the groundwater in the ORR aquitards range from a mixed-cation-bicarbonate water type at shallow depths to a sodium-bicarbonate water type at deeper depths, to sodium-calcium-chloride water type as evidenced from very deep wells. These chloride-rich waters appear to be a zone of dilution on top of deeper saline sodium-calcium-chloride brines, similar to those encountered within the Conasauga Group at depths greater than 1000 ft in Melton Valley (Reference 2.3.3-11). The Knox aquifer is characterized by a calcium-magnesium-bicarbonate water type. The hydrogeologic conditions at the CRN Site are similar to those observed at the ORR with the exception of land disturbance areas resulting from earlier site work performed for the CRBRP where excavations and fill material are present.

2.3.3.2.1.2 Local Hydrogeochemical Characteristics

The hydrogeochemical characteristics of the groundwater are summarized on Figure 2.3.1-23. The shallow groundwater is characterized by mixed cation-bicarbonate type water, intermediate depth sodium-bicarbonate water, and deep sodium-chloride type water (Reference 2.3.3-12). The transition to sodium-chloride type water occurs below approximately 300 ft and thus is not intercepted by onsite monitoring wells. A study of groundwater circulation in the deep system was conducted on the ORR, which included one well adjacent to the site (GW-214) (Reference 2.3.3-13). This well appears to be at the top of the saline zone (sodium-chloride type water) at a depth of 393 ft with a total dissolved solids measurement of 1693 ppm. The results of this study indicated that some active exchange of water from the shallower groundwater is occurring. This exchange was characterized as highly variable as a result of the paucity of vertically interconnecting fractures. A more recent study performed as part of the Melton Valley exit pathway monitoring program indicated a similar depth to saline groundwater (385 ft for monitoring well OMW1c) (Reference 2.3.3-14).

2.3.3.2.1.3 Site Hydrogeochemical Characteristics

Site-specific groundwater chemistry data were collected from selected onsite observation wells (Reference 2.3.3-15). Table 2.3.3-9 summarizes the field parameter measurements for the selected wells. Table 2.3.3-10 summarizes the analytical results. Regional groundwater chemistry information was obtained from the USGS National Water-Quality Assessment Program (NAWQA) website for groundwater analyses from Roane, Anderson, and Knox counties to compare with the site-specific data. The results of these analyses are presented on a Piper trilinear diagram shown on Figure 2.3.3-2 (Reference 2.3.3-16). The site groundwater ranges mostly from calcium-bicarbonate to magnesium-bicarbonate type. The water is generally near neutral pH with a total dissolved solids concentration of less than 500 ppm. Examination of the figure indicates that, in general, the site groundwater chemistry is similar to the regional information from NAWQA. A notable exception is OW-202L, which is based on water chemistry, appears to be associated with the intermediate depth groundwater zone as defined on the ORR with a sodium-bicarbonate water type, alkaline pH, and higher total dissolved solids concentration. OW-202L was purged dry during sampling and had the highest field turbidity and pH measurement of the wells sampled (Table 2.3.3-9).

2.3.3.2.2 Groundwater Quality

2.3.3.2.2.1 Local Groundwater Quality

The CRN Site is located adjacent to the ORR which includes three DOE facilities: the Oak Ridge National Laboratory (ORNL), the Y-12 National Security Complex (Y-12), and the East Tennessee Technology Park (ETTP). The ORNL is composed of subareas including Melton Valley, Bethel Valley, and White Oak Creek. The Y-12 facility includes Bear Creek Valley, Upper East Fork Poplar Creek, and Chestnut Ridge. These facilities were constructed as part of the Manhattan Project during World War II and were involved with nuclear weapons production and research. A variety of chemicals and radionuclides are present at the sites. The primary classes of contaminants present include VOCs and radionuclides (primarily uranium, tritium, and strontium-90). Figure 2.3.3-3 presents a map showing the major groundwater plumes associated with the facilities (Reference 2.3.3-17). Examination of the map with respect to the location of the CRN Site indicates that none of the major groundwater plumes are impacting the site area.

2.3.3.2.2.2 Site Groundwater Quality

To support the evaluation of the suitability of the proposed SMR site, the CRN Site field investigation includes monitoring groundwater at the CRN Site. As discussed in Subsection 2.3.1.2.1.4.2 and shown in Figure 2.3.1-18, observation wells were installed across the CRN Site to characterize the groundwater. Analytical results of quarterly sampling provide information on baseline groundwater conditions for the site.

<u>Legacy Contaminants</u>

Current groundwater conditions at the CRN Site are influenced through proximity to ORR. As mentioned in Subsection 2.3.3.2.2.1, legacy contaminants from historic ORR operations include VOCs and radionuclides associated with the facilities. Contaminant plumes on ORR include volatile organic compounds along with cesium-137, strontium-90, and tritium at ORNL. Contaminant plumes at Y-12 include uranium, nitrate, and mercury. Plumes at ETTP also include chromium-6 and technetium-99. (Reference 2.3.3-18) In addition, the regularly maintained, fenced White Oak Dam complex continues to settle legacy ORNL contaminants into the sediment of its 25-ac lake and, potentially, groundwater in the region. Groundwater monitoring, assessment, and corrective action are ongoing at the ORR sites.

Legacy groundwater contaminant plumes also include the former American Nuclear Corporation, located 15 mi southwest of the CRN Site on Braden Branch Creek near CRM 50.5. From 1962 until 1970, American Nuclear Corporation produced radioactive sources and detectors. In 1970, contamination entering the Clinch River was traced to the American Nuclear Corporation, the operational license was revoked, and the plant closed. The plant was cleaned and fenced to allow the radioactive materials to decay in place. Contaminants include cobalt-60 and cesium-137. (Reference 2.3.3-19)

Monitoring Network Baseline

Observation wells were sampled on a quarterly basis by TVA from December 2013 through November 2014 to help characterize seasonal variations throughout the annual cycle to baseline current groundwater conditions (Reference 2.3.3-18). Sampling events were performed in December 2013 to January 2014, in April 2014, in August 2014, and in November 2014 to characterize groundwater conditions in winter, spring, summer, and fall, respectively. Groundwater samples were collected using a submersible bladder pump. Each well was evacuated until field parameters stabilized; field parameters included sample depth, temperature, pH, oxidation-reduction potential, specific conductance, dissolved oxygen, and turbidity. Once stabilized, analytical samples were collected. Sample analysis included volatile organic compounds, semivolatile organic compounds, pesticides, PCBs, total petroleum hydrocarbons, metals, cyanide, radionuclides, and polycyclic aromatic compounds. (Reference 2.3.3-18)

The baseline range of field parameters for groundwater is summarized in Table 2.3.3-11. A more detailed summary, detailing data by sample depth and season is shown in Table 2.3.3-12.

Unlike most of the other field parameters, the minimum and maximum groundwater sample temperatures overlap during the annual cycle as shown in Table 2.3.3-13. Minimum temperatures range from 8.36 to 20.74 degrees Celsius (°C; 47.05 to 69.33 degrees Fahrenheit [°F]) and maximum temperatures range from 13.7 to 24.44°C (56.66 to 75.99°F). The effect of well depth on the seasonal variance in temperatures is not apparent due to the wide range in depths for each well designation (i.e., upper, lower, and deep). Wells designated as upper had depths ranging from 8.76 to 31.5 m, while lower wells ranged from 35.97 to 50.3 m and deep wells ranged from 57.3 to 80 m; thus making the depth ranges rather continuous and less discrete.

As presented in TVA's Groundwater Quality Monitoring Report, analytical results of the 2013/2014 baseline sampling summarized in Table 2.3.3-14, were examined for legacy contaminants and for detections exceeding drinking water maximum contaminant levels (MCLs). A detailed summary of sampling results is presented in Appendix 2.3.3-2-A. Only two detected analytes exceeded their MCL. Five fluoride results exceeded the MCL of 4 μg/L; ranging from 6.9 to 14.2 μg/L with the smallest exceedance from the OW422D well and the other four from the OW415L well. Lead had three detections, 5.5, 10.6, and 120 μg/L, with the maximum detection from the fall sampling of OW419U exceeding lead's action level of 15 μg/L. (Reference 2.3.3-18)

A summary of legacy contaminant detections is presented in Table 2.3.3-15. Of the regional legacy contaminants, none of the wells had detections of mercury or uranium. Similarly, none of the wells had detections of trichloroethylene or 1,1-dichloroethane. Detected legacy volatile organic compounds were limited to a solitary detection of tetrachloroethylene, along with twenty-two low level chloroform detections. Additionally, some wells exhibited nitrate detections; all low level. Detected legacy metals include a solitary arsenic detection, along with two detections of cadmium. Barium was detected at low levels in several wells and chromium had five detections. The legacy radionuclides tritium, strontium 90, and technetium 99 were detected a few times.

Table 2.3.3-16 presents a summary of detected analytes.

Well Cluster 422

During the CRN Site subsurface investigation, a three-well cluster was installed east of the OW-101 well cluster, at boring location MP-422 (OW-422 U, L, and D). Following drilling, wells were scheduled to be completed by casing, screening, filtering, sealing, and packing to produce a viable groundwater monitoring well. During well completion, groundwater contamination was observed in OW-422L. TDEC was notified and was provided with the results of well sampling. The contamination was determined to be non-radiological, petroleum products (gasoline range organics). Due to the contamination in OW-422L, this well cluster (OW-422 U, L, and D) was not developed; however, the well cluster remains in place, locked and under TVA control. TVA has no plans to perform any additional work in the location, and TDEC will make a determination regarding the disposition of the well cluster. Because the wells were not developed and monitoring of water levels in these wells was not performed, the OW-422 well series is not included in the discussion of site observation wells. Well clusters OW-428 and OW-429 (installed north and south of the OW-422 cluster) were installed to provide replacement geological/groundwater data. (Reference 2.3.3-18)

Some permanent observation well clusters (OW-428 and OW429), located in the area around OW-422, were sampled after well development and no evidence of petroleum products (gasoline range organics) was observed in January 2014. The contamination seems to be restricted to the immediate area around well OW-422. No evidence of petroleum products (gasoline range organics) was observed before or after the 72-hour (hr) pumping test conducted near the OW-428 U,L, and D well cluster (up dip [higher in the geologic unit] of OW-422L). Water quality sampling in discharge water from the 72-hr pumping test also showed no detection of volatile organic compounds. Finally, gross alpha and beta radionuclides were below minimum detectable concentration levels in the discharge water from the pumping test. Therefore, the contamination seems to be a localized issue around well OW-422.

2.3.3.3 References

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Reference 2.3.3-18. Fisher, Anna B., "Clinch River Small Modular Reactor Site - Groundwater Quality Monitoring Report - Revision 3," May 9, 2017.

Reference 2.3.3-19. Oak Ridge Site Specific Advisory Board, Two Studies on Historic Preservation Offer Suggestions for K-25/Oak Ridge Reservation, Website: http://energy.gov/sites/prod/files/2013/11/f5/April_11.pdf, April, 2011.

Reference 2.3.3-20. Hem, J., "Study and Interpretation of the Chemical Characteristics of Natural Water, Water-Supply Paper 2254," U.S. Geological Survey (Third Edition): 1-272, 1985.

Table 2.3.3-1
Surface Water Bodies near CRN Site listed in 2012 303(d)

Water Body	Acres	Characteristics that Violate Water Quality Standards
Watts Bar Reservoir	34,075	PCBs in sediment
Fort Loudoun Reservoir	14,066	PCBs in sediment
	534	Atmospheric deposition of mercury
Tellico Reservoir	16,500	PCBs in sediment and atmospheric deposition of mercury
Norris Reservoir	23,198	Atmospheric deposition of mercury
Upper Clinch River	16.88 (river miles)	Loss of native mussel species
Poplar Creek Embayment of Watts Bar Reservoir	141	PCBs from an industrial point source, mercury in contaminated sediments
Clinch River arm of Watts Bar Reservoir	2682	PCBs from industrial point source, chlordane in contaminated sediment, and atmospheric deposition of mercury
Melton Hill Reservoir	5960	PCBs and chlordane in contaminated sediment
Whiteoak Creek	5.3 (river miles)	Cesium, strontium, and loss of biological integrity
Emory River Arm of Watts Bar Reservoir	283.36	Mercury, PCBs, and chlordane from an industrial point source, atmospheric deposition, and contaminated sediments
	454.98	Arsenic, coal ash, aluminum, mercury, PCBs, and chlordane from various sources (including the 2008 Kinston coal ash spill)
	362.64	Mercury, PCBs, and chlordane from atmospheric deposition and contaminated sediments

Source: (Reference 2.3.3-4)

Table 2.3.3-2 (Sheet 1 of 2)
Maximum Concentrations for Quarterly Surface Water Samples at the CRN Site
(July 2013; March, May, November 2014; and February, April, and June, 2015)

Parameter	CRS8 Maximum	CRS9 Maximum	CRS10 Maximum	CRS12 Maximum	Most Stringent TDEC Numeric Criterion	Comments
Temperature, °C (°F)	24.5 (76.1)	22.3 (72.1)	24.5 (76.1)	26.8 (80.2)	30.5 (86.9)	
pH (SU)	6.4-7.7	6.6 - 7.7	6.1-7.0	6.3-7.3	6.0 - 9.0	
Oil and Grease (mg/L)	< 5.3	< 5.3	< 5.0	< 5.0	NANA	
Cyanide (mg/L)	< 0.005	< 0.005	< 0.005	< 0.005	0.0052	
T. Phenols (mg/L)	0.059	0.14	< 0.010	< 0.010	10	
BOD (mg/L)	< 5.0	< 5.0	< 2.0	8.85	NA	
TSS (mg/L)	< 5.0	4.6	13.4	4.4	NA	
Color (PC Units)	5.0	20	50	5.0	NA	
Bromide (mg/L)	< 1.0	< 1.0	0.10	0.10	NA	
Surfactants (mg/L)	< 0.20	0.20	< 0.20	< 0.20	NA	
TOC (mg/L)	13.1	13.0	13.2	18.1	NA	
Sulfide (mg/L)	< 0.10	< 0.10	< 0.10	< 0.10	NA	
Ammonia-N (mg/L)	0.21	< 0.10	< 0.10	< 0.10	1.24	Calculated for pH 8 and 25°C
Nitrate/Nitrite (mg/L)	1.5	1.1	0.47	0.49	10	
T. Organic Nitrogen (mg/L)	< 0.50	< 0.50	< 0.50	< 0.50	NA	
Total Kjeldahl Nitrogen (mg/L)	< 0.50	< 0.50	< 0.50	< 0.50	NA	
T. Phosphorus (mg/L)	< 0.10	< 0.10	< 0.050	< 0.050	NA	
COD (mg/L)	< 25	< 25	< 25	< 25	NA	
T. Fluoride (mg/L)	< 0.50	< 0.50	< 0.50	< 0.50	NA	
Sulfate (mg/L)	22.3	22.3	24.3	22.30	NA	
Metals (mg/L)						
T. Aluminum	0.121	0.172	0.747	0.0873	NA	
T. Magnesium	11.4	11.0	11.1	11.2	NA	
T. Calcium	39.1	38.9	37.7	38.8	NA	
T. Iron	0.191	0.232	0.149	0.164	NA	
T. Copper	< 0.0010	0.0010	0.0015	0.0011	0.009	Based on 100 mg/L TH
T. Zinc	< 0.010	0.010	< 0.0050	0.005	0.120	Based on 100 mg/L TH

Table 2.3.3-2 (Sheet 2 of 2)
Maximum Concentrations for Quarterly Surface Water Samples at the CRN Site
(July 2013; March, May, and November 2014; and February, April, and June, 2015)

Parameter	CRS8 Maximum	CRS9 Maximum	CRS10 Maximum	CRS12 Maximum	Most Stringent TDEC Numeric Criterion	Comments
T. Barium	0.0375	0.0372	0.0366	0.0384	2.0	
T. Boron	< 0.20	< 0.20	0.05	0.050	NA	
T. Cobalt	< 0.0010	0.0010	0.0010	0.0010	NA	
T. Manganese	0.0594	0.0436	0.895	0.060	NA	
T. Molybdenum	0.0010	< 0.0020	0.0010	0.0010	NA	
T. Tin	< 0.050	0.050	0.050	0.050	NA	
T. Titanium	< 0.010	< 0.010	< 0.010	< 0.010	NA	
T. Antimony	< 0.0010	0.0010	0.0010	0.0010	0.006	
T. Arsenic	< 0.0010	< 0.0010	< 0.0010	< 0.0010	0.010	
T. Beryllium	< 0.0010	0.0010	0.00010	0.00010	0.004	
T. Cadmium	< 0.00050	< 0.00050	0.00010	0.00010	0.00025	See note below
T. Chromium	0.0014	0.0010	0.0012	0.0010	0.011	Criterion for Cr_{+6}
T. Lead	0.0010	0.0010	0.0021	0.0010	0.003	
T. Mercury						
LL Mercury (ng/L)	0.934	0.5420	5.08	5.33	50	Based on 100 mg/L TH
T. Nickel	0.0010	0.0010	0.0010	0.0010	0.052	Based on 100 mg/L TH
T. Selenium	0.0010	0.0010	0.0010	0.0010	0.005	
T. Silver	< 0.00050	< 0.00050	0.00010	0.00010	0.0032	Based on 100 mg/L TH
T. Thallium	0.0010	0.0010	0.0010	0.0010	0.00024	Criterion is below RL
T. Hardness	143	143	140	143	NA	
Radioactivity						
Gross Alpha (ρCi/L)	<MDC	<MDC	<MDC	<MDC	NA	
Gross Beta (ρCi/L)	2.85 ± 1.05	<MDC	2.31 ± 1.11	<MDC	NA	
Total Alpha Radium (ρCi/L)	<MDC	<MDC			NA	
Radium 226 (ρCi/L)	<MDC	<MDC	<MDC	0.719 ± 0.217	NA	
Radium 228 (ρCi/L)	<MDC	<MDC	<MDC	<MDC	NA	

Source: (Reference 2.3.3-8)

Table 2.3.3-3 (Sheet 1 of 2)
Maximum Concentrations for Quarterly Stormwater Samples at the CRN Site
(July 2013, and March, May, and November 2014)

Parameter	CRS1 Maximum	CRS2 Maximum	CRS3 Maximum	CRS6 Maximum	CRS11 Maximum	Most Stringent TDEC Numeric Criterion	Comments
Temperature, °C (°F)	24.7 (76.5)	31.3 (88.3)	23.9 (75.0)	21.1 (70.0)	12.0 (53.6)	30.5 (86.9)	WQC apply in-stream
pH (SU)	6.8 - 7.3	6.7 - 8.1	6.7 - 7.6	6.8 - 7.3	6.7	6.0 - 9.0	
Oil and Grease (mg/L)	< 5.3	< 5.6	< 5.3	< 5.3	< 5.0	NA	
Cyanide (mg/L)	< 0.0050	< 0.0050	< 0.0050	< 0.0050	< 0.0050	0.0052	
T. Phenols (mg/L)	0.071	0.054	0.083	0.064	< 0.010	10	
BOD (mg/L)	< 5	< 5	< 5	< 5	< 2.0	NA	
TSS (mg/L)	26.2	69.8	114	77.1	5.7	NA	
Color (PC Units)	80	40	45	50	5.0	NA	
Bromide (mg/L)	< 1.0	< 1.0	< 1.0	2.0	0.10	NA	
Surfactants (mg/L)	0.14	< 2.0	0.13	0.16	< 0.20	NA	
TOC (mg/L)	26.5	37.0	21.9	24.2	11.0	NA	
Sulfide (mg/L)	< 0.10	< 0.10	< 0.10	< 0.10	< 0.10	NA	
Ammonia-N (mg/L)	0.12	0.13	< 0.10	< 0.10	< 0.10	1.24	For pH 8 and 25°C
Nitrate/Nitrite (mg/L)	0.48	0.95	0.24	0.25	0.027	10	
T. Organic Nitrogen (mg/L)	1.1	< 0.50	0.62	0.65	< 0.50	NA	
Total Kjeldahl Nitrogen (mg/L)	1.1	< 0.50	0.62	0.65	< 0.50	NA	
T. Phosphorus (mg/L)	0.11	0.11	0.23	0.13	< 0.050	NA	
COD (mg/L)	43.0	61.0	42.0	62.0	< 25.0	NA	
T. Fluoride (mg/L)	< 0.50	0.25	< 0.50	0.17	< 0.50	NA	
Sulfate (mg/L)	22.8	130	128	16.0	9.10	NA	
Metals (mg/L)							
T. Aluminum	0.531	1.37	2.18	1.77	0.0658	NA	
T. Magnesium	16.4	31	33.1	10.4	6.99	NA	
T. Calcium	59.2	52.2	87.3	76.5	23.2	NA	
T. Iron	0.702	1.8	2.88	1.84	1.98	NA	
T. Copper	0.0016	0.0024	0.0050	0.0021	0.0010	0.009	Based on 100 mg/L TH
T. Zinc	0.0075	0.0078	0.025	0.0115	0.0062	0.120	Based on 100 mg/L TH

**Table 2.3.3-3 (Sheet 2 of 2)
Maximum Concentrations for Quarterly Stormwater Samples at the CRN Site
(July 2013, and March, May, and November 2014)**

Parameter	CRS1 Maximum	CRS2 Maximum	CRS3 Maximum	CRS6 Maximum	CRS11 Maximum	Most Stringent TDEC Numeric Criterion	Comments
T. Barium	0.046	0.051	0.041	0.0815	0.0446	2.0	
T. Boron	< 0.20	< 0.20	< 0.20	< 0.20	0.050	NA	
T. Cobalt	0.0010	0.0010	0.005	0.0010	0.0019	NA	
T. Manganese	0.136	0.040	0.175	0.0655	0.884	NA	
T. Molybdenum	< 0.0020	< 0.0020	< 0.0020	0.0012	0.0010	NA	
T. Tin	0.050	0.050	0.050	0.050	0.050	NA	
T. Titanium	0.0197	0.0353	0.0369	0.0332	< 0.010	NA	
T. Antimony	0.0010	0.0010	0.0010	0.0010	0.0010	0.006	
T. Arsenic	0.0010	0.0010	0.0050	0.0015	< 0.0010	0.010	
T. Beryllium	< 0.0010	< 0.0010	0.00018	< 0.0010	0.00010	0.004	
T. Cadmium	< 0.00050	< 0.00050	< 0.00050	< 0.00050	0.00010	0.00025	
T. Chromium	0.0010	0.0019	0.005	0.0023	0.0010	0.011	Criterion for Cr+6
T. Lead	0.0010	0.0010	0.0030	0.0017	0.0010	0.0025	Based on 100 mg/L TH
T. Mercury					1.22		
LL Mercury (ng/L)	4.17	3.96	5.64	2.83	1.22	50	
T. Nickel	0.0010	0.0021	0.0050	0.0024	0.0012	0.052	Based on 100 mg/L TH
T. Selenium	0.0018	0.0010	0.0050	0.0033	0.0010	0.005	
T. Silver	< 0.00050	< 0.00050	0.00050	< 0.00050	0.00010	0.0032	Based on 100 mg/L TH
T. Thallium	0.0010	0.0010	0.0010	0.0010	0.001	0.00024	Criterion is below RL
T. Hardness	201	186	324	216	86.8	NA	
Radioactivity							
Gross Alpha (ρCi/L)	<MDC	<MDC	2.39 ± 1.21	1.50 ± 0.890	<MDC	NA	
Gross Beta (ρCi/L)	3.12 ± 1.41	2.18 ± 1.10	2.69 ± 1.20	2.85 ± 1.28	<MDC	NA	
Total Alpha Radium (ρCi/L)	<MDC	<MDC	<MDC	<MDC		NA	
Radium 226 (ρCi/L)	<MDC	<MDC	<MDC	<MDC	<MDC	NA	
Radium 228 (ρCi/L)	<MDC	<MDC	<MDC	<MDC	<MDC	NA	

Notes:
NA = Not applicable
Source: (Reference 2.3.3-8)

Table 2.3.3-4 (Sheet 1 of 3)
Analytical Results for Standard Water Quality Parameters and Chlorophyll a in Samples Collected Monthly March through December 2011 at CRM 15.5, 18.5, 19.7 and 22.0

Parameter			Alkalinity	Ammonia Nitrogen	Dissolved Solids	Hardness, Total (as CaCO3)	Kjeldahl Nitrogen, TKN	Nitrate-Nitrite	Phosphate,Ortho	Phosphorus,Total	Suspended Solids	Total Organic Carbon	Turbidity	Apparent Chlorophyll a	Corrected Chlorophyll a	Corrected Phaeo a
Units			**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**mg/L**	**NTU**	**µg/L**	**µg/L**	**µg/L**
Reporting Limit			**20**	**0.1**	**10**	**30**	**0.1**	**0.1**	**0.025**	**0.003**	**1.0**	**1.0**	**0.1**	**1.0**	**1.0**	**1.0**
Location	**QC**	**Date**														
CRM 15.5		03/24/2011	120	<0.10	170	NM	<0.10	0.48	<0.025	0.005	2.8	1.4	4.9	1	<1.0	<1.0
		4/26/2011	120	<0.10	170	140	0.14	0.52	<0.025	0.01	6.5	3.6	7.5	2	1	1.4
		5/24/2011	110	---	170	140	0.41	0.6	<0.025	0.006	2.9	1.4	2.7	2	1	<1.0
		6/21/2011	110	0.17	160	140	0.33	0.47	<0.025	0.029	3	2.6	4.9	<1.0	<1.0	2
		7/18/2011	100	0.13	200	140	0.44	0.51	<0.025	0.015	3.4	1.3	4	2	1	<1.0
	T1	8/22/2011	100	0.11	200	140	0.49	0.58	<0.025	0.018	1.9	1.2	1.8	1	<1.0	<1.0
	T2	8/22/2011	110	<0.10	190	140	0.36	0.58	<0.025	0.016	2	1.2	1.9	2	<1.0	1.3
	T3	8/22/2011	110	<0.10	190	140	0.36	0.59	<0.025	0.016	2.4	1.2	2.1	2	1	1.2
		9/19/2011	95	0.11	160	140	0.37	0.49	<0.025	0.022	2	2.5	0.7	2	1	<1.0
		10/11/2011	110	0.16	160	150	0.38	0.35	<0.025	0.005	1.5	3.5	1.5	1	<1.0	<1.0
		11/10/2011	110	---	160	160	0.79	0.36	<0.025	0.01	2.2	3.2	3.5	1	1	<1.0
		12/13/2011	110	0.11	170	150	<0.10	0.56	<0.025	0.01	4	2.8	6.4	1	<1.0	<1.0
CRM 18.5		3/24/2011	130	0.15	170	NM	0.18	0.48	<0.025	0.012	8.4	1.5	12	2.0	1.0	1.4
		4/26/2011	120	<0.10	170	140	0.14	0.53	<0.025	0.006	11.0	3.3	8.0	2.0	2.0	<1.0
	T1	05/24/2011	110	<0.10	170	140	0.13	0.61	<0.025	0.005	1.8	1.4	1.6	1.0	1.0	<1.0
	T2	05/24/2011	110	0.11	150	140	0.13	0.61	<0.025	0.005	1.5	1.3	1.3	1.0	<1.0	<1.0
	T3	05/24/2011	110	<0.10	160	140	0.20	0.61	<0.025	<0.003	1.6	1.4	1.6	1.0	<1.0	<1.0
		6/21/2011	110	0.11	170	140	0.31	0.44	<0.025	0.018	2.5	1.4	3.4	1.0	<1.0	<1.0
		7/18/2011	100	---	200	140	0.71	0.53	<0.025	0.048	2.5	1.6	2.1	2.0	1.0	<1.0
		8/22/2011	110	0.14	190	140	0.42	0.61	<0.025	0.02	2.8	1.2	2.2	2.0	1.0	1.2

Table 2.3.3-4 (Sheet 2 of 3)
Analytical Results for Standard Water Quality Parameters and Chlorophyll a in Samples Collected Monthly March through December 2011 at CRM 15.5, 18.5, 19.7 and 22.0

Parameter			Alkalinity	Ammonia Nitrogen	Dissolved Solids	Hardness, Total (as CaCO3)	Kjeldahl Nitrogen, TKN	Nitrate-Nitrite	Phosphate,Ortho	Phosphorus,Total	Suspended Solids	Total Organic Carbon	Turbidity	Apparent Chlorophyll a	Corrected Chlorophyll a	Corrected Phaeo a
Units			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	NTU	µg/L	µg/L	µg/L
Reporting Limit			20	0.1	10	30	0.1	0.1	0.025	0.003	1.0	1.0	0.1	1.0	1.0	1.0
Location	QC	Date														
CRM 18.5 (cont'd)		9/19/2011	97	<0.10	160	130	0.34	0.54	<0.025	0.027	1.5	2.6	0.6	1.0	<1.0	<1.0
		10/11/2011	110	<0.10	160	150	0.31	0.34	<0.025	0.005	1.5	1.8	1.6	2.0	1.0	<1.0
		11/10/2011	120	0.12	160	150	0.25	0.35	<0.025	0.008	1.1	3.1	2.6	1.0	<1.0	<1.0
		12/13/2011	110	<0.10	180	140	<0.10	0.54	<0.025	0.010	3.5	2.2	9.8	<1.0	<1.0	<1.0
CRM 19.7		3/25/2011	130	<0.10	170	NM	<0.10	0.7	<0.025	<0.003	2.5	1.3	2.9	<1.0	<1.0	<1.0
		4/26/2011	120	<0.10	180	140	0.31	0.52	<0.025	<0.003	2.8	3.1	2.9	2.0	2.0	<1.0
		5/23/2011	110	---	170	140	0.12	0.5	<0.025	0.006	3.0	1.4	3.3	3.0	<1.0	6.5
		6/20/2011	100	0.17	160	140	<0.10	0.5	<0.025	0.010	3.4	1.8	2.9	2.0	2.0	<1.0
		7/19/2011	100	0.14	180	140	0.27	0.54	<0.025	0.021	1.2	1.4	1.7	1.0	1.0	<1.0
		8/22/2011	110	0.19	200	140	0.38	0.6	<0.025	0.03	4.5	1.2	5.6	3.0	2.0	2.3
		9/19/2011	97	<0.10	160	130	0.37	0.51	<0.025	0.024	1.7	2.7	0.7	2.0	1.0	<1.0
		10/11/2011	110	<0.10	170	150	0.35	0.36	<0.025	0.007	1.1	1.8	1.1	1.0	2.0	<1.0
		11/10/2011	110	0.11	160	150	0.28	0.34	<0.025	0.012	1.1	3.0	3.6	<1.0	<1.0	<1.0
		12/13/2011	110	<0.10	160	140	0.11	0.53	<0.025	0.011	3.1	2.0	7.5	1.0	<1.0	1.2
CRM 22.0		3/25/2011	130	<0.10	170	NM	0.11	0.66	<0.025	0.004	3.1	1.4	3.8	1.0	<1.0	<1.0
		4/26/2011	120	<0.10	170	140	0.38	0.53	<0.025	<0.003	2.2	2.9	2.8	2.0	2.0	<1.0
		5/23/2011	110	<0.10	170	130	0.15	0.49	<0.025	0.010	3.2	1.4	5.0	4.0	3.0	1.3
		6/20/2011	100	0.12	170	140	0.19	0.49	<0.025	0.010	2.0	2.1	2.1	2.0	2.0	<1.0
		7/19/2011	110	0.12	190	140	0.25	0.58	<0.025	0.015	1.9	1.3	2.1	2.0	1.0	<1.0
		8/22/2011	110	<0.10	200	150	0.34	0.57	<0.025	0.027	4.3	1.2	4.9	5.0	5.0	1.3

Table 2.3.3-4 (Sheet 3 of 3)
Analytical results for Standard Water Quality Parameters and Chlorophyll a in Samples Collected Monthly March through December 2011 at CRM 15.5, 18.5, 19.7 and 22.0

Parameter			Alkalinity	Ammonia Nitrogen	Dissolved Solids	Hardness, Total (as CaCO3)	Kjeldahl Nitrogen, TKN	Nitrate-Nitrite	Phosphate,Ortho	Phosphorus,Total	Suspended Solids	Total Organic Carbon	Turbidity	Apparent Chlorophyll a	Corrected Chlorophyll a	Corrected Phaeo a
Units			mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	NTU	µg/L	µg/L	µg/L
Reporting Limit			20	0.1	10	30	0.1	0.1	0.025	0.003	1.0	1.0	0.1	1.0	1.0	1.0
Location	QC	Date														
CRM 22.0 (cont'd)		9/19/2011	96	0.11	160	130	0.41	0.52	<0.025	0.032	1.8	2.8	2.1	<1.0	<1.0	<1.0
		10/11/2011	110	<0.10	170	150	0.40	0.39	<0.025	0.014	1.2	2.4	1.1	1.0	1.0	<1.0
		11/10/2011	110	0.11	160	150	0.22	0.35	<0.025	0.018	1.2	2.6	1.9	1.0	1.0	<1.0
		12/13/2011	110	<0.10	170	150	0.14	0.52	<0.025	0.008	3.6	2.8	7.8	1.0	1.0	<1.0
Container Blank		5/25/2011	<20	<0.10	<10	<30	<0.10	<0.10	<0.025	<0.003	<1.0	<1.0	<0.1	NM	NM	NM
Container Blank		8/23/2011	<20	<0.10	<10	<30	<0.10	<0.10	<0.025	<0.003	<1.0	<1.0	0.2	NM	NM	NM

Notes:
T1, T2, and T3 are Triplicate Samples that are three distinct samples, each collected separately and in the same manner.
Container Blanks are sample containers filled with deionized (DI) water directly from the DI system.
NM = Not Measured.
Symbol (---) = Non-reportable results.

Source: (Reference 2.3.3-8)

Table 2.3.3-5 (Sheet 1 of 2)
Concentrations of Total and Dissolved Metals in Water Samples Collected Bi-Monthly April through December 2011 at CRM 15.5, 18.5, 19.7 and 22.0[1]

Metals, Total and Dissolved (µg/IL)			Aluminum	Aluminum, Dissolved	Arsenic	Arsenic, Dissolved	Cadmium	Cadmium, Dissolved	Calcium	Chromium	Chromium, Dissolved	Copper	Copper, Dissolved	Iron	Iron, Dissolved
Method Reporting Limit			**100**	**100**	**1.0**	**1.0**	**0.5**	**0.5**	**500**	**2.0**	**2.0**	**2.0**	**1.0/ 2.0**	**100**	**100**
Location	**QC**	**Date**													
CRM 15.5		4/26/2011	800	<100	<1.0	<1.0	<0.5	<0.5	33000	<2.0	<2.0	<2.0	<1.0	610	<100
		6/21/2011	290	<100	<1.0	<1.0	<0.5	<0.5	33000	<2.0	<2.0	<2.0	2.2 DT	170	<100
	T1	8/22/2011	<100	<100	<1.0	<1.0	<0.5	<0.5	36000	<2.0	<2.0	<2.0	<2.0	<100	<100
	T2	8/22/2011	<100	<100	1.1	<1.0	<0.5	<0.5	37000	<2.0	<2.0	<2.0	<2.0	<100	<100
	T3	8/22/2011	<100	<100	1.0	<1.0	<0.5	<0.5	36000	<2.0	<2.0	<2.0	<2.0	<100	<100
		10/11/2011	<100	<100	<1.0	<1.0	<0.5	<0.5	38000	<2.0	<2.0	<2.0	---	<100	<100
		12/13/2011	170	<100	<1.0	<1.0	<0.5	<0.5	36000	<2.0	<2.0	<2.0	<2.0	230	<100
CRM 18.5		4/26/2011	680	<100	<1.0	<1.0	<0.5	<0.5	33000	<2.0	<2.0	<2.0	<1.0	480	<100
		6/21/2011	170	<100	<1.0	<1.0	<0.5	<0.5	33000	<2.0	<2.0	<2.0	<2.0	<100	<100
		8/22/2011	<100	<100	1.1	<1.0	<0.5	<0.5	35000	<2.0	<2.0	<2.0	<2.0	<100	<100
		10/11/2011	<100	150 DT	<1.0	<1.0	<0.5	<0.5	37000	<2.0	<2.0	<2.0	---	<100	<100
		12/13/2011	180	<100	<1.0	<1.0	<0.5	<0.5	36000	<2.0	<2.0	<2.0	<2.0	200	<100
CRM 19.7		4/26/2011	<100	<100	<1.0	<1.0	<0.5	<0.5	33000	<2.0	<2.0	<2.0	<1.0	120	<100
		6/20/2011	120	<100	<1.0	<1.0	<0.5	<0.5	34000	<2.0	<2.0	<2.0	<2.0	110	<100
		8/22/2011	150	<100	1.1	<1.0	<0.5	<0.5	36000	<2.0	<2.0	<2.0	<2.0	150	<100
		10/11/2011	<100	<100	<1.0	<1.0	<0.5	<0.5	37000	<2.0	<2.0	<2.0	---	<100	<100
		12/13/2011	170	<100	<1.0	<1.0	<0.5	<0.5	35000	<2.0	<2.0	<2.0	<2.0	130	<100
CRM 22.0		4/26/2011	140	<100	<1.0	<1.0	<0.5	<0.5	33000	<2.0	<2.0	<2.0	<1.0	130	<100
		6/20/2011	110	<100	<1.0	<1.0	<0.5	<0.5	34000	<2.0	<2.0	<2.0	<2.0	<100	<100
		8/22/2011	110	<100	<1.0	<1.0	<0.5	<0.5	37000	<2.0	<2.0	<2.0	<2.0	100	<100
		10/11/2011	<100	<100	<1.0	<1.0	<0.5	<0.5	37000	<2.0	<2.0	<2.0	---	<100	<100
		12/13/2011	180	<100	<1.0	<1.0	<0.5	<0.5	36000	<2.0	<2.0	<2.0	<2.0	140	<100
Container Blank		08/23/2011	<100	<100	<1.0	<1.0	<0.5	<0.5	<500	<2.0	<2.0	<2.0	<2.0	<100	<100

Table 2.3.3-5 (Sheet 2 of 2)
Concentrations of Total and Dissolved Metals in Water Samples Collected Bi-Monthly April through December 2011 at CRM 15.5, 18.5, 19.7 and 22.0[1]

Metals, Total and Dissolved (µg/IL)			Lead	Lead, Dissolved	Magnesium	Magnesium, Dissolved	Manganese	Manganese, Dissolved	Nickel	Nickel, Dissolved	Selenium	Selenium, Dissolved	Zinc	Zinc, Dissolved
Method Reporting Limit			1.0	1.0	100	100	10	10	1.0	1.0	1.0	1.0	10	10.0
Location	**QC**	**Date**												
CRM 15.5		4/26/2011	<1.0	<1.0	11000	9900	58	<10	1.3	2.5 DT	<1.0	<1.0	<10	<10
		6/21/2011	8.6	<1.0	10000	11000	29	10	1.0	<1.0	<1.0	<1.0	<10	<10
	T1	8/22/2011	<1.0	<1.0	10000	10000	33	<10	3.1	<1.0	<1.0	<1.0	<10	<10
	T2	8/22/2011	<1.0	<1.0	11000	11000	20	<10	1.1	<1.0	<1.0	<1.0	<10	<10
	T3	8/22/2011	<1.0	<1.0	11000	11000	21	<10	1.4	1.0	<1.0	<1.0	<10	<10
		10/11/2011	<1.0	<1.0	10000	11000	15	42 DT	<1.0	<1.0	<1.0	<1.0	<10	<10
		12/13/2011	<1.0	<1.0	11000	11000	48	<10	<1.0	<1.0	<1.0	<1.0	<10	<10
CRM 18.5		4/26/2011	<1.0	<1.0	10000	10000	42	<10	1.1	1.9 DT	<1.0	<1.0	<10	<10
		6/21/2011	1.4	<1.0	10000	11000	20	<10	1.1	1.1	<1.0	<1.0	<10	<10
		8/22/2011	<1.0	<1.0	10000	10000	31	<10	<1.0	<1.0	<1.0	<1.0	<10	<10
		10/11/2011	<1.0	<1.0	10000	12000	14	<10	<1.0	<1.0	<1.0	<1.0	<10	<10
		12/13/2011	<1.0	<1.0	11000	11000	47	<10	<1.0	<1.0	<1.0	<1.0	<10	<10
CRM 19.7		4/26/2011	<1.0	<1.0	10000	10000	12	<10	<1.0	1.8 DT	<1.0	<1.0	<10	<10
		6/20/2011	<1.0	<1.0	11000	11000	29	<10	<1.0	<1.0	<1.0	<1.0	<10	<10
		8/22/2011	<1.0	1.3 DT	11000	11000	52	<10	1.3	<1.0	<1.0	<1.0	<10	<10
		10/11/2011	<1.0	<1.0	10000	11000	12	<10	<1.0	<1.0	<1.0	<1.0	<10	<10
		12/13/2011	<1.0	<1.0	11000	11000	40	<10	<1.0	<1.0	<1.0	<1.0	<10	<10
CRM 22.0		4/26/2011	<1.0	<1.0	10000	10000	14	<10	1.3	1.9 DT	<1.0	<1.0	<10	<10
		6/20/2011	<1.0	<1.0	11000	11000	24	<10	<1.0	<1.0	<1.0	<1.0	<10	<10
		8/22/2011	<1.0	1.5 DT	10000	11000	46	<10	2.3	<1.0	<1.0	<1.0	<10	<10
		10/11/2011	<1.0	<1.0	11000	12000	17	<10	<1.0	<1.0	<1.0	<1.0	<10	<10
		12/13/2011	<1.0	<1.0	11000	11000	47	<10	<1.0	<1.0	<1.0	<1.0	<10	<10
Container Blank		08/23/2011	<1.0	1.3 DT	<100	<100	**0**	<10	<1.0	<1.0	<1.0	<1.0	<10	<10

[1] Metals samples were not collected during November 2012 to September 2013

Notes: DT= Dissolved fraction exceeded the total recoverable metal concentration. Symbol (---) = Non-reportable results

Source: (Reference 2.3.3-8)

Table 2.3.3-6
Maximum Concentrations of Selected Metals in Water Samples Collected at CRM 15.5, 18.5, 19.7, and 22.0 and Respective Water Quality Criteria for the Protection of Fish and Aquatic Life

State Criteria[1]	Metal	Water Quality Criteria		Maximum Concentration (µg/l)			
		Acute[2] (µg/l)	Chronic[3] (µg/l)	CRM 15.5	CRM 18.5	CRM 19.7	CRM 22.0
West Virginia	Aluminum[4]	750	750	<100	150 DT	<100	<100
Tennessee	Arsenic (III)[4]	340	150	<1.0	<1.0	<1.0	<1.0
	Cadmium[5]	2.60	0.30	<0.5	<0.5	<0.5	<0.5
	Chromium (III)[5]	706	92	<2.0	<2.0	<2.0	<2.0
	Copper[5]	17	11.2	2.2 DT	<2.0	<2.0	<2.0
	Lead[5]	86	3.3	<1.0	<1.0	1.3 DT	1.5 DT
	Nickel[5]	585	65	2.5 DT	1.9 DT	1.8 DT	1.9 DT
	Selenium[6]	20	5	<1.0	<1.0	<1.0	<1.0
	Zinc[5]	146	140	<10	<10	<10	<10

1 The State of West Virginia's criteria for aluminum was used for comparison. The State of Tennessee has not promulgated criteria for aluminum.
2 The acute exposure limit is a one hour average concentration which is not to be exceeded more than once every three years on the average.
3 The chronic exposure limit is a four day average concentration which is not to be exceeded more than once every three years on the average.
4 Criteria for these metals are expressed as dissolved.
5 Criteria for these metals are expressed as dissolved and are a function of total hardness (130 mg/L).
6 Criteria are expressed in terms of total recoverable metal.

Note:
DT = Dissolved fraction exceeded the total recoverable metal concentration in the sample.

Source: (Reference 2.3.3-8)

Table 2.3.3-7 (Sheet 1 of 2)
Pesticide and PCB Concentrations in Sediments Collected at CRM's 15.5, 18.5, and 22.0 in 2011 and at Far-Field Locations (CRM 24.5, TRM 560.8, and TRM 532.5) in 2010 and 2011

			METHOD		Organochlorine Pesticides and PCB's (ug/kg dry weight)											
					(EPA 8081A)				(EPA Method 8082)							
									Polychlorinated Biphenyls (PCB's)							
	Reservoir	Mile No.	Replicate	Collection Date	ENDRIN ALDEHYDE	HEPTACHLOR	HEPTACHLOR EPOXIDE	METHOXYCHLOR	1016	1221	1232	1242	1248	1254	1260	TOTAL
Clinch SMR	Watts Bar	CRM 15.5	1	06/21/2011	< 10	< 10	< 10	< 10	< 25	< 25	< 25	< 25	< 25	< 25	< 25	< 25
Clinch SMR	Watts Bar	CRM 15.5	2	6/21/2011	< 10	< 10	< 10	< 10	< 25	< 25	< 25	< 25	< 25	< 25	< 25	< 25
Clinch SMR	Watts Bar	CRM 18.5	1	6/21/2011	< 10	< 10	< 10	< 10	< 25	< 25	< 25	< 25	< 25	< 25	< 25	< 25
Clinch SMR	Watts Bar	CRM 22.0	1	6/21/2011	< 10	< 10	< 10	< 10	< 25	< 25	< 25	< 25	< 25	< 25	< 25	< 25
Far-field	Melton Hill	CRM 24.0	1	6/21/2011	< 10	< 10	< 10	< 10	< 25	< 25	< 25	310	< 25	< 25	< 25	310
Far-field	Melton Hill	CRM 24.0	1	6/8/2011	< 10	< 10	< 10	< 10	< 25	< 25	< 25	72	< 25	< 25	< 25	72
Far-field	Watts Bar	TRM 532.5	1	6/15/2010	< 10	< 10	< 10	< 10	< 25	< 25	< 25	160	< 25	< 25	< 25	160
Far-field	Watts Bar	TRM 532.5	2	6/15/2010	< 10	< 10	< 10	< 10	< 25	< 25	< 25	150	< 25	< 25	< 25	150
Far-field	Watts Bar	TRM 532.5	1	6/16/2010	< 10	< 10	< 10	< 10	< 25	< 25	< 25	77	< 25	< 25	< 25	77
Far-field	Watts Bar	TRM 560.8	1	6/15/2010	< 10	< 10	< 10	< 10	< 25	< 25	< 25	110	< 25	< 25	< 25	110
Far-field	Watts Bar	TRM 560.8	2	6/15/2010	< 10	< 10	< 10	< 10	< 25	< 25	< 25	140	< 25	< 25	< 25	140
Far-field	Watts Bar	TRM 560.8	1	6/16/2011	< 10	< 10	< 10	< 10	< 25	< 25	< 25	57	< 25	< 25	< 25	57

Table 2.3.3-7 (Sheet 2 of 2)
Pesticide and PCB Concentrations in Sediments Collected at CRM’s 15.5, 18.5, and 22.0 in 2011 and at Far-Field Locations (CRM 24.5, TRM 560.8, and TRM 532.5) in 2010 and 2011

	METHOD				Organochlorine Pesticides and PCB's (ug/kg dry weight) (EPA Method 8081A)														
							Benzene Hexachloride (BHC)						DDT's			Endosulfan			
	Reservoir	Mile No.	Replicate	Collection Date	TOXAPHENE	ALDRIN	ALPHA	BETA	DELTA	GAMMA	CHLORDANE	DIELDRIN	P,P DDD	P,P DDE	P,P DDT	ALPHA	BETA	SULPHATE	ENDRIN
Clinch SMR	Watts Bar	CRM 15.5	1	06/21/2011	< 500	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
	Watts Bar	CRM 15.5	2	6/21/2011	< 500	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
	Watts Bar	CRM 18.5	1	6/21/2011	< 500	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
	Watts Bar	CRM 22.0	1	6/21/2011	< 500	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
Far-field	Melton Hill	CRM 24.0	1	6/21/2011	< 500	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
	Melton Hill	CRM 24.0	1	6/8/2011	< 500	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
	Watts Bar	TRM 532.5	1	6/15/2010	< 500	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
	Watts Bar	TRM 532.5	2	6/15/2010	< 500	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
	Watts Bar	TRM 532.5	1	6/16/2010	< 500	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
	Watts Bar	TRM 560.8	1	6/15/2010	< 500	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
	Watts Bar	TRM 560.8	2	6/15/2010	< 500	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10
	Watts Bar	TRM 560.8	1	6/16/2011	< 500	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10	< 10

Source: (Reference 2.3.3-8)

Table 2.3.3-8
Metals Concentrations in Sediments Collected at CRM's 15.5, 18.5, and 22.0 in 2011 and at Far-Field Locations (CRM 24.5, TRM 560.8, and TRM 532.5) in 2010 and 2011

					Metals (mg/kg, dry weight)												
		METHOD			(EPA 6010)	(EPA 7060)	(EPA 6010)								(EPA 7471)	(EPA 7060)	
	Reservoir	River Mile No.	Replicate	Collection Date	ALUMINUM	ARSENIC	CADMIUM	CALCIUM	CHROMIUM	COPPER	IRON	LEAD	MAGNESIUM	MANGANESE	MERCURY	NICKEL	ZINC
Clinch SMR	Watts Bar	CRM 15.5	1	06/21/2011	4300	1.5	< 0.50	810	7.6	3.1	6500	5.9	650	430	< 0.10	5.7	22
	Watts Bar	CRM 15.5	2	6/21/2011	4800	1.6	< 0.50	1100	12	3.8	7400	6.2	720	480	< 0.10	7.8	24
	Watts Bar	CRM 18.5	1	6/21/2011	10000	6.2	< 0.50	2900	18	8.7	14000	16	1400	1500	< 0.10	14	51
	Watts Bar	CRM 22.0	1	6/21/2011	11000	4.7	< 0.50	2200	14	8.1	15000	16	1400	1100	< 0.10	12	50
Far-field	Melton Hill	CRM 24.0	1	6/21/2011	31000	15	< 0.50	24000	32	41	35000	29	4500	3742	0.1	31	110
	Melton Hill	CRM 24.0	1	6/8/2011	35000	20	< 0.50	20000	31	38	39000	27	3100	3600	0.11	29	120
	Watts Bar	TRM 532.5	1	6/15/2010	43000	18	< 0.50	3500	41	41	45000	28	4100	3100	0.43	33	160
	Watts Bar	TRM 532.5	2	6/15/2010	44000	18	< 0.50	3600	41	41	46000	28	4100	3100	0.42	32	160
	Watts Bar	TRM 532.5	1	6/16/2011	43000	20	0.58	3500	49	51	46000	35	3600	2900	0.31	42	160
	Watts Bar	TRM 560.8	1	6/15/2010	37000	23	< 0.50	4200	38	46	37000	28	3800	2600	0.47	34	150
	Watts Bar	TRM 560.8	2	6/15/2010	38000	24	< 0.50	4000	38	47	37000	28	3700	2700	0.49	34	150
	Watts Bar	TRM 560.8	1	6/16/2011	37000	22	0.71	3800	39	56	41000	34	3500	2900	0.42	39	160
EPA Region 4 Ecological Screening Values (ESV) for Sediment (2001)[1]					NA	7.24	1	NA	52.3	18.7	NA	30.2	NA	NA	0.13	15.9	124

[1] EPA ecological screening values for metals in sediments are provided as a reference only. Since these numbers are based on conservative endpoints and sensitive ecological effects data, they represent a preliminary screening of site contaminant levels. Concentrations that exceed these values are not necessarily above expected background levels for a given region or area.

Source: (Reference 2.3.3-8)

Table 2.3.3-9
Field Geochemical Results

Well Number	Date	Geologic Unit Formation	pH (standard units)	Specific Conductance (µS/cm)1	Turbidity (NTU)	Dissolved Oxygen (ppm)	Temperature, °C (°F)[2]	REDOX (□mv)	Purge Water Appearance
OW-101L	11/19/2013	Chickamauga Rockdell	7.17	620	3.86	0.05	16.5 (61.7)	-152.5	Clear, faint sulfur odor
OW-202L[3]	11/19/2013	Chickamauga Fleanor Member	9.58	978	193.00	5.16	17.0 (62.6)	-116.9	Red, purged dry
OW-401L	11/21/2013	Knox Newala	7.78	340	14.30	4.21	19.5 (67.1)	9.7	Clear
OW-409U	11/19/2013	Chickamauga Rockdell	7.10	672	49.70	45.30[4]	17.2 (63.0)	186.2	Clear
OW-409L	11/18/2013	Chickamauga Rockdell	7.80	849	25.20	3.31	16.0 (60.8)	30.5	Clear
OW-415U	11/20/2013	Chickamauga Bowen/Benbolt	7.24	598	122.00	3.61	17.3 (63.1)	75.7	Clear to slightly cloudy
OW-416L	11/21/2013	Chickamauga Rockdell	7.04	694	1.07	0.25	17.4 (63.3)	-188.1	Clear, sulfur odor
OW-417L	11/21/2013	Chickamauga Fleanor Member	7.21	609	2.55	1.51	16.3 (61.3)	53.4	Clear
OW-418U	11/19/2013	Chickamauga Eidson Member	7.47	517	2.84	1.18	18.8 (65.8)	119.8	Clear
OW-419U	11/20/2013	Knox Newala	6.97	532	1.27	1.15	16.3 (61.3)	63.0	Clear
OW-420L	11/22/2013	Knox Newala	7.56	472	69.90	9.21	17.7 (63.9)	57.5	Clear
OW-421L	11/22/2013	Chickamauga/Knox Blackford/Newala	8.00	400	17.50	8.53	17.0 (62.6)	44.3	Clear
OW-423U	11/19/2013	Chickamauga Eidson Member	6.99	599	5.82	4.70	16.7 (62.1)	90.6	Clear

[1] Specific Conductance in mS/cm converted to Specific Conductance in µS/cm by multiplying by 1000
[2] Values rounded to the nearest 0.1°C and the nearest 0.1°F
[3] Well purged dry; insufficient water for field parameter testing at time of sampling. Values are last before purged dry.
[4] Suspect results – concentration in excess of maximum oxygen saturation value.

Notes: Adapted from (Reference 2.3.3-15) Table 3.2

Table 2.3.3-10 (Sheet 1 of 5)
Laboratory Geochemical Results

Well Number	Date	Geologic Unit Formation	Water Type	Analytical Error[1] %	Nitrate as N ppm	Qualifier[2]	Nitrite as N ppm	Qualifier[2]	Fluoride ppm	Qualifier[2]	Chloride ppm	Qualifier[2]	Bromide ppm	Qualifier[2]
OW-101L	11/19/2013	Chickamauga Rockdell	Calcium-Bicarbonate	12	0.0054	JQ	<0.020	U	0.22		2.1		0.038	JQ
OW-101L Dup	11/19/2013	Chickamauga Rockdell	Calcium-Bicarbonate	3	0.0099	JQ	<0.020	U	0.19		2.1		0.04	JQ
OW-202L	11/22/2013	Chickamauga Fleanor Member	Sodium-Bicarbonate	-3.2	0.028		<0.020	UL	7.4		24		0.17	JQ
OW-401L	11/21/2013	Knox Newala	Calcium-Bicarbonate	1.4	0.15		<0.020	UL	0.20	JH	1.4		<0.25	U
OW-409U	11/19/2013	Chickamauga Rockdell	Calcium-Bicarbonate	12	0.88		<0.020	UL	0.25		1.8		<0.25	U
OW-409L	11/19/2013	Chickamauga Rockdell	Sodium-Bicarbonate	1.1	0.12		0.0052	JQ	0.37		2.2		<0.25	U
OW-415U	11/20/2013	Chickamauga Bowen/Benbolt	Calcium-Bicarbonate	16	0.90		<0.020	UL	0.13		8.8		0.053	JQ
OW-416L	11/21/2013	Chickamauga Rockdell	Calcium-Bicarbonate	-1.7	0.20		<0.020	U	0.39		7.6		0.071	JQ
OW-417L	11/21/2013	Chickamauga Fleanor Member	Calcium-Bicarbonate	-0.76	<0.020	U	<0.020	U	0.18		2.8		0.048	JQ
OW-418U	11/20/2013	Chickamauga Eidson Member	Calcium-Bicarbonate	0.019	0.68		<0.020	U	0.3		2.7		<0.25	U
OW-419U	11/20/2013	Knox Newala	Calcium-Bicarbonate	2.0	0.43		<0.020	U	0.16		1.3		<0.25	U
OW-420L	11/22/2013	Knox Newala	Calcium-Bicarbonate	2.1	0.36	J	<0.020	UL	0.31	JH	2.1	J	<0.25	U
OW-420L Dup	11/22/2013	Knox Newala	Calcium-Bicarbonate	-0.019	0.25	J	<0.020	UL	0.35		2.6	J	<0.25	U
OW-421L	11/22/2013	Chickamauga/Knox Blackford/Newala	Magnesium-Bicarbonate	3.9	1.6		<0.020	UL	0.58		2.6		<0.25	U
OW-423U	11/19/2013	Chickamauga Eidson Member	Calcium-Bicarbonate	4.1	0.14		<0.020	U	0.090	JQ	2.7		<0.25	U

Table 2.3.3-10 (Sheet 2 of 5)
Laboratory Geochemical Results

Well Number	Date	Geologic Unit Formation	Water Type	Analytical Error[1] %	Sulfate ppm	Bicarbonate ppm[3]	Total Alkalinity ppm as $CaCO_3$	Bicarbonate Alkalinity ppm as $CaCO_3$	Carbonate Alkalinity ppm as $CaCO_3$	Qualifier[2]
OW-101L	11/19/2013	Chickamauga Rockdell	Calcium-Bicarbonate	12	42	366	300	300	<5.0	U
OW-101L Dup	11/19/2013	Chickamauga Rockdell	Calcium-Bicarbonate	3	43	354	290	290	<5.0	U
OW-202L	11/22/2013	Chickamauga Fleanor Member	Sodium-Bicarbonate	-3.2	93	732[(4)]	680	600	78	
OW-401L	11/21/2013	Knox Newala	Calcium-Bicarbonate	1.4	6.9	219	180	180	<5.0	U
OW-409U	11/19/2013	Chickamauga Rockdell	Calcium-Bicarbonate	12	83	329	270	270	<5.0	U
OW-409L	11/19/2013	Chickamauga Rockdell	Sodium-Bicarbonate	1.1	150	366	300	300	<5.0	U
OW-415U	11/20/2013	Chickamauga Bowen/Benbolt	Calcium-Bicarbonate	16	36	329	270	270	<5.0	U
OW-416L	11/21/2013	Chickamauga Rockdell	Calcium-Bicarbonate	-1.7	63	366	300	300	<5.0	U
OW-417L	11/21/2013	Chickamauga Fleanor Member	Calcium-Bicarbonate	-0.76	13	390	320	320	<5.0	U
OW-418U	11/20/2013	Chickamauga Eidson Member	Calcium-Bicarbonate	0.019	20	329	270	270	<5.0	U
OW-419U	11/20/2013	Knox Newala	Calcium-Bicarbonate	2.0	17	329	270	270	<5.0	U
OW-420L	11/22/2013	Knox Newala	Calcium-Bicarbonate	2.1	14	280	230	230	<5.0	U
OW-420L Dup	11/22/2013	Knox Newala	Calcium-Bicarbonate	-0.019	15	293	240	240	<5.0	U
OW-421L	11/22/2013	Chickamauga/Knox Blackford/Newala	Magnesium-Bicarbonate	3.9	8.3	256	210	210	<5.0	U
OW-423U	11/19/2013	Chickamauga Eidson Member	Calcium-Bicarbonate	4.1	24	354	290	290	<5.0	U

Table 2.3.3-10 (Sheet 3 of 5)
Laboratory Geochemical Results

Well Number	Date	Geologic Unit Formation	Water Type	Analytical Error[1] %	Ammonia ppm	Qualifier[2]	Total Dissolved Solids ppm	Calcium ppm	Qualifier[2]	Iron ppm	Qualifier[2]
OW-101L	11/19/2013	Chickamauga Rockdell	Calcium-Bicarbonate	12	0.31	J	370	130	J	0.33	
OW-101L Dup	11/19/2013	Chickamauga Rockdell	Calcium-Bicarbonate	3	0.35	J	370	99	J	0.31	
OW-202L	11/22/2013	Chickamauga Fleanor Member	Sodium-Bicarbonate	-3.2	0.58	J	1100	23		19	
OW-401L	11/21/2013	Knox Newala	Calcium-Bicarbonate	1.4	0.140	J	190	40		0.14	
OW-409U	11/19/2013	Chickamauga Rockdell	Calcium-Bicarbonate	12	0.099	J	410	140		0.22	
OW-409L	11/19/2013	Chickamauga Rockdell	Sodium-Bicarbonate	1.1	0.710	J	520	46		0.068	
OW-415U	11/20/2013	Chickamauga Bowen/Benbolt	Calcium-Bicarbonate	16	0.140	J	370	150		0.39	
OW-416L	11/21/2013	Chickamauga Rockdell	Calcium-Bicarbonate	-1.7	0.120	J	420	99		0.072	
OW-417L	11/21/2013	Chickamauga Fleanor Member	Calcium-Bicarbonate	-0.76	0.140	J	340	61		0.041	JQ
OW-418U	11/20/2013	Chickamauga Eidson Member	Calcium-Bicarbonate	0.019	0.059	J	300	52		0.055	
OW-419U	11/20/2013	Knox Newala	Calcium-Bicarbonate	2.0	0.140	J	290	72		0.023	JQ
OW-420L	11/22/2013	Knox Newala	Calcium-Bicarbonate	2.1	0.110	J	270	59		0.25	
OW-420L Dup	11/22/2013	Knox Newala	Calcium-Bicarbonate	-0.019	0.140	J	280	59		0.29	
OW-421L	11/22/2013	Chickamauga/Knox Blackford/Newala	Magnesium-Bicarbonate	3.9	<0.050	UL	230	38		0.23	
OW-423U	11/19/2013	Chickamauga Eidson Member	Calcium-Bicarbonate	4.1	0.083	J	340	99		0.076	

Table 2.3.3-10 (Sheet 4 of 5)
Laboratory Geochemical Results

Well Number	Date	Geologic Unit Formation	Water Type	Analytical Error[1] %	Potassium ppm	Magnesium ppm	Manganese ppm	Sodium ppm	Silicon ppm	Silica ppm
OW-101L	11/19/2013	Chickamauga Rockdell	Calcium-Bicarbonate	12	2.1	23	0.05	7.8	3.9	8.3
OW-101L Dup	11/19/2013	Chickamauga Rockdell	Calcium-Bicarbonate	3	2.1	22	0.048	7.6	4.2	9
OW-202L	11/22/2013	Chickamauga Fleanor Member	Sodium-Bicarbonate	-3.2	14	9.9	0.16	280	82	170
OW-401L	11/21/2013	Knox Newala	Calcium-Bicarbonate	1.4	1.8	22	0.008	0.91	4.7	10
OW-409U	11/19/2013	Chickamauga Rockdell	Calcium-Bicarbonate	12	1.2	23	0.011	4.8	7.6	16
OW-409L	11/19/2013	Chickamauga Rockdell	Sodium-Bicarbonate	1.1	8.1	31	0.017	99	4.6	9.9
OW-415U	11/20/2013	Chickamauga Bowen/Benbolt	Calcium-Bicarbonate	16	2.4	13	0.046	5.2	7.6	16
OW-416L	11/21/2013	Chickamauga Rockdell	Calcium-Bicarbonate	-1.7	0.77	13	0.020	29	5	11
OW-417L	11/21/2013	Chickamauga Fleanor Member	Calcium-Bicarbonate	-0.76	3.4	31	0.021	22	6.1	13
OW-418U	11/20/2013	Chickamauga Eidson Member	Calcium-Bicarbonate	0.019	2.7	19	0.0037	40	8.7	19
OW-419U	11/20/2013	Knox Newala	Calcium-Bicarbonate	2.0	1.5	29	0.0023	0.91	3.2	6.8
OW-420L	11/22/2013	Knox Newala	Calcium-Bicarbonate	2.1	1.8	26	0.033	1.2	4.2	9
OW-420L Dup	11/22/2013	Knox Newala	Calcium-Bicarbonate	-0.019	1.9	26	0.032	1.3	4.4	9.4
OW-421L	11/22/2013	Chickamauga/Knox Blackford/Newala	Magnesium-Bicarbonate	3.9	12	27	0.01	12	6	13
OW-423U	11/19/2013	Chickamauga Eidson Member	Calcium-Bicarbonate	4.1	1.3	19	0.051	8.7	7.2	15

Table 2.3.3-10 (Sheet 5 of 5)
Laboratory Geochemical Results

[1] Analytical error is the difference between the sum of the cations and the sum of the anions divided by the sum of the anions and cations and multiplied by 100% (the anion and cation concentrations are in milliequivalents per liter). The analytical error represents the charge balance error of the analysis.

[2] Data Qualifier Definitions:

J = Estimated quantitation based on associated QC data
JQ = Estimated quantitation; value is between the reporting limit and the detection limit
JH = Estimated quantitation; possibly biased high based on QC data
U = Undetected
UL = Undetected; data biased low: the reporting detection limit is higher than indicated

[3] Bicarbonate concentration determined by dividing the Bicarbonate Alkalinity by 0.8202 (Reference 2.3.3-20)

[4] Bicarbonate concentration is suspect due to high sample pH (pH = 9.58)

Notes:
Dup = Duplicate sample
Data adapted from (Reference 2.3.3-15) Table 5.13

Table 2.3.3-11
Baseline Range of Field Parameters for Groundwater

Baseline Groundwater Conditions	Minimum	Maximum
Temperature, degrees C (degrees F)	8.36 (47.05)	24.44 (75.99)
Oxidation reduction potential (mV)	-19	478
Specific Conductance, Field (umhos/cm)	72.36	4723.2
Oxygen, dissolved (mg/L)	0	13
pH, Field (pH)	5.3	9.7
Turbidity, Field (NTU)	0.9	114

Source: (Reference 2.3.3-18)

Table 2.3.3-12 (Sheet 1 of 2)
Detailed Summary - Baseline Range of Field Parameters for Groundwater

Baseline Groundwater Conditions	Minimum of Temperature, °C (°F)	Maximum of Temperature, °C (°F)	Minimum of Oxidation reduction potential (mV)	Maximum of Oxidation reduction potential (mV)	Minimum of Specific Conductance, Field (umhos/cm)	Maximum of Specific Conductance, Field (umhos/cm)
Winter 2013						
Upper	8.79 (47.82)	16.23 (61.21)	166	478	341.9	938.1
Lower	8.36 (47.05)	13.7 (56.66)	-19	471	72.36	4425
Deep	11.34 (52.41)	24.1 (75.38)	55	331	414.1	808.3
Spring 2014						
Upper	12.03 (53.65)	17 (62.60)	75	414	363	890
Lower	13.19 (55.74)	18.2 (64.76)	47	364	406.1	4338
Deep	15.16 (59.29)	22.37 (72.27)	11	294	408	866.2
Summer 2014						
Upper	16.4 (61.52)	24.1 (75.38)	158	469	369	897.7
Lower	17.48 (63.46)	24.44 (75.99)	67	441	109.3	4723.2
Deep	20.74 (69.33)	22 (71.60)	105	255	446	830
Fall 2014						
Upper	11.7 (53.06)	17.52 (63.54)	138	418	356	870.9
Lower	14 (57.20)	18.3 (64.94)	36	433	392	4651
Deep	12.64 (54.75)	16.45 (61.61)	9	391	405	731.6
All Samples	8.36 (47.05)	24.44 (75.99)	-19	478	72.36	4723.2

Table 2.3.3-12 (Sheet 2 of 2)
Detailed Summary - Baseline Range of Field Parameters for Groundwater

Baseline Groundwater Conditions	Minimum of Oxygen, dissolved (mg/L)	Maximum of Oxygen, dissolved (mg/L)	Minimum of pH, Field (pH)	Maximum of pH, Field (pH)	Minimum of Turbidity, Field (NTU)	Maximum of Turbidity, Field (NTU)
Winter 2013						
Upper	0.4	8.6	6.1	7.2	0.9	46.2
Lower	1.1	8.4	6.4	8.8	5.8	69.7
Deep	0.4	13	5.6	7.3	7.8	55.9
Spring 2014						
Upper	0.1	7.4	6.4	7.3	2.7	68.6
Lower	0.1	7.9	5.3	9.6	9.9	114
Deep	1.7	8.1	6.1	7.4	11.9	20.3
Summer 2014						
Upper	0.5	6.3	6.5	7.1	2.2	46.4
Lower	0.9	8.1	6.8	9.7	6.6	56.2
Deep	0	1.4	6.4	6.9	34	87.1
Fall 2014						
Upper	0.1	6.1	5.4	7.1	1.9	71
Lower	1.5	6.6	5.9	7.3	8.4	38.1
Deep	1.3	4.5	6	7.3	8.6	18.2
All Samples	0	13	5.3	9.7	0.9	114

Source: (Reference 2.3.3-18)

Table 2.3.3-13
Baseline Groundwater Temperatures and Sample Depths

Baseline	Minimum Temperature, °C (°F)	Maximum Temperature, °C (°F)	Average Temperature °C (°F)	Minimum Sample Depth (m)	Maximum Sample Depth (m)	Average Sample Depth (m)
Winter 2013						
Upper	8.79 (47.82)	16.23 (61.21)	11.90 (53.43)	8.76	31.5	18.88315789
Lower	8.36 (47.05)	13.7 (56.66)	11.26 52.27)	35.97	50.3	41.0625
Deep	11.34 (52.41)	24.1 (75.38)	15.65 (60.16)	57.3	80	66.91333333
Spring 2014						
Upper	12.03 (53.65)	17.00 (62.60)	14.12 (57.42)	8.76	31.5	18.358
Lower	13.19 (55.74)	18.20 (64.76)	15.24 (59.42)	35.97	50.3	41.188125
Deep	15.16 (59.29)	22.37 (72.27)	18.47 (65.25)	57.3	70.03	64.296
Summer 2014						
Upper	16.40 (61.52)	24.1 (75.38)	19.80 (67.64)	8.76	31.5	18.11214286
Lower	17.48 (63.46)	24.44 (75.99)	20.21 (68.37)	35.97	50.3	41.63071429
Deep	20.74 (69.33)	22.00 (71.60)	21.25 (70.24)	57.3	70.03	63.07333333
Fall 2014						
Upper	11.70 (53.06)	17.52 (63.54)	15.54 (59.98)	11.8	31.5	19.44
Lower	14.00 (57.20)	18.30 (64.94)	15.72 (60.29)	36	50.3	42.06615385
Deep	12.64 (54.75)	16.45 (61.61)	14.54 (58.17)	57.3	70	64.8

Source: (Reference 2.3.3-18)

Table 2.3.3-14 (Sheet 1 of 6)
Baseline Groundwater Summary

Analyte	MCL	Minimum Detect	Maximum Detect
Temperature, degrees C (degrees F)	NE	8.36 (47.05)	24.44 (75.99)
Oxidation reduction potential (mV)	NE	-19	478
Specific Conductance, Field (umhos/cm)	NE	72.36	4723.2
Oxygen, dissolved (mg/L)	NE	0	13
pH, Field (pH)	NE	5.3	9.7
GW Elevation (m above s/l) (m)	NE	223.81	247.85
Sample Depth (m)	NE	8.8	103.3
Well Depth (m)	NE	5.75	76.28
Water Level Depth (m)	NE	1.18	22.49
Turbidity, Field (NTU)	NE	0.9	114
Anions			
Bromide (mg/L)	NE	0.079	6.46
Chloride, total (mg/L)	NE	0.811	614
Sulfate, total (mg/L)	NE	3.33	2240
Fluoride, total (mg/L)	4	0.085	14.2
General Chemistry			
Color (Pt-Co units)	NE	5	50
Chlorine, Total Residual (mg/L)	NE	0.201	0.307
Biological Oxygen Demand (mg/L)	NE	2	291
COD, Low Level (mg/L)	NE	24.1	58.5
pH, Lab (pH)	NE	5.87	9.94
Phenols, total (ug/L)	NE	74	74
Alkalinity, Lab (mg/L)	NE	158	653
TSS (mg/L)	NE	0.8	1570
Oil & Grease (mg/L)	NE	10.7	10.7
Nitrogen, Ammonia (mg/L)	NE	0.076	12
Nitrite + Nitrate (mg/L)	NE	0.035	2.62
Phosphorus, total (mg/L)	NE	0.106	1.68
Carbon, total organic (mg/L)	NE	0.566	6.78
Cyanide, total (mg/L)	0.2	0.004	0.115
Sulfide, total (mg/L)	NE	ND	ND
Methylene Blue Active Sub	NE	0	0.205

Table 2.3.3-14 (Sheet 2 of 6)
Baseline Groundwater Summary

Analyte	MCL	Minimum Detect	Maximum Detect
Metals (total)			
Aluminum (mg/L)	NE	0.112	10.4
Antimony (ug/L)	6	ND	ND
Arsenic, (ug/L)	10	7	7
Barium (ug/L)	2000	12	582
Beryllium (ug/L)	4	1.4	1.4
Boron (ug/L)	NE	25.9	2170
Cadmium (ug/L)	5	0.3	1.2
Calcium (mg/L)	NE	1.2	187
Chromium (ug/L)	100	5.4	11.6
Cobalt (ug/L)	NE	7.4	7.4
Copper (ug/L)	130	14.8	21.7
Iron (ug/L)	NE	33.5	11900
Lead (ug/L)	15	5.5	120
Magnesium (mg/L)	NE	1.72	65.1
Manganese (ug/L)	NE	7.5	902
Molybdenum (ug/L)	NE	0.9	0.9
Nickel (ug/L)	100	4.9	18.8
Potassium (mg/L)	NE	0.873	33.3
Selenium (ug/L)	50	ND	ND
Silver (ug/L)	100	ND	ND
Sodium (mg/L)	NE	0.812	1650
Thallium (ug/L)	2	ND	ND
Tin (ug/L)	NE	ND	ND
Titanium (ug/L)	NE	36.9	36.9
Zinc (ug/L)	NE	33.8	72.9
Gross Alpha and Gross Beta Radioactivity			
Alpha, total (pCi/L)	NE	2.93	13
Beta, total (pCi/L)	NE	1.13	30.2
Tritium (pCi/L)	NE	284	847
Radium 226, total (pCi/L)	NE	0.108	1.31
Radium 228, total (pCi/L)	NE	0.295	1.06
Strontium 90, total (pCi/L)	NE	0.317	0.428
Technetium 99 (pCi/L)	NE	2.02	8.16

Table 2.3.3-14 (Sheet 3 of 6)
Baseline Groundwater Summary

Analyte	MCL	Minimum Detect	Maximum Detect
Semivolatile Organic Compounds (ug/L)			
1,2,4-Trichlorobenzene	70	ND	ND
1,2,5,6-Dibenzanthracene	NE	ND	ND
1,2-Dichlorobenzene	NE	ND	ND
1,2-Diphenylhydrazine	NE	ND	ND
1,3-Dichlorobenzene	NE	ND	ND
1,4-Dichlorobenzene	NE	ND	ND
2,4,6-Trichlorophenol	NE	ND	ND
2,4-Dichlorophenol	NE	ND	ND
2,4-Dimethylphenol	NE	ND	ND
2,4-Dinitrophenol	NE	ND	ND
2,4-Dinitrotoluene	NE	ND	ND
2,6-Dinitrotoluene	NE	ND	ND
2-Chloronaphthalene	NE	ND	ND
2-Chlorophenol	NE	ND	ND
2-Nitrophenol	NE	ND	ND
3,3'-Dichlorobenzidine	NE	ND	ND
4-Bromophenyl Phenyl Ether	NE	ND	ND
4-Chlorophenyl Phenyl Ether	NE	ND	ND
4-Nitrophenol	NE	ND	ND
Acenaphthene	NE	ND	ND
Acenaphthylene	NE	ND	ND
Anthracene	NE	ND	ND
Benzidine	NE	ND	ND
Benzo(a)anthracene	NE	ND	ND
Benzo(B)fluoranthene	NE	ND	ND
Benzo(ghi)perylene	NE	ND	ND
Benzo(K)fluoranthene	NE	ND	ND
Benzo-a-pyrene	0.2	ND	ND
Bis (2-Chloroethoxy) Methylene	NE	ND	ND
Bis (2-Chloroisopropyl) Ethylene	NE	ND	ND
Bis(2-Ethylhexyl) Phthalate	NE	6.27	99
Bis(chloromethyl)ether	NE	ND	ND
Chrysene	NE	ND	ND
Diethyl Phthalate	NE	ND	ND
Dimethyl Phthalate	NE	ND	ND

Table 2.3.3-14 (Sheet 4 of 6)
Baseline Groundwater Summary

Analyte	MCL	Minimum Detect	Maximum Detect
Di-n-Butyl Phthalate	NE	ND	ND
Di-n-Octyl Phthalate	NE	ND	ND
DNOC (4,6-Dinitro-Ortho-Cresol)	NE	ND	ND
Fluoranthene	NE	ND	ND
Fluorene	NE	ND	ND
Hexachlorobenzene	1	ND	ND
Hexachlorobutadiene	NE	ND	ND
Hexachlorocyclopentadiene	50	ND	ND
Hexachloroethane	NE	ND	ND
Indeno (1,2,3-cd)Pyrene	NE	ND	ND
Isophorone	NE	ND	ND
Naphthalene	NE	4	41
N-Butyl Benzyl Phthalate	NE	ND	ND
Nitrobenzene	NE	ND	ND
Nitrosodimethylamine, n-	NE	ND	ND
N-nitrosodi-n-propylamine	NE	ND	ND
N-nitrosodiphenylamine	NE	ND	ND
Parachlorometa Cresol	NE	ND	ND
PCP (Pentachlorophenol)	NE	ND	ND
Phenanthrene	NE	ND	ND
Phenol(C6H5OH)-Single Com	NE	ND	ND
Pyrene	NE	ND	ND
Volatile Organic Compounds (ug/L)			
1,1,1-Trichloroethane	200	ND	ND
1,1,2,2-TetrachloroEthane	NE	ND	ND
1,1,2-TrichloroEthane	5	ND	ND
1,1-Dichloroethane	NE	ND	ND
1,2-Dichloroethane	5	ND	ND
1,2-Dichloroethylene	NE	ND	ND
1,2-DichloroPropane	5	ND	ND
2-ChloroEthyl Vinyl Ether	NE	ND	ND
Acrolein	NE	ND	ND
Acrylonitrile	NE	ND	ND
Benzene, total	NE	0.131	5.49
Bromoform	NE	ND	ND
Bromomethane	NE	ND	ND

Table 2.3.3-14 (Sheet 5 of 6)
Baseline Groundwater Summary

Analyte	MCL	Minimum Detect	Maximum Detect
Carbon Tetrachloride	5	ND	ND
ChloroBenzene	100	ND	ND
Chlorodibromomethane	NE	ND	ND
ChloroEthane	NE	ND	ND
Chloroform	80	0.291	4.02
Chloromethane	NE	ND	ND
Cis-1,3-DichloroPropene	NE	ND	ND
Dichlorobromomethane (mg/L)	700	ND	ND
Ethylbenzene	1000	1.46	1.7
Hexane, n-	NE	1.81	14
Methylene Chloride	NE	0.484	0.484
Tetrachloroethylene	NE	0.499	0.499
Toluene	NE	0.132	12.6
Trans-1,3-DichloroPropene	NE	ND	ND
Trichloroethylene	5	ND	ND
Polychlorinated Biphenyl Compounds (PCBs) (ug/L)			
PCB-1016	NE	ND	ND
PCB-1221	NE	ND	ND
PCB-1232	NE	ND	ND
PCB-1242	NE	0.591	3.88
PCB-1248	NE	ND	ND
PCB-1254	NE	ND	ND
PCB-1260	NE	ND	ND
Organochlorine Pesticides (ug/L)			
4,4'-DDD	NE	ND	ND
4,4'-DDE	NE	ND	ND
Aldrin	NE	ND	ND
alpha-BHC	NE	ND	ND
alpha-Chlordane	NE	ND	ND
beta-BHC	NE	0.0225	0.0225
Chlordane, gamma	NE	ND	ND
DDT	NE	ND	ND
delta-BHC	NE	ND	ND
Dieldrin	2	ND	ND
Endosulfan I	NE	ND	ND
Endosulfan II	NE	ND	ND

Table 2.3.3-14 (Sheet 6 of 6)
Baseline Groundwater Summary

Analyte	MCL	Minimum Detect	Maximum Detect
Endosulfan Sulfate	NE	ND	ND
Endrin	2	ND	ND
Endrin Aldehyde	NE	ND	ND
Endrin Ketone	NE	ND	ND
gamma-BHC (Lindane)	0.2	ND	ND
Heptachlor	0.4	0.058	0.058
Heptachlor Epoxide	0.2	ND	ND
Toxaphene	3	ND	ND
Mercury (ug/L)			
Mercury, total	2	ND	ND

Note:
NE = not established
ND = not detected

Source: (Reference 2.3.3-18)

Table 2.3.3-15
Baseline Groundwater Summary Legacy Contaminants

Analyte	MCL	Number Detects	Number Samples	Minimum Detect	Maximum Detect	Maximum Location	Maximum Date
Nitrite + Nitrate (mg/L)	NE	54	80	0.035	2.62	OW421U	December 2013
Arsenic, (ug/L)	10	1	81	7	7	OW42OU	April 2014
Barium (ug/L)	2000	73	81	12	582	OW420L	December 2013
Cadmium (ug/L)	5	2	81	0.3	1.2	OW42OU	April 2014
Chromium (ug/L)	100	5	81	5.4	11.6	OW42OU	April 2014
Tritium (pCi/L)	NE	4	81	284	847	OW428D	December 2013
Strontium 90, total (pCi/L)	NE	5	81	0.317	0.428	OW416L	August 2014
Technetium 99 (pCi/L)	NE	3	80	2.02	8.16	OW401D	August 2014
1,1-Dichloroethane (ug/L)	NE	0	81	ND	ND	ND	ND
Chloroform (ug/L)	80	22	81	0.291	4.02	OW429L	April 2014
Tetrachloroethylene (ug/L)	NE	1	81	0.499	0.499	OW42OU	April 2014
Trichloroethylene (ug/L)	5	0	81	ND	ND	ND	ND
Mercury, total (ug/L)	2	0	81	ND	ND	ND	ND

Notes:
NE = Not established
ND = not detectable

Source: (Reference 2.3.3-18)

Table 2.3.3-16 (Sheet 1 of 3)
Baseline Groundwater Summary of Detected Analytes

Analyte	MCL	Minimum Detect	Maximum Detect	Number Detects
Temperature, Celsius (degrees C)	NE	8.36	24.44	NA
Oxidation reduction potential (mV)	NE	-19	478	NA
Specific Conductance, Field (umhos/cm)	NE	72.36	4723.2	NA
Oxygen, dissolved (mg/L)	NE	0	13	NA
pH, Field (pH)	NE	5.3	9.7	NA
GW Elevation (m above s/l) (m)	NE	223.81	247.85	NA
Sample Depth (m)	NE	8.8	103.3	NA
Well Depth (m)	NE	5.75	76.28	NA
Water Level Depth (m)	NE	1.18	22.49	NA
Turbidity, Field (NTU)	NE	0.9	114	NA
Anions				
Bromide (mg/L)	NE	0.079	6.46	13
Chloride, total (mg/L)	NE	0.811	614	62
Sulfate, total (mg/L)	NE	3.33	2240	77
Fluoride, total (mg/L)	4	0.085	14.2	77
General Chemistry				
Color (Pt-Co units)	NE	5	50	63
Chlorine, Total Residual (mg/L)	NE	0.201	0.307	2
Biological Oxygen Demand (mg/L)	NE	2	291	32
COD, Low Level (mg/L)	NE	24.1	58.5	9
pH, Lab (pH)	NE	5.87	9.94	78
Phenols, total (ug/L)	NE	74	74	1
Alkalinity, Lab (mg/L)	NE	158	653	81
TSS (mg/L)	NE	0.8	1570	76
Oil & Grease (mg/L)	NE	10.7	10.7	1
Nitrogen, Ammonia (mg/L)	NE	0.076	12	56
Nitrite + Nitrate (mg/L)	NE	0.035	2.62	54
Phosphorus, total (mg/L)	NE	0.106	1.68	22
Carbon, total organic (mg/L)	NE	0.566	6.78	57
Cyanide, total (mg/L)	0.2	0.004	0.115	8
Methylene Blue Active Sub	NE	0	0.205	21

Table 2.3.3-16 (Sheet 2 of 3)
Baseline Groundwater Summary of Detected Analytes

Analyte	MCL	Minimum Detect	Maximum Detect	Number Detects
Metals (total)				
Aluminum (mg/L)	NE	0.112	10.4	45
Arsenic, (ug/L)	10	7	7	1
Barium (ug/L)	2000	12	582	73
Beryllium (ug/L)	4	1.4	1.4	1
Boron (ug/L)	NE	25.9	2170	38
Cadmium (ug/L)	5	0.3	1.2	2
Calcium (mg/L)	NE	1.2	187	81
Chromium (ug/L)	100	5.4	11.6	5
Cobalt (ug/L)	NE	7.4	7.4	1
Copper (ug/L)	130	14.8	21.7	2
Iron (ug/L)	NE	33.5	11900	43
Lead (ug/L)	15	5.5	120	3
Magnesium (mg/L)	NE	1.72	65.1	76
Manganese (ug/L)	NE	7.5	902	30
Molybdenum (ug/L)	NE	0.9	0.9	1
Nickel (ug/L)	100	4.9	18.8	2
Potassium (mg/L)	NE	0.873	33.3	71
Sodium (mg/L)	NE	0.812	1650	71
Titanium (ug/L)	NE	36.9	36.9	1
Zinc (ug/L)	NE	33.8	72.9	2
Gross Alpha and Gross Beta Radioactivity				
Alpha, total (pCi/L)	NE	2.93	13	22
Beta, total (pCi/L)	NE	1.13	30.2	45
Tritium (pCi/L)	NE	284	847	4
Radium 226, total (pCi/L)	NE	0.108	1.31	41
Radium 228, total (pCi/L)	NE	0.295	1.06	11
Strontium 90, total (pCi/L)	NE	0.317	0.428	5
Technetium 99 (pCi/L)	NE	2.02	8.16	3
Semivolatile Organic Compounds (ug/L)				
Bis(2-Ethylhexyl) Phthalate	NE	6.27	99	21
Naphthalene	NE	4	41	4

Table 2.3.3-16 (Sheet 3 of 3)
Baseline Groundwater Summary of Detected Analytes

Analyte	MCL	Minimum Detect	Maximum Detect	Number Detects
Volatile Organic Compounds (ug/L)				
Benzene, total	NE	0.131	5.49	7
Chloroform	80	0.291	4.02	22
Ethylbenzene	1000	1.46	1.7	2
Hexane, n-	NE	1.81	14	3
Methylene Chloride	NE	0.484	0.484	1
Tetrachloroethylene	NE	0.499	0.499	1
Toluene	NE	0.132	12.6	10
Polychlorinated Biphenyl Compounds (PCBs) (ug/L)				
PCB-1242	NE	0.591	3.88	4
Organochlorine Pesticides (ug/L)				
beta-BHC	NE	0.0225	0.0225	1
Heptachlor	0.4	0.058	0.058	1

Notes:
NE = Not established
NA = Not available

Source: (Reference 2.3.3-18)

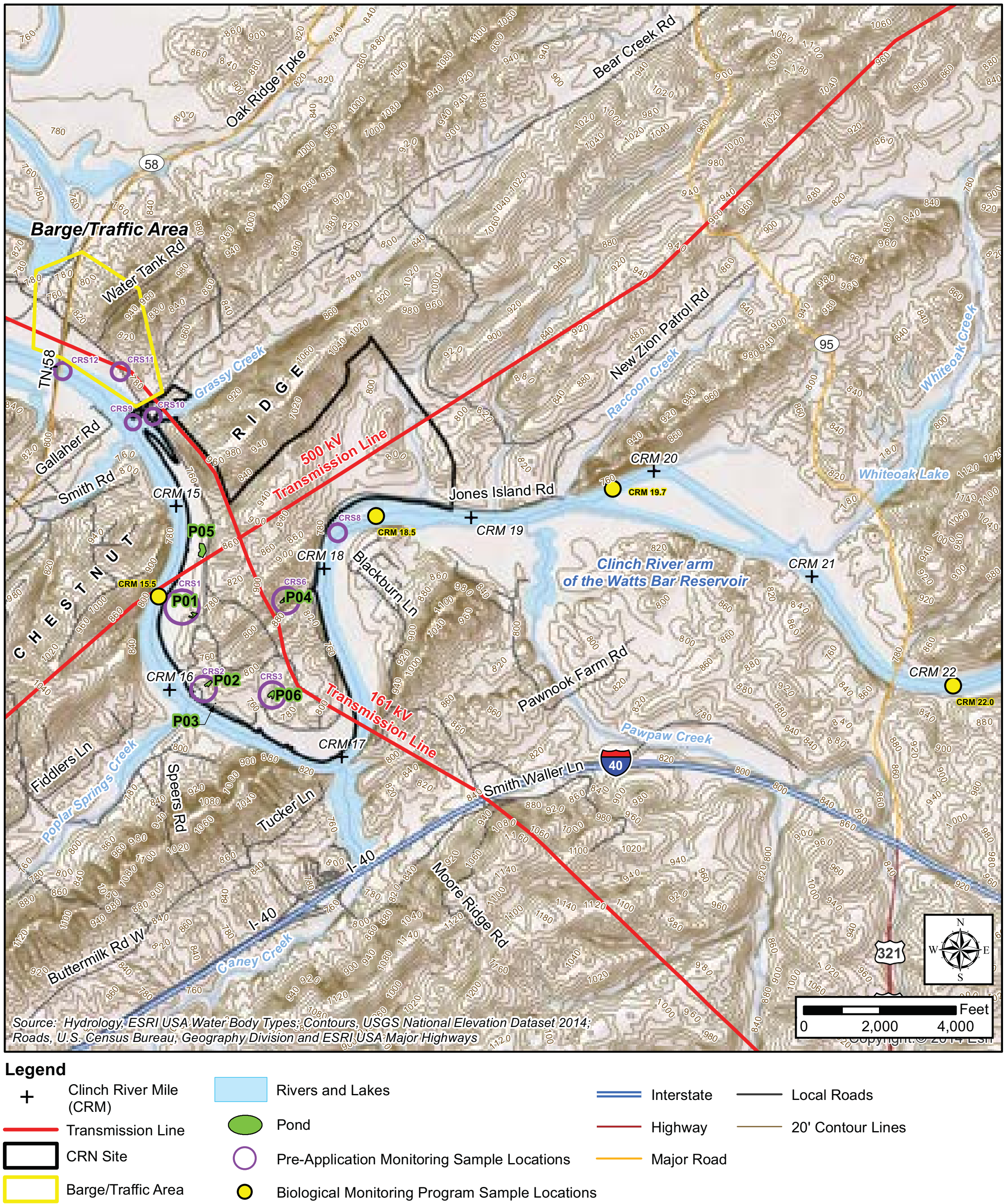
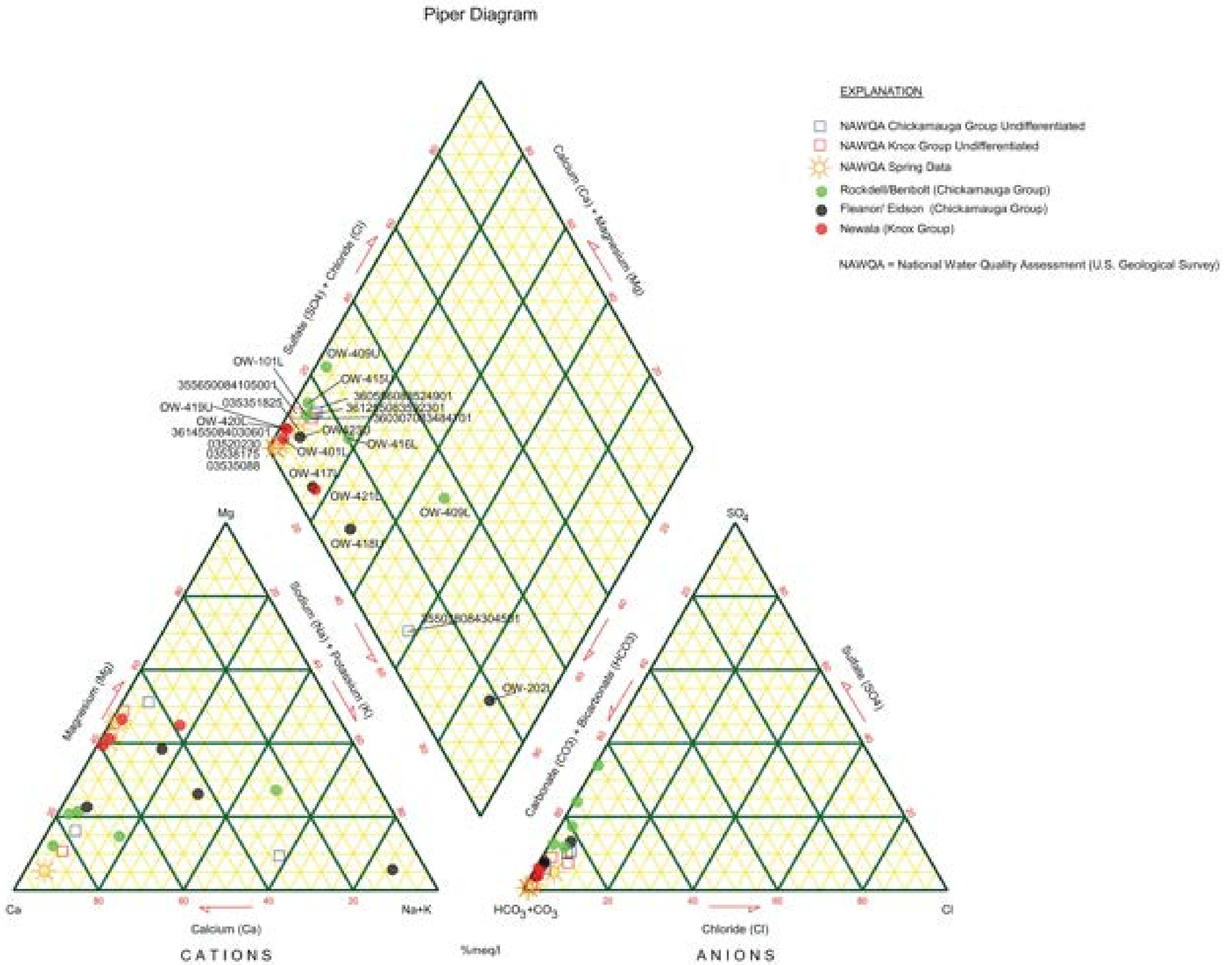
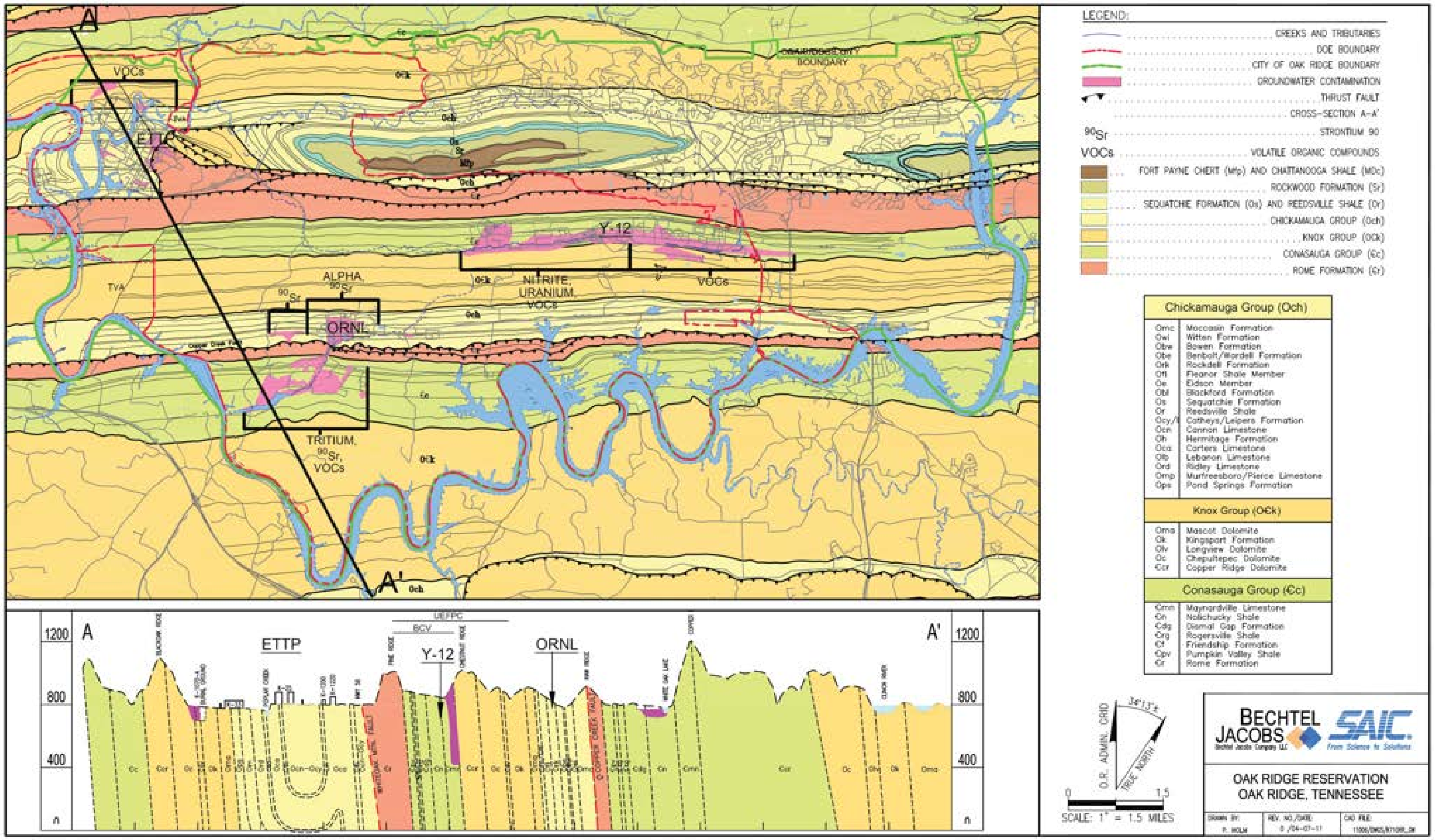


Figure 2.3.3-1. CRN Site Surface Water Monitoring Locations



Sources: (Reference 2.3.2-15; Reference 2.3.2-16)

Figure 2.3.3-2. Piper Trilinear Diagram



Adapted from: (Reference 2.3.2-17)

Figure 2.3.3-3. ORR Groundwater Contamination Map

APPENDIX 2.3-A
Oak Ridge Reservation Selected Bedrock Hydraulic Conductivity Test Results

Table 2.3-A (Sheet 1 of 14)
A Selection of Oak Ridge Reservation Published Bedrock Aquifer Testing Results

Well	Data Source	Geologic Unit	Group	Top Depth (ftbgs)	Bottom Depth (ftbgs)	Interval Midpoint (ftbgs)	Test Type	Interpretation Method	Hydraulic Cond. K_{avg} cm/s	Hydraulic Cond. K_{avg} ft/d	Trans-missivity(4) ft^2/d	Storage Coefficient(4)
55-1A	A	Nolichucky Shale	Conasauga	14.3	19.3	16.8	Slug	Hvorslev	4.2E-04	1.2	NA	NA
55-1B	A	Nolichucky Shale	Conasauga	33.8	38.8	36.3	Slug	Hvorslev	3.9E-04	1.1	NA	NA
55-1C	A	Nolichucky Shale	Conasauga	70.7	75.7	73.2	Slug	Hvorslev	1.2E-04	0.34	NA	NA
55-2C	A	Nolichucky Shale	Conasauga	71	76	73.5	Slug	Hvorslev	4.9E-04	1.4	NA	NA
55-3A	A	Nolichucky Shale	Conasauga	9.3	14.3	11.8	Slug	Hvorslev	6.0E-04	1.7	NA	NA
55-3B	A	Nolichucky Shale	Conasauga	33.1	38.1	35.6	Slug	Hvorslev	1.6E-03	4.6	NA	NA
55-3C	A	Nolichucky Shale	Conasauga	72.5	77.5	75	Slug	Hvorslev	6.7E-05	0.19	NA	NA
55-4B	A	Nolichucky Shale	Conasauga	20.5	25.5	23	Slug	Hvorslev	4.6E-04	1.3	NA	NA
55-4C	A	Nolichucky Shale	Conasauga	67.6	72.6	70.1	Slug	Hvorslev	1.7E-04	0.49	NA	NA
56-1A	A	Nolichucky Shale	Conasauga	14	19	16.5	Slug	Hvorslev	4.9E-05	0.14	NA	NA
56-1C	A	Nolichucky Shale	Conasauga	70.3	75.3	72.8	Slug	Hvorslev	6.7E-04	1.9	NA	NA
56-2A	A	Nolichucky Shale	Conasauga	10.1	15.1	12.6	Slug	Hvorslev	8.1E-04	2.3	NA	NA
56-2B	A	Nolichucky Shale	Conasauga	33.8	38.8	36.3	Slug	Hvorslev	3.0E-04	0.84	NA	NA
56-2C	A	Nolichucky Shale	Conasauga	72.3	77.3	74.8	Slug	Hvorslev	1.6E-04	0.45	NA	NA
56-3A	A	Nolichucky Shale	Conasauga	12.8	17.8	15.3	Slug	Hvorslev	2.8E-04	0.8	NA	NA
56-3C	A	Nolichucky Shale	Conasauga	50.5	55.5	53	Slug	Hvorslev	5.6E-04	1.6	NA	NA
56-4C	A	Nolichucky Shale	Conasauga	71.3	76.3	73.8	Slug	Hvorslev	1.3E-03	3.6	NA	NA
56-5C	A	Maynardville Limestone	Conasauga	66.6	71.6	69.1	Slug	Hvorslev	2.5E-02	70	NA	NA
GW-1	A	Dismal Gap Formation	Conasauga	14.4	25.7	20.1	Bailer-Rec	Not Specified	2.6E-05	0.074	NA	NA
GW-2	A	Dismal Gap Formation	Conasauga	47.8	60	53.9	Packer	Not Specified	1.1E-05	0.03	NA	NA
GW-2	A	Dismal Gap Formation	Conasauga	38.9	60	49.5	Packer	Not Specified	4.9E-06	0.014	NA	NA
GW-2	A	Dismal Gap Formation	Conasauga	39.6	46.7	43.2	Packer	Not Specified	9.5E-06	0.027	NA	NA
GW-2	A	Dismal Gap Formation	Conasauga	34.8	41.9	38.4	Packer	Not Specified	2.8E-06	0.008	NA	NA
GW-3	A	Nolichucky Shale	Conasauga	23.9	35	29.5	Packer	Not Specified	5.1E-05	0.145	NA	NA
GW-3	A	Nolichucky Shale	Conasauga	20.9	32	26.5	Packer	Not Specified	4.1E-05	0.115	NA	NA
GW-3	A	Nolichucky Shale	Conasauga	18	23	20.5	Bailer-Rec	Not Specified	1.3E-05	0.038	NA	NA
GW-4	A	Nolichucky Shale	Conasauga	17	27.2	22.1	Packer	Not Specified	1.1E-03	3.23	NA	NA
GW-4	A	Nolichucky Shale	Conasauga	27.2	50.6	38.9	Packer	Not Specified	7.2E-04	2.05	NA	NA
GW-5	A	Nolichucky Shale	Conasauga	3	12.5	7.8	Bailer-Rec	Not Specified	2.0E-04	0.575	NA	NA
GW-6	A	Nolichucky Shale	Conasauga	35.7	46.8	41.3	Packer	Not Specified	6.7E-05	0.189	NA	NA
GW-6	A	Nolichucky Shale	Conasauga	15.3	31.5	23.4	Bailer-Rec	Not Specified	3.1E-05	0.088	NA	NA
GW-7	A	Nolichucky Shale	Conasauga	8.7	16.5	12.6	Bailer-Rec	Not Specified	1.9E-04	0.548	NA	NA
GW-8	A	Nolichucky Shale	Conasauga	13	21.9	17.5	Bailer-Rec	Not Specified	1.5E-04	0.438	NA	NA
GW-9	A	Nolichucky Shale	Conasauga	51.5	55.3	53.4	Packer	Not Specified	6.8E-05	0.192	NA	NA
GW-9	A	Nolichucky Shale	Conasauga	39.6	49.8	44.7	Packer	Not Specified	9.0E-05	0.255	NA	NA
GW-9	A	Nolichucky Shale	Conasauga	30.4	40.6	35.5	Packer	Not Specified	7.9E-04	2.25	NA	NA

Table 2.3-A (Sheet 2 of 14)
A Selection of Oak Ridge Reservation Published Bedrock Aquifer Testing Results

Well	Data Source	Geologic Unit	Group	Top Depth (ftbgs)	Bottom Depth (ftbgs)	Interval Midpoint (ftbgs)	Test Type	Interpretation Method	Hydraulic Cond. K_{avg} cm/s	Hydraulic Cond. K_{avg} ft/d	Trans-missivity(4) ft^2/d	Storage Coefficient(4)
GW-9	A	Nolichucky Shale	Conasauga	20.5	30.7	25.6	Packer	Not Specified	2.8E-04	0.795	NA	NA
GW-10	A	Nolichucky Shale	Conasauga	9.6	15	12.3	Bailer-Rec	Not Specified	8.0E-05	0.222	NA	NA
GW-11	A	Nolichucky Shale	Conasauga	27.8	39.5	33.7	Packer	Not Specified	2.4E-04	0.685	NA	NA
GW-11	A	Nolichucky Shale	Conasauga	19.7	31.4	25.6	Packer	Not Specified	4.6E-04	1.29	NA	NA
GW-11	A	Nolichucky Shale	Conasauga	48.7	60.8	54.8	Packer	Not Specified	5.0E-05	0.137	NA	NA
GW-11	A	Nolichucky Shale	Conasauga	39	50.8	44.9	Packer	Not Specified	4.2E-05	0.118	NA	NA
GW-12	A	Nolichucky Shale	Conasauga	8.7	14.7	11.7	Bailer-Rec	Not Specified	3.4E-05	0.096	NA	NA
GW-13	A	Nolichucky Shale	Conasauga	6	14	10	Bailer-Rec	Not Specified	3.3E-05	0.093	NA	NA
GW-13	A	Nolichucky Shale	Conasauga	22.5	33.9	28.2	Packer	Not Specified	5.8E-04	1.64	NA	NA
GW-13	A	Nolichucky Shale	Conasauga	15.6	27.4	21.5	Packer	Not Specified	6.0E-04	1.7	NA	NA
GW-43	A	Dismal Gap Formation	Conasauga	28.6	35	31.8	Bailer-Rec	Not Specified	5.0E-05	0.14	NA	NA
GW-44	A	Dismal Gap Formation	Conasauga	27.1	38.7	32.9	Packer	Not Specified	1.3E-04	0.381	NA	NA
GW-44	A	Dismal Gap Formation	Conasauga	58	64	61	Packer	Not Specified	2.1E-05	0.06	NA	NA
GW-44	A	Dismal Gap Formation	Conasauga	47.5	64	55.8	Packer	Not Specified	6.3E-05	0.178	NA	NA
GW-44	A	Dismal Gap Formation	Conasauga	47.6	64	55.8	Packer	Not Specified	1.8E-04	0.521	NA	NA
GW-44	A	Dismal Gap Formation	Conasauga	35.3	46.9	41.1	Packer	Not Specified	8.7E-05	0.247	NA	NA
GW-58	A	Maynardville Limestone	Conasauga	21.5	33.2	27.4	Packer	Not Specified	3.7E-04	1.036	NA	NA
GW-58	A	Maynardville Limestone	Conasauga	30.2	41.9	36.1	Packer	Not Specified	2.0E-03	5.81	NA	NA
GW-59	A	Maynardville Limestone	Conasauga	18.2	27	22.6	Packer	Not Specified	4.1E-03	11.63	NA	NA
GW-62	A	Maynardville Limestone	Conasauga	22.5	32.5	27.5	Packer	Not Specified	3.3E-03	9.3	NA	NA
GW-62	A	Maynardville Limestone	Conasauga	34	44	39	Packer	Not Specified	8.9E-05	0.252	NA	NA
GW-62	A	Maynardville Limestone	Conasauga	44	54	49	Packer	Not Specified	4.6E-05	0.129	NA	NA
GW-131	A	Knox Group	Knox	120	147	133.5	Packer	Homer Semi-Log	4.6E-04	1.3	NA	NA
GW-131	A	Knox Group	Knox	240	267	253.5	Packer	Homer Semi-Log	1.3E-03	3.67	NA	NA
GW-131	A	Knox Group	Knox	290	317	303.5	Packer	Homer Semi-Log	7.0E-08	0.0002	NA	NA
GW-131	A	Knox Group	Knox	370	397	383.5	Packer	Homer Semi-Log	4.4E-05	0.124	NA	NA
GW-131	A	Knox Group	Knox	450	477	463.5	Packer	Homer Semi-Log	1.9E-04	0.544	NA	NA
GW-131	A	Knox Group	Knox	490	517	503.5	Packer	Homer Semi-Log	1.1E-06	0.003	NA	NA
GW-131	A	Maynardville Limestone	Conasauga	665	692	678.5	Packer	Homer Semi-Log	1.0E-05	0.029	NA	NA
GW-131	A	Maynardville Limestone	Conasauga	765	792	778.5	Packer	Homer Semi-Log	3.5E-06	0.01	NA	NA
GW-131	A	Maynardville Limestone	Conasauga	892	919	905.5	Packer	Homer Semi-Log	7.0E-08	0.0002	NA	NA
GW-131	A	Maynardville Limestone	Conasauga	988	1015	1001.5	Packer	Homer Semi-Log	3.3E-04	0.932	NA	NA
GW-132	A	Friendship Formation	Conasauga	145	172	158.5	Packer	Homer Semi-Log	1.1E-08	0.00003	NA	NA
GW-132	A	Pumpkin Valley Shale	Conasauga	305	332	318.5	Packer	Homer Semi-Log	3.5E-06	0.01	NA	NA
GW-132	A	Pumpkin Valley Shale	Conasauga	347	374	360.5	Packer	Homer Semi-Log	3.5E-06	0.01	NA	NA
GW-132	A	Pumpkin Valley Shale	Conasauga	490	517	503.5	Packer	Homer Semi-Log	2.1E-06	0.006	NA	NA

Table 2.3-A (Sheet 3 of 14)
A Selection of Oak Ridge Reservation Published Bedrock Aquifer Testing Results

Well	Data Source	Geologic Unit	Group	Top Depth (ftbgs)	Bottom Depth (ftbgs)	Interval Midpoint (ftbgs)	Test Type	Interpretation Method	Hydraulic Cond. K_{avg} cm/s	Hydraulic Cond. K_{avg} ft/d	Trans-missivity[(4)] ft^2/d	Storage Coefficient[(4)]
GW-132	A	Pumpkin Valley Shale	Conasauga	557	584	570.5	Packer	Homer Semi-Log	1.5E-05	0.042	NA	NA
GW-132	A	Rome Formation	Rome	642	669	655.5	Packer	Homer Semi-Log	3.9E-04	1.1	NA	NA
GW-132	A	Rome Formation	Rome	690	717	703.5	Packer	Homer Semi-Log	3.2E-07	0.0009	NA	NA
GW-133	A	Dismal Gap Formation	Conasauga	105	132	118.5	Packer	Homer Semi-Log	1.1E-07	0.0003	NA	NA
GW-133	A	Dismal Gap Formation	Conasauga	148	175	161.5	Packer	Homer Semi-Log	1.1E-06	0.003	NA	NA
GW-133	A	Dismal Gap Formation	Conasauga	230	257	243.5	Packer	Homer Semi-Log	1.8E-07	0.0005	NA	NA
GW-133	A	Dismal Gap Formation	Conasauga	305	332	318.5	Packer	Homer Semi-Log	1.4E-06	0.004	NA	NA
GW-133	A	Rogersville Shale	Conasauga	428	455	441.5	Packer	Homer Semi-Log	7.1E-07	0.002	NA	NA
GW-133	A	Friendship Formation	Conasauga	543	570	556.5	Packer	Homer Semi-Log	2.1E-07	0.0006	NA	NA
GW-134	A	Maynardville Limestone	Conasauga	75	102	88.5	Packer	Homer Semi-Log	2.4E-04	0.67	NA	NA
GW-134	A	Nolichucky Shale	Conasauga	173	200	186.5	Packer	Homer Semi-Log	2.8E-06	0.008	NA	NA
GW-134	A	Nolichucky Shale	Conasauga	270	297	283.5	Packer	Homer Semi-Log	1.8E-06	0.005	NA	NA
GW-134	A	Nolichucky Shale	Conasauga	360	387	373.5	Packer	Homer Semi-Log	3.5E-08	0.0001	NA	NA
GW-134	A	Nolichucky Shale	Conasauga	450	477	463.5	Packer	Homer Semi-Log	3.2E-07	0.0009	NA	NA
GW-134	A	Nolichucky Shale	Conasauga	560	587	573.5	Packer	Homer Semi-Log	3.5E-07	0.001	NA	NA
GW-134	A	Dismal Gap Formation	Conasauga	730	757	743.5	Packer	Homer Semi-Log	7.1E-07	0.002	NA	NA
GW-134	A	Dismal Gap Formation	Conasauga	793	820	806.5	Packer	Homer Semi-Log	1.4E-07	0.0004	NA	NA
GW-135	A	Knox undifferentiated	Knox	190	217	203.5	Packer	Homer Semi-Log	5.6E-06	0.016	NA	NA
GW-135	A	Knox undifferentiated	Knox	324	351	337.5	Packer	Homer Semi-Log	7.2E-05	0.203	NA	NA
GW-135	A	Knox undifferentiated	Knox	397	425	411	Packer	Homer Semi-Log	9.6E-05	0.272	NA	NA
GW-135	A	Knox undifferentiated	Knox	446	473	459.5	Packer	Homer Semi-Log	7.8E-05	0.222	NA	NA
GW-135	A	Knox undifferentiated	Knox	588	615	601.5	Packer	Homer Semi-Log	3.5E-06	0.01	NA	NA
GW-135	A	Maynardville Limestone	Conasauga	710	737	723.5	Packer	Homer Semi-Log	1.8E-06	0.005	NA	NA
GW-135	A	Maynardville Limestone	Conasauga	832	859	845.5	Packer	Homer Semi-Log	1.8E-05	0.052	NA	NA
GW-135	A	Maynardville Limestone	Conasauga	945	972	958.5	Packer	Homer Semi-Log	3.5E-07	0.001	NA	NA
GW-135	A	Maynardville Limestone	Conasauga	990	1017	1003.5	Packer	Homer Semi-Log	2.5E-06	0.007	NA	NA
GW-135	A	Maynardville Limestone	Conasauga	1124	1151	1137.5	Packer	Homer Semi-Log	1.5E-04	0.411	NA	NA
GW-135	A	Maynardville Limestone	Conasauga	1185	1212	1198.5	Packer	Homer Semi-Log	2.5E-06	0.007	NA	NA
GW-157	A	Knox undifferentiated	Knox	145	157	151	Packer	Homer Semi-Log	8.5E-05	0.24	NA	NA
GW-157	A	Knox undifferentiated	Knox	215	227	221	Packer	Homer Semi-Log	1.8E-04	0.502	NA	NA
GW-157	A	Knox undifferentiated	Knox	265	277	271	Packer	Homer Semi-Log	1.1E-03	3.03	NA	NA
GW-157	A	Knox undifferentiated	Knox	282	294	288	Packer	Homer Semi-Log	2.0E-04	0.561	NA	NA
GW-157	A	Knox undifferentiated	Knox	314	326	320	Packer	Homer Semi-Log	3.2E-06	0.009	NA	NA
GW-157	A	Knox undifferentiated	Knox	326	338	332	Packer	Homer Semi-Log	3.1E-04	0.89	NA	NA
GW-157	A	Knox undifferentiated	Knox	344	356	350	Packer	Homer Semi-Log	7.1E-08	0.0002	NA	NA
GW-157	A	Knox undifferentiated	Knox	392	404	398	Packer	Homer Semi-Log	2.8E-07	0.0008	NA	NA
GW-157	A	Knox undifferentiated	Knox	432	444	438	Packer	Homer Semi-Log	7.4E-05	0.209	NA	NA

Table 2.3-A (Sheet 4 of 14)
A Selection of Oak Ridge Reservation Published Bedrock Aquifer Testing Results

Well	Data Source	Geologic Unit	Group	Top Depth (ftbgs)	Bottom Depth (ftbgs)	Interval Midpoint (ftbgs)	Test Type	Interpretation Method	Hydraulic Cond. K_{avg} cm/s	Hydraulic Cond. K_{avg} ft/d	Trans-missivity[(4)] ft^2/d	Storage Coefficient[(4)]
GW-157	A	Knox undifferentiated	Knox	468	480	474	Packer	Homer Semi-Log	1.5E-04	0.417	NA	NA
GW-456[(1)]	A	Nolichucky Shale	Conasauga	Not Specified	Not Specified	Not Specified	Pump	Theis	9.2E-04	2.6	180	0.0021
GW-457[(1)]	A	Nolichucky Shale	Conasauga	Not Specified	Not Specified	Not Specified	Pump	Theis	1.2E-04	0.34	24	0.00046
GW-458[(1)]	A	Nolichucky Shale	Conasauga	Not Specified	Not Specified	Not Specified	Pump	Theis	1.1E-04	0.31	13	0.00088
GW-459[(1)]	A	Nolichucky Shale	Conasauga	Not Specified	Not Specified	Not Specified	Pump	Theis	2.5E-03	7.1	530	0.0048
GW-460[(1)]	A	Nolichucky Shale	Conasauga	Not Specified	Not Specified	Not Specified	Pump	Theis	3.3E-04	0.96	61	0.0013
GW-461[(1)]	A	Nolichucky Shale	Conasauga	Not Specified	Not Specified	Not Specified	Pump	Theis	9.9E-04	2.8	138	0.0018
GW-462[(1)]	A	Nolichucky Shale	Conasauga	Not Specified	Not Specified	Not Specified	Pump	Theis	5.6E-05	0.16	17	NA
GW-427	A	Maynardville Limestone	Conasauga	38	48	43	Pump	Theis	3.5E-02	99	7690	0.000056
GW-428[(1)]	A	Maynardville Limestone	Conasauga	Not Specified	Not Specified	Not Specified	Pump	Theis	1.6E-02	45	NA	NA
GW-463	A	Maynardville Limestone	Conasauga	45.8	55.8	50.8	Pump	Theis	8.1E-03	23	950	0.0004
GW-464[(1)]	A	Maynardville Limestone	Conasauga	Not Specified	Not Specified	Not Specified	Pump	Theis	7.4E-03	21	1037	0.00083
GW-465	A	Maynardville Limestone	Conasauga	31	41	36	Pump	Theis	2.2E-03	6.2	372	0.0023
GW-466	A	Maynardville Limestone	Conasauga	32	42	37	Pump	Theis	5.3E-03	15	631	0.00046
GW-467	A	Maynardville Limestone	Conasauga	38.5	58.5	48.5	Pump	Theis	7.4E-03	21	NA	NA
1063	A	Nolichucky Shale	Conasauga	20	70	45	Pump	Theis	NA	NA	12	0.00024
1062/OB-4	A	Nolichucky Shale	Conasauga	20	70	45	Pump	Theis	NA	NA	68	0.0066
1061/OB-5	A	Nolichucky Shale	Conasauga	20	70	45	Pump	Theis	NA	NA	51	0.0041
1060/OB-8	A	Nolichucky Shale	Conasauga	20	70	45	Pump	Theis	NA	NA	38	0.0006
1059/OB-1	A	Nolichucky Shale	Conasauga	20	70	45	Pump	Theis	NA	NA	19	NA
1058/OB-3	A	Nolichucky Shale	Conasauga	20	70	45	Pump	Theis	NA	NA	18	0.00013
1057/OB-7	A	Nolichucky Shale	Conasauga	20	70	45	Pump	Theis	NA	NA	17	0.00019
1056/OB-2	A	Nolichucky Shale	Conasauga	20	70	45	Pump	Theis	NA	NA	18	0.00025
1055/OB-6	A	Nolichucky Shale	Conasauga	20	70	45	Pump	Theis	NA	NA	25	0.0007
1002/AP-2	A	Dismal Gap Formation	Conasauga	35	45	40	Slug	Not Specified	7.3E-04	2.08	NA	NA
1003/AP-3	A	Nolichucky Shale	Conasauga	27	37	32	Slug	Not Specified	9.4E-05	0.266	NA	NA
1027/BG-1	A	Dismal Gap Formation	Conasauga	20	30	25	Packer	Not Specified	1.0E-04	0.296	NA	NA
1027/BG-1	A	Dismal Gap Formation	Conasauga	30	40	35	Packer	Not Specified	6.7E-04	1.9	NA	NA
1027/BG-1	A	Dismal Gap Formation	Conasauga	40	50	45	Packer	Not Specified	1.3E-04	0.381	NA	NA
1032/BG-6	A	Maynardville Limestone	Conasauga	43	53	48	Slug	Not Specified	2.3E-04	0.66	NA	NA
1032/BG-6	A	Maynardville Limestone	Conasauga	43	53	48	Slug	Not Specified	1.8E-04	0.507	NA	NA
1035/BG-9	A	Pumpkin Valley Shale	Conasauga	20	30	25	Packer	Not Specified	2.3E-05	0.066	NA	NA
1035/BG-9	A	Pumpkin Valley Shale	Conasauga	30	40	35	Packer	Not Specified	1.2E-04	0.334	NA	NA
1035/BG-9	A	Pumpkin Valley Shale	Conasauga	35	45	40	Packer	Not Specified	9.8E-05	0.279	NA	NA
1035/BG-9	A	Pumpkin Valley Shale	Conasauga	35	45	40	Packer	Not Specified	1.2E-04	0.331	NA	NA

Table 2.3-A (Sheet 5 of 14)
A Selection of Oak Ridge Reservation Published Bedrock Aquifer Testing Results

Well	Data Source	Geologic Unit	Group	Top Depth (ftbgs)	Bottom Depth (ftbgs)	Interval Midpoint (ftbgs)	Test Type	Interpretation Method	Hydraulic Cond. K_{avg} cm/s	Hydraulic Cond. K_{avg} ft/d	Trans-missivity(4) ft^2/d	Storage Coefficient(4)
1035/BG-9	A	Pumpkin Valley Shale	Conasauga	40	50	45	Packer	Not Specified	1.2E-04	0.331	NA	NA
1035/BG-9	A	Pumpkin Valley Shale	Conasauga	40	50	45	Packer	Not Specified	1.0E-04	0.29	NA	NA
1051/OD-4	A	Nolichucky Shale	Conasauga	18	28	23	Slug	Not Specified	6.0E-04	1.69	NA	NA
1051/OD-4	A	Nolichucky Shale	Conasauga	18	28	23	Slug	Not Specified	3.7E-04	1.06	NA	NA
1095/SD-1	A	Knox undifferentiated	Knox	108	118	113	Slug	Not Specified	3.1E-04	0.874	NA	NA
1055/OB-6	A	Nolichucky Shale	Conasauga	20	70	45	Pump	Theis	1.9E-04	0.54	10	0.0009
1056/OB-2	A	Nolichucky Shale	Conasauga	20	70	45	Pump	Theis	1.7E-04	0.48	16.7	0.0072
1057/OB-7	A	Nolichucky Shale	Conasauga	20	70	45	Pump	Theis	9.4E-04	2.66	4.7	0.00041
1058/OB-3	A	Nolichucky Shale	Conasauga	20	70	45	Pump	Theis	4.9E-05	0.14	NA	0.00053
1059/OB-1	A	Nolichucky Shale	Conasauga	20	70	45	Pump	Theis	1.7E-04	0.48	32.2	0.0013
1060/OB-8	A	Nolichucky Shale	Conasauga	20	70	45	Pump	Theis	9.2E-04	2.6	20.7	0.0017
1061/OB-5	A	Nolichucky Shale	Conasauga	20	70	45	Pump	Theis	1.3E-03	3.67	NA	0.0047
1062/OB-4	A	Nolichucky Shale	Conasauga	20	70	45	Pump	Theis	8.6E-04	2.44	39.4	0.0054
1044/BG18	A	Maynardville Limestone	Conasauga	100	160	130	Pump	Hantush	NA	NA	16	NA
1031/BG8	A	Nolichucky Shale	Conasauga	37	47	42	Pump	Hantush	1.1E-07	0.0003	41	0.0003
1034/BG5	A	Nolichucky Shale	Conasauga	35	45	40	Pump	Hantush	3.2E-09	0.000009	20	0.000009
GW-104	A	Nolichucky Shale	Conasauga	51	74	62.5	Pump	Jacob	NA	NA	37	NA
GW-245	A	Nolichucky Shale	Conasauga	30	75	52.5	Pump	Theis	NA	NA	13.4	NA
GW-246	A	Nolichucky Shale	Conasauga	30	75	52.5	Pump	Theis	NA	NA	28	0.001
GW-247	A	Nolichucky Shale	Conasauga	30	75	52.5	Pump	Theis	NA	NA	16	0.0004
GW-122	A	Maynardville Limestone	Conasauga	92	142	117	Not Specified	Not Specified	9.7E-06	0.0274	NA	NA
GW-120	A	Nolichucky Shale	Conasauga	130	180	155	Not Specified	Not Specified	1.9E-06	0.0055	NA	NA
GW-117	A	Nolichucky Shale	Conasauga	480	530	505	Not Specified	Not Specified	7.1E-08	0.0002	NA	NA
GW-123	A	Nolichucky Shale	Conasauga	525	575	550	Not Specified	Not Specified	1.8E-08	0.00005	NA	NA
GW-473	A	Not Specified	Not Specified	30	45	37.5	Pump	Chow	7.0E-05	0.1984	NA	NA
GW-132	A	Friendship Formation	Conasauga	850	Not Specified	850	Packer	Not Specified	1.02E-06	0.0029	NA	NA
GW-132	A	Pumpkin Valley Shale	Conasauga	720	Not Specified	720	Packer	Not Specified	3.75E-06	0.0106	NA	NA
GW-132	A	Pumpkin Valley Shale	Conasauga	650	Not Specified	650	Packer	Not Specified	4.04E-06	0.0115	NA	NA
GW-132	A	Pumpkin Valley Shale	Conasauga	520	Not Specified	520	Packer	Not Specified	1.99E-06	0.0056	NA	NA
GW-132	A	Pumpkin Valley Shale	Conasauga	450	Not Specified	450	Packer	Not Specified	1.47E-05	0.0417	NA	NA
GW-132	A	Rome Formation	Rome	380	Not Specified	380	Packer	Not Specified	4.08E-04	1.1565	NA	NA
GW-132	A	Rome Formation	Rome	320	Not Specified	320	Packer	Not Specified	3.05E-07	0.0009	NA	NA
GW-133	A	Dismal Gap Formation	Conasauga	920	Not Specified	920	Packer	Not Specified	1.0E-07	0.0003	NA	NA
GW-133	A	Dismal Gap Formation	Conasauga	850	Not Specified	850	Packer	Not Specified	1.07E-06	0.003	NA	NA
GW-133	A	Dismal Gap Formation	Conasauga	760	Not Specified	760	Packer	Not Specified	1.7E-07	0.0005	NA	NA
GW-133	A	Dismal Gap Formation	Conasauga	680	Not Specified	680	Packer	Not Specified	1.49E-06	0.0042	NA	NA

Table 2.3-A (Sheet 6 of 14)
A Selection of Oak Ridge Reservation Published Bedrock Aquifer Testing Results

Well	Data Source	Geologic Unit	Group	Top Depth (ftbgs)	Bottom Depth (ftbgs)	Interval Midpoint (ftbgs)	Test Type	Interpretation Method	Hydraulic Cond. K_{avg} cm/s	Hydraulic Cond. K_{avg} ft/d	Trans-missivity(4) ft^2/d	Storage Coefficient(4)
GW-133	A	Rogersville Shale	Conasauga	550	Not Specified	550	Packer	Not Specified	6.42E-07	0.0018	NA	NA
GW-133	A	Friendship Formation	Conasauga	450	Not Specified	450	Packer	Not Specified	1.98E-07	0.0006	NA	NA
GW-134	A	Maynardville Limestone	Conasauga	920	Not Specified	920	Packer	Not Specified	2.37E-04	0.6718	NA	NA
GW-134	A	Maynardville Limestone	Conasauga	800	Not Specified	800	Packer	Not Specified	2.87E-06	0.0081	NA	NA
GW-134	A	Nolichucky Shale	Conasauga	650	Not Specified	650	Packer	Not Specified	1.74E-06	0.0049	NA	NA
GW-134	A	Nolichucky Shale	Conasauga	560	Not Specified	560	Packer	Not Specified	5.14E-06	0.0145	NA	NA
GW-134	A	Nolichucky Shale	Conasauga	500	Not Specified	500	Packer	Not Specified	3.17E-07	0.0009	NA	NA
GW-134	A	Nolichucky Shale	Conasauga	400	Not Specified	400	Packer	Not Specified	4.26E-07	0.0012	NA	NA
GW-134	A	Dismal Gap Formation	Conasauga	240	Not Specified	240	Packer	Not Specified	5.55E-07	0.0016	NA	NA
GW-134	A	Dismal Gap Formation	Conasauga	200	Not Specified	200	Packer	Not Specified	1.33E-07	0.0004	NA	NA
GW-135	A	Knox undifferentiated	Knox	950	Not Specified	950	Packer	Not Specified	5.49E-06	0.0156	NA	NA
GW-135	A	Knox undifferentiated	Knox	820	Not Specified	820	Packer	Not Specified	7.15E-05	0.2027	NA	NA
GW-135	A	Knox undifferentiated	Knox	750	Not Specified	750	Packer	Not Specified	9.61E-05	0.2724	NA	NA
GW-135	A	Knox undifferentiated	Knox	700	Not Specified	700	Packer	Not Specified	7.84E-05	0.2222	NA	NA
GW-135	A	Knox undifferentiated	Knox	550	Not Specified	550	Packer	Not Specified	3.55E-06	0.0101	NA	NA
GW-135	A	Maynardville Limestone	Conasauga	400	Not Specified	400	Packer	Not Specified	1.69E-04	0.0048	NA	NA
GW-135	A	Maynardville Limestone	Conasauga	300	Not Specified	300	Packer	Not Specified	1.83E-05	0.0519	NA	NA
GW-135	A	Maynardville Limestone	Conasauga	150	Not Specified	150	Packer	Not Specified	4.30E-07	0.0012	NA	NA
GW-135	A	Maynardville Limestone	Conasauga	100	Not Specified	100	Packer	Not Specified	2.30E-06	0.0065	NA	NA
GW-135	A	Maynardville Limestone	Conasauga	50	Not Specified	50	Packer	Not Specified	1.45E-04	0.411	NA	NA
GW-135	A	Maynardville Limestone	Conasauga	100	Not Specified	100	Packer	Not Specified	2.55E-06	0.0072	NA	NA
458	B	Not Specified	Conasauga	150	203	176.5	Slug	Not Specified	1.06E-05	0.03	1.6	1.50E-08
458	B	Not Specified	Conasauga	190	203	196.5	Slug	Not Specified	1.06E-05	0.03	0.3	1.60E-12
458	B	Not Specified	Conasauga	150	203	176.5	Pump	Not Specified	1.06E-05	0.03	1.6	1.60E-05
459	B	Not Specified	Conasauga	100	150	125	Slug	Not Specified	7.06E-08	0.0002	0.011	1.60E-04
459	B	Not Specified	Conasauga	136	150	143	Slug	Not Specified	2.86E-05	0.081	1.1	1.60E-05
460	B	Not Specified	Conasauga	44	100	72	Slug	Not Specified	7.06E-06	0.020	1.4	1.60E-04
460	B	Not Specified	Conasauga	84	100	92	Slug	Not Specified	5.29E-06	0.015	0.2	1.40E-04
460	B	Not Specified	Conasauga	44	100	72	Pump	Not Specified	1.06E-05	0.03	1.6	7.50E-04
439	B	Not Specified	Conasauga	24	34	29	Slug	Not Specified	2.05E-04	0.58	NA	NA
440	B	Not Specified	Conasauga	26	36	31	Slug	Not Specified	1.87E-05	0.053	NA	NA
472	B	Not Specified	Conasauga	15	20	17.5	Slug	Not Specified	1.16E-04	0.33	NA	NA
464	B	Not Specified	Conasauga	6	11	8.5	Slug	Not Specified	2.68E-04	0.76	NA	NA
468	B	Not Specified	Conasauga	10	15	12.5	Slug	Not Specified	1.73E-04	0.49	NA	NA
OMW-01A	C	Not Specified	Conasauga(6)	210	258	234	Slug	Bouwer-Rice	1.05E-05	0.03	NA	NA
OMW-01AA	C	Not Specified	Conasauga(6)	120	170	145	Slug	Bouwer-Rice	8.91E-06	0.025	NA	NA

Table 2.3-A (Sheet 7 of 14)
A Selection of Oak Ridge Reservation Published Bedrock Aquifer Testing Results

Well	Data Source	Geologic Unit	Group	Top Depth (ftbgs)	Bottom Depth (ftbgs)	Interval Midpoint (ftbgs)	Test Type	Interpretation Method	Hydraulic Cond. K_{avg} cm/s	Hydraulic Cond. K_{avg} ft/d	Trans-missivity(4) ft^2/d	Storage Coefficient(4)
OMW-02A	C	Not Specified	Conasauga(6)	200	250	225	Slug	Bouwer-Rice	1.20E-05	0.034	NA	NA
OMW-02AA	C	Not Specified	Conasauga(6)	120	170	145	Slug	Bouwer-Rice	1.49E-05	0.042	NA	NA
OMW-02B	C	Not Specified	Conasauga(6)	300	350	325	Slug	Bouwer-Rice	9.84E-06	0.028	NA	NA
OMW-03A	C	Not Specified	Conasauga(6)	60	120	90	Slug	Bouwer-Rice	2.46E-04	0.697	NA	NA
OMW-03B(2)	C	Not Specified	Conasauga(6)	152.7	177.7	165.2	Slug	Bouwer-Rice	4.12E-05	0.117	NA	NA
OMW-04A(2)	C	Not Specified	Conasauga(6)	30	90	60	Slug	Bouwer-Rice	5.81E-04	1.646	NA	NA
OMW-04B	C	Not Specified	Conasauga(6)	119	164	141.5	Slug	Bouwer-Rice	4.40E-06	0.012	NA	NA
OMW-04C	C	Not Specified	Conasauga(6)	182.7	217.7	200.2	Slug	Bouwer-Rice	1.58E-04	0.448	NA	NA
7-1(3)	D	Not Specified	Conasauga	60	120	90	Slug	Hvorslev	3.86E-06	0.011	NA	NA
7-2(3)	D	Not Specified	Conasauga	35	95	65	Slug	Hvorslev	5.10E-05	0.145	NA	NA
7-3	D	Not Specified	Conasauga	68	88	78	Slug	Hvorslev	2.98E-04	0.845	NA	NA
7-4	D	Not Specified	Conasauga	70	90	80	Slug	Hvorslev	1.05E-05	0.030	NA	NA
7-5	D	Not Specified	Conasauga	76	95	85.5	Slug	Hvorslev	3.84E-05	0.109	NA	NA
7-7	D	Not Specified	Conasauga	18	28	23	Slug	Hvorslev	1.12E-04	0.317	NA	NA
7-8	D	Not Specified	Conasauga	20	30	25	Slug	Hvorslev	2.29E-05	0.065	NA	NA
7-9	D	Not Specified	Conasauga	20	30	25	Slug	Hvorslev	6.59E-05	0.187	NA	NA
7-11(3)	D	Not Specified	Conasauga	38	86	62	Slug	Hvorslev	1.42E-05	0.040	NA	NA
7-12	D	Not Specified	Conasauga	60	70	65	Slug	Hvorslev	1.13E-06	0.003	NA	NA
7-13(3)	D	Not Specified	Conasauga	10	28	19	Slug	Hvorslev	1.47E-04	0.417	NA	NA
7-14	D	Not Specified	Conasauga	60	70	65	Slug	Hvorslev	8.21E-06	0.023	NA	NA
ETF-1	E	Dismal Gap Formation	Conasauga	24.8	28.7	26.7	Slug/Pump	Hvorslev	3.10E-04	0.879	24.6	5.12E-04
ETF-2	E	Dismal Gap Formation	Conasauga	27.9	31.8	29.8	Slug	Hvorslev	2.30E-05	0.065	NA	NA
ETF-3	E	Dismal Gap Formation	Conasauga	26.9	30.8	28.9	Slug/Pump	Hvorslev	5.00E-05	0.142	67.6	0.01
ETF-4	E	Dismal Gap Formation	Conasauga	26.8	30.8	28.8	Slug	Hvorslev	1.30E-04	0.369	NA	NA
ETF-5	E	Dismal Gap Formation	Conasauga	26.3	30.2	28.3	Slug	Hvorslev	3.00E-04	0.850	NA	NA
ETF-6	E	Dismal Gap Formation	Conasauga	26.2	30.1	28.1	Slug	Hvorslev	3.90E-04	1.106	NA	NA
ETF-7	E	Dismal Gap Formation	Conasauga	26.5	30.4	28.4	Slug	Hvorslev	2.00E-04	0.567	NA	NA
ETF-8	E	Dismal Gap Formation	Conasauga	25.8	29.8	27.8	Slug/Pump	Hvorslev	3.10E-04	0.879	58	0.03
ETF-9	E	Dismal Gap Formation	Conasauga	27	30.9	28.9	Slug/Pump	Hvorslev	5.10E-05	0.145	19.4	0.01
ETF-10	E	Dismal Gap Formation	Conasauga	27.1	31.1	29.1	Pump	Theis	NA	NA	27	3.34E-04
ETF-11	E	Dismal Gap Formation	Conasauga	41.7	49.6	45.6	Slug	Hvorslev	2.40E-04	0.680	NA	NA
ETF-12	E	Dismal Gap Formation	Conasauga	42.2	50.1	46.2	Slug	Hvorslev	4.10E-04	1.162	NA	NA
ETF-13	E	Dismal Gap Formation	Conasauga	240.9	250.7	245.8	Slug	Hvorslev	1.70E-05	0.048	NA	NA
ETF-14	E	Dismal Gap Formation	Conasauga	84.7	94.6	89.7	Slug	Hvorslev	2.30E-05	0.065	NA	NA
ETF-15	E	Dismal Gap Formation	Conasauga	36.9	46.8	41.8	Slug	Hvorslev	6.60E-06	0.019	NA	NA
ETF-16	E	Dismal Gap Formation	Conasauga	234.6	244.5	239.6	Slug	Hvorslev	2.90E-05	0.082	NA	NA

Table 2.3-A (Sheet 8 of 14)
A Selection of Oak Ridge Reservation Published Bedrock Aquifer Testing Results

Well	Data Source	Geologic Unit	Group	Top Depth (ftbgs)	Bottom Depth (ftbgs)	Interval Midpoint (ftbgs)	Test Type	Interpretation Method	Hydraulic Cond. K_{avg} cm/s	Hydraulic Cond. K_{avg} ft/d	Trans-missivity[4] ft^2/d	Storage Coefficient[4]
ETF-17	E	Dismal Gap Formation	Conasauga	12.8	18.7	15.8	Slug	Hvorslev	9.60E-06	0.027	NA	NA
ETF-20	E	Dismal Gap Formation	Conasauga	15.9	21.8	18.9	Slug	Hvorslev	2.30E-04	0.652	NA	NA
ETF-21	E	Dismal Gap Formation	Conasauga	14.5	20.4	17.5	Slug	Hvorslev	1.10E-05	0.031	NA	NA
ETF-22	E	Dismal Gap Formation	Conasauga	16.6	22.5	19.6	Slug	Hvorslev	4.50E-05	0.128	NA	NA
ETF-23	E	Dismal Gap Formation	Conasauga	14.4	20.3	17.4	Slug	Hvorslev	6.00E-05	0.170	NA	NA
ETF-24	E	Dismal Gap Formation	Conasauga	15.7	21.7	18.7	Slug	Hvorslev	6.00E-04	1.701	NA	NA
ETF-25	E	Dismal Gap Formation	Conasauga	15.7	21.6	18.6	Slug	Hvorslev	7.60E-05	0.215	NA	NA
ETF-26	E	Dismal Gap Formation	Conasauga	15.3	21.2	18.2	Slug	Hvorslev	4.70E-05	0.133	NA	NA
ETF-27	E	Dismal Gap Formation	Conasauga	14.5	20.4	17.5	Slug	Hvorslev	2.20E-05	0.062	NA	NA
ETF-28	E	Dismal Gap Formation	Conasauga	14.4	20.3	17.4	Slug	Hvorslev	9.20E-06	0.026	NA	NA
ETF-29	E	Dismal Gap Formation	Conasauga	14.8	20.7	17.8	Slug	Hvorslev	2.20E-05	0.062	NA	NA
ETF-31	E	Dismal Gap Formation	Conasauga	11.4	17.3	14.3	Slug	Hvorslev	2.40E-05	0.068	NA	NA
ETF-32	E	Dismal Gap Formation	Conasauga	13.9	19.8	16.9	Slug	Hvorslev	2.90E-05	0.082	NA	NA
ETF-33	E	Dismal Gap Formation	Conasauga	14.1	20	17.1	Slug	Hvorslev	2.38E-03	6.746	NA	NA
ETF-34	E	Dismal Gap Formation	Conasauga	16	21.9	19.0	Slug	Hvorslev	2.10E-05	0.060	NA	NA
ETF-35	E	Dismal Gap Formation	Conasauga	14.7	20.6	17.7	Slug	Hvorslev	1.50E-05	0.043	NA	NA
ETF-36	E	Dismal Gap Formation	Conasauga	15.3	21.2	18.2	Slug	Hvorslev	3.00E-05	0.085	NA	NA
ETF-37	E	Dismal Gap Formation	Conasauga	15.5	21.4	18.5	Slug	Hvorslev	7.90E-05	0.224	NA	NA
ETF-38	E	Dismal Gap Formation	Conasauga	16.1	22	19.1	Slug	Hvorslev	9.70E-05	0.275	NA	NA
ETF-39	E	Dismal Gap Formation	Conasauga	16.3	22.2	19.2	Slug	Hvorslev	4.30E-05	0.122	NA	NA
ETF-40	E	Dismal Gap Formation	Conasauga	14.8	20.7	17.7	Slug	Hvorslev	5.60E-05	0.159	NA	NA
668	F	Not Specified	Conasauga	11	13	12.0	Injection	Not Specified	5.21E-05	0.148	0.301	NA
668	F	Not Specified	Conasauga	13	15	14.0	Injection	Not Specified	1.40E-06	0.004	0.080	NA
669	F	Not Specified	Conasauga	7.5	8.5	8.0	Injection	Not Specified	9.84E-05	0.279	0.28	NA
739	F	Not Specified	Conasauga	25	27.5	26.3	Injection	Not Specified	4.75E-04	1.345	3.34	NA
741	F	Not Specified	Conasauga	15	21	18.0	Injection	Not Specified	2.31E-04	0.656	3.98	NA
747	F	Not Specified	Conasauga	16	24	20.0	Injection	Not Specified	3.82E-05	0.108	0.872	NA
748	F	Not Specified	Conasauga	14.5	23.5	19.0	Injection	Not Specified	5.09E-05	0.144	1.292	NA
749	F	Not Specified	Conasauga	14	16	15.0	Injection	Not Specified	1.97E-05	0.056	0.118	NA
749	F	Not Specified	Conasauga	18	21	19.5	Injection	Not Specified	7.64E-05	0.217	0.646	NA
756	F	Not Specified	Conasauga	18	20.5	19.3	Injection	Not Specified	2.55E-03	7.218	18.3	NA
757	F	Not Specified	Conasauga	12	16	14.0	Injection	Not Specified	2.78E-05	0.079	0.312	NA
757	F	Not Specified	Conasauga	16	22	19.0	Injection	Not Specified	6.94E-05	0.197	1.184	NA
758	F	Not Specified	Conasauga	14	23	18.5	Injection	Not Specified	9.72E-06	0.028	0.248	NA
759	F	Not Specified	Conasauga	14	15.5	14.8	Injection	Not Specified	4.05E-04	1.148	1.722	NA
759	F	Not Specified	Conasauga	20	23	21.5	Injection	Not Specified	1.74E-04	0.492	1.507	NA

Table 2.3-A (Sheet 9 of 14)
A Selection of Oak Ridge Reservation Published Bedrock Aquifer Testing Results

Well	Data Source	Geologic Unit	Group	Top Depth (ftbgs)	Bottom Depth (ftbgs)	Interval Midpoint (ftbgs)	Test Type	Interpretation Method	Hydraulic Cond. K_{avg} cm/s	Hydraulic Cond. K_{avg} ft/d	Trans-missivity[(4)] ft^2/d	Storage Coefficient[(4)]
760	F	Not Specified	Conasauga	14	23	18.5	Injection	Not Specified	6.37E-05	0.180	1.615	NA
766	F	Not Specified	Conasauga	10	13.5	11.8	Injection	Not Specified	2.20E-04	0.623	2.153	NA
767	F	Not Specified	Conasauga	38	40	39.0	Injection	Not Specified	5.09E-05	0.144	0.291	NA
768	F	Not Specified	Conasauga	7	15	11.0	Injection	Not Specified	1.09E-05	0.031	0.248	NA
774	F	Not Specified	Conasauga	8	10	9.0	Injection	Not Specified	6.83E-03	19.357	38.75	NA
775	F	Not Specified	Conasauga	39	40	39.5	Injection	Not Specified	2.89E-04	0.820	0.818	NA
775	F	Not Specified	Conasauga	40	42	41.0	Injection	Not Specified	8.45E-05	0.240	0.474	NA
777	F	Not Specified	Conasauga	37	38	37.5	Injection	Not Specified	3.59E-05	0.102	0.103	NA
779	F	Not Specified	Conasauga	39	41	40.0	Injection	Not Specified	3.36E-04	0.951	1.938	NA
779	F	Not Specified	Conasauga	41	43	42.0	Injection	Not Specified	7.99E-05	0.226	0.452	NA
781	F	Not Specified	Conasauga	29	33	31.0	Injection	Not Specified	3.70E-05	0.105	0.431	NA
781	F	Not Specified	Conasauga	33	35	34.0	Injection	Not Specified	2.66E-04	0.755	1.507	NA
782	F	Not Specified	Conasauga	12	14	13	Injection	Not Specified	5.90E-04	1.673	3.552	NA
783	F	Not Specified	Conasauga	28	29	28.5	Injection	Not Specified	4.51E-04	1.28	1.292	NA
904	F	Not Specified	Conasauga	41	44	42.5	Injection	Not Specified	1.62E-03	4.593	13.993	NA
905	F	Not Specified	Conasauga	36	37.5	36.8	Injection	Not Specified	2.78E-04	0.787	1.184	NA
1118	F	Not Specified	Conasauga	8	12	10	Injection	Not Specified	6.60E-05	0.187	0.743	NA
1119	F	Not Specified	Conasauga	24.5	27	25.8	Injection	Not Specified	2.55E-04	0.722	1.830	NA
1119	F	Not Specified	Conasauga	30.5	33	31.8	Injection	Not Specified	1.74E-04	0.492	1.184	NA
1121	F	Not Specified	Conasauga	8.5	9.5	9	Injection	Not Specified	7.18E-04	2.034	2.045	NA
1121	F	Not Specified	Conasauga	9.5	11.5	10.5	Injection	Not Specified	2.20E-04	0.623	1.184	NA
1122	F	Not Specified	Conasauga	38	41	39.5	Injection	Not Specified	3.36E-05	0.095	0.280	NA
1122	F	Not Specified	Conasauga	41	42.5	41.8	Injection	Not Specified	2.08E-04	0.591	0.883	NA
1122	F	Not Specified	Conasauga	44	46	45	Injection	Not Specified	4.17E-05	0.118	0.237	NA
1126	F	Not Specified	Conasauga	48	49.5	48.8	Injection	Not Specified	8.91E-04	2.526	3.767	NA
1126	F	Not Specified	Conasauga	56	57	56.5	Injection	Not Specified	3.36E-04	0.951	0.947	NA
1127	F	Not Specified	Conasauga	17.5	19	18.3	Injection	Not Specified	3.24E-04	0.919	1.399	NA
1127	F	Not Specified	Conasauga	20.2	21	20.6	Injection	Not Specified	5.21E-04	1.476	1.184	NA
1128	F	Not Specified	Conasauga	46	52	49.0	Injection	Not Specified	6.13E-05	0.174	1.055	NA
1128	F	Not Specified	Conasauga	56	57	56.5	Injection	Not Specified	4.63E-05	0.131	0.129	NA
1129	F	Not Specified	Conasauga	32	33	32.5	Injection	Not Specified	6.25E-05	0.177	0.172	NA
1129	F	Not Specified	Conasauga	35.5	36.5	36	Injection	Not Specified	2.20E-04	0.623	0.614	NA
GW-404[(2)]	G	Dismal Gap Formation	Conasauga	26.5	38.5	32.5	Packer	Multiple	1.90E-05	0.054	NA	NA
GW-404[(2)]	G	Dismal Gap Formation	Conasauga	38	50	44	Packer	Multiple	9.40E-06	0.027	NA	NA
GW-404[(2)]	G	Dismal Gap Formation	Conasauga	50	62	56	Packer	Multiple	9.36E-06	0.027	NA	NA
GW-404[(2)]	G	Dismal Gap Formation	Conasauga	62	74	68	Packer	Multiple	7.00E-06	0.020	NA	NA

Table 2.3-A (Sheet 10 of 14)
A Selection of Oak Ridge Reservation Published Bedrock Aquifer Testing Results

Well	Data Source	Geologic Unit	Group	Top Depth (ftbgs)	Bottom Depth (ftbgs)	Interval Midpoint (ftbgs)	Test Type	Interpretation Method	Hydraulic Cond. K_{avg} cm/s	Hydraulic Cond. K_{avg} ft/d	Trans-missivity(4) ft^2/d	Storage Coefficient(4)
GW-404(2)	G	Dismal Gap Formation	Conasauga	74	86	80	Packer	Multiple	4.30E-05	0.122	NA	NA
GW-404(2)	G	Dismal Gap Formation	Conasauga	86	98	92	Packer	Multiple	5.42E-06	0.015	NA	NA
GW-404(2)	G	Dismal Gap Formation	Conasauga	98	110	104	Packer	Multiple	6.57E-05	0.186	NA	NA
GW-404(2)	G	Dismal Gap Formation	Conasauga	110	122	116	Packer	Multiple	1.72E-04	0.488	NA	NA
GW-404(2)	G	Dismal Gap Formation	Conasauga	122	134	128	Packer	Multiple	2.90E-05	0.082	NA	NA
GW-404(2)	G	Dismal Gap Formation	Conasauga	134	146	140	Packer	Multiple	5.86E-05	0.166	NA	NA
GW-404(2)	G	Dismal Gap Formation	Conasauga	146	158	152	Packer	Multiple	5.44E-06	0.015	NA	NA
GW-404(2)	G	Dismal Gap Formation	Conasauga	158	170	164	Packer	Multiple	4.07E-05	0.115	NA	NA
GW-404(2)	G	Dismal Gap Formation	Conasauga	170	182	176	Packer	Multiple	2.77E-06	0.008	NA	NA
GW-455(2)	G	Nolichucky Shale	Conasauga	65	87	76	Packer	Multiple	6.47E-05	0.183	NA	NA
GW-455(2)	G	Nolichucky Shale	Conasauga	87	109	98	Packer	Multiple	1.60E-05	0.045	NA	NA
GW-455(2)	G	Dismal Gap Formation/ Nolichucky Shale	Conasauga	109	131	120	Packer	Multiple	4.64E-07	0.001	NA	NA
GW-455(2)	G	Dismal Gap Formation	Conasauga	138	160	149	Packer	Multiple	2.61E-05	0.074	NA	NA
GW-455(2)	G	Dismal Gap Formation	Conasauga	152.8	174.8	163.8	Packer	Multiple	6.41E-05	0.182	NA	NA
GW-471(2)	G	Dismal Gap Formation	Conasauga	33	45	39	Packer	Multiple	3.09E-04	0.876	NA	NA
GW-471(2)	G	Dismal Gap Formation	Conasauga	45	57	51	Packer	Multiple	2.29E-04	0.649	NA	NA
GW-471(2)	G	Dismal Gap Formation	Conasauga	57	69	63	Packer	Multiple	4.61E-05	0.131	NA	NA
GW-471(2)	G	Dismal Gap Formation	Conasauga	69	81	75	Packer	Multiple	5.80E-06	0.016	NA	NA
GW-471(2)	G	Dismal Gap Formation	Conasauga	81	93	87	Packer	Multiple	5.39E-06	0.015	NA	NA
GW-471(2)	G	Dismal Gap Formation	Conasauga	84.4	96.4	90.4	Packer	Multiple	7.10E-05	0.201	NA	NA
GW-403	G	Dismal Gap Formation	Conasauga	306	328	317	Packer	Multiple	4.90E-08	0.0001	NA	NA
GW-403	G	Dismal Gap Formation	Conasauga	387	409	398	Packer	Multiple	1.37E-07	0.0004	NA	NA
GW-455	G	Dismal Gap Formation	Conasauga	157.7	185.8	171.8	Slug	Hvorslev	4.57E-05	0.130	NA	NA
GW-471	G	Dismal Gap Formation	Conasauga	89.7	103.4	96.6	Slug	Hvorslev	1.18E-06	0.003	NA	NA
GW-473	G	Dismal Gap Formation	Conasauga	68.4	94.4	81.4	Slug	Hvorslev	3.93E-05	0.111	NA	NA
GW-474	G	Dismal Gap Formation	Conasauga	27.9	45.1	36.5	Slug	Hvorslev	3.33E-05	0.094	NA	NA
GW-475A	G	Dismal Gap Formation	Conasauga	86.4	99.7	93.1	Slug	Hvorslev	7.85E-07	0.002	NA	NA
GW-475B	G	Dismal Gap Formation	Conasauga	49.9	62.9	56.4	Slug	Hvorslev	6.96E-05	0.197	NA	NA
GW-476A	G	Dismal Gap Formation	Conasauga	69.9	83	76.5	Slug	Hvorslev	6.61E-06	0.019	NA	NA
GW-476B	G	Dismal Gap Formation	Conasauga	36.9	49.4	43.2	Slug	Hvorslev	7.96E-05	0.226	NA	NA
GW-477A	G	Dismal Gap Formation	Conasauga	54.7	68.7	61.7	Slug	Hvorslev	1.37E-05	0.039	NA	NA
GW-477B	G	Maynardville Limestone	Conasauga	22.3	34.9	28.6	Slug	Hvorslev	1.12E-05	0.032	NA	NA
GW-478A	G	Dismal Gap Formation	Conasauga	66.9	81.3	74.1	Slug	Hvorslev	9.81E-06	0.028	NA	NA
GW-478B	G	Dismal Gap Formation	Conasauga	35.2	47.2	41.2	Slug	Hvorslev	2.35E-05	0.067	NA	NA
GW-480A	G	Dismal Gap Formation	Conasauga	33.6	37.6	35.6	Slug	Hvorslev	2.86E-06	0.008	NA	NA

Table 2.3-A (Sheet 11 of 14)
A Selection of Oak Ridge Reservation Published Bedrock Aquifer Testing Results

Well	Data Source	Geologic Unit	Group	Top Depth (ftbgs)	Bottom Depth (ftbgs)	Interval Midpoint (ftbgs)	Test Type	Interpretation Method	Hydraulic Cond. K_{avg} cm/s	Hydraulic Cond. K_{avg} ft/d	Trans-missivity(4) ft^2/d	Storage Coefficient(4)
GW-480B	G	Maynardville Limestone	Conasauga	28.6	32.6	30.6	Slug	Hvorslev	5.23E-06	0.015	NA	NA
GW-481A	G	Dismal Gap Formation	Conasauga	31.4	35.1	33.3	Slug	Hvorslev	1.81E-04	0.513	NA	NA
GW-481B	G	Maynardville Limestone	Conasauga	28.6	32.6	30.6	Slug	Hvorslev	6.76E-06	0.019	NA	NA
GW-482A	G	Dismal Gap Formation	Conasauga	32.7	36.7	34.7	Slug	Hvorslev	1.82E-06	0.005	NA	NA
GW-482B	G	Maynardville Limestone	Conasauga	26.2	30.2	28.2	Slug	Hvorslev	2.29E-05	0.065	NA	NA
GW-483	G	Maynardville Limestone	Conasauga	18.4	28	23.2	Slug	Hvorslev	3.27E-05	0.093	NA	NA
GW-474	G	Dismal Gap Formation	Conasauga	27.9	45.1	36.5	Pump	Multiple	2.66E-05	0.075	2.26	NA
GW-475B	G	Dismal Gap Formation	Conasauga	49.9	62.9	56.4	Pump	Multiple	2.88E-05	0.082	2.45	1.35E-04
GW-476B	G	Dismal Gap Formation	Conasauga	36.9	49.4	43.2	Pump	Multiple	6.47E-05	0.183	5.50	2.38E-04
GW-477B	G	Maynardville Limestone	Conasauga	22.3	34.9	28.6	Pump	Multiple	7.48E-05	0.212	6.36	7.92E-04
GW-478B	G	Dismal Gap Formation	Conasauga	35.2	47.2	41.2	Pump	Multiple	3.54E-05	0.100	3.01	1.64E-04
GW-471	G	Dismal Gap Formation	Conasauga	89.7	105.6	97.7	Pump	Multiple	1.28E-05	0.036	0.72	1.47E-04
GW-473	G	Dismal Gap Formation	Conasauga	68.4	94.4	81.4	Pump	Multiple	1.01E-05	0.029	0.57	NA
GW-475A	G	Dismal Gap Formation	Conasauga	86.4	99.7	93.1	Pump	Multiple	1.23E-05	0.035	0.70	1.65E-03
GW-476A	G	Dismal Gap Formation	Conasauga	69.9	83	76.5	Pump	Multiple	1.14E-05	0.032	0.65	3.60E-05
GW-477A	G	Dismal Gap Formation	Conasauga	54.7	68.7	61.7	Pump	Multiple	1.63E-05	0.046	0.92	1.51E-04
GW-478A	G	Dismal Gap Formation	Conasauga	67.9	81.3	74.6	Pump	Multiple	1.00E-05	0.028	0.57	1.62E-04
GW-136	H	Nolichucky Shale	Conasauga	53	80	66.5	Packer	Log-Log	6.10E-06	0.173	NA	NA
GW-136	H	Nolichucky Shale	Conasauga	113	140	126.5	Packer	Log-Log	4.40E-06	0.012	NA	NA
GW-136	H	Nolichucky Shale	Conasauga	175	202	188.5	Packer	Log-Log	4.50E-06	0.013	NA	NA
GW-136	H	Nolichucky Shale	Conasauga	216	243	229.5	Packer	Log-Log	1.50E-06	0.004	NA	NA
GW-136	H	Nolichucky Shale	Conasauga	221	248	234.5	Packer	Log-Log	2.80E-07	0.001	NA	NA
GW-136	H	Nolichucky Shale	Conasauga	283	310	296.5	Packer	Log-Log	2.40E-05	0.068	NA	NA
GW-136	H	Nolichucky Shale	Conasauga	288	315	301.5	Packer	Log-Log	3.90E-05	0.111	NA	NA
GW-136	H	Nolichucky Shale	Conasauga	420	447	433.5	Packer	Log-Log	1.00E-05	0.028	NA	NA
GW-136	H	Nolichucky Shale	Conasauga	501	528	514.5	Packer	Log-Log	4.20E-07	0.001	NA	NA
GW-137	H	Nolichucky Shale	Conasauga	337	364	350.5	Packer	Log-Log	1.40E-04	0.397	NA	NA
GW-137	H	Nolichucky Shale	Conasauga	675	702	688.5	Packer	Log-Log	1.30E-07	0.0004	NA	NA
GW-139	H	Nolichucky Shale	Conasauga	195	217	206.0	Packer	Log-Log	5.90E-06	0.017	NA	NA
GW-139	H	Nolichucky Shale	Conasauga	300	322	311.0	Packer	Log-Log	1.70E-06	0.005	NA	NA
GW-139	H	Nolichucky Shale	Conasauga	382	404	393.0	Packer	Log-Log	2.70E-07	0.001	NA	NA
GW-401	H	Nolichucky Shale	Conasauga	125	147	136.0	Packer	Log-Log	8.20E-06	0.023	NA	NA
GW-401	H	Nolichucky Shale	Conasauga	244	266	255.0	Packer	Log-Log	1.50E-06	0.004	NA	NA
GW-401	H	Nolichucky Shale	Conasauga	266	288	277.0	Packer	Log-Log	6.50E-06	0.018	NA	NA
GW-401	H	Nolichucky Shale	Conasauga	317	339	328.0	Packer	Log-Log	7.80E-07	0.002	NA	NA
GW-401	H	Nolichucky Shale	Conasauga	386	408	397.0	Packer	Log-Log	1.00E-05	0.028	NA	NA

Table 2.3-A (Sheet 12 of 14)
A Selection of Oak Ridge Reservation Published Bedrock Aquifer Testing Results

Well	Data Source	Geologic Unit	Group	Top Depth (ftbgs)	Bottom Depth (ftbgs)	Interval Midpoint (ftbgs)	Test Type	Interpretation Method	Hydraulic Cond. K_{avg} cm/s	Hydraulic Cond. K_{avg} ft/d	Trans-missivity(4) ft^2/d	Storage Coefficient(4)
GW-401	H	Nolichucky Shale	Conasauga	266	273	269.5	Packer	Log-Log	9.50E-06	0.027	NA	NA
GW-401	H	Nolichucky Shale	Conasauga	273	280	276.5	Packer	Log-Log	5.30E-05	0.150	NA	NA
GW-401	H	Nolichucky Shale	Conasauga	280	287	283.5	Packer	Log-Log	3.00E-05	0.085	NA	NA
GW-401	H	Nolichucky Shale	Conasauga	386	393	389.5	Packer	Log-Log	1.60E-05	0.045	NA	NA
GW-401	H	Nolichucky Shale	Conasauga	393	400	396.5	Packer	Log-Log	2.70E-05	0.077	NA	NA
GW-401	H	Nolichucky Shale	Conasauga	400	407	403.5	Packer	Log-Log	4.80E-07	0.001	NA	NA
GW-401	H	Nolichucky Shale	Conasauga	448	455	451.5	Packer	Log-Log	3.80E-05	0.108	NA	NA
GW-402	H	Nolichucky Shale	Conasauga	110	137	123.5	Packer	Log-Log	1.30E-05	0.037	NA	NA
GW-402	H	Nolichucky Shale	Conasauga	150	177	163.5	Packer	Log-Log	2.50E-05	0.071	NA	NA
GW-402	H	Nolichucky Shale	Conasauga	192	219	205.5	Packer	Log-Log	1.20E-06	0.003	NA	NA
GW-402	H	Nolichucky Shale	Conasauga	243	270	256.5	Packer	Log-Log	2.40E-06	0.007	NA	NA
GW-402	H	Nolichucky Shale	Conasauga	270	297	283.5	Packer	Log-Log	2.90E-07	0.001	NA	NA
GW-402	H	Nolichucky Shale	Conasauga	302	329	315.5	Packer	Log-Log	4.60E-08	0.0001	NA	NA
GW-402	H	Nolichucky Shale	Conasauga	333	360	346.5	Packer	Log-Log	5.50E-08	0.0002	NA	NA
GW-402	H	Nolichucky Shale	Conasauga	373	400	386.5	Packer	Log-Log	1.20E-07	0.0003	NA	NA
GW-402	H	Nolichucky Shale	Conasauga	403	430	416.5	Packer	Log-Log	2.70E-07	0.001	NA	NA
GW-402	H	Nolichucky Shale	Conasauga	525	552	538.5	Packer	Log-Log	2.00E-07	0.001	NA	NA
GW-402	H	Nolichucky Shale	Conasauga	559	586	572.5	Packer	Log-Log	4.40E-08	0.0001	NA	NA
GW-403	H	Nolichucky Shale	Conasauga	92	114	103	Packer	Log-Log	1.60E-03	4.535	NA	NA
GW-403	H	Nolichucky Shale	Conasauga	160	182	171	Packer	Log-Log	7.80E-06	0.022	NA	NA
GW-403	H	Nolichucky Shale	Conasauga	234	256	245	Packer	Log-Log	9.10E-05	0.258	NA	NA
GW-403	H	Nolichucky Shale	Conasauga	275	297	286	Packer	Log-Log	3.50E-05	0.099	NA	NA
GW-403	H	Nolichucky Shale	Conasauga	306	328	317	Packer	Log-Log	4.90E-08	0.0001	NA	NA
GW-468	H	Nolichucky Shale	Conasauga	109	131	120	Packer	Log-Log	1.70E-05	0.048	NA	NA
GW-468	H	Nolichucky Shale	Conasauga	138	160	149	Packer	Log-Log	9.00E-05	0.255	NA	NA
GW-468	H	Nolichucky Shale	Conasauga	210	232	221	Packer	Log-Log	3.40E-06	0.010	NA	NA
GW-468	H	Nolichucky Shale	Conasauga	279	301	290	Packer	Log-Log	1.40E-06	0.004	NA	NA
GW-468	H	Nolichucky Shale	Conasauga	355	377	366	Packer	Log-Log	1.80E-05	0.051	NA	NA
GW-468	H	Nolichucky Shale	Conasauga	413	435	424	Packer	Log-Log	9.40E-09	0.00003	NA	NA
GW-468	H	Nolichucky Shale	Conasauga	465	487	476	Packer	Log-Log	1.00E-07	0.0003	NA	NA
GW-468	H	Nolichucky Shale	Conasauga	109	116	112.5	Packer	Log-Log	4.40E-05	0.125	NA	NA
GW-134	H	Nolichucky Shale	Conasauga	173	200	186.5	Packer	Not Specified	2.87E-06	0.0081	NA	NA
GW-134	H	Nolichucky Shale	Conasauga	270	297	283.5	Packer	Not Specified	1.74E-06	0.0049	NA	NA
GW-134	H	Nolichucky Shale	Conasauga	360	387	373.5	Packer	Not Specified	5.14E-08	0.0001	NA	NA
GW-134	H	Nolichucky Shale	Conasauga	450	477	463.5	Packer	Not Specified	3.17E-07	0.0009	NA	NA
GW-134	H	Nolichucky Shale	Conasauga	560	587	573.5	Packer	Not Specified	4.26E-07	0.0012	NA	NA
GW-381	I	Maynardville Limestone	Conasauga	46.3	60.4	53.4	Pump	Theis	3.33E-03	9.45	2834.78	2.78E-03

Table 2.3-A (Sheet 13 of 14)
A Selection of Oak Ridge Reservation Published Bedrock Aquifer Testing Results

Well	Data Source	Geologic Unit	Group	Top Depth (ftbgs)	Bottom Depth (ftbgs)	Interval Midpoint (ftbgs)	Test Type	Interpretation Method	Hydraulic Cond. K_{avg} cm/s	Hydraulic Cond. K_{avg} ft/d	Trans-missivity[4] ft^2/d	Storage Coefficient[4]
GW-153	I	Maynardville Limestone	Conasauga	49.5	59.5	54.5	Pump	Theis	1.08E-02	30.52	9156.35	6.00E-03
GW-223	I	Maynardville Limestone	Conasauga	80	90	85.0	Pump	Theis	1.51E-03	4.28	1284.16	1.62E-03
GW-151	I	Maynardville Limestone	Conasauga	86	96	91.0	Pump	Theis	7.94E-04	2.25	674.68	4.72E-04
GW-750	I	Maynardville Limestone	Conasauga	61.2	72.7	67.0	Pump	Theis	6.53E-04	1.85	555.62	1.93E-03
GW-735	I	Maynardville Limestone	Conasauga	67.9	78.1	73.0	Pump	Theis	5.86E-04	1.66	498.92	1.50E-03
GW-734	I	Maynardville Limestone	Conasauga	59.4	Not Specified	59.4	Pump	Theis	1.20E-03	3.40	1020.52	1.40E-03
GW-168	I	Maynardville Limestone	Conasauga	104	135.4	119.7	Pump	Theis	2.65E-04	0.75	223.95	9.50E-05
GW-733	I	Maynardville Limestone	Conasauga	240.1	256.5	248.3	Pump	Theis	1.48E-04	0.42	125.30	3.80E-04
GW-722	I	Maynardville Limestone	Conasauga	333	333	333.0	Pump	Theis	9.17E-05	0.26	78.52	1.69E-05
4434	J	Rome Formation[6]	Rome[6]	49.75[5]	83.35[5]	66.6[5]	Slug	Bouwer-Rice	4.57E-04	1.30	NA	NA
4435	J	Rome Formation[6]	Rome[6]	62.41[5]	79.9[5]	71.2[5]	Slug	Bouwer-Rice	7.70E-04	2.18	NA	NA
4436	J	Rome Formation[6]	Rome[6]	46.17[5]	65[5]	55.6[5]	Slug	Bouwer-Rice	5.83E-05	0.17	NA	NA
4437	J	Rome Formation[6]	Rome[6]	43.47[5]	63.77[5]	53.6[5]	Slug	Bouwer-Rice	8.33E-04	2.36	NA	NA
GW-838	J	Rome Formation[6]	Rome[6]	19.12[5]	35.45[5]	27.3[5]	Slug	Bouwer-Rice	7.58E-04	2.15	NA	NA
BRW-115[2]	K	Not Specified	Knox[6]	88.8	98.8	93.8	Slug	Bouwer-Rice	1.08E-03	3.06	NA	NA
BRW-116[2]	K	Not Specified	Knox[6]	45	55	50.0	Slug	Bouwer-Rice	3.73E-03	10.56	NA	NA
BRW-117[2]	K	Not Specified	Knox[6]	38.1	43.1	40.6	Slug	Bouwer-Rice	2.35E-02	66.76	NA	NA
BRW-118[2]	K	Rome Formation[6]	Rome[6]	45	65	55.0	Slug	Bouwer-Rice	6.48E-05	0.18	NA	NA
UA-1	L	Not Specified	Conasauga[6]	41.6	50.5	46.1	Slug	Cooper	2.26E-05	0.064	0.57	NA
UA-2	L	Not Specified	Conasauga[6]	142	169	155.5	Slug	Cooper	3.88E-09	0.00001	0.0003	NA
UB-1	L	Dismal Gap Formation[6]	Conasauga[6]	25.9	35.5	30.7	Slug	Cooper	1.48E-04	0.420	4	NA
UB-2	L	Dismal Gap Formation[6]	Conasauga[6]	101	126.1	113.6	Slug	Cooper	5.29E-07	0.002	0.037	NA
UC-1	L	Rome Formation[6]	Rome[6]	77	86.2	81.6	Slug	Cooper	9.17E-05	0.260	2.4	NA
UC-2	L	Not Specified	Chickamauga[6]	188.2	206.7	197.5	Slug	Cooper	8.11E-06	0.023	0.42	NA
UD-2	L	Pumpkin Valley Shale[6]	Conasauga[6]	180	205	192.5	Slug	Cooper	3.32E-09	0.00001	0.00023	NA
UE-1	L	Dismal Gap Formation[6]	Conasauga[6]	69.2	76.7	73.0	Slug	Cooper	1.59E-04	0.450	3.4	NA
UE-2	L	Dismal Gap Formation[6]	Conasauga[6]	175.7	197.7	186.7	Slug	Cooper	3.88E-08	0.0001	0.0023	NA
UF-1	L	Dismal Gap Formation[6]	Conasauga[6]	16.5	23.5	20.0	Slug	Cooper	8.47E-04	2.400	17	NA
UG-1	L	Nolichucky Shale[6]	Conasauga[6]	25	32	28.5	Slug	Cooper	3.03E-04	0.860	6.1	NA
UG-2	L	Dismal Gap Formation[6]	Conasauga[6]	242	300	271.0	Slug	Cooper	1.73E-09	0.000005	0.00028	NA
UG-3	L	Dismal Gap Formation[6]	Conasauga[6]	180	200	190.0	Slug	Cooper	1.09E-06	0.003	0.063	NA
UH-1	L	Nolichucky Shale[6]	Conasauga[6]	19	26	22.5	Slug	Cooper	1.06E-04	0.30	2.1	NA
UH-2	L	Nolichucky Shale[6]	Conasauga[6]	231	288	259.5	Slug	Cooper	3.53E-09	0.00001	0.00059	NA

Table 2.3-A (Sheet 14 of 14)
A Selection of Oak Ridge Reservation Published Bedrock Aquifer Testing Results

Well	Data Source	Geologic Unit	Group	Top Depth (ftbgs)	Bottom Depth (ftbgs)	Interval Midpoint (ftbgs)	Test Type	Interpretation Method	Hydraulic Cond. K_{avg} cm/s	Hydraulic Cond. K_{avg} ft/d	Trans-missivity[4] ft^2/d	Storage Coefficient[4]
UI-1	L	Nolichucky Shale[6]	Conasauga[6]	18	25	21.5	Slug	Cooper	2.65E-04	0.75	5.2	NA
UI-2	L	Nolichucky Shale[6]	Conasauga[6]	188	210	199.0	Slug	Cooper	5.29E-08	0.0002	0.0034	NA
HHMS1B	L	Not Specified	Conasauga[6]	182.3	201.2	191.8	Slug	Cooper	2.01E-05	0.057	1.1	NA
HHMS1C	L	Not Specified	Conasauga[6]	63.7	101	82.4	Slug	Cooper	2.82E-05	0.08	3	NA
HHMS2A	L	Not Specified	Conasauga[6]	380	400.6	390.3	Slug	Cooper	1.38E-07	0.0004	0.008	NA
HHMS2B	L	Not Specified	Conasauga[6]	180.6	200.6	190.6	Slug	Cooper	2.29E-06	0.007	0.13	NA
HHMS2C	L	Not Specified	Conasauga[6]	62.3	81.1	71.7	Slug	Cooper	1.34E-05	0.038	0.72	NA
HHMS3A	L	Not Specified	Conasauga[6]	380.5	399.1	389.8	Slug	Cooper	1.90E-07	0.0005	0.01	NA
HHMS3B	L	Not Specified	Conasauga[6]	189.7	211.6	200.7	Slug	Cooper	2.36E-07	0.0007	0.0015	NA
HHMS3C	L	Not Specified	Conasauga[6]	62	80.6	71.3	Slug	Cooper	1.48E-05	0.042	0.78	NA
HHMS4B	L	Not Specified	Conasauga[6]	174.3	215.3	194.8	Slug	Cooper	1.13E-05	0.032	1.3	NA
HHMS5B	L	Not Specified	Conasauga[6]	196.1	219.5	207.8	Slug	Cooper	4.23E-06	0.012	0.29	NA
HHMS5C	L	Not Specified	Conasauga[6]	42.1	63	52.6	Slug	Cooper	5.64E-05	0.16	3.4	NA
HHMS6B	L	Not Specified	Conasauga[6]	145	165.4	155.2	Slug	Cooper	5.64E-06	0.016	0.32	NA
HHMS6C	L	Not Specified	Conasauga[6]	40.8	60.8	50.8	Slug	Cooper	4.59E-05	0.13	2.7	NA

Notes: NA = Not Available   Maryville Limestone has been re-designated Dismal Gap Formation and Rutledge Limestone has been re-designated Friendship Formation

(1) Not included in analysis because depth information is missing
(2) average of rising and falling tests or geometric mean of two interpretation methods
(3) multiple zones screened
(4) Where multiple aquifer pumping test interpretations are available, the method results are reported
(5) Depths are relative to top of casing
(6) Geologic unit and/or group estimated based on available geologic information

Sources:
A (Reference 2.3-A-1), Table F.10
B (Reference 2.3-A-2)
C (Reference 2.3-A-3), Table D.1
D (Reference 2.3-A-4), Table 14
E (Reference 2.3-A-5), Tables 25 and 26
F (Reference 2.3-A-6), Table 2
G (Reference 2.3-A-7), Tables 4.2, 4.3, 4.4, 4.5, 8.1, 9.1, and 9.2
H (Reference 2.3-A-8), Tables A.1 and A.2
I (Reference 2.3-A-9), Table 4.2
J (Reference 2.3-A-10)
K (Reference 2.3-A-11), Appendix B
L (Reference 2.3-A-12), Table 2

Repeated Test Results

REFERENCES

Reference 2.3-A-1. Jacobs EM Team, "Feasibility Study for the Bear Creek Valley at the Oak Ridge Y-12 Plant, Oak Ridge, Tennessee," DOE/OR/02-1525/V2&D2, U.S. Department of Energy Office of Environmental Management under contract DE-AC05-93OR22028, November, 1997.

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Reference 2.3-A-6. Moore, G. K. and Young, S. C., "Identification of Groundwater-Producing Fractures by Using an Electromagnetic Borehole Flowmeter in Monitoring Wells on the Oak Ridge Reservation, Oak Ridge, Tennessee," ORNL/ER-91, U.S. Department of Energy Office of Environmental Restoration and Waste Management under contract DE-AC05-840R21400, Oak Ridge National Laboratory Environmental Sciences Division, March, 1992.

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Reference 2.3-A-8. Science Applications International Corporation, "Decision Document for Performing a Long-Term Pumping Test at the S-3 Site, Oak Ridge Y-12 Plant, Oak Ridge, Tennessee," Y/ER-210, U.S. Department of Energy Office of Environmental Restoration and Waste Management under contract DE-AC05-84OR21400, February, 1995.

Reference 2.3-A-9. Science Applications International Corporation, "East End VOC Plume Pump and Tracer Test Technical Memorandum," BJC/OR-103, U.S. Department of Energy Office of Environmental Management under contract DE-AC05-98OR22700, August, 1998.

Reference 2.3-A-10. Jacobs EM Team, "Task Order 125 - Documentation Regarding Slug Test Data and Analysis, White Wing Scrap Yard and East Bear Creek Valley Sites Task 35H83125," JE/OR/97-01839, Memorandum for Steve Lampkins, September 29, 1997.

Reference 2.3-A-11. URS and CH2M Oak Ridge LLC, "Final Zone 1 Remedial Investigation and Feasibility Study for East Tennessee Technology Park, Oak Ridge, Tennessee," DOE/OR/01-2561&D1, U.S. Department of Energy Office of Environmental Management under contract DE-SC-0004645, March, 2012.

Reference 2.3-A-12. Tucci, P., "Hydrology of Melton Valley at Oak Ridge National Laboratory, Tennessee," U.S. Geological Survey, Water-Resources Investigations Report 92-4131, 1992.

APPENDIX 2.3-B
Clinch River Breeder Reactor Project Packer Test Results

Table 2.3-B (Sheet 1 of 6)
Clinch River Breeder Reactor Project Investigation Packer Test Results

Boring	Date	Test Section (ft bgs)	Test Length (ft)	C_p (ft^2/ gpm-yr)	Flow Q (gpm)	Total Head H (ft)	Hydraulic Conductivity K[a] (ft/yr)	Hydraulic Conductivity K[b] (ft/d)	Hydraulic Conductivity K[b] (cm/s)	Geologic Horizon[c]	Geologic Strata[d]
B-26	10/2/1973	24 - 298	274	320	8.9	68.6	42	0.12	4.06E-05	U.A.S.S.	Chickamauga Group
	9/28/1973	30 - 298	268	325	10.1	64.7	51	0.14	4.93E-05	U.A.S.S.	Chickamauga Group
	9/28/1973	50 - 298	248	350	8.4	64.7	45	0.12	4.35E-05	U.A.S.S.	Chickamauga Group
	9/29/1973	70 - 298	228	380	8.6	99.4	33	0.09	3.19E-05	U.A.S.S.	Chickamauga Group
	---	90 - 298	208	420	4.9	61.7	33	0.09	3.19E-05	U.A.S.S.	Chickamauga Group
	10/2/1973	110 - 298	188	450	5.5	67.1	37	0.10	3.57E-05	U.A.S.S.	Chickamauga Group
	10/2/1973	150 - 298	148	540	7.2	67.1	58	0.16	5.60E-05	A.L.S.	Chickamauga Group
	10/2/1973	220 - 298	78	920	6.9	67.1	95	0.26	9.18E-05	L.A.S.S.	Chickamauga Group
B-27	11/8/1973	35 - 245	210	410	3.5	47.6	30	0.08	2.90E-05	A.L.S.	Chickamauga Group
	11/8/1973	60 - 245	185	460	2.8	47.6	27	0.07	2.61E-05	A.L.S.	Chickamauga Group
	11/8/1973	80 - 245	165	500	2.3	70.7	16	0.04	1.55E-05	A.L.S.	Chickamauga Group
	11/8/1973	100 - 245	145	550	1.1	70.7	9	0.02	8.69E-06	A.L.S.	Chickamauga Group
	11/8/1973	120 - 245	125	620	0.8	70.7	7	0.02	6.76E-06	L.A.S.S.	Chickamauga Group
B-28	11/13/1973	16 - 25	9	5300	8.7	44.6	1040[e]	2.85	1.00E-03	U.A.S.S.	Chickamauga Group
	11/13/1973	19 - 28	9	5300	8.8	41.6	980[e]	2.68	9.47E-04	U.A.S.S.	Chickamauga Group
	11/13/1973	27 - 36	9	5300	3.1	55.6	298[e]	0.82	2.88E-04	U.A.S.S.	Chickamauga Group
	11/13/1973	50 - 271	221	390	0.47	65.1	2.8	0.01	2.70E-06	U.A.S.S.	Chickamauga Group
	11/13/1973	90 - 271	181	470	0.96	65.1	6.9	0.02	6.66E-06	U.A.S.S.	Chickamauga Group
B-29	11/12/1973	30 - 335	305	290	2.5	61.1	11.9	0.03	1.15E-05	U.A.S.S.	Chickamauga Group
	11/12/1973	40 - 335	295	300	0.21	84.2	0.75	0.002	7.24E-07	U.A.S.S.	Chickamauga Group
	11/12/1973	50 - 335	285	305	0.76	107.3	2.2	0.01	2.12E-06	U.A.S.S.	Chickamauga Group
	11/12/1973	80 - 335	255	340	4.45	130.4	11.6	0.03	1.12E-05	U.A.S.S.	Chickamauga Group

Table 2.3-B (Sheet 2 of 6)
Clinch River Breeder Reactor Project Investigation Packer Test Results

Boring	Date	Test Section (ft bgs)	Test Length (ft)	C_p (ft^2/gpm-yr)	Flow Q (gpm)	Total Head H (ft)	Hydraulic Conductivity K[a] (ft/yr)	Hydraulic Conductivity K[b] (ft/d)	Hydraulic Conductivity K[b] (cm/s)	Geologic Horizon[c]	Geologic Strata[d]
B-30	12/4/1973	11 - 20	9	5300	11.3	39.6	1510[e]	4.14	1.46E-03	U.A.S.S.	Chickamauga Group
	12/5/1973	20 - 253.5	233.5	370	14.8	68.1	80	0.22	7.73E-05	U.A.S.S.	Chickamauga Group
	12/5/1973	65 - 253.5	188.5	450	9.9	68.1	65	0.18	6.28E-05	U.A.S.S.	Chickamauga Group
	12/5/1973	88 - 253.5	165.5	500	2.2	91.2	12	0.03	1.16E-05	U.A.S.S.	Chickamauga Group
	12/5/1973	144 - 253.5	139.5	560	0.5	91.2	3.1	0.01	2.99E-06	A.L.S.	Chickamauga Group
B-31	11/1/1973	82 - 91	9	5300	12.5	89.5	740	2.03	7.15E-04	A.L.S.	Chickamauga Group
	11/1/1973	92 - 101	9	5300	12	89.5	711	1.95	6.87E-04	A.L.S.	Chickamauga Group
	11/1/1973	101 - 110	9	5300	12	89.5	711	1.95	6.87E-04	A.L.S.	Chickamauga Group
	10/21/1973	110 - 252	142	560	1.8	89.5	112[e]	0.31	1.08E-04	L.A.S.S.	Chickamauga Group
B-34	10/30/1973	45.5 - 54.5	9	5300	12.2	73.1	885	2.42	8.55E-04	A.L.S.	Chickamauga Group
	10/30/1973	54.5 - 63.5	9	5300	12.1	82.1	781	2.14	7.54E-04	A.L.S.	Chickamauga Group
	10/30/1973	56 - 65	9	5300	11.5	83.1	733	2.01	7.08E-04	A.L.S.	Chickamauga Group
	10/29/1973	92.5 - 248	155.5	520	6	84.1	37	0.10	3.57E-05	A.L.S./L.A.S.S.	Chickamauga Group
	10/29/1973	105 - 248	143	550	2	84.1	13	0.04	1.26E-05	L.A.S.S.	Chickamauga Group
	10/29/1973	130 - 248	118	660	1.8	84.1	14	0.04	1.35E-05	L.A.S.S.	Chickamauga Group
	10/29/1973	165 - 248	83	880	1.6	84.1	17	0.05	1.64E-05	L.A.S.S.	Chickamauga Group
	10/29/1973	172 - 248	76	950	4.5	84.1	51	0.14	4.93E-05	L.A.S.S.	Chickamauga Group
B-35	10/27/1973	51.5 - 284	232.5	375	6.2	34.6	67	0.18	6.47E-05	A.L.S./L.A.S.S.	Chickamauga Group
	10/27/1973	95 - 284	189	450	4.9	41.6	53	0.15	5.12E-05	L.A.S.S.	Chickamauga Group
	10/26/1973	130 - 284	154	525	4.8	51.6	49	0.13	4.73E-05	L.A.S.S.	Chickamauga Group
	10/27/1973	169 - 284	115	670	3.3	51.6	42[e]	0.12	4.06E-05	L.A.S.S.	Chickamauga Group
	10/27/1973	218 - 284	66	1080	2.7	51.6	57	0.16	5.51E-05	L.A.S.S.	Chickamauga Group
	10/27/1973	238 - 284	46	1450	2	74.7	39	0.11	3.77E-05	L.A.S.S./Knox	Chickamauga Group/Knox Group

Table 2.3-B (Sheet 3 of 6)
Clinch River Breeder Reactor Project Investigation Packer Test Results

Boring	Date	Test Section (ft bgs)	Test Length (ft)	C_p (ft^2/gpm-yr)	Flow Q (gpm)	Total Head H (ft)	Hydraulic Conductivity K[a] (ft/yr)	Hydraulic Conductivity K[b] (ft/d)	Hydraulic Conductivity K[b] (cm/s)	Geologic Horizon[c]	Geologic Strata[d]
B-36	11/1/1973	36.5 - 274.5	238	365	3.9	123.2	12	0.03	1.16E-05	L.A.S.S.	Chickamauga Group
	11/1/1973	50 - 274.5	244.5	385	4.4	123.2	14	0.04	1.35E-05	L.A.S.S.	Chickamauga Group
	11/1/1973	70 - 274.5	204.5	420	3.1	123.2	11	0.03	1.06E-05	L.A.S.S.	Chickamauga Group
	11/1/1973	90 - 274.5	184.5	460	2.6	123.2	10	0.03	9.66E-06	L.A.S.S.	Chickamauga Group
	11/1/1973	110 - 274.5	164.5	500	3	123.2	12	0.03	1.16E-05	L.A.S.S.	Chickamauga Group
B-38	10/4/1973	41 - 47.5	--	--	0	--	0	0	0	B	Chickamauga Group
	10/4/1973	44.5 - 51	--	--	0	--	0	0	0	B	Chickamauga Group
	10/3/1973	70 - 380.9	--	--	0	--	0	0	0	B	Chickamauga Group
	10/3/1973	100 - 380.9	--	--	0	--	0	0	0	B	Chickamauga Group
	10/3/1973	140 - 380.9	--	--	0	--	0	0	0	U.A.S.S.	Chickamauga Group
	10/3/1973	170 - 380.9	--	--	0	--	0	0	0	U.A.S.S.	Chickamauga Group
	10/3/1973	190 - 380.9	--	--	0	--	0	0	0	U.A.S.S.	Chickamauga Group
B-39	11/9/1973	20 - 29	9	5300	4	87.8	242[e]	0.66	2.34E-04	U.A.S.S.	Chickamauga Group
	11/8/1973	28.5 - 329	300.5	290	7.5	64.7	33.5[e]	0.09	3.24E-05	U.A.S.S.	Chickamauga Group
	11/8/1973	50 - 329	279	310	5.5	64.7	26.4	0.07	2.55E-05	U.A.S.S.	Chickamauga Group
	11/8/1973	65 - 329	264	330	5.1	64.7	26.0	0.07	2.51E-05	U.A.S.S.	Chickamauga Group
	11/8/1973[f]	85 - 329	244	360	1.03	87.6	4.2	0.01	4.06E-06	U.A.S.S.	Chickamauga Group
	11/8/1973[f]	85 - 329	244	360	2.32	110.9	7.5	0.02	7.24E-06	U.A.S.S.	Chickamauga Group
B-40	9/25/1973	30 - 39	9	5300	9.8	59.6	871	2.39	8.41E-04	A.L.S.	Chickamauga Group
	9/25/1973	36 - 45	9	5300	5.8	65.6	471[e]	1.29	4.55E-04	A.L.S.	Chickamauga Group
	9/25/1973	46 - 55	9	5300	9.1	75.6	637[e]	1.75	6.15E-04	A.L.S.	Chickamauga Group
	9/25/1973	57.5 - 66.5	9	5300	2.1	87.1	128	0.35	1.24E-04	A.L.S.	Chickamauga Group
	9/25/1973	68.5 - 77.5	9	5300	9.5	106.9	470[e]	1.29	4.54E-04	A.L.S.	Chickamauga Group
	9/24/1973	81 - 90	9	5300	2	125.2	85	0.23	8.21E-05	A.L.S.	Chickamauga Group

Table 2.3-B (Sheet 4 of 6)
Clinch River Breeder Reactor Project Investigation Packer Test Results

Boring	Date	Test Section (ft bgs)	Test Length (ft)	C_p (ft^2/gpm-yr)	Flow Q (gpm)	Total Head H (ft)	Hydraulic Conductivity K[a] (ft/yr)	Hydraulic Conductivity K[b] (ft/d)	Hydraulic Conductivity K[b] (cm/s)	Geologic Horizon[c]	Geologic Strata[d]
B-40	9/24/1973	91 - 100	9	5300	0.5	102.1	26	0.07	2.51E-05	A.L.S.	Chickamauga Group
	9/24/1973	101 - 110	9	5300	2.1	105.1	108[e]	0.30	1.04E-04	A.L.S.	Chickamauga Group
	9/23/1973	110 - 314	204	420	5.5	124	19	0.05	1.84E-05	L.A.S.S.	Chickamauga Group
	9/23/1973	140 - 314	174	480	6.1	101.6	29	0.08	2.80E-05	L.A.S.S.	Chickamauga Group
	9/23/1973	184 - 314	130	600	6.1	101.1	36	0.10	3.48E-05	L.A.S.S.	Chickamauga Group
	9/23/1973	220 - 314	94	800	5.2	106.1	39	0.11	3.77E-05	L.A.S.S.	Chickamauga Group
	9/23/1973	259.5 - 314	54.5	1250	3.2	106.1	38	0.10	3.67E-05	Knox	Knox Group
B-42	11/5/1973	60 - 301.5	241.5	360	2.92	101.1	10	0.03	9.66E-06	B	Chickamauga Group
	11/5/1973	85 - 301.5	216.5	400	0	--	0	0	0	B	Chickamauga Group
	11/5/1973	140 - 301.5	161.5	500	1.22	101.1	6	0.02	5.80E-06	B/U.A.S.S.	Chickamauga Group
	11/5/1973	150 - 301.5	151.5	530	1.54	101.1	8	0.02	7.73E-06	U.A.S.S.	Chickamauga Group
B-46	11/6/1973	30 - 78.9	48.9	1380	6.24	77.9	111	0.30	1.07E-04	U.A.S.S.	Chickamauga Group
	11/6/1973	65 - 78.9	13.9	3900	0.15	101	6	0.02	5.80E-06	U.A.S.S.	Chickamauga Group
B-47	12/4/1973	83 - 92	9	5300	6	83.7	380	1.04	3.67E-04	A.L.S.	Chickamauga Group
	12/3/1973	89 - 98	9	5300	4.8	83.7	304	0.83	2.94E-04	A.L.S.	Chickamauga Group
	12/3/1973	98 - 107	9	5300	11.0	83.7	697	1.91	6.73E-04	A.L.S.	Chickamauga Group
	11/30/1973	108 - 370	262	340	3.7	83.7	15	0.04	1.45E-05	L.A.S.S.	Chickamauga Group
	11/30/1973	115 - 370	255	340	3.1	106.8	10	0.03	9.66E-06	L.A.S.S.	Chickamauga Group
	11/30/1973	140 - 370	230	380	1.1	106.8	4	0.01	3.86E-06	L.A.S.S.	Chickamauga Group
	11/30/1973	150 - 370	220	400	1.2	106.8	4	0.01	3.86E-06	L.A.S.S.	Chickamauga Group
B-48	9/20/1973	33 - 114	81	900	2.5	52.4	43	0.12	4.15E-05	B	Chickamauga Group
	9/20/1973	43 - 114	71	1000	1.4	53.1	27[e]	0.07	2.61E-05	B	Chickamauga Group
	--	56 - 114	58	1200	0.7	60.9	14	0.04	1.35E-05	B	Chickamauga Group
	9/17/1973	85 - 114	29	2000	0.5	68.6	15	0.04	1.45E-05	U.A.S.S.	Chickamauga Group

Table 2.3-B (Sheet 5 of 6)
Clinch River Breeder Reactor Project Investigation Packer Test Results

Boring	Date	Test Section (ft bgs)	Test Length (ft)	C_p (ft^2/gpm-yr)	Flow Q (gpm)	Total Head H (ft)	Hydraulic Conductivity K[a] (ft/yr)	Hydraulic Conductivity K[b] (ft/d)	Hydraulic Conductivity K[b] (cm/s)	Geologic Horizon[c]	Geologic Strata[d]
B-49	11/7/1973	57.5 - 144	86.5	860	10.8	94.9	98	0.27	9.47E-05	B	Chickamauga Group
	11/7/1973	70 - 144	74	980	2.2	118	18	0.05	1.74E-05	B	Chickamauga Group
	11/7/1973	85 - 144	59	--	0	--	0	0	0	B	Chickamauga Group
	11/6/1973	110 - 144	34	--	0	--	0	0	0	U.A.S.S.	Chickamauga Group
B-50	11/2/1973	78 - 241	163	500	2.7	91.1	15	0.04	1.45E-05	B	Chickamauga Group
	11/2/1973	90 - 241	151	535	2.6	91.1	15	0.04	1.45E-05	B	Chickamauga Group
	11/2/1973	100 - 241	141	560	2.6	91.1	16	0.04	1.55E-05	B	Chickamauga Group
	11/2/1973	201 - 241	40	1650	1.4	91.1	25	0.07	2.41E-05	U.A.S.S.	Chickamauga Group
B-51	11/20/1973	31 - 40	9	5300	1	60.6	91[e]	0.25	8.79E-05	A.L.S.	Chickamauga Group
	11/20/1973	36.5 - 45.5	9	5300	0.46	66.1	37	0.10	3.57E-05	A.L.S.	Chickamauga Group
	11/20/1973	45.5 - 54.5	9	5300	0.11	75.1	8	0.02	7.73E-06	A.L.S.	Chickamauga Group
	11/20/1973	34.5 - 63.5	9	5300	17.2	82.1	1110	3.04	1.07E-03	A.L.S.	Chickamauga Group
	11/20/1973	83 - 338.5	255.5	340	2.67	105.2	9	0.02	8.69E-06	A.L.S.	Chickamauga Group
	11/20/1973	100 - 338.5	238.5	365	1.86	105.2	6	0.02	5.80E-06	A.L.S./L.A.S.S.	Chickamauga Group
B-53	11/29/1973	53 - 200	147	540	0.15	131.7	0.6	0.002	5.80E-07	Knox	Knox Group
	11/29/1973	90 - 200	110	700	0.15	108.6	1	0.003	9.66E-07	Knox	Knox Group
B-66	11/29/1973	37 - 101	64	1100	0.12	92.9	1.4	0.004	1.35E-06	Knox	Knox Group
	11/29/1973	50 - 101	51	1350	0.08	92.9	1.2	0.003	1.16E-06	Knox	Knox Group
	11/29/1973	73 - 101	28	2200	0.12	92.9	2.8	0.01	2.70E-06	Knox	Knox Group
B-67	11/17/1973	24 - 33	9	5300	0.08	76.3	5.6	0.02	5.41E-06	Knox	Knox Group
	11/17/1973	33 - 42	9	5300	0	--	0	0	0	Knox	Knox Group
	11/17/1973	42 - 51	9	5300	0	---	0	0	0	Knox	Knox Group
	11/17/1973	51 - 60	9	5300	9.1	59.7	807[e]	2.21	7.79E-04	Knox	Knox Group

Table 2.3-B (Sheet 6 of 6)
Clinch River Breeder Reactor Project Investigation Packer Test Results

Boring	Date	Test Section (ft bgs)	Test Length (ft)	C_p (ft^2/gpm-yr)	Flow Q (gpm)	Total Head H (ft)	Hydraulic Conductivity K[(a)] (ft/yr)	Hydraulic Conductivity K[(b)] (ft/d)	Hydraulic Conductivity K[(b)] (cm/s)	Geologic Horizon[(c)]	Geologic Strata[(d)]
B-67	11/16/1973	40 - 100	60	1180	9.2	59.7	182	0.50	1.76E-04	Knox	Knox Group
	11/15/1973	61 - 100	39	--	0	--	0	0	0	Knox	Knox Group

Notes:

(a) $K = C_p \frac{Q}{H}$

(b) Hydraulic conductivity in ft/yr converted to ft/d by dividing by 365 and converted to cm/s by multiplying by 9.6590 x 10^{-7}

(c) Geologic Horizon from Table 24-17 of Reference
U.A.S.S. = Upper Unit A Siltstone
A.L.S. = Unit A Limestone
L.A.S.S. = Lower Unit A Siltstone
B = Unit B Limestone
Knox = Knox Group

(d) Geologic Strata nomenclature used in current investigation

(e) Yellow highlighted values indicate discrepancy between values reported on Table 24-17 of Reference and values calculated using the formula shown above

(f) Orange highlighted values are duplicate tests- the maximum value is used in hydraulic conductivity analysis

Reference: Reference 2.3-B-1. Project Management Corporation, "Clinch River Breeder Reactor Project, Preliminary Safety Analysis Report," Volume 2, Amendment 68, May, 1982.

APPENDIX 2.3-C
Vertical Hydraulic Gradients

Table 2.3-C (Sheet 1 of 26)
Vertical Hydraulic Gradients

Well Pair	Date	Upper Zone				Lower Zone				Deeper Zone				Δz (ft)	Δh (ft)	i_v
		Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)	Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)	Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)			
OW-101U/L (Upper /Lower)	24-Sep-13	774.6	754.6	764.6	790.71	662.7	642.7	652.7	768.33	---	---	---	---	111.9	22.38	0.20
	1-Oct-13	774.6	754.6	764.6	784.18	662.7	642.7	652.7	766.37	---	---	---	---	111.9	17.81	0.16
	9-Oct-13	774.6	754.6	764.6	783.14	662.7	642.7	652.7	761.90	---	---	---	---	111.9	21.24	0.19
	26-Oct-13	774.6	754.6	764.6	782.73	662.7	642.7	652.7	756.89	---	---	---	---	111.9	25.84	0.23
	5-Nov-13	774.6	754.6	764.6	782.69	662.7	642.7	652.7	753.48	---	---	---	---	111.9	29.21	0.26
	12-Nov-13	774.6	754.6	764.6	782.84	662.7	642.7	652.7	749.60	---	---	---	---	111.9	33.24	0.30
	23-Nov-13	774.6	754.6	764.6	783.95	662.7	642.7	652.7	762.05	---	---	---	---	111.9	21.90	0.20
	9-Dec-13	774.6	754.6	764.6	798.42	662.7	642.7	652.7	773.47	---	---	---	---	111.9	24.95	0.22
	20-Dec-13	774.6	754.6	764.6	790.65	662.7	642.7	652.7	768.74	---	---	---	---	111.9	21.91	0.20
	13-Jan-14	774.6	754.6	764.6	795.74	662.7	642.7	652.7	771.52	---	---	---	---	111.9	24.22	0.22
	16-Jan-14	774.6	754.6	764.6	795.38	662.7	642.7	652.7	771.11	---	---	---	---	111.9	24.27	0.22
	18-Feb-14	774.6	754.6	764.6	791.86	662.7	642.7	652.7	768.70	---	---	---	---	111.9	23.16	0.21
	16-Mar-14	774.6	754.6	764.6	785.52	662.7	642.7	652.7	766.01	---	---	---	---	111.9	19.51	0.17
	15-Apr-14	774.6	754.6	764.6	788.72	662.7	642.7	652.7	767.45	---	---	---	---	111.9	21.27	0.19
	15-May-14	774.6	754.6	764.6	792.69	662.7	642.7	652.7	768.01	---	---	---	---	111.9	24.68	0.22
	16-Jun-14	774.6	754.6	764.6	791.90	662.7	642.7	652.7	768.62	---	---	---	---	111.9	23.28	0.21
	16-Jul-14	774.6	754.6	764.6	783.11	662.7	642.7	652.7	762.61	---	---	---	---	111.9	20.50	0.18
	18-Aug-14	774.6	754.6	764.6	789.18	662.7	642.7	652.7	767.59	---	---	---	---	111.9	21.59	0.19
	4-Nov-14	774.6	754.6	764.6	783.64	662.7	642.7	652.7	764.05	---	---	---	---	111.9	19.59	0.18
	12-Feb-15	774.6	754.6	764.6	786.53	662.7	642.7	652.7	766.59	---	---	---	---	111.9	19.94	0.18
	19-May-15	774.6	754.6	764.6	782.96	662.7	642.7	652.7	763.31	---	---	---	---	111.9	19.65	0.18
	10-Aug-15	774.6	754.6	764.6	783.54	662.7	642.7	652.7	764.88	---	---	---	---	111.9	18.66	0.17
																0.20

Table 2.3-C (Sheet 2 of 26)
Vertical Hydraulic Gradients

Well Pair	Date	Upper Zone				Lower Zone				Deeper Zone				Δz (ft)	Δh (ft)	i_v
		Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)	Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)	Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)			
OW-101U/D (Upper/Deeper)	24-Sep-13	774.6	754.6	764.6	790.71	---	---	---	---	570.2	550.2	560.2	743.45	204.4	47.26	0.23
	1-Oct-13	774.6	754.6	764.6	784.18	---	---	---	---	570.2	550.2	560.2	743.03	204.4	41.15	0.20
	9-Oct-13	774.6	754.6	764.6	783.14	---	---	---	---	570.2	550.2	560.2	741.77	204.4	41.37	0.20
	26-Oct-13	774.6	754.6	764.6	782.73	---	---	---	---	570.2	550.2	560.2	741.33	204.4	41.40	0.20
	5-Nov-13	774.6	754.6	764.6	782.69	---	---	---	---	570.2	550.2	560.2	740.52	204.4	42.17	0.21
	12-Nov-13	774.6	754.6	764.6	782.84	---	---	---	---	570.2	550.2	560.2	739.89	204.4	42.95	0.21
	23-Nov-13	774.6	754.6	764.6	783.95	---	---	---	---	570.2	550.2	560.2	739.25	204.4	44.70	0.22
	9-Dec-13	774.6	754.6	764.6	798.42	---	---	---	---	570.2	550.2	560.2	749.39	204.4	49.03	0.24
	20-Dec-13	774.6	754.6	764.6	790.65	---	---	---	---	570.2	550.2	560.2	741.05	204.4	49.60	0.24
	13-Jan-14	774.6	754.6	764.6	795.74	---	---	---	---	570.2	550.2	560.2	745.15	204.4	50.59	0.25
	16-Jan-14	774.6	754.6	764.6	795.38	---	---	---	---	570.2	550.2	560.2	744.49	204.4	50.89	0.25
	18-Feb-14	774.6	754.6	764.6	791.86	---	---	---	---	570.2	550.2	560.2	741.50	204.4	50.36	0.25
	16-Mar-14	774.6	754.6	764.6	785.52	---	---	---	---	570.2	550.2	560.2	739.22	204.4	46.30	0.23
	15-Apr-14	774.6	754.6	764.6	788.72	---	---	---	---	570.2	550.2	560.2	740.92	204.4	47.80	0.23
	15-May-14	774.6	754.6	764.6	792.69	---	---	---	---	570.2	550.2	560.2	743.81	204.4	48.88	0.24
	16-Jun-14	774.6	754.6	764.6	791.90	---	---	---	---	570.2	550.2	560.2	743.33	204.4	48.57	0.24
	16-Jul-14	774.6	754.6	764.6	783.11	---	---	---	---	570.2	550.2	560.2	742.43	204.4	40.68	0.20
	18-Aug-14	774.6	754.6	764.6	789.18	---	---	---	---	570.2	550.2	560.2	743.45	204.4	45.73	0.22
	4-Nov-14	774.6	754.6	764.6	783.64	---	---	---	---	570.2	550.2	560.2	742.16	204.4	41.48	0.20
	12-Feb-15	774.6	754.6	764.6	786.53	---	---	---	---	570.2	550.2	560.2	739.98	204.4	46.55	0.23
	19-May-15	774.6	754.6	764.6	782.96	---	---	---	---	570.2	550.2	560.2	742.70	204.4	40.26	0.20
	10-Aug-15	774.6	754.6	764.6	783.54	---	---	---	---	570.2	550.2	560.2	743.18	204.4	40.36	0.20
																0.22

Table 2.3-C (Sheet 3 of 26)
Vertical Hydraulic Gradients

Well Pair	Date	Upper Zone				Lower Zone				Deeper Zone				Δz (ft)	Δh (ft)	i_v
		Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)	Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)	Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)			
OW-101L/D (Lower/Deeper)	24-Sep-13	---	---	---	---	662.7	642.7	652.7	768.33	570.2	550.2	560.2	743.45	92.5	24.88	0.27
	1-Oct-13	---	---	---	---	662.7	642.7	652.7	766.37	570.2	550.2	560.2	743.03	92.5	23.34	0.25
	9-Oct-13	---	---	---	---	662.7	642.7	652.7	761.90	570.2	550.2	560.2	741.77	92.5	20.13	0.22
	26-Oct-13	---	---	---	---	662.7	642.7	652.7	756.89	570.2	550.2	560.2	741.33	92.5	15.56	0.17
	5-Nov-13	---	---	---	---	662.7	642.7	652.7	753.48	570.2	550.2	560.2	740.52	92.5	12.96	0.14
	12-Nov-13	---	---	---	---	662.7	642.7	652.7	749.60	570.2	550.2	560.2	739.89	92.5	9.71	0.11
	23-Nov-13	---	---	---	---	662.7	642.7	652.7	762.05	570.2	550.2	560.2	739.25	92.5	22.80	0.25
	9-Dec-13	---	---	---	---	662.7	642.7	652.7	773.47	570.2	550.2	560.2	749.39	92.5	24.08	0.26
	20-Dec-13	---	---	---	---	662.7	642.7	652.7	768.74	570.2	550.2	560.2	741.05	92.5	27.69	0.30
	13-Jan-14	---	---	---	---	662.7	642.7	652.7	771.52	570.2	550.2	560.2	745.15	92.5	26.37	0.29
	16-Jan-14	---	---	---	---	662.7	642.7	652.7	771.11	570.2	550.2	560.2	744.49	92.5	26.62	0.29
	18-Feb-14	---	---	---	---	662.7	642.7	652.7	768.70	570.2	550.2	560.2	741.50	92.5	27.20	0.29
	16-Mar-14	---	---	---	---	662.7	642.7	652.7	766.01	570.2	550.2	560.2	739.22	92.5	26.79	0.29
	15-Apr-14	---	---	---	---	662.7	642.7	652.7	767.45	570.2	550.2	560.2	740.92	92.5	26.53	0.29
	15-May-14	---	---	---	---	662.7	642.7	652.7	768.01	570.2	550.2	560.2	743.81	92.5	24.20	0.26
	16-Jun-14	---	---	---	---	662.7	642.7	652.7	768.62	570.2	550.2	560.2	743.33	92.5	25.29	0.27
	16-Jul-14	---	---	---	---	662.7	642.7	652.7	762.61	570.2	550.2	560.2	742.43	92.5	20.18	0.22
	18-Aug-14	---	---	---	---	662.7	642.7	652.7	767.59	570.2	550.2	560.2	743.45	92.5	24.14	0.26
	4-Nov-14	---	---	---	---	662.7	642.7	652.7	764.05	570.2	550.2	560.2	742.16	92.5	21.89	0.24
	12-Feb-15	---	---	---	---	662.7	642.7	652.7	766.59	570.2	550.2	560.2	739.98	92.5	26.61	0.29
	19-May-15	---	---	---	---	662.7	642.7	652.7	763.31	570.2	550.2	560.2	742.70	92.5	20.61	0.22
	10-Aug-15	---	---	---	---	662.7	642.7	652.7	764.88	570.2	550.2	560.2	743.18	92.5	21.70	0.23
																0.25

Table 2.3-C (Sheet 4 of 26)
Vertical Hydraulic Gradients

Well Pair	Date	Upper Zone				Lower Zone				Deeper Zone				Δz (ft)	Δh (ft)	i_v
		Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)	Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)	Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)			
OW-202U/L (Upper /Lower)	24-Sep-13	796.1	776.1	786.1	798.65	661.5	641.5	651.5	766.92	---	---	---	---	134.6	31.73	0.24
	1-Oct-13	796.1	776.1	786.1	796.31	661.5	641.5	651.5	766.17	---	---	---	---	134.6	30.14	0.22
	9-Oct-13	796.1	776.1	786.1	792.89	661.5	641.5	651.5	765.36	---	---	---	---	134.6	27.53	0.20
	26-Oct-13	796.1	776.1	786.1	788.51	661.5	641.5	651.5	762.86	---	---	---	---	134.6	25.65	0.19
	5-Nov-13	796.1	776.1	786.1	787.32	661.5	641.5	651.5	761.76	---	---	---	---	134.6	25.56	0.19
	12-Nov-13	796.1	776.1	786.1	786.75	661.5	641.5	651.5	761.12	---	---	---	---	134.6	25.63	0.19
	23-Nov-13	796.1	776.1	786.1	797.43	661.5	641.5	651.5	705.78	---	---	---	---	134.6	91.65	0.68
	9-Dec-13	796.1	776.1	786.1	800.15	661.5	641.5	651.5	778.27	---	---	---	---	134.6	21.88	0.16
	20-Dec-13	796.1	776.1	786.1	798.10	661.5	641.5	651.5	773.58	---	---	---	---	134.6	24.52	0.18
	13-Jan-14	796.1	776.1	786.1	799.47	661.5	641.5	651.5	776.79	---	---	---	---	134.6	22.68	0.17
	16-Jan-14	796.1	776.1	786.1	798.96	661.5	641.5	651.5	776.08	---	---	---	---	134.6	22.88	0.17
	18-Feb-14	796.1	776.1	786.1	798.84	661.5	641.5	651.5	772.85	---	---	---	---	134.6	25.99	0.19
	16-Mar-14	796.1	776.1	786.1	795.76	661.5	641.5	651.5	771.33	---	---	---	---	134.6	24.43	0.18
	15-Apr-14	796.1	776.1	786.1	796.29	661.5	641.5	651.5	772.92	---	---	---	---	134.6	23.37	0.17
	15-May-14	796.1	776.1	786.1	799.44	661.5	641.5	651.5	768.85	---	---	---	---	134.6	30.59	0.23
	16-Jun-14	796.1	776.1	786.1	798.71	661.5	641.5	651.5	766.50	---	---	---	---	134.6	32.21	0.24
	16-Jul-14	796.1	776.1	786.1	795.66	661.5	641.5	651.5	764.40	---	---	---	---	134.6	31.26	0.23
	18-Aug-14	796.1	776.1	786.1	796.22	661.5	641.5	651.5	770.31	---	---	---	---	134.6	25.91	0.19
	4-Nov-14	796.1	776.1	786.1	795.68	661.5	641.5	651.5	766.10	---	---	---	---	134.6	29.58	0.22
	12-Feb-15	796.1	776.1	786.1	796.03	661.5	641.5	651.5	772.22	---	---	---	---	134.6	23.81	0.18
	19-May-15	796.1	776.1	786.1	795.47	661.5	641.5	651.5	767.00	---	---	---	---	134.6	28.47	0.21
	10-Aug-15	796.1	776.1	786.1	795.67	661.5	641.5	651.5	768.56	---	---	---	---	134.6	27.11	0.20
																0.20

Table 2.3-C (Sheet 5 of 26)
Vertical Hydraulic Gradients

Well Pair	Date	Upper Zone				Lower Zone				Deeper Zone				Δz (ft)	Δh (ft)	i_v
		Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)	Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)	Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)			
OW-202U/D (Upper /Deeper)	24-Sep-13	796.1	776.1	786.1	798.65	---	---	---	---	535.7	515.7	525.7	759.34	260.4	39.31	0.15
	1-Oct-13	796.1	776.1	786.1	796.31	---	---	---	---	535.7	515.7	525.7	758.96	260.4	37.35	0.14
	9-Oct-13	796.1	776.1	786.1	792.89	---	---	---	---	535.7	515.7	525.7	757.50	260.4	35.39	0.14
	26-Oct-13	796.1	776.1	786.1	788.51	---	---	---	---	535.7	515.7	525.7	755.67	260.4	32.84	0.13
	5-Nov-13	796.1	776.1	786.1	787.32	---	---	---	---	535.7	515.7	525.7	754.85	260.4	32.47	0.12
	12-Nov-13	796.1	776.1	786.1	786.75	---	---	---	---	535.7	515.7	525.7	754.28	260.4	32.47	0.12
	23-Nov-13	796.1	776.1	786.1	797.43	---	---	---	---	535.7	515.7	525.7	755.05	260.4	42.38	0.16
	9-Dec-13	796.1	776.1	786.1	800.15	---	---	---	---	535.7	515.7	525.7	763.64	260.4	36.51	0.14
	20-Dec-13	796.1	776.1	786.1	798.10	---	---	---	---	535.7	515.7	525.7	762.41	260.4	35.69	0.14
	13-Jan-14	796.1	776.1	786.1	799.47	---	---	---	---	535.7	515.7	525.7	764.04	260.4	35.43	0.14
	16-Jan-14	796.1	776.1	786.1	798.96	---	---	---	---	535.7	515.7	525.7	764.76	260.4	34.20	0.13
	18-Feb-14	796.1	776.1	786.1	798.84	---	---	---	---	535.7	515.7	525.7	761.97	260.4	36.87	0.14
	16-Mar-14	796.1	776.1	786.1	795.76	---	---	---	---	535.7	515.7	525.7	760.31	260.4	35.45	0.14
	15-Apr-14	796.1	776.1	786.1	796.29	---	---	---	---	535.7	515.7	525.7	761.88	260.4	34.41	0.13
	15-May-14	796.1	776.1	786.1	799.44	---	---	---	---	535.7	515.7	525.7	759.74	260.4	39.70	0.15
	16-Jun-14	796.1	776.1	786.1	798.71	---	---	---	---	535.7	515.7	525.7	758.67	260.4	40.04	0.15
	16-Jul-14	796.1	776.1	786.1	795.66	---	---	---	---	535.7	515.7	525.7	757.06	260.4	38.60	0.15
	18-Aug-14	796.1	776.1	786.1	796.22	---	---	---	---	535.7	515.7	525.7	761.01	260.4	35.21	0.14
	4-Nov-14	796.1	776.1	786.1	795.68	---	---	---	---	535.7	515.7	525.7	757.89	260.4	37.79	0.15
	12-Feb-15	796.1	776.1	786.1	796.03	---	---	---	---	535.7	515.7	525.7	760.11	260.4	35.92	0.14
	19-May-15	796.1	776.1	786.1	795.47	---	---	---	---	535.7	515.7	525.7	758.58	260.4	36.89	0.14
	10-Aug-15	796.1	776.1	786.1	795.67	---	---	---	---	535.7	515.7	525.7	758.68	260.4	36.99	0.14
																0.14

Table 2.3-C (Sheet 6 of 26)
Vertical Hydraulic Gradients

Well Pair	Date	Upper Zone				Lower Zone				Deeper Zone				Δz (ft)	Δh (ft)	i_v
		Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)	Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)	Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)			
OW-202L/D (Lower /Deeper)	24-Sep-13	---	---	---	---	661.5	641.5	651.5	766.92	535.7	515.7	525.7	759.34	125.8	7.58	0.06
	1-Oct-13	---	---	---	---	661.5	641.5	651.5	766.17	535.7	515.7	525.7	758.96	125.8	7.21	0.06
	9-Oct-13	---	---	---	---	661.5	641.5	651.5	765.36	535.7	515.7	525.7	757.50	125.8	7.86	0.06
	26-Oct-13	---	---	---	---	661.5	641.5	651.5	762.86	535.7	515.7	525.7	755.67	125.8	7.19	0.06
	5-Nov-13	---	---	---	---	661.5	641.5	651.5	761.76	535.7	515.7	525.7	754.85	125.8	6.91	0.05
	12-Nov-13	---	---	---	---	661.5	641.5	651.5	761.12	535.7	515.7	525.7	754.28	125.8	6.84	0.05
	23-Nov-13	---	---	---	---	661.5	641.5	651.5	705.78	535.7	515.7	525.7	755.05	125.8	-49.27	-0.39
	9-Dec-13	---	---	---	---	661.5	641.5	651.5	778.27	535.7	515.7	525.7	763.64	125.8	14.63	0.12
	20-Dec-13	---	---	---	---	661.5	641.5	651.5	773.58	535.7	515.7	525.7	762.41	125.8	11.17	0.09
	13-Jan-14	---	---	---	---	661.5	641.5	651.5	776.79	535.7	515.7	525.7	764.04	125.8	12.75	0.10
	16-Jan-14	---	---	---	---	661.5	641.5	651.5	776.08	535.7	515.7	525.7	764.76	125.8	11.32	0.09
	18-Feb-14	---	---	---	---	661.5	641.5	651.5	772.86	535.7	515.7	525.7	761.97	125.8	10.89	0.09
	16-Mar-14	---	---	---	---	661.5	641.5	651.5	771.33	535.7	515.7	525.7	760.31	125.8	11.02	0.09
	15-Apr-14	---	---	---	---	661.5	641.5	651.5	772.92	535.7	515.7	525.7	761.88	125.8	11.04	0.09
	15-May-14	---	---	---	---	661.5	641.5	651.5	768.85	535.7	515.7	525.7	759.74	125.8	9.11	0.07
	16-Jun-14	---	---	---	---	661.5	641.5	651.5	766.50	535.7	515.7	525.7	758.67	125.8	7.83	0.06
	16-Jul-14	---	---	---	---	661.5	641.5	651.5	764.40	535.7	515.7	525.7	757.06	125.8	7.34	0.06
	18-Aug-14	---	---	---	---	661.5	641.5	651.5	770.31	535.7	515.7	525.7	761.01	125.8	9.30	0.07
	4-Nov-14	---	---	---	---	661.5	641.5	651.5	766.10	535.7	515.7	525.7	757.89	125.8	8.21	0.07
	12-Feb-15	---	---	---	---	661.5	641.5	651.5	772.22	535.7	515.7	525.7	760.11	125.8	12.11	0.10
	19-May-15	---	---	---	---	661.5	641.5	651.5	767.00	535.7	515.7	525.7	758.58	125.8	8.42	0.07
	10-Aug-15	---	---	---	---	661.5	641.5	651.5	768.56	535.7	515.7	525.7	758.68	125.8	9.88	0.08
																0.08

Table 2.3-C (Sheet 7 of 26)
Vertical Hydraulic Gradients

Well Pair	Date	Upper Zone				Lower Zone				Deeper Zone				Δz (ft)	Δh (ft)	i_v
		Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)	Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)	Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)			
OW-401U/L (Upper/Lower)	24-Sep-13	802.2	782.2	792.2	810.96	682.0	662.0	672.0	783.49	---	---	---	---	120.2	27.47	0.23
	1-Oct-13	802.2	782.2	792.2	810.52	682.0	662.0	672.0	781.71	---	---	---	---	120.2	28.81	0.24
	9-Oct-13	802.2	782.2	792.2	810.19	682.0	662.0	672.0	780.43	---	---	---	---	120.2	29.76	0.25
	26-Oct-13	802.2	782.2	792.2	809.94	682.0	662.0	672.0	778.67	---	---	---	---	120.2	31.27	0.26
	5-Nov-13	802.2	782.2	792.2	809.82	682.0	662.0	672.0	778.16	---	---	---	---	120.2	31.66	0.26
	12-Nov-13	802.2	782.2	792.2	809.78	682.0	662.0	672.0	778.20	---	---	---	---	120.2	31.58	0.26
	23-Nov-13	802.2	782.2	792.2	809.63	682.0	662.0	672.0	780.61	---	---	---	---	120.2	29.02	0.24
	9-Dec-13	802.2	782.2	792.2	813.14	682.0	662.0	672.0	791.75	---	---	---	---	120.2	21.39	0.18
	20-Dec-13	802.2	782.2	792.2	810.63	682.0	662.0	672.0	787.29	---	---	---	---	120.2	23.34	0.19
	13-Jan-14	802.2	782.2	792.2	811.60	682.0	662.0	672.0	795.55	---	---	---	---	120.2	16.05	0.13
	18-Feb-14	802.2	782.2	792.2	810.86	682.0	662.0	672.0	788.69	---	---	---	---	120.2	22.17	0.18
	16-Mar-14	802.2	782.2	792.2	810.41	682.0	662.0	672.0	785.22	---	---	---	---	120.2	25.19	0.21
	15-Apr-14	802.2	782.2	792.2	810.56	682.0	662.0	672.0	788.03	---	---	---	---	120.2	22.53	0.19
	15-May-14	802.2	782.2	792.2	811.11	682.0	662.0	672.0	784.36	---	---	---	---	120.2	26.75	0.22
	16-Jun-14	802.2	782.2	792.2	810.66	682.0	662.0	672.0	784.03	---	---	---	---	120.2	26.63	0.22
	16-Jul-14	802.2	782.2	792.2	809.9	682.0	662.0	672.0	780.40	---	---	---	---	120.2	29.50	0.25
	18-Aug-14	802.2	782.2	792.2	810.33	682.0	662.0	672.0	784.45	---	---	---	---	120.2	25.88	0.22
	4-Nov-14	802.2	782.2	792.2	810.01	682.0	662.0	672.0	780.60	---	---	---	---	120.2	29.41	0.24
	12-Feb-15	802.2	782.2	792.2	810.25	682.0	662.0	672.0	784.05	---	---	---	---	120.2	26.20	0.22
	19-May-15	802.2	782.2	792.2	809.78	682.0	662.0	672.0	781.11	---	---	---	---	120.2	28.67	0.24
	10-Aug-15	802.2	782.2	792.2	809.76	682.0	662.0	672.0	780.44	---	---	---	---	120.2	29.32	0.24
																0.22

Table 2.3-C (Sheet 8 of 26)
Vertical Hydraulic Gradients

Well Pair	Date	Upper Zone				Lower Zone				Deeper Zone				Δz (ft)	Δh (ft)	i_v
		Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)	Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)	Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)			
OW-401U/D (Upper/Deeper)	24-Sep-13	802.2	782.2	792.2	810.96	---	---	---	---	591.6	571.6	581.6	781.67	210.6	29.29	0.14
	1-Oct-13	802.2	782.2	792.2	810.52	---	---	---	---	591.6	571.6	581.6	782.70	210.6	27.82	0.13
	9-Oct-13	802.2	782.2	792.2	810.19	---	---	---	---	591.6	571.6	581.6	780.97	210.6	29.22	0.14
	26-Oct-13	802.2	782.2	792.2	809.94	---	---	---	---	591.6	571.6	581.6	777.33	210.6	32.61	0.15
	5-Nov-13	802.2	782.2	792.2	809.82	---	---	---	---	591.6	571.6	581.6	772.88	210.6	36.94	0.18
	12-Nov-13	802.2	782.2	792.2	809.78	---	---	---	---	591.6	571.6	581.6	777.09	210.6	32.69	0.16
	23-Nov-13	802.2	782.2	792.2	809.63	---	---	---	---	591.6	571.6	581.6	780.49	210.6	29.14	0.14
	9-Dec-13	802.2	782.2	792.2	813.14	---	---	---	---	591.6	571.6	581.6	786.87	210.6	26.27	0.12
	20-Dec-13	802.2	782.2	792.2	810.63	---	---	---	---	591.6	571.6	581.6	781.23	210.6	29.40	0.14
	13-Jan-14	802.2	782.2	792.2	811.60	---	---	---	---	591.6	571.6	581.6	794.33	210.6	17.27	0.08
	18-Feb-14	802.2	782.2	792.2	810.86	---	---	---	---	591.6	571.6	581.6	791.44	210.6	19.42	0.09
	16-Mar-14	802.2	782.2	792.2	810.41	---	---	---	---	591.6	571.6	581.6	787.87	210.6	22.54	0.11
	15-Apr-14	802.2	782.2	792.2	810.56	---	---	---	---	591.6	571.6	581.6	792.09	210.6	18.47	0.09
	15-May-14	802.2	782.2	792.2	811.11	---	---	---	---	591.6	571.6	581.6	783.04	210.6	28.07	0.13
	16-Jun-14	802.2	782.2	792.2	810.66	---	---	---	---	591.6	571.6	581.6	783.31	210.6	27.35	0.13
	16-Jul-14	802.2	782.2	792.2	809.9	---	---	---	---	591.6	571.6	581.6	780.86	210.6	29.04	0.14
	18-Aug-14	802.2	782.2	792.2	810.33	---	---	---	---	591.6	571.6	581.6	788.07	210.6	22.26	0.11
	4-Nov-14	802.2	782.2	792.2	810.01	---	---	---	---	591.6	571.6	581.6	781.55	210.6	28.46	0.14
	12-Feb-15	802.2	782.2	792.2	810.25	---	---	---	---	591.6	571.6	581.6	785.60	210.6	24.65	0.12
	19-May-15	802.2	782.2	792.2	809.78	---	---	---	---	591.6	571.6	581.6	780.82	210.6	28.96	0.14
	10-Aug-15	802.2	782.2	792.2	809.76	---	---	---	---	591.6	571.6	581.6	780.66	210.6	29.10	0.14
																0.13

Table 2.3-C (Sheet 9 of 26)
Vertical Hydraulic Gradients

Well Pair	Date	Upper Zone				Lower Zone				Deeper Zone				Δz (ft)	Δh (ft)	i_v
		Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)	Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)	Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)			
OW-401L/D (Lower/Deeper)	24-Sep-13	---	---	---	---	682.0	662.0	672.0	783.49	591.6	571.6	581.6	781.67	90.4	1.82	0.02
	1-Oct-13	---	---	---	---	682.0	662.0	672.0	781.71	591.6	571.6	581.6	782.70	90.4	-0.99	-0.01
	9-Oct-13	---	---	---	---	682.0	662.0	672.0	780.43	591.6	571.6	581.6	780.97	90.4	-0.54	-0.01
	26-Oct-13	---	---	---	---	682.0	662.0	672.0	778.67	591.6	571.6	581.6	777.33	90.4	1.34	0.01
	5-Nov-13	---	---	---	---	682.0	662.0	672.0	778.16	591.6	571.6	581.6	772.88	90.4	5.28	0.06
	12-Nov-13	---	---	---	---	682.0	662.0	672.0	778.20	591.6	571.6	581.6	777.09	90.4	1.11	0.01
	23-Nov-13	---	---	---	---	682.0	662.0	672.0	780.61	591.6	571.6	581.6	780.49	90.4	0.12	0.00
	9-Dec-13	---	---	---	---	682.0	662.0	672.0	791.75	591.6	571.6	581.6	786.87	90.4	4.88	0.05
	20-Dec-13	---	---	---	---	682.0	662.0	672.0	787.29	591.6	571.6	581.6	781.23	90.4	6.06	0.07
	13-Jan-14	---	---	---	---	682.0	662.0	672.0	795.55	591.6	571.6	581.6	794.33	90.4	1.22	0.01
	18-Feb-14	---	---	---	---	682.0	662.0	672.0	788.69	591.6	571.6	581.6	791.44	90.4	-2.75	-0.03
	16-Mar-14	---	---	---	---	682.0	662.0	672.0	785.22	591.6	571.6	581.6	787.87	90.4	-2.65	-0.03
	15-Apr-14	---	---	---	---	682.0	662.0	672.0	788.03	591.6	571.6	581.6	792.09	90.4	-4.06	-0.04
	15-May-14	---	---	---	---	682.0	662.0	672.0	784.36	591.6	571.6	581.6	783.04	90.4	1.32	0.01
	16-Jun-14	---	---	---	---	682.0	662.0	672.0	784.03	591.6	571.6	581.6	783.31	90.4	0.72	0.01
	16-Jul-14	---	---	---	---	682.0	662.0	672.0	780.40	591.6	571.6	581.6	780.86	90.4	-0.46	-0.01
	18-Aug-14	---	---	---	---	682.0	662.0	672.0	784.45	591.6	571.6	581.6	788.07	90.4	-3.62	-0.04
	4-Nov-14	---	---	---	---	682.0	662.0	672.0	780.60	591.6	571.6	581.6	781.55	90.4	-0.95	-0.01
	12-Feb-15	---	---	---	---	682.0	662.0	672.0	784.05	591.6	571.6	581.6	785.60	90.4	-1.55	-0.02
	19-May-15	---	---	---	---	682.0	662.0	672.0	781.11	591.6	571.6	581.6	780.82	90.4	0.29	0.00
	10-Aug-15	---	---	---	---	682.0	662.0	672.0	780.44	591.6	571.6	581.6	780.66	90.4	-0.22	0.00
																0.00

Table 2.3-C (Sheet 10 of 26)
Vertical Hydraulic Gradients

Well Pair	Date	Upper Zone				Lower Zone				Deeper Zone				Δz (ft)	Δh (ft)	i_v
		Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)	Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)	Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)			
OW-409U/L (Upper/Lower)	24-Sep-13	752.0	732.0	742.0	744.72	717.6	697.6	707.6	771.91	---	---	---	---	34.4	-27.19	-0.79
	1-Oct-13	752.0	732.0	742.0	742.84	717.6	697.6	707.6	770.47	---	---	---	---	34.4	-27.63	-0.80
	9-Oct-13	752.0	732.0	742.0	741.31	717.6	697.6	707.6	764.45	---	---	---	---	34.4	-23.14	-0.67
	26-Oct-13	752.0	732.0	742.0	740.84	717.6	697.6	707.6	760.40	---	---	---	---	34.4	-19.56	-0.57
	5-Nov-13	752.0	732.0	742.0	740.79	717.6	697.6	707.6	759.02	---	---	---	---	34.4	-18.23	-0.53
	12-Nov-13	752.0	732.0	742.0	739.77	717.6	697.6	707.6	758.21	---	---	---	---	34.4	-18.44	-0.54
	23-Nov-13	752.0	732.0	742.0	739.10	717.6	697.6	707.6	768.26	---	---	---	---	34.4	-29.16	-0.85
	9-Dec-13	752.0	732.0	742.0	762.56	717.6	697.6	707.6	779.22	---	---	---	---	34.4	-16.66	-0.48
	20-Dec-13	752.0	732.0	742.0	741.99	717.6	697.6	707.6	773.06	---	---	---	---	34.4	-31.07	-0.90
	13-Jan-14	752.0	732.0	742.0	756.04	717.6	697.6	707.6	777.13	---	---	---	---	34.4	-21.09	-0.61
	16-Jan-14	752.0	732.0	742.0	753.35	717.6	697.6	707.6	776.43	---	---	---	---	34.4	-23.08	-0.67
	18-Feb-14	752.0	732.0	742.0	743.63	717.6	697.6	707.6	774.07	---	---	---	---	34.4	-30.44	-0.88
	16-Mar-14	752.0	732.0	742.0	738.31	717.6	697.6	707.6	769.68	---	---	---	---	34.4	-31.37	-0.91
	15-Apr-14	752.0	732.0	742.0	741.14	717.6	697.6	707.6	771.70	---	---	---	---	34.4	-30.56	-0.89
	15-May-14	752.0	732.0	742.0	746.09	717.6	697.6	707.6	769.67	---	---	---	---	34.4	-23.58	-0.69
	16-Jun-14	752.0	732.0	742.0	743.56	717.6	697.6	707.6	770.54	---	---	---	---	34.4	-26.98	-0.78
	16-Jul-14	752.0	732.0	742.0	741.15	717.6	697.6	707.6	761.63	---	---	---	---	34.4	-20.48	-0.60
	18-Aug-14	752.0	732.0	742.0	743.10	717.6	697.6	707.6	770.31	---	---	---	---	34.4	-27.21	-0.79
	4-Nov-14	752.0	732.0	742.0	740.91	717.6	697.6	707.6	760.74	---	---	---	---	34.4	-19.83	-0.58
	12-Feb-15	752.0	732.0	742.0	738.39	717.6	697.6	707.6	766.10	---	---	---	---	34.4	-27.71	-0.81
	19-May-15	752.0	732.0	742.0	741.10	717.6	697.6	707.6	756.67	---	---	---	---	34.4	-15.57	-0.45
	10-Aug-15	752.0	732.0	742.0	741.84	717.6	697.6	707.6	756.68	---	---	---	---	34.4	-14.84	-0.43
																-0.69

Table 2.3-C (Sheet 11 of 26)
Vertical Hydraulic Gradients

Well Pair	Date	Upper Zone				Lower Zone				Deeper Zone				Δz (ft)	Δh (ft)	i_v
		Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)	Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)	Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)			
OW-415U/L (Upper/Lower)	24-Sep-13	756.0	736.0	746.0	758.80	628.8	608.8	618.8	763.83	---	---	---	---	127.2	-5.03	-0.04
	1-Oct-13	756.0	736.0	746.0	757.81	628.8	608.8	618.8	765.02	---	---	---	---	127.2	-7.21	-0.06
	9-Oct-13	756.0	736.0	746.0	756.09	628.8	608.8	618.8	765.46	---	---	---	---	127.2	-9.37	-0.07
	26-Oct-13	756.0	736.0	746.0	755.21	628.8	608.8	618.8	765.40	---	---	---	---	127.2	-10.19	-0.08
	5-Nov-13	756.0	736.0	746.0	754.89	628.8	608.8	618.8	765.26	---	---	---	---	127.2	-10.37	-0.08
	12-Nov-13	756.0	736.0	746.0	754.78	628.8	608.8	618.8	765.19	---	---	---	---	127.2	-10.41	-0.08
	23-Nov-13	756.0	736.0	746.0	756.38	628.8	608.8	618.8	766.13	---	---	---	---	127.2	-9.75	-0.08
	9-Dec-13	756.0	736.0	746.0	772.02	628.8	608.8	618.8	771.91	---	---	---	---	127.2	0.11	0.00
	20-Dec-13	756.0	736.0	746.0	764.40	628.8	608.8	618.8	770.87	---	---	---	---	127.2	-6.47	-0.05
	13-Jan-14	756.0	736.0	746.0	767.22	628.8	608.8	618.8	NM	---	---	---	---	127.2	NA	NA
	18-Feb-14	756.0	736.0	746.0	763.22	628.8	608.8	618.8	769.68	---	---	---	---	127.2	-6.46	-0.05
	16-Mar-14	756.0	736.0	746.0	760.06	628.8	608.8	618.8	767.15	---	---	---	---	127.2	-7.09	-0.06
	15-Apr-14	756.0	736.0	746.0	762.12	628.8	608.8	618.8	768.06	---	---	---	---	127.2	-5.94	-0.05
	15-May-14	756.0	736.0	746.0	762.46	628.8	608.8	618.8	767.42	---	---	---	---	127.2	-4.96	-0.04
	16-Jun-14	756.0	736.0	746.0	760.81	628.8	608.8	618.8	768.16	---	---	---	---	127.2	-7.35	-0.06
	16-Jul-14	756.0	736.0	746.0	756.13	628.8	608.8	618.8	766.02	---	---	---	---	127.2	-9.89	-0.08
	18-Aug-14	756.0	736.0	746.0	760.70	628.8	608.8	618.8	769.69	---	---	---	---	127.2	-8.99	-0.07
	4-Nov-14	756.0	736.0	746.0	756.24	628.8	608.8	618.8	766.51	---	---	---	---	127.2	-10.27	-0.08
	12-Feb-15	756.0	736.0	746.0	759.92	628.8	608.8	618.8	767.63	---	---	---	---	127.2	-7.71	-0.06
	19-May-15	756.0	736.0	746.0	756.84	628.8	608.8	618.8	766.55	---	---	---	---	127.2	-9.71	-0.08
	10-Aug-15	756.0	736.0	746.0	757.09	628.8	608.8	618.8	766.77	---	---	---	---	127.2	-9.68	-0.08
																-0.06

Table 2.3-C (Sheet 12 of 26)
Vertical Hydraulic Gradients

Well Pair	Date	Upper Zone				Lower Zone				Deeper Zone				Δz (ft)	Δh (ft)	i_v
		Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)	Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)	Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)			
OW-416U/L (Upper/Lower)	24-Sep-13	734.1	714.1	724.1	741.44	698.8	678.8	688.8	741.48	---	---	---	---	35.3	-0.04	0.00
	1-Oct-13	734.1	714.1	724.1	741.04	698.8	678.8	688.8	741.08	---	---	---	---	35.3	-0.04	0.00
	9-Oct-13	734.1	714.1	724.1	740.06	698.8	678.8	688.8	740.13	---	---	---	---	35.3	-0.07	0.00
	26-Oct-13	734.1	714.1	724.1	739.89	698.8	678.8	688.8	739.92	---	---	---	---	35.3	-0.03	0.00
	5-Nov-13	734.1	714.1	724.1	739.74	698.8	678.8	688.8	739.79	---	---	---	---	35.3	-0.05	0.00
	12-Nov-13	734.1	714.1	724.1	738.85	698.8	678.8	688.8	738.90	---	---	---	---	35.3	-0.05	0.00
	23-Nov-13	734.1	714.1	724.1	737.22	698.8	678.8	688.8	737.29	---	---	---	---	35.3	-0.07	0.00
	9-Dec-13	734.1	714.1	724.1	745.93	698.8	678.8	688.8	745.56	---	---	---	---	35.3	0.37	0.01
	20-Dec-13	734.1	714.1	724.1	738.50	698.8	678.8	688.8	738.56	---	---	---	---	35.3	-0.06	0.00
	13-Jan-14	734.1	714.1	724.1	742.62	698.8	678.8	688.8	742.60	---	---	---	---	35.3	0.02	0.00
	18-Feb-14	734.1	714.1	724.1	739.24	698.8	678.8	688.8	739.30	---	---	---	---	35.3	-0.06	0.00
	16-Mar-14	734.1	714.1	724.1	736.64	698.8	678.8	688.8	736.75	---	---	---	---	35.3	-0.11	0.00
	15-Apr-14	734.1	714.1	724.1	739.02	698.8	678.8	688.8	739.08	---	---	---	---	35.3	-0.06	0.00
	15-May-14	734.1	714.1	724.1	741.99	698.8	678.8	688.8	742.00	---	---	---	---	35.3	-0.01	0.00
	16-Jun-14	734.1	714.1	724.1	741.19	698.8	678.8	688.8	741.24	---	---	---	---	35.3	-0.05	0.00
	16-Jul-14	734.1	714.1	724.1	740.70	698.8	678.8	688.8	740.72	---	---	---	---	35.3	-0.02	0.00
	18-Aug-14	734.1	714.1	724.1	740.92	698.8	678.8	688.8	740.98	---	---	---	---	35.3	-0.06	0.00
	4-Nov-14	734.1	714.1	724.1	739.92	698.8	678.8	688.8	739.97	---	---	---	---	35.3	-0.05	0.00
	12-Feb-15	734.1	714.1	724.1	736.89	698.8	678.8	688.8	736.94	---	---	---	---	35.3	-0.05	0.00
	19-May-15	734.1	714.1	724.1	740.44	698.8	678.8	688.8	740.49	---	---	---	---	35.3	-0.05	0.00
	10-Aug-15	734.1	714.1	724.1	741.15	698.8	678.8	688.8	741.18	---	---	---	---	35.3	-0.03	0.00
																0.00

Table 2.3-C (Sheet 13 of 26)
Vertical Hydraulic Gradients

Well Pair	Date	Upper Zone				Lower Zone				Deeper Zone				Δz (ft)	Δh (ft)	i_v
		Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)	Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)	Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)			
OW-417U/L (Upper/Lower)	24-Sep-13	722.2	702.2	712.2	746.97	677.7	657.7	667.7	750.41	---	---	---	---	44.5	-3.44	-0.08
	1-Oct-13	722.2	702.2	712.2	746.77	677.7	657.7	667.7	750.17	---	---	---	---	44.5	-3.40	-0.08
	9-Oct-13	722.2	702.2	712.2	746.41	677.7	657.7	667.7	749.89	---	---	---	---	44.5	-3.48	-0.08
	26-Oct-13	722.2	702.2	712.2	745.93	677.7	657.7	667.7	749.15	---	---	---	---	44.5	-3.22	-0.07
	5-Nov-13	722.2	702.2	712.2	745.58	677.7	657.7	667.7	748.74	---	---	---	---	44.5	-3.16	-0.07
	12-Nov-13	722.2	702.2	712.2	745.09	677.7	657.7	667.7	748.44	---	---	---	---	44.5	-3.35	-0.08
	23-Nov-13	722.2	702.2	712.2	744.30	677.7	657.7	667.7	747.77	---	---	---	---	44.5	-3.47	-0.08
	9-Dec-13	722.2	702.2	712.2	748.15	677.7	657.7	667.7	748.61	---	---	---	---	44.5	-0.46	-0.01
	20-Dec-13	722.2	702.2	712.2	747.39	677.7	657.7	667.7	750.11	---	---	---	---	44.5	-2.72	-0.06
	13-Jan-14	722.2	702.2	712.2	749.18	677.7	657.7	667.7	752.28	---	---	---	---	44.5	-3.10	-0.07
	16-Jan-14	722.2	702.2	712.2	749.42	677.7	657.7	667.7	752.53	---	---	---	---	44.5	-3.11	-0.07
	18-Feb-14	722.2	702.2	712.2	747.71	677.7	657.7	667.7	751.87	---	---	---	---	44.5	-4.16	-0.09
	16-Mar-14	722.2	702.2	712.2	746.82	677.7	657.7	667.7	751.44	---	---	---	---	44.5	-4.62	-0.10
	15-Apr-14	722.2	702.2	712.2	746.63	677.7	657.7	667.7	751.29	---	---	---	---	44.5	-4.66	-0.10
	15-May-14	722.2	702.2	712.2	747.35	677.7	657.7	667.7	750.56	---	---	---	---	44.5	-3.21	-0.07
	16-Jun-14	722.2	702.2	712.2	745.42	677.7	657.7	667.7	749.38	---	---	---	---	44.5	-3.96	-0.09
	16-Jul-14	722.2	702.2	712.2	744.94	677.7	657.7	667.7	748.66	---	---	---	---	44.5	-3.72	-0.08
	18-Aug-14	722.2	702.2	712.2	745.17	677.7	657.7	667.7	748.55	---	---	---	---	44.5	-3.38	-0.08
	4-Nov-14	722.2	702.2	712.2	744.94	677.7	657.7	667.7	748.32	---	---	---	---	44.5	-3.38	-0.08
	12-Feb-15	722.2	702.2	712.2	745.80	677.7	657.7	667.7	750.96	---	---	---	---	44.5	-5.16	-0.12
	19-May-15	722.2	702.2	712.2	746.05	677.7	657.7	667.7	750.79	---	---	---	---	44.5	-4.74	-0.11
	10-Aug-15	722.2	702.2	712.2	745.92	677.7	657.7	667.7	750.16	---	---	---	---	44.5	-4.24	-0.10
																-0.08

Table 2.3-C (Sheet 14 of 26)
Vertical Hydraulic Gradients

Well Pair	Date	Upper Zone				Lower Zone				Deeper Zone				Δz (ft)	Δh (ft)	i_v
		Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)	Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)	Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)			
OW-418U/L (Upper/Lower)	24-Sep-13	715.0	705.0	710.0	750.96	674.6	654.6	664.6	748.21	---	---	---	---	45.4	2.75	0.06
	1-Oct-13	715.0	705.0	710.0	751.02	674.6	654.6	664.6	746.88	---	---	---	---	45.4	4.14	0.09
	9-Oct-13	715.0	705.0	710.0	750.61	674.6	654.6	664.6	745.77	---	---	---	---	45.4	4.84	0.11
	26-Oct-13	715.0	705.0	710.0	749.38	674.6	654.6	664.6	744.96	---	---	---	---	45.4	4.42	0.10
	5-Nov-13	715.0	705.0	710.0	748.53	674.6	654.6	664.6	744.31	---	---	---	---	45.4	4.22	0.09
	12-Nov-13	715.0	705.0	710.0	747.83	674.6	654.6	664.6	743.54	---	---	---	---	45.4	4.29	0.09
	23-Nov-13	715.0	705.0	710.0	747.17	674.6	654.6	664.6	742.98	---	---	---	---	45.4	4.19	0.09
	9-Dec-13	715.0	705.0	710.0	761.40	674.6	654.6	664.6	750.56	---	---	---	---	45.4	10.84	0.24
	20-Dec-13	715.0	705.0	710.0	754.59	674.6	654.6	664.6	752.07	---	---	---	---	45.4	2.52	0.06
	13-Jan-14	715.0	705.0	710.0	757.14	674.6	654.6	664.6	753.03	---	---	---	---	45.4	4.11	0.09
	18-Feb-14	715.0	705.0	710.0	755.36	674.6	654.6	664.6	751.43	---	---	---	---	45.4	3.93	0.09
	16-Mar-14	715.0	705.0	710.0	754.81	674.6	654.6	664.6	749.21	---	---	---	---	45.4	5.60	0.12
	15-Apr-14	715.0	705.0	710.0	755.25	674.6	654.6	664.6	749.83	---	---	---	---	45.4	5.42	0.12
	15-May-14	715.0	705.0	710.0	752.70	674.6	654.6	664.6	748.58	---	---	---	---	45.4	4.12	0.09
	16-Jun-14	715.0	705.0	710.0	750.61	674.6	654.6	664.6	747.88	---	---	---	---	45.4	2.73	0.06
	16-Jul-14	715.0	705.0	710.0	749.86	674.6	654.6	664.6	745.04	---	---	---	---	45.4	4.82	0.11
	18-Aug-14	715.0	705.0	710.0	750.95	674.6	654.6	664.6	750.26	---	---	---	---	45.4	0.69	0.02
	4-Nov-14	715.0	705.0	710.0	749.93	674.6	654.6	664.6	745.07	---	---	---	---	45.4	4.86	0.11
	12-Feb-15	715.0	705.0	710.0	753.45	674.6	654.6	664.6	747.99	---	---	---	---	45.4	5.46	0.12
	19-May-15	715.0	705.0	710.0	751.81	674.6	654.6	664.6	746.24	---	---	---	---	45.4	5.57	0.12
	10-Aug-15	715.0	705.0	710.0	752.26	674.6	654.6	664.6	746.41	---	---	---	---	45.4	5.85	0.13
																0.10

Table 2.3-C (Sheet 15 of 26)
Vertical Hydraulic Gradients

Well Pair	Date	Upper Zone				Lower Zone				Deeper Zone				Δz (ft)	Δh (ft)	i_v
		Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)	Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)	Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)			
OW-419U/L (Upper/Lower)	24-Sep-13	742.8	722.8	732.8	757.40	695.3	675.3	685.3	756.40	---	---	---	---	47.5	1.00	0.02
	1-Oct-13	742.8	722.8	732.8	753.19	695.3	675.3	685.3	752.89	---	---	---	---	47.5	0.30	0.01
	9-Oct-13	742.8	722.8	732.8	749.58	695.3	675.3	685.3	749.68	---	---	---	---	47.5	-0.10	0.00
	26-Oct-13	742.8	722.8	732.8	748.62	695.3	675.3	685.3	748.72	---	---	---	---	47.5	-0.10	0.00
	5-Nov-13	742.8	722.8	732.8	748.41	695.3	675.3	685.3	748.52	---	---	---	---	47.5	-0.11	0.00
	12-Nov-13	742.8	722.8	732.8	748.31	695.3	675.3	685.3	748.45	---	---	---	---	47.5	-0.14	0.00
	23-Nov-13	742.8	722.8	732.8	751.16	695.3	675.3	685.3	751.07	---	---	---	---	47.5	0.09	0.00
	9-Dec-13	742.8	722.8	732.8	767.70	695.3	675.3	685.3	763.57	---	---	---	---	47.5	4.13	0.09
	20-Dec-13	742.8	722.8	732.8	759.76	695.3	675.3	685.3	758.77	---	---	---	---	47.5	0.99	0.02
	13-Jan-14	742.8	722.8	732.8	763.71	695.3	675.3	685.3	761.86	---	---	---	---	47.5	1.85	0.04
	18-Feb-14	742.8	722.8	732.8	758.78	695.3	675.3	685.3	758.00	---	---	---	---	47.5	0.78	0.02
	16-Mar-14	742.8	722.8	732.8	755.60	695.3	675.3	685.3	755.12	---	---	---	---	47.5	0.48	0.01
	15-Apr-14	742.8	722.8	732.8	757.75	695.3	675.3	685.3	757.09	---	---	---	---	47.5	0.66	0.01
	15-May-14	742.8	722.8	732.8	753.90	695.3	675.3	685.3	752.49	---	---	---	---	47.5	1.41	0.03
	16-Jun-14	742.8	722.8	732.8	757.11	695.3	675.3	685.3	755.99	---	---	---	---	47.5	1.12	0.02
	16-Jul-14	742.8	722.8	732.8	748.44	695.3	675.3	685.3	748.59	---	---	---	---	47.5	-0.15	0.00
	18-Aug-14	742.8	722.8	732.8	759.19	695.3	675.3	685.3	757.84	---	---	---	---	47.5	1.35	0.03
	4-Nov-14	742.8	722.8	732.8	748.77	695.3	675.3	685.3	748.84	---	---	---	---	47.5	-0.07	0.00
	12-Feb-15	742.8	722.8	732.8	753.79	695.3	675.3	685.3	753.23	---	---	---	---	47.5	0.56	0.01
	19-May-15	742.8	722.8	732.8	748.18	695.3	675.3	685.3	748.34	---	---	---	---	47.5	-0.16	0.00
	10-Aug-15	742.8	722.8	732.8	748.46	695.3	675.3	685.3	748.53	---	---	---	---	47.5	-0.07	0.00
																0.01

Table 2.3-C (Sheet 16 of 26)
Vertical Hydraulic Gradients

Well Pair	Date	Upper Zone				Lower Zone				Deeper Zone				Δz (ft)	Δh (ft)	i_v
		Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)	Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)	Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)			
OW-420U/L (Upper/Lower)	24-Sep-13	776.9	756.9	766.9	758.87	672.2	652.2	662.2	742.13	---	---	---	---	104.7	16.74	0.16
	1-Oct-13	776.9	756.9	766.9	757.99	672.2	652.2	662.2	741.38	---	---	---	---	104.7	16.61	0.16
	9-Oct-13	776.9	756.9	766.9	757.04	672.2	652.2	662.2	740.97	---	---	---	---	104.7	16.07	0.15
	26-Oct-13	776.9	756.9	766.9	Dry	672.2	652.2	662.2	741.01	---	---	---	---	104.7	NA	NA
	5-Nov-13	776.9	756.9	766.9	Dry	672.2	652.2	662.2	740.66	---	---	---	---	104.7	NA	NA
	12-Nov-13	776.9	756.9	766.9	Dry	672.2	652.2	662.2	740.05	---	---	---	---	104.7	NA	NA
	23-Nov-13	776.9	756.9	766.9	758.61	672.2	652.2	662.2	736.59	---	---	---	---	104.7	22.02	0.21
	9-Dec-13	776.9	756.9	766.9	760.58	672.2	652.2	662.2	744.97	---	---	---	---	104.7	15.61	0.15
	20-Dec-13	776.9	756.9	766.9	758.88	672.2	652.2	662.2	739.99	---	---	---	---	104.7	18.89	0.18
	13-Jan-14	776.9	756.9	766.9	759.04	672.2	652.2	662.2	745.43	---	---	---	---	104.7	13.61	0.13
	18-Feb-14	776.9	756.9	766.9	759.13	672.2	652.2	662.2	741.77	---	---	---	---	104.7	17.36	0.17
	16-Mar-14	776.9	756.9	766.9	758.33	672.2	652.2	662.2	739.83	---	---	---	---	104.7	18.50	0.18
	15-Apr-14	776.9	756.9	766.9	758.69	672.2	652.2	662.2	741.64	---	---	---	---	104.7	17.05	0.16
	15-May-14	776.9	756.9	766.9	759.28	672.2	652.2	662.2	743.53	---	---	---	---	104.7	15.75	0.15
	16-Jun-14	776.9	756.9	766.9	759.23	672.2	652.2	662.2	741.98	---	---	---	---	104.7	17.25	0.16
	16-Jul-14	776.9	756.9	766.9	758.02	672.2	652.2	662.2	741.21	---	---	---	---	104.7	16.81	0.16
	18-Aug-14	776.9	756.9	766.9	758.72	672.2	652.2	662.2	741.75	---	---	---	---	104.7	16.97	0.16
	4-Nov-14	776.9	756.9	766.9	758.06	672.2	652.2	662.2	740.67	---	---	---	---	104.7	17.39	0.17
	12-Feb-15	776.9	756.9	766.9	758.67	672.2	652.2	662.2	739.28	---	---	---	---	104.7	19.39	0.19
	19-May-15	776.9	756.9	766.9	756.92	672.2	652.2	662.2	741.72	---	---	---	---	104.7	15.20	0.15
	10-Aug-15	776.9	756.9	766.9	757.12	672.2	652.2	662.2	741.62	---	---	---	---	104.7	15.50	0.15
																0.16

Table 2.3-C (Sheet 17 of 26)
Vertical Hydraulic Gradients

Well Pair	Date	Upper Zone				Lower Zone				Deeper Zone				Δz (ft)	Δh (ft)	i_v
		Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)	Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)	Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)			
OW-421U/L (Upper/Lower)	24-Sep-13	750.4	730.4	740.4	753.23	700.0	680.0	690.0	709.27	---	---	---	---	50.4	43.96	0.87
	1-Oct-13	750.4	730.4	740.4	754.36	700.0	680.0	690.0	737.20	---	---	---	---	50.4	17.16	0.34
	8-9 Oct-13	750.4	730.4	740.4	754.48	700.0	680.0	690.0	746.66	---	---	---	---	50.4	7.82	0.16
	26-Oct-13	750.4	730.4	740.4	754.12	700.0	680.0	690.0	747.92	---	---	---	---	50.4	6.20	0.12
	5-Nov-13	750.4	730.4	740.4	754.14	700.0	680.0	690.0	748.04	---	---	---	---	50.4	6.10	0.12
	12-Nov-13	750.4	730.4	740.4	754.18	700.0	680.0	690.0	747.90	---	---	---	---	50.4	6.28	0.12
	23-Nov-13	750.4	730.4	740.4	754.15	700.0	680.0	690.0	688.34	---	---	---	---	50.4	65.81	1.31
	9-Dec-13	750.4	730.4	740.4	754.23	700.0	680.0	690.0	744.68	---	---	---	---	50.4	9.55	0.19
	20-Dec-13	750.4	730.4	740.4	754.45	700.0	680.0	690.0	749.45	---	---	---	---	50.4	5.00	0.10
	13-Jan-14	750.4	730.4	740.4	754.55	700.0	680.0	690.0	750.43	---	---	---	---	50.4	4.12	0.08
	18-Feb-14	750.4	730.4	740.4	754.45	700.0	680.0	690.0	750.26	---	---	---	---	50.4	4.19	0.08
	16-Mar-14	750.4	730.4	740.4	754.51	700.0	680.0	690.0	750.11	---	---	---	---	50.4	4.40	0.09
	15-Apr-14	750.4	730.4	740.4	754.70	700.0	680.0	690.0	750.39	---	---	---	---	50.4	4.31	0.09
	15-May-14	750.4	730.4	740.4	754.51	700.0	680.0	690.0	750.30	---	---	---	---	50.4	4.21	0.08
	16-Jun-14	750.4	730.4	740.4	754.30	700.0	680.0	690.0	750.11	---	---	---	---	50.4	4.19	0.08
	16-Jul-14	750.4	730.4	740.4	754.31	700.0	680.0	690.0	749.88	---	---	---	---	50.4	4.43	0.09
	18-Aug-14	750.4	730.4	740.4	754.31	700.0	680.0	690.0	749.93	---	---	---	---	50.4	4.38	0.09
	4-Nov-14	750.4	730.4	740.4	754.06	700.0	680.0	690.0	749.98	---	---	---	---	50.4	4.08	0.08
	12-Feb-15	750.4	730.4	740.4	754.57	700.0	680.0	690.0	749.86	---	---	---	---	50.4	4.71	0.09
	19-May-15	750.4	730.4	740.4	754.12	700.0	680.0	690.0	750.06	---	---	---	---	50.4	4.06	0.08
	10-Aug-15	750.4	730.4	740.4	754.10	700.0	680.0	690.0	750.10	---	---	---	---	50.4	4.00	0.08
																0.11

Table 2.3-C (Sheet 18 of 26)
Vertical Hydraulic Gradients

Well Pair	Date	Upper Zone				Lower Zone				Deeper Zone				Δz (ft)	Δh (ft)	i_v
		Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)	Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)	Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)			
OW-421U/D (Upper/Deeper)	24-Sep-13	750.4	730.4	740.4	753.23	---	---	---	---	626.8	606.8	616.8	629.04	123.6	124.19	1.00
	1-Oct-13	750.4	730.4	740.4	754.36	---	---	---	---	626.8	606.8	616.8	669.54	123.6	84.82	0.69
	8-9 Oct-13	750.4	730.4	740.4	754.48	---	---	---	---	626.8	606.8	616.8	703.13	123.6	51.35	0.42
	26-Oct-13	750.4	730.4	740.4	754.12	---	---	---	---	626.8	606.8	616.8	733.19	123.6	20.93	0.17
	5-Nov-13	750.4	730.4	740.4	754.14	---	---	---	---	626.8	606.8	616.8	739.70	123.6	14.44	0.12
	12-Nov-13	750.4	730.4	740.4	754.18	---	---	---	---	626.8	606.8	616.8	741.91	123.6	12.27	0.10
	23-Nov-13	750.4	730.4	740.4	754.15	---	---	---	---	626.8	606.8	616.8	743.40	123.6	10.75	0.09
	9-Dec-13	750.4	730.4	740.4	754.23	---	---	---	---	626.8	606.8	616.8	744.02	123.6	10.21	0.08
	20-Dec-13	750.4	730.4	740.4	754.45	---	---	---	---	626.8	606.8	616.8	745.20	123.6	9.25	0.07
	13-Jan-14	750.4	730.4	740.4	754.55	---	---	---	---	626.8	606.8	616.8	719.16	123.6	35.39	0.29
	18-Feb-14	750.4	730.4	740.4	754.45	---	---	---	---	626.8	606.8	616.8	744.70	123.6	9.75	0.08
	16-Mar-14	750.4	730.4	740.4	754.51	---	---	---	---	626.8	606.8	616.8	745.90	123.6	8.61	0.07
	15-Apr-14	750.4	730.4	740.4	754.70	---	---	---	---	626.8	606.8	616.8	745.78	123.6	8.92	0.07
	15-May-14	750.4	730.4	740.4	754.51	---	---	---	---	626.8	606.8	616.8	742.91	123.6	11.60	0.09
	16-Jun-14	750.4	730.4	740.4	754.30	---	---	---	---	626.8	606.8	616.8	746.18	123.6	8.12	0.07
	16-Jul-14	750.4	730.4	740.4	754.31	---	---	---	---	626.8	606.8	616.8	746.47	123.6	7.84	0.06
	18-Aug-14	750.4	730.4	740.4	754.31	---	---	---	---	626.8	606.8	616.8	746.53	123.6	7.78	0.06
	4-Nov-14	750.4	730.4	740.4	754.06	---	---	---	---	626.8	606.8	616.8	746.59	123.6	7.47	0.06
	12-Feb-15	750.4	730.4	740.4	754.57	---	---	---	---	626.8	606.8	616.8	745.48	123.6	9.09	0.07
	19-May-15	750.4	730.4	740.4	754.12	---	---	---	---	626.8	606.8	616.8	746.55	123.6	7.57	0.06
	10-Aug-15	750.4	730.4	740.4	754.10	---	---	---	---	626.8	606.8	616.8	747.10	123.6	7.00	0.06
																0.08

Table 2.3-C (Sheet 19 of 26)
Vertical Hydraulic Gradients

Well Pair	Date	Upper Zone				Lower Zone				Deeper Zone				Δz (ft)	Δh (ft)	i_v
		Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)	Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)	Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)			
OW-421L/D (Lower/Deeper)	24-Sep-13	---	---	---	---	700.0	680.0	690.0	709.27	626.8	606.8	616.8	629.04	73.2	80.23	1.10
	1-Oct-13	---	---	---	---	700.0	680.0	690.0	737.20	626.8	606.8	616.8	669.54	73.2	67.66	0.92
	8-9 Oct-13	---	---	---	---	700.0	680.0	690.0	746.66	626.8	606.8	616.8	703.13	73.2	43.53	0.59
	26-Oct-13	---	---	---	---	700.0	680.0	690.0	747.92	626.8	606.8	616.8	733.19	73.2	14.73	0.20
	5-Nov-13	---	---	---	---	700.0	680.0	690.0	748.04	626.8	606.8	616.8	739.70	73.2	8.34	0.11
	12-Nov-13	---	---	---	---	700.0	680.0	690.0	747.90	626.8	606.8	616.8	741.91	73.2	5.99	0.08
	23-Nov-13	---	---	---	---	700.0	680.0	690.0	688.34	626.8	606.8	616.8	743.40	73.2	-55.06	-0.75
	9-Dec-13	---	---	---	---	700.0	680.0	690.0	744.68	626.8	606.8	616.8	744.02	73.2	0.66	0.01
	20-Dec-13	---	---	---	---	700.0	680.0	690.0	749.45	626.8	606.8	616.8	745.20	73.2	4.25	0.06
	13-Jan-14	---	---	---	---	700.0	680.0	690.0	750.43	626.8	606.8	616.8	719.16	73.2	31.27	0.43
	18-Feb-14	---	---	---	---	700.0	680.0	690.0	750.26	626.8	606.8	616.8	744.70	73.2	5.56	0.08
	16-Mar-14	---	---	---	---	700.0	680.0	690.0	750.11	626.8	606.8	616.8	745.90	73.2	4.21	0.06
	15-Apr-14	---	---	---	---	700.0	680.0	690.0	750.39	626.8	606.8	616.8	745.78	73.2	4.61	0.06
	15-May-14	---	---	---	---	700.0	680.0	690.0	750.30	626.8	606.8	616.8	742.91	73.2	7.39	0.10
	16-Jun-14	---	---	---	---	700.0	680.0	690.0	750.11	626.8	606.8	616.8	746.18	73.2	3.93	0.05
	16-Jul-14	---	---	---	---	700.0	680.0	690.0	749.88	626.8	606.8	616.8	746.47	73.2	3.41	0.05
	18-Aug-14	---	---	---	---	700.0	680.0	690.0	749.93	626.8	606.8	616.8	746.53	73.2	3.40	0.05
	4-Nov-14	---	---	---	---	700.0	680.0	690.0	749.98	626.8	606.8	616.8	746.59	73.2	3.39	0.05
	12-Feb-15	---	---	---	---	700.0	680.0	690.0	749.86	626.8	606.8	616.8	745.48	73.2	4.38	0.06
	19-May-15	---	---	---	---	700.0	680.0	690.0	750.06	626.8	606.8	616.8	746.55	73.2	3.51	0.05
	10-Aug-15	---	---	---	---	700.0	680.0	690.0	750.10	626.8	606.8	616.8	747.10	73.2	3.00	0.04
																0.07

Table 2.3-C (Sheet 20 of 26)
Vertical Hydraulic Gradients

Well Pair	Date	Upper Zone				Lower Zone				Deeper Zone				Δz (ft)	Δh (ft)	i_v
		Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)	Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)	Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)			
OW-423U/L (Upper/Lower)	24-Sep-13	755.2	735.2	745.2	761.43	658.4	638.4	648.4	771.60	---	---	---	---	96.8	-10.17	-0.11
	1-Oct-13	755.2	735.2	745.2	760.46	658.4	638.4	648.4	769.65	---	---	---	---	96.8	-9.19	-0.09
	9-Oct-13	755.2	735.2	745.2	760.36	658.4	638.4	648.4	765.89	---	---	---	---	96.8	-5.53	-0.06
	26-Oct-13	755.2	735.2	745.2	758.49	658.4	638.4	648.4	763.72	---	---	---	---	96.8	-5.23	-0.05
	5-Nov-13	755.2	735.2	745.2	757.93	658.4	638.4	648.4	762.85	---	---	---	---	96.8	-4.92	-0.05
	12-Nov-13	755.2	735.2	745.2	757.29	658.4	638.4	648.4	762.13	---	---	---	---	96.8	-4.84	-0.05
	23-Nov-13	755.2	735.2	745.2	758.68	658.4	638.4	648.4	763.36	---	---	---	---	96.8	-4.68	-0.05
	9-Dec-13	755.2	735.2	745.2	765.60	658.4	638.4	648.4	780.29	---	---	---	---	96.8	-14.69	-0.15
	20-Dec-13	755.2	735.2	745.2	760.92	658.4	638.4	648.4	774.24	---	---	---	---	96.8	-13.32	-0.14
	13-Jan-14	755.2	735.2	745.2	762.28	658.4	638.4	648.4	776.65	---	---	---	---	96.8	-14.37	-0.15
	16-Jan-14	755.2	735.2	745.2	762.00	658.4	638.4	648.4	777.16	---	---	---	---	96.8	-15.16	-0.16
	18-Feb-14	755.2	735.2	745.2	761.51	658.4	638.4	648.4	775.23	---	---	---	---	96.8	-13.72	-0.14
	16-Mar-14	755.2	735.2	745.2	761.17	658.4	638.4	648.4	774.00	---	---	---	---	96.8	-12.83	-0.13
	15-Apr-14	755.2	735.2	745.2	761.26	658.4	638.4	648.4	774.83	---	---	---	---	96.8	-13.57	-0.14
	15-May-14	755.2	735.2	745.2	762.04	658.4	638.4	648.4	772.85	---	---	---	---	96.8	-10.81	-0.11
	16-Jun-14	755.2	735.2	745.2	760.81	658.4	638.4	648.4	771.24	---	---	---	---	96.8	-10.43	-0.11
	16-Jul-14	755.2	735.2	745.2	759.71	658.4	638.4	648.4	768.64	---	---	---	---	96.8	-8.93	-0.09
	18-Aug-14	755.2	735.2	745.2	760.62	658.4	638.4	648.4	773.19	---	---	---	---	96.8	-12.57	-0.13
	4-Nov-14	755.2	735.2	745.2	759.97	658.4	638.4	648.4	770.46	---	---	---	---	96.8	-10.49	-0.11
	12-Feb-15	755.2	735.2	745.2	760.89	658.4	638.4	648.4	774.03	---	---	---	---	96.8	-13.14	-0.14
	19-May-15	755.2	735.2	745.2	760.34	658.4	638.4	648.4	771.95	---	---	---	---	96.8	-11.61	-0.12
	10-Aug-15	755.2	735.2	745.2	760.49	658.4	638.4	648.4	771.38	---	---	---	---	96.8	-10.89	-0.11
																-0.11

Table 2.3-C (Sheet 21 of 26)
Vertical Hydraulic Gradients

Well Pair	Date	Upper Zone				Lower Zone				Deeper Zone				Δz (ft)	Δh (ft)	i_v
		Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)	Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)	Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)			
OW-423U/D (Upper/Deeper)	24-Sep-13	755.2	735.2	745.2	761.43	---	---	---	---	551.8	531.8	541.80	775.52	203.4	-14.09	-0.07
	1-Oct-13	755.2	735.2	745.2	760.46	---	---	---	---	551.8	531.8	541.80	775.77	203.4	-15.31	-0.08
	9-Oct-13	755.2	735.2	745.2	760.36	---	---	---	---	551.8	531.8	541.80	774.88	203.4	-14.52	-0.07
	26-Oct-13	755.2	735.2	745.2	758.49	---	---	---	---	551.8	531.8	541.80	772.06	203.4	-13.57	-0.07
	5-Nov-13	755.2	735.2	745.2	757.93	---	---	---	---	551.8	531.8	541.80	771.19	203.4	-13.26	-0.07
	12-Nov-13	755.2	735.2	745.2	757.29	---	---	---	---	551.8	531.8	541.80	770.81	203.4	-13.52	-0.07
	23-Nov-13	755.2	735.2	745.2	758.68	---	---	---	---	551.8	531.8	541.80	772.70	203.4	-14.02	-0.07
	9-Dec-13	755.2	735.2	745.2	765.60	---	---	---	---	551.8	531.8	541.80	782.28	203.4	-16.68	-0.08
	20-Dec-13	755.2	735.2	745.2	760.92	---	---	---	---	551.8	531.8	541.80	782.42	203.4	-21.50	-0.11
	13-Jan-14	755.2	735.2	745.2	762.28	---	---	---	---	551.8	531.8	541.80	784.91	203.4	-22.63	-0.11
	16-Jan-14	755.2	735.2	745.2	762.00	---	---	---	---	551.8	531.8	541.80	786.36	203.4	-24.36	-0.12
	18-Feb-14	755.2	735.2	745.2	761.51	---	---	---	---	551.8	531.8	541.80	782.40	203.4	-20.89	-0.10
	16-Mar-14	755.2	735.2	745.2	761.17	---	---	---	---	551.8	531.8	541.80	780.98	203.4	-19.81	-0.10
	15-Apr-14	755.2	735.2	745.2	761.26	---	---	---	---	551.8	531.8	541.80	783.21	203.4	-21.95	-0.11
	15-May-14	755.2	735.2	745.2	762.04	---	---	---	---	551.8	531.8	541.80	778.91	203.4	-16.87	-0.08
	16-Jun-14	755.2	735.2	745.2	760.81	---	---	---	---	551.8	531.8	541.80	776.92	203.4	-16.11	-0.08
	16-Jul-14	755.2	735.2	745.2	759.71	---	---	---	---	551.8	531.8	541.80	774.48	203.4	-14.77	-0.07
	18-Aug-14	755.2	735.2	745.2	760.62	---	---	---	---	551.8	531.8	541.80	778.31	203.4	-17.69	-0.09
	4-Nov-14	755.2	735.2	745.2	759.97	---	---	---	---	551.8	531.8	541.80	775.30	203.4	-15.33	-0.08
	12-Feb-15	755.2	735.2	745.2	760.89	---	---	---	---	551.8	531.8	541.80	781.84	203.4	-20.95	-0.10
	19-May-15	755.2	735.2	745.2	760.34	---	---	---	---	551.8	531.8	541.80	777.84	203.4	-17.50	-0.09
	10-Aug-15	755.2	735.2	745.2	760.49	---	---	---	---	551.8	531.8	541.80	776.72	203.4	-16.23	-0.08
																-0.09

Table 2.3-C (Sheet 22 of 26)
Vertical Hydraulic Gradients

Well Pair	Date	Upper Zone				Lower Zone				Deeper Zone				Δz (ft)	Δh (ft)	i_v
		Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)	Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)	Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)			
OW-423L/D (Lower/Deeper)	24-Sep-13	---	---	---	---	658.4	638.4	648.4	771.60	551.8	531.8	541.8	775.52	106.6	-3.92	-0.04
	1-Oct-13	---	---	---	---	658.4	638.4	648.4	769.65	551.8	531.8	541.8	775.77	106.6	-6.12	-0.06
	9-Oct-13	---	---	---	---	658.4	638.4	648.4	765.89	551.8	531.8	541.8	774.88	106.6	-8.99	-0.08
	26-Oct-13	---	---	---	---	658.4	638.4	648.4	763.72	551.8	531.8	541.8	772.06	106.6	-8.34	-0.08
	5-Nov-13	---	---	---	---	658.4	638.4	648.4	762.85	551.8	531.8	541.8	771.19	106.6	-8.34	-0.08
	12-Nov-13	---	---	---	---	658.4	638.4	648.4	762.13	551.8	531.8	541.8	770.81	106.6	-8.68	-0.08
	23-Nov-13	---	---	---	---	658.4	638.4	648.4	763.36	551.8	531.8	541.8	772.70	106.6	-9.34	-0.09
	9-Dec-13	---	---	---	---	658.4	638.4	648.4	780.29	551.8	531.8	541.8	782.28	106.6	-1.99	-0.02
	20-Dec-13	---	---	---	---	658.4	638.4	648.4	774.24	551.8	531.8	541.8	782.42	106.6	-8.18	-0.08
	13-Jan-14	---	---	---	---	658.4	638.4	648.4	776.65	551.8	531.8	541.8	784.91	106.6	-8.26	-0.08
	16-Jan-14	---	---	---	---	658.4	638.4	648.4	777.16	551.8	531.8	541.8	786.36	106.6	-9.20	-0.09
	18-Feb-14	---	---	---	---	658.4	638.4	648.4	775.23	551.8	531.8	541.8	782.40	106.6	-7.17	-0.07
	16-Mar-14	---	---	---	---	658.4	638.4	648.4	774.00	551.8	531.8	541.8	780.98	106.6	-6.98	-0.07
	15-Apr-14	---	---	---	---	658.4	638.4	648.4	774.83	551.8	531.8	541.8	783.21	106.6	-8.38	-0.08
	15-May-14	---	---	---	---	658.4	638.4	648.4	772.85	551.8	531.8	541.8	778.91	106.6	-6.06	-0.06
	16-Jun-14	---	---	---	---	658.4	638.4	648.4	771.24	551.8	531.8	541.8	776.92	106.6	-5.68	-0.05
	16-Jul-14	---	---	---	---	658.4	638.4	648.4	768.64	551.8	531.8	541.8	774.48	106.6	-5.84	-0.05
	18-Aug-14	---	---	---	---	658.4	638.4	648.4	773.19	551.8	531.8	541.8	778.31	106.6	-5.12	-0.05
	4-Nov-14	---	---	---	---	658.4	638.4	648.4	770.46	551.8	531.8	541.8	775.30	106.6	-4.84	-0.05
	12-Feb-15	---	---	---	---	658.4	638.4	648.4	774.03	551.8	531.8	541.8	781.84	106.6	-7.81	-0.07
	19-May-15	---	---	---	---	658.4	638.4	648.4	771.95	551.8	531.8	541.8	777.84	106.6	-5.89	-0.06
	10-Aug-15	---	---	---	---	658.4	638.4	648.4	771.38	551.8	531.8	541.8	776.72	106.6	-5.34	-0.05
																-0.06

Table 2.3-C (Sheet 23 of 26)
Vertical Hydraulic Gradients

Well Pair	Date	Upper Zone				Lower Zone				Deeper Zone				Δz (ft)	Δh (ft)	i_v
		Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)	Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)	Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)			
OW-428U/L(Upper/Lower)	5-Nov-13	763.9	743.9	753.9	765.27	688.7	668.7	678.7	NM	---	---	---	---	75.20	NA	NA
	12-Nov-13	763.9	743.9	753.9	764.94	688.7	668.7	678.7	758.83	---	---	---	---	75.20	6.11	0.08
	23-Nov-13	763.9	743.9	753.9	773.13	688.7	668.7	678.7	782.21	---	---	---	---	75.20	-9.08	-0.12
	9-Dec-13	763.9	743.9	753.9	790.27	688.7	668.7	678.7	787.21	---	---	---	---	75.20	3.06	0.04
	20-Dec-13	763.9	743.9	753.9	785.43	688.7	668.7	678.7	778.42	---	---	---	---	75.20	7.01	0.09
	9-Jan-14	763.9	743.9	753.9	NM	688.7	668.7	678.7	NM	---	---	---	---	75.20	NA	NA
	13-Jan-14	763.9	743.9	753.9	791.44	688.7	668.7	678.7	789.46	---	---	---	---	75.20	1.98	0.03
	16-Jan-14	763.9	743.9	753.9	NM	688.7	668.7	678.7	NM	---	---	---	---	75.20	NA	NA
	18-Feb-14	763.9	743.9	753.9	788.43	688.7	668.7	678.7	790.14	---	---	---	---	75.20	-1.71	-0.02
	16-Mar-14	763.9	743.9	753.9	785.08	688.7	668.7	678.7	790.74	---	---	---	---	75.20	-5.66	-0.08
	15-Apr-14	763.9	743.9	753.9	787.62	688.7	668.7	678.7	791.00	---	---	---	---	75.20	-3.38	-0.04
	15-May-14	763.9	743.9	753.9	786.42	688.7	668.7	678.7	790.97	---	---	---	---	75.20	-4.55	-0.06
	16-Jun-14	763.9	743.9	753.9	782.39	688.7	668.7	678.7	790.89	---	---	---	---	75.20	-8.50	-0.11
	16-Jul-14	763.9	743.9	753.9	776.93	688.7	668.7	678.7	790.84	---	---	---	---	75.20	-13.91	-0.18
	18-Aug-14	763.9	743.9	753.9	782.16	688.7	668.7	678.7	790.88	---	---	---	---	75.20	-8.72	-0.12
	4-Nov-14	763.9	743.9	753.9	777.56	688.7	668.7	678.7	791.00	---	---	---	---	75.20	-13.44	-0.18
	12-Feb-15	763.9	743.9	753.9	785.41	688.7	668.7	678.7	791.37	---	---	---	---	75.20	-5.96	-0.08
	19-May-15	763.9	743.9	753.9	779.93	688.7	668.7	678.7	791.33	---	---	---	---	75.20	-11.40	-0.15
	10-Aug-15	763.9	743.9	753.9	779.84	688.7	668.7	678.7	791.15	---	---	---	---	75.20	-11.31	-0.15
																-0.07

Table 2.3-C (Sheet 24 of 26)
Vertical Hydraulic Gradients

Well Pair	Date	Upper Zone				Lower Zone				Deeper Zone				Δz (ft)	Δh (ft)	i_v
		Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)	Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)	Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)			
OW-428U/D (Upper/Deeper)	5-Nov-13	763.9	743.9	753.9	765.27	---	---	---	---	613.5	593.5	603.5	NM	150.4	NA	NA
	12-Nov-13	763.9	743.9	753.9	764.94	---	---	---	---	613.5	593.5	603.5	629.81	150.4	135.13	0.90
	23-Nov-13	763.9	743.9	753.9	773.13	---	---	---	---	613.5	593.5	603.5	761.53	150.4	11.60	0.08
	9-Dec-13	763.9	743.9	753.9	790.27	---	---	---	---	613.5	593.5	603.5	795.98	150.4	-5.71	-0.04
	20-Dec-13	763.9	743.9	753.9	785.43	---	---	---	---	613.5	593.5	603.5	779.64	150.4	5.79	0.04
	9-Jan-14	763.9	743.9	753.9	NM	---	---	---	---	613.5	593.5	603.5	788.66	150.4	NA	NA
	13-Jan-14	763.9	743.9	753.9	791.44	---	---	---	---	613.5	593.5	603.5	NM	150.4	NA	NA
	16-Jan-14	763.9	743.9	753.9	NM	---	---	---	---	613.5	593.5	603.5	795.60	150.4	NA	NA
	18-Feb-14	763.9	743.9	753.9	788.43	---	---	---	---	613.5	593.5	603.5	797.23	150.4	-8.80	-0.06
	16-Mar-14	763.9	743.9	753.9	785.08	---	---	---	---	613.5	593.5	603.5	795.07	150.4	-9.99	-0.07
	15-Apr-14	763.9	743.9	753.9	787.62	---	---	---	---	613.5	593.5	603.5	795.60	150.4	-7.98	-0.05
	15-May-14	763.9	743.9	753.9	786.42	---	---	---	---	613.5	593.5	603.5	793.60	150.4	-7.18	-0.05
	16-Jun-14	763.9	743.9	753.9	782.39	---	---	---	---	613.5	593.5	603.5	793.43	150.4	-11.04	-0.07
	16-Jul-14	763.9	743.9	753.9	776.93	---	---	---	---	613.5	593.5	603.5	790.55	150.4	-13.62	-0.09
	18-Aug-14	763.9	743.9	753.9	782.16	---	---	---	---	613.5	593.5	603.5	795.44	150.4	-13.28	-0.09
	4-Nov-14	763.9	743.9	753.9	777.56	---	---	---	---	613.5	593.5	603.5	788.77	150.4	-11.21	-0.07
	12-Feb-15	763.9	743.9	753.9	785.41	---	---	---	---	613.5	593.5	603.5	794.07	150.4	-8.66	-0.06
	19-May-15	763.9	743.9	753.9	779.93	---	---	---	---	613.5	593.5	603.5	790.81	150.4	-10.88	-0.07
	10-Aug-15	763.9	743.9	753.9	779.84	---	---	---	---	613.5	593.5	603.5	791.22	150.4	-11.38	-0.08
																-0.07

Table 2.3-C (Sheet 25 of 26)
Vertical Hydraulic Gradients

Well Pair	Date	Upper Zone				Lower Zone				Deeper Zone				Δz (ft)	Δh (ft)	i_v
		Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)	Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)	Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)			
OW-428L/D (Lower/Deeper)	5-Nov-13	---	---	---	---	688.7	668.7	678.7	NM	613.5	593.5	603.5	NM	75.2	NA	NA
	12-Nov-13	---	---	---	---	688.7	668.7	678.7	758.83	613.5	593.5	603.5	629.81	75.2	129.02	1.72
	23-Nov-13	---	---	---	---	688.7	668.7	678.7	782.21	613.5	593.5	603.5	761.53	75.2	20.68	0.27
	9-Dec-13	---	---	---	---	688.7	668.7	678.7	787.21	613.5	593.5	603.5	795.98	75.2	-8.77	-0.12
	20-Dec-13	---	---	---	---	688.7	668.7	678.7	778.42	613.5	593.5	603.5	779.64	75.2	-1.22	-0.02
	9-Jan-14	---	---	---	---	688.7	668.7	678.7	NM	613.5	593.5	603.5	788.66	75.2	NA	NA
	13-Jan-14	---	---	---	---	688.7	668.7	678.7	789.46	613.5	593.5	603.5	NM	75.2	NA	NA
	16-Jan-14	---	---	---	---	688.7	668.7	678.7	NM	613.5	593.5	603.5	795.60	75.2	NA	NA
	18-Feb-14	---	---	---	---	688.7	668.7	678.7	790.14	613.5	593.5	603.5	797.23	75.2	-7.09	-0.09
	16-Mar-14	---	---	---	---	688.7	668.7	678.7	790.74	613.5	593.5	603.5	795.07	75.2	-4.33	-0.06
	15-Apr-14	---	---	---	---	688.7	668.7	678.7	791.00	613.5	593.5	603.5	795.60	75.2	-4.60	-0.06
	15-May-14	---	---	---	---	688.7	668.7	678.7	790.97	613.5	593.5	603.5	793.60	75.2	-2.63	-0.03
	16-Jun-14	---	---	---	---	688.7	668.7	678.7	790.89	613.5	593.5	603.5	793.43	75.2	-2.54	-0.03
	16-Jul-14	---	---	---	---	688.7	668.7	678.7	790.84	613.5	593.5	603.5	790.55	75.2	0.29	0.00
	18-Aug-14	---	---	---	---	688.7	668.7	678.7	790.88	613.5	593.5	603.5	795.44	75.2	-4.56	-0.06
	4-Nov-14	---	---	---	---	688.7	668.7	678.7	791.00	613.5	593.5	603.5	788.77	75.2	2.23	0.03
	12-Feb-15	---	---	---	---	688.7	668.7	678.7	791.37	613.5	593.5	603.5	794.07	75.2	-2.70	-0.04
	19-May-15	---	---	---	---	688.7	668.7	678.7	791.33	613.5	593.5	603.5	790.81	75.2	0.52	0.01
	10-Aug-15	---	---	---	---	688.7	668.7	678.7	791.15	613.5	593.5	603.5	791.22	75.2	-0.07	0.00
																-0.04

Table 2.3-C (Sheet 26 of 26)
Vertical Hydraulic Gradients

Well Pair	Date	Upper Zone				Lower Zone				Deeper Zone				Δz (ft)	Δh (ft)	i_v
		Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)	Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)	Top of screen (ft NAVD88)	Bottom of screen (ft NAVD88)	Midpoint (ft NAVD88)	Elevation of Water (ft NAVD88)			
OW-429U/L(Upper/Lower)	12-Nov-13	759.4	739.4	749.4	758.70	651.2	631.2	641.2	636.85	---	---	---	---	108.2	121.85	1.13
	23-Nov-13	759.4	739.4	749.4	762.10	651.2	631.2	641.2	638.49	---	---	---	---	108.2	123.61	1.14
	9-Dec-13	759.4	739.4	749.4	766.89	651.2	631.2	641.2	640.19	---	---	---	---	108.2	126.70	1.17
	20-Dec-13	759.4	739.4	749.4	768.22	651.2	631.2	641.2	641.29	---	---	---	---	108.2	126.93	1.17
	13-Jan-14	759.4	739.4	749.4	768.20	651.2	631.2	641.2	639.49	---	---	---	---	108.2	128.71	1.19
	18-Feb-14	759.4	739.4	749.4	766.89	651.2	631.2	641.2	642.72	---	---	---	---	108.2	124.17	1.15
	16-Mar-14	759.4	739.4	749.4	766.17	651.2	631.2	641.2	644.89	---	---	---	---	108.2	121.28	1.12
	15-Apr-14	759.4	739.4	749.4	766.46	651.2	631.2	641.2	647.32	---	---	---	---	108.2	119.14	1.10
	15-May-14	759.4	739.4	749.4	764.73	651.2	631.2	641.2	644.54	---	---	---	---	108.2	120.19	1.11
	16-Jun-14	759.4	739.4	749.4	763.42	651.2	631.2	641.2	646.99	---	---	---	---	108.2	116.43	1.08
	16-Jul-14	759.4	739.4	749.4	762.42	651.2	631.2	641.2	649.17	---	---	---	---	108.2	113.25	1.05
	18-Aug-14	759.4	739.4	749.4	764.16	651.2	631.2	641.2	651.84	---	---	---	---	108.2	112.32	1.04
	4-Nov-14	759.4	739.4	749.4	762.46	651.2	631.2	641.2	662.02	---	---	---	---	108.2	100.44	0.93
	12-Feb-15	759.4	739.4	749.4	765.26	651.2	631.2	641.2	674.70	---	---	---	---	108.2	90.56	0.84
	19-May-15	759.4	739.4	749.4	764.20	651.2	631.2	641.2	686.34	---	---	---	---	108.2	77.86	0.72
	10-Aug-15	759.4	739.4	749.4	764.28	651.2	631.2	641.2	695.56	---	---	---	---	108.2	68.72	0.64
																1.03

Indicates averages of the vertical hydraulic gradient for the nested well pair.

Indicates an anomaly or suspect measurement.

NM = Not Measured

NA = Not Applicable

Dry = Water level was below the bottom of the well.

APPENDIX 2.3-D
Detailed Analytes Table

Table 2.3-D (Sheet 1 of 25)
Detailed Analytes

																	ANIONS				GENERAL CHEMISTRY			
Well ID	Sample Date	Lab Report ID	Formation	Quarter	Depth	Sample_ depth (m)	Temperature, Celsius (degrees C)	Oxidation reduction potential (mV)	Specific Conductance, Field (umhos/cm)	Oxygen, dissolved (mg/L)	pH, Field (pH)	GW Elevation (m above s/l) (m)	Sample Depth (m)	Well Depth (m)	Water Level Depth (m)	Turbidity, Field (NTU)	Bromide (mg/L)	Chloride, total (mg/L)	Sulfate, total (mg/L)	Fluoride, total (mg/L)	Color (Pt-Co units)	Chlorine, Total Residual (mg/L)	Biological Oxygen Demand (mg/L)	COD, Low Level (mg/L)
Values from 2016 EPA RSLs MCL Ref.																	NA	NA	NA	4	NA	NA	NA	NA
CRS-OW401D	1/10/2014	490-44246-1	Newala	1	D	70	24.1	331	801	13	5.6	241.39	70	76.28	8.98	12	-	-	-	-	-	-	-	-
CRS-OW401D	1/10/2014	490-44246-1	Newala	1	D	70.03	-	-	-	-	-	-	-	-	-	-	<0.1	1.89	34.1	0.732	<5	<0.1	5.45	<20
CRS-OW401D	4/22/2014	490-51531-1	Newala	2	D	70	22.37	294	824.8	8.1	6.1	239.53	70	76.28	10.84	-	-	-	-	-	-	-	-	-
CRS-OW401D	4/23/2014	490-51531-1	Newala	2	D	70.03	-	-	-	-	-	-	-	-	-	-	<0.1	1.77	25.1	0.696	<5	<0.1	<2	<20
CRS-OW401D	8/25/2014	490-60159-1	Newala	3	D	70	20.74	255	701	0	6.4	239.24	70	76.28	11.13	87.1	-	-	-	-	-	-	-	-
CRS-OW401D	8/25/2014	490-60159-1	Newala	3	D	70.03	-	-	-	-	-	-	-	-	-	-	<0.1	1.43	37.9	0.589	5	<0.1	<2	<20
CRS-OW401D	11/5/2014	490-65588-1	Newala	4	D	70	-	-	-	-	-	-	-	-	-	-	<0.1	2.44	<1	0.745	5	<0.1	7.79	58.5
CRS-OW401D	11/5/2014	490-65588-1	Newala	4	D	70	14.53	391	657.8	4.5	6.3	239.24	20.2	76.28	11.13	-	-	-	-	-	-	-	-	-
CRS-OW401L	12/12/2013	490-42566-1	Newala	1	L	45.3	8.36	471	406.9	6.6	6.4	243.22	45.3	48.5	6.84	69.7	<0.1	<1	6.03	0.281	15	0.307	<2	<20
CRS-OW401L	4/21/2014	490-51372-1	Newala	2	L	42.29	-	-	-	-	-	-	-	-	-	-	<0.1	1.07	7.37	0.142	<5	<0.1	<2	<20
CRS-OW401L	4/21/2014	490-51372-1	Newala	2	L	42.3	17.27	334	440.5	7.9	7.2	239.88	42.3	48.5	10.18	114	-	-	-	-	-	-	-	-
CRS-OW401L	8/27/2014	490-60308-1	Newala	3	L	45.29	-	-	-	-	-	-	-	-	-	-	<0.1	<1	8.4	0.213	5	<0.1	-	<20
CRS-OW401L	8/27/2014	490-60308-1	Newala	3	L	45.3	17.48	239	426	7.4	7	239.01	45.3	48.5	11.05	56.2	-	-	-	-	-	-	-	-
CRS-OW401L	11/10/2014	490-65956-1	Newala	4	L	45.29	-	-	-	-	-	-	-	-	-	-	<0.1	1.29	5.28	0.158	5	<0.1	<2	<20
CRS-OW401L	11/10/2014	490-65956-1	Newala	4	L	45.3	14.64	166	437	5.6	7.1	237.65	45.3	48.5	12.41	35.8	-	-	-	-	-	-	-	-
CRS-OW401U	12/10/2013	490-42335-1	Newala	1	U	8.76	9.8	384	500.7	5.5	7.2	247.85	8.8	11.83	2.27	8.3	<0.1	1.06	10	0.23	15	<0.1	19.9	53.7
CRS-OW401U	4/18/2014	490-51285-1	Newala	2	U	8.76	-	-	-	-	-	-	-	-	-	-	<0.1	<1	9.44	0.172	5	<0.1	<2	<20
CRS-OW401U	4/18/2014	490-51285-1	Newala	2	U	8.8	13.31	311	478	7.3	7	247.21	8.8	11.83	2.91	21.2	-	-	-	-	-	-	-	-
CRS-OW401U	8/27/2014	490-60310-1	Newala	3	U	8.76	-	-	-	-	-	-	-	-	-	-	<0.1	<1	4.07	0.195	5	<0.1	<2	<20
CRS-OW401U	8/27/2014	490-60310-1	Newala	3	U	8.8	16.4	469	503	5.4	7.1	246.9	8.8	11.83	3.22	13.6	-	-	-	-	-	-	-	-
CRS-OW401U	11/10/2014	490-65960-1	Newala	4	U	11.8	11.7	380	356	6	7.1	246.97	11.8	11.83	3.15	30.5	-	-	-	-	-	-	-	-
CRS-OW401U	11/10/2014	490-65960-1	Newala	4	U	11.83	-	-	-	-	-	-	-	-	-	-	<0.1	<1	9.69	0.163	5	<0.1	<2	<20
CRS-OW415L	1/9/2014	490-44141-1	Benbolt	1	L	50.3	11.5	357	4425	1.1	8	223.81	50.3	54.41	15.98	5.8	2.21	202	1090	14.2	5	<0.1	2.91	<20
CRS-OW415L	4/23/2014	490-51557-1	Benbolt	2	L	50.3	15.5	144	4338	0.8	8	233.67	50.3	54.41	6.12	13.3	1.63	213	1230	12.4	-	<0.1	2.9	<20
CRS-OW415L	8/20/2014	490-59827-1	Benbolt	3	L	50.3	21.6	67	4723.2	1.1	7.3	235.34	50.3	54.41	4.45	8.3	1.72	233	1310	14.2	5	<0.1	<2	<20
CRS-OW415L	11/11/2014	490-66031-1	Benbolt	4	L	50.3	16.41	36	4651	1.5	7	233.53	50.3	54.41	6.26	17.6	1.9	201	1540	13.4	-	-	-	-
CRS-OW415U	12/17/2013	490-42946-1	Bowen/ Benbolt	1	U	12.5	16.23	328	555.3	3.8	7	233.69	12.5	15.75	6.22	4.7	<0.1	4.33	41.8	0.249	10	<0.1	<2	<20
CRS-OW415U	4/21/2014	490-51380-1	Bowen/ Benbolt	2	U	12.5	17	401	600	1.3	6.4	231.41	12.5	5.75	8.5	6.6	<0.1	1.95	27.8	<0.1	5	<0.1	<60	<20
CRS-OW415U	8/19/2014	490-59741-1	Bowen/ Benbolt	3	U	12.5	17.5	340	485.1	2.1	6.9	232.11	12.5	15.75	7.8	2.2	<0.1	1.95	18.8	0.189	5	<0.1	<2	<20
CRS-OW415U	11/11/2014	490-66017-1	Bowen/ Benbolt	4	U	12.5	17.52	303	592.9	0.1	6.8	230.29	12.5	15.75	9.62	5.8	<0.1	2.04	31.1	0.147	5	<0.1	27	24.5
CRS-OW416L	12/19/2013	490-43206-1	Rockdell	1	L	37.7	13.7	-19	72.36	1.2	6.7	225.3	37.7	40.96	22.35	8.4	-	-	-	-	-	-	-	-
CRS-OW416L	12/19/2013	490-43206-1	Rockdell	1	L	37.73	-	-	-	-	-	-	-	-	-	-	<0.1	11.7	58.2	0.568	10	<0.1	<2	<20
CRS-OW416L	12/19/2013	490-43206-2	Rockdell	1	L	37.7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW416L	4/16/2014	490-51116-1	Rockdell	2	L	37.7	13.7	47	750	0.1	5.3	225.19	37.7	40.96	22.46	17.4	-	-	-	-	-	-	-	-
CRS-OW416L	4/16/2014	490-51116-1	Rockdell	2	L	37.74	-	-	-	-	-	-	-	-	-	-	0.166	13.1	63.3	0.937	<5	<0.1	<2	<20
CRS-OW416L	8/18/2014	490-59654-1	Rockdell	3	L	37.7	19.46	84	710.3	0.9	6.8	225.76	37.7	40.96	21.89	8.6	-	-	-	-	-	-	-	-
CRS-OW416L	8/18/2014	490-59654-1	Rockdell	3	L	37.74	-	-	-	-	-	-	-	-	-	-	0.136	8.52	66.8	0.425	5	<0.1	<2	<20
CRS-OW416L	11/6/2014	490-65718-1	Rockdell	4	L	37.7	18.3	130	718	2.1	5.9	225.37	37.7	40.96	22.28	8.4	-	-	-	-	-	-	-	-
CRS-OW416L	11/6/2014	490-65718-1	Rockdell	4	L	37.74	-	-	-	-	-	-	-	-	-	-	<0.1	7.09	69.1	0.407	10	<0.1	2.02	<20
CRS-OW416U	12/18/2013	490-43060-1	Rockdell	1	U	27	12.42	401	619.5	1.6	6.7	225.55	27	30.24	22.1	46.2	-	-	-	-	-	-	-	-
CRS-OW416U	12/18/2013	490-43060-1	Rockdell	1	U	27.01	-	-	-	-	-	-	-	-	-	-	<0.1	3.75	47.9	0.295	10	<0.1	<2	<20
CRS-OW416U	4/15/2014	490-51008-1	Rockdell	2	U	27	13	414	581	1.2	6.9	225.16	27	30.24	22.49	68.6	-	-	-	-	-	-	-	-
CRS-OW416U	4/15/2014	490-51008-1	Rockdell	2	U	27.01	-	-	-	-	-	-	-	-	-	-	<0.1	3.43	44.6	0.246	10	<0.1	<2	<20

Table 2.3-D (Sheet 2 of 25)
Detailed Analytes

																	ANIONS				GENERAL CHEMISTRY			
Well ID	Sample Date	Lab Report ID	Formation	Quarter	Depth	Sample_ depth (m)	Temperature, Celsius (degrees C)	Oxidation reduction potential (mV)	Specific Conductance, Field (umhos/cm)	Oxygen, dissolved (mg/L)	pH, Field (pH)	GW Elevation (m above s/l) (m)	Sample Depth (m)	Well Depth (m)	Water Level Depth (m)	Turbidity, Field (NTU)	Bromide (mg/L)	Chloride, total (mg/L)	Sulfate, total (mg/L)	Fluoride, total (mg/L)	Color (Pt-Co units)	Chlorine, Total Residual (mg/L)	Biological Oxygen Demand (mg/L)	COD, Low Level (mg/L)
CRS-OW416U	8/22/2014	490-60044-1	Rockdell	3	U	22.3	18.3	420	609	1.1	6.8	226.14	70.8	30.24	21.51	36	<0.1	2.12	60.1	0.269	5	<0.1	2.37	<20
CRS-OW416U	11/5/2014	490-65583-1	Rockdell	4	U	22.3	16.3	349	640	1.2	6.7	225.46	22.3	30.24	22.19	43.3	-	-	-	-	-	-	-	-
CRS-OW416U	11/5/2014	490-65583-1	Rockdell	4	U	22.32	-	-	-	-	-	-	-	-	-	-	<0.1	3.72	<1	0.152	<5	<0.1	<2	<20
CRS-OW416U	11/5/2014	490-65592-1	Rockdell	4	U	22.3	-	-	-	-	-	-	-	-	-	-	<0.1	3.69	<1	0.19	5	<0.1	<2	29.2
CRS-OW418L	12/19/2013	490-43197-1	Blackford	1	L	45.78	-	-	-	-	-	-	-	-	-	-	<0.1	<1	8.39	0.446	10	<0.1	-	<20
CRS-OW418L	12/19/2013	490-43197-1	Blackford	1	L	45.8	11.19	449	505.9	5.3	6.9	229.51	45.8	48.86	18.78	7.9	-	-	-	-	-	-	-	-
CRS-OW418L	12/19/2013	490-43197-2	Blackford	1	L	45.8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<2	-
CRS-OW418L	4/16/2014	490-51124-1	Blackford	2	L	45.78	-	-	-	-	-	-	-	-	-	-	<0.1	0.811	8.48	0.414	<5	<0.1	3.25	<20
CRS-OW418L	4/16/2014	490-51124-1	Blackford	2	L	45.8	13.19	237	530.3	5.3	6.9	229.07	45.8	48.86	19.22	13	-	-	-	-	-	-	-	-
CRS-OW418L	8/18/2014	490-59650-1	Blackford	3	L	45.78	-	-	-	-	-	-	-	-	-	-	<0.1	<1	7.49	0.367	5	<0.1	<2	<20
CRS-OW418L	8/18/2014	490-59650-1	Blackford	3	L	45.8	24.44	276	491.1	5.9	7	228.74	45.8	48.86	19.55	16	-	-	-	-	-	-	-	-
CRS-OW418L	11/12/2014	490-66157-1	Blackford	4	L	45.78	-	-	-	-	-	-	-	-	-	-	<0.1	1.48	7.44	0.363	<5	<0.1	<2	<20
CRS-OW418L	11/12/2014	490-66157-1	Blackford	4	L	45.8	15.2	176	484.2	5.2	7	226.82	45.8	48.8	21.47	18.8	-	-	-	-	-	-	-	-
CRS-OW418U	12/18/2013	490-43053-1	Blackford	1	U	31.49	-	-	-	-	-	-	-	-	-	-	<0.1	1.76	18.8	0.353	10	<0.1	<2	<20
CRS-OW418U	12/18/2013	490-43053-1	Eidson	1	U	31.5	14.26	420	545.8	5.1	7.2	229.32	31.5	33.06	18.45	3.7	-	-	-	-	-	-	-	-
CRS-OW418U	4/15/2014	490-50993-1	Eidson	2	U	31.5	12.03	341	520	2.1	7.3	230.17	103.3	33.06	17.6	2.7	<0.1	1.59	17.6	0.316	5	<0.1	<2	<20
CRS-OW418U	8/19/2014	490-59748-1	Eidson	3	U	31.49	-	-	-	-	-	-	-	-	-	-	<0.1	1.23	16.8	0.325	<5	<0.1	<2	<20
CRS-OW418U	8/19/2014	490-59748-1	Eidson	3	U	31.5	20.43	158	494.3	1.6	6.6	228.84	31.5	33.06	18.93	8.3	-	-	-	-	-	-	-	-
CRS-OW418U	11/7/2014	490-65801-1	Eidson	4	U	31.49	-	-	-	-	-	-	-	-	-	-	<0.1	1.72	16.6	0.34	5	<0.1	<2	<20
CRS-OW418U	11/7/2014	490-65801-1	Eidson	4	U	31.5	15.95	138	545.7	1.3	6.3	228.5	31.5	33.06	19.27	1.9	-	-	-	-	-	-	-	-
CRS-OW419L	1/6/2014	490-44045-1	Newala	1	L	36	9.78	351	482.7	2.8	6.6	231.5	36	39.01	13.16	20.3	-	-	-	-	-	-	-	-
CRS-OW419L	1/8/2014	490-44045-1	Newala	1	L	35.97	-	-	-	-	-	-	-	-	-	-	0.157	1.11	17.6	0.165	5	<0.1	<2	<20
CRS-OW419L	4/24/2014	490-51664-1	Newala	2	L	35.98	-	-	-	-	-	-	-	-	-	-	<0.1	<1	13.7	0.247	5	<0.1	<2	<20
CRS-OW419L	4/24/2014	490-51664-1	Newala	2	L	36	18.2	332	456	2.8	7.3	229.16	36	39.01	15.5	15.7	-	-	-	-	-	-	-	-
CRS-OW419L	8/26/2014	490-60223-1	Newala	3	L	35.97	-	-	-	-	-	-	-	-	-	-	<0.1	<1	14.6	0.251	5	<0.1	2	<20
CRS-OW419L	8/26/2014	490-60223-1	Newala	3	L	36	18.36	424	466	2.3	7.2	230.73	36	39.01	13.93	6.6	-	-	-	-	-	-	-	-
CRS-OW419L	11/12/2014	490-66161-1	Newala	4	L	36	14.31	336	421.5	3.1	7.2	227.99	36	39.01	16.67	38.1	<0.1	10.3	11.8	0.206	5	<0.1	20.6	28.1
CRS-OW419U	12/20/2013	490-43281-1	Newala	1	U	21.58	-	-	-	-	-	-	-	-	-	-	<0.1	<1	16.3	0.212	10	<0.1	<2	<20
CRS-OW419U	12/20/2013	490-43281-1	Newala	1	U	21.6	14.92	398	507.9	0.4	6.8	231.5	21.6	24.65	13.26	4.1	-	-	-	-	-	-	-	-
CRS-OW419U	4/23/2014	490-51552-1	Newala	2	U	21.58	-	-	-	-	-	-	-	-	-	-	<0.1	<1	20.6	0.199	<5	<0.1	<2	<20
CRS-OW419U	4/23/2014	490-51552-1	Newala	2	U	21.6	15.36	359	537.8	1.5	6.7	229.18	21.6	24.65	15.58	1.6	-	-	-	-	-	-	-	-
CRS-OW419U	8/18/2014	490-59664-1	Newala	3	U	21.6	24.1	366	508	1	6.6	230.38	21.6	24.65	14.38	9	<0.1	<1	12.3	0.171	10	<0.1	<2	<20
CRS-OW419U	11/4/2014	490-65428-1	Newala	4	U	21.6	16.34	411	571.3	0.3	5.4	227.39	70.8	24.65	17.37	19.7	<0.1	<1	23.7	0.182	5	<0.1	291	<20
CRS-OW420L	12/10/2013	490-42325-1	Newala	1	L	43.89	-	-	-	-	-	-	-	-	-	-	<0.1	1.24	11.5	0.283	15	<0.1	17.8	<20
CRS-OW420L	12/10/2013	490-42325-1	Newala	1	L	43.9	13.42	354	464	8	7.3	227.32	43.9	47.09	18.44	9.3	-	-	-	-	-	-	-	-
CRS-OW420L	4/17/2014	490-51210-1	Newala	2	L	43.89	-	-	-	-	-	-	-	-	-	-	<0.1	1.12	12.3	0.237	<5	<0.1	<2	<20
CRS-OW420L	4/17/2014	490-51210-1	Newala	2	L	43.9	15.11	312	484.2	7.2	7	225.9	43.9	47.09	19.86	10.1	-	-	-	-	-	-	-	-
CRS-OW420L	8/26/2014	490-60209-1	Newala	3	L	43.89	-	-	-	-	-	-	-	-	-	-	<0.1	<1	12.5	0.346	5	<0.1	<2	<20
CRS-OW420L	8/26/2014	490-60209-1	Newala	3	L	43.9	19.9	441	489.2	8.1	7	226.51	43.9	47.09	19.25	16.2	-	-	-	-	-	-	-	-
CRS-OW420L	11/6/2014	490-65714-1	Newala	4	L	43.89	-	-	-	-	-	-	-	-	-	-	<0.1	1.06	11.6	0.286	5	<0.1	3.88	<20
CRS-OW420L	11/6/2014	490-65714-1	Newala	4	L	43.9	17.79	379	442	6.6	7.1	224.32	43.9	47.09	21.44	18.6	-	-	-	-	-	-	-	-
CRS-OW420U	12/12/2013	490-42580-1	Newala	1	U	14.4	-	-	-	-	-	-	-	-	-	-	0.468	<1	14.5	<0.1	20	0.201	<2	<20
CRS-OW420U	4/16/2014	490-51107-1	Newala	2	U	14.4	-	-	-	-	-	-	-	-	-	-	0.079	<1	15.5	0.152	-	<0.1	-	<20
CRS-OW420U	8/26/2014	490-60217-1	Newala	3	U	14.4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.87	-
CRS-OW421D	1/9/2014	490-44157-1	Newala	1	D	57.3	11.34	55	414.1	0.4	7.3	228.82	57.3	60.65	16.61	7.8	<0.1	2.41	25.2	1.1	10	<0.1	9.31	<20
CRS-OW421D	4/21/2014	490-51368-1	Newala	2	D	57.3	17.89	11	408	2	7.4	227.3	57.3	60.65	18.13	11.9	<0.1	2.24	19.9	1.09	25	<0.1	<2	<20
CRS-OW421D	8/21/2014	490-59912-1	Newala	3	D	57.32	-	-	-	-	-	-	-	-	-	-	<0.1	1.73	18.6	1.21	5	<0.1	6.49	<20

Table 2.3-D (Sheet 3 of 25)
Detailed Analytes

																	ANIONS				GENERAL CHEMISTRY			
Well ID	Sample Date	Lab Report ID	Formation	Quarter	Depth	Sample_ depth (m)	Temperature, Celsius (degrees C)	Oxidation reduction potential (mV)	Specific Conductance, Field (umhos/cm)	Oxygen, dissolved (mg/L)	pH, Field (pH)	GW Elevation (m above s/l) (m)	Sample Depth (m)	Well Depth (m)	Water Level Depth (m)	Turbidity, Field (NTU)	Bromide (mg/L)	Chloride, total (mg/L)	Sulfate, total (mg/L)	Fluoride, total (mg/L)	Color (Pt-Co units)	Chlorine, Total Residual (mg/L)	Biological Oxygen Demand (mg/L)	COD, Low Level (mg/L)
CRS-OW421D	8/27/2014	490-59912-1	Newala	3	D	57.3	21	120	446	1.4	6.6	227.73	57.3	60.5	17.7	34	-	-	-	-	-	-	-	-
CRS-OW421D	11/12/2014	490-66145-1	Newala	4	D	57.3	12.64	9	405	1.3	7.3	227.53	57.3	60.65	17.9	18.2	<0.1	2.06	16.5	1.13	5	<0.1	2.84	<20
CRS-OW421L	1/13/2014	490-44348-1	Blackford/ Newala	1	L	35.97	-	-	-	-	-	-	-	-	-	-	<0.1	2.24	8.43	0.647	10	<0.1	4.56	<20
CRS-OW421L	1/13/2014	490-44348-1	Blackford/ Newala	1	L	36	9.2	280	398	8.4	6.7	229.9	36	39.12	17.02	18.4	-	-	-	-	-	-	-	-
CRS-OW421L	4/17/2014	490-51196-1	Blackford/ Newala	2	L	35.97	-	-	-	-	-	-	-	-	-	-	<0.1	2.21	10.6	0.619	5	<0.1	11.2	24.1
CRS-OW421L	4/17/2014	490-51196-1	Blackford/ Newala	2	L	36	15.61	364	406.1	7.4	7.4	230.06	36	39.12	16.86	9.9	-	-	-	-	-	-	-	-
CRS-OW421L	8/20/2014	490-59831-1	Blackford/ Newala	3	L	36	20.89	333	109.3	1.5	7.3	230.2	36	39.12	16.72	9	<0.1	2.32	9.63	0.722	5	<0.1	<2	<20
CRS-OW421L	11/12/2014	490-66149-1	Blackford/ Newala	4	L	36	14	433	392	2.4	7.3	229.65	36	39.12	17.27	10	<0.1	2.22	9.19	0.665	<5	<0.1	3.72	33
CRS-OW421U	12/17/2013	490-42941-1	Blackford	1	U	20.7	11.17	389	528.9	8.6	7	230.48	20.7	23.92	16.53	12.5	-	-	-	-	-	-	-	-
CRS-OW421U	12/17/2013	490-42941-1	Blackford	1	U	20.72	-	-	-	-	-	-	-	-	-	-	<0.1	1.07	5.83	0.624	10	<0.1	3.74	<20
CRS-OW421U	4/18/2014	490-51291-1	Blackford	2	U	20.7	14.19	387	566.4	7.4	6.8	230.65	20.7	23.92	16.36	44.1	-	-	-	-	-	-	-	-
CRS-OW421U	4/18/2014	490-51291-1	Blackford	2	U	20.72	-	-	-	-	-	-	-	-	-	-	<0.1	1.23	6.64	0.446	<5	<0.1	<2	<20
CRS-OW421U	8/27/2014	490-60305-1	Blackford	3	U	20.7	19.65	462	554	6.3	6.9	230.77	20.7	23.92	16.24	46.4	-	-	-	-	-	-	-	-
CRS-OW421U	8/27/2014	490-60305-1	Blackford	3	U	20.72	-	-	-	-	-	-	-	-	-	-	<0.1	<1	6.8	0.562	5	<0.1	4.72	<20
CRS-OW421U	11/7/2014	490-65803-1	Blackford	4	U	21.56	-	-	-	-	-	-	-	-	-	-	<0.1	1.62	4.92	0.639	5	<0.1	3.62	<20
CRS-OW421U	11/7/2014	490-65803-1	Blackford	4	U	21.6	14.6	418	533	6.1	6.9	230.15	21.6	23.92	16.86	71	-	-	-	-	-	-	-	-
CRS-OW422	4/2/2014	490-49943-1	-	2	-	0	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW422D	1/16/2014	490-44692-1	-	1	D	80	-	-	-	-	-	-	-	-	-	-	0.373	19.2	62.4	6.97	5	<0.1	2.83	25.7
CRS-OW428D	12/17/2013	490-42947-1	Rockdell	1	D	62.05	-	-	-	-	-	-	-	-	-	-	0.12	6.69	63.4	0.503	10	<0.1	2.6	<20
CRS-OW428D	12/17/2013	490-42947-1	Rockdell	1	D	62.1	11.5	300	808.3	3.1	6.5	243.09	62.1	65.26	2.86	55.9	-	-	-	-	-	-	-	-
CRS-OW428D	4/22/2014	490-51441-1	Rockdell	2	D	62.05	-	-	-	-	-	-	-	-	-	-	<0.1	<1	<1	<0.1	<5	<0.1	<2	<20
CRS-OW428D	4/22/2014	490-51441-1	Rockdell	2	D	62.1	15.16	43	866.2	1.7	7.3	242.02	62.1	65.26	3.93	20.3	-	-	-	-	-	-	-	-
CRS-OW428D	8/20/2014	490-59832-1	Rockdell	3	D	61.89	-	-	-	-	-	-	-	-	-	-	<0.1	5.9	48.2	0.523	5	<0.1	7.64	<20
CRS-OW428D	8/20/2014	490-59832-1	Rockdell	3	D	61.9	22	105	830	1.4	6.9	244.77	61.9	65.26	1.18	64	-	-	-	-	-	-	-	-
CRS-OW428D	11/6/2014	490-65712-1	Rockdell	4	D	61.9	16.45	157	731.6	3.3	6	240.28	61.9	65.26	5.67	8.6	<0.1	4.56	40.7	0.483	5	<0.1	<2	<20
CRS-OW428L	12/16/2013	490-42801-1	Rockdell	1	L	39.56	-	-	-	-	-	-	-	-	-	-	<0.1	2.99	16.7	1.87	15	<0.1	<2	<20
CRS-OW428L	12/16/2013	490-42801-1	Rockdell	1	L	39.6	12.93	236	532.6	4.6	8.8	239.22	39.6	42.35	6.79	23	-	-	-	-	-	-	-	-
CRS-OW428L	4/18/2014	490-51286-1	Rockdell	2	L	39.56	-	-	-	-	-	-	-	-	-	-	<0.1	2.74	15.2	1.64	15	<0.1	<2	<20
CRS-OW428L	4/18/2014	490-51286-1	Rockdell	2	L	39.6	13.3	189	569	1.6	9.6	241.06	39.6	42.35	4.95	24.1	-	-	-	-	-	-	-	-
CRS-OW428L	8/22/2014	490-60048-1	Rockdell	3	L	39.56	-	-	-	-	-	-	-	-	-	-	<0.1	2.61	14.9	2.2	15	<0.1	3.86	<20
CRS-OW428L	8/22/2014	490-60048-1	Rockdell	3	L	39.6	19.52	272	543	1.2	9.7	242.06	39.6	42.35	3.95	11.2	-	-	-	-	-	-	-	-
CRS-OW428L	11/5/2014	490-65575-1	Rockdell	4	L	39.56	-	-	-	-	-	-	-	-	-	-	<0.1	2.66	13.6	2.17	10	<0.1	4.85	<20
CRS-OW428L	11/5/2014	490-65575-1	Rockdell	4	L	39.6	15.08	55	544.1	1.9	7.2	241.11	39.6	42.35	4.9	8.5	-	-	-	-	-	-	-	-
CRS-OW428U	12/16/2013	490-42809-1	Rockdell	1	U	15.2	9.08	307	341.9	4	6.5	240.5	15.2	19.61	5.63	8.2	-	-	-	-	-	-	-	-
CRS-OW428U	12/16/2013	490-42809-1	Rockdell	1	U	15.24	-	-	-	-	-	-	-	-	-	-	<0.1	0.861	4.75	0.139	15	<0.1	<2	<20
CRS-OW428U	4/17/2014	490-51204-1	Rockdell	2	U	15.2	13.5	375	363	2.8	6.8	239.63	15.2	19.61	6.5	16.8	-	-	-	-	-	-	-	-
CRS-OW428U	4/17/2014	490-51204-1	Rockdell	2	U	15.24	-	-	-	-	-	-	-	-	-	-	<0.1	1.05	4.59	0.085	5	<0.1	<2	<20
CRS-OW428U	8/21/2014	490-59917-1	Rockdell	3	U	15.2	21.43	439	369	2.7	6.5	239.93	15.2	19.61	6.2	13.5	-	-	-	-	-	-	-	-
CRS-OW428U	8/21/2014	490-59917-1	Rockdell	3	U	15.24	-	-	-	-	-	-	-	-	-	-	<0.1	<1	3.33	0.115	20	<0.1	<2	<20
CRS-OW428U	11/6/2014	490-65716-1	Rockdell	4	U	15.2	16	347	421	2.1	6.6	235.68	15.2	19.61	10.45	7.4	-	-	-	-	-	-	-	-
CRS-OW428U	11/6/2014	490-65716-1	Rockdell	4	U	15.24	-	-	-	-	-	-	-	-	-	-	<0.1	1.24	5.01	0.103	50	<0.1	<2	38.2
CRS-OW429L	4/24/2014	490-51678-1	Benbolt	2	L	46.2	-	-	-	-	-	-	-	-	-	-	6.46	614	2240	3.84	15	<0.1	7.34	<20
CRS-OW429U	12/18/2013	490-43067-1	Benbolt	1	U	15.16	-	-	-	-	-	-	-	-	-	-	<0.1	2.23	44.1	0.138	-	<0.1	-	<20

Table 2.3-D (Sheet 4 of 25)
Detailed Analytes

																	ANIONS				GENERAL CHEMISTRY			
Well ID	Sample Date	Lab Report ID	Formation	Quarter	Depth	Sample_ depth (m)	Temperature, Celsius (degrees C)	Oxidation reduction potential (mV)	Specific Conductance, Field (umhos/cm)	Oxygen, dissolved (mg/L)	pH, Field (pH)	GW Elevation (m above s/l) (m)	Sample Depth (m)	Well Depth (m)	Water Level Depth (m)	Turbidity, Field (NTU)	Bromide (mg/L)	Chloride, total (mg/L)	Sulfate, total (mg/L)	Fluoride, total (mg/L)	Color (Pt-Co units)	Chlorine, Total Residual (mg/L)	Biological Oxygen Demand (mg/L)	COD, Low Level (mg/L)
CRS-OW429U	12/18/2013	490-43067-1	Benbolt	1	U	15.2	8.79	478	938.1	5.3	6.5	234.78	15.2	18.36	9.49	5.4	-	-	-	-	-	-	-	-
CRS-OW429U	12/19/2013	490-43227-1	Benbolt	1	U	15.16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW429U	12/19/2013	490-43227-1	Benbolt	1	U	15.2	12.04	166	912.6	3.9	6.1	234.82	15.2	18.36	9.45	1.1	-	-	-	-	-	-	-	-
CRS-OW429U	12/20/2013	490-43274-1	Benbolt	1	U	15.16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	10	-	<2	-
CRS-OW429U	12/20/2013	490-43274-1	Benbolt	1	U	15.2	10.32	380	871.2	3	6.4	234.82	15.2	18.36	9.45	0.9	-	-	-	-	-	-	-	-
CRS-OW429U	4/22/2014	490-51453-1	Benbolt	2	U	15.16	-	-	-	-	-	-	-	-	-	-	0.327	2.75	42.9	0.162	<5	<0.1	2.52	<20
CRS-OW429U	4/22/2014	490-51453-1	Benbolt	2	U	15.2	14.6	75	890	0.1	6.5	234	15.2	18.36	10.27	6.6	-	-	-	-	-	-	-	-
CRS-OW429U	8/25/2014	490-60164-1	Benbolt	3	U	15.16	-	-	-	-	-	-	-	-	-	-	<0.1	1.66	39.5	0.111	5	<0.1	<2	<20
CRS-OW429U	8/25/2014	490-60164-1	Benbolt	3	U	15.2	20.6	366	897.7	0.5	6.5	233.65	15.2	18.36	10.62	5	-	-	-	-	-	-	-	-
CRS-OW429U	11/11/2014	490-66027-1	Benbolt	4	U	15.16	-	-	-	-	-	-	-	-	-	-	<0.1	2.27	42.4	<0.1	<5	<0.1	2.93	<20
CRS-OW429U	11/11/2014	490-66027-1	Benbolt	4	U	15.2	15.93	288	870.9	1.4	6.3	232.94	15.2	18.36	11.33	7.8	-	-	-	-	-	-	-	-

Table 2.3-D (Sheet 5 of 25)
Detailed Analytes

			GENERAL CHEMISTRY													METALS (total)												
Well ID	Sample Date	Lab Report ID	pH, Lab (pH)	Phenols, total (ug/L)	Alka-linity, Lab (mg/L)	TSS (mg/L)	Oil & Grease (mg/L)	Nitrogen, Ammonia (mg/L)	Nitrite + Nitrate (mg/L)	Phos-phorus, total (mg/L)	Carbon, total organic (mg/L)	Cyanide, total (mg/L)	Sulfide, total (mg/L)	Methy-lene Blue Active Sub	Aluminum (mg/L)	Antimony (ug/L)	Arsenic (ug/L)	Barium (ug/L)	Beryllium (ug/L)	Boron (ug/L)	Cadmium (ug/L)	Calcium (mg/L)	Chromium (ug/L)	Cobalt (ug/L)	Copper (ug/L)	Iron (ug/L)	Lead (ug/L)	Magnesium (mg/L)
Values from 2016 EPA RSLs MCL Ref.			NA	NA	NA	NA	NA	NA	NA	NA	NA	0.2	NA	NA	NA	6	10	2000	4	NA	5	NA	100	NA	130	NA	15	NA
CRS-OW401D	1/10/2014	490-44246-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401D	1/10/2014	490-44246-1	6.48	<50	311	4.9	<4.47	0.146	0.689	<0.1	<1	<0.01	<0.1	0.087	<0.1	<10	<10	352	<4	53.8	<1	62.6	<5	<10	<10	<100	<5	25.5
CRS-OW401D	4/22/2014	490-51531-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401D	4/23/2014	490-51531-1	6.76	<50	302	11.2	<4.47	0.138	0.409	<0.1	1.24	<0.01	<0.1	0.153	<0.1	<10	<10	324	<4	53.5	<1	54.6	<5	<10	<10	<100	<5	23.9
CRS-OW401D	8/25/2014	490-60159-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401D	8/25/2014	490-60159-1	6.8	<50	349	56.8	<4.31	0.227	0.585	<0.1	1.97	<0.01	<0.1	<0.05	0.653	<10	<10	296	<4	111	<1	57.4	<5	<10	<10	531	<5	24.3
CRS-OW401D	11/5/2014	490-65588-1	7.13	<50	239	2.2	<4.41	0.651	0.599	<0.1	6.78	<0.01	<0.1	0.071	<0.1	<10	<10	267	<4	71	<1	49.5	<5	<10	<10	<100	<5	23.8
CRS-OW401D	11/5/2014	490-65588-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401L	12/12/2013	490-42566-1	6.85	<50	181	14.1	<4.63	0.728	0.162	<0.1	<1	<0.01	<0.1	<0.05	0.698	<10	<10	380	<4	<50	<1	59.1	10.5	<10	<10	543	<5	29.4
CRS-OW401L	4/21/2014	490-51372-1	7.83	<50	247	29.6	<4.13	0.155	0.22	1.68	<1	<0.01	<0.1	0.032	0.887	<10	<10	386	<4	<50	<1	68	8.2	<10	<10	708	<5	31.9
CRS-OW401L	4/21/2014	490-51372-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401L	8/27/2014	490-60308-1	6.91	<50	209	-	-	0.134	0.183	<0.1	<1	<0.01	<0.1	0	0.137	<10	<10	430	<4	<50	<1	50.6	6.6	<10	<10	124	<5	28
CRS-OW401L	8/27/2014	490-60308-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401L	11/10/2014	490-65956-1	7.41	<50	204	23.4	<4.36	<0.1	0.129	<0.1	<1	<0.01	<0.1	<0.05	0.381	<10	<10	424	<4	<50	<1	52.4	5.4	<10	<10	196	<5	29.2
CRS-OW401L	11/10/2014	490-65956-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401U	12/10/2013	490-42335-1	7.38	<50	271	5.9	<4.86	<0.1	0.534	<0.1	<1	<0.01	<0.1	<0.05	0.22	<10	<10	309	<4	<50	<1	59.8	<5	<10	<10	181	<5	32.9
CRS-OW401U	4/18/2014	490-51285-1	7.47	<50	264	3.9	<4.74	<0.1	0.214	<0.1	1.04	<0.01	<0.1	<0.05	0.2	<10	<10	312	<4	<50	<1	54.2	<5	<10	<10	158	<5	30.4
CRS-OW401U	4/18/2014	490-51285-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401U	8/27/2014	490-60310-1	7.32	<50	247	13.2	<4.22	0.603	0.328	<0.1	1.95	0.115	<0.1	<0.05	<0.1	<10	<10	363	<4	<50	<1	62.7	<5	<10	<10	<100	<5	35.2
CRS-OW401U	8/27/2014	490-60310-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401U	11/10/2014	490-65960-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401U	11/10/2014	490-65960-1	8.1	<50	253	28.2	<4.52	<0.1	0.217	0.259	1.45	0.021	<0.1	<0.05	0.118	<10	<10	398	<4	<50	<1	66	<5	<10	<10	<100	<5	37.9
CRS-OW415L	1/9/2014	490-44141-1	8.17	<50	649	5.23	<4.52	0.659	<0.1	<0.1	<1	<0.01	<0.1	<0.05	0.227	<10	<10	<10	<4	1910	<1	7.5	<5	<10	<10	164	<5	4.2
CRS-OW415L	4/23/2014	490-51557-1	-	<50	653	9.3	-	0.745	<0.1	<0.1	1.42	<0.01	<0.1	<0.05	<0.5	<50	<50	<50	<20	2070	<5	8.41	<25	<50	<50	<500	<25	<5
CRS-OW415L	8/20/2014	490-59827-1	7.62	<50	596	4.7	<4.22	0.744	<0.1	<0.1	1.1	<0.01	<0.1	<0.05	<0.5	<50	<50	<50	<20	2170	<5	8.48	<25	<50	<50	<500	<25	5.29
CRS-OW415L	11/11/2014	490-66031-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW415U	12/17/2013	490-42946-1	7.2	<50	235	3.2	<4	<0.1	0.897	<0.1	<1	<0.01	<0.1	<0.05	<0.1	<10	<10	20.8	<4	<50	<1	118	<5	<10	<10	<100	<5	3.57
CRS-OW415U	4/21/2014	490-51380-1	7.14	74	297	2.5	<4.41	0.184	1.08	<0.1	<1	<0.01	<0.1	0.021	<0.1	<10	<10	29.7	<4	<50	<1	114	<5	<10	<10	<100	<5	7.74
CRS-OW415U	8/19/2014	490-59741-1	7.21	<50	220	3.1	<4.31	<0.1	0.852	<0.1	1.51	<0.01	<0.1	<0.05	<0.1	<10	<10	18.5	<4	<50	<1	104	<5	<10	<10	<100	<5	3.46
CRS-OW415U	11/11/2014	490-66017-1	6.92	<50	265	<1.05	<4.47	<0.1	0.746	0.184	1.37	<0.01	<0.1	<0.05	<0.1	<10	<10	40.6	<4	<50	<1	105	<5	<10	<10	<100	<5	14.7
CRS-OW416L	12/19/2013	490-43206-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW416L	12/19/2013	490-43206-1	7.61	<50	279	2	<4.74	0.142	<0.1	0.425	<1	<0.01	<0.1	<0.05	<0.1	<10	<10	51.9	<4	199	<1	97.1	<5	<10	<10	194	<5	15.5
CRS-OW416L	12/19/2013	490-43206-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW416L	4/16/2014	490-51116-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW416L	4/16/2014	490-51116-1	5.87	<50	329	7.5	<4.57	<0.1	0.075	0.577	1.07	<0.01	<0.1	0.027	0.347	<10	<10	56.3	<4	205	0.3	101	<5	<10	<10	448	<5	14.6
CRS-OW416L	8/18/2014	490-59654-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW416L	8/18/2014	490-59654-1	7.37	<50	280	6.8	<4.57	0.109	<0.1	<0.1	1.45	<0.01	<0.1	<0.05	0.425	<10	<10	52.9	<4	170	<1	103	<5	<10	<10	379	<5	15.1
CRS-OW416L	11/6/2014	490-65718-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW416L	11/6/2014	490-65718-1	6.22	<50	279	4.5	<4.31	0.624	<0.1	<0.1	1.48	<0.01	<0.1	<0.05	<0.1	<10	<10	48.5	<4	181	<1	120	<5	<10	<10	131	<5	16
CRS-OW416U	12/18/2013	490-43060-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW416U	12/18/2013	490-43060-1	7.53	<50	255	8.49	<4.74	0.192	0.207	<0.1	1.34	<0.01	<0.1	<0.05	0.396	<10	<10	32.2	<4	<50	<1	101	<5	<10	<10	327	<5	17.4
CRS-OW416U	4/15/2014	490-51008-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW416U	4/15/2014	490-51008-1	7.17	<50	274	47.2	<4.63	0.125	0.249	<0.1	1.38	<0.01	<0.1	0.025	0.365	<10	<10	32	<4	25.9	<1	105	<5	<10	<10	327	<5	16.3
CRS-OW416U	8/22/2014	490-60044-1	7.37	<50	251	8.9	<4.68	0.746	0.206	0.144	4.97	<0.01	<0.1	<0.05	0.54	<10	<10	34.7	<4	<50	<1	105	<5	<10	<10	566	<5	16.7
CRS-OW416U	11/5/2014	490-65583-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW416U	11/5/2014	490-65583-1	7.14	<50	268	12.4	<4.41	2.18	<0.1	<0.1	1.55	<0.01	<0.1	<0.05	<0.1	<10	<10	36.7	<4	62	<1	131	<5	<10	<10	<100	<5	18.1
CRS-OW416U	11/5/2014	490-65592-1	7.15	<50	272	12.8	<4.41	0.778	<0.1	<0.1	1.61	<0.01	<0.1	<0.05	<0.1	<10	<10	36.3	<4	69.7	<1	130	<5	<10	<10	<100	<5	18.2
CRS-OW418L	12/19/2013	490-43197-1	7.75	<50	238	-	<4.52	0.125	1.18	0.239	<1	<0.01	<0.1	<0.05	<0.1	<10	<10	353	<4	<50	<1	57	<5	<10	<10	<100	<5	36.4

Table 2.3-D (Sheet 6 of 25)
Detailed Analytes

			GENERAL CHEMISTRY													METALS (total)															
Well ID	Sample Date	Lab Report ID	pH, Lab (pH)	Phenols, total (ug/L)	Alka-linity, Lab (mg/L)	TSS (mg/L)	Oil & Grease (mg/L)	Nitrogen, Ammonia (mg/L)	Nitrite + Nitrate (mg/L)	Phos-phorus, total (mg/L)	Carbon, total organic (mg/L)	Cyanide, total (mg/L)	Sulfide, total (mg/L)	Methy-lene Blue Active Sub	Aluminum (mg/L)	Antimony (ug/L)	Arsenic (ug/L)	Barium (ug/L)	Beryllium (ug/L)	Boron (ug/L)	Cadmium (ug/L)	Calcium (mg/L)	Chromium (ug/L)	Cobalt (ug/L)	Copper (ug/L)	Iron (ug/L)	Lead (ug/L)	Magnesium (mg/L)
CRS-OW418L	12/19/2013	490-43197-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW418L	12/19/2013	490-43197-2	-	-	-	<1.02	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW418L	4/16/2014	490-51124-1	7.52	<50	276	15.3	<4.47	<0.1	1.32	<0.1	1.28	<0.01	<0.1	0.028	<0.1	<10	<10	343	<4	<50	<1	55.9	<5	<10	<10	33.5	<5	35.3
CRS-OW418L	4/16/2014	490-51124-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW418L	8/18/2014	490-59650-1	7.4	<50	254	19	10.7	<0.1	1.14	<0.1	1.76	0.01	<0.1	<0.05	0.14	<10	<10	334	<4	<50	<1	54.7	<5	<10	<10	<100	<5	35.4
CRS-OW418L	8/18/2014	490-59650-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW418L	11/12/2014	490-66157-1	7.24	<50	238	9	<4.57	0.547	1.26	<0.1	<1	<0.01	<0.1	<0.05	0.269	<10	<10	324	<4	<50	<1	49.3	<5	<10	<10	132	<5	32.2
CRS-OW418L	11/12/2014	490-66157-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW418U	12/18/2013	490-43053-1	7.61	<50	241	<1	<4.47	0.169	0.659	<0.1	<1	<0.01	<0.1	<0.05	0.12	<10	<10	128	<4	193	<1	50.5	<5	<10	<10	<100	<5	17.9
CRS-OW418U	12/18/2013	490-43053-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW418U	4/15/2014	490-50993-1	7.64	<50	273	0.8	<4.74	0.076	0.722	<0.1	0.566	<0.01	<0.1	0.023	<0.1	<10	<10	134	<4	189	<1	53.9	<5	<10	<10	<100	<5	17.9
CRS-OW418U	8/19/2014	490-59748-1	6.37	<50	237	1.21	<4.57	<0.1	0.545	0.143	<1	0.012	<0.1	<0.05	<0.1	<10	<10	139	<4	202	<1	52.5	<5	<10	<10	<100	<5	18.6
CRS-OW418U	8/19/2014	490-59748-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW418U	11/7/2014	490-65801-1	6.68	<50	252	1.1	<4.52	<0.111	0.426	0.106	1.29	<0.01	<0.1	<0.05	<0.1	<10	<10	171	<4	213	<1	53.2	<5	<10	<10	<100	<5	20.2
CRS-OW418U	11/7/2014	490-65801-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW419L	1/6/2014	490-44045-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW419L	1/8/2014	490-44045-1	7.18	<50	220	2.6	<4.17	0.221	0.344	0.169	<1	<0.01	<0.1	<0.05	0.166	<10	<10	130	<4	<50	<1	57.8	<5	<10	<10	128	<5	30.1
CRS-OW419L	4/24/2014	490-51664-1	7.67	<50	233	5.9	<4.47	0.154	0.284	<0.1	<1	<0.01	<0.1	0.027	0.43	<10	<10	193	<4	<50	<1	48	<5	<10	<10	285	<5	29.4
CRS-OW419L	4/24/2014	490-51664-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW419L	8/26/2014	490-60223-1	7.56	<50	211	2.8	<4.47	<0.1	0.318	<0.1	1.04	<0.01	<0.1	<0.05	<0.1	<10	<10	175	<4	<50	<1	53.5	<5	<10	<10	<100	<5	30.8
CRS-OW419L	8/26/2014	490-60223-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW419L	11/12/2014	490-66161-1	7.35	<50	203	24.4	<4.47	<0.1	0.34	<0.1	<1	<0.01	<0.1	<0.05	0.741	<10	<10	190	<4	<50	<1	43.8	<5	<10	<10	375	<5	27.3
CRS-OW419U	12/20/2013	490-43281-1	7.12	<50	239	1.7	<4.52	0.105	0.231	0.182	1.2	<0.01	<0.1	<0.05	<0.1	<10	<10	25.6	<4	<50	<1	73.1	<5	<10	<10	<100	<5	27
CRS-OW419U	12/20/2013	490-43281-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW419U	4/23/2014	490-51552-1	7.22	<50	290	2.2	<4.52	0.108	0.161	<0.1	1.18	<0.01	<0.1	<0.05	<0.1	<10	<10	27.4	<4	<50	<1	70.7	<5	<10	<10	<100	<5	29.4
CRS-OW419U	4/23/2014	490-51552-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW419U	8/18/2014	490-59664-1	6.96	<50	245	4.3	<4.52	0.18	0.229	<0.1	2.07	<0.01	<0.1	<0.05	0.136	<10	<10	26.1	<4	<50	<1	70.5	<5	<10	<10	<100	<5	29.7
CRS-OW419U	11/4/2014	490-65428-1	5.95	<50	268	5.1	<4.47	<0.1	0.129	<0.1	1.56	<0.01	<0.1	<0.05	0.36	<10	<10	35.1	<4	<50	<1	82.7	<5	<10	<10	234	120	34.9
CRS-OW420L	12/10/2013	490-42325-1	7.49	<50	242	2.5	<4.31	<0.1	0.617	0.896	<1	<0.01	<0.1	<0.05	0.114	<10	<10	582	<4	<50	<1	65.7	<5	<10	<10	<100	<5	28.4
CRS-OW420L	12/10/2013	490-42325-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW420L	4/17/2014	490-51210-1	7.55	<50	240	1.4	<4.68	<0.1	0.558	<0.1	1.22	<0.01	<0.1	0.028	<0.1	<10	<10	421	<4	<50	<1	60.9	<5	<10	<10	<100	<5	28.9
CRS-OW420L	4/17/2014	490-51210-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW420L	8/26/2014	490-60209-1	7.64	<50	199	1.2	<4.63	<0.1	0.502	<0.1	1.42	<0.01	<0.1	<0.05	<0.1	<10	<10	446	<4	<50	<1	58.7	<5	<10	<10	<100	<5	26
CRS-OW420L	8/26/2014	490-60209-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW420L	11/6/2014	490-65714-1	7.39	<50	215	3.9	<4.52	0.209	0.492	<0.1	1.66	<0.01	<0.1	<0.05	<0.1	<10	<10	544	<4	<50	<1	65.5	<5	<10	<10	<100	<5	27.1
CRS-OW420L	11/6/2014	490-65714-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW420U	12/12/2013	490-42580-1	7.42	<50	229	561	<4.47	0.246	<0.1	0.168	<1	<0.01	<0.1	<0.05	3.45	<10	<10	70	<4	<50	<1	95.6	<5	<10	<10	4660	5.5	37.2
CRS-OW420U	4/16/2014	490-51107-1	-	-	248	-	-	<0.1	0.094	<0.1	1.08	-	-	-	10.4	<10	7	138	1.4	<50	1.2	143	11.6	7.4	21.7	11900	10.6	65.1
CRS-OW420U	8/26/2014	490-60217-1	-	-	242	1570	-	-	-	-	-	-	-	<0.05	1.55	<10	<10	62.7	<4	<50	<1	109	<5	<10	14.8	2210	<5	47.5
CRS-OW421D	1/9/2014	490-44157-1	7.58	<50	188	16	<4.47	12	<0.1	0.126	2.81	<0.01	<0.1	<0.05	0.112	<10	<10	120	<4	258	<1	19.5	<5	<10	<10	<100	<5	15
CRS-OW421D	4/21/2014	490-51368-1	7.82	<50	200	9.57	<4.22	0.324	<0.1	1.6	1.7	<0.01	<0.1	<0.05	<0.1	<10	<10	124	<4	231	<1	17.8	<5	<10	<10	<100	<5	13.5
CRS-OW421D	8/21/2014	490-59912-1	7.43	<50	181	31.4	<4.63	0.22	<0.1	<0.1	1.66	<0.01	<0.1	<0.05	0.416	<10	<10	166	<4	237	<1	25.5	<5	<10	<10	287	<5	16.8
CRS-OW421D	8/27/2014	490-59912-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW421D	11/12/2014	490-66145-1	7.4	<50	186	48.7	<4.47	0.324	<0.1	<0.1	3.04	<0.01	<0.1	<0.05	0.168	<10	<10	152	<4	273	<1	19.5	<5	<10	<10	<100	<5	16.2
CRS-OW421L	1/13/2014	490-44348-1	7.57	<50	199	4.3	<4.57	0.116	1.62	0.13	<1	<0.01	<0.1	0.078	<0.1	<10	<10	113	<4	172	<1	32.2	<5	<10	<10	<100	<5	25.8
CRS-OW421L	1/13/2014	490-44348-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW421L	4/17/2014	490-51196-1	7.89	<50	183	3.8	<4.36	0.138	1.97	<0.1	5.99	<0.01	<0.1	<0.05	<0.1	<10	<10	91.6	<4	185	<1	32.3	<5	<10	<10	<100	<5	24.9

Table 2.3-D (Sheet 7 of 25)
Detailed Analytes

			GENERAL CHEMISTRY													METALS (total)													
Well ID	Sample Date	Lab Report ID	pH, Lab (pH)	Phenols, total (ug/L)	Alka-linity, Lab (mg/L)	TSS (mg/L)	Oil & Grease (mg/L)	Nitrogen, Ammonia (mg/L)	Nitrite + Nitrate (mg/L)	Phos-phorus, total (mg/L)	Carbon, total organic (mg/L)	Cyanide, total (mg/L)	Sulfide, total (mg/L)	Methy-lene Blue Active Sub	Aluminum (mg/L)	Antimony (ug/L)	Arsenic (ug/L)	Barium (ug/L)	Beryllium (ug/L)	Boron (ug/L)	Cadmium (ug/L)	Calcium (mg/L)	Chromium (ug/L)	Cobalt (ug/L)	Copper (ug/L)	Iron (ug/L)	Lead (ug/L)	Magnesium (mg/L)
CRS-OW421L	4/17/2014	490-51196-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW421L	8/20/2014	490-59831-1	7.51	<50	183	13.5	<4.47	0.722	1.78	<0.1	<1	<0.01	<0.1	<0.05	<0.1	<10	<10	74.5	<4	191	<1	32.1	<5	<10	<10	<100	<5	24.6
CRS-OW421L	11/12/2014	490-66149-1	7.57	<50	183	9.15	<4.31	0.113	1.91	<0.1	1.74	0.013	<0.1	<0.05	<0.1	<10	<10	77.4	<4	179	<1	30.6	<5	<10	<10	<100	<5	23.1
CRS-OW421U	12/17/2013	490-42941-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW421U	12/17/2013	490-42941-1	7.71	<50	269	2.5	<4	0.173	2.62	<0.1	<1	<0.01	<0.1	<0.05	0.379	<10	<10	20.4	<4	<50	<1	76.5	<5	<10	<10	375	<5	28.4
CRS-OW421U	4/18/2014	490-51291-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW421U	4/18/2014	490-51291-1	7.33	<50	305	38.8	<4.52	<0.1	2.22	<0.1	<1	<0.01	<0.1	0.027	1.51	<10	<10	27.8	<4	<50	<1	78.1	<5	<10	<10	1620	<5	28.4
CRS-OW421U	8/27/2014	490-60305-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW421U	8/27/2014	490-60305-1	7.19	<50	266	26.3	<4.57	0.114	2.09	<0.1	1.79	<0.01	<0.1	<0.05	1.38	<10	<10	27.8	<4	<50	<1	85.2	<5	<10	<10	1430	<5	30.3
CRS-OW421U	11/7/2014	490-65803-1	7.27	<50	258	5.4	<4.22	<0.1	1.91	<0.1	1.25	<0.01	<0.1	<0.05	<0.1	<10	<10	14.5	<4	<50	<1	74.5	<5	<10	<10	128	<5	25.2
CRS-OW421U	11/7/2014	490-65803-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW422	4/2/2014	490-49943-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW422D	1/16/2014	490-44692-1	9.6	<50	462	7.1	<4.68	0.474	<0.1	0.146	1.36	<0.01	<0.1	0.205	0.242	<10	<10	<10	<4	1100	<1	1.2	<5	<10	<10	207	<5	<1
CRS-OW428D	12/17/2013	490-42947-1	6.87	<50	334	7.8	<4	0.277	<0.1	0.152	1.69	<0.01	<0.1	<0.05	0.48	<10	<10	104	<4	471	<1	22.9	<5	<10	<10	573	<5	12
CRS-OW428D	12/17/2013	490-42947-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428D	4/22/2014	490-51441-1	7.43	<50	368	8.7	<4.41	0.456	<0.1	<0.1	1.27	<0.01	<0.1	0.024	0.125	<10	<10	207	<4	520	<1	26.4	<5	<10	<10	221	<5	20.1
CRS-OW428D	4/22/2014	490-51441-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428D	8/20/2014	490-59832-1	6.97	<50	324	6	<4.74	0.282	<0.1	0.438	2.62	<0.01	<0.1	<0.05	0.377	<10	<10	137	<4	553	<1	26.1	<5	<10	<10	417	<5	14.8
CRS-OW428D	8/20/2014	490-59832-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428D	11/6/2014	490-65712-1	6.05	<50	336	2.5	<4.63	0.386	<0.1	<0.1	1.8	<0.01	<0.1	<0.05	<0.1	<10	<10	228	<4	567	<1	36.9	<5	<10	<10	152	<5	21.5
CRS-OW428L	12/16/2013	490-42801-1	8.36	<50	242	5.51	<4.52	0.266	<0.1	<0.1	2.86	<0.01	<0.1	<0.05	0.388	<10	<10	12.7	<4	200	<1	4.96	<5	<10	<10	237	<5	1.72
CRS-OW428L	12/16/2013	490-42801-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428L	4/18/2014	490-51286-1	9.57	<50	278	8.4	<4.36	0.254	<0.1	0.109	1.32	<0.01	<0.1	<0.05	0.646	<10	<10	<10	<4	186	<1	3.72	<5	<10	<10	364	<5	<1
CRS-OW428L	4/18/2014	490-51286-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428L	8/22/2014	490-60048-1	9.94	<50	243	4.4	<4.27	0.435	<0.1	0.332	3.14	<0.01	<0.1	<0.05	0.687	<10	<10	<10	<4	235	<1	3.03	<5	<10	<10	360	<5	<1
CRS-OW428L	8/22/2014	490-60048-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428L	11/5/2014	490-65575-1	8.02	<50	247	3.6	<4.57	4.88	<0.1	0.166	2.74	<0.01	<0.1	<0.05	0.5	<10	<10	<10	<4	252	<1	2.82	<5	<10	<10	243	<5	<1
CRS-OW428L	11/5/2014	490-65575-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428U	12/16/2013	490-42809-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428U	12/16/2013	490-42809-1	7.13	<50	190	1.63	<4.8	<0.1	0.035	<0.1	1.97	0.004	<0.1	0.016	0.148	<10	<10	15.1	<4	<50	<1	71.8	<5	<10	<10	109	<5	4.35
CRS-OW428U	4/17/2014	490-51204-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428U	4/17/2014	490-51204-1	7.36	<50	199	1.7	<4.52	<0.1	0.266	<0.1	1.17	<0.01	<0.1	<0.05	0.208	<10	<10	13.3	<4	<50	<1	77	<5	<10	<10	151	<5	4.65
CRS-OW428U	8/21/2014	490-59917-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428U	8/21/2014	490-59917-1	6.75	<50	158	2.7	<4.36	0.259	1.47	<0.1	5.37	<0.01	<0.1	0.062	0.239	<10	<10	12	<4	<50	<1	69.5	<5	<10	<10	185	<5	3.9
CRS-OW428U	11/6/2014	490-65716-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428U	11/6/2014	490-65716-1	7.16	<50	182	2.3	<4.27	0.511	0.916	<0.1	2.99	<0.01	<0.1	<0.05	0.362	<10	<10	14.7	<4	<50	<1	89	<5	<10	<10	264	<5	5.89
CRS-OW429L	4/24/2014	490-51678-1	8.28	<50	415	281	<4.52	0.822	2.36	<0.1	2.18	0.019	<0.1	0.047	<1	<100	<100	<100	<40	1380	<10	22.6	<50	<100	<100	<1000	<50	13.3
CRS-OW429U	12/18/2013	490-43067-1	-	-	428	-	-	0.108	<0.1	<0.1	1.59	-	-	-	0.416	<10	<10	37.9	<4	<50	<1	183	<5	<10	<10	<100	<5	10.5
CRS-OW429U	12/18/2013	490-43067-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW429U	12/19/2013	490-43227-1	-	<50	-	-	-	-	-	-	-	0.019	<0.1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW429U	12/19/2013	490-43227-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW429U	12/20/2013	490-43274-1	6.96	-	-	1.4	<4.8	-	-	-	-	-	-	<0.05	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW429U	12/20/2013	490-43274-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW429U	4/22/2014	490-51453-1	6.88	<50	477	1.4	<4.57	0.149	<0.1	<0.1	1.76	<0.01	<0.1	0.029	<0.1	<10	<10	36.2	<4	52.7	<1	187	<5	<10	<10	106	<5	12.9
CRS-OW429U	4/22/2014	490-51453-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW429U	8/25/2014	490-60164-1	6.86	<50	420	1.4	<3.92	0.146	<0.1	<0.1	1.58	<0.01	<0.1	0.064	<0.1	<10	<10	28.9	<4	58.7	<1	181	<5	<10	<10	<100	<5	9.63
CRS-OW429U	8/25/2014	490-60164-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW429U	11/11/2014	490-66027-1	6.57	<50	410	2.84	<4.63	<0.1	<0.1	<0.1	1.55	<0.01	<0.1	<0.05	<0.1	<10	<10	29.2	<4	<50	<1	186	<5	<10	<10	<100	<5	9.71
CRS-OW429U	11/11/2014	490-66027-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2.3-D (Sheet 8 of 25)
Detailed Analytes

			METALS (total)											GROSS ALPHA AND GROSS BETA RADIOACTIVITY							SEMIVOLATILE ORGANIC COMPOUNDS (ug/L)					
Well ID	Sample Date	Lab Report ID	Manganese (ug/L)	Molybdenum (ug/L)	Nickel (ug/L)	Potassium (mg/L)	Selenium (ug/L)	Silver (ug/L)	Sodium (mg/L)	Thallium (ug/L)	Tin (ug/L)	Titanium (ug/L)	Zinc (ug/L)	Alpha, total (pCi/L)	Beta, total (pCi/L)	Tritium (pCi/L)	Radium 226, total (pCi/L)	Radium 228, total (pCi/L)	Sr-90, total (pCi/L)	Tec-99 (pCi/L)	1,2,4-Trichlorobenzene	1,2,5,6-Dibenzanthracene	1,2-Dichlorobenzene	1,2-Diphenylhydrazine	1,3-Dichlorobenzene	1,4-Dichlorobenzene
Values from 2016 EPA RSLs MCL Ref.			NA	NA	100	NA	50	100	NA	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	70	NA	NA	NA	NA	NA
CRS-OW401D	1/10/2014	490-44246-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401D	1/10/2014	490-44246-1	125	<50	<10	13.2	<10	<5	29	<10	<50	<50	<50	7.02	13.9	<500	1.02	0.496	<3	<3	<8.93	<1.79	<8.93	<8.93	<8.93	<8.93
CRS-OW401D	4/22/2014	490-51531-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401D	4/23/2014	490-51531-1	87.6	<50	<10	33.3	<10	<5	24.9	<10	<50	<50	<50	9.74	28.7	<500	0.876	<1	<3	<3	<9.62	<1.92	<9.62	<9.62	<9.62	<9.62
CRS-OW401D	8/25/2014	490-60159-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401D	8/25/2014	490-60159-1	118	<50	<10	29.8	<10	<5	73.4	<10	<50	<50	<50	10.8	27.2	<500	1.31	0.541	<3	8.16	<9.09	<1.82	<9.09	<9.09	<9.09	<9.09
CRS-OW401D	11/5/2014	490-65588-1	40.1	<50	<10	10.8	<10	<5	39.2	<10	<50	<50	<50	8.62	9.66	<500	0.738	0.478	<3	<3	<9.62	<1.92	<9.62	<9.62	<9.62	<9.62
CRS-OW401D	11/5/2014	490-65588-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401L	12/12/2013	490-42566-1	18.9	<50	<10	2.15	<10	<5	1.33	<10	<50	<50	<50	3.39	1.45	<500	0.416	<1	<3	<3	<8.93	<1.79	<8.93	<8.93	<8.93	<8.93
CRS-OW401L	4/21/2014	490-51372-1	17.7	<50	<10	2.95	<10	<5	5.05	<10	<50	<50	72.9	<3	2.86	<500	0.44	0.413	<3	<3	<9.62	<1.92	<9.62	<9.62	<9.62	<9.62
CRS-OW401L	4/21/2014	490-51372-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401L	8/27/2014	490-60308-1	<15	<50	<10	1.97	<10	<5	1.2	<10	<50	<50	<50	<3	1.68	<500	0.385	0.509	<3	<3	<9.62	<1.92	<9.62	<9.62	<9.62	<9.62
CRS-OW401L	8/27/2014	490-60308-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401L	11/10/2014	490-65956-1	<15	<50	<10	2.07	<10	<5	1.04	<10	<50	<50	<50	2.93	2.42	<500	0.402	<1	<3	<3	<9.43	<1.89	<9.43	<9.43	<9.43	<9.43
CRS-OW401L	11/10/2014	490-65956-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401U	12/10/2013	490-42335-1	<15	<50	<10	1.58	<10	<5	<1	<10	<50	<50	<50	<3	<4	<500	0.293	<1	<3	<3	<8.93	<1.79	<8.93	<8.93	<8.93	<8.93
CRS-OW401U	4/18/2014	490-51285-1	<15	<50	<10	1.67	<10	<5	<1	<10	<50	<50	<50	8.09	<4	<500	0.436	<1	<3	<3	<9.62	<1.92	<9.62	<9.62	<9.62	<9.62
CRS-OW401U	4/18/2014	490-51285-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401U	8/27/2014	490-60310-1	<15	<50	<10	1.71	<10	<5	<1	<10	<50	<50	<50	3.01	3.2	<500	0.287	<1	0.35	<3	<9.43	<1.89	<9.43	<9.43	<9.43	<9.43
CRS-OW401U	8/27/2014	490-60310-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401U	11/10/2014	490-65960-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401U	11/10/2014	490-65960-1	<15	<50	<10	1.8	<10	<5	<1	<10	<50	<50	<50	5.56	1.71	<500	0.399	<1	<3	<3	<9.43	<1.89	<9.43	<9.43	<9.43	<9.43
CRS-OW415L	1/9/2014	490-44141-1	<15	<50	<10	8.84	<10	<5	1080	<10	<50	<50	<50	<3	<4	<500	0.163	<1	<3	<3	<8.93	<1.79	<8.93	<8.93	<8.93	<8.93
CRS-OW415L	4/23/2014	490-51557-1	<75	<250	<50	5.73	<50	<25	1070	<50	<250	<250	<250	<3	<4	<500	0.429	<1	0.359	<3	<10	<2	<10	<10	<10	<10
CRS-OW415L	8/20/2014	490-59827-1	<75	<250	<50	6.28	<50	<25	1150	<50	<250	<250	<250	<3	30.2	<500	<1	<1	<3	<3	<9.8	<1.96	<9.8	<9.8	<9.8	<9.8
CRS-OW415L	11/11/2014	490-66031-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW415U	12/17/2013	490-42946-1	<15	<50	<10	1.75	<10	<5	5.38	<10	<50	<50	<50	5.2	<4	<500	<1	<1	<3	<3	<8.93	<1.79	<8.93	<8.93	<8.93	<8.93
CRS-OW415U	4/21/2014	490-51380-1	<15	<50	<10	6.32	<10	<5	4.73	<10	<50	<50	<50	<3	<4	<500	0.132	<1	<3	<3	<9.26	<1.85	<9.26	<9.26	<9.26	<9.26
CRS-OW415U	8/19/2014	490-59741-1	<15	<50	<10	1.11	<10	<5	3.74	<10	<50	<50	<50	<3	1.16	<500	<1	<1	<3	<3	<9.43	<1.89	<9.43	<9.43	<9.43	<9.43
CRS-OW415U	11/11/2014	490-66017-1	<15	<50	<10	3.09	<10	<5	5.02	<10	<50	<50	<50	<3	1.13	<500	<1	<1	<3	<3	<9.43	<1.89	<9.43	<9.43	<9.43	<9.43
CRS-OW416L	12/19/2013	490-43206-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW416L	12/19/2013	490-43206-1	38.1	<50	<10	<1	<10	<5	45.4	<10	<50	<50	<50	<3	<4	<500	0.17	<1	<3	<3	<9.26	<1.85	<9.26	<9.26	<9.26	<9.26
CRS-OW416L	12/19/2013	490-43206-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW416L	4/16/2014	490-51116-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW416L	4/16/2014	490-51116-1	30.7	<50	<10	0.873	<10	<5	50.2	<10	<50	<50	<50	<3	<4	<500	<1	<1	<3	<3	<9.62	<1.92	<9.62	<9.62	<9.62	<9.62
CRS-OW416L	8/18/2014	490-59654-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW416L	8/18/2014	490-59654-1	23.9	<50	<10	<1	<10	<5	38.6	<10	<50	<50	<50	<3	8.62	<500	<1	<1	0.428	<3	<9.43	<1.89	<9.43	<9.43	<9.43	<9.43
CRS-OW416L	11/6/2014	490-65718-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW416L	11/6/2014	490-65718-1	19.2	<50	<10	<1	<10	<5	34.3	<10	<50	<50	<50	<3	<4	<500	<1	<1	<3	<3	<9.09	<1.82	<9.09	<9.09	<9.09	<9.09
CRS-OW416U	12/18/2013	490-43060-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW416U	12/18/2013	490-43060-1	20.8	<50	<10	1.81	<10	<5	4.27	<10	<50	<50	<50	<3	<4	<500	<1	<1	<3	<3	<8.93	<1.79	<8.93	<8.93	<8.93	<8.93
CRS-OW416U	4/15/2014	490-51008-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW416U	4/15/2014	490-51008-1	7.5	<50	<10	1.54	<10	<5	4.1	<10	<50	<50	<50	<3	2.12	<500	<1	<1	<3	<3	<10.4	<2.08	<10.4	<10.4	<10.4	<10.4
CRS-OW416U	8/22/2014	490-60044-1	21.2	<50	<10	1.7	<10	<5	3.28	<10	<50	<50	<50	<3	2	<500	<1	<1	<3	<3	<9.43	<1.89	<9.43	<9.43	<9.43	<9.43
CRS-OW416U	11/5/2014	490-65583-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW416U	11/5/2014	490-65583-1	41.9	<50	<10	1.6	<10	<5	4.1	<10	<50	<50	<50	<3	<4	<500	<1	<1	<3	<3	<9.62	<1.92	<9.62	<9.62	<9.62	<9.62
CRS-OW416U	11/5/2014	490-65592-1	40.4	<50	<10	1.57	<10	<5	4.04	<10	<50	<50	<50	<3	<4	<500	<1	<1	<3	<3	<9.62	<1.92	<9.62	<9.62	<9.62	<9.62
CRS-OW418L	12/19/2013	490-43197-1	<15	<50	<10	1.86	<10	<5	3.18	<10	<50	<50	<50	<3	<4	<500	0.163	<1	<3	<3	<8.62	<1.72	<8.62	<8.62	<8.62	<8.62
CRS-OW418L	12/19/2013	490-43197-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2.3-D (Sheet 9 of 25)
Detailed Analytes

			METALS (total)											GROSS ALPHA AND GROSS BETA RADIOACTIVITY							SEMIVOLATILE ORGANIC COMPOUNDS (ug/L)					
Well ID	Sample Date	Lab Report ID	Manganese (ug/L)	Molybdenum (ug/L)	Nickel (ug/L)	Potassium (mg/L)	Selenium (ug/L)	Silver (ug/L)	Sodium (mg/L)	Thallium (ug/L)	Tin (ug/L)	Titanium (ug/L)	Zinc (ug/L)	Alpha, total (pCi/L)	Beta, total (pCi/L)	Tritium (pCi/L)	Radium 226, total (pCi/L)	Radium 228, total (pCi/L)	Sr-90, total (pCi/L)	Tec-99 (pCi/L)	1,2,4-Trichlorobenzene	1,2,5,6-Dibenzanthracene	1,2-Dichlorobenzene	1,2-Diphenylhydrazine	1,3-Dichlorobenzene	1,4-Dichlorobenzene
CRS-OW418L	12/19/2013	490-43197-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW418L	4/16/2014	490-51124-1	<15	<50	<10	1.75	<10	<5	2.92	<10	<50	<50	<50	<3	<4	<500	<1	<1	<3	<3	<8.77	<1.75	<8.77	<8.77	<8.77	<8.77
CRS-OW418L	4/16/2014	490-51124-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW418L	8/18/2014	490-59650-1	<15	<50	<10	1.71	<10	<5	3.16	<10	<50	<50	<50	3.76	3.95	<500	<1	<1	0.383	<3	<9.62	<1.92	<9.62	<9.62	<9.62	<9.62
CRS-OW418L	8/18/2014	490-59650-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW418L	11/12/2014	490-66157-1	<15	<50	<10	1.88	<10	<5	2.99	<10	<50	<50	<50	4.17	<4	<500	0.273	<1	<3	<3	<9.43	<1.89	<9.43	<9.43	<9.43	<9.43
CRS-OW418L	11/12/2014	490-66157-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW418U	12/18/2013	490-43053-1	<15	<50	<10	2.51	<10	<5	39.1	<10	<50	<50	<50	<3	<4	<500	<1	<1	<3	<3	<8.93	<1.79	<8.93	<8.93	<8.93	<8.93
CRS-OW418U	12/18/2013	490-43053-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW418U	4/15/2014	490-50993-1	<15	0.9	18.8	2.24	<10	<5	39.8	<10	<50	<50	<50	<3	<4	<500	0.168	<1	<3	<3	<9.26	<1.85	<9.26	<9.26	<9.26	<9.26
CRS-OW418U	8/19/2014	490-59748-1	<15	<50	<10	2.17	<10	<5	36.4	<10	<50	<50	<50	<3	4.18	<500	0.122	<1	<3	<3	<9.43	<1.89	<9.43	<9.43	<9.43	<9.43
CRS-OW418U	8/19/2014	490-59748-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW418U	11/7/2014	490-65801-1	<15	<50	<10	2.36	<10	<5	32.5	<10	<50	<50	<50	<3	<4	284	0.208	<1	<3	<3	<9.43	<1.89	<9.43	<9.43	<9.43	<9.43
CRS-OW418U	11/7/2014	490-65801-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW419L	1/6/2014	490-44045-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW419L	1/8/2014	490-44045-1	<15	<50	<10	2.56	<10	<5	5.08	<10	<50	<50	<50	<3	1.61	<500	0.16	<1	<3	<3	<8.77	<1.75	<8.77	<8.77	<8.77	<8.77
CRS-OW419L	4/24/2014	490-51664-1	<15	<50	<10	2.46	<10	<5	2.39	<10	<50	<50	<50	5.78	<4	<500	<1	<1	<3	<3	<9.62	<1.92	<9.62	<9.62	<9.62	<9.62
CRS-OW419L	4/24/2014	490-51664-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW419L	8/26/2014	490-60223-1	<15	<50	<10	2.32	<10	<5	2.65	<10	<50	<50	<50	<3	2.69	<500	0.21	0.372	<3	<3	<9.09	<1.82	<9.09	<9.09	<9.09	<9.09
CRS-OW419L	8/26/2014	490-60223-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW419L	11/12/2014	490-66161-1	20	<50	<10	2.46	<10	<5	2.15	<10	<50	<50	<50	4.56	2.08	<500	0.525	<1	<3	<3	<9.43	<1.89	<9.43	<9.43	<9.43	<9.43
CRS-OW419U	12/20/2013	490-43281-1	<15	<50	<10	1.35	<10	<5	<1	<10	<50	<50	<50	<3	<4	<500	<1	<1	<3	<3	<8.33	<1.67	<8.33	<8.33	<8.33	<8.33
CRS-OW419U	12/20/2013	490-43281-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW419U	4/23/2014	490-51552-1	<15	<50	<10	1.28	<10	<5	1.07	<10	<50	<50	<50	<3	<4	<500	<1	<1	<3	<3	<8.77	<1.75	<8.77	<8.77	<8.77	<8.77
CRS-OW419U	4/23/2014	490-51552-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW419U	8/18/2014	490-59664-1	<15	<50	<10	1.24	<10	<5	<1	<10	<50	<50	<50	<3	<4	<500	<1	<1	0.317	<3	<9.62	<1.92	<9.62	<9.62	<9.62	<9.62
CRS-OW419U	11/4/2014	490-65428-1	<15	<50	<10	1.71	<10	<5	1.37	<10	<50	<50	<50	<3	<4	<500	<1	<1	<3	<3	<9.62	<1.92	<9.62	<9.62	<9.62	<9.62
CRS-OW420L	12/10/2013	490-42325-1	<15	<50	<10	1.68	<10	<5	1.09	<10	<50	<50	<50	<3	1.73	<500	0.473	<1	<3	<3	<8.93	<1.79	<8.93	<8.93	<8.93	<8.93
CRS-OW420L	12/10/2013	490-42325-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW420L	4/17/2014	490-51210-1	<15	<50	<10	2.3	<10	<5	1.42	<10	<50	<50	<50	<3	1.82	<500	0.31	<1	<3	<3	<10	<2	<10	<10	<10	<10
CRS-OW420L	4/17/2014	490-51210-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW420L	8/26/2014	490-60209-1	<15	<50	<10	2.23	<10	<5	1.44	<10	<50	<50	<50	<3	1.78	<500	0.256	0.295	<3	<3	<9.26	<1.85	<9.26	<9.26	<9.26	<9.26
CRS-OW420L	8/26/2014	490-60209-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW420L	11/6/2014	490-65714-1	<15	<50	<10	1.23	<10	<5	<1	<10	<50	<50	<50	<3	<4	<500	0.248	<1	<3	<3	<9.43	<1.89	<9.43	<9.43	<9.43	<9.43
CRS-OW420L	11/6/2014	490-65714-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW420U	12/12/2013	490-42580-1	319	<50	<10	1.81	<10	<5	<1	<10	<50	<50	<50	13	4.71	<500	0.551	0.915	<3	<3	<8.93	<1.79	<8.93	<8.93	<8.93	<8.93
CRS-OW420U	4/16/2014	490-51107-1	902	<50	4.9	2.19	<10	<5	0.812	<10	<50	36.9	33.8	-	-	-	-	<1	<3	-	<10	<2	<10	<10	<10	<10
CRS-OW420U	8/26/2014	490-60217-1	256	<50	<10	1.33	<10	<5	1.12	<10	<50	<50	<50	-	-	<500	1.2	1.06	<3	<3	-	-	-	-	-	-
CRS-OW421D	1/9/2014	490-44157-1	<15	<50	<10	27.4	<10	<5	35	<10	<50	<50	<50	4.56	23.5	<500	0.326	<1	<3	<3	<8.93	<1.79	<8.93	<8.93	<8.93	<8.93
CRS-OW421D	4/21/2014	490-51368-1	18.6	<50	<10	23.7	<10	<5	31	<10	<50	<50	<50	6.71	20.2	<500	0.365	<1	<3	<3	<9.26	<1.85	<9.26	<9.26	<9.26	<9.26
CRS-OW421D	8/21/2014	490-59912-1	31.4	<50	<10	25	<10	<5	37.5	<10	<50	<50	<50	4.12	26.4	<500	0.362	<1	<3	<3	<9.43	<1.89	<9.43	<9.43	<9.43	<9.43
CRS-OW421D	8/27/2014	490-59912-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW421D	11/12/2014	490-66145-1	28.7	<50	<10	26.3	<10	<5	33.7	<10	<50	<50	<50	4.38	21.8	<500	<1	<1	<3	<3	<9.43	<1.89	<9.43	<9.43	<9.43	<9.43
CRS-OW421L	1/13/2014	490-44348-1	<15	<50	<10	13.2	<10	<5	11.8	<10	<50	<50	<50	5.39	10.2	<500	0.11	<1	<3	2.89	<8.93	<1.79	<8.93	<8.93	<8.93	<8.93
CRS-OW421L	1/13/2014	490-44348-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW421L	4/17/2014	490-51196-1	<15	<50	<10	13.6	<10	<5	18.3	<10	<50	<50	<50	3.59	10.4	<500	0.248	<1	<3	<3	<9.43	<1.89	<9.43	<9.43	<9.43	<9.43
CRS-OW421L	4/17/2014	490-51196-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW421L	8/20/2014	490-59831-1	<15	<50	<10	14.2	<10	<5	15.8	<10	<50	<50	<50	3.37	23	<500	0.223	<1	<3	<3	<9.26	<1.85	<9.26	<9.26	<9.26	<9.26
CRS-OW421L	11/12/2014	490-66149-1	<15	<50	<10	14	<10	<5	14.3	<10	<50	<50	<50	<3	12.3	<500	<1	<1	<3	<3	<9.62	<1.92	<9.62	<9.62	<9.62	<9.62
CRS-OW421U	12/17/2013	490-42941-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2.3-D (Sheet 10 of 25)
Detailed Analytes

			METALS (total)											GROSS ALPHA AND GROSS BETA RADIOACTIVITY							SEMIVOLATILE ORGANIC COMPOUNDS (ug/L)					
Well ID	Sample Date	Lab Report ID	Manganese (ug/L)	Molybdenum (ug/L)	Nickel (ug/L)	Potassium (mg/L)	Selenium (ug/L)	Silver (ug/L)	Sodium (mg/L)	Thallium (ug/L)	Tin (ug/L)	Titanium (ug/L)	Zinc (ug/L)	Alpha, total (pCi/L)	Beta, total (pCi/L)	Tritium (pCi/L)	Radium 226, total (pCi/L)	Radium 228, total (pCi/L)	Sr-90, total (pCi/L)	Tec-99 (pCi/L)	1,2,4-Trichlorobenzene	1,2,5,6-Dibenzanthracene	1,2-Dichlorobenzene	1,2-Diphenylhydrazine	1,3-Dichlorobenzene	1,4-Dichlorobenzene
CRS-OW421U	12/17/2013	490-42941-1	<15	<50	<10	<1	<10	<5	1.09	<10	<50	<50	<50	<3	1.48	<500	<1	<1	<3	<3	<8.93	<1.79	<8.93	<8.93	<8.93	<8.93
CRS-OW421U	4/18/2014	490-51291-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW421U	4/18/2014	490-51291-1	<15	<50	<10	<1	<10	<5	<1	<10	<50	<50	<50	<3	<4	<500	<1	<1	<3	<3	<8.93	<1.79	<8.93	<8.93	<8.93	<8.93
CRS-OW421U	8/27/2014	490-60305-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW421U	8/27/2014	490-60305-1	<15	<50	<10	1.06	<10	<5	1.43	<10	<50	<50	<50	<3	<4	<500	<1	<1	<3	<3	<9.43	<1.89	<9.43	<9.43	<9.43	<9.43
CRS-OW421U	11/7/2014	490-65803-1	<15	<50	<10	<1	<10	<5	1.29	<10	<50	<50	<50	<3	<4	<500	0.174	<1	<3	<3	<9.62	<1.92	<9.62	<9.62	<9.62	<9.62
CRS-OW421U	11/7/2014	490-65803-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW422	4/2/2014	490-49943-1	-	-	-	-	-	-	-	-	-	-	-	<3	8.19	-	-	-	<3	-	-	-	-	-	-	-
CRS-OW422D	1/16/2014	490-44692-1	<15	<50	<10	5.22	<10	<5	250	<10	<50	<50	<50	<3	3.35	405	0.108	<1	<3	<3	<8.93	<1.79	<8.93	<8.93	<8.93	<8.93
CRS-OW428D	12/17/2013	490-42947-1	27.1	<50	<10	4.81	<10	<5	149	<10	<50	<50	<50	<3	4.7	847	<1	<1	<3	<3	<8.93	<1.79	<8.93	<8.93	<8.93	<8.93
CRS-OW428D	12/17/2013	490-42947-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428D	4/22/2014	490-51441-1	24.4	<50	<10	5.01	<10	<5	120	<10	<50	<50	<50	<3	3.87	<500	<1	<1	<3	<3	<10	<2	<10	<10	<10	<10
CRS-OW428D	4/22/2014	490-51441-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428D	8/20/2014	490-59832-1	31.2	<50	<10	6.43	<10	<5	162	<10	<50	<50	<50	<3	8.34	<500	<1	<1	<3	<3	<9.62	<1.92	<9.62	<9.62	<9.62	<9.62
CRS-OW428D	8/20/2014	490-59832-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428D	11/6/2014	490-65712-1	39.2	<50	<10	5.16	<10	<5	125	<10	<50	<50	<50	<3	4.14	329	<1	<1	<3	<3	<9.62	<1.92	<9.62	<9.62	<9.62	<9.62
CRS-OW428L	12/16/2013	490-42801-1	<15	<50	<10	6.06	<10	<5	109	<10	<50	<50	<50	<3	4.24	<500	<1	<1	<3	<3	<8.93	<1.79	<8.93	<8.93	<8.93	<8.93
CRS-OW428L	12/16/2013	490-42801-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428L	4/18/2014	490-51286-1	<15	<50	<10	4.73	<10	<5	112	<10	<50	<50	<50	<3	3.55	<500	0.13	<1	<3	<3	<9.43	<1.89	<9.43	<9.43	<9.43	<9.43
CRS-OW428L	4/18/2014	490-51286-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428L	8/22/2014	490-60048-1	<15	<50	<10	4.63	<10	<5	122	<10	<50	<50	<50	<3	3.4	<500	<1	<1	<3	<3	<9.62	<1.92	<9.62	<9.62	<9.62	<9.62
CRS-OW428L	8/22/2014	490-60048-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428L	11/5/2014	490-65575-1	<15	<50	<10	4.3	<10	<5	141	<10	<50	<50	<50	<3	3.15	<500	<1	0.427	<3	<3	<9.62	<1.92	<9.62	<9.62	<9.62	<9.62
CRS-OW428L	11/5/2014	490-65575-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428U	12/16/2013	490-42809-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428U	12/16/2013	490-42809-1	<15	<50	<10	<1	<10	<5	1.09	<10	<50	<50	<50	<3	<4	<500	<1	0.469	<3	<3	<8.93	<1.79	<8.93	<8.93	<8.93	<8.93
CRS-OW428U	4/17/2014	490-51204-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428U	4/17/2014	490-51204-1	<15	<50	<10	<1	<10	<5	1.15	<10	<50	<50	<50	<3	<4	<500	<1	<1	<3	<3	<9.62	<1.92	<9.62	<9.62	<9.62	<9.62
CRS-OW428U	8/21/2014	490-59917-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428U	8/21/2014	490-59917-1	<15	<50	<10	<1	<10	<5	<1	<10	<50	<50	<50	<3	8.89	<500	<1	<1	<3	<3	<9.26	<1.85	<9.26	<9.26	<9.26	<9.26
CRS-OW428U	11/6/2014	490-65716-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428U	11/6/2014	490-65716-1	<15	<50	<10	<1	<10	<5	1.77	<10	<50	<50	<50	<3	<4	<500	<1	<1	<3	<3	<9.26	<1.85	<9.26	<9.26	<9.26	<9.26
CRS-OW429L	4/24/2014	490-51678-1	<150	<500	<100	16.5	<100	<50	1650	<100	<500	<500	<500	<3	<4	<500	0.271	<1	<3	<3	<10	<2	<10	<10	<10	<10
CRS-OW429U	12/18/2013	490-43067-1	535	<50	<10	1.16	<10	<5	5.06	<10	<50	<50	<50	<3	<4	<500	-	-	-	<3	-	-	-	-	-	-
CRS-OW429U	12/18/2013	490-43067-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW429U	12/19/2013	490-43227-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.119	<1	<3	-	<8.62	<1.72	<8.62	<8.62	<8.62	<8.62
CRS-OW429U	12/19/2013	490-43227-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW429U	12/20/2013	490-43274-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW429U	12/20/2013	490-43274-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW429U	4/22/2014	490-51453-1	790	<50	<10	1.47	<10	<5	7.13	<10	<50	<50	<50	<3	<4	<500	<1	<1	<3	<3	<10	<2	<10	<10	<10	<10
CRS-OW429U	4/22/2014	490-51453-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW429U	8/25/2014	490-60164-1	702	<50	<10	1	<10	<5	6.45	<10	<50	<50	<50	<3	<4	<500	<1	<1	<3	2.02	<9.26	<1.85	<9.26	<9.26	<9.26	<9.26
CRS-OW429U	8/25/2014	490-60164-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW429U	11/11/2014	490-66027-1	728	<50	<10	1.05	<10	<5	5.63	<10	<50	<50	<50	<3	<4	<500	<1	<1	<3	<3	<9.8	<1.96	<9.8	<9.8	<9.8	<9.8
CRS-OW429U	11/11/2014	490-66027-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2.3-D (Sheet 11 of 25)
Detailed Analytes

Well ID	Sample Date	Lab Report ID	SEMIVOLATILE ORGANIC COMPOUNDS (ug/L)																						
			2,4,6-Tri-chloro-phenol	2,4-Di-chloro-phenol	2,4-Di-methylp henol	2,4-Di-nitro-phenol	2,4-Di-nitro-toluene	2,6-Dinitro-toluene	2-Chloro-naph-thalene	2-Chloro phenol	2-Nitro-phenol	3,3'-Dichloro-benzidine	4-Bromo-phenyl Phenyl Ether	4-Chloro-phenyl Phenyl Ether	4-Nitro-phenol	Acenph-thene	Acenaph-thylene	Anth-racene	Ben-zidine	Benzo(a) anthracene	Benzo(B) fluor anthene	Benzo (ghi) perylene	Benzo(K) fluor anthene	Benzo-a-pyrene	Bis (2-Chloro-ethoxy) Methylene
Values from 2016 EPA RSLs MCL Ref.			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	0.2	NA
CRS-OW401D	1/10/2014	490-44246-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401D	1/10/2014	490-44246-1	<8.93	<8.93	<8.93	<22.3	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93	<22.3	<1.79	<1.79	<1.79	<44.6	<1.79	<1.79	<1.79	<1.79	<1.79	<8.93
CRS-OW401D	4/22/2014	490-51531-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401D	4/23/2014	490-51531-1	<9.62	<9.62	<9.62	<24	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62	<24	<1.92	<1.92	<1.92	<48.1	<1.92	<1.92	<1.92	<1.92	<1.92	<9.62
CRS-OW401D	8/25/2014	490-60159-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401D	8/25/2014	490-60159-1	<9.09	<9.09	<9.09	<22.7	<9.09	<9.09	<9.09	<9.09	<9.09	<9.09	<9.09	<9.09	<22.7	<1.82	<1.82	<1.82	<45.5	<1.82	<1.82	<1.82	<1.82	<1.82	<9.09
CRS-OW401D	11/5/2014	490-65588-1	<9.62	<9.62	<9.62	<24	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62	<24	<1.92	<1.92	<1.92	<48.1	<1.92	<1.92	<1.92	<1.92	<1.92	<9.62
CRS-OW401D	11/5/2014	490-65588-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401L	12/12/2013	490-42566-1	<8.93	<8.93	<8.93	<22.3	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93	<22.3	<1.79	<1.79	<1.79	<44.6	<1.79	<1.79	<1.79	<1.79	<1.79	<8.93
CRS-OW401L	4/21/2014	490-51372-1	<9.62	<9.62	<9.62	<24	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62	<24	<1.92	<1.92	<1.92	<48.1	<1.92	<1.92	<1.92	<1.92	<1.92	<9.62
CRS-OW401L	4/21/2014	490-51372-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401L	8/27/2014	490-60308-1	<9.62	<9.62	<9.62	<24	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62	<24	<1.92	<1.92	<1.92	<48.1	<1.92	<1.92	<1.92	<1.92	<1.92	<9.62
CRS-OW401L	8/27/2014	490-60308-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401L	11/10/2014	490-65956-1	<9.43	<9.43	<9.43	<23.6	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43	<23.6	<1.89	<1.89	<1.89	<47.2	<1.89	<1.89	<1.89	<1.89	<1.89	<9.43
CRS-OW401L	11/10/2014	490-65956-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401U	12/10/2013	490-42335-1	<8.93	<8.93	<8.93	<22.3	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93	<22.3	<1.79	<1.79	<1.79	<44.6	<1.79	<1.79	<1.79	<1.79	<1.79	<8.93
CRS-OW401U	4/18/2014	490-51285-1	<9.62	<9.62	<9.62	<24	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62	<24	<1.92	<1.92	<1.92	<48.1	<1.92	<1.92	<1.92	<1.92	<1.92	<9.62
CRS-OW401U	4/18/2014	490-51285-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401U	8/27/2014	490-60310-1	<9.43	<9.43	<9.43	<23.6	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43	<23.6	<1.89	<1.89	<1.89	<47.2	<1.89	<1.89	<1.89	<1.89	<1.89	<9.43
CRS-OW401U	8/27/2014	490-60310-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401U	11/10/2014	490-65960-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401U	11/10/2014	490-65960-1	<9.43	<9.43	<9.43	<23.6	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43	<23.6	<1.89	<1.89	<1.89	<47.2	<1.89	<1.89	<1.89	<1.89	<1.89	<9.43
CRS-OW415L	1/9/2014	490-44141-1	<8.93	<8.93	<8.93	<22.3	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93	<22.3	<1.79	<1.79	<1.79	<44.6	<1.79	<1.79	<1.79	<1.79	<1.79	<8.93
CRS-OW415L	4/23/2014	490-51557-1	<10	<10	<10	<25	<10	<10	<10	<10	<10	<10	<10	<10	<25	<2	<2	<2	<50	<2	<2	<2	<2	<2	<10
CRS-OW415L	8/20/2014	490-59827-1	<9.8	<9.8	<9.8	<24.5	<9.8	<9.8	<9.8	<9.8	<9.8	<9.8	<9.8	<9.8	<24.5	<1.96	<1.96	<1.96	<49	<1.96	<1.96	<1.96	<1.96	<1.96	<9.8
CRS-OW415L	11/11/2014	490-66031-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW415U	12/17/2013	490-42946-1	<8.93	<8.93	<8.93	<22.3	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93	<22.3	<1.79	<1.79	<1.79	<44.6	<1.79	<1.79	<1.79	<1.79	<1.79	<8.93
CRS-OW415U	4/21/2014	490-51380-1	<9.26	<9.26	<9.26	<23.1	<9.26	<9.26	<9.26	<9.26	<9.26	<9.26	<9.26	<9.26	<23.1	<1.85	<1.85	<1.85	<46.3	<1.85	<1.85	<1.85	<1.85	<1.85	<9.26
CRS-OW415U	8/19/2014	490-59741-1	<9.43	<9.43	<9.43	<23.6	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43	<23.6	<1.89	<1.89	<1.89	<47.2	<1.89	<1.89	<1.89	<1.89	<1.89	<9.43
CRS-OW415U	11/11/2014	490-66017-1	<9.43	<9.43	<9.43	<23.6	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43	<23.6	<1.89	<1.89	<1.89	<47.2	<1.89	<1.89	<1.89	<1.89	<1.89	<9.43
CRS-OW416L	12/19/2013	490-43206-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW416L	12/19/2013	490-43206-1	<9.26	<9.26	<9.26	<23.1	<9.26	<9.26	<9.26	<9.26	<9.26	<9.26	<9.26	<9.26	<23.1	<1.85	<1.85	<1.85	<46.3	<1.85	<1.85	<1.85	<1.85	<1.85	<9.26
CRS-OW416L	12/19/2013	490-43206-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW416L	4/16/2014	490-51116-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW416L	4/16/2014	490-51116-1	<9.62	<9.62	<9.62	<24	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62	<24	<1.92	<1.92	<1.92	<48.1	<1.92	<1.92	<1.92	<1.92	<1.92	<9.62
CRS-OW416L	8/18/2014	490-59654-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW416L	8/18/2014	490-59654-1	<9.43	<9.43	<9.43	<23.6	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43	<23.6	<1.89	<1.89	<1.89	<47.2	<1.89	<1.89	<1.89	<1.89	<1.89	<9.43
CRS-OW416L	11/6/2014	490-65718-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW416L	11/6/2014	490-65718-1	<9.09	<9.09	<9.09	<22.7	<9.09	<9.09	<9.09	<9.09	<9.09	<9.09	<9.09	<9.09	<22.7	<1.82	<1.82	<1.82	<45.5	<1.82	<1.82	<1.82	<1.82	<1.82	<9.09
CRS-OW416U	12/18/2013	490-43060-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW416U	12/18/2013	490-43060-1	<8.93	<8.93	<8.93	<22.3	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93	<22.3	<1.79	<1.79	<1.79	<44.6	<1.79	<1.79	<1.79	<1.79	<1.79	<8.93
CRS-OW416U	4/15/2014	490-51008-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW416U	4/15/2014	490-51008-1	<10.4	<10.4	<10.4	<26	<10.4	<10.4	<10.4	<10.4	<10.4	<10.4	<10.4	<10.4	<26	<2.08	<2.08	<2.08	<52.1	<2.08	<2.08	<2.08	<2.08	<2.08	<10.4
CRS-OW416U	8/22/2014	490-60044-1	<9.43	<9.43	<9.43	<23.6	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43	<23.6	<1.89	<1.89	<1.89	<47.2	<1.89	<1.89	<1.89	<1.89	<1.89	<9.43
CRS-OW416U	11/5/2014	490-65583-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW416U	11/5/2014	490-65583-1	<9.62	<9.62	<9.62	<24	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62	<24	<1.92	<1.92	<1.92	<48.1	<1.92	<1.92	<1.92	<1.92	<1.92	<9.62
CRS-OW416U	11/5/2014	490-65592-1	<9.62	<9.62	<9.62	<24	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62	<24	<1.92	<1.92	<1.92	<48.1	<1.92	<1.92	<1.92	<1.92	<1.92	<9.62
CRS-OW418L	12/19/2013	490-43197-1	<8.62	<8.62	<8.62	<21.6	<8.62	<8.62	<8.62	<8.62	<8.62	<8.62	<8.62	<8.62	<21.6	<1.72	<1.72	<1.72	<43.1	<1.72	<1.72	<1.72	<1.72	<1.72	<8.62

Table 2.3-D (Sheet 12 of 25)
Detailed Analytes

Well ID	Sample Date	Lab Report ID	SEMIVOLATILE ORGANIC COMPOUNDS (ug/L)																						
			2,4,6-Tri-chloro-phenol	2,4-Di-chloro-phenol	2,4-Di-methylp henol	2,4-Di-nitro-phenol	2,4-Di-nitro-toluene	2,6-Dinitro-toluene	2-Chloro-naph-thalene	2-Chloro phenol	2-Nitro-phenol	3,3'-Dichloro-benzidine	4-Bromo-phenyl Phenyl Ether	4-Chloro-phenyl Phenyl Ether	4-Nitro-phenol	Acenph-thene	Acenaph-thylene	Anth-racene	Ben-zidine	Benzo(a) anthracene	Benzo(B) fluor anthene	Benzo (ghi) perylene	Benzo(K) fluor anthene	Benzo-a-pyrene	Bis (2-Chloro-ethoxy) Methylene
CRS-OW418L	12/19/2013	490-43197-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW418L	12/19/2013	490-43197-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW418L	4/16/2014	490-51124-1	<8.77	<8.77	<8.77	<21.9	<8.77	<8.77	<8.77	<8.77	<8.77	<8.77	<8.77	<8.77	<21.9	<1.75	<1.75	<1.75	<43.9	<1.75	<1.75	<1.75	<1.75	<1.75	<8.77
CRS-OW418L	4/16/2014	490-51124-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW418L	8/18/2014	490-59650-1	<9.62	<9.62	<9.62	<24	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62	<24	<1.92	<1.92	<1.92	<48.1	<1.92	<1.92	<1.92	<1.92	<1.92	<9.62
CRS-OW418L	8/18/2014	490-59650-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW418L	11/12/2014	490-66157-1	<9.43	<9.43	<9.43	<23.6	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43	<23.6	<1.89	<1.89	<1.89	<47.2	<1.89	<1.89	<1.89	<1.89	<1.89	<9.43
CRS-OW418L	11/12/2014	490-66157-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW418U	12/18/2013	490-43053-1	<8.93	<8.93	<8.93	<22.3	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93	<22.3	<1.79	<1.79	<1.79	<44.6	<1.79	<1.79	<1.79	<1.79	<1.79	<8.93
CRS-OW418U	12/18/2013	490-43053-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW418U	4/15/2014	490-50993-1	<9.26	<9.26	<9.26	<23.1	<9.26	<9.26	<9.26	<9.26	<9.26	<9.26	<9.26	<9.26	<23.1	<1.85	<1.85	<1.85	<46.3	<1.85	<1.85	<1.85	<1.85	<1.85	<9.26
CRS-OW418U	8/19/2014	490-59748-1	<9.43	<9.43	<9.43	<23.6	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43	<23.6	<1.89	<1.89	<1.89	<47.2	<1.89	<1.89	<1.89	<1.89	<1.89	<9.43
CRS-OW418U	8/19/2014	490-59748-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW418U	11/7/2014	490-65801-1	<9.43	<9.43	<9.43	<23.6	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43	<23.6	<1.89	<1.89	<1.89	<47.2	<1.89	<1.89	<1.89	<1.89	<1.89	<9.43
CRS-OW418U	11/7/2014	490-65801-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW419L	1/6/2014	490-44045-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW419L	1/8/2014	490-44045-1	<8.77	<8.77	<8.77	<21.9	<8.77	<8.77	<8.77	<8.77	<8.77	<8.77	<8.77	<8.77	<21.9	<1.75	<1.75	<1.75	<43.9	<1.75	<1.75	<1.75	<1.75	<1.75	<8.77
CRS-OW419L	4/24/2014	490-51664-1	<9.62	<9.62	<9.62	<24	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62	<24	<1.92	<1.92	<1.92	<48.1	<1.92	<1.92	<1.92	<1.92	<1.92	<9.62
CRS-OW419L	4/24/2014	490-51664-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW419L	8/26/2014	490-60223-1	<9.09	<9.09	<9.09	<22.7	<9.09	<9.09	<9.09	<9.09	<9.09	<9.09	<9.09	<9.09	<22.7	<1.82	<1.82	<1.82	<45.5	<1.82	<1.82	<1.82	<1.82	<1.82	<9.09
CRS-OW419L	8/26/2014	490-60223-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW419L	11/12/2014	490-66161-1	<9.43	<9.43	<9.43	<23.6	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43	<23.6	<1.89	<1.89	<1.89	<47.2	<1.89	<1.89	<1.89	<1.89	<1.89	<9.43
CRS-OW419U	12/20/2013	490-43281-1	<8.33	<8.33	<8.33	<20.8	<8.33	<8.33	<8.33	<8.33	<8.33	<8.33	<8.33	<8.33	<20.8	<1.67	<1.67	<1.67	<41.7	<1.67	<1.67	<1.67	<1.67	<1.67	<8.33
CRS-OW419U	12/20/2013	490-43281-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW419U	4/23/2014	490-51552-1	<8.77	<8.77	<8.77	<21.9	<8.77	<8.77	<8.77	<8.77	<8.77	<8.77	<8.77	<8.77	<21.9	<1.75	<1.75	<1.75	<43.9	<1.75	<1.75	<1.75	<1.75	<1.75	<8.77
CRS-OW419U	4/23/2014	490-51552-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW419U	8/18/2014	490-59664-1	<9.62	<9.62	<9.62	<24	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62	<24	<1.92	<1.92	<1.92	<48.1	<1.92	<1.92	<1.92	<1.92	<1.92	<9.62
CRS-OW419U	11/4/2014	490-65428-1	<9.62	<9.62	<9.62	<24	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62	<24	<1.92	<1.92	<1.92	<48.1	<1.92	<1.92	<1.92	<1.92	<1.92	<9.62
CRS-OW420L	12/10/2013	490-42325-1	<8.93	<8.93	<8.93	<22.3	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93	<22.3	<1.79	<1.79	<1.79	<44.6	<1.79	<1.79	<1.79	<1.79	<1.79	<8.93
CRS-OW420L	12/10/2013	490-42325-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW420L	4/17/2014	490-51210-1	<10	<10	<10	<25	<10	<10	<10	<10	<10	<10	<10	<10	<25	<2	<2	<2	<50	<2	<2	<2	<2	<2	<10
CRS-OW420L	4/17/2014	490-51210-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW420L	8/26/2014	490-60209-1	<9.26	<9.26	<9.26	<23.1	<9.26	<9.26	<9.26	<9.26	<9.26	<9.26	<9.26	<9.26	<23.1	<1.85	<1.85	<1.85	<46.3	<1.85	<1.85	<1.85	<1.85	<1.85	<9.26
CRS-OW420L	8/26/2014	490-60209-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW420L	11/6/2014	490-65714-1	<9.43	<9.43	<9.43	<23.6	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43	<23.6	<1.89	<1.89	<1.89	<47.2	<1.89	<1.89	<1.89	<1.89	<1.89	<9.43
CRS-OW420L	11/6/2014	490-65714-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW420U	12/12/2013	490-42580-1	<8.93	<8.93	<8.93	<22.3	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93	<22.3	<1.79	<1.79	<1.79	<44.6	<1.79	<1.79	<1.79	<1.79	<1.79	<8.93
CRS-OW420U	4/16/2014	490-51107-1	<10	<10	<10	<25	<10	<10	<10	<10	<10	<10	<10	<10	<25	<2	<2	<2	<50	<2	<2	<2	<2	<2	<10
CRS-OW420U	8/26/2014	490-60217-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW421D	1/9/2014	490-44157-1	<8.93	<8.93	<8.93	<22.3	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93	<22.3	<1.79	<1.79	<1.79	<44.6	<1.79	<1.79	<1.79	<1.79	<1.79	<8.93
CRS-OW421D	4/21/2014	490-51368-1	<9.26	<9.26	<9.26	<23.1	<9.26	<9.26	<9.26	<9.26	<9.26	<9.26	<9.26	<9.26	<23.1	<1.85	<1.85	<1.85	<46.3	<1.85	<1.85	<1.85	<1.85	<1.85	<9.26
CRS-OW421D	8/21/2014	490-59912-1	<9.43	<9.43	<9.43	<23.6	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43	<23.6	<1.89	<1.89	<1.89	<47.2	<1.89	<1.89	<1.89	<1.89	<1.89	<9.43
CRS-OW421D	8/27/2014	490-59912-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW421D	11/12/2014	490-66145-1	<9.43	<9.43	<9.43	<23.6	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43	<23.6	<1.89	<1.89	<1.89	<47.2	<1.89	<1.89	<1.89	<1.89	<1.89	<9.43
CRS-OW421L	1/13/2014	490-44348-1	<8.93	<8.93	<8.93	<22.3	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93	<22.3	<1.79	<1.79	<1.79	<44.6	<1.79	<1.79	<1.79	<1.79	<1.79	<8.93
CRS-OW421L	1/13/2014	490-44348-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW421L	4/17/2014	490-51196-1	<9.43	<9.43	<9.43	<23.6	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43	<23.6	<1.89	<1.89	<1.89	<47.2	<1.89	<1.89	<1.89	<1.89	<1.89	<9.43
CRS-OW421L	4/17/2014	490-51196-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW421L	8/20/2014	490-59831-1	<9.26	<9.26	<9.26	<23.1	<9.26	<9.26	<9.26	<9.26	<9.26	<9.26	<9.26	<9.26	<23.1	<1.85	<1.85	<1.85	<46.3	<1.85	<1.85	<1.85	<1.85	<1.85	<9.26

Table 2.3-D (Sheet 13 of 25)
Detailed Analytes

			SEMIVOLATILE ORGANIC COMPOUNDS (ug/L)																						
Well ID	Sample Date	Lab Report ID	2,4,6-Tri-chloro-phenol	2,4-Di-chloro-phenol	2,4-Di-methylphenol	2,4-Di-nitro-phenol	2,4-Di-nitro-toluene	2,6-Dinitro-toluene	2-Chloro-naph-thalene	2-Chloro phenol	2-Nitro-phenol	3,3'-Dichloro-benzidine	4-Bromo-phenyl Phenyl Ether	4-Chloro-phenyl Phenyl Ether	4-Nitro-phenol	Acenph-thene	Acenaph-thylene	Anth-racene	Ben-zidine	Benzo(a) anthracene	Benzo(B) fluor anthene	Benzo (ghi) perylene	Benzo(K) fluor anthene	Benzo-a-pyrene	Bis (2-Chloro-ethoxy) Methylene
CRS-OW421L	11/12/2014	490-66149-1	<9.62	<9.62	<9.62	<24	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62	<24	<1.92	<1.92	<1.92	<48.1	<1.92	<1.92	<1.92	<1.92	<1.92	<9.62
CRS-OW421U	12/17/2013	490-42941-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW421U	12/17/2013	490-42941-1	<8.93	<8.93	<8.93	<22.3	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93	<22.3	<1.79	<1.79	<1.79	<44.6	<1.79	<1.79	<1.79	<1.79	<1.79	<8.93
CRS-OW421U	4/18/2014	490-51291-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW421U	4/18/2014	490-51291-1	<8.93	<8.93	<8.93	<22.3	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93	<22.3	<1.79	<1.79	<1.79	<44.6	<1.79	<1.79	<1.79	<1.79	<1.79	<8.93
CRS-OW421U	8/27/2014	490-60305-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW421U	8/27/2014	490-60305-1	<9.43	<9.43	<9.43	<23.6	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43	<23.6	<1.89	<1.89	<1.89	<47.2	<1.89	<1.89	<1.89	<1.89	<1.89	<9.43
CRS-OW421U	11/7/2014	490-65803-1	<9.62	<9.62	<9.62	<24	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62	<24	<1.92	<1.92	<1.92	<48.1	<1.92	<1.92	<1.92	<1.92	<1.92	<9.62
CRS-OW421U	11/7/2014	490-65803-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW422	4/2/2014	490-49943-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW422D	1/16/2014	490-44692-1	<8.93	<8.93	<8.93	<22.3	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93	<22.3	<1.79	<1.79	<1.79	<44.6	<1.79	<1.79	<1.79	<1.79	<1.79	<8.93
CRS-OW428D	12/17/2013	490-42947-1	<8.93	<8.93	<8.93	<22.3	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93	<22.3	<1.79	<1.79	<1.79	<44.6	<1.79	<1.79	<1.79	<1.79	<1.79	<8.93
CRS-OW428D	12/17/2013	490-42947-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428D	4/22/2014	490-51441-1	<10	<10	<10	<25	<10	<10	<10	<10	<10	<10	<10	<10	<25	<2	<2	<2	<50	<2	<2	<2	<2	<2	<10
CRS-OW428D	4/22/2014	490-51441-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428D	8/20/2014	490-59832-1	<9.62	<9.62	<9.62	<24	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62	<24	<1.92	<1.92	<1.92	<48.1	<1.92	<1.92	<1.92	<1.92	<1.92	<9.62
CRS-OW428D	8/20/2014	490-59832-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428D	11/6/2014	490-65712-1	<9.62	<9.62	<9.62	<24	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62	<24	<1.92	<1.92	<1.92	<48.1	<1.92	<1.92	<1.92	<1.92	<1.92	<9.62
CRS-OW428L	12/16/2013	490-42801-1	<8.93	<8.93	<8.93	<22.3	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93	<22.3	<1.79	<1.79	<1.79	<44.6	<1.79	<1.79	<1.79	<1.79	<1.79	<8.93
CRS-OW428L	12/16/2013	490-42801-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428L	4/18/2014	490-51286-1	<9.43	<9.43	<9.43	<23.6	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43	<23.6	<1.89	<1.89	<1.89	<47.2	<1.89	<1.89	<1.89	<1.89	<1.89	<9.43
CRS-OW428L	4/18/2014	490-51286-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428L	8/22/2014	490-60048-1	<9.62	<9.62	<9.62	<24	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62	<24	<1.92	<1.92	<1.92	<48.1	<1.92	<1.92	<1.92	<1.92	<1.92	<9.62
CRS-OW428L	8/22/2014	490-60048-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428L	11/5/2014	490-65575-1	<9.62	<9.62	<9.62	<24	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62	<24	<1.92	<1.92	<1.92	<48.1	<1.92	<1.92	<1.92	<1.92	<1.92	<9.62
CRS-OW428L	11/5/2014	490-65575-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428U	12/16/2013	490-42809-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428U	12/16/2013	490-42809-1	<8.93	<8.93	<8.93	<22.3	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93	<22.3	<1.79	<1.79	<1.79	<44.6	<1.79	<1.79	<1.79	<1.79	<1.79	<8.93
CRS-OW428U	4/17/2014	490-51204-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428U	4/17/2014	490-51204-1	<9.62	<9.62	<9.62	<24	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62	<24	<1.92	<1.92	<1.92	<48.1	<1.92	<1.92	<1.92	<1.92	<1.92	<9.62
CRS-OW428U	8/21/2014	490-59917-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428U	8/21/2014	490-59917-1	<9.26	<9.26	<9.26	<23.1	<9.26	<9.26	<9.26	<9.26	<9.26	<9.26	<9.26	<9.26	<23.1	<1.85	<1.85	<1.85	<46.3	<1.85	<1.85	<1.85	<1.85	<1.85	<9.26
CRS-OW428U	11/6/2014	490-65716-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428U	11/6/2014	490-65716-1	<9.26	<9.26	<9.26	<23.1	<9.26	<9.26	<9.26	<9.26	<9.26	<9.26	<9.26	<9.26	<23.1	<1.85	<1.85	<1.85	<46.3	<1.85	<1.85	<1.85	<1.85	<1.85	<9.26
CRS-OW429L	4/24/2014	490-51678-1	<10	<10	<10	<25	<10	<10	<10	<10	<10	<10	<10	<10	<25	<2	<2	<2	<50	<2	<2	<2	<2	<2	<10
CRS-OW429U	12/18/2013	490-43067-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW429U	12/18/2013	490-43067-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW429U	12/19/2013	490-43227-1	<8.62	<8.62	<8.62	<21.6	<8.62	<8.62	<8.62	<8.62	<8.62	<8.62	<8.62	<8.62	<21.6	<1.72	<1.72	<1.72	<43.1	<1.72	<1.72	<1.72	<1.72	<1.72	<8.62
CRS-OW429U	12/19/2013	490-43227-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW429U	12/20/2013	490-43274-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW429U	12/20/2013	490-43274-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW429U	4/22/2014	490-51453-1	<10	<10	<10	<25	<10	<10	<10	<10	<10	<10	<10	<10	<25	<2	<2	<2	<50	<2	<2	<2	<2	<2	<10
CRS-OW429U	4/22/2014	490-51453-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW429U	8/25/2014	490-60164-1	<9.26	<9.26	<9.26	<23.1	<9.26	<9.26	<9.26	<9.26	<9.26	<9.26	<9.26	<9.26	<23.1	<1.85	<1.85	<1.85	<46.3	<1.85	<1.85	<1.85	<1.85	<1.85	<9.26
CRS-OW429U	8/25/2014	490-60164-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW429U	11/11/2014	490-66027-1	<9.8	<9.8	<9.8	<24.5	<9.8	<9.8	<9.8	<9.8	<9.8	<9.8	<9.8	<9.8	<24.5	<1.96	<1.96	<1.96	<49	<1.96	<1.96	<1.96	<1.96	<1.96	<9.8
CRS-OW429U	11/11/2014	490-66027-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2.3-D (Sheet 14 of 25)
Detailed Analytes

Well ID	Sample Date	Lab Report ID	SEMIVOLATILE ORGANIC COMPOUNDS (ug/L)																							
			Bis (2-Chloro iso propyl) Ethylene	Bis(2-Ethyl hexyl) Phthalate	Bis (chloro methyl) ether	Chry sene	Di ethyl Phthalate	Di methyl Phthalate	Di-n-Butyl Phthalate	Di-n-Octyl Phthalate	DNOC (4,6-Dinitro-Ortho-Cresol)	Fluor anthene	Fluorene	Hexa chloro benzene	Hexa chloro butadiene	Hexa chloro cyclo penta diene	Hexa chloro ethane	Indeno (1,2,3-cd) Pyrene	Iso phorone	Naphthal ene	N-Butyl Benzyl Phthalate	Nitro benzene	Nitro sodi methyl amine, n-	N-nitro sodi-n-propy lamine	N-nitro sodi pheny lamine	Para-chlorom eta Cresol
Values from 2016 EPA RSLs MCL Ref.			NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	1	NA	50	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
CRS-OW401D	1/10/2014	490-44246-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401D	1/10/2014	490-44246-1	<8.93	<8.93	<8.93	<1.79	<8.93	<8.93	<8.93	<8.93	<22.3	<1.79	<1.79	<8.93	<8.93	<8.93	<8.93	<1.79	<8.93	<1.79	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93
CRS-OW401D	4/22/2014	490-51531-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401D	4/23/2014	490-51531-1	<9.62	<9.62	<9.62	<1.92	<9.62	<9.62	<9.62	<9.62	<24	<1.92	<1.92	<9.62	<9.62	<9.62	<9.62	<1.92	<9.62	<1.92	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62
CRS-OW401D	8/25/2014	490-60159-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401D	8/25/2014	490-60159-1	<9.09	<9.09	<9.09	<1.82	<9.09	<9.09	<9.09	<9.09	<22.7	<1.82	<1.82	<9.09	<9.09	<9.09	<9.09	<1.82	<9.09	<1.82	<9.09	<9.09	<9.09	<9.09	<9.09	<9.09
CRS-OW401D	11/5/2014	490-65588-1	<9.62	14	<9.62	<1.92	<9.62	<9.62	<9.62	<9.62	<24	<1.92	<1.92	<9.62	<9.62	<9.62	<9.62	<1.92	<9.62	<1.92	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62
CRS-OW401D	11/5/2014	490-65588-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401L	12/12/2013	490-42566-1	<8.93	20.7	<8.93	<1.79	<8.93	<8.93	<8.93	<8.93	<22.3	<1.79	<1.79	<8.93	<8.93	<8.93	<8.93	<1.79	<8.93	<1.79	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93
CRS-OW401L	4/21/2014	490-51372-1	<9.62	<9.62	<9.62	<1.92	<9.62	<9.62	<9.62	<9.62	<24	<1.92	<1.92	<9.62	<9.62	<9.62	<9.62	<1.92	<9.62	<1.92	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62
CRS-OW401L	4/21/2014	490-51372-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401L	8/27/2014	490-60308-1	<9.62	<9.62	<9.62	<1.92	<9.62	<9.62	<9.62	<9.62	<24	<1.92	<1.92	<9.62	<9.62	<9.62	<9.62	<1.92	<9.62	7	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62
CRS-OW401L	8/27/2014	490-60308-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401L	11/10/2014	490-65956-1	<9.43	<9.43	<9.43	<1.89	<9.43	<9.43	<9.43	<9.43	<23.6	<1.89	<1.89	<9.43	<9.43	<9.43	<9.43	<1.89	<9.43	<1.89	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43
CRS-OW401L	11/10/2014	490-65956-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401U	12/10/2013	490-42335-1	<8.93	99	<8.93	<1.79	<8.93	<8.93	<8.93	<8.93	<22.3	<1.79	<1.79	<8.93	<8.93	<8.93	<8.93	<1.79	<8.93	<1.79	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93
CRS-OW401U	4/18/2014	490-51285-1	<9.62	<9.62	<9.62	<1.92	<9.62	<9.62	<9.62	<9.62	<24	<1.92	<1.92	<9.62	<9.62	<9.62	<9.62	<1.92	<9.62	<1.92	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62
CRS-OW401U	4/18/2014	490-51285-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401U	8/27/2014	490-60310-1	<9.43	<9.43	<9.43	<1.89	<9.43	<9.43	<9.43	<9.43	<23.6	<1.89	<1.89	<9.43	<9.43	<9.43	<9.43	<1.89	<9.43	<1.89	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43
CRS-OW401U	8/27/2014	490-60310-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401U	11/10/2014	490-65960-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401U	11/10/2014	490-65960-1	<9.43	<9.43	<9.43	<1.89	<9.43	<9.43	<9.43	<9.43	<23.6	<1.89	<1.89	<9.43	<9.43	<9.43	<9.43	<1.89	<9.43	<1.89	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43
CRS-OW415L	1/9/2014	490-44141-1	<8.93	<8.93	<8.93	<1.79	<8.93	<8.93	<8.93	<8.93	<22.3	<1.79	<1.79	<8.93	<8.93	<8.93	<8.93	<1.79	<8.93	<1.79	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93
CRS-OW415L	4/23/2014	490-51557-1	<10	<10	<10	<2	<10	<10	<10	<10	<25	<2	<2	<10	<10	<10	<10	<2	<10	<2	<10	<10	<10	<10	<10	<10
CRS-OW415L	8/20/2014	490-59827-1	<9.8	<9.8	<9.8	<1.96	<9.8	<9.8	<9.8	<9.8	<24.5	<1.96	<1.96	<9.8	<9.8	<9.8	<9.8	<1.96	<9.8	<1.96	<9.8	<9.8	<9.8	<9.8	<9.8	<9.8
CRS-OW415L	11/11/2014	490-66031-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW415U	12/17/2013	490-42946-1	<8.93	<8.93	<8.93	<1.79	<8.93	<8.93	<8.93	<8.93	<22.3	<1.79	<1.79	<8.93	<8.93	<8.93	<8.93	<1.79	<8.93	<1.79	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93
CRS-OW415U	4/21/2014	490-51380-1	<9.26	<9.26	<9.26	<1.85	<9.26	<9.26	<9.26	<9.26	<23.1	<1.85	<1.85	<9.26	<9.26	<9.26	<9.26	<1.85	<9.26	<1.85	<9.26	<9.26	<9.26	<9.26	<9.26	<9.26
CRS-OW415U	8/19/2014	490-59741-1	<9.43	<9.43	<9.43	<1.89	<9.43	<9.43	<9.43	<9.43	<23.6	<1.89	<1.89	<9.43	<9.43	<9.43	<9.43	<1.89	<9.43	<1.89	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43
CRS-OW415U	11/11/2014	490-66017-1	<9.43	<9.43	<9.43	<1.89	<9.43	<9.43	<9.43	<9.43	<23.6	<1.89	<1.89	<9.43	<9.43	<9.43	<9.43	<1.89	<9.43	<1.89	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43
CRS-OW416L	12/19/2013	490-43206-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW416L	12/19/2013	490-43206-1	<9.26	<9.26	<9.26	<1.85	<9.26	<9.26	<9.26	<9.26	<23.1	<1.85	<1.85	<9.26	<9.26	<9.26	<9.26	<1.85	<9.26	<1.85	<9.26	<9.26	<9.26	<9.26	<9.26	<9.26
CRS-OW416L	12/19/2013	490-43206-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW416L	4/16/2014	490-51116-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW416L	4/16/2014	490-51116-1	<9.62	12.2	<9.62	<1.92	<9.62	<9.62	<9.62	<9.62	<24	<1.92	<1.92	<9.62	<9.62	<9.62	<9.62	<1.92	<9.62	<1.92	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62
CRS-OW416L	8/18/2014	490-59654-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW416L	8/18/2014	490-59654-1	<9.43	<9.43	<9.43	<1.89	<9.43	<9.43	<9.43	<9.43	<23.6	<1.89	<1.89	<9.43	<9.43	<9.43	<9.43	<1.89	<9.43	41	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43
CRS-OW416L	11/6/2014	490-65718-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW416L	11/6/2014	490-65718-1	<9.09	10.6	<9.09	<1.82	<9.09	<9.09	<9.09	<9.09	<22.7	<1.82	<1.82	<9.09	<9.09	<9.09	<9.09	<1.82	<9.09	<1.82	<9.09	<9.09	<9.09	<9.09	<9.09	<9.09
CRS-OW416U	12/18/2013	490-43060-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW416U	12/18/2013	490-43060-1	<8.93	<8.93	<8.93	<1.79	<8.93	<8.93	<8.93	<8.93	<22.3	<1.79	<1.79	<8.93	<8.93	<8.93	<8.93	<1.79	<8.93	<1.79	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93
CRS-OW416U	4/15/2014	490-51008-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW416U	4/15/2014	490-51008-1	<10.4	6.27	<10.4	<2.08	<10.4	<10.4	<10.4	<10.4	<26	<2.08	<2.08	<10.4	<10.4	<10.4	<10.4	<2.08	<10.4	<2.08	<10.4	<10.4	<10.4	<10.4	<10.4	<10.4
CRS-OW416U	8/22/2014	490-60044-1	<9.43	<9.43	<9.43	<1.89	<9.43	<9.43	<9.43	<9.43	<23.6	<1.89	<1.89	<9.43	<9.43	<9.43	<9.43	<1.89	<9.43	<1.89	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43
CRS-OW416U	11/5/2014	490-65583-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW416U	11/5/2014	490-65583-1	<9.62	<9.62	<9.62	<1.92	<9.62	<9.62	<9.62	<9.62	<24	<1.92	<1.92	<9.62	<9.62	<9.62	<9.62	<1.92	<9.62	<1.92	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62
CRS-OW416U	11/5/2014	490-65592-1	<9.62	<9.62	<9.62	<1.92	<9.62	<9.62	<9.62	<9.62	<24	<1.92	<1.92	<9.62	<9.62	<9.62	<9.62	<1.92	<9.62	<1.92	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62
CRS-OW418L	12/19/2013	490-43197-1	<8.62	<8.62	<8.62	<1.72	<8.62	<8.62	<8.62	<8.62	<21.6	<1.72	<1.72	<8.62	<8.62	<8.62	<8.62	<1.72	<8.62	<1.72	<8.62	<8.62	<8.62	<8.62	<8.62	<8.62

Table 2.3-D (Sheet 15 of 25)
Detailed Analytes

			SEMIVOLATILE ORGANIC COMPOUNDS (ug/L)																							
Well ID	Sample Date	Lab Report ID	Bis (2-Chloro iso propyl) Ethylene	Bis(2-Ethyl hexyl) Phthalate	Bis (chloro methyl) ether	Chry sene	Di ethyl Phthalate	Di methyl Phthalate	Di-n-Butyl Phthalate	Di-n-Octyl Phthalate	DNOC (4,6-Dinitro-Ortho-Cresol)	Fluor anthene	Fluorene	Hexa chloro benzene	Hexa chloro butadiene	Hexa chloro cyclo penta diene	Hexa chloro ethane	Indeno (1,2,3-cd) Pyrene	Iso phorone	Naphthal ene	N-Butyl Benzyl Phthalate	Nitro benzene	Nitro sodi methyl amine, n-	N-nitro sodi-n-propy lamine	N-nitro sodi pheny lamine	Para-chlorom eta Cresol
CRS-OW418L	12/19/2013	490-43197-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW418L	12/19/2013	490-43197-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW418L	4/16/2014	490-51124-1	<8.77	11.2	<8.77	<1.75	<8.77	<8.77	<8.77	<8.77	<21.9	<1.75	<1.75	<8.77	<8.77	<8.77	<8.77	<1.75	<8.77	<1.75	<8.77	<8.77	<8.77	<8.77	<8.77	<8.77
CRS-OW418L	4/16/2014	490-51124-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW418L	8/18/2014	490-59650-1	<9.62	<9.62	<9.62	<1.92	<9.62	<9.62	<9.62	<9.62	<24	<1.92	<1.92	<9.62	<9.62	<9.62	<9.62	<1.92	<9.62	<1.92	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62
CRS-OW418L	8/18/2014	490-59650-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW418L	11/12/2014	490-66157-1	<9.43	9.47	<9.43	<1.89	<9.43	<9.43	<9.43	<9.43	<23.6	<1.89	<1.89	<9.43	<9.43	<9.43	<9.43	<1.89	<9.43	<1.89	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43
CRS-OW418L	11/12/2014	490-66157-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW418U	12/18/2013	490-43053-1	<8.93	<8.93	<8.93	<1.79	<8.93	<8.93	<8.93	<8.93	<22.3	<1.79	<1.79	<8.93	<8.93	<8.93	<8.93	<1.79	<8.93	<1.79	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93
CRS-OW418U	12/18/2013	490-43053-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW418U	4/15/2014	490-50993-1	<9.26	7.6	<9.26	<1.85	<9.26	<9.26	<9.26	<9.26	<23.1	<1.85	<1.85	<9.26	<9.26	<9.26	<9.26	<1.85	<9.26	<1.85	<9.26	<9.26	<9.26	<9.26	<9.26	<9.26
CRS-OW418U	8/19/2014	490-59748-1	<9.43	<9.43	<9.43	<1.89	<9.43	<9.43	<9.43	<9.43	<23.6	<1.89	<1.89	<9.43	<9.43	<9.43	<9.43	<1.89	<9.43	<1.89	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43
CRS-OW418U	8/19/2014	490-59748-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW418U	11/7/2014	490-65801-1	<9.43	<9.43	<9.43	<1.89	<9.43	<9.43	<9.43	<9.43	<23.6	<1.89	<1.89	<9.43	<9.43	<9.43	<9.43	<1.89	<9.43	<1.89	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43
CRS-OW418U	11/7/2014	490-65801-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW419L	1/6/2014	490-44045-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW419L	1/8/2014	490-44045-1	<8.77	<8.77	<8.77	<1.75	<8.77	<8.77	<8.77	<8.77	<21.9	<1.75	<1.75	<8.77	<8.77	<8.77	<8.77	<1.75	<8.77	<1.75	<8.77	<8.77	<8.77	<8.77	<8.77	<8.77
CRS-OW419L	4/24/2014	490-51664-1	<9.62	<9.62	<9.62	<1.92	<9.62	<9.62	<9.62	<9.62	<24	<1.92	<1.92	<9.62	<9.62	<9.62	<9.62	<1.92	<9.62	<1.92	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62
CRS-OW419L	4/24/2014	490-51664-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW419L	8/26/2014	490-60223-1	<9.09	<9.09	<9.09	<1.82	<9.09	<9.09	<9.09	<9.09	<22.7	<1.82	<1.82	<9.09	<9.09	<9.09	<9.09	<1.82	<9.09	<1.82	<9.09	<9.09	<9.09	<9.09	<9.09	<9.09
CRS-OW419L	8/26/2014	490-60223-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW419L	11/12/2014	490-66161-1	<9.43	<9.43	<9.43	<1.89	<9.43	<9.43	<9.43	<9.43	<23.6	<1.89	<1.89	<9.43	<9.43	<9.43	<9.43	<1.89	<9.43	<1.89	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43
CRS-OW419U	12/20/2013	490-43281-1	<8.33	<8.33	<8.33	<1.67	<8.33	<8.33	<8.33	<8.33	<20.8	<1.67	<1.67	<8.33	<8.33	<8.33	<8.33	<1.67	<8.33	<1.67	<8.33	<8.33	<8.33	<8.33	<8.33	<8.33
CRS-OW419U	12/20/2013	490-43281-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW419U	4/23/2014	490-51552-1	<8.77	<8.77	<8.77	<1.75	<8.77	<8.77	<8.77	<8.77	<21.9	<1.75	<1.75	<8.77	<8.77	<8.77	<8.77	<1.75	<8.77	<1.75	<8.77	<8.77	<8.77	<8.77	<8.77	<8.77
CRS-OW419U	4/23/2014	490-51552-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW419U	8/18/2014	490-59664-1	<9.62	<9.62	<9.62	<1.92	<9.62	<9.62	<9.62	<9.62	<24	<1.92	<1.92	<9.62	<9.62	<9.62	<9.62	<1.92	<9.62	<1.92	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62
CRS-OW419U	11/4/2014	490-65428-1	<9.62	<9.62	<9.62	<1.92	<9.62	<9.62	<9.62	<9.62	<24	<1.92	<1.92	<9.62	<9.62	<9.62	<9.62	<1.92	<9.62	<1.92	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62
CRS-OW420L	12/10/2013	490-42325-1	<8.93	<8.93	<8.93	<1.79	<8.93	<8.93	<8.93	<8.93	<22.3	<1.79	<1.79	<8.93	<8.93	<8.93	<8.93	<1.79	<8.93	<1.79	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93
CRS-OW420L	12/10/2013	490-42325-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW420L	4/17/2014	490-51210-1	<10	<10	<10	<2	<10	<10	<10	<10	<25	<2	<2	<10	<10	<10	<10	<2	<10	<2	<10	<10	<10	<10	<10	<10
CRS-OW420L	4/17/2014	490-51210-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW420L	8/26/2014	490-60209-1	<9.26	<9.26	<9.26	<1.85	<9.26	<9.26	<9.26	<9.26	<23.1	<1.85	<1.85	<9.26	<9.26	<9.26	<9.26	<1.85	<9.26	<1.85	<9.26	<9.26	<9.26	<9.26	<9.26	<9.26
CRS-OW420L	8/26/2014	490-60209-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW420L	11/6/2014	490-65714-1	<9.43	10.3	<9.43	<1.89	<9.43	<9.43	<9.43	<9.43	<23.6	<1.89	<1.89	<9.43	<9.43	<9.43	<9.43	<1.89	<9.43	<1.89	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43
CRS-OW420L	11/6/2014	490-65714-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW420U	12/12/2013	490-42580-1	<8.93	<8.93	<8.93	<1.79	<8.93	<8.93	<8.93	<8.93	<22.3	<1.79	<1.79	<8.93	<8.93	<8.93	<8.93	<1.79	<8.93	<1.79	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93
CRS-OW420U	4/16/2014	490-51107-1	<10	17.7	<10	<2	<10	<10	<10	<10	<25	<2	<2	<10	<10	<10	<10	<2	<10	<2	<10	<10	<10	<10	<10	<10
CRS-OW420U	8/26/2014	490-60217-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW421D	1/9/2014	490-44157-1	<8.93	17.5	<8.93	<1.79	<8.93	<8.93	<8.93	<8.93	<22.3	<1.79	<1.79	<8.93	<8.93	<8.93	<8.93	<1.79	<8.93	<1.79	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93
CRS-OW421D	4/21/2014	490-51368-1	<9.26	14	<9.26	<1.85	<9.26	<9.26	<9.26	<9.26	<23.1	<1.85	<1.85	<9.26	<9.26	<9.26	<9.26	<1.85	<9.26	<1.85	<9.26	<9.26	<9.26	<9.26	<9.26	<9.26
CRS-OW421D	8/21/2014	490-59912-1	<9.43	36.2	<9.43	<1.89	<9.43	<9.43	<9.43	<9.43	<23.6	<1.89	<1.89	<9.43	<9.43	<9.43	<9.43	<1.89	<9.43	<1.89	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43
CRS-OW421D	8/27/2014	490-59912-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW421D	11/12/2014	490-66145-1	<9.43	21.2	<9.43	<1.89	<9.43	<9.43	<9.43	<9.43	<23.6	<1.89	<1.89	<9.43	<9.43	<9.43	<9.43	<1.89	<9.43	<1.89	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43
CRS-OW421L	1/13/2014	490-44348-1	<8.93	<8.93	<8.93	<1.79	<8.93	<8.93	<8.93	<8.93	<22.3	<1.79	<1.79	<8.93	<8.93	<8.93	<8.93	<1.79	<8.93	<1.79	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93
CRS-OW421L	1/13/2014	490-44348-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW421L	4/17/2014	490-51196-1	<9.43	10	<9.43	<1.89	<9.43	<9.43	<9.43	<9.43	<23.6	<1.89	<1.89	<9.43	<9.43	<9.43	<9.43	<1.89	<9.43	<1.89	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43
CRS-OW421L	4/17/2014	490-51196-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW421L	8/20/2014	490-59831-1	<9.26	<9.26	<9.26	<1.85	<9.26	<9.26	<9.26	<9.26	<23.1	<1.85	<1.85	<9.26	<9.26	<9.26	<9.26	<1.85	<9.26	<1.85	<9.26	<9.26	<9.26	<9.26	<9.26	<9.26

Table 2.3-D (Sheet 16 of 25)
Detailed Analytes

Well ID	Sample Date	Lab Report ID	SEMIVOLATILE ORGANIC COMPOUNDS (ug/L)																							
			Bis (2-Chloro iso propyl) Ethylene	Bis(2-Ethyl hexyl) Phthalate	Bis (chloro methyl) ether	Chry sene	Di ethyl Phthalate	Di methyl Phthalate	Di-n-Butyl Phthalate	Di-n-Octyl Phthalate	DNOC (4,6-Dinitro-Ortho-Cresol)	Fluor anthene	Fluorene	Hexa chloro benzene	Hexa chloro butadiene	Hexa chloro cyclo penta diene	Hexa chloro ethane	Indeno (1,2,3-cd) Pyrene	Iso phorone	Naphthal ene	N-Butyl Benzyl Phthalate	Nitro benzene	Nitro sodi methyl amine, n-	N-nitro sodi-n-propy lamine	N-nitro sodi pheny lamine	Para-chlorom eta Cresol
CRS-OW421L	11/12/2014	490-66149-1	<9.62	<9.62	<9.62	<1.92	<9.62	<9.62	<9.62	<9.62	<24	<1.92	<1.92	<9.62	<9.62	<9.62	<9.62	<1.92	<9.62	<1.92	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62
CRS-OW421U	12/17/2013	490-42941-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW421U	12/17/2013	490-42941-1	<8.93	<8.93	<8.93	<1.79	<8.93	<8.93	<8.93	<8.93	<22.3	<1.79	<1.79	<8.93	<8.93	<8.93	<8.93	<1.79	<8.93	<1.79	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93
CRS-OW421U	4/18/2014	490-51291-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW421U	4/18/2014	490-51291-1	<8.93	10.7	<8.93	<1.79	<8.93	<8.93	<8.93	<8.93	<22.3	<1.79	<1.79	<8.93	<8.93	<8.93	<8.93	<1.79	<8.93	<1.79	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93
CRS-OW421U	8/27/2014	490-60305-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW421U	8/27/2014	490-60305-1	<9.43	<9.43	<9.43	<1.89	<9.43	<9.43	<9.43	<9.43	<23.6	<1.89	<1.89	<9.43	<9.43	<9.43	<9.43	<1.89	<9.43	4	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43
CRS-OW421U	11/7/2014	490-65803-1	<9.62	<9.62	<9.62	<1.92	<9.62	<9.62	<9.62	<9.62	<24	<1.92	<1.92	<9.62	<9.62	<9.62	<9.62	<1.92	<9.62	<1.92	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62
CRS-OW421U	11/7/2014	490-65803-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW422	4/2/2014	490-49943-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW422D	1/16/2014	490-44692-1	<8.93	<8.93	<8.93	<1.79	<8.93	<8.93	<8.93	<8.93	<22.3	<1.79	<1.79	<8.93	<8.93	<8.93	<8.93	<1.79	<8.93	<1.79	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93
CRS-OW428D	12/17/2013	490-42947-1	<8.93	<8.93	<8.93	<1.79	<8.93	<8.93	<8.93	<8.93	<22.3	<1.79	<1.79	<8.93	<8.93	<8.93	<8.93	<1.79	<8.93	<1.79	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93
CRS-OW428D	12/17/2013	490-42947-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428D	4/22/2014	490-51441-1	<10	57.9	<10	<2	<10	<10	<10	<10	<25	<2	<2	<10	<10	<10	<10	<2	<10	<2	<10	<10	<10	<10	<10	<10
CRS-OW428D	4/22/2014	490-51441-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428D	8/20/2014	490-59832-1	<9.62	<9.62	<9.62	<1.92	<9.62	<9.62	<9.62	<9.62	<24	<1.92	<1.92	<9.62	<9.62	<9.62	<9.62	<1.92	<9.62	10	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62
CRS-OW428D	8/20/2014	490-59832-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428D	11/6/2014	490-65712-1	<9.62	15.1	<9.62	<1.92	<9.62	<9.62	<9.62	<9.62	<24	<1.92	<1.92	<9.62	<9.62	<9.62	<9.62	<1.92	<9.62	<1.92	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62
CRS-OW428L	12/16/2013	490-42801-1	<8.93	<8.93	<8.93	<1.79	<8.93	<8.93	<8.93	<8.93	<22.3	<1.79	<1.79	<8.93	<8.93	<8.93	<8.93	<1.79	<8.93	<1.79	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93
CRS-OW428L	12/16/2013	490-42801-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428L	4/18/2014	490-51286-1	<9.43	18.7	<9.43	<1.89	<9.43	<9.43	<9.43	<9.43	<23.6	<1.89	<1.89	<9.43	<9.43	<9.43	<9.43	<1.89	<9.43	<1.89	<9.43	<9.43	<9.43	<9.43	<9.43	<9.43
CRS-OW428L	4/18/2014	490-51286-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428L	8/22/2014	490-60048-1	<9.62	<9.62	<9.62	<1.92	<9.62	<9.62	<9.62	<9.62	<24	<1.92	<1.92	<9.62	<9.62	<9.62	<9.62	<1.92	<9.62	<1.92	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62
CRS-OW428L	8/22/2014	490-60048-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428L	11/5/2014	490-65575-1	<9.62	10.3	<9.62	<1.92	<9.62	<9.62	<9.62	<9.62	<24	<1.92	<1.92	<9.62	<9.62	<9.62	<9.62	<1.92	<9.62	<1.92	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62
CRS-OW428L	11/5/2014	490-65575-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428U	12/16/2013	490-42809-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428U	12/16/2013	490-42809-1	<8.93	<8.93	<8.93	<1.79	<8.93	<8.93	<8.93	<8.93	<22.3	<1.79	<1.79	<8.93	<8.93	<8.93	<8.93	<1.79	<8.93	<1.79	<8.93	<8.93	<8.93	<8.93	<8.93	<8.93
CRS-OW428U	4/17/2014	490-51204-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428U	4/17/2014	490-51204-1	<9.62	<9.62	<9.62	<1.92	<9.62	<9.62	<9.62	<9.62	<24	<1.92	<1.92	<9.62	<9.62	<9.62	<9.62	<1.92	<9.62	<1.92	<9.62	<9.62	<9.62	<9.62	<9.62	<9.62
CRS-OW428U	8/21/2014	490-59917-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428U	8/21/2014	490-59917-1	<9.26	<9.26	<9.26	<1.85	<9.26	<9.26	<9.26	<9.26	<23.1	<1.85	<1.85	<9.26	<9.26	<9.26	<9.26	<1.85	<9.26	<1.85	<9.26	<9.26	<9.26	<9.26	<9.26	<9.26
CRS-OW428U	11/6/2014	490-65716-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428U	11/6/2014	490-65716-1	<9.26	<9.26	<9.26	<1.85	<9.26	<9.26	<9.26	<9.26	<23.1	<1.85	<1.85	<9.26	<9.26	<9.26	<9.26	<1.85	<9.26	<1.85	<9.26	<9.26	<9.26	<9.26	<9.26	<9.26
CRS-OW429L	4/24/2014	490-51678-1	<10	<10	<10	<2	<10	<10	<10	<10	<25	<2	<2	<10	<10	<10	<10	<2	<10	<2	<10	<10	<10	<10	<10	<10
CRS-OW429U	12/18/2013	490-43067-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW429U	12/18/2013	490-43067-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW429U	12/19/2013	490-43227-1	<8.62	<8.62	<8.62	<1.72	<8.62	<8.62	<8.62	<8.62	<21.6	<1.72	<1.72	<8.62	<8.62	<8.62	<8.62	<1.72	<8.62	<1.72	<8.62	<8.62	<8.62	<8.62	<8.62	<8.62
CRS-OW429U	12/19/2013	490-43227-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW429U	12/20/2013	490-43274-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW429U	12/20/2013	490-43274-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW429U	4/22/2014	490-51453-1	<10	<10	<10	<2	<10	<10	<10	<10	<25	<2	<2	<10	<10	<10	<10	<2	<10	<2	<10	<10	<10	<10	<10	<10
CRS-OW429U	4/22/2014	490-51453-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW429U	8/25/2014	490-60164-1	<9.26	<9.26	<9.26	<1.85	<9.26	<9.26	<9.26	<9.26	<23.1	<1.85	<1.85	<9.26	<9.26	<9.26	<9.26	<1.85	<9.26	<1.85	<9.26	<9.26	<9.26	<9.26	<9.26	<9.26
CRS-OW429U	8/25/2014	490-60164-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW429U	11/11/2014	490-66027-1	<9.8	<9.8	<9.8	<1.96	<9.8	<9.8	<9.8	<9.8	<24.5	<1.96	<1.96	<9.8	<9.8	<9.8	<9.8	<1.96	<9.8	<1.96	<9.8	<9.8	<9.8	<9.8	<9.8	<9.8
CRS-OW429U	11/11/2014	490-66027-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2.3-D (Sheet 17 of 25)
Detailed Analytes

Well ID	Sample Date	Lab Report ID	VOLATILE ORGANIC COMPOUNDS (ug/L)																		
			1,1,1-Trichloro ethane	1,1,2,2-Tetrachloro Ethane	1,1,2-Trichloro Ethane	1,1-Dichloro ethane	1,2-Dichloro ethane	1,2-Dichloro ethylene	1,2-Dichloro Propane	2-ChloroEthyl Vinyl Ether	Acrolein	Acrylonitrile	Benzene, total	Bromo form	Bromo methane	Carbon Tetra chloride	Chloro Benzene	Chloro dibromo methane	Chloro Ethane	Chloro form	Chloro methane
Values from 2016 EPA RSLs MCL Ref.			200	NA	5	NA	5	NA	5	NA	NA	NA	NA	NA	NA	5	100	NA	NA	80	NA
CRS-OW401D	1/10/2014	490-44246-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401D	1/10/2014	490-44246-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	1.87	<1
CRS-OW401D	4/22/2014	490-51531-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401D	4/23/2014	490-51531-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	1.87	<1
CRS-OW401D	8/25/2014	490-60159-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401D	8/25/2014	490-60159-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	1.13	<1
CRS-OW401D	11/5/2014	490-65588-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	<1	<1
CRS-OW401D	11/5/2014	490-65588-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401L	12/12/2013	490-42566-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	<1	<1
CRS-OW401L	4/21/2014	490-51372-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	0.349	<1
CRS-OW401L	4/21/2014	490-51372-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401L	8/27/2014	490-60308-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	<1	<1
CRS-OW401L	8/27/2014	490-60308-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401L	11/10/2014	490-65956-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	<1	<1
CRS-OW401L	11/10/2014	490-65956-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401U	12/10/2013	490-42335-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	<1	<1
CRS-OW401U	4/18/2014	490-51285-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	<1	<1
CRS-OW401U	4/18/2014	490-51285-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401U	8/27/2014	490-60310-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	<1	<1
CRS-OW401U	8/27/2014	490-60310-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401U	11/10/2014	490-65960-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401U	11/10/2014	490-65960-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	<1	<1
CRS-OW415L	1/9/2014	490-44141-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	<1	<1
CRS-OW415L	4/23/2014	490-51557-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	<1	<1
CRS-OW415L	8/20/2014	490-59827-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	<1	<1
CRS-OW415L	11/11/2014	490-66031-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW415U	12/17/2013	490-42946-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	<1	<1
CRS-OW415U	4/21/2014	490-51380-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	0.291	<1
CRS-OW415U	8/19/2014	490-59741-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	<1	<1
CRS-OW415U	11/11/2014	490-66017-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	<1	<1
CRS-OW416L	12/19/2013	490-43206-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW416L	12/19/2013	490-43206-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	<1	<1
CRS-OW416L	12/19/2013	490-43206-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW416L	4/16/2014	490-51116-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW416L	4/16/2014	490-51116-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	0.131	<1	<1	<1	<1	<1	<1	<1	<1
CRS-OW416L	8/18/2014	490-59654-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW416L	8/18/2014	490-59654-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	<1	<1
CRS-OW416L	11/6/2014	490-65718-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW416L	11/6/2014	490-65718-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	<1	<1
CRS-OW416U	12/18/2013	490-43060-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW416U	12/18/2013	490-43060-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	<1	<1
CRS-OW416U	4/15/2014	490-51008-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW416U	4/15/2014	490-51008-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	<1	<1
CRS-OW416U	8/22/2014	490-60044-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	<1	<1
CRS-OW416U	11/5/2014	490-65583-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW416U	11/5/2014	490-65583-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	<1	<1
CRS-OW416U	11/5/2014	490-65592-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	<1	<1
CRS-OW418L	12/19/2013	490-43197-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	<1	<1
CRS-OW418L	12/19/2013	490-43197-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW418L	12/19/2013	490-43197-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2.3-D (Sheet 18 of 25)
Detailed Analytes

Well ID	Sample Date	Lab Report ID	VOLATILE ORGANIC COMPOUNDS (ug/L) 1,1,1-Trichloro ethane	1,1,2,2-Tetrachloro Ethane	1,1,2-Trichloro Ethane	1,1-Dichloro ethane	1,2-Dichloro ethane	1,2-Dichloro ethylene	1,2-Dichloro Propane	2-ChloroEthyl Vinyl Ether	Acrolein	Acrylonitrile	Benzene, total	Bromo form	Bromo methane	Carbon Tetra chloride	Chloro Benzene	Chloro dibromo methane	Chloro Ethane	Chloro form	Chloro methane
CRS-OW418L	4/16/2014	490-51124-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	<1	<1
CRS-OW418L	4/16/2014	490-51124-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW418L	8/18/2014	490-59650-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	<1	<1
CRS-OW418L	8/18/2014	490-59650-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW418L	11/12/2014	490-66157-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	<1	<1
CRS-OW418L	11/12/2014	490-66157-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW418U	12/18/2013	490-43053-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	1.78	<1
CRS-OW418U	12/18/2013	490-43053-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW418U	4/15/2014	490-50993-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	0.985	<1
CRS-OW418U	8/19/2014	490-59748-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	<1	<1
CRS-OW418U	8/19/2014	490-59748-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW418U	11/7/2014	490-65801-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	<1	<1
CRS-OW418U	11/7/2014	490-65801-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW419L	1/6/2014	490-44045-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW419L	1/8/2014	490-44045-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	<1	<1
CRS-OW419L	4/24/2014	490-51664-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	<1	<1
CRS-OW419L	4/24/2014	490-51664-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW419L	8/26/2014	490-60223-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	<1	<1
CRS-OW419L	8/26/2014	490-60223-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW419L	11/12/2014	490-66161-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	<1	<1
CRS-OW419U	12/20/2013	490-43281-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	<1	<1
CRS-OW419U	12/20/2013	490-43281-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW419U	4/23/2014	490-51552-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	<1	<1
CRS-OW419U	4/23/2014	490-51552-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW419U	8/18/2014	490-59664-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	<1	<1
CRS-OW419U	11/4/2014	490-65428-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	<1	<1
CRS-OW420L	12/10/2013	490-42325-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	1.03	<1
CRS-OW420L	12/10/2013	490-42325-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW420L	4/17/2014	490-51210-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	2	<1
CRS-OW420L	4/17/2014	490-51210-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW420L	8/26/2014	490-60209-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	<1	<1
CRS-OW420L	8/26/2014	490-60209-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW420L	11/6/2014	490-65714-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	<1	<1
CRS-OW420L	11/6/2014	490-65714-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW420U	12/12/2013	490-42580-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	<1	<1
CRS-OW420U	4/16/2014	490-51107-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	<1	<1
CRS-OW420U	8/26/2014	490-60217-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	<1	<1
CRS-OW421D	1/9/2014	490-44157-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	1.87	<1
CRS-OW421D	4/21/2014	490-51368-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	0.134	<1	<1	<1	<1	<1	<1	1.47	<1
CRS-OW421D	8/21/2014	490-59912-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	1.28	<1
CRS-OW421D	8/27/2014	490-59912-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW421D	11/12/2014	490-66145-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	<1	<1
CRS-OW421L	1/13/2014	490-44348-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	1.14	<1
CRS-OW421L	1/13/2014	490-44348-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW421L	4/17/2014	490-51196-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	1.06	<1
CRS-OW421L	4/17/2014	490-51196-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW421L	8/20/2014	490-59831-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	<1	<1
CRS-OW421L	11/12/2014	490-66149-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	<1	<1
CRS-OW421U	12/17/2013	490-42941-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW421U	12/17/2013	490-42941-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	<1	<1
CRS-OW421U	4/18/2014	490-51291-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2.3-D (Sheet 19 of 25)
Detailed Analytes

Well ID	Sample Date	Lab Report ID	VOLATILE ORGANIC COMPOUNDS (ug/L)																		
			1,1,1-Trichloro ethane	1,1,2,2-Tetrachloro Ethane	1,1,2-Trichloro Ethane	1,1-Dichloro ethane	1,2-Dichloro ethane	1,2-Dichloro ethylene	1,2-Dichloro Propane	2-ChloroEthyl Vinyl Ether	Acrolein	Acrylonitrile	Benzene, total	Bromo form	Bromo methane	Carbon Tetra chloride	Chloro Benzene	Chloro dibromo methane	Chloro Ethane	Chloro form	Chloro methane
CRS-OW421U	4/18/2014	490-51291-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	<1	<1
CRS-OW421U	8/27/2014	490-60305-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW421U	8/27/2014	490-60305-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	<1	<1
CRS-OW421U	11/7/2014	490-65803-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	<1	<1
CRS-OW421U	11/7/2014	490-65803-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW422	4/2/2014	490-49943-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW422D	1/16/2014	490-44692-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	<1	<1
CRS-OW428D	12/17/2013	490-42947-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	1.26	<1	<1	<1	<1	<1	<1	3.29	<1
CRS-OW428D	12/17/2013	490-42947-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428D	4/22/2014	490-51441-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	5.49	<1	<1	<1	<1	<1	<1	0.648	<1
CRS-OW428D	4/22/2014	490-51441-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428D	8/20/2014	490-59832-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	4.67	<1	<1	<1	<1	<1	<1	<1	<1
CRS-OW428D	8/20/2014	490-59832-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428D	11/6/2014	490-65712-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	2.82	<1	<1	<1	<1	<1	<1	<1	<1
CRS-OW428L	12/16/2013	490-42801-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	4	<1
CRS-OW428L	12/16/2013	490-42801-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428L	4/18/2014	490-51286-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	2.09	<1
CRS-OW428L	4/18/2014	490-51286-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428L	8/22/2014	490-60048-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	1.7	<1
CRS-OW428L	8/22/2014	490-60048-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428L	11/5/2014	490-65575-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	1.07	<1
CRS-OW428L	11/5/2014	490-65575-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428U	12/16/2013	490-42809-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428U	12/16/2013	490-42809-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	<1	<1
CRS-OW428U	4/17/2014	490-51204-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428U	4/17/2014	490-51204-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	<1	<1
CRS-OW428U	8/21/2014	490-59917-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428U	8/21/2014	490-59917-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	<1	<1
CRS-OW428U	11/6/2014	490-65716-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428U	11/6/2014	490-65716-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	<1	<1
CRS-OW429L	4/24/2014	490-51678-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	4.02	<1
CRS-OW429U	12/18/2013	490-43067-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	<1	<1
CRS-OW429U	12/18/2013	490-43067-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW429U	12/19/2013	490-43227-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW429U	12/19/2013	490-43227-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW429U	12/20/2013	490-43274-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW429U	12/20/2013	490-43274-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW429U	4/22/2014	490-51453-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	0.149	<1	<1	<1	<1	<1	<1	0.415	<1
CRS-OW429U	4/22/2014	490-51453-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW429U	8/25/2014	490-60164-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	<1	<1
CRS-OW429U	8/25/2014	490-60164-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW429U	11/11/2014	490-66027-1	<1	<1	<1	<1	<1	<1	<1	<5	<50	<10	<1	<1	<1	<1	<1	<1	<1	<1	<1
CRS-OW429U	11/11/2014	490-66027-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2.3-D (Sheet 20 of 25)
Detailed Analytes

									PCB (ug/L)														
Well ID	Sample Date	Lab Report ID	Hexane, n-	Methylene Chloride	Tetra chloro ethylene	Toluene	Trans-1,3-Dichloro Propene	Trichloro ethylene	PCB-1016	PCB-1221	PCB-1232	PCB-1242	PCB-1248	PCB-1254	PCB-1260	4,4'-DDD	4,4'-DDE	Aldrin	alpha-BHC	alpha-Chlordane	beta-BHC	Chlordane, gamma	DDT
Values from 2016 EPA RSLs MCL Ref.			NA	NA	NA	NA	NA	5	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
CRS-OW401D	1/10/2014	490-44246-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401D	1/10/2014	490-44246-1	<1	<5	<1	<1	<1	<1	<0.481	<0.481	<0.481	<0.481	<0.481	<0.481	<0.481	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024
CRS-OW401D	4/22/2014	490-51531-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401D	4/23/2014	490-51531-1	<1	<5	<1	1.01	<1	<1	<0.403	<0.403	<0.403	<0.403	<0.403	<0.403	<0.403	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216
CRS-OW401D	8/25/2014	490-60159-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401D	8/25/2014	490-60159-1	<1	<5	<1	<1	<1	<1	<0.417	<0.417	<0.417	<0.417	<0.417	<0.417	<0.417	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	0.0225	<0.0208	<0.0208
CRS-OW401D	11/5/2014	490-65588-1	<1	<5	<1	<1	<1	<1	<0.431	<0.431	<0.431	<0.431	<0.431	<0.431	<0.431	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216
CRS-OW401D	11/5/2014	490-65588-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401L	12/12/2013	490-42566-1	<1	<5	<1	<1	<1	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
CRS-OW401L	4/21/2014	490-51372-1	<1	<5	<1	0.166	<1	<1	<0.417	<0.417	<0.417	<0.417	<0.417	<0.417	<0.417	<0.0329	<0.0329	<0.0329	<0.0329	<0.0329	<0.0329	<0.0329	<0.0329
CRS-OW401L	4/21/2014	490-51372-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401L	8/27/2014	490-60308-1	<1	<5	<1	<1	<1	<1	<0.463	<0.463	<0.463	3.88	<0.463	<0.463	<0.463	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208
CRS-OW401L	8/27/2014	490-60308-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401L	11/10/2014	490-65956-1	<1	<5	<1	<1	<1	<1	<0.417	<0.417	<0.417	<0.417	<0.417	<0.417	<0.417	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208
CRS-OW401L	11/10/2014	490-65956-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401U	12/10/2013	490-42335-1	<1	<5	<1	<1	<1	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
CRS-OW401U	4/18/2014	490-51285-1	<1	<5	<1	<1	<1	<1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401U	4/18/2014	490-51285-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401U	8/27/2014	490-60310-1	<1	<5	<1	<1	<1	<1	<0.446	<0.446	<0.446	3.11	<0.446	<0.446	<0.446	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216
CRS-OW401U	8/27/2014	490-60310-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401U	11/10/2014	490-65960-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401U	11/10/2014	490-65960-1	<1	<5	<1	<1	<1	<1	<0.431	<0.431	<0.431	<0.431	<0.431	<0.431	<0.431	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216
CRS-OW415L	1/9/2014	490-44141-1	<1	<5	<1	<1	<1	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024
CRS-OW415L	4/23/2014	490-51557-1	<1	<5	<1	<1	<1	<1	<0.446	<0.446	<0.446	<0.446	<0.446	<0.446	<0.446	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216
CRS-OW415L	8/20/2014	490-59827-1	<1	<5	<1	<1	<1	<1	<0.446	<0.446	<0.446	<0.446	<0.446	<0.446	<0.446	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216
CRS-OW415L	11/11/2014	490-66031-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW415U	12/17/2013	490-42946-1	<1	<5	<1	<1	<1	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
CRS-OW415U	4/21/2014	490-51380-1	<1	<5	<1	<1	<1	<1	<0.417	<0.417	<0.417	0.591	<0.417	<0.417	<0.417	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208
CRS-OW415U	8/19/2014	490-59741-1	<1	<5	<1	<1	<1	<1	<0.403	<0.403	<0.403	<0.403	<0.403	<0.403	<0.403	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208
CRS-OW415U	11/11/2014	490-66017-1	<1	<5	<1	<1	<1	<1	<0.403	<0.403	<0.403	<0.403	<0.403	<0.403	<0.403	<0.0202	<0.0202	<0.0202	<0.0202	<0.0202	<0.0202	<0.0202	<0.0202
CRS-OW416L	12/19/2013	490-43206-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW416L	12/19/2013	490-43206-1	<1	<5	<1	<1	<1	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024
CRS-OW416L	12/19/2013	490-43206-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW416L	4/16/2014	490-51116-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW416L	4/16/2014	490-51116-1	<1	<5	<1	<1	<1	<1	<0.417	<0.417	<0.417	<0.417	<0.417	<0.417	<0.417	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223
CRS-OW416L	8/18/2014	490-59654-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW416L	8/18/2014	490-59654-1	<1	<5	<1	<1	<1	<1	<0.391	<0.391	<0.391	<0.391	<0.391	<0.391	<0.391	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216
CRS-OW416L	11/6/2014	490-65718-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW416L	11/6/2014	490-65718-1	<1	<5	<1	<1	<1	<1	<0.446	<0.446	<0.446	<0.446	<0.446	<0.446	<0.446	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223
CRS-OW416U	12/18/2013	490-43060-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW416U	12/18/2013	490-43060-1	<1	<5	<1	<1	<1	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024
CRS-OW416U	4/15/2014	490-51008-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW416U	4/15/2014	490-51008-1	<1	<5	<1	<1	<1	<1	<0.391	<0.391	<0.391	<0.391	<0.391	<0.391	<0.391	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223
CRS-OW416U	8/22/2014	490-60044-1	<1	<5	<1	<1	<1	<1	<0.446	<0.446	<0.446	<0.446	<0.446	<0.446	<0.446	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024
CRS-OW416U	11/5/2014	490-65583-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW416U	11/5/2014	490-65583-1	<1	<5	<1	<1	<1	<1	<0.431	<0.431	<0.431	<0.431	<0.431	<0.431	<0.431	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216
CRS-OW416U	11/5/2014	490-65592-1	<1	<5	<1	<1	<1	<1	<0.431	<0.431	<0.431	<0.431	<0.431	<0.431	<0.431	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216
CRS-OW418L	12/19/2013	490-43197-1	<1	<5	<1	<1	<1	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208
CRS-OW418L	12/19/2013	490-43197-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW418L	12/19/2013	490-43197-2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2.3-D (Sheet 21 of 25)
Detailed Analytes

Well ID	Sample Date	Lab Report ID	Hexane, n-	Methylene Chloride	Tetra chloro ethylene	Toluene	Trans-1,3-Dichloro Propene	Trichloro ethylene	PCB (ug/L) PCB-1016	PCB-1221	PCB-1232	PCB-1242	PCB-1248	PCB-1254	PCB-1260	4,4'-DDD	4,4'-DDE	Aldrin	alpha-BHC	alpha-Chlordane	beta-BHC	Chlordane, gamma	DDT
CRS-OW418L	4/16/2014	490-51124-1	<1	<5	<1	<1	<1	<1	<0.417	<0.417	<0.417	<0.417	<0.417	<0.417	<0.417	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223
CRS-OW418L	4/16/2014	490-51124-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW418L	8/18/2014	490-59650-1	<1	<5	<1	<1	<1	<1	<0.417	<0.417	<0.417	<0.417	<0.417	<0.417	<0.417	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024
CRS-OW418L	8/18/2014	490-59650-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW418L	11/12/2014	490-66157-1	<1	<5	<1	<1	<1	<1	<0.833	<0.833	<0.833	<0.833	<0.833	<0.833	<0.833	<0.0417	<0.0417	<0.0417	<0.0417	<0.0417	<0.0417	<0.0417	<0.0417
CRS-OW418L	11/12/2014	490-66157-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW418U	12/18/2013	490-43053-1	<1	<5	<1	<1	<1	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223
CRS-OW418U	12/18/2013	490-43053-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW418U	4/15/2014	490-50993-1	<1	<5	<1	<1	<1	<1	<0.391	<0.391	<0.391	<0.391	<0.391	<0.391	<0.391	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223
CRS-OW418U	8/19/2014	490-59748-1	<1	<5	<1	<1	<1	<1	<0.391	<0.391	<0.391	<0.391	<0.391	<0.391	<0.391	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223
CRS-OW418U	8/19/2014	490-59748-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW418U	11/7/2014	490-65801-1	<1	<5	<1	<1	<1	<1	<0.446	<0.446	<0.446	<0.446	<0.446	<0.446	<0.446	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223
CRS-OW418U	11/7/2014	490-65801-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW419L	1/6/2014	490-44045-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW419L	1/8/2014	490-44045-1	<1	<5	<1	<1	<1	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024
CRS-OW419L	4/24/2014	490-51664-1	<1	<5	<1	<1	<1	<1	<0.446	<0.446	<0.446	<0.446	<0.446	<0.446	<0.446	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208
CRS-OW419L	4/24/2014	490-51664-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW419L	8/26/2014	490-60223-1	<1	<5	<1	<1	<1	<1	<0.431	<0.431	<0.431	<0.431	<0.431	<0.431	<0.431	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208
CRS-OW419L	8/26/2014	490-60223-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW419L	11/12/2014	490-66161-1	<1	<5	<1	<1	<1	<1	<0.862	<0.862	<0.862	<0.862	<0.862	<0.862	<0.862	<0.0431	<0.0431	<0.0431	<0.0431	<0.0431	<0.0431	<0.0431	<0.0431
CRS-OW419U	12/20/2013	490-43281-1	<1	<5	<1	<1	<1	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208
CRS-OW419U	12/20/2013	490-43281-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW419U	4/23/2014	490-51552-1	<1	<5	<1	<1	<1	<1	<0.446	<0.446	<0.446	<0.446	<0.446	<0.446	<0.446	<0.0231	<0.0231	<0.0231	<0.0231	<0.0231	<0.0231	<0.0231	<0.0231
CRS-OW419U	4/23/2014	490-51552-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW419U	8/18/2014	490-59664-1	<1	<5	<1	<1	<1	<1	<0.417	<0.417	<0.417	<0.417	<0.417	<0.417	<0.417	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208
CRS-OW419U	11/4/2014	490-65428-1	<1	<5	<1	<1	<1	<1	<0.431	<0.431	<0.431	<0.431	<0.431	<0.431	<0.431	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216
CRS-OW420L	12/10/2013	490-42325-1	<1	<5	<1	<1	<1	<1	<0.446	<0.446	<0.446	<0.446	<0.446	<0.446	<0.446	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
CRS-OW420L	12/10/2013	490-42325-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW420L	4/17/2014	490-51210-1	<1	<5	<1	<1	<1	<1	<0.417	<0.417	<0.417	<0.417	<0.417	<0.417	<0.417	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223
CRS-OW420L	4/17/2014	490-51210-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW420L	8/26/2014	490-60209-1	<1	<5	<1	<1	<1	<1	<0.431	<0.431	<0.431	<0.431	<0.431	<0.431	<0.431	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208
CRS-OW420L	8/26/2014	490-60209-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW420L	11/6/2014	490-65714-1	<1	<5	<1	<1	<1	<1	<0.446	<0.446	<0.446	<0.446	<0.446	<0.446	<0.446	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223
CRS-OW420L	11/6/2014	490-65714-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW420U	12/12/2013	490-42580-1	<1	<5	<1	<1	<1	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.0156	<0.0156	<0.0156	<0.0156	<0.0156	<0.0156	<0.0156	<0.0156
CRS-OW420U	4/16/2014	490-51107-1	<1	<5	0.499	<1	<1	<1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW420U	8/26/2014	490-60217-1	<1	<5	<1	<1	<1	<1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW421D	1/9/2014	490-44157-1	<1	<5	<1	<1	<1	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024
CRS-OW421D	4/21/2014	490-51368-1	<1	<5	<1	0.902	<1	<1	<0.417	<0.417	<0.417	<0.417	<0.417	<0.417	<0.417	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208
CRS-OW421D	8/21/2014	490-59912-1	<1	<5	<1	<1	<1	<1	<0.446	<0.446	<0.446	<0.446	<0.446	<0.446	<0.446	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223
CRS-OW421D	8/27/2014	490-59912-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW421D	11/12/2014	490-66145-1	<1	<5	<1	<1	<1	<1	<0.862	<0.862	<0.862	<0.862	<0.862	<0.862	<0.862	<0.0431	<0.0431	<0.0431	<0.0431	<0.0431	<0.0431	<0.0431	<0.0431
CRS-OW421L	1/13/2014	490-44348-1	<1	<5	<1	<1	<1	<1	<0.481	<0.481	<0.481	<0.481	<0.481	<0.481	<0.481	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
CRS-OW421L	1/13/2014	490-44348-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW421L	4/17/2014	490-51196-1	<1	<5	<1	0.377	<1	<1	<0.417	<0.417	<0.417	<0.417	<0.417	<0.417	<0.417	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223
CRS-OW421L	4/17/2014	490-51196-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW421L	8/20/2014	490-59831-1	<1	<5	<1	<1	<1	<1	<0.446	<0.446	<0.446	<0.446	<0.446	<0.446	<0.446	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223
CRS-OW421L	11/12/2014	490-66149-1	<1	<5	<1	<1	<1	<1	<0.862	<0.862	<0.862	<0.862	<0.862	<0.862	<0.862	<0.0431	<0.0431	<0.0431	<0.0431	<0.0431	<0.0431	<0.0431	<0.0431
CRS-OW421U	12/17/2013	490-42941-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW421U	12/17/2013	490-42941-1	<1	<5	<1	<1	<1	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
CRS-OW421U	4/18/2014	490-51291-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2.3-D (Sheet 22 of 25)
Detailed Analytes

									PCB (ug/L)														
Well ID	Sample Date	Lab Report ID	Hexane, n-	Methylene Chloride	Tetra chloro ethylene	Toluene	Trans-1,3-Dichloro Propene	Trichloro ethylene	PCB-1016	PCB-1221	PCB-1232	PCB-1242	PCB-1248	PCB-1254	PCB-1260	4,4'-DDD	4,4'-DDE	Aldrin	alpha-BHC	alpha-Chlordane	beta-BHC	Chlordane, gamma	DDT
CRS-OW421U	4/18/2014	490-51291-1	<1	<5	<1	<1	<1	<1	<0.417	<0.417	<0.417	<0.417	<0.417	<0.417	<0.417	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223
CRS-OW421U	8/27/2014	490-60305-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW421U	8/27/2014	490-60305-1	<1	<5	<1	<1	<1	<1	<0.446	<0.446	<0.446	2.88	<0.446	<0.446	<0.446	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223
CRS-OW421U	11/7/2014	490-65803-1	<1	<5	<1	<1	<1	<1	<0.446	<0.446	<0.446	<0.446	<0.446	<0.446	<0.446	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223
CRS-OW421U	11/7/2014	490-65803-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW422	4/2/2014	490-49943-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW422D	1/16/2014	490-44692-1	<1	<5	<1	2.83	<1	<1	<0.446	<0.446	<0.446	<0.446	<0.446	<0.446	<0.446	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
CRS-OW428D	12/17/2013	490-42947-1	<1	<5	<1	<1	<1	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024
CRS-OW428D	12/17/2013	490-42947-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428D	4/22/2014	490-51441-1	14	0.484	<1	12.6	<1	<1	<0.417	<0.417	<0.417	<0.417	<0.417	<0.417	<0.417	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223
CRS-OW428D	4/22/2014	490-51441-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428D	8/20/2014	490-59832-1	4.19	<5	<1	8.6	<1	<1	<0.431	<0.431	<0.431	<0.431	<0.431	<0.431	<0.431	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223
CRS-OW428D	8/20/2014	490-59832-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428D	11/6/2014	490-65712-1	1.81	<5	<1	4.63	<1	<1	<0.446	<0.446	<0.446	<0.446	<0.446	<0.446	<0.446	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223
CRS-OW428L	12/16/2013	490-42801-1	<1	<5	<1	<1	<1	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
CRS-OW428L	12/16/2013	490-42801-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428L	4/18/2014	490-51286-1	<1	<5	<1	0.132	<1	<1	<0.417	<0.417	<0.417	<0.417	<0.417	<0.417	<0.417	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223
CRS-OW428L	4/18/2014	490-51286-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428L	8/22/2014	490-60048-1	<1	<5	<1	<1	<1	<1	<0.446	<0.446	<0.446	<0.446	<0.446	<0.446	<0.446	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223
CRS-OW428L	8/22/2014	490-60048-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428L	11/5/2014	490-65575-1	<1	<5	<1	<1	<1	<1	<0.446	<0.446	<0.446	<0.446	<0.446	<0.446	<0.446	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223
CRS-OW428L	11/5/2014	490-65575-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428U	12/16/2013	490-42809-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428U	12/16/2013	490-42809-1	<1	<5	<1	<1	<1	<1	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
CRS-OW428U	4/17/2014	490-51204-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428U	4/17/2014	490-51204-1	<1	<5	<1	<1	<1	<1	<0.417	<0.417	<0.417	<0.417	<0.417	<0.417	<0.417	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223
CRS-OW428U	8/21/2014	490-59917-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428U	8/21/2014	490-59917-1	<1	<5	<1	<1	<1	<1	<0.463	<0.463	<0.463	<0.463	<0.463	<0.463	<0.463	<0.0313	<0.0313	<0.0313	<0.0313	<0.0313	<0.0313	<0.0313	<0.0313
CRS-OW428U	11/6/2014	490-65716-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428U	11/6/2014	490-65716-1	<1	<5	<1	<1	<1	<1	<0.446	<0.446	<0.446	<0.446	<0.446	<0.446	<0.446	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223
CRS-OW429L	4/24/2014	490-51678-1	<1	<5	<1	<1	<1	<1	<0.481	<0.481	<0.481	<0.481	<0.481	<0.481	<0.481	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208
CRS-OW429U	12/18/2013	490-43067-1	<1	<5	<1	<1	<1	<1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW429U	12/18/2013	490-43067-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW429U	12/19/2013	490-43227-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW429U	12/19/2013	490-43227-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW429U	12/20/2013	490-43274-1	-	-	-	-	-	-	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025
CRS-OW429U	12/20/2013	490-43274-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW429U	4/22/2014	490-51453-1	<1	<5	<1	0.224	<1	<1	<0.481	<0.481	<0.481	<0.481	<0.481	<0.481	<0.481	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216
CRS-OW429U	4/22/2014	490-51453-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW429U	8/25/2014	490-60164-1	<1	<5	<1	<1	<1	<1	<0.417	<0.417	<0.417	<0.417	<0.417	<0.417	<0.417	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208
CRS-OW429U	8/25/2014	490-60164-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW429U	11/11/2014	490-66027-1	<1	<5	<1	<1	<1	<1	<0.463	<0.463	<0.463	<0.463	<0.463	<0.463	<0.463	<0.0231	<0.0231	<0.0231	<0.0231	<0.0231	<0.0231	<0.0231	<0.0231
CRS-OW429U	11/11/2014	490-66027-1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table 2.3-D (Sheet 23 of 25)
Detailed Analytes

			PCB (ug/L)												
Well ID	Sample Date	Lab Report ID	delta-BHC	Dieldrin	Endosulfan I	Endosulfan II	Endosulfan Sulfate	Endrin	Endrin Aldehyde	Endrin Ketone	gamma-BHC (Lindane)	Heptachlor	Heptachlor Epoxide	Toxaphene	Mercury, total ug/L)
Values from 2016 EPA RSLs MCL Ref.			NA	2	NA	NA	NA	2	NA	NA	0.2	0.4	0.2	3	2
CRS-OW401D	1/10/2014	490-44246-1	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401D	1/10/2014	490-44246-1	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<1.92	<0.2
CRS-OW401D	4/22/2014	490-51531-1	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401D	4/23/2014	490-51531-1	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<1.72	<0.2
CRS-OW401D	8/25/2014	490-60159-1	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401D	8/25/2014	490-60159-1	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	0.058	<0.0208	<1.67	<0.2
CRS-OW401D	11/5/2014	490-65588-1	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<1.72	<0.2
CRS-OW401D	11/5/2014	490-65588-1	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401L	12/12/2013	490-42566-1	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<2	<0.2
CRS-OW401L	4/21/2014	490-51372-1	<0.0329	<0.0329	<0.0329	<0.0329	<0.0329	<0.0329	<0.0329	<0.0329	<0.0329	<0.0329	<0.0329	<2.63	<0.2
CRS-OW401L	4/21/2014	490-51372-1	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401L	8/27/2014	490-60308-1	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<1.67	<0.2
CRS-OW401L	8/27/2014	490-60308-1	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401L	11/10/2014	490-65956-1	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<1.67	<0.2
CRS-OW401L	11/10/2014	490-65956-1	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401U	12/10/2013	490-42335-1	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<2	<0.2
CRS-OW401U	4/18/2014	490-51285-1	-	-	-	-	-	-	-	-	-	-	-	-	<0.2
CRS-OW401U	4/18/2014	490-51285-1	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401U	8/27/2014	490-60310-1	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<1.72	<0.2
CRS-OW401U	8/27/2014	490-60310-1	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401U	11/10/2014	490-65960-1	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW401U	11/10/2014	490-65960-1	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<1.72	<0.2
CRS-OW415L	1/9/2014	490-44141-1	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<1.92	<0.2
CRS-OW415L	4/23/2014	490-51557-1	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<1.72	<0.2
CRS-OW415L	8/20/2014	490-59827-1	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<1.72	<0.2
CRS-OW415L	11/11/2014	490-66031-1	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW415U	12/17/2013	490-42946-1	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<2	<0.2
CRS-OW415U	4/21/2014	490-51380-1	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<1.67	<0.2
CRS-OW415U	8/19/2014	490-59741-1	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<1.67	<0.2
CRS-OW415U	11/11/2014	490-66017-1	<0.0202	<0.0202	<0.0202	<0.0202	<0.0202	<0.0202	<0.0202	<0.0202	<0.0202	<0.0202	<0.0202	<1.61	<0.2
CRS-OW416L	12/19/2013	490-43206-1	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW416L	12/19/2013	490-43206-1	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<1.92	<0.2
CRS-OW416L	12/19/2013	490-43206-2	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW416L	4/16/2014	490-51116-1	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW416L	4/16/2014	490-51116-1	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<1.79	<0.2
CRS-OW416L	8/18/2014	490-59654-1	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW416L	8/18/2014	490-59654-1	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<1.72	<0.2
CRS-OW416L	11/6/2014	490-65718-1	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW416L	11/6/2014	490-65718-1	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<1.79	<0.2
CRS-OW416U	12/18/2013	490-43060-1	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW416U	12/18/2013	490-43060-1	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<1.92	<0.2
CRS-OW416U	4/15/2014	490-51008-1	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW416U	4/15/2014	490-51008-1	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<1.79	<0.2
CRS-OW416U	8/22/2014	490-60044-1	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<1.92	<0.2
CRS-OW416U	11/5/2014	490-65583-1	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW416U	11/5/2014	490-65583-1	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<1.72	<0.2
CRS-OW416U	11/5/2014	490-65592-1	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<1.72	<0.2
CRS-OW418L	12/19/2013	490-43197-1	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<1.67	<0.2
CRS-OW418L	12/19/2013	490-43197-1	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW418L	12/19/2013	490-43197-2	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW418L	4/16/2014	490-51124-1	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<1.79	<0.2

Table 2.3-D (Sheet 24 of 25)
Detailed Analytes

			PCB (ug/L)												
Well ID	Sample Date	Lab Report ID	delta-BHC	Dieldrin	Endosulfan I	Endosulfan II	Endosulfan Sulfate	Endrin	Endrin Aldehyde	Endrin Ketone	gamma-BHC (Lindane)	Heptachlor	Heptachlor Epoxide	Toxaphene	Mercury, total ug/L)
CRS-OW418L	4/16/2014	490-51124-1	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW418L	8/18/2014	490-59650-1	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<1.92	<0.2
CRS-OW418L	8/18/2014	490-59650-1	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW418L	11/12/2014	490-66157-1	<0.0417	<0.0417	<0.0417	<0.0417	<0.0417	<0.0417	<0.0417	<0.0417	<0.0417	<0.0417	<0.0417	<3.33	<0.2
CRS-OW418L	11/12/2014	490-66157-1	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW418U	12/18/2013	490-43053-1	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<1.79	<0.2
CRS-OW418U	12/18/2013	490-43053-1	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW418U	4/15/2014	490-50993-1	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<1.79	<0.2
CRS-OW418U	8/19/2014	490-59748-1	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<1.79	<0.2
CRS-OW418U	8/19/2014	490-59748-1	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW418U	11/7/2014	490-65801-1	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<1.79	<0.2
CRS-OW418U	11/7/2014	490-65801-1	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW419L	1/6/2014	490-44045-1	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW419L	1/8/2014	490-44045-1	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<1.92	<0.2
CRS-OW419L	4/24/2014	490-51664-1	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<1.67	<0.2
CRS-OW419L	4/24/2014	490-51664-1	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW419L	8/26/2014	490-60223-1	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<1.67	<0.2
CRS-OW419L	8/26/2014	490-60223-1	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW419L	11/12/2014	490-66161-1	<0.0431	<0.0431	<0.0431	<0.0431	<0.0431	<0.0431	<0.0431	<0.0431	<0.0431	<0.0431	<0.0431	<3.45	<0.2
CRS-OW419U	12/20/2013	490-43281-1	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<1.67	<0.2
CRS-OW419U	12/20/2013	490-43281-1	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW419U	4/23/2014	490-51552-1	<0.0231	<0.0231	<0.0231	<0.0231	<0.0231	<0.0231	<0.0231	<0.0231	<0.0231	<0.0231	<0.0231	<1.85	<0.2
CRS-OW419U	4/23/2014	490-51552-1	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW419U	8/18/2014	490-59664-1	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<1.67	<0.2
CRS-OW419U	11/4/2014	490-65428-1	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<1.72	<0.2
CRS-OW420L	12/10/2013	490-42325-1	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<2	<0.2
CRS-OW420L	12/10/2013	490-42325-1	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW420L	4/17/2014	490-51210-1	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<1.79	<0.2
CRS-OW420L	4/17/2014	490-51210-1	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW420L	8/26/2014	490-60209-1	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<1.67	<0.2
CRS-OW420L	8/26/2014	490-60209-1	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW420L	11/6/2014	490-65714-1	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<1.79	<0.2
CRS-OW420L	11/6/2014	490-65714-1	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW420U	12/12/2013	490-42580-1	<0.0156	<0.0156	<0.0156	<0.0156	<0.0156	<0.0156	<0.0156	<0.0156	<0.0156	<0.0156	<0.0156	<1.25	<0.2
CRS-OW420U	4/16/2014	490-51107-1	-	-	-	-	-	-	-	-	-	-	-	-	<0.2
CRS-OW420U	8/26/2014	490-60217-1	-	-	-	-	-	-	-	-	-	-	-	-	<0.2
CRS-OW421D	1/9/2014	490-44157-1	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<1.92	<0.2
CRS-OW421D	4/21/2014	490-51368-1	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<1.67	<0.2
CRS-OW421D	8/21/2014	490-59912-1	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<1.79	<0.2
CRS-OW421D	8/27/2014	490-59912-1	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW421D	11/12/2014	490-66145-1	<0.0431	<0.0431	<0.0431	<0.0431	<0.0431	<0.0431	<0.0431	<0.0431	<0.0431	<0.0431	<0.0431	<3.45	<0.2
CRS-OW421L	1/13/2014	490-44348-1	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<2	<0.2
CRS-OW421L	1/13/2014	490-44348-1	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW421L	4/17/2014	490-51196-1	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<1.79	<0.2
CRS-OW421L	4/17/2014	490-51196-1	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW421L	8/20/2014	490-59831-1	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<1.79	<0.2
CRS-OW421L	11/12/2014	490-66149-1	<0.0431	<0.0431	<0.0431	<0.0431	<0.0431	<0.0431	<0.0431	<0.0431	<0.0431	<0.0431	<0.0431	<3.45	<0.2
CRS-OW421U	12/17/2013	490-42941-1	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW421U	12/17/2013	490-42941-1	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<2	<0.2
CRS-OW421U	4/18/2014	490-51291-1	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW421U	4/18/2014	490-51291-1	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<1.79	<0.2

Table 2.3-D (Sheet 25 of 25)
Detailed Analytes

			PCB (ug/L)												
Well ID	Sample Date	Lab Report ID	delta-BHC	Dieldrin	Endosulfan I	Endosulfan II	Endosulfan Sulfate	Endrin	Endrin Aldehyde	Endrin Ketone	gamma-BHC (Lindane)	Heptachlor	Heptachlor Epoxide	Toxaphene	Mercury, total ug/L)
CRS-OW421U	8/27/2014	490-60305-1	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW421U	8/27/2014	490-60305-1	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<1.79	<0.2
CRS-OW421U	11/7/2014	490-65803-1	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<1.79	<0.2
CRS-OW421U	11/7/2014	490-65803-1	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW422	4/2/2014	490-49943-1	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW422D	1/16/2014	490-44692-1	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<2	<0.2
CRS-OW428D	12/17/2013	490-42947-1	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<0.024	<1.92	<0.2
CRS-OW428D	12/17/2013	490-42947-1	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428D	4/22/2014	490-51441-1	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<1.79	<0.2
CRS-OW428D	4/22/2014	490-51441-1	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428D	8/20/2014	490-59832-1	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<1.79	<0.2
CRS-OW428D	8/20/2014	490-59832-1	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428D	11/6/2014	490-65712-1	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<1.79	<0.2
CRS-OW428L	12/16/2013	490-42801-1	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<2	<0.2
CRS-OW428L	12/16/2013	490-42801-1	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428L	4/18/2014	490-51286-1	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<1.79	<0.2
CRS-OW428L	4/18/2014	490-51286-1	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428L	8/22/2014	490-60048-1	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<1.79	<0.2
CRS-OW428L	8/22/2014	490-60048-1	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428L	11/5/2014	490-65575-1	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<1.79	<0.2
CRS-OW428L	11/5/2014	490-65575-1	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428U	12/16/2013	490-42809-1	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428U	12/16/2013	490-42809-1	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<2	<0.2
CRS-OW428U	4/17/2014	490-51204-1	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428U	4/17/2014	490-51204-1	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<1.79	<0.2
CRS-OW428U	8/21/2014	490-59917-1	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428U	8/21/2014	490-59917-1	<0.0313	<0.0313	<0.0313	<0.0313	<0.0313	<0.0313	<0.0313	<0.0313	<0.0313	<0.0313	<0.0313	<2.5	<0.2
CRS-OW428U	11/6/2014	490-65716-1	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW428U	11/6/2014	490-65716-1	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<0.0223	<1.79	<0.2
CRS-OW429L	4/24/2014	490-51678-1	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<1.67	<0.2
CRS-OW429U	12/18/2013	490-43067-1	-	-	-	-	-	-	-	-	-	-	-	-	<0.2
CRS-OW429U	12/18/2013	490-43067-1	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW429U	12/19/2013	490-43227-1	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW429U	12/19/2013	490-43227-1	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW429U	12/20/2013	490-43274-1	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<0.025	<2	-
CRS-OW429U	12/20/2013	490-43274-1	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW429U	4/22/2014	490-51453-1	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<0.0216	<1.72	<0.2
CRS-OW429U	4/22/2014	490-51453-1	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW429U	8/25/2014	490-60164-1	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<0.0208	<1.67	<0.2
CRS-OW429U	8/25/2014	490-60164-1	-	-	-	-	-	-	-	-	-	-	-	-	-
CRS-OW429U	11/11/2014	490-66027-1	<0.0231	<0.0231	<0.0231	<0.0231	<0.0231	<0.0231	<0.0231	<0.0231	<0.0231	<0.0231	<0.0231	<1.85	<0.2
CRS-OW429U	11/11/2014	490-66027-1	-	-	-	-	-	-	-	-	-	-	-	-	-

Notes:
Ref. MCL reference values from January 2016 EPA RSLs.
- blank = Table D entry is blank
< = nondetected analytes
m = meters
mg/L = milligrams per liter
NA = not available
ug/L = micrograms per liter

Source: Reference 2.3-D-1. Fisher, Anna B., "Clinch River Small Modular Reactor Site - Groundwater Quality Monitoring Report - Revision 3," May 9, 2017. Table 1 and App D Table

2.4 ECOLOGY

This section describes the terrestrial, wetland, and aquatic ecology of the Clinch River Nuclear (CRN) Site and resources in the vicinity of the CRN Site that could be affected by the construction and operation of two or more small modular reactors (SMRs). Details regarding the locations of proposed facilities on the CRN Site and in offsite areas, construction activities and the areas affected, and the planned operation of facility systems, are provided in Chapter 3. Subsection 2.4.1 describes the potentially affected terrestrial resources, including wetlands, and Subsection 2.4.2 describes the potentially affected aquatic resources. Transmission lines from the facility are expected to be added within existing onsite and offsite transmission line rights-of-way (ROWs) and within a short segment of a new ROW within the CRN Site. ROWs for cooling water intake and discharge pipelines are located within the CRN Site.

2.4.1 Terrestrial Ecology

The construction and operation of two or more SMRs at the CRN Site has the potential to affect terrestrial resources occurring on and within the vicinity of the approximately 935-acre (ac) CRN Site, including upland and wetland habitats and the ecological communities they support. In addition, upland and wetland communities could be affected by construction in two offsite areas: the Barge/Traffic Area immediately northwest of the CRN Site entrance, and the approximately 5-mile (mi) segment of the existing 500-kilovolt (kV) transmission line ROW east of the CRN Site. Improvements to the barge facility, roads, and intersections are planned at the Barge/Traffic Area. Installation of a 69-kV underground transmission line is planned for the existing ROW east of the CRN Site. This subsection describes the ecological characteristics of the terrestrial resources potentially affected by the construction and operation of SMRs at the CRN Site, barge and roadway infrastructure improvements in the Barge/Traffic Area, installation of a 69-kV underground transmission line, and modifications to the existing transmission system.

2.4.1.1 Upland Habitats

2.4.1.1.1 CRN Site

The CRN Site is located within the Ridge and Valley Ecoregion, a relatively low-lying area with roughly parallel ridges and valleys that extends across eastern Tennessee between the Blue Ridge Mountains to the east and the Cumberland Plateau to the west. The CRN Site overlaps two subdivisions of the Ridge and Valley Ecoregion: the Southern Limestone/Dolomite Valleys and Rolling Hills Ecoregion and the Southern Dissected Ridges and Knobs Ecoregion (Figure 2.4.1-1). Over 95 percent of the CRN Site is within the Southern Limestone/Dolomite Valleys and Rolling Hills, a diverse ecoregion with a geology characterized by limestone, cherty dolomite, and mostly undulating landforms of rounded ridges and valleys with many caves and springs. Vegetation land cover includes forests, pasture, and agricultural crops, and development in the ecoregion includes commercial, industrial, and residential land uses. Only the southern tip of the Clinch River Property peninsula is within the Southern Dissected Ridges and Knobs Ecoregion. The vegetation community within these lower elevations of the Southern Dissected Ridges and Knobs Ecoregion is mainly mixed mesophytic forest dominated by white oak (*Quercus alba*) and tulip poplar (*Liriodendron tulipifera*). (Reference 2.4.1-1)

Field surveys of vegetation on the Clinch River Property, including the CRN Site as well as the adjacent Grassy Creek Habitat Protection Area (HPA), were conducted by Tennessee Valley Authority (TVA) in April and July of 2011 and September of 2013. The surveys were performed to characterize terrestrial vegetation communities, identify invasive plants, and search for listed plant species with the potential to occur in the habitats present (Reference 2.4.1-1). Based on interpretation of aerial photographs and the findings of these field surveys, dominant vegetation communities and other land cover types on the CRN Site were mapped (Figure 2.4.1-1). Over 75 percent of the CRN Site is covered by forest, approximately 22 percent is covered by herbaceous vegetation, and less than 1 percent (approximately 0.3 percent) is covered by small ponds. The remaining 2 percent of the CRN Site is classified as roads and developed areas. Table 2.4.1-1 shows the percentage of the CRN Site covered by each type of vegetation community or land use and the estimated acreage of each type based on a total CRN Site area of approximately 935 ac. Figure 2.4.1-1 depicts land cover types on the CRN Site.

TVA identified the dominant vegetation communities on the CRN Site as mixed evergreen-deciduous forest, deciduous forest, evergreen forest, and herbaceous vegetation. Characteristics of the vegetation communities on the CRN Site are described below, including examples of species generally representative of these community types. Lists of species actually recorded in vegetation surveys of the communities on the Clinch River Property are identified by their common and scientific names in Table 2.4.1-2. (Reference 2.4.1-1)

Mixed evergreen-deciduous forest consists of forest stands in which both evergreen and deciduous species contribute 25 to 75 percent of the total canopy cover. On the CRN Site, this forest occurs mostly as oak-hickory-pine dry forest on ridges. The dominant oaks include black oak (*Quercus velutina*), chestnut oak (*Q. montana*), northern red oak (*Q. rubra*), southern red oak (*Q. falcata*), and white oak. The dominant hickories include mockernut hickory (*Carya tomentosa*), pignut hickory (*C. glabra*), and shagbark hickory (*C. ovata*). The dominant pine is the Virginia pine (*Pinus virginiana*), and scattered eastern red cedars (*Juniperus virginiana*) are also present. Common understory species include black gum (*Nyssa sylvatica*), muscle wood (*Carpinus caroliniana*), and sourwood (*Oxydendrum arboreum*), and the herbaceous layer includes running ground cedar (*Diphasiastrum digitatum*), spotted wintergreen (*Chimaphila maculata*), ebony spleenwort (*Asplenium platyneuron*), black snakeroot (*Cimicifuga racemosa*), Christmas fern (*Polystichum acrostichoides*), little brown jug (*Hexastylis arifolia*), southern wood sorrel (*Oxalis corniculata*), and yellow giant hyssop (*Agastache nepetoides*). (Reference 2.4.1-1)

Deciduous forest, the second most prevalent forest type on the CRN Site, is characterized by trees with overlapping crowns and a canopy of more than 75 percent deciduous species. The deciduous forests on the CRN Site include three subtypes. The most extensive subtype is mixed mesophytic hardwood forest with a canopy that is dominated by tulip poplar and also includes American beech (*Fagus grandifolia*), white oak, and yellow buckeye (*Aesculus flava*). The understory is varied and includes American holly (*Ilex opaca*), Carolina buckthorn (*Rhamnus caroliniana*), flowering dogwood (*Cornus florida*), maple-leaf viburnum (*Viburnum acerifolium*), pawpaw (*Asimina triloba*), sassafras (*Sassafras albidum*), serviceberry (*Amelanchier arborea*), and wild black cherry (*Prunus serotina*). The diverse herbaceous layer includes bishop's cap (*Mitella diphylla*), blue cohosh (*Caulophyllum thalictroides*), blood root (*Sanguinaria canadensis*), dog-tooth violet (*Erythronium americanum*), foam-flower (*Tiarella cordifolia*), Jack-in-the-pulpit (*Arisaema triphyllum*), maidenhair fern (*Adiantum pedatum*), Solomon's seal (*Polygonatum biflorum*), and many others. (Reference 2.4.1-1)

A second deciduous forest subtype, calcareous forest, occurs in several areas within the CRN Site that are underlain by limestone. The majority of the forested areas underlain by limestone are within the Grassy Creek HPA on the Clinch River Property immediately north of the CRN Site and on a few mesic slopes on the CRN Site adjacent to the Clinch River arm of the Watts Bar Reservoir. Species with affinities for calcareous soils occur in these areas, including eastern red cedar, eastern redbud (*Cercis canadensis*), bladdernut (*Staphylea trifolia*), and herbs such as Appalachian bugbane (*Cimicifuga rubifolia*), glade fern (*Diplazium pycnocarpon*), green violet (*Hybanthus concolor*), Jacob's ladder (*Polemonium reptans*), and walking fern (*Asplenium rhizophyllum*). Two Tennessee species of special concern that occur in this forest are the herbs American ginseng (*Panax quinquefolius*) and spreading false-foxglove (*Aureolaria patula*). (Reference 2.4.1-1)

A third deciduous forest subtype, wetland forest, occurs near the edge of the Clinch River arm of the Watts Bar Reservoir and in association with the riparian areas of tributaries on the CRN Site. These forests are dominated by American sycamore (*Platanus occidentalis*), black willow, buttonbush (*Cephalanthus occidentalis*), silky dogwood (*Cornus amomum*), and tag alder (*Alnus serrulata*). Other common trees and shrubs observed include persimmon (*Diospyros virginiana*), box elder (*Acer negundo*), Chinese privet (*Ligustrum sinense*), tall false indigo (*Amorpha fruticosa*), multiflora rose (*Rosa multiflora*), and silver maple (*Acer saccharinum*). Herbaceous species in these wetland forests include netted chain fern (*Woodwardia areolata*), jewelweed (*Impatiens capensis*), lizard tail (*Saururus cernuus*), rose mallow (*Hibiscus* sp.), waterwillow (*Justicia americana*), yellow flag (*Iris pseudacorus*), and several species of grasses, rushes, and sedges. (Reference 2.4.1-1) Each of the wetlands on the CRN Site is described in Subsection 2.4.1.2 and mapped in Figure 2.4.1-1.

Evergreen forest present on the CRN Site consists of remnant areas of loblolly pine (*Pinus taeda*) and white pine (*Pinus strobus*) plantations, which cover a total of approximately 3 percent of the CRN Site (Reference 2.4.1-1).

An herbaceous vegetation community consists of greater than 25 percent grasses and forbs. Herbaceous vegetation is the dominant cover on approximately 22 percent of the CRN Site, largely as a result of historical construction activities during which approximately 240 ac of the CRN Site were cleared (Reference 2.4.1-2). Much of this area was eventually refilled and revegetated with non-native species, such as tall fescue (*Festuca arundinacea*) and sericea lespedeza (*Lespedeza cuneata*). These areas are undergoing secondary succession, principally by weedy species that include black-eyed Susan (*Rudbeckia hirta*), broom-sedge (*Andropogon virginicus*), Canada goldenrod (*Solidago canadensis*), Johnson grass (*Sorghum halepense*), Queen Anne's lace (*Daucus carota*), tickseed (*Coreopsis grandiflora*), and other common forbs. Eastern red cedar is scattered throughout these areas, resulting in the appearance of a cedar barren or glade. (Reference 2.4.1-1)

One area of herbaceous vegetation differs from that found on the rest of CRN Site in having a predominantly native flora. This small area covers about 1.4 ac in a transmission line ROW and resembles a disturbed cedar glade, which is an area of exposed limestone that supports sparse vegetation dominated by low-growing herbaceous species and eastern red cedar. In addition to red cedar and winged elm, herbs found in the marginal cedar glade area include butterfly weed (*Asclepias tuberosa*), hoary puccoon (*Lithospermum canescens*), false pennyroyal (*Hedeoma pulegioides*), pale spiked lobelia (*Lobelia spicata*), rose pink (*Sabatia angularis*), roundleaf thoroughwort (*Eupatorium rotundifolium*), twining snoutbean (*Rhynchosia tomentosa*), and whorled milkweed (*Ascelpias verticilliata*). Though the CRN Site contains several native species found in cedar glade habitat, its small size and high level of previous disturbance limits the importance of the CRN Site. (Reference 2.4.1-1) Given its position on the landscape, it is likely the plant community formed as a result of disturbance associated with previous work on the Clinch River Site and construction of the 161-kV Kingston FP – Fort Loudoun HP #1 line. Considered along with the small size and anthropogenic origin of the plant community, the absence of any rare plant species typical of glades further indicates that this area possesses little if any conservation value.

Barge/Traffic Area

In the Barge/Traffic Area, field surveys were conducted in May 2015 to characterize the terrestrial plant communities of the area east of TN 58. Surveys were conducted on the portions of the Barge/Traffic Area (101-ac) with the highest potential for disturbance that had not been previously surveyed. The survey included areas representative of each vegetation type present in the Barge/Traffic Area. Vegetation types found in this area were a combination of deciduous forest and herbaceous vegetation. These plant communities are common and well-represented throughout the region. None of the forest stands had characteristics indicative of old growth forest. (Reference 2.4.1-3)

Deciduous forest covers more than 90 percent of the Barge/Traffic Area. Common overstory species in dry upland forest include American beech, black gum, chestnut oak, mockernut hickory, red maple, scarlet oak (*Quercus coccinea*), sourwood, umbrella magnolia, and white oak. The understory consists of flowering dogwood, lowbush blueberry (*Vaccinium angustifolium*), and mountain laurel (*Kalmia latifolia*). Herbaceous plants are sparse and include Christmas fern, muscadine (*Vitis rotundifolia*), and wild yam (*Dioscorea villosa*). The deciduous forest in the Barge/Traffic Area also includes forested wetlands located in bottomlands associated with the Clinch River arm of the Watts Bar Reservoir. These deciduous forests contain overstory species that include American sycamore, black willow, green ash, red maple, and sweetgum. (Reference 2.4.1-3)

Herbaceous vegetation occurs on less than 10 percent of the surveyed portion of the Barge/Traffic Area. Fields and maintained power line ROWs account for the vast majority of herbaceous vegetation in the area. Most of these herbaceous communities are dominated by plants indicative of early successional habitats, including many non-native species. Common species in these disturbed areas include Japanese honeysuckle, lobed tickseed (*Coreopsis auriculata*), sericea lespedeza, showy goldenrod (*Solidago speciosa*), Small's ragwort (*Packera anonyma*), southern blackberry (*Rubus* sp.), and winged sumac (*Rhus copallinum*). Several small, emergent wetlands support a higher proportion of native species including buttonbush, common rush (*Juncus effusus*), groundnut (*Apios americana*), jewelweed, lizard's tail, shallow sedge (*Carex lurida*), silky dogwood, squarrose sedge, and tall false indigo. (Reference 2.4.1-3)

2.4.1.2 Wetland Habitats

Sections 401 and 404 of the Clean Water Act and Executive Order 11990, *Wetlands Protection*, provide regulatory protection for wetlands. Executive Order 11990 requires all federal agencies to minimize the destruction, loss, or degradation of wetlands when carrying out their responsibilities, and to preserve and enhance the natural and beneficial values of wetlands. Before performing certain activities in wetlands, a Section 404 permit from the U.S. Army Corps of Engineers (USACE) may be required, depending on the size of the wetland and its hydrologic connectivity to a navigable waterway. Section 401 provides states with the ability to verify whether activities allowed under Section 404 are compliant with state water quality standards. In Tennessee, the Division of Water Pollution Control of the Tennessee Department of Environment and Conservation (TDEC) is in charge of issuing Section 401 water quality certifications through the Aquatic Resource Alteration Permit. (Reference 2.4.1-4)

2.4.1.2.1 CRN Site Wetlands

Screening of wetland habitats on the CRN Site initially involved a review of National Wetland Inventory (NWI) maps and soil survey maps. Subsequently, field surveys were performed during January, April, and May of 2011, and the boundaries of the 12 wetlands on the CRN Site were delineated. Wetland identifications were performed in accordance with USACE methods, which require documentation of hydrophytic vegetation, hydric soils, and wetland hydrology. Broader definitions of wetlands, such as those provided by Executive Order 11990, the U.S. Fish and Wildlife Service (USFWS), and the TVA Environmental Review Procedures, also were considered in the wetland determinations for the CRN Site.

During a site visit on September 23, 2013, jurisdictional determinations were conducted by staff of the USACE to determine if each wetland meets the criteria for regulation under USACE jurisdiction. The TVA Rapid Assessment Method (RAM) was used to evaluate wetland conditions and identify wetlands with possible ecological significance. The TVA RAM uses six metrics that correspond to wetland indicator functions to differentiate wetlands on the basis of their condition: wetland area/size; upland buffers and surrounding land use; hydrology; habitat alteration and development; special wetlands (biodiversity); and plant communities, interspersion, and microtopography. Wetlands may be classified into three categories of wetland quality using the TVA RAM. Assignment to categories is based on scoring of wetland characteristics based on the six metrics, with a higher total score generally indicating that a wetland warrants assignment to a higher category. Category 1 includes wetlands that are "limited quality waters," which are wetlands that have been degraded, have limited potential for restoration, or are of such low functionality that lower standards for avoidance, minimization, and mitigation can be applied. Category 2 includes wetlands of moderate quality as well as wetlands that are degraded but have a reasonable potential for restoration. Category 3 typically includes wetlands of very high quality and wetlands of concern regionally and/or statewide, such as wetlands that provide habitat for threatened or endangered species. (Reference 2.4.1-4)

Characteristics of each of the onsite wetlands, including wetland classification, TVA RAM category and score, acreage, and jurisdictional status, are summarized in Table 2.4.1-3. The locations of the onsite wetlands are shown in Figure 2.4.1-2, and each wetland is described below.

Wetland 1 (W001) is a forested wetland associated with a floodplain/terrace of the Clinch River. This wetland covers 0.67 ac of the CRN Site and exhibits wetland hydrology and connectivity. Field indicators of hydric soils are absent, possibly due to extensive site disturbance in the 1970s during site preparation for the Clinch River Breeder Reactor project and subsequent sedimentation. Dominant hydrophytic vegetation includes sweetgum *(Liquidambar styraciflua*), slippery elm (*Ulmus rubra*), tulip poplar, silver maple (*Acer saccharinum*), and Chinese privet (*Ligustrum sinense*). Based on its TVA RAM score, this wetland is in Category 2, moderate quality. (Reference 2.4.1-4)

Wetland 2 (W002) is a small, emergent wetland in the central part of the CRN Site in close proximity to the former Clinch River Breeder Reactor Site. This wetland covers 0.13 ac on the CRN Site and demonstrates strong hydrology indicators but is not connected to any surface water feature, including waters of the United States or the state. The wetland formed in a small depression in a previously graded area. Field indicators of hydric soils are absent, possibly due to widespread site disturbance in the 1970s during site preparation for the Clinch River Breeder Reactor project. The main wetland vegetation includes squarestem spikerush (*Eleocharis quadrangulata*), narrow-leaf cattail (*Typha latifolia*), and softstem bulrush (*Schoenoplectus tabernaemontana*). Based on its TVA RAM score, this wetland is in Category 1, limited quality. (Reference 2.4.1-4)

Wetland 3 (W003) is a small, forested wetland situated on a small embayment on the shoreline of the Clinch River arm of the Watts Bar Reservoir. This wetland covers 0.18 ac of the CRN Site and exhibits wetland hydrology, hydric soils, and connectivity. The main vegetation includes American sycamore (*Platanus occidentalis*), boxelder (*Acer negundo*), creeping Jenny (*Lysimachia nummularia*), and Chinese privet. Based on its TVA RAM score, this wetland is in Category 2, moderate quality. (Reference 2.4.1-4)

Wetland 4 (W004) is a small, forested wetland associated with a floodplain/terrace of the Clinch River. This wetland covers 0.24 ac of the CRN Site and exhibits wetland hydrology, hydric soils, and connectivity. The main vegetation includes persimmon (*Diospyros virginiana*), boxelder, silky dogwood, and Japanese honeysuckle (*Lonicera japonica*). Based on its TVA RAM score, this wetland is in Category 2, moderate quality. (Reference 2.4.1-4)

Wetland 5 (W005) is a small, forested wetland situated on a small embayment on the shoreline of the Clinch River arm of the Watts Bar Reservoir and two small intermittent streams. This wetland covers 0.36 ac on the CRN Site and demonstrates wetland hydrology, hydric soils, and connectivity. The main vegetation includes green ash (*Fraxinus pennsylvanica*), American sycamore, buttonbush (*Cephalanthus occidentalis*), silky dogwood, Nepalese browntop (*Microstegium vimineum*), and Japanese honeysuckle. Based on its TVA RAM score, this wetland is in Category 2, moderate quality. (Reference 2.4.1-4)

Wetland 6 (W006) is a small (0.11 ac), emergent/scrub-shrub wetland situated in the west-central portion of the CRN Site near the reservoir. This wetland has developed in a wide, shallow drainage ditch along the southern edge of the 500-kV TVA transmission line ROW that crosses the CRN Site. The wetland exhibits wetland hydrology, hydric soils, and connectivity. Water from W006 ultimately flows into W001. Dominant vegetation includes black willow (*Salix nigra*), lateflowering thoroughwort (*Eupatorium serotinum*), and tall fescue (*Festuca arundinacea*). Based on its TVA RAM score, this wetland is in Category 2, moderate quality. (Reference 2.4.1-4)

Wetland 7 (W007) is a small, fringe scrub-shrub/forested wetland located on the same embayment of the reservoir shoreline as W003. W007 and W003 are separated by River Road and a culvert. W007 covers 0.17 ac of the CRN Site and exhibits wetland hydrology, hydric soils, and connectivity. Dominant vegetation includes slippery elm, American sycamore, Chinese privet, smooth alder (*Alnus serrulata*), silky dogwood, rice cutgrass (*Leersia oryzoides*), and Nepalese browntop. Based on its TVA RAM score, this wetland is in Category 2, moderate quality. (Reference 2.4.1-4)

Wetland 8 (W008) is a small, forested wetland associated with an unnamed, intermittent tributary to the Clinch River that rises below a sediment basin on the east side of the CRN Site. The hydrology of the wetland has been affected by a culvert and River Road as well as water levels on the Clinch River arm of the Watts Bar Reservoir. The wetland is separated from the river by the road and culvert. The wetland covers 0.23 ac and exhibits wetland hydrology, hydric soils, and connectivity. Dominant vegetation includes sycamore, sweetgum, Chinese privet, spicebush (*Lindera benzoin*), American elm (*Ulmus americana*), silky dogwood, an unidentified aster (*Aster* sp.), jewelweed (*Impatiens* sp.), poison ivy (*Toxicodendron radicans*), and trumpet creeper (*Campsis radicans*). Based on its TVA RAM score, this wetland is in Category 2, moderate quality. (Reference 2.4.1-4)

Wetland 9 (W009) is a large, diverse, wetland complex associated with an unnamed, perennial tributary to the Clinch River close to the eastern boundary of the CRN Site. The hydrology of the wetland has been affected by a beaver dam at its south end and an active groundwater influence, including numerous seeps and springs, in the north end. The wetland includes a diversity of habitats. A semi-permanently flooded, scrub-shrub community in the south portion grades into a seasonally flooded forest in the south-central area, then into a saturated, forested wetland in the north-central area. At the north end is a saturated emergent and scrub-shrub community in the 500-kV TVA transmission line ROW, which is occasionally mowed. The wetland covers 5.66 ac and exhibits wetland hydrology, hydric soils, and connectivity. Dominant vegetation includes green ash, sycamore, buttonbush (*Cephalanthus occidentalis*), silky dogwood, black willow, an unidentified aster, blunt broom sedge (*Carex tribuloides*), fox sedge (*Carex vulpinoidea*), and Frank's sedge (*Carex frankii*). Based on the TVA RAM score for this wetland, which reflects its size and the diversity of its plant communities and habitat, this wetland is in Category 3, high quality. (Reference 2.4.1-4)

Wetland 10 (W010) is a small wetland complex associated with the same unnamed, perennial tributary to the Clinch River that is associated with W009. W010 is located upstream to the north of W009 and is separated from W009 by River Road and a culvert. The south end of the wetland is a combination of emergent and scrub-shrub habitat in the 500-kV TVA transmission line ROW. The northern portion is forested wetland habitat. The wetland hydrology is influenced by the stream and numerous groundwater seeps. The CRN Site appears to have experienced extensive disturbance in the past before acquisition by the U.S. Department of Energy (DOE) and TVA. The wetland covers 1.79 ac and exhibits wetland hydrology, hydric soils, and connectivity. Dominant vegetation includes loblolly pine (*Pinus taeda*), balm-of-Gilead (*Populus x jackii*), green ash, Nepalese browntop, and poison ivy. Based on its TVA RAM score, this wetland is in Category 2, moderate quality. (Reference 2.4.1-4)

Wetland 11 (W011) is a large, forested wetland associated with a floodplain/terrace of the Clinch River near the northwestern site boundary. The wetland is situated between the main access road and the river. The hydrology of the wetland has been altered by a road and culvert at its north end. Wetland 11 covers 5.87 ac on the CRN Site and includes an additional 3.2 ac area that extends north beyond the site boundary into the embayment near Grassy Creek. This wetland demonstrates wetland hydrology, hydric soils, and connectivity. Dominant vegetation includes silver maple, green ash, American elm, creeping Jenny (*Lysimachia nummularia*), roundleaf greenbrier (*Smilax rotundifolia*), trumpet creeper, and Japanese honeysuckle. Based on its TVA RAM score, this wetland is in Category 3, high quality. (Reference 2.4.1-4)

Wetland 12 (W012) is a small, emergent wetland that has developed in a wet-weather drainage in the central portion of the CRN Site in a previously graded area near the former Clinch River Breeder Reactor site. This wetland covers 0.13 ac and demonstrates wetland hydrology and connectivity. Field indicators of hydric soils are absent perhaps due to widespread site disturbance in the 1970s during site preparation for the Clinch River Breeder Reactor project. Dominant wetland vegetation includes black willow, tall fescue, and an unidentified rush (*Juncus* sp.). Based on its TVA RAM score, this wetland is in Category 1, limited quality. (Reference 2.4.1-4)

2.4.1.2.2 Barge/Traffic Area Wetlands

Field surveys of wetlands in the Barge/Traffic Area were completed by TVA in April 2015. Wetland determinations and assessments of wetland quality were performed as described above for the CRN Site. (Reference 2.4.1-5) Characteristics of each of the Barge/Traffic Area wetlands, including wetland classification, TVA RAM category and score, acreage, and jurisdictional status, are summarized in Table 2.4.1-3. The locations of the Barge/Traffic Area wetlands are shown in Figure 2.4.1-2, and each wetland is described below.

Wetland 13 (W013) is a scrub-shrub/emergent wetland associated with a channelized, perennial, unnamed tributary to the Clinch River arm of the Watts Bar Reservoir. The wetland is under a transmission line and is maintained as a scrub-shrub/emergent wetland as the result of vegetation maintenance in the ROW. This wetland covers 3.73 ac and exhibits wetland hydrology and connectivity. Field indicators of hydric soils are lacking, possibly due to extensive site disturbance during the 1970s during site preparation for the Clinch River Breeder Reactor project and subsequent sedimentation. Dominant hydrophytic vegetation in the ROW includes green ash, black willow, broom panicgrass (*Dicanthelium scoparium*), silky dogwood, common rush, swamp rose (*Rosa palustris*), southern blackberry (*Rubus argutus*), red maple, and swamp dock (*Rumex verticillatus*). Based on its TVA RAM score, this wetland is in Category 2, moderate quality). (Reference 2.4.1-5)

Wetland 14 (W014) lies southeast of Wetland 13, and the two wetlands are separated by the existing road bed from the barge facility. Wetland 14 is similar in type, landscape position, and vegetation to Wetland 13 and is associated with the same unnamed perennial stream. The wetland covers 3.05 ac. Based on its TVA RAM score, this wetland is in Category 2, moderate quality. (Reference 2.4.1-5)

Wetland 15 (W015) is a forested wetland located along the southern shoulder of Bear Creek Road. The wetland covers 1.95 ac and exhibits wetland hydrology, hydric soils, and connectivity. Dominant vegetation includes American sycamore, common rush, Virginia creeper, sweetgum, red maple, green ash, Nepalese browntop, poison ivy, river oats (*Chasmanthium latifolium*), and Chinese privet. Based on its TVA RAM score, this wetland is in Category 2, moderate quality. (Reference 2.4.1-5)

Wetland 16 (W016) is a small (0.11-ac), emergent wetland associated with the terminus of an intermittent stream. Dominant vegetation includes jewelweed, aster, bedstraw (*Galium* spp.), and false nettle (*Boehmeria cylindrica*). Based on its TVA RAM score, this wetland is in Category 2, moderate quality. (Reference 2.4.1-5)

Wetland 17 (W017) is a scrub-shrub wetland located on a small embayment on the shoreline of Watts Bar Reservoir. The wetland covers 1.33 ac and exhibits wetland hydrology, hydric soils, and connectivity. Dominant vegetation includes green ash, American sycamore, giant river cane (*Arundinaria gigantea*), and common rush. Based on its TVA RAM score, this wetland is in Category 3, high quality. (Reference 2.4.1-5)

2.4.1.3 Important Terrestrial Habitats

U.S. Nuclear Regulatory Commission (NRC) guidance (NUREG 1555, *Standard Review Plans for Environmental Reviews for Nuclear Power Plants: Environmental Standard Review Plan,* and Regulatory Guide 4.2, *Preparation of Environmental Reports for Nuclear Power Stations*) identifies important habitats as the following:

- Wildlife sanctuaries, refuges, and preserves
- Habitats identified by the USFWS or state Natural Heritage Programs as unique, rare, or a priority for protection
- Critical habitats designated by the USFWS to protect listed species
- Wetlands, floodplains, or other resources protected by federal regulations or executive orders or by state regulations (Floodplains are discussed in Section 2.3, Water)

Important terrestrial habitats include natural areas as well as habitats such as these that have been identified by government agencies as unique, rare, or a priority for protection. Natural areas include managed areas and ecologically significant sites. Managed areas include lands held in public ownership that are managed by an agency to protect and maintain certain ecological and/or recreational features. Ecologically significant sites are either tracts of privately owned land that are recognized by resource biologists as having significant environmental resources or identified tracts on TVA lands that are ecologically significant but not specifically managed by the TVA's Natural Areas program. (Reference 2.4.1-6)

A 2011 report by the TVA assessed natural areas on, adjacent to, and within 3 mi of the CRN Site. A review of the TVA Natural Heritage Project Database indicates that a number of natural areas are located immediately adjacent to the CRN Site. (Reference 2.4.1-6) These areas are described below:

- The Grassy Creek HPA adjoins the northern boundary of the CRN Site and is located along and south of Grassy Creek (Figure 2.4.1-1). The Grassy Creek HPA includes 265 ac that provide a buffer for sensitive habitat surrounding and immediately south of Grassy Creek and the Grassy Creek embayment of the Clinch River arm of the Watts Bar Reservoir. (Reference 2.4.1-6) A plant species designated as a state species of special concern, spreading false-foxglove (*Aureolaria patula*), is among the species with habitat protected by the Grassy Creek HPA and was found in the HPA during field surveys (Reference 2.4.1-1).

- The Oak Ridge Reservation (ORR) adjoins the land boundaries of the CRN Site to the east, north, and west. The DOE manages this 34,000-ac reservation, which is used variously for manufacturing, laboratory research, forest management, and ecosystem process research (Reference 2.4.1-6). An analysis by the Oak Ridge National Laboratory (ORNL) of natural areas, managed areas, and other designated areas within the ORR identified the following categories and numbers of terrestrial or wetland areas:

- 47 natural areas
- 18 reference areas
- 5 conservation management areas
- 8 habitat areas
- 8 potential habitat areas
- 8 special management zones (Reference 2.4.1-7)

Figure 2.4.1-3 provides a map of these ORR designated areas within approximately 3 mi of the CRN Site. Five of these designated terrestrial or wetland areas on the ORR are immediately adjacent to the CRN Site or in close proximity:

- The East Tennessee Technology Park Filtration Plant Wetland (Natural Area 33) is a 7-ac wetland adjacent to a water filtration lagoon located near the northwest corner of the CRN Site. This area provides habitat for shining ladies'-tresses (*Spiranthes lucida*), a plant species state listed as threatened.
- The Grassy Creek Power Line Area (Cooperative Management Area 1) is a 51-ac linear area extending northeast along Bear Creek Road adjacent to the northern corner of the Grassy Creek HPA.
- The Grassy Creek Security Site (Reference Area 22) includes 43 ac adjoining the northern tip of the CRN Site and the Grassy Creek HPA. Reference areas contain special habitats or features and also may serve as control areas for research, monitoring, or related activities. This area includes limestone outcrops and some plants uncommon on the ORR.
- The Raccoon Creek Barren (Reference Area 8) includes 62 ac located approximately 1500 feet (ft) east of the eastern corner of the CRN Site and extending upland from the shoreline of the Clinch River arm of the Watts Bar Reservoir. It contains a rare community, a cedar-post oak barren-glade on shallow limestone. It has been proposed by TDEC for protection under the Natural Areas Preservation Act.
- The New Zion Boggy Area (Natural Area 42) includes 376 ac located less than 0.5 mi northeast of the CRN Site at its closest point. It contains oak-hickory uplands and a boggy forested wetland that is a rare natural community. It is called "boggy" because the area includes groundwater seeps and a sinking creek in a headwater area with a sphagnum moss/fern wetland and pools. This uncommon habitat and the presence of red chokeberry (*Aronia arbutifolia*) contribute to the conservation value of this area. (Reference 2.4.1-7) This area is located within a small subwatershed of an unnamed tributary of the Clinch River arm of the Watts Bar Reservoir, immediately east of the CRN Site.

- The Oak Ridge State Wildlife Management Area (WMA) is located primarily on the ORR and adjacent to the CRN Site. The WMA is a 37,000-ac area managed by the Tennessee

Wildlife Resources Agency (TWRA) for hunting of small and large game. (Reference 2.4.1-6)

- The Oak Ridge National Environmental Research Park (NERP) includes approximately 20,000 ac within the boundaries of the ORR and adjoining the CRN Site. The NERP is managed by the ORNL for the DOE. It provides protected land for use in education and research in environmental sciences and is used as an outdoor laboratory for studying present and future environmental consequences from energy-related issues. (Reference 2.4.1-6) The NERP was designated as an international biosphere reserve in 1989; it is one of six units of the Southern Appalachian Biosphere Reserve (Reference 2.4.1-8).

Also within the boundaries of the ORR, five proposed state natural areas (SNA) have been nominated for future designation and protection under the Natural Areas Preservation Act. These five areas are considered ecological core areas and contain several smaller natural areas within their boundaries. One proposed SNA, New Zion, is immediately adjacent to the CRN Site. The other four proposed SNAs are within 3 mi of the CRN Site. (Reference 2.4.1-6) These five proposed SNAs on the ORR are described below.

- The New Zion Unit proposed SNA comprises 2891 ac in the western portion of the ORR and immediately east of the CRN Site. It includes portions of the Haw Ridge uplands, including rock outcrops, and the Raccoon Creek Embayment of the Clinch River arm of the Watts Bar Reservoir as well as wetlands. Several rare and uncommon plant species occur in this area. (Reference 2.4.1-6)
- The Copper Ridge Unit proposed SNA comprises 3908 ac in the southern portion of the ORR and is located 2.3 mi southeast of the CRN Site. Prominent features include Copper Ridge, extensive river bluffs along Melton Hill Reservoir, a variety of forest community types, several caves and sink holes, ravines, springs, seeps, and forested wetlands. (Reference 2.4.1-6)
- The Black Oak Ridge Unit proposed SNA comprises 2929 ac in the western part of the ORR northeast of the CRN Site. This natural area includes two sections, East Black Oak Ridge and West Black Oak Ridge, separated by the Poplar Creek water gap and Blair Road. Prominent features are the East Fork Poplar Creek floodplain, Black Oak Ridge and McKinney Ridge, river bluffs, mixed hardwood-native pine forest, and a large forested wetland. (Reference 2.4.1-6)
- The Pine Ridge-Bear Creek Valley Unit proposed SNA comprises 4584 ac adjacent to the northern boundary of the DOE Reservation northeast of the CRN Site. Topographic features of the area include Pine Ridge and the western portion of East Fork Ridge. Also included are an extensive area of unfragmented forest and a variety of wetland habitat types, including headwater wetlands, seeps, marshes, and forested wetlands and sandstone outcrops. (Reference 2.4.1-6)
- The Walker Branch-Three Bend Unit proposed SNA comprises 6059 ac to the east of the CRN Site in the eastern portion of the ORR. It includes the entire Three Bend Scenic and

Wildlife Area and one of the world's largest populations of a rare wildflower species, tall larkspur. (Reference 2.4.1-6)

Outside the ORR, two officially designated SNAs are located within a 3-mi radius of the CRN Site (Reference 2.4.1-6):

- The Campbell Bend Barrens designated SNA is approximately 1.7 mi northwest of and across the Clinch River from the CRN Site. This 35-ac area managed by TDEC consists of small barrens that are a rare community type in a region where much of the land has been developed or converted to agriculture. The barrens community within the natural area covers approximately 4 to 6 ac. Eastern red cedar, white pine, post oak (*Quercus stellata*), dwarf chinquapin oak (*Q. prinoides*), and other hardwoods are scattered throughout the open grassland community of Campbell Bend, and the dominant grasses include little bluestem (*Andropogon scoparius*), big bluestem (*A. gerardii*), and side-oats gramma (*Bouteloua curtipendula*). (Reference 2.4.1-6)
- The Crowder Cemetery Cedar Barrens designated SNA is approximately 1.8 mi west of and across the Clinch River from the CRN Site. This 15-ac area managed by TDEC has grasslands in a matrix of mixed oak-pine with eastern red cedar and hardwoods that are scattered throughout the barrens. Grasses at Crowder Cemetery include little bluestem and side-oats gramma, and rare plants include slender blazing star (*Liatris gracilis*) and prairie dock (*Silphium terebinthinaceum*). Dwarf chinquapin oak, which is uncommon in Tennessee, also is found there. (Reference 2.4.1-6)

2.4.1.4 Wildlife

Terrestrial animal surveys conducted at the CRN Site and other areas of the Clinch River Property and at the Barge/Traffic Area spanned multiple seasons (i.e., spring, summer, fall, and winter), habitat types (e.g., mature forest, herbaceous, riparian), and detection methods (e.g., visual, aural, ultrasonic, traps). The resulting inventory of species documented on the Clinch River Property and the Barge/Traffic Area is therefore believed to represent the majority of species that would occur on or near the CRN Site. Most of the species observed are considered to be regionally abundant and common. (Reference 2.4.1-9) None of the animals observed during terrestrial animal surveys exhibited indicators, morphological or otherwise, that suggested impacts from exposure to an unusual environmental stress (e.g., pollutants). Domestic animals, such as cows or goats, are not present on the CRN Site or the Barge/Traffic Area. (The potential numbers and distribution of domestic animals in areas surrounding the CRN Site are discussed in conjunction with Section 5.4.)

2.4.1.4.1 Clinch River Property

TVA environmental staff performed field surveys to observe terrestrial animals on the Clinch River Property during spring and summer of 2011 (April, May, and July) and during all four seasons in 2013 (February, April, July, and October). Diurnal surveys were conducted by boat along the Clinch River arm of the Watts Bar Reservoir adjacent to the CRN Site perimeter, noting any animal heard or seen along the bank. Diurnal surveys of the Clinch River Property also were conducted along multiple linear land transects distributed across the landscape in a manner that maximized sampling of habitat types present across the Clinch River Property. Nocturnal surveys for singing frogs were conducted in close proximity to select water features on the CRN Site. Minnow traps, small mammal traps, and cover boards were set up and monitored to assess the presence of amphibians, small mammals, and herpetofauna, respectively. Bats were collected in mist nets at eight locations in July 2011. Acoustic monitoring equipment was used to detect and collect the calls of bats in July of 2011 and spring, summer, and fall of 2013. (Reference 2.4.1-9)

In addition to the terrestrial wildlife surveys described above, wildlife visual encounter surveys also were conducted quarterly along the Clinch River arm of the Watts Bar Reservoir in March, June, August, and October 2011 by TVA environmental staff. Surveys were centered at Clinch River mile (CRM) 15, downstream of the potential discharge location, and CRM 18.5, upstream of the potential intake location. (Reference 2.4.1-9) Transects approximately 2100 meters (m) in length were centered at each of these locations parallel to the shoreline along each bank. For each observation period, an area along each transect approximately 60 m in width (30 m inshore to 30 m offshore) was surveyed. Observed species were identified to general categories and by common name when possible, and their numbers were estimated. (Reference 2.4.1-10)

Species observed on the Clinch River Property using this combination of survey methods are identified by their common and scientific names in Table 2.4.1-4. Most of these species are regionally abundant. Although some of the observed species prefer specific habitat types, many are generalists and may occur in all habitat types on the CRN Site. Mammals observed on the Clinch River Property include the white-tailed deer (*Odocoileus virginianus*), coyote (*Canis latrans*), red fox (*Vulpes vulpes*), eastern gray squirrel (*Sciurus carolinensis*), eastern chipmunk (*Tamias striatus*), eastern cottontail (*Sylvilagus floridanus*), raccoon (*Procyon lotor*), Virginia opossum (*Didelphis virginiana*), and short-tailed shrew (*Blarina brevicauda*). In April 2011, roosting bats were observed in Rennies Cave, which is north of the CRN Site within the Grassy Creek HPA. Two individual bats were photographed: one was identified as a tricolored bat (*Perimyotis subflavus*) and the other could not be identified. Sightings of an elk (*Cervus elaphus*) were reported within the Clinch River Property in December 2012. The elk was a radio-collared female that migrated from Royal Blue Wildlife Management Area in Campbell County, Tennessee, where an elk restoration program has been underway for several years. A few years earlier, TWRA staff reported that a male elk was observed on the Clinch River Property. Bobcat sightings also have been reported from the Clinch River Property. (Reference 2.4.1-9)

Breeding birds observed in the wildlife surveys include the American crow (*Corvus brachyrhynchos*), blue jay (*Cyanocitta cristata*), Carolina chickadee (*Poecile carolinensis*), Carolina wren (*Thryothorus ludovicianus*), tufted titmouse (*Baeolophus bicolor*), pileated woodpecker (*Dryocopus pileatus*), red-bellied woodpecker (*Melanerpes carolinus*), hairy woodpecker (*Picoides villosus*), wild turkey (*Meleagris gallopavo*), barred owl (*Strix varia*), red-shouldered hawk (*Buteo lineatus*), Cooper’s hawk (*Accipiter cooperii*), ruby-throated hummingbird (*Archilochus colubris*), yellow-billed cuckoo (*Coccyzus americanus*), red-eyed vireo (*Vireo olivaceus*), yellow-throated vireo (*Vireo flavifrons*), white-eyed vireo (*Vireo griseus*), scarlet tanager (*Piranga olivacea*), chuck-wills-widow (*Caprimulgus carolinensis*), and whip-poor-will (*Caprimulgus vociferus*). Birds observed along the riparian zone include the belted kingfisher (*Megaceryle alcyon*), great blue heron (*Ardea herodias*), tree swallow (*Tachycineta bicolor*), and osprey (*Pandion haliaetus*). An osprey nest was observed on the CRN Site on a transmission line structure within a corridor that crosses the CRN Site. (Reference 2.4.1-9) Birds observed that typically occur in riverine habitat include the great blue heron, black-crowned night heron (*Nycticorax nycticorax*), belted kingfisher, bald eagle (*Haliaeetus leucocephalus*), osprey, wood duck (*Aix sponsa*), Canada goose (*Branta canadensis*), double-crested cormorant (*Phalacrocorax auritus*), and swallows (Reference 2.4.1-10).

Amphibians observed on the Clinch River Property include the gray treefrog (*Hyla versicolor*), American toad (*Bufo americanus*), green frog (*Rana clamitans*), and eastern narrow-mouthed toad (*Gastrophryne carolinensis*). Reptiles observed were the black rat snake (*Elaphe obsoleta obsoleta*), corn snake (*Elaphe guttata guttata*), and aquatic turtles, including the common snapping turtle (*Chelydra serpentina*), painted turtle (*Chrysemys picta*), river cooter (*Pseudemys concinna*), and Cumberland slider (*Trachemys scripta troostii*). (Reference 2.4.1-9)

2.4.1.4.2 Barge/Traffic Area

TVA environmental staff performed field surveys to observe terrestrial animals on the Barge/Traffic Area during November 2014 and January, April, and June 2015 using methods that were essentially the same as those used on the Clinch River Property but were modified for the smaller area. Wildlife surveys were conducted for approximately one week in each of the four seasons. (Reference 2.4.1-11)

Four linear transects for wildlife surveys were established across the Barge/Traffic Area. Two transects were established within upland mature deciduous forest, one in edge habitat between wetland forest along the reservoir and an upland pine forest fragment, and one through a stand of pine trees adjacent to a transmission line ROW and large wetland. Survey techniques included Sherman traps, cover boards, and visual and aural encounters. A total of 20 Sherman traps and 16 cover boards were deployed along the four transects to survey small mammals and herpetofauna, respectively. Four minnow traps were deployed within the Barge/Traffic Area to inventory frogs and salamanders: two traps in an inlet of the reservoir in a transmission line ROW and two traps in an emergent wetland along Bear Creek Road. Anuran call surveys were conducted adjacent to two aquatic sites on the Barge/Traffic Area. Techniques for baiting and checking traps, visual and aural encounter surveys, anuran surveys, and opportunistic detections were identical to those used for terrestrial animal surveys of the Clinch River Property. Boat surveys along the Clinch River arm of the Watts Bar Reservoir previously were conducted in the vicinity of the CRN Site, including the Barge/Traffic Area, and were not repeated. Species observed on the Barge/Traffic Area using this combination of survey methods are identified by their common and scientific names in Table 2.4.1-4. (Reference 2.4.1-11)

Visual and aural observations of terrestrial animals on the Barge/Traffic Area were very similar to terrestrial animal observations on the Clinch River Property. Most species observed are generalists and found in multiple habitats across the Barge/Traffic Area, though some are habitat specialists and observed only in specific habitat types. Examples of bird species observed included the American goldfinch (*Spinus tristis*), barred owl, blue jay, Carolina chickadee, Carolina wren, cedar waxwing (*Bombycilla cedrorum*), downy woodpecker (*Picoides pubescens*), eastern phoebe, eastern towhee (*Pipilo erythrophthalmus*), field sparrow (*Spizella pusilla*), golden-crowned kinglet (*Regulus satrapa*), hermit thrush (*Catharus guttatus*), northern cardinal (*Cardinalis cardinalis*), northern flicker (*Colaptes auratus*), pine warbler (*Setophaga pinus*), prairie warbler (*Setophaga discolor*), red-bellied woodpecker, red-eyed vireo, red-tailed hawk (*Buteo jamaicensis*), red-winged blackbird (*Agelaius phoeniceus*), ruby-throated hummingbird, song sparrow (*Melospiza melodia*), tufted titmouse, yellow-rumped warbler (*Setophaga coronata*), and white-eyed vireo. The belted kingfisher, great blue heron, and tree swallow were observed along the riparian corridor. A juvenile bald eagle and several ospreys were observed flying over the area. Common amphibians and reptiles observed were the American toad, southern leopard frog (*Rana utricularia*), pickerel frog (*Rana palustris*), spring peeper (*Pseudacris crucifer*), northern water snake (*Nerodia sipedon*), red-eared slider (*Trachemys scripta elegans*), and box turtle (*Terrapene carolina carolina*). Tadpoles of the upland chorus frog (*Pseudacris triseriata feriarum*) were observed in a wet depression of a mowed area at the northwestern corner of the Barge/Traffic Area. (Reference 2.4.1-11)

Common mammals observed in the Barge/Traffic Area included the American beaver (*Castor canadensis*), white-tailed deer, coyote, eastern gray squirrel, eastern chipmunk, eastern cottontail, raccoon, and Virginia opossum. Surveys specifically designed for detecting bats also were conducted in 2014 and 2015. Acoustic monitors for bats in the Barge/Traffic Area were directed at two locations on a rarely used, forested road corridor (Water Tank Road) located east of the proposed location of the eastern highway access ramp (Figure 2.1-3); across an inlet of the reservoir; and across a large wetland. (Reference 2.4.1-11) Acoustic monitor placement and acoustic analysis for these surveys followed the most current USFWS Indiana bat survey guidelines. Forest-dwelling bats and those that forage and travel in and along forests are likely to be recorded along forest corridors such as Water Tank Road, while the wetland and inlet are likely used by multiple bats for drinking and foraging. It also is likely that individual bats were detected and recorded multiple times due to repeated visits to these aquatic features. Individual bats likely visited these sites multiple times, perhaps making multiple passes in front of the monitor during a single visit, thus resulting in multiple recordings. (Reference 2.4.1-11)

The acoustic monitors detected 10 species across the Barge/Traffic Area. The most prevalent species detected were the tricolored bat, red bat (*Lasiurus borealis*), evening bat (*Nycticeius humeralis*), gray bat (*Myotis grisescens*), big brown bat (*Eptesicus fuscusl*), and silver-haired bat (*Lasionycteris noctivagans*). Other species recorded were the hoary bat (*Lasiurus cinereus*), little brown bat (*Myotis lucifugus*), and northern long-eared bat (*Myotis septentrionalis*). Recordings that were identified by acoustic software as the Indiana bat (*Myotis sodalis*) suggest this species may be present in the Barge/Traffic Area; however, visual assessment of these calls determined that identification of the species based on these recordings is not definitive. (Reference 2.4.1-11)

Terrestrial animal surveys on the Barge/Traffic Area observed a total of 117 terrestrial animal species, 13 of which were not observed on the Clinch River Property. These species were observed visually, heard, trapped, noted based on sign (e.g., scat remains), and/or acoustically detected across one or more seasons using multiple detection methods. A combined total of 190 terrestrial animal species were observed across both the Clinch River Property and the Barge/Traffic Area over the course of all terrestrial animal studies from 2011-2015. (Reference 2.4.1-11) Table 2.4.1-4 provides a master list of species for the Clinch River Property and Barge/Traffic Area.

2.4.1.5 Important Terrestrial Species

According to NUREG-1555, important species include species that are federally listed as threatened or endangered, as well as species that are proposed for or candidates for federal listing. Also important are species with a state listing status or other state status due to rarity. In conjunction with agency coordination regarding listed species, TVA sent letters to the USFWS and TDEC in September 2016 requesting their concurrence with the listed species identified as important species for the site. These letters are included in Appendix A. Information provided in the consultation responses from USFWS and TDEC will be incorporated when received, and the responses will be included in Appendix A.

In addition to listed species, commercially or recreationally valuable species could be important, and nuisance species could be important, particularly if they may cause problems for operation of two or more SMRs at the CRN Site. Species also may be important if they are critical to the survival of a rare species or to the local ecosystem, or if they are indicators of potential biological effects; however, such species were not identified for the CRN Site or the Barge/Traffic Area. Thus, the important terrestrial species to be discussed below for the CRN Site and the Barge/Traffic Area include federally and state-listed species, commercially or recreationally valuable species, and nuisance species.

Field surveys of the Clinch River Property to observe and identify important plant species were conducted in 2011 and 2013 as described in Subsection 2.4.1.1.1. Field surveys of the Clinch River Property to observe and identify important animal species were conducted in 2011 and 2013 as described in Subsections 2.4.1.4 and 2.4.1.5.1. Field surveys of the Barge/Traffic Area to identify important plant species were conducted in 2015 as described in Subsection 2.4.1.1.1. Field surveys to identify important animal species in the Barge/Traffic Area were conducted in 2014 and 2015 as described in Subsection 2.4.1.4.2. The design and extent of surveys conducted on the CRN Site, other areas of the Clinch River Property, and the Barge/Traffic Area provide approximate estimates of the numbers of these species that may occur on the CRN Site or in the Barge/Traffic Area.

2.4.1.5.1 Federally Listed Species

Terrestrial and wetland species with federal listing status (currently listed, proposed for listing, or candidates for listing) and recorded occurrences in Roane County, Tennessee are identified in Table 2.4.1-5. Based on a review of the TVA Regional Natural Heritage Database in November 2013, rare species potentially occur in the vicinity (i.e., within 3 to 5 mi) of the CRN Site. (Reference 2.4.1-9) Five federally-listed threatened or endangered species and one proposed threatened species have documented occurrences in Roane County. These include two bats that are listed as endangered, one bat that is listed as threatened, two plants that are listed as threatened, and one plant that has a status of proposed threatened (Reference 2.4.1-12; Reference 2.4.1-13). None of these species have designated critical habitat in the vicinity of the CRN Site.

The two bats in Roane County that are federally listed as endangered are the gray bat (*Myotis grisescens*) and Indiana bat (*Myotis sodalis*). The bat listed as threatened is the northern long-eared bat. In 2011, habitats on the Clinch River Property were surveyed in late winter and spring to identify suitable habitat for listed bat species. Based on results of the habitat surveys, mist net surveys for listed bat species were conducted in July 2011 at eight locations throughout the Clinch River Property. In addition, acoustic monitoring using Anabat™ technology also was performed concurrent with mist net sampling at locations in close proximity to the mist net survey locations. Additional acoustic monitoring was performed at six locations on the Clinch River Property in spring, summer, and fall of 2013. (Reference 2.4.1-9) As discussed in Subsection 2.4.1.4.2, acoustic surveys for bats also were conducted in the Barge/Traffic Area in 2014 and 2015. These three bat species and the survey results for each species are discussed below.

The two plant species in Roane County that are federally-listed as threatened are American Hart's-tongue fern *(Asplenium scolopendrium* var. *americanum)* and Virginia spiraea *(Spiraea virginiana*). The candidate for listing is the white fringeless orchid (*Platanthera integrilabia*). Field surveys for listed plant species on the CRN Site were performed by TVA in April and July 2011 and September 2013. Habitat suitable for these plants was not found on the Clinch River Property. (Reference 2.4.1-1) Brief descriptions of these species are provided below.

Gray Bat (Myotis grisescens)

The endangered gray bat hibernates in caves in large numbers during winter months and migrates to warmer caves to form summer maternity colonies (composed of adult females and young) or bachelor colonies (composed of adult males). The gray bat is closely associated with rivers, lakes, and other large bodies of water over which it forages for mainly aquatic insects. The gray bat has responded positively to conservation measures, and the majority of its populations are stable or increasing. The gray bat forages over large areas, and it is known to forage along the Clinch River. Gray bats also have been detected foraging along a pond on the ORR approximately 2 mi north of the CRN Site. Summer roosting gray bats have been documented in Marble Bluff Cave, located at Tennessee River Mile 578.3, approximately 9 mi (25 river mi) from the CRN Site. (Reference 2.4.1-9)

The gray bat has been reported to occur in Roane County, and it was recorded on the Clinch River Property by surveys performed by TVA in 2011 and 2013. One gray bat was captured in 2011 at a mist net location in the southwest area of the Clinch River Property, and gray bats were detected acoustically in 2011 at three other Clinch River Property locations. In 2013, gray bats were detected at all six acoustic survey locations on the Clinch River Property and were detected during every monitoring season (spring, summer, and fall), which suggest that winter and summer cave habitat exists for this species nearby. The gray bat is likely to use the area near the reservoir for foraging. (Reference 2.4.1-9) Although studies have shown that gray bats forage primarily over aquatic systems, they also would venture short distances into adjacent terrestrial habitat to forage, or they would cross terrestrial habitats to access streams, rivers, and reservoirs. (Reference 2.4.1-14)

The gray bat has been found to forage on the Clinch River Property, as documented in both mist nest and acoustic surveys. Its foraging activities are likely to occur primarily over the nearby reservoir and other riparian areas on or near the CRN Site. The gray bat may roost on the Clinch River Property; however, this has not been confirmed. All five documented caves on the Clinch River Property are located within the Grassy Creek TVA Habitat Protection Area. It is likely that the presence of the gray bat is seasonal and restricted to summer, when this species is roosting in nearby caves. Gray bats were detected at all acoustic survey locations during 2013 acoustic surveys, which suggest a minimum of six bats potentially simultaneously foraging across the Clinch River Property during the survey. Potential numbers of gray bats on the Clinch River Property during the summer may reflect a proportion of the number of roosting bats in caves in the vicinity, such as Marble Bluff Cave (approximately 9 mi away), with numbers of emerging gray bats ranging from 0 to greater than 200 across past summer surveys. Gray bats may travel as much as 80 kilometers (50 mi) of river or lake shore to forage. This suggests that gray bats foraging on the Clinch River Property may originate from multiple caves. Approximating the number of gray bats that may be present on the CRN Site on a given night during the summer is therefore challenging. (Reference 2.4.1-9) Acoustic surveys of the Barge/Traffic Area identified gray bats foraging in that area as well (Reference 2.4.1-11).

The entire Clinch River Property was investigated for the presence of caves. Two previously documented caves, Rennies Cave and 2-Batteries Cave, are located within the Grassy Creek HPA. Two individual bats were observed roosting in Rennies Cave by archaeological surveyors in April 2011. One of these bats was identified from photos as a tricolored bat and the other bat could not be identified. TVA environmental staff have determined that neither Rennies Cave nor 2-Batteries Cave contains suitable habitat for maternity or hibernaculum use by the gray bat (or the Indiana bat or northern long-eared bat). Three additional caves near Grassy Creek were found by TVA environmental staff during surveys of the HPA. One of these features was a rock shelter, a shallow cave feature unsuitable for these species. The other two features were shallow "pit" caves with no obvious chamber suitable for bat roosting. All caves were located within the Grassy Creek HPA (Reference 2.4.1-9).

Indiana bat (Myotis sodalis)

The endangered Indiana bat hibernates in caves and mines in winter and migrates to summer habitats in wooded areas. The large winter colonies disperse in spring, and reproductive females form smaller maternity colonies in wooded areas. Males and nonreproductive females roost in trees but typically do not roost in colonies. The range of the Indiana bat extends from the northeast through the east-central United States. The Indiana bat typically forages in semi-open forested habitats and forest edges as well as riparian areas. Suitable summer roosting habitat requires dead, dying, or living trees of sufficient size with sufficient exfoliating bark. Multiple roost sites generally are used. Primary summer roosts typically are behind the bark of large, dead trees, particularly those that are in gaps in the forest canopy or along forest edges so that they receive sufficient sun exposure. (Reference 2.4.1-15) Indiana bats have smaller summer home ranges than gray bats and forage within 2.5 mi of roost trees. Numbers of the Indiana bat are stable or decreasing throughout portions of its range due to disease (white-nose syndrome) and loss of habitat. (Reference 2.4.1-9)

The closest record of the Indiana bat to the CRN Site in the summer was a mist net capture of an adult male on the ORR in June 2013 over an inlet of Melton Hill Lake, approximately 10 mi from the CRN Site. The closest record of the Indiana bat to the CRN Site in winter was from a hibernaculum at Norris Dam Cave, approximately 27 mi to the northeast in Campbell County, Tennessee. However, no Indiana bats were observed in this cave during more recent winter surveys conducted in 2002, 2010, and 2011 to 2013. The closest records of summer roosting of the Indiana bat are from 27 to 29 mi to the southeast in the Cherokee National Forest (Monroe County, Tennessee). Cave surveys of the Clinch River Property by TVA environmental staff did not find caves that contain suitable habitat for hibernaculum use by the Indiana bat. (Reference 2.4.1-9)

Although the Indiana bat has not been previously reported to occur in Roane County, it was recorded on the Clinch River Property by acoustic surveys performed in the spring and summer of 2013. To assess the presence of suitable habitat for the Indiana bat on the Clinch River Property, surveys specifically designed to identify habitat suitable for summer roosting by the Indiana bat were conducted in the spring of 2011. Habitat survey results indicated potentially suitable summer roosting habitat within the forested areas in the northern half of the Clinch River Property. TVA environmental staff subsequently conducted mist net and acoustical surveys of the Clinch River Property. Although no Indiana bats were captured or detected on the Clinch River Property in 2011, they were detected acoustically in 2013 at five of six locations. The mist net capture of an Indiana bat in June 2013 on the ORR and the 2013 acoustic detections on the Clinch River Property support the potential presence of the Indiana bat at the Clinch River Property during spring and summer months (April-August). Moderate to high quality roosting habitat for the Indiana bat occurs on the northern half of the Clinch River Property. However, no roost trees have been documented on the Clinch River Property, which makes it difficult to estimate numbers of this species on the Clinch River Property or the CRN Site. Given the rarity of the Indiana bat, numbers would be expected to be low to none in any given year during the warm, non-hibernating season. (Reference 2.4.1-9) Acoustic surveys of the

Barge/Traffic Area potentially identified Indiana bats foraging in that area as well. However, visual assessment of the acoustic recordings determined that the identification of the Indiana bat based on software analysis of the recordings is not definitive. (Reference 2.4.1-11)

Northern Long-eared Bat (Myotis septentrionalis)

The northern long-eared bat was listed by the USFWS as threatened in May 2015 (Reference 2.4.1-16). The decision to list the northern long-eared bat as federally threatened was primarily due to the threat posed to the species by white-nose syndrome, a fungal disease that has resulted in substantial mortality to the species, particularly in the northeastern United States. Although declines in populations of this species have been observed in the southeast region, the declines have not been as dramatic as those in the northeast. (Reference 2.4.1-9)

One northern long-eared bat was captured by mist net in the southern half of the Clinch River Property in summer of 2011. This species was detected acoustically at three locations in the northern half of the Clinch River Property in spring and summer of 2013. It also was captured on the ORR (10 mi from the CRN Site) during mist net surveys in 2013. These detections and their locations indicate the presence of the northern long-eared bat in association with forested areas and aquatic features on the Clinch River Property. The northern long-eared bat hibernates in caves during winter and migrates to roost on the landscape during summer. Although studies of their use of habitat during summer are few or ongoing, available data suggest that summer habitat use by the northern long-eared bat is probably similar to that of the Indiana bat. (Reference 2.4.1-9) Cave surveys of the Clinch River Property by TVA environmental staff did not find caves that contain suitable habitat for hibernaculum use by the northern long-eared bat.

Northern long-eared bats have smaller summer home ranges than gray bats and forage within 1.5 mi of roost trees. No occupied roost trees have been documented on Clinch River Property, which makes an estimate of numbers of this species on Clinch River Property difficult. Although southeastern populations have declined, the northern long-eared bat is a relatively common species in this region, and its presence at the Clinch River Property would be expected during the warm, non-hibernating season. Populations of the northern long-eared bat in this region are likely to be larger than those of the Indiana bat. These regional population relationships are likely to be reflected in the numbers of individual bats that occur on the Clinch River Property (i.e., numbers of individuals of the northern long-eared bat are likely greater than those of the Indiana bat). (Reference 2.4.1-9) Acoustic surveys of the Barge/Traffic Area identified northern long-eared bats foraging in that area as well (Reference 2.4.1-11).

American Hart's-tongue Fern (Asplenium scolopendrium var. americanum)

American Hart's-tongue fern, which is federally listed as threatened, has large, glossy, unserrated fronds from 20 centimeters (cm) to 40 cm long. The typical habitat of American Hart's-tongue fern is shaded, moist, deciduous forests where the fern grows from small cracks in limestone boulders and ledges, which provide the high magnesium levels it requires. (Reference 2.4.1-17) This fern usually is found in areas with outcrops of dolomitic limestone, including gorges and limestone sinkholes in mature hardwood forests. It needs the high humidity and deep shade provided by mature forest canopies or overhanging rock cliffs. Its range extends from Alabama to Canada; however, its distribution within this range is discrete and very limited. Populations usually are small due to its specific habitat requirements. American Hart's-tongue fern is threatened by logging, which reduces shade and humidity, and also by quarrying, recreation, and residential development. (Reference 2.4.1-18) The report of American Hart's-tongue fern in Roane County is a historical record and the population is thought to be extirpated at the Roane County location where it was previously recorded. The nearest known extant population is found in a sinkhole near South Pittsburg, Tennessee. (Reference 2.4.1-19) American Hart's-tongue fern was not observed in field surveys of the Clinch River Property, and its preferred habitat was not found to be present (Reference 2.4.1-1).

Virginia Spiraea (Spiraea virginiana)

Virginia spiraea, which is federally listed as threatened, is a perennial shrub of the rose family that has dark gray mature stems with creamy white flowers in closely packed bunches. The majority of the current populations of this shrub contain only a small number of clumps. The typical habitat of Virginia spiraea is on the scoured banks of high-gradient streams or on meanders, point bars, natural levees, and braided features of lower-gradient stream segments. The soils in which Virginia spirea is found typically are sandy, silty, or clayey, and it occurs at elevations ranging from 1000 to 2400 ft. The range of Virginia spiraea is the southern Blue Ridge Mountains or Appalachian plateau in Alabama, Tennessee, Kentucky, Ohio, West Virginia, Virginia, North Carolina, and Georgia. A critical requirement for sustaining this plant seems to be removal of woody competition by erosion. Virginia spiraea is threatened by factors such as impoundments, road maintenance, beaver damage, off-road vehicle use, deer browse, non-native plant species, and pollution. (Reference 2.4.1-20) Virginia spiraea was not observed in field surveys of the Clinch River Property, and its preferred habitat was not found to be present (Reference 2.4.1-21; Reference 2.4.1-1).

White Fringeless Orchid (Platanthera integrilabia)

The status of white fringeless orchid (also known as monkey-face orchid) was changed from a candidate for federal listing to proposed for listing as threatened in September 2015 (Federal Register [Vol 80, No 178, 9/15/15]). White fringeless orchid is a perennial herb that blooms from late July to early September. The typical habitat of white fringeless orchid is partially shaded, flat, boggy areas at the heads of streams or seepage slopes. This orchid is usually found in acidic muck or sand in association with sphagnum moss and cinnamon fern, netted chain fern, and New York fern. The white fringeless orchid is uncommon throughout its range in the southeastern and south central United States. It is threatened by habitat modification, mainly alteration of hydrology. (Reference 2.4.1-22) White fringeless orchid was not observed in field surveys of the Clinch River Property, and its preferred habitat was not found to be present (Reference 2.4.1-1; Reference 2.4.1-21).

2.4.1.5.2 State-Listed Species

Forty-eight terrestrial or wetland species with a state listing status or other state protected status have recorded occurrences in Roane County (Table 2.4.1-5). The animal species with state status include four birds, nine mammals, two reptiles, and one amphibian that are state-listed as threatened or endangered or are deemed in need of management. The plant species with state status include 30 species that are state-listed as endangered, threatened, or of special concern; one species of special concern due to commercial exploitation; and one species that is of special concern and possibly extirpated. (Reference 2.4.1-12) Four of these state-listed animals and plants also are federally listed, and one is proposed for federal listing as threatened. In Subsection 2.4.1.5.1, the animals with federal listing status were discussed and found to have the potential to occur on the Clinch River Property, and the plants with federal listing status were eliminated from further evaluation because field surveys did not find them on the Clinch River Property and suitable habitat was not present on the Clinch River Property.

The remaining species that have a state listing status or other protective status were further considered with regard to their potential to occur on the CRN Site given the proximity of their recorded occurrences and their habitat requirements. Table 2.4.1-6 identifies the species with state status and recorded occurrences in Roane County, briefly describes their characteristic habitats, and denotes the subset of species that have recorded occurrences within 6 mi of the CRN Site. Based on a review of the TVA Regional Natural Heritage Database in November 2013 and observation of Indiana bats and bald eagles during wildlife surveys at the CRN Site, occurrences of 27 species with a state listing status or other state protected status have been recorded within 6 mi of the CRN Site. Two of these animal species, the gray bat and Indiana bat, are federally listed and were discussed in Subsection 2.4.1.5.1. One of these plant species is of concern because it is commercially exploited. Of the remaining 24 species with state status and recorded occurrences within 6 mi, seven are animals and 17 are plants.

Four state-status animal species were observed at the CRN Site during wildlife surveys: the gray bat, Indiana bat, sharp-shinned hawk (*Accipiter striatus*), and bald eagle (*Haliaeetus leucocephalus*) (Reference 2.4.1-9). Field surveys of the CRN Site to search for possible rare plant species found that no state-status plant species occur on the CRN Site. Two state-status plant species were observed during field surveys on the Clinch River Property within the Grassy Creek HPA: spreading false foxglove (*Aureolaria patula*) and American ginseng (*Panax quinquefolius*) (Reference 2.4.1-1). Although the Clinch River Property potentially could provide suitable habitat for many of the terrestrial and wetland species with state status included in Table 2.4.1-6, only these four animal species and two plant species were observed during recent or earlier surveys of the Clinch River Property (Reference 2.4.1-1; Reference 2.4.1-9).

In the Barge/Traffic Area, state-status animal species observed include the gray bat (endangered), Indiana bat (endangered), and bald eagle (in need of management) (Reference 2.4.1-11). Two state-status plants have been previously reported to occur (most recently in 2000) in a small portion of the southern part of the Barge/Traffic Area: spreading false foxglove and shining ladies'-tresses (*Spiranthes lucida*). However, field surveys of the Barge/Traffic Area in 2015 did not find these plants to be present. (Reference 2.4.1-3)

Of the four state-status animal species observed on the Clinch River Property, the two species not discussed as federally listed species in Subsection 2.4.1.5.1 are the sharp-shinned hawk and bald eagle. These two birds and the two plants are briefly discussed below.

Sharp-Shinned Hawk (Accipiter striatus)

The sharp-shinned hawk has a state status of in need of management. This small hawk inhabits forest and open woodland where it preys mainly on small birds. In eastern North America, its breeding habitat extends from eastern Canada south to northern Alabama, with the greatest nesting densities occurring in eastern Canada. Young, dense, mixed or coniferous woodlands are preferred for nesting. (Reference 2.4.1-23) The sharp-shinned hawk has been observed on the ORR during its breeding season. Marginally suitable habitat is available for this species within the upland ridge and valley forest habitat in the northern half of the Clinch River Property. A sharp-shinned hawk was observed at the CRN Site in winter during a 2011 wildlife survey along the Clinch River arm of Watts Bar Reservoir. (Reference 2.4.1-9)

Bald Eagle (Haliaeetus leucocephalus)

Although no longer federally listed, the bald eagle remains federally protected by the Bald and Golden Eagle Protection Act, and it is designated by the State of Tennessee as in need of management. The bald eagle has increased in numbers in east Tennessee in the past decade. It builds large nests in trees near reservoirs and rivers, and numerous nests are present along Watts Bar Reservoir. The bald eagle also may occur in nearby forested habitats. The closest documented nest is approximately 8 mi from the CRN Site on Watts Bar Reservoir. Bald eagles were not observed during any of the field investigations conducted by TVA environmental staff on the CRN Site in 2011 or 2013. However, TVA environmental staff did observe bald eagles in flight in 2013 during their quarterly visual encounter surveys along the Clinch River at the CRN Site. (Reference 2.4.1-9) Also, a juvenile bald eagle was observed flying over the Barge/Traffic Area during wildlife surveys (Reference 2.4.1-11).

Spreading False-Foxglove (Aureolaria patula)

Spreading false-foxglove has a state status of special concern. It is a perennial member of the figwort family that is parasitic on the roots of oaks. It grows on steep, partially shaded, calcareous slopes above rivers and large streams, often within a few feet of the water. It flowers from August through the first frost. (Reference 2.4.1-1)

American Ginseng (Panax quinquefolius)

American ginseng has a state status of special concern – commercially exploited. This herb is commercially exploited for the purported medicinal value of its roots. Collection of ginseng is regulated by the State of Tennessee through the Ginseng Dealer Registration Act of 1983 and the Ginseng Harvest Season Act of 1985. Ginseng prefers mesic habitats and flowers from May to July, with fruits ripening later in summer. (Reference 2.4.1-1)

2.4.1.5.3 Species of Commercial or Recreational Value

As discussed in Subsection 2.4.1.5.2, American ginseng is a plant species of commercial value that occurs on the Clinch River Property. The populations of American ginseng on the Clinch River Property are within the Grassy Creek HPA and are not available for commercial harvesting (Reference 2.4.1-1).

Terrestrial wildlife species that are hunted recreationally in the vicinity occur on the Clinch River Property and the Barge/Traffic Area, including the white-tailed deer, gray squirrel, eastern cottontail, raccoon, Canada goose, wood duck, and wild turkey. The Oak Ridge State WMA is located primarily on the ORR and is managed by the TWRA for hunting of small and large game. The Clinch River Property is adjacent to the WMA but is not within the area, and hunting is not allowed on the Clinch River Property. The Barge/Traffic Area is within the WMA and hunting is allowed in the area.

2.4.1.5.4 Nuisance Species

Terrestrial nuisance species typically are invasive species that are non-native and likely to cause economic and/or environmental harm. These species also are described as alien, non-indigenous, exotic, or undesirable species. (474 Tennessee Wildlife Resources Agency 2008)

Nuisance animal species observed on the Clinch River Property during wildlife surveys conducted in 2011 and 2013 were the European starling (*Sturnus vulgaris*) and rock pigeon (*Columba livia*). The American beaver (*Castor canadensis*), which is native but also can be a nuisance species if it destroys trees or causes flooding, also was observed on the Clinch River Property. (Reference 2.4.1-9) Nuisance plant species are much more numerous on the Clinch River Property and include trees, shrubs, vines, grasses, and forbs. Much of the Clinch River Property was extensively altered during site preparation for the CRBRP, resulting in the introduction and spread of invasive, non-native plant species on the Clinch River Property. (Reference 2.4.1-1) Executive Order 13112, issued in 1999, defines an invasive species as an alien species (not native to the region or area) whose introduction causes or is likely to cause economic or environmental harm or harm to human health. (Reference 2.4.1-24) Invasive plants are robust and lack the natural predators and diseases that tend to keep native plants in natural balance. Invasive plants can reduce forest productivity, hinder forest use and management activities, and degrade diversity and wildlife habitat. Some invasive plants have been introduced into this country accidentally, but most were brought here as ornamentals or for livestock forage. (Reference 2.4.1-1) Common nuisance species of plants occurring on the Clinch River Property include the following:

- Japanese honeysuckle (*Lonicera japonica*)

- Chinese privet (*Ligustrum sinense*)
- Johnson's grass (*Sorghum halepense*)
- Multiflora rose (*Rosa multiflora*)
- Autumn olive (*Elaeagnus umbellata*)
- Chinese (sericea) lespedeza (*Lespedeza cuneata*)
- Japanese stilt grass (Nepalese browntop) (*Microstegium vimineum*)
- Mimosa (*Albizia julibrissin*) (Reference 2.4.1-1)

Japanese honeysuckle, Chinese privet, Chinese lespedeza, and Japanese stilt grass also were observed on the Barge/Traffic Area (Reference 2.4.1-3). These nuisance species have the potential to spread rapidly and displace native vegetation, and they are considered a severe threat in Tennessee. No federal noxious weeds (plants designated by the United States Department of Agriculture as potentially damaging to agriculture, natural resources, public health, or the environment [7 USC 7701 *et seq.*]) were observed during field surveys of the Clinch River Property. (Reference 2.4.1-1)

2.4.1.6 Transmission Corridor Habitats and Species

Two transmission line corridors currently traverse the CRN Site: a 161-kV line that crosses the reservoir at the southeastern tip of the peninsula and extends to the northwestern corner of the CRN Site, and a 500-kV line that crosses the reservoir and the western boundary of the CRN Site and extends northeast across the widest part of the CRN Site (Figure 2.2-1). The 500-kV line continues approximately 5 mi northeast to the Bethel Valley substation. The only new transmission line proposed for construction at a location off the CRN Site is a 69-kV underground line to be installed within the existing 500-kV ROW between the CRN Site and the Bethel Valley substation. Within the CRN Site, an approximately 1.2-mi segment of the 161-kV line is to be re-routed from its current alignment. The new 161-kV ROW extends north from the reservoir parallel to the shoreline before turning northwest and connecting to the existing ROW slightly northwest of where it crosses the 500-kV ROW. The new 161-kV ROW overlaps areas to be cleared for facility construction except for approximately 1200 ft at the southern end of the new ROW. Subsection 2.4.1.1 describes the vegetation typical of the herbaceous/grassland community on the CRN Site, which is maintained within the ROWs by control of woody vegetation under the transmission lines. A similar herbaceous community is maintained within the 5-mi segment of the 500-kV ROW in which the installation of a 69-kV underground transmission is planned. The terrestrial habitats within this ROW are not known to include wetlands or occurrences of federally or state-listed species.

Installation of a 69-kV underground transmission line is planned within the approximately 5-mi segment of the existing 500-kV ROW that extends northeast from the CRN Site to the Bethel Valley substation. Installation of the proposed underground transmission line potentially could affect terrestrial plants within the existing ROW. The vegetation within the ROW is actively maintained by TVA as an herbaceous community, which includes plant species and habitat for animal species such as those described above for the CRN Site and Barge/Traffic Area. Federally or state-listed plant species are not known to occur in the terrestrial communities within this ROW. Listed animal species, such as bats, potentially could forage in these open corridor habitats within the ROWs.

As discussed in Subsections 2.2.3 and 3.7.3.8, segments of the transmission system outside the CRN Site (other than the segment containing the 69-kV underground line discussed above) would require modifications involving uprating, reconductoring, or rebuilding. However, additional ROWs would not be established, cleared, or developed. The lines that include segments or structures that may need to be modified are overlaid on a map of regional land cover types in Figure 2.2-7. The vegetation communities within the ROWs for these lines are actively maintained by TVA as predominantly herbaceous communities consisting of plant and animal species such as those described above for such communities on the CRN Site and the Barge/Traffic Area. Based on TVA's Natural Heritage database, Table 2.4.1-7 identifies the biological resources that have been identified as potentially occurring on or near the ROWs for these lines. These resources include important terrestrial habitats such as state parks, state forests, and wildlife management areas; wetlands; and federal and state listed terrestrial species (Indiana bat, northern long-eared bat, and plants).

2.4.1.7 References

Reference 2.4.1-1. Cox, Patricia B., Dattilo, Adam J., and Baxter, Jr. J. T., "Clinch River Small Modular Reactor Site - Terrestrial Plant Communities and Botanical Resources Survey Report - Revision 5," Tennessee Valley Authority, October 28, 2015.

Reference 2.4.1-2. U.S. Department of Energy, "Clinch River Breeder Reactor Plant Project Site Redress Plan," March, 1984.

Reference 2.4.1-3. Dattilo, Adam J., "Clinch River Barge/Traffic Area - Terrestrial Plant Communities and Botanical Resources Survey Report," Tennessee Valley Authority, June 18, 2015.

Reference 2.4.1-4. Pilarski-Hall, Kim and Lees, Britta P., "Clinch River Small Modular Reactor Site - Wetland Survey Report - Revision 4," November 19, 2015.

Reference 2.4.1-5. Pilarski-Hall, Kim and Kennon, R. A., "Clinch River Small Modular Reactor Site - Supplemental Wetland Survey Report Barge/Traffic Area - Revision 1," Tennessee Valley Authority, June 17, 2015.

Reference 2.4.1-6. Pilarski-Hall, Kim, "Clinch River Small Modular Reactor Site - Technical Report Natural Areas (Managed Areas & Sites) - Revision 2," Tennessee Valley Authority, November 19, 2015.

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Table 2.4.1-1
Vegetation/Land Cover Types, Percent Coverage, and Acreage on the CRN Site[1]

Vegetation/Land Cover Type	Approximate Acreage	Percent Site Coverage
Mixed evergreen-deciduous forest[2]	390	42
Deciduous forest[3]	292	31
Herbaceous vegetation[4]	204	22
Evergreen forest	32	3
Roads/developed areas	14	2
Ponds	3	<1
Total	935	100

1 Table 2.4.1-1 presents a more refined representation of vegetation/land cover types on the CRN Site than the data presented in Section 2.2, Table 2.2-1. Dominant vegetation communities and other land cover types on the CRN Site were drawn in GIS based on aerial photographs and information from TVA field surveys.
2 Includes 1.0 ac of wetlands
3 Includes 12.72 ac of wetlands
4 Includes 1.82 ac of wetlands

Table 2.4.1-2 (Sheet 1 of 6)
Plants Observed on the Clinch River Property (2011 and 2013) and Barge/Traffic Area (2015)

Common Name	*Scientific Name*
American beech[1]	*Fagus grandifolia*
American ginseng	*Panax quinquefolius*
American holly	*Ilex opaca*
American sycamore[1]	*Platanus occidentalis*
Amur honeysuckle	*Lonicera maackii*
Angularfruit milkvine	*Matelea gonocarpos*
Appalachian bugbane	*Cimicifuga rubifolia*
Autumn olive	*Elaeagnus umbellata*
Axilflower	*Mecardonia acuminata*
Balm of Gilead	*Populus X jackii*
Beaked panic grass	*Panicum anceps*
Beech drops	*Epifagus virginiana*
Big bluestem	*Andropogon gerardii*
Bishop's cap	*Mitella diphylla*
Black oak	*Quercus velutina*
Black snakeroot	*Cimicifuga racemosa*
Black walnut	*Juglans nigra*
Black willow[1]	*Salix nigra*
Black-eyed Susan	*Rudbeckia hirta*
Black gum[1]	*Nyssa sylvatica*
Bladdernut	*Staphylea trifolia*
Bloodroot	*Sanguinaria canadensis*
Blue cohosh	*Caulophyllum thalictroides*
Blue phlox	*Phlox divaricata*
Box elder	*Acer negundo*
Bradford pear	*Pyrus calleryana*
Broad beech fern	*Phegopteris hexagonoptera*
Bulbous lip fern	*Cystopteris bulbifera*
Butterfly weed	*Asclepias tuberosa*
Buttonbush[1]	*Cephalanthus occidentalis*
Canada violet	*Viola canadensis*
Carolina buckthorn	*Rhamnus caroliniana*
Carolina coralbeads	*Cocculus carolinus*
Cattail	*Typha latifolia*
Chestnut oak[1]	*Quercus montana*

Table 2.4.1-2 (Sheet 2 of 6)
Plants Observed on the Clinch River Property (2011 and 2013) and Barge/Traffic Area (2015)

Common Name	*Scientific Name*
Chinese (sericea) lespedeza[1]	*Lespedeza cuneata*
Chinese privet[1]	*Ligustrum sinense*
Christmas fern[1]	*Polystichum acrostichoides*
Common adder's tongue fern	*Ophioglossum vulgatum*
Common rush[2]	*Juncus effusus*
Common threesquare	*Schoenoplectus pungens*
Creeping jenny	*Lysimachia nummularia*
Crownbeard	*Verbesina alternifolia*
Crownbeard	*Verbesina occidentalis*
Cucumber magnolia	*Magnolia acuminata*
Dog-tooth violet	*Erythronium americanum*
Doll's eyes	*Actaea pachypoda*
Dutchman's breeches	*Dicentra cucullaria*
Dwarf larkspur	*Delphinium tricorne*
Eastern red bud	*Cercis canadensis*
Eastern red cedar	*Juniperus virginiana*
Ebony spleenwort	*Asplenium platyneuron*
Fall bentgrass	*Agrostis perennans*
Field thistle	*Cirsium discolor*
Flowering dogwood[1]	*Cornus florida*
Fluxweed	*Isanthus brachiatus*
Foam flower	*Tiarella cordifolia*
Frank's sedge	*Carex frankii*
Fringeleaf wild petunia	*Ruellia humilis*
Frost weed	*Verbesina virginica*
Giant chickweed	*Stellaria pubera*
Giant sedge	*Carex gigantea*
Glade fern	*Diplazium pycnocarpon*
Golden eye saxifrage	*Saxifraga careyana*
Green ash[1]	*Fraxinus pennsylvanica*
Green violet	*Hybanthus concolor*
Grooved flax	*Linum sulcatum*
Groundnut[2]	*Apios americana*
Hairy small-leaf tick trefoil	*Desmodium ciliare*
Harbinger of spring	*Erigenia bulbosa*

**Table 2.4.1-2 (Sheet 3 of 6)
Plants Observed on the Clinch River Property (2011 and 2013)
and Barge/Traffic Area (2015)**

Common Name	*Scientific Name*
Harper's triparted violet	*Viola tripartita* var. *glaberrima*
Hoary puccoon	*Lithospermum canescens*
Hyssopleaf thoroughwort	*Eupatorium hyssopifolium*
Indian pink	*Spigelia marilandica*
Jack in the pulpit	*Arisaema triphyllum*
Jacob's ladder	*Polemonium reptans*
Japanese honeysuckle[1]	*Lonicera japonica*
Japanese stiltgrass (Nepalese browntop)[1]	*Microstegium vimineum*
Jewel weed[1]	*Impatiens capensis*
Johnson's grass	*Sorghum halepense*
Kudzu	*Pueraria montana* var. *lobata*
Largeleaf waterleaf	*Hydrophyllum macrophyllum*
Leafy bulrush	*Scirpus polyphyllus*
Little brown jug	*Hexastylis arifolia*
Lizard tail[1]	*Saururus cernuus*
Lobed tickseed[2]	*Coreopsis auriculata*
Loblolly pine	*Pinus taeda*
Longleaf summer bluet	*Houstonia longifolia*
Lowbush blueberry[2]	*Vaccinium angustifolium*
Maiden hair fern	*Adiantum pedatum*
Maple-leaf viburnum	*Viburnum acerifolium*
Maryland senna	*Senna marilandica*
Mockernut hickory[1]	*Carya tomentosa*
Monkey flower	*Mimulus alatus*
Mountain laurel[2]	*Kalmia latifolia*
Multiflora rose	*Rosa multiflora*
Muscadine[2]	*Vitis rotundifolia*
Muscle wood	*Carpinus caroliniana*
Narrowleaf vervain	*Verbena simplex*
Netted chain fern	*Woodwardia areolata*
Nettleleaf sage	*Salvia urticifolia*
Northern red oak	*Quercus rubra*
Orange coneflower	*Rudbeckia fulgida*
Oriental bittersweet	*Celastrus orbiculatus*
Pale spike lobelia	*Lobelia spicata*

Table 2.4.1-2 (Sheet 4 of 6)
Plants Observed on the Clinch River Property (2011 and 2013) and Barge/Traffic Area (2015)

Common Name	*Scientific Name*
Pawpaw	*Asimina triloba*
Persimmon	*Diospyros virginiana*
Pignut hickory	*Carya glabra*
Poison hemlock	*Conium maculatum*
Poison ivy	*Toxicodendron radicans*
Princess tree	*Paulownia tomentosa*
Prostrate ground tick trefoil	*Desmodium rotundifolium*
Rattlesnake plantain	*Goodyera pubescens*
Red maple[1]	*Acer rubrum*
Red mulberry	*Morus rubra*
Red trillium	*Trillium erectum*
Resurrection fern	*Pleopeltis polypodiodies*
Rose mallow	*Hibiscus moscheutos*
Rose pink	*Sabatia angularis*
Roughseed St. John's wort	*Hypercium sphaerocarpum*
Roundhead lespedeza	*Lespedeza capitata*
Roundleaf thoroughwort	*Eupatorium rotundifolium*
Running ground pine	*Diphasiastrum digitatum*
Rusty blackhaw	*Viburnum rufidulum*
Sassafras	*Sassafras albidum*
Scarlet oak[2]	*Quercus coccinea*
Serviceberry	*Amelanchier* sp.
Shallow sedge[2]	*Carex lurida*
Showy goldenrod[2]	*Solidago speciosa*
Showy orchis	*Galearis spectabilis*
Silky dogwood[1]	*Cornus amomum*
Silver plume grass	*Saccharum alopecuroides*
Silver maple	*Acer saccharinum*
Small’s ragwort[2]	*Packera anonyma*
Solomon's plume	*Maianthemum racemosum*
Solomon's seal	*Polygonatum biflorum*
Sourwood[1]	*Oxydendrum arboreum*
Southern blackberry[2]	*Rubus* sp.
Spicebush	*Lindera benzoin*
Spiked-flowered lobelia	*Lobelia spicata*

Table 2.4.1-2 (Sheet 5 of 6)
Plants Observed on the Clinch River Property (2011 and 2013) and Barge/Traffic Area (2015)

Common Name	*Scientific Name*
Spotted wintergreen	*Chimaphila maculata*
Sprangle-top	*Tridens flavus*
Spreading false foxglove	*Aureolaria patula*
Squarestem spike rush	*Eleocharis quadrangulata*
Squarrose sedge[1]	*Carex squarrosa*
Sugar maple	*Acer saccharum*
Sugarberry	*Celtis laevigata*
Swamp milkweed	*Asclepias incarnata*
Sweetgum[1]	*Liquidambar styraciflua*
Tag alder	*Alnus serrulata*
Tall false indigo[1]	*Amorpha fruticosa*
Tall thoroughwort	*Eupatorium altissimum*
Trailing lespedeza	*Lespedeza procumbens*
Tree-of-Heaven	*Ailanthus altissima*
Trumpet creeper	*Campsis radicans*
Tulip poplar	*Liriodendron tulipifera*
Twining snoutbean	*Rhynchosia tomentosa*
Twinleaf	*Jeffersonia diphylla*
Umbrella magnolia[1]	*Magnolia tripetala*
Vasey's trillium	*Trillium vaseyi*
Virginia dayflower	*Commelina virginica*
Virginia pine	*Pinus virginiana*
Walking fern	*Asplenium rhizophyllum*
Water willow	*Decodon verticillatus*
White grass	*Leersia virginica*
White oak[1]	*Quercus alba*
White pine	*Pinus strobus*
White-blue-eyed grass	*Sisyrinchium albidum*
Whorled milkweed	*Asclepias verticillata*
Wild basil	*Satureja vulgaris*
Wild black cherry	*Prunus serotina*
Wild geranium	*Geranium maculatum*
Wild ginger	*Asarum canadensis*
Wild yam[2]	*Dioscorea villosa*
Winged elm	*Ulmus alata*

**Table 2.4.1-2 (Sheet 6 of 6)
Plants Observed on the Clinch River Property (2011 and 2013)
and Barge/Traffic Area (2015)**

Common Name	*Scientific Name*
Winged sumac[2]	*Rhus copallinum*
Wood sorrel	*Oxalis* sp.
Wool grass	*Scirpus cyperinus*
Wooly mallow	*Hibiscus moscheutos*
Yellow buckeye	*Aesculus flava*
Yellow flag	*Iris pseudacorus*
Yellow giant hyssop	*Agastache nepetoides*
Yellow trillium	*Trillium luteum*

Notes:
This is a list of plants observed on the Clinch River Property and Barge/Traffic Area by TVA botanists. It is not a complete list of plant species that occur in these areas. Plant field surveys were conducted in April 2011, July 2011, and September 2013 on the Clinch River Property and in May 2015 on the Barge/Traffic Area.

Area where observed is the Clinch River Property unless otherwise noted:
1 Both Clinch River Property and Barge/Traffic Area
2 Barge/Traffic Area only

Sources: (Reference 2.4.1-3; Reference 2.4.1-1)

Table 2.4.1-3 (Sheet 1 of 2)
Wetlands on the CRN Site and Barge/Traffic Area

Wetland ID	Wetland Classification[1]	TVARAM[2] Category (Score)	Wetland Acreage on CRN Site	Jurisdictional Status[3]
CRN Site				
W001	PFO1E	2 (54)	0.67	jurisdictional wetland
W002	PEM1E	1 (22)	0.13	TDEC jurisdiction
W003	PFO1E	2 (46)	0.18	jurisdictional wetland
W004	PFO1E	2 (49)	0.24	jurisdictional wetland
W005	PFO1E	2 (57)	0.36	jurisdictional wetland
W006	PEM1E/PSS1E	2 (42)	0.11	jurisdictional wetland
W007	PSS1E/PFO1E	2 (57)	0.17	jurisdictional wetland
W008	PFO1E	2 (43)	0.23	jurisdictional wetland
W009	PEM1E/PSS1E/PFO1E	3 (90)	5.66	jurisdictional wetland
W010	PEM1E/PSS1E/PFO1E	2 (46)	1.79	jurisdictional wetland
W011	PFO1E	3 (62)	5.87	jurisdictional wetland
W012	PEM1E	1 (20)	0.13	to be determined[4]
Total CRN Site			15.54	
Barge/Traffic Area				
W013	PSS1E/PEM1E	2 (41)	3.73	to be determined
W014	PSS1E/PEM1E	2 (41)	3.05	to be determined
W015	PFO1E	2 (55)	1.95	to be determined
W016	PEM1F	2 (53)	0.11	to be determined
W017	PSS1Hh	3 (68)	1.33	to be determined
Total Barge/Traffic Area			10.17	
Total Wetland Acreage of CRN Site and Barge/Traffic Area			25.71	

Notes:
CRN Site:
1 Classification codes: PEM1E – Palustrine emergent, persistent vegetation, seasonally flooded/saturated; PSS1E – Palustrine scrub-shrub, broad-leaved deciduous vegetation, seasonally flooded/saturated; PFO1E – Palustrine forested, broad-leaved deciduous vegetation, seasonally flooded/saturated.
2 TVARAM = TVA Rapid Assessment Method
Category 3 indicates wetlands of high quality
Category 2 indicates wetlands of moderate quality
Category 1 indicates wetlands of limited quality
Score is based on values assigned for six metrics (described in Subsection 2.4.1.2)
3 Jurisdictional status as determined by USACE during CRN Site visit on September 23, 2013, or to be determined in future site visit.
4 W012 may be associated with historic grading activities.

Table 2.4.1-3 (Sheet 2 of 2)
Wetlands on the CRN Site and Barge/Traffic Area

Notes (continued):

Barge/Traffic Area:

[1] Classification codes as defined in Cowardin et al. 1979: PSS1E - Palustrine scrub-shrub, persistent vegetation, seasonally flooded/saturated; PEM1E - Palustrine emergent, persistent vegetation, seasonally flooded/saturated; PFO1E - Palustrine forested, broad-leaved deciduous vegetation, seasonally flooded/saturated; PEM1F - Palustrine emergent, persistent vegetation, semi-permanently flooded; PSS1Hh - Palustrine scrub-shrub, broad-leaved deciduous vegetation, permanently flooded, diked/impounded.

[2] TVARAM = TVA Rapid Assessment Method
Category 3 indicates wetlands of high quality
Category 2 indicates wetlands of moderate quality
Category 1 indicates wetlands of limited quality

[3] Jurisdictional status to be determined by USACE personnel during future site visit.

Source: (Reference 2.4.1-25; Reference 2.4.1-4)

**Table 2.4.1-4 (Sheet 1 of 6)
Animals Observed on the Clinch River Property (2011 to 2013)
and Barge/Traffic Area (2014 to 2015)**

Common Name	Scientific Name
Mammals	
American beaver	*Castor canadensis*
big brown bat	*Eptesicus fuscus*
coyote	*Canis latrans*
eastern chipmunk	*Tamias striatus*
eastern cottontail	*Sylvilagus floridanus*
eastern gray squirrel	*Sciurus carolinensis*
elk	*Cervus elaphus*
evening bat	*Nycticeius humeralis*
gray bat	*Myotis grisescens*
hispid cotton rat	*Sigmodon hispidus*
hoary bat	*Lasiurus cinereus*
Indiana bat	*Myotis sodalis*
little brown bat	*Myotis lucifugus*
muskrat	*Ondatra zibethicus*
deer mouse	*Peromyscus maniculatus*
northern long-eared bat	*Myotis septentrionalis*
opossum	*Didelphis virginiana*
raccoon	*Procyon lotor*
red bat	*Lasiurus borealis*
red fox	*Vulpes vulpes*
short-tailed shrew	*Blarina brevicauda*
silver-haired bat	*Lasionycteris noctivagans*
small-footed bat	*Myotis leibii*
striped skunk	*Mephitis mephitis*
tricolored bat	*Perimyotis subflavus*
white-footed mouse	*Peromyscus leucopus*
white-tailed deer	*Odocoileus virginianus*
Birds	
Acadian flycatcher	*Empidonax virescens*
American crow	*Corvus brachyrhynchos*
American goldfinch	*Spinus tristis*
American robin	*Turdus migratorius*
American tree sparrow	*Spizella arborea*
bald eagle	*Haliaeetus leucocephalus*
bank swallow	*Riparia riparia*
barn swallow	*Hirundo rustica*

Table 2.4.1-4 (Sheet 2 of 6)
Animals Observed on the Clinch River Property (2011 to 2013)
and Barge/Traffic Area (2014 to 2015)

Common Name	Scientific Name
Birds (continued)	
barred owl	*Strix varia*
bay-breasted warbler	*Setophaga castanea*
belted kingfisher	*Megaceryle alcyon*
black-crowned night heron	*Nycticorax nycticorax*
black-and-white warbler	*Mniotilta varia*
blackpoll warbler	*Setophaga striata*
black vulture	*Coragyps atratus*
blue-gray gnatcatcher	*Polioptila caerulea*
blue jay	*Cyanocitta cristata*
blue-winged warbler	*Vermivora cyanoptera*
brown-headed cowbird	*Molothrus ater*
brown thrasher	*Toxostoma rufum*
Canada goose	*Branta canadensis*
Canada warbler	*Cardellina canadensis*
Carolina chickadee	*Poecile carolinensis*
Carolina wren	*Thryothorus ludovicianus*
cedar waxwing	*Bombycilla cedrorum*
chestnut-sided warbler	*Setophaga pensylvanica*
chimney swift	*Chaetura pelagica*
chuck-wills-widow	*Antrostomus carolinensis*
common grackle	*Quiscalus quiscula*
common yellowthroat	*Geothlypis trichas*
Cooper’s hawk	*Accipiter cooperii*
blue-headed vireo	*Vireo solitarius*
double-crested cormorant	*Phalacrocorax auritus*
downy woodpecker	*Picoides pubescens*
eastern bluebird	*Sialia sialis*
eastern kingbird	*Tyrannus tyrannus*
eastern meadowlark	*Sturnella magna*
eastern towhee	*Pipilo erythrophthalmus*
eastern phoebe	*Sayornis phoebe*
European starling	*Sturnus vulgaris*
field sparrow	*Spizella pusilla*
golden-crowned kinglet	*Regulus satrapa*
gray catbird	*Dumetella carolinensis*
great blue heron	*Ardea herodias*
hairy woodpecker	*Picoides villosus*

Table 2.4.1-4 (Sheet 3 of 6)
Animals Observed on the Clinch River Property (2011 to 2013) and Barge/Traffic Area (2014 to 2015)

Common Name	Scientific Name
Birds (continued)	
hermit thrush	*Catharus guttatus*
hooded warbler	*Setophaga citrina*
indigo bunting	*Passerina cyanea*
Kentucky warbler	*Geothlypis formosa*
killdeer	*Charadrius vociferus*
palm warbler	*Setophaga palmarum*
Louisiana waterthrush	*Parkesia motacilla*
mallard	*Anas platyrhynchos*
mourning dove	*Zenaida macroura*
Nashville warbler	*Oreothlypis ruficapilla*
northern cardinal	*Cardinalis cardinalis*
northern flicker	*Colaptes auratus*
northern mockingbird	*Mimus polyglottos*
northern parula warbler	*Setophaga americana*
northern rough-winged swallow	*Stelgidopteryx serripennis*
osprey	*Pandion haliaetus*
Philadelphia vireo	*Vireo philadelphicus*
pileated woodpecker	*Dryocopus pileatus*
pine warbler	*Setophaga pinus*
prairie warbler	*Setophaga discolor*
prothonotary warbler	*Protonotaria citrea*
purple martin	*Progne subis*
red-bellied woodpecker	*Melanerpes carolinus*
red-eyed vireo	*Vireo olivaceus*
red-headed woodpecker	*Melanerpes erythrocephalus*
red-shouldered hawk	*Buteo lineatus*
red-tailed hawk	*Buteo jamaicensis*
red-winged blackbird	*Agelaius phoeniceus*
ruby-throated hummingbird	*Archilochus colubris*
rock pigeon	*Columba livia*
savannah sparrow	*Passerculus sandwichensis*
scarlet tanager	*Piranga olivacea*
sharp-shinned hawk	*Accipiter striatus*
song sparrow	*Melospiza melodia*
spotted sandpiper	*Actitis macularius*
summer tanager	*Piranga rubra*
Tennessee warbler	*Oreothlypis peregrina*

**Table 2.4.1-4 (Sheet 4 of 6)
Animals Observed on the Clinch River Property (2011 to 2013)
and Barge/Traffic Area (2014 to 2015)**

Common Name	Scientific Name
Birds (continued)	
tree swallow	*Tachycineta bicolor*
tufted titmouse	*Baeolophus bicolor*
turkey vulture	*Cathartes aura*
whip-poor-will	*Caprimulgus vociferous*
white-breasted nuthatch	*Sitta carolinensis*
white-eyed vireo	*Vireo griseus*
white-throated sparrow	*Zonotrichia albicollis*
wild turkey	*Meleagris gallopavo*
wood duck	*Aix sponsa*
wood thrush	*Hylocichla mustelina*
worm-eating warbler	*Helmitheros vermivorum*
yellow-bellied sapsucker	*Sphyrapicus varius*
yellow-billed cuckoo	*Coccyzus americanus*
yellow-breasted chat	*Icteria virens*
yellow-rumped warbler	*Setophaga coronata*
yellow-shafted flicker	*Colaptes auratus*
yellow-throated vireo	*Vireo flavifrons*
yellow-throated warbler	*Setophaga dominica*
Reptiles & Amphibians	
American bullfrog	*Rana catesbeiana*
American toad	*Bufo americanus*
black rat snake	*Elaphe obsoleta obsoleta*
box turtle	*Terrapene carolina carolina*
common map turtle	*Graptemys geographica*
common snapping turtle	*Chelydra serpentina*
corn snake	*Elaphe guttata guttata*
Cumberland slider	*Trachemys scripta troostii*
eastern red-spotted newt	*Notophthalmus viridescens*
eastern worm snake	*Carphophis amoenus amoenus*
gray treefrog	*Hyla versicolor*
green frog	*Rana clamitans*
narrowmouth toad	*Gastrophryne carolinensis*
northern water snake	*Nerodia sipedon*
Ouachita map turtle	*Graptemys ouachitensis*
painted turtle	*Chrysemys picta*
pickerel frog	*Rana palustris*

Table 2.4.1-4 (Sheet 5 of 6)
Animals Observed on the Clinch River Property (2011 to 2013)
and Barge/Traffic Area (2014 to 2015)

Common Name	Scientific Name
Reptiles & Amphibians (continued)	
red-eared slider	*Trachemys scripta elegans*
river cooter	*Pseudemys concinna*
southern leopard frog	*Rana utricularia*
spiny softshell turtle	*Apalone spinifera*
spring peeper	*Pseudacris crucifer*
upland chorus frog	*Pseudacris triseriata feriarum*
Invertebrates	
ashy clubtail	*Gomphus lividus*
black-and-yellow orb-weaving spider	*Argiope aurantia*
black ants	Formicidae
cave cricket	*Ceuthophilus maculatus*
cicada	Cicadidae
red admiral butterfly	*Vanessa atalanta*
clouded sulfur butterfly	*Colias philodice*
crayfish	Cambaridae
dragonfly nymph	Odonata
duskywing butterfly	*Erynnis* sp.
eastern pondhawk	*Erythemis simplicicollis*
eastern tailed blue butterfly	*Cupido comyntas*
eastern tiger swallowtail	*Papilio glaucus*
honey bee	*Apis mellifera*
Horace's duskywing butterfly	*Erynnis horatius*
juniper hairstreak	*Callophrys gryneus*
mourning cloak butterfly	*Nymphalis antiopa*
pearl crescent butterfly	*Phyciodes tharos*
pipevine swallowtail butterfly	*Battus philenor*
prawn	*Penaeus* sp.
red-banded hairstreak	*Calycopis cecrops*
silver spotted skipper	*Epargyreus clarus*
spicebush swallowtail	*Papilio troilus*
tiger swallowtail butterfly	*Papilio glaucus*
terrestrial snails	Pulmonata
tiger moth	Arctiidae
walking stick	Phasmidae
wasp species	Vespidae
water boatman	*Corixa* sp.

Table 2.4.1-4 (Sheet 6 of 6)
Animals Observed on the Clinch River Property (2011 to 2013) and Barge/Traffic Area (2014 to 2015)

Common Name	Scientific Name
Invertebrates (continued)	
West Virginia white	*Pieris virginiensis*
white-marked tussock moth	*Orgyia leucostigma*
widow skimmer	*Libellula luctuosa*
wild indigo duskywing	*Erynnis baptisiae*
black and yellow centipede	*Apheloria virginiensis*
zebra swallowtail butterfly	*Eurytides marcellus*
Fish	
green sunfish	*Lepomis cyanellus*
red-breasted sunfish	*Lepomis auritus*
warmouth	*Lepomis gulosus*

Source: (Reference 2.4.1-9)

Table 2.4.1-5 (Sheet 1 of 3)
Terrestrial and Wetland Species with Federal or State Status and Recorded Occurrences in Roane County, Tennessee

Scientific Name	Common Name	Federal Status	State Status
Birds			
Accipiter striatus	sharp-shinned hawk	–	NMGT
Aimophila aestivalis	Bachman's sparrow	–	E
Haliaeetus leucocephalus	bald eagle	–	NMGT
Limnothlypis swainsonii	Swainson's warbler	–	NMGT
Mammals			
Myotis grisescens[1]	gray bat	E	E
Myotis septentrionalis[2]	northern long-eared bat	T	–
Myotis sodalis[3]	Indiana bat	E	E
Napaeozapus insignis	woodland jumping mouse	–	NMGT
Sorex cinereus	cinereus shrew	–	NMGT
Sorex dispar	long-tailed shrew	–	NMGT
Sorex fumeus	smoky shrew	–	NMGT
Sorex longirostris	southeastern shrew	–	NMGT
Synaptomys cooperi	southern bog lemming	–	NMGT
Zapus hudsonius	meadow jumping mouse	–	NMGT
Reptiles			
Ophisaurus attenuatus longicaudus	eastern slender glass lizard	–	NMGT
Pituophis melanoleucus melanoleucus	northern pinesnake	–	T
Amphibians			
Hemidactylium scutatum	four-toed salamander	–	NMGT
Vascular Plants			
Agalinis auriculata	earleaved false-foxglove	–	E
Asplenium scolopendrium var. *americanum*	Hart's-tongue fern	T	E
Aureolaria patula[4]	spreading false-foxglove	–	S
Bolboschoenus fluviatilis	river bulrush	–	S
Delphinium exaltatum	tall larkspur	–	E
Diervilla lonicera	northern bush-honeysuckle	–	T
Diervilla sessilifolia var. *rivularis*	mountain bush-honeysuckle	–	T
Draba ramosissima	branching Whitlow-grass	–	S
Erysimum capitatum	western wallflower	–	E
Eurybia schreberi	Schreber's aster	–	S
Helianthus occidentalis	naked-stem sunflower	–	S
Juglans cinerea	butternut	–	T

Table 2.4.1-5 (Sheet 2 of 3)
Terrestrial and Wetland Species with Federal or State Status and Recorded Occurrences in Roane County, Tennessee

Scientific Name	Common Name	Federal Status	State Status
Vascular Plants (continued)			
Juncus brachycephalus	small-headed rush	–	S
Leucothoe racemosa	fetter-bush	–	T
Liatris cylindracea	slender blazing-star	–	T
Liparis loeselii	fen orchis	–	T
Lonicera dioica	mountain honeysuckle	–	S
Marshallia grandiflora	large-flowered Barbara's-buttons	–	E
Panax quinquefolius	American ginseng	–	S-CE
Pedicularis lanceolata	swamp lousewort	–	S
Platanthera flava var. *herbiola*	tubercled rein-orchid	–	T
Platanthera integrilabia	white fringeless orchid	PT	E
Pseudognaphalium helleri	Heller's catfoot	–	S
Ribes missouriense	Missouri gooseberry	–	S
Solidago ptarmicoides	prairie goldenrod	–	E
Spiraea virginiana	Virginia spiraea	T	E
Spiranthes lucida	shining ladies'-tresses	–	T
Symphyotrichum pratense	barrens silky aster	–	E
Thuja occidentalis	northern white cedar	–	S
Viola tripartita var. *tripartita*	three-parted violet	–	S
Non-Vascular Plants			
Myurella julacea	a moss	–	S-P
Preissia quadrata	a liverwort	–	T

[1] The gray bat was recorded on the Site by acoustic surveys performed in spring and summer of 2013.(Reference 2.4.1-9)

[2] The northern long-eared bat (*Myotis septentrionalis*) was officially listed as threatened in May 2015. It was recorded on the CRN Site in 2011 by mist net surveys and in 2011 and 2013 by acoustic surveys; Records of this species in Roane County were unknown prior to these surveys. (Reference 2.4.1-9)

[3] Although no records of the Indiana bat (*Myotis sodalis*) are known from Roane County, it was recorded on the Site by acoustic surveys performed in spring and summer of 2013. (Reference 2.4.1-9)

[4] Spreading false-foxglove was found growing on the Grassy Creek HPA during field visits in April and July 2011. (Reference 2.4.1-1)

Notes:
Federal status definitions:
E = Endangered
T = Threatened
C = Candidate for listing
PE = Proposed for listing as endangered
PT = Proposed for listing as threatened

Table 2.4.1-5 (Sheet 3 of 3)
Terrestrial and Wetland Species with Federal or State Status and Recorded Occurrences in Roane County, Tennessee

Notes (continued):

State status definitions:

E = Endangered

T = Threatened

NMGT = In need of management (nongame wildlife)

S = Special concern (plants)

S-CE = Special concern (plants) – commercially exploited

S-P = Special concern (plants) – possibly extirpated

Source of species status and occurrences: (Reference 2.4.1-12) (Federal Register [Vol 80, No 178, 9/15/15])

Table 2.4.1-6 (Sheet 1 of 3)
Habitats of Terrestrial and Wetland Species with State Status and Recorded Occurrences in Roane County, Tennessee

Scientific Name[1]	Common Name	State Status	Habitat
Animals			
Accipiter striatus	sharp-shinned hawk	NMGT	Forests and open woodlands
Aimophila aestivalis	Bachman's sparrow	E	Dry open pine or oak woods; nests on the ground in dense cover
Haliaeetus leucocephalus	bald eagle[2]	NMGT	Areas close to large bodies of water; roosts in sheltered sites in winter; communal roost sites common
Limnothlypis swainsonii	Swainson's warbler	NMGT	Mature, rich, damp, deciduous floodplain and swamp forests
Myotis grisescens	gray bat	E	Cave obligate year-round; frequents forested areas; migratory
Myotis sodalis	Indiana bat[2]	E	Hibernates in caves; spring/summer maternity roosts are normally under the bark of standing trees
Napaeozapus insignis	woodland jumping mouse	NMGT	Deciduous and coniferous forests with herbaceous groundcover; middle and east Tennessee
Sorex cinereus	cinereus shrew	NMGT	Rich woodlands of many types; open fields; middle and east Tennessee
Sorex dispar	long-tailed shrew	NMGT	Mountainous, forested areas with loose talus; east Tennessee
Sorex fumeus	smoky shrew	NMGT	Damp wooded areas including coniferous or mixed forests; middle and east Tennessee
Sorex longirostris	southeastern shrew	NMGT	Various habitats including wet meadows, damp woods, and uplands; statewide
Synaptomys cooperi	southern bog lemming	NMGT	Marshy meadows, wet balds, rich upland forests
Zapus hudsonius	meadow jumping mouse	NMGT	Open grassy fields; often abundant in thick vegetation near water bodies; statewide
Ophisaurus attenuatus longicaudus	eastern slender glass lizard	NMGT	Dry upland areas including brushy, cut-over woodlands and grassy fields; fossorial; nearly statewide but obscure
Pituophis melanoleucus melanoleucus	northern pinesnake	T	Well-drained sandy soils in pine/pine-oak woods; dry mountain ridges; E portions of west TN, E to lower elevations of the Appalachians
Hemidactylium scutatum	four-toed salamander	NMGT	Woodland swamps, shallow depressions, sphagnum mats on acidic soils; middle and east Tennessee

Table 2.4.1-6 (Sheet 2 of 3)
Habitats of Terrestrial and Wetland Species with State Status and Recorded Occurrences in Roane County, Tennessee

Scientific Name[1]	Common Name	State Status	Habitat
Plants			
Agalinis auriculata	earleaved false-foxglove	E	Barrens
Asplenium scolopendrium var. *americanum*	Hart's-tongue fern	E	Sinks
Aureolaria patula	spreading false-foxglove	S	Oak woods and edges
Bolboschoenus fluviatilis	river bulrush	S	Marshes
Delphinium exaltatum	tall larkspur	E	Glades and barrens
Diervilla lonicera	northern bush-honeysuckle	T	Rocky woodlands and bluffs
Diervilla sessilifolia var. *rivularis*	mountain bush-honeysuckle	T	Dry cliffs and bluffs
Draba ramosissima	branching Whitlow-grass	S	Calcareous bluffs
Erysimum capitatum	western wallflower	E	Rocky bluffs
Eurybia schreberi	Schreber's aster	S	Mesic woods and seepage slopes
Helianthus occidentalis	naked-stem sunflower	S	Limestone glades and barrens
Juglans cinerea	butternut	T	Rich woods and hollows
Juncus brachycephalus	small-headed rush	S	Seeps and wet bluffs
Leucothoe racemosa	fetter-bush	T	Acidic wetlands and swamps
Liatris cylindracea	slender blazing-star	T	Barrens
Liparis loeselii	fen orchis	T	Calcareous seeps
Lonicera dioica	mountain honeysuckle	S	Mountain woods and thickets
Marshallia grandiflora	large-flowered Barbara's-buttons	E	Rocky river bars
Myurella julacea	a moss	S-P	Shale bluffs

Table 2.4.1-6 (Sheet 3 of 3)
Habitats of Terrestrial and Wetland Species with State Status and Recorded Occurrences in Roane County, Tennessee

Scientific Name[1]	Common Name	State Status	Habitat
Plants (continued)			
Panax quinquefolius	American ginseng	S-CE	Rich woods
Pedicularis lanceolata	swamp lousewort	S	Wet acidic barrens and seeps
Platanthera flava* var. *herbiola	tubercled rein-orchid	T	Swamps and floodplains
Platanthera integrilabia	white fringeless orchid	E	Acidic seeps and stream heads
Preissia quadrata	a liverwort	T	Seepy limestone cliffs and bluffs
Pseudognaphalium helleri	Heller's catfoot	S	Dry sandy woods
Ribes missouriense	Missouri gooseberry	S	Rocky woods
Solidago ptarmicoides	prairie goldenrod	E	Barrens
Spiraea virginiana	Virginia spiraea	E	Stream bars and ledges
Spiranthes lucida	shining ladies'-tresses	T	Alluvial woods and moist slopes
Symphyotrichum pratense	barrens silky aster	E	Barrens
Thuja occidentalis	northern white cedar	S	Calcareous rocky seeps, cliffs

1 Scientific names in bold indicate that the species has a recorded occurrence within 6 mi of the Site.
2 The bald eagle and Indiana bat were observed during wildlife surveys at the Clinch River Property but were not previously recorded as occurring in Roane County according to the TDEC county list.

Notes:
State status definitions:
E = Endangered
T = Threatened
NMGT = In need of management (nongame wildlife)
S = Special concern (plants)
S-CE = Special concern (plants) – commercially exploited
S-P = Special concern (plants) – possibly extirpated

Source: (Reference 2.4.1-12)

Table 2.4.1-7 (Sheet 1 of 4)
Biological Resources in ROWs of Transmission System Line Segments to be Modified

Line Modification	Line Number/ Name	Resource Type	Resource Description[1]
Rebuild	**L5092 Volunteer-N Knoxville No 1**	Wetland	Wetlands (potential, and field verified)
Reconductor	**L5125 Norris HP-Lafollette-Pineville (Incl Sweet Gum Flats)**	Terrestrial	Indiana bat and northern long-eared bat
		Botany	State listed species in vicinity
		Wetland	Wetlands (potential)
		Aquatic	Sensitive aquatic species in the vicinity
		Natural	Cumberland Trail State Park, north
		Natural	North Cumberland State WMA
		Natural	Chimney Rock, unique geologic feature
		Natural	Corrigan Wildlife Management Area, KY
		Natural	Kentucky Ridge Forest WMA
Uprate	**L5167 Winchester-Smith Mountain SW STA (Incl Pelham, Coalmont)**	Botany	Federal and state listed species in vicinity
		Wetland	Wetlands (potential, ponds)
		Aquatic	Sensitive aquatic species in the vicinity
		Natural	Collins River
Uprate	**L5173 Watts Bar HP-Great Falls HP (Incl Pikeville)**	Terrestrial	Indiana bat and northern long-eared bat
		Botany	Special circumstance
		Botany	Federal and state listed species in vicinity
		Wetland	Wetlands (potential)
		Aquatic	Sensitive aquatic species in the vicinity
		Natural	Piney River Tree Farm
		Natural	Slabside pearlymussel designated critical habitat
		Natural	Bledsoe State Forest
Uprate	**L5173 Watts Bar HP-Great Falls HP (Incl Pikeville) (continued)**	Natural	Fall Creek Falls State Park
		Natural	Great Falls Reservoir reservation
		Natural	Center Hill Lake - USACE
		Natural	Center Hill Reservoir reservation
		Natural	Rock Island State Park

Table 2.4.1-7 (Sheet 2 of 4)
Biological Resources in ROWs of Transmission System Line Segments to be Modified

Line Modification	Line Number/ Name	Resource Type	Resource Description[1]
Uprate	**L5186 John Sevier FP - Cherokee HP No 1**	Terrestrial	Indiana bat and northern long-eared bat
		Botany	State listed species in vicinity
		Wetland	Wetlands (potential, field verified 2013, ponds)
		Aquatic	Sensitive aquatic species in the ROW and vicinity
		Natural	Cherokee Reservoir Reservation
		Natural	Grainger County Park
		Natural	Fluted kidneyshell designated critical habitat
		Natural	Lower French Broad and Lower Holston nonessential experimental population status
		Natural	National Rivers Inventory - Holston River
Reconductor	**L5204 Monterey - Peavine SW STA 161 KV (Incl Campbell Junction, Fredonia, Crossville, W Crossville)**	Terrestrial	Indiana bat and northern long-eared bat
		Botany	Federal and state listed species in vicinity
		Wetland	Wetlands (potential, ponds)
		Aquatic	Sensitive aquatic species in the vicinity
Uprate	**L5205 Rockwood - Peavine SW STA (Incl Crossville)**	Terrestrial	Indiana bat and northern long-eared bat
		Botany	Federal and state listed species in the ROW and vicinity
		Wetland	Wetlands (potential, ponds)
Uprate	**L5205 Rockwood - Peavine SW STA (Incl Crossville) (continued)**	Natural	Cumberland Trail
		Natural	Cumberland Trail State Park
Reconductor	**L5235 Elza - Spallation Neutron Source**	Terrestrial	Indiana bat and northern long-eared bat
		Botany	State listed species in the ROW and vicinity
		Wetland	Wetlands (potential)
		Natural	Oak Ridge National Laboratory and ORR
Reconductor	**L5280 Oak Ridge National Laboratory - Spallation Neutron Source 161 KV**	Terrestrial	Indiana bat and northern long-eared bat
		Botany	State listed species in the ROW and vicinity
		Wetland	Wetland (jurisdictional - field delineation)
		Wetland	Wetlands (potential)
		Natural	Oak Ridge National Laboratory and ORR

Table 2.4.1-7 (Sheet 3 of 4)
Biological Resources in ROWs of Transmission System Line Segments to be Modified

Line Modification	Line Number/ Name	Resource Type	Resource Description[1]
Uprate	**L5624 John Sevier FP-White Pine No 2 (Incl Greenville)**	Botany	State listed species in vicinity
		Wetland	Wetlands (potential, pond)
		Wetland	Wetlands (field verified 2013)
		Aquatic	Sensitive aquatic species in the ROW and vicinity
		Natural	Cherokee Reservoir Reservation
Reconductor	**L5659 Bull Run FP-N Knoxville No 1**	Terrestrial	Indiana bat and northern long-eared bat
		Botany	State listed species in vicinity
		Wetland	Wetlands (potential, pond)
		Natural	Brushy Valley Park
		Natural	Upper Bull Run Bluffs TVA Habitat Protection Area
Reconductor	**L5697 Oglethorpe - Concord (Incl Cloud Springs)**	Botany	State listed species in vicinity
		Wetland	Wetlands (potential)
		Aquatic	Sensitive aquatic species in the vicinity
Reconductor	**L5702 FRANKLIN-WINCHESTER**	Terrestrial	Indiana bat and northern long-eared bat
		Botany	State listed species in vicinity
		Wetland	Wetlands (potential)
		Natural	AEDC and Woods State Wildlife Management Area
		Natural	AEDC Military Reservation
		Natural	AEDC Wildlife Management Area and Woods Reservoir
		Natural	Arnold Engineering Development Center (AEDC)
		Natural	AEDC Double Powerline Barrens
Reconductor	**L5743 Kingston FP-Rockwood-Roane No 1 (Incl Harriman, K33)**	Terrestrial	Indiana bat and northern long-eared bat
		Terrestrial	Heronry
		Botany	Federal and state listed species in vicinity
		Wetland	Wetlands (potential, ponds)
		Aquatic	Sensitive aquatic species in the vicinity
		Natural	Oak Ridge National Laboratory and ORR
		Natural	Watts Bar Reservoir Reservation

Table 2.4.1-7 (Sheet 4 of 4)
Biological Resources in ROWs of Transmission System Line Segments to be Modified

Line Modification	Line Number/ Name	Resource Type	Resource Description[1]
Uprate/ Reconductor	**L5882 Elza-Huntsville (Incl Braytown, Windrock)**	Terrestrial	Indiana bat and northern long-eared bat
		Botany	Federal and state listed species in vicinity
		Wetland	Wetlands (potential, pond)
		Natural	Big South Fork National River and Recreation Area, National Park Service
		Natural	North Cumberland State WMA
		Natural	East Fork Ridge State Protection Planning Site
		Natural	Oak Ridge National Laboratory and ORR
Uprate	**L5940 White Pine-Dumplin Valley**	Terrestrial	Indiana bat and northern long-eared bat
		Wetland	Wetlands (potential, pond)
Uprate/ Reconductor	**L5957 Douglas HP - White Pine (Incl Newport)**	Terrestrial	Bald eagle
		Wetland	Wetlands (pond/potential wetland, lake)
		Natural	Rankin Bottoms State WMA & Wildlife Observation Area

1 Summary of resources identified as occurring in one or more of the affected segments of each line based on data from the TVA Natural Heritage database. Line segments affected and the lengths and acreage of the lines are included in Table 3.7-1.

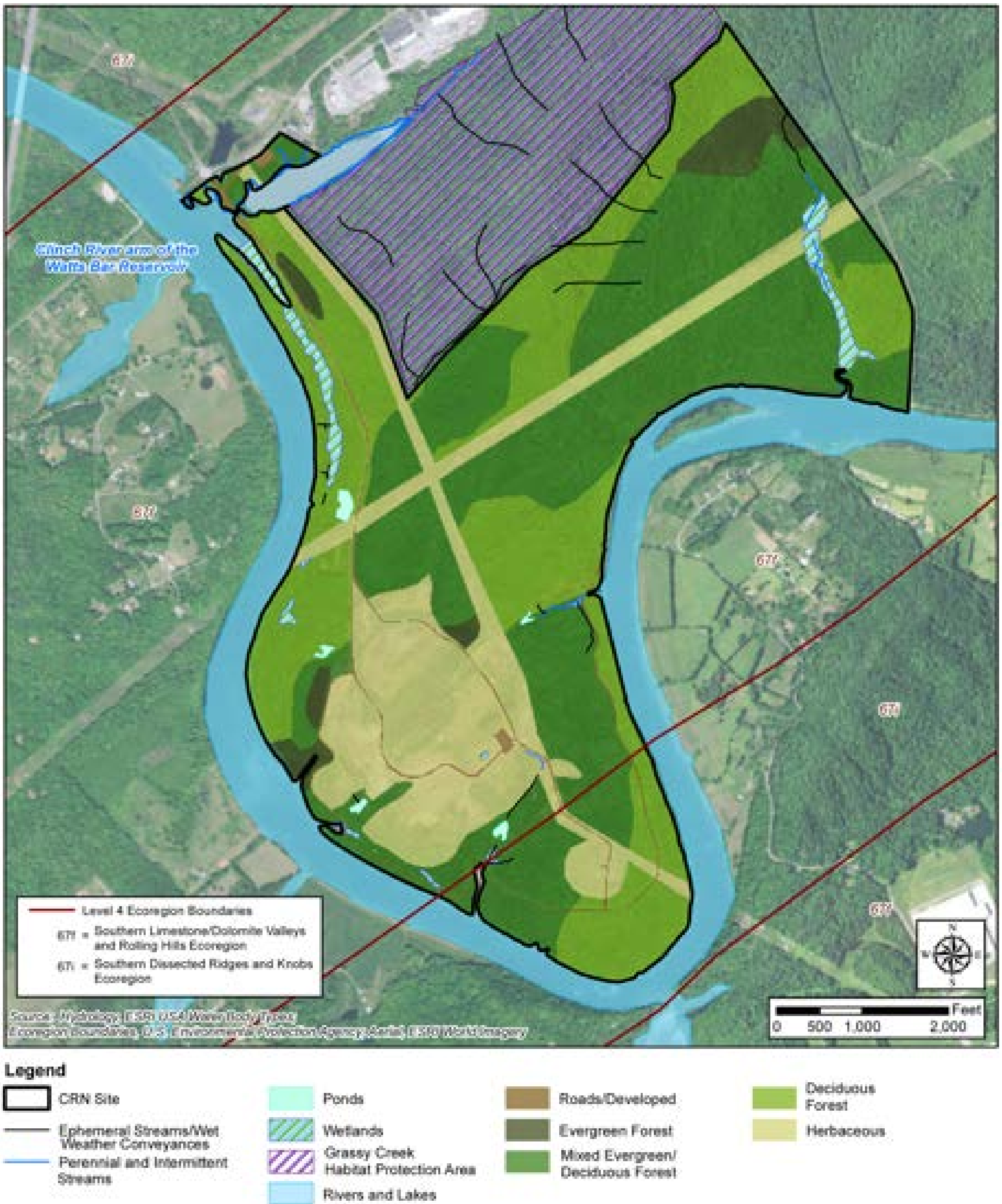

Figure 2.4.1-1. Land Cover Types on the CRN Site

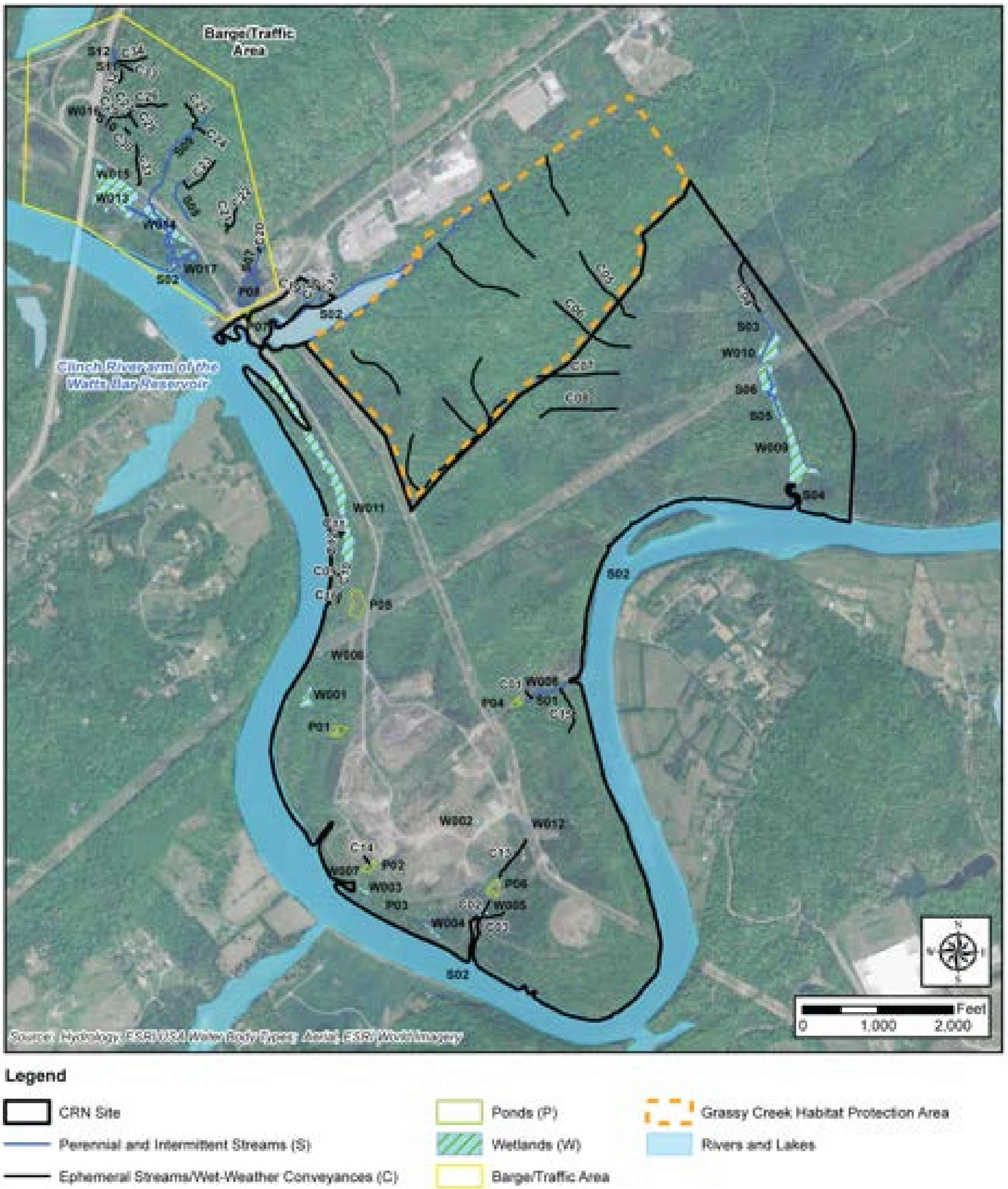

Figure 2.4.1-2. Streams, Ponds, and Wetlands on the CRN Site and Barge/Traffic Area

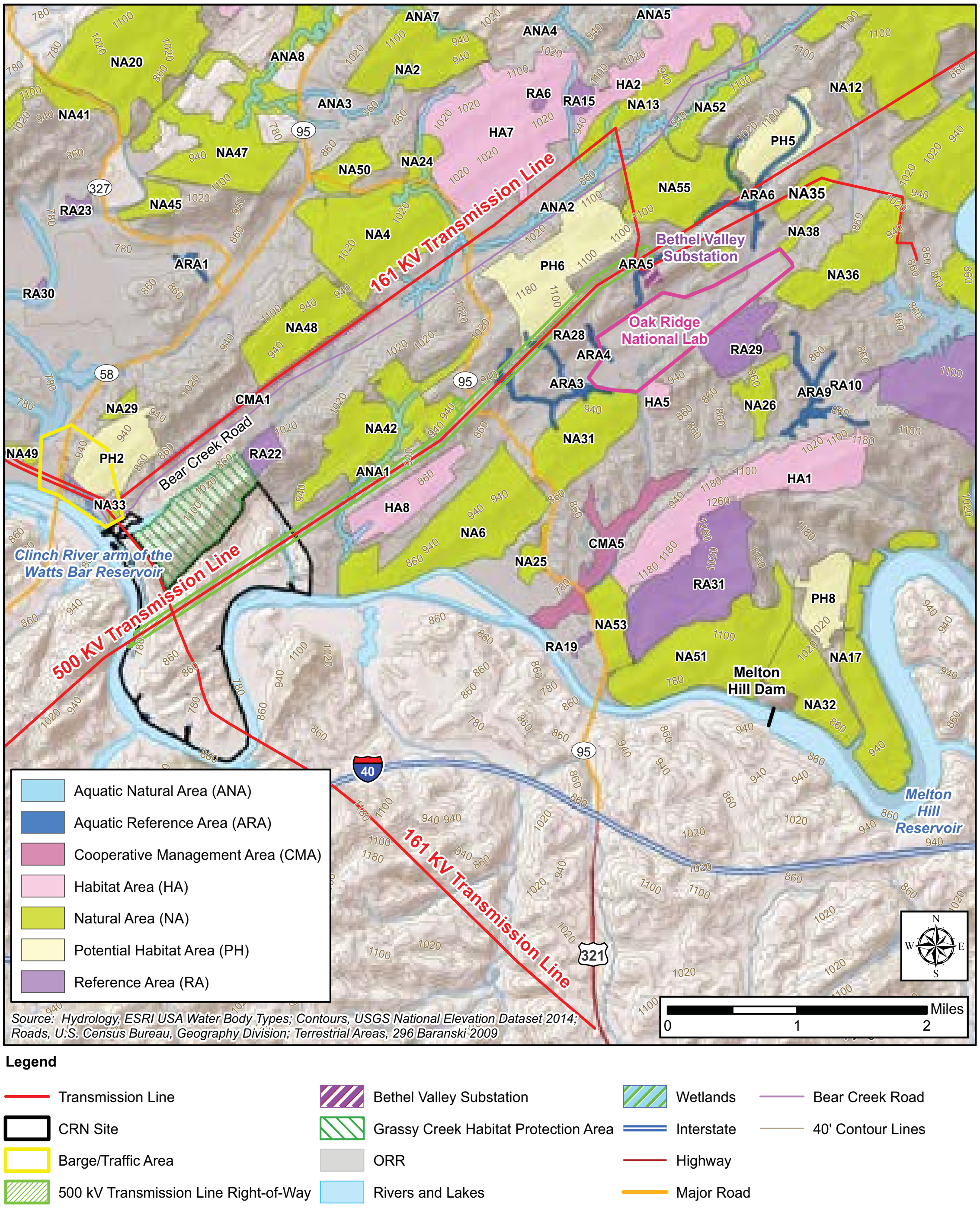

Figure 2.4.1-3. ORR Designated Areas in the Vicinity of the CRN Site

2.4.2 Aquatic Ecology

The construction and operation of two or more small modular reactors (SMRs) on the Clinch River Nuclear (CRN) Site has the potential to affect aquatic resources within the Lower Clinch River watershed. Potentially affected aquatic resources include reservoirs, ponds, and streams on and in the vicinity of the CRN Site. Wetlands and riparian habitats are discussed in conjunction with terrestrial ecology in Subsection 2.4.1. This subsection describes the ecological characteristics of the aquatic resources potentially affected by the Clinch River (CR) SMR Project.

2.4.2.1 Aquatic Habitats

The CRN Site is located between approximately Clinch River mile (CRM) 14.5 and CRM 19 (Reference 2.4.2-1). The proposed location of the condenser cooling water intake is at approximately CRM 17.9, and the proposed location of the cooling water discharge is near CRM15.5. These locations are shown in Figure 2.1-3.

Tennessee Valley Authority's (TVA's) Watts Bar Dam was built in 1942 at Tennessee River mile (TRM) 529.9 to create the Watts Bar Reservoir. This dam effectively impounded the portion of the Clinch River that flows past the CRN Site; accordingly, this reach of the Clinch River is considered part of Watts Bar Reservoir. (Reference 2.4.2-2) TVA's Melton Hill Dam, which was completed in 1963, is 5.2 miles (mi) upstream of the proposed cooling water intake structure for the CRN Site. Although Melton Hill Reservoir is a run-of-river reservoir that does not hold water long-term, this dam also affects water flow rates past the CRN Site. Releases from Fort Loudoun Dam and Watts Bar Dam downstream also can influence water velocity adjacent to the CRN Site. (Reference 2.4.2-3)

The aquatic habitats with the potential to be affected by the CR SMR Project include the Clinch River arm of the Watts Bar Reservoir, Melton Hill Reservoir, and streams and ponds on the CRN Site. Watts Bar Reservoir would be directly affected by water withdrawals and discharges. Melton Hill Reservoir may be affected indirectly through changes in water management associated with downstream withdrawals for the CR SMR Project. Ponds and streams on or near the CRN Site may be directly affected if they are located within areas required for construction or operation of two or more SMRs. The ecological characteristics of these potentially affected water bodies are described below.

2.4.2.1.1 Clinch River Arm of the Watts Bar Reservoir

TVA assesses the ecological health of its reservoirs through periodic sampling conducted historically under its Vital Signs Monitoring Program and currently under ongoing ecological health and compliance monitoring programs. The programs use multi-metric evaluation techniques to assess trends in aquatic resources and overall conditions in the reservoirs. These monitoring activities focus on:

- Physical and chemical characteristics of the water
- Physical and chemical characteristics of the sediment
- Fish community sampling
- Benthic macroinvertebrate community sampling (Reference 2.4.2-4)

TVA monitors four locations on the Watts Bar Reservoir, usually on a 2-year (yr) cycle. Monitoring occurred in even-numbered years beginning in 1994, with an additional monitoring event in 2009. The four monitoring locations were: the forebay area of deep water near the dam, the middle part of the reservoir, and the riverine areas at the extreme upper ends of the reservoir in the Tennessee River and the Clinch River, called the Tennessee and Clinch inflow locations. (Reference 2.4.2-5) The Clinch inflow location is at CRM 22 below Melton Hill Dam. To obtain seasonal data specifically from the reach of the Watts Bar Reservoir adjacent to the CRN Site, TVA initiated additional studies in 2011 to characterize baseline conditions of the aquatic habitats and communities in the reservoir immediately upstream and downstream of the CRN Site (Reference 2.4.2-6).

Physical and Chemical Characteristics

The physical and chemical characteristics of the water body affect the aquatic habitats and ecological communities present in the Clinch River arm of the Watts Bar Reservoir adjacent to the CRN Site. These characteristics are discussed in more detail in Subsection 2.3.3. Water quality and sediment quality parameters were measured in 2011, 2012, and 2013 as part of the preapplication monitoring study of aquatic habitats of the Watts Bar Reservoir in the area of the CRN Site. Water quality samples were taken at CRMs 18.5, 19.7, and 22.0 (upstream), and at CRM 15.5 (downstream). The sample analyses included metals, radionuclides (gross alpha, gross beta, radium-226, and radium-228), nutrients (Kjeldahl nitrogen, nitrate plus nitrite-nitrogen, ammonia-nitrogen, total phosphorus, and orthophosphate), total organic carbon (TOC), alkalinity, hardness, water clarity (turbidity and suspended solids), dissolved solids, and other constituents. Additionally, parameters such as water temperature, dissolved oxygen (DO), conductivity, and pH were measured. (Reference 2.4.2-7) Surface water sample results for the Clinch River arm of the Watts Bar Reservoir upstream and downstream of the CRN Site indicate that TDEC’s most stringent numeric water quality criteria are being met. In addition, the results of stormwater sampling indicate that site runoff would not have a significant impact on water quality. (Reference 2.4.2-7)

Water quality in the vicinity of the CRN Site is influenced by Melton Hill Dam and Norris Dam and the water quality of the inflow to Melton Hill Reservoir. Consistent with the geology of the area, water of the Clinch River arm of Watts Bar Reservoir was slightly alkaline, moderately hard, and well buffered. Nutrient concentrations were relatively high for nitrogen and moderate to low for phosphorus. The low phosphorus levels could limit phytoplankton growth and abundance. Maximum water temperatures in summer, near 72 degrees Fahrenheit (°F) in June and July, were well below the State of Tennessee maximum temperature criterion of 86.9°F.

The water column tended to be well mixed, though appreciable vertical gradients in oxygen were observed in July. DO concentrations often varied spatially about 1.0 to 1.5 milligrams per liter (mg/L). Several water quality parameters varied seasonally in response to variations in rainfall and runoff as well as processes in the reservoir related to dam operations. Concentrations of metals in water were below maximum concentrations established by the State of Tennessee for protection of aquatic life. (Reference 2.4.2-6) As discussed in Subsection 2.3.1.1.2.7, daily thermal gradients were documented to occur during summer due to surficial warming during the hottest time of the day. However, the warmer surface water was then either flushed out by daily dam releases from Melton Hill Dam, or its heat dissipated with nighttime atmospheric cooling.

Physical and chemical characteristics of the Clinch River arm of Watts Bar Reservoir resulting from historical human activities in the area have affected aquatic habitats and ecological communities. The hydrological characteristics of the Clinch River arm of the Watts Bar Reservoir near of the CRN Site were changed by the construction of Norris Dam on the Clinch River in 1936, Watts Bar Dam on the Tennessee River in 1942, and Melton Hill Dam on the Clinch River in 1963. (Reference 2.4.2-4) Dams create impoundments that can alter water quality, resulting in effects such as excessive nutrient levels, accumulation of sediment, and growth of aquatic plants. The altered flow pattern can change the physical character of the channel morphology and substrate composition. These changes affect the types of habitats present and the chemical characteristics of the water. Dams also impede the movement of aquatic organisms and reduce the likelihood of reproductive dispersal. These dam-induced mechanisms change the composition of the ecological communities present. (Reference 2.4.2-8) The Clinch River arm of Watts Bar Reservoir also has been affected by the historical release of pollutants. For example, contaminants released from the Oak Ridge National Laboratory (ORNL) have resulted in sediment toxicity issues between White Oak Creek (at CRM 21, upstream of the CRN Site) and Watts Bar Dam (TRM 530) that may have contributed to mussel declines in this area. (Reference 2.4.2-4)

In addition to water quality, sediment quality was assessed at three locations (CRMs 15.5, 18.5, and 22.0) during the 2011 surveys. Sediment samples were analyzed for pesticides, polychlorinated biphenyls (PCBs), and metals. Metals concentrations were below U.S. Environmental Protection Agency (EPA) Region 4 ecological screening levels for sediment, and pesticides and PCBs were not detected in the sediment samples collected near the CRN Site. Sediments at these locations contained lower metals concentrations than typically found in more lacustrine environments within TVA reservoirs. Substrate composition was characterized at eight downstream transects and eight upstream transects. Sand was the dominant substrate downstream, followed by cobble, silt, and gravel. Clay was the dominant substrate upstream, followed by gravel, cobble, and bedrock. (Reference 2.4.2-6)

Although contaminants were not detected in sediments near the CRN Site, the Division of Water Pollution Control of the Tennessee Department of Environment and Conservation (TDEC) has issued fish consumption advisories for Watts Bar Reservoir due to PCBs and for Melton Hill Reservoir due to PCBs and chlordane. These fish consumption advisories were issued because these contaminants were detected in sediments in other areas of these reservoirs. (Reference 2.4.2-6)

Biological Communities

Since 1990 TVA has systematically monitored the aquatic biological communities in its reservoirs as part of the former Vital Signs Monitoring Program and its ongoing ecological health and compliance monitoring programs. The Clinch River inflow area of Watts Bar Reservoir upstream of the CRN Site has been monitored under this program. (Reference 2.4.2-4) To obtain additional data specifically from the reach of Watts Bar Reservoir adjacent to the CRN Site, TVA initiated additional studies in 2011 to characterize the aquatic communities occurring in the reservoir immediately upstream and downstream of the CRN Site. These 2011 studies were designed to evaluate the diversity, abundance, and condition of resident fish, benthic macroinvertebrate, and plankton communities in the vicinity of the CRN Site in order to establish baseline conditions existing prior to construction and operation of two or more SMRs. During these studies of aquatic habitat, submerged aquatic vegetation (macrophytes) was not observed at either of the study locations. (Reference 2.4.2-6)

<u>Fish Community</u>

Fish communities are used to evaluate ecological conditions because of their importance in the aquatic food web and because fish life cycles are long enough to integrate conditions over time. Impoundments have affected the characteristics of the fish community in the Clinch River arm of Watts Bar Reservoir (Reference 2.4.2-6). The cool water of Melton Hill Reservoir is released to Watts Bar Reservoir at CRM 23.1, approximately 4.1 mi upstream of the CRN Site. Although the water warms with distance below the Melton Hill Dam, its relatively cooler temperatures may limit fish species diversity and abundance downstream (Reference 2.4.2-6). To characterize the fish community currently present in the reach of Watts Bar Reservoir adjacent to the CRN Site, TVA implemented fisheries studies there in 2011. In conjunction with the Vital Signs Monitoring Program, TVA previously developed a fisheries monitoring tool, the Reservoir Fish Assemblage Index (RFAI) (Reference 2.4.2-4). The RFAI was thoroughly tested on TVA reservoirs and other reservoirs and published in peer-reviewed literature. The RFAI was used in the 2011 aquatic habitat study to characterize the fish community in the vicinity of the CRN Site. (Reference 2.4.2-6)

Fish Community Characterization

To characterize the fish community in the Clinch River arm of Watts Bar Reservoir at the CRN Site, TVA selected two fish sampling locations: one located downstream of the CRN Site between CRMs 14 and 16 (referred to as location CRM 15.0), and one located upstream of the CRN Site between CRMs 18 and 19.8 (referred to as location CRM 18.5). Sampling by electrofishing and gill netting was conducted in February, May, July, and October of 2011 to document seasonal variation in fish community composition. The fish collected were identified by species, counted, and examined for anomalies such as disease, deformations, parasites, or hybridization. The resulting data were analyzed using RFAI methodology. (Reference 2.4.2-6)

The RFAI uses 12 fish community metrics from four general categories: Species Richness (numbers of species) and Composition; Trophic Composition; Abundance; and Fish Health. Individual species can be utilized for more than one metric. Together, these 12 metrics provide a balanced evaluation of fish community integrity. (Reference 2.4.2-6) The 12 metrics, grouped by category, are summarized below:

- Species Richness and Composition
  - Total number of indigenous species (greater than 29 required for highest score): Greater numbers of indigenous species are considered representative of a healthier aquatic ecosystem. As conditions degrade, numbers of species in an area decline.
  - Number of centrarchid species (greater than four required for highest score): Sunfish species (excluding black basses) are invertivores, and a high diversity of this group is indicative of reduced siltation and suitable sediment quality in littoral areas.
  - Number of benthic invertivore species (greater than seven required for highest score): Due to the special dietary requirements of this species group and the limitations of their food source in degraded environments, numbers of benthic invertivore species increase with better environmental quality.
  - Number of intolerant species (greater than four required for highest score): A group composed of species that are particularly intolerant of physical, chemical, and thermal habitat degradation. Higher numbers of intolerant species suggest the presence of fewer environmental stressors.
  - Percentage of tolerant individuals (less than 31 percent of electrofishing samples and less than 16 percent of gill net samples required for highest score): This metric signifies poorer water quality with increasing percentages of individuals tolerant of degraded conditions.
  - Percent dominance by one species (less than 20 percent of electrofishing samples and less than 14 percent of gill net samples required for highest score): Ecological quality is considered reduced if one species inordinately dominates the resident fish community.
  - Percentage of non-indigenous species (less than 3 percent of electrofishing samples and less than 5 percent of gill net samples required for highest score): This metric is based on the assumption that non-indigenous species reduce the quality of resident fish communities.
  - Number of top carnivore species (greater than seven required for highest score): Higher diversity of piscivores is indicative of the availability of forage species and the presence of suitable habitat.

- Trophic Composition
  - Percentage of individuals as top carnivores (greater than 11 percent of electrofishing samples and greater than 52 percent of gill net samples required for highest score): This metric is a measure of the functional aspect of top carnivores that feed on lower trophic levels.
  - Percentage of individuals as omnivores (less than 22 percent of electrofishing samples and less than 23 percent of gill net samples required for highest score): Omnivores are less sensitive to environmental stresses due to their ability to vary their diets. As trophic links are disrupted due to degraded conditions, specialist species such as insectivores decline while opportunistic, omnivorous species increase in relative abundance.
- Abundance
  - Average number per run (number of individuals) (greater than 210 from electrofishing samples and greater than 24 from gill net samples required for highest score): This metric is based on the assumption that high-quality fish assemblages support large numbers of individuals.
- Fish Health
  - Percentage of individuals with anomalies (less than 2 percent of gill net and electrofishing samples required for highest score): Occurrences of diseases, lesions, tumors, external parasites, deformities, blindness, and natural hybridization are noted. A higher percentage of individuals exhibiting such conditions can indicate poor environmental conditions. (Reference 2.4.2-6)

The fish species collected from the Clinch River arm of Watts Bar Reservoir in the 2011 study are listed in Table 2.4.2-1. The trophic level for each species is shown, indigenous species are identified, and those species designated as tolerant and intolerant also are identified. The RFAI scores for each location in each season and the associated ecological health ratings for the fish community are summarized in Table 2.4.2-2.

The overall RFAI scores resulted in an ecological health rating for the fish community of “fair” for each season at the downstream location. The ecological health rating for the fish community at the upstream location was “fair” for winter, summer, and autumn, and “good” for spring. These scores are similar to other assessment locations on the Clinch River downstream of Melton Hill Dam. (Reference 2.4.2-6)

Overall RFAI ratings for each season for the downstream and upstream sampling locations were similar. RFAI scores during each of the four seasons differed by four points or less between the two sampling sites. RFAI scores have an intrinsic variability of plus or minus three points. This variability comes from various sources, including:

- Annual variations in air temperature and stream flow

- Variations in pollutant loadings from nonpoint sources
- Changes in habitat, such as extent and density of aquatic vegetation
- Natural population cycles and movements of the species being measured

In addition, nearly any practical measurement, lethal or non-lethal, of a biological community is a sample rather than a measurement of the entire population. This variability due to methods must be considered when comparing scores between sampling locations. (Reference 2.4.2-6)

Both sampling locations received low scores for the metric “average number per run” for both electrofishing and gill net samples each season. Cool water temperatures from Norris Dam releases upstream may limit overall productivity, thus reducing abundance of some species in this portion of the Clinch River arm of Watts Bar Reservoir. Although catch rates were low, species diversity was relatively high at both locations. Averages of 33 (28 indigenous) and 36 species (31 indigenous) were collected at the downstream and upstream locations, respectively. Distinct differences in trophic guild composition of the fish community were evident between locations during each season. The upstream location contained higher proportions of omnivores and fewer proportions of insectivores than the downstream location in each season. Proportions of top carnivores were higher at the upstream location during spring but were similar at the two locations during other seasons. The downstream location had a much higher proportion of benthic invertivores during autumn. (Reference 2.4.2-6)

Thermally sensitive species were defined as those having an upper lethal limit of water temperatures greater than or equal to 90°F. Thermally sensitive species collected in the 2011 sampling are identified in Table 2.4.2-1. On average, two thermally sensitive species were present during all four seasons at both sampling locations. All fish species collected were considered Representative Important Species because they were used to obtain an overall RFAI score. Representative Important Species are defined by the EPA as those species that are representative in terms of their biological requirements of a balanced, indigenous community of fish, shellfish, and wildlife in the body of water into which a discharge is released. (Reference 2.4.2-6)

<u>Fish Eggs and Larvae</u>

Also in 2011, TVA investigated fish eggs and larvae in Watts Bar Reservoir at the CRN Site to assess the temporal occurrence, abundance, and species composition of ichthyoplankton in that part of the reservoir. Samples were collected adjacent to the CRN Site at an upstream location at CRM 18 and a downstream location at CRM 15.5. Eight samples were collected from each location at the following frequencies: once in February 2011, weekly from March through August 2011, and once a month from September 2011 through January 2012. (Reference 2.4.2-3) The sampling frequency was selected to capture seasonal spawning activity of fishes. Thus, sampling was performed weekly during March through August when the majority of spawning occurs and monthly from September through February when little to no spawning occurs. Each sampling event included the collection of eight samples (four day and four night) along a transect at each location. The four day and four night samples were collected along the transects at mid-channel full stratum, mid-channel bottom only, right descending bank, and left descending bank. The species abundance data also were used with sample volume data to calculate species-specific densities of fish eggs and larvae in the water column. (Reference 2.4.2-3)

The total numbers of fish eggs and larvae collected at the upstream and downstream locations and the percentage composition of the samples represented by each taxon are summarized in Table 2.4.2-3. The taxa identified in the samples are organized in the table by family. The families represented in the egg and larvae samples and the principal species identified from each family include the following (Percidae and Polyodontidae constitute less than 1 percent of the total eggs or larvae collected):

- Atherinopsidae (silversides, predominantly Mississippi silversides)
- Catostomidae (buffalofishes, carpsuckers, redhorses)
- Centrarchidae (crappie, sunfishes)
- Clupeidae (gizzard shad, threadfin shad, unidentifiable clupeids, skipjack herring)
- Cyprinidae (common carp, minnows of genus *Pimephales*)
- Moronidae (temperate basses)
- Percidae (darters, yellow perch, walleye)
- Polyodontidae (paddlefish)
- Sciaenidae (freshwater drum) (Reference 2.4.2-3)

A total of 7814 fish eggs were collected at both locations. The families represented, in order of frequency, were:

- Sciaenid (freshwater drum) eggs (53.6 percent)
- Clupeid eggs (23.4 percent)
- Moronid eggs (14.3 percent)
- Unidentifiable eggs (8.7 percent)
- Percid eggs (less than 1 percent) (Reference 2.4.2-3)

A total of 3949 larval fish were collected, representing nine families. Larvae were more abundant downstream than upstream, mainly due to a high number of catostomid larvae downstream. The dominant larval taxon at both transects was the clupeids (67.4 percent). The other taxa contributing at least 1 percent of the total composition were:

- Catostomids (11.7 percent)

- Moronids (10.2 percent)
- Centrarchids (5.6 percent)
- Atherinopsids (1.8 percent)
- Sciaenids/freshwater drum (1.3 percent)
- Cyprinids (1.3 percent) (Reference 2.4.2-3)

A single larval paddlefish was collected at the upstream location (CRM 18) during the survey. The paddlefish is highly valued for its eggs, and the paddlefish fishery throughout the Tennessee Valley has been of special concern and is closely monitored and regulated. This larva is significant in that it indicates that at least some minimal spawning is occurring in the Clinch River arm of the Watts Bar Reservoir in the tailwater below Melton Hill Dam. (Reference 2.4.2-3)

<u>Benthic Macroinvertebrate Community</u>

TVA assessed benthic macroinvertebrate communities of its reservoirs using the Reservoir Benthic Index (RBI) methodology. RBI is a metric used to assess relative conditions at selected locations within TVA reservoirs across the reservoir system. This index does not provide an absolute measure of aquatic community health as compared to an unimpounded river. Therefore, an RBI score of "excellent" does not necessarily equate to an excellent benthic community, rather it indicates an excellent condition of the benthic community as compared to other, similar, reservoir-influenced sites within the TVA reservoir system. Because benthic macroinvertebrates are relatively immobile, negative effects on aquatic ecosystems can be detected earlier in benthic macroinvertebrate communities than in fish communities. Accordingly, RBI data are used to supplement RFAI results to provide a more thorough characterization of aquatic communities. (Reference 2.4.2-6)

The RBI methodology was used in the 2011 aquatic habitat assessment of the CRN Site. Benthic macroinvertebrate communities were sampled along transects with a Peterson or Ponar dredge downstream (CRM 15.0) and upstream (CRM 18.8) of the CRN Site during spring, summer, and autumn of 2011. RBI metrics were scored using evaluation criteria for lab-processed samples collected in the “inflow” reservoir zone. In addition to dredge sampling, during the autumn sampling event, shoreline benthic samples were collected with a kick-net and from rocks along the shoreline at both sites to obtain additional species richness and density data. (Reference 2.4.2-6)

Benthic community results were evaluated using seven metrics for assessing community characteristics. Results for each metric were assigned a rating of 1 (poor), 3 (good), or 5 (excellent), depending on how they scored based on reference conditions developed for Tennessee River reservoir inflow sample sites. The ratings for the seven metrics were then summed to produce a benthic score for each sample site. Potential benthic scores ranged from

7 to 35. Ecological health ratings were then assigned based on the scores using the following scale:

- 7 to 12 = “Very Poor”
- 13 to 18 = “Poor”
- 19 to 23 = “Fair”
- 24 to 29 = “Good”
- 30 to 35 = “Excellent”

The individual metric ratings and overall RBI scores for the downstream and upstream locations based on the 2011 dredge samples are summarized in Table 2.4.2-4. (Reference 2.4.2-6) The individual metrics are summarized below:

- Average number of taxa (greater than 8.3 required for highest score): This metric is calculated by averaging the total number of taxa present in each sample at a site. Higher numbers of taxa (taxa richness) usually indicate better conditions than lower numbers of taxa. (Reference 2.4.2-6)
- Proportion of samples with long-lived organisms (greater than 0.8 required for highest score): This is a presence/absence metric that is assigned based on the proportion of samples collected at a given location containing at least one long-lived organism (e.g., *Corbicula* greater than 10 millimeters (mm), *Hexagenia* greater than 10 mm, mussels, snails). The presence of long-lived organisms is indicative of conditions that allow long-term survival. (Reference 2.4.2-6)
- Average number of Ephemeroptera, Plecoptera, and Trichoptera (EPT) Taxa (greater than 1.9 required for highest score): This metric is calculated by averaging the number of EPT taxa present in each sample at a site. Higher diversity (i.e., a higher average number) of EPT taxa indicates good water quality and better habitat conditions. (Reference 2.4.2-6)
- Percentage as oligochaetes (less than 12.0 percent required for highest score): This metric is calculated by averaging the percentage of oligochaetes in each sample at a site. Oligochaetes are considered tolerant organisms, so a higher percentage indicates poor water quality. (Reference 2.4.2-6)
- Percentage as dominant taxa (less than 73.1 percent required for highest score): This metric is calculated by selecting the two most abundant taxa in a sample, summing the number of individuals in those two taxa, dividing that sum by the total number of individuals in the sample, and multiplying that number by 100 to obtain a percentage. The percentages for each of the 10 samples collected from each location are then averaged. Often, the most abundant taxa differ among the 10 samples at a site. This method for calculating the percentage allows more discretion to identify imbalances at a site than developing an average for a single dominant taxon for all samples at a location. This metric is used as an

evenness indicator. Dominance of one or two taxa indicates poor conditions. (Reference 2.4.2-6)

- Average density excluding chironomids and oligochaetes (density greater than 609.9 required for highest score): This metric is calculated using a two step process. First, the number of organisms in each sample excluding chironomids and oligochaetes is summed to obtain the density without chironomids and oligochaetes. Then an average of these densities for the 10 samples at a site is calculated. This metric examines the community by excluding taxa that often dominate under adverse conditions. A higher abundance of non-chironomids and non-oligochaetes indicates good water quality conditions. (Reference 2.4.2-6)
- Proportion of samples containing no organisms (no empty samples required for highest score): This metric is the proportion of samples at a site that have no organisms present. Empty samples, or "zero samples," indicate living conditions unsuitable to support aquatic life (e.g., due to toxicity or unsuitable substrate). (Reference 2.4.2-6)

The shorelines also were sampled for benthic invertebrates in autumn of 2011. Invertebrate samples were collected from submerged rocks at the upstream location. However, there was not sufficient rock substrate present at the downstream location to collect a sample. Therefore, a kick net was used to collect the sample from the downstream location. The differences in sampling techniques and habitat sampled limit direct comparisons of the results from these two locations. At the downstream location, chironomids and oligochaetes were the dominant taxa. At the upstream location, zebra mussels (*Dreissena polymorpha*), dipterans, hydrobiid snails, and oligochaetes were dominant. Mean densities (organisms/ square meter [m^2]) were about 2 to 3 times higher at the upstream location than at the downstream location, but taxa richness values were similar downstream and upstream. (Reference 2.4.2-6)

Overall, the RBI scores calculated for samples collected from both the upstream and downstream locations during spring, summer, and autumn of 2011 were high. The ecological health rating for the downstream location was "good" in spring and autumn and "excellent" in summer. The ecological health rating for the upstream location was "good" in spring and "excellent" in summer and autumn. The downstream location received the lowest score (1) in only two metrics, the average number of EPT taxa in spring and the average percentage of oligochaetes in autumn. The upstream location received a score of 1 only in the average number of EPT taxa metric in spring. All other metrics were 3 or 5. Taxa richness was higher in samples from the upstream location than in samples from the downstream location during each of the seasons. Mean densities were higher in autumn than in spring or summer at both locations, due to high densities of zebra mussels. The most abundant species collected at either location in spring and summer was the snail *Amnicola limosa*. The Chironomidae family was particularly diverse, with more than 55 distinct species, and was the second most abundant taxon collected at either location during each of the seasons. In the shoreline samples, taxa richness was similar at the upstream and downstream locations. Very few taxa were present in shoreline samples that were not encountered in dredge samples. Overall, these data depict an ecologically healthy benthic macroinvertebrate community in the reservoir both upstream and downstream of the CRN Site. The presence of high densities of zebra mussels upstream and downstream of the CRN Site is of concern because it indicates a potential for biofouling issues. (Reference 2.4.2-6)

In addition to its 2011 RBI assessment of the benthic macroinvertebrate community and the aquatic habitat assessment at the CRN Site, TVA also conducted an evaluation in 2011 that focused on the freshwater mollusk community of the reservoir adjacent to the CRN Site. Both qualitative and semi-quantitative sampling methods were used to characterize the composition, density, and distribution of species within the mollusk community between CRM 15.0 and CRM 19.0. Bank-to-bank survey transects were spaced approximately 300 meters (m) apart and additional transects were placed about 50 m upstream and downstream of the anticipated locations of the discharge and intake structures near CRM 16.0 and CRM 17.9, respectively. Thus, a total of 25 transects were sampled using semi-quantitative methods. In addition, qualitative sampling consisted of 1-hour (hr) timed searches at each of five sites: the discharge site, the intake site, and three sites in areas with the most suitable mollusk habitat, as determined based on data from the semi-quantitative sampling. The report documenting the details of the mollusk survey methods and results is provided in Appendix B of the TVA Technical Report: *Clinch River Small Modular Reactor Site – Evaluation of Aquatic Habitats and Protected Aquatic Animals*. (Reference 2.4.2-4)

The survey collected 74 live mussels from the following six species:

- Pimpleback (*Quadrula pustulosa*) (71.6 percent of the mussels collected)
- Fragile papershell (*Leptodea fragilis*) (17.6 percent of the mussels collected)
- Purple wartyback (*Cyclonaias tuberculata*) (less than 5 percent of the mussels collected)
- Pink heelsplitter (*Potamilus alatus*) (less than 5 percent of the mussels collected)
- Giant floater (*Pyganodon grandis*) (less than 5 percent of the mussels collected)
- Elephant ear (*Elliptio crassidens*) (less than 5 percent of the mussels collected) (Reference 2.4.2-4)

None of these species are federally listed as threatened or endangered. However, relic (nonliving) specimens of four mussel species federally listed as endangered were collected:

- Dromedary pearlymussel (*Dromus dromas*)
- Fanshell (*Cyprogenia stegaria*)
- Rabbitsfoot (*Quadrula cylindrica*)
- Spectaclecase (*Cumberlandia monodonta*)(Reference 2.4.2-4)

The presence of these relic specimens indicates that these species once resided in the Clinch River arm of the Watts Bar Reservoir near the CRN Site. Other relic mussel shells also were collected, including those of the following species:

- Black sandshell (*Ligumia recta*)
- Butterfly (*Ellipsaria lineolata*)
- Fluted kidneyshell (*Ptychobranchus fasciolaris*)
- Longsolid (*Fusconaia subrotunda*)
- Mucket (*Actinonaias ligamentina*)
- Ohio pigtoe (*Pleurobema cordatum*)
- Pocketbook (*Lampsilis ovata*)
- Pyramid pigtoe (*Pleurobema rubrum*)
- Round hickorynut (*Obovaria subrotunda*) (Reference 2.4.2-4)

The only snail species collected was the silty hornsnail (*Pleurocera canaliculata*), which is common within the Tennessee River basin (Reference 2.4.2-4).

Mean mussel density (semi-quantitative sampling) was 0.02 mussels/m^2 and the mean catch rate (qualitative sampling) was 4.2 mussels per hour. The mussels did not appear to be distributed in a particular pattern, but they were most abundant upstream at transects 2 and 3 near CRM 19 and downstream around transect 21 at CRM 16. Substrates where mussels were encountered during the survey contained mixtures of cobble, gravel, and sand, but in numerous areas with this substrate type mussels were less abundant or absent. Unsuitable substrates included bedrock and heavily silted areas, which were located along the banks of the river. (Reference 2.4.2-4)

The survey concluded that the mussel community at the CRN Site is in poor condition. Evaluation of the 2011 mollusk and habitat survey in conjunction with historical surveys near the CRN Site indicated that habitat conditions to support mussels are generally inadequate, despite improvements in reservoir releases from Melton Hill Dam and Watts Bar Dam that began in 1991. In previous studies in the Clinch River arm of the Watts Bar Reservoir in the vicinity of the CRN Site, 16 mussel species were found in 1918, 10 species were found in 1982, 15 species were found in 1991, and six species were found in 1994. Comparing the 2011 mussel survey results to the 1982 survey results and accounting for sampling effort, the decline in numbers was estimated to be approximately 60 percent. In addition, no evidence of recent mussel reproduction was found in the 2011 survey, because no juvenile mussels were found and individuals 15 yr old or older were common. (Reference 2.4.2-4)

Plankton Community

The plankton component of the aquatic ecosystem is made up of drifting organisms, including algae (phytoplankton), protists, metazoans and larvae (zooplankton), and bacteria and archaea (bacterioplankton). These organisms form the bottom of the trophic food chain upon which the other levels depend. (Reference 2.4.2-9) During 2011, TVA surveyed both phytoplankton and zooplankton while characterizing the aquatic communities at the CRN Site. Plankton samples were collected at the same time as the water chemistry samples, monthly from March through December 2011. (Reference 2.4.2-6)

Phytoplankton

For each sample, chlorophyll a concentrations were determined and a fraction of the algal community was identified and counted until the standard error for mean abundance was less than 10 percent. Basic statistics were calculated, including cell densities, biovolume, and mean abundance. Chlorophyll a concentrations were low in all samples, ranging from less than 1.0 to 5.0 micrograms per liter (µg/L). In approximately 40 percent of the samples, concentrations were undetectable, and only two samples contained greater than 2 µg/L. These low concentrations indicate that phytoplankton growth was very limited at the CRN Site. Turbulence causing light limitation was the most likely factor influencing growth. Occasional higher concentrations upstream were attributed to releases from the Melton Hill Reservoir, which is less turbulent. (Reference 2.4.2-6)

A total of 81 phytoplankton taxa were collected during the 2011 survey. The taxa collected were:

- Chlorophytes (32 taxa)
- Bacillariophytes (17 taxa)
- Cyanophytes (16 taxa)
- Chrysophytes (eight taxa)
- Euglenophytes (three taxa)
- Pyrrophytes (three taxa)
- Cryptophytes (two taxa)

The phytoplankton was numerically dominated by cyanophytes, which represented 90 to 99 percent of the samples at all locations and sampling times. The other algal groups consistently represented less than 2 percent of the assemblage each. Chrysophytes and cryptophytes represented approximately 1 percent of the assemblage, and euglenophytes and pyrrophytes were below 1 percent. (Reference 2.4.2-6)

Phytoplankton population size estimates ranged from 3600 to 52,000 cells per milliliter (cells/mL). Variability among locations and dates was accounted for by the abundance of cyanophytes due to their overall dominance. Other algal groups showed the same trend. Highest abundances were present at CRM 22, followed by CRM 15.5; lowest abundances were present at CRM 18.5. Higher abundance upstream may be due to releases from Melton Hill Reservoir. Abundance trended downward generally in the autumn, due to factors including seasonal declines in water temperature, light levels, and nutrients. (Reference 2.4.2-6)

Phytoplankton biovolume varied from 23,000 to 920,000 cubic micrometers per milliliter ($\mu m^3/mL$), with a maximum in spring. The sample with maximum biovolume contained the diatom *Melosira*, which represented 60 percent of the total. This species is usually found in reservoirs rather than in flowing waters. Diatoms dominated biovolume in most months. Although the cyanophytes dominated numerical abundance, they contributed an average of only approximately 7 percent of the total biovolume due to their small individual size. Euglenophytes and pyrrophytes often include large-celled phytoplankton. Therefore, a few individuals can contribute considerable biovolume. The pyrrophytes *Glenodinium, Gymnodinium*, and *Peridinium* contributed up to 65 percent of total biovolume when present. (Reference 2.4.2-6)

Phytoplankton populations in the area of the CRN Site were characterized by low abundance and appeared to result mainly from phytoplankton populations generated within Melton Hill Reservoir and transported downstream. Based on chlorophyll results, phytoplankton productivity in the sampled reach was very limited. Phytoplankton populations were essentially in a senescent phase. Productivity was likely light-limited due to turbulence within the water column. (Reference 2.4.2-6)

Similar temporal patterns in the structure of the phytoplankton communities were evident among the sampling locations, though many phytoplankton taxa occurred at various times and locations. Quantitative characteristics (total and group cell densities) often varied substantially. Overall, cyanophytes were dominant numerically throughout the 10-month study period, and bacillariophytes (diatoms) were typically dominant in terms of biovolume. Although no definitive spatial trends were evident, there was a general pattern of higher population densities at the most upstream site from March through August. These higher densities likely are related to entrainment of phytoplankton in releases from Melton Hill Dam and the proximity of the most upstream location to the dam. This pattern was not evident after August, when phytoplankton densities were substantially lower at all sampling locations due to increased flow and the interrelated effects of seasonal changes. (Reference 2.4.2-6)

Zooplankton

Eighteen zooplankton taxa were collected during the 2011 survey. The most diverse group was the cladocerans (eight taxa), followed by the rotifers (seven taxa) and copepods (three taxa). More copepod taxa may have been collected, but identification past the level of order was not possible. The three taxa identified were *Diaptomus* sp., *Tropocyclops prasinus* and *Cyclops* sp. Overall taxa richness varied between four and eight taxa. Individual samples consisted of one to seven taxa. Only seven of the taxa were collected in all three sites in one sample period. Seven taxa were represented in only one sample. *Bosmina longirostrus* was the most common species, present in 63 percent of the samples. Other common taxa were *Daphnia lumholtzi* and *Asplanchna brightwellii*. Cyclopoid copepods were present in 70 percent of the samples. Calanoid copepods were in 43 percent of the samples. (Reference 2.4.2-6)

Zooplankton abundance was generally low, although variable, ranging from 34 to 12,790 individuals. Seasonally, densities rose through spring, peaked in July, then declined through December. Copepods were numerically dominant in April at all locations. Rotifers, including *Asplanchna brightwellii* and *Conochilus unicornis*, were dominant in May. Zooplankton density in May was highest at the farthest upstream location (CRM 22). All populations reached their highest levels in June. During this peak, the cladocerans were the dominant taxonomic group. Common species included *Daphnia lumholtzi*, *Daphnia pulicaria*, *Diaphanosoma leuchtenbergianum, Bosmina longirostris*, and *Chydorus sphaericus*. *Daphnia lumholtzi* was the only taxon collected from the CRM 18.5 sampling location in June. Populations were low in abundance from August to December, generally with less than 500 organisms per cubic meter. The lowest densities occurred in October and November, when samples contained high numbers of rotifers in the family Notommatidae. (Reference 2.4.2-6)

Biomass of the zooplankton community ranged from 1 to 42,300 micrograms dry weight per cubic meter. Most samples were characterized as low or sparse in biomass, with exceptions during peak densities in June and July. The clodocerans were the largest organisms and contributed the most to biomass estimates, followed by the copepods and rotifers. Biomass was highest in mid-summer and lowest in late autumn. The relative biomass of individual taxa was highly variable, in part due to succession within the assemblage, but also because of low abundance and diversity overall. (Reference 2.4.2-6)

Zooplankton assemblages in the vicinity of the CRN Site were characterized by low abundance and diversity throughout the 10-month sampling period. High turbulence and advection within the sampling reach likely limited zooplankton populations and affected their distribution. Zooplankton assemblages often showed a notable degree of spatial heterogeneity in terms of both species composition and total abundance, but no systematic differences were evident. Conversely, similar temporal patterns were evident among sites due to seasonal succession within the zooplankton communities and the proximity of the locations sampled. At each sampling location, copepods were the dominant taxonomic group in early spring (March and April). Rotifers were the dominant taxonomic group in May. Peak zooplankton abundance and biomass occurred during June and/or July and were dominated by Cladocera. These peaks were associated with warmer water temperatures and generally low flow. Abundance and biomass were extremely sparse throughout the remainder of the year, with no ecologically significant differences evident among sites. (Reference 2.4.2-6)

2.4.2.1.2 Melton Hill Reservoir

Melton Hill Dam is operated primarily for the purposes of navigation and hydroelectricity generation. As discussed in Subsection 2.3.1.1.2.4, the main source of water for the Clinch River arm of the Watts Bar Reservoir at the CRN Site is the release from Melton Hill Dam.

Releases from Melton Hill Dam range from no discharge to the maximum turbine capacity of about 21,000 cubic feet per second (cfs) to 23,000 cfs. Intervals of 12 to 22 hr with no releases are common. For the period 2004 through 2013, the overall average release was approximately 4670 cfs. Approximately 80 percent of the total annual inflow to Melton Hill Reservoir is discharged from Norris Dam. Because the water is discharged from deep within Norris Reservoir, water temperatures in the lower half of the water column of the Melton Hill forebay often remain cold (54 to 66°F) from early spring until late autumn. (Reference 2.4.2-6) Melton Hill Reservoir exhibits a temperature gradient from north to south, which is influenced by the coal-fired Bull Run Fossil Plant that discharges warm water at approximately CRM 77. In January of 2000, surface water temperatures in Melton Hill Reservoir were 46.4°F at CRM 65, 68°F at CRM 77, 55.4°F at CRM 44, and 46.4°F at CRM 32. (Reference 2.4.2-10)

TVA monitors the ecological health of Melton Hill Reservoir at three locations: the forebay near the dam, the mid-reservoir, and the inflow at the upper end of the reservoir. TVA assesses the ecological health of the reservoir using measurements of DO, chlorophyll, fish and benthic macroinvertebrate communities, and sediment quality. Monitoring usually is performed on a 2-yr cycle, and the most recent ecological health ratings for Melton Hill Reservoir are based on monitoring in 2012. (Reference 2.4.2-11)

Physical and Chemical Characteristics

Based on ecological health monitoring data for DO, the mid-reservoir has been rated “good” during every year of monitoring. DO typically also has been rated “good” in the forebay, except that it was rated “fair” in the forebay in 2000, 2001, and 2008 and “poor” in 2012 due to extended periods with low-flow conditions. (Reference 2.4.2-11) TVA valley-wide monitoring data from 2011 collected from the forebay (CRM 24.0) above Melton Hill Dam and the tailrace (CRM 23.1) below the dam indicated that DO in the forebay ranged from a depth-averaged concentration of 6.2 mg/L in June to 11.2 mg/L in March. DO concentrations in the tailrace ranged from 6.5 mg/L in June to 9.7 mg/L in May. (Reference 2.4.2-6)

In 2012 sediments at the forebay location were rated “fair” due to slightly elevated levels of arsenic. The mid-reservoir location was rated “good” because no PCBs or pesticides were detected and no metals concentrations were elevated in the sediment samples in 2012. However, chlordane, PCBs, arsenic, and copper have been detected at elevated levels in sediment samples in some previous years. (Reference 2.4.2-11) Sediments collected in Melton Hill Reservoir in 2011 contained PCBs (Aroclor 1242). TDEC has issued fish consumption advisories for the reservoir due to PCBs and chlordane. (Reference 2.4.2-6)

Biological Communities

TVA’s reservoir monitoring program measures ecological health based on three biological indicators: chlorophyll, fish, and bottom life. Chlorophyll concentrations in Melton Hill Reservoir historically have been measured at the forebay and mid-reservoir locations. Ratings for 2012 were “fair” at the forebay and “good” at the mid-reservoir locations. Since 1998, chlorophyll ratings at the forebay location have fluctuated between “fair” and “poor.” Ratings at mid-reservoir have varied through time with no clear trend. Reservoir flows play a role in the yearly fluctuations because lower flows allow more time for the algal community to expand. (Reference 2.4.2-11) In 2011, chlorophyll a concentrations at the forebay location ranged from 6 to 19 µg/L and averaged 11.8 µg/L (Reference 2.4.2-6).

The fish assemblage in 2012 was rated “good” at the forebay, “fair” at mid-reservoir, and “poor” at the inflow location. This was consistent with previous ratings, which reflected a fish assemblage at each location characterized by a lower abundance of fish and higher proportions of tolerant species than would be expected. In 2012, as in most previous years, higher diversity at the forebay and mid-reservoir resulted in higher ratings at those locations (Reference 2.4.2-11)

The benthic community was rated “fair” at the forebay and mid-reservoir and “poor” at the inflow in 2012. Most of the organisms collected were considered tolerant of poor conditions. Historically, ratings were “fair” to “poor” at the forebay and “poor” at the inflow. Ratings have recently improved due to an increase in less tolerant species. (Reference 2.4.2-11)

2.4.2.1.3 Streams and Ponds on the CRN Site and the Barge/Traffic Area

During several visits to the CRN Site and adjacent Grassy Creek Habitat Protection Area (HPA) in April and May 2011, October 2013, and October 2014, TVA mapped the locations of waterbodies within the survey area using a global positioning system (GPS). Also in 2014, TVA performed a survey of waterbodies in the Barge/Traffic Area between the CRN Site entrance and Tennessee State Highway (TN) 58. Surveys were conducted on the portions of the Barge/Traffic Area (101-ac) with the highest potential for disturbance that had not been previously surveyed. All streams documented in the surveyed areas, with the exception of the Clinch River arm of the Watts Bar Reservoir and associated backwaters, are first-order, unnamed tributaries of the reservoir. (Reference 2.4.2-4) Perennial streams have a well-defined channel, flowing water throughout the year under normal weather conditions, and support aquatic organisms. Intermittent streams have a well-defined channel, flowing water during wet seasons but not the entire year, and support aquatic organisms during periods when water is present. Intermittent streams flow in response to major rainfall events or as long as ground water is abundant. (Reference 2.4.2-12) The streams were determined to be perennial or intermittent based on the geomorphology of the channel, hydrologic characteristics, and the presence of visually observable aquatic fauna. Ephemeral streams/wet-weather conveyances (WWCs) flow diffusely over depressions, usually not in a well-defined channel, and only for short periods in response to major rainfall events. Flow in WWCs is not driven by ground water sources, and aquatic organisms are not present. (Reference 2.4.2-12)

Other than the Clinch River arm of the Watts Bar Reservoir and associated backwaters, TVA identified four perennial streams on the CRN Site and two perennial streams in the Barge/Traffic Area. One additional stream identified on the CRN Site and four additional streams in the Barge/Traffic Area were determined to be intermittent. Six ponds were identified on the CRN

Site, all of which were determined to be man-made and four of which were originally created as stormwater retention ponds. Two ponds were identified in the Barge/Traffic Area. Descriptions of these streams and ponds are included in Table 2.4.2-5, and their locations are shown in Figure 2.4.1-2. (Reference 2.4.2-4)

Table 2.4.2-5 also includes the streamside management zone (SMZ) categories determined for the onsite streams and ponds. An SMZ consists of a stream and an adjacent management area of variable width where management practices are modified to protect water quality. They are intended to “filter sediment and nutrients from overland runoff, allow water to soak into the ground, protect stream banks and lakeshores, provide shade for streams and improve the aesthetics of forestry operations.” Perennial streams and intermittent streams with a well-defined channel and water flow 40 to 90 percent of the time require SMZs. The SMZs should be at least 50 feet (ft) wide, with increasing width depending on the percent slope of the adjacent land. WWCs do not require SMZs but would be protected by established Best Management Practices (BMPs) to the extent practical. (Reference 2.4.2-12) Based on the SMZ categories determined for the streams and ponds on the CRN Site, all but one are Category A and require a 50-ft SMZ, and one stream is Category B and requires a 100-ft SMZ. Stream S06 was designated as Category B to provide more protection to the spring from which it originates. (Reference 2.4.2-4).

In addition to the perennial and intermittent streams on the CRN Site and the Barge/Traffic Area, the TVA survey identified the WWCs shown in Figure 2.4.1-2 (Reference 2.4.2-4). The WWCs on the CRN Site and the Barge/Traffic Area are listed in Table 2.4.2-5 and each is identified as natural or constructed.

A Hydrologic Determination Field Data Sheet, which is a form developed by the Tennessee Division of Water Pollution Control, was completed for each watercourse. The data sheets, which include scores for and descriptions of the onsite water bodies evaluated, are provided in Appendix A of the TVA report *Clinch River Small Modular Reactor and Barge/Traffic Site – Evaluation of Aquatic Habitats and Protected Aquatic Animals Technical Report*. (Reference 2.4.2-4)

In March 2015, biological surveys were conducted on seven of the streams previously delineated on the CRN Site and the Barge/Traffic Area that were considered to have the greatest potential to support aquatic communities. Four of those streams are perennial and three are intermittent. An additional perennial stream located north of the CRN Site, Grassy Creek, also was sampled due to its proximity and habitat likely to support fish and crayfish. The streams were sampled using timed searches with a backpack electrofishing unit and a seine. All available habitat types were sampled in each stream (e.g., pool, riffle, run). On the CRN Site, the three streams sampled were perennial streams S01, S05, and S06 (Figure 2.4.1-2). The entire length of stream S01 (approximately 925 ft) was sampled, and no fish were collected. A few crayfish were observed but were too small for identification. In stream S05, one fish (a banded sculpin) and one crayfish were collected. No fish or crayfish were collected in stream S06. In the Barge/Traffic Area, one crayfish was identified in intermittent stream S09, and no fish or crayfish were collected in the other three streams sampled (S07, S08, and S12) (Figure 2.4.1-2). Thus, only one fish was collected or observed in any of the streams on the CRN Site or the Barge/Traffic Area, and stable habitat supportive of a viable fish community was not observed in these streams. In Grassy Creek, 70 individuals of nine fish species were collected. Of the aquatic species documented in any of the streams sampled, none were federally or state-listed. (Reference 2.4.2-13)

2.4.2.1.4 Aquatic Habitats in Offsite Transmission Line ROWs

In addition to Watts Bar Reservoir and the streams and ponds on the CRN Site and Barge/Traffic Area, potentially affected aquatic habitats also could include offsite streams that intersect the 500-kV transmission line right-of-way (ROW) east of the CRN Site. Installation of a 69-kV underground transmission line is planned within the 5-mi segment of the existing ROW that extends east from the CRN Site to the Bethel Valley substation. Installation of the proposed underground transmission line potentially could affect aquatic organisms within streams crossed by the 69-kV line.

Three streams that cross the ROW are designated as aquatically sensitive areas (Figure 2.4.1-3). Ish Creek is an aquatic natural area that crosses the ROW approximately 0.5 mi from the CRN Site. Northwest Tributary is an aquatic reference area consisting of three small streams, two of which cross the ROW approximately 2 to 2.5 mi from the CRN Site. There are no recorded occurrences of federally or state-listed aquatic species within this ROW. The Tennessee dace, a fish designated by the state as in need of management, has been recorded in Ish Creek approximately 0.25 mi downstream of this ROW. Up to three additional streams also would be crossed: Streams S03 and/or S06 on the CRN Site near the northeastern boundary (Figure 2.4.1-2), and a small stream that crosses the ROW slightly southwest of the Bethel Valley substation.

As discussed in Subsections 2.2.3, 2.4.1.6, and 3.7.3.8, the transmission system structures within ROWs outside the CRN Site (other than the 69-kV underground line) would require modification by uprating, reconductoring, or rebuilding activities, but additional ROWs would not be developed. The lines that include segments or structures that may need to be modified are overlaid on a map of regional land cover types in Figure 2.2-7. Based on TVA’s Natural Heritage database, the aquatic resources that potentially occur within the ROWs of the lines that may be modified are identified in Table 2.4.1-7. These resources include designated critical habitats for two endangered mussel species (one line segment to be uprated crosses over a riverine habitat unit for each species). Aquatic habitats within these existing ROWs would not be affected by these activities because of the limited potential for impacts associated with the types of activities to be performed and the use of BMPs to prevent or minimize erosion and sedimentation.

2.4.2.2 Important Aquatic Habitats

U.S. Nuclear Regulatory Commission (NRC) guidance (NUREG 1555, *Standard Review Plans for Environmental Reviews for Nuclear Power Plants: Environmental Standard Review Plan*) identifies important aquatic habitats as follows:

- Wildlife sanctuaries, refuges, and preserves
- Habitats identified by the State Natural Heritage Program, the U. S. Fish and Wildlife Service (USFWS), or the National Marine Fisheries Service as unique, rare, or of priority for protection
- Wetlands, floodplains, or other resources protected by federal regulations or executive orders or by state regulations
- Critical habitats designated by the USFWS to protect listed species

Wetlands are discussed in Subsection 2.4.1, Terrestrial Ecology, and floodplains are discussed in Section 2.3, Water.

A 2015 report by TVA assessed natural areas on, adjacent to, and within 3 mi of the CRN Site. These areas are described in Subsection 2.4.1.3 and shown in Figure 2.4.1-3. Those that encompass notable aquatic habitats near the CRN Site include the Grassy Creek HPA, the eight aquatic natural areas and seven aquatic reference areas within the Oak Ridge Reservation (ORR), and the New Zion Unit Proposed State Natural Area (SNA). The Grassy Creek HPA adjoins the north end of the CRN Site and includes 265 acres (ac) intended to provide a buffer for sensitive habitat surrounding Grassy Creek and the Grassy Creek embayment of Watts Bar Reservoir. Within the ORR, the Ish Creek aquatic natural area (ANA1 on Figure 2.4.1-3) is located east of the CRN Site and within approximately 0.25 mi of the Site Boundary at its closest point. The New Zion Unit Proposed SNA is immediately east of the CRN Site and includes wetlands and the Raccoon Creek embayment of Watts Bar Reservoir. (Reference 2.4.2-14; Reference 2.4.2-15)

2.4.2.3 Important Aquatic Species

According to NUREG-1555, important species may include:

- Rare species, including:
  - Species federally listed as threatened or endangered
  - Species that are proposed for federal listing
  - Species that are candidates for federal listing
  - Species that are state-listed as threatened, endangered, or a species of concern
- Commercially or recreationally valuable species

- Species that are essential to the maintenance and survival of rare or commercially or recreationally valuable species
- Species that are critical to the structure and function of the local ecosystem
- Species that may serve as biological indicators to monitor the effects of the proposed facility on the environment
- Nuisance species that could cause problems for facility operations

Aquatic species that are important with regard to the CRN Site are discussed below. In conjunction with agency coordination regarding listed species, TVA sent letters to the USFWS and TDEC in September 2016 requesting their concurrence with the listed species identified as important species for the site. These letters are included in Appendix A. Information provided in the consultation responses from USFWS and TDEC will be incorporated when received, and the responses will be included in Appendix A.

2.4.2.3.1 Federally Listed Species

Species with federal listing status (currently listed, proposed for listing, or candidates for listing) and recorded occurrences in Roane County, Tennessee are identified in Table 2.4.2-6. There are 13 aquatic, federally-listed, threatened or endangered species and one candidate species with documented occurrences in Roane County, Tennessee. These include 12 freshwater mussels that are listed as endangered, one fish that is listed as threatened, and an aquatic cave salamander that is a candidate for listing. Eight of these federally endangered mussel species have Natural Heritage element occurrence rankings of “historical” (last recorded occurrence in the county greater than 25 yr old) or “considered extirpated” (no longer occurs in this portion of its former range). The species with only historical records of occurrence are:

- Spectaclecase
- Fanshell
- Fine-rayed pigtoe
- Alabama lampmussel
- Ring pink
- Orangefoot pimpleback
- Purple bean (Reference 2.4.2-4)

The turgid blossom pearlymussel is considered extirpated. Because these eight historical or extirpated species have not been detected in many decades, including the 2011 mollusk survey at the CRN Site, and habitat conditions in this area appear to remain unsuitable for mollusks, TVA has determined that these species either do not occur or occur at extremely low (undetectable) levels near the CRN Site. (Reference 2.4.2-4) Accordingly, these eight mussels are not considered to have the potential to be affected by the CR SMR Project and are not addressed further.

The federally listed aquatic species potentially occurring in Roane County and ranked as extant (recorded occurrence less than or equal to 25 yr old) in the region are discussed below. Although these species historically have occurred or potentially could occur in the vicinity of the CRN Site, recent surveys, including a survey performed by TVA in 2011, did not detect any aquatic federally listed species in the Clinch River arm of the Watts Bar Reservoir. (Reference 2.4.2-4)

Pink mucket (Lampsilis abrupta)

The pink mucket mussel was historically found in 25 river systems in the Tennessee, Cumberland, and Ohio River drainages, including the Clinch River. A recovery plan was prepared by the USFWS in 1985. At that time, the pink mucket was known to exist in 16 rivers throughout these drainages. Reasons for the decline of this species include impoundment, siltation, and pollution. The pink mucket is usually found in medium to large rivers greater than 20 m wide in moderate to fast flowing water. (Reference 2.4.2-16) However, individuals occasionally become established in small to medium sized tributaries of large rivers. The pink mucket inhabits rocky bottoms with swift current, usually in less than 3 ft of water. It appears to be tolerant of reservoir conditions with some flow. (Reference 2.4.2-4) The pink mucket has an elliptical shell approximately 105 mm long, 82 mm high, and 61 mm wide at full size. The surface of the shell is smooth except for the growth rings. Reproduction is similar to the other freshwater mussels. Females collect broadcast sperm and larvae (glochidia) temporarily attach to a fish host for dispersal. (Reference 2.4.2-16) The pink mucket spawns from August to September and releases larvae the following year between May and July. Fish hosts of the larval stage include largemouth bass, smallmouth bass, spotted bass, and walleye. (Reference 2.4.2-4)

The pink mucket mussel is federally listed as endangered and is listed by the State of Tennessee as endangered (Reference 2.4.2-4). The recovery plan for this species states that, as of 1985, individuals had recently been found downstream of the Melton Hill Dam (Reference 2.4.2-16). A live pink mucket was collected in 1984 slightly upstream of the CRN Site at CRM 19.1. However, the 2011 surveys of the Clinch River arm of the Watts Bar Reservoir adjacent to the CRN Site did not find any live or relic specimens of the pink mucket. (Reference 2.4.2-4)

Sheepnose (Plethobasus cyphyus)

The sheepnose is a medium-sized mussel, generally reaching less than 5 inches (in.) long. The shell is elongated and ovate with thick solid valves. The anterior is rounded and the posterior is bluntly pointed. The outer surface has a row of large, broad, tubercular swellings in the center. The sheepnose is light yellow to yellowish brown in color with slightly darker growth arrest ridges. The interior of the shell is white, pinkish, or cream colored with iridescence at the posterior. The details of the life history of the sheepnose are unknown. The sheepnose is thought to reach sexual maturity at a few years of age and spawns in early summer. The sheepnose is believed to be a short-term brooder that releases glochidia in masses. (Reference 2.4.2-17) The fish host has been identified as the sauger (Reference 2.4.2-4). Recent laboratory studies also have shown that successful metamorphosis can be obtained on fathead minnow (*Pimephales promelas*), creek chub (*Semotilus atrromaculatus*), central stoneroller (*Campostoma anomalum*), and brook stickleback (*Culaea inconstans*) (Reference 2.4.2-17).

The sheepnose mussel is federally listed as endangered, but is not listed by the State of Tennessee (Reference 2.4.2-4). The sheepnose is found in large streams in shallow shoals with moderate to swift currents. Substrates inhabited include sand, gravel, mud, cobble, and boulders. Historically, the sheepnose occurred in at least 76 streams and rivers in the Mississippi, Ohio, and Tennessee River basins across 14 states. The sheepnose is currently known to exist in 25 streams and rivers in the same 14 states, including the Clinch River. Individuals have been recorded in the Clinch River as recently as 2006. (Reference 2.4.2-17) A living sheepnose was collected in 1994 at CRM 21.4 (Reference 2.4.2-4). Habitat destruction and degradation are the reasons for the decline of this species. No critical habitat has been designated for the sheepnose. (Reference 2.4.2-17) The 2011 surveys of the Clinch River arm of the Watts Bar Reservoir adjacent to the CRN Site did not find any live or relic specimens of the sheepnose (Reference 2.4.2-4).

Rough rabbitsfoot (Quadrula cylindrica strigillata)

The rough rabbitsfoot is a medium-sized mussel reaching up to 5 in. long (Reference 2.4.2-18). The rough rabbitsfoot has a yellow to greenish shell covered in green rays and blotches. The interior of the shell is silvery to white and iridescent. The rough rabbitsfoot is found in a range of waterbodies, from small headwater streams to large rivers in moderate to swift current. Substrates inhabited include silt, sand, gravel, and cobble. The rough rabbitsfoot spawns from May through June. (Reference 2.4.2-19) The rough rabbitsfoot is a short-term brooder, and the fish hosts for its glochidia include the whitetail shiner (*Cyprinella galactura*), spotfin shiner (*C. spiloptera*), and bigeye chub (*Hybopsis amblops*) (Reference 2.4.2-18).

The rough rabbitsfoot is federally listed as endangered, and is listed by the State of Tennessee as endangered (Reference 2.4.2-20). The rough rabbitsfoot is endemic to the Tennessee River system and was historically found in the Clinch River above Norris Reservoir. The rough rabbitsfoot currently is found only in three streams and rivers in Tennessee and Virginia, including the Clinch River. Reasons for the decline of this species are habitat destruction and deterioration as a result of human activities. (Reference 2.4.2-19) Critical habitat has been designated for the rough rabbitsfoot in the Clinch River in Hancock County in Tennessee and Scott, Russell, and Tazewell Counties in Virginia (Reference 2.4.2-21). The 2011 surveys of the Clinch River arm of the Watts Bar Reservoir adjacent to the CRN Site did not find any live or relic specimens of the rough rabbitsfoot (Reference 2.4.2-4).

Spotfin chub (Erimonax monachus)

The spotfin chub is a small fish reaching a maximum length of 92 mm. The spotfin chub is dusky green above the lateral line and silver on the lower sides, bordered by gold and green stripes. There is no speckling on the body, but there is a distinct caudal fin spot. The sexes are dimorphic, with males having longer dorsal, anal, and pelvic fins. (Reference 2.4.2-22) The spotfin chub inhabits clear upland rivers in swift currents over boulder substrates. Spawning occurs from May through August (Reference 2.4.2-4).

The spotfin chub is federally listed as threatened, and is listed by the State of Tennessee as threatened (Reference 2.4.2-4). The spotfin chub existed historically in 24 streams in the upper and middle Tennessee River system. The spotfin chub is now found in only four rivers. (Reference 2.4.2-23) The historical range included the Clinch River, and a single specimen was collected in 1893 in the area now occupied by the Norris Reservoir. Reasons for the decline of this species include habitat destruction by impoundment, channelization, pollution, turbidity or siltation, temperature changes, and possible over-collecting and interspecific competition. Critical habitat has been designated for the spotfin chub in North Carolina and Virginia and in Cumberland, Fentress, and Morgan Counties in Tennessee. (Reference 2.4.2-22) The spotfin chub has been observed and collected in the City of Oak Ridge and could be present on the ORR (Reference 2.4.2-24). An individual was found in East Poplar Creek in 2002 during an ORNL stream sampling event (Reference 2.4.2-25). Although it has been recorded in Roane County, the spotfin chub is extremely unlikely to occur in the Clinch River arm of the Watts Bar Reservoir due to the unsuitable habitat conditions present in the reservoir (Reference 2.4.2-4).

Berry Cave salamander (Gyrinophilus gulolineatus)

The Berry Cave salamander is aquatic and an obligate cave dweller. The Berry Cave salamander reaches a maximum length of 136 mm and has a broad head with a truncated and spatulate snout and very small eyes. The gills are long and pink with purplish flecks. The tail is laterally compressed and has a fin that extends up the back. Adults typically are mottled dark brown, and juveniles are lighter in color. Unpigmented sensory pores are present on the head and along the sides of the body. (Reference 2.4.2-26) The Berry Cave salamander usually retains some larval characteristics as an adult, but it can metamorphose and lose these characteristics. Generally, cave salamanders become sexually mature without complete metamorphosis into the adult stage. Very little is known of its breeding habits or life span. The habitat of the Berry Cave salamander is subterranean waters in the Appalachian Valley and Ridge Province in East Tennessee. The Berry Cave salamander requires cave habitats with an inflow of organic detritus and aquatic prey. (Reference 2.4.2-27)

The Berry Cave salamander is a candidate for federal listing as endangered or threatened by the USFWS, and is listed by the State of Tennessee as threatened (Reference 2.4.2-20). Ongoing threats to the species include lye leaching from quarrying activities, urban development, water quality degradation, and genetic hybridization with other salamander species (Reference 2.4.2-28). Water quality issues that threaten the species include pesticide use, agricultural runoff, roadway runoff, and siltation due to forestry operations (Reference 2.4.2-27). The known locations of the Berry Cave salamander are in the Upper Tennessee River and Clinch River drainages. The Berry Cave population is in Roane County, Tennessee (Reference 2.4.2-28). Berry Cave is located approximately 9 mi south of the CRN Site and a few hundred yards west of Watts Bar Reservoir. None of the caves in which the Berry Cave salamander is known to occur are located on or adjacent to the CRN Site (Reference 2.4.2-26).

2.4.2.3.2 State-Listed Species

Seventeen aquatic species with a state listing or other state protected status have recorded occurrences in Roane County (Table 2.4.2-6). These include two amphibians, five fish, nine mussels, and one plant that are state-listed as threatened or endangered, are deemed in need of management, or are of special concern. Eleven of these species also are federally listed. In Subsection 2.4.2.3.1, these federally listed species either were identified for evaluation or were eliminated from further evaluation because they are not considered to have the potential to be affected by the CR SMR Project due to their extirpation or historical absence from the area. The remaining aquatic species that have a state listing or other protective status include one amphibian, four fish, and one plant. None of these species were observed during biological surveys of aquatic habitats performed at the CRN Site in March 2015. These species are briefly discussed below.

Hellbender (Cryptobranchus alleganiensis)

The hellbender has been designated by TDEC as in need of management (Reference 2.4.2-20). The hellbender is a completely aquatic, large salamander that can reach a length of up to 29 in. The hellbender is brown to grayish in color with irregular dark blotches. The body is flattened horizontally, and the tail is flattened vertically. The hellbender has four short legs with four toes on the front feet and five toes on the rear feet. Along the body, between the front and hind legs, are skin folds that are used in respiration. Larval hellbenders have external gills, but at 18 months of age, a metamorphosis results in the loss of these gills. Hellbender breeding season occurs between September and early November. Males dig shallow depressions under a rock or log in which females deposit two long strings of eggs, which are fertilized by the male as they are laid. The males brood the eggs in the nest for 2 to 4 months. Hellbenders become sexually mature at 5 to 7 yr and can live up to 30 yr. Lack of suitable large objects has been proposed as a population-limiting factor for the hellbender. The hellbender usually is found in medium to large streams and rivers with fast-flowing water and rocky substrates. (Reference 2.4.2-29) Hellbenders have been found in the tail waters below Melton Hill dam upstream of the CRN Site. The Clinch River arm of the Watts Bar Reservoir potentially provides habitat suitable for the hellbender, including large rocks and logs for breeding sites, but the hellbender has not been documented near the CRN Site. (Reference 2.4.2-30) The last known record of the hellbender in the Clinch River arm of the Watts Bar Reservoir was a collection in the Melton Hill dam tailwaters in 1989. This species has not been reported from the Clinch River since then and is assumed to no longer be present. (Reference 2.4.2-31)

Blue sucker (Cycleptus elongatus)

The blue sucker is listed as threatened by TDEC (Reference 2.4.2-4). The blue sucker is a fish which is olive-blue or slate-olive on its back and sides with a lighter bluish-white ventral coloring. Its lips are white and its fins are dark blue-gray to black. The blue sucker reaches a maximum of 825 mm in length. Spawning occurs in April through May in deep riffles with substrates of cobble and bedrock. The blue sucker reaches sexual maturity at ages 3 through 5 yr and can live up to 22 yr. (Reference 2.4.2-32) The blue sucker is found in deep pools of large, free-flowing rivers with swift currents (Reference 2.4.2-4). Characteristic habitats have very swift flow and cobble or bedrock substrates. Juveniles are found in shallower and less turbulent areas. (Reference 2.4.2-32) Blue sucker populations have declined drastically due to the effects on large rivers from impoundments and increased siltation (Reference 2.4.2-4). The blue sucker is extremely unlikely to occur in the Clinch River arm of the Watts Bar Reservoir due to the unsuitable habitat conditions present in the reservoir.

Flame chub (Hemitremia flammea)

The flame chub has been designated by TDEC as in need of management (Reference 2.4.2-4). The flame chub is a small minnow that reaches a maximum length of approximately 3 in. The flame chub has a distinct caudal spot and a dark lateral stripe bordered above by a pale gold area. Sexually active males are bright scarlet to orange ventrally and retain some of this coloring throughout the year. Spawning occurs from late January to June. The flame chub can live for up to 2 yr. Spawning has been reported in flooded agricultural fields and pastures. The flame chub inhabits springs, spring-fed streams, and shallow seepage waters in locations where gravel and aquatic vegetation are present. (Reference 2.4.2-33) Populations have declined with the continued alteration of spring habitats (Reference 2.4.2-4). The flame chub is unlikely to occur and was not found in surveys of streams on the CRN Site or Barge/Traffic Area, which lack suitable habitat conditions.

Tangerine darter (Percina aurantiaca)

The tangerine darter has been designated by TDEC as in need of management (Reference 2.4.2-4). The tangerine darter is a fish that reaches a maximum length of 7 in. Males have an orangish red to tangerine color on the lower sides and ventral area, while females are yellow in this area. A black stripe extends from head to tail, and small black dots above this stripe are unique to the species. Male dorsal fins are dusky orange and female dorsal fins are yellow. Males reach sexual maturity after 1 yr and females reach sexual maturity after 2 yr. Spawning occurs in May through July in gravel-bottomed riffles. Eggs and sperm are released onto the gravel bed with no brooding or nesting. (Reference 2.4.2-34) The tangerine darter inhabits clearer reaches of moderate to large headwater tributaries of the upper Tennessee River drainage and is most abundant in smaller tributaries. Preferred habitats most of the year are deeper riffles and runs with substrates of bedrock, boulders, and large rubble, but in winter, deeper pools are used. (Reference 2.4.2-4) The tangerine darter potentially could occur in some sections of Grassy Creek. It is unlikely to occur and was not found in surveys of streams on the CRN Site or Barge/Traffic Area due to the unsuitable habitat conditions.

Tennessee dace (Chrosomus tennesseensis)

The Tennessee dace has been designated by TDEC as in need of management (Reference 2.4.2-4). The Tennessee dace is a small minnow reaching a maximum length of approximately 2 in. The Tennessee dace is found in pools in spring-fed headwaters and small creeks, typically 1 to 2 m wide with substrates of gravel, sand, and silt (Reference 2.4.2-35). The Tennessee dace typically inhabits shallow pools in association with undercut banks and debris in small, low-gradient, woodland tributaries of the upper Tennessee River drainage. The Tennessee dace spawns from April through July. (Reference 2.4.2-4) The Tennessee dace has been observed on the ORR and potentially could occur in some sections of Grassy Creek (Reference 2.4.2-24). It is unlikely to occur and was not found in surveys of streams on the CRN Site or Barge/Traffic Area due to the unsuitable habitat conditions.

Nutall's waterweed (Elodea nutallii)

Nuttall's waterweed has been designated by TDEC as a species of special concern (Reference 2.4.2-20). Nuttall's waterweed is a submerged, aquatic, perennial plant with stems growing up to 40 in. long. The stems are branched, and the white flowers float on top of the water. Male and female flowers grow on separate plants. (Reference 2.4.2-36) Nuttall's waterweed reproduces sexually with seeds during June, July, and August. The male flowers break off the plant and split open, spreading the pollen on the water's surface. Pollination occurs when the pollen comes in contact with a female flower. Nuttall's waterweed also can reproduce vegetatively by fragmentation of the stem, which is the most common method. (Reference 2.4.2-37) The leaves are linear to lance-like, bright green, and do not have stalks. The edges are folded, and there are two to three leaves per whorl. Nuttall's waterweed generally is found in still water growing in fine sediment. (Reference 2.4.2-36) Nuttall's waterweed prefers quiet waters of lakes or streams and typically is found in calcareous (hard) water (Reference 2.4.2-37).

2.4.2.3.3 Species of Commercial or Recreational Value

TVA and state fisheries agencies developed a Sport Fishing Index that was used until 2008 to provide an indication of the quality of sport fishing for individual species in TVA reservoirs (Reference 2.4.2-38). Sportfish surveys were performed in the spring, but not every reservoir was sampled each year (Reference 2.4.2-39). TVA discontinued the spring sport fish survey after 2014 (Reference 2.4.2-40). The Sport Fishing Index scores for each reservoir and species were based on population measures (the number of fish and the size and health of individual fish) and information about angler use of the reservoir and their success (the number of anglers fishing for a particular type of fish and the number of that type that they actually catch). The Sport Fishing Index score for a given species could range from 60 (excellent) to 20 (very poor).(Reference 2.4.2-38) For Watts Bar Reservoir, the most recent sport fish survey statistics available are from 2014, but the most recently calculated Sport Fishing Index score available is from 2008. The 2008 Sport Fishing Index scores for Watts Bar Reservoir indicate that scores for black basses, smallmouth bass, striped bass, white bass, crappie, white crappie, and channel catfish were below the 2008 average across the TVA region and the scores for black crappie, largemouth bass, and spotted bass were above the average. (Reference 2.4.2-39; Reference 2.4.2-38; Reference 2.4.2-41)

To characterize the fish community in the Clinch River arm of the Watts Bar Reservoir, TVA selected two fish sampling locations, one upstream and one downstream of the CRN Site. Sampling by electrofishing and gill netting was conducted in February, May, July, and October of 2011 to document seasonal variation in fish community composition. An average of 14 commercially valuable and 22 recreationally valuable fish species were collected at the downstream location during 2011 and an average of 15 commercially valuable and 24 recreationally valuable species were collected at the upstream location. The commercially and recreationally valuable fish species collected are identified in Table 2.4.2-1. Commercially valuable species are defined as those that can be legally harvested by commercial fishing methods for sale as meat, roe, or bait. Recreationally valuable species are those species that are commonly sought by anglers or bowfishers or are used for bait. (Reference 2.4.2-6) As discussed in Subsection 2.4.2.1.1, fish consumption advisories have been posted by TDEC on Watts Bar Reservoir in the vicinity of the CRN Site warning that, due to the levels of contaminants (PCBs) in their tissues, consumption of catfish and sauger should be limited to about two meals per month and striped bass should not be eaten (Reference 2.4.2-42).

For Melton Hill Reservoir, the 2008 Sport Fishing Index scores for black basses, largemouth bass, smallmouth bass, spotted bass, crappie, black crappie, white crappie, and sauger were below the 2008 average across the TVA region, while the scores for channel catfish and striped bass were above the average (Reference 2.4.2-39). Melton Hill Reservoir is popular for sportfishing for species that include muskellunge, striped bass, hybrid striped bass, white crappie, largemouth bass, and skipjack herring. In 2008, there was an advisory against the consumption of catfish from the reservoir due to PCB levels. Muskellunge are stocked annually in Melton Hill Reservoir by the Tennessee Wildlife Resources Agency. (Reference 2.4.2-43)

2.4.2.3.4 Nuisance Species

Aquatic invasive species are non-native species that are likely to cause economic and/or environmental harm. Other terms for these types of species are nuisance, alien, non-indigenous, exotic, or undesirable species. (Reference 2.4.2-44) Within the Tennessee Valley, TVA has identified seven invasive species that constitute the greatest threat to rare native species or the balance of the aquatic community in general. These seven species are:

- Common carp (*Cyprinus carpio*)
- Grass carp (*Ctenopharyndogon idella*)
- Alewife (*Alosa pseudoharengus*)
- Blueback herring (*Alosa aestivalis*)

- Rusty crayfish (*Orconectes rusticus*)
- Asiatic clam
- Zebra mussel (Reference 2.4.2-45)

The Kentucky River crayfish (*Orconectes juvenilis*) is an invasive, non-native species that is very similar to the rusty crayfish, and until recently *Orconectes juvenilis* was considered to be the same species as *Orconectes rusticus* (Reference 2.4.2-46). The Asiatic clam and zebra mussel were found in the 2011 sampling by TVA in the Clinch River arm of the Watts Bar Reservoir (Reference 2.4.2-6). The Asiatic clam and zebra mussel potentially are the most problematic of these nuisance species because they contribute to biofouling of water intake systems (Reference 2.4.2-44). TVA has a monitoring and eradication program for these species at generating facilities, including the use of chemical and heated-water treatments. Nuisance species can cause other problems as well, including negative effects on fishing and musseling, and they can contribute to the decline of native species through competition or predation (Reference 2.4.2-44).

Federal regulations regarding invasive species include Executive Order 13112 – Invasive Species, which requires federal agencies to:

- Prevent the introduction of invasive species
- Detect and respond rapidly to control populations of such species in a cost-effective and environmentally sound manner
- Monitor invasive species populations accurately and reliably
- Provide for restoration of native species and habitat conditions in ecosystems that have been invaded

The nuisance species that occur in the vicinity and have the greatest potential to affect the CR SMR Project, the Asiatic clam and zebra mussel, are briefly described below.

Asiatic Clam (Corbicula fluminea)

The Asiatic clam is a small, filter-feeding bivalve with a maximum size of 1.5 in. The outer surface is light yellow to dark brown or black and the interior is white to light purple. The Asiatic clam is hermaphroditic and capable of self-fertilization and does not require a host fish for successful development. Larvae are brooded in the gills, and individuals can release up to 70,000 juveniles per yr. The Asiatic clam is native to China, Korea, and southeast Russia. The Asiatic clam was first collected in Washington State in 1938. The Asiatic clam is currently distributed across 38 states and the District of Columbia, including almost every river and reservoir in Tennessee. It is hypothesized that the Asiatic clam entered the country as a food item used by Chinese immigrants. Currently, the Asiatic clam is spread by human activities such as accidental bait bucket introductions and aquaculture species, and intentional introductions by people that eat them. The Asiatic clam causes environmental harm by competing for habitat and food with native bivalves. The Asiatic clam causes economic harm by biofouling water intakes of power plants and industrial and municipal water supplies. (Reference 2.4.2-44)

Zebra Mussel (Dreissena polymorpha)

The zebra mussel is a small mussel reaching a maximum size of 1.5 in. The outer shell can be cream colored without banding but is usually striped with parallel brown or black bands. The inside surface is bluish white. The zebra mussel attaches to hard surfaces using byssal threads. The zebra mussel spawns in spring or summer at water temperatures of 14 to 16ºC (57 to 60ºF). The zebra mussel is a broadcast spawner, with the eggs fertilized in the water column. Larvae hatch within 3 to 5 days and do not require a fish host for successful development. The zebra mussel is native to the Black, Caspian, and Azov Seas and was first discovered in the United States in Lake St. Claire in 1988. The zebra mussel is thought to have arrived in the ballast of a commercial cargo ship and later spread by passive drifting of the larvae and adults attachment to boats and other water gear. By 1990 the zebra mussel was found in all of the Great Lakes, and by 1991 the zebra mussel had invaded the Illinois and Hudson Rivers. In 1994 the zebra mussel was reported in 19 states, and by 2002 the zebra mussel had invaded 23 states. (Reference 2.4.2-44)

The zebra mussel causes harm by biofouling intake pipes of power plants and industrial and municipal water supplies. Biofouling by the zebra mussel can be so intense that is has sunk navigational buoys and deteriorated dock pilings. The zebra mussel also competes with native bivalves for habitat and food. After its arrival in the Great Lakes, the biomass of plankton was significantly reduced. Zebra mussels also settle on native mussel species, which can cause death by interfering with normal valve operation, causing shell deformity, smothering siphons, competing for food, impairing movement, and depositing metabolic waste into underlying mussels. (Reference 2.4.2-44) During the mollusk survey by TVA at the CRN Site in 2011, biologists noted an abundance of zebra mussels throughout that reach of the reservoir. Only three of the other mussel species found were not infested with zebra mussels. Zebra mussels were particularly abundant in areas with solid and stable substrates, and were especially dense on bedrock. (Reference 2.4.2-47)

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Table 2.4.2-1 (Sheet 1 of 3)
Fish Species Collected in 2011 Sampling During Four Seasons at Locations Upstream (CRM 18.5) and Downstream (CRM 15.0) of the CRN Site

Common Name[1]	Scientific Name	Trophic Level[2]	Indigenous Species	Tolerance[3]	Thermally Sensitive Species	Commercially Valuable Species	Recreationally Valuable Species
Atherinopsidae							
Brook silverside	*Labidesthes sicculus*	IN	X	INT	-	X	-
Mississippi silverside	*Menidia audens*	IN	-	-	-	X	X
Catostomidae							
Black buffalo	*Ictiobus niger*	OM	X	-	-	X	-
Black redhorse	*Moxostoma duquesnei*	BI	X	INT	-	-	-
Golden redhorse	*Moxostoma erythrurum*	BI	X	-	-	X	-
Northern hogsucker	*Hypentelium nigricans*	BI	X	INT	-	-	-
Quillback	*Carpiodes cyprinus*	OM	X	-	-	X	-
River carpsucker	*Carpiodes carpio*	OM	X	TOL	-	X	-
Silver redhorse	*Moxostoma anisurum*	BI	X	-	-	X	-
Smallmouth buffalo	*Ictiobus bubalus*	OM	X	-	-	X	-
Smallmouth redhorse	*Moxostoma breviceps*	BI	X	-	-	-	-
Spotted sucker	*Minytrema melanops*	BI	X	INT	X	X	-
White sucker	*Catostomus commersoni*	OM	X	TOL	X	X	-
Centrarchidae							
Black crappie	*Pomoxis nigromaculatus*	TC	X	-	-	-	X
Bluegill	*Lepomis macrochirus*	IN	X	TOL	-	-	X
Green sunfish	*Lepomis cyanellus*	IN	X	TOL	-	-	X
Hybrid sunfish	Hybrid *Lepomis* sp.	IN	X	-	-	-	X
Largemouth bass	*Micropterus salmoides*	TC	X	TOL	-	-	X
Redbreast sunfish	*Lepomis auritus*	IN	-	TOL	-	-	X
Redear sunfish	*Lepomis microlophus*	IN	X	-	-	-	X
Rock bass	*Ambloplites rupestris*	TC	X	INT	-	-	X
Smallmouth bass	*Micropterus dolomieu*	TC	X	INT	-	-	X

Table 2.4.2-1 (Sheet 2 of 3)
Fish Species Collected in 2011 Sampling During Four Seasons at Locations Upstream (CRM 18.5) and Downstream (CRM 15.0) of the CRN Site

Common Name[1]	Scientific Name	Trophic Level[2]	Indigenous Species	Tolerance[3]	Thermally Sensitive Species	Commercially Valuable Species	Recreationally Valuable Species
Spotted bass	*Micropterus punctulatus*	TC	X	-	-	-	X
Warmouth	*Lepomis gulosus*	IN	X	-	-	-	X
White crappie	*Pomoxis annularis*	TC	X	TOL	-	-	X
Clupeidae							
Gizzard shad	*Dorosoma cepedianum*	OM	X	TOL	-	X	X
Hybrid shad	Hybrid *Dorosoma*	OM	X	-	-	-	X
Skipjack herring	*Alosa chrysochloris*	TC	X	INT	-	X	X
Threadfin shad	*Dorosoma petenense*	PK	X	-	-	X	X
Cottidae							
Banded sculpin	*Cottus carolinae*	IN	X	-	-	-	-
Cyprinidae							
Bluntnose minnow	*Pimephales notatus*	OM	X	TOL	-	-	-
Bullhead minnow	*Pimephales vigilax*	IN	X	-	-	-	-
Common carp	*Cyprinus carpio*	OM	-	TOL	-	X	X
Fathead minnow	*Pimephales promelas*	OM	-	TOL	-	X	X
Golden shiner	*Notemigonus crysoleucas*	OM	X	TOL	-	X	X
Largescale stoneroller	*Campostoma oligolepis*	HB	X	-	-	-	X
Spotfin shiner	*Cyprinella spiloptera*	IN	X	TOL	-	-	-
Esocidae							
Muskellunge	*Esox masquinongy*	TC	-	INT	-	-	X
Ictaluridae							
Blue catfish	*Ictalurus furcatus*	OM	X	-	-	X	X
Channel catfish	*Ictalurus punctatus*	OM	X	-	-	X	X
Flathead catfish	*Pylodictis olivaris*	TC	X	-	-	X	X

Table 2.4.2-1 (Sheet 3 of 3)
Fish Species Collected in 2011 Sampling During Four Seasons at Locations Upstream (CRM 18.5) and Downstream (CRM 15.0) of the CRN Site

Common Name[1]	Scientific Name	Trophic Level[2]	Indigenous Species	Tolerance[3]	Thermally Sensitive Species	Commercially Valuable Species	Recreationally Valuable Species
Lepisosteidae							
Longnose gar	*Lepisosteus osseus*	TC	X	TOL	-	X	-
Spotted gar	*Lepisosteus oculatus*	TC	X	-	-	X	-
Moronidae							
Hybrid striped bass	Hybrid *Morone*	TC	-	-	-	-	X
Striped bass	*Morone saxatilis*	TC	-	-	-	-	X
White bass	*Morone chrysops*	TC	X	-	-	-	X
Yellow bass	*Morone mississippiensis*	TC	X	-	-	X	X
Percidae							
Dusky darter	*Percina sciera*	IN	X	-	-	-	-
Greenside darter	*Etheostoma blennioides*	SP	X	-	X	-	-
Logperch	*Percina caprodes*	BI	X	-	X	-	-
Sauger	*Sander canadensis*	TC	X	-	-	-	X
Saugeye	Hybrid *Sander*	TC	X	-	-	-	X
Snubnose darter	*Etheostoma simoterum*	SP	X	-	-	-	-
Walleye	*Sander vitreus*	TC	X	-	-	-	X
Yellow perch	*Perca flavescens*	IN	-	-	-	-	X
Poeciliidae							
Western mosquitofish	*Gambusia affinis*	IN	X	TOL	-	-	-
Sciaenidae							
Freshwater drum	*Aplodinotus grunniens*	BI	X	-	-	X	X

[1] Species listed by family in alphabetical order by common name
[2] Trophic level: BI = benthic invertivore, HB = herbivore, IN = insectivore, OM = omnivore, PK = planktivore, SP = specialized insectivore, TC = top carnivore
[3] Tolerance: INT = intolerant species, TOL = tolerant species
Source: (Reference 2.4.2-6)

Table 2.4.2-2
Summary of Reservoir Fish Assemblage Index (RFAI) Scores and Ecological Health Ratings

	Seasonal RFAI Scores Calculated from 2011 Fish Community Data							
	February		May		July		October	
Metrics	Down-stream	Up-stream	Down-stream	Up-stream	Down-stream	Up-stream	Down-stream	Up-stream
<u>Species Richness and Composition</u>								
No. of indigenous species	3	3	3	5	5	5	3	5
No. of centrarchid species	5	5	3	5	5	3	5	5
No. of benthic invertivore species	3	3	3	3	3	5	3	3
No. of intolerant species	3	3	5	5	5	5	5	5
Percent tolerant individuals	4	3	4	3	3	2	4	3
Percent dominance by one species	2	2	3	3	3	2	2	3
Percent non-indigenous species	1	1	2	1	1	1	3	1
No. of top carnivore species	5	3	3	5	5	5	3	5
<u>Trophic Composition</u>								
Percent top carnivores	3	3	3	4	2	3	1	2
Percent omnivores	5	3	4	4	2	1	3	2
<u>Fish Abundance and Health</u>								
Average no. per run	2	2	2	2	2	2	1	1
Percent anomalies	2	5	3	2	3	3	4	5
Overall RFAI Score	38	36	38	42	39	37	37	40
Ecological Health Rating	Fair	Fair	Fair	Good	Fair	Fair	Fair	Fair

Notes:
Sampling locations within the Clinch River arm of Watts Bar Reservoir:
Downstream at CRM 15.0, upstream at CRM 18.5
Assignment of ecological health ratings based on RFAI Scores:
12 to 21 = very poor 22 to 31 = poor 32 to 40 = fair 41 to 50 = good 51 to 60 = excellent
Source: (Reference 2.4.2-6)

Table 2.4.2-3 (Sheet 1 of 2)
Numbers and Percent Composition of Fish Eggs and Larvae Collected in Ichthyoplankton Samples from Upstream (CRM 18.0) and Downstream (CRM 15.5) of the CRN Site – February 2011 through January 2012

Taxon	Upstream (CRM 18.0)		Downstream (CRM 15.5)		Total	
	Total Numbers	**Percent Comp. (%)**	**Total Numbers**	**Percent Comp. (%)**	**Total Numbers**	**Percent Comp. (%)**
FISH EGGS						
Sciaenidae	**3839**	**64.2**	**353**	**19.2**	**4192**	**53.6**
Aplodinotus grunniens (freshwater drum) eggs	3839	64.2	353	19.2	4192	53.6
Clupeidae	**1109**	**18.5**	**718**	**39.1**	**1827**	**23.4**
Clupeid (not skipjack herring) eggs	1108	18.5	609	33.2	1717	22.0
Alosa chrysochloris (skipjack herring)	1	T	109	5.9	110	1.4
Moronidae	**699**	**11.7**	**415**	**22.6**	**1114**	**14.3**
Morone (not *M. saxatilis*)	699	11.7	415	22.6	1114	14.3
Unidentifiable fish eggs	**331**	**5.5**	**349**	**19.1**	**680**	**8.7**
Percidae	**1**	**T**	**-**	**-**	**1**	**T**
Walleye egg	1	T	-	-	1	T
Total	**5979**	**100**	**1835**	**100**	**7814**	**100**
FISH LARVAE						
Clupeidae	**1253**	**76.2**	**1407**	**61.1**	**2660**	**67.4**
Clupeid spp.	1223	74.3	1399	60.7	2622	66.3
Dorosoma spp. (shad)	8	0.5	-	-	8	0.2
Dorosoma cepedianum (gizzard shad)	10	0.6	4	0.2	14	0.4
Dorosoma petenense (threadfin shad)	1	0.1	-	-	1	T
Alosa chrysochloris (skipjack herring)	11	0.7	4	0.2	15	0.4
Catostomidae	**14**	**0.9**	**448**	**19.4**	**462**	**11.7**
Ictiobinae (buffalofishes or carpsuckers)	13	0.8	448	19.4	461	11.7
Moxostoma spp. (redhorse)	1	0.1	-	-	1	T
Moronidae	**206**	**12.5**	**197**	**8.6**	**403**	**10.2**
Moronid spp.	5	0.3	13	0.6	18	0.5
Moronid (not *M. saxatilis*)	201	12.2	184	8.0	385	9.7

Table 2.4.2-3 (Sheet 2 of 2)
Numbers and Percent Composition of Fish Eggs and Larvae Collected in Ichthyoplankton Samples from Upstream (CRM 18.0) and Downstream (CRM 15.5) of the CRN Site – February 2011 through January 2012

Taxon	Upstream (CRM 18.0)		Downstream (CRM 15.5)		Total	
	Total Numbers	Percent Comp. (%)	Total Numbers	Percent Comp. (%)	Total Numbers	Percent Comp. (%)
Centrarchidae	**104**	**6.3**	**116**	**5.0**	**220**	**5.6**
Lepomis spp. (sunfish)	97	5.9	103	4.5	200	5.1
Pomoxis spp. (crappie)	7	0.4	13	0.6	20	0.5
Atherinopsidae	**20**	**1.2**	**52**	**2.3**	**72**	**1.8**
Atherinopsid spp.	3	0.2	1	T	4	0.1
Menidia audens (Mississippi silverside)	17	1.0	51	2.2	68	1.7
Sciaenidae	**17**	**1.0**	**36**	**1.6**	**53**	**1.3**
Aplodinotus grunniens (freshwater drum)	17	1.0	36	1.6	53	1.3
Cyprinidae	**21**	**1.3**	**32**	**1.4**	**53**	**1.3**
Cyprinus carpio (common carp)	21	1.3	31	1.3	52	1.3
Cyprinid spp. (*Pimephales* group)	-	-	1	T	1	T
Percidae	**5**	**0.3**	**9**	**0.4**	**14**	**0.4**
Etheostoma spp.	1	0.1	-	-	1	T
Perca flavescens (yellow perch)	-	-	1	T	1	T
Percina spp. (*Etheostoma* type)	3	0.2	8	0.3	11	0.3
Percina spp. (*P. caprodes* type)	1	0.1	-	-	1	T
Polyodontidae	**1**	**0.1**	**-**	**-**	**1**	**T**
Polyodon spathula (paddlefish)	1	0.1	-	-	1	T
Unidentifiable fish larvae	**4**	**0.2**	**7**	**0.3**	**11**	**0.3**
Total	**1645**	**100.0**	**2304**	**100.0**	**3949**	**100.0**

Notes:
Comp. = composition
CRM = Clinch River mile
Spp. = species
T = trace (< 0.1%)
- = not present

Source: (Reference 2.4.2-3)

Table 2.4.2-4
Summary of Overall Reservoir Benthic Index (RBI) Scores and Ecological Health Ratings

Metric	Seasonal RBI Scores Calculated from 2011 Data					
	May		July		October	
	Down-stream	Up-stream	Down-stream	Up-stream	Down-stream	Up-stream
Average number of taxa	5	5	5	5	5	5
Proportion of samples with long-lived organisms	5	3	5	5	3	5
Average number of EPT taxa	1	1	3	3	3	5
Percentage as oligochaetes	3	5	5	3	1	5
Percentage as dominant taxa	3	3	3	5	3	3
Average density excluding chironomids and oligochaetes	5	5	5	5	5	5
Proportion of samples containing no organisms	5	5	5	5	5	5
Benthic Index Score	27	27	31	31	25	33
Ecological Health Rating	Good	Good	Excellent	Excellent	Good	Excellent

Notes:
Sampling locations within the Clinch River arm of Watts Bar Reservoir:
Downstream at CRM 15.0, upstream at CRM 18.8
Assignment of ecological health ratings based on RBI Scores:
7 to 12 = very poor 13 to 18 = poor 19 to 23 = fair 24 to 29 = good 30 to 35 = excellent
Source: (Reference 2.4.2-6)

Table 2.4.2-5 (Sheet 1 of 3)
Water Bodies Documented on the CRN Site and Barge/Traffic Area

Map ID	Type	Streamside Management Zone Category	Name	Description
		Ponds		
CRN Site				
P01	Pond	Category A (50 ft)	Unnamed	Stormwater retention pond
P02	Pond	Category A (50 ft)	Unnamed	Stormwater retention pond
P03	Pond	Category A (50 ft)	Unnamed	Small dug out pond
P04	Pond	Category A (50 ft)	Unnamed	Stormwater retention pond
P05	Pond	Category A (50 ft)	Unnamed	Stormwater retention pond
P06	Pond	Category A (50 ft)	Unnamed	Stormwater retention pond
Barge/Traffic Area				
P07	Pond	Category A (50 ft)	Unnamed	Small pond connected to backwater of the reservoir
P08	Pond	Category A (50 ft)	Unnamed	Large pond
		Streams		
CRN Site				
S01	Perennial	Category A (50 ft)	Unnamed tributary to reservoir	Small channel being fed by pond and spring; flows through wetland.
S02	Perennial	Category A (50 ft)	Clinch River	Watts Bar Reservoir
S03	Perennial	Category A (50 ft)	Unnamed tributary to reservoir	Channel 2 ft wide by 1 ft deep.
S04	Intermittent	Category A (50 ft)	Unnamed tributary to reservoir	Deep channel flowing out from beaver dam to reservoir.
S05	Perennial	Category A (50 ft)	Unnamed tributary to reservoir	Channel with clay substrate; flows through wetland.
S06	Perennial	Category A (50 ft)	Unnamed tributary to reservoir	Spring with small spring/run channel.

Table 2.4.2-5 (Sheet 2 of 3)
Water Bodies Documented on the CRN Site and Barge/Traffic Area

Map ID	Type	Streamside Management Zone Category	Name	Description
CRN Site (continued)				
C01	WWC	NA	Unnamed	Natural
C02	WWC	NA	Unnamed	Constructed
C03	WWC	NA	Unnamed	Natural
C04	WWC	NA	Unnamed	Natural
C05	WWC	NA	Unnamed	Natural
C06	WWC	NA	Unnamed	Natural
C07	WWC	NA	Unnamed	Natural
C08	WWC	NA	Unnamed	Natural
C09	WWC	NA	Unnamed	Natural
C10	WWC	NA	Unnamed	Natural
C11	WWC	NA	Unnamed	Natural
C12	WWC	NA	Unnamed	Natural
C13	WWC	NA	Unnamed	Constructed
C14	WWC	NA	Unnamed	Natural
C15	WWC	NA	Unnamed	Constructed
C16	WWC	NA	Unnamed	Natural
C17	WWC	NA	Unnamed	Natural
C18	WWC	NA	Unnamed	Natural
C19	WWC	NA	Unnamed	Natural
Barge/Traffic Area				
S07	Perennial	Category B (100 ft)	Unnamed tributary to reservoir	Small channel with gravel/silt substrate; flooding at time of survey.
S08	Intermittent	Category A (50 ft)	Unnamed tributary to reservoir	Channel 3 ft wide by 3 ft deep with gravel/silt/clay substrate; originates from seep area.
S09	Intermittent	Category A (50 ft)	Unnamed tributary to reservoir	First order stream with 3 ft wide by 2 ft deep channel and substrate of gravel with some cobble.

Table 2.4.2-5 (Sheet 3 of 3)
Water Bodies Documented on the CRN Site and Barge/Traffic Area

Map ID	Type	Streamside Management Zone Category	Name	Description
Barge/Traffic Area (continued)				
S10	Intermittent	Category A (50 ft)	Unnamed tributary to reservoir	Small stream that scored below TDEC threshold but was elevated due to water flow and wetland plants within the channel.
S11	Intermittent	Category A (50 ft)	Unnamed tributary to reservoir	Small channel with bedrock/silt substrate.
S12	Perennial	Category A (50 ft)	Unnamed tributary to reservoir	Small stream that has been impounded by beaver activity.
C20	WWC	NA	Unnamed	Natural
C21	WWC	NA	Unnamed	Natural
C22	WWC	NA	Unnamed	Natural
C23	WWC	NA	Unnamed	Natural
C24	WWC	NA	Unnamed	Natural
C25	WWC	NA	Unnamed	Natural
C26	WWC	NA	Unnamed	Natural
C27	WWC	NA	Unnamed	Constructed
C28	WWC	NA	Unnamed	Natural
C29	WWC	NA	Unnamed	Natural
C30	WWC	NA	Unnamed	Natural
C31	WWC	NA	Unnamed	Natural
C32	WWC	NA	Unnamed	Natural
C33	WWC	NA	Unnamed	Natural
C34	WWC	NA	Unnamed	Natural

Notes:
WWC ephemeral streams/wet-weather conveyance
NA Streamside management zones are not applicable to WWCs

Source: (Reference 2.4.2-4)

Table 2.4.2-6
Aquatic Species with Federal or State Status and Recorded Occurrences in Roane County, Tennessee

Scientific Name	Common Name	Federal Status	State Status
AMPHIBIANS			
Cryptobranchus alleganiensis	hellbender	–	NMGT
Gyrinophilus gulolineatus	Berry Cave salamander	C	T
FISH			
Chrosomus tennesseensis	Tennessee dace	–	NMGT
Cycleptus elongatus	blue sucker	–	T
Erimonax monachus	spotfin chub	T	T
Hemitremia flammea	flame chub	–	NMGT
Percina aurantiaca	tangerine darter	–	NMGT
MUSSELS			
Cumberlandia monodonta	spectaclecase	E	Rare (not listed)
Cyprogenia stegaria	fanshell	E	E
Epioblasma turgidula	turgid blossom pearlymussel	E	Extirpated
Fusconaia cor	shiny pigtoe	E	E
Fusconaia cuneolus	finerayed pigtoe	E	E
Lampsilis abrupta	pink mucket	E	E
Lampsilis virescens	Alabama lampmussel	E	E
Obovaria retusa	ring pink	E	E
Plethobasus cooperianus	orangefoot pimpleback	E	E
Plethobasus cyphyus	sheepnose	E	Rare (not listed)
Pleurobema rubrum	pyramid pigtoe	–	Rare (not listed)
Quadrula cylindrica strigillata	rough rabbitsfoot	E	E
Villosa perpurpurea	purple bean	E	E
SNAILS			
Io fluvialis	spiny riversnail	–	Rare (not listed)
Lithasia geniculata	ornate rocksnail	–	Rare (not listed)
VASCULAR PLANTS			
Elodea nutallii	Nutall's waterweed	–	S

Notes:
Federal status definitions: E = Endangered; T = Threatened; C = Candidate for listing

State status definitions: E = Endangered; T = Threatened; NMGT = In need of management (nongame wildlife); S = Special concern (plants)

Natural Heritage Element Occurrence Rank:
All species shown are ranked as extant (record ≤ 25 yr old) except the following mussels:
Considered extirpated –Turgid blossom pearlymussel
Historical record > 25 yr old – Spectaclecase, fanshell, finerayed pigtoe, Alabama lampmussel, ring pink, orangefoot pimpleback, and purple bean.

Source: (Reference 2.4.2-20; Reference 2.4.2-4)

2.5 SOCIOECONOMICS

Construction and operation of two or more small modular reactors (SMRs) at the Clinch River Nuclear (CRN) Site has the potential to affect the social and economic characteristics of the region surrounding the CRN Site. This section describes the socioeconomic characteristics potentially affected by the Clinch River (CR) SMR Project, including demography, community characteristics, historic properties, and environmental justice.

Tennessee Valley Authority (TVA) analyzed regional socioeconomic data to determine the appropriate geographical area of interest, which is defined by the areas where construction and operations workforce and their families would reside, spend their income, and use their benefits, thereby affecting the economic conditions of the region. The geographical area of interest identified for the proposed CR SMR Project is the four-county area (Anderson, Knox, Loudon, and Roane counties, Tennessee) where approximately 87 percent of the federal and contractor employees at the U.S. Department of Energy (DOE) Oak Ridge facilities reside (Reference 2.5.1-1). The DOE employee residence statistics were used as an indication of the potential pattern of residence for the proposed CR SMR Project workforce because the DOE mission is primarily nuclear in nature and employs highly trained technical workers, similar to the proposed CR SMR Project. Socioeconomic analyses were also conducted, as appropriate, for the 50-mile (mi) CRN Site region.

2.5.1 Demography

This subsection describes the following demographic characteristics: population data by sector, population data by political jurisdiction, population density, and transient populations. The demography within the geographical area of interest and the 50-mi radius are characterized in the following subsections.

2.5.1.1 Population Data by Sector

The population distribution surrounding the CRN Site, up to a 50-mi radius, is estimated based upon the 2010 U.S. Census Bureau decennial census data. The population distribution is estimated in fifteen concentric bands at 0 to 0.3 mi, 0.3 to 1 mi, 1 to 2 mi, 2 to 3 mi, 3 to 4 mi, 4 to 5 mi, 5 to 6 mi, 6 to 7 mi, 7 to 8 mi, 8 to 9 mi, 9 to 10 mi, 10 to 20 mi, 20 to 30 mi, 30 to 40 mi, and 40 to 50 mi from the CRN Site center point. These bands are subdivided into 16 directional sectors, each centered on one of the 16 compass directions and consisting of 22.5 degrees. Population sectors out to 2 mi are shown in Figure 2.5.1-3, population sectors out to 10 mi are shown in Figure 2.5.1-1, and population sectors out to 50 mi are shown in Figure 2.5.1-2.

The population projections are derived from county estimates obtained from the states and based on cohort component (Kentucky and Tennessee) and cohort survey (North Carolina) methodologies. The counties that were used for the population projections are listed in Table 2.5.1-1. Using linear or polynomial regression, an equation was derived to analyze population growth for each county. The equation was used in conjunction with the 2010 census data to produce a growth ratio. Ratios were calculated for each county and for each year, then weighted by area and summed into sectors. The ratio set was then used to produce a sector-level population projection ratio set for the 50-mi region. For a county with a projected negative growth rate, the 2010 population values for that county are held constant to produce conservative results without overestimating (a growth ratio of one is used). For counties predicting a decline at the end of the states' projection data set, the highest population value in the projection period is held constant (i.e., the ratio calculated for the last data point of the states' data set was used for the remaining projected years).

The census population counts were then sorted into the radial grid. In instances where census blocks were divided by sector boundary lines, the population was weighted by area to produce proportionate data values. These values were summed and multiplied by their projection ratio to produce the final permanent population radial grid maps (Figures 2.5.1-1, 2.5.1-2, and 2.5.1-3). The years selected for the projection period represent the 2010 census, calculation development year (2013), projected start of construction date (2021), projected commencement of operation date for the last unit (2027), and 40 years (yr) beyond the last date.

Permanent population is projected to 40 yr beyond the projected 2027 commencement of operation date for the last unit. Table 2.5.1-2 shows the projected permanent population for each sector out to 10 mi, for the years 2010, 2013, 2021, 2027, 2037, 2047, 2057, and 2067. Population for all sectors in the 10-mi radius for each projected year is shown in Table 2.5.1-3. Table 2.5.1-4 shows the projected permanent population for each sector in the 10- to 50-mi region for the years 2010, 2013, 2021, 2027, 2037, 2047, 2057, and 2067. The total number of people in the 10- to 50-mi region for each projected year is shown in Table 2.5.1-5.

2.5.1.2 Population Data by Political Jurisdiction

The region within 50 mi of the CRN Site includes all or part of 33 counties in Tennessee, North Carolina, and Kentucky (Table 2.5.1-1). Knoxville is the largest city within 50 mi, with a 2010 population of 178,874, followed by Oak Ridge with 29,330 and Maryville with 27,465 (Reference 2.5.1-2). Smaller cities within the region include Sevierville (14,807), Athens (13,458), Crossville (10,795), La Follette (7456), Dayton (7191), Fairfield Glade (6989), Pigeon Forge (5875), Sweetwater (5764), Rockwood (5562), Madisonville (4577), Etowah (3490) and Norris (1491) (Reference 2.5.1-3; Reference 2.5.1-2). Many other smaller towns and cities are distributed within the region. Figure 2.1-1 illustrates the location of these cities and towns in relation to the CRN Site.

Most of the nine-county Knoxville, Tennessee metropolitan statistical area (MSA) is located within the 50-mi CRN Site region, including all of Anderson, Blount, Knox, Loudon, Morgan, and Roane counties, Tennessee; most of Campbell and Union counties, Tennessee; and a portion of Grainger County, Tennessee (Reference 2.5.1-4). The Knoxville, Tennessee MSA has a 2010 population of 837,571 and an estimated 2013 population of 852,715 (Reference 2.5.1-5). Small portions of the Cleveland, Tennessee and Morristown, Tennessee MSAs are located in the southwest and northeast areas, respectively, of the 50-mi region (Reference 2.5.1-4).

Historic and projected population levels for the geographical area of interest and the State of Tennessee are presented in Table 2.5.1-6. Population levels for 1970 through 2010 included in Table 2.5.1-6 are U.S. Census Bureau decennial census data. From 2000 to 2010, Roane and Anderson counties grew at an annual average annual growth rate of 0.44 percent and 0.53 percent, respectively, and Knox and Loudon counties grew at annual average annual growth rates of 1.31 percent and 2.42 percent, respectively. During the same period, the State of Tennessee grew at an average annual growth rate of 1.15 percent. (Reference 2.5.1-6)

Population projections for the state and counties of Tennessee were developed by the University of Tennessee Center for Business and Economic Research. Between 2010 and 2040, the annual growth rates for Anderson, Knox, Loudon, and Roane counties as well as the State of Tennessee are projected to decline, indicating a slowing in population growth. By 2035, Roane County is projected to begin decreasing in population. (Reference 2.5.1-7)

Table 2.5.1-7 presents the age and gender distribution in 2010 for the populations in Anderson, Knox, Loudon, and Roane counties, Tennessee, as well as for the State of Tennessee.

2.5.1.3 Transient Population

Transient populations are defined as “people (other than those just passing through the area) [who] work, reside part-time, or engage in recreational activities, and are not permanent residents of the area” as described in U.S. Nuclear Regulatory Commission Regulatory Guidance 4.7, *General Site Suitability for Nuclear Power Stations*. Though relatively rural in nature, the region surrounding the CRN Site has numerous tourist attractions and events that contribute to the transient population. The 50-mi region includes both large cities (e.g., Knoxville) and smaller cities (e.g., Pigeon Forge and Sevierville) that are well known for their transient attractions.

Major contributors to the regional total transient population include events and attractions, one commercial airport, and state and national parks. Each of these is discussed in the following paragraphs.

Transient data for recreational activities were gathered through personal communications with businesses, event coordinators, local chambers of commerce, and tourism departments within the region. This method for collecting transient data provides an accurate assessment of people visiting the area and a precise location of transient contributors. The events and attractions that contribute to the transient population in the CRN Site region are shown in Table 2.5.1-8. Transient data are not generally available at a city level. One city, Pigeon Forge, which is located near the Great Smoky Mountains National Park, has developed a comprehensive report that includes visitor counts from 1987 through 2012. According to this report, Pigeon Forge had a total annual visitor count of 2,856,682 in 2012. This value was used to calculate the daily visitor estimate (7826 persons) of this city for inclusion into the transient population calculation. Pigeon Forge is home to numerous transient attractions, including Dollywood, Titanic Museum Attraction, and WonderWorks.

There are 14 events and attractions within 10 mi of the CRN Site that contribute approximately 15,556 peak daily visitors to the transient population. The City of Kingston, located about 7.2 mi west, hosts several events throughout the year. The largest of these events is the Smokin the Water Celebration, which occurs over a two-day period during the July 4th holiday and contributes approximately 12,000 peak daily visitors. The second largest is the Kingston Country Fair. This event occurs the first Saturday in October and hosts approximately 980 people (see Table 2.5.1-8).

Within the 10- to 50-mi radii, there are over 100 events and attractions contributing approximately 500,000 peak daily visitors to the total transient population. The top two attractions, each contributing over 100,000 peak daily visitors, are Neyland Stadium and the Rossini Festival located in Knoxville. Neyland Stadium, located approximately 25.9 mi east, is the University of Tennessee's football stadium and home to the Tennessee Volunteers (Reference 2.5.1-8). The Rossini Festival, located approximately 26 mi east, is a single day event that occurs in April of each year (see Table 2.5.1-8).

There is one large commercial airport, McGhee Tyson Airport, in the CRN Site region. The Bureau of Transportation Statistics reports that in 2013, McGhee Tyson Airport hosted approximately 813,000 arrival passengers and 817,000 departure passengers. (Reference 2.5.1-9) To develop a realistic peak daily visitor count for this facility, the maximum occupancy of the airport terminal (3587 people) was used. McGhee Tyson Airport is located approximately 22.0 mi east-southeast of the CRN Site in Alcoa, Tennessee.

Outdoor recreation is an important pastime in Tennessee and a large draw for transient population into the region. Table 2.5.1-9 lists the national and state parks located within the region that maintain visitor counts. There are 10 Tennessee state parks and three national parks that maintain visitor counts located within the 50-mi region. The state park with the largest daily peak visitor estimate is the Cumberland Mountain State Park with approximately 3944 daily visitors. The Hiwassee / Ocoee Scenic River State Park, Big Ridge State Park, Cove Lake State Park and Indian Mountain State Park also significantly contribute to the total transient population with 3763, 2894, 1849, and 1678 peak daily visitors, respectively. The remaining five state parks each have peak daily visitor estimates ranging from approximately 650 to 300 persons. The three national parks that maintain visitor counts within the region are Big South Fork National River and Recreation Area, Obed Wild and Scenic River, and Great Smoky Mountains National Park. The national park with the largest transient population is the Great Smoky Mountains National Park. Located approximately 31 mi southeast, the Great Smoky Mountains National Park recorded an annual visitor count of 9,685,829 persons (Reference 2.5.1-10). The peak daily visitor estimates for state and national parks within the region that contributed to the total transient population are listed in Table 2.5.1-9.

The transient population projections are derived from the survey data collected to identify the events, facilities, parks, and attractions that contribute to the total transient population estimate. The transient population data were converted into a common persons/day format. The location of each event was identified so that the data could be integrated into the appropriate sector. For areas such as parks and public lands, an even spatial distribution of the transient populations was assumed, and those populations were divided into sectors. The transient population is summed for each sector and used as a base transient population. A ratio of transient population and the 2010 permanent population was produced. The projected transient population was calculated by multiplying the 2010 base population by the county projection ratio for the years of interest and then multiplying that result by the transient ratio. The result was a final projected transient population for each sector by the year of interest.

Transient population is projected to 40 yr beyond the 2027 projected commencement of operation date for the last unit. Table 2.5.1-10 shows the projected transient population for each sector for the years 2013, 2021, 2027, 2037, 2047, 2057, and 2067 for the non-zero sectors. The sectors that have zero values are not illustrated in the table. The population values shown represent the peak or calculated peak daily population for each sector and year. The total projected transient population estimates for each projected year are represented in the “total” field of Table 2.5.1-10. The estimated peak daily transient population for 2013 for the CRN Site region is 573,138 persons.

The population of transient workers entering the region for work also was evaluated. This population consists of individuals who reside in one county and work in another. The U.S. Census Bureau tracks worker flows in and out of counties; data are available representing the five-year period 2006-1010 (Reference 2.5.1-11). The transient worker discussion includes those 17 counties whose land area is primarily (at least 50 percent) within the 50-mile radius of the CRN Site. Table 2.5.1-11 identifies the number of workers who travel into each of those 17 counties for work. Workers traveling from one county to another within the 17 counties are not counted as transients. A total of 30,868 workers were identified as traveling into the 17 counties for work.

A notable special population source within 10 mi of the CRN Site is the Oak Ridge National Laboratory (ORNL) located within the City of Oak Ridge. ORNL employs a total of 4400 staff and 3200 guest researchers per year (Reference 2.5.1-12). While these employees are counted by the U.S. Census at their residences, it is noted that the daily fluctuation associated with this workforce increases the temporary population of the City of Oak Ridge.

2.5.1.4 Total Permanent and Transient Populations

Tables 2.5.1-2 through 2.5.1-5 show contributors to the transient population in the 50-mi region. Table 2.5.1-10 summarizes the total transient population by sector and year of interest. The peak daily transient population for the region in 2013 is approximately 573,138 people. The estimated permanent population for 2013 in the region is approximately 1,199,275 people. The total 2013 projected population for the region is approximately 1,772,413 people. Using a calculated growth rate of 0.72, the estimated cumulative total population for 2067 is 2,643,269 people.

2.5.1.5 Population Density

Information on population density and distribution in the area surrounding the CRN Site is useful for conducting the socioeconomic analysis in this Environmental Report. NUREG-1437, *Generic Environmental Impact Statement for License Renewal of Nuclear Plants*, Rev. 1, provides a population characterization methodology based on two factors: "sparseness" and "proximity." Sparseness describes population density and city size within 20 mi of a site, and proximity describes population density and city size within 50 mi of a site. Demographic categories based on sparseness and proximity are presented in Table 2.5.1-12. In accordance with NUREG-1437, the matrix presented in Table 2.5.1-13 is used to rank the population density category of an area as low, medium, or high.

The 2010 census data were used to characterize the population density within the CRN Site region. A total of 331,238 people live within 20 mi of the CRN Site (Tables 2.5.1-3 and 2.5.1-5). A 20-mi radius area contains 1257 square miles (sq mi); therefore the population density is approximately 264 persons per sq mi. This population density is classified as a Category 4 sparseness (greater than or equal to 120 persons per sq mi within 20 mi).

Based on the 2010 census data, 1,158,026 people live within 50 mi of the CRN Site (Tables 2.5.1-3 and 2.5.1-5). A 50-mi radius area contains 7854 sq mi; therefore the population density is approximately 147 persons per sq mi. This population density is classified as Category 3 proximity (one or more cities with 100,000 or more persons and less than 190 persons per sq mi within 50 mi). Because the CRN Site is classified as a Category 4 sparseness and Category 3 proximity, the NUREG-1437 matrix indicates the CRN Site is located in a high population area.

2.5.1.6 References

Reference 2.5.1-1. U.S. Department of Energy, DOE-Related Employment, Payroll, and Residence Statistics for Oak Ridge Area, December 31, 2012, Website: http://www.oakridge.doe.gov/external/portals/0/hr/12-31-12%20payroll%20&%20residence.pdf; 2013.

Reference 2.5.1-2. U.S. Department of Commerce, Tennessee: 2010 Population and Housing Unit Counts - Table 10. Rank by 2010 Population and Housing Units: 2000 and 2010, Website: http://www.census.gov/prod/cen2010/cph-2-44.pdf, September, 2012.

Reference 2.5.1-3. U.S. Census Bureau, Community Facts: Oak Ridge City, Tennessee, Website: http://factfinder2.census.gov/faces/nav/jsf/pages/community_facts.xhtml, 2010.

Reference 2.5.1-4. Executive Office of the President and Office of Management and Budget, Revised Delineations of Metropolitan Statistical Areas, Micropolitan Statistical Areas, and Combined Statistical Areas, and Guidance on Uses of the Delineations of These Areas; OMB Bulletin No. 13-01, Website: http://www.whitehouse.gov/sites/default/files/omb/bulletins/2013/b-13-01.pdf, February 28, 2013.

Reference 2.5.1-5. U.S. Census Bureau, Annual Estimates of the Resident Population: April 1, 2010 to July 1, 2013 - United States - Metropolitan and Micropolitan Statistical Area; and for Puerto Rico - 2013 Population Estimates, Website: http://factfinder2.census.gov/faces/nav/jsf/pages/searchresults.xhtml?refresh=t, 2013.

Reference 2.5.1-6. U.S. Census Bureau, Profile of General Demographic. Table DP-1. Census 2000 Summary File 1 (SF 1) 100-Percent Data., Website: www.census.gov, 2000.

Reference 2.5.1-7. Tennessee Advisory Commission on Intergovernmental Relations, Population Projections for the State of Tennessee, Website: http://www.state.tn.us/tacir/population.html, 2014.

Reference 2.5.1-8. University of Tennessee Athletics, Neyland Stadium, Website: http://www.utsports.com/facilities/neyland_stadium.html, 2013.

Reference 2.5.1-9. Bureau of Transportation Statistics, Transportation Statistics: Knoxville, TN: McGhee Tyson (TYS), Website: http://www.transtats.bts.gov/airports.asp?pn=1&Airport=TYS&Airport_Name=Knoxville,%20TN:%20McGhee%20Tyson&carrier=FACTS, 2013.

Reference 2.5.1-10. National Park Service, Welcome to Visitor Use Statistics, Website: https://irma.nps.gov/Stats/, August 28, 2013.

Reference 2.5.1-11. U.S. Census Bureau, Metropolitan and Micropolitan, Website: http://www.census.gov/population/metro/data/other.html, May 6, 2013.

Reference 2.5.1-12. Oak Ridge National Laboratory, Oak Ridge National Laboratory Fact Sheet, Website: http://www.ornl.gov/about-ornl, 2015.

Table 2.5.1-1
Counties Wholly or Partially Within the 50-Mile Radius

State	Counties	
Kentucky	McCreary	Whitley
North Carolina	Cherokee	Graham
	Swain	
Tennessee	Anderson	Meigs
	Bledsoe	Monroe
	Blount	Morgan
	Bradley	Overton
	Campbell	Pickett
	Claiborne	Polk
	Cumberland	Putnam
	Fentress	Rhea
	Grainger	Roane
	Hamilton	Scott
	Jefferson	Sevier
	Knox	Union
	Loudon	Van Buren
	McMinn	White

Note: See Figure 2.5.1-2

Table 2.5.1-2 (Sheet 1 of 5)
Projected Permanent Population for Each Sector 0 to 10 Miles (0 to 16 km)

Year	Direction							
	Sector 0-0.3 (mi)	Sector 0.3-1 (mi)	Sector 1-2 (mi)	Sector 2-3 (mi)	Sector 3-4 (mi)	Sector 4-5 (mi)	Sector 5-10 (mi)	Sector 0-10 (mi)
North								
2010	0	0	0	0	0	104	2591	2695
2013	0	0	0	0	0	106	2633	2739
2021	0	0	0	0	0	109	2725	2834
2027	0	0	0	0	0	109	2762	2871
2037	0	0	0	0	0	110	2788	2898
2047	0	0	0	0	0	110	2803	2913
2057	0	0	0	0	0	110	2819	2929
2067	0	0	0	0	0	110	2850	2960
North-Northeast								
2010	0	0	0	0	0	0	7644	7644
2013	0	0	0	0	0	0	7763	7763
2021	0	0	0	0	0	0	8022	8022
2027	0	0	0	0	0	0	8155	8155
2037	0	0	0	0	0	0	8298	8298
2047	0	0	0	0	0	0	8395	8395
2057	0	0	0	0	0	0	8511	8511
2067	0	0	0	0	0	0	8678	8678
Northeast								
2010	0	5	0	0	0	0	1287	1292
2013	0	5	0	0	0	0	1309	1314
2021	0	5	0	0	0	0	1360	1365
2027	0	5	0	0	0	0	1393	1398
2037	0	5	0	0	0	0	1436	1441
2047	0	5	0	0	0	0	1466	1471
2057	0	5	0	0	0	0	1503	1508
2067	0	5	0	0	0	0	1555	1560
East-Northeast								
2010	0	8	8	1	0	0	1084	1101
2013	0	8	8	1	0	0	1119	1136
2021	0	8	9	1	0	0	1207	1225
2027	0	8	9	1	0	0	1270	1288

Table 2.5.1-2 (Sheet 2 of 5)
Projected Permanent Population for Each Sector 0 to 10 Miles (0 to 16 km)

Year	Direction							
	Sector 0-0.3 (mi)	Sector 0.3-1 (mi)	Sector 1-2 (mi)	Sector 2-3 (mi)	Sector 3-4 (mi)	Sector 4-5 (mi)	Sector 5-10 (mi)	Sector 0-10 (mi)
2037	0	8	9	1	0	0	1368	1386
2047	0	8	9	1	0	0	1464	1482
2057	0	8	9	1	0	0	1568	1586
2067	0	8	9	1	0	0	1670	1688
East								
2010	0	7	13	110	34	85	5276	5525
2013	0	7	13	113	35	88	5491	5747
2021	0	8	14	118	38	94	6060	6332
2027	0	8	14	121	40	98	6467	6748
2037	0	8	14	123	41	103	7110	7399
2047	0	8	14	125	43	106	7748	8044
2057	0	8	14	127	45	110	8438	8742
2067	0	8	14	130	47	116	9101	9416
East-Southeast								
2010	0	6	37	92	112	262	6686	7195
2013	0	6	38	94	118	278	7075	7609
2021	0	6	39	99	135	317	8076	8672
2027	0	6	39	102	147	344	8740	9378
2037	0	6	39	104	161	377	9603	10,290
2047	0	6	39	106	172	404	10,278	11,005
2057	0	6	39	109	185	434	11,068	11,841
2067	0	6	39	112	203	475	12,098	12,933
Southeast								
2010	0	8	40	81	214	200	12,408	12,951
2013	0	8	40	82	222	211	13,139	13,702
2021	0	8	42	84	241	241	15,017	15,633
2027	0	8	42	85	253	260	16,262	16,910
2037	0	8	42	85	267	285	17,867	18,554
2047	0	8	42	85	278	304	19,108	19,825
2057	0	8	42	85	290	327	20,567	21,319
2067	0	8	42	85	307	357	22,492	23,291

Table 2.5.1-2 (Sheet 3 of 5)
Projected Permanent Population for Each Sector 0 to 10 Miles (0 to 16 km)

Year	Direction							
	Sector 0-0.3 (mi)	Sector 0.3-1 (mi)	Sector 1-2 (mi)	Sector 2-3 (mi)	Sector 3-4 (mi)	Sector 4-5 (mi)	Sector 5-10 (mi)	Sector 0-10 (mi)
South-Southeast								
2010	0	7	57	64	223	264	1661	2276
2013	0	7	57	65	226	275	1759	2389
2021	0	7	59	67	232	301	2010	2676
2027	0	7	59	67	234	318	2177	2862
2037	0	7	59	67	234	338	2391	3096
2047	0	7	59	67	234	353	2557	3277
2057	0	7	59	67	234	372	2753	3492
2067	0	7	59	67	234	396	3010	3773
South								
2010	0	12	27	36	143	183	1546	1947
2013	0	12	28	36	145	186	1616	2023
2021	0	13	28	37	148	195	1792	2213
2027	0	13	29	38	150	199	1904	2333
2037	0	13	29	38	150	203	2044	2477
2047	0	13	29	38	150	205	2152	2587
2057	0	13	29	38	150	209	2279	2718
2067	0	13	29	38	150	213	2446	2889
South-Southwest								
2010	0	13	29	39	142	140	1123	1486
2013	0	13	30	40	144	142	1142	1511
2021	0	14	30	41	148	145	1183	1561
2027	0	14	31	41	149	147	1200	1582
2037	0	14	31	41	150	147	1211	1594
2047	0	14	31	41	150	147	1219	1602
2057	0	14	31	41	150	147	1229	1612
2067	0	14	31	41	150	147	1242	1625
Southwest								
2010	0	12	49	66	126	252	919	1424
2013	0	13	50	67	128	256	932	1446
2021	0	13	51	69	131	263	957	1484
2027	0	13	51	69	132	265	964	1494

Table 2.5.1-2 (Sheet 4 of 5)
Projected Permanent Population for Each Sector 0 to 10 Miles (0 to 16 km)

Year	Direction							
	Sector 0-0.3 (mi)	Sector 0.3-1 (mi)	Sector 1-2 (mi)	Sector 2-3 (mi)	Sector 3-4 (mi)	Sector 4-5 (mi)	Sector 5-10 (mi)	Sector 0-10 (mi)
2037	0	13	51	69	132	265	965	1495
2047	0	13	51	69	132	265	965	1495
2057	0	13	51	69	132	265	965	1495
2067	0	13	51	69	132	265	965	1495
West-Southwest								
2010	0	15	65	164	144	355	5814	6557
2013	0	15	65	166	146	360	5893	6645
2021	0	16	67	171	150	369	6052	6825
2027	0	16	68	172	151	372	6099	6878
2037	0	16	68	172	151	373	6105	6885
2047	0	16	68	172	151	373	6105	6885
2057	0	16	68	172	151	373	6105	6885
2067	0	16	68	172	151	373	6105	6885
West								
2010	0	17	102	153	174	706	4666	5818
2013	0	17	104	156	176	716	4729	5898
2021	0	17	107	160	181	735	4857	6057
2027	0	18	107	161	182	741	4895	6104
2037	0	18	107	161	183	742	4900	6111
2047	0	18	107	161	183	742	4900	6111
2057	0	18	107	161	183	742	4900	6111
2067	0	18	107	161	183	742	4900	6111
West-Northwest								
2010	0	20	85	237	82	210	5050	5684
2013	0	21	86	240	84	213	5119	5763
2021	0	21	88	246	86	218	5257	5916
2027	0	21	89	248	87	220	5298	5963
2037	0	21	89	248	87	220	5303	5968
2047	0	21	89	248	87	220	5303	5968
2057	0	21	89	248	87	220	5303	5968
2067	0	21	89	248	87	220	5303	5968

Table 2.5.1-2 (Sheet 5 of 5)
Projected Permanent Population for Each Sector 0 to 10 Miles (0 to 16 km)

Year	Direction							
	Sector 0-0.3 (mi)	Sector 0.3-1 (mi)	Sector 1-2 (mi)	Sector 2-3 (mi)	Sector 3-4 (mi)	Sector 4-5 (mi)	Sector 5-10 (mi)	Sector 0-10 (mi)
Northwest								
2010	0	19	24	48	13	80	1574	1758
2013	0	19	24	49	13	81	1602	1788
2021	0	19	25	50	14	83	1664	1855
2027	0	20	25	50	14	84	1692	1885
2037	0	20	25	50	14	84	1714	1907
2047	0	20	25	50	14	84	1728	1921
2057	0	20	25	50	14	84	1743	1936
2067	0	20	25	50	14	84	1771	1964
North-Northwest								
2010	0	0	1	0	0	149	1700	1850
2013	0	0	1	0	0	151	1739	1891
2021	0	0	1	0	0	155	1831	1987
2027	0	0	1	0	0	156	1883	2040
2037	0	0	1	0	0	156	1936	2093
2047	0	0	1	0	0	156	1972	2129
2057	0	0	1	0	0	156	2008	2165
2067	0	0	1	0	0	156	2077	2234
Totals								
2010	0	149	537	1091	1407	2990	61,029	67,203
2013	0	151	544	1109	1437	3063	63,060	69,364
2021	0	155	560	1143	1504	3225	68,070	74,657
2027	0	157	564	1155	1539	3313	71,161	77,889
2037	0	157	564	1159	1570	3403	75,039	81,892
2047	0	157	564	1163	1594	3469	78,163	85,110
2057	0	157	564	1168	1621	3549	81,759	88,818
2067	0	157	564	1174	1658	3654	86,263	93,470

Note: Based on 2010 USCB data. See Section 2.5.1.1 for methodology used to generate permanent population projections. No permanent population distribution is within the exclusion area boundary.

Table 2.5.1-3
Projected Permanent Population for Each Sector 0 to 10 Miles (0 to 16 km)

Cumulative Totals	0-0.3 (mi)	0-1 (mi)	0-2 (mi)	0-3 (mi)	0-4 (mi)	0-5 (mi)	0-10 (mi)
2010	0	149	686	1777	3184	6174	67,203
2013	0	151	695	1804	3241	6304	69,364
2021	0	155	715	1858	3362	6587	74,657
2027	0	157	721	1876	3415	6728	77,889
2037	0	157	721	1880	3450	6853	81,892
2047	0	157	721	1884	3478	6947	85,110
2057	0	157	721	1889	3510	7059	88,818
2067	0	157	721	1895	3553	7207	93,470

Note: Based on 2010 USCB data. See Section 2.5.1.1 for methodology used to generate permanent population projections.

Table 2.5.1-4 (Sheet 1 of 5)
Projected Permanent Population for Each Sector 10 to 50 Miles (16 to 80 km)

Year	Direction				
	Sector 10-20 (mi)	Sector 20-30 (mi)	Sector 30-40 (mi)	Sector 40-50 (mi)	Sector 10-50 (mi)
North					
2010	2059	516	5058	6279	13,912
2013	2102	522	5111	6346	14,081
2021	2205	538	5261	6517	14,521
2027	2270	546	5330	6604	14,750
2037	2352	553	5387	6680	14,972
2047	2409	556	5398	6693	15,056
2057	2472	559	5406	6704	15,141
2067	2574	570	5499	6828	15,471
North-Northeast					
2010	8698	10,535	25,119	9337	53,689
2013	8847	10,647	25,224	9397	54,115
2021	9191	10,977	25,808	9650	55,626
2027	9,413	11,132	25,910	9716	56,171
2037	9705	11,308	25,914	9742	56,669
2047	9911	11,432	25,917	9743	57,003
2057	10,157	11,581	25,921	9744	57,403
2067	10,509	11,793	25,926	9793	58,021
Northeast					
2010	32,319	22,447	11,747	10,948	77,461
2013	32,879	22,977	11,995	11,187	79,038
2021	34,168	24,289	12,577	11,722	82,756
2027	35,001	25,189	12,891	11,985	85,066
2037	36,106	26,521	13,189	12,147	87,963
2047	36,891	27,706	13,379	12,157	90,133
2057	37,824	29,024	13,588	12,177	92,613
2067	39,148	30,477	13,808	12,290	95,723
East-Northeast					
2010	63,674	172,503	47,676	21,238	305,091
2013	65,974	179,276	49,522	22,012	316,784
2021	72,026	197,268	54,409	23,911	347,614
2027	76,378	210,290	57,928	25,109	369,705

Table 2.5.1-4 (Sheet 2 of 5)
Projected Permanent Population for Each Sector 10 to 50 Miles (16 to 80 km)

Year	Direction				
	Sector 10-20 (mi)	Sector 20-30 (mi)	Sector 30-40 (mi)	Sector 40-50 (mi)	Sector 10-50 (mi)
2037	83,326	231,277	63,557	26,575	404,735
2047	90,257	252,501	69,232	27,642	439,632
2057	97,744	275,348	75,340	28,853	477,285
2067	104,860	296,672	81,037	30,684	513,253
East					
2010	75,605	58,268	36,761	46,774	217,408
2013	78,598	60,614	38,599	49,636	227,447
2021	86,527	66,761	43,398	57,086	253,772
2027	92,255	71,167	46,816	62,351	272,589
2037	101,408	77,966	51,999	70,213	301,586
2047	110,528	84,330	56,718	77,246	328,822
2057	120,319	91,086	61,690	84,628	357,723
2067	129,684	98,239	67,225	93,135	388,283
East-Southeast					
2010	15,702	71,929	7738	3236	98,605
2013	16,397	74,935	8067	3406	102,805
2021	18,187	82,625	8909	3834	113,555
2027	19,437	88,039	9502	4137	121,115
2037	21,215	95,720	10,346	4599	131,880
2047	22,676	101,710	11,010	5014	140,410
2057	24,228	107,836	11,690	5443	149,197
2067	26,220	116,490	12,639	5938	161,287
Southeast					
2010	6322	13,059	309	2602	22,292
2013	6665	13,617	321	2672	23,275
2021	7547	15,039	352	2868	25,806
2027	8139	16,026	373	3017	27,555
2037	8918	17,396	402	3263	29,979
2047	9522	18,450	425	3509	31,906
2057	10,211	19,544	448	3754	33,957
2067	11,132	21,114	481	4000	36,727

Table 2.5.1-4 (Sheet 3 of 5)
Projected Permanent Population for Each Sector 10 to 50 Miles (16 to 80 km)

Year	Direction				
	Sector 10-20 (mi)	Sector 20-30 (mi)	Sector 30-40 (mi)	Sector 40-50 (mi)	Sector 10-50 (mi)
South-Southeast					
2010	13,319	6959	1896	543	22,717
2013	14,054	7237	1970	555	23,816
2021	15,933	7923	2151	587	26,594
2027	17,165	8345	2262	608	28,380
2037	18,725	8813	2382	635	30,555
2047	19,895	9081	2448	654	32,078
2057	21,268	9386	2523	674	33,851
2067	23,172	10,035	2693	707	36,607
South					
2010	9010	16,818	13,722	4509	44,059
2013	9460	17,453	14,161	4620	45,694
2021	10,595	19,004	15,228	4889	49,716
2027	11,326	19,948	15,869	5042	52,185
2037	12,220	20,970	16,553	5188	54,931
2047	12,851	21,526	16,929	5257	56,563
2057	13,588	22,166	17,378	5352	58,484
2067	14,716	23,614	18,360	5583	62,273
South-Southwest					
2010	3443	10,838	28,433	12,972	55,686
2013	3596	11,097	29,031	13,273	56,997
2021	3978	11,720	30,463	14,013	60,174
2027	4220	12,084	31,282	14,462	62,048
2037	4517	12,464	32,112	14,984	64,077
2047	4736	12,685	32,586	15,367	65,374
2057	4993	12,970	33,226	15,838	67,027
2067	5357	13,526	34,477	16,533	69,893
Southwest					
2010	2802	4804	9786	22,268	39,660
2013	2841	4908	10,047	22,877	40,673
2021	2920	5139	10,661	24,315	43,035
2027	2945	5253	11,028	25,188	44,414

Table 2.5.1-4 (Sheet 4 of 5)
Projected Permanent Population for Each Sector 10 to 50 Miles (16 to 80 km)

Year	Direction				
	Sector 10-20 (mi)	Sector 20-30 (mi)	Sector 30-40 (mi)	Sector 40-50 (mi)	Sector 10-50 (mi)
2037	2948	5333	11,442	26,202	45,925
2047	2948	5377	11,749	26,984	47,058
2057	2948	5428	12,093	27,856	48,325
2067	2948	5502	12,551	28,953	49,954
West-Southwest					
2010	4599	5117	4656	8054	22,426
2013	4661	5281	4809	8219	22,970
2021	4787	5683	5183	8597	24,250
2027	4824	5942	5424	8815	25,005
2037	4829	6272	5712	9031	25,844
2047	4829	6518	5901	9136	26,384
2057	4829	6793	6125	9310	27,057
2067	4829	7185	6495	9635	28,144
West					
2010	11,651	3396	27,389	8304	50,740
2013	11,920	3572	28,824	8720	53,036
2021	12,543	4017	32,446	9765	58,771
2027	12,858	4294	34,703	10,418	62,273
2037	13,127	4575	37,002	11,098	65,802
2047	13,254	4696	37,989	11,406	67,345
2057	13,399	4842	39,175	11,764	69,180
2067	13,772	5254	42,542	12,745	74,313
West-Northwest					
2010	3926	4808	7666	8927	25,327
2013	4046	5021	8025	9278	26,370
2021	4348	5560	8924	10,141	28,973
2027	4537	5899	9478	10,662	30,576
2037	4756	6262	10,038	11,222	32,278
2047	4900	6446	10,277	11,516	33,139
2057	5047	6653	10,566	11,867	34,133
2067	5335	7165	11,394	12,665	36,559

Table 2.5.1-4 (Sheet 5 of 5)
Projected Permanent Population for Each Sector 10 to 50 Miles (16 to 80 km)

Year	Direction				
	Sector 10-20 (mi)	Sector 20-30 (mi)	Sector 30-40 (mi)	Sector 40-50 (mi)	Sector 10-50 (mi)
Northwest					
2010	5348	3228	2918	10,824	22,318
2013	5520	3332	3006	11,088	22,946
2021	5957	3596	3223	11,692	24,468
2027	6238	3765	3355	11,990	25,348
2037	6572	3967	3502	12,195	26,236
2047	6796	4102	3587	12,167	26,652
2057	7024	4240	3680	12,211	27,155
2067	7461	4504	3885	12,657	28,507
North-Northwest					
2010	5558	575	6223	7076	19,432
2013	5735	589	6337	7203	19,864
2021	6182	623	6606	7490	20,901
2027	6470	645	6767	7646	21,528
2037	6814	669	6927	7775	22,185
2047	7043	683	6983	7784	22,493
2057	7278	697	7041	7806	22,822
2067	7726	731	7287	8041	23,785
Totals					
2010	264,035	405,800	237,097	183,891	1,090,823
2013	273,295	421,078	245,049	190,489	1,129,911
2021	297,094	460,762	265,599	207,077	1,230,532
2027	313,476	488,564	278,918	217,750	1,298,708
2037	337,538	530,066	296,464	231,549	1,395,617
2047	359,446	567,799	310,528	242,275	1,480,048
2057	383,329	608,153	325,890	253,981	1,571,353
2067	409,443	652,871	346,299	270,187	1,678,800

Note: Based on 2010 USCB data. See Section 2.5.1.1 for methodology used to generate permanent population projections.

Table 2.5.1-5
Projected Permanent Population for Each Sector 10 to 50 Miles (16 to 80 km)

Cumulative Totals	10-20 (mi)	10-30 (mi)	10-40 (mi)	10-50 (mi)
2010	264,035	669,835	906,932	1,090,823
2013	273,295	694,373	939,422	1,129,911
2021	297,094	757,856	1,023,455	1,230,532
2027	313,476	802,040	1,080,958	1,298,708
2037	337,538	867,604	1,164,068	1,395,617
2047	359,446	927,245	1,237,773	1,480,048
2057	383,329	991,482	1,317,372	1,571,353
2067	409,443	1,062,314	1,408,613	1,678,800

Note: Based on 2010 USCB data. See Section 2.5.1.1 for methodology used to generate permanent population projections.

Table 2.5.1-6
Historical and Projected Population

	Anderson County		Knox County		Loudon County		Roane County		State of Tennessee	
	Population	Annual Percent Growth	Population	Annual Percent Growth	Population	Annual Percent Growth	Population	Annual Percent Growth	Population	Annual Percent Growth
1970	60,300	NA	276,293	NA	24,266	NA	38,881	NA	3,923,687	NA
1980	67,346	1.17	319,694	1.57	28,553	1.77	48,425	2.45	4,591,120	1.70
1990	68,250	0.13	335,749	0.50	31,255	0.95	47,227	-0.25	4,877,185	0.62
2000	71,330	0.45	382,032	1.38	39,086	2.51	51,910	0.99	5,689,283	1.67
2010	75,129	0.53	432,226	1.31	48,556	2.42	54,181	0.44	6,346,105	1.15
2015	77,285	0.57	460,612	1.31	53,324	1.96	55,411	0.45	6,735,022	1.23
2020	79,061	0.46	488,993	1.23	57,923	1.72	56,301	0.32	7,107,296	1.11
2025	80,713	0.42	516,603	1.13	62,151	1.46	56,805	0.18	7,460,624	0.99
2030	82,202	0.37	543,302	1.03	65,869	1.20	56,897	0.03	7,799,933	0.91
2035	83,444	0.30	569,659	0.97	68,918	0.93	56,583	-0.11	8,127,930	0.84
2040	84,438	0.24	595,787	0.92	71,421	0.73	55,948	-0.22	8,449,472	0.79

Note:
NA = Not Applicable

Table 2.5.1-7
Age and Gender Distribution, 2010

Age Groups	Anderson County		Knox County		Loudon County		Roane County		Tennessee	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent	Number	Percent
Under 5 years	4212	5.6	26,168	6.1	2560	5.3	2699	5.0	407,813	6.4
5 to 14 years	9205	12.3	52,681	12.2	5552	11.4	6521	12.0	831,122	13.1
15 to 24 years	8804	11.7	65,816	15.2	4978	10.3	5825	10.8	863,430	13.6
25 to 44 years	17,706	23.6	116,712	27.0	10,553	21.7	12,118	22.4	1,678,127	26.4
45 to 64 years	22,138	29.5	114,358	26.5	14,479	29.8	16,963	31.3	1,712,151	27.0
65 years and over	13,064	17.4	56,491	13.1	10,434	21.5	10,055	18.6	853,462	13.4
TOTAL	75,129	100.0	432,226	100.0	48,556	100.0	54,181	100.0	6,346,105	100.0
Median Age (years)	42.6		37.2		46.0		44.9		38.0	
Gender										
Male	36,308	48.3	210,085	48.6	23,828	49.1	26,628	49.1	3,093,504	48.7
Female	38,821	51.7	222,141	51.4	24,728	50.9	27,553	50.9	3,252,601	51.3

Table 2.5.1-8 (Sheet 1 of 4)
Contributors to Transient Population within the 50-Mile (80 km) Region[1]

Event or Location	City	Peak Daily Visitors[2]
Freedom Fest	Alcoa	30,000
Spring Sprint	Alcoa	452
Allardt Pumpkin Festival & Pumpkin Run	Allardt	10,000
Benefit Dinner	Athens	1500
James L. Robb Gym	Athens	1000
Pumpkintown Festival	Athens	8000
Sunshine Hollow	Athens	100
Tennessee Wesleyan Halloween Festival	Athens	1300
Tennessee Wesleyan Soccer	Athens	150
Louie Bluie Festival	Caryville	7500
International Cowpea Festival & Cookoff	Charleston	3500
Autumn Acres	Crossville	295
Clyde York 4-H Center	Crossville	1500
Cumberland Chamber of Commerce	Crossville	250
Deer Creek Golf Club	Crossville	100
Lake Tansi Village Golf	Crossville	122
Palace Theater	Crossville	302
Stonehenge Golf Club	Crossville	145
The Bear Trace at Cumberland Mountain	Crossville	164
Dayton Horse & Carriage Parade	Dayton	2000
Holiday Stroll	Dayton	2000
PumpkinFest	Dayton	5000
Scopes Festival	Dayton	600
Strawberry Festival	Dayton	700
Savannah Oaks Winery	Delano	500
The Gem Players and Theater	Etowah	525
Dorchester Golf Club	Fairfield Glade	172
Druid Hills Golf Club	Fairfield Glade	164
Heatherhurst Golf Club	Fairfield Glade	370
Fontana Village Resort	Fontana Dam	2500
W.E. Rock Eastern Series	Graysville	1400
Emory Golf Course	Harriman	150

Table 2.5.1-8 (Sheet 2 of 4)
Contributors to Transient Population within the 50-Mile (80 km) Region[1]

Event or Location	City	Peak Daily Visitors[2]
Obrien Theatre	Harriman	489
The Princess Theatre	Harriman	540
Brimstone Recreation	Huntsville	3333
Highland Manor Winery	Jamestown	150
Pickett State Park	Jamestown	1291
58 Landing	Kingston	300
Colonial Christmas Candlelight Tour	Kingston	122
Kingston City Park	Kingston	300
Kingston Community Center	Kingston	190
Kingston Country Fair	Kingston	980
Ladd Delaney Park	Kingston	300
Lakeside Golf	Kingston	125
RedBones on the River	Kingston	165
Roane County Healthy Schools 5k	Kingston	106
Smokin the Water	Kingston	12,000
Stormin the Fort Olympic Triathlon	Kingston	161
The Gravel Pit	Kingston	300
Barksdale Stadium	Knoxville	2000
Bijou Theatre	Knoxville	758
BUDDY'S Race Against Cancer	Knoxville	5000
Civic Auditorium and Coliseum	Knoxville	7141
Covenant Health Knoxville Marathon	Knoxville	9200
Game on Against Cancer	Knoxville	250
Knoxville Municipal Golf Course	Knoxville	150
Komen Race for the Cure	Knoxville	10,000
Light the Night Walk	Knoxville	2000
Lindsey Nelson Stadium	Knoxville	3800
Museum of Art	Knoxville	250
Neyland Stadium	Knoxville	102,455
Regal Soccer Stadium	Knoxville	3000
Rossini Festival	Knoxville	100,000

Table 2.5.1-8 (Sheet 3 of 4)
Contributors to Transient Population within the 50-Mile (80 km) Region[1]

Event or Location	City	Peak Daily Visitors[2]
Sherri Parker Lee Stadium	Knoxville	1622
Tennessee Theatre	Knoxville	1638
Thompson-Boling Arena	Knoxville	21,678
Tour de Rockytop	Knoxville	380
Trideltathon	Knoxville	260
Twinkle Toes 5k Run/Walk	Knoxville	150
West Site Y Triathlon	Knoxville	200
Christmas in Old Loudon	Loudon	2000
Fall Pig Roast	Loudon	500
Riverfest	Loudon	5000
Fine Arts Blount Kite Festival	Maryville	1500
Foothills Fall Festival	Maryville	25,000
Foothills Sprint Triathlon	Maryville	230
Ruby Tuesday's Triple Crown of Running	Maryville	646
Smoky Mountains Softball Classic	Maryville	1750
Spring Arts and Crafts Show	Maryville	6750
Red Gate Rodeo	Maynardville	2000
Union County Heritage Festival	Maynardville	5000
River Glen Equestrian Park	New Market	660
Butterflies for Hope 5k	Oak Ridge	100
Butterflies for Hope Bike Ride	Oak Ridge	130
Secret City Festival	Oak Ridge	10,000
BSF Vintage Train Festival	Oneida	5000
Spring Planting Festival	Oneida	3000
Wings Over Big South Fork	Oneida	20,000
World Pig Championship	Pall Mall	100
Rockwood Event Center	Rockwood	400
Rockwood Golf and Country Club	Rockwood	240
Historic Rugby Visitor Centre	Rugby	136

Table 2.5.1-8 (Sheet 4 of 4)
Contributors to Transient Population within the 50-Mile (80 km) Region[1]

Event or Location	City	Peak Daily Visitors[2]
Tennessee Valley Theatre	Spring City	300
Ride the Plains	Strawberry Plains	250
National Muscadine Festival	Sweetwater	10,000
The Lost Sea	Sweetwater	411
Blue Springs Marina	Ten Mile	900
Townsend Fall Festival	Townsend	10,000
Tuckaleechee Caverns	Townsend	500
Rarity Bay Golf Club	Vonore	328
Fort Loudoun State Historic Area	Vonore	2000
Sequoyah Birthplace Museum	Vonore	3000

1 Events and locations listed in this table contributed > 100 daily visitors.
2 Values presented in this column represent the peak daily visitors. For events or locations where peak visitor data were not available, average daily visitors were calculated using seasonal and/or annual visitor information.

Note: Information collected by means of a transient population survey. See Section 2.5.1.3 for description of survey methodology.

Table 2.5.1-9
National and State Parks Within 50 Miles with Reported Visitor Data

Tennessee State Parks	Peak Daily Visitors[1]
Big Ridge State Park	2894
Bledsoe State Forest	612
Cove Lake State Park	1849
Cumberland Mountain State Park	3944
Cumberland Trail	504
Fort Loudoun State Historic Park	493
Frozen Head State Park and Natural Area	656
Hiwassee/Ocoee Scenic River State Park	3763
Indian Mountain State Park	1678
Norris Dam State Park	314
National Parks	**Peak Daily Visitors[1]**
Great Smoky Mountains National Park	26,537
Big South Fork National River and Recreation Area	1644
Obed Wild Scenic River	582

1 Values presented in this column represent peak or calculated peak daily visitors.

Table 2.5.1-10 (Sheet 1 of 2)
Peak Daily Projected Transient Population for Each Sector 0 to 50 Miles (0 to 80 km)

Distance (mi)	Direction	Year						
		2013	2021	2027	2037	2047	2057	2067
4	E	7	8	8	9	9	9	10
7	WSW	127	130	131	131	131	131	131
8	W	12,660	13,002	13,103	13,116	13,116	13,116	13,116
8	SSE	529	605	655	720	770	829	906
9	W	775	796	803	803	803	803	803
9	WSW	1692	1737	1751	1753	1753	1753	1753
20	NNW	549	592	619	652	674	697	739
20	NW	27	29	31	33	34	35	37
20	WNW	557	598	624	654	674	694	734
20	W	1360	1431	1467	1497	1512	1528	1571
20	SW	913	938	946	947	947	947	947
20	SSE	7733	8767	9445	10,303	10,947	11,702	12,749
20	E	468	515	549	604	658	716	772
20	NE	10,407	10,815	11,079	11,429	11,677	11,973	12,392
20	N	16	17	18	18	19	19	20
30	NNW	88	93	97	100	102	104	109
30	NW	298	322	337	355	367	380	403
30	WNW	870	964	1023	1086	1118	1153	1242
30	W	226	254	272	290	297	307	333
30	SSW	10,238	10,814	11,149	11,500	11,703	11,966	12,480
30	S	431	469	492	517	531	547	583
30	SSE	5716	6258	6591	6961	7172	7413	7926
30	SE	25	28	29	32	34	36	39
30	ESE	72,837	80,312	85,575	93,040	98,863	104,817	113,229
30	E	67,159	73,970	78,852	86,386	93,436	100,922	108,848
30	ENE	250,589	275,737	293,940	323,275	352,941	384,877	414,683
30	NE	74	78	81	85	89	93	98
30	NNE	398	411	416	423	428	433	441
40	NNW	3704	3860	3955	4048	4081	4115	4259
40	NW	22	24	25	26	27	27	29
40	WNW	150	166	177	187	192	197	212
40	W	6736	7582	8109	8647	8877	9155	9941

Table 2.5.1-10 (Sheet 2 of 2)
Peak Daily Projected Transient Population for Each Sector 0 to 50 Miles (0 to 80 km)

Distance (mi)	Direction	Year						
		2013	2021	2027	2037	2047	2057	2067
40	WSW	385	415	434	458	473	491	520
40	SW	103	109	113	117	120	124	128
40	SSW	12,349	12,958	13,307	13,660	13,862	14,134	14,666
40	S	571	614	640	667	682	700	740
40	SE	2374	2603	2759	2973	3138	3308	3557
40	ESE	12,587	13,901	14,827	16,144	17,180	18,241	19,721
40	NE	10,125	10,617	10,881	11,133	11,293	11,470	11,655
40	NNE	9214	9427	9464	9466	9467	9468	9470
50	NNW	24,252	25,220	25,747	26,181	26,211	26,285	27,076
50	NW	10,413	10,981	11,260	11,453	11,426	11,468	11,886
50	WNW	324	354	373	392	402	415	443
50	W	126	141	151	161	165	170	185
50	WSW	205	215	220	225	228	232	241
50	SW	12,089	12,850	13,311	13,846	14,260	14,721	15,301
50	SSW	4093	4321	4460	4620	4739	4884	5,098
50	S	3855	4080	4208	4329	4387	4467	4659
50	SE	4437	4762	5010	5418	5826	6233	6641
50	ESE	4958	5581	6022	6695	7299	7924	8645
50	E	8352	9606	10,492	11,815	12,998	14,241	15,672
50	ENE	943	1025	1076	1139	1184	1236	1315
50	NNE	1237	1270	1279	1282	1282	1283	1289
50	N	5060	5196	5266	5326	5337	5345	5444
Total		585,436	637,568	673,646	727,127	775,942	828,332	885,887

Note: See Section 2.5.1.3 for methodology used to generate transient population projections.

Table 2.5.1-11

Transient Workers Entering the 50-Mile Region, 2006-2010[1]

Workplace County		Number of Workers Residing Outside the Region and Traveling to Work Inside the Region
North Carolina:	Graham	358
Tennessee:	Anderson	1047
	Blount	857
	Campbell	1164
	Cumberland	1360
	Fentress	288
	Knox	13,294
	Loudon	143
	McMinn	1926
	Meigs	134
	Monroe	312
	Morgan	49
	Rhea	2734
	Roane	373
	Scott	553
	Sevier	5807
	Union	469
Total Transient Workers		30,868

[1] Includes those counties with at least 50 percent of their area within the 50-mi radius.

Table 2.5.1-12
Description of Sparseness and Proximity Demographic Categories

Demographic Categories Based on Sparseness	
Category	*Description*
Most sparse	1. Less than 40 persons per sq. mi. and no community with 25,000 or more persons within 20 mi.
	2. 40 to 60 persons per sq. mi. and no community with 25,000 or more persons within 20 mi.
	3. 60 to 120 persons per sq. mi. or less than 60 persons per sq. mi. with at least one community with 25,000 or more persons within 20 mi.
Least sparse	4. Greater than or equal to 120 persons per sq. mi. within 20 mi.
Demographic Categories Based on Proximity	
Category	*Description*
Not in close proximity	1. No city with 100,000 or more persons and less than 50 persons per sq. mi. within 50 mi.
	2. No city with 100,000 or more persons and between 50 and 190 persons per sq. mi. within 50 mi.
	3. One or more cities with 100,000 or more persons and less than 190 persons per sq. mi. within 50 mi.
In close proximity	4. Greater than or equal to 190 persons per sq. mi. within 50 mi.

Source: NUREG-1437

Table 2.5.1-13
Generic Environmental Impact Statement Sparseness and Proximity Matrix

		Proximity Value			
		1	**2**	**3**	**4**
Sparseness Value	1	1.1	1.2	1.3	1.4
	2	2.1	2.2	2.3	2.4
	3	3.1	3.3	3.3	3.4
	4	4.1	4.2	4.3	4.4

Low Population Area (light grey: 1.1, 1.2, 2.1)

Medium Population Area (white)

High Population Area (dark grey: 3.4, 4.3, 4.4)

Source: NUREG-1437

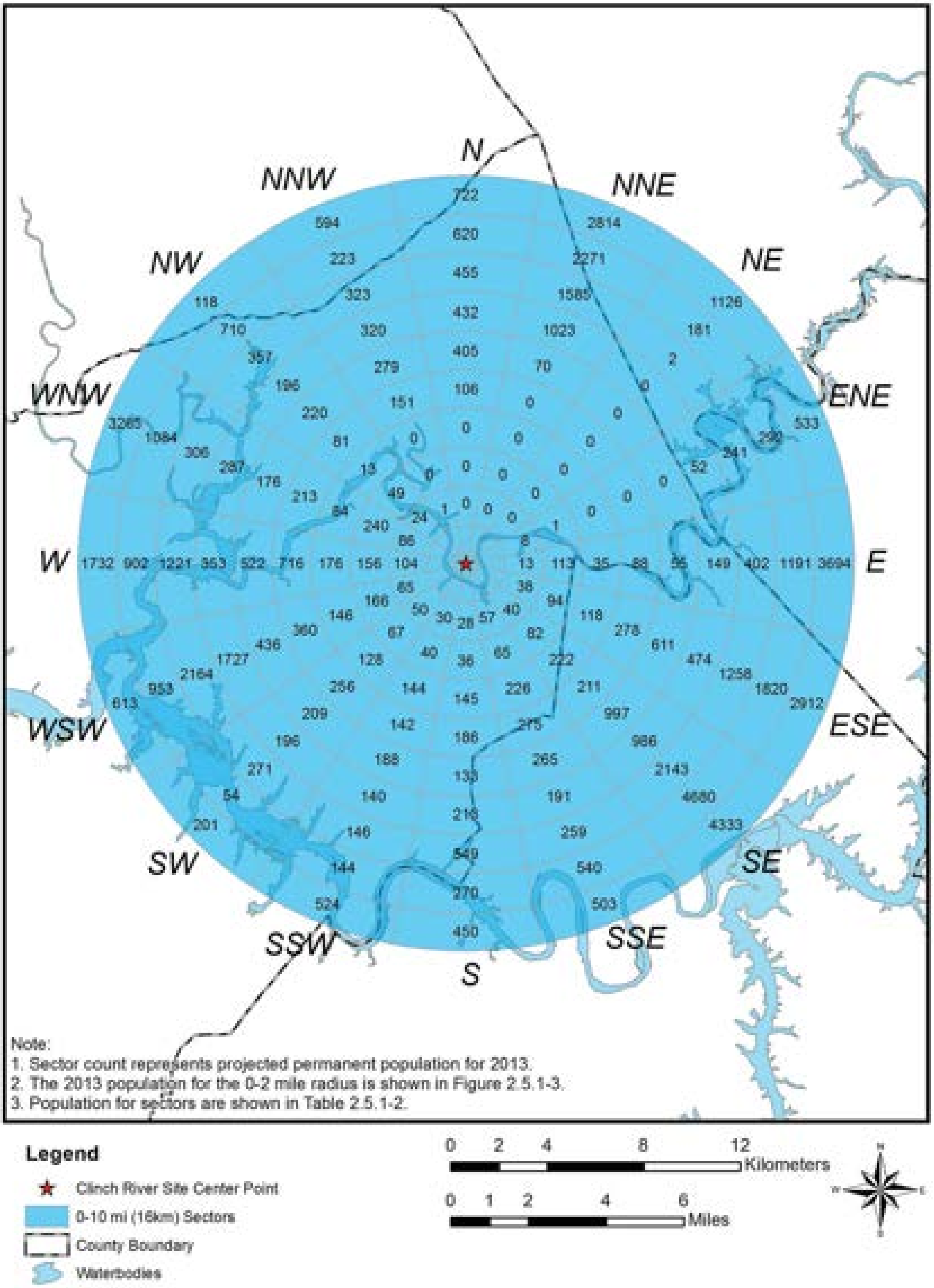

Figure 2.5.1-1. 0 to 10 Mile Population Sector Map

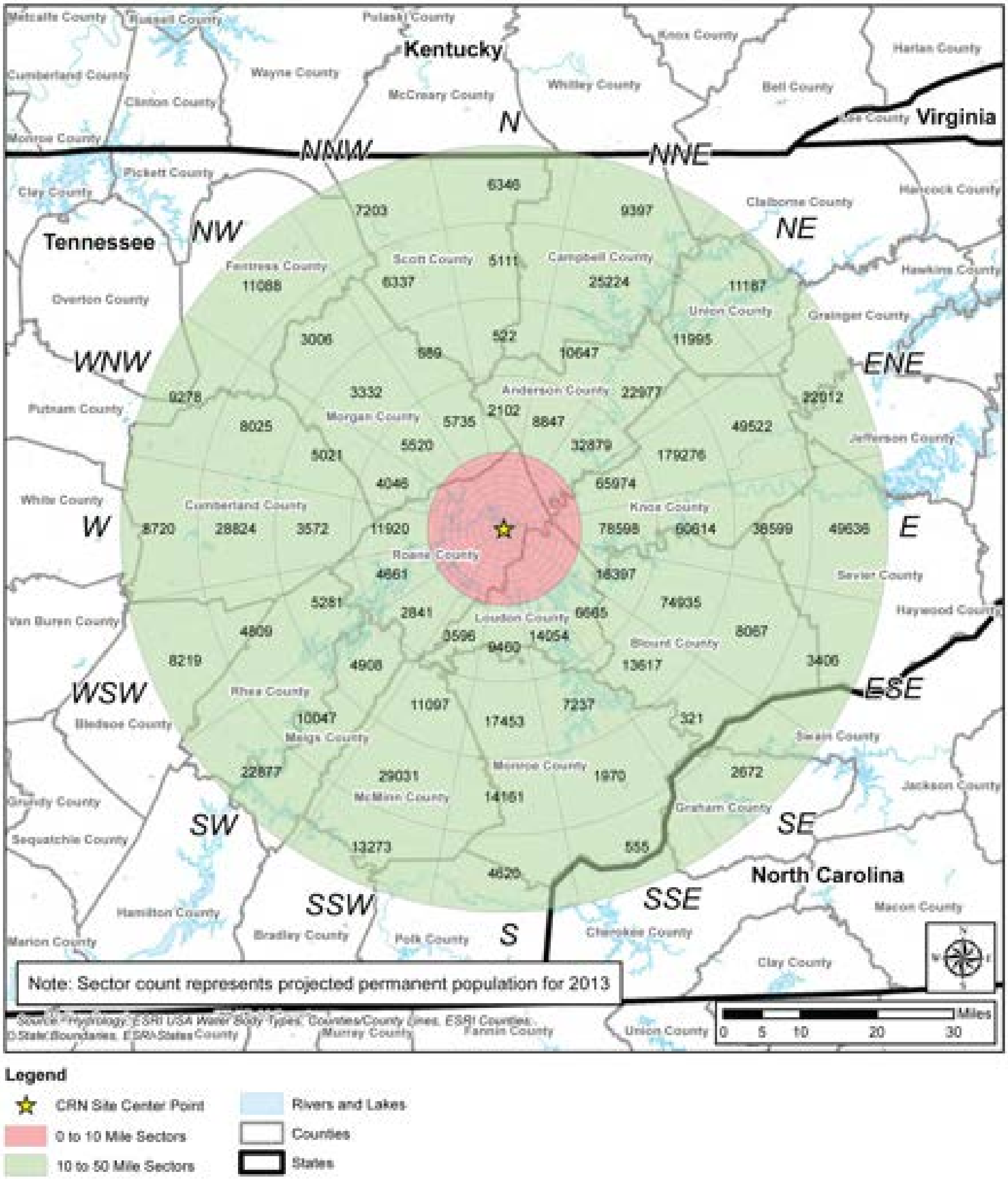

Figure 2.5.1-2. 10 to 50 Mile Population Sector Map

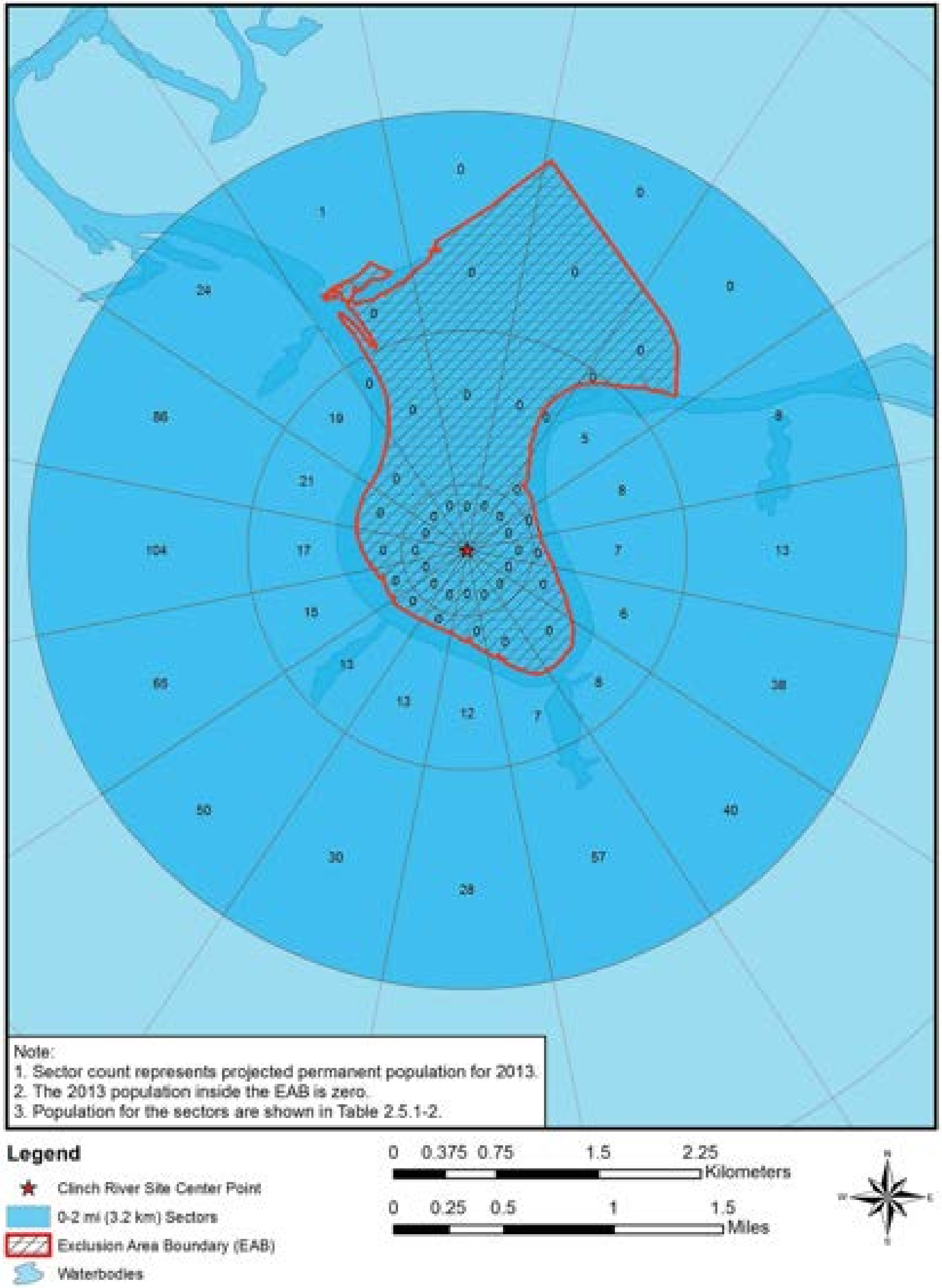

Figure 2.5.1-3. 0 to 2 Mile Population Sector Map

2.5.2 Community Characteristics

This subsection describes the following community characteristics potentially affected by the construction and operation of two or more small modular reactors (SMRs): economy, transportation, taxes, land use, aesthetics and recreation, housing, community infrastructure and public services, and education. The geographic area of interest is the area with the greatest potential to be affected by construction and operation of two or more SMRs. For the socioeconomics community characteristics, the geographic area of interest is the four county area (Anderson, Knox, Loudon, and Roane Counties) surrounding and including the CRN Site because the majority of the SMR workforce (both for construction and operations) and families are expected to live within these counties.

2.5.2.1 Economy

Table 2.5.2-1 presents total employment and employment levels by industrial sector (by place of work) for the four counties in the geographic area of interest. The principal economic centers in the geographic area of interest are Knoxville, Tennessee (Knox County); Oak Ridge, Tennessee (Roane and Anderson Counties); and Loudon, Tennessee (Loudon County). Knoxville is the largest of these economic centers.

In Anderson County in 2011, the sectors with the highest employment levels were services (43.4 percent of total employment) and manufacturing (18.8 percent). The industry with the largest growth from 2001 to 2011 was services, with an increase in employment of 119 percent. The industry with the largest decline from 2001 to 2011 was farming (-22.6 percent). Total number of jobs in the county increased from 2001 to 2011 by 6.6 percent, or an average of 0.7 percent annually. (Reference 2.5.2-1)

In Knox County in 2011, the sectors with the highest employment levels were services (48.7 percent) and government (12.8 percent). The industry with the largest growth from 2001 to 2011 was finance, insurance and real estate, with an increase of 36.6 percent. The industry with the largest decline from 2001 to 2011 was manufacturing (-40.8 percent). Total number of jobs in the county increased from 2001 to 2011 by 10.5 percent, or an average of 1.1 percent annually. (Reference 2.5.2-2)

In Loudon County in 2011, the sectors with the highest employment levels were services (34.0 percent) and manufacturing (15.7 percent). The industry with the largest growth from 2001 to 2011 was services, with an increase of 76.6 percent. The industry with the largest decline from 2001 to 2011 was farming (-24.5 percent). Total number of jobs in the county increased from 2001 to 2011 by 19.7 percent, or an average of 2.0 percent annually. (Reference 2.5.2-3)

In Roane County in 2011, the sectors with the highest employment levels were services (43.8 percent) and government (17.7 percent). The industry with the largest growth from 2001 to 2011 was services, with an increase in employment of 43.5 percent. The industry with the largest decline from 2001 to 2011 was manufacturing (-46.7 percent). Total number of jobs in the county increased from 2001 to 2011 by 5.6 percent, or an average of 0.6 percent annually. (Reference 2.5.2-4)

Table 2.5.2-2 shows employment trends (by place of residence) for Anderson, Knox, Loudon, and Roane counties. A total of 301,164 people were employed in the geographic area of interest in 2011; the total labor force was 325,167 people. From 2001 to 2011, the number of employed people in the geographic area of interest increased an average of 1.0 percent annually. The number of people employed increased the most in Loudon County (average 2.0 percent annually) and increased the least in Anderson County (average 0.2 percent annually). During the same period, employment in Tennessee increased an average of 0.4 percent annually, going from 2,728,528 in 2001 to 2,828,616 in 2011. (Reference 2.5.2-5; Reference 2.5.2-6)

Table 2.5.2-3 lists the top employers in Anderson, Knox, Loudon, and Roane counties. The largest employers within the geographic area of interest are Covenant Health (10,458 employees), with locations in Knox and Anderson counties; the U.S. Department of Energy (DOE) Y-12 National Security Complex, which employs 7000 persons in Anderson County; and Knox County Schools (6804 employees) and University of Tennessee in Knoxville (6660 employees), located in Knox County. The largest employer in Roane County is the DOE Oak Ridge National Laboratory, which employs 4374 persons. The largest employer in Loudon County is Loudon County Schools (600 employees). Kimberly Clark Corporation employs a total of 654 persons in Knox and Loudon counties. (Reference 2.5.2-7)

A total of 24,003 people were unemployed in the geographic area of interest in 2011, while 288,319 were unemployed in the State of Tennessee in 2011 (Table 2.5.2-2). The county in the geographic area of interest with the highest unemployment rate in 2011 was Anderson County with 8.5 percent. The county in the geographic area of interest with the lowest unemployment rate was Knox County with 7.1 percent. The geographic area of interest had an unemployment rate of 7.4 percent in 2011, while the State of Tennessee had an unemployment rate of 9.3 percent. (Reference 2.5.2-5; Reference 2.5.2-6)

Income distribution by household is shown in Table 2.5.2-4 for the three communities closest to the Clinch River Nuclear (CRN) Site (Reference 2.5.2-8). Table 2.5.2-5 presents the per capita income trends for Anderson, Knox, Loudon, and Roane counties. In the geographic area of interest, per capita personal income ranged from a high of $38,894 in Knox County to a low of $35,142 in Roane County in 2011. The Tennessee average personal per capita income in 2011 was $36,567. The state per capita income grew at an average annual rate of 3.3 percent between 2001 and 2011. (Reference 2.5.2-9)

Heavy construction work force data were analyzed for the states of Tennessee, North Carolina, Georgia, and Kentucky because the heavy construction industry would be expected to draw workers from a larger geographic area than would general construction, and the data are not available below the state level. Tennessee had 24,338 people employed in heavy and civil engineering construction in 2002 (Reference 2.5.2-10). By 2007, this number had decreased to 17,810 (Reference 2.5.2-11). North Carolina had 42,925 people employed in heavy and civil engineering construction in 2002, decreasing to 39,779 in 2007 (Reference 2.5.2-12; Reference 2.5.2-13). Georgia had 52,566 people employed in heavy and civil engineering construction in 2002, decreasing to 37,314 in 2007 (Reference 2.5.2-14; Reference 2.5.2-15). Kentucky had 13,814 people employed in heavy and civil engineering construction in 2002, decreasing to 11,578 in 2007 (Reference 2.5.2-16; Reference 2.5.2-17).

Section 3.10, Workforce Characterization, presents information on the workforce required to construct the plant, including number of workers during the various phases of construction, and how many jobs would be associated with plant operations once construction is complete.

2.5.2.2 Transportation

The area around the CRN Site is served by a transportation network of federal and state highways; three freight rail lines; one major navigable river; one commercial passenger airport, McGhee Tyson Airport; and one reliever airport, Knoxville Downtown Island Airport. Figure 1.1-1 illustrates the road, highway, railroad, and airport systems in the area.

2.5.2.2.1 Roads

Eight federal highways provide access to the geographic area of interest: Interstate (I-) 40, I-75, US 11, US 27, US 70, US 129, US 321, and US 441. The closest interstate highway to the CRN Site is I-40, which runs east to west approximately 0.6 miles (mi) southeast of the CRN Site at its closest border. The two largest nearby populated areas along I-40 are Nashville, Tennessee to the west (135.8 mi) and Knoxville, Tennessee to the east-northeast (24.9 mi). I-75 is located 7.0 mi east of the CRN Site and runs northeast to southwest. The two largest nearby populated areas along I-75 are Knoxville, Tennessee to the east-northeast (24.9 mi) and Chattanooga, Tennessee to the southwest (78.0 mi; Figure 1.1-1).

Tennessee State Highways (TN) in the geographic area of interest include TN 58, TN 95, TN 326, TN 327, TN 61, TN 62, and TN 1. TN 58 (Gallaher Road/Oak Ridge Turnpike) and TN 95 (White Wing Road) are the primary roadways near the CRN Site. TN 58 runs northeast to southwest approximately 0.9 mi northwest of the nearest border of the CRN Site. TN 95 runs north to south approximately 2.6 mi east of the nearest border of the CRN Site and connects to the City of Oak Ridge, Tennessee business district approximately 10 mi to the northeast. The junction of TN 58 and TN 95 is located approximately 3.2 mi north-northeast of the nearest border of the CRN Site (Figure 1.1-1).

Construction workers and plant staff would be expected to commute because there are no provisions for housing at the CRN Site. Driveway access to and from the CRN Site would be from one roadway, Bear Creek Road (Figure 1.1-1). For workers who live in Roane, Anderson, Loudon, and Knox counties, TN 58 and TN 95 provide access to Bear Creek Road. For workers commuting from the north and south, there are interchanges on I-40 for both TN 58 and TN 95. For workers commuting from the west, TN 61 and TN 62 provide access to Bear Creek Road via TN 327. From the east, US 321/TN95 intersects with Bear Creek Road. The roadway configuration results in a concentration, or funneling, of facility-related traffic onto Bear Creek Road.

2.5.2.2.2 Road Conditions and Mileage

Each of the four counties in the geographic area of interest has hundreds of miles of public maintained roadways. Anderson County contains 12 interstate road miles (RM), 127 state RM, 428 county RM, and 281 city RM (Reference 2.5.2-18). Knox County contains 69 interstate RM, 225 state RM, 1501 county RM, and 942 city RM (Reference 2.5.2-19). Loudon County contains 24 interstate RM, 92 state RM, 455 county RM, and 106 city RM (Reference 2.5.2-20). Roane County contains 23 interstate RM, 127 state RM, 632 county RM, and 209 city RM (Reference 2.5.2-21).

2.5.2.2.3 Traffic Conditions

Vehicle volume on roads is provided by the Tennessee Department of Transportation in the form of estimated annual average daily traffic (AADT) counts. The AADT counts for the primary access roads to the CRN Site were last updated in 2012.

TN 58 (Gallaher Road/Oak Ridge Turnpike) is a five-lane northeast/southwest principal arterial north of the CRN Site that connects I-40 to TN 95 via an interchange carrying approximately 10,500 vehicles per day with 3 percent heavy vehicles. Posted speed limits along TN 58 vary between 45 and 55 mi per hour (mph). Bear Creek Road is accessed from northbound TN 58 shortly after crossing the Clinch River bridge. Access to Bear Creek Road is provided by a loop ramp that travels underneath TN 58. (Reference 2.5.2-22)

TN 95 (White Wing Road/Oak Ridge Turnpike) is a two-lane north/south principal arterial approximately 2.6 mi east of the CRN Site that connects I-40 to TN 58 (eventually to the City of Oak Ridge, Tennessee). TN 95 is joined by TN 58 north of the CRN Site via an interchange carrying approximately 6600 vehicles per day with 3 percent heavy vehicles. Posted speed limits along TN 95 are primarily 55 mph. Several locations along TN 95 contain 35 mph advisory speed limits signs due to the horizontal (corners/bends) and vertical (hills/valleys) curvature. (Reference 2.5.2-22)

TN 327 (Blair Road) is a two-lane north/south major collector that connects TN 58 to TN 61 carrying approximately 3000 vehicles per day with 2 percent heavy vehicles. TN 61 connects the towns of Oliver Springs and Harriman, Tennessee. Posted speed limits along TN 327 are primarily 35 mph. (Reference 2.5.2-22)

Bear Creek Road is a two-lane northeast/southwest roadway that connects TN 58 to TN 95 (Figure 1.1-1) carrying approximately 500 vehicles per day with up to 10 percent heavy vehicles. Posted speed limits along Bear Creek Road are primarily 45 mph. Access to and from the CRN Site would be provided by a single driveway on Bear Creek Road. (Reference 2.5.2-22)

Capacity analyses were performed for the four intersections most likely to be affected by the construction and operation of the proposed project at the CRN Site (Reference 2.5.2-22). Figure 2.5.2-1 shows the locations of the intersections investigated during the traffic study. These intersections are TN 58 at Bear Creek Road ramp (Location 1), TN 58 at TN 327 (Location 2), TN 95 at Bear Creek Road (Location 3), and Bear Creek Road at Bear Creek Road ramp (Location 4). Capacity analyses were performed for 2013 AM and PM peak hours for all the intersections analyzed.

The traffic carrying ability of a roadway is described by level of service (LOS), which ranges from LOS A (progression is extremely favorable) to LOS F (poor progression, extreme delay) (Table 2.5.2-6). Typically, LOS C is considered the minimum acceptable LOS at an intersection (signalized or unsignalized) in a rural setting. (Reference 2.5.2-23)

TN 58 at Bear Creek Road Ramp

This unsignalized intersection currently operates at an LOS B in the AM peak hour and an LOS C during the PM peak hour. No significant queuing is present at this intersection. (Reference 2.5.2-22)

TN 58 at TN 327

This signalized intersection currently operates at an LOS A in the AM and PM peak hours. No significant queuing is present at this intersection. (Reference 2.5.2-22)

TN 95 at Bear Creek Road

This unsignalized intersection currently operates at an LOS B in the AM peak hour (eastbound approach) and a LOS C during the PM peak hour (westbound approach). In the morning peak hour, the major turning movement is the southbound left-turn from TN 95 onto East Bear Creek Road. In the afternoon, most of the vehicles leaving East Bear Creek Road use the designated right-out only exit, located approximately 1000 feet (ft) north of this study intersection. Traffic volumes on movements to and from West Bear Creek Road (proposed access to the CRN Site) are very low and traffic is minimal along TN 95. No significant queuing is present at this intersection. (Reference 2.5.2-22)

Bear Creek Road at Bear Creek Road Ramp

The unsignalized intersection currently operates at an LOS A in the AM and PM peak hours. In the AM peak hour, the major turning movement is the southbound left-turn from Bear Creek Road ramp onto Bear Creek Road. This movement is stop-controlled; however, low volumes on Bear Creek Road allow this stop-controlled intersection to operate with minimal delay. In the afternoon, most of the vehicles turn right onto Bear Creek Road ramp from Bear Creek Road. This movement operates under yield control with minimal delay. The west leg (Bear Creek Road) of this intersection carries minimal traffic because it is restricted to personnel entering the

DOE's Oak Ridge Reservation (ORR) as indicated on a sign. No significant queuing is present at this intersection. (Reference 2.5.2-22)

2.5.2.2.4 Traffic Accidents

The three primary roadways providing access to the CRN Site via Bear Creek Road are TN 58, TN 95, and TN 327. Crash data (from February 2008 through November 2012) were analyzed for segments of these three roadways to determine rates of traffic accidents and related injuries and fatalities. Traffic accident data for the primary CRN Site roadways are presented in Table 2.5.2-22. Of the three roadways, TN 95 had the greatest number of accidents, injuries, and fatalities; and TN 327 had the fewest.

2.5.2.2.5 Road Modifications

In 2013, approximately nine state road improvement projects were in progress in Anderson County, 47 projects were in progress in Knox County,14 projects were in progress in Loudon County , and 24 projects were in progress in Roane County (Reference 2.5.2-24; Reference 2.5.2-25). Of the projects in Roane County, two are located on access routes to the CRN Site within Oak Ridge. The other projects in all four counties are located on roads that are not on the access routes to the CRN Site. The Roane County road improvement projects in the vicinity of the CRN Site include intersection improvements at TN 95 and Bethel Valley Road, and reconstruction of approximately 3 mi of TN 95 from TN 58 to near Westover Drive (which has been completed). (Reference 2.5.2-25) There are seven future state road improvement projects scheduled in Knox County and one future state road improvement project in Loudon County. All of these projects are scheduled on roads that are not on the access routes to the CRN Site. There are no future modifications planned for state roads in either Roane County or Anderson County. (Reference 2.5.2-26) Tennessee's 25-Year Transportation Plan presents a statewide 10-year (yr) corridor initiative to improve the operation of key corridors, including the roads that serve the Oak Ridge and Knoxville areas (Reference 2.5.2-27).

2.5.2.2.6 Railroads

Figure 1.1-1 shows railways within the area surrounding the CRN Site. In Oak Ridge, Energy Solutions, LLC operates the 11.5-mi Heritage Railroad shortline serving the East Tennessee Technology Park (ETTP) (Reference 2.5.2-28). A second shortline, operated by Knoxville and Holston River Railroad, extends 18 mi from Knoxville through Knox County (Reference 2.5.2-29). Both of these lines connect with rail lines operated by Norfolk Southern Railway Company. Norfolk Southern rail lines are located approximately 7.5 mi northwest and 9 mi southeast of the CRN Site. The line to the southeast runs through Knoxville, Tennessee, connecting Chattanooga, Tennessee with Johnson City and Kingsport, Tennessee (Reference 2.5.2-30). A rail spur (EnergySolutions Heritage Railroad) is located approximately 2.5 mi north-northwest of the center point of the CRN Site, northwest of TN 58 (Figure 2.1-2) (Reference 2.5.2-31).

2.5.2.2.7 Waterways

The CRN Site is immediately adjacent to the Clinch River (Clinch River arm of the Watts Bar Reservoir) between approximately Clinch River Miles (CRMs) 14.5 and 19 (Reference 2.5.2-32). The Clinch River is a major tributary of the Tennessee River. The Tennessee River has a main navigable channel 652 mi long beginning at Knoxville and merging with the Ohio River in Paducah, Kentucky. This channel is controlled by a series of nine mainstream dams and locks which are part of Tennessee Valley Authority's (TVA's) integrated river control system consisting of a total of 49 dams and 15 navigation locks (Reference 2.5.2-33). Commercial navigation occurs on the Clinch River for 61 mi (Reference 2.5.2-34). The commercially navigable portion of the Clinch River extends from its mouth near Kingston, Tennessee upstream to Clinton, Tennessee (Reference 2.5.2-35). The navigable portion of the Clinch River includes a navigation lock at the Melton Hill Dam. The lock is 75 ft by 400 ft and has a maximum lift of 60 ft. (Reference 2.5.2-36)

2.5.2.2.8 Airports

The closest commercial airport to the CRN Site is the McGhee Tyson Airport in Alcoa, Tennessee. This airport is approximately 22.0 mi east-southeast of the CRN Site. Approximately 1,600,000 passengers (813,000 arrivals and 817,000 departures) traveled through the McGhee Tyson Airport in 2013 (Reference 2.5.2-37). Five operating airlines scheduled services out of this airport that carried approximately 89 percent of the passengers: ExpressJet, PSA, Endeavor Air (formerly Pinnacle), Allegiant, and American Eagle. (ExpressJet, PSA, and Endeavor Air are regional carriers that operate flights for Delta, United, and American Airlines, respectively (Reference 2.5.2-38; Reference 2.5.2-39).) Approximately 96 million pounds of freight were transported through the airport in 2013 (Reference 2.5.2-37). Another smaller airport, the Knoxville Downtown Island Airport, is located in Knoxville. It is a reliever airport, designed to provide additional capacity for the McGhee Tyson Airport (Reference 2.5.2-40). It has a single runway and is a base for over 100 private and corporate aircraft (Reference 2.5.2-41).

The Metropolitan Knoxville Airport Authority is planning the development of a general aviation airport located in Oak Ridge, Tennessee. The airport would be funded by federal, state and local funds. The proposed airport would be constructed on the site of a large industrial complex (ETTP) that is being redeveloped, located approximately 3.5 mi north of the CRN Site. Although the final plans have not yet been completed, the airport design includes a 5000-foot runway which could be used by corporate jets, private airplanes, and Emergency Medical Service aircraft. The current design would impact Blair Road (TN 327) to the east of the industrial park. Construction could begin as early as the end of 2017. (Reference 2.5.2-42)

2.5.2.2.9 Public Transportation

Public transportation is available in all four counties within the geographic area of interest. The East Tennessee Human Resource Agency (ETHRA) provides bus transportation to the sixteen county area of East Tennessee including Anderson, Knox, Loudon, and Roane Counties. The ETHRA provides special purpose bus transportation service and medical transportation (not on fixed, scheduled routes) to the general public. (Reference 2.5.2-43) ETHRA also operates Oak Ridge Transit, which provides bus service within Oak Ridge City limits (Reference 2.5.2-44). Knoxville Area Transit (KAT) provides bus transportation primarily within the City of Knoxville but also within Knox County outside of city limits. KAT provides fixed route bus service, downtown trolley routes, University of Tennessee campus service, and paratransit services. The Knox County Community Action Committee Transit provides service to Knox County residents who have no other means of transportation. (Reference 2.5.2-45)

2.5.2.3 Taxes

The tax structure for all of Tennessee, unless specifically noted at the city or county level, is found in Title 67 of the Tennessee Code Annotated (TCA) and its revisions. Anderson, Knox, Loudon, and Roane counties, are the tax districts that are assumed to be most directly affected by the construction and operation of two or more SMRs. Table 2.5.2-7 shows total annual revenues for Anderson, Knox, Loudon, and Roane Counties for fiscal year (FY) 2010-2011 through FY 2013-2014.

Several tax revenue categories would be affected by the construction and operation of new power production units. These include income taxes on corporate profits, and sales and use taxes on construction- and operation-related purchases and on purchases made by project-related workers. Table 2.5.2-8 shows tax collections by category for Anderson, Knox, Loudon, and Roane counties. The percentage of property tax assessments by category for the State of Tennessee are shown in Table 2.5.2-9.

Corporate income taxes are levied pursuant to guidelines contained in Title 67 of the TCA. Businesses in Anderson, Knox, Loudon, and Roane counties have tax incentives available to them, including capital-investment tax credits (Reference 2.5.2-46; Reference 2.5.2-47; Reference 2.5.2-48; Reference 2.5.2-49).

Corporate taxes, sales and use taxes, and property taxes contribute to the total funds for the State of Tennessee. The percentage of appropriation by category for state funds for FY 2012-2013 (July 2012 through June 2013) is shown in Table 2.5.2-10.

Under Section 13 of the TVA Act of 1933, TVA makes tax-equivalent payments to eight states, including the State of Tennessee. TVA pays 5 percent of its gross proceeds from the sale of power (with certain exclusions) to states and counties where its power operations are carried out (the State of Tennessee and Roane County for the construction and operation of two or more SMRs). Payments to each state are determined based upon the proportion of TVA power property and power sales, in each state, compared to TVA's total power property and power sales, respectively.

The State of Tennessee then allocates its tax-equivalent payments from TVA in accordance with Title 67 “Taxes and Licenses”, Chapter 9 “Payments in Lieu of Taxes”, Part 1 “Tennessee Valley Authority (Tennessee State Revenue Sharing Act)”. The TVA tax-equivalent payments are divided as follows:

- 48.5 percent is retained by the State of Tennessee
- 48.5 percent is distributed to local governments
- 3 percent is paid to impacted local governing areas that are experiencing TVA construction activity on facilities made to produce power. Such impacted areas are designated by TVA. Such payments to impacted areas are made during the period of construction activity and for one full year after completion of such activity. If, in any fiscal year, there are no impacted areas, the funds are allocated in accordance with § 67-9-102(b)(3). (Reference 2.5.2-50).

Of the 48.5 percent distributed to local governments, 70 percent is distributed to counties and 30 percent to municipalities. For the county distributions, 30 percent of the total is distributed based on the percent of state population, 30 percent is distributed based on the percent of state land, and 10 percent is distributed based on the county’s percent of TVA acreage in Tennessee. The distribution to municipalities is determined solely based on the percent of state population.

Following the payment distributions outlined above, the State of Tennessee allocation paid by TVA during FY 2013-2014 was $331.6 million. Tennessee paid $96.1 million to counties throughout the state during its 2013-2014 fiscal year. Of this Anderson County received $1.1 million, Knox County received $3.4 million, Loudon County received $1.1 million, and Roane County received $1.6 million. The Tennessee Department of Revenue estimates that the allocation for the State of Tennessee is to increase by approximately $18.9 million for FY 2014-2015. It is estimated that for FY 2014-2015, the State of Tennessee allocation is to be $350.6 million. From that, Tennessee is to pay an estimated $100.8 million to counties throughout the state in FY 2014-2015. Of this, Anderson County is to receive an estimated $1.2 million, Knox County an estimated $3.6 million, Loudon County an estimated $1.1 million, and Roane County an estimated $1.6 million.(Reference 2.5.2-51) TVA tax-equivalent payments for FY 2010-2011 through FY 2014-2015 are provided in Table 2.5.2-11.

The State of Tennessee sets aside a percentage of the tax equivalent payments received from TVA each year to redistribute to counties designated by TVA as affected by construction of major facilities used by TVA to produce electric power. These Impact Payments are received by Tennessee counties directly from the State. TVA’s designation of counties is based on anticipated effects such as an increase in local traffic, larger numbers of school-age children entering the county school systems, and a greater demand for the county’s health and safety services. (Reference 2.5.2-52)

2.5.2.4 Land Use

The CRN Site is located within the Oak Ridge city limits in eastern Roane County. The northwestern portion of Loudon County and part of the southwestern portion of Anderson County are included within the CRN Site vicinity, defined as a 6-mi radius from the center of the CRN Site. Figure 1.1-1 shows the location of communities in the CRN Site vicinity. Section 2.2, Land, describes the existing land use at the CRN Site and in its vicinity. Land use based on land-cover classification categories developed by the U.S. Geological Survey (USGS) and the latest data from the National Land Cover Database is shown in Figure 2.2-4 for the CRN Site and vicinity. The vicinity of the CRN Site is primarily rural, consisting of forest and pasture/hay. Based on the USGS land-cover data, land use within the vicinity is categorized and shown in Table 2.2-4. Examination of historic aerial photographs and topographic maps shows that historic land use patterns have remained largely unchanged within the CRN Site vicinity and the region. Small areas of development have occurred in isolated locations throughout the region. Greater amounts of development have occurred in and around the urban and suburban areas. It is anticipated that land use changes would continue in a similar fashion in the future with no large scale changes likely.

The Watts Bar Reservoir Land Management Plan specifies two different land use zones for the CRN Site. The majority of the CRN Site is designated as Zone 2 – Project Operations. A strip along the reservoir shoreline is designated Zone 3 – Sensitive Resource Management. (Reference 2.5.2-53)

Land use in the unincorporated areas of the geographic area of interest (i.e., outside of city limits) is regulated by the counties, primarily through zoning and subdivision regulations. Control of land use in the cities is regulated by the individual municipalities, which have zoning authority for the lands within their boundaries. Counties and municipalities use comprehensive plans to guide land use. The CRN Site is located within the city limits of Oak Ridge, Tennessee. However, although the CRN Site is within the city limits, Oak Ridge zoning does not apply to federal property.

In Anderson County outside of the corporate city limits, land use is regulated by the county zoning resolution, which establishes zoning districts and development-related requirements (Reference 2.5.2-54). The five municipalities in Anderson County, including Clinton, Oak Ridge (partially in Roane County), Rocky Top (formerly Lake City), Oliver Springs (partially in Roane and Morgan Counties), and Norris, have zoning ordinances (Reference 2.5.2-55; Reference 2.5.2-56; Reference 2.5.2-57; Reference 2.5.2-58; Reference 2.5.2-59). Anderson County does not have a current land use plan. The county is in the process of updating its 20-yr-old growth plan. However, the Anderson County Growth Plan Map was updated in 2007. It identifies urban growth boundaries encompassing planned growth areas adjacent to the cities of Clinton, Rocky Top (formerly Lake City), Norris, and Oak Ridge (Reference 2.5.2-60)

The Knox County zoning ordinance regulates land use in the unincorporated areas of the county and provides standard requirements for development of property (Reference 2.5.2-61). The two municipalities within Knox County, Farragut and Knoxville, have zoning ordinances (Reference 2.5.2-62; Reference 2.5.2-63). The Knoxville-Knox County General Plan 2033 was adopted in 2003. It is a 30-yr comprehensive plan for Knoxville and Knox County that includes physical and economic development policies and future land use recommendations for the city and county. (Reference 2.5.2-64)

In the unincorporated areas of Loudon County, the county zoning ordinance regulates land use and imposes development requirements (Reference 2.5.2-65). The five municipalities within Loudon County, including Philadelphia, Lenoir City, Greenback, Loudon, and Farragut, have zoning ordinances (Reference 2.5.2-66; Reference 2.5.2-67; Reference 2.5.2-68; Reference 2.5.2-69; Reference 2.5.2-62). The *Loudon County Growth Management Plan – 20-Year Land Use Plan* map identifies future land use for the county and municipalities, with nonresidential uses concentrated in the cities of Loudon and Lenoir City and along major highways (Reference 2.5.2-70).

In Roane County outside of the corporate city limits, land use is regulated by the county zoning resolution, which establishes zoning districts and development standards (Reference 2.5.2-71). The five municipalities in Roane County, including Harriman, Kingston, Oak Ridge, Oliver Springs, and Rockwood, have zoning ordinances (Reference 2.5.2-72; Reference 2.5.2-73; Reference 2.5.2-56; Reference 2.5.2-58; Reference 2.5.2-74). The Roane County Future Land Use Plan, adopted in 1998, covers the unincorporated areas of the county. The plan identifies the best direction for growth and recommends future land use patterns for the year 2020 based on land suitability and future land use demands. (Reference 2.5.2-75)

The Roane Alliance is the primary economic development organization for Roane County. This organization works in coordination with the Roane County Chamber of Commerce and Roane County Industrial Development Board to attract new industries to the county and promote existing industries. The Anderson County Economic Development Association, in association with the Anderson County Development Corporation, promotes the location of new industries in the county and fosters the expansion of existing industries. The Development Corporation of Knox County provides assistance to and promotes the growth of businesses in the county. The Loudon County Economic Development Agency provides economic and community development programs for the county and the cities of Lenoir City and Loudon.

The supply of vacant land available for industrial development in each of the four counties within the geographic area of interest is discussed below:

- A combined 140 acres (ac) are available for industrial development in four industrial parks in Clinton, Anderson County (Reference 2.5.2-76). An additional 144 ac of industrial land is available in three industrial parks in Oak Ridge, Anderson County (Reference 2.5.2-77).
- A combined 164 ac are available for industrial development in the two industrial parks in Knox County. Of this amount, 153 ac are located in the Mascot community of northeast Knox County and 11 ac are located in west Knox County (Reference 2.5.2-78).

- A combined 1783 ac are available for industrial development within six industrial parks in Loudon County. Of this amount, 484 ac are located in Loudon, Tennessee; 99 ac are located in Lenoir City, Tennessee; and 1200 ac are located in Greenback, Tennessee. (Reference 2.5.2-79)
- A combined 1004 ac are available for industrial development in six industrial parks in Roane County. Of this amount, 424 ac are located in Oak Ridge, Tennessee (the former DOE property in the ETTP); 256 ac are located in Kingston; 233 ac are located in Rockwood, Tennessee; and 91 ac are located in Harriman. (Reference 2.5.2-80; Reference 2.5.2-81) An additional 160 ac of DOE property, located across TN 58 from the ETTP, also is available (Reference 2.5.2-82).
- A combined 245 ac are available for industrial development in the Roane Regional Business and Technology Park, which is located approximately half a mile east of the CRN Site. This park, the nearest to the CRN Site, occupies 655 ac extending from I-40 north to the Clinch River shoreline. (Reference 2.5.2-80)

2.5.2.5 Aesthetics and Recreation

Aesthetics in the context of this subsection refers to the quality of visual resources or the visual experience. Aesthetics and recreation are linked because common outdoor recreational activities typically take place in areas with visual appeal. The aesthetic and recreational resources potentially affected by the construction and operation of two or more SMRs are those in the vicinity of the CRN Site within Roane County.

2.5.2.5.1 Aesthetics

The physical, biological, and man-made features seen in the landscape provide any selected geographic area with its particular visual qualities and aesthetic character. The varied combinations of natural features and human alterations that shape landscape character also help define their scenic importance. The presence or absence of these features along with aesthetic attributes such as uniqueness, variety, pattern, vividness, contrast, and harmony make the visual resources of an area identifiable and distinct. The scenic value of these resources is based on human perceptions of intrinsic beauty as expressed in the forms, colors, textures, and visual composition seen in each landscape.

Current methods used by TVA for analysis of visual resources involve measures for identifying the scenic and aesthetic character of the existing landscape and assessing the visibility of the CRN Site from public viewpoints. These measures for assessing the aesthetic quality of visual resources include:

- Scenic attractiveness (based on the intrinsic beauty of natural features)
- Scenic integrity (based on the visual unity of the landscape and the degree of harmony versus disruption in its elements, such as disruption due to human alterations)

- Scenic visibility (based on viewer context and sensitivity and the effects of viewing distance on the level of detail that can be seen)
  - Sensitivity (based on the concern of people for the scenic qualities of the project area and considerations such as the type and number of viewers, frequency and duration of viewing, and influence of adjacent scenery)
  - Viewing distance (based on how far away a subject can be seen and the degree of visible detail). Viewing distance may be divided into three categories: foreground (0 to 0.5 mi from the observer, where most details of objects are clearly seen), middleground (0.5 to 4 mi from the observer, where single objects or groups tend to merge into larger patterns), and background (4 mi to the horizon, where objects are seen as broad outline patterns and forms, and details and colors are not readily discernible unless they are large, stand alone, or have strong contrast). (Reference 2.5.2-83)

Overall scenic value generally is assessed on the basis of the combined ratings of these measures, as well as consideration of the capacity of the landscape to absorb visual change. The greater the absorption capacity of a landscape, the greater its ability to accept human alteration without substantial loss of its scenic quality.

The overall scenic value of the CRN Site under current conditions is good. Its scenic attractiveness is of common quality, with generally positive but typical attributes and a basic variety of forms, colors, and textures that are normally seen in the landscape.

The scenic integrity of the CRN Site is moderate, with areas that have been altered but with the deviations subordinate to the overall landscape and largely natural in appearance. The topography in the vicinity of the CRN Site is characterized by parallel elongated ridges and valleys that run from northeast to southwest. The difference in height between the valleys and ridges is generally about 300 to 350 ft, and the ridges have steep profiles, often steeper than 45 degrees. (Reference 2.5.2-84) The topography of the CRN Site was altered during construction related to the Clinch River Breeder Reactor Project (CRBRP) in the 1980s. Approximately 240 ac of the CRN Site were disturbed by the CRBRP, including the removal of approximately 3 million cubic yards of earth and rock (Reference 2.5.2-85). This excavation area has become revegetated over the years and now is covered by open areas with herbaceous vegetation and eastern red cedars scattered throughout. However, the excavation area remains a prominent feature in the landscape due to the severe topographic contrast on all sides of the project area. The remainder of the CRN Site topography includes both steep hills and flat meadows, with elevations that range from approximately 745 ft above mean sea level (msl) at the shoreline of Watts Bar Reservoir to approximately 940 ft msl in the northern portion of the CRN Site. (Reference 2.5.2-86; Reference 2.5.2-87) Vegetation covering most of the CRN Site is dense and consists of a mixture of mature hardwood forest, stands of evergreen trees, and shrubs.

Scenic visibility of the CRN Site from surrounding areas is moderate. Land uses in the areas surrounding the CRN Site generally are rural, agricultural, or undeveloped. However, several major industrial developments are located in the immediate vicinity of the CRN Site:

- Clinch River Industrial Park, adjoining the northwestern side of the Clinch River Property, on Bear Creek Road
- ETTP, approximately 1 mi to the north
- Oak Ridge National Laboratory, approximately 2.5 mi to the east
- Roane Regional Business and Technology Park, approximately 0.5 mi to the southeast (Reference 2.5.2-88)

The ORR adjoining the CRN Site to the northeast is mostly undeveloped. The ORR was acquired by the federal government in the 1940s; since then, the majority of the reservation has reverted from agricultural fields to forest. (Reference 2.5.2-84)

Scenic views are common in the area surrounding the CRN Site and typically include contrasts between features such as forested ridges and relatively flat valleys, including agricultural fields and reservoirs. The aesthetic appeal of the scenery in the area derives predominantly from a natural landscape that provides ample opportunities for visual appreciation, with relatively limited visual interruptions due to industrial and other highly developed areas. The thickly forested slopes and valleys help to hide and soften the appearance of the industrial areas.

Views of the CRN Site from surrounding areas beyond the river valley to the east, south, and west are characterized by the waters within the winding channel of the Clinch River arm of the Watts Bar Reservoir; forested shorelines, bluffs, and ridges; and areas of old fields in the south central portion of the CRN Site affected by the earlier CRBRP. Views of the CRN Site from the north are blocked by Chestnut Ridge. The areas across the river from the CRN Site are rural and sparsely populated. Minor human alterations may be seen in the foreground but are barely noticeable in the middleground. The principal aesthetic disturbances on the CRN Site when viewed from the areas across the river are the two transmission lines that cross the CRN Site. The transmission lines are minor visual intrusions that can be seen from most locations in the foreground and middleground distances. Smaller structures currently present on the CRN Site, such as the construction trailers, also are minor intrusions on the landscape. These structures are relatively unobtrusive and small in comparison to the overall landscape. Views from the Clinch River arm of the Watts Bar Reservoir adjacent to the CRN Site are dominated by the forested riparian zone and are interrupted by the two transmission lines that cross overhead. The view from higher surrounding areas also includes the Clinch River arm of the Watts Bar Reservoir and agricultural fields associated with the floodplain in the foreground to middleground, and forested hills in the background. Additional information about the features and appearance of the CRN Site is provided in Subsection 2.2.1.1; additional information about the vicinity of the CRN Site is provided in Subsection 2.2.1.2.

Key observation points were identified through visual modeling analysis of the CRN Site. As stated in Table 3.1-2 item 1.1.1, the maximum height of any structures at the facility is anticipated to be 160 ft. Assuming the entire footprint of the plant would be constructed to the maximum height of 160 ft, visual modeling analysis determined locations in the surrounding vicinity from which the plant could potentially be visible. Key observation points were identified by considering the land use and socioeconomic characteristics of these areas from which the plant could potentially be visible. Photographs were collected from these points in December 2013 to establish the baseline viewshed conditions. Figure 5.8-1 shows the location of the key observation points.

2.5.2.5.2 Recreation

Recreational activities that could be affected by the construction and operation of two or more SMRs include mainly outdoor, nature-oriented activities such as boating, fishing, hunting, camping, bicycling, and hiking. Public recreation facilities in the vicinity of the CRN Site include:

- Clinch River arm of the Watts Bar Reservoir
- Melton Hill Reservoir and Melton Hill Dam Reservation
- Gallaher Recreation Area
- ETTP Visitor’s Overlook
- Oak Ridge State Wildlife Management Area (WMA) (Reference 2.5.2-88)

The Clinch River arm of the Watts Bar Reservoir, Melton Hill Reservoir, and the Melton Hill Dam Reservation have public facilities for boating, fishing, swimming, hiking, walking, bicycling, picnicking, and nature observation. The Melton Hill Dam Reservation also has camping facilities and features a sustainable facilities and technologies demonstration project. (Reference 2.5.2-89; Reference 2.5.2-88)

The Gallaher Recreation Area, located on the left descending bank of the Clinch River arm of the Watts Bar Reservoir southwest of the CRN Site, is a 45-ac, state-owned facility that is managed by the City of Oak Ridge. It features a parking area, boat ramp, and small beach. (Reference 2.5.2-88)

The ETTP Visitors Overlook includes a pavilion, historic marker, historic display, parking, and picnic areas. It commemorates the role of Oak Ridge as part of the Manhattan Project during World War II and through the Cold War. The overlook provides a view of the Technology Park, which is owned by the DOE. (Reference 2.5.2-88)

The Oak Ridge State WMA on the ORR is jointly managed by the Tennessee Wildlife Resources Agency (TWRA) and DOE. A joint management agreement provides for protection and restoration of wildlife habitat and regulated public hunting. Within the Oak Ridge WMA, approximately 2920 ac along the Clinch River on the eastern boundary of the ORR are managed by TWRA as the Three Bend Scenic and Wildlife Management Refuge Area. (Reference 2.5.2-84) Portions of the WMA are open to seasonal hunting for white-tailed deer, wild turkeys, Canada geese, and ducks. Access to the ORR is restricted, and public recreational activities other than permitted hunting are not known to occur there. The CRN Site was included in the WMA until 2011, when TVA requested that it be removed. (Reference 2.5.2-90) Beginning in the fall of 2014, limited hunting has been allowed on the CRN Site under a revised agreement with TWRA that incorporated the CRN Site into the Oak Ridge WMA managed-hunt program for deer and wild turkey (Reference 2.5.2-91).

Private recreational opportunities in the area include:

- Private boat ramps
- Wheat Community African Burial Ground
- Southern Appalachian Railway Museum
- Soaring Eagle Campground and recreational vehicle (RV) Park (Reference 2.5.2-88)

The Wheat Community African Burial Ground, located near the visitors overlook, commemorates the graves of unknown slaves from the mid-1800s. The Burial Ground consists of a fenced cemetery at the end of a short gravel drive, a marker with historical information, and a monument. (Reference 2.5.2-88)

The Southern Appalachian Railway Museum is across TN 58 from the Burial Ground. This small museum consists of a converted guardhouse and 12 restored rail cars and operates the Secret City Scenic Excursion Train. (Reference 2.5.2-88)

The Soaring Eagle Campground and RV Park is privately owned and operated. The campground includes 90 camp sites for tents or recreational vehicles, and is used by approximately 13,000 patrons per year. Amenities at the campground include a boat ramp and dock, swimming pool and play area, picnic pavilions, bathhouse, and other facilities. The boat ramp at the campground provides access to Caney Creek embayment, which connects to Watts Bar Reservoir south of the southernmost tip of the CRN Site peninsula (Reference 2.5.2-88). Recreation activities at the campground include camping, swimming, boating, fishing, water skiing, and nature walks (Reference 2.5.2-92).

2.5.2.6 Housing

Construction workers and plant staff for the CR SMR Project would require temporary and permanent housing, except for those who already reside near the CRN Site. Employees would be expected to reside in the geographic area of interest. As an indication of the potential pattern of residence, 87 percent of the federal and contractor employees at the DOE Oak Ridge facilities live in four counties, with over 40 percent living in Knox County, followed by Anderson, Roane, and Loudon counties (Reference 2.5.2-93). Within the 50 mi CRN Site region, residential areas are found in cities, towns, smaller rural communities, and farms. Within the vicinity of the CRN Site, the residents are concentrated in neighborhoods within the cities of Oak Ridge, Harriman, Kingston, and Lenoir City, and the town of Farragut, Tennessee.

Table 2.5.2-12 presents detailed 2010 Census data on housing in Anderson, Knox, Loudon, and Roane counties and communities in the vicinity of the CRN Site. Total housing units, occupation status, vacant housing units, and housing units for rent and for sale in each of these counties and communities are provided. Table 2.5.2-13 shows the age of housing in the communities in the vicinity of the CRN Site, including the percentage of houses built per decade.

Anderson County has a total of 34,717 housing units, 31,253 of which are occupied. Of the total housing units, 9377 are renter occupied (27 percent), 21,876 are owner-occupied (63 percent), and 3464 units (10 percent) are vacant. Of the vacant housing units, 1087 are for rent and 523 are for sale. The remainder of vacant housing units is classified by the U.S. Census Bureau as: rented, not occupied; sold, not occupied; for seasonal, recreational, or occasional use; for migratory workers; or “other vacant.” (Reference 2.5.2-94)

The City of Oak Ridge, located in Anderson and Roane Counties, has a total of 14,494 housing units, 8230 of which are owner occupied (56.8 percent), 4542 of which are renter occupied (31.3 percent), and 1722 of which are vacant units (11.9 percent). Of the vacant housing units, 762 are for rent and 303 are for sale. (Reference 2.5.2-95)

Knox County has a total of 194,949 housing units, 177,249 of which are occupied. Of the total housing units, 117,412 are owner-occupied (60.2 percent), 59,837 are renter occupied (30.7 percent), and 17,700 are vacant (9.1 percent). Of the vacant housing units, 6777 are for rent and 3747 are for sale. (Reference 2.5.2-96) The Town of Farragut, in Knox County, has a total of 7982 housing units, 6724 of which are owner occupied (84.2 percent), 942 of which are renter occupied (11.8 percent), and 316 of which are vacant units (4.0 percent). Of the vacant housing units, 52 are for rent and 136 are for sale. (Reference 2.5.2-97)

Loudon County has a total of 21,725 housing units, 19,826 of which are occupied. Of the total available units, 4291 are renter occupied (19.8 percent), 15,535 are owner occupied (71.5 percent), and 1899 are vacant (8.7 percent). Of the vacant housing units, 360 are for rent and 431 are for sale. (Reference 2.5.2-98) Lenoir City, in Loudon County, has 3703 total housing units, 1987 of which are owner occupied (53.7 percent), 1382 of which are renter occupied (37.3 percent), and 334 of which are vacant units (9.0 percent). Of the vacant housing units, 103 are for rent and 66 are for sale. (Reference 2.5.2-99)

Roane County has a total of 25,716 housing units, 22,376 of which are occupied. Of the total housing units, 5547 are renter occupied (21.6 percent), 16,829 are owner occupied (65.4 percent), and 3340 (13.0 percent) are vacant. Of the vacant properties in the county, 760 are for rent and 419 are for sale. (Reference 2.5.2-100) The City of Kingston, in Roane County, has a total of 2814 housing units, 1763 of which are owner occupied (62.7 percent), 793 of which are renter occupied (28.2 percent), and 258 of which are vacant units (9.2 percent). Of the vacant housing units, 79 are for rent and 61 are for sale. (Reference 2.5.2-101) The City of Harriman, also in Roane County, has a total of 3185 housing units, 1484 of which are owner occupied (46.6 percent), 1172 of which are renter occupied (36.8 percent), and 529 of which are vacant units (16.6 percent). Of the vacant housing units, 201 are for rent and 66 are for sale. (Reference 2.5.2-102)

Knoxville is the largest housing market in the geographic area of interest. As of the second quarter 2013, the Knoxville area had a 13-month supply of homes and sales had increased by 18 percent over the previous year (Reference 2.5.2-103).

In addition to the housing supply counted in the 2010 Census, as discussed above, there are new housing units under construction in the geographic area of interest. (These are considered future housing units and are not included in the count of existing housing.) There are two large housing developments in progress in Oak Ridge: Centennial Bluffs, a retirement community, and Rarity Ridge. Both developments faced financial difficulties. Centennial Bluffs is a planned $120 million dollar development of 406 condominiums in 15 buildings in eastern Oak Ridge overlooking the Melton Hill Reservoir in Anderson County. Started in 2007, only the clubhouse, one condominium building and a portion of the main road had been constructed as of 2012. Centennial Bluff, LLC filed for bankruptcy in March 2012, one day before a foreclosure auction was to occur. (Reference 2.5.2-104) As of 2015, condominiums were still being offered for sale at $209,500 to $300,000 (Reference 2.5.2-105). Only a small portion of the development is complete.

Rarity Ridge is a planned 1217-ac housing development with many amenities, located in western Oak Ridge, Tennessee along the Clinch River in Roane County. By 2010, fewer than 150 of the planned 3000 units had been completed. The property has been purchased by a realty management company and is now called The Preserve at Clinch River (Reference 2.5.2-104). This development is only partially complete. Amenities at The Preserve include the Discovery Center, Wellness Center, water complex, tennis courts, children’s playground and a private community marina on the Clinch River (Reference 2.5.2-106).

Rarity Pointe is a luxury waterfront community on Tellico Reservoir in Lenoir City, Loudon County, Tennessee. The properties at Rarity Pointe were foreclosed in 2012 and purchased by a real estate investment company, WindRiver Investments, LLC. (Reference 2.5.2-107) The name was changed to WindRiver. The partially-completed development includes more than 180 residential lots and an operational golf course. (Reference 2.5.2-108) Amenities at WindRiver include WindRiver Marina on Tellico Lake. WindRiver construction projects scheduled for 2015 include a six-acre lakefront community park, a floating restaurant, and a Sports and Wellness Club. New single-family residences are also being constructed. (Reference 2.5.2-107)

Two large apartment complexes were permitted in Knox County in 2013. The Preserve at Hardin Valley (296 units) is located in the northwest sector of the county and University Walk (207 units) is in the central sector of the city Knoxville, Tennessee (Reference 2.5.2-109). A large mixed-use redevelopment project in Knoxville, Tennessee was announced in June 2013, Bridges at Riverside. Plans include a riverfront apartment complex with 300 luxury apartments and 225 student apartments, as well as a 150-room hotel and office and retail space. Construction was slated to begin in the end of 2013 and to be completed by 2015. (Reference 2.5.2-110) In January 2015 demolition of previous buildings was still continuing and construction of the Bridges at Riverside was behind schedule, with anticipated start date later in 2015 (Reference 2.5.2-111).

Some construction workers and some visiting operational staff may have a need for temporary housing in the vicinity of the CRN Site. Temporary housing could include hotels, seasonal homes (for long-term rentals), and RV parks and campgrounds. There are 176 hotels listed on the Tennessee Department of Tourism Development website in the Knoxville/Middle East Tennessee region. According to the Visit Knoxville website, there are over 8100 hotel rooms in the Knoxville area (Reference 2.5.2-112). The Oak Ridge Convention and Visitors Bureau lists seven hotels with a total of 680 rooms (Reference 2.5.2-113). The Roane Alliance lists 10 hotels with a total of 517 rooms in Roane County (Reference 2.5.2-114). The Loudon County Chamber of Commerce lists six hotels and motels in Loudon and Lenoir City in Loudon County with a total of 194 rooms (Reference 2.5.2-115; Reference 2.5.2-116; Reference 2.5.2-117; Reference 2.5.2-118). The Anderson County Tourism Council lists ten hotels in Clinton and Oak Ridge in Anderson County with a total of 474 rooms (Reference 2.5.2-119; Reference 2.5.2-120; Reference 2.5.2-121; Reference 2.5.2-122; Reference 2.5.2-123; Reference 2.5.2-124; Reference 2.5.2-125; Reference 2.5.2-126).

Seasonal homes are classified by the U.S. Census Bureau as vacant for seasonal use (Reference 2.5.2-127). According to the 2010 Census, Anderson County has 297 seasonal housing units, Knox County has 1048 units, Loudon County has 373 units, and Roane County has 611 units (Reference 2.5.2-128).

Temporary housing also includes recreational facilities. Within the four-county area there are many opportunities for camping, including campgrounds, RV sites, and cabins. Recreational facilities that can provide temporary housing, subject to possible limits on long-term camping, are presented in Table 2.5.2-14.

2.5.2.7 Community Infrastructure and Public Services

Public services and community infrastructure consist of the political structure, public water and wastewater treatment systems, police and fire departments, medical facilities, and schools. These elements are typically located within municipalities or near population centers. Schools are described in Subsection 2.5.2.8 Education. The other infrastructure and service elements are described in the following subsections.

2.5.2.7.1 Political Structure

The CRN Site is located in Roane County, approximately 10 mi southwest of the City of Oak Ridge business district and within the Oak Ridge city limits. The City of Oak Ridge lies within Roane and Anderson counties.

There are two congressional districts, Tennessee Districts 2 and 3, located within the geographic area of interest (Reference 2.5.2-129). The CRN Site is located within Tennessee General Assembly House District 32 (Reference 2.5.2-130).

Clinton is the Anderson County seat (Reference 2.5.2-131). There are five incorporated municipalities in the county, as well as unincorporated areas, and the services offered by each vary. The incorporated municipalities include Clinton, Norris, Oak Ridge, Oliver Springs, and Rocky Top (formerly Lake City). (Reference 2.5.2-132; Reference 2.5.2-133) (A portion of Oak Ridge is located in Roane County, parts of Oliver Springs are located in Roane and Morgan counties, and Rocky Top extends into Campbell County). Each of the municipal governments within Anderson County has a mayor and three to six council members (Reference 2.5.2-134; Reference 2.5.2-135; Reference 2.5.2-136; Reference 2.5.2-137; Reference 2.5.2-138). The Anderson County Commission is the governing body for Anderson County government. This Commission consists of 16 members, which include two members representing each of the county's eight election districts. Anderson County also has a county mayor, who is elected for a four-year term, and nine other elected county officials. (Reference 2.5.2-131; Reference 2.5.2-139)

Knoxville is the Knox County seat. There are two incorporated municipalities in the county, as well as unincorporated areas, and the services offered by each vary. The incorporated municipalities are categorized as a city (Knoxville) and a town (Farragut). A portion of Farragut is also located in Loudon County. (Reference 2.5.2-140) Knoxville has a mayor and nine council members (Reference 2.5.2-141; Reference 2.5.2-142). Farragut has a mayor and four aldermen (Reference 2.5.2-143). The Knox County Commission is the governing body for Knox County government. This Commission consists of 11 members, representing each of the county's 11 election districts. Knox County also has a county mayor who is elected for a four-year term and seven other elected county officials. (Reference 2.5.2-144)

Loudon is the Loudon County seat (Reference 2.5.2-145). There are four incorporated municipalities in the county, as well as unincorporated areas, and the services offered by each vary. The incorporated municipalities are categorized as cities (Greenback, Lenoir City, and Philadelphia) and a town (Loudon). (Reference 2.5.2-146) Each of the city and town governments within Loudon County has a mayor and two to six council members (Reference 2.5.2-147; Reference 2.5.2-148; Reference 2.5.2-149; Reference 2.5.2-150). The Loudon County Commission is the governing body for Loudon County government. This Commission consists of 10 members representing the county's seven election districts (Districts 1, 2, and 5 each elect two commissioners). Loudon County also has a county mayor who is elected for a four-year term and seven other elected county officials. (Reference 2.5.2-145)

Kingston is the Roane County seat (Reference 2.5.2-151). There are five incorporated municipalities in Roane County, as well as unincorporated areas, and the services offered by each vary. The incorporated municipalities are categorized as cities (Harriman, Kingston, Oak Ridge, and Rockwood) and a town (Oliver Springs). Oak Ridge is located in both Anderson and Roane counties and Oliver Springs is primarily within Anderson County. (Reference 2.5.2-133;

Reference 2.5.2-152) Each of the three city governments located entirely within Roane County has a mayor and four or five council members (Reference 2.5.2-153; Reference 2.5.2-154; Reference 2.5.2-155). The Roane County Commission is the governing body for Roane County government. This Commission consists of 15 members representing the county's seven election districts. Roane County also has a county executive, who serves as the chief financial officer of the county, and six other elected county officials. (Reference 2.5.2-151)

Each of the four counties in the geographic area of interest has emergency management offices which support local efforts to prepare for, respond to, and recover from disasters. Anderson and Roane counties each have an Office of Emergency Management and Homeland Security (Reference 2.5.2-156; Reference 2.5.2-157). Knox County has an Emergency and Bioterrorism Preparedness Department and Loudon County has an Emergency Management Agency (Reference 2.5.2-158; Reference 2.5.2-159). Emergency planning for radiological events related to the CRN Site are addressed in ESPA Part 5, Emergency Plan.

The cities and towns located in the CRN Site vicinity either provide and maintain their own community services and infrastructure or contract with one another to provide specific services to their individual populations. Anderson, Knox, Loudon, and Roane counties each maintain and build county roads, maintain county property records, perform district and circuit court actions, and operate the Sheriff's Department. Each county's Sheriff's Department provides law enforcement and protection for the unincorporated areas of the county. The Public Works Departments in Anderson, Knox, Loudon, and Roane Counties oversee public works projects throughout each county including responsibility for maintaining county roads.

Information about distinctive communities within the geographic area of interest, which have unique economic, social, or human health circumstances and lifestyle practices, is provided in Subsection 2.5.4.4 and Tables 2.5.4-1 and 2.5.4-2.

2.5.2.7.2 Public Water Supplies and Wastewater Treatment Systems

There are over 20 public water systems providing potable water to the residents of Anderson, Knox, Loudon, and Roane counties, Tennessee (Reference 2.5.2-160). Table 2.5.2-15 summarizes the water source type, maximum daily capacity, and average daily consumption for each of the water systems in the geographic area of interest. Water systems in the four counties are operating below capacity. One water supplier, the Knox-Chapman Utility District, is expanding its daily capacity. TVA expects to obtain potable water for human consumption at the CRN Site from the City of Oak Ridge Public Works Department, which draws water directly from Melton Hill Reservoir.

Wastewater treatment is provided by local jurisdictions. Currently, there are five wastewater treatment systems in Anderson County (including the City of Oak Ridge), eight in Knox County, three in Loudon County, and six in Roane County (not including the City of Oak Ridge). The Rarity Ridge treatment facility operated by the City of Oak Ridge would be expected to provide. wastewater treatment for the CRN Site. This plant has a maximum capacity of 0.6 million gallons per day (mgd) and is currently operating at 0.09 to 0.1 mgd. Table 2.5.2-16 summarizes the public wastewater treatment facilities, their capacities, and their average daily utilization for Anderson, Knox, Loudon, and Roane counties. Households in rural areas of Anderson, Knox, Loudon, and Roane counties generally operate on septic systems.

There are five landfills in the geographic area of interest that could receive construction debris and waste from the CRN Site. One landfill located in Anderson County is legally allowed to accept inert and sanitary waste. It is estimated the landfill can operate for approximately 50 more years at normal projected growth. One landfill located in Loudon County is able to accept solid and municipal waste. This landfill is expected to be able to be expanded as needed. Three landfills located in Knox County are able to accept construction debris. It is estimated these landfills can operate for approximately 17 to 24 yr at normal projected growth.

Solid waste from the CRN Site operations would be managed by a TVA-approved solid waste disposal vendor. The waste would be processed at the Meadowbranch Landfill in Athens, Tennessee (located in McMinn County). The Meadowbranch Landfill under its current permit can operate for approximately 6.5 yr at normal projected growth. Property has been acquired, designs have been drafted, and a new permit application is in progress for an expansion to the Meadowbranch Landfill. Under the expansion the landfill could operate for approximately 50 to 60 yr at normal projected growth.

For a discussion of groundwater availability and uses, refer to Section 2.3.

2.5.2.7.3 Police, Fire, and Medical Services

As discussed in Subsection 2.5.1, as of 2010, the population of Anderson County was 75,129; the population of Loudon County was 48,556; the population of Knox County was 432,226; and the population of Roane County was 54,181.

Police Services

Based on the Federal Bureau of Investigations data, current as of 2013, the numbers of sworn law enforcement officers by county range from 33 in Roane County to 458 in Knox County (Reference 2.5.2-161). In addition, individual cities maintain their own police departments with jurisdictions usually limited by the city limits. The numbers of sworn law enforcement officers by city range from 12 in Kingston, Tennessee to 393 in Knoxville, Tennessee (Reference 2.5.2-162). Information on sworn law enforcement officers by county and city is shown on Table 2.5.2-17.

The recommended police officer-to-resident ratio is between 1 and 4 officers per 1000 residents, or a police-to-resident ratio between 1:250 and 1:1000 (Reference 2.5.2-163). Tennessee currently has one law enforcement officer per approximately 400 residents (Reference 2.5.2-164). Officer-to-resident ratios by county range from 1:1000 in Knox County and Loudon County to 1:1600 in Roane County (Reference 2.5.2-161; Reference

2.5.2-165). Approximate officer-to-resident ratios by city range from 1:350 in Clinton, Lenoir City, and Harriman, Tennessee to 1:500 in Oak Ridge, Kingston, and Knoxville, Tennessee (Reference 2.5.2-162). Table 2.5.2-17 presents officer-to-resident ratios by county and city.

The State of Tennessee overall and all of the municipalities are well within the recommended range, whereas the counties are slightly under the recommended ratios.

<u>Fire Services</u>

Fire departments staffed by volunteer and/or paid firefighters provide fire services in the geographic area of interest. The number of volunteer and career firefighters in each county, as reported in 2013, are:

- Anderson County – 106 volunteer and 110 career firefighters
- Knox County – 94 volunteer and 510 career firefighters
- Loudon County – 141 volunteer and 60 career firefighters
- Roane County – 155 volunteer and 109 career firefighters

In addition, the Oak Ridge National Laboratory fire department has 40 career firefighters. (Reference 2.5.2-166)

The National Fire Protection Association estimates that in 2012 there were 1,129,250 firefighters in the United States (Reference 2.5.2-167). Dividing the 2012 estimated population of the United States (313,914,040) by the number of firefighters provides a ratio of 1 firefighter for every 278 persons (Reference 2.5.2-168). The approximate firefighter-to-resident ratio by county is:

- 1:350 in Anderson County
- 1:715 in Knox County
- 1:240 in Loudon County
- 1:205 in Roane County

This indicates that the firefighter ratios in the area, with the exception of Knox County, are close to the national average.

The City of Oak Ridge Fire Department (ORFD) would provide the primary fire and emergency medical services (EMS) emergency response to the CRN Site. The ORFD employs 73 firefighters at four fire stations. The department owns the following equipment:

- 8 pumper trucks and one ladder truck
- 4 rescue trucks

- 2 hazmat vehicles
- 2 ambulances
- 5 command staff vehicles
- 13 utility and special use vehicles
- 16 trailers to support special operations
- 4 diesel powerplants
- 3 boats

The ORFD Station 4, located at the ETTP, would be the first responder and ORFD Station 2, located on the Oak Ridge Turnpike, would be the secondary responder. The City of Kingston Fire Department would be the primary backup for the CRN Site.

Medical Services

There are 11 medical centers in the geographic area of interest for the CR SMR Project. Two medical centers are located in Anderson County (in Oak Ridge) with a total of 275 beds. Seven medical centers are located in Knox County with a total of 1839 beds. One medical center is located in Loudon County with 40 beds. One medical center is located in Roane County with 36 beds. (Reference 2.5.2-169; Reference 2.5.2-170) These medical centers, along with their locations, number of physicians, and number of beds, are listed in Table 2.5.2-18.

Five nursing homes are located in Anderson County with a total of 596 beds. Fifteen nursing homes are located in Knox County with a total of 1933 beds. Two nursing homes are located in Loudon County with a total of 286 beds. Three nursing homes are located in Roane County with a total of 467 beds. (Reference 2.5.2-171) These nursing homes, along with their locations and number of beds, are shown on Table 2.5.2-19.

The health departments in the geographic area of interest provide general medical services, such as pediatric and women's health clinics, immunization programs, environmental health, and social services, for example. The Anderson County Health Department is located in Clinton; the county's Emergency Preparedness Department and Disaster Response Team are affiliated with the Health Department (Reference 2.5.2-172; Reference 2.5.2-173). The Knox County Health Department is located in Knoxville; emergency preparedness is managed through the Knox County Health Department (Reference 2.5.2-159). The Roane County Health Department is located in Rockwood (Reference 2.5.2-174). General health services in Loudon County are provided by the Tennessee Department of Health (Reference 2.5.2-158; Reference 2.5.2-175).

In addition to the ORFD EMS described previously, there are several county-based EMS services within the geographic area of interest. Anderson County EMS operates six full time Advanced Life Support (ALS) paramedic units on duty 24 hours (hr) per day, 7 days per week. To supplement the ALS units, Anderson County EMS operates five Basic Life Support units on a limited schedule. (Reference 2.5.2-176) Rural/Metro Corporation provides EMS services 24 hr per day, 7 days per week for Knox and Loudon counties and other counties in East Tennessee. The company has a fleet of emergency and non-emergency vehicles available. (Reference 2.5.2-177) The Roane County Office of Emergency Services EMS Division operates four ALS units 24 hr per day, 7 days per week in response to both emergency and non-emergency requests for service (Reference 2.5.2-178).

2.5.2.8 Education

The Tennessee Department of Education oversees all county and local school districts. Statewide reforms (First to the Top) currently are underway to improve the achievement levels of all students in the state. In 2010, the state received $501 million from the federal government's Race to the Top program. In 2012, Tennessee was granted a waiver from the federally mandated No Child Left Behind program, and the state enacted its own accountability measures for teacher effectiveness. Tennessee now has a comprehensive student-outcome-based teacher evaluation system using the Tennessee Educator Acceleration Model. The Common Core Standards assure that the state curriculum requirements provide students with the knowledge necessary for college and potential employment. (Reference 2.5.2-179)

The 50 mi region encompasses 24 county school districts containing 348 schools that serve over 190,000 elementary, middle, and high school students. For the 2010 academic year, the overall student-teacher ratio for these schools was 15:1. (Reference 2.5.2-180) Primary, secondary, and higher education are addressed for the geographic area of interest, where the construction and operations workforce and their families principally would reside. Because students are more likely to travel longer distances for higher education, colleges and universities within the 50 mi region are also addressed. Table 2.5.2-20 provides information on the primary and secondary schools for each county within the geographic area of interest, including the number of schools, total students enrolled, and spending per pupil. Table 2.5.2-21 lists the institutions of higher learning located within the 50 mi region.

Anderson County

In 2010 in Anderson County, Tennessee, approximately 12,800 students were enrolled in public schools (Table 2.5.2-20) (Reference 2.5.2-181). The county contains 28 public schools and three private schools. Of the public schools, 16 are elementary schools, six are middle schools, three are high schools, two are preschools, and one is a vocational school. The three private schools enroll pre-kindergarten or kindergarten through 12th grade students. (Reference 2.5.2-182) In the 2009-2010 academic year, Anderson County spent $9617 per pupil including federal, state, and local funding (Reference 2.5.2-183). Within Anderson County, the City of Oak Ridge has its own school district containing eight public schools, including four elementary schools, two middle schools, one high school, and one preschool. In 2010, approximately 4800 students were enrolled in the city public school system. (Reference 2.5.2-184) These schools and students are included in the county statistics above. In the 2009-2010 academic year, Oak Ridge spent $11,681 per pupil (Reference 2.5.2-183).

Knox County

In 2010 Knox County, Tennessee, had approximately 58,000 students enrolled in the public school system (Table 2.5.2-20) and approximately 9400 students enrolled in private schools (Reference 2.5.2-185; Reference 2.5.2-186). There are 86 public schools and 36 private schools in Knox County. Of the public schools, 44 are elementary schools, 16 are middle schools, 13 are high schools, and 13 are specialized education centers. (Reference 2.5.2-186) Of the private schools, nine enroll pre-kindergarten or kindergarten through 12th grade students, 22 enroll pre-kindergarten or kindergarten through elementary or middle school students, and five enroll middle to high school students (Reference 2.5.2-185). In the 2009-2010 academic year, Knox County spent $8504 per pupil, including federal, state, and local funding (Reference 2.5.2-187; Reference 2.5.2-188).

Loudon County

In 2010, Loudon County, Tennessee, had approximately 7500 students enrolled in the public school system (Table 2.5.2-20) and approximately 109 students enrolled in private schools (Reference 2.5.2-189; Reference 2.5.2-190). There are 12 public schools and one private school in Loudon County. Of the public schools, six are elementary schools, three are middle schools, two are high schools, and one enrolls pre-kindergarten through eighth grade students (Reference 2.5.2-189). The private school enrolls pre-kindergarten through 12th grade students (Reference 2.5.2-190). Lenoir City has its own public school district that enrolls approximately 2300 students in one elementary, one middle, and one high school. These students and schools are included in the county statistics above. (Reference 2.5.2-191) In the 2009-2010 academic year, Loudon County spent $8416 per pupil, and Lenoir City spent a total of $8929 per student (Reference 2.5.2-192). Revenue sources for this per-pupil expenditure included federal, state, and local funding (Reference 2.5.2-193).

Roane County

In 2010 in Roane County, Tennessee, approximately 7400 students were enrolled in the public school system (Table 2.5.2-20), and approximately 250 students were enrolled in private schools (Reference 2.5.2-194). The county contains 18 public schools and five private schools. Of the public schools, eight are elementary, four are middle, and five are high schools, and one enrolls pre-kindergarten through 12th grade students. Of the private schools, two enroll pre-kindergarten or kindergarten through 12th grade students and three are special education schools. (Reference 2.5.2-195) In the 2009-2010 academic year, Roane County spent $8699 per pupil, including federal, state, and local funding (Reference 2.5.2-196).

Higher Education Institutions

Within the 50 mi region, there are sixteen institutions of higher education in Tennessee, including fourteen 4-yr colleges and two 2-yr colleges (Table 2.5.2-21). The University of Tennessee in Knoxville is the largest institution in the University of Tennessee system and is within the 50 mi region (Reference 2.5.2-197). No colleges or universities were identified within the 50 mi region in Kentucky or North Carolina.

Thirteen colleges and universities are located within the geographic area of interest. Eleven of them are located in Knox County with a total enrollment exceeding 43,000 students. The University of Tennessee in Knoxville had the highest enrollment with approximately 27,000 students. Pellissippi State Community College was the other major institution of higher learning in Knox County with an enrollment of over 11,000 students. One college, Roane State Community College, is located in Roane County and has an enrollment of over 6500 students. (Reference 2.5.2-198; Reference 2.5.2-199; Reference 2.5.2-200; Reference 2.5.2-201; Reference 2.5.2-202; Reference 2.5.2-203; Reference 2.5.2-204; Reference 2.5.2-197; Reference 2.5.2-205; Reference 2.5.2-206; Reference 2.5.2-207; Reference 2.5.2-208)

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Table 2.5.2-1
Employment By Industry (2001 to 2011)

County	Anderson, TN			Knox, TN			Loudon, TN			Roane, TN			Total		
Year	2001	2011	Percent Change 2001-2011 (%)	2001	2011	Percent Change 2001-2011 (%)	2001	2011	Percent Change 2001-2011 (%)	2001	2011	Percent Change 2001-2011 (%)	2001	2011	Percent Change 2001-2011 (%)
Total Employment	50,589	53,943	6.6	270,325	298,779	10.5	15,832	18,954	19.7	20,909	22,087	5.6	357,655	393,763	10.1
Wage and Salary Employment	39,989	41,823	4.6	225,512	239,331	6.1	11,732	14,481	23.4	18,623	19,811	6.4	295,856	315,446	6.6
Proprietors Employment	10,600	12,120	14.3	44,813	59,448	32.7	4100	4473	9.1	2286	2276	-0.4	61,799	78,317	26.7
Farm	633	490	-22.6	1660	1195	-28.0	1530	1155	-24.5	779	541	-30.6	4602	3381	-26.5
Agricultural Services, Forestry, Fishing, and Other	(D)[1]	82	NA	219	259	18.3	(D)[1]	(D)[1]	NA	(D)[1]	(D)[1]	NA	219	341	NA
Mining	(D)[1]	307	NA	512	323	-36.9	(D)[1]	(D)[1]	NA	(D)[1]	(D)[1]	NA	512	630	NA
Construction	2,983	4178	40.1	16,479	16,108	-2.3	(D)[1]	1,238	NA	(D)[1]	(D)[1]	NA	19,462	21,524	NA
Manufacturing	10,039	10,153	1.1	20,416	12,085	-40.8	3020	2,985	-1.2	2260	1204	-46.7	35,735	26,427	-26.0
Transportation and Utilities	(D)[1]	(D)[1]	NA	9802	10,355	5.6	679	895	31.8	394	(D)[1]	NA	10,875	11,250	NA
Wholesale Trade	1061	979	-7.7	13,228	13,399	1.3	(D)[1]	482	NA	(D)[1]	(D)[1]	NA	14,289	14,860	NA
Retail Trade	5001	4497	-10.1	35,327	35,102	-0.6	1796	2188	21.8	2,250	2155	-4.2	44,374	43,942	-1.0
Finance, Insurance, and Real Estate	2572	3589	39.5	19,338	26,417	36.6	912	1227	34.5	648	642	-0.9	23,470	31,875	35.8
Services	10,692	23,414	119.0	115,534	145,429	25.9	3649	6445	76.6	6737	9668	43.5	136,612	184,956	35.4
Government	5362	5348	-0.3	37,810	38,107	0.8	2022	2167	7.2	4371	3908	-10.6	49,565	49,530	-0.1

1 (D) indicates the information is not disclosed, although the estimates for these items are included in the Total Employment. Ten-year growth rates for these rows are labeled NA.
Note: Data are estimates of total full-time and part-time employment by place of work (number of jobs), based on the 2012 North American Industry Classification System. The information is provided by U.S. Bureau of Economic Analysis through its Regional Economic Information System.

Sources: (Reference 2.5.2-1; Reference 2.5.2-2; Reference 2.5.2-4; Reference 2.5.2-3)

Table 2.5.2-2
Employment Trends (2001 to 2011)

	2001	2011	Avg. Annual Change (%)
Anderson, TN			
Labor Force	34,442	36,739	0.7
Employed	32,805	33,620	0.2
Unemployed	1637	3119	9.1
Unemployment Rate	4.8%	8.5%	
Knox, TN			
Labor Force	205,871	235,250	1.4
Employed	198,949	218,576	1.0
Unemployed	6922	16,674	14.1
Unemployment Rate	3.4%	7.1%	
Loudon, TN			
Labor Force	20,188	25,132	2.4
Employed	19,326	23,177	2.0
Unemployed	862	1955	12.7
Unemployment Rate	4.3%	7.8%	
Roane, TN			
Labor Force	24,987	28,046	1.2
Employed	23,798	25,791	0.8
Unemployed	1189	2255	9.0
Unemployment Rate	4.8%	8.0%	
Regional Total			
Labor Force	285,488	325,167	1.4
Employed	274,878	301,164	1.0
Unemployed	10,610	24,003	12.6
Unemployment Rate	3.7%	7.4%	
Tennessee			
Labor Force	2,863,521	3,116,935	0.9
Employed	2,728,528	2,828,616	0.4
Unemployed	134,993	288,319	11.4
Unemployment Rate	4.7%	9.3%	

Note: Data are from the Local Area Unemployment Statistics program and represent labor force by place of residence. They are estimates of key indicators of local economic conditions.

Sources: (Reference 2.5.2-5; Reference 2.5.2-6)

Table 2.5.2-3 (Sheet 1 of 2)
Top Employers Located in Anderson, Knox, Loudon, and Roane Counties, Tennessee

Company	Total Employees	Description
Anderson County		
Y-12 National Security Complex	7000	Refurbishing nuclear weapon components and storage and recycling of nuclear material.
Anderson County Schools	1050	Local public education system
Oak Ridge Associated Universities	933	University consortium that creates collaborative partnerships between scientific research, government & industry
SL Tennessee	750	Manufacture gear shift assemblies, park brake levers, head & rear lights
Sitel	725	Global customer interaction solutions provider with over 450 world-class clients
Eagle Bend Manufacturing	671	Manufactures auto body parts
Oak Ridge City Schools	668	Local public education system
Energy Solutions	625	Nuclear engineering services
Aisin Automotive Casting Tennessee Inc.	580	Manufacture, casting, machining & assembly of timing chain covers, pistons, pumps, VVT's
Science Applications International Corp. (SAIC)	550	Science & engineering consulting, energy, national security
Knox County		
Covenant Health[1]	10,458	Local health care system
Knox County Schools	6804	Local public education system
The University of Tennessee - Knoxville	6660	State university
University of Tennessee Medical Center	4224	Local health care system
Tennova Healthcare[1]	4067	Local health care system
State of Tennessee - Regional Offices	3226	State administrative offices
Knox County Government	3014	County government
City of Knoxville	2828	Municipal government
East Tennessee Children's Hospital	1900	Area children's hospital
Team Health, Inc.	1640	Local health care providers
TVA	1600	Regional power authority and development agency providing improvement for river navigation, flood damage reduction, agricultural & industrial development, & electric power in a 7-state region

Table 2.5.2-3 (Sheet 2 of 2)
Top Employers Located in Anderson, Knox, Loudon, and Roane Counties, Tennessee

Company	Total Employees	Description
Loudon County		
Kimberly Clark Corporation[2]	654	Paper towels and bath tissue
Loudon County Schools	600	Local public education system
Monterey Mushrooms, Inc.	585	Mushrooms
Roane County		
Oak Ridge National Lab	4374	Dept. of energy facility that conducts research & development.
Roane County Schools	1150	Public education system
UCOR	565	Engineering, environmental management & clean-up

1 Includes employees at regional facilities.
2 Includes employees in Knox County.

Source: (Reference 2.5.2-7)

Table 2.5.2-4
Household Income Distribution in Communities Closest to Clinch River Site

	Kingston, TN		Lenoir City, TN		Oak Ridge, TN	
Income	**Number**	**Percent (%)**	**Number**	**Percent (%)**	**Number**	**Percent (%)**
Less than $10,000	165	6.0	418	11.7	949	7.6
$10,000 to $14,999	198	7.2	283	7.9	788	6.3
$15,000 to $24,999	437	15.9	815	22.7	1287	10.3
$25,000 to $34,999	339	12.3	278	7.8	1105	8.9
$35,000 to $49,999	323	11.7	389	10.8	1637	13.2
$50,000 to $74,999	548	19.9	702	19.6	2240	18.0
$75,000 to $99,999	399	14.5	373	10.4	1542	12.4
$100,000 to $149,999	188	6.8	146	4.1	1730	13.9
$150,000 to $199,999	47	1.7	26	0.7	677	5.4
$200,000 or more	107	3.9	156	4.4	490	3.9

Source: (Reference 2.5.2-8)

Table 2.5.2-5
Per Capita Personal Income (2001 to 2011)

	Per Capita Personal Income (Dollars)		
	2001	**2011**	**Avg. Annual Growth (%)**
Anderson County, TN	26,758	36,289	3.6
Knox County, TN	30,102	38,894	2.9
Loudon County, TN	25,974	37,698	4.5
Roane County, TN	22,805	35,142	5.4
Tennessee	27,551	36,567	3.3

Source: (Reference 2.5.2-9)

Table 2.5.2-6
Level of Service (LOS) Index

LOS	Traffic Flow Conditions	Delay (seconds) Signalized Intersections	Delay (seconds) Unsignalized Intersections
A	Progression is extremely favorable and most vehicles do not stop at all	0-10	0-10
B	Good progression, some delay	10-20	10-15
C	Fair progression, higher delay	20-35	15-25
D	Unfavorable progression, congestion becomes apparent	35-55	25-35
E	Poor progression, significant delay	55-80	35-50
F	Poor progression, extreme delay	>80	>50

Source: (Reference 2.5.2-23)

Table 2.5.2-7
Total Revenues for Anderson, Knox, Loudon, and Roane Counties FY 2010 through FY 2014

Fiscal Year	Anderson County	Knox County	Loudon County	Roane County
2009-2010	$95.4	$740.9	$64.7	$94.0
2010-2011	$98.0	$785.3	$65.4	$102.2
2011-2012	$110.8	$808.7	$72.2	$110.5
2012-2013	$99.3	$822.9	$111.1	$94.4
2013-2014	$109.6	$846.9	$67.3	$91.3

Note: $ in millions.
Source: (Reference 2.5.2-209)

Table 2.5.2-8
Anderson, Knox, Loudon, and Roane County Tax Collections by Category

Category of Tax	July 2012 - June 2013	July 2011 - June 2012	July 2010 - June 2011	July 2009 - June 2010
Income				
Anderson County	$1,968,515	$1,575,868	$1,530,346	$1,438,650
Knox County	$45,989,199	$20,652,793	$29,123,768	$34,794,117
Loudon County	$2,887,761	$2,330,636	$2,458,379	$2,237,490
Roane County	$803,924	$732,038	$680,892	$676,312
Inheritance, Gift and Estate				
Anderson County	$725,715	$758,465	$1,271,837	$594,469
Knox County	$7,804,953	$7,596,948	$8,100,884	$5,862,597
Loudon County	$664,080	$690,794	$586,436	$555,044
Roane County	$431,847	$327,606	$132,777	$675,603
Motor Vehicle				
Anderson County	$2,666,171	$2,696,968	$2,618,413	$2,661,736
Knox County	$12,609,990	$12,732,014	$12,425,272	$12,096,208
Loudon County	$1,645,092	$1,632,452	$1,658,036	$1,659,640
Roane County	$1,485,565	$1,531,098	$1,503,164	$1,531,883
Realty Transfer and Mortgage				
Anderson County	$1,146,950	$892,777	$1,014,343	$1,059,985
Knox County	$11,394,844	$10,971,507	$9,005,730	$9,843,116
Loudon County	$1,459,830	$1,083,551	$1,169,124	$1,297,700
Roane County	$790,205	$628,981	$727,255	$732,347
State Sales				
Anderson County	$65,604,268	$67,687,676	$66,012,268	$65,302,009
Knox County	$559,083,177	$566,834,256	$514,295,050	$490,452,261
Loudon County	$37,606,209	$38,115,626	$34,604,248	$32,190,322
Roane County	$44,442,643	$49,878,618	$46,743,505	$43,470,677
Local Sales				
Anderson County	$21,020,530	$21,579,178	$21,450,182	$21,127,175
Knox County	$155,950,973	$158,422,676	$143,702,808	$139,648,687
Loudon County	$8,335,130	$8,551,488	$7,806,899	$7,333,465
Roane County	$13,811,128	$13,930,618	$14,172,830	$13,878,046

Sources: (Reference 2.5.2-210; Reference 2.5.2-211; Reference 2.5.2-212; Reference 2.5.2-213)

Table 2.5.2-9
Tennessee Property Tax Classes

Description	Assessment Percent (%)
Residential Property	25
Farm Property	25
Commercial and Industrial Property	40
Public Utility Property	55
Business Personal Property	30

Source: (Reference 2.5.2-214)

Table 2.5.2-10
Appropriation of Tennessee State Funds for Fiscal Year 2012-2013

Tax Appropriation Category	Percentage (%)
Education	42
Health and Social Services	28
Law, Safety, and Correction	10
Cities and Counties	7
Transportation	6
Resources and Regulation	3
General Government	3
Business and Economic Development	1
Total	100

Source: (Reference 2.5.2-215)

Table 2.5.2-11
TVA Tax Equivalent Payments to State of Tennessee and Counties FY 2011 through FY 2015

Fiscal Year	Total Distribution to State	Total Distribution to Counties	Anderson County	Knox County	Loudon County	Roane County
2010-2011	$319.3	$93.3	$1.1	$3.3	$1.0	$1.5
2011-2012	$351.0	$99.9	$1.1	$3.5	$1.1	$1.6
2012-2013	$334.3	$98.8	$1.1	$3.5	$1.1	$1.6
2013-2014	$331.6	$96.1	$1.1	$3.4	$1.1	$1.6
2014-2015	$350.6	$100.8	$1.2	$3.6	$1.1	$1.6

Note: $ in millions.

Table 2.5.2-12
Housing in Anderson, Knox, Loudon and Roane Counties, Tennessee

County/Community	Total Housing Units	Number Owner-Occupied	Number Renter-Occupied	Number Vacant	Number for Rent	Number for Sale
Anderson County	34,717	21,876	9377	3464	1087	523
Oak Ridge[1]	14,494	8230	4542	1722	762	303
Knox County	194,949	117,412	59,837	17,700	6777	3747
Farragut	7982	6724	942	316	52	136
Loudon County	21,725	15,535	4291	1899	360	431
Lenoir City	3703	1987	1382	334	103	66
Roane County	25,716	16,829	5547	3340	760	419
Kingston	2814	1763	793	258	79	61
Harriman	3185	1484	1172	529	201	66

[1] City of Oak Ridge is located in Anderson and Roane Counties, Tennessee.

Sources: (Reference 2.5.2-100; Reference 2.5.2-94; Reference 2.5.2-96; Reference 2.5.2-98; Reference 2.5.2-97; Reference 2.5.2-102; Reference 2.5.2-101; Reference 2.5.2-99; Reference 2.5.2-95)

Table 2.5.2-13
Percent of Houses Built by Decade

Date of Construction	Farragut (%)	Harriman (%)	Kingston (%)	Lenoir City (%)	Oak Ridge (%)
Before 1940	1.1	21.1	0.9	24.3	2.6
1940 to 1949	0.9	12.9	5.5	6.7	31.7
1950 to 1959	1.4	19.9	27.1	14.8	17.1
1960 to 1969	8.1	18.3	9.7	2.8	12.5
1970 to 1979	18.5	13.8	20.1	10.9	11.7
1980 to 1989	23.8	9.3	9.8	10.6	9.9
1990 to 1999	28.9	2.8	12.6	13.9	6.6
2000 to 2004	11.8	1.2	6.0	10.1	3.1
2005 or Later	5.5	0.6	8.3	6.0	4.7

Sources: (Reference 2.5.2-216; Reference 2.5.2-217; Reference 2.5.2-218; Reference 2.5.2-219; Reference 2.5.2-220)

Table 2.5.2-14
Temporary Housing at Recreational Sites

County	Total Campgrounds	Name	RV Sites	Cabins	Tent Sites/ Boat Slips	County Total
Anderson	7	Anderson County Park Commission	50	0	22	419
		Clinton / Knoxville North KOA	77	2	6	
		Half Moon	NA	NA	NA	
		Indian Creek RV Resort	20	NA	NA	
		Norris Dam State Park	75	29	10	
		Sportsman's Campground and RV Park	33	3	50	
		Windrock Park	39	14	75	
Roane	5	Caney Creek	170	0	230	631
		Riley Creek	45	0	-[1]	
		Crosseyed Cricket	47	0	-[1]	
		Four Seasons	34	0	-[1]	
		Soaring Eagle	105	0	-[1]	
Loudon	5	Yarberry Peninsula	45	0	-[1]	111
		Lazy Acres	66	0	-[1]	
		Sweetwater Valley KOA	59	6	10	
		Lotterdale Cove	90	0	28	
		Melton Hill Dam	56	0	-[1]	
Knox (near Knoxville)	3	Raccoon Valley	78	0	-[1]	275
		Southlake	90	0	27	
		Volunteer Park	100	0	-[1]	

[1] Tent sites not listed individually; however, RV sites could be utilized as tent sites.

Notes:
NA = Not Available

Sources: (Reference 2.5.2-221; Reference 2.5.2-222; Reference 2.5.2-223; Reference 2.5.2-224; Reference 2.5.2-225; Reference 2.5.2-226; Reference 2.5.2-114; Reference 2.5.2-227; Reference 2.5.2-228; Reference 2.5.2-229; Reference 2.5.2-230; Reference 2.5.2-231; Reference 2.5.2-232; Reference 2.5.2-233; Reference 2.5.2-234)

Table 2.5.2-15
Public Water Supply Systems and Capacities in Anderson, Knox, Loudon, and Roane Counties, Tennessee

Water System	Water Source Type	Maximum Daily Capacity (mgd)	Average Daily Consumption (mgd)
	Anderson County		
Anderson County Water Authority	Surface Water	2	1.21
Clinton Utilities Board	Surface Water	3.2	1.86
Rocky Top Water Department	Purchased Surface Water	0 [3]	14
Norris Water Commission	Groundwater under Influence of Surface Water	0.53	0.2
Oak Ridge Department of Public Works	Surface Water	9.9	7.7
	Knox County		
First Utility District of Knox County	Surface Water	34	11
Hallsdale Powell Utility District	Surface Water	12	6.8
Johnson University	Groundwater	-	0.01
Knox-Chapman Utility District[1]	Surface Water	6.4	3.65
Knoxville Utilities Board	Surface Water	61.2	32.7
Northeast Knox Utility District	Surface Water	6.91	2.0
West Knox Utility District	Surface Water	18	5.5
	Loudon County		
Creekside Mobile Home Subdivision	Groundwater	Not metered	NA
Lenoir City Utility Board[2]	Surface Water	3.9	2.4
Loudon Utilities Board	Surface Water	14	9.7
Martel Utility District	Purchased Surface Water	0 [3]	NA
Tellico Village Property Owners Association	Purchased Surface Water	0 [3]	1.2
	Roane County		
Cumberland Utility District	Surface Water	2.3	1.2 - 1.5
Harriman Utility Board	Surface Water	3.2	1.3 - 1.7
Kingston Water System	Surface Water	2.8	0.74
Oliver Springs Water Board	Purchased Surface Water	0.86	Unknown
Roane Central Utility District	Purchased Surface Water	0.7	0.35 - 0.4
Rockwood Water System	Surface Water	6	2.5
Watts Bar East Utility District	Purchased Surface Water	0 [3]	NA

[1] A new water treatment plant with a maximum daily capacity of 10 mgd was placed online in 2014.
[2] Water is also purchased from First Utility District, in varying unknown amounts.
[3] Purchased

Notes:
mgd = million gallons per day; NA = not available

Sources: (Reference 2.5.2-235; Reference 2.5.2-236)

Table 2.5.2-16
Public Wastewater Treatment Facilities in Anderson, Knox, Loudon, and Roane Counties, Tennessee

Treatment Facility	Maximum Daily Capacity (mgd)	Utilization (mgd)
Anderson County		
Oak Ridge	30	5 - 7
City of Oak Ridge - Rarity Ridge	0.63	0.09 - 0.1
Clinton STP #1	3	1.5 - 1.9
Norris	0.2	Wet Season 0.5 Dry Season 0.06
Rocky Top	0.95	0.3 - 0.4
Knox County		
First Utility District of Knox County - Turkey Creek	18	7
Johnson University	0.14	0.07
Hallsdale Powell Utility District	16	9
Knoxville Utilities Board - Eastbridge	1.3	0.57
Knoxville Utilities Board - Fourth Creek	10.8	7.3
Knoxville Utilities Board - Kuwahee	44	35.1
Knoxville Utilities Board - Loves Creek	10.3	3.3
West Knox Utility District - Karns Beaver Creek	4	3.6
Loudon County		
Lenoir City Utilities Board	3	1.5
Loudon Utility Board	14	8.09
Tellico Village Property Owners Association	Treated by Loudon Utilities	0.1
Roane County		
Kingston	2.0	0.45
Harriman Utility Board	5	0.9 - 1.0
Oliver Springs	0.74	0.4
Roane County Wastewater	1	Not available
Rockwood	1.65	1.3
Watts Bar Utility District	Decentralized/Purchased	Not applicable

Notes:
mgd - million gallons per day

Table 2.5.2-17
Police Services

	Number of Sworn Law Enforcement Officers	Officer to Resident Ratio
Anderson County	60	1:1250
Clinton	27	1:350
Oak Ridge	61	1:500
Knox County	458	1:1000
Knoxville	393	1:500
Loudon County	49	1:1000
Lenoir City	24	1:350
Roane County	33	1:1600
Harriman	18	1:350
Kingston	12	1:500

Sources: (Reference 2.5.2-162; Reference 2.5.2-161; Reference 2.5.2-165)

Table 2.5.2-18
Area Hospitals and Medical Centers

Hospital/Medical Center	County	Location	Number of Beds	Number of Physicians	Number of Employees
Methodist Medical Center of Oak Ridge	Anderson	Oak Ridge	255	180	1000
Ridgeview Psychiatric Hospital and Center	Anderson	Oak Ridge	20	NA	52
Turkey Creek Medical Center	Knox	Knoxville	101	811[1]	441
East Tennessee Children's Hospital	Knox	Knoxville	152	100[2]	1283
Fort Sanders Regional Medical Center	Knox	Knoxville	402	350[2]	1611
Parkwest Medical Center	Knox	Knoxville	297	400[2]	1462
Physicians Regional Medical Center	Knox	Knoxville	243	811[1]	1364
North Knoxville Medical Center	Knox	Knoxville	108	811[1]	478
University of Tennessee Medical Center	Knox	Knoxville	536	800[2]	3212
Fort Loudoun Medical Center	Loudon	Lenoir City	40	200[2]	235
Roane Medical Center	Roane	Harriman	36	NA	283

1 Physician total, 811, includes the three Hospitals: Turkey Creek Medical Center, Physicians Regional Medical Center, and North Knoxville Medical Center.

2 Number of physicians provided in the reference is expressed as “greater than” the number shown on the table. An exact number is not provided.

Notes: NA – Not Available

Sources: (Reference 2.5.2-237; Reference 2.5.2-169; Reference 2.5.2-170; Reference 2.5.2-238; Reference 2.5.2-239; Reference 2.5.2-240; Reference 2.5.2-241; Reference 2.5.2-242; Reference 2.5.2-243; Reference 2.5.2-244)

Table 2.5.2-19
Nursing Homes in Anderson, Knox, Loudon, and Roane Counties, Tennessee

Nursing Home	Location	Number of Beds
Anderson County		
Briarcliff Health Care Center	Oak Ridge	120
Golden LivingCenter - Windwood	Clinton	120
NHC HealthCare	Oak Ridge	128
Norris Health and Rehabilitation Center	Andersonville	103
Summit View of Rocky Top	Rocky Top	125
Knox County		
Beverly Park Place Health and Rehab	Knoxville	271
Brakebill Nursing Home Inc.	Knoxville	222
Fort Sanders TCU	Knoxville	24
Holston Health & Rehabilitation Center	Knoxville	109
Island Home Park Health and Rehab	Knoxville	95
Kindred Health and Rehabilitation - Northhaven	Knoxville	96
NHC HealthCare, Farragut	Knoxville	100
NHC HealthCare, Ft.Sanders	Knoxville	166
NHC HealthCare, Knoxville	Knoxville	99
Senator Ben Atchley State Veterans' Home	Knoxville	140
Serene Manor Medical Center	Knoxville	79
Shannondale Health Care Center	Knoxville	200
Summit View of Farragut, LLC	Knoxville	113
Tennova Health Care - Tennova TCU	Knoxville	25
West Hills Health and Rehab	Knoxville	194
Loudon County		
Baptist Health Care Center	Lenoir City	104
Kindred Nursing and Rehabilitation - Loudon	Loudon	182
Roane County		
The Bridge at Rockwood	Rockwood	157
Harriman Care & Rehab Center	Harriman	180
Renaissance Center	Harriman	130

Source: (Reference 2.5.2-171)

Table 2.5.2-20
Public Schools in Anderson, Knox, Loudon, and Roane Counties, Tennessee

County	Total Public Schools	Schools	Number of Schools	Student Total	Amount spent per pupil in 2009-2010 academic year
Anderson	28	Elementary	16	12,800	$9,617
		Middle	6		
		High School	3		
		Preschool	2		
		Vocational	1		
City of Oak Ridge[1]	8	Elementary	4	4800	$11,681
		Middle	2		
		High School	1		
		Preschool	1		
Knox	86	Elementary	44	58,000	$8,504
		Middle	16		
		High School	13		
		Specialized Education Center	13		
Loudon	12	Elementary	6	7500	$8,416
		Middle	3		
		High School	2		
		Pre-kindergarten through eighth grade	1		
Lenoir City[2]	3	Elementary	1	2300	$8,929
		Middle	1		
		High School	1		
Roane	18	Elementary	8	7400	$8,699
		Middle	4		
		High School	5		
		Pre-kindergarten through 12th grade	1		

1 Included within data for Anderson County
2 Included within data for Loudon County

Sources: (Reference 2.5.2-194; Reference 2.5.2-196; Reference 2.5.2-181; Reference 2.5.2-183; Reference 2.5.2-184; Reference 2.5.2-186; Reference 2.5.2-188; Reference 2.5.2-189; Reference 2.5.2-191; Reference 2.5.2-192)

Table 2.5.2-21
Colleges and Universities within 50 Miles of the CRN Site

Institutions	Location	County	Institution Type (2 or 4 year)	Approximate Enrollment
Maryville College	Maryville, TN	Blount	4	1093
Carson-Newman College	Jefferson City, TN	Jefferson	4	1967
Fountainhead College of Technology	Knoxville, TN	Knox	4	180
ITT Technical Institute	Knoxville, TN	Knox	4	400
Johnson University	Knoxville, TN	Knox	4	954
Lincoln Memorial University – Duncan School of Law	Knoxville, TN	Knox	4	104
Pellissippi State Community College	Knoxville, TN	Knox	2	11,259
South College	Knoxville, TN	Knox	4	1116
Strayer University	Knoxville, TN	Knox	4	509
The Crown College of the Bible	Powell, TN	Knox	4	700
Tusculum College – Graduate and Professional Studies	Knoxville, TN	Knox	4	2055
University of Tennessee	Knoxville, TN	Knox	4	27,000
Virginia College – Knoxville	Knoxville, TN	Knox	4	602
Tennessee Wesleyan College	Athens, TN	McMinn	4	1084
Bryan College	Dayton, TN	Rhea	4	1704
Roane State Community College	Harriman, TN	Roane[1]	2	6508

[1] Campuses are also located in eight other counties (Reference 2.5.2-245)

Sources: (Reference 2.5.2-204; Reference 2.5.2-205; Reference 2.5.2-197; Reference 2.5.2-246; Reference 2.5.2-247; Reference 2.5.2-248; Reference 2.5.2-203; Reference 2.5.2-202; Reference 2.5.2-201; Reference 2.5.2-200; Reference 2.5.2-199; Reference 2.5.2-249; Reference 2.5.2-206; Reference 2.5.2-207; Reference 2.5.2-198; Reference 2.5.2-208; Reference 2.5.2-250)

Table 2.5.2-22
Traffic Incident Rates in the Vicinity of the Clinch River Site
(February 2008 to November 2012)

Roadway	2011 Average Daily Traffic (ADT)	Length (miles)	# of Crashes (2008-2012)	# of Injuries (2008-2012)	# of Fatalities (2008-2012)	Crashes per Year (100 MVM)	Injuries per Year (100MVM)	Fatalities per Year (100MVM)
TN 58 (L.M. 17.60 to L.M. 20.18)	10,500	2.58	28	9	0	59.62	19.16	0.00
TN 95 (L.M. 0.00 to L.M. 3.00)	6600	3.00	32	10	3	90.30	29.13	8.74
TN 327 (L.M. 0.00 to L.M. 2.20)	3000	2.20	9	4	0	78.65	34.96	0.00

Notes:
MVM = million vehicle miles
L.M. = log mile

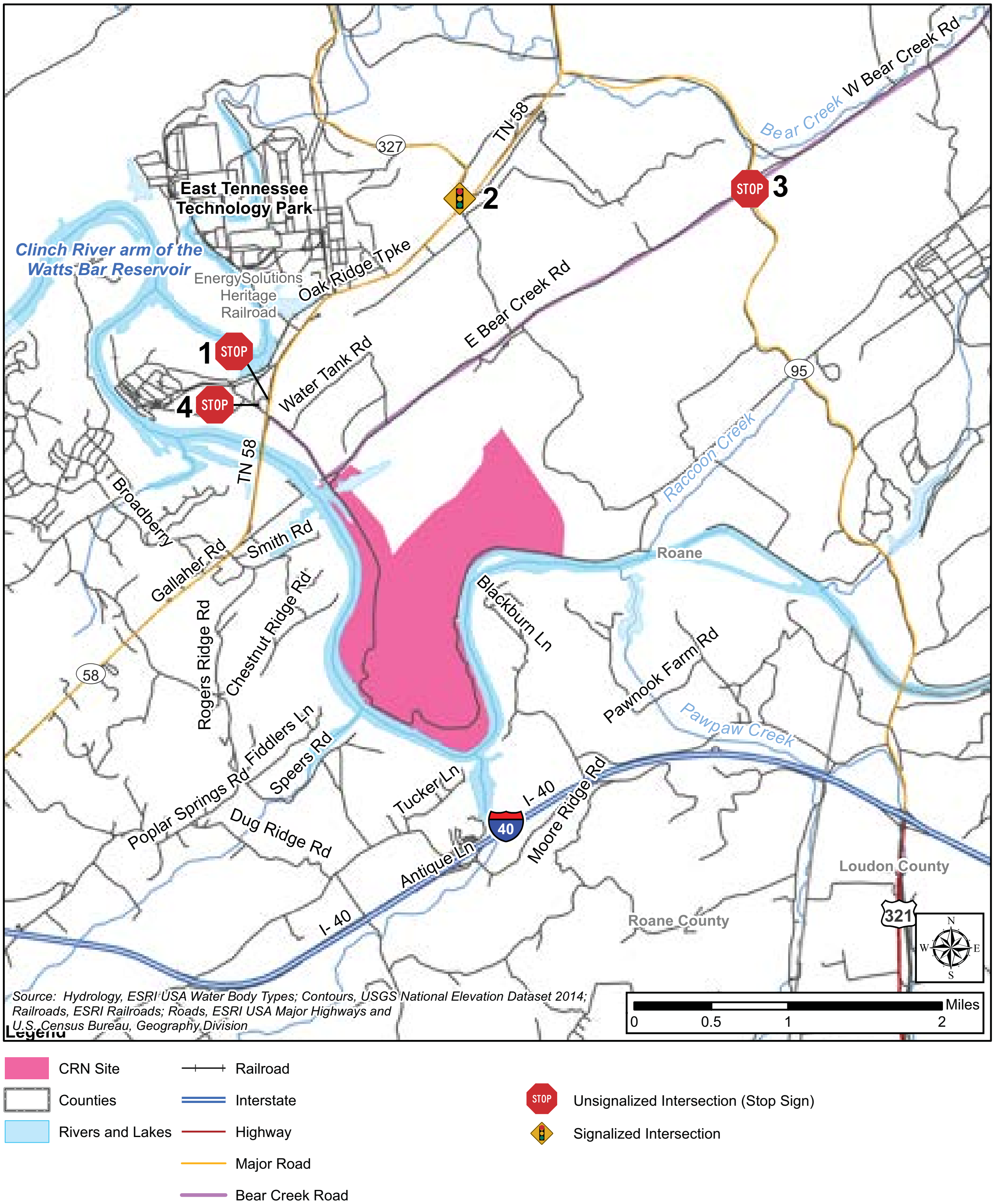

Figure 2.5.2-1. Traffic Study Intersections Potentially Impacted by the Proposed Project

This Subsection contains information withheld under 10 CFR 2.390(a)(3)

2.5.3 Historic Properties

This section of the Environmental Report (ER) focuses on a description of the existing archaeological resources and historic properties on and immediately adjacent to the Clinch River Property (Figure 2.5.3-1) and the Melton Hill Dam as well as the historic properties within a 10-mile (mi) radius of the center of the Clinch River Nuclear (CRN) Site (Figure 2.5.3-2). The 10-mi radius includes portions of Anderson, Knox, Loudon, Roane, and Morgan Counties as shown on Figure 2.5.3-2. As defined by Title 36 of the Code of Federal Regulations (36 CFR) 800.16 (l)(1), historic properties are those properties deemed eligible for listing or that are already listed on the National Register of Historic Places (NRHP).

As a federal project requesting a permit from a federal agency, the Clinch River (CR) Small Modular Reactor (SMR) Project is subject to review and consultation under Section 106 of the National Historic Preservation Act (16 U.S. Code [USC] § 470 et seq.) and its implementing regulations 36 CFR Part 800. Additionally the CR SMR Project is subject to the Native American Graves Protection and Repatriation Act (25 USC 3001 et seq.), the Archaeological Resources Protection Act (16 USC 470aa-mm), the American Indian Religious Freedom Act (42 USC 1996), and the Archaeological and Historic Preservation Act (16 USC 469).

A total of 59 recorded archaeological sites, four isolated finds (IF-1 [2015], IF-1 [2011], IF-2, IF-3), one non-site locality (NS-1), and one cemetery have been identified within or immediately adjacent to the approximately 1305-acre (ac) CR SMR Project archaeological Area of Potential Effect (CR SMR Project archaeological APE). Some of these sites are solely prehistoric, some solely historic, and others contain both prehistoric and historic components. None of these archaeological sites are currently listed on the NRHP.

The Tennessee Valley Authority (TVA) determined a 0.5-mi radius surrounding the area in which vegetation clearing would take place at the CRN Site as the historic architecture APE (CR SMR Project historic architecture APE). TVA identified no historic architectural resources listed or eligible for listing on the NRHP within the CR SMR Project historic architecture APE.

No NRHP-listed properties are located on or immediately adjacent to the CRN Site as shown in Figure 2.5.3-2. Twenty-six NRHP-listed properties are located within a 10-mi radius of the center of the CRN Site as shown in Figure 2.5.3-2 and described in Table 2.5.3-1. In Anderson County, there are three aboveground NRHP-listed properties within the 10-mi radius. The NRHP-listed Woodland-Scarboro Historic District also in Anderson County contains another 622 aboveground structures that contribute directly to the significance and integrity of the district. An additional nine aboveground NRHP-listed properties are located in Loudon County within the 10-mi radius. Eleven aboveground NRHP-listed properties and two historic districts are located in Roane County within the 10-mi radius. The two Roane County historic districts contain another 131 buildings and 33 structures that contribute directly to the significance and integrity of the district.

TVA identified the need for a future minor modification to the flow of the Clinch River in the project vicinity. A number of alternatives are being considered for providing the additional required flow; some could require changes at the Melton Hill Dam. TVA is currently preparing to nominate the Melton Hill Hydroelectric Project/Melton Hill Dam, completed in 1964, as a National Register of Historic Places District. The proposed district contains eight buildings, two sites, and five structures, including the concrete dam, powerhouse, navigational lock, a lock operation building, and a visitor's building, that contribute directly to the significance and integrity of the district. The draft application states that the Melton Hill Hydroelectric Project meets National Register criteria A and C for its historical significance as an integral part of the TVA Hydroelectric Project. It is significant for the improvement of navigation, expansion of energy, and improvement of quality of life through transmission of electricity, control of seasonal flooding and creation of public recreational facilities. (Reference 2.5.3-65)

In April 2016, the Keeper of the National Register approved TVA's multiple properties documentation form for the "Historic Resources of the TVA Hydroelectric System, 1933-1979". The Melton Hill Hydroelectric Project/Melton Hill Dam is one of these documented properties. This documentation process was the first step completed in the individual nomination process for each hydroelectric project. (Reference 2.5.3-66)

Archaeological surveys have been conducted in the past at the Melton Hill Dam reservation. At present no ground-disturbing activities are anticipated in the vicinity of the Melton Hill Dam. Therefore, the dam has not been included in the CR SMR Project archaeological APE. The potential changes at the Melton Hill Dam could result in aesthetic or visual changes to the dam. However, the nature of the potential changes needed are currently unknown. Therefore, an historic architecture APE will be established for the Melton Hill Dam at a future date and assessed at that time.

In August 2016, TVA consulted with the SHPO regarding an expansion to the CR SMR Project APE to include Melton Hill Dam and a 0.5-mi radius surrounding the dam (Reference 2.5.3-67).

The following subsections describe the existing archaeological resources and historic properties on and immediately adjacent to the Clinch River Property.

2.5.3.1 Cultural Resource Surveys

The CR SMR Project APE includes the approximately 1200-ac Clinch River Property, an additional approximately 105 ac northwest of the property near the CRN Site entrance and along Bear Creek Road and Tennessee State Highway (TN) 58, the Melton Hill Dam, and a 0.5-mi radius around the Melton Hill Dam. The CR SMR Project archaeological APE is shown in Figure 2.5.3-1. Between the years of 2003 and 2015, the entirety of the CR SMR Project archaeological APE was surveyed (Reference 2.5.3-1; Reference 2.5.3-2). TVA conducted four archaeological surveys (one in 2003, two in 2011, and one in 2015) including all parts of the CR SMR Project archaeological APE with the exceptions of approximately 14.6-ac of U.S.

Exempted from Disclosure by Statute – Withheld Under 10 CFR 2.390(a)(3)

Department of Energy (DOE) land in the northwestern part of the CR SMR Project archaeological APE that had been included in a recent (2008-2010) DOE archaeological survey. Additionally, several previous cultural resource surveys have been conducted at and in the vicinity of the CR SMR Project archaeological APE in conjunction with various planned development activities. The various surveys that have occurred at the CRN Site are described in this subsection. The areas investigated for the majority of these past surveys are shown on Figure 2.5.3-3.

The first recorded archaeological investigation in the Clinch River valley occurred in 1886 [ ] Exempted from Disclosure by Statute. [ ] Exempted from Disclosure by Statute a Native American mound complex with associated camps, villages, and burials was reported. The investigation team also observed the presence of two mounds [ ] Exempted from Disclosure by Statute. (Reference 2.5.3-3)

In 1941, five archaeological sites were recorded along the river within the CR SMR Project archaeological APE. This 1941 survey is the first record of these five sites: 40RE104, 40RE105, 40RE106, 40RE107, and 40RE108 (Reference 2.5.3-3).

A 1972 survey reinvestigated the five sites originally identified in 1941 and recorded five additional sites. The authors recommended no further investigation for sites 40RE104 and 40RE106. Further investigation of sites 40RE105, 40RE107, and 40RE108 was recommended. (Reference 2.5.3-3) Additionally, the authors recommended the preparation of drawings and photographs of five additional sites: 40RE119, 40RE120, 40RE121, 40RE122, and 40RE123 (Reference 2.5.3-4; Reference 2.5.3-3).

A January 1973 survey resulted in the production of plan maps and identification of additional historic features at sites 40RE120 and 40RE121 (Reference 2.5.3-5). In November 1973, it was discovered that the historic log structure at 40RE123 had been completely destroyed by parties unknown (Reference 2.5.3-6).

TVA conducted a survey to assess NRHP eligibility of the area outside, but in the vicinity of the CR SMR Project archaeological APE, in 1973. During this survey, the closest NRHP-listed site identified was located 4 mi from the CR SMR Project archaeological APE boundary. A field survey of the surrounding area identified five locations containing structures potentially eligible for listing on the NRHP. (Reference 2.5.3-7)

In the winter of 1973 to 1974, researchers investigated sites 40RE108 and the newly identified site 40RE124. The authors recommended further investigation of both of these sites. (Reference 2.5.3-8; Reference 2.5.3-9)

A survey to assess potential historic sites within the CR SMR Project archaeological APE was conducted in spring 1974 utilizing information from a 1940 map. During the 1974 survey, 12 land parcels were investigated within the CR SMR Project archaeological APE. Whole or partial historic structures were identified in nine locations. One additional structure was found to have been moved from its 1940 location within the CRN Site to a new location a short distance away within the CRN Site sometime before 1974. Finally, an additional historic feature was located within the CR SMR Project archaeological APE, but outside of the area covered on the 1940 map. The authors of the 1974 survey recommended additional investigation of these sites. (Reference 2.5.3-6)

Site 40RE129 was first identified and investigated in 1974, at which time it was thought to be a prehistoric earthen burial mound. Site 40RE129 [ ] Exempted from Disclosure by Statute was not identified in any previous surveys, despite its prominent location which would have been easily viewed during the 1941 survey. The 1974 investigation determined this site contained cultural material suggesting it is an historic Anglo-American feature constructed in the first half of the 20th century. It was constructed for an unknown reason, likely using material from the immediate vicinity. (Reference 2.5.3-10) Tennessee site records indicate the site number for 40RE129 has been vacated (Reference 2.5.3-11).

Cultural resources surveys conducted on and around the CR SMR Project archaeological APE in 1974 and 1975 identified four previously unrecorded sites (Reference 2.5.3-12). The 1974 survey identified site 40RE125. The 1975 survey resulted in the identification of sites 40RE138, 40RE139, and 40RE140. (Reference 2.5.3-13) Further investigation of site 40RE138 was recommended due to the significance and extent of the site. [ ] Exempted from Disclosure by Statute No further work was recommended at sites 40RE125 and 40RE139. (Reference 2.5.3-14)

A survey in the winter of 1981 to 1982 investigated portions of the CR SMR Project archaeological APE not previously surveyed. The 1981-1982 survey resulted in the identification of 17 previously unrecorded sites and the redefinition of three previously recorded sites (40RE106, 40RE125, and 40RE128 [ ]). (Reference 2.5.3-13) The 17 new sites were 40RE151, 40RE152, 40RE153, 40RE154, 40RE155, 40RE156, 40RE157, 40RE158, 40RE159, 40RE160, 40RE161, 40RE162, 40RE163, 40RE164, 40RE165, 40RE166, 40RE167. The authors recommended no further investigation for sites 40RE151, 40RE152, 40RE153, 40RE154, 40RE155, 40RE156, 40RE157, 40RE158, 40RE159, 40RE160, 40RE161, 40RE162, 40RE163, and 40RE164. (Reference 2.5.3-14) The authors also recommended that in the event of potential disturbance, sites 40RE166, 40RE167 and two unassigned loci (L-19 and L-20) be further investigated. The authors also recommended Site 40RE165 was a “significant cultural resource.” (Reference 2.5.3-13)

A survey was completed in 1995 in the northwestern portion of the CR SMR Project archaeological APE during the planning stages for proposed modifications to TN 58 and TN 95. This survey identified seven archeological sites within the new right of way needed for the road modifications. Three of these sites are in the CR SMR Project archaeological APE: 40RE135, 40RE138, and 40RE233. Sites 40RE135 and 40RE138 were originally discovered by Fielder in 1974 and 1975, respectively. During the 1995 survey, profile cuts were made in the riverbanks in the vicinity of Gallaher Bridge. No pre-historical artifacts were found; only historical items that were presumed to be from the construction of the bridge in the 1960s were found. Site 40RE233 was recommended as potentially eligible for the NRHP under Criterion A; further investigation was recommended. Site 40RE232 was discovered during the 1995 survey. Site 40RE232 is located outside of but adjacent to the CR SMR Project archaeological APE. The survey was unable to determine NRHP-eligibility. (Reference 2.5.3-15)

In 2002, a survey of a low-lying area in the central portion of the CR SMR Project archaeological APE identified three previously unrecorded archaeological sites in the CR SMR Project archaeological APE: 40RE547, 40RE548, and 40RE549. The authors recommended no further investigation of sites 40RE547 and 40RE548. Site 40RE549 was recommended as potentially eligible for listing on the NRHP and the authors recommended additional site investigation prior to any future construction or use. Sites 40RE121 and 40RE122 were reinvestigated but no further investigation was recommended. During this survey the authors unsuccessfully attempted to relocate 40RE156, 40RE157, and 40RE158 and additional investigation was deemed unnecessary (Reference 2.5.3-16; Reference 2.5.3-15).

A Phase I and Phase II survey and testing of 40RE233 was performed in January 2008, May 2009, and July 2010. Site 40RE233 is known historically as the Happy Valley temporary worker housing area. The site was occupied by workers at the K-25 Oak Ridge Gaseous Diffusion Plant, part of the Manhattan Project during World War II. Researchers recommended that Site 40RE233 is eligible for the NRHP under Criteria A, C, and D. Site 40RE219, the Wheat Community African Burial Ground, was also reinvestigated and further investigation of the immediate vicinity of the cemetery was recommended if ground disturbing activities were to occur in this area. (Reference 2.5.3-17)

In 2011, TVA performed two archaeological cultural resource surveys (Reference 2.5.3-11). The archaeological portion of the surveys covered the majority of the approximately 1200-ac Clinch River Property managed by TVA. The surveys did not reexamine the portion of the Clinch River Property investigated in the 2002 survey. In conjunction with the archaeological surveys, TVA also performed an assessment of the architectural resources within the CR SMR Project historic architecture APE, the 0.5-mi radius centered on the previous Clinch River Breeder Reactor Project (CRBRP) construction area (Reference 2.5.3-18).

The first of the two surveys occurred in the winter of 2011 and consisted of an archaeological survey of 687-ac within the Clinch River Property. The purpose of this survey was for site investigations and infrastructure improvements. The winter 2011 survey consisted of a Phase I archaeological survey of approximately 157 ac and identified five previously unrecorded archaeological sites: 40RE585, 40RE586, 40RE587, 40RE588, and 40RE589. The authors recommended sites 40RE585, 40RE586, 40RE587, and 40RE589 as ineligible for listing on the NRHP and recommended no further work at these sites. Site 40RE588 is the historic Hensley Cemetery, which the authors recommended as ineligible for the NRHP. However, because of the presence of human burials, the authors recommended this site be avoided. (Reference 2.5.3-11)

The winter 2011 survey also reinvestigated 12 previously identified sites: 40RE106, 40RE107, 40RE108, 40RE120, 40RE129, 40RE152, 40RE153, 40RE154, 40RE159, 40RE163, 40RE165, and 40RE166. The authors recommended that sites 40RE106, 40RE107, 40RE108, 40RE165, and 40RE166 are eligible for the NRHP and should be avoided. If it is not possible to avoid these sites, the authors recommend development of a data recovery plan for the affected sites. The authors concluded that 40RE120, 40RE152, 40RE154, and 40RE163 are ineligible for the NRHP and no further work is recommended at these sites. As described previously, the site number for 40RE129 has been vacated. The authors of the winter 2011 survey recommended no further work at 40RE129. The authors were unable to locate site 40RE159 and assumed it was destroyed during previous site activities. No further work was recommended at 40RE159. The authors recommended no further work for site 40RE153 because it was located outside of the winter 2011 survey area for the site investigations and infrastructure improvements work. (Reference 2.5.3-11) TVA consulted with the State Historic Preservation Officer (SHPO) in February 2011 with regard to the findings of the winter 2011 survey. The SHPO concurred with TVA's determinations on NRHP eligibility.

The second survey occurred in the spring of 2011. The purpose of this survey was to investigate the balance of the Clinch River Property. The spring 2011 survey investigated 35 sites, including 15 previously unrecorded sites: 40RE590, 40RE591, 40RE592, 40RE593, 40RE594, 40RE595, 40RE596, 40RE597, 40RE598, 40RE600, 40RE601, 40RE602, 40RE605, 40RE606, and 40RE607 in addition to three isolated finds. The authors recommended 12 of the investigated sites as potentially eligible for the NRHP (40RE104, 40RE105, 40RE106, 40RE108, 40RE124, 40RE128, 40RE140, 40RE167, 40RE549, 40RE595, 40RE600, and 40RE601). The remaining 23 sites and the three isolated finds were recommended as ineligible for the NRHP (40RE122, 40RE123, 40RE125, 40RE151, 40RE153, 40RE155, 40RE160, 40RE161, 40RE162, 40RE163, 40RE164, 40RE590, 40RE591, 40RE592, 40RE593, 40RE594, 50RE596, 40RE597, 40RE598, 40RE602, 40RE605, 40RE606, 40RE607, IF-1 (2011), IF-2, and IF-3). The spring 2011 survey also investigated two caves. No cultural material was identified in these caves; therefore, the authors recommended no further work for these locations. (Reference 2.5.3-1) TVA consulted with the SHPO in August 2011 regarding the results of the spring 2011 survey. The SHPO concurred with TVA's determinations on NRHP eligibility and requested that the 12 potentially-eligible sites identified in the survey be avoided by all ground-disturbing activities or subjected to Phase II archaeological testing investigations. (Reference 2.5.3-19)

In August 2011 TVA performed a Phase I architectural survey of the CR SMR Project historic architecture APE, the 0.5-mi radius around the previously disturbed CRBRP area. This previously disturbed area was chosen as a focal point because it was defined as the area most likely to be impacted by the CR SMR Project. A total of approximately 1289 ac was evaluated during this survey. The architectural survey began with a records search of Roane County, NRHP, and Tennessee Historical Commission records followed by the field survey. The historic architectural survey identified no previously unrecorded architectural resources with the CR SMR Project historic architecture APE. Based on the results of the survey, researchers recommended no further investigation of aboveground properties in association with the proposed action. (Reference 2.5.3-18)

An additional survey was conducted in 2015. The purpose of this survey was to investigate the Barge/Traffic Area (101 ac), which is the offsite area extending from the entrance to the CRN Site to the area at the junction of TN 58 and Bear Creek Road. The refurbishment of a barge terminal and roadway modifications are planned in the Barge/Traffic Area. This survey included the reinvestigation of four sites (40RE135, 40RE138, 40RE139, and 40RE202) and the discovery of one isolated find (IF-1) and one non-site locality. This investigation included an area of approximately 110 ac, which included the Barge/Traffic Area and a portion of the Clinch River Property near the site entrance on the northwest side of Grassy Creek. The findings indicated that avoidance or further investigation is warranted for 40RE138. The other sites (40RE135, 40RE139 and 40RE202), IF-1, and the non-site locality were recommended as ineligible for the NRHP. Site 40RE233 is located within the 110-ac area investigated; however, reinvestigation of the site was not conducted because a thorough investigation had been conducted of the site in 2010-2011. Site 40RE233 is discussed in further detail in Subsection 2.5.3.5. (Reference 2.5.3-2)

2.5.3.2 Consultations with the State Historic Preservation Office and Native American Tribes

Fifty-nine recorded archaeological sites, four isolated finds, one non-site locality, and one cemetery have been identified within or immediately adjacent to the approximately 1305-ac CR SMR Project archaeological APE. The prehistoric sites are discussed in Subsection 2.5.3.3, the multi-component prehistoric and historic sites are discussed in Subsection 2.5.3.4, and the historic sites are discussed in Subsection 2.5.3.5. Table 2.5.3-2 lists the archaeological and historic sites within and immediately adjacent to the CR SMR Project APE identified during the surveys described above. A small number of cultural resource sites have been identified in the vicinity of the CR SMR Project APE, including a cave located across the river, historic cemeteries in the surrounding area, and some prehistoric and historic sites on TVA and DOE land. All sites with the potential to be impacted by the current undertaking are discussed in the subsections below and in Subsections 4.1.2 and 5.1.3.

TVA consulted with the Tennessee SHPO and federally-recognized Native American tribes regarding the 2002 cultural resources survey, the two archaeological surveys conducted in 2011, the 2015 survey, and the 2011 architectural survey. TVA consulted on a government-to-government basis with the Eastern Band of Cherokee Indians, Cherokee Nation, Chickasaw Nation, Alabama Quassarte Tribal Town, Muscogee (Creek) Nation, Alabama-Coushatta Tribe of Texas, Thlopthlocco Tribal Town, Seminole Nation of Oklahoma, Eastern Shawnee Tribe of Oklahoma, Absentee Shawnee Tribe of Oklahoma, Kialegee Tribal Town, United Keetoowah Band of Cherokee Indians in Oklahoma, Seminole Tribe of Florida, Shawnee Tribe, and Poarch Band of Creek Indians. The SHPO has concurred with TVA's determinations on the eligibility of the 59 archaeological sites and one cemetery that have been identified within the Clinch River Property. TVA and the SHPO agree that 16 of the archaeological sites (40RE104, 40RE105, 40RE106, 40RE107, 40RE108, 40RE124, 40RE128, 40RE138, 40RE140, 40RE165, 40RE166, 40RE167, 40RE549, 40RE595, 40RE600, and 40R601) are potentially eligible for listing in the NRHP, and the remaining 44 archaeological sites, four isolated finds, one non-site locality, and the cemetery are ineligible for listing in the NRHP. The SHPO also concurred with TVA's determinations that no architectural resources listed on or eligible for listing on the NRHP are located within the CR SMR Project historic architecture APE. TVA in consultation with the SHPO executed a Programmatic Agreement (PA) to address the management of cultural resources affected by the CR SMR Project. (Reference 2.5.3-20) The PA was initially signed in August 2015, was later revised and signed in April 2016 by TVA and May 2016 by the SHPO. In August 2016, TVA reinitiated consultation with the SHPO under Section I.A of the PA to expand the CR SMR Project APE to include the Melton Hill Dam and a 0.5-mi radius around the dam.

TVA also consulted with federally recognized tribes in or with cultural interest in the region. TVA received a reply from the United Keetoowah Band of Cherokee Indians in Oklahoma on August 29, 2011, who stated they had no objections to TVA's proposed undertaking. In April 2015, in response to notification from TVA regarding the expanded APE, the Muscogee (Creek) Nation responded they were unaware of any culturally significant sites within the project areas and concurred with TVA's determination that Site 40RE233 is eligible for the NRHP and would be avoided. In July 2015 TVA received a response from the United Keetowah Band of Cherokee Indians in Oklahoma acknowledging the revised PA. ER Appendix A includes letters sent to and received from regulatory agencies and Native American tribes regarding the cultural resources consultation associated with the proposed SMR project.

2.5.3.3 Prehistoric Archaeological Sites

A total of 39 of the recorded archaeological sites and three of the isolated finds within the CR SMR Project archeological APE are prehistoric and are addressed in this subsection. An additional two of the recorded archaeological sites are multi-component prehistoric and historic and are discussed in Subsection 2.5.3.4.

The 2003 and 2011 surveys revisited previously recorded sites in the CR SMR Project archaeological APE. Archaeological sites 40RE104, 40RE105, 40RE106, 40RE107, 40RE108, 40RE128, 40RE166, 40RE167, 40RE549, 40RE595, 40RE600, and 40RE601 contain intact subsurface archaeological deposits representative of prehistoric open habitation. TVA and

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SHPO agreed these sites are potentially eligible for listing on the NRHP under Criterion D of 36 CFR 60.4; TVA plans to avoid these sites if possible. If avoidance is not possible, further investigation may be required. (Reference 2.5.3-1)

One additional prehistoric site, 40RE138, was investigated in the 2015 survey. It is a previously recorded prehistoric multi-component (Paleoindian – Woodland periods) prehistoric site [ ] Exempted from Disclosure by Statute. In conjunction with pedestrian reconnaissance, systematic subsurface excavations, and geomorphological analyses, only a small portion of the site was identified during the 2015 survey. A portion of the site may extend [ ] Exempted from Disclosure by Statute but is covered by historic fill that made it impossible to determine the full extent of the site. Avoidance or additional investigation of 40RE138 is recommended in the event of ground disturbance. (Reference 2.5.3-2)

Site 40RE124 consists of the remains of a Late Woodland period mound containing intact subsurface archaeological deposits. It is also possible this site may contain human remains. TVA and SHPO agreed this site is potentially eligible for the NRHP under Criterion D of 36 CFR 60.4. TVA has agreed to avoid Site 40RE124 [ ] Exempted from Disclosure by Statute. (Reference 2.5.3-1)

Based on the studies performed, TVA has determined several of the prehistoric archaeological sites and the three prehistoric isolated finds are ineligible for listing on the NRHP because of a lack of research potential and lack of intact archaeological deposits. These sites generally consist of prehistoric open habitation and/or contain light scatter of lithic debitage and/or prehistoric ceramics. The sites include 40RE125, 40RE135, 40RE151, 40RE152, 40RE153, 40RE154, 40RE155, 40RE160, 40RE163, 40RE202, 40RE547, 40RE548, 40RE585, 40RE589, 40RE592, 40RE602, 40RE605, IF-1 (from the 2015 survey), and IF-2 and IF-3 (from the 2011 surveys). No further work is recommended at these sites. (Reference 2.5.3-1)

The 2003, 2011, and 2015 surveys were unable to relocate previously investigated prehistoric sites 40RE139, 40RE156, 40RE157, 40RE158, 40RE159, 40RE161, 40RE162, and 40RE164 (Reference 2.5.3-1; Reference 2.5.3-16; Reference 2.5.3-2; Reference 2.5.3-11). These sites are presumed destroyed by previous site activities [ ] Exempted from Disclosure by Statute. No further work at these sites was performed.

2.5.3.4 Multicomponent Archaeological Sites

Two sites, 40RE140 and 40RE165, include both prehistoric and historic archaeological resources. Site 40RE140 consists of [ ] Exempted from Disclosure by Statute containing intact prehistoric and historic archaeological resources. Prehistoric resources indicate this site was occupied during the Late Archaic and Early Woodland Periods. Historic resources include the remains of a moonshine still and a scattering of animal bone. Earlier surveys recovered human remains and intact subsurface deposits [ ] Exempted from Disclosure by Statute. Based on these findings, 40RE140 is potentially eligible for listing on the NRHP under Criterion D of 36

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CFR 60.4. [

] Exempted from Disclosure by Statute (Reference 2.5.3-1) Site 40RE165 consists of a prehistoric open habitation with light scatter and lithic debitage and an historic fish weir and is potentially eligible for listing on the NRHP under Criterion D of 36 CFR 60.4. (Reference 2.5.3-11)

2.5.3.5 Historic Archeological Sites

Twenty-one of the recorded archaeological sites, one isolated find, and the one non-site locality identified within or immediately adjacent to the CR SMR Project archaeological APE are determined as historic sites or isolated finds. Two of these sites are multi-component prehistoric and historic and are discussed in Subsection 2.5.3.4. In addition to the identified historic sites, two historic roads, the Access Road and River Road shown on Figure 3.1-2, are located on the Clinch River Property. The Access Road that connects the interior of the CRN Site to Bear Creek Road is visible on aerial photographs from 1939. The River Road that circles the southern portion appears to have been constructed by 1952. This road is absent from a 1943 TVA land transfer map. It appears on an April 30, 1952 TVA aerial photograph, and on the 1953 editions of the U.S. Geological Survey (USGS) Bethel and Elverton 7.5-minute quadrangle maps. The road is labelled “Cane Island Patrol Road” on TVA’s 1961 “D-stage” map, which documents land changes after the construction of Watts Bar Reservoir. No information is available that identifies which year the River Road was constructed, but the date can be bracketed between 1943 and 1952 based on the above information. The Access Road appears to have connected individual homesteads to Bear Creek Road. The River Road/Cane Island Patrol Road may have been associated with the K-25 Oak Ridge Gaseous Diffusion Plant during the Manhattan Project of World War II, given the decade of its construction and the name it was given. Both the Access Road and River Road are currently dirt/gravel roads that have been modified with the addition of culverts and grading (both during the CRBRP and at other times) since their original construction. The NRHP-eligibility for these roads has not been determined, but they most likely would not be eligible. Although the River Road, if constructed by the Atomic Energy Commission as part of the Manhattan Project, would be associated with events of historic significance, it no longer retains its integrity of association due to changes in land use that have taken place in the past six decades, nor its integrity of materials or workmanship due to the modifications. This subsection addresses the remaining historic sites.

Site 40RE233 is the Happy Valley temporary worker housing area, occupied by workers at the K-25 Oak Ridge Gaseous Diffusion Plant, part of the Manhattan Project during World War II. The site was occupied from 1943 to 1947. Population ranged from 9000 to nearly 15,000 workers during this period. Facilities at the site included hutments, barracks, trailers, a school, a commercial center, a theater, and recreation halls. Because of the secrecy surrounding all components of the Manhattan Project at the time, limited information exists about daily life at Happy Valley. Records that record information about Happy Valley include maps, photographs, archival records, and oral history interviews. Happy Valley is one of the largest and best preserved workers camps associated with the Manhattan Project. The site remains part of the

DOE Oak Ridge Reservation and therefore possesses fair integrity of setting. Though the buildings and structures have been removed, the site has good archaeological integrity in that the substructural elements remain in place. The site retains strong integrity of workmanship, “it expresses the landscape and design” of the community and the remains of streets, utilities, building foundations, and other features can be matched up with maps of the camp. The loss of site architecture has impacted the integrity of feeling, however. The site retains a strong integrity of association with the Manhattan Project, a significant event in United States history. Researchers recommended that Site 40RE233 is eligible for the NRHP under Criteria A, C, and D. Site 40RE219, the Wheat Community African Burial Ground, was also reinvestigated and further investigation on the immediate vicinity of the cemetery was recommended if ground disturbing activities were to occur in this area. (Reference 2.5.3-17)

Site 40RE232 was discovered during the 1995 survey. This site is located outside of but adjacent to the CR SMR Project archaeological APE. This historic site was identified based on a posted sign identifying an inactive waste site, “Old Firehouse and Burn Area” “K-1085.” The boundaries of the site are unknown. Because of the potential presence of surface and subsurface hazardous materials, no subsurface investigations were conducted. Because of the inability to investigate the site or to gain more detailed information about the site, the NRHP-eligibility has not been determined. (Reference 2.5.3-15)

Based on the survey findings, TVA and SHPO agreed 13 of the historic sites, one isolated find, and the one non-site locality are ineligible for listing on the NRHP due to a lack of research potential and intact archaeological deposits. Historic sites 40RE120, 40RE121, 40RE122, 40RE123,40RE586, 40RE587, 40RE591, 40RE593, 40RE594, 40RE596, 40RE598, and one isolated find (IF-1, from the 2011 survey) consist of 19th to 20th century farmstead structural debris and historic artifacts (Reference 2.5.3-6; Reference 2.5.3-4; Reference 2.5.3-11). Sites 40RE590 and 40RE597 consist of historic artifact scatter including the remains of a 20th century moonshine still. (Reference 2.5.3-1) The non-site locality consists of five aboveground structural elements that do not appear to be more than 50 years of age. No further work is recommended for these thirteen sites, IF-1 (2011), and the non-site locality.

The historic Hensley Cemetery is site 40RE588. In 1972, this site was designated as site 40RE119; however, that site number was later reassigned to another offsite location (Reference 2.5.3-11). Generally, cemeteries are not eligible for the NRHP unless they contain the graves of persons of particular significance, distinctive design features, or from their association with historic events. The Hensley Cemetery fulfills none of these requirements and is therefore recommended as ineligible for inclusion in the NRHP.

However, due to the presumed presence of human remains, TVA has consulted with the SHPO regarding the Hensley Cemetery and has committed to avoiding the cemetery under the proposed undertaking. If the site cannot be avoided, any actions would be subject to Tennessee state law with respect to treatment of cemeteries. (Reference 2.5.3-11; Reference 2.5.3-19).

Three sites within the CR SMR Project archaeological APE consist of single or multiple stone mounds. In the 1974 survey site 40RE129 was determined to be a recent historic soil disturbance (Reference 2.5.3-10). The site number was vacated in the Tennessee state records (Reference 2.5.3-11). Two series of stone mounds are located at sites 40RE606 and 40RE607. A single disc plow blade was the only artifact recovered in one mound at each site. These mounds are presumed to be remnants from previous ridge clearing in association with mid-20th century farming activities and are assumed to be ineligible for listing on the NRHP. No further work is planned at these sites. (Reference 2.5.3-1)

2.5.3.6 Caves

One cave, [ ] Exempted from Disclosure by Statute containing prehistoric and historic cultural material was identified during the 1975 survey. The 2011 survey also investigated two additional caves within the CR SMR Project archaeological APE, Rennies Cave and 2-Batteries Cave. No prehistoric or historic cultural material was located within these caves. No further archaeological work is planned with respect to these caves. [ ] Exempted from Disclosure by Statute

2.5.3.7 Historic Sites

As described above, no aboveground historic sites with intact standing structures were identified on the CRN Site during the previous surveys as being potentially eligible for listing, eligible for listing, or listed on the NRHP. However, within a 10-mi radius of the center point of the CRN Site, there are 23 individual NRHP-listed properties and three NRHP-listed historic districts as shown in Figure 2.5.3-2 and described in Table 2.5.3-1. In Anderson County, there are three aboveground NRHP-listed properties within the 10-mi radius. The NRHP-listed Woodland-Scarboro Historic District contains another 622 aboveground structures that contribute directly to the significance and integrity of the district. An additional nine aboveground NRHP-listed properties are located in Loudon County within the 10-mi radius. Eleven aboveground NRHP-listed properties and two historic districts are located in Roane County within the 10-mi radius. The two historic districts contain another 131 buildings and 33 structures that contribute directly to the significance and integrity of the district.

2.5.3.7.1 National Register of Historic Places Listed Sites

The NRHP is a list of buildings, districts, sites, structures, and objects significant to local, state, or national history. Properties may qualify for inclusion in the NRHP under one of four criteria:

- Criterion A: This criterion is associated with events that have made a significant contribution to the broad patterns of American history. This criterion includes literature, ethnic heritage, health/medicine, transportation, and many others.
- Criterion B: This criterion is associated with the life of significant persons. An example of an NRHP property nominated under Criterion B is George Washington's Mt. Vernon estate.

- Criterion C: This criterion is the embodiment of the distinctive characteristics of a type, period, or method of construction. This inclusion also includes the works of a master or buildings that possess high artistic value. Criterion C applies to architecture.
- Criterion D: This criterion includes properties that have yielded or may be likely to yield information important in history or prehistory. This category is mainly relevant to archaeological properties.

In addition to these criteria, a property must also possess integrity of location, design, setting, materials, workmanship, feeling, and association as described in 36 CFR 60.4 to be considered NRHP-eligible.

Twenty-nine NRHP-listed properties (26 individual properties and three historic districts) are located within a 10-mi radius of the center of the CRN property. One eligible historic district is included within the CR SMR Project APE. Following are brief descriptions of the 26 NRHP-listed individual properties. The historic districts are addressed in Subsection 2.5.3.7.2.

George Jones Memorial Baptist Church

The George Jones Memorial Baptist Church, located in Roane County, was listed on the NRHP in 1992. It was constructed in 1901 using funding from Pastor George Jones, lumber donated by the congregation, and bricks which were made onsite. It is a gable front brick church on a stone foundation with a metal roof, wooden siding, and a square bell tower. There are two interior rooms, an anteroom, and a sanctuary leading to a basement. The original siding and wood floors remain. The church is listed on the NRHP under Criterion A for its significance in social history and Criterion C for its architecture. The period of significance is 1901 to 1942. The social significance is due to its importance in the Wheat Community where the building served as a church, a school, and a community gathering center until its purchase by DOE in 1942. The George Jones Memorial Baptist Church represents conditions present in late 19th and early 20th century rural Tennessee prior to the inception of the Manhattan Project. (Reference 2.5.3-21)

X-10 Reactor, Oak Ridge National Laboratory

The X-10 Reactor at the Oak Ridge National Laboratory, located in Roane County, was listed on the NRHP in 1979, at which time the building was still in active use. The reactor was constructed as part of the Manhattan Project in 1943; it was built to supply the initial quantities of Plutonium-239 for the development of the atomic bomb. The reactor began operations in 1943 and was the first full scale nuclear reactor globally. It was also the first reactor to produce significant amounts of heat energy and plutonium isotopes. The reactor made radioactive isotopes for medical therapy beginning in 1946 and was an atomic research facility until it was shut down in 1963. The reactor is listed on the NRHP under Criterion A for its importance to the Manhattan Project. The reactor was opened to the public for tours and educational visits in 1968. (Reference 2.5.3-22)

New Bethel Baptist Church

The New Bethel Baptist Church, also known as Bethel Church, was listed on the NHRP in 1992. It is a one story, three bay rectangular church with a small square bell tower, built in approximately 1900. The existing building was completed in 1924, but the church was organized in 1851. It was partially updated over the years, but the interior has not been significantly changed. The church contains the original pews, floors and paneled walls. The church is located in Roane County on Bethel Valley Road, directly across from Oak Ridge Reservation's X-10 facility. There is also a marker at the site commemorating the last service conducted in the church on Memorial Day, 1949; this marker is a contributing object to the historic significance of the church. There is a cemetery behind the church containing approximately 250 gravestones, mostly dating from the 1880s to the 1940s. There are also two gravehouses which are also included as historical contributing structures. The church is significant under Criterion A for its role in the social history of Oak Ridge and for its military association; it was used as a meeting room during the Manhattan Project. The church is also significant under Criterion C for its architecture. The gravehouses are significant as examples of mortuary folk architecture built between the 1880s and 1960s in rural areas throughout the south to represent the tombs of wealthy area residents. (Reference 2.5.3-23)

Oak Ridge Turnpike Checking Station

The Oak Ridge Turnpike Checking Station is located in Roane County on the Oak Ridge Turnpike and consists of two concrete buildings, one on each side of the road. The checking station was listed on the NHRP in 1992. The larger building is located on the north side of the road and consists of a one story structure with a two story tower. The smaller building is a small guard house located on the south side of the road. The checking station is significant under Criterion A due to its importance in relation to the military history of Oak Ridge. This checking station was one of seven entry points into the Oak Ridge Reservation. It replaced a war-time checking station for the Manhattan Project in 1949 when it was decided that operations at the Oak Ridge Reservation would continue past World War II. The gates surrounding the town site were removed in 1949 and active security at the checking stations was discontinued in 1959. (Reference 2.5.3-24)

Roane County Courthouse

The Roane County Courthouse, located in Kingston Tennessee, was listed on the NRHP in 1971. It was accepted officially by the county in 1856, although it had been completed earlier. It is of the Greek revival design with an open central hall with office wings on either side of the ground floor and two flights of stairs leading to second and third floor offices and the courtroom. It has a dome and cupola on the top in which a gallows still remains. A three story brick addition was added to the rear of the building in 1936. It is significant under Criterion C (architecture) as an example of early Tennessee courthouses which were used for a multitude of public purposes. As of 1971, the Roane County Courthouse was one of only seven remaining courthouses in Tennessee constructed before the Civil War. (Reference 2.5.3-25)

Colonel Gideon Morgan House

The Colonel Gideon Morgan House, located in Kingston, Roane County, Tennessee, was listed on the NRHP in 1983. It was built between 1810 and 1813 and is a Federal style building. It is located across the street from the Roane County Courthouse. The Colonel Gideon Morgan House is a Flemish bond brick house with a one and a half story front section and a one story rear section and a two story facade. There are five rooms on the first floor; a large central room with two flanking rooms on each side. The second story was believed to have been built as a single room and partitioned later in the late 19th century. The house is significant because it is believed to be the oldest building in Roane County and is the only surviving example of the Federal style. Many of the original construction materials remain, including windows, doors and the Flemish brickwork. The house is listed under Criteria B and C for its association with Colonel Gideon Morgan and later owners and for its architecture. (Reference 2.5.3-26)

Bethel Cemetery

Bethel Cemetery, located in Kingston, Roane County, Tennessee, was listed on the NRHP in 2006. The older section of the cemetery dates back to 1811 and the newer portion dates back to 1920. It operated as a city cemetery and therefore does not have strict denominational associations. On the north side of the cemetery there is a historic pedestrian entrance and a marker commemorating the restoration of the cemetery by the City of Kingston and the Southwest Point Chapter of the Daughters of the American Revolution (DAR). An information kiosk describes pioneer families buried in the cemetery. The Southwest Point DAR Bethel Millennium Project has identified over 800 individual burials in the cemetery and each is marked on a grid location. Due to modifications and maintenance, it is possible that 100 unmarked graves are also located in the cemetery. Grave markers vary from thin slab stone to ornamental headstones (sculpted pillars, and obelisks used during the second half of the 19th century) to thick relatively unadorned blocks (used in the 20th century). Bethel Cemetery also contains four box tombs, which are relatively unusual in Tennessee. The cemetery is still active, though currently burials are only available to those who already have a family plot. The cemetery is considered significant under Criterion A due to its importance to local social history and as the burial place of most of Kingston’s prominent citizens and families. Additionally, it is the only known cemetery in the state which has a war veteran buried there from each war with American involvement up to the Vietnam War. The cemetery also contains a large number of ‘steamboat’ men, who were part of the important trade route up and down the Tennessee River in the late 19th century. (Reference 2.5.3-27)

Southwest Point

Southwest Pont, located in Kingston, Roane County, Tennessee, was listed on the NRHP in 1972. The fort was built in 1792 at the conjunction of the Clinch and Tennessee Rivers. At the time this location was in the State of North Carolina and the Territory Southwest of the River Ohio. The fort was initially manned by the Territorial militia, but was then garrisoned by the United States Army in 1794. The fort provided a good vantage point against Native American attacks and it was in a good position to receive supplies along the rivers. After 1796, when Congress passed an act to preserve peace on the frontier, the fort served to protect Native Americans from the settlers. In 1972, nothing remained of the original buildings or other structures and the site was being used as a recreation area by the City of Kingston. Southwest Point is historically significant under Criterion A due to its role in Native American-settler relations in the early settlement of Tennessee. (Reference 2.5.3-28) Southwest Point was also the first location of the Roane post office and the first Native American school. Restoration of the site began in 1974 with archeological investigations (Reference 2.5.3-29). Currently the palisade and several buildings have been reconstructed and a museum and tours operate on the grounds (Reference 2.5.3-30).

Harriman City Hall

The Harriman City Hall, located in Roane County, was listed on the NRHP in 1971. It was built in approximately 1890 for the East Tennessee Land Company, which founded the town of Harriman. It was used as the American Temperance University from 1893 to 1909. After that time it housed a prep school for boys. From 1912 to 1950, the structure became Harriman City Hall. The building has three stories and a partial basement and is built of brick and stone. It has Romanesque arches, four Norman towers, a slate roof, and it is heated by a steam system. (Reference 2.5.3-31) The interior is divided into office spaces. It has been at least partially restored and is currently home to the Harriman Heritage Museum, which is open to the public by appointment only (Reference 2.5.3-32). Harriman City Hall is listed under Criterion A for its association with the founding of the city and Criterion C for its architecture (Reference 2.5.3-31).

Colonial Hall

Colonial Hall, located in Oliver Springs, was listed on the NRHP in 1975. It is the oldest house in Oliver Springs; it was constructed before 1799. It was originally a two story log house with a dog trot. A front porch, which enclosed the dog trot, was added in 1898. The first story contains an oval shaped living room, a dining room, and a kitchen. The second story consists of two bedrooms and a bath. There is an L-shaped addition on the back of the house which serves as a second living room and dining area. Behind the house there is a brick patio, a 90-foot well, a smoke house, and a formal garden. The house is significant under Criterion B for its association with many prominent citizens important to area history. The house was originally constructed by Major Moses C. Winters who settled Winters Gap, Tennessee before 1799. The house was sold to Joseph Estabrook, the fifth president of the University of Tennessee, in 1852. Later prominent owners and residents included Major John Scott, Mrs. Eliza Gerding Hannah McFerrin, and her sons General Harvey H. Hannah and Gerald Gerding Hannah. (Reference 2.5.3-33)

Abston Garage (Oliver Springs Motor Company, Oliver Springs Theater, or Daughtery Motor Company)

The Abston Garage is located in Oliver Springs, Roane County and was listed on the NRHP in 2009. It is a one-story brick commercial garage constructed in approximately 1922. It was converted to a movie theater and performance venue in 1942, and returned to service as a garage in 1951. It is constructed of local brick, with decorative brick detailing, on a poured concrete foundation. It has structural brick pilasters, and a composite shingle, gable roof with a deck concealed by brick. Although reversible changes were made to the building as its function changed, it retains much of its original components. It is significant under Criteria A and C for its role in commerce and transportation, as an entertainment/recreation destination, and its historical architecture. (Reference 2.5.3-34)

Dr. Fred Stone, Sr. Hospital

The Dr. Fred Stone, Sr. Hospital, located in Oliver Springs, Roane County, Tennessee, was listed on the NRHP in 2006. It was constructed in approximately 1920 as a medical clinic and commercial rental space. It was originally a two story brick building, but was extensively expanded beginning in 1943. It was expanded in an eccentric fashion, including circumventing a tree, irregular exterior terraces and stairways, and a six story square tower. During this expansion it began to function as a hospital, but it also still housed Dr. Stone’s clinic and the two commercial rental units. If viewed from the side, the expansions can be distinguished; the original 1920’s structure is in the front, then there is a three to four story middle section with a six story tower, and then there is a later four story section at the rear. Portions of the building were also upgraded in the 1970’s for Dr. Stone’s son’s dental practice. The interior rooms are generally simple and functional, providing space for the clinic and family functions. Because of the modifications, there are a variety of floor, ceiling, and wall materials throughout the structure. Considerable damage was incurred due to structural failure of a portion of the building in 2003 when a concrete slab collapsed on the two floors beneath it. This damage has since been repaired with reference to photographs from 1946. The nomination includes the one and a half story bungalow adjacent to the hospital, which was built in 1924 for Dr. Hayes (who also ran a clinic in the hospital) and his wife. It is a large brick structure with a Spanish tile roof. As of 2006, the upstairs was largely an unfinished attic, but the remainder of the house contained a living room, kitchen, a dining room, and two bedrooms. The two buildings are significant under Criterion A because of their association with local medical history. They provide an example of early professionalization of the medical practice in Tennessee. Dr. Stone and Dr. Hayes were examples of very few formally educated and licensed doctors in the early 1900s in this part of Tennessee. (Reference 2.5.3-35)

Lenoir City Company

The Lenoir City Company, located in Lenoir City, Loudon County, Tennessee, was listed on the NRHP in 1982. It was constructed in 1890 as an office building in the Stick style. It was originally a ticket office for the East Tennessee Virginia and Georgia Railway in addition to being the offices of the Lenoir City Company. It is a small cottage-like building with a hipped roof, a single dormer window and wooden shingles. The building was expanded when the original ticket window was enclosed to make more office space. A front porch was also added after the initial construction. The interior door and window trim, wainscoting, doors, and ticket window were still intact at the time of the nomination. It is significant under Criterion A for its association with the Lenoir City Company, which planned and developed Lenoir City, Tennessee, and Criterion C as an example of Victorian Cottage architecture. In 1982, the Lenoir City Company was still operating out of this original building, managing over 700 parcels of land. (Reference 2.5.3-36) The structure is now a museum open to the public (Reference 2.5.3-37).

Lenoir Cotton Mill Warehouse

The Lenoir Cotton Mill Warehouse, located in Lenoir City, Loudon County, Tennessee, was listed on the NRHP in 2006. It is a one and a half story wooden framed warehouse built in approximately 1830. It was constructed as a raw cotton storage space for the Lenoir Cotton Mill, with access to the confluence of the Tennessee and Little Tennessee Rivers. The associated cotton mill was also on the NRHP, but it was destroyed in a fire in 1991. Renovations to the warehouse began in 2004, after over 20 years of abandonment. Damage repaired included rotten wood floors and siding, a rusted metal roof, and broken windows and doors. Restoration of the exterior was consistent with a drawing from 1872, but the work included modern amenities such as a heating, ventilation, and air conditioning (HVAC) system and adherence to the current building codes. Minor interior accommodations were also made for plumbing and electrical systems. Despite these modernizations, the historic appearance is retained, illustrated by an exposed timber frame with brick fill and original or reproduced hardware and windows. The building is significant under Criterion A because of its association with the Lenoir City Cotton Mill and because it is one of two extant resources associated with Lenoir City's 19th century commercial and industrial history. (Reference 2.5.3-38)

War Memorial Building

The War Memorial Building is located in Lenoir City and was listed on the NRHP in 2011. It was completed in 1951 and honors the citizens of Lenoir City who served in the military. It is situated in an urban area with a high density of multi-story commercial buildings and single family housing. The main section is a two-story brick building and the secondary section is a one-story gymnasium. The interior finishes include tile and wood floors, painted concrete, and acoustic asbestos ceiling tiles. The west façade shows three large bays, with the central bay protruding and containing a recessed entryway. The building displays decorative modern architectural elements and has an industrial appearance. In the entryway there are three plaques recording the names of those who died in World War I, World War II, the Korean War and the Vietnam War. The building is significant under Criterion A, for its social history. (Reference 2.5.3-39)

Bussell Island Site (40LD17)

The Bussell Island Site is located on the northern end of Bussell Island, at the confluence of the Little Tennessee and Tennessee Rivers. It is an archeological site which was first investigated in 1887, then again in 1919 and finally in the early to mid-1970s. It was listed on the NRHP in 1978 (Reference 2.5.3-40). Investigations have identified the presence of Early and Late Archaic, Early and Middle Woodland, Early and Late Mississippian, and historic Cherokee components. The significance of the site relates to the duration of occupation, the site features, and the state of preservation. The significance of the site relates to the duration of occupation, the site features, and the state of preservation. First, the presence of components demonstrating over 9000 years of occupation is significant and provides the opportunity to study cultural change in the region. Additionally, Bussell Island components indicate it was previously the site of an Early Archaic base camp. At the time of nomination in 1978, Bussell Island was the only known example of this type of settlement (other known sites had been inundated by filling of Tellico Reservoir). It is also significant due to the fact that the artifacts and other materials from various periods of occupation are well preserved. (1467 National Park Service 1978)

John Winton House

The John Winton House, also known as Magnolia Manor, located in Lenoir City, Loudon County, Tennessee, was listed on the NRHP in 2003. The site is actually a complex containing five contributing resources: a two story brick home built in 1839, a timber frame saddlebag cottage from approximately 1795, a smokehouse, a limestone springhouse, and a limestone wall with an iron gate. These items are located on a hill that was once known as Muddy Creek, which was originally part of Roane County. The property retains some of its prior appearance even though many changes have taken place. Changes that have occurred include multiple landscaping projects, a move of the driveway, and changes to the front porch and façade. The Winton House itself is a brick five-bay, two story I-house. It has three chimneys and gables and a low hip roof over the main section of the house. The cottage was originally a single pen with an exterior chimney, most likely of post and grit construction. The second pen was added in approximately 1800. The cottage was remodeled in 1961, which resulted in upgrades such as a concrete patio and asphalt roof shingles. The springhouse is located between the cottage and the Winton House. The springhouse roof was replaced in the 1940s and the dry-placed limestone was mortared over sometime in the 1900s. The springhouse was once used to allow visitors and neighbors to refresh themselves after a long journey. The two story smokehouse is located behind the main house. It was probably built between 1880 and 1900 and had a staircase added in the 1940s. Two non-contributing resources on the property include a carport and a gazebo. The Winton House is significant under Criterion C as an example of early local architecture, as an I-house with Greek Revival details and later Queen Anne, Colonial Revival, and Craftsman/Bungalow influences. John Winton was a wealthy land owner and Methodist preacher and he led campground meetings at the Muddy Creek property. (Reference 2.5.3-41)

Albert Lenoir House

The Albert Lenoir House, located in Loudon, Loudon County, Tennessee, was listed on the NRHP in 1973. It is a large three story brick structure built in a plantation style. It was originally built in 1857, but was altered to include large two-storied pillars to replace the front porch. The entry way has double doors which lead to a small hall, a parlor on the right, and a living room on the left. The central winding stairway rises through all three stories. The kitchen and the dining room were originally on the basement floor, but have since been relocated to the main floor. The house is located on 225 ac which also contain a brick slave house and smokehouse in good repair. The house was built by Albert Lenoir, who was the son of William Lenoir, who founded Lenoir City. It is significant under Criterion A for its association with Albert Lenoir and under Criterion C for its architecture. (Reference 2.5.3-42)

Mason Place

Mason Place, located in Loudon, Loudon County, Tennessee, was listed on the NRHP in 1990. It was constructed in approximately 1865. The property contains four contributing resources: a two story Greek Revival I-house, a brick smokehouse, a grain house, and a log barn. Mason Place is a three bay, two story, wood frame house with a brick foundation and full basement. There is a full height entry porch on the front façade. The central area of the house has a central hall and four rooms per floor. The first adjustments to the house were made in the 1900s, including the installation of gas light fixtures, the addition of closets, and the replacement of some door and window hardware. Some of the original windows were replaced during a 1940s remodeling and one of the chimneys has been rebuilt. Plumbing was also installed at a later date. The brick one story smokehouse was also built in approximately 1865. This area originally contained a log servant’s quarters and outhouse, but these were torn down in the 1940s and replaced with a two story garage and apartment. The grain house and log barn are located on another tract, separated by a service road. The grain house was built in the mid-1800s as a one story wood frame structure on a brick foundation with a metal gable roof. The log barn, which was built before the main house, was used as a mule barn. There are also six non-contributing structures on the property: the garage/apartment, a board garage, a workshop/equipment storage building, a small frame shed, two frame barns, and a grain silo. These were all constructed around 1940. The property is significant under Criterion B for its association with Thomas Jefferson Mason and Eliza Mason, community leaders in the early development of Loudon County. It is also significant under Criterion C as an example of residential Greek Revival architecture in East Tennessee. (Reference 2.5.3-43) Mason Place is currently a privately-run bed and breakfast hotel (Reference 2.5.3-44).

Orme Wilson and Company Storehouse

The Orme Wilson and Company Storehouse, located in Loudon, Loudon County, Tennessee, was listed on the NRHP in 1980. The storehouse was built in 1852 and is a two story brick commercial building with a brick foundation and a flat roof. It has a simple façade with three bays with round-head openings. Two of the original double doors remain, but the third has been paved in with brick. The storehouse is significant under Criterion A for its importance as part of the commercial center of Loudon when the Tennessee River was one of the main arteries in East Tennessee. The storehouse was built after the town built a steam boat wharf in 1820. This commercial center declined when the railroad reached Loudon in 1853. It is also significant under Criterion C for its architecture. In 1980, the building was still in use as a commercial warehouse. (Reference 2.5.3-45) As of 2006, the storehouse was home to the Wharf Street Coffeehouse (Reference 2.5.3-46).

Cumberland Presbyterian Church of Loudon

The Cumberland Presbyterian Church of Loudon in Loudon County, Tennessee was listed on the NRHP in 1982. The church is a Victorian Gothic period ecclesiastical building built in 1882. It is a simple weather boarded building on a stone foundation with a central decorative tower. As of 1999 it had not been significantly altered and was in excellent condition. The front façade is three bays wide and the entryway has a round stained glass window over double doors. All of the windows, including the stained glass, were added in 1929. There is an addition in the rear of the church. The first floor of this addition was constructed in 1919 and the second floor in 1939. The church is significant under Criterion C as an example of Victorian Gothic architecture in Loudon, Tennessee. The Cumberland Presbyterian congregation constructed the building after they had been worshipping in other buildings in Loudon since 1853. (Reference 2.5.3-47) The Church is still active today (Reference 2.5.3-48).

Loudon County Courthouse

The Loudon County Courthouse, located in Loudon, Tennessee, was listed on the NRHP in 1975. The courthouse was completed in 1870, two years after Loudon County was established. It is a brick building in the Italian Villa style. The structure is two stories tall with white wood trim and a cupola. It has a central rectangular block with two wings. Each wing has a centrally located door. The main courtrooms are on the second story. As of 1977, very few changes had been made and the building was in very good condition. The courthouse played a large role in the community; besides being used for court functions, it was also the town meeting house and was a center for religious and political gatherings and public auctions. Loudon County was originally part of Roane, Blount, and Monroe counties, and the courthouse played an important part in solidifying the new county, which was created in 1870. It is significant under Criterion A for its association with the establishment of Loudon County and Criterion C for its architecture. The courthouse is still operating today. (Reference 2.5.3-49)

Blair's Ferry Storehouse

The Blair’s Ferry Warehouse, located in Loudon, Loudon County, Tennessee, was listed on the NRHP in 1977. It is a two story brick storehouse which is two bays wide and three bays deep. The warehouse was constructed in approximately 1935, and a two story porch was added in 1936. As of 1974 it still had the original molded brick cornice, floors, doors, mantels, and interior partitions. It was built to support the river boat trade and was functioning as a retail space until at least 1974. It is considered a local landmark and has been the center of economic activity for the surrounding area. The warehouse is significant under Criterion A for its historical associations and Criterion C for its architecture. (Reference 2.5.3-50)

Freel’s Cabin

Freel’s Cabin, located in Anderson County, Tennessee, was listed on the NHRP in 1992. It is a one story log cabin that was built in two stages, one in approximately 1810 and one in approximately 1844. A porch was added in the late 1940s. The cabin has a stone pier foundation, a wood shingle roof, and a stone chimney. The doors and windows were added in approximately 1900. The interior has exposed log walls and a wood floor, which was also added in approximately 1900. When it was built and until the construction of Melton Hill Dam, the cabin overlooked a small gulley draining into the Clinch River; it now faces Melton Hill Reservoir. A contributing structure on the property is a one story log crib, which was constructed in approximately 1840. This building has been remodeled into a restroom facility, but still retains its exterior form. After the purchase of the land by the War Department in 1942, the cabin was used as a picnic area for Manhattan Project employees. Freel’s Cabin is significant under Criterion A as a representative of early settlement in Anderson County, Tennessee. It is also significant under Criterion C as an excellent example of a saddlebag log dwelling, one of the earliest permanent structures built on the frontier. (Reference 2.5.3-51)

Oliver Springs Banking Company

The Oliver Springs Banking Company in Anderson County, Tennessee was listed on the NRHP in 1992. It is an elaborate two story brick building built in 1907. The building is trimmed in white marble capitols, window sills, and a beltcourse. It has a 14-foot high first floor, a 9-foot high second floor, and a roof parapet. The oak double doors still retain an elaborate brass door pull and are located under a large plate glass window with a transom light. The original interior was a single large space with a metal ceiling. This ceiling was covered over and damaged by modernization, but has been recently restored. Both fireplace mantels have been removed and walled over; however, most of the original trim remains. The structure is significant under Criterion A for its role in the banking history of the small community of Oliver Springs. It is also significant under Criterion C for its architecture and its importance to Oliver Springs and Anderson County. (Reference 2.5.3-52)

Bear Creek Road Checking Station

The Bear Creek Road Checking Station is located in Anderson County and was listed on the NRHP in 1992. The Bear Creek Road Checking Station is identical in nature and appearance to the Oak Ridge Turnpike Checking Station, and is also significant under Criterion A as one of the security checkpoints utilized during and after the Manhattan Project. The Bear Creek Road Checking Station was one of three built in 1947 to control access from Oak Ridge into the Y-12 plant after World War II. This checking station also has not been used since 1959. (Reference 2.5.3-53)

2.5.3.7.2 National Register of Historic Places Listed Historic Districts

A National Register Historic District (NRHD) derives its importance from being a diverse group of resources unified by one or more of the NRHP criteria as described in Subsection 2.5.3.7.1. A district can reflect one principal purpose, such as a medical district, or a grouping of archaeological sites related by common elements. NRHDs can also represent a collection of buildings with a common type or style that, as a group, embodies the characteristics of construction within a period.

Following are brief descriptions of the three NRHDs within a 10-mi radius of the center point of the CRN Site and the one eligible district within the CR SMR Project APE.

Cornstalk Heights Historic District

The Cornstalk Heights Historic District in the City of Harriman in Roane County was listed on the NRHP in 1991. The district is roughly bounded by Georgia Avenue, Sewanee Street, Morgan Avenue, and Trenton Street. The Cornstalk Heights Historic District is located approximately 9 mi from the CRN Site (Figure 2.5.3-2). The district contains 101 contributing buildings and 33 contributing structures. Some of the district was included in the original area platted as Harriman by the East Tennessee Land Company in the 1880s. The streets in the district are on a grid pattern with Walden Avenue marking the southern boundary. Larger lots are situated at the crest of a local ridge; smaller lots are located towards the edges of the district. Although the streets were covered in concrete and asphalt in the mid-1890s, some of the streets retain the original brick sidewalks. Historic resources in the district range in construction date from 1890 to 1940. Earlier buildings are predominantly Victorian, such as the public school which was built in 1891. Later buildings are generally in the revival styles such as Dutch Colonial, Tudor, Neoclassical, and Colonial. Other styles include Four Square, Bungalow, Craftsman, and Minimal traditional. Almost all of the 134 listed buildings and structures have been altered, but retain their architectural integrity and setting. The town of Harriman is somewhat unique in its development because it changed from a rural area consisting of two farms to a town of approximately 4000 residents in the period between 1890 and 1892. This growth was due to the influence of the East Tennessee Land Company, which spearheaded development with ministers, farmers, bankers, businessmen, and developers. Therefore, the architecture in the district hails from a distinctly narrow period of history, ranging from 1890 to 1940. Planning included lot sizes, home sizes, street paving, a community park, and a temperance provision which stated that intoxicating beverages could not be made, stored, or sold on the premises. The Cornstalk Heights Historic District is significant under Criterion A (event) and Criterion C (architecture). (Reference 2.5.3-54)

Roane Street Commercial Historic District

The Roane Street Commercial Historic District in the City of Harriman in Roane County was listed in the NRHP in 1989. The district is roughly bounded by Roane Street between Morgan Avenue NW and Crescent Avenue NW. It is located approximately 9.2 mi from the CRN Site (Figure 2.5.3-2). The district contains 31 contributing buildings, nearly all of which are commercial or retail in use. The district began to be constructed at the same time as the Cornstalk Heights Historic District. Over one-third of the buildings in the Roane Street Commercial Historic District were built between 1890 and 1895. Slower paced growth occurred between 1895 and 1939. The dominant style is Commercial; other styles include Romanesque, Revival and Modern Movement. Almost all of the buildings are brick and range from one to three stories. Although a few original storefronts remain, most were remodeled in the 1960s. Despite this, the district retains its architectural and historical integrity. The East Tennessee Land Company paved and graded the streets prior to the incorporation of Harriman. The Roane Street Commercial Historic District is significant under Criterion A (event) and Criterion C (architecture). (Reference 2.5.3-55)

Woodland-Scarboro Historic District

The Woodland-Scarboro Historic District in the City of Oak Ridge in Anderson County was listed in the NRHP in 1991. The district is roughly bounded by Rutgers Avenue, Lafayette Drive, Benedict Avenue, Wilburforce Avenue, and Illinois Avenue. It is located approximately 9.4 mi from the CRN Site (Figure 2.5.3-2). The district contains 622 contributing structures and 294 noncontributing structures. The Skidmore Owings and Merrill Stone and Webster Engineering Firm designed the community for the Atomic Energy Commission in 1948. The plan consisted of thousands of new housing units in Woodland, Scarboro, and Oak Ridge to alleviate housing shortages due to the war. Both Woodland and Scarboro were built in 1949; the first residents arrived in 1950. The architects designed 10 different house types, five apartment types, and one dormitory style accommodation for the towns. These replaced the trailer camps and hutment areas that existed during the war. The streets are laid out in curves that respect the natural slopes of the land. The homes are simple and generally of concrete block or frame construction. Residents were allowed to purchase their homes beginning in 1956. At this point people began to make alterations, including gabled roofs and the conversion of duplexes to single family homes. It is estimated that over 900 houses were constructed and of the 885 that were surveyed, 70 percent are considered contributing resources. The district is significant within the historical context of Oak Ridge, one of the first ‘atomic cities’. Additionally, the district is significant in African American history because it provides an example of the federal government's 'separate but equal' policy at the time of its construction. The Woodland-Scarboro Historic District is significant under Criterion A (event) and Criterion C (architecture). (Reference 2.5.3-56)

Melton Hill Hydroelectric Project/Melton Hill Dam

TVA intends to nominate the Melton Hill Hydroelectric Project/Melton Hill Dam District in Roane County, as an NRHD. The district is located on the Clinch River, 23.1 mi upstream of the confluence of the Clinch River with the Tennessee River. It is located 9 mi south of the City of Oak Ridge and 19 mi west of the City of Knoxville. The Melton Hill Hydroelectric Project impounds the Melton Hill Reservoir. The reservoir extends 44 mi upstream and has a maximum width of 0.8 mi. The Melton Hill Dam is the only TVA tributary dam with a navigational lock. Construction of the Melton Hill Hydroelectric Project began in 1960 and was completed in 1964.

The Melton Hill Hydroelectric Project/Melton Hill Dam proposed NRHD consists of 15 contributing resources (eight buildings, two sites, and five structures) and seven non-contributing resources (seven buildings). Contributing resources include the Melton Hill Dam (a concrete non-overflow dam and spillway), powerhouse, navigational lock, lock control buildings 1 and 2, the lock operation building, switchyard and transmission lines, visitor building, main office building, flammable materials storage shed, hazardous materials storage shed, visitor building picnic area, recreation area, and bathhouse 1 and 2. The Melton Hill Hydroelectric Project/Melton Hill Dam is proposed to be nominated as significant under Criterion A (event) and C (architecture). (Reference 2.5.3-65)

2.5.3.8 National Historic Parks

The US Congress Passed the National Defense Authorization Act of 2015. This Act established the Manhattan Project as a National Historical Park (Reference 2.5.3-57). The park is located in three separate locations where work was completed during the Manhattan Project; Hanford, Washington, Los Alamos, New Mexico and Oak Ridge Tennessee (Reference 2.5.3-58). According to the National Park Service, the Oak Ridge Portion of the park includes three separate locations:

- The X-10 Graphite Reactor National Historic Landmark, a pilot nuclear reactor which produced small quantities of plutonium
- Buildings 9731 and 9204-3 at the Y-12 complex, home to the electromagnetic separation process for uranium enrichment
- The site of the K-25 Building, where gaseous diffusion uranium enrichment technology was pioneered. Buildings 9731, 9204-3 and K-25 together enriched a portion of the material for the uranium bomb (Reference 2.5.3-59)

2.5.3.9 Historic Cemeteries

One extant Euroamerican cemetery has been identified within the CRN Site. The Hensley Cemetery is labeled on the Elverton 7.5' USGS quadrangle map and is shown as 40RE588 in Figure 2.5.3-1 (Reference 2.5.3-60). Five identifiable grave markers and one illegible metal marker are present in the Hensley Cemetery (Reference 2.5.3-3). The graves in the cemetery date from the late 19th to mid-20th century. Generally cemeteries are ineligible for the NRHP and this cemetery is not an exception (Reference 2.5.3-11). Other small family cemeteries are located within 10 mi of the center of the CRN Site; however, none of these have been evaluated for inclusion in the NRHP.

The African American Wheat Community Burial Ground (Site 40RE219) is located approximately 1 mi northwest of northern boundary of the CRN Site on the east side of TN 58. A single marker stands within the burial ground which describes the history of the cemetery. Approximately 90 to 100 graves with no inscribed markers are present within this cemetery. It is presumed that slaves and their dependents who lived and worked on plantations and farms in the area are buried here. Historical records indicate the cemetery dates from the mid-19th century (Reference 2.5.3-61).

2.5.3.10 Traditional Cultural Properties

No specific traditional cultural properties of special sensitivity or concern have been identified on or very near the CRN Site.

2.5.3.11 References

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Table 2.5.3-1 (Sheet 1 of 3)
Previously Recorded Aboveground Historic Properties Within a 10-Mile Radius of the CRN Site

Property Name	Address (if known)	General Location	Property Association	NRHP/Tennessee Landmark Status
George Jones Memorial Baptist Church	Blair Rd.	Roane County	Individual	Listed
X-10 Reactor, Oak Ridge National Laboratory	Oak Ridge National Laboratory	Roane County	Individual	Listed
New Bethel Baptist Church	Bethel Valley Rd.	Roane County	Individual	Listed
Oak Ridge Turnpike Checking Station	Oak Ridge Tpk.	Roane County	Individual	Listed
Roane County Courthouse	Kentucky Ave.	Kingston, Roane County	Individual	Listed
Colonel Gideon Morgan House	149 Kentucky St.	Kingston, Roane County	Individual	Listed
Bethel Cemetery	Euclid Ave., and Third St.	Kingston, Roane County	Individual	Listed
Southwest Point	1 mi. SW of Kingston	Kingston, Roane County	Individual	Listed
Harriman City Hall	Roane and Walden Sts	Harriman, Roane County	Individual	Listed
Colonial Hall	Spring and Main Sts	Oliver Springs, Roane County	Individual	Listed
Abston Garage	505 Winter Gap Avenue	Oliver Springs, Roane County	Individual	Listed
Dr. Fred Stone, Sr. Hospital	105 Roane St.	Oliver Springs, Roane County	Individual	Listed

Table 2.5.3-1 (Sheet 2 of 3)
Previously Recorded Aboveground Historic Properties Within a 10-Mile Radius of the CRN Site

Property Name	Address (if known)	General Location	Property Association	NRHP/Tennessee Landmark Status
Cornstalk Heights Historic District	Bounded by Georgia Ave., Sewanee St., Morgan Ave., and Trenton St.	Harriman, Roane County	Historic District	Listed
Roane Street Commercial Historic District	Roughly Roane St. between Morgan Ave. NW. and Crescent Ave. NW.	Harriman, Roane County	Historic District	Listed
Lenoir City Company	Depot St.	Lenoir City, Loudon County	Individual	Listed
Lenoir Cotton Mill Warehouse	150 Bussells Ferry Rd.	Lenoir City, Loudon County	Individual	Listed
War Memorial Building	103 North B Street	Lenoir City, Loudon County	Individual	Listed
Bussell Island (40LD17)	Bussell Island	Lenoir City, Loudon County	Individual	Listed
John Winton House	18350 Martel Rd.	Lenoir City, Loudon County	Individual	Listed
Albert Lenoir House	W. of Loudon on River Rd. (TN72)	Loudon County	Individual	Listed
Mason Place	600 Commercial St.	Loudon County	Individual	Listed
Orme Wilson and Company Storehouse	Hackberry St.	Loudon County	Individual	Listed
Cumberland Presbyterian Church of Loudon	College St.	Loudon County	Individual	Listed
Loudon County Courthouse	Grove and Mulberry Sts.	Loudon County	Individual	Listed

Table 2.5.3-1 (Sheet 3 of 3)
Previously Recorded Aboveground Historic Properties Within a 10-Mile Radius of the CRN Site

Property Name	Address (if known)	General Location	Property Association	NRHP/Tennessee Landmark Status
Blair's Ferry Storehouse	800 Main St.	Loudon County	Individual	Listed
Freel's Cabin	Freels Bend Rd.	Anderson County	Individual	Listed
Oliver Springs Banking Company	Tri County Blvd	Oliver Springs, Anderson County	Individual	Listed
Bear Creek Road Checking Station	Jct, of S. Illinois Ave, and Bear Creek Rd.	Anderson County	Individual	Listed
Woodland-Scarboro Historic District	Rutgers Ave., Lafayette Dr., Benedict, Wilburforce and Illinois Aves	Anderson County	Historic District	Listed
Manhattan Project National Historic Landmark	Three locations, X-10 Graphite Reactor East Tennessee Technology Park (former home to the K-25 gaseous diffusion building) Y-12 New Hope Center.	Oak Ridge, Roane County	Historic Landmark	Established by the National Defense Authorization Act, 2015.
Melton Hill Hydroelectric Project/Melton Hill Dam	2009 Grubb Road, Lenoir City	Roane County	Historic District	Eligible, Nomination pending

Sources: Reference 2.5.3-62; Reference 2.5.3-39; Reference 2.5.3-59; Reference 2.5.3-63; Reference 2.5.3-21; Reference 2.5.3-22; Reference 2.5.3-23; Reference 2.5.3-24; Reference 2.5.3-25; Reference 2.5.3-26; Reference 2.5.3-27; Reference 2.5.3-30; Reference 2.5.3-31; Reference 2.5.3-33; Reference 2.5.3-35; Reference 2.5.3-36; Reference 2.5.3-38; Reference 2.5.3-41; Reference 2.5.3-42; Reference 2.5.3-43; Reference 2.5.3-45; Reference 2.5.3-47; Reference 2.5.3-49; Reference 2.5.3-50; Reference 2.5.3-51; Reference 2.5.3-52; Reference 2.5.3-53; Reference 2.5.3-54; Reference 2.5.3-64; Reference 2.5.3-57; Reference 2.5.3-34; Reference 2.5.3-65

Table 2.5.3-2 (Sheet 1 of 9)
Prehistoric and Historic Archaeological Sites on and in the Vicinity of the CRN Site

Site Number	Relative Location to Clinch River Site APE	Site Type	Time Range of Site Occupation and Time Period	Previous Survey Recommendation	NRHP Status	Disturbed by Previous Site Construction
40RE104	Figures 2.5.3-1 and 2.5.3-3	Prehistoric	Undetermined Prehistoric	Site should be avoided if possible; if site disturbance is necessary further investigation is recommended	Potentially Eligible	
40RE105	Figures 2.5.3-1 and 2.5.3-3	Prehistoric	Woodland	Site should be avoided if possible; if site disturbance is necessary further investigation is recommended	Potentially Eligible	
40RE106	Figures 2.5.3-1 and 2.5.3-3	Prehistoric	Middle and Late Woodland	Site should be avoided if possible; if site disturbance is necessary further investigation is recommended	Potentially Eligible	
40RE107	Figures 2.5.3-1 and 2.5.3-3	Prehistoric	Early Archaic and Woodland	Site should be avoided if possible; if site disturbance is necessary data recovery plan should be established	Potentially Eligible	
40RE108	Figures 2.5.3-1 and 2.5.3-3	Prehistoric	Late Archaic, Woodland, Mississippian	Site should be avoided if possible; if site disturbance is necessary further investigation is recommended	Potentially Eligible	
40RE120	Figures 2.5.3-1 and 2.5.3-3	Historic	Late 19th to Early 20th Century	No Further Work	Not Eligible	

Table 2.5.3-2 (Sheet 2 of 9)
Prehistoric and Historic Archaeological Sites on and in the Vicinity of the CRN Site

Site Number	Relative Location to Clinch River Site APE	Site Type	Time Range of Site Occupation and Time Period	Previous Survey Recommendation	NRHP Status	Disturbed by Previous Site Construction
40RE121	Figures 2.5.3-1 and 2.5.3-3	Historic	Late 19th to Early 20th Century	No Further Work	Not Eligible	
40RE122	Figures 2.5.3-1 and 2.5.3-3	Historic	Late 19th to Mid-20th Century	No Further Work	Not Eligible	
40RE123	Figures 2.5.3-1 and 2.5.3-3	Historic	20th Century	No Further Work	Not Eligible	Site destroyed by unknown persons in 1973
40RE124	Figures 2.5.3-1 and 2.5.3-3	Prehistoric	Late Woodland	Site should be avoided if possible; if site disturbance is necessary further investigation is recommended	Potentially Eligible	
40RE125	Figures 2.5.3-1 and 2.5.3-3	Prehistoric	Archaic and Woodland	No further work	Not Eligible	
40RE128	Figures 2.5.3-1 and 2.5.3-3	Prehistoric	Woodland	Site should be avoided if possible; if site disturbance is necessary further investigation is recommended	Potentially Eligible	
40RE129	Figures 2.5.3-1 and 2.5.3-3	Historic	20th Century	No Further Work	Not Eligible	
40RE135	Figures 2.5.3-1 and 2.5.3-3	Prehistoric	Undetermined Prehistoric	No Further Work	Not Eligible	Site probably destroyed by the construction of the Gallaher Bridge

Table 2.5.3-2 (Sheet 3 of 9)
Prehistoric and Historic Archaeological Sites on and in the Vicinity of the CRN Site

Site Number	Relative Location to Clinch River Site APE Boundary	Site Type	Time Range of Site Occupation and Time Period	Previous Survey Recommendation	NRHP Status	Disturbed by Previous Site Construction
40RE138	Figures 2.5.3-1 and 2.5.3-3	Prehistoric	Early Archaic through Mississippian	Request or conduct intensive cultural resources field survey	Potentially Eligible	Site partially disturbed during construction of bridge and barge terminal
40RE139	Figures 2.5.3-1 and 2.5.3-3	Prehistoric	Undetermined Prehistoric	No further work	Not Eligible	
40RE140	Figures 2.5.3-1 and 2.5.3-3	Prehistoric and Historic	Late Archaic to Early Woodland, and 20th Century	Site should be avoided if possible; if site disturbance is necessary further investigation is recommended	Potentially Eligible	Site is known to relic hunters, signs of past disturbance evident
40RE151	Figures 2.5.3-1 and 2.5.3-3	Prehistoric	Undetermined Prehistoric	No Further Work	Not Eligible	
40RE152	Figures 2.5.3-1 and 2.5.3-3	Prehistoric	Undetermined Prehistoric	No Further Work	Not Eligible	
40RE153	Figures 2.5.3-1 and 2.5.3-3	Prehistoric	Undetermined Prehistoric	No Further Work	Not Eligible	
40RE154	Figures 2.5.3-1 and 2.5.3-3	Prehistoric	Undetermined Prehistoric	No Further Work	Not Eligible	
40RE155	Figures 2.5.3-1 and 2.5.3-3	Prehistoric	Undetermined Prehistoric	No Further Work	Not Eligible	
40RE156	Figures 2.5.3-1 and 2.5.3-3	Prehistoric	Undetermined Prehistoric	No Further Work	Not Eligible	

Table 2.5.3-2 (Sheet 4 of 9)
Prehistoric and Historic Archaeological Sites on and in the Vicinity of the CRN Site

Site Number	Relative Location to Clinch River Site APE Boundary	Site Type	Time Range of Site Occupation and Time Period	Previous Survey Recommendation	NRHP Status	Disturbed by Previous Site Construction
40RE157	Figures 2.5.3-1 and 2.5.3-3	Prehistoric	Undetermined Prehistoric	No Further Work	Not Eligible	
40RE158	Figures 2.5.3-1 and 2.5.3-3	Prehistoric	Undetermined Prehistoric	No Further Work	Not Eligible	
40RE159	Figures 2.5.3-1 and 2.5.3-3	Prehistoric	Undetermined Prehistoric	No Further Work	Not Eligible	Presumed destroyed during grading operations in early 1980s
40RE160	Figures 2.5.3-1 and 2.5.3-3	Prehistoric	Undetermined Prehistoric	No Further Work	Not Eligible	
40RE161	Figures 2.5.3-1 and 2.5.3-3	Prehistoric	Undetermined Prehistoric	No Further Work	Not Eligible	Site may have been destroyed by logging activities
40RE162	Figures 2.5.3-1 and 2.5.3-3	Prehistoric	Undetermined Prehistoric	No Further Work	Not Eligible	Site may have been destroyed by logging activities
40RE163	Figures 2.5.3-1 and 2.5.3-3	Prehistoric	Undetermined Prehistoric	No Further Work	Not Eligible	
40RE164	Figures 2.5.3-1 and 2.5.3-3	Prehistoric	Undetermined Prehistoric	No Further Work	Not Eligible	Site may have been destroyed by logging activities

Table 2.5.3-2 (Sheet 5 of 9)
Prehistoric and Historic Archaeological Sites on and in the Vicinity of the CRN Site

Site Number	Relative Location to Clinch River Site APE Boundary	Site Type	Time Range of Site Occupation and Time Period	Previous Survey Recommendation	NRHP Status	Disturbed by Previous Site Construction
40RE165	Figures 2.5.3-1 and 2.5.3-3	Prehistoric and Historic	Early and Late Archaic; Historic	Site should be avoided if possible; if site disturbance is necessary further investigation is recommended	Potentially Eligible	
40RE166	Figures 2.5.3-1 and 2.5.3-3	Prehistoric	Middle to Late Archaic and Early to Middle Woodland	Site should be avoided if possible; if site disturbance is necessary further investigation is recommended	Potentially Eligible	
40RE167	Figures 2.5.3-1 and 2.5.3-3	Prehistoric	Early Archaic, Woodland, and Mississippian	Site should be avoided if possible; if site disturbance is necessary further investigation is recommended	Potentially Eligible	
40RE202	Figures 2.5.3-1 and 2.5.3-3	Prehistoric	Undetermined Prehistoric	No Further Work	Not Eligible	Destroyed by the construction of the sedimentation basin for the K-1515 water sanitation plant.
40RE232	Figures 2.5.3-1 and 2.5.3-3	Historic	Early to Mid-20th Century	Site should be avoided if possible; if site disturbance is necessary further investigation is recommended	Potentially Eligible	

Table 2.5.3-2 (Sheet 6 of 9)
Prehistoric and Historic Archaeological Sites on and in the Vicinity of the CRN Site

Site Number	Relative Location to Clinch River Site APE Boundary	Site Type	Time Range of Site Occupation and Time Period	Previous Survey Recommendation	NRHP Status	Disturbed by Previous Site Construction
40RE233	Figures 2.5.3-1 and 2.5.3-3	Historic	Mid-20th Century	Site should be avoided if possible; if site disturbance is necessary further investigation is recommended	Eligible	Disturbed by road construction and demolished in the 1960s. Foundations and cultural material remain.
40RE547	Figures 2.5.3-1 and 2.5.3-3	Prehistoric	Undetermined Prehistoric	No Further Work	Not Eligible	
40RE548	Figures 2.5.3-1 and 2.5.3-3	Prehistoric	Undetermined Prehistoric	No Further Work	Not Eligible	
40RE549	Figures 2.5.3-1 and 2.5.3-3	Prehistoric	Undetermined Prehistoric; possible pre-Woodland	Site should be avoided if possible; if site disturbance is necessary further investigation is recommended	Potentially Eligible	
40RE585	Figures 2.5.3-1 and 2.5.3-3	Prehistoric	Undetermined Prehistoric	No Further Work	Not Eligible	
40RE586	Figures 2.5.3-1 and 2.5.3-3	Historic	Late 19th to Mid-20th Century	No Further Work	Not Eligible	
40RE587	Figures 2.5.3-1 and 2.5.3-3	Historic	Late 19th to Mid-20th Century	No Further Work	Not Eligible	

Table 2.5.3-2 (Sheet 7 of 9)
Prehistoric and Historic Archaeological Sites on and in the Vicinity of the CRN Site

Site Number	Relative Location to Clinch River Site APE Boundary	Site Type	Time Range of Site Occupation and Time Period	Previous Survey Recommendation	NRHP Status	Disturbed by Previous Site Construction
40RE588 (previously 40RE119)	Figures 2.5.3-1 and 2.5.3-3	Historic	Early to Mid-20th Century	Hensley Cemetery; site should be avoided if possible; if site disturbance is necessary Tennessee state law regarding treatment of cemeteries must be followed	Not Eligible	
40RE589	Figures 2.5.3-1 and 2.5.3-3	Prehistoric	Undetermined Prehistoric	No Further Work	Not Eligible	
40RE590	Figures 2.5.3-1 and 2.5.3-3	Historic	20th Century	No Further Work	Not Eligible	
40RE591	Figures 2.5.3-1 and 2.5.3-3	Historic	Late 19th to 20th Century	No Further Work	Not Eligible	
40RE592	Figures 2.5.3-1 and 2.5.3-3	Prehistoric	Undetermined Prehistoric	No Further Work	Not Eligible	
40RE593	Figures 2.5.3-1 and 2.5.3-3	Historic	Late 19th to 20th Century	No Further Work	Not Eligible	
40RE594	Figures 2.5.3-1 and 2.5.3-3	Historic	Late 19th to 20th Century	No Further Work	Not Eligible	
40RE595	Figures 2.5.3-1 and 2.5.3-3	Prehistoric	Early Archaic	Site should be avoided if possible; if site disturbance is necessary further investigation is recommended	Potentially Eligible	

Table 2.5.3-2 (Sheet 8 of 9)
Prehistoric and Historic Archaeological Sites on and in the Vicinity of the CRN Site

Site Number	Relative Location to Clinch River Site APE Boundary	Site Type	Time Range of Site Occupation and Time Period	Previous Survey Recommendation	NRHP Status	Disturbed by Previous Site Construction
40RE596	Figures 2.5.3-1 and 2.5.3-3	Historic	Late 19th to 20th Century	No Further Work	Not Eligible	
40RE597	Figures 2.5.3-1 and 2.5.3-3	Historic	20th Century	No Further Work	Not Eligible	
40RE598	Figures 2.5.3-1 and 2.5.3-3	Historic	Late 19th to 20th Century	No Further Work	Not Eligible	
40RE600	Figures 2.5.3-1 and 2.5.3-3	Prehistoric	Undetermined Prehistoric	Site should be avoided if possible; if site disturbance is necessary further investigation is recommended	Potentially Eligible	
40RE601	Figures 2.5.3-1 and 2.5.3-3	Prehistoric	Undetermined Prehistoric	Site should be avoided if possible; if site disturbance is necessary further investigation is recommended	Potentially Eligible	
40RE602	Figures 2.5.3-1 and 2.5.3-3	Prehistoric	Late Woodland to Mississippian	No Further Work	Not Eligible	
40RE605	Figures 2.5.3-1 and 2.5.3-3	Prehistoric	Undetermined Prehistoric	No Further Work	Not Eligible	
40RE606	Figures 2.5.3-1 and 2.5.3-3	Historic	Mid-20th Century	No Further Work	Not Eligible	
40RE607	Figures 2.5.3-1 and 2.5.3-3	Historic	Mid-20th Century	No Further Work	Not Eligible	

Table 2.5.3-2 (Sheet 9 of 9)
Prehistoric and Historic Archaeological Sites on and in the Vicinity of the CRN Site

Site Number	Relative Location to Clinch River Site APE Boundary	Site Type	Time Range of Site Occupation and Time Period	Previous Survey Recommendation	NRHP Status	Disturbed by Previous Site Construction
IF-1[1]	Figures 2.5.3-1 and 2.5.3-3	Prehistoric	Undetermined Prehistoric	No Further Work	Not Eligible	
IF-1[2]	Figures 2.5.3-1 and 2.5.3-3	Historic	Late 19th to Early 20th Century	No Further Work	Not Eligible	
IF-2	Figures 2.5.3-1 and 2.5.3-3	Prehistoric	Undetermined Prehistoric	No Further Work	Not Eligible	
IF-3	Figures 2.5.3-1 and 2.5.3-3	Prehistoric	Undetermined Prehistoric	No Further Work	Not Eligible	
NS-1	Figures 2.5.3-1 and 2.5.3-3	Historic	Mid-20th Century	No Further Work	Not Eligible	

1 IF-1 locale identified in (Reference 2.5.3-2)

2 IF-1 locale identified in (Reference 2.5.3-1; Reference 2.5.3-11)

Sources: (Reference 2.5.3-16; Reference 2.5.3-1; Reference 2.5.3-11; Reference 2.5.3-2)

Exempted from Disclosure by Statute Withheld Under 10 CFR 2.390(a)(3)

(See Part 7 of this Early Site Permit Application)

Figure 2.5.3-1. Prehistoric/Historic Archaelogical Sites On and Adjacent to the Clinch River Property

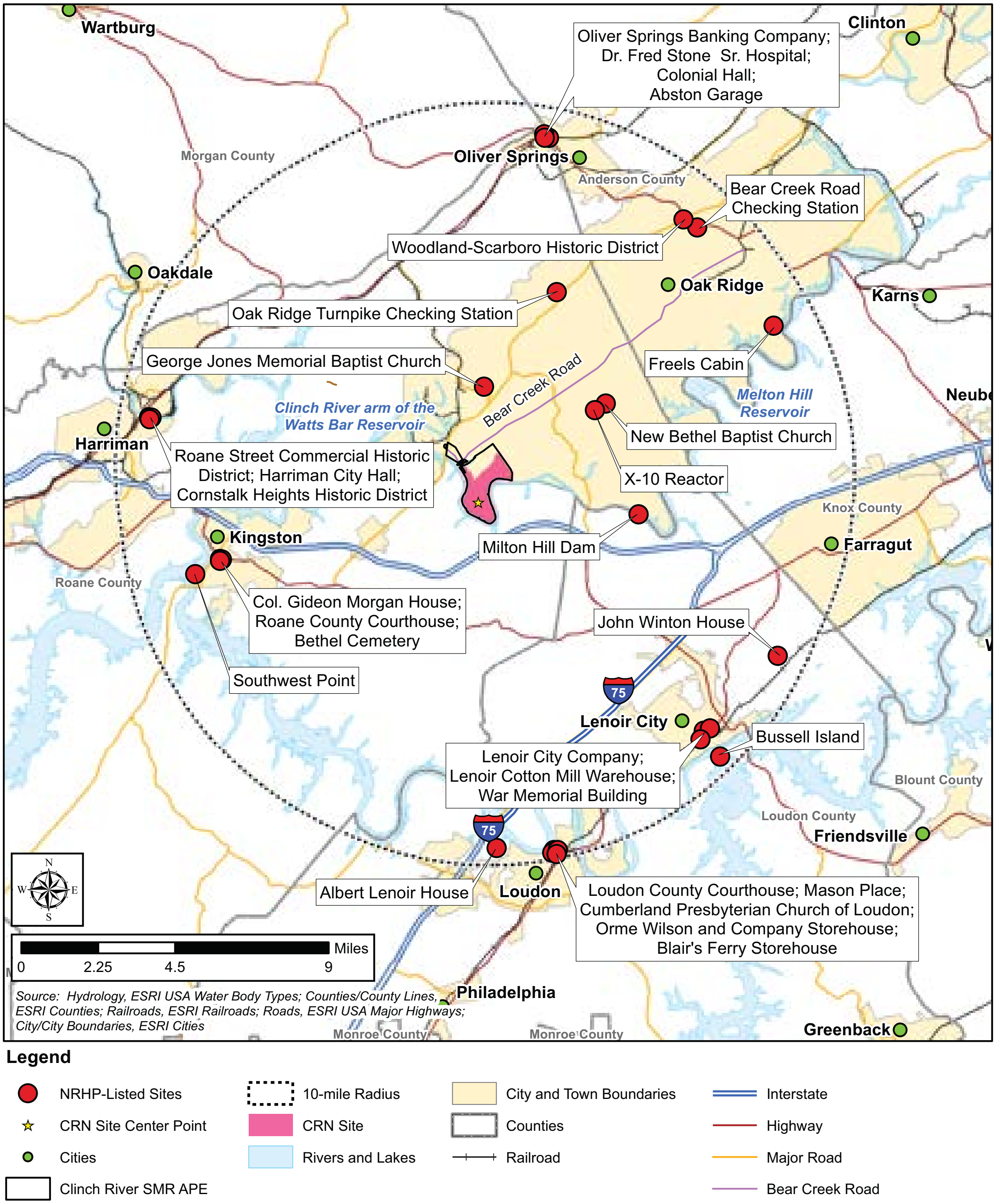

Figure 2.5.3-2. NRHP-Listed Aboveground Historic Properties Within 10-Mile of the Center Point of the CRN Site

Exempted from Disclosure by Statute Withheld Under 10 CFR 2.390(a)(3)

(See Part 7 of this Early Site Permit Application)

Figure 2.5.3-3. Previous Surveys On and Adjacent to the CR SMR APE

2.5.4 Environmental Justice

Environmental Justice refers to a federal policy under which each federal agency identifies and addresses, as appropriate, potential disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority and low-income populations. President Clinton issued Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," in 1994 to address environmental justice issues. The order directs federal agencies to make environmental justice part of their mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of their programs, policies, and activities on minority populations and low-income populations (Reference 2.5.4-1). Tennessee Valley Authority's (TVA's) policy is to consider environmental justice in its environmental reviews.

The Council on Environmental Quality has provided guidance for addressing environmental justice in *Environmental Justice: Guidance Under the National Environmental Policy Act* (Reference 2.5.4-2). The U.S. Environmental Protection Agency (EPA) also provided guidance in *Final Guidance For Incorporating Environmental Justice Concerns in EPA's NEPA Compliance Analyses* (Reference 2.5.4-3). On August 24, 2004 (69 Federal Register 52040), the U.S. Nuclear Regulatory Commission (NRC) issued its "Policy Statement on the Treatment of Environmental Justice Matters in NRC Regulatory and Licensing Actions."

This subsection identifies, locates, and describes minority populations and low-income populations, addressing the information needs specified in NRC's NUREG-1555, *Standard Review Plans for Environmental Reviews for Nuclear Power Plants: Environmental Standard Review Plan* and RS-002, *Processing Applications for Early Site Permits*. The purpose of the environmental justice analysis is to:

- Describe the racial, ethnic, and special characteristics of all minority populations located within the potentially affected area of the proposed project
- Define the income characteristics of all low-income populations located within the potentially affected area of the proposed project
- Describe the resource dependencies, customs and practices, circumstances of living (e.g., migrant labor), or preconditions (e.g., pre-existing health conditions or access to particular facilities or locations) of particular minority or low-income populations that may make them likely to experience disproportionate environmental effects from the proposed project

2.5.4.1 Methodology

TVA considered information requirements for environmental justice determinations in the NUREG-1555 and the NRC's *Environmental Issues Associated with New Reactors Interim Staff Guidance* (Combined License and Early Site Permit COL/ESP-ISG-026). The guidance documents also contain a methodology to identify the locations of minority and low-income populations of interest. The guidance suggests that a 50-mile (mi) radius (i.e., the Clinch River Nuclear [CRN] Site region) could reasonably be expected to contain the area of potential effect and that the state could be considered an appropriate geographic area for comparative analysis. U.S. Census Bureau demographic data provide the necessary information on race, ethnicity, and individual and family poverty.

NRC guidance recommends use of American Community Survey (ACS) 5-Year (yr) Summary Data at the census block group level. The most recent ACS 5-yr data on race, ethnicity, and poverty are for the 2008 to 2012 time period. It is acceptable to use the 10-yr U.S. Census data on race and ethnicity if it has been recently released and there is no significant change when compared to the ACS information. (The 10-yr Census does not provide the necessary poverty data.) The 2010 Census data for race and ethnicity were selected for use in this analysis. The two data sets were compared and no significant change between the 2010 count and the 2008 to 2012 estimate was identified. Also, the 2010 Census is based on a count of all United States residents while the ACS is based on estimated projections and small sample sizes. The ACS 2008 to 2012 data were used for the low-income population analysis.

The demographic data are used in conjunction with geographic information system software (ArcGIS) to determine the minority and income characteristics of resident populations by census block groups. Block groups represent the smallest subdivision of census tracts for which the U.S. Census Bureau tabulates detailed demographic data. If any part of a block group is included within the 50-mi radius, the entire block group is included in the analysis. A total of 759 block groups were evaluated for this analysis.

In addition to demographic data, the NRC guidance recommends requesting information from local planning departments, social service agencies, other local offices, and state agencies to identify minority or low-income groups that may not be identified through the census data. The methodology contained in the NRC guidance to identify and locate minority and low-income populations within the region was used in this environmental justice analysis. The specific methods employed for this analysis related to obtaining relevant local information (beyond the use of demographic data) are described in Subsection 2.5.4.4.

Potential health or environmental effects on minority or low-income communities are identified and discussed in Sections 4.4 and 5.8.

2.5.4.2 Minority Populations

NRC guidance considers individuals who identify themselves as members of the following racial and ethnic categories in the census to be minority individuals:

- Black or African American
- American Indian or Alaska Native
- Asian

- Native Hawaiian and other Pacific Islander
- Some other race
- Two or more races (i.e., multiracial)
- Hispanic, Latino, or Spanish origin (may be of any race)

According to the U.S. Census Bureau, Hispanic ethnicity is not a race. Therefore, a Hispanic individual can be counted in any of the race categories as well as the Hispanic origin category. Each minority category was evaluated separately and the total of all minority categories combined was evaluated as the “aggregate” minority population. (Aggregate minority population is calculated as the total population minus people who identified themselves as White, Not Hispanic or Latino). NRC guidance indicates that a minority population exists if either of the following two conditions occurs:

1. The minority population of an affected area exceeds 50 percent (the “census block group” is the recommended affected area), or

2. The minority population percentage of the affected area is meaningfully (at least 20 percentage points) greater than the minority population percentage in the general population or other appropriate unit of geographic analysis. (The State of Tennessee is the geographic area chosen for comparative analysis for the CRN Site.)

All census block groups that are located within or are intersected by the boundary of the CRN Site region were included in this analysis. The region extends into three states: Tennessee, North Carolina, and Kentucky. For each of the 759 block groups within the 50-mi radius, the percentage of the block group’s population represented by each minority category was calculated. If any block group minority percentage exceeded 50 percent then the block group was identified as containing a minority population. Each state served as the geographic area of comparison for the block groups within that state that fell within the 50-mi radius. Percentages of each minority category within each state were calculated. The individual block group percentages were compared to the appropriate state percentage. If any block group percentage exceeded the corresponding state percentage by 20 percentage points or more, then a minority population was determined to exist within that block group.

Table 2.5.4-1 presents the results of the minority population analysis. The table includes the total number of block groups for each county located within the 50-mi radius, the number of block groups in an individual county meeting either of the criteria for each category of minority population, and the totals for the complete 50-mi radius. The percentage of each minority category within the three states, which forms the basis for determining block groups that meet the 20-percentage point criterion, is also presented. The distributions of aggregate minority and Hispanic ethnicity block groups within the 50-mi radius are displayed in Figure 2.5.4-1.

Minority populations vary among the three states. For each of the 759 block groups within the 50-mi radius, a total of 18 met the NRC criteria for Black minority population; one block group met the criteria for a minority population of some other race. A total of four block groups met the criteria for Hispanic minority populations. A total of 20 block groups met the criteria for aggregate minority populations. For all categories except the North Carolina aggregate minority population, 20 percentage points greater than the state average was the limiting criterion. For the aggregate minority population in North Carolina, 50 percentage points was the limiting criterion. Only one block group, located in Sevier County, Tennessee, met the criteria for two or more minority categories.

The majority of the block groups with a minority population are located within the geographical area of interest discussed in Subsection 2.5.2 (i.e., Anderson, Knox, Loudon, and Roane counties). Most of the block groups (18 of 20) with an aggregate minority population fall within Knox County, Tennessee, within the boundaries of the City of Knoxville. The largest number of block groups (3 of 4) with a Hispanic minority population occurs in Loudon County, Tennessee. No block groups in Roane County (in which the CRN Site is located) or in Anderson County contain minority populations (Figure 2.5.4-1). The identified aggregate minority population closest to the CRN Site is in census tract 9801 block group 01 located approximately 20 mi to the east in Blount County, Tennessee. The closest Hispanic minority population is located in census tract 602.02 block group 04 in Loudon County, Tennessee, approximately 9 m southeast of the CRN Site.

In addition to the identification of minority populations based on census data, two locations of potential significance to minority communities were identified: the Wheat Community Burial Ground and the community of Scarboro. The African American Wheat Community Burial Ground is located approximately 1 mi northwest of the northern boundary of the CRN Site on the east side of Tennessee State Highway 58. Approximately 90 to 100 graves with no inscribed markers are present within this cemetery. It is presumed that slaves and their dependents that lived and worked on plantations and farms in the area are buried here. Historical records indicate the cemetery dates from the mid-19th century. (Reference 2.5.4-4) The Scarboro community is a small residential area in Anderson County within the City of Oak Ridge, approximately 0.5 mi from the Oak Ridge Reservation Y-12 plant. It is separated from the Y-12 plant by Pine Ridge. The community was established in 1950 to provide housing and an elementary school to African American Oak Ridge residents. Scarboro has remained predominantly African American. (Reference 2.5.4-5)

2.5.4.3 Low-Income Populations

NRC guidance defines low-income populations as individuals or families living below the poverty level based on statistical poverty thresholds from the U.S. Census Bureau. A population is considered low-income if either of the following two conditions is met:

1. The low-income population of an affected area (i.e., census block group) exceeds 50 percent, or

2. The percentage of the population below the poverty level in the affected area is meaningfully (at least 20 percentage points) greater than the low-income population percentage in the geographic area chosen for comparative analysis. The geographic area chosen for comparative analysis for the CRN Site is the individual states.

The same geographic area used in Subsection 2.5.4.2 was used for this analysis (i.e., all census block groups that are located within or are intersected by the boundary of the CRN Site region). The ACS census data for poverty status were used for the identification of low-income populations per NRC guidance. The U.S. Census Bureau determines poverty status for the ACS by comparing a person's total family income in the last 12 months with the appropriate poverty threshold for that person's family size and composition (i.e., number of family members under 18 yr old). The poverty thresholds are arranged in a matrix based on size of family unit cross-classified by number of children. Anyone meeting the matrix criteria for poverty is counted as an individual in poverty. A family is considered to include the householder and individuals living in the household who are related by marriage, birth or adoption to the householder. For individuals not living with anyone related, the person's own income is compared with his or her poverty threshold. (Reference 2.5.4-6)

The number of low-income individuals in each census block group was divided by the total number of individuals within that block group to obtain the percentage of low-income persons per block group. These were compared to the respective state percentages to determine the block groups with low-income populations that meet either of the NRC criteria listed above. Table 2.5.4-1 and Figure 2.5.4-2 illustrate the number and distribution of low-income block groups within the 50-mi radius based on the NRC criteria. Table 2.5.4-1 also displays the percentage of low-income individuals within each state. Among the 759 block groups within the 50-mi radius, 60 met the NRC criteria. Within the geographical area of interest, a total of 33 block groups have low-income populations. The majority of the low-income population (27 block groups) in the geographical area of interest is in the City of Knoxville, in Knox County, Tennessee. There is one low-income population block group in Roane County where the CRN Site is located. The closest low-income population to the CRN Site is located in census tract 602.02 block group 01 in Loudon County, Tennessee, approximately 7 mi southeast of the CRN Site. As seen on Figures 2.5.4-1 and 2.5.4-2 there is some overlap between the locations of minority and low-income population groups.

2.5.4.4 Communities with Unique Characteristics

NRC guidance (NUREG-1555) recommends the identification of any unique economic, social, or human health circumstances and lifestyle practices of minority and low-income populations that could result in disproportionately high and adverse impacts to these populations from plant construction and operation. Such circumstances and practices may include, for example, exceptional dependence on subsistence resources such as fish and wildlife, unusual concentrations of minority or low-income population within a compact area (e.g., Native American settlement), or pre-existing health conditions within a community that might make it more susceptible to potential plant-related impacts.

In order to identify minority or low-income populations that may not be identified using census data, NUREG-1555 and ISG-026 recommend supplementing those data with inquiries to local agencies such as planning departments, social services agencies, and other local offices. The NRC guidance focuses on populations with unique characteristics that are located next to or in close proximity to a proposed plant site, indicating that potential impacts could disproportionately affect those populations more than the general population. Various organizations were contacted to identify any uniquely vulnerable minority or low-income communities located near the CRN Site. Table 2.5.4-2 lists the agencies, organizations, academic institutions, and businesses contacted. Telephone calls were made and emails were sent to local and county agencies and organizations within Anderson, Knox, Loudon, and Roane counties, Tennessee as well as to east Tennessee regional organizations. The persons contacted were asked if they are aware of any concentration of minority or low-income populations within a compact area, and whether any of those populations historically obtain or supplement their food supply through hunting or fishing. Their responses produced no information that would help identify subsistence populations. Any recommendations to contact another agency or organization were pursued. Research was extended to contacting local sporting goods and bait and tackle shops in an effort to identify subsistence populations. The responses by those businesses produced no pertinent information.

County health departments for Anderson, Knox, Loudon, and Roane counties, Tennessee were contacted to identify any pre-existing health conditions through which minority or low-income populations could be disproportionately adversely affected by the proposed project. Loudon County provided no response to the information request. Anderson, Knox, and Roane counties responded; however, the responses produced no information that would help identify pre-existing health conditions.]

National and state online sources of public health-related information were consulted, including the Centers for Disease Control and Prevention (CDC) and Tennessee Department of Health (TDOH). The CDC has national data that identify examples of health disparities in racial and ethnic minority populations. The *CDC Health Disparities and Inequalities Report–U.S. 2013* identifies key factors that affect health and lead to health disparities in the United States, including environmental hazards (Reference 2.5.4-7). The identified hazard that could potentially be relevant to the proposed project is related to location: minorities, foreign-born persons, and persons who speak Spanish or another non-English language at home were more likely to be living near major highways. This suggests increased exposure to traffic-related air pollution. However, no minority or low-income populations have been identified along the access roads to the CRN Site (see Figures 2.5.4-1 and 2.5.4-2).

The TDOH Division of Minority Health and Disparity Elimination maintains data on population health issues. Priority areas to reduce health disparities include diabetes and heart disease/stroke (Reference 2.5.4-8; Reference 2.5.4-9). However, county-level reports are not provided.

No CDC or TDOH data profiling pre-existing health conditions were found specific to Anderson, Knox, Loudon, or Roane County, Tennessee or the other counties in the region.

The Agency for Toxic Substances and Disease Registry (ATSDR) conducted a public health assessment (published in 2004) to evaluate the releases of uranium from the Y-12 plant in regard to past and current exposures to residents living near the Oak Ridge Reservation, including residents of the Scarboro community in Anderson County. Scarboro was used as the reference community that represents the City of Oak Ridge. The Scarboro community is a residential area within the city, approximately 0.5 mi from the Y-12 plant, which was established in 1950 to provide housing to African American Oak Ridge residents. Scarboro has remained predominantly African American. As part of its public health assessment, ATSDR examined three investigations conducted between 1997 and 2001 to address community health concerns. The Scarboro Community Health Investigation (conducted in 1997 and 1998 by CDC and TDOH) focused on a reported excess of respiratory illnesses in the Scarboro neighborhood and included a community health survey and follow-up medical evaluation of children. The rates of asthma and wheezing among children in Scarboro determined by the survey were found to be within the ranges reported throughout the United States and internationally, respectively. The medical examinations did not indicate any unusual pattern of illness among children in Scarboro. An Environmental Study (conducted in 1998 by the Environmental Sciences Institute at Florida Agricultural and Mechanical University for the U.S. Department of Energy [DOE]) sampled soil, sediment, and surface water in the Scarboro neighborhood to address community concerns about the validity of environmental monitoring. An Environmental Sampling Validation Study (conducted in 2001 by the EPA) re-sampled a portion of the locations investigated in the Environmental Study. The results of the DOE and EPA sampling efforts are consistent with each other and indicate that chemical, metal, and radionuclide concentrations are not elevated above a regulatory health level of concern and the residents of Scarboro are not being exposed to harmful levels of substances from the Y-12 plant. (Reference 2.5.4-5)

Health conditions within the Roane County community were investigated in regard to the release of fly ash following a dike failure at the TVA Kingston Fossil Plant in December 2008. The plant is located west of the CRN Site between the cities of Harriman and Kingston in Roane County. TVA funded an independent health screening of people who resided near the ash spill, which was conducted by Oak Ridge Associated Universities and physician medical toxicologists from Vanderbilt University Medical Center. A total of 214 people representing 112 households participated voluntarily in the screening process; all were residents of Roane County. Approximately half lived within 2 mi from the spill and half lived outside the 2-mi radius. Participants lived in four cities: Harriman (73 percent), Kingston (22 percent), Ten Mile (3 percent), and Rockwood (2 percent). The majority of participants (98 percent) self-identified as white and 2 percent as black (compared to 96 percent white and 3 percent black in Roane County as a whole). No other racial or ethnic categories were represented. The most common symptoms reported by participants were related to upper airway irritation, including runny nose, cough, and congestion. As part of the medical evaluation, lung function tests were done for all participants older than six years of age. The majority of the participants had normal lung function tests, with 25 percent having mild to severe abnormalities. There was a similar distribution of abnormalities for those living within and outside of the 2-mi radius from the spill. The study concluded that these abnormalities may be due to multiple factors, such as emphysema, smoking, asthma, and respiratory infections at the time of testing.(Reference 2.5.4-10)

In summary, the investigation described in this subsection did not identify any unique economic, social, or human health circumstances and lifestyle practices of minority and low-income populations that could result in disproportionately high and adverse impacts to these populations from plant construction and operation.

2.5.4.5 Migrant Populations

Migrant farm workers are individuals whose employment requires travel to harvest agricultural crops. These workers may or may not have a permanent residence. Some migrant workers may follow the harvesting of crops, particularly fruits and vegetables, throughout the eastern United States rural areas. Others may be permanent residents near the CRN Site who travel from farm to farm harvesting crops.

Migrant workers may be members of minority or low-income populations. Because they travel and can spend a significant amount of time in an area without being actual residents, migrant workers may be unavailable for counting by census takers. If uncounted, these workers would be “underrepresented” in U.S. Census Bureau minority and low-income population counts.

Information on migrant workers is collected by the Census of Agriculture. The most recent data source for this information is the 2007 Census of Agriculture. Farm operators were asked whether any hired or contract workers were migrant workers. Table 2.5.4-3 provides information on farms in the region that employ hired workers who are migrant workers and that employ temporary farm workers Information is included for the counties within a 50-mi radius of the CRN Site. Farm operators were asked whether any hired workers were migrant workers, defined as a farm worker whose employment required travel that prevented the worker from returning to his permanent place of residence the same day. Migrant workers tend to work short-duration, labor-intensive jobs. Temporary farm laborers include those working fewer than 150 days per year. It is assumed that the migrant workers are included in the temporary worker values reported.

According to the 2007 Census of Agriculture, as shown on Table 2.5.4-3, there were a total of 11,083 farms in the region, with 3881 temporary farm workers (those working fewer than 150 days per year) employed on 1718 of those farms. The county with the greatest number of temporary workers (623 on 202 farms) was Knox County, Tennessee. Roane County, Tennessee, reported 178 temporary workers on 82 farms. A total of 153 farms in the region reported hiring migrant workers. Monroe County, Tennessee, had the greatest number of farms with hired migrant workers (22 farms), followed by McMinn County, Tennessee (21 farms). Only one farm in Roane County reported employing migrant workers. Impacts to migrant workers are discussed in Sections 4.4 and 5.8.

2.5.4.6 References

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Reference 2.5.4-2. Council on Environmental Quality, "Environmental Justice, Guidance Under the National Environmental Policy Act," Executive Office of the President, Washington, DC, December 10, 1997.

Reference 2.5.4-3. U.S. Environmental Protection Agency, "Final Guidance for Incorporating Environmental Justice Concerns in EPA's NEPA Compliance Analyses," April, 1998.

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Reference 2.5.4-5. Agency for Toxic Substances and Disease Registry, "Public Health Assessment Y-12 Uranium Releases, Oak Ridge Reservation (USDOE), Oak Ridge, Anderson County, Tennessee, EPA Facility ID: TN1890090003," January 30, 2004.

Reference 2.5.4-6. U.S. Census Bureau, American Community Survey and Puerto Rico Community Survey - 2012 Subject Definitions, Website: http://www.census.gov/acs/www/Downloads/data_documentation/SubjectDefinitions/2012_ACSSubjectDefinitions.pdf, 2012.

Reference 2.5.4-7. Centers for Disease Control and Prevention, CDC Health Disparities and Inequalities Report - U.S. 2013, Website: http://www.cdc.gov/disparitiesanalytics/Docs/CHDIR13_factsheet_nov_20_2013_final_508.pdf, November, 2013.

Reference 2.5.4-8. Tennessee Department of Health, Racial and Ethnic Minority Tennesseans and Diabetes, Website: http://health.state.tn.us/dmhde/diabetes.shtml, 2014.

Reference 2.5.4-9. Tennessee Department of Health, Racial and Ethnic Minority Tennesseans and Heart Disease and Stroke, Website: http://health.state.tn.us/dmhde/hdandstroke.shtml, 2014.

Reference 2.5.4-10. Oak Ridge Associated Universities, "Kingston Project Surveillance Program: Baseline Medical Screening Results," ORAU 10-OEWH-1174, August 17, 2010.

Reference 2.5.4-11. U.S. Department of Agriculture, Census of Agriculture, Table 1. County Summary Highlights: 2007 - North Carolina, Website: http://www.agcensus.usda.gov/Publications/2007/, 2007.

Reference 2.5.4-12. U.S. Department of Agriculture, Census of Agriculture, Table 1. County Summary Highlights: 2007 - Tennessee, Website: http://www.agcensus.usda.gov/Publications/2007/, 2007.

Reference 2.5.4-13. U.S. Department of Agriculture, Census of Agriculture, Table 7. Hired Farm Labor - Workers and Payroll: 2007 - North Carolina, Website: http://www.agcensus.usda.gov/Publications/2007/, 2007.

Reference 2.5.4-14. U.S. Department of Agriculture, Census of Agriculture, Table 7. Hired Farm Labor - Workers and Payroll: 2007 - Tennessee, Website: http://www.agcensus.usda.gov/Publications/2007/, 2007.

Table 2.5.4-1 (Sheet 1 of 3)
Minority and Low-Income Populations within 50-Mile Radius[1]

STATE/County	Total Number of Block Groups	Black	American Indian or Native Alaskan	Asian	Native Hawaiian or Other Pacific Islander	Some Other Race	Multiracial[2]	Aggregate[3]	Hispanic	Low-Income[4]
		Minority or Low-Income Block Groups								
TENNESSEE	**745**									
Anderson	53	0	0	0	0	0	0	0	0	3
Bledsoe	8	0	0	0	0	0	0	0	0	0
Blount	78	1	0	0	0	0	0	2	0	3
Bradley	6	0	0	0	0	0	0	0	0	0
Campbell	32	0	0	0	0	0	0	0	0	4
Claiborne	4	0	0	0	0	0	0	0	0	1
Cumberland	32	0	0	0	0	0	0	0	0	3
Fentress	12	0	0	0	0	0	0	0	0	3
Grainger	6	0	0	0	0	0	0	0	0	0
Hamilton	2	0	0	0	0	0	0	0	0	0
Jefferson	12	0	0	0	0	0	0	0	0	0
Knox	242	17	0	0	0	0	0	18	0	27
Loudon	31	0	0	0	0	0	0	0	3	2
McMinn	34	0	0	0	0	0	0	0	0	2
Meigs	6	0	0	0	0	0	0	0	0	0
Monroe	28	0	0	0	0	0	0	0	0	3
Morgan	15	0	0	0	0	0	0	0	0	0
Overton	3	0	0	0	0	0	0	0	0	1

Table 2.5.4-1 (Sheet 2 of 3)
Minority and Low-Income Populations within 50-Mile Radius[1]

STATE/County	Total Number of Block Groups	Black	American Indian or Native Alaskan	Asian	Native Hawaiian or Other Pacific Islander	Some Other Race	Multiracial[2]	Aggregate[3]	Hispanic	Low-Income[4]
		Minority or Low-Income Block Groups (continued)								
Pickett	1	0	0	0	0	0	0	0	0	0
Polk	7	0	0	0	0	0	0	0	0	0
Putnam	2	0	0	0	0	0	0	0	0	0
Rhea	19	0	0	0	0	0	0	0	0	2
Roane	41	0	0	0	0	0	0	0	0	1
Scott	16	0	0	0	0	0	0	0	0	3
Sevier	39	0	0	0	0	1	0	0	1	2
Union	14	0	0	0	0	0	0	0	0	0
White	2	0	0	0	0	0	0	0	0	0
KENTUCKY	**4**									
McCreary	2	0	0	0	0	0	0	0	0	0
Whitley	2	0	0	0	0	0	0	0	0	0
NORTH CAROLINA	**10**									
Cherokee	3	0	0	0	0	0	0	0	0	0
Graham	5	0	0	0	0	0	0	0	0	0
Swain	2	0	0	0	0	0	0	0	0	0
50-mi Region Total	759	18	0	0	0	1	0	20	4	60

Table 2.5.4-1 (Sheet 3 of 3)
Minority and Low-Income Populations within 50-Mile Radius[1]

STATE/County	Total	Black	American Indian or Native Alaskan	Asian	Native Hawaiian or Other Pacific Islander	Some Other Race	Multiracial[2]	Aggregate[3]	Hispanic	Low-Income[4]
	State Population	%	%	%	%	%	%	%	%	%
TENNESSEE	6,346,105	16.7	0.3	1.4	0.1	2.2	1.7	24.4	4.6	17.3
KENTUCKY	4,339,367	7.8	0.2	1.1	0.1	1.3	1.7	13.7	3.1	18.6
NORTH CAROLINA	9,535,483	21.5	1.3	2.2	0.1	4.3	2.2	34.7	8.4	16.8

1 Block groups where minorities and low-income populations exceed 50 percent or exceed the state average by 20 percentage points or more.
2 Persons who identified themselves as a member of two or more races.
3 Everyone except persons who identified themselves as White, Not Hispanic or Latino.
4 Based on poverty status of individuals in family households and in non-family households.

Table 2.5.4-2 (Sheet 1 of 2)
Organizations Contacted to Identify Communities with Unique Characteristics

Local, County, and Regional Agencies, Organizations, and Institutions
Anderson County Economic Development Office
Anderson County United Way
Catholic Charities of East Tennessee
Centro Hispano of East Tennessee
City of Knoxville, Community Development Department
City of Oak Ridge Community Development
East Tennessee Development District
East Tennessee Quality Growth
Highlander Research and Education Foundation
Hindu Community Center of Knoxville
Kingston Public Library
Knox County Public Library
Knox County United Way
Knoxville Area Rescue Ministry
Knoxville Area Urban League
Knoxville Chamber of Commerce
Knoxville-Knox County Metropolitan Planning Commission
Legal Aid of East Tennessee
Loudon County Chamber of Commerce
Loudon County Economic Development Agency
Loudon County United Way
Maryville College
Nourish Knoxville
Oak Ridge Chamber of Commerce
Oak Ridge City Clerk's Office
Oak Ridge Public Library
Pellissippi State Community College
PlanET
Roane County Chamber of Commerce
Roane County United Way
Roane State Community College
Tennessee Department of Economic and Community Development
Tennessee Department of Health, Office of Minority Health and Disparities Elimination
Tennessee Housing Development Agency
Tennessee Wildlife Federation - Hunters for the Hungry
Tennessee Wildlife Resources Agency
The Hindu Community Center of Knoxville
The Roane Alliance
Trinity Out-Reach Center of Hope (TORCH)
University of Tennessee, Knoxville
University of Tennessee Extension - Anderson County Agriculture Office
University of Tennessee Extension - Knox County Agriculture Office
University of Tennessee Extension - Loudon County Agriculture Office

Table 2.5.4-2 (Sheet 2 of 2)
Organizations Contacted to Identify Communities with Unique Characteristics

Hunting and Fishing Suppliers
Smoky Mountain Pawn
County Health Departments
Anderson County Health Department
Knox County Health Department
Loudon County Health Department
Roane County Health Department

Note: Attempts were made to contact additional organizations, but were unsuccessful.

Table 2.5.4-3
Farms that Employ Migrant Labor in the Clinch River Nuclear Site Region, 2007

County[1]	Total Farms	Number of Temporary Workers[2]	Farms with Temporary Workers	Farms with Hired Migrant Workers
NORTH CAROLINA				
Graham	126	ND	15	1
TENNESSEE				
Anderson	538	138	69	3
Blount	1154	395	162	15
Campbell	404	163	73	7
Cumberland	842	431	140	9
Fentress	623	283	121	13
Knox	1224	623	202	10
Loudon	768	263	124	12
McMinn	1204	443	171	21
Meigs	367	ND	76	0
Monroe	935	387	145	22
Morgan	407	ND	59	4
Rhea	449	231	59	7
Roane	580	178	82	1
Scott	261	117	49	2
Sevier	707	229	89	8
Union	494	ND	82	18
Region Total	11083	3881	1718	153

1 Includes counties with more than approximately half their area within a 50-mi radius of the CRN Site.
2 Hired workers that have worked less than 150 days in 2007.

Notes:
ND Number withheld by U.S. Department of Agriculture to avoid disclosing data for individual farms. (Region Total does not include any withheld data.)

Sources: (Reference 2.5.4-11; Reference 2.5.4-12; Reference 2.5.4-13; Reference 2.5.4-14)

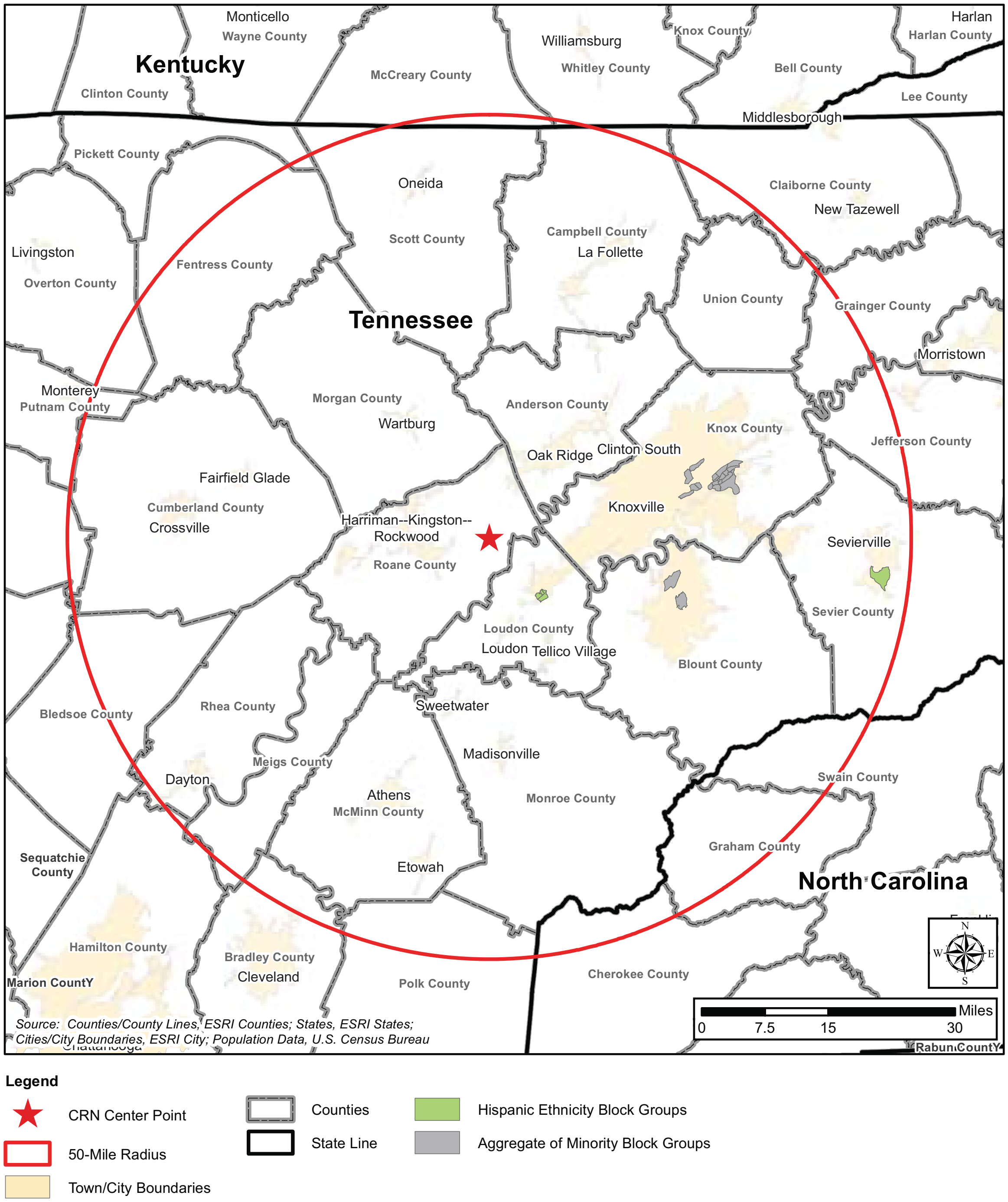

Figure 2.5.4-1. Minority Population Block Groups Within 50 Miles of the CRN Site

Legend

CRN Center Point
50-Mile Radius
Town/City Boundaries
Counties
State Line
Low-Income Household Block Groups

Figure 2.5.4-2. Low-Income Population Block Groups Within 50 Miles of the CRN Site

2.6 GEOLOGY

The geological conditions at the Clinch River Nuclear (CRN) Site are summarized in this section. The site information is subdivided into three categories: physiography, stratigraphy, and structural geology. The information provided in these subsections is developed in accordance with the guidance provided in the U.S. Nuclear Regulatory Commission's (NRC's) Regulatory Guide (RG) 4.2, *Preparation of Environmental Reports for Nuclear Power Stations*, RG 4.7, "*General Site Suitability Criteria for Nuclear Power Stations*," and the NRC's *Standard Review Plans for Environmental Reviews for Nuclear Power Plants: Environmental Standard Review Plan*, (NUREG-1555), Section 2.6 – Geology.

The geological information in this section is based on the information contained in Site Safety Analysis Report (SSAR) Subsection 2.5.1 Geologic Characterization Information.

2.6.1 Geological Conditions

The CRN Site is located within the western portion of Oak Ridge, Tennessee, in the Valley and Ridge physiographic province (Figure 2.6-1). The Valley and Ridge province is the topographic expression of the geologic structures of the southern Appalachian foreland fold-thrust belt, which formed during the Pennsylvanian to Permian Alleghanian orogeny and the lithologies underlying those structures (see SSAR Subsections 2.5.1.1.2 and 2.5.1.1.4) (Reference 2.6-1).

2.6.1.1 Physiography

The CRN Site topography is characterized by northeast–southwest trending ridges and intervening valleys typical of the regional physiographic setting of the Valley and Ridge (SSAR Subsection 2.5.1.1.1) (Figure 2.6-2).

The Clinch River arm of the Watts Bar Reservoir follows a meandering south-westerly stream course across the CRN Site area with incised water gaps at each of the major ridges that cross the CRN Site (Figures 2.6-2 and 2.6- 4). The water level elevation of the Clinch River arm of the Watts Bar Reservoir at the CRN Site is approximately 740 feet (ft) National Geodetic Vertical Datum of 1929 (NGVD29; equivalent to 739.6 ft North American Vertical Datum of 1988 [NAVD88]). The plant grade is to be at an elevation of approximately 821 ft NAVD88, placing the power block area about 81 ft above the water level of the river. Most of the ephemeral and perennial tributaries in the major valleys follow stream courses consistent with the current topographic setting except where streams have carved incised water gaps through resistant bedrock ridges (Figure 2.6-2). The southeastern third of the CRN Site area is characterized by low hills and lacks a major northeast-southwest trending axial valley, but instead has a dendritic drainage pattern. This area is underlain by Chickamauga Group carbonate rocks with occasional karst features that have influenced the local stream network and resulted in sinking streams at several locations.

2.6.1.2 Stratigraphy

Strata sampled during the CRN Site subsurface investigation are shown in Figure 2.6-3 as they occur from the ground surface to varying depths beneath the CRN Site. A total of 82 borings (76 cored in bedrock) were drilled as part of the CRN Site subsurface investigation.

Residual soils and artificial fill are the dominant surficial sediment types, whereas the alluvial and colluvial soils are located surficially in the southern portion of the CRN Site peninsula and along the banks of the Clinch River arm of the Watts Bar Reservoir. The Quaternary surficial units in the CRN Site are described in SSAR Subsection 2.5.3.2.5.1 and are mapped on Figure 2.6-4. Colluvium (Qc) deposits consist of weathered residuum transported by hillslope processes including slopewash and creep. Colluvium is deposited at the toe of hillslopes and in hollows on the hillsides. Holocene alluvium (Qha) is deposited in hillside gullies and in the principal tributary valleys across the CRN Site (Figure 2.6-4). Unit Qha includes channel bottom alluvium and low terrace deposits that are undivided at the scale of mapping. The unit is composed largely of silt; with sand and gravel present in varying amounts dependent on the local bedrock parent material. Artificial fill is located in redress areas of the former Clinch River Breeder Reactor Project Site.

Underlying a mantle of fill/residual soil and weathered bedrock, stratigraphy at the CRN Site comprises rocks of the Lower Cambrian Rome Formation, Middle Cambrian to Lower Ordovician age rocks belonging to the Knox Group and Middle Ordovician age rocks of the Chickamauga Group (Figure 2.6-4). The Copper Creek thrust fault, located approximately 0.6 miles south of the power block area, places the Rome Formation over the Ordovician Moccasin Formation of the Chickamauga Group (Reference 2.6-2). The geologic cross section shown on Figure 2.6-3 illustrates the bedrock structure and succession of stratigraphic units encountered at the CRN Site. Orientated perpendicular to the strike of the bedding planes, rocks belonging to the Knox Group outcrop to the northwest and the progressively younger rocks belonging to the Chickamauga Group outcrop to the southeast (Figure 2.6-4). Rocks of the Rome Formation do not outcrop at the CRN Site, but they were encountered by two subsurface investigation boreholes (Figures 2.6-3 and 2.6-4). The stratigraphic units beneath the Knox Group were not encountered during the subsurface investigation boring program and include from oldest to youngest: Precambrian basement comprised of gneisses, granites, and amphibolites; the Rome Formation comprised of sandstones and shales; and the Conasauga Group comprised mostly of shales with minor amounts of limestones.

2.6.1.3 Structural Geology

Throughout the Valley and Ridge portion of the CRN Site, bedding of Paleozoic strata consistently strikes northeast (mostly between N 30 E and N 60 E) with moderate southeast dips. In general, the strike of primary bedding surfaces is roughly consistent throughout the CRN Site. Overall structural style changes significantly toward the northwestern portion of the CRN Site vicinity, which includes portions of the Cumberland Plateau physiographic province (see SSAR Subsections 2.5.1.1.1 and 2.5.1.1.4 for more detailed discussion of physiographic provinces). Alleghanian deformation was much less intense within this province; bedding is mostly subhorizontal, with maximum dips on the order of 20° to 25°. At the CRN Site location within the Valley and Ridge province, bedding strikes approximately N 52°E and dips consistently 32° to 35°SE.

Macroscale folds in the CRN Site vicinity are open, upright to overturned kilometer-scale synclines and anticlines with axes that trend parallel to major faults and the strike of lithologic units (Reference 2.6-3; Reference 2.6-2; Reference 2.6-4; Reference 2.6-5; Reference 2.6-6) (Figure 2.6-4). Fold axes can generally be traced for 0.5 to greater than 7 mi throughout the CRN Site vicinity, although macroscopic Valley and Ridge folds can locally be traced over much greater distances. Fold axes are normal to the inferred shortening direction, which supports timing of folding coincident with Alleghanian emplacement of Valley and Ridge thrust sheets (e.g., (Reference 2.6-7)).

The vast majority of faults within the CRN Site vicinity can be characterized as bedding-parallel thrusts that formed during thin-skinned deformation of the Appalachian foreland (Reference 2.6-8). The tectonic history of the region, including deformation of late Paleozoic siliciclastic strata, indicates that Valley and Ridge province faults and folds were active during the late stages of the Alleghanian orogeny (e.g., (Reference 2.6-9)). Numerous radiometric age determinations of features associated with deformation and shortening in the Valley and Ridge agree with this timing, and range from 265-290 million years ago (Ma) (Reference 2.6-10; Reference 2.6-11; Reference 2.6-12; Reference 2.6-13; Reference 2.6-14; Reference 2.6-15; Reference 2.6-16). Recent $^{39}Ar/^{40}Ar$ analyses of fault gouge illite from several Valley and Ridge faults including the Copper Creek fault in the southern portion of the CRN Site peninsula (Figure 2.6-4) suggest emplacement occurred 276-280 Ma (Reference 2.6-17).

2.6.2 References

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Reference 2.6-16. Roeder, D. and Witherspoon, W. D., "Palinspastic Map of East Tennessee," American Journal of Science (278): 543-550, 1978.

Reference 2.6-17. Hnat, J. S. and van der Pluijm, B. A., "Fault gouge dating in the southern Appalachians, USA," Geological Society of American Bulletin, 2014.

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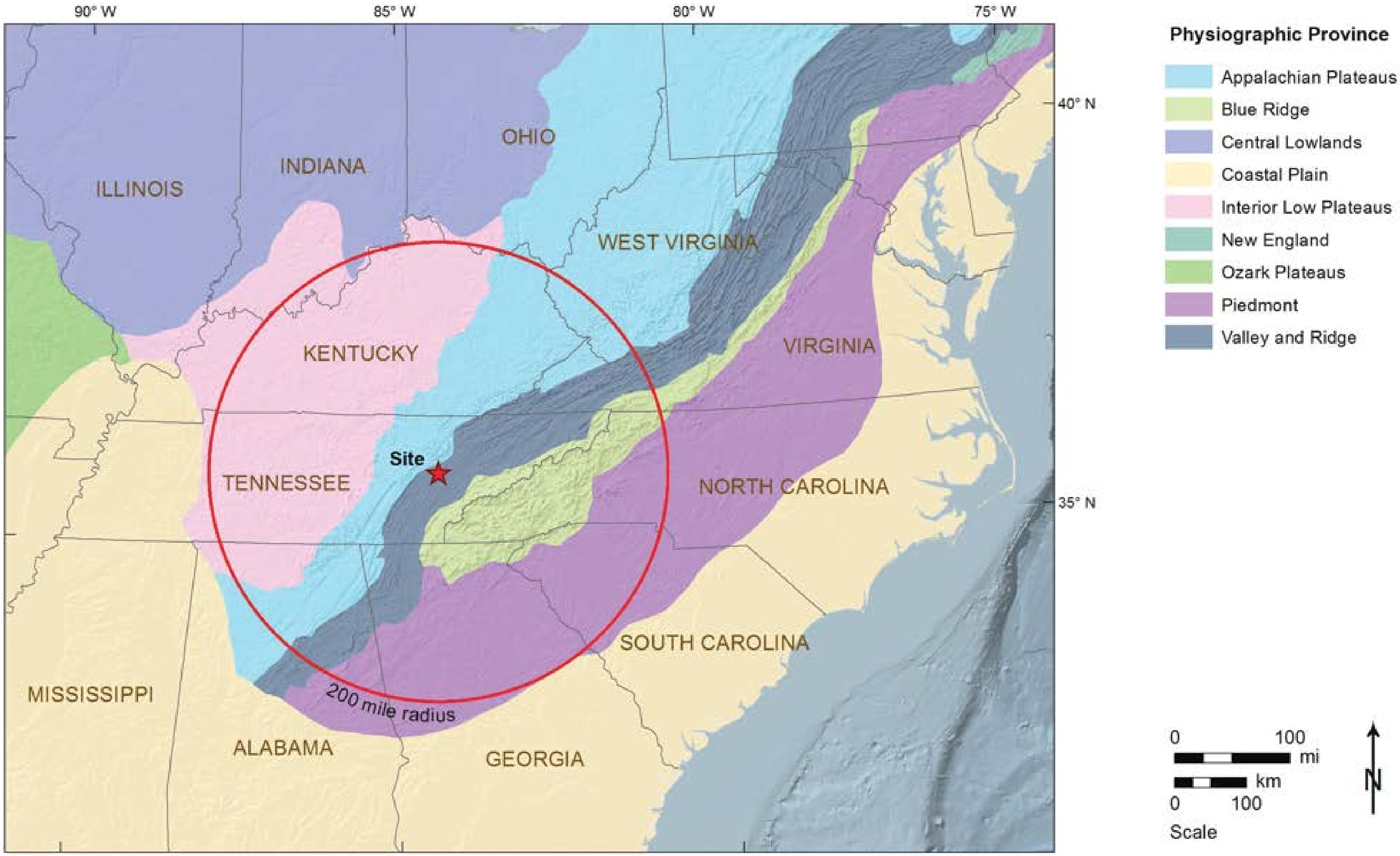
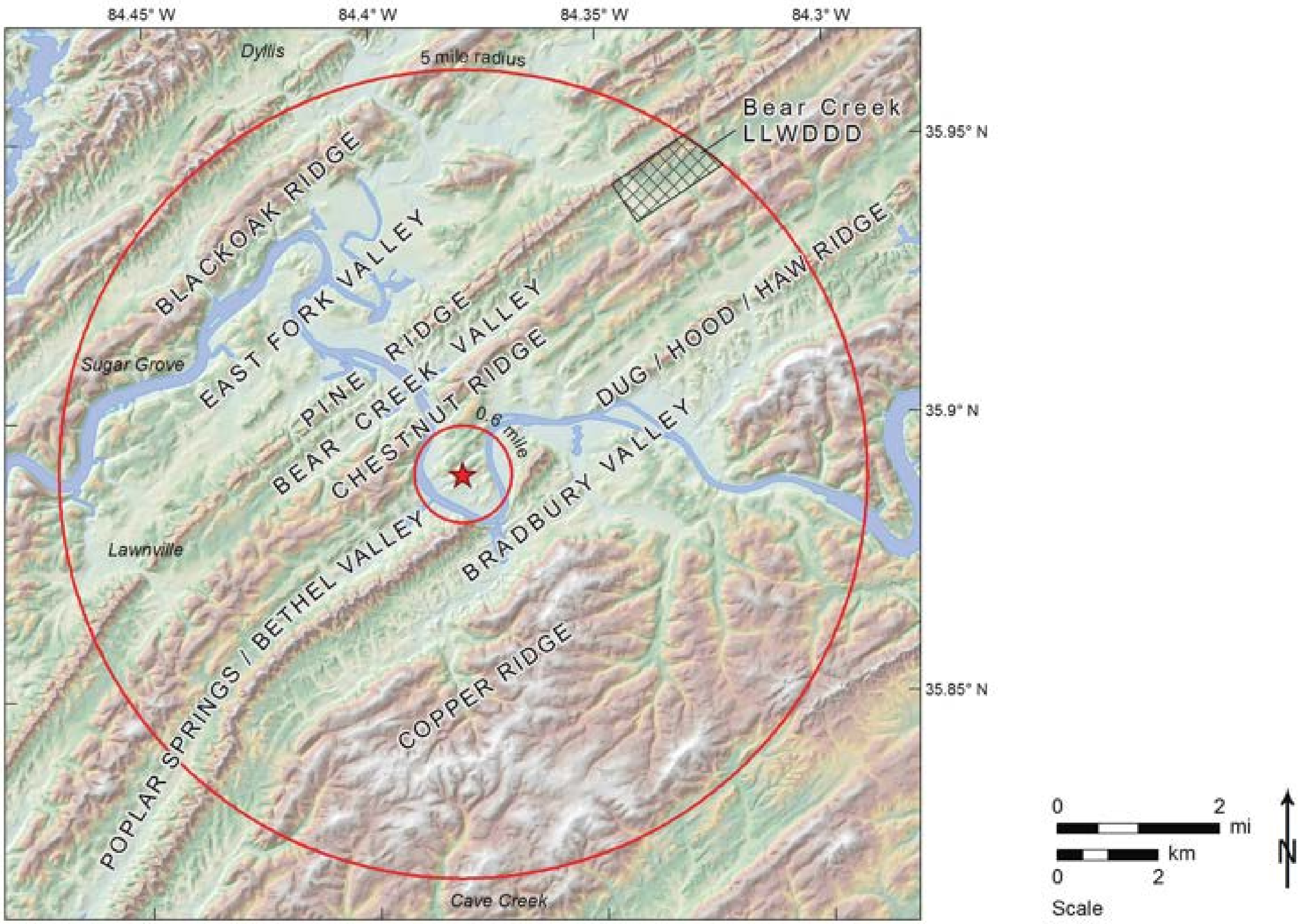
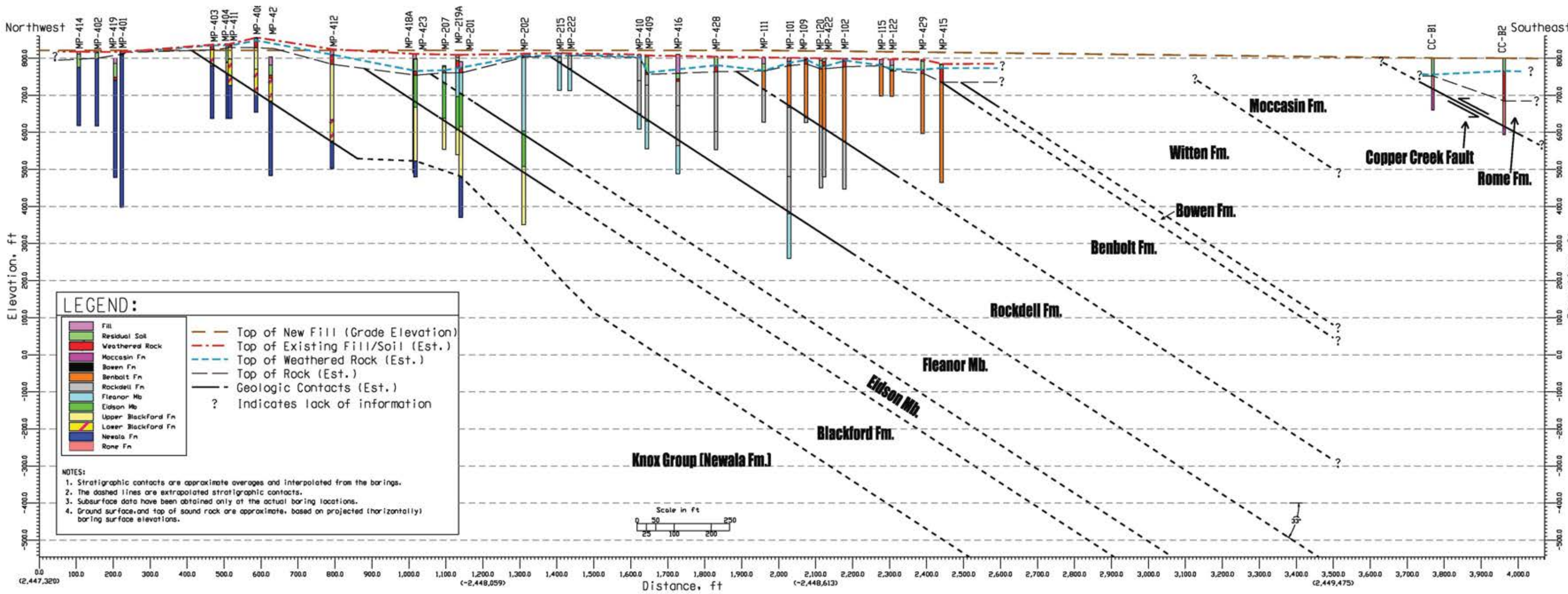


Figure 2.6-1. Map of Physiographic Provinces



Note: Local geographic nomenclature from Reference 2.6-18.

Figure 2.6-2. Local Physiography



Note: Location of cross section (K–K) is provided in Figure 2.6-3, Sheet 2 of 2

Figure 2.6-3. (Sheet 1 of 2) Geologic Cross Section of the CRN Site

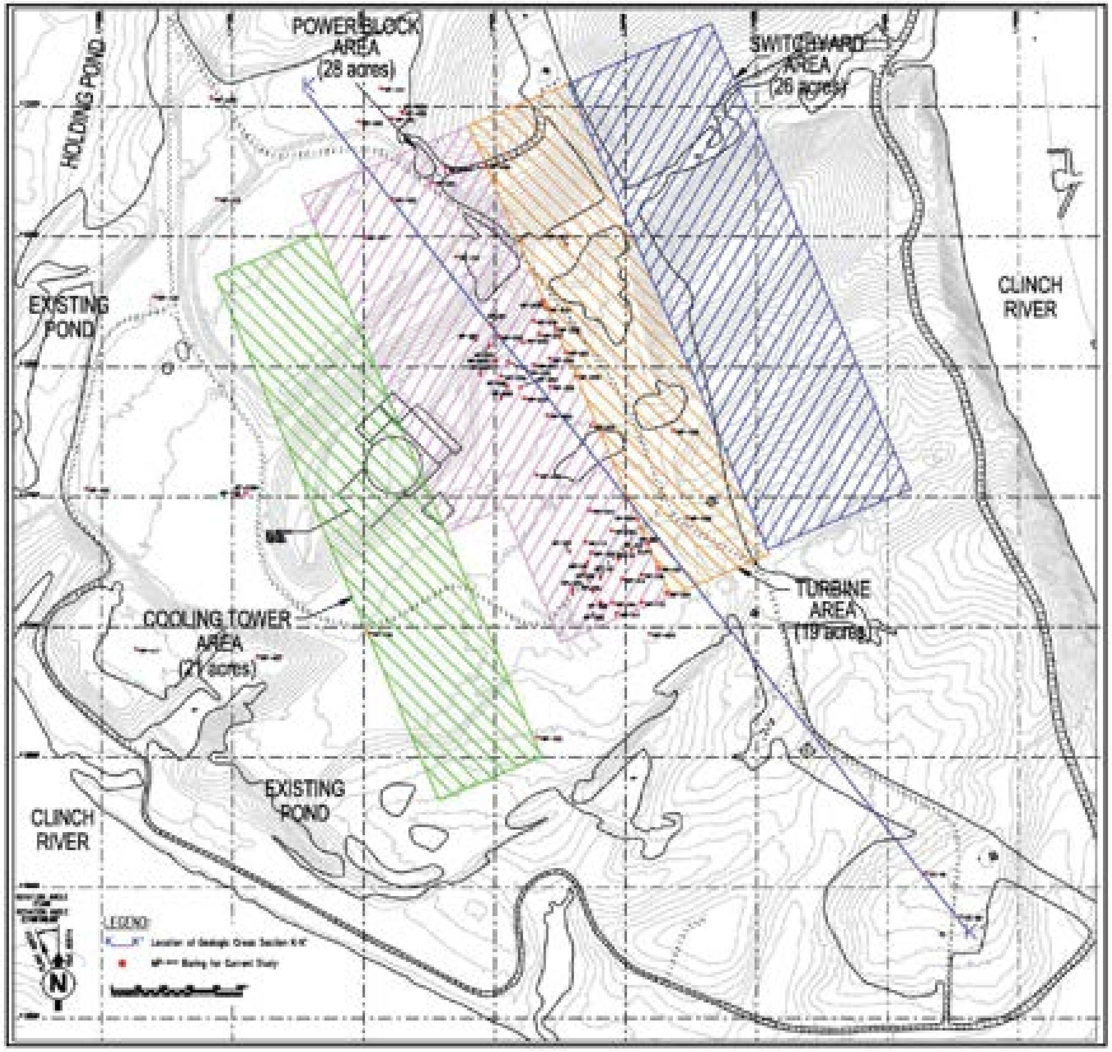


Figure 2.6-3. (Sheet 2 of 2) Geologic Cross Section of the CRN Site

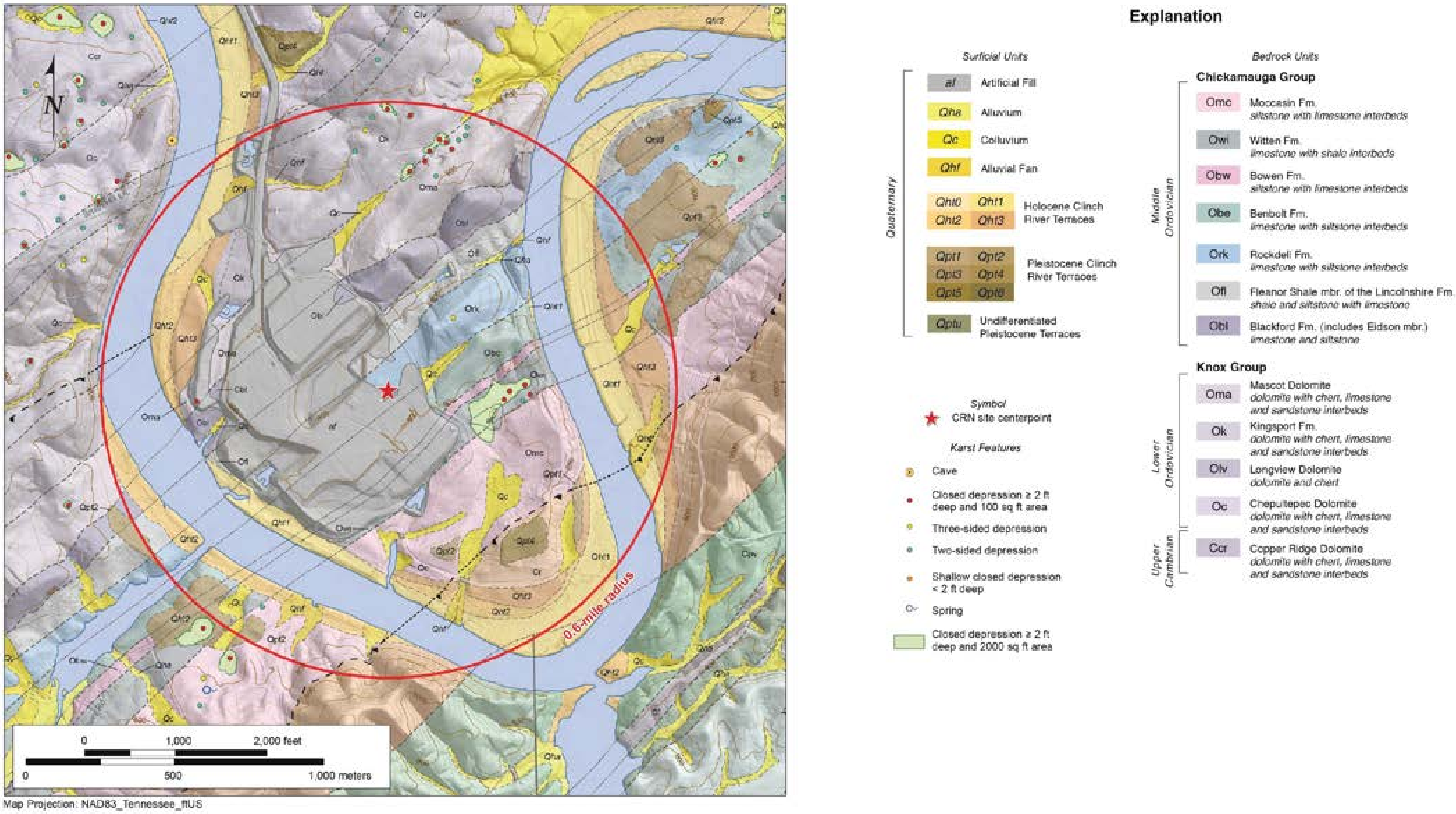


Figure 2.6-4. CRN Site Geologic Map

2.7 METEOROLOGY AND AIR QUALITY

This section of the Environmental Report (ER) addresses the local and regional climatology and meteorology, as well as air quality in the vicinity of the Clinch River Nuclear (CRN) Site. The information supports independent evaluations and assessments of atmospheric diffusion characteristics and impacts of construction and operation of two or more small modular reactors (SMRs) on the environment.

2.7.1 Regional Climatology

2.7.1.1 Data Sources

Data sources for the preparation of this section include:

- Annual Local Climatological Data (LCD) presenting National Weather Service (NWS) Station data collected at Oak Ridge, Knoxville, Chattanooga, the Bristol/Johnson City/Kingsport area, and Nashville, as tabulated and published by the National Climatic Data Center (NCDC)
- Online NETSTATE Tennessee Geography information
- Air pollution data publications available from the Tennessee Department of Environment and Conservation (TDEC)
- U.S. Environmental Protection Agency (EPA) website information / documents on air quality, attainment / nonattainment areas, and mixing heights
- The NCDC’s Online Storm Events Database
- U.S. Nuclear Regulatory Commission (NRC) NUREG documents and Regulatory Guides
- Onsite CRN meteorological data collected under Tennessee Valley Authority’s (TVA’s) meteorological data monitoring program
- Various meteorological data-related publications

2.7.1.2 Tennessee Climate Description

The State of Tennessee extends approximately 450 miles (mi) from east to west and the weather and climate across the state vary as a result of the geography of the state, air masses over the southeastern United States and their origin, and the track of low pressure systems as they move west to east or up from the Gulf of Mexico (Reference 2.7.1-1). In general, winters are moderate and summers are warm and humid over most of the state. In the eastern mountain areas, the elevated topography can have a tempering effect on summer conditions and create colder temperatures during winter. Overall, precipitation is distributed relatively evenly over the state, although there are peaks during winter and spring from synoptic scale, frontal storms, and during summer from thunderstorm activity. (Reference 2.7.1-2)

The geography of Tennessee can be described by six regions (Figure 2.3.1-16).

- Blue Ridge
- Appalachian Ridge and Valley Region
- Appalachian Plateau or Cumberland Plateau
- Highland Rim
- Nashville Basin
- Gulf Coast Plain (Reference 2.7.1-1)

The Blue Ridge region is located on the eastern side of Tennessee and borders North Carolina. This area falls to the east of the CRN Site and includes the Great Smoky Mountains. The average elevation of this region is approximately 5000 feet (ft) above mean sea level (msl), with Clingman's Dome (the highest elevation in the State of Tennessee) reaching 6643 ft msl. (Reference 2.7.1-1)

The Appalachian Ridge and Valley Region extends to the west from the Blue Ridge Region for approximately 55 mi (Reference 2.7.1-1). Elevations in this region range from approximately 1500 ft msl down to 700 ft msl (Reference 2.7.1-2). The region is characterized by valleys separated by ridges. The CRN Site is located in the western half of this region, which is commonly referred to as "The Great Valley." (Reference 2.7.1-1)

The Appalachian Plateau or Cumberland Plateau is located to the west of the Appalachian Ridge and Valley Region, and is the next region west of the CRN Site. The primary features associated with this region are flat-topped mountains with sharp valleys between. Elevations in this area extend up to 1800 ft msl. (Reference 2.7.1-1)

The next region, moving west, is referred to as the Highland Rim. Elevations in the region rise to approximately 1000 ft msl (Reference 2.7.1-2). This region is characterized as an elevated plain that surrounds the Nashville Basin region (Reference 2.7.1-1).

The Nashville Basin Region, with the Highland Rim surrounding it, includes steep slopes along its perimeter. The basin area includes fertile farming land. (Reference 2.7.1-1)

The sixth major region of Tennessee is the western most area named the Gulf Coast Plain. This area is part of the larger Gulf Coast Plain that reaches from the Gulf of Mexico up into the southern portion of Illinois. Much of this area, primarily to the east of Memphis is rolling hills. At the western side of the region is the Mississippi River. (Reference 2.7.1-1) Elevations in the Gulf Plain are generally in the range of 200 to 600 ft msl (Reference 2.7.1-2).

Tables 2.7.1-1 and 2.7.1-2 provide temperature and precipitation data, respectively, representative of the eastern portion of Tennessee in which the CRN Site is located. Figure 2.7.1-1 provides a map showing the location of the NWS Station at each of the cities included in Tables 2.7.1-1 and 2.7.1-2.

Temperature data in Table 2.7.1-1 indicate the effect of geography and elevation; the coldest temperatures are reported on the eastern side of the state at the Bristol/Johnson City/Kingsport area, which is at the highest elevation (approximately 1500 ft msl) of the cities included in the table (Reference 2.7.1-3). The annual average temperature at the Bristol/Johnson City/Kingsport Airport is 55.6 degrees Fahrenheit (°F).

Of the cities included in the table (Table 2.7.1-1), the highest temperatures are reported at the Chattanooga Lovell Field Airport, which is located approximately 70 mi to the southwest of the CRN Site (Reference 2.7.1-4). Chattanooga has a reported annual average temperature of 60.8°F. For the remaining interior cities, the annual average temperatures are 59.3°F at Nashville, 58.8°F at Oak Ridge, and 59.1°F at Knoxville, all within one degree of each other. The maximum monthly average temperature of 80.0°F is reported at Chattanooga in July, and the minimum monthly average temperature of 35.2°F is reported at the Bristol/Johnson City/Kingsport Airport in January.

Table 2.7.1-2 provides monthly and annual average precipitation data for NWS Stations from Nashville to the Bristol/Johnson City/Kingsport area. Annual precipitation averages around 50 inches (in.) per year throughout much of the eastern portion of the state, with the exception of the Bristol/Johnson City/Kingsport area where the annual average precipitation is around 41 in.

The highest reported average annual precipitation is 52.48 in. at Chattanooga. Although precipitation is distributed relatively evenly throughout the year, the lowest monthly amounts occur during the period from August to October, depending on location. Of the five cities included in Table 2.7.1-2, the city with the lowest monthly average is the Bristol/Johnson City/Kingsport area, with 2.10 in. in October. The month with the highest average precipitation varies across the state, occurring anytime from May to November. In the Oak Ridge-Knoxville area, the maximum precipitation amounts occur in July. The city with the highest monthly precipitation is Nashville, where on average 5.50 in. of precipitation falls in May.

2.7.1.3 CRN Site Regional Climate

The CRN Site is located in Roane County in the eastern portion of Tennessee. As noted in Subsection 2.7.1.2, the CRN Site is part of a region commonly referred to as “The Great Valley.” The CRN Site in its regional setting is shown in Figure 2.1-1 of Section 2.1 (Site Location). As indicated in Section 2.1, the center point of the CRN Site is located approximately 10.7 mi southwest of the City of Oak Ridge, Tennessee business district.

On the larger, synoptic scale, weather in the region is influenced by the position of the jet stream, which is typically situated to the north of the CRN Site during the warmer times of year, allowing for higher temperatures and humid conditions. From late spring and into fall, the area is influenced by maritime tropical air masses. During winter, the jet stream typically shifts to the south and its orientation can significantly influence temperatures in the region around the CRN Site. In general, a west- to east-oriented jet stream produces more moderate conditions for the region. However, if the jet stream penetrates downward into the southern United States, polar continental air masses can affect the region producing cold temperatures (Reference 2.7.1-5).

The CRN Site is in the Appalachian Ridge and Valley Region, which is dominated much of the year by the Azores-Bermuda anti-cyclonic circulation (commonly referred to as the "Bermuda High"). This dominance is most pronounced in late summer and early fall and is accompanied by extended periods of fair weather and atmospheric stagnation. (Reference 2.7.1-6) In winter and early spring, eastward moving migratory high- or low-pressure systems bring alternately cold and warm air masses into the area. In the summer and early fall, the migratory systems are less frequent and less intense (Reference 2.7.1-2). Frequent incursions of warm, moist air from the Gulf of Mexico and occasionally from the Atlantic Ocean are experienced in the summer. The CRN Site is primarily affected by cyclones from the southwest and Gulf Coast that move toward the northeast United States by passing along either the west side or the east side of the Appalachian chain and by cyclones from the Plains or Midwest that move up the Ohio River Valley.

At the mesoscale, topography influences the weather and climate of the region around the CRN Site. Figures 2.7.1-2 and 2.7.1-3 show the topography within a 5 mi (8 kilometer [km]) and 50 mi (80 km) radius of the CRN Site, respectively. The CRN Site is located in the Oak Ridge area, which is situated in Appalachian Ridge and Valley Region between two major mountain regions. To the northwest are the Cumberland Mountains and to the southeast are the Great Smoky Mountains. These mountainous regions orient "The Great Valley" in a southwest to northeast alignment. Prevailing winds in the region reflect the channeling of air flow caused by the orientation of the valleys and ridges. Wind speeds are low, with a mean annual wind speed of 2.9 mi per hour (mph) at Oak Ridge. During winter when the jet stream moves southward, the Cumberland Mountains also serve to retard or moderate cold outbreaks by blocking dense, cold polar continental air masses. (Reference 2.7.1-7) In summer, the topography in the region may enhance thunderstorm activity (Reference 2.7.1-2).

The following provides long-term data describing the climatology of the CRN Site based on data collected at the Oak Ridge and Knoxville NWS Stations.

Dry Bulb Temperatures

Table 2.7.1-3 provides average monthly and average annual average normal daily maximum and normal daily minimum temperatures for Oak Ridge and Knoxville for 30 years (yr; 1981 to 2010). Temperatures indicate warm summers and mild winters. In January, normal maximum temperatures are approximately 47°F and normal minimum temperatures are approximately 29°F. In July, normal maximum temperatures are approximately 88°F, and the normal minimum temperatures are approximately 69°F. The normal annual average (dry-bulb) temperature is 58.8°F at Oak Ridge and 59.1°F at Knoxville.

At Oak Ridge, the highest daily maximum temperature was 105°F in July 1952 and again in June 2012. The lowest daily minimum temperature was -17°F recorded in January 1985. (Reference 2.7.1-7)

Atmospheric Water Vapor

The long-term annual relative humidity averages 73 percent based on data from the Knoxville NWS Station (Table 2.7.1-4). Maximum relative humidity readings typically occur in the early morning and the lowest relative humidity occurs in the early to mid-afternoon hours. Average monthly relative humidity ranges from a high of 76 percent in August to a low of 65 percent in April. Table 2.7.1-4 provides monthly averages of relative humidity at the Knoxville NWS Station based on 30 yr of data (1981 to 2010).

Mean wet bulb and dew point temperatures for the Oak Ridge and Knoxville NWS Stations are also presented in Table 2.7.1-4. The mean annual wet bulb temperature is 50.2°F at the Oak Ridge NWS Station and 51.9°F at the Knoxville NWS Station. The maximum mean monthly wet bulb temperature is 69.0 to 69.9°F in July and the minimum mean monthly wet bulb temperature is 31.0 to 33.5°F in January (Oak Ridge NWS and Knoxville NWS).

The mean annual dew point temperature for the Oak Ridge and Knoxville NWS Stations is approximately 50°F. The maximum mean monthly dew point temperatures are 69.7°F and 68.7°F at Oak Ridge NWS Station and Knoxville NWS Station, respectively. The lowest mean monthly dew point temperatures are 31.8°F at Oak Ridge NWS Station and 31.1°F at Knoxville NWS Station. (Reference 2.7.1-7; Reference 2.7.1-5)

Precipitation

Precipitation in the area averages approximately 50 in. annually (Table 2.7.1-2). Winter (January through March) is usually the wettest season, with more than 14 in. at Oak Ridge NWS Station, and late summer-early autumn (August through October) is the driest time of the year, with less than 10 in. The wettest month of the year is July, with normal monthly precipitation of 5.27 in. at the Oak Ridge NWS Station and 5.08 in. at the Knoxville NWS Station (Table 2.7.1-2).

Snowfall in the area is normally light, and, if it occurs, it usually occurs during November through March. The Oak Ridge NWS Station data reports an average of 11.1 in. annually and the Knoxville NWS Station data reports a normal annual value of 6.5 in. (Reference 2.7.1-8; Reference 2.7.1-5).

Severe storms are relatively infrequent because the region is east of maximum tornado activity, south of the most significant snow storms, and inland from hurricane and tropical storm tracks (Reference 2.7.1-2).

The Oak Ridge area is not prone to drought conditions (discussed further in Subsection 2.7.3.6).

Wind Conditions

Monthly average wind data for the Oak Ridge NWS Station and the Knoxville NWS Station are shown in Table 2.7.1-5. The mean annual wind speed at Oak Ridge NWS Station is 2.9 mph, with a maximum monthly mean of 4.0 mph in March and minimum monthly mean wind speed of 2.1 mph in September. The mean annual wind speed at the Knoxville NWS Station is 6.0 mph, which is about twice that of the Oak Ridge NWS Station. In general, mean monthly wind speeds at Knoxville NWS Station are about twice those at Oak Ridge NWS Station. Ridges associated with the local topography are a primary factor related to the decreased wind speeds at Oak Ridge NWS Station. The peak 3-second wind speed, or wind gust, reported for Oak Ridge NWS Station is 53 mph. This occurred in February 2009.

Monthly and annual prevailing winds at the Oak Ridge NWS Station, as shown in Table 2.7.1-5, reflect the northeast-southwest-oriented topography in the region. The prevailing wind direction for the year at Oak Ridge is from the northeast. The monthly prevailing directions have either a northeasterly or southwesterly component, consistent with the orientation of the mountain ranges around the Oak Ridge area.

2.7.1.4 References

Reference 2.7.1-1. netstate.com, The Geography of Tennessee, Website: http://www.netstate.com/states/geography/tn_geography.htm, January 5, 2014.

Reference 2.7.1-2. Chattanooga/Hamilton County Air Pollution Control Bureau, "Ambient Air Monitoring Plan 2012," Chattanooga/Hamilton County Air Pollution Control Bureau, Knox County Health Department, Memphis/Shelby County Health Department, Metropolitan Health Department, and Tennessee Department of Environment and Conservation, June 15, 2012.

Reference 2.7.1-3. National Oceanic and Atmospheric Administration, 2013 Local Climatological Data Annual Summary with Comparative Data - Bristol/Jhnsn Cty/Kingsprt, Tennessee, Website: http://www.ncdc.noaa.gov/IPS/lcd/lcd.html, 2015.

Reference 2.7.1-4. National Oceanic and Atmospheric Administration, 2013 Local Climatological Data Annual Summary with Comparative Data - Chattanooga, Tennessee, Website: http://www.ncdc.noaa.gov/IPS/lcd/lcd.html, 2015.

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Reference 2.7.1-6. Davis, Robert E., Hayden, Bruce P., Gay, David A., Phillips, William L., and Jones, Gregory V., "The North Atlantic Subtropical Anticyclone," Journal of Climate 10: 728-744, April, 1997.

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Reference 2.7.1-8. National Oceanic and Atmospheric Administration, 1998 Local Climatological Data Annual Summary with Comparative Data - Oak Ridge, Tennessee, Website: http://www.ncdc.noaa.gov/IPS/lcd/lcd.html, 2015.

Reference 2.7.1-9. National Oceanic and Atmospheric Administration, 2013 Local Climatological Data Annual Summary with Comparative Data - Nashville, Tennessee, Website: http://www.ncdc.noaa.gov/IPS/lcd/lcd.html, 2015.

Table 2.7.1-1
Normal Temperatures (°F) Across Tennessee

Month	Nashville[1]	Chattanooga[2]	Oak Ridge[2]	Knoxville[2]	Tri-Cities[3,4]
January	37.7	40.5	37.7	38.2	35.2
February	41.7	44.4	41.8	42.4	39.0
March	50.0	52.2	50.4	50.3	46.7
April	59.0	60.5	58.8	58.8	55.2
May	67.5	68.6	66.8	67.2	63.5
June	75.7	76.5	75.1	75.0	71.5
July	79.4	80.0	78.5	78.4	74.6
August	78.7	79.4	77.6	77.8	73.8
September	71.5	72.5	70.7	71.1	67.1
October	60.3	61.5	59.5	59.9	56.3
November	49.8	51.2	48.9	49.7	46.6
December	40.4	42.6	40.3	40.8	37.8
Annual Average	59.3	60.8	58.8	59.1	55.6

1 Nashville Basin Region
2 Appalachian Ridge and Valley Region
3 Eastern edge of Appalachian Ridge and Valley Region, near Blue Ridge Region
4 Tri-Cities includes Bristol/Johnson City/Kingsport, TN area

Sources:
(Reference 2.7.1-9; Reference 2.7.1-4; Reference 2.7.1-7; Reference 2.7.1-5; Reference 2.7.1-3)

Table 2.7.1-2
Normal Precipitation (inches) Across Tennessee

Month	Nashville[1]	Chattanooga[2]	Oak Ridge[2]	Knoxville[2]	Tri-Cities[3,4]
January	3.75	4.91	4.54	4.32	3.37
February	3.94	4.84	4.57	4.26	3.45
March	4.11	4.98	5.06	4.34	3.44
April	4.00	3.99	4.18	4.01	3.33
May	5.50	4.10	4.29	4.51	3.80
June	4.14	4.05	4.28	3.81	3.90
July	3.64	4.91	5.27	5.08	4.69
August	3.17	3.48	2.76	3.27	3.47
September	3.41	4.04	3.69	3.24	2.99
October	3.04	3.28	2.92	2.51	2.10
November	4.31	5.00	4.49	4.01	3.10
December	4.24	4.90	4.86	4.50	3.37
Total Annual	47.25	52.48	50.91	47.86	41.01

1 Nashville Basin Region
2 Appalachian Ridge and Valley Region
3 Eastern edge of Appalachian Ridge and Valley Region, near Blue Ridge Region
4 Tri-Cities includes Bristol/Johnson City/Kingsport, TN area

Sources:
(Reference 2.7.1-9; Reference 2.7.1-4; Reference 2.7.1-7; Reference 2.7.1-5; Reference 2.7.1-3)

Table 2.7.1-3
Dry Bulb Temperatures at the Oak Ridge NWS and Knoxville NWS Stations

	Oak Ridge			Knoxville		
	Normal Daily Maximum Temperature (°F)	Normal Dry-Bulb Temperature (°F)	Normal Daily Minimum Temperature (°F)	Normal Daily Maximum Temperature (°F)	Normal Dry-Bulb Temperature (°F)	Normal Daily Minimum Temperature (°F)
Jan	46.6	37.7	28.9	47.3	38.2	29.2
Feb	51.9	41.8	31.7	52.3	42.4	32.4
Mar	61.4	50.4	39.3	61.4	50.3	39.2
Apr	70.6	58.8	46.9	70.3	58.8	47.3
May	78.3	66.8	55.2	78.1	67.2	56.2
Jun	85.7	75.1	64.5	85.4	75.0	64.7
Jul	88.4	78.5	68.6	88.2	78.4	68.7
Aug	88.0	77.6	67.2	87.8	77.8	67.8
Sep	81.7	70.7	59.7	81.8	71.1	60.4
Oct	71.1	59.5	48.0	71.2	59.9	48.5
Nov	59.6	48.9	38.3	60.4	49.7	39.0
Dec	49.6	40.3	31.1	49.8	40.8	31.7
Annual Average	69.4	58.8	48.3	69.5	59.1	48.8

Sources: (Reference 2.7.1-7; Reference 2.7.1-5)

Table 2.7.1-4
Mean Wet Bulb Temperatures, Dew Point Temperatures and Relative Humidity at the Oak Ridge and Knoxville NWS Stations

	Oak Ridge[1]		Knoxville		
	Mean Wet Bulb Temperature (°F)	Mean Dew Point Temperature (°F)	Mean Wet Bulb Temperature (°F)	Mean Dew Point Temperature (°F)	Normal Relative Humidity (%)
Jan	31.0	31.8	33.5	31.1	74
Feb	32.8	34.0	36.0	33.6	70
Mar	40.2	40.7	43.0	39.6	66
Apr	48.8	49.8	50.4	47.6	65
May	58.3	58.8	59.6	57.8	73
Jun	65.2	65.8	66.6	65.3	75
Jul	69.0	69.7	69.9	68.7	75
Aug	68.3	68.9	69.1	67.9	76
Sep	62.0	62.3	63.2	61.5	75
Oct	51.2	51.8	52.6	50.9	75
Nov	41.0	41.7	43.0	40.9	74
Dec	34.1	34.1	36.1	33.9	75
Annual Average	50.2	50.8	51.9	49.9	73

1 Relative humidity not reported for Oak Ridge in 2013 LCD.

Sources:
(Reference 2.7.1-7; Reference 2.7.1-5)

Table 2.7.1-5
Wind Data for the Oak Ridge and Knoxville NWS Stations

	Oak Ridge[1]			Knoxville[2]		
	Mean Speed (mph)	Maximum 3-Second Speed (mph)	Prevailing Wind Direction	Mean Speed (mph)	Maximum 3-Second Speed (mph)	Prevailing Wind Direction
Jan	3.4	41	SW	6.7	54	WSW
Feb	3.6	53	NE	7.0	56	WSW
Mar	4.0	40	NE	7.3	58	WSW
Apr	3.8	39	SW	7.1	76	WSW
May	2.9	46	SW	6.2	55	WSW
Jun	2.6	51	SSW	5.6	58	WSW
Jul	2.5	40	SSW	5.4	68	WSW
Aug	2.2	43	ENE	4.8	61	WSW
Sep	2.1	38	ENE	4.9	45	NE
Oct	2.2	41	ENE	5.0	56	NE
Nov	2.5	40	NE	5.5	61	NE
Dec	2.9	44	NE	6.2	57	WSW
Annual[3]	2.9	53	NE	6.0	76	WSW

1 Oak Ridge wind speeds based on 14 years, wind direction based on 15 years data.
2 Knoxville mean wind speed based on 30 years, 3-second gust speed based on 18 years, and wind direction on 40 years of data.
3 Wind speed is annual average, 3-second speed is maxima over period of record, and wind direction is prevailing direction over period of record.

Sources:
(Reference 2.7.1-7; Reference 2.7.1-5)

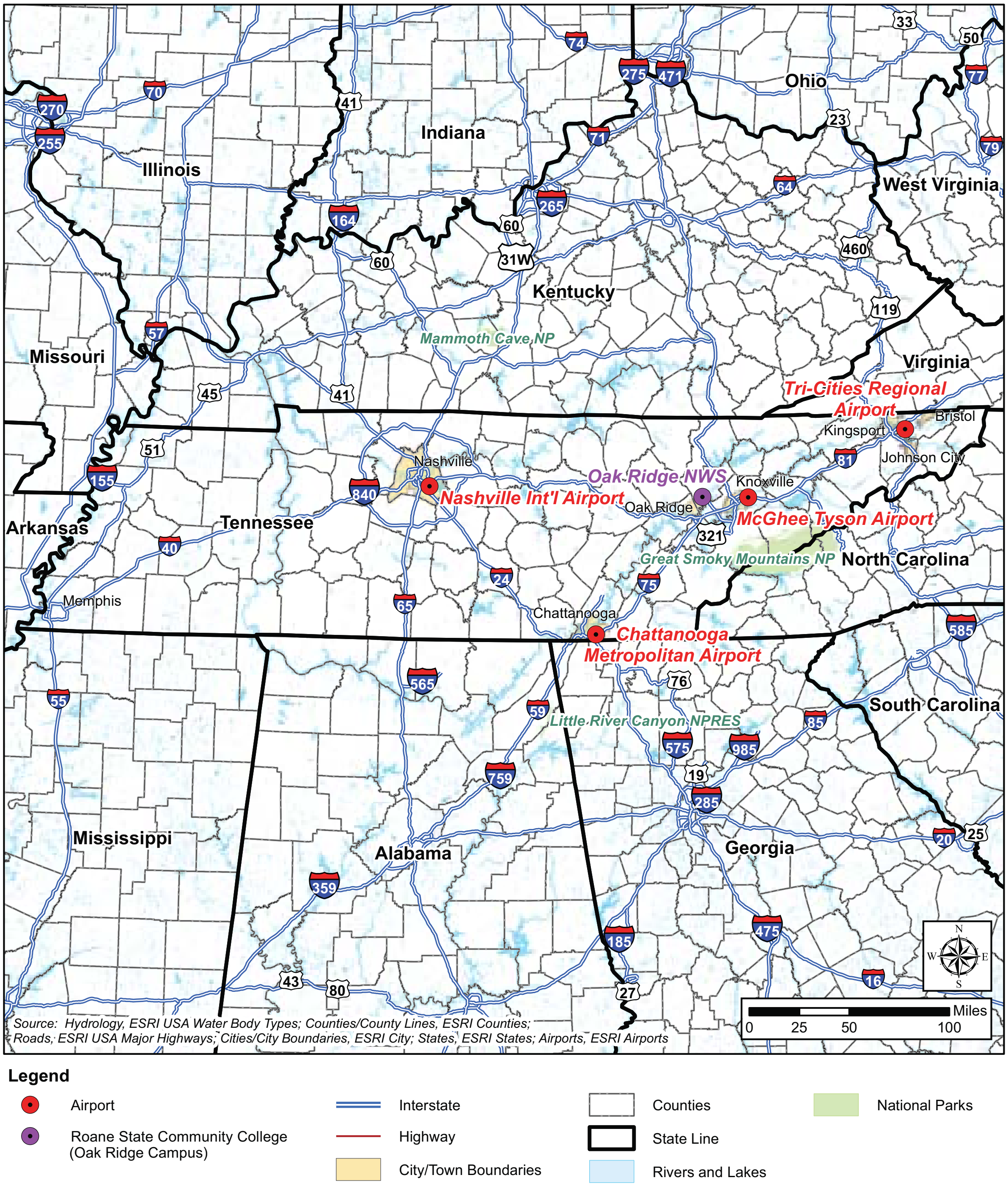


Figure 2.7.1-1. Tennessee Meteorological Data Monitoring City Locations

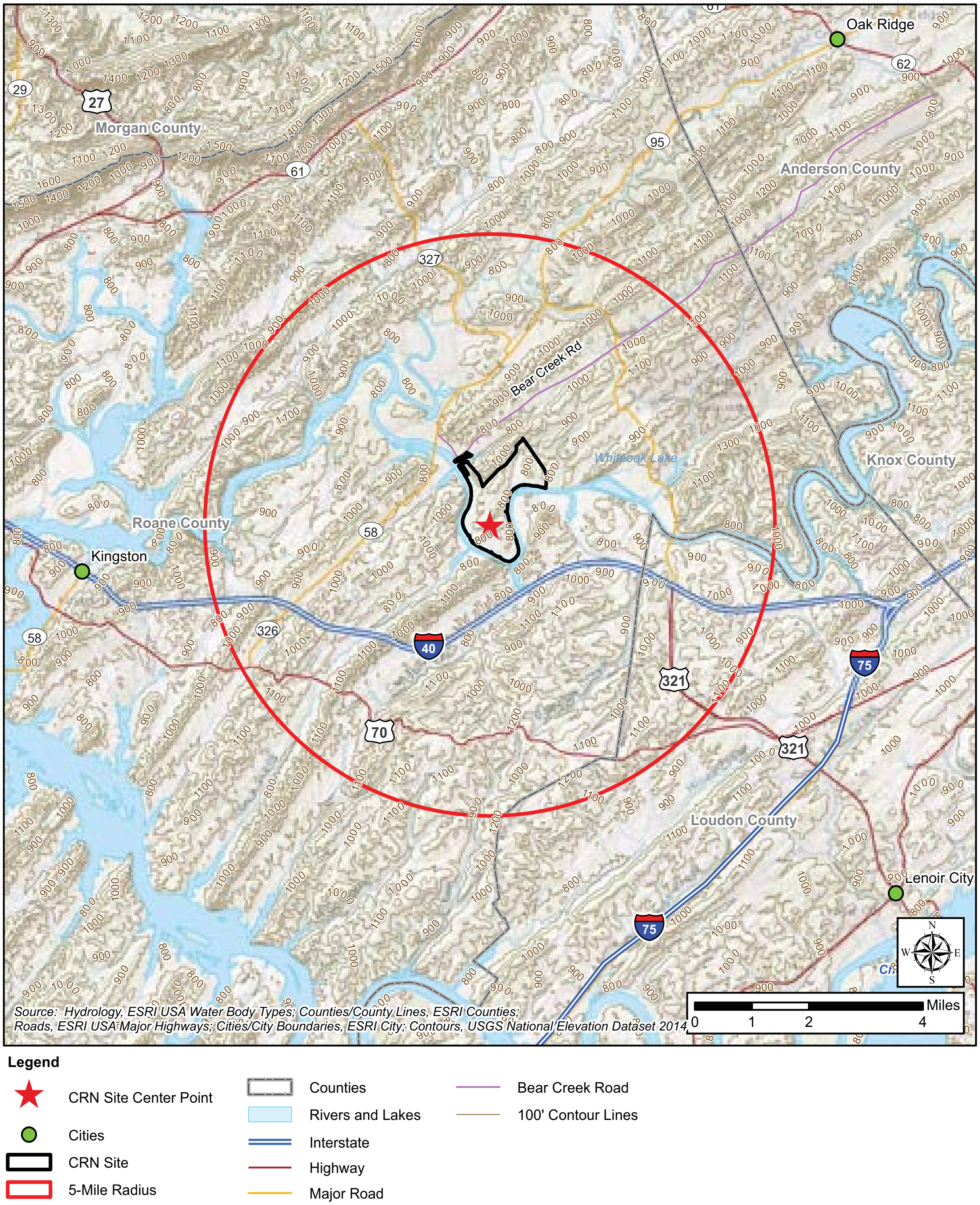


Figure 2.7.1-2. Topographical Features Within 5 Miles of the CRN Site

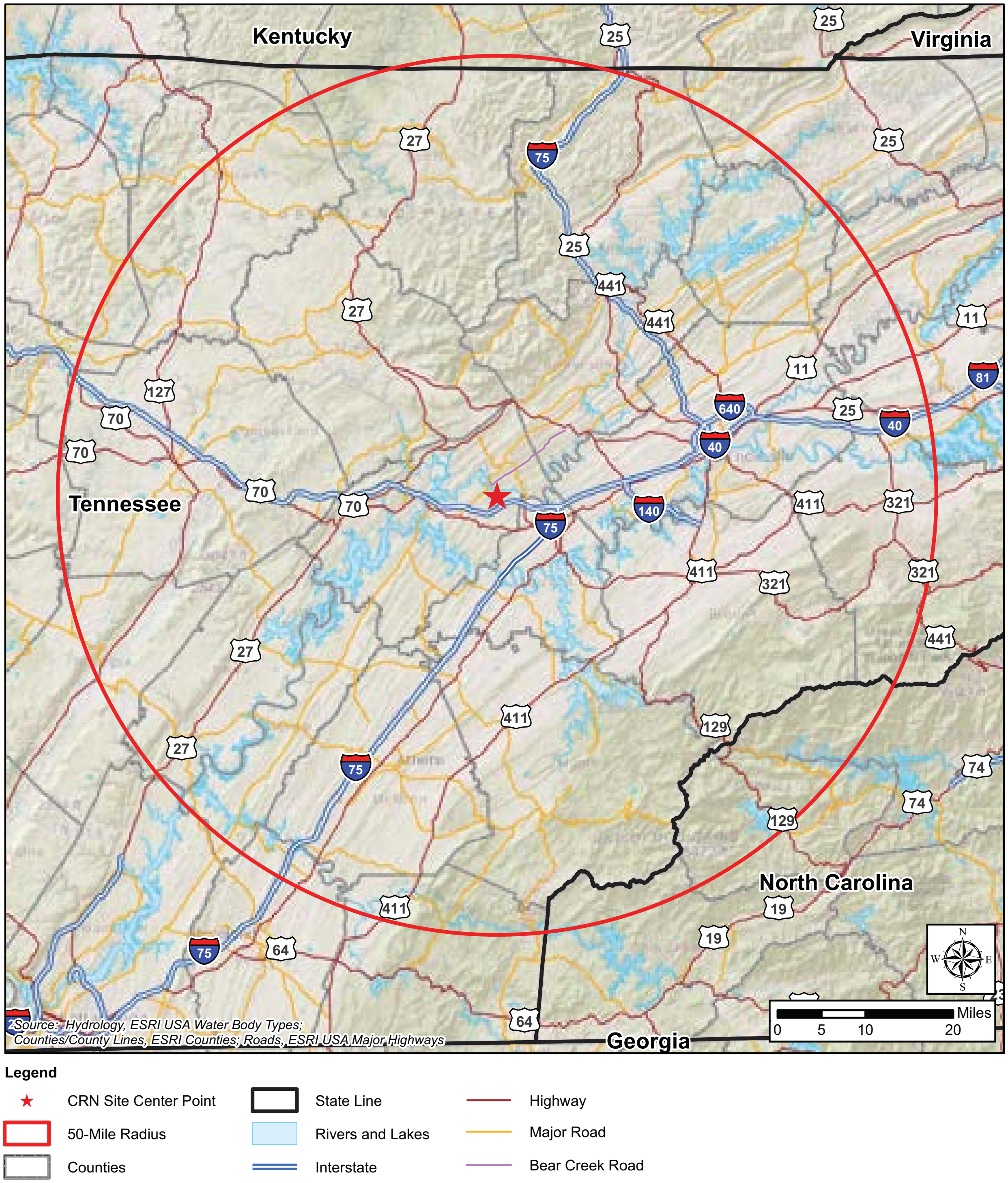


Figure 2.7.1-3. Topographical Features Within 50 Miles of the CRN Site

2.7.2 Regional Air Quality

Existing air quality for the Clinch River Nuclear (CRN) Site and surrounding areas is presented in this subsection, along with potential air emissions sources associated with the construction and operation of two or more small modular reactors (SMRs). Existing air quality is defined by whether the U.S. Environmental Protection Agency (EPA) ambient standards are met.

The CRN Site is located in Roane County. Details of the CRN Site location are provided in Sections 2.1 and 2.2, which describe the 6-mile (mi) vicinity and 50-mi region surrounding the CRN Site.

2.7.2.1 Background Air Quality

The Clean Air Act of 1977 (CAA), which was last amended in 1990, requires the EPA to set National Ambient Air Quality Standards (NAAQS) for pollutants considered harmful to public health and the environment. The EPA has set NAAQS for six criteria pollutants [carbon monoxide (CO), lead, nitrogen dioxide (NO_2), ozone, sulfur oxides (SO_2), particulate matter with a diameter of less than 10 microns (PM_{10}), and particulate matter with a diameter of less than 2.5 microns ($PM_{2.5}$)] for which air quality in an area is determined to be either in attainment or in nonattainment. Pollutant concentrations in nonattainment areas are greater than acceptable levels established by NAAQS, which indicates poor air quality. Attainment areas meet the NAAQS.

Table 2.7.2-1 provides the counties in Tennessee designated as of July 13, 2015 as nonattainment areas (NAAs).

Census Block Group 47-145-0307-2 is the portion of Roane County that is designated as nonattainment for $PM_{2.5}$ (both the 1997 and 2006 standards). Figure 2.7.2-1 shows this "nonattainment" census block group is located approximately 6 mi west of the CRN Site. The portion of Roane County in which the CRN Site is located is in attainment for $PM_{2.5}$ and all air pollutants. However, neighboring counties (Anderson, Blount, Knox, and Loudon) and part of Roane County (not including the CRN Site) are designated nonattainment for $PM_{2.5}$. (Reference 2.7.2-1; Reference 2.7.2-2) Once a state implements mitigation measures to improve air quality in nonattainment areas and an area meets the ambient air quality standards and other re-designation requirements under the CAA, EPA can re-designate that area as a maintenance area. Maintenance areas are designated by pollutant. Table 2.7.2-2 identifies the locations in Tennessee, listed as maintenance areas.

The CAA and amendments identify "areas worthy of added protection," designated as Prevention of Significant Deterioration (PSD) Class I areas. PSD Class I areas include national wilderness areas, memorial parks that exceed 2023.4 hectares (ha; 5000 acres [ac]), national parks that exceed 2428.1 ha (6000 ac), and international parks (Reference 2.7.2-3). The PSD Class I Areas closest to the CRN Site are the Great Smoky Mountains National Park (Gatlinburg, Tennessee), located approximately 31 mi to the east-southeast; the Joyce-Kilmer

Slickrock Wilderness Area (Graham County, North Carolina), located approximately 36 mi to the southeast; and the Cohutta Wilderness Area (Blue Ridge, Georgia), located approximately 61 mi to the south.

2.7.2.2 Projected Air Quality

Generation of electricity associated with two or more SMRs would not be a source of criteria or toxic air pollutants. Supporting equipment such as cooling towers, emergency diesel generators, auxiliary boilers, combustion turbines and other potential sources emit criteria pollutants; however, these activities are not expected to be a significant source of emissions.

Potential air quality impacts for these sources are discussed in Subsection 5.8.1.2, including the project’s area of influence. Subsection 5.8.1.2 also addresses potential air emissions of both criteria pollutants and greenhouse gases. Because the project is not located in a nonattainment area for any pollutant, the Clinch River (CR) SMR Project is not subject to Nonattainment New Source Review. In addition, supporting emissions data presented in Subsection 5.8.1.2 indicate that based on expected bounding CR SMR Project emissions values, the project is not expected to be a major source of air pollution under the Prevention of Significant Deterioration air regulations either.

Potential air emissions and mitigation measures associated with the preconstruction and construction phases are discussed in Subsection 4.4.1.2.

2.7.2.3 Restrictive Dispersion Conditions

Atmospheric dispersion can be described as the horizontal and vertical transport and diffusion of pollutants released into the atmosphere. Horizontal and vertical wind dispersion is controlled primarily by variation in wind direction and wind speed, atmospheric stability, and the height of the mixing layer. In general, lower wind speeds represent less turbulent air flow, which is restrictive to both horizontal and vertical dispersion. Lower wind speeds also allow air contaminants to concentrate into a smaller volume of air. Wind direction tends to be more variable under lower wind speed conditions (which increases horizontal dispersion); however, under these conditions air pollutants may be recirculated within a limited area, thereby increasing air contaminant concentrations. Atmospheric stability is affected by the heating of the ground by the sun, which in turn heats the atmosphere from the ground up. Under unstable conditions (associated with warmer ground temperatures), dispersion is enhanced; under stable atmospheric conditions, dispersion is restricted. The height of the mixing layer, which depends on the vertical temperature profile, limits mixing of air contaminants (mixing occurs only up to the height of the mixing layer). Under unstable conditions and a lower mixing layer height, less atmosphere is available for mixing, and air contaminant concentrations generally increase.

Wind data, atmospheric stability, and mixing heights for the CRN Site, along with wind direction persistence and inversions, are discussed in more detail in Subsection 2.7.4.

2.7.2.4 References

Reference 2.7.2-1. U.S. Environmental Protection Agency, Tennessee Nonattainment/Maintenance Status for Each County by Year for All Criteria Pollutants, Website: http://www.epa.gov/oaqps001/greenbk/anayo_tn.html, January 30, 2015.

Reference 2.7.2-2. U.S. Environmental Protection Agency, EPA Approves Redesignation of Knoxville Area to Attainment for the 2008 8-Hour Ozone Standard, Website: http://yosemite.epa.gov/opa/admpress.nsf/d0cf6618525a9efb85257359003fb69d/c0535b494c0ee0be85257e81004f5475!opendocument, July 13, 2015.

Reference 2.7.2-3. U.S. Environmental Protection Agency, Visibility Maps of Protected Areas, Website: http://www.epa.gov/visibility/maps.html, May 31, 2012.

Table 2.7.2-1
Tennessee County Nonattainment Areas

County	NAAQS and Pollutant by Year	NAA Area Name
Anderson County	1997 $PM_{2.5}$ 2006 $PM_{2.5}$	Knoxville, TN (Moderate) Knoxville-Sevierville-La Follette, TN (Moderate)
Blount County	1997 $PM_{2.5}$ 2006 $PM_{2.5}$	Knoxville, TN (Moderate) Knoxville-Sevierville-La Follette, TN (Moderate)
Hamilton County	1997 $PM_{2.5}$	Chattanooga, TN-GA-AL (Moderate)
Knox County	1997 $PM_{2.5}$ 2006 $PM_{2.5}$	Knoxville, TN (Moderate) Knoxville-Sevierville-La Follette, TN (Moderate)
Loudon County	1997 $PM_{2.5}$ 2006 $PM_{2.5}$	Knoxville, TN (Moderate) Knoxville-Sevierville-La Follette, TN (Moderate)
Roane County	1997 $PM_{2.5}$ (Partial) 2006 $PM_{2.5}$ (Partial)	Knoxville, TN (Moderate) Knoxville- Sevierville-La Follette, TN (Moderate)
Shelby County	2008 8-hr Ozone	Memphis, TN-MS-AR (Marginal)
Sullivan County	2008 Lead (Partial) 2010 SO_2 (Partial)	Bristol, TN Sullivan County, TN

Source: (Reference 2.7.2-1; Reference 2.7.2-2)

Table 2.7.2-2
Maintenance Areas in Tennessee

County[1]	Year of NAAQS and Pollutant	Maintenance Area Name
Anderson County	1997 8-hr Ozone	Knoxville, TN
Benton County	1971 SO_2 (Partial)	Benton County, TN
Blount County	1997 8-hr Ozone	Knoxville, TN
Cocke County	1997 8-hr Ozone (Partial)	Knoxville, TN
Davidson County	1979 1-hr Ozone	Nashville, TN
Fayette County	1978 Lead (Partial)	Fayette County, TN
Humphreys County	1971 SO_2 (Partial)	Humphreys County, TN
Jefferson County	1997 8-hr Ozone	Knoxville, TN
Knox County	1979 1-hr Ozone 1997 8-hr Ozone	Knoxville, TN Knoxville, TN
Loudon County	1997 8-hr Ozone	Knoxville, TN
Montgomery County	1997 8-hr Ozone	Clarksville-Hopkinsville, TN-KY
Polk County	1971 SO_2	Polk County, TN
Rutherford County	1979 1-hr Ozone	Nashville, TN
Sevier County	1997 8-hr Ozone	Knoxville, TN
Shelby County	1971 CO 1979 1-hr Ozone 1997 8-hr Ozone 1978 Lead (Partial)	Memphis, TN Memphis, TN Memphis, TN-AR Shelby County, TN
Sumner County	1979 1-hr Ozone	Nashville, TN
Williamson County	1979 1-hr Ozone 1978 Lead (Partial)	Nashville, TN Williamson County, TN
Wilson County	1979 1-hr Ozone	Nashville, TN

1 Roane County does not contain any maintenance areas.

Source: (Reference 2.7.2-1)

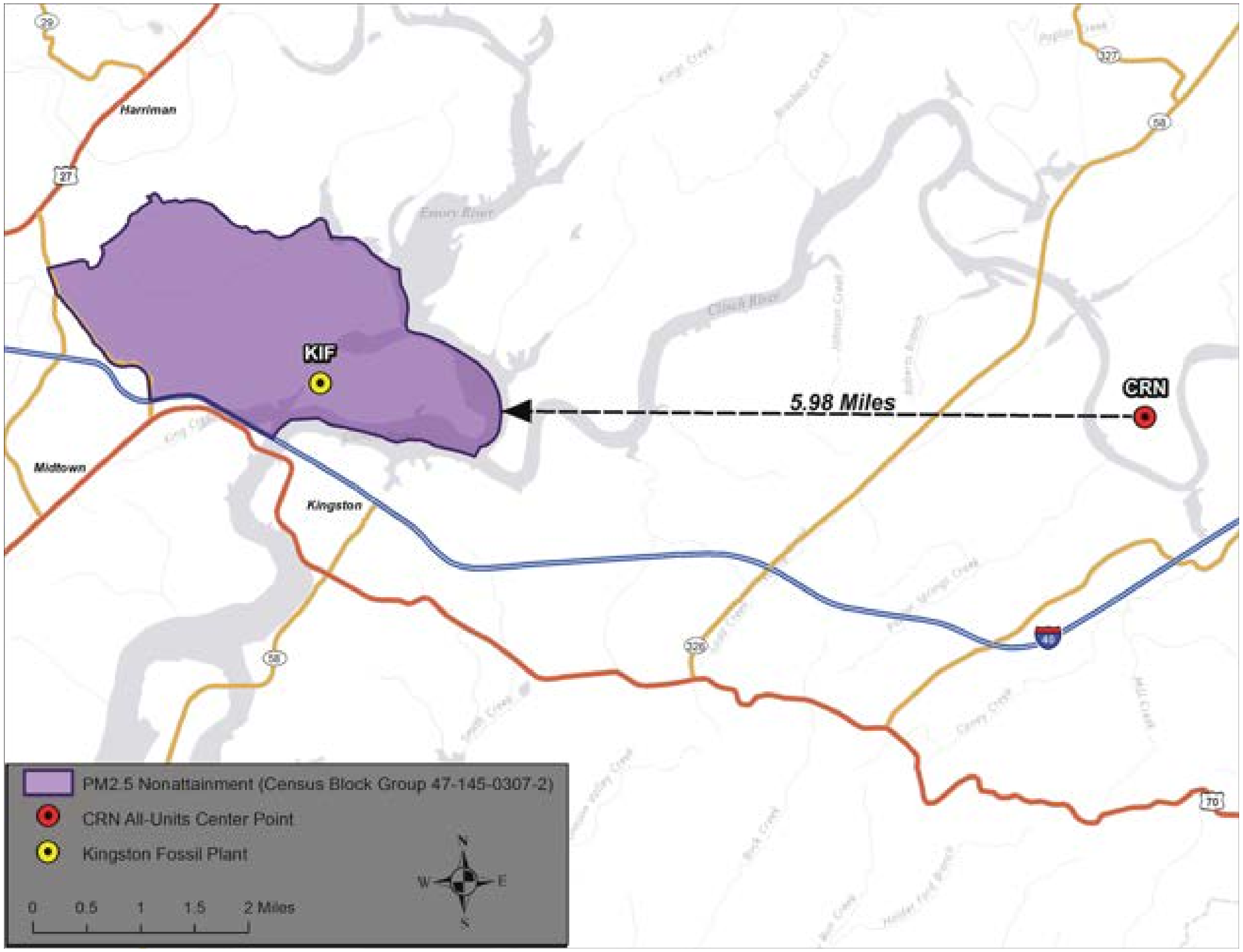


Figure 2.7.2-1. Roane County Census Block Group PM2.5 Non-Attainment Area Relative to CRN Site

2.7.3 Severe Weather

2.7.3.1 Thunderstorms, Hail and Lightning

2.7.3.1.1 Thunderstorms

Thunderstorms are common in the region and normally occur 42 to 55 days per year (Reference 2.7.3-1; Reference 2.7.3-2; Reference 2.7.3-3; Reference 2.7.3-4). (This region includes data from National Weather Service [NWSs] Stations in Chattanooga, the Bristol/Johnson City/Kingsport area, Knoxville and Nashville; data was not available from the Oak Ridge NWS Station.) Thunderstorms occur most frequently during the summer with a range of 31 to 36 days during May through August. This is characteristic of a diurnal afternoon thunderstorm pattern due to solar heating.

2.7.3.1.2 Hail

In Roane County, severe hail (3/4 inches [in.] in diameter or larger) was reported 32 days during the period from 1950 through January 31, 2015 (Reference 2.7.3-5). During the same period, severe hail was reported in adjacent Loudon and Knox counties 44 and 84 days, respectively (Reference 2.7.3-6; Reference 2.7.3-7). This corresponds to about 0.49, 1.29, and 0.68 days per year with severe hail for Roane, Knox, and Loudon counties, respectively.

2.7.3.1.3 Lightning

The Clinch River Nuclear (CRN) Site averages 13 cloud-to-ground lightning flashes per square mile (sq mi) annually (Reference 2.7.3-8). The power block area is expected to be 28 acres (ac) or 0.0438 sq mi. Based on the region's estimated annual number of cloud-to-ground lightning flashes per sq mi, the estimated frequency of potential lightning strikes to an area the size of the power block area is 0.57 per year, or approximately one lightning strike every other year.

2.7.3.2 Extreme Winds

Windstorms are relatively infrequent at the CRN Site, but may occur several times a year, and are usually associated with thunderstorms. Moderate and occasionally strong winds sometimes accompany migrating cyclones and air mass fronts.

Strong winds are usually associated with lines of thunderstorms along or ahead of cold fronts and are more probable in the late winter and spring than any other time of the year. Brief, strong gusts of wind due to downdraft and outflow from individual thunderstorms can occur, but are generally limited to the large, intense thunderstorms that develop in the spring and summer. The National Climatic Data Center [NCDC] Storm Events Database provides long-term data for thunderstorm winds. From 1950 through January 31, 2015 (65.083 yr), 214 thunderstorm wind events were reported for Roane County (Reference 2.7.3-9). Therefore just over three (3.29) thunderstorm wind events per year occur on average.

Estimated extreme winds for the CRN Site region are based on climatological data from the Oak Ridge NWS Station and Knoxville NWS Station, along with hourly observations from the CRN Site. The reported and estimated maximum wind measurements (fastest mile and fastest 3-second gust) for the NWS stations are shown in Table 2.7.3-1. The maximum estimated wind speed is a fastest mile of 73 miles per hour (mph; which corresponds to a 3-second gust of 87 mph). Hourly average wind speed observations at the 10-meter (m) level are available from the CRN Site for April 2011 through July 2014. The maximum observed hourly wind speed was 15.1 mph at the CRN Site which correspond to a 3-second gust of 23 mph.

The basic design wind speed for the CRN Site is 90 mph (50-year [yr] return period, 3-second gust wind speed at 33 ft above ground level) based on the American Society of Civil Engineers (ASCE) design loads for buildings and structures. This converts to a 100-yr return period 3-second gust wind speed of 96.3 mph (ASCE).

The 100-yr recurrence interval fastest mile of wind in the CRN Site area is approximately 90 mph (Reference 2.7.3-10).

Hurricane winds are mainly a concern for coastal locations as shown by the wind speed contours presented in NRC Regulatory Guide (RG) 1.221, *Design-Basis Hurricane and Hurricane Missiles for Nuclear Power Plants*, and NUREG/CR-7005, *Technical Basis for Regulatory Guidance on Design-Basis Hurricane Wind Speeds for Nuclear Power Plants*. The wind speed contours in RG 1.221 and NUREG/CR-7005 place the CRN Site in the 130-mph design basis wind speed range. This design basis wind speed is a 3-second gust with an annual exceedance probability of 10^{-7}. A discussion of hurricane and tropical storm frequencies is provided in Subsection 2.7.3.5.

2.7.3.3 Tornadoes

2.7.3.3.1 Tornado Strike Probability

The probability of a tornado occurring at the CRN Site is low based on records from the NWS Morristown Tornado Database and the NCDC Storm Events Database. During the 64-yr period from 1950 through 2013, five tornadoes were reported within 10 mi of the CRN Site. Data for these five tornadoes are summarized in Table 2.7.3-2. Only one of these (tornado occurring on February 21, 1993) had a magnitude greater than the Fugita Tornado Damage Scale F0 or Enhanced Fugita Scale EF0. (F0 and EF0 are the lowest levels of the Fugita and Enhanced Fugita scales.)

NRC NUREG/CR-4461, *Tornado Climatology of the Contiguous United States*, provides the number of tornado events within 2 degree boxes for the Contiguous United States for the period from January 1950 through August 2003. During this period, 226 tornado events occurred for the 2 degree box that includes the CRN Site.

Using the principle of geometric probability described by H.C.S. Thom, the probability of a tornado striking any point within a 1° latitude by 1° longitude square (3887 sq mi) is calculated for the CRN Site. The annual probability of a tornado striking any point in the area around the CRN Site is 1.43E-04 and the recurrence interval is 6993 yr.

2.7.3.3.2 Design Basis Tornado (DBT) Parameters

The CRN Site is located in Region I for DBT considerations (NRC RG 1.76, *Design-Basis Tornado and Tornado Missiles for Nuclear Power Plants*). The design-basis characteristics applicable to structures, systems, and components important to safety at the proposed CRN Site include the following parameters (NRC RG 1.76, Table 1):

- Maximum Wind Speed = 230 mph
- Translational Speed = 46 mph
- Maximum Rotational Speed = 184 mph
- Radius of Maximum Rotational Speed = 150 feet (ft)
- Pressure Drop = 1.2 pounds per square inch (psi)
- Rate of Pressure Drop = 0.5 psi/second

2.7.3.4 Winter Storms

Winter storms producing snowfall or glaze ice in excess of 1 in. are infrequent for Eastern Tennessee (Reference 2.7.3-1; Reference 2.7.3-2; Reference 2.7.3-3; Reference 2.7.3-4; Reference 2.7.3-11; Reference 2.7.3-12). The NCDC Storm Events Database reports 18 winter storms for Roane County from 1950 through January 31, 2015 (Reference 2.7.3-13).

2.7.3.4.1 Snow

Snowfall records for stations around the CRN Site (Table 2.7.3-3) show a maximum 24-hr snowfall of 20.0 in. (March 1993) at the Chattanooga NWS Station. At the Oak Ridge NWS Station, the maximum 24-hr reported snowfall is 12 in. in March 1960. Maximum monthly snowfall is 23.3 in. at the Knoxville NWS Station reported in February 1960.

The normal number of days per year with snowfall greater than one inch, for the stations around the CRN Site, is a maximum of 2.2 days per year (Table 2.7.3-3).

2.7.3.4.2 Ice Storms

Estimations of regional glaze probabilities have been made by Tattelman and Gringorten. For Region V, which contains Tennessee, storms with ice ≥ 2.5 centimeters (cm) occurred 5 times in 50 yr and storms with ice ≥ 5.0 cm occurred 2 times in 50 yr. (Reference 2.7.3-12)

For ice storms with wind gusts ≥ 20 meters per second (m/s), the estimated ice thickness is < 2.5 cm for 25- and 50-yr return periods, and 3.6 cm for a 100-yr return period (Reference 2.7.3-12).

For glaze ice, the point probabilities are 0.20 for ice thickness ≥ 1.25 cm and 0.36 for ice thickness ≥ 0.63 cm (Reference 2.7.3-12). These probabilities correspond to, recurrence intervals of once in five years and once in three years, respectively.

2.7.3.5 Tropical Cyclones

Due to the significant inland distance from both the Atlantic Ocean and the Gulf of Mexico (more than 300 mi), tropical storm impacts are rare at the CRN Site, and are mostly from tropical storm remnants (Reference 2.7.3-14).

The NCDC Storm Events Database shows no hurricanes impacting Roane County from 1950 through January 31, 2015, and only one tropical storm is recorded for Roane County over this same period (Reference 2.7.3-15; Reference 2.7.3-16). The tropical storm is reported on September 16, 2004 and is from the remnant of Hurricane Ivan (Reference 2.7.3-17).

2.7.3.6 Droughts

Precipitation is well spread throughout the year and droughts are generally uncommon (Reference 2.7.3-11). The NCDC Storm Events Database reports that during the period of 1950 through January 31, 2015, drought conditions in Roane and surrounding counties occurred in late summer of 1998, throughout much of 2007 and 2008, and in mid-summer 2012. (Reference 2.7.3-18)

2.7.3.7 Heavy Fog

Episodes of heavy fog (visibility less than or equal to 0.25 mi) are reported to occur at the Oak Ridge NWS Station on average 51.9 days per year and 29.7 days per year at the Knoxville NWS Station. At the Oak Ridge NWS Station, the months with the maximum mean number of days with heavy fog are September and October (7.5 days for each month) and the minimum is 1.4 days in February. (Reference 2.7.3-2; Reference 2.7.3-11)

2.7.3.8 References

Reference 2.7.3-1. National Oceanic and Atmospheric Administration, 2013 Local Climatological Data Annual Summary with Comparative Data - Chattanooga, Tennessee, Website: http://www.ncdc.noaa.gov/IPS/lcd/lcd.html, 2015.

Reference 2.7.3-2. National Oceanic and Atmospheric Administration, 2013 Local Climatological Data Annual Summary with Comparative Data - Knoxville, Tennessee, Website: http://www.ncdc.noaa.gov/IPS/lcd/lcd.html, 2015.

Reference 2.7.3-3. National Oceanic and Atmospheric Administration, 2013 Local Climatological Data Annual Summary with Comparative Data - Nashville, Tennessee, Website: http://www.ncdc.noaa.gov/IPS/lcd/lcd.html, 2015.

Reference 2.7.3-4. National Oceanic and Atmospheric Administration, 2013 Local Climatological Data Annual Summary with Comparative Data - Bristol/Jhnsn Cty/Kingsprt, Tennessee, Website: http://www.ncdc.noaa.gov/IPS/lcd/lcd.html, 2015.

Reference 2.7.3-5. National Oceanic and Atmospheric Administration, NCDC Storm Events Database - Roane County, TN Hail Events: 1950-2015, Website: http://www.ncdc.noaa.gov/stormevents/, 2015.

Reference 2.7.3-6. National Oceanic and Atmospheric Administration, NCDC Storm Events Database - Knox County, TN Hail Events: 1950-2015, Website: http://www.ncdc.noaa.gov/stormevents/, 2015.

Reference 2.7.3-7. National Oceanic and Atmospheric Administration, NCDC Storm Events Database - Loudon County, TN Hail Events: 1950-2015, Website: http://www.ncdc.noaa.gov/stormevents/, 2015.

Reference 2.7.3-8. Changnon, S. A., "Thunderstorms Across the Nation, Figure 29," 2001.

Reference 2.7.3-9. National Oceanic and Atmospheric Administration, NCDC Storm Events Database - Roane County, TN Thunderstorm Wind Events: 1950-2015, Website: http://www.ncdc.noaa.gov/stormevents/, 2015.

Reference 2.7.3-10. Thom, H. C. S., "New Distributions of Extreme Winds in the United States, Figure 5," Journal of the Structural Division, Proceedings of the American Society of Civil Engineers 94(No. ST 7): 1787-1801, July, 1968.

Reference 2.7.3-11. National Oceanic and Atmospheric Administration, 2013 Local Climatological Data Annual Summary with Comparative Data - Oak Ridge, Tennessee, Website: http://www.ncdc.noaa.gov/IPS/lcd/lcd.html, 2015.

Reference 2.7.3-12. Tattelman, Paul and Gringorten, Irving I., "Estimated Glaze Ice and Wind Loads at the Earth's Surface for the Contiguous United States," AFCRL-TR-73-0646, Air Force Cambridge Research Laboratories, October 16, 1973.

Reference 2.7.3-13. National Oceanic and Atmospheric Administration, NCDC Storm Events Database - Roane County, TN Winter Storm Events: 1950-2015, Website: http://www.ncdc.noaa.gov/stormevents/, 2015.

Reference 2.7.3-14. Chattanooga/Hamilton County Air Pollution Control Bureau, "Ambient Air Monitoring Plan 2012," Chattanooga/Hamilton County Air Pollution Control Bureau, Knox

County Health Department, Memphis/Shelby County Health Department, Metropolitan Health Department, and Tennessee Department of Environment and Conservation, June 15, 2012.

Reference 2.7.3-15. National Oceanic and Atmospheric Administration, NCDC Storm Events Database - Roane County, TN Tropical Storm Events: 1950-2015, Website: http://www.ncdc.noaa.gov/stormevents/, 2015.

Reference 2.7.3-16. National Oceanic and Atmospheric Administration, NCDC Storm Events Database - Roane County, TN Hurricane Events: 1950-2015, Website: http://www.ncdc.noaa.gov/stormevents/, 2015.

Reference 2.7.3-17. Franklin, James L., Pasch, Richard J., Avila, Lixion A., Beven II, John L., Lawrence, Miles B., Stewart, Stacy R., and Blake, Eric S., Monthly Weather Review, Atlantic Hurricane Season of 2004, Website: http://www.aoml.noaa.gov/hrd/hurdat/mwr_pdf/2004.pdf, March, 2006.

Reference 2.7.3-18. National Oceanic and Atmospheric Administration, NCDC Storm Events Database - Roane County, TN Drought Events: 1950-2015, Website: http://www.ncdc.noaa.gov/stormevents/, 2015.

Reference 2.7.3-19. National Oceanic and Atmospheric Administration, 1998 Local Climatological Data Annual Summary with Comparative Data - Oak Ridge, Tennessee, Website: http://www.ncdc.noaa.gov/IPS/lcd/lcd.html, 2015.

Reference 2.7.3-20. National Oceanic and Atmospheric Administration, 1974 Local Climatological Data Annual Summary with Comparative Data - Knoxville, Tennessee, Website: http://www.ncdc.noaa.gov/IPS/lcd/lcd.html, 2015.

Reference 2.7.3-21. National Oceanic and Atmospheric Administration, 1995 Local Climatological Data Annual Summary with Comparative Data - Knoxville, Tennessee, Website: http://www.ncdc.noaa.gov/IPS/lcd/lcd.html, 2015.

Table 2.7.3-1
Maximum Wind Speeds at Oak Ridge and Knoxville

Station	Time Period	Observed Maximum (mph)		Estimated Maximum (mph)	
		Fastest Mile	3-Second Gust	Fastest Mile	3-Second Gust
Oak Ridge NWS	1985-1998[1]	NR	51 (Nov 1995)	40	51
	2000-2013[2]	NR	53 (Feb 2009)	42	53
Knoxville NWS	1942-1974[3]	73 (Jul 1961)	NR	**73**	**87**
	1985-1995[4]	NR	86 (Aug 1995)	72	86
	1996-2013[5]	NR	76 (Apr 1996)	63	76

[1] (Reference 2.7.3-19)
[2] (Reference 2.7.3-11)
[3] (Reference 2.7.3-20)
[4] (Reference 2.7.3-21)
[5] (Reference 2.7.3-2)

Notes:
Conversions are based on TIA-222-G
NR = not recorded

Table 2.7.3-2
Tornadoes reported within 10 Miles of CRN Site (1950-2013)

Date	County(s)	Magnitude (WS range)	Length (miles)	Width (yards)	Closest Distance to CRN Site
10/1/1977	Roane	F0 (40-72 mph)	0.2	100	7 miles
2/21/1993	Roane Loudon	F3 (158-206 mph)	30	100	5 miles
5/18/1995	Morgan	F0 (40-72 mph)	0.5	23	8 miles
4/27/2011	Knox	EF0 (65-85 mph)	1	50	10 miles
6/22/2011	Roane	EF0 (65-85 mph)	0.6	20	8 miles

Sources:
NWS Morristown Tornado Database (*http://innovation.srh.noaa.gov/tors/index.php?cw=mrx*).
NCDC Storm Events Database (*http://www.ncdc.noaa.gov/stormevents*).

Table 2.7.3-3
Extreme Snowfall for NWS Stations Around CRN

Station	Period of Record (years)	Max 24-hour Snowfall (in.)	Max Monthly Snowfall (in.)
Oak Ridge NWS	52	12.0 (Mar 1960)	21.0 (Mar 1960)
Knoxville NWS	69	18.2 (Nov 1952)	23.3 (Feb 1960)
Chattanooga NWS	76	20.0 (Mar 1993)	20.0 (Mar 1993)
Nashville NWS	66	10.2 (Dec 1963)	18.9 (Feb 1979)

Sources:
(Reference 2.7.3-1; Reference 2.7.3-2; Reference 2.7.3-3; Reference 2.7.3-11)

This Subsection contains information withheld under 10 CFR 2.390(a)(3)

2.7.4 Local Meteorology

Site-specific meteorological data, collected from the Tennessee Valley Authority (TVA) meteorological facility at the CRN Site during April 21, 2011 through July 9, 2013, are the primary basis for dispersion meteorology analyses and the description of local meteorological conditions. In addition to onsite measurements, data representative of the Clinch River Nuclear (CRN) Site or data indicative of CRN Site conditions were also obtained from climatological records for Oak Ridge National Weather Service (NWS) Station, Knoxville NWS Station, and from the TVA Watts Bar Nuclear Plant site.

2.7.4.1 Normal, Mean, and Extreme Values

Long-term meteorological data records were examined to determine if data collected at the CRN Site are consistent with regional conditions, both spatially and over time.

Comparisons of common CRN Site measurements for the different data periods over which data were collected are presented in Table 2.7.4-1. Common variables (except wind direction) are compared directly in the table. There is generally good agreement among the different data periods, especially the latter two data sets. Differences fall within the range of normally expected variations considering none of the data sets individually represent a long-term climatological period and also due to the difference in measurement locations onsite (see Table 2.7.4-16). In general, the average meteorological values calculated are similar. Therefore, it is assumed that meteorological characteristics for the CRN Site have not changed significantly over time.

Comparing data from nearby offsite locations helps to determine if the CRN Site is consistent with regional conditions. Data were examined for April 21, 2011 through June 30, 2013 (Table 2.7.4-1), which represents the primary onsite data set for the CRN project. There is good agreement between the CRN Site data and the offsite locations, especially the average values. Average values at the CRN Site fall between, or near, the Oak Ridge NWS Station and Watts Bar Nuclear values.

Figures 2.7.4-5 and 2.7.4-6 present composite wind roses from the CRN Site for the period of April 21, 2011 through June 30, 2013 at the 10-meters (m) and 60-m heights, respectively. The CRN wind roses show the effect of the regional southwest to northeast orientation of terrain. However, these wind roses also indicate the effects of more local terrain. This is most evident at the lower 10-m level where there is a stronger east, east-southeast, and west-northwest/northwest wind component. These local effects are discussed further in Subsection 2.7.4.2.

Comparisons presented above indicate that, for these variables, data from the CRN Site are consistent with meteorological conditions in the vicinity. Presumably, this is characteristic of the similarity in controlling synoptic influences throughout the region. Other meteorological parameters are assumed to be subject to the same synoptic controls. Meteorological data collected onsite and at nearby NWS stations are presented and evaluated in the following subsections in more detail.

2.7.4.1.1 Winds

Both 10-m and 60-m wind data were collected on the meteorological tower at the CRN Site. The meteorological facility generally met criteria for obtaining "data representative of the atmospheric conditions." Two nearby obstructions were noted by TVA to exceed the 1-to-10 height-to-distance criteria specified in NRC RG 1.23, *Meteorological Monitoring Programs for Nuclear Power Plants*. These two obstructions included:

1. A power line transmission tower about 120 m northeast of the meteorological tower, and
2. Trees about 70 m southeast of the meteorological tower.

TVA meteorologists determined these obstructions would have minimal impact on data collected at the CRN Site based on the following: (1) the transmission tower is an open, lattice structure so that it presents no obstruction to wind flow observed at the meteorological tower and (2) the trees cover only a relatively small arc with respect to the meteorological tower. [ ] Exempted from Disclosure by Statute

Much of the following discussion considers the 10-m wind data because it is most representative of the local meteorological conditions closest to the ground where releases for dispersion modeling are expected. Local ground level conditions are most important in evaluating ground level releases, because maximum air concentrations from contaminants released into the atmosphere generally occur close to the release point.

<u>Average Wind Direction and Wind Speed</u>

Monthly wind roses for the 10-m level at the CRN Site, the 60-m level at the CRN Site, and Oak Ridge NWS are presented in Figure 2.7.4-1 (CRN 10-m), Figure 2.7.4-2 (CRN 60-m), and Figure 2.7.4-3 (Oak Ridge NWS). Figures 2.7.4-5 and 2.7.4-6 provide both 10-m and 60-m composite wind roses for the entire, approximate two year period that data were collected at the CRN Site, and Table 2.7.4-2 presents 10-m and 60-m wind speed and wind direction joint frequency distributions for the approximate two-year CRN Site sampling period. Figure 2.7.4-7 presents an annual wind rose for the Oak Ridge NWS.

Wind speeds at CRN during 2011 through 2013 were generally light with an average 10-m speed of 2.74 miles per hour (mph; summarized in Table 2.7.4-1). This is consistent with the 30 year (yr) normal wind speed of 2.9 mph for the Oak Ridge NWS (Reference 2.7.4-1). The maximum 10-m hourly average (scalar) speed was 15.1 mph (Table 2.7.4-1). 10-m winds were calm (less than 0.6 mph) for 458 hour (hr; 2.4 percent of observations). The prevailing wind direction at 10-m is the west-southwest direction though there is also a strong west-northwesterly component (Figure 2.7.4-5). In general, west-southwesterly winds are prominent throughout most of the year.

At the 60-m level, the prevailing wind direction is west-southwest, with a prominent peak in the opposite direction from the northeast (Table 2.7.4-2 and Figure 2.7.4-6). The 60-m wind rose shows greater evidence of the southwest to northeast orientation of the region's topography, and the 10-m level reflects more of the local conditions associated with the area near the CRN Site. At the 60-m level, the maximum hourly average observed wind speed was 27.1 mph (Table 2.7.4-1) and calms occurred 0.14 percent of the time. The average 60-m level wind speed was 4.86 mph for the CRN Site meteorological sampling period.

Figure 2.7.4-7 shows the wind rose for the Oak Ridge NWS, which indicates winds consistent with the southwest to northeast orientation of the terrain in the region.

Wind Direction Persistence

Generally, the longer winds blow in the same direction, the lower the atmosphere's dilution potential because effluents mix less horizontally to the sides of the plume. Wind direction persistence is an indicator of the duration of atmospheric transport from a single sector (same sector, 22.5 degrees), three adjoining sectors (± 1 sector, 67.5 degrees), and five adjoining sectors (± 2 sectors, 112.5 degrees). For the CRN Site (Table 2.7.4-3), maximum wind persistence at 10-m is 19 hr from the W for one sector, 46 hr from the west-northwest (WNW)-north-northwest (NNW) for three adjoining sectors (± 1 sector), and 106 hr from the southwest (SW)-northwest (NW) for five adjoining sectors (± 2 sectors).

The 10-m wind data also show a consistent pattern with predominant winds from the west-southwest (WSW)-NW. There is little seasonal variation (Figure 2.7.4-4). Due to the combination of uniformly light winds speeds and surrounding terrain, transport from the CRN Site is expected to be limited.

2.7.4.1.2 Air Temperature

Temperature data for Knoxville and Oak Ridge are presented in Tables 2.7.4-4 and 2.7.4-5, respectively. Mean monthly temperatures range from the upper 30s (degrees Fahrenheit [°F]) in the winter to the upper 70s (°F) in the summer at both locations. Mean maxima ranged from about 47°F in mid-winter to about 88°F in mid-summer. The mean minima ranged from about 29°F in mid-winter to about 69°F in mid-summer. The extreme maxima recorded were 105°F (June and July 2012) at Knoxville and 105°F (July 1952 and June 2012) at Oak Ridge, and the extreme minima (during January 1985) were -24°F and -17°F, respectively.

Table 2.7.4-6 compares the mean monthly and annual temperatures from the CRN Site to the climatological average monthly and annual temperatures at the Oak Ridge NWS Station and

Knoxville NWS Station. These data indicate a consistency between the CRN Site temperatures with those at the NWS Stations. Average yearly dry-bulb temperatures are around 59°F. The maximum monthly average temperature is approximately 78°F (July) at each location. The minimum monthly average temperature ranges from around 38°F to 42°F (January) with the CRN Site having the slightly higher temperature. In general the monthly mean temperatures at the 10-m level for the site correspond well with the Oak Ridge NWS Station temperatures, with the greatest difference being in September and October (around 4°F).

During the approximately two year period of the most current data collection at the CRN Site, the maximum dry bulb temperature was 100.95°F at 60-m and 102.17°F at 10-m (both in June 2012), and the minima temperatures recorded were 17.36°F at 60-m (February 2012) and 17.18°F at 10-m (January 2012).

2.7.4.1.3 Atmospheric Moisture

Humidity

Long-term relative humidity and wet bulb temperatures for the Knoxville NWS Station and the Oak Ridge NWS Station are presented in Table 2.7.4-7, along with the short-term data based on 10-m measurements at the onsite meteorological tower.

CRN Site data trend well with the long-term data. The mean annual relative humidity is 75.02 percent at the CRN Site which compares well to the long-term mean annual relative humidity of 73 percent at Knoxville NWS Station. The CRN Site data ranges from 66.10 percent in March to 80.90 percent in September. The Knoxville NWS Station data range is 65 percent in April to 76 percent in August.

Wet-bulb temperature annual averages are 53.01°F at the CRN Site, 50.2°F at the Oak Ridge NWS Station, and 51.9°F at the Knoxville NWS Station (Reference 2.7.4-2; Reference 2.7.4-1). Maximum monthly mean wet-bulb temperatures are 71.91°F, 69.0°F, and 69.9°F at the CRN Site, Oak Ridge NWS Station, and Knoxville NWS Station during July. Minimum monthly mean wet bulb temperatures are recorded in January; these are 37.41°F, 31.0°F, and 33.5°F for the CRN Site, Oak Ridge NWS Station, and Knoxville NWS Station, respectively.

The maximum 5-day average of daily wet bulb temperatures at the CRN Site, for the period from April 21, 2011 through June 30, 2013, was 74.36°F at 60-m and 75.12°F at 10-m. The concurrent 5-day average of daily wet bulb temperatures at the Oak Ridge NWS Station was 75.41°F. For a 30-day period, the maximum average of daily wet bulb temperatures at the CRN Site was 72.61°F at 60-m and 73.34°F at 10- m, and the concurrent 30-day average wet bulb temperature at the Oak Ridge NWS Station was 73.96°F.

Concurrent mean monthly dew point temperatures and wet bulb temperatures are presented and compared for the CRN Site, the Oak Ridge NWS Station, and Watts Bar Nuclear Plant in Figures 2.7.4-8 and 2.7.4-9 for the period from April 2011 through June 2013. The plots indicate good agreement between concurrent data. Average maximum and minimum monthly dew point temperatures are presented in Table 2.7.4-7 for the 10-m level at the CRN Site and Oak Ridge NWS Station. The data show that corresponding temperatures are generally within a degree or two of each other.

Precipitation

Valid reliable onsite precipitation observations are not available from the CRN Site. Hourly data collected at the Oak Ridge NWS Station (approximately 12 miles [mi] northeast of the CRN Site) are used in the absence of valid onsite data.

Precipitation data from the Oak Ridge NWS Station are presented in Table 2.7.4-8. Precipitation occurs an average of about 125 days per year, and the normal annual precipitation is nearly 51 in. The maximum monthly rainfall has ranged from about 7 in. to just over 19 in. The minimum monthly amount was a trace in October 1963. The maximum in 24 hr was 7.48 in. in August 1960. With the exception of late-summer/early-autumn (which are slightly dryer) precipitation is fairly uniformly distributed through the year. March and July are normally the wettest months of the year.

The Oak Ridge NWS Station precipitation data during the 2011 through 2013 CRN sampling period are presented in Table 2.7.4-9. The data show that the years 2011 and 2013 were much wetter than normal, and 2012 was slightly dryer though close to normal. Precipitation was approximately 22 in. greater than normal for the CRN sampling period.

Approximately 49 thunderstorms occur in a typical year (Table 2.7.4-8). Thunderstorm activity is greatest during the spring and summer months, and the maximum frequency of thunderstorm days is normally in July.

Table 2.7.4-10 shows composite 2011 through 2013 precipitation data based on the Oak Ridge NWS Station hourly precipitation and CRN wind directions. For lighter precipitation events, precipitation was primarily associated with wind directions from SW-NW with a secondary maximum for wind directions from NE-ENE. For periods of greatest precipitation intensity, winds were from the south-southeast (SSE), WNW or NW.

Snow

Appreciable snowfall is relatively infrequent in the area. Snowfall data are summarized in Table 2.7.4-11 for Knoxville NWS Station and Oak Ridge NWS Station. Mean annual snowfall has ranged from 6.5 in. at Knoxville NWS Station to about 11 in. at Oak Ridge NWS Station. The maximum normal monthly snowfall is 2.7 in. in January at Knoxville NWS Station and 4.0 in. at Oak Ridge NWS Station in January.

Generally, significant snowfall is limited to November through March. Respective 24-hr maximum snowfalls are 18.2 and 12.0 in. at Knoxville NWS Station and Oak Ridge NWS

Station. Recorded maximum monthly snowfalls are 23.3 in. (February 1960) at Knoxville NWS and 21.0 in. (March 1960) at Oak Ridge NWS Station.

Fog

The occurrence of heavy fog at Knoxville NWS Station and Oak Ridge NWS Station is summarized in Table 2.7.4-12. These data indicate that heavy fog (visibility ≤ 0.25 mi) occurs about 30 days per year at Knoxville NWS Station and 52 days per year at Oak Ridge NWS, with the autumn normally the foggiest season. Because the CRN Site is closer to the Oak Ridge NWS Station and due to both sites being located along the west side of the Appalachian Ridge and Valley Region, the CRN Site is likely to have conditions more similar to the Oak Ridge NWS Station than the Knoxville NWS Station.

2.7.4.1.4 Atmospheric Stability

Atmospheric stability is based on the temperature difference (ΔT interval) between the 60-m and 10-m levels from the CRN Site meteorological monitoring program. The frequency occurrence of Pasquill atmospheric stability classes (Classes A through G) is presented in Table 2.7.4-13. While neutral lapse conditions (Class D) occur most frequently of any one stability class (31.06 percent of the time), stable lapse conditions (classes E through G) occur almost 57 percent of the time. These stable conditions are indicative of ground level inversions, which can inhibit the dispersion of contaminants released into the atmosphere. The most common stable case is Stability Class E which occurs on the order of 23 percent of the time. The most stable class (class G) occurs 17 percent of the time. Unstable conditions which are associated with more rapid dispersion occur about 12 percent of the time.

Inversions

Table 2.7.4-14 summarizes the occurrence of consecutive hours of stability classes E, F, or G based on the CRN Site data collected from April 21, 2011 through June 30, 2013. The longest contiguous period of stable conditions, which are indicative of inversion conditions, is 19 hr. This occurred four times over the CRN Site data collection period.

Mixing Heights

Average morning and afternoon mixing heights for the region are based on data provided by Holzworth for the four seasons and annually (Reference 2.7.4-3). Mixing heights are presented in Table 2.7.4-15. Mixing height defines the vertical extent of the mixing layer. Generally, as the mixing layer height increases air contaminant concentrations decrease. Table 2.7.4-15 shows that average mixing heights in the region extend to almost 1900 m during summer afternoons. This is typical of summer afternoon conditions when the ground is heated by the sun, and the ground then heats the lower part of the atmosphere. This heating of the atmosphere (from the ground up) results in the building up of the mixing layer.

2.7.4.2 Topographic Description and Potential Modifications

The CRN Site elevation ranges from 745 feet (ft) above mean sea level (msl) to 940 ft msl on a peninsula formed by a meander in the Clinch River arm of the Watts Bar Reservoir. Terrain in the vicinity of the CRN Site (Figure 2.7.4-10) is characterized as alternating ridges and valleys oriented along a southwest-to-northeast axis. Nearby ridges reach an elevation of 1100 ft msl (approximately 300 ft above plant grade). There are significant gaps in the ridges to the east (Clinch River arm of the Watts Bar Reservoir flowing into the CRN Site), south-southeast (Caney Creek flowing into Clinch River arm of the Watts Bar Reservoir), and northwest (Clinch River arm of the Watts Bar Reservoir flowing away from the CRN Site).

Figure 2.7.4-12 provides line diagrams of the maximum elevation at the 16 compass directions radiating out from the CRN Site to a distance of 50 mi (80 kilometers).

The geographic orientation of the ridges and valleys generally aligns with the prevailing regional winds from the southwest, but the gaps in the ridges permit wind flow from other directions as well. The combination of high pressure associated with the Azores-Bermuda anti-cyclonic circulation and the nearby ridges result in generally light wind speeds. Average surface wind speeds for the site are 2.74 mph at the 10-m level and 4.86 mph at the 60-m level.

Meteorological measurements were made using three different meteorological towers on the CRN Site over different periods of time (Table 2.7.4-16). Data from the three meteorological towers were used to evaluate the impact of topography. The principal impact is on wind direction (Figure 2.7.4-11).

The predominant up-valley/down-valley flow is readily apparent at the three meteorological towers (Figure 2.7.4-11) that have collected data at the CRN Site. For the meteorological towers and all time periods, levels 25-m and higher have two peaks in the wind direction frequency; up-valley from the SW-WSW, and down-valley from the NE-ENE. This bimodal flow also exists at the 10-m levels for the three meteorological towers (Figure 2.7.4-11), though not as prominent as at the upper, 60-m level.

However, local effects are also apparent, due to the placement of the meteorological towers relative to surrounding terrain (see Table 2.7.4-16 for meteorological tower descriptions).

- The 10-m level on the supplemental Meteorological Tower (Ms) has a much greater frequency of winds from the ENE-E than the other towers, because it is more exposed to wind flow from the E. Clinch River arm of the Watts Bar Reservoir Gap. At the other meteorological towers, the flow through this gap tends to merge with the overall down-valley flow.
- The 10-m level on the primary Meteorological Tower (Mp) has a greater frequency of winds from the SSE than the other meteorological towers, because of wind flow from the Caney Creek Gap.

- The temporary Meteorological Tower (Mt) has a noticeable sharp peak at all levels for winds from the WNW, due to wind flow from the N. Clinch River arm of the Watts Bar Reservoir Gap, and the river orientation near the meteorological tower site. This sharp peak is not as apparent at the other meteorological towers (Figure 2.7.4-11).

2.7.4.3 Potential Influence of Plant and its Facilities on Local Air Meteorology

Larger structures onsite would influence wind conditions (wind speed, direction and turbulence), although these effects are not expected to be significant beyond 10 building/structure heights from the building or structure in question (NRC RG 1.23). Close in to the measuring location, added turbulence from building structures can enhance the near-field dispersion of air contaminants, thus reducing ambient concentrations.

The only facility systems which may have any noticeable effects on the local meteorology are cooling towers. There would also be some minor impacts on local air quality during construction.

Cooling tower impacts are addressed in Section 5.3. Construction impacts would be mitigated using construction best management practices according to TVA procedures.

2.7.4.4 Global Climate Change

The expected operating life time for the CR SMR Project is 40 to 60 yr dependent on extension requests. Historical long-term meteorological data are evaluated and used for consideration of the project’s impact on the CRN Site’s surroundings. Though global climate change, in both its magnitude effects, is uncertain, projected trends are discussed in relationship to current conditions. Consistent with NRC Interim Staff Guidance 026 (August 2014), the following considers the normal project life time and resources that may be impacted by climate change.

The National Climate Assessment (NCA) Report provides detailed information related to the potential effects of climate change on the United States by region. The CRN Site is located in the southeast region as defined by the report. In general the NCA Report states that the southeast region is “vulnerable to sea level rise, extreme heat events, hurricanes, and decreased water availability”. (Reference 2.7.4-4)

The NCA Report found that over the last 100 yr, the southeast has experienced the following cycles of extended warm and cool periods:

- Warm temperatures peaked during the 1930s and 1940s
- Cooler temperatures occurred during the 1960s and 1970s
- Warmer temperatures have occurred from the 1970s until present (with an average increase of 2°F) (Reference 2.7.4-4)

Further, there have been an increasing number of days that exceed 95°F, nights that exceed 75°F, and a decrease in the number of “extremely cold” days since the 1970s (Reference 2.7.4-4).

The report projects that southeast region temperatures are expected to increase from 4°F to 8°F by the year 2100 (Reference 2.7.4-4). These are probabilistic predictions; however, if these numbers are simply interpolated for the next 50 yr, results indicate an approximate increase of 2°F to 4°F for the operating life time of the CR SMR Project. With these increased temperatures, the report also finds that the number of days that exceed 95°F would increase and there is likely to be a decrease in days with freezing temperatures (Reference 2.7.4-4).

The NCA report states that precipitation pattern projections for the southeast “are less certain than projections for temperature increases” in the southeast. This is primarily due to the southeast being located in a “transition zone” between the southwestern United States, which is dryer and the Northern United States, which is wetter. Model predictions therefore only show “small changes relative to natural variations.” Though precipitation patterns are uncertain, the NCA Report finds that reduced water availability is expected from increased evaporation due to higher temperatures in the southeast. (Reference 2.7.4-4)

The NCA has investigated severe weather events including hurricane and tornadoes. The NCA Report states that warmer temperature projections would result in a decrease in tropical storms globally, however, those that develop would be of greater intensity (Reference 2.7.4-4). The CRN Site is generally too far inland to experience the most severe impacts of hurricanes. For tornadoes, the study reports that the number of major tornadoes has increased in the past 50 yr, however, there is “no statistically significant trend.” The study indicates that the increase in the number of tornadoes reported may be attributable to expanded and better reporting of tornadoes. (Reference 2.7.4-4)

Projections indicate sea levels are expected to rise around coastal areas of the southeast Threats associated with these conditions would not have a direct effect on the CRN Site due to its inland location and significant elevation above sea level.

Based on the NCA Report, the greatest potential effects of climate change are increased temperatures and reduced water availability for the CRN Site and its surroundings. As the models used to develop these projections are based on future estimates of population growth, land use, energy consumption, emissions patterns, etc., there is a level of uncertainty associated with the events and meteorological conditions predicted. The CR SMR Project is required to continuously monitor meteorological and environmental conditions throughout the life cycle of the project to ensure it remains within its allowable licensed limits of operation.

2.7.4.5 References

Reference 2.7.4-1. National Oceanic and Atmospheric Administration, 2013 Local Climatological Data Annual Summary with Comparative Data - Oak Ridge, Tennessee, Website: http://www.ncdc.noaa.gov/IPS/lcd/lcd.html, 2015.

Reference 2.7.4-2. National Oceanic and Atmospheric Administration, 2013 Local Climatological Data Annual Summary with Comparative Data - Knoxville, Tennessee, Website: http://www.ncdc.noaa.gov/IPS/lcd/lcd.html, 2015.

Reference 2.7.4-3. U.S. Environmental Protection Agency, "Mixing Heights, Wind Speeds, and Potential for Urban Air Pollution Throughout the Contiguous United States-Table B-1," January, 1972.

Reference 2.7.4-4. U.S. Global Change Research Program, "Climate Change Impacts in the United States - Chapter 17 Southeast and the Caribbean," October, 2014.

Reference 2.7.4-5. National Oceanic and Atmospheric Administration, 2011 Local Climatological Data - Oak Ridge, Tennessee, Website: http://www.ncdc.noaa.gov/IPS/lcd/lcd.html, April, 2011.

Reference 2.7.4-6. National Oceanic and Atmospheric Administration, 1998 Local Climatological Data Annual Summary with Comparative Data - Oak Ridge, Tennessee, Website: http://www.ncdc.noaa.gov/IPS/lcd/lcd.html, 2015.

Reference 2.7.4-7. National Oceanic and Atmospheric Administration, 2012 Local Climatological Data Annual Summary with Comparative Data - Oak Ridge, Tennessee, Website: http://www.ncdc.noaa.gov/IPS/lcd/lcd.html, 2015.

Reference 2.7.4-8. National Oceanic and Atmospheric Administration, 2011 Local Climatological Data Annual Summary with Comparative Data - Oak Ridge, Tennessee, Website: http://www.ncdc.noaa.gov/IPS/lcd/lcd.html, 2015.

Table 2.7.4-1
Comparisons of Meteorological Tower Measurements

a. Historical Primary Tower Measurements

Variable	February 16, 1977 to March 6, 1978			March 25, 1982 to November 4, 1983			April 21, 2011 to June 30, 2013		
	Min	**Avg**	Max	Min	**Avg**	Max	Min	**Avg**	Max
60-m Average (scalar) Wind Speed (mph)	0.0	**5.70**	33.0	0.1	**4.90**	32.8	0.3	**4.88**	27.1
10-m Average (scalar) Wind Speed (mph)	0.0	**3.45**	19.6	0.1	**2.80**	19.2	0.2	**2.75**	15.1
60-m Temperature (°F)	4.60	**55.64**	92.70	16.38	**60.81**	98.12	17.36	**60.03**	100.95
10-m Temperature (°F)	4.60	**54.92**	93.90	16.93	**60.06**	99.44	17.18	**59.11**	102.17
10-m Dewpoint (°F)	-13.1	**46.19**	76.90	-5.13	**52.12**	79.19	-3.43	**50.05**	78.19
Solar Radiation (langley/min)	0.00	**0.23**	1.43	0.00	**0.26**	1.48	0.00	**0.27**	1.51
60-10 Stability (from ΔT)	% Occurrence			% Occurrence			% Occurrence		
Unstable (Classes A-C)	7.88			13.02			13.69		
Neutral (Class D)	36.63			33.10			30.05		
Stable (Class E-G)	55.49			53.88			56.26		

b. Comparison of 10-meter CRN Site with Offsite Locations[1]

Variable	CRN 10-meters			Oak Ridge NWS[2]			Watts Bar Nuclear 10-meters		
	Min	**Avg**	Max	Min	**Avg**	Max	Min	**Avg**	Max
Wind Speed (mph)	0.2	**2.75**	15.1	0	**2.31**	26	0.00	**3.46**	17.3
Temperature (°F)	17.18	**59.11**	102.17	17	**60.79**	105	17.71	**60.70**	102.77
Dewpoint (°F)	-3.43	**50.05**	78.19	-10	**49.44**	77	-3.05	**50.28**	78.30

1 Data Period: April 21, 2011 to June 30, 2013.
2 2011 – 2013 Oak Ridge LCDs (Reference 2.7.4-5)

c. Average CRN 10-meter wind speeds (2011 through 2013)

		Average 10-meter Wind Speed (mph)
2011	2nd quarter	2.74
	3rd quarter	2.29
	4th quarter	2.59
2012	1st quarter	3.30
	2nd quarter	2.49
	3rd quarter	2.07
	4th quarter	2.77
2013	1st quarter	3.72
	2nd quarter	2.79
OVERALL		**2.74**

Table 2.7.4-2 (Sheet 1 of 2)
CRN Site 10-Meter Joint Frequency Distribution by Wind Speed and Direction for All Stability Classes
(April 21, 2011 through July 9, 2013)

a. CRN Site 10-Meter Joint Frequency Distribution by Wind Speed and Direction for All Stability Classes (April 21, 2011 through July 9, 2013)

Wind Direction	Wind Speed (mph)									
	Calm	0.6 - 1.4	1.5 - 3.4	3.5 - 5.4	5.5 - 7.4	7.5 - 12.4	12.5 - 18.4	18.5 - 24.4	>=24.5	Total
N	0.110	1.788	1.348	0.467	0.156	0.005	0.000	0.000	0.000	3.873
NNE	0.112	1.576	1.617	0.752	0.073	0.000	0.000	0.000	0.000	4.129
NE	0.141	1.690	2.343	1.529	0.389	0.036	0.000	0.000	0.000	6.128
ENE	0.153	2.265	2.125	1.037	0.347	0.083	0.000	0.000	0.000	6.011
E	0.186	3.732	1.591	0.451	0.057	0.000	0.000	0.000	0.000	6.017
ESE	0.219	4.904	1.353	0.259	0.021	0.000	0.000	0.000	0.000	6.755
SE	0.191	4.095	1.384	0.197	0.005	0.010	0.000	0.000	0.000	5.883
SSE	0.116	2.208	1.125	0.347	0.114	0.119	0.000	0.000	0.000	4.030
S	0.102	1.337	1.571	0.793	0.378	0.311	0.026	0.000	0.000	4.518
SSW	0.091	0.974	1.643	0.793	0.244	0.026	0.000	0.000	0.000	3.772
SW	0.110	0.985	2.151	1.757	0.695	0.187	0.000	0.000	0.000	5.884
WSW	0.155	1.368	3.079	3.317	1.643	0.674	0.005	0.000	0.000	10.242
W	0.192	2.089	3.400	2.265	0.695	0.555	0.067	0.000	0.000	9.263
WNW	0.211	2.960	3.079	1.700	1.223	0.917	0.041	0.000	0.000	10.132
NW	0.178	2.877	2.213	1.591	1.218	1.166	0.010	0.000	0.000	9.254
NNW	0.108	1.856	1.244	0.565	0.249	0.088	0.000	0.000	0.000	4.110
Subtotal	2.374	36.704	31.267	17.821	7.506	4.178	0.150	0.000	0.000	100.000

Total Hours Of Valid Wind Observations:	19292	Meteorological Facility: CRN Site
Total Hours Of Observations:	19464	Wind Speed and Direction Measured at 9.78 Meter Level
Recoverability Percentage:	99.1	Mean Wind Speed = 2.74
Total Hours Calm:	458	

Note: Totals and subtotals are obtained from unrounded numbers.

Table 2.7.4-2 (Sheet 2 of 2)
CRN Site 60-Meter Joint Frequency Distribution by Wind Speed and Direction for All Stability Classes
(April 21, 2011 through July 9, 2013)

b. CRN Site 60-Meter Joint Frequency Distribution by Wind Speed and Direction for All Stability Classes (April 21, 2011 through July 9, 2013)

Wind Direction	Wind Speed (mph)									
	Calm	**0.6 - 1.4**	**1.5 - 3.4**	**3.5 - 5.4**	**5.5 - 7.4**	**7.5 - 12.4**	**12.5 - 18.4**	**18.5 - 24.4**	**>=24.5**	**Total**
N	0.007	0.832	1.302	0.481	0.279	0.269	0.000	0.000	0.000	3.169
NNE	0.009	0.744	2.005	0.925	0.537	0.258	0.021	0.000	0.000	4.499
NE	0.010	0.785	2.382	1.829	1.468	1.679	0.109	0.005	0.005	8.273
ENE	0.012	0.775	2.899	1.674	1.147	0.801	0.026	0.000	0.000	7.334
E	0.009	0.816	2.046	0.868	0.341	0.114	0.010	0.000	0.000	4.205
ESE	0.007	0.827	1.390	0.372	0.114	0.078	0.010	0.000	0.000	2.797
SE	0.006	0.682	1.359	0.289	0.145	0.031	0.016	0.005	0.000	2.533
SSE	0.005	0.455	1.095	0.372	0.155	0.145	0.041	0.005	0.000	2.273
S	0.005	0.470	1.266	0.770	0.553	0.760	0.372	0.072	0.000	4.269
SSW	0.007	0.450	1.798	1.731	1.178	0.723	0.021	0.000	0.000	5.908
SW	0.008	0.481	2.212	2.723	2.186	2.088	0.176	0.000	0.000	9.873
WSW	0.013	0.729	3.271	3.473	2.666	2.377	0.563	0.052	0.000	13.143
W	0.014	1.044	3.566	2.356	1.504	1.690	0.584	0.284	0.026	11.068
WNW	0.012	1.049	2.687	1.359	1.256	2.336	1.080	0.103	0.005	9.887
NW	0.010	0.956	2.181	1.142	0.956	1.824	0.661	0.031	0.000	7.761
NNW	0.006	0.847	1.111	0.455	0.315	0.248	0.026	0.000	0.000	3.008
Subtotal	0.140	11.942	32.570	20.820	14.800	15.420	3.715	0.558	0.036	100.000

Total Hours Of Valid Wind Observations:	19352	Meteorological Facility: CRN Site
Total Hours Of Observations:	19464	Wind Speed and Direction Measured at 60.11 Meter Level
Recoverability Percentage:	99.4	Mean Wind Speed = 4.86
Total Hours Calm:	27	

Note: Totals and subtotals are obtained from unrounded numbers.

Table 2.7.4-3
10-Meter Wind Direction (WD) Persistence for CRN[1]

	Maximum Hours of WD Persistence		
	Same Sector	Three Adjoining Sectors (± 1 sector)	Five Adjoining Sectors (± 2 sectors)
N	6	15	59
NNE	7	15	35
NE	10	29	39
ENE	8	26	32
E	6	17	31
ESE	6	17	26
SE	6	13	25
SSE	10	17	25
S	8	14	23
SSW	4	14	39
SW	7	33	44
WSW	15	36	55
W	19	36	106
WNW	11	43	86
NW	15	46	67
NNW	7	45	69

[1] Data Period: April 21, 2011 through June 30, 2013

Note: Shading indicates maximum value.

Table 2.7.4-4

Air Temperatures for the Knoxville NWS Station

	Normal Daily Maximum (°F)	Normal Dry Bulb (°F)	Normal Daily Minimum (°F)	Extreme Daily Maximum (°F)	Extreme Daily Minimum (°F)
Period of Record (yrs)	30[1]	30[1]	30[1]	72[2]	72[2]
January	47.3	38.2	29.2	77	-24[4]
February	52.3	42.4	32.4	83	-8
March	61.4	50.3	39.2	86	1
April	70.3	58.8	47.3	92	22
May	78.1	67.2	56.2	96	32
June	85.4	75.0	64.7	105[3]	43
July	88.2	78.4	68.7	105[3]	49
August	87.8	77.8	67.8	102	49
September	81.8	71.1	60.4	103	36
October	71.2	59.9	48.5	91	25
November	60.4	49.7	39.0	84	5
December	49.8	40.8	31.7	80	-6
Annual[5]	69.5	59.1	48.8	105[3]	-24[4]

1 1981 to 2010
2 Precise dates unavailable
3 June 2012 and July 2012
4 January 1985
5 Annual average for “Normal” data columns and extreme value over period of record in the two right most “Extreme” data columns.

Source: (Reference 2.7.4-2)

Table 2.7.4-5

Air Temperatures for the Oak Ridge NWS Station

	Normal Daily Maximum (°F)	Normal Dry Bulb (°F)	Normal Daily Minimum (°F)	Extreme Daily Maximum (°F)	Extreme Daily Minimum (°F)
Period of Record (yrs)	*30*[1]	*30*[1]	*30*[1]	*66*[2]	*66*[2]
January	46.6	37.7	28.9	76	-17[4]
February	51.9	41.8	31.7	79	-13
March	61.4	50.4	39.3	86	1
April	70.6	58.8	46.9	92	20
May	78.3	66.8	55.2	95	30
June	85.7	75.1	64.5	105[3]	39
July	88.4	78.5	68.6	105[3]	49
August	88.0	77.6	67.2	103	50
September	81.7	70.7	59.7	102	33
October	71.1	59.5	48.0	90	21
November	59.6	48.9	38.3	83	0
December	49.6	40.3	31.1	78	-7
Annual[5]	69.4	58.8	48.3	105[3]	-17[4]

1 1981 to 2010
2 Precise dates unavailable
3 July 1952 and June 2012
4 January 1985
5 Annual average for “Normal” data columns and extreme value over period of record in the two right most “Extreme” data columns.

Source: (Reference 2.7.4-1)

Table 2.7.4-6
CRN Site, Oak Ridge and Knoxville Mean Monthly Dry Bulb Temperatures

	CRN Site[1]		NWS Stations[2]	
	60-Meter Mean Dry-Bulb Temperature (°F)	**10-Meter Mean Dry-Bulb Temperature (°F)**	**Oak Ridge Normal Dry-Bulb Temperature (°F)**	**Knoxville Normal Dry-Bulb Temperature (°F)**
Jan	41.80	40.98	37.7	38.2
Feb	43.53	42.68	41.8	42.4
Mar	51.64	50.86	50.4	50.3
Apr	59.92	59.15	58.8	58.8
May	66.78	65.96	66.8	67.2
Jun	73.94	73.07	75.1	75.0
Jul	78.27	77.67	78.5	78.4
Aug	75.35	74.30	77.6	77.8
Sep	67.40	66.58	70.7	71.1
Oct	56.34	55.41	59.5	59.9
Nov	48.77	47.09	48.9	49.7
Dec	45.12	43.97	40.3	40.8
Annual Average	59.07	58.14	58.8	59.1

1 Data Period: April 21, 2011 through June 30, 2013
2 (Reference 2.7.4-2; Reference 2.7.4-1)

Table 2.7.4-7
Relative Humidity and Wet Bulb Temperatures for CRN Site (10-Meters), Oak Ridge NWS Station, and Knoxville NWS Station

	Mean Relative Humidity (%)		Mean Wet Bulb Temperatures (°F)		
	CRN Site 10-meters[1]	Knoxville[2]	CRN Site 10-meters[1]	Oak Ridge[3]	Knoxville[2]
Jan	74.30	74	37.41	31.0	33.5
Feb	69.10	70	38.29	32.8	36.0
Mar	66.10	66	44.90	40.2	43.0
Apr	68.45	65	51.74	48.8	50.4
May	76.83	73	60.46	58.3	59.6
Jun	75.70	75	66.69	65.2	66.6
Jul	79.00	75	71.91	69.0	69.9
Aug	76.50	76	67.92	68.3	69.1
Sep	80.90	75	62.10	62.0	63.2
Oct	77.30	75	50.86	51.2	52.6
Nov	76.35	74	42.97	41.0	43.0
Dec	79.65	75	40.89	34.1	36.1
Annual	75.02	73	53.01	50.2	51.9

[1] Data from CRN Site April 2011 through June 2013
[2] 30 years of data (Reference 2.7.4-2)
[3] Relative humidity not available. 14 years of data. (Reference 2.7.4-1)

CRN Site (10-Meter) and Oak Ridge NWS Station Average Maximum and Minimum Monthly Dew Point Temperatures

	CRN Site (10-meters)		Oak Ridge NWS Station	
	Average Maximum Dew Point Temperature (°F)	Average Minimum Dew Point Temperature (°F)	Average Maximum Dew Point Temperature (°F)	Average Minimum Dew Point Temperature (°F)
Jan	33.80	30.67	32.34	31.58
Feb	35.05	26.65	34.30	28.40
Mar	45.89	31.03	45.89	29.55
Apr	54.65	44.09	54.59	42.93
May	60.11	54.95	59.66	54.78
Jun	65.82	59.96	65.59	58.81
Jul	70.47	68.90	70.54	68.68
Aug	65.30	64.75	65.42	64.51
Sep	59.80	59.49	59.66	59.24
Oct	47.88	46.45	46.99	46.02
Nov	41.96	35.13	41.33	33.04
Dec	37.92	36.90	37.05	36.54
Annual	55.24	43.33	55.17	42.37

Note: Data from CRN Site April 2011 through June 2013

Table 2.7.4-8
Historical Precipitation Data for the Oak Ridge NWS Station

	Normal Monthly (in.)	Maximum Monthly (in.)	Minimum Monthly (in.)	Maximum in 24 hours (in.)	Days with Precipitation (≥ 0.01 inch)	Days with Thunderstorms[1]
Period of Record (yrs)	*30*[2]	*66*[3]	*66*[3]	*66*[3]	*30*[2]	*17*[3]
January	4.54	13.27	0.93	4.25	10.9	0.7
February	4.57	12.78	0.84	5.18	10.1	1.7
March	5.06	12.24	2.13	4.74	11.2	2.5
April	4.18	14.03	0.88	6.24	10.4	4.0
May	4.29	10.70	0.80	4.41	11.9	7.0
June	4.28	11.14	0.53	3.70	10.8	7.6
July	5.27	19.27[4]	1.23	4.91	13.0	10.4
August	2.76	10.46	0.54	7.48[6]	8.9	8.7
September	3.69	10.14	0.41	6.54	8.4	3.3
October	2.92	6.95	T[5]	2.66	8.3	1.3
November	4.49	12.22	1.14	5.29	9.3	1.1
December	4.86	12.64	0.67	5.12	11.3	0.8
Annual[7]	50.91	19.27[4]	T[5]	7.48[6]	124.5	49.1

1 From 1998 Annual Oak Ridge Local Climatological Data
2 1981 to 2010
3 Precise dates unavailable
4 July 1967
5 October 1963 (T=Trace)
6 August 1960
7 Values in columns “Normal Monthly”, “Days with Precipitation (≥ 0.01 inch)”, and “Days with Thunderstorms” are total over the 12 months. Other columns provide the extreme monthly value.

Sources:
(Reference 2.7.4-1; Reference 2.7.4-6)

Table 2.7.4-9
Precipitation at the Oak Ridge NWS Station During CRN Meteorological Sampling Period

Year	Month	Monthly Observed[1] (in.)	Annual[1] (in.)	Monthly Normal[2] (in.)	Annual[2] (in.)
2011	January	3.99	71.26	4.54	50.91
	February	5.70		4.57	
	March	6.65		5.06	
	April	9.13		4.18	
	May	2.14		4.29	
	June	7.30		4.28	
	July	4.80		5.27	
	August	0.91		2.76	
	September	10.14		3.69	
	October	4.59		2.92	
	November	10.89		4.49	
	December	5.02		4.86	
2012	January	6.52	48.49	4.54	50.91
	February	3.76		4.57	
	March	5.59		5.06	
	April	3.10		4.18	
	May	2.84		4.29	
	June	1.40		4.28	
	July	5.84		5.27	
	August	2.89		2.76	
	September	7.17		3.69	
	October	1.66		2.92	
	November	1.14		4.49	
	December	6.58		4.86	
2013	January	10.51	67.39	4.54	50.91
	February	2.32		4.57	
	March	5.72		5.06	
	April	6.37		4.18	
	May	5.33		4.29	
	June	7.92		4.28	
	July	8.04		5.27	
	August	4.61		2.76	
	September	3.38		3.69	
	October	0.72		2.92	
	November	4.43		4.49	
	December	8.04		4.86	
CRN Sampling Period (May 2011 to June 2013):		132.45		110.39	
Total Period (2011 to 2013):			**187.14**		152.73

1 (Reference 2.7.4-7; Reference 2.7.4-8; Reference 2.7.4-1)
2 (Reference 2.7.4-1)
Note: Shaded area indicates CRN Site meteorological monitoring data collection period.

Table 2.7.4-10
Oak Ridge NWS Station Precipitation by CRN Wind Direction

CRN Wind Direction (blowing from)	Percent Occurrence of Oak Ridge Precipitation				
	All Precipitation	Precip. > 0.10 in.	Precip. > 0.25 in.	Precip. > 0.50 in.	Precip. > 1.00 in.
N	3.81	5.03	10.17	6.45	0.00
NNE	3.81	3.66	3.39	6.45	0.00
NE	7.99	9.38	6.78	3.23	0.00
ENE	6.93	9.15	5.93	0.00	0.00
E	4.91	5.49	5.08	0.00	0.00
ESE	3.73	4.12	5.08	3.23	0.00
SE	2.80	2.75	2.54	3.23	0.00
SSE	3.04	2.97	4.24	9.68	33.33
S	4.58	3.66	5.93	0.00	0.00
SSW	3.65	4.12	6.78	12.90	0.00
SW	6.16	7.09	11.02	12.90	0.00
WSW	12.49	9.38	7.63	16.13	0.00
W	11.64	11.67	8.47	3.23	0.00
WNW	11.35	7.78	5.08	6.45	33.33
NW	8.56	8.24	3.39	3.23	33.33
NNW	4.54	5.49	8.47	12.90	0.00

Note: Data Period: April 21, 2011 to June 30, 2013

Table 2.7.4-11
Historical Snowfall (Inches) for the Knoxville and Oak Ridge NWS Stations

	Normal Monthly	**Maximum Monthly**	**Maximum in 24 hours**	**Maximum Snow Depth (in.)**	**Normal Number of Days with Snowfall ≥ 1.0 in.**
			Knoxville		
Period of Record (yrs)	*30*[1]	*69*[2]	*69*[2]	*62*[2]	*30*[1]
January	2.7	15.1	12.0	10	1.0
February	1.6	23.3[3]	17.5	15[5]	0.6
March	0.9	20.2	14.1	15[5]	0.2
April	0.5	10.7	10.7	7	0.1
May thru October	0.0	T	T	0	0.0
November	0.0	18.2	18.2[4]	10	0.0
December	0.8	12.2	8.9	6	0.3
Annual	6.5	23.3[3]	18.2[4]	15[5]	2.2
			Oak Ridge		
Period of Record (yrs)	*30*[5]	*51*[2]	*51*[2]	*33*[2]	*30*[5]
January	4.0	9.6	8.3	8	1.4
February	3.8	17.2	11.3	6	1.3
March	0.8	21.0[7]	12.0[7]	3	0.2
April	0.2	5.9	5.4	3	0.1
May thru October	0.0	T	T	0	0.0
November	0.1	6.5	6.5	1	0.0
December	2.2	14.8	10.8	10[8]	0.6
Annual	11.1	21.0[7]	12.0[7]	10[8]	3.6

[1] 1981 to 2010
[2] Precise dates unavailable
[3] February 1960
[4] November 1952
[5] February 1960 and March 1993
[6] 1961 to 1990
[7] March 1960
[8] December 1963

Note:
T = Trace

Sources: (Reference 2.7.4-2; Reference 2.7.4-6)

Table 2.7.4-12
Fog Occurrence for the Knoxville and Oak Ridge NWS Stations

	Number of Days with Heavy Fog (visibility ≤ 1/4 mile)	
	Knoxville	**Oak Ridge**
Period of Record (yrs)	*50*[1]	*14*[1]
January	2.6	2.2
February	1.8	1.4
March	1.6	1.7
April	1.3	2.3
May	2.2	5.4
June	1.7	4.5
July	2.0	5.5
August	3.3	5.3
September	3.7	7.5
October	4.2	7.5
November	2.9	5.0
December	2.4	3.6
Total Annual	29.7	51.9

[1] Precise dates unavailable

Sources: (Reference 2.7.4-2; Reference 2.7.4-1)

Table 2.7.4-13
Pasquill Atmospheric Stabilities for CRN Site

Stability Class	***Percent***
A	2.83
B	3.51
C	6.01
D	31.06
E	23.23
F	16.34
G	17.01
Unstable (A through C)	12.35
Neutral (D)	31.06
Stable (E through G)	56.59

Note: Atmospheric Stability Class based on 60-10 meter
ΔTemperature Difference for June 1, 2011 to May 31, 2013.

Table 2.7.4-14
Frequency Distribution of Consecutive Hours of Inversion Conditions[1]

Number of Consecutive Hours	All Inversion Conditions (Stability Classes E, F or G)
2	847
3	763
4	713
5	672
6	653
7	630
8	601
9	573
10	548
11	518
12	481
13	392
14	268
15	170
16	97
17	51
18	20
19	4
20	0

1 CRN Site Data for Period: April 21, 2011 through June 30, 2013

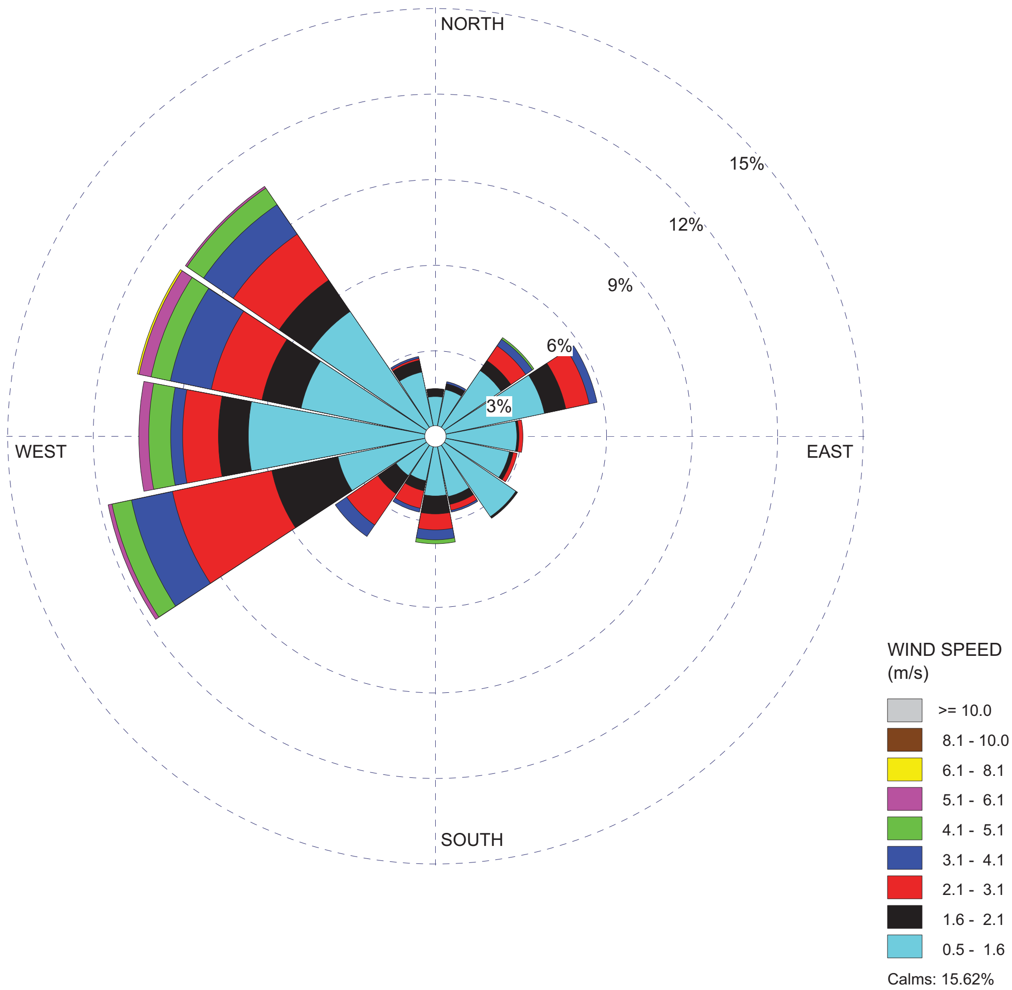
Table 2.7.4-15
Average Mixing Height Data[1]

	Morning Mixing Height (meters)	Afternoon Mixing Height (meters)
Winter	563	1123
Spring	606	1783
Summer	441	1874
Autumn	357	1473
Annual	492	1563

1 Based on data for Nashville, TN. (Reference 2.7.4-3)

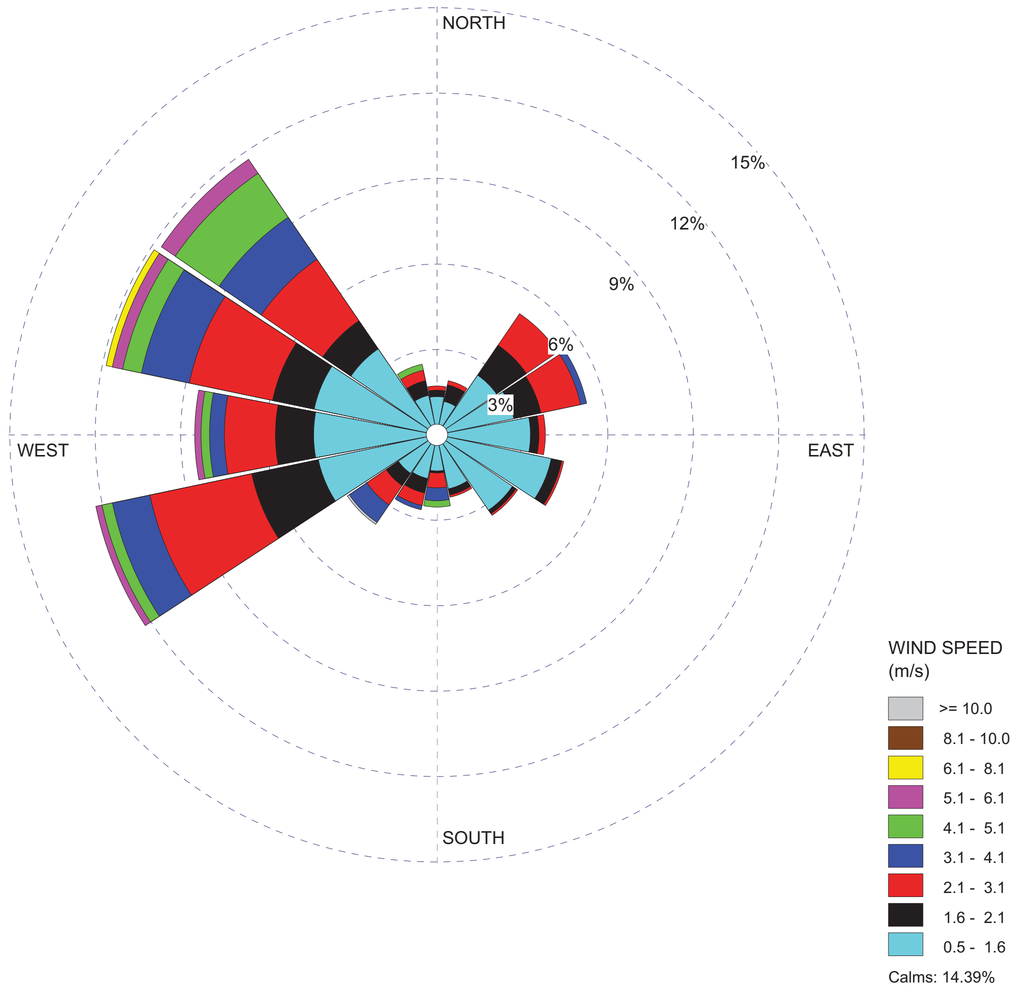
Table 2.7.4-16
CRN Site Historical Meteorological Towers

Tower	Location	Data Collected	Data Collection Period
Clinch River Breeder Reactor Project (CRBRP)			
[Mt] Temporary	Latitude: 35° 53' 20" N Longitude: 84° 23' 10" W Elevation: 772.5 ft-msl UTM: Zone 16 Northing = 3974.58 km Easting = 735.95 km	60-, 25-m Wind 60-, 25-m Temperature	April 11, 1973 to April 2, 1974
		60-, 25-, 10-m Wind 60-, 25-, 10-m Temperature 10-m Dewpoint (1975+)	April 3, 1974 to March 2, 1978
[Mp] Primary	Latitude: 35° 53' 07" N Longitude: 84° 22' 33" W Elevation: 800.1 ft-msl UTM: Zone 16 Northing = 3974.21 km Easting = 736.88 km	110-, 60-, 10-m Wind 110-, 60-, 10-m Temperature 10-m Dewpoint Rainfall Atmospheric Pressure Solar Radiation	February 16, 1977 to March 6, 1978
		110-, 60-, 10-m Wind 110-, 60-, 10-m Temperature 10-m Dewpoint Rainfall Solar Radiation	March 25, 1982 to November 4, 1983
[Ms] Supplemental	Latitude: 35° 53' 43" N Longitude: 84° 22' 56" W Elevation: 851.9 ft-msl UTM: Zone 16 Northing = 3975.31 km Easting = 736.28 km	10-m Wind	February 16, 1977 to March 6, 1978
		10-m Wind	March 25, 1982 to November 4, 1983
CRN Site			
[Mp] Primary	**Same as CRBRP Primary** Latitude: 35° 53' 07" N Longitude: 84° 22' 33" W Elevation: 800.1 ft-msl UTM: Zone 16 Northing = 3974.21 km Easting = 736.88 km	60-, 10-m Wind 60-, 10-m Temperature 60-, 10-m Dewpoint Rainfall Atmospheric Pressure Solar Radiation	April 21, 2011 to July 9, 2013



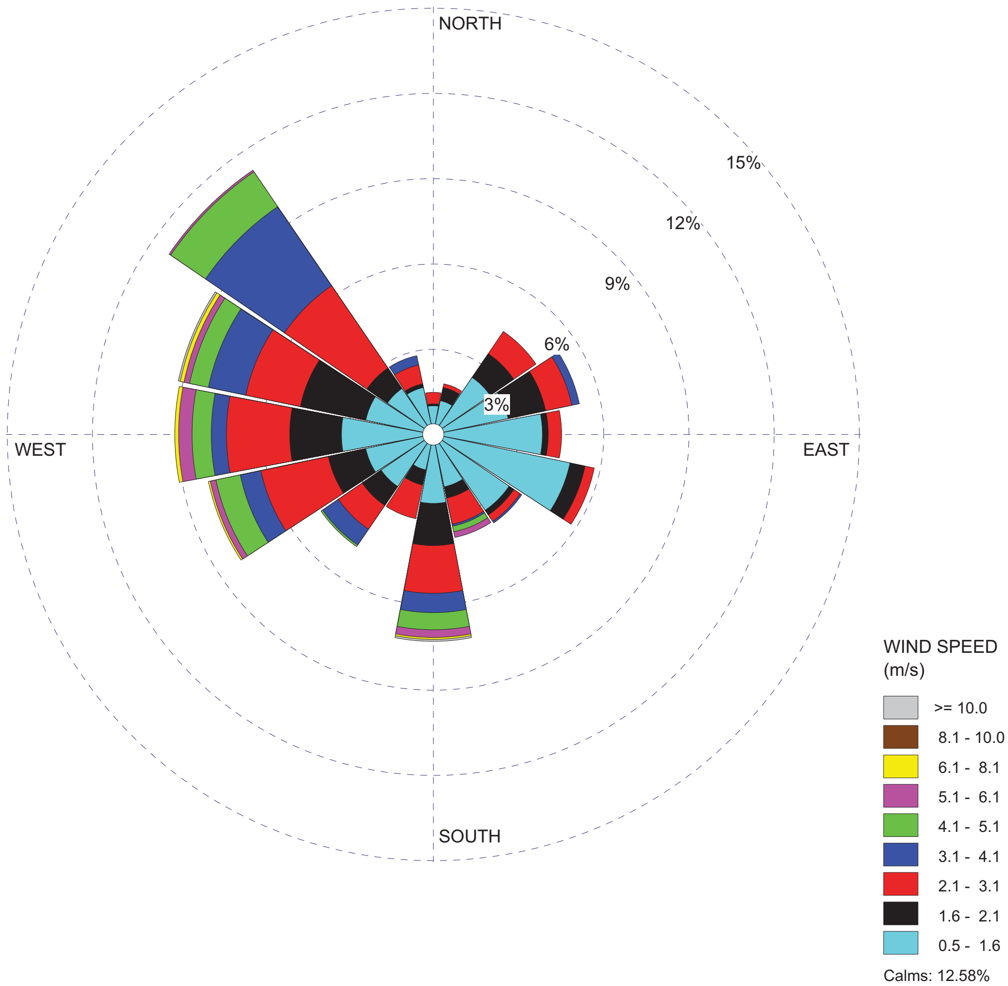
Sampling Period: April 21, 2011 to June 30, 2013

Figure 2.7.4-1. (Sheet 1 of 12) Wind Rose CRN Site 10-meter January



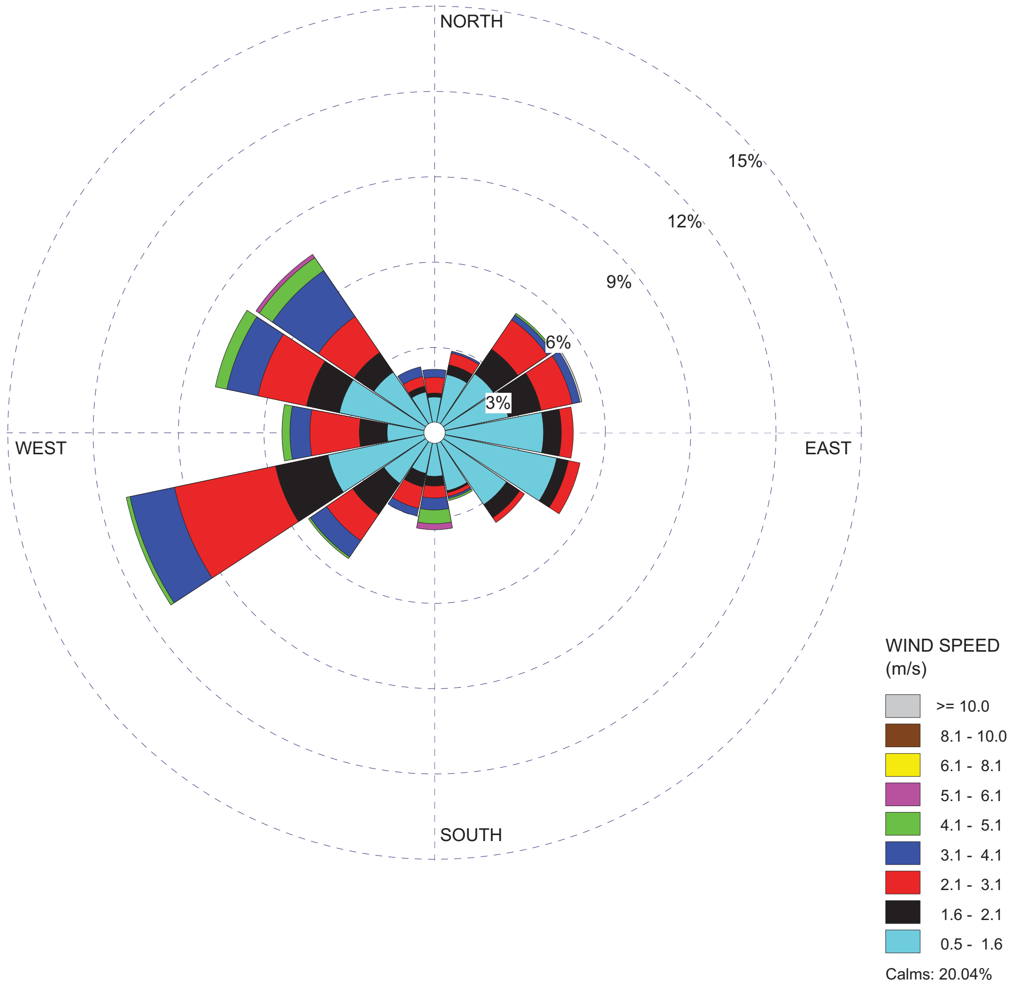
Sampling Period: April 21, 2011 to June 30, 2013

Figure 2.7.4-1. (Sheet 2 of 12) Wind Rose CRN Site 10-meter February



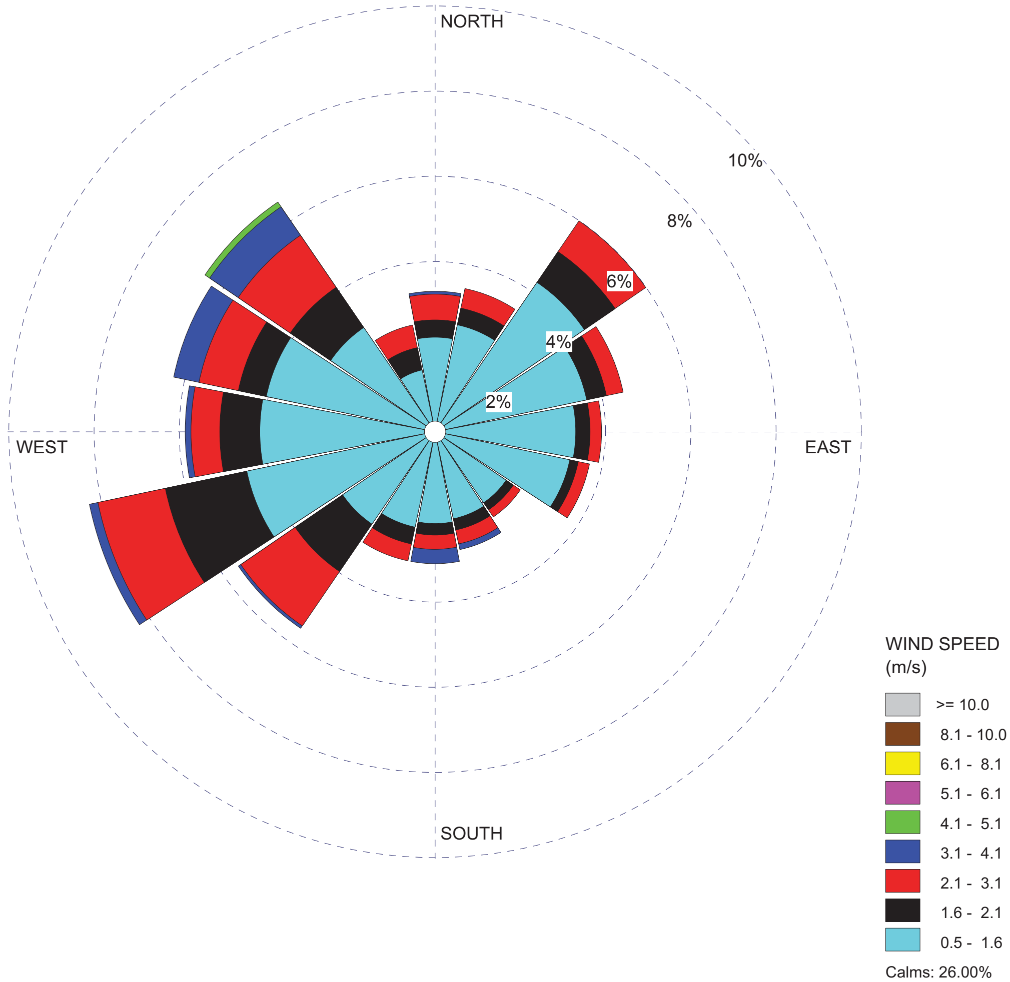
Sampling Period: April 21, 2011 to June 30, 2013

Figure 2.7.4-1. (Sheet 3 of 12) Wind Rose CRN Site 10-meter March



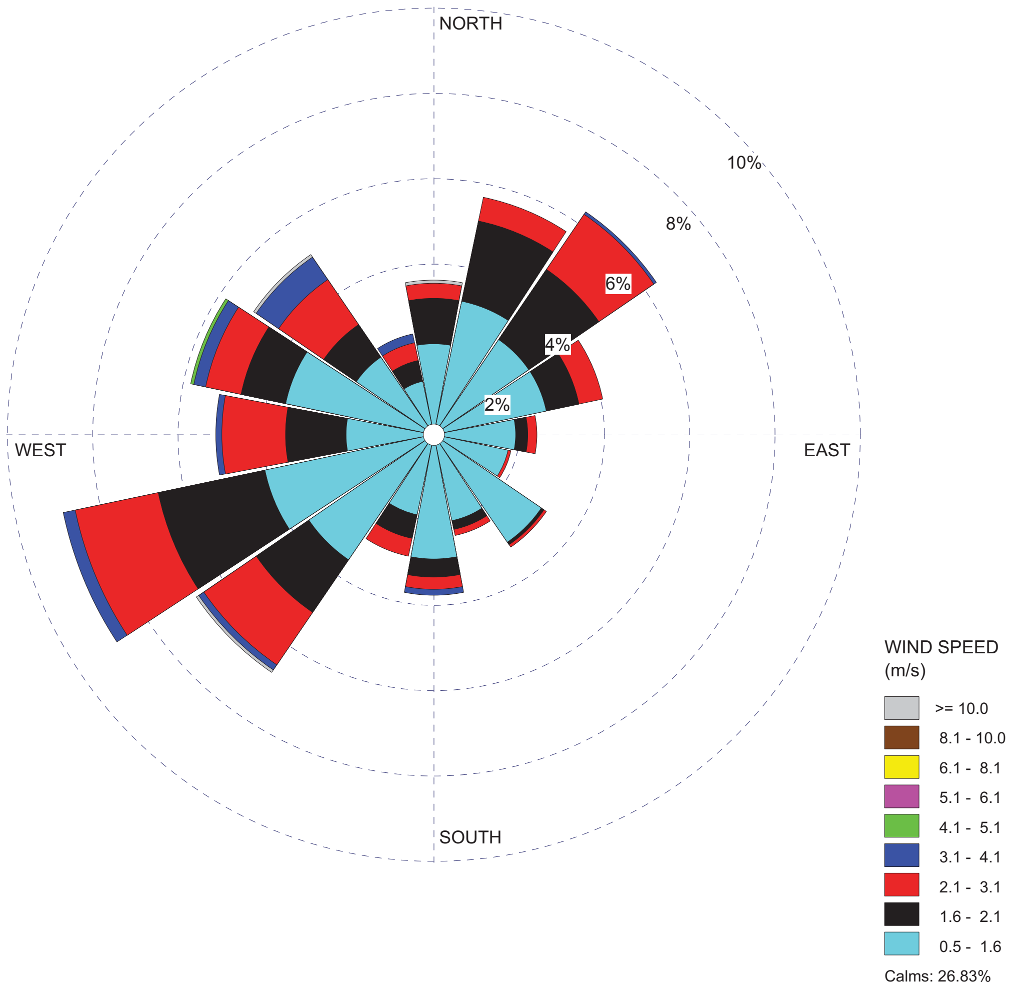
Sampling Period: April 21, 2011 to June 30, 2013

Figure 2.7.4-1. (Sheet 4 of 12) Wind Rose CRN Site 10-meter April



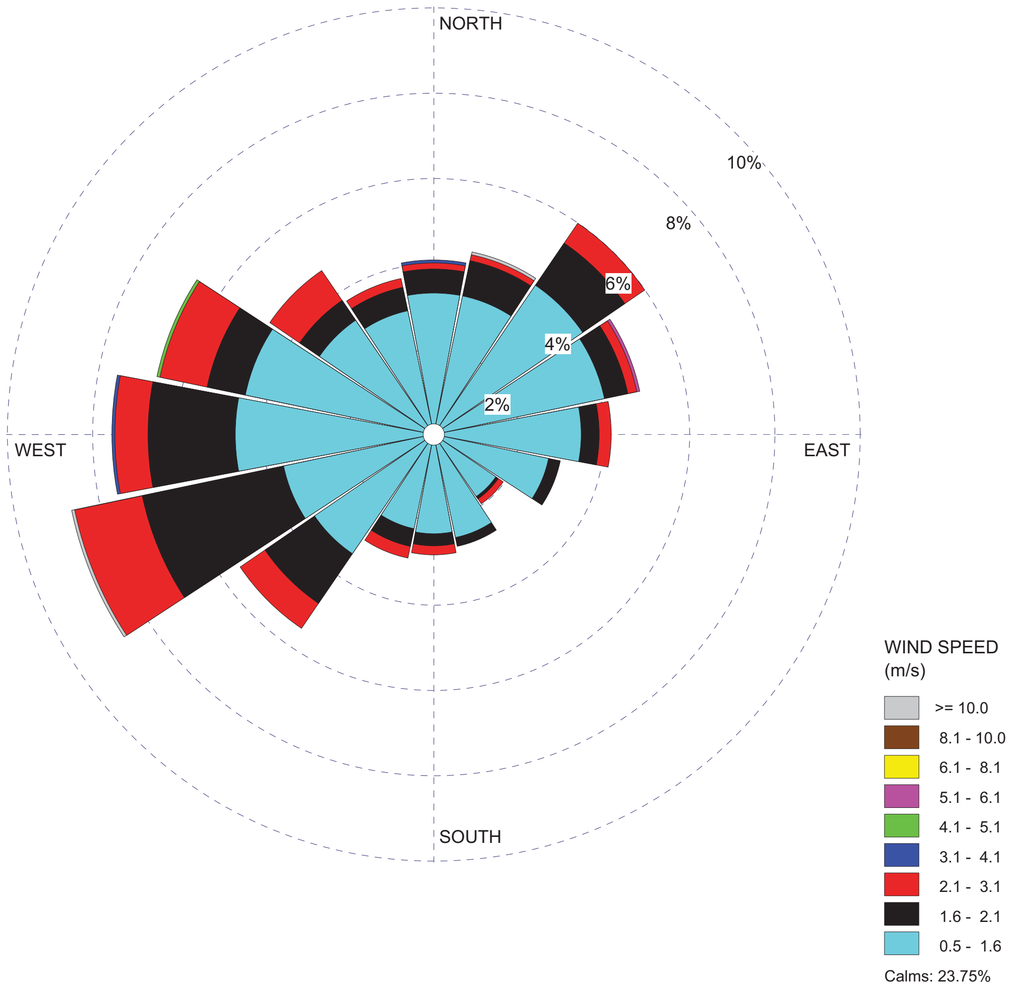
Sampling Period: April 21, 2011 to June 30, 2013

Figure 2.7.4-1. (Sheet 5 of 12) Wind Rose CRN Site 10-meter May



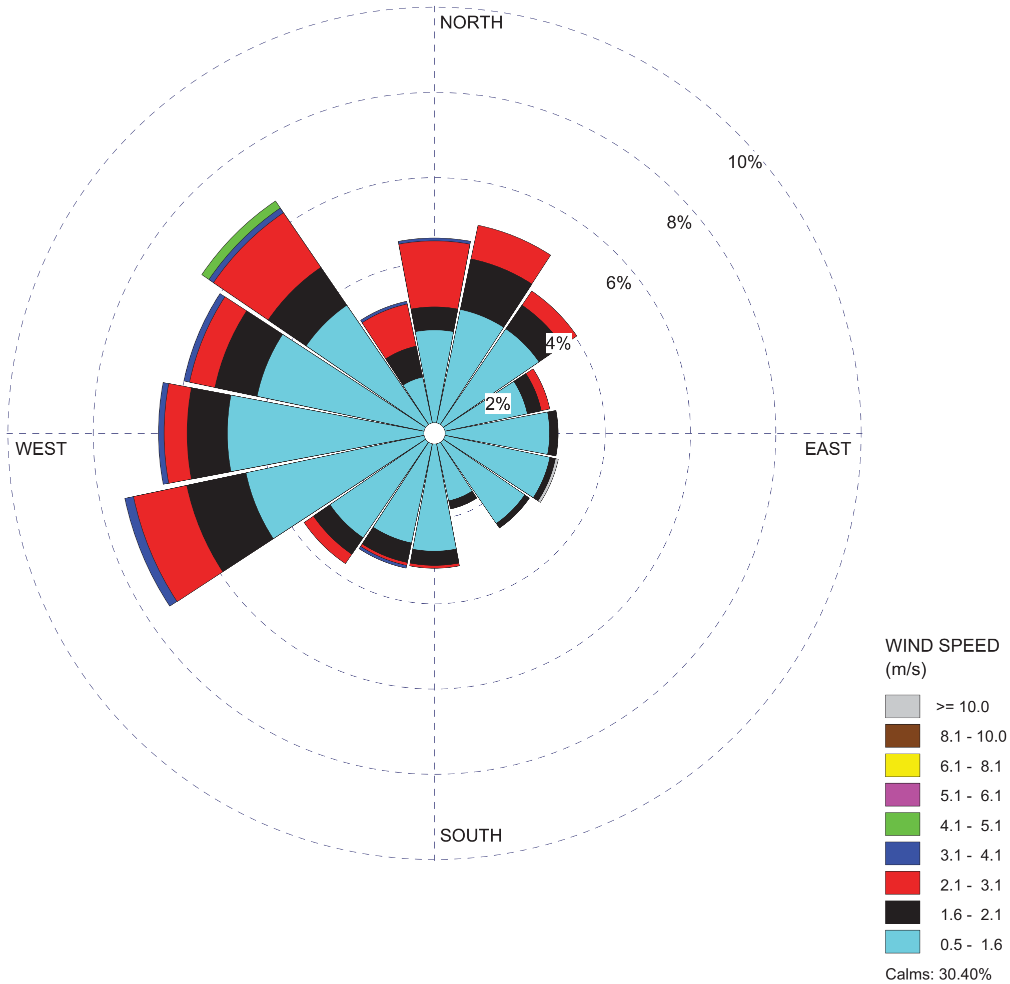
Sampling Period: April 21, 2011 to June 30, 2013

Figure 2.7.4-1. (Sheet 6 of 12) Wind Rose CRN Site 10-meter June



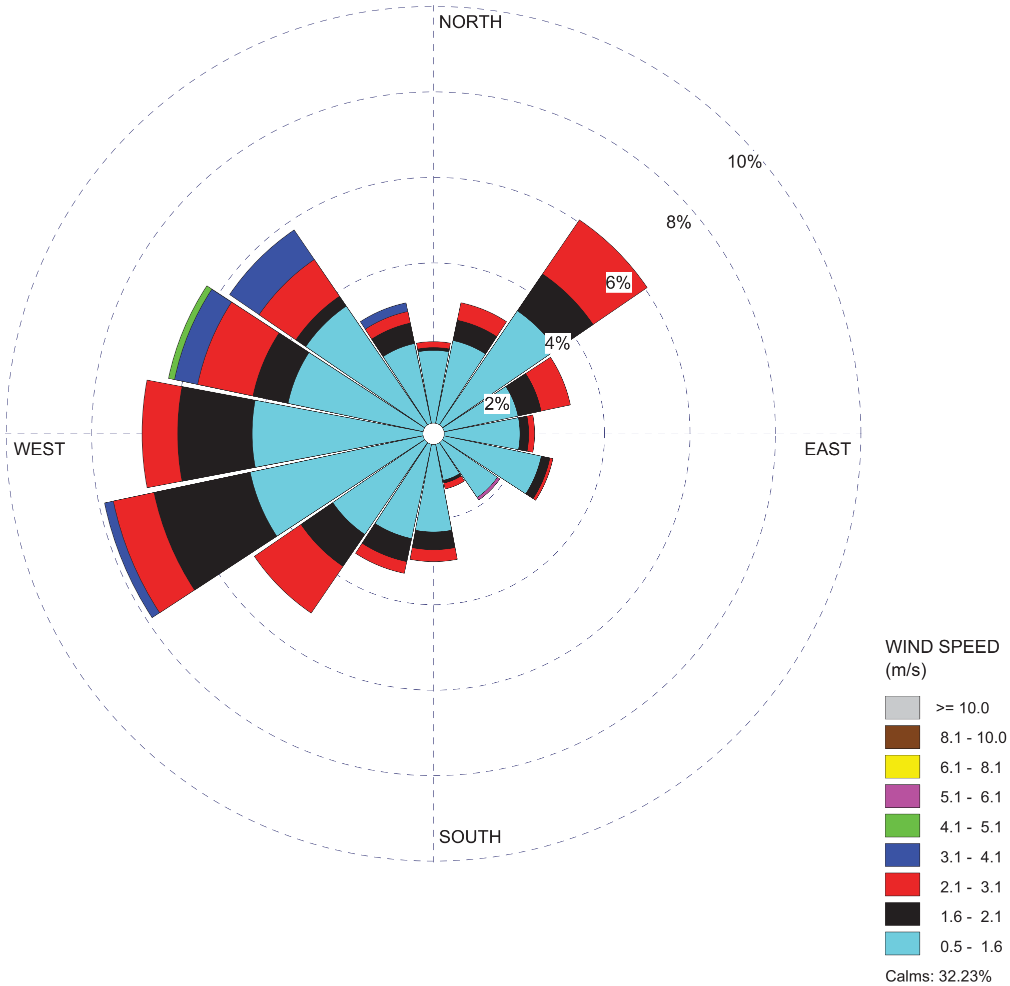
Sampling Period: April 21, 2011 to June 30, 2013

Figure 2.7.4-1. (Sheet 7 of 12) Wind Rose CRN Site 10-meter July



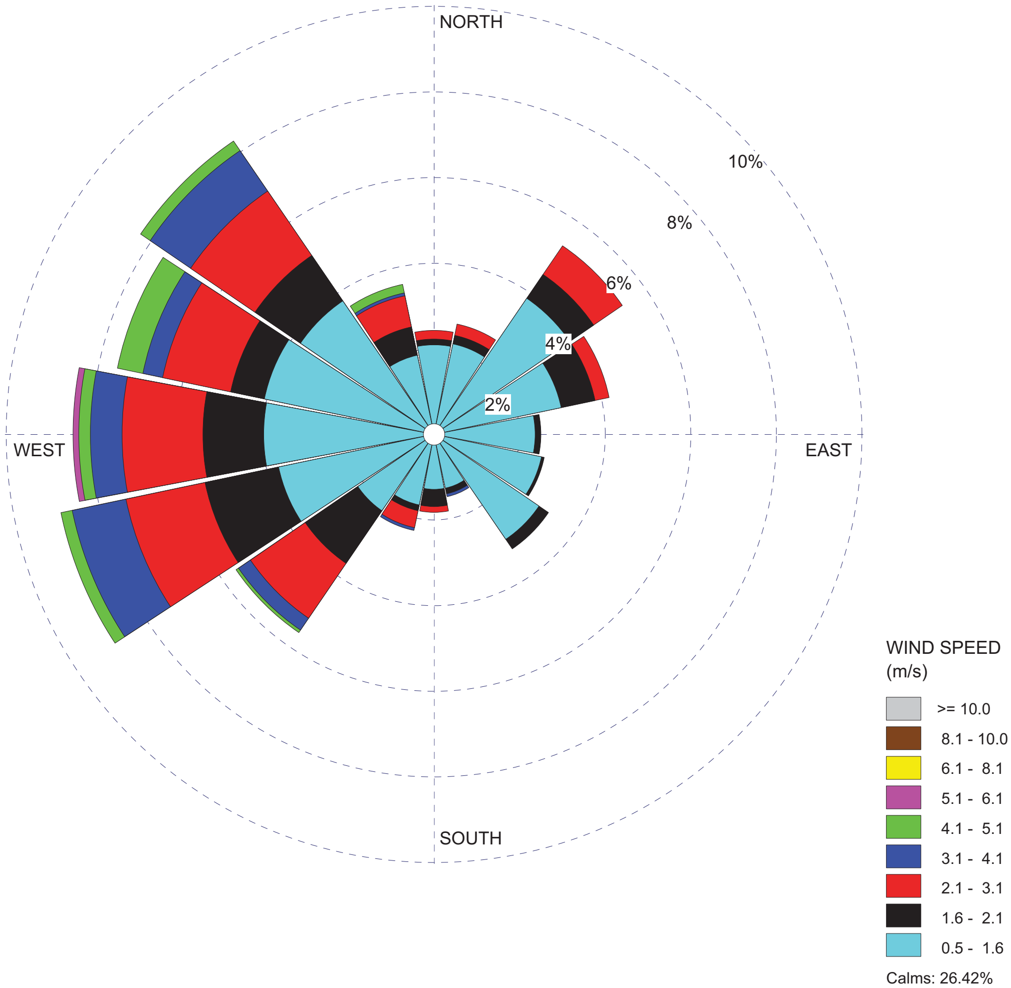
Sampling Period: April 21, 2011 to June 30, 2013

Figure 2.7.4-1. (Sheet 8 of 12) Wind Rose CRN Site 10-meter August



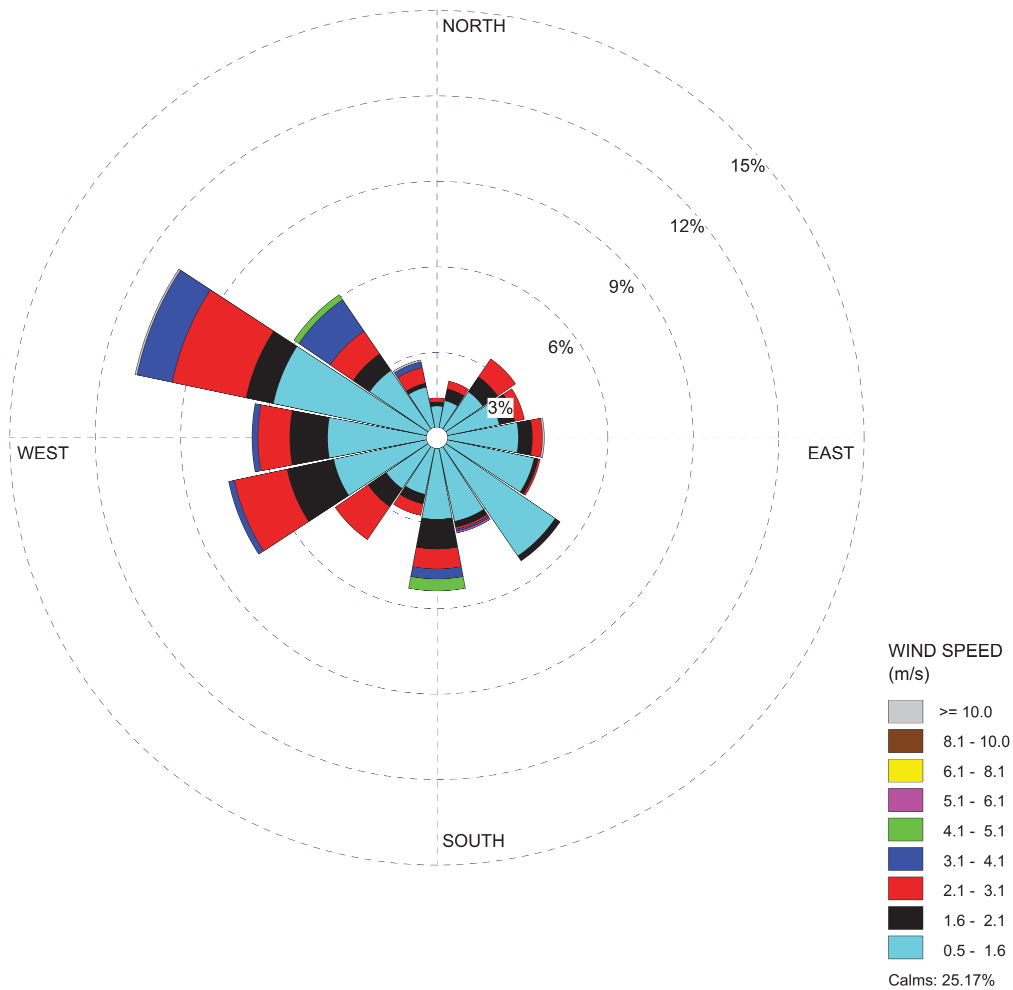
Sampling Period: April 21, 2011 to June 30, 2013

Figure 2.7.4-1. (Sheet 9 of 12) Wind Rose CRN Site 10-meter September



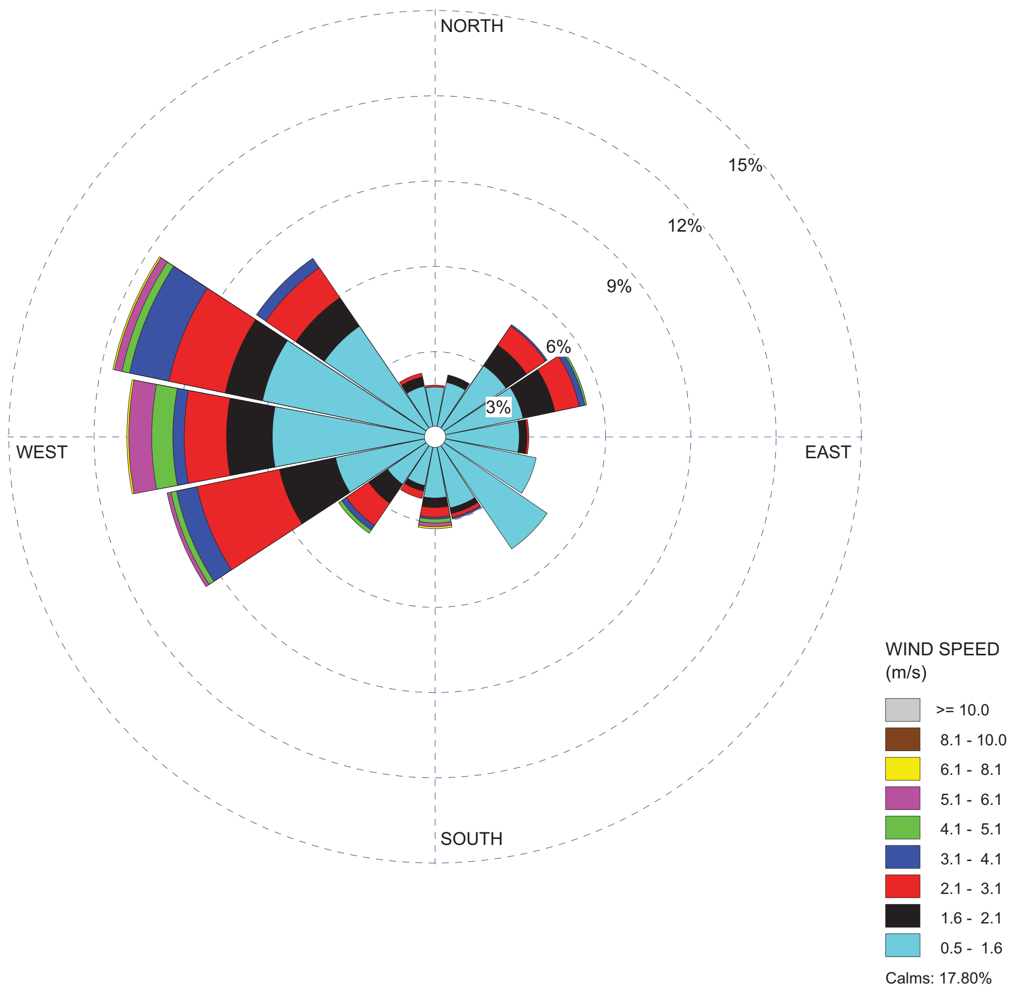
Sampling Period: April 21, 2011 to June 30, 2013

Figure 2.7.4-1. (Sheet 10 of 12) Wind Rose CRN Site 10-meter October



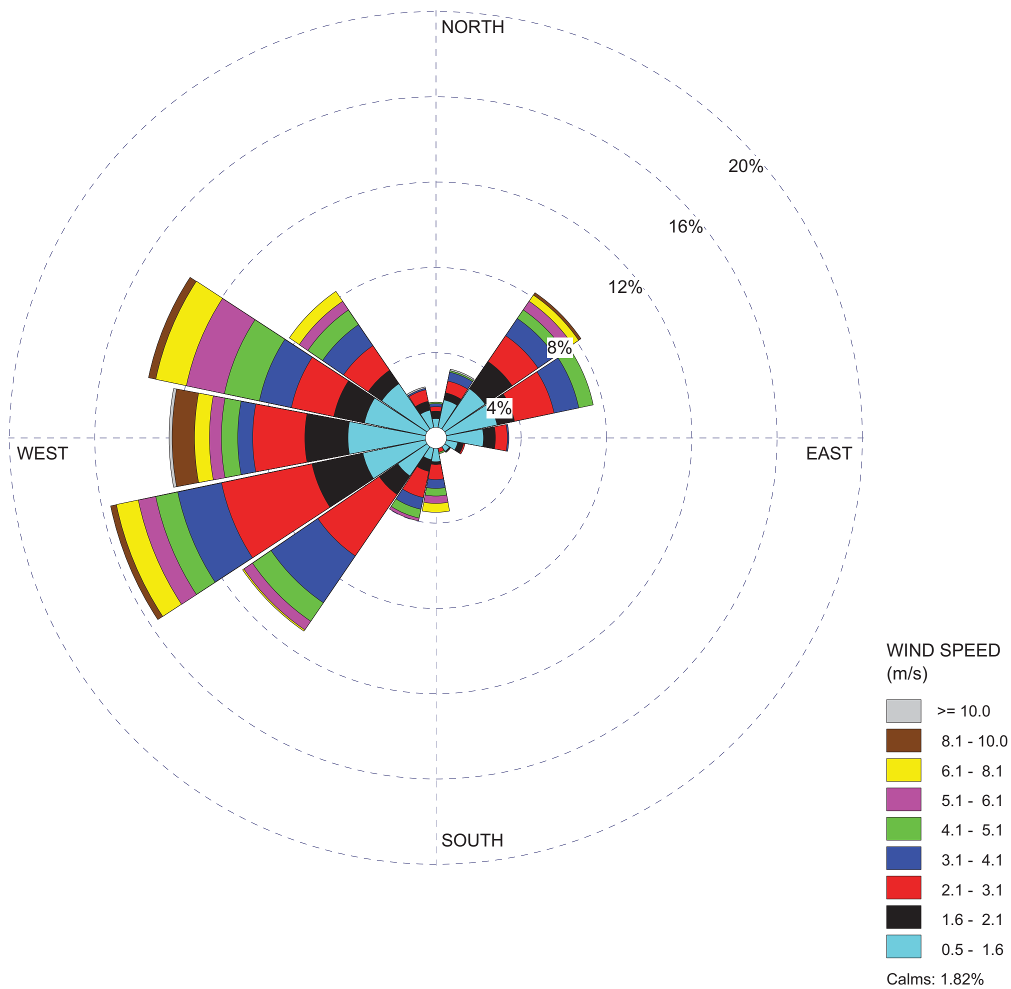
Sampling Period: April 21, 2011 to June 30, 2013

Figure 2.7.4-1. (Sheet 11 of 12) Wind Rose CRN Site 10-meter November



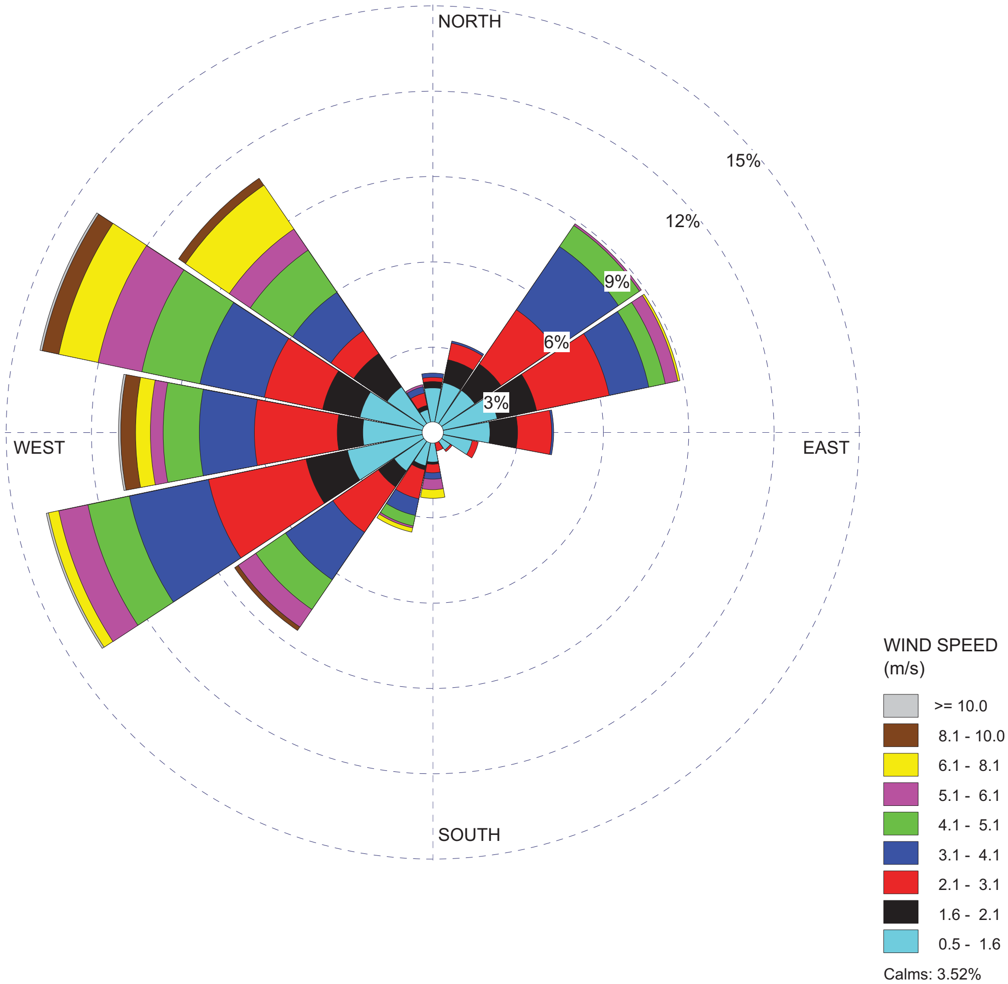
Sampling Period: April 21, 2011 to June 30, 2013

Figure 2.7.4-1. (Sheet 12 of 12) Wind Rose CRN Site 10-meter December



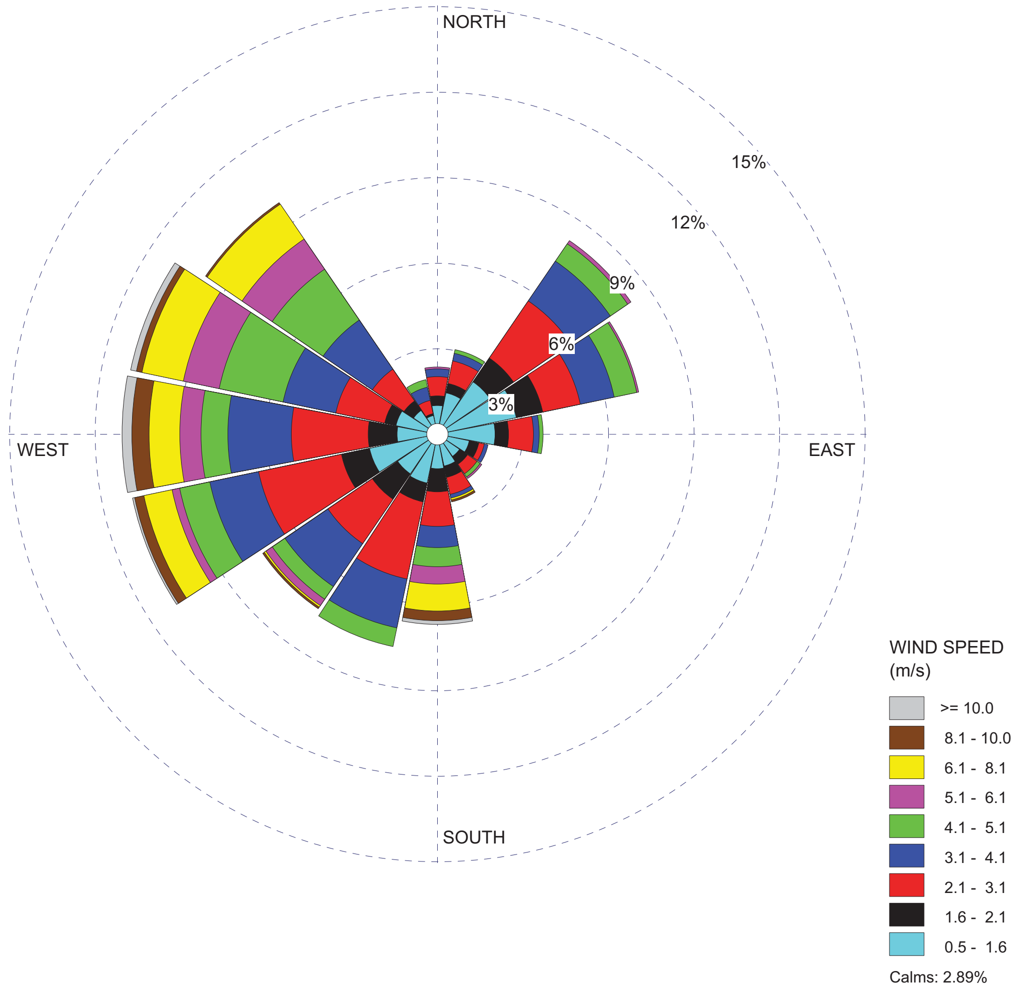
Sampling Period: April 21, 2011 to June 30, 2013

Figure 2.7.4-2. (Sheet 1 of 12) Wind Rose CRN Site 60-meter January



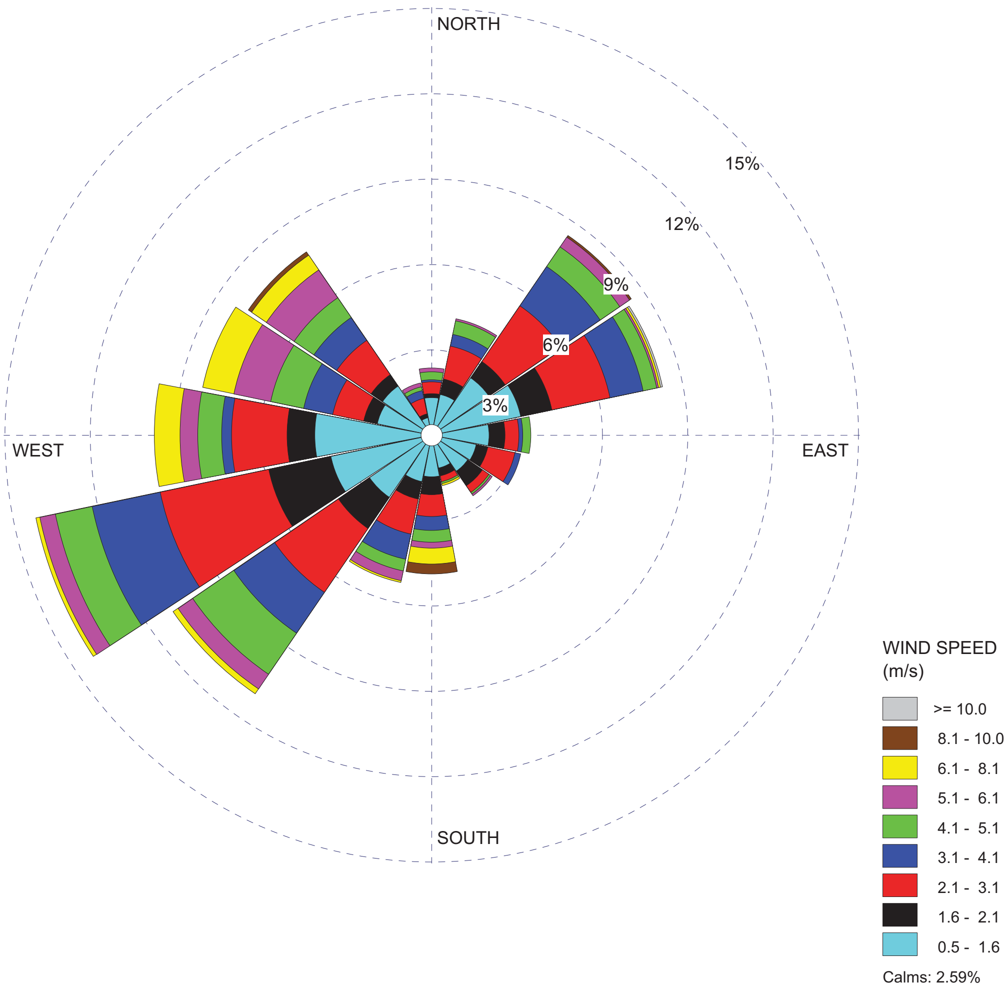
Sampling Period: April 21, 2011 to June 30, 2013

Figure 2.7.4-2. (Sheet 2 of 12) Wind Rose CRN Site 60-meter February



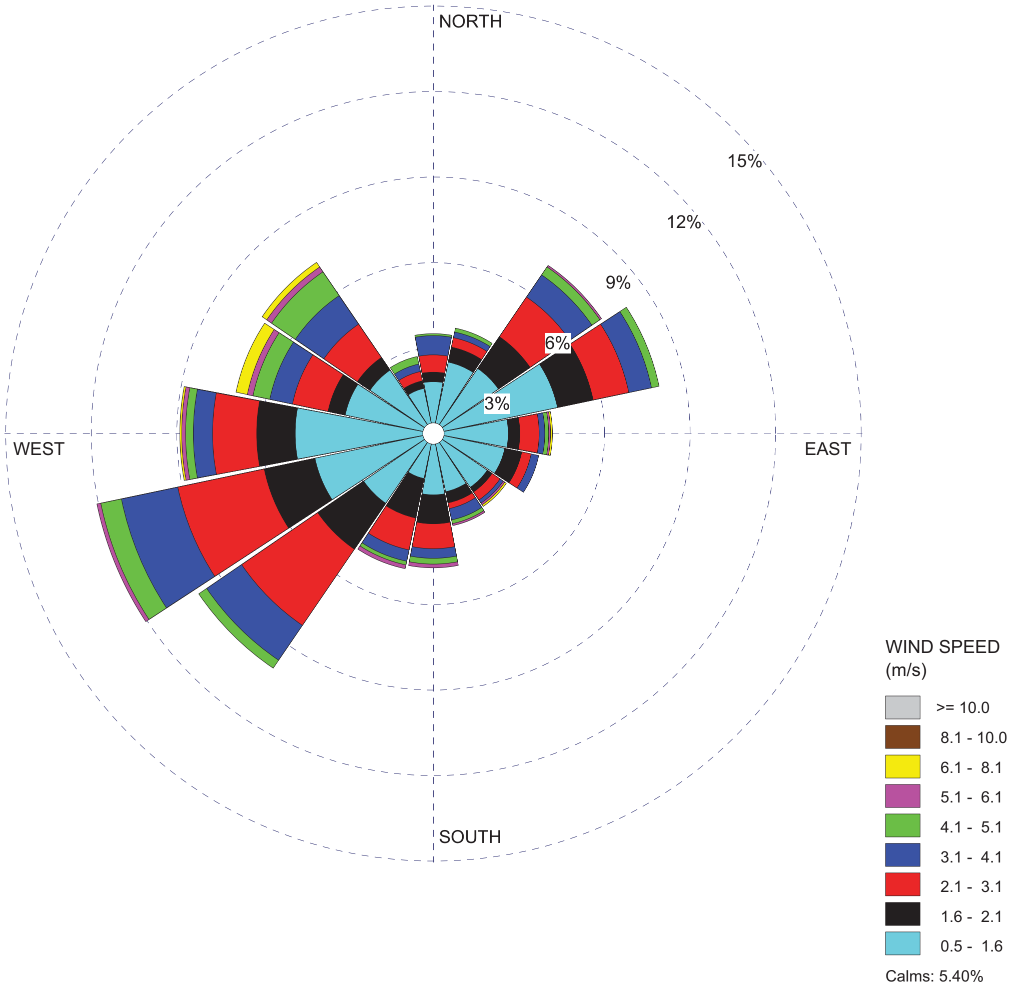
Sampling Period: April 21, 2011 to June 30, 2013

Figure 2.7.4-2. (Sheet 3 of 12) Wind Rose CRN Site 60-meter March



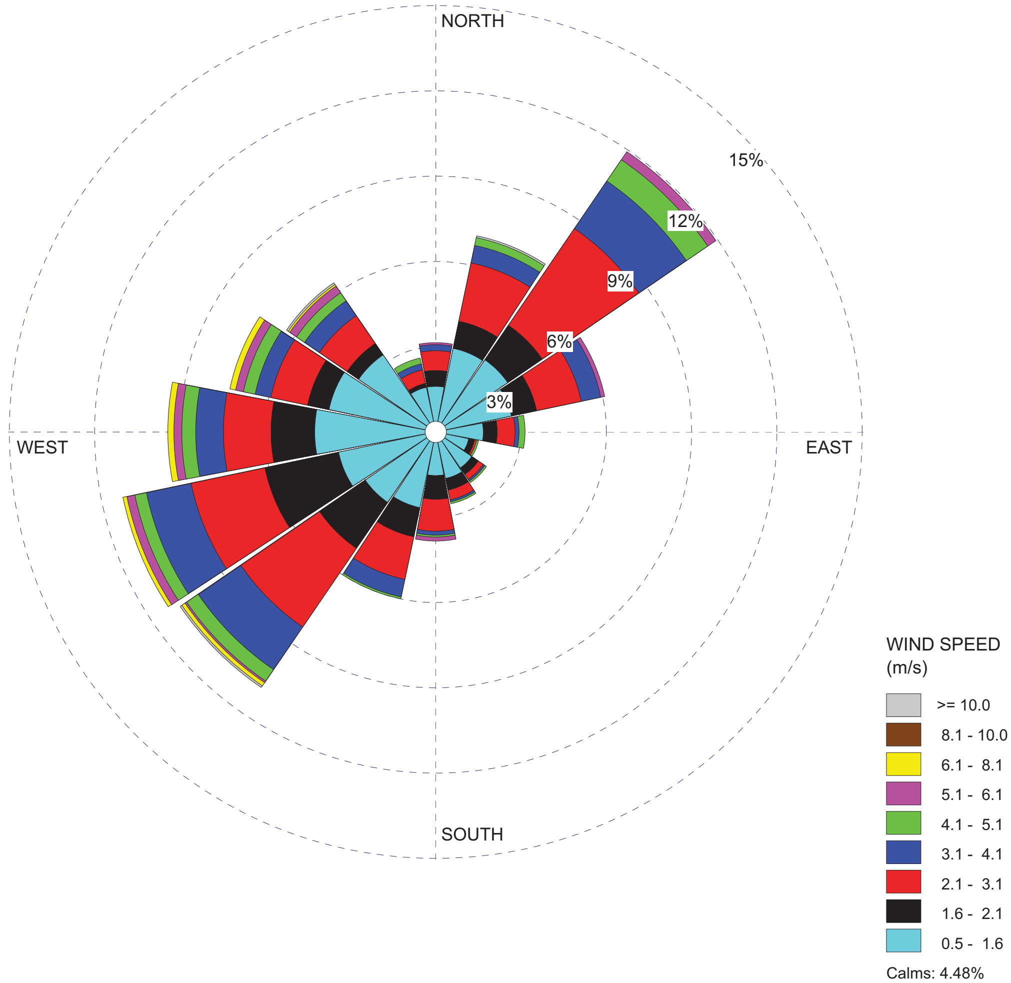
Sampling Period: April 21, 2011 to June 30, 2013

Figure 2.7.4-2. (Sheet 4 of 12) Wind Rose CRN Site 60-meter April



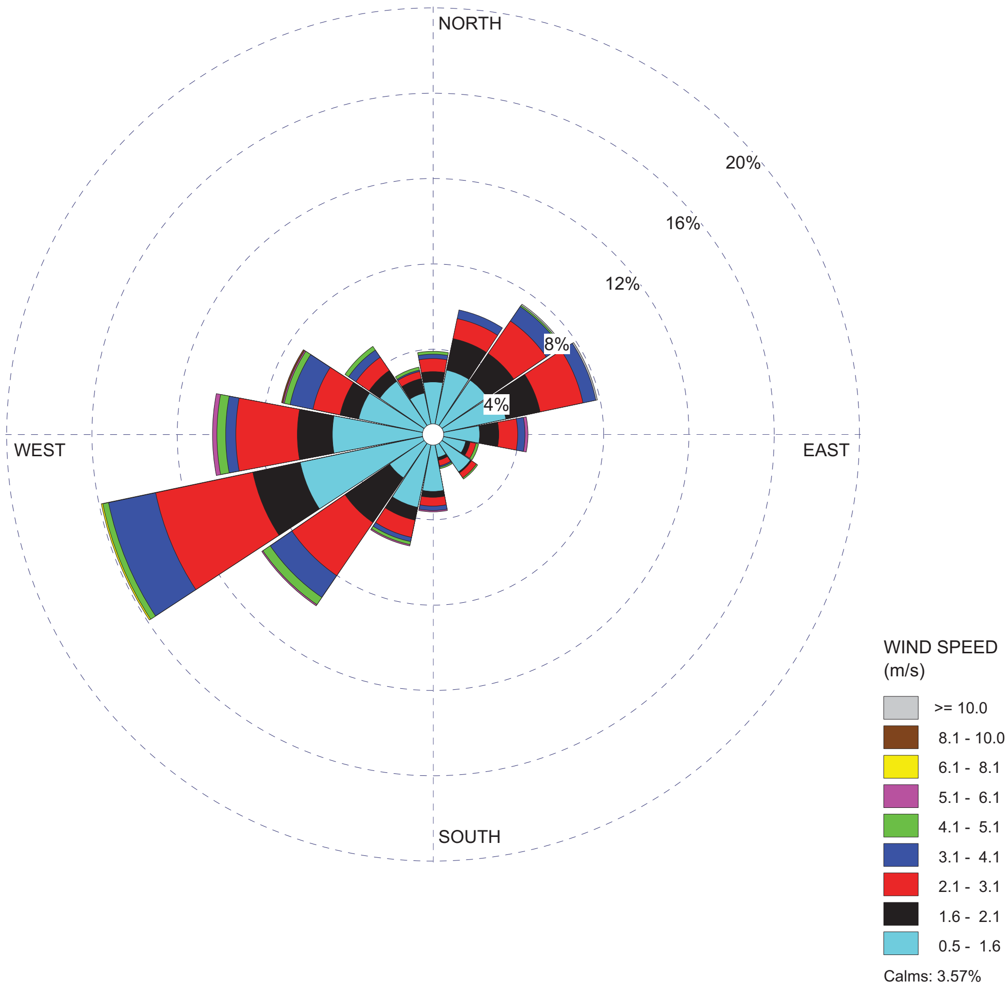
Sampling Period: April 21, 2011 to June 30, 2013

Figure 2.7.4-2. (Sheet 5 of 12) Wind Rose CRN Site 60-meter May



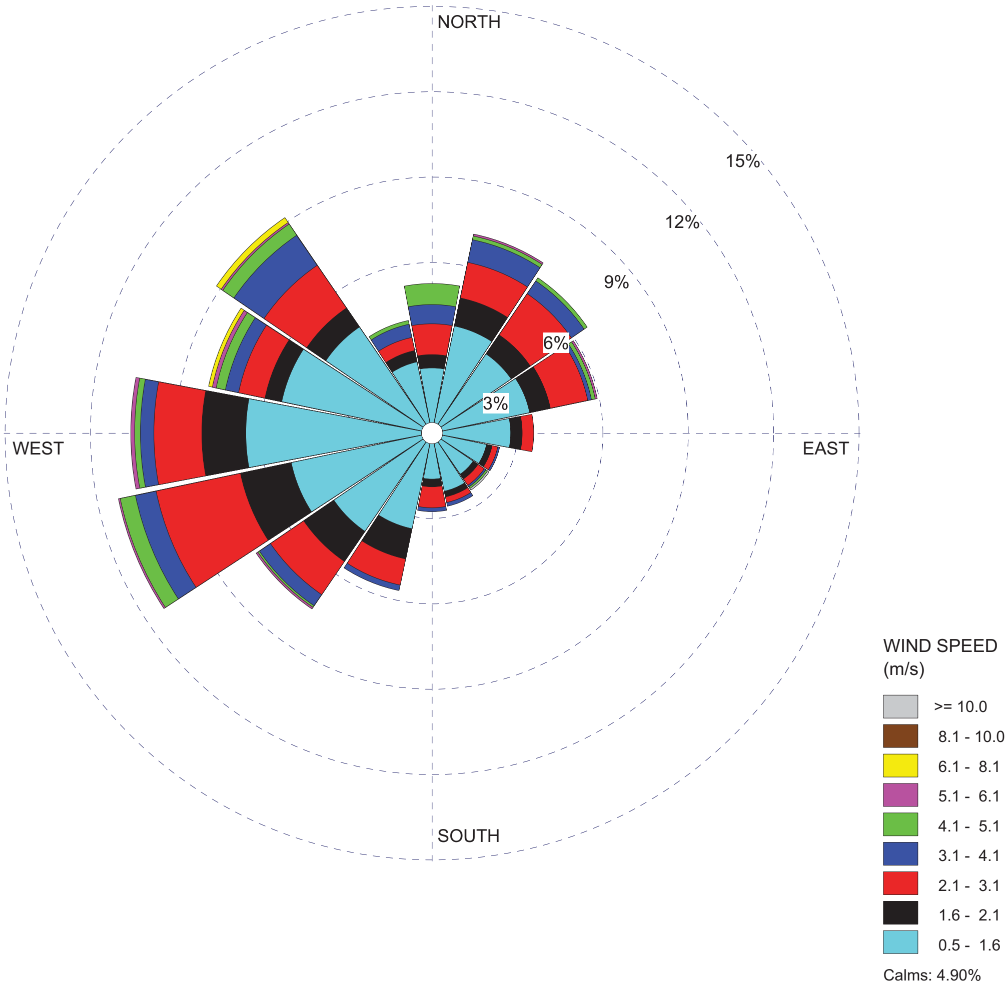
Sampling Period: April 21, 2011 to June 30, 2013

Figure 2.7.4-2. (Sheet 6 of 12) Wind Rose CRN Site 60-meter June



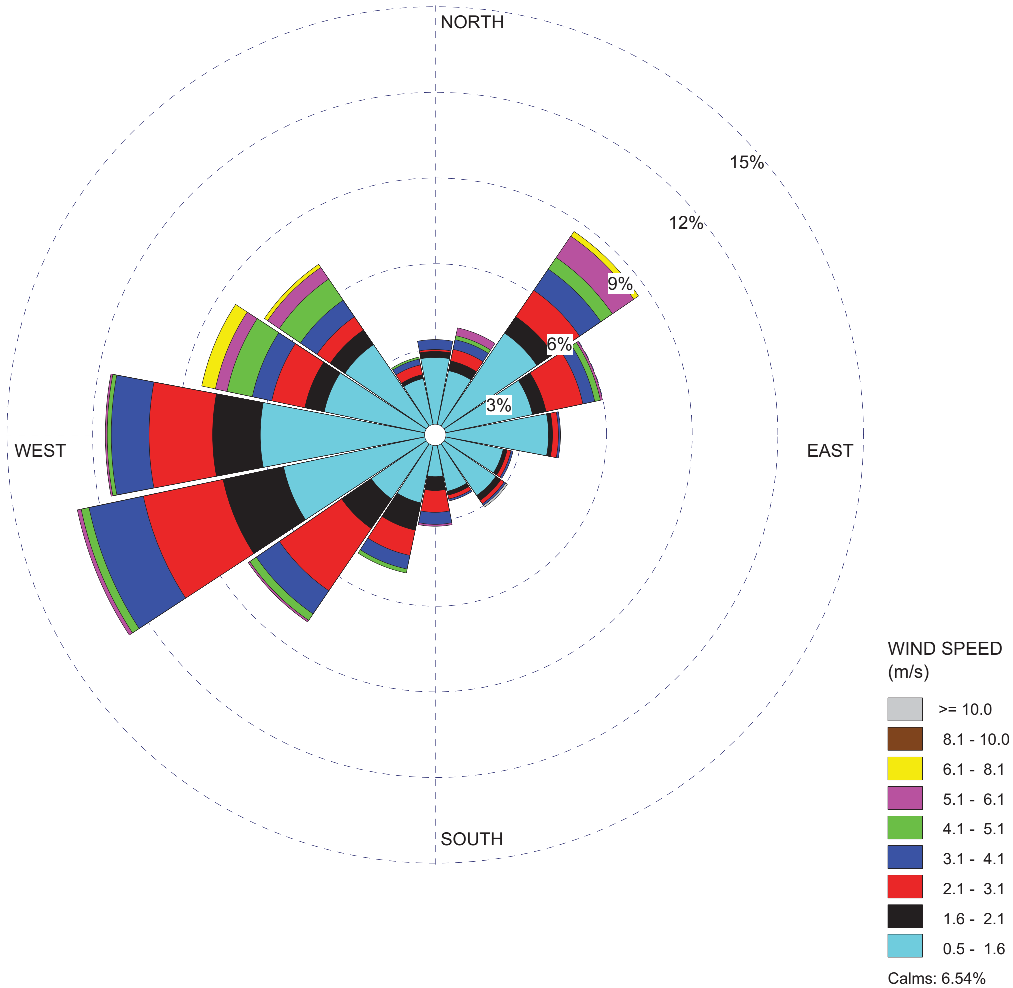
Sampling Period: April 21, 2011 to June 30, 2013

Figure 2.7.4-2. (Sheet 7 of 12) Wind Rose CRN Site 60-meter July



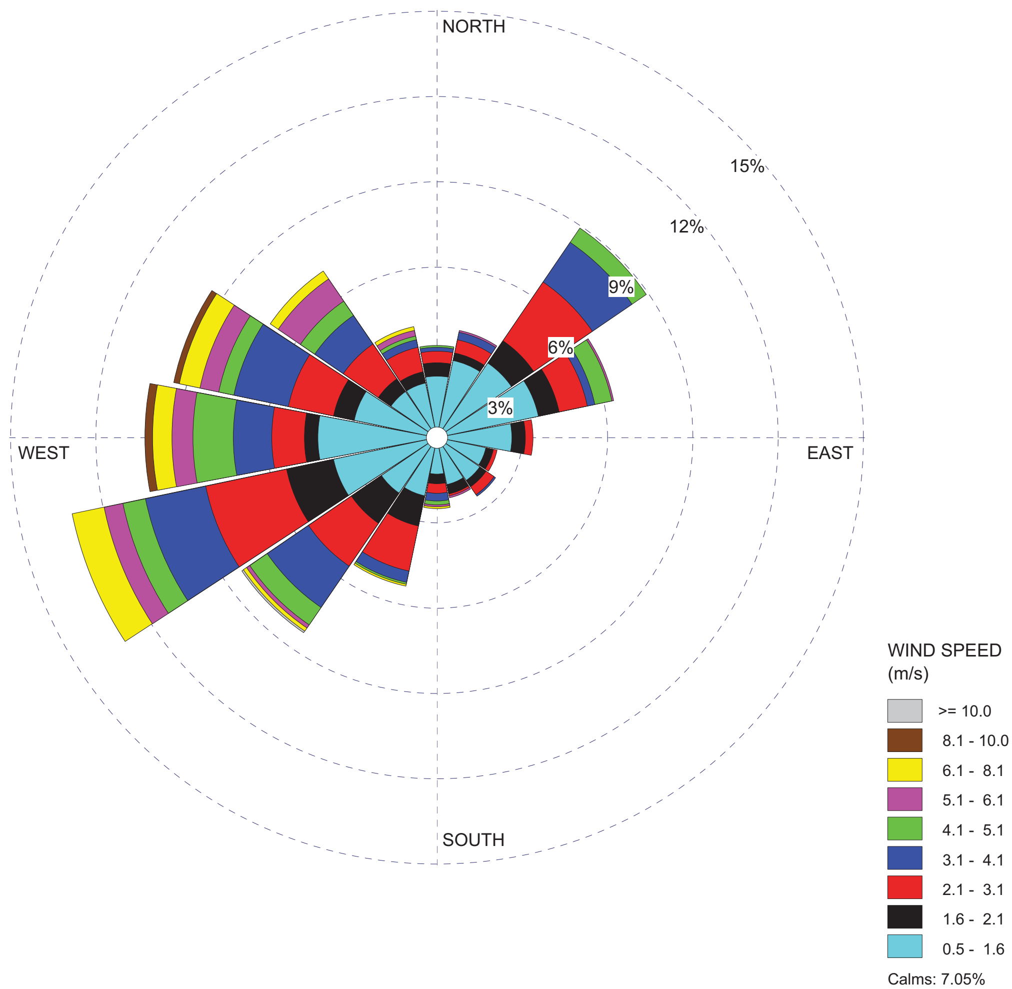
Sampling Period: April 21, 2011 to June 30, 2013

Figure 2.7.4-2. (Sheet 8 of 12) Wind Rose CRN Site 60-meter August



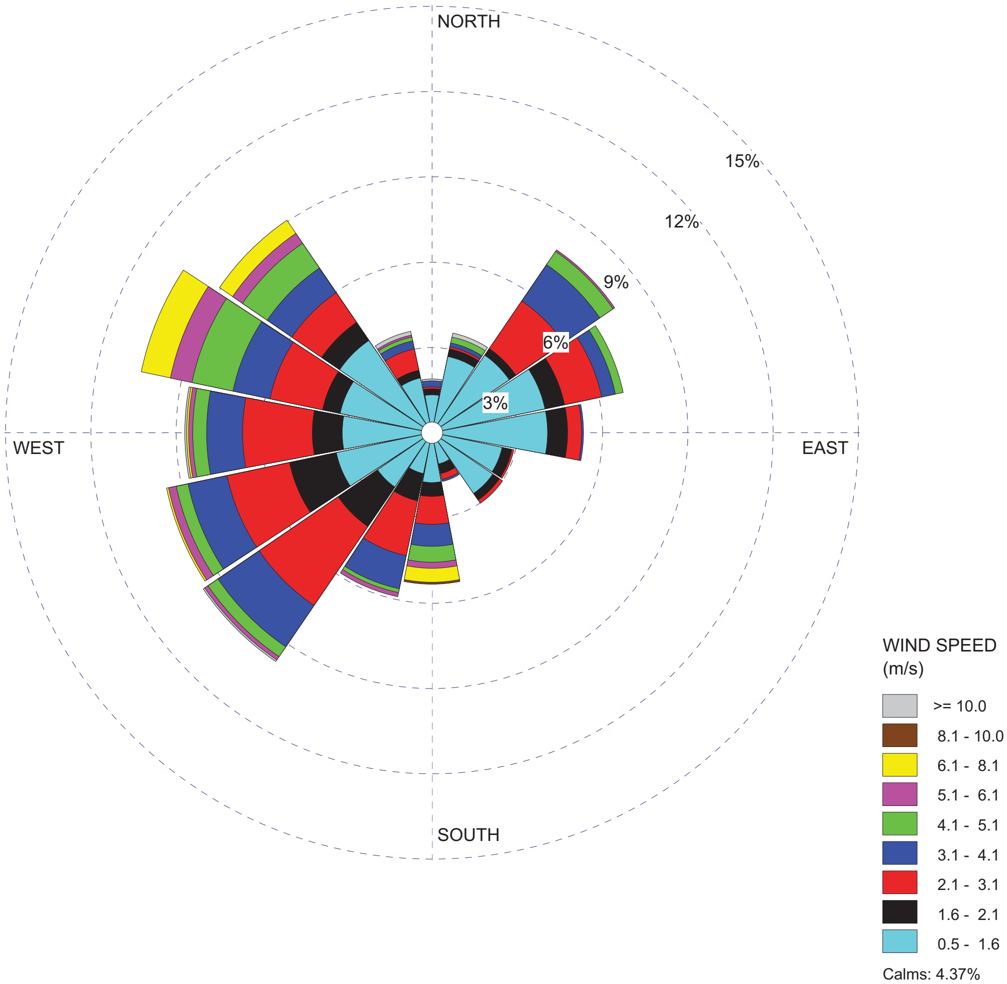
Sampling Period: April 21, 2011 to June 30, 2013

Figure 2.7.4-2. (Sheet 9 of 12) Wind Rose CRN Site 60-meter September



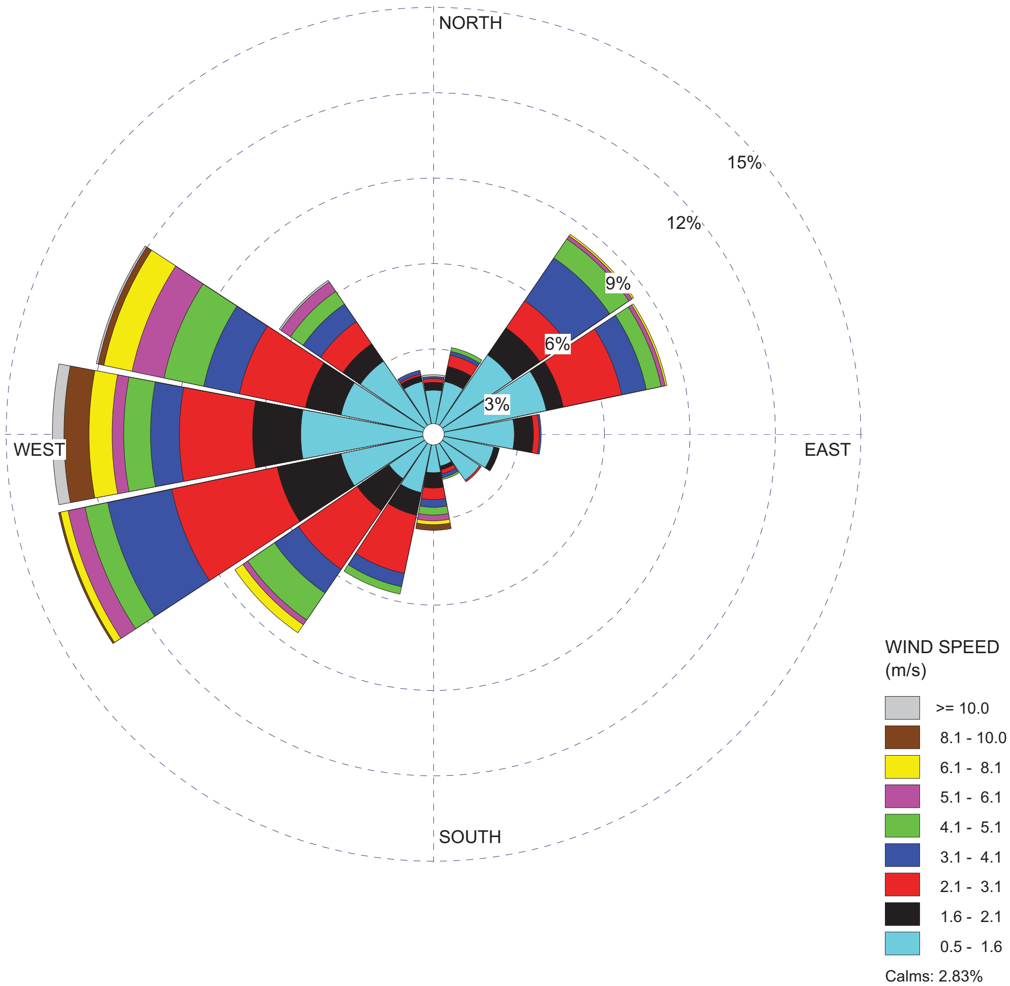
Sampling Period: April 21, 2011 to June 30, 2013

Figure 2.7.4-2. (Sheet 10 of 12) Wind Rose CRN Site 60-meter October



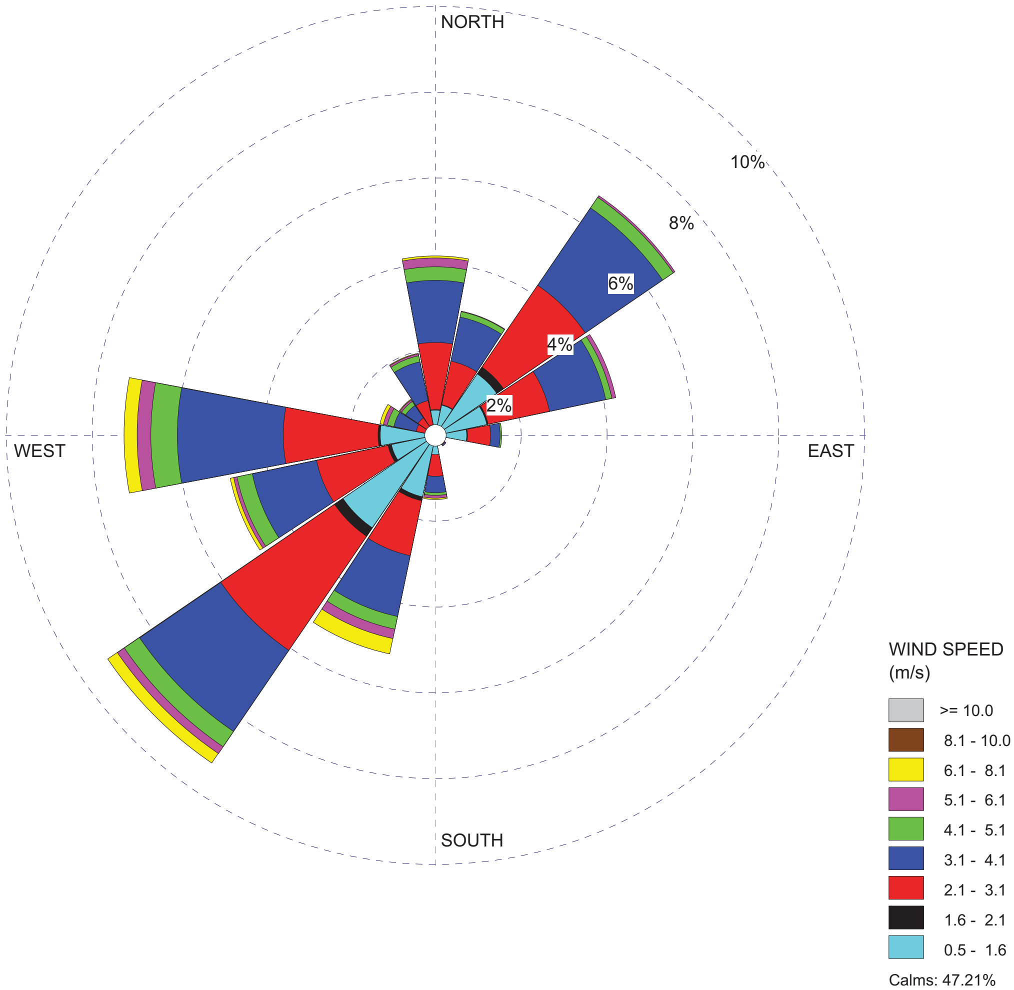
Sampling Period: April 21, 2011 to June 30, 2013

Figure 2.7.4-2. (Sheet 11 of 12) Wind Rose CRN Site 60-meter November



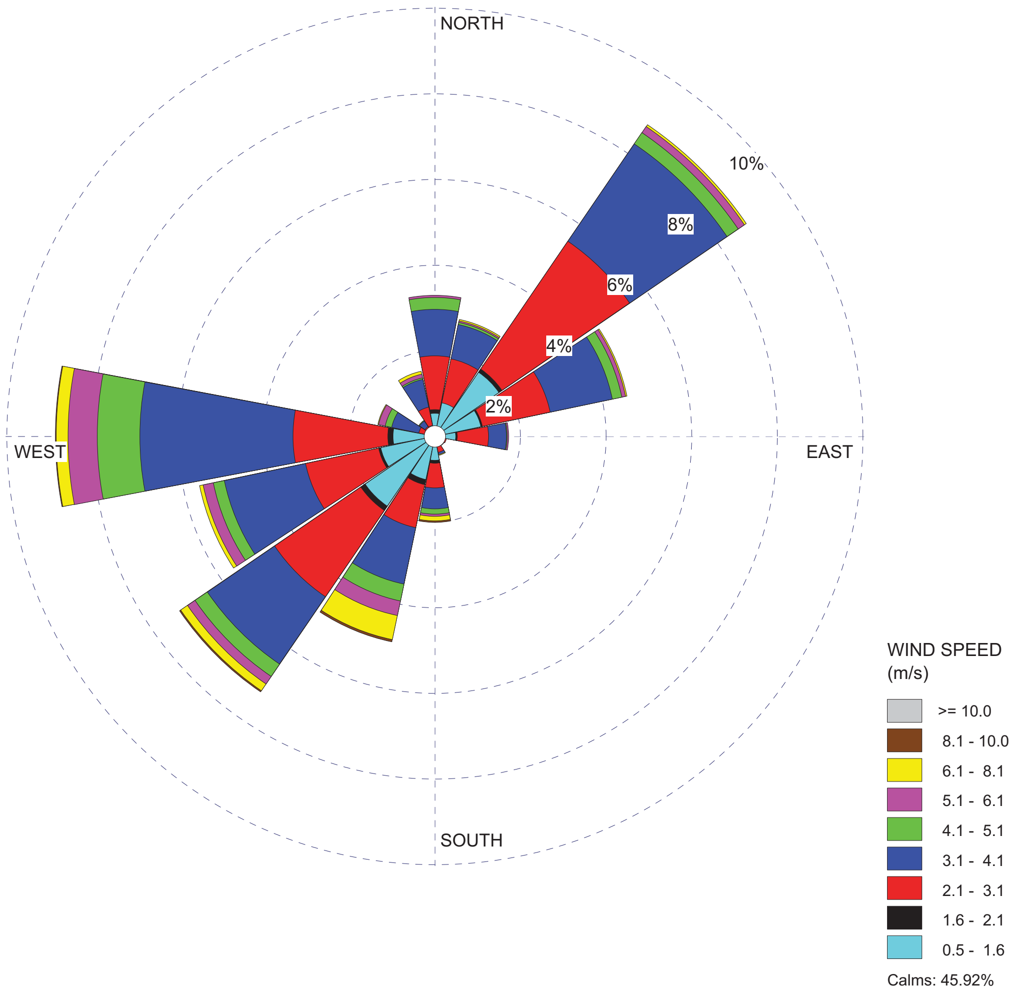
Sampling Period: April 21, 2011 to June 30, 2013

Figure 2.7.4-2. (Sheet 12 of 12) Wind Rose CRN Site 60-meter December



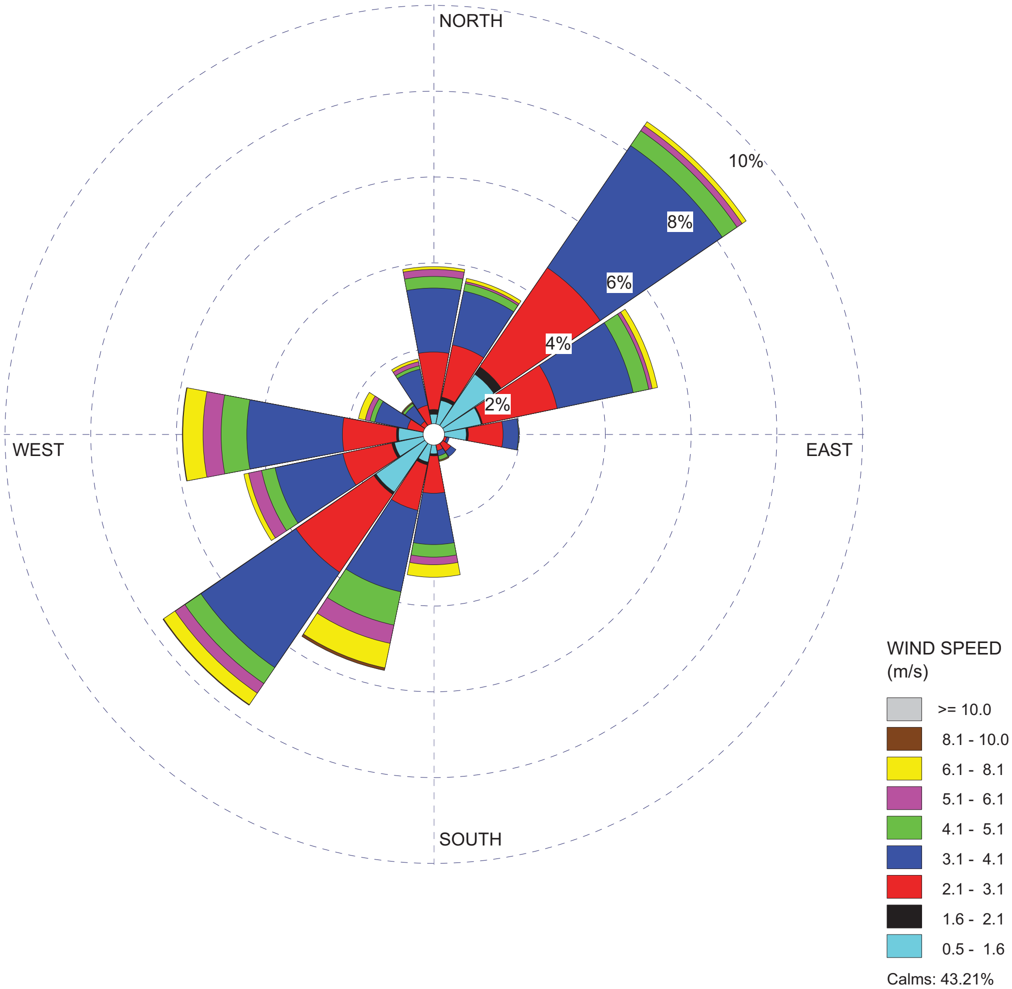
Sampling Period: 2000 to 2009

Figure 2.7.4-3. (Sheet 1 of 12) Wind Rose Oak Ridge NWS 10 Years January



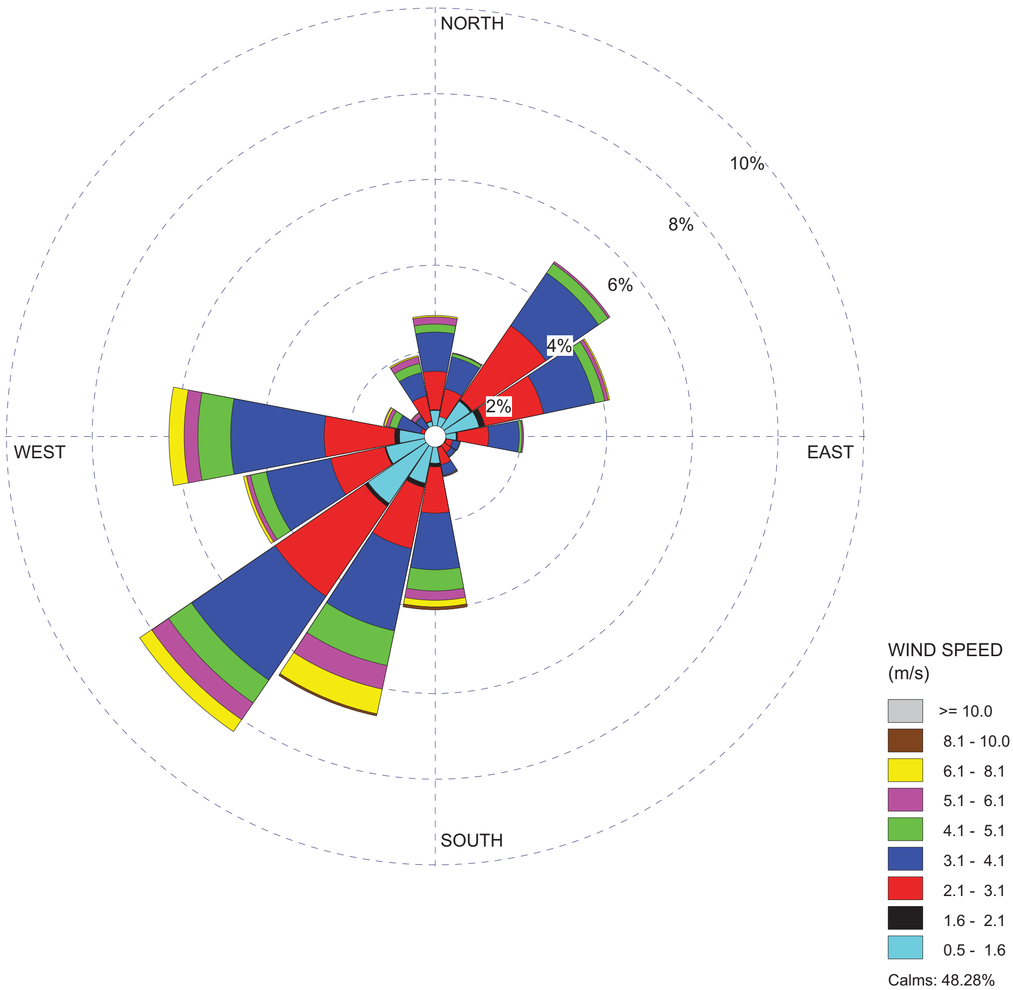
Sampling Period: 2000 to 2009

Figure 2.7.4-3. (Sheet 2 of 12) Wind Rose Oak Ridge NWS 10 Years February



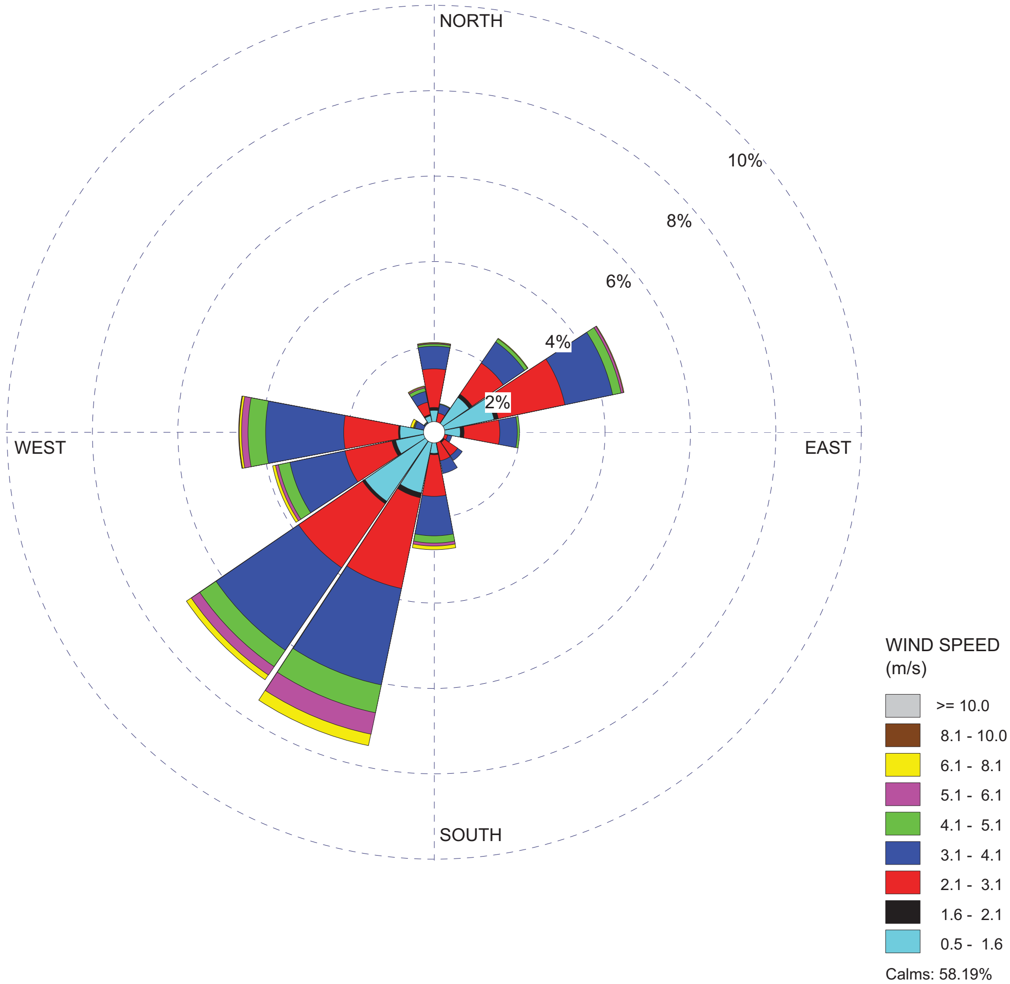
Sampling Period: 2000 to 2009

Figure 2.7.4-3. (Sheet 3 of 12) Wind Rose Oak Ridge NWS 10 Years March



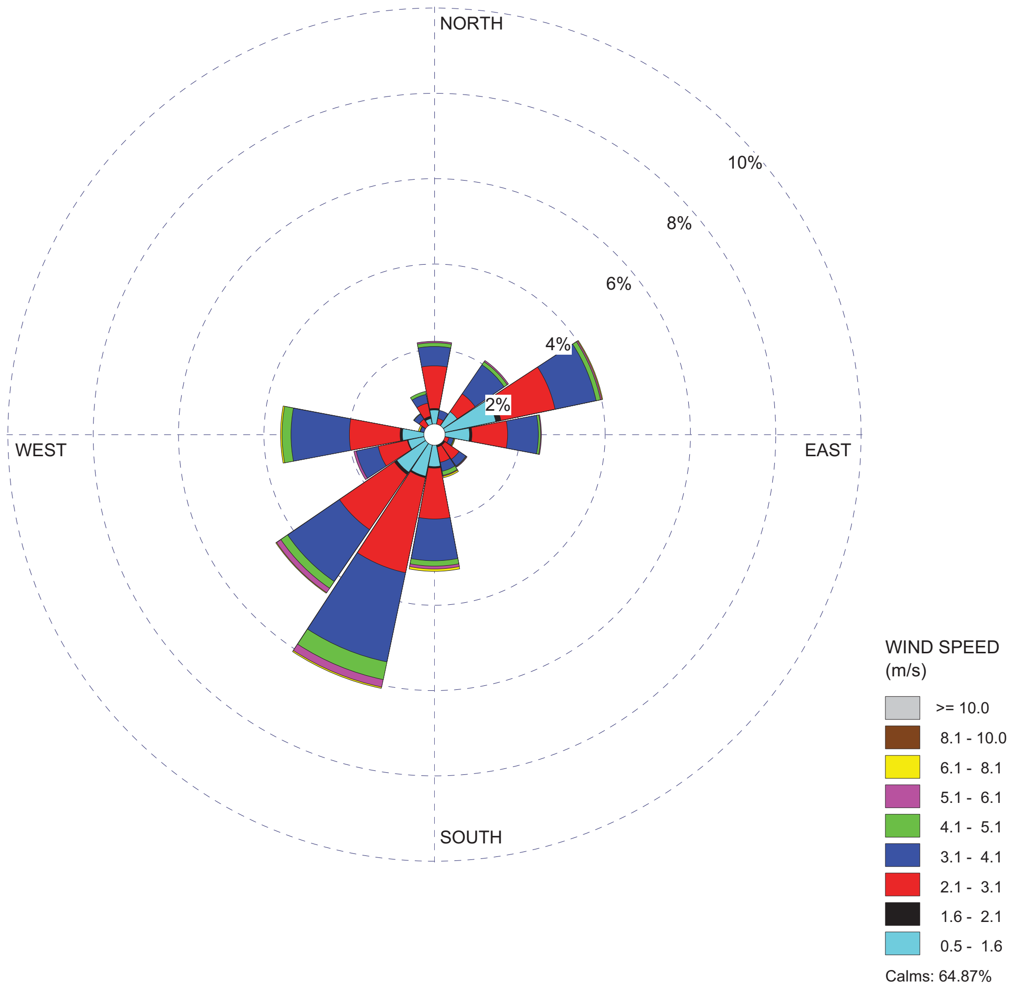
Sampling Period: 2000 to 2009

Figure 2.7.4-3. (Sheet 4 of 12) Wind Rose Oak Ridge NWS 10 Years April



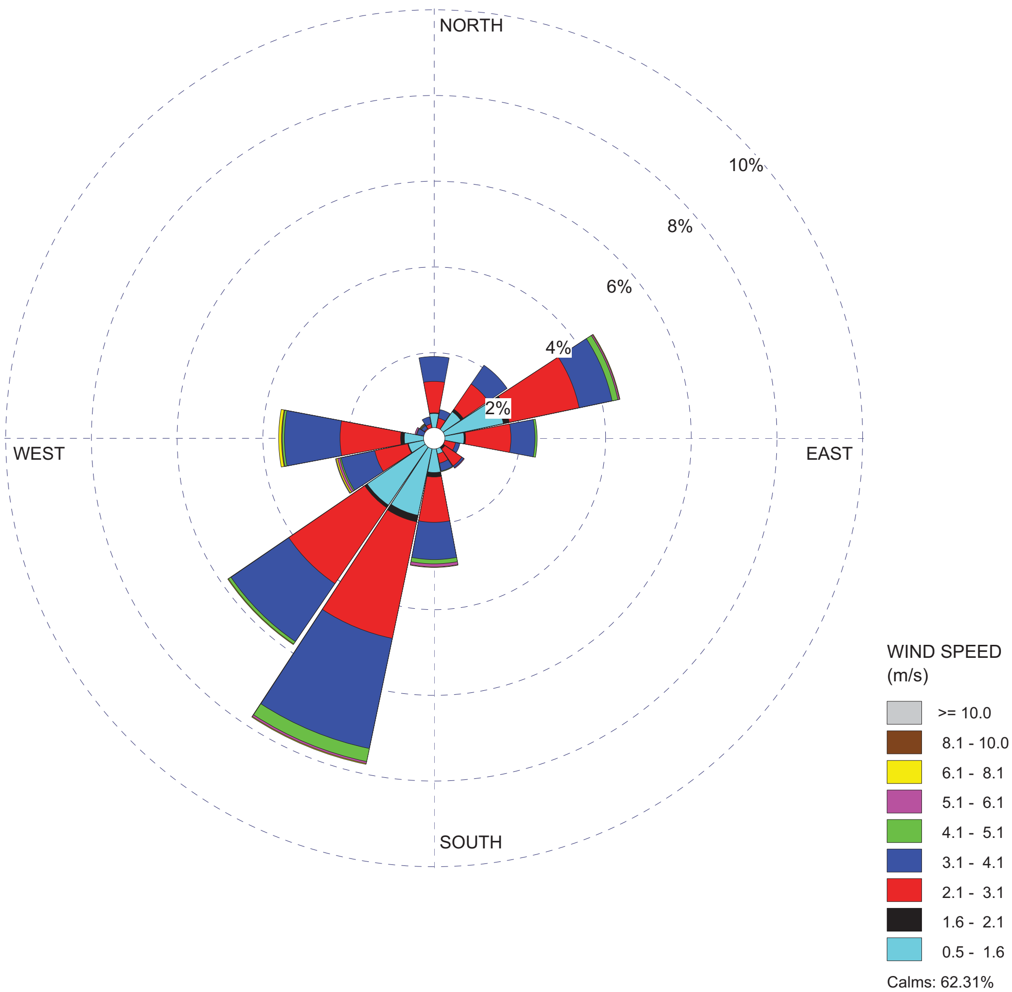
Sampling Period: 2000 to 2009

Figure 2.7.4-3. (Sheet 5 of 12) Wind Rose Oak Ridge NWS 10 Years May



Sampling Period: 2000 to 2009

Figure 2.7.4-3. (Sheet 6 of 12) Wind Rose Oak Ridge NWS 10 Years June



Sampling Period: 2000 to 2009

Figure 2.7.4-3. (Sheet 7 of 12) Wind Rose Oak Ridge NWS 10 Years July

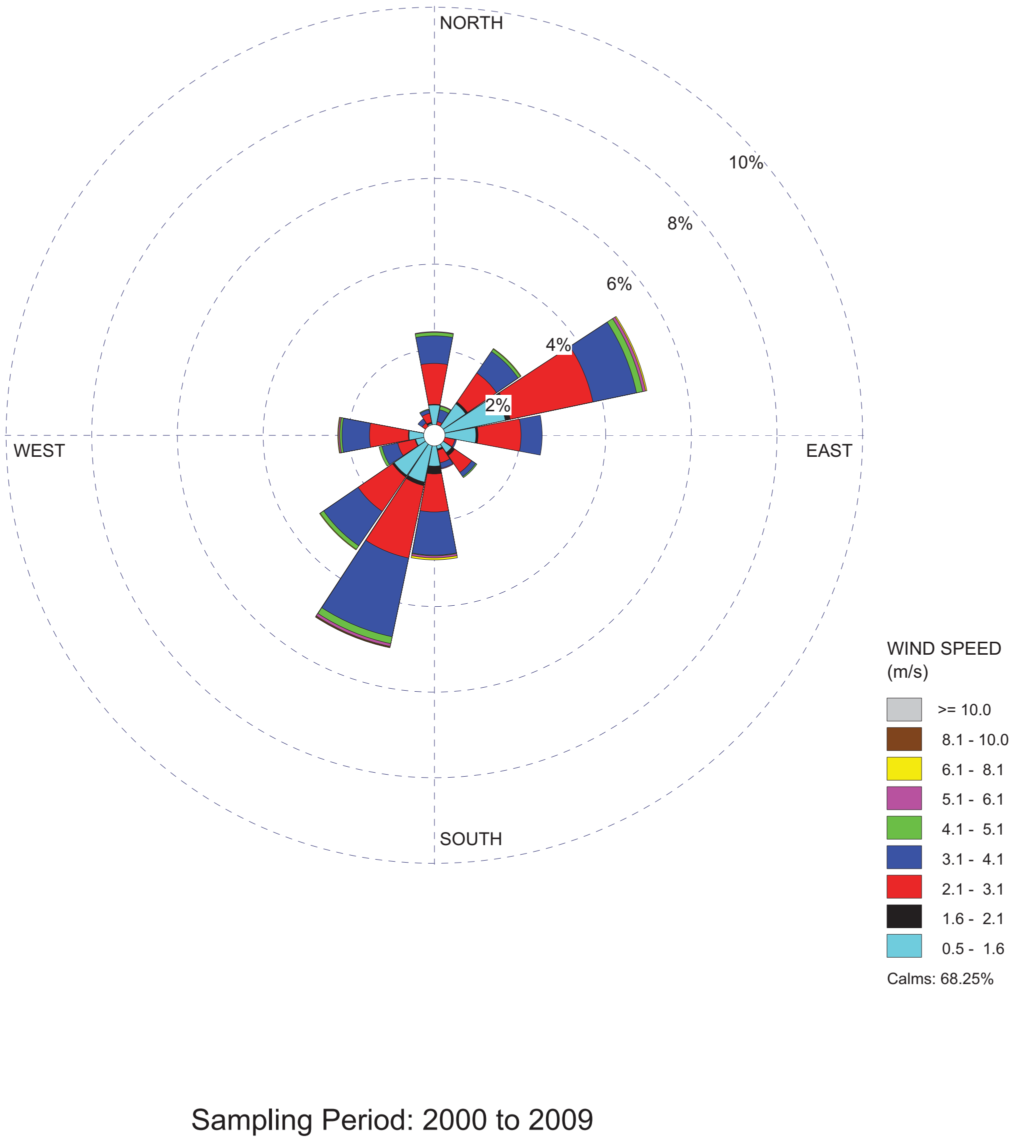
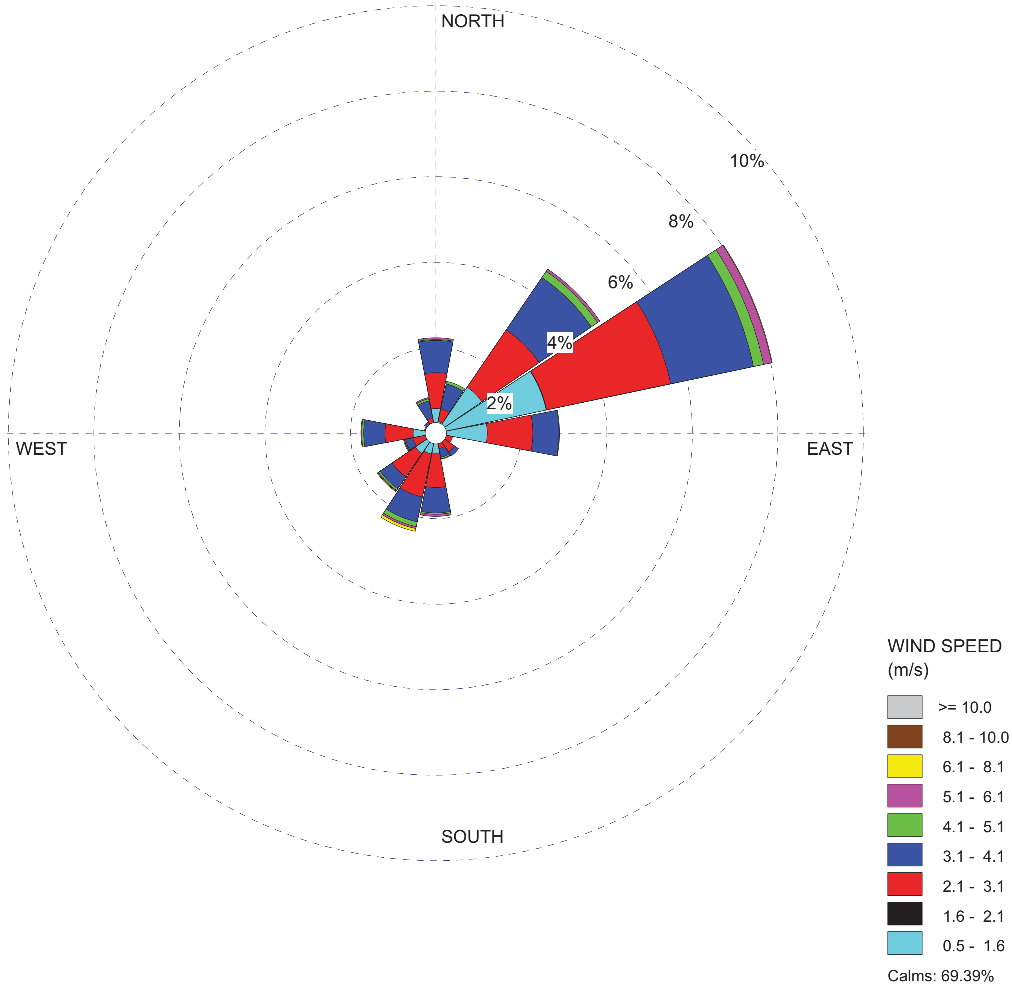
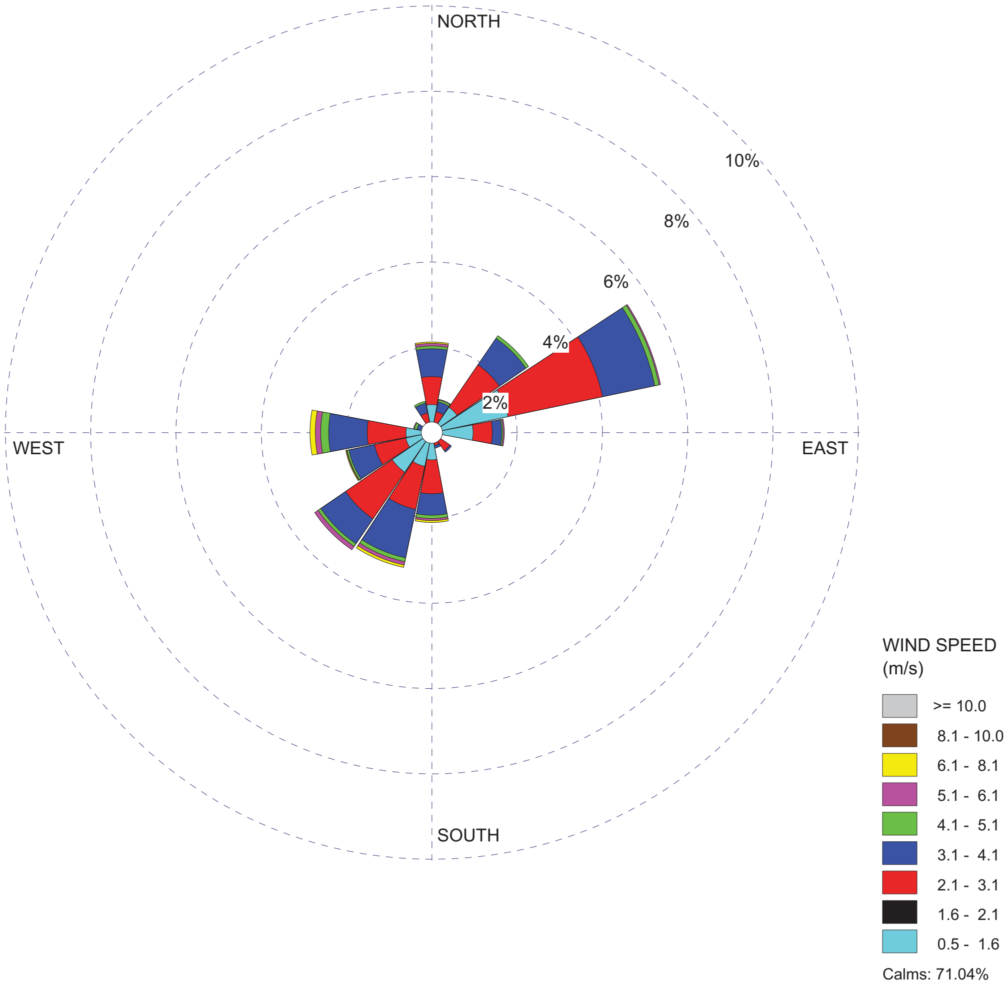


Figure 2.7.4-3. (Sheet 8 of 12) Wind Rose Oak Ridge NWS 10 Years August



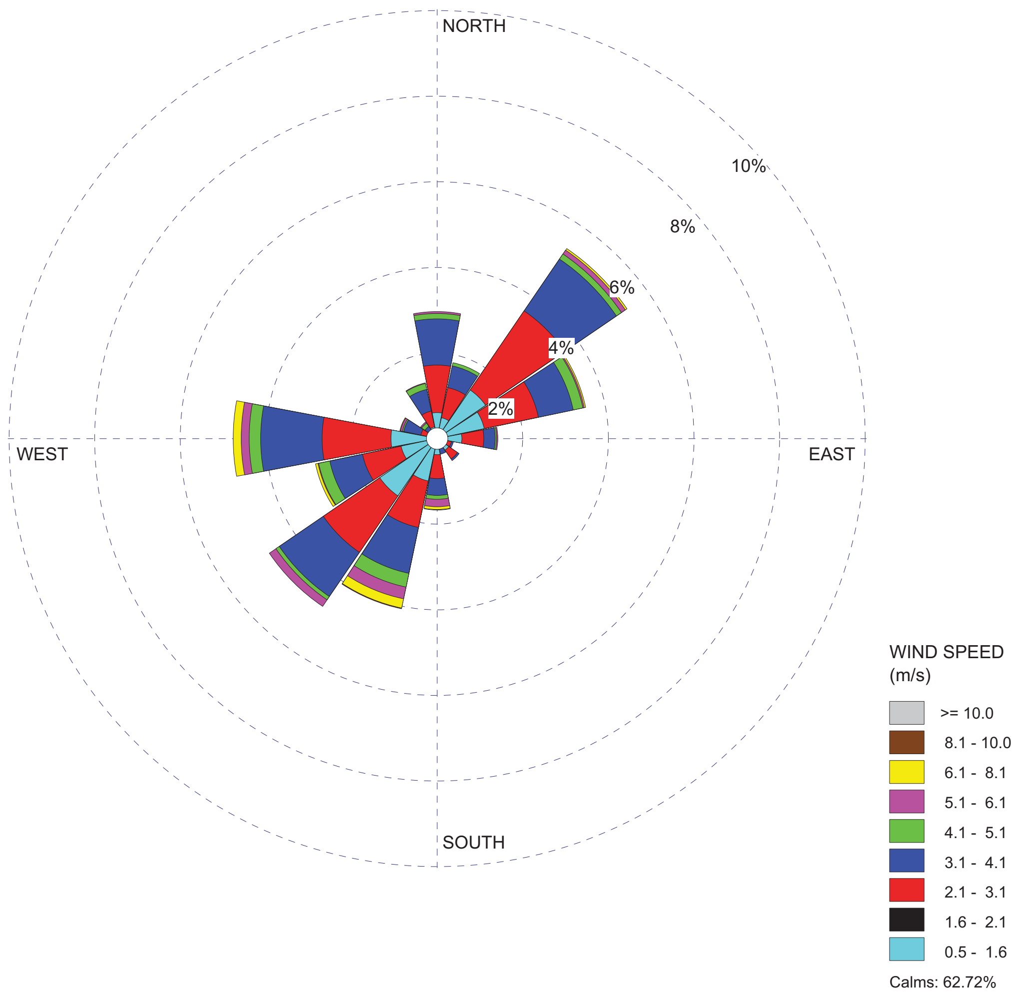
Sampling Period: 2000 to 2009

Figure 2.7.4-3. (Sheet 9 of 12) Wind Rose Oak Ridge NWS 10 Years September



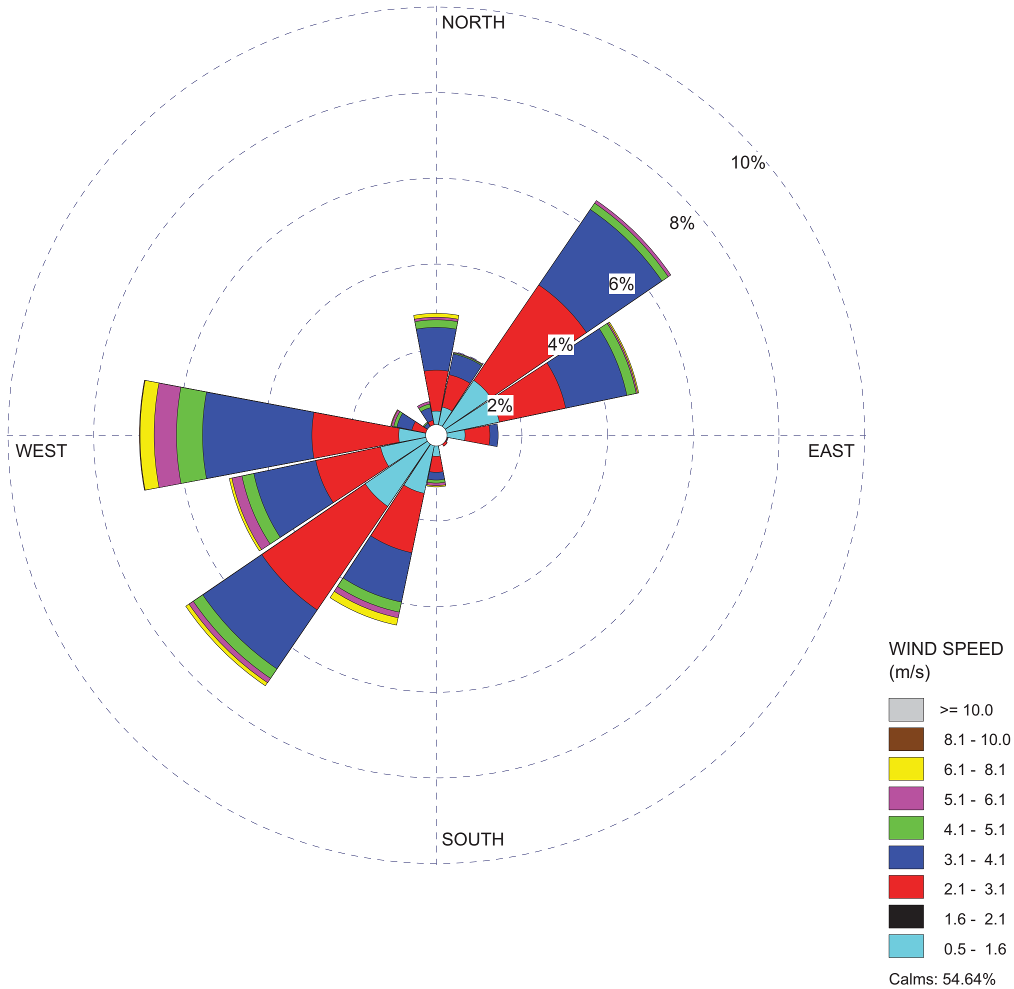
Sampling Period: 2000 to 2009

Figure 2.7.4-3. (Sheet 10 of 12) Wind Rose Oak Ridge NWS 10 Years October



Sampling Period: 2000 to 2009

Figure 2.7.4-3. (Sheet 11 of 12) Wind Rose Oak Ridge NWS 10 Years November



Sampling Period: 2000 to 2009

Figure 2.7.4-3. (Sheet 12 of 12) Wind Rose Oak Ridge NWS 10 Years December

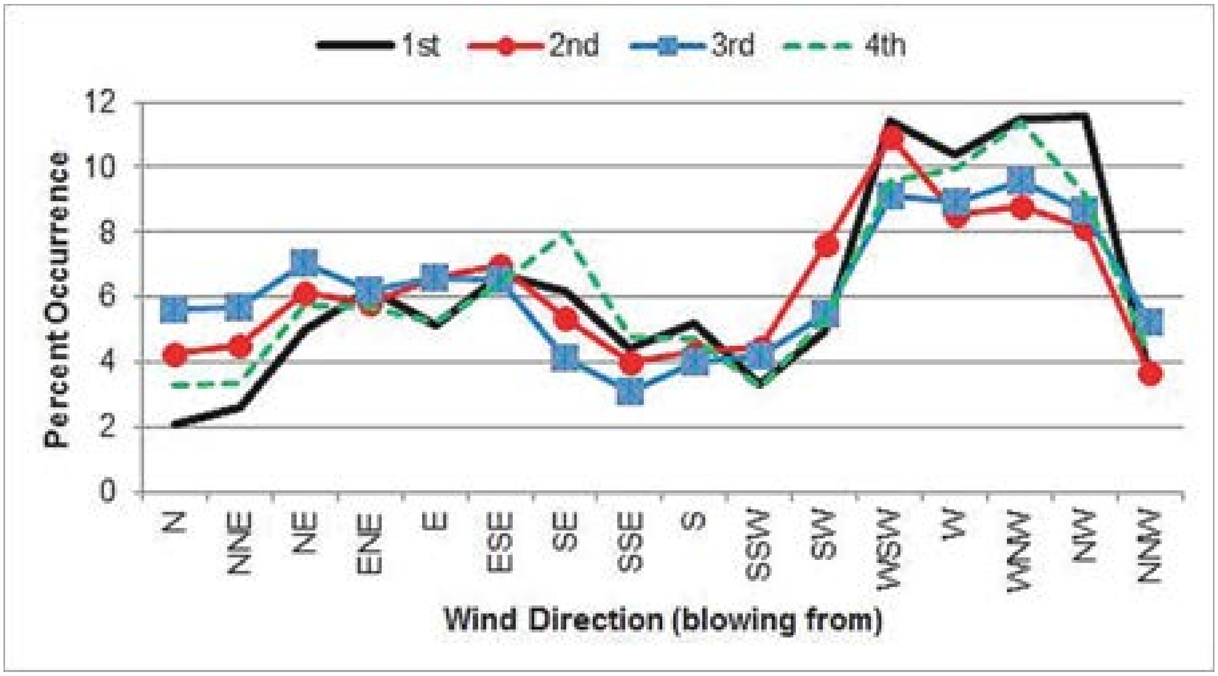
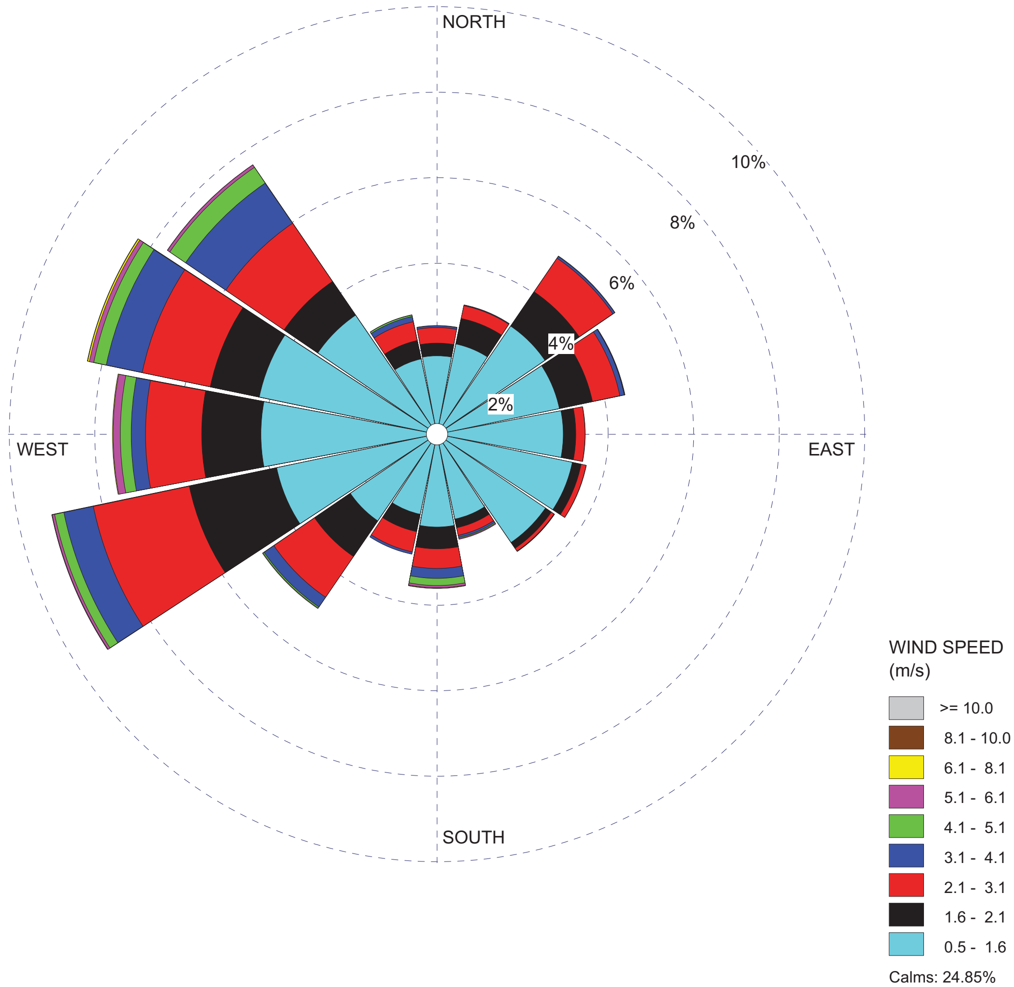
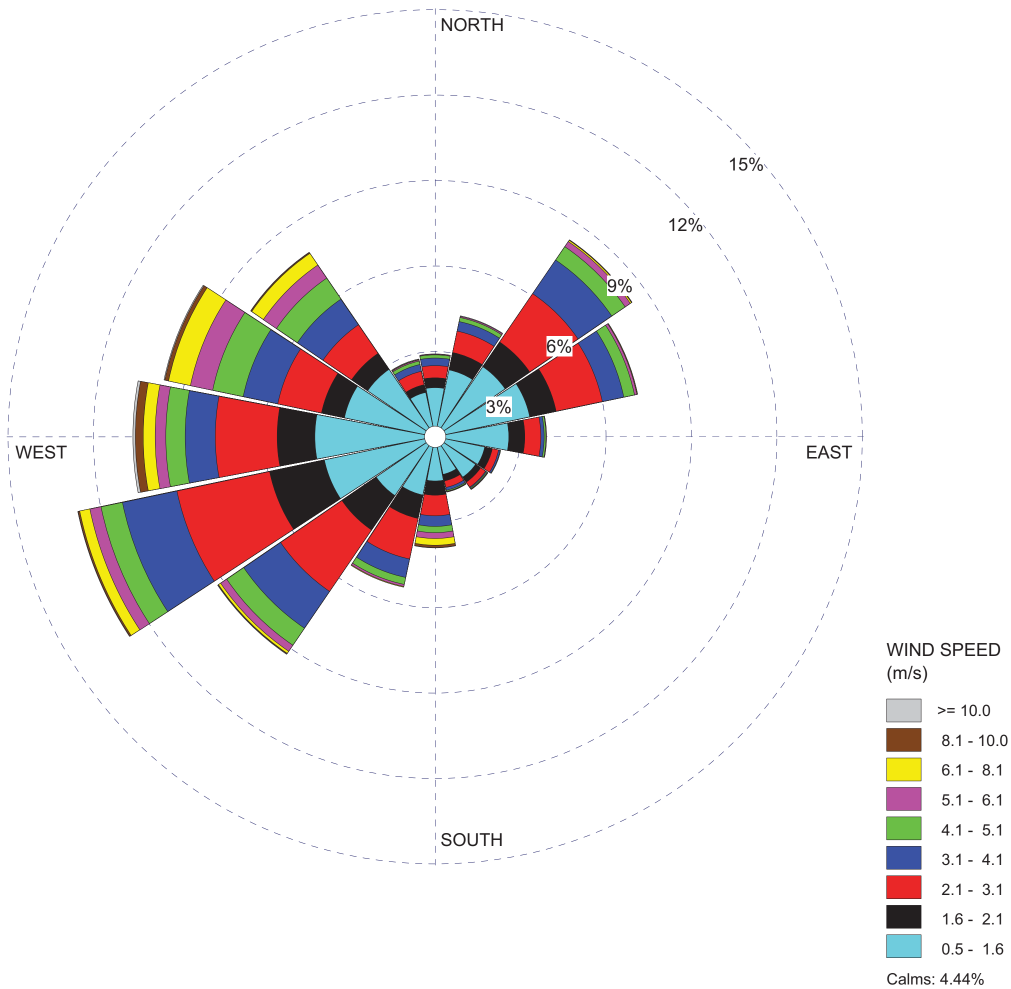


Figure 2.7.4-4. Clinch River Property Average 10-Meter Wind Direction (by Quarter)



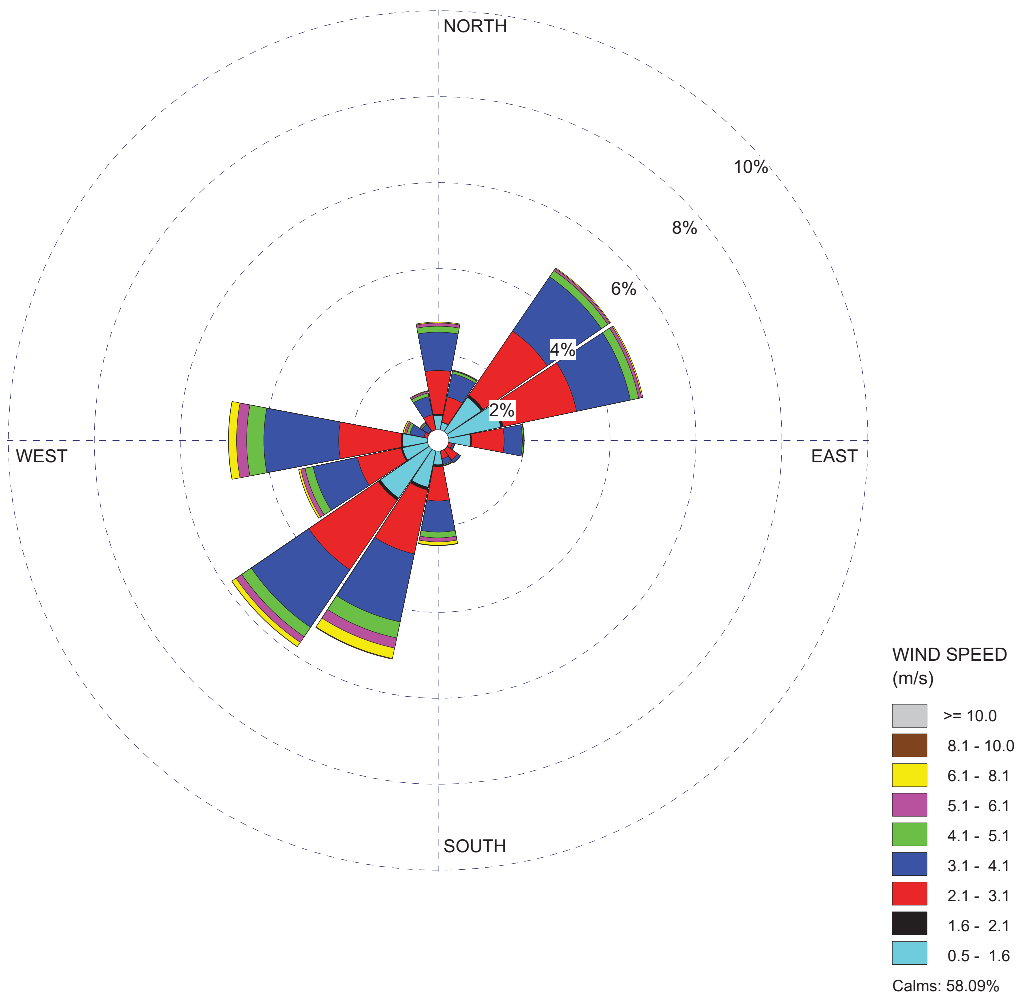
Sampling Period: April 21, 2011 to June 30, 2013

Figure 2.7.4-5. Wind Rose CRN Site 10-Meter All Data



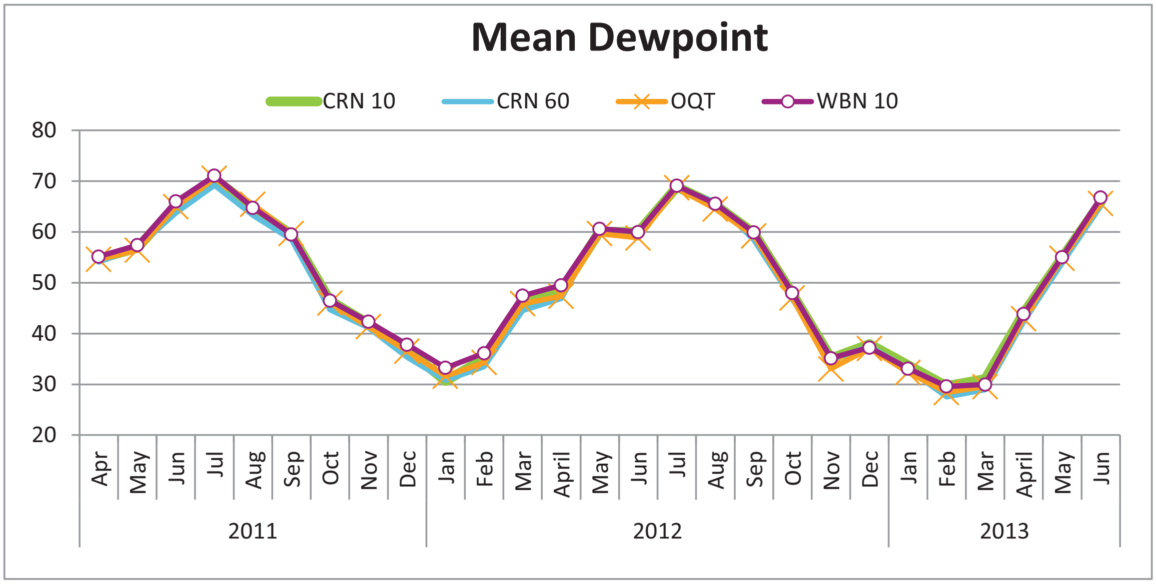
Sampling Period: April 21, 2011 to June 30, 2013

Figure 2.7.4-6. Wind Rose CRN Site 60-Meter All Data



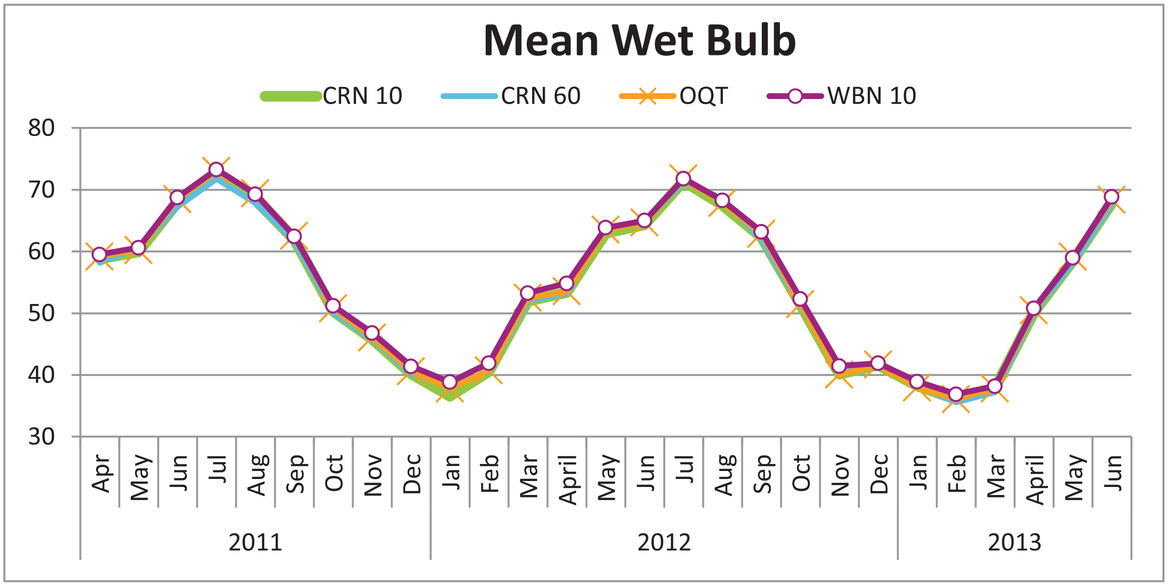
Sampling Period: 2000 to 2009

Figure 2.7.4-7. Wind Rose Oak Ridge NWS 10 Years All Data



Note:
CRN 10 = CRN Site 10-meter data
CRN 60 = CRN Site 60-meter
OQT = Oak Ridge NWS
WBN = Watts Bar Nuclear Site

Figure 2.7.4-8. Concurrent Mean Dew Point Temperatures (Fahrenheit)



Note:
CRN 10 = CRN Site 10-meter data
CRN 60 = CRN Site 60-meter
OQT = Oak Ridge NWS
WBN = Watts Bar Nuclear Site

Figure 2.7.4-9. Concurrent Mean Wet Bulb Temperatures (Fahrenheit)

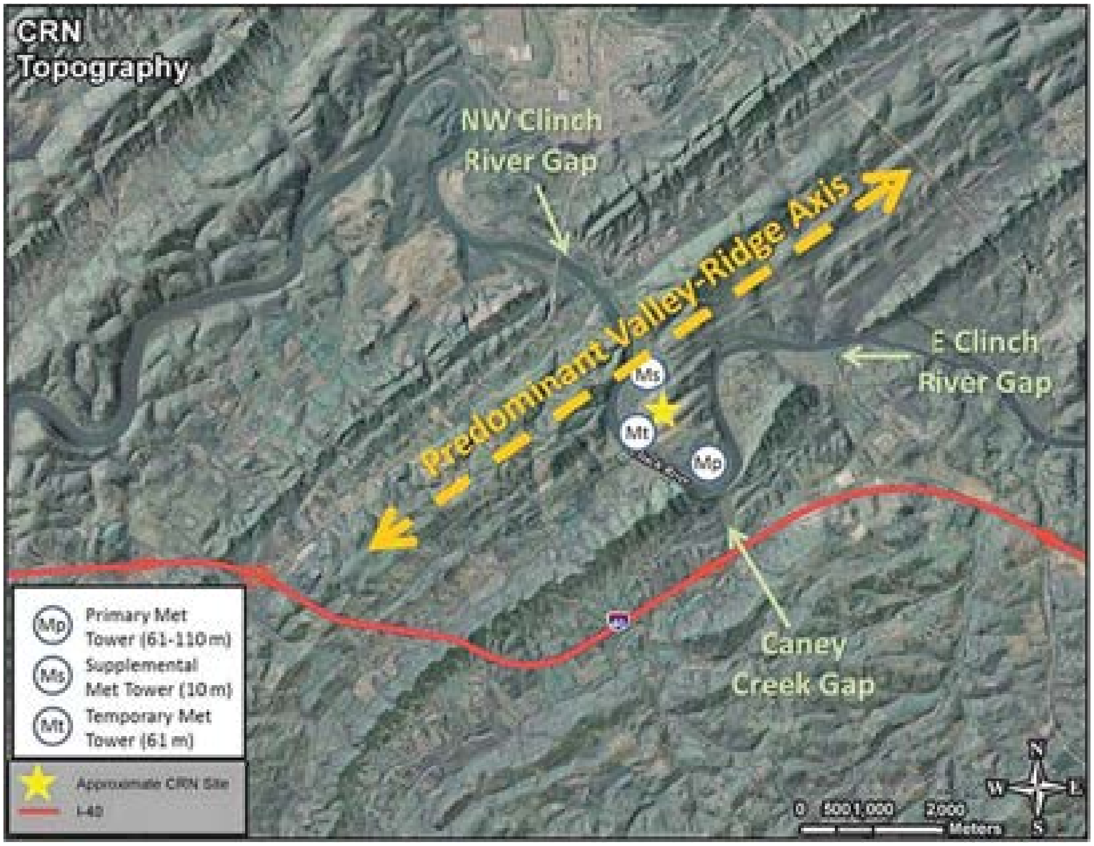
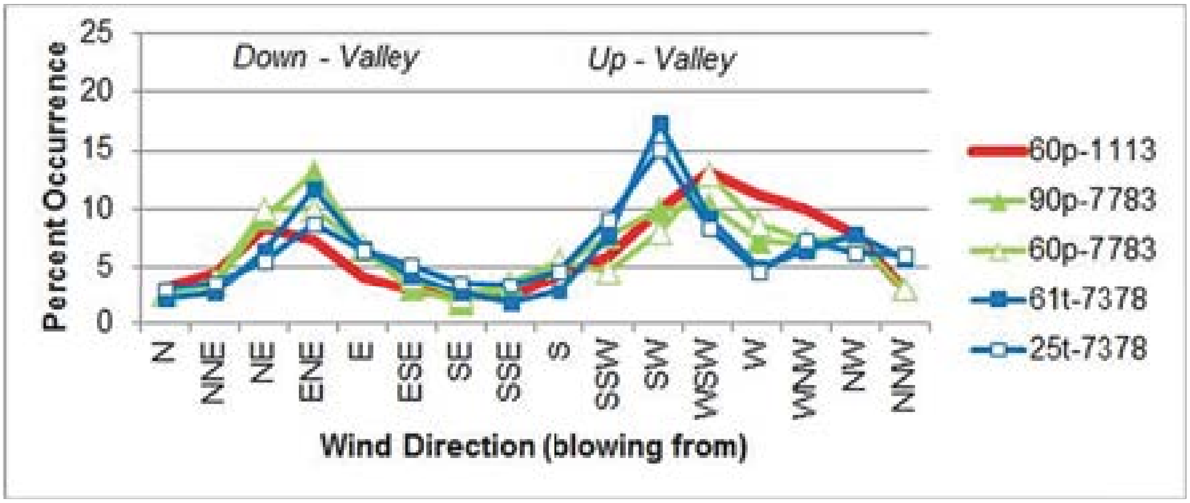
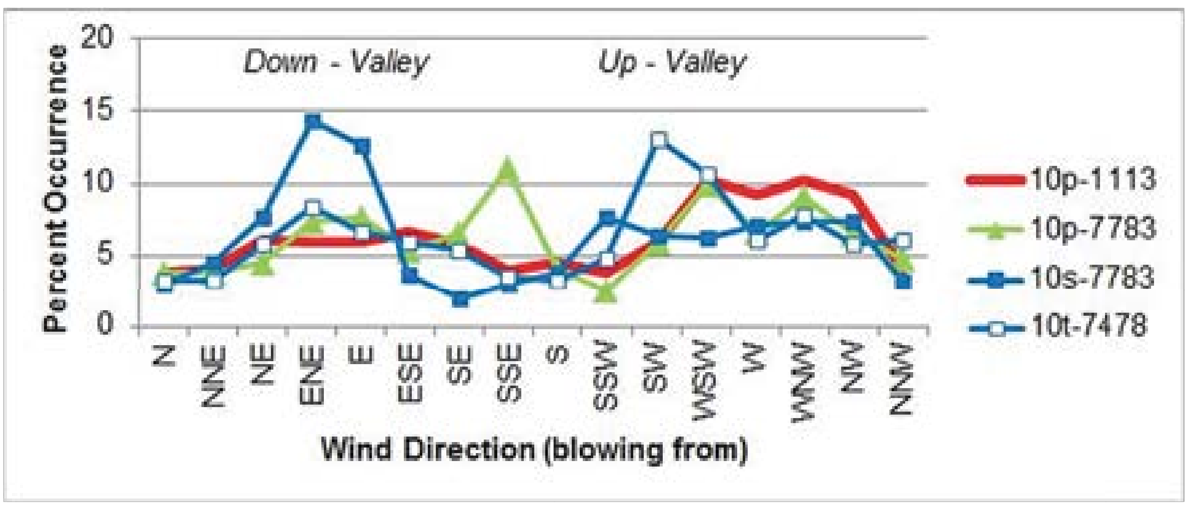


Figure 2.7.4-10. Topography in the Vicinity of the CRN Site



Primary Tower (Mp):	Temporary Tower (Mt):
60p-1113 = 60 m (4/21/2011-6/30/2013)	**61t-7378** = 61 m (4/11/1973-3/2/1978)
90p-7783 = 90 m (2/16/1977-11/4/1983)	**25t-7378** = 25 m (4/11/1973-3/2/1978)
60p-7783 = 60 m (2/16/1977-11/4/1983)	

Frequency of Elevated Wind Directions

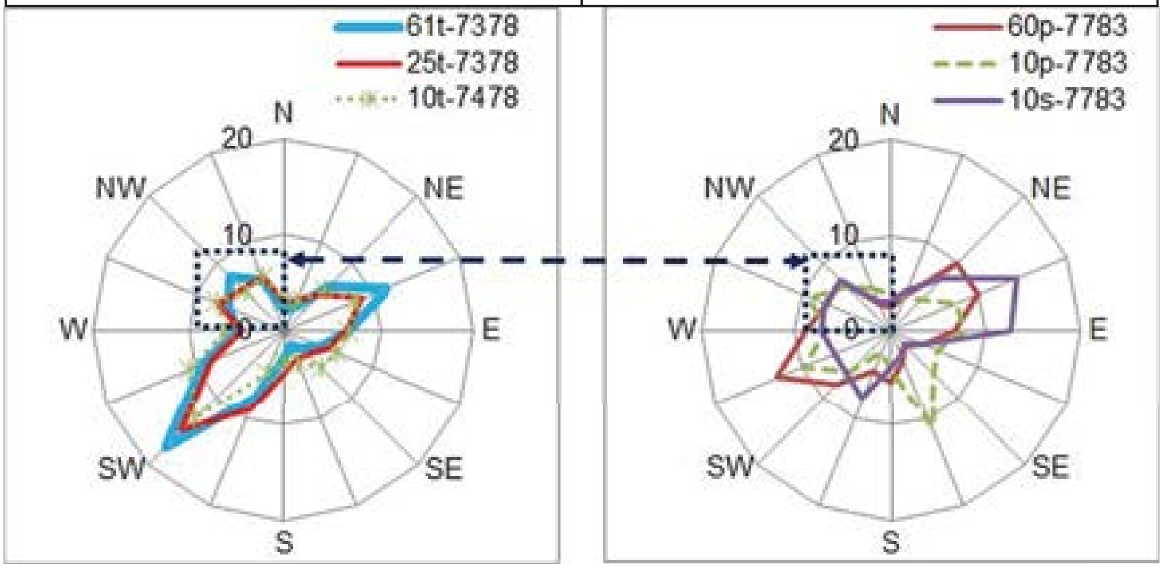


Primary Tower (Mp):	Supplemental Tower (Ms):
10p-1113 = 10 m (4/21/2011-6/30/2013)	**10s-7783** = 10 m (4/11/1973-3/2/1978)
10p-7783 = 10 m (2/16/1977-11/4/1983)	**Temporary Tower (Mt):**
	10t-7478 = 10 m (4/3/1974-3/2/1978)

Frequency of 10-meter Wind Directions

Figure 2.7.4-11. (Sheet 1 of 2) Effects of Topography on Wind Flow in the CRN Site Vicinity

Temporary Tower	Other Towers

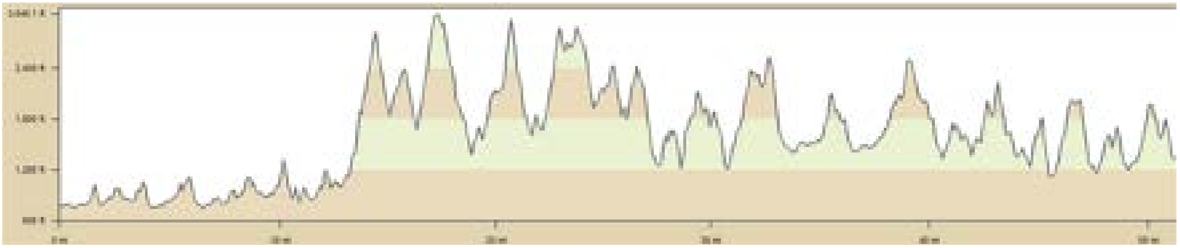


61t-7378 = [temporary] 61 m (1973-1978)
25t-7378 = [temporary] 25 m (1973-1978)
10t-7478 = [temporary] 10 m (1974-1978)

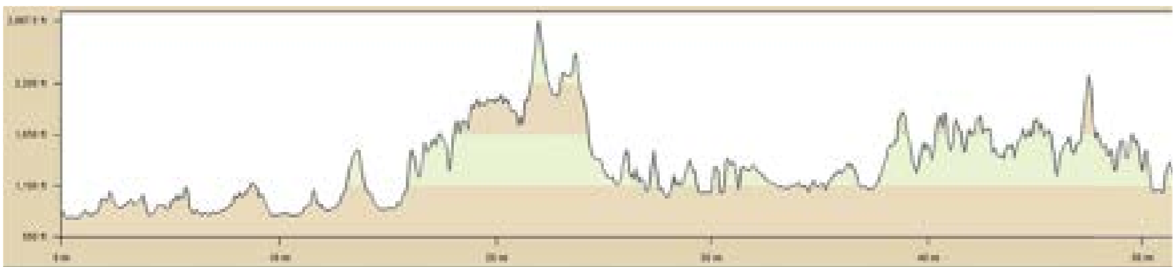
60p-7783 = [primary] 61 m (1977-1983)
10p-7783 = [primary] 10 m (1977-1983)
10s-7783 = [supplemental] 10 m (1977-1983)

Comparison of Peaks between Temporary Tower and Other Towers

Figure 2.7.4-11. (Sheet 2 of 2) Effects of Topography on Wind Flow in the CRN Site Vicinity

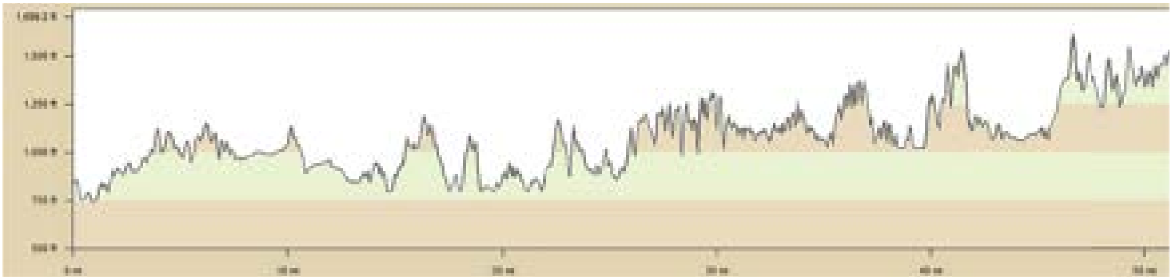


North

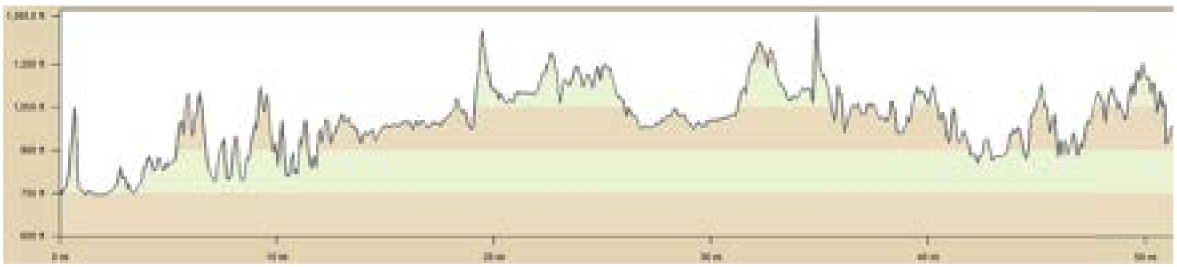


North Northeast

Figure 2.7.4-12. (Sheet 1 of 8) Elevation Profiles 0 to 50 Miles from CRN Site

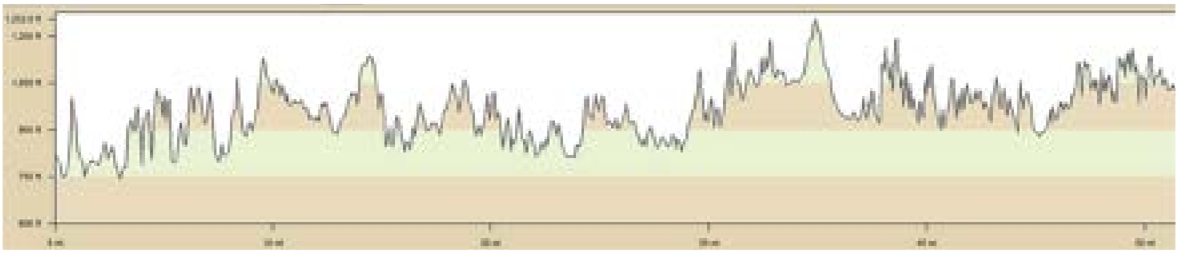


Northeast



East Northeast

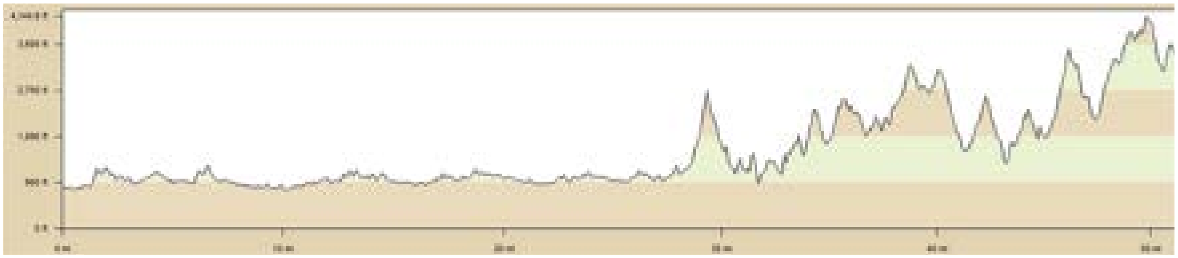
Figure 2.7.4-12. (Sheet 2 of 8) Elevation Profiles 0 to 50 Miles from CRN Site



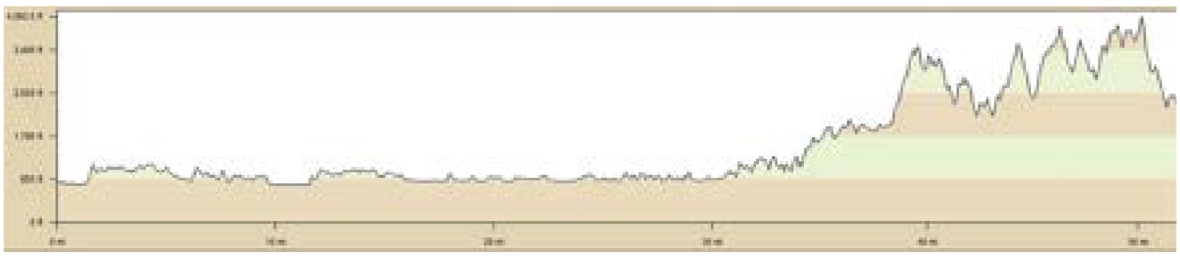
East

East Southeast

Figure 2.7.4-12. (Sheet 3 of 8) Elevation Profiles 0 to 50 Miles from CRN Site

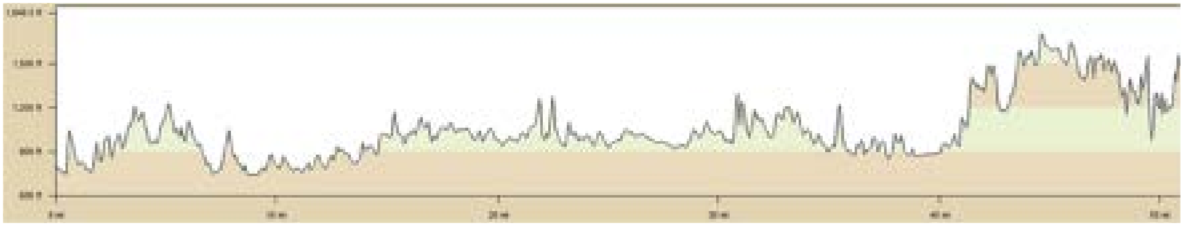


Southeast

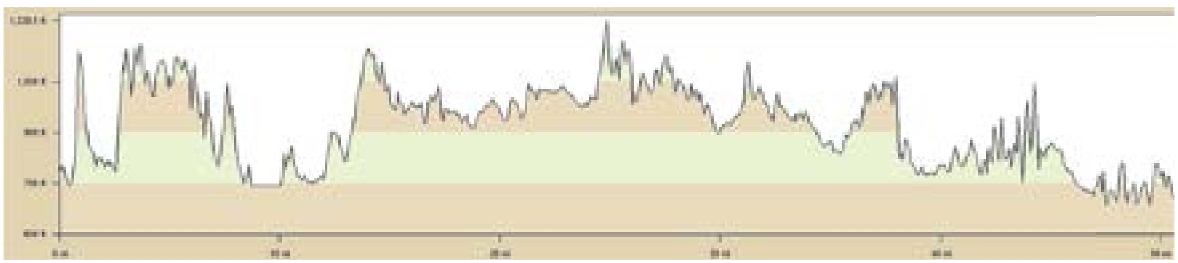


South Southeast

Figure 2.7.4-12. (Sheet 4 of 8) Elevation Profiles 0 to 50 Miles from CRN Site

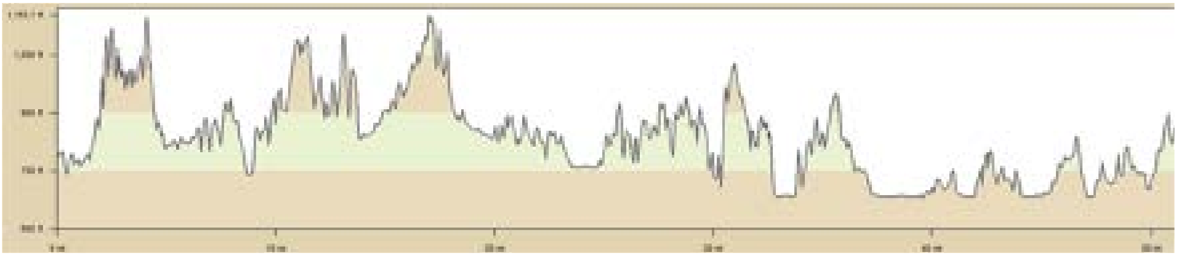


South

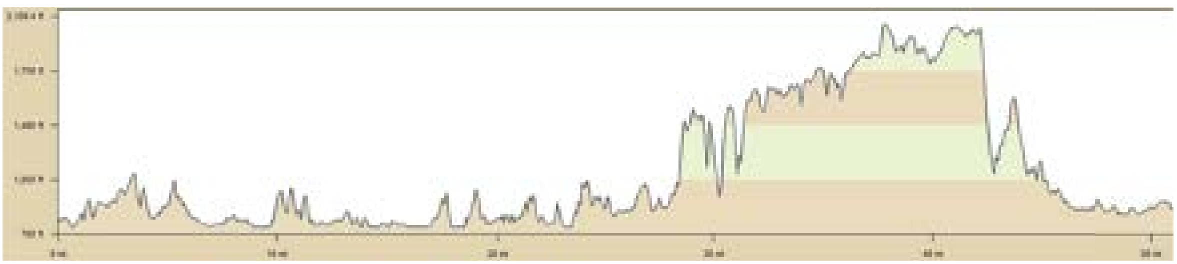


South Southwest

Figure 2.7.4-12. (Sheet 5 of 8) Elevation Profiles 0 to 50 Miles from CRN Site

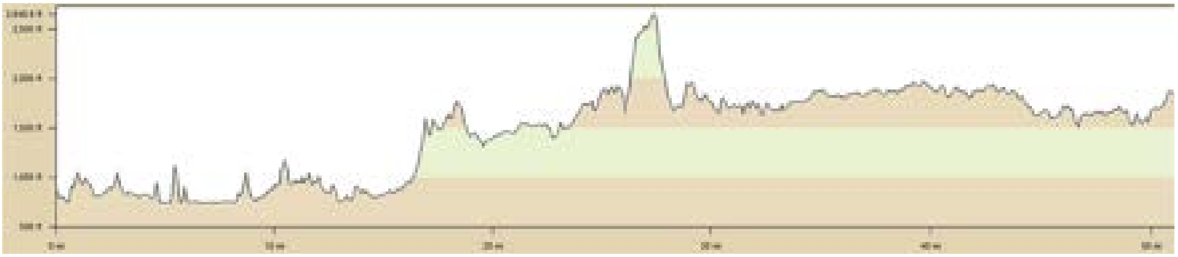


Southwest

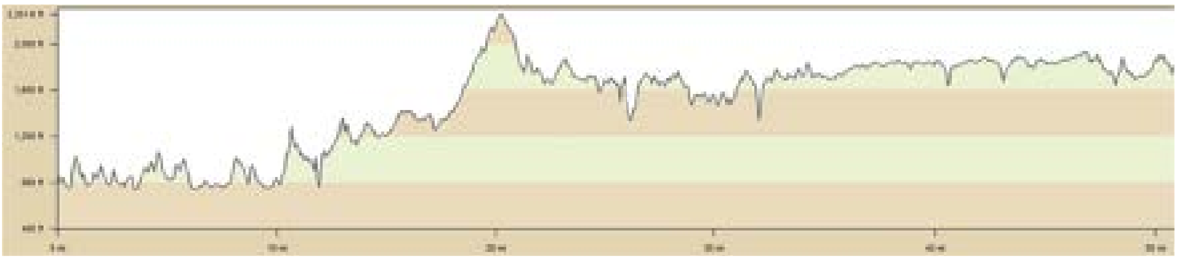


West Southwest

Figure 2.7.4-12. (Sheet 6 of 8) Elevation Profiles 0 to 50 Miles from CRN Site

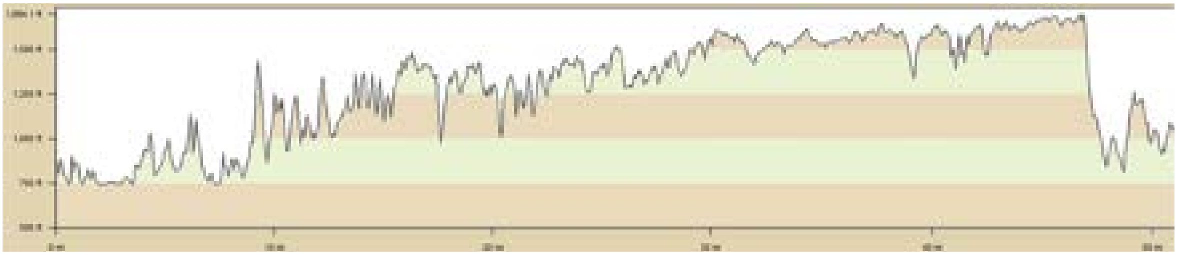


West

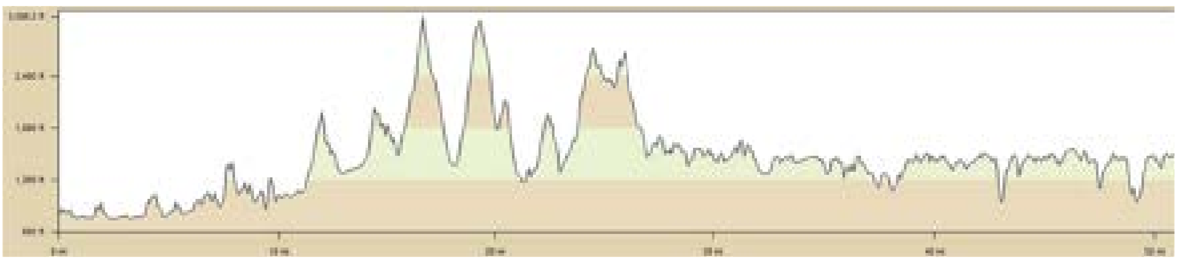


West Northwest

Figure 2.7.4-12. (Sheet 7 of 8) Elevation Profiles 0 to 50 Miles from CRN Site



Northwest



North Northwest

Figure 2.7.4-12. (Sheet 8 of 8) Elevation Profiles 0 to 50 Miles from CRN Site

2.7.5 Short-Term Diffusion Estimates

Short-term diffusion estimates are developed in support of evaluating postulated accidental releases of radioactive material from the Clinch River (CR) Small Modular Reactor (SMR) Project. The consequence of a design basis accident in terms of personnel exposure is a function of the atmospheric dispersion conditions around the Clinch River Nuclear (CRN) Site. Atmospheric dispersion consists of two components: 1) atmospheric transport, or the downwind movement of effluents through the atmosphere; and 2) atmospheric diffusion, or the spread of effluents away from the plume centerline. Atmospheric dispersion conditions are represented by relative air concentration (*X*/Q) values. This subsection describes the development of conservative short-term atmospheric diffusion estimates for receptors located on the Exclusion Area Boundary (EAB) and the outer boundary of the Low Population Zone (LPZ).

2.7.5.1 Purpose and Background

According to Title 10 of the Code of Federal Regulations (10 CFR) 100.11, the limiting design basis fission product release and site meteorological conditions should be used to derive an exclusion area, low population zone, and a population center distance. To demonstrate compliance with 10 CFR Part 100, it is necessary to consider doses for various time periods immediately following the onset of a postulated accident at the EAB and for the duration of exposure for the LPZ.

As a result, estimates of atmospheric dispersion, expressed as *X*/Q, were calculated for accidental releases from the CRN Site for specified time intervals at the EAB and the LPZ, as required under 10 CFR 100 and 10 CFR 50.

2.7.5.2 Calculation Methodology and Assumptions

The atmospheric dispersion calculations were performed using the PAVAN computer program, NUREG/CR-2858, *PAVAN: An Atmospheric-Dispersion Program for Evaluating Design-Basis Accidental Releases of Radioactive Materials from Nuclear Power Stations,* which was developed and is used by the U.S. Nuclear Regulatory Commission (NRC). The PAVAN program implements the guidance provided in NRC Regulatory Guide (RG) 1.145, *Atmospheric Dispersion Models for Potential Accident Consequence Assessments at Nuclear Power Plants*. The PAVAN model calculates *X/Q* values based on the theory that material released to the atmosphere are normally distributed (Gaussian) about the plume centerline. Therefore, a straight-line trajectory is modeled between the point of release and distances for which *X*/Q values are calculated in accordance with NUREG/CR-2858 and NRC RG 1.145.

NRC RG 4.7, *General Site Suitability Criteria for Nuclear Power Stations,* states that for site approval, each applicant should collect at least one year of meteorological information that is representative of the site conditions for calculating radiation doses resulting from the release of fission products as a consequence of a postulated accident. NRC RG 1.23 recommends using meteorological data from a consecutive 24-month period. Two full years (June 1, 2011 through

May 31, 2013) of CRN Site-specific meteorological tower data were used as input to the PAVAN code. Meteorological data were input as joint frequency distributions (JFDs), in percent frequency, of wind direction and wind speed by atmospheric stability class. Stability classes were based on the classification system given in Table 1 of NRC RG 1.23, and are listed in Table 2.7.5-1 herein.

Validated data from the lower meteorological tower level (10-meters [m]) of the CRN Site's meteorological monitoring program were used to prepare JFDs for the PAVAN modeling. Of the 17,544 hours (hr) of possible data, 17,380 hr had valid data combinations of wind speed, wind direction, and stability class. The resulting data recovery was 99.07 percent, well above the 90 percent data recovery required by NRC RG 1.23. Calms hours were distributed into the first wind speed category in the JFDs, based on this PAVAN input option. Thirteen wind speed categories were defined in the JFDs and used in the modeling. The wind speed categories used in the PAVAN analysis are shown in the JFD tables; the JFD tables for each stability class are given in Tables 2.7.5-2 through 2.7.5-8. For the two years of data modeled, there were no hourly recordings of wind speed greater than 18.0 miles per hour (mph; 8.0 miles per second [m/s]). The percent occurrence of hours for each wind direction is shown in Table 2.7.5-9, and the percent occurrence of hours in each stability class is given in Table 2.7.5-10.

Using the JFDs, PAVAN provides the X/Q values as a function of direction for various time periods at the EAB and the LPZ. According to NRC RG 4.7, an applicant is required by Subpart A of 10 CFR Part 100 (100.11) and Subpart B of 10 CFR Part 100 (100.20) to designate an exclusion area and to have authority to determine all activities within that area, including removal of personnel and property. The exclusion area is required to be of such a size that an individual assumed to be located at any point on its boundary would not receive a radiation dose in excess of 25 rem total effective dose equivalent (TEDE) over any 2-hr period following a postulated fission product release. The required exclusion area size involves consideration of the atmospheric dispersion characteristics of the site as well as plant design.

NRC RG 1.145 requires that, for each of the 16 compass sectors, the distance to the EAB should be the minimum distance between the effluent release point and the EAB within a 45-degree sector centered on the compass direction of interest. For conservatism and simplicity, the effluent release point is evaluated as a circular effluent release boundary (ERB) that encloses potential release points from the nuclear island as shown in Figure 2.7.5-1. A circular analytical EAB is established 1100 ft (335 m) from the ERB. For X/Q modelling (Table 2.7.5-11), the analytical EAB is used as a bounding representative distance to the EAB.

To account for multiple units on site, nuclear islands are positioned at multiple locations within the power block area with associated ERBs and EABs as shown in Figure 2.7.5-2 (note that although the nuclear islands for vendors 1 and 4 are depicted in the figure, the nuclear islands, associated ERBs, and analytical EABs for vendors 1, 2, 3, and 4 fit within the EAB ellipse). The analytical EABs can be encompassed by an ellipse fixed completely within the CRN Property boundary, i.e. the actual EAB (Figure 2.7.5-2), which demonstrates that dispersion factor computations are conservative.

The site center point is determined as the centerline midpoint of the EAB ellipse (Figure 2.7.5-2). The ellipse has a short axis of 0.326 mi (524 m) from the site center point and long axis of 0.535 mi (864 m) from the center point.

According to NRC RG 4.7, an applicant is also required by 10 CFR Part 100 to designate an area immediately beyond the exclusion area as a LPZ. The size of the LPZ must be such that the distance to the nearest boundary of a densely populated center containing more than about 25,000 residents (population center distance) must be at least one and one-third times the distance from the reactor to the outer boundary of the LPZ. The boundary of the population center should be determined upon consideration of population distribution, not political boundaries. In addition, the LPZ must be of such a size that an individual located on its outer radius for the course of the postulated accident (assumed to be 30 days) would not receive a radiation dose in excess of 25 rem TEDE.

The LPZ is defined by a circular area with a radius of 1-mile (1609 m), centered on the site as shown in Figure 2.7.5-3.

Other plant specific data considered for PAVAN includes minimum building cross-sectional area, building height, and meteorological tower height at which the wind speed was measured (NUREG/CR-2858). These are listed in Table 2.7.5-12. The building height and minimum cross-sectional area are used in the determination of building wake effects. Building cross-sectional area is defined in NRC RG 1.145 as the smallest vertical-plane cross-sectional area of the containment structure, in square meters (sq m). NRC RG 1.111, *Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors,* identifies the tallest adjacent building, either up- or downwind from the release point(s), as appropriate for use. Because the dose calculations for the EAB and LPZ are both located beyond the building wake's significant zone of influence, the height and cross-sectional area have less effect on *X/Q* values. Therefore, for conservatism, no building wake credit was used in the PAVAN model (e.g., the building height and cross-sectional area were both set to zero in the model).

Based on NRC RG 1.145, a ground release includes release points that are effectively less than two and one-half times the height of adjacent solid structures. Compared to an elevated release, a groundlevel release usually results in higher groundlevel concentrations at downwind receptors due to the plume centerline being at groundlevel. Because the groundlevel release scenario provides a bounding case, elevated releases are not considered in this application.

The meteorological tower height used in PAVAN is the height above ground level at which the wind speed was measured (NUREG/CR-2858). For a groundlevel release, the lower wind speed and direction measurement height of 9.78 m is used (Table 2.7.5-12).

Because a groundlevel release scenario provides the most conservative *X/Q* values at the EAB, a groundlevel release was used in the modeling. As detailed in NRC RG 1.145, Section 1.3.1, for release modes that are effectively lower than two and one-half times the height of adjacent solid structures (ground-release mode), two sets of meteorological conditions are treated differently in order to consider the effects of building wake mixing and plume meander (NUREG/CR-2858).

During neutral (D) or stable (E, F, or G) atmospheric stability conditions when the wind speed is less than 6 m/s, horizontal plume meander is considered. The PAVAN model (NUREG/CR-2858) calculates the relative concentration (*X*/Q) values through the selective use of the following set of equations for groundlevel relative concentrations at the plume centerline.

$$\frac{X}{Q} = \frac{1}{\bar{U}_{10}\left(\pi\sigma_y\sigma_z + \frac{A}{2}\right)} \qquad \text{Equation 1}$$

$$\frac{X}{Q} = \frac{1}{\bar{U}_{10}(3\pi\sigma_y\sigma_z)} \qquad \text{Equation 2}$$

$$\frac{X}{Q} = \frac{1}{(\bar{U}_{10}\pi\sum_y \sigma_z)} \qquad \text{Equation 3}$$

Where:

- *X*/Q = centerline groundlevel relative concentration (sec/m^3).
- σ_y = lateral plume spread as a function of atmospheric stability and distance (m).
- σ_z = vertical plume spread as a function of atmospheric stability and distance (m).
- A = minimum building vertical-plane cross-sectional area (m^2).
- $\bar{U}_{10}$ = average wind speed at 10 m above plant grade (m/s).
- Σ_y = lateral plume spread with plume meander and building wake effects (m), as a function of atmospheric stability, wind speed, and distance.

The PAVAN model calculates *X*/Q values using Equations 1, 2, and 3. The model compares the values from Equations 1 and 2, and the higher value is selected. This value is then compared with the value from Equation 3, and the lower value of these two is selected as the appropriate *X*/Q value.

During unstable (A, B, or C) atmospheric stability and / or 10-m level wind speeds of 6 m/s or more, plume meander (Equation 3) is not considered. The higher value calculated from Equation 1 or 2 is used as the appropriate *X*/Q value.

NRC RG 1.145 requires that the *X/Q* values at the EAB and LPZ boundaries be calculated from the sector-independent, 50-percent overall site *X/Q*.

2.7.5.3 Results and Conclusions

The 50 percent *X/Q* results for the SMR release zone, based on the two years of CRN Site-specific meteorological data (June 2011 through May 2013), are given in Table 2.7.5-13.

Table 2.7.5-1
Classification of Atmospheric Stability

Stability Classification	Pasquill Categories	Temperature change with height (°C/100m)
Extremely unstable	A	$\Delta T \leq -1.9$
Moderately unstable	B	$-1.9 < \Delta T \leq -1.7$
Slightly unstable	C	$-1.7 < \Delta T \leq -1.5$
Neutral	D	$-1.5 < \Delta T \leq -0.5$
Slightly stable	E	$-0.5 < \Delta T \leq 1.5$
Moderately stable	F	$1.5 < \Delta T \leq 4.0$
Extremely stable	G	$\Delta T > 4.0$

Note: Based on Table 1 in NRC RG 1.23.

Table 2.7.5-2
Joint Frequency Distribution (Hours) of Wind Speed and Direction by Atmospheric Stability Class – Stability Class A
June 1, 2011 to May 31, 2013

WIND DIRECTION	WIND SPEED (MPH)														
	CALM	≤0.50	≤1.10	≤1.70	≤2.20	≤2.80	≤3.40	≤4.50	≤6.70	≤8.90	≤11.20	≤13.40	≤18.00	>18.00	TOTAL
N	0	0	0	1	0	3	3	9	16	2	0	0	0	0	34
NNE	0	0	0	1	1	4	10	23	23	0	0	0	0	0	62
NE	0	0	0	0	3	5	4	22	37	5	0	0	0	0	76
ENE	0	0	0	2	1	2	3	13	19	9	0	0	0	0	49
E	0	0	0	0	1	0	0	7	4	0	0	0	0	0	12
ESE	0	0	0	0	3	0	0	3	3	0	0	0	0	0	9
SE	0	0	0	0	0	2	0	1	0	0	0	0	0	0	3
SSE	0	0	0	1	0	0	1	0	2	1	0	0	0	0	5
S	0	0	0	0	2	0	0	0	0	0	0	0	0	0	2
SSW	0	0	0	1	1	0	0	1	0	0	0	0	0	0	3
SW	0	0	0	0	1	1	1	1	1	1	0	0	0	0	6
WSW	0	0	0	1	1	3	0	8	9	9	2	0	0	0	33
W	0	0	0	0	0	1	1	4	14	6	4	4	1	0	35
WNW	0	0	0	0	0	0	0	1	9	18	5	3	1	0	37
NW	0	0	0	1	2	0	1	6	21	48	23	4	0	0	106
NNW	0	0	0	1	0	1	0	5	9	4	0	0	0	0	20
Subtotal	0	0	0	9	16	22	24	104	167	103	34	11	2	0	492

Notes:
1. JFDs based on 17380 total hours of valid wind direction-wind speed-stability observations.
2. Stability based on ΔT between 8.44 and 59.22 meters (ΔT ≤ -1.9°C/100 M).
3. Total hours of valid wind direction and wind speed in Stability Class A = 492.
4. Wind speed, direction measured at 9.78 meters; mean wind speed = 5.73 mph.
5. Totals and subtotals are obtained from unrounded numbers.

Table 2.7.5-3
Joint Frequency Distribution (Hours) of Wind Speed and Direction by Atmospheric Stability Class – Stability Class B
June 1, 2011 to May 31, 2013

WIND DIRECTION	WIND SPEED (MPH)													
	CALM	≤0.50	≤1.10	≤1.70	≤2.20	≤2.80	≤3.40	≤4.50	≤6.70	≤8.90	≤11.20	≤13.40	≤18.00	>18.00	TOTAL
N	0	0	0	0	1	3	7	9	9	0	0	0	0	0	29
NNE	0	0	0	0	0	1	12	20	5	0	0	0	0	0	38
NE	0	0	0	0	1	8	12	24	36	3	0	0	0	0	84
ENE	0	0	0	0	0	5	7	10	16	1	0	0	0	0	39
E	0	0	0	0	0	0	5	12	8	0	0	0	0	0	25
ESE	0	0	0	0	0	1	1	6	1	0	0	0	0	0	9
SE	0	0	0	0	0	1	2	1	0	0	0	0	0	0	4
SSE	0	0	0	0	0	0	2	7	5	0	0	0	0	0	14
S	0	0	0	0	0	0	3	5	10	0	1	2	0	0	21
SSW	0	0	0	0	0	0	1	2	4	1	0	0	0	0	8
SW	0	0	0	0	0	0	2	11	13	4	0	0	0	0	30
WSW	0	0	0	0	0	1	8	23	41	18	5	1	0	0	97
W	0	0	0	0	0	1	3	18	14	2	1	2	1	0	42
WNW	0	0	0	0	0	0	4	7	20	17	6	2	1	0	57
NW	0	0	0	0	0	0	5	12	26	31	10	1	0	0	85
NNW	0	0	0	0	0	0	4	10	11	3	0	0	0	0	28
Subtotal	0	0	0	0	2	21	78	177	219	80	23	8	2	0	610

Notes:
1. JFDs based on 17380 total hours of valid wind direction-wind speed-stability observations.
2. Stability based on ΔT between 8.44 and 59.22 meters (-1.9 < ΔT ≤ -1.7°C/100 M).
3. Total hours of valid wind direction and wind speed in Stability Class B = 610.
4. Wind speed, direction measured at 9.78 meters; mean wind speed = 5.17 mph.
5. Totals and subtotals are obtained from unrounded numbers.

Table 2.7.5-4
Joint Frequency Distribution (Hours) of Wind Speed and Direction by Atmospheric Stability Class – Stability Class C
June 1, 2011 to May 31, 2013

WIND DIRECTION	WIND SPEED (MPH)													
	CALM	≤0.50	≤1.10	≤1.70	≤2.20	≤2.80	≤3.40	≤4.50	≤6.70	≤8.90	≤11.20	≤13.40	≤18.00	>18.00	TOTAL
N	0	0	0	0	3	7	15	6	13	0	0	0	0	0	44
NNE	0	0	0	1	0	13	12	21	3	0	0	0	0	0	50
NE	0	0	0	1	6	13	23	26	10	1	0	0	0	0	80
ENE	0	0	0	1	5	8	12	16	9	1	0	0	0	0	52
E	0	0	0	1	2	4	11	12	5	0	0	0	0	0	35
ESE	0	0	0	0	3	6	6	9	3	0	0	0	0	0	27
SE	0	0	0	0	2	8	2	6	5	0	0	0	0	0	23
SSE	0	0	0	0	1	3	10	4	2	1	0	2	0	0	23
S	0	0	0	0	1	4	4	13	15	4	2	1	0	0	44
SSW	0	0	0	0	1	6	9	12	12	3	0	0	0	0	43
SW	0	0	0	0	1	10	14	26	43	12	0	0	0	0	106
WSW	0	0	0	0	0	9	33	60	70	13	5	1	0	0	191
W	0	0	0	0	2	4	27	34	35	7	6	3	0	0	118
WNW	0	0	0	0	1	4	10	21	26	15	4	2	0	0	83
NW	0	0	0	0	0	1	11	14	38	20	7	0	0	0	91
NNW	0	0	0	0	2	4	4	9	8	4	3	0	0	0	34
Subtotal	0	0	0	4	30	104	203	289	297	81	27	9	0	0	1044

Notes:
1. JFDs based on 17380 total hours of valid wind direction-wind speed-stability observations.
2. Stability based on ΔT between 8.44 and 59.22 meters (-1.7 ≤ ΔT ≤ -1.5°C/100 M).
3. Total hours of valid wind direction and wind speed in Stability Class C = 1044.
4. Wind speed, direction measured at 9.78 meters; mean wind speed = 4.54 mph.
5. Totals and subtotals are obtained from unrounded numbers.

Table 2.7.5-5
Joint Frequency Distribution (Hours) of Wind Speed and Direction by Atmospheric Stability Class – Stability Class D
June 1, 2011 to May 31, 2013

WIND DIRECTION	WIND SPEED (MPH)													
	CALM	≤0.50	≤1.10	≤1.70	≤2.20	≤2.80	≤3.40	≤4.50	≤6.70	≤8.90	≤11.20	≤13.40	≤18.00	>18.00	TOTAL
N	0	1	14	57	33	27	17	22	21	2	0	0	0	0	194
NNE	0	0	6	53	49	39	25	42	11	0	0	0	0	0	225
NE	0	0	16	41	55	65	77	82	71	3	1	0	0	0	411
ENE	0	0	12	42	38	59	54	71	68	8	1	1	0	0	354
E	0	1	8	19	42	33	29	21	10	1	0	0	0	0	164
ESE	0	0	6	19	15	15	13	12	5	0	0	0	0	0	85
SE	0	0	6	10	17	21	19	10	1	1	0	1	0	0	86
SSE	0	0	4	9	12	25	11	12	10	4	7	1	0	0	95
S	0	0	3	13	23	37	44	51	56	30	25	7	3	0	292
SSW	0	1	8	16	23	39	41	44	49	6	0	0	0	0	227
SW	0	0	2	14	38	59	75	123	116	29	4	0	0	0	460
WSW	0	0	0	16	54	95	93	219	254	83	29	8	0	0	851
W	0	0	13	34	48	79	87	132	99	46	31	20	1	0	590
WNW	0	0	10	43	42	72	49	98	140	79	36	9	4	0	582
NW	0	0	19	48	43	58	48	85	139	75	35	6	0	0	556
NNW	0	0	16	41	30	33	30	27	35	11	4	0	0	0	227
Subtotal	0	3	143	475	562	756	712	1051	1085	378	173	53	8	0	5399

Notes:
1. JFDs based on 17380 total hours of valid wind direction-wind speed-stability observations.
2. Stability based on ΔT between 8.44 and 59.22 meters (-1.5 < ΔT ≤ -0.5°C/100 M).
3. Total hours of valid wind direction and wind speed in Stability Class D = 5399.
4. Wind speed, direction measured at 9.78 meters; mean wind speed = 4.01 mph.
5. Totals and subtotals are obtained from unrounded numbers.

Table 2.7.5-6
Joint Frequency Distribution (Hours) of Wind Speed and Direction by Atmospheric Stability Class – Stability Class E
June 1, 2011 to May 31, 2013

WIND DIRECTION	WIND SPEED (MPH)													
	CALM	≤0.50	≤1.10	≤1.70	≤2.20	≤2.80	≤3.40	≤4.50	≤6.70	≤8.90	≤11.20	≤13.40	≤18.00	>18.00	TOTAL
N	0	0	86	73	27	14	9	3	3	0	0	0	0	0	215
NNE	0	3	84	58	29	14	4	3	1	0	0	0	0	0	196
NE	0	3	79	63	30	27	16	24	7	1	1	0	0	0	251
ENE	0	2	57	60	34	39	22	17	12	1	0	0	0	0	244
E	0	2	67	55	29	23	15	7	7	0	0	0	0	0	205
ESE	0	5	54	58	18	10	9	3	2	0	0	0	0	0	159
SE	0	1	46	68	16	12	5	2	2	1	0	0	0	0	153
SSE	0	0	43	32	21	19	11	11	12	4	2	0	0	0	155
S	0	2	22	43	34	24	21	12	8	7	0	0	0	0	173
SSW	0	0	18	41	28	17	17	16	5	1	1	0	0	0	144
SW	0	1	26	44	30	35	33	16	12	5	0	0	0	0	202
WSW	0	2	39	52	44	51	54	49	39	12	3	0	0	0	345
W	0	2	54	63	65	65	47	59	50	8	1	1	1	0	416
WNW	0	3	90	118	60	48	35	54	68	29	5	2	0	0	512
NW	0	3	111	96	36	40	29	46	57	20	4	0	0	0	442
NNW	0	2	82	66	21	24	11	16	4	0	0	0	0	0	226
SUBTOTAL	0	31	958	990	522	462	338	338	289	89	17	3	1	0	4038

Notes:
1. JFDs based on 17380 total hours of valid wind direction-wind speed-stability observations.
2. Stability based on ΔT between 8.44 and 59.22 meters ($-0.5 < \Delta T \leq 1.5$°C/100 M).
3. Total hours of valid wind direction and wind speed in Stability Class E = 4038.
4. Wind speed, direction measured at 9.78 meters; mean wind speed = 2.32 mph.
5. Totals and subtotals are obtained from unrounded numbers.

Table 2.7.5-7
Joint Frequency Distribution (Hours) of Wind Speed and Direction by Atmospheric Stability Class – Stability Class F
June 1, 2011 to May 31, 2013

WIND DIRECTION	WIND SPEED (MPH)														
	CALM	≤0.50	≤1.10	≤1.70	≤2.20	≤2.80	≤3.40	≤4.50	≤6.70	≤8.90	≤11.20	≤13.40	≤18.00	>18.00	TOTAL
N	0	14	90	12	1	1	1	0	0	0	0	0	0	0	119
NNE	0	14	83	23	2	3	2	1	0	0	0	0	0	0	128
NE	0	10	97	24	2	2	0	0	0	0	0	0	0	0	135
ENE	0	17	138	29	14	5	2	0	1	0	0	0	0	0	206
E	0	14	187	74	15	2	2	0	1	0	0	0	0	0	295
ESE	0	15	185	87	22	2	4	0	0	0	0	0	0	0	315
SE	0	14	153	76	15	3	1	1	0	0	0	0	0	0	263
SSE	0	5	79	32	8	4	1	1	0	0	0	0	0	0	130
S	0	11	49	29	6	5	3	2	1	0	0	0	0	0	106
SSW	0	7	32	23	11	0	2	0	2	0	0	0	0	0	77
SW	0	2	38	26	12	4	2	3	0	0	0	0	0	0	87
WSW	0	5	42	24	10	3	8	3	1	0	0	0	0	0	96
W	0	1	91	39	15	17	4	5	3	0	0	0	0	0	175
WNW	0	10	131	101	33	9	4	6	4	2	0	0	0	0	300
NW	0	16	156	59	15	13	3	2	1	0	0	0	0	0	265
NNW	0	14	99	25	3	2	0	0	0	0	0	0	0	0	143
SUBTOTAL	0	169	1650	683	184	75	39	24	14	2	0	0	0	0	2840

Notes:
1. JFDs based on 17380 total hours of valid wind direction-wind speed-stability observations.
2. Stability based on ΔT between 8.44 and 59.22 meters (1.5 < ΔT ≤ 4.0°C/100 M).
3. Total hours of valid wind direction and wind speed in Stability Class F = 2840.
4. Wind speed, direction measured at 9.78 meters; mean wind speed = 1.16 mph.
5. Totals and subtotals are obtained from unrounded numbers.

Table 2.7.5-8
Joint Frequency Distribution (Hours) of Wind Speed and Direction by Atmospheric Stability Class – Stability Class G
June 1, 2011 to May 31, 2013

WIND DIRECTION	WIND SPEED (MPH)													
	CALM	≤0.50	≤1.10	≤1.70	≤2.20	≤2.80	≤3.40	≤4.50	≤6.70	≤8.90	≤11.20	≤13.40	≤18.00	>18.00	TOTAL
N	0	10	34	3	2	0	0	0	0	0	0	0	0	0	49
NNE	0	5	27	1	0	0	0	1	0	0	0	0	0	0	34
NE	0	7	31	5	2	1	1	0	0	0	0	0	0	0	47
ENE	0	10	103	15	5	2	0	1	0	0	0	0	0	0	136
E	0	27	226	53	13	0	0	0	1	0	0	0	0	0	320
ESE	0	32	372	164	14	0	0	1	0	0	0	0	0	0	583
SE	0	21	334	139	7	1	2	1	0	0	0	0	0	0	505
SSE	0	17	209	41	4	1	0	0	0	0	0	0	0	0	272
S	0	15	101	21	5	0	0	0	0	0	0	0	0	0	142
SSW	0	5	73	19	5	1	0	1	0	1	0	0	0	0	105
SW	0	9	46	13	2	1	0	1	0	0	0	0	0	0	72
WSW	0	7	94	21	5	0	1	0	0	0	0	0	0	0	128
W	0	8	104	56	2	4	2	1	1	0	0	0	0	0	178
WNW	0	15	120	65	16	5	2	2	0	0	0	0	0	0	225
NW	0	9	73	19	1	1	0	0	0	0	0	0	0	0	103
NNW	0	12	40	6	0	0	0	0	0	0	0	0	0	0	58
Subtotal	0	209	1987	641	83	17	8	9	2	1	0	0	0	0	2957

Notes:
1. JFDs based on 17380 total hours of valid wind direction-wind speed-stability observations.
2. Stability based on ΔT between 8.44 and 59.22 meters (ΔT > 4.0°C/100 M).
3. Total hours of valid wind direction and wind speed in Stability Class G = 2957.
4. Wind speed, direction measured at 9.78 meters; mean wind speed = 1.00 mph.
5. Totals and subtotals are obtained from unrounded numbers.

Table 2.7.5-9
Percent Occurrence for Each Wind Direction
June 1, 2011 to May 31, 2013

Direction	Percent
N	3.936
NNE	4.217
NE	6.237
ENE	6.214
E	6.076
ESE	6.830
SE	5.967
SSE	3.993
S	4.488
SSW	3.493
SW	5.541
WSW	10.017
W	8.941
WNW	10.334
NW	9.482
NNW	4.235

Table 2.7.5-10
Percent in Each Stability Class
June 1, 2011 to May 31, 2013

2011 to 2013 Data	Class A	Class B	Class C	Class D	Class E	Class F	Class G
Hours	2.831	3.510	6.007	31.064	23.234	16.341	17.014

Note: Stability class is based on ΔT between 10 and 60 meters; wind speed and direction measured at 10 meters.

Table 2.7.5-11
Distances for the EAB and LPZ at the 16 Wind Direction Sectors

Wind Direction Sector	Distance from ERB to Analytical EAB		LPZ Distance	
	(feet)	(meters)	(miles)	(meters)
S	1100	335	1	1609
SSW	1100	335	1	1609
SW	1100	335	1	1609
WSW	1100	335	1	1609
W	1100	335	1	1609
WNW	1100	335	1	1609
NW	1100	335	1	1609
NNW	1100	335	1	1609
N	1100	335	1	1609
NNE	1100	335	1	1609
NE	1100	335	1	1609
ENE	1100	335	1	1609
E	1100	335	1	1609
ESE	1100	335	1	1609
SE	1100	335	1	1609
SSE	1100	335	1	1609

Notes:
1. The Effluent Release Boundary (ERB) includes the nuclear island, which consists of the reactor service building and all associated buildings.
2. The LPZ was determined as an area with a 1-mi (1609 m) radius from the CRN Site center point.

Table 2.7.5-12
PAVAN Modeling Inputs

PAVAN Model Input Variable	Value
Number of Wind Speed Categories (NVEL)	13
Type of Release	Ground
Building Min. Cross Sectional Area (A)	0.0 m^2
Containment Building Height (D)	0.0 m
Release Height (HS)	10.0 m
Wind Sensor Height (TOWERH)	9.78 m
Conversion Correction Factor (UCOR)	150
Lower-T Sensor Height	8.44 m
Upper-T Sensor Height	59.22 m
Distance from Effluent Release Boundary to Analytical EAB	335 m
Distance to LPZ	1609 m

Note: According to NUREG/CR-2858, for a groundlevel release, a release point height (HS) of 10 m is to be used.

Table 2.7.5-13
CRN Site SMR 50 Percent Probability Level *X*/Q Values

50% Probability Level *X*/Q Values (sec/m^3) at the EAB and LPZ					
Location	**0-2 Hours**	**0-8 Hours**	**8-24 Hours**	**1-4 Days**	**4-30 Days**
Release Zone to EAB	5.58E-04	NA	NA	NA	NA
LPZ	NA	4.27E-05	3.80E-05	2.94E-05	2.04E-05

Notes:
1. A circular, analytical EAB was defined at a fixed distance from the effluent release boundary. The distance used from the effluent release boundary to the analytical EAB was 1100 ft (335 m).
2. The LPZ was determined as an area with a 1-mi (1609-m) radius, centered on the site.

NA = Not Applicable

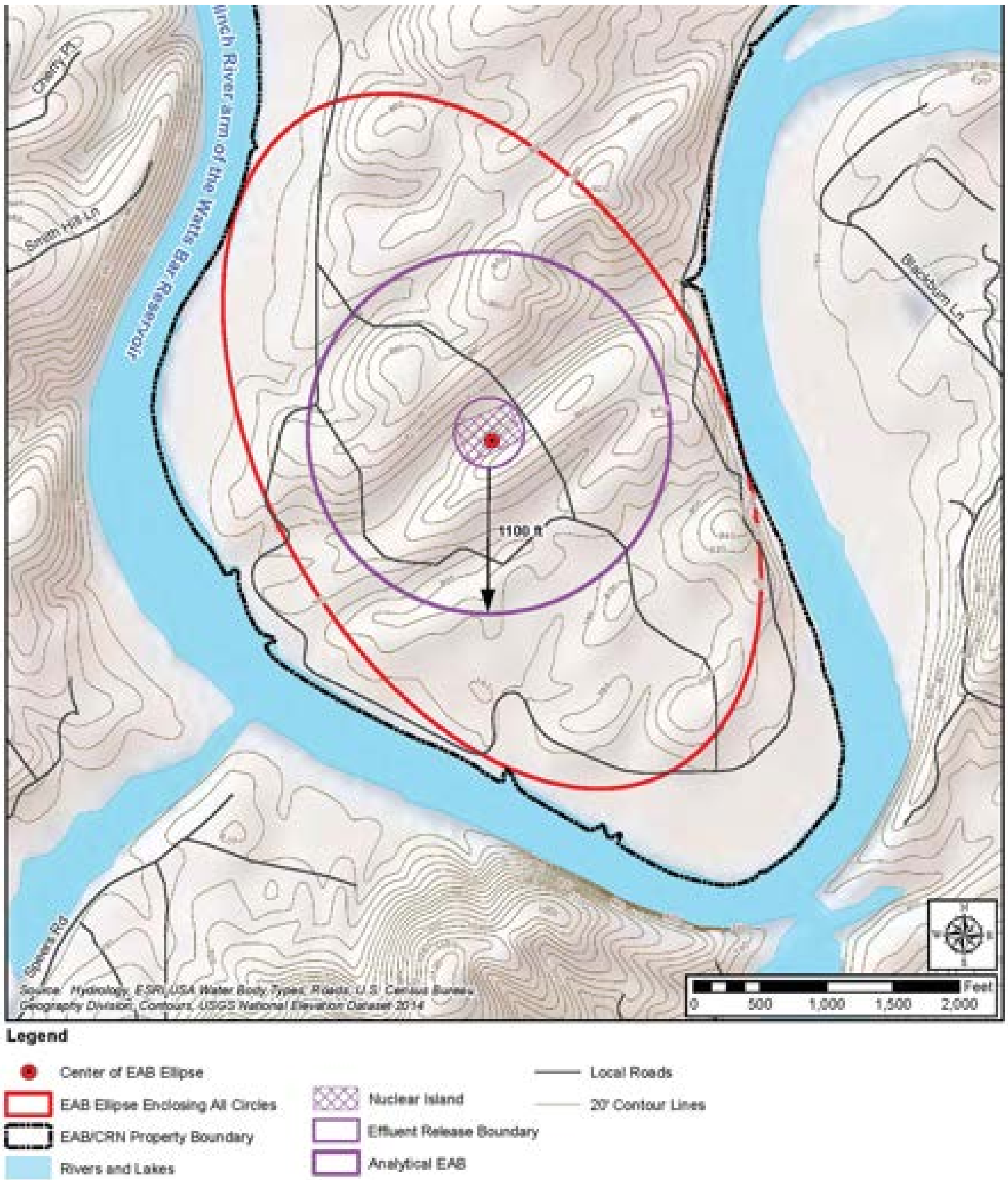


Figure 2.7.5-1. Effluent Release Boundary with Analytical EAB

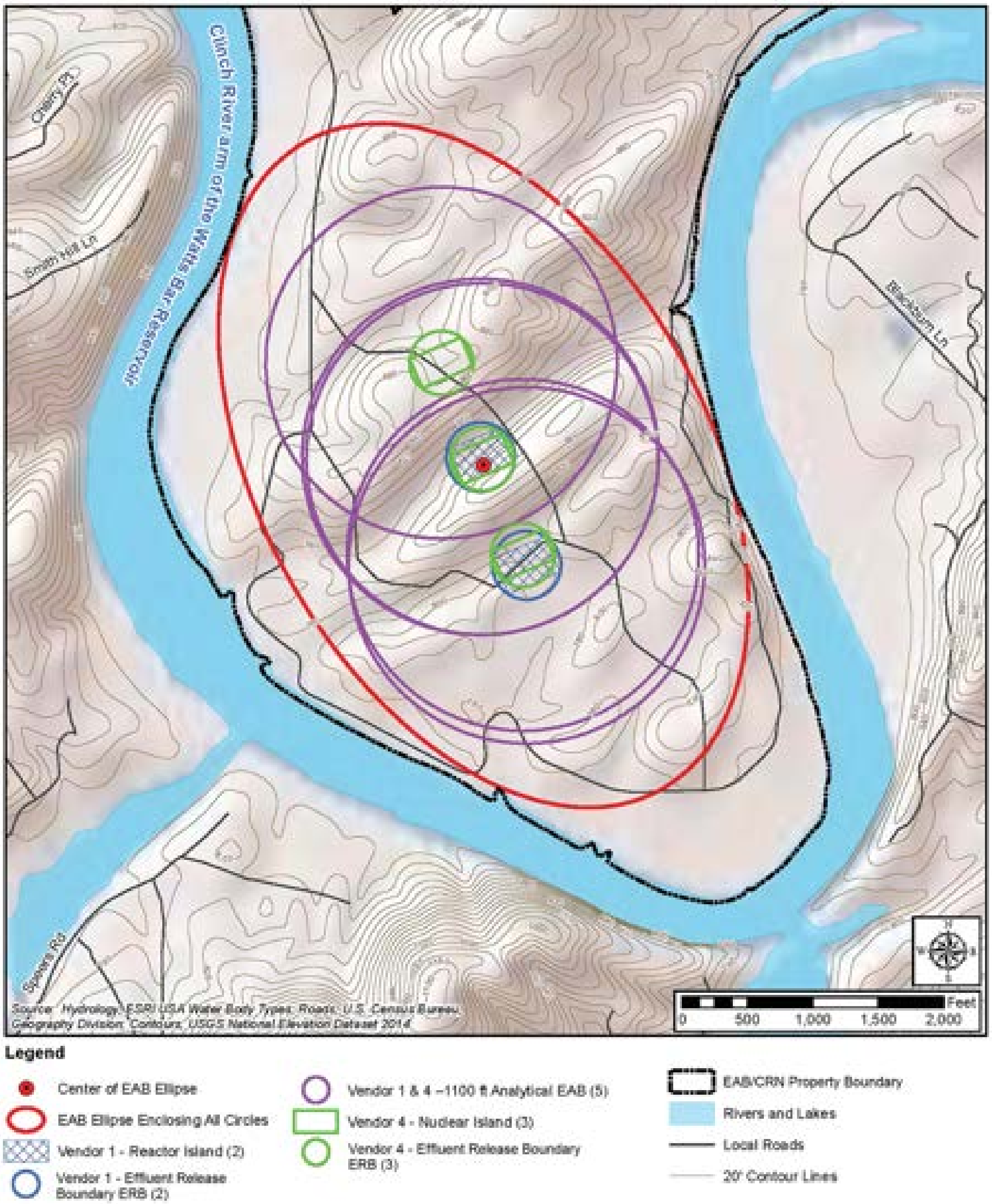


Figure 2.7.5-2. Effluent Release Boundaries (ERBs), Analytical EAB, and Site EAB

Legend

All-Units Center Point
LPZ (1 mile from center point)
CRN Site
Interstate
Highway
Major Road

Figure 2.7.5-3. Site Center Point and Distance to the LPZ

2.7.6 Long-Term (Routine) Diffusion Estimates

For routine releases to the atmosphere, the concentration of radioactive material in the surrounding region depends on the amount of effluent released, the height of the release, the momentum and buoyancy of the emitted plume, the wind speed and direction, atmospheric stability, airflow patterns around the site, and various effluent removal mechanisms. Annual average relative concentration, *X/Q*, and annual average relative deposition, *D/Q*, for routine effluent releases to the atmosphere were calculated for the Clinch River Nuclear (CRN) Site. This subsection describes the development of the long-term diffusion and deposition estimates.

As required by Title 10 of the Code of Federal Regulations (10 CFR) 100 and 10 CFR 50, estimates of atmospheric relative concentrations, *X/Q*, and relative deposition values, *D/Q*, were calculated for routine releases from the CRN Site for long-term (annual) time intervals. The XOQDOQ-82 (XOQDOQ) modeling program is the U.S. Nuclear Regulatory Commission (NRC)-recommended dispersion model for evaluating routine releases (NUREG/CR-2919, *XOQDOQ: Computer Program for the Meteorological Evaluation of Routine Effluent Releases at Nuclear Power Stations*) as it implements the assumptions outlined in NRC Regulatory Guide (RG) 1.111, *Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Cooled Reactors*. Using Joint Frequency Distributions (JFDs) of wind speed, wind direction, and atmospheric stability class, the XOQDOQ program provides annual average *X/Q* and *D/Q* values at the required distances and sectors. Radioactive decay and dry deposition are considered, and a straight-line Gaussian trajectory is modeled between the point of release and receptors at distances for which *X/Q* and *D/Q* values are calculated.

2.7.6.1 Calculation Methodology and Assumptions

NRC RG 4.7, *General Site Suitability Criteria for Nuclear Power Stations,* states that for site approval, each applicant should collect at least one year of meteorological information that is representative of the site conditions for calculating radiation doses resulting from the release of fission products. NRC RG 1.23, *Quality Assurance Requirements for Control of Procurement of Items and Services for Nuclear Power Plants,* recommends using meteorological data from a consecutive 24-month period. Site-specific, validated meteorological data covering the 2-year (yr) period of record from June 1, 2011 through May 31, 2013 was used to quantitatively evaluate routine-releases at the CRN Site. The meteorological data needed for the *X/Q* and *D/Q* calculations in XOQDOQ included wind speed, wind direction, and atmospheric stability as JFDs. A description of the methods used to determine the JFDs is provided in Subsection 2.7.5.2. Fourteen wind speed categories were defined in the JFDs and used in the XOQDOQ analyses.

Using the JFDs, XOQDOQ provides the *X/Q* values as a function of wind direction for various time periods at the exclusion area boundary (EAB), at points of maximum individual exposure, and at points within a radial grid of sixteen 22-1/2 degree sectors extending to a distance of 50 mile (mi). As discussed above, a circular, analytical EAB was defined at a fixed distance from an effluent release boundary (ERB) release zone.

The ERB was considered in calculating atmospheric dispersion factors at the analytical EAB. A distance of 1100 feet (ft; 335 meters [m]) was modeled from the ERB to the analytical EAB (Figure 2.7.5-1).

Both *X/Q* and *D/Q* estimates were also calculated for the nearest residence, the nearest vegetable garden, and the nearest meat animal at each of the 16 wind direction sectors. The locations of the sensitive receptors were determined from the land use surveys conducted in January and April 2014 (Figure 2.7.6-1).

Other plant specific data considered in the XOQDOQ model include building minimum cross-sectional area, building height, and meteorological tower height at which wind speed was measured. The building height and cross-sectional area are used in the calculation of building wake effects. NRC RG 1.111 identifies the tallest adjacent building as appropriate for use. Building area is defined as the smallest vertical-plane, cross-sectional area of the affected building, in square meters. The dose calculated at the EAB and the LPZ are located beyond the building wake influence zone, so the height and cross-sectional area have less effect on building wake *X/Q* values. Therefore, for conservatism, no building wake credit was used in the XOQDOQ model (e.g., cross-sectional area and building height were both set to zero).

As discussed for the PAVAN modeling in Subsection 2.7.5.2, a groundlevel release was also evaluated in the XOQDOQ model as this scenario provides the bounding case.

Other inputs to the model included a release height and a representative wind height. NUREG/CR-2919 indicates that for a ground level release, average vent velocity (EXIT) and stack diameter (DIAMTR) must be set to 0.0 m, and the wind release height (SLEV) must be set to 10 m. Therefore, the default values were used. Vent height is set to wind height in the XOQDOQ model. For a groundlevel release, the lower wind speed measurement height (9.78 m) was used. The inputs used in the XOQDOQ model are listed in Table 2.7.6-1.

Consistent with NRC RG 1.111 in regard to the radiological impact evaluations, radioactive decay and deposition were considered. For conservative estimates of radioactive decay, a half-life of 2.26 days for short-lived noble gases, a half-life of 101 days for long-lived noble gases, and a half-life of 8 days for iodines are acceptable for releases to the atmosphere. At sites where there is not a well-defined rainy season associated with a local grazing season, wet deposition does not have a significant impact. In addition, the dry deposition rate of noble gases is such that depletion is negligible within 50 mi (RG 1.111). Therefore, in this analysis, only the effects of dry deposition of iodines were considered. The calculations considering “dry deposition” and “no deposition” are identified in the output as "depleted" and "undepleted.”

2.7.6.2 Complex Terrain Modeling Analysis

As discussed in Subsection 2.7.4.2, the CRN Site is surrounded by complex terrain, with alternating ridges and valleys oriented along a SW to NE axis. The local wind patterns are influenced by the complex terrain, with up-valley (SW-WSW) and down-valley flow (NE-ENE) patterns common, and stable conditions with light winds frequently observed, especially during the summer and fall seasons. There are also potential local influences associated with the terrain that follows the Clinch River arm of the Watts Bar Reservoir. These terrain features along with light, variable winds can produce nonlinear flows as the trajectory of a plume changes in speed and direction with distance from its release point. These nonlinear flow patterns can influence the dispersion around the CRN Site (Reference 2.7.6-1).

For complex terrain sites where these nonlinear dispersion effects are apparent, adjustments to a straight-line model (as XOQDOQ) are possibly warranted. Specifically, adjustment factors for terrain confinement and recirculation effects on annual average dispersion concentrations at boundary locations must be considered. In the XOQDOQ model (NUREG/CR-2919), the computed groundlevel concentrations can be adjusted to account for nonlinear trajectories (plume recirculation or stagnation). As outlined in NUREG/CR-2919, the adjustments can be accomplished in two ways. First, a standard default correction factor that is a function of distance can be applied to the *X/*Q and *D/*Q values for each of the directional sectors. Second, adjustments can be made by a comparison of results with a variable trajectory model. If the variable trajectory model produces higher concentrations than the straight-line model, the concentration ratio, or adjustment factor, is used in the straight-line model to correct for non-linear dispersion effects.

This evaluation involved a comparison of estimated long-term *X/*Q values between the CALPUFF variable trajectory model system and the XOQDOQ model at the LPZ and an analytical EAB. The CALPUFF Version 6.42 dispersion modeling system is an advanced, non-steady-state, meteorological and air quality modeling system listed by the U.S. Environmental Protection Agency in its Guideline on Air Quality Models that can be applied in near-field applications involving complex meteorological conditions (Reference 2.7.6-2; Reference 2.7.6-3). The modeling system is comprised of a meteorological processor, CALMET, Version 6.334, which develops hourly wind and temperature fields on a three-dimensional gridded modeling domain, with two-dimensional fields of mixing height, surface characteristics, and dispersion properties (Reference 2.7.6-4). The CALPUFF model is a multi-layer, multi-species, non-steady-state puff dispersion model that simulates the effects of time- and space-varying meteorological conditions on pollution transport, transformation and removal. The concentrations and deposition files produced from CALPUFF are post-processed by the CALPOST, Version 6.292, processor program into tables and plot files of concentrations at given receptors. The latest version of CALPUFF was used in order to incorporate the latest chemistry mechanisms and modeling updates.

Both the CALPUFF modeling system and the XOQDOQ model were used to simulate the meteorological data encompassing the June 1, 2011 through May 31, 2013 period in which the

CRN meteorological tower was in operation. For the meteorological processing, CALMET requires comprehensive surface, precipitation, and upper air data. The surface data was processed from the CRN meteorological tower. Because of repeated problems with the CRN Site rain gauge measurements, hourly data collected from the Oak Ridge Automated Surface Observing System (ASOS) (approximately 12 mi northeast of the CRN Site) were used as an alternative. (Subsection 6.4.2.4 provides details regarding the problems related with the onsite rain gauge, required data capture, and justification for using the Oak Ridge ASOS data.) Upper air data were taken from the Nashville National Weather Service (NWS) Station. Finally, 22 vertical layers were used in the CALMET model to provide enhanced stratification of the upper air field. For the XOQDOQ model, JFDs of CRN onsite meteorological wind and stability data during the same period were used as input.

The CALPUFF modeling system, Version 6.42, has the ability to model up to 23 radioactive species, each with a default-assigned decay half-life. It also allows the user to assign the associated mass lost to one or more other modeled species using a mass yield factor. As XOQDOQ provides default estimates of radioactive decay using a half-life of 2.26 days for short-lived noble gases, 8 days for iodines, and up to 101 days for long-lived noble gases; the following three radioactive species were modeled in CALPUFF: xenon-133M (Xe-133M), iodine-131 (I-131), and krypton-85 (Kr-85). Xe-133M has a half-life of 2.16 days, I-131 has a half-life of 8 days, and Kr-85 has a half-life of 11 yr. Kr-85 was selected as the long-lived noble gas because its long half-life and resistance to dry and wet deposition would provide a more conservative estimate of undepleted decay. Furthermore, wet and dry deposition of I-131 was not considered in CALPUFF, which also allowed for a more conservative estimate of final concentrations from the CALPUFF model.

Both the CALPUFF and XOQDOQ models used a single groundlevel point source located at the center point of the site with no building wake credit. To model a groundlevel release in CALPUFF, stack parameters must be set to nonzero values, with the exception of stack height. Therefore, to closely simulate a groundlevel release that would be dominated by plume momentum, a stack diameter of 1.0 m and an exit velocity of 0.1 meter per second (m/s) was assumed. A stack height of 10 m was used to maintain consistency with the XOQDOQ default stack height for groundlevel releases. As indicated in NUREG/CR-2919, nuclear power vents generally have ambient temperature plumes, so the source exit temperature in CALPUFF was set to 68 degrees Fahrenheit (°F; 293 K). With the center point of the site as the source location, both models included discrete receptors at an analytical EAB with radius equal to the shorter distance of the EAB ellipse (0.326 mi (524 m)) and at the 1.0 mi (1609 m) LPZ distance for each of the 16 wind direction sectors (Figure 2.7.6-2). The CALPUFF input options are summarized in Table 2.7.6-2.

The multiple-year average *X/Q* values[1] for the undepleted case, the 2-day decay case, and the 8-day decay case at the LPZ and analytical EAB were compared between the two models, and the results are summarized in Tables 2.7.6-3 and 2.7.6-4, respectively. The *X/Q* values at both distances demonstrated that the highest *X/Q* values were estimated by the XOQDOQ model for the 16 wind direction sectors. Therefore, it was concluded that the XOQDOQ model did not underestimate the annual average *X/Q* values, and no nonlinear adjustment factors were applied to the XOQDOQ annual average *X/Q* and *D/Q* values at the CRN Site.

2.7.6.3 Summary of XOQDOQ Results and Conclusions

Consistent with NRC RG 1.111, the long-term, routine-release *X/Q* and *D/Q* values were evaluated with the XOQDOQ model for the analytical EAB, at receptor points of maximum individual exposure, and at points within a radial grid of sixteen 22½ degree sectors extending to a distance of 50 mi from the CRN Site. The offsite receptor locations and distances for the sensitive receptors at the nearest residences, nearest gardens, and nearest meat animals included in the evaluation are given in Table 2.7.6-5. For the sector-based receptors out to 50 mi, these were located at increments of 0.25 mi to a distance of 1 mi from the CRN Site; at increments of 0.5 mi from a distance of 1 mi to 5 mi; at increments of 2.5 mi from a distance of 5 mi to 10 mi; and at increments of 5 mi out to a distance of 50 mi. Estimates of *X/Q* (undecayed and undepleted; depleted for radioiodines) and D/Q are provided at each of these points. The results of the modeling analysis, based on two years of onsite meteorological data, are presented in Table 2.7.6-6 through Table 2.7.6-10.

As seen from the results, the highest concentrations at the site boundaries, nearest garden, and nearest residence, are found in the sectors that lie to the WNW of the plant. Highest relative deposition is generally to the east-southeast (ESE).

The two complete years of onsite meteorological data used for the long-term (routine) release calculations were representative of the overall site conditions and long-term trends for the CRN Site. As documented in Subsection 2.7.4, the location of the CRN Site meteorological tower was sufficiently removed from any structures or significant topographic features to ensure that adequate data were provided to represent onsite meteorological conditions and to describe the local and regional atmospheric transport and diffusion characteristics. The representativeness of observed meteorology at the site was assessed, and no long-term trends were observed which would bias the *X/Q* and *D/Q* estimates.

[1] The long-term average values reflect the CRN June 2011 through May 2013 meteorological monitoring period.

2.7.6.4 References

Reference 2.7.6-1. Project Management Corporation, "Clinch River Breeder Reactor Plant Environmental Report Volume I," April, 1982.

Reference 2.7.6-2. Scire, Joseph S., Strimaitis, David G., and Yamartino, Robert J., "A User's Guide for the CALPUFF Dispersion Model (Version 5)," Earth Tech, Inc., January, 2000.

Reference 2.7.6-3. Scire, J., Strimaitis, D., Robe, F., Phadnis, M., and Popovic, J., "CALPUFF Modeling System Version 6 User Instructions," Earth Tech, Inc., April, 2011.

Reference 2.7.6-4. Scire, Joseph S., Robe, Francoise R., Fernau, Mark E., and Yamartino, Robert J., "A User's Guide for the CALMET Meteorological Model (Version 5)," Earth Tech, Inc., January, 2000.

Reference 2.7.6-5. Paynter, Dale, "XOQDOQ Calculation - Method, Tools and Pitfalls," Operations Management Group, October 13, 2006.

Table 2.7.6-1
List of Inputs used in the XOQDOQ Modeling

XOQDOQ Input Variable	Value
Wind Sensor Height (PLEV)	9.78 m
Conversion Correction Factor (UCOR)	150
Lower-T Sensor Height	8.44 m
Upper-T sensor Height	59.22 m
Type of Release	Ground
Vent Average Velocity (EXIT)	0.0 m/s
Vent Inside Diameter (DIAMTR)	0.0 m
Vent Release Height (HSTACK)	10.0 m
Containment Building Height (HBLDG)	0.0 m
Building Min. Cross Sectional Area (CRSEC)	0.0 m^2
Wind Height (SLEV)	10.0 m

Notes:
1. No building wake credit was used in the modeling. Therefore, the building height and cross-sectional area were set to zero.
2. According to NUREG/CR-2919, for a groundlevel release, the exit velocity and diameter are set to zero, while the wind height is set to 10 m.
3. Vent height should be equal to wind height (Reference 2.7.6-5).
4. For the complex terrain modeling, radial receptors were modeled at 524 m and 1609 m consistent with the CALPUFF modeling (see Table 2.7.6-2). For the routine release modeling of actual CRN Site conditions, the analytical EAB of 1100 ft was modeled, along with sector based sensitive receptors (at the nearest residences, nearest gardens, and nearest meat animals) and sector based receptors out to 50 mi.

Table 2.7.6-2
CALPUFF Model Input Configuration for Complex Terrain Analysis

CALPUFF Parameter	Input Value
Episode Modeled	June 1, 2011 to May 31, 2013
Domain Size	10-mile radius
No. of Grid Cells	111 x 111
Grid Spacing	350 m
# of Vertical (Height) Levels	22
Upper Air Data	Nashville NWS
Precipitation Data	Oak Ridge ASOS
Surface Data	CRN Met Tower
Source Location	Site Center Coordinates (NAD27)
Base Elevation	250.2 m
Distance to Analytical EAB	524 m radius
Distance to LPZ	1609 m radius
# of Stacks (Vents)	1
Stack #1 Height	10.0 m
Stack #1 Diameter	1.0 m
Stack #1 Exit Velocity	0.1 m/s
Stack #1 Exit Temperature	293 K (68°F)

Note: For the complex terrain modeling, the analytical EAB was defined as an area with a 0.326-mi (524-m) radius from the center point of the CRN Site. The LPZ was defined as an area with a 1-mi (1609-m) radius from the center point of the CRN Site.

Table 2.7.6-3
Long-Term Average *X*/Q Values Estimated from XOQDOQ and CALPUFF at the EAB

EAB Sector	Long-Term Average *X*/Q Values (sec/m^3)								
	Undepleted			2-Day Decay			8-Day Decay		
	XOQDOQ	CALPUFF	Ratio	XOQDOQ	CALPUFF	Ratio	XOQDOQ	CALPUFF	Ratio
S	2.70E-05	2.01E-06	0.07	2.70E-05	2.01E-06	0.07	2.50E-05	2.01E-06	0.08
SSW	2.40E-05	1.95E-06	0.08	2.40E-05	1.95E-06	0.08	2.30E-05	1.95E-06	0.08
SW	2.80E-05	1.32E-06	0.05	2.80E-05	1.32E-06	0.05	2.60E-05	1.32E-06	0.05
WSW	4.20E-05	1.17E-06	0.03	4.10E-05	1.17E-06	0.03	3.80E-05	1.17E-06	0.03
W	6.70E-05	1.15E-06	0.02	6.60E-05	1.14E-06	0.02	6.10E-05	1.15E-06	0.02
WNW	9.10E-05	6.51E-07	0.01	9.10E-05	6.49E-07	0.01	8.40E-05	6.51E-07	0.01
NW	7.80E-05	1.38E-06	0.02	7.70E-05	1.38E-06	0.02	7.20E-05	1.38E-06	0.02
NNW	4.60E-05	3.01E-06	0.07	4.50E-05	3.01E-06	0.07	4.20E-05	3.01E-06	0.07
N	3.10E-05	2.93E-06	0.09	3.10E-05	2.92E-06	0.09	2.90E-05	2.92E-06	0.10
NNE	2.20E-05	3.75E-06	0.17	2.20E-05	3.74E-06	0.17	2.00E-05	3.75E-06	0.19
NE	2.20E-05	2.11E-06	0.10	2.20E-05	2.11E-06	0.10	2.00E-05	2.11E-06	0.11
ENE	3.30E-05	2.26E-06	0.07	3.30E-05	2.26E-06	0.07	3.10E-05	2.26E-06	0.07
E	4.10E-05	2.78E-06	0.07	4.10E-05	2.77E-06	0.07	3.80E-05	2.78E-06	0.07
ESE	5.70E-05	3.68E-06	0.06	5.60E-05	3.67E-06	0.07	5.20E-05	3.68E-06	0.07
SE	4.60E-05	2.23E-06	0.05	4.60E-05	2.23E-06	0.05	4.20E-05	2.23E-06	0.05
SSE	2.90E-05	2.57E-06	0.09	2.90E-05	2.57E-06	0.09	2.70E-05	2.57E-06	0.10

Notes:
1. Long-term average values are reflective of a multi-year average from the CRN June 1, 2011 - May 31, 2013 meteorological episode. Both the XOQDOQ and CALPUFF *X*/Q values reflect the undepleted, 2-day decay, and 8-day decay cases.
2. For the complex terrain analysis, the analytical EAB was defined as an area with a 0.326-mi (524-m) radius from the center point of the CRN Site.
3. The ratio is determined by the CALPUFF concentration divided by the XOQDOQ concentration.

Table 2.7.6-4
Long-Term Average *X*/Q Values Estimated from XOQDOQ and CALPUFF at the Low Population Zone (LPZ)

LPZ Sector	Long-Term Average *X*/Q Values (sec/m^3)								
	Undepleted			2-Day Decay			8-Day Decay		
	XOQDOQ	CALPUFF	Ratio	XOQDOQ	CALPUFF	Ratio	XOQDOQ	CALPUFF	Ratio
S	3.80E-06	4.52E-07	0.12	3.70E-06	4.50E-07	0.12	3.30E-06	4.52E-07	0.14
SSW	3.40E-06	6.31E-07	0.19	3.40E-06	6.28E-07	0.19	3.00E-06	6.30E-07	0.21
SW	4.00E-06	6.86E-07	0.17	3.90E-06	6.82E-07	0.18	3.50E-06	6.85E-07	0.19
WSW	5.80E-06	3.71E-07	0.06	5.70E-06	3.68E-07	0.06	5.10E-06	3.70E-07	0.07
W	9.30E-06	3.38E-07	0.04	9.10E-06	3.36E-07	0.04	8.10E-06	3.38E-07	0.04
WNW	1.30E-05	2.28E-07	0.02	1.20E-05	2.26E-07	0.02	1.10E-05	2.28E-07	0.02
NW	1.10E-05	2.35E-07	0.02	1.10E-05	2.33E-07	0.02	9.40E-06	2.34E-07	0.02
NNW	6.30E-06	5.51E-07	0.09	6.20E-06	5.48E-07	0.09	5.50E-06	5.50E-07	0.10
N	4.40E-06	8.74E-07	0.20	4.30E-06	8.69E-07	0.20	3.80E-06	8.72E-07	0.23
NNE	3.10E-06	4.92E-07	0.16	3.00E-06	4.90E-07	0.16	2.70E-06	4.91E-07	0.18
NE	3.10E-06	6.10E-07	0.20	3.00E-06	6.08E-07	0.20	2.70E-06	6.09E-07	0.23
ENE	4.60E-06	6.05E-07	0.13	4.60E-06	6.03E-07	0.13	4.00E-06	6.05E-07	0.15
E	5.80E-06	6.55E-07	0.11	5.70E-06	6.52E-07	0.11	5.00E-06	6.54E-07	0.13
ESE	7.90E-06	5.65E-07	0.07	7.80E-06	5.62E-07	0.07	6.90E-06	5.64E-07	0.08
SE	6.50E-06	8.66E-07	0.13	6.40E-06	8.63E-07	0.14	5.60E-06	8.65E-07	0.15
SSE	4.20E-06	5.96E-07	0.14	4.10E-06	5.94E-07	0.15	3.60E-06	5.95E-07	0.16

Notes:
1. Long-term average values are reflective of a multi-year average from the CRN June 1, 2011 - May 31, 2013 meteorological episode. Both the XOQDOQ and CALPUFF X/Q values reflect the undepleted, 2-day depletion, and 8-day depletion cases.
2. For the complex terrain analysis, the LPZ was defined as an area with a 1.0-mile (1609-m) radius from the center point of the CRN Site.
3. The ratio is determined by the CALPUFF concentration divided by the XOQDOQ concentration.

Table 2.7.6-5
CRN OffSite Receptor Locations

Sector	Nearest Residence		Nearest Garden		Nearest Meat Animal	
	Distance (m)	Elevation (m)	Distance (m)	Elevation (m)	Distance (m)	Elevation (m)
S	1359	283	4254	259	3144	254
SSW	1113	240	1113	240	4488	250
SW	995	240	1522	230	4695	264
WSW	1136	246	2203	297	1138	246
W	1470	301	2861	255	4984	250
WNW	1066	285	1848	253	1120	298
NW	992	273	1978	233	1627	239
NNW	6997	312	7833	233	7833	233
N	7814	236	none	none	none	none
NNE	none	none	none	none	none	none
NE	1072	239	1072	239	none	none
ENE	1149	243	none	none	none	none
E	1118	249	3802	259	4629	245
ESE	1117	253	1482	249	4492	254
SE	1288	252	3111	347	4171	303
SSE	1304	250	1486	241	3106	313

Note: Distances and elevations, in meters, from the CRN Site center point to the nearest receptor of each type for a given sector.

Table 2.7.6-6 (Sheet 1 of 3)
Annual Average *X*/Q for No Decay, Undepleted for Specified Distances at Each Sector

Annual Average *X*/Q (sec/m³) for No Decay, Undepleted											
Sector	**Distance (miles)**										
	0.25	**0.5**	**0.75**	**1**	**1.5**	**2**	**2.5**	**3**	**3.5**	**4**	**4.5**
S	4.31E-05	1.26E-05	6.14E-06	3.79E-06	1.99E-06	1.29E-06	9.23E-07	7.08E-07	5.67E-07	4.69E-07	3.97E-07
SSW	3.91E-05	1.14E-05	5.58E-06	3.44E-06	1.81E-06	1.16E-06	8.34E-07	6.38E-07	5.11E-07	4.22E-07	3.57E-07
SW	4.53E-05	1.32E-05	6.45E-06	3.98E-06	2.08E-06	1.34E-06	9.60E-07	7.34E-07	5.87E-07	4.84E-07	4.09E-07
WSW	6.66E-05	1.94E-05	9.41E-06	5.82E-06	3.07E-06	1.99E-06	1.43E-06	1.10E-06	8.84E-07	7.33E-07	6.22E-07
W	1.07E-04	3.10E-05	1.50E-05	9.26E-06	4.91E-06	3.20E-06	2.32E-06	1.79E-06	1.44E-06	1.20E-06	1.02E-06
WNW	1.47E-04	4.25E-05	2.04E-05	1.27E-05	6.73E-06	4.39E-06	3.19E-06	2.47E-06	1.99E-06	1.66E-06	1.41E-06
NW	1.25E-04	3.61E-05	1.74E-05	1.08E-05	5.73E-06	3.74E-06	2.71E-06	2.10E-06	1.69E-06	1.41E-06	1.20E-06
NNW	7.30E-05	2.12E-05	1.02E-05	6.30E-06	3.35E-06	2.19E-06	1.59E-06	1.23E-06	9.89E-07	8.23E-07	7.01E-07
N	5.03E-05	1.46E-05	7.06E-06	4.37E-06	2.31E-06	1.50E-06	1.09E-06	8.37E-07	6.73E-07	5.59E-07	4.75E-07
NNE	3.53E-05	1.03E-05	4.96E-06	3.07E-06	1.62E-06	1.05E-06	7.59E-07	5.84E-07	4.69E-07	3.89E-07	3.30E-07
NE	3.53E-05	1.03E-05	4.98E-06	3.08E-06	1.62E-06	1.04E-06	7.49E-07	5.75E-07	4.60E-07	3.80E-07	3.22E-07
ENE	5.33E-05	1.55E-05	7.51E-06	4.64E-06	2.44E-06	1.57E-06	1.13E-06	8.64E-07	6.92E-07	5.72E-07	4.84E-07
E	6.60E-05	1.92E-05	9.32E-06	5.76E-06	3.03E-06	1.96E-06	1.41E-06	1.08E-06	8.70E-07	7.20E-07	6.11E-07
ESE	9.08E-05	2.65E-05	1.29E-05	7.94E-06	4.19E-06	2.71E-06	1.96E-06	1.50E-06	1.21E-06	1.00E-06	8.48E-07
SE	7.34E-05	2.15E-05	1.05E-05	6.46E-06	3.40E-06	2.19E-06	1.58E-06	1.21E-06	9.68E-07	8.00E-07	6.77E-07
SSE	4.72E-05	1.38E-05	6.72E-06	4.15E-06	2.19E-06	1.41E-06	1.02E-06	7.79E-07	6.24E-07	5.17E-07	4.38E-07

Table 2.7.6-6 (Sheet 2 of 3)
Annual Average *X*/Q for No Decay, Undepleted for Specified Distances at Each Sector

Annual Average *X*/Q (sec/m^3) for No Decay, Undepleted											
Sector	**Distance (miles)**										
	5	**7.5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**
S	3.42E-07	1.95E-07	1.32E-07	7.67E-08	5.25E-08	3.92E-08	3.09E-08	2.53E-08	2.13E-08	1.83E-08	1.60E-08
SSW	3.07E-07	1.75E-07	1.18E-07	6.81E-08	4.65E-08	3.46E-08	2.73E-08	2.23E-08	1.88E-08	1.61E-08	1.41E-08
SW	3.53E-07	2.00E-07	1.35E-07	7.80E-08	5.32E-08	3.96E-08	3.12E-08	2.55E-08	2.15E-08	1.84E-08	1.61E-08
WSW	5.37E-07	3.09E-07	2.10E-07	1.23E-07	8.46E-08	6.35E-08	5.03E-08	4.13E-08	3.49E-08	3.01E-08	2.63E-08
W	8.82E-07	5.12E-07	3.51E-07	2.08E-07	1.44E-07	1.09E-07	8.64E-08	7.13E-08	6.04E-08	5.22E-08	4.59E-08
WNW	1.23E-06	7.15E-07	4.92E-07	2.93E-07	2.04E-07	1.54E-07	1.23E-07	1.02E-07	8.63E-08	7.47E-08	6.57E-08
NW	1.04E-06	6.08E-07	4.18E-07	2.49E-07	1.73E-07	1.31E-07	1.05E-07	8.64E-08	7.33E-08	6.35E-08	5.58E-08
NNW	6.08E-07	3.55E-07	2.44E-07	1.45E-07	1.01E-07	7.62E-08	6.08E-08	5.03E-08	4.26E-08	3.69E-08	3.25E-08
N	4.11E-07	2.38E-07	1.63E-07	9.60E-08	6.64E-08	5.00E-08	3.97E-08	3.28E-08	2.77E-08	2.40E-08	2.10E-08
NNE	2.86E-07	1.65E-07	1.12E-07	6.59E-08	4.55E-08	3.42E-08	2.71E-08	2.23E-08	1.89E-08	1.63E-08	1.43E-08
NE	2.78E-07	1.59E-07	1.08E-07	6.26E-08	4.29E-08	3.21E-08	2.54E-08	2.09E-08	1.76E-08	1.51E-08	1.33E-08
ENE	4.18E-07	2.39E-07	1.62E-07	9.41E-08	6.45E-08	4.83E-08	3.82E-08	3.14E-08	2.65E-08	2.28E-08	2.00E-08
E	5.27E-07	3.03E-07	2.05E-07	1.20E-07	8.26E-08	6.19E-08	4.90E-08	4.03E-08	3.40E-08	2.93E-08	2.57E-08
ESE	7.33E-07	4.21E-07	2.86E-07	1.68E-07	1.15E-07	8.66E-08	6.86E-08	5.64E-08	4.76E-08	4.10E-08	3.59E-08
SE	5.84E-07	3.34E-07	2.26E-07	1.31E-07	8.98E-08	6.71E-08	5.30E-08	4.34E-08	3.66E-08	3.14E-08	2.75E-08
SSE	3.78E-07	2.16E-07	1.46E-07	8.51E-08	5.83E-08	4.36E-08	3.44E-08	2.82E-08	2.38E-08	2.05E-08	1.79E-08

Table 2.7.6-6 (Sheet 3 of 3)
Annual Average *X*/Q for No Decay, Undepleted for Specified Distances at Each Sector

Annual Average *X*/Q (sec/m^3) for No Decay, Undepleted										
Sector	**Distance (miles)**									
	0.5-1	**1-2**	**2-3**	**3-4**	**4-5**	**5-10**	**10-20**	**20-30**	**30-40**	**40-50**
S	6.53E-06	2.08E-06	9.34E-07	5.70E-07	3.98E-07	2.00E-07	7.82E-08	3.94E-08	2.54E-08	1.84E-08
SSW	5.93E-06	1.88E-06	8.44E-07	5.13E-07	3.58E-07	1.79E-07	6.95E-08	3.48E-08	2.24E-08	1.61E-08
SW	6.85E-06	2.17E-06	9.71E-07	5.90E-07	4.11E-07	2.05E-07	7.96E-08	3.99E-08	2.56E-08	1.85E-08
WSW	1.00E-05	3.20E-06	1.45E-06	8.89E-07	6.23E-07	3.16E-07	1.25E-07	6.38E-08	4.14E-08	3.01E-08
W	1.60E-05	5.12E-06	2.34E-06	1.45E-06	1.02E-06	5.23E-07	2.11E-07	1.09E-07	7.15E-08	5.23E-08
WNW	2.19E-05	7.01E-06	3.22E-06	2.00E-06	1.42E-06	7.29E-07	2.97E-07	1.55E-07	1.02E-07	7.48E-08
NW	1.86E-05	5.96E-06	2.74E-06	1.70E-06	1.20E-06	6.20E-07	2.53E-07	1.32E-07	8.66E-08	6.36E-08
NNW	1.09E-05	3.49E-06	1.60E-06	9.94E-07	7.03E-07	3.62E-07	1.47E-07	7.66E-08	5.04E-08	3.70E-08
N	7.54E-06	2.41E-06	1.10E-06	6.76E-07	4.76E-07	2.43E-07	9.76E-08	5.03E-08	3.28E-08	2.40E-08
NNE	5.30E-06	1.69E-06	7.67E-07	4.71E-07	3.31E-07	1.68E-07	6.71E-08	3.44E-08	2.24E-08	1.63E-08
NE	5.31E-06	1.69E-06	7.58E-07	4.62E-07	3.23E-07	1.62E-07	6.38E-08	3.23E-08	2.09E-08	1.52E-08
ENE	8.00E-06	2.54E-06	1.14E-06	6.95E-07	4.85E-07	2.44E-07	9.59E-08	4.86E-08	3.15E-08	2.28E-08
E	9.93E-06	3.16E-06	1.43E-06	8.74E-07	6.12E-07	3.09E-07	1.22E-07	6.23E-08	4.04E-08	2.94E-08
ESE	1.37E-05	4.37E-06	1.98E-06	1.21E-06	8.50E-07	4.31E-07	1.71E-07	8.71E-08	5.65E-08	4.11E-08
SE	1.11E-05	3.54E-06	1.59E-06	9.72E-07	6.79E-07	3.41E-07	1.34E-07	6.75E-08	4.35E-08	3.15E-08
SSE	7.15E-06	2.28E-06	1.03E-06	6.28E-07	4.39E-07	2.21E-07	8.68E-08	4.39E-08	2.83E-08	2.05E-08

Table 2.7.6-7 (Sheet 1 of 3)
Annual Average *X*/Q for 2.26 Day Decay, Undepleted for Specified Distances at Each Sector

Annual Average *X*/Q (sec/m^3) for 2.26 Day Decay, Undepleted											
Sector	**Distance (miles)**										
	0.25	**0.5**	**0.75**	**1**	**1.5**	**2**	**2.5**	**3**	**3.5**	**4**	**4.5**
S	4.29E-05	1.25E-05	6.05E-06	3.72E-06	1.93E-06	1.24E-06	8.79E-07	6.67E-07	5.29E-07	4.33E-07	3.63E-07
SSW	3.89E-05	1.13E-05	5.50E-06	3.38E-06	1.76E-06	1.12E-06	7.96E-07	6.03E-07	4.78E-07	3.91E-07	3.28E-07
SW	4.51E-05	1.31E-05	6.36E-06	3.91E-06	2.03E-06	1.30E-06	9.19E-07	6.97E-07	5.52E-07	4.52E-07	3.78E-07
WSW	6.63E-05	1.92E-05	9.29E-06	5.72E-06	2.99E-06	1.92E-06	1.37E-06	1.04E-06	8.30E-07	6.82E-07	5.73E-07
W	1.06E-04	3.07E-05	1.47E-05	9.09E-06	4.77E-06	3.08E-06	2.21E-06	1.69E-06	1.35E-06	1.11E-06	9.35E-07
WNW	1.46E-04	4.21E-05	2.01E-05	1.24E-05	6.55E-06	4.24E-06	3.05E-06	2.34E-06	1.87E-06	1.54E-06	1.30E-06
NW	1.24E-04	3.58E-05	1.71E-05	1.06E-05	5.58E-06	3.61E-06	2.60E-06	1.99E-06	1.59E-06	1.32E-06	1.11E-06
NNW	7.27E-05	2.10E-05	1.00E-05	6.19E-06	3.26E-06	2.11E-06	1.52E-06	1.16E-06	9.28E-07	7.66E-07	6.46E-07
N	5.01E-05	1.45E-05	6.96E-06	4.28E-06	2.25E-06	1.45E-06	1.03E-06	7.89E-07	6.29E-07	5.17E-07	4.35E-07
NNE	3.52E-05	1.02E-05	4.90E-06	3.02E-06	1.58E-06	1.02E-06	7.28E-07	5.55E-07	4.43E-07	3.64E-07	3.06E-07
NE	3.51E-05	1.02E-05	4.92E-06	3.03E-06	1.58E-06	1.01E-06	7.20E-07	5.48E-07	4.35E-07	3.57E-07	3.00E-07
ENE	5.31E-05	1.54E-05	7.43E-06	4.57E-06	2.38E-06	1.53E-06	1.09E-06	8.27E-07	6.58E-07	5.40E-07	4.53E-07
E	6.58E-05	1.91E-05	9.22E-06	5.68E-06	2.97E-06	1.91E-06	1.36E-06	1.04E-06	8.28E-07	6.81E-07	5.73E-07
ESE	9.04E-05	2.63E-05	1.27E-05	7.82E-06	4.09E-06	2.63E-06	1.88E-06	1.43E-06	1.14E-06	9.39E-07	7.90E-07
SE	7.31E-05	2.13E-05	1.03E-05	6.35E-06	3.31E-06	2.12E-06	1.51E-06	1.15E-06	9.13E-07	7.48E-07	6.28E-07
SSE	4.70E-05	1.37E-05	6.62E-06	4.07E-06	2.12E-06	1.36E-06	9.66E-07	7.34E-07	5.82E-07	4.77E-07	4.00E-07

Table 2.7.6-7 (Sheet 2 of 3)
Annual Average *X*/Q for 2.26 Day Decay, Undepleted for Specified Distances at Each Sector

Annual Average *X*/Q (sec/m^3) for 2.26 Day Decay, Undepleted											
Sector	Distance (miles)										
	5	7.5	10	15	20	25	30	35	40	45	50
S	3.10E-07	1.68E-07	1.08E-07	5.71E-08	3.55E-08	2.42E-08	1.75E-08	1.31E-08	1.02E-08	8.06E-09	6.50E-09
SSW	2.80E-07	1.52E-07	9.76E-08	5.16E-08	3.22E-08	2.20E-08	1.60E-08	1.20E-08	9.35E-09	7.43E-09	6.01E-09
SW	3.23E-07	1.76E-07	1.13E-07	6.02E-08	3.78E-08	2.60E-08	1.89E-08	1.43E-08	1.12E-08	8.94E-09	7.27E-09
WSW	4.91E-07	2.70E-07	1.76E-07	9.42E-08	5.96E-08	4.12E-08	3.01E-08	2.29E-08	1.79E-08	1.43E-08	1.16E-08
W	8.02E-07	4.45E-07	2.91E-07	1.57E-07	9.99E-08	6.92E-08	5.06E-08	3.85E-08	3.01E-08	2.41E-08	1.96E-08
WNW	1.12E-06	6.25E-07	4.11E-07	2.25E-07	1.44E-07	1.00E-07	7.38E-08	5.64E-08	4.43E-08	3.56E-08	2.90E-08
NW	9.55E-07	5.34E-07	3.52E-07	1.93E-07	1.24E-07	8.65E-08	6.38E-08	4.88E-08	3.84E-08	3.09E-08	2.52E-08
NNW	5.56E-07	3.10E-07	2.04E-07	1.11E-07	7.09E-08	4.93E-08	3.62E-08	2.76E-08	2.17E-08	1.74E-08	1.41E-08
N	3.73E-07	2.06E-07	1.34E-07	7.20E-08	4.55E-08	3.14E-08	2.30E-08	1.74E-08	1.36E-08	1.09E-08	8.85E-09
NNE	2.63E-07	1.45E-07	9.51E-08	5.16E-08	3.29E-08	2.29E-08	1.69E-08	1.29E-08	1.02E-08	8.17E-09	6.69E-09
NE	2.56E-07	1.41E-07	9.15E-08	4.92E-08	3.13E-08	2.17E-08	1.60E-08	1.22E-08	9.61E-09	7.74E-09	6.35E-09
ENE	3.88E-07	2.14E-07	1.40E-07	7.56E-08	4.83E-08	3.37E-08	2.49E-08	1.92E-08	1.52E-08	1.22E-08	1.01E-08
E	4.91E-07	2.72E-07	1.78E-07	9.72E-08	6.24E-08	4.37E-08	3.24E-08	2.50E-08	1.98E-08	1.60E-08	1.32E-08
ESE	6.77E-07	3.74E-07	2.45E-07	1.33E-07	8.48E-08	5.92E-08	4.37E-08	3.35E-08	2.64E-08	2.13E-08	1.75E-08
SE	5.37E-07	2.94E-07	1.91E-07	1.02E-07	6.47E-08	4.48E-08	3.28E-08	2.49E-08	1.96E-08	1.57E-08	1.28E-08
SSE	3.42E-07	1.86E-07	1.20E-07	6.33E-08	3.94E-08	2.69E-08	1.95E-08	1.46E-08	1.13E-08	8.99E-09	7.26E-09

Table 2.7.6-7 (Sheet 3 of 3)
Annual Average *X*/Q for 2.26 Day Decay, Undepleted for Specified Distances at Each Sector

Annual Average *X*/Q (sec/m^3) for 2.26 Day Decay, Undepleted										
Sector	Distance (miles)									
	0.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	6.44E-06	2.02E-06	8.89E-07	5.31E-07	3.64E-07	1.73E-07	5.88E-08	2.45E-08	1.33E-08	8.11E-09
SSW	5.85E-06	1.84E-06	8.06E-07	4.81E-07	3.29E-07	1.56E-07	5.32E-08	2.23E-08	1.21E-08	7.47E-09
SW	6.77E-06	2.12E-06	9.31E-07	5.55E-07	3.80E-07	1.81E-07	6.20E-08	2.63E-08	1.44E-08	8.99E-09
WSW	9.91E-06	3.12E-06	1.39E-06	8.35E-07	5.75E-07	2.77E-07	9.69E-08	4.16E-08	2.30E-08	1.44E-08
W	1.58E-05	4.98E-06	2.23E-06	1.35E-06	9.38E-07	4.56E-07	1.62E-07	7.00E-08	3.88E-08	2.42E-08
WNW	2.16E-05	6.83E-06	3.08E-06	1.88E-06	1.31E-06	6.40E-07	2.30E-07	1.01E-07	5.68E-08	3.57E-08
NW	1.84E-05	5.82E-06	2.63E-06	1.60E-06	1.11E-06	5.47E-07	1.98E-07	8.73E-08	4.91E-08	3.10E-08
NNW	1.08E-05	3.40E-06	1.53E-06	9.33E-07	6.48E-07	3.17E-07	1.14E-07	4.98E-08	2.78E-08	1.74E-08
N	7.44E-06	2.34E-06	1.05E-06	6.32E-07	4.36E-07	2.11E-07	7.40E-08	3.18E-08	1.76E-08	1.09E-08
NNE	5.24E-06	1.65E-06	7.36E-07	4.45E-07	3.07E-07	1.49E-07	5.29E-08	2.32E-08	1.30E-08	8.21E-09
NE	5.25E-06	1.65E-06	7.29E-07	4.38E-07	3.01E-07	1.45E-07	5.06E-08	2.20E-08	1.23E-08	7.78E-09
ENE	7.92E-06	2.49E-06	1.10E-06	6.61E-07	4.55E-07	2.20E-07	7.76E-08	3.41E-08	1.93E-08	1.23E-08
E	9.84E-06	3.10E-06	1.38E-06	8.33E-07	5.75E-07	2.79E-07	9.98E-08	4.42E-08	2.51E-08	1.61E-08
ESE	1.35E-05	4.27E-06	1.90E-06	1.15E-06	7.92E-07	3.84E-07	1.36E-07	5.98E-08	3.37E-08	2.14E-08
SE	1.10E-05	3.46E-06	1.53E-06	9.17E-07	6.30E-07	3.02E-07	1.05E-07	4.53E-08	2.51E-08	1.58E-08
SSE	7.05E-06	2.22E-06	9.77E-07	5.85E-07	4.01E-07	1.91E-07	6.52E-08	2.73E-08	1.48E-08	9.04E-09

Table 2.7.6-8 (Sheet 1 of 3)
Annual Average *X*/Q for 8 Day Decay, Depleted for Specified Distances at Each Sector

Annual Average *X*/Q (sec/m^3) for 8 Day Decay, Depleted											
Sector	**Distance (miles)**										
	0.25	**0.5**	**0.75**	**1**	**1.5**	**2**	**2.5**	**3**	**3.5**	**4**	**4.5**
S	4.00E-05	1.14E-05	5.45E-06	3.30E-06	1.68E-06	1.05E-06	7.38E-07	5.53E-07	4.34E-07	3.52E-07	2.92E-07
SSW	3.63E-05	1.04E-05	4.95E-06	3.00E-06	1.52E-06	9.53E-07	6.67E-07	4.99E-07	3.91E-07	3.17E-07	2.63E-07
SW	4.21E-05	1.20E-05	5.72E-06	3.46E-06	1.76E-06	1.10E-06	7.68E-07	5.75E-07	4.50E-07	3.64E-07	3.03E-07
WSW	6.19E-05	1.76E-05	8.36E-06	5.07E-06	2.59E-06	1.63E-06	1.15E-06	8.62E-07	6.78E-07	5.51E-07	4.59E-07
W	9.92E-05	2.81E-05	1.33E-05	8.06E-06	4.14E-06	2.62E-06	1.85E-06	1.40E-06	1.10E-06	8.99E-07	7.51E-07
WNW	1.36E-04	3.85E-05	1.81E-05	1.10E-05	5.67E-06	3.60E-06	2.55E-06	1.93E-06	1.53E-06	1.25E-06	1.04E-06
NW	1.16E-04	3.28E-05	1.54E-05	9.38E-06	4.83E-06	3.07E-06	2.17E-06	1.64E-06	1.30E-06	1.06E-06	8.88E-07
NNW	6.79E-05	1.92E-05	9.03E-06	5.49E-06	2.82E-06	1.79E-06	1.27E-06	9.59E-07	7.58E-07	6.19E-07	5.18E-07
N	4.68E-05	1.33E-05	6.26E-06	3.80E-06	1.95E-06	1.23E-06	8.67E-07	6.54E-07	5.15E-07	4.20E-07	3.50E-07
NNE	3.28E-05	9.31E-06	4.41E-06	2.68E-06	1.37E-06	8.63E-07	6.07E-07	4.57E-07	3.60E-07	2.93E-07	2.44E-07
NE	3.28E-05	9.31E-06	4.43E-06	2.68E-06	1.36E-06	8.57E-07	6.00E-07	4.50E-07	3.53E-07	2.87E-07	2.39E-07
ENE	4.96E-05	1.41E-05	6.67E-06	4.04E-06	2.06E-06	1.29E-06	9.04E-07	6.78E-07	5.32E-07	4.32E-07	3.59E-07
E	6.13E-05	1.74E-05	8.28E-06	5.02E-06	2.56E-06	1.61E-06	1.13E-06	8.51E-07	6.69E-07	5.44E-07	4.53E-07
ESE	8.44E-05	2.40E-05	1.14E-05	6.92E-06	3.54E-06	2.23E-06	1.57E-06	1.18E-06	9.27E-07	7.54E-07	6.28E-07
SE	6.83E-05	1.95E-05	9.29E-06	5.63E-06	2.86E-06	1.80E-06	1.26E-06	9.46E-07	7.43E-07	6.03E-07	5.01E-07
SSE	4.39E-05	1.25E-05	5.97E-06	3.62E-06	1.84E-06	1.16E-06	8.11E-07	6.08E-07	4.78E-07	3.88E-07	3.22E-07

Table 2.7.6-8 (Sheet 2 of 3)
Annual Average *X*/Q for 8 Day Decay, Depleted for Specified Distances at Each Sector

Annual Average *X*/Q (sec/m^3) for 8 Day Decay, Depleted											
Sector	Distance (miles)										
	5	7.5	10	15	20	25	30	35	40	45	50
S	2.48E-07	1.32E-07	8.37E-08	4.37E-08	2.73E-08	1.88E-08	1.37E-08	1.04E-08	8.21E-09	6.61E-09	5.42E-09
SSW	2.23E-07	1.18E-07	7.49E-08	3.90E-08	2.43E-08	1.67E-08	1.22E-08	9.31E-09	7.33E-09	5.90E-09	4.84E-09
SW	2.56E-07	1.36E-07	8.61E-08	4.49E-08	2.80E-08	1.93E-08	1.41E-08	1.08E-08	8.49E-09	6.85E-09	5.63E-09
WSW	3.90E-07	2.09E-07	1.34E-07	7.07E-08	4.45E-08	3.09E-08	2.27E-08	1.74E-08	1.38E-08	1.12E-08	9.20E-09
W	6.40E-07	3.47E-07	2.23E-07	1.19E-07	7.55E-08	5.25E-08	3.88E-08	2.99E-08	2.37E-08	1.92E-08	1.59E-08
WNW	8.90E-07	4.85E-07	3.14E-07	1.69E-07	1.07E-07	7.51E-08	5.57E-08	4.30E-08	3.42E-08	2.78E-08	2.30E-08
NW	7.58E-07	4.13E-07	2.67E-07	1.44E-07	9.17E-08	6.41E-08	4.76E-08	3.68E-08	2.93E-08	2.39E-08	1.98E-08
NNW	4.42E-07	2.41E-07	1.56E-07	8.34E-08	5.31E-08	3.71E-08	2.75E-08	2.12E-08	1.69E-08	1.37E-08	1.14E-08
N	2.98E-07	1.61E-07	1.03E-07	5.48E-08	3.46E-08	2.40E-08	1.77E-08	1.36E-08	1.08E-08	8.72E-09	7.19E-09
NNE	2.08E-07	1.12E-07	7.18E-08	3.81E-08	2.41E-08	1.68E-08	1.24E-08	9.54E-09	7.57E-09	6.15E-09	5.08E-09
NE	2.02E-07	1.08E-07	6.89E-08	3.63E-08	2.28E-08	1.58E-08	1.16E-08	8.91E-09	7.05E-09	5.71E-09	4.71E-09
ENE	3.05E-07	1.63E-07	1.04E-07	5.49E-08	3.46E-08	2.40E-08	1.77E-08	1.36E-08	1.08E-08	8.77E-09	7.25E-09
E	3.85E-07	2.07E-07	1.33E-07	7.02E-08	4.44E-08	3.09E-08	2.29E-08	1.76E-08	1.40E-08	1.14E-08	9.42E-09
ESE	5.34E-07	2.87E-07	1.84E-07	9.74E-08	6.15E-08	4.27E-08	3.15E-08	2.43E-08	1.93E-08	1.56E-08	1.29E-08
SE	4.25E-07	2.27E-07	1.45E-07	7.59E-08	4.76E-08	3.29E-08	2.42E-08	1.85E-08	1.46E-08	1.18E-08	9.74E-09
SSE	2.73E-07	1.46E-07	9.27E-08	4.85E-08	3.03E-08	2.09E-08	1.53E-08	1.16E-08	9.15E-09	7.37E-09	6.05E-09

Table 2.7.6-8 (Sheet 3 of 3)
Annual Average *X*/Q for 8 Day Decay, Depleted for Specified Distances at Each Sector

Annual Average *X*/Q (sec/m^3) for 8 Day Decay, Depleted										
Sector	Distance (miles)									
	0.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	5.82E-06	1.76E-06	7.48E-07	4.36E-07	2.93E-07	1.36E-07	4.53E-08	1.90E-08	1.05E-08	6.64E-09
SSW	5.29E-06	1.60E-06	6.76E-07	3.94E-07	2.64E-07	1.22E-07	4.05E-08	1.70E-08	9.39E-09	5.93E-09
SW	6.11E-06	1.84E-06	7.79E-07	4.53E-07	3.04E-07	1.41E-07	4.66E-08	1.96E-08	1.09E-08	6.89E-09
WSW	8.95E-06	2.71E-06	1.16E-06	6.82E-07	4.61E-07	2.16E-07	7.31E-08	3.12E-08	1.75E-08	1.12E-08
W	1.43E-05	4.34E-06	1.87E-06	1.11E-06	7.54E-07	3.57E-07	1.23E-07	5.32E-08	3.01E-08	1.93E-08
WNW	1.95E-05	5.94E-06	2.58E-06	1.53E-06	1.05E-06	4.99E-07	1.74E-07	7.59E-08	4.33E-08	2.79E-08
NW	1.66E-05	5.06E-06	2.20E-06	1.31E-06	8.91E-07	4.25E-07	1.48E-07	6.49E-08	3.70E-08	2.40E-08
NNW	9.71E-06	2.96E-06	1.28E-06	7.62E-07	5.20E-07	2.48E-07	8.60E-08	3.75E-08	2.14E-08	1.38E-08
N	6.72E-06	2.04E-06	8.79E-07	5.18E-07	3.52E-07	1.66E-07	5.66E-08	2.43E-08	1.37E-08	8.76E-09
NNE	4.73E-06	1.43E-06	6.15E-07	3.62E-07	2.45E-07	1.15E-07	3.94E-08	1.70E-08	9.61E-09	6.18E-09
NE	4.74E-06	1.43E-06	6.09E-07	3.56E-07	2.39E-07	1.12E-07	3.75E-08	1.60E-08	8.97E-09	5.74E-09
ENE	7.14E-06	2.16E-06	9.16E-07	5.36E-07	3.61E-07	1.68E-07	5.68E-08	2.43E-08	1.37E-08	8.81E-09
E	8.87E-06	2.69E-06	1.15E-06	6.74E-07	4.55E-07	2.13E-07	7.26E-08	3.13E-08	1.77E-08	1.14E-08
ESE	1.22E-05	3.71E-06	1.59E-06	9.33E-07	6.31E-07	2.96E-07	1.01E-07	4.33E-08	2.44E-08	1.57E-08
SE	9.93E-06	3.01E-06	1.28E-06	7.47E-07	5.03E-07	2.34E-07	7.86E-08	3.33E-08	1.86E-08	1.19E-08
SSE	6.38E-06	1.93E-06	8.22E-07	4.81E-07	3.24E-07	1.51E-07	5.02E-08	2.11E-08	1.17E-08	7.41E-09

Table 2.7.6-9 (Sheet 1 of 3)
Annual Average D/Q at Specified Distances for Each Sector

Annual Average D/Q (m^{-2})											
Sector	**Distance (miles)**										
	0.25	**0.5**	**0.75**	**1**	**1.5**	**2**	**2.5**	**3**	**3.5**	**4**	**4.5**
S	2.28E-08	7.71E-09	3.96E-09	2.43E-09	1.21E-09	7.35E-10	4.97E-10	3.60E-10	2.74E-10	2.16E-10	1.75E-10
SSW	2.44E-08	8.26E-09	4.24E-09	2.60E-09	1.30E-09	7.87E-10	5.32E-10	3.86E-10	2.93E-10	2.31E-10	1.87E-10
SW	3.61E-08	1.22E-08	6.27E-09	3.85E-09	1.92E-09	1.16E-09	7.87E-10	5.70E-10	4.34E-10	3.42E-10	2.77E-10
WSW	3.60E-08	1.22E-08	6.25E-09	3.84E-09	1.91E-09	1.16E-09	7.85E-10	5.69E-10	4.33E-10	3.41E-10	2.76E-10
W	3.52E-08	1.19E-08	6.11E-09	3.75E-09	1.87E-09	1.13E-09	7.67E-10	5.56E-10	4.23E-10	3.33E-10	2.70E-10
WNW	3.95E-08	1.34E-08	6.87E-09	4.22E-09	2.10E-09	1.28E-09	8.62E-10	6.25E-10	4.75E-10	3.74E-10	3.03E-10
NW	3.46E-08	1.17E-08	6.00E-09	3.68E-09	1.84E-09	1.11E-09	7.53E-10	5.46E-10	4.15E-10	3.27E-10	2.65E-10
NNW	2.31E-08	7.82E-09	4.01E-09	2.47E-09	1.23E-09	7.45E-10	5.04E-10	3.65E-10	2.78E-10	2.19E-10	1.77E-10
N	2.60E-08	8.79E-09	4.51E-09	2.77E-09	1.38E-09	8.38E-10	5.66E-10	4.10E-10	3.12E-10	2.46E-10	1.99E-10
NNE	2.02E-08	6.84E-09	3.51E-09	2.16E-09	1.08E-09	6.52E-10	4.41E-10	3.19E-10	2.43E-10	1.91E-10	1.55E-10
NE	3.21E-08	1.09E-08	5.57E-09	3.42E-09	1.71E-09	1.03E-09	6.99E-10	5.07E-10	3.85E-10	3.04E-10	2.46E-10
ENE	5.80E-08	1.96E-08	1.01E-08	6.18E-09	3.08E-09	1.87E-09	1.26E-09	9.16E-10	6.97E-10	5.49E-10	4.44E-10
E	5.17E-08	1.75E-08	8.98E-09	5.52E-09	2.75E-09	1.67E-09	1.13E-09	8.17E-10	6.21E-10	4.90E-10	3.96E-10
ESE	5.98E-08	2.02E-08	1.04E-08	6.38E-09	3.18E-09	1.93E-09	1.30E-09	9.45E-10	7.19E-10	5.66E-10	4.58E-10
SE	5.49E-08	1.86E-08	9.53E-09	5.85E-09	2.92E-09	1.77E-09	1.20E-09	8.67E-10	6.59E-10	5.19E-10	4.21E-10
SSE	2.45E-08	8.29E-09	4.26E-09	2.61E-09	1.30E-09	7.90E-10	5.34E-10	3.87E-10	2.95E-10	2.32E-10	1.88E-10

Table 2.7.6-9 (Sheet 2 of 3)
Annual Average D/Q at Specified Distances for Each Sector

Annual Average D/Q (m^{-2})											
Sector	Distance (miles)										
	5	7.5	10	15	20	25	30	35	40	45	50
S	1.44E-10	7.08E-11	4.44E-11	2.24E-11	1.36E-11	9.11E-12	6.53E-12	4.90E-12	3.81E-12	3.04E-12	2.48E-12
SSW	1.55E-10	7.58E-11	4.76E-11	2.41E-11	1.46E-11	9.76E-12	6.99E-12	5.25E-12	4.08E-12	3.26E-12	2.66E-12
SW	2.29E-10	1.12E-10	7.04E-11	3.56E-11	2.15E-11	1.44E-11	1.03E-11	7.76E-12	6.04E-12	4.82E-12	3.94E-12
WSW	2.28E-10	1.12E-10	7.02E-11	3.55E-11	2.15E-11	1.44E-11	1.03E-11	7.74E-12	6.02E-12	4.81E-12	3.93E-12
W	2.23E-10	1.09E-10	6.85E-11	3.46E-11	2.10E-11	1.41E-11	1.01E-11	7.56E-12	5.88E-12	4.70E-12	3.84E-12
WNW	2.51E-10	1.23E-10	7.70E-11	3.89E-11	2.36E-11	1.58E-11	1.13E-11	8.50E-12	6.61E-12	5.28E-12	4.31E-12
NW	2.19E-10	1.07E-10	6.73E-11	3.40E-11	2.06E-11	1.38E-11	9.89E-12	7.43E-12	5.78E-12	4.61E-12	3.77E-12
NNW	1.47E-10	7.18E-11	4.50E-11	2.28E-11	1.38E-11	9.24E-12	6.62E-12	4.97E-12	3.87E-12	3.09E-12	2.52E-12
N	1.65E-10	8.07E-11	5.06E-11	2.56E-11	1.55E-11	1.04E-11	7.44E-12	5.59E-12	4.34E-12	3.47E-12	2.83E-12
NNE	1.28E-10	6.28E-11	3.94E-11	1.99E-11	1.21E-11	8.08E-12	5.79E-12	4.35E-12	3.38E-12	2.70E-12	2.20E-12
NE	2.03E-10	9.96E-11	6.25E-11	3.16E-11	1.91E-11	1.28E-11	9.19E-12	6.90E-12	5.36E-12	4.28E-12	3.50E-12
ENE	3.68E-10	1.80E-10	1.13E-10	5.71E-11	3.46E-11	2.32E-11	1.66E-11	1.25E-11	9.70E-12	7.75E-12	6.32E-12
E	3.28E-10	1.61E-10	1.01E-10	5.10E-11	3.08E-11	2.07E-11	1.48E-11	1.11E-11	8.65E-12	6.91E-12	5.64E-12
ESE	3.79E-10	1.86E-10	1.17E-10	5.89E-11	3.57E-11	2.39E-11	1.71E-11	1.29E-11	1.00E-11	7.99E-12	6.52E-12
SE	3.48E-10	1.71E-10	1.07E-10	5.41E-11	3.27E-11	2.19E-11	1.57E-11	1.18E-11	9.18E-12	7.33E-12	5.98E-12
SSE	1.55E-10	7.61E-11	4.78E-11	2.41E-11	1.46E-11	9.80E-12	7.02E-12	5.27E-12	4.10E-12	3.27E-12	2.67E-12

Table 2.7.6-9 (Sheet 3 of 3)
Annual Average D/Q at Specified Distances for Each Sector

Annual Average D/Q (m^{-2})										
Sector	Distance (miles)									
	0.5-1	1-2	2-3	3-4	4-5	5-10	10-20	20-30	30-40	40-50
S	4.11E-09	1.27E-09	5.05E-10	2.76E-10	1.76E-10	7.54E-11	2.34E-11	9.27E-12	4.95E-12	3.06E-12
SSW	4.41E-09	1.36E-09	5.42E-10	2.96E-10	1.88E-10	8.08E-11	2.51E-11	9.93E-12	5.30E-12	3.28E-12
SW	6.52E-09	2.01E-09	8.01E-10	4.38E-10	2.78E-10	1.20E-10	3.71E-11	1.47E-11	7.84E-12	4.85E-12
WSW	6.50E-09	2.01E-09	7.99E-10	4.37E-10	2.77E-10	1.19E-10	3.70E-11	1.47E-11	7.82E-12	4.84E-12
W	6.35E-09	1.96E-09	7.80E-10	4.26E-10	2.71E-10	1.16E-10	3.61E-11	1.43E-11	7.64E-12	4.73E-12
WNW	7.13E-09	2.20E-09	8.77E-10	4.79E-10	3.05E-10	1.31E-10	4.06E-11	1.61E-11	8.59E-12	5.32E-12
NW	6.23E-09	1.93E-09	7.66E-10	4.19E-10	2.66E-10	1.14E-10	3.55E-11	1.41E-11	7.50E-12	4.64E-12
NNW	4.17E-09	1.29E-09	5.13E-10	2.80E-10	1.78E-10	7.65E-11	2.37E-11	9.40E-12	5.02E-12	3.11E-12
N	4.69E-09	1.45E-09	5.76E-10	3.15E-10	2.00E-10	8.60E-11	2.67E-11	1.06E-11	5.64E-12	3.49E-12
NNE	3.65E-09	1.13E-09	4.49E-10	2.45E-10	1.56E-10	6.69E-11	2.08E-11	8.22E-12	4.39E-12	2.72E-12
NE	5.79E-09	1.79E-09	7.12E-10	3.89E-10	2.47E-10	1.06E-10	3.29E-11	1.31E-11	6.97E-12	4.31E-12
ENE	1.05E-08	3.23E-09	1.29E-09	7.03E-10	4.47E-10	1.92E-10	5.95E-11	2.36E-11	1.26E-11	7.80E-12
E	9.33E-09	2.88E-09	1.15E-09	6.27E-10	3.99E-10	1.71E-10	5.31E-11	2.10E-11	1.12E-11	6.95E-12
ESE	1.08E-08	3.34E-09	1.33E-09	7.25E-10	4.61E-10	1.98E-10	6.14E-11	2.43E-11	1.30E-11	8.04E-12
SE	9.91E-09	3.06E-09	1.22E-09	6.65E-10	4.23E-10	1.82E-10	5.63E-11	2.23E-11	1.19E-11	7.38E-12
SSE	4.42E-09	1.37E-09	5.44E-10	2.97E-10	1.89E-10	8.11E-11	2.52E-11	9.97E-12	5.33E-12	3.30E-12

Table 2.7.6-10 (Sheet 1 of 4)
***X*/Q and D/Q Values for No Decay, Decay, and Undepleted, at Each Receptor Location**

RECEPTOR	SECTOR	DISTANCE		*X*/Q Values (sec/m³)			D/Q
				No Decay	2.26 Day Decay	8.00 Day Decay	
		(Miles)	(Meters)	Undepleted	Undepleted	Depleted	(m^{-2})
Analytical EAB	S	0.21	335	6.0E-05	5.9E-05	5.6E-05	3.0E-08
Analytical EAB	SSW	0.21	335	5.4E-05	5.4E-05	5.1E-05	3.2E-08
Analytical EAB	SW	0.21	335	6.3E-05	6.3E-05	5.9E-05	4.7E-08
Analytical EAB	WSW	0.21	335	9.2E-05	9.2E-05	8.6E-05	4.7E-08
Analytical EAB	W	0.21	335	1.5E-04	1.5E-04	1.4E-04	4.6E-08
Analytical EAB	WNW	0.21	335	2.0E-04	2.0E-04	1.9E-04	5.2E-08
Analytical EAB	NW	0.21	335	1.7E-04	1.7E-04	1.6E-04	4.5E-08
Analytical EAB	NNW	0.21	335	1.0E-04	1.0E-04	9.5E-05	3.0E-08
Analytical EAB	N	0.21	335	7.0E-05	7.0E-05	6.5E-05	3.4E-08
Analytical EAB	NNE	0.21	335	4.9E-05	4.9E-05	4.6E-05	2.7E-08
Analytical EAB	NE	0.21	335	4.9E-05	4.9E-05	4.6E-05	4.2E-08
Analytical EAB	ENE	0.21	335	7.4E-05	7.4E-05	6.9E-05	7.6E-08
Analytical EAB	E	0.21	335	9.2E-05	9.1E-05	8.5E-05	6.8E-08
Analytical EAB	ESE	0.21	335	1.3E-04	1.3E-04	1.2E-04	7.9E-08
Analytical EAB	SE	0.21	335	1.0E-04	1.0E-04	9.5E-05	7.2E-08
Analytical EAB	SSE	0.21	335	6.5E-05	6.5E-05	6.1E-05	3.2E-08

Note: A circular, analytical EAB was defined at a fixed distance from the effluent release boundary. The distance used from the effluent release boundary to the analytical EAB was 1100 ft (335 m).

Table 2.7.6-10 (Sheet 2 of 4)
***X*/Q and D/Q Values for No Decay, Decay, and Undepleted, at Each Receptor Location**

RECEPTOR	SECTOR	DISTANCE		*X*/Q Values (sec/m³)			D/Q
				No Decay	2.26 Day Decay	8.00 Day Decay	
		(Miles)	(Meters)	Undepleted	Undepleted	Depleted	(m^{-2})
GARDEN	S	2.64	4254	8.5E-07	8.1E-07	6.8E-07	4.5E-10
GARDEN	SSW	0.69	1113	6.4E-06	6.3E-06	5.7E-06	4.9E-09
GARDEN	SW	0.95	1522	4.4E-06	4.3E-06	3.8E-06	4.2E-09
GARDEN	WSW	1.37	2203	3.5E-06	3.4E-06	3.0E-06	2.2E-09
GARDEN	W	1.78	2861	3.8E-06	3.7E-06	3.2E-06	1.4E-09
GARDEN	WNW	1.15	1848	1.0E-05	9.9E-06	8.7E-06	3.3E-09
GARDEN	NW	1.23	1978	7.8E-06	7.6E-06	6.7E-06	2.6E-09
GARDEN	NNW	4.87	7833	6.3E-07	5.8E-07	4.6E-07	1.5E-10
GARDEN	NE	0.67	1072	6.1E-06	6.1E-06	5.5E-06	6.8E-09
GARDEN	E	2.36	3802	1.5E-06	1.5E-06	1.2E-06	1.2E-09
GARDEN	ESE	0.92	1482	9.1E-06	9.0E-06	8.0E-06	7.3E-09
GARDEN	SE	1.93	3111	2.3E-06	2.2E-06	1.9E-06	1.9E-09
GARDEN	SSE	0.92	1486	4.7E-06	4.6E-06	4.1E-06	3.0E-09

Note: The nearest garden is defined as the minimum distance from the center point of the CRN Site.

Table 2.7.6-10 (Sheet 3 of 4)
***X*/Q and D/Q Values for No Decay, Decay, and Undepleted, at Each Receptor Location**

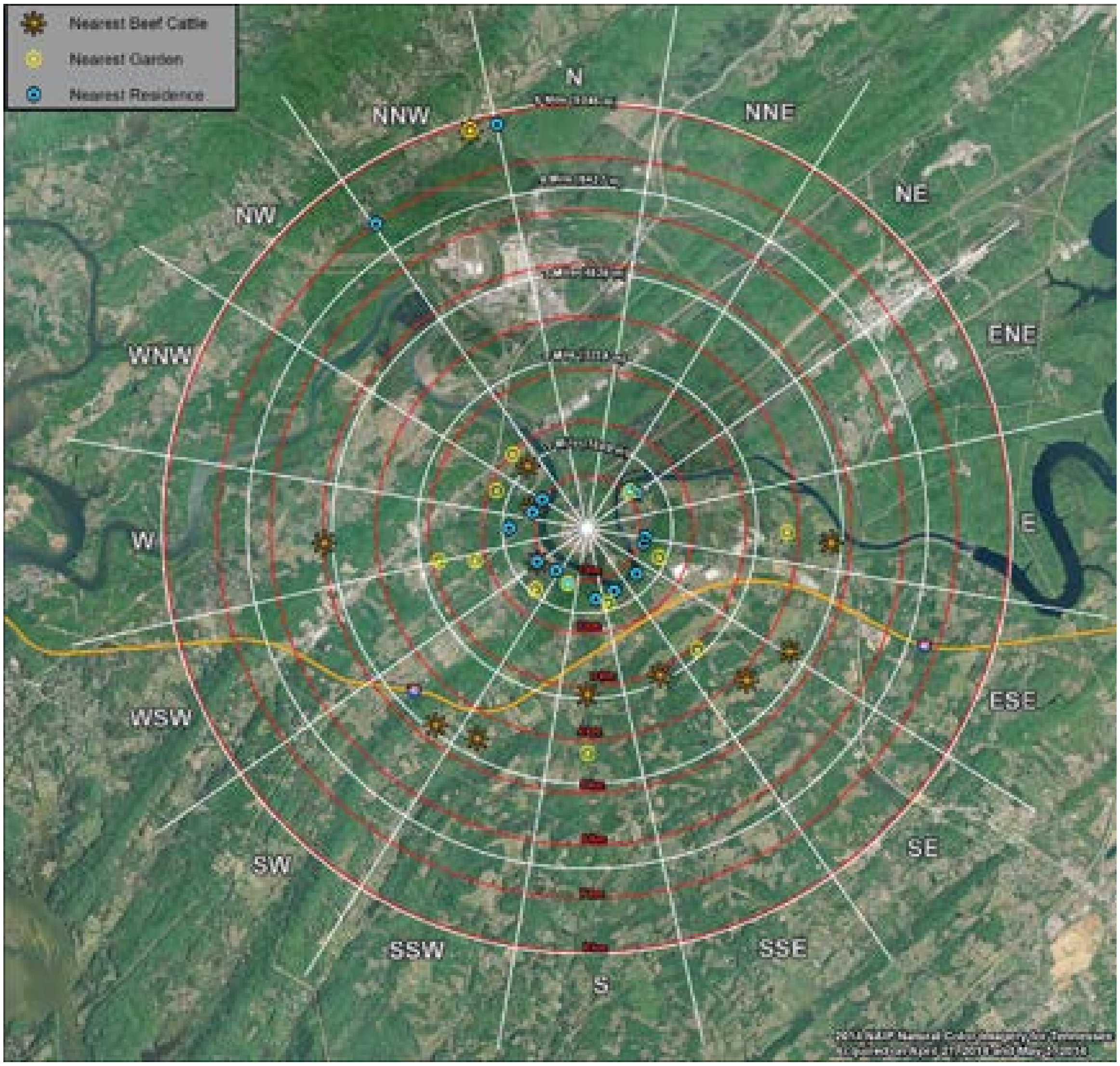
RECEPTOR	SECTOR	DISTANCE		X/Q Values (sec/m3)			D/Q
				No Decay	2.26 Day Decay	8.00 Day Decay	
		(Miles)	(Meters)	Undepleted	Undepleted	Depleted	(m-2)
RESIDENCE	S	0.84	1359	5.0E-06	4.9E-06	4.4E-06	3.2E-09
RESIDENCE	SSW	0.69	1113	6.4E-06	6.3E-06	5.7E-06	4.9E-09
RESIDENCE	SW	0.62	995	9.1E-06	9.0E-06	8.2E-06	8.6E-09
RESIDENCE	WSW	0.71	1136	1.0E-05	1.0E-05	9.3E-06	6.9E-09
RESIDENCE	W	0.91	1470	1.1E-05	1.1E-05	9.4E-06	4.4E-09
RESIDENCE	WNW	0.66	1066	2.5E-05	2.5E-05	2.3E-05	8.5E-09
RESIDENCE	NW	0.62	992	2.5E-05	2.5E-05	2.2E-05	8.3E-09
RESIDENCE	NNW	4.35	6997	7.3E-07	6.8E-07	5.5E-07	1.9E-10
RESIDENCE	N	4.86	7814	4.3E-07	3.9E-07	3.1E-07	1.7E-10
RESIDENCE	NE	0.67	1072	6.1E-06	6.1E-06	5.5E-06	6.8E-09
RESIDENCE	ENE	0.71	1149	8.2E-06	8.1E-06	7.3E-06	1.1E-08
RESIDENCE	E	0.69	1118	1.1E-05	1.1E-05	9.5E-06	1.0E-08
RESIDENCE	ESE	0.69	1117	1.5E-05	1.5E-05	1.3E-05	1.2E-08
RESIDENCE	SE	0.8	1288	9.4E-06	9.2E-06	8.3E-06	8.5E-09
RESIDENCE	SSE	0.81	1304	5.9E-06	5.8E-06	5.2E-06	3.7E-09

Note: The nearest residence is defined as the minimum distance from the center of the reactor containment building.

Table 2.7.6-10 (Sheet 4 of 4)
***X*/Q and D/Q Values for No Decay, Decay, and Undepleted, at Each Receptor Location**

RECEPTOR	SECTOR	DISTANCE		*X*/Q Values (sec/m^3)			D/Q
				No Decay	2.26 Day Decay	8.00 Day Decay	
		(Miles)	(Meters)	Undepleted	Undepleted	Depleted	(m^{-2})
BEEF ANIMAL	S	1.95	3144	1.3E-06	1.3E-06	1.1E-06	7.7E-10
BEEF ANIMAL	SSW	2.79	4488	7.1E-07	6.7E-07	5.6E-07	4.4E-10
BEEF ANIMAL	SW	2.92	4695	7.6E-07	7.3E-07	6.0E-07	6.0E-10
BEEF ANIMAL	WSW	0.71	1138	1.0E-05	1.0E-05	9.3E-06	6.9E-09
BEEF ANIMAL	W	3.1	4984	1.7E-06	1.6E-06	1.3E-06	5.3E-10
BEEF ANIMAL	WNW	0.7	1120	2.3E-05	2.3E-05	2.1E-05	7.8E-09
BEEF ANIMAL	NW	1.01	1627	1.1E-05	1.0E-05	9.2E-06	3.6E-09
BEEF ANIMAL	NNW	4.87	7833	6.3E-07	5.8E-07	4.6E-07	1.5E-10
BEEF ANIMAL	E	2.88	4629	1.2E-06	1.1E-06	9.1E-07	8.8E-10
BEEF ANIMAL	ESE	2.79	4492	1.7E-06	1.6E-06	1.3E-06	1.1E-09
BEEF ANIMAL	SE	2.59	4171	1.5E-06	1.4E-06	1.2E-06	1.1E-09
BEEF ANIMAL	SSE	1.93	3106	1.5E-06	1.4E-06	1.2E-06	8.4E-10

Note: There were no milk-producing animals within 5 miles of the CRN Site. Therefore, the nearest beef animal was analyzed.

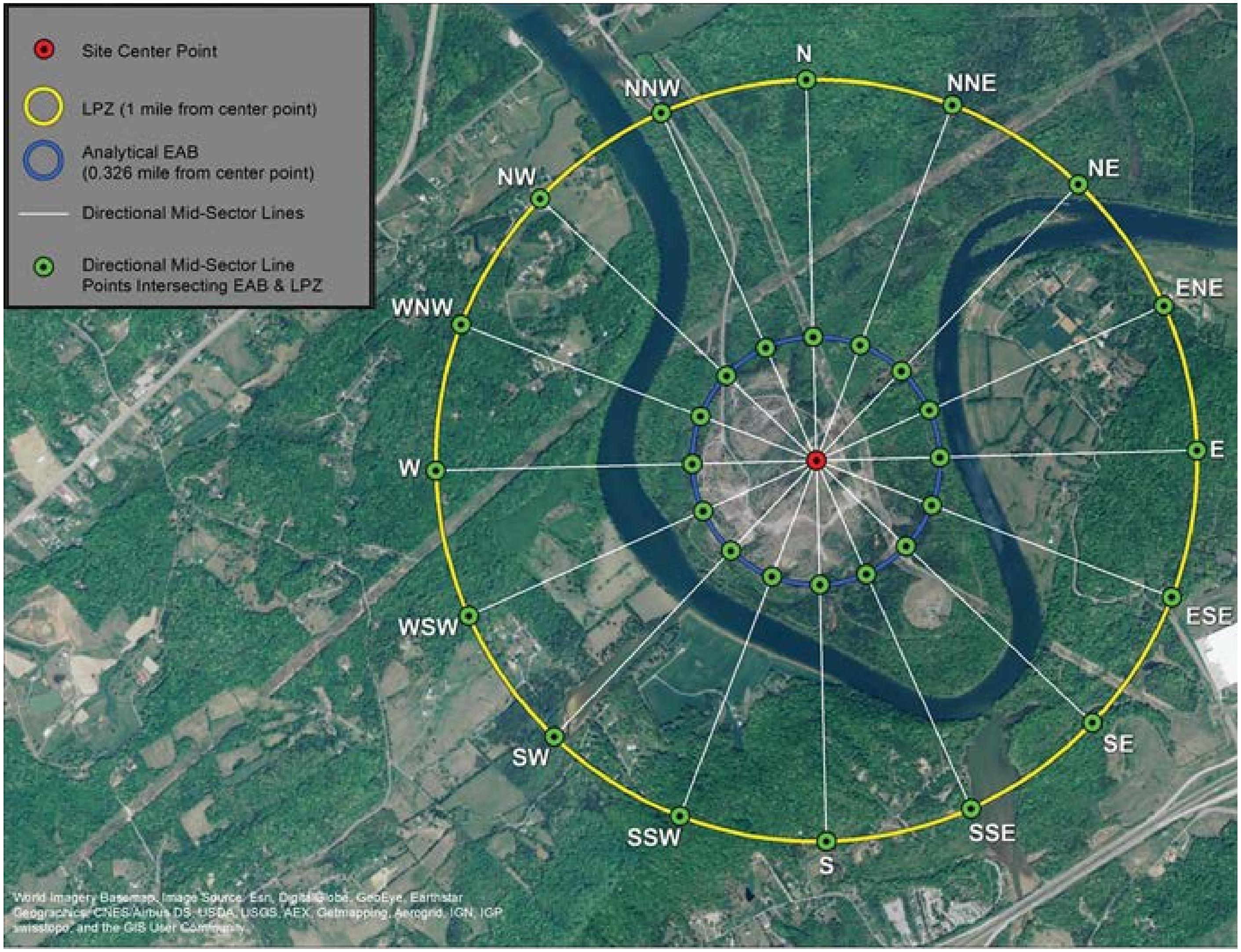


Notes:

The ArcGIS software package (www.esri.com) was used to plot the locations of the sensitive receptors determined by the land use survey.

The distances were measured from the centerpoint of the site.

Figure 2.7.6-1. Location of Sensitive Receptors (Land Use Survey)



Notes:
The ArcGIS software package (www.esri.com) was used to determine the coordinates of the EAB and LPZ for each of the 16 directional sectors.

Figure 2.7.6-2. LPZ and Analytical EAB Distances Used for the Complex Terrain Analysis

2.8 NOISE

Ambient noise is the all-encompassing sound associated with a given environment at a specified time. It is generally a composite of sound from numerous sources, both near and far away, and in many directions. In 2013, a noise assessment was conducted in the vicinity of the Clinch River Nuclear (CRN) Site. The survey was conducted during July 14 through July 17, 2013, and December 17 through December 18, 2013. Ambient noise within the CRN Site was observed to come from various sources including vehicle traffic, bioacoustical sources (e.g., general wildlife, birds, insects, and humans), the natural environment (e.g., wind through foliage and rain), and mechanical sources (e.g., construction/industrial equipment). Within the surrounding local community, ambient noise was observed to originate from various sources including vehicle traffic, bioacoustical sources (i.e., general wildlife, livestock, birds, insects, and humans), the natural environment (i.e., wind through foliage and rain) and mechanical sources (i.e., farming equipment and watercraft/boating). Although the occurrence of these intermittent sources is difficult to predict, they are the primary contributors to ambient noise within the area. The spatial relationship between a noise source and receptor and differences in both terrain and vegetation may cause variations in ambient noise conditions at each noise receptor location. (Reference 2.8-1)

Site visits were conducted and aerial photography and maps were reviewed to identify nearby locations with potential sensitivity to noise within a 5-mile (mi) radius of the CRN Site. Potentially sensitive receptors identified outside of the CRN Site include residences, churches, cemeteries, facilities for outdoor/community use, schools, and National Register of Historic Places (NRHP)-listed sites. The sensitive receptors are shown in Figure 2.8-1 (Reference 2.8-1).

Within a 1-mi radius of the CRN Site, potential sensitive receptors include:

- 150 residences
- 1 church
- 2 schools (one private school and one historical school location)
- 8 cemeteries
- 1 facility for outdoor/community use

No NRHP-listed historic sites were identified within the 1-mi buffer. The Hensley Cemetery is located on the CRN Site and has conditional access; the remaining identified cemeteries are offsite. The identified community facility is the Bradbury Community Center.

Between 1 and 5 mi of the CRN Site, potential sensitive receptors include:

- 22 churches
- 10 schools (six of which are historic)

- 3 facilities for outdoor/community use
- 4 NRHP-listed sites

Residences and cemeteries were not individually counted beyond the 1-mi radius, although numerous examples of each are present within this distance from the CRN Site. The identified community facilities are the Gallaher Recreation Area, Soaring Eagle Campground, and the Melton Hill Dam Sustainable Recreation Area.

An ambient noise survey was conducted at the CRN Site from July 14 through July 17, 2013, and December 17 through December 18, 2013. Nine sampling locations were selected to provide a general representation of ambient sound levels within the 5 mi area around the CRN Site.

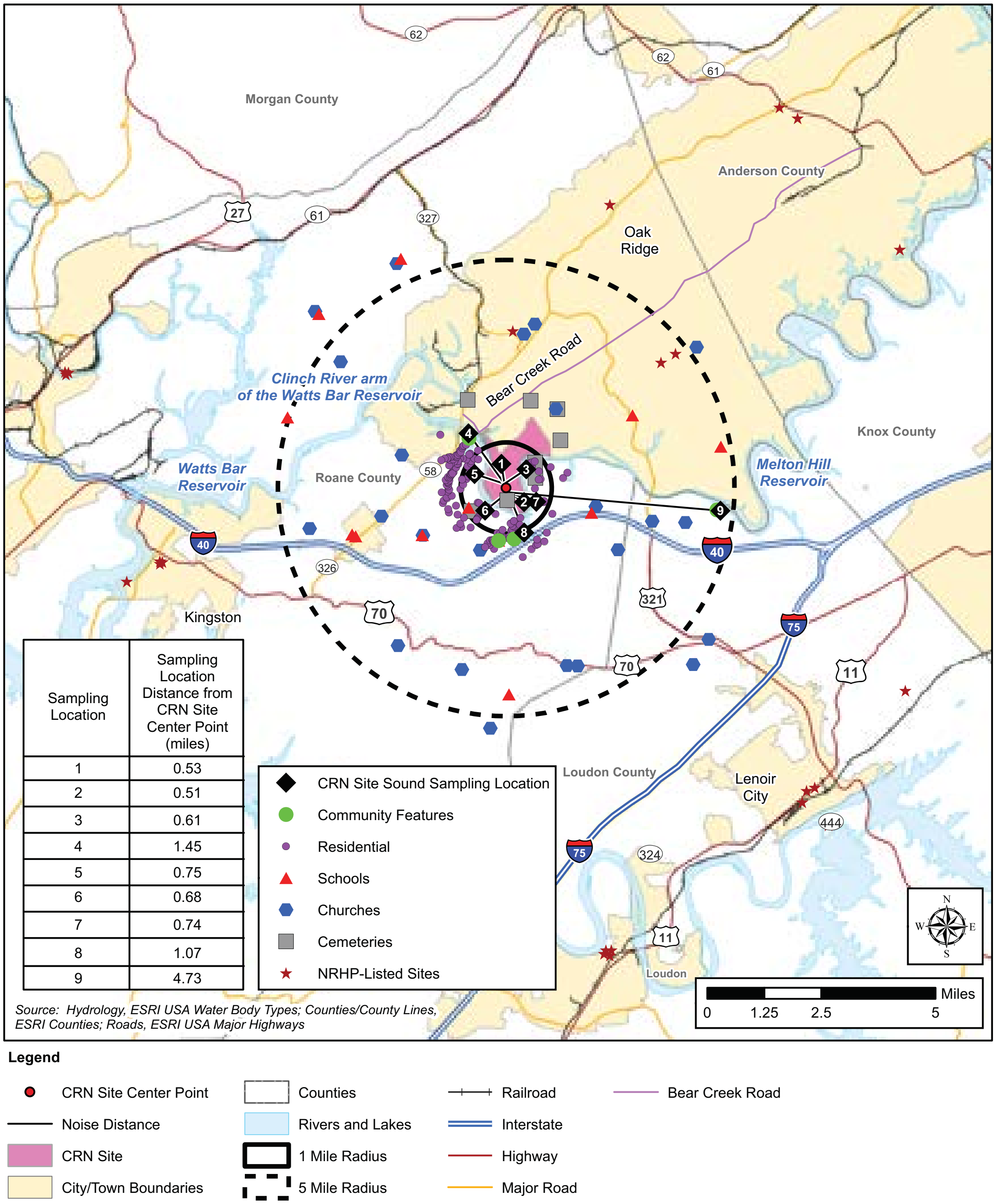
- Location 1: Near the center of the CRN Site, within the intersecting easements of the Bull Run FP to Watts Bar NP 500 kV transmission line and the Kingston FP to Fort Loudon HP 161 kV transmission line
- Location 2: The southeast area of the CRN Site, adjacent to the Clinch River arm of the Watts Bar Reservoir, within the easement of the Kingston FP to Fort Loudon HP 161 kv transmission line, just northwest of River Road
- Location 3: Northeast of the CRN Site, on the west side of Blackburn Lane in a residential area
- Location 4: Northwest of the CRN Site, at the Gallaher Recreation Area boat ramp
- Location 5: West of the CRN Site, on the south side of the intersection of Chestnut Ridge Road and Smith Hill Lane in a residential area
- Location 6: Southwest of the CRN Site, on the northwest side of Speers Road in a residential area
- Location 7: East of the CRN Site, on the west side of Blackburn Lane in a residential area
- Location 8: South of the CRN Site, at Soaring Eagle Campground tent area, near Caney Creek
- Location 9: East of the CRN Site, at Melton Hill Dam Sustainable Recreational Area

Locations used for measuring sound levels are shown in Figure 2.8-1. Figure 2.8-1 also shows the distances between these sampling locations and the CRN Site center point. Publicly accessible locations were selected to represent noise levels in nearby communities. (Reference 2.8-1)

The ambient noise assessment concluded that sound levels onsite ranged between 46 and 48 A-weighted decibels (dBA) during the daytime and between 41 and 49 dBA during the nighttime. The Day-Night Average Sound Level (DNL) ranged between 49 and 55 dBA. The DNL is the sound level average over a 24-hour period used to define the level of average noise exposure to a community during that time period. Within this calculation, an additional 10 decibels (dB) is added to nighttime (10 PM to 7 AM) sound levels to account for the increased sensitivity of the community to nighttime noise. Offsite sound levels ranged between 42 and 63 dBA during the daytime and between 35 and 58 dBA during the nighttime. The offsite DNL ranged between 51 and 64 dBA. (Reference 2.8-1)

2.8.1 References

Reference 2.8-1. AECOM, "Final Clinch River Site Ambient Noise Assessment Technical Report - Revision 1," Tennessee Valley Authority, April, 2014.



Sampling Location	Sampling Location Distance from CRN Site Center Point (miles)
1	0.53
2	0.51
3	0.61
4	1.45
5	0.75
6	0.68
7	0.74
8	1.07
9	4.73

Figure 2.8-1. Ambient Noise Measurement Locations

2.9 RELATED FEDERAL PROJECT ACTIVITIES

The purpose of this section is to identify any federal or other activities within the region that are related to the Clinch River (CR) Small Modular Reactor (SMR) Project and could have cumulative impacts on the proposed action. Actions related only to the granting of licenses, permits, or approvals by other federal agencies are not considered in this review. This section also determines the potential need for another agency to cooperatively participate in the Environmental Report (ER) process.

For the purposes of this section of the ER, the activities or projects evaluated are limited to federal projects or activities that meet the following criteria:

- Federal projects or activities associated with acquisition and/or use of the proposed project site and transmission corridors or of any other offsite property needed for the proposed project
- Federal projects or activities that are required either to provide an adequate source of facility cooling water or to ensure an adequate supply of cooling water is available over the operating lifetime of the facility
- Federal projects or activities that must be completed as a condition of facility construction or operation
- Federal agency plans or commitments that result in significant new power purchases within the applicant's service area that have been used to justify a need for power
- Federal projects that are contingent on facility construction and operation

Three federal activities associated with the CR SMR Project were identified that meet one or more of the criteria listed above. These federal activities are: (1) roadway modifications to Tennessee State Highway (TN) 58, Bear Creek Road, and West (W) Bear Creek Road; (2) refurbishment of the barge terminal along Bear Creek Road; and (3) new transmission lines and substations. These three identified activities are described in the following sections.

2.9.1 TN 58/Bear Creek Road Modifications

As indicated in Subsection 4.4.2.3, roadway modifications are required along TN 58 and Bear Creek Road to support the construction of the Clinch River Nuclear (CRN) Site. The U.S. Department of Energy (DOE) currently manages part of the land to be impacted. To accommodate anticipated traffic accessing the CRN Site during the estimated peak traffic year (largest number of onsite construction and operations workers), necessary modifications include:

- Adding an additional loop ramp connecting TN 58 and Bear Creek Road
- Closing existing left-bound turn lanes onto the current loop ramp

- Adding additional turn lanes on TN 58 and Bear Creek Road
- Constructing a dual-lane roundabout on Bear Creek Road
- Widening Bear Creek Road from two to four lanes including the ability for reversible lanes
- Straightening and realigning Bear Creek Road at the CRN Site entrance (Reference 2.9-1)

The area in which the proposed modifications would occur is shown on Figure 3.1-1 (CRN Site Utilization Plan) and 3.1-2.

Modifications of these public roadways will be coordinated with the Tennessee Department of Transportation and with DOE, which currently manages part of the land that would be impacted.

2.9.2 Barge Terminal Refurbishment

Some construction materials and equipment could be transported to the CRN Site by barge. Therefore, construction of the CR SMR Project could also require refurbishment of the inactive DOE barge terminal located at CRM 14.1, near Bear Creek Road and the TN 58 ramp (Figure 3.1-1). Refurbishment of the terminal will be coordinated with DOE, which currently manages the land on which the barge terminal is located. Additional details of proposed barge terminal modifications are to be provided at COLA.

2.9.3 69 kV Underground Transmission Line

To meet the project objective of demonstrating a more reliable electric power supply through SMR operation in “power island” mode to critical facilities, the proposed CR SMR Project requires an additional 69 kilovolt (kV) transmission line. This new line connects the power plant to the Bethel Valley substation located approximately 5 miles (mi) to the northeast of the CRN Site. The proposed new transmission line is underground and primarily within the existing Bull Run SP-Watts Bar NP 500 kV transmission line right-of-way (ROW; Figure 3.7-2). The construction of this new line may also require new access roads. An expansion of the Bethel Valley substation is part of this process.

Tennessee Valley Authority (TVA) proposes to accomplish all of the upgrades and new switchyard construction within existing ROWs and/or existing substation locations. The ROW, the substations, and the surrounding property are currently owned and maintained by either TVA or DOE. Additional details of proposed new transmission lines are to be provided at COLA.

2.9.4 Summary

Aside from the three identified federal activities discussed above, no other activities associated with the CR SMR Project have been identified.

The three activities discussed above require coordination with other federal agencies. However, the federal agencies involved in these additional activities do not need to cooperatively participate in the preparation of the ER or the U.S. Nuclear Regulatory Commission's (NRC) Environmental Impact Statement process.

In September 2008, NRC and the U.S. Army Corps of Engineers (USACE) signed an updated memorandum of understanding regarding environmental reviews for authorizations to construct and operate nuclear power plants (Reference 2.9-2). No federal agencies other than USACE have been identified as potential cooperating agencies. However, some collaboration with federal agencies may be required as part of the COLA preparation due to the need for permits, authorizations, and consultations associated with construction or operation of two or more SMRs. Permits, authorizations, and consultations are discussed in Section 1.2.

2.9.5 References

Reference 2.9-1. AECOM, "Clinch River Site Traffic Assessment, Final Technical Report, Revision 0," Tennessee Valley Authority, March, 2015.

Reference 2.9-2. Flanders, Scott C., Notice of Availability of Memorandum of Understanding between U.S. Army Corps of Engineers and U.S. Nuclear Regulatory Commission on Environmental Reviews Related to the Issuance of Authorizations to Construct and Operate Nuclear Power Plants, September 19, 2008.